CHAPTER

72

ENGINES

ENGINE GENERAL

TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

Please insert the revised pages into this manual and delete obsoleted pages in accordance with the following List of Effective Pages. Revised pages are indicated by the letter "R", added pages by the letter "A", and deleted pages by the letter "D". Superseded pages shall be removed and destroyed.

The List of Effective Pages records not only each page of subject revision but also each previously issued page which is still current. Blank pages and pages which are no longer current do not appear on this list. If there is any question about the currency of the maintained copy, it is recommended that each page of the manual be checked off against this List of Effective Pages. Any page which does not check out with this list, either by number or by date, shall be discarded. This list is reissued in its entirety whenever this manual section is revised.

LIST OF EFFECTIVE PAGES

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-00-00			(CONTINUED)	
OH TOOLS	R	346		MAY 1/08
	R	347		MAY 1/08
	R	348		MAY 1/08
	R	349		MAY 1/08
	R	350		MAY 1/08
	R	351		MAY 1/08
	R	352		MAY 1/08
	R	353		MAY 1/08
	R	354		MAY 1/08
	R	355		MAY 1/08
	R	356		MAY 1/08
	R	357		MAY 1/08
	R	358		MAY 1/08
	R	359		MAY 1/08
	R	360		MAY 1/08
	R	361		MAY 1/08
	R	362		MAY 1/08
	R	363		MAY 1/08
	R	364		MAY 1/08
	R	365		MAY 1/08
	R	366		MAY 1/08
	R	367		MAY 1/08
	R	368		MAY 1/08
	R	369		MAY 1/08
	R	370		MAY 1/08
	R	371		MAY 1/08
	R	372		MAY 1/08
	R	373		MAY 1/08
	R	374		MAY 1/08
	R	375		MAY 1/08
	R	376		MAY 1/08
	R	377		MAY 1/08
	R	378		MAY 1/08
	R	379		MAY 1/08
	R	380		MAY 1/08
	R	381		MAY 1/08
	R	382		MAY 1/08
	R	383		MAY 1/08
	R	384		MAY 1/08
	R	385		MAY 1/08
	R	386		MAY 1/08
	R	387		MAY 1/08
	R	388		MAY 1/08
	R	389		MAY 1/08
	A	390		MAY 1/08
72-00-00 DISMANT/ASSY		401	-ALL	APR 1/07
		402		APR 1/07
	R	403		MAY 1/08
	R	404		MAY 1/08
		405		APR 1/07
		406		APR 1/07
		407		APR 1/07
		408		APR 1/07
		409		APR 1/07
		410		APR 1/07
		411		APR 1/07
		412		APR 1/07
		413		APR 1/07
		414		APR 1/07
		415		APR 1/07
		416		APR 1/07
		417		APR 1/07
		418		APR 1/07
		419		APR 1/07
		420		APR 1/07
		421		APR 1/07
		422		APR 1/07
		423		APR 1/07
		424		APR 1/07
		425		APR 1/07
		426		APR 1/07
		427		APR 1/07
		428		APR 1/07
72-00-00			(CONTINUED)	
DISMANT/ASSY		429		APR 1/07
		430		APR 1/07
		431		APR 1/07
		432		APR 1/07
		433		APR 1/07
		434		APR 1/07
		435		APR 1/07
		436		APR 1/07
		437		APR 1/07
		438		APR 1/07
		439		APR 1/07
		440		APR 1/07
		441		APR 1/07
		442		APR 1/07
		443		APR 1/07
		444		APR 1/07
	R	445		MAY 1/08
	R	446		MAY 1/08
		447		APR 1/07
		448		APR 1/07
	R	449		MAY 1/08
	R	450		MAY 1/08
		451		APR 1/07
		452		APR 1/07
		453		APR 1/07
		454		APR 1/07
	R	455		MAY 1/08
	R	456		MAY 1/08
	R	457		MAY 1/08
	R	458		MAY 1/08
	R	459		MAY 1/08
	R	460		MAY 1/08
	R	461		MAY 1/08
	R	462		MAY 1/08
	R	463		MAY 1/08
	R	464		MAY 1/08
	R	465		MAY 1/08
	R	466		MAY 1/08
	R	467		MAY 1/08
	R	468		MAY 1/08
	R	469		MAY 1/08
	R	470		MAY 1/08
	D	471		APR 1/07
	D	472		APR 1/07
	D	473		APR 1/07
	D	474		APR 1/07
	D	475/476		APR 1/07
72-00-00 CLEANING	R	501	-ALL	MAY 1/08
	R	502		MAY 1/08
	R	503		MAY 1/08
	R	504		MAY 1/08
	R	505		MAY 1/08
	R	506		MAY 1/08
	R	507		MAY 1/08
	R	508		MAY 1/08
	R	509		MAY 1/08
	R	510		MAY 1/08
	R	511		MAY 1/08
	R	512		MAY 1/08
	R	513/514		MAY 1/08
72-00-00 INSP/REP-00		601	-ALL	APR 1/07
		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07

LIST OF EFFECTIVE PAGES

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-00-00			(CONTINUED)	
INSP/REP-00		613		APR 1/07
		614		APR 1/07
		615		APR 1/07
		616		APR 1/07
		617		APR 1/07
		618		APR 1/07
	R	619		MAY 1/08
	R	620		MAY 1/08
	R	621		MAY 1/08
	R	622		MAY 1/08
	R	623		MAY 1/08
	R	624		MAY 1/08
		625		APR 1/07
		626		APR 1/07
		627		APR 1/07
		628		APR 1/07
		629		APR 1/07
		630		APR 1/07
		631		APR 1/07
		632		APR 1/07
		633		APR 1/07
		634		APR 1/07
		635		APR 1/07
		636		APR 1/07
		637		APR 1/07
		638		APR 1/07
		639		APR 1/07
		640		APR 1/07
		641		APR 1/07
		642		APR 1/07
		643		APR 1/07
		644		APR 1/07
		645		APR 1/07
		646		APR 1/07
		647		APR 1/07
		648		APR 1/07
72-00-00		701	-ALL	APR 1/07
ASSY/SUBASSY		702		APR 1/07
	R	703		MAY 1/08
	R	704		MAY 1/08
		705		APR 1/07
		706		APR 1/07
		707		APR 1/07
		708		APR 1/07
		709		APR 1/07
		710		APR 1/07
		711		APR 1/07
		712		APR 1/07
		713		APR 1/07
		714		APR 1/07
		715		APR 1/07
		716		APR 1/07
		717		APR 1/07
		718		APR 1/07
		719		APR 1/07
		720		APR 1/07
		721		APR 1/07
		722		APR 1/07
		723		APR 1/07
		724		APR 1/07
	R	725		MAY 1/08
	R	726		MAY 1/08
		727		APR 1/07
		728		APR 1/07
		729		APR 1/07
		730		APR 1/07
		731		APR 1/07
		732		APR 1/07
	R	733		MAY 1/08
	R	734		MAY 1/08
		735		APR 1/07
		736		APR 1/07
		737		APR 1/07
72-00-00			(CONTINUED)	
ASSY/SUBASSY		738		APR 1/07
		739		APR 1/07
		740		APR 1/07
		741		APR 1/07
		742		APR 1/07
		743		APR 1/07
		744		APR 1/07
		745		APR 1/07
		746		APR 1/07
		747		APR 1/07
		748		APR 1/07
	R	749		MAY 1/08
	R	750		MAY 1/08
		751		APR 1/07
		752		APR 1/07
		753		APR 1/07
		754		APR 1/07
		755		APR 1/07
		756		APR 1/07
		757		APR 1/07
		758		APR 1/07
		759		APR 1/07
		760		APR 1/07
		761		APR 1/07
		762		APR 1/07
		763		APR 1/07
		764		APR 1/07
		765		APR 1/07
		766		APR 1/07
		767		APR 1/07
		768		APR 1/07
		769		APR 1/07
		770		APR 1/07
		771		APR 1/07
		772		APR 1/07
	R	773		MAY 1/08
	R	774		MAY 1/08
	R	775		MAY 1/08
	R	776		MAY 1/08
	R	777		MAY 1/08
	R	778		MAY 1/08
		779		APR 1/07
		780		APR 1/07
		781		APR 1/07
		782		APR 1/07
		783		APR 1/07
		784		APR 1/07
		785		APR 1/07
		786		APR 1/07
	R	787		MAY 1/08
	R	788		MAY 1/08
	R	789		MAY 1/08
	R	790		MAY 1/08
		791		APR 1/07
		792		APR 1/07
	R	793		MAY 1/08
	R	794		MAY 1/08
	R	794A		MAY 1/08
	R	794B		MAY 1/08
	R	794C		MAY 1/08
	R	794D		MAY 1/08
	R	794E		MAY 1/08
	R	794F		MAY 1/08
	R	794G		MAY 1/08
	R	794H		MAY 1/08
	R	794I		MAY 1/08
	R	794J		MAY 1/08
	R	794K		MAY 1/08
	R	794L		MAY 1/08
	R	794M		MAY 1/08
	R	794N		MAY 1/08
	R	794O		MAY 1/08
	R	794P		MAY 1/08
	R	794Q		MAY 1/08

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-00-00			(CONTINUED)	
ASSY/SUBASSY	R	794R		MAY 1/08
	R	794S		MAY 1/08
	R	794T		MAY 1/08
	R	794U		MAY 1/08
	R	794V		MAY 1/08
72-00-00		801	-ALL	APR 1/07
FINAL ASSY		802		APR 1/07
	R	803		MAY 1/08
	R	804		MAY 1/08
		805		APR 1/07
		806		APR 1/07
		807		APR 1/07
		808		APR 1/07
		809		APR 1/07
		810		APR 1/07
		811		APR 1/07
		812		APR 1/07
		813		APR 1/07
		814		APR 1/07
		815		APR 1/07
		816		APR 1/07
		817		APR 1/07
		818		APR 1/07
		819		APR 1/07
		820		APR 1/07
		821		APR 1/07
		822		APR 1/07
	R	823		MAY 1/08
	R	824		MAY 1/08
		825		APR 1/07
		826		APR 1/07
	R	827		MAY 1/08
	R	828		MAY 1/08
		829		APR 1/07
		830		APR 1/07
	R	831		MAY 1/08
	R	832		MAY 1/08
		833		APR 1/07
		834		APR 1/07
		835		APR 1/07
		836		APR 1/07
		837		APR 1/07
		838		APR 1/07
		839		APR 1/07
		840		APR 1/07
		841		APR 1/07
		842		APR 1/07
		843		APR 1/07
		844		APR 1/07
		845		APR 1/07
		846		APR 1/07
		847		APR 1/07
		848		APR 1/07
		849		APR 1/07
		850		APR 1/07
		851		APR 1/07
		852		APR 1/07
		853		APR 1/07
		854		APR 1/07
		855/856		APR 1/07
72-00-00	R	901	-ALL	MAY 1/08
TESTING	R	902		MAY 1/08
		903		APR 1/07
		904		APR 1/07
		905		APR 1/07
		906		APR 1/07
		907		APR 1/07
		908		APR 1/07
		909		APR 1/07
		910		APR 1/07
		911		APR 1/07
		912		APR 1/07
72-00-00			(CONTINUED)	
TESTING		913		APR 1/07
		914		APR 1/07
		915		APR 1/07
		916		APR 1/07
		917		APR 1/07
		918		APR 1/07
		919		APR 1/07
		920		APR 1/07
		921		APR 1/07
		922		APR 1/07
		923		APR 1/07
		924		APR 1/07
		925		APR 1/07
		926		APR 1/07
		927		APR 1/07
		928		APR 1/07
		929		APR 1/07
		930		APR 1/07
		931		APR 1/07
		932		APR 1/07
		933		APR 1/07
		934		APR 1/07
		935		APR 1/07
		936		APR 1/07
		937		APR 1/07
		938		APR 1/07
		939		APR 1/07
		940		APR 1/07
		941		APR 1/07
		942		APR 1/07
		943		APR 1/07
		944		APR 1/07
		945		APR 1/07
		946		APR 1/07
		947		APR 1/07
		948		APR 1/07
		949		APR 1/07
		950		APR 1/07
		951		APR 1/07
		952		APR 1/07
		953		APR 1/07
		954		APR 1/07
		955		APR 1/07
		956		APR 1/07
		957		APR 1/07
		958		APR 1/07
		959		APR 1/07
		960		APR 1/07
		961		APR 1/07
		962		APR 1/07
		963		APR 1/07
		964		APR 1/07
		965		APR 1/07
		966		APR 1/07
		967		APR 1/07
		968		APR 1/07
	R	969		MAY 1/08
	R	970		MAY 1/08
	R	971		MAY 1/08
	R	972		MAY 1/08
	R	973		MAY 1/08
	R	974		MAY 1/08
		975		APR 1/07
		976		APR 1/07
		977		APR 1/07
		978		APR 1/07
	R	979		MAY 1/08
	R	980		MAY 1/08
		981		APR 1/07
		982		APR 1/07
		983		APR 1/07
		984		APR 1/07
		985		APR 1/07
		986		APR 1/07

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-00-00			(CONTINUED)	
TESTING		987		APR 1/07
		988		APR 1/07
		989		APR 1/07
		990		APR 1/07
		991		APR 1/07
		992		APR 1/07
	R	993		MAY 1/08
	R	994		MAY 1/08
	R	994A		MAY 1/08
	R	994B		MAY 1/08
	R	994C		MAY 1/08
	R	994D		MAY 1/08
	R	994E		MAY 1/08
	R	994F		MAY 1/08
	R	994G		MAY 1/08
	R	994H		MAY 1/08
	R	994I		MAY 1/08
	R	994J		MAY 1/08
	R	994K		MAY 1/08
	R	994L		MAY 1/08
	R	994M		MAY 1/08
	R	994N		MAY 1/08
	R	994O		MAY 1/08
	R	994P		MAY 1/08
	R	994Q		MAY 1/08
	R	994R		MAY 1/08
	R	994S		MAY 1/08
	R	994T		MAY 1/08
	R	994U		MAY 1/08
	R	994V		MAY 1/08
	R	994W		MAY 1/08
	R	994X		MAY 1/08
	R	994Y		MAY 1/08
	R	994Z		MAY 1/08
	R	995		MAY 1/08
	R	996		MAY 1/08
	R	996A		MAY 1/08
	R	996B		MAY 1/08
	R	996C		MAY 1/08
	R	996D		MAY 1/08
	R	996E		MAY 1/08
	R	996F		MAY 1/08
	R	996G		MAY 1/08
	R	996H		MAY 1/08
	R	996I		MAY 1/08
	R	996J		MAY 1/08
	R	996K		MAY 1/08
	R	996L		MAY 1/08
	R	996M		MAY 1/08
	R	996N		MAY 1/08
	R	996O		MAY 1/08
	R	996P		MAY 1/08
	R	996Q		MAY 1/08
	R	996R		MAY 1/08
	R	996S		MAY 1/08
	R	996T		MAY 1/08
	R	996U		MAY 1/08
	R	996V		MAY 1/08
	R	996W		MAY 1/08
	R	996X		MAY 1/08
	R	996Y		MAY 1/08
	R	996Z		MAY 1/08
	R	997		MAY 1/08
	R	998		MAY 1/08
	R	998A		MAY 1/08
	R	998B		MAY 1/08
	R	998C		MAY 1/08
	R	998D		MAY 1/08
	R	998E		MAY 1/08
	R	998F		MAY 1/08
	R	998G		MAY 1/08
	R	998H		MAY 1/08
	R	998I		MAY 1/08
	R	998J		MAY 1/08

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-00-00			(CONTINUED)	
TESTING	R	998K		MAY 1/08
	R	998L		MAY 1/08
	R	998M		MAY 1/08
	R	998N		MAY 1/08
	R	998O		MAY 1/08
	R	998P		MAY 1/08
	R	998Q/998R		MAY 1/08
72-00-00	R	1001	-ALL	MAY 1/08
TABLE OF LIM	R	1002		MAY 1/08
	R	1003		MAY 1/08
	R	1004		MAY 1/08
	R	1005		MAY 1/08
	R	1006		MAY 1/08
	R	1007		MAY 1/08
	R	1008		MAY 1/08
	R	1009		MAY 1/08
	R	1010		MAY 1/08
	R	1011		MAY 1/08
	R	1012		MAY 1/08
		1013		APR 1/07
		1014		APR 1/07
	R	1015		MAY 1/08
	R	1016		MAY 1/08
	R	1017		MAY 1/08
	R	1018		MAY 1/08
	R	1019		MAY 1/08
	R	1020		MAY 1/08
	R	1021		MAY 1/08
	R	1022		MAY 1/08
	R	1023		MAY 1/08
	R	1024		MAY 1/08
	R	1025		MAY 1/08
	R	1026		MAY 1/08
	R	1027		MAY 1/08
	R	1028		MAY 1/08
	R	1029		MAY 1/08
	R	1030		MAY 1/08
	R	1031		MAY 1/08
	R	1032		MAY 1/08
	R	1033		MAY 1/08
	R	1034		MAY 1/08
	R	1035		MAY 1/08
	R	1036		MAY 1/08
	R	1037		MAY 1/08
	R	1038		MAY 1/08
	R	1039		MAY 1/08
	R	1040		MAY 1/08
	R	1041		MAY 1/08
	R	1042		MAY 1/08
	R	1043		MAY 1/08
	R	1044		MAY 1/08
	R	1045		MAY 1/08
	R	1046		MAY 1/08
	R	1047		MAY 1/08
	R	1048		MAY 1/08
	R	1049		MAY 1/08
	R	1050		MAY 1/08
	R	1051		MAY 1/08
	R	1052		MAY 1/08
	R	1053		MAY 1/08
	R	1054		MAY 1/08
	R	1055		MAY 1/08
	R	1056		MAY 1/08
	R	1057		MAY 1/08
	R	1058		MAY 1/08
	R	1059		MAY 1/08
	R	1060		MAY 1/08
	R	1061		MAY 1/08
	R	1062		MAY 1/08
	R	1063		MAY 1/08
	R	1064		MAY 1/08
	R	1065		MAY 1/08
	R	1066		MAY 1/08

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-00-00			(CONTINUED)	
TABLE OF LIM	R	1067		MAY 1/08
	R	1068		MAY 1/08
	R	1069		MAY 1/08
	R	1070		MAY 1/08
	R	1071		MAY 1/08
	R	1072		MAY 1/08
	R	1073		MAY 1/08
	R	1074		MAY 1/08
	R	1075		MAY 1/08
	R	1076		MAY 1/08
	R	1077		MAY 1/08
	R	1078		MAY 1/08
	R	1079		MAY 1/08
	R	1080		MAY 1/08
	R	1081		MAY 1/08
	R	1082		MAY 1/08
	R	1083		MAY 1/08
	R	1084		MAY 1/08
	R	1085		MAY 1/08
	R	1086		MAY 1/08
	R	1087		MAY 1/08
	R	1088		MAY 1/08
	R	1089		MAY 1/08
	R	1090		MAY 1/08
	R	1091		MAY 1/08
	R	1092		MAY 1/08
	R	1093		MAY 1/08
	R	1094		MAY 1/08
	R	1094A		MAY 1/08
	R	1094B		MAY 1/08
	R	1094C		MAY 1/08
	R	1094D		MAY 1/08
	R	1094E		MAY 1/08
	R	1094F		MAY 1/08
	R	1094G		MAY 1/08
	R	1094H		MAY 1/08
	R	1094I		MAY 1/08
	R	1094J		MAY 1/08
	R	1094K		MAY 1/08
	R	1094L		MAY 1/08
	R	1094M		MAY 1/08
	R	1094N		MAY 1/08
	R	1094O		MAY 1/08
	R	1094P		MAY 1/08
	R	1094Q		MAY 1/08
	R	1094R		MAY 1/08
	R	1094S		MAY 1/08
	R	1094T		MAY 1/08
	R	1094U		MAY 1/08
	R	1094V		MAY 1/08
	R	1094W		MAY 1/08
	R	1094X		MAY 1/08
	R	1094Y		MAY 1/08
	R	1094Z		MAY 1/08
	R	1095		MAY 1/08
	R	1096		MAY 1/08
	R	1096A		MAY 1/08
	R	1096B		MAY 1/08
	R	1096C		MAY 1/08
	R	1096D		MAY 1/08
	R	1096E		MAY 1/08
	R	1096F		MAY 1/08
	R	1096G		MAY 1/08
	R	1096H		MAY 1/08
	R	1096I		MAY 1/08
	R	1096J		MAY 1/08
	R	1096K		MAY 1/08
	R	1096L		MAY 1/08
	R	1096M		MAY 1/08
	R	1096N		MAY 1/08
	R	1096O		MAY 1/08
	R	1096P		MAY 1/08
	R	1096Q		MAY 1/08
	R	1096R		MAY 1/08

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-00-00			(CONTINUED)	
TABLE OF LIM	R	1096S		MAY 1/08
	R	1096T		MAY 1/08
	R	1096U		MAY 1/08
	R	1096V		MAY 1/08
	R	1096W		MAY 1/08
	R	1096X		MAY 1/08
	R	1096Y		MAY 1/08
	R	1096Z		MAY 1/08
	R	1097		MAY 1/08
	R	1098		MAY 1/08
	R	1098A		MAY 1/08
	R	1098B		MAY 1/08
	R	1098C		MAY 1/08
	R	1098D		MAY 1/08
	R	1098E		MAY 1/08
	R	1098F		MAY 1/08
	R	1098G		MAY 1/08
	R	1098H		MAY 1/08
	R	1098I		MAY 1/08
	R	1098J		MAY 1/08
	R	1098K		MAY 1/08
	R	1098L		MAY 1/08
	R	1098M		MAY 1/08
	R	1098N		MAY 1/08
	R	1098O		MAY 1/08
	R	1098P		MAY 1/08
	R	1098Q		MAY 1/08
	R	1098R		MAY 1/08
	R	1098S		MAY 1/08
	A	1098T		MAY 1/08
	A	1098U		MAY 1/08
	A	1098V		MAY 1/08
	A	1098W		MAY 1/08
	A	1098X		MAY 1/08
LIST OF EFFECTIVE PAGES				
		A		MAY 1/08
		B		MAY 1/08
		C		MAY 1/08
		D		MAY 1/08
		E		MAY 1/08
		F		MAY 1/08

TEMPORARY REVISION NO. 72-0001

PURPOSE: This Temporary Revision adds assembly requirements for JFTD12A compressor blades with the current inspection classification system.

APPLICABLE MANUAL REVISION: Revision Number 075.

TR FILING INSTRUCTIONS: For a printed manual, put this Temporary Revision in the manual location specified below. Write the Temporary Revision Number on the Record of Temporary Revisions, which is adjacent to the Volume 1 Title Page. For a CD-ROM version of this manual, put this Temporary Revision in the reference file in sequence by Chapter/Section to show that this Temporary Revision is added to the manual.

MANUAL LOCATION:

CHAPTER/SECTION	PROCEDURE	LOCATION
72-00-00	ASSEMBLY OF SUBASSEMBLIES	Page 704

CHANGED DATA:

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-00-00 ASSY/SUBASSY	704 -706 708 -710 713 715 723 726 729 733 -734 739 -742 744 -746	Added reference to blade inspection class limits at installation or JFTD12A. (EA 08JC003)	-ALL

TO: RECIPIENTS OF JT12 OVERHAUL MANUAL, PART NUMBER 435108

REVISION NO. 75 DATED MAY 1, 2008

HIGHLIGHTS - ENGINE GENERAL

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-00-00	211	Removed non-applicable	
DESCRIPTION	233	gearbox breather	-ALL
		valve description.	
		(Editorial)	
72-00-00	310	Corrected tool	
OH TOOLS	318	data.	-ALL
	328	(Editorial)	
	-329	Added PWA 107529	
	339	Puller for 9th	
	344	stage compressor disk	
	-354	air seals.	
	356	(TDS 107529)	
	-357		
	359		
	-360		
	362		
	-363		
	365		
	-371		
	373		
	-376		
72-00-00	403	Corrected text	
DISMANT/ASSY	445	references.	-ALL
	-446	(Editorial)	
	450	Added 9th stage	
	455	compressor disk	
	-456	airseal puller	
	465	procedures.	
	467	(TDS 107529)	
	-470		
72-00-00	502	Removed non-applicable	
CLEANING	-503	case cleaning	-ALL
	505	procedures.	
	507	(CTS request)	
	-508		
	511		
	-513/		
	514		

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-00-00 INSP/REP-00	619 -620 622 624	Revised free turbine tierod inspection to FPI. (PSAF 04EC219D) Increased FPI of free turbine airseal to SPOP 84. (PSAF 04EC219D)	-ALL
72-00-00 ASSY/SUBASSY	704 725 734 750 774 -776 778 788 790 793 794B 794F 794H -794I 794O 794U	Corrected text references. (Editorial)	-ALL
72-00-00 FINAL ASSY	803 823 827 -828 831	Corrected text references. (Editorial) Revised diffuser case flange sealant. (CTS IOC 10-19-05)	-ALL
72-00-00 TESTING	901 970 972 974 980 994S 996 996C 998J	Corrected text references. (Editorial)	-ALL

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-00-00 TABLE OF LIM	1002 -1003 1007 1012 1015 1017 1020 -1021 1025 -1026 1028 -1029 1037 -1039 1042 -1043 1047 1052 -1054 1056 -1058 1060 1064 -1066 1075 1078 1080 1086 1090 1094I 1094Y 1096X -1096Z 1098E -1098F 1098L -1098O	Corrected limits text. (Editorial)	-ALL

ENGINE GENERAL - DESCRIPTION

1. General

A. These engines are continuous-flow gas turbine engines that use a two stage reaction turbine to drive a single rotor axial flow compressor. See Figure 201. The free turbine engines utilize the gas turbine section exhaust gasses to drive a two stage free turbine assembly.

B. The axial flow compressor consists of a nine stage rotor and eight stator stages. The gaspath of the compressor has a nearly constant outside diameter and an increasing inside diameter. The compressor has a moderate compression ratio. The rotating parts of the compressor are connected to the 1st and 2nd stage turbines by the turbine shaft and the shaft lock.

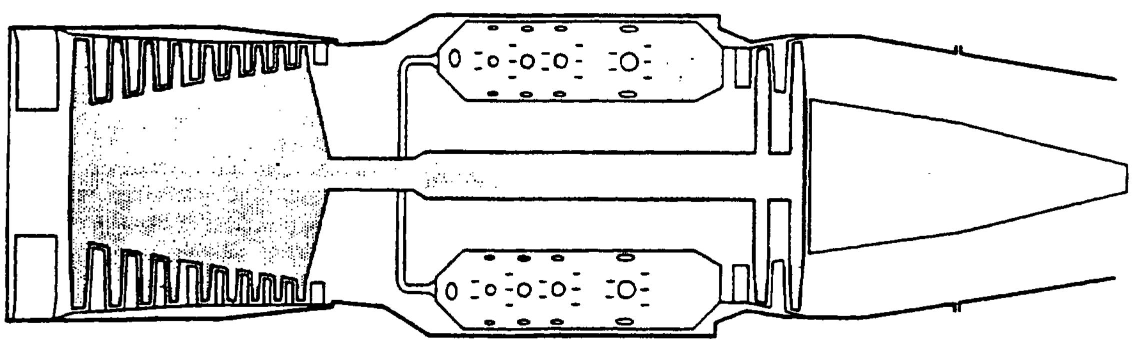
C. An automatically controlled interstage airbleed is used at startup and for low power engine operation. An anti-icing air system prevents dangerous icing on the compressor inlet surfaces in the engine, by directing compressor discharge air into the hollow compressor inlet guide vanes.

D. To the rear of the compressor is the diffuser section, which reduces the air velocity for entry into the combustion chambers. High pressure air from this section is bled off for anti-icing and airframe functions.

E. The combustion section houses the combustion chambers and the fuel manifolds. Eight separate combustion chambers arranged annularly (can-annular) are connected by flame tubes. Sparkigniters (only used at startup) are installed in number three and number six combustion chambers.

F. The range of operation from Idle to Takeoff demands a wide variation in fuel flow. It is important that the proper spray pattern be maintained for effective atomization of the fuel, in order to avoid undesirable effects from inefficient combustion during any stage of engine operation.

(1) The correct spray pattern for engine operation below a predetermined point is effectively accomplished by using a duplex nozzle through the smaller or primary manifold. From this point to Takeoff operation, additional fuel is delivered at the same time through the larger or secondary manifold to the secondary orifice of the nozzle.



L-07542 (0000)

Engine Schematic
Figure 201

G. The turbine section is near the rear of the combustion section. The turbine case is the convergent-divergent type and houses the 1st stage outer turbine rotor seal and the turbine rotor assembly. In turbojet engines, the turbine exhaust case is attached to the turbine case rear flange and contains the 2nd stage turbine outer seal and the exhaust cone and strut assembly. In the free turbine engine, the free turbine section is attached to the turbine case rear flange.

2. Compressor Section

A. Compressor Case Assembly

(1) The compressor inlet case consists of the outer and inner inlet cases, the outer and inner inlet vane shrouds, and the hollow inlet vanes.

(2) At the 12 o'clock position, the front flanges include mounting lugs to attach the engine to the airframe.

(3) Bosses and pads are provided on the outer case for the No. 1 bearing compartment breather, scavenge, pressure connections, inlet air pressure sensing, inlet air temperature sensing, and anti-icing air.

(4) The No. 1 bearing housing is bolted to the inner inlet case rear flange and the inlet case cover is bolted to the flange.

(5) The compressor outer inlet case houses the first four compressor rotor and compressor vane and shroud stages. Ports in the rear of the case allow bleed air to discharge into the secondary airstream within the engine compartment.

B. Compressor Rotor and Stator Assembly

(1) The compressor rotor and stator assembly consists of nine rotor stages, eight vane and shroud assemblies, eight rotor disk spacers, and the front and rear hubs. The 1st, 2nd, 3rd, 4th, and 7th stage compressor blades are made of titanium.

(2) The following items are placed on the front hub: the seal spacer, center seal spacer, seal spacer, No. 1 bearing inner race and rollers, and the inner race retaining nut. Carbon seals are placed in the center spacer to isolate the bearing compartment from the air stream.

(3) The 1st stage blades have a molybdenum coating around a section of the airfoil to dampen vibrations. The 1st stage blades are attached directly to the front hub. In the remaining stages, the blades are attached to the rotor disks.

(4) The blades in stages one and two use a pin root double tang to attach the blades to the hub and disk. They are secured in place with pins and washers. In stages three thru nine, the blades have a single dovetail and are secured in place with blade locks in the broached slots of the disks.

(5) The first three stages are secured together with tie-bolts and disk spacers. Tierod bolts secure this assembly to the remaining disk and blade assemblies, and to the rear hub. When the individual disk and blade assemblies and the front and rear hubs are bolted together, they become the compressor rotor. Counterweights are attached to the front and rear hubs to dynamically balance the rotor.

(6) The eight vane shroud assemblies are located between successive compressor disk and blade assemblies. Each vane and shroud assembly consists of a compressor vane outer shroud, a vane outer shroud ring, an inner shroud (stages four thru eight), and the compressor vanes. Interlocking lugs and slots in the vane outer shrouds prevent the vane and shroud assemblies from rotating.

(7) The interlocking assemblies are lockwired together at four places in each of the last four stages. The stator spacer is located between stages three and four. The lugs on the 3rd stage vane outer shroud and the lugs inside the compressor front case engage slots in the spacer to prevent the stator assembly from rotating. Four equally spaced pins in the compressor front case retain the spacer in position.

(8) Air seals located between each compressor stage hold compressor interstage air leakage to a minimum. The air seals are not part of the disk spacers in stages one thru three. The 4th stage seal is integral to the 3rd to 4th stage spacer. The remaining seals are attached to the disks.

(9) The compressor rotor is coupled with a locking bolt to the turbine shaft. The locking bolt, lock, spring, and spring guide are secured with a retaining ring in the compressor rear hub.

(10) The No. 2 bearing oil distributing sleeve and the main component drive gear are located on the rear hub. The No. 2 bearing face plate, the No. 2 bearing (ball) and retaining ring, and the classified spacer are located on the oil distributing sleeve. The No. 2 bearing oil scoop retains the drive gear on the rear hub.

3. Diffuser Section

A. Diffuser Case and Stator Assembly

(1) The diffuser case and stator are located between the compressor inlet case assembly and the combustion chamber assembly. The diffuser case and stator assembly consists of the diffuser case assembly, 9th stage vane and shroud assembly, outer shroud compressor vane support, and the 9th stage air seal ring.

(2) The compressor rear case houses stages five thru nine of the compressor rotor and vane shroud assemblies.

B. Diffuser Case Assembly

(1) The diffuser case assembly consists of the compressor rear case, diffuser inner and outer cases, No. 2 bearing housing, eight hollow struts that support the inner and outer cases, and the main component drive gearshaft housing. Bosses located on four of the struts provide attaching points for the fuel manifolds.

(2) The engine mount pads are on the outer case located at the three and nine o'clock positions on the horizontal centerline of the engine. Anti-icing air manifolds are on the outer periphery of the diffuser case. Bosses used to install the gearbox and the fuel pressurizing and dump valve are at the bottom of the case.

4. Combustion Section

A. The combustion section consists of the combustion chamber outer case, combustion chamber inner case, right and left fuel manifolds, eight combustion chambers, and the combustion chamber outlet duct.

(1) The right and left fuel manifolds are bolted to bosses on the diffuser case struts, and are secured by the pressurizing and dump valve adapter to the bottom of the diffuser case (at the fuel pressurizing and dump valve mount pad). Ferrules in the adapter transfer fuel from the pressurizing valve to the manifolds.

(2) A fuel drain valve that provides automatic draining of the combustion section after engine operation is located at the bottom rear of the combustion chamber case. The flanges on this case include jackscrew holes.

B. Each combustion chamber consists of six liners, a fuel nozzle cup, a fuel nozzle cup adapter, and a male or female flame tube.

(1) Combustion chambers are secured by a split ring and a retaining ring to each fuel nozzle air swirl guide, and by a retaining clamp to the outlet duct. The retaining clamp allows the combustion chamber to move, permits the engine to compensate for expansion and contraction, and facilitates combustion chamber removal and replacement.

(2) Flame tubes interconnect all combustion chambers, and chambers three and six have sparkigniter cutouts.

C. The combustion chamber inner case assembly consists of the combustion chamber inner case, No. 3 bearing support, No. 3 bearing heat shield, turbine shaft heat shield, and No. 3 bearing oil pressure and scavenge tubes. The assembly is secured to the rear inner flange of the diffuser case.

D. The combustion chamber outlet duct consists of the outlet duct diaphragm, the combustion chamber positioning guide, and the outlet duct.

(1) The combustion chamber outlet duct is secured to the combustion chamber inner case rear flange.

(2) The outlet duct, the 1st stage turbine vane inner shroud, and the No. 3 bearing seal assembly are attached to the combustion chamber inner case.

(3) The outer support, turbine case-to-combustion chamber outer case bolts and ring bolt retainers comprise the outlet duct outer support, which fastens to the outlet duct with nuts and bolts.

5. Turbine Section

A. Turbine Rotor Assembly

(1) The turbine rotor assembly consists of the turbine shaft, 1st and 2nd stage disks and blades, turbine rotor inner seal, and classified balance weights.

(2) The turbine disks are bolted to the turbine shaft hub, and are separated from each other by the turbine rotor inner seal.

NOTE: The 1st and 2nd stage turbine blades are shrouded. When the engine is running, the shrouds form a continuous band that tends to reduce blade vibration, improve airflow characteristics, and increase turbine efficiency.

(3) During assembly, the turbine shaft splines into the compressor rear hub and is secured by the turbine locking bolt. A classified spacer, located between the compressor rear hub and the shaft, controls the 1st stage turbine disk locating dimension.

(4) The 1st stage turbine has 92 blades and the 2nd stage turbine has 80 blades. The blades are set in fir tree serrations in the outer periphery of the disks and are held in place with rivets. The air seals on the outer shrouds and the stepped outer seals form a labyrinth type gas seal for both turbine stages.

(5) The turbine rotor is supported by the No. 3 bearing and by the splined end of the compressor rear hub. The No. 3 bearing seal assembly, seal cooling oil scoop, No. 3 bearing inner race, and inner race retaining nut are installed on the turbine shaft. The retaining nut is held in place by a tablock and a retaining ring prevents the tablock from loosening.

B. Turbine Case

(1) The combustion chamber outlet duct assembly is attached to the turbine case with flat-headed screws. The 1st stage turbine vanes are removable. The vanes can be removed from the turbine case when the combustion chamber outer case and chambers are removed, and when the outlet duct is moved back alongside the combustion chamber inner case.

(2) The vanes are inserted into slots in the inner shroud and retained in place with shouldered pins. When the outlet duct is secured in place, the flange of the duct outer seal butts up against the pins and prevents them from falling out.

(3) The 2nd stage vanes are held in place by the inner shroud and by slots in the turbine case. The 1st stage turbine outer seal separates the 1st and 2nd stage vanes.

C. Turbine Exhaust Case (Turbojet Engines)

(1) The turbine exhaust case assembly consists of the turbine exhaust case, bosses used to install the temperature and pressure indicating probes, and bosses used to attach the turbine exhaust cone and strut assembly.

(2) The exhaust cone and strut assembly consists of the exhaust cone, stiffeners, and six exhaust struts. The cone and strut assembly is attached to the exhaust case with bolts that pass through bosses in the case and into holes in the struts.

6. Free Turbine Section (Free Turbine Engine)

A. Free Turbine Rotor

(1) The free turbine rotor assembly consists of the free turbine shaft, 1st stage disk and blades, 2nd stage disk and blades, free turbine coupling, free turbine accessory drive gear, No. 4 bearing seal plate, No. 4 and 5 bearing oil scoops, and the No. 5 bearing inner race retaining nut.

(2) Tiebolts secure the disk and blade assemblies to the front end of the turbine shaft. The shaft is supported at the rear by the No. 5 bearing and at the forward end by the No. 4 bearing. The No. 4 bearing (ball bearing), No. 4 bearing seal plate, and free turbine accessory drive gear are fixed to the forward journal of the shaft by the No. 4 bearing oil scoop.

(3) The free turbine coupling is fastened to the rear of the shaft by the coupling nut. The No. 5 bearing inner race and No. 5 bearing oil scoop are fastened to the coupling by the No. 5 bearing inner race retaining nut.

B. Free Turbine Inlet Case

(1) The free turbine inlet case assembly houses the free turbine inlet duct assembly, 1st and 2nd stage vanes, 1st stage disk and blades, free turbine 1st stage turbine outer seal, and free turbine rotor 2nd stage inner seal.

(2) Screws secure the free turbine rotor 2nd stage outer seal to the turbine case rear flange. Bosses used to install the turbine temperature and pressure probes are provided around the forward case OD. The free turbine inlet case front flange secures to the turbine case rear flange.

C. Free Turbine Inlet duct

(1) The free turbine inlet duct assembly consists of an inner and outer duct, free turbine inlet vanes and vane shroud, and the inlet and 1st stage rotor inner air seals.

(2) The inlet air seal is riveted to a support flange at the forward end of the inner duct, and the 1st stage rotor air seal is riveted to a support at the rear end of the inner duct. Inner bosses used to install the turbine temperature and pressure probes are located around the forward end of the inner duct.

D. Free Turbine Case

(1) The free turbine case assembly consists of the free turbine outer case, inner front case, inner rear case, four hollow struts and the strut outer shroud, 12 free turbine exhaust struts, and the No. 4 bearing housing.

(2) Bosses used to attach the oil and breather connection and the free turbine accessory drive gearbox are provided on the OD of the case. Housed in the case are the free turbine 2nd stage disk and blades, 2nd stage inner and outer airseals, No. 4 bearing, No. 4 bearing seal, No. 4 bearing oil nozzle, and the free turbine accessory drive gear and shaft assembly.

E. Free Turbine Exhaust Duct

(1) The free turbine exhaust duct assembly consists of inner and outer duct assemblies, stiffeners, an exhaust duct ring, and front and rear flanges. The free turbine shaft and free turbine shaft inner and outer case assemblies are housed in the exhaust duct. The exhaust duct is bolted to the free turbine case rear flange.

F. Free Turbine Shaft Outer Case

(1) The free turbine shaft outer case front flange is attached to the rear flange of the free turbine inner rear case. The No. 5 bearing seal support is attached to the rear flange of the outer case.

G. Free Turbine Shaft Inner Case

(1) The free turbine shaft inner case houses the free turbine shaft and the No. 5 bearing assembly. The case assembly consists of the front, intermediate, and rear case assembly, No. 5 bearing housing, No. 5 bearing oil pressure and scavenge tubes, and No. 5 bearing front and rear oil nozzles.

(2) Nuts and bolts secure the front of the case to the free turbine case inner rear flange and secure the rear of the case to the No. 5 bearing seal support.

7. Accessory Section

A. Component Drive Gearbox

(1) The component drive gearbox is located at the bottom of the engine and is attached by mounting lugs to the diffuser case. Power is supplied to the gearbox from the compressor rotor shaft through the tower shaft.

(2) The engine fuel pump is mounted on the right front pad, and the starter-generator is mounted on the left front pad. Gearing is provided to drive the fuel pump starter-generator, a fluid power pump, and a tachometer.

(3) The oil strainer, oil pressure relief valve, oil pump, and engine accessory drive gears are located in the component drive gearbox.

(4) The main oil pump assembly has four single-stage, positive displacement, gear-type pump sections. One section supplies pressure oil for the lubrication system and the other three sections scavenge oil from the bearing compartments and the gearbox. Free turbine engine oil pumps have two additional sections that scavenge oil from the free turbine assembly.

(5) The rotary breather is a component of the fluid power pump drive gearshaft. The various compartments within the engine and the oil tank are interconnected, and the rotary breather in the gearbox removes the oil from the
R air by a centrifuge action.

8. Engine Bearings

A. No. 1 Bearing

(1) The No. 1 bearing inner race and rollers, and the rear, center and front seal spacers are located on the compressor front hub.

(2) The bearing inner race is secured to the hub by the inner race retaining nut. The bearing outer race is installed in the bearing housing and secured by the outer race retaining nut. Pressure oil from the No. 1 bearing nozzle lubricates the bearing.

B. No. 2 Bearing

(1) The No. 2 bearing, oil distributing sleeve, seal plate, classified main component drive spacer, and main component drive gear are secured on the compressor rear by the No. 2 bearing oil scoop.

(2) The bearing inner race is secured on the distributing sleeve by a retaining ring. The outer race is secured in the bearing housing by a retaining nut. This bearing is the center support for the engine rotating parts.

C. No. 3 Bearing

(1) The No. 3 bearing outer race and rollers are secured in the bearing support by a retaining nut and a lockring.

(2) Located on the turbine shaft are the cooling air scoop, the No. 3 bearing inner race and inner race retaining nut, a tablock, and a retaining ring.

D. No. 4 Bearing (Free Turbine Engine)

(1) The No. 4 bearing is a ball bearing assembly with separable inner and outer races. This bearing supports the forward end of the free turbine rotor assembly.

(2) A retaining nut secures the outer race in the bearing support located in the free turbine case assembly. An oil scoop secures the inner race (plus the No. 4 bearing seal plate, the free turbine accessory gear, and the key washer) on the free turbine shaft.

E. No. 5 Bearing (Free Turbine Engine)

(1) The No. 5 bearing is a roller bearing with a non-separable outer race and a separable inner race. This bearing supports the rear end of the free turbine rotor assembly.

(2) A retaining nut secures the outer race and rollers in the bearing support located in the free turbine shaft inner case. The inner race (and the No. 5 bearing seal plate) is secured on the free turbine shaft by the No. 5 bearing oil scoop.

9. Oil Seals

A. General

(1) Oil sealing is very important in jet engines because oil vapor can wet the blades or vanes, which allows dust and dirt to accumulate on the airfoil surfaces. A dirty blade or vane presents high friction to the air flow decreasing engine efficiency, and resulting in a noticeable decrease in thrust or an increase in fuel consumption.

(2) There are two configurations of main seals used in the engine. The No. 1 bearing seal consists of two ring-type seals, and the No. 2 and 3 bearing seals, which are spring-loaded face-type seals. Cylindrical-type seals made of synthetic rubber are used in the accessory drives. O-ring seals and packings are used between non-moving parts where sealing is necessary.

(3) No. 1 Bearing Seal

(a) The No. 1 bearing seals are located in the center seal spacer. To pressurize the seals, 9th stage air travels via holes in the compressor rear hub into the center of the compressor rotor and out through holes in the front hub and center seal spacer.

(b) Leakage between the carbon seals and the seal spacers causes the air to flow toward the hub in one direction and toward the rear of the No. 1 bearing in the other direction, preventing the bearing oil from entering the airstream.

(4) No. 2 Bearing Seal

(a) The No. 2 bearing seal assembly is bolted to the bearing support. The seal assembly consists of the seal housing, the seal and seal support, the metal seal ring, springs, and loading pin guides.

(b) The metal seal ring sits in the groove in the OD of the seal support. The springs are positioned over the guides. The seal assembly sits on the seal support secured in place by two cotter pins. The springs push the seal assembly against the cotter pins.

(c) When the assembly is bolted in place in the diffuser case, the springs hold the seal against the seal plate on the compressor rear hub. The 9th stage air pressurizes the seal and prevents oil leakage into the airstream.

(5) No. 3 Bearing Seal

R
R

(a) The No. 3 bearing seal assembly construction is similar to the No. 2 bearing seal assembly. The seal assembly is positioned on the turbine shaft. The cooling oil scoop, the inner race and the retaining nut are installed on the shaft.

(b) When the shaft is installed in the engine, the seal housing is bolted to the bearing support. The bearing support is an integral part of the combustion chamber inner case. Compressor discharge air pressurizes the seal and prevents oil leakage into the airstream.

(6) No. 4 Bearing Seal (Free Turbine Engine)

(a) The No. 4 bearing seal assembly consists of the seal housing, the seal and seal support, the metal seal ring, locating pins, and springs.

(b) The metal seal ring and the seal are positioned in the housing. The housing is positioned over the pins and springs in the support and is retained in place with cotter pins.

(c) Springs hold the seal against the seal plate when the seal is installed in the engine. The 9th stage compressor air pressurizes the seal.

(7) No. 5 Bearing Seal (Free Turbine Engine)

(a) Screws secure the No. 5 bearing seal support to the No. 5 bearing support. The seal assembly consists of the seal and seal support, the seal housing, the metal seal ring, guide pins, and springs.

(b) The guide pins and springs position the seal against the seal plate. The metal seal ring, which is located in the seal support groove, prevents air leakage between the seal housing and the seal support.

R
R

10. Lubrication And Breather Systems

A. General

(1) The lubrication system provides an adequate supply of clean oil to all the bearings and gears within the engine. Oil lubricates and cools the engine bearings.

(2) Oil from the oil supply tank travels to the pressure pump section of the oil pump, then moves through the external and internal oil tubes to the bearing compartments.

(3) Oil from the No. 1 and 2 bearing compartments is scavenged by two sections of the oil pump. The third section of the oil pump scavenges the oil from the gearbox.

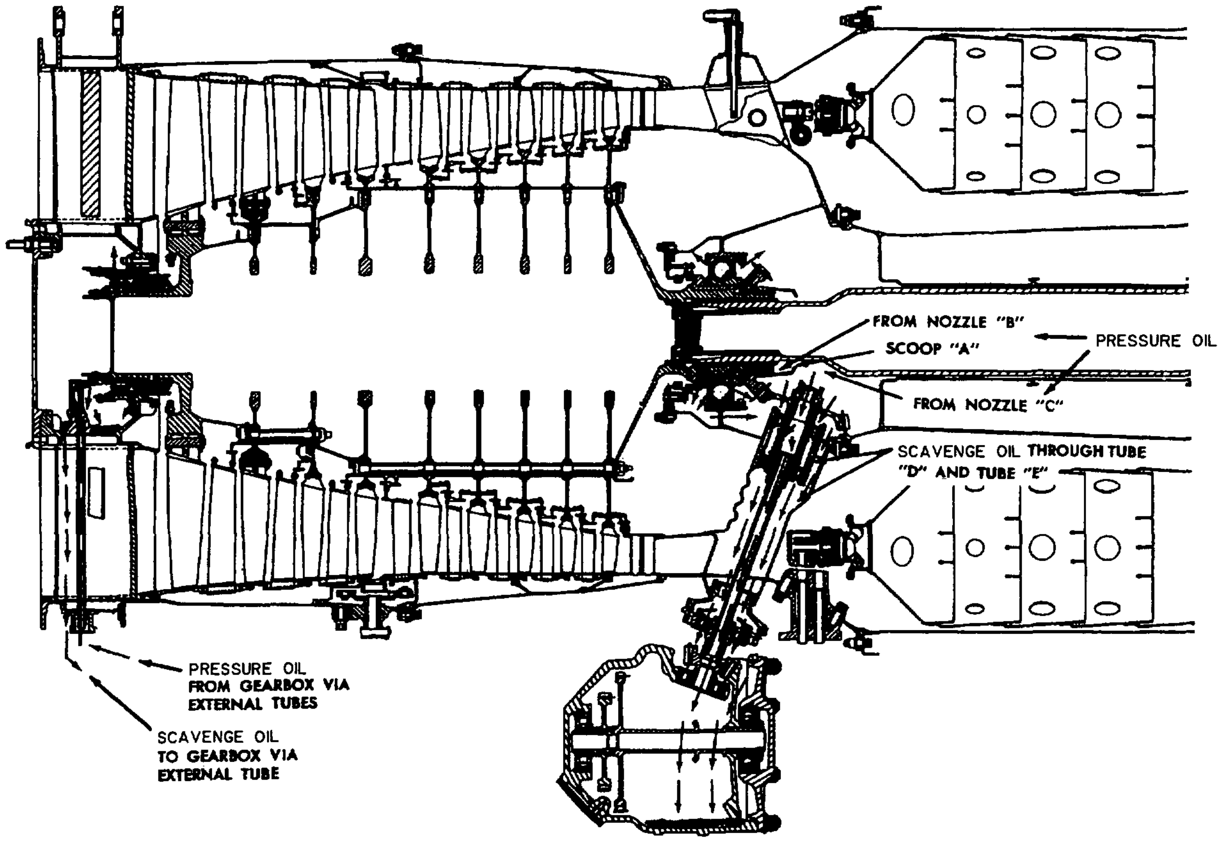
(4) In free turbine engines, two additional scavenge sections scavenge oil from the No. 4 and 5 bearings. Oil from the scavenge pumps flows through a fuel-oil cooler and back to the oil tank.

NOTE: On the JFTD12A engine, the fuel-oil cooler is located on the oil tank-to oil pump supply line, which directly routes the scavenge oil from the scavenge pump to the oil tank.

B. Pressure Oil System

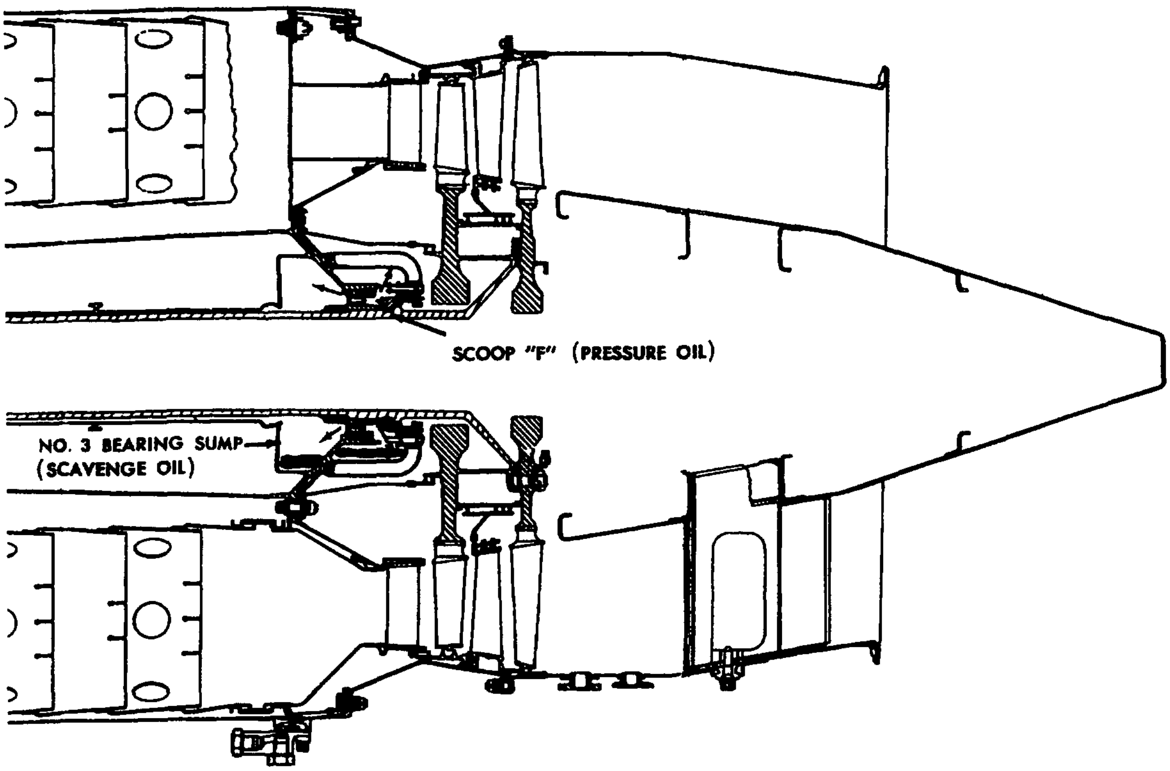
(5) Oil is supplied to the inlet of the pressure section in the oil pump. The pump forces the oil through the oil strainer, into external tubing, then to the No. 1 and No. 2 bearing compartments. Oil to the No. 3 bearing compartment is supplied by an internal tube that connects with the No. 2 bearing supply.

(6) In free turbine engines, pressure oil also flows through an external tube to a connector on the free turbine case then to the free turbine accessory drive gearbox. An internal line carries oil from the connector to the No. 4 and 5 bearing compartments.



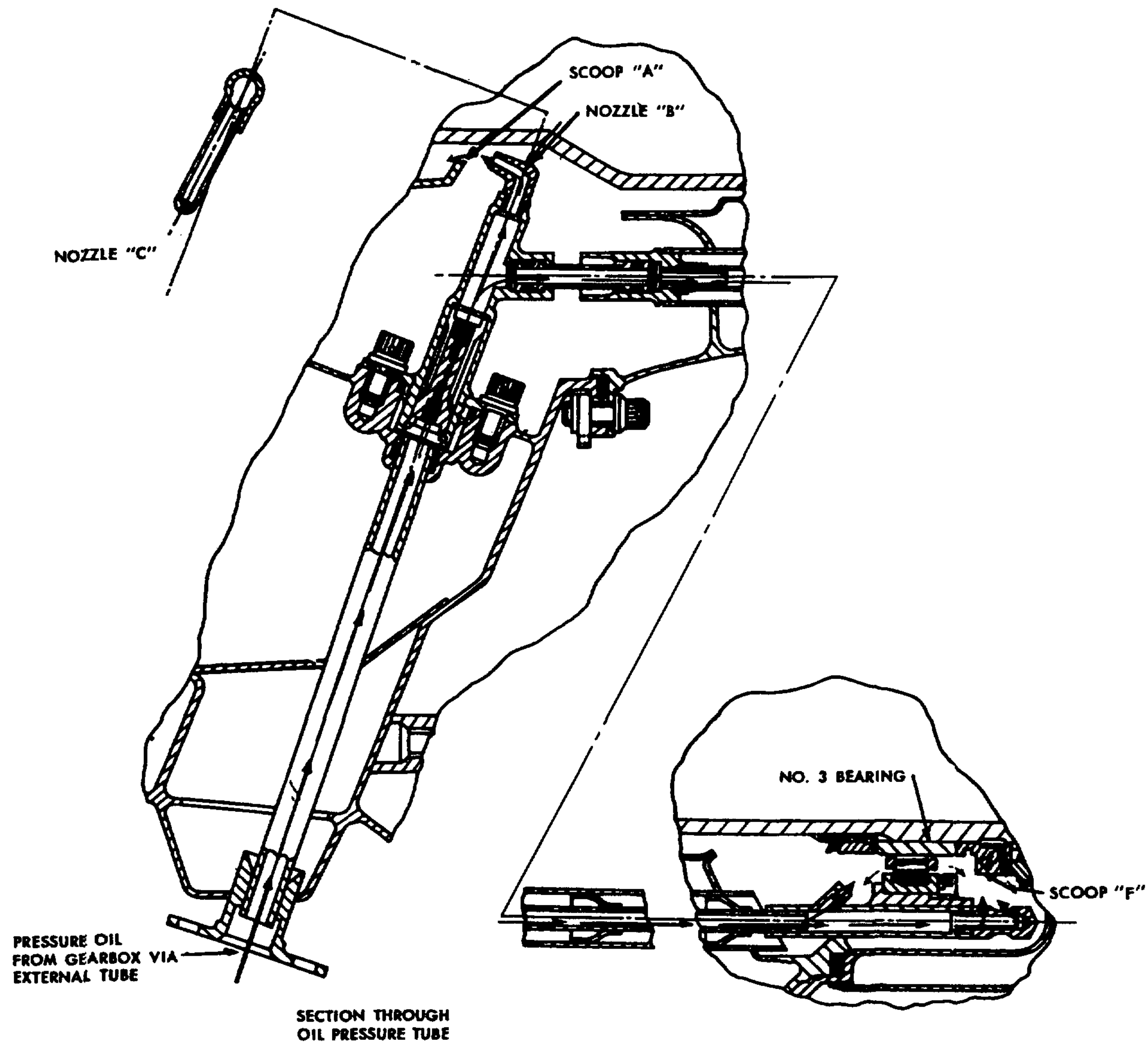
L-H8084 (0307)

Engine Lubrication System
Figure 202 (Sheet 1)



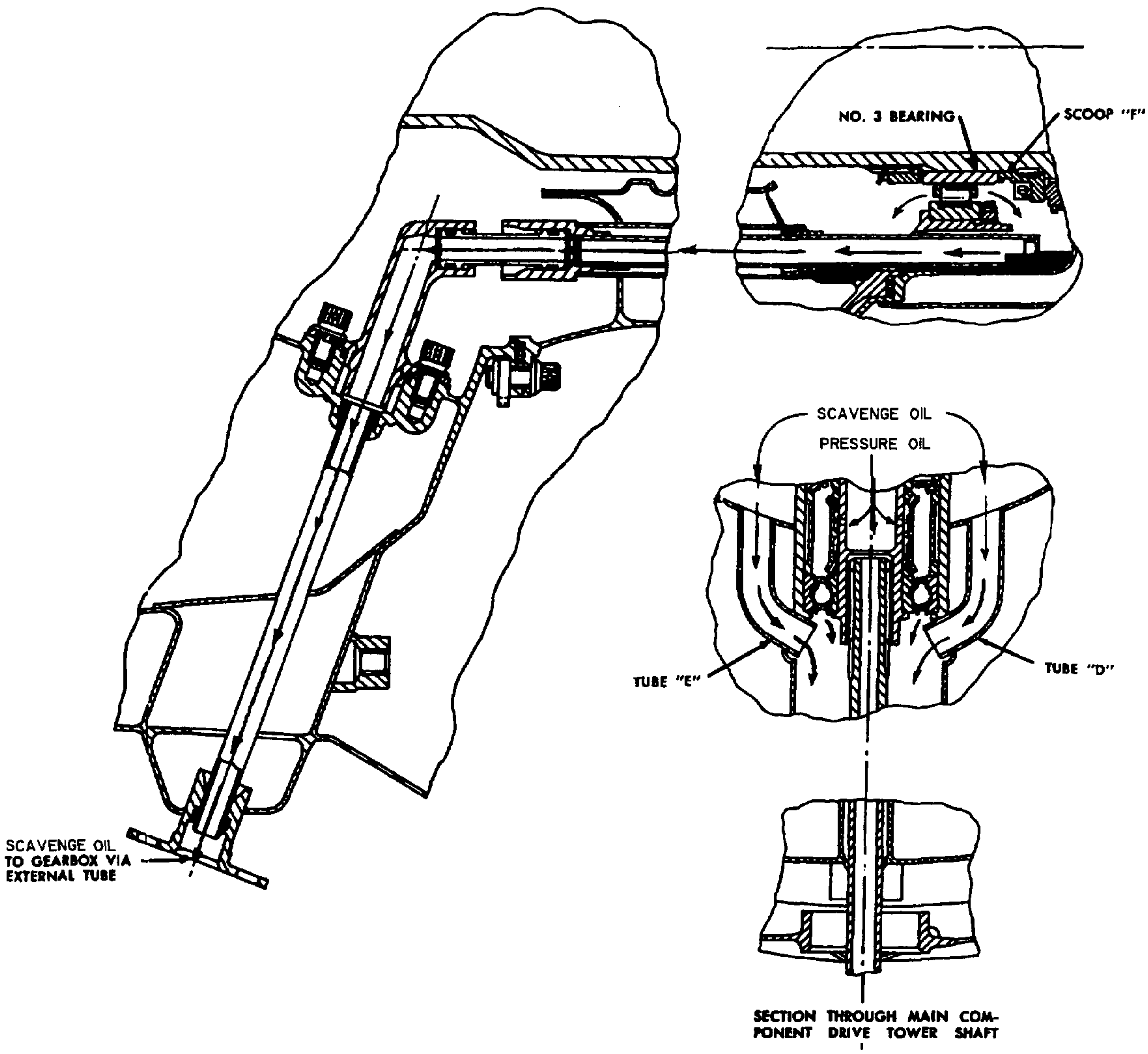
L-H8085 (0307)

Engine Lubrication System
Figure 202 (Sheet 2)



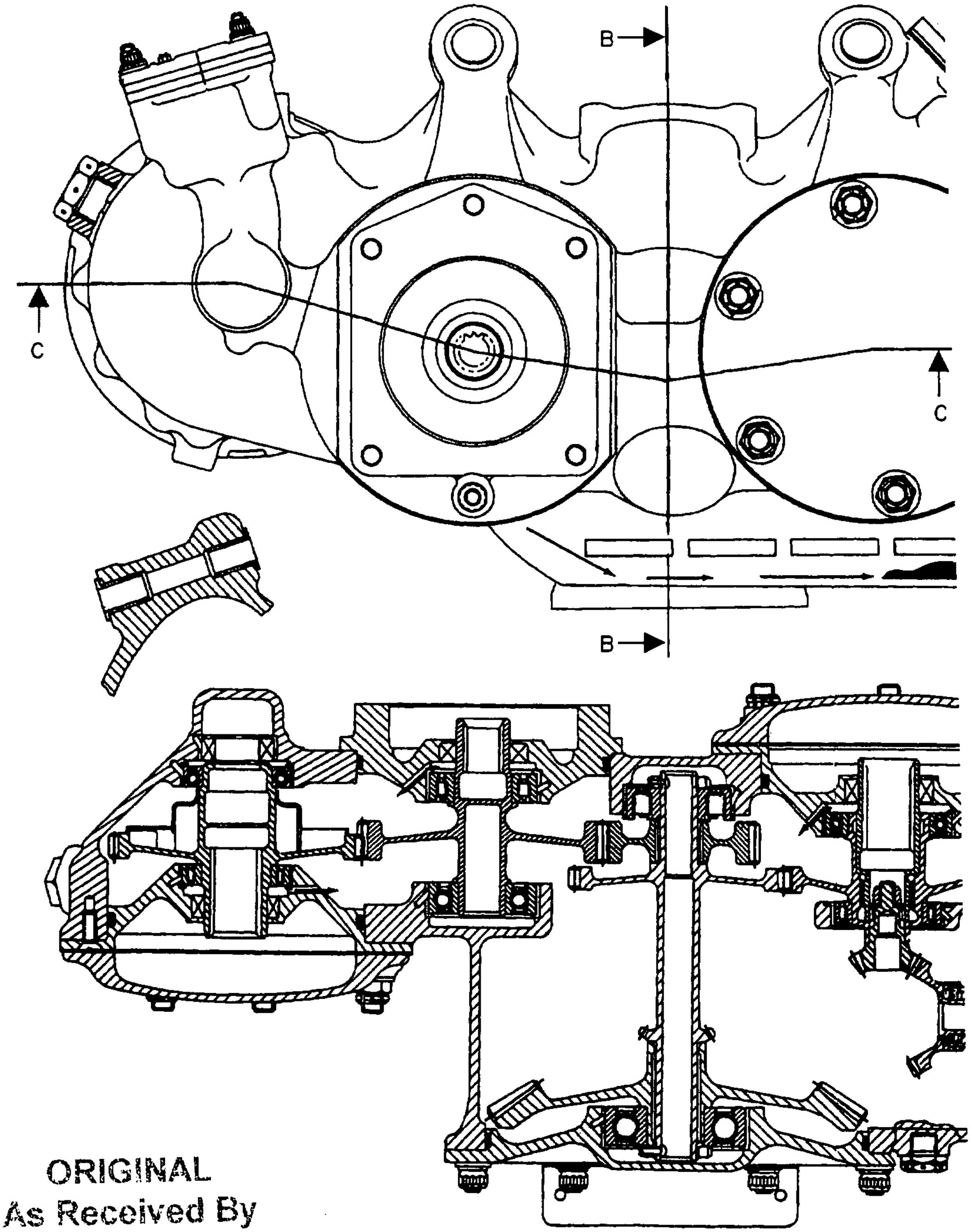
L-H8086 (0307)

Engine Lubrication System
Figure 202 (Sheet 3)

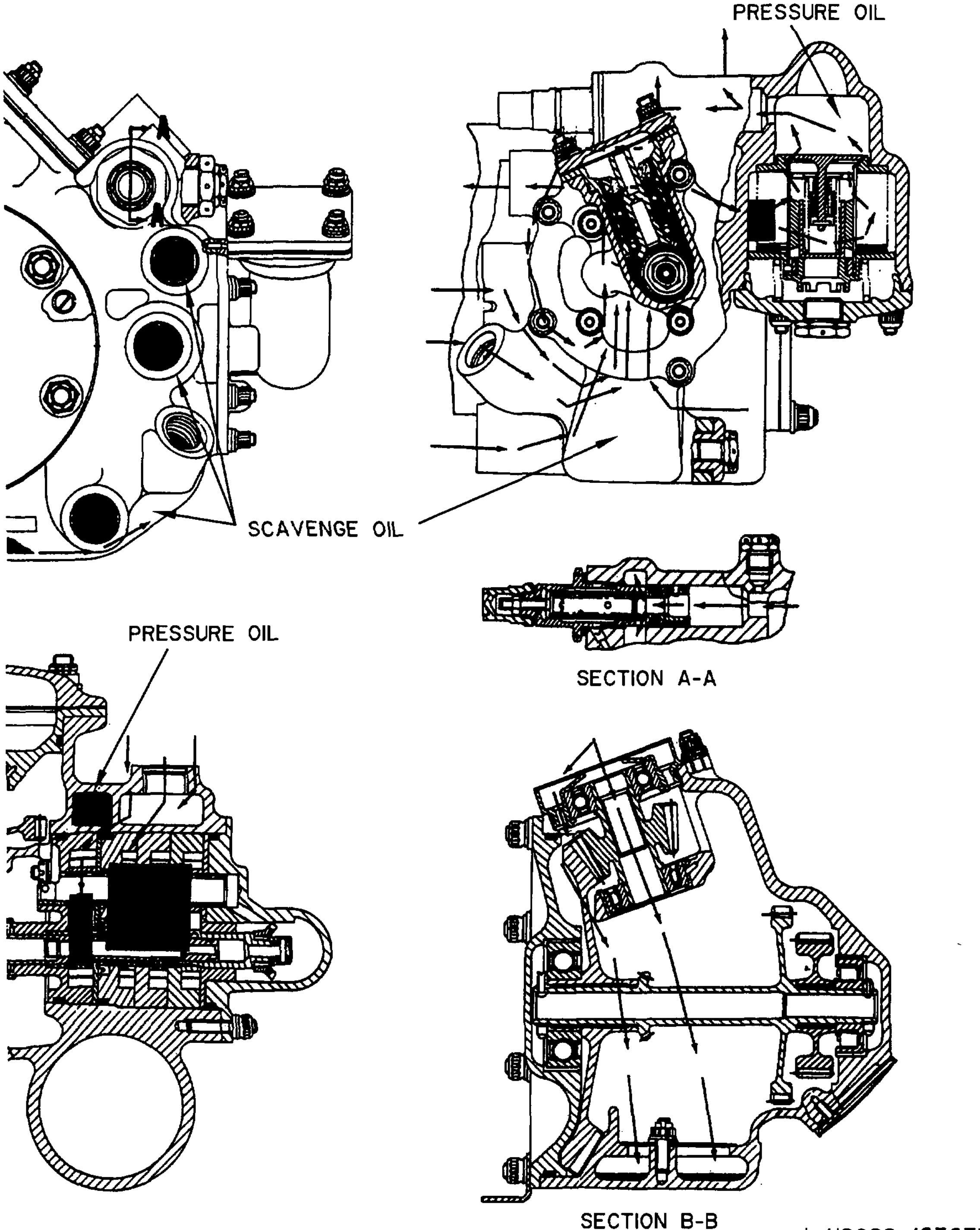


L-H8087 (0307)

Engine Lubrication System
Figure 202 (Sheet 4)



Engine Lubrication System
Figure 202 (Sheet 5)



Engine Lubrication System
Figure 202 (Sheet 6)

(7) Pressure oil flow is maintained by metering orifices, which provide a relatively constant oil flow at all engine operating speeds. A pressure relief valve controls the oil pressure differential. In the event the oil strainer becomes clogged, a bypass valve opens to permit the oil to flow and to allow engine operation to continue.

B. Scavenge Oil System

(1) Oil is scavenged from the bearing compartments and the component drive gearbox by three stages of the main oil pump (five for free turbine engines). The stage adjacent to the pressure pump scavenges the No. 1 bearing compartment and the remaining stages, from inside out, scavenge the No. 3 bearing compartment and the gearbox (the No. 4 and 5 bearing compartments, respectively, for free turbine engines). The No. 2 bearing oil is scavenged with the gearbox oil.

(2) Oil from these free turbine bearing compartments reaches the pump via external tubes. The output of these sections empties into a common tube that returns the scavenge oil to the oil tank. Return oil passes through a can-type deaerator, an integral part of the oil tank that removes most of the air. The oil tank contains baffles to prevent re-aeration of the oil.

C. Breather Pressurizing System

(1) The bearing compartments and the oil tank vent to the component drive gearbox. The common overboard vent goes through a rotary breather (part of the fluid power pump gearshaft assembly), which prevents the majority of oil particles from being carried overboard into the breather airflow. Seal leakage air that enters the oil system provides pressurization.

11. Air Systems

A. General

(1) The engine has two separate airbleed systems, a high pressure air system and an overboard airbleed. The high pressure air system is available for airframe component use, and the overboard airbleed is required to prevent engine compressor instability. In addition, high pressure air is used to anti-ice the engine inlet.

B. Compressor Bleed System

(1) The engine has a compressor bleed system that consists of the bleed valve assembly and the external linkage to the fuel control. Air from the 4th stage passes through holes in the compressor stator and into a cavity formed by the compressor stator spacer, the 4th stage vane outer shroud support ring, and the compressor case.

(2) Linkage (operated by the fuel control) triggers the opening and closing of the bleed valve. The compressor bleed valve is a strap secured to the rear of the compressor case by the compressor bleed valve roller guide. The bleed valve strap is positioned in a wide slot in the 4th stage stator spacer and is pinned at both ends to a clevis. Each clevis is secured to a link, which in turn is secured to the bellcrank.

(3) Linkage from the fuel control to the bellcrank produces the bleed valve operation. Turning the bellcrank tightens or loosens the bleed valve strap.

C. Anti-icing Air System

(1) An anti-icing air system is incorporated in the engine to prevent icing on the compressor inlet surfaces. Compressor discharge air is carried forward to the inlet case by an external tube located on the left side of the engine. Airflow through this tube is controlled by a solenoid actuated valve.

(2) When icing conditions occur, a switch is thrown to de-energize the solenoid, allowing anti-icing air to pass forward. Anti-icing air enters the compressor inlet outer case through the anti-icing air boss and into the cavity formed by the compressor inlet outer case and the inlet vane outer shroud.

(3) The air passes through the hollow inlet guide vanes and into the chamber formed by the compressor inlet inner case and the inlet vane inner shroud. Thirty-two equally spaced holes in the compressor inlet vane inner shroud front flange provide openings for the air to eject into the airstream.

D. Cooling Air System

(1) The 9th stage air passes through holes in the compressor rotor rear hub, flows down the inside of the rotor, goes out through holes in the front hub and flows into the turbine rotor shaft. This air pressurizes the main bearing seals and cools the hot section parts. See Figure 203.

12. Electrical System

A. General

(1) The electrical system is designed to facilitate engine removal by connecting the electrical leads from all the engine components (with the exception of the turbine exhaust thermocouples) into a common harness. This efficient design reduces to an absolute minimum the number of fittings that must be disconnected.

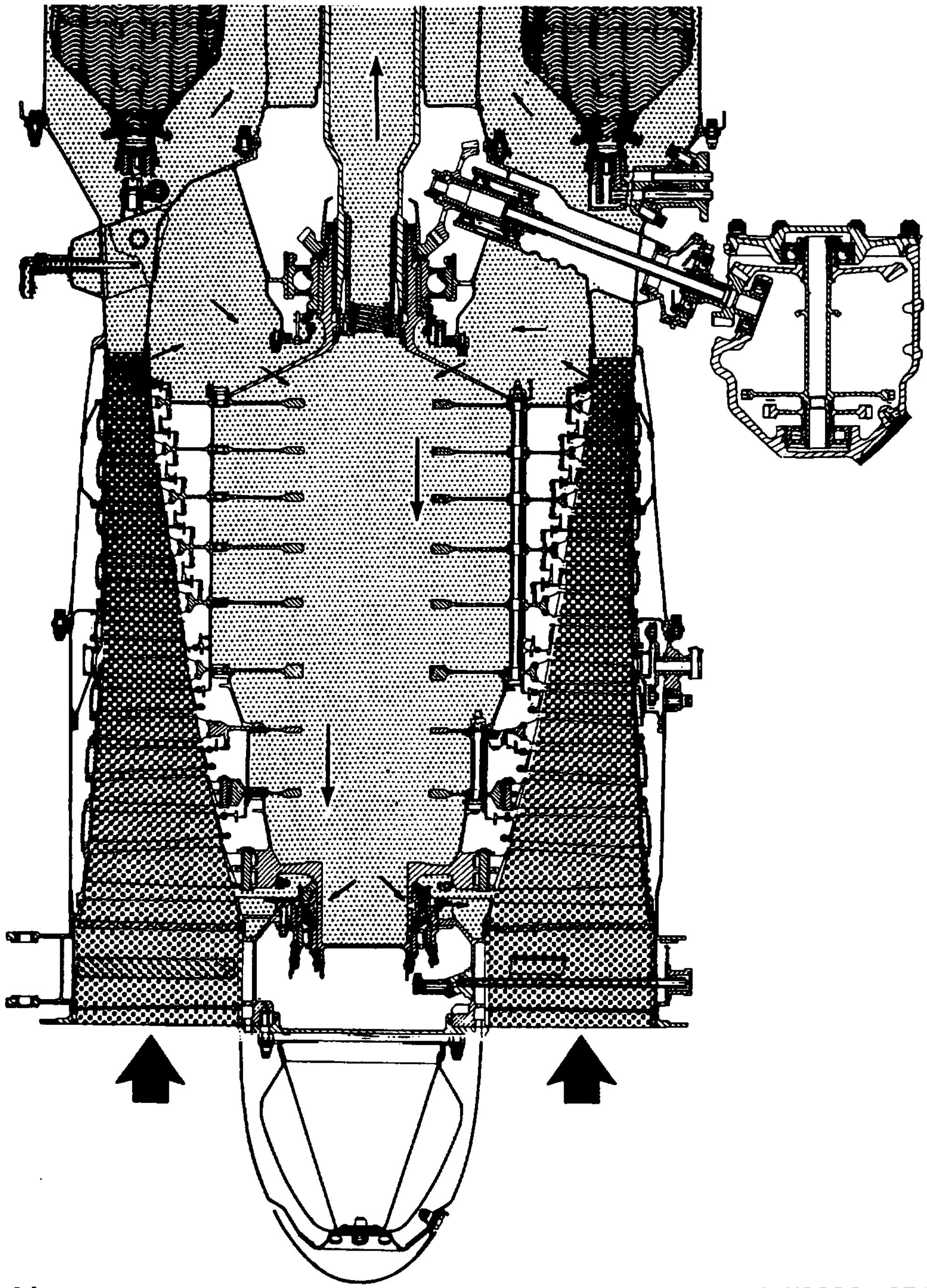
B. Ignition System (Intermittent)

(1) General

(a) The ignition system consists of two identical, four-joule, independent units, one for each igniter plug. The ignition system operates satisfactorily with 14 - 30 volts DC input voltage. The spark rate, which depends on the input voltage, is 1.6 - 3.3 per second. An input filter is incorporated in each unit to eliminate radio interference.

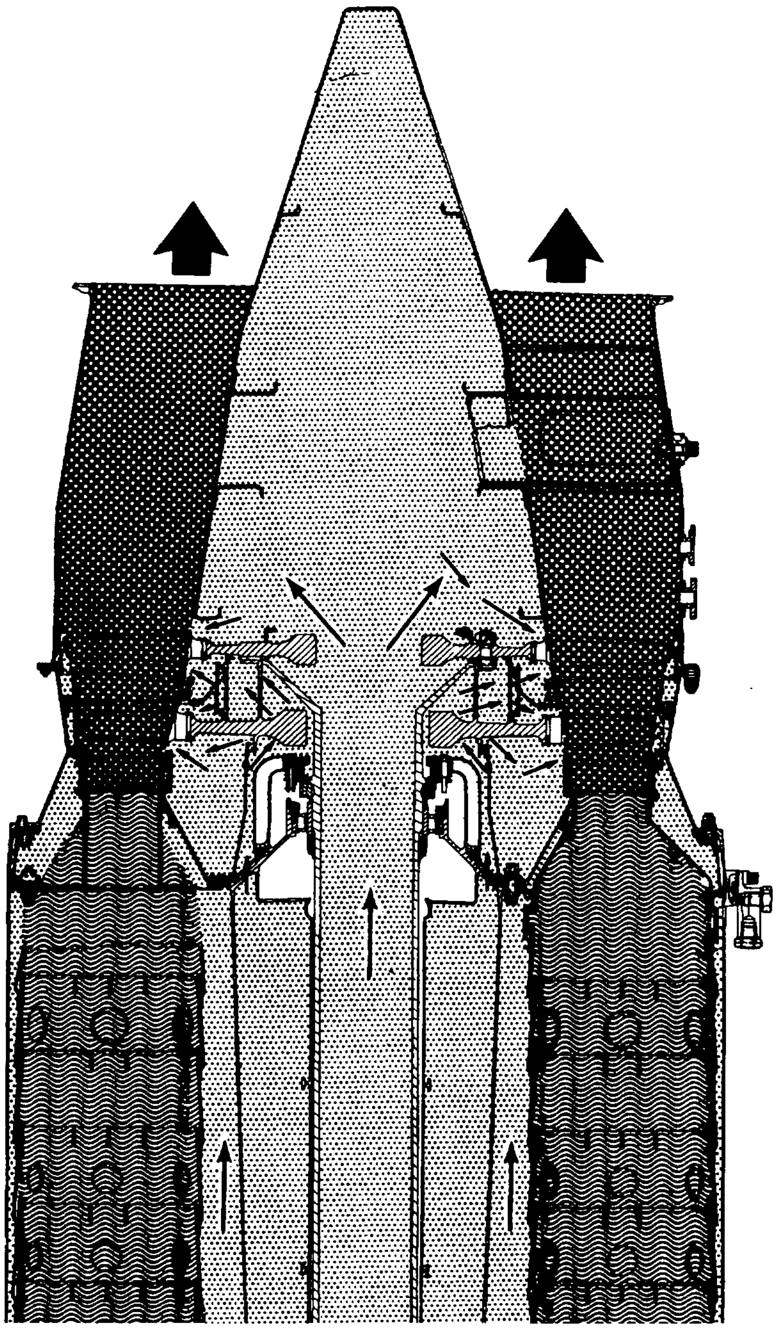
(2) Operation
See Figure 204.

(a) Input voltage supplied to the exciter passes through a radio noise filter to prevent high frequency feedback into the aircraft electrical system. From the filter, the voltage reaches the vibrator and passes through the primary of the stepper transformer, the vibrator driver coil, a pair of contacts (typically closed), and goes to ground. A point capacitor connected across these contacts dampens excessive arcing.



L-H8090 (0307)

Engine Cooling System
Figure 203 (Sheet 1)



L-H8091 (0307)

Engine Cooling System
Figure 203 (Sheet 2)

(b) With the contacts closed, current flows through the primary of the stepper transformer, producing a magnetic field, and flows through the driver coil. The driver coil pulls the contacts open, interrupts the current flow, and causes the magnetic field to collapse. Spring action returns the contacts to a closed position and the cycle continues.

(c) The collapse of the magnetic field in the primary of the stepper transformer induces a high voltage in the secondary of the stepper transformer. This high voltage produces successive pulses flowing into the storage capacitor through the gas charged rectifier tube, which limits the flow to a single direction.

(d) With repeated pulses the capacitor stores a greater and greater charge, at a constantly increasing voltage. When the voltage reaches the predetermined level set for the spark gap in the sealed discharge tube, the gap breaks down, allowing the accumulated energy to flow through the lead to the electrodes of the sparkigniter.

(e) Bleeder resistors help to protect exciter components in the event of unintended operation in open circuit condition. The spark rate will vary, depending on the value of input voltage. At lower values, more time is required to raise the voltage on the storage capacitor to the level necessary to break down the spark gap. However, because the level remains constant (established by the physical properties of the gap) the storage capacitor accumulates a full normal store of energy before discharge.

C. Ignition System (Continuous-Optional)

(1) General

(a) The continuous duty ignition system employs one high tension and intermittent duty exciter and one high tension and continuous duty exciter. Because the system is composed of one intermittent and one continuous exciter, the electrical system must take into account the two different duty cycles.

(b) During startup, the two exciters are operating and the duty cycle, established by intermittent exciter requirements, should be observed. Whenever conditions warrant continuous ignition, only the continuous exciter (which has a removable resonant type vibrator, a removable discharger tube, and a silicon rectifier for longer life) should function.

(2) Operation

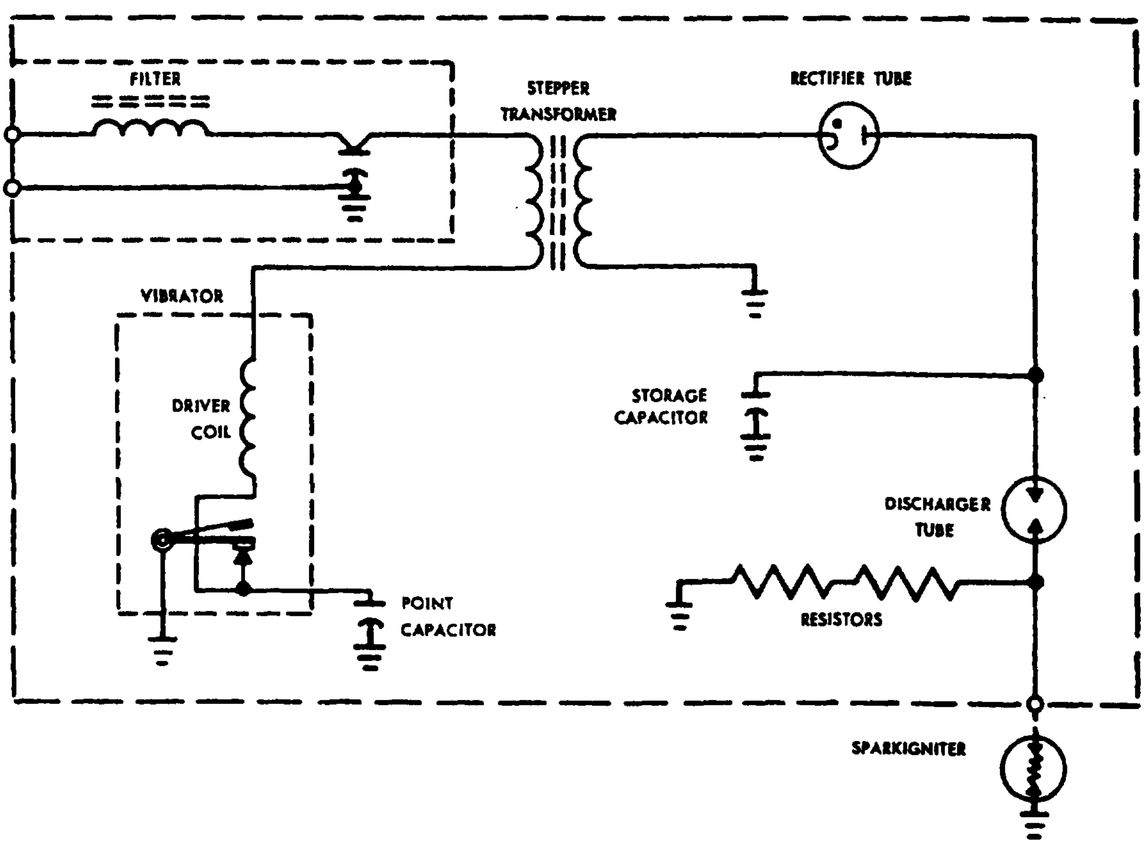
(a) The DC power supply for the high tension exciter input connector routes through a radio noise filter to prevent high frequency feedback to the aircraft power line, which is generated from the primary winding of the transformer and the vibrator.

(b) The input voltage operates the vibrator driver coil and supplies the primary of the stepper transformer. The voltage in the drive coil goes to ground through a set of typically closed contacts. A point capacitor connected across the contacts dampens excessive arcing.

(c) With the contacts closed, the current flows through the primary of the stepper transformer producing a magnetic field. The vibrator driver coil action opens the contacts, the current flow stops, and the magnetic field collapses inducing a high alternating voltage in the secondary of the stepper transformer.

(d) The high alternating voltage in the form of successive pulses flows into the storage capacitors through the rectifier, which limits the flow to a single direction. The storage capacitors absorb a greater and greater charge at a constantly increasing voltage. When the voltage reaches the level calibrated for the sealed discharger tube, the gap breaks down.

(e) A portion of the accumulated charge from the storage capacitors passes through the primary of the trigger transformer and the series trigger capacitor. The surge of current induces a very high voltage in the secondary of the transformer, which ionizes the air gap at the sparkigniter and produces a preliminary or trigger spark.



L-07501 (0000)

Engine Ignition System Schematic
Figure 204

(f) When the air gap is made conductive, the storage capacitor discharges the remainder of the accumulated energy, together with the charge from the trigger capacitor, which results in a very high energy capacitive spark. The bleeder resistor in the trigger circuit serves to dissipate any residual charge on the trigger capacitor between the time of the spark and the start of the next cycle.

(g) In addition, a resistor is connected across the discharger tube of the continuous duty exciter in order to bleed off any residual charge from the storage capacitor, minimizing shock hazard when the discharge tube is removed from the exciter.

13. Engine Indicating Systems

A. Turbine Pressure Sensing System

(1) The turbine pressure sensing system consists of four manifold assemblies that are interconnected to form an averaging pressure sensing system. Pressure taps on the manifolds provide airframe connections. Each manifold assembly consists of a pressure probe and tubing.

B. Turbine Temperature Sensing System

(1) The turbine temperature sensing system consists of one dual junction thermocouple cable and three dual junction thermocouples. Two connectors are provided in the thermocouple cable, one for connecting to an averaging indicator and one to individually check the thermocouples.

14. Fuel System

A. Fuel Pump

(1) The engine fuel system uses a single element, centrifugal boost main fuel pump mounted on the component drive gearbox. On the rear of the pump is a mounting pad with a passage for fuel to flow through to the engine fuel control.

(2) Fuel enters the pump centrifugal boost impeller at an aircraft boost pressure of -2.7 to 50 psig. The impeller raises this pressure to approximately 40 psi. On some engines, the fuel leaves the impeller, passes through the filter, and flows to the main pumping element.

(3) The main pumping element increases the fuel pressure to 800 psig before it passes out of the pump to the engine fuel control. The engine returns unneeded fuel to the pump at the main stage inlet area.

B. Fuel De-icing Heater

(1) The fuel de-icing heater and a cockpit controlled electrically operated shut-off valve are attached to the lower right side of the compressor inlet case.

(2) An external tube transfers compressor discharge air from the diffuser case, through the shut-off valve, to the fuel heater. Fuel pump interstage fuel is externally routed to the heater and back to the pump.

(3) When ice in the fuel causes the pressure drop across the fuel pump interstage filter to exceed 7 - 8 psi, a differential switch (on the fuel pump) turns on a warning light as a sign to use the fuel heater. Opening the shut-off valve allows warm compressor discharge air to flow to the heater. The air flows through tubes in the heater core raising the temperature of pump interstage fuel circulating around the core tubes.

C. Fuel Coolant Oil Cooler

(1) The engine lubricating oil supply temperature is controlled by the fuel coolant oil cooler that is attached to the lower left side of the compressor inlet case. The cooler consists of a housing containing a heat exchanger case and a thermostatically compensated pressure valve, which is located in the return oil system between the scavenge pumps and the oil tank.

(2) Oil temperature is reduced by circulating the oil around heat exchanger case tubes where fuel control discharge flow is routed. Return oil pressure and temperature control the opening and closing of the valve. The valve position determines the amount of return oil that circulates through the heat exchanger.

D. Fuel Pressurizing and Dump Valve

(1) Metered fuel flows from the fuel control through the fuel coolant oil cooler, then through a fuel flowmeter to the fuel pressurizing and dump valve. The fuel pressurizing and dump valve housing contains two separate valves, the pressurizing valve and the dump valve.

(2) The pressurizing valve divides the fuel flow between the fuel nozzle orifices (primary and secondary) to ensure proper atomization of fuel discharge into the combustion chambers. The valve remains closed, sending all fuel to the primary nozzle orifices until a predetermined pressure is reached.

(3) As the pressure increases, the valve opens allowing a portion of the fuel to flow to the secondary nozzle orifices. An adjustment is provided to regulate valve operation.

(4) The dump valve provides a means to drain fuel from the fuel manifold at engine shutdown. The valve, which is spring loaded to open, is closed by a fuel signal during engine operation. When the engine is shut down, the valve opens and allows the fuel to drain.

(5) An inlet strainer with a bypass feature to offset strainer clogging, is located in the pressurizing and dump valve. A poppet-type inlet check valve is located downstream from the inlet strainer.

(6) Bolts attach the fuel pressurizing and dump valve to an adapter located on the diffuser case. The fuel pressurizing and dump valve attaching boss has four discharge ports. Two of the ports direct primary fuel flow through ferrules to the primary fuel inlets of the fuel manifold. The other two ports direct secondary fuel flow through ferrules to the secondary fuel inlets of the fuel manifold.

E. Fuel Manifold

(1) The engine fuel manifold is a two section, split-type manifold with concentric primary and secondary fuel tubes. The manifold consists of a primary manifold and a secondary manifold split at the inlet flange and between the number one and the number eight fuel nozzle bosses.

(2) The secondary manifold is located within the primary manifold. Each section of the manifold contains bosses for attaching the fuel nozzles, and contains lugs for
R attaching the manifold to bosses in the diffuser case.

F. Fuel Nozzles

(1) Eight duplex fuel nozzles, one for each combustion chamber, are located around the fuel manifold. Air swirl guides that swirl the air entering the combustion chambers to provide the proper combustion rate also serve as retaining nuts for the fuel nozzles.

(2) Each nozzle has a primary orifice and a secondary orifice. Fuel sprays from the primary orifice during low flow operation and from both orifices at higher flow operation. Fuel strainers in the primary and the secondary passages of each nozzle prevent foreign matter from clogging the orifices.

G. Fuel Control (Holley)

(1) The fuel control is a hydromechanical type. No secondary system exists within the control as an alternate to the primary computing and metering system. All critical factors influencing the metering of fuel flow for efficient engine performance under all variable conditions are sensed and interpreted by the computing section. Signals are sent to the metering section to obtain the correct fuel flow.

(2) The fuel control senses the pressure of air entering the engine (Pt2), the pressure of air in the engine burner section (Pb), and the speed of the engine (N), to regulate and maintain the required output.

(3) When the power lever setting is changed, and while adapting to a new steady-state fuel rate, the fuel control varies the fuel flow between the limiting values established by safe turbine inlet temperatures and the lean mixture combustibility. The control permits the fuel flow to reach these limits during acceleration and deceleration, but does not permit transgression in either direction, in order to prevent excessive turbine inlet temperature at the rich limit and flameout at the lean limit.

(4) The fuel control is divided into two major sections, the computing section and the metering section. The computing section contains the sensing devices, as well as the servo systems actuated by these devices, to move the fuel metering valve axially and rotationally. Consequently, the correct metering port area for any combination of conditions can be obtained in order to control the required rate of fuel flow.

(5) The basic function of the metering section is to meter fuel through variable ports in the hydraulically operated fuel metering valve. Another function returns excess fuel to the interstage of the fuel pump.

(6) The fuel metering valve meters fuel to the engine through rectangular ports in the fuel valve sleeve. The pressure drop through the ports is maintained constant by means of a bypass valve. This valve returns all fuel flow, in excess of engine requirements, through the high return system to the interstage pressure of the fuel pump. Because the pressure drop across the valve can be kept constant, fuel flow can be varied proportionately by increasing or decreasing the rectangular port area of the fuel metering valve.

(7) The total flow area of the metering ports is determined by the computing section. The computing section establishes the various hydraulic pressures used to position the fuel metering valve for the correct amount of fuel to the engine combustion chambers at all times.

(8) The input signals to the computing section include: burner pressure (Pb), compressor inlet air pressure (Pt2), engine speed (N), and control power lever angle (PLA). Fuel is metered to the engine to maintain the desired engine speed, and acceleration and deceleration (minimum ratio), for any combination of varying signals.

(9) The axial position of the fuel metering valve is determined by changes in engine speed and power lever angle. The rotational position of the fuel metering valve is determined by changes in burner pressure (Pb). Therefore, the fuel metering valve moves both axially and rotationally to establish the metering orifice required for different conditions of engine operation.

H. Fuel Control Fuel System

(1) General

(a) Four systems in the fuel control unit position the fuel metering valve by means of hydraulic pressures to meter the correct fuel requirements for different engine operating conditions. The four systems include: governing, acceleration, deceleration or minimum flow, and shutoff.

(2) Governing System

(a) The governing system uses control power lever angle (PLA), compressor inlet air pressure (Pt2), burner pressure (Pb), and engine speed (N) to regulate the metering of fuel to maintain engine steady-state operation.

(b) The governor cam is positioned rotationally by power lever angle (PLA) and axially by compressor inlet air pressure (Pt2). The governor cam lever (working with the governor servo and the governor set lever) establishes a spring load on the governor piston in opposition to the speed sense piston signal.

(c) The centrifugal force speed sense piston (driven by engine speed) supplies a hydraulic signal that positions the governor piston. The governor piston works with the acceleration lever assembly and the fuel servo valve to move the fuel metering valve axially, keeping it between the limits established by the acceleration cam and the minimum ratio stop.

(3) Acceleration System

(a) The acceleration system controls the metered fuel flow rate during engine acceleration. Acceleration fuel flow is a function of burner pressure (Pb), engine speed (N), and compressor inlet air pressure (Pt2). As the power lever is advanced for acceleration, the governor cam is repositioned rotationally, which in turn repositions the governor servo.

(b) The changed governor servo position moves the governor set lever to increase the spring force on the governor piston. At this time, the acceleration lever spring moves the acceleration lever assembly to make contact with the acceleration cam, which limits travel of the fuel servo valve in the increasing fuel flow direction.

(c) The increase in fuel flow through the metering valve causes a change in engine speed (N), which increases the burner pressure (Pb) and moves the (Pb) servo piston. With an increase or decrease in burner pressure (Pb), the fuel metering valve is rotated accordingly, by means of the Yankee screw driver principle.

(d) As the engine accelerates to the newly selected speed, increased centrifugal speed sense piston differential force causes the acceleration cam to rotate by the action of the speed loop piston. The force increases the governor spring force via the governor piston, which causes the acceleration lever assembly to move off the acceleration cam, and reduces the port area of the fuel metering valve until the correct steady-state fuel flow is established.

(e) Axial positioning of the acceleration cam is accomplished when the acceleration and governor cam lever reposition via the operation of the dual bellows system. With a change in compressor inlet air pressure (Pt2), the sensing bellows, opposed by the evacuated reference bellows, translates a force to the servo lever.

(f) Movement of the servo lever repositions the servo and results in a change in pressure differential across the servo piston. This change in pressure differential moves the servo piston and repositions the governor cam axially. As the governor cam is repositioned the acceleration cam also is repositioned, due to the acceleration and governor cam lever.

(4) Minimum Flow System

(a) The minimum ratio system, which is part of the minimum flow system, limits the axial closing of the fuel metering valve, thereby scheduling constant minimum ratio (fuel flow per unit of burner pressure) fuel flow. An adjustable minimum flow ratio stop limits axial travel of the fuel metering valve in the closing direction.

(b) The ratio of deceleration of minimum fuel flow to burner pressure (Pb) is maintained constant down to a burner pressure value of 29 psia. As the fuel flow reduces, due to the new position assumed by the fuel servo valve that is determined by the minimum ratio stop, burner pressure (Pb) drops as a result of reduced speed, causing the servo piston to rotate the fuel metering valve in accordance with changes in burner pressure (Pb).

(c) Incorporated within the control is a fixed minimum fuel flow system that maintains an absolute minimum fuel flow level at a predetermined constant fuel flow. As the minimum fuel flow rate is approached, the minimum flow check valve is seated by spring force, and the pressure drop becomes a function of fuel flow through the orifice in the minimum flow check valve.

(d) The pressure differential across the minimum fuel flow diaphragm and piston decreases, and spring force causes the minimum fuel flow make-up valve to open, allowing control inlet fuel pressure (F1) to move through the orifice in the minimum flow check valve, while maintaining the absolute fuel flow level at a predetermined constant fuel flow.

(5) Shutoff System

(a) To shut down the engine, a two-position fuel shutoff valve is incorporated in the fuel control. When the power lever is closed to shut down the engine, a cam moves the recirculation valve to the open position, permitting metered fuel to return to the interstage of the two-stage fuel pump through the return fuel passage. The metered fuel pressure drops and allows the throttling shutoff valve springs to move the throttling valve (shutoff valve) against its seat below six degrees power lever shaft rotation.

(6) Operation

(a) Engine main pump fuel pressure (F1) is supplied to the control, and a quantity of this fuel is filtered through a servo fuel filter to provide fuel pressure for the computing section. In the event this filter becomes contaminated, a ball check valve bypasses unfiltered fuel to the computing section when the pressure differential exceeds design specifications.

(b) As fuel enters the control, the bypass valve maintains a constant pressure differential between primary fuel pressure (F1) and metered fuel pressure (Tv), by bypassing excess fuel to the interstage of the two-stage fuel pump.

(c) Because this pressure differential has been established as constant, fuel flow is a function of the fuel metering valve port area. The fuel metering valve is designed to open or close rotationally with changes in burner pressure (Pb); to open or close axially with changes in speed (N) and compressor inlet air pressure (Pt2) on acceleration; and to open and close axially with power lever angle (PLA), speed (N) and compressor inlet air pressure (Pt2) on governing.

I. Fuel Control For JT12A Engine (Hamilton JFC46-3, -4, -8, and -10)

(1) The fuel control is a hydromechanical type. Fuel is metered and varies according to a predetermined flow schedule, which is a function of the power lever position, compressor discharge pressure, compressor inlet pressure, and engine rpm.

(2) The fuel control consists of the following major components:

(a) Fuel filter

(b) Filter bypass valves

(c) Pressure regulating valve and sensor

(d) Pressure regulating valve relief valve

(e) Minimum pressure and shut-off valve

(f) Windmill bypass and shut-off valve

(g) Throttle valve

(h) Compressor discharge pressure sensor

(i) Compressor inlet pressure sensor

(j) Speed sensing governor

(k) Compressor bleed actuator and override valve

(l) Linkage housing

(m) Hydraulic housing

(n) Mounting base.

In addition, the necessary linkage is included that is used to transpose the various parameters into one integrated signal that will result in the proper fuel flow.

(3) The fuel control is designed to schedule the fuel flow needed by the engine to deliver the intended amount of thrust that is dictated by the power lever position and the particular operating conditions of the engine. The fuel control accurately governs the engine steady-state selected speed, acceleration, and deceleration. The speed governing system is the proportional or droop type.

J. Fuel Control Fuel System

(1) General

(a) The fuel control consists of a metering and computing system. The metering system selects the rate of fuel flow to supply to the engine burners according to the amount of thrust demanded by the pilot. However, the rate is subject to engine operating limitations as scheduled by the computing system, which is a result of monitoring various engine operational parameters.

(b) The computing system senses and combines the various parameters to control the output of the metering section of the fuel control during all stages of engine operation.

(2) Metering System

(a) The engine-driven fuel pump supplies the high pressure fuel to the control inlet. First the fuel encounters the fine servo supply filter that protects the computing system against solid contaminants. Next the fuel encounters the coarse filter that protects the metering section against large particles of fuel contaminants.

(b) In the event these screens become clogged to the extent that the pressure drop across them could exceed approximately 20 psi, ball valves open as a protective measure to allow the fuel to bypass. An annular trap prevents the dumping of the clogging contaminant into the control when fuel bypasses the filter screens.

(c) The fuel then flows through the metering, or throttle valve, where a constant pressure differential is maintained by the pressure regulating valve. The throttle valve is a window type valve and is positioned by a half-area servo. Because of the constant pressure drop maintained across the throttle valve the fuel flow is proportional to the position of the piston.

(d) The fuel flow rate for the full travel of the throttle valve is externally adjustable by rotating the outer, or fixed, sleeve relative to the piston. A fail-safe feature is provided in the event of a failure in the increase flow direction. As the throttle valve is translated beyond the maximum opening, fuel flow will decrease until the valve reaches an externally adjustable stop, which is preset for a specific value of fuel flow. An adjustable stop also is provided to limit the motion of the piston in the decrease fuel flow direction to permit selection of the proper minimum fuel flow.

(e) The pressure drop across the throttle valve is maintained nominally at 40 psi by the bypass type pressure regulating valve system. All high pressure fuel in excess of the amount required to maintain the pressure differential is bypassed to pump interstage. The pressure regulating valve system consisting of a sensor and a pressure regulating valve is servo controlled.

(f) The servo senses the pressure differential across the throttle valve. Any deviation from the preset value of this pressure differential will displace the rotating pilot valve from its hydraulic null position and cause motion of the pressure regulating valve. A relief valve is placed between the spring side of the pressure regulating valve and the metered fuel flow line for protection, in the event the sensor sticks in the down position causing high pressure to port to the spring side of the pressure regulating valve.

(g) When the pressure drop across the relief valve exceeds approximately 14 to 22 psi, the valve will open to allow the high pressure to bleed off, permitting the pressure regulating valve to bypass excess flow. Variations in fuel temperature are compensated for by the action of a bimetallic disk working on the spring in the sensor.

(h) Fuel leaving the throttle valve passes through the minimum pressure and shut-off valve on its way to the engine. This valve is essentially a plunger type valve, spring loaded to the closed position, and designed to shut off the flow of metered fuel to the engine when the pilot moves the power lever to the OFF position.

(i) When the power lever is moved to the ON position, the high pressure on the spring side of the valve is replaced by pump interstage pressure. When metered fuel pressure has increased sufficiently to overcome the spring and low pressure fuel force, the valve opens and fuel flow to the engine is initiated. Subsequently, the valve provides minimum operating pressure within the fuel control to ensure that adequate pressure is always available for servo operation during low flow conditions.

(j) In addition to supplying the high pressure signal for the shut-off function, the windmill bypass and shut-off valve also provides a windmill bypass feature.

K. Computing System

(1) The computing system positions the throttle valve to control fuel flow during steady-state operation, acceleration, and deceleration, by using the ratio of metered fuel flow to engine compressor discharge pressure (Wf/P3) as a control parameter. The positioning is determined by using a calculating system that multiplies the Wf/P3 signal for acceleration, deceleration, or steady-state speed control, by a signal proportional to compressor discharge pressure.

(2) The compressor discharge pressure sensor assembly consists of a pair of matched bellows, the evacuated and the motor bellows, and a sensor lever.

(3) Deceleration control is provided by the constant radius portion of the droop cam and by adjusting the roller positioning linkage to limit the travel of the rollers toward decreasing fuel flow. Effecting a minimum Wf/P3 ratio stop provides a linear relationship between fuel flow and compressor discharge pressure that results in blow-out free deceleration.

(4) Acceleration control is provided by adjusting the roller positioning linkage to effect a maximum Wf/P3 ratio stop for a particular value of speed and compressor inlet pressure. The maximum Wf/P3 ratio value at the stop is controlled by a three-dimensional cam that is translated by a signal proportional to engine speed, and rotated by a signal proportional to compressor inlet pressure.

(5) The three-dimensional cam is contoured to define a schedule of Wf/P3 versus compressor inlet pressure, which is used as a limiting value for each speed throughout the acceleration transient. This combination will permit engine accelerations within the overtemperature and surge limits of the engine. When the acceleration limiting lever is operating to control the maximum value of the Wf/P3 ratio, it overrides the speed setting linkage.

(6) The speed sensing governor consists of a rotating pilot valve, the flyweights, and the flyweight head.

(7) The compressor inlet pressure servo consists of an evacuated bellows, a rotating pilot valve, and a servo piston. The compressor inlet pressure servo resets the speed to maintain constant turbine inlet temperature in order to provide the maximum amount of thrust without exceeding the temperature limits of the engine.

(8) Engine speed control is achieved by comparing the actual speed, indicated by the position of the speed servo, to the specified speed value required for the power, which is selected by the pilot via a power lever positioned speed set cam. The power lever actuates the speed set cam to select a governor droop line. The position of this droop line is biased by compressor inlet pressure. The deviation of specified speed from actual speed (speed error) causes the speed servo movement.

(9) This speed servo movement is transmitted through a lever to reposition the droop cam. The rollers in the multiplication system move into position, by the action of the droop cam, to become a function of the speed error. Consequently, repositioning the rollers provides the required steady-state Wf/P3 ratio setting.

(10) A compressor bleed actuator system provides for bleeding off excess air action in order to prevent compressor surge during acceleration and deceleration.

L. Bleed Valve Actuator

(1) General

(a) The bleed valve actuator is incorporated to control the position of the engine compressor bleed valve. At a predetermined speed, the three dimensional acceleration cam sends a signal through the bleed valve cam lever to reposition the bleed valve actuator servo. Filtered fuel pressure (F2) is ported through the bleed valve actuator servo to operate a piston, which controls the opening and the closing of the engine compressor bleed valve.

R M. Fuel Control For JFC56-2 (JFTD12A), JFC56-4 (JFTD12-4A), and
R JFC56-6 (JFTD12A-5A) (Free Turbine Engines)

(1) The fuel control is a hydromechanical control designed to meter fuel to the JFTD12A engine. The control has a fuel metering system and a computing system. The metering system selects the rate of fuel flow supplied to the engine according to the amount of power requested. However, it is subject to engine operating limitations scheduled by the computing system, as a result of monitoring various operating parameters. The computing system allows the maximum engine performance available without exceeding engine operating limits.

(2) Metering System

(a) After entering the fuel control, the fuel flow passes through the fine servo supply filter. This filter is a 40 micron screen of the wash-through type that is self-cleaning, because the fuel velocity through the axis of the cylindrical screen is significantly greater than the flow through the mesh that supplies the servo control valves.

(b) Downstream of this portion of the filter, the fuel proceeds through a fuel flow 100 mesh screen. Ball valves protect both screens and allow the flow to bypass the screens when they are clogged to the extent that a pressure drop across them could exceed 15 psi. An annular trap prevents dumping the clogging contaminants into the control when they bypass the fuel flow screen.

(c) Fuel from the filter goes to the metering, or throttle valve. This valve is a window type that is positioned by a half area servo. Piston position is controlled by a rotating pilot valve displaced from its hydraulic null (steady-state) position by compressor discharge pressure, engine speed, rotor load, power lever, or any combination of these parameters. These actuating signals work in conjunction with each other to produce a net torque on the multiplying lever.

(d) A balancing torque is created by a spring load varied with throttle valve position. As long as the resultant torque is zero, the throttle valve maintains a constant position. Any change in signal torque displaces the pilot valve, and causes motion of the throttle valve until the unbalanced signal torque is equalized by the new valve position and the corresponding spring force.

(e) Fuel from the throttle valve passes through the minimum pressure and shutoff valve on its way to the engine. The valve is referenced to pump interstage pressure and a spring force to ensure that control inlet pressure is a minimum of 120 psi above interstage pressure for positive servo actuation during starting and high altitude conditions.

(f) This referencing also ensures that the control discharge pressure is 80 psi minimum above interstage pressure when the gas generator power lever is in operating position. When actuated for the shutoff function, control inlet pressure is directed to the spring side of the valve where it closes the valve and allows the spring to keep it in the shutoff position. The valve has an O-seal on the seat to ensure drop tight closing.

(g) To ensure a predictable flow, the pressure drop across the throttle valve is maintained nominally at 40 psi by a bypass type regulating valve and sensor. The flow forces acting on the regulating valve are compensated for by utilizing the impulse bucket principle to improve the accuracy of the basic valve. Improving the accuracy minimizes the work required of the pressure regulating valve sensor and increases the accuracy of pressure regulation.

(h) The lower end of the pressure regulating valve is subjected to servo pressure; the upper end is balanced by modulated pressure, nominally 30 psi less than throttle valve supply, and a spring force equivalent to 30 psi. The purpose of plumbing the valve in this manner is to limit the authority of the pressure regulating valve sensor. In the event of a failure in the direction of low control discharge pressure, the control will meter at the 30 psi level and prevent bypassing the total flow back to the pump inlet.

(i) Variations in fuel temperature are compensated for by the action of bimetallic disk working on the 40 psi (nominal) equivalent reference spring in the pressure regulating valve sensor. The pressure regulating valve is capable of bypassing 8500 pounds per hour flow with a pressure drop across the bypass ports below 100 psi. This low pressure drop prevents the pump from operating against an excessively high head, or from causing large increases in fuel temperature if the pressure drop is needed for cooling purposes.

(j) The windmill bypass and shutoff control valve is plumbed into the line leading to the spring side of the pressure regulating valve. The gas generator power lever moving to the shutoff position, or the free turbine overspeed raising beyond a specified maximum value, displaces this control valve to the left, which changes the pressure on the spring side of the regulating valve to pump interstage pressure.

(k) When this happens, the regulating valve acts as a 30 psi relief valve with ample capacity to handle the full windmilling fuel flow. Because of the reduced pressure upstream of the throttle valve, a port located in this line downstream of the filter provides the automatic fuel manifold dump valves with a pressure signal 30 psi above interstage pressure, replacing the high pressure signal supplied during normal operation.

(l) With the windmill bypass and shutoff valve pilot valve in shutoff position, the control inlet pressure is directed to the spring side of the shutoff valve. This action closes the valve and allows the spring to keep it in the shutoff position. The control valve is dimensioned to sequence the shutoff, and the dump valve signal functions with the gas generator power lever in the zero degrees to ten degrees range of operation.

(3) Computing System (Gas Generator Speed Control)

(a) To set the maximum available engine power with this control, the gas generator power lever actuates the speed set cam to select a gas generator governor droop line. The position of this governor droop line is biased by rotor blade pitch. In the event of a free turbine governor failure, the bias prevents the gas generator from causing rotor overspeed before a pitch correction can be made. Resetting the gas generator droop line limits the amount of power the gas generator can deliver to the free turbine to correct for the apparent underspeed.

(b) Actual gas generator speed is represented in the control by the position of a double acting piston, which is also a three dimensional cam. A flyweight governor driven by the gas generator controls the motion of this piston by displacing a rotating pilot valve from steady-state position. A proportional feedback system provides a unique piston position for every speed. A second three dimensional cam, located on the gas generator power lever, rotates to provide a "required" speed input and translates to reposition the gas generator droop line with pitch.

(c) The interrelated action of these controlling parameters positions the rollers in the multiplying system as a function of speed by rotating the droop cam. Controlling the minimum Wf/P3 ratio for lean blowout protection is provided by a constant radius portion of this cam that limits the travel of the rollers toward decreasing fuel flow.

(4) Free Turbine Speed Control

(a) The free turbine power lever actuates a speed setting cam to select a free turbine governor droop line. The position of this droop line is biased by a rotor pitch signal supplied by an external control shaft. The free turbine flyweight speed governor is mounted on the control and it positions a piston in the control to provide a position signal representing actual free turbine speed. The free turbine speed signal is transmitted to the control via a flexible cable.

(5) Free Turbine Overspeed Cutoff

(a) The control provides a means of automatically shutting off all fuel flow to the engine if the free turbine speed exceeds a specified maximum value. In the event of this overspeed, the piston indicating free turbine speed actuates a tripping lever to move the windmill bypass and shutoff control valve to the shut-off position. To prevent premature restarts, the tripping lever becomes locked in position and can only be released by moving the gas generator power lever to the shutoff position, which releases the locking latch and resets the overspeed mechanism.

(6) Acceleration Limiting Control

(a) The acceleration of the engine is controlled by a three dimensional cam containing a Wf/P3 function. The Wf/P3 value multiplied in the linkage by compressor discharge pressure produces a resulting value of fuel flow. When the acceleration cam is operating to control the maximum value of Wf/P3, it overrides the speed setting linkage.

(b) The acceleration limiting cam has a provision to protect against a broken gas generator speed sensing driveshaft. In the event of such a failure, the speed servo (3-D cam) bottoms in its bore in the low speed direction, while the push rod on the speed servo bottoms on an adjustable stop set near the zero speed position to eliminate feedback to the governor pilot valve. The three dimensional cam places the limiting linkage at a Wf/P3 ratio corresponding to the value selected for this failure condition.

(7) Compressor Discharge Pressure Sensing

(a) The compressor discharge pressure sensor assembly consists of a pair of matched bellows, the evacuated and motor bellows, and a sensor lever. The motor bellows is externally exposed to compressor discharge pressure, and the resultant force caused by P3 pressure on the bellows is opposed by an evacuated bellows of equal size. The net force, which is proportional to absolute compressor discharge pressure, is transmitted through the sensor lever to a set of rollers with a position proportional to the required Wf/P3.

(b) These rollers ride between the sensor lever and a multiplying lever. A force proportional to compressor discharge pressure is transmitted through the rollers to the multiplying lever. Any change in the roller position or the compressor discharge pressure signal results in an unbalanced torque, which will displace the rotating pilot valve from its hydraulic null position and reposition the throttle valve. The movement of the throttle valve extends or relaxes a spring that returns the multiplying lever to its equilibrium position when the throttle valve reaches the required position.

(c) Both the motor and the evacuated bellows are located in a chamber vented to ambient pressure so that, in the event of an evacuated bellows failure, the fuel flow error is only the difference between the flow required for the absolute pressure reading and the flow required for a gage pressure reading. In the event of a motor bellows failure, the compressor discharge pressure is sensed on the external surfaces of the evacuated bellows and the system continues to function. The vent line to the bellows chamber contains an orifice that allows compressor discharge pressure sensing should a gross motor bellows failure occur.

(8) Compressor Bleed Control

(a) The compressor bleed control uses a control valve and a power piston to provide mechanical output motion to operate the compressor bleed strap as a function of actual corrected speed. With the use of a modulated bleed signal, the control valve is actuated by a linkage from the three dimensional cam that is translated by the gas generator speed piston. Feedback from the output repositions the control valve at null, allowing the bleed strap position to be set as a function of N1 speed.

(9) Collective Pitch Lever

(a) The collective pitch control shaft repositions the free turbine speed setting linkage, and translates the three dimensional speed setting cam in the gas generator speed linkage. This function changes the position of the multiplying rollers and resets both governor droop lines due to changes in rotor blade pitch.

(10) Speed Governor (Free Turbine Engine)

(b) The speed governor mounted on the free turbine case transmits a free turbine speed signal through external tubes to the fuel control.

N. Fuel Pressurizing and Dump Valve

(1) Metered fuel flows from the fuel control, through the fuel coolant oil cooler and a flowmeter, and on to the fuel pressurizing and dump valve. The fuel pressurizing and dump valve contains two valves, the pressurizing valve and the dump valve.

(2) The pressurizing valve divides the fuel flow between the primary and secondary fuel manifolds, and between the primary and secondary fuel nozzle orifices, to ensure proper atomization of fuel discharge into the combustion chambers. The valve remains closed and sends all flow to the primary orifices of the nozzles until a predetermined pressure is reached. When this pressure is reached, the valve opens to allow a portion of the fuel to flow to the secondary orifices of the nozzles. An adjustment is provided to regulate valve operation.

(3) The dump valve provides a means to drain fuel from the fuel manifold at engine shutdown. This valve, which is spring loaded to open, is closed by a fuel pressure signal during engine operation. When the engine is shut down, the valve opens and allows fuel to drain.

(4) A fuel strainer with a bypass feature to offset strainer clogging is located in the pressurizing and dump valve inlet. A poppet-type check valve is located downstream of the strainer.

(5) Bolts attach the fuel pressurizing and dump valve to an adapter located on the diffuser case. The valve attaching boss has four discharge ports. Two ports direct flow through ferrules to the manifold primary inlets. The other two ports direct flow through ferrules to the manifold secondary inlets.

O. Engine Controls and Instrumentation

(1) General

(a) In addition to the turbine discharge pressure or engine pressure ratio indicator, the following controls are generally considered necessary for normal engine control and operation. The controls check the mechanical condition of the engine and check or adjust the thrust output of the engine.

(b) These controls and instrumentation may differ in the various installations, but they must be available for some phase of ground operation.

ENGINE GENERAL - DESCRIPTION

1 The Anti-icing Heat Light indicates that the engine air inlet anti-iciing system is in operation.

2 The Anti-icing Heat Switch opens and closes the valve that admits the flow of compressor bleed air to the engine inlet for anti-icing.

3 The Engine Master Switch controls all electrical power to the engine.

4 The Engine Starter Switch actuates the starter mechanism that turns the compressor rotor.

5 The Exhaust Gas Temperature Indicator displays the turbine discharge temperature. The indicator usually indicates the average of several exhaust gas temperature probes; however, individual probe readings may be provided in some installations.

6 The Fuel Boost Pump Switch energizes an external fuel boost pump at startup and during all engine operations.

7 The Fuel Flow Indicator displays fuel flow, in pounds per hour, to the inlet of the engine-driven fuel pump.

8 The Fuel Inlet Pressure Indicator displays fuel boost pump pressure at the inlet of the engine-driven fuel pump.

9 The Fuel System Shutoff Switch opens and closes the emergency shutoff valve, which in turn isolates the engine fuel system from the external fuel supply.

10 The Ignition Switch energizes the ignition system for startup.

11 The Oil-in Temperature Indicator displays the temperature of the engine oil as it enters the oil pressure pump.

12 The Oil Pressure Indicator displays engine oil pressure.

13 The Tachometer indicates engine rpm during startup and monitors engine operation to make certain that the compressor is not overspeeding.

14 The power lever on turbojet engines modulates engine thrust from Idle to Military. The detent provided for Idle represents the lowest permissible level of thrust for engine operation. Fuel to the engine automatically shuts off at throttle positions below Idle.

15 The hydromechanical fuel control incorporates the following three control levers on free turbine engines:

a The Gas Generator Power Limit Lever (N1 Lever) schedules gas generator speed (N1) in the engine, starting the IDLE speed range. It provides topping governor rpm control in the power range and, when moved below the IDLE position, closes the control fuel shutoff valve.

b The Free Turbine Speed Selector Lever (N2 Lever) permits selecting the desired free turbine speed.

c The Pitch (Load Governing) Lever is not a direct engine control, but a helicopter rotor blade pitch control lever with a position fed into the engine as a signal.

P. Engine Mounts (Turbojet Engines)

(1) Front Mount

(a) Two mount fittings provide two-point vertical suspension on the compressor case. The front mount takes only vertical loads.

(2) Main Mount

(a) A main mount is located on each side of the diffuser case. Side, vertical, axial, torque and engine thrust loads are taken at one or the other of these mounts, but not at both. The main mounts are ball and socket type mounts with provisions for thermal expansion.

(3) Rear Mount (Alternate)

(a) Single-point vertical suspension is provided by a mount fitting on the turbine case. This mount, used when the front mount is not used, only takes vertical loads and should allow engine axial movement.

Q. Engine Specifications (Turbojet Engines)

(1) Models........................JT12A-6, JT12A-6A(L)
JT12A-6A(N), JT12A-8(L)
JT12A-8(N)

(2) Type..........................Axial-flow, Gas Turbine

(3) Compressor

(a) Type......................Axial, Single Spool

(b) Stages....................Nine

(c) Direction of Rotation.....Clockwise

(4) Turbine

(a) Type......................Reaction

(b) Stages....................Two

(c) Direction of Rotation.....Clockwise

(5) Combustion Chambers

(a) Type......................Can-Annular, Straight Flow

(b) Number....................Eight

(c) Location..................No. 1 - 8 Clockwise
No. 1 At Top To Right
Of Vertical Centerline

(6) Engine Dimensions (in inches at room temperature) See Figure 205 and Figure 205A.

(a) Length - Largest axial length of engine, including any local axial projections and placement of any moveable or adjustable parts in the position that result in maximum axial length.

78.......................JT12A-6, JT12A-6A(L)
JT12A-8(L)

70 1/2...................JT12A-6A(N), JT12A-8(N)

(b) Diameter - Diameter of largest circle concentric with the engine axis, including local radial projections around the full circumference of the engine.

22.......................JT12A-6, JT12A-6A(L)
JT12A-8(L), JT12A-6A(N)
JT12A-8(N)

(7) Fuel System

(a) Specification.............PWA-522

(8) Lubrication System

(a) Specification.............PWA-521B Type II
Lubricating Oil

(9) Equipment

(a) Fuel pump

(b) Fuel control

(c) Ignition system

(d) Air inlet

(e) Anti-icing system

(f) Exhaust temperature thermocouples

(g) Pressure probes

(h) Associated plumbing.

(10) Additional Equipment

(a) Oil tank

(b) Fuel-oil cooler

(c) Fuel heater

(d) Flowmeter

(e) Fuel control cross shaft

(f) Nose cone

(g) Associated plumbing.

(11) Engine Dry Weight (including standard equipment)

(h) 448 lbs. (approx.)............JT12A-6, JT12A-6A

(i) 468 lbs. (approx.)............JT12A-8.

R. Engine Specifications (Free Turbine Engine)

(1) Models.........................JFTD12A-4A, JFTD12A-5A

(2) Type...........................Axial-Flow, Gas Turbine

(3) Compressor

(a) Type.....................Axial, Single Spool

(b) Stages...................Nine

(c) Direction of Rotation.....Clockwise

(4) Turbine

(a) Type.....................Reaction

(b) Stages...................Two

(c) Direction of Rotation.....Clockwise

(5) Free Turbine

(a) Type.....................Reaction

(b) Stages...................Two

(c) Direction of Rotation.....Counterclockwise

(6) Combustion Chambers

(a) Type......................Can-Annular, Straight

(b) Number....................Eight

(c) Location..................No. 1 - 8 Clockwise
No. 1 at Top to Right
of Vertical Centerline

(7) Fuel System

(a) Specification.............PWA-522

(8) Lubrication System

(a) Specification.............PWA-521B Type II
Lubricating Oil

(9) Engine Dimensions (inches at room temperature)
See Figure 206.

(a) Length - Largest axial length of engine, including any local axial projections and placement of any movable or adjustable parts in the position that result in maximum axial length.

107........................JFTD12A-4A, JFTD12A-5A

(b) Diameter - diameter of largest circle concentric with engine axis, including local radial projections around the full circumference of the engine.

30..........................JFTD12A-4A, JFTD12A-5A

(10) Equipment

(c) Oil tank

(d) Fuel-oil cooler

(e) Flowmeter

(f) Nose cone

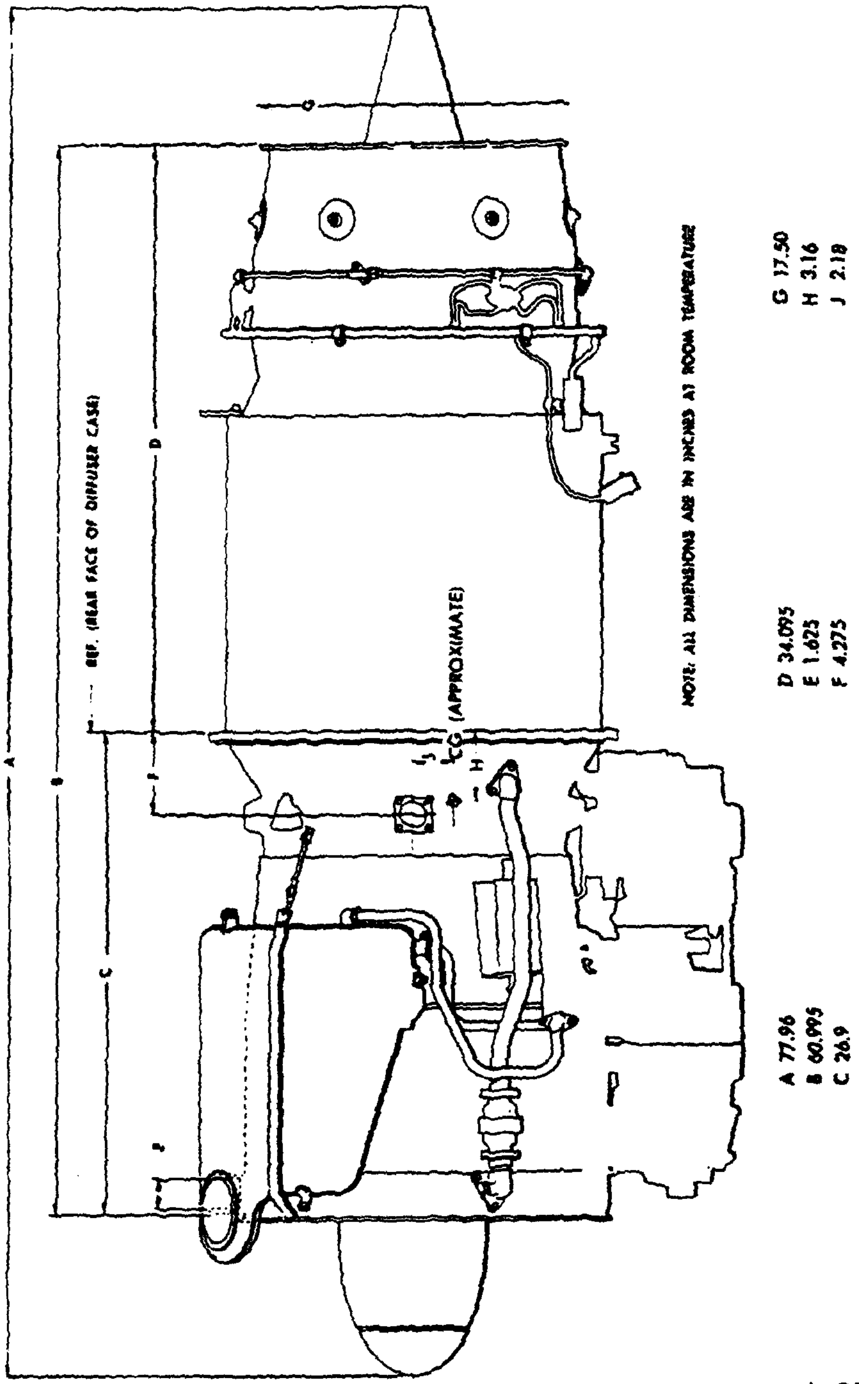
(g) Fuel heater

(h) Associated plumbing.

(11) Engine Dry Weight (including standard equipment)

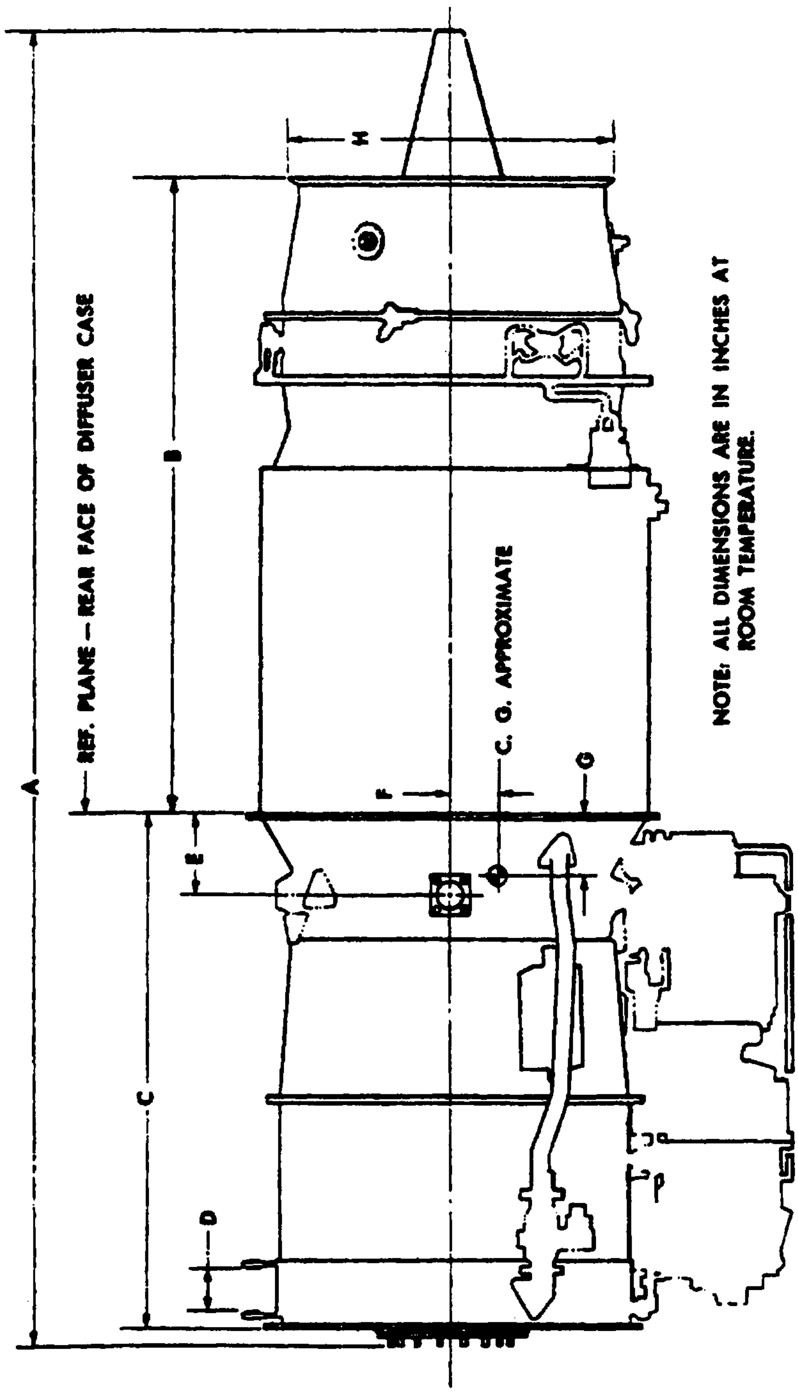
(i) 920 lbs. (approx.).............JFTD12A-4A

(j) 935 lbs. (approx.).............JFTD12A-5A.



L-08717 (00)

Engine Dimensions (JT12A-6,-6A,-8)
(Lockheed)
Figure 205 (Sheet 1)

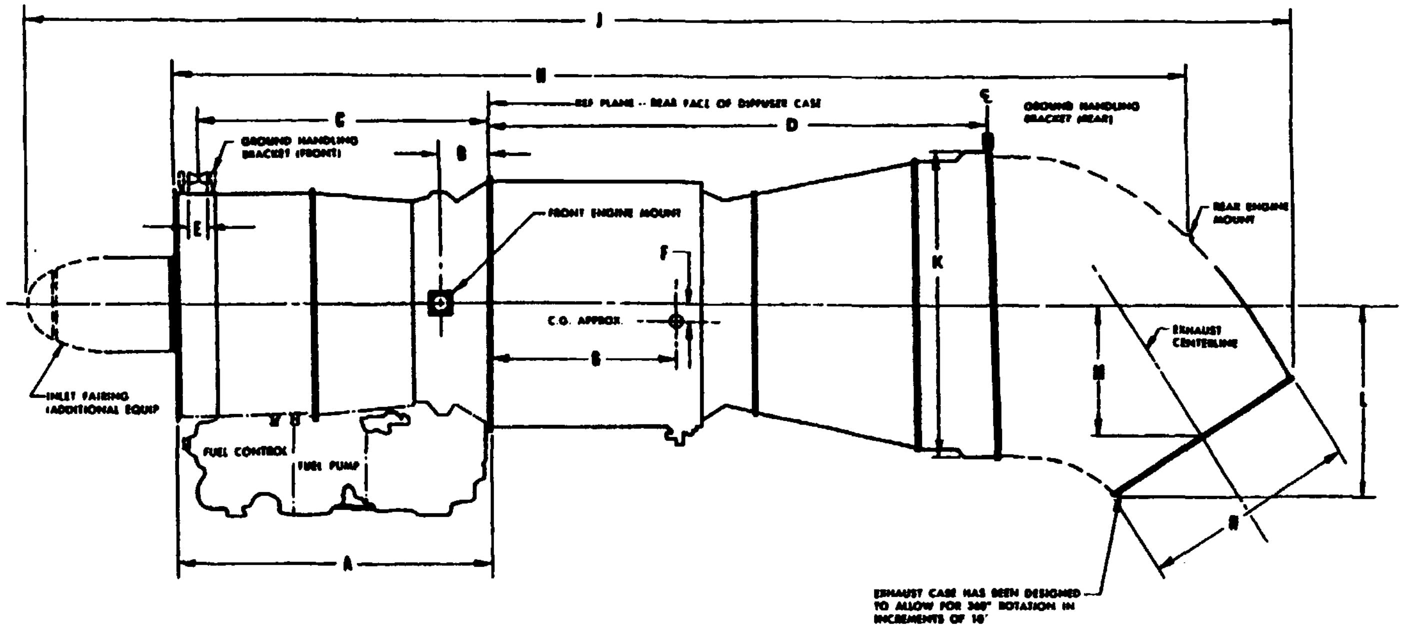


NOTE: ALL DIMENSIONS ARE IN INCHES AT ROOM TEMPERATURE.

SYMBOL	DIMENSION	SYMBOL	DIMENSION
A	70.45	E	4.275
B	34.095	F	2.22
C	27.567	G	3.46
D	1.625	H	17.50

L-08714 (0000)

Engine Dimensions (JT12A-6,-8)
(North American)
Figure 205 (Sheet 2)



SYMBOL	DIMENSION	SYMBOL	DIMENSION	SYMBOL	DIMENSION
A	27.57	F (-4A)	1.34*	J	107.46
B	4.28	F (-5A)	1.31*	K	22.19
C	25.92	G (-4A)	16.31*	L	22.31**
D (-4A)	43.23	G (-5A)	16.07*	M	13.21
D (-5A)	43.57	H	90.00	N	20.96
E	1.62				

*Depends on amount of additional equipment used

**Radial dimension

NOTE

All dimensions are in inches at room temperature.

L-29231 (0000)

Engine Dimensions
(JFTD12 Free Turbine)
Figure 206

ENGINE GENERAL - OVERHAUL TOOLS

1. General

A. The functional and numerical tool lists in this section are indexes of names and PWA numbers of the specific tools recommended to use in the manual procedures. All tool numbers are included in the functional tool group list (Table 301) by Group Name of the engine part, engine assembly, or function with which the tool is identified. The Group Names are in alphabetical order and the tools in the Groups are in alphabetical order. The Groups have hyphenated numbers or alphabetical letters after their number (for example 8A or 11-1), if it was necessary in a previous revision to add a new engine section or function in alphabetical order between new numbers.

B. The tools in this manual are referenced by Group Number. Wherever possible, the tool name referred to in the procedure starts with a capital letter to indicate a PWA tool listed in a table below within its applicable Group (for example, "Lift the assembly with the Sling").

C. A numerical list in Table 302 includes all PWA special tools in numerical order, including their Tool Groups.

D. A list in Table 303 includes Tool Groups for accessories. These Groups have the letter "A" in front of their numbers to indicate that they are different from Groups for the engine.

E. Canceled or superseded tools are eliminated from these lists.

F. Some specific tools are shown in figures at the back of this section as identification and function references.

1. Engine Functional Tool Group List

Tool Group	Tool Name	Tool No.	Fig No.
1.	Accessory Component Drive Gearbox Removal		
	Adapter - Lifting	PWA 13109	307
	Fixture - Storage	PWA 13110	307
	Stand - Storage	PWA 13070	307
1A.	Ball Bearing Contact Angle Measurement		
	Gage - Contact Angle	PWA 13369	

Tool Group List
Table 301

Tool Group	Tool Name	Tool No.	Fig No.
1B.	Bearing (Accessory) Support And Transfer Tubes Air Leak Check (Free Turbine)		
	Cover - No. 4 Bearing Support Front Tube Leak Test	PWA 13509	
	Cover - No. 4 Bearing Support Rear Tube Leak Test	PWA 13510	
	Cap - No. 4 Bearing Breather Pressure And Scavenge Tube Leak Test	PWA 13511	
	Plug - No. 4 Bearing Support Accessory Drive Port Air Leak Test	PWA 13512	
	Regulator - Air Leak Test	PWA 6814	
2.	Bearing (No. 1) Compartment Air Check		
	Adapter - Inlet Case Oil Breather Boss Air Inlet	PWA 13047	
	Cover - Inlet Case Oil Scavenge Boss	PWA 13046	
	Cover - Inlet Case Oil Pressure Boss	PWA 13044	
3.	Bearing (No. 1) Compartment Oil Jet Oil Flow Check		
	Adapter - oil Nozzle Oil Flow	PWA 13042	
4.	Deleted		
5.	Bearing (No. 2) Assembly		
	Drift - Bearing Outer Race	PWA 13075	
	Drift - Bearing Inner Race	PWA 13077	
6.	Bearing (No. 2) Removal		
	Base - Oil Distributing Sleeve	PWA 7368	
	Drift - Outer Race	PWA 13076	
	Drift - Oil Distributing Sleeve	PWA 13083	
	Plate - Oil Distributing Sleeve	PWA 13082	
	Wrench - Outer Race Retaining Nut	PWA 13078	
7.	Bearing (No. 2) Seal Air Check		
	Fixture - Seal Assembly Airflow	PWA 13763	
	Flowmeter - Oil Seal Airflow	PWA 6507	
8.	Bearing (No. 2) And Seal Nozzle Directional Oil Flow Check		
	Adapter - Seal Nozzle Directional Oil Flow	PWA 13315	
	Adapter - Bearing Nozzle Airflow	PWA 13043	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
8A.	Bearing (No. 2) Oil Nozzle		
	Wrench - Oil Nozzle Bolts	PWA 7025-4	
9.	Bearing (No. 3) Inner Race Removal		
	Collar - 1st Stage Disk To Fixture	PWA 13294	
	Fixture - Turbine Assembly Build And Transport	PWA 13295	
	Holder - No. 3 Bearing Inner Race	PWA 13094	
	Puller - No. 3 Bearing Inner Race	PWA 13883	
R	Pump - Hydraulic	PWA 29389	
R		(Replaces PWA 3755)	
	Stand - Turbine Assembly Build And Transport	PWA 13070	307
	Wrench - Inner Race Retaining Nut	PWA 13086	
	Wrench - Inner Race Retaining Nut	PWA 13872	
	Adapter - Inner Race Retaining Nut Wrench	PWA 13873	
	Wrench - Inner Race Retaining Nut (Optional To PWA 13872)	PWA 13919	
	Adapter - Inner Race Retaining Nut Wrench Optional To PWA 13873)	PWA 13920	
10.	Bearing (No. 3) Installation		
	Collar - 1st Stage Disk To Fixture	PWA 13294	
	Drift - Bearing Inner Race	PWA 13088	
	Holder - Bearing Inner Race Torquing	PWA 13094	
	Riveter - Retaining Nut Rivet	PWA 13312	
	Sling - Lifting	PWA 6580	301
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Outer Race Retaining Nut	PWA 13316	
	Wrench - Inner Race Retaining Nut	PWA 13872	
	Adapter - Inner Race Retaining Nut Wrench	PWA 13873	
	Wrench - Inner Race Retaining Nut (Optional To PWA 13872)	PWA 13919	
	Adapter - Inner Race Retaining Nut Wrench (Optional To PWA 13873)	PWA 13920	
11.	Bearing (No. 3) Seal Air Check		
	Fixture - Seal Airflow	PWA 13011	
	Flowmeter - Airflow	PWA 6507	

Tool Group	Tool Name	Tool No.	Fig No.
11-1.	Bearing (No. 4) Compartment Air Check		
	Cover - No. 4 Bearing Scavenge Tube	PWA 13506	
	Cover - No. 4 Bearing Pressure Tube	PWA 13507	
	Cover - No. 4 Bearing Support	PWA 13508	
	Adapter - Free Turbine Bearing Oil And Air Inlet	PWA 13503	
11-2.	Bearing (No. 4) And Seal Nozzle Directional Oil Flow Check		
	Fixture - No. 4 Bearing Nozzle Directional Oil Flow	PWA 13504	
	Adapter - Free Turbine Bearing Nozzle Oil	PWA 13503	
11A.	Bearing (No. 4) Installation		
	Drift - No. 4 Bearing Inner Race, Seal Plate	PWA 13477	
	Holder - No. 4 Bearing Outer Race, Cage, And Balls	PWA 13478	
	Riveter - No. 4 Bearing Outer Race Retaining Nut Rivet	PWA 13476	
	Wrench - Hydraulic	PWA 8050	301
	Wrench - No. 4 Bearing Inner Race Retaining Nut	PWA 13473	
	Wrench - No. 4 Bearing Outer Race Retaining Nut	PWA 13474	
11B.	Bearing (No. 4) Removal		
	Holder - No. 4 Bearing Outer Race, Cage, And Balls	PWA 13478	
	Puller - No. 4 Bearing Inner And Outer Race	PWA 13475	
	Wrench - Hydraulic	PWA 8050	301
	Wrench - No. 4 Bearing Inner Race Retaining Nut	PWA 13473	
	Wrench - No. 4 Bearing Outer Race Retaining Nut	PWA 13474	
11B-1.	Bearing (No. 4) Seal Assembly, Support Assembly and Seal Support Assembly Removal And Disassembly		
	Bracket - Free Turbine Case Lift And Turn	PWA 13766	
	Puller - No. 4 Bearing Inner And Outer Race	PWA 13475	
	Sling - Lift And Turn	PWA 6580	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
11C.	Bearing (No. 5) Installation		
	Drift - No. 5 Bearing Outer Race	PWA 13469	
	Riveter - No. 5 Bearing Outer Race Retaining Nut Rivet	PWA 13476	
	Wrench - Hydraulic	PWA 8050	301
	Wrench - No. 5 Bearing Outer Race Retaining Nut	PWA 13468	
11D.	Bearing (No. 5) Removal		
	Wrench - Hydraulic	PWA 8050	301
	Wrench - No. 5 Bearing Outer Race Retaining Nut	PWA 13468	
11E.	Bearing (No. 4) Sump Removal And Disassembly		
	Holder - Free Turbine Tachometer Drivegear	PWA 13867	
	Wrench - Tachometer Drivegear Retaining Nut	PWA 13471	
12.	Bearing Sections Air Pressure Test		
	Adapter - Free Turbine Bearing Nozzle Oil Inlet	PWA 13503	
	Adapter - No. 1 Bearing Oil Nozzle Airflow	PWA 13016	
	Adapter - No. 2 And No. 3 Bearing Compartment	PWA 13050	
	Adapter - No. 2 And No. 3 Bearing Nozzle Airflow	PWA 13043	
	Cover - Diffuser Case Anti-icing Air Boss	PWA 13134	
	Cover - Inlet Case Anti-icing Air Boss	PWA 13130	
	Cover - Inlet Case Oil Breather Boss	PWA 13129	
	Cover - Inlet Case Sensing Probe Boss	PWA 13131	
	Plate - Engine Build Lift And Turn (Front)	PWA 13061	
	Plug - Diffuser Case Igniter Boss (two required)	PWA 13133	
12A.	Bearing Flushing		
	Fixture - Bearing Cleaning	PWA 10836	
	Holder - Bearing Cleaning	PWA 10838	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
12B.	Bearing Flushness Check		
	Adapter - Bearing Flushness	PWA 13370	
	Gage - Bearing Flushness	PWA 8282	
	Weight - Bearing Flushness	PWA 11108	
12C.	Bearing (Free Turbine Gearbox) Oil Jet Flow Check		
	Fixture - Free Turbine Gearbox Nozzle Oil Flow	PWA 13505	
13.	Bearings (No. 2 And No. 3) Compartment Air Check		
	Adapter - Compartment Air Inlet Compartment	PWA 13050	
	Cover - Diffuser Case Oil Pressure And Scavenge Boss	PWA 13045	
13-1.	Bearings (No. 4 and No. 5) Compartment Air Check (Free Turbine)		
	Cover - No. 4 Bearing Scavenge Tube	PWA 13506	
	Cover - No. 4 Bearing Pressure Tube	PWA 13507	
	Adapter - Free Turbine Bearings Nozzle Oil And Air Inlet	PWA 13503	
13-2.	Bearings (No. 4 and No. 5) And Seals Nozzle Oil Jet Flow Check (Free Turbine)		
	Fixture - Free Turbine Bearing Nozzle Oil Flow	PWA 13502	
	Adapter - Free Turbine Bearing Nozzle Oil Inlet	PWA 13503	
13A.	Bleed Valve Cover Installation		
	Cover - Bleed Valve	PWA 13298	308
14.	Bleed Valve Linkage		
	Compressor - Bleed Valve Linkage Spring	PWA 13274	
	Jig - Bleed Valve Housing And Cover	PWA 13270	
14A.	Boss Welding		
	Fixture - Holding, Exhaust Case Welding	PWA 13758	
15.	Breather Oil Seal Assembly		
	Drift - Seal (Carbon Face)	PWA 13023	303

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
16.	Breather Oil Seal Removal		
	Puller - Breather Oil Seal	PWA 13024	
17.	Combustion chamber Inner Case Oil Tube Replacement		
	Locator - Oil Pressure And Scavenge Tube	PWA 13681	
18.	Combustion Chamber Inner Case Removal		
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Bearing Outer Race Retaining Nut	PWA 13316	
18A.	Combustion Chamber Inner Case Assembly		
	Fixture - Pressure Test	PWA 13682	
	Locator - Oil Pressure And Scavenge Tube	PWA 13681	
18B.	Combustion Chamber Outer Case Nickel-Cadmium Plating		
	Fixture - Plating	PWA 13752	
	Holding Ring - Anode	PWA 12976	
18C.	Combustion Chamber Outlet Duct Guide Assembly Replacement		
	Clamp - Tack Welding	PWA 13850	
	Fixture - Machining	PWA 13847	
	Fixture - Welding	PWA 13849	
19.	Component Drive Bevel Gear Assembly		
	Base - Bevel Gear Bearing (Ball)	PWA 13232	
	Drift - Bevel Gear Bearing (Ball)	PWA 13848	
	Drift - Bevel Gear Bearing (Roller)	PWA 13236	
20.	Component Drive Bevel Gear Assembly		
	Base - Gearshaft	PWA 7368	
	Drift - Gear And Ball Bearing	PWA 13223	
	Drift - Gear And Roller Bearing	PWA 13220	
	Holder - Component Drives Gearshaft	PWA 13226	
	Holder - Component Drives Gearshaft	PWA 13217	
	Plate - Gear And Ball Bearing Support	PWA 13222	
	Plate - Gear And Roller Bearing Support	PWA 13219	
	Puller - Ball Bearing	PWA 13224	
	Wrench - Ball Bearing Retaining Nut	PWA 13227	
	Wrench - Roller Bearing Retaining Nut	PWA 13218	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
21.	Component Drivegear Assembly		
	Drift - Bevel Gear And Bearing	PWA 13229	
	Drift - Fuel Control Gear And Bearing (Roller)	PWA 13221	
	Holder - Gearshaft	PWA 13226	
	Holder - Drivegear	PWA 13217	
	Support - Bearing Nut Rivet	PWA 13225	
	Wrench - Bearing Retaining Nut	PWA 13227	
	Wrench - Bearing Retaining Nut (Used When Key-type Washer Is Incorporated)	PWA 13792	
22.	Component Drives Gearbox Assembly		
	Adapter - Accessory Section Vertical Lifting	PWA 13109	307
23.	Component Drive Gearshaft Gear Disassembly		
	Base - Support	PWA 6660	
	Drift - Component Drive Bevel Gear	PWA 13231	
	Drift - Component Drive Gearshaft And Ball Bearing	PWA 13832	
	Pliers - Snapring Disengagement	PWA 13923	
	Plate - Ball Bearing Inner Race Support	PWA 13230	
	Plate - Roller Bearing inner Race Support	PWA 13234	
	Puller - Roller Bearing Outer Race	PWA 13297	
	Puller - Roller Bearing Outer Race	PWA 13644	
24.	Component Drives Gear Mounting Distance Measurement		
	Gage - Drivegear Mounting Distance	PWA 13550	
25.	Component Drives Gearbox Mounting Lug Bushing Replacement		
	Drift - Mounting Lug	PWA 13329	
	Gage - Bushing	PWA 1805-181	
	Puller - Mounting Lug Bushing	PWA 13138	
26.	Component Drive Main Gearshaft Bearing Rear Liner Replacement		
	Drift - Gearshaft Bearing Rear Liner	PWA 13361	
	Jig - Gearshaft Bearing Rear Liner	PWA 13154	
26A.	Deleted		

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
26B.	Deleted		
27.	Compressor Air Bleed Valve Linkage		
	Adapter - Bleed Valve Torque (Holley)	PWA 13376	
	Adapter - Bleed Valve Torque (Hamilton)	PWA 13551	
	Handle - Bleed Valve Torque Adapter (Hamilton)	PWA 13417	
27A.	Compressor Blades Plating		
	Fixture - Compressor Blades Plating	PWA 12581	
27B.	Compressor Blade Removal		
	Fixture - Compressor Tablock Unbend	PWA 13731	
28.	Compressor Blade Trailing Edge Erosion		
	Measurement Gage - Erosion Limit	PWA 13780	
29.	Compressor Disassembly - Removing Vanes, Disks, And Shrouds		
	Puller - Compressor Rear Hub	PWA 13632	
	Pusher - Compressor Disk (3rd Stage)	PWA 13825	
	Pusher - Compressor Disk (5th And 6th Stages)	PWA 13289	
	Pusher - Compressor disk (Stages 7 Thru 9)	PWA 13290	
	Pusher - Compressor Spacers	PWA 13583	
	Spreader - Compressor Vane And Shroud	PWA 13243	
29-1.	Compressor Disk Spacer Concentricity And Flatness Check (3rd To 4th Stage)		
	Fixture - Compressor Disk Spacer Checking	PWA 13796	
	Pump - Hydraulic	PWA 3755 (Replaced By PWA 29389)	
29-1A.	Compressor Disk Spacer Sleeve Replacement		
	Base - Compressor Spacer	PWA 13908	
	Drift - Compressor Disk Spacer	PWA 13907	
29-1B.	Compressor Disk Spacer Plating (3rd To 4th Stage)		
	Fixture - Plating	PWA 39028	

R
R

	Tool Group	Tool Name	Tool No.	Fig No.
	29-2.	Compressor Rotor Disk Airseal Removal		
		Puller - Compressor Disk Airseal (Stages 3, 5, And 6)	PWA 13870	
R		Puller - Compressor Disk Airseal (Stages 7 and 8)	PWA 13871	
R R		Puller - Compressor Disk Airseal (Stage 9)	PWA 107529	
	29A.	Compressor Rotor Disk Plating And Repair		
		Fixture - 2nd Stage Compressor Disk	PWA 13423	
		Fixture - 3rd Stage Compressor Disk	PWA 13424	
		Fixture - 4th Stage Compressor Disk	PWA 13425	
		Fixture - 5th Stage Compressor Disk (Plating)	PWA 13925	
		Fixture - 5th Stage Compressor Disk (Stripping)	PWA 13426	
		Fixture - 6th Stage Compressor Disk (Plating)	PWA 13926	
		Fixture - 6th Stage Compressor Disk (Stripping)	PWA 13427	
		Fixture - 7th Stage Compressor Disk	PWA 13428	
		Fixture - 8th Stage Compressor Disk (Plating)	PWA 13928	
		Fixture - 8th Stage Compressor Disk (Stripping)	PWA 13429	
		Fixture - 9th Stage compressor Disk (Plating)	PWA 13929	
		Fixture - 9th Stage Compressor Disk (Stripping)	PWA 13430	
		Fixture - Rear Hub	PWA 13704	
	29A-1.	Compressor Vane And Shroud Plating		
		Fixture - 1st Stage Compressor Stator Plating	PWA 13724	
		Fixture - 4th Stage Compressor Stator Plating	PWA 13736	
		Fixture - 5th Stage Compressor Stator Plating	PWA 13737	
		Fixture - 6th Stage Compressor Stator Plating	PWA 13738	
		Fixture - 7th Stage Compressor Stator Plating	PWA 13739	
		Fixture - 8th Stage Compressor Stator Plating	PWA 13740	

Tool Group List
Table 301 (Continued)

ENGINE GENERAL - OVERHAUL TOOLS

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)			
	Fixture - 9th Stage Compressor Stator Plating	PWA 13741	
	Fixture - Stages 7 Thru 9 Stator Airseal Ring Plating	PWA 13742	
	Hanger - Compressor Stator Assembly Plating Fixture	PWA 13735	
	Riveter - 1st Stage Compressor Airseal Ring	PWA 13678	
29B.	Deleted		
30.	Compressor Front Hub And 2nd Stage Disk And Blades Assembly Static Balance		
	Adapter - Disk And Blades Static Balance	PWA 13634	
	Anvil - Forming (1st And 2nd Stages)	PWA 13539	
	Anvil - Pin Supporting (1st Stage)	PWA 13538	
	Anvil - Pin Supporting (1st Stage)	PWA 13541	
	Anvil - Pin Supporting (2nd Stage)	PWA 13542	
	Riveter - Compressor Blades	PWA 13490	
30A.	Compressor Inlet Case Air Pressure Check		
	Adapter - Oil Breather Tube	PWA 13612	
	Adapter - Oil Pressure Tube	PWA 13613	
	Adapter - Oil Scavenge Tube	PWA 13611	
	Plug - Anti-icing Air	PWA 13607	
	Plug - No. 1 Bearing Area	PWA 13605	
	Plug - Oil Pressure Tube	PWA 13610	
	Plug - Pressure Probe Hole	PWA 13606	
31.	Compressor Inlet Case Assembly		
	Drift - Bearing Outer Race	PWA 13265	
	Fixture - Bearing Seal Housing Holding	PWA 13311	
	Guide - Plug And Seal	PWA 13946	
	Pusher - Compressor Front Bearing Housing	PWA 13818	
	Riveter - Inner And Outer Race Retaining Nut Rivet	PWA 13312	
	Riveter - Inner Race Retaining Nut Rivet	PWA 13977	
	Wrench - Outer Race Retaining Nut	PWA 13037	

ENGINE GENERAL - OVERHAUL TOOLS

Tool Group	Tool Name	Tool No.	Fig No.
32.	Compressor Inlet Case Disassembly		
	Fixture - Bearing Seal Housing Holding	PWA 13311	
	Puller - Outer Race And Seal Housing	PWA 13310	
	Wrench - Outer Race Retaining Nut	PWA 13037	
33.	Compressor Inlet Case Installation		
	Blanket - Inlet Case Heating	PWA 13320	
	Fixture - Concentricity Checking	PWA 13300	
	Sling - Compressor Inlet Case	PWA 6580	301
34.	Compressor Inlet Case And No. 1 Bearing Removal		
	Adapter - Rotor And Stator To Jack	PWA 13318	
	Blanket - Inlet Case Heating	PWA 13320	
	Fixture - Rotor And Stator Locating	PWA 13090	
	Puller - Hub Plug	PWA 13974	
	Puller - No. 1 Bearing Inner Race	PWA 13939	
	Remover - Inner Race Retaining Nut Rivet	PWA 13963	
	Wrench - Hydraulic	PWA 8050	301
	Wrench - No. 1 Bearing Inner Race Retaining Nut	PWA 13273	
	Wrench - No. 2 Bearing Oil Scoop	PWA 13113	
	Puller - No. 1 Bearing Seal And Spacers	PWA 13829	
34-1.	Compressor Inlet Case Oil Pressure Tube Replacement		
	Adapter - Bearing Area	PWA 13844	
	Cover - Breather Oil Tube	PWA 13879	
	Cover - Pressure Oil Tube	PWA 13610	
	Cover - Scavenge Oil Tube	PWA 13880	
34A.	Compressor Rotor Airsealing Ring And Vane Stiffening Ring Replacement (2nd And 3rd Stages)		
	Anvil - 2nd And 3rd Stage Compressor Rotor Airsealing Ring	PWA 13667	
	Punch - 2nd And 3rd Stage Compressor Rotor Airsealing Ring	PWA 13668	
	Riveter - 2nd And 3rd Stage Compressor Rotor Airsealing Ring	PWA 9789	
	Riveter - 2nd And 3rd Stage Compressor Vane Stiffening Ring	PWA 13688	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
35.	Compressor Rotor And Stator Assembly Build		
	Adapter And Bearing Assembly	PWA 13628	
	Adapter - Compressor Stator Locating	PWA 13635	
	Adapter - Fixture-To-Stand	PWA 13228	
	Base - Compressor Assembly	PWA 13627	
	Gage - Compressor Rotor Front Tierod Stretch	PWA 13630	
	Gage - Compressor Rotor Rear Tierod Stretch	PWA 13631	
	Heater - Compressor Spacer	PWA 13723	
	Jack - Compressor And Turbine Locating	PWA 13267	
	Pusher - Compressor Disks And Spacers	PWA 13636	
	Spacer - Compressor Rear Balance Bearing	PWA 13548	
	Spacer - Compressor Rotor Rear Tierod Stretch Gage	PWA 13757	
	Stand - Engine Build And Transport	PWA 13060	306
	Support - Compressor Front Tierod Wrenches	PWA 13629	
	Wrench - Compressor Front Tierod Retaining Nut	PWA 13292	
	Wrench - Compressor Rear Bearing Oil Scoop (Nut)	PWA 13113	
	Wrench - Compressor Rear Tierod Retaining Nut	PWA 13162	
36.	Compressor Rotor Front Hub Assembly		
	Bearing - No. 1 Balance	PWA 21350-12	
	Drift - No. 1 Balance Bearing	PWA 13679	
	Fixture - Concentricity Build	PWA 13440	
	Nut - No. 1 Balance Bearing Retaining	PWA 13918	
	Sling - Compressor Lift and Turn	PWA 6580	301
	Wrench - Bearing Retaining Nut	PWA 13171	
37.	Compressor Rotor Concentricity And Squareness Check		
	Fixture - Concentricity Check	PWA 6320	
	Fixture - Concentricity Check	PWA 13300	
	Housing - No. 1 And No. 2 Balance Bearing	PWA 8170-28	
	Sling - Lifting	PWA 6580	301
	Puller - Compressor Rear Hub	PWA 13632	

Tool Group	Tool Name	Tool No.	Fig No.
38.	Compressor Rotor Dynamic Balance Check		
	Base - Bearing Seal Support	PWA 6660	
	Drift - Oil Distributing Sleeve	PWA 13083	
	Drift - Bearing Inner Race	PWA 13052	
	Fixture - Concentricity Check	PWA 13300	
	Guide - Hub Plug And Seal	PWA 13946	
	Plate - Compressor Oil Distributing Sleeve	PWA 13082	
	Puller - Compressor Front Bearing	PWA 13365	
	Puller - Compressor Rear Bearing	PWA 13173	
	Pulley - Compressor Balance	PWA 13547	
	Riveter - Counterweight Retaining Nut	PWA 13166	
	Riveter - Inner Race Retaining Nut Rivet	PWA 13312	
	Riveter - Inner Race Retaining Nut Rivet	PWA 13977	
	Sling - Compressor Rotor	PWA 6580	301
	Stand - Rotor Assembly	PWA 13170	
	Wrench - Bearing Retaining Nut	PWA 13918	
	Wrench - Bearing Inner Race Retaining Nut, Hydraulic	PWA 13273	
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Compressor Oil Scoop	PWA 13113	
	Wrench - Compressor Balance Pulley	PWA 13546	
38-1.	Compressor Rotor Hydraulic Stacking (Front Tierods)		
	Adapter - Front Tierod Hydraulic Stretch	PWA 13782	
	Distributor - Tierod Hydraulic Stretch	PWA 12745	
	Fixture - Hydraulic Ram Unit And Distributor, Pressure Check	PWA 13788	
	Hydraulic Ram Unit	PWA 13784	
	Pump - Hydraulic	PWA 3755	
R		(Replaced By	
R		PWA 29389)	
	Thimble And Rod Assembly (Long) (For 0.250-32 Thread)	PWA 13785	
	Thimble And Rod Assembly (Short) (For 0.250-32 Thread)	PWA 13786	
	Thimble And Rod Assembly (Long) (For 0.250-28 Thread)	PWA 39022	
	Thimble And Rod Assembly (Short) (For 0.250-28 Thread)	PWA 39023	
	Wrench - Compressor Front Tierod	PWA 13787	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
38A.	Compressor Rotor Hydraulic Stacking (Rear Tierods)		
	Adapter - Compressor Rotor Rear Tierod Hydraulic Stretch	PWA 13789	
	Distributor - Hydraulic Pressure	PWA 12745	
	Fixture, Hydraulic Ram Unit And Distributor - Pressure Check	PWA 13788	
	Hydraulic Pump	PWA 3755 (Replaced By PWA 29389)	
	Hydraulic Ram Unit - Tierod Stretch	PWA 13784	
	Thimble And Rod - Compressor Rotor Rear Tierod Hydraulic Stretch	PWA 13791	
	Wrench - Compressor Rotor Rear Tierod Hydraulic Stretch	PWA 13787	
39.	Compressor Rotor Rear Hub Assembly		
	Bearing - No. 2 Balance	PWA 21350-13	
	Guide - Distributing Sleeve	PWA 13328	
	Spacer - Hub And Balance Bearing	PWA 13164	
39A.	Compressor Rotor Spacer - Static Balance		
	Adapter	PWA 13633	
40.	Compressor Section - Installing In Vertical Stand		
	Adapter - Inlet Case	PWA 13181	308
	Fixture - Compressor Balance	PWA 13300	
	Jack - Compressor And Turbine Locating	PWA 13267	
	Plate - Engine Lift And Turn	PWA 13061	306
	Sling - Engine Lifting	PWA 6580	301
	Stand - Engine Complete Build And Transport	PWA 13060	
40-1.	Deleted		
40A.	Compressor Vanes Replacement		
	Bar - 1st Stage leading Edge Angle Bending	PWA 13576	
	Bar - 1st Stage Leading Edge Angle Bending	PWA 13577	
	Bar - 1st Stage Trailing Edge Angle Bending	PWA 13578	
	Bar - 2nd Stage Trailing Edge Angle Bending	PWA 13664	

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)			
	Bar - 2nd Stage Trailing Edge Angle Bending	PWA 13802	
	Bar - 3rd Stage Leading Edge Angle Bending	PWA 13665	
	Bar - 3rd Stage Trailing Edge Angle Bending	PWA 13666	
	Bar - 4th Stage Leading Edge Angle Bending	PWA 13398	
	Bar - 4th Stage Trailing Edge Angle Bending	PWA 13400	
	Bar - 5th Stage Leading Edge Angle Bending	PWA 13401	
	Bar - 5th Stage Trailing Edge Angle Bending	PWA 13403	
	Bar - 6th Stage Leading Edge Angle Bending	PWA 13404	
	Bar - 6th Stage Trailing Edge Angle Bending	PWA 13405	
	Bar - 7th Stage Leading Edge Angle Bending	PWA 13407	
	Bar - 7th Stage Trailing Edge Angle Bending	PWA 13408	
	Bar - 8th Stage Leading Edge Angle Bending	PWA 13536	
	Bar - 8th Stage Trailing Edge Angle Bending	PWA 13410	
	Bar - 9th Stage (Primary) Leading Edge Angle Bending	PWA 13411	
	Bar - 9th Stage Exit (Secondary) Trailing Edge Angle Bending	PWA 13413	
	Fixture - 9th Stage Brazing And Stress-Relief	PWA 13732	
	Gage - 1st Stage Leading Edge Angles	PWA 13580	
	Gage - 1st Stage Trailing Edge Angles	PWA 13581	
	Gage - 2nd And 3rd Stage Leading Edge Angles	PWA 13397	
	Gage - 2nd And 3rd Stage Trailing Edge Angles	PWA 13399	
	Gage - 4th Stage Leading Edge Angles	PWA 13397	
	Gage - 4th Stage Trailing Edge Angles	PWA 13537	
	Gage - 8th Stage Leading Edge Angles	PWA 13560	
	Gage - Stages 5 Thru 7 Leading Edge Angles	PWA 13399	
	Gage - Stages 6 Thru 8 Trailing Edge Angles	PWA 13406	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)			
	Gage - 9th Stage (Primary) Leading Edge Angles	PWA 13412	
	Gage - 9th Stage (Secondary) Trailing Edge Angles	PWA 13414	
	Gage - Stages 4 Thru 9 Vane Angles (Vial Type)	PWA 13415	
	Master - Stages 4 Thru 8 Vane Bending	PWA 9827	
40B.	Diffuser Case Air Leak Check		
	Cover - Front Flange	PWA 13555	
	Cover - Rear Flange	PWA 13554	
	Cover - Oil Tubes (Two Required)	PWA 13558	
	Plug - Accessory Drive Strut	PWA 13556	
	Regulator - Air Leak Test	PWA 6814	
41.	Diffuser Case Disassembly		
	Brackets - Lift And Trunnion	PWA 13080	
	Jack - Compressor And Turbine Locating	PWA 13267	
	Mount - Rear Left	PWA 13004	303
	Mount - Rear Right	PWA 13005	303
	Pusher - Compressor Rear Hub	PWA 13112	
	Sling - Engine	PWA 6580	301
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Retaining Nut	PWA 13084	
41A.	Diffuser Case Front Flange Replacement		
	Fixture - Machining	PWA 13857	
	Fixture - Stress-Relief	PWA 13863	
	Fixture - Welding	PWA 13862	
	Plate - Drill	PWA 13858	
	Plate - Stress-Relief	PWA 13865	
	Ring - Stress-Relief	PWA 13864	
42.	Diffuser Case Installation		
	Brackets - Lift And Trunnion	PWA 13080	
	Guide - Oil Distributing Sleeve	PWA 13328	
	Pusher - Main Component Drivegear	PWA 13081	
	Riveter - Retaining Nut	PWA 13312	
	Sling - Engine	PWA 6580	301
	Mounts - Test, Left	PWA 13004	303
	Mounts - Test, Right	PWA 13005	303
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Inner Race Retaining Nut	PWA 13084	
	Wrench - Outer Race Retaining Nut	PWA 13078	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
43.	Diffuser Section Main Component Drive Splined Coupling		
	Drift - Accessory Driveshaft Bearings And Spacers	PWA 13106	
44.	Disks, Blades, And Seals Assembly (Stages 3 Thru 9)		
	Fixture - Compressor Blade Lock	PWA 13260	
	Weight - Compressor Rotor Airseal Retaining	PWA 13261	
44A.	Disk And Blade Assemblies (Stages 2 Thru 9) - Optional Method		
	Universal Tab Bending And Rivet Flaring Machine (Model ADTB-1)	PWA 22634	
	Adapter - 2nd And 3rd Disk And Blade	PWA 13985	
	Adapter - Stages 4 Thru 9 Disk And Blade	PWA 13986	
	Anvil, Backup - 2nd Stage Rivet	PWA 13987	
	Anvil, Backup - 3rd and 6th Stage Tablock	PWA 13989	
	Anvil, Backup - 4th And 5th Stage Tablock	PWA 13990	
	Anvil, Backup - 7th, 8th And 9th Stage Tablock	PWA 13991	
	Punch, Flaring - 2nd Stage Rivet	PWA 13988	
	Punch, Prebend - 3rd Stage Tablock	PWA 22654	
R	Punch, Prebend - 4th, 5th And 6th Stage Tablock	PWA 22653	
	Punch, Prebend - 7th, 8th And 9th Stage Tablock	PWA 13992	
	Punch, Finish Bend - 3rd, 4th, 5th, 6th, And 8th Stage Tablock	PWA 13993	
	Punch, Finish Bend - 7th And 9th Stage Tablock	PWA 13994	
45.	Engine - Installation In Vertical Stand		
	Adapter - Inlet Case To Front Plate	PWA 13181	308
	Plate - Engine Build Lift And Turn	PWA 13061	306
	Stand - Engine Complete Build And Transport	PWA 13060	306

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
45A.	Engine - Installing Covers		
	Cover - Inlet Case (Free Turbine Engines)	PWA 13391	
	Cover - Inlet Case	PWA 13393	
	Cover - Turbine Exhaust Case (Free Turbine Engines)	PWA 13392	
	Cover - Turbine Exhaust Case	PWA 13389	
46.	Engine Mount Bushing Replacement		
	Puller - Bushing Liner	PWA 13158	
47.	Engine - Positioning Horizontally		
	Collar - Turbine Nozzle	PWA 13065	306
	Plate - Engine Lift and Turn	PWA 13061	
	Sling - Engine Lift And Trunnion	PWA 13067	306
	Sling - Engine Lift And Turn	PWA 6580	
47A.	Engine Preservation - Miscellaneous		
	Cover - Inlet Case	PWA 13393	
	Cover - Turbine Exhaust Case	PWA 13389	
48.	Engine Removal From Shipping Box		
	Cover - Bleed Valve	PWA 13298	308
	Sling - Engine Lift And Trunnion	PWA 13067	306
49.	Engine Rotation Check		
	Adapter - Turning	PWA 13041	305
50.	Engine Test - Preparation For		
	Adapter - Bellmouth (Remote)	PWA 13532	
	Adapter - Engine Test Mount Rear (Two Required)	PWA 13007	
	Adapter - Fuel Pump Fuel Inlet	PWA 13168	
	Bellmouth - Engine Test	PWA 13806	
	Bellmouth - Engine Test (Remote)	PWA 13533	
	Bracket - Inlet Case Vibration Pickup (Horizontal And Vertical - Two Required)	PWA 13574	
	Bracket - Free Turbine Case	PWA 13372	
	Bracket - Gearbox Vibration Pickup	PWA 13252	
	Bracket - Burner Cover Vibration Pickup	PWA 13575	
	Cap - Oil Tank Pressure Test	PWA 22324	
	Fairing - Engine Test	PWA 13002	
	Mount - Engine Test Front	PWA 13268	
	Mount - Engine Test Front	PWA 13501	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)			
	Mount - Engine Test Rear (Left)	PWA 13004	303
	Mount - Engine Test Rear (Right)	PWA 13005	303
	Mount - Engine Test Rear (Free Turbine Engines)	PWA 13500	
	Nozzle - Turbine Exhaust	PWA 13317	
	Nozzle - Turbine Exhaust (Only JT12A-8[N])	PWA 13765	
	Plug - Bellmouth Probe Hole	PWA 13385	
	Probe - Air Inlet Pressure (Pt2) (Six Required)	PWA 13014	
	Ring - Free Turbine Exhaust Duct Reinforcing	PWA 13856	
	Screen Assembly - Bellmouth	PWA 13001	
	Screen Assembly - Bellmouth (Remote)	PWA 13534	
	Stand - Bellmouth And Screen Assembly (Remote) (Floor-mounted Test Stands)	PWA 13535	
	Thermocouple Harness - Inlet Air Temperature	PWA 14558	
	Thermocouple - Anti-icing Elbow	PWA 13169	
50A.	Exhaust Strut Bolt And Bushing Replacement		
	Drift - Exhaust Case Boss Bushing	PWA 13708	
	Puller - Exhaust Case Bushing (Optional To PWA 13708)	PWA 39027	
51.	1st Stage Turbine Vanes And Turbine Case - Assembly		
	Drift - Turbine Vane Retaining Nut	PWA 13285	308
	Fixture - Nozzle Case Support	PWA 13089	
51A.	1st And 2nd Stage Free Turbine Blade Retaining Rivet Installation		
	Punch - 1st Stage Blade Rivet	PWA 13661	
	Punch - 2nd Stage Blade Rivet	PWA 13662	
	Riveter - Blade Retaining Rivet	PWA 10337	
52.	1st Stage Turbine Vanes And Turbine Case - Removal		
	Fixture - Turbine Support	PWA 13089	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
53.	Fluid (Hydraulic) Pump Drive Oil Seal Installation		
	Base - Driveshaft Seal Assembly	PWA 13026	304
	Drift - Seal	PWA 13028	304
	Drift - Seal	PWA 13617	
	Drift - Roller Bearing Outer Race	PWA 13373	
	Guide - Driveshaft Seal Assembly	PWA 13030	304
54.	Fluid (Hydraulic) Pump Drive Oil Seal Removal		
	Puller - Fluid Power Pump Pad	PWA 13022	302
	Puller - Gearshaft Bearing Outer Race	PWA 13598	
55.	Fluid (Hydraulic) Pump Drive Gearshaft Bearing Assembly		
	Base - Gearshaft Bearing (Roller	PWA 13190	
	Base - Gearshaft Bearing (Ball)	PWA 13194	
	Drift - Gearshaft Bearing (Roller)	PWA 13191	
	Drift - Gearshaft Bearing (Ball)	PWA 13195	
56.	Fluid (Hydraulic) Pump Drive Gearshaft Bearings Disassembly		
	Base - Gearshaft	PWA 7368	
	Drift - Gearshaft Bearing (Roller)	PWA 13189	
	Drift - Gearshaft Bearing (Ball)	PWA 13193	
	Plate - Gearshaft Bearing (Ball)	PWA 13192	
	Plate - Gearshaft Support	PWA 13188	
	Puller - Gearshaft Bearing (Ball)	PWA 13309	
56-1.	Free Turbine Accessories Driveshaft Coupling Disassembly		
	Base - Accessory Drive Bearing From Coupling	PWA 6660	
	Plate - Accessory Drive Bearing From Coupling	PWA 13485	
56A.	Free Turbine Accessory Drive And Gearbox Disassembly		
	Base - Accessory Drive Bearing From Coupling	PWA 6660	
	Drift - Free Turbine Accessory Drive Gearshaft	PWA 16680	
	Plate - Free Turbine Accessory Bearings From Gearshaft	PWA 13672	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
56B.	Free Turbine Accessory Drive And Gearbox Removal		
	Puller - Accessory Driveshaft Heat Shield	PWA 13467	
56C.	Free Turbine Accessory Drive Coupling And Gear Assembly		
	Base - Accessory Drive Holding	PWA 13484	
	Drift - Accessory Drive Bearing To Coupling	PWA 13483	
	Holder - Tachometer Drivegear And Housing	PWA 13470	
	Riveter - Tachometer Drivegear Retaining Nut Rivet	PWA 13472	
	Wrench - Tachometer Drivegear Retaining Nut	PWA 13471	
56C-1.	Free Turbine Blade Installation		
	Belt - Free Turbine Blade Support	PWA 11339	
	Fixture - Turbine Blade	PWA 17629	
	Pusher - Turbine Blades	PWA 11336	
	Support - Turbine Disk And Blades	PWA 11337	
56D.	Free Turbine Case Installation		
	Bracket - Engine Lift And Turn	PWA 13766	
	Sling - Engine Lift And Turn	PWA 6580	
56E.	Free Turbine Case Removal And Disassembly		
	Adapter - No. 4 Bearing Inner Race Retaining Nut	PWA 13843	
	Adapter - Free Turbine Disk To Jack	PWA 13457	
	Bracket - Free Turbine Case Lift And Turn	PWA 13766	
	Jack - Free Turbine Assembly Supporting	PWA 13267	
	Sling - Free Turbine Case Lift And Turn	PWA 6580	301
	Wrench - Hydraulic	PWA 8050	301
	Wrench - No. 4 Bearing Inner Race Retaining Nut	PWA 13838	
	Wrench - No. 4 Bearing Outer Race Retaining Nut	PWA 13474	

Tool Group List
Table 301 (Continued)

	Tool Group	Tool Name	Tool No.	Fig No.
	56E-1.	Free Turbine Blade Inspection		
		Gage - 1st Stage Free Turbine Blade Stretch	PWA 13941	
		Gage - 2nd Stage Free Turbine Blade Stretch	PWA 13942	
R		Jaws - Z Plane, 1st Stage Free Turbine Stretch	PWA 29316-11	
R		Jaws - Z Plane, 2nd Stage Free Turbine Stretch	PWA 29316-12	
R		Setting Block - 1st Stage Free Turbine Knife-Edge Seal (LE)	PWA 29317-80	
R		Setting Block - 1st Stage Free Turbine Knife-Edge Seal (TE)	PWA 29317-81	
R		Setting Block - 2nd Stage Free Turbine Knife-Edge Seal (LE)	PWA 29317-82	
R		Setting Block - 2nd Stage Free Turbine Knife-Edge Seal (TE)	PWA 29317-83	
R		Template - 1st Stage Free Turbine Blade Notch	PWA 102373	
R		Template - 2nd Stage Free Turbine Blade Notch	PWA 102374	
R	56E-2.	Free Turbine Blade (1st Stage) Dimensional Inspection		
R		Gage - Knife-Edge Seal Height	PWA 29260	
R		Jaws - Z Plane	PWA 29316-11	
R		Setting Block - Knife-Edge Seal Height (LE)	PWA 29317-80	
R		Setting Block - Knife-Edge Seal Height (TE)	PWA 29317-81	
R		Inspection Block - Cross-Notch, Shroud Angle	PWA 102375	
R		Inspection Gage - Cross-Notch, Shroud Angle	PWA 102362	
R		Inspection Gage - Shroud Location	PWA 102364	
R		Inspection Gage - Shroud Step	PWA 102377	
R		Inspection Gage	PWA 17019	
R		Fixture - Twist, Check, Correct	PWA 101193	
R		Gage - Twist	PWA 102381	
R		Jaws - Check And Correct	PWA 102507	
R		Master - Twist	PWA 102379	

	Tool Group	Tool Name	Tool No.	Fig No.
R	56E-3.	Free Turbine Blade (2nd Stage) Dimensional Inspection		
R		Gage - Knife-Edge Seal Height	PWA 29260	
R		Jaws - Z Plane	PWA 29316-12	
R		Setting Block - Knife-Edge Seal Height (LE)	PWA 29317-82	
R		Setting Block - Knife-Edge Seal Height (TE)	PWA 29317-83	
R		Inspection Block - Cross-Notch, Shroud Angle	PWA 102376	
R		Inspection Gage - Cross-Notch, Shroud Angle	PWA 102363	
R		Inspection Gage - Shroud Location	PWA 102365	
R		Inspection Gage - Shroud Step	PWA 102378	
R		Inspection Gage	PWA 17019	
R		Fixture - Twist, Check, Correct	PWA 101193	
R		Gage - Twist	PWA 102381	
R		Jaws - Check And Correct	PWA 102507	
R		Master - Twist	PWA 102379	
R	56E-4.	Free Turbine Blade (1st Stage) Knife-Edge Seal Weld Repair		
R		Adapter - Beltsander	PWA 101536	
R		Fixture - Beltsander	PWA 102372	
R		Wheel - Beltsander	PWA 102370	
R	56E-5.	Free Turbine Blade (2nd Stage) Knife-Edge Seal Weld Repair		
R		Adapter - Beltsander	PWA 101536	
R		Fixture - Beltsander	PWA 102361	
R		Wheel - Beltsander	PWA 102371	
R	56E-6.	Free Turbine Blade (1st Stage) Shroud Pretwist		
R		Fixture - Twist, Check, Correct	PWA 101193	
R		Gage - Twist	PWA 102381	
		Insert	PWA 17781	
R		Jaws - Check And Correct	PWA 102507	
R		Master - Twist	PWA 102379	
R		Wrench - Twist	PWA 17775	

	Tool Group	Tool Name	Tool No.	Fig No.
R	56E-7.	Free Turbine Blade (2nd Stage) Shroud		
R		Pretwist		
R		Fixture - Twist, Check, Correct	PWA 101193	
R		Gage - Twist	PWA 102381	
R		Insert	PWA 17783	
R		Jaws - Check And Correct	PWA 102507	
R		Master - Twist	PWA 102379	
R		Wrench - Twist	PWA 17775	
	56F.	Free Turbine Coupling Assembly		
		Adapter - No. 5 Bearing Inner Race Torque	PWA 13875	
		Drift - No. 5 Bearing Inner Race And Seal Plate	PWA 13463	
		Holder - No. 5 Bearing, Seal Plate, And Coupling	PWA 13462	
		Wrench - Hydraulic	PWA 8050	301
		Wrench - No. 5 Bearing Inner Race Retaining Nut	PWA 13874	
	56G.	Free Turbine Coupling Disassembly		
		Adapter - No. 5 Bearing Inner Race Torque	PWA 13875	
		Base - No. 5 Bearing, Seal Plate, And Coupling	PWA 7368	
		Drift - No. 5 Bearing, Seal Plate, And Coupling	PWA 13465	
		Holder - No. 5 Bearing, Seal Plate, And Coupling	PWA 13462	
		Plate - No. 5 Bearing, Seal Plate, And Coupling	PWA 13464	
		Wrench - Hydraulic	PWA 8050	301
		Wrench - No. 5 Bearing Inner Race Retaining Nut	PWA 13874	
	56G-1.	Free Turbine Disk And Blade Assembly Deblading		
		Fixture - Turbine Blade Removal	PWA 17629	
		Pilot - 1st Stage Turbine Disk	PWA 13621	
		Pilot - 2nd Stage Turbine Disk	PWA 13622	
		Pusher - 1st Stage Turbine Disk	PWA 13625	
		Pusher - 2nd Stage Turbine Disk	PWA 13626	
		Ring - Turbine Blade Support	PWA 13623	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
56G-2.	Free Turbine Disk And Blade Assembly Static Balancing		
	Adapter - Static Balance	PWA 13634	
	Riveter - Free Turbine Counterweight	PWA 13819	
56H.	Free Turbine Engine Installation In Stand		
	Collar - Turbine Nozzle Case	PWA 13065	306
	Stand - Engine Build And Transport	PWA 13060	306
	Stand - Free Turbine Assembly	PWA 13452	
	Support - Engine Front	PWA 13313	
	Support - Turbine Nozzle Case	PWA 13064	
56H-1.	Free Turbine Engine Removal From Shipping Box		
	Cover - Bleed Valve	PWA 13298	
	Sling - Engine Lift And Trunnion	PWA 13515	
56J.	Free Turbine 1st Stage Turbine Vanes Installation		
	Adapter - Free Turbine Disk-To-Jack	PWA 13457	
	Jack - Compressor And Turbine Locating	PWA 13267	
	Plate - Free Turbine Assembly Front Case-To-Jack	PWA 13458	
	Stand - Engine Build And Transport	PWA 13060	306
56K.	Free Turbine Rotor Installation And Removal		
	Eye - Turbine Shaft Lifting	PWA 13479	
56L.	Free Turbine Section Installation		
	Pin - Free Turbine Assembly Aligning (Two Required)	PWA 13353	
	Stand - Free Turbine Assembly	PWA 13452	
56M.	Free Turbine Section Installation In Build And Transport Stand		
	Adapter - Free Turbine Disk-To-Jack	PWA 13457	
	Eye - Free Turbine Assembly Lifting (Rear)	PWA 13459	
	Jack - Compressor And Turbine Locating	PWA 13267	
	Plate - Free Turbine Assembly Front Case-To-Jack	PWA 13458	
	Sling - Engine Lift And Turn	PWA 6580	301
	Stand - Engine Build And Transport	PWA 13060	
	Stand - Free Turbine Assembly	PWA 13452	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
56N.	Free Turbine Section Installation In Free Turbine Stand		
	Eye - Free Turbine Assembly Lifting (Rear)	PWA 13459	
	Stand - Free Turbine Assembly	PWA 13452	
56P.	Free Turbine Shaft Coupling Installation		
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Turbine Shaft Coupling Nut	PWA 13461	
56Q.	Free Turbine Shaft Coupling Removal		
	Puller - Turbine Shaft Lock	PWA 13460	
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Turbine Shaft Coupling Nut	PWA 13461	
56Q-1.	Free Turbine Shaft Inner Case Assembly Pressure Test		
	Adapter - Case Front Pressure Test	PWA 13877	
	Plate - Case Rear Pressure Test	PWA 13876	
56Q-2.	Free Turbine Shaft Inner Case Oil Tube And Tube Heatshield Replacement		
	Locator - Oil Pressure And Scavenge Tube Welding	PWA 13944	
56R.	Free Turbine Vane Preloading And Measurement		
	Fixture, Loading - 1st and 2nd Stage Free Turbine Vanes	PWA 13807	
	Gage - Turbine Vane Force Loading	PWA 13810	
	Support - Free Turbine 1st Stage Vane Loading Fixture	PWA 13811	
	Support - Free Turbine 2nd Stage Vane Loading Fixture	PWA 13812	
57.	Fuel Control Drive Bearing Liner Replacement		
	Drift - Bearing Liner	PWA 13359	
	Jig - Drill	PWA 13360	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
58.	Fuel Control Drive Gearshaft Bearing Assembly		
	Base - Gearshaft (Rear)	PWA 13199	
	Base - Gearshaft (Front)	PWA 13203	
	Base - Gearshaft (Front)	PWA 13638	
	Drift - Gearshaft Front Bearing	PWA 13200	
	Drift - Gearshaft Front Bearing	PWA 13639	
	Drift - Gearshaft Rear Bearing	PWA 13204	
59.	Fuel Control Drive Gearshaft Bearing Removal		
	Base - Gearshaft Support	PWA 7368	
	Drift - Gearshaft Rear Bearing	PWA 13202	
	Drift - Gearshaft Front Bearing	PWA 13198	
	Drift - Gearshaft Front Bearing	PWA 13640	
	Plate - Front Bearing Support	PWA 13197	
	Plate - Rear Bearing Support	PWA 13308	
	Plate - Rear Bearing Support	PWA 13201	
60.	Fuel Control Drive Oil Seal Assembly		
	Base - Oil Seal	PWA 13049	305
	Drift - Oil Seal Assembly	PWA 13029	304
	Drift - Fuel Control Driveshaft	PWA 13618	
	Guide - Shaft Seal	PWA 13027	304
60A.	Fuel control Oil Lubricated Flexible Shaft		
	Drift - Bearing	PWA 39008	
	Drift - Snapring	PWA 39009	
	Drift - Seal	PWA 39010	
	Base - Flange - Shaft	PWA 39013	
61.	Fuel Control Drive Oil Seal Removal		
	Puller - Fuel Control Pad	PWA 13022	302
62.	Fuel Coolant Oil Cooler Installation/ Removal		
	Wrench - Oil Cooler Rear Securing Nut	PWA 13845	
63.	Fuel Manifold Removal		
	Fixture - Fuel Manifold Holding	PWA 13271	308
64.	Deleted		
R 65.	Deleted		

Tool Group List
Table 301 (Continued)

	Tool Group	Tool Name	Tool No.	Fig No.
R	66.	Fuel Pressurizing and Dump Valve		
R		Pressure Check		
R		Adapter - P&D Valve signal	PWA 10723	303
R		Adapter - P&D Valve Inlet	PWA 13012	303
R		Adapter - P&D Valve Drain	PWA 13013	302
R		Adapter - P&D Valve Drain	PWA 13151	308
R		Clamp - Fuel Nozzle Sealing (8)	PWA 13979	
R		Tip - Fuel Nozzle Sealing Clamp	PWA 13979-3	
R	67.	Fuel Pump and Fuel Control Bearing		
R		Liner Replacement		
R		Adapter - Bearing Liner (Holding)	PWA 13156	
R		Drift - Bearing Liner	PWA 13354	
R		Jig - Bearing Liner	PWA 13358	
R	68.	Gearbox Roller Bearing Outer Race		
R		Installation		
R		Drift - Roller Bearing Outer Race	PWA 13296	
R	69.	Generator and Starter Bearing Liner		
R		Replacement		
R		Drift - Bearing Liner	PWA 13344	
R		Jig - Drill	PWA 13358	
R	70.	Hydraulic Pump Drive Front Oil Seal		
R		Housing Liner Replacement		
R		Adapter - Holding	PWA 13156	
R		Drift - Seal Housing	PWA 13122	
R		Gage - Liner	PWA 1805-188	
R		Jig - Drill	PWA 13357	
R		Puller - Oil Seal Liner	PWA 13136	
R	70A.	Hydraulic Pump Drive Gearshaft Bearing		
R		Bearing Liner Replacement		
R		Drift-Bearing Liner	PWA 13344	
R		Jig - Drill	PWA 13348	
	71.	Hydraulic Pump Drive Gearshaft Front		
		Bearing Liner		
		Adapter - Holding	PWA 13156	
		Drift - Bearing Liner	PWA 13347	
		Jig - Drill	PWA 13357	
		Puller - Bearing Liner	PWA 13356	

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
71A.	Main Component Drive Gearshaft And Housing Assembly - Assembly And Installation (Dual Housing Configuration)		
	Base - Ball Bearing	PWA 13232	
	Drift - Ball Bearing	PWA 13848	
	Drift - Roller Bearing	PWA 13236	
	Drift - Roller Bearing Outer Race	PWA 13296	
	Drift - Upper Housing	PWA 13830	
	Puller And Driver	PWA 13826	
71B.	Main Component Drive Gearshaft And Housing Assembly - Removal And Disassembly (Dual Housing Configuration)		
	Base - Drivegear Bearing	PWA 6660	
	Base - Housing Disassembly	PWA 13827	
	Drift - Bearing	PWA 13231	
	Drift - Gearshaft And Bearing Assembly Removal	PWA 13832	
	Drift - Roller Bearing Outer Race	PWA 13833	
	Drift - Upper Housing	PWA 13828	
	Fixture - Upper Housing Disassembly	PWA 13851	
	Plate - Ball Bearing	PWA 13230	
	Plate - Roller Bearing	PWA 13234	
	Plate - Upper Housing	PWA 13831	
	Puller And Driver	PWA 13826	
72.	Main Component Drivegear Assembly		
	Holder - Accessory Driveshaft Coupling	PWA 13388	
	Wrench - Accessory Drivegear Retaining Nut	PWA 13085	
73.	Main Component Drivegear Disassembly		
	Holder - Accessory Driveshaft Coupling	PWA 13388	
	Puller - Accessory Drivegear	PWA 13375	
	Wrench - Accessory Drivegear Retaining Nut	PWA 13085	
74.	Main Component Drive Splined Coupling		
	Base - Accessory Drive Coupling	PWA 6660	
	Drive - Accessory Drive Coupling	PWA 13104	
	Holder - Accessory Driveshaft Coupling	PWA 13388	
	Plate - Accessory Drive Coupling	PWA 13103	

Tool Group	Tool Name	Tool No.	Fig No.
75.	Main Component Driveshaft Lower Bearing Liner Replacement		
	Adapter - Holding	PWA 13156	
	Drift - Bearing Liner	PWA 13124	
	Jig - Drill	PWA 13125	
	Puller - Bearing Liner	PWA 13531	
75A.	Main Component Driveshaft Lower Bearing Liner Replacement (Reinforced Housing)		
	Adapter - Gearbox Holding	PWA 13156	
	Drift - Bearing Liner	PWA 13124	
	Jig - Drill	PWA 13940	
76.	Main Component Gearshaft Front Bearing Liner Replacement		
	Adapter - Holding	PWA 13156	
	Drift - Bearing Liner	PWA 6516	
	Jig - Component Drive Gearshaft	PWA 13355	
	Puller - Bearing Liner	PWA 13371	
77.	Main Oil Pressure Relief Valve		
	Riveter - Relief Valve Retaining Rivet	PWA 13304	
78.	Main Oil Pump Assembly		
	Drift - Inner Cover Oil Seal	PWA 13147	307
	Drift - Inner Body Oil Seal	PWA 13148	307
	Guide - Inner Body Oil Seal	PWA 13149	307
79.	Main Oil Pump Removal (JT12A-6, -6A [L], And -8 [L])		
	Puller - Main Oil Pump	PWA 13251	308
79-1.	Main Oil Pump Removal (JT12A-6A, [N], And -8 [N])		
	Puller - Main Oil Pump	PWA 13387	
79A.	Main Oil Pump Removal (Free Turbine Engine)		
	Puller - Oil Pump	PWA 13386	
79B.	Main Oil Strainer Installation		
	Drift - Straight Shaft	PWA 13167	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
80.	Main Oil Strainer Assembly		
	Holder - Oil Screen Support	PWA 13036	305
	Wrench - Retaining Nut	PWA 13035	305
80A.	Main Oil Strainer Installation		
	Clamp - Main oil Strainer	PWA 13943	
81.	Main Oil Strainer Removal		
	Clamp - Main Oil Strainer	PWA 13943	
	Holder - Oil Screen	PWA 13036	305
	Wrench - Retaining Nut	PWA 13035	305
82.	9th Stage Compressor Vane Outer Shroud Supports And/Or Diffuser Case Replacement		
	Jig - Rivet Hole Drill	PWA 13284	
83.	Oil Jet Flow check		
	Fixture - Oil Jet Oil Flow	PWA 13157	
83-1.	Oil Pressure Transmitter Boss Helical Coil Repair		
	Counterbore - Gearbox Oil Pressure Transmitter Boss Repair	PWA 16752	
	Fixture - Gearbox Oil Pressure Transmitter Boss Repair	PWA 13707	
83A.	Positioning Free Turbine Engine Horizontally		
	Adapter - Inlet Case To Plate	PWA 13181	308
	Collar - Turbine Nozzle	PWA 13065	306
	Plate - Engine Lift And Turn	PWA 13061	306
	Sling - Engine Lifting	PWA 6580	301
	Stand - Engine complete Build And Transport	PWA 13060	306
83B.	Power Lever Cross Shaft Bearing Installation		
	Drift - Needle Bearings	PWA 10503	
83C.	Power Lever Cross Shaft Arm Bearing Removal Installation		
	Base - Power Lever Cross Shaft Bearing	PWA 13706	
	Drift - Power Lever Cross Shaft Bearing	PWA 13705	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
83D.	Power Lever Cross Shaft Bearing Removal		
	Drift - Needle Bearings	PWA 13892	
84.	2nd Stage Turbine Disk And Blades Removal		
	Puller - Turbine Disk	PWA 13055	
	Pump - Hydraulic	PWA 3755 (Replaced By PWA 29389)	
84A.	2nd Stage Turbine Vane And Shroud Assembly Preloading		
	Fixture - Loading, Turbine Nozzle Vane	PWA 13808	
	Gage - Force Turbine Vane Loading Fixture	PWA 13810	
	Support - 2nd Stage Turbine Vane Stator Shroud	PWA 13813	
84B.	2nd Stage Turbine Vane Inner Buttress Front Face Repair		
	Fixture - 2nd Stage Vane Machining	PWA 13976	
	First Stage Free Turbine Vane Repair		
	Grind Fixture (Convex Side Face)	PWA 102500	
	Grind Fixture (Concave Side Face)	PWA 102501	
85.	2nd Stage Turbine Vane Removal		
	Puller - Turbine Rotor Inner Seal	PWA 13099	
85-1.	2nd Stage Turbine Vane Tang Repair		
	Fixture - 2nd Stage Vane Tang Grinding	PWA 13754	
	Fixture - 2nd Stage Vane Tang Welding	PWA 13753	
	Fixture - 2nd Stage Vane Tang Checking	PWA 13755	
	Grind Fixture (Convex Side Face)	PWA 102502	
	Grind Fixture (Concave Side Face)	PWA 102503	
85A.	Igniter Plug Boss Repair		
	Tap Igniter Plug Boss	PWA 13032	
86.	Starter-Generator Drive Assembly		
	Base - Oil Pump Drive Gearshaft	PWA 13194	
	Drift - Oil Pump Drive Gearshaft	PWA 13250	

R
R

Tool Group List
Table 301 (Continued)

ENGINE GENERAL - OVERHAUL TOOLS

Tool Group	Tool Name	Tool No.	Fig No.
87.	Starter - Generator Drive Disassembly		
	Drift - Bevel Gear	PWA 13214	
	Plate - Bevel Gear Support	PWA 13213	
	Puller - Driveshaft	PWA 13216	
88.	Starter - Generator Drive Oil Seal		
	Base - Driveshaft Seal Assembly	PWA 13026	304
	Drift - Driveshaft Ball Bearing	PWA 13028	304
	Drift - Driveshaft Seal Assembly	PWA 13617	
	Drift - Starter - Generator Oil Seal	PWA 13718	
	Guide - Driveshaft Seal Assembly	PWA 13030	304
89.	Starter - Generator Drive Oil Seal Removal		
	Puller - Starter - Generator Pad	PWA 13022	302
90.	Starter - Generator Driveshaft Bearings Removal		
	Base - Gearshaft Support	PWA 7368	
	Base - Gearshaft Support	PWA 6660	
	Drift - Driveshaft Ball Bearing	PWA 13210	
	Drift - Driveshaft Roller Bearing	PWA 13206	
	Plate - Gearshaft Ball Bearing Support	PWA 13209	
	Plate - Gearshaft Roller Bearing	PWA 13188	
91.	Deleted		
92.	Starter - Generator Gearshaft Bearing Assembly		
	Base - Gearshaft Bearing (Ball)	PWA 13211	
	Base - Gearshaft Bearing (Roller)	PWA 13207	
	Drift - Gearshaft Bearing (Ball)	PWA 13212	
	Drift - Gearshaft Bearing (Roller)	PWA 13208	
93.	Starter - Generator Gearshaft Bearing Liner Replacement		
	Adapter - component Drive Gearshaft (Holding)	PWA 13156	
	Drift - Gearshaft Bearing Liner	PWA 13344	
	Jig - Gearshaft Bearing Liner	PWA 13345	
	Puller - Bearing Liner	PWA 13346	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
94.	Tachometer Drive Assembly (JT12A-6, -6A [L], And -8 [L])		
	Base - Drive Gearshaft Bearing	PWA 13186	
	Drift - Drive Gearshaft	PWA 13176	
	Drift - Oil Seal	PWA 13178	
	Drift - Oil Seal	PWA 13620	
	Guide - Drive Housing oil Seal	PWA 13179	
94A.	Tachometer Drive Assembly (JT12A-6A [N], -8 [N], and Free Turbine Engines)		
	Base - Gearshaft	PWA 13240	
	Base - Seal Housing	PWA 13020	
	Drift - Bearings	PWA 13241	
	Drift - Seal	PWA 13048	
	Drift - Seal	PWA 13619	
	Plate - Gearshaft	PWA 13235	
95.	Tachometer Drive Disassembly (JT12A-6, -6A [L], And -8 [L])		
	Puller - Pilot Bearing And Spacer	PWA 13177	
95A.	Tachometer Drive Disassembly (JT12A-6A [N], -8 [N], And Free Turbine Engines)		
	Base - Inner Race	PWA 7368	
	Drift - Bearing Shaft	PWA 13239	
	Plate - Inner Race	PWA 13238	
	Puller - Bearing Support	PWA 13237	
	Puller - Seal Housing	PWA 13051	
95B.	Trim Balance Procedure		
	Adapter - Hydraulic Pump Pad	PWA 13949	
	Adapter - Tachometer	PWA 13950	
	Guide - Hub Plug	PWA 13946	
	Inserter - Counterweight	PWA 13964	
	Periscope - Observation	PWA 13952A	
	Puller - Hub Plug	PWA 13974	
	Remover - Counterweight	PWA 13969	
	Remover - Inner Race Retaining Nut Rivet	PWA 13963	
	Riveter - Bearing Nut Retaining Rivet	PWA 13977	
	Riveter - Turbine Counterweight	PWA 13277	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
96.	Turbine Blade Classification		
	Adapter - Blade (1st Stage)	PWA 16600-66	
	Adapter - Blade (2nd Stage)	PWA 16600-61	
	Scale - Blade Classification	PWA 16605	
96A.	Turbine Blade Inspection		
	Gage - Stretch (1st Stage)	PWA 13351	309
	Gage - Stretch (2nd Stage)	PWA 39025	309
96A-1.	Turbine Blade Notch Repair - 1st Stage		
	Fixture - Checking	PWA 13446	
	Fixture - Grinding (Concave)	PWA 13563	
	Fixture - Grinding (Convex)	PWA 13436	
	Gage - Notch Depth (Convex)	PWA 17138	
	Gage - Notch Step	PWA 17137	
	Holder - Dial Indicator	PWA 17019	
	Master	PWA 13566	
	Template - Wheel Dressing	PWA 13444	
96A-2.	Turbine Blade Notch Repair - 2nd Stage		
	Fixture - Checking	PWA 13572	
	Fixture - Grinding (Concave)	PWA 13571	
	Fixture - Grinding (Convex)	PWA 13570	
	Gage - Notch Depth (Convex)	PWA 17138	
	Gage - Notch Step	PWA 17137	
	Holder - Dial Indicator	PWA 17019	
	Master	PWA 13573	
	Template - Wheel Dressing	PWA 13569	
96A-3.	Turbine Blade Pretwist		
	Fixture - Turbine blade Pretwist Checking	PWA 13544	
	Insert - Turbine Blade Twist Wrench	PWA 17783	
	Wrench - Turbine Blade Twist	PWA 17775	
96B.	Turbine Blades Removal		
	Fixture - Turbine Blade Removal	PWA 17629	
	Pilot - Turbine disk (1st Stage)	PWA 13497	
	Pilot - Turbine Disk (2nd Stage)	PWA 13381	
	Pump - Hydraulic	PWA 3755 (Replaced By PWA 29389)	
	Pusher - Turbine Disk (1st Stage)	PWA 13499	
	Pusher - Turbine Disk (2nd Stage)	PWA 13383	
	Ring - Turbine Disk Support (1st Stage)	PWA 13498	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)			
	Ring - Turbine Disk Support (2nd Stage)	PWA 13382	
96C.	Turbine Disk Inspection		
	Plug - Gaging Point Locating (Two Required)	PWA 17751	
96C-1.	Turbine Exhaust Case Rear Flange Replacement		
	Fixture - Drill	PWA 13842	
	Fixture - Machining	PWA 13841	
	Fixture - Welding	PWA 13840	
96C-2.	Turbine Exhaust Case Crack Repair		
	Fixture - Exhaust Case Welding	PWA 13758	
	Fixture - Machining	PWA 13841	
96D.	Turbine Nozzle Guide Vanes - Straightening		
	Adapter - Preliminary Restrike - 1st Stage	PWA 15676	
	Adapter - Preliminary Restrike - 2nd Stage	PWA 15596	
	Die - 1st Stage Restrike	PWA 15669	
	Die - 1st Stage Preliminary Straightening	PWA 15675	
	Die - 2nd Stage Restrike	PWA 15595	
	Die - 2nd Stage Preliminary Straightening	PWA 15597	
	Heatshield	PWA 16964	
	Insert - 1st Stage (Class 5)	PWA 15672	
	Insert - 1st Stage (Class 8)	PWA 15673	
	Insert - 2nd Stage (Class 4)	PWA 15598	
	Insert - 2nd Stage (class 7)	PWA 15599	
	Locator - 1st Stage	PWA 15671	
	Locator - 2nd Stage	PWA 15670	
	Press	PWA 35183	
	Safety Block	PWA 15361	
97.	Turbine Positioning Spacer Installation		
	Drift - Positioning Spacer	PWA 13096	
	Fixture - Turning Positioning	PWA 13059	

R
R

Tool Group	Tool Name	Tool No.	Fig No.
98.	Turbine Positioning Spacer Measurement		
	Collar - 1st Stage Turbine Disk To Fixture	PWA 13294	
	Fixture - Section Build And Gage	PWA 13305	
	Gage - Position Indicating	PWA 13098	
	Gage - Diffuser Flange To Compressor Rear Hub	PWA 13097	
	Pins - Aligning	PWA 13184	308
	Plug - Turbine Section Gage	PWA 13073	
	Sling - Lifting	PWA 6580	301
	Stand - Engine Complete Build And Support	PWA 13060	306
99.	Turbine Positioning Spacer Removal		
	Collar - 1st Stage Disk to Fixture	PWA 13294	
	Fixture - Shaft Assembly	PWA 13095	
	Puller - Positioning Spacer	PWA 13072	
	Sling - 1st Stage Disk to Fixture	PWA 6580	301
100.	Turbine Rotor Assembly Installation		
	Adapter - Hydraulic Wrench	PWA 13053	
	Collar - 1st Stage Disk To Fixture	PWA 13294	
	Eye - Lifting	PWA 13093	
	Holder - Seal Assembly To Shaft	PWA 13101	
	Pin - Bearing Support Guide	PWA 13107	
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Turbine Retaining Locking Bolt	PWA 13056	
101.	Turbine Rotor Assembly Removal		
	Adapter - Hydraulic Wrench	PWA 13053	
	Eye - Lifting	PWA 13093	
	Sling - Lifting	PWA 6580	301
	Wrench - Hydraulic	PWA 8050	301
	Wrench - Locking Bolt	PWA 13056	
102.	Turbine Rotor Build For Concentricity And Dynamic Balance		
	Bearing - Rear Balance	PWA 21350-13	
	Bearing - Front Balance	PWA 21350-14	
	Belt - Turbine Blade Support	PWA 11339	
	Collar - 1st Stage Disk To Fixture	PWA 13294	
	Drift - Balance Bearing	PWA 13275	
	Drift - Bearing Inner Race	PWA 13088	
	Fixture - Build And Transport	PWA 13295	
	Fixture - Disk To Shaft Assembly	PWA 13095	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)			
	Fixture - Turbine Blades	PWA 17629	
	Holder - Bearing Inner Race Torquing	PWA 13094	
	Pilot - Turbine Disk	PWA 13381	
	Pump - Hydraulic	PWA 3755 (Replaced By PWA 29389)	
	Pusher - Turbine Blades	PWA 11336	
	Riveter - 1st Stage Blade Retaining Rivet	PWA 13701	
	Riveter - 2nd Stage Blade Retaining Rivet	PWA 13702	
	Sling - Lifting	PWA 6580	301
	Stand - Turbine And Transport	PWA 13070	307
	Support - Turbine Disk And Blade	PWA 11337	
	Wrench - Bearing Inner Race Retaining Nut	PWA 13086	
102A.	Turbine Rotor Build For Concentricity And Dynamic Balance Check (Free Turbine)		
	Bearing - Balance (Two Required)	PWA 21350-13	
	Collar - 2nd Stage Turbine Disk And Blades	PWA 13517	
	Drift - No. 4 Bearing Inner Race And Seal Plate	PWA 13477	
	Drift - No. 5 Bearing Inner Race And Seal Plate	PWA 13463	
	Fixture - Turbine Assembly To Stand	PWA 13518	
	Fixture - Turbine Disk And Shaft Holding	PWA 13520	
	Holder - No. 5 Bearing, Seal Plate, And Coupling	PWA 13462	
	Holder - Turbine Assembly Bearing Torque	PWA 13523	
	Holder - Turbine Assembly Coupling	PWA 13530	
	Pilot - Turbine Disk	PWA 13381	
	Sling - Lifting	PWA 6580	301
	Spacer - No. 4 Balance Bearing	PWA 13519	
	Stand - Turbine Assembly Build And Transport	PWA 13070	307
	Wrench - No. 4 Bearing Inner Race Retaining Nut - Hand	PWA 13521	
	Wrench - No. 5 Bearing Inner Race Retaining Nut	PWA 13874	
R	Wrench - Turbine Shaft Coupling Nut -	PWA 13525	

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)	Hand		
103.	Turbine Rotor Concentricity Check Assembly		
	Fixture - Concentricity Check	PWA 6320	
	Housing - Front And Rear Balance Bearing (13 Inch OD)	PWA 8170-29	
	Sling - Lifting	PWA 6580	301
103A.	Turbine Rotor Concentricity Check (Free Turbine)		
	Clamp - Free Turbine Rotor	PWA 13937	
	Eye - Turbine Shaft Lifting	PWA 13479	
	Fixture - Concentricity Check	PWA 6320	
	Housing - Front And Rear Balance Bearing (13 Inch OD)	PWA 8170-29	
	Sling - Lifting	PWA 6580	301
	Support - Free Turbine Rotor Balance	PWA 13524	
103B.	Turbine Rotor Disassembly (Free Turbine)		
	Collar - 1st Stage Turbine Disk And Blade Lifting	PWA 13516	
	Collar - 2nd Stage Turbine Disk And Blade Lifting	PWA 13517	
	Eye - Free Turbine Rotor Lifting	PWA 13479	
	Fixture - Turbine Assembly To Stand	PWA 13518	
	Fixture - Turbine Blade Removal	PWA 17629	
	Jackscrew - 1st Stage Free Turbine Airsealing Ring	PWA 13769	
	Pilot - Turbine Disk	PWA 13381	
	Puller - 1st Stage Turbine Airseal Ring	PWA 10313	
	Puller - 1st Stage Turbine Disk	PWA 13526	
	Puller - 2nd Stage Turbine Disk	PWA 13767	
	Pump - Hydraulic	PWA 3755 (Replaced By PWA 29389)	
	Pusher - Turbine Disk	PWA 13383	
	Ring - Turbine Blade Support	PWA 13382	
	Sling - Lifting	PWA 6580	301
	Stand - Turbine Assembly Build And Transport	PWA 13070	307

Tool Group	Tool Name	Tool No.	Fig No.
104.	Turbine Rotor Disassembly After Dynamic Balance		
	Collar - 1st Stage Disk To Fixture	PWA 13294	
	Fixture - Turbine Build And Transport	PWA 13295	
	Holder - Bearing Inner Race Torquing	PWA 13094	
	Puller - Balance Bearing And Seal Plate	PWA 13367	
	Puller - Front Balance Bearing	PWA 13366	
	Sling - Lifting	PWA 6580	301
	Stand - Turbine Assembly Build And Transport	PWA 13070	307
	Wrench - Bearing Inner Race Retaining Nut	PWA 13086	
104A.	Turbine Rotor Disassembly After Dynamic Balance (Free Turbine)		
	Base - No. 5 Bearing Seal Plate And Coupling	PWA 7368	
	Drift - No. 5 Bearing Seal Plate And Coupling	PWA 13465	
	Eye - Turbine Shaft Lifting	PWA 13479	
	Fixture - Turbine Assembly To Stand	PWA 13518	
	Holder - Turbine Balance Bearing Torque	PWA 13523	
	Holder - Turbine Coupling	PWA 13530	
	Holder - No. 5 Bearing Seal Plate And Coupling	PWA 13462	
	Plate - No. 5 Bearing Seal Plate And Coupling	PWA 13464	
	Puller - Front Balance Bearing	PWA 13522	
	Stand - Turbine Assembly Build And Transport	PWA 13070	307
	Wrench - Coupling Retaining Nut - Hand	PWA 13525	
	Wrench - No. 4 Bearing Inner Race Retaining Nut - Hand	PWA 13521	
	Wrench - No. 5 Bearing Inner Race Retaining Nut	PWA 13874	
	Wrench - Turbine Shaft Coupling Nut	PWA 13461	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
105.	Turbine Rotor Dynamic Balance Check		
	Fixture - Turbine Build And Transport	PWA 13295	
	Housing - Front And Rear Balance Bearing (13 Inch OD)	PWA 8170-29	
	Riveter - Counterweight Retaining Rivets	PWA 13277	
	Shroud - Turbine Balance	PWA 13730	
	Sling - Lifting	PWA 6580	301
	Stand - Turbine Assembly Build And Transport	PWA 13070	307
	Strap - Front Balance Bearing Retaining	PWA 13368	
105A.	Turbine Rotor Dynamic Balance Check (Free Turbine)		
	Housing - Front And Rear Balance Bearing (13 Inch OD)	PWA 8170-29	
	Strap - Front Balance Bearing Retaining	PWA 13368	
	Sling - Lifting	PWA 6580	301
105B.	Turbine Shaft Coupling Plating		
	Fixture - Turbine Shaft Coupling Plating	PWA 13729	
105B-1.	Turbine Shaft Plating		
	Fixture, Plating - Turbine Shaft	PWA 13703	
105C.	Turbine Shaft Splined Lockring Plating		
	Fixture - Turbine Shaft Splined Lockring Plating	PWA 13727	
105D.	Turbine Shaft Lockplating		
	Fixture - Turbine Shaft Lockplating	PWA 13728	
106.	Turbine Vane Classification (Using Limited Contact Gage - Type I)		
	Gage - Vane Classification (1st Stage - JT12A-6, -6A, JFTD12A-4A, And -5A)	PWA 13337	
	Gage - Vane Classification (1st Stage - JT12A-8N and -8L)	PWA 13734	
	Gage - Vane Classification (2nd Stage Turbine)	PWA 13339	
	Gage - Vane Classification (1st Stage Free Turbine)	PWA 35125	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)			
	Gage - Vane Classification (2nd Stage Free Turbine)	PWA 35127	
	Master - Vane Classification (1st Stage - JT12A-6, 6A, JFTD12A-4A, And -5A)	PWA 13338	
	Master - Vane Classification (1st Stage JT12A-8N And -8L)	PWA 13743	
	Master - Vane Classification (2nd Stage Turbine)	PWA 13340	
	Master - Vane Classification (1st Stage Free Turbine)	PWA 13601	
	Master - Vane Classification (2nd Stage Free Turbine)	PWA 13603	
107.	Turbine Vane Classification (Using Multi-Contact Gage - Type II)		
	Gage - Turbine Vane Classification (1st Stage Turbine - JT12A-6, -6A, JFTD12A-4A, And -5A)	PWA 35058	
	Gage - Turbine Vane Classification (1st Stage Turbine - JT12A-8N And -8L)	PWA 35121	
	Gage - Turbine Vane Classification (2nd Stage Turbine - All Models)	PWA 35117	
	Gage - Free Turbine Vane Classification (1st Stage Free Turbine - JFTD12A-4A And -5A)	PWA 35125	
	Gage - Free Turbine Vane Classification (2nd Stage Free Turbine - JFTD12A-4A And -5A)	PWA 35127	
	Master - Turbine Vane Classification Gage (1st Stage Turbine - JT12A-6, -6A, JFTD12A-4A, And -5A)	PWA 35059	
	Master - Turbine Vane Classification Gage (1st Stage Turbine - JT12A-8N And -8L)	PWA 35122	
	Master - Turbine Vane Classification Gage (2nd Stage Turbine - All Models)	PWA 35118	
	Master - Free Turbine Vane Classification Gage (1st Stage Free Turbine - JFTD12A-4A And -5A)	PWA 35126	

R
R

Tool Group List
Table 301 (Continued)

Tool Group	Tool Name	Tool No.	Fig No.
(CONTINUED)	Master - Free Turbine Vane Classification Gage (2nd Stage Free Turbine - JFTD12A-4A And -5A)	PWA 35128	

Tool Group List
Table 301 (Continued)

2. Engine Numerical Tool List

Tool No.	Tool Name	Tool Group
PWA 1805-181	Gage	25
PWA 1805-188	Gage	70
PWA 3755 (Replaced By PWA 29389)	Pump	9,29-1,38-1,38A,84, 96B,102,103B
PWA 6320	Fixture	37,103,103A
PWA 6507	Flowmeter	7,11
PWA 6516	Drift	67,76
PWA 6580	Sling	10,11B-1,33,36,37, 38,40,41,42,47, 56D,56E,56M,83A, 98,99,101,102, 102A,103,103A, 103B,104,105,105A
PWA 6660	Base	23,38,56-1,56A,71B, 74,90
PWA 6814	Regulator	40B
PWA 7025-4	Wrench	8A
R PWA 7368	Base	R 6,23,56,56G, 59,90,95A,104A

Numerical Tool List
Table 302

	Tool No.	Tool Name	Tool Group
R R R R	PWA 8050	Wrench	10,11A,11B,11C, 11D,18,34,38,41, 42,56E,56F,56G, 56P,56Q,100,101
R	PWA 8170-28	Housing	37
R	PWA 8170-29	Housing	103,103A,105,105A
R	PWA 8282	Gage	12A
R	PWA 9789	Riveter	34A
R	PWA 9827	Master	40A
R	PWA 10313	Puller	103B
R	PWA 10337	Riveter	51A
R	PWA 10503	Drift	83B
R	PWA 10723	Adapter	66
	PWA 10836	Fixture	12A
	PWA 10838	Holder	12A
	PWA 11091 Superseded By PWA 17629	Fixture	56G-1
	PWA 11108	Weight	12A
	PWA 11336	Pusher	56C-1,102
	PWA 11337	Support	56C-1,102
	PWA 11339	Belt	56C-1,102
	PWA 12581	Fixture	27A
	PWA 12745	Distributor	38-1,38A
	PWA 12976	Holding Ring	18B
	PWA 13000	Bellmouth	50

Numerical Tool List
Table 302 (Continued)

Tool No.	Tool Name	Tool Group
PWA 13001	Screen	50
PWA 13002	Fairing	50
PWA 13004	Test Mount	41,42,50
PWA 13005	Test Mount	41,42,50
PWA 13006 Superseded By PWA 13574	Bracket	50
PWA 13007	Adapter	50
PWA 13010 Superseded By PWA 13763	Fixture	7
PWA 13011	Fixture	11
PWA 13012	Adapter	66
PWA 13013	Adapter	66
PWA 13014	Probe	50
PWA 13015 Superseded By PWA 13979	Clamp	A5
PWA 13015-1 Superseded By PWA 13979-3	Tip	A5
PWA 13016	Adapter	12
PWA 13020	*Base*	*94A*
PWA 13022	Puller	51,54,89
PWA 13023	Drift	15
PWA 13024	Puller	16
PWA 13026	Base	53,58
R PWA 13027	Guide	60

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13028	Drift	
R	Superseded by		
R	PWA 13617		
R	PWA 13029	Drift	
R	Superseded by		
R	PWA 13618		
R	PWA 13030	Guide	53,58
R	PWA 13032	Tap	85A
R	PWA 13033	Puller	
R	Superseded by		
R	PWA 13553		
R	PWA 13035	Wrench	80,81
R	PWA 13036	Holder	80,81
R	PWA 13037	Wrench	31,32
R	PWA 13041	Adapter	49
R	PWA 13042	Adapter	3
R	PWA 13043	Adapter	8,12
R	PWA 13044	Cover	2
R	PWA 13045	Cover	13
R	PWA 13046	Cover	2
R	PWA 13047	Adapter	2
R	PWA 13048	Drift	94A
R	PWA 13049	Drift	60
R	PWA 13050	Adapter	12,13
R	PWA 13051	Puller	95A
R	PWA 13052	Drift	38
R	PWA 13053	Adapter	100,101

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13065	Collar	47,56H,83A
R	PWA 13055	Puller	84
R	PWA 13056	Wrench	100,101
R R R	PWA 10358 Superseded by PWA 13883	Puller	
R	PWA 10359	Fixture	97
R R	PWA 13060	Stand	35,40,45,56H,56J, 56M,83A,98
R	PWA 13061	Plate	12,40,45,47,83A
R	PWA 13064	Support	46H
R	PWA 13065	Collar	47,56H,83A
R R	PWA 13067	Sling	1,9,102,102A,103B, 104
	PWA 13070	Stand	1,9,102,102A,103B, 104
	PWA 13072	Puller	99
	PWA 13073	Plug	98
	PWA 13074 Superseded By PWA 13490	Riveter	30
	PWA 13075	Drift	5
	PWA 13076	Drift	6
	PWA 13077	Drift	5
	PWA 13078	Wrench	6,42
	PWA 13080	Bracket	41,42
R	PWA 13081	Pusher	42

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13082	Plate	6,38
R	PWA 13083	Drift	6,38
R	PWA 13084	Wrench	41,42
R	PWA 13085	Wrench	72,73
R	PWA 13086	Wrench	9,102,104
R	PWA 13089	Fixture	51,52
R	PWA 13090	Fixture	34
R	PWA 13093	Eye	100,101
R	PWA 13094	Holder	10,102,104
	PWA 13095	Fixture	99,102
	PWA 13096	Drift	97
	PWA 13097	Gage	98
	PWA 13098	Gage	98
	PWA 13099	Puller	85
	PWA 13100 Superseded By PWA 13550	Gage	
	PWA 13101	Holder	100
	PWA 13102 Superseded By PWA 13375	Puller	
	PWA 13103	Plate	74
	PWA 13104	Drift	74
	PWA 13105 Superseded By PWA 13388	Holder	
	PWA 13106	Drift	43

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
	PWA 13107	Pin	100
	PWA 13109	Adapter	1,22
	PWA 13110	Fixture	1
	PWA 13111 Superseded By PWA 13328	Guide	
	PWA 13112	Pusher	41
	PWA 13113	Wrench	28,34,35,38
	PWA 13114 Superseded By PWA 13367	Puller	
	PWA 13122	Drift	70
	PWA 13124	Drift	75,75A
	PWA 13125	Jig	75
	PWA 13129	Cover	12
	PWA 13130	Cover	12
	PWA 13131	Cover	12
	PWA 13133	Plug	12
	PWA 13134	Cover	12
	PWA 13136	Puller	70
	PWA 13137 Superseded By PWA 13531	Puller	
R	PWA 13138	Drift	25
R	PWA 13147	Drift	78
R	PWA 13148	Drift	78
R	PWA 13149	Guide	78

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13151	Adapter	66
R	PWA 13154	Jig	26
R R	PWA 13156	Adapter	67,70,71,75,75A, 76,93
R	PWA 13157	Fixture	83
R	PWA 13158	Puller	46
R R R	PWA 13160 Superseded by PWA 13300	Fixture	
R	PWA 13162	Wrench	35
R	PWA 13164	Spacer	39
R	PWA 13166	Riveter	38
R	PWA 13167	Drift	79B
R	PWA 13168	Adapter	50
R	PWA 13169	Thermocouple	50
R	PWA 13170	Stand	38
R	PWA 13171	Wrench	36,38
R R R	PWA 13172 Superseded by PWA 13365	Puller	
R	PWA 13173	Puller	38
R	PWA 13176	Drift	94
R	PWA 13177	Puller	95
R	PWA 13178	Drift	94
R	PWA 13179	Guide	94

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13180-2	Bearing	
R	Superseded by		
R	PWA 13380-3		
R	PWA 13180-4	Bearing	
R	Superseded by		
R	PWA 13380-2		
R	PWA 13181	Adapter	40,45,83A
R	PWA 13184	Pins	98
R	PWA 13186	Base	94
	PWA 13188	Plate	56,90
	PWA 13189	Drift	56
	PWA 13190	Base	55
	PWA 13191	Drift	55
	PWA 13192	Plate	56
	PWA 13193	Drift	56
	PWA 13194	Base	55,86
	PWA 13195	Drift	55
	PWA 13197	Plate	59
	PWA 13198	Drift	59
	PWA 13199	Base	58
	PWA 13200	Drift	58
	PWA 13201	Plate	59
	PWA 13202	Drift	59
	PWA 13203	Base	58
	PWA 13204	Drift	58
	PWA 13206	Drift	90

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
	PWA 13208	Drift	92
	PWA 13209	Plate	90
	PWA 13210	Drift	90
	PWA 13211	Base	92
	PWA 13212	Drift	92
	PWA 13213	Plate	87
	PWA 13214	Drift	87
	PWA 13216	Puller	87
	PWA 13217	Holder	21,23
	PWA 13218	Wrench	23
	PWA 13219	Plate	23
	PWA 13220	Drift	23
	PWA 13221	Drift	21
	PWA 13222	Plate	23
	PWA 13223	Drift	23
R	PWA 13224	Puller	23
R	PWA 13225	Support	21
R	PWA 13226	Holder	21,23
R	PWA 13227	Wrench	21,23
R	PWA 13228	Adapter	35
R	PWA 13229	Drift	21
R	PWA 13230	Plate	23,71B
R	PWA 13231	Drift	23,71B
R	PWA 13232	Base	19,71A

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R R R	PWA 13233 Superseded by PWA 13848	Drift	
R	PWA 13234	Plate	23,71B
R	PWA 13235	Plate	94A
R	PWA 13236	Drift	19,71A
R	PWA 13237	Puller	95A
R	PWA 13238	Puller	95A
R	PWA 13239	Drift	95A
R	PWA 13240	Base	94A
R	PWA 13241	Drift	94A
R	PWA 13243	Spreader	29
R	PWA 13250	Drift	86
R	PWA 13251	Puller	79
R	PWA 13252	Bracket	50
R	PWA 13253	Bracket	50
R	PWA 13260	Fixture	44
R	PWA 13261	Weight	44
R	PWA 13265	Drift	31
R R	PWA 13267	Jack	35,40,41,56E, 56J,56M
R	PWA 13268	Mount	50
R	PWA 13270	Jig	14
R	PWA 13271	Fixture	63
R	PWA 13273	Wrench	34,38

Numerical Tool List
Table 302 (Continued)

Tool No.	Tool Name	Tool Group
PWA 13274	Compressor	14
PWA 13275	Drift	102
PWA 13277	Riveter	95B,105
PWA 13284	Jig	82
PWA 13285	Drift	51
PWA 13286	Spacer	35
PWA 13288 Superseded By PWA 13631	Gage	
PWA 13289	Pusher	28,29
PWA 13290	Pusher	28,29
PWA 13291 Superseded By PWA 13630	Gage	
PWA 13292	Wrench	35
PWA 13293	Fixture	30
PWA 13294	Collar	9,10,98,99,102,104, 105
PWA 13295	Fixture	9,102,104,105
PWA 13296	Drift	68,71A
PWA 13297	Puller	23
PWA 13298	Cover	13A,48,56H-1
PWA 13300	Fixture	33,37,38,40
PWA 13304	Riveter	77
PWA 13305	Fixture	98

R
R

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
	PWA 13306 Superseded By PWA 13634	Adapter	
	PWA 13308	Plate	59
	PWA 13309	Puller	56
	PWA 13310	Puller	32
	PWA 13311	Fixture	31,32
	PWA 13312	Riveter	10,31,38,42
	PWA 13313	Support	56H
	PWA 13315	Adapter	8
	PWA 13316	Wrench	10,18
	PWA 13317	Nozzle	50
R	PWA 13318	Adapter	34
R	PWA 13320	Heater	33,34
R R	PWA 13328 Supersedes PWA 13111	Guide	
R	PWA 13329	Drift	25
R	PWA 13337	Gage	106
R	PWA 13338	Master	106
R	PWA 13339	Gage	106
R	PWA 13340	Master	106
R	PWA 13344	Drift	69,70A,93
R	PWA 13345	Jig	93
R	PWA 13346	Puller	93
R	PWA 13347	Drift	71

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13348	Jig	70A
R R R	PWA 13350 Superseded by PWA 13450	Stand	
R	PWA 13351	Gage	96A
R	PWA 13353	Pin	56L
R	PWA 13354	Jig	67
R	PWA 13355	Jig	76
R	PWA 13356	Puller	71
R	PWA 13357	Jig	71
R	PWA 13358	Jig	69
R	PWA 13359	Drift	57
R	PWA 13360	Jig	57
R	PWA 13361	Drift	26
R R R	PWA 13362 Superseded by PWA 39025	Gage	
R	PWA 13363	Puller	6
R R R	PWA 13364 Superseded by PWA 13547	Puller	
R	PWA 13365	Puller	38
R	PWA 13366	Puller	104
R	PWA 13367	Puller	104
	PWA 13368	Strap	105,105A
	PWA 13369	Gage	1A
	PWA 13370	Adapter	12A

Numerical Tool List
Table 302 (Continued)

Tool No.	Tool Name	Tool Group
PWA 13371	Puller	76
PWA 13372	Bracket	50
PWA 13373	Drift	53
PWA 13374 Superseded By PWA 13598	Puller	
PWA 13375 Supersedes PWA 13102	Puller	73
PWA 13376	Adapter	27
PWA 13378	Support	35
PWA 13380-2 Superseded By PWA 21350-12	Bearing	
PWA 13380-3 Superseded By PWA 21350-13	Bearing	
PWA 13380-4 Superseded By PWA 21350-14	Bearing	
PWA 13381	Pilot	96B,102,102A,103B
PWA 13382	Ring	96B,103B
PWA 13383	Pusher	96B,103B
PWA 13385	Plug	50
PWA 13386	Puller	94A
PWA 13387	Puller	79-1
PWA 13388 Supersedes PWA 13105	Holder	72,73,74
PWA 13389	Cover	45A,47A
PWA 13391	Cover	45A

R
R

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
	PWA 13392	Cover	45A
	PWA 13393	Cover	45A,47A
	PWA 13397	Gage	40A
	PWA 13398	Bar	40A
	PWA 13399	Gage	40A
	PWA 13400	Bar	40A
	PWA 13401	Bar	40A
R	PWA 13403	Bar	40A
R	PWA 13404	Bar	40A
R	PWA 13405	Bar	40A
R	PWA 13406	Gage	40A
R	PWA 13407	Bar	40A
R	PWA 13408	Bar	40A
R	PWA 13410	Bar	40A
R	PWA 13411	Bar	40A
R	PWA 13412	Gage	40A
R	PWA 13413	Bar	40A
R	PWA 13414	Gage	40A
R	PWA 13415	Gage	40A
R R R	PWA 13416 Superseded by PWA 13574	Bracket	
R	PWA 13417	Handle	27
R R R	PWA 13418 Superseded by PWA 13351	Adapter	

	Tool No.	Tool Name	Tool Group
R	PWA 13423	Fixture	29A
R	PWA 13424	Fixture	29A
R	PWA 13425	Fixture	29A
R	PWA 13426	Fixture	29A,29B
R	PWA 13427	Fixture	29A,29B
R	PWA 13428	Fixture	29A
R	PWA 13429	Fixture	29A,29B
R	PWA 13430	Fixture	29A,29B
R	PWA 13436	Fixture	96A-1
R	PWA 13440	Fixture	36
R	PWA 13444	Template	96A-1
R	PWA 13446	Fixture	96A-1
R R R	PWA 13450 Superseded by PWA 13452	Stand	
R	PWA 13452	Stand	56H,56L,56N
R	PWA 13457	Adapter	56E,56J,56M
	PWA 13458	Plate	56J,56M
	PWA 13459	Eye	56M,56N,56Q
	PWA 13460	Puller	56Q
	PWA 13461	Wrench	56P,56Q,102A,104A
	PWA 13462	Holder	56F,56G
	PWA 13463	Drift	56F,102A
	PWA 13464	Plate	56G,104A
	PWA 13465	Drift	56G,104A

Numerical Tool List
Table 302 (Continued)

Tool No.	Tool Name	Tool Group
PWA 13466 Superseded By PWA 13874	Wrench	
PWA 13467	Puller	56B
PWA 13468	Wrench	11C,11D
PWA 13469	Drift	11C
PWA 13470	Holder	56A,56C
PWA 13471	Wrench	11E,56C
PWA 13472	Riveter	56C
PWA 13473 Superseded By PWA 13838	Wrench	
PWA 13474	Wrench	11A,11B,56E
PWA 13475	Puller	11B,11B-1
PWA 13476	Riveter	11A,11C
PWA 13477	Drift	11A,102A
PWA 13478	Holder	11A,11B
PWA 13479	Eye	56K,103A,103B,104A
PWA 13483	Drift	56C
PWA 13484	Base	56C
PWA 13485	Plate	56-1,56A
PWA 13486	Drift	
PWA 13487 Superseded By PWA 13766	Bracket	

	Tool No.	Tool Name	Tool Group
	PWA 13490 Supersedes PWA 13074 Superseded By PWA 13701 And PWA 13702	Riveter	30,102
	PWA 13492 Superseded By PWA 13704	Fixture	
R	PWA 13497	Pilot	96B
R	PWA 13498	Ring	96B
R	PWA 13499	Pusher	96B
R	PWA 13500	Mount	50
R	PWA 13501	Mount	50
R R	PWA 13503	Adapter	11-1,11-2,12,13-1, 13-2
R	PWA 13504	Fixture	11-2
R	PWA 13505	Fixture	12C
R	PWA 13506	Cover	11-1,13-1
R	PWA 13507	Cover	11-1,13-1
R	PWA 13508	Cover	11-1
R	PWA 13509	Cover	1B
R	PWA 13510	Cover	1B
R	PWA 13511	Cap	1B
R	PWA 13512	Plug	1B
R	PWA 13515	Sling	56H-1
R	PWA 13516	Collar	103B
R	PWA 13517	Collar	102A

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13518	Fixture	102A,103B,104A
R	PWA 13519	Spacer	102A
R	PWA 13520	Fixture	102A
R	PWA 13521	Wrench	102A,104A
R	PWA 13522	Puller	104A
R	PWA 13523	Holder	102A,104A
R	PWA 13524	Support	103A
R	PWA 13525	Wrench	102A,104A
R	PWA 13526	Puller	103B
R R R	PWA 13527 Superseded by PWA 13767	Puller	
R	PWA 13530	Holder	102A,104A
R R	PWA 13531 Supersedes PWA 13137	Puller	75
	PWA 13532	Adapter	50
	PWA 13533	Bellmouth	50
	PWA 13534	Screen	50
	PWA 13535	Stand	50
	PWA 13536 Supersedes PWA 13409	Bar	40A
	PWA 13537	Gage	40A
	PWA 13538	Anvil	30
	PWA 13539 Superseded By PWA 13701 And PWA 13702	Anvil	

Numerical Tool List
Table 302 (Continued)

Tool No.	Tool Name	Tool Group
PWA 13541	Anvil	30
PWA 13542	Anvil	30
PWA 13544	Fixture	96A-3
PWA 13546	Wrench	38
PWA 13547 Supersedes PWA 13364	Pulley	38
PWA 13548	Spacer	35
PWA 13550 Supersedes PWA 13100	Gage	24
PWA 13551 Supersedes PWA 13418	Adapter	27
PWA 13553 Supersedes PWA 13033 Superseded By PWA 13939	Puller	
PWA 13554	Cover	40B
PWA 13555	Cover	40B
PWA 13556	Plug	40B
PWA 13557 Superseded By PWA 13627	Base	
PWA 13558	Cover	40B
PWA 13560	Gage	40A
PWA 13562 Superseded By PWA 13628	Adapter	
PWA 13563	Fixture	96A-1
PWA 13566	Master	96A-1
PWA 13569	Template	96A-2

	Tool No.	Tool Name	Tool Group
	PWA 13570	Fixture	96A-2
R	PWA 13571	Fixture	96A-2
R	PWA 13572	Fixture	96A-2
R	PWA 13573	Master	96A-2
R	PWA 13574	Bracket	50
R	Supersedes PWA 13006		
R	PWA 13575	Bracket	50
R	PWA 13576	Bar	40A
R	PWA 13577	Bar	40A
R	PWA 13578	Bar	40A
R	PWA 13579	Bar	40A
R	PWA 13580	Gage	40A
R	PWA 13581	Gage	40A
R	PWA 13583	Pusher	29
R	PWA 13598	Puller	54
R	Supersedes PWA 13374		
R	PWA 13600	Gage	106
R	PWA 13601	Master	106
R	PWA 13602	Gage	106
R	PWA 13603	Master	106
R	PWA 13605	Plug	30A
R	PWA 13606	Plug	30A
R	PWA 13607	Plug	30A
R	PWA 13610	Plug	30A,34-1
R	PWA 13611	Adapter	30A

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13612	Adapter	30A
R	PWA 13613	Adapter	30A
R R	PWA 13617 Supersedes PWA 13028	Drift	53,88
R	PWA 13618	Drift	60
R	PWA 13619	Drift	94A
R	PWA 13620	Drift	94
R	PWA 13621	Pilot	56G-1
R	PWA 13622	Pilot	56G-1
R	PWA 13623	Pilot	56G-1
	PWA 13625	Pusher	56G-1
	PWA 13626	Pusher	56G-1
	PWA 13627 Supersedes PWA 13557	Base	35
	PWA 13628 Supersedes PWA 13562	Adapter And Bearing Assembly	35
	PWA 13629	Support	35
	PWA 13630 Supersedes PWA 13291	Gage	35
	PWA 13631 Supersedes PWA 13288	Gage	35
	PWA 13632	Puller	29,37
	PWA 13633	Adapter	39A
	PWA 13634	Adapter	30,56G-2
	PWA 13635	Adapter	35
	PWA 13636	Pusher	35

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
	PWA 13638	Base	64
	PWA 13639	Drift	64
	PWA 13640	Drift	65
	PWA 13644	Puller	23
	PWA 13661	Punch	51A
	PWA 13662	Punch	51A
	PWA 13664	Bar	40A
	PWA 13665	Bar	40A
	PWA 13666	Bar	40A
	PWA 13667	Anvil	34A
	PWA 13668	Punch	34A
	PWA 13672	Plate	56A
	PWA 13678	Riveter	29A-1
	PWA 13679	Drift	36
	PWA 13681	Locator	17,18A
	PWA 13682	Fixture	18A
	PWA 13688	Riveter	34A
R R R	PWA 13701 Supersedes PWA 13490 and PWA 13539	Riveter	102
R R R	PWA 13702 Supersedes PWA 13490 and PWA 13539	Riveter	102
R	PWA 13703	Fixture	105B-1
R R	PWA 13704 Supersedes PWA 13492	Fixture	29A,29B

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13705	Drift	83C
R	PWA 13706	Base	83C
R	PWA 13707	Fixture	83-1
R	PWA 13708	Drift	50A
R	PWA 13718	Drift	88
R	PWA 13723	Heater	35
R	PWA 13724	Fixture	29A-1
R	PWA 13727	Fixture	117B
R	PWA 13728	Fixture	117C
R	PWA 13729	Fixture	117A
R	PWA 13730	Shroud	105
R R R	PWA 13731 Superseded by PWA 13866	Fixture	
R	PWA 13732	Fixture	40A
R	PWA 13734	Gage	106
R	PWA 13735	Hanger	29A-1
R	PWA 13736	Fixture	29A-1
R	PWA 13737	Fixture	29A-1
R	PWA 13738	Fixture	29A-1
R	PWA 13739	Fixture	29A-1
R	PWA 13740	Fixture	29A-1
R	PWA 13741	Fixture	29A-1
R	PWA 13742	Fixture	29A-1
R	PWA 13752	Fixture	18B

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13753	Fixture	85-1
R	PWA 13754	Fixture	85-1
	PWA 13755	Fixture	85-1
	PWA 13757	Spacer	35
	PWA 13758	Fixture	14A,96C-2
	PWA 13763 Supersedes PWA 13010	Fixture	7
	PWA 13765	Nozzle	50
	PWA 13766 Supersedes PWA 13487	Bracket	11B-1,56D,56E
	PWA 13768 Superseded By PWA 13819	Riveter	
	PWA 13771 Superseded By PWA 13819	Punch	
	PWA 13772 Superseded By PWA 13819	Anvil	
	PWA 13780	Gage	28
	PWA 13782	Adapter	38-1
	PWA 13784	Ram	38-1,38A
	PWA 13785	Thimble	38-1
	PWA 13786	Thimble	38-1
	PWA 13787	Wrench	38-1,38A
	PWA 13788	Fixture	38-1,38A
	PWA 13789	Adapter	38A
	PWA 13791	Thimble And Rod	38A

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
	PWA 13792	Wrench	21
	PWA 13796	Fixture	29-1
	PWA 13802	Bar	40A
	PWA 13806	Bellmouth	50
	PWA 13807	Fixture	56R
	PWA 13808	Fixture	84A
	PWA 13810	Gage	56R,84A
	PWA 13811	Support	56R
	PWA 13812	Support	56R
	PWA 13813	Support	84A
	PWA 13818	Pusher	31
	PWA 13819 Supersedes PWA 13768	Riveter	56G-2
R	PWA 13825	Pusher	29
R	PWA 13826	Puller/Driver	71A,71B
R	PWA 13827	Base	71B
R	PWA 13828	Drift	71B
R	PWA 13829	Puller	34
R	PWA 13830	Drift	71A
R	PWA 13831	Plate	71B
R	PWA 13832	Drift	23,71B
R	PWA 13833	Drift	71B
R	PWA 13838	Wrench	56E
R	PWA 13840	Fixture	96C-1

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 13841	Fixture	96C-1,96C-2
R	PWA 13842	Fixture	96C-1
R	PWA 13843	Adapter	56E
R	PWA 13844	Adapter	34-1
R	PWA 13845	Wrench	62
R R R	PWA 13846 Superseded by PWA 13923	Fixture	
R	PWA 13847	Fixture	18C
R	PWA 13848	Drift	19,71A
R	PWA 13849	Fixture	18C
R	PWA 13850	Fixture	18C
R	PWA 13851	Fixture	71B
R	PWA 13856	Ring	50
R	PWA 13857	Fixture	41A
R	PWA 13858	Plate	41A
R	PWA 13862	Fixture	41A
R	PWA 13863	Fixture	41A
R	PWA 13864	Ring	41A
R	PWA 13865	Plate	41A
R R	PWA 13866 Supersedes PWA 13731	Fixture	27B
R	PWA 13867	Holder	11E
	PWA 13870	Puller	29-2
	PWA 13871	Puller	29-2

Numerical Tool List
Table 302 (Continued)

Tool No.	Tool Name	Tool Group
PWA 13872	Wrench	10
PWA 13873	Adapter	10
PWA 13874 Supersedes PWA 13466	Wrench	56F
PWA 13875	Adapter	56F
PWA 13876	Plate	56Q-1
PWA 13877	Adapter	56Q-1
PWA 13879	Cover	34-1
PWA 13880	Cover	34-1
PWA 13883 Supersedes PWA 13058	Puller	9
PWA 13892	Drift	83D
PWA 13907	Drift	29-1A
PWA 13908	Base	29-1A
PWA 13918	Nut	36
PWA 13919	Wrench	10
PWA 13920	Adapter	10
PWA 13923	Pliers	23
PWA 13925	Fixture	29A
PWA 13926	Fixture	29A
PWA 13928	Fixture	29A
PWA 13929	Fixture	29A
PWA 13937	Clamp	103A
PWA 13939	Puller	34
PWA 13940	Jig	75A

R
R

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
	PWA 13941	Gage	56E-1
	PWA 13942	Gage	56E-1
	PWA 13943	Clamp	80A,81
	PWA 13944	Locator	56Q-2
R	PWA 13946	Guide	31,38.95B
R	PWA 13949	Adapter	95B
R	PWA 13950	Adapter	95B
R	PWA 13952A	Periscope	95B
R	PWA 13963	Remover	34,95B
R	PWA 13964	Inserter	95B
R	PWA 13969	Remover	95B
R	PWA 13974	Puller	34,95B
R R R	PWA 13975 Superseded by PWA 13977	Riveter	
R	PWA 13976	Fixture	84B
R R	PWA 13977 Supersedes PWA 13975	Riveter	31,38,95B
R R	PWA 13979 Supersedes PWA 13015	Clamp	66
R	PWA 13985	Adapter	44A
R	PWA 13986	Adapter	44A
R	PWA 13987	Anvil	44A
R	PWA 13988	Punch	44A
R	PWA 13989	Anvil	44A
R	PWA 13990	Anvil	44A

	Tool No.	Tool Name	Tool Group
R	PWA 13991	Punch	44A
R	PWA 13992	Punch	44A
R	PWA 13993	Punch	44A
R	PWA 13994	Punch	44A
R R	PWA 14558 Supersedes PWA 13152	Harness	50
R	PWA 15225	Stand	66
R	PWA 15361	Safety Block	96D
R	PWA 15595	Die	96D
R	PWA 15597	Die	96D
R	PWA 15598	Insert	96D
R	PWA 15599	Insert	96D
	PWA 15669	Die	96D
	PWA 15670	Locator	96D
	PWA 15671	Locator	96D
	PWA 15672	Insert	96D
	PWA 15673	Insert	96D
	PWA 15675	Die	96D
	PWA 15676	Adapter	96D
	PWA 16397 Superseded By PWA 17751	Plug	
	PWA 16600-61	Adapter	96
	PWA 16600-66	Adapter	96
	PWA 16680	Drift	56A

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
	PWA 16980 Superseded By PWA 35183	Press	
	PWA 17019	Holder	96A-1,96A-2
	PWA 17137	Gage	96A-1,96A-2
	PWA 17138	Gage	96A-1,96A-2
	PWA 17629 Supersedes PWA 11091	Fixture	56C-1,56G-1,96B,102, 103B
	PWA 17751 Supersedes PWA 16397	Plug	96C
	PWA 17775	Wrench	96A-3
	PWA 17783	Insert	96A-3
	PWA 21350-12	Bearing	36
	PWA 21350-13	Bearing	36,102,102A
	PWA 22324	Cap	50
	PWA 22634	Riveting And Tab Bending Machine	44A
R	PWA 22653	Punch	44A
R	PWA 22654	Punch	44A
R	PWA 35058	Gage	107
R	PWA 35059	Master	107
R	PWA 35117	Gage	107
R	PWA 35118	Master	107
R	PWA 35121	Gage	107
R	PWA 35122	Master	107
R	PWA 35125	Gage	107

Numerical Tool List
Table 302 (Continued)

	Tool No.	Tool Name	Tool Group
R	PWA 35126	Master	107
R	PWA 35127	Gage	107
R	PWA 35128	Master	107
	PWA 35183	Press	96D
	PWA 39008	Drift	60A
	PWA 39009	Drift	60A
	PWA 39010	Drift	60A
	PWA 39013	Base	60A
	PWA 39019 Replaced By PWA 39028	Fixture	29-1B
	PWA 39022	Thimble	38-1
	PWA 39023	Thimble	38-1
	PWA 39025 Supersedes PWA 13362	Gage	96A
	PWA 39027	Puller	50A
	PWA 39028 Replaces PWA 39019	Fixture	29-1B
R	PWA 107529	Puller	29-2

Numerical Tool List
Table 302 (Continued)

3. Accessory Functional Tool Group List

Tool Group	Tool Name	Tool No.
A1.	Differential Fluid Pressure Switch Holding Adapter	PWA 15343

Tool Group List
Table 303

Tool Group	Tool Name	Tool No.
A2.	Fuel Coolant Oil Cooler	
	Thermostatic Valve Cold Length Gage	PWA 13341
	Oil-In And Oil-Out Adapter	PWA 13342
	Core Oil Flow Shut-off Valve	PWA 13343
	Thermostatic Valve Seat Drift	PWA 13420
	Fuel-In Port Adapter	PWA 13480
	Fuel-Out Port Adapter	PWA 13481
	Wrench	PWA 13726
A3.	Fuel De-icing Heater	
	Front Cover Insert Driver	PWA 6009-11
	Front Cover Insert Drill Jig	PWA 13263
	Static Pressure Test Fixture	PWA 13302
	Reaming Fixture	PWA 13930
	Reaming Bushing	PWA 13931
	Reamer	PWA 13932
	Bushing Hole Reamer	PWA 13933
	Bushing Drift	PWA 13934
	Drill Fixture	PWA 13935
	Pin Drift	PWA 13936
A4.	Fuel De-icing Shutoff Valve	
	Retaining Nut Wrench	PWA 13139
	Base	PWA 13141
	Bearing To Housing Drift	PWA 13174
	Bearing Drift	PWA 13175
	Test Fixture	PWA 13377
A5.	Fuel Manifold	
	Burrette And Valve Assembly	PWA 7441
	Fuel Nozzle Sealing Clamp	PWA 13979
	Fuel Nozzle Retaining Nut Wrench	PWA 13978
	Fuel Nozzle Retaining Nut Torque Support	PWA 13118
	Fuel Nozzle Tablock Crimper	PWA 13264
	Holding Fixture	PWA 13271
	Leak Check Adapter	PWA 13981
A6.	Fuel Nozzle	
	Holder	PWA 13324
A6A.	Fuel Dump Valve Assembly And Installation	
	Coil Spring Inserter	HS 9072
	Pilot Sleeve	PWA 13822

R
R

Tool Group List
Table 303 (Continued)

Tool Group	Tool Name	Tool No.
A7.	Fuel Pressurizing And Dump Valve	
	Liner Puller	PWA 13150
	Holding Fixture	PWA 13254
	Static Head Adapter	PWA 13255
	Spring Compressor	PWA 13301
A8.	Deleted	
A9.	Thermocouple Cable	
	Hand Pump (Used With PWA 12730)	PWA 3755 (Replaced By PWA 29389)
	Spacer Closing Die (For PN 457135)	PWA 13421
	Terminal Closing Press	PWA 12730
	Terminal Closing Die (Small Ears)	PWA 16690
	Terminal Closing Die (Large Ears)	PWA 16691
	Band Closing Die	PWA 16692
	Spacer Closing Die (For PN 418535)	PWA 16694

Tool Group List
Table 303 (Continued)

4. Accessory Numerical Tool List

Tool No.	Tool Name	Tool Group
HS 9072	Inserter	A6A
PWA 3755 (Replaced By PWA 29389)	Pump	A9
PWA 6009-11	Driver	A3
PWA 7441	Burrette And Valve Assembly	A5
PWA 12730 Supersedes PWA 16689	Press	A9
PWA 13015 Superseded By PWA 13979	Clamp	

R
R

Numerical Tool List
Table 304

Tool No.	Tool Name	Tool Group
PWA 13018 Superseded By PWA 13978	Wrench	
PWA 13118	Support	A5
PWA 13139	Wrench	A4
PWA 13141	Base	A4
PWA 13150	Puller	A7
PWA 13174	Drift	A4
PWA 13175	Drift	A4
PWA 13254	Fixture	A7
PWA 13480	Adapter	A2
PWA 13481	Adapter	A2
PWA 13726	Wrench	A2
PWA 13822	Sleeve	A6A
PWA 13930	Reaming Fixture	A3
PWA 13931	Reaming Bushing	A3
PWA 13932	Reamer	A3
PWA 13933	Bushing Hole Reamer	A3
PWA 13934	Bushing Drift	A3
PWA 13935	Drill Fixture	A3
PWA 13936	Pin Drift	A3
PWA 13255	Adapter	A7
PWA 13263	Jig	A3
PWA 13264	Crimper	A5

R
R

Numerical Tool List
Table 304 (Continued)

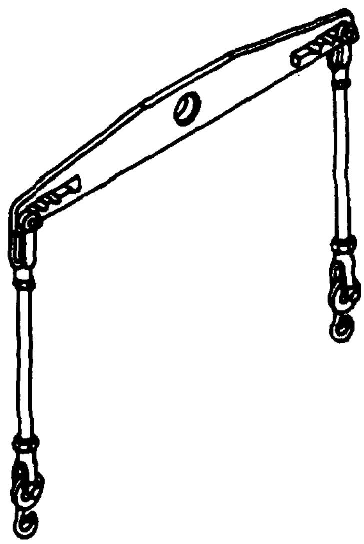
Tool No.	Tool Name	Tool Group
PWA 13271	Fixture	A5
PWA 13272 Superseded By PWA 13981	Adapter	
PWA 13301	Compressor	A7
PWA 13302	Fixture	A3
PWA 13303 Superseded By PWA 15343	Adapter	
PWA 13324	Holder	A6
PWA 13341	Gage	A2
PWA 13342	Adapter	A2
PWA 13343	Valve	A2
PWA 13377	Fixture	A4
PWA 13420	Drift	A2
PWA 13421	Die	A9
PWA 13978 Supersedes PWA 13018		A5
PWA 13979 Supersedes PWA 13015		A5
PWA 13981 Supersedes PWA 13272		A5
PWA 15343 Supersedes PWA 13303	Adapter	A2
PWA 16689 Superseded By PWA 12730	Press	
PWA 16690	Die	A9

R
R

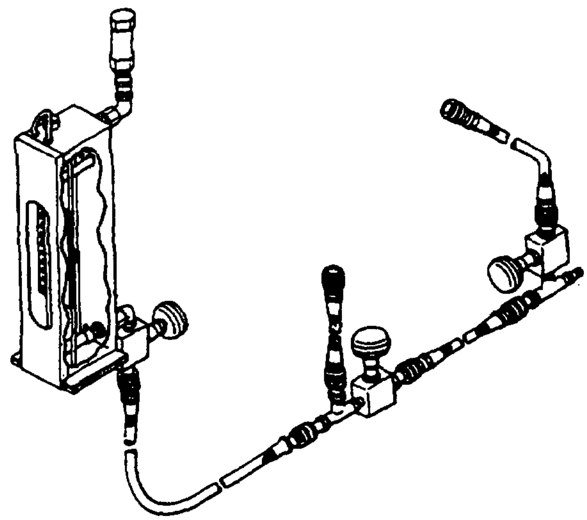
Numerical Tool List
Table 304 (Continued)

Tool No.	Tool Name	Tool Group
PWA 16691	Die	A9
PWA 16692	Die	A9
PWA 16694	Die	A9

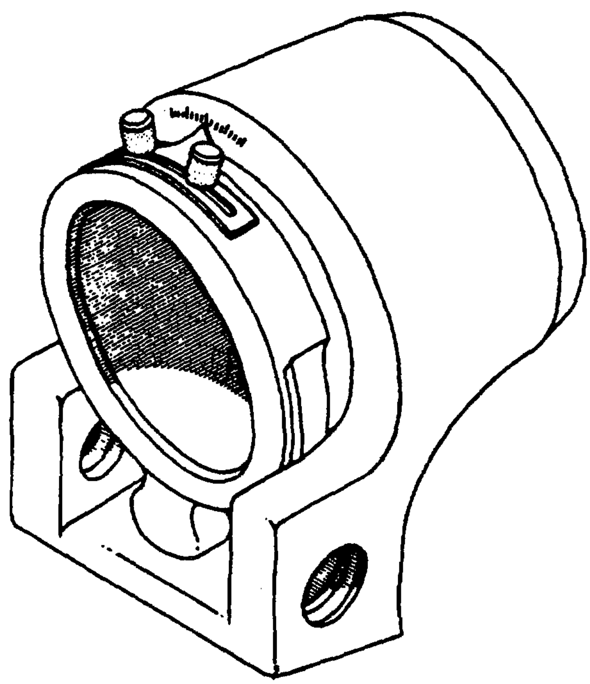
Numerical Tool List
Table 304 (Continued)



PWA-6580 Sling



PWA-7441 Burette

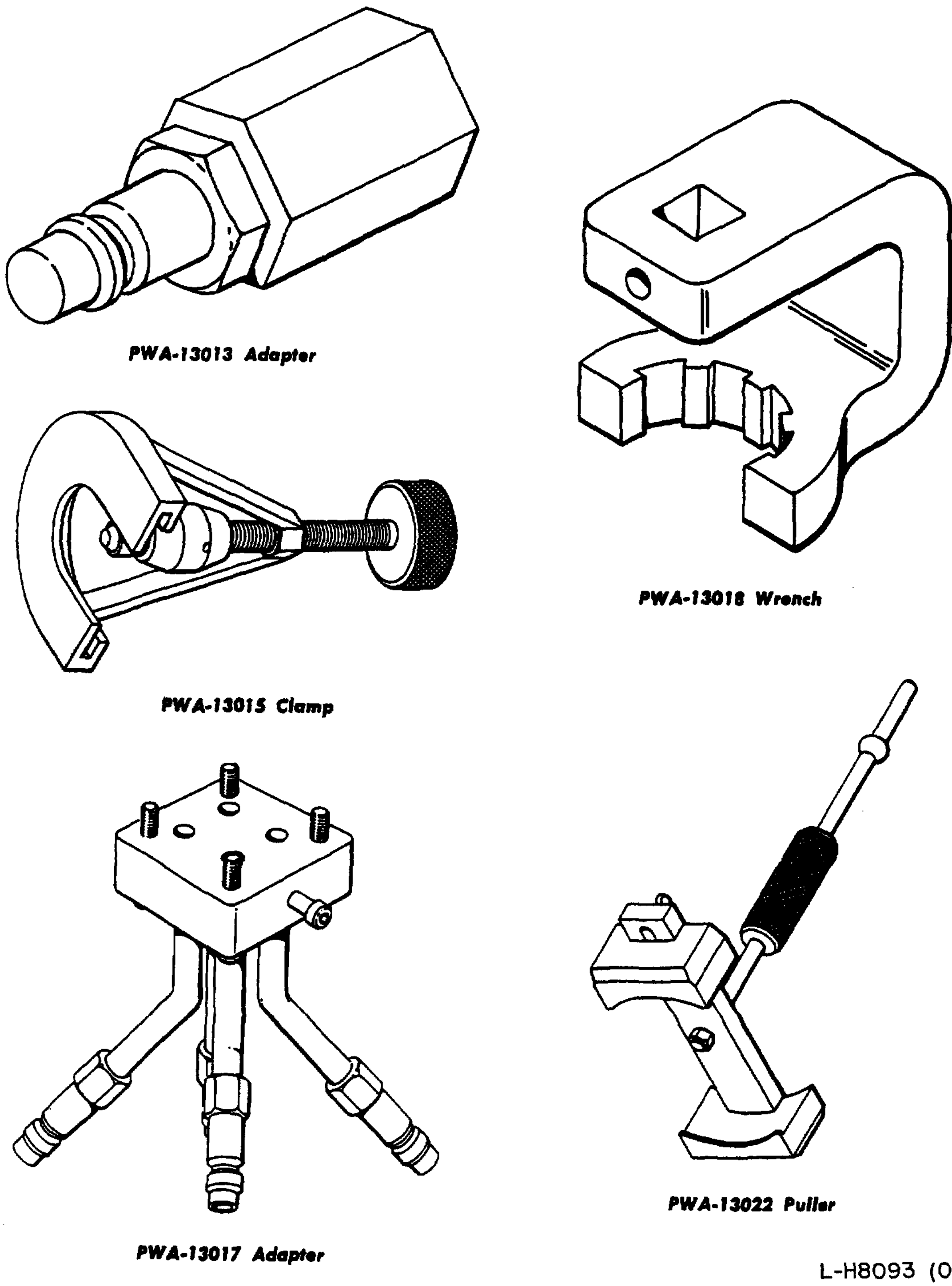


PWA-8050 Hydraulic Wrench

L-H8092 (0307)

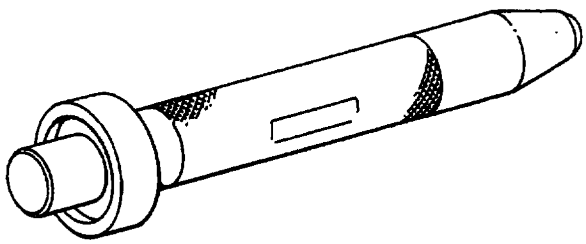
R
R

Tool Illustrations
Figure 301

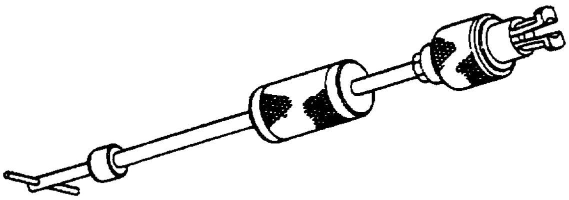


R
R

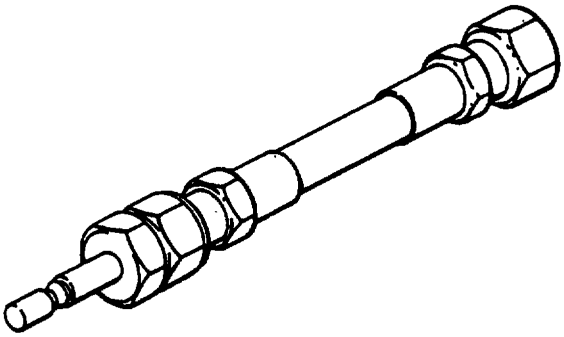
Tool Illustrations
Figure 302



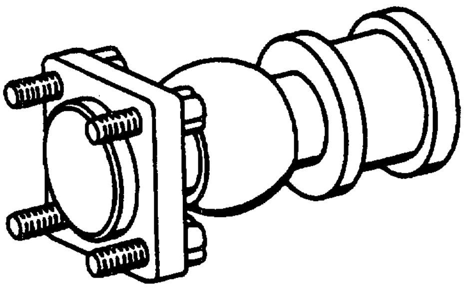
PWA-13023 Drift



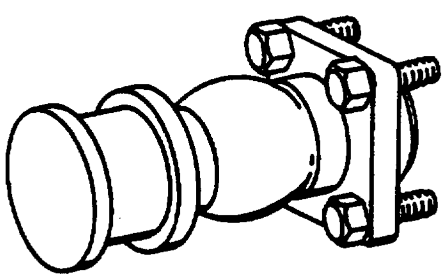
PWA-13024 Puller



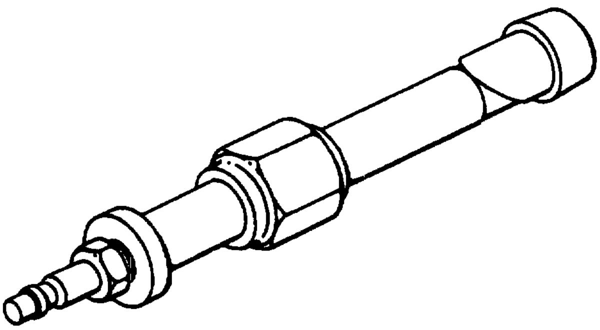
PWA-10723 Adapter



PWA-13005 Mount



PWA-13004 Mount

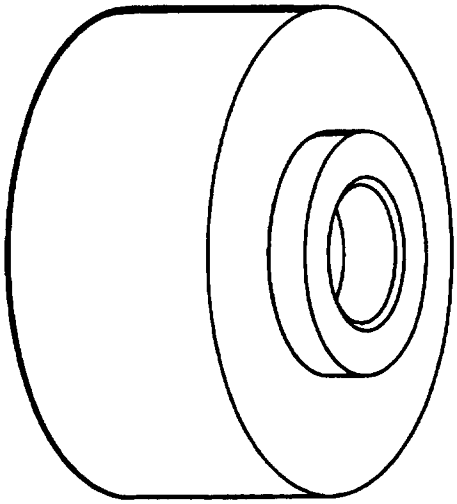


PWA-13012 Adapter

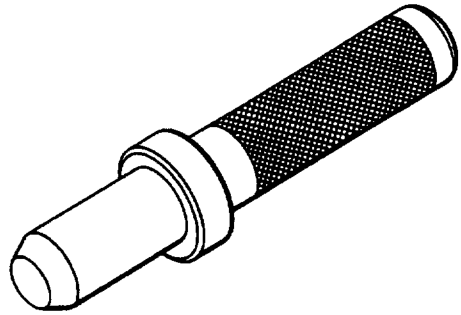
L-H8094 (0307)

R
R

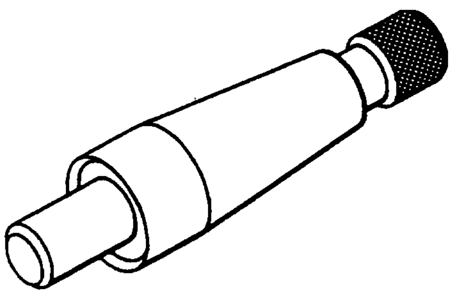
Tool Illustrations
Figure 303



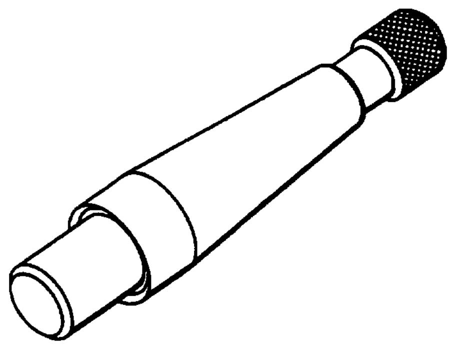
PWA-13026 Base



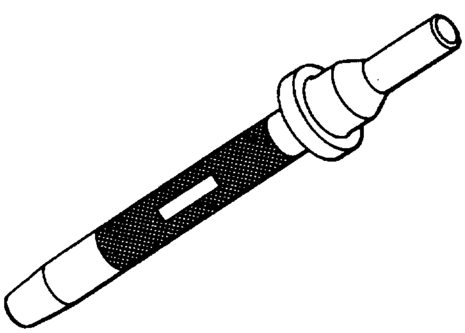
PWA-13029 Seal Drift



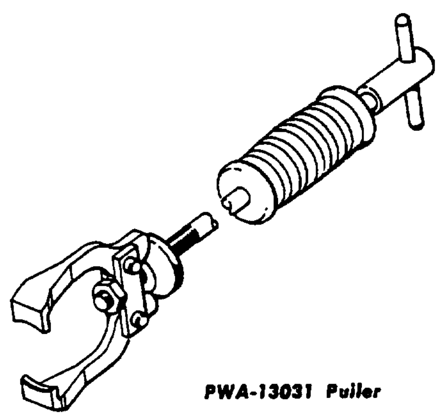
PWA-13027 Seal Guide



PWA-13030 Guide



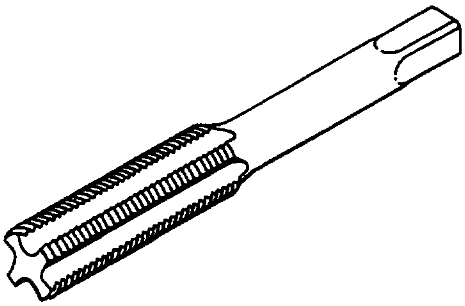
PWA-13028 Drift



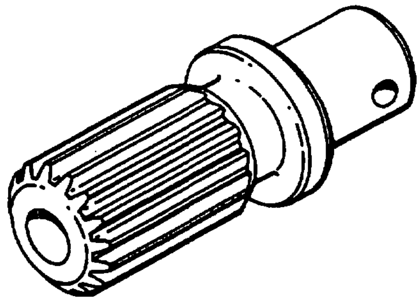
PWA-13031 Puller

L-H8095 (0307)

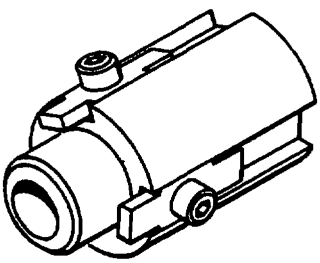
Tool Illustrations
Figure 304



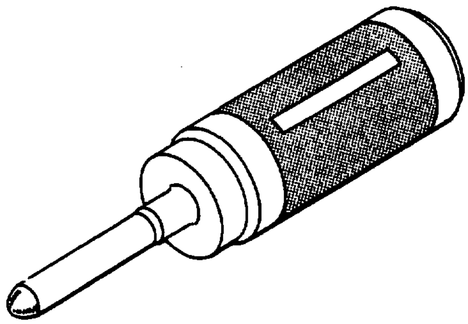
PWA-13032 Tap



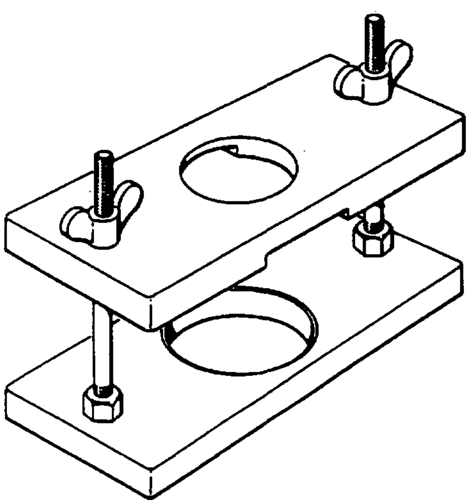
PWA-13041 Turning Adapter



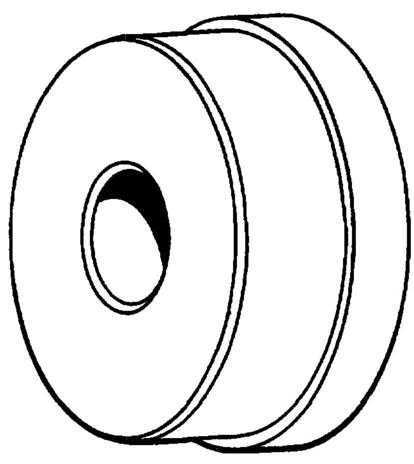
PWA-13035 Wrench



PWA-13048 Drift



PWA-13036 Holder



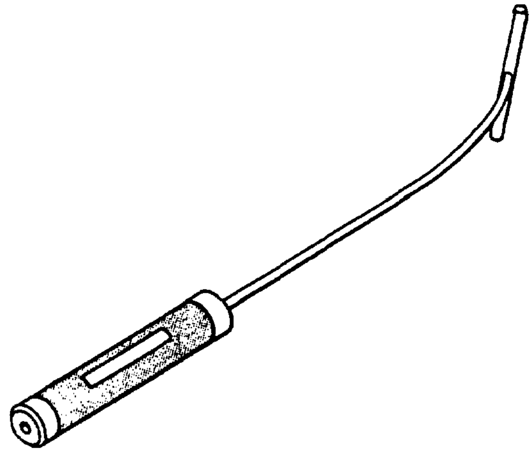
PWA-13049 Base

L-H8096 (0307)

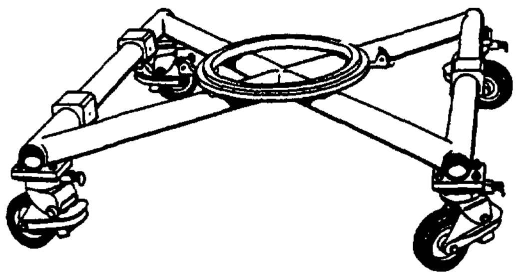
R
R

Tool Illustrations
Figure 305

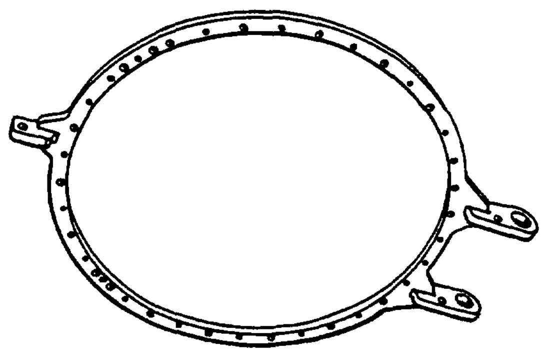
PWA-13051 Puller



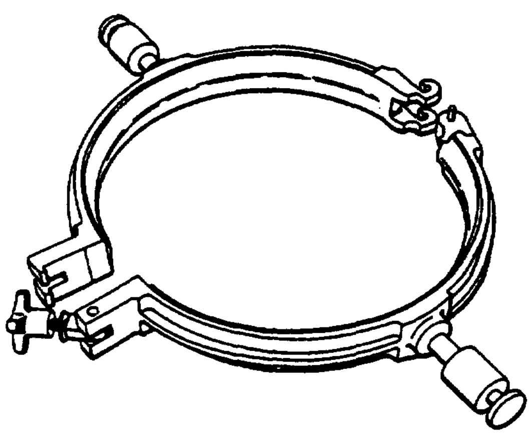
PWA-13054 Warpage Gage



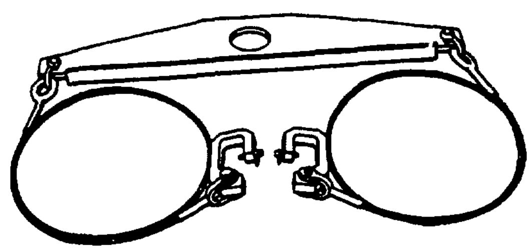
PWA-13060 Stand



PWA-13061 Plate



PWA-13065 Collar

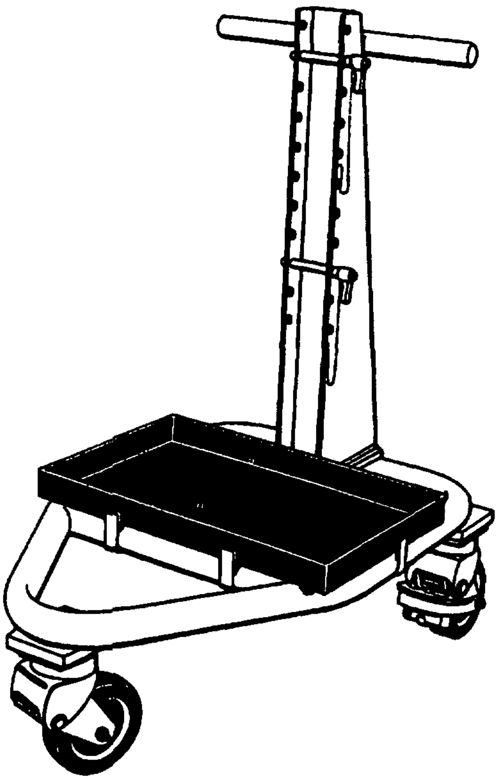


PWA-13067 Sling

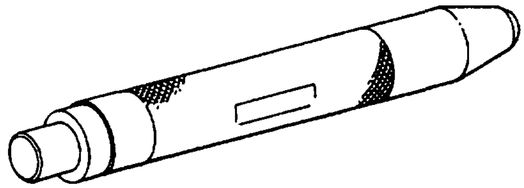
L-H8097 (0307)

R
R

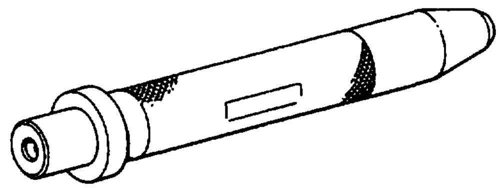
Tool Illustrations
Figure 306



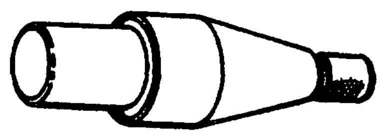
PWA-13070 Stand



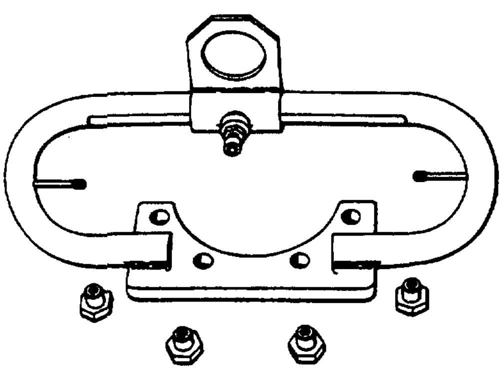
PWA-13147 Drift



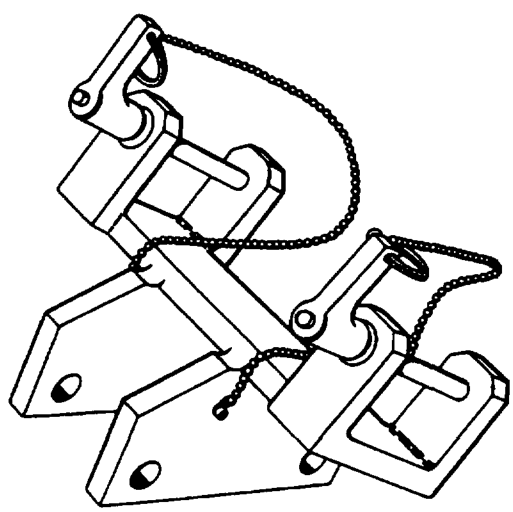
PWA-13148 Drift



PWA-13149 Guide



PWA-13109 Adapter

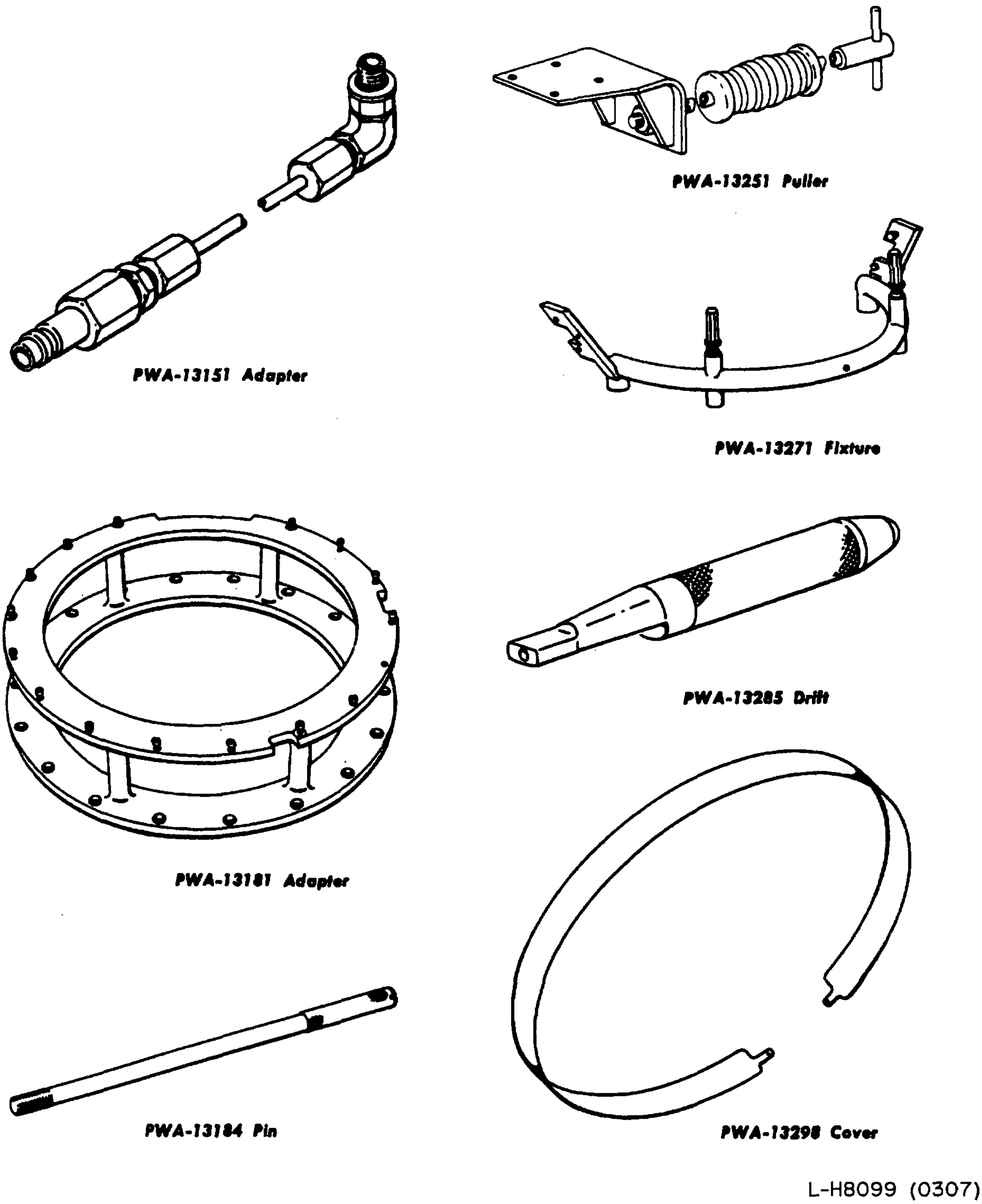


PWA-13110 Fixture

L-H8098 (0307)

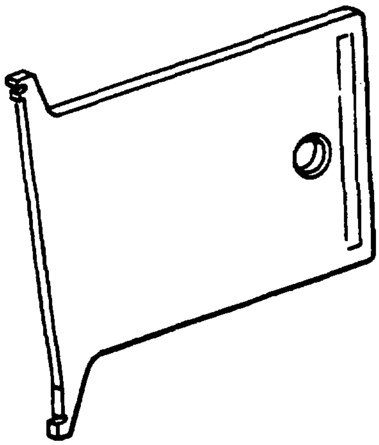
R
R

Tool Illustrations
Figure 307

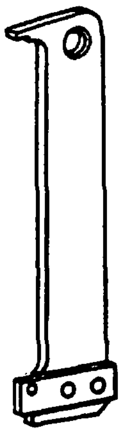


R
R

Tool Illustrations
Figure 308



PWA 13351 Gage



PWA 39025 Gage

L-H8100 (0307)

R
R

Tool Illustrations
Figure 309

ENGINE GENERAL - DISMANTLING/DISASSEMBLY

1. General

CAUTION: AT ONE TIME SOME ENGINE PARTS CONTAINED ASBESTOS FIBERS, AND IT IS POSSIBLE THAT SOME OF THESE PARTS CONTINUE IN SERVICE. REFER TO COMMERCIAL ENGINE SERVICE BULLETINS FOR A LIST OF PARTS THAT AT ONE TIME CONTAINED ASBESTOS. IN SOME PARTS THE MATERIAL THAT CONTAINED ASBESTOS WAS THE ADHESIVE. IT IS IMPORTANT TO USE CORRECT PRECAUTIONS WHILE WORKING WITH THESE PARTS. OPERATORS MUST OBEY ALL LOCAL REGULATIONS AND EMPLOYER WORK POLICIES WHEN PARTS THAT CONTAIN ASBESTOS ARE TOUCHED OR DISCARDED.

THE ASBESTOS USED IN PRATT & WHITNEY ENGINE PARTS WAS USUALLY ENCAPSULATED AND DID NOT RELEASE DUST UNLESS THE PARTS WERE GROUND, SANDED, CUT, OR BROKEN. WHILE IT HAS BEEN OUR EXPERIENCE THAT THESE OPERATIONS USUALLY DO NOT RELEASE ASBESTOS AT LEVELS HIGHER THAN ALLOWABLE EXPOSURE LIMITS, OPERATORS MUST USE ALL APPLICABLE PRECAUTIONS WHEN THEY TOUCH THE PARTS.

A. The disassembly instructions that follow are written with the understanding that all lockwire, cotter pins, rivets, nuts, tablocks, bolts, and screws will be removed before an attempt is made to disassemble any part of the engine.

CAUTION: BEFORE USING TOOLS WITH PROTECTIVE COVERING, MAKE SURE THAT THERE IS SUFFICIENT PROTECTIVE MATERIAL ON THE TOOL TO PREVENT DAMAGE TO THE PART.

B. To protect critical areas of engine parts (such as compressor and turbine disks) against scratches and nicks, tool surfaces contacting these areas must be covered with a protective material.

C. During disassembly of various external tube assemblies, remove the lose ferrule and the nuts from each tube prior to cleaning and inspection. Use two wrenches to remove the loose nut to avoid damage to the tube. Hold the nipple with one wrench and loosen or tighten the nut with the other wrench. Do not bend the tubing during part disassembly.

NOTE: To prevent blockage and to protect open lines against contamination, install dust caps over the tube ends and not inside the tube ends.

D. Use suitable plugs and coverings on all accessory openings, and take every precaution to prevent dirt and foreign matter from entering the component.

E. During various stages of disassembly, examine all engine parts for signs of scoring, burning, or any other evident damage. Note physical conditions that would not be apparent after cleaning, and tag involved parts before they are cleaned and laid out for detailed inspection. The various clearance and concentricity checks that are made and recorded during disassembly are used as guides in making any indicated repairs and adjustments.

F. Protect assemblies and parts from damage by placing them on a parts rack immediately after removing them from the engine. Provide proper covering or support when handling subassemblies to protect shafts, gears, studs, or any projecting part from being bent, scratched, or otherwise damaged. Refer to Section 70-51-00, General-01 in the Standard Practices Manual for the proper segregation of nuts and bolts used in the hot section of the engine.

CAUTION: EXERCISE EXTREME CARE IN HANDLING AND DISPOSITION OF BEARINGS.

BEFORE CLEANING ANY ENGINE PART, REFER TO SECTION 72-00-00, CLEANING.

2. Preliminary

A. Remove The Engine From The Shipping Box (Turbojet Engines) See Tool Group 48.

(1) Attach a sling to the top of the shipping box and secure a hoist to the sling.

(2) Remove bolts and washers that secure the top and the sides of the box to the base.

(3) Lift the top and side panels as one unit from the shipping box base.

(4) Remove all papers from the record receptacle.

(5) Remove the protective cover from the engine.

R
R

(6) Start at the lower right side of the engine, pass the bleed valve cover upward (under all tubes, brackets and the oil tank), and wrap the cover around the compressor inlet case and the covering bleed valve ports.

NOTE: Install the cover so that the red side faces outward and the arrow points toward the rear of the engine.

(7) Pass half of the two-foot length of lockwire through the hole in the lower end of the bleed valve cover.

(8) Grasp both ends of the lockwire and pull the lower end of the cover toward the bleed valve bellcrank as far as it will go.

(9) Pass one strand of lockwire on each side of the bleed valve bellcrank. Pass one strand of lockwire through the hole in the other end of the cover. Secure the cover by twisting together the two wire strands.

(10) Position the lifting sling hooks around the engine shipping mounts.

CAUTION: THE ENGINE MUST BE STEADIED WHILE SUSPENDED BY THE SLING. DO NOT ALLOW THE ENGINE TO CONTACT THE SHIPPING BOX SUPPORT WHILE IT IS BEING RAISED.

(11) Detach shipping mounts from the container stand and lift the engine from the container.

NOTE: When the engine is in the horizontal position, the compressor inlet cone, cover, and No. 1 bearing oil nozzle must be removed before trunnioning the engine in the vertical stand.

B. Free Turbine Engine Removal From Shipping Container
R See Tool Group 56H-1.

(1) Attach the sling to lifting rings on the top section of the container.

(2) Remove bolts that fasten the top section of the base to the container.

(3) Raise the top section straight up until it is free and clear of the engine support structure. Draw aside the cover.

(4) Remove all the papers from the engine record receptacle.

(5) Remove the protection cover from the engine.

NOTE: Open the vaporproof bag along the end and side seams that seal the engine in the bag. Allow sufficient material to remain in order to reseal the bag when it is reused.

(6) Start at the lower right side of the engine and pass the bleed valve cover upward (inboard of all tubes, brackets, and the oil tank). Wrap the cover around the compressor inlet case to cover the bleed valve ports.

(7) Attach the sling to the engine at the inlet case and at the free turbine lifting eye.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD THE ENGINE SLING OR THE ENGINE HOIST FITTINGS BE USED TO HOIST THE ENGINE WHILE THEY ARE ATTACHED TO THE BASE OF THE ENGINE CONTAINER.

(8) Remove eight bolts that hold the diffuser case support brackets to the engine support cradle.

(9) Loosen only four bolts that hold the free turbine bracket to the engine support cradle.

(10) Raise the hoist until the slings first begin to lift the engine. Remove four bolts that support the free turbine bracket, and carefully hoist up the engine and the vaporproof bag until they are free and clear of the container.

(11) Remove the intermediate and free turbine support brackets and the vaporproof bag from the engine.

(12) Install the engine in the stand.

NOTE: The nuts that hold the free turbine support to the free turbine, and the spacers attached to the engine support cradle are part of the engine. These items should remain with the engine and not with the shipping container.

C. Compressor Inlet Cone

(1) Remove bolts that secure the compressor inlet outer front cone to the outer rear cone.

R
R

(2) Remove the bolt that secures the outer rear cone to the inner cone. Unfasten nuts that secure the inner cone to the compressor inlet case.

D. No. 1 Bearing Oil Nozzle

(1) Remove the compressor inlet case cover from the front of the compressor inlet case.

(2) Remove nuts that secure the No. 1 bearing oil nozzle to the oil pressure boss. Remove the oil nozzle.

(3) Remove the gasket from the oil pressure boss.

(4) Remove the oil strainer from the oil nozzle.

E. Installing Free Turbine Engine In Stand
See Tool Group 56H.

(1) Attach the free turbine stand to the engine build and transport stand.

(2) Retract two free turbine stand wheels located nearest to the engine build and transport stand.

(3) Remove the top support from the free turbine stand.

(4) Install the turbine nozzle case support onto the engine build and transport stand.

(5) Install the engine front support onto the single mount pad opposite the turbine nozzle case support.

(6) With the engine in a horizontal position on the hoist, install the engine lift, and use the lifting eyes to turn the plate on the front face of the inlet case to the two and ten o'clock positions.

(7) Attach the turbine nozzle case collar onto the turbine case as follows:

(a) Assemble two collar halves around the case with the face marked FRONT aimed toward the front of the engine and the trunnions positioned at three and nine o'clock.

(b) Tighten the retaining device until the collar parting surfaces meet.

(8) Lower the engine onto the stand, engaging the lift and turn plate with the engine front support and engaging the turbine case collar with the nozzle case support. Adjust the rear mounting pad as necessary, and attach it to the rear engine mounting pad. Lock the pad in position and remove the sling.

(9) Carefully pass the free turbine stand front support over the top of the free turbine. Adjust the support mount as necessary, and attach it to the ground handling mount at the 12 o'clock position. Secure the mount to the flats provided on the stand.

F. Free Turbine Overspeed Switch Cable Removal

(1) Loosen threaded connectors that attach the free turbine overspeed branched cable to the free turbine overspeed switch at one end and to the linear directional control valve at the other end.

(2) Remove screws and nuts that secure the cable connector to the bracket on the diffuser case rear flange.

(3) Remove all clip assemblies that secure the cable to the engine.

(4) Remove the cable from the engine.

G. Linear Directional Control Valve And External Pressure Sensing Tubes Removal

(1) Loosen tube nuts that attach the front Pt3 tube assembly to the connectors on the linear directional control valve and to the fuel control. Remove the tube.

(2) Loosen tube nuts that attach the fuel control pressure tube assembly to the connectors on the linear directional control valve and to the diffuser case tube connector. Remove the tube.

(3) Loosen tube nuts that attach the Pt3 rear tube assembly to the pressure sensing probe assembly and to the connector on the linear directional control valve. Remove the tube.

(4) Remove bolts and locknuts that attach the valve to the bracket on the diffuser case flange. Remove the valve.

Note: Refer to the installation instructions and the accompanying figure in Subassembly to identify the tubes involved in this procedure.

H. Free Turbine Section Removal

(1) Remove the following:

(a) No. 4 and 5 bearing pressure and scavenge oil external tubes

(b) No. 4 bearing rear external breather tube

(c) Free turbine governor to the fuel control signal tube

<u>NOTE</u>: If the free turbine speed sensing flexible driveshaft is riveted to the bevel gearshaft in the free turbine accessory drive gearbox, then first disconnect the shaft assembly from the fuel control in order to slide the casing back for rivet removal.

(d) Thermocouple cable

(e) Turbine discharge pressure sensing manifold

<u>NOTE</u>: The gas generator portion of the free turbine engine will be disassembled in the same manner as the turbojet engine, except where noted.

(2) Remove bolts that secure the free turbine inlet case to the turbine case.

(3) Lower the free turbine stand jacks until they reach the floor.

(4) Disconnect the free turbine stand from the engine build and transport stand.

(5) Lower the free turbine stand wheels and adjust the jacks until the wheels touch the floor. Now the free turbine section can be rolled away.

I. Installing Engine In Vertical Stand
See Tool Group 45.

(1) Bolt the inlet case adapter to the front face of the inlet case.

(2) Bolt the build and turn plate to the adapter, keeping the narrow part of the ring at the 12:00 o'clock position and the lifting eyes at the ten and two o'clock positions.

(3) Trunnion the engine into a vertical position and lower it onto the transport stand, aligning the plate locking holes with the holes in the stand base.

(4) Install ball lock pins and remove sling and shipping mounts.

J. External Tubing

(1) Remove all external tubes and hoses from the engine. Tag each tube with a nomenclature and a location. Plug or cap all tubes and hoses and all openings on the engine.

3. Electrical System

A. Igniter Plug

(1) Disconnect the right and left igniter plug leads.

(2) Remove the right and left plugs.

NOTE: For engines that incorporate one continuous and one intermittent duty ignition system, replace the continuous ignition igniter plug (right side) after a maximum of 150 hours of continuous igniter operation.

B. Ignition Exciter

(1) Disconnect the electrical harness at the right ignition exciter.

(2) Unfasten bolts that secure the exciter to the supports. Remove the exciter.

(3) Remove the left exciter in the same manner.

C. Electrical System Wiring Harness

(1) Disconnect the wiring harness at the fuel pump and at the fuel anti-icing heater anti-icing valve actuator.

(2) Remove the harness receptacle from the inlet case rear flange.

(3) Unfasten any clips that secure the harness to the engine. Remove the harness.

4. Indicating System

A. Thermocouples

(1) Remove the branch leads from the thermocouples.

(2) Remove nuts and bolts that secure the thermocouples to the exhaust case. Remove the thermocouples.

B. Thermocouple Cable

NOTE: When handling and storing thermocouple cables, be sure they are hung on racks or laid on clean tables free of oil and entangling materials. Severe repeated flexing and hard bending or twisting will break or fray exposed insulation. When cables are hung on racks, do not place small radius bends in any part of the assemblies. Racks should be similar to a segment of a two-foot diameter circle.

(1) Remove brackets and clips that secure the cable to the turbine exhaust case.

(2) Remove nuts and bolts that secure the thermocouple cable connectors to the bracket on the turbine case.

(3) Remove the thermocouple cable from the turbine exhaust case.

C. Turbine Pressure Sensing Manifold

(1) Loosen manifold tube nuts at each probe.

(2) Remove nuts and bolts that secure the manifolds to the bosses on the turbine exhaust case. Remove the manifolds.

D. Pressure Sensing Probes

(1) Remove the fuel control pressure sensing probe from the diffuser case.

(2) Remove the pressure probe from the compressor inlet case.

E. Anti-icing System

(1) Remove the electrical lead from the anti-icing valve solenoid.

(2) Remove bolts and locknuts that secure the anti-icing system to the inlet and diffuser cases. Remove the anti-icing tube, valve, and elbow from the engine.

(3) Unfasten bolts that secure the anti-icing valve to the elbow and tube.

(4) Separate the elbow and tube from the valve.

5. External Components

A. Oil Tank

(1) Remove bolts that secure the oil tank to the engine.

(2) Unfasten straps that secure the oil tank to the engine and remove the oil tank.

(3) Remove four mounts from underneath the oil tank.

(4) Remove straps from brackets on the inlet case. Remove the turnbuckle and clevises from brackets on the diffuser case.

B. Fuel Coolant Oil Cooler Removal
See Tool Group 62.

(1) Remove the bolt that secures the oil cooler to the bracket on Flange B.

(2) Use a PWA-13845 wrench to remove the bolt that secures the oil cooler to Flange C and to the plate spacer.

(3) Remove the oil cooler.

C. Fuel Pressurizing And Dump Valve

(1) Remove bolts that secure the pressurizing and dump valve to the bottom of the diffuser case. Remove the valve.

D. Fuel De-icing Heater

(1) Remove the diffuser case to anti-icing valve air supply tube. Disconnect the fuel pump-to-heater fuel pressure tube at the heater, if not already done.

(2) Remove bolts that secure the heater rod and flange to the compressor inlet case flange.

(3) Remove the bolt that secures the heater upper front mounting lug to the compressor inlet case.

(4) Remove the nut, washer, and bolt that secure the lower front mounting lug of the heater to the compressor inlet case.

(5) Remove the nut that secures the rear mounting stud of the heater to the heater support.

(6) Remove the bolt that secures the top front lug to the compressor inlet case.

(7) Pull the heater forward, disengaging the fuel outlet tube. Remove the heater.

E. Power Lever Cross Shaft
See Tool Group 83D.

(1) Remove the power lever cross shaft arm and spacer from the power lever cross shaft.

(2) Remove nuts, bolts, and washers that secure the left and right cross shaft supports to the compressor inlet case. Remove the cross shaft and support assembly from the case.

(3) Remove the nut and bolt from the left nut spacer. Remove the spacer and left support from the shaft.

(4) Remove the right support from the shaft.

(5) Remove needle bearings from the supports with a drift.

F. Fuel Flowmeter

(1) Unfasten bolts that secure the flowmeter at the nine o'clock position on the inlet case. Remove the flowmeter.

6. Accessory Component Drive Gearbox

A. Removal From Engine
See Tool Group 1.

(1) Install the lifting adapter onto the component drive gearbox cover studs and secure it with barrel nuts.

(2) Attach the hoist to the eye at the top of the adapter cross rod and lock the eye in position. Apply slight tension to the hoist chain.

NOTE: Position the eye over components in a way that prevents lifting the gearbox in an unbalanced condition.

(3) Disconnect the fuel control power lever and the compressor bleed valve linkage from the fuel control.

CAUTION: DO NOT WRENCH THE HOLLEY FUEL CONTROL BLEED STRAP SIGNAL VALVE SCREW, PN 5A31001, AT ANY TIME TO ACTUATE THE BLEED STRAP MECHANISM, AS SHEARING OF SERRATION WILL OCCUR IN THE BLEED ACTUATOR HOUSING WHEN THE LEVER AND SHAFTS ARE DISENGAGED.

(4) Remove the gearbox retaining bolts from the diffuser case mounting lugs.

(5) Remove the gearbox from the diffuser case.

CAUTION: THE MAIN COMPONENT DRIVE TOWER SHAFT MAY FALL OUT OF THE DIFFUSER CASE WHEN REMOVING THE GEARBOX.

(6) Perform the following steps to remove the positioning adapter from the diffuser case and to disassemble the adapter:

(a) Remove the gearbox drive bearing nozzle from inside the adapter.

(b) Unthread and remove the strainer assembly from the adapter tube. Remove the preformed packing from the strainer assembly.

(c) Remove the preformed packings from the top and bottom OD grooves of the adapter.

NOTE: For engines not incorporating an oil nozzle, omit steps (a) and (b).

(7) Remove the main component drive tower shaft and positioning adapter from the diffuser case.

(8) Install the storage fixture on the gearbox mounting lugs and secure in position with ball lock pins.

(9) Attach the storage fixture to the vertical member of the storage stand.

(10) Remove the hoist and lifting adapter from the gearbox.

B. Fuel Control

CAUTION: WHEN REMOVING THE FUEL CONTROL, DO NOT DAMAGE THE DRIVE SPLINE BY ALLOWING THE CONTROL TO HANG BY THIS SHAFT. BE SURE TO SUPPORT THE CONTROL UNTIL IT IS REMOVED FROM THE FUEL PUMP.

(1) Remove locknuts that secure the fuel control to the fuel pump. Remove the control.

C. Fuel Pump

(1) Remove locknuts that secure the fuel pump to the gearbox. Remove the pump.

CAUTION: DO NOT DAMAGE THE FUEL PUMP DRIVE SPLINE BY ALLOWING THE PUMP TO HANG BY THIS SHAFT. SUPPORT THE PUMP UNTIL IT IS REMOVED FROM THE GEARBOX.

(2) Remove the fluid pressure differential switch from the pump.

D. Main Oil Strainer
See Tool Group 81.

(1) Remove the hexhead plug in the oil strainer cover and drain any existing oil into a suitable container.

(2) Engines that incorporate a bypass valve with a threaded boss require an oil strainer removal clamp installation as follows:

(a) Insert the clamp end through the drain plug hole and thread it into the bypass valve. Use a wrench detail to prevent valve rotation.

(b) Install a wingnut and washer on the clamp, and handtighten until the spring that is located between the oil strainer element plate assembly and the oil strainer cover is fully compressed.

(3) Remove nuts that secure the oil strainer cover to the gearbox. Remove the cover and spring.

(4) Remove the strainer assembly from the gearbox.

(5) If a removal clamp was used to remove the strainer, then unthread and remove the tool from the bypass valve.

(6) Place the oil screen holder base in a vise or on the bench.

(7) Position the strainer flange in the holder locating recess.

(8) Install the top plate so that the cutouts fit the lugs on the screen support and the upright bolts pass through holes in the top plate.

(9) Install wingnuts on the bolts and compress the spacers.

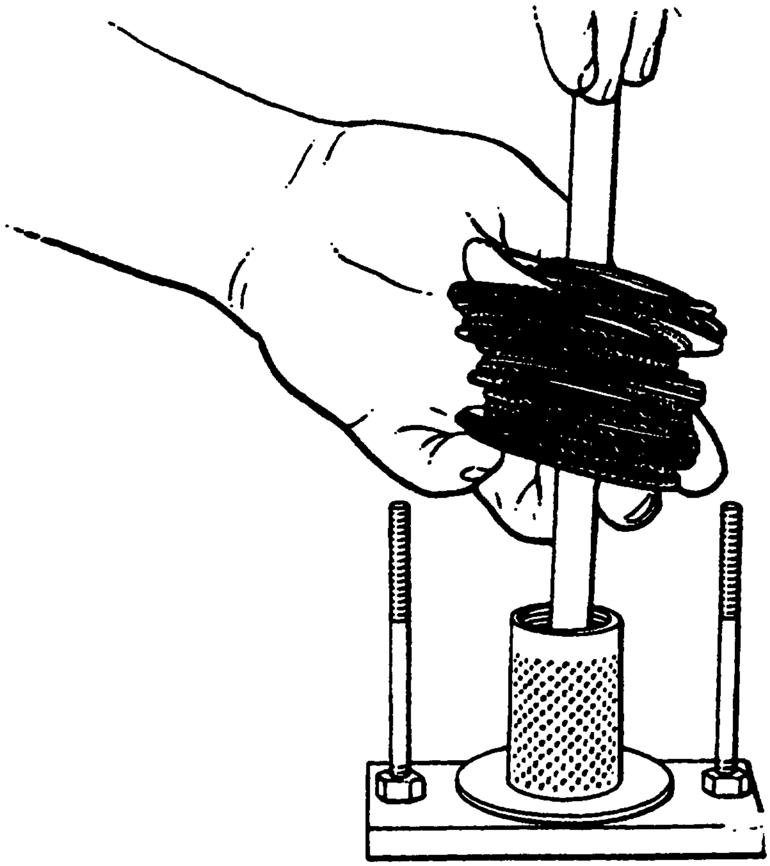
(10) Remove the oil screen spacer retaining nut with a retaining nut wrench.

(11) Remove the bypass valve and spring.

(12) Remove the strainer cover from the fixture. Keep the screens and spacers in proper order and slide them onto a suitable rod, Figure 401. Remove the strainer support from the fixture.

<u>NOTE</u>: The rod should have stops on both ends to keep the screens and spacers from sliding off during cleaning.

E. Main Oil Pressure Relief Valve
See Figure 402.



L-09056 (0000)

ORIGINAL
As Received By
ATP

Removing Oil Strainer Screens
And Spacers
Figure 401

(1) Remove the main oil pressure relief valve cap and gasket.

(2) Remove the relief valve from the gearbox housing.

(3) Remove the gasket and seal from the relief valve housing.

(4) Remove the metering plug from the gearbox housing.

(5) Back off the nut on the valve set screw and back out the screw to relieve spring pressure.

(6) Remove the split rivet, or drill out the tubular rivet that secures the relief valve seat retainer to the valve housing, and screw out the retainer.

(7) Remove the seat, spring, and set screw from the valve housing. Remove the packing from the seat.

F. Main Oil Pump Removal (JT12A06, -6A(L), And -8(L) Engines) See Tool Group 79.

(1) Remove nuts that secure the main oil pump to the component drive gearbox.

(2) Remove the tachometer drive housing cover and install a main oil pump puller on the tachometer drive housing studs.

(3) Secure the puller with nuts. Use the puller to remove the pump from the gearbox.

G. Main Oil Pump Removal (JT12A-6A[N] And -8[N] Engines) See Tool Group 79-1.

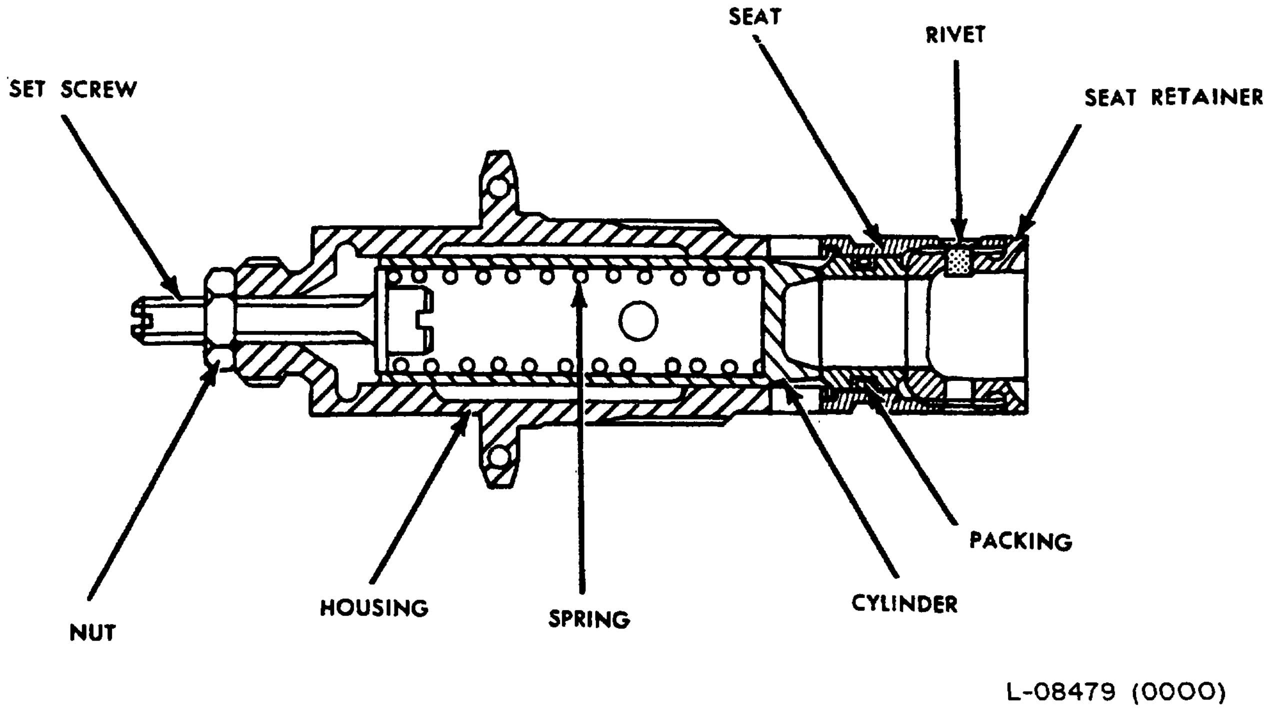
(1) Remove the main oil pump hold-down nuts.

(2) Position the puller jaws on the puller lug of the oil pump cover and pull the pump from the gearbox.

H. Main Oil Pump Removal (Free Turbine Engines) See Tool Group 79A.

(1) Remove nuts that secure the main oil pump to the component drive gearbox.

(2) Position the puller thumb screws in the bolthead's internal threads and pull the pump from the gearbox.



R
R

Oil Pressure Relief Valve
Figure 402

I. Main Oil Pump Disassembly (JT12A-6, -6A[L] And -8[L] Engines)

(1) Remove nuts from the bolts and studs that secure the pump sections together. Remove the bolts.

(2) Remove the tachometer drive housing assembly from the main oil pump.

(3) Remove the rivet from the tachometer drive bevel gear nut.

(4) Remove the nut.

(5) Remove the tachometer drive bevel gear.

(6) Remove the main oil pump spur gearshaft support.

(7) Remove the gearbox scavenge pump drive spur gearshaft and idler spur gear.

(8) Remove the following items in the order listed:

(a) First main oil pump housing

(b) No. 3 bearing scavenge pump drive and idler spur gears

(c) Second main oil pump (No. 3 bearing scavenge pump) housing

(d) No. 1 bearing scavenge pump drive and idler spur gears

(e) Third main oil pump housing

(f) Main oil pump plate

(g) Main oil pressure pump drive and idler spur gears.

(9) Remove the main oil pump bevel gearshaft from the pump inner cover.

R (10) Use an applicable puller (like the formerly available
R Patton Series PM-1000) to remove the oil seals from the main oil pump inner housing and the No. 3 bearing scavenge pump outer housing.

J. Main Oil Pump Disassembly (JT12A-6A[N] And -8[N] Engines)

(1) Place the main oil pump assembly on the bench. Remove four nuts and withdraw them through bolts that secure the pump sections together.

(2) Remove the main oil pump cover and the following sections of the pump:

(a) Gearbox scavenge pump drive and idler spur gears

(b) Lockring and plug from the drive spur gear

(c) First main oil pump housing

(d) No. 3 bearing scavenge pump drive and idler spur gears

(e) Second main oil pump housing

(f) No. 1 bearing scavenge pump drive and idler spur gears

(g) Main oil pump housing, packing and seals

(h) Main oil pump plate

(i) Main pressure oil pump spur gears.

(3) Withdraw the bevel gearshaft from the main oil pump inner cover and remove the preformed packing from the gearshaft. Remove the oil seal from the cover.

K. Main Oil Pump Disassembly (Free Turbine Engines)

(1) Place the main oil pump assembly on the bench. Remove nuts and withdraw them through bolts that secure the pump sections together.

(2) Remove the main oil pump outer cover and seals on the pump OD.

(3) Remove the following sections of the pump:

(a) No. 5 bearing scavenge pump idler and drive spur gears

(b) First oil pump housing

(c) No. 4 bearing scavenge pump idler and drive spur gears

(d) Second oil pump housing

(e) No. 2 bearing and gearbox scavenge pump idler and drive spur gears

(f) Third oil pump housing

NOTE: The third housing incorporates a dowel pin.

(g) No. 3 bearing scavenge pump idler and drive spur gears

(h) Fourth oil pump housing

(i) No. 1 bearing scavenge pump idler and drive spur gears

(j) Fifth oil pump housing; then the oil seal and preformed packing from the housing

(k) Main oil pump plate

(l) Main oil pressure pump idler and drive spur gears.

(4) Withdraw the bevel gearshaft from the main oil pump inner cover and remove the preformed packing from the gearshaft. Remove the oil seal from the cover.

L. Tachometer Drive Disassembly (JT12A-6, -6A[L] And -8[L] Engines)
See Tool Group 95.

(1) Remove the gasket from the tachometer-generator mounting pad.

(2) Remove the tachometer drive bearing housing (with bearings, spacer, and gearshaft) from the tachometer drive housing.

(3) Position the bearing housing (mounting pad down) on the bench.

(4) Use Truarc Series 21 pliers (tip bent 45 degrees or equivalent) to remove the bearing retaining ring from the groove in the housing.

(5) Remove the tachometer drive gearshaft (with bearings) from the housing.

(6) Invert the gearshaft (geared end down) on the bench, and use Truarc Series 22 pliers, or equivalent, to remove the bearing retaining ring from the groove in the gearshaft.

(7) Position the tachometer drive gearshaft (geared end up) on the bench, and insert the pin punch through the hole in the gear and against the bearing outer race. Tap punch with a mallet (moving to different holes around the gear to prevent cocking bearing) until the gap between the bearing inner race and the gearshaft shoulder is wide enough to insert the bearing puller jaws.

(8) Position the pilot of the pilot bearing and spacer puller on the end of the gearshaft, and position the jaws of the puller under the inner bearing inner race. Turn the puller screw to remove the bearings and spacer from the gearshaft.

R (9) Use an applicable puller (like the formerly available
R Patton Series PM-1000) to remove the tachometer drive oil seal from the bearing housing.

M. Tachometer Drive Disassembly (JT12A-6A[N], -8[N], And Free Turbine Engines)
See Tool Group 95A.

(1) Remove nuts that secure the tachometer drive cover to the gearbox. Remove the cover and gasket. Remove the retaining ring located on the tachometer drive bearing support ID.

(2) Install the jaws of the bearing support puller in the groove on the support ID. Screw the rod in until the jaws are held firmly in position, then use knocker action to remove the support from the gearbox. Remove the preformed packing on the support upper OD.

(3) Position the jaws of the seal housing puller through scallops in the housing and turn the tool until the jaws are held firmly in the groove. Use knocker action to remove the seal housing and seal.

(4) Remove the gearshaft bearing retaining ring from the tachometer drive gearshaft.

(5) Support the gearshaft inner bearing inner race with the inner race plate and the inner race base. Install the bearing shaft drift into the gearshaft ID and press out the shaft.

(6) Remove the bearing from the support. Remove the sleeve.

N. Gearbox Housing

(1) Remove all plugs and covers from the gearbox housing.

(2) Remove the airframe bracket located on the component drive gearbox housing cover studs.

(3) For engines that do not incorporate SB 4178, remove the fuel signal tube clip bracket at the fuel control pad.

(4) Remove nuts and washers at the breather pressurizing valve. Remove the breather pressurizing valve elbow, gaskets and spacer.

(5) Remove bolts and tabwashers that secure the gearbox data plate. Remove the plate and seal.

O. Starter-Generator Drive Oil Seal
See Tool Group 89.

(1) Remove screws that secure the starter-generator bearing support to the gearbox housing.

(2) Move the adjustable jaw of the starter-generator bearing support puller outward, and engage the fixed jaw in the puller groove of the bearing support.

(3) Position the movable jaw in the puller groove and secure it in position. Remove the bearing support from the housing.

(4) Position the bearing support (front face up) on the bench and drift out the seal.

P. Hydraulic Pump Drive Oil Seal
See Tool Group 54.

(1) Remove screws that secure the hydraulic pump bearing support to the gearbox housing.

R
R

(2) Move the adjustable jaw of the hydraulic pump support puller outward, and engage the fixed jaw in the puller groove of the support.

(3) Position the movable jaw in the puller groove and secure it in position. Remove the support from the housing.

(4) Position the support (front face up) on the bench and drift out the seal.

(5) Remove the roller bearing outer race from the support by using the puller.

Q. Breather Oil Seal
See Tool Group 16.

(1) Remove the hydraulic pump gearshaft (with the bearings) from the gearbox.

(2) Insert the breather oil seal puller, with the jaws collapsed, into the gearbox housing and through the ID of the breather oil seal.

(3) Turn the knurled nut until the puller jaws engage the seal and remove the seal.

R. Hydraulic Pump Drive Gearshaft Bearings
See Tool Group 56.

(1) Position the gearshaft support plate around the hub of the gearshaft, supporting the inner race of the roller bearing.

(2) Place the plate on the gearshaft base with the gearshaft inside the base.

(3) Use an arbor press and the gearshaft drift to press out the gearshaft from the bearing.

<u>CAUTION</u>: INDIVIDUAL PARTS OF THE BEARING MUST BE KEPT TOGETHER AND STORED IN A SUITABLE CONTAINER.

(4) Position the pilot of the gearshaft bearing puller in the end of the gearshaft, and position the puller jaws over the ball bearing with the ends of the jaws in three slots of the gearshaft.

(5) Remove the bearing by pulling on the inner race.

NOTE: If the gearshaft does not incorporate slots to accommodate the bearing puller, then remove the bearing by using the plate and drift.

S. Fuel Control Drive oil Seal
See Tool Group 61.

(1) Move the adjustable jaw of the fuel control pad puller outward, and engage the fixed jaw in the puller groove of the fuel control pad.

(2) Position the movable jaw in the puller groove and secure it in position. Remove the pad from the gearbox.

(3) Position the pad (front face up) on the bench and drift the seal from the pad.

(4) Remove the roller bearing outer race from the boss.

T. Fuel Control Drive Gearshaft Bearings
See Tool Group 59.

(1) Remove the fuel control gearshaft from the gearshaft.

(2) Place the gearshaft bearing base on the bench.

(3) Position the front bearing plate halves around the front shoulder of the gearshaft to support the inner race.

(4) Place the plate and gearshaft on the base, front bearing up.

(5) Install the pilot of the front bearing drift into the gearshaft ID, and push out the shaft from the front bearing race.

NOTE: Use PWA 13640 drift for gearshaft PN 500348.

(6) Position the rear bearing plate halves around the rear shoulder of the gearshaft to support the inner race.

NOTE: Use PWA 13308 plate with a gearshaft that has a rear bearing shoulder diameter of 0.950 - 0.970 inch.

(7) Place the plate and gearshaft on the base.

(8) Install the pilot of the rear bearing drift into the gearshaft ID, and push out the gearshaft from the bearing race.

(9) Remove the rear bearing outer race from the gearbox.

U. Starter-Generator Drive
See Tool Group 87.

(1) Remove the starter gearshaft from the gearbox.

(2) Remove the nut and washer, securing the oil pump bevel gearshaft to the starter-generator driveshaft.

(3) Position the bevel gear support plate between the gearshaft and the bevel gear.

(4) Insert the bevel gear drift into the gearshaft until it rests on the threaded end of the bevel gear. Drift out the bevel gear from the gearshaft.

(5) Install the collar part of the driveshaft puller inside the diameter of the driveshaft, securing the puller in the groove behind the spline.

(6) Use knocker action to remove the driveshaft from the gearshaft.

V. Starter-Generator Driveshaft Bearings
See Tool Group 90.

(1) Place the gearshaft bearing base on the bench and position the gearshaft on the pilot of the base.

(2) Install the roller bearing support plate around the shoulder of the gearshaft, supporting the inner race of the roller bearing.

(3) Install the pilot of the roller bearing drift inside the diameter of the gearshaft and drift bearing.

CAUTION: INDIVIDUAL PARTS OF THE BEARING MUST BE KEPT TOGETHER AND STORED IN A SUITABLE CONTAINER.

(4) Remove the roller bearing outer race from the gearbox.

(5) With the gearshaft support base on the bench, position the gearshaft on the pilot of the base.

(6) Install the ball bearing support plate around the flange of the gearshaft, supporting the ball bearing inner race.

(7) Install the pilot of the ball bearing drift inside the diameter of the gearshaft, and drift out the gearshaft from the bearing.

W. Component Drive Bevel Gear
See Tool Group 20.

(1) Remove nuts that secure the component drive cover to the gearbox. Remove the cover and assembled component drive.

(2) Remove the rivet that secures the gearshaft roller bearing inner race retaining nut to the gearshaft.

(3) Position the assembled main component gearshaft (ball bearing end down) in the component drive gearshaft holder. Secure the gearshaft to the holder with a clamp.

(4) Install the pilot of the roller bearing retaining nut wrench into the gearshaft ID. Remove the retaining nut.

(5) Remove the gearshaft from the gearshaft holder.

(6) Remove the rivet that secures the gearshaft ball bearing inner race retaining nut to the gearshaft.

(7) Position the gearshaft in the gearshaft holder, securing it with a stop and clamp.

(8) Install the ball bearing retaining nut wrench on the retaining nut. Remove the nut.

(9) Remove the gearshaft from the holder.

(10) Position the roller bearing support plate between the fuel control drivegear and the bevel spur gearshaft.

(11) Insert the plate into the gearshaft base.

(12) Position the pilot on the gear and roller bearing drift, and drift out the gearshaft from the fuel control drivegear and the gearshaft roller bearing.

(13) Position the ball bearing support plate around the hub of the bevel gear.

(14) Insert the plate into the gearshaft base.

(15) Position the gear and ball bearing drift in the end of the gearshaft, and drift out the gearshaft from the bevel gear and the gearshaft ball bearing.

(16) Install the pilot of the ball bearing puller inside the diameter of the bevel gear, positioning the jaws of the puller between the gear and inner race of the bearing.

(17) Turn the screw on the puller until the bearing can be withdrawn from the gear.

(18) Remove the roller bearing outer race from the gearbox.

X. Component Drive Gearshaft Gear
See Tool Group 23.

(1) Unfasten nuts that secure the component drive gearshaft gear support, and remove the support with assembled gear from the housing.

NOTE: The bevel gear lower bearing (roller) outer race will remain in the housing.

(2) Perform the following steps to remove the snapring that secures the assembled gear to the support, and then remove the support:

(a) Insert plier prongs into holes at either end of the retaining ring. Apply sufficient force to displace the ring from the groove.

(b) Position the gearshaft and ball bearing drift on top of the housing, aligning the three drift pins with holes in the housing. Press out the ball bearing and gearshaft from the housing.

(3) Place the ball bearing support plate on the support base. Position the plate around the gearshaft gear ball bearing flange so that it supports the bearing inner race.

(4) Press out the gear from the bearing by using bevel drift.

(5) Place the roller bearing support plate on the support base. Position the plate between the gear and roller bearing so that it supports the bearing inner race.

CAUTION: INDIVIDUAL PARTS OF THE BEARING MUST BE KEPT TOGETHER AND STORED IN A SUITABLE CONTAINER.

(6) Press out the gear with the Drift.

(7) Position the body of the roller bearing outer race puller against the roller bearing liner flange, with the screw protruding through the liner far enough to install a C-washer.

NOTE: Use PWA 13297 Puller for the bearing installed in bushing PN 432587. Use PWA 13644 Puller in bushing PN 432542.

(8) Turn the puller screw until the washer is tight against the rear of the bearing outer race. Further tighten the screw to remove the outer race from the liner.

Y. Component Drive Gearbox Gearshaft Removal And Disassembly (Dual Housing Configuration)
See Tool Group 71B and Figure 403.

(1) Gearshaft Assembly From Gearbox Removal.

(a) Remove nuts that secure the upper and lower gearbox drive bearing housings to the main gearbox.

(b) Position the lower detail plate of the puller and driver directly below the lower end of the gearshaft. Place the puller and driver shaft through the gearshaft ID and thread it into the detail plate.

(c) Use knocker action to remove the lower and upper housings as one unit from the gearbox.

(2) Lower Housing Removal:

(a) Place the housing disassembly base on the arbor press. With the upper housing down, position the assembly on the base so that the pins on the base extend into holes provided on the upper housing.

NOTE: The tops of the pins will contact the lower housing OD flange, enabling separation of the two housings.

(b) Place the upper housing disassembly drift over the assembly, and press out the upper housing (ball bearing and gearshaft, including roller bearing inner race and rollers) from the lower housing.

NOTE: The roller bearing outer race will stay with the lower housing.

(3) Upper Housing Removal:

(a) Position the upper housing (including ball bearing, roller bearing and gearshaft) on the upper housing disassembly fixture, aligning the fixture jackscrews and holes on the small upper housing OD.

(b) Tighten the jackscrews to displace the roller bearing retaining ring from the groove.

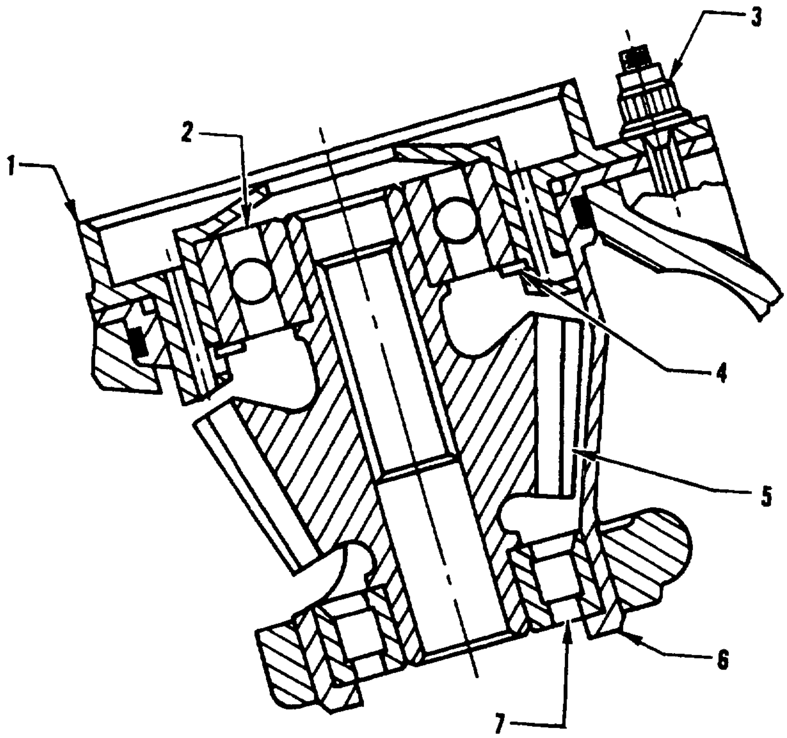
NOTE: Three full turns on each jackscrew, upon contact with the ring, should be sufficient to remove the ring. DO NOT OVERTIGHTEN.

(c) With the upper housing plate positioned on the main component drive bevel gear bearing base, position the upper housing, gearshaft and bearings as one unit on the plate.

(d) Align the gearshaft and bearing assembly removal drift with holes on top of the housing. Drift the bearing and gearshaft from the housing.

(4) Gearshaft Bearing Removal:

(a) Place the ball bearing plate around the gearshaft ball bearing flange. Support the plate and gearshaft on the bearing base.



ORIGINAL
As Received By
ATP

1. Upper Housing
2. Ball Bearing
3. Retaining Nut
4. Retaining Ring
5. Gearshaft
6. Lower Housing
7. Roller Bearing

Main Component Drivegear And
Housing Assembly Removal
And Disassembly
Figure 403

(b) Remove the ball bearing from the gearshaft by installing the pilot of the bearing drift into the gearshaft ID, and drift out the gearshaft from the ball bearing.

(c) Place the roller bearing plate on the main component drive bevel gear bearing base. Position the gearshaft so that the plate supports the bearing inner race.

CAUTION: INDIVIDUAL PARTS OF THE BEARING MUST BE KEPT TOGETHER AND STORED IN A SUITABLE CONTAINER.

(d) Press out the gearshaft by using bearing drift.

(5) Roller Bearing Outer Race Removal:

(a) Position the lower housing on the bench with bearing end up.

CAUTION: INDIVIDUAL PARTS OF THE BEARING MUST BE KEPT TOGETHER AND STORED IN A SUITABLE CONTAINER.

(b) With roller bearing outer race drift contacting the race (using scallops in the housing), drift the bearing race from the housing.

Z. Gearbox Oil Strainer

(1) Unfasten the nut that secures the oil strainer screen assembly to the component drives gearbox, and remove the strainer from the gearbox.

7. Combustion And Turbine Sections

A. Turbine Exhaust Case

(1) Remove bolts that secure the turbine exhaust case to the turbine case rear flange, and remove the turbine exhaust case.

B. Exhaust Cone And Strut

(1) Position the turbine exhaust case (front flange down) on the bench, and remove the strut-locating bolts from the case OD.

(2) Lift the exhaust case from the cone and strut assembly.

C. Combustion Chamber Outer Case

(1) Remove bolts and upper and lower gangnut angle fireseals that secure the combustion chamber outer case front flange to the diffuser case rear flange.

(2) Remove locknuts that secure the case to the turbine case front flange.

(3) Insert jackscrews in the jackscrew holes in the combustion chamber outer case rear flange, and turn the jackscrews to loosen the case.

(4) Lift the case over the turbine case.

D. Combustion Chamber Fuel Drain Valve

(1) Remove bolts that secure the combustion chamber fuel drain valve adapter to the combustion chamber case.

(2) Remove the fuel drain valve adapter and the combustion chamber fuel drain valve.

E. Combustion Chambers

(1) Remove the retaining ring that secures the retaining ring segments to the No. 1 combustion chamber and to the fuel nozzle swirl guide. Remove the split segments.

(2) Loosen the clamp that secures the rear of the No. 1 combustion chamber to the outlet duct.

NOTE: Combustion chamber No. 1, 3, 5, and 7 must be removed prior to removing chamber No. 2, 4, 6, and 8.

(3) Remove the No. 1 combustion chamber.

(4) Place protective covering over the fuel nozzle.

(5) Remove the remaining chambers in the same manner.

F. Second Stage Turbine Disk And Blades
See Tool Group 84.

(1) Straighten the turbine disk retaining nut tabwashers and remove the nuts.

(2) Insert the plate of the turbine disk puller through the center of the disk, and position the plate against the flared part of the turbine shaft.

(3) Engage the puller legs behind the disk and, with hydraulic pressure, remove the disk from the shaft.

(4) Remove rivets and counterweights from the disk.

G. Second Stage Turbine Blades
See Tool Group 96B.

(1) Position the turbine blade support ring and turbine disk pilot on the base of the turbine disk removal fixture.

(2) Position the rotor assembly on the ring and pilot with flared ends of rivets facing upward.

(3) Use the punch to remove the flares from rivets and drift the rivets from the disk.

(4) Attach the pusher to the fixture pushing detail. Position the pushing detail over the rod in the base of fixture and secure the ram and details.

(5) Apply extreme pressure grease (Lubriplate 130-A), to fir-tree serrations and blade shrouds to prevent galling and pickup.

<u>NOTE</u>: Lubriplate 130-A is available from Source Code 73219 in Section 70-12-01, General-02 in the Standard Practices Manual.

(6) Use the hydraulic pump to deblade the disk.

H. Second Stage Turbine Vanes Removal
See Tool Group 85.

(1) Engage the pin at the end of the turbine rotor inner seal puller in one of the holes in the turbine rotor inner seal OD and pull the seal from the turbine disk.

(2) Remove screws that secure the 2nd stage turbine rotor outer seal to the turbine case rear flange. Remove the seal from the flange.

CAUTION: THE 2ND STAGE TURBINE VANE INNER SHROUD MUST BE SUPPORTED DURING REMOVAL OF THE LAST FEW VANES.

(3) Tip the outer end of the turbine vane rearward and remove the vane from the inner shroud (Figure 404). Repeat this procedure (each time going to a vane diametrically opposite the one removed) until all the vanes are removed.

(4) Remove the turbine vane inner shroud and seal assembly.

I. Turbine Rotor Assembly
See Tool Group 101.

(1) Remove bolts that secure the combustion chamber outlet duct, turbine bearing seal support, and 1st stage turbine vane inner shroud to the combustion chamber inner case.

(2) Lower the turbine onto the rear of the diffuser case. Install the locking bolt wrench through the turbine shaft ID and into the turbine shaft locking bolt.

NOTE: For JT12A-8, JFTD12A-4A, and -5A engines, attempts to lower the turbine case and the 1st stage turbine rotor outer seal simultaneously will cause seal damage. Slip the case free of the seal and remove the seal from the shroud separately (refer to Paragraph K.).

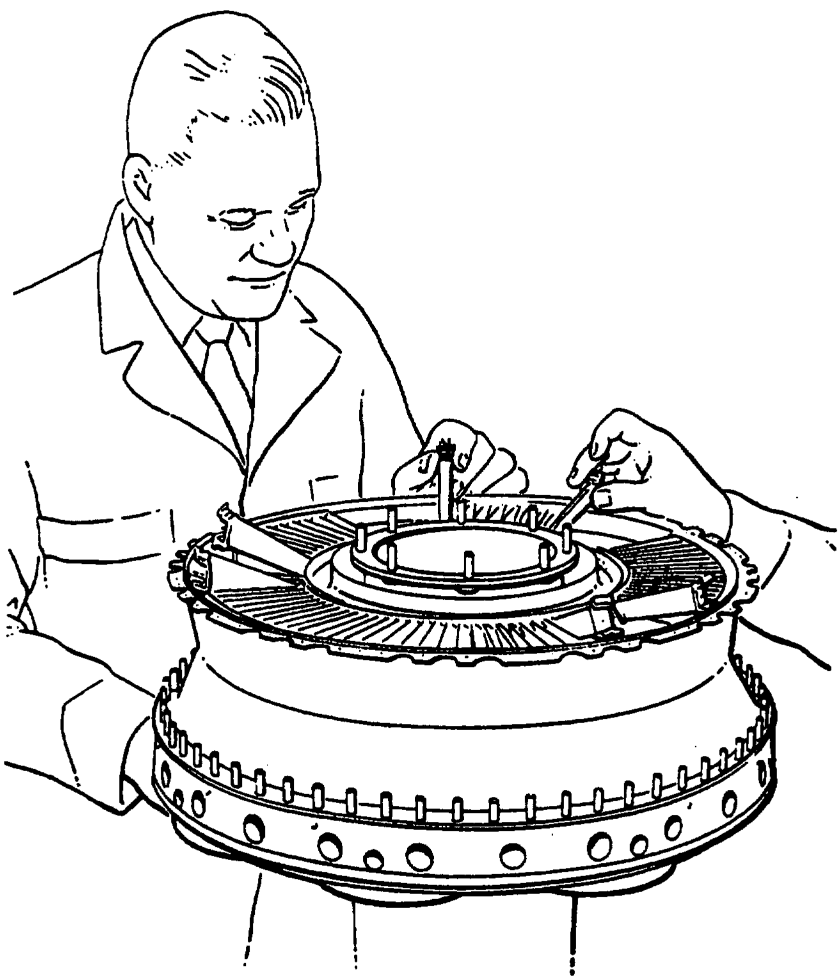
(3) Move the wrench up and down (feeling for the lock movement) until the lock moves forward approximately 1/4 inch.

(4) Bolt the wrench adapter to the hydraulic wrench.

(5) Lower the hydraulic wrench over the locking bolt wrench, and secure the adapter front flange to the turbine disk retaining bolts with engine nuts.

(6) Use hydraulic pressure to turn the wrench clockwise and unlock the shaft. See Figure 405.

(7) Remove the hydraulic wrench and locking bolt wrench. Install the lifting eye over the turbine disk retaining bolts and secure with engine nuts.



L-08602 (0000)

Removing 2nd Stage Turbine Vanes
Figure 404

(8) Suspend the lifting sling from the hoist and attach the sling hooks to the lifting eye. Hoist the turbine rotor assembly from the engine.

J. First Stage Turbine Rotor Outer Seal Removal (JFTD12A-4A, -5A, And JT12A-8 Engines)

(1) Move the seal eccentrically to obtain an area of maximum radial clearance between the blade shroud spoiler OD and the seal ID.

(2) At the mid-point of radial clearance, snap the seal free. Use outward hand pressure to continue circumferentially until the seal is removed.

(3) Place the seal in the turbine case.

K. No. 3 Bearing Inner Race
See Tool Group 9.

(1) Lock the 1st stage disk-to-fixture collar around the 1st stage turbine disk and blades assembly OD to ensure that blade tips bottom in the collar.

(2) Remove the retaining ring and tablock from the No. 3 bearing inner race retaining nut.

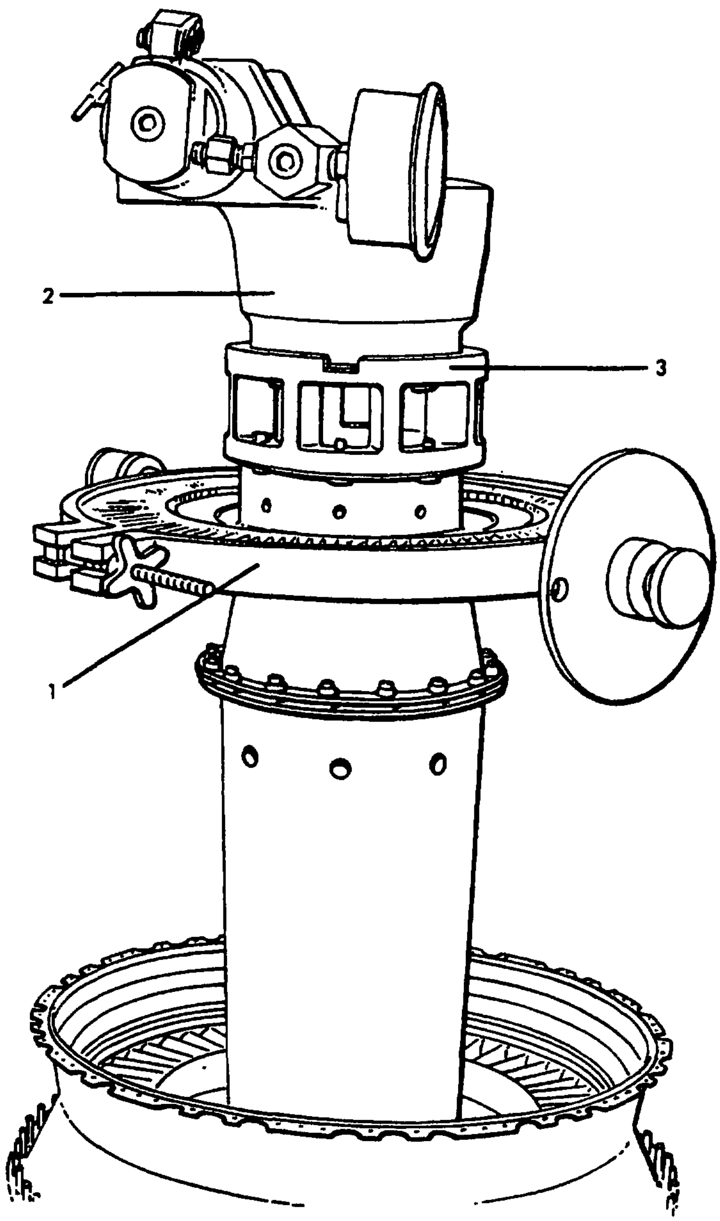
(3) Install the build and transport fixture on the turbine assembly stand, with the fixture frame directly over the stand base. Secure the fixture to the stand with the quick-disconnect.

(4) With the turbine shaft facing upward, lower the turbine rotor into the fixture, positioning the inner spools of the collar into hinged mounts. Lock the hinged mounts and remove the sling and lifting eye.

(5) Perform the following steps to remove the inner race retaining nut from the turbine shaft:

(a) Install the adapter over the turbine shaft so that the adapter ID spline engages the shaft OD splines.

(b) Bolt the No. 3 bearing inner race retaining nut wrench to the hydraulic wrench.



L-08523 (0000)

Loosening Turbine Locking Bolt
Figure 405

1. Turbine Disk To Fixture Collar
2. Hydraulic Wrench
3. Turbine Locking Bolt Wrench Adapter

Key to Figure 405

(c) Slide the assembled wrenches over the adapter, or equivalent, and position the wrenches so that the retaining nut wrench teeth engage the nut slots and splines, and the hydraulic wrench engages the adapter splines.

(d) Use hydraulic pressure to loosen the nut. Remove the tooling and nut from the shaft.

CAUTION: INDIVIDUAL PARTS OF THE NO. 3 BEARING MUST BE KEPT TOGETHER AND STORED IN A SUITABLE CONTAINER. NOTE WHETHER THE SERIAL NUMBER IS FACING THE ENGINE FRONT OR REAR IN ORDER TO ENSURE REINSTALLATION IN THE SAME MANNER.

(6) Position the jaws of the bearing inner race puller into puller slots in the seal cooling oil scoop, and secure the jaws in position with the retaining ring. Use the hydraulic pump connected to the puller to remove the scoop and race from the shaft.

L. No. 3 Bearing Seal Assembly

(1) Remove the No. 3 bearing seal and support assembly from the turbine shaft.

(2) Position the No. 3 bearing seal support (mounting flange up) on the bench.

(3) Straighten and remove the cotter pins from the seal retaining loading pins.

(4) Lift the seal housing and seal from the seal support.

(5) Remove springs from the loading pins.

(6) Position the seal housing (carbon seal up) on the bench.

(7) Insert a screwdriver into the gap of the metal seal ring and pry one end of the ring out of the groove in the support.

(8) Use peeling action to remove the ring from the groove.

M. Turbine Positioning Spacer
See Tool Group 99.

(1) Position the jaws of the positioning spacer puller over the flats on the turbine positioning spacer OD and against the rear of the spacer front flange.

(2) Pull the spacer from the turbine shaft.

(3) Remove bolt retaining rings and bolts from the turbine shaft flange, taking care not to separate the disk from the shaft.

(4) Install four shaft assembly fixture work bolts (bolthead flats adjacent to disk flange OD) through unoccupied disk and shaft flange holes. Secure bolts with retaining nuts.

(5) Attach the lifting sling to the disk and fixing collar, and remove the turbine shaft and disk from the stand.

(6) Install the turbine rotor (flanged end down) into the shaft assembly fixture, with the fixture guide pins protruding through four holes in the flange.

(7) Remove the collar from the turbine disk.

N. First Stage Turbine Disk And Blades
See Tool Group 96B.

(1) Position the turbine blade support ring and turbine disk pilot on the turbine blade removal fixture base.

(2) Position the rotor assembly on the ring and pilot with the flared ends of the rivets facing upward.

(3) Use a punch to remove the flare from the rivets and drift the rivets from the disk.

(4) Soak the disk at the blade roots with penetrating oil for ten minutes.

<u>NOTE</u>: The soaking may be done any time prior to the deblading operation.

(5) Attach the pusher to the fixture pushing detail. Position the pushing detail over the rod in the fixture base and secure the ram and details.

(6) Use the hydraulic pump to deblade the disk.

(7) Remove work bolts that secure the disk to the rotor flange.

(8) Separate the disk from the shaft.

O. Combustion Chamber Inner Case
See Tool Group 18.

(1) Remove bolts that secure the combustion chamber inner case front flange to the diffuser case inner rear flange.

CAUTION: WHEN THE COMBUSTION CHAMBER INNER CASE IS LIFTED FROM THE DIFFUSER INNER CASE, THE TWO SMALL OIL TRANSFER TUBES AT THE FRONT END MAY COME WITH IT. TAKE CARE TO PREVENT THESE TUBES FROM FALLING OUT OF THE CASE.

(2) Remove the combustion chamber inner case from the diffuser case and up through the turbine case.

(3) Remove the two oil transfer tubes from either the combustion inner case or from the diffuser case. See Figure 406.

(4) Install the combustion chamber inner case (front flange down) on the bench.

(5) Remove the No. 3 bearing outer race retaining nut rivet.

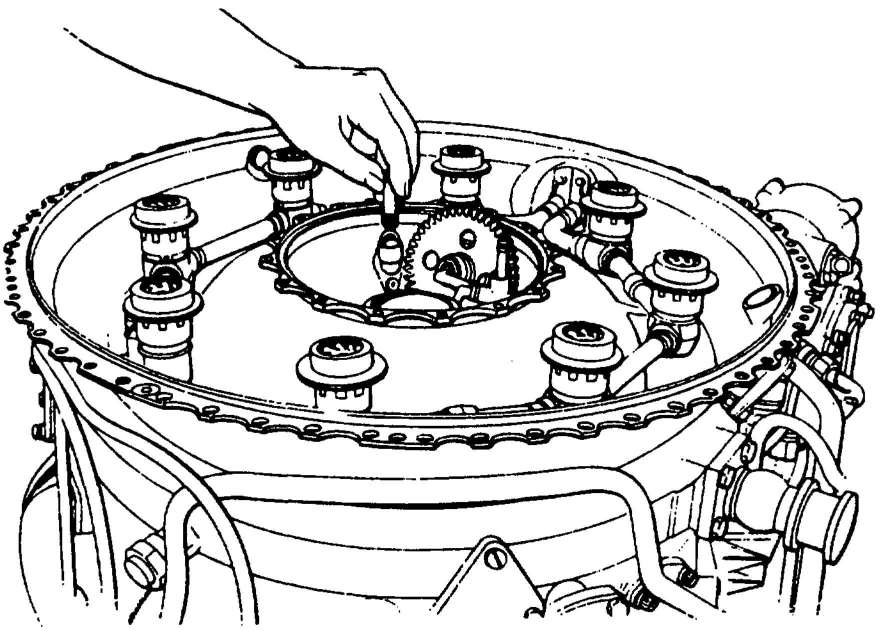
(6) Bolt the retaining nut wrench outer part to the hydraulic wrench.

(7) Bolt the hydraulic wrench to the combustion chamber inner case rear flange.

(8) Lower the retaining nut wrench inner part into position, engaging the teeth in the outer race retaining nut. Use hydraulic pressure to loosen the outer race retaining nut by turning counterclockwise.

(9) Remove the retaining nut wrench and the hydraulic wrench.

(10) Remove the outer race retaining nut.



L-08796 (0000)

ORIGINAL
As Received By
ATP

Removing Oil Transfer Tube
Figure 406

CAUTION: INDIVIDUAL PARTS OF THE NO. 3 BEARING MUST BE KEPT TOGETHER AND STORED IN A SUITABLE CONTAINER.

(11) Remove the outer race and rollers from the No. 3 bearing support.

P. Turbine Case And 1st Stage Turbine Vanes

(1) Lift the turbine case from the diffuser case. Place the turbine support fixture (posts facing up) on the workbench.

(2) Position the turbine case (rear flange down) into the support, engaging the fixture outer ring dowel in the offset hole in the case rear flange and engaging the dowel on one of the fixture posts in the offset hole in the 1st stage turbine vane inner shroud.

(3) Remove bolts that secure the combustion chamber outlet duct to the outlet duct support. Remove the outlet duct from the turbine case.

(4) Remove the retaining pin that secures the outer end of each vane to the turbine case. Remove each vane by pulling the outer end upward and disengaging the inner end from the inner shroud.

(5) Lift the 1st stage turbine vane inner shroud from the fixture.

(6) Lift the turbine case from the fixture and position the case (rear flange up) on the bench.

(7) Remove the 1st stage turbine outer seal segments.

(8) Remove the combustion chamber outlet duct support from the turbine case.

8. Diffuser Section

A. Fuel Manifold
See Tool Group 63.

(1) Remove screws that secure the fuel transfer valve adapter to the fuel manifolds. Remove the adapter.

CAUTION: TO PREVENT DISTORTION, BE CAREFUL WHEN REMOVING, HANDLING, AND STORING THE MANIFOLDS.

(2) Remove bolts that secure the fuel manifolds to the diffuser case. Remove the manifolds and spacers.

(3) Secure the manifolds in the holding fixture.

B. Diffuser Case
See Tool Group 41.

(1) Secure the rear left and right test mounts to the mount pads on each side of the diffuser case.

(2) Suspend the engine sling from the hoist and attach the sling to the mounts.

(3) Unfasten the quick disconnect that secures the plate to the build stand. Raise the engine to a height of about one foot above the stand.

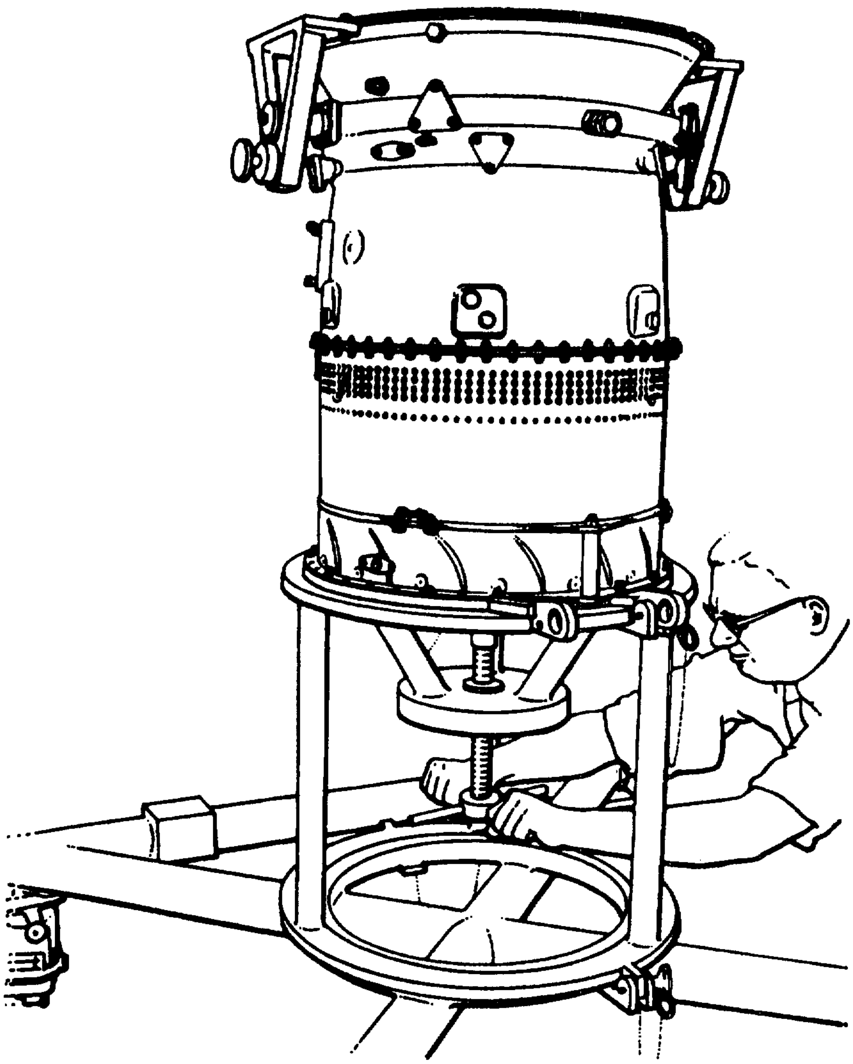
(4) Attach the turbine locating jack to the stand with the two quick disconnects.

(5) Lower the engine onto the jack and secure the plate to the jack with the quick disconnect.

CAUTION: DO NOT OVERTIGHTEN THE JACK PAD AGAINST THE ROTOR HUB. OVERTIGHTENING WILL DAMAGE THE COMPRESSOR.

(6) Turn the jackscrew handle until the jack pad contacts and supports the compressor rotor front hub. See Figure 407.

(7) Insert the retaining nut wrench into the hydraulic wrench, aligning retaining nut wrench flange holes with hydraulic wrench holes. Secure with bolts.



L-0846I (0000)

ORIGINAL
As Received By
ATP

Tightening The Jackscrew Handle
Figure 407

(8) Install the retaining nut wrench adapter into the hydraulic wrench, engaging adapter slots with retaining nut wrench driving dogs and engaging adapter splines with hydraulic wrench splines.

(9) Retract the retaining nut wrench locator by turning the knurled locator ring to full counterclockwise position.

(10) Lower the wrench into the compressor rear hub, engaging drive splines with hub splines and engaging locator splines with No. 3 bearing oil scoop splines.

(11) Use hydraulic pressure to turn the retaining nut wrench counterclockwise and to loosen the oil scoop.

(12) Remove the hydraulic wrench and the retaining nut wrench.

(13) Remove the No. 2 bearing oil scoop from the compressor rear hub.

(14) Bolt the lift and trunnion brackets (180 degrees apart) to the diffuser case rear flange.

(15) Suspend the engine sling from the hoist and secure the sling hooks to spools on the brackets.

(16) Remove nuts and bolts that secure the diffuser case front flange to the compressor case.

(17) Engage the cross bar of the rear hub pusher with the front face of the diffuser case inner flange, and position the jackscrew plug on the compressor rear hub. Use jackscrew action to remove the diffuser case. See
R Figure 408.

NOTE: The component drive gear and spacer must be removed from the compressor rear hub as the diffuser case is being removed.

(18) Remove the 4th stage compressor vane outer shroud support ring from the compressor inlet case rear flange.

C. No. 2 Bearing Oil Nozzle
See Tool Group 8A.

(1) Use a wrench to remove bolts that secure the No. 2 bearing oil nozzle to the boss in the diffuser case.

(2) Remove the oil nozzle and the preformed packing.

(3) Remove the snapring that secures the strainer in the nozzle. Remove the strainer.

D. No. 3 Bearing Oil Suction Tube Elbow

(1) Remove bolts that secure the No. 3 bearing oil suction elbow to the boss in the diffuser case.

(2) Remove the elbow and the preformed packing.

E. No. 2 Bearing Seal Assembly

(1) Position the diffuser case (rear flange down) on the bench.

(2) Remove bolts that secure the No. 2 bearing seal assembly to the diffuser case inner front flange, and remove the seal assembly from the diffuser case.

(3) Position the seal assembly (carbon seal up) on the bench, and remove the cotter pins that secure the seal housing on the retaining pins.

(4) Remove the seal housing from the seal support.

(5) Remove seal loading springs.

(6) Insert a screwdriver into the gap of the metal seal ring and pry one end of the ring out of the groove in the support. Grasp the end of the seal ring and use peeling action to remove the ring from the groove.

F. No. 2 Bearing
See Tool Group 6.

(1) Place the diffuser case (rear flange up) on the bench.

(2) Remove the rivet from the No. 2 bearing outer race retaining nut.

(3) Engage the retaining nut wrench in the outer race retaining nut. Loosen the nut by striking the wrench
R handle with a mallet. Remove the nut.

(4) Invert the diffuser case (rear flange down) on the bench.

CAUTION: BE CAREFUL NOT TO DROP THE BEARING WHEN REMOVING IT FROM THE LINER.

(5) Position the outer race drift on the front face of the No. 2 bearing outer race, and drift the bearing (with the oil distributing sleeve and the seal face plate) from the liner.

(6) Remove the No. 2 bearing inner race retaining ring.

(7) Engage the oil distributing sleeve plate halves in the groove of the No. 2 bearing seal face plate.

(8) Install the plate on the oil distributing sleeve base.

CAUTION: INDIVIDUAL PARTS OF THE NO. 2 BEARING MUST BE KEPT TOGETHER AND STORED IN A SUITABLE CONTAINER.

(9) Position the oil distributing sleeve drift in the oil distributing sleeve, and use an arbor press to remove the sleeve from the bearing and seal plate.

G. Main Component Drive Gear
See Tool Group 73.

(1) Install the coupling holder shaft up through the strut located between the gearbox mounting at the bottom of the diffuser case. Secure the holder to one of the lugs with the ball lockpin.

(2) Engage the coupling holder rod splines in the main component drive coupling splines, and secure the rod in position in the holder with the thumb screw. The coupling is now locked.

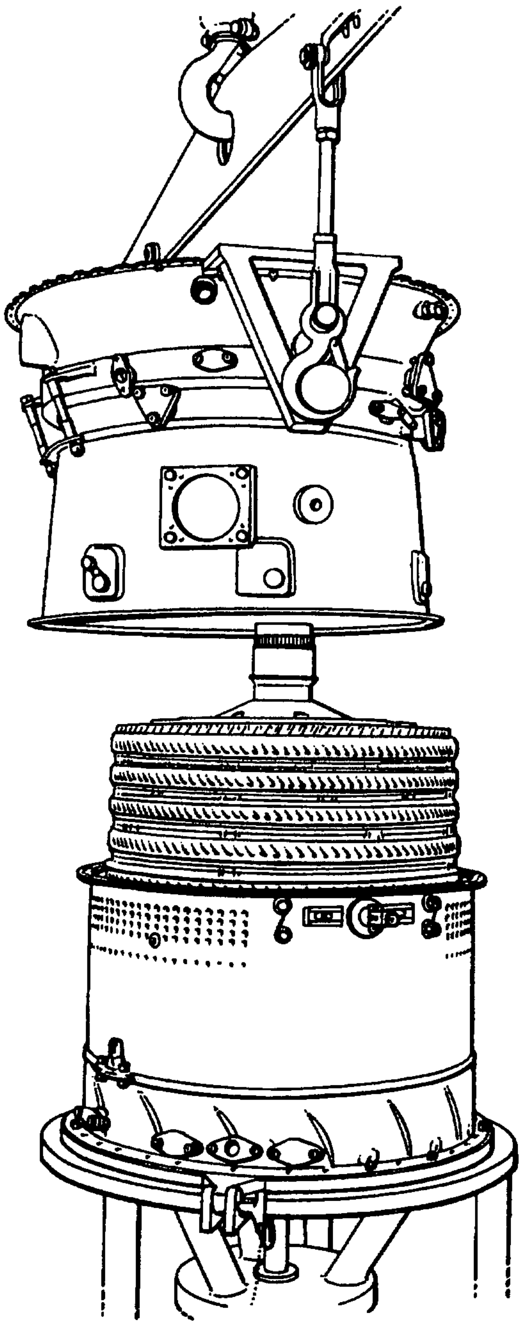
(3) Remove the main component drive gear retaining nut lock.

(4) Use the retaining nut wrench to remove the retaining nut.

(5) Position the legs of the drive gear puller through the component drive gear holes, and use the jackscrew to pull the gear from the coupling.

(6) Remove the drive gear spacer from the coupling.

H. Main Component Drive Splined Coupling
See Tool Group 74.



L-08807 (0000)

Removing Diffuser Case
Figure 408

(1) Remove the bearing retaining ring from the diffuser case component drive housing.

(2) Loosen the thumbscrew of the shaft coupling holder rod. Gently tap the rod toward the center of the diffuser case, pulling the coupling (with bearings and spacers) from the housing.

(3) Install the drive coupling plate onto the coupling base.

(4) Position the coupling on the plates with the coupling splined ID end in the hole in the split plate.

(5) Place the drive coupling drift on the end of the coupling. Use an arbor press to press the coupling from the bearing and spacer.

I. Ninth Stage Compressor Vane And Shroud Assembly

(1) Position the diffuser case (rear flange down) on the bench.

(2) Remove rivets that secure the 9th stage vane assembly inner shroud and airseal ring to the diffuser case.

(3) Remove 9th stage vane and shroud assembly with the airseal ring from the diffuser case.

9. Compressor Section

A. Compressor Bleed Valve Removal

(1) Disconnect the bleed valve linkage at the compressor bleed valve linkage arm.

(2) Remove the locknut that secures the compressor bleed valve linkage arm to the bleed valve arm. Remove the linkage arm.

(3) Remove the bearing retaining ring and remove the bearing from the bleed valve arm.

(4) Remove locknuts that secure bearings on the compressor bleed valve rigid connecting links.

(5) Remove bearings and spacers.

R
R

(6) Remove bolts that secure the bleed valve bearing guide to the compressor inlet case and remove the bearing guide.

(7) Remove the lockwire and pins that secure the ends of the bleed valve strap to the bleed valve carriages.

(8) Grasp one end of the strap and pull the strap free of the guides.

B. Compressor Inlet Case And No. 1 Bearing Removal
See Tool Group 34.

(1) Position the locating fixture on the compressor section, engaging the fixture small ID on the compressor rear hub and the large ID on the compressor rear flange.

(2) Use the rear oil scoop wrench to secure the fixture on the hub with the No. 2 bearing oil scoop.

CAUTION: THE COMPRESSOR INLET CASE MAY DROP OFF WHEN THE FIXTURE IS DISCONNECTED AT THE FLANGE.

(3) Lift the compressor assembly from the stand and unfasten the compressor rear flange from the fixture.

NOTE: If the case does not slide off in the downward position, then remove it after the assembly is trunnioned onto the rear hub.

(4) Trunnion the assembly rear hub down and position it in the rotor and stator storage stand.

(5) Wrap a heating blanket around the case and heat to the required temperature.

(6) Use a rubber mallet to tap the case until it separates
R from the compressor stator spacer. Remove the inlet case.

NOTE: The No. 1 bearing outer race retaining nut, outer race, and seal housing will come off with the compressor inlet case.

(7) Unfasten the rivet that secures the No. 1 bearing inner race retaining nut. Attach the retaining nut wrench outer detail to the body of the hydraulic wrench. Place the assembly on the retaining nut with the inner detail engaging the hub slots and the outer detail engaging the nut. Use hydraulic pressure to uncouple the nut.

NOTE: Uncouple the nut in a counterclockwise direction.

(8) Use the inner race puller to perform the following steps to remove the inner race and rollers:

NOTE: If the front compressor hub incorporates a hub plug, then the plug must be removed before the inner race can be removed as specified.

(a) Remove bolts that secure the plug in the hub.

(b) Remove the plug with PWA 13974 Puller.

(c) Remove the packing from the groove in the plug.

(d) The rivet that secures the inner race retaining nut must be removed before the plug can be removed.

(9) Position the puller so that the center puck rests on the front hub and the puller jaws engage the bearing inner race puller grooves.

(10) Ensure that the jaws are secured by seating the ring with a light mallet.

(11) Use the wrench to rotate the jackscrew until the race is free of the front hub.

(12) Use the puller to perform the following steps to remove the No. 1 bearing seal assembly spacer (front), the seal assembly, and the spacer (rear):

(a) With the jackscrew retracted and the retaining ring removed by sliding it rearward, spread the puller jaws and position the puller so that the jaws contact the angle face of the rear spacer.

(b) Secure the jaws with the retaining ring and tighten the jackscrew by hand until the jackscrew plug engages the front hub ID.

(c) Use the hand wrench to continue to tighten the jackscrew to remove the seal assembly from the hub.

(d) Position the rotor and stator adapter onto the jack and secure with ball lockpins. Lower the rotor onto the jack until the outer shroud fits in the mating diameter of the adapter.

C. Compressor Inlet Case Disassembly
See Tool Group 32.

(1) Place the inlet case (front flange up) on the bench.

(2) Unfasten the nut that secures the compressor front bearing housing to the compressor inlet case.

(3) Remove the housing, the outer race, and the retaining nut by using the seal housing puller.

(4) Remove the seal from the compressor inlet case inner case.

(5) Secure the holding fixture to the bench and position the housing, with race and nut, in the fixture.

(6) Unfasten the rivet that secures the outer race to the housing, and remove the nut by using the retaining nut wrench. Remove the outer race with the Puller.

10. Compressor Rotor Disassembly

A. Removing Disks, Vanes, And Shrouds
See Tool Group 29.

CAUTION: LOOSEN DIAMETRICALLY OPPOSITE NUTS, NOT MORE THAN 1/4 TURN AT A TIME, WORKING AROUND THE HUB UNTIL ALL NUTS ARE LOOSE AND THE STRETCH IS RELIEVED.

(1) Remove twelve rear tierod nuts and washers from the rotor assembly.

(2) Attach the puller to the thread at the end of the compressor rear hub, allowing the legs to rest on the rear face of the rear disk. Use jackscrew action to pull the hub from the rotor assembly.

NOTE: Balance counterweights will come off with the hub, and may be removed by straightening the washer tablocks and rotating the counterweights until they clear the hub flange.

(3) Insert the pusher in the compressor assembly, and place it between the 8th and 9th stage disks so that the stop on the pusher holds down the spacer.

(4) Adjust the handle of the pusher so the cam contacts the disk, and push down the handle to remove the disk from the spacer.

(5) Place the spacer pusher on the rear face of the 8th stage disk, fitting it into the disk ID, and secure the clamp. Adjust the lever and pusher assembly to fit under the flange of the spacer. Strike the lever handle with a mallet to push up the spacer.

(6) Remove lockwire at four places on the outer shroud of the 7th stage vane and shroud assembly.

(7) Install the vane and shroud spreader between the 7th and 8th stage vane and shroud assembly so that the jaws of the spreader rest between faces formed by welds at the outer shrouds of the adjacent vanes.

(8) Separate vane assemblies by squeezing the handles of the spreader. Remove the 8th stage vane and shroud.

(9) Repeat steps (1) thru (8) above to remove disks, spacers, and vane and shroud assemblies down to the 4th stage disk. Use the spacer pusher to remove Stages 7 thru 4 spacers.

NOTE: Use the 5th and 6th stage Pusher to remove 5th and 6th stage disks.

(10) Remove the compressor stator spacer from the 3rd stage vane and shroud.

(11) Remove 4th stage disk and blades by tapping rearward with a rubber mallet.

CAUTION: LOOSEN DIAMETRICALLY OPPOSITE NUTS, NOT MORE THAN 1/4 TURN AT A TIME, WORKING AROUND THE DISK UNTIL ALL NUTS ARE LOOSE AND THE STRETCH IS RELIEVED.

(12) Unfasten 16 tierod nuts that secure the 2nd and 3rd stage disks and blades. Remove the nuts and washers.

(13) Remove the 3rd and 4th stage disk space. Remove the compressor rear tierods and seal from the spacer.

(14) Remove the 3rd stage vane and shroud by using the spreader.

(15) Use the compressor disk pusher to perform the following steps to remove the 3rd stage disk and blades:

(a) Position the pusher between the 2nd and 3rd stage disks until the step on the bottom corner of the tool rests on the front flange of the disk spacer.

(b) Position the lever so that the cam contacts the front face of the 3rd stage disk and separates the disk from the spacer.

(16) Remove the spacer from the 2nd stage disk and blades.

(17) Repeat steps (1) thru (15) above to remove the 2nd stage vane and shroud and the 2nd stage disk and blades.

(18) Unfasten the compressor front tierods front nuts and remove tierods and the airseal from the compressor front hub.

(19) Remove the 1st stage vane and shroud. Remove the front hub from the jack.

B. Compressor Blades Removal
See Tool Group 27B.

(1) Perform the following steps to position the 9th stage disk on the fixture and straighten the blade retaining tablock:

(a) Position the disk and blade assembly (trailing edge up) on the tablock unbend fixture so that the disk rests on the center locator with four supports adjusted for disk size.

(b) Adjust the slide lever for proper height and positioning over the tablock so that the anvil end of the lever will engage the tablock.

NOTE: The unbending anvil is dual purpose. The angled side engages the tablock to partially lift it away from the disk. The vertical side completes the unbending process.

(c) Pull the lever to straighten the tablock.

(2) Tap out each blade and tablock by working clockwise around the disk.

(3) Remove blades from Stages 3 thru 8 disks in the same manner.

C. Compressor Disk Airseal Removal
See Tool Group 29-2.

(1) Remove the compressor disk front and rear airseals (this is necessary for inspection of the compressor disk airseal flanges):

NOTE: Remove airseals only from steel compressor disks. It is permitted to use airseals again if they are serviceable (refer to the Repair section).

CAUTION: BE CAREFUL NOT TO CAUSE DAMAGE TO THE DISK FLANGE DURING AIRSEAL REMOVAL.

(a) Stage 3 and 5 thru 8 disks

1 Put the Puller on the disk with the tool knife-edge against the ID radius of the disk (immediately under the seal).

2 Push down lightly on the puller handle to start to disengage the seal, then move one or two inches along the seal and do the procedure again.

3 Continue the procedure as many times as necessary to disengage the seal without damage to the seal (do not cause distortion of the seal).

(b) Stage 9 disk

1 Put the 9th stage compressor disk on a bench rear side up. Put the Puller on the bench and move the jaws in toward the center of the ring.

CAUTION: MAKE SURE THAT THE JAWS ARE MOVED OUT AWAY FROM THE CENTER OF THE RING TO FULLY ENGAGE THE JAW LIP UNDER THE AIRSEAL.

2 Tighten the capscrews finger tight. Put the Puller on the disk and adjust the four jack-screws and jaws where necessary to engage the jaw lip under the the inner edge of the airseal. Tighten the eight capscrews to attach the jaws to the ring. Tighten the jackscrews equally (a quarter-turn at a time) to remove the airseal from the disk.

D. Compressor Front Hub (1st Stage) And 2nd Stage Disks

(1) Remove counterweights from the front hub by removing rivets.

(2) Position the front hub and blades assembly shaft end down.

(3) Remove pins that secure blades to the hub by breaking flare at pin end. Remove the 1st stage blades.

(4) Remove the 2nd stage blades as described in steps (1) thru (3).

E. Turbine Shaft Coupling

(1) Position the compressor rotor rear hub on the bench shaft end down.

(2) Remove the snapring that secures the compressor drive turbine shaft coupling.

(3) Disassemble the coupling in the following sequence:

(a) Spring lock guide

(b) Spring

(c) Turbine shaft lock

(d) Turbine shaft coupling.

11. Free Turbine Section Disassembly

A. Installing Free Turbine Section In Build And Transport Stand See Tool Group 56M.

(1) Attach the compressor and turbine locating jack to the build and transport stand. Secure with a ball lock pin. Retract the jack to its lowest position.

(2) Position the free turbine disk-to-jack adapter on the jack with the cup-shaped part of the adapter contacting the jack pad and the stepped plug facing upward.

(3) Attach the free turbine assembly lifting eye (rear) to the coupling at the rear of the free turbine shaft. Secure the hoist to the eye.

(4) Remove the rear support of the free turbine assembly stand.

(5) Lift the assembly and remove the front support.

(6) Attach the free turbine assembly front case-to-jack plate on the front face of the free turbine assembly, positioning trunnion spools on the horizontal centerline of the free turbine assembly.

(7) Suspend the engine lift and turn sling from a second hoist. Secure the sling to the front plate trunnion spools.

(8) Use both hoists to turn the assembly to the vertical position (front end down).

(9) Lower the assembly onto the jack, being careful to prevent the assembly from contacting the disk-to-jack adapter.

(10) Secure the plate to the jack with the ball lock pins.

(11) Remove the sling and the lifting eye.

B. Free Turbine Exhaust Case Removal

(1) Remove nuts and bolts that secure the free turbine exhaust case to the free turbine case. Remove the exhaust case and stabilizing ring (if incorporated).

C. Free Turbine Exhaust Duct Fuel Drain And Cover Removal (Applicable Only To JFTD12A-4A And -5A)

(1) Remove the bolt that secures the fuel drain to the boss and remove the drain and gasket for the boss.

(2) From the fuel drain boss located 180 degrees from the boss referenced above, remove bolts, cover and gasket.

D. Free Turbine Shaft Coupling Lock, Coupling, And Seal Assembly Removal
See Tool Group 56Q.

(1) Remove the retaining ring from the groove in the coupling nut ID.

(2) Engage the turbine shaft lock puller lugs in the turbine shaft coupling lock puller groove. Use the collar to expand the lugs. Use jackscrew action to remove the lock.

(3) Remove bolts that secure the seal support to the seal housing support.

(4) Remove the seal assembly and seal support from the engine.

(5) Remove the retaining ring from the turbine shaft coupling nut ID. Use the puller to remove the nut cover.

NOTE: Soak the cover in oil prior to removing.

(6) Attach the outer part of the turbine shaft coupling nut wrench to the hydraulic wrench. Install the assembly onto the coupling.

(7) Lower the coupling nut wrench inner part through the hydraulic wrench and into the coupling nut.

(8) Use hydraulic pressure to loosen and remove the coupling nut.

(9) Thread the lifting eye onto the coupling, and remove the free turbine coupling (with No. 5 bearing oil scoop seal plate, inner race, and inner race retaining nut attached) from the turbine shaft.

E. Free Turbine Coupling Disassembly
See Tool Group 56G.

(1) Position the free turbine shaft coupling (splined OD down) in the holder.

(2) Remove the retaining ring and the key washer that secures the No. 5 bearing inner race retaining nut.

(3) Position the adapter in the coupling ID to permit the adapter spline to engage the coupling spline.

(4) Bolt the No. 5 bearing inner race retaining nut wrench to the hydraulic wrench.

(5) Position wrenches over the adapter and coupling. Install wrenches as follows:

(a) Engage wrench teeth in inner race retaining nut slots.

(b) Engage adapter splines in hydraulic wrench splines.

(6) Use hydraulic pressure to loosen the inner race retaining nut. Remove the nut.

(7) Remove wrenches and the adapter. Remove the coupling from the holder.

(8) Position the No. 5 bearing, seal plate, and coupling plate around the coupling, engaging the plate into the puller groove in the seal plate.

(9) Position the coupling (inner race up) on the No. 5 bearing seal plate and the coupling base.

(10) Position the No. 5 bearing seal plate and the coupling drift on the coupling. Press out the coupling from the seal plate and the inner base.

F. No. 5 Bearing Seal Disassembly

(1) Position the seal assembly (carbon seal up) on the bench.

(2) Exert slight downward force on the carbon seal assembly to compress the seal springs. Remove the cotter pins from the locks and remove the guides.

R
R

(3) Lift the seal assembly from the locks.

(4) Remove the springs.

(5) Remove the seal ring from the seal support.

G. Free Turbine Shaft Outer Case

(1) Remove nuts that secure the rear flange of the free turbine shaft outer case of the No. 5 bearing seal housing, if not previously removed.

(2) Remove nuts, washers (post-SB 6217) and bolts that secure the front flange of the free turbine shaft outer case to the free turbine inner case.

(3) Remove the outer case.

H. Free Turbine Shaft Inner Case Removal And Disassembly

(1) Remove bolts that secure the No. 5 seal housing support to the free turbine case inner rear flange. Remove the support and packing. Remove bolts and snaprings from the support.

(2) Remove bolts that secure the free turbine shaft inner case to the No. 4 bearing sump.

(3) Carefully remove the inner case.

(4) Remove and discard the gasket at the front flange of the case.

(5) Remove the transfer tubes from the end of the pressure and scavenge oil tubes.

(6) Remove the snapring and strainer assembly from the pressure oil transfer tube bellows in the free turbine inner case.

I. No. 5 Bearing Outer Race Removal
See Tool Group 11D.

(1) Remove the rivet that secures the outer race retaining nut to the free turbine inner case bearing support.

(2) Secure the wrench base to the rear flange of the free turbine inner case with detail bolts.

(3) Attach the wrench outer detail to the installed wrench. Lower the inner detail into the wrench and engage nut slots.

(4) Use hydraulic pressure to loosen the nut. Remove the nut from the free turbine inner case bearing support.

(5) Remove the bearing outer race from the support.

J. Free Turbine Accessory Drive And Related Tubes Removal
See Tool Group 56B.

(1) Adjust the collar of the accessory driveshaft heat shield puller to collapse the jaws. Insert the puller into the heat shield.

(2) Adjust the collar to engage the puller jaws under the flange of the heat shield.

(3) Use knocker action to pull the heat shield out of the case.

(4) Remove the free turbine accessory driveshaft from the heat shield.

<u>NOTE</u>: Due to fit, the driveshaft and heat shield may be removed from the case simultaneously. Then remove the driveshaft from the heat shield.

(5) Remove bolts and locknuts that secure the oil pressure tube connector to the boss on the free turbine case. Remove the oil tube connector, hex nut, and backup ring from the connector.

(6) Remove four oil transfer tubes from the free turbine case. Remove the snapring and strainer assembly from the No. 4 bearing internal pressure tube assembly ID.

K. Free Turbine Gearbox Disassembly
See Tool Group 56A.

(1) Remove nuts that secure the gearbox cover. Remove the cover and heat shield from the bearing housing.

(2) Remove bearing housings from each end of the gearbox. Remove the bevel gearshaft and attached bearings from the gearbox housing.

NOTE: If it is difficult to remove the bearing housings from the gearbox housing, then insert a feeler stock between mating surfaces to unstick the housings.

(3) Perform the following steps to remove the bearings from the gearshaft:

(a) Position plate halves around the gearshaft so that plates rest on the underside of the bearing. Lower the assembly into the base.

(b) Use a nylon mallet, or arbor press, and drift to drift the gearshaft out of the bearing.

(c) Repeat steps (a) and (b) to remove the remaining bearing.

(4) Use a nylon mallet and a suitable fiber drift to remove the seals from each housing.

(5) Remove bolts that secure the oil nozzle assembly to the housing. Remove the nozzle assembly.

(6) Perform the following steps to remove the bevel gearshaft and bearings from the gearbox housing:

(a) Remove the snapring from the gearshaft.

(b) Insert the accessories driveshaft into the bevel gearshaft ID. Use the nylon mallet to tap on the end of the shaft until the gearshaft comes out of the lower bearing ID. Remove the bearing from the housing.

(c) Remove the gearshaft and attached upper bearing from the housing.

(7) Refer to step (3) to remove the upper bearing from the gearshaft.

L. Free Turbine Overspeed Switch Removal

(1) Remove four locknuts that secure the switch to the free turbine gearbox.

R
R

(2) Remove the switch assembly from the gearbox.

(3) Remove two locknuts that attach the heat shield to the switch. Remove the heat shield.

(4) Remove remaining locknuts and washers that secure the cover and gasket to the switch. Then, remove the cover and gasket.

M. No. 4 Bearing Sump Removal And Disassembly
See Tool Group 11E.

(1) Remove bolts that secure the No. 4 bearing sump assembly to the No. 4 bearing support. Remove the sump assembly and gasket.

(2) Position the No. 4 bearing sump assembly on the bench, large diameter down.

(3) Remove the rivet that secures the drivegear nut to the gear.

(4) Position the Holder to that the detail plugs engage the gear lightening holes.

NOTE: The holder is used to keep the gear from turning when loosening the retaining nut.

(5) Perform the following steps to disassemble the No. 4 bearing sump assembly:

(a) Use the tachometer drivegear retaining nut wrench to loosen and remove the retaining nut. Remove the holder.

(b) Remove the gear from the support.

(c) Remove the retaining ring that secures the coupling assembly in the support. Remove the coupling assembly.

N. Free Turbine Accessories Driveshaft Coupling Disassembly

(1) Position the halves of the coupling plate on the base.

(2) Position the coupling assembly so that the large OD end of the coupling faces down, and the plate halves rest on the face of the upper bearing.

(3) Use a suitable drift and arbor press to drift the coupling out of the bearings and spacer.

O. Removal And Disassembly Of Free Turbine Case
See Tool Group 56E.

(1) Straighten the tabs of the No. 4 bearing oil scoop key washer.

(2) Attach the No. 4 bearing inner race retaining nut wrench to the body of the hydraulic wrench. Install wrenches on the No. 4 bearing oil scoop.

(3) Install the No. 4 bearing inner race retaining nut adapter so that the adapter engages the hydraulic wrench ID spline and the spline on the end of the turbine shaft.

CAUTION: PRIOR TO LOOSENING THE OIL SCOOP, CHECK TO ENSURE THAT THE FREE TURBINE SUPPORTING JACK IS RAISED SUFFICIENTLY TO ENSURE THE ADAPTER IS SUPPORTING THE FREE TURBINE ROTOR.

(4) Use hydraulic pressure to turn the No. 4 bearing oil scoop in a counterclockwise direction to loosen.

(5) Remove the wrenches. Remove the oil scoop.

(6) Remove the key washer.

(7) Remove the accessory drivegear.

(8) Mount the No. 4 bearing inner and outer race puller on the end of the turbine shaft, engaging the puller jaws in the bearing rear inner race puller groove. Use jackscrew action to pull the rear inner race.

(9) Remove two screws that secure the seal support assembly to the free turbine case inner flange.

NOTE: The removal permits the seal and support assembly to move forward in the case.

(10) Remove bolts and nuts that secure the free turbine case to the free turbine inlet case. Remove the fuel control flexible shaft bracket, oil breather tube bracket, and clip bracket.

R
R

CAUTION: TO PREVENT DAMAGE TO THE NO. 4 BALL BEARING, ENSURE THAT THE BEARING AND CAGE REMAIN IN POSITION ON THE FREE TURBINE SHAFT WHEN REMOVING THE FREE TURBINE CASE.

(11) Attach two free turbine case lift and turn brackets to the rear free turbine case rear flange. Attach a lift and turn sling to spools on the brackets. Use the hoist to remove the free turbine case from the free turbine and position the case on the bench.

(12) Remove the rivet from the No. 4 bearing outer race retaining nut.

(13) Attach the No. 4 bearing outer race retaining nut wrench outer part to the hydraulic wrench.

(14) Install the retaining nut wrench inner part into the No. 4 bearing outer race retaining nut.

(15) Lower the hydraulic wrench so that two pins in the retaining nut wrench engage two holes in the bearing support, and the retaining nut wrench inner part splines engage the hydraulic wrench splines.

(16) Use hydraulic pressure to turn the retaining nut counterclockwise. Remove the nut and wrenches.

CAUTION: BE CAREFUL TO PREVENT DAMAGE TO THE BEARING DURING REMOVAL.

(17) Remove the bearing outer race from the free turbine case by using the nylon mallet and a suitable drift.

(18) Pass the jaws of the puller over the bearing front inner race, engaging the jaws in the No. 4 bearing seal ring puller groove. Use jackscrew action to pull the seal ring and inner race from the shaft.

R P. No. 4 Bearing Support Assembly, Seal Assembly, And Seal Support Assembly Removal And Disassembly
See Tool Group 11B-1.

(1) Remove the loosened assembly from the free turbine inlet case. Position the assembly (large OD up) on the bench.

(2) Push the seal assembly downward slightly to relieve the spring tension on the cotter pins.

(3) Remove cotter pins from the pins, and slowly relax pressure on the seal.

(4) Remove the seal assembly from the pins.

(5) Remove the sealing ring from the seal holder OD.

(6) Remove springs from the pins.

(7) Mount the No. 4 bearing inner and outer race puller on the end of the turbine shaft, engaging the puller jaws in the bearing rear inner race puller groove. Use jackscrew action to pull the rear inner race.

(8) Remove two screws that secure the seal support assembly to the free turbine case inner flange.

NOTE: The removal will permit the seal and support assembly to move forward in the case.

(9) Remove bolts and nuts that secure the free turbine case to the free turbine inlet case. Remove the fuel control flexible shaft bracket, oil breather tube bracket, and clip bracket.

CAUTION: TO PREVENT DAMAGE TO THE NO. 4 BALL BEARING, ENSURE THAT THE BEARING AND CAGE REMAIN IN POSITION ON THE FREE TURBINE SHAFT WHEN REMOVING THE FREE TURBINE CASE.

(10) Attach two free turbine case lift and turn brackets to the rear flange of the free turbine case. Attach the lift and turn sling to spools on the brackets. Use the hoist to remove the free turbine case from the free turbine and position the case on the bench.

(11) Remove the rivet from the No. 4 bearing outer race retaining nut.

(12) Attach the No. 4 bearing outer race retaining nut wrench outer part to the hydraulic wrench.

(13) Install the retaining nut wrench inner part into the No. 4 bearing outer race retaining nut.

(14) Lower the hydraulic wrench until two pins in the retaining nut wrench engage two holes in the bearing support, and the retaining nut wrench inner part splines engage the hydraulic wrench splines.

R
R

(15) Use hydraulic pressure to turn the retaining nut counterclockwise. Remove the nut and wrenches.

CAUTION: BE CAREFUL TO PREVENT DAMAGE TO THE BEARING DURING REMOVAL.

(16) Remove the bearing outer race from the free turbine case by using the nylon mallet and a suitable drift.

(17) Pass the puller jaws over the bearing front inner race, engaging the jaws in the No. 4 bearing seal ring puller groove. Use jackscrew action to pull the seal ring and inner race from the shaft.

R Q. Free Turbine Rotor Removal
See Tool Group 56K.

(1) Attach the free turbine shaft lifting eye to the end of the free turbine shaft.

(2) Remove screws that secure the free turbine Stage 2 outer seal to the free turbine inlet case, and proceed as follows:

(a) Secure the length of lockwire to the bolthole on the outer seal flange.

(b) Pass the lockwire through the lifting eye and secure the end of the wire to the flange bolthole 180 degrees opposite the other end of the wire.

NOTE: The lockwire will hold the seal in position against the rear spoiler of Stage 2 blades, permitting Stage 2 guide vanes to be unlocked.

(3) Attach the hoist to the lifting eye, and raise the rotor to its highest position.

(4) Unlock Stage 2 vanes by exerting upward force on the outer vane leg. Place strips of cardboard between the vanes legs and the free turbine inlet case rear flange to prevent the vanes from returning to their original position.

(5) Remove the rotor assembly from the engine by using the hoist.

(6) Remove vanes from the vane shroud assembly and place them in a suitable container.

(7) Remove the lockwire and the Stage 2 outer seal by passing the seal over the Stage 1 turbine disk and blades assembly.

R R. Free Turbine Rotor Disassembly
See Tool Group 103B.

(1) Install the turbine assembly-to-stand fixture on the turbine assembly build and transport stand.

(2) Install the lifting collar around the Stage 2 disk and blades assembly. Attach the lifting sling to spools of the collar.

(3) Attach the hoist to the lifting sling and lower the rotor assembly into the fixture. Secure with detail fixture mounts.

(4) Remove the lift eye and sling.

(5) Attach the turbine disk lifting collar to the Stage 1 disk and blades assembly.

(6) Bend down the tabs of the tabwashers and remove nuts and tabwashers that secure the airseal ring and Stage 1 turbine disk to the free turbine shaft.

(7) Thread four jackscrews into the threaded holes of the airseal ring, 90 degrees apart. Use jackscrew action to remove the seal ring from the Stage 1 disk.

WARNING: WORK NUTS PREVENT THE DISK FROM FLYING OFF THE SHAFT WHEN THE DISK SUDDENLY SEPARATES DURING THE APPLICATION OF HYDRAULIC PRESSURE.

(8) Install four work nuts loosely on the tierods.

(9) Use the puller and hydraulic pump to separate the disk from the shaft. Remove four work nuts and the disk and blade assembly.

(10) Remove the Stage 2 vane and shroud assembly.

(11) Remove retaining rings that secure the tierods to the shaft. Remove the tierods.

(12) Attach the puller and hydraulic pump to the turbine shaft. Push out the shaft from the Stage 2 disk and blade assembly. Remove the shaft.

(13) Use a diameter tape to perform diametrical measurement of Stages 1 and 2 disk and blade assembly knife-edge seals. Record the measurement.

R S. Free Turbine Disk And Blades Assembly Deblading
See Tool Group 56G-1.

(1) Perform the following steps to remove Stage 2 blades from the disk:

(a) Position the turbine blade support ring and turbine disk pilot on the turbine blade removal fixture base.

(b) Position the disk and blades assembly on the ring and pilot with the flared ends of the rivets facing upward.

(c) Soak the disk at the blade roots with oil for 10 minutes to facilitate blade removal.

CAUTION: ENSURE THAT THE PUSHER RESTS FLAT ON THE FACE OF THE DISK TO PRECLUDE DAMAGE TO THE DISK.

(d) Attach the pusher to the fixture pushing detail. Position the pushing detail over the rod on the fixture base, and secure the ram and details.

CAUTION: ENSURE THAT THE PUSHER DETAIL DOES NOT TILT BY TAPPING THE PUSHER DETAIL WITH A NYLON MALLET DURING THE APPLICATION OF HYDRAULIC PRESSURE.

(e) Use the hydraulic pump to deblade the disk by pushing out the disk from the blades.

(f) Remove the disk from the fixture base.

(g) Place the blades in suitable individual containers.

(h) Use a brass drift of a suitable diameter to remove the flare from the rivets. Drift the rivets from the disk.

(i) Remove the support ring and pilot from the turbine blade removal fixture base.

(2) Perform the following steps to remove Stage 1 blades from the disk:

(a) Install the support ring and free turbine disk pilot onto the blade removal fixture base.

(b) Repeat steps (b) and (c) in step (1).

(c) Attach the pusher to the fixture pushing detail. Position the pushing detail over the rod in the fixture base and secure the ram and details.

(d) Perform the deblading operation described in steps (e) thru (i) in step (1).

R T. Free Turbine Stage 1 Vanes, Airseal Segments Removal

(1) Measure and record the ID dimension of the installed airseal ring segments (refer to Reference Number 1325 and 1377 in the Table of Limits)

(2) Remove airseal ring segments from the free turbine inlet case.

(3) Remove pins that secure the free turbine Stage 1 vane lock to the free turbine inlet case.

(4) Remove the three segments of the lock.

(5) Remove vanes by lifting the outer end of each vane from the step in the case, and disengaging the tabs at the inner end from slots in the inner shroud.

(6) Remove the free turbine inlet duct assembly from the free turbine inlet case.

ENGINE GENERAL - CLEANING

1. Engine Part Cleaning Procedures

A. General

WARNING: AT ONE TIME SOME ENGINE PARTS CONTAINED ASBESTOS FIBERS, AND IT IS POSSIBLE THAT SOME OF THESE PARTS CONTINUE IN SERVICE. REFER TO COMMERCIAL ENGINE SERVICE BULLETINS FOR A LIST OF PARTS THAT AT ONE TIME CONTAINED ASBESTOS. IN SOME PARTS THE MATERIAL THAT CONTAINED ASBESTOS WAS THE ADHESIVE. IT IS IMPORTANT TO USE CORRECT PRECAUTIONS DURING WORK WITH THESE PARTS. OPERATORS MUST OBEY ALL LOCAL REGULATIONS AND EMPLOYER WORK POLICIES WHEN PARTS THAT CONTAIN ASBESTOS ARE TOUCHED OR DISCARDED.

THE ASBESTOS USED IN PRATT & WHITNEY ENGINE PARTS WAS USUALLY ENCAPSULATED AND WILL NOT RELEASE DUST UNLESS THE PARTS ARE GROUND, SANDED, CUT, OR BROKEN. WHILE IT IS OUR EXPERIENCE THAT THESE OPERATIONS DO NOT USUALLY RELEASE ASBESTOS AT LEVELS MORE THAN PERMITTED EXPOSURE LIMITS, OPERATORS MUST USE ALL APPLICABLE PRECAUTIONS WHEN THEY TOUCH SUCH PARTS.

B. SPOP Specifications

(1) When more than one SPOP is specified for a part, refer to Section 70-20-00 in the Standard Practices Manual for selection of the applicable cleaning Service Process Operation Procedure (SPOP).

(2) Refer to Section 70-20-00 in the Standard Practices Manual for important cleaning requirements that are a supplement to the SPOPs specified for the parts in the table below.

(3) Refer to Section 70-21-00 in the Standard Practices Manual for the SPOP procedures in this list.

(4) Table 501 is a list of engine parts and the SPOPs that are applicable to these parts.

(a) The parts are in the list in alphabetical order.

(b) The SPOPs for each part are in the list in numerical order.

C. Oil Tank Cleaning

R
R

(1) Remove surface grease from the tank by SPOP 209, then clean the tank by SPOP 203. Refer to Section 70-21-00 in the Standard Practices Manual.

(2) Flow rinse water through the tank in a direction opposite to the usual oil flow direction, for two hours.

(3) Rinse the tank in hot water and dry it.

D. Oil Tubes

R (1) Clean oil tubes by SPOP 209 or SPOP 203. Refer to Section 70-21-00 in the Standard Practices Manual.

E. Carbon Seals

(1) Clean carbon seals by SPOP 215. Refer to Section 70-21-00 in the Standard Practices Manual.

(2) Keep seals in individual boxes with a cardboard collar around the carbon part of the seal.

(3) Do not remove seals from their boxes until it is time to install them in an engine.

(4) When a seal is removed from its protective container, be careful to prevent damage to the carbon seal element. Do not put seals in a stack, one on the other.

(5) Keep seals away from all foreign material, such as dirt, grit, or lint.

F. Free Turbine Inlet Duct (PN 427204 Only)

(1) Clean the duct (with its applicable aluminized coating on the vane buttress mating face and around the vane tang slots) as follows:

(a) Clean the duct by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

(b) Clean all remaining dirty areas with a soft wire brush, wet abrasive blast by SPOP 9 or SPOP 219, by dry abrasive blast by SPOP 10 or SPOP 218, or by SPOP 19 plastic blast. Refer to Section 70-21-00 in the Standard Practices Manual.

NOTE: Apply masks to aluminized areas before blasting operations.

(c) If a duct has aluminized areas which are not in good condition, clean the duct by SPOP 203, SPOP 211, or SPOP 213. Refer to Section 70-21-00 in the Standard Practices Manual.

G. Free Turbine 2nd Stage Seal (PN 423701 Only)

(1) Clean the seal with the procedures specified for the inlet duct in Paragraph F.

	Nomenclature	SPOP
	Accessory Drive Cover	19, 209, 260
	NOTE: Remove paint by SPOP 19 or SPOP 260 if necessary.	
	Accessory Drive Tachometer Cover	19, 209
	Air Sensing Tube Coupling Nut	203, 209
	Breather Pressurizing Valve Elbow	19, 209
	Carbon Seals	215
	Combustion Chamber Assembly	203, 209, 218
	Combustion Chamber Case Assembly	209, 258 (Use 9 or 10 to remove corrosion after SPOP 258 if necessary)
	Combustion Chamber Fireseal Nut Assembly	203, 209
R	Combustion Chamber Fuel Drain Valve Adapter Assembly	203, 209, 211, 213
R	Combustion Chamber Inner Case Assembly	203, 209, 211, 213

Engine Part Cleaning Procedures
Table 501

Nomenclature	SPOP
Combustion Chamber Outlet Duct Assembly	203, 209, 218
Combustion Chamber Outlet Duct Support Assembly	203, 209, 211, 213
Combustion Chamber Retaining Clamp Assembly	203, 209, 218
Component Drive Gearbox Bevel Gear	203, 209
Component Drive Gearbox Gearshaft	203, 209
Component Drive Gearbox Gearshaft Bearing	216
Component Drive Gearbox Housing Assembly	19, 209
Component Drive Gearbox Housing Cover	19, 209
Component Drive Gearbox Main Bearing Support	203, 209
Component Drive Gearbox Main Mounting Bolt	203, 209
Component Drive Gearbox To Positioning Boss Adapter	203, 209
Component Drive Gearbox Driveshaft Coupling	203, 209
Compressor Blade (Stages 1, 2, 3, 4, 5, and 7) (Titanium)	18, 19, 209
NOTE: Remove antigalling compound by SPOP 19.	
Compressor Blade (Stages 6, 8, and 9) (Steel) (Nickel-Cadmium Plated)	19, 203, 209
NOTE: Remove antigalling compound by SPOP 19.	

R
R

Engine Part Cleaning Procedures
Table 501 (Continued)

Nomenclature	SPOP
Compressor Blade (Stages 6, 8, and 9) (Steel) (PWA 110 Coated)	209, 258
Compressor Inlet Case Assembly (Aluminum)	19, 207, 209
Compressor Inlet Case Cover (Aluminum)	19, 207, 209
Compressor Inlet Cone Support (Aluminum)	207, 209
Compressor Inlet Outer Front Cone (Aluminum)	207, 209
Compressor Inlet Outer Rear Cone (Aluminum)	207, 209
Compressor Rotor Airseals R (Stages 7, 8, and 9) (Steel) (Nickel-Cadmium Plated)	203, 209, *211, *213 (See Note)
R *NOTE: Use SPOP 211 or SPOP 213 only if the airseal will get nickel-cadmium plate replacement.	
Compressor Rotor Airseals (Stages 7, 8, and 9) (Steel) (PWA 110 Coated)	209, 258
Compressor Rotor Disk (Stages 1, 2, 3, 4, and 7) (Titanium)	18, 19, 209
Compressor Rotor Disk (Stages 5, 6, R 8, and 9) (Steel) (Nickel-Cadmium Plated)	19, 203, 209, *211, *213 (See Note)
R *NOTE: Use SPOP 211 or SPOP 213 only if the disk will get nickel-cadmium plate replacement.	
Compressor Rotor Disk (Stages 5, 6, 8, and 9) (Steel) (PWA 110 Coated)	209, 258

Engine Part Cleaning Procedures
Table 501 (Continued)

Nomenclature	SPOP
Compressor Rotor Disk Spacer	
Stage 2-3, 3-4 (Titanium)	18, 209
Stage 4-5, 5-6, 6-7 (Steel) (PWA 110 Coated)	209, 258
Stage 7-8, 8-9 (Steel) (Nickel-Cadmium Plated)	203, 209
Compressor Rotor Front Hub (Titanium)	18, 19, 209
Compressor Rotor Rear Hub (Steel) (Nickel-Cadmium Plated)	203, 209
Compressor Rotor Rear Hub (Steel) (PWA 110 Coated)	209, 258
Compressor Rotor Tierod (Nickel-Cadmium Plated)	19, 203, 209
Compressor Rotor Tierod Nut (Silver Plated)	203, 209
Compressor Stator Spacer	203, 209, 211, 213
Compressor Vane And Shroud Assembly (Stage 1) (Steel) (PWA 110 Coated)	209, 258
Compressor Vane and Shroud Assembly (Stages 2 and 3) (Aluminum) (PWA 110 Coated)	19, 207, 209
Compressor Vane and Shroud Assembly (Stages 4 thru 8) (Nickel-Cadmium Plated or PWA 110 Coated)	19, 203, 209, 258
Compressor Vane and Shroud Assembly (Stage 9) (Nickel-Cadmium Plated)	19, 203, 209, 258
Compressor Vane and Shroud Assembly (Stage 9) (PWA 110 Coated)	209, 258
Compressor Vane Outer Shroud Support Ring	203, 209, 211, 213

R
R

Engine Part Cleaning Procedures
Table 501 (Continued)

	Nomenclature	SPOP
R	Diffuser Case Assembly	203, 209, 211, 213
	Diffuser Case Assembly (PWA 110 Coated)	209, 258
	Flowmeter To Oil Cooler Fuel Tube	203, 209
	Free Turbine Accessory Bevel Gear	203, 209
	Free Turbine Accessory Drive Gearbox Housing Assembly	19, 209
	Free Turbine Accessory Driveshaft Bevel Gear	203, 209
	Free Turbine Accessory Driveshaft	203, 209
	Free Turbine Accessory Driveshaft Coupling	203, 209
	Free Turbine Accessory Driveshaft Spacer	203, 209
	Free Turbine Bevel Gearshaft	203, 209
	Free Turbine Case Assembly	203, 209, 211, 213
	Free Turbine Coupling	203, 209
	Free Turbine Exhaust Duct Assembly	203, 209, 211, 213
	Free Turbine Gearbox Bearing Housing	209
	Free Turbine Gearbox Bevel Gearshaft	203, 209
	Free Turbine Gearbox Drive Scavenge Tube	203, 209
	Free Turbine Inlet Case	203, 209, 211, 213
	Free Turbine Inlet Duct Assembly	203, 209, 211, 213
	Free Turbine Rotor Rear Stage 2 Airseal	203, 209

Engine Part Cleaning Procedures
Table 501 (Continued)

Nomenclature	SPOP
Free Turbine Rotor Stage 1 Airsealing Ring	203, 209
Free Turbine Shaft Nickel-Cadmium Plated PWA 110 Coated	203, 209 209, 258
Free Turbine Shaft Coupling Lock Ring	203, 209
Free Turbine Shaft Coupling Nut	203, 209
Free Turbine Shaft Inner Case Assembly	203, 209, 211, 213
Free Turbine Shaft Stabilizing Ring	203, 209, 211, 213
Free Turbine Stage 1 Airsealing Ring Segment	203, 209, 211, 213
R R Free Turbine Stage 1 and 2 Blade	9, 10, 209, 211, 213, 219
Free Turbine Stage 1 and 2 Disk	203, 209, 211, 213
Free Turbine Stage 2 Shroud	203, 209, 211, 213
Free Turbine Stage 1 and 2 Vane	9, 10, 203, 209, 211, 213, 218, 219
Free Turbine Stage 1 Lock	203, 209, 211, 213
Fuel Control Boss Assembly	19, 209
Fuel Control Drive Gearshaft	203, 209
Fuel Control Gearshaft Bearing	216
Fuel Control Drive Spur Gear	203, 209
Fuel Anti-Icing Heater Fuel Pressurizing Tube	203, 209
Fuel Pressurizing And Dump Valve Elbow	203, 209

Engine Part Cleaning Procedures
Table 501 (Continued)

Nomenclature	SPOP
Fuel Signal Tube	203, 209
Hydraulic Pump Drive Shaftgear Bearing	216
Hydraulic Pump Pad Bearing	216
Hydraulic Pump Pad Seal	209
Main Component Drivegear	203, 209
Main Component Drivegear Retaining Nut	203, 209
Main Component Drive Gearbox Bevel Spur Gearshaft	203, 209
Main Component Drive Gearbox Shaftgear Bearing	216
Main Component Driveshaft Upper Bearing	216
Main Component Driveshaft Upper Bearing Sleeve Inner Spacer	203, 209
Main Component Driveshaft Upper Bearing Sleeve Outer Spacer	203, 209
Main Oil Pump Bevel Gearshaft	203, 209
Main Oil Pump Gearshaft	203, 209
Main Oil Pump Gearshaft Bearing	216
Main Oil Pump Idler Spur Gear	203, 209
Main Oil Pump Inner Cover Assembly	19, 209
Main Oil Pump Inner Housing	19, 209
Main Oil Pump Outer Housing (Aluminum)	19, 209
Main Oil Pump Straight Shaft	203, 209
Main Oil Pump Suction Spur Gear	203, 209

R
R

Engine Part Cleaning Procedures
Table 501 (Continued)

Nomenclature	SPOP
Main Oil Strainer Cover (Magnesium)	19, 209, 260
Main Oil Strainer Support Assembly (Aluminum)	209
No. 1 Bearing	216
No. 1 Bearing Housing	203, 209
No. 1 Bearing Nut	203, 209
No. 2 Bearing	216
No. 2 Bearing Oil Distributing Sleeve	203, 209
No. 2 Bearing Oil Scoop	203, 209
No. 2 Bearing Ring	203, 209
No. 2 Bearing Seal Support Assembly	203, 209
No. 3 Bearing	216
No. 3 Bearing Heat Shield	203, 209, 211, 213
No. 3 Bearing Inner Race	216
No. 3 Bearing Inner Race Retaining Nut	203, 209
No. 3 Bearing Seal Support	203, 209
No. 4 Bearing	216
No. 4 Bearing Key Washer	203, 209
No. 4 Bearing Nut Key Washer	209
No. 4 Bearing Oil Scoop	209
No. 4 Bearing Seal Ring	209
No. 4 Bearing Sump Assembly	209

R
R

Engine Part Cleaning Procedures
Table 501 (Continued)

Nomenclature	SPOP
CAUTION: CLEAN CARBON SEALS BY SPOP 215 ONLY. DO NOT USE DEGREASING PROCEDURES ON THESE SEALS (THIS WILL CAUSE SEAL DAMAGE).	
No. 4 Bearing and Seal Support Assembly	209
No. 5 Bearing	216
No. 5 Bearing Inner Race Retaining Nut	203, 209
No. 5 Bearing Oil Scoop	203, 209
No. 5 Bearing Pressure and Scavenge Oil Tubes	203, 209
No. 5 Bearing Seal Housing Support	203, 209
CAUTION: CLEAN CARBON SEALS BY SPOP 215 ONLY. DO NOT USE DEGREASING PROCEDURES ON THESE SEALS (THIS WILL CAUSE SEAL DAMAGE).	
R No. 5 Bearing Seal Housing Support Assembly	203, 209
Oil Cooler Tube Assembly	203, 209
Oil Pressure Relief Valve Assembly	203, 209
Oil Pressure Relief Valve Cap (Aluminum)	209
Oil Screen	203, 209
Oil Screen Inlet Spacer	209
Oil Screen Outlet Spacer	209
Oil Strainer Bypass Valve Spring	203, 209
Pressure Sensing Tube Assembly	203, 209
Starter and Generator Drive Bearing (Magnesium)	19, 209, 260

Engine Part Cleaning Procedures
Table 501 (Continued)

Nomenclature	SPOP
Starter and Generator Drive Gearshaft	203, 209
Starter and Generator Drive Gearshaft Bearing	216
Starter and Generator Driveshaft	203, 209
Tachometer Drive Bevel Gearshaft	203, 209
Tachometer Drivegear	203, 209
Tachometer Drive Gearshaft Bearing	216
Tachometer Drive Housing Assembly (Magnesium)	19, 209, 260
Thermocouple Cable Electrical Bracket	203, 209, 211, 213

CAUTION: DO NOT BLAST COATED 1ST AND 2ND STAGE BLADES TOO MUCH (THE RESULT CAN BE REMOVAL OF THE COATING).

Nomenclature	SPOP
R Turbine Blades (Coated and Uncoated)	203, 209, 218, 219
Turbine Case Assembly	203, 209, 211, 213
Turbine Disks	9, 10, 203, 211, 213, 218, 219

NOTE: Blast disks by SPOP 218 or SPOP 219 only in the firtree slots after chemical cleaning by SPOP 211 or SPOP 213. It is permitted to blast disks in all areas by SPOP 9 or SPOP 10 after SPOP 211 or SPOP 213 cleaning.

Nomenclature	SPOP
Turbine Exhaust Case Assembly	203, 209, 211, 213, 218
Turbine Exhaust Cone and Strut Assembly	203, 209, 211, 213, 218
Turbine Rotor Bolt	203, 209, 211, 213
Turbine Rotor Bolt Nut	203, 209, 211, 213

Engine Part Cleaning Procedures
Table 501 (Continued)

Nomenclature	SPOP
Turbine Rotor 1st Stage Outer Seal	203, 209, 211, 213, 218
Turbine Rotor 2nd Stage Outer Seal	203, 209, 211, 213, 218
Turbine Shaft	
R (Nickel-Cadmium Plated)	203, 209
R (PWA 110 Coated)	209, 258
Turbine Shaft Coupling	203, 209
Turbine Shaft Lock	203, 209
Turbine Shaft Lockring	203, 209
Turbine Shaft Lockring Spring	203, 209
Turbine Vane 1st Stage Inner Shroud	9, 10, 203, 209, 211, 213, 218, 219
Turbine Vane 2nd Stage Shroud and Seal Assembly	9, 10, 203, 209, 211, 213, 218, 219
CAUTION: DO NOT BLAST COATED 1ST AND 2ND STAGE VANES TOO MUCH (THE RESULT CAN BE REMOVAL OF THE COATING).	
Turbine Vanes	
Uncoated	203, 209, 218, 219
Coated (PWA 73)	90

Engine Part Cleaning Procedures
Table 501 (Continued)

ENGINE GENERAL - INSPECTION, REPAIR, AND REPLACEMENT

1. General

A. Hazardous Materials

WARNING: AT ONE TIME SOME ENGINE PARTS CONTAINED ASBESTOS FIBERS, AND IT IS POSSIBLE THAT SOME OF THESE PARTS CONTINUE IN SERVICE. REFER TO COMMERCIAL ENGINE SERVICE BULLETINS FOR A LIST OF PARTS THAT AT ONE TIME CONTAINED ASBESTOS. IN SOME PARTS THE MATERIAL THAT CONTAINED ASBESTOS WAS THE ADHESIVE. IT IS IMPORTANT TO USE CORRECT PRECAUTIONS DURING WORK WITH THESE PARTS. OPERATORS MUST OBEY ALL LOCAL REGULATIONS AND EMPLOYER WORK POLICIES WHEN PARTS THAT CONTAIN ASBESTOS ARE TOUCHED OR DISCARDED.

THE ASBESTOS USED IN PRATT & WHITNEY ENGINE PARTS WAS USUALLY ENCAPSULATED AND WILL NOT RELEASE DUST UNLESS THE PARTS ARE GROUND, SANDED, CUT, OR BROKEN. WHILE IT IS OUR EXPERIENCE THAT THESE OPERATIONS DO NOT USUALLY RELEASE ASBESTOS AT LEVELS MORE THAN PERMITTED EXPOSURE LIMITS, OPERATORS MUST USE ALL APPLICABLE PRECAUTIONS WHEN THEY TOUCH SUCH PARTS.

(1) The curing agent methylene (BIS)-2 chloroaniline is used in the compounding of urethane and polyurethane and polyurethane elastomers. This agent has been declared a carcinogenic substance by the U.S. Department of Labor, pursuant to the Occupational Safety and Health Act and as such may be handled only in accordance with the rigid controls described in the Federal Register, Volume 38, No. 85 - Title 29, Chapter XVII, Part 1910. These controls dictate that personnel engaged in any operation involving a carcinogenic substance be protected to a zero exposure level. At this level there must be no personal contact with the material. Accordingly the following equipment and installations must be provided to preclude contamination: Clean, fully impervious pressurized air-supplied suits, controlled areas, dirty change room, shower, clean change room, medical posting and monitoring, and facilities for cleanup and waste disposal. It is not intended that this warning be a substitute for a full and complete reading of the Federal Register, Volume 38, No. 85 - Title 29, Chapter XVII, Part 1910. It is recommended that such a full and complete reading be accomplished.

B. Inspection

(1) Thorough and intelligent inspection of engine parts is a controlling factor in efficient and dependable overhaul. Too much emphasis cannot be placed on the importance of careful inspection and the decisions it involves.

(2) Parts should be arranged on an inspection table so an inspector can judge the condition of the engine as a whole and can refer readily to other parts which may have been affected by a worn part. The cause of abnormal wear can often be determined using this procedure.

(3) For interpretation of Feature Control Symbols used in inspection and repair illustrations, refer to the Standard Practices Manual.

2. Records

A. Inspection

(1) During inspection, keep a record of the condition of all parts and of all fits, clearances, and spring pressures. Refer to the Table Of Limits section for limits.

(2) When making out inspection records or reports, use only descriptive words which accurately qualify existing conditions. To eliminate confusion and maintain consistent terminology, the various physical conditions and the determination of the usual causes of wear or damage to engine parts which may be encountered during inspection are defined in this section.

B. Repair/Replacement

(3) If a part is found to be unfit for further service, attach a tag indicating that replacement is necessary. Attach a tag describing the necessary reconditioning to a part that requires repair. If reconditioning will affect a fit or clearance, the tag should remain attached to the part until final assembly and should be marked with a warning to check the fit or clearance.

(4) If inspection indicates it is necessary to replace a fitted spacer, tag the spacer to indicate that replacement should be made with a part of the same thickness to facilitate assembly operations.

(5) When a new part is to be installed and it is important that it be identified as to engine number or position in the engine, mark it in the same manner and in the same location as the part it replaces. A new part should be tagged so that any involved fits or clearances will be checked at assembly.

(6) When making out inspection records or reports, use only descriptive words which accurately qualify existing conditions. To eliminate confusion and to maintain consistent terminology, the various physical conditions and the determination of the usual causes of wear or damage to engine parts which may be encountered during inspection are defined in this section.

3. Use Of Damaged Engines And Parts

A. Engines and engine parts involved in abnormal operational circumstances require special disposition before a determination can be made as to their continued serviceability.

B. Abnormal operational circumstances are defined as events which fall outside the operating envelope for the engine, aircraft, or engine/aircraft combination as originally certified. These circumstances include such events as:

(1) Accidents

(2) Serious Operational Events

(3) Impacted/Dropped Engines

(4) Tailpipe Fires.

C. Refer to the Standard Practices Manual, Chapter/Section 70-00-00 for detailed instructions regarding disposition of engines and parts involved in abnormal operational circumstances.

4. Tubing - Inspection And Repair

A. Pressure check external pressure, scavenge and breather tubes at 50 psi.

NOTE: All tubing shall be inspected for the following conditions. In the absence of specific limits, the following general limits shall be followed.

B. Corrosion, Rust and Stain

(1) Tubing is serviceable if rust and stain is removable by light polishing with crocus cloth.

C. Dents

(1) Dents without sharp edges or corners, are acceptable if OD of tubes is not reduced more than five percent. Dents are not permitted within 1/4 inch of ferrules.

D. Pitting

(1) Isolated pitting is acceptable, after blending, if no deeper than 0.003 inch: no longer than 1/8 inch; no wider than 0.010 inch; and no closer than 1/4 inch. Clustered pitting is acceptable if removable by blending to depth no greater than 0.005 inch.

E. Nicks

(1) Raised edges, sharp corners, and depressions caused by impact with sharp objects are acceptable, after blending, if no deeper than 0.003 inch; no longer than 1/16 inch; no wider than 0.010 inch; no closer than 12 inches. After blending, three-quarters of wall thickness must remain and blended area must not exceed 1/2 square inch.

F. Scratches

(1) Minor scratches, leaving no appreciable depth, are acceptable without repair. Circumferential scratches are acceptable, after blending, if required blend repair does not exceed 45 percent of circumference and wall thickness is not reduced more than 25 percent. Longitudinal scratches are acceptable, after blending, if no longer than six inches, and required blend repair does not reduce wall thickness more than 25 percent.

5. Service Time Marking Of Parts
See Figure 601 thru Figure 604.

A. Service time operating hours between overhaul of certain jet engine parts are required for record or warranty purposes.

B. An index card system may be used to maintain record of operating hours between overhaul. Refer to Section 70-30-00, General-01 in the Standard Practices Manual for available options.

C. When marking parts, use vibration peen marking method. Stone marked area to remove raised edges. Unless otherwise specified, locate markings adjacent to part number.

6. Engine Bearings - Inspection
See Table 601 and Table 602.

A. Inspect bearings using procedures specified in the Standard Practices Manual and basic dimensions listed in referenced tables.

B. Permissible deviations from listed dimensions may be found in the Standard Practices Manual. See Bearings, Anti-friction-Service Limits.

C. The units of measurement are as follows: Dimensional limits are expressed in inches; contact angle is expressed in degrees; hardness is expressed in Rockwell units; load under which contact angle, flushness and total internal radial clearance are measured is expressed in pounds and is shown within parentheses or otherwise specified when required.

PN	ID	OD	Contact Angle	Ring Hardness (Minimum)	Total Internal Radial Clearance	Difference Between Major and Minor Axes
370434*	3.1496 3.1494	5.1181 5.1177	28.5° 24.5° (60)	C-58	.0041 .0029 (33)	
370483	3.1496 3.1493	4.3307 4.3297		C-57	.0024 .0018 (33)	.014 .012

Basic Bearing Limits
Table 601

PN	ID	OD	Contact Angle	Ring Hardness (Minimum)	Total Internal Radial Clearance	Difference Between Major and Minor Axes
410694**	3.1496 3.1494	5.9055 5.9051	24.0° (60)	C-58	.0060 .0048 (33)	
410786	2.9528 2.9525	4.1339 4.1329		C-58	.0024 .0018 (33)	.011 .009
410787	2.9528 2.9525	4.1339 4.1329		C-58	.0024 .0018 (33)	.011 .009
419403*	3.1496 3.1494	5.1181 5.1177	28.5° 24.5° (60)	C-58	.0041 .0029 (33)	
428851*	3.1496 3.1494	5.1181 5.1177	22.0° 19.0° (60)	C-58	.0030 .0018 (33)	
443347	2.9528 2.9525	4.1339 4.1329		C-58	.0024 .0018 (33)	.011 .009
447266*	3.1496 3.1494	5.1181 5.1177	22.0° 19.0° (30)	C-58	.0029 .0020 (33)	
478553	2.9528 2.9525	4.1339 4.1329		C-58	.0024 .0018 (33)	.011 .009
481180	2.9528 2.9525	4.1339 4.1329		C-58	.0024 .0018 (33)	.011 .009
636045	3.1496 3.1493	4.3307 4.3297		C-60	.0024 .0018 (33)	.014 .012
736441	2.9528 2.9525	4.1339 4.1329		C-58	.0024 .0018 (33)	.011 .009

Basic Bearing Limits
Table 601 (Continued)

PN	ID	OD	Contact Angle	Ring Hardness (Minimum)	Total Internal Radial Clearance	Difference Between Major and Minor Axes
736442*	3.1496 3.1494	5.1181 5.1177	25.0° 20.0° (60)	C-58	.0041 .0029 (33)	
736820	3.1496 3.1493	4.3307 4.3297		C-60	.0024 .0018 (33)	.014 .012
736821**	3.1496 3.1494	5.9055 5.9051	24.0° (60)	C-58	.0063 .0046 (33)	

*Flushness requirement is 0.001 inch at 400 lb. load.
**Flushness requirement is 0.001 inch at 22 lb. load.

Basic Bearing Limits
Table 601 (Continued)

Part No.	ID	OD	Ring Hardness Minimum	Total Internal Radial Clearance
313566	1.1811 1.1809	2.1654 2.1651	C-58	.0024 .0015 (11)
317300	.9843 .9841	2.0472 2.0469	C-58	.0015 .0010 (11)
333814	.7874 .7872	1.6535 1.6533	C-58	.0020 .0012 (11)
333815	.7874 .7872	1.6535 1.6533	C-58	.0015 .0010 (11)
352077	.9843 .9841	2.0472 2.0469	C-58	.0017 .0007 (11)

Basic Bearing Limits (Main
Bearings Excluded)
Table 602

Part No.	ID	OD	Ring Hardness Minimum	Total Internal Radial Clearance
356115	.7874 .7872	1.8504 1.8502	C-57	.0012 .0007 (11)
356116	.7874 .7872	1.8504 1.8502	C-58	.0021 .0012 (11)
365434	.4724 .4722	.9449 .9447	C-58	.0010 .0006 (5.5)
365435	.4724 .4722	.9499 .9447	C-58	.0012 .0008 (5.5)
367080	1.1811 1.1809	1.8504 1.8502	C-58	.0013 .0006 (11)
367081	1.1811 1.1809	1.8504 1.8502	C-58	.0015 .0010 (11)
370432	.7874 .7872	1.6535 1.6533	C-58	.0011 .0005 (11)
370433	.7874 .7872	1.6535 1.6533	C-58	.0012 .0008 (11)
370575	.6693 .6691	1.8504 1.8502	C-58	.0013 .0006 (5.5)
370590	1.3780 1.3778	2.1654 2.1651	C-58	.0013 .0006 (11)
370688	.6693 .6691	1.8504 1.8502	C-58	.0015 .0005 (5.5)

Basic Bearing Limits (Main Bearings Excluded)
Table 602 (Continued)

Part No.	ID	OD	Ring Hardness Minimum	Total Internal Radial Clearance
370689	1.3780 1.3778	2.1654 2.1651	C-58	.0017 .0012 (11)
375727	.9843 .9841	2.0472 2.0469	C-58	.0019 .0011 (11)
387848	.7874 .7872	1.8504 1.8502	C-58	.0015 .0010 (11)
387860	.7874 .7872	1.8504 1.8502	C-58	.0013 .0006 (0.0)
387861	.7874 .7872	1.8505 1.8502	C-58	.0015 .0010 (11)
387866	.9843 .9841	2.4409 2.4406	C-58	.0015 .0008 (11)
387867	.9843 .9841	2.4409 2.4406	C-58	.0015 .0010 (5.5)
403446	.1875 .1872	.5000 .4996	C-58	.0009 .0003 (0.0)
423144	.3750 .3747	.8750 .8746	C-58	.0007 .0002 (5.5)
438892	1.1811 1.1809	2.1654 2.1651	C-58	.0019 .0010 (11)
467845	.3937 .3934	1.1811 1.1807	C-58	.0004 Max. (5.5)

Basic Bearing Limits (Main Bearings Excluded)
Table 602 (Continued)

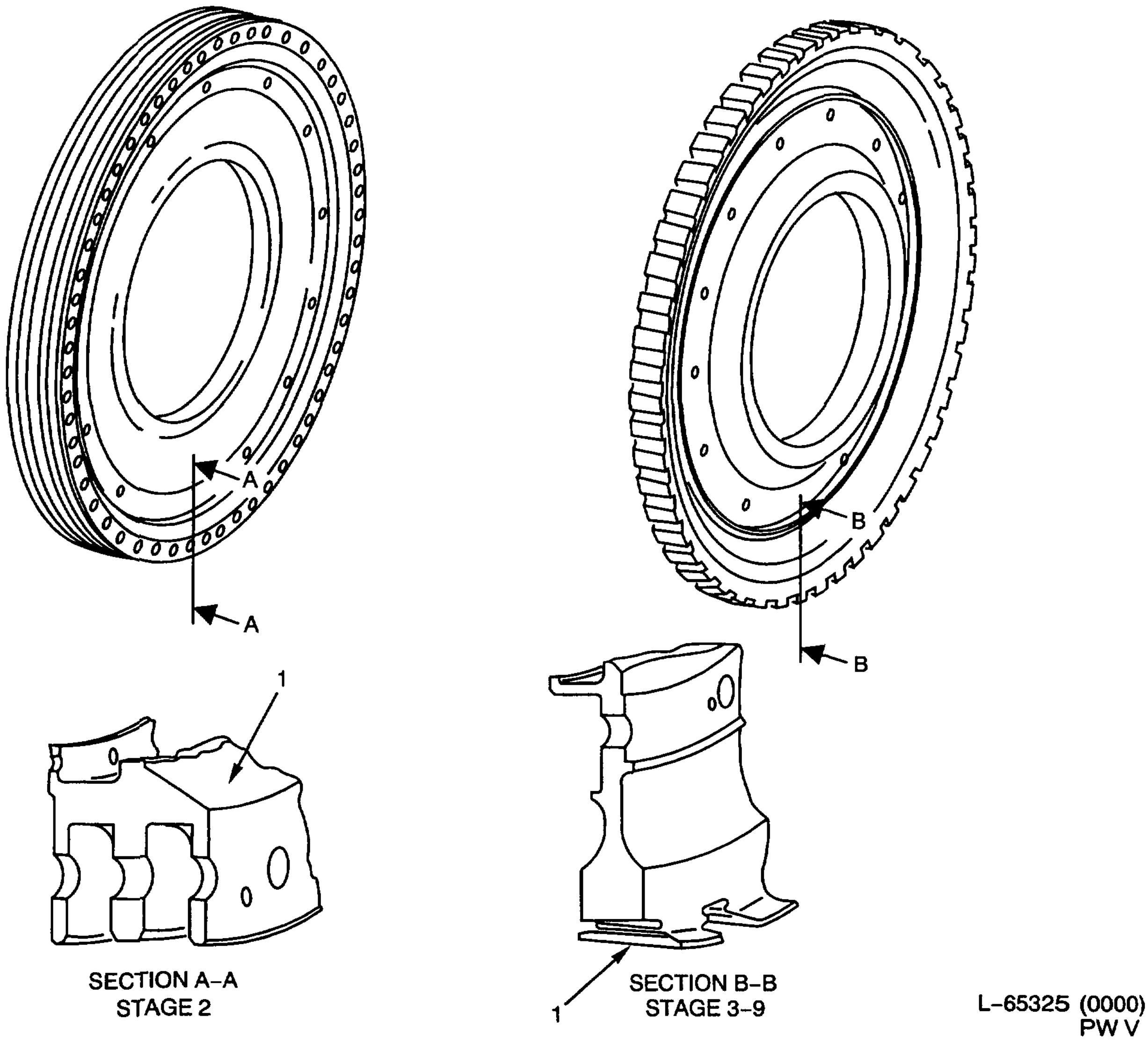
Part No.	ID	OD	Ring Hardness Minimum	Total Internal Radial Clearance
501829	.3150 .3148	.8661 .8659	C-61	.0015 .0009 (5.5)
501830	.3150 .3148	.8661 .8659	C-60	.0015 .0009 (5.5)
528468	.7874 .7872	1.8504 1.8502	C-58	.0013 .0006 (11)
528469	.7874 .7872	1.8504 1.8502	C-58	.0015 .0010 (11)
565327	.9843 .9841	2.4409 2.4406	C-60	.0015 .0008 (11)
565328	.9843 .9841	2.4409 2.4406	C-60	.0015 .0010 (5.5)
568134	.7874 .7872	1.6535 1.6533	C-60	.0020 .0012 (11)
613014	.7874 .7872	1.8504 1.8502	C-60	.0008 .0004 (11)
627332	.7874 .7872	1.8504 1.8502	C-58	.0008 .0003 (11)
664078	.3150 .3148	.8661 .8659	C-60	.0015 .0009 (5.5)
691008	.7874 .7872	1.8504 1.8502	C-60	.0008 .0004 (11)

Basic Bearing Limits (Main Bearings Excluded)
Table 602 (Continued)

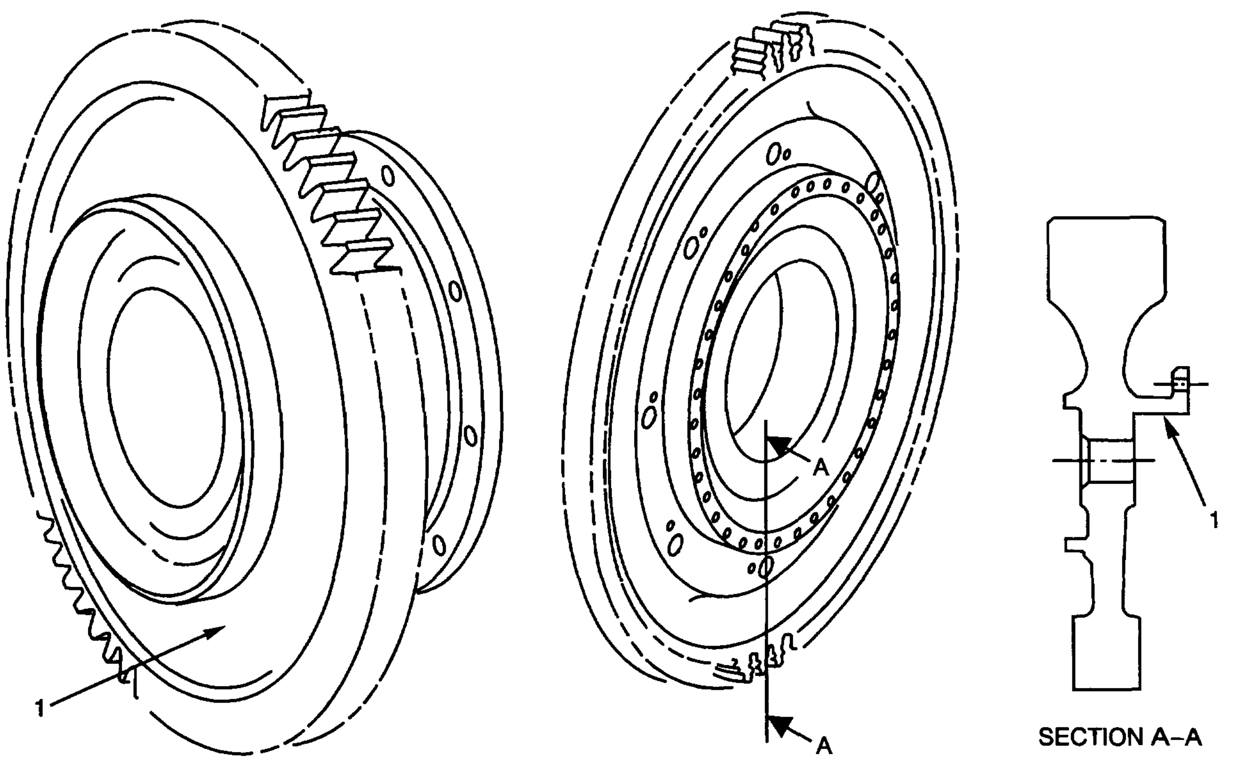
	Part No.	ID	OD	Ring Hardness Minimum	Total Internal Radial Clearance
	735006	.7874	1.8504	C-58	.0015
		.7872	1.8502		.0010
					(11)
	736833	.7874	1.6535	C-60	.0020
		.7872	1.6533		.0012
					(11)
	736837	.7874	1.8504	C-58	.0021
		.7875	1.8502		.0012
					(11)
	736841	.1875*	.5000*	C-58	.0009
		.1872	.4996		.0003
					(2.2)
	736849	.7874	1.8504	C-60	.0025
		.7872	1.8502		.0015
					(11)
	770705	.3750	.8750	C-58	.0007
		.3747	.8745		.0002
					(5.5)
	772677	.9843	2.0472	C-58	.0011
		.9841	2.0469		.0019
					(11)
R	772680	1.1811	2.1654	C-58	.0019
R		1.1809	2.1651		.0010
					(11)
	782519	.3939	1.1811	C-27 (outer)	
		.3934	1.1806	C-40 (inner)	
R	2183599	.3150	.8661	C-60	.0015
R		.3148	.8659		.0009
R	2184028	.3150	.8661	C-60	.0015
R		.3148	.8659		.0009
R					(5.5 - 2)

* Average diameter may be 0.0002 inch out of round

Basic Bearing Limits (Main
Bearings Excluded)
Table 602 (Continued)

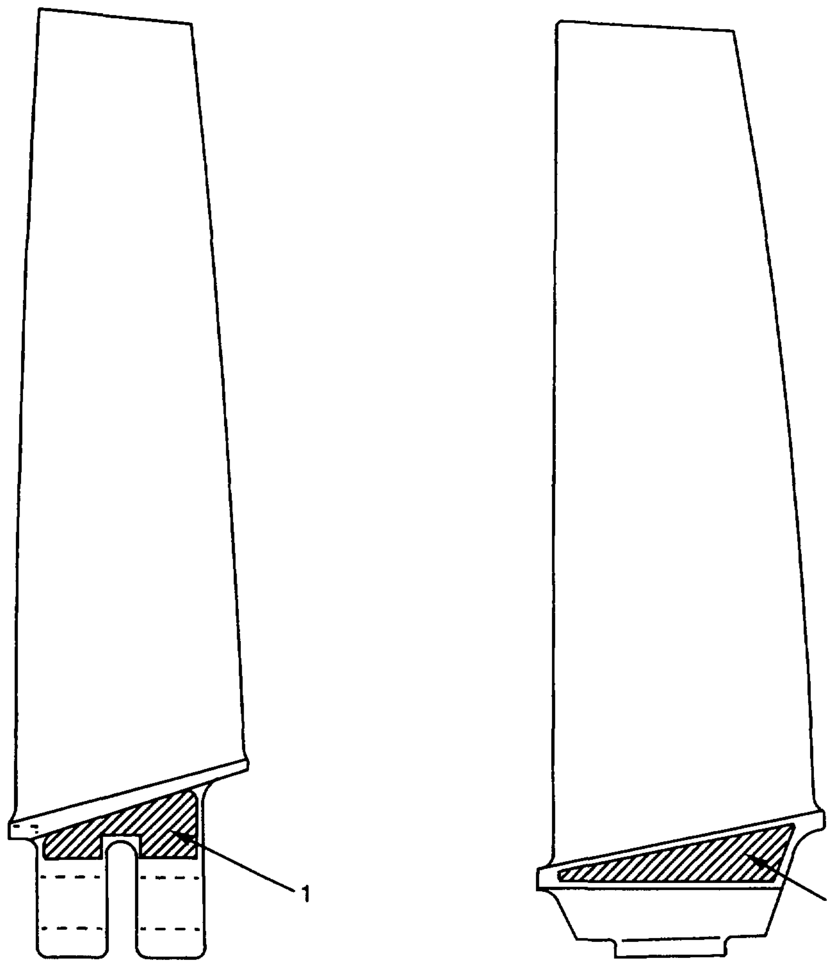


1. Location For Marking Service Time And Flight Cycles Accumulated Since Last Overhaul.



1. Location For Marking Service Time And Flight Cycles Accumulated Since Last Overhaul.

Service Time Marking - Turbine Disks
Figure 602

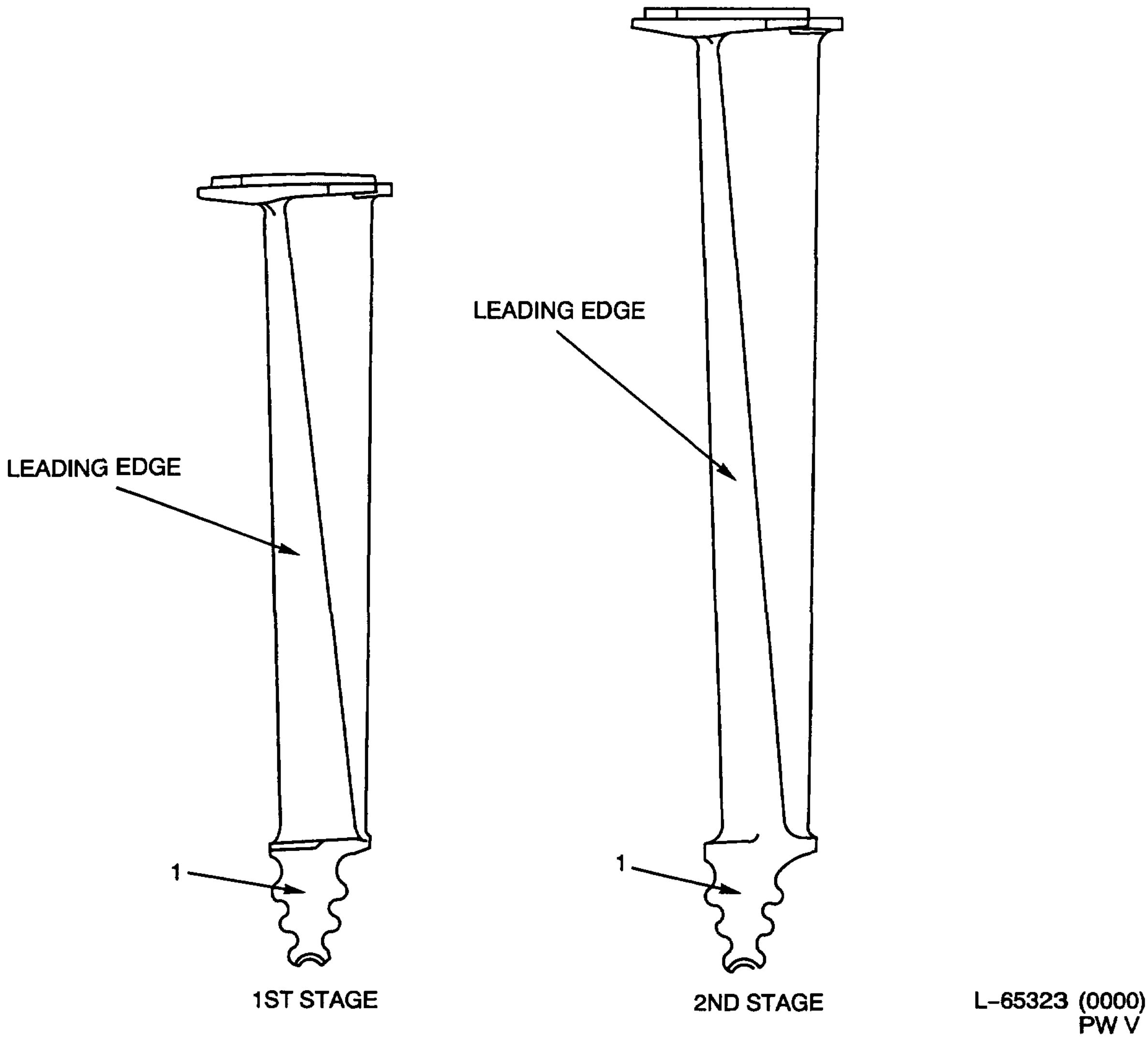


1. Location For Marking Service Time Accumulated Since Last Overhaul. Service Time May Be Logged Using Following Code:

Time	Code
0 - 49 hours	-
50 - 99 hours	+
100 - 149 hours	1-
150 - 199 hours	1+
200 - 249 hours	2-

where sum of 1- and 1+ equals 3 (300 hours).

Service Time Marking - Compressor Blades
Figure 603



Service Time Marking -
Turbine Blades
Figure 604

ENGINE GENERAL - INSPECTION, REPAIR, AND REPLACEMENT

1. Location For Marking Service Time Accumulated Since The Last Overhaul. The Time Logged Must Be To The Nearest Increment Of Ten Hours With The Units Digit Replaced By A Dash.

Example:

Service Time	Marking
60 hours	6-
121 hours	12-
329 hours	33-
524 hours	52-
525 hours	53-

Key to Figure 604

7. Balance Bearings - Inspection

A. Inspect balance bearings as specified in Section 70-35-00, Inspection/Check-06 in the Standard Practices Manual.

Tool No.	ID*	ID Tolerance	OD**	OD Tolerance	Internal Radial Clearance
PWA 21350-12	2.9540	+.00000 -.00025	5.6250	+.0000 -.0004	.0019 .0014 (33±2)
PWA 21350-13	3.1493	+.00000 -.00025	5.6250	+.0000 -.0004	.0019 .0014 (33±2)
PWA 21350-14	2.9991	+.00000 -.00025	5.6250	+.0000 -.0004	.0019 .0014 (33±2)

*0.0001 inch FIR Maximum Runout
**0.001 inch FIR Maximum Runout

Balance Bearing Limits
Table 603

8. Fluorescent Magnetic Particle/Fluorescent Penetrant Inspection
See Table 604 and Table 605.

A. Parts which require fluorescent magnetic particle or fluorescent penetrant inspection are listed in alphabetical order in referenced tables. Where more than one procedure is listed, part must be inspected by each.

Nomenclature	Procedure
Combustion Chamber Outer Case	SPOP 117 1. Rod 3500A 2. Manual or Induced Current Fixture 1000A

NOTE: SPOP 117 is an alternate procedure to SPOP 82 fluorescent penetrant inspection.

Nomenclature	Procedure
Component Drive Gearbox Bevel Gear	SPOP 103 1. Rod 4500A 2. OD 2000A
Component Drive Gearbox Gearshaft	SPOP 101 1. Rod 1500A
Component Gearbox Driveshaft Assembly	SPOP 106 1. Ends 1000A 2. Solenoid 500A
Component Gearbox Driveshaft Coupling	SPOP 102 1. Rod 1000A 2. Solenoid 500A
Compressor Blades R (Steel) (Stages 6, 8 and 9)	SPOP 106 1. Ends (Front and Rear platform) 500A (Blades thru 5th stage) 200A (Stages 6 thru 9 Blades) 2. Solenoid 500A
Compressor Rotor Airseal (2nd Stage)	SPOP 115 1. Rod 1000A 2. Manual or Induced Current Fixture 3000A
Compressor Rotor Airseal (4th Stage)	SPOP 115 1. Rod 1500A 2. Manual or Induced Current Fixture Method 3000A

Fluorescent Magnetic
Particle Inspection
Table 604

	Nomenclature	Procedure
R	Compressor Rotor Disks (Steel) (Stages 5, 6, 8, and 9) NOTE: This inspection is for disks with the blades removed.	SPOP 112 1. Manual or Knife Switch Method 3000A 2. Manual Method 5000A or Induced Current Fixture Method 4000A (Use Fluorescent Magnetic Particle Inspection only.)
R	Compressor Rotor Disk Spacers (Stages 4-5, 5-6, 6-7, 7-8, 8-9)	SPOP 115 1. Rod 3000A 2. Manual or Induced Current Fixture 3000A
	Compressor Rotor Front Hub (Steel)	SPOP 115 1. Rod 3500A (Use two soft-tipped one inch diameter rods) 2. Manual or Induced Current Fixture 3000A (Flange End)
	Compressor Rotor Rear Airseal (9th Stage)	SPOP 115 1. Rod 1000A 2. Manual or Induced Current Fixture 3000A
R	Compressor Rotor Rear Hub	SPOP 115 1. Rod 4500A 2. Induced 3000A
	Compressor Rotor Tierods	SPOP 106 1. Ends 500A 2. Solenoid 500A
	Compressor Rotor Tierod Nuts	SPOP 101 1. Rod 500A
	Compressor Vanes and Shrouds (1st Stage - steel)	SPOP 112 1. Manual or Knife Switch Method 1000A 2. Manual or Induced Current Fixture Method 1500A
	Free Turbine Coupling	SPOP 102 1. Rod 2000A 2. Solonoid 500A

Fluorescent Magnetic Particle Inspection
Table 604 (Continued)

Nomenclature	Procedure
Free Turbine Accessories Drive Shaft Coupling	SPOP 106 1. Ends 500A 2. Solenoid 500A
Free Turbine Accessories Bevel Gear	SPOP 103 1. Rod 2500A 2. OD 1000A
R Free Turbine Accessories Drive Shaft Bevel Gear	SPOP 101 1. Rod 1500A
Free Turbine Gearbox Bevel Gearshaft	SPOP 103 1. Ends 1000A 2. OD 1000A
Free Turbine Bevel Gearshaft	SPOP 102 1. Rod 1000A 2. Solenoid 500A
Free Turbine Serrated Lock Ring	SPOP 101 1. Rod 1000A
Free Turbine Shaft Coupling Nut	SPOP 102 1. Rod 2000A 2. Solenoid 500A
Free Turbine Bearing Retaining Nut	SPOP 101 1. Rod 1000A
Free Turbine Rear Bearing Retaining Nut	SPOP 101 1. Rod 1000A
Free Turbine Front Bearing Oil Scoop	SPOP 101 1. Rod 1500A
Free Turbine Rear Bearing Oil Scoop	SPOP 101 1. Rod 1500A
Free Turbine Rotor 1st Stage Airseal	SPOP 115 1. Rod 2000A
Free Turbine Shaft	SPOP 102 1. Rod 5000A 2. Solenoid 1000A

Fluorescent Magnetic Particle Inspection
Table 604 (Continued)

Nomenclature	Procedure
Free Turbine Accessories Driveshaft	SPOP 106 1. Ends 500A 2. Solenoid 500A
Free Turbine Rear Bearing Seal Housing Support	SPOP 103 1. Rod 2500A R 2. OD 1000A
Fuel Control Drive Gearshaft	SPOP 103 1. Rod 2000A 2. OD 2000A
Fuel Control Drive Spur Gear	SPOP 103 1. Rod 2000A 2. OD 1000A
Hydraulic Pump Drive Gearshaft Breather Assembly	SPOP 103 1. Rod 2500A 2. OD 1500A
Main Component Drivegear	SPOP 103 1. Rod 2500A 2. OD 1000A
Main Component Drive Gearbox Bevel Spur Gearshaft	SPOP 106 1. Ends 2000A 2. Solenoid 1000A
Main Oil Pump Bevel Gearshaft	SPOP 106 1. Ends 1000A 2. Solenoid 500A
Main Oil Pump Gearshaft	SPOP 106 1. Ends 500A 2. Solenoid 500A
Main Oil Pump Idler Spur Gear	SPOP 101 1. Rod 1000A
Main Oil Pump Pressure Spur Gear	SPOP 101 1. Rod 1000A
Main Oil Pump Spur Gear	SPOP 102 1. Rod 1000A 2. Solenoid 500A

Fluorescent Magnetic Particle Inspection
Table 604 (Continued)

Nomenclature	Procedure
Main Oil Pump Spur Gear	SPOP 101 1. Rod 1000A
Main Oil Pump Suction Spur Gear	SPOP 101 1. Rod 1000A
No. 1 Bearing (Outer Race Only)	SPOP 101 1. Rod 2000A
No. 1 Bearing Housing	SPOP 115 1. Rod 2000A 2. Manual or Induced Current Fixture 3000A
No. 2 Bearing	SPOP 101 1. Rod 2000A Each Race
No. 2 Bearing Oil Distributing Sleeve	SPOP 115 1. Rod 1000A 2. Manual or Induced Current Fixture 3000A
No. 2 Bearing Oil Scoop	SPOP 101 1. Rod 1000A
No. 3 Bearing (Inner Race)	SPOP 101 1. Rod 2000A
No. 3 Bearing Inner Race Retaining Nut	SPOP 101 1. Rod 500A
No. 3 Bearing (Inner Race Only)	SPOP 101 1. Rod 2000A
Starter and Generator Drive Gearshaft	SPOP 103 1. Rod 2500A 2. OD 1000A
Starter and Generator Driveshaft	SPOP 102 1. Rod 500A 2. Solenoid 500A
Tachometer Drive Bevel Gearshaft	SPOP 102 1. Rod 1000A 2. Solenoid 500A

R
R

Fluorescent Magnetic Particle Inspection
Table 604 (Continued)

Nomenclature	Procedure
Tachometer Drivegear	SPOP 101 1. Rod 500A
Turbine Shaft (N1)	SPOP 102 1. Rod 5000A 2. Solenoid 1000A
Turbine Shaft Coupling	SPOP 102 1. Rod 1000A 2. Solenoid 500A
Turbine Shaft Lock	SPOP 101 1. Rod 500A
Turbine Shaft Splined Lockring	SPOP 101 1. Rod 1000A

Fluorescent Magnetic
Particle Inspection
Table 604 (Continued)

Nomenclature	SPOP
Combustion Chamber Assembly	62
Combustion Chamber Case Assembly	82
NOTE: SPOP 82 is an alternate procedure to SPOP 117 fluorescent magnetic particle inspection.	
Combustion Chamber Inner Case	62
Combustion Chamber Outlet Duct Assembly	62
Combustion Chamber Outlet Duct Support Assembly	62
Combustion Chamber Retaining Clamp	62
Component Drive Gearbox Housing Assembly	62
R Compressor Blades - (Titanium or Steel) (Stages 1, 2, 3, 4, 5, and 7)	84

Fluorescent Penetrant Inspection
Table 605

Nomenclature	SPOP
Compressor Inlet Case Assembly	62
Compressor Inlet Cone Support	62
Compressor Inlet Outer Front Cone	62
Compressor Inlet Outer Rear Cone	62
Compressor Rotor Airseal (3rd stage)	62
Compressor Rotor Airseals (Stages 5 thru 9)	62
Compressor Rotor Disks (Titanium) (Stages 2, 3, 4, and 7)	84
Compressor Rotor Disk Spacers (Titanium) (Stages 2-3, 3-4)	84
Compressor Rotor Front Hub (Titanium)	84
Compressor Tierod Nuts	82
Compressor Vane and Shroud Assembly (Stages 1 thru 3)	82
Compressor Vane and Shroud Assembly (Stages 4 thru 9)	82
Diffuser Case Assembly	62
Flowmeter to Oil Cooler Fuel Tube	62
Free Turbine 1st Stage Blade	82
Free Turbine 2nd Stage Blade	82
Free Turbine Case	62
Free Turbine Inlet Case	62
Free Turbine Shaft Inner Case	62
Free Turbine Shaft Outer Case	62
Free Turbine 1st Stage Disk	84

R
R

Fluorescent Penetrant Inspection
Table 605 (Continued)

	Nomenclature	SPOP
	Free Turbine 2nd Stage Disk	84
	Free Turbine Exhaust Duct	62
	Free Turbine Inlet Duct	62
R	Free Turbine Rotor Tierod	84
	Free Turbine Vane Lock	62
	Free Turbine Ring (Segments)	62
	Free Turbine Rotor 2nd Stage Airseal Ring	62
R	Free Turbine Rotor 1st Stage Airseal	84
	Free Turbine Accessories Drive Support	62
	Free Turbine 1st Stage Vane	82
	Free Turbine 2nd Stage Vane	82
	Free Turbine No. 4 Bearing Key Washer	62
	Free Turbine Sump, No. 4 Bearing	62
	Free Turbine Rotor 1st Stage Airseal	82
	Free Turbine Rotor Tierods	82
	Fuel Control to Flowmeter Tube	62
	Fuel De-Icing Heater Fuel Pressurizing Tube	62
	Fuel De-Icing Heater Housing	62
	Fuel/Oil Cooler Housing	62
	Fuel Pressurizing and Dump Valve Elbow	62
	Main Oil Strainer Cover	62

Fluorescent Penetrant Inspection
Table 605 (Continued)

Nomenclature	SPOP
Oil Cooler Fuel Outlet Elbow	62
Oil Cooler Tube	62
Pressure Sensing Tube	62
Turbine Blades (Stages 1 and 2)	82
Turbine Case Assembly	62
Turbine Disks (Stages 1 and 2)	84
Turbine Exhaust Case Assembly	62
Turbine Exhaust Cone and Strut Assembly	62
Turbine Rotor Bolt	82
Turbine Rotor Bolt Nut	82
Turbine Rotor 1st Stage Outer Seal	62
Turbine Rotor 1st Stage Outer Seal Spacer	62
Turbine Rotor Inner Seal	84
Turbine Rotor 2nd Stage Outer Seal	62
Turbine Vanes (Stages 1 and 2)	82
Turbine Vane 1st State Inner Shroud	62
Turbine Vane 2nd Stage Shroud and Seal Assembly	62

Fluorescent Penetrant Inspection
Table 605 (Continued)

9. Main Bearing Seal Air Checks

A. No. 2 Bearing Seal Air Check
See Tool Group 7.

(1) Install the Airflow Test Fixture in the Airflow Metering Stand.

(2) Install the detail-12 spacer (with the seal down) in the cover and attach it with the screws.

NOTE: You can use the engine part seal plate in place of the detail-12 spacer for total air leakage past the seal and seal rings only. Make sure that the packings and gaskets on the fixture are in good condition before the test to be sure that they will seal correctly.

(3) Carefully put the No. 2 bearing seal assembly in the fixture body.

(4) Install the cover and attach it with the hand knob.

(5) Put 85 psi air into the regulator valve of the fixture and monitor the total air leakage through the flowmeter. Leakage must not be more than two cfm.

(6) If the leakage is more than three cfm, unlock and remove the cover and turn the detail-12 spacer around to make it be against the carbon seal when assembled. Install the detail-12 spacer and install the cover again. Do the air check again.

(7) If the seal leakage continues, this shows that the seal rings do not seal correctly. If the leakage is not more than limits, this shows that the carbon seal did not seal correctly.

(8) To stop leakage past the seal ring, unlock and remove the seal assembly from the fixture. Put the seal assembly on the bench and push down and release the seal assembly against its springs one or two times. Make sure that the ring gaps are 180 degrees apart. Put the assembly back in the fixture and do the check again.

(9) If the leakage is past the carbon seal, unlock and remove the seal assembly from the fixture and lap the seal face. Clean the seal and install it back in the fixture. Unlock and turn the detail-12 spacer around in the cover and do the air check again.

(10) When the air check is completed, unlock the fixture and remove the seal assembly from the fixture.

B. No. 3 Bearing Seal Air Check
See Tool Group 11.

(1) Install the Airflow Test Fixture in the Airflow Metering Stand.

(2) Install the detail-28 ring (with the seal down) in the bottom of the fixture body.

<u>NOTE</u>: You can use the engine part seal plate in place of the detail-28 ring for total air leakage past the seal and seal rings only. Make sure that the packings and gaskets on the fixture are in good condition before the test to be sure that they will seal correctly.

(3) Carefully put the No. 3 bearing seal assembly in the fixture body.

(4) Install the fixture cover on the body.

(5) Put 45 psi air into the fixture and monitor the total air leakage through the flowmeter. Leakage must not be more than three cfm.

(6) If the leakage is more than 1.25 cfm, unlock and remove the fixture cover and the seal assembly.

(7) Install the spacer, seal side up, in the body of the fixture.

(8) Install the seal assembly and fixture cover. Attach the cover and do the air check again as specified above.

(9) If the seal leakage continues, this shows that the seal rings do not seal correctly. If the leakage is not more than limits, this shows that the carbon seal did not seal correctly.

(10) To stop leakage past the seal rings, unlock and remove the seal assembly from the fixture. Put the seal assembly on the bench and push down and release the seal assembly against its springs one or two times. Make sure that the ring gaps are 180 degrees apart. Put the assembly back in the fixture and do the check again.

(11) If the leakage is past the carbon seal, unlock and remove the seal assembly from the fixture and lap the seal face. Clean the seal and install it back in the fixture with the detail-28 ring face down. Do the air check again.

(12) When the air check is completed, unlock the fixture and remove the seal assembly from the fixture.

10. Main Bearing And Seal Jet Oil Flow Checks

A. General

(1) To make sure of satisfactory operation of main engine bearings and seal, oil flow must be in limits. Record flows and jet hole sizes on each engine.

B. Equipment

(1) Oil flow bench which can supply 0 - 50 pounds per minute at 45 psig of PWA 521B Type II oil or equivalent at 85° - 99°C (185° - 210°F).

(2) Rotameter or pans and scales to measure oil flow from 2 - 20 pounds per minute, accurate to ± three percent.

(3) Temperature measuring device to monitor oil temperature, accurate to ± one psi.

(4) Oil flow fittings to connect oil supply system to the engine cases.

NOTE: The fittings must be the same as the tube flanges that attach to the main engine cases. The pressure measuring tap must be as near as possible to where the oil goes into the engine case.

(5) Filters or fine mesh screens (maximum of 0.005 inch opening) must be immediately upstream of pressure points in the oil line to the engine.

C. Test Procedure
See Table 606.

(1) Measure the oil flow from each specified jet (assembled with parts which have an effect on its flow). Supply oil through approved fittings at 45 psig plus or minus one psi and 90° - 99°C (195° - 210°F) oil inlet temperature. All jets supplied from a common case passage must get flow together with the specified pressure applied at the case passage inlet, or at the inlet of test parts of the same passage design. It is permitted to do a flow check of the No. 1 bearing jet separately.

(2) Do not measure flow until the oil that comes out of the jets is at 88°C (190°F) minimum. The jet discharge must be to the open air or to a hose of not less than 5/8 inch ID (adapted to the jets by fittings which do not decrease the oil flow).

(3) The flow inspection for each jet is not final until all jets supplied by individual supply fittings flow in their specified ranges at the time they are measured.

(4) All jet plugs must be flush to 0.020 inch lower than the surface of the tubes they are installed in.

(5) Where applicable, stake jet plugs tightly after the flow checks are completed.

Supply Fitting Connection	Oil Jet	Oil Flow (lbs/min.)
Front Case	No. 1 Bearing	2.0 - 2.5
Diffuser Case	No. 2 Bearing and Seal	8.5 - 9.25
	Towershaft Bearings and Gearbox	1.75 - 2.25
	No. 3 Bearing	
	Front	1.5 - 2.0
	Rear	1.5 - 2.0
	Seal	2.5 - 3.0

Oil Jet Flow Limits
Table 606

D. No. 1 Bearing Oil Jet Flow Check
See Tool Group 3.

(1) Attach the No. 1 bearing oil nozzle to the end of the Oil Nozzle Adapter.

(2) Put the assembly above an oil catch pan.

(3) Attach supply lines from the test stand to the oil inlet and pressure connections. Measure the oil flow on the stand flowmeter to the limits in Table 606.

(4) Remove the nozzle from the Adapter.

E. No. 2 Bearing And Seal, Towershaft And Bearings, No. 3 Bearing Front, Rear, And Seal Jet Oil Flow Check
See Tool Group 83.

(1) Install the combustion chamber inner case assembly in the Oil Flow Jet Fixture. Attach the adapter detail of the fixture to the No. 2 bearing oil nozzle. Adjust the tool details to each of the jets.

(2) Measure the oil flow of each jet to the limits in Table 606.

NOTE: Oil leakage flow at the slip joint in the pressure oil tube that supplies oil to the No. 3 bearing of a maximum of 1.5 pounds per minute is permitted.

F. No. 2 Bearing and Seal Nozzle Directional Oil Flow Check
See Tool Group 8.

(1) Attach the Oil Flow Adapter to the No. 2 bearing support in the diffuser case with the tool details. Install the No. 2 bearing nozzle assembly on its boss on the diffuser case with the engine parts.

(2) Close the oil jet and oil-out hole that does not get the oil flow check. Attach the bearing nozzle Airflow Adapter to the oil pressure flange on the OD of the diffuser case and do an oil flow check of the nozzle. The oil stream from the jet must go in the annulus between the shaft and retaining nut (this is simulated by the oil flow adapter).

G. No. 4 Bearing And Seal And No. 5 Bearing Front, Rear, And Seal Oil Jet Flow Check
See Tool Group 13-2.

(1) Install the assembled free turbine bearing support to the Oil Flow Fixture. Attach the Oil Inlet Adapter to the outer end of the oil inlet tube.

(2) Measure the oil flow from each jet to the limits in Table 607.

Supply Fitting Connection	Oil Jet	Oil Flow (lbs/min.)
Free Turbine Exhaust Case	No. 4 Bearing and Seal	8 - 9
	No. 5 Bearing Front	1.5 - 2.5
	No. 5 Bearing Rear	1.5 - 2.5
	No. 5 Bearing Seal	3.5 - 4.5
Free Turbine Accessory Gearbox	Speed Sense Jet	0.25 - 0.5
	Aux. Jet (Towershaft)	0.5 - 1.0

Oil Jet Flow Limits
(Free Turbine)
Table 607

H. Free Turbine (N2) Gearbox Bearing Nozzle Oil Jet Flow Check
See Tool Group 12C.

(1) Install the nozzle only in the Oil Flow Fixture. Attach the flared tube and locknut assembly to the end of the nozzle. Attach the detail oil inlet adapter.

(2) Measure the oil flow and compare it with the limits shown in Table 607.

I. No. 4 Bearing and Seal Nozzle Directional Oil Flow Check
See Tool Group 11-2.

(1) Attach the No. 4 bearing nozzle and the oil pressure tube to the bearing support assembly. Attach the directional Oil Flow Adapter to the large diameter of the support assembly (put the detail nut under the oil nozzle).

(2) Attach the Oil Inlet Adapter to the oil inlet tube. Close off the oil jet and oil-out hole that will not get the oil flow check, then do an oil flow check of the oil nozzle. The oil stream from the jet must go in the annulus between the shaft and the detail nut.

11. Air Pressure Check Of Engine Compartments

A. General

(1) Measure the airflow through the specified engine bearing compartments. Put air through the breather fittings into each section as specified in the paragraphs below.

(2) Equipment

(a) Airflow meters, pressure gage, and an air pressure regulator set at 10 psig. The instrument must be accurate ± one percent.

B. No. 1 Bearing Compartment
See Tool Group 2.

(1) With the No. 1 bearing and front cover installed, install the Inlet Case Oil Pressure Cover on the oil pressure boss and the Inlet Case Oil Scavenge Cover on the oil scavenge boss on the inlet case.

(2) Pressure the compartment through the breather pad with the Air Inlet Adapter.

(3) Leakage more than 5 phr at 10 psig is cause to reject the assembly.

C. No. 2 And 3 Bearing Compartment
See Tool Group 13.

(1) With the turbine shaft and the No. 3 bearing seal housing assembled in position, use the Scavenge Boss Cover on the oil pressure and scavenge bosses on the diffuser case.

(2) Install the Air Inlet Adapter in the diffuser case main accessory drives housing and attach with two ball-lock pins through the gearbox retaining ears on the OD of the diffuser case.

(3) Pressure the No. 2 and 3 bearing compartment through the Air Inlet Adapter.

(4) Leakage more than 17 phr at 10 psig is cause to reject the assembly.

D. No. 4 Bearing Compartment And Transfer Tubes (Free Turbine See Tool Group 11-1.

(1) With the No. 4 bearing seal housing, No. 4 bearing, and turbine shaft assembled in position, install and torque the No. 4 bearing oil pressure, scavenge, and breather tubes. Put plugs in all tubes (but not in the breather).

(2) Install the No. 4 bearing support cover.

(3) Pressurize the accessory bearing support through the breather tube. No leakage is permitted around the transfer tube seats. It is permitted to lap surfaces to prevent leakage. It is permitted (with the free turbine in a vertical position) to fill the cavity around the outside of the No. 4 seal housing with water. It will then be easy to see leakage around the transfer tubes.

E. No. 4 And 5 Bearing Compartment (Free Turbine) See Tool Group 13-1.

(1) With free turbine shaft and No. 5 seal housing assembled in place, plug oil pressure and scavenge pads and accessory drive gearbox pad.

(2) Pressurize compartments through breather pad.

(3) Any leakage in excess of 17 phr shall be cause for rejection.

F. Oil Pump And Accessory Drives Housing Assembly Static Oil Leakage Check

NOTE: Check applies only to engines equipped with main oil strainers which incorporate check valves.

(1) Nature of Test: To ensure that static oil leakage through oil pump and accessory drives housing meets engine requirements.

(2) General Requirements: To ensure that amount of leakage through oil pump and accessory drives housing assembly, under a three-foot head of oil, meets operational requirements.

(3) Equipment Required

(a) A container capable of indicating small quantities involved, and a bracket capable of holding container three feet above center of inlet to main oil pump.

(b) Tube and connector to connect to main oil pump inlet.

(c) Graduated beaker.

(d) Supply of lubricating oil at room temperature.

(4) Procedure

(a) Set oil pump and accessory drives housing assembly level in shallow pan to catch leakage oil.

(b) Cap all main and scavenge oil connections except main oil pump inlet and highest connection on main oil pump discharge.

(c) Fill supply container with oil, and allow pump housing to fill up by rotating pump by hand until no air bubbles accompany oil from pump inlet connection.

(d) Fill container to three-foot level and allow to stand for one-half hour.

(e) Refill container to three-foot level and record amount added. Amount added shall be less than 0.025 pound (12.5 cc).

(f) If leakage is excessive, check following, and then repeat check:

1 Oil coming from scavenge pump inlet inside case indicates leakage of seals between main and scavenge stages inside pump. If leakage is excessive, inspect shaft and rubber seals.

2 Oil coming out of discharge port indicates leakage by filter valve and/or relief valve. If leakage is excessive, check seats of both valves.

G. Air Pressure Testing Of Bearing Sections
See Tool Group 12.

(1) Nature of Test: To ensure suitable lubrication of bearings and cooling of seals by determining that oil passages are clear and properly sealed in the assembled engine.

(2) General Requirements

(a) Measure airflow through individual bearing sections by introducing air through pressure oil line into each bearing section.

(3) Equipment Required

(a) A flowbench, including airflow meters, pressure gage, and an air-pressure regulator (set to ten psig). Instruments should have an accuracy of plus or minus one percent.

(b) Special oil line pressure fittings. Fittings for admitting air to oil lines must be standardized for each location, must have pressure measurement point as near engine case as possible, and must have fine mesh screens (0.005 inch maximum opening) immediately upstream of pressure measurement location.

(4) Procedure

(a) Cover oil scavenge line before testing. Failure to do this will result in air-pressure loss making it impossible to meet airflow limits.

(b) With engine completely assembled, (JFTD12A engine assembled completely except for free turbine), excluding pressure oil lines, use oil nozzle airflow adapters to airflow bearing nozzles to meet following limits:

Location	Airflow (phr)	Air Pressure (psig)
No. 1 Bearing	2 - 3	10
No. 2 & No. 3 Bearing	17 - 24	10
No. 4 & No. 5 Bearing	18 - 22	10

(c) As an alternate to the foregoing, this test may be made on subassemblies completed and ready for engine assembly. If subassemblies are diassembled after airflow, airflow check must be repeated after reassembly.

(d) Keep record of measured airflows and air leakage for each check.

12. Carbon Seals

A. Inspection

(1) On sealing face, chips, nicks, and scratches are acceptable provided the following conditions are met:

(a) Fifty percent of original width of seal face in damaged area remains undamaged.

(b) A concentric circular area of not less than 45 percent of original width of seal face makes a sealing contact.

(c) Scratches extending across the sealing face of seal will be acceptable provided depth is less than 0.005 inch and width is less that 0.010 inch. Scratches larger than this should be partially removed by lapping to the above limits. When lapping, seal width must not be reduced below dimension given in Figure 605.

(2) In areas other than sealing face, nicks, chips and scratches are acceptable provided:

(a) At least 70 percent of normal cross-section of seal is still available.

(b) Area on ID contacted by rings is undamaged.

(3) Cracks in any portion of seal or deterioration of carbon element (as evidenced by crumbling carbon) are cause for rejection.

(4) Wear exceeding limits of Figure 605 and Table of Limits shall be cause for replacing carbon element.

NOTE: Ring type carbon seals are to be checked in a ring gage or equivalent. Gap shall be as specified in Table of Limits when seal is in full contact with gage (a radial load may be applied to seal to satisfy this requirement).

B. Repair

(1) Lap and inspect carbon seals for flatness. See Blending, Grinding, and Lapping in the Standard Practices Manual.

13. No. 1, 2, 3, 4, And 5 Bearing Retaining Nuts

A. Repair

(1) At each overhaul remove plating from retaining nuts and silver plate 0.0003 - 0.0006 inch thick by SPOP 23.

NOTE: Ensure that all holes on PN 400547 oil scoop are clear after plate.

14. Main Bearing Seal Plate And Spacers

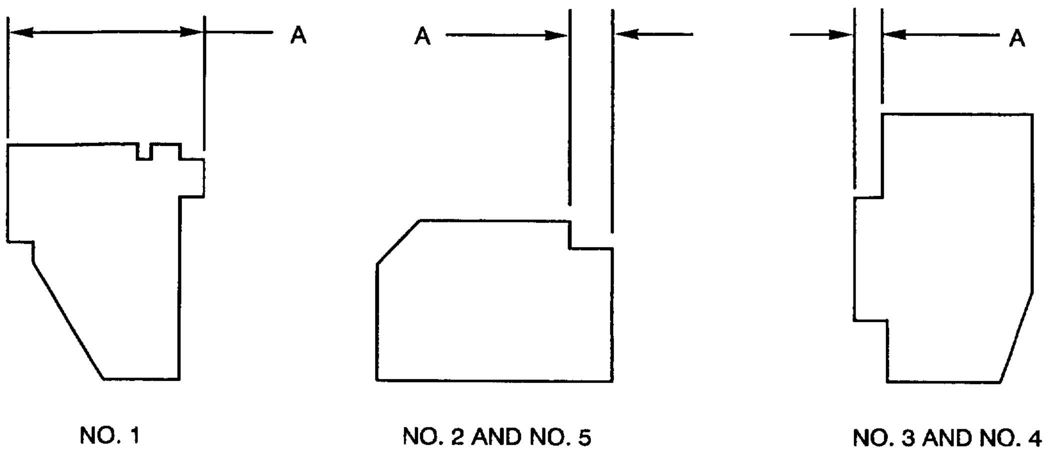
A. Visual Inspection

(1) Inspect chromium plated surface of seal plates for nicks and dents.

(2) Replace any seal plate if nicks or dents have produced protruding material on the face.

(3) Replace any seal plate which shows signs of unevenness on chromium plated surface.

NOTE: Unevenness on the chromed surface should not be confused with discolorations due to oxidation.



Bearing Location	Minimum Dimension A (Inches)
No. 1	0.300
No. 2 And 5	0.063
No. 3 And 4	0.043

Carbon Seal Wear Limits
Figure 605

(4) Chips at OD on face of chromium surface (area that is contacted by mating carbon seal) of multiple ring-type seal spacers are acceptable provided chips are not greater in radial or circumferential length than 0.050 inch and closer than 0.125 inch to each other with with a combined length does not exceed 0.400 inch.

(5) The maximum number of chips permissible on OD is 20 if total length does not exceed 0.400 inch.

(6) Chipping at ID (area where carbon seal does not ride) of chromium plate is acceptable provided chips are less than 0.050 inch in radial width and 0.100 inch in length.

(7) Face type seal plates with chips not extending into the area contacted by the mating carbon seal may be continued-in-service.

(8) Nicks, dents, or chips on the chromium surface should not be confused with checking (small cracks), which is allowable.

(9) Scratches extending across sealing face of seal face plate are not acceptable.

(10) Widely scattered pitting on chrome plated surface is acceptable provided there are not indications that plate is flaking.

(11) If new plate is installed, carefully inspect it for signs of nicks or dents caused by improper handling. Use carbon paper to blue a new plate to its mating part, excluding carbon seals, with resultant 100 percent seating surface.

(12) If seating requirement cannot be met, parallelism of plate faces should be checked with micrometer. Faces should be parallel within 0.0005 inch.

(13) Squareness runout of seal plate face that contacts mating carbon face, as installed, should not exceed 0.001 inch FIR (therefore, check seating carefully).

(14) Flatness of bearing seal plates and spacers must be within limits specified in Figure 606 thru Figure 611.

B. Repair

(1) Lapping. Refer to Blending, Grinding and Lapping in the Standard Practices Manual, Section 70-45-00.

(2) Chromium Plating

(a) Remove chromium plate from parts.

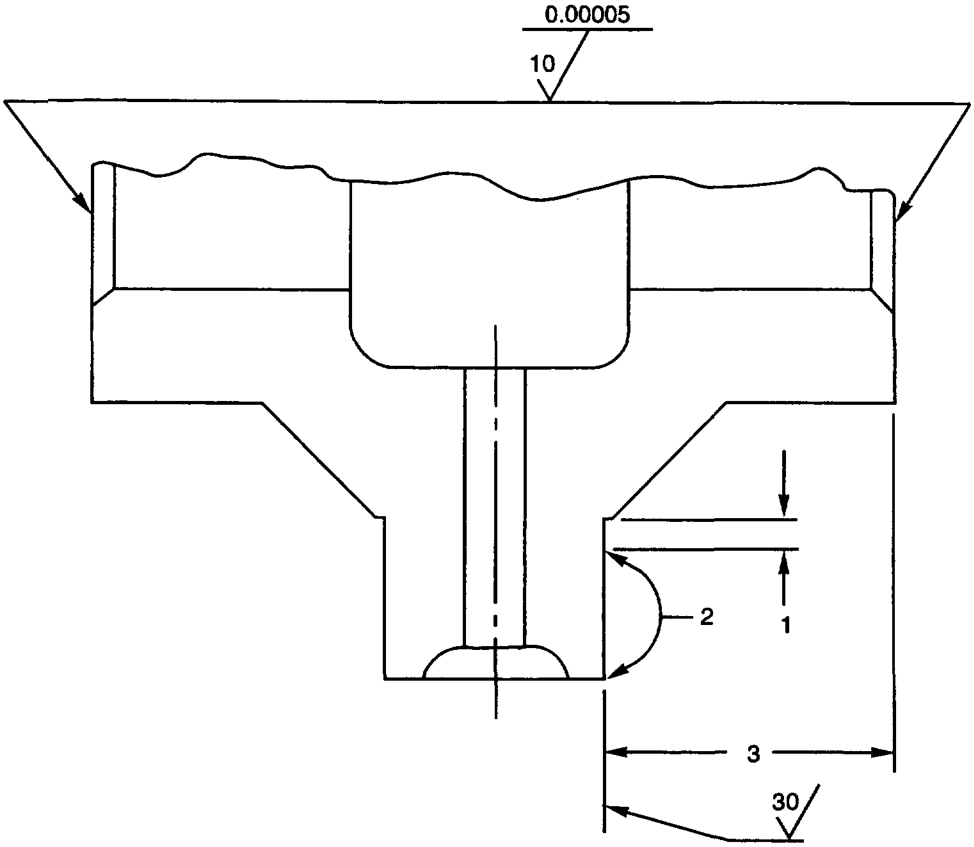
(b) Inspect seal surface to be chromium plated for nicks and dents.

(c) Refinish seal plate face by removing minor nicks and dents. Do not remove more material than is permitted to be replaced by chromium plating.

(d) Apply chromium plate by SPOP 22. Refer to Section 70-44-01 in the Standard Practices Manual. Maximum thickness of chromium plate on seal plates may be increased by 0.010 inch after finish grinding. See Figure 606 thru Figure 611.

(e) Lap seating surface. Refer to Section 70-45-00 in the Standard Practices Manual.

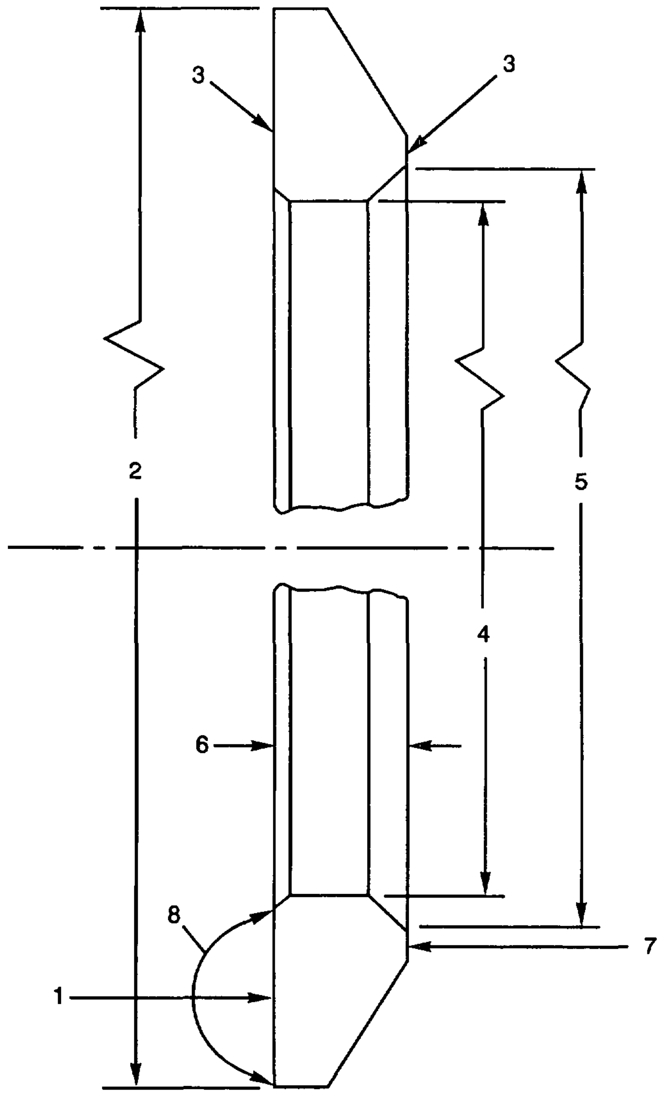
(f) After lapping do a flatness check. Refer to SPOP 504 in Section 70-45-00 in the Standard Practices Manual.



L-22520 (0000)
PW V

1. 0.040 Inch Maximum, Both Sides
2. Chromium Plate Area, 0.001 - 0.003 Inch Thick. All Other Surfaces Are Optional. Plating May Be Incomplete In Optional Areas. All Dimensions Specified Are After Plating.
3. 0.319 - 0.322 Inch, Both Sides

No. 1 Bearing Center Seal Spacer
Figure 606

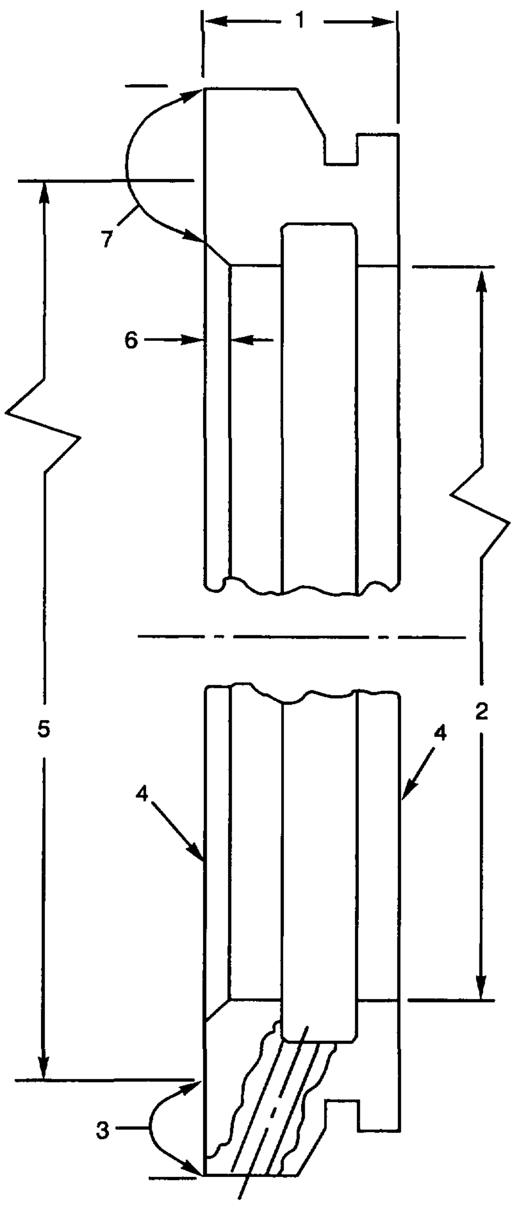


L-23049 (0000)
PW V

No. 1 Bearing Seal Spacer
(Front and Rear)
Figure 607

1. Five Micro-inch Allowable Roughness With A Waviness Limit Of 0.00004 Inch
2. 3.826 - 3.828 Inches. This Diameter Must Be Concentric With Diameter A Within 0.002 Inch FIR
3. These Faces Must Be Parallel Within 0.0005 Inch FIR And Square With Diameter A Within 0.001 Inch FIR.
4. 2.9554 - 2,9567 Inch Diameter.
5. 3.220 - 3.240 Inch Diameter
6. 0.270 - 0.271 Inch
7. Ten Micro-inch Allowable Roughness With A Waviness Limit Of 0.00005 Inch
8. Chromium Plate Area, 0.004 - 0.006 Inch Thick

Key to Figure 607

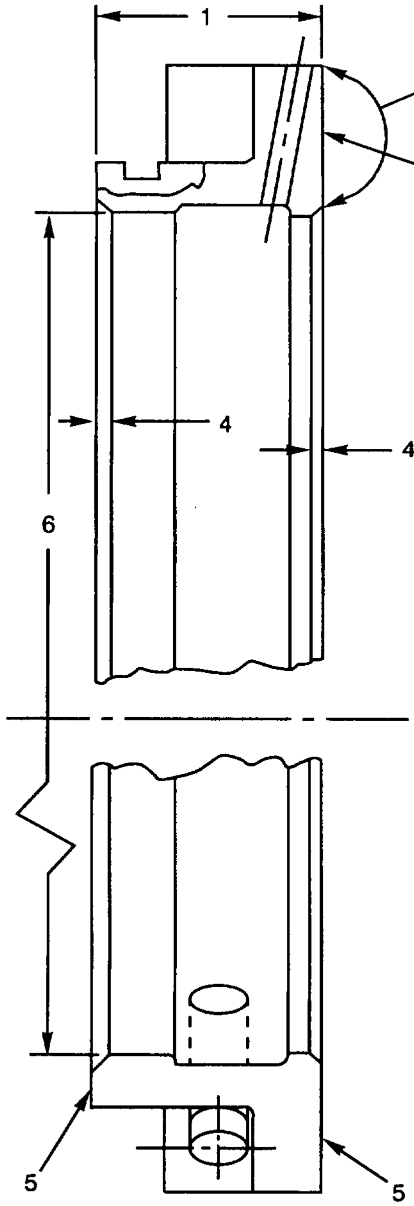


L-21203 (0000)
PW V

No. 2 Bearing Seal Spacer
Figure 608

1. 0.449 - 0.451 Inch
2. Reference Diameter
3. Five Micro-inch Allowable Roughness With Waviness Limit Of 0.00002 Inch
4. These Faces Must Be Parallel Within 0.0005 Inch FIR And Square With Diameter (2) Within 0.001 Inch FIR
5. 3.500 Inch Maximum Diameter
6. Chamfer 0.020 - 0.050 Inch At 43 - 47 Degrees
7. Chromium Plate Area, 0.003 - 0.005 Inch Thick. Dimensions Specified Are After Plating.

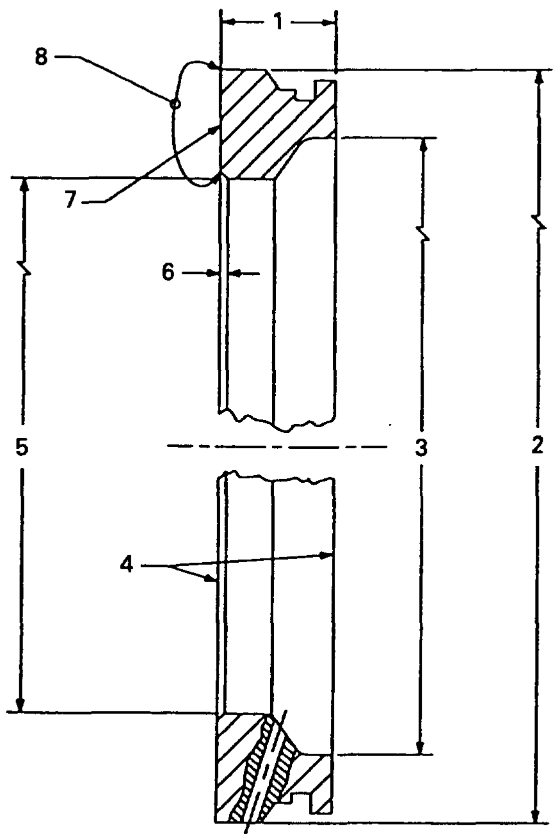
Key to Figure 608



L-21206 (0000)
PW V

1. 0.578 - 0.582 Inch
2. Chromium Plate Area, 0.004 - 0.006 Inch Thick Dimensions Specified Are After Plating
3. Five Micro-inch Allowable Roughness With A Waviness Limit Of 0.00002 Inch
4. Chamfer 0.020 - 0.030 Inch At 40 - 50 Degrees
5. These Faces Must Be Parallel Within 0.0005 Inch FIR And Square With Diameter (6) Within 0.001 Inch FIR
6. 3.1515 - 3.1525 Inch Diameter

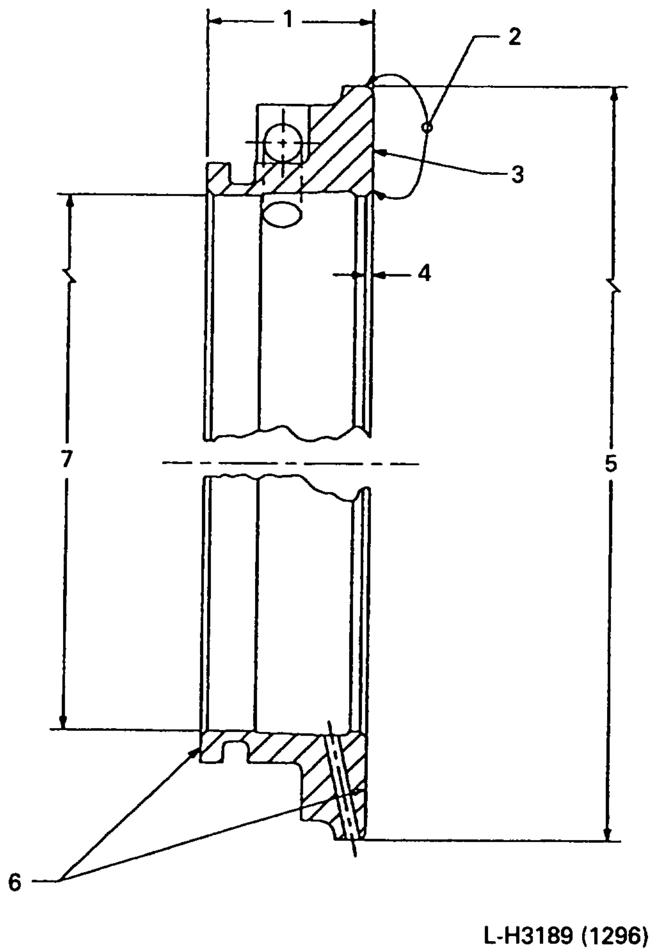
No. 3 Bearing Seal Spacer
Figure 609



L-H3188 (1296)

1. 0.459 - 0.461 Inch
2. 4.010 - 4.030 Inch Diameter
3. 3.470 - 3.490 Inch Diameter
4. These Faces Must Be Parallel Within 0.0005 Inch FIR And Square With Diameter (Index 5) Within 0.001 Inch FIR
5. 3.1507 - 3.1542 Inch Diameter
6. Chamfer 0.020 - 0.040 Inch By 43 - 47 Degrees
7. Five Micro-inch Allowable Roughness With Waviness Limit Of 0.00002 Inch
8. Chromium Plate Area, 0.003 - 0.005 Inch Thick.

No. 4 Bearing Seal Seat
Figure 610



1. 0.659 - 0.661 Inch
2. Chromium Plate Area, 0.004 - 0.006 Inch Thick. Dimensions Specified Are After Plating
3. Five Micro-inch Allowable Roughness With Waviness Limit Of 0.00002 Inch
4. Chamfer 0.020 - 0.030 Inch By 40 - 50 Degrees (Both Ends)
5. 4.020 - 4.040 Inch Diameter
6. These Faces Must Be Parallel Within 0.00005 Inch FIR And Square With Index 7 Diameter 0.001 Inch FIR Maximum
7. 3.1515 - 3.1525 Inch Diameter

Free Turbine Rear Bearing
Oil Scoop
Figure 611

ENGINE GENERAL - ASSEMBLY OF SUBASSEMBLIES

1. General

A. General
See Figure 701.

WARNING: AT ONE TIME SOME ENGINE PARTS CONTAINED ASBESTOS FIBERS, AND IT IS POSSIBLE THAT SOME OF THESE PARTS CONTINUE IN SERVICE. REFER TO COMMERCIAL ENGINE SERVICE BULLETINS FOR A LIST OF PARTS THAT AT ONE TIME CONTAINED ASBESTOS. IN SOME PARTS THE MATERIAL THAT CONTAINED ASBESTOS WAS THE ADHESIVE. IT IS IMPORTANT TO USE CORRECT PRECAUTIONS DURING WORK WITH THESE PARTS. OPERATORS MUST OBEY ALL LOCAL REGULATIONS AND EMPLOYER WORK POLICIES WHEN PARTS THAT CONTAIN ASBESTOS ARE TOUCHED OR DISCARDED.

THE ASBESTOS USED IN PRATT & WHITNEY ENGINE PARTS WAS USUALLY ENCAPSULATED AND WILL NOT RELEASE DUST UNLESS THE PARTS ARE GROUND, SANDED, CUT, OR BROKEN. WHILE IT IS OUR EXPERIENCE THAT THESE OPERATIONS DO NOT USUALLY RELEASE ASBESTOS AT LEVELS MORE THAN PERMITTED EXPOSURE LIMITS, OPERATORS MUST USE ALL APPLICABLE PRECAUTIONS WHEN THEY TOUCH SUCH PARTS.

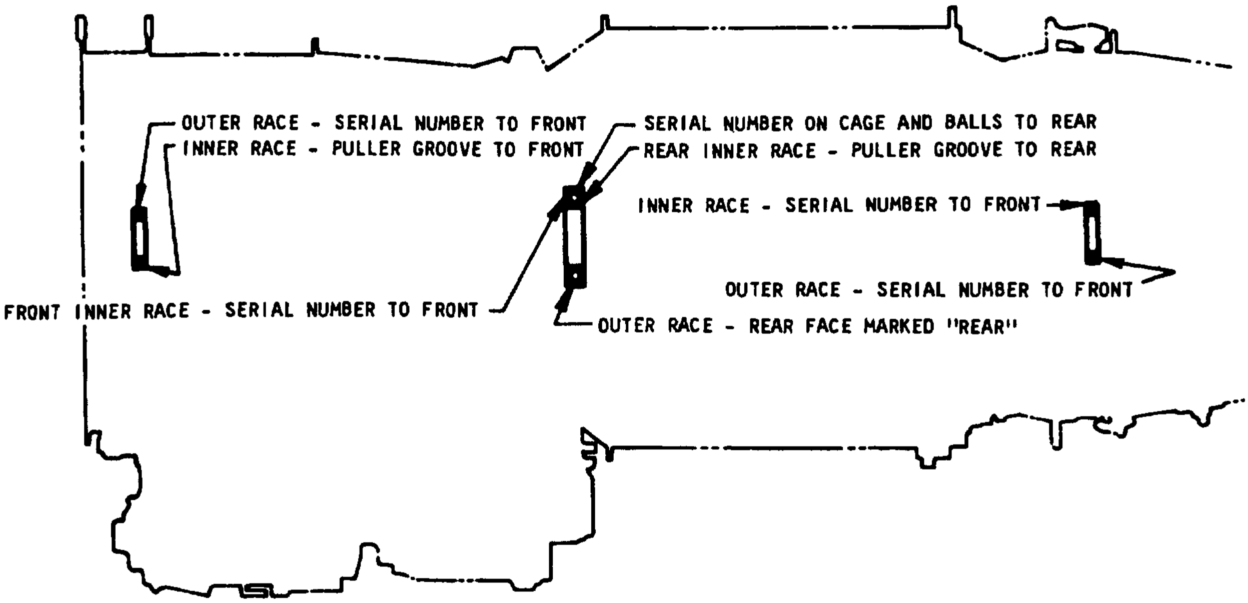
CAUTION: IT IS POSSIBLE TO ASSEMBLE CERTAIN ENGINE PARTS IN A LOCATION OR IN OTHER MODELS OF ENGINES FOR WHICH THESE PARTS WERE NOT INTENDED. BECAUSE SUCH MIS-ASSEMBLY CAN POSSIBLY RESULT IN A FAILURE, CHECK EACH PART NUMBER TO BE SURE THAT THE CORRECT PART IS USED.

B. To avoid unnecessary repetition in the detailed instructions, certain general assembly methods and procedures are described in the paragraphs that follow and in Section 70-00-00 in the Standard Practices Manual. These items play an important part in efficient engine assembly. The ultimate life and performance of the engine may be seriously affected if they are slighted through carelessness or neglect.

C. Main Bearings and Seals

(1) Install main engine bearings as shown in Figure 701. Install bearings with their serial numbers and other identifying marks in the specified direction.

(2) When installing a carbon seal, lubricate the seal face with PWA 521B engine oil.



Bearing Positions
Figure 701

D. Torques

(1) Use specified torques for all threaded parts. Refer to The Table of Limits section and Section 70-52-00 in the Standard Practices Manual.

E. Installation of Jamnut Fittings

(1) Refer to Section 70-00-00, Assembly-04 in the Standard Practices Manual for locknut-type fitting assembly.

F. Antigalling Compounds

(1) Refer to Section 70-41-00 in the Standard Practices Manual for antigalling/antiseize compounds permitted on engine parts.

2. Compressor Inlet Case
See Tool Group 31.

A. Assembly

(1) Secure the No. 1 bearing housing Holding Fixture to a bench and position the No. 1 bearing housing in the fixture.

(2) Install No. 1 bearing outer race in housing with tightest fit to liner located on a plane extending through the 45 and 225 degree positions as viewed from the rear. Seat the race with the Outer Race Drift.

NOTE: Bearing serial number must face toward front of engine.

(3) Install and torque retaining nut, using outer race retaining nut wrench. (See Reference 352, Section XI).

(4) Install a rivet, preformed head toward ID of housing. Flare the rivet with the Riveter.

(5) With compressor inlet case front flange up on bench, install a seal on inner case.

(6) Using pusher install assembled housing in compressor inlet case and secure with nuts and bolts.

R
R

3. Compressor Assembly

A. Blade Inspection Classification Requirements (JFTD12A)

(1) Before blades are installed in the compressor hub (1st stage) and 2nd thru 9th stage disks, make sure that all used blades are in limits for inspection and repair as specified in 72-30-00, Inspection, Repair, And Replacement-01.

(2) All used blades have the classification of Category A or Category B.

(3) Install blades around the circumference of a disk or hub as follows:

(a) There is a limit to how many lower category (Category B) blades are permitted in a disk or hub stage (a maximum of 20 percent per stage).

(b) Category B blades must be in random positions around the circumference of a disk or hub stage.

(c) Blades with blend repairs are not permitted to be Category A. Identify these blades as Category B (make sure that the chord dimensions are in limits).

(d) No more than 10 percent of the Category B blades in a disk or hub stage (half of the Category B limit) can have blend repairs.

(e) For the above limits to be applicable, it will be necessary to have all leading edge repairs done before the blades go back into service.

(f) If it is necessary to move blades to correct imbalance (see below), the position of moved blades must continue to be in the above limits.

B. Front Hub And 2nd Stage Disks And Blades

(1) Position compressor front hub shaft end up on bench, and install 1st stage compressor blades.

NOTE: Individual blades must be weighed to nearest one-hundredth of an ounce and weights marked on blades using red crayon. Lay out blades in order of diminishing weight and install heaviest blade in hub. Install next heaviest blade

72-0001

diametrically opposite first installed blade. Install lightest blade adjacent to and clockwise from first installed blade. Install next lightest blade diametrically opposite lightest blade. Proceed in order of maximum to minimum weight progressively around hub. Ensure that rotor assembly part number is marked on hub front face. If necessary, mark by vibration peening. Refer to Compressor Rotor Assembly Marking.

(2) Install washer on pin and drift one end to obtain 0.195 - 0.205 inch flare. Install pin, formed head toward hub, to hold blade in position.

NOTE: For engines incorporating PN 447320 rivet and and PN 447321 washer, flare rivet to 0.265 - 0.275 inch.

CAUTION: INSTALL A NEW PIN AT EVERY OVERHAUL. FIRST AND SECOND STAGE BLADE RETAINING PINS MUST NOT BE REUSED.

(3) Temporarily secure washer and pin with masking tape.

(4) Install 2nd stage blades on the disk as just described.

NOTE: Second stage blade retaining pins must be flared 0.115 - 0.125 inch.

R C. Static Balance Adapter - General Instructions

(1) Setup

NOTE: Balancing machine spindle balance should be checked and, if necessary, corrected before adapter is installed.

(a) Secure detail plate assembly to spindle and balance.

(b) Install locating plugs in proper locations for part, with zero marking in line with scribed radial line, toward rim for OD part mating diameter and toward center for ID part mating diameter. Install hold down details and balance resulting assembly indexing for accuracy.

(c) Measure dimension across opposite locating plug buttons, outside for ID part mating diameter and inside for OD, and record results (it is suggested that dimensions be permanently recorded for each setup to avoid repetition.)

(d) Using average part mating diameters either by mensuration or from inspection records, adjust locating plugs for 0.0005T by setting each plug as indicated below.

(S = Setting, D = Average Mating Diameter, P = Measurement across plugs)

For Snap ID: S = D-P + .0005 /2
For Snap OD: S = P-D + .0005 /2

(e) Check measurement across opposite plugs for correct fit and make minor corrections, if required. All locating plugs must be in approximately same relative position.

(2) Installation of Part

(a) Clean before installation.

(b) Position adapter with one hold down plug toward operator and mark plug and other hold down details.

(c) Position part with two tierod holes in line with hold down plugs, avoiding offset holes.

(d) Engage diameter first on locating plugs opposite operator and then on those toward operator.

(e) Secure part and mark tierod hole toward operator for indexing reference.

NOTE: Always return hold down details to same position relative to adapter.

R D. Compressor Hub And 2nd Stage Disk And Blades Assembly - Static Balance Check
See Tool Group 30.

(1) Install base of balancing adapter on balance machine spindle.

(2) With a zero reference point marked on base toward operator, install plugs on appropriate circle for disk to be balanced as follows:

(a) Detail (2) plugs at 4:30 and 7:30 o'clock positions.

(b) Detail (8) at 9:30 and 1:30 o'clock position.

(c) Detail (3) hold down plugs at three and nine o'clock position.

(3) Position disk and blade assembly on plugs, aligning a tierod hole with threaded hole in detail hold-down plugs. Then, install two detail cap screws through tierod hole into hold-down plug.

<u>NOTE</u>: When balancing front hub and blades assembly, secure hub to base, using detail adapter and associated details if hub incorporates a solid member through ID. For hubs without interference through ID, install detail post in center of base and secure hub with detail place.

(4) With hold-down cap screws loose and zero reference point on base facing operator, pull disk firmly against two detail plugs and alternately secure with cap screws. Maintain pressure on disk against plugs.

<u>NOTE</u>: On disks incorporating OD mating diameters, displacement will be away from operator against detail plugs.

(5) Start machine and null out reflected unbalance. (This may be accomplished by machine compensation or by adding weight to balance adapter). Calibrate machine or set potentiometer, if applicable.

<u>NOTE</u>: On balance machines incorporating dual compensators and features for reducing second compensation to one-half, calibration may be performed after step (8).

(6) Stop machine, and with the zero reference point toward operator, rotate disk and blades assembly 180 degrees with respect to adapter.

(7) Repeat step (4).

(8) Start machine and determine angle and amount of unbalance. Reduce this value to one-half, using a second compensator (or wax on the adapter), maintaining the same angle.

NOTE: If machine has not been calibrated, unbalance reading must be nulled out by compensator, then calibrated and compensation reduced by one half.

(9) Correct unbalance to following requirements:

(a) Unbalance must not exceed 0.1 oz-in. (0.05 oz-in. if pattern stacking is used) when work piece is rotated at minimum speed of 900 rpm.

(b) If necessary, reposition blades (diametrically) and recheck for unbalance.

(c) After balancing, mark point of most unbalance on rear side of each hub or disk assembly with layout dye.

(10) Install washers on pins, and flare 1st and 2nd stage compressor blade retaining pins, using proper anvils and riveter.

CAUTION: CHECK PIN FOR CRACKING AFTER FLARING.

(11) Flare 1st stage pin 0.195 - 0.205 inch and 2nd stage pins 0.115 - 0.125 inch.

NOTE: For engines incorporating PN 447320 rivet and PN 447321 washer, flare rivet to 0.265 - 0.275 inch.

NOTE: On 2nd stage disk and blade assemblies, use 2nd stage blade retaining pin holding fixture to hold disk and flare pins to 0.115 - 0.125 inch.

R E. Compressor Disk Airseals Installation - Stages 3 and 5 thru 9 See Tool Group 44 and Figure 702.

NOTE: Serviceable airseals may be reused.

(1) To install airseal, heat compressor disk to 288°C (550°F) for two hours and cool seals to -73°C (-100°F) for one hour.

(2) Place disk on bench, front face up, and assemble seal to front of flange of disk.

NOTE: The 5th stage has a rear seal only. For identification and assembly purposes, compressor disk rear faces are marked REAR.

(3) Turn disk over, and repeat operation for rear seal.

NOTE: Third stage disk employs front airseal only.

(4) Place retaining weight on rear seal and allow assembly to stabilize at room temperature.

(5) Remove weight and, using feeler stock, check clearance between disk flange and seal, as indicated in Figure 702. If clearance exceeds 0.015 inch, seal has not bottomed properly.

R F. Compressor Blades Installation (Stages 3 Thru 9) See Tool Group 44, Figure 703, and Table 701.

NOTE: Post-SB 6387 3rd stage blades and locks are interchangeable pre- and post- the SB only as specified in Table 701. Pre-SB 6387 blades must use pre-SB 6387 locks, and post-SB 6387 blades must use post-SB 6387 locks (it is permitted to mix pre-SB blades/locks and post-SB blades/locks in a compressor disk and blade assembly, but rotor assembly with full sets of post-SB parts is recommended).

(1) Position disk, front face up, on bench.

(2) Position blade lock in blade, prebent tab at leading edge so that tab will extend radially inward when blade is installed.

NOTE: To insert blades from rear face, position disk face down on bench. Install tab to blade, prebent tab at trailing edge so that it will extend radially inward when blade is installed, then insert blade, trailing edge up.

ENGINE GENERAL - ASSEMBLY OF SUBASSEMBLIES

POST-SB 6387 BLADE PN	DESCRIPTION	PRE-SB 6387 BLADE PN
536203-001	3rd Stage Blade Use With	536203
819858	Blade Lock	536210
822103	3rd Stage Blade Use With	536203
819858	Blade Lock	536210
822103	3rd Stage Blade Use With	405703
819858	Blade Lock	504128 Or 503791

Third Stage Compressor Blade/Lock
Interchangeability
Table 701

(3) Insert blade into disk, leading edge up.

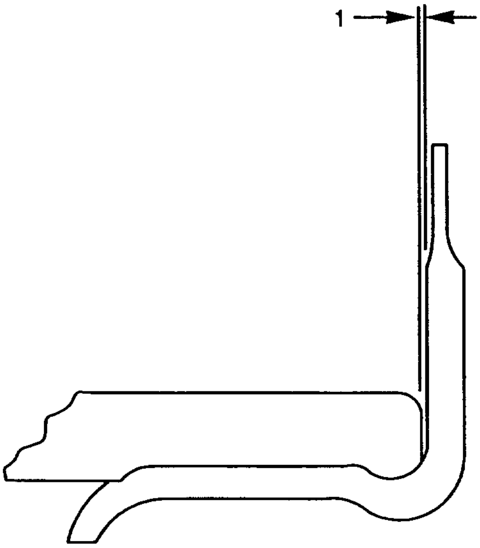
CAUTION: TABLOCKS SHALL BE CENTERED AT BASE OF BLADE SLOT WITH TABS BENT RADIALLY INWARD AND PARALLEL WITH SURFACE OF DISK. FOR EXAMPLES OF ACCEPTABLE AND UNACCEPTABLE INSTALLATION, SEE FIGURE 703.

(4) Place disk and blade assembly, straight tab up, on blade lock fixture. Adjust anvil of fixture so it backs tab to be bent, and, using peening punch, bend rear tab of each blade lock radially inward (refer to Table of Limits). A blend must be accomplished by working out from bend with series of blows. Care must be taken to ensure blade and disk surfaces are flush when tablocks are bent.

R G. Compressor Blades Machine Tablock Bending And Rivet Forming (Stages 2 thru 9) Optional Method
See Tool Group No. 44A.

NOTE: First stage cannot be done on machine due to disk interference.

(1) Set up Machine. (Consult special instructions available from machine manufacturer, or furnished with machine, as required).



L-11897 (0000)
PW V

1. 0.015 maximum

R
R

Compressor Seal Clearance Limit
Figure 702

72-0e01

1. Tab Is Moved So That Gap Between Blade Slot And Lock Is All On One Side.
2. Blade Lock Is Not Centered Under Blade Root
3. Tab Is Twisted With One Edge Raised Rather Than Being Parallel With Disk Face.
4. Obvious Tool Marks Show On Edge Of Tab Indicating Impact From The Side.

Key to Figure 703

(2) Attach appropriate adapter to locating bung on vertical column of machine and secure with cap screws from machine. Hold disk to adapter with four thumb screws through tierod holes. Using specified PWA anvils and purchase and following special instructions, form rivets or bend tablocks.

R H. Stages 3 Thru 9 Disks And Blades - Static Balance Stages 3 Thru 9 Disks And Blades With The Procedure Described For Compressor Rotor Front Hub, Omitting Steps (10) And (11).

R I. Compressor Rotor Rear Hub Assembly
See Tool Group 39 and Figure 704.

(1) Place compressor rotor rear hub on bench, shaft end down.

(2) Assemble compressor drive turbine shaft locking bolt in hub in following sequence. See Figure 704.

(a) Shaft coupling

(b) Shaft lock

(c) Spring

(d) Spring lock guide

(e) Retaining ring.

R J. Compressor Rotor Spacers - Static Balance
See Tool Group 39A, Figure 705, and Figure 706.

(1) Correct static unbalance of 2nd to 3rd, 4th to 5th, 5th to 6th, 6th to 7th, 7th to 8th, and 8th to 9th stage spacers by adding PN 506268 counterweights, selecting class required.

NOTE: It is permissible to reduce Dimension A (Figure 705) of counterweight, any of three classes, to a minimum of 0.375 inch in order to utilize only large class weights and make small balance adjustments. All sharp edges left by cutting or grinding operations must be broken, 0.003 - 0.015 inch. Material is AMS 5518 steel and must not be altered in temper.

(2) Correct static unbalance of 3rd to 4th stage spacer by removing material in accordance with Figure 706.

(3) Unbalance must not exceed 0.10 ounce-inch (0.05 oz-in. if pattern stacking is used) when work piece is rotated at minimum speed of 600 rpm.

NOTE: If it is necessary to locate a counterweight over a spacer sleeve marked with an arrow and the word FRONT, remark another sleeve which does not require a weight.

(4) After balancing, mark rear mating face of each spacer at point of most unbalance with layout dye.

R K. Compressor Rotor And Stator Assembly Build See Tool Group 35 and Table of Limits.

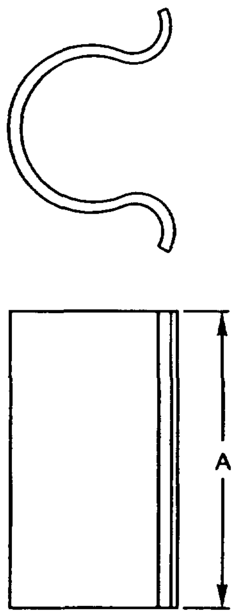
NOTE: At assembly of the compressor rotor, indexing of the disks and spacers will be governed either by the points of greatest unbalance or by the out-of-parallelism high points depending upon the procedure chosen by the overhaul shop. Customarily the build shall be performed utilizing the unbalance points at 60 degree increments; however, if difficulty is encountered building a satisfactory assembly, the pattern stacking technique may be employed, using the out-of-parallelism high points. In either case, the order in which the parts are assembled is not affected, only the indexing of parts in relation to one another. For information regarding pattern stacking, refer to Paragraphs K. and L.

CAUTION: LINE-REAMING OF TIEROD HOLES OF ASSEMBLED ROTOR IS PROHIBITED.

(1) Prior to commencing build operation, ensure that the following steps have been performed.

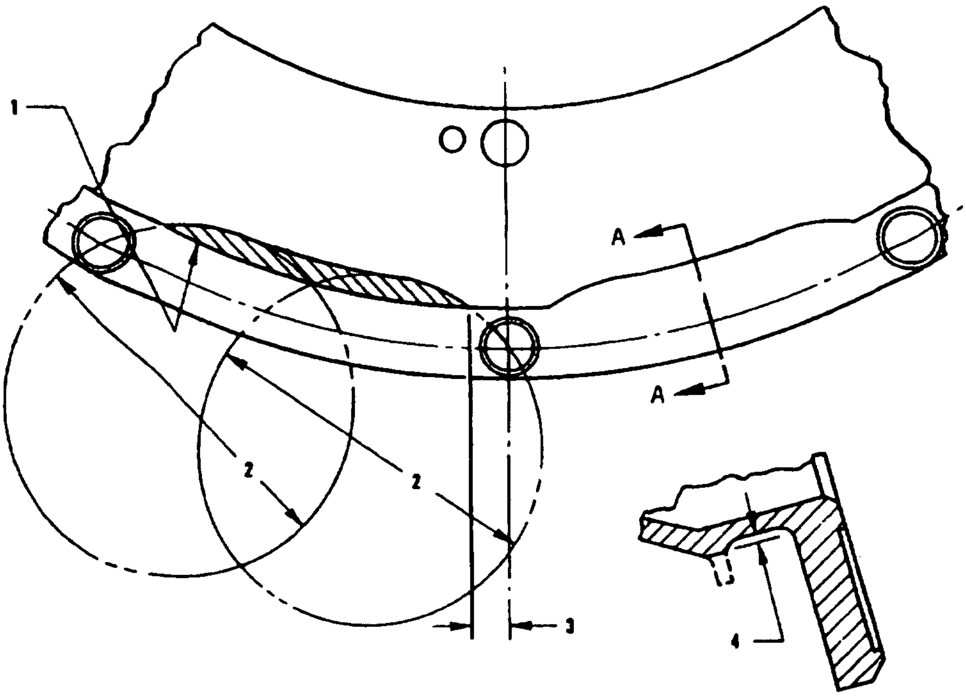
(a) All spacers and disks have been marked FRONT and REAR.

72-0001



R
R

Machining Counterweight
Figure 705



1. Shaded Area Represents The Maximum Amount Of Material Which May Be Removed By Machining Area 4 To Dimensions In Indexes 2 And 3 At Number Of Places Required To Obtain Balance.
2. 2.000 Inch Minimum Diameter
3. 0.200 Inch Minimum Each Side
4. 0.005 Inch Minimum

R
R

Machining Spacer
Figure 706

72-0001

(b) All spacers and disks have been marked as to their point of greatest unbalance or their out-of-parallelism high point if pattern stacking technique is to be used.

(c) Offset lug is marked on vane and shroud assemblies.

(d) All mating surfaces on disks and spacers have been cleaned with Arkansas stone.

(2) Install compressor rotor front hub in build stand assembly, forward end down, as follows:

(a) Mount adapter and bearing assembly on compressor assembly base, and install front hub, journal end down, into adapter and bearing assembly. Secure hub to base with previously removed retaining nut.

(b) Position compressor stator locating adapter on base mounts to properly locate stators. Place hub and base on compressor and turbine locating jack on engine build and transport stand.

CAUTION: ENSURE JACK PAD CONTACTS HUB WHEN MATING SNAP DIAMETERS OF DISKS, SEALS AND SPACERS TO PREVENT BEARING DAMAGE. LOWER JACK PAD WHEN CHECKING CONCENTRICITY AND PARALLELISM.

(3) Position front tierod front nut, rounded corners forward, under hub rear flange, and thread in front tierod to fingertight to three-quarter turn loose. Refer to the Table of Limits and set the nuts. Repeat this procedure for remaining 15 tierods.

NOTE: Apply engine lubrication oil, PWA-521B, to tierod threads before installing in nuts.

NOTE: When selecting front tierods, if PN 669845 tierods with increased land diameters are to be used; ensure that 2nd and 3rd stage disks (PN 670802 and 670403) with enlarged tierod holes are installed. The above parts shall be used in sets only.

(4) Using appropriate air gage, or dial indicator, measure concentricity of hub at integral spacer inside snap diameter. Runout shall not exceed 0.001 inch FIR. Measure parallelism on integral spacer rear mating face. Flatness shall not exceed 0.001 inch FIR.

R
R

(5) Heat 2nd state airseal to at least 44°C (80°F) higher temperature than hub integral spacer. Install seal, with knife-edge down, over tierods and on spacer OD.

(6) Install 1st stage vane and shroud assembly, large OD down, on base. Check blade tips for clearance. No rub is permitted.

NOTE: Limits for References 124 thru 132 in the Table of Limits are for reference only. Steel vane and shroud assembly may be coated with light film of preservative oil, and then wiped with dry cloth to minimize surface oxidation.

(7) Mount center post of pusher in front hub. Install 2nd stage disk and blade assembly, rear face up, over tierods and on spacer ID. Use pusher to seal disk.

NOTE: Weight of pusher alone will seat disk on spacer. Heat hub, or chill disk and blade assembly, to maintain at least 44°C (80°F) temperature difference. Assemble disk with unbalance point 60 degrees from hub unbalance point, or in Paragraph K.

(8) With 2nd stage disk and spacer unbalance points 60 degrees apart, or in accordance with Paragraph K, install 2nd-to-3rd stage disk spacer, using pusher.

NOTE: Succeeding spacers shall be assembled with unbalance points at 60 degrees apart from unbalance point of its forward mating disk or in accordance with Paragraph K.

NOTE: Indexing of spacer and disk unbalance points in increments of 60 degrees may be performed in either clockwise or counterclockwise direction, provided direction is consistent throughout rotor build.

(9) Install 2nd stage vane and shroud assembly, aligning offset slot with offset lug of 1st stage shroud. Check blade clearance.

NOTE: Use plastic mallet to seat vane and shroud assembly.

(10) Install 3rd stage disk and blade assembly, using pusher.

R
R

72-0001

(11) Insert 12 rear tierods in 3rd-to-4th stage spacer, and install spacer, using pusher. To keep tierods vertical and to facilitate assembly, wrap spring (one-quarter OD by 12 inches long) around tierods.

NOTE: Compressor disk spacers (PN 668974, 668975, 668976, 668977, and 668978) and compressor rear hub (PN 668985) each with increased diameter tierod holes and tierods (PN 668985) with increased diameter lands shall be installed in sets.

(12) Apply lubricating oil to rear threads of front tierods, and install tabwashers, ensuring that washer prebent tabs are inserted in holes provided in 3rd - 4th stage compressor disk spacer.

(13) Thread tierod nuts onto tierods ensuring that rounded corners are up.

(14) Apply initial torque to tierod nuts, using 16 wrenches. Ensure that tierods are prevented from turning by holding smaller hex on end of wrench while torquing tierod nuts. For torquing sequence, refer to Table of Limits. Allow assembly to cool before proceeding beyond initial torque.

NOTE: If hydraulic loading procedure is to be used, the initial torque shall be 20 - 30 lb-in. Remove wrenches and proceed as indicated in Paragraph L. Steps (15) and (16) below shall be complied with only when tierods are to be manually loaded. It should be noted, however, that hydraulic loading is the preferable procedure.

(15) Position gage on assembly with expandable plug in hub. Align indicator probes with tierods, and secure tool by pulling cam handle down.

(16) Complete torquing nuts. See Table of Limits. Remove gage, and recheck torque.

(17) Bend up washer tabs. At least one tab shall be flush against nut flat. Remove protective cover.

(18) Install 3rd stage vane and shroud assembly, aligning offset lug and slot. Check blade clearance.

R
R

(19) Install airseal, knife-edge forward, and 4th stage disk and blade assembly with Pusher.

NOTE: Maintain at least 44°C (80°F) temperature difference for remaining spacers, disks, and rear hub.

(20) Measure parallelism of 4th stage disk on mating face adjacent to tierods. Then, measure concentricity at ID snap of same disk. Maximum runout for both checks is 0.002 inch FIR.

NOTE: Use pusher and retorque, as required, for runout. Disassemble and reindex, as necessary, to obtain runout. Reassemble, using previous build procedure.

(21) Install compressor stator spacer to 3rd stage vane shroud, and install 4th stage vane and shroud to spacer.

(22) Lockwire four tabs on shroud to spacer. See Table of Limits.

(23) Using heater, heat and install 4th stage spacer, small-diameter, knife-edge seal forward. After heating spacer, remove heater and continue stacking disks and blades, vanes and shrouds, and spacers. Use Pusher to seat disks and spacers. Lockwire lugs on Stages 4 thru 8 outer shrouds. See Table of Limits.

NOTE: Position 2nd-to-3rd stage spacer with flange lightening holes rearward and 4th-to-5th stage spacer with knife edges forward. All spacers should have arrows on inner tubes that point forward, but these spacers should be installed by reference to their unique features since this is a more reliable method of assuring correct rotor assembly. Symmetrical spacers are marked with arrows to assure each assembly of mating disks and spacers is in the same relative position. Check blade clearance for each stage. Assembly shall be completed as rapidly as possible to maintain mating of parts.

R
R

72-0001

(24) Install assembled rear hub, aligning holes (with scallops) on tierods, and unbalance point 60 degrees from 9th stage disk unbalance point or in accordance with paragraph K. Apply engine lubricating oil to tierod threads and mating faces of washers and nuts. Install tabwashers and nuts (rounded corners up). Torque nuts with Wrench. See Table of Limits. Cool assembly to room temperature and check torque.

(25) Install gage over hub and with indicators through holes in wrenches. Torque nuts, and stretch tierods. See Table of Limits.

NOTE: For mechanical stretching of 9.468 inch long tierods (designed for hydraulic stretching), Install spacer between rear hub and tierod stretch gage.

CAUTION: DO NOT EXCEED 0.025 INCH STRETCH, AS BENDING MOVEMENT IMPOSES ADDITIONAL STRESSES, EQUIVALENT TO STRETCH.

(26) Measure concentricity and parallelism of rear hub. Maximum runout of oil distributing sleeve bearing journal is 0.004 inch FIR and seal plate shoulder is 0.001 inch FIR.

NOTE: If runout requirements are not met, disassemble to 3rd-to-4th stage spacer, reindex spacer and rebuild assembly, using previous build procedure.

(27) Using guide, install No. 2 bearing oil distributor sleeve on compressor rear hub, aligning "X" mark on sleeve with mark on hub.

(28) Install seal plate on sleeve with face toward front.

NOTE: "X" marks on seal plate and sleeve shall be aligned.

(29) Using drift, install No. 2 balance bearing on sleeve.

NOTE: Balance bearing shall have been heated to 82° - 90°C (180° - 200°F) before installation.

(30) Check faces of balance bearing inner and outer races to ensure that they are square and parallel 0.0005 inch FIR maximum.

R
R

(31) Install work spacer on rear hub, and secure with No. 2 bearing oil scoop nut. Tighten to recommended torque, using wrench.

(32) Lockwire all compressor stator assembly tabs (refer to the clearance charts in the Table of Limits).

R L. Compressor Rotor Pattern Stacking - General
See Figure 707.

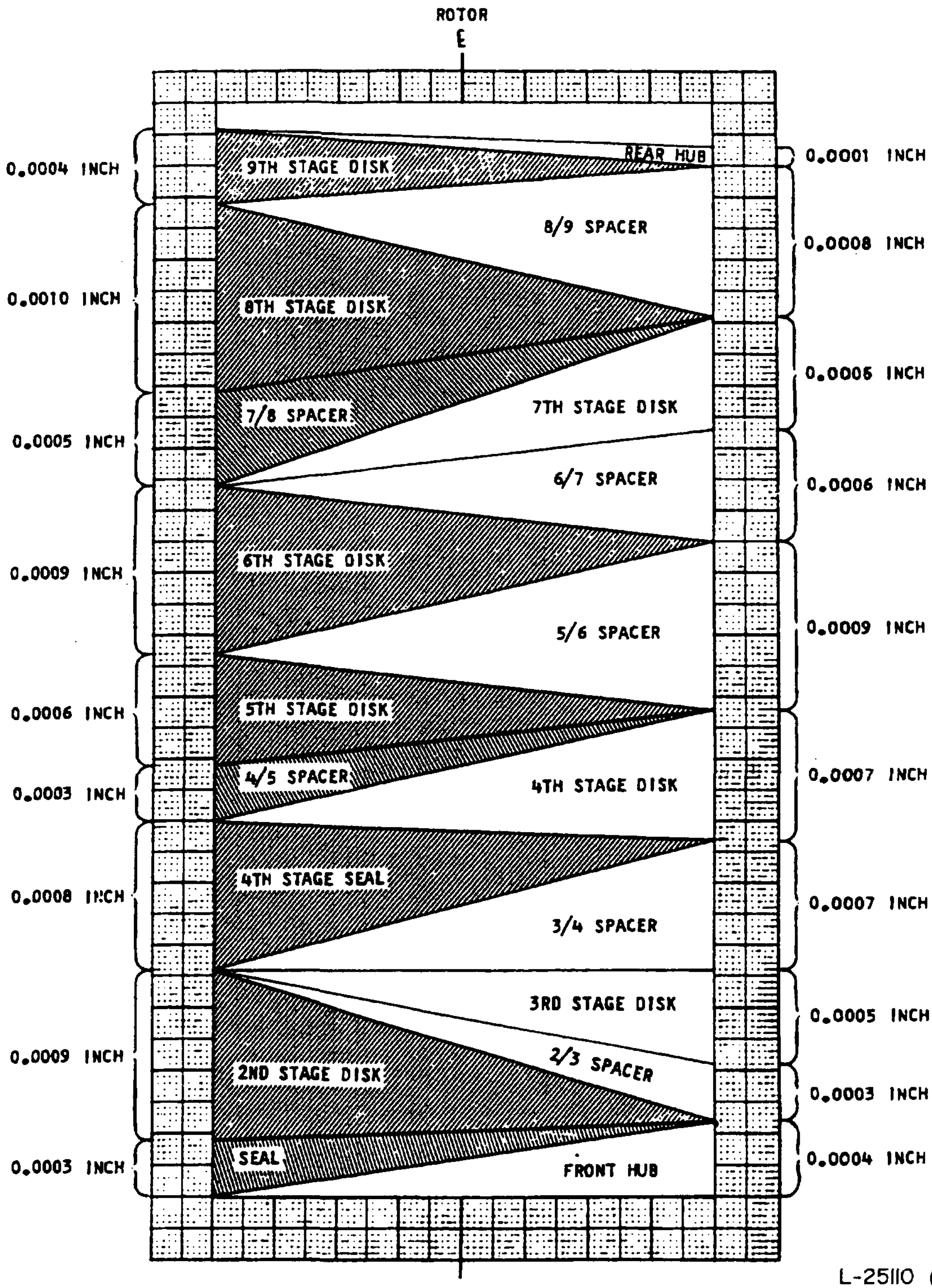
(1) The compressor rotor pattern stacking figure represents an arrangement (using out-of-parallelism high points) of compressor rotor spacers, hubs, and disks that will result in the building of an optimum square stack. These parts are represented in a relative assembly position on illustration. Wedges that have been shaded represent out-of-parallelism high points of parts that will be installed at the six o'clock position. Non-shaded wedges represent high point of those parts that will be installed at the 12 o'clock position.

NOTE: At assembly, 12 o'clock position will be a point facing away from operator. After installation of front hub, installation position will be referenced from mark on hub.

(2) The pattern stacking technique permits the operator to determine, prior to assembly, the relative position of the disks and spacers to ensure the building of an optimum square stack. This is done by arranging the out-of-parallelism high points so that points are diametrically opposed as indicated in sample figure.

NOTE: Depending upon out-of-parallelism variation between compressor rotor components, it may be necessary to assemble two or more adjacent parts so that their out-of-parallelism high points are indexed in the same relative position. In this manner, a cumulative out-of-parallelism is created to offset extreme out-of-parallelism of parts whose high points are diametrically opposed. Examples of this are shown in figure where two or more shaded or unshaded wedges are grouped together.

R M. Compressor Rotor Disks And Spacers Measurement For Compressor Rotor Build, Using Pattern Stacking Technique



L-25110 (0000)

R
R

Compressor Rotor Pattern
Stacking Diagram (Sample)
Figure 707

NOTE: In Determining The Build Of An Optimum Square Rotor, The Difference Between The Total Out-Of-Parallelism At The 6 And 12 O'clock Positions Will Yield The Residual Out-Of-Parallelism For The Entire Rotor. This Calculation Will Be Instrumental In Determining The Effectiveness Of The Pattern Selected Prior To The Actual Build.

Key To Figure 707

(1) Measure parallelism of front hub integral spacer mating face and bearing seal spacer mating face. Mark highest point of out-of-parallelism on hub rear surface, and record.

(2) Measure parallelism at mating faces of the following parts:

(a) Second stage airseal

(b) Fourth stage airseal

(c) Compressor rotor disks

(d) Compressor rotor spacers.

(3) Mark highest point of out-of-parallelism on rear of each part, and record.

(4) Measure parallelism of rear hub disk mating face and oil distributing sleeve mating face. Mark highest point of out-of-parallelism on hub rim, and record.

(5) Using high points determined above, establish relative assembly positions of parts as follows:

(a) Using graph paper, plot dimensional high point of front hub on right side of graph. Label high point dimension of part as shown in sample figure. Draw line from right side of graph to base line on left side.

<u>NOTE</u>: Right side of graph represents 12 o'clock assembly position.

(b) Complete positioning dimensional high points of remaining parts on graph until optimum square stack is evidenced. Clearly label parts as shown in sample illustration.

R
R

72-0001

(6) Indicate relative assembly position (6 or 12 o'clock) of disks and spacers, by part number, on suitable form. This form will be used at compressor rotor build to denote spacer and disk positioning.

(7) Assemble compressor rotor as indicated in Paragraph J. indexing compressor rotor component in accordance with pattern stacking technique.

R N. Compressor Front Tierod Hydraulic Loading See Tool Group 38-1 and Table 702.

CAUTION: PN 406090 AND PN 468243 TIERODS ARE NOT DESIGNED FOR HYDRAULIC LOADING. IF THESE TIERODS ARE INSTALLED, MANUAL LOADING PROCEDURE SHALL BE USED. REFER TO PARAGRAPH J.

(1) Test hydraulic ram units and distributor of hydraulic loading fixture as follows:

NOTE: This test need not be performed each time these tools are used, but it is provided as a periodic check to ensure that tools are functioning properly.

(a) Secure rams and distributor to test fixture.

(b) Connect hydraulic lines to rams and distributor and in turn connect hydraulic pump to the latter.

(c) Apply 6000 psig and hold for 15 minutes. Then check for any leaks. Any deficiencies shall be corrected.

(d) Decrease pressure to 300 psig and zero-in all dial indicators.

(e) Increase pressure to 4980 - 5020 psig. All dial indicators must agree 0.0005 inch total.

(2) Assemble hydraulic loading fixtures as follows:

(a) Position adapter with lifting eye up.

(b) Install hydraulic rams in T-slots of adapter.

(c) Secure distributor to adapter and connect hydraulic lines to distributor and rams.

(3) Install hydraulic loading fixture and related tooling on compressor stack as follows:

(a) Place wrenches over tierod nuts, with wrench handles extending radially outward.

(b) Position fixture on 3rd-to-4th stage compressor disk spacer, aligning ram units with ends of tierods.

(c) Insert long thimbles into upper ram units. Thread thimbles onto tierod until thimbles bottom on tops of tierod nuts; then back off two complete turns.

NOTE: Thread on thimbles must match thread on tierods.

(d) Install short thimbles through lower ram units and thread onto tierods as indicated in step (c).

(e) Position and secure dial indicators so that indicator probes are centered on ends of thimbles.

(f) Connect hydraulic pump to distributor.

(4) Load compressor front tierods as follows:

(a) Check operation of fixture as indicated below:

NOTE: For poundage and equivalent gage pressures associated with loads referenced below, see Table 702.

Load Level	Load (Lbs.)	Equivalent Gage Pressures (PSIG)
BASELINE	55	60
CHECK	2490 - 2530	2700 - 2750
FINAL	3780 - 3820	4100 - 4150

CAUTION: DO NOT CONFUSE LOAD WITH PRESSURE. THIS CONVERSION OF LOAD INTO EQUIVALENT GAGE PRESSURE READING APPLIES ONLY WHEN HYDRAULIC RAMS, PWA 13784, ARE USED.

Specifications For Hydraulic
Loading Of Compressor Front Tierods
Table 702

R
R

72-0001

1 To ensure that tierods do not rotate when loosening nuts, apply hydraulic load of at least 500 lb. (540 psig) but not more than 750 lb. (810 psig); then back off tierod nuts sufficiently to ensure that no contact is made with 3rd-to-4th stage disk spacer at BASELINE load. Excessive loosening of tierod nuts causing contact with thimbles shall be avoided. Zero-in all dial indicators allowing for minimum free travel of 0.030 inch. Ensure that dial indicators are contacting thimble platforms.

2 Increase load to CHECK load level. Dial indicators must agree within 0.030 inch. If dial indicators are not within limits, tierods, stack up or fixtures may be at fault. Deficiencies may be at fault. If no deficiencies are found, decrease load to BASELINE and zero in all dial indicators.

(b) Complete hydraulic loading of compressor tierods as follows:

1 Increase load to CHECK load level. All dial indicators must agree within 0.003 inch. Correct deficiencies as required.

2 Increase to FINAL load. All dial indicators must agree within 0.003 inch. Correct deficiencies as required.

3 Apply 15 - 18 lb-in. torque to tierod nuts. Torque shall be applied simultaneously to diametrically opposed nuts. Appropriate sequence is shown in Section XI, Compressor and Turbine Clearance charts. Then, in the same sequence increase torque to 24 - 26 lb-in. All indicators must agree within 0.004 inch.

NOTE: A slight decrease in hydraulic pressure will be observed while torquing nuts. Do not adjust pressure.

4 Decrease load to BASELINE. All indicators must agree within 0.004 inch.

NOTE: A very low, or near-zero, dial indicator reading indicates an untorqued not at pressure release. Correct by repeating tierod loading.

R O. Compressor Rotor Hydraulic Loading - Rear Tierods
See Tool Group 38A, Figure 708, and Table 703.

Load Level	Load (lbs)	Estimated Gage Pressures PSIG
Baseline	136 - 156	148 - 169
Check	1980 - 2020	2150 - 2193
Break-Away	2230 - 2270	2420 - 2465
Initial	2965 - 3005	3219 - 3269
Final	2685 - 2705	2915 - 2937

Specifications For Hydraulic Loading
Of Compressor Rear Tierods (For
PWA 13784 Hydraulic Ram Units Only)
Table 703

WARNING: DO NOT APPLY HYDRAULIC LOADS TO PN 409227 TIERODS (REPLACE THESE TIERODS WITH PN 572252).

(1) Prior to hydraulic loading, test hydraulic ram units and distributor as follows:

(a) Secure rams to test fixture by handtightening test tierods provided; then, fasten distributor to raised support on fixture.

(b) Connect hydraulic lines between distributor and rams.

(c) Connect hydraulic pump to distributor.

(d) Apply 6000 psig and hold for 15 minutes. Check for leaks and correct any deficiency.

(e) Decrease pressure to 300 psig and zero dial indicators.

72-0001

(f) Increase pressure to 4980 - 5020 psig. All dial indicators must agree within 0.0005 inch if tooling is functioning properly.

(g) After test, disconnect hydraulic lines and remove distributor and rams from test fixture.

(2) Set up hydraulic loading tools as follows: See Figure 708.

(a) Position adapter on bench so that "T" slots are inverted.

(b) Insert rams into "T" slots of adapter.

(c) Secure distributor to adapter and connect hydraulic lines between distributor and rams.

(d) Torque tierod nuts to 50 - 85 lb-in. in diametrically opposed pairs as shown in Table of Limits. See Figure 1001.

(e) Place special wrenches on torqued nuts so that wrench handles extend radially outward.

(f) Position hydraulic loading fixture on compressor rotor rear hub.

(g) Insert thimbles into hydraulic rams, and screw onto tierods until handtight; then, back off two turns to obtain clearance between thimble and tierod nut.

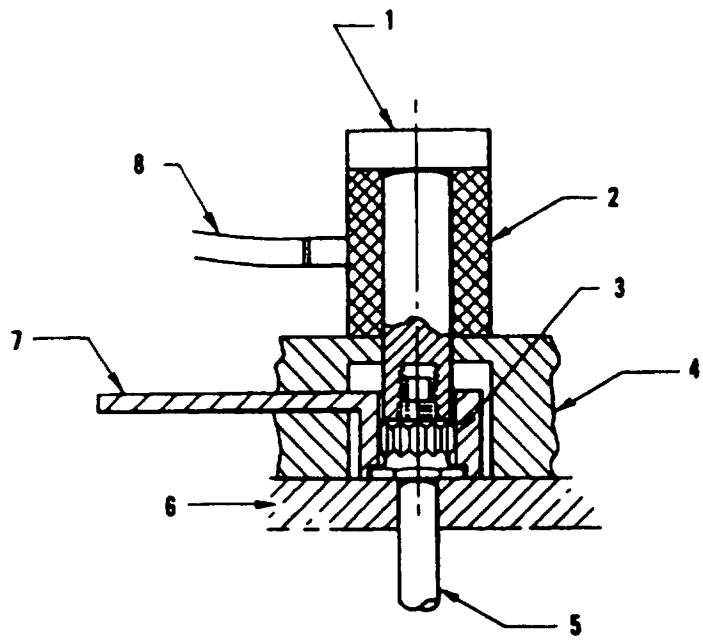
(h) Position and secure dial indicators with indicator probes contacting top surfaces of thimble and rod assemblies.

(i) Connect hydraulic pump to distributor.

(3) Check operation of fixture as follows:

NOTE: To obtain pound and gage pressure equivalents for loads referenced below, see Table 712.

R
R



L-21822 (0000)

1. Thimble And Rod Assembly
2. Hydraulic Ram Unit
3. Tierod Nut
4. Adapter
5. Tierod
6. Rear Hub
7. Wrench
8. Hydraulic Pressure Line

R Specifications For Hydraulic
R Loading Of Compressor Rear Tierods
(For Use With PWA 13784 Hydraulic
Ram Units Only)
Figure 708

72-0001

CAUTION: DO NOT CONFUSE LOAD WITH PRESSURE. THE CONVERSION OF LOAD INTO EQUIVALENT GAGE PRESSURE READING APPLIES ONLY WHEN HYDRAULIC RAMS, PWA 13784, ARE USED.

(a) Apply BREAK-AWAY load. Then, back off tierod nuts to avoid contact with stack when load is decreased to BASELINE load. Do not back off nuts so far that contact is made with thimble.

(b) Reduce to BASELINE load. Ensure that nuts are free of stack; then, zero dial indicators, allowing for minimum free travel of 0.040 inch.

(c) Increase to CHECK load. Dial indicators must agree within 0.003 inch. If not, either tierods, compressor stack, or fixture is at fault.

NOTE: If dial indicators are in agreement, do not decrease load below BASELINE until stacking procedure is completed.

(4) Perform hydraulic loading as follows:

(a) Increase to initial load. Dial indicators must agree within 0.003 inch.

(b) Decrease to BASELINE load, and zero all dial indicators.

(c) Increase to FINAL load. Dial indicators must agree within 0.003 inch.

(d) Apply 15 - 18 lb-in. torque to tierod nuts in diametrically opposed pairs. (See Section XI) Then, in same manner, increase torque of tierod nuts to 24 - 26 lb-in. All dial indicators must agree within 0.004 inch.

NOTE: Do not adjust pressure to compensate for decrease due to torquing procedure.

(e) Decrease to BASELINE load. All indicators must agree within 0.004 inch.

NOTE: A low or near zero dial indicator reading indicates failure to torque tierod nut prior to pressure release. Correct by repeating tierod loading.

R
R

(f) Reduce hydraulic pressure, remove fixture, and secure nuts with tablocks.

R P. Compressor Rotor Front Hub Assembly
See Tool Group 36.

(1) Position rear half of concentricity build fixture over rotor stack, and secure by positioning fixture lugs on underside of No. 2 balance bearing.

NOTE: Slot in offset lug of fixture must be aligned with offset lug on vane and shroud assembly.

(2) Loosen detail nut securing front hub to adapter. Then, lift compressor rotor assembly from build stand assembly.

(3) Attach front half of fixture to rear half of fixture, and secure with detail bolts. Lock aligning pins.

NOTE: Front half of fixture is installed by passing over front section of compressor rotor.

(4) Remove adapter and bearing assembly, compressor assembly base, and stator locator adapter from build stand assembly, and install compressor balance fixture-to-stand adapter on compressor build jack.

(5) Trunnion rotor assembly, using sling, and position in build stand assembly, rear hub down.

(6) Remove front half of concentricity build fixture, and raise jack to contact rear hub face.

(7) Install No. 1 bearing seal rear spacer (angular face to rear) on compressor rotor front hub.

(8) Install center seal spacer followed by front spacer with angular face to front and bearing work spacer with large OD against balance bearing. "X" marks on spacers and hub shall be aligned.

NOTE: Front and rear seal spacers are identical.

72-0001

(9) Heat and install No. 1 balance bearing, using drift. Thread No. 1 balance bearing retaining nut (Tool) on front hub. Tighten, using retaining nut wrench.

NOTE: Heat the balance bearing to 82° - 95°C (180° - 200°F).

(10) Check to ensure that faces of inner race of balance bearing are square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 in FIR.

(11) Retract jack, and attach front half of concentricity and build fixture to rear half. See step (3) for procedure.

R Q. Compressor Rotor Squareness Check
See Tool Group 37 and Figure 709.

(1) Install and secure balance bearing housing in cradles of concentricity check fixture.

(2) Attach rear half of concentricity check fixture and secure with quick-disconnect. Attach lifting sling to fixture, and trunnion rotor assembly into concentricity fixture.

(3) Using height gage and indicator, check squareness runout of rear face of front spacer and front face of rear spacer on front hub and front face of seal plate on rear hub. Squareness runout of these surfaces must not exceed 0.001 inch when rotor is mounted on its bearing journals (Points A and B) as shown in the figure.

NOTE: Details may be rotated to meet this requirement. Using layout dye, mark radial position of all related parts on front and rear hub in order that reinstallation in correct position is assured.

CAUTION: USE PULLER TO REMOVE REAR HUB. DO NOT STRIKE REAR HUB WITH MALLET AS THIS WILL UPSET STACK.

(4) Remove rotor from concentricity fixture and install, front hub down, in build stand. Remove rear half of concentricity check fixture.

R R. Compressor Rotor Dynamic Balance Check
See Tool Group 38 and Figure 709.

1. Squareness Runout Of These surfaces Must Not exceed 0.001 Inch FIR When Assembly Is Mounted On Journals A And B. Spacers May Be Rotated For This Requirement.
2. Squareness Runout Of This surface Must Not Exceed 0.001 Inch FIR When Assembly Is Mounted On Journals A And B.
3. Squareness Runout Of This surface Must Not exceed 0.001 Inch FIR When assembly Is Mounted On Journals A And B. Plate May Be Rotated For This Requirement.
4. Rivet-Type Counterweight
5. Minimum Counterweight Flare, 0.125 Inch
6. Material May Be Removed From This Shoulder
7. To Dynamically Balance, Material May Be Removed To This Shoulder (See NOTE.)
8. Material May Be Removed To This Shoulder.

NOTE: Dynamic unbalance at 1700 rpm minimum in Planes X and Y when mounted on Journals A and B: residual unbalance must not exceed 1.0 oz-in. per plane or must not exceed 0.5 oz-in. per plane if unbalance vectors are within 90 degrees of each other. Disks and spacers may be rotated to meet this requirement. Final unbalance must not exceed 0.1 oz-in. per plane. Correct by adding weights.

Key to Figure 709

(1) Install and secure balance motor pulley to motor driveshaft. Check pulley for runout and squareness.

(2) Position rear half of concentricity checking fixture on front half, and secure with quick-disconnect.

(3) Attach lifting sling to spools of fixture, and trunnion compressor rotor assembly into balance machine.

(4) Install compressor balance pulley into hub, engaging spline in hub. Tighten pulley, using wrench; then install balance machine drive belt.

(5) Start machine, and gradually increase speed until rotor assembly is rotating at minimum speed of 1700 rpm. Amount of dynamic unbalance of rotor assembly must not exceed one oz-in. per plane (front and rear) or must not exceed 0.5 oz-in. per plane if unbalance vectors are within 90 degrees of each other, prior to addition of any counterweights.

<u>NOTE</u>: If dynamic unbalance is in excess of one oz-in., disassemble rotor, and rotate spacers and disks

R
R

72-0001

until one oz-in. limit is met. Recheck rotor squareness.

(6) When unbalance in rotor assembly is one oz-in. or less, determine amount and angular location of unbalance. Amount of dynamic unbalance must not exceed 0.100 oz-in. when rotating at minimum of 1700 rpm.

(7) Install two balance counterweights on counterweight flange of front hub, one on each side of "minus" balance location. Gradually move counterweight toward "minus" location until final balance is achieved. Use "rivet-type" flat counterweights, (Index 4) Figure 709, to correct for small increments of residual unbalance. Install classified balance plugs and washers on hub, and balance as just described.

NOTE: During trial balancing, secure front hub counterweights in position with rivets. Secure rivets and "rivet-type" counterweights with masking tape. Do not flare rivets and "rivet-type" counterweights, or bend counterweight washer tabs until final balance weight and location are determined.

NOTE: Any combination of riveted counterweights may be used, provided no more than eight rivets are used when installing weights and a rivet is used in each counterweight hole. A maximum of six "rivet-type" weights may be used on the front hub.

(8) Fine balance is obtained by removing material from front counterweight lip up to shoulder as shown in (Index 8) Figure 709, or from ends of counterweight. If ends are machined, ensure that at least 0.100 inch of material remains between end and edge of nearest rivet hole.

(9) After final balance has been achieved, rivet front hub counterweights, using counterweight retaining rivet riveter. Set tabs on rear counterweights.

NOTE: Mark point of greatest axial runout of mating surface for turbine shaft positioning spacer (inside compressor rear hub). This point will be indexed 180 degrees from point of greatest axial runout of turbine spacer at mating of parts.

R
R

(10) Remove balance machine drive belt, and remove compressor balance pulley, using wrench. Attach lifting sling to spools of fixture.

(11) Trunnion rotor assembly, rear hub down, onto assembly stand. Secure rotor assembly to stand with lockpins, and remove front half of fixture.

(12) Remove No. 1 bearing retaining nut, and pull off balance bearing. Remove front and center seal plates. Install rear carbon seal, center seal plate, front carbon seal, and front seal plate. Maintain same radial position of seal plates.

(13) Heat No. 1 bearing inner race in hot oil and install it on hub, puller groove up with the Inner Race Drift.

(14) Install No. 1 bearing inner race retaining nut and torque nut as follows:

(a) Install outer detail of inner race retaining nut wrench to body of hydraulic wrench. Install retaining nut wrench detail into hydraulic wrench.

(b) Place assembly on retaining nut with inner detail engaging slots in hub and outer detail engaging nut.

(c) Using hydraulic wrench, tighten nut (refer to the Table of Limits).

(d) Further tighten to align rivet hole in housing with rivet hole in nut. Install rivet, preformed head toward ID of compressor front hub. Flare the rivet with the Riveter.

NOTE: If front compressor hub incorporates hub plug, this must be installed before inner race retaining nut rivet is installed. Place packing in plug groove; then, install plug in hub, using PWA 13946 Guide. Align the three tapped holes in plug with the three 3/16 inch diameter holes in hub. Install bolts and key washers at three tapped hole locations. Torque bolts, and bend key washers to secure. Install inner race retaining nut rivet. Head of rivet goes inside larger hole in plug. Flare rivet, using PWA 13977 Riveter. For

R
R

72-001

engines incorporating SB 4110, plug (PN 733514) has been machined to fit ID of hub and does not require a packing. If plug is to be replaced, new plug (PN 735369) must be machined to appropriate class and reidentified by SB 4110.

(15) Reinstall front half of balance fixture. Using sling, trunnion compressor assembly onto front hub and lower it back into stand.

(16) Remove rear half of balance fixture and remove No. 2 bearing inner race retaining nut, using oil scoop wrench; then remove main component drive bevel gear and balance spacer.

(17) Install jaws of rear bearing puller in groove of No. 2 bearing oil sleeve and secure them with retaining ring. Using jackscrew action of puller, remove sleeve and balance bearing.

(18) Fit distributing sleeve plate into groove of No. 2 bearing seal plate and install plate on seal support base.

(19) Place distributing sleeve drift into top of bearing sleeve and press sleeveout of bearing and seal plate.

R S. Compressor Inlet Case Installation
See Tool Group 33.

(1) Attach rear half of concentricity checking fixture to front half of fixture and attach lifting sling to spools of fixture. Lift compressor assembly off build stand.

CAUTION: ENSURE THAT VANE SHROUD LUGS ARE ENGAGED WITH ADJACENT SHROUD SLOTS.

(2) Trunnion compressor assembly and lower it back into build stand with rear hub down. Remove rear half of fixture.

ENGINE GENERAL - ASSEMBLY OF SUBASSEMBLIES

CAUTION: USE EXTREME CAUTION WHEN MATING NO. 1 BEARING OUTER RACE IN INLET CASE TO NO. 1 BEARING INNER RACE AND ROLLERS ON COMPRESSOR ROTOR FRONT HUB.

(3) Heat compressor inlet case with heating blanket and install it on the compressor. Mate the slots in the 4th stage spacer with the lugs in the case, aligning the offset lug with its corresponding slot.

R T. Diffuser Case Air Leak Check
See Tool Group 40B.

(1) Before assembling diffuser case, perform an air leakage check of No. 2 bearing compartment and No. 2 bearing oil pressure and scavenge tubes.

(2) Install and secure plug into accessory drive strut from outside.

(3) Install cover on front flange of No. 2 bearing compartment, and secure with nuts and bolts.

(4) Install cover on rear flange of No. 2 bearing compartment, securing with cap screws.

(5) Install cover on oil pressure tube flange and oil scavenge tube flange.

(6) Connect regulator to an air supply and to cover on rear flange of case.

(7) Introduce air at 10 psi.

(8) Check walls of oil tubes and bearing compartment, using suitable leak detection fluid. No leakage is permissible.

R U. Ninth Stage Compressor Vane And Shroud Assembly Installation

(1) Position diffuser case rear flange down on a bench.

(2) Install ninth stage vane and shroud assembly in case, engaging pins in case with vane outer shroud holes. Align locating marks made during disassembly and install airseal ring.

72-0001

(3) Rivet airseal ring and vane inner shroud to diffuser case.

NOTE: ID of 9th stage airseal ring must be concentric with ID of No. 2 bearing support within 0.010 inch FIR and concentric with centerline of inner shroud rivet holes within 0.019 inch FIR. Enlarged rivet holes in vane inner shroud may be drilled to accept next larger size rivets or puddle-welded and redrilled to original size (refer to Repair). Enlarged rivet holes in airseal may be drilled to accept next larger size rivets, or ring may be reindexed midway between existing rivet holes and new holes made. Old holes must be plugged by welding.

R V. Main Component Drive Splined Coupling
See Tool Group 43.

(1) Using bearing and spacer drift and an arbor press, install ball bearing, outer spacers, and roller bearing on component drive splined coupling.

(2) Install component drive splined coupling (threaded end toward center of diffuser case) into main component drive housing of diffuser case.

(3) Install coupling retaining ring in groove in housing.

R W. No. 2 Bearing
See Tool Group 5.

(1) Position No. 2 bearing oil distributing sleeve (flanged end down) on bench. Install No. 2 bearing seal plate (large face down) on sleeve aligning X-marks on plate and sleeve.

(2) Heat No. 2 bearing front and rear inner races in hot oil. Install No. 2 bearing front inner race on sleeve aligning X-marks on race and sleeve. Position inner race drift on inner race and seat inner race against seal plate by striking drift with mallet. Place No. 2 bearing cage and balls in outer race; then install outer race and balls on front inner race.

NOTE: Rear face of outer race is marked REAR to facilitate assembly.

(3) Install rear inner race puller groove up on sleeve so X-mark on rear inner race is aligned with X-mark on front inner race. Position drift on race and seat race against front inner race by striking drift with a mallet.

(4) Install No. 2 bearing inner race retaining ring, ensuring that it is in sleeve groove.

(5) Place bearing assembly in bearing liner of diffuser case. Using outer race drift on outer race, seat bearing in liner.

(6) Install No. 2 bearing outer race retaining nut. Using nut wrench and torque wrench, tighten nut. See the Table of Limits.

(7) Mark alignment of retaining nut and No. 2 bearing support. Ensure that rivet hole in nut and support is aligned.

(8) Remove retaining nut.

R X. No. 2 Bearing Seal Assembly
See Figure 710.

(1) Place No. 2 bearing seal support (large diameter down) on bench.

(2) Install metal seal ring (angular face down) in groove of seal support.

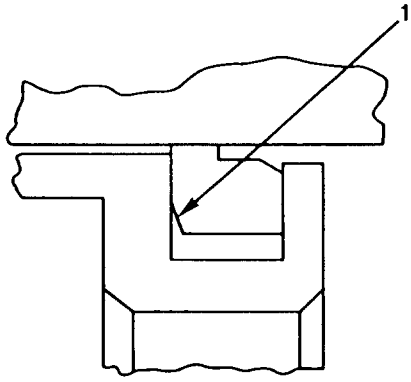
(3) Position seal loading spring on each of short pins in seal support.

(4) Position seal housing assembly (carbon seal up) on seal support, inserting pins into springs and engaging seal housing lockpins in holes in seal housing flange. Install cotter pin in hole in each seal housing lockpin and bend legs of cotter pin around lockpin. Trim cotter pin as necessary to maintain minimum clearance of 0.040 inch between cotter pin and rear flange of seal housing.

R Y. No. 2 Bearing Seal Assembly Installation

(1) Position diffuser case (front flange up) on bench.

72-0001



L-18786 (0000)
PW V

1. Angular Face Of Seal Must Face Forward.

R
R
No. 2 Bearing Seal Assembly
Installation Of Metal Seal Ring
Figure 710

(2) Install gasket on No. 2 bearing seal support flange rear face.

(3) Position No. 2 bearing seal assembly on diffuser case front inner flange (carbon seal down) aligning flange holes of seal assembly with diffuser case flange holes.

(4) Secure seal assembly to diffuser case with bolts. Tighten bolts to recommended torque and lockwire.

R Z. Component Drivegear Mounting Distance Measurement See Tool Group 24.

(1) Remove torque nut and spacer from long rod of component drive coupling gaging part of mounting distance gage.

(2) Install rod into coupling with threaded end protruding from case at gearbox mounting pad.

(3) Position inner block (flat face up) and install spacer and torque nut on rod. Tighten torque nut until it slips.

(4) Position main component drivegear gage block (straddling narrow part of drive coupling section) into No. 2 bearing oil distributing sleeve.

(5) Position drivegear gage block locator on front face of diffuser case inner front flange. Secure locator to drivegear gage block with torque nut. Tighten nut until head of torque bolt slips.

(6) Place dial indicator on master and set green line on indicator face at zero.

(7) Position dial indicator anvil on main component drivegear gage block with plunger resting on rear face of main component drivegear gage block. Dial pointer now indicates correct main component drivegear spacer thickness. Position dial indicator anvil on angular face of component drivegear gage block with plunger (inserted through the gage block hole) resting on inner face of component drivegear gage block. Dial pointer now indicates correct component drivegear spacer thickness.

(8) Grind the spacers (if necessary) to the required thickness.

72-0001

R AA. Main Component Drive Gear
See Tool Group 72.

(1) Install the shaft of the coupling holder up through the strut located between the gearbox mounting lugs at the bottom of the diffuser case. Secure the holder to one of the four lugs on the diffuser case with the ball lockpin.

(2) Engage the coupling holder rod splines in the main component drive coupling splines and secure the rod in position with the thumb screw. The coupling is now locked.

(3) Position the component drive gear spacer and the component drive gear on the component drive gear coupling.

(4) Position the component drive gear retaining nut lock (wide end down and bent outward) in the slot in the component drive coupling. Install the component drive gear nut on the coupling.

(5) Using the retaining nut wrench and a standard torque wrench, tighten the retaining nut to the recommended torque, aligning one of the slots in the nut with the retaining nut lock.

(6) Bend the retaining nut lock into the slot on the nut.

(7) Remove the coupling holder.

R AB. Fuel Manifolds

(1) Position the right and left fuel manifolds into the opening on the bottom of the diffuser case and on the bosses in the rear of the diffuser case.

(2) Place a spacer between each mounting boss and the fuel manifolds. Secure the manifolds to the diffuser case with the tabwashers and bolts. Tighten the bolts to the recommended torque.

(3) Bend each tabwasher against a flat on the bolt. Lockwire the bolts to holes in case bosses.

(4) Position transfer valve connector on mounting pad at bottom of diffuser case.

(5) Secure connector with bolts. Tighten bolts to 75 - 85 lb-in. and lockwire.

R AC. Fuel Pressurizing and Dump Valve Installation

(1) Place two packings on each transfer tube and install tubes in fuel pressurizing and dump valve.

(2) Position pressurizing and dump valve on fuel transfer valve connector at bottom of diffuser case, aligning tubes with holes in fuel manifold.

(3) Secure valve to connector with washers and bolts. Torque bolts to 75 - 85 lb-in. and lockwire.

(4) Pressure check fuel pressurizing and dump valve parting surfaces.

R AD. Pressure Check Of The Fuel Pressurizing And Dump Valve Parting Surfaces
See Tool Group 66.

(1) Attach the signal adapter to the fuel signal connection on the dump valve.

(2) Attach the drain adapter to the dump valve drain.

(3) Connect the inlet adapter to the inlet connector of the valve.

(4) Remove the plug from the secondary pressure tap and install dump valve drain adapter.

(5) Install a sealing clamp on each fuel nozzle.

(6) Connect test stand outlet ports to the inlet adapter and signal adapter. Connect the return port to the secondary pressure tap adapter and close return port shutoff valve.

(7) Supply test fluid at a pressure of at least 200 psig to the signal adapter to close the dump valve.

(8) Pressurize system through pressurizing and dump valve inlet and bleed trapped air from the fuel manifolds by lifting one nozzle seal on the nozzle in each manifold furthest away from the pressurizing and dump valve.

(9) Increase the pressure at the test stand to 600 psig and maintain for five minutes.

(10) Inspect for leakage at the following locations:

(a) The joints between the fuel manifolds.

(b) Between the fuel manifold and the fuel transfer valve adapter.

(c) Between the fuel transfer valve adapter and the fuel pressurizing and dump valve.

(11) After completion of the inspection, connect remaining fuel return hose to dump valve adapter and shut off stand to relieve pressure.

(12) Shut off inlet and signal lines and start stand.

(13) Open valve on secondary pressure tap line.

(14) Drain manifold of fluid using ejector in test stand.

(15) Disconnect test stand and adapters.

CAUTION: DO NOT DISTURB ANY CONNECTIONS THAT HAVE BEEN PRESSURE CHECKED.

(16) Replace secondary pressure tap plug, torque and lockwire.

4. Combustion And Turbine Sections

A. Combustion Chamber Fuel Drain Valve Installation

(1) Position combustion chamber fuel drain valve (valve flapper inward) on combustion chamber fuel drain valve flange, aligning holes in valve with holes in flange.

(2) Position combustion chamber fuel drain valve adapter (drain outlet ports facing down and forward) over fuel drain valve.

(3) Install bolts securing adapter and valve to flange. Tighten bolts to recommended torque and lockwire.

B. First Stage Turbine Vanes
See Tool Group 51.

R
R

(1) Place support fixture (posts upward) on bench.

(2) Position turbine case (front flange up) on fixture engaging offset dowel of fixture in offset hole in case.

(3) Position first stage turbine vane inner shroud (mounting flange up) on fixture, engaging offset dowel of fixture in offset hole of shroud flange.

(4) Position inner end of first stage turbine vane in slot in inner shroud, aligning hole in vane outer end with hole in turbine case.

(5) Position first stage turbine vane retaining pin in retaining pin drift. Insert exposed end of pin into hole in vane. Using mallet, drift pin into hole until drift bottoms.

(6) Install remaining first stage turbine vanes in same manner.

(7) Position combustion chamber outlet duct (rear flange down) on outlet duct support, aligning offset hole in duct inner flange with offset hole in 1st stage turbine vane inner shroud.

NOTE: SB 5091 provides combustion chambers and clamps with additional cooling air holes, and combustion chamber outlet duct assembly with an increased air gap between detail lugs and duct. These chambers, clamps, and duct must be used as complete sets.

(8) Secure outlet duct to outlet duct support with bolts. Tighten bolts to recommended torque and lockwire.

(9) Remove turbine case assembly from fixture.

C. Turbine Rotor Build For Concentricity And Dynamic Balance Check
See Tool Group 102.

(1) Install turbine shaft (flange end down) and 1st stage disk into shaft assembly fixture with guide pins protruding through four of holes in flange and disk.

NOTE: Temperature difference of at least 44°C (80°F) is required when assembling disk to shaft.

R
R

72-0001

(2) Install four work bolts (bolt head flats adjacent to disk mounting flange OD) through unoccupied disk and shaft flange holes. Secure bolts with retaining nuts.

(3) Apply extreme pressure grease to fir tree serrations and blade shrouds to present galling or pickup.

(4) Install each blade using following procedure:

(a) Install support into ID of fixture and install pilot.

(b) Place the disk over pilot and adjust jacks on support until they contact disk.

(c) Install detail part into fixture and secure belt around disk.

NOTE: Leave three-eighths to one-half inch of fir-tree slot extending above belt.

(d) Install blades in counterclockwise direction in fir-tree slots down to belt.

NOTE: Install blades in disk so that any two blades 180 degrees apart have same "moment" classification letters. As an optional procedure to be used at discretion of operator, blades may be assembled by "mass" weighing individual blades to nearest one-hundredth of an ounce and marking weights on blades, using red crayon. Lay out blades in order of diminishing weight, and install heaviest blade on disk. Install next heaviest blade diametrically opposite first installed blade. Install lightest blade adjacent to and clockwise from first installed blade. Install next lightest blade diametrically opposite lightest blade. Proceed in order of maximum weight progressively around hub.

(e) Remove belt from turbine disk.

(f) Position pusher over centerpost, and adjust roller position if over flat portion of turbine blade.

(g) Rotate pusher counterclockwise, applying slight downward pressure until all blades are flush with disk.

NOTE: Pusher must be rotated counterclockwise only.

(5) Lubricate rivets with extreme pressure grease.

(6) Install half of rivets (heads to rear of disk) in rivet holes. Using retaining rivet riveter, flare rivets to minimum diameter of 0.140 inch by turning jackscrew.

(7) Install and flare remaining rivets.

CAUTION: THERE MUST BE NO AXIAL PLAY IN RIVETS AFTER RIVETING. FORE AND AFT MOVEMENT OF INSTALLED TURBINE BLADES SHOULD BE NEGLIGIBLE IN SHROUD AREA. LIGHT DRAG, OR AT LEAST SURFACE CONTACT, MUST BE OBSERVED IN NOTCH AREAS WHEN BLADES ARE MOVED BY HAND IN PLANE OF ROTATION. NO AUDIBLE CLATTER OR RATTLE SHOULD OCCUR WHEN BLADES ARE LIGHTLY STRUMMED BY FINGERS. DISK AND BLADE SUBASSEMBLY IS CONSIDERED REJECTED IF BLADE RATTLE OR SHROUD LOOSENESS IS DETECTED, AND IS CAUSE FOR INDIVIDUAL PART INSPECTION AND/OR REPLACEMENT.

(8) Position disk to fixture collar around 1st stage blades, and attach lifting sling to spools of collar.

(9) Install transport fixture on transport stand so frame of fixture is directly over base of stand. Secure with quick-disconnect.

(10) Open hinged mounting devices on fixture, and trunnion on rotor hub and disk and blades assembly with collar, onto fixture. See Figure 711.

(11) Trunnion turbine rotor, shaft end down, and remove work bolts.

(12) Install turbine rotor bolts, and secure with retaining rings.

(13) Position 2nd stage turbine disk (front face up) on bench.

R
R

72-0001

(14) Apply extreme pressure grease to fir-tree serrations and blade shrouds to prevent galling and pickup.

CAUTION: DO NOT MIX PN 392561 BLADES WITH PN 475302 BLADES. THESE BLADES HAVE DIFFERENT SHROUD NOTCH ANGLES, AND WILL NOT MATE CORRECTLY.

(15) Install blades, and rivet them in position in same manner described for 1st stage turbine disk.

NOTE: A maximum of 0.010 inch axial movement is permitted at the root area of the 2nd stage turbine blade, but the retaining rivet must be tight and there must be no end play. Fore and aft movement of installed turbine blades should be negligible in the shroud area. There must be light drag, or at least surface contact, felt by hand in the plane of rotation. No audible clatter or rattle should occur when blades are lightly strummed by fingers. Disk and blade subassembly is considered rejected if blade rattle or shroud looseness is detected, and is cause for individual part inspection and/or replacement.

(16) Install turbine rotor inner seal (flanged end forward) on 1st stage turbine disk.

(17) Position 2nd stage turbine disk on turbine shaft flange, aligning offset hole in disk with offset hole in flange, and engaging front face flange in ID of turbine rotor inner seal.

NOTE: Temperature difference of at least 44°C (80°F) is required when assembling disk to shaft.

(18) Place tabwasher on each bolt, engaging long tab in small hole adjacent to each bolt.

(19) Install nuts on bolts and tighten bolts, as follows:

(a) Tighten nuts simultaneously in pairs 180 degrees apart.

(b) Loosen nuts simultaneously in pairs 180 degrees apart to zero lb-in.; then retighten to specified limits.

NOTE: Loosening and tightening must be done simultaneously in pairs 180 degrees apart.

R
R

(20) Install No. 3 bearing oil scoop on turbine rotor shaft (sealing face to rear).

(21) Install balance bearing (rear) using Bearing Drift.

NOTE: Do not heat balance bearing above 82° - 95°C (180° - 200°F).

(22) Install No. 3 bearing inner race retaining nut handtight. Place Retaining Nut Wrench on shaft.

(23) Bolt inner race torquing holder to bench. Using lifting sling, lift rotor assembly from stand onto holder, installing shaft in splined holder.

(24) Using wrench, tighten No. 3 bearing inner race retaining nut to recommended torque.

(25) Using lifting sling, remove turbine assembly from holder and trunnion it back onto build stand.

(26) Start balance bearing (front) on turbine shaft. Place bearing drift over end of shaft and tap with mallet until end of shaft contacts drift. This will place bearing in proper position.

NOTE: Do not heat balance bearing above 82° - 95°C (180° - 200°F).

D. Turbine Rotor Concentricity Check
See Tool Group 103 and Figure 712.

(1) Install and secure the front and rear balance bearing housings in the pedestals of the concentricity check fixture.

(2) Using lifting sling, lift rotor assembly from stand onto concentricity fixture. Remove collar from around 1st stage blades.

NOTE: Face of the inner races of bearings used for concentricity and runout check must be square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 inch FIR.

(3) Using a height gage and a dial indicator, check rear (sealing) face of No. 3 bearing oil scoop for squareness runout. Squareness runout must not exceed 0.001 inch FIR. The scoop may be rotated to meet this requirement.

1. To Dynamically Balance, Material May Be Removed To This Shoulder Or On The Ends Of Counterweights Provided A Wall Thickness Of 0.140 Inch Is Left At The Rivets. Each Multi-hole Counterweight Must Be Mounted With A Rivet In Each End Hole.
2. Squareness Runout Of These Surfaces Must Not Exceed 0.005 Inch FIR When Assembly Is Supported At Planes B And C.
3. Squareness Runout Of This Surface Must Not Exceed 0.001 Inch FIR When Assembly Is Supported At Planes B And C. Plate May Be Rotated For This Requirement.

NOTE: Faces of inner races of bearings used during balance operations or concentricity and runout checks must be square with the ID of the bearing 0.0005 inch FIR maximum and parallel 0.0005 inch FIR maximum.

NOTE: Semi-dynamic unbalance of the assembly when held at Planes B and C must not be more than 1.0 oz-in. in Plane A or 0.2 oz-in. in Plane B at 1700 rpm. Turn the spacer as necessary to get unbalance in these limits. Residual unbalance must not be more than 0.1 oz-in. in Plane A. Correct with counterweights.

Key To Figure 712

(4) After runout requirements have been met, mark radial position of scoop with layout dye.

(5) Using a height gage and an indicator, check squareness runout of turbine disks. Runout is measured from the front face of the 1st stage disk inside rivet circle to the rear face of the 2nd stage disk inside rivet circle. Squareness runout must not exceed 0.005 inch FIR.

(6) Check high point of axial runout on front face of turbine shaft spacer. Mark point of greatest runout on turbine blade in-line with this point.

NOTE: This point will be indexed 180 degrees with high point of runout of mating hub.

(7) Using layout dye, mark radial position of spacer to hub.

(8) Reinstall sling, and lift assembly from fixture onto storage stand.

E. Turbine Rotor Dynamic Balance Check
See Tool Group 105.

R
R

(1) Install and secure front and rear balance bearing housings in cradles of balance machine.

(2) Lift turbine rotor from build and transport fixture using strap. Lower rotor onto balance machine so that disks and blades enter bottom half of turbine balance shroud.

(3) Secure front balance bearing to its housing on balance machine using retaining strap. Place strap around bearing and bolt it to housing.

(4) Remove lifting strap, slip drive belt over turbine shaft before lowering rotor, and close cover of turbine balance shroud.

NOTE: Faces of the inner races used for balancing must be square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 inch FIR.

(5) Start rotor spinning, gradually increasing its speed until it is rotating at 1700 rpm.

(6) Semi-dynamic unbalance of complete assembly must not exceed 0.200 ounce-inch when rotating at 1700 rpm.

(7) Unbalance can be corrected by adding counterweights at Plane A, Figure 712. Install four rivets in each counterweight, preformed head toward the front.

NOTE: Not more than three counterweights and 12 rivets may be added to correct unbalance. Fine balance may be obtained by removing material from shoulder or on the ends provided a wall thickness of 0.140 inch is left at the rivets and two rivets in end holes hold each counterweight.

NOTE: Mark point of most unbalance on rear face of turbine shaft flange. Use a temporary marking method. Refer to Section 70-11-00 in the Standard Practices Manual.

(8) After final balance has been achieved, flare counterweight rivets with the retaining rivet Riveter to obtain a 0.130 inch diameter flare.

(9) Mark radial location of turbine rotor inner seal in line with offset hole on 2nd stage turbine disk.

R
R

72-0001

(10) Remove straps from the front balance bearing housing.

(11) Using lifting strap, lift turbine rotor assembly from balance machine and reinstall it in fixture and build stand.

F. Turbine Rotor Disassembly After Dynamic Balance
See Tool Group 104.

(1) With turbine rotor assembly secured by disk to fixture collar, transport fixture, and transport stand, engage jaws of front balance bearing puller behind turbine front balance bearing inner race. Using jackscrew action, pull bearing off shaft.

(2) Place retaining nut wrench on shaft and attach lifting sling on spools of collar.

(3) Lift turbine off fixture and stand onto inner race torquing holder, installing shaft splines in splines of holder.

(4) Using wrench, remove No. 3 bearing inner race retaining nut.

(5) Using sling, remove turbine assembly from holder and reinstall it on stand.

(6) Engage three puller jaws of balance bearing puller in slots of No. 3 bearing oil scoop and secure with retaining ring. Turn jackscrew so pad rests on end of shaft and pull oil scoop and bearing from shaft.

(7) Remove nuts securing 2nd stage turbine disk and blades to hub and lift off 2nd stage disk.

(8) Remove turbine rotor inner air seal off 1st stage disk.

NOTE: Make certain radial location of air seal has been marked with respect to the offset in the 2nd stage disk.

G. No. 3 Bearing Seal Assembly

(1) Install metal seal ring (angular face forward) in groove of No. 3 bearing seal housing. See Figure 710 and Table of Limits.

(2) Place No. 3 bearing seal support (mounting flange up) on bench.

(3) Position spring on each seal loading pin.

(4) Install seal housing (carbon seal up) in support with loading pins protruding through holes in housing.

(5) Install cotter pin (head toward OD of support) in each of three loading pins which have cotter pin holes. Secure each cotter pin by bending legs around pin.

H. No. 3 Bearing Seal Installation

(1) Position No. 3 bearing seal assembly (mounting flange up) over turbine shaft and lower seal assembly until turbine rotor 1st stage front inner seal rests on turbine disk.

I. No. 3 Bearing Installation
See Tool Group 10 and the Table of Limits.

(1) Position combustion chamber inner case (rear flange up) on bench.

(2) Position No. 3 bearing outer race in bearing housing.

<u>CAUTION</u>: OLD RACE SHALL BE REINSTALLED WITH SERIAL NUMBER SAME WAY AS WHEN REMOVED. NEW RACE SHALL BE INSTALLED WITH SERIAL NUMBER FACING AWAY FROM OPERATOR.

(3) Install No. 3 bearing outer race retaining nut handtight.

(4) Install anchor plate on combustion chamber inner case rear flange.

(5) Mount hydraulic wrench on anchor plate and secure with thumbscrews.

(6) Insert socket (through hydraulic wrench) into retaining nut.

(7) Mount ratchet adapter and torque wrench on hydraulic wrench.

R (8) Using hydraulic wrench, tighten outer race nut (refer to
R Reference 359 in the Table of Limits).

(9) Install and flare the rivet with the Riveter.

(10) Install No. 3 bearing oil scoop, puller groove forward, on turbine shaft.

(11) Trunnion turbine rotor into horizontal position.

(12) Heat No. 3 bearing inner race in hot oil.

(13) Position No. 3 bearing inner race on turbine shaft and position inner race drift over shaft and against front face of inner race. Drift inner race into position.

CAUTION: OLD RACE SHALL BE REINSTALLED WITH SERIAL NUMBER IN SAME WAY AS WHEN REMOVED. NEW RACE SHALL BE INSTALLED WITH SERIAL NUMBER FACING OPERATOR.

(14) Install No. 3 bearing inner race retaining nut on turbine shaft. Tighten nut handtight.

(15) Torque inner race retaining nut as follows:

(a) Install adapter over turbine shaft so that ID splines of adapter engage OD splines of shaft.

(b) Bolt No. 3 bearing inner race retaining nut wrench to hydraulic wrench.

(c) Slide assembled wrenches over adapter and position wrenches so that teeth of retaining nut wrench engages slots in nut and splines and hydraulic wrench engages splines of adapter.

(d) Using hydraulic pressure, torque nut (refer to Reference 360 in the Table of Limits).

(16) Install inner race retaining nut tablock, inserting straight tabs in turbine shaft slots and bent tabs in castellations of retaining nut.

CAUTION: ENSURE THAT TABLOCK IS PROPERLY INSTALLED.

(17) Install tablock retaining ring in groove in retaining nut.

CAUTION: ENSURE THAT RING IS PROPERLY INSTALLED.

(18) Determine turbine positioning spacer thickness.

R
R

J. Turbine Positioning Spacer Measurement
See Tool Group 98 and Figure 713.

(1) Install gage fixture on transport stand, positioning frame of fixture directly over base of stand. Secure fixture to stand with quick-disconnect device.

(2) Install gage plug in hole in base of fixture.

NOTE: All surfaces of gage plug must be clean.

(3) With first stage turbine rotor outer airseal installed in turbine case place turbine case over pedestal on fixture so that outlet duct rests on the base of fixture.

(4) Position combustion chamber inner case on pedestal and install gasket on inner case rear flange.

(5) To ensure accurate turbine rotor positioning measurement, disk must be flush with shaft flange. Using suitable spacer or washers and four nuts secure disk to flange using care not to damage retaining rings.

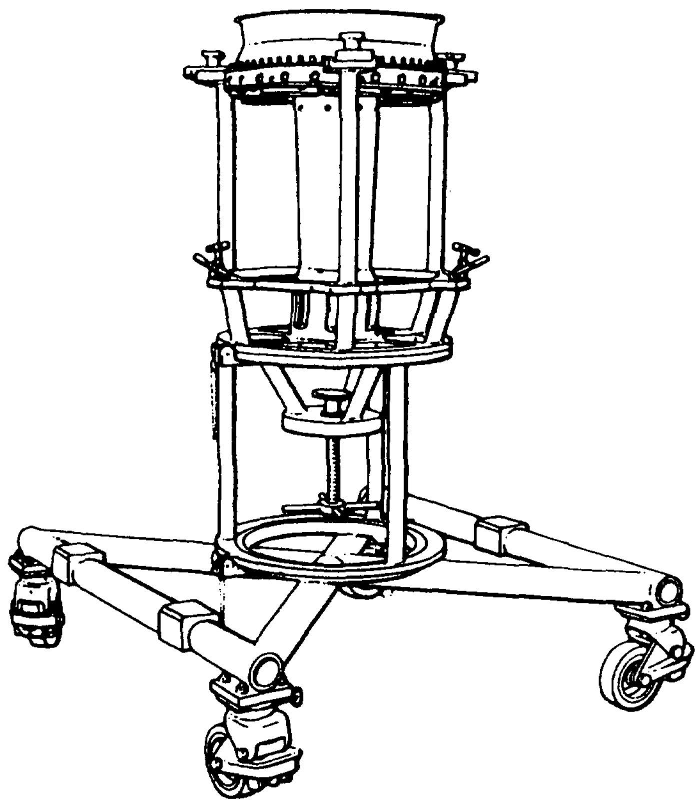
(6) Lock disk to fixture collar around OD of the 1st stage turbine disk and blades, making certain that the blade tips bottom in the collar.

(7) Suspend the lifting sling from a hoist and secure the sling hook to the outer trunnion spools of the collar.

(8) Lower the turbine rotor through the combustion chamber inner case until the front end of the shaft rests on the gage. Remove the sling and collar.

CAUTION: ONLY HAND-OPERATED CHAIN HOISTS SHALL BE USED TO LOWER THE TURBINE ROTOR. IF THE ROLLERS OF THE NO. 3 BEARING ARE ACCIDENTALLY STRUCK DURING THIS OPERATION, THE BEARING COMPONENTS MUST BE REMOVED AND CAREFULLY CHECKED FOR DAMAGE OR DISTORTION. EXTREME CARE SHALL BE EXERCISED WHENEVER HOISTS OF ANY KIND ARE

72-0001



L-08467 (0000)

R
R
Turbine Positioning Spacer
Measurement Build
Figure 713

USED TO PRECLUDE DAMAGE TO ENGINE BEARINGS AND/OR RELATED PARTS.

(9) Raise turbine case and attach to vertical support of fixture.

NOTE: For JT12A-8, JFTD12A-4A and -5A engines, 1st stage turbine rotor seal must be snapped over blade shroud prior to positioning of turbine case. Install as follows:

(a) Lift seal from turbine case and position on front of 1st stage disk and blade assembly by tilting so that portion of rear knife-edge is behind blade shroud spoiler.

(b) Move seal until portion of knife-edge behind spoiler abuts shroud, ensuring maximum radial clearance for unengaged portion of seal.

(c) Moving circumferentially from engaged area of seal, apply outward hand pressure until remainder of rear knife-edge snaps over spoiler. Align seal with retaining groove when turbine case is raised.

(10) Using aligning pins, line up holes in No. 3 bearing seal assembly, the inner case rear flange, the 1st stage turbine vane inner shroud, and the outlet duct flange. Secure with the bolts. Tighten the bolts to the recommended torque and lockwire.

(11) Retract the vertical supports from the turbine case.

(12) Install combustion chamber outer case and secure to turbine case with nuts. Tighten nuts to recommended torque.

(13) Position indicating gage across rear flange of turbine case with the flush pin resting on the rear face of the 1st stage turbine disk between two blade retaining rivets.

(14) Install dial indicator on the gage with the plunger resting on the controlled flat of the gage frame.

(15) Set dial face to read 0.400 inch and lock dial face.

(16) Slide dial indicator along the frame until plunger rests on end of flush pin.

R
R

(17) Record dial readings as Dimension A.

(18) Repeat steps (13) thru (17), taking reading at location 180 degrees from first reading. Any variance in Dimension A indicates improperly positioned disk or gage.

(19) Position compressor rear hub gage across rear flange of diffuser case with indicator pin resting on the platform in compressor rear hub.

NOTE: This procedure must be coordinated with installation of diffuser case. Refer to Final Assembly.

(20) Slide dial indicator until plunger rests on the controlled flat of the gage frame.

(21) Set dial at zero and lock in position.

(22) Slide dial indicator until plunger rests on gage indicator pin.

(23) Record dial reading as Dimension B.

(24) Sum of Dimension A and Dimension B is correct turbine positioning spacer thickness.

NOTE: After calculations have been made and required clearance met, measurements and all calculations shall be checked by another individual to ensure correct rotor position. Based on measurement check, spacer removed at disassembly shall be used at final assembly provided turbine runout requirement can be met. Selection of new spacer or grinding of one used previously will require new turbine rotor runout check. This will be necessary to determine rotor high point at spacer for proper indexing with compressor at final assembly. (Refer to Turbine Rotor Concentricity Check).

(25) Unfasten nuts and remove combustion chamber outer case.

K. Turbine Positioning Spacer Grinding
See Figure 714.

(1) If complete stock of classified spacers is not available, thicker spacer may be ground to required class. See Figure 714.

(1) Obliterate existing class marking and stamp new classification as indicated.

(2) Record date, required width of spacer (Dimension X in the figure), and class of spacer used in the engine build record.

L. Turbine Positioning Spacer Installation
See Tool Group 97.

(1) Attach turbine positioning fixture on turbine shaft flange and lift turbine section from build and gage fixture.

(2) Position turbine positioning spacer on spacer drift.

(3) Using mallet, drift spacer (small ID down) into turbine shaft until it seats on shoulder in shaft.

(4) Lower turbine section back into build and gage fixture.

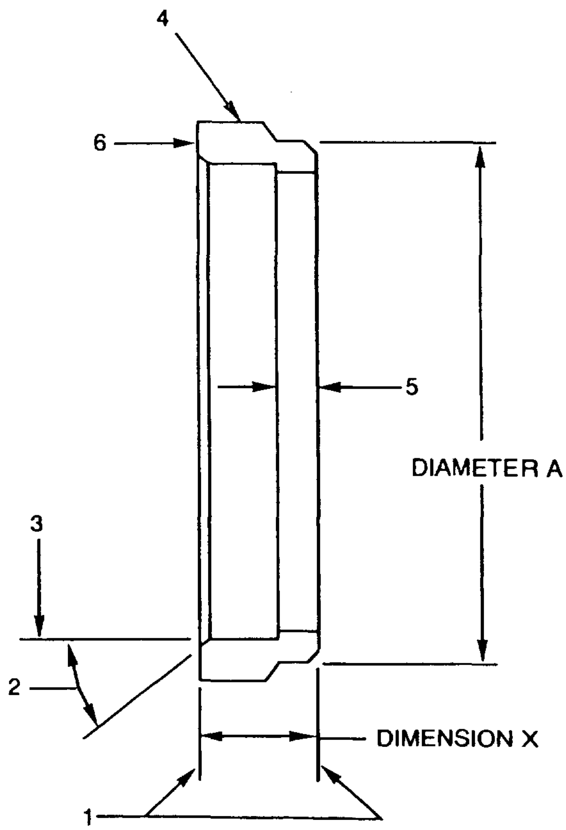
M. Exhaust Cone and Strut Installation

(1) Place exhaust cone and strut assembly (front end down) on a bench.

(2) Position turbine exhaust case over cone and strut assembly, aligning boltholes in end of struts with holes in case.

(3) Install locating bolts. Tighten bolts to recommended torque and lockwire.

CLASS	DIMENSION X
A	.399-.403
B	.404-.408
C	.409-.413
D	.414-.418
E	.419-.423
F	.424-.428
G	.429-.433
H	.434-.438
J	.439-.443
K	.444-.448
L	.449-.453
M	.454-.458
N	.459-.463
P	.464-.468
R	.469-.473
S	.474-.478
T	.479-.483



L-08915 (0000)
PW V

R
R

Turbine Positioning Spacer Grinding
Figure 714

1. These Surfaces Must Be Parallel Within 0.0002 inch FIR. 15 Micro-Inch Allowable Roughness.
2. 30 degrees ± 2 degrees
3. 1.870 - 1.890 Inch Diameter
4. Mark Class Here
5. 0.115 - 0.125 Inch
6. Grind Only This Face To Obtain Desired Class

Key to Figure 714

5. Accessory Section

A. Gearbox Oil Strainer

(1) Position oil strainer screen assembly on its stud over gearbox sump.

(2) Secure strainer to gearbox with washer and nut. Lockwire nut.

B. Breather Oil Seal Assembly
See Tool Group 15.

(1) Place carbon seal into carbon seal drift so that protruding carbon enters cavity in drift.

(2) Insert seal into housing and press it firmly into liner.

C. Installing Roller Bearing Outer Races In Gearbox Housing
See Tool Group 68.

(1) Install fuel control drive gearshaft roller bearing outer race in its liner in gearbox housing.

(2) Install main component drive gearbox gearshaft roller bearing outer race in housing.

(3) Install starter and generator drive gearshaft roller bearing outer race in housing.

(4) Position component drive gearbox gearshaft roller bearing outer race on outer race drift. Install drift and race through opening in gearbox housing until outer race starts into liner; then push outer race into position.

D. Hydraulic Pump Drive Gearshaft Assembly
See Tool Group 55.

R
R

72-0001

(1) Place roller bearing base on a bench and install gearshaft over pilot of base. Place inner race and rollers on shaft.

(2) Position roller bearing drift over end of gearshaft and drift roller bearing inner race into position.

(3) With ball bearing base on a bench, install gearshaft over pilot of base. Start ball bearing on shaft.

(4) Position ball bearing drift in ID of gearshaft and push bearing into position.

(5) Install assembled gearshaft into gearbox.

E. Fuel Control Drive Gearshaft Assembly
See Tool Group 58.

(1) Place gearshaft from base on bench and install splined end of gearshaft on pilot of base.

NOTE: Use PWA 13638 base for gearshaft PN 500348.

(2) Position rear bearing inner race and rollers on end of gearshaft. Insert pilot of rear bearing drift into gearshaft and push inner race and rollers into position.

(3) Place gearshaft rear base on bench and install rear end of shaft on pilot of base.

(4) Start front bearing on shaft, then install pilot of front bearing drift into shaft ID until OD of drift rests on bearing inner race. Push bearing into position.

NOTE: Use PWA 13639 drift for gearshaft PN 500348.

(5) Coat gearshaft bearing rollers with petrolatum and install gearshaft into gearbox.

F. Starter - Generator Gearshaft Bearings Assembly
See Tool Group 92.

(1) Place ball bearing base on a bench and install gearshaft into hole in base. Place ball bearing on shaft.

(2) Position ball bearing drift into gearshaft and drift ball bearing into position.

R
R

(3) Place roller bearing base on a bench and install gearshaft on pilot of base. Place inner race and rollers on shaft.

(4) Install pilot of drift into ID of gearshaft and push inner race and rollers into position.

G. Starter-Generator Drive Assembly
See Tool Group 86.

(1) Lubricate preformed packing and install it in groove of previously assembled gearshaft.

(2) Insert starter-generator driveshaft into gearshaft, mating external splines of driveshaft with internal splines of gearshaft.

(3) Place gearshaft base on bench and install gearshaft on pilot of base.

(4) Position main oil pump gearshaft into starter-generator gearshaft. Install drift into main oil pump gearshaft. Install drift into main oil pump gearshaft and drift gearshaft into position, pushing on bottom of 0.432 - 0.442 inch diameter hole.

(5) Install washer and nut through starter-generator driveshaft onto threaded end of main oil pump gearshaft; then torque nut.

(6) Lubricate bearing rollers with petrolatum and install starter-generator drive assembly into gearbox.

H. Component Drivegear Assembly
See Tool Group 21.

(1) Drift ball bearing onto component drive bevel gear using bearing drift.

(2) Position component drive bevel spur gearshaft on pilot of gearshaft holder and secure with clamp.

(3) Place bevel gear and ball bearing on bevel spur gearshaft. Install pilot of bevel gear and bearing drift in ID of gearshaft with drift resting on bevel gear and ball bearing. Drift gear and bearing into position.

72-0001

(4) Place ball bearing retaining nut on bevel spur gearshaft. Install retaining nut wrench in ID of gearshaft with teeth in nut. Torque nut to minimum of 500 lb-in.

(5) Insert rivet in inside diameter of gearshaft through retaining nut. Install bearing nut rivet support into end of gearshaft, under head of rivet, until rivet is held in position. Flare end of rivet.

(6) Position bevel spur gearshaft and bevel gear on pilot of component drivegear holder and secure with stop and clamp.

(7) Place fuel control drive spur gear on mating splines of bevel spur gearshaft. Using roller bearing drift, drift gear into position.

(8) Place bearing inner race and rollers on bevel spur gearshaft and push into position with drift.

CAUTION: ENSURE THAT RIVET IS PROPERLY FLARED.

(9) Place roller bearing inner race retaining nut on gearshaft. Install retaining nut wrench in ID of bevel spur gearshaft with teeth in nut and torque to minimum of 250 lb-in. Install rivet.

I. Component Drive Gearbox Gearshaft
See Tool Group 19 and Figure 715.

CAUTION: USE AN ARBOR PRESS TO INSTALL BEARINGS (IMPACT CAN SERIOUSLY DAMAGE BEARINGS).

(1) Using arbor press and suitable drift, install ball bearing into support and secure with retaining ring.

(2) With gearshaft mounted on ball bearing base, position roller bearing inner race on gearshaft. Engage pilot of roller bearing drift into ID of gearshaft; then, with drift resting on inner race seat bearing race on gearshaft using arbor press.

(3) Measure Dimensions A and B on separate assemblies as shown in Figure 715.

R
R

(4) Position gearshaft on base with roller bearing inner race down. Then place ball bearing and support assembly on gearshaft so that bearing bore and bearing journal on shaft are partially engaged.

(5) Position ball bearing drift pilot in gearshaft ID; expand jaws to contact ball bearing inner race; drift ball bearing and support assembly onto gearshaft.

(6) To ensure that gearshaft and ball bearings are properly seated measure Dimension C as shown. If Dimension C exceeds sum of Dimensions A and B by more than 0.003 inch, repeat step (5) until assembly is in limits.

(7) Install preformed packing in support.

(8) Install assembled support in gearbox housing and secure with nuts.

CAUTION: USE CAUTION WHEN MATING ROLLER BEARING OUTER RACE AND ROLLERS TO PREVIOUSLY INSTALLED OUTER RACE.

J. Main Component Drive Gearbox Gearshaft And Housing Assembly - Assembly And Installation (Dual Housing Configuration) See Tool Group 71A and Figure 716.

(1) Ball Bearing Installation

(a) Position upper housing (bearing diameter up) on bench.

(b) Using suitable drift, seat bearing in housing and secure with retaining ring.

(2) Gearshaft Installation

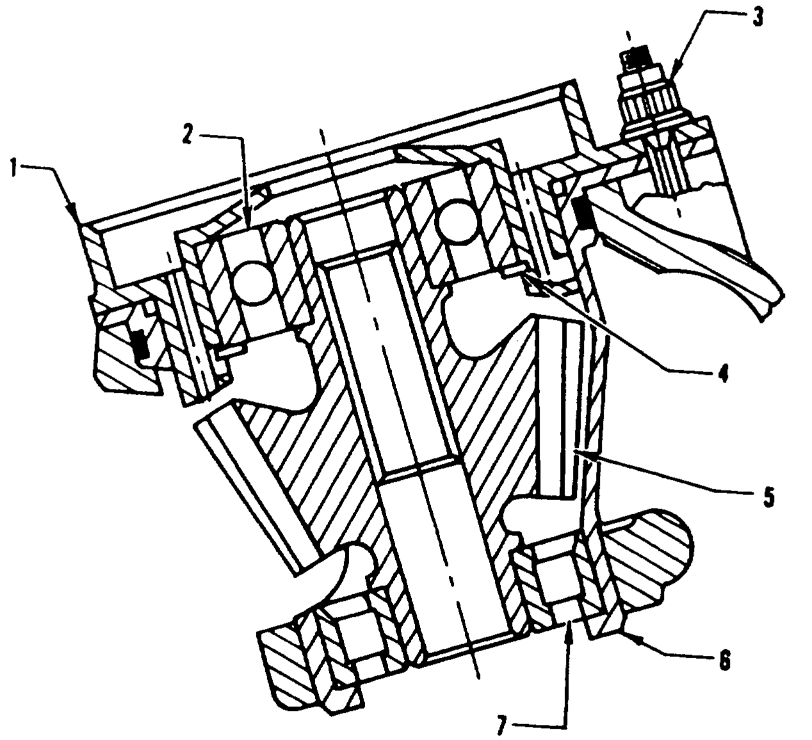
(a) Place ball bearing base on bench and position gearshaft on pilot of base with smaller end of bevel gear down.

(b) Position upper housing (with ball bearing installed) on end of gearshaft.

(c) Insert drift through opening in upper housing and expand jaws to enable drift contact with inner race of ball bearing. Seat upper housing and bearing on gear shaft. Retract drift jaws and remove drift.

(3) Roller Bearing Inner Race Installation on Gearshaft.

R
R



L-24269 (0000)

R
R

Component Drive Gearshaft
And Housing Assembly
Figure 716

1. Upper Housing
2. Ball Bearing
3. Retaining Nut
4. Retaining Ring
5. Gearshaft
6. Lower Housing
7. Roller Bearing

Key to Figure 716

(a) Position assembly (comprised of gearshaft, upper housing, and ball bearing) on ball bearing base.

(b) Place inner race and rollers on end of gearshaft. Then, with drift pilot engaged in gearshaft ID, seat race and rollers ensuring contact is made with shoulder on shaft.

(4) Roller Bearing Outer Race Installation in Lower Housing.

(a) Position lower housing on bench with OD flange up.

(b) With race positioned on roller bearing outer race drift, seat race in lower housing.

(5) Lower Housing Installation

(a) Position lower housing (with roller bearing outer race installed) on arbor press base with housing OD flange up.

(b) Place upper housing assembly (consisting of housing, ball bearing, gearshaft, and roller bearing less outer race) on lower housing.

(c) With upper housing drift positioned on face of upper housing, seat upper housing inside lower housing using arbor press.

(6) Assembly Installation in Gearbox

(a) Install preformed packing in groove of lower housing.

(b) Position lower detail plate of puller and driver on end of lower housing. Then, install puller and driver by inserting shaft of tool through gearshaft and threading into detail plate.

R
R

72-0061

(c) With housing flange holes aligned with gearbox studs, seat assembly in gearbox using knocker action of tool.

(d) Remove detail plate to puller and driver; then secure assembly with retaining nuts.

K. Hydraulic Pump Drive Support Assembly
See Tool Group 53.

(1) Position hydraulic pump drive bearing support (bearing liner up) on seal assembly base.

(2) Place hydraulic pump driveshaft seal on seal assembly drift.

<u>NOTE</u>: Use PWA 13617 drift for PN 511196 and 511197.

(3) Insert pilot of drift into hole in base and press seal into support.

(4) Start roller bearing outer race in its liner in support and push into position using drift.

(5) Place seal assembly guide in splined end of hydraulic pump drive gearshaft.

(6) Install new preformed packing in groove of support and position support over guide. Tap support into gearbox, aligning screw holes in support with screw holes in housing.

(7) Secure assembled hydraulic pump support to gearbox housing with screws.

(8) Install hydraulic pump drive assembly cover and secure with washers and nuts.

L. Fuel Control Drive Oil Seal
See Tool Group 60.

(1) Position fuel control drive boss (bearing liner up) on shaft seal base and place seal on shaft seal drift. Press seal into boss.

<u>NOTE</u>: Use PWA 13618 drift for PN 511199 and 511200.

(2) Install new preformed packing in groove of boss.

(3) Place shaft seal guide in driveshaft and position pad over guide. Tap boss into gearbox.

M. Starter-Generator Drive Oil Seal.
See Tool Group 88.

(1) Position starter-generator support (bearing liner up) on seal assembly base.

(2) Place starter-generator drive oil seal on seal assembly drift. Position pilot of drift in hole in base. Press seal into support.

NOTE: Use PWA 13617 drift for PN 511196 and 511197. Use PWA 13718 drift with carbon seals.

(3) Place preformed packing in groove of support.

(4) Place seal assembly guide on starter-generator driveshaft and position support over guide. Tap support into position, aligning screw holes in support with screw holes in housing.

(5) Secure support to housing with screws.

(6) Install starter-generator cover and secure with nuts and washers.

N. Gearbox Housing Assembly

(1) Install all plugs in gearbox housing. Lockwire plugs.

NOTE: For engines incorporating oil drain plug bushing with lockwire holes, install bushing and lockwire. See Table of Limits.

(2) Install component drive gearbox housing cover and install airframe bracket to bottom studs. Secure cover and bracket to housing with nuts and washers.

(3) For engines not incorporating SB 4178, install fuel signal tube clip bracket at fuel control mounting pad.

(4) Secure breather pressurizing valve elbow to its pad, making sure to place gasket, spacer, and gasket in sequence between elbow and pad.

(5) Position data plate seal and data plate on gearbox housing and secure with bolts and tabwashers.

R
R

72-0001

O. Main Oil Strainer Assembly
See Tool Group 80.

(1) Place base of oil screen support holder in vise or on bench.

(2) Position flange of strainer in locating recess of holder.

(3) Stack spacers and screens on baffle with outlet spacer at each end and with each screen between outlet and inlet spacer.

(4) Place oil screen support over assembled screens and spacers with pin in support aligned with slot in bushing.

(5) Install top plate of holder, engaging cutouts in plate with lugs on strainer support, and with upright bolts through holes in plate. Secure plate with wing nuts

(6) Place spring and bypass valve inside strainer support.

(7) Install spacer retaining nut in baffle bushing and tighten nut with retaining nut wrench so that spacers and screens cannot be rotated by hand. Nut must be torqued until it contacts end of strainer support.

NOTE: Complete sets of parts consisting of two screens and one each of outlet and inlet spacers must be added or removed to meet tightening requirement.

(8) Remove strainer assembly from holding fixture.

P. Main Oil Strainer Installation
See Table of Limits and Figure 717.

(1) Install strainer in oil strainer bore of gearbox (refer to the figure).

(2) Place new seal on OD of strainer cover, and install spring and cover over oil strainer.

(3) Secure cover to gearbox with washers and locknuts. Torque nuts to recommended torque (refer to Table of Limits).

(4) Install plug and new seal in cover. Tighten plug to be recommended torque as indicated in Table of Limits.

R
R

Q. Main Oil Strainer Installation
(For Engines Incorporating Threaded Bypass Valve)
See Tool Group 80A and Table of Limits.

(1) Place new preformed packing on OD of strainer cover.

(2) With spring sandwiched between strainer assembly and cover, insert end of installation clamp through cover drain hole and thread into bypass valve. Install washer detail and handtighten wing nut until spring is fully compressed.

(3) Insert strainer (with cover and spring attached) into oil strainer housing of gearbox.

(4) Secure cover to gearbox with washers and nuts. Torque and lockwire nuts as required in Table of Limits, then remove clamp.

(5) Install drain plug and new preformed packing in strainer cover. Tighten plug to recommended torque as indicated in Table of Limits.

R. Main Oil Pressure Relief Valve
See Tool Group 77 and Figure 718.

(1) Install setscrew through ID of pressure relief valve housing and thread nut on set screw.

(2) Install cylinder and spring; then place packing in recess on seat and install seat.

(3) Install seat retainer full depth into valve housing.

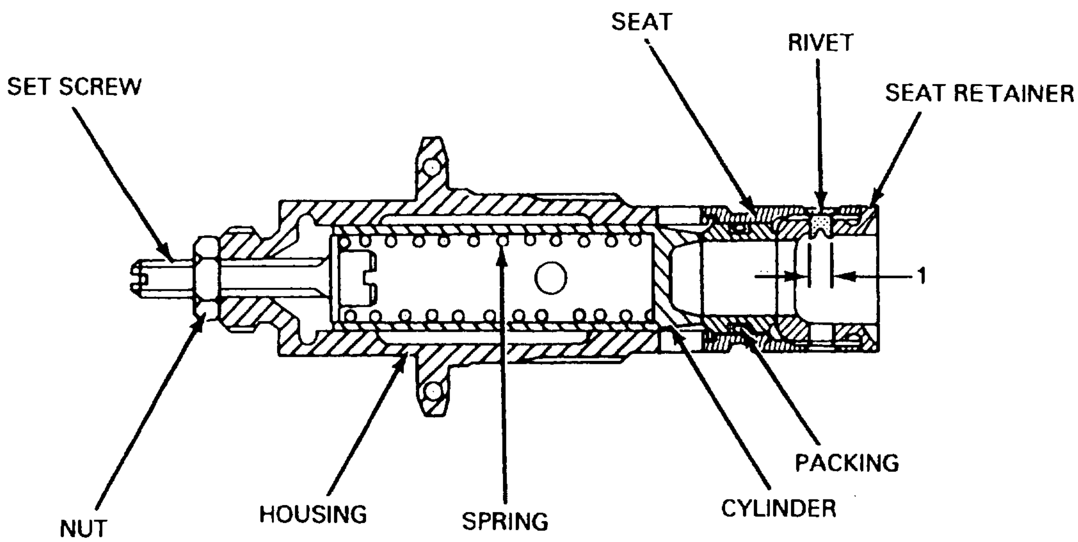
NOTE: Back off seat retainer to align rivet hole, if necessary.

(4) Install retaining rivet locating rivet head toward OD. Flare rivet at ID using riveter. For PN 488661 and 511847 valve assemblies, use PN 488355 rivet. For PN 745113 and 745114 valve assemblies, use PN 745112 rivet. PN 745112 rivet may be flared to meet dimensions shown in Figure 718. No cracks are allowed in rivet after it is flared.

NOTE: Riveter is not used with split rivets.

R
R

72-0001



1. 0.135 - 0.160 Inch Diameter

R
R

Oil Pressure Relief Valve
Figure 718

(5) Install a gasket and relief cap on valve.

NOTE: Do not tighten cap until after relief valve pressure has been established at engine test.

(6) Install metering plug in gearbox housing.

(7) Install gasket and seal on relief valve housing and thread housing into gearbox. Tighten valve until all sealing surfaces are in contact, then turn through angle of 180 degrees.

S. Tachometer Drive Assembly
(JT12A-6, -6A [L], And -8 [L] Engines)
See Tool Group 94.

(1) Position gearshaft bearing base on a bench.

(2) Position one of gearshaft bearings in recess in the base. Insert gearshaft (through bearing) into guide bushing in base.

(3) Position drive gearshaft drift in gearshaft. Using arbor press, press gearshaft through bearing until gearshaft shoulder contacts bearing inner race.

(4) Remove gearshaft from base and position gearshaft bearing spacer on gearshaft.

(5) Position second gearshaft bearing in recess of base and insert gearshaft into bearing. Using drift, press gearshaft into bearing until spacer contacts inner race.

(6) Using Truarc Series 22 pliers, or equivalent, install bearing retaining ring in gearshaft groove.

(7) Position tachometer gearshaft bearing housing (mounting pad up) on bench, and position tachometer drive oil seal (angular face up) in housing. Insert oil seal drift into seal until shoulder of drift contacts seal. Push seal into place in housing.

NOTE: Use PWA 13178 drift for PN 365463.

(8) Install oil seal guide in hole end of tachometer drive gearshaft.

(9) Invert gearshaft bearing housing (mounting pad down) and insert tachometer drive gearshaft (gear up) into housing until lower bearing bottoms on housing shoulder.

(10) Using Truarc Series 21, 45 degree bent tip pliers, or equivalent, install retaining ring in groove in ID of housing.

(11) Install preformed packing in groove in OD of bearing housing. Aligning holes in mounting pad with studs in tachometer drive housing, install bearing housing in tachometer drive housing. Install gasket and cover on mounting pad.

T. Tachometer Drive Assembly
(JT12A-6A [N], -8 [N], And JFTD12A Engines)
See Tool Group 94A.

(1) Position gearshaft base on bench and install gearshaft over pilot, with gearshaft resting on pilot shoulder.

(2) Place one ball bearing over shaft and, using drift, press bearing until inner race seats on shoulder of gearshaft.

(3) Remove gearshaft from base and install plate around gearshaft. Position it back into base.

(4) Place tachometer drive bearing support over gearshaft, with inside groove resting on outer race of installed bearing.

(5) Install sleeve spacer over gearshaft.

(6) Place second bearing over gearshaft. Using drift, press bearing until outer race seats on shoulder of tachometer drive bearing support.

(7) Insert retaining ring in groove located above bearing on gearshaft.

(8) Place base on bench and insert seal housing, open end up, in cavity on top of base.

(9) Install seal on drift, and insert pilot of drift into base. Press seal into housing.

NOTE: Use PWA 13048 drift for PN 365463.

(10) Install preformed packing in groove located on outside diameter of housing. Insert housing into tachometer drive bearing support. Insert retaining ring in groove located above seal housing on inside of bearing support.

(11) Place preformed packing in groove located on outside diameter of bearing support, and install bearing support in gearbox.

(12) Install gasket and cover on mounting pad and secure with washers and nuts. Tighten to recommended torque and lockwire.

U. Main Oil Pump Assembly
(JT12A-6, -6A [L], And -8 [L] Engines)
See Tool Group 78 and Table of Limits.

(1) Position main oil pump inner cover (bevel gearshaft boss up) on a bench, and position seal in groove in bevel gearshaft boss, as shown in Table Limits. Insert cover oil seal drift through seal into cover and push seal into place.

(2) Position main oil pump inner housing (seal grooves up) on a bench and position oil seal in groove around bevel gearshaft hole, as shown in Table of Limits. Insert body oil seal drift through seal into housing and push seal into place.

(3) Install preformed packing in groove around straight shaft hole. Position main oil pump plate (hole chamfers up) on housing, aligning holes in plate with holes in housing.

(4) Position body oil seal guide in main oil pump pressure spur gear. Push gear (short journal down) through plate and seal into main oil pump inner housing.

(5) Install a preformed packing in groove at gear end of main oil pump bevel gearshaft. Position gearshaft in main oil pump inner cover.

(6) Position inner housing so that both gearshafts point upward. Install main oil pressure pump idler spur gear over straight shaft.

72-0001

(7) Install main oil pump inner housing over gearshafts, engaging main oil pump pressure spur gear splines with gearshaft splines and meshing pressure spur gear with idler spur gear.

(8) Install No. 1 bearing suction drive spur gear (journal down) on bevel gearshaft. Position No. 1 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(9) Position No. 3 bearing scavenge pump outer housing (flat face down) over gearshafts and against inner housing.

(10) Install No. 3 bearing suction drive spur gear (journal down) on bevel gearshaft. Position No. 3 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(11) Position main oil pump outer housing (flat face down) over gearshaft.

(12) Install a preformed packing in groove in end of main oil pump bevel gearshaft.

(13) Install gearbox scavenge pump spur gearshaft (threaded end up) over bevel gearshaft. Position gearbox scavenge pump idler spur gear over straight shaft, meshing with spur gearshaft.

(14) Install main oil pump gearshaft support (flat face down) over shafts and against pump outer housing.

(15) Position tachometer drive bevel gear (flat face down) over splines of gearbox scavenge pump spur gearshaft.

CAUTION: DO NOT EXCEED RECOMMENDED MAXIMUM TORQUE.

(16) Install bevel gear retaining nut on gearbox scavenge pump spur gearshaft. Tighten to recommended minimum torque. If necessary, tighten further until two holes in nut are aligned with hole in gearshaft.

(17) Install and flare retaining nut rivet.

(18) Position tachometer drive housing assembly on gearshaft support, meshing tachometer drive gearshaft with tachometer drive bevel gear.

(19) Install bolts and nuts securing pump sections together. Tighten nuts to recommended torque and lockwire.

(20) Position gasket and cover on tachometer drive housing mounting pad and secure with locknuts.

(21) Turn bevel gearshaft by hand and check for freedom of rotation.

V. Main Oil Pump Assembly
(JT12A-6A [N] And -8 [N] Engines)
See Tool Group 78.

(1) Position main oil pump inner cover (bevel gearshaft boss up) on bench and position seal in groove in bevel gearshaft boss, as shown in Table of Limits. Insert body oil seal drift through seal into housing and push seal into place.

(2) Position main oil pump inner housing (seal grooves up) on bench and position oil seal in groove around bevel gearshaft hole, as shown in Table of Limits. Insert body oil seal drift through seal into housing and push seal into place.

(3) Install a preformed packing in groove around straight shaft hole. Position main oil pump plate (hole chamfers up) over straight shaft onto front cover, aligning holes in plate with holes in cover.

(4) Position body oil seal guide in main oil pump pressure spur gear. Push gear (short journal down), through plate and seal, into main oil pump inner housing.

(5) Install a preformed packing in groove at the gear end of main oil pump bevel gearshaft. Position gearshaft in main oil pump inner cover.

(6) Position inner cover so that both gearshafts point upward. Install main oil pressure pump idler spur gear over straight shaft.

(7) Install main oil pump inner housing over gearshafts, engaging main oil pump pressure spur gear splines with gearshaft splines and meshing pressure spur gear with idler spur gear.

R
R

72-0001

(8) Install No. 1 bearing suction drive spur gear (journal down) on bevel gearshaft. Position No. 1 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(9) Position No. 3 bearing scavenge pump outer housing (flat face down) over gearshafts and against inner housing.

(10) Install No. 3 bearing suction drive spur gear (journal down) on bevel gearshaft. Position No. 3 bearing idler spur gear on straight shaft, meshing with the drive spur gear.

(11) Install main pump outer housing (flat face down) over gearshafts.

(12) Install a preformed packing in groove in end of main oil pump bevel gearshaft.

(13) Install gearbox suction drive spur gear (splined end down) on the bevel gearshaft.

(14) Insert main oil pump spur gear plug into spur gear and secure with retaining ring.

(15) Position gearbox suction idler gear on straight shaft, meshing with drivegear.

(16) Install main oil pump outer cover on pump.

(17) Insert four bolts (heads toward outer cover) in holes through pump. Secure with washers and locknuts. Tighten nuts to recommended torque.

(18) Turning bevel gearshaft by hand, check pump for freedom of rotation.

W. Main Oil Pump Assembly
(JFTD12A Engines)
See Tool Group 78 and Table of Limits.

(1) Position main oil pump inner cover, bevel gearshaft boss up, on bench. Position seal in groove in bevel gearshaft base, as shown in Table of Limits. Insert oil seal drift through seal into cover and push seal into place.

(2) Position main oil pump No. 5 housing (seal grooves up) on bench and position oil seal in groove around bevel gearshaft hole, as shown in Table of Limits. Insert oil seal drift through seal into housing and push seal into place.

(3) Install a preformed packing in groove around straight shaft hole. Position main oil pump plate (hole chamfers down) on No. 5 housing, aligning holes in plate with holes in cover.

(4) Position oil seal guide in main oil pump pressure spur gear. Push gear (journal up), through plate and seal, into main oil pump No. 5 housing.

(5) Install a preformed packing in groove at gear end of main oil pump bevel gearshaft. Position gearshaft in main oil pump inner cover.

(6) Position inner cover so that both gearshafts point upward. Install main oil pressure pump idler spur gear over straight shaft.

(7) Install main oil pump No. 5 housing over gearshafts, engaging main oil pump pressure spur gear splines with gearshaft splines and meshing pressure spur gear with idler spur gear.

(8) Install No. 1 bearing scavenge drive spur gear (journal down) on bevel gearshaft. Position No. 1 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(9) Position No. 4 housing (flat face down) over gearshafts and against No. 5 housing.

(10) Install No. 3 bearing scavenge drive spur gear (journal down) on bevel gearshaft. Position No. 3 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(11) Install main oil pump No. 3 housing (flat face down) over gearshafts.

NOTE: Housing incorporates dowel pin.

(12) Install No. 2 bearing and gearbox scavenge drive spur gear (splined end down) on bevel gearshaft.

R
R

(13) Position No. 2 bearing and gearbox scavenge idler gear on straight shaft, meshing with drivegear.

(14) Install main oil pump No. 2 housing on pump, aligning hole in housing with dowel pin in No. 3 housing.

(15) Position No. 4 bearing scavenge drive spur gear (splined end down) on bevel gearshaft.

(16) Position No. 4 bearing scavenge idler gear on straight shaft, meshing with drivegear.

(17) Install main oil pump No. 1 housing (flat face down) over gearshafts.

(18) Position No. 5 bearing scavenge drive spur gear (splined end down) on bevel gearshaft.

(19) Position No. 5 bearing scavenge idler gear over straight shaft, meshing with drivegear.

(20) Install main oil pump outer cover on pump.

(21) Insert four bolts (heads toward outer cover) in holes through pump. Secure with washers and locknuts. Tighten nuts to recommended torque.

(22) Turning bevel gearshaft by hand, check pump for freedom of rotation.

X. Main Oil Pump Installation (JT12A-6, -6 [L], and -8 [L] Engines)

(1) Place new preformed packings in grooves of oil pump.

(2) Install pump in gearbox, meshing drive bevel gearshaft with main drivegear.

(3) Secure pump to gearbox with nuts. Tighten nuts to recommended torque.

(4) Position new gasket on tachometer drive housing pad.

(5) Secure tachometer drive housing cover to housing with nuts.

Y. Main Oil Pump Installation (JT12A-6A [N] and-8 [N] Engines)

R
R

(1) Install new preformed packings on pump.

(2) Install pump in gearbox, engaging dowel in pump mounting pad in hole in oil pump outer housing.

(3) Secure pump to gearbox with washers and locknuts. Tighten locknuts to recommended torque.

Z. Main Oil Pump Installation
(JFTD12A Engines)
See Tool Group 78.

(1) Place new preformed packings in grooves of oil pump.

(2) Install pump in gearbox, meshing drive bevel gearshaft with main drivegear.

(3) Secure pump to gearbox with nuts. Tighten nuts to recommended torque.

AA. Fuel Pump Installation

(1) Place two seals on fluid pressure differential switch and install switch (connector facing rearward) on pump.

(2) Secure switch to pump with washers and bolts. Tighten bolts to recommended torque and lockwire.

(3) Apply coating of grease, Plastilube Moly No. 3 to pump drive spline. Excessive amounts of lubricant are not necessary. Apply even coat on spline surfaces with small, clean paste brush.

NOTE: Plastilube Moly No. 3 is available from:

Thiem Corp.,
Sub. of Koppers Co., Inc.
5151 Denison Avenue
P.O. Box 93019
Cleveland, OH 44101-5019 USA

CAUTION: DO NOT APPLY LUBRICANT TO WET FUEL PUMP DRIVE SPLINES IDENTIFIED BY SPLINE LOCATION RECESSED WITHIN GEARSHAFT. THESE SPLINES ARE LUBRICATED INTERNALLY BY CIRCULATION OF ENGINE OIL, WHICH MAY BE RETARDED BY APPLICATION OF GREASE. THESE PUMPS MAY BE IDENTIFIED AS CECO

R
R

72-0001

P/L 9489, (PWA-PN 524383) AND CECO P/L 9486, (PWA-PN 524382)

(4) Put a new packing in the ring groove in the periphery of the fuel pump driveshaft and install the pump (with a new gasket) on the mounting pad of the gearbox. Attach the pump with washers and locknuts. Tighten the locknuts to the recommended torque.

CAUTION: WHEN INSTALLING FUEL PUMP, CARE MUST BE TAKEN NOT TO CAUSE DAMAGE TO DRIVE SPLINE BY ALLOWING PUMP TO HANG BY SHAFT. PUMP MUST BE SUPPORTED UNTIL IT IS SECURED TO GEARBOX WITH LOCKNUTS.

AB. Fuel Control Installation

CAUTION: WHEN INSTALLING FUEL CONTROL, CARE MUST BE TAKEN SO AS NOT TO CAUSE DAMAGE TO DRIVE SPLINE BY ALLOWING CONTROL TO HANG BY SHAFT. FUEL CONTROL MUST BE SUPPORTED UNTIL IT IS SECURED TO PUMP WITH LOCKNUTS.

(1) Install fuel control on mounting pad of pump, and secure with washers and locknuts.

NOTE: Do not apply lubricant to fuel control driveshaft splines.

(2) Connect compressor bleed actuating rod to fuel control.

CAUTION: DO NOT WRENCH HOLLEY FUEL CONTROL BLEED STRAP SIGNAL VALVE SCREW, PN 5A31001, AT ANY TIME TO ACTUATE BLEED STRAP MECHANISM AS SHEARING OF SERRATION WILL OCCUR IN THE BLEED ACTUATOR HOUSING WHEN LEVER AND SHAFTS ARE DISENGAGED.

(3) Install power lever linkage on fuel control, securing lever arm to control with self-locking nut. If the linkage appears excessively stiff, actuate at least 50 times to facilitate bearing run-in.

NOTE: For engines with Holley fuel controls, lever arm shall be secured with hex nut. Torque to 35 - 45 lb-in., and lockwire.

R
R

6. Free Turbine Section Assembly Installation

A. Free Turbine Inlet Duct And 1st Stage Vanes
See Tool Group 56J.

NOTE: Complete set of classified vanes must be used. Space vanes of the same class evenly around the vane circle.

(1) Install compressor and turbine locating jack on engine build and transport stand. Secure with ball to lock pin. Retract jack to its lowest position.

(2) Position free turbine disk-to-jack adapter on jack with cup-shaped part of adapter contacting jack pad, and stepped plug facing upward.

(3) Attach free turbine assembly front case-to-jackplate on front face of free turbine inlet case, positioning trunnion spools on horizontal centerline.

(4) Install free turbine inlet case on jack. Secure plate to jack with ball lock pins.

(5) Install free turbine inlet duct assembly into free turbine inlet case, aligning wide lug on inlet duct with wide slot in case.

(6) Measure dimension from front flange of inlet case to front of inner airseal attached to front flange of inlet duct assembly. Measurement shall fall within limits shown in the Table of Limits.

(7) Install 1st stage vanes by inserting tabs on inner end of each vane into slots in vane inner shroud and engaging groove in outer end over shoulders to inner and outer inlet case flanges.

(8) Install three 1st stage vanes outer seal sections so that seal lip secures each vane and holes line up with pinholes in case flange.

NOTE: Assembly sequence number is etched on outer platform of vanes. Install No. 1 vane at 12 o'clock position. Install remaining vanes in clockwise direction.

(9) Install three sections of 1st stage vane lock sections so that lock lip secures each vane and holes line up with pinholes in case flange.

R
R

(10) Secure vane lock sections with pins.

B. Free Turbine Vane Preloading And Measurement
See Tool Group 56R and Figure 719.

(1) With inlet duct assembly, 1st stage vanes, and vane locking ring installed in free turbine inlet case, fasten case to surface plate (front flange down).

(2) First Stage Preload and Measurement

(a) With leaves folded inward toward shaft of 1st stage vane preloading support, lower support into inlet duct assembly. Fold down leaves, and secure with quarter-turn locks.

(b) Position preloading fixture on free turbine inlet case rear flange, and fasten force gage to fixture. Then fasten support positioned in inlet duct assembly to force gage.

(c) Center support so that leaves will have uniform bearing on front shoulder, (Index 1) in the figure, of 1st stage vane inner shroud when load is applied.

(d) Apply 200 - 300 lbs. rearward axial load to 1st stage vanes.

(e) Insert depth micrometer rod through hole provided in fixture, and measure depth from gage surface on fixture to rear face of 1st stage vane inner seal.

(f) From depth micrometer reading, subtract dimension between gage surface on fixture and rear flange of free turbine inlet case.

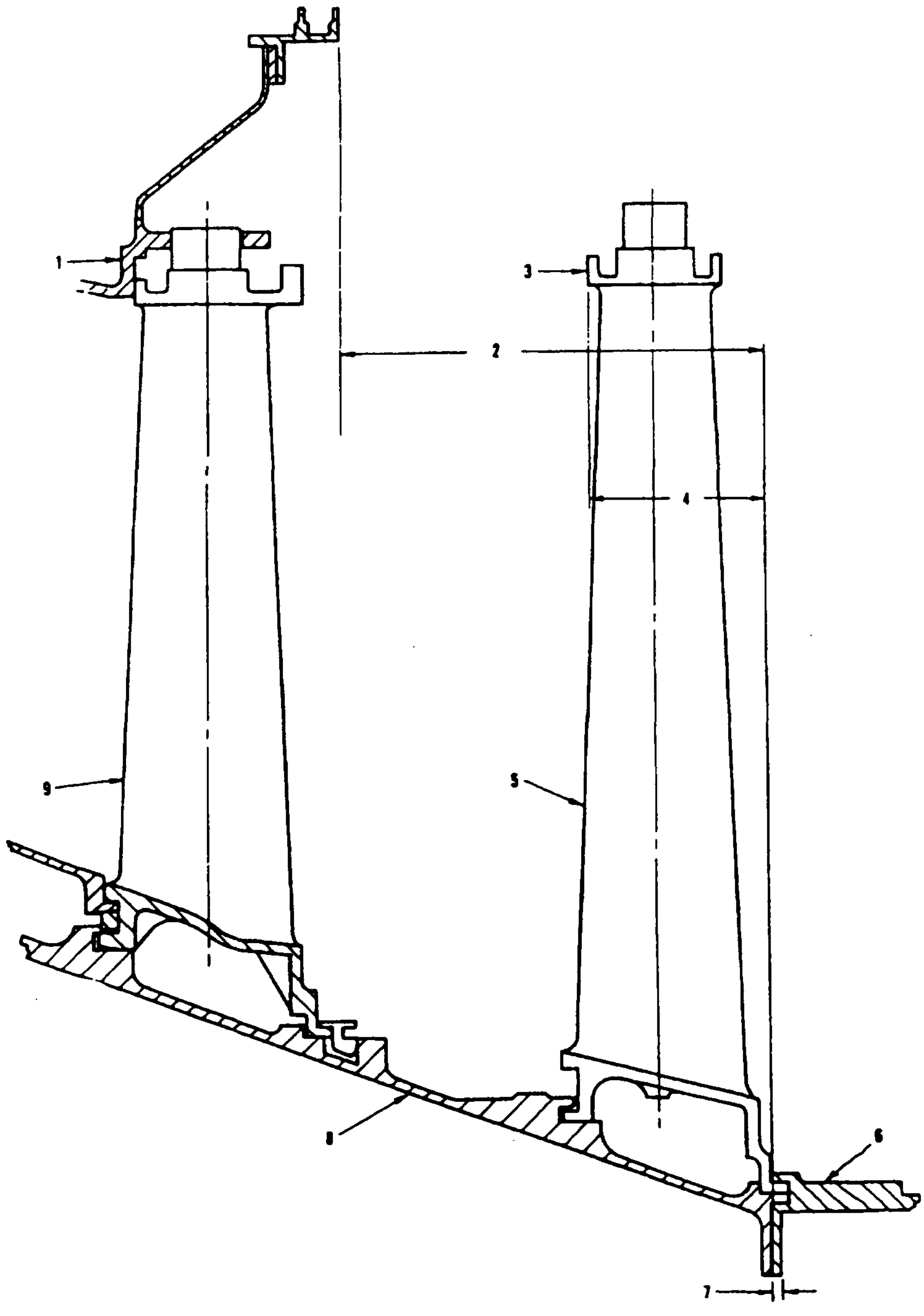
NOTE: This dimension may be obtained by resting fixture on surface plate and measuring from fixture gage surface to surface plate with depth micrometer.

(g) For acceptability of final dimension, refer to (Index 2) of the figure.

(3) Second Stage Preload and Measurement

(a) Position 2nd stage vane preloading support on 1st stage vanes, and install 2nd stage vanes.

R
R



R
R

Free Turbine Vane
Loading and Measurement
Figure 719

72-0001

1. Apply 250 Lbs. Rearward (Axial Load On This Surface For 1st Stage Vane Loading.
2. 3.488 - 3.595 Inches 1st Stage Measurement.
3. Apply 190 - 210 Lbs. Rearward (Axial Load On This Surface For 2nd Stage Vane Loading.
4. 1.423 - 1.451 Inch 2nd Stage Measurement.
5. Second Stage Vane
6. Second Stage Blade Outer Airsealing Ring
7. Airsealing Ring Flange Thickness (Used In Computation Of Dimension 4)
8. Free Turbine Inlet Case Assembly
9. First Stage Vane

Key to Figure 719

(b) Measure thickness of airseal ring flange (7) Figure 719, and record for calculation of final measurement.

(c) Lock 2nd stage vanes in place by fastening airseal ring to rear flange of inlet case.

(d) Position preloading fixture on rear face of airseal ring flange.

(e) Fasten force gage to fixture and preloading support positioned between 1st and 2nd stage vanes.

(f) Apply 190 - 210 lbs. rearward, axial load.

(g) Insert depth micrometer rod through hole provided in fixture. Rod end shall pass between vane tangs of two adjacent vanes and abut surface of support.

(h) Measure distance from fixture measuring surface to support surface, and subtract dimension referenced in note following step (2)(f). Then subtract airseal ring flange thickness step (3)(b) to obtain critical dimension. Refer to Index 4 in Figure 719. After taking measurement, remove 2nd stage free turbine rotor outer airseal, 2nd stage vanes, and tooling.

C. Free Turbine 1st Stage Blade Outer Airseal Installation

(1) Install three segments of airseal with forward end of airseal engaged in 1st stage vane locking ring groove.

R
R

D. Assembly Of Free Turbine Disk and Blades
See Tool Group 56C-1.

(1) Position 1st stage turbine rotor disk on bench.

(2) Apply extreme pressure grease to fir-tree serrations and blade shrouds to prevent galling or pickup.

NOTE: Individual blades must be weighed to nearest one-hundredth of an ounce, and weights marked on blades with red crayon. Lay out blades in order of diminishing weight, and install heaviest blade on disk. Install next heaviest blade diametrically opposite first installed blade. Install lightest blade adjacent to and clockwise from first installed blade. Install next lightest blade diametrically opposite lightest blade. Continue to install remaining blades in this manner progressively around disk.

(3) Install each blade, using following procedure:

(a) Install support into ID of Fixture, and install pilot.

(b) Place disk over pilot, and adjust jacks on support until they contact disk.

(c) Install detail part into fixture, and secure belt around disk, leaving 1/8 to 1/4 inch of fir-tree slot extending above belt.

(d) Install blades in fir-tree slots (180 degrees apart) proceeding in counterclockwise direction around disk. Blade roots shall contact belt.

(e) Remove bolt, and install the Pusher over center post. Adjust the roller into position if over flat portion of turbine blade.

(f) Rotate pusher counterclockwise, applying slight downward pressure until all blades are flush with disk.

NOTE: Pusher must be rotated counterclockwise only.

(g) Insert minimum of eight workbolts into rivet holes around disk to secure blades to disk while performing static balance operation.

R
R

(4) Install 2nd stage free turbine blades, using above procedures.

E. Static Balance Of Stage 1 And 2 Free Turbine Disk And Blades Assembly
See Tool Group 56G-2.

(1) Install static balance disk and blade adapter on spindle of balance machine. See Paragraph 3.B(1).

(2) Balance installed adapter.

(3) Install and balance disk and blades assembly as outlined in Paragraph 3.C(1) thru (6).

(4) Static unbalance of disk and blades assembly must be less than 0.600 oz-in. If necessary, reposition blades (diametrically), and recheck for unbalance.

(5) After residual unbalance limit is attained, final static balance disk and blade assemblies, and correct for unbalance as follows:

<u>NOTE</u>: Final unbalance point shall not exceed 9.100 oz-in. This may be obtained by adding a maximum of three correction weights, taped to disk flanges. When proper balance is obtained, secure weights, using punch and riveter.

(a) Correct for final unbalance of 1st stage disk and blade assembly by adding one counterweight (riveted type) and remainder of counterweights (plug type), all located within plus or minus 60 degrees of unbalance vector.

<u>NOTE</u>: Riveted-type counterweight is installed on rear side of counterweight flange, and is secured in position with rivets, preformed head toward 1st stage disk. Plug-type counterweight is installed on rear side of counterweight flange, and is secured in position by forming flare on tubular end of weight.

(b) After final unbalance limit (0.100 oz-in.) is obtained, rivet counterweight into position, using rivets and counterweight riveter. Form flare on tubular end of plug-type counterweight and on end of rivet, to minimum diameter of 0.125 inch.

R
R

(c) Correct for final unbalance of 2nd stage disk and blades assembly by adding one counterweight (flanged, riveted type) and remainder of counterweights (plug type), or three units of counterweight (plug type).

NOTE: Flanged, riveted-type counterweight is installed on forward side of counterweight flange, and is secured in position with rivet, preformed head facing rear face of 2nd stage disk.

(d) Rivet 2nd stage disk and blade assembly counterweights into position as outlined in step (b).

F. Free Turbine Blade Retaining Rivet Installation
See Tool Group 51A.

(1) Remove previously installed workbolts, and install rivets in 1st stage disk as follows:

(a) Lubricate rivets with extreme-pressure grease (refer to the Standard Practices Manual.)

(b) Install half of rivets in alternate rivet holes, heads facing rearward. Using riveter and punch, flare end of rivets to 0.170 inch diameter minimum.

(c) Install and flare remaining rivets.

(2) Install 2nd stage free turbine blade rivets, using above procedures. Use Punch with Riveter to form the flare (0.170 inch minimum diameter) at the rivet end.

G. Free Turbine Rotor Build
See Figure 720 and Tool Group 102A.

(1) Install alignment pins into the holes of the turbine disk and shaft Holding Fixture.

(2) Put the lower plate of the free turbine rotor clamp in position on the holding fixture dowel pins.

(3) Chill the 1st stage turbine disk and heat the turbine shaft to 260°C (500°F).

R
R

(4) Install the disk on the fixture, front side down.

NOTE: The alignment pins will extend through the disk.

(5) Install the turbine shaft on disk. Tap the shaft into position against the disk.

(6) Install the upper plate of the free turbine rotor clamp on the rear of the free turbine shaft. Then install the clamp tierod through the center of the shaft and turn it into the thread of the clamp lower plate. Tighten the tierod until the 1st stage turbine disk and free turbine shaft are tightly held together before the assembly is removed from the fixture.

(7) Lift the shaft and disk assembly off the fixture and remove the alignment pins. Put the shaft and disk assembly back on the fixture and align it with the holes in the fixture.

(8) Install the tiebolts in the 2nd stage disk and attach the tiebolts with retaining rings. Apply antiseize compound (PWA 586) to the tiebolt threads. Heat the 2nd stage turbine disk assembly to 260°C (500°F).

(9) Measure the dimension from the front surface of the 2nd stage vane inner airseal support to the rear face of the inner airseal as shown in Figure 720. If this dimension is in limits, install the 2nd stage vane inner shroud and seal assembly on the shaft until it is against the rear face of the 1st stage disk.

(10) With the shaft and disk assembly installed in the fixture (shaft upward), install the 2nd stage disk and blade assembly as follows:

(a) Install the heated disk and tiebolts on the rear of the free turbine shaft and 1st stage disk. Engage the tiebolts in the holes in the fixture.

NOTE: The minimum temperature differential between the disk and shaft must be 44°C (80°F).

(b) Tap on the web area of the 2nd stage disk with a nylon mallet to install it tightly against the rear of the turbine shaft.

(11) Install free turbine disk and blades assembly lifting collar around 2nd stage blades, and proceed as follows:

(a) Attach lifting sling to spools on collar, and lift rotor from fixture.

NOTE: Underside of 1st stage disk must be supported when performing lifting operation to prevent separating 2nd stage disk from shaft.

(b) Install nuts handtight on tiebolts, and remove free turbine rotor clamp.

(c) Using sling, lower rotor assembly into build stand assembly.

(d) Remove tiebolt nuts, and install heated seal over tiebolts.

NOTE: Seal shall have been heated to 260°C (500°F).

(e) Install tablocks and nuts on tiebolts, and torque in accordance with Table of Limits.

H. Free Turbine Rotor Balance Bearing Installation For Concentricity and Dynamic Balance Check

(1) Install No. 4 balance bearing with the Bearing Drift, then install balance spacer on shaft. Install tabwasher on shaft, engaging washer spline in shaft splines.

(2) Install No. 4 bearing oil scoop handtight.

(3) Position inner race retaining nut hand wrench over shaft, and secure splined end of shaft with holder. tighten nut, using retaining nut wrench and mallet.

(4) Assemble free turbine coupling, as follows:

(a) Mount coupling holder on bench.

(b) Install coupling (splined OD down) into holder.

(c) Position No. 5 bearing seal plate (puller groove up) on coupling.

(d) Heat No. 5 balance bearing in hot oil.

(e) Using drift, seat balance bearing and seal plate on coupling.

(f) With the Retaining Nut Wrench and a standard torque wrench, install the inner race nut on the coupling, then tighten the nut.

(5) Install free turbine coupling on turbine shaft and install coupling nut handtight into turbine shaft.

(6) Position Holder on coupling spline, and install wrench into coupling, engaging slots in nut. Secure holder and tighten nut with wrench.

I. Free Turbine Rotor Concentricity Check.
See Tool Group 103A and Figure 721.

(1) Install and secure front and rear balance bearing housings in pedestals of concentricity check fixture.

(2) Install rotor lifting eye to free turbine rotor coupling; then hoist rotor assembly onto bench, front end down.

(3) Remove top half of each of two details of balancing support.

(4) Assemble remainder of support to turbine assembly, placing vane shroud into retaining groove and bearing into its housing.

(5) Install top halves of support detail, and secure; then attach lifting sling to trunnion spools, and trunnion assembly onto concentricity check fixture.

NOTE: Faces of inner races of bearings used for concentricity and runout check must be square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 inch FIR.

(6) Using height gage and dial indicator, check front face of No. 4 bearing seal plate and rear face of No. 5 bearing seal plate for squareness runout. Squareness runout must not exceed 0.001 inch FIR. Plates may be rotated to meet this requirement.

(7) After runout requirements have been met, mark the radial positions of the seal plates and coupling in relation to the shaft, as shown in the figure.

(8) With a height gage and indicator do a squareness runout check of the free turbine disks. Measure runout from the front face of the 1st stage disk below the rivet to the rear face of the 2nd stage disk below the rivet. The squareness runout must not be more than 0.005 inch FIR.

(9) Use a hoist to lift the rotor assembly off the concentricity fixture.

J. Free Turbine Rotor Dynamic Balance Check
See Tool Group 105A and Figure 721.

(1) Install and secure the front and rear balance bearing housings in the cradles of the balance machine.

(2) Attach the lifting sling to the trunnion spools of the balancing support, and hoist the rotor assembly onto the balance machine.

(3) Secure the front balance bearing to its housing on the balance machine, using the retaining strap. Place the strap around the bearing, and bolt it to the housing.

(4) Remove sling, and slip drive belt over turbine shaft.

NOTE: Faces of inner races of bearings used for balancing must be square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 inch FIR.

(5) Start rotor spinning, gradually increasing speed to 1400 rpm.

(6) Semidynamic unbalance of complete assembly must not exceed 0.200 oz-in. when rotating at 1400 rpm.

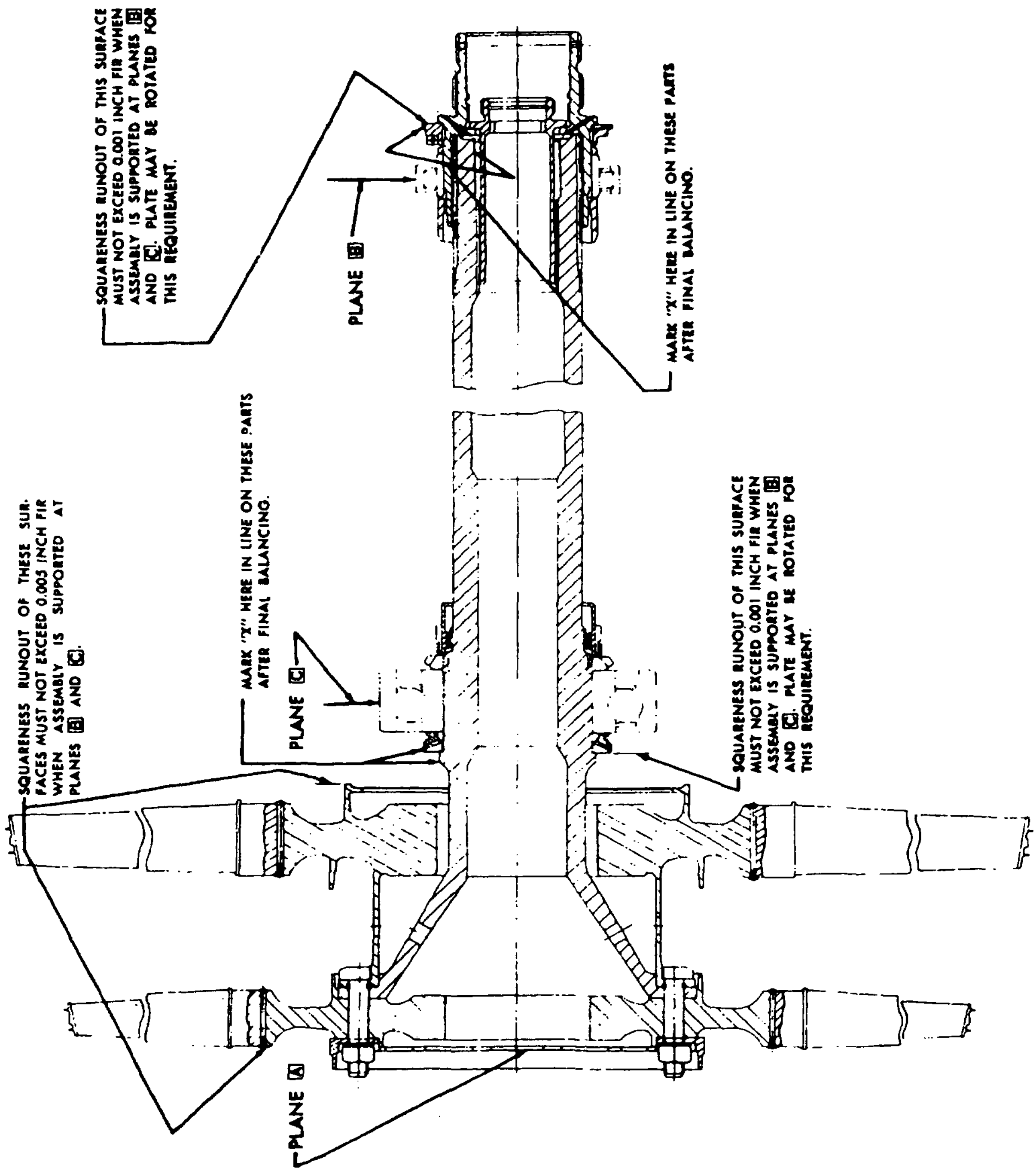
(7) Unbalance can be corrected by adding classified balanced plugs and tabwashers at Plane A. See Figure 721, as required.

(8) After final balance, remove strap from front balance bearing housing, and reinstall lifting sling.

(9) Using hoist, lift free turbine rotor assembly from balance machine.

R
R

72-0001



L-29165 (0000)

Free Turbine Rotor Balance and
Concentricity Check
Figure 721

K. Free Turbine Rotor Balance Bearing Removal After Dynamic Balance
See Tool Group 104A.

(1) With turbine assembly-to-build stand fixture on build and transport stand, open fixture mounts.

(2) Attach rotor lifting eye to free turbine rotor coupling; then hoist rotor assembly onto build and transport stand.

(3) Attach outer part of turbine shaft coupling nut wrench to hydraulic wrench. Install assembly on coupling.

(4) Lower inner part of coupling nut wrench through hydraulic wrench into coupling nut.

(5) Using hydraulic pressure, loosen and remove coupling nut.

(6) Remove free turbine coupling (with the No. 5 bearing seal plate, inner race, and inner race nut attached) from turbine shaft, using wrench and coupling holder.

(7) Position coupling (splined OD down) in seal plate and coupling holder.

(8) Using No. 5 bearing inner race retaining nut wrench, loosen and remove retaining nut. Remove coupling from holder.

(9) Position No. 5 bearing plate around coupling, engaging plate into puller groove in seal plate.

(10) Position coupling (inner race up) on No. 5 bearing seal plate and coupling base.

(11) Position No. 5 bearing seal plate and coupling drift on coupling. Press coupling out of seal plate and inner race.

(12) Position No. 4 bearing inner race retaining nut hand wrench over shaft, and secure splined end of shaft holder.

(13) Using wrench and mallet, loosen inner race retaining nut.

R
R

(14) Remove wrench; then remove oil scoop, tabwasher, and balance spacer.

(15) Mount No. 4 bearing inner race puller on end of turbine shaft, engaging puller jaws in puller groove of seal plate behind bearing. Using jackscrew action, pull seal plate and work bearing.

L. Second Stage Free Turbine Vanes Attachment To Inner Shroud

(1) Install free turbine 2nd stage turbine vanes in vane inner shroud, inserting vane tangs into slots and with front of vane inner end butting against flange on shroud.

(2) Secure vanes in shroud by passing length of lockwire around circle formed by vane outer ends. Secure ends of lockwire together.

M. Free Turbine Rotor Installation
See Tool Group 56K.

(1) Secure turbine shaft lifting eye to rear end of free turbine shaft. Attach hoist to lifting eye.

(2) Lift rotor, and position over free turbine inlet case.

(3) Slowly lower rotor into case, engaging outer ends of 2nd stage vanes into groove in case flange.

(4) Raise compressor and turbine locating jack until disk-to-jack adapter contacts and supports rotor.

(5) Remove hoist and lifting eye.

(6) Remove lockwire used to retain vanes. Remove cloth used to support vanes.

N. No. 4 Bearing Seal Assembly

(1) Position seal housing (large OD up) on bench.

(2) Position spring on each pin.

(3) Install seal ring (angular face toward carbon seal) on OD of seal holder.

(4) Position seal holder and seal on pins (compressing seal ring so that it enters ID of seal support).

R
R

(5) Push down to slightly compress springs, and insert cotter pins in holes in pins at 12, five, and seven o'clock positions. Bend cotter pins to secure.

O. No. 4 Bearing Seal Installation.

(1) Position free turbine case (rear flange down) on bench.

(2) Install new seal in groove of seal support.

(3) Position No. 4 bearing seal assembly on free turbine case inner flange, aligning nuts with boltholes in flange.

(4) Secure seal assembly to flange with bolts.

(5) Tighten bolts to recommended torque.

P. Free Turbine Case Installation
See Tool Group 56D.

(1) Bolt free turbine case lift and turn brackets to rear flange of free turbine case.

(2) Suspend engine lift and turn sling from hoist, and secure sling hooks to brackets.

(3) Install free turbine second stage vane outer seal on rear flange of free turbine inlet case. Secure with screws and nuts.

(4) Lift case, and position over free turbine rotor.

(5) Slowly lower free turbine case onto free turbine inlet case, carefully guiding case over turbine shaft, and aligning holes in case flanges.

(6) Secure case with bolts and nuts. Tighten nuts to recommended torque.

Q. No. 4 Bearing Installation
See Tool Group 11A.

(1) Adjust compressor and turbine locating jack to bring seal plate retaining shoulder on free turbine shaft in line with bearing support front flange.

<u>NOTE</u>: Rotor is jacked up at this time to prevent damaging carbon seal when installing bearing.

R
R

72-0001

(2) Position seal plate (puller groove up) on turbine shaft aligning X-mark on seal plate with X-mark on shaft.

(3) Using No. 4 bearing inner race and seal plate installation drift, seat plate against shoulder on shaft.

(4) Position No. 4 bearing inner race (ball path facing up) on shaft and, using drift, seat race against seal plate.

(5) Position balls and cage in cage and balls holder and install in bearing support. Remove holder.

(6) Install rear inner race (puller groove up).

(7) Retract jack until outer race seats in support.

(8) Install accessory drivegear on shaft.

(9) Install tabwasher on shaft engaging washer splines in shaft splines.

(10) Install No. 4 bearing oil scoop handtight.

(11) Attach outer part of No. 4 bearing inner race retaining nut wrench to hydraulic wrench. Position on oil scoop.

(12) Install inner part of wrench so that it engages inner splines of hydraulic wrench and spline on end of turbine shaft.

(13) Using hydraulic pressure, tighten oil scoop to recommended initial torque. Loosen to zero lb-in. Retighten to recommended initial torque and angle of turn. Remove wrenches.

(14) Bend tabs of tabwasher to secure oil scoop.

(15) Install No. 4 bearing outer race retaining nut handtight.

(16) Bolt outer part of No. 4 bearing outer race retaining nut wrench to hydraulic wrench.

(17) Install inner part of wrench into outer race retaining nut.

(18) Lower hydraulic wrench engaging pins of retaining nut wrench outer part into two holes in bearing support, and engaging splines of hydraulic wrench with splines of inner part of retaining nut wrench.

(19) Using hydraulic pressure, tighten nut to recommended initial torque. Loosen to zero lb-in. Retighten to recommended initial torque and minimum angle of turn. Further tighten, if necessary, to align rivet hole in nut with rivet hole in support. Remove wrenches.

CAUTION: DO NOT EXCEED RECOMMENDED MAXIMUM ANGLE OF TURN.

(20) Install rivet in aligned holes.

(21) Using No. 4 bearing outer race retaining nut riveter, flare rivet.

R. Free Turbine Rotor Positioning Measurement
See Figure 722.

(1) Using parallel bar and depth micrometer measure distance from front face of free turbine inlet case front flange to front face of 1st stage disk.

(2) For acceptable dimension. See Figure 722.

NOTE: Since free turbine rotor final running position is established with installation of No. 4 bearing, this positioning check may be performed at any practical time after No. 4 bearing installation.

S. Accessory Drive Coupling And Gear Buildup
See Tool Group 56C.

(1) Position accessory drive coupling base on bench.

(2) Place accessory drive coupling (flange down) on Base.

(3) Install upper bearing on coupling. Using accessory drive bearing-to-coupling drift, seat bearing against coupling flange.

(4) Install bearing spacer on coupling.

(5) Insert pin into coupling.

1. 10.413 - 10.491 Inches
2. Free Turbine Inlet Case Front Flange

Key to Figure 722

(6) Install lower bearing on coupling. Using accessory drive bearing-to-coupling drift, seat bearing against spacer.

(7) Remove coupling from base.

(8) Install coupling in support and secure with retaining ring installed with cap center toward bearing.

(9) Secure tachometer drivegear and support holder on bench.

(10) Position coupling support (larger diameter down) on holder. Secure with bolts.

(11) Secure coupling with locking device of holder.

(12) Install accessory drivegear on coupling.

(13) Install drivegear retaining nut handtight.

(14) Using tachometer drivegear retaining nut wrench, and standard torque wrench, tighten nut to recommended minimum torque.

CAUTION: DO NOT EXCEED RECOMMENDED MAXIMUM TORQUE.

(15) Further tighten nut to align rivet hole with hole in coupling.

(16) Install the rivet and (with the tachometer drive gear retaining nut Riveter) flare the rivet.

T. Accessory Drive Installation

(1) Install the oil tubes in the support and secure with lockwire.

(2) Position a new seal on the front flange of the accessory drive coupling support.

(3) Position the support on the free turbine case inner flange meshing the gears and secure with the bolts. Tighten the bolts to the recommended torque.

R
R

(4) Insert the accessory driveshaft through the case into the coupling.

(5) Install new seals on the accessory driveshaft heat shield.

(6) Install the heat shield into the case and support.

U. Free Turbine Gearbox Assembly And Installation
See Table of Limits.

NOTE: Before assembling gearbox, perform bearing nozzle oil jet flow check.

(1) Install upper bearing on free turbine gearshaft, using base and drift.

(2) Install gearshaft into drive housing.

(3) Using drift, install lower bearing on gearshaft. Secure bearing in position with retaining ring.

(4) Install new preformed packing in groove of gearbox housing located at base of gearbox.

(5) Install new seals in bearing housings as follows:

(a) Position housing on pilot of base, large flange of housing up.

(b) Place seal on drift, and position pilot of drift into hole in base.

(c) Press seal into housing. Seal shall be positioned as shown in the Table of Limits.

(6) Install preformed packing on OD of rear bearing housing. Install bearing housing over gearbox studs into gearbox housing.

(7) Using base, and drift, install bearings on gearshaft.

R
R

(8) Position end of pilot, in hub end of gearshaft. Install gearshaft assembly into housing so that end of gearshaft passes through installed seal, and bearing is positioned against shoulder of seal housing. Remove pilot from gearshaft.

NOTE: Ensure that gears are meshed properly. Check backlash of gearbox gearshafts. See Table of Limits.

NOTE: For engines incorporating overspeed switch install as indicated in Paragraph V. Then continue with steps (10) thru (13).

(9) Install gasket and cover on gearbox studs. Install airframe heat shield assembly on studs so that scooped portion of heat shield faces upward when gearbox is installed on free turbine. Install locknuts and washers. Tighten locknuts to recommended torque.

(10) Install new preformed packing on bearing front housing, and install bearing housing into gearbox housing.

(11) Install new preformed packing on gearbox oil nozzle. Install oil nozzle and plug in gearbox housing and secure with bolts.

(12) Install gearbox on free turbine case boss, engaging splines of shaft in ID of coupling. Secure with locknuts. Tighten to recommended torque.

(13) Perform No. 4 bearing compartment and transfer tubes pressure check.

V. Free Turbine Overspeed Switch Installation

(1) Position cover and gasket on overspeed switch studs, and secure with nuts and washers on outboard studs of switch assembly.

(2) Install heat shield on inboard studs, and attach with locknuts.

(3) Torque all four locknuts to recommended torque.

(4) Position assembled overspeed switch on free turbine gearbox studs with heat shield at inboard position. Secure with four locknuts, and tighten to recommended torque.

R
R

(5) Install electrical branched cable connection on overspeed switch. Tighten the connector fingertight, then turn to a maximum of 45 degrees.

W. Free Turbine Shaft Inner Case

(1) Position a new seal on the free turbine case inner flange.

(2) Install new preformed packings on each end of the oil tube ferrules.

(3) Install the ferrules in the oil tubes in the free turbine case.

(4) Carefully lower the turbine shaft in a case over the free turbine shaft onto the free turbine case flange engaging the oil tub ferrules into the oil pressure and scavenge tubes.

(5) Secure the flanges with the nuts and bolts. Tighten the nuts to the recommended torque.

X. No. 5 Bearing Installation
See Tool Group 11C.

(1) Install the No. 5 bearing outer race and rollers in the bearing support.

(2) Using the No. 5 bearing outer race Drift and a mallet, seat the bearing in the support.

(3) Install the outer race retaining nut in the support.

(4) Attach the outer part of the No. 5 bearing outer race retaining nut wrench to the hydraulic wrench. Secure to the rear flange of the bearing support with the nuts and bolts.

(5) Lower the inner part of the retaining nut wrench through the hydraulic wrench, and engage the slots in the nut.

(6) Using hydraulic pressure, tighten the retaining nut to the recommended initial torque. Loosen to zero lb-in. Tighten to the recommended initial torque and minimum angle of turn. If necessary, tighten the nut further to align a rivet hole in the nut with the hole in the support.

R
R

72-0001

CAUTION: DO NOT EXCEED THE RECOMMENDED MAXIMUM ANGLE OF TURN.

(7) Install a rivet in the rivet holes (head inward), and using No. 5 bearing outer race retaining nut rivet Riveter, flare the rivet.

Y. Turbine Shaft Outer Case

(1) Install the bolts (heads forward) in the holes in the OD of the No. 5 bearing support with the flats of the heads against the shoulder. Secure the bolts with the retaining rings.

(2) Position a new seal on the free turbine inner case rear flange.

(3) Install the support on the inner case rear flange, and secure with the bolts. Tighten the bolts to the recommended torque.

(4) Position the turbine flange outer case over the inner case engaging the rear flange holes over the bolts.

(5) Secure the front flange of the case to the free turbine case flange with the bolts, key washers (with SB 6217) and nuts. Tighten the nuts to the recommended torque.

Z. Free Turbine Coupling Buildup
See Tool Group 56F.

(1) Mount the No. 5 bearing seal plate, bearing, and coupling Holder on a bench.

(2) Install the coupling (splined OD down) into the holder.

(3) Position the No. 5 bearing seal plate (puller groove up) on the coupling, aligning the X-mark on the plate with the X-mark on the coupling.

(4) Heat No. 5 bearing inner race in hot oil, and position race on coupling.

NOTE: Install bearing inner race as marked (REAR toward rear of engine).

(5) Using No. 5 bearing inner race and oil scoop seal plate drift and mallet, seat race and seal plate on coupling.

R
R

(6) Install inner race retaining nut on coupling.

(7) Position adapter in ID of coupling, permitting spline of adapter to engage coupling spline.

(8) Bolt No. 5 bearing inner race retaining nut wrench to hydraulic wrench.

(9) Position wrenches over adapter and coupling. Install as follows:

(a) Engage wrench teeth in slots of inner race retaining nut.

(b) Engage splines of adapter in splines of hydraulic wrench.

(10) Using hydraulic pressure, tighten inner race retaining nut to recommended initial torque. Loosen to zero lb-in. Retighten to recommended initial torque and angle of turn. See the Table of Limits. Remove wrenches.

(11) Install retaining nut lock washer and retaining ring.

AA. Free Turbine Coupling Installation
See Tool Group 56P.

(1) Install free turbine coupling on turbine shaft, aligning X-mark on coupling with X-mark on ID of shaft.

(2) Install coupling nut hand tight into turbine shaft.

(3) Attach outer part of turbine shaft coupling nut wrench to hydraulic wrench. Install on coupling.

(4) Lower inner part of coupling nut wrench to hydraulic wrench and into coupling nut.

(5) Using hydraulic pressure, tighten coupling nut to recommended initial torque. Turn further to align lock splines on OD of nut with lock splines on ID of coupling.

CAUTION: DO NOT EXCEED RECOMMENDED MAXIMUM ANGLE OF TURN.

(6) Install new seal on coupling nut plug and install plug in coupling nut. Secure with retaining ring.

R
R

72-0001

(7) Install coupling nut lock, engaging splines of coupling and coupling nut.

(8) Secure with retaining ring.

AB. No. 5 Bearing Seal Assembly

(1) Position No. 5 bearing seal support (pins upward) on bench.

(2) Install seal ring in groove in support (angled face down).

(3) Install springs on seal pins.

(4) Position seal assembly on support.

(5) Exerting slight downward force on seal to compress springs, install cotter pins in holes of three projecting pins. Bend outboard leg of each cotter pin around pin to retain seal assembly.

NOTE: Do not bend the inside leg of cotter pins.

AC. No. 5 Bearing Seal Installation

(1) Install new packing on seal support flange.

(2) Position No. 5 bearing seal assembly (carbon seal down) over coupling aligning boltholes with holes in seal support flange.

(3) Secure seal assembly with bolts.

(4) Tighten bolts to recommended torque and lockwire.

AD. Free Turbine Exhaust Duct

NOTE: If stabilizing ring is incorporated, install ring between free turbine case rear flange and exhaust duct front flange.

(1) Position exhaust duct over free turbine shaft outer case onto free turbine case rear flange.

NOTE: Case installation shall be accomplished without undue force. Should installation difficulties arise, inspect for case deformation. If engine is to be installed in shipping container, duct shall be installed with opening in vertical position.

(2) Secure case front flange to free turbine case with nuts and bolts.

(3) Tighten the nuts to the recommended torque.

AE. Free Turbine Exhaust Duct Fuel Drain And Cover Installation

(1) Position gasket and fuel drain on boss and secure with bolts. Tighten to recommended torque. Ensure that fuel drain elbow faces forward.

(2) Secure cover and gasket to diametrically opposed boss using bolts. Tighten to recommended torque.

AF. Installing Free Turbine Section in Free Turbine Stand See Tool Group 56N.

(1) Install free turbine assembly Lifting Eye to turbine shaft coupling.

(2) Attach hoist to lifting eye.

(3) Attach second hoist to front case-to-jack plate.

(4) Disconnect front case-to-jack plate from compressor and turbine locating jack.

(5) Remove top support from free turbine stand.

(6) Using two hoists, lift free turbine assembly and turn to horizontal position. Lower into free turbine stand.

(7) Adjust rear mounting pad of free turbine stand as necessary and attach to rear engine mounting pad. Lock pad in position.

(8) Carefully pass top support over top of free turbine. Adjust support mount as necessary and attach to ground handling mount at 12 o'clock position. Secure mount to flats on stand. Remove slings, lifting eye, and plate.

3. Compressor Assembly

A. Front Hub And 2nd Stage Disks And Blades

(1) Position compressor front hub shaft end up on bench, and install 1st stage compressor blades.

NOTE: Individual blades must be weighed to nearest one-hundredth of an ounce and weights marked on blades using red crayon. Lay out blades in order of diminishing weight and install heaviest blade in hub. Install next heaviest blade diametrically opposite first installed blade. Install lightest blade adjacent to and clockwise from first installed blade. Install next lightest blade diametrically opposite lightest blade. Proceed in order of maximum to minimum weight progressively around hub. Ensure that rotor assembly part number is marked on hub front face. If necessary, mark by vibration peening. Refer to Compressor Rotor Assembly Marking.

(2) Install washer on pin and drift one end to obtain 0.195 - 0.205 inch flare. Install pin, formed head toward hub, to hold blade in position.

NOTE: For engines incorporating PN 447320 rivet and and PN 447321 washer, flare rivet to 0.265 -
R 0.275 inch.

CAUTION: INSTALL A NEW PIN AT EVERY OVERHAUL. FIRST AND SECOND STAGE BLADE RETAINING PINS MUST NOT BE REUSED.

(3) Temporarily secure washer and pin with masking tape.

(4) Install 2nd stage blades on the disk as just described.

NOTE: Second stage blade retaining pins must be flared 0.115 - 0.125 inch.

B. Static Balance Adapter - General Instructions

(1) Setup

NOTE: Balancing machine spindle balance should be checked and, if necessary, corrected before adapter is installed.

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

(a) Secure detail plate assembly to spindle and balance.

(b) Install locating plugs in proper locations for part, with zero marking in line with scribed radial line, toward rim for OD part mating diameter and toward center for ID part mating diameter. Install hold down details and balance resulting assembly indexing for accuracy.

(c) Measure dimension across opposite locating plug buttons, outside for ID part mating diameter and inside for OD, and record results (it is suggested that dimensions be permanently recorded for each setup to avoid repetition.)

(d) Using average part mating diameters either by mensuration or from inspection records, adjust locating plugs for 0.0005T by setting each plug as indicated below.

(S = Setting, D = Average Mating Diameter, P = Measurement across plugs)

For Snap ID: S = D-P + .0005 /2
For Snap OD: S = P-D + .0005 /2

(e) Check measurement across opposite plugs for correct fit and make minor corrections, if required. All locating plugs must be in approximately same relative position.

(2) Installation of Part

(a) Clean before installation.

(b) Position adapter with one hold down plug toward operator and mark plug and other hold down details.

(c) Position part with two tierod holes in line with hold down plugs, avoiding offset holes.

(d) Engage diameter first on locating plugs opposite operator and then on those toward operator.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(e) Secure part and mark tierod hole toward operator for indexing reference.

NOTE: Always return hold down details to same position relative to adapter.

C. Compressor Hub And 2nd Stage Disk And Blades Assembly - Static Balance Check
See Tool Group 30.

(1) Install base of balancing adapter on balance machine spindle.

(2) With a zero reference point marked on base toward operator, install plugs on appropriate circle for disk to be balanced as follows:

(a) Detail (2) plugs at 4:30 and 7:30 o'clock positions.

(b) Detail (8) at 9:30 and 1:30 o'clock position.

(c) Detail (3) hold down plugs at three and nine o'clock position.

(3) Position disk and blade assembly on plugs, aligning a tierod hole with threaded hole in detail hold-down plugs. Then, install two detail cap screws through tierod hole into hold-down plug.

NOTE: When balancing front hub and blades assembly, secure hub to base, using detail adapter and associated details if hub incorporates a solid member through ID. For hubs without interference through ID, install detail post in center of base and secure hub with detail place.

(4) With hold-down cap screws loose and zero reference point on base facing operator, pull disk firmly against two detail plugs and alternately secure with cap screws. Maintain pressure on disk against plugs.

NOTE: On disks incorporating OD mating diameters, displacement will be away from operator against detail plugs.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(5) Start machine and null out reflected unbalance. (This may be accomplished by machine compensation or by adding weight to balance adapter). Calibrate machine or set potentiometer, if applicable.

NOTE: On balance machines incorporating dual compensators and features for reducing second compensation to one-half, calibration may be performed after step (8).

(6) Stop machine, and with the zero reference point toward operator, rotate disk and blades assembly 180 degrees with respect to adapter.

(7) Repeat step (4).

(8) Start machine and determine angle and amount of unbalance. Reduce this value to one-half, using a second compensator (or wax on the adapter), maintaining the same angle.

NOTE: If machine has not been calibrated, unbalance reading must be nulled out by compensator, then calibrated and compensation reduced by one half.

(9) Correct unbalance to following requirements:

(a) Unbalance must not exceed 0.1 oz-in. (0.05 oz-in. if pattern stacking is used) when work piece is rotated at minimum speed of 900 rpm.

(b) If necessary, reposition blades (diametrically) and recheck for unbalance.

(c) After balancing, mark point of most unbalance on rear side of each hub or disk assembly with layout dye.

(10) Install washers on pins, and flare 1st and 2nd stage compressor blade retaining pins, using proper anvils and riveter.

R
R

CAUTION: CHECK PIN FOR CRACKING AFTER FLARING.

(11) Flare 1st stage pin 0.195 - 0.205 inch and 2nd stage pins 0.115 - 0.125 inch.

NOTE: For engines incorporating PN 447320 rivet and PN 447321 washer, flare rivet to 0.265 - 0.275 inch.

NOTE: On 2nd stage disk and blade assemblies, use 2nd stage blade retaining pin holding fixture to hold disk and flare pins to 0.115 - 0.125 inch.

D. Compressor Disk Airseals Installation - Stages 3 and 5 thru 9 See Tool Group 44 and Figure 702.

NOTE: Serviceable airseals may be reused.

(1) To install airseal, heat compressor disk to 288°C (550°F) for two hours and cool seals to -73°C (-100°F) for one hour.

(2) Place disk on bench, front face up, and assemble seal to front of flange of disk.

NOTE: The 5th stage has a rear seal only. For identification and assembly purposes, compressor disk rear faces are marked REAR.

(3) Turn disk over, and repeat operation for rear seal.

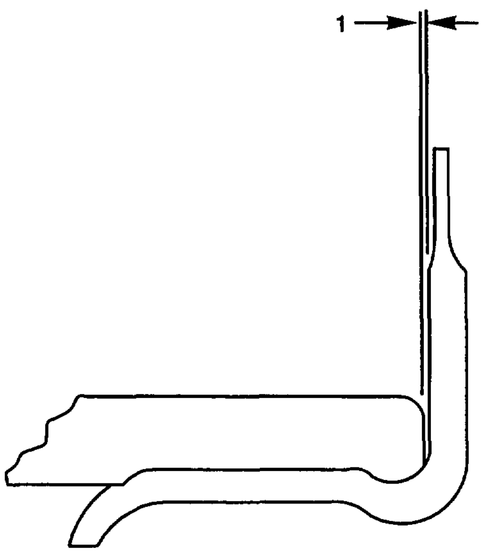
NOTE: Third stage disk employs front airseal only.

(4) Place retaining weight on rear seal and allow assembly to stabilize at room temperature.

(5) Remove weight and, using feeler stock, check clearance between disk flange and seal, as indicated in Figure 702. If clearance exceeds 0.015 inch, seal has not bottomed properly.

E. Compressor Blades Installation (Stages 3 Thru 9) See Tool Group 44, Figure 703, and Table 701.

R NOTE: Post-SB 6387 3rd stage blades and locks are
R interchangeable pre- and post- the SB only as
R specified in Table 701. Pre-SB 6387 blades must use
R pre-SB 6387 locks, and post-SB 6387 blades must use
R post-SB 6387 locks (it is permitted to mix pre-SB



L-11897 (0000)
PW V

1. 0.015 maximum

NOTE: Please see the
TEMPORARY
REVISION
that revises this page.

R
R

Compressor Seal Clearance Limit
Figure 702

blades/locks and post-SB blades/locks in a compressor disk and blade assembly, but rotor assembly with full sets of post-SB parts is recommended).

(1) Position disk, front face up, on bench.

(2) Position blade lock in blade, prebent tab at leading edge so that tab will extend radially inward when blade is installed.

NOTE: To insert blades from rear face, position disk face down on bench. Install tab to blade, prebent tab at trailing edge so that it will extend radially inward when blade is installed, then insert blade, trailing edge up.

POST-SB 6387 BLADE PN	DESCRIPTION	PRE-SB 6387 BLADE PN
536203-001	3rd Stage Blade	536203
	Use With	
819858	Blade Lock	536210
822103	3rd Stage Blade	536203
	Use With	
819858	Blade Lock	536210
822103	3rd Stage Blade	405703
	Use With	
819858	Blade Lock	504128
		Or
		503791

Third Stage Compressor Blade/Lock Interchangeability
Table 701

(3) Insert blade into disk, leading edge up.

CAUTION: TABLOCKS SHALL BE CENTERED AT BASE OF BLADE SLOT WITH TABS BENT RADIALLY INWARD AND PARALLEL WITH SURFACE OF DISK. FOR EXAMPLES OF ACCEPTABLE AND UNACCEPTABLE INSTALLATION, SEE FIGURE 703.

(4) Place disk and blade assembly, straight tab up, on blade lock fixture. Adjust anvil of fixture so it backs tab to be bent, and, using peening punch, bend rear tab of each blade lock radially inward (refer to Table of

Limits). A blend must be accomplished by working out from bend with series of blows. Care must be taken to ensure blade and disk surfaces are flush when tablocks are bent.

F. Compressor Blades Machine Tablock Bending And Rivet Forming (Stages 2 thru 9) Optional Method
See Tool Group No. 44A.

NOTE: First stage cannot be done on machine due to disk interference.

(1) Set up Machine. (Consult special instructions available from machine manufacturer, or furnished with machine, as required).

(2) Attach appropriate adapter to locating bung on vertical column of machine and secure with cap screws from machine. Hold disk to adapter with four thumb screws through tierod holes. Using specified PWA anvils and purchase and following special instructions, form rivets or bend tablocks.

G. Stages 3 Thru 9 Disks And Blades - Static Balance Stages 3 Thru 9 Disks And Blades With The Procedure Described For Compressor Rotor Front Hub, Omitting Steps (10) And (11).

H. Compressor Rotor Rear Hub Assembly
See Tool Group 39 and Figure 704.

(1) Place compressor rotor rear hub on bench, shaft end down.

(2) Assemble compressor drive turbine shaft locking bolt in hub in following sequence. See Figure 704.

(a) Shaft coupling

(b) Shaft lock

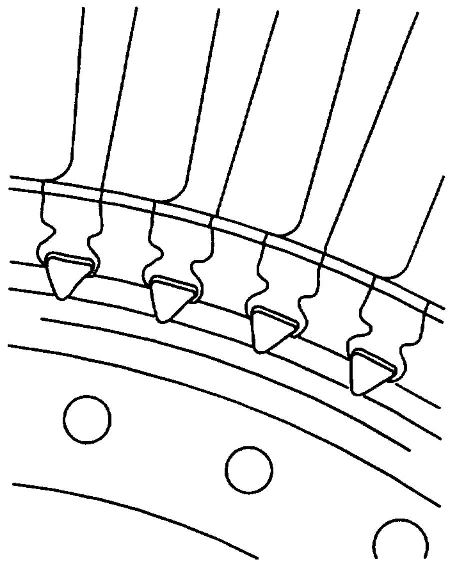
(c) Spring

(d) Spring lock guide

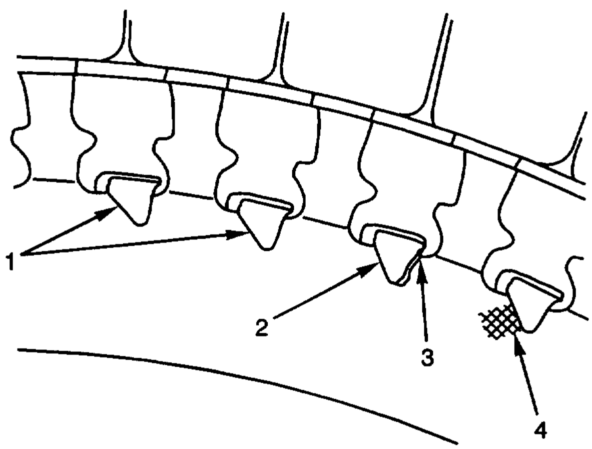
(e) Retaining ring.

I. Compressor Rotor Spacers - Static Balance
See Tool Group 39A, Figure 705, and Figure 706.

NOTE: Please see the TEMPORARY REVISION that revises this page.



CORRECT TABLOCK INSTALLATION



INCORRECT TABLOCK INSTALLATION

L-H8047 (0307)
PW V

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

Acceptable Tablock Installation
Figure 703

1. Tab Is Moved So That Gap Between Blade Slot And Lock Is All On One Side.
2. Blade Lock Is Not Centered Under Blade Root
3. Tab Is Twisted With One Edge Raised Rather Than Being Parallel With Disk Face.
4. Obvious Tool Marks Show On Edge Of Tab Indicating Impact From The Side.

Key to Figure 703

(1) Correct static unbalance of 2nd to 3rd, 4th to 5th, 5th to 6th, 6th to 7th, 7th to 8th, and 8th to 9th stage spacers by adding PN 506268 counterweights, selecting class required.

NOTE: It is permissible to reduce Dimension A (Figure 705) of counterweight, any of three classes, to a minimum of 0.375 inch in order to utilize only large class weights and make small balance adjustments. All sharp edges left by cutting or grinding operations must be broken, 0.003 - 0.015 inch. Material is AMS 5518 steel and must not be altered in temper.

(2) Correct static unbalance of 3rd to 4th stage spacer by removing material in accordance with Figure 706.

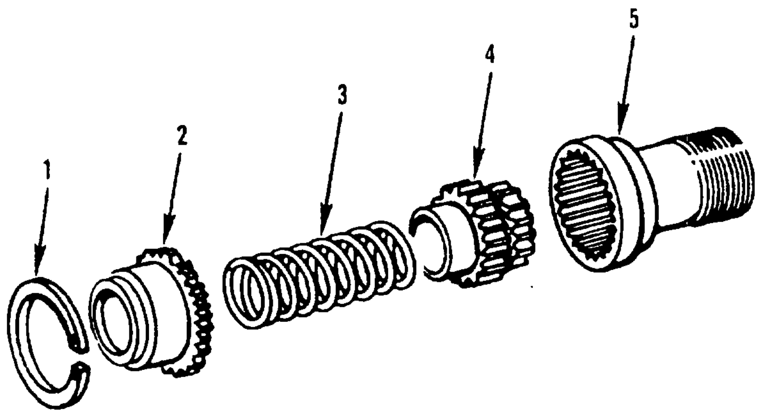
(3) Unbalance must not exceed 0.10 ounce-inch (0.05 oz-in. if pattern stacking is used) when work piece is rotated at minimum speed of 600 rpm.

NOTE: If it is necessary to locate a counterweight over a spacer sleeve marked with an arrow and the word FRONT, remark another sleeve which does not require a weight.

(4) After balancing, mark rear mating face of each spacer at point of most unbalance with layout dye.

J. Compressor Rotor And Stator Assembly Build
See Tool Group 35 and Table of Limits.

NOTE: At assembly of the compressor rotor, indexing of the disks and spacers will be governed either by the points of greatest unbalance or by the out-of-parallelism high points depending upon the procedure chosen by the overhaul shop. Customarily the build shall be performed utilizing the unbalance points at 60 degree increments; however, if difficulty is encountered building a satisfactory assembly, the



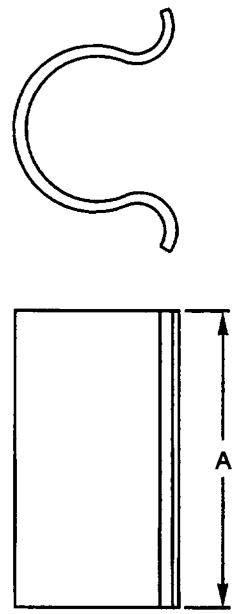
ORIGINAL
As Received By
ATP

L-20219 (0000)

1. Retaining Ring
2. Spring Lock Guide
3. Spring
4. Turbine Shaft Lock
5. Turbine Shaft Coupling

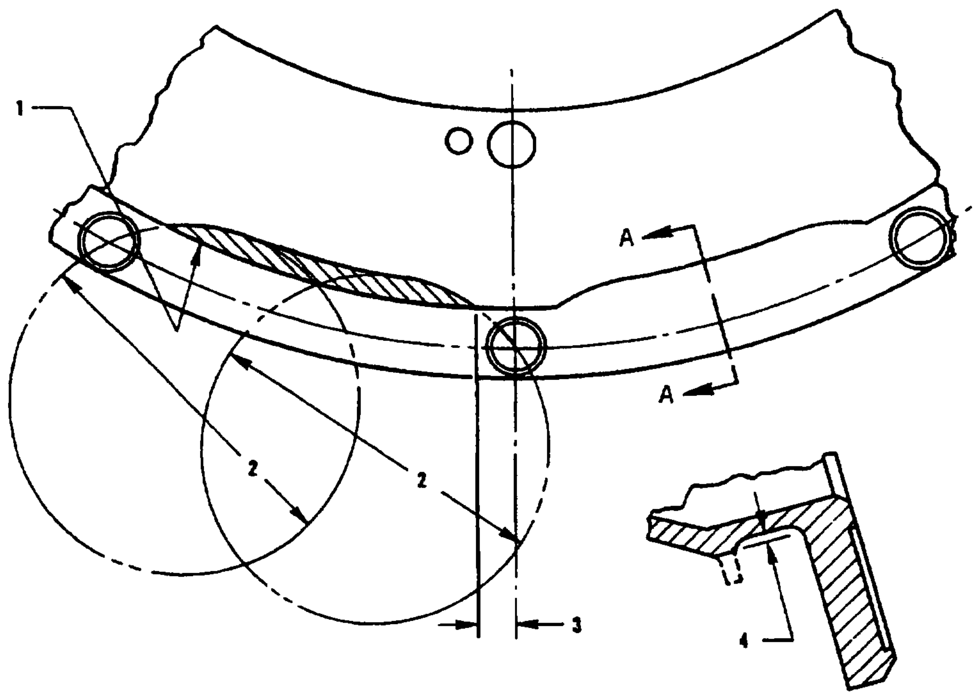
NOTE: Please see the TEMPORARY REVISION that revises this page.

Compressor Drive Turbine Shaft
Locking Bolt
Figure 704



L-15612 (0000)
PW V

Machining Counterweight
Figure 705



1. Shaded Area Represents The Maximum Amount Of Material Which May Be Removed By Machining Area 4 To Dimensions In Indexes 2 And 3 At Number Of Places Required To Obtain Balance.
2. 2.000 Inch Minimum Diameter
3. 0.200 Inch Minimum Each Side
4. 0.005 Inch Minimum

NOTE: Please see the **TEMPORARY REVISION** that revises this page.

Machining Spacer
Figure 706

pattern stacking technique may be employed, using the out-of-parallelism high points. In either case, the order in which the parts are assembled is not affected, only the indexing of parts in relation to one another. For information regarding pattern stacking, refer to Paragraphs K. and L.

CAUTION: LINE-REAMING OF TIEROD HOLES OF ASSEMBLED ROTOR IS PROHIBITED.

(1) Prior to commencing build operation, ensure that the following steps have been performed.

(a) All spacers and disks have been marked FRONT and REAR.

(b) All spacers and disks have been marked as to their point of greatest unbalance or their out-of-parallelism high point if pattern stacking technique is to be used.

(c) Offset lug is marked on vane and shroud assemblies.

(d) All mating surfaces on disks and spacers have been cleaned with Arkansas stone.

(2) Install compressor rotor front hub in build stand assembly, forward end down, as follows:

(a) Mount adapter and bearing assembly on compressor assembly base, and install front hub, journal end down, into adapter and bearing assembly. Secure hub to base with previously removed retaining nut.

(b) Position compressor stator locating adapter on base mounts to properly locate stators. Place hub and base on compressor and turbine locating jack on engine build and transport stand.

CAUTION: ENSURE JACK PAD CONTACTS HUB WHEN MATING SNAP DIAMETERS OF DISKS, SEALS AND SPACERS TO PREVENT BEARING DAMAGE. LOWER JACK PAD WHEN CHECKING CONCENTRICITY AND PARALLELISM.

(3) Position front tierod front nut, rounded corners forward, under hub rear flange, and thread in front tierod to fingertight to three-quarter turn loose.

Refer to the Table of Limits and set the nuts. Repeat this procedure for remaining 15 tierods.

NOTE: Apply engine lubrication oil, PWA-521B, to tierod threads before installing in nuts.

NOTE: When selecting front tierods, if PN 669845 tierods with increased land diameters are to be used; ensure that 2nd and 3rd stage disks (PN 670802 and 670403) with enlarged tierod holes are installed. The above parts shall be used in sets only.

(4) Using appropriate air gage, or dial indicator, measure concentricity of hub at integral spacer inside snap diameter. Runout shall not exceed 0.001 inch FIR. Measure parallelism on integral spacer rear mating face. Flatness shall not exceed 0.001 inch FIR.

(5) Heat 2nd state airseal to at least 44°C (80°F) higher temperature than hub integral spacer. Install seal, with knife-edge down, over tierods and on spacer OD.

(6) Install 1st stage vane and shroud assembly, large OD down, on base. Check blade tips for clearance. No rub is permitted.

NOTE: Limits for References 124 thru 132 in the Table of Limits are for reference only. Steel vane and shroud assembly may be coated with light film of preservative oil, and then wiped with dry cloth to minimize surface oxidation.

(7) Mount center post of pusher in front hub. Install 2nd stage disk and blade assembly, rear face up, over tierods and on spacer ID. Use pusher to seal disk.

NOTE: Weight of pusher alone will seat disk on spacer. Heat hub, or chill disk and blade assembly, to maintain at least 44°C (80°F) temperature difference. Assemble disk with unbalance point 60 degrees from hub unbalance point, or in Paragraph K.

(8) With 2nd stage disk and spacer unbalance points 60 degrees apart, or in accordance with Paragraph K, install 2nd-to-3rd stage disk spacer, using pusher.

NOTE: Succeeding spacers shall be assembled with unbalance points at 60 degrees apart from unbalance point of its forward mating disk or in accordance with Paragraph K.

NOTE: Indexing of spacer and disk unbalance points in increments of 60 degrees may be performed in either clockwise or counterclockwise direction, provided direction is consistent throughout rotor build.

(9) Install 2nd stage vane and shroud assembly, aligning offset slot with offset lug of 1st stage shroud. Check blade clearance.

NOTE: Use plastic mallet to seat vane and shroud assembly.

(10) Install 3rd stage disk and blade assembly, using pusher.

(11) Insert 12 rear tierods in 3rd-to-4th stage spacer, and install spacer, using pusher. To keep tierods vertical and to facilitate assembly, wrap spring (one-quarter OD by 12 inches long) around tierods.

NOTE: Compressor disk spacers (PN 668974, 668975, 668976, 668977, and 668978) and compressor rear hub (PN 668985) each with increased diameter tierod holes and tierods (PN 668985) with increased diameter lands shall be installed in sets.

(12) Apply lubricating oil to rear threads of front tierods, and install tabwashers, ensuring that washer prebent tabs are inserted in holes provided in 3rd - 4th stage compressor disk spacer.

(13) Thread tierod nuts onto tierods ensuring that rounded corners are up.

(14) Apply initial torque to tierod nuts, using 16 wrenches. Ensure that tierods are prevented from turning by holding smaller hex on end of wrench while torquing tierod nuts. For torquing sequence, refer to Table of Limits. Allow assembly to cool before proceeding beyond initial torque.

NOTE: If hydraulic loading procedure is to be used, the initial torque shall be 20 - 30 lb-in. Remove wrenches and proceed as indicated in Paragraph L. Steps (15) and (16) below shall be complied with only when tierods are to be manually loaded. It should be noted, however, that hydraulic loading is the preferable procedure.

(15) Position gage on assembly with expandable plug in hub. Align indicator probes with tierods, and secure tool by pulling cam handle down.

(16) Complete torquing nuts. See Table of Limits. Remove gage, and recheck torque.

(17) Bend up washer tabs. At least one tab shall be flush against nut flat. Remove protective cover.

(18) Install 3rd stage vane and shroud assembly, aligning offset lug and slot. Check blade clearance.

(19) Install airseal, knife-edge forward, and 4th stage disk and blade assembly with Pusher.

NOTE: Maintain at least 44°C (80°F) temperature difference for remaining spacers, disks, and rear hub.

(20) Measure parallelism of 4th stage disk on mating face adjacent to tierods. Then, measure concentricity at ID snap of same disk. Maximum runout for both checks is 0.002 inch FIR.

NOTE: Use pusher and retorque, as required, for runout. Disassemble and reindex, as necessary, to obtain runout. Reassemble, using previous build procedure.

(21) Install compressor stator spacer to 3rd stage vane shroud, and install 4th stage vane and shroud to spacer.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(22) Lockwire four tabs on shroud to spacer. See Table of Limits.

(23) Using heater, heat and install 4th stage spacer, small-diameter, knife-edge seal forward. After heating spacer, remove heater and continue stacking disks and blades, vanes and shrouds, and spacers. Use Pusher to seat disks and spacers. Lockwire lugs on Stages 4 thru 8 outer shrouds. See Table of Limits.

NOTE: Position 2nd-to-3rd stage spacer with flange lightening holes rearward and 4th-to-5th stage spacer with knife edges forward. All spacers should have arrows on inner tubes that point forward, but these spacers should be installed by reference to their unique features since this is a more reliable method of assuring correct rotor assembly. Symmetrical spacers are marked with arrows to assure each assembly of mating disks and spacers is in the same relative position. Check blade clearance for each stage. Assembly shall be completed as rapidly as possible to maintain mating of parts.

(24) Install assembled rear hub, aligning holes (with scallops) on tierods, and unbalance point 60 degrees from 9th stage disk unbalance point or in accordance with paragraph K. Apply engine lubricating oil to tierod threads and mating faces of washers and nuts. Install tabwashers and nuts (rounded corners up). Torque nuts with Wrench. See Table of Limits. Cool assembly to room temperature and check torque.

(25) Install gage over hub and with indicators through holes in wrenches. Torque nuts, and stretch tierods. See Table of Limits.

NOTE: For mechanical stretching of 9.468 inch long tierods (designed for hydraulic stretching), Install spacer between rear hub and tierod stretch gage.

CAUTION: DO NOT EXCEED 0.025 INCH STRETCH, AS BENDING MOVEMENT IMPOSES ADDITIONAL STRESSES, EQUIVALENT TO STRETCH.

(26) Measure concentricity and parallelism of rear hub. Maximum runout of oil distributing sleeve bearing

journal is 0.004 inch FIR and seal plate shoulder is 0.001 inch FIR.

NOTE: If runout requirements are not met, disassemble to 3rd-to-4th stage spacer, reindex spacer and rebuild assembly, using previous build procedure.

(27) Using guide, install No. 2 bearing oil distributor sleeve on compressor rear hub, aligning "X" mark on sleeve with mark on hub.

(28) Install seal plate on sleeve with face toward front.

NOTE: "X" marks on seal plate and sleeve shall be aligned.

(29) Using drift, install No. 2 balance bearing on sleeve.

NOTE: Balance bearing shall have been heated to 82° - 90°C (180° - 200°F) before installation.

(30) Check faces of balance bearing inner and outer races to ensure that they are square and parallel 0.0005 inch FIR maximum.

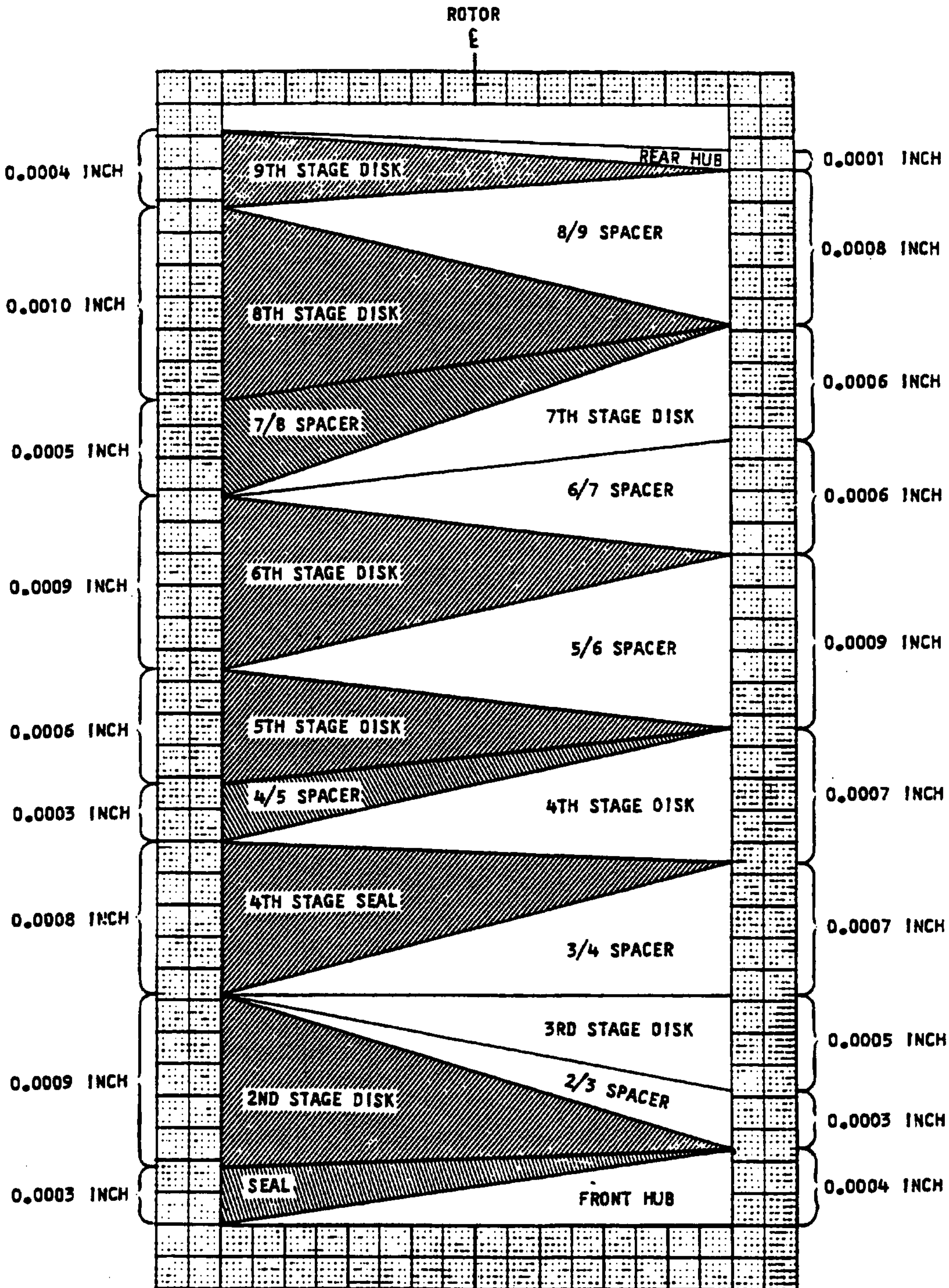
(31) Install work spacer on rear hub, and secure with No. 2 bearing oil scoop nut. Tighten to recommended torque, using wrench.

(32) Lockwire all compressor stator assembly tabs (refer to the clearance charts in the Table of Limits).

K. Compressor Rotor Pattern Stacking - General
See Figure 707.

(1) The compressor rotor pattern stacking figure represents an arrangement (using out-of-parallelism high points) of compressor rotor spacers, hubs, and disks that will result in the building of an optimum square stack. These parts are represented in a relative assembly position on illustration. Wedges that have been shaded represent out-of-parallelism high points of parts that will be installed at the six o'clock position. Non-shaded wedges represent high point of those parts that will be installed at the 12 o'clock position.

NOTE: At assembly, 12 o'clock position will be a point facing away from operator. After installation



L-25110 (0000)

NOTE: Please see the *TEMPORARY REVISION* that revises this page.

Compressor Rotor Pattern
Stacking Diagram (Sample)
Figure 707

NOTE: In Determining The Build Of An Optimum Square Rotor, The Difference Between The Total Out-Of-Parallelism At The 6 And 12 O'clock Positions Will Yield The Residual Out-Of-Parallelism For The Entire Rotor. This Calculation Will Be Instrumental In Determining The Effectiveness Of The Pattern Selected Prior To The Actual Build.

Key To Figure 707

of front hub, installation position will be referenced from mark on hub.

(2) The pattern stacking technique permits the operator to determine, prior to assembly, the relative position of the disks and spacers to ensure the building of an optimum square stack. This is done by arranging the out-of-parallelism high points so that points are diametrically opposed as indicated in sample figure.

<u>NOTE</u>: Depending upon out-of-parallelism variation between compressor rotor components, it may be necessary to assemble two or more adjacent parts so that their out-of-parallelism high points are indexed in the same relative position. In this manner, a cumulative out-of-parallelism is created to offset extreme out-of-parallelism of parts whose high points are diametrically opposed. Examples of this are shown in figure where two or more shaded or unshaded wedges are grouped together.

L. Compressor Rotor Disks And Spacers Measurement For Compressor Rotor Build, Using Pattern Stacking Technique

(1) Measure parallelism of front hub integral spacer mating face and bearing seal spacer mating face. Mark highest point of out-of-parallelism on hub rear surface, and record.

(2) Measure parallelism at mating faces of the following parts:

(a) Second stage airseal

(b) Fourth stage airseal

(c) Compressor rotor disks

(d) Compressor rotor spacers.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(3) Mark highest point of out-of-parallelism on rear of each part, and record.

(4) Measure parallelism of rear hub disk mating face and oil distributing sleeve mating face. Mark highest point of out-of-parallelism on hub rim, and record.

(5) Using high points determined above, establish relative assembly positions of parts as follows:

(a) Using graph paper, plot dimensional high point of front hub on right side of graph. Label high point dimension of part as shown in sample figure. Draw line from right side of graph to base line on left side.

NOTE: Right side of graph represents 12 o'clock assembly position.

(b) Complete positioning dimensional high points of remaining parts on graph until optimum square stack is evidenced. Clearly label parts as shown in sample illustration.

(6) Indicate relative assembly position (6 or 12 o'clock) of disks and spacers, by part number, on suitable form. This form will be used at compressor rotor build to denote spacer and disk positioning.

(7) Assemble compressor rotor as indicated in Paragraph J. indexing compressor rotor component in accordance with pattern stacking technique.

M. Compressor Front Tierod Hydraulic Loading
R See Tool Group 38-1 and Table 702.

CAUTION: PN 406090 AND PN 468243 TIERODS ARE NOT DESIGNED FOR HYDRAULIC LOADING. IF THESE TIERODS ARE INSTALLED, MANUAL LOADING PROCEDURE SHALL BE USED. REFER TO PARAGRAPH J.

(1) Test hydraulic ram units and distributor of hydraulic loading fixture as follows:

NOTE: This test need not be performed each time these tools are used, but it is provided as a periodic check to ensure that tools are functioning properly.

(a) Secure rams and distributor to test fixture.

(b) Connect hydraulic lines to rams and distributor and in turn connect hydraulic pump to the latter.

(c) Apply 6000 psig and hold for 15 minutes. Then check for any leaks. Any deficiencies shall be corrected.

(d) Decrease pressure to 300 psig and zero-in all dial indicators.

(e) Increase pressure to 4980 - 5020 psig. All dial indicators must agree 0.0005 inch total.

(2) Assemble hydraulic loading fixtures as follows:

(a) Position adapter with lifting eye up.

(b) Install hydraulic rams in T-slots of adapter.

(c) Secure distributor to adapter and connect hydraulic lines to distributor and rams.

(3) Install hydraulic loading fixture and related tooling on compressor stack as follows:

(a) Place wrenches over tierod nuts, with wrench handles extending radially outward.

(b) Position fixture on 3rd-to-4th stage compressor disk spacer, aligning ram units with ends of tierods.

(c) Insert long thimbles into upper ram units. Thread thimbles onto tierod until thimbles bottom on tops of tierod nuts; then back off two complete turns.

<u>NOTE</u>: Thread on thimbles must match thread on tierods.

(d) Install short thimbles through lower ram units and thread onto tierods as indicated in step (c).

(e) Position and secure dial indicators so that indicator probes are centered on ends of thimbles.

(f) Connect hydraulic pump to distributor.

R
R

(4) Load compressor front tierods as follows:

(a) Check operation of fixture as indicated below:

NOTE: For poundage and equivalent gage pressures associated with loads referenced below, see Table 702.

Load Level	Load (Lbs.)	Equivalent Gage Pressures (PSIG)
BASELINE	55	60
CHECK	2490 - 2530	2700 - 2750
FINAL	3780 - 3820	4100 - 4150

CAUTION: DO NOT CONFUSE LOAD WITH PRESSURE. THIS CONVERSION OF LOAD INTO EQUIVALENT GAGE PRESSURE READING APPLIES ONLY WHEN HYDRAULIC RAMS, PWA 13784, ARE USED.

Specifications For Hydraulic Loading Of Compressor Front Tierods
Table 702

1 To ensure that tierods do not rotate when loosening nuts, apply hydraulic load of at least 500 lb. (540 psig) but not more than 750 lb. (810 psig); then back off tierod nuts sufficiently to ensure that no contact is made with 3rd-to-4th stage disk spacer at BASELINE load. Excessive loosening of tierod nuts causing contact with thimbles shall be avoided. Zero-in all dial indicators allowing for minimum free travel of 0.030 inch. Ensure that dial indicators are contacting thimble platforms.

2 Increase load to CHECK load level. Dial indicators must agree within 0.030 inch. If dial indicators are not within limits, tierods, stack up or fixtures may be at fault. Deficiencies may be at fault. If no deficiencies are found, decrease load to BASELINE and zero in all dial indicators.

(b) Complete hydraulic loading of compressor tierods as follows:

1 Increase load to CHECK load level. All dial indicators must agree within 0.003 inch. Correct deficiencies as required.

2 Increase to FINAL load. All dial indicators must agree within 0.003 inch. Correct deficiencies as required.

3 Apply 15 - 18 lb-in. torque to tierod nuts. Torque shall be applied simultaneously to diametrically opposed nuts. Appropriate sequence is shown in Section XI, Compressor and Turbine Clearance charts. Then, in the same sequence increase torque to 24 - 26 lb-in. All indicators must agree within 0.004 inch.

NOTE: A slight decrease in hydraulic pressure will be observed while torquing nuts. Do not adjust pressure.

4 Decrease load to BASELINE. All indicators must agree within 0.004 inch.

NOTE: A very low, or near-zero, dial indicator reading indicates an untorqued not at pressure release. Correct by repeating tierod loading.

N. Compressor Rotor Hydraulic Loading - Rear Tierods
See Tool Group 38A, Figure 708, and Table 703.

Load Level	Load (lbs)	Estimated Gage Pressures PSIG
Baseline	136 - 156	148 - 169
Check	1980 - 2020	2150 - 2193
Break-Away	2230 - 2270	2420 - 2465
Initial	2965 - 3005	3219 - 3269
Final	2685 - 2705	2915 - 2937

Specifications For Hydraulic Loading Of Compressor Rear Tierods (For PWA 13784 Hydraulic Ram Units Only)
Table 703

ENGINE GENERAL - ASSEMBLY OF SUBASSEMBLIES

WARNING: DO NOT APPLY HYDRAULIC LOADS TO PN 409227 TIERODS (REPLACE THESE TIERODS WITH PN 572252).

(1) Prior to hydraulic loading, test hydraulic ram units and distributor as follows:

(a) Secure rams to test fixture by handtightening test tierods provided; then, fasten distributor to raised support on fixture.

(b) Connect hydraulic lines between distributor and rams.

(c) Connect hydraulic pump to distributor.

(d) Apply 6000 psig and hold for 15 minutes. Check for leaks and correct any deficiency.

(e) Decrease pressure to 300 psig and zero dial indicators.

(f) Increase pressure to 4980 - 5020 psig. All dial indicators must agree within 0.0005 inch if tooling is functioning properly.

(g) After test, disconnect hydraulic lines and remove distributor and rams from test fixture.

(2) Set up hydraulic loading tools as follows: See Figure 708.

(a) Position adapter on bench so that "T" slots are inverted.

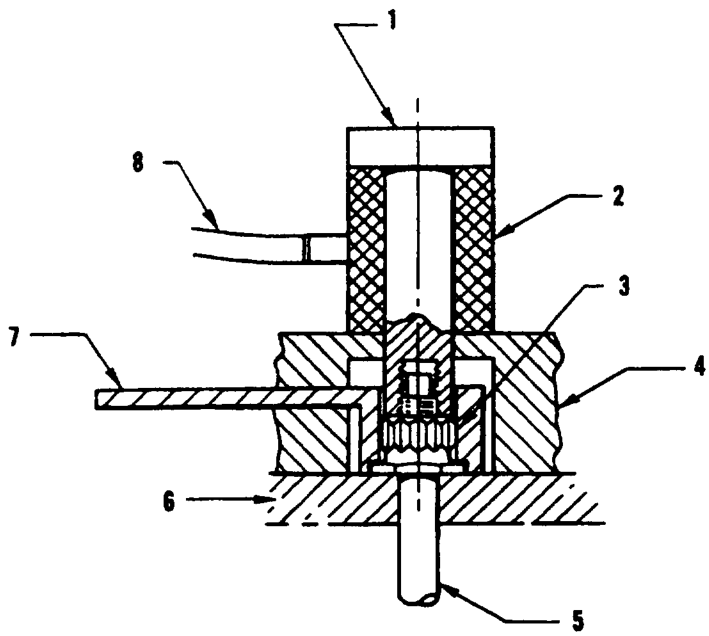
(b) Insert rams into "T" slots of adapter.

(c) Secure distributor to adapter and connect hydraulic lines between distributor and rams.

(d) Torque tierod nuts to 50 - 85 lb-in. in diametrically opposed pairs as shown in Table of Limits. See Figure 1001.

(e) Place special wrenches on torqued nuts so that wrench handles extend radially outward.

(f) Position hydraulic loading fixture on compressor rotor rear hub.



L-21822 (0000)

1. Thimble And Rod Assembly
2. Hydraulic Ram Unit
3. Tierod Nut
4. Adapter
5. Tierod
6. Rear Hub
7. Wrench
8. Hydraulic Pressure Line

Specifications For Hydraulic
Loading Of Compressor Rear Tierods
(For Use With PWA 13784 Hydraulic
Ram Units Only)
Figure 708

(g) Insert thimbles into hydraulic rams, and screw onto tierods until handtight; then, back off two turns to obtain clearance between thimble and tierod nut.

(h) Position and secure dial indicators with indicator probes contacting top surfaces of thimble and rod assemblies.

(i) Connect hydraulic pump to distributor.

(3) Check operation of fixture as follows:

NOTE: To obtain pound and gage pressure equivalents for loads referenced below, see Table 712.

CAUTION: DO NOT CONFUSE LOAD WITH PRESSURE. THE CONVERSION OF LOAD INTO EQUIVALENT GAGE PRESSURE READING APPLIES ONLY WHEN HYDRAULIC RAMS, PWA 13784, ARE USED.

(a) Apply BREAK-AWAY load. Then, back off tierod nuts to avoid contact with stack when load is decreased to BASELINE load. Do not back off nuts so far that contact is made with thimble.

(b) Reduce to BASELINE load. Ensure that nuts are free of stack; then, zero dial indicators, allowing for minimum free travel of 0.040 inch.

(c) Increase to CHECK load. Dial indicators must agree within 0.003 inch. If not, either tierods, compressor stack, or fixture is at fault.

NOTE: If dial indicators are in agreement, do not decrease load below BASELINE until stacking procedure is completed.

(4) Perform hydraulic loading as follows:

(a) Increase to initial load. Dial indicators must agree within 0.003 inch.

(b) Decrease to BASELINE load, and zero all dial indicators.

(c) Increase to FINAL load. Dial indicators must agree within 0.003 inch.

(d) Apply 15 - 18 lb-in. torque to tierod nuts in diametrically opposed pairs. (See Section XI) Then, in same manner, increase torque of tierod nuts to 24 - 26 lb-in. All dial indicators must agree within 0.004 inch.

NOTE: Do not adjust pressure to compensate for decrease due to torquing procedure.

(e) Decrease to BASELINE load. All indicators must agree within 0.004 inch.

NOTE: A low or near zero dial indicator reading indicates failure to torque tierod nut prior to pressure release. Correct by repeating tierod loading.

(f) Reduce hydraulic pressure, remove fixture, and secure nuts with tablocks.

O. Compressor Rotor Front Hub Assembly
See Tool Group 36.

(1) Position rear half of concentricity build fixture over rotor stack, and secure by positioning fixture lugs on underside of No. 2 balance bearing.

NOTE: Slot in offset lug of fixture must be aligned with offset lug on vane and shroud assembly.

(2) Loosen detail nut securing front hub to adapter. Then, lift compressor rotor assembly from build stand assembly.

(3) Attach front half of fixture to rear half of fixture, and secure with detail bolts. Lock aligning pins.

NOTE: Front half of fixture is installed by passing over front section of compressor rotor.

(4) Remove adapter and bearing assembly, compressor assembly base, and stator locator adapter from build stand assembly, and install compressor balance fixture-to-stand adapter on compressor build jack.

(5) Trunnion rotor assembly, using sling, and position in build stand assembly, rear hub down.

(6) Remove front half of concentricity build fixture, and raise jack to contact rear hub face.

(7) Install No. 1 bearing seal rear spacer (angular face to rear) on compressor rotor front hub.

(8) Install center seal spacer followed by front spacer with angular face to front and bearing work spacer with large OD against balance bearing. "X" marks on spacers and hub shall be aligned.

NOTE: Front and rear seal spacers are identical.

(9) Heat and install No. 1 balance bearing, using drift. Thread No. 1 balance bearing retaining nut (Tool) on front hub. Tighten, using retaining nut wrench.

NOTE: Heat the balance bearing to 82° - 95°C (180° - 200°F).

(10) Check to ensure that faces of inner race of balance bearing are square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 in FIR.

(11) Retract jack, and attach front half of concentricity and build fixture to rear half. See step (3) for procedure.

P. Compressor Rotor Squareness Check
See Tool Group 37 and Figure 709.

(1) Install and secure balance bearing housing in cradles of concentricity check fixture.

(2) Attach rear half of concentricity check fixture and secure with quick-disconnect. Attach lifting sling to fixture, and trunnion rotor assembly into concentricity fixture.

(3) Using height gage and indicator, check squareness runout of rear face of front spacer and front face of rear spacer on front hub and front face of seal plate on rear hub. Squareness runout of these surfaces must not exceed 0.001 inch when rotor is mounted on its bearing
R journals (Points A and B) as shown in the figure.

NOTE: Details may be rotated to meet this requirement. Using layout dye, mark radial position of all related parts on front and rear hub in order that reinstallation in correct position is assured.

CAUTION: USE PULLER TO REMOVE REAR HUB. DO NOT STRIKE REAR HUB WITH MALLET AS THIS WILL UPSET STACK.

(4) Remove rotor from concentricity fixture and install, front hub down, in build stand. Remove rear half of concentricity check fixture.

Q. Compressor Rotor Dynamic Balance Check
See Tool Group 38 and Figure 709.

(1) Install and secure balance motor pulley to motor driveshaft. Check pulley for runout and squareness.

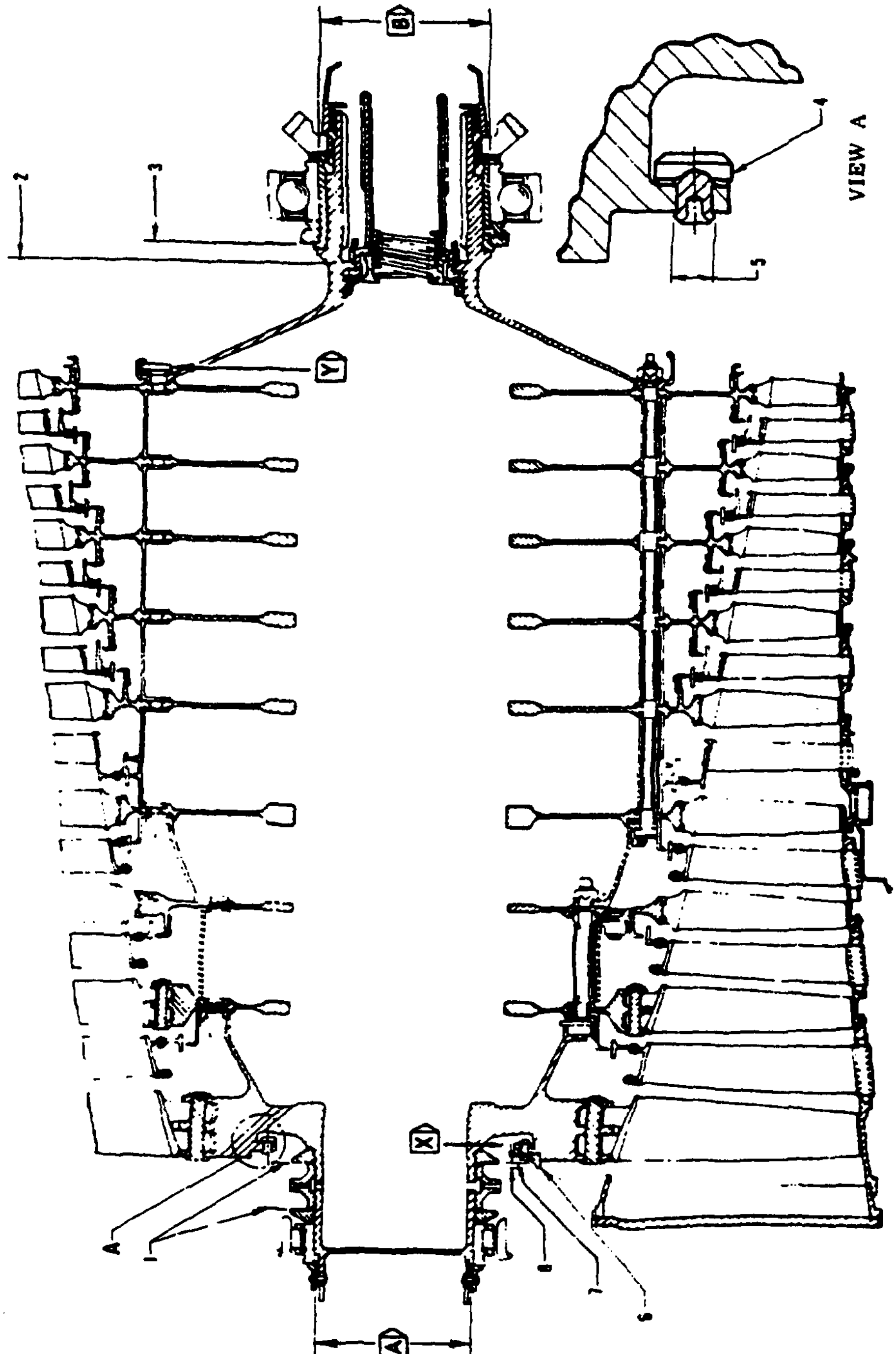
(2) Position rear half of concentricity checking fixture on front half, and secure with quick-disconnect.

(3) Attach lifting sling to spools of fixture, and trunnion compressor rotor assembly into balance machine.

(4) Install compressor balance pulley into hub, engaging spline in hub. Tighten pulley, using wrench; then install balance machine drive belt.

(5) Start machine, and gradually increase speed until rotor assembly is rotating at minimum speed of 1700 rpm. Amount of dynamic unbalance of rotor assembly must not exceed one oz-in. per plane (front and rear) or must not exceed 0.5 oz-in. per plane if unbalance vectors are within 90 degrees of each other, prior to addition of any counterweights.

NOTE: If dynamic unbalance is in excess of one oz-in., disassemble rotor, and rotate spacers and disks until one oz-in. limit is met. Recheck rotor squareness.



L-23122 (0270)

ORIGINAL
As Received By
ATP

NOTE: Please see the
TEMPORARY
REVISION
that revises this page.

Compressor Rotor Squareness
and Dynamic Balance Check
Figure 709

1. Squareness Runout Of These surfaces Must Not exceed 0.001 Inch FIR When Assembly Is Mounted On Journals A And B. Spacers May Be Rotated For This Requirement.
2. Squareness Runout Of This surface Must Not Exceed 0.001 Inch FIR When Assembly Is Mounted On Journals A And B.
3. Squareness Runout Of This surface Must Not exceed 0.001 Inch FIR When assembly Is Mounted On Journals A And B. Plate May Be Rotated For This Requirement.
4. Rivet-Type Counterweight
5. Minimum Counterweight Flare, 0.125 Inch
6. Material May Be Removed From This Shoulder
7. To Dynamically Balance, Material May Be Removed To This Shoulder (See NOTE.)
8. Material May Be Removed To This Shoulder.

NOTE: Dynamic unbalance at 1700 rpm minimum in Planes X and Y when mounted on Journals A and B: residual unbalance must not exceed 1.0 oz-in. per plane or must not exceed 0.5 oz-in. per plane if unbalance vectors are within 90 degrees of each other. Disks and spacers may be rotated to meet this requirement. Final unbalance must not exceed 0.1 oz-in. per plane. Correct by adding weights.

Key to Figure 709

(6) When unbalance in rotor assembly is one oz-in. or less, determine amount and angular location of unbalance. Amount of dynamic unbalance must not exceed 0.100 oz-in. when rotating at minimum of 1700 rpm.

(7) Install two balance counterweights on counterweight flange of front hub, one on each side of "minus" balance location. Gradually move counterweight toward "minus" location until final balance is achieved. Use "rivet-type" flat counterweights, (Index 4) Figure 709, to correct for small increments of residual unbalance. Install classified balance plugs and washers on hub, and balance as just described.

<u>NOTE</u>: During trial balancing, secure front hub counterweights in position with rivets. Secure rivets and "rivet-type" counterweights with masking tape. Do not flare rivets and "rivet-type" counterweights, or bend counterweight washer tabs until final balance weight and location are determined.

NOTE: Please see the TEMPORARY REVISION that revises this page.

NOTE: Any combination of riveted counterweights may be used, provided no more than eight rivets are used when installing weights and a rivet is used in each counterweight hole. A maximum of six "rivet-type" weights may be used on the front hub.

(8) Fine balance is obtained by removing material from front counterweight lip up to shoulder as shown in (Index 8) Figure 709, or from ends of counterweight. If ends are machined, ensure that at least 0.100 inch of material remains between end and edge of nearest rivet hole.

(9) After final balance has been achieved, rivet front hub counterweights, using counterweight retaining rivet riveter. Set tabs on rear counterweights.

NOTE: Mark point of greatest axial runout of mating surface for turbine shaft positioning spacer (inside compressor rear hub). This point will be indexed 180 degrees from point of greatest axial runout of turbine spacer at mating of parts.

(10) Remove balance machine drive belt, and remove compressor balance pulley, using wrench. Attach lifting sling to spools of fixture.

(11) Trunnion rotor assembly, rear hub down, onto assembly stand. Secure rotor assembly to stand with lockpins, and remove front half of fixture.

(12) Remove No. 1 bearing retaining nut, and pull off balance bearing. Remove front and center seal plates. Install rear carbon seal, center seal plate, front carbon seal, and front seal plate. Maintain same radial position of seal plates.

(13) Heat No. 1 bearing inner race in hot oil and install it on hub, puller groove up with the Inner Race Drift.

(14) Install No. 1 bearing inner race retaining nut and torque nut as follows:

(a) Install outer detail of inner race retaining nut wrench to body of hydraulic wrench. Install retaining nut wrench detail into hydraulic wrench.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(b) Place assembly on retaining nut with inner detail engaging slots in hub and outer detail engaging nut.

(c) Using hydraulic wrench, tighten nut (refer to the Table of Limits).

(d) Further tighten to align rivet hole in housing with rivet hole in nut. Install rivet, preformed head toward ID of compressor front hub. Flare the rivet with the Riveter.

<u>NOTE</u>: If front compressor hub incorporates hub plug, this must be installed before inner race retaining nut rivet is installed. Place packing in plug groove; then, install plug in hub, using PWA 13946 Guide. Align the three tapped holes in plug with the three 3/16 inch diameter holes in hub. Install bolts and key washers at three tapped hole locations. Torque bolts, and bend key washers to secure. Install inner race retaining nut rivet. Head of rivet goes inside larger hole in plug. Flare rivet, using PWA 13977 Riveter. For engines incorporating SB 4110, plug (PN 733514) has been machined to fit ID of hub and does not require a packing. If plug is to be replaced, new plug (PN 735369) must be machined to appropriate class and reidentified by SB 4110.

(15) Reinstall front half of balance fixture. Using sling, trunnion compressor assembly onto front hub and lower it back into stand.

(16) Remove rear half of balance fixture and remove No. 2 bearing inner race retaining nut, using oil scoop wrench; then remove main component drive bevel gear and balance spacer.

(17) Install jaws of rear bearing puller in groove of No. 2 bearing oil sleeve and secure them with retaining ring. Using jackscrew action of puller, remove sleeve and balance bearing.

(18) Fit distributing sleeve plate into groove of No. 2 bearing seal plate and install plate on seal support base.

(19) Place distributing sleeve drift into top of bearing sleeve and press sleeveout of bearing and seal plate.

R. Compressor Inlet Case Installation
See Tool Group 33.

(1) Attach rear half of concentricity checking fixture to front half of fixture and attach lifting sling to spools of fixture. Lift compressor assembly off build stand.

CAUTION: ENSURE THAT VANE SHROUD LUGS ARE ENGAGED WITH ADJACENT SHROUD SLOTS.

(2) Trunnion compressor assembly and lower it back into build stand with rear hub down. Remove rear half of fixture.

CAUTION: USE EXTREME CAUTION WHEN MATING NO. 1 BEARING OUTER RACE IN INLET CASE TO NO. 1 BEARING INNER RACE AND ROLLERS ON COMPRESSOR ROTOR FRONT HUB.

(3) Heat compressor inlet case with heating blanket and install it on the compressor. Mate the slots in the 4th stage spacer with the lugs in the case, aligning the offset lug with its corresponding slot.

S. Diffuser Case Air Leak Check
See Tool Group 40B.

(1) Before assembling diffuser case, perform an air leakage check of No. 2 bearing compartment and No. 2 bearing oil pressure and scavenge tubes.

(2) Install and secure plug into accessory drive strut from outside.

(3) Install cover on front flange of No. 2 bearing compartment, and secure with nuts and bolts.

(4) Install cover on rear flange of No. 2 bearing compartment, securing with cap screws.

(5) Install cover on oil pressure tube flange and oil scavenge tube flange.

(6) Connect regulator to an air supply and to cover on rear flange of case.

(7) Introduce air at 10 psi.

(8) Check walls of oil tubes and bearing compartment, using suitable leak detection fluid. No leakage is permissible.

T. Ninth Stage Compressor Vane And Shroud Assembly Installation

(1) Position diffuser case rear flange down on a bench.

(2) Install ninth stage vane and shroud assembly in case, engaging pins in case with vane outer shroud holes. Align locating marks made during disassembly and install airseal ring.

(3) Rivet airseal ring and vane inner shroud to diffuser case.

NOTE: ID of 9th stage airseal ring must be concentric with ID of No. 2 bearing support within 0.010 inch FIR and concentric with centerline of inner shroud rivet holes within 0.019 inch FIR. Enlarged rivet holes in vane inner shroud may be drilled to accept next larger size rivets or puddle-welded and redrilled to original size (refer to Repair). Enlarged rivet holes in airseal may be drilled to accept next larger size rivets, or ring may be reindexed midway between existing rivet holes and new holes made. Old holes must be plugged by welding.

U. Main Component Drive Splined Coupling
See Tool Group 43.

(1) Using bearing and spacer drift and an arbor press, install ball bearing, outer spacers, and roller bearing on component drive splined coupling.

(2) Install component drive splined coupling (threaded end toward center of diffuser case) into main component drive housing of diffuser case.

(3) Install coupling retaining ring in groove in housing.

V. No. 2 Bearing
See Tool Group 5.

(1) Position No. 2 bearing oil distributing sleeve (flanged end down) on bench. Install No. 2 bearing seal plate (large face down) on sleeve aligning X-marks on plate and sleeve.

(2) Heat No. 2 bearing front and rear inner races in hot oil. Install No. 2 bearing front inner race on sleeve aligning X-marks on race and sleeve. Position inner race drift on inner race and seat inner race against seal plate by striking drift with mallet. Place No. 2 bearing cage and balls in outer race; then install outer race and balls on front inner race.

NOTE: Rear face of outer race is marked REAR to facilitate assembly.

(3) Install rear inner race puller groove up on sleeve so X-mark on rear inner race is aligned with X-mark on front inner race. Position drift on race and seat race against front inner race by striking drift with a mallet.

(4) Install No. 2 bearing inner race retaining ring, ensuring that it is in sleeve groove.

(5) Place bearing assembly in bearing liner of diffuser case. Using outer race drift on outer race, seat bearing in liner.

(6) Install No. 2 bearing outer race retaining nut. Using nut wrench and torque wrench, tighten nut. See the Table of Limits.

(7) Mark alignment of retaining nut and No. 2 bearing support. Ensure that rivet hole in nut and support is aligned.

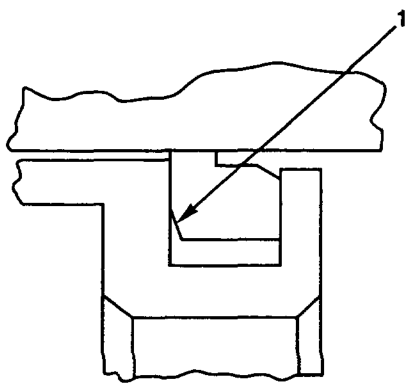
(8) Remove retaining nut.

W. No. 2 Bearing Seal Assembly
See Figure 710.

(1) Place No. 2 bearing seal support (large diameter down) on bench.

(2) Install metal seal ring (angular face down) in groove of seal support.

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-18786 (0000)
PW V

NOTE: Please see the **TEMPORARY REVISION** that revises this page.

1. Angular Face Of Seal Must Face Forward.

No. 2 Bearing Seal Assembly
Installation Of Metal Seal Ring
Figure 710

(3) Position seal loading spring on each of short pins in seal support.

(4) Position seal housing assembly (carbon seal up) on seal support, inserting pins into springs and engaging seal housing lockpins in holes in seal housing flange. Install cotter pin in hole in each seal housing lockpin and bend legs of cotter pin around lockpin. Trim cotter pin as necessary to maintain minimum clearance of 0.040 inch between cotter pin and rear flange of seal housing.

X. No. 2 Bearing Seal Assembly Installation

(1) Position diffuser case (front flange up) on bench.

(2) Install gasket on No. 2 bearing seal support flange rear face.

(3) Position No. 2 bearing seal assembly on diffuser case front inner flange (carbon seal down) aligning flange holes of seal assembly with diffuser case flange holes.

(4) Secure seal assembly to diffuser case with bolts. Tighten bolts to recommended torque and lockwire.

Y. Component Drivegear Mounting Distance Measurement See Tool Group 24.

(1) Remove torque nut and spacer from long rod of component drive coupling gaging part of mounting distance gage.

(2) Install rod into coupling with threaded end protruding from case at gearbox mounting pad.

(3) Position inner block (flat face up) and install spacer and torque nut on rod. Tighten torque nut until it slips.

(4) Position main component drivegear gage block (straddling narrow part of drive coupling section) into No. 2 bearing oil distributing sleeve.

(5) Position drivegear gage block locator on front face of diffuser case inner front flange. Secure locator to drivegear gage block with torque nut. Tighten nut until head of torque bolt slips.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(6) Place dial indicator on master and set green line on indicator face at zero.

(7) Position dial indicator anvil on main component drivegear gage block with plunger resting on rear face of main component drivegear gage block. Dial pointer now indicates correct main component drivegear spacer thickness. Position dial indicator anvil on angular face of component drivegear gage block with plunger (inserted through the gage block hole) resting on inner face of component drivegear gage block. Dial pointer now indicates correct component drivegear spacer thickness.

(8) Grind the spacers (if necessary) to the required thickness.

Z. Main Component Drive Gear
See Tool Group 72.

(1) Install the shaft of the coupling holder up through the strut located between the gearbox mounting lugs at the bottom of the diffuser case. Secure the holder to one of the four lugs on the diffuser case with the ball lockpin.

(2) Engage the coupling holder rod splines in the main component drive coupling splines and secure the rod in position with the thumb screw. The coupling is now locked.

(3) Position the component drive gear spacer and the component drive gear on the component drive gear coupling.

(4) Position the component drive gear retaining nut lock (wide end down and bent outward) in the slot in the component drive coupling. Install the component drive gear nut on the coupling.

(5) Using the retaining nut wrench and a standard torque wrench, tighten the retaining nut to the recommended torque, aligning one of the slots in the nut with the retaining nut lock.

(6) Bend the retaining nut lock into the slot on the nut.

(7) Remove the coupling holder.

NOTE: Please see the TEMPORARY REVISION that revises this page.

AA. Fuel Manifolds

(1) Position the right and left fuel manifolds into the opening on the bottom of the diffuser case and on the bosses in the rear of the diffuser case.

(2) Place a spacer between each mounting boss and the fuel manifolds. Secure the manifolds to the diffuser case with the tabwashers and bolts. Tighten the bolts to the recommended torque.

(3) Bend each tabwasher against a flat on the bolt. Lockwire the bolts to holes in case bosses.

(4) Position transfer valve connector on mounting pad at bottom of diffuser case.

(5) Secure connector with bolts. Tighten bolts to 75 - 85 lb-in. and lockwire.

AB. Fuel Pressurizing and Dump Valve Installation

(1) Place two packings on each transfer tube and install tubes in fuel pressurizing and dump valve.

(2) Position pressurizing and dump valve on fuel transfer valve connector at bottom of diffuser case, aligning tubes with holes in fuel manifold.

(3) Secure valve to connector with washers and bolts. Torque bolts to 75 - 85 lb-in. and lockwire.

(4) Pressure check fuel pressurizing and dump valve parting surfaces.

AC. Pressure Check Of The Fuel Pressurizing And Dump Valve Parting Surfaces
See Tool Group 66.

(1) Attach the signal adapter to the fuel signal connection on the dump valve.

(2) Attach the drain adapter to the dump valve drain.

(3) Connect the inlet adapter to the inlet connector of the valve.

(4) Remove the plug from the secondary pressure tap and install dump valve drain adapter.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(5) Install a sealing clamp on each fuel nozzle.

(6) Connect test stand outlet ports to the inlet adapter and signal adapter. Connect the return port to the secondary pressure tap adapter and close return port shutoff valve.

(7) Supply test fluid at a pressure of at least 200 psig to the signal adapter to close the dump valve.

(8) Pressurize system through pressurizing and dump valve inlet and bleed trapped air from the fuel manifolds by lifting one nozzle seal on the nozzle in each manifold furthest away from the pressurizing and dump valve.

(9) Increase the pressure at the test stand to 600 psig and maintain for five minutes.

(10) Inspect for leakage at the following locations:

(a) The joints between the fuel manifolds.

(b) Between the fuel manifold and the fuel transfer valve adapter.

(c) Between the fuel transfer valve adapter and the fuel pressurizing and dump valve.

(11) After completion of the inspection, connect remaining fuel return hose to dump valve adapter and shut off stand to relieve pressure.

(12) Shut off inlet and signal lines and start stand.

(13) Open valve on secondary pressure tap line.

(14) Drain manifold of fluid using ejector in test stand.

(15) Disconnect test stand and adapters.

CAUTION: DO NOT DISTURB ANY CONNECTIONS THAT HAVE BEEN PRESSURE CHECKED.

(16) Replace secondary pressure tap plug, torque and lockwire.

NOTE: Please see the TEMPORARY REVISION that revises this page.

4. Combustion And Turbine Sections

A. Combustion Chamber Fuel Drain Valve Installation

(1) Position combustion chamber fuel drain valve (valve flapper inward) on combustion chamber fuel drain valve flange, aligning holes in valve with holes in flange.

(2) Position combustion chamber fuel drain valve adapter (drain outlet ports facing down and forward) over fuel drain valve.

(3) Install bolts securing adapter and valve to flange. Tighten bolts to recommended torque and lockwire.

B. First Stage Turbine Vanes
See Tool Group 51.

(1) Place support fixture (posts upward) on bench.

(2) Position turbine case (front flange up) on fixture engaging offset dowel of fixture in offset hole in case.

(3) Position first stage turbine vane inner shroud (mounting flange up) on fixture, engaging offset dowel of fixture in offset hole of shroud flange.

(4) Position inner end of first stage turbine vane in slot in inner shroud, aligning hole in vane outer end with hole in turbine case.

(5) Position first stage turbine vane retaining pin in retaining pin drift. Insert exposed end of pin into hole in vane. Using mallet, drift pin into hole until drift bottoms.

(6) Install remaining first stage turbine vanes in same manner.

(7) Position combustion chamber outlet duct (rear flange down) on outlet duct support, aligning offset hole in duct inner flange with offset hole in 1st stage turbine vane inner shroud.

NOTE: SB 5091 provides combustion chambers and clamps with additional cooling air holes, and combustion chamber outlet duct assembly with an increased air gap between detail lugs and duct. These chambers, clamps, and duct must be used as complete sets.

(8) Secure outlet duct to outlet duct support with bolts. Tighten bolts to recommended torque and lockwire.

(9) Remove turbine case assembly from fixture.

C. Turbine Rotor Build For Concentricity And Dynamic Balance Check
See Tool Group 102.

(1) Install turbine shaft (flange end down) and 1st stage disk into shaft assembly fixture with guide pins protruding through four of holes in flange and disk.

NOTE: Temperature difference of at least 44°C (80°F) is required when assembling disk to shaft.

(2) Install four work bolts (bolt head flats adjacent to disk mounting flange OD) through unoccupied disk and shaft flange holes. Secure bolts with retaining nuts.

(3) Apply extreme pressure grease to fir tree serrations and blade shrouds to present galling or pickup.

(4) Install each blade using following procedure:

(a) Install support into ID of fixture and install pilot.

(b) Place the disk over pilot and adjust jacks on support until they contact disk.

(c) Install detail part into fixture and secure belt around disk.

NOTE: Leave three-eighths to one-half inch of fir-tree slot extending above belt.

(d) Install blades in counterclockwise direction in fir-tree slots down to belt.

NOTE: Install blades in disk so that any two blades 180 degrees apart have same "moment" classification letters. As an optional procedure to be used at discretion of operator, blades may be assembled by "mass" weighing individual blades to nearest one-hundredth of an ounce and marking weights on blades, using red crayon. Lay out blades in order of diminishing weight, and install heaviest blade on disk. Install next heaviest blade diametrically opposite first installed blade. Install lightest blade adjacent to and clockwise from first installed blade. Install next lightest blade diametrically opposite lightest blade. Proceed in order of maximum weight progressively around hub.

(e) Remove belt from turbine disk.

(f) Position pusher over centerpost, and adjust roller position if over flat portion of turbine blade.

(g) Rotate pusher counterclockwise, applying slight downward pressure until all blades are flush with disk.

NOTE: Pusher must be rotated counterclockwise only.

(5) Lubricate rivets with extreme pressure grease.

(6) Install half of rivets (heads to rear of disk) in rivet holes. Using retaining rivet riveter, flare rivets to minimum diameter of 0.140 inch by turning jackscrew.

(7) Install and flare remaining rivets.

CAUTION: THERE MUST BE NO AXIAL PLAY IN RIVETS AFTER RIVETING. FORE AND AFT MOVEMENT OF INSTALLED TURBINE BLADES SHOULD BE NEGLIGIBLE IN SHROUD AREA. LIGHT DRAG, OR AT LEAST SURFACE CONTACT, MUST BE OBSERVED IN NOTCH AREAS WHEN BLADES ARE MOVED BY HAND IN PLANE OF ROTATION. NO AUDIBLE CLATTER OR RATTLE SHOULD OCCUR WHEN BLADES ARE LIGHTLY STRUMMED BY FINGERS. DISK AND BLADE SUBASSEMBLY IS CONSIDERED REJECTED IF BLADE RATTLE OR SHROUD LOOSENESS IS DETECTED, AND IS CAUSE FOR INDIVIDUAL PART INSPECTION AND/OR REPLACEMENT.

(8) Position disk to fixture collar around 1st stage blades, and attach lifting sling to spools of collar.

R
R

(9) Install transport fixture on transport stand so frame of fixture is directly over base of stand. Secure with quick-disconnect.

(10) Open hinged mounting devices on fixture, and trunnion on rotor hub and disk and blades assembly with collar, onto fixture. See Figure 711.

(11) Trunnion turbine rotor, shaft end down, and remove work bolts.

(12) Install turbine rotor bolts, and secure with retaining rings.

(13) Position 2nd stage turbine disk (front face up) on bench.

(14) Apply extreme pressure grease to fir-tree serrations and blade shrouds to prevent galling and pickup.

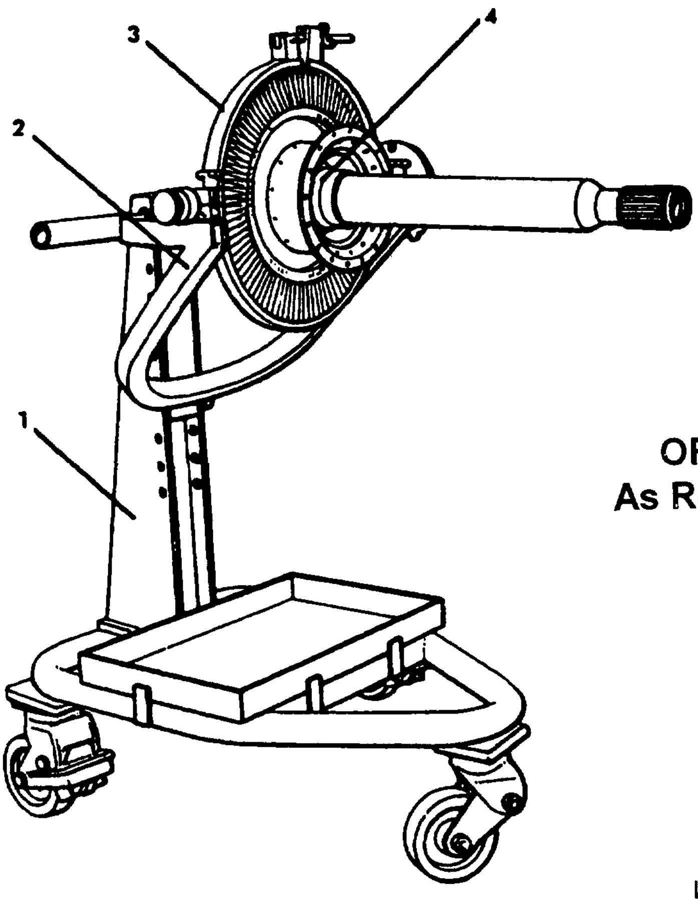
CAUTION: DO NOT MIX PN 392561 BLADES WITH PN 475302 BLADES. THESE BLADES HAVE DIFFERENT SHROUD NOTCH ANGLES, AND WILL NOT MATE CORRECTLY.

(15) Install blades, and rivet them in position in same manner described for 1st stage turbine disk.

R NOTE: A maximum of 0.010 inch axial movement is per-
R mitted at the root area of the 2nd stage turbine
R blade, but the retaining rivet must be tight and
R there must be no end play. Fore and aft movement
R of installed turbine blades should be negligible
R in the shroud area. There must be light drag,
R or at least surface contact, felt by hand in the
plane of rotation. No audible clatter or
rattle should occur when blades are lightly
strummed by fingers. Disk and blade subassembly
is considered rejected if blade rattle or shroud
looseness is detected, and is cause for
individual part inspection and/or replacement.

(16) Install turbine rotor inner seal (flanged end forward) on 1st stage turbine disk.

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-08902 (0000)

1. Turbine Assembly Build And Transport Stand
2. Turbine Assembly Build And Transport Fixture
3. First Stage Disk to Fixture Collar
4. Turbine Rotor Assembly

Turbine Rotor In Build Stand
Figure 711

(17) Position 2nd stage turbine disk on turbine shaft flange, aligning offset hole in disk with offset hole in flange, and engaging front face flange in ID of turbine rotor inner seal.

NOTE: Temperature difference of at least 44°C (80°F) is required when assembling disk to shaft.

(18) Place tabwasher on each bolt, engaging long tab in small hole adjacent to each bolt.

(19) Install nuts on bolts and tighten bolts, as follows:

(a) Tighten nuts simultaneously in pairs 180 degrees apart.

(b) Loosen nuts simultaneously in pairs 180 degrees apart to zero lb-in.; then retighten to specified limits.

NOTE: Loosening and tightening must be done simultaneously in pairs 180 degrees apart.

(20) Install No. 3 bearing oil scoop on turbine rotor shaft (sealing face to rear).

(21) Install balance bearing (rear) using Bearing Drift.

NOTE: Do not heat balance bearing above 82° - 95°C (180° - 200°F).

(22) Install No. 3 bearing inner race retaining nut handtight. Place Retaining Nut Wrench on shaft.

(23) Bolt inner race torquing holder to bench. Using lifting sling, lift rotor assembly from stand onto holder, installing shaft in splined holder.

(24) Using wrench, tighten No. 3 bearing inner race retaining nut to recommended torque.

(25) Using lifting sling, remove turbine assembly from holder and trunnion it back onto build stand.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(26) Start balance bearing (front) on turbine shaft. Place bearing drift over end of shaft and tap with mallet until end of shaft contacts drift. This will place bearing in proper position.

NOTE: Do not heat balance bearing above 82° - 95°C (180° - 200°F).

D. Turbine Rotor Concentricity Check
See Tool Group 103 and Figure 712.

(1) Install and secure the front and rear balance bearing housings in the pedestals of the concentricity check fixture.

(2) Using lifting sling, lift rotor assembly from stand onto concentricity fixture. Remove collar from around 1st stage blades.

NOTE: Face of the inner races of bearings used for concentricity and runout check must be square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 inch FIR.

(3) Using a height gage and a dial indicator, check rear (sealing) face of No. 3 bearing oil scoop for squareness runout. Squareness runout must not exceed 0.001 inch FIR. The scoop may be rotated to meet this requirement.

(4) After runout requirements have been met, mark radial position of scoop with layout dye.

(5) Using a height gage and an indicator, check squareness runout of turbine disks. Runout is measured from the front face of the 1st stage disk inside rivet circle to the rear face of the 2nd stage disk inside rivet circle. Squareness runout must not exceed 0.005 inch FIR.

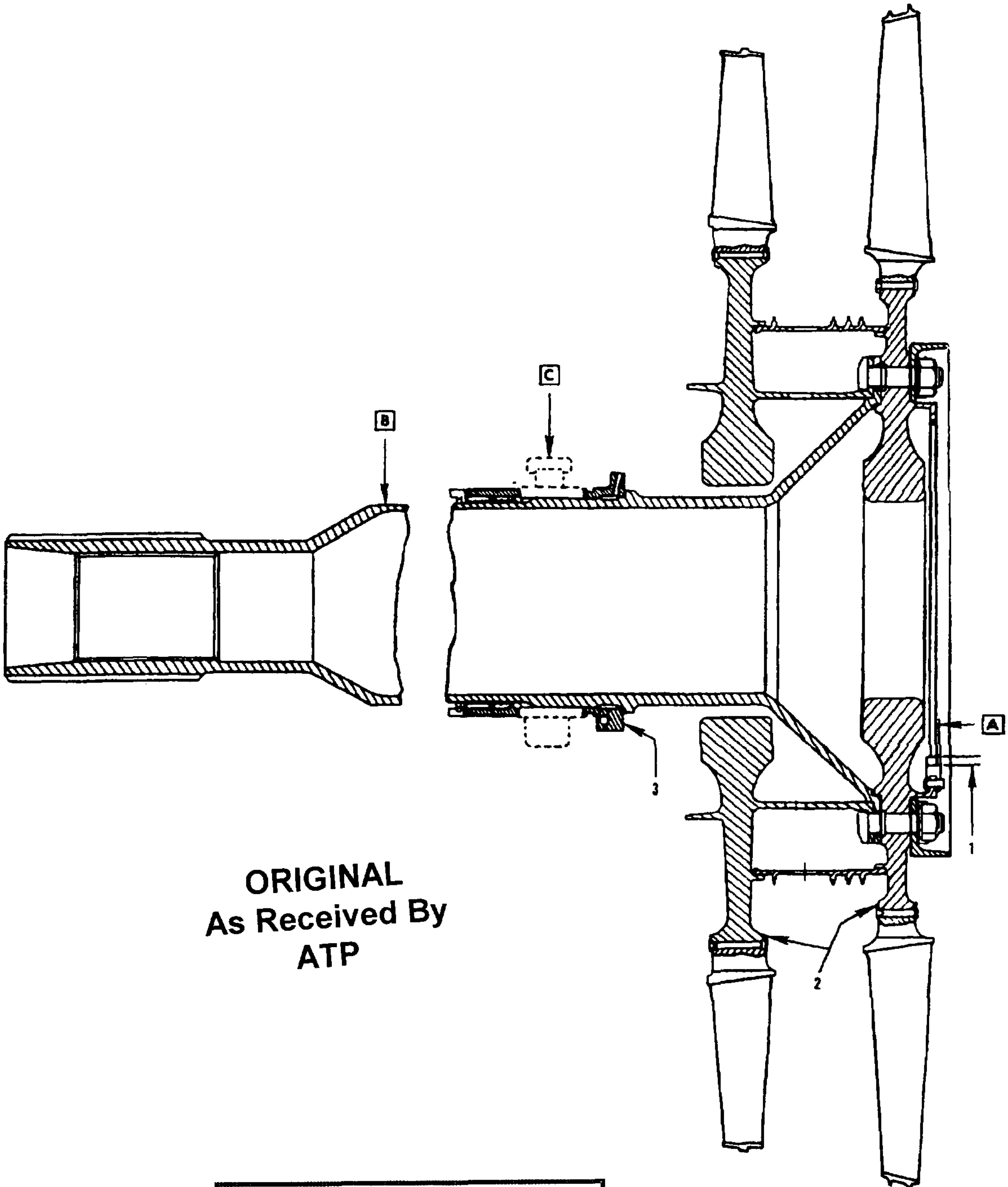
(6) Check high point of axial runout on front face of turbine shaft spacer. Mark point of greatest runout on turbine blade in-line with this point.

NOTE: This point will be indexed 180 degrees with high point of runout of mating hub.

(7) Using layout dye, mark radial position of spacer to hub.

(8) Reinstall sling, and lift assembly from fixture onto storage stand.

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-09218 (0470)

Turbine Rotor Concentricity
and Squareness Check
Figure 712

ENGINE GENERAL - ASSEMBLY OF SUBASSEMBLIES

1. To Dynamically Balance, Material May Be Removed To This Shoulder Or On The Ends Of Counterweights Provided A Wall Thickness Of 0.140 Inch Is Left At The Rivets. Each Multi-hole Counterweight Must Be Mounted With A Rivet In Each End Hole.
2. Squareness Runout Of These Surfaces Must Not Exceed 0.005 Inch FIR When Assembly Is Supported At Planes B And C.
3. Squareness Runout Of This Surface Must Not Exceed 0.001 Inch FIR When Assembly Is Supported At Planes B And C. Plate May Be Rotated For This Requirement.

NOTE: Faces of inner races of bearings used during balance operations or concentricity and runout checks must be square with the ID of the bearing 0.0005 inch FIR maximum and parallel 0.0005 inch FIR maximum.

NOTE: Semi-dynamic unbalance of the assembly when held at Planes B and C must not be more than 1.0 oz-in. in Plane A or 0.2 oz-in. in Plane B at 1700 rpm. Turn the spacer as necessary to get unbalance in these limits. Residual unbalance must not be more than 0.1 oz-in. in Plane A. Correct with counterweights.

Key To Figure 712

E. Turbine Rotor Dynamic Balance Check
See Tool Group 105.

(1) Install and secure front and rear balance bearing housings in cradles of balance machine.

(2) Lift turbine rotor from build and transport fixture using strap. Lower rotor onto balance machine so that disks and blades enter bottom half of turbine balance shroud.

(3) Secure front balance bearing to its housing on balance machine using retaining strap. Place strap around bearing and bolt it to housing.

(4) Remove lifting strap, slip drive belt over turbine shaft before lowering rotor, and close cover of turbine balance shroud.

<u>NOTE</u>: Faces of the inner races used for balancing must be square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 inch FIR.

(5) Start rotor spinning, gradually increasing its speed until it is rotating at 1700 rpm.

(6) Semi-dynamic unbalance of complete assembly must not exceed 0.200 ounce-inch when rotating at 1700 rpm.

(7) Unbalance can be corrected by adding counterweights at Plane A, Figure 712. Install four rivets in each counterweight, preformed head toward the front.

NOTE: Not more than three counterweights and 12 rivets may be added to correct unbalance. Fine balance may be obtained by removing material from shoulder or on the ends provided a wall thickness of 0.140 inch is left at the rivets and two rivets in end holes hold each counterweight.

NOTE: Mark point of most unbalance on rear face of turbine shaft flange. Use a temporary marking method. Refer to Section 70-11-00 in the Standard Practices Manual.

(8) After final balance has been achieved, flare counterweight rivets with the retaining rivet Riveter to obtain a 0.130 inch diameter flare.

(9) Mark radial location of turbine rotor inner seal in line with offset hole on 2nd stage turbine disk.

(10) Remove straps from the front balance bearing housing.

(11) Using lifting strap, lift turbine rotor assembly from balance machine and reinstall it in fixture and build stand.

F. Turbine Rotor Disassembly After Dynamic Balance
See Tool Group 104.

(1) With turbine rotor assembly secured by disk to fixture collar, transport fixture, and transport stand, engage jaws of front balance bearing puller behind turbine front balance bearing inner race. Using jackscrew action, pull bearing off shaft.

(2) Place retaining nut wrench on shaft and attach lifting sling on spools of collar.

(3) Lift turbine off fixture and stand onto inner race torquing holder, installing shaft splines in splines of holder.

(4) Using wrench, remove No. 3 bearing inner race retaining nut.

(5) Using sling, remove turbine assembly from holder and reinstall it on stand.

(6) Engage three puller jaws of balance bearing puller in slots of No. 3 bearing oil scoop and secure with retaining ring. Turn jackscrew so pad rests on end of shaft and pull oil scoop and bearing from shaft.

(7) Remove nuts securing 2nd stage turbine disk and blades to hub and lift off 2nd stage disk.

(8) Remove turbine rotor inner air seal off 1st stage disk.

NOTE: Make certain radial location of air seal has been marked with respect to the offset in the 2nd stage disk.

G. No. 3 Bearing Seal Assembly

(1) Install metal seal ring (angular face forward) in groove of No. 3 bearing seal housing. See Figure 710 and Table of Limits.

(2) Place No. 3 bearing seal support (mounting flange up) on bench.

(3) Position spring on each seal loading pin.

(4) Install seal housing (carbon seal up) in support with loading pins protruding through holes in housing.

(5) Install cotter pin (head toward OD of support) in each of three loading pins which have cotter pin holes. Secure each cotter pin by bending legs around pin.

H. No. 3 Bearing Seal Installation

(1) Position No. 3 bearing seal assembly (mounting flange up) over turbine shaft and lower seal assembly until turbine rotor 1st stage front inner seal rests on turbine disk.

I. No. 3 Bearing Installation
See Tool Group 10 and the Table of Limits.

(1) Position combustion chamber inner case (rear flange up) on bench.

(2) Position No. 3 bearing outer race in bearing housing.

CAUTION: OLD RACE SHALL BE REINSTALLED WITH SERIAL NUMBER SAME WAY AS WHEN REMOVED. NEW RACE SHALL BE INSTALLED WITH SERIAL NUMBER FACING AWAY FROM OPERATOR.

(3) Install No. 3 bearing outer race retaining nut handtight.

(4) Install anchor plate on combustion chamber inner case rear flange.

(5) Mount hydraulic wrench on anchor plate and secure with thumbscrews.

(6) Insert socket (through hydraulic wrench) into retaining nut.

(7) Mount ratchet adapter and torque wrench on hydraulic wrench.

(8) Using hydraulic wrench, tighten outer race nut (refer to Reference 359 in the Table of Limits).

(9) Install and flare the rivet with the Riveter.

(10) Install No. 3 bearing oil scoop, puller groove forward, on turbine shaft.

(11) Trunnion turbine rotor into horizontal position.

(12) Heat No. 3 bearing inner race in hot oil.

(13) Position No. 3 bearing inner race on turbine shaft and position inner race drift over shaft and against front face of inner race. Drift inner race into position.

CAUTION: OLD RACE SHALL BE REINSTALLED WITH SERIAL NUMBER IN SAME WAY AS WHEN REMOVED. NEW RACE SHALL BE INSTALLED WITH SERIAL NUMBER FACING OPERATOR.

(14) Install No. 3 bearing inner race retaining nut on turbine shaft. Tighten nut handtight.

(15) Torque inner race retaining nut as follows:

(a) Install adapter over turbine shaft so that ID splines of adapter engage OD splines of shaft.

(b) Bolt No. 3 bearing inner race retaining nut wrench to hydraulic wrench.

(c) Slide assembled wrenches over adapter and position wrenches so that teeth of retaining nut wrench engages slots in nut and splines and hydraulic wrench engages splines of adapter.

(d) Using hydraulic pressure, torque nut (refer to Reference 360 in the Table of Limits).

(16) Install inner race retaining nut tablock, inserting straight tabs in turbine shaft slots and bent tabs in castellations of retaining nut.

CAUTION: ENSURE THAT TABLOCK IS PROPERLY INSTALLED.

(17) Install tablock retaining ring in groove in retaining nut.

CAUTION: ENSURE THAT RING IS PROPERLY INSTALLED.

(18) Determine turbine positioning spacer thickness.

J. Turbine Positioning Spacer Measurement
See Tool Group 98 and Figure 713.

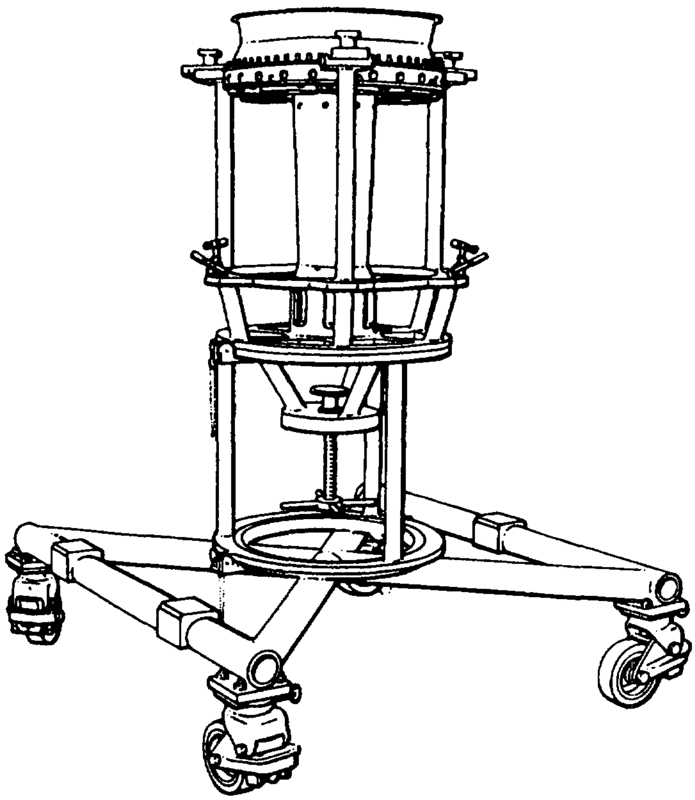
(1) Install gage fixture on transport stand, positioning frame of fixture directly over base of stand. Secure fixture to stand with quick-disconnect device.

(2) Install gage plug in hole in base of fixture.

NOTE: All surfaces of gage plug must be clean.

(3) With first stage turbine rotor outer airseal installed in turbine case place turbine case over pedestal on fixture so that outlet duct rests on the base of fixture.

(4) Position combustion chamber inner case on pedestal and install gasket on inner case rear flange.



L-08467 (0000)

ORIGINAL
As Received By
ATP

NOTE: Please see the TEMPORARY REVISION that revises this page.

Turbine Positioning Spacer
Measurement Build
Figure 713

(5) To ensure accurate turbine rotor positioning measurement, disk must be flush with shaft flange. Using suitable spacer or washers and four nuts secure disk to flange using care not to damage retaining rings.

(6) Lock disk to fixture collar around OD of the 1st stage turbine disk and blades, making certain that the blade tips bottom in the collar.

(7) Suspend the lifting sling from a hoist and secure the sling hook to the outer trunnion spools of the collar.

(8) Lower the turbine rotor through the combustion chamber inner case until the front end of the shaft rests on the gage. Remove the sling and collar.

CAUTION: ONLY HAND-OPERATED CHAIN HOISTS SHALL BE USED TO LOWER THE TURBINE ROTOR. IF THE ROLLERS OF THE NO. 3 BEARING ARE ACCIDENTALLY STRUCK DURING THIS OPERATION, THE BEARING COMPONENTS MUST BE REMOVED AND CAREFULLY CHECKED FOR DAMAGE OR DISTORTION. EXTREME CARE SHALL BE EXERCISED WHENEVER HOISTS OF ANY KIND ARE USED TO PRECLUDE DAMAGE TO ENGINE BEARINGS AND/OR RELATED PARTS.

(9) Raise turbine case and attach to vertical support of fixture.

NOTE: For JT12A-8, JFTD12A-4A and -5A engines, 1st stage turbine rotor seal must be snapped over blade shroud prior to positioning of turbine case. Install as follows:

(a) Lift seal from turbine case and position on front of 1st stage disk and blade assembly by tilting so that portion of rear knife-edge is behind blade shroud spoiler.

(b) Move seal until portion of knife-edge behind spoiler abuts shroud, ensuring maximum radial clearance for unengaged portion of seal.

(c) Moving circumferentially from engaged area of seal, apply outward hand pressure until remainder of rear knife-edge snaps over spoiler. Align seal with retaining groove when turbine case is raised.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(10) Using aligning pins, line up holes in No. 3 bearing seal assembly, the inner case rear flange, the 1st stage turbine vane inner shroud, and the outlet duct flange. Secure with the bolts. Tighten the bolts to the recommended torque and lockwire.

(11) Retract the vertical supports from the turbine case.

(12) Install combustion chamber outer case and secure to turbine case with nuts. Tighten nuts to recommended torque.

(13) Position indicating gage across rear flange of turbine case with the flush pin resting on the rear face of the 1st stage turbine disk between two blade retaining rivets.

(14) Install dial indicator on the gage with the plunger resting on the controlled flat of the gage frame.

(15) Set dial face to read 0.400 inch and lock dial face.

(16) Slide dial indicator along the frame until plunger rests on end of flush pin.

(17) Record dial readings as Dimension A.

(18) Repeat steps (13) thru (17), taking reading at location 180 degrees from first reading. Any variance in Dimension A indicates improperly positioned disk or gage.

(19) Position compressor rear hub gage across rear flange of diffuser case with indicator pin resting on the platform in compressor rear hub.

NOTE: This procedure must be coordinated with installation of diffuser case. Refer to Final Assembly.

(20) Slide dial indicator until plunger rests on the controlled flat of the gage frame.

(21) Set dial at zero and lock in position.

(22) Slide dial indicator until plunger rests on gage indicator pin.

(23) Record dial reading as Dimension B.

(24) Sum of Dimension A and Dimension B is correct turbine positioning spacer thickness.

NOTE: After calculations have been made and required clearance met, measurements and all calculations shall be checked by another individual to ensure correct rotor position. Based on measurement check, spacer removed at disassembly shall be used at final assembly provided turbine runout requirement can be met. Selection of new spacer or grinding of one used previously will require new turbine rotor runout check. This will be necessary to determine rotor high point at spacer for proper indexing with compressor at final assembly. (Refer to Turbine Rotor Concentricity Check).

(25) Unfasten nuts and remove combustion chamber outer case.

K. Turbine Positioning Spacer Grinding
See Figure 714.

(1) If complete stock of classified spacers is not available, thicker spacer may be ground to required class. See Figure 714.

(1) Obliterate existing class marking and stamp new classification as indicated.

(2) Record date, required width of spacer (Dimension X in the figure), and class of spacer used in the engine build record.

L. Turbine Positioning Spacer Installation
See Tool Group 97.

(1) Attach turbine positioning fixture on turbine shaft flange and lift turbine section from build and gage fixture.

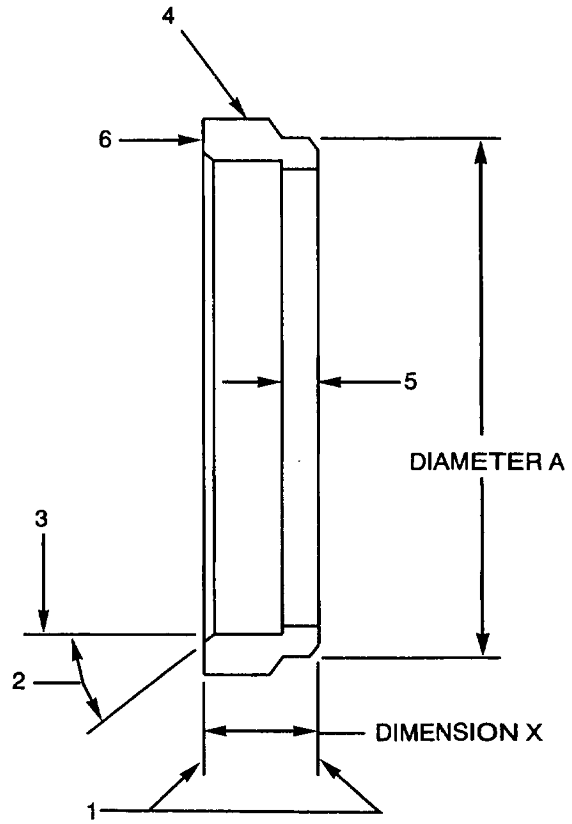
(2) Position turbine positioning spacer on spacer drift.

(3) Using mallet, drift spacer (small ID down) into turbine shaft until it seats on shoulder in shaft.

(4) Lower turbine section back into build and gage fixture.

M. Exhaust Cone and Strut Installation

CLASS	DIMENSION X
A	.399–.403
B	.404–.408
C	.409–.413
D	.414–.418
E	.419–.423
F	.424–.428
G	.429–.433
H	.434–.438
J	.439–.443
K	.444–.448
L	.449–.453
M	.454–.458
N	.459–.463
P	.464–.468
R	.469–.473
S	.474–.478
T	.479–.483



L–08915 (0000)
PW V

NOTE: Please see the **TEMPORARY REVISION** that revises this page.

Turbine Positioning Spacer Grinding
Figure 714

1. These Surfaces Must Be Parallel Within 0.0002 inch FIR.
   15 Micro-Inch Allowable Roughness.
2. 30 degrees ± 2 degrees
3. 1.870 - 1.890 Inch Diameter
4. Mark Class Here
5. 0.115 - 0.125 Inch
6. Grind Only This Face To Obtain Desired Class

Key to Figure 714

(1) Place exhaust cone and strut assembly (front end down) on a bench.

(2) Position turbine exhaust case over cone and strut assembly, aligning boltholes in end of struts with holes in case.

(3) Install locating bolts. Tighten bolts to recommended torque and lockwire.

5. Accessory Section

A. Gearbox Oil Strainer

(1) Position oil strainer screen assembly on its stud over gearbox sump.

(2) Secure strainer to gearbox with washer and nut. Lockwire nut.

B. Breather Oil Seal Assembly
See Tool Group 15.

(1) Place carbon seal into carbon seal drift so that protruding carbon enters cavity in drift.

(2) Insert seal into housing and press it firmly into liner.

C. Installing Roller Bearing Outer Races In Gearbox Housing
See Tool Group 68.

(1) Install fuel control drive gearshaft roller bearing outer race in its liner in gearbox housing.

(2) Install main component drive gearbox gearshaft roller bearing outer race in housing.

(3) Install starter and generator drive gearshaft roller bearing outer race in housing.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(4) Position component drive gearbox gearshaft roller bearing outer race on outer race drift. Install drift and race through opening in gearbox housing until outer race starts into liner; then push outer race into position.

D. Hydraulic Pump Drive Gearshaft Assembly
See Tool Group 55.

(1) Place roller bearing base on a bench and install gearshaft over pilot of base. Place inner race and rollers on shaft.

(2) Position roller bearing drift over end of gearshaft and drift roller bearing inner race into position.

(3) With ball bearing base on a bench, install gearshaft over pilot of base. Start ball bearing on shaft.

(4) Position ball bearing drift in ID of gearshaft and push bearing into position.

(5) Install assembled gearshaft into gearbox.

E. Fuel Control Drive Gearshaft Assembly
See Tool Group 58.

(1) Place gearshaft from base on bench and install splined end of gearshaft on pilot of base.

NOTE: Use PWA 13638 base for gearshaft PN 500348.

(2) Position rear bearing inner race and rollers on end of gearshaft. Insert pilot of rear bearing drift into gearshaft and push inner race and rollers into position.

(3) Place gearshaft rear base on bench and install rear end of shaft on pilot of base.

(4) Start front bearing on shaft, then install pilot of front bearing drift into shaft ID until OD of drift rests on bearing inner race. Push bearing into position.

NOTE: Use PWA 13639 drift for gearshaft PN 500348.

(5) Coat gearshaft bearing rollers with petrolatum and install gearshaft into gearbox.

F. Starter - Generator Gearshaft Bearings Assembly
See Tool Group 92.

(1) Place ball bearing base on a bench and install gearshaft into hole in base. Place ball bearing on shaft.

(2) Position ball bearing drift into gearshaft and drift ball bearing into position.

(3) Place roller bearing base on a bench and install gearshaft on pilot of base. Place inner race and rollers on shaft.

(4) Install pilot of drift into ID of gearshaft and push inner race and rollers into position.

G. Starter-Generator Drive Assembly
See Tool Group 86.

(1) Lubricate preformed packing and install it in groove of previously assembled gearshaft.

(2) Insert starter-generator driveshaft into gearshaft, mating external splines of driveshaft with internal splines of gearshaft.

(3) Place gearshaft base on bench and install gearshaft on pilot of base.

(4) Position main oil pump gearshaft into starter-generator gearshaft. Install drift into main oil pump gearshaft. Install drift into main oil pump gearshaft and drift gearshaft into position, pushing on bottom of 0.432 - 0.442 inch diameter hole.

(5) Install washer and nut through starter-generator driveshaft onto threaded end of main oil pump gearshaft; then torque nut.

(6) Lubricate bearing rollers with petrolatum and install starter-generator drive assembly into gearbox.

H. Component Drivegear Assembly
See Tool Group 21.

(1) Drift ball bearing onto component drive bevel gear using bearing drift.

(2) Position component drive bevel spur gearshaft on pilot of gearshaft holder and secure with clamp.

(3) Place bevel gear and ball bearing on bevel spur gearshaft. Install pilot of bevel gear and bearing drift in ID of gearshaft with drift resting on bevel gear and ball bearing. Drift gear and bearing into position.

(4) Place ball bearing retaining nut on bevel spur gearshaft. Install retaining nut wrench in ID of gearshaft with teeth in nut. Torque nut to minimum of 500 lb-in.

(5) Insert rivet in inside diameter of gearshaft through retaining nut. Install bearing nut rivet support into end of gearshaft, under head of rivet, until rivet is held in position. Flare end of rivet.

(6) Position bevel spur gearshaft and bevel gear on pilot of component drivegear holder and secure with stop and clamp.

(7) Place fuel control drive spur gear on mating splines of bevel spur gearshaft. Using roller bearing drift, drift gear into position.

(8) Place bearing inner race and rollers on bevel spur gearshaft and push into position with drift.

CAUTION: ENSURE THAT RIVET IS PROPERLY FLARED.

(9) Place roller bearing inner race retaining nut on gearshaft. Install retaining nut wrench in ID of bevel spur gearshaft with teeth in nut and torque to minimum of 250 lb-in. Install rivet.

I. Component Drive Gearbox Gearshaft
See Tool Group 19 and Figure 715.

CAUTION: USE AN ARBOR PRESS TO INSTALL BEARINGS (IMPACT CAN SERIOUSLY DAMAGE BEARINGS).

(1) Using arbor press and suitable drift, install ball bearing into support and secure with retaining ring.

(2) With gearshaft mounted on ball bearing base, position roller bearing inner race on gearshaft. Engage pilot of roller bearing drift into ID of gearshaft; then, with drift resting on inner race seat bearing race on gearshaft using arbor press.

(3) Measure Dimensions A and B on separate assemblies as shown in Figure 715.

(4) Position gearshaft on base with roller bearing inner race down. Then place ball bearing and support assembly on gearshaft so that bearing bore and bearing journal on shaft are partially engaged.

(5) Position ball bearing drift pilot in gearshaft ID; expand jaws to contact ball bearing inner race; drift ball bearing and support assembly onto gearshaft.

(6) To ensure that gearshaft and ball bearings are properly seated measure Dimension C as shown. If Dimension C exceeds sum of Dimensions A and B by more than 0.003 inch, repeat step (5) until assembly is in limits.

(7) Install preformed packing in support.

(8) Install assembled support in gearbox housing and secure with nuts.

CAUTION: USE CAUTION WHEN MATING ROLLER BEARING OUTER RACE AND ROLLERS TO PREVIOUSLY INSTALLED OUTER RACE.

J. Main Component Drive Gearbox Gearshaft And Housing Assembly - Assembly And Installation (Dual Housing Configuration) See Tool Group 71A and Figure 716.

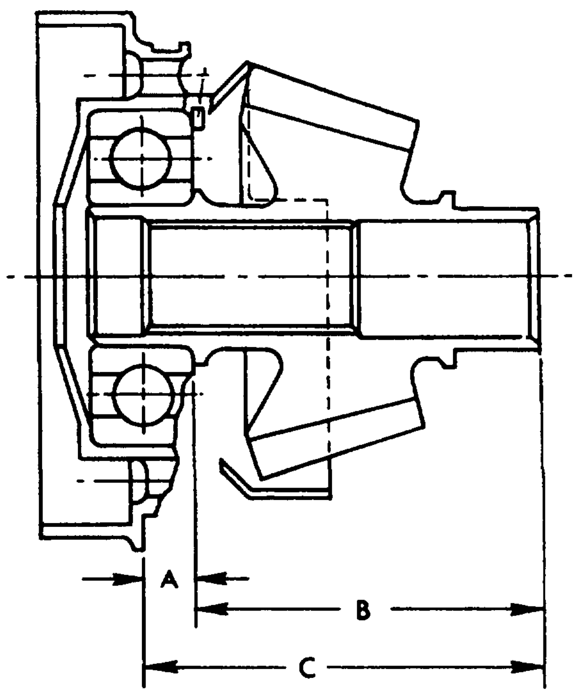
(1) Ball Bearing Installation

(a) Position upper housing (bearing diameter up) on bench.

(b) Using suitable drift, seat bearing in housing and secure with retaining ring.

(2) Gearshaft Installation

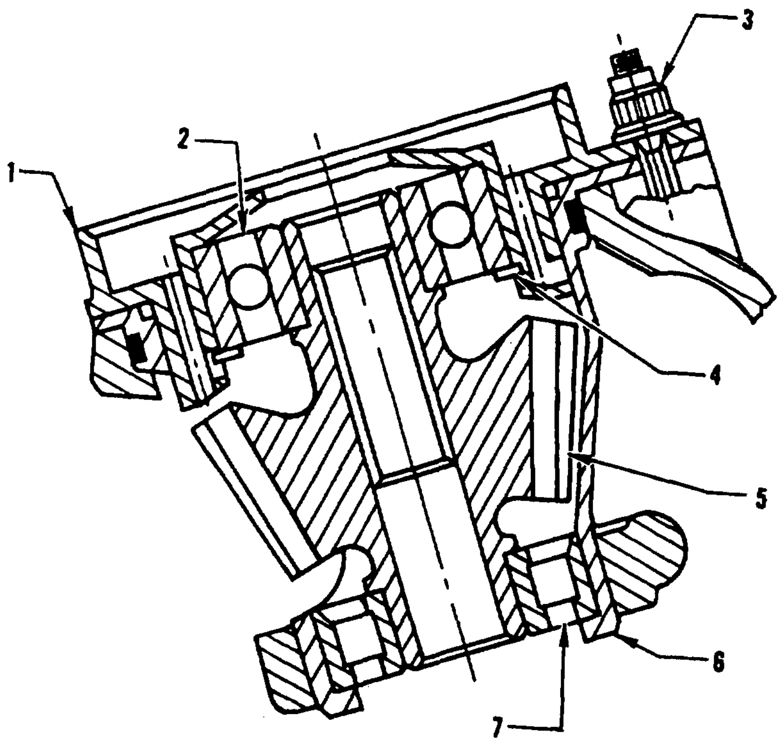
(a) Place ball bearing base on bench and position gearshaft on pilot of base with smaller end of bevel gear down.



L-24585 (0000)

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

Component Drive Gearbox Gearshaft
And Bearing Assembly Measurements
Figure 715



L-24269 (0000)

ORIGINAL
As Received By
ATP

NOTE: Please see the
TEMPORARY
REVISION
that revises this page.

Component Drive Gearshaft
And Housing Assembly
Figure 716

1. Upper Housing
2. Ball Bearing
3. Retaining Nut
4. Retaining Ring
5. Gearshaft
6. Lower Housing
7. Roller Bearing

Key to Figure 716

(b) Position upper housing (with ball bearing installed) on end of gearshaft.

(c) Insert drift through opening in upper housing and expand jaws to enable drift contact with inner race of ball bearing. Seat upper housing and bearing on gear shaft. Retract drift jaws and remove drift.

(3) Roller Bearing Inner Race Installation on Gearshaft.

(a) Position assembly (comprised of gearshaft, upper housing, and ball bearing) on ball bearing base.

(b) Place inner race and rollers on end of gearshaft. Then, with drift pilot engaged in gearshaft ID, seat race and rollers ensuring contact is made with shoulder on shaft.

(4) Roller Bearing Outer Race Installation in Lower Housing.

(a) Position lower housing on bench with OD flange up.

(b) With race positioned on roller bearing outer race drift, seat race in lower housing.

(5) Lower Housing Installation

(a) Position lower housing (with roller bearing outer race installed) on arbor press base with housing OD flange up.

(b) Place upper housing assembly (consisting of housing, ball bearing, gearshaft, and roller bearing less outer race) on lower housing.

(c) With upper housing drift positioned on face of upper housing, seat upper housing inside lower housing using arbor press.

(6) Assembly Installation in Gearbox

(a) Install preformed packing in groove of lower housing.

(b) Position lower detail plate of puller and driver on end of lower housing. Then, install puller and driver by inserting shaft of tool through gearshaft and threading into detail plate.

(c) With housing flange holes aligned with gearbox studs, seat assembly in gearbox using knocker action of tool.

(d) Remove detail plate to puller and driver; then secure assembly with retaining nuts.

K. Hydraulic Pump Drive Support Assembly
See Tool Group 53.

(1) Position hydraulic pump drive bearing support (bearing liner up) on seal assembly base.

(2) Place hydraulic pump driveshaft seal on seal assembly drift.

NOTE: Use PWA 13617 drift for PN 511196 and 511197.

(3) Insert pilot of drift into hole in base and press seal into support.

(4) Start roller bearing outer race in its liner in support and push into position using drift.

(5) Place seal assembly guide in splined end of hydraulic pump drive gearshaft.

(6) Install new preformed packing in groove of support and position support over guide. Tap support into gearbox, aligning screw holes in support with screw holes in housing.

(7) Secure assembled hydraulic pump support to gearbox housing with screws.

(8) Install hydraulic pump drive assembly cover and secure with washers and nuts.

R
R

L. Fuel Control Drive Oil Seal
See Tool Group 60.

(1) Position fuel control drive boss (bearing liner up) on shaft seal base and place seal on shaft seal drift. Press seal into boss.

NOTE: Use PWA 13618 drift for PN 511199 and 511200.

(2) Install new preformed packing in groove of boss.

(3) Place shaft seal guide in driveshaft and position pad over guide. Tap boss into gearbox.

M. Starter-Generator Drive Oil Seal.
See Tool Group 88.

(1) Position starter-generator support (bearing liner up) on seal assembly base.

(2) Place starter-generator drive oil seal on seal assembly drift. Position pilot of drift in hole in base. Press seal into support.

R NOTE: Use PWA 13617 drift for PN 511196 and 511197. Use PWA 13718 drift with carbon seals.

(3) Place preformed packing in groove of support.

(4) Place seal assembly guide on starter-generator driveshaft and position support over guide. Tap support into position, aligning screw holes in support with screw holes in housing.

(5) Secure support to housing with screws.

(6) Install starter-generator cover and secure with nuts and washers.

N. Gearbox Housing Assembly

(1) Install all plugs in gearbox housing. Lockwire plugs.

NOTE: For engines incorporating oil drain plug bushing with lockwire holes, install bushing and lockwire. See Table of Limits.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(2) Install component drive gearbox housing cover and install airframe bracket to bottom studs. Secure cover and bracket to housing with nuts and washers.

(3) For engines not incorporating SB 4178, install fuel signal tube clip bracket at fuel control mounting pad.

(4) Secure breather pressurizing valve elbow to its pad, making sure to place gasket, spacer, and gasket in sequence between elbow and pad.

(5) Position data plate seal and data plate on gearbox housing and secure with bolts and tabwashers.

O. Main Oil Strainer Assembly
See Tool Group 80.

(1) Place base of oil screen support holder in vise or on bench.

(2) Position flange of strainer in locating recess of holder.

(3) Stack spacers and screens on baffle with outlet spacer at each end and with each screen between outlet and inlet spacer.

(4) Place oil screen support over assembled screens and spacers with pin in support aligned with slot in bushing.

(5) Install top plate of holder, engaging cutouts in plate with lugs on strainer support, and with upright bolts through holes in plate. Secure plate with wing nuts

(6) Place spring and bypass valve inside strainer support.

(7) Install spacer retaining nut in baffle bushing and tighten nut with retaining nut wrench so that spacers and screens cannot be rotated by hand. Nut must be torqued until it contacts end of strainer support.

<u>NOTE</u>: Complete sets of parts consisting of two screens and one each of outlet and inlet spacers must be
R added or removed to meet tightening requirement.

(8) Remove strainer assembly from holding fixture.

NOTE: Please see the TEMPORARY REVISION that revises this page.

P. Main Oil Strainer Installation
R See Table of Limits and Figure 717.

R (1) Install strainer in oil strainer bore of gearbox (refer
R to the figure).

(2) Place new seal on OD of strainer cover, and install spring and cover over oil strainer.

(3) Secure cover to gearbox with washers and locknuts. Torque nuts to recommended torque (refer to Table of Limits).

(4) Install plug and new seal in cover. Tighten plug to be recommended torque as indicated in Table of Limits.

Q. Main Oil Strainer Installation
(For Engines Incorporating Threaded Bypass Valve)
See Tool Group 80A and Table of Limits.

(1) Place new preformed packing on OD of strainer cover.

(2) With spring sandwiched between strainer assembly and cover, insert end of installation clamp through cover drain hole and thread into bypass valve. Install washer detail and handtighten wing nut until spring is fully compressed.

(3) Insert strainer (with cover and spring attached) into oil strainer housing of gearbox.

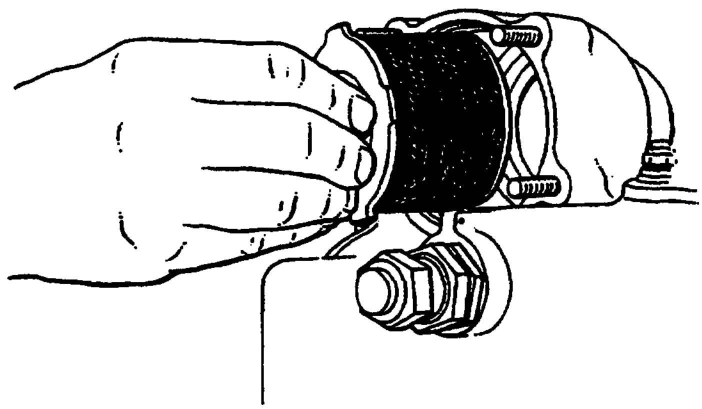
(4) Secure cover to gearbox with washers and nuts. Torque and lockwire nuts as required in Table of Limits, then remove clamp.

(5) Install drain plug and new preformed packing in strainer cover. Tighten plug to recommended torque as indicated in Table of Limits.

R. Main Oil Pressure Relief Valve
See Tool Group 77 and Figure 718.

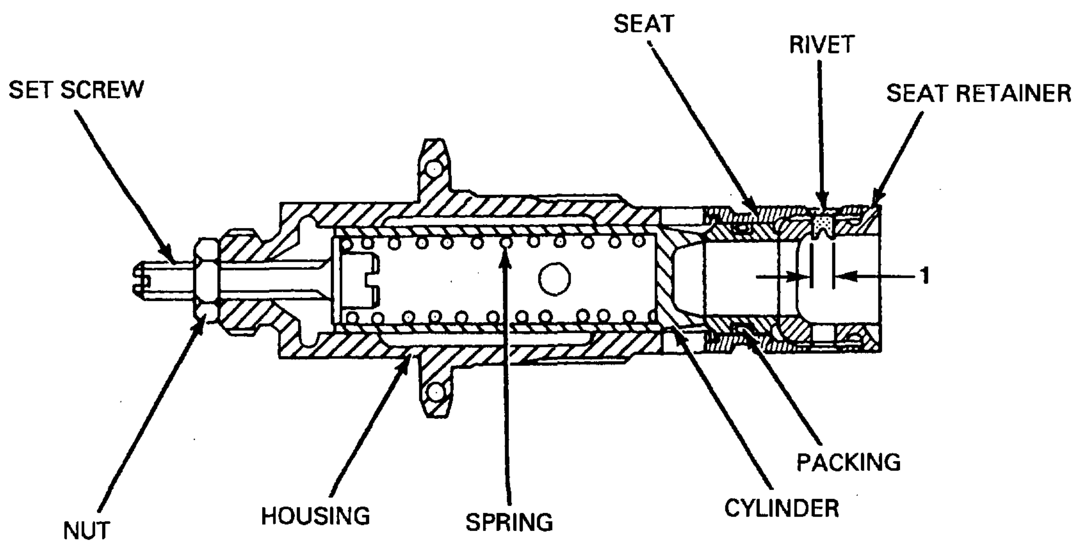
(1) Install setscrew through ID of pressure relief valve housing and thread nut on set screw.

(2) Install cylinder and spring; then place packing in recess on seat and install seat.



R
R

Installing Main Oil Strainer
Figure 717



L-H8380 (0108)
PW C

NOTE: Please see the
TEMPORARY REVISION
that revises this page.

1. 0.135 - 0.160 Inch Diameter

Oil Pressure Relief Valve
Figure 718

(3) Install seat retainer full depth into valve housing.

NOTE: Back off seat retainer to align rivet hole, if necessary.

(4) Install retaining rivet locating rivet head toward OD. Flare rivet at ID using riveter. For PN 488661 and 511847 valve assemblies, use PN 488355 rivet. For PN 745113 and 745114 valve assemblies, use PN 745112 rivet. PN 745112 rivet may be flared to meet dimensions shown in Figure 718. No cracks are allowed in rivet after it is flared.

NOTE: Riveter is not used with split rivets.

(5) Install a gasket and relief cap on valve.

NOTE: Do not tighten cap until after relief valve pressure has been established at engine test.

(6) Install metering plug in gearbox housing.

(7) Install gasket and seal on relief valve housing and thread housing into gearbox. Tighten valve until all sealing surfaces are in contact, then turn through angle of 180 degrees.

S. Tachometer Drive Assembly
(JT12A-6, -6A [L], And -8 [L] Engines)
See Tool Group 94.

(1) Position gearshaft bearing base on a bench.

(2) Position one of gearshaft bearings in recess in the base. Insert gearshaft (through bearing) into guide bushing in base.

(3) Position drive gearshaft drift in gearshaft. Using arbor press, press gearshaft through bearing until gearshaft shoulder contacts bearing inner race.

(4) Remove gearshaft from base and position gearshaft bearing spacer on gearshaft.

(5) Position second gearshaft bearing in recess of base and insert gearshaft into bearing. Using drift, press gearshaft into bearing until spacer contacts inner race.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(6) Using Truarc Series 22 pliers, or equivalent, install bearing retaining ring in gearshaft groove.

(7) Position tachometer gearshaft bearing housing (mounting pad up) on bench, and position tachometer drive oil seal (angular face up) in housing. Insert oil seal drift into seal until shoulder of drift contacts seal. Push seal into place in housing.

NOTE: Use PWA 13178 drift for PN 365463.

(8) Install oil seal guide in hole end of tachometer drive gearshaft.

(9) Invert gearshaft bearing housing (mounting pad down) and insert tachometer drive gearshaft (gear up) into housing until lower bearing bottoms on housing shoulder.

(10) Using Truarc Series 21, 45 degree bent tip pliers, or equivalent, install retaining ring in groove in ID of housing.

(11) Install preformed packing in groove in OD of bearing housing. Aligning holes in mounting pad with studs in tachometer drive housing, install bearing housing in tachometer drive housing. Install gasket and cover on mounting pad.

T. Tachometer Drive Assembly
(JT12A-6A [N], -8 [N], And JFTD12A Engines)
See Tool Group 94A.

(1) Position gearshaft base on bench and install gearshaft over pilot, with gearshaft resting on pilot shoulder.

(2) Place one ball bearing over shaft and, using drift, press bearing until inner race seats on shoulder of gearshaft.

(3) Remove gearshaft from base and install plate around gearshaft. Position it back into base.

(4) Place tachometer drive bearing support over gearshaft, with inside groove resting on outer race of installed bearing.

(5) Install sleeve spacer over gearshaft.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(6) Place second bearing over gearshaft. Using drift, press bearing until outer race seats on shoulder of tachometer drive bearing support.

(7) Insert retaining ring in groove located above bearing on gearshaft.

(8) Place base on bench and insert seal housing, open end up, in cavity on top of base.

(9) Install seal on drift, and insert pilot of drift into base. Press seal into housing.

NOTE: Use PWA 13048 drift for PN 365463.

(10) Install preformed packing in groove located on outside diameter of housing. Insert housing into tachometer drive bearing support. Insert retaining ring in groove located above seal housing on inside of bearing support.

(11) Place preformed packing in groove located on outside diameter of bearing support, and install bearing support in gearbox.

(12) Install gasket and cover on mounting pad and secure with washers and nuts. Tighten to recommended torque and lockwire.

U. Main Oil Pump Assembly
(JT12A-6, -6A [L], And -8 [L] Engines)
See Tool Group 78 and Table of Limits.

(1) Position main oil pump inner cover (bevel gearshaft boss up) on a bench, and position seal in groove in bevel gearshaft boss, as shown in Table Limits. Insert cover oil seal drift through seal into cover and push seal into place.

(2) Position main oil pump inner housing (seal grooves up) on a bench and position oil seal in groove around bevel gearshaft hole, as shown in Table of Limits. Insert body oil seal drift through seal into housing and push seal into place.

(3) Install preformed packing in groove around straight shaft hole. Position main oil pump plate (hole chamfers up) on housing, aligning holes in plate with holes in housing.

(4) Position body oil seal guide in main oil pump pressure spur gear. Push gear (short journal down) through plate and seal into main oil pump inner housing.

(5) Install a preformed packing in groove at gear end of main oil pump bevel gearshaft. Position gearshaft in main oil pump inner cover.

(6) Position inner housing so that both gearshafts point upward. Install main oil pressure pump idler spur gear over straight shaft.

(7) Install main oil pump inner housing over gearshafts, engaging main oil pump pressure spur gear splines with gearshaft splines and meshing pressure spur gear with idler spur gear.

(8) Install No. 1 bearing suction drive spur gear (journal down) on bevel gearshaft. Position No. 1 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(9) Position No. 3 bearing scavenge pump outer housing (flat face down) over gearshafts and against inner housing.

(10) Install No. 3 bearing suction drive spur gear (journal down) on bevel gearshaft. Position No. 3 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(11) Position main oil pump outer housing (flat face down) over gearshaft.

(12) Install a preformed packing in groove in end of main oil pump bevel gearshaft.

(13) Install gearbox scavenge pump spur gearshaft (threaded end up) over bevel gearshaft. Position gearbox scavenge pump idler spur gear over straight shaft, meshing with spur gearshaft.

(14) Install main oil pump gearshaft support (flat face down) over shafts and against pump outer housing.

(15) Position tachometer drive bevel gear (flat face down) over splines of gearbox scavenge pump spur gearshaft.

CAUTION: DO NOT EXCEED RECOMMENDED MAXIMUM TORQUE.

(16) Install bevel gear retaining nut on gearbox scavenge pump spur gearshaft. Tighten to recommended minimum torque. If necessary, tighten further until two holes in nut are aligned with hole in gearshaft.

(17) Install and flare retaining nut rivet.

(18) Position tachometer drive housing assembly on gearshaft support, meshing tachometer drive gearshaft with tachometer drive bevel gear.

(19) Install bolts and nuts securing pump sections together. Tighten nuts to recommended torque and lockwire.

(20) Position gasket and cover on tachometer drive housing mounting pad and secure with locknuts.

(21) Turn bevel gearshaft by hand and check for freedom of rotation.

V. Main Oil Pump Assembly
(JT12A-6A [N] And -8 [N] Engines)
See Tool Group 78.

(1) Position main oil pump inner cover (bevel gearshaft boss up) on bench and position seal in groove in bevel gearshaft boss, as shown in Table of Limits. Insert body oil seal drift through seal into housing and push seal into place.

(2) Position main oil pump inner housing (seal grooves up) on bench and position oil seal in groove around bevel gearshaft hole, as shown in Table of Limits. Insert body oil seal drift through seal into housing and push seal into place.

(3) Install a preformed packing in groove around straight shaft hole. Position main oil pump plate (hole chamfers up) over straight shaft onto front cover, aligning holes in plate with holes in cover.

(4) Position body oil seal guide in main oil pump pressure spur gear. Push gear (short journal down), through plate and seal, into main oil pump inner housing.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(5) Install a preformed packing in groove at the gear end of main oil pump bevel gearshaft. Position gearshaft in main oil pump inner cover.

(6) Position inner cover so that both gearshafts point upward. Install main oil pressure pump idler spur gear over straight shaft.

(7) Install main oil pump inner housing over gearshafts, engaging main oil pump pressure spur gear splines with gearshaft splines and meshing pressure spur gear with idler spur gear.

(8) Install No. 1 bearing suction drive spur gear (journal down) on bevel gearshaft. Position No. 1 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(9) Position No. 3 bearing scavenge pump outer housing (flat face down) over gearshafts and against inner housing.

(10) Install No. 3 bearing suction drive spur gear (journal down) on bevel gearshaft. Position No. 3 bearing idler spur gear on straight shaft, meshing with the drive spur gear.

(11) Install main pump outer housing (flat face down) over gearshafts.

(12) Install a preformed packing in groove in end of main oil pump bevel gearshaft.

(13) Install gearbox suction drive spur gear (splined end down) on the bevel gearshaft.

(14) Insert main oil pump spur gear plug into spur gear and secure with retaining ring.

(15) Position gearbox suction idler gear on straight shaft, meshing with drivegear.

(16) Install main oil pump outer cover on pump.

(17) Insert four bolts (heads toward outer cover) in holes through pump. Secure with washers and locknuts. Tighten nuts to recommended torque.

(18) Turning bevel gearshaft by hand, check pump for freedom of rotation.

W. Main Oil Pump Assembly
(JFTD12A Engines)
See Tool Group 78 and Table of Limits.

(1) Position main oil pump inner cover, bevel gearshaft boss up, on bench. Position seal in groove in bevel gearshaft base, as shown in Table of Limits. Insert oil seal drift through seal into cover and push seal into place.

(2) Position main oil pump No. 5 housing (seal grooves up) on bench and position oil seal in groove around bevel gearshaft hole, as shown in Table of Limits. Insert oil seal drift through seal into housing and push seal into place.

(3) Install a preformed packing in groove around straight shaft hole. Position main oil pump plate (hole chamfers down) on No. 5 housing, aligning holes in plate with holes in cover.

(4) Position oil seal guide in main oil pump pressure spur gear. Push gear (journal up), through plate and seal, into main oil pump No. 5 housing.

(5) Install a preformed packing in groove at gear end of main oil pump bevel gearshaft. Position gearshaft in main oil pump inner cover.

(6) Position inner cover so that both gearshafts point upward. Install main oil pressure pump idler spur gear over straight shaft.

(7) Install main oil pump No. 5 housing over gearshafts, engaging main oil pump pressure spur gear splines with gearshaft splines and meshing pressure spur gear with idler spur gear.

(8) Install No. 1 bearing scavenge drive spur gear (journal down) on bevel gearshaft. Position No. 1 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(9) Position No. 4 housing (flat face down) over gearshafts and against No. 5 housing.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(10) Install No. 3 bearing scavenge drive spur gear (journal down) on bevel gearshaft. Position No. 3 bearing idler spur gear on straight shaft, meshing with drive spur gear.

(11) Install main oil pump No. 3 housing (flat face down) over gearshafts.

NOTE: Housing incorporates dowel pin.

(12) Install No. 2 bearing and gearbox scavenge drive spur gear (splined end down) on bevel gearshaft.

(13) Position No. 2 bearing and gearbox scavenge idler gear on straight shaft, meshing with drivegear.

(14) Install main oil pump No. 2 housing on pump, aligning hole in housing with dowel pin in No. 3 housing.

(15) Position No. 4 bearing scavenge drive spur gear (splined end down) on bevel gearshaft.

(16) Position No. 4 bearing scavenge idler gear on straight shaft, meshing with drivegear.

(17) Install main oil pump No. 1 housing (flat face down) over gearshafts.

(18) Position No. 5 bearing scavenge drive spur gear (splined end down) on bevel gearshaft.

(19) Position No. 5 bearing scavenge idler gear over straight shaft, meshing with drivegear.

(20) Install main oil pump outer cover on pump.

(21) Insert four bolts (heads toward outer cover) in holes through pump. Secure with washers and locknuts. Tighten nuts to recommended torque.

(22) Turning bevel gearshaft by hand, check pump for freedom of rotation.

X. Main Oil Pump Installation (JT12A-6, -6 [L], and -8 [L] Engines)

(1) Place new preformed packings in grooves of oil pump.

(2) Install pump in gearbox, meshing drive bevel gearshaft with main drivegear.

(3) Secure pump to gearbox with nuts. Tighten nuts to recommended torque.

(4) Position new gasket on tachometer drive housing pad.

(5) Secure tachometer drive housing cover to housing with nuts.

Y. Main Oil Pump Installation (JT12A-6A [N] and-8 [N] Engines)

(1) Install new preformed packings on pump.

(2) Install pump in gearbox, engaging dowel in pump mounting pad in hole in oil pump outer housing.

(3) Secure pump to gearbox with washers and locknuts. Tighten locknuts to recommended torque.

Z. Main Oil Pump Installation (JFTD12A Engines) See Tool Group 78.

(1) Place new preformed packings in grooves of oil pump.

(2) Install pump in gearbox, meshing drive bevel gearshaft with main drivegear.

(3) Secure pump to gearbox with nuts. Tighten nuts to recommended torque.

AA. Fuel Pump Installation

(1) Place two seals on fluid pressure differential switch and install switch (connector facing rearward) on pump.

(2) Secure switch to pump with washers and bolts. Tighten bolts to recommended torque and lockwire.

(3) Apply coating of grease, Plastilube Moly No. 3 to pump drive spline. Excessive amounts of lubricant are not

R
R

necessary. Apply even coat on spline surfaces with small, clean paste brush.

NOTE: Plastilube Moly No. 3 is available from:

Thiem Corp.,
Sub. of Koppers Co., Inc.
5151 Denison Avenue
P.O. Box 93019
Cleveland, OH 44101-5019 USA

CAUTION: DO NOT APPLY LUBRICANT TO WET FUEL PUMP DRIVE SPLINES IDENTIFIED BY SPLINE LOCATION RECESSED WITHIN GEARSHAFT. THESE SPLINES ARE LUBRICATED INTERNALLY BY CIRCULATION OF ENGINE OIL, WHICH MAY BE RETARDED BY APPLICATION OF GREASE. THESE PUMPS MAY BE IDENTIFIED AS CECO P/L 9489, (PWA-PN 524383) AND CECO P/L 9486, (PWA-PN 524382)

R (4) Put a new packing in the ring groove in the periphery of
R the fuel pump driveshaft and install the pump (with a
R new gasket) on the mounting pad of the gearbox. Attach
R the pump with washers and locknuts. Tighten the lock-
R nuts to the recommended torque.

CAUTION: WHEN INSTALLING FUEL PUMP, CARE MUST BE TAKEN NOT TO CAUSE DAMAGE TO DRIVE SPLINE BY ALLOWING PUMP TO HANG BY SHAFT. PUMP MUST BE SUPPORTED UNTIL IT IS SECURED TO GEARBOX WITH LOCKNUTS.

AB. Fuel Control Installation

CAUTION: WHEN INSTALLING FUEL CONTROL, CARE MUST BE TAKEN SO AS NOT TO CAUSE DAMAGE TO DRIVE SPLINE BY ALLOWING CONTROL TO HANG BY SHAFT. FUEL CONTROL MUST BE SUPPORTED UNTIL IT IS SECURED TO PUMP WITH LOCKNUTS.

(1) Install fuel control on mounting pad of pump, and secure with washers and locknuts.

NOTE: Do not apply lubricant to fuel control driveshaft splines.

(2) Connect compressor bleed actuating rod to fuel control.

CAUTION: DO NOT WRENCH HOLLEY FUEL CONTROL BLEED STRAP SIGNAL VALVE SCREW, PN 5A31001, AT ANY TIME TO ACTUATE BLEED STRAP MECHANISM AS SHEARING OF SERRATION WILL OCCUR IN THE BLEED ACTUATOR HOUSING WHEN LEVER AND SHAFTS ARE DISENGAGED.

(3) Install power lever linkage on fuel control, securing lever arm to control with self-locking nut. If the linkage appears excessively stiff, actuate at least 50 times to facilitate bearing run-in.

NOTE: For engines with Holley fuel controls, lever arm shall be secured with hex nut. Torque to 35 - 45 lb-in., and lockwire.

6. Free Turbine Section Assembly Installation

A. Free Turbine Inlet Duct And 1st Stage Vanes
See Tool Group 56J.

NOTE: Complete set of classified vanes must be used. Space vanes of the same class evenly around the vane circle.

(1) Install compressor and turbine locating jack on engine build and transport stand. Secure with ball to lock pin. Retract jack to its lowest position.

(2) Position free turbine disk-to-jack adapter on jack with cup-shaped part of adapter contacting jack pad, and stepped plug facing upward.

(3) Attach free turbine assembly front case-to-jackplate on front face of free turbine inlet case, positioning trunnion spools on horizontal centerline.

(4) Install free turbine inlet case on jack. Secure plate to jack with ball lock pins.

(5) Install free turbine inlet duct assembly into free turbine inlet case, aligning wide lug on inlet duct with wide slot in case.

(6) Measure dimension from front flange of inlet case to front of inner airseal attached to front flange of inlet duct assembly. Measurement shall fall within limits shown in the Table of Limits.

R
R

ENGINE GENERAL - ASSEMBLY OF SUBASSEMBLIES

(7) Install 1st stage vanes by inserting tabs on inner end of each vane into slots in vane inner shroud and engaging groove in outer end over shoulders to inner and outer inlet case flanges.

(8) Install three 1st stage vanes outer seal sections so that seal lip secures each vane and holes line up with pinholes in case flange.

NOTE: Assembly sequence number is etched on outer platform of vanes. Install No. 1 vane at 12 o'clock position. Install remaining vanes in clockwise direction.

(9) Install three sections of 1st stage vane lock sections so that lock lip secures each vane and holes line up with pinholes in case flange.

(10) Secure vane lock sections with pins.

B. Free Turbine Vane Preloading And Measurement See Tool Group 56R and Figure 719.

(1) With inlet duct assembly, 1st stage vanes, and vane locking ring installed in free turbine inlet case, fasten case to surface plate (front flange down).

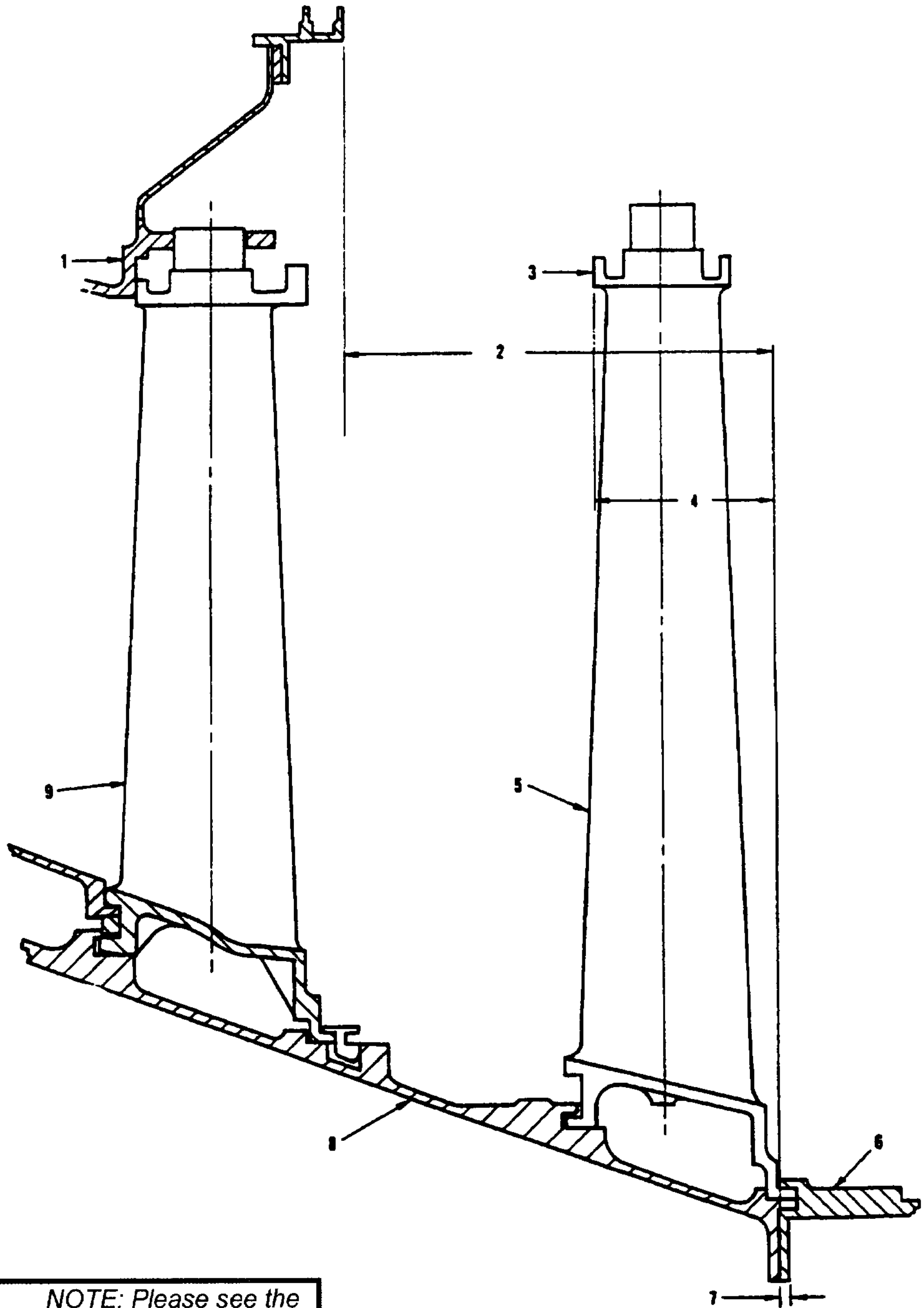
R (2) First Stage Preload and Measurement

(a) With leaves folded inward toward shaft of 1st stage vane preloading support, lower support into inlet duct assembly. Fold down leaves, and secure with quarter-turn locks.

(b) Position preloading fixture on free turbine inlet case rear flange, and fasten force gage to fixture. Then fasten support positioned in inlet duct assembly to force gage.

(c) Center support so that leaves will have uniform bearing on front shoulder, (Index 1) in the figure, of 1st stage vane inner shroud when load is applied.

(d) Apply 200 - 300 lbs. rearward axial load to 1st stage vanes.



L-20164 (0000)

Free Turbine Vane
Loading and Measurement
Figure 719

1. Apply 250 Lbs. Rearward (Axial Load On This Surface For 1st Stage Vane Loading.
2. 3.488 - 3.595 Inches 1st Stage Measurement.
3. Apply 190 - 210 Lbs. Rearward (Axial Load On This Surface For 2nd Stage Vane Loading.
4. 1.423 - 1.451 Inch 2nd Stage Measurement.
5. Second Stage Vane
6. Second Stage Blade Outer Airsealing Ring
7. Airsealing Ring Flange Thickness (Used In Computation Of Dimension 4)
8. Free Turbine Inlet Case Assembly
9. First Stage Vane

Key to Figure 719

(e) Insert depth micrometer rod through hole provided in fixture, and measure depth from gage surface on fixture to rear face of 1st stage vane inner seal.

(f) From depth micrometer reading, subtract dimension between gage surface on fixture and rear flange of free turbine inlet case.

NOTE: This dimension may be obtained by resting fixture on surface plate and measuring from fixture gage surface to surface plate with depth micrometer.

(g) For acceptability of final dimension, refer to (Index 2) of the figure.

(3) Second Stage Preload and Measurement

(a) Position 2nd stage vane preloading support on 1st stage vanes, and install 2nd stage vanes.

(b) Measure thickness of airseal ring flange (7) Figure 719, and record for calculation of final measurement.

(c) Lock 2nd stage vanes in place by fastening airseal ring to rear flange of inlet case.

(d) Position preloading fixture on rear face of airseal ring flange.

(e) Fasten force gage to fixture and preloading support positioned between 1st and 2nd stage vanes.

(f) Apply 190 - 210 lbs. rearward, axial load.

(g) Insert depth micrometer rod through hole provided in fixture. Rod end shall pass between vane tangs of two adjacent vanes and abut surface of support.

(h) Measure distance from fixture measuring surface to support surface, and subtract dimension referenced in note following step (2)(f). Then subtract airseal ring flange thickness step (3)(b) to obtain critical dimension. Refer to Index 4 in Figure 719. After taking measurement, remove 2nd stage free turbine rotor outer airseal, 2nd stage vanes, and tooling.

C. Free Turbine 1st Stage Blade Outer Airseal Installation

(1) Install three segments of airseal with forward end of airseal engaged in 1st stage vane locking ring groove.

D. Assembly Of Free Turbine Disk and Blades
See Tool Group 56C-1.

(1) Position 1st stage turbine rotor disk on bench.

(2) Apply extreme pressure grease to fir-tree serrations and blade shrouds to prevent galling or pickup.

<u>NOTE</u>: Individual blades must be weighed to nearest one-hundredth of an ounce, and weights marked on blades with red crayon. Lay out blades in order of diminishing weight, and install heaviest blade on disk. Install next heaviest blade diametrically opposite first installed blade. Install lightest blade adjacent to and clockwise from first installed blade. Install next lightest blade diametrically opposite lightest blade. Continue to install remaining blades in this manner progressively around disk.

(3) Install each blade, using following procedure:

(a) Install support into ID of Fixture, and install pilot.

(b) Place disk over pilot, and adjust jacks on support until they contact disk.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(c) Install detail part into fixture, and secure belt around disk, leaving 1/8 to 1/4 inch of fir-tree slot extending above belt.

(d) Install blades in fir-tree slots (180 degrees apart) proceeding in counterclockwise direction around disk. Blade roots shall contact belt.

(e) Remove bolt, and install the Pusher over center post. Adjust the roller into position if over flat portion of turbine blade.

(f) Rotate pusher counterclockwise, applying slight downward pressure until all blades are flush with disk.

NOTE: Pusher must be rotated counterclockwise only.

(g) Insert minimum of eight workbolts into rivet holes around disk to secure blades to disk while performing static balance operation.

(4) Install 2nd stage free turbine blades, using above procedures.

E. Static Balance Of Stage 1 And 2 Free Turbine Disk And Blades Assembly
See Tool Group 56G-2.

(1) Install static balance disk and blade adapter on spindle of balance machine. See Paragraph 3.B(1).

(2) Balance installed adapter.

(3) Install and balance disk and blades assembly as outlined in Paragraph 3.C(1) thru (6).

(4) Static unbalance of disk and blades assembly must be less than 0.600 oz-in. If necessary, reposition blades (diametrically), and recheck for unbalance.

R
R

(5) After residual unbalance limit is attained, final static balance disk and blade assemblies, and correct for unbalance as follows:

NOTE: Final unbalance point shall not exceed 9.100 oz-in. This may be obtained by adding a maximum of three correction weights, taped to disk flanges. When proper balance is obtained, secure weights, using punch and riveter.

(a) Correct for final unbalance of 1st stage disk and blade assembly by adding one counterweight (riveted type) and remainder of counterweights (plug type), all located within plus or minus 60 degrees of unbalance vector.

NOTE: Riveted-type counterweight is installed on rear side of counterweight flange, and is secured in position with rivets, preformed head toward 1st stage disk. Plug-type counterweight is installed on rear side of counterweight flange, and is secured in position by forming flare on tubular end of weight.

(b) After final unbalance limit (0.100 oz-in.) is obtained, rivet counterweight into position, using rivets and counterweight riveter. Form flare on tubular end of plug-type counterweight and on end of rivet, to minimum diameter of 0.125 inch.

(c) Correct for final unbalance of 2nd stage disk and blades assembly by adding one counterweight (flanged, riveted type) and remainder of counterweights (plug type), or three units of counterweight (plug type).

NOTE: Flanged, riveted-type counterweight is installed on forward side of counterweight flange, and is secured in position with rivet, preformed head facing rear face of 2nd stage disk.

(d) Rivet 2nd stage disk and blade assembly counterweights into position as outlined in step (b).

F. Free Turbine Blade Retaining Rivet Installation
See Tool Group 51A.

R
R

(1) Remove previously installed workbolts, and install rivets in 1st stage disk as follows:

(a) Lubricate rivets with extreme-pressure grease (refer to the Standard Practices Manual.)

(b) Install half of rivets in alternate rivet holes, heads facing rearward. Using riveter and punch, flare end of rivets to 0.170 inch diameter minimum.

(c) Install and flare remaining rivets.

(2) Install 2nd stage free turbine blade rivets, using above procedures. Use Punch with Riveter to form the flare (0.170 inch minimum diameter) at the rivet end.

G. Free Turbine Rotor Build
R See Figure 720 and Tool Group 102A.

(1) Install alignment pins into the holes of the turbine disk and shaft Holding Fixture.

(2) Put the lower plate of the free turbine rotor clamp in position on the holding fixture dowel pins.

(3) Chill the 1st stage turbine disk and heat the turbine shaft to 260°C (500°F).

(4) Install the disk on the fixture, front side down.

NOTE: The alignment pins will extend through the disk.

(5) Install the turbine shaft on disk. Tap the shaft into position against the disk.

(6) Install the upper plate of the free turbine rotor clamp on the rear of the free turbine shaft. Then install the clamp tierod through the center of the shaft and turn it into the thread of the clamp lower plate. Tighten the tierod until the 1st stage turbine disk and free turbine shaft are tightly held together before the assembly is removed from the fixture.

(7) Lift the shaft and disk assembly off the fixture and remove the alignment pins. Put the shaft and disk assembly back on the fixture and align it with the holes in the fixture.

(8) Install the tiebolts in the 2nd stage disk and attach the tiebolts with retaining rings. Apply antiseize compound (PWA 586) to the tiebolt threads. Heat the 2nd stage turbine disk assembly to 260°C (500°F).

(9) Measure the dimension from the front surface of the 2nd stage vane inner airseal support to the rear face of the inner airseal as shown in Figure 720. If this dimension is in limits, install the 2nd stage vane inner shroud and seal assembly on the shaft until it is against the rear face of the 1st stage disk.

(10) With the shaft and disk assembly installed in the fixture (shaft upward), install the 2nd stage disk and blade assembly as follows:

(a) Install the heated disk and tiebolts on the rear of the free turbine shaft and 1st stage disk. Engage the tiebolts in the holes in the fixture.

<u>NOTE</u>: The minimum temperature differential between the disk and shaft must be 44°C (80°F).

(b) Tap on the web area of the 2nd stage disk with a nylon mallet to install it tightly against the rear of the turbine shaft.

(11) Install free turbine disk and blades assembly lifting collar around 2nd stage blades, and proceed as follows:

(a) Attach lifting sling to spools on collar, and lift rotor from fixture.

<u>NOTE</u>: Underside of 1st stage disk must be supported when performing lifting operation to prevent separating 2nd stage disk from shaft.

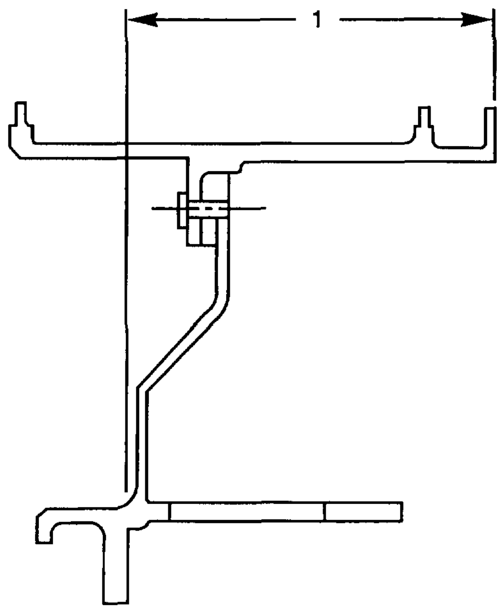
(b) Install nuts handtight on tiebolts, and remove free turbine rotor clamp.

(c) Using sling, lower rotor assembly into build stand assembly.

(d) Remove tiebolt nuts, and install heated seal over tiebolts.

<u>NOTE</u>: Seal shall have been heated to 260°C (500°F).

R
R



L-20165 (0000)
PW V

1. 1.470 - 1.510 Inch

NOTE: Please see the TEMPORARY REVISION that revises this page.

R
R

Free Turbine 2nd Stage Vane
Inner Shroud and Seal Assembly
Pre-installation Measurement
Figure 720

(e) Install tablocks and nuts on tiebolts, and torque in accordance with Table of Limits.

H. Free Turbine Rotor Balance Bearing Installation For Concentricity and Dynamic Balance Check

(1) Install No. 4 balance bearing with the Bearing Drift, then install balance spacer on shaft. Install tabwasher on shaft, engaging washer spline in shaft splines.

(2) Install No. 4 bearing oil scoop handtight.

(3) Position inner race retaining nut hand wrench over shaft, and secure splined end of shaft with holder. tighten nut, using retaining nut wrench and mallet.

(4) Assemble free turbine coupling, as follows:

(a) Mount coupling holder on bench.

(b) Install coupling (splined OD down) into holder.

(c) Position No. 5 bearing seal plate (puller groove up) on coupling.

(d) Heat No. 5 balance bearing in hot oil.

(e) Using drift, seat balance bearing and seal plate on coupling.

(f) With the Retaining Nut Wrench and a standard torque wrench, install the inner race nut on the coupling, then tighten the nut.

(5) Install free turbine coupling on turbine shaft and install coupling nut handtight into turbine shaft.

(6) Position Holder on coupling spline, and install wrench into coupling, engaging slots in nut. Secure holder and tighten nut with wrench.

I. Free Turbine Rotor Concentricity Check. See Tool Group 103A and Figure 721.

(1) Install and secure front and rear balance bearing housings in pedestals of concentricity check fixture.

R
R

(2) Install rotor lifting eye to free turbine rotor coupling; then hoist rotor assembly onto bench, front end down.

(3) Remove top half of each of two details of balancing support.

(4) Assemble remainder of support to turbine assembly, placing vane shroud into retaining groove and bearing into its housing.

(5) Install top halves of support detail, and secure; then attach lifting sling to trunnion spools, and trunnion assembly onto concentricity check fixture.

NOTE: Faces of inner races of bearings used for concentricity and runout check must be square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 inch FIR.

(6) Using height gage and dial indicator, check front face of No. 4 bearing seal plate and rear face of No. 5 bearing seal plate for squareness runout. Squareness runout must not exceed 0.001 inch FIR. Plates may be rotated to meet this requirement.

(7) After runout requirements have been met, mark the radial positions of the seal plates and coupling in relation to the shaft, as shown in the figure.

R (8) With a height gage and indicator do a squareness runout
R check of the free turbine disks. Measure runout from
R the front face of the 1st stage disk below the rivet to
R the rear face of the 2nd stage disk below the rivet.
R The squareness runout must not be more than 0.005 inch
R FIR.

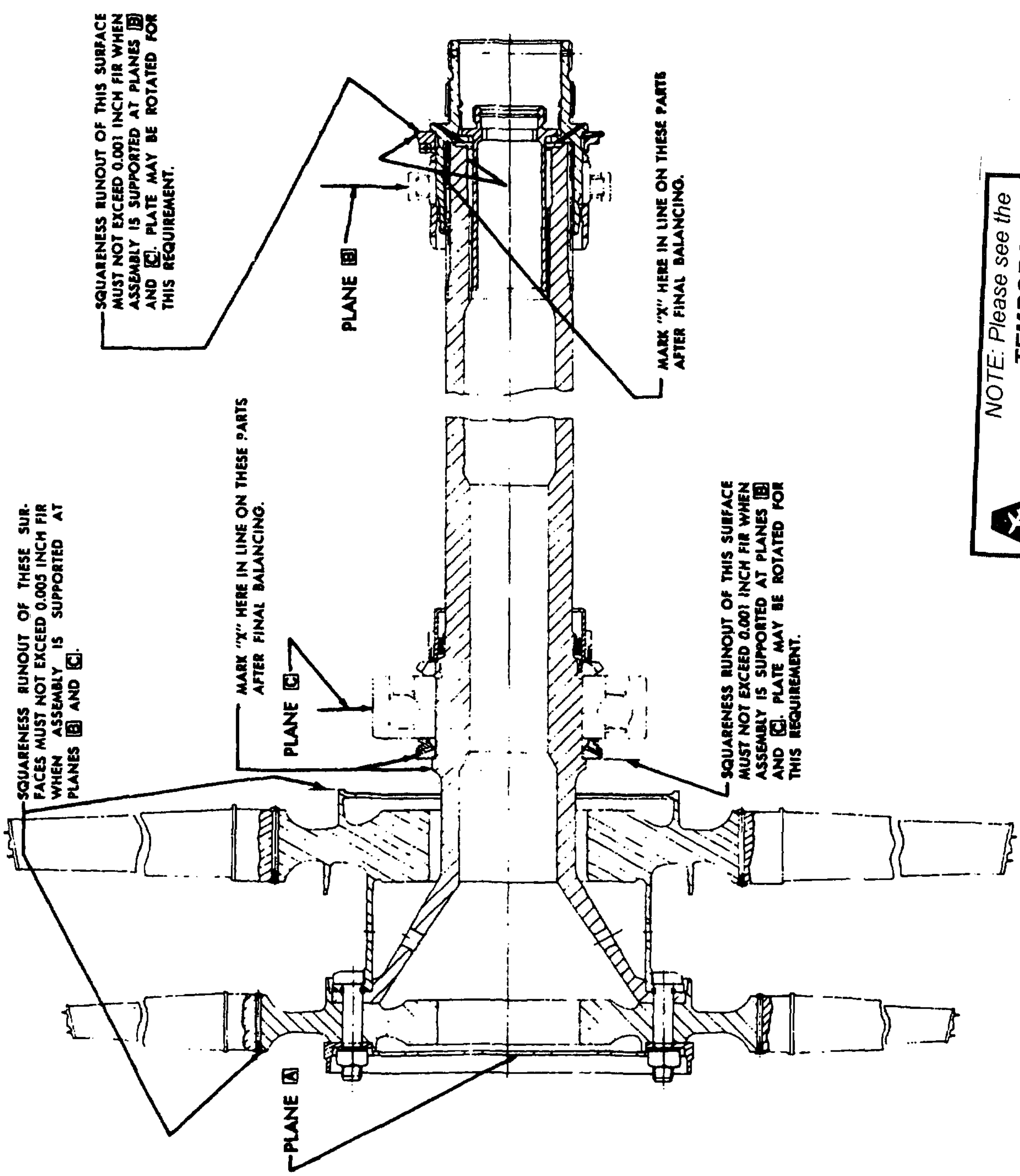
R (9) Use a hoist to lift the rotor assembly off the concentricity fixture.

J. Free Turbine Rotor Dynamic Balance Check
See Tool Group 105A and Figure 721.

(1) Install and secure the front and rear balance bearing housings in the cradles of the balance machine.

(2) Attach the lifting sling to the trunnion spools of the balancing support, and hoist the rotor assembly onto the balance machine.

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-29165 (0000)

R
R

Free Turbine Rotor Balance and
Concentricity Check
Figure 721

(3) Secure the front balance bearing to its housing on the balance machine, using the retaining strap. Place the strap around the bearing, and bolt it to the housing.

(4) Remove sling, and slip drive belt over turbine shaft.

NOTE: Faces of inner races of bearings used for balancing must be square with ID of bearing within 0.0005 inch FIR and parallel within 0.0005 inch FIR.

(5) Start rotor spinning, gradually increasing speed to 1400 rpm.

(6) Semidynamic unbalance of complete assembly must not exceed 0.200 oz-in. when rotating at 1400 rpm.

(7) Unbalance can be corrected by adding classified balanced plugs and tabwashers at Plane A. See
R Figure 721, as required.

(8) After final balance, remove strap from front balance bearing housing, and reinstall lifting sling.

(9) Using hoist, lift free turbine rotor assembly from balance machine.

K. Free Turbine Rotor Balance Bearing Removal After Dynamic Balance
See Tool Group 104A.

(1) With turbine assembly-to-build stand fixture on build and transport stand, open fixture mounts.

(2) Attach rotor lifting eye to free turbine rotor coupling; then hoist rotor assembly onto build and transport stand.

(3) Attach outer part of turbine shaft coupling nut wrench to hydraulic wrench. Install assembly on coupling.

(4) Lower inner part of coupling nut wrench through hydraulic wrench into coupling nut.

(5) Using hydraulic pressure, loosen and remove coupling nut.

(6) Remove free turbine coupling (with the No. 5 bearing seal plate, inner race, and inner race nut attached) from turbine shaft, using wrench and coupling holder.

(7) Position coupling (splined OD down) in seal plate and coupling holder.

(8) Using No. 5 bearing inner race retaining nut wrench, loosen and remove retaining nut. Remove coupling from holder.

(9) Position No. 5 bearing plate around coupling, engaging plate into puller groove in seal plate.

(10) Position coupling (inner race up) on No. 5 bearing seal plate and coupling base.

(11) Position No. 5 bearing seal plate and coupling drift on coupling. Press coupling out of seal plate and inner race.

(12) Position No. 4 bearing inner race retaining nut hand wrench over shaft, and secure splined end of shaft holder.

(13) Using wrench and mallet, loosen inner race retaining nut.

(14) Remove wrench; then remove oil scoop, tabwasher, and balance spacer.

(15) Mount No. 4 bearing inner race puller on end of turbine shaft, engaging puller jaws in puller groove of seal plate behind bearing. Using jackscrew action, pull seal plate and work bearing.

R L. Second Stage Free Turbine Vanes Attachment To Inner Shroud

(1) Install free turbine 2nd stage turbine vanes in vane inner shroud, inserting vane tangs into slots and with front of vane inner end butting against flange on shroud.

(2) Secure vanes in shroud by passing length of lockwire around circle formed by vane outer ends. Secure ends of lockwire together.

M. Free Turbine Rotor Installation
See Tool Group 56K.

ENGINE GENERAL - ASSEMBLY OF SUBASSEMBLIES

(1) Secure turbine shaft lifting eye to rear end of free turbine shaft. Attach hoist to lifting eye.

(2) Lift rotor, and position over free turbine inlet case.

(3) Slowly lower rotor into case, engaging outer ends of 2nd stage vanes into groove in case flange.

(4) Raise compressor and turbine locating jack until disk-to-jack adapter contacts and supports rotor.

(5) Remove hoist and lifting eye.

(6) Remove lockwire used to retain vanes. Remove cloth used to support vanes.

N. No. 4 Bearing Seal Assembly

(1) Position seal housing (large OD up) on bench.

(2) Position spring on each pin.

(3) Install seal ring (angular face toward carbon seal) on OD of seal holder.

(4) Position seal holder and seal on pins (compressing seal ring so that it enters ID of seal support).

(5) Push down to slightly compress springs, and insert cotter pins in holes in pins at 12, five, and seven o'clock positions. Bend cotter pins to secure.

O. No. 4 Bearing Seal Installation.

(1) Position free turbine case (rear flange down) on bench.

(2) Install new seal in groove of seal support.

(3) Position No. 4 bearing seal assembly on free turbine case inner flange, aligning nuts with boltholes in flange.

(4) Secure seal assembly to flange with bolts.

(5) Tighten bolts to recommended torque.

R P. Free Turbine Case Installation
R See Tool Group 56D.

(1) Bolt free turbine case lift and turn brackets to rear flange of free turbine case.

(2) Suspend engine lift and turn sling from hoist, and secure sling hooks to brackets.

(3) Install free turbine second stage vane outer seal on rear flange of free turbine inlet case. Secure with screws and nuts.

(4) Lift case, and position over free turbine rotor.

(5) Slowly lower free turbine case onto free turbine inlet case, carefully guiding case over turbine shaft, and aligning holes in case flanges.

(6) Secure case with bolts and nuts. Tighten nuts to recommended torque.

Q. No. 4 Bearing Installation
See Tool Group 11A.

(1) Adjust compressor and turbine locating jack to bring seal plate retaining shoulder on free turbine shaft in line with bearing support front flange.

<u>NOTE</u>: Rotor is jacked up at this time to prevent damaging carbon seal when installing bearing.

(2) Position seal plate (puller groove up) on turbine shaft aligning X-mark on seal plate with X-mark on shaft.

(3) Using No. 4 bearing inner race and seal plate installation drift, seat plate against shoulder on shaft.

(4) Position No. 4 bearing inner race (ball path facing up) on shaft and, using drift, seat race against seal plate.

(5) Position balls and cage in cage and balls holder and install in bearing support. Remove holder.

(6) Install rear inner race (puller groove up).

(7) Retract jack until outer race seats in support.

(8) Install accessory drivegear on shaft.

R
R

(9) Install tabwasher on shaft engaging washer splines in shaft splines.

(10) Install No. 4 bearing oil scoop handtight.

(11) Attach outer part of No. 4 bearing inner race retaining nut wrench to hydraulic wrench. Position on oil scoop.

(12) Install inner part of wrench so that it engages inner splines of hydraulic wrench and spline on end of turbine shaft.

(13) Using hydraulic pressure, tighten oil scoop to recommended initial torque. Loosen to zero lb-in. Retighten to recommended initial torque and angle of turn. Remove wrenches.

(14) Bend tabs of tabwasher to secure oil scoop.

(15) Install No. 4 bearing outer race retaining nut handtight.

(16) Bolt outer part of No. 4 bearing outer race retaining nut wrench to hydraulic wrench.

(17) Install inner part of wrench into outer race retaining nut.

(18) Lower hydraulic wrench engaging pins of retaining nut wrench outer part into two holes in bearing support, and engaging splines of hydraulic wrench with splines of inner part of retaining nut wrench.

(19) Using hydraulic pressure, tighten nut to recommended initial torque. Loosen to zero lb-in. Retighten to recommended initial torque and minimum angle of turn. Further tighten, if necessary, to align rivet hole in nut with rivet hole in support. Remove wrenches.

CAUTION: DO NOT EXCEED RECOMMENDED MAXIMUM ANGLE OF TURN.

(20) Install rivet in aligned holes.

(21) Using No. 4 bearing outer race retaining nut riveter, flare rivet.

R. Free Turbine Rotor Positioning Measurement
See Figure 722.

R
R

(1) Using parallel bar and depth micrometer measure distance from front face of free turbine inlet case front flange to front face of 1st stage disk.

(2) For acceptable dimension. See Figure 722.

NOTE: Since free turbine rotor final running position is established with installation of No. 4 bearing, this positioning check may be performed at any practical time after No. 4 bearing installation.

S. Accessory Drive Coupling And Gear Buildup
See Tool Group 56C.

(1) Position accessory drive coupling base on bench.

(2) Place accessory drive coupling (flange down) on Base.

(3) Install upper bearing on coupling. Using accessory drive bearing-to-coupling drift, seat bearing against coupling flange.

(4) Install bearing spacer on coupling.

(5) Insert pin into coupling.

(6) Install lower bearing on coupling. Using accessory drive bearing-to-coupling drift, seat bearing against spacer.

(7) Remove coupling from base.

(8) Install coupling in support and secure with retaining ring installed with cap center toward bearing.

(9) Secure tachometer drivegear and support holder on bench.

(10) Position coupling support (larger diameter down) on holder. Secure with bolts.

(11) Secure coupling with locking device of holder.

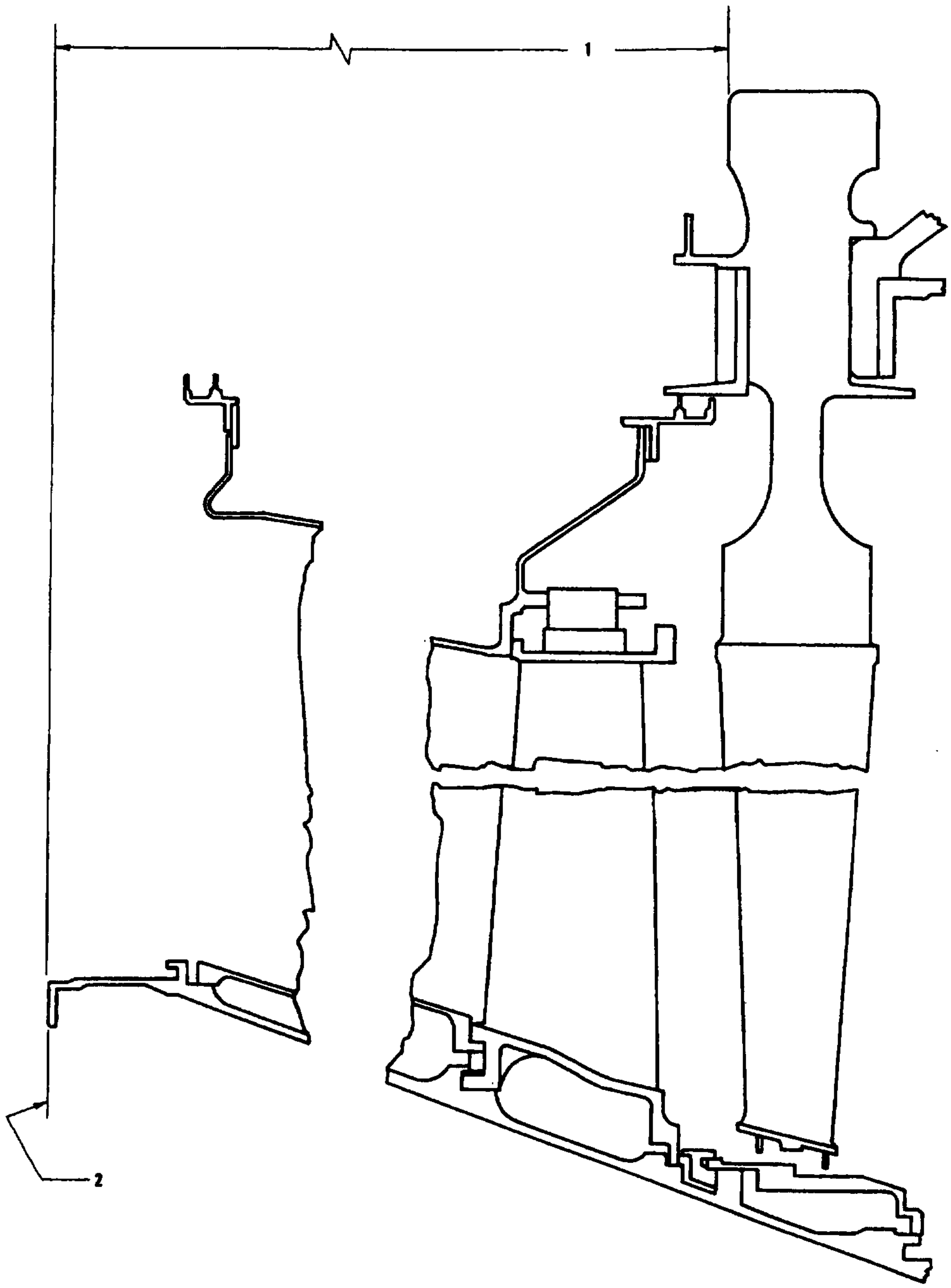
(12) Install accessory drivegear on coupling.

(13) Install drivegear retaining nut handtight.

(14) Using tachometer drivegear retaining nut wrench, and standard torque wrench, tighten nut to recommended minimum torque.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-20163 (0000)

R
R

Free Turbine Rotor
Positioning Measurement
Figure 722

1. 10.413 - 10.491 Inches
2. Free Turbine Inlet Case Front Flange

Key to Figure 722

CAUTION: DO NOT EXCEED RECOMMENDED MAXIMUM TORQUE.

(15) Further tighten nut to align rivet hole with hole in coupling.

R (16) Install the rivet and (with the tachometer drive gear
R retaining nut Riveter) flare the rivet.

T. Accessory Drive Installation

(1) Install the oil tubes in the support and secure with lockwire.

(2) Position a new seal on the front flange of the accessory drive coupling support.

(3) Position the support on the free turbine case inner flange meshing the gears and secure with the bolts. Tighten the bolts to the recommended torque.

(4) Insert the accessory driveshaft through the case into the coupling.

(5) Install new seals on the accessory driveshaft heat shield.

(6) Install the heat shield into the case and support.

U. Free Turbine Gearbox Assembly And Installation
See Table of Limits.

NOTE: Before assembling gearbox, perform bearing nozzle oil jet flow check.

(1) Install upper bearing on free turbine gearshaft, using base and drift.

(2) Install gearshaft into drive housing.

(3) Using drift, install lower bearing on gearshaft. Secure bearing in position with retaining ring.

(4) Install new preformed packing in groove of gearbox housing located at base of gearbox.

(5) Install new seals in bearing housings as follows:

(a) Position housing on pilot of base, large flange of housing up.

(b) Place seal on drift, and position pilot of drift into hole in base.

(c) Press seal into housing. Seal shall be positioned as shown in the Table of Limits.

(6) Install preformed packing on OD of rear bearing housing. Install bearing housing over gearbox studs into gearbox housing.

(7) Using base, and drift, install bearings on gearshaft.

(8) Position end of pilot, in hub end of gearshaft. Install gearshaft assembly into housing so that end of gearshaft passes through installed seal, and bearing is positioned against shoulder of seal housing. Remove pilot from gearshaft.

NOTE: Ensure that gears are meshed properly. Check backlash of gearbox gearshafts. See Table of Limits.

NOTE: For engines incorporating overspeed switch install as indicated in Paragraph V. Then continue with steps (10) thru (13).

(9) Install gasket and cover on gearbox studs. Install airframe heat shield assembly on studs so that scooped portion of heat shield faces upward when gearbox is installed on free turbine. Install locknuts and washers. Tighten locknuts to recommended torque.

(10) Install new preformed packing on bearing front housing, and install bearing housing into gearbox housing.

(11) Install new preformed packing on gearbox oil nozzle. Install oil nozzle and plug in gearbox housing and secure with bolts.

(12) Install gearbox on free turbine case boss, engaging splines of shaft in ID of coupling. Secure with locknuts. Tighten to recommended torque.

R
R

(13) Perform No. 4 bearing compartment and transfer tubes pressure check.

V. Free Turbine Overspeed Switch Installation

(1) Position cover and gasket on overspeed switch studs, and secure with nuts and washers on outboard studs of switch assembly.

(2) Install heat shield on inboard studs, and attach with locknuts.

(3) Torque all four locknuts to recommended torque.

(4) Position assembled overspeed switch on free turbine gearbox studs with heat shield at inboard position. Secure with four locknuts, and tighten to recommended torque.

(5) Install electrical branched cable connection on overspeed switch. Tighten the connector fingertight, then turn to a maximum of 45 degrees.

W. Free Turbine Shaft Inner Case

(1) Position a new seal on the free turbine case inner flange.

(2) Install new preformed packings on each end of the oil tube ferrules.

(3) Install the ferrules in the oil tubes in the free turbine case.

(4) Carefully lower the turbine shaft in a case over the free turbine shaft onto the free turbine case flange engaging the oil tub ferrules into the oil pressure and scavenge tubes.

(5) Secure the flanges with the nuts and bolts. Tighten the nuts to the recommended torque.

X. No. 5 Bearing Installation
See Tool Group 11C.

(1) Install the No. 5 bearing outer race and rollers in the bearing support.

R
R

(2) Using the No. 5 bearing outer race Drift and a mallet, seat the bearing in the support.

(3) Install the outer race retaining nut in the support.

(4) Attach the outer part of the No. 5 bearing outer race retaining nut wrench to the hydraulic wrench. Secure to the rear flange of the bearing support with the nuts and bolts.

(5) Lower the inner part of the retaining nut wrench through the hydraulic wrench, and engage the slots in the nut.

(6) Using hydraulic pressure, tighten the retaining nut to the recommended initial torque. Loosen to zero lb-in. Tighten to the recommended initial torque and minimum angle of turn. If necessary, tighten the nut further to align a rivet hole in the nut with the hole in the support.

CAUTION: DO NOT EXCEED THE RECOMMENDED MAXIMUM ANGLE OF TURN.

(7) Install a rivet in the rivet holes (head inward), and using No. 5 bearing outer race retaining nut rivet Riveter, flare the rivet.

Y. Turbine Shaft Outer Case

(1) Install the bolts (heads forward) in the holes in the OD of the No. 5 bearing support with the flats of the heads against the shoulder. Secure the bolts with the retaining rings.

(2) Position a new seal on the free turbine inner case rear flange.

(3) Install the support on the inner case rear flange, and secure with the bolts. Tighten the bolts to the recommended torque.

(4) Position the turbine flange outer case over the inner case engaging the rear flange holes over the bolts.

(5) Secure the front flange of the case to the free turbine case flange with the bolts, key washers (with SB 6217) and nuts. Tighten the nuts to the recommended torque.

R
R

Z. Free Turbine Coupling Buildup
See Tool Group 56F.

(1) Mount the No. 5 bearing seal plate, bearing, and coupling Holder on a bench.

(2) Install the coupling (splined OD down) into the holder.

(3) Position the No. 5 bearing seal plate (puller groove up) on the coupling, aligning the X-mark on the plate with the X-mark on the coupling.

(4) Heat No. 5 bearing inner race in hot oil, and position race on coupling.

NOTE: Install bearing inner race as marked (REAR toward rear of engine).

(5) Using No. 5 bearing inner race and oil scoop seal plate drift and mallet, seat race and seal plate on coupling.

(6) Install inner race retaining nut on coupling.

(7) Position adapter in ID of coupling, permitting spline of adapter to engage coupling spline.

(8) Bolt No. 5 bearing inner race retaining nut wrench to hydraulic wrench.

(9) Position wrenches over adapter and coupling. Install as follows:

(a) Engage wrench teeth in slots of inner race retaining nut.

(b) Engage splines of adapter in splines of hydraulic wrench.

(10) Using hydraulic pressure, tighten inner race retaining nut to recommended initial torque. Loosen to zero lb-in. Retighten to recommended initial torque and angle of turn. See the Table of Limits. Remove wrenches.

(11) Install retaining nut lock washer and retaining ring.

AA. Free Turbine Coupling Installation
See Tool Group 56P.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page.

(1) Install free turbine coupling on turbine shaft, aligning X-mark on coupling with X-mark on ID of shaft.

(2) Install coupling nut hand tight into turbine shaft.

(3) Attach outer part of turbine shaft coupling nut wrench to hydraulic wrench. Install on coupling.

(4) Lower inner part of coupling nut wrench to hydraulic wrench and into coupling nut.

(5) Using hydraulic pressure, tighten coupling nut to recommended initial torque. Turn further to align lock splines on OD of nut with lock splines on ID of coupling.

<u>CAUTION</u>: DO NOT EXCEED RECOMMENDED MAXIMUM ANGLE OF TURN.

(6) Install new seal on coupling nut plug and install plug in coupling nut. Secure with retaining ring.

(7) Install coupling nut lock, engaging splines of coupling and coupling nut.

(8) Secure with retaining ring.

AB. No. 5 Bearing Seal Assembly

(1) Position No. 5 bearing seal support (pins upward) on bench.

(2) Install seal ring in groove in support (angled face down).

(3) Install springs on seal pins.

(4) Position seal assembly on support.

(5) Exerting slight downward force on seal to compress springs, install cotter pins in holes of three projecting pins. Bend outboard leg of each cotter pin around pin to retain seal assembly.

<u>NOTE</u>: Do not bend the inside leg of cotter pins.

AC. No. 5 Bearing Seal Installation

(1) Install new packing on seal support flange.

R
R

(2) Position No. 5 bearing seal assembly (carbon seal down) over coupling aligning boltholes with holes in seal support flange.

(3) Secure seal assembly with bolts.

(4) Tighten bolts to recommended torque and lockwire.

AD. Free Turbine Exhaust Duct

NOTE: If stabilizing ring is incorporated, install ring between free turbine case rear flange and exhaust duct front flange.

(1) Position exhaust duct over free turbine shaft outer case onto free turbine case rear flange.

NOTE: Case installation shall be accomplished without undue force. Should installation difficulties arise, inspect for case deformation. If engine is to be installed in shipping container, duct shall be installed with opening in vertical position.

(2) Secure case front flange to free turbine case with nuts and bolts.

R (3) Tighten the nuts to the recommended torque.

AE. Free Turbine Exhaust Duct Fuel Drain And Cover Installation

(1) Position gasket and fuel drain on boss and secure with bolts. Tighten to recommended torque. Ensure that fuel drain elbow faces forward.

(2) Secure cover and gasket to diametrically opposed boss using bolts. Tighten to recommended torque.

AF. Installing Free Turbine Section in Free Turbine Stand See Tool Group 56N.

(1) Install free turbine assembly Lifting Eye to turbine shaft coupling.

(2) Attach hoist to lifting eye.

(3) Attach second hoist to front case-to-jack plate.

(4) Disconnect front case-to-jack plate from compressor and turbine locating jack.

(5) Remove top support from free turbine stand.

(6) Using two hoists, lift free turbine assembly and turn to horizontal position. Lower into free turbine stand.

(7) Adjust rear mounting pad of free turbine stand as necessary and attach to rear engine mounting pad. Lock pad in position.

(8) Carefully pass top support over top of free turbine. Adjust support mount as necessary and attach to ground handling mount at 12 o'clock position. Secure mount to flats on stand. Remove slings, lifting eye, and plate.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page.

ENGINE GENERAL - FINAL ASSEMBLY

1. General

A. General

R WARNING: AT ONE TIME SOME ENGINE PARTS CONTAINED ASBESTOS
R FIBERS, AND IT IS POSSIBLE THAT SOME OF THESE PARTS
R CONTINUE IN SERVICE. REFER TO COMMERCIAL ENGINE
R SERVICE BULLETINS FOR A LIST OF PARTS THAT AT ONE
R TIME CONTAINED ASBESTOS. IN SOME PARTS THE MATERIAL
R THAT CONTAINED ASBESTOS WAS THE ADHESIVE. IT IS
R IMPORTANT TO USE CORRECT PRECAUTIONS DURING WORK
R WITH THESE PARTS. OPERATORS MUST OBEY ALL LOCAL
R REGULATIONS AND EMPLOYER WORK POLICIES WHEN PARTS
R THAT CONTAIN ASBESTOS ARE TOUCHED OR DISCARDED.

R THE ASBESTOS USED IN PRATT & WHITNEY ENGINE PARTS
R WAS USUALLY ENCAPSULATED AND WILL NOT RELEASE DUST
R UNLESS THE PARTS ARE GROUND, SANDED, CUT, OR
R BROKEN. WHILE IT IS OUR EXPERIENCE THAT THESE
R OPERATIONS DO NOT USUALLY RELEASE ASBESTOS AT
R LEVELS MORE THAN PERMITTED EXPOSURE LIMITS,
R OPERATORS MUST USE ALL APPLICABLE PRECAUTIONS
R WHEN THEY TOUCH SUCH PARTS.

B. The general instructions in Assembly of Subassemblies are to be followed whenever applicable in performing the final operations described in the subsequent paragraphs.

C. Because of the lightweight construction of the engine, it is especially important that care be exercised in the handling of the engine and its detail parts. Specific examples where such care must be taken are listed as follows:

(1) Major Case Flanges. All case flanges are relatively thin, and they can be permanently distorted if improperly handled. Care shall be taken to ensure that case flanges are not inadvertently struck against bench tops and other hard surfaces during handling. Under no circumstances shall case flanges be used to force excessively tight snap fits together.

(2) Flange Bolts. Specified bolt torques for flange bolts must be observed strictly at all times. Many of these bolts are No. 10 size (0.190 inch minimum diameter), and excessive torque can result in permanent distortion of the bolt. Conversely, insufficient torque will result in overstressing of the bolt during subsequent engine operation.

(3) Combustion Chamber Drain Boss. The drain boss is welded directly to the wall of the combustion chamber case. Because the case wall is thin, care must be taken when torquing the drain line. If the drain elbow is not properly supported during torquing, the case wall may be overstressed with resultant damage.

(4) Combustion Chamber Inner Case. This assembly forms a cantilever support for the No. 3 bearing. The wall thickness of the assembly is quite thin, and improper handling can result in denting or twisting.

(5) Burner Cans. The wall thickness of the burner cans is relatively thin (0.018 inch) and care must be taken to guard against denting during handling.

(6) External Tubing. External tubing (rigid as well as flexible type), shall not be used for hand or foot holds. The engine shall never be moved by pushing or pulling on these lines.

2. Compressor Section

A. Installing The Compressor Section In The Vertical Stand See Tool Group 40.

(1) Bolt inlet case adapter to front face of inlet case.

(2) Bolt plate to adapter, keeping narrow part of ring at 12 o'clock position and lifting eyes at ten and 12 o'clock positions.

(3) Install locating jack on transport stand and secure with quick disconnects. Retract jack pad until it is below top flange of jack.

(4) Attach lifting sling to spools of rear half of balance fixture and trunnion compressor assembly onto build stand.

NOTE: Compressor assembly was left in balancing fixture after installation of inlet case in Assembly of Subassemblies.

(5) Install fourth stage vane outer shroud support ring on compressor case rear flange.

B. Compressor Bleed Valve (Non-Crisscross Strap)

(1) Pass bleed valve strap through bleed valve opening in compressor inlet case and around engine, engaging strap in guides location around compressor stator spacer.

(2) Secure ends of strap to bleed valve carriages with pins and lockwire.

NOTE: When securing pin to clevis with lockwire insert wire through clevis first and then through pin. Twist lockwire straight out and parallel to bleed strap.

R (3) Position bleed valve bearing guide on compressor inlet case, engaging threaded ends of rigid connecting links in holes and bearing guide to case with bolts. Tighten bolts to recommended torque and lockwire.

(4) Position spacer and bearing on each rigid connecting link. Secure with locknuts. Tighten locknuts to recommended torque.

(5) Install bearing on bleed valve arm. Secure with retaining ring.

(6) Position bleed valve linkage arm on bleed valve arm. Secure with locknut. Tighten locknut to recommended torque.

(7) Attach bleed valve linkage to bellcrank with pin and cotter pin.

NOTE: Lubricate compressor bleed valve linkage shaft assembly at grease fitting with Plastilube Moly No. 3. This grease is available from:

Thiem Corp.
Sub. of Koppers Co. Inc.
5151 Denison Avenue
Cleveland, OH 44101-5019 USA

Tel: (216) 961-0035

C. Compressor Bleed Valve (Crisscross Strap)
See Figure 801 and Figure 802.

ENGINE GENERAL - FINAL ASSEMBLY

(1) Pass bleed strap slotted end counterclockwise through rectangular opening of compressor inlet case into bleed strap compartment.

NOTE: If difficulty is encountered when inserting bleed strap, a metal band (obsolete non-crisscross strap, if available) placed against strap cushions will facilitate installation. After strap is in place, pull out band.

(2) Cross strap ends by inserting narrow end through slotted end.

(3) For free turbine engines, incorporating non-cushioned bleed strap and left and right bleed strap springs, install springs as follows:

(a) With bleed strap held taut, insert right and left springs through rectangular opening into bleed strap compartment so that springs press on outside of bleed strap.

(b) Position right and left strap supports inside sharp bends of their respective springs.

(c) Secure right spring and support to inlet case with washers and bolts. Torque and lockwire.

NOTE: Left support and spring cannot be secured until bleed valve bearing guide is installed.

(4) Place clevis on each end of strap. Ensure that clevis yoke is outward and towards center of bleed valve assembly.

(5) Insert pins through clevis and strap (head of pin at right up and head of pin at left down). Secure pins with cotter pins.

(6) Attach bleed valve strap lever assembly to both clevises. Ensure that lever right connecting link offset is up and that wide spline of bellcrank stem is up and to the right of center. Secure left and right connecting links to clevises with spacers, bearings, and nuts. Handtighten nuts.

(7) Insert lever assembly into rectangular opening in inlet case, positioning links to seat assembly properly.

(8) Place compressor bleed valve bearing guide on bench with outboard side up. Install bearing into center boss and secure with retaining ring.

(9) Position guide on lever assembly, inserting lever assembly bellcrank stem through guide bearing and link bearings through guide slots. Secure guide to inlet case with bolts. Fingertighten. If strap support and spring are being installed, secure left support and spring to bearing guide with washers, bolts, and lockwire.

(10) Install bearing and pin through bottom of left yoke and bearing and thrust washer on top. Secure with cotter pin. Repeat procedure for right yoke.

(11) Tighten two locknuts on clevis assemblies to recommended torques.

(12) Actuate bleed strap to ensure proper assembly.

CAUTION: DO NOT WRENCH HOLLEY FUEL CONTROL BLEED STRAP SIGNAL VALVE SCREW. PN 5A31001, AT ANY TIME TO ACTUATE BLEED STRAP MECHANISM AS SHEARING OF SERRATION WILL OCCUR IN THE BLEED ACTUATOR HOUSING WHEN LEVER AND SHAFTS ARE DISENGAGED.

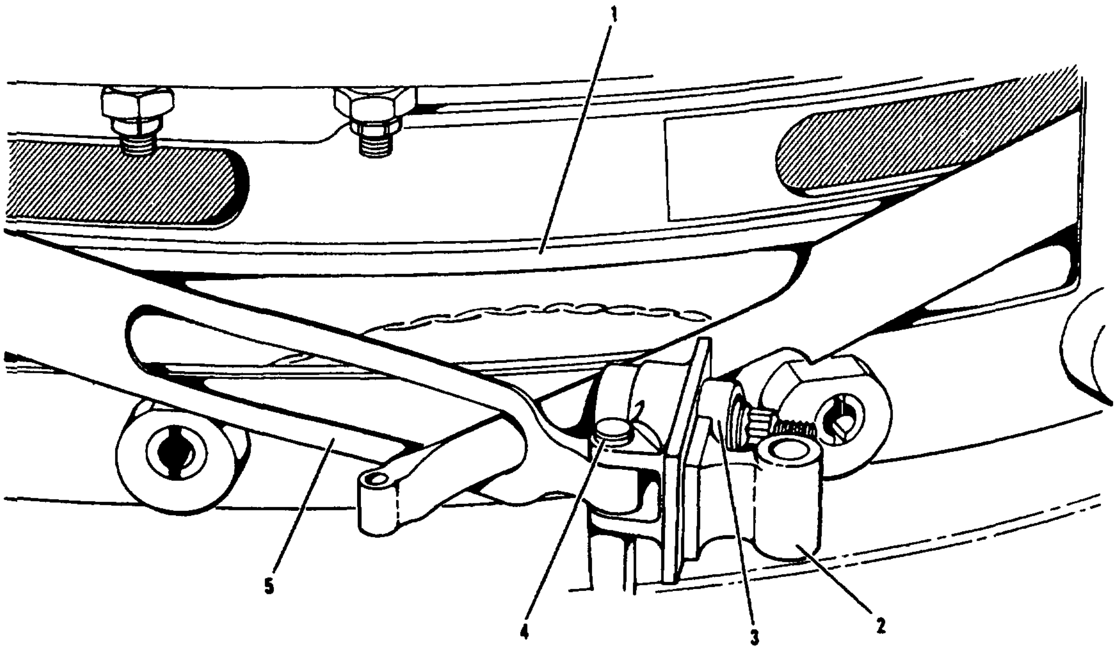
(13) Tighten bolts securing guide to inlet case. Tighten to recommended torque.

NOTE: Crisscross bleed system mechanism operates entirely on antifriction bearings, and should not be lubricated.

D. Diffuser Section

(1) Diffuser Case
See Tool Group 42, Figure 803 and Figure 804.

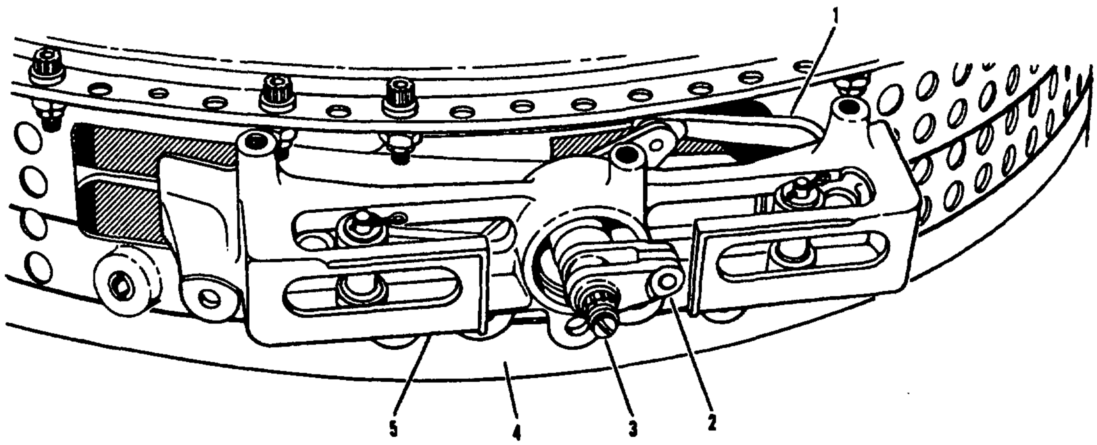
(a) Bolt Trunnion Brackets (180° apart) to diffuser case rear flange. Suspend lifting sling from hoist and secure sling hooks to brackets.



L-21620 (0000)

1. Inlet Case
2. Clevis Yoke
3. Connecting Link Bearing
4. Clevis Pin Head
5. Strap

Install Bleed Strap Into Clevis
Figure 801



L-21619 (0000)

1. Connecting Link
2. Bleed Arm
3. Bellcrank Stem
4. Inlet Case
5. Bleed Valve Guide Assembly

Installing Bellcrank In Inlet Case
Figure 802

ENGINE GENERAL - FINAL ASSEMBLY

(b) Install oil distributing sleeve guide on compressor rear hub, engaging inner part of guide with locking bolt threads. Position rollpin in hub spline and spline on OD of guide. Tighten center part of guide and remove rollpin.

(c) Using hoist, position diffuser case over compressor section (guiding No. 2 bearing seal and No. 2 bearing oil distributing sleeve over guide) until end of compressor hub protrudes slightly from rear of oil distributing sleeve.

(d) Position main component drivegear spacer (flat face rearward) over No. 2 bearing inner race retaining ring on compressor rear hub. Position main component drivegear on compressor rear hub.

(e) Install Drivegear Pusher, engaging center bolt in guide on compressor hub. Tighten pusher until slight tension is felt on bolt. Alternately lower diffuser case (aligning offset holes in diffuser and compressor case flanges) and turn bolt into guide until diffuser case is seated on compressor case. Remove pusher and guide.

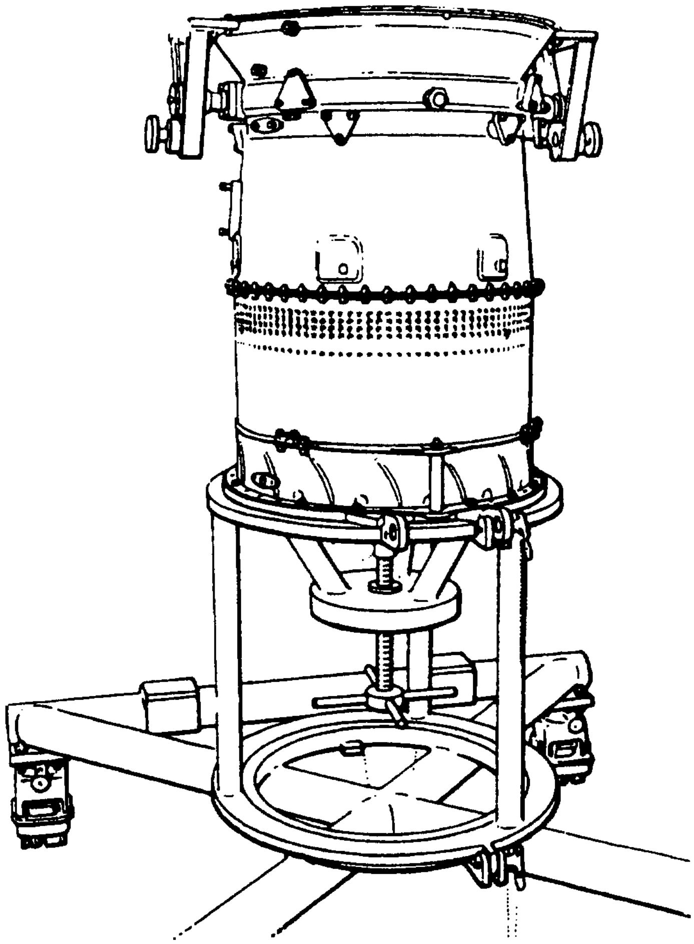
(f) Secure diffuser case to compressor case rear flange with bolts, washers, and nuts. Tighten nuts to recommended torque.

NOTE: Transfer point of most unbalance mark on OD of splined end of compressor rotor rear hub to rear flange of diffuser case.

(g) Using outer race retaining nut wrench and standard torque wrench, tighten nut (refer to the Table Of Limits). Install the rivet with the Riveter.

(h) Insert inner race Retaining Nut Wrench into Hydraulic Wrench, aligning holes in retaining nut wrench flange with holes in hydraulic wrench. Secure with bolts.

(i) Install retaining nut wrench adapter into hydraulic wrench, engaging slots in adapter with driving dogs of retaining nut wrench, and engaging adapter splines with splines of hydraulic wrench.



L-08460 (OOOO)

Compressor And Diffuser Section
In Build Stand
Figure 803

(j) Retract retaining nut wrench locator by turning knurled locator ring to full counterclockwise position.

(k) Lower wrench into compressor rear hub, engaging drive splines with hub splines and engaging locator splines with splines in No. 2 bearing oil scoop.

(l) Using hydraulic pressure, turn wrench clockwise and tighten oil scoop until recommended initial torque and minimum angle of turn are obtained. See Figure 804.

CAUTION: DO NOT EXCEED MAXIMUM ANGLE OF TURN.

(m) Release hydraulic pressure and turn knurled locator ring clockwise, moving locator into compressor rear hub. If oil scoop spline is aligned with hub spline, locator will enter hub splines. If locator does not enter hub splines, retract locator and tighten oil scoop additional two degrees. Continue to tighten oil scoop in two degree increments until alignment is obtained.

(n) Release hydraulic pressure and remove hydraulic wrench and retaining nut wrench.

(o) Remove diffuser case brackets.

(p) Bolt left and right Test Mounts to pads on diffuser case.

(q) Suspend sling from hoist and secure sling hooks to test mounts.

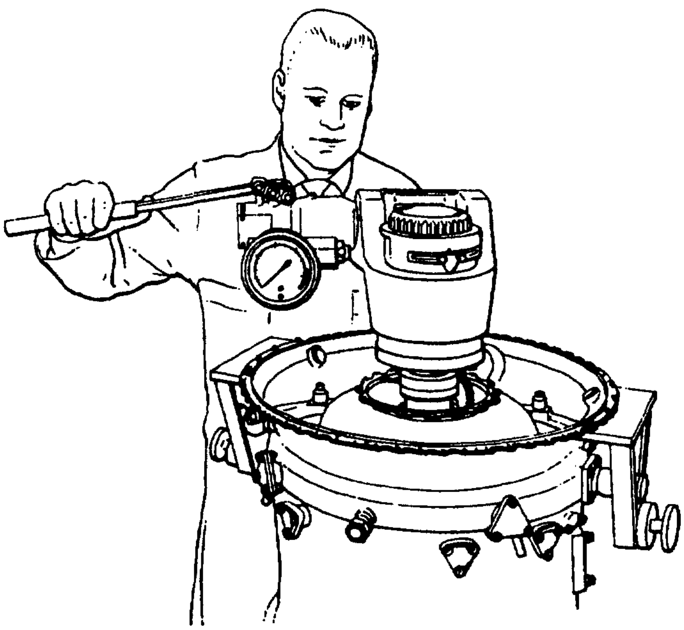
(r) Unfasten quick-disconnects securing lift and turn plate to jack and raise engine.

(s) Remove jack from stand.

(t) Lower engine onto stand and secure lift and turn plate to stand with quick-disconnects.

(u) Remove sling.

(2) No. 2 Bearing Oil Nozzle
See Tool Group 8A.



L-08797 (0000)

Tightening No. 2 Bearing Oil Scoop
Figure 804

(a) Install strainer in No. 2 bearing oil nozzle and secure in position with snapring.

(b) Position new preformed packing on oil nozzle.

(c) Position No. 2 bearing oil nozzle (upper nozzle facing forward) on boss in diffuser case, aligning hole in nozzle flange with dowel in boss.

(d) Secure oil nozzle to boss with bolts. Using Wrench, tighten bolts to recommended torque and lockwire.

(3) No. 3 Bearing Oil Scavenge Tube Elbow

(a) Position new preformed packing on No. 3 bearing oil scavenge tube nozzle.

(b) Position oil scavenge tube elbow on boss in diffuser case, aligning hole in elbow flange with dowel in boss.

(c) Secure elbow to boss with bolts. Tighten bolts to recommended torque and lockwire.

3. Combustion And Turbine Sections

A. Turbine

(1) Turbine Section Installation
See Tool Group 100 and Figure 805.

(a) Place preformed packings on oil transfer tubes and install one transfer tube in the No. 2 bearing oil suction tube elbow and other in No. 2 bearing oil nozzle in diffuser case. Install new seal on diffuser case rear flange.

(b) Position one guide pin nut (over one of the holes) on forward face of diffuser case inner rear flange. Insert guide pin through hole and screw pin through nut until pin jams against diffuser case and is secured in hole by nut. Install second guide pin (180 degrees from first pin) in same manner.

(c) Using sling, remove turbine section from build and gage fixture.

(d) Lower turbine assembly into engine, guiding splines through No. 2 bearing oil scoop, and engaging splines of compressor rear hub.

NOTE: Point of greatest axial runout of turbine shaft spacer (marked on turbine blade) must be kept 180 degrees from point of greatest axial runout of mating area in compressor rear hub.

NOTE: Do not bolt front end of combustion chamber inner case into diffuser case at this time.

(e) Remove lifting eye and install locking bolt wrench through ID of turbine shaft, into shaft locking bolt.

(f) Move the wrench up and down (feeling for lock movement) until the lock moves forward approximately one quarter of an inch.

(g) Bolt the hydraulic wrench adapter to the hydraulic wrench.

(h) Lower the hydraulic wrench over the locking bolt wrench and secure the adapter to the turbine disk retaining bolts with the engine nuts.

(i) Using hydraulic pressure, turn the locking bolt wrench counterclockwise and tighten the locking bolt to the recommended initial torque and the recommended minimum angle of turn.

(j) Release the hydraulic pressure and move the locking bolt wrench rearward approximately one-half inch.

(k) Determine whether the turbine lock has snapped into position by depressing the indicating rod and feeling for turbine lock spring action. If no spring action is felt, continue to turn the turbine locking bolt counterclockwise until the lock snaps into position as indicated by one-quarter inch rearward movement of the indicating rod.

(l) Remove the wrenches and the adapter.

(m) Secure the combustion chamber inner case to the diffuser case with the nuts and bolts. Replace the guide pins with nuts and bolts. Tighten the nuts to the recommended torque and lockwire.

(n) Using bar stock and a depth micrometer, check turbine disk locating dimension as shown in Figure 805.

NOTE: After every installation of turbine rotor for final assembly, turbine disk locating dimension shall be recorded.

(2) First Stage Turbine Rotor Outer Airseal Spacer Installation

(a) Install spacer through rear of turbine case (grooved face rearward) so that front face will abut rear surface at 1st stage turbine rotor outer airseal.

(3) Second Stage Turbine Vanes - Installation See Table of Limits, Figure 806 and Figure 807.

(a) Position turbine vane inner shroud assembly on bench with rivet flange down.

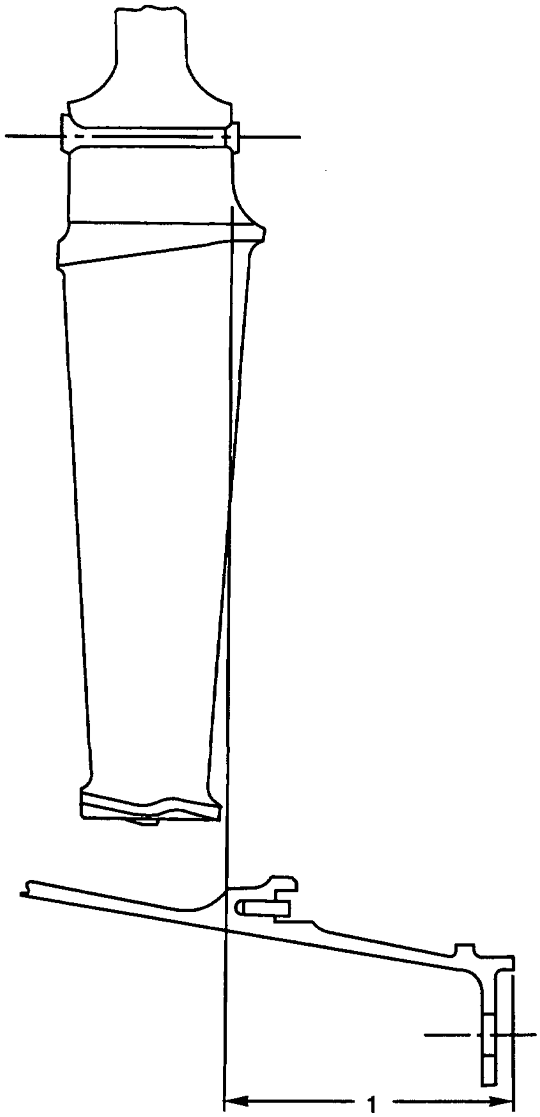
(b) Position full complement of vanes around the inner shroud assembly with vane tangs inserted into slots of inner shroud and vane outer buttress retaining pin slots down.

NOTE: Install vanes in accordance with Turbine Vane - Classification in Table Of Limits.

(c) To prevent separation of vanes from inner shroud during installation into turbine case, wrap wire around vane outer buttresses.

(d) Place vane and shroud assembly in turbine case and remove wire as soon as front legs of vane outer buttresses enter case.

CAUTION: DO NOT FORCE VANES OVER 1ST STAGE TURBINE ROTOR SEAL SPACER BY TAPPING WITH A HAMMER. DOING SO MAY SERIOUSLY DAMAGE REAR LIP OF VANE AND ALLOW VANE TO ENTER TURBINE ROTOR DURING ENGINE OPERATION. IF NECESSARY, REPLACE



1. 1.407 - 1.417 Inch

Turbine Disk Locating Dimension
Figure 805

1ST STAGE ROTOR SEAL SPACER TO FACILITATE INSTALLATION OF VANES.

(e) Position vane outer buttress front flanges in retaining groove of turbine case so that retaining pins engage slots in outer buttresses.

(f) To hold vanes in place, position 2nd stage blade outer airseal on rear flange of turbine case. Prior to fastening with screws align offset holes in seal and turbine case flange.

<u>NOTE</u>: To facilitate procedure for 2nd stage turbine vane and shroud assembly pre-loading and measurement, determine dimensions in Figure 806 prior to installation of 2nd stage turbine rotor outer airseal.

B. Second Stage Turbine Vane And Shroud Assembly Preloading And Measurement
See Tool Group 84A and Figure 806 and Figure 807.

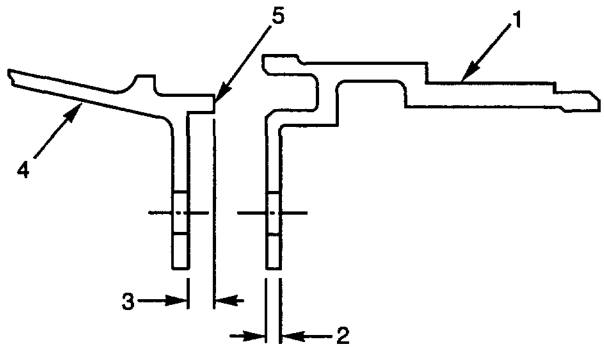
(1) With 2nd stage vanes, inner shroud assembly, and 2nd stage turbine rotor outer airseal installed, attach Preloading Support to rear of 2nd inner shroud by tightening clamps on rear flange of shroud.

(2) Mount loading fixture on rear face of 2nd stage turbine rotor outer airseal flange.

(3) Fasten force gage to loading fixture and in turn fasten support to force gage.

(4) Apply 100 - 200 lb-in. rearward axial load.

(5) Using slots provided in fixture, place parallel bar on rear face of 2nd stage turbine rotor outer airseal. Then, with depth micrometer measure from the parallel bar to rear face of inner airsealing ring and to rear surface of 2nd stage turbine rotor outer airseal flange.



1. Second Stage Turbine Rotor Outer Airseal
2. Dimension A
3. Dimension B
4. Turbine Case Rear Flange
5. Reference Surface

NOTE: Subtract Dimension A from Dimension B to determine reference dimension (Index 11) in Figure 807.

Second Stage Turbine Rotor
Outer Airseal Dimensional Check
Figure 806

(6) Determine axial position of rear surface of inner airsealing ring in relation to rear surface of turbine case utilizing above dimensions in step (5) and (Index 11) in Figure 807.

NOTE: After every installation of 2nd stage vanes these measurements shall be checked by another individual to ensure that correct assembly position is made.

C. Second Stage Turbine Disk and Blades

(1) Position 2nd stage turbine disk (front face down) on turbine shaft flange, aligning offset hole in disk with offset hole in flange, and engaging front face flange in ID of turbine rotor inner seal.

NOTE: Turbine rotor inner seal must be aligned with disk as marked after dynamic balance check of turbine rotor assembly.

(2) Place tabwasher on each bolt, engaging long tab in small hole adjacent to each bolt.

(3) Install nuts on bolts. Tighten bolts as follows:

(a) Tighten nuts simultaneously in pairs 180 degrees apart.

(b) Loosen nuts simultaneously in pairs 180 degrees apart to zero lb-in., then retighten to specified limits.

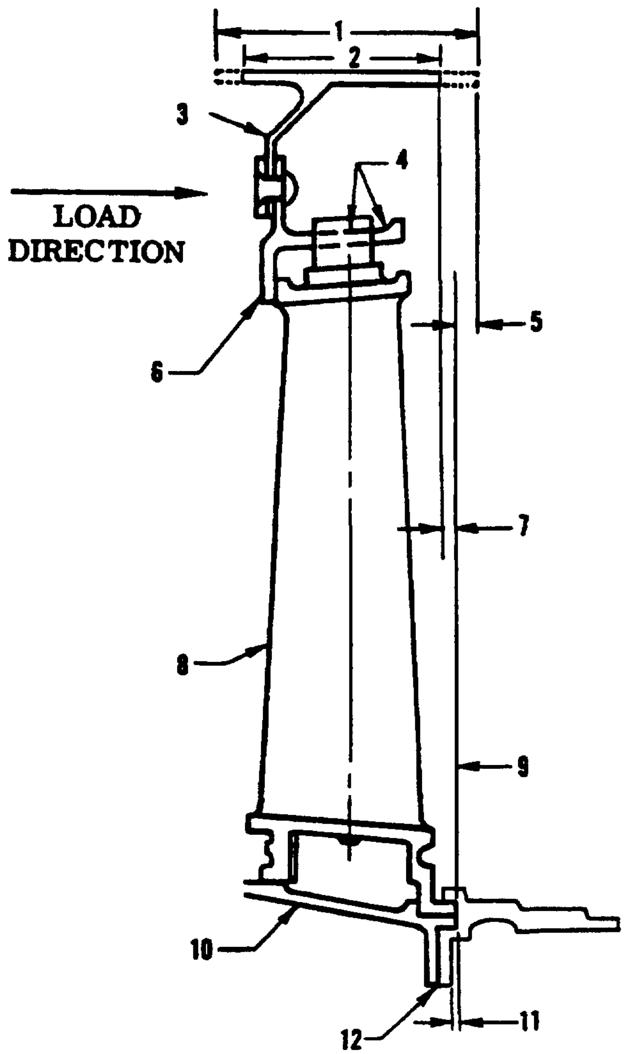
NOTE: Loosening and tightening must be done simultaneously in pairs 180 degrees apart.

(4) Check squareness runout of 2nd stage disk at rear face just below blade rivet. Runout must not exceed 0.003 inch FIR.

(5) Bend tabwashers up to lock nuts.

D. Turbine Exhaust Case (Turbojet Engines Only).

(1) Position exhaust case (front flange down) on turbine case, aligning offset holes in flanges, and engaging rear of 2nd stage turbine rotor outer seal under lip of turbine exhaust case.



L-22086 (0000)

Second Stage Turbine Vane And Shroud Assembly Loading and Measurement
Figure 807

1. 1.335 - 1.355 Inches
2. 1.205 - 1.225 Inches
3. Airsealing Ring
4. Apply Simultaneously 100 - 200 Pound Loads On Areas Indicated. Measurements Shall Be Taken With Full Complement Of Vanes And 2nd Stage Turbine Rotor Outer Airseal Installed.

   NOTE: Of two airsealing ring configurations, differing in width, ring employed will determine measuring procedure and applicable dimension, (Index 5) or (Index 7).

5. 0.054 - 0.130 Inch
6. Vane Inner Shroud
7. 0.005 - 0.081 Inch
8. Second Stage Vane
9. Reference Line
10. Turbine Case
11. Reference Dimension (See Figure 806)
12. Second Stage Turbine Rotor Outer Airseal

Key to Figure 807

E. Combustion Chambers

<u>CAUTION</u>: COMBUSTION CHAMBERS WITH FRONT 360 DEGREE AIR SCOOP ARE NOT PERMITTED (REFER TO SERVICE BULLETIN 1584).

(1) Place retaining clamp around each combustion chamber.

(2) Position No. 2 combustion chamber on fuel nozzle air swirl guide and against outlet duct.

<u>NOTE</u>: SB 5091 provides combustion chambers and clamps with additional cooling airholes, and combustion chamber outlet duct assembly with an increased air gap between detail lugs and duct. These chambers, clamps and duct must be used as complete sets.

<u>NOTE</u>: To ensure maximum durability of mating combustion chambers and clamps, hardfaced and non-hardfaced parts should not be used together. If unlike surfaces are to be mated, hardfaced surfaces shall have been polished to a surface finish of at least 250AA and treated with antigalling compound. Refer to Section 70-00-00, Assembly-01 in the Standard Practices Manual.

(3) Apply antigalling compound (PWA 586) to combustion chamber outlet duct in areas that mate with combustion chamber clamps.

(4) Slide retaining clamps rearward, engaging positioning lugs on clamp with indents in combustion chamber and in outlet duct.

NOTE: For plasma coated combustion chamber, use uncoated area at guide to assist in positioning lug with indents.

(5) Coat retaining clamp bolt threads with PWA 586 and install bolt but do not tighten.

(6) Position two retaining ring segments over air swirl guide and fuel nozzle cup adapter.

(7) Secure segments in place with retaining ring.

CAUTION: COMBUSTION CHAMBER RETAINING RINGS MUST BE REPLACED AT EVERY OVERHAUL.

(8) Tighten retaining clamp bolts to 30 - 40 lb-in. and lockwire.

(9) Install remaining combustion chambers in same manner.

NOTE: Combustion chambers No. 2, 4, 6, and 8 must be installed prior to installing combustion chambers No. 1, 3, 5, and 7. Combustion chambers may also be installed as mirror image of original arrangement. This entails interchanging No. 3 with No. 6 chamber and mating crossover tubes on balance of chambers.

Normal Position	Revised Arrangement
1	4
2	7
3	6
4	1
5	8
6	3
7	2
8	5

F. Combustion Chamber Case

NOTE: If there is reason to anticipate air leakage at combustion chamber outer case front flange either due to prior engine testing or evidence of poor fit, apply sealant as described in Paragraph G.

(1) Position combustion chamber case on diffuser case rear flange, aligning offset holes in flanges.

(2) Position upper gangnut angle fireseal on combustion chamber outer case rear flange, aligning elongated hole of fireseal with offset hole of case.

(3) Secure combustion chamber case to diffuser case with bolts and locknuts.

(4) Position lower fireseal on case rear flange and install bolts.

(5) Secure combustion chamber case rear flange to turbine case with locknuts.

(6) Tighten locknuts on both flanges to recommended torque.

G. Combustion Chamber Outer Case Front Flange Sealant Application

(1) If there is reason to anticipate leakage problem apply sealant as follows; otherwise, procedure is optional.

(a) Thoroughly clean rear surface of diffuser case rear flange with SPOP 208 solvent and let the surface dry for 30 minutes. Refer to Section 70-21-00 in the Standard Practices Manual.

R (b) Apply PWA 617 (DC 3145 RTV) sealant to the diffuser
R case flange immediately before the diffuser and
R combustion chamber cases go together. Refer to
R 70-12-00, General-06 in the Standard Practices
R Manual.

<u>NOTE</u>: Sealant may be applied by hand. Primers need not be used to improve bonding.

4. <u>Accessory Section</u>

A. Component Drive Gearbox
See Tool Group 22 and Figure 808.

(1) Install lifting adapter to component drive gearbox housing cover. Secure adapter on studs with barrel nuts.

(2) Attach hoist to eye at top of lifting adapters cross rod and lock eye in position. Lift gearbox.

<u>NOTE</u>: Eye must be positioned over components in such a manner as to prevent lifting gearbox in an unbalanced condition.

(3) Position main component drive towershaft (flat shouldered spline toward gearbox) in bottom opening in diffuser case, engaging shaft splines with main component drive coupling splines.

(4) Assemble positioning adapter as follows:

(a) Coat threads of oil nozzle with sealing compound (PWA 549) and install nozzle on underside of positioning adapter.

(b) Tighten nozzle to recommended torque (see the Table Of Limits).

(c) Install packing in groove of strainer element and thread element into positioning adapter tube.

(d) Tighten to recommended torque and lockwire.

ENGINE GENERAL - FINAL ASSEMBLY

(e) Install preformed packing in top and bottom OD grooves of adapter.

(f) Insert adapter into opening in diffuser case.

NOTE: For engines not incorporating oil nozzle, omit steps (a) thru (d).

(5) Position gearbox on positioning adapter, engaging towershaft splines in splines of gearbox bearing adapter, and positioning gearbox mounting lugs between diffuser case mounting lugs.

(6) Insert two mount bolts (heads to rear) through mounting lugs. Secure mount bolts with washers and locknuts. Tighten locknuts to recommended torque.

(7) Remove lifting adapter from gearbox housing cover and install cover retaining locknuts. Tighten locknuts to recommended torque.

(8) Install the gearbox drain plug or tee as follows: See Figure 808.

(a) Pre-SB 6312:

1 Install the insert in the gearbox drain port with a lubricated packing and torque the insert to the specified value.

2 Install the plug with a lubricated packing and torque to the specified value. Refer to Section 70-00-00, Assembly-04 in the Standard Practices Manual.

(b) Post-SB 6312 (free turbine engines)

1 Install the locknut, ring, and a lubricated packing on the tee and turn the tee into the gearbox drain port with the right-angle drain port down as shown in the figure.

R
R

R 2 Turn the locknut down against the gearbox drain
R boss surface and torque it to the specified
R value. Refer to Section 70-00-00, Assembly-04
R in the Standard Practices Manual.

R NOTE: Make sure that the tee has an adapter and
R packing in the end and a plug and packing
R in the bottom port as shown in the
R figure.

5. External Parts

A. Compressor Air Bleed Valve Linkage
See Tool Group 27.

(1) Install bleed valve arm on bleed valve bellcrank. Secure with the bolt and locknut. Tighten locknut to recommended torque

CAUTION: DO NOT BEND THE LINKAGE DURING INSTALLATION AND ADJUSTMENT.

(2) Install the jamnut on rod end clevis and install clevis in linkage spring housing.

NOTE: Do not tighten jamnut.

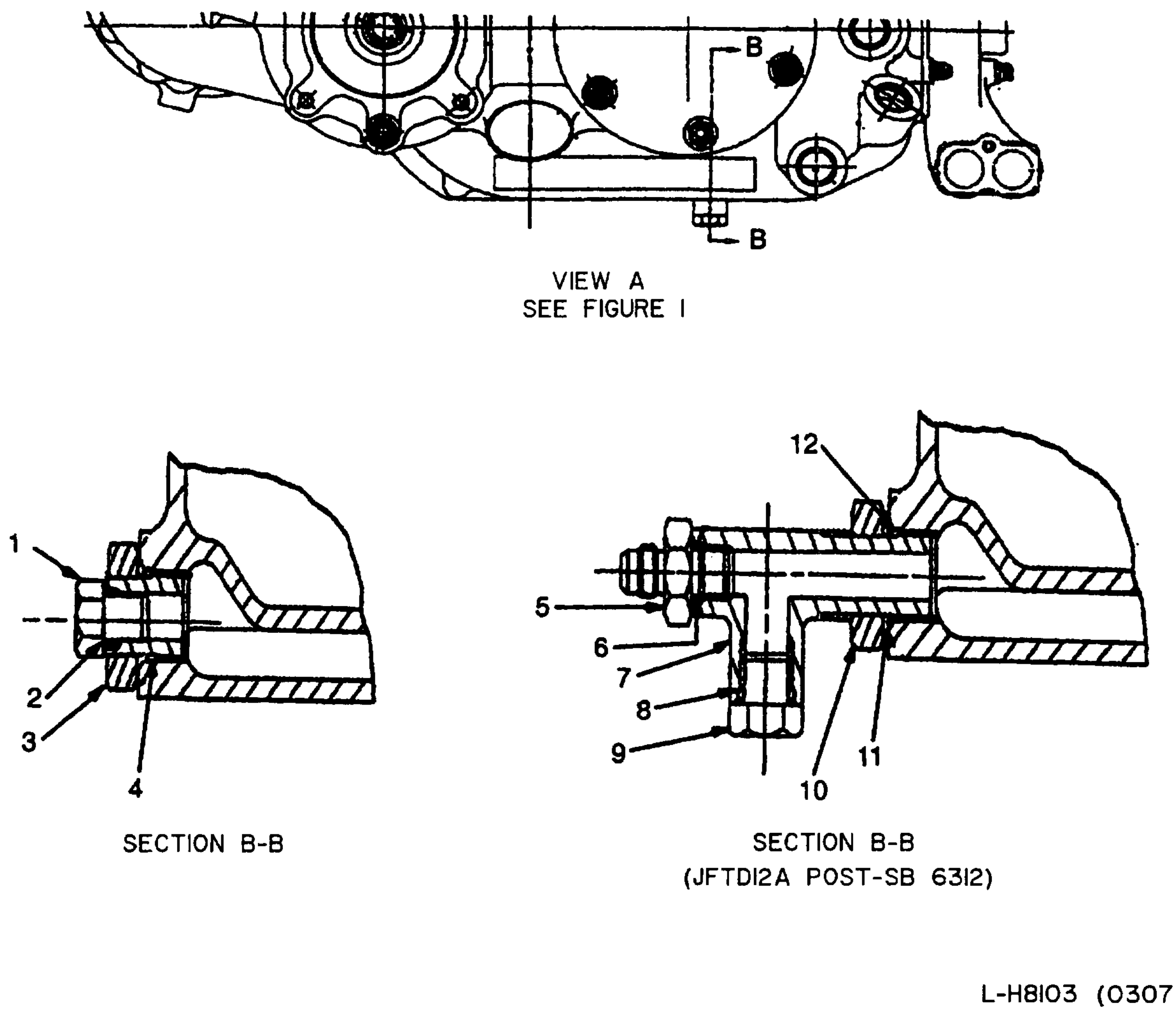
(3) Secure housing to fuel control bleed valve lever with pin (head inward), washer, and cotter pin.

(4) Using torque adapter and a standard torque wrench, apply 200 lb-in. torque in a clockwise direction to bleed valve arm.

NOTE: For engines incorporating Holley fuel control use PWA 13376 adapter. Use PWA 13417 handle and PWA 13551 adapter for engines incorporating Hamilton Standard fuel control.

NOTE: Care must be exercised when installing and using tools to avoid damage to adjacent tubes.

(5) Holding torque on arm, move housing assembly attached to fuel control bleed valve lever forward as far as it will go. Adjust linkage length by turning rod end clevis until holes are aligned with hole in bleed valve arm.



1. Plug
2. Packing
3. Insert
4. Packing
5. Adapter
6. Packing
7. Tee
8. Packing
9. Plug
10. Locknut
11. Ring
12. Packing

Gearbox Drain Plug/Tee Installation
Figure 808

(6) Shorten crisscross bleed strap linkage by turning bearing end of rod two complete revolutions. Torque jamnut to 20 - 30 lb-in. and lockwire.

NOTE: Shorten linkage of noncrisscross bleed strap by turning clevis end of rod three complete revolutions. For JFTD12A-4A and -5A engine, turn bearing end rod three and one-half revolutions.

(7) Secure clevis to bleed valve arm with pin and cotter pin.

B. Fuel Coolant Oil Cooler
See Tool Group 62 and the Table of Limits.

(1) Secure oil cooler to Flange B bracket and Flange C with bolts, washers, and locknuts.

NOTE: For flange locations, see External Parts Clearance Charts in the Table Of Limits section.

(2) Tighten locknuts to recommended torque.

NOTE: Use PWA 13845 wrench to hold locknut while turning bolt securing oil cooler to Flange C and plate spacer.

C. Oil Tank

(1) Insert two small mounts into rear holes in underside of oil tank.

R (2) Insert two large mounts into four holes in underside of oil tank.

(3) Position oil tank on engine so that the oil tank brackets are aligned with bosses on the engine.

(4) Secure oil tank to bosses with bolts and locknuts. Tighten locknuts and bolts to recommended torque and lockwire.

(5) Secure straps to the brackets on inlet case. Secure turnbuckle and clevises to brackets on diffuser case with bolts and locknuts.

(6) Tighten nuts to recommended torque.

(7) Position straps over oil tank and insert adjusting bolts into turnbuckles. Tighten turnbuckles to recommended torque and lockwire.

D. Fuel De-icing Heater

(1) Insert end of de-icing valve air manifold into air inlet port of fuel de-icing heater front cover.

(2) Install new seals on fuel outlet transfer tube and insert one end of the tube into the fuel pump elbow.

(3) Secure the fuel de-icing heater support to compressor inlet case rear flange with bolts and nuts. Tighten nuts to recommended torque and lockwire.

(4) Position heater support expansion joint sleeve on front of support.

(5) Install sleeve spacer (ring groove forward) in top front mounting lug of heater. Secure with retaining ring.

(6) Install sleeve spacer (ring groove forward) in lower front mounting lug. Secure with retaining ring.

(7) Position heater on support engaging following:

(a) Sleeve spacer (passed through case flange) into expansion sleeve.

(b) Top rear mounting stud of heater, into hole in support flange.

(c) Fuel outlet port onto fuel outlet transfer tube.

(8) Secure top front mounting lug to case with bolt.

(9) Install nut on rear mounting stud.

(10) Secure lower front mounting lug to compressor inlet case
R flange with bolt (head forward), washer, and nut.

(11) Tighten nuts and bolts to recommended torque.

(12) Secure fuel pump-to-fuel anti-icing heater fuel supply tube to fuel inlet port of heater with nuts and bolts. Tighten nuts to recommended torque.

(13) Install new gasket on front flange of diffuser case-to-anti-icing valve air supply tube. Secure rear of air supply tube to diffuser case boss and secure front flange of tube to anti-icing valve. Tighten bolts to recommended torque and lockwire.

E. Fuel Flowmeter

(1) Install flowmeter at nine o'clock position on inlet using bolts.

6. Free Turbine (JFTD12A Engines)

A. Positioning Free Turbine Engine Horizontally
See Tool Group 83A.

(1) Attach turbine nozzle case collar at turbine case using following procedure.

(a) Assemble two halves of collar around nozzle case with face marked "front" toward the front of engine and trunnions at three and nine o'clock positions.

(b) Tighten retaining device until parting surfaces of collar meet.

(2) Attach sling to spools of collar.

(3) Disconnect ball lockpin and secure sling to eyes of lift and turn plate on inlet case front flange.

(4) Using two hoists, lift engine from build and transport stand.

(5) Remove compressor and turbine locating jack from stand.

(6) Install turbine nozzle case support on engine build and transport stand.

(7) Install engine front support on single mount pad opposite turbine nozzle case support.

(8) Lower engine into stand, engaging lift and turn plate with engine front support, and engaging turbine case collar with nozzle case support.

(9) Remove lifting slings.

B. Free Turbine Section Installation
See Tool Group 56L.

(1) Roll free turbine section up to gas generator.

(2) Jack up free turbine stand and attached to engine build and transport stand.

(3) Install free turbine assembly aligning pins at three and nine o'clock positions in turbine case rear flange.

(4) Using adjustments provided on free turbine stand and aligning pins, align free turbine inlet case front flange with turbine case rear flange.

(5) Secure with bolts and nuts. Tighten nuts to recommended torque.

7. Oil/Air Tube Installation

A. Pressure Oil Tubes

(1) Place packing in groove ID of front connector of No. 1 bearing pressure oil tube and secure tube to inlet case with bolts and locknuts. Tighten nuts to required torque.

WARNING: ENSURE PACKING IS INSTALLED PROPERLY IN FRONT CONNECTOR AND NOT ON TUBE. A LEAK AT THIS PACKING ALLOWS OIL TO ENTER ANTI-ICE AIR PASSAGES, EXITING THROUGH NOSE CONE ANTI-ICE AIR HOLES AND WETTING COMPRESSOR GAS PATH AND ENGINE EXTERIOR AT FOURTH STAGE BLEED. A SEVERE LEAK CAN CAUSE CONTAMINATION OF CABIN BLEED AIR.

(2) Pressure check front connector for leaks.

(a) Remove compressor inlet case cover.

(b) Install rubber cap on No. 1 bearing jet to restrict degrees of air.

(c) Connect free end of tube to supply of dry air at 50 psi.

(d) Apply soap solution (PMC 1223) around mating surfaces of connector and check for leak bubbles.

(e) Remove air supply line from oil tube.

(f) Remove rubber cap from oil jet.

(g) Reinstall inlet case cover.

(3) Place packing on rear connector.

(4) Install oil pressure manifold in gearbox.

(5) Attach the rear connector of the No. 1 bearing pressure tube to the connector on the oil pressure manifold with bolts and locknuts. Tighten the locknuts to the recommended torque.

(6) Put packings in the oil manifold and attach the tube to the diffuser case with bolts and locknuts. Tighten the locknuts to the recommended torque.

(7) Attach the remaining end of the manifold to the adapter. Tighten the tube nuts to the recommended torque and safety them with lockwire.

(8) On engines equipped with external gearbox drive bearing oil supply (Reference SB 2447 and SB 3668), install gearbox drive bearing pressure tube between tee on main bearing pressure manifold and strainer assembly on tower shaft positioning adapter. Tighten to recommended torque and lockwire.

(9) On free turbine engines, also perform following:

(a) Position free turbine gearbox oil pressure external tube with one end on gearbox connector and other end on connector on free turbine case.

(b) Secure tube to connectors with tube nuts. Tighten nuts to recommended torque and lockwire.

(c) Install new packing on forward end of No. 4 bearing oil pressure tube.

(d) Position No. 4 bearing oil pressure tube with forward end on flange of gearbox connector and other end on connector at free turbine case.

(e) Secure the forward end to the gearbox connector with the bolts and nuts. Tighten the nuts to the recommended torque.

(f) Secure the other end of the tube to the connector on the free turbine case with the tube nut. Tighten the tube to the recommended torque and lockwire.

B. Scavenge Oil Tubes

NOTE: When fastening oil tubes to connector on gearbox, hold gearbox connector with wrench while torquing coupling nut. This will ensure that torque on connector is not increased inadvertently, thereby stripping gearbox housing threads.

(1) Place a packing on each of the four connectors and install the connectors in the openings on the left side of the gearbox. Tighten the connectors to the recommended torque.

(2) Position the oil supply tube on the left side of the engine so that the upper fitting is at the oil tank outlet boss.

(3) Place the packing on the fitting and secure the oil supply tube to the boss with the bolts and locknuts. Tighten the bolts to the recommended torque. Tighten the tube nut at the gearbox connector to the recommended torque and lockwire.

(4) Place the packing on the No. 3 bearing external oil return tube.

(5) Position the No. 3 bearing oil return external tube between the gearbox and the diffuser case so that the fitting on the tube is positioned against the boss on the right side of the diffuser case and the other end is against the connector at the gearbox.

(6) Place the packing on the fitting end of the tube and secure the tube to the boss with bolts and locknuts. Tighten the locknuts to the recommended torque.

(7) Secure the other end of the tube to the connector with the tube nut. Tighten the nut to the recommended torque and lockwire.

(8) Place the packing on the fitting end of the No. 1 bearing scavenge tube and secure the tube to the boss on the inlet case with the bolts and locknuts. Tighten the locknuts to the recommended torque.

R
R

(9) Secure the other end of the tube to the connector with the tube nut. Tighten the nut to the recommended torque and lockwire.

(10) Install the packing on the fitting of the oil cooler oil inlet manifold and secure the manifold to the cooler with the locknuts. Tighten the locknuts to the recommended torque and lockwire.

(11) Secure the other end of the manifold to the connector with the tube nut. Tighten the nut to the recommended torque and lockwire.

(12) Place the packings in the oil cooler-to-oil tank return tube and secure the tube to the oil tank with bolts and locknuts and to the cooler with locknuts. Tighten the locknuts to the recommended torque.

(13) On free turbine engines, also perform the following:

(a) Position two packings on the connector at the rear end of the No. 4 and No. 5 bearings external oil return tubes.

(b) Install new packings on the sleeve and position the sleeve on the forward end of the No. 4 and 5 bearings external oil return tubes.

(c) Position the tubes with the rear connector on the free turbine case connector and the forward ends in the oil pump connectors.

(d) Secure the rear connector to the free turbine case connector with the bolts. Tighten the bolts to the recommended torque and lockwire.

(e) Secure the forward end of the tubes to the oil pump with the nut. Tighten the nut to the recommended torque.

C. Breather System Tubes

NOTE: When fastening oil tubes to connector on gearbox, hold gearbox connector with wrench while torquing coupling nut. This will ensure that torque on connector is not increased inadvertently, thereby stripping gearbox housing threads.

(1) Place the packing on the connector and install the connector in the opening on the right side of the gearbox. Tighten the connector to the recommended torque.

(2) Place a packing on the oil tank connector of the rear breather manifold.

(3) Position the rear breather manifold on the engine with the connector against the flange on the oil tank and the bottom end of the connector in the gearbox.

(4) Secure the manifold to the connector with the tube nut. Do not tighten the tube nut.

(5) Secure the manifold to the oil tank with the bolts and nuts. Tighten the nuts to the recommended torque.

(6) Tighten the manifold tube nut at the gearbox to the recommended torque and lockwire the nut and the connector.

(7) Place the packing in the groove of the front external breather manifold and insert the tube in the junction adapter of the rear breather manifold.

(8) Secure the tube to the manifold with the tube nut. Do not tighten the nut.

(9) Place the packing in the front end of the manifold and secure the manifold to the inlet case with bolts and locknuts. Tighten the locknuts to the recommended torque.

(10) Tighten the nut and bolts securing the front and rear manifolds together to the recommended torque and lockwire.

(11) On free turbine engines, also perform the following:

(a) Position the No. 4 bearing front external breather tube on the gearbox connector and secure with the tube nut.

NOTE: Do not tighten the tube nut.

(b) Position two new packings on the forward end of the No. 4 bearing rear external breather tube.

(c) Position a new packing on the rear end of the No. 4 bearing rear external breather tube.

(d) Position the rear external tube, engaging the forward end into the front external tube, with the rear connector flange on the flange of the boss of the free turbine case.

(e) Secure rear tube to free turbine case boss with bolts and locknuts. Tighten locknuts to recommended torque.

(f) Tighten tube nut on gearbox connector to recommended torque and lockwire.

D. Fuel System Tubes

(1) Install new seal on elbow at oil cooler end of oil cooler-to-pressurizing and dump valve fuel tube.

(2) Position tube with the tube nut on pressurizing and dump valve inlet connector and other end at oil cooler fuel outlet. Secure tubes to oil cooler with nuts. Tighten nuts to recommended torque.

(3) Secure tube to pressurizing and dump valve connector with tube nut. Tighten nut to recommended torque and lockwire.

NOTE: Ensure that flight-rated plugs have been installed and lockwired on fuel signal port of fuel control, and fuel signal port and overboard drain port of fuel pressurizing and dump valve.

(4) Position flowmeter-to-fuel control upper tube on flowmeter. Tighten tube nut to recommended torque and lockwire.

(5) Install new seal at fuel control end of fuel control-to-flowmeter lower tube.

(6) Position flowmeter-to-fuel control lower tube between fuel control and upper tube. Secure lower tube to fuel control with nuts. Secure lower and upper tubes together with tube nut. Tighten nuts and tube nut to recommended torque. Lockwire tube nut.

(7) Install new seal on oil cooler end of flowmeter-to-oil-cooler tube.

(8) Position flowmeter-to-oil-cooler tube on flowmeter outlet and oil cooler fuel inlet. Secure to oil cooler with nuts. Tighten nuts to recommended torque. Secure tube to flowmeter with tube nut. Tighten nut to recommended torque and lockwire.

(9) Position inlet air pressure sensing tube on air inlet probe (at bottom front of compressor inlet case) and on fuel control connector. Secure with tube nuts. Tighten nuts to recommended torque and lockwire.

(10) Position diffuser air pressure sensing tube on diffuser air pressure probe (on right side of diffuser case) and on fuel control connector. Secure with tube nuts. Tighten nuts to recommended torque and lockwire.

E. Free Turbine Speed Sensing Flexible Shaft Installation - Oil Pressure Lubricated
See Tool Group No. 60A, Figure 809, Figure 810, and Figure 811.

(1) Assemble flexible cable assembly as follows:

NOTE: This assembly must be done in a relatively dirt and dust free environment. It is recommended that these parts be preassembled, and be available prior to installation on an engine, or held for future parts replacement.

(a) Install packings on fuel control flexible shaft bearing assembly. See Figure 809.

CAUTION: LUBRICATE THREADS ON BEARING ASSEMBLY WITH ENGINE OIL, AND THREAD FLANGE ONTO BEARING ASSEMBLY CAREFULLY TO AVOID THREAD DAMAGE.

(b) Thread flexible shaft flange onto bearing assembly, handtight, as far as it will go.

(c) Slide assembled flange and bearing assembly over flexible shaft core and clamp swaged portion of flexible core in a soft jaw vise in vertical position.

(d) Heat bearing in hot oil and install onto core. Drift to seat.

(e) Install snapring.

(f) Install bearing and flexible core in flange using drift and base; then secure with snapring.

(g) Install seal with drift only far enough to expose snapring groove in flange; then secure with snapring.

(h) Remove assembly from base.

(i) Thread adapter, with attached preformed packing, into flange.

(2) Install flexible shaft as follows:

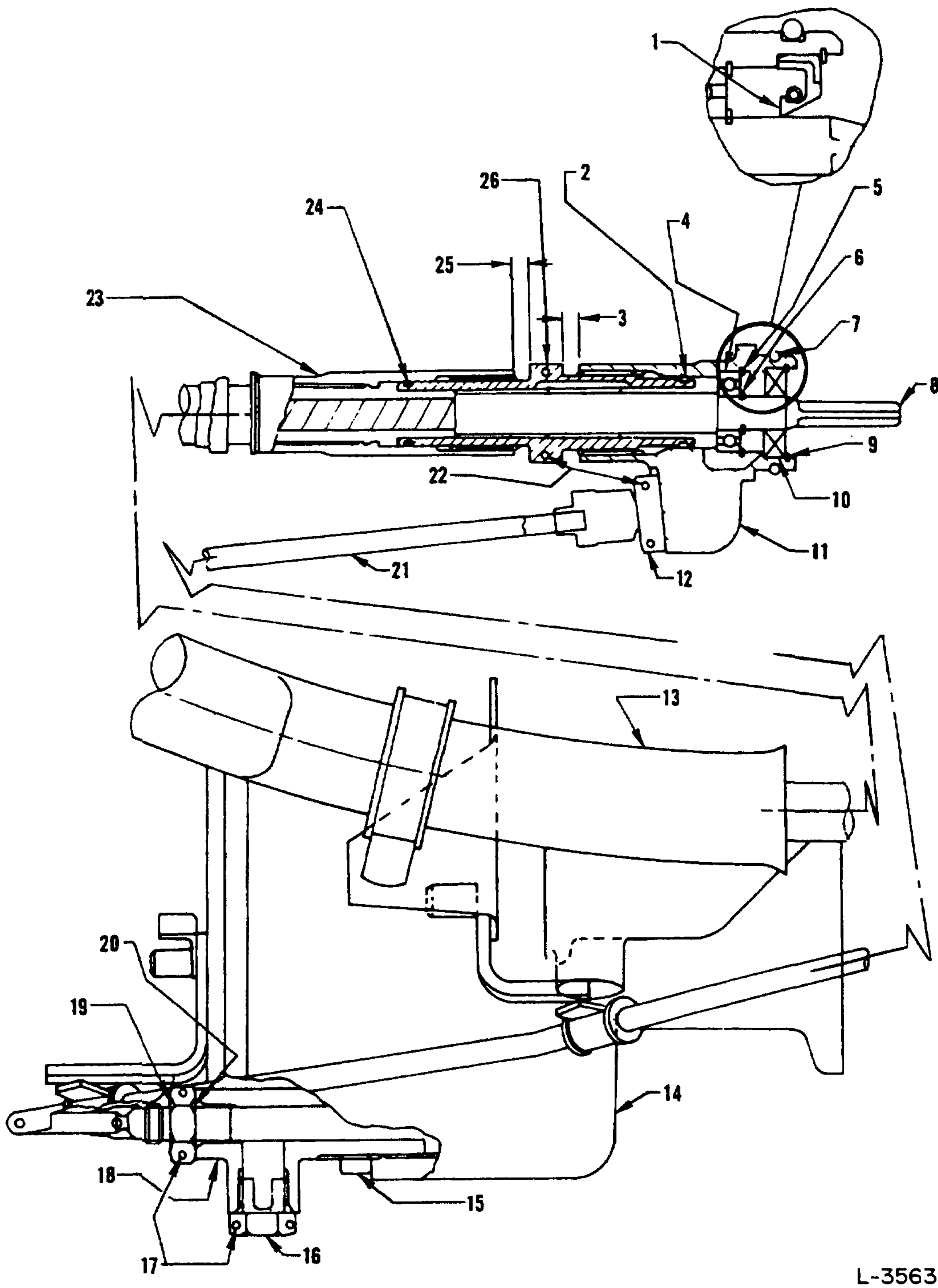
(a) Feed shaft casing through metal heat shield, from free turbine end, until it extends beyond lower end of heat shield. See Figure 810.

NOTE: Care must be taken not to bend casing at its flange junctions. Prior to installing core in casing, lightly clean pilot diameter and chamfer with crocus cloth, and then clean core with petroleum-base solvent, such as Stoddard petroleum solvent (PMC 9001). Coat core and bearing with engine oil, with emphasis on pilot diameters at free turbine gearbox end. See Figure 810. Also, core should be inserted into N2 gearbox bevel gearshaft to ensure free and complete engagement. Without free and full movement of core in bevel gearshaft, adjustment required in Figure 810 will be very difficult to obtain.

(b) Feed shaft core into casing at lower end of heat shield until casing lower flange and bearing assembly threads engage.

CAUTION: THREADS OF BEARING ASSEMBLY MUST BE LUBRICATED WITH ENGINE OIL, AND CARE MUST BE TAKEN TO AVOID THREAD DAMAGE WHILE ASSEMBLING ONTO BEARING ASSEMBLY.

(c) Hold bearing assembly and rotate shaft casing to thread casing into bearing assembly. Thread casing fully but do not tighten. Bearing assembly, with left and right-hand threads, will be used to adjust shaft core length extending from casing. See Figure 810.



Fuel Control Flexible Shaft Assembly
Figure 809

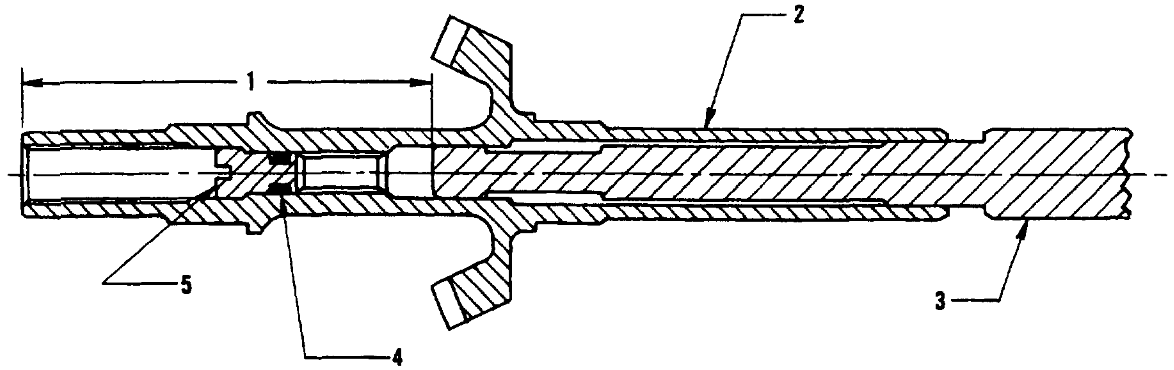
1. Assemble With Seal Element In Position Shown.
2. Packing
3. 0.370 Inch Maximum
4. Bearing
5. Snapring Outer
6. Snapring Inner
7. Packing
8. Flexible Shaft Core
9. Snapring
10. Seal
11. Fuel Control Flexible Shaft Flange
12. Adapter And Packing
13. Metal Heat Shield
14. Main Gearbox Assembly
15. Locknut And Packing
16. Plug And Packing
17. Lockwire
18. Tee Assembly
19. Adapter
20. Packing
21. Drain Tube Assembly
22. Lockwire Both Directions
23. Flexible Shaft Casing
24. Packing
25. 0.370 Inch Maximum Adjusted Gap
26. Bearing Assembly

Key to Figure 809

(d) Install preformed packing on flexible shaft flange and align shaft core square end with fuel control square slot. Guide shaft core and flange into fuel control housing and secure with two previously used bolts. Lockwire bolts.

<u>NOTE</u>: Do not bend shaft core casing at flange junction. If necessary, slide assembly up metal heat shield, and guide core straight into fuel control.

(e) Position packing against shoulder of nut on free turbine gearbox end of flexible shaft casing.



L-35632 (0000)

1. Distance After Adjustment, 1.890 ± 0.050 Inches
2. Free Turbine Bevel Gearshaft Assembly
3. Flexible Shaft Core
4. Packing
5. Plug

Bevel Gearshaft Assembly
Figure 810

(f) Install gasket between free turbine gearbox and flange.

NOTE: At this point of assembly, bearing assembly must have no gap on either side of wrench flats. Flexible shaft casing must be fully threaded into fuel control flexible shaft flange.

(g) With minimum bending of core, insert core into free turbine gearbox bevel gearshaft, ensuring that both pilot diameters of core, see Figure 810, fully engage gearshaft with free axial movement of core. Bolt flange to gearbox housing with nuts. Tighten and torque nuts. See Figure 809.

NOTE: Ensure that flange oil port is aligned with manifold assembly before securing gearbox.

(h) Install free turbine gearbox on free turbine case. Adjust bearing assembly to ensure proper alignment of gearbox driveshaft in free turbine with mating gearbox shaft. Free turbine will have to be rotated to align drive splines before gearbox is installed. Secure with nuts.

(i) Install preformed packing to adapter, and thread into porthole on flange.

(j) To ensure free movement of core in bevel gearshaft, press drift or small-diameter rod against core, through bevel gearshaft. Slight core movement must be felt with core springing back.

(k) Secure pressure manifold assembly to adapter and gearbox housing. Lockwire nut to adapter.

(3) Core Length Adjustment

(a) Prior to core length adjustment, ensure that following are secure:

1 Metal heat shield

2 Free turbine gearbox to free turbine case

3 Flange to flexible shaft casing

4 Flange to fuel control

R
R

5 Gearbox rear flange to free turbine gearbox.

NOTE: Interference or contact may exist between area adjacent to wrench flats on flexible shaft casing and fuel pump filter housing flange. Fuel pump flange may be filed to obtain 0.003 - 0.005 inch clearance. Rotating wrench flats can assist in achieving necessary clearance with minimum material removal from pump flange.

(b) Secure flange of free turbine gearbox temporarily with two nuts to allow for accurate cable length adjustment. See Figure 811.

(c) Insert a one to two inch depth micrometer into exposed open end of bevel gearshaft to contact cable core end. Adjust coupling assembly until distance between gearshaft end and cable is 1.890 ± 0.050 inches. See Figure 811.

NOTE: The maximum adjusted gap on either side of bearing assembly is 0.370 inch. Repeat adjustment procedure if gap on either side is greater. See Figure 809.

(d) Lockwire bearing assembly in both directions after completing adjustment.

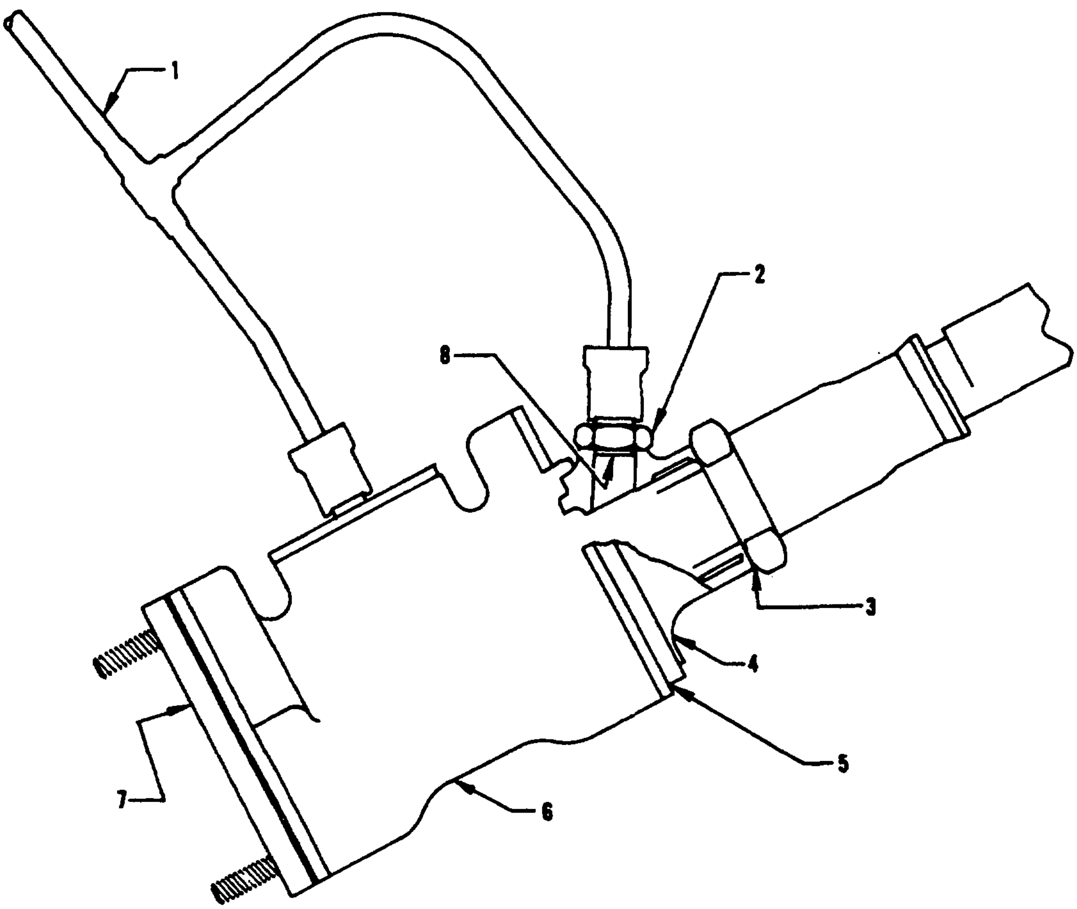
R (e) With PWA 36500 Lubricant or engine oil, liberally coat packing and plug threads, and install into free turbine bevel gearshaft. See Figure 810.

(f) Install fuel control flexible shaft oil drain tube assembly and secure to brackets with clamps.

F. Free Turbine Speed Sensing Flexible Shaft Installation - Grease Lubricated
See Figure 812.

(1) On free turbine engines, install free turbine speed sensing flexible shaft assembly as follows:

(a) Lubricate square drive of core at gearbox end with lubricating grease (Lubriplate Molith No. 2) in Section 70-12-00, General-08 in the Standard Practices Manual.



1. Manifold Assembly
2. Adapter
3. Packing
4. Flange
5. Gasket
6. Free Turbine Gearbox Assembly
7. Secure This Flange With Two Nuts Prior To Taking Cable Length Measurement.
8. Packing

Manifold Assembly Installation
Figure 811

(b) Install square drive in gearbox by inserting drive into gearshaft and securing with rivet.

(c) Slide gasket and end fitting over core, position on free turbine gearbox pad, and secure with washers and locknuts. Tighten to recommended torque.

(d) Lubricate entire core including square drive at fuel control end. Use 0.7 - 1.0 ounce of grease specified in step (a).

(e) Slide casing over core.

(f) Thread casing onto end fitting (previously secured to free turbine gearbox). Tighten casing to recommended torque and lockwire.

(g) Slide shield over casing, but do not secure to engine at this time.

(h) Check fuel drain hole in fuel control (adjacent to two-hole flange where core is installed) to ensure that hole is unobstructed.

CAUTION: GREASE-PLUGGED HOLE WILL CAUSE FUEL TO WASH OFF OR DILUTE LUBRICANT INSIDE CASING.

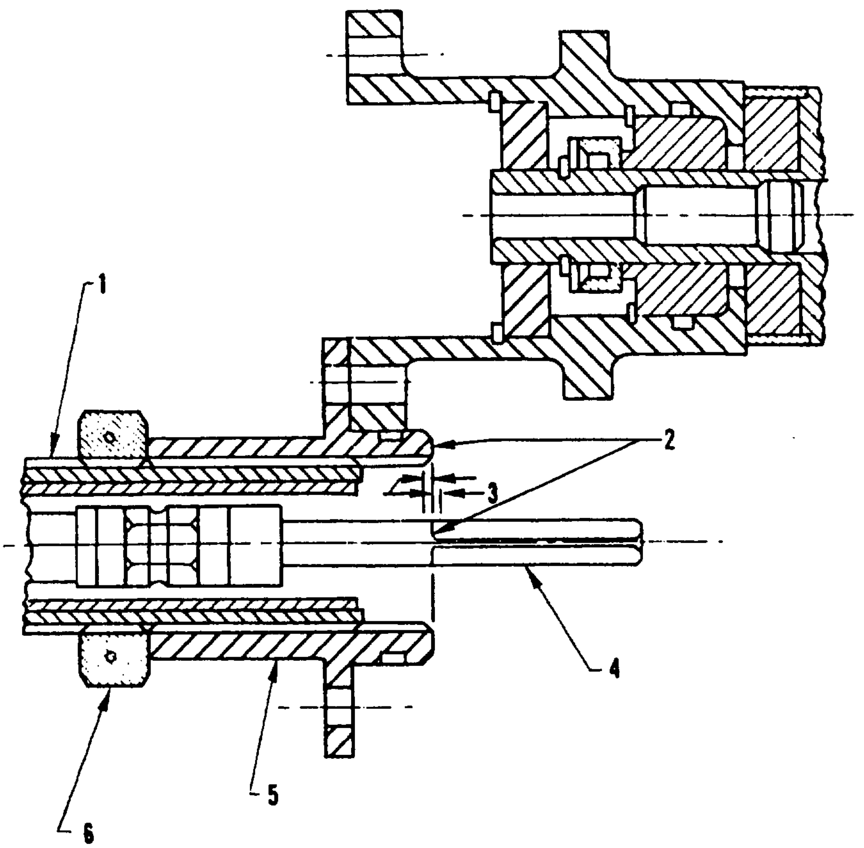
(i) Adjust flexible shaft casing front end fitting as follows to get the specified core projection:

1 Thread nut and end fitting onto forward end of casing.

2 Slide shield along casing so that its position will approximate final installed position. Then temporarily secure shield to engine bracket using nut and bolt fingertight.

3 Position casing front end fitting alongside mating flange of fuel control as shown in Figure 812.

4 Rotate end fitting so that rear end of square drive aligns with front face of end fitting within 0.060 inch, as shown in Figure 811. Then secure by tightening check nut, ensuring that screw holes in end fitting align with those on fuel control.



L-26567 (0669)

ORIGINAL
As Received By
ATP

Flexible Shaft End Fitting Alignment
Figure 812

1. Casing
2. These Surfaces Must Be Flush Within 1/16 Inch Prior To Attachment To Fuel Control.
3. 1/16 Inch Maximum
4. Core
5. End Fitting
6. Check Nut

Key to Figure 812

(j) Connect flexible shaft to fuel control as follows:

1 Place preformed packing on end fitting.

2 Visually align square drive with mating square drive hole in fuel control. If necessary, turn the free turbine rotor to align the drives.

3 Remove nut and bolt (temporarily securing shield to engine) and slide shield rearward as far as possible. This will allow maximum freedom of motion for flexible shaft installation.

4 Install the end of the flexible shaft into the fuel control as follows:

CAUTION: DO NOT BEND THE CASING AT TOO ACUTE AN ANGLE. BE VERY CAREFUL NOT TO BEND THE SQUARE DRIVE OR THE ADJACENT SMALL DIAMETER.

a Pull the shield to the rear as far as possible and hold it back with one hand. With the other hand align the square drive with the mating boss on the fuel control (be careful not to pull the end of the square drive across the face of the fuel control boss) (this could bend the drive).

b Push the square drive core and the cable forward to engage the drive in the fuel control boss.

NOTE: If the square drive does not easily engage in the fuel control, it can be necessary to turn the free turbine rotor or the female drive in the fuel control to align the drive surfaces.

5 Secure end fitting to fuel control with screws. Tighten to recommended torque and lockwire. Then apply final torque of 120 - 150 lb-in. to check nut, and lockwire.

(k) Slide shield into position and secure with clips, nuts, and bolts.

G. Linear Directional Control Valve And External Pressure Sensing Tubes Installation
See Figure 813.

(1) Position linear directional control valve on bracket so that electrical branched cable threaded connection is facing aft. Secure with bolts and locknuts, tightening to recommended torque.

(2) Position front Pt3 tube assembly on engine so that one end to tube is located at fuel control connector and other end at control valve as shown in Index (2). Attach tube assembly to connectors with tube nuts. Tighten nuts to recommended torque.

(3) Position pressure sensing tube assembly on diffuser case so that one end of tube is located at diffuser case tube connector and other end at connector on directional control valve as shown in Index (2). Attach tube assembly to adapter and connector with tube nuts. Tighten nuts to recommended torque.

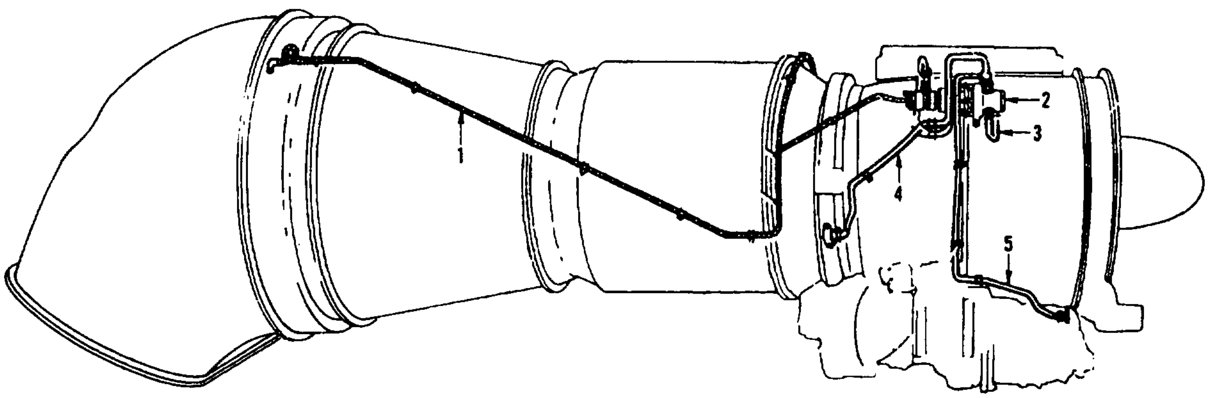
(4) Position rear Pt3 tube assembly on right side of diffuser case so that elbow end of tube is located at fuel control pressure sensing probe assembly and other end of tube is at linear directional control valve as shown in Index (2) of figure. Secure with tube nuts and tighten to recommended torque.

H. Fuel Flowmeter Tubes and Brackets
(For Engines Incorporating SB 847)

(1) Install PN 522882 bracket at boltholes No. 24 and 25. Tighten nuts and bolts only fingertight permitting considerable movement of bracket relative to inlet case.

(2) Install PN 522886 tube assembly to elbow of short section PN 431546 tube. Position U of tube to forward cover on flowmeter, and handtighten tube nuts.

(3) Torque PN 431546 tube flange nuts to 75 - 85 lb-in.



L-29206 (0000)

1. Electrical Branched Cable
2. Liner Directional Control Valve
3. Fuel Control Pressure Sensing Tube
4. Rear Pt3 Tube
5. Front Pt3 Tube

Free Turbine Overspeed
Protection System
Figure 813

(4) Secure PN 522886 tube to lower end of bracket at forward face of diffuser-inlet case flange (Flange C) with clip loop inwards and toward fuel control. Secure with screw (head outward) and nut. Torque screw to 30 lb-in.

(5) Lightly coat seal, and install to flange groove of PN 522884 tube. Attach tube, flange end forward, to flowmeter aft adapter, and secure fingertight.

(6) Secure both flowmeter tubes with clips, assemblies back to back and clip ends outward. Position clips to flowmeter-to-cooler tube, approximately five inches to left of right-angle bend of tube, and clip on adjacent tube forward of first clip. Position spacer between clip ends, and secure with screw (head rearward) and nut. Torque to 35 - 40 lb-in..

(7) Tighten tube adapter to oil cooler studs with nuts, torquing to 65 - 85 lb-in.

CAUTION: HOLD FLATS OF FLOWMETER BRACKET AND ELBOW OF TUBE WHILE APPLYING TORQUE TO PREVENT STRESSING FUEL LINES.

(8) Torque nuts and bolts of flowmeter bracket to 35 - 40 lb-in. Check flowmeter tube alignment.

(9) Retorque flowmeter tube nuts (at flowmeter) and lockwire.

I. Anti-Icing Air System

(1) Place a gasket, spacer, and gasket on rear flange of anti-icing valve; and secure valve to anti-icing tube with bolts.

(2) Insert guide into valve, and secure guide and elbow to valve. Tighten bolts to recommended torque.

(3) Place a gasket on rear flange of anti-icing tube, and position anti-icing assembly on pads at inlet and diffuser cases.

(4) Secure anti-icing assembly to pads with bolts and locknuts. Tighten locknuts to recommended torque.

J. Electrical System Wiring Harness

(1) Install wiring harness on engine by passing harness input receptacle (from left to right) underneath compressor section at compressor inlet case rear flange.

(2) Secure input receptacle to compressor case flange with screws and locknuts. Tighten locknuts to recommended torque.

(3) Connect ignition input leads to ignition exciters, anti-icing input lead to anti-icing solenoid, fuel anti-icing input lead to the anti-icing solenoids, and remaining lead to fuel pump differential switch.

(4) Tighten lead nuts to recommended torque and lockwire.

(5) Fasten clip securing harness to the engine.

(6) Arrange leads in large radius bend and tighten terminal nuts.

<u>CAUTION</u>: CARE MUST BE TAKEN TO PREVENT LEAD TERMINALS FROM TURNING AND TAKING ALL THE SLACK OUT OF BRANCH LEADS.

(7) Install cable connectors to bracket on turbine case, and secure with the nuts and bolts. Tighten nuts to recommended torque.

K. Ignition Exciters
See Table of Limits.

(1) Fasten right and left ignition exciters to supports on diffuser case.

<u>CAUTION</u>: FOR ENGINES INCORPORATING LOCKNUTS, ENSURE THAT TANGS ON LOCKNUTS DO NOT CONTACT SIDES OF IGNITION EXCITER SUPPORTS WHEN TORQUING BOLTS.

(2) Tighten mounting bolts to recommended torque.
See Table of Limits.

L. Igniter Plugs

(1) Apply antiseize compound (BG Mica Lube A768) sparingly on igniter plug shell threads. Refer to Section 70-12-00, General-08 for the source of this compound.

<u>NOTE</u>: To prevent contamination of igniter plug to electrode, do not apply compound to first thread.

(2) Install igniter plug and gasket in each boss of the diffuser case.

(3) Tighten igniter plugs to recommended torque.

M. Igniter Plug Leads

(1) Apply molybdenum disulfide powder (PWA 36221) on threads of plug and ignition exciter connector.

(2) Install left and right leads on each plug and ignition exciter.

CAUTION: DO NOT TWIST LEAD WHEN TIGHTENING NUTS. INSUFFICIENT TORQUE ON HIGH TENSION LEAD NUT AT IGNITER PLUG END CAN CAUSE IGNITION RADIATED NOISE TO BE PICKED UP BY THE AIRCRAFT RADIO EQUIPMENT.

(3) Torque nuts to 140 - 160 lb-in.

(4) Lockwire lead nuts.

NOTE: Later igniter plug leads have self-locking units which do not require lockwiring.

(5) Secure lead to diffuser case with clip.

N. Turbine Pressure Sensing Manifold

(1) Install manifold in each of bosses in turbine exhaust case, and secure with bolts and nuts. Tighten tube nuts to recommended torque.

(2) Connect manifolds together with tube nuts. Tighten tube nuts to recommended torque and lockwire.

O. Power Lever Cross Shaft
See Tool Group 83B.

(1) Lubricate needle bearings, with grease (PMC 9625) and install in left and right power lever cross shaft supports, using drift and arbor press.

(2) Position right support on shaft end with long splines.

(3) Position spacer on shaft splines.

(4) Position arm on shaft, engaging master arm spline with master shaft spline. See Table of Limits.

(5) Install bolt and self-locking nut in arm and tighten to recommended torque to secure arm to shaft.

(6) Position left support on opposite shaft end.

(7) Install bolt and self-locking nut on spacer and position spacer on shaft end, engaging master spacer spline with master shaft spline; tighten nut to recommended torque to secure spacer to shaft.

(8) Position shaft and support assembly on inlet case flanges and secure with bolts, washers, and self-locking nuts; tighten nuts to recommended torque.

P. Pressure Check of Turbine Pressure Sensing Manifold

(1) Connect source of clean, dry air to manifolds.

(2) Regulate air pressure at manifold to 100 psig.

R (3) Check each connection for leakage with PMC 2277 or
R PMC 9569 leak check fluid.

Q. Thermocouples

(1) Install thermocouples in bosses on turbine exhaust case.

(2) Secure thermocouples to bosses with bolts and nuts. Tighten nuts to recommended torque.

R. Thermocouple Cable

(1) Place thermocouple cable in position around turbine exhaust case, and secure in position with clips.

NOTE: Always work from center of cable towards ends.

(2) Connect each branch lead to indicating thermocouple. Tighten nuts on larger diameter thermocouple studs (alumel) to 10 - 15 lb-in.; tighten nuts on smaller diameter thermocouple stud (chrome) to 8 - 12 lb-in.

S. Bleed Valve Cover Installation
See Tool Group 13A.

(1) Starting at lower right side of engine, pass the bleed valve cover, upward (under all tubes, brackets and oil tank) wrapping cover around compressor inlet case and covering bleed valve ports.

NOTE: Install cover so that red side faces outward and arrow points toward rear of engine.

(2) Pass half of two-foot length of lockwire through hole in lower end of bleed valve cover.

(3) Grasp both ends of lockwire, and pull lower end of cover towards bleed valve bellcrank as far as it will go.

(4) Pass one strand of lockwire on each side of bleed valve bellcrank. Pass one strand of lockwire through hole in other end of cover. Secure cover by twisting two strands of wire together.

T. Positioning Engine Horizontally
See Tool Group 47.

(1) Assemble two sections of turbine nozzle collar around turbine case (face marked "front" toward front of engine and trunnions at three and nine o'clock positions). Tighten collar until parting surface of both sections meet.

(2) Attach lift and turn plate on front face of inlet case, being certain narrow part of ring is at 12 o'clock position and lifting eyes at ten and two o'clock positions.

(3) Attach lift and trunnion sling to hoist, and secure sling books to spools of turbine nozzle collar.

(4) Attach lift and turn sling to hoist, and secure sling to eyes of plate.

(5) Raise engine, and position horizontally.

U. No. 1 Bearing Oil Nozzle

(1) Place new gasket on No. 1 bearing oil pressure boss.

(2) Install strainer in No. 1 bearing oil nozzle.

(3) Position oil nozzle on oil pressure boss, and secure with locknuts. Tighten locknuts to recommended torque.

(4) Place new preformed gasket on rear flange of compressor inlet case cover.

(5) Position compressor inlet case cover over inlet case studs, and secure with washers and nuts. Tighten nuts to recommended torque.

V. Installing Nose Cone

(1) Secure inner cone to compressor inlet case with nuts, and lockwire if drilled hexagonal nuts are used.

(2) Attach outer rear cone to inner cone with bolt.

(3) Secure compressor inlet outer front cone to outer rear cone with bolts.

W. Rotation Check Of Engine
See Tool Group 49.

(1) Following procedure provides check of rotation after engine build. This check is intended to reveal presence of blade-end rubbing and any foreign object which may have become lodged in engine.

(2) Check compressor by engaging adapter with starter shaft and turning starter drive.

(3) If there is any unusual resistance or unusual sound, an investigation shall be made to determine the cause.

CAUTION: DAMAGE TO ENGINE CAN RESULT WHEN ROTORS ARE TURNED BACKWARD TO NORMAL RUNNING DIRECTION (CLOCKWISE WHEN VIEWING ENGINE FROM REAR). EXTREME CAUTION SHALL BE EXERCISED BY PERSONNEL INVOLVED IN ANY NECESSARY ROTATION OF ANY ROTOR IN REVERSE OF NORMAL RUNNING DIRECTION. IT SHOULD BE NOTED THAT REVERSE ROTATION CAN RESULT FROM TURNING ROTORS IN REVERSE OR BY ROTATING ENGINE ITSELF IN DIRECTION WHICH WOULD, DUE TO INERTIA OF ROTOR, CAUSE ROTOR TO TURN IN REVERSE IN RELATION TO OUTER CASE.

X. Installing Engine Covers
See Tool Group 45A.

(1) Install Cover over turbine exhaust case.

(2) Install Cover over compressor inlet case.

ENGINE GENERAL - TESTING

1. Safety Precautions

A. Hazardous Materials

WARNING: AT ONE TIME SOME ENGINE PARTS CONTAINED ASBESTOS FIBERS, AND IT IS POSSIBLE THAT SOME OF THESE PARTS CONTINUE IN SERVICE. REFER TO COMMERCIAL ENGINE SERVICE BULLETINS FOR A LIST OF PARTS THAT AT ONE TIME CONTAINED ASBESTOS. IN SOME PARTS THE MATERIAL THAT CONTAINED ASBESTOS WAS THE ADHESIVE. IT IS IMPORTANT TO USE CORRECT PRECAUTIONS WHILE WORKING WITH THESE PARTS. OPERATORS MUST OBEY ALL LOCAL REGULATIONS AND EMPLOYER WORK POLICIES WHEN PARTS THAT CONTAIN ASBESTOS ARE TOUCHED OR DISCARDED.

THE ASBESTOS USED IN PRATT & WHITNEY ENGINE PARTS IS USUALLY ENCAPSULATED AND WILL NOT RELEASE DUST UNLESS THE PARTS ARE GROUND, SANDED, CUT, OR BROKEN. WHILE IT IS OUR EXPERIENCE THAT THESE OPERATIONS DO NOT USUALLY RELEASE ASBESTOS AT LEVELS MORE THAN THE PERMITTED EXPOSURE LIMITS, OPERATORS MUST CONTINUE TO USE ALL APPLICABLE PRECAUTIONS WHEN THEY TOUCH THESE PARTS.

B. Engine Temperature

(1) After engine operation, do not work on or inspect areas near the tail pipe for 1/2 hour or more (more is safer). Use protective gloves when work is necessary immediately after shutdown. Usually, it is possible to work on other engine parts without danger.

C. Compressor Bleed Valve

(1) During a compressor bleed valve check (or during some other procedure adjacent to the bleed valve when the engine is in operation), be careful to stay clear of the engine during bleed valve-open operation. When the bleed valve opens, air at high pressure and high velocity is released to the side of the engine.

D. Operation With Broken Bleed Strap

CAUTION: WHEN AN ENGINE IS OPERATED AT MORE THAN 12,600 RPM FOR AN EXTENDED PERIOD OF TIME
R WITH THE BLEED STRAP OPEN, IT WILL BE

NECESSARY REPLACE THE 5TH STAGE (STEEL) COMPRESSOR BLADES.

(1) Try not to operate the engine to more than 12,600 rpm if the bleed strap is broken or does not close. Operating the engine in areas where the bleeds are usually closed can cause stress to compressor rotor component parts. Investigate an engine that has indications of a broken strap and replace the strap. Indications of a broken strap include low exhaust pressure ratio (EPR) at normal power settings, or higher rpm than necessary to keep EPR at its correct level. These conditions can result in increased fuel flow and exhaust gas temperature (EGT).

E. Engine Noise

(1) Modern jet engines make noise that can cause temporary, as well as permanent, hearing loss. High noise levels (for a short or long period of time) can cause damage to the eardrum. All personnel near an engine must wear ear protection during engine operation.

F. Engine Ignition

(1) The jet ignition system is high in electrical energy. A system of this type can be a dangerous (possibly fatal) source of electrical shock unless personnel take the applicable safety precautions.

G. Jet Fuel And Lubricants

(1) All fuels can dry the skin, which can cause injury. Avoid getting fuel on the skin.

2. Engine Dress And Installation In Test Stand

A. General
See Tool Group 50.

(1) Test Stand Calibration

(a) Engine testing is conducted on a suitably calibrated test stand. Procedures for the Commercial Overhaul Test Stand Correlation are provided in Installation Engineering Report No. PWA Instruction 544.

B. Engine Dress

NOTE: Most of the following dressing operations can be performed before the engine is installed in the test stand.

(1) Install the following test accessories, instrumentation, and leads onto the engine.

(a) Install the test starter on the left front side of the gearbox.

(b) Install the tachometer generator on the gearbox mounting pad.

CAUTION: THE TACHOMETER GENERATOR MUST HAVE A GEAR RATIO THAT WILL RECORD THE ACTUAL ROTOR RPM ON THE TACHOMETER GAGE.

FOR ENGINES JT12A-6, JT12A-6A [L], JT12A-8 [L] TACHOMETER DRIVE AT THE GEARBOX = 0.264:1

FOR ENGINES JT12A-6A [N] AND JT12A-8 [N] TACHOMETER DRIVE AT THE GEARBOX = 0.262:1

FOR ENGINES JT12A-6A [N] AND -8 [N] TACHOMETER 100 PERCENT REPRESENTS 16,030 RPM

FOR ENGINES JT12A-6, -6A [L], AND -8 [L] TACHOMETER 100 PERCENT REPRESENTS 15,909 RPM

(c) Remove the plug from the upper front of the gearbox (in line with the main oil screen), and install the oil temperature thermocouple.

(d) Attach the anti-icing air thermocouple to one of the bolts that secures the anti-icing air elbow to the inlet case.

(e) Install drain lines at all overboard fuel drain connections.

(f) Install a fuel pump inlet adapter on the fuel pump.

(g) Install vibration pickup mount brackets and vibration pickups in the locations described in the steps below (viewed from the rear of the engine). See Figure 901.

1 Install the compressor inlet case front flange at the 2nd and 3rd holes, clockwise from the 12 o'clock position hole.

2 Install the compressor inlet case front flange on the right-hand side of the engine, horizontal to the centerline.

3 Install the combustion chamber case rear flange on the right-hand side of the engine at the horizontal centerline.

NOTE: A transit pad, or equivalent, must be placed between the pickup and bracket at the combustion chamber outer case location.

4 Install the component drives gearbox onto the bottom left-hand stud of the gearbox cover (on the rear of the gearbox).

5 Attach a test line to the oil pressure gage connection located near the oil temperature thermocouple.

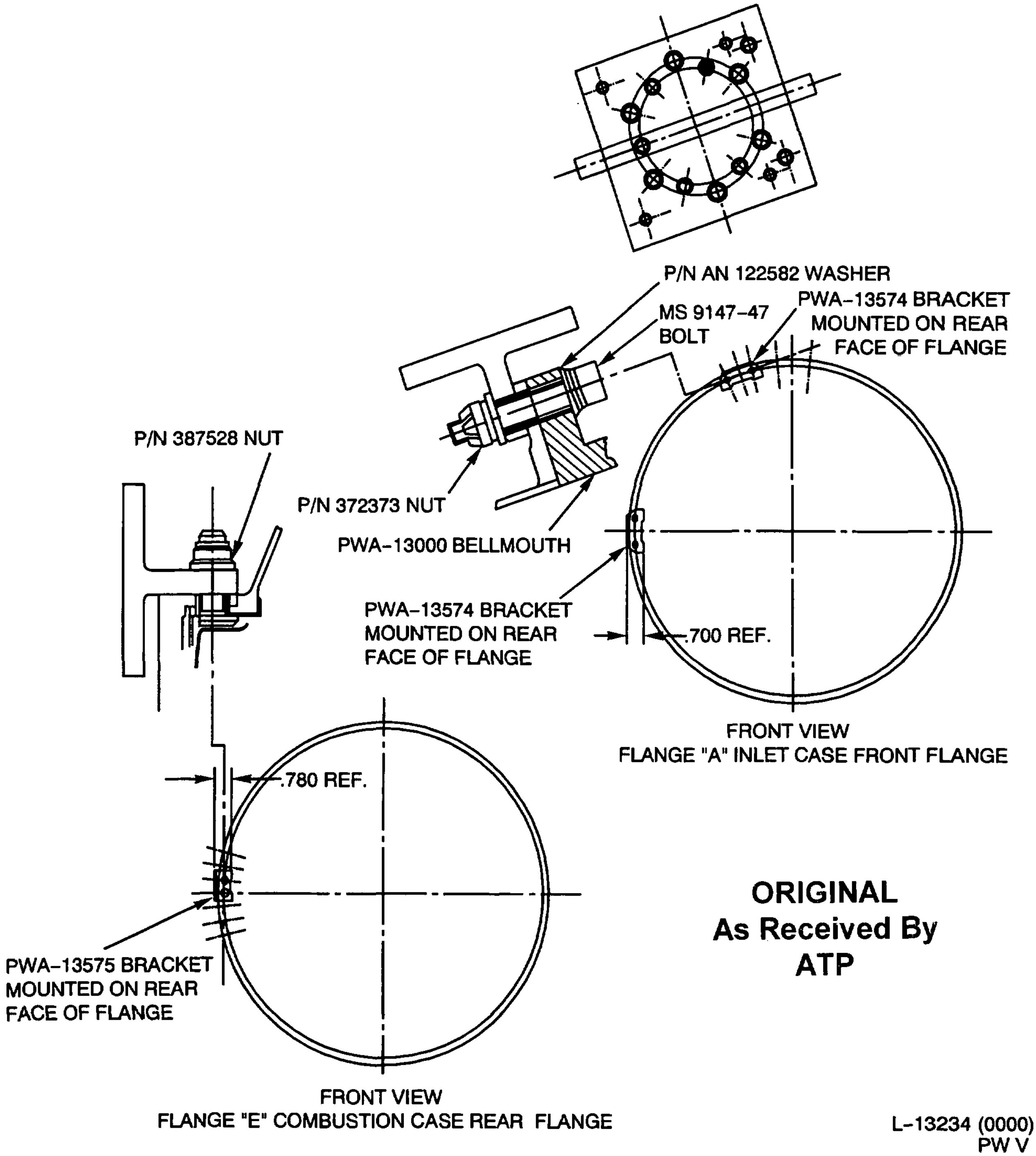
6 Secure inner details of the engine test fairing to 2 studs on the face of the inlet case center support cover.

7 Attach the outer shell of the test fairing to inner details by securing it with a nose nut and lockpin.

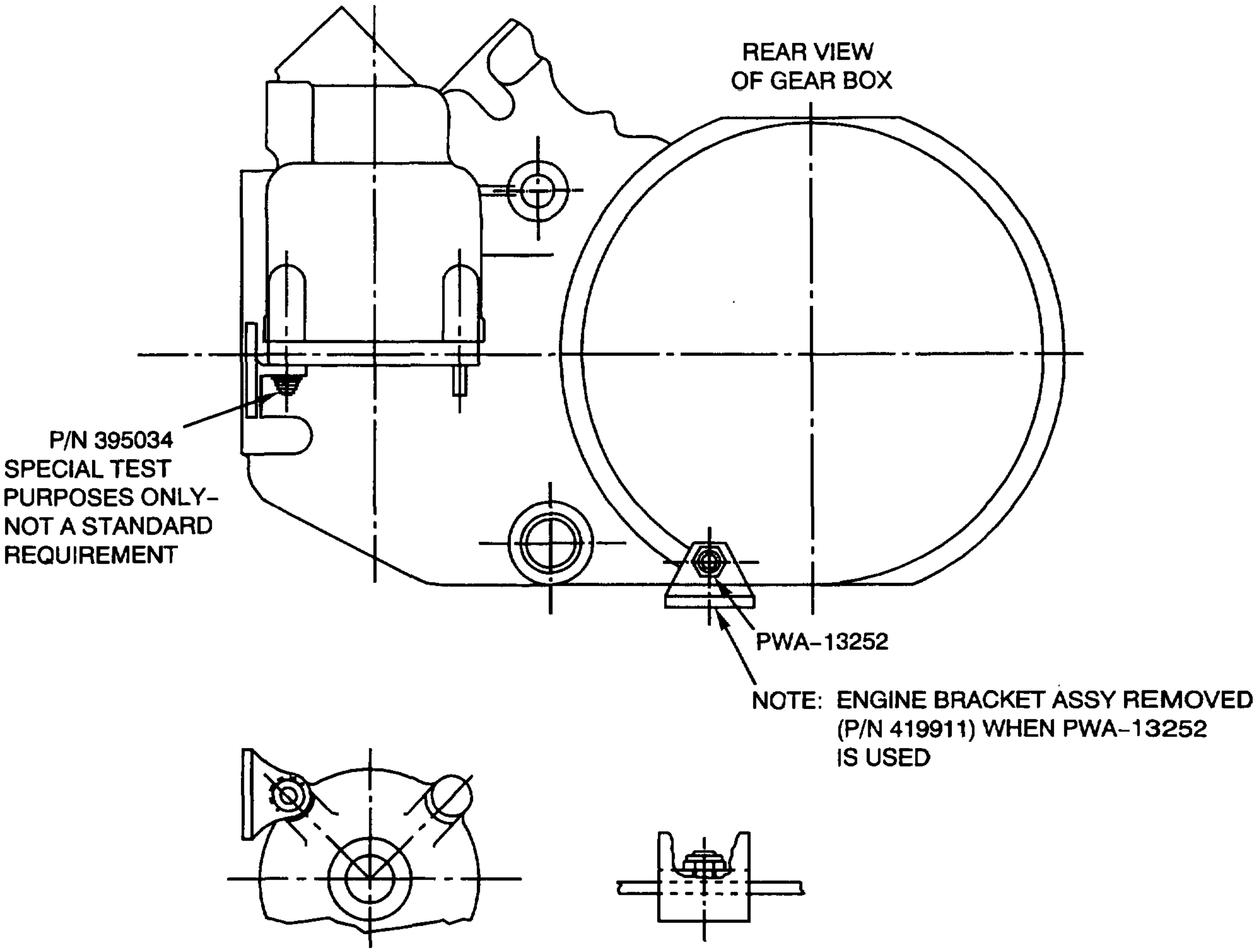
NOTE: Engines used on Lockheed airframes already have a fairing installed.

8 Attach the inlet screen to the PWA-13806 bellmouth.

9 Attach the test thermocouple harness to the bellmouth screen with the long lead toward the bellmouth. Position leads equally around the screen.



Vibration Pickup Locations
Figure 901 (Sheet 1)



L-13235
PW V

Vibration Pickup Locations
Figure 901 (Sheet 2)

10 Install 6 air inlet pressure probes into positions provided in the bellmouth.

NOTE: Use a probe hole plug when it is necessary to omit the probe due to interference with engine parts, such as the fuel flowmeter.

11 Install the bellmouth and screen on the engine inlet case.

NOTE: If the bellmouth will be remote-mounted (with floor-mounted test stand), then attach the screen assembly to the bellmouth and attach the bellmouth to the remote stand. Use an adapter to mount the stand on the engine.

12 Bolt the turbine exhaust nozzle to the turbine exhaust case.

C. Installing Engine In Test Stand

(1) Lift the engine from the transport stand and attach the left and right rear test mounts to the diffuser case pads by using 4 bolts to secure each mount. Install 2 rear mount adapters.

(2) Install the front test mount at the 12 o'clock position on the inlet case and secure the engine in the test stand.

(3) Level the engine.

(4) Connect the fuel supply to the fuel pump inlet.

NOTE: A "workhorse" fuel pump filter can be used during the test. Replace the "workhorse" filter with a new filter after the test.

(5) Connect the engine power control lever to the linkage of the operator's power lever.

(6) If the remote trimmer will be used, then install it at this time.

NOTE: It is recommended that a remote trimmer, available from Lear Siegler Inc., be used when trimming the engine.

(7) Attach instrumentation leads to the turbine discharge temperature and pressure connections.

(8) Connect all test stand lines to the test accessories and instrumentation that were installed when the engine was dressed.

(9) Connect the electrical lead to the wiring harness.

(10) After the engine is completely installed in the test cell, wash down the engine accessory drive gearbox with Varsol and steam or hot water to remove all oil film from the case. Ensure the overhead breather line is located far enough rearward from the bottom accessory section so that oil fumes do not recirculate on the engine. Start with a dry oil-free accessory case and accessories so that any oil leaks can be readily observed and corrected.

CAUTION: PROTECT PREPACKED BEARINGS THAT ARE USED IN THE POWER LEVER CROSS SHAFT ASSEMBLY TO PREVENT DILUTION OF THE BEARING LUBRICATING MEDIUM DURING ANY WASHING PROCESS. THE SAME PRECAUTIONS MUST BE TAKEN WHEN FUEL LINES NEAR THIS ASSEMBLY ARE DISCONNECTED AND FUEL IS, OR MAY BE, IN THESE LINES. SOME ENGINES DO NOT HAVE A POWER LEVER CROSS SHAFT.

(11) Wash down the test cell floor and ensure the floor is free of foreign objects. Check the bellmouth screen for any loose objects, such as pieces of wire or rivets on the inlet case. Also, check all equipment in the test cell and on the floor or wall for security, and check for loose bolts, nuts, or lag bolts.

3. Prestartup Inspection

A. General

(1) Visually inspect all external tubes and components for security.

(2) Check the fuel and oil supplies. Fill the oil system with PWA 521B, Type II engine lubricating oil.

NOTE: If the engine will be placed in storage after completing the test, then it is not necessary to further preserve the oil system.

(3) Check the power lever for full travel, ease of movement, and security.

NOTE: Hamilton Sundstrand controls from a later design must have part power stop installed, as shown in Figure 902.

(4) Ensure that all protective covers, such as compressor bleed valve covers, are removed.

(5) Inspect the surrounding area for cleanliness.

(6) Prior to starting the engine after overhaul, or after any operation that might introduce air into the fuel system, perform the following steps:

(a) Disconnect the pressurizing and dump valve-to-fuel control signal line at the fuel pressurizing and dump valve and the cap signal line.

(b) Place a suitable container under the dump valve overboard drain.

(c) Motor the engine with the starter under these conditions:

1 Ignition Switch - OFF

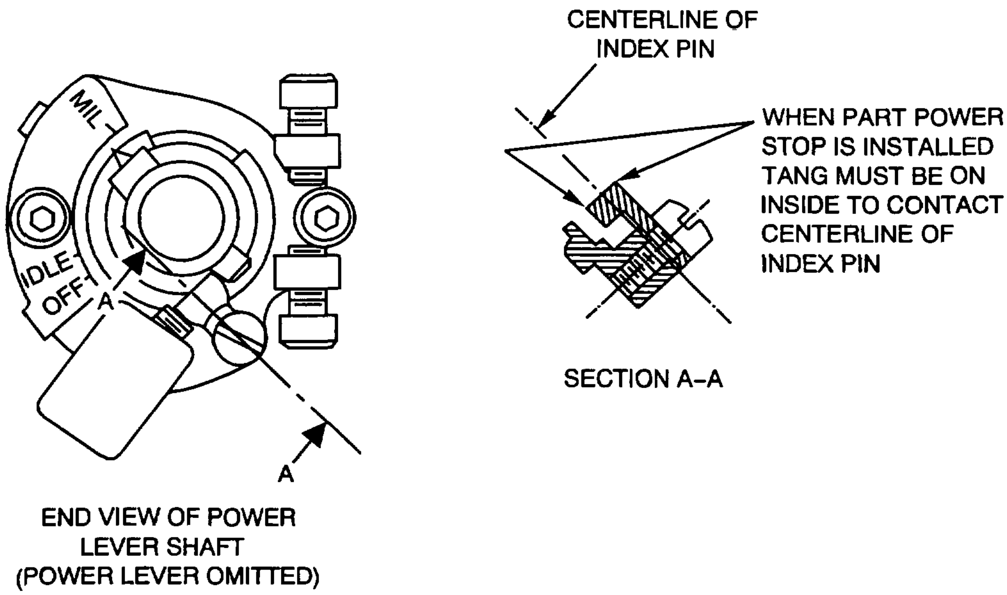
2 Fuel Shutoff Valve - OPEN

3 Fuel Boost Pump - ON

4 Fuel Control Lever - OPEN.

(d) When uninterrupted fuel flow from the dump valve overboard drain is observed, close the fuel control lever, disengage the starter, and shut off the fuel boost pump switch.

(e) Remove the signal line cap and reconnect to the fuel pressurizing and dump valve.



L–13519 (0000)
PW V

Part Power Stop Position
(Hamilton Sundstrand)
Figure 902

4. Engine Startup Procedure

A. The following sequence of steps apply to engines equipped with electric, pneumatic, or combustion starters. When using combustion starters, which have a very limited burning time, perform the steps described below as quickly as possible.

(1) Engine Anti-Icing Switch - OFF

(2) Power Lever - OFF

(3) Engine Master Switch - ON

(4) Engine Fuel Shutoff Switch - OPEN

(5) Fuel Boost Pump Switch - ON

(6) Engine Starter Switch - ON (check for oil pressure rise)

CAUTION: DO NOT TURN ON THE IGNITION SWITCH PRIOR TO ENGAGING THE STARTER, BECAUSE FUEL THAT ACCUMULATES IN THE ENGINE COULD CAUSE AN INTERNAL FIRE OR EXPLOSION.

(7) Ignition Switch - ON (when tachometer indicates 5 - 7 percent minimum)

NOTE: The operating cycle for continuous use of high-energy ignition for the first startup attempt is 2 minutes ON and 3 minutes OFF. For the second attempt, the operating cycle is 2 minutes ON and 23 minutes OFF to allow the ignition system components to cool. In some cases, restrictions imposed on the start operation will govern the use of ignition.

(8) Power Lever - IDLE (when tachometer indicates 10 percent)

(9) Engine Starter Switch - OFF (as soon as a successful start is assured)

(10) Ignition Switch - OFF.

NOTE: On every engine startup cycle, make sure that the tail pipe does not emit flames and that the turbine discharge temperature does not rise rapidly.

B. Satisfactory Start

(1) The engine has started satisfactorily when all the following conditions are met:

(a) Light-Up takes place within 20 seconds or less after the power lever is placed in the IDLE position.

NOTE: A 20 second time interval is an arbitrary value. The actual time to Light-Up depends on the amount of torque supplied by the starter.

(b) The engine will accelerate to approximately 43 percent rpm.

(c) The turbine discharge temperature does not exceed the maximum startup temperature limit of 525°C (977°F) during the transition period to idle rpm.

(d) The oil pressure is at least 35 psi (relative to the internal engine scavenge compartment).

CAUTION: IF THE POWER LEVER IS ACCIDENTALLY PULLED BACK TO THE OFF POSITION, THEN DO NOT REOPEN THE POWER LEVER IN AN ATTEMPT TO REGAIN THE START. THE NORMAL STARTUP SEQUENCE MUST BE REPEATED. INTRODUCING UNBURNED FUEL INTO THE ENGINE CREATES A FIRE HAZARD.

(e) The turbine discharge temperature will drop below 515°C (959°F) after Idle rpm is reached.

C. Unsatisfactory Start

(1) An unsatisfactory start occurs when one or more of the following conditions exist:

NOTE: Following an unsatisfactory start, clear the engine by using the procedure in Paragraph 5. Clear Engine Procedure.

(a) Hot Start - The turbine discharge temperature exceeds the startup temperature limit of 525°C (977°F). When greater than normal fuel flow is observed after the power lever is placed in IDLE, Hot Start could occur and the start operation should be aborted before the turbine discharge temperature is exceeded.

(b) False Start or Hung Start - After Light-Up has occurred, the rpm does not increase to IDLE, but remains at a lower rpm. The turbine discharge temperature could continue to rise, and the start operation should be aborted before the temperature limits are exceeded.

(c) No Start - The engine does not Light-Up within 20 seconds after the power lever is placed in IDLE. If the turbine discharge temperature gage does not indicate a temperature rise, or if the rpm does not increase, then Light-Up has not been achieved.

5. Clear Engine Procedure

A. Perform the following sequence of steps to clear the engine of trapped fuel or vapors:

(1) Power Lever - OFF

(2) Ignition Switch - OFF

(3) Engine Fuel Shutoff Switch - OPEN

(4) Fuel Boost Pump Switch - ON

(5) Engine Starter Switch - ON

(6) Maintain starter operation for 10 - 20 seconds or for the burning time of the cartridge starter.

(7) Engine Starter Switch - OFF

(8) Fuel Boost Pump Switch - OFF

(9) Allow a fuel drainage period of at least 30 seconds before attempting another start.

6. Engine Shutdown Procedure

A. Operate the engine at IDLE for 2 - 5 minutes (depending on the intensity of prior running) to ensure adequate internal cooling.

B. Increase to 75 percent rpm for 30 seconds to provide the proper residual oil scavenging; then slowly return the power lever to OFF.

CAUTION: DO NOT USE VALVES UPSTREAM OF FUEL CONTROL (SUCH AS FIREWALL SHUTOFF VALVES OR TEST STAND FUEL SUPPLY SHUTOFF VALVES), OR TURN OFF FUEL BOOST PUMPS TO SHUT DOWN THE ENGINE. DOING SO ALLOWS THE ENGINE FUEL PUMP TO OPERATE IN A DRY STATE THAT CAN RESULT IN PUMP FAILURE. IF THE ENGINE IS SHUT DOWN IN THIS MANNER FOR ANY REASON, THEN INSPECT ALL FUEL SYSTEM FILTERS AND STRAINERS FOR EVIDENCE OF FUEL PUMP DAMAGE.

R R R R	OPER COND	CORRECTED JET THRST LBS	CORRECTED COMPRSSR RPM (N)	ENG PRSSR RATIO (EPR)	CORR SFC LBS/HR/LB THRUST	MAX IND TURBINE DISCHRG TEMP*	TIME LMTS (MIN)
R R R R	Take-off	3000	16367 max	2.090 to 2.135	0.960	Must be below line of Fig 903	20
R R	Max Cont	2400	15110 max	-	0.895	"	Cont
C R R	Max Climb	2400	15110 max	-	0.895	Same as Max Cont	Cont
R R	Max Cruise	2250	14840 max	-	0.890	-	Cont
R R R R	Idle	Must be below line in Fig 917	Must be within band in Fig 915	-	-	-	Cont
R R	Strtng	-	-	-	-	525°C (977°F)	Momentary

R Engine Check Chart (JT12A-6)
R (Engine Serial Number Without Suffix A)
R Table 901

OPER COND	CORRECTED JET THRST LBS	CORRECTED COMPRSSR RPM (N)	ENG PRSSR RATIO (EPR)	CORR SFC LBS/HR/LB THRUST	MAX IND TURBINE DISCHRG TEMP*	TIME LMTS (MIN)
Accl-rtn	-	-	-	-	649°C (1200°F)	2
Part Power	2615	-	1.932 to 1.977	-	-	-

*During and just after acceleration, the above stabilized limits may be exceeded to a maximum of 666°C (1230°F) for not more than 2 minutes.
Prior to establishing the final trim setting, the indicated take-off limit must not be exceeded.

NOTE: The maximum safe indicated compressor speed is 16,700 rpm.

Engine Check Chart (JT12A-6)
(Engine Serial Number Without Suffix A)
Table 901 (Continued)

OPER COND	CORRECTED JET THRST LBS	CORRECTED COMPRSSR RPM (N)	ENG PRSSR RATIO (EPR)	CORR SFC LBS/HR/LB THRUST	MAX IND TURBINE DISCHRG TEMP*	TIME LMTS (MIN)
Take-off	3000	16530	2.090 to 2.135	0.960	Must be below line of Fig 903	20
Max Cont	2400	15260	-	0.895	"	Cont
Max Climb	2400	15260	-	0.895	Same as Max Cont	Cont
Max Cruise	2250	15200	-	0.890	-	Cont
Idle	Must be below line in Fig 917	Must be within band in Fig 915	-	-	525°C (977°F)	Cont

Engine Check Chart (JT12A-6)
(Engine Serial Number With Suffix A)
Table 902

OPER COND	CORRECTED JET THRST LBS	CORRECTED COMPRSSR RPM (N)	ENG PRSSR RATIO (EPR)	CORR SFC LBS/HR/LB THRUST	MAX IND TURBINE DISCHRG TEMP*	TIME LMTS (MIN)
Strtng	-	-	-	-	"	Momentary
Accl-rtn	-	-	-	-	649°C (1200°F)	2
Part Power	2615	-	1.932 to 1.977	-	-	-

*During and just after acceleration, the above stabilized limits may be exceeded to a maximum of 666° C (1230° F) for not more than 2 minutes.
Prior to establishing the final trim setting, the indicated take-off limit must not be exceeded.

NOTE: The maximum safe indicated compressor speed is 16,700 rpm.

Engine Check Chart (JT12A-6)
(Engine Serial Number With Suffix A)
Table 902 (Continued)

OPER COND	CORRECTED JET THRST LBS	CORRECTED COMPRSSR RPM (N)	ENG PRSSR RATIO (EPR)	CORR SFC LBS/HR/LB THRUST	MAX IND TURBINE DISCHRG TEMP*	TIME LMTS (MIN)
Take-off	3000	16500	2.090 to 2.135	0.960	Must be below line of Fig 904	20
Max Cont	2570	15600	-	0.905	"	Cont
Max Climb	2570	15600	-	0.905	Same as Max Cont	Cont
Max Cruise	2570	15600	-	0.905	-	Cont

Engine Check Chart (JT12A-6A)
(Engine Serial Number With Suffix A)
Table 903

	OPER COND	CORRECTED JET THRST LBS	CORRECTED COMPRSSR RPM (N)	ENG PRSSR RATIO (EPR)	CORR SFC LBS/HR/LB THRUST	MAX IND TURBINE DISCHRG TEMP*	TIME LMTS (MIN)
R	Idle	Must be below line in Fig 917	Must be within band in Fig 915	-	-	525°C (977°F)	Cont
R	Strtng	-	-	-	-	"	Momen tary
R	Accl- rtn	-	-	-	-	666°C (1230°F)	2
R	Part Power	2615	-	1.932 to 1.977	-	-	-

R *During and just after acceleration, the above stabilized limits may
R be exceeded to a maximum of 666° C (1230° F) for not more than
2 minutes.
R Prior to establishing the final trim setting, the indicated
R take-off limit must not be exceeded.

R NOTE: The maximum safe indicated compressor speed is 16,700 rpm.

R Engine Check Chart (JT12A-6A)
R (Engine Serial Number With Suffix A)
R Table 903 (Continued)

	OPER COND	CORRECTED JET THRST LBS	CORRECTED COMPRSSR RPM (N)	ENG PRSSR RATIO (EPR)	CORR SFC LBS/HR/LB THRUST	MAX IND TURBINE DISCHRG TEMP*	TIME LMTS (MIN)
R	Take- off*	3300	16450	2.243 to 2.288	0.995	Must be below line of Fig 905	5
R	Max Cont*	3000	15900	-	0.960	"	Cont
R	Max Climb	3000	15900	-	0.960	Same as Max Cont	Cont

R Engine Check Chart (JT12A-8)
R Table 904

OPER COND	CORRECTED JET THRST LBS	CORRECTED COMPRSSR RPM (N)	ENG PRSSR RATIO (EPR)	CORR SFC LBS/HR/LB THRUST	MAX IND TURBINE DISCHRG TEMP*	TIME LMTS (MIN)
Max Cruise	2800	15600	-	0.935	525°C (977)°F	Cont
Idle	Must be line in Fig 918	Must be band in Fig 916	-	"	"	Cont
Strtng	"	"	-	"	"	Momen tary
Accl- rtn	-	-	-	-	707°C (1305°F)	2
Part Power	2720	-	2.001 to 2.046	-	-	-

*It is permissible for thrust setting purposes within the required thrust in Figure 906 to exceed the limits in Figure 905 by 17°C (30°F). However, the engine must meet the minimum line of the applicable thrust band without exceeding the temperature limit shown in Figure 905.

**During and just after acceleration, TAKE-OFF AND MAX. CONTINUOUS stabilized limits may be exceeded to a maximum of 707°C (1305°F) for not more than 2 minutes. Prior to establishing the final trim setting, the indicated take-off limit must not be exceeded.

NOTE: The maximum safe indicated compressor speed is 16,700 rpm.

Engine Check Chart (JT12A-8)
Table 904 (Continued)

OPER COND	OIL PRSSR	OIL TEMP (INLT)	OIL BRTHR PRSSR	OIL CON- SUMP	FUEL TEMP (INLT)	FUEL PRSSR (INLT)	FUEL DRAIN LEAKAGE P&D VALV	FUEL DRAIN LEAKAGE CONTRL &PUMP	IGNTN SYSTM
Take- off	40 to 50 psig	121°C (250°F) max	2"Hg at stdy state	0.11 gph max dur test	(See NOTE)	5 to 50 psig	300cc per hour (dur eng run)	20cc per hour	24vdc nom 14 vdc min with 5

Engine Check Chart (All JT12A)
Table 905

OPER COND	OIL PRSSR	OIL TEMP (INLT)	OIL BRTHR PRSSR	OIL CON-SUMP	FUEL TEMP (INLT)	FUEL PRSSR (INLT)	FUEL DRAIN LEAKAGE P&D VALV	FUEL DRAIN LEAKAGE CONTRL &PUMP	IGNTN SYSTM
(CONTINUED)									amp load at inpt term
Max Cont	"	"	"	"	"	"	"	"	"
Max Clmb	"	"	"	"	"	"	"	"	"
Max Cruse	"	"	"	"	"	"	"	"	"
Idle	35 min	"	"	"	"	"	"	"	"
Strt-ng	"	"	"	"	"	"	"	"	"
Accl-rtn	"	"	4"Hg max	"	"	"	"	"	"

NOTE: Fuel Temperature (Inlet):
JT12A-6, -6A 38°C (100°F) Maximum
JT12A-8 43°C (110°F) Maximum

Engine Check Chart (All JT12A)
Table 905 (Continued)

C. Fuel Boost Pump Switch - OFF

NOTE: To prevent air from getting into fuel lines, set the power lever to OFF before the fuel boost pump is turned OFF.

D. Engine Fuel Shutoff Switch - CLOSED

E. Engine Master Switch - OFF

F. Ascertain whether the compressor decelerates freely.

NOTE: In the event of inadvertent, or emergency shutdown, rotor rotational freedom must be checked before attempting another start.

NOTE: During engine run-down, under conditions of low pump rpm and high discharge pressures, the fuel pump may produce noise. This noise is characteristic and should not be the reason for removing the pump from service.

7. Limits For Test

A. Deleted

B. Engine Check Chart For JT12A-6
(Engine serial number without suffix A - See Table 901 and Table 905)

C. Engine Check Chart For JT12A-6
(Engine serial number with suffix A - See Table 902 and Table 905)

D. Engine Check Chart For JT12A-6A
(Engine serial number with suffix A - See Table 903 and Table 905)

E. Engine Check Chart For JT12A-8
(See Table 904 and Table 905)

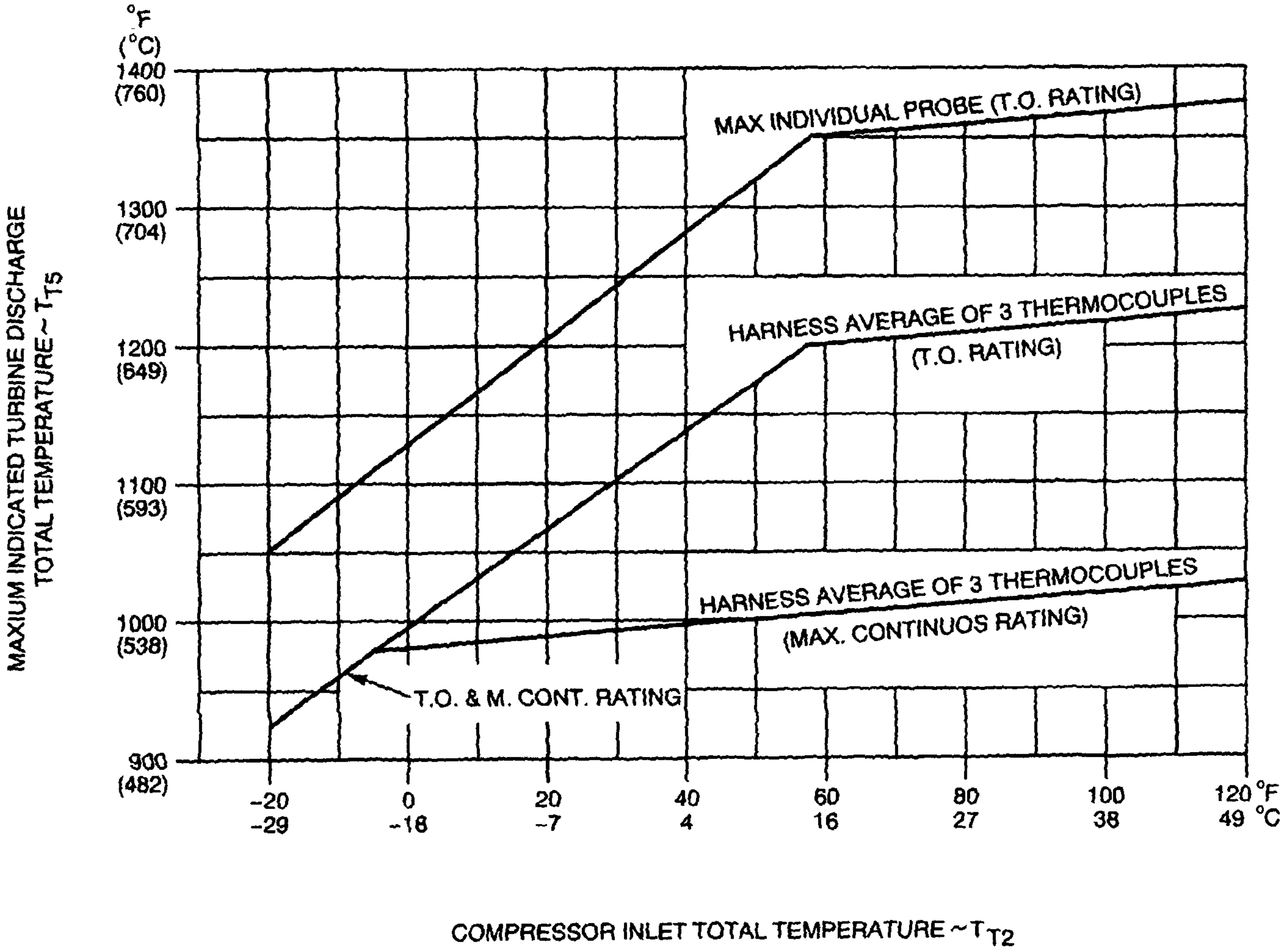
8. Engine Thrust
(Refer to Paragraph 7. Limits For Test)

A. Obtain the TAKEOFF rating for this engine by setting EPR (Pt5/P52), and by adjusting the fuel control to obtain the correct trim at the part power lever position. As a result of this trimming and operating procedure, the TAKEOFF thrust rating can be obtained below the full power lever position. The fuel control power lever is varied (slowed down) with increasing inlet temperatures above approximately 15°C (60°F) in order to maintain the required corrected TAKEOFF thrust, as indicated by Band A in Figure 906 thru Figure 908.

CAUTION: DO NOT RUN THE ENGINE WITH THE POWER LEVER ADVANCED BEYOND THE POSITION NECESSARY TO MEET CORRECTED THRUST REQUIREMENTS FOR INLET TEMPERATURE, AS INDICATED IN FIGURE 906, FIGURE 907 OR FIGURE 908.

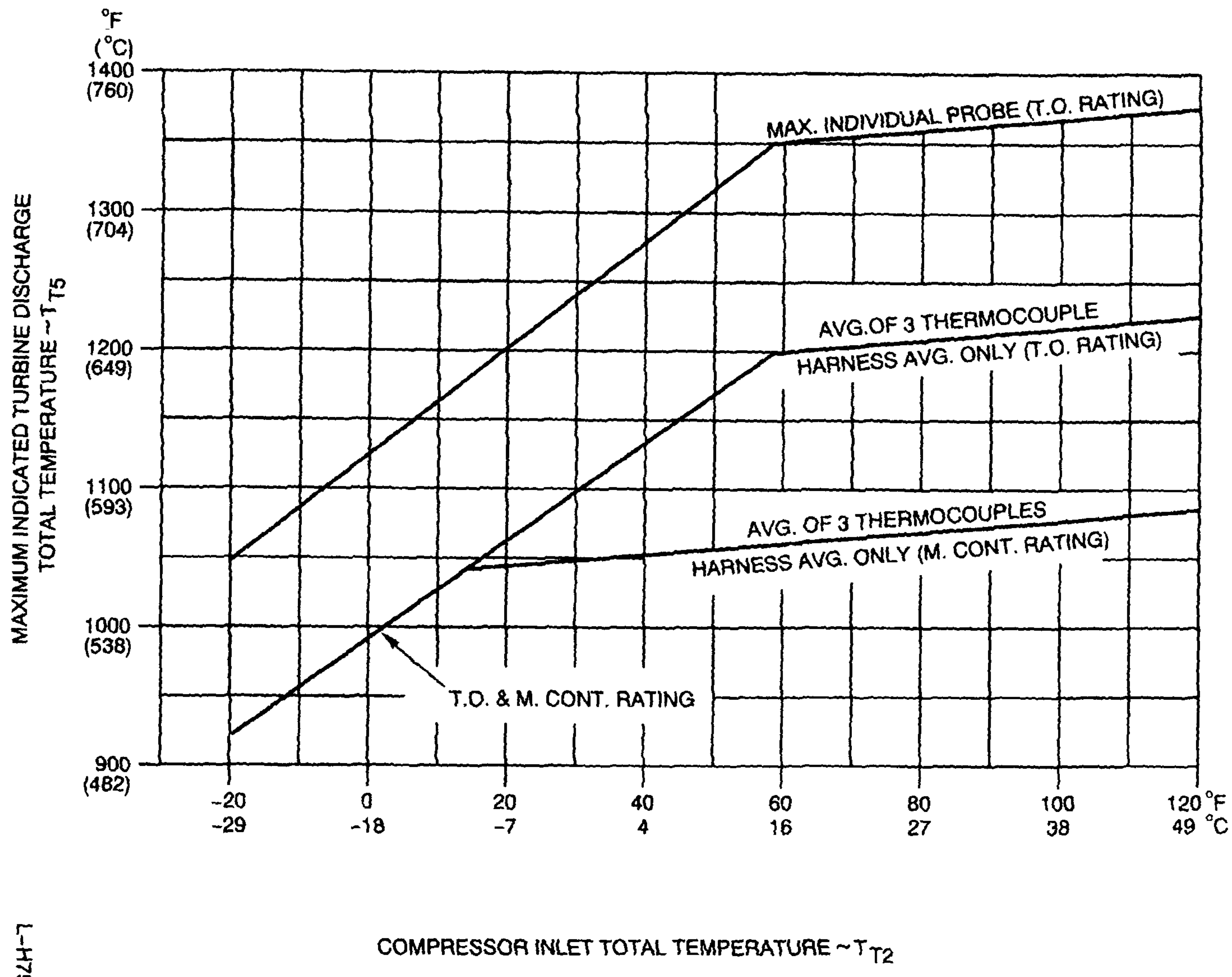
B. Fuel System (Refer to Paragraph 7. Limits For Test)

R
R



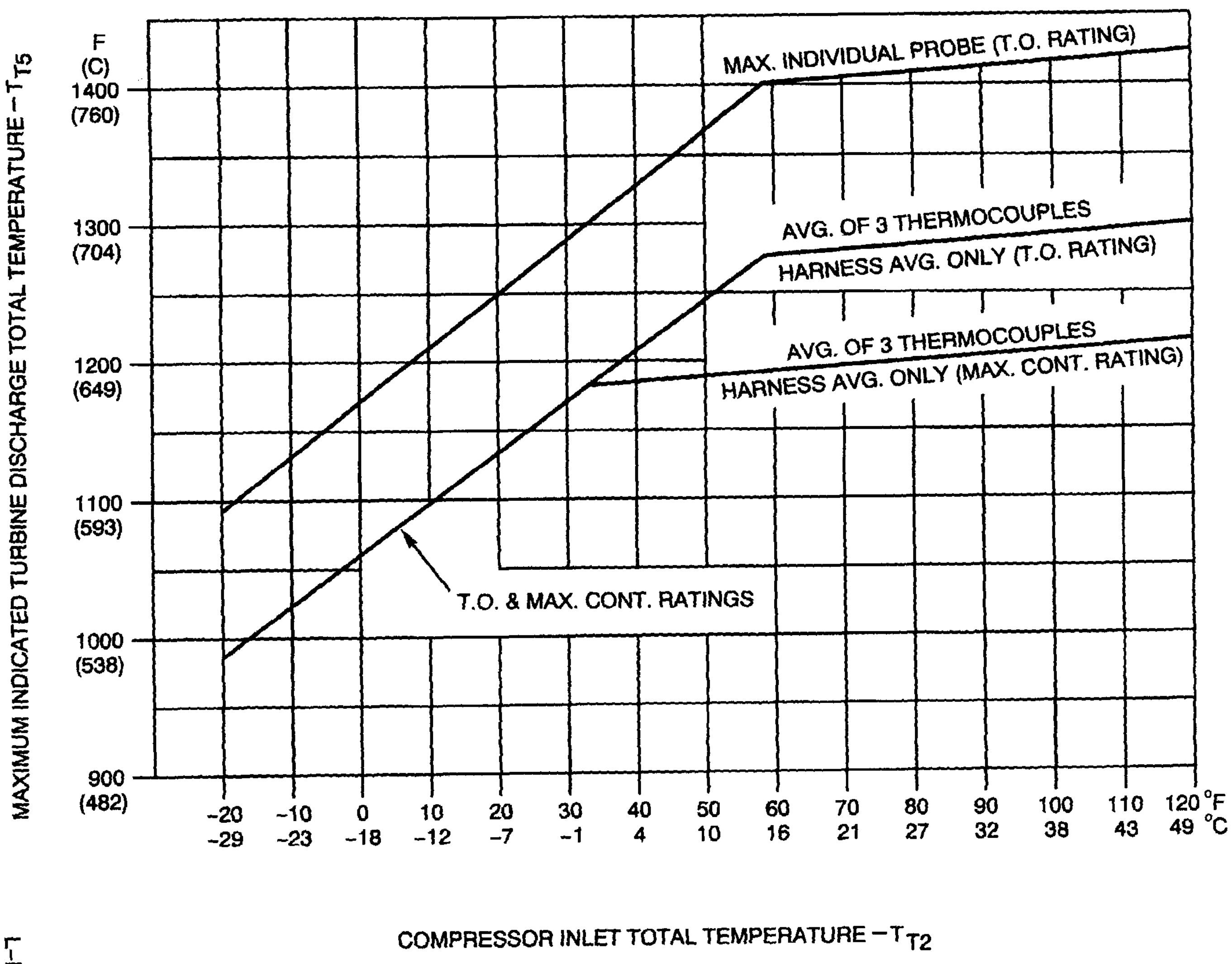
L-H7986 (0107)
PW V

Maximum Indicated Turbine Discharge Total Temperature Tt5 (JT12A-6)
Figure 903



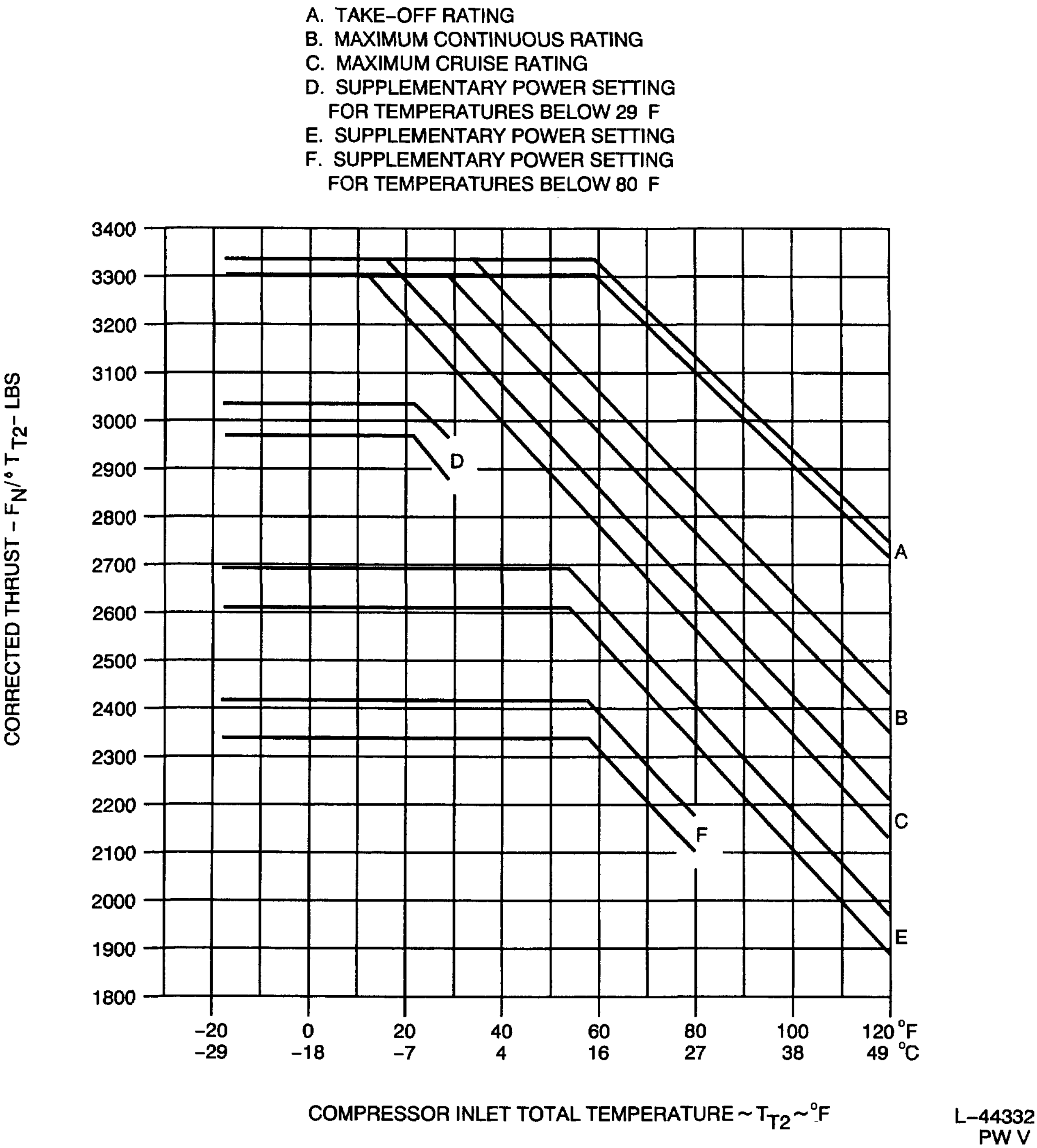
L-H7987 (0107)
PW V

Maximum Indicated Turbine Discharge Total Temperature
(JT12A-6A)
Figure 904

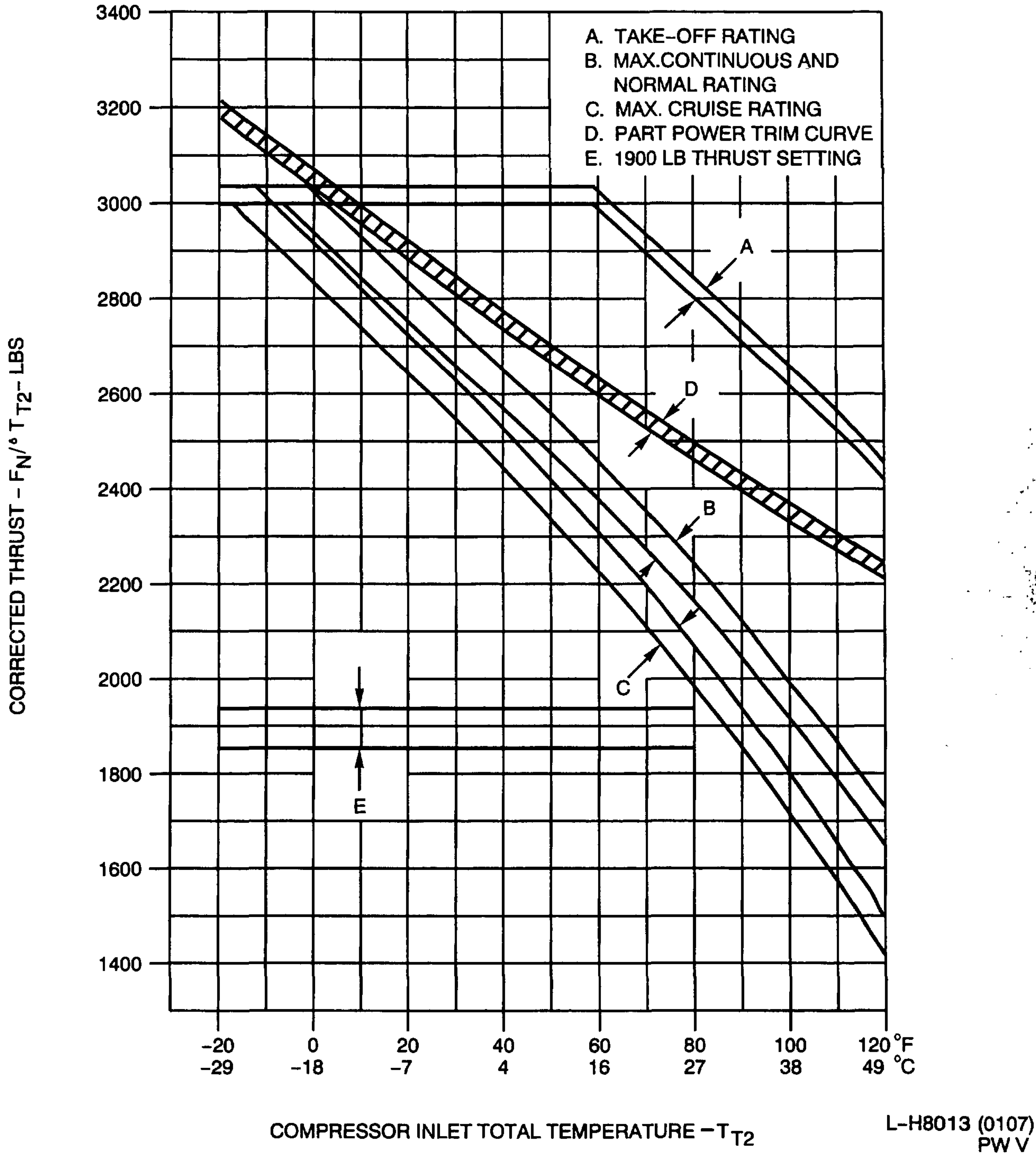


L-H7988 (0107)
PW V

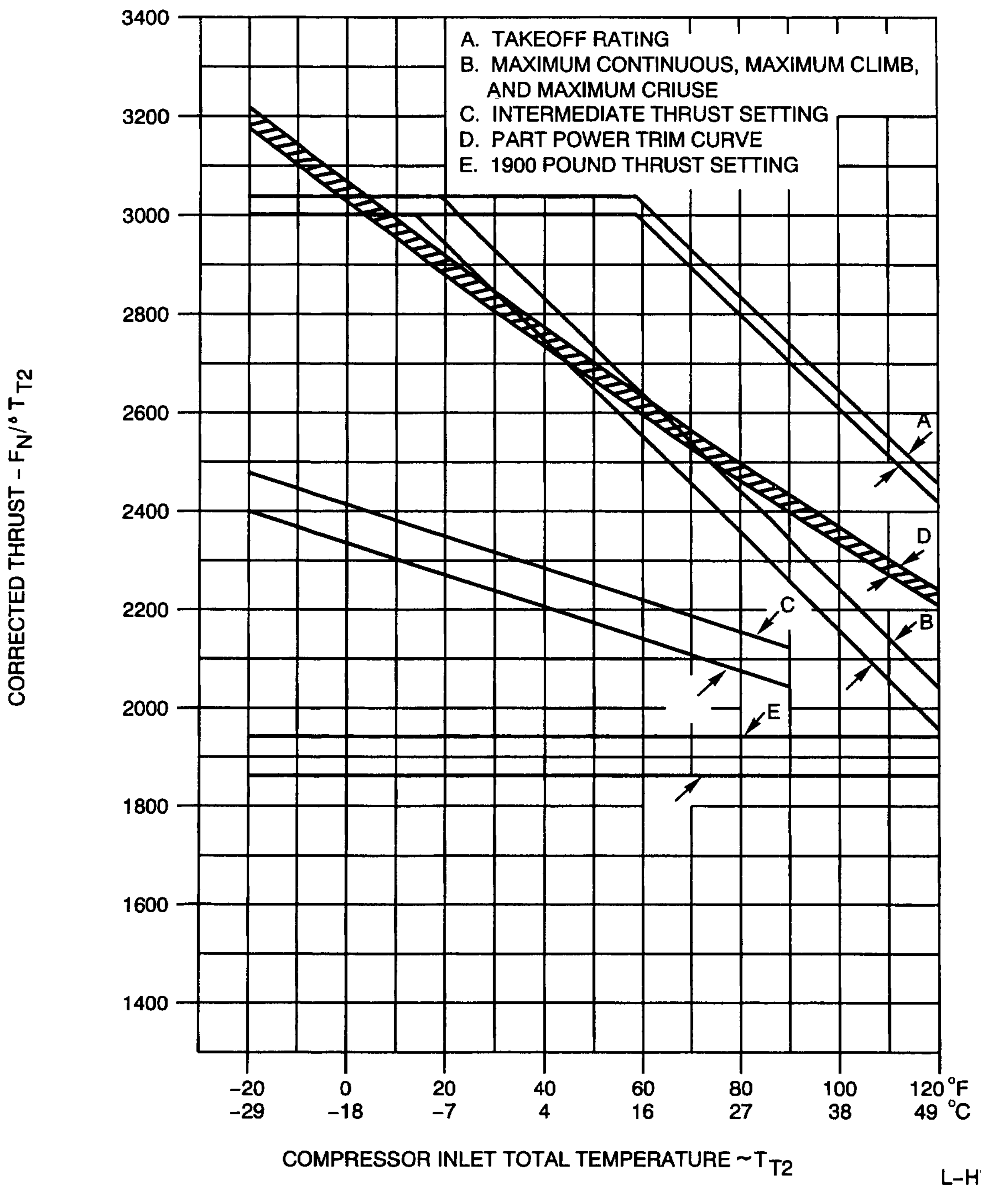
Maximum Indicated Turbine
Discharge Total Temperature
(JT12A-8)
Figure 905



Thrust Setting And Trim Curve
(JT12A-8)
Figure 906



Thrust Setting And Trim Curve
(JT12A-6)
Figure 907



Thrust Setting And Trim Curve
(JT12A-6A)
Figure 908

C. Oil System (Refer to Paragraph 7. Limits For Test)

NOTE: Prior to checking the oil level or servicing the oil tank, run the engine in IDLE for 2 - 5 minutes (depending on the intensity of prior running) and accelerate to 75 percent rpm for 30 seconds, then return the power lever to OFF. Due to the short duration of the test, newly overhauled engines may initially consume a slightly greater amount of oil. Therefore, if the initial oil consumption Figure from the acceptance test is greater than 0.35, then perform a recheck involving 2 hours of continuous engine operation, including 2 acceptance runs plus a balance of time at normal rated power.

9. Electrical System
(Refer to Paragraph 7. Limits For Test)

A. Instrumentation

(1) Frequently calibrate all instruments and equipment to ensure reported data has static accuracy within the limits listed below for values obtained at the TAKEOFF thrust rating.

(a)	Pam	Ambient pressure	±0.01 inch Hg
(b)	Pt2	Compressor Inlet Total Pressure	±0.10 inch H2O
(c)	Ps3	Compressor Discharge Static Pressure	±0.25 percent
(d)	Pt5	Turbine Discharge Total Pressure	±0.10 inch Hg
(e)	Tt2	Compressor Inlet Total Temperature	±2°F (± 1.1°C)
(f)	Tt5	Turbine Discharge Total Temperature (Exhaust Gas Temperature) Average and Individual	±5°F (± 2.8°C)
(g)	OBT	Control Room Temperature	±1°F (± .5°C)

(h)	Tf	Inlet Fuel Temperature	±1°F (± .5°C)
(i)	Wf	Fuel Flow	±0.75 percent
(j)	N1	Compressor Rotor Speed	±0.10 percent
(k)	Fn	Thrust	±0.40 percent

10. Engine Test Vibration Limits

A. Vibration monitoring is used in the overhaul of gas turbine engines to provide an indication of correct assembly. The vibration limits are exceeded when the main engine rotor assembly is incorrectly assembled and balanced.

B. Vibration amplitudes must be observed at a steady state running at all speeds in the operating range and must not exceed the specified limits. Refer to Paragraph 7. Limits For Test.

NOTE: Momentary vibration peaks during transient operating conditions in excess of limits listed are not cause for rejection, as long as steady state readings are within limits. Limits are valid only when pickups are mounted as shown in Figure 901.

11. Engine Test Vibration Equipment

A. Use the following combination of suitably calibrated vibration measuring equipment, or an equivalent combination, to monitor vibration during an engine test.

(1) Model ED-156-4 vibration meter (or equivalent).

NOTE: This vibration meter was formerly available from Glenn Hathaway Electronics of Canaan, CT.

(2) Compatible 40 cps filter for a vibration meter.

(3) Model 4-103 or 4-123 vibration pickups (or equivalent).

NOTE: These vibration pickups were formerly available from Consolidated Electrodynamics Corp. of Pasadena, CA USA.

B. To ensure accuracy, frequently calibrate the vibration indicator and filter used to monitor vibration during the test, and ensure the frequency in cps versus relative frequency response in percent falls within the band in Figure 909.

12. Drain Leakage Check Of Fuel System

A. During the engine run, overboard drain seal leakage from the main engine fuel control, fuel pump, and pressurizing and dump valve must be collected in individual containers. Individual leakage of the listed controls must not exceed the limits in Paragraph 7. Limits For Test.

13. Maximum Indicated Speed
(Refer to Paragraph 7. Limits For Test)

14. Correction Of Indicated Readings

A. Correct the observed data at TAKEOFF, MAX, CONTINUOUS, and NORMAL conditions for thrust, fuel consumption, compressor rpm, and turbine discharge temperature, as indicated in step C. below. Check against the ratings.

B. Before making the data corrections, correct the thrust for test house bulkhead pressure drop:

Multiply the cross-sectional area, based on the tail pipe OD where it goes through the bulkhead, by inches of water bulkhead pressure drop converted to pounds per square inch (inches of water x 0.03613 = psi). Also, correct thrust for momentum (ram) drag and engine pressure ratio in accordance with the correction curve for each test stand.

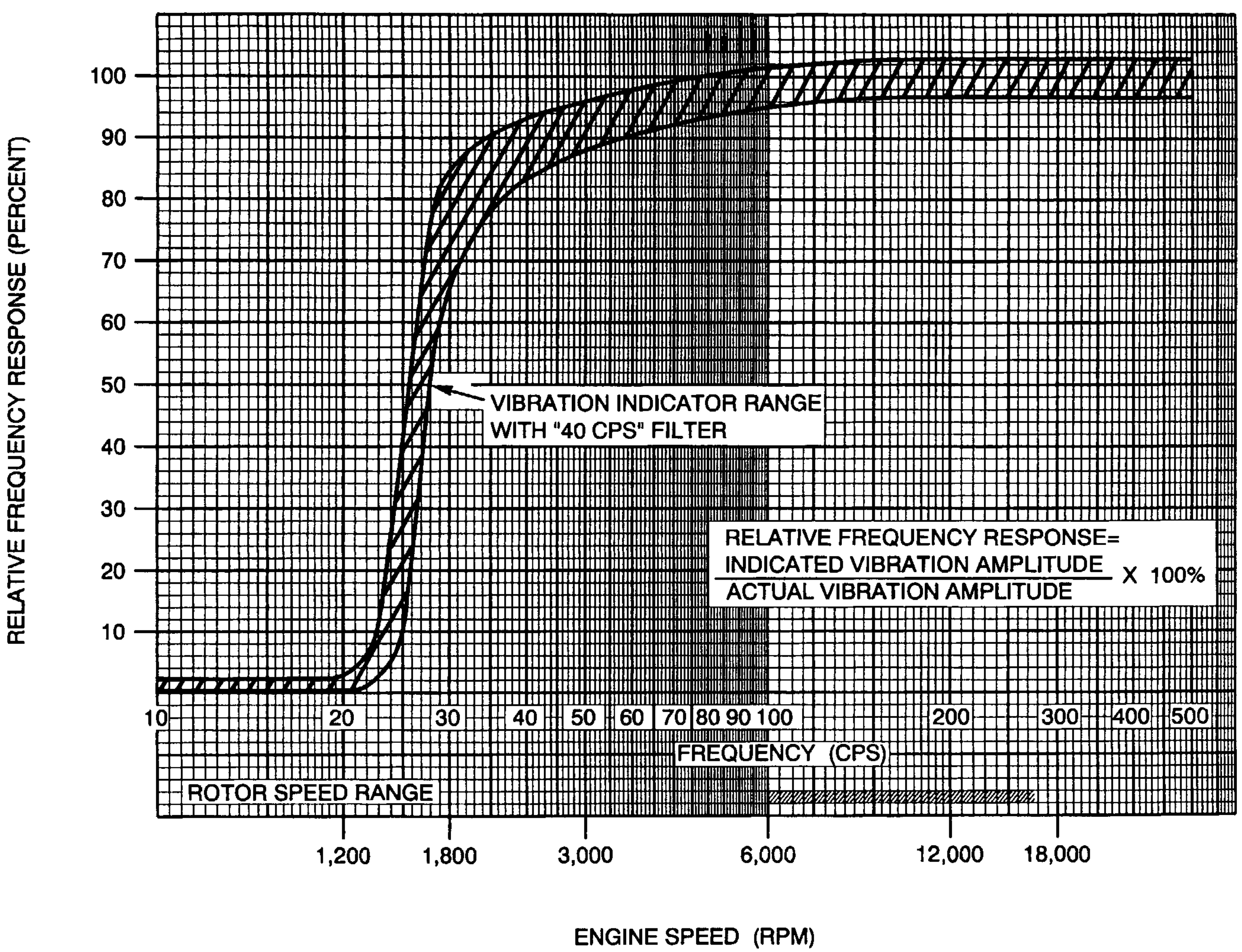
C. Calculate the corrected values with the formula in Figure 909A.

15. Compressor Inlet Total Pressure (Pt2) Conversion

A. Convert Pt2 inches water (gage) to inches mercury (gage): Multiply inches water by 0.07355.

B. Obtain Pt2 inches mercury absolute: Subtract Pt2 inches mercury from barometer reading, taken at the time of the test.

C. Obtain the true main oil pressure: Convert engine breather pressure in inches of Hg to psi (inches Hg x 0.49), and subtract it from the observed main oil pressure gage reading.



L-13745
PW V

Vibration Indicator And
Filter Characteristics
Figure 909

FUEL FLOW (PHR CORRECTED FOR SPECIFIC GRAVITY ONLY) = W_f

K_p = (SEE FIGURE 910.)

THRUST (lbs.) = F_n

$$\delta = \frac{P_{t2}\ \text{(IN. Hg ABSOLUTE)}}{29.92\ \text{IN. Hg}}$$

$$\theta = \frac{T_{t2}\ (^{\circ}F) + 459.7}{518.7}$$

L-H7990 (0107)
PW V

Correction Factors
Figure 909A (Sheet 1)

$$\text{CORRECTED } F_n = \frac{\text{OBSERVED } F_n}{\delta} + \text{TEST CELL CORRECTION}$$

$$\text{CORRECTED RPM} = \frac{\text{OBSERVED RPM}}{\sqrt{\theta}}$$

$$\text{CORRECTED } W_f = \frac{\text{OBSERVED } W_f \times K_p}{\delta \sqrt{\theta}}$$

$$\text{CORRECTED EXHAUST GAS TEMPERATURE } (^{\circ}F) = \frac{\text{OBSERVED EGT} + 459.7}{\theta} \text{ MINUS } 459.7$$

$$\text{CORRECTED THRUST SPECIFIC FUEL CONSUMPTION} = \frac{\text{CORRECTED } W_f}{\text{CORRECTED } F_n}$$

L-H7991 (0107)
PW V

Correction Factors
Figure 909A (Sheet 2)

D. Perform all engine trimming by measuring the turbine discharge pressure (Pt5) with a precision bore mercury manometer. The manometer is pressure tested for leaks by applying air pressure equal to 2/3 capacity of the manometer to the tube connection from the engine, and by observing that the manometer reading stays constant for at least 2 minutes. Make all Pt5 readings to the nearest 0.1 inch Hg, and add them to the observed true barometer that is read to the nearest 0.01 inch Hg.

E. Correct turbine discharge pressure (Pt5) mercury manometer readings for temperature effect by Figure 911.

16. Belting-In

A. With the ignition OFF or grounded, the fuel ON, and the power control lever CLOSED, operate the engine by external power at a speed sufficiently high to ensure the oil system is fully primed and the oil pump maintains steady pressure.

(1) Check for oil leakage outside the engine.

(2) Check the function of the fuel drain valves by briefly exercising the control lever to pressurize the fuel system.

(3) Check for fuel leaks.

B. After a satisfactory check and before starting the engine, dry out the engine by performing the Clear Engine Procedure.

17. Engine Log Sheet

A. Record the following data on the engine log sheet:

(1) Time of day

(2) Date of test

(3) True barometric pressure (during erratic weather conditions, record the pressure every half-hour)

(4) Observed and corrected speed rpm

(5) Observed and corrected thrust

(6) Observed and corrected fuel flow

(7) Compressor inlet pressure (Pt2)

(8) Compressor inlet temperature (Tt2)

(9) Turbine discharge pressure (Pt5)

(10) Turbine discharge temperature (Tt5)

(11) Observed and corrected main oil pressure

(12) Oil temperature

(13) Oil consumption

(14) Oil tank breather pressure

(15) Fuel inlet pressure

(16) Anti-icing air temperature

(17) Vibration amplitude

(18) Duration of test period

(19) Control room temperature

(20) Inlet fuel temperature

(21) Miscellaneous data:

(a) Grade of fuel and specific gravity

(b) Grade of oil

(c) Reason for any non-scheduled engine shutdown

(d) Reason for any engine rejection

(e) Time in seconds that the Tt5 exceeds the specific limits

(f) Time to ignition and N1 at ignition

(g) Time to starter cutout and N1 at cutout

(h) Time to stabilized IDLE and N1 at IDLE

(i) Maximum Tt5

(j) Noticeable flat spots in acceleration

(k) Compressor static pressure (Ps3)

(l) Acceleration and deceleration times during three 10 minute cycles

(m) Repairs made to the engine during the test

(n) Serial numbers of engine components (fuel pump, fuel control)

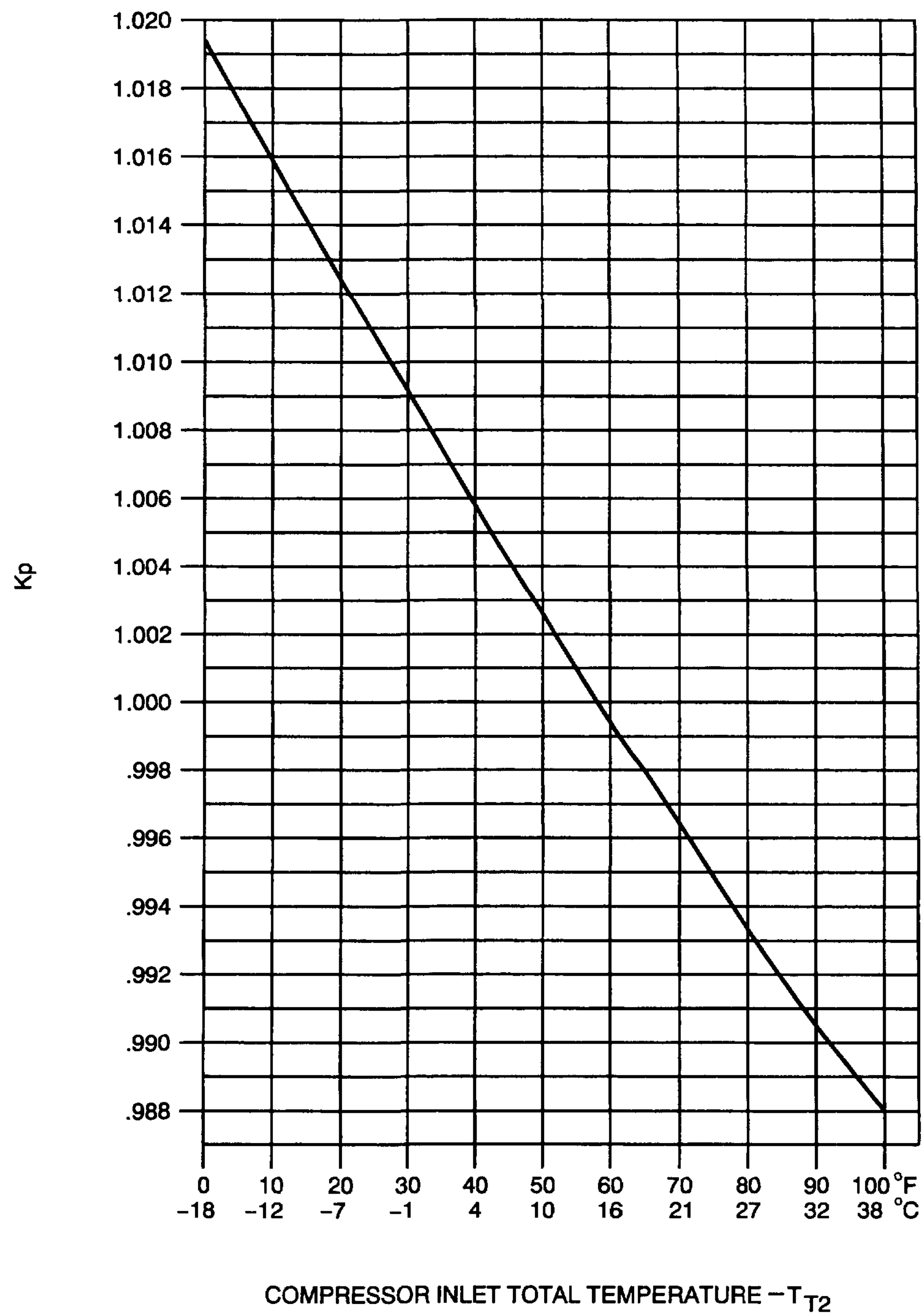
(o) Engine type, model, and serial number

(p) Test operator signature

(q) Test inspector signature.

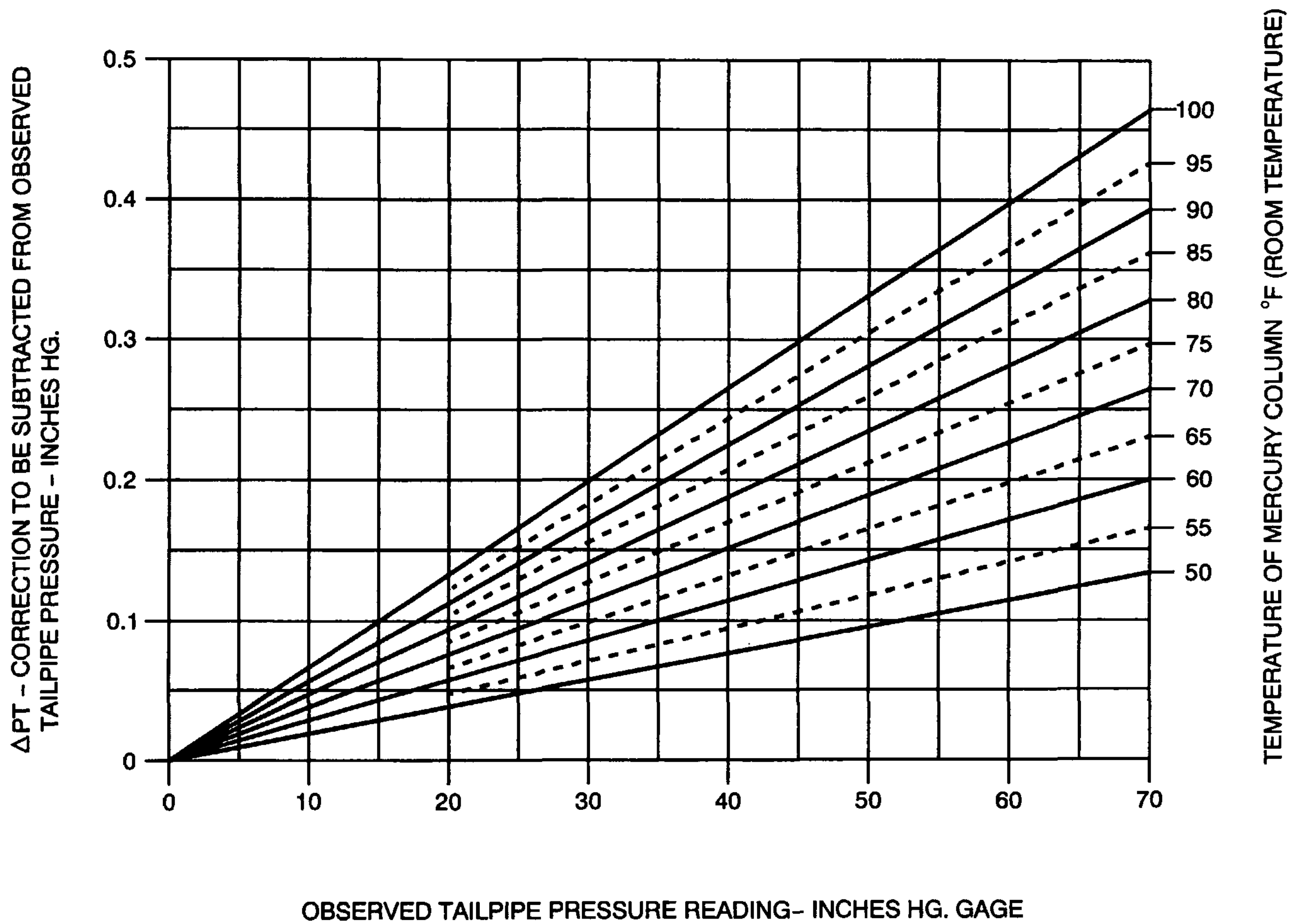
18. Running Prior To Acceptance Test (JT12A-6, -6A, And -8)

	OPERATION	CHECKS AND REMARKS
1.	Belting-in	Refer to Paragraph 16.
2.	Engine startup	Refer to Paragraph 4. Determine and record the overall time from initiating the startup cycle to idle speed.
3.	Accelerate to 13,000 rpm	The automatic bleed must be fully open until 12,600 rpm is reached, and fully closed at 13,000 rpm. Note the speed prior to bleed actuation.
4.	Vibration survey	Vibration limits must be met. Refer to Paragraph 7. Limits For Test. NOTE: Refer to Paragraph 21. Engine Trim Balance Procedure.
5.	Engine shutdown	Refer to Paragraph 6. Check for fuel and oil leaks and correct as necessary.



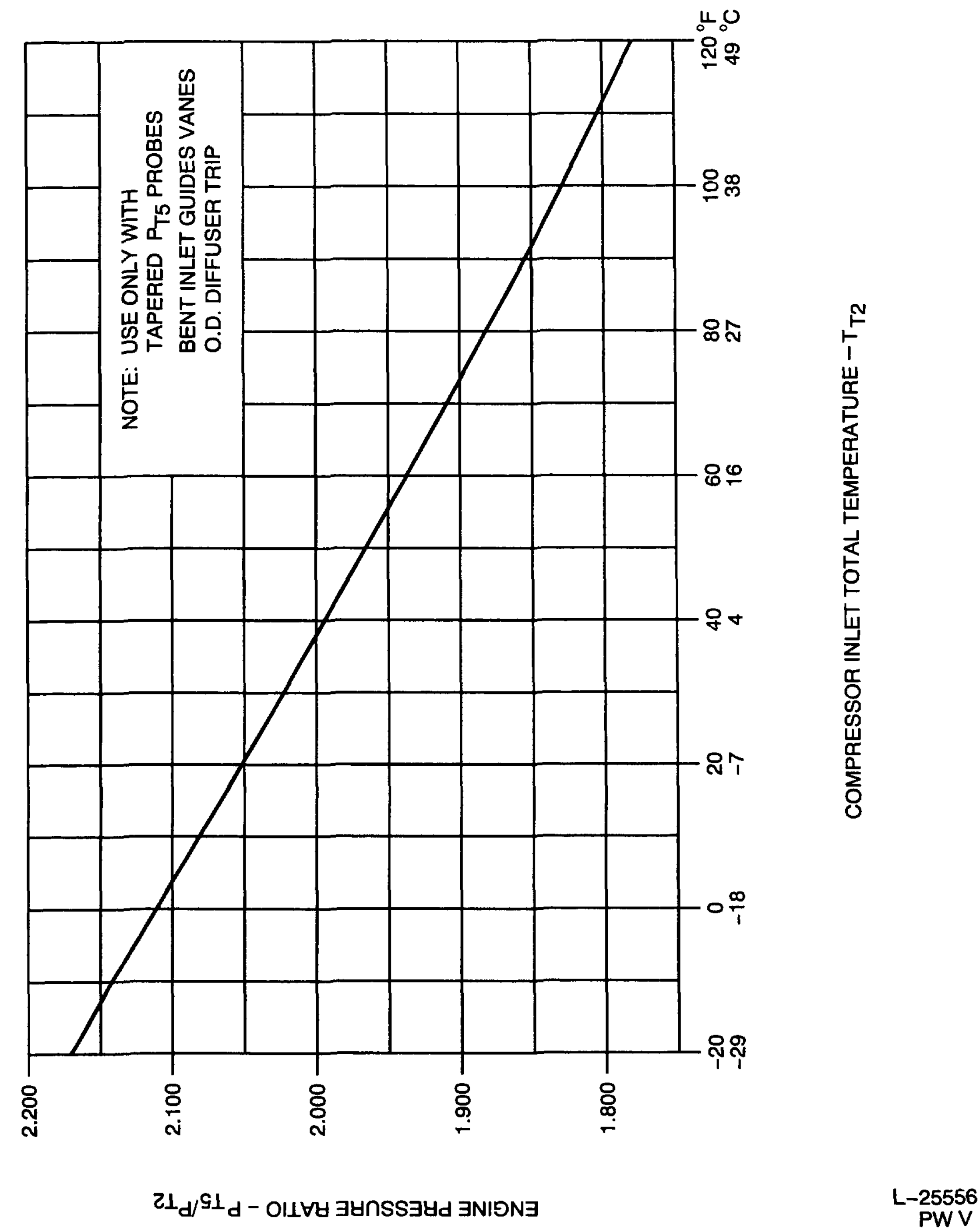
Fuel Flow Correction Curve
Figure 910

SPECIFIC GRAVITY
TEMPERATURE CORRECTION TO MERCURY MANOMETERS

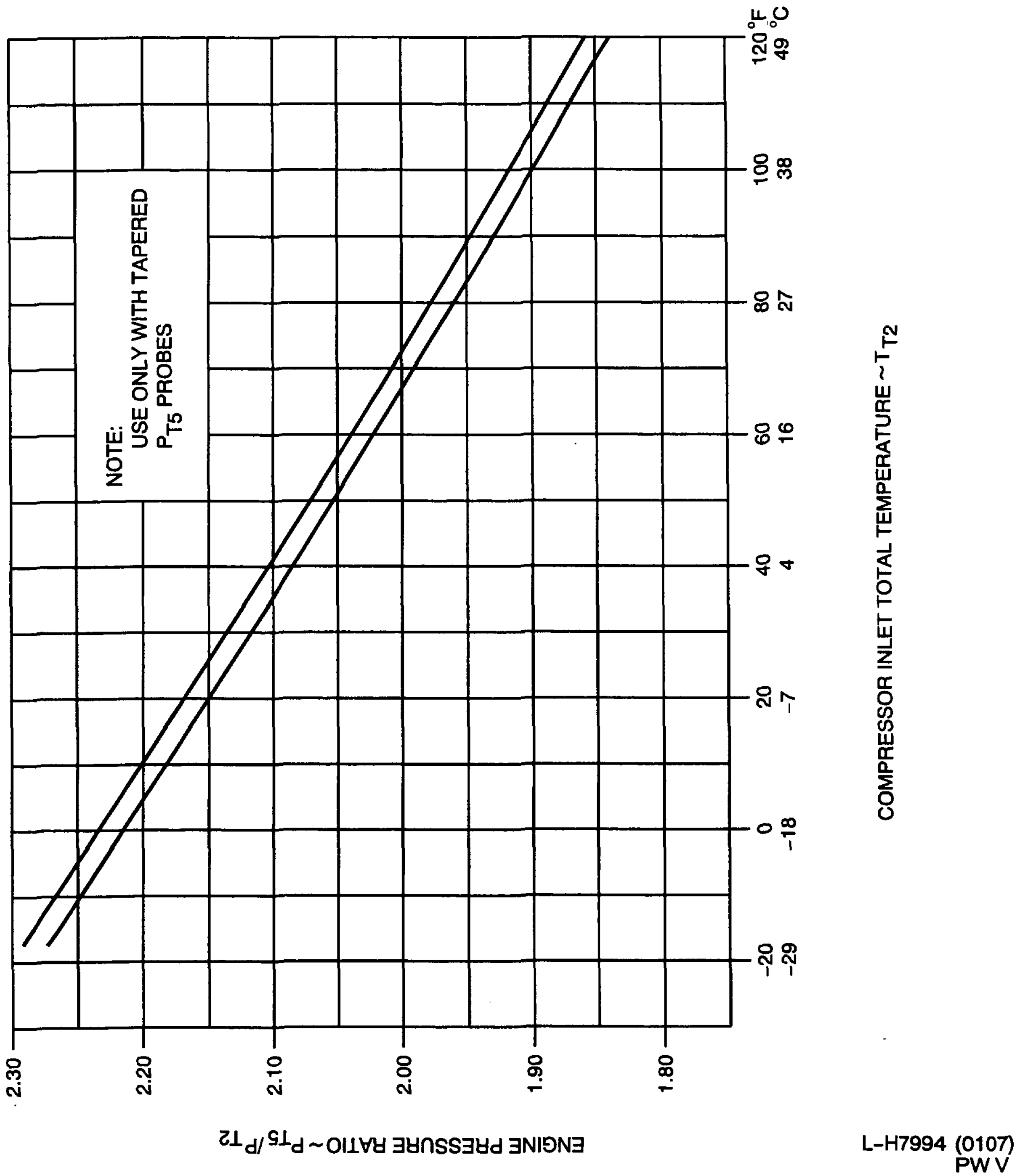


L-H7993 (0107)
PW V

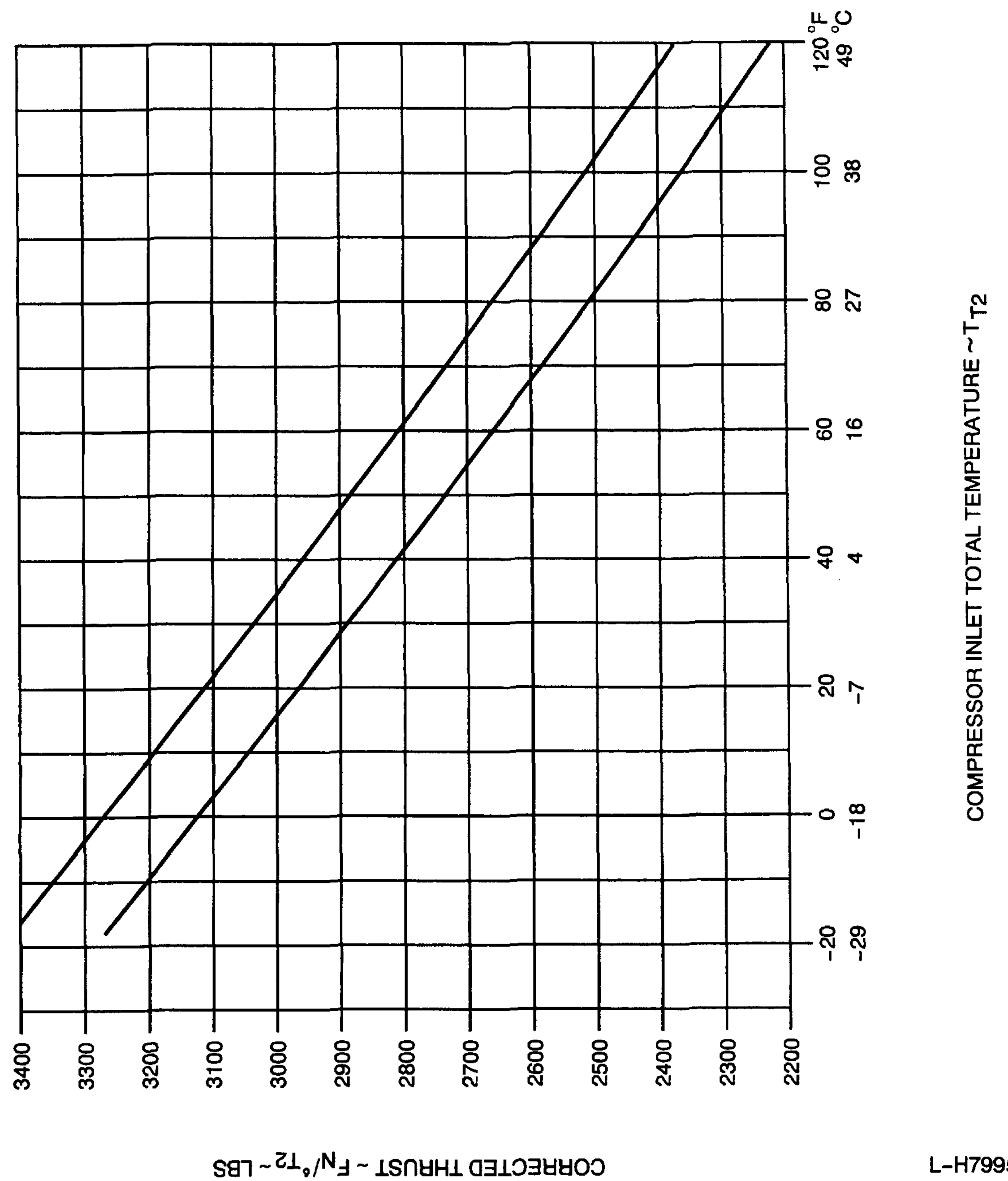
Temperature Correction
For Mercury Manometers
Figure 911



Minimum Engine Pressure Ratio
At Part Power Trim
(JT12A-6 And JT12A-6A)
Figure 912

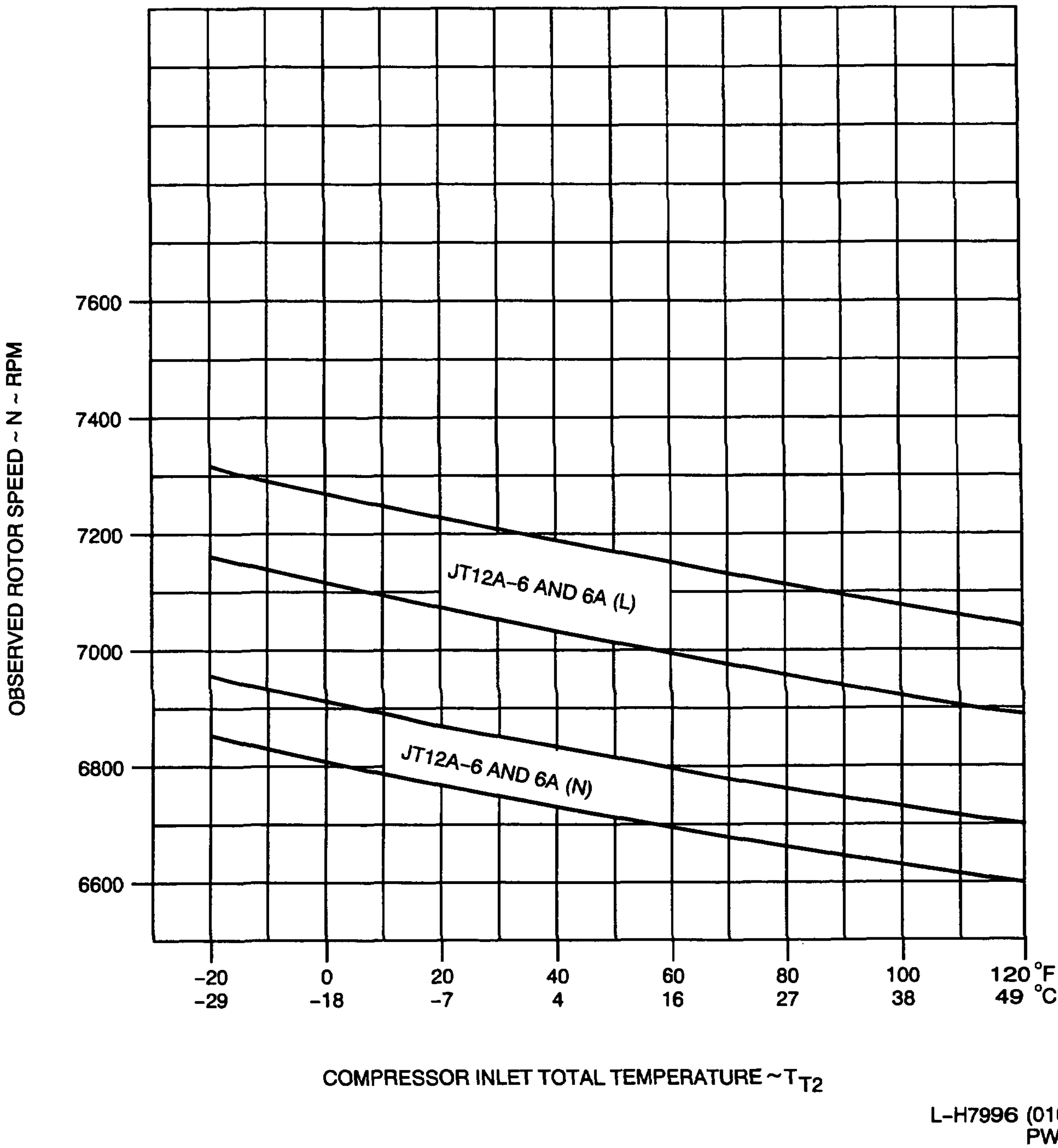


Part Power Trim Curve (JT12A-8)
Figure 913

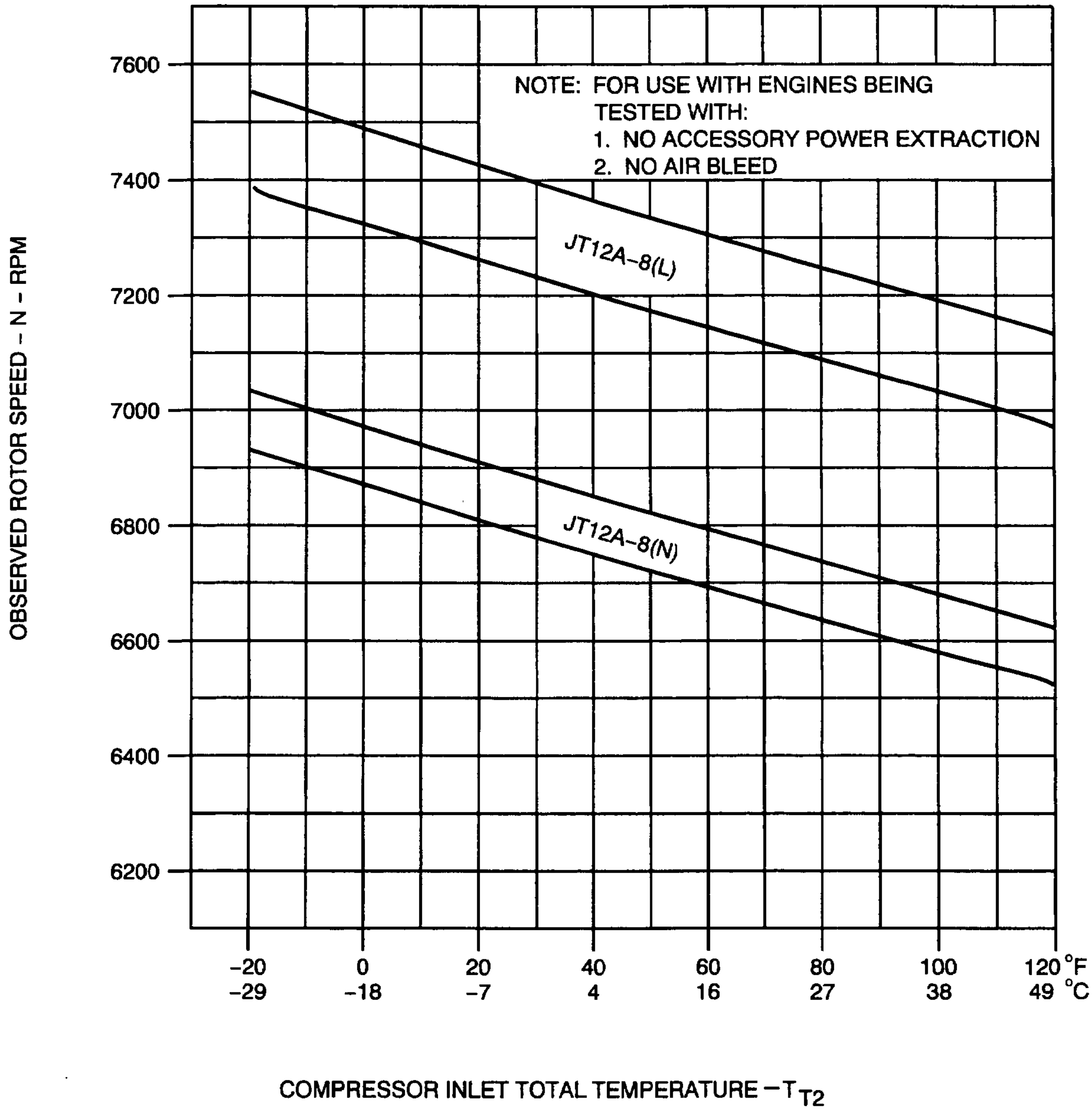


L-H7995 (0107)
PW V

Part Power Trim Thrust Check Curve
(JT12A-8)
Figure 914

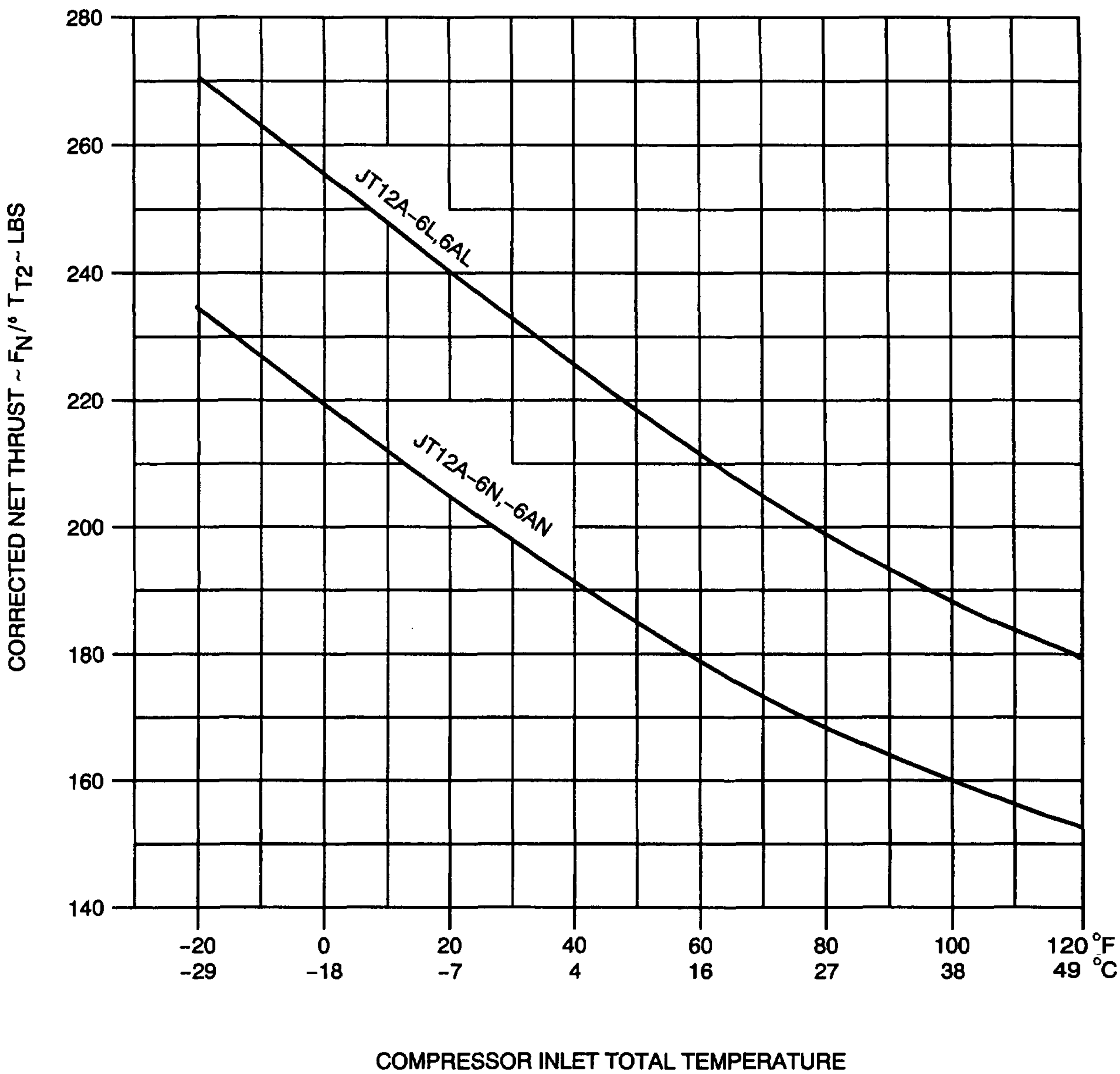


Idle Speed Trim Curve
(JT12A-6 And -6A)
Figure 915



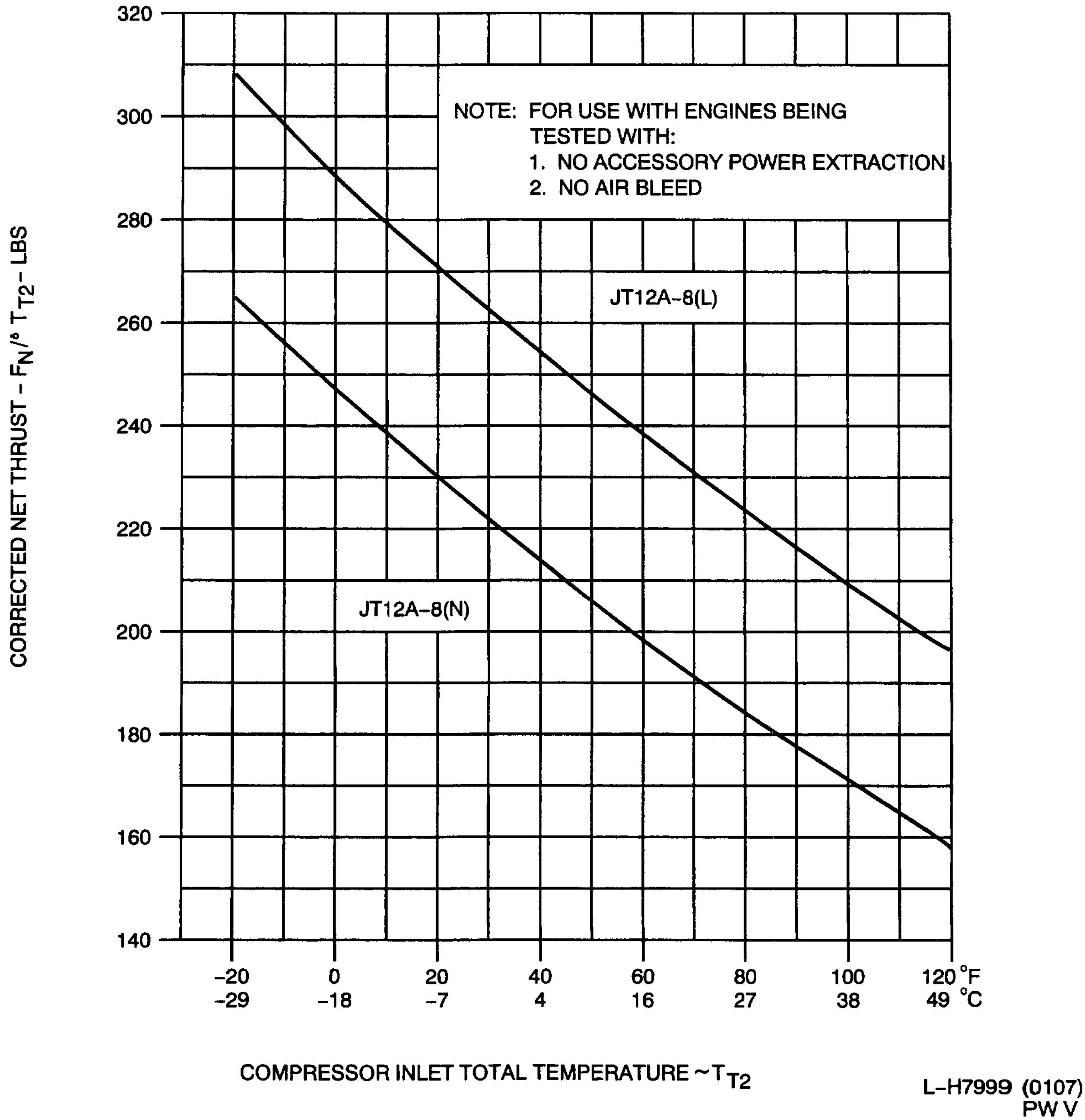
L-H7997 (0107)
PW V

Idle Speed Trim Curve (JT12A-8)
Figure 916



L-H7998 (0107)
PW V

Idle Thrust Check Curve
(JT12A-6 and -6A)
Figure 917



Idle Thrust Check Curve (JT12A-8)
Figure 918

19. Engine Acceptance Test Procedures (JT12A-6 And -6A)

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

1. (O) Engine Startup

(C&R) Refer to Paragraph 4. Determine and record the overall time from initiating the startup cycle to idle speed.

2. (O) Accelerate to: 1860 - 1940 pounds corrected thrust
Run at: 1860 - 1940 pounds corrected thrust

(D) 6 minutes

(C&R) Corrected thrust must correspond to Band E, Figure 907 and Figure 908. Record all data.

CAUTION: ON HAMILTON SUNDSTRAND FUEL CONTROL, IDLE AND MAXIMUM SPEED TRIMMERS AFFECT EACH OTHER. REPEAT OPERATIONS 3 AND 4 UNTIL PREFERRED SETTINGS ARE OBTAINED WITHOUT INTERMEDIATE ADJUSTMENT.

3. (O) Move power lever to IDLE.

(C&R) a. Adjust the idle trim screw so that the observed rotor rotor speed is in Figure 915 or Figure 916 bands. Record all data.

CAUTION: POWER LEVER TRAVEL WILL BE MUCH LESS THAN FULL POWER. DO NOT APPLY EXCESSIVE FORCE TO POWER LEVER.

NOTE: If the engine corrected thrust does not fall below the lines in Figure 917 or Figure 918, then the thrustmeter, exhaust nozzle section and tachometer must be checked and the idle trimming procedure repeated.

b. Install the part power stop.

4. (O) Move the power lever against the part power trim stop. Stabilize for 6 minutes.

(C&R) a. For JT12A-6 and -6A, adjust the fuel control maximum trim screw until the thrust falls within trim Band D in Figure 907 and Figure 908 and the observed engine pressure ratio (Pt5/Pt2) falls on or above the line in Figure 912.

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

(CONTINUED)

CAUTION: ADJUSTING THE TRIM SCREW TO EITHER EXTREME POSITION CAN CAUSE THE GOVERNOR LEVER TO BIND, WHICH WILL CAUSE THE POWER LEVER TO BIND. IF THIS CONDITION OCCURS, THEN TURN THE TRIM SCREW 1/2 - 2 1/2 TURNS IN THE DIRECTION OPPOSITE THE EXTREME POSITION TO FREE THE POWER LEVER. FULL TRIM SCREW TRAVEL IS NOT REQUIRED TO TRIM THE ENGINE TO ALLOWABLE LIMITS.

CAUTION: FOR HAMILTON SUNDSTRAND FUEL CONTROLS, PN 579313 STOP MUST REMAIN WITH THE SAME CONTROL. PN 706392-1 STOPS ARE INTERCHANGEABLE ONLY WITH EACH OTHER.

b. Remove the part power stop.

NOTE: Once during step 4., open the fuel de-icing valve. The fuel-out temperature of the heat exchanger must increase at least 80°F (44°C) in 1 minute after the valve is opened. Do not adjust the power lever for thrust loss. Check that indicator lights operate properly during valve actuation.

5. (O) Accelerate to TAKEOFF
Run at TAKEOFF

(D) 6 minutes

(C&R) a. Adjust the power lever to give stabilized corrected TAKEOFF thrust per Band A, Figure 907 or Figure 908. Perform acceleration with movement of the power lever in one-half to one second. Take readings from individual (EGT in 1/2 - 1 thermocouple) circuits during the first stabilized point at TAKEOFF.

b. Check the dual junction exhaust temperature gas measurement system. Take the readings from individual thermocouple circuits and compute the average. The average must fall within -20°F (-11°C) of the reading taken with the averaging harness. If the reading of an individual thermocouple is above the line in Figure 903 or 904 and the accuracy of indicating thermocouples and the gage is verified, then check the fuel nozzle flow. Refer to the instruc-

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

(CONTINUED)

tions in Section 73-00-00, Accessories.

CAUTION: WITH THE ENGINE TAKEOFF TRIMMER SET BY THE PART POWER TRIM PROCEDURE IN PARAGRAPH 18. A TAKEOFF THRUST RATING CAN BE OBTAINED BELOW THE FULL POWER LEVER POSITION. DO NOT RUN THE ENGINE WITH THE POWER LEVER ADVANCED BEYOND THE POSITION REQUIRED TO MEET CORRECTED THRUST REQUIREMENTS FOR THE PRESENT INLET TEMPERATURE, AS SHOWN IN FIGURE 907 AND FIGURE 908. IF THE DESIRED THRUST CANNOT BE OBTAINED PRIOR TO REACHING THE FULL POWER LEVER POSITION, THEN RECHECK THE PART POWER TRIM PROCEDURE.

6. (O) Decelerate to IDLE
Run at IDLE

(D) 3 minutes

(C&R) Perform deceleration by moving the power lever in 1/2 - 1 second.

NOTE: Acceleration and deceleration times must be recorded once during Operations 5, 6, 7, 8, 9, or 10. The time limit is 7 seconds from IDLE to 95 percent TAKEOFF thrust (200 rpm less than rotor speed corresponding to TAKEOFF thrust). The time limit from TAKEOFF thrust to 7250 rpm for JT12A-6N and -6AN, or to 7600 rpm for JT12A-6L and -6AL engines must fall below the line in Figure 919.

7. (O) Accelerate to TAKEOFF
Run at TAKEOFF

(D) 2 minutes

(C&R) Perform acceleration by moving the power lever in 1/2 - 1 second.

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

8. (O) Decelerate to IDLE
Run at IDLE

(D) 3 minutes

(C&R) Perform deceleration by moving the power lever in 1/2 - 1 second.

9. (O) Accelerate to TAKEOFF
Run at TAKEOFF

(D) 2 minutes

(C&R) Perform acceleration by moving the power lever in 1/2 - 1 second.

10. (O) Decelerate to IDLE
Run at IDLE

(D) 3 minutes

(C&R) Perform deceleration by moving the power lever in 1/2 - 1 second.

11. (O) Accelerate to TAKEOFF
Run at TAKEOFF

(D) 2 minutes

(C&R) Perform acceleration by moving the power lever in 1/2 - 1 second.

NOTE: Operate the anti-icing controls at least twice during TAKEOFF rated runs. The anti-icing air temperature must increase at least 100°F (55°C) after the valve is opened. Check that the indicator light operates correctly during valve actuation. Do not record performance data while the valve is open. If the EPR increases when anti-ice air is used, then check for leakage into the Pt2 probe/sense line.

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

12. (O) Engine shutdown

(C&R) a. Refer to Paragraph 6.

b. Record the oil level and temperature after stabilization.

c. Determine and record the consumption (gallons per hour) since Operation 3.

d. Inspect for oil and fuel leaks; repair as necessary. Refer to Paragraph 20. (only after the repair).

13. (O) Plot the graph

(C&R) a. Use previously recorded data to plot the graph for standard sea level data evaluation, and determine the corrected rpm at Pt5/Pt2 of 1.966 for data plate trim speed. Refer to Paragraph 7. Limits For Test.

b. The value of EPR at corrected TAKEOFF thrust must conform to the limits in Paragraph 7. Limits For Test.

NOTE: If the EPR at corrected TAKEOFF thrust is not within limits, then check the test stand instrumentation and determine that the proper exhaust nozzle is used. Repeat Operations 7 thru 10.

c. The value of EPR at corrected part power thrust must conform to the limits in Paragraph 7. Limits For Test.

20. Engine Run Procedures (JT12A-8)

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

1. (O) Engine startup

(C&R) Refer to Paragraph 4. Determine and record the overall time from initiating the startup cycle to idle speed.

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

2. (O) Accelerate to: supplementary power setting
Run at: supplementary power setting

(D) 6 minutes

(C&R) Corrected thrust must correspond to Band E in Figure 906. Record all data.

CAUTION: ON HAMILTON SUNDSTRAND FUEL CONTROL, IDLE AND MAXIMUM SPEED TRIMMERS AFFECT EACH OTHER. REPEAT OPERATIONS 3. AND 4. UNTIL PREFERRED SETTINGS ARE OBTAINED WITHOUT INTERMEDIATE ADJUSTMENT.

3. (O) Move the power lever to IDLE.

(C&R) a. Adjust the idle trim screw so that the observed rotor speed falls within the band in Figure 915 or Figure 916. Record all data.

CAUTION: THE POWER LEVER TRAVEL WILL BE MUCH LESS THAN FULL POWER. DO NOT APPLY EXCESSIVE FORCE TO THE POWER LEVER.

b. Install the part power stop.

NOTE: If engine corrected thrust does not fall below the line in Figure 917 or Figure 918, then the thrustmeter, exhaust nozzle section and tachometer must be checked and the idle trimming procedure repeated.

4. (O) Move the power lever against the part power trim stop. Stabilize of 6 minutes.

(C&R) a. For JT12A-8, adjust the maximum trim screw until EPR falls within the trim band in Figure 913, and the corrected thrust falls within the check band in Figure 914. Refer to Paragraph 7. for correction formula.

CAUTION: ADJUSTING THE TRIM SCREW TO EITHER EXTREME POSITION CAN CAUSE THE GOVERNOR LEVER TO BIND, WHICH BIND, WHICH WILL CAUSE THE POWER LEVER TO BIND. IF THIS CONDITION OCCURS, THEN TURN THE TRIM SCREW 1/2 - 2 1/2 TURNS IN THE DIRECTION OPPOSITE THE

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

(CONTINUED)

EXTREME POSITION TO FREE THE POWER LEVER. FULL TRIM SCREW TRAVEL IS NOT REQUIRED TO TRIM THE ENGINE TO ALLOWABLE LIMITS.

CAUTION: FOR HAMILTON SUNDSTRAND FUEL CONTROLS, PN 579313 STOP MUST REMAIN WITH THE SAME CONTROL. PN 706392-1 STOPS ARE INTERCHANGEABLE ONLY WITH EACH OTHER.

NOTE: Once during step 4, open the fuel de-icing valve. The fuel-out temperature of the heat exchanger must increase at least 80°F (44°C) in 1 minute after the valve is opened. Do not adjust the power lever for thrust loss. Check that indicator lights operate properly during valve actuation.

b. Remove the part power stop.

5. (O) Accelerate to TAKEOFF
Run at TAKEOFF

(D) 6 minutes

(C&R) a. Adjust the power lever to give stabilized, corrected, TAKEOFF thrust by the Band A in Figure 906. Perform acceleration by moving the power lever in 1/2 - 1 second. Take readings from individual (EGT thermocouple) circuits during the first stabilized point at TAKEOFF.

b. Check the dual junction exhaust temperature gas measurement system. Take readings from individual thermocouple circuits and compute the average. The average must not vary more than -20° to -40°F (-11° to +22°C) from the reading taken with the averaging harness. If the reading of an individual thermocouple is above the line in Figure 905, and the accuracy of indicating thermocouples and the gage is verified, then check the fuel nozzle flow.

CAUTION: WITH THE ENGINE TAKEOFF TRIMMER SET PER THE POWER TRIM PROCEDURE IN PARAGRAPH 18. A TAKEOFF THRUST RATING CAN BE OBTAINED BELOW THE FULL POWER LEVER POSITION. DO NOT RUN THE ENGINE WITH THE POWER LEVER

(O) OPERATION/(D) DURATION (minutes)/(C&R) CHECKS AND REMARKS

(CONTINUED)

ADVANCED BEYOND THE POSITION REQUIRED TO MEET CORRECTED THRUST REQUIREMENTS FOR THE PRESENT INLET TEMPERATURE, AS SHOWN IN FIGURE 906. IF THE DESIRED THRUST CANNOT BE OBTAINED PRIOR TO REACHING THE FULL POWER LEVER POSITION, THEN RECHECK THE PART POWER TRIM PROCEDURE.

6. (O) Decelerate to IDLE
Run at IDLE

(D) 3 minutes

(C&R) Perform deceleration by moving the power lever in 1/2 - 1 second.

NOTE: Acceleration and deceleration times must be recorded once during operations 3, 4, 5, 6, or 7. The time limit is 7 seconds from IDLE to 95 percent TAKEOFF thrust (200 rpm less than rotor speed corresponding to TAKEOFF thrust). The time limit from TAKEOFF thrust to 7400 rpm must fall below the line in Figure 920.

7. (O) Accelerate to TAKEOFF
Run at TAKEOFF

(D) 2 minutes

(C&R) Accelerate by moving the power lever in 1/2 - 1 second.

8. (O) Decelerate to IDLE
Run at IDLE

(D) 3 minutes

(C&R) Decelerate by moving the power lever in 1/2 - 1 second.

9. (O) Accelerate to IDLE
Run at IDLE

(D) 2 minutes

(C&R) Accelerate by moving the power lever in 1/2 - 1 second.

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

10. (O) Decelerate to IDLE
Run at IDLE

(D) 3 minutes

(C&R) Decelerate by moving the power lever in 1/2 - 1 second.

11. (O) Accelerate to TAKEOFF
Run at TAKEOFF

(D) 2 minutes

(C&R) Accelerate by moving the power lever in 1/2 - 1 second.

NOTE: Operate the Anti-icing controls at least twice during TAKEOFF rated runs. The anti-icing air temperature must increase at least 100°F (55°C) after the valve is opened. During valve actuation, ensure the indicator light operates correctly.

12. (O) Engine shutdown

(C&R) a. Refer to Paragraph 6.

b. Record the oil level and temperature after stabilization.

c. Determine and record consumption (gallons per hour) since Operation 3.

d. Inspect for oil and fuel leaks and repair as necessary. Refer to Section 20A. only after the repair.

13. (O) Plot the graph

(C&R) a. Use previously recorded data to plot the graph for standard sea level data evaluation, and determine corrected rpm at Pt5/Pt2 of 2.034 for data plate trim speed (refer to Paragraph 7. for the correction formula). Refer to Paragraphs 14. and 15.

b. The value of EPR at corrected TAKEOFF thrust must conform to limits in Paragraph 7. Limits For Test.

NOTE: If EPR at corrected TAKEOFF thrust is not in limits, then check the test stand instrumentation and exhaust nozzle section

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

(CONTINUED)

and repeat Operations 7 thru 10.

c. The value of EPR at corrected part power thrust must conform to Paragraph 7. Limits For Test.

21. Engine Test After Leak Repairs

	CORRECTED DISCREPANCY	REQUIRED TEST
A.	Oil leaks at connections and fittings	Run the engine at MAX. CONT. (NORMAL) rated HP for 5 minutes.
B.	Fuel leaks at connections and and fittings	Run the engine at TAKEOFF (MILITARY) rated HP for 5 minutes.
C.	Overboard drain leakage	Run the engine at MAX. CONT. (NORMAL) rated HP for 5 minutes and at TAKEOFF (MILITARY) rated HP for 5 minutes.
D.	Accessory drive seals and parting surfaces leakage	Run the engine at MAX. CONT. (NORMAL) rated HP for 10 minutes and at TAKEOFF (MILITARY) rated HP for 5 minutes.

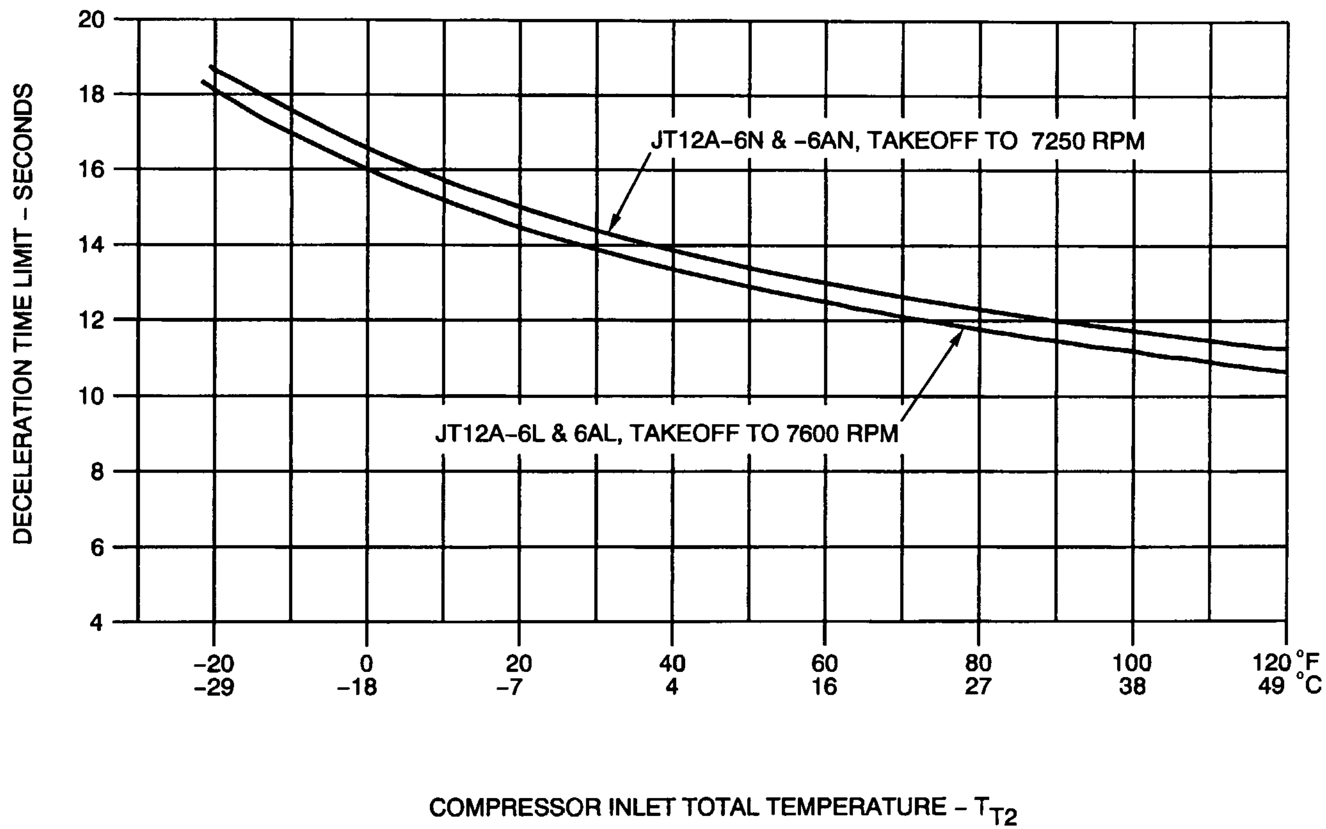
22. Marking Data Plate

A. Established in Paragraphs 19. and 20. the value of corrected rpm at Pt5/Pt2 of 1.966 for JT12A-6 and JT12A-6A engines, and Pt5/Pt2 of 2.034 for JT12A-8 engines must be expressed in both rpm and percent of: 15,909 rpm for JT12A-6, JT12A-6(L) and JT12A-8(L) engines, and 16,030 rpm for JT12A-6A(N) and JT12A-8(N) engines.

Stamp the result on the data plate. Express the percent to 2 decimal places as follows: See Figure 921.

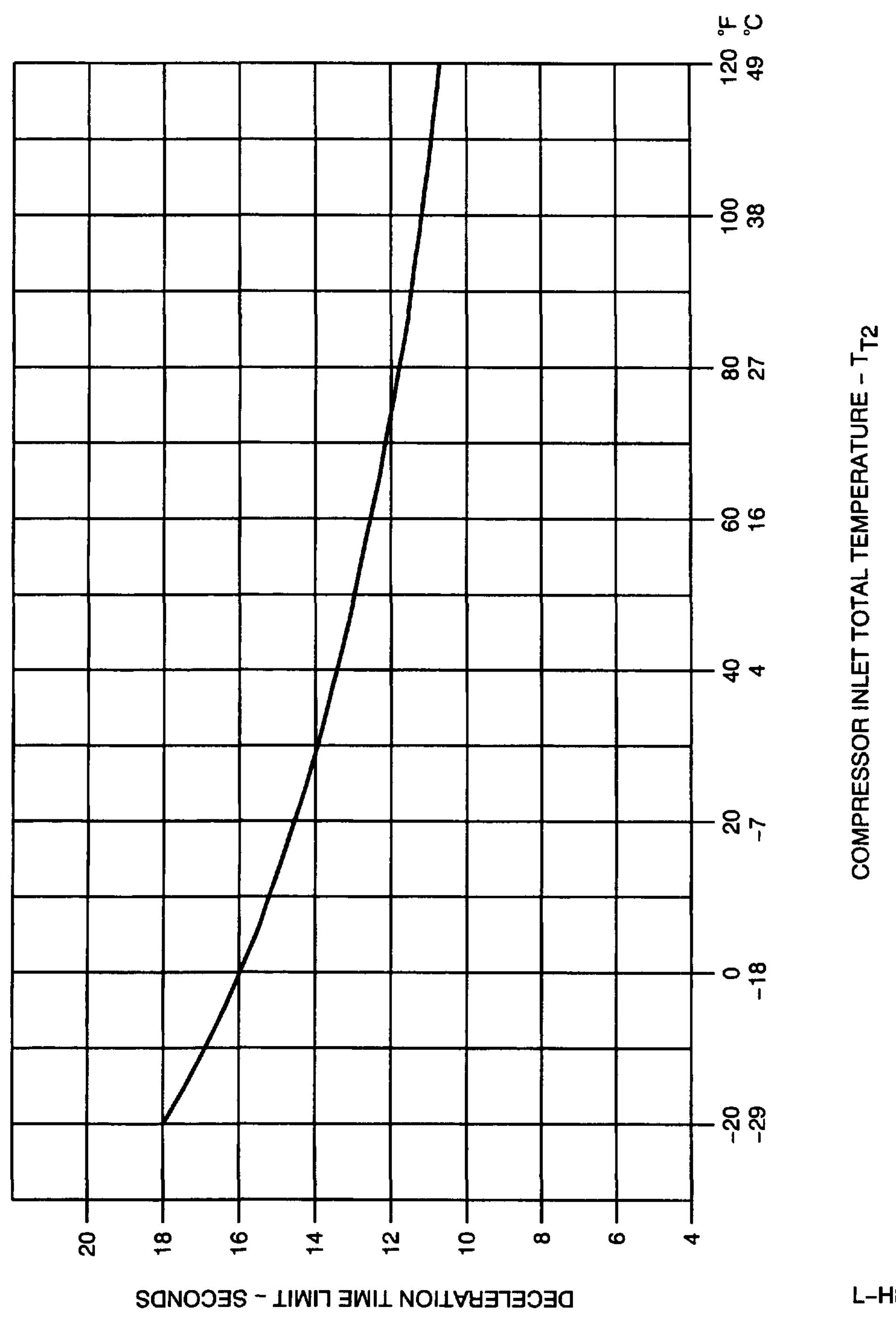
"Part Power Trim Speed at 60°F: N 00000 rpm, 00.00 percent."

NOTE: Replacing parts that affect the gaspath, such as compressor and turbine rotors, the diffuser case, and the turbine nozzle, requires recomputing the data plate speed.



L-H8000 (0107)
PW V

Deceleration Time Limit
(JT12A-6 And -6A)
Figure 919



L-H8001 (0107)
PW V

Deceleration Time Limit - TAKEOFF
To 7400 RPM (JT12A-8)
Figure 920

23. Operating Limits

A. Overtemperature

(1) Overtemperature conditions are usually preceded by an excessively rapid rise in fuel flow, compressor speed, and/or temperature. Several momentarily high overtemperatures affect engine service life as seriously as a single prolonged overtemperature condition. The higher the temperature, the sooner the engine damage occurs, and therefore, the more extensive the inspection required.

(2) When an overtemperature condition is anticipated or has occurred, perform engine shutdown by Paragraph 6. Avoid emergency shutdown unless it is obvious that continued operation will result in more than overtemperature damage.

	Tt5 CONDITION	Tt5 ACTION REQUIRED
A	●Exceeds 525°C (977°F) ●Does not exceed 595°C (1103°F) for more than 5 seconds ●Does not exceed 630°C (1166°F)	Determine the cause of overtemperature. Correct the overtemperature.
B(1)	●Exceeds 630°C (1166°F) for 5 seconds or less ●does not exceed 700°C (1292°F)	Perform a visual inspection of hot section parts: (a) Inspect exhaust duct for foreign particles. (b) Inspect turbine rear for apparent damage. (c) Inspect burner section and turbine vanes.
(2)	●Exceeds 595°C (1103°F) for more than 5 seconds ●Does not exceed 630°C (1166°F)	
C(1)	●Exceeds 700°C (1292°F) for 5 seconds or less ●Does not exceed 800°C (1472°F)	Perform teardown inspection of all hot section parts: Refer to Section 72-40-00 and 72-50-00, Inspection.

R
R Overtemperature Limits
(Engine Starting - JT12A-6 And -6A)
Table 906

	Tt5 CONDITION	Tt5 ACTION REQUIRED
	(2) ●Exceeds 630°C (1166°F) for more than 5 seconds ●Does not exceed 800°C (1472°F)	(a) Fluorescent penetrant inspect (FPI) turbine blades. (b) Inspect turbine vanes for bow, bend, and twist. (c) Inspect turbine blades for stretch. (d) Inspect turbine disks for growth and hardness. Hardness must be at least Rockwell A66.
D	●Exceeds 800°C (1472°F) for any length of time	Perform complete overhaul inspection of hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.
R		(a) Scrap all turbine blades except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate; refer to the Standard Practices Manual, Section 70-36-00. Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that reach 1094°C (2000°F) or more.
R		(b) Scrap all turbine vanes that are not PN 512751.
R		(c) FPI PN 512751 vanes. Refer to Section 72-00-00, Inspection.
R		(d) Examine PN 512751 vanes for bow, bend, and twist.

Overtemperature Limits
(Engine Starting - JT12A-6 And -6A)
Table 906 (Continued)

	Tt5 CONDITION	Tt5 ACTION REQUIRED
	(CONTINUED)	
R R		Refer to Section 72-50-00, Inspection.
R R R R		(e) Do growth and hardness checks on all turbine disks. Hardness must be Rockwell A66 or more.

Overtemperature Limits
(Engine Starting - JT12A-6 And -6A)
Table 906 (Continued)

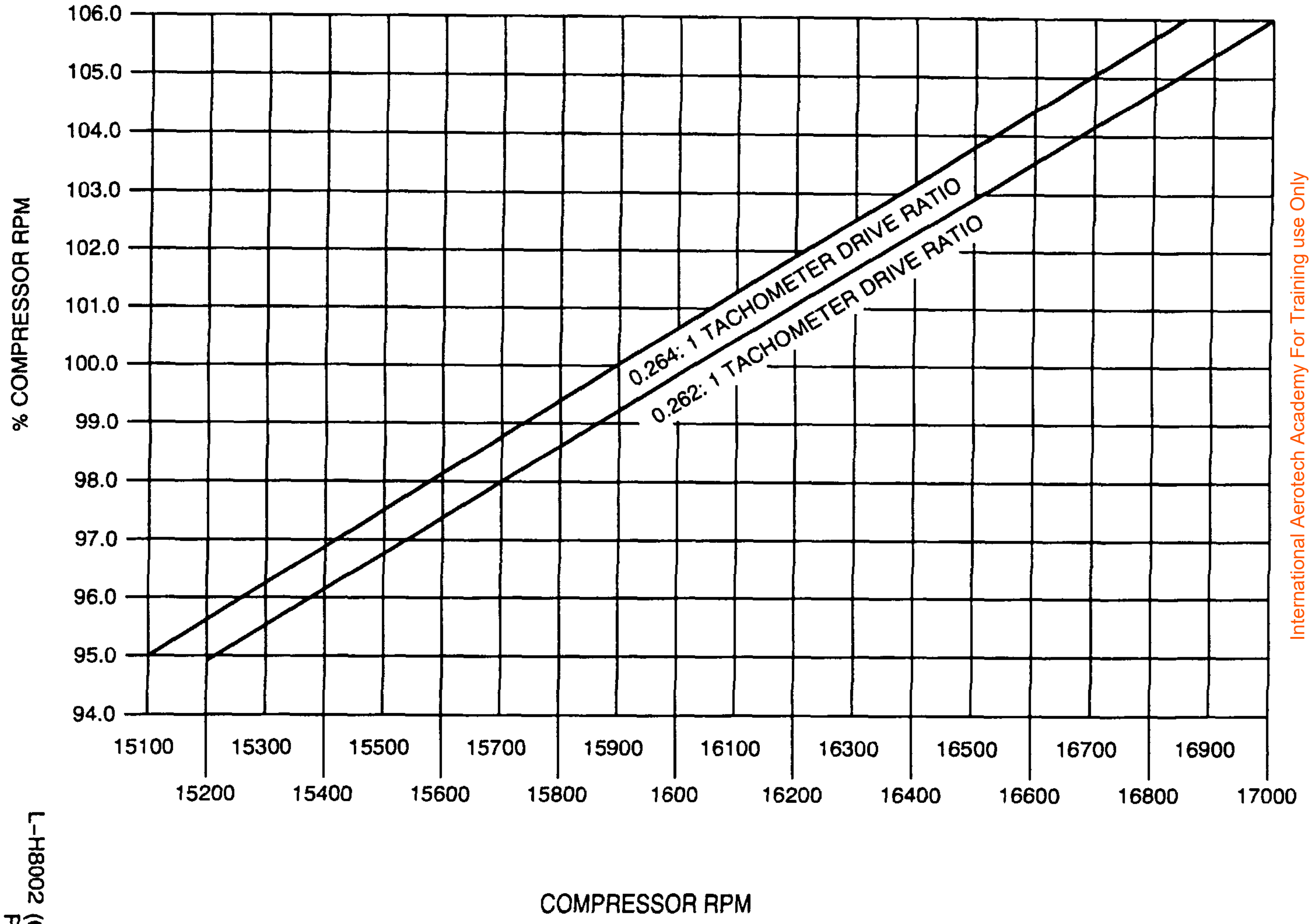
	Tt5 CONDITION	Tt5 ACTION REQUIRED
A	•Exceeds 677°C (1250°F) •Does not exceed 690°C (1274°F) for more than 5 seconds •Does not exceed 720°C (1328°F)	Determine the cause of overtemperature. Correct the overtemperature.
B(1)	•Exceeds 720°C (1328°F) for 5 seconds or less •Does not exceed 730°C (1346°F)	Perform a visual inspection of hot section parts:
(2)	•Exceeds 690°C (1274°F) for more than 5 seconds but less than 2 minutes •Does not exceed 720°C (1328°F)	(a) Inspect exhaust duct for foreign particles. (b) Inspect turbine rear for apparent damage. (c) Inspect burner section and turbine vanes.
C(1)	•Exceeds 690°C (1274°F) for more than 2 minutes •Does not exceed 800°C (1472°F)	Perform a teardown inspection of hot section parts: Refer to Section 72-40-00 and 72-50-00, Inspection.
(2)	•Exceeds 720°C (1328°F) for more than 5 seconds but less than 5 minutes •Does not exceed 800°C (1472°F)	(a) FPI turbine blades. (b) Inspect turbine vanes for bow, bend, and twist. (c) Inspect turbine blades for stretch.
(3)	•Exceeds 730°C (1346°F) for 5 seconds or less •Does not exceed 800°C (1472°F)	(d) Inspect turbine disks for growth and hardness. Hardness must be at least Rockwell A66.

Overtemperature Limits
(Engine Operation - JT12A-6 And -6A)
Table 907

	Tt5 CONDITION	Tt5 ACTION REQUIRED
D	• Exceeds 800°C (1472°F) for any length of time	Perform a complete overhaul inspection of hot section parts: Refer to Section 72-40-00 and 72-50-00, Inspection.
R		(a) Scrap all turbine blades except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that reach 1094°C (2000°F) or more.
R		(b) Scrap all turbine vanes that are not PN 512751.
R		(c) FPI PN 512751 vanes. Refer to Section 72-00-00, Inspection.
R		(d) Examine PN 512751 vanes for bow, bend, and twist. Refer to Section 72-50-00, Inspection.
R		(e) Do growth and hardness checks on all turbine disks. Hardness must be Rockwell A66 or more.

Overtemperature Limits
(Engine Operation - JT12A-6 And -6A)
Table 907 (Continued)

RPM/%RPM CONVERSION CURVE
(ERROR ± .01%)



L-H8002 (0107)
PW V

RPM To Percent RPM
Conversion Curve
Figure 921

	Tt5 CONDITION	Tt5 ACTION REQUIRED
A	•Exceeds 525°C (977°F) •Does not exceed 595°C (1103°F) for more than 5 seconds •Does not exceed 630°C (1166°F)	Determine the cause of overtemperature. Correct the overtemperature.
B(1)	•Exceeds 630°C (1166°C) for 5 seconds or less •Does not exceed 700°C (1292°F)	Perform a visual inspection of hot section parts:
(2)	•Exceeds 595°C (1103°F) for more than 5 seconds •Does not exceed 630°C (1166°F)	(a) Inspect exhaust duct for foreign particles. (b) Inspect turbine rear for apparent damage. (c) Inspect burner section and turbine vanes.
C(1)	•Exceeds 700°C (1292°F) for 5 seconds or less •Does not exceed 800°C (1472°F)	Perform a teardown inspection of hot section parts: Refer to Section 72-40-00 and 72-50-00, Inspection.
(2)	•Exceeds 630°C (1166°F) for more than 5 seconds •Does not exceed 800°C (1472°F)	(a) FPI all turbine blades and vanes. (b) Inspect turbine vanes for bow, bend, and twist. (c) Inspect turbine blades for stretch. (d) Inspect all turbine disks for growth and hardness. Hardness must be at least Rockwell A66.
D	•Exceeds 800°C (1472°F) for any length of time	Perform a complete overhaul inspection of hot section parts: Refer to Section 72-40-00 and 72-50-00, Inspection.
R		(a) Scrap all turbine blades except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate (refer to the

Overtemperature Limits
(Engine Starting - JT12A-8)
Table 908

Tt5 CONDITION	Tt5 ACTION REQUIRED
(CONTINUED)	Standard Practices Manual, Section 70-36-00). Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that reach 1094°C (2000°F) or more.
	(b) FPI all turbine vanes. Refer to Section 72-00-00, Inspection.
	(c) Examine all turbine vanes for bow, bend, and twist. Refer to Section 72-50-00, Inspection.
	(d) Do growth and hardness checks on all turbine disks. Hardness must be Rockwell A66 or more.

Overtemperature Limits
(Engine Starting - JT12A-8)
Table 908 (Continued)

	Tt5 CONDITION	Tt5 ACTION REQUIRED
A	•Exceeds 720°C (1328°F) •Does not exceed 730°C (1346°F) for more than 5 seconds •Does not exceed 760°C (1400°F)	Determine the cause of overtemperature. Correct the overtemperature.
B(1)	•Exceeds 760°C (1400°C) for 5 seconds or less •Does not exceed 770°C (1420°F)	Perform a visual inspection of hot section parts: (a) Inspect exhaust duct for foreign particles.
(2)	•Exceeds 730°C (1346°F) for more than 5 seconds but less than 2 minutes •Does not exceed 760°C (1400°F)	(b) Inspect turbine rear for apparent damage. (c) Inspect burner section and turbine vanes.

Overtemperature Limits
(Engine Operation - JT12A-8)
Table 909

		Tt5 CONDITION	Tt5 ACTION REQUIRED
	C(1)	●Exceeds 730°C (1346°F) for more than 2 minutes ●Does not exceed 800°C (1472°F)	Perform a teardown inspection of hot section parts: Refer to Section 72-40-00 and 72-50-00, Inspection.
	(2)	●Exceeds 760°C (1400°F) for more than 5 seconds but less than 5 minutes ●Does not exceed 800°C (1472°F)	(a) FPI turbine blades and vanes. (b) Inspect turbine vanes for bow, bend, and twist. (c) Inspect turbine blades for stretch. (d) Inspect turbine disks for growth and hardness. Hardness must be at least Rockwell A66.
	(3)	●Exceeds 770°C (1420°F) for 5 seconds or less ●Does not exceed 800°C (1472°F)	
	D	●Exceeds 800°C (1472°F) for any length of time	Perform a complete overhaul inspection of hot section parts: (Refer to Section 72-40-00 and 72-50-00, Inspection)
R			(a) Scrap all turbine blades except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. limits. Scrap blades that reach 1094°C (2000°F) or more.
R			(b) FPI all turbine vanes. Refer to Section 72-00-00, Inspection.
R			(c) Examine all turbine vanes

Overtemperature Limits
(Engine Operation - JT12A-8)
Table 909 (Continued)

Tt5 CONDITION	Tt5 ACTION REQUIRED
(CONTINUED)	
R R R	for bow, bend, and twist. Refer to Section 72-50-00, Inspection.
R R R R	(d) Do growth and hardness checks on all turbine disks. Hardness must be Rockwell A66 or more.

Overtemperature Limits
(Engine Operation - JT12A-8)
Table 909 (Continued)

CONDITION	ACTION REQUIRED
If observed N rotor speed exceeds 16,700 rpm but does not exceed 16,900 rpm NOTE: For JT12A-6A(N),-8(N) engines with 0.262:1 tachometer drive ratio: 16,700 rpm = 104.2% 16,900 rpm = 105.4%	(a) Check N rotor for free rotation and visually inspect inlet and exhaust ducts for foreign particles or evidence of rubbing. Check the compressor and turbine blades for damage. If satisfactory, keep engine in service.
For JT12A-6,-6A(L),-8(L) engines with 0.264:1 tachometer drive ratio: 16,700 rpm = 105% 16,900 rpm = 106.2%	(b) If any abnormal condition is evident, perform the teardown inspection.
If observed N rotor speed exceeds 16,900 rpm	Shut down the engine as soon as feasible and send it to overhaul for a complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).

Engine Overspeed Procedures
Table 910

24. Engine Preservation - Short Term Inactivity

NOTE: The following procedure must be followed to preserve engines with compressors that can be rotated and that are expected to operate within 2 months. This procedure should be repeated weekly after the first 2 weeks.

A. Rotate the engine with the starter or auxiliary power source at the starter pad until there is indication of oil pressure and compressor rotor speed.

B. Continue this rotation for 5 minutes or the allowable starter operating period, whichever is less.

C. During this time, actuate the fuel control lever from OFF to IDLE (engine ignition switch OFF) and verify whether the dump valve closes by observing that overboard fuel draining stops.

D. Return the fuel control lever to OFF and verify whether the dump valve opens by observing that fuel drains overboard.

25. Engine Preservation - Long Term Inactivity

NOTE: The following procedure must be followed to preserve engines that are inactive for periods that exceed 2 months.

A. Lubrication System

NOTE: If the engine was tested with PWA-521B, Type II oil, then additional lubricating system preservation is unnecessary.

(1) Drain the oil from the oil tank and the accessory and component drives gearbox into a suitable container.

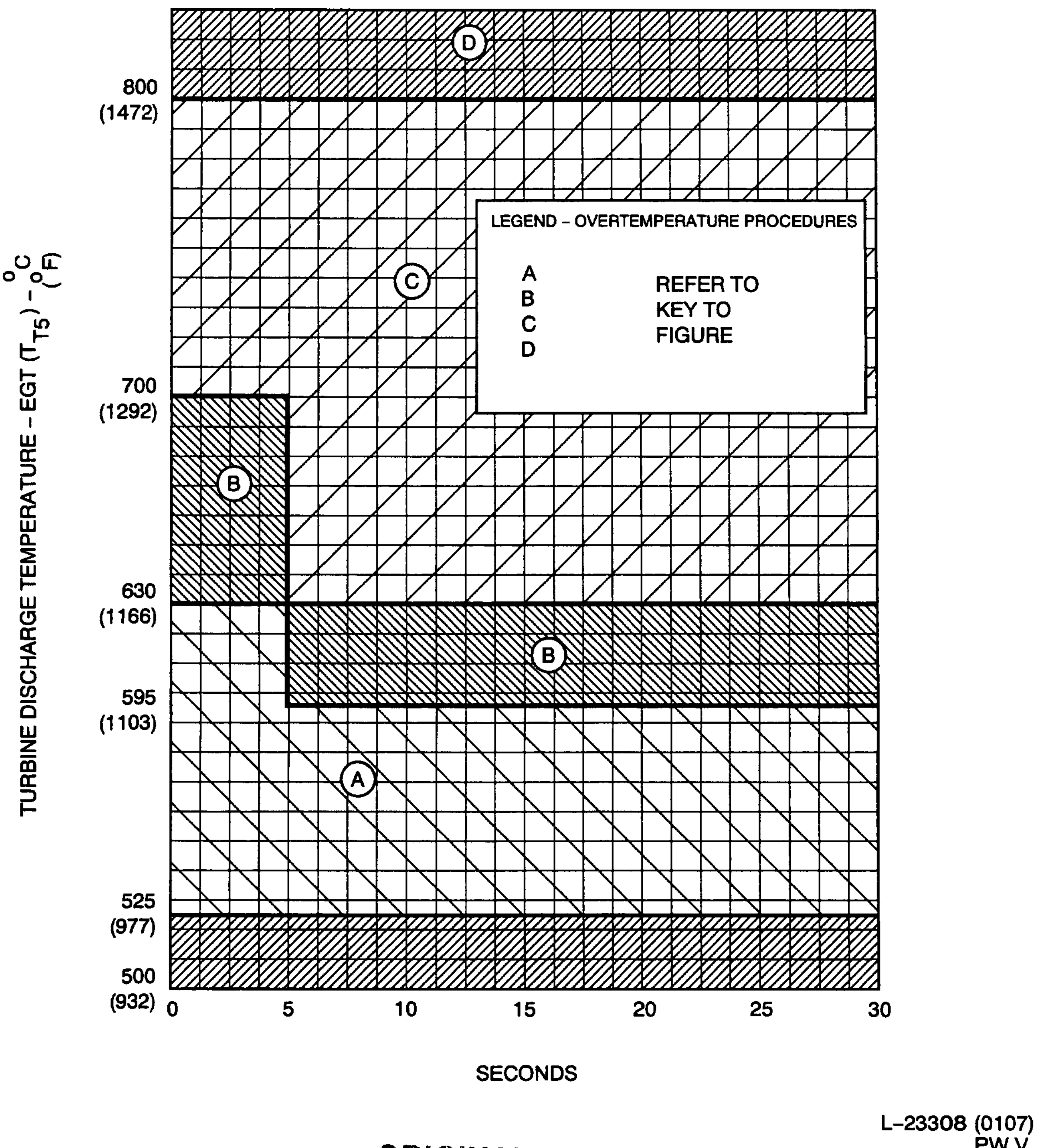
(2) Coat the drain plugs with PWA-521B, Type II oil and reinstall.

B. Fuel System

(1) Remove the large hex plug located just under the dump valve inlet connection and remove the inlet screen. Place a suitable container under the dump valve to receive preservative discharge from the dump valve screen boss.

NOTE: Do not insert the fitting or hose.

R
R



ORIGINAL
As Received By
ATP

R
R

Engine Starting Overtemperature
Limits (JT12A-6 And -6A)
Figure 922

Notes for Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Inspect the combustion section and the turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend, and twist.

(3) Do stretch inspections of all turbine blades.

(4) Do growth and hardness checks of all turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Scrap all turbine blades except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that reach 1094°C (2000°F) or more.

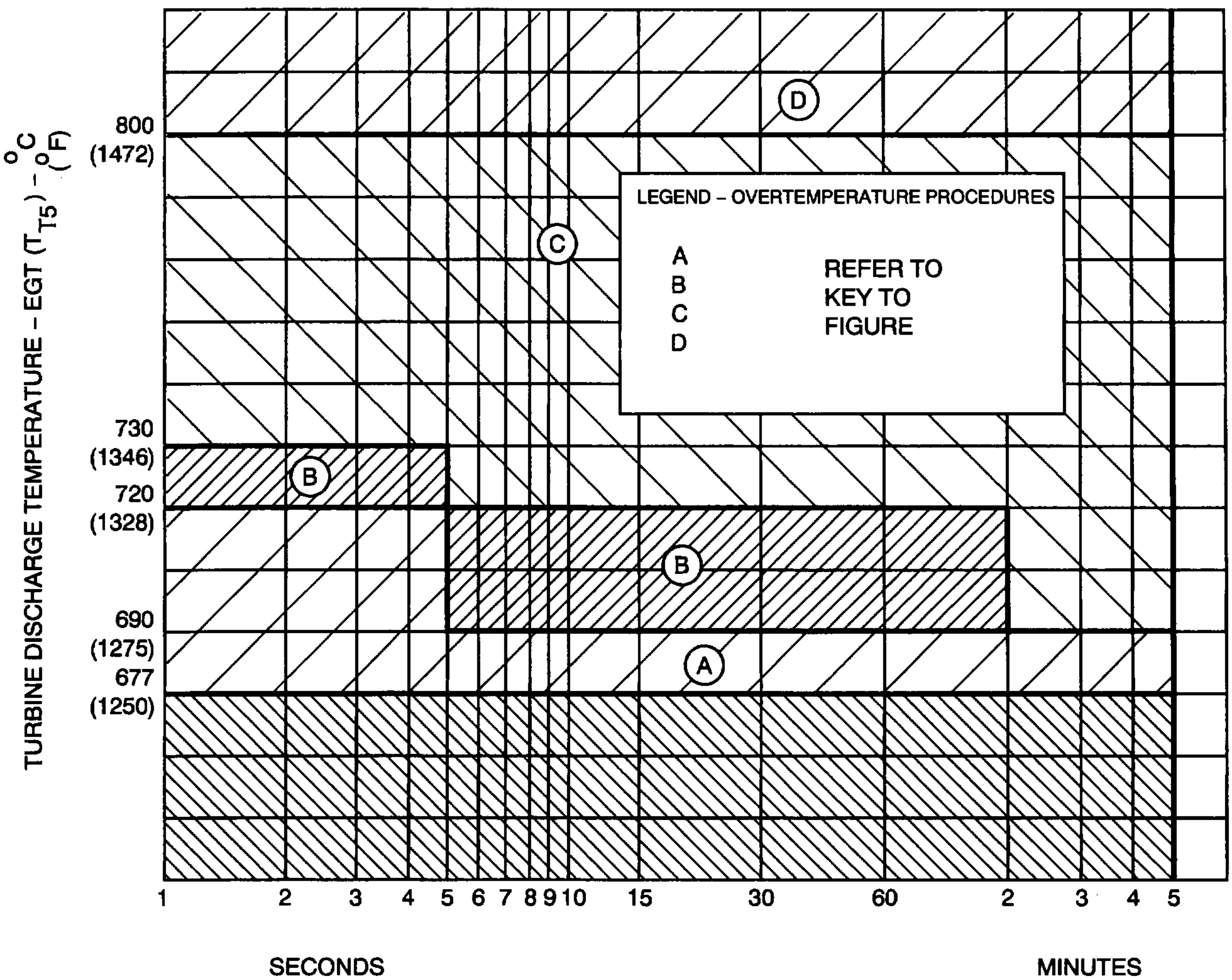
(2) Scrap all turbine vanes that are not PN 512751.

(3) FPI PN 512751 vanes. Refer to Section 72-00-00, Inspection.

(4) Examine PN 512751 vanes for bow, bend, and twist. Refer to Section 72-50-00, Inspection.

(5) Do growth and hardness checks on all turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 922



L-25139 (0107)
PW V

R
R

Engine Operation Overtemperature
Limits (JT12A-6 And -6A)
Figure 923

Notes for Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Inspect the combustion section and the turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend, and twist.

(3) Do stretch inspections of all turbine blades.

(4) Do growth and hardness checks of all turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Scrap all turbine blades except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to find the temperature at which they operated (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not have indications that they got to 1094°C (2000°F) can return to service if they are in all inspection limits. Scrap blades with indications that they got to 1094°C (2000°F) or more.

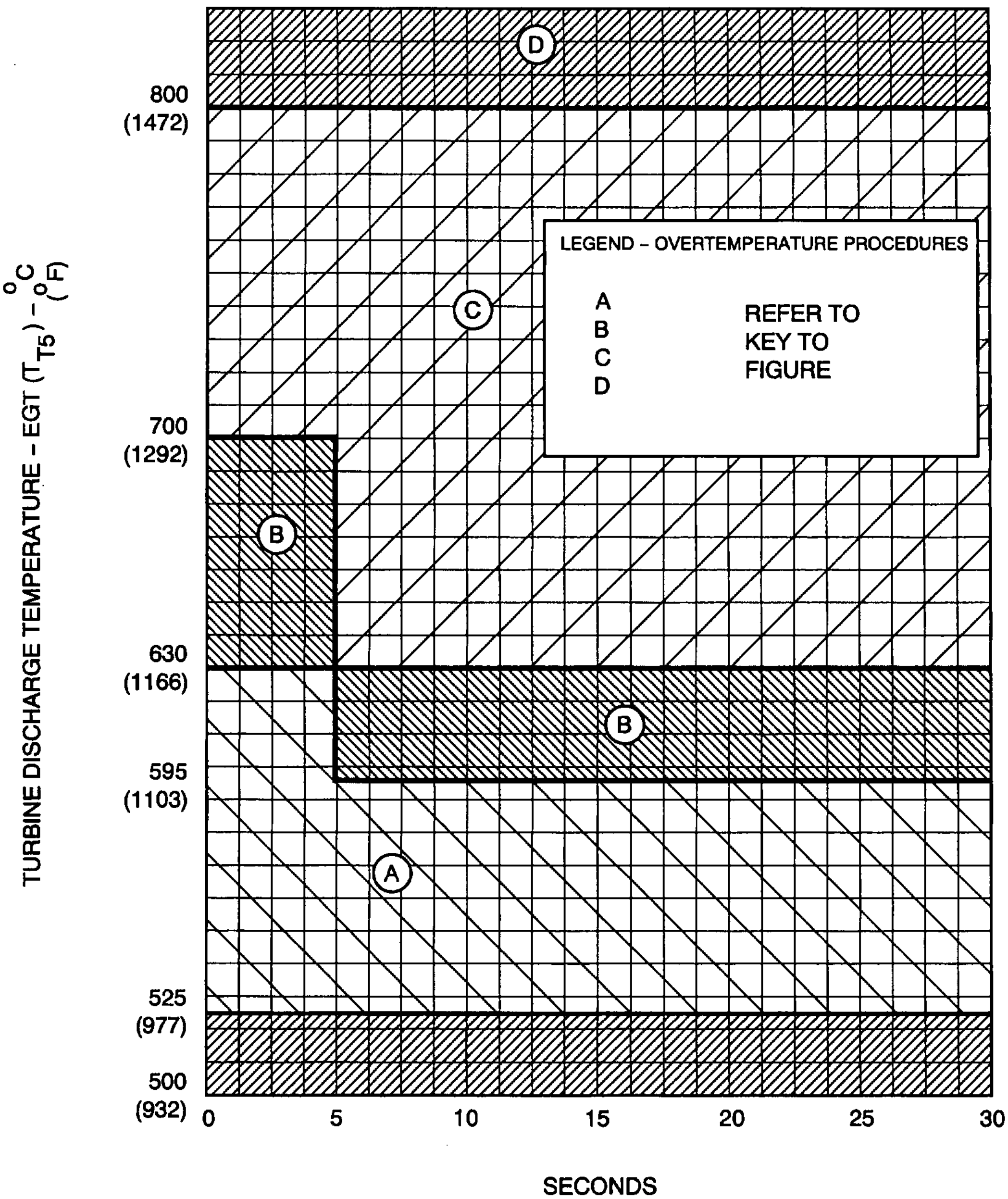
(2) Scrap all turbine vanes that are not PN 512751.

(3) FPI PN 512751 vanes. Refer to Section 72-00-00, Inspection.

(4) Examine PN 512751 vanes for bow, bend, and twist. Refer to Section 72-50-00, Inspection.

(5) Do growth and hardness checks on all turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 923



L-23314 (0107)
PW V

R
R

Engine Starting Overtemperature
Limits (JT12A-8)
Figure 924

Notes for Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Inspect the combustion section and the turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend, and twist.

(3) Do stretch inspections of all turbine blades.

(4) Do growth and hardness checks of all turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

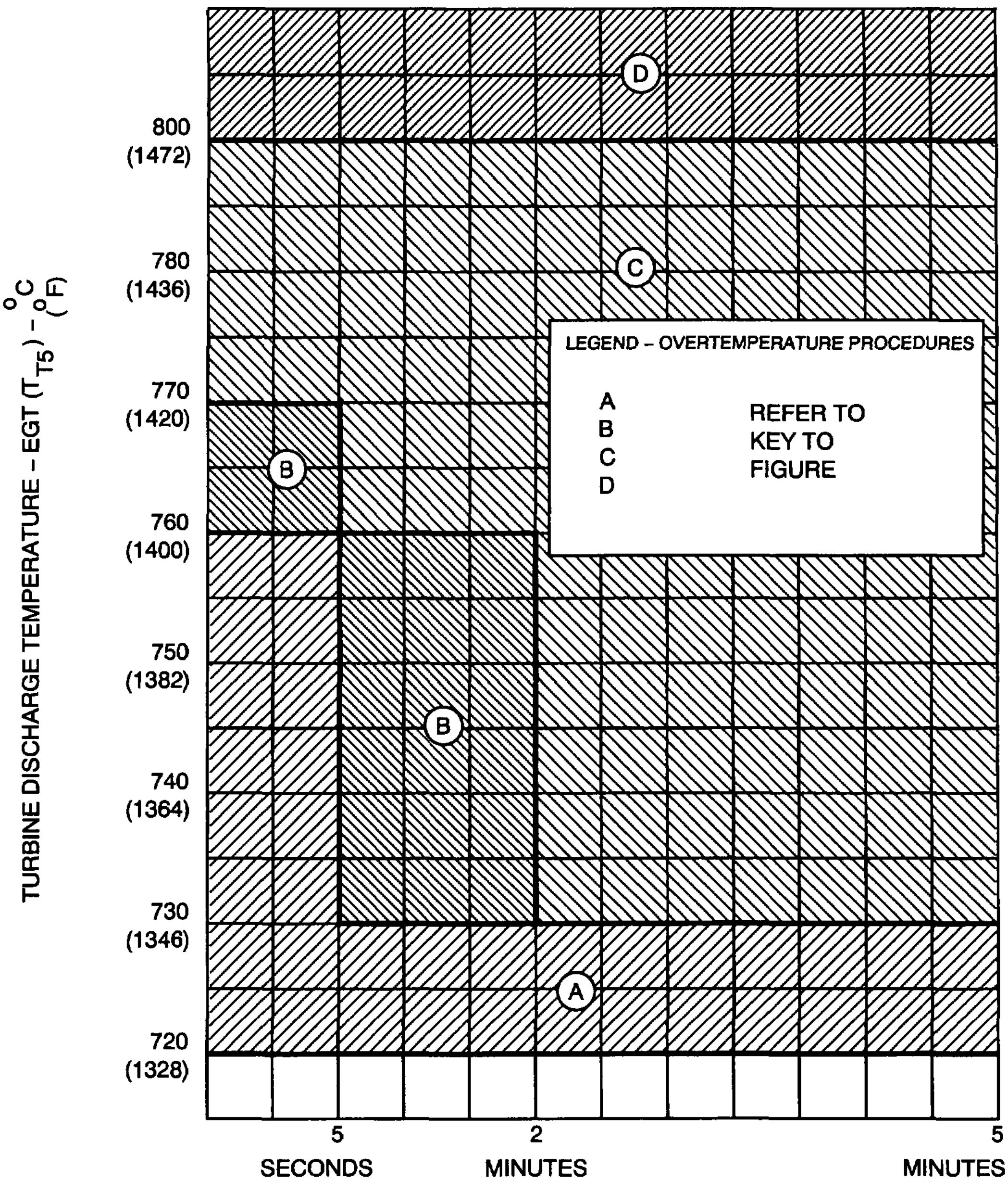
(1) Scrap all turbine blades except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to find the temperature at which they operated (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not have indications that they got to 1094°C (2000°F) can return to service if they are in all inspection limits. Scrap blades that have indications that they got to 1094°C (2000°F) or more.

(2) FPI all turbine vanes. Refer to Section 72-00-00, Inspection.

(3) Examine all turbine vanes for bow, bend, and twist. Refer to Section 72-50-00, Inspection.

(4) Do growth and hardness checks on all turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 924



L-50816 (0107)
PW V

R
R

Engine Operation Overtemperature
Limits (JT12A-8)
Figure 925

Notes for Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Inspect the combustion section and the turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend, and twist.

(3) Do stretch inspections of all turbine blades.

(4) Do growth and hardness checks of all turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Scrap all turbine blades except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the
R remaining blades to find the temperature at which they
R operated (refer to the Standard Practices Manual, Section
R 70-36-00). Blades that do not have indications that they
R got to 1094°C (2000°F) can return to service if they are in
R all inspection limits. Scrap blades that have indications
R that they got to 1094°C (2000°F) or more.

(2) FPI all turbine vanes. Refer to Section 72-00-00, Inspection.

(3) Examine all turbine vanes for bow, bend, and twist. Refer to Section 72-50-00, Inspection.

(4) Do growth and hardness checks on all turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 925

(2) Disconnect the fuel-in line, and connect it to the supply of flushing oil at an inlet pressure of 5 - 25 psi and a minimum temperature of 15°C (60°F). Be very careful to ensure foreign material is not drawn into the engine fuel system. Equipment must be provided with suitable filters and/or strainers that have mesh no coarser than is used in the engine.

(3) With the ignition OFF, and the control lever OPEN, motor the engine with the starter at 1500 - 1200 rpm. During motor startup, move the throttle from OPEN to CLOSED to OPEN. This sequence must be timed so that the throttle is in the CLOSED position at least half the time during motor startup.

(4) Close the power lever and discontinue engine rotation when not less than 3 but no more than 4 gallons of fluid is obtained from the dump valve inlet screen boss.

(5) Thoroughly clean the dump valve screen, slushing it with preservation oil. Reinstall the screen and hex plug into the dump valve. Torque the hex plug to 125 - 175 lb-in.

(6) Remove the oil filter, clean it thoroughly, and slush with preservative oil. Reinstall the filter.

26. Miscellaneous Preservation Procedures
(Refer to Tool Group 47A)

A. Remove cover plates from unused accessory drives, and spray the exposed surfaces with preservative oil. Replace the cover plates.

B. Plugs, caps and covers must be installed over all openings to prevent foreign material access and moisture accumulation.

C. For engines that remain in the aircraft, dispense a sufficient amount of dehydrating agent in the engine compartment. Distribute half this amount around the engine, and distribute the remaining half in equal amounts in the aircraft inlet and exhaust ducts.

CAUTION: OPEN THE DEHYDRATING AGENT CONTAINER AS LITTLE AS POSSIBLE TO PREVENT EXCESSIVE EXPOSURE TO THE ATMOSPHERE. ALSO, REMOVE THE DEHYDRATING AGENT FROM THE STORAGE CONTAINER AND SEAL THE ENGINE COMPARTMENT IN THE SHORTEST TIME POSSIBLE.

D. The fuel control lever and the oil filler cap should be tagged with the preservative used and the preservation date.

E. Place an airtight moisture barrier or other suitable cover over the air inlet and exhaust end of the engine compartment.

F. Install a humidity indicator at each end of the engine compartment.

NOTE: Provide inspection windows in each cover for viewing the humidity indicators.

G. Inspect the engine every 2 weeks when the aircraft is stored outside, and every 30 days when the aircraft is stored inside.

H. The entire engine must be depreserved and then represerved when the relative humidity exceeds 40% within the compartment.

27. Engine Depreservation - Long Term Inactivity

NOTE: Follow the procedure below for depreserving engines that have been preserved for long term inactivity.

A. Fill the oil tank with PWA 521B, Type II engine oil.

B. Connect the fuel supply line to the fuel inlet pad on the fuel pump.

C. Place a suitable container with a minimum capacity of 5 gallons under the dump valve overboard drain.

D. Disconnect the fuel pressurizing and dump valve-to-fuel signal tube at either the dump valve or the fuel control.

E. Leave the dump valve connection open to the atmosphere, and plug the fuel control with a suitable plugged fitting to prevent dumping out fuel.

F. With the ignition switch OFF, the fuel shutoff valve OPEN, and the fuel control lever OPEN, motor the engine with the starter at 1500 - 2100 rpm.

G. When at least 1 gallon of fuel is obtained from the overboard drain, close the fuel control lever and disengage the starter.

CAUTION: LIMIT ENGINE ROTATION TO THE SHORTEST TIME POSSIBLE. DO NOT EXCEED THE STARTER OPERATING LIMIT.

H. Remove the plugged fitting from the fuel pressurizing and dump valve signal tube, and reconnect the tube to the dump valve.

I. Remove the preservation tags and make the applicable entry in the engine records.

28. Testing After Overhaul (Free Turbine Engines)

A. Safety Precautions

(1) Engine Temperature

(a) After engine operation, do not perform work or inspection on the tail pipe for at least 1/2 hour (preferably longer). If work is necessary immediately after shutdown, then wear asbestos gloves. Typically, all other engine parts can be worked on without danger.

(2) Compressor Bleed Valve

(a) When checking the bleed valve operation or doing other work in or adjacent to the compressor bleed valve while the engine is running, be sure to stand clear during the bleed valve "open" operation. When the bleed valve opens, high pressure air at high velocity is dumped overboard.

(3) Engine Noise

(a) Modern jet engines produce noise capable of causing temporary, as well as permanent, loss of hearing. Even short exposures to extreme noise can result in damage to the eardrum. All personnel must use ear protection.

(4) Engine Ignition

WARNING: THE JET ENGINE IGNITION SYSTEM IS CHARACTERISTICALLY HIGH IN ENERGY, WHICH CAUSES IT TO BE A HAZARDOUS, AND POSSIBLY FATAL, SOURCE OF ELECTRICAL SHOCK UNLESS NECESSARY PRECAUTIONS ARE TAKEN.

(5) Jet Fuels And Lubricating Oils

CAUTION: ALL FUELS HAVE A DRYING EFFECT THAT CAN INJURE THE SKIN. AVOID CONTACT WITH FUELS AS MUCH AS POSSIBLE.

B. Dressing And Installing Engine In Test Stand

(1) General
Refer to Tool Group 50, Figure 926 and Figure 927.

(a) Install the following test accessories, instrumentation, and leads on the engine.

NOTE: Most of the following dressing operations can be performed before the engine is installed in the test stand.

1 Install the test starter on the left front side of the gearbox.

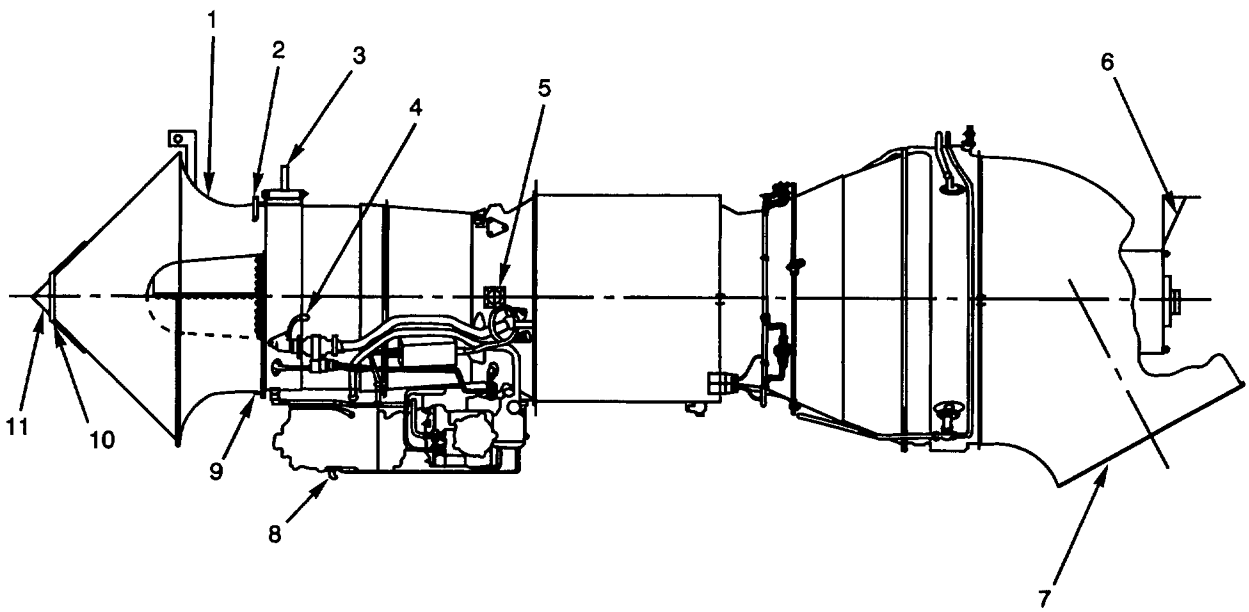
2 Install the tachometer generator on the gearbox tachometer mounting pad.

3 Install the tachometer generator on the free turbine gearbox tachometer mounting pad.

CAUTION: TACHOMETER GENERATORS MUST HAVE A GEAR RATIO THAT WILL RECORD THE ACTUAL ROTOR RPM ON TACHOMETER GAGES. THE TACHOMETER DRIVE AT THE COMPRESSOR GEARBOX IS 0.262:1 AND THE FREE TURBINE TACHOMETER DRIVE IS 0.464:1.

4 Install an oil temperature thermocouple at the fuel-oil cooler oil outlet.

5 Attach a PWA-13169 anti-icing air thermocouple to one bolt that secures the anti-icing air elbow to the inlet case.



L-29807
PW V

R
R

Test Equipment Installation
Figure 926

1. Bellmouth (PWA 13806)
2. Probe - Static Pressure Air Inlet - Pt2 (PWA 13014)
3. Adapter - Front Mount (PWA 13501)
4. Thermocouple - Anti-icing (PWA 13169)
5. Mount - Diffuser Case - Left And Right (PWA 13004), (PWA 13005) And Adapters (PWA 13501)
6. Mount - Free Turbine (PWA 13500)
7. Ring - Free Turbine Exhaust Duct Reinforcing (PWA 13856)
8. Adapter - Fuel Pump Inlet (PWA 13168)
9. Plug - Probe Hole (PWA 13385)
10. Thermocouple - Tt2 (PWA 14558)
11. Screen - Inlet (PWA 13534)

Key to Figure 926

R

6 Install drain lines at all overboard fuel drain connections.

7 Install a PWA-13168 fuel pump inlet adapter on the fuel pump.

8 Install vibration pickup mount brackets and vibration pickups at the following locations:

a Bottom of the gearbox

b Radially horizontal (2) and radially vertical at the inlet case front

c Combustion case rear

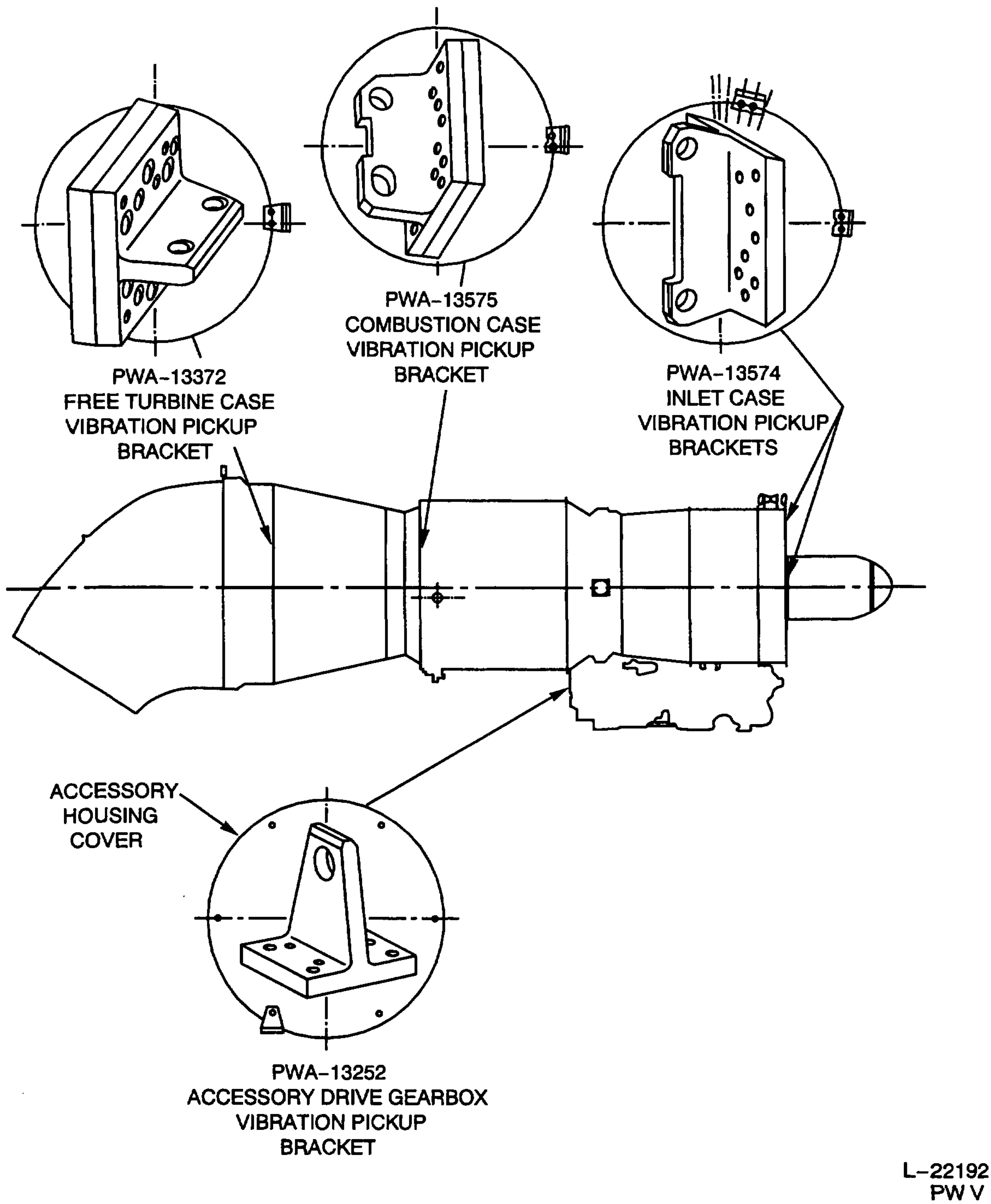
d Free turbine case front

e Install the PWA-13574 vibration pickup mount bracket and vibration pickup approximately one bolt hole counterclockwise from the 12 o'clock position on the rear face of the forward flange of the inlet case, as viewed from the front.

NOTE: A transit pad, or equivalent, must be placed between the pickup and the bracket at the burner case location.

9 Attach the test line to the oil pressure gage connection located near the oil temperature thermocouple.

10 Attach PWA 13534 inlet screen to the bellmouth.



Vibration Pickup Bracket
Installation
Figure 927

11 Attach PWA 14558 test thermocouple harness to the bellmouth screen with the long lead toward the bellmouth. Position leads equally around the screen.

12 Install 6 PWA 13014 air inlet pressure probes into the indicated position in the bellmouth.

13 Install the bellmouth and screen on the engine inlet case.

14 Install PWA 13856 ring on the rear flange of the free turbine exhaust duct, ensuring that the side marked FRONT faces the front of the engine. Secure with nuts and bolts torqued 32 - 36 lb-in.

15 Lift the engine from the transport stand, and attach PWA 13004 left and PWA 13005 right rear test mounts to the diffuser case pads, with 4 bolts securing each mount. Install 2 PWA 13007 rear mount adapters.

16 Install test mounts on the diffuser case and at the rear of the free turbine.

17 Level the engine.

18 Connect the fuel supply to the fuel pump inlet.

19 Connect the gas generator power limit lever (N1 lever) to the operator's N1 power lever linkage.

20 Connect the free turbine speed selector lever (N2 lever) to the operator's N2 lever linkage.

21 Couple the dynamometer to the free turbine shaft after a vibration check.

22 Connect the pitch (load governing) lever to the operator's pitch lever linkage.

NOTE: Ensure the pitch lever is in the minimum (zero) position.

23 Attach instrumentation leads to the turbine discharge temperature and pressure connections.

24 Connect all test stand lines to test accessories and instrumentation installed when the engine was dressed, including Ps8 probes to PWA 13856 re-enforcing ring.

25 Connect the electrical lead to the wiring harness.

26 Install PWA 107523 Pressure Probe on the engine:

1 PWA 107523 Pressure Probe is a hard stainless steel pitot tube attached to a 30-foot flexible pneumatic hose. The other end of the hose is connected to a 0-5 psig pressure gage.

2 The pressure probe is used to find the points at which the compressor bleed band opens and closes. The pitot tube is installed in the bleed overboard dump cavity and will transmit increased pressure to the gage when the bleed is open and decreased pressure when the bleed is closed.

3 The reference points at which the bleed opens and closes are compared to ambient conditions and the engine N1 speed. The test data is then compared to fuel control unit adjustments made at overhaul.

4 The pressure gage on the tool is hand-held by the operator in the test stand control room during bleed checks.

5 Install the pitot tube detail of the Probe at the right side of the engine, below the No. 1 bearing tube. Put the non-flared end of the tube in the hole in the case wall to which there is the easiest access, with the open end of the pitot tube toward the bleed band. Use the detail clamps to attach the pitot tube to the breather tube and tighten the clamp screws and nuts. See Figure 927A.

CAUTION: MAKE SURE THAT THE PITOT TUBE IS TIGHTLY ATTACHED TO THE ENGINE AND CANNOT TURN. ATTACH THE HOSE SAFELY TO THE ENGINE AND KEEP IT

TR 72-0005

R AWAY FROM HOT SURFACES, CONTROL
R CABLES, AND THE ENGINE INLET.

R 6 Connect the hose to the pitot tube and attach
R the hose to the engine with cable ties where
R necessary.

R 7 Attach the pressure gage to the hose.

R 8 Do the compressor bleed check as specified
R in Engine Trim Procedures below.

R 9 If the bleed band schedule is not in limits,
R make adjustments where necessary and do the
R bleed check again.

R 10 If the bleed schedule continues to not be in
R limits, remove and replace the fuel control
R and do the bleed band check again as
R necessary.

(b) After the engine is completely installed in the test cell, wash down the engine accessory drive gearbox with Varsol and steam or hot water to remove the oil film. Overboard breather lines must be located far enough rearward from the bottom accessory section so that oil fumes do not recirculate through or over the engine. Starting with a dry oil-free accessory case and accessories ensures oil leaks are readily observed and corrected.

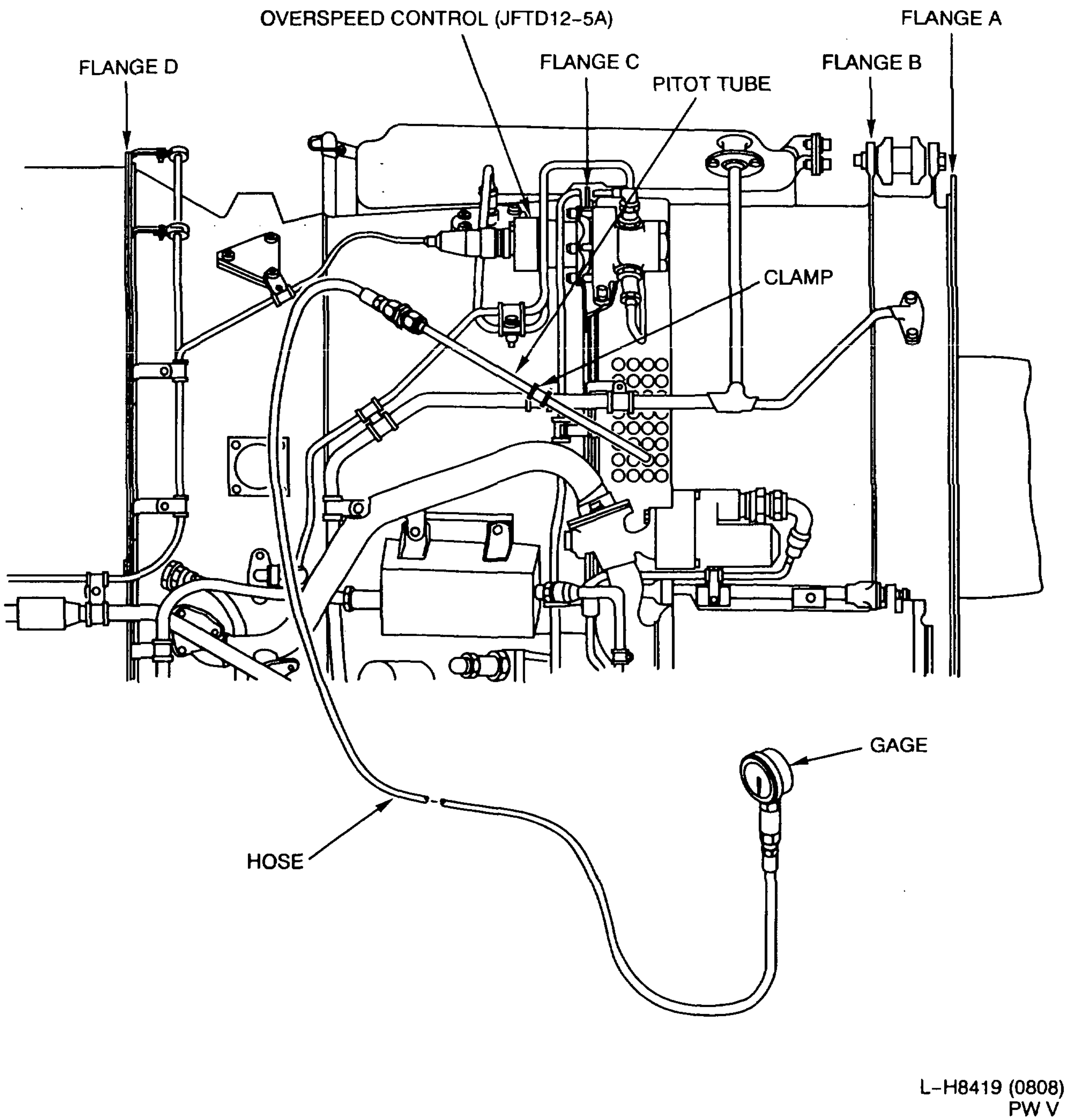
(c) Wash down the test cell floor and remove foreign objects. Check the bellmouth screen for loose objects, such as pieces of wire or rivets on the inlet case. Also, all equipment in the test cell, including on the floor and wall, must be checked for security and for any loose nuts or bolts.

(2) Prestarting Inspection

(a) General

1 Visually inspect all external tubes and components for security.

2 Check the fuel and oil supply. When necessary, fill the oil system with PWA 521B, Type II lubricating oil.



PWA 107523 Probe Installed On
Engine For Bleed Check
Figure 927A

TR 72-0005

3 Check N1 lever, N2 lever, pitch lever, and the dynamometer control.

4 Ensure all protective covers, such as compressor bleed valve covers, are removed.

5 Inspect the surrounding area for cleanliness.

(3) Engine Starting Procedure

(a) The following sequence of steps apply to engines equipped with electric pneumatic or combustion starters. When using combustion starters, which have a very limited burning time, perform the steps described below as quickly as possible.

1 Engine Anti-icing Switch - OFF

2 N1 Lever - OFF

3 Pitch Lever - Minimum Position

4 Dynamometer Load Applied

5 Engine Master Switch - ON

6 Engine Fuel Shutoff Switch - OPEN

7 Fuel Boost Pump Switch - ON

8 Engine Starter Switch - ON (check for rise in oil pressure)

9 Ignition Switch - ON at 1200 to 1500 rpm

CAUTION: DO NOT TURN ON THE IGNITION SWITCH PRIOR TO ENGAGING THE STARTER, BECAUSE FUEL THAT ACCUMULATES IN THE ENGINE COULD CAUSE AN INTERNAL FIRE OR EXPLOSION.

10 N1 Lever - IDLE above 1600 rpm

NOTE: The operating cycle for continuous use of high-energy ignition for the first startup attempt is 2 minutes ON and 3 minutes OFF. For the second attempt, the operating cycle is 2 minutes ON and 23 minutes OFF to allow the ignition

R
R

system components to cool. In some cases, restrictions imposed on the start operation will govern the use of ignition.

11 Engine Starter Switch - OFF as soon as a successful start occurs

12 Ignition Switch - OFF

NOTE: On every engine startup cycle, make sure that the tail pipe does not emit flames and that the turbine discharge temperature does not rise rapidly.

(4) Satisfactory Start

(a) The engine has started satisfactorily when all the following conditions are met:

1 Light-Up takes place within 20 seconds or less after the N1 lever is placed in the IDLE position. Light-up is evident by a rise in turbine discharge temperature.

NOTE: A 20 second time interval is an arbitrary value. The actual time to Light-Up depends on the amount of torque supplied by the starter.

2 The engine will accelerate to approximately 38 percent rpm.

3 The turbine discharge temperature does not exceed the maximum startup temperature limit of 525°C (977°F) during the transition period to idle rpm.

4 The oil pressure is at least 20 psi (relative to the internal engine scavenge compartment).

5 The turbine discharge temperature will drop below 515°C (959°F) after idle rpm is reached.

R
R

CAUTION: IF THE N1 LEVER INADVERTENTLY SLOWS DOWN AND RETURNS TO THE OFF POSITION, THEN DO NOT REOPEN THE N1 LEVER IN AN ATTEMPT TO REGAIN LIGHT. THE NORMAL STARTUP SEQUENCE MUST BE REPEATED. INTRODUCING UNBURNED FUEL INTO THE ENGINE CREATES A FIRE HAZARD.

(5) Unsatisfactory Start

(a) An unsatisfactory start occurs when one or more of the following conditions exist:

1 Hot Start - The turbine discharge temperature exceeds the startup temperature limit of 525°C (977°F). When greater than normal fuel flow is observed after the N1 lever is placed in IDLE, Hot Start could occur and the start operation should be aborted before the turbine discharge temperature is exceeded. A Hot Start also can be caused by a false or hung start.

2 False Start or Hung Start - After Light-Up has occurred, the rpm does not increase to IDLE, but remains at a lower rpm. The turbine discharge temperature could continue to rise, and the start operation should be aborted before the temperature limits are exceeded.

3 No Start - The engine does not Light-Up within 20 seconds after the N1 lever is placed in IDLE. If the turbine discharge temperature gage does not indicate a temperature rise, or if the rpm does not increase, then Light-Up has not been achieved.

4 Perform the following sequence of steps if any of the requirements of a satisfactory start are not met, or if any of the unsatisfactory start conditions occur.

a N1 Lever - OFF

b Ignition Switch - OFF

c Engine Starter Switch - OFF

d Fuel Boost Pump Switch - OFF

e Allow a 2 minute fuel drainage period before attempting another start.

(6) Clear Engine Procedure

(a) Perform the following sequence of steps to clear the engine of trapped fuel or vapors:

1 N1 Lever - OFF

2 Ignition Switch - OFF

3 Engine Fuel Shutoff Switch - OPEN

4 Fuel Boost Pump Switch - ON

5 Engine Starter Switch - ON

6 Maintain starter operation for 10 - 20 seconds for the burning time of the cartridge starter.

7 Engine Starter Switch - OFF

8 Fuel Boost Pump Switch - OFF

9 Allow a 30 second fuel drainage period before attempting another start.

(7) Engine Shutdown Procedure

(a) Set the N1 lever to provide 75% N1 rpm for 30 seconds to provide the proper residual oil scavenging; then slowly return the N1 lever to OFF.

CAUTION: WHEN THE ENGINE HAS BEEN OPERATING AT HIGH SETTINGS FOR AN APPRECIABLE LENGTH OF TIME, OPERATE THE ENGINE IN IDLE FOR APPROXIMATELY 5 MINUTES PRIOR TO SHUTDOWN TO PREVENT SEIZURE OF THE ROTOR AND/OR OVERHEATING OF THE NO. 3 BEARING DUE TO RESIDUAL HEAT IN THE TURBINE ROTOR.

CAUTION: DO NOT USE VALVES UPSTREAM OF FUEL CONTROL (SUCH AS FIREWALL SHUTOFF VALVES OR TEST STAND FUEL SUPPLY SHUTOFF VALVES), OR TURN OFF FUEL BOOST PUMPS TO SHUT DOWN THE ENGINE. DOING SO ALLOWS THE ENGINE FUEL PUMP TO OPERATE IN A DRY STATE THAT CAN RESULT IN PUMP FAILURE.

R
R

TR 72-0005

IF THE ENGINE IS SHUT DOWN IN THIS MANNER FOR ANY REASON, THEN INSPECT ALL FUEL SYSTEM FILTERS AND STRAINERS FOR EVIDENCE OF FUEL PUMP DAMAGE.

(b) Fuel Boost Pump Switch - OFF

NOTE: To prevent air from getting into fuel lines, set the N1 lever to OFF before the fuel boost pump is turned OFF.

(c) Engine Fuel Shutoff Switch - CLOSED

(d) Engine Master Switch - OFF

(e) Ascertain whether the compressor decelerates freely.

NOTE: In the event of inadvertent, or emergency shutdown, rotor rotational freedom must be checked before attempting another start.

(8) Limits For Test Instruments And Equipment

(a) Engine Check Chart For JFTD12A-4A: See Table 911.

(b) Engine Check Chart For JFTD12A-5A: See Table 912.

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1)RPM(1)	FREE TURB (N1)RPM(2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP(3)	TIME LMTS (MIN)
Take-off	4500	16530	9000	2.130 to 2.185	0.690	Must be below line of Fig 928	5
30 MIN	4500	16530	"	2.130 to 2.185	0.690	"	30
Max Cont	4000	16055	"	2.039 to 2.095	0.695	See Fig 928	Cont

R
R

Engine Check Chart (JFTD12A-4A)
Table 911 (Sheet 1)

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1) RPM (1)	FREE TURB (N1) RPM (2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP (3)	TIME LMTS (MIN)
80% Max Cont	3200	-	"	1.884 to 1.942	-	-	"
50% Max Cont	2000	-	"	1.643 to 1.696	-	-	"
Flt Idle (no load)	-	-	-	-	-	-	"
Strtng	-	-	-	-	-	525°C (977°F)	Momen tary
Accl-rtn	-	-	-	-	-	688°C (1270°F)	2

Notes:

(1) Vibration Limits (Single Amplitude) (4) - 15,500 rpm N1 and above limits for all pickups are 1.7 mils; below 15,500 rpm is 1.9 mils; and limit for free turbine case pickup with free turbine driveshaft uncoupled and above 8000 rpm N2 is 0.8 mil; coupled is 1.5 mils.

(2) Maximum permissible N1 rotor observed speed is 16,700 rpm.

(3) Maximum permissible N2 rotor indicated speed is 9,500 rpm for steady power operation.

Maximum permissible N2 rotor operating indicated speed is 9600 rpm.

(4) During and just after acceleration, the above stabilized limits may be exceeded to a maximum of 688°C (1270°F) for a period of not more than 2 minutes. Prior to establishing final trim setting line, the indicated TAKEOFF limits must not be exceeded.

R
R

Engine Check Chart (JFTD12A-4A)
Table 911 (Sheet 1) (Continued)

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1)RPM(1)	FREE TURB (N1)RPM(2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP(3)	TIME LMTS (MIN)

(5) If the vibration reading of the free turbine is above 1.5 mils when coupled to dynamometer and below 0.8 mils when uncoupled, then the coupling must be reindexed to minimize the coupled vibration readings.

If the vibration readings continue to be unacceptable when coupled and do not exceed 0.8 mil uncoupled, then it is permissible to run the acceptance test coupled to the dynamometer and accept free turbine vibration not exceeding 2.5 mils.

Engine Check Chart (JFTD12A-4A)
Table 911 (Sheet 1) (Continued)

							FUEL LEAKAGE		
PWR RATNG	OIL PRSSR PSIG	OIL TEMP INLT	OIL BRTHR PRSSR	OIL CONSMP	FUEL TEMP INLT	FUEL PRSSR INLT	P&D VALV	CNTRL & PMP	IGNTN SYSTM
Take-off	45-55	15°-121°C 59°-250°F	2.5in Hg stdy state	0.11gph max dur accpt	43°C 110°F max	5-50 psig	300cc per hour dur eng run	20cc per hour (12cc per hour for F'C speed sense unit)	24vdc nom (14vdc with 5 amp load at input term)
30 MIN	"	"	"	"	"	"	"	"	"
Max Cont	"	"	"	"	"	"	"	"	"
80% Max Cont	"	"	"	"	"	"	"	"	"
50% Max Cont	"	"	"	"	"	"	"	"	"
Flt Idle (no load)	40 Min	10°-121°C 50°-250°F	"	"	"	"	"	"	"
Strtng	-	-	-	"	"	"	"	"	"
Accl-rtn	45-55	15°to 121°C 59°-250°F	4in. Hg max	"	"	"	"	"	"

R
R

Engine Check Chart (JFTD12A-4A)
Table 911 (Sheet 2)

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1) RPM (1)	FREE TURB (N1) RPM (2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP (3)	TIME LMTS (MIN)
Take-off	4800	16350	9000	2.195 to 2.253	0.655	Must be below line of Fig 928	5
30 MIN	4800	16350	"	2.198 to 2.253	0.655	"	30
Max Cont	4430	16050	"	2.130 to 2.183	0.665	See Fig 928	Cont
80% Max Cont	3200	-	"	1.893 to 1.938	-	"	"
60% Max Cont	2000	-	"	1.643 to 1.688	-	"	"
Idle (no load)	-	-	-	-	-	-	"
Strtng	-	-	-	-	-	525°C (977°F)	Momentary
Accl-rtn	-	-	-	-	-	720°C (1328°F)	2

Notes:

(1) Vibration Limits (Single Amplitude) (4) - 15,500 rpm N1 and above limits for all pickups are 1.7 mils; below 15,500 rpm is 1.9 mils; and limit for free turbine case pickup with free turbine drive disconnected and above 8000 rpm N2 is 0.8 mil; coupled is 1.5 mils.

(2) Maximum permissible N1 rotor observed speed is 16,700 rpm.

R
R

Engine Check Chart (JFTD12A-5A)
Table 912 (Sheet 1)

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1)RPM(1)	FREE TURB (N1)RPM(2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP(3)	TIME LMTS (MIN)

(3) Maximum permissible N2 rotor indicated speed is 9,500 rpm for steady power operation.

Maximum permissible N2 rotor operating indicated speed is 9,600 rpm.

(4) During and just after acceleration, the above stabilized limits may be exceeded to a maximum of 720°C (1328°F) for a period of not more than 2 minutes. Prior to establishing final trim setting line, the indicated TAKEOFF limits must not be exceeded.

(5) If the vibration reading of the free turbine is above 1.5 mils when coupled to dynamometer and below 0.8 mils when uncoupled, then the coupling must be reindexed to minimize the coupled vibration readings.

If the vibration readings continue to be unacceptable when coupled and do not exceed 0.8 mil uncoupled, then it is permissible to run the acceptance test coupled to the dynamometer and accept free turbine vibration not exceeding 2.5 mils.

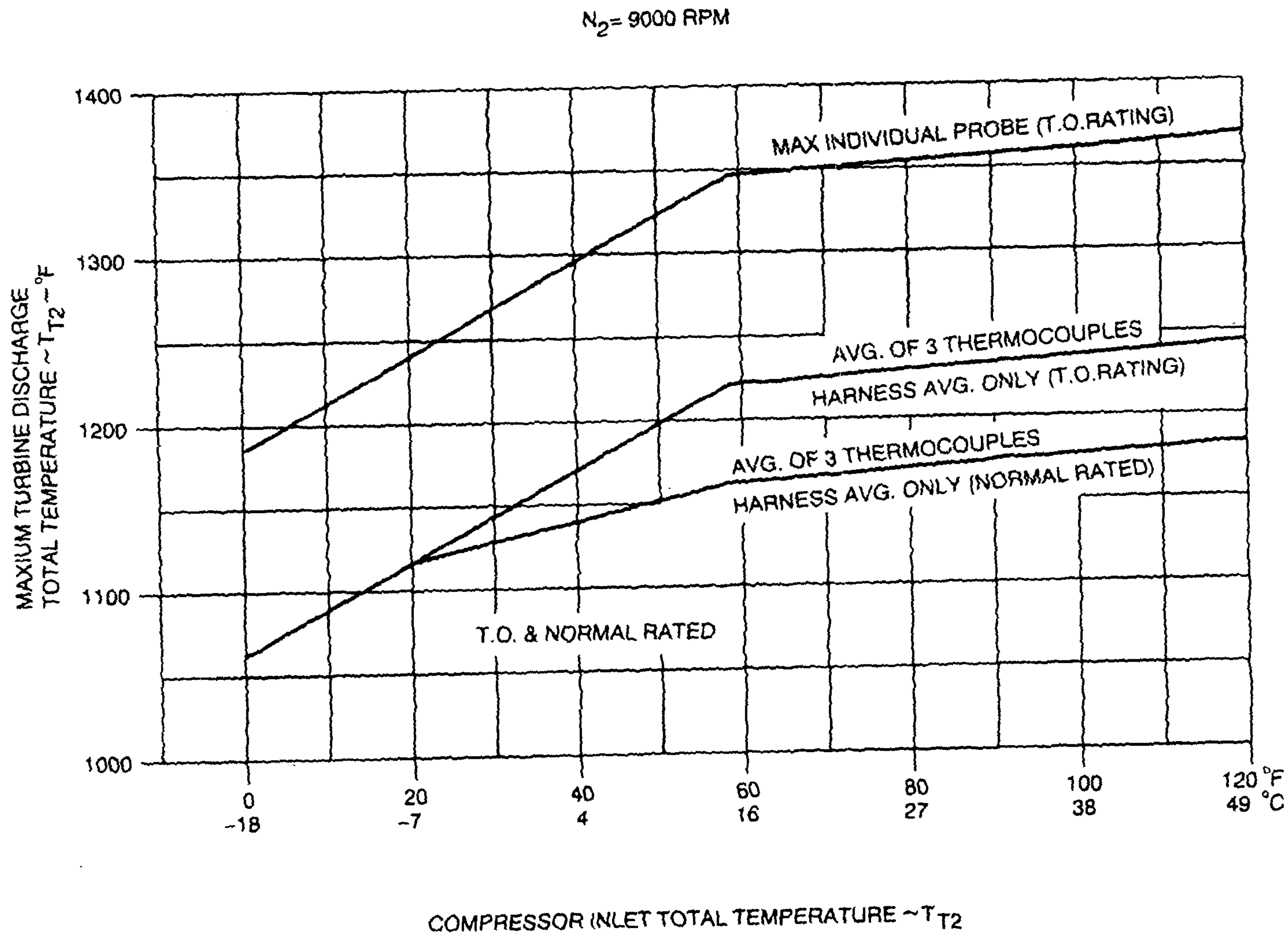
Engine Check Chart (JFTD12A-5A)
Table 912 (Sheet 1) (Continued)

R
R

PWR RATNG	OIL PRSSR PSIG	OIL TEMP INLT	OIL BRTHR PRSSR	OIL CONSMP	FUEL TEMP INLT	FUEL PSSR INLT	FUEL LEAKAGE P&D VALV	FUEL LEAKAGE CNTRL & PMP	IGNTN SYSTM
Take-off	45-55	121°C 250°F max	2 in Hg stdy state	0.11gph during accpt	43°C 110°F max	5-50 psig	300cc per hour dur eng run	20cc per hour (12cc per hour for F'C speed sense unit)	24vdc nom (14vdc with 5 amp load at input term)
30 MIN	"	"	"	"	"	"	"	"	"
Max Cont	"	"	"	"	"	"	"	"	"
80% Max Cont	"	"	"	"	"	"	"	"	"
60% Max Cont	40 Min	-	"	"	"	"	"	"	"
Flt Idle (no load)	40 Min	-	"	"	"	"	"	"	"
Strtng	-	-	"	"	"	"	"	"	"
Accl-rtn	-	-	4in. Hg max	"	"	"	"	"	"

R
R

Engine Check Chart (JFTD12A-5A)
Table 912 (Sheet 2)



L-H8003 (0107)
PWA

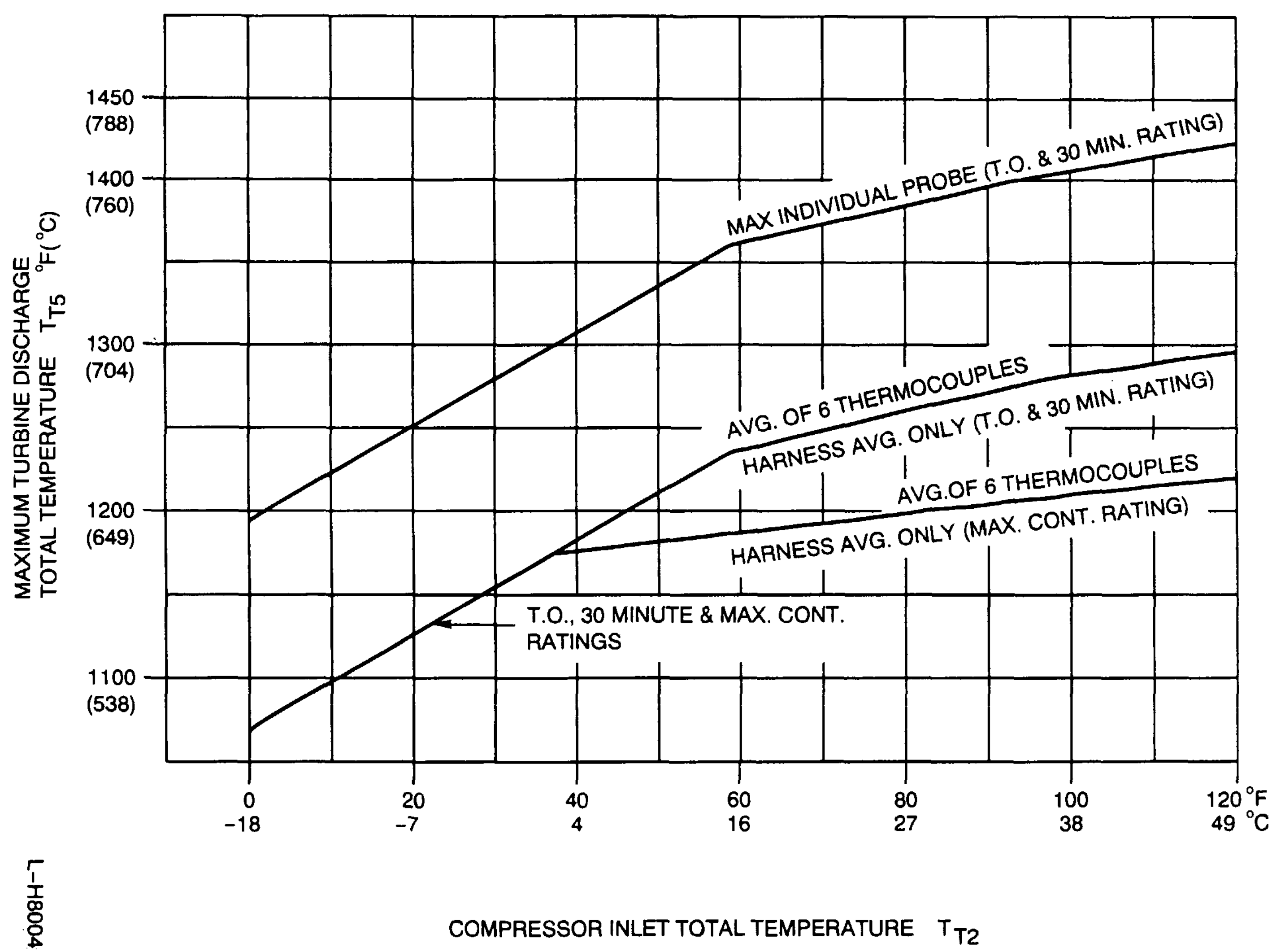
R
R

EFFECTIVITY - ALL

Maximum Turbine Discharge Temperature (Tt5) (JFTD12A-4A)
Figure 928 (Sheet 1)

TAKEOFF, 30 MINUTE MAXIMUM CONTINUOUS RATINGS

N_2= 9000 RPM



L-H8004 (0107)
PW V

Maximum Turbine Discharge
Temperature (Tt5) (JFTD12A-5A)
Figure 928 (Sheet 2)

R
R

(c) The TAKEOFF rating for this engine can be obtained above 15°C (59°F) without attaining maximum gas generator speed, and below 15°C (59°F) at maximum gas generator speed equivalent to the constant gas generator power lever setting. Take care not to run engine above conditions required to meet corrected TAKEOFF horsepower requirements for the inlet temperature time indicated in Figures 929 (Sheets 1 or 2).

(d) Fuel System (Refer to Engine Check Chart For JFTD12A-4A or Engine Check Chart For JFTD12A-5A)

(e) Oil System (Refer to Engine Check Chart For JFTD12A-4A or Engine Check Chart For JFTD12A-5A)

(f) Electrical System (Refer to Engine Check Chart For JFTD12A-4A or Engine Check Chart for JFTD12A-5A)

(g) Instrumentation

1 All instruments and equipment should be calibrated often enough to ensure reported data has a static accuracy within the limits listed below for values obtained at the TAKEOFF SHP rating.

a	Pam	Ambient Pressure	±0.01 inch Hg
b	Pt2	Compressor Inlet Total Pressure	±0.10 inch H2O
c	Ps3	Compressor Discharge Static Pressure	±0.25%
d	Pt5	Turbine Discharge Total Pressure	±0.10 inch Hg
e	Ps8	Exhaust Duct Exit Static Pressure	±0.10 inch Hg
f	Tt2	Compressor Inlet Total Temperature	±2°F (±1.1°C)
g	Tt5	Turbine Discharge Total Temperature (Exhaust Gas Temperature) Average and Individual	±5°F (±2.8°C)

R
R

h	OBT	Control Room Temperature	±1°F (±.5°C)
i	Tf	Inlet Fuel Temperature	±1°F (±.5°C)
j	Wf	Fuel Flow	±0.75%
k	N1	Compressor Rotor Speed	±0.10%
l	N2	Free Turbine Rotor Speed	±0.10%
m	DL	Dynamometer Load	±0.50%

(h) Engine Vibration Limits

1 Vibration monitoring is used in overhaul of gas turbine engines to provide an indication of correct assembly. Unless the main engine rotor assembly is correctly assembled and balanced, vibration limits will be exceeded.

2 Vibration amplitude must be observed at steady state running at all speeds in the operating range, and must not exceed the limits referenced in Section 7.

NOTE: Momentary vibration peaks during transient operating conditions in excess of limits listed are not cause for rejections as long as steady state readings are within limits.

(i) Engine Test Vibration Equipment

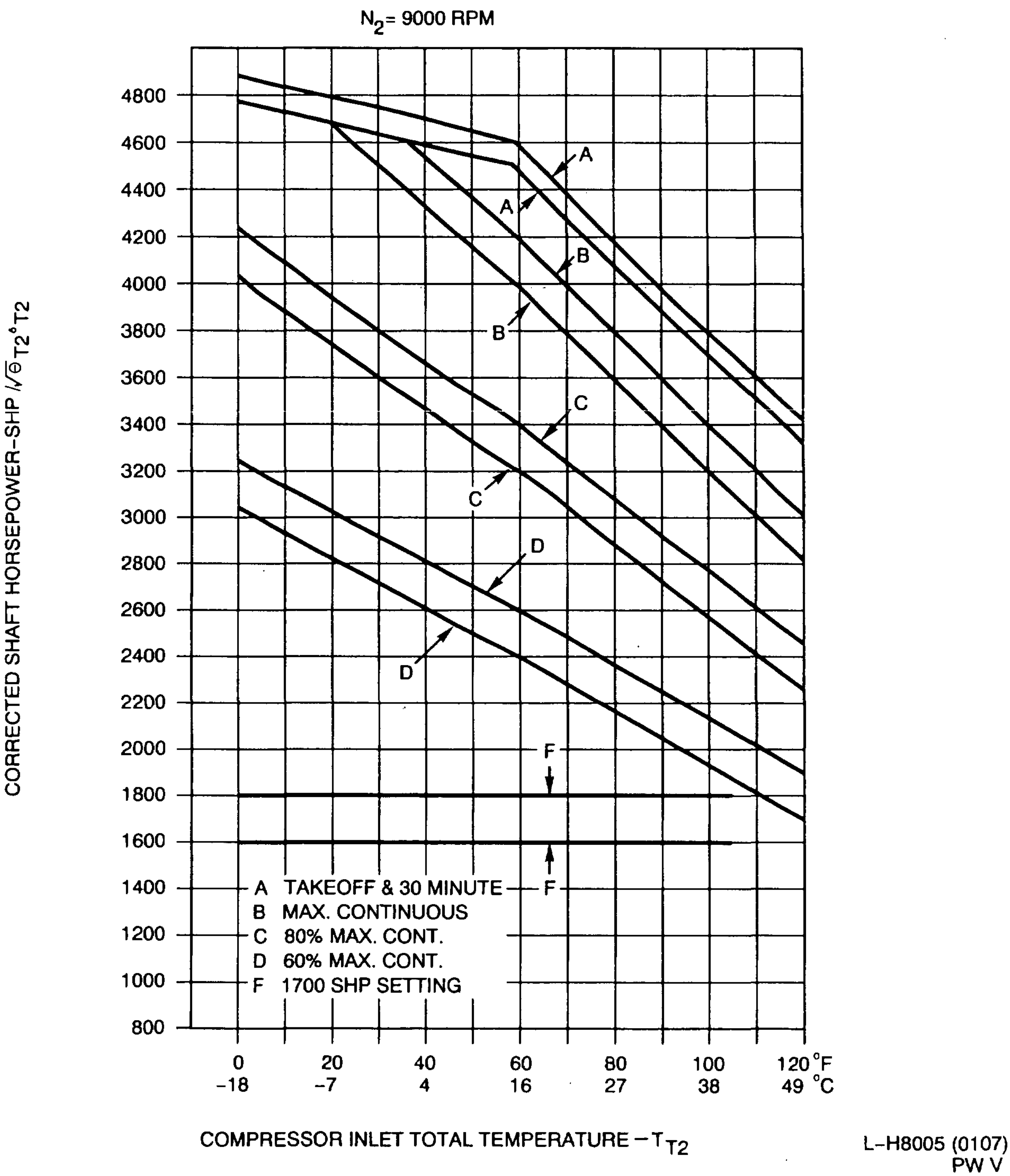
1 The following combination of suitably calibrated vibration measuring equipment, or equivalent combination, must be used to monitor vibration during the engine test:

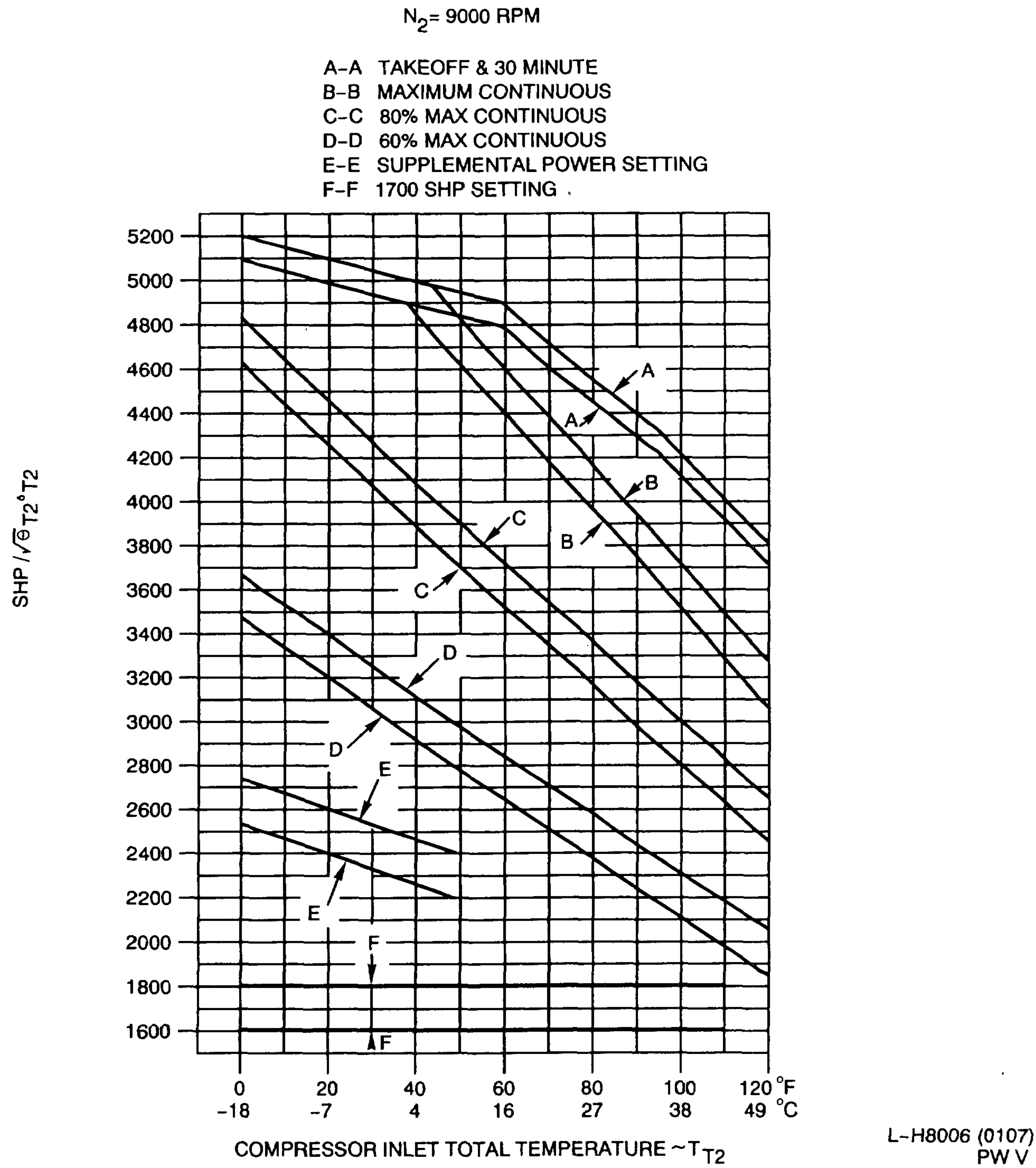
a Model ED-156-4 Vibration Meter (or equivalent).

NOTE: This vibration meter was formerly available from Glenn Hathaway Electronics of Canaan, CT.

b Compatible 40 cps filter for vibration meter.

R
R


N2= 9000 RPM
CORRECTED SHAFT HORSEPOWER-SHP /√θ T2 °T2
4800
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
A
A
B
B
C
C
D
D
F
F
A TAKEOFF & 30 MINUTE
B MAX. CONTINUOUS
C 80% MAX. CONT.
D 60% MAX. CONT.
F 1700 SHP SETTING
0 20 40 60 80 100 120 °F
-18 -7 4 16 27 38 49 °C
COMPRESSOR INLET TOTAL TEMPERATURE — TT2
L-H8005 (0107)
PW V



R
R

Power Setting Curve (JFTD12A-5A)
Figure 929 (Sheet 2)

c Model 4-103 or 4-123 vibration pickups (or equivalent).

NOTE: These vibration pickups were formerly available from Consolidated Electrodynamics Corp. of Pasadena, CA.

d The vibration indicator and filter used to monitor vibration during the test must be calibrated often enough to ensure the accuracy and frequency in cps vs. relative frequency response in percent fall within the band in Figure 909.

(9) Drain Leakage Check of Fuel System

(a) During an engine run, the overboard drain seal leakage from the main engine fuel control, fuel pump, and pressurizing and dump valve must be collected in individual containers.

(b) Individual leakage of the listed controls must not exceed the limits referenced above.

(c) Record leakage obtained from the Fuel Control Speed Sense Unit.

(10) Maximum Indicated N1 Speed: Refer to Paragraph 7.

(11) Maximum Indicated N2 RPM: Refer to Paragraph 7.

(12) Correction of Observed Readings

(a) Observed data taken during engine operation at each power setting in the bands in Figure 929 for horsepower, fuel consumption, compressor rpm, and turbine discharge temperature, must be corrected as described below and checked against ratings.

(b) First correct the indicated horsepower for the test stand exit pressure loss in accordance with the correction curve, before any other corrections are made. See Figure 929. Observed horsepower must be corrected for gearbox horsepower loss.

(c) Obtain the corrected values with the formulae in Figure 909A.

(d) Engine breather pressure in inches Hg must be converted to psi (in. Hg x 0.49) and subtracted from the observed main oil pressure gage reading to obtain the true main oil pressure.

(e) All engine idle trimming must be done by measuring the gas generator rotor speed in relation to the inlet temperature (Tt2). See Figure 931.

(13) Compressor Inlet Total Pressure (Pt2) Conversion

(a) Convert Pt2 inches water (gage) to inches mercury (gage): multiply inches water by 0.07355.

(b) To obtain P5t2 inches mercury absolute: subtract Pt2 inches mercury from the barometer, taken at the time of the test.

(14) Turbine Discharge Pressure (Pt5) Manometer Test

(a) All engine trimming must be done by measuring Pt5 with a precision bore manometer.

(b) Leak test the manometer by applying air pressure, equal to 2/3 capacity of the manometer, to the tube connection from the engine.

(c) The manometer must remain constant for 2 minutes minimum.

(d) All Pt5 readings must be made to the nearest 0.1 inch mercury and added, to the nearest 0.01 inch, to the observed true barometer reading.

(e) Correct Pt5 manometer readings for temperature effect according to Figure 911.

(15) Belting-In (Dynamometer Not Connected)

(a) Ignition OFF, or grounded

(b) Fuel ON

(c) N1 lever CLOSED

(d) Motor the engine by using external power; the speed must be sufficiently high to ensure the oil system is fully primed and the oil pump maintains steady pressure.

R
R

18 Exhaust re-enforcing ring assembly number.

(b) During startup, record the following data on the log sheet:

1 Time the engine is started

2 Maximum average turbine temperature encountered

3 Fuel flow

4 N1 rpm

5 Main oil pressure.

(c) During engine operation, record the following data on the log sheet:

1 Time of day

2 Total hours of engine operation

3 True barometric pressure

NOTE: During erratic weather conditions, record the pressure every half hour.

4 Control room temperature

5 Fuel specific gravity

6 Fuel specific gravity at temperature

7 Observed and corrected main oil pressure

8 Oil tank breather pressure

9 Main oil pump corrected oil scale level

10 Oil temperature

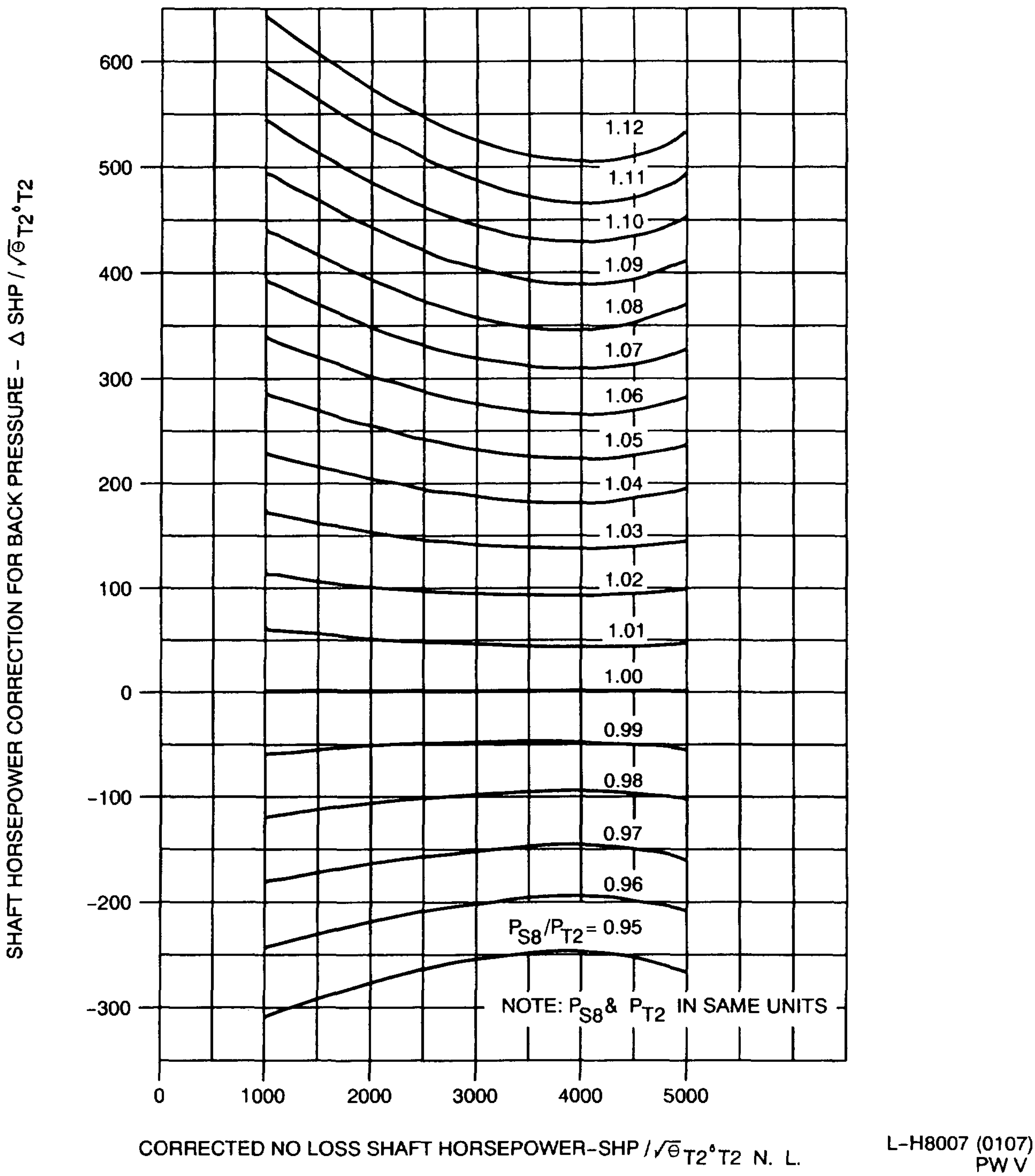
11 Vibration amplitude

12 Compressor inlet differential pressure

13 Compressor inlet total pressure

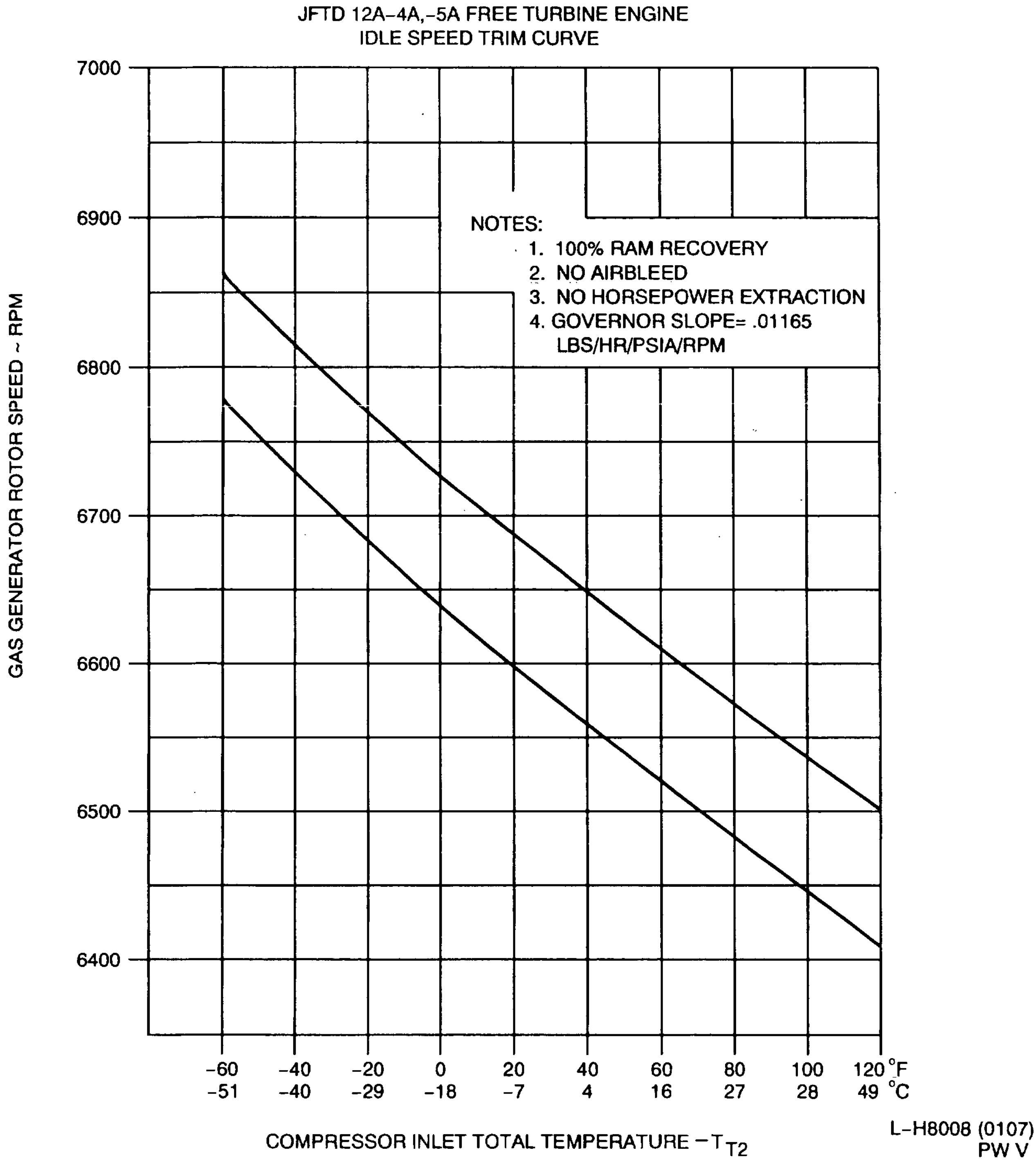
14 Observed and corrected turbine discharge temperature

R
R



R
R

Estimated Shaft Horsepower
Correction For Back
Pressure Effect
Figure 930



R
R

Idle Speed Trim Curve
(JFTD12A-4A, -5A)
Figure 931

15 Dynamometer load

16 Observed and corrected compressor rpm

17 Observed free turbine rotor rpm

18 Fuel flow - observed and corrected

19 Fuel flow specific gravity correction

20 Oil consumption

21 Fuel pressure stack temperature

22 Brake specific fuel consumption

23 Fuel flow temperature

24 Free Turbine exhaust gas static pressure

25 Compressor static discharge pressure

26 Compressor inlet temperature

27 Record the following times:

a Time to ignition and N1 at ignition

b Time to starter cutout and N1 at cutout

c Time to stabilized idle and N1 at idle.

28 Observed and corrected turbine discharge pressure

29 Corrected indicated shaft horsepower

30 Engine pressure ratio

31 Compressor bleed system operation

32 Miscellaneous data:

a Reason for any nonscheduled engine shutdown

b Reason for any engine rejection

c Performance of any penalty tests

R
R

d Time in seconds that Tt5 exceeds specific limits

e Repairs made to the engine during the test.

(d) Record the engine coast-down time. This time is defined as the time lapse between the moment the N1 lever is placed in the full closed position and the moment the engine N1 rotor comes to a complete stop.

NOTE: Coast-down time has no absolute value: however, all the engine records combined will determine the expected coast-down time. Any engine with an abnormally short coast-down time should be thoroughly checked to determine the cause.

(17) Engine Trim Procedures (JFTD12A-4A And -5A)

(O)OPERATION/(C&R)CHECKS AND REMARKS

1. (O) Belting-in

(C&R) Refer to Paragraph 14.

2. (O) Engine startup (dynamometer not connected)

(C&R) a. Refer to Paragraph 4.

b. Determine and record:
the time from start cycle initiation to idle speed; the times to ignition and rpm, starter cutout and rpm, maximum exhaust gas temperature, and noticeable flat spots in acceleration.

CAUTION: DO NOT ADVANCE THE N1 LEVER BEYOND IDLE UNTIL 38°C (100°F) OIL-IN TEMPERATURE IS REACHED. CHECK FOR FUEL AND OIL LEAKS AND CORRECT AS NECESSARY BEFORE CONTINUING THE RUN.

R
R

(O)OPERATION/(C&R)CHECKS AND REMARKS

3. (O) Accelerate free turbine 8000 to 9500 rpm.

(C&R) Run a vibration survey on the free turbine from 8000 N2 to 9500 N2. Read all generator and free turbine pickups at 9000 N2, 9500 N2, and at peak vibration points. Refer to Paragraph B.(8), Limits For Test Instruments And Equipment.

NOTE: The maximum allowable N2 operating speed for this test is 9600 rpm.

4. (O) Engine shutdown

(C&R) Refer to Paragraph 6.

5. (O) Connect dynamometer to engine.

6. (O) Install part power trim stop.

(C&R) See Figure 902.

7. (O) Engine startup

(C&R) Refer to Paragraph 4. Determine and record the overall time from start cycle initiation to idle speed.

8. (O) Run at ground IDLE

(C&R) a. N1 lever at IDLE

b. N2 and pitch levers at minimum positions

c. Adjust IDLE trimmer to obtain the limits in Figure 931.

d. After a 5 minute stabilization, record the following data:

N1, N2, load, Tt2, Pt2, Pt5, Wf, Ps3
oil and breather pressure
oil temperature
vibration.

e. Advance the N2 lever and pitch lever to the maximum position.

CAUTION: THIS POSITION WILL BE CONSIDERABLY LESS THAN

R
R

(O)OPERATION/(C&R)CHECKS AND REMARKS

(CONTINUED)

FULL N1 LEVER TRAVEL. DO NOT APPLY EXCESSIVE FORCE TO THE N1 LEVER.

9. (O) Move the N1 lever to part power trim stop, then back to ground idle position.

<u>NOTE</u>: Adjust the dynamometer load to limit N2 to maximum 9000 rpm.

(C&R) a. During acceleration, the automatic modulated bleed 1 fuel control arm must start to close at N1 between 10,450 and 11,000 rpm and be fully closed at 13,000 rpm.

b. During deceleration, the arm must be:
fully closed at N1 of 13,000 rpm
start to open between 13,000 and 12,400 rpm
and
fully open between 11,000 and 10,450 rpm.

c. Record N1 prior to initiating bleed actuation on
R acceleration and deceleration. Increased pressure
R on the gage of PWA 107523 Probe will show that the
R bleed opens, and decreased pressure will show that
R the bleed closes.

<u>NOTE</u>: The arm position during bleed opening and closing should vary smoothly with engine speed.

<u>CAUTION</u>: DO NOT OPERATE ENGINES ABOVE 12,000 RPM FOR EXTENDED PERIODS WITH THE BLEED VALVE OPEN. EXCESSIVE STRESS TO 5TH STAGE STEEL BLADES REQUIRES REPLACING THEM. TITANIUM BLADES DO NOT NEED TO BE REPLACED.

10. (O) Move N1 lever to part power trim stop.

<u>CAUTION</u>: THIS POSITION WILL BE CONSIDERABLY LESS THAN FULL N1 LEVER TRAVEL. DO NOT APPLY EXCESSIVE FORCE TO THE N1 LEVER.

(C&R) a. While maintaining N2 at 9,000 rpm by adjusting the load, adjust the MAX trim screw on the fuel control To obtain the proper engine pressure ratio (EPR) from Figure 932 and check the corrected shaft horse-power from Figure 933.

(O)OPERATION/(C&R)CHECKS AND REMARKS

(CONTINUED)

CAUTION: ADJUSTING FUEL CONTROL MAX TRIM SCREW TO EITHER EXTREME POSITION CAN RESULT IN BINDING OF THE GOVERNOR LEVER, WHICH WILL CAUSE N1 LEVER BINDING. IF THIS CONDITION IS ENCOUNTERED, THE TRIM SCREW MUST BE TURNED 1/2 - 2 1/2 TURNS IN THE DIRECTION OPPOSITE FROM THE EXTREME TO FREE THE N1 LEVER. FULL TRIM SCREW TRAVEL SHOULD NOT BE REQUIRED TO TRIM THE ENGINE TO ALLOWABLE LIMITS.

b. Record all data after a 5 minute stabilization.

11. (O) Decelerate to GROUND IDLE

(C&R) a. Recheck N1 idle speed from Figure 931.

b. Adjust the idle trimmer, if necessary, and repeat the operation.

c. Record all data after a 5 minute stabilization.

CAUTION: IDLE AND MAX TRIMMERS AFFECT EACH OTHER. THEREFORE, IT MAY BE NECESSARY TO REPEAT OPERATIONS 10 AND 11 UNTIL THE PREFERRED SETTINGS ARE OBTAINED WITHOUT INTERMEDIATE ADJUSTMENT.

12. (O) Remove the part power trim stop, and replace it on the fuel control.

NOTE: PN 579313 stop must remain with the same control at all times. PN 706392-1 stops are interchangeable with each other.

13. (O) Accelerate to TAKEOFF position

(C&R) a. Adjust N1 lever and the load to develop TAKEOFF power by Figure 927A or Figure 927B, while maintaining N2 at 9000 rpm.

b. Record all data after a 5 minute stabilization.

R
R

(O)OPERATION/(C&R)CHECKS AND REMARKS

14. (O) Decelerate to IDLE (JFTD12A-5A only)

(C&R) Place the overspeed system test switch in the TEST position.

15. (O) Accelerate slowly to dropoff point (JFTD12A-5A only)

(C&R) a. N2 speed will increase and then drop off sharply.

b. Record N2 speed prior to the dropoff (speed must be between 8590 and 8990 rpm.)

c. After at least 2 cycles, place the test switch in the RUN position during acceleration. Continue to cycle.

16. (O) Add more acceleration (JFTD12A-5A only)

(C&R) N2 speed must increase above the dropoff noted speed.

CAUTION: DO NOT EXCEED 9500 RPM N2.

17. (O) Engine shutdown

(C&R) a. Refer to Paragraph 6.

b. Inspect for oil and fuel leaks. Correct as needed.

(18) Engine Acceptance Test Procedures (JFTD12A-4A And -5A)

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

1. (O) Engine startup

(C&R) a. Refer to Paragraph 4.

b. Determine and record the overall time from start cycle initiation to idle speed.

CAUTION: DO NOT ADVANCE THE N1 LEVER BEYOND GROUND IDLE UNTIL 38°C (100°F) OIL-IN TEMPERATURE IS REACHED. CHECK FOR FUEL AND OIL LEAKS AND CORRECT, AS NEEDED, BEFORE CONTINUING RUN.

R
R

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

2. (O) Minimal load

(D) 5 minutes

(C&R) Record the oil level and oil inlet temperature when the temperature stabilizes after 5 minutes.

NOTE: During the operation at no-load and all subsequent power settings, maintain N2 at 9000 rpm.

NOTE: During Operations 3, 5, or 7, actuate the anti-icing controls at least twice. The anti-icing air temperature, downstream of the valve, must increase at least 55°C (100°F) when the valve is open. The indicator light must be ON when the valve is open. Record the temperature and the indicator light operation.

3. (O) TAKEOFF load

(D) 5 minutes

(C&R) Adjust the control levers and the dynamometer load to the corrected horsepower in Band A of Figure 929.

4. (O) Minimal load

(D) 5 minutes

5. (O) TAKEOFF load

(D) 5 minutes

(C&R) Refer to Operation 3.

6. (O) No-load

(D) 5 minutes

7. (O) TAKEOFF load

(D) 5 minutes

(C&R) Refer to Operation 3.

R
R

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

8. (O) 1700 HP load

(D) 10 minutes

(C&R) Adjust control levers and dynamometer load to 1700 HP by Band F in Figure 929. Record all data when the engine is stabilized.

9. (O) Supplemental power load (required only if Tt2 is 10°C (50°F) or lower for JFTD12A-5A only)

(D) 10 minutes

(C&R) Adjust control levers and dynamometer load by Band E in Figure 929 (Sheet 2). Record all data when the engine is stabilized.

10. (O) 60% MAXIMUM CONTINUOUS HP load

(D) 10 minutes

(C&R) Adjust control levers and dynamometer load by Band D in Figure 929. Record all data when the engine is stabilized.

11. (O) 80% MAXIMUM CONTINUOUS HP load

(D) 10 minutes

(C&R) Adjust control levers and dynamometer load by Band C in Figure 929. Record all data when the engine is stabilized.

12. (O) MAXIMUM CONTINUOUS HP load

(D) 10 minutes

(C&R) a. Adjust control levers and dynamometer load by Band B in Figure 929. Record all data when the engine is stabilized.

b. Check the operation of the fuel de-icing system during this time. With the air valve open, the fuel-out temperature of the heat exchanger must increase at least 44°C (80°F) in 1 minute.

NOTE: Do not adjust control levers for resultant

R
R

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

(CONTINUED)

loss of power. Do not record data while the valve is open.

13. (O) TAKEOFF HP load

(D) 10 minutes

(C&R) a. Adjust control levers and dynamometer load to the corrected TAKEOFF horsepower requirements for the inlet temperature by Band A in Figure 929. Record all data when the engine is stabilized.

b. Check the dual junction exhaust gas measurement system. Take readings from individual reading thermocouple circuits and compute the average, which should fall within ± 11°C (± 20°F) of readings taken with the averaging harness. If an individual thermocouple reading is above the line in Figure 929 and the thermocouple and gage are accurate, then make a fuel nozzle flow check. Refer to the instructions in Section 73-00-00, Accessories.

14. (O) Minimal load

(D) 5 minutes

(C&R) Record the oil level and temperature after stabilization. Determine the oil consumption (gallons per hour) since Operation 2 and record.

15. (O) Engine shutdown

(C&R) Refer to Paragraph 6.

16. (O) Plot the graph

(C&R) a. Use data previously recorded to plot the graph for standard sea level evaluation. Determine the corrected data plate check speed at Pt5/Pt2 of 1.65 in rpm and as a percent of 16,030 rpm to 2 decimal places. Refer to Paragraph 11. and Figure 921, using 0.262:1 tachometer drive ratio.

b. The value of EPR at corrected power settings must conform to the limits in Paragraph 7.

R
R

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

(CONTINUED)

NOTE: If the EPR at corrected TAKEOFF thrust is not within the limits, then check the test stand instrumentation and repeat Operations 9 thru 13.

17. (O) Inspect filters and strainer

(C&R) a. Remove and inspect the main oil strainer, fuel control filter, and fuel pump filter for contamination.

b. Reinstall the uncontaminated strainer and filters.

c. Perform a leak check during preservation cycle.

(19) Marking Data Plate

(a) The value of the corrected N1 determined as Pt5/Pt2 of 1.65 and established in Engine Acceptance Test must be expressed in both rpm and a percent of 16,030 rpm to 2 decimal places, then stamped on the data plate as follows:

Data plate check speed at 59°F: 00000 rpm, 00.00%

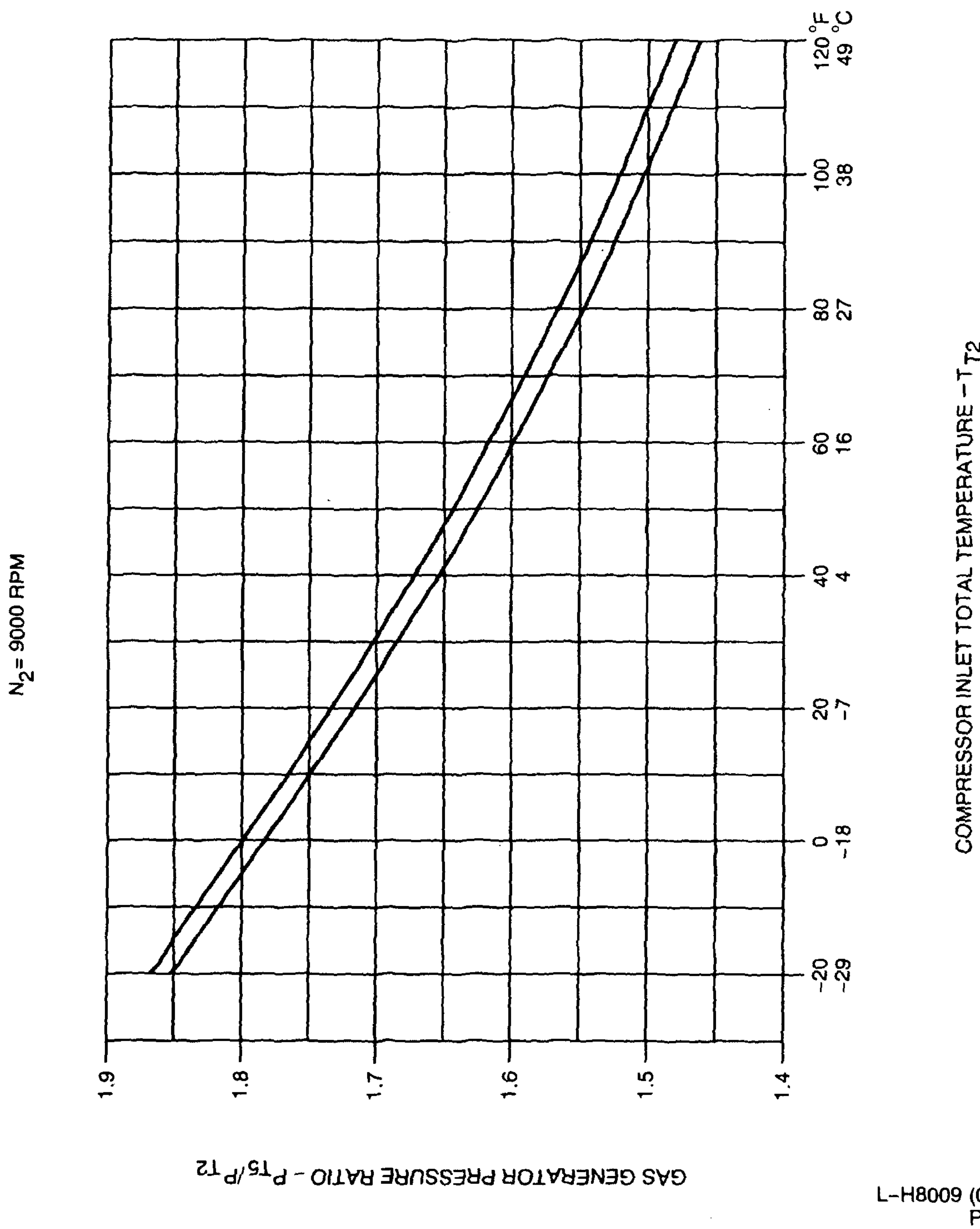
NOTE: Replacing parts that affect the gaspath, such as the compressor and turbine rotors, diffuser case and turbine nozzle, requires recomputing the data plate speed.

(20) Operating Limits

(a) Overtemperature

1 Overtemperature conditions are usually preceded by an excessively rapid rise in fuel flow, compressor speed, and/or temperature. Several momentarily high overtemperatures affect engine service life as seriously as a single prolonged overtemperature condition. The higher the temperature, the greater the threat of serious engine damage, resulting in more extensive inspections.

R
R

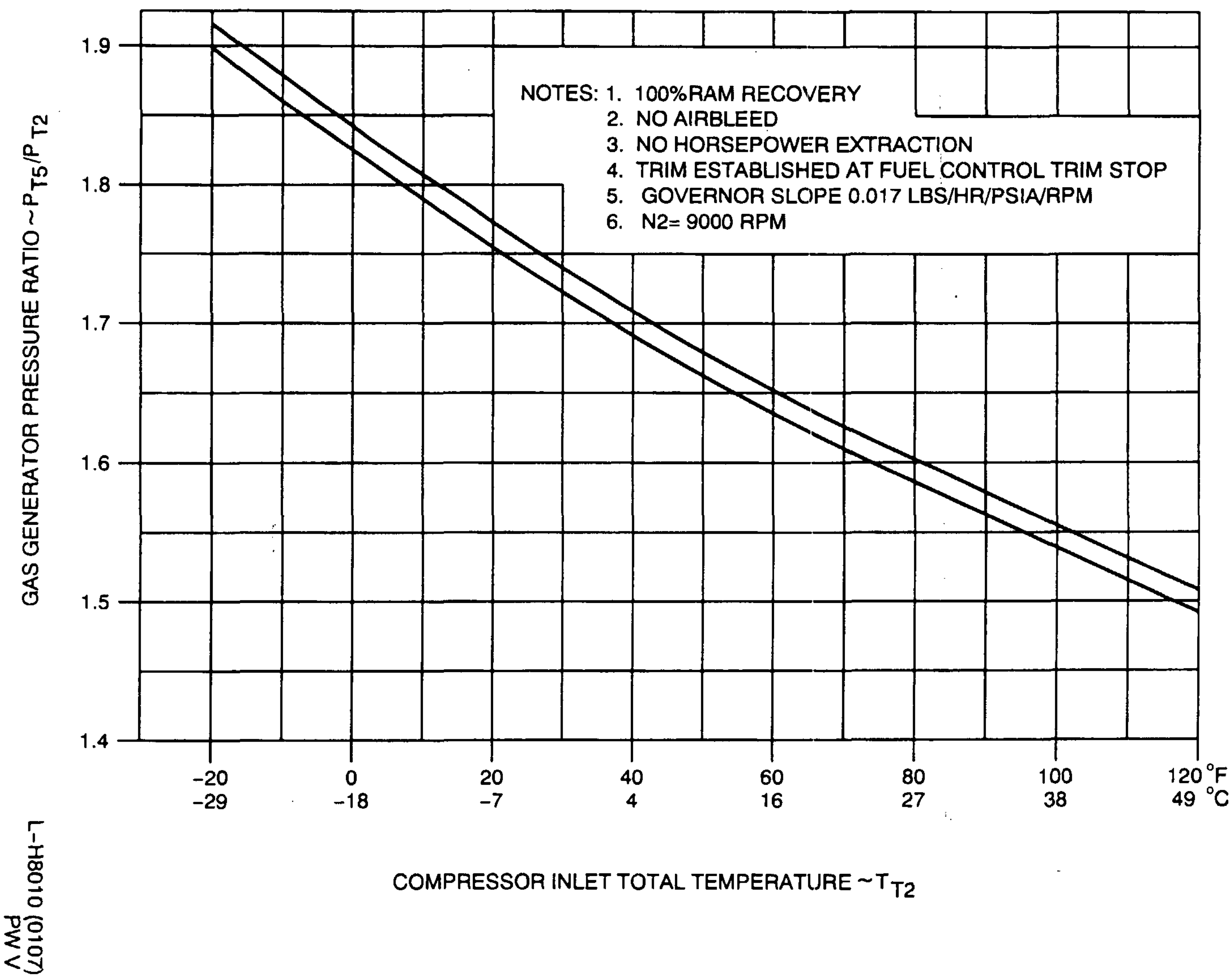


L-H8009 (0107)
PW V

R
R

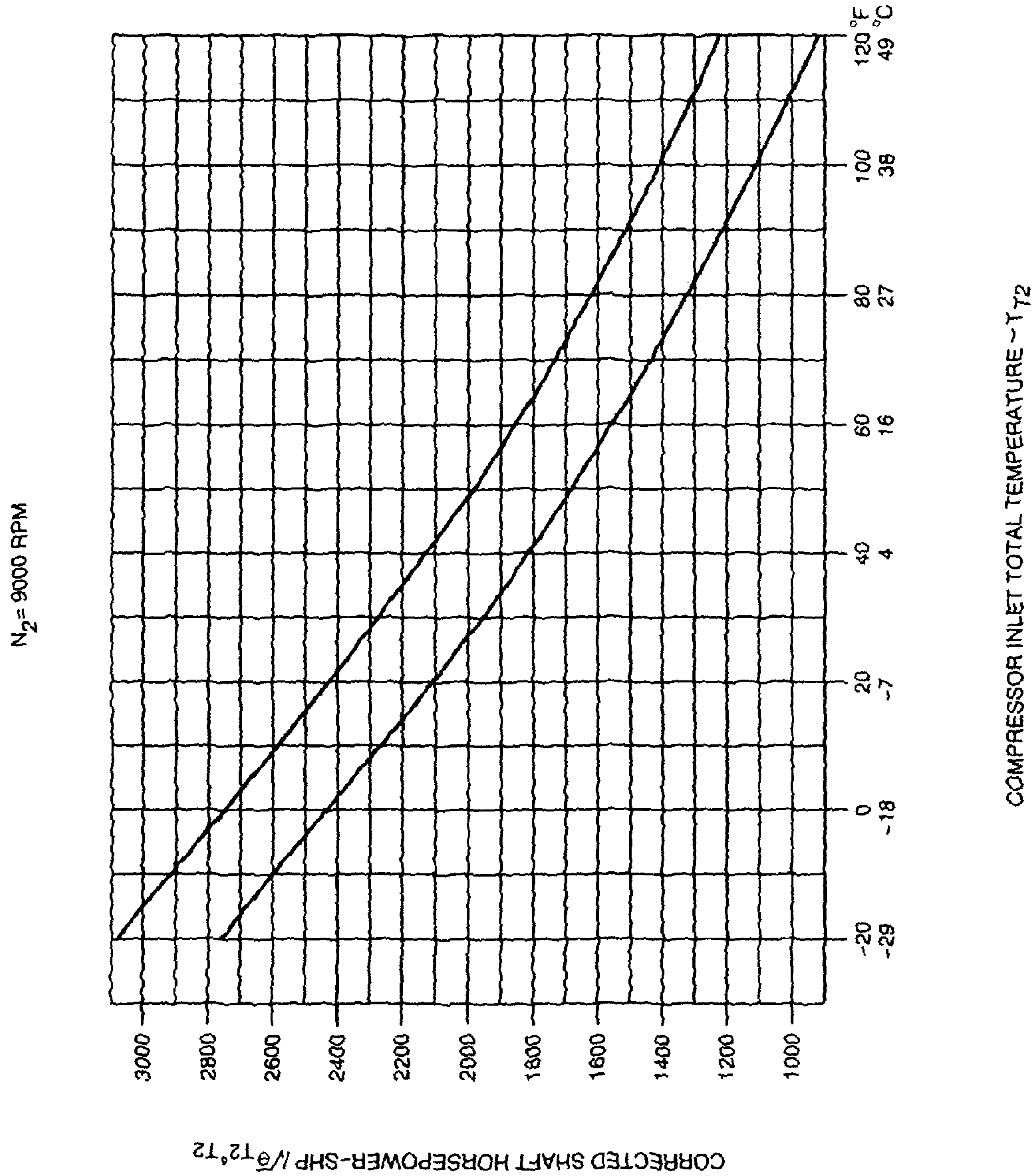
Part Power Trim Curve (JFTD12A-4A)
Figure 932 (Sheet 1)

JFTD12A-5A FREE TURBINE DRIVE ENGINE
ESTIMATED REDUCED SHAFT HORSEPOWER TRIM CURVE



Part Power Trim Curve (JFTD12A-5A)
Figure 932 (Sheet 2)

R
R



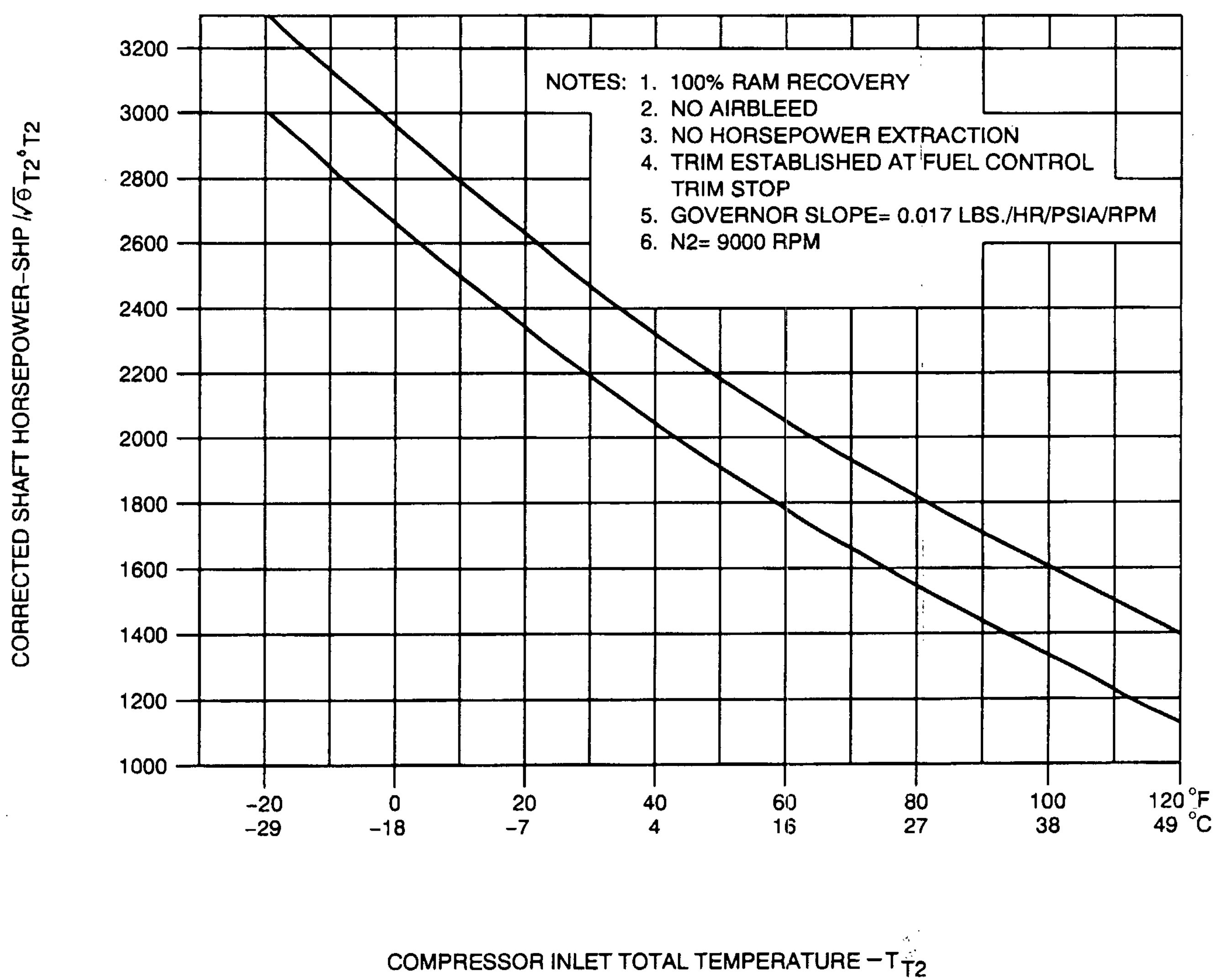
L-H8011 (0107)
PW V

R
R

Part Power Corrected Shaft
Horsepower Check Curve
(JFTD12A-4A)
Figure 933 (Sheet 1)

R
R

JFTD12A-5A FREE TURBINE DRIVE ENGINE
ESTIMATED REDUCED SHAFT HORSEPOWER TRIM CHECK CURVE



L-H8012 (0107)
PW V

Part Power Corrected Shaft Horsepower Check Curve
(JFTD12A-5A)
Figure 933 (Sheet 2)

72-0005

2 When an overtemperature condition is anticipated or has occurred, perform engine shutdown by Paragraph 6. Avoid emergency shutdown unless it becomes obvious that continued operation will result in more than overtemperature damage.

3 Overtemperature limits and corresponding inspection procedures are presented in Table 913 and Table 914, and in Figure 934, Figure 935 (Sheet 1), and Figure 935 (Sheet 2).

4 The charts list overtemperature conditions in the left-hand column and the action to take in the right-hand column. For example, if Tt5 is observed for a given length of time and falls within a category listed in the left-hand column, then refer to the applicable instructions in the right-hand column.

5 In Figure 934, Figure 935 (Sheet 1), and Figure 935 (Sheet 2) the left margin contains the temperature (Tt5°C/°F) and the bottom margin contains the time in seconds. The temperature and time lines intersect within coded blocks in the graph. Plot the temperature and time on the graph to the point where they intersect. The letter code in the block indicates the procedure to follow in the legend.

(21) Overspeed
See Table 915 and Table 916.

(a) Overspeed Cutout System

1 This system (incorporated in the fuel control), which is set to cut out at 10,350 (N2) rpm, automatically shuts off the fuel flow. In the event the fuel flow shuts off, proceed as follows:

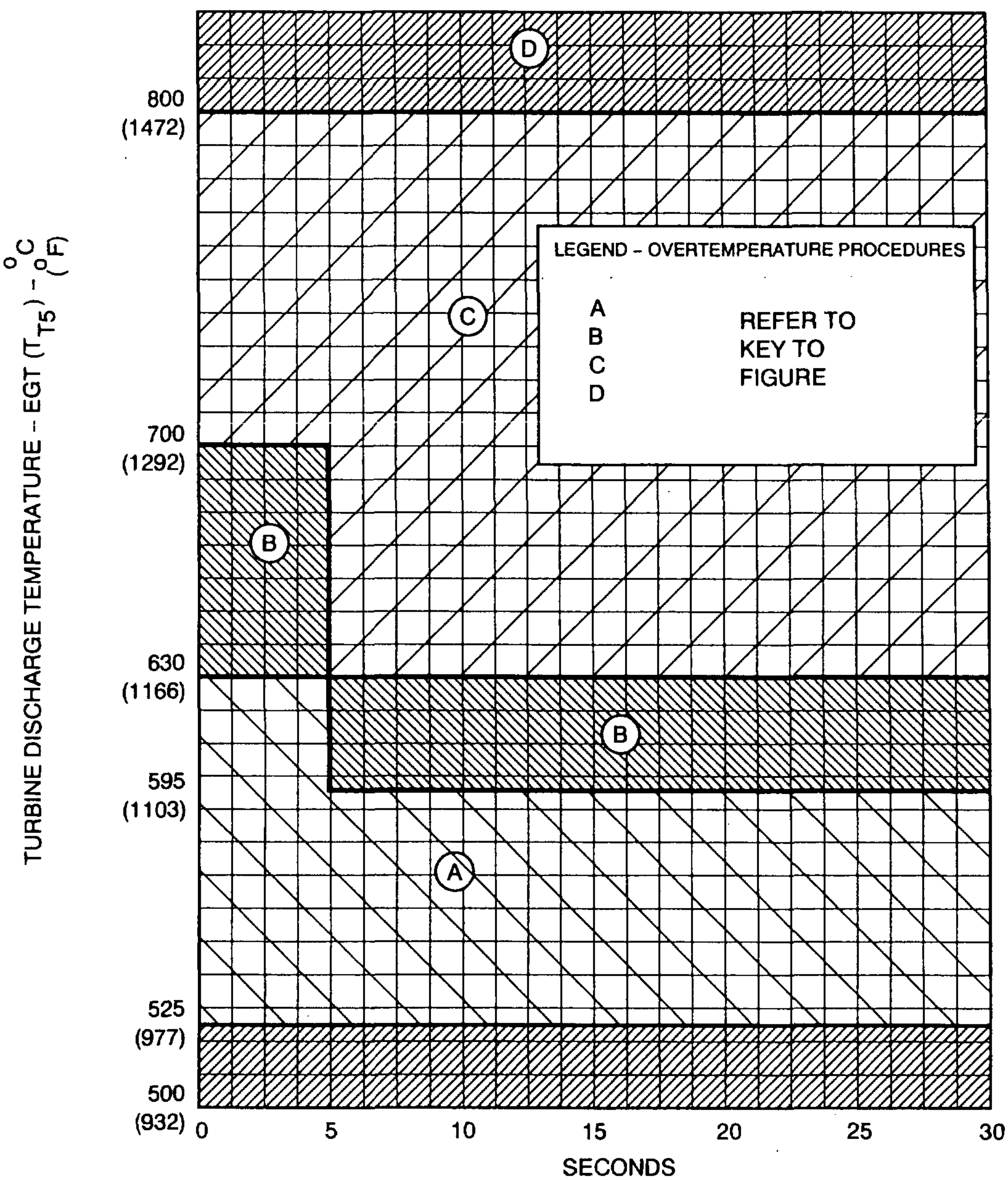
a Slowly return the N1 lever to OFF.

b Decrease the pitch lever to the minimum position.

c Apply the maximum dynamometer load.

d Restart the engine by using the standard startup procedure.

R
R



L-50815 (0107)
PW V

R
R

Engine Startup Overtemperature
(JFTD12A-4A, And -5A)
Figure 934

Notes For Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Do inspections of the combustion section and turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine and free turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend and twist.

(3) Examine all free turbine vanes for bow.

(4) Do stretch inspections of all turbine and free turbine blades.

(5) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to find the temperature at which they operated. Refer to the Standard Practices Manual, Section 70-36-00. Blades that do not have indications that they got to 1094°C (2000°F) can return to service if they are in all inspection limits. Scrap blades that have indications that they got to 1094°C (2000°F) or more.

(2) FPI all turbine vanes and all free turbine blades and vanes. Refer to Section 72-00-00, Inspection.

(3) Examine all turbine vanes for bow, bend, and twist.

Key to Figure 934

(4) Examine all free turbine vanes for bow.

(5) Examine all free turbine blades for stretch.

(6) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 934 (Continued)

	Tt5 CONDITION	Tt5 ACTION REQUIRED
A	•Exceeds 688°C (1271°F) •Does not exceed 730°C (1346°F) for more than 5 seconds •Does not exceed 760°C (1400°F)	Determine the cause of overtemperature. Correct the overtemperature.
B(1)	•Exceeds 760°C (1400°F) for 5 seconds or less •Does not exceed 770°C (1420°F)	Perform a visual inspection of hot section parts:
(2)	•Exceeds 730°C (1346°F) for more than 5 seconds but less than 2 minutes •Does not exceed 760°C (1400°F)	(a) Inspect exhaust duct for foreign particles. (b) Inspect turbine rear for apparent damage (c) Inspect combustion section, turbine vanes, and turbine section front for excessive distortion or damage.
C(1)	•Exceeds 730°C (1346°F) for more than 2 minutes •Does not exceed 800°C (1472°F)	Perform a teardown inspection of hot section parts: (Refer to Section 72-40-00, Inspection)
(2)	•Exceeds 760°C (1400°F) for more than 5 seconds but less than 5 minutes •Does not exceed 800°C (1472°F)	(a) FPI turbine and free turbine blades and vanes. (b) Inspect turbine vanes for bow, bend, and twist. (c) Inspect turbine vanes for bow. (d) Inspect turbine and free turbine disks for growth and hardness. Hardness must be at least Rockwell A66.
(3)	•Exceeds 770°C (1420°F) for 5 seconds or less •Does not exceed 800°C (1472°F)	

R
R

Overtemperature Limits
(Engine Operating - JFTD12A-4A)
Table 913

72-0005

	Tt5 CONDITION	Tt5 ACTION REQUIRED
D	•Exceeds 800°C (1472°F) for any length of time	Perform a complete overhaul inspection of hot section parts: (Refer to Section 72-40-00, Inspection) (a) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that reach 1094°C (2000°F) or more. (b) FPI all turbine vanes and free turbine blades and vanes. Refer to Section 72-00-00, Inspection. (c) Examine turbine vanes for bow, bend and twist. Refer to Section 72-50-00, Inspection. (d) Examine free turbine vanes for bow. Refer to Section 72-50-00, Inspection. (e) Inspect free turbine blades for stretch. Refer to Section 72-50-00, Inspection. (f) Do growth and hardness checks of all turbine and free turbine disks.

R
R
Overtemperature Limits
(Engine Operating - JFTD12A-4A)
Table 913 (Continued)

Tt5 CONDITION	Tt5 ACTION REQUIRED
	Hardness must be Rockwell A66 or more.

Overtemperature Limits
(Engine Operating - JFTD12A-4A)
Table 913 (Continued)

	Tt5 CONDITION	Tt5 ACTION REQUIRED
A	●Exceeds 720°C (1328°F) ●Does not exceed 730°C (1346°F) for more than 5 seconds ●Does not exceed 760°C (1400°F)	Determine the cause of overtemperature. Correct the overtemperature.
B(1)	●Exceeds 760°C (1400°F) for 5 seconds or less ●Does not exceed 770°C (1420°F)	Perform a visual inspection of hot section parts: (a) Inspect exhaust duct for foreign particles. (b) Inspect turbine rear for apparent damage (c) Inspect combustion section, turbine vanes, and turbine section front for excessive distortion or damage.
(2)	●Exceeds 730°C (1346°F) for more than 5 seconds but less than 2 minutes ●Does not exceed 760°C (1400°F)	
C(1)	●Exceeds 730°C (1346°F) for more than 2 minutes ●Does not exceed 800°C (1472°F)	Perform a teardown inspection of hot section parts: (Refer to Section 72-40-00, Inspection) (a) FPI turbine and free turbine blades and vanes. (b) Inspect turbine vanes for bow, bend, and twist. (c) Inspect free turbine vanes for bow. (d) Inspect turbine and free turbine blades for stretch. (e) Inspect turbine and free turbine disks for growth and hardness. Hardness must be at least Rockwell
(2)	●Exceeds 760°C (1400°F) for more than 5 seconds but less than 5 minutes ●Does not exceed 800°C (1472°F)	
(3)	●Exceeds 770°C (1420°F) for 5 seconds or less ●Does not exceed 800°C (1472°F)	

R Overtemperature Limits
R (Engine Operating - JFTD12A-5A)
Table 914

Tt5 CONDITION		Tt5 ACTION REQUIRED
(CONTINUED)		A66.
D	•Exceeds 800°C (1472°F) for any length of time	Perform a complete overhaul inspection of hot section parts: (Refer to Section 72-40-00, Inspection) (a) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that reach 1094°C (2000°F) or more. (b) FPI all turbine vanes and free turbine blades and vanes. Refer to Section 72-00-00, Inspection. (c) Examine turbine vanes for bow, bend and twist. Refer to Section 72-50-00, Inspection. (d) Examine free turbine vanes for bow. Refer to Section 72-50-00, Inspection. (e) Inspect free turbine blades for stretch. Refer to Section 72-50-00, Inspection.

R
R
Overtemperature Limits
(Engine Operating - JFTD12A-5A)
Table 914 (Continued)

Tt5 CONDITION	Tt5 ACTION REQUIRED
(CONTINUED)	(f) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

Overtemperature Limits
(Engine Operating - JFTD12A-5A)
Table 914 (Continued)

OBSERVED N1 CONDITION	OBSERVED N1 ACTION REQUIRED
A ●Rotor speed exceeds 16,700 rpm (104.2%) ●Does not exceed 16,900 rpm (105.4%)	(a) Check N1 rotor for free rotation and visually inspect inlet and exhaust ducts for foreign particles or evidence of rubbing. (b) Check compressor and turbine vanes and blades for damage. (c) Check free turbine blades and vanes for damage. If satisfactory, continue the engine in service. (d) If an abnormal condition is evident, then perform the teardown inspection.
B ●Rotor speed exceeds 16,900 rpm (105.4%)	Shut down the engine and send the engine to overhaul for a complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).

Overspeed Procedures
Table 915

R
R

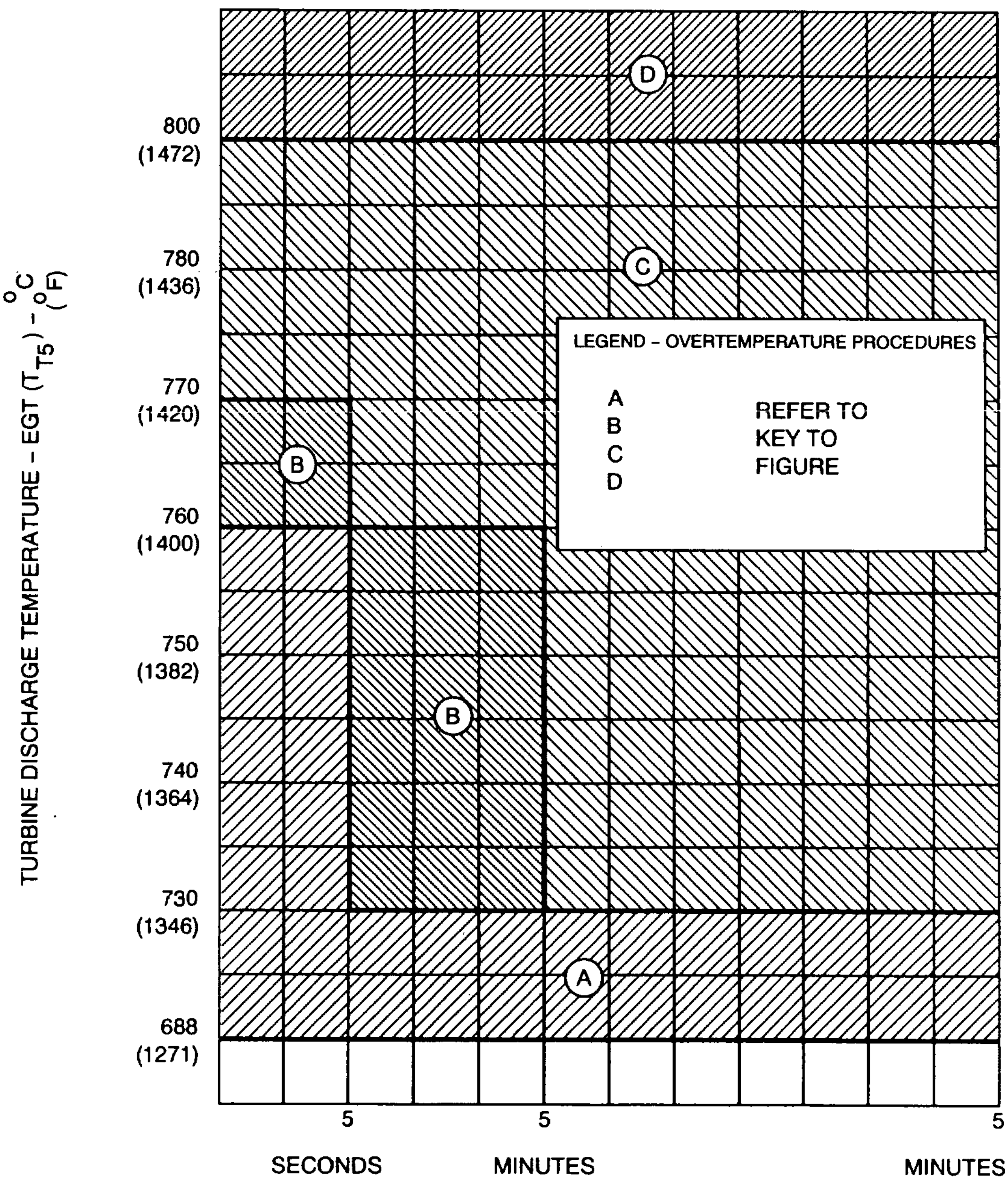
	OBSERVED N2 CONDITION	OBSERVED N2 ACTION REQUIRED
A	●Rotor speed exceeds 10,350 rpm ●Does not exceed 10,800 rpm	(a) Remove and inspect N2 speed cable. (b) Inspect N2 gearbox for positive rotation of cable drive output shaft during free turbine rotation. (c) Check the free turbine for free rotation. (d) Visually inspect exhaust ducts for particles or evidence of rubbing. (e) Check turbine blades for damage. If satisfactory, continue the engine in service. (f) If an abnormal condition is evident, then remove the free turbine and send it to overhaul.
B	●Rotor speed exceeds 10,800 rpm	Shut down the free turbine and perform a complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).

Free Turbine Overspeed Procedures
Table 916

29. <u>Engine Trim Balance Procedure</u>
(Refer to Tool Group 95B)

A. Engines with rotating parts that are balanced, as specified in Subassembly, will usually have some residual unbalance resulting in detectable vibration during engine operation. This vibration may be minimized by trim balancing, a procedure that installs counterweights positioned to offset compressor or turbine residual unbalance. Engines that exceed vibration limits during standard testing, but qualify per Paragraph B. may be trim balanced. This procedure is performed in the test cell.

<u>NOTE</u>: Trim balance can be done only on turbojet and free turbine engines that incorporate a removable front compressor hub plug.



L-50813 (0107)
PW V

R
R

Engine Operation Overtemperature Limits (JTFD12A-4A)
Figure 935 (Sheet 1)

ENGINE GENERAL - TESTING

NOTES For Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Do inspections of the combustion section and turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine and free turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend and twist.

(3) Examine all free turbine vanes for bow.

(4) Do stretch inspections of all turbine and free turbine blades.

(5) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to find the temperature at which they operate. Refer to the Standard Practices Manual, Section 70-36-00. Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that do not reach 1094°C (2000°F) or more.

(2) FPI all turbine vanes and all free turbine blades and vanes. Refer to Section 72-00-00, Inspection.

Key to Figure 935 (Sheet 1)

(3) Examine all turbine vanes for bow, bend, and twist.

(4) Examine all free turbine vanes for bow.

(5) Examine all free turbine blades for stretch.

(6) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 935 (Sheet 1) (Continued)

B. Engine Qualification For Trim Balance

(1) Trim balancing is limited by the following conditions:

(a) Only overhauled engines and repaired engines (light overhaul) that have had compressor and turbine rotors disassembled, inspected, reassembled, and balanced, can be trim balanced.

NOTE: Engines that develop a vibration while in service must not be trim balanced prior to rotor subassembly balance at overhaul or light overhaul.

(b) Engines with a vibration at any pickup point that exceeds the limit specified in Table 917 do not qualify for trim balancing.

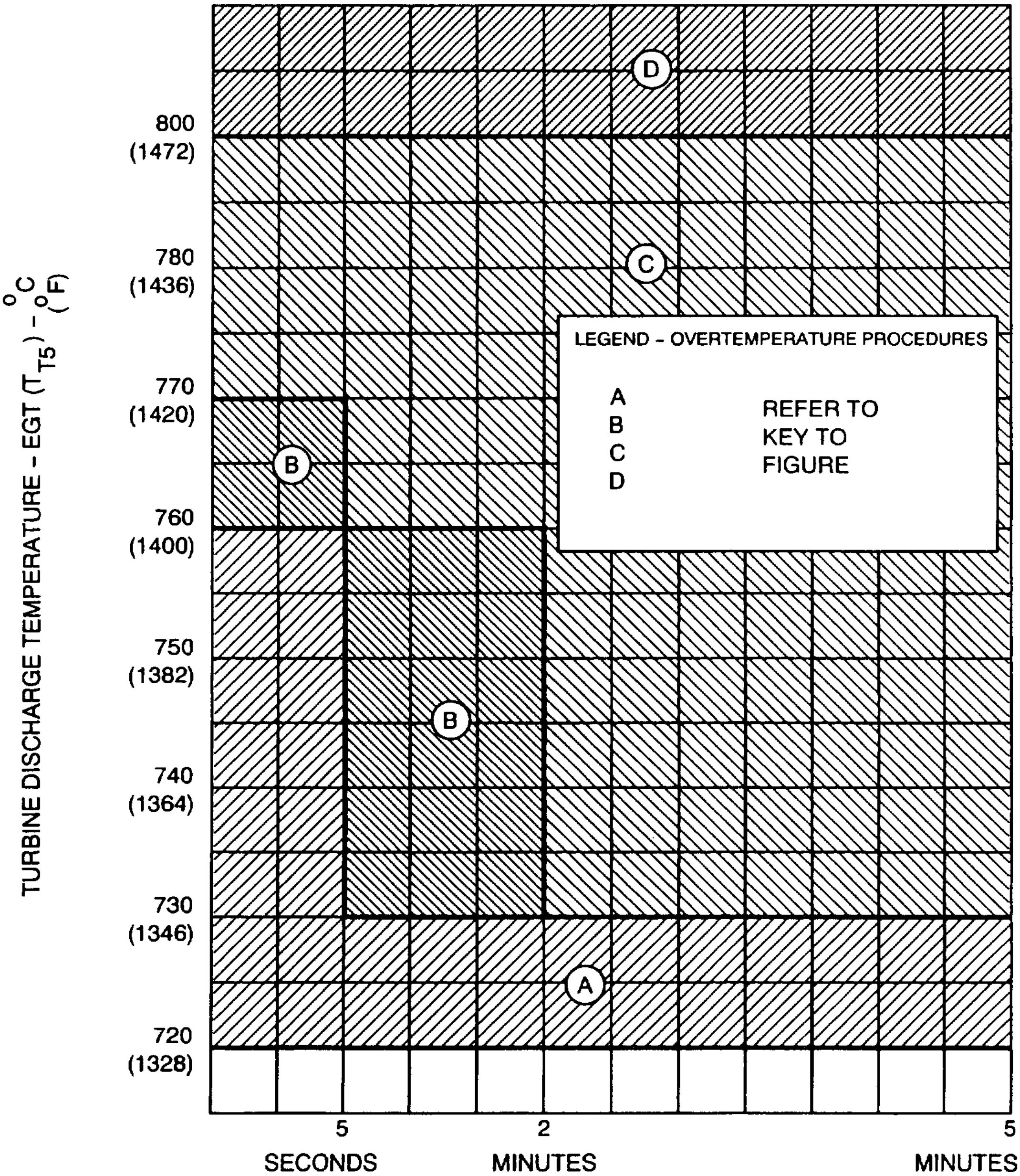
NOTE: Table 917 allows for relaxing the vibration amplitude during trim balance runs. To be acceptable, a vibration must fall within the limits in Table 921 at the completion of the trim balance.

C. Engine Classification

(1) The engine must be classified by comparing results of the prebalance vibration survey with Figure 936 and Table 918 (turbojet engines), or with Figure 937 and Table 919 (free turbine engines). It is possible for an engine to have vibration characteristics that place it in more than one class. When this happens, place the engine in a class where the highest amplitude occurs. Trim balance the vibration within limits and proceed to the next class.

D. Equipment Required For Trim Balancing
See Figure 938.

R
R



L-50817 (0107)
PW V

R
R

Engine Operation Overtemperature Limits (JFTD12A-5A)
Figure 935 (Sheet 2)

NOTEs For Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Do inspections of the combustion section and turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine and free turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend and twist.

(3) Examine all free turbine vanes for bow.

(4) Do stretch inspections of all turbine and free turbine blades.

(5) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to find the temperature at which they operate. Refer to the Standard Practices Manual, Section 70-36-00. Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that do not reach 1094°C (2000°F) or more.

(2) FPI all turbine vanes and all free turbine blades and vanes. Refer to Section 72-00-00, Inspection.

(3) Examine all turbine vanes for bow, bend, and twist.

Key to Figure 935 (Sheet 2)

R
R

(4) Examine all free turbine vanes for bow.

(5) Examine all free turbine blades for stretch.

(6) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 935 (Sheet 2) (Continued)

(1) The following recommended equipment is used to measure the parameters required to perform trim balance, such as vibration amplitude, rotor speed, and phase angle.

(a) Vibration Pickups - Phased velocity type, CEC 4-123A, or equivalent. Accelerometers can be used, however, if the readout is in velocity, then phase angle lags are affected and trim balance displacement limits require conversion to velocity.

NOTE: Vibration pickups can be obtained from Consolidated Electrodynamics Corporation, or another manufacturer with equivalent equipment.

VIBRATION PICKUP	ABOVE 15,500 RPM	BELOW 15,500 RPM
	TURBOJET ENGINES	
No. 1 Inlet Case-Flange A Vertical	.0020 inch (2.0 mils)	.0024 inch (2.4 mils)
No. 2 Inlet Case-Flange A Horizontal	.0020 inch (2.0 mils)	.0024 inch (2.4 mils)
No. 3 Combustion Chamber Outer Case-Flange E Horizontal	.0020 inch (2.0 mils)	.0020 inch (2.0 mils)
No. 4 Gearbox-Vertical	.0020 inch (2.0 mils)	.0024 inch (2.4 mils)
	FREE TURBINE ENGINES	
No. 1 Inlet Case-Flange A Vertical	.0023 inch (2.3 mils)	.0025 inch (2.5 mils)

R Maximum Vibration Limits (Single
R Amplitude) (Trim Balance
Qualification)
Table 917

VIBRATION PICKUP	ABOVE 15,500 RPM	BELOW 15,500 RPM
No. 2 Inlet Case-Flange A Horizontal	.0023 inch (2.3 mils)	.0025 inch (2.5 mils)
No. 3 Combustion Chamber Outer Case-Flange E Horizontal	.0023 inch (2.3 mils)	.0025 inch (2.5 mils)
No. 4 Gearbox-Vertical	.0023 inch (2.3 mils)	.0025 inch (2.5 mils)

NOTE: During the trim balance run, vibration amplitudes at rotor frequency up to 0.0030 inch (single amplitude) are allowable on all vibration pickups.

Maximum Vibration Limits (Single Amplitude) (Trim Balance Qualification)
Table 917 (Continued)

(b) Speed And Reference Signal Generator - Generator (pip), Model ET-207 (or equivalent), one triangular tooth 1/16 inch flat.

NOTE: This signal generator was formerly available from Standard Electric Company of Springfield, MA.

(c) Narrow Band Filter - All portions of a vibration signal, other than rotor frequency component, are filtered out of the signal input to phase meter. The filter can be either manual or automatic tracking. If a manual filter is used, exercise caution when tuning the filters to eliminate phase errors.

(d) Pip To Sine Converter - This converter accepts the speed pip and produces a sine wave the exact frequency of, as well as locked with, the speed pip.

(e) Phase Meter - The phase angle between the filtered vibration signal and the sine wave reference signal determines the angular location of the residual unbalance.

R
R

(f) Frequency Counter - A frequency counter with a 10 second time base that determines rotor speed to 1 part in 1000.

(g) Vibration Meter Integrator - This system accepts the input signal from a vibration pickup mounted on the engine. The signal is integrated to convert it from velocity proportional to displacement proportional.

(h) Sine Wave Oscillator - The oscillator is used to calibrate the trim balance console.

(i) Oscilloscope - A dual display oscilloscope monitors the vibration and reference signals to ensure proper equipment setup and operation.

(j) X-Y Plotter (optional) - The plotter can show a plot of amplitude vs. speed, which is very helpful in classifying engine vibrations.

E. Trim Balance Equipment Setup

(1) Check vibration pickups to ensure they are in phase (positive outward displacement provides positive voltage output).

(2) Install vibration pickups by Paragraph 2.

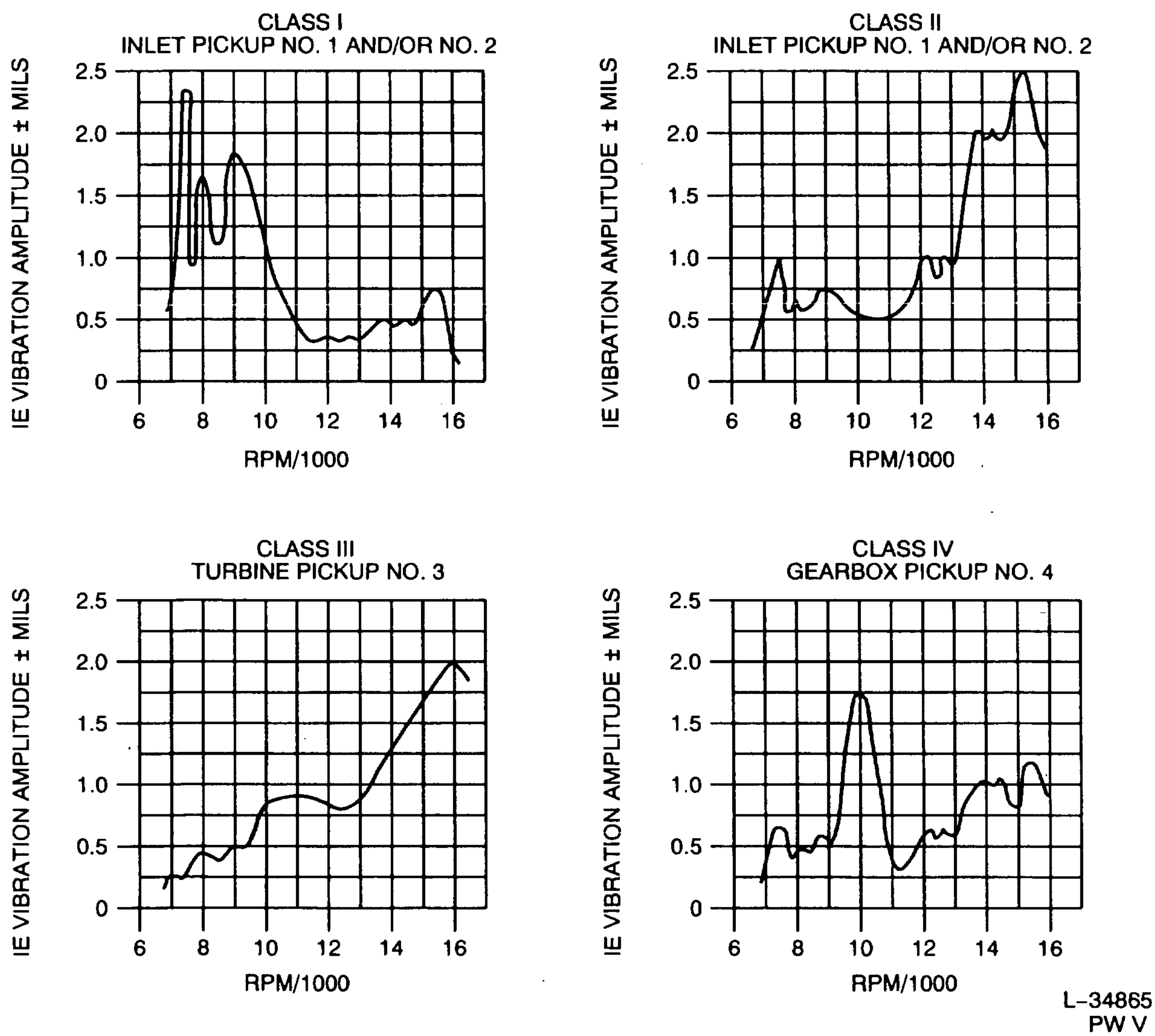
(3) Perform the following steps to install the tachometer and reference signal generator by using tachometer adapter PWA-13950 and hydraulic pump pad adapter PWA-13949:

(a) Remove nuts and washers that secure the hydraulic pump drive pad cover to the gearbox. Remove the cover.

(b) Install tachometer mount adapter PWA-13950 onto the pad and secure by using previously removed nuts and washers. Torque to 275 - 300 lb-in.

(c) Install hydraulic pump drive support adapter PWA-13949 onto the tachometer mount adapter and secure with capscrews. Connect the reference signal generator to the adapter.

R
R



R
R

Turbojet Engine Trim Balance
Classification
Figure 936

(4) Index the rotor to determine the 0 position for phase angle measurement. Align the single tooth of the pulse generator with the tip of the impulse pickup, which can be seen through the small window in the pulse generator. 0° points to 12:00 with the rotor in this position. Mark the blade and case with layout dye so that the rotor can be reindexed without realigning the tooth with the impulse pickup.

NOTE: Turn the rotor in the direction of engine rotation (counterclockwise facing the engine inlet) to pick up the backlash of the tachometer drive.

(5) Calibrate the trim balance console per the equipment manufacturer's instructions by applying an oscillator signal of known amplitude and frequency to the vibration pickup and the tachometer inputs.

(6) Set the selected speed points and allow the engine to stabilize.

(7) On automatic consoles, actuate the phase check switch to ensure that phase errors do not exist due to improper calibrating or to a tracking filter malfunction. Release the switch and read the amplitude and phase.

(8) On manual consoles, tune to the rotor frequency and read the amplitude. Actuate the phase check switch to ensure that phase errors do not exist due to improper tuning of the filter. Release the switch and read the phase.

SYMPTOM	CORRECTIVE ACTION
	CLASS I
Vibration is above limits on No. 1 and/or No. 2 pickups below 10,000 rpm.	2nd to 3rd stage spacer balance - Use No. 1 and 2 pickups. Take data at all peaks in speed range below 10,000 rpm. Determine the size and location of the first trial weight by performing trim balance at maximum vibration peak using sensitivity and phase angle lag data from Table 917. If counterweight 1 does not reduce vibration within limits, then repeat trim balance by using calculated

R
R
Vibration Classification And Corrective Action For Turbojet Engines
Table 918

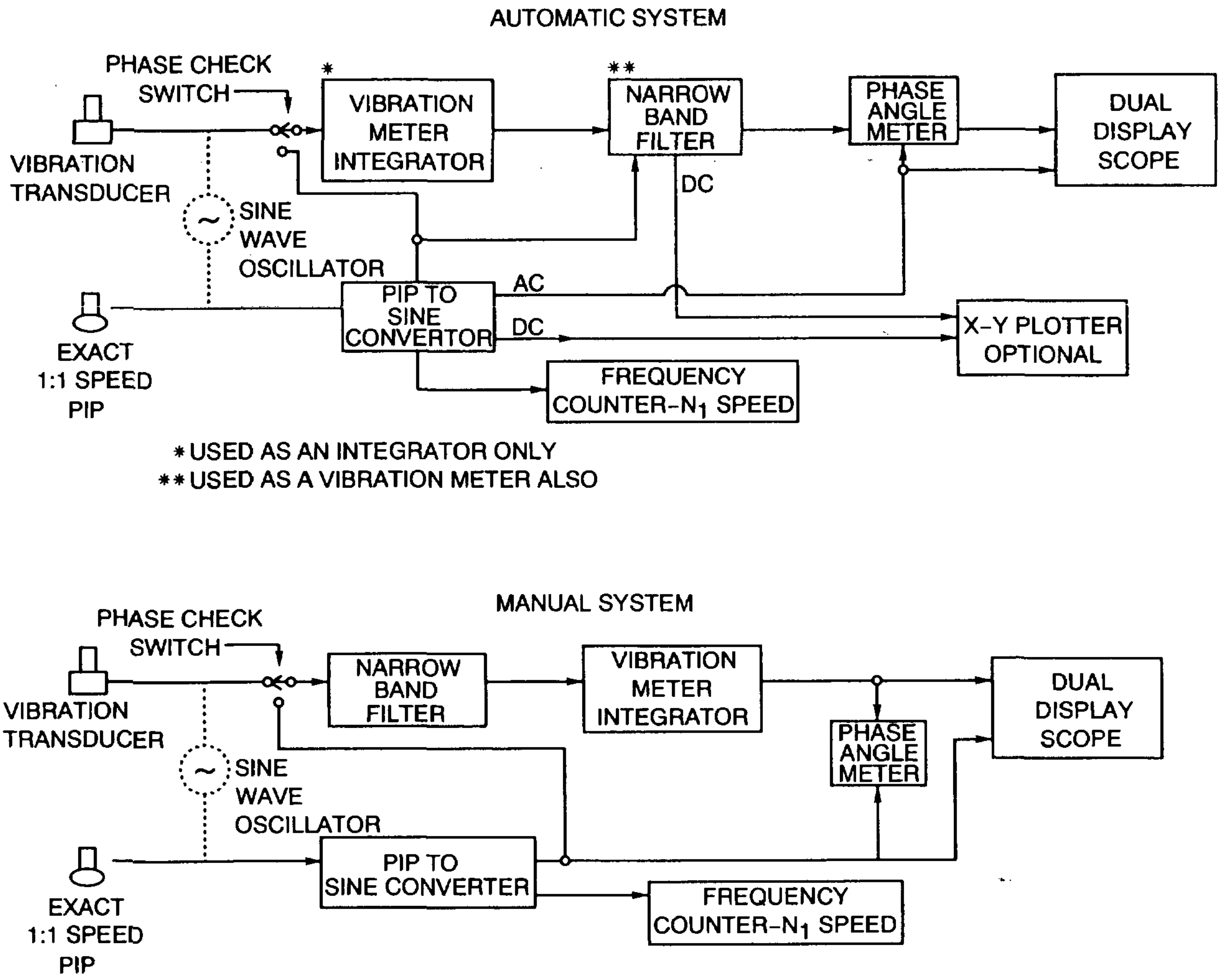
SYMPTOM	CORRECTIVE ACTION
(CONTINUED)	sensitivity and phase angle lags for the specific engine.
	CLASS II
Vibration is above limits on No. 1 and/or No. 2 pickups above 10,000 rpm.	8th to 9th stage spacer balance - Use No. 1 and 2 pickups. Take data at all peaks in speed range above 10,000 rpm. Determine the size and location of the first trial weight by performing trim balance at maximum vibration peak using sensitivity and phase angle lag data from Table 917. If counterweight 1 does not reduce vibration within limits, then repeat trim balance by using calculated sensitivity and phase angle lags for the specific engine.
	CLASS III
Vibration is above limits on No. 3 pickup generally above 10,000 rpm.	Turbine balance - Use No. 3 pickup. Take data at all peaks in speed range. Determine the size and location of the first trial weight by performing trim balance at maximum vibration peak using sensitivity and phase angle lag data from Table 917. If counterweight 1 does not reduce vibration within limits, repeat trim balance by using calculated sensitivity and phase angle lags for the specific engine.
	CLASS IV
Vibration is above limits on No. 4 pickup but within limits at all other pickups.	Review the vibration survey and determine where the highest vibration amplitude is present on the No. 1 and No. 2 pickups. If below 10,000 rpm, then use the 2nd to 3rd stage spacer balance in Class I. If above 10,000 rpm, then use the 8th to 9th stage spacer balance in Class II.

Vibration Classification And
Corrective Action For
Turbojet Engines
Table 918 (Continued)

R
R

SYMPTOM	CORRECTIVE ACTION
	CLASS I
Vibration is above limits at No. 4 pickup (sometimes No. 1 and No. 2) generally above 12,000 rpm.	8th to 9th stage spacer balance - Use No. 1, 2 and 4 pickups. Take data at all peaks in speed range. Install 1 Class 3 weight (.44 oz-in.) at any known angular location. Calculate sensitivity and phase angle lag for the engine, and repeat balance. If success is limited, then repeat on 2nd to 3rd stage spacer.
	CLASS II
Vibration is above limits at No. 3 pickup generally above 12,000 rpm.	Turbine balance - Use No. 3 pickup. Take data at all peaks in speed range. Determine the size and location of first trial weight by performing trim balance at maximum vibration peak using sensitivity and phase angle lag data from Table 917. If counterweight 1 does not reduce vibration within limits, then repeat trim balance by using calculated sensitivity and phase angle lags for the specific engine.

Vibration Classification And
Corrective Action For
Free Turbine Engines
Table 919



TRIM BALANCE SYSTEMS

L-29929
PW V

R
R

Trim Balance Systems
Figure 938

F. Detailed Trim Balance Procedure

(1) Definition Of Terms:

(a) 1E - Rotor fundamental vibration amplitude.

(b) CW - Counterweights (CW1, CW2, etc.) used to balance the engine.

(c) Phase Angle - Phase meter reading of angle that integrated vibration signal lags use to reference signal.

(d) Phase Angle Lag - Calculated angle indicating the lag between passing of unbalance weight and response signal.

(e) Assumed Phase Angle Lag - The average of phase angle lags determined during the previous balance attempts with an emphasis on current data.

(f) Sensitivity To Unbalance - Number of mils vibration produced by 1 oz-in. unbalance, stated in ±mils/oz.-in. However, it is more convenient to use the reciprocal (oz-in./± mil) throughout this procedure.

(g) Assumed Sensitivity - The average of sensitivities determined during the previous balance attempts with an emphasis on current data.

(2) Trim Balance Sequence:

(a) Conduct the prebalance vibration survey to determine suitability of the engine for trim balance and to provide the basis for classification. The survey should include the measurement of 1E and overall vibration amplitudes.

(b) Install a tachometer by Paragraph E. and run and run AS IS speed points by Table 915 or Table 916 for the model and class engine being balanced. Record 1E amplitudes and phase angles.

R
R

(c) From the AS IS data, plot the 1E amplitude and phase angle of the relevant location pickup at the relevant speed on polar coordinate graph paper. Lay out the angle counter to engine rotation direction from the 12 o'clock position, which is the A vector. Draw the R vector equal and opposite the A vector. Refer to Paragraph G.

(d) Obtain assumed phase angle lag from Table 917 for the class balance being done. The assumed phase angle lag is laid off from R vector in the direction of rotation and indicates the angular location of Counterweight 1. Refer to Paragraph G.

(e) Obtain assumed sensitivity from Table 917 for the class balance being done. Multiply the amplitude of A vector by assumed sensitivity to determine oz-in. value of Counterweight 1. Refer to Paragraph G.

(f) Reindex the rotor by aligning dye marks on the blade and case. Install counterweight 1 at the correct location by Paragraph D.

(g) Rerun the engine as in step (b) above, repeating each speed point within ±.20 rev/sec (±12 rpm) on the counter at a time base of 10 seconds. Record 1E amplitudes.

(h) If 1E amplitudes are above limits in Table 918, then the engine is still unacceptable. Calculate and install counterweight 2 by steps (d) and (f) and rerun. All weights and locations (Counterweights 1, 2, etc.) are calculated with respect to the AS IS data.

R <u>NOTE</u>: Maximum correction (all counterweights) for trim balancing the compressor must not exceed a total vector sum of 2.5 oz-in. Maximum correction (all counterweights) for trim balancing the turbine must not exceed a total vector sum of 1.0 oz-in. Prior installed weights used for balancing rotor components on the balance machine may be moved or replaced. The total number of weights used on the final rotor assembly must not exceed 4 bill of material weights per balance flange, and 6 compressor spacer clip-on weights per spacer.

R

(i) If the engine is acceptable, then repeat the vibration survey to ensure that 1E amplitudes repeat within ± 0.3 mils.

(j) Calculate phase angle lags and sensitivities by using AS IS and final balance weight data. Compile this information for future balances.

(3) Test Equipment And Inlet Case Cover Removal

(a) Remove the test equipment (pressure hoses, bellmouth, Tt2 lead, etc.) to gain access to the front of the inlet case.

(b) Remove the inlet cone assembly as follows:

1 Remove the front cone assembly followed by the outer cone assembly.

2 Remove the support assembly from the center cover of the inlet case.

(c) Remove wire, nuts and washers that secure the inlet case cover to the inlet case. Remove the cover.

(d) Protect the oil scavenge tube with a suitable cover, and remove wire, nuts and washers that secure the No. 1 bearing oil jet. Remove the oil jet and strainer.

NOTE: Be careful not to lose the strainer. Make sure that the oil jet location is suitably covered.

(4) Installation Of Compressor And Turbine Weights

(a) Perform the following steps to install the compressor counterweights:

1 Remove the rivet that secures the No. 1 bearing inner race retaining nut to the front compressor hub by using remover PWA 13963.

2 Remove 3 bolts and key washers that secure the plug in the front compressor hub.

3 Remove the front hub plug by using puller PWA 13974 or equivalent. Position the jaw ends of the puller into 11/32 inch diameter holes in the plug, and secure in place by adjusting the screw nut. Use knocker hammer action to remove the plug. Remove the packing from the rear groove in the plug.

4 Rotate the compressor so that the counterweight installation location is in the 6 o'clock position.

5 Install tierod sleeve clip-on counterweights (See Table 919) with compressor rotor trim balance counterweight inserter PWA 13964 and observation periscope PWA 13952A, or equivalents.

a Position the periscope mirror and light assembly to line up with the spacer that requires counterweight installation. Insert the full length of the periscope through the opening in the hub.

b Place the counterweight between the holding clips on the inserter. Pass the inserter through the periscope, the periscope side slot, and into the compressor.

Pickup	Speed RPM	Sensitivity oz-in/±MIL	Phase Angle Lag	Balance Plane
Inlet Pickup- Vertical No. 1	7,500	0.61	135°	2nd to 3rd Stage Spacer
	8,000	0.85	155°	2nd to 3rd Stage Spacer
	9,000	0.78	170°	2nd to 3rd Stage Spacer
	12,250	0.75	220°	2nd to 3rd Stage Spacer
	12,250	0.99	225°	8th to 9th Stage Spacer
	13,000	1.03	225°	8th to 9th Stage Spacer
	14,000	0.51	245°	8th to 9th Stage Spacer

R Trim Balance Data (Class I, II,
R And IV Turbojet And Class I
Free Turbine Engines
Table 920

Pickup	Speed RPM	Sensitivity oz-in/±MIL	Phase Angle Lag	Balance Plane
(CONTINUED)	14,500	0.47	260°	8th to 9th Stage Spacer
	15,600	0.35	320°	8th to 9th Stage Spacer
	16,000	0.48	340°	8th to 9th Stage Spacer
Inlet Pickup-Horizontal No. 2	7,500	1.37	155°	2nd to 3rd Stage Spacer
	8,000	0.98	190°	2nd to 3rd Stage Spacer
	9,000	0.83	215°	2nd to 3rd Stage Spacer
	12,250	0.84	285°	2nd to 3rd Stage Spacer
	12,250	0.94	300°	8th to 9th Stage Spacer
	13,000	0.67	325°	8th to 9th Stage Spacer
	14,000	0.59	345°	8th to 9th Stage Spacer
	14,500	0.46	350°	8th to 9th Stage Spacer
	15,600	0.39	10°	8th to 9th Stage Spacer
	16,000	0.45	30°	8th to 9th Stage Spacer
	Turbine Balance - Class II Free Turbine Engines			
Turbine Pickup-No. 3	12,250	0.41	5°	Turbine Balance Ring
	13,000	0.33	5°	Turbine Balance Ring
	14,000	0.42	40°	Turbine Balance Ring
	14,500	0.74	55°	Turbine Balance Ring
	15,600	0.93	85°	Turbine Balance Ring
	Turbine Balance - Class III Turbojet Engines			

R
R

Trim Balance Data (Class I, II, And IV Turbojet And Class I Free Turbine Engines
Table 920 (Continued)

Pickup	Speed RPM	Sensitivity oz-in/±MIL	Phase Angle Lag	Balance Plane
Turbine Pickup- No. 3	14,000	1.51	280°	Turbine Balance Ring
	14,500	1.13	280°	Turbine Balance Ring
	15,600	1.00	315°	Turbine Balance Ring
	16,000	0.89	315°	Turbine Balance Ring

NOTE: Keep records of Sensitivity and Phase angle Lag on the runs made, because in the future it may be necessary to make changes to the table. Refer to Paragraph K.

Trim Balance Data (Class I, II, And IV Turbojet And Class I Free Turbine Engines
Table 920 (Continued)

Vibration Pickup Location	Below 15,500 RPM	Above 15,500 RPM
Turbojet Engine		
No. 1 Inlet Case Flange A Vertical	.0016 in.(1.6 mils)	.0012 in.(1.2 mils)
No. 2 Inlet Case Flange A Horizontal	.0016 in.(1.6 mils)	.0012 in.(1.2 mils)
No. 3 Combustion Chamber Outer Case Flange E Horizontal	.0012 in.(1.2 mils)	.0012 in.(1.2 mils)
No. 4 Gearbox Vertical	.0016 in.(1.6 mils)	.0012 in.(1.2 mils)
Free Turbine Engine		
No. 1 Inlet Case Flange A Vertical	.0017 in.(1.7 mils)	.0015 in.(1.5 mils)
No. 2 Inlet Case Flange A Horizontal	.0017 in.(1.7 mils)	.0015 in.(1.5 mils)

R Maximum Vibration Limits (Single
R Amplitude) After Trim Balance
Table 921

Vibration Pickup Location	Below 15,500 RPM	Above 15,500 RPM
No. 3 Combustion Chamber Outer Case Flange E Horizontal	.0017 in.(1.7 mils)	.0015 in.(1.5 mils)
No. 4 Gearbox Vertical	.0017 in.(1.7 mils)	.0015 in.(1.5 mils)

NOTE: After the trim balance, vibration amplitudes must be observed at steady state, running at all speeds in the operating range, and must not exceed the limits in the table above. A second vibration survey must be made to demonstrate repeatability. Variations between runs must not exceed 0.0003 inch (0.3 mils) single amplitude.

Maximum Vibration Limits (Single Amplitude) After Trim Balance
Table 921 (Continued)

c Position the inserter over the spacer sleeve that requires the counterweight. Exert pressure on the inserter in the direction of the spacer sleeve (radially outward) until the counterweight snaps into place.

d Remove the inserter by exerting pressure in the opposite direction until holder clips are released from the counterweight. Slowly remove the inserter from the periscope. Remove the periscope.

6 Remove the trim balance counterweights by using counterweight remover PWA 13969 and observation periscope PWA 13952A, or equivalents.

a Position the periscope mirror and light assembly so they line up with the spacer that requires counterweight removal. Insert the full length of the periscope through the opening in the hub.

Class	Weight (oz)	Moment (oz-in) 2nd to 3rd Stage Spacer	Moment (oz-in) 8th to 9th Stage Spacer
1	.061	.21	.28
2	.082	.29	.38

R
R

Compressor Counterweights
Table 922

Class	Weight(oz)	Moment (oz-in) 2nd to 3rd Stage Spacer	Moment (oz-in) 8th to 9th Stage Spacer
3	.095	.33	.44

NOTE: There are 16 tiebolt sleeves at 22.5° intervals in the 2nd to 3rd stage spacer. There are 12 tiebolt sleeves at 30.0° intervals in the 8th to 9th stage spacer.

Compressor Counterweights
Table 922 (Continued)

b Insert the counterweight remover through the periscope, the periscope side slot, and into the compressor, positioning it on the counterweight to be removed. Turn the knurled knob at the end of the remover to engage the jaws under the counterweight. Continue turning the knob until the counterweight is off the spacer sleeve.

c Slowly remove the tool from the periscope. Remove the periscope. Remove the counterweight from the tool by retracting the knurled knob.

7 Install packing on the front hub plug. Reinstall the plug in the front hub by using guide PWA 13946 or equivalent. Align the 3 tapped holes in the plug with the three 3/16 inch diameter holes in the hub.

NOTE: For engines that incorporate SB 4110, classified plug (PN 733514) has been machined to fit the hub ID and does not require packing. If the plug needs replacing, then a new plug (PN 735369) must be machined to the appropriate class and identified by SB 4110.

8 Install bolts and key washers at 3 tapped hole locations. Torque and bend key washers to secure.

R
R

9 Install a rivet to secure the No. 1 bearing inner race retaining nut to the front compressor hub. The head of the rivet sits inside the larger hole in the plug. Flare the rivet by using riveter PWA 13975 or equivalent.

10 Reinstall the oil jet, inlet case cover, inlet cone assembly, and the previously removed test equipment.

(b) Perform the following steps to install the turbine counterweights:

1 Remove the free turbine and/or exhaust case.

2 Install counterweights (See Table 924) on the rear balance flange by using turbine weight riveter PWA 13277 or equivalent.

3 Replace the free turbine and/or exhaust case.

G. Example Of Trim Balance Procedure - Hypothetical

(1) This example of a turbojet engine trim balance demonstrates the procedure step by step.

(a) A vibration survey indicates that an engine is above limits throughout the speed range on the No. 1 and 2 pickups. Figure 939 shows the pre-trim balance survey transient data. Table 921 lists the maximum amplitude readings.

(b) The engine has vibration characteristics that place it in Classes I and II. (See Table 915) However, the engine is placed first in the class where the highest amplitude vibration occurs: Class I that requires 2nd to 3rd stage spacer balance. Refer to Run No. 1 in Table 921.

(c) Plot Vector A (±1.9 mils at 330°). Lay out the angle counter to engine rotation from the 12 o'clock location. Draw Vector R (vector required to balance the engine) equal and opposite to Vector A. See Figure 942.

(d) Apply the assumed phase angle lag (135 degrees from Table 925) laying it off from R in the direction of engine rotation. Therefore, Counterweight 1 should be installed at 15 degrees, measured from the 12 o'clock reference location indicated in Paragraph.

Class	Weight (oz)	Moment (oz-in)
A (2 holes)	.220	.60
B (3 holes)	.346	.96
C (4 holes)	.467	1.29

NOTE: The rivet weight, .00044 oz., is included in the calculation of the turbine weight moment.

NOTE: There are 36 holes at 10° intervals on the turbine balance ring.

Turbine Counterweights
Table 923

Run No.	Speed (RPM)	Frequency (Hz)	Vibration Amplitude (±MIL) 1E	Overall	Phase Angle	Pickup No.
Pre-trim Balance Survey	7560	126.1	1.9	2.1		1
	15620	260.3	1.8	1.8		1
1	7560	126.0	1.9		330°	1
2	7560	126.0	1.5		250°	1
3	7570	126.1	0.25		220°	1
High Speed Run Vibration Survey	15620	260.3	2.0	2.1		1
4	15620	260.3	2.0		50°	1
5	7560	126.0	0.4		210°	1
	15620	260.3	0.3		340°	1

R
R

Trim Balance Vibration Surveys
Table 924

Run No.	Speed (RPM)	Frequency (Hz)	Vibration Amplitude (±MIL) 1E	Overall	Phase Angle	Pickup No.
6	7560	126.0	0.4	0.5		1
	15620	260.3	0.4	0.5		1

Trim Balance Vibration Surveys
Table 924 (Continued)

(e) Apply the assumed sensitivity from Table 917. Multiply the amplitude of A vector (±1.9 mil) by the assumed sensitivity (.61 oz-in./±mil). The magnitude of counterweight 1 should be 1.16 oz-in.

(f) Install Counterweight 1. Counterweight locations are restricted to spacer sleeve locations. Install 1 Class I weight and 1 Class III weight (.54 oz-in. each) at 0° and 22.5° on the 2nd to 3rd stage spacer sleeves, for a vector sum of 1.07 oz-in. at 11 degrees. Use Figure 941 to calculate the vector sum as follows:

1 Plot Points B and C. These points represent the angular location and magnitude of each selected counterweight.

2 Construct Lines AB and AC followed by BD parallel to AC, and CD parallel to AB.

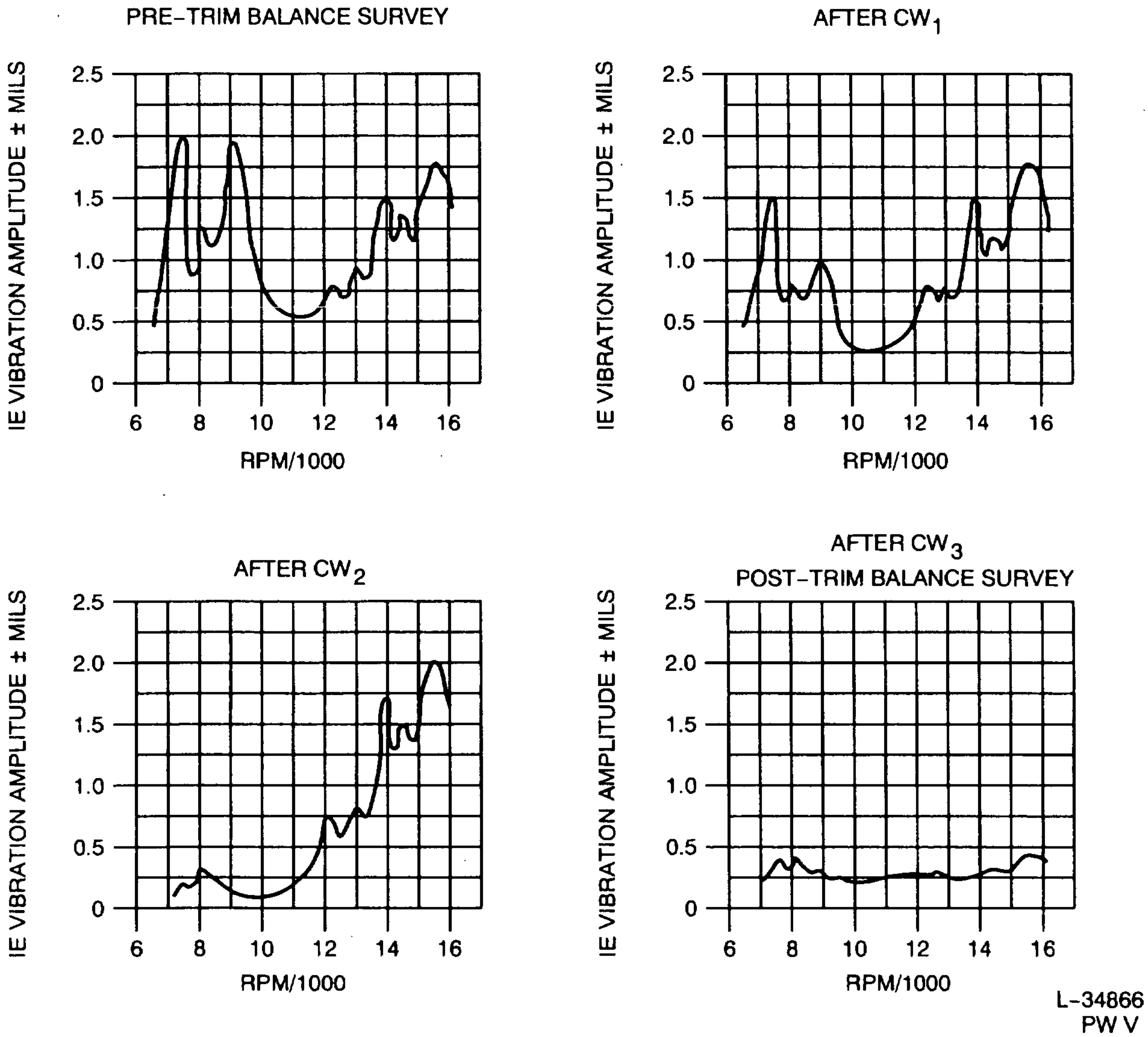
3 Determine vector sum AD by using the intersecting point between Lines BD and CD.

(g) The balance point is rerun. Refer to Run No. 2 in Table 924. Refer to After CW1 (Counterweight 1) in Figure 939 for transient data.

(h) Plot Vector C (±1.5 mils at 250°) shown in Figure 940. Plot the vector difference (VD):

1 Subtract Vector A from Vector C; Draw VD from A to C with the arrow pointing to C; Translate VD to the origin; and maintain parallelism with AC.

R
R



R
R

Trim Balance Surveys Of
Hypothetical Example
Figure 939

2 VD represents the effect of Counterweight 1 alone, both in magnitude and direction, to eliminate unbalance. VD must be rotated and adjusted in length to coincide with R vector.

(i) Calculate the amount and location of 2 counterweight:

1 $$CW2 = CW1 \text{ X } \frac{A(mils)}{VD(mils)} - 1.07 \text{ X } \frac{1.9}{2.2} = .92 \text{ oz-in.}$$

2 Determine the location of counterweight 2 as follows: The angle between VD (at 192°) and R

3 Remove counterweight 1, and install Counterweight 2 (.92 oz-in.) 42 degrees from Counterweight 1 in the direction of rotation, which is 329 degrees. See Figure 944.

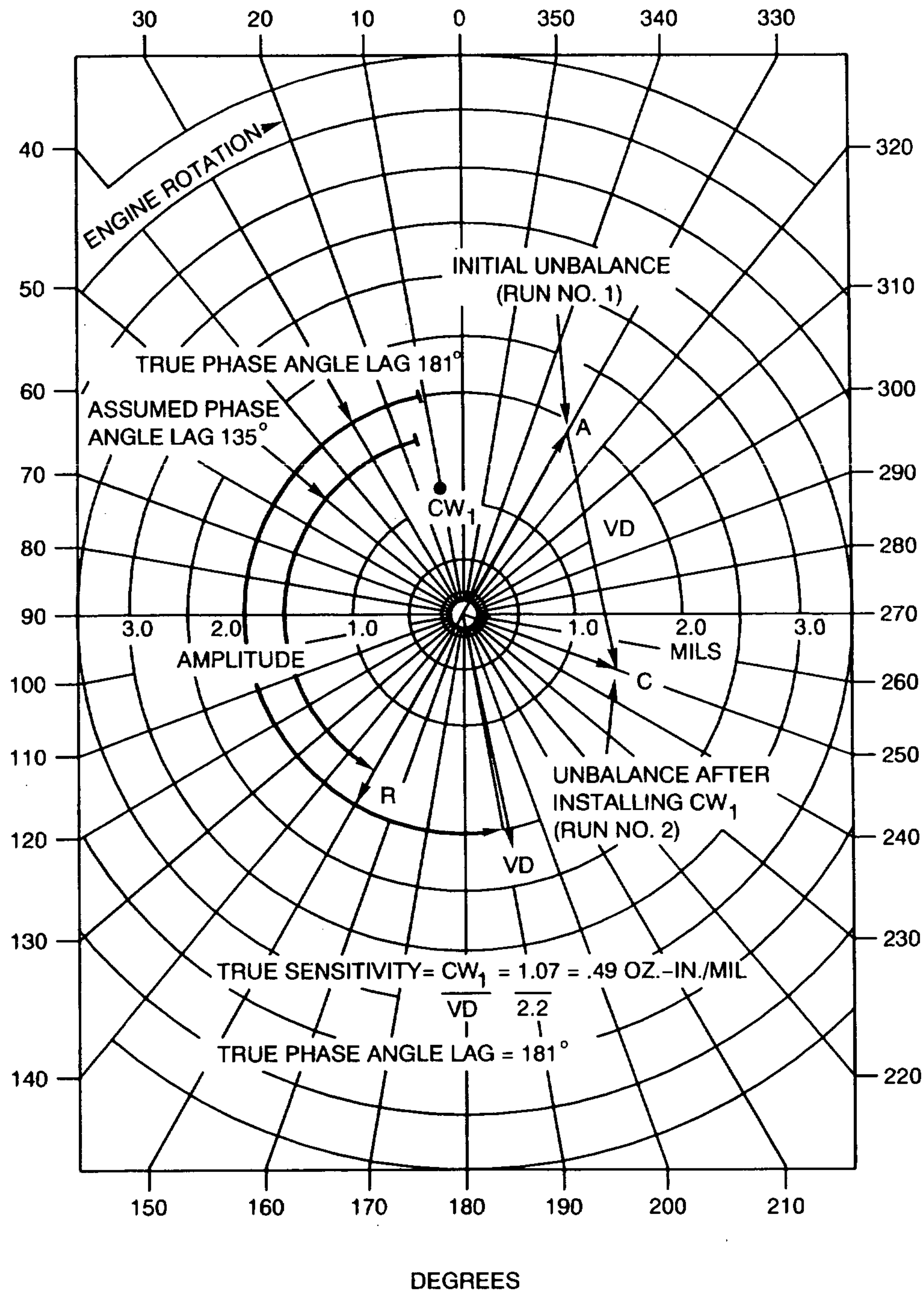
(j) Install 1 Class I weight (.54 oz-in.) at 337.5° and 1 Class III weight (.33 oz-in.) at 315° on 2nd to 3rd stage spacer sleeves, for a vector sum of .86 oz-in. at 329°.

NOTE: Perform the vector sum calculation by constructing lines AB', AC', B'D', and C'D' (See Figure 941) by using the procedures in step (g) above.

(k) The balance point is rerun, indicating low speed points brought within limits. Refer to Run No. 3 in Table 924 and Figure 939, After CW2 (Counterweight 2).

(l) Actual sensitivities and phase angle lags are calculated as shown in Figure 942 to provide information for future balances. The average of the data from a number of balances provide assumed phase angle lags and sensitivities (Table 920), which are used for future balances.

(m) A repeat vibration survey shows the engine is still above limits on the No. 1 and 2 pickups in the high speed range. See Table 921. Note the 2nd to 3rd stage spacer weights have slightly affected the high speed vibration on the No. 1 pickup.

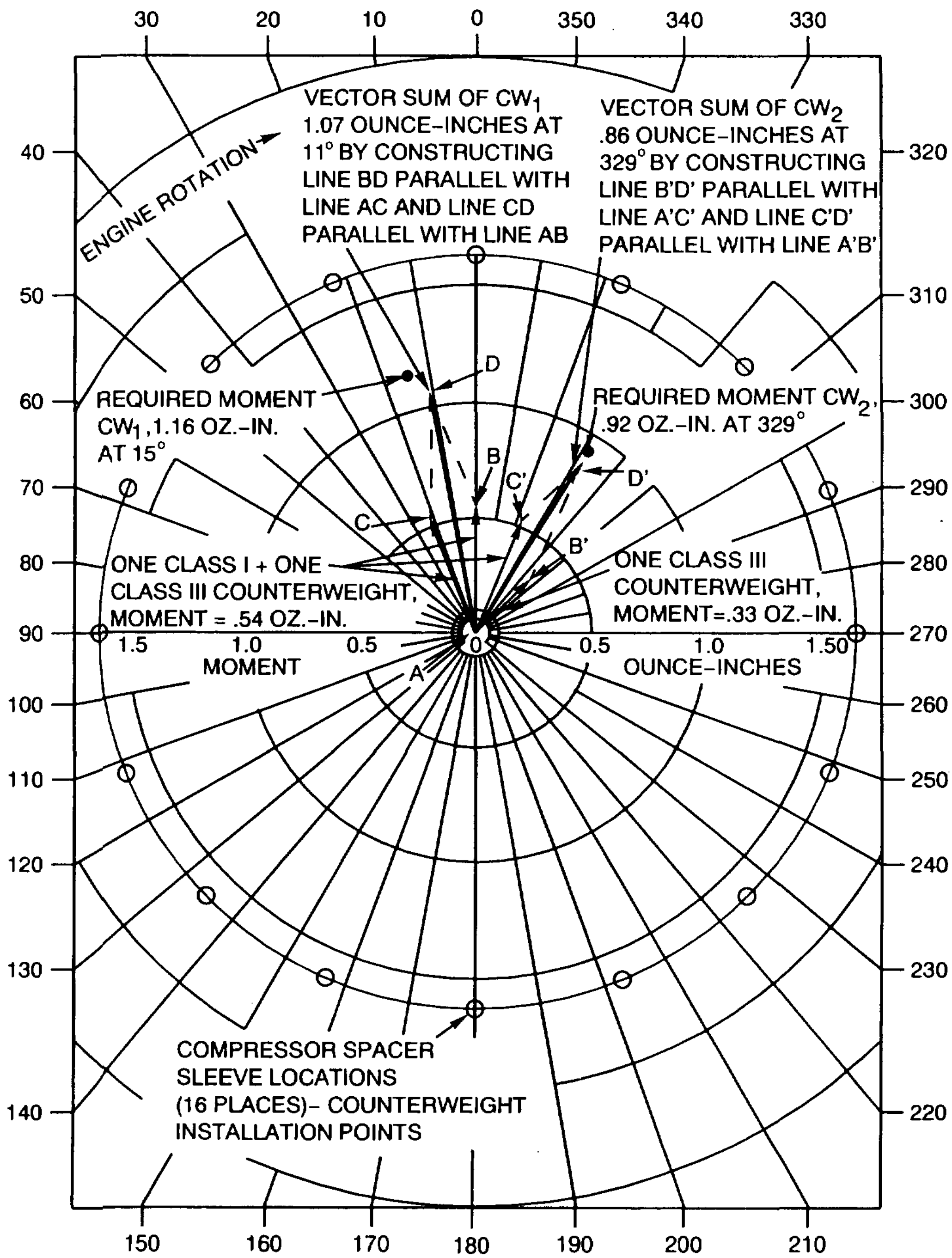


L-34905
PW V

R
R

Balance Effect Of Counterweight 1
Hypothetical Example
Figure 940

72-0005



R
R

Vector Summation Method
Hypothetical Example
Figure 941

(n) As in step (2), the engine is classified as Class II, requiring 8th to 9th stage spacer balance. Refer to Run 4 in Table 924.

(o) Plot Vector A (±2.0 mils at 50°). Lay out the angle counter to engine rotation from the 12 o'clock position. Draw Vector R (vector required to balance engine) equal and opposite Vector A. See Figure 943.

(p) Apply the assumed phase angle lag (320° from Table 920), laying it off from R in the direction of engine rotation. Therefore, counterweight 3 should be applied at 270 degrees measured from the 12 o'clock reference location, indicated in Paragraph E.(4), counter to engine rotation. See Figure 943.

(q) Apply assumed sensitivity. Multiply the amplitudes of A vector (± 2.0 mils) by the assumed sensitivity (.35 oz-in./±mil from Table 920) (the magnitude of Counterweight 3 should be .70 oz-in.).

(r) Install one Class III weight (.44 oz-in.) at 300 degrees and one Class III weight (.44 oz-in.) at 40 degrees, for a vector sum of .76 oz-in. at 270 degrees.

(s) The balance point is rerun, indicating high speed points brought within limits, while low speed points remain within limits. Refer to Run No. 5 in Table 924 and Figure 941, Post-trim Balance Survey.

(t) Actual sensitivities and phase angle lags are calculated as shown in Figure 945 to provide information for future balances. The average of the data from a number of balances provide the assumed phase angle lags and sensitivities (Table 920), which are used for future balances.

(u) A second vibration survey is run to demonstrate repeatability. Variations between runs may not exceed 0.0003 inch (0.3 mils) single amplitude. 1E and overall amplitude was repeatable and within limits. Refer to Run No. 6 in Table 924.

30. Preservation And Depreservation Of Engine

A. The following procedures cover the steps to preserve or depreserve lubrication and fuel systems. They may be done while the engine is in the aircraft or installed in a test stand. Check engine records before following these procedures. Make the appropriate entries in the applicable engine records when the work is complete.

CAUTION: UNDER NO CIRCUMSTANCES MUST PRESERVATIVE OIL BE SPRAYED INTO THE COMPRESSOR OR ENGINE TURBINE. DIRT PARTICLES THAT DEPOSIT ON BLADES AND VANES DURING ENGINE OPERATION WILL ALTER AIRFOIL SHAPE AND HAVE AN ADVERSE AFFECT ON COMPRESSOR EFFICIENCY.

B. Engine Preservation-Short Term Inactivity

NOTE: The following procedure must be followed for preservation of engines with a compressor that can be rotated, and that expect to be in operation within 2 months. This procedure should be repeated weekly after the first 2 weeks.

NOTE: Engines incorporating the intent of SB 4178 have no fuel pressure signal tube, and the signal port and overboard drain port are plugged. When preserving these engines, remove the plugs from the signal and overboard drain ports and collect the discharge.

(1) Rotate the engine with the starter or auxiliary power source at the starter pad until the oil pressure and compressor rotor speed are indicated.

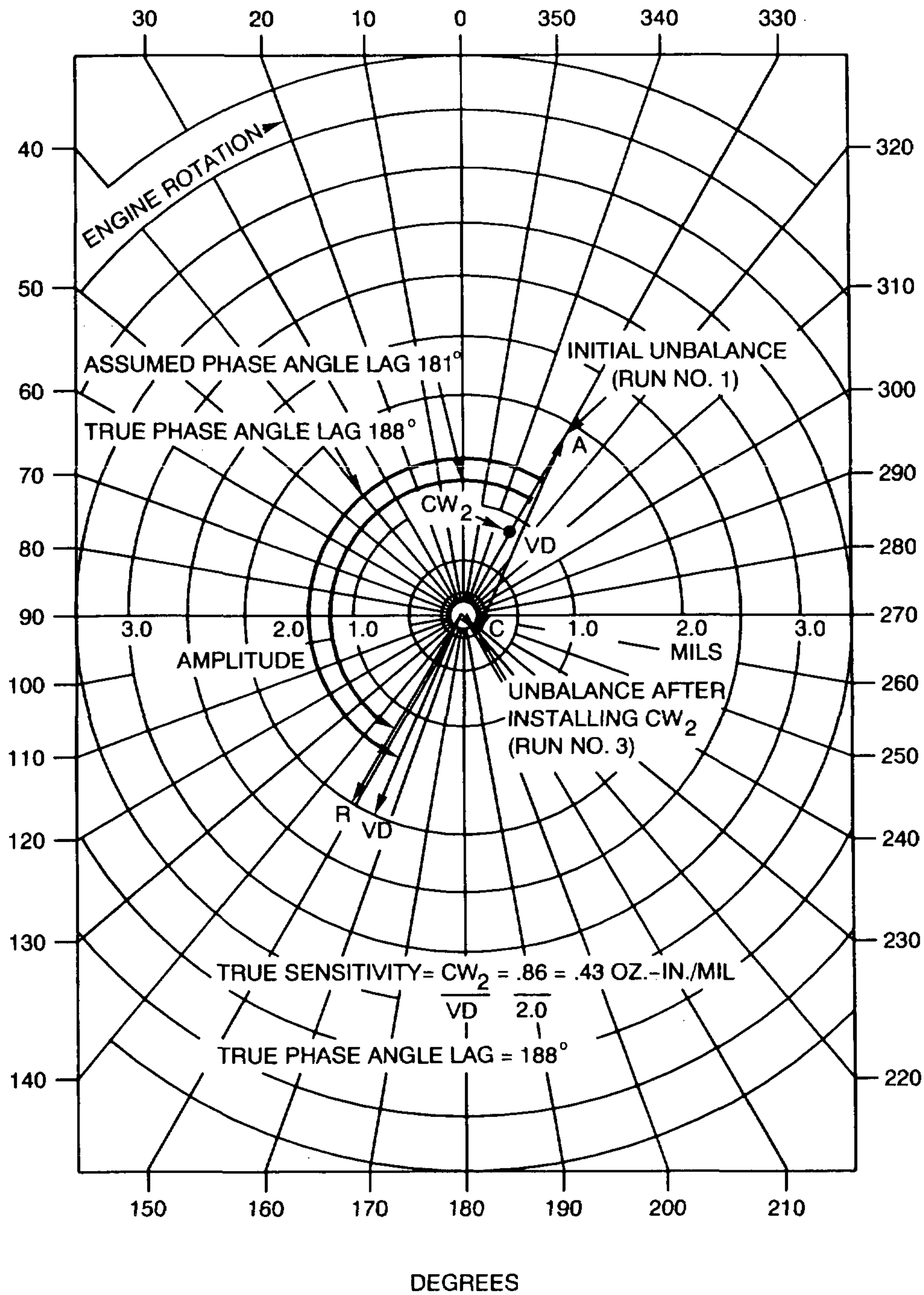
(2) Continue this rotation for 5 minutes or an allowable starter operating period, whichever is less.

(3) During this period, actuate the N1 lever from OFF to IDLE (engine ignition switch OFF), and check whether the dump valve closes, indicated by cessation of the overboard fuel drainage.

(4) Return the N1 lever to OFF and check whether the dump valve opens, indicated by fuel draining overboard.

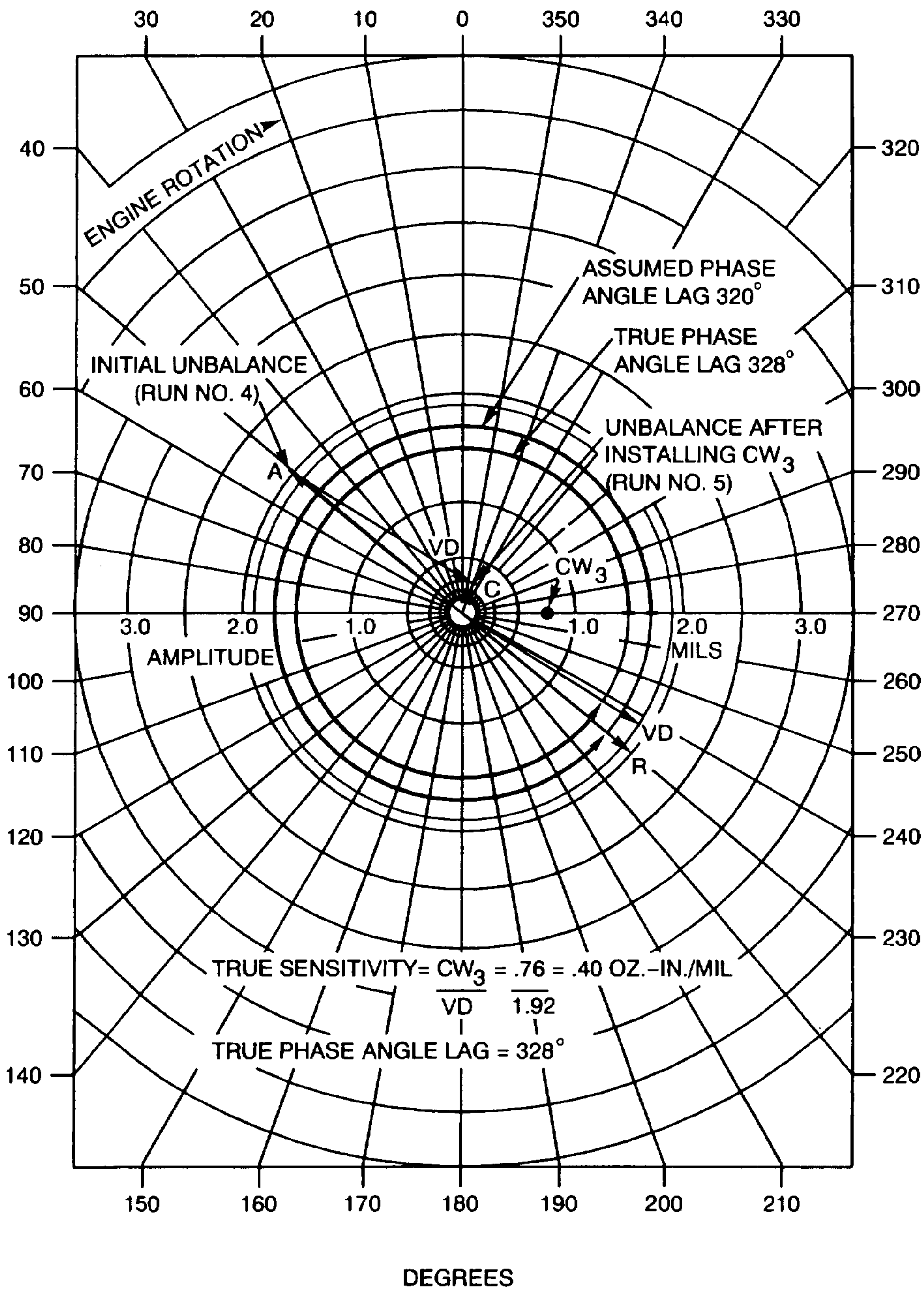
NOTE: For engines incorporating the intent of SB 4178, reinstall the plugs in the signal and overboard drain ports.

R
R



R
R

Balance Effect Of Counterweight 2
Hypothetical Example
Figure 942



L-34900
PW V

R
R

Balance Effect Of Counterweight 3
Hypothetical Example
Figure 943

C. Engine Depreservation-Short Term Inactivity

(1) The only required reactivation treatment for these engines consists of starting the engine and operating it for 15 minutes at 75 percent normal rated thrust.

D. Engine Preservation-Long Term Inactivity

NOTE: The following procedures must be followed for preservation of engines that are inactive for periods that exceed 2 months.

E. Lubrication System

NOTE: If the engine has been tested by using PWA 521B, Type II lubricating oil, then additional preservation of the lubricating system is unnecessary.

(1) Drain the oil from the oil tank and accessory and component drives gearbox into suitable containers.

(2) Coat the drain plugs with PWA 521B, Type II oil. Reinstall the plugs.

NOTE: Do not drain the oil until the fuel system preservation is complete.

(3) Remove and rinse the oil strainer in petroleum solvent.

(4) Inspect the strainer and slush it in PWA 521B, Type II oil. Reinstall the strainer.

F. Fuel System

NOTE: Engines incorporating the intent of SB 4178 have no fuel pressure signal tube, and the signal port and overboard drain port are plugged. When preserving these engines, remove the plugs from the signal and overboard drain ports and collect the discharge.

(1) Remove the large hex plug located just under the dump valve inlet connection. Remove the inlet screen. Place a suitable container under the dump valve to catch the preservative discharge from the dump valve screen boss.

NOTE: Do not insert a fitting or hose.

R
R

(2) Disconnect the fuel-in line and connect it to the supply of flushing oil at an inlet pressure of 5 to 25 psi and a minimum temperature of 15°C (60°F). Take extreme care to prevent foreign material from being drawn into the engine fuel system. Provide equipment with suitable filters and/or strainers that have mesh no coarser than is used in the engine.

(3) With the ignition off and all control levers in the maximum position, motor the engine with the starter at 1500 to 2100 rpm. During motor startup, move the N1 lever from OPEN to CLOSED to OPEN. This sequence must be timed so that the lever is in the CLOSED position at least half the time during motor startup.

(4) When not less than 3 but no more than 4 gallons of fluid has been obtained from the dump valve inlet screen boss, close the N1 lever and discontinue engine rotation.

(5) Thoroughly clean the dump valve screen and slush it with preservation oil. Reinstall the screen and hex plug in the dump valve. Torque the hex plug to 125 - 175 lb-in.

(6) Remove the oil filter and thoroughly clean and slush it with preservative oil. Reinstall the oil filter.

NOTE: For engines incorporating the intent of SB 4178, reinstall the plugs in the signal and overboard drain ports.

31. Miscellaneous Preservation Procedures
(Refer to Tool Group 47A)

A. Remove cover plates from unused accessory drives and spray the exposed surfaces with preservative oil. Replace the cover plates.

B. Plugs, caps and covers must be installed over all the openings to prevent foreign material access and moisture accumulation.

C. For engines that remain in the aircraft, dispense a sufficient amount of dehydrating agent in the engine compartment. Distribute half this amount around the engine, and distribute the remaining half in equal amounts in the aircraft inlet and exhaust ducts.

R
R

CAUTION: OPEN THE DEHYDRATING AGENT CONTAINER AS LITTLE AS POSSIBLE TO PREVENT EXCESSIVE EXPOSURE TO THE ATMOSPHERE. ALSO, REMOVE THE DEHYDRATING AGENT FROM THE STORAGE CONTAINER AND SEAL THE ENGINE COMPARTMENT IN THE SHORTEST TIME POSSIBLE.

D. The N1 lever and the oil filler cap should be tagged with the preservative used and the preservation date.

E. Place an airtight moisture barrier or other suitable cover over the air inlet and exhaust end of the engine compartment.

F. Install a humidity indicator at each end of the engine compartment.

NOTE: Provide inspection windows in each cover for viewing the humidity indicators.

G. Inspect the engine every 2 weeks when the aircraft is stored outside, and every 30 days when the aircraft is stored inside.

H. The entire engine must be depreserved and then represerved when the relative humidity exceeds 40 percent within the compartment.

32. Engine Depreservation - Long Term Inactivity

NOTE: The following procedure must be followed for depreservation of engines that have been preserved for long term inactivity.

A. Check all oil passages for possible obstructions before installing accessories that are dependent on engine oil. Remove all covers, plugs and the dehydrating agent.

B. Fill the oil tank with engine oil specification PWA-521B, Type II.

C. Connect the fuel supply line to the fuel inlet pad on the fuel pump.

NOTE: Engines incorporating the intent of SB 4178 have no fuel pressure signal tube, and the signal port and overboard drain port are plugged. When depreserving these engines remove the plugs from the signal and overboard drain ports and collect the discharge. Disregard Paragraphs E. and F.

R
R

D. Place a suitable container (with a minimum capacity of 5 gallons) under the dump valve overboard drain.

E. Disconnect the fuel pressurizing and dump valve-to-fuel control signal tube at either the dump valve or the fuel control.

F. Leave the dump valve connection open to the atmosphere, and plug the fuel control with a suitable plugged fitting to prevent dumping out fuel.

G. With the ignition switch OFF, the fuel shutoff valve OPEN, and all fuel control levers in the maximum position, motor the engine with the starter at 1500 - 2100 rpm.

H. When at least 1 gallon of fuel is obtained from the overboard drain, close the N1 lever and disengage the starter.

CAUTION: LIMIT ENGINE ROTATION TO THE SHORTEST TIME POSSIBLE. DO NOT EXCEED THE STARTER OPERATING LIMIT.

I. Remove the plugged fitting from the fuel pressurizing and dump valve signal tube, and reconnect the tube to the dump valve.

NOTE: For engines incorporating the intent of SB 4178, reinstall the plugs in the signal and overboard drain ports.

J. Remove the preservation tags and make the applicable entry in the engine records.

24 Connect all test stand lines to test accessories and instrumentation installed when the engine was dressed, including Ps8 probes to PWA 13856 re-enforcing ring.

25 Connect the electrical lead to the wiring harness.

(b) After the engine is completely installed in the test cell, wash down the engine accessory drive gearbox with Varsol and steam or hot water to remove the oil film. Overboard breather lines must be located far enough rearward from the bottom accessory section so that oil fumes do not recirculate through or over the engine. Starting with a dry oil-free accessory case and accessories ensures oil leaks are readily observed and corrected.

(c) Wash down the test cell floor and remove foreign objects. Check the bellmouth screen for loose objects, such as pieces of wire or rivets on the inlet case. Also, all equipment in the test cell, including on the floor and wall, must be checked for security and for any loose nuts or bolts.

(2) Prestarting Inspection

(a) General

1 Visually inspect all external tubes and components for security.

2 Check the fuel and oil supply. When necessary, fill the oil system with PWA 521B, Type II lubricating oil.

3 Check N1 lever, N2 lever, pitch lever, and the dynamometer control.

4 Ensure all protective covers, such as compressor bleed valve covers, are removed.

5 Inspect the surrounding area for cleanliness.

(3) Engine Starting Procedure

NOTE: Please see the TEMPORARY REVISION that revises this page

(a) The following sequence of steps apply to engines equipped with electric pneumatic or combustion starters. When using combustion starters, which have a very limited burning time, perform the steps described below as quickly as possible.

1 Engine Anti-icing Switch - OFF

2 N1 Lever - OFF

3 Pitch Lever - Minimum Position

4 Dynamometer Load Applied

5 Engine Master Switch - ON

6 Engine Fuel Shutoff Switch - OPEN

7 Fuel Boost Pump Switch - ON

8 Engine Starter Switch - ON (check for rise in oil pressure)

9 Ignition Switch - ON at 1200 to 1500 rpm

CAUTION: DO NOT TURN ON THE IGNITION SWITCH PRIOR TO ENGAGING THE STARTER, BECAUSE FUEL THAT ACCUMULATES IN THE ENGINE COULD CAUSE AN INTERNAL FIRE OR EXPLOSION.

10 N1 Lever - IDLE above 1600 rpm

NOTE: The operating cycle for continuous use of high-energy ignition for the first startup attempt is 2 minutes ON and 3 minutes OFF. For the second attempt, the operating cycle is 2 minutes ON and 23 minutes OFF to allow the ignition system components to cool. In some cases, restrictions imposed on the start operation will govern the use of ignition.

11 Engine Starter Switch - OFF as soon as a successful start occurs

NOTE: Please see the TEMPORARY REVISION that revises this page

12 Ignition Switch - OFF

NOTE: On every engine startup cycle, make sure that the tail pipe does not emit flames and that the turbine discharge temperature does not rise rapidly.

(4) Satisfactory Start

(a) The engine has started satisfactorily when all the following conditions are met:

1 Light-Up takes place within 20 seconds or less after the N1 lever is placed in the IDLE position. Light-up is evident by a rise in turbine discharge temperature.

NOTE: A 20 second time interval is an arbitrary value. The actual time to Light-Up depends on the amount of torque supplied by the starter.

2 The engine will accelerate to approximately 38 percent rpm.

3 The turbine discharge temperature does not exceed the maximum startup temperature limit of 525°C (977°F) during the transition period to idle rpm.

4 The oil pressure is at least 20 psi (relative to the internal engine scavenge compartment).

5 The turbine discharge temperature will drop below 515°C (959°F) after idle rpm is reached.

CAUTION: IF THE N1 LEVER INADVERTENTLY SLOWS DOWN AND RETURNS TO THE OFF POSITION, THEN DO NOT REOPEN THE N1 LEVER IN AN ATTEMPT TO REGAIN LIGHT. THE NORMAL STARTUP SEQUENCE MUST BE REPEATED. INTRODUCING UNBURNED FUEL INTO THE ENGINE CREATES A FIRE HAZARD.

(5) Unsatisfactory Start

(a) An unsatisfactory start occurs when one or more of the following conditions exist:

NOTE: Please see the TEMPORARY REVISION that revises this page

1 Hot Start - The turbine discharge temperature exceeds the startup temperature limit of 525°C (977°F). When greater than normal fuel flow is observed after the N1 lever is placed in IDLE, Hot Start could occur and the start operation should be aborted before the turbine discharge temperature is exceeded. A Hot Start also can be caused by a false or hung start.

2 False Start or Hung Start - After Light-Up has occurred, the rpm does not increase to IDLE, but remains at a lower rpm. The turbine discharge temperature could continue to rise, and the start operation should be aborted before the temperature limits are exceeded.

3 No Start - The engine does not Light-Up within 20 seconds after the N1 lever is placed in IDLE. If the turbine discharge temperature gage does not indicate a temperature rise, or if the rpm does not increase, then Light-Up has not been achieved.

4 Perform the following sequence of steps if any of the requirements of a satisfactory start are not met, or if any of the unsatisfactory start conditions occur.

a N1 Lever - OFF

b Ignition Switch - OFF

c Engine Starter Switch - OFF

d Fuel Boost Pump Switch - OFF

e Allow a 2 minute fuel drainage period before attempting another start.

(6) Clear Engine Procedure

(a) Perform the following sequence of steps to clear the engine of trapped fuel or vapors:

1 N1 Lever - OFF

2 Ignition Switch - OFF

3 Engine Fuel Shutoff Switch - OPEN

NOTE: Please see the TEMPORARY REVISION that revises this page

4 Fuel Boost Pump Switch - ON

5 Engine Starter Switch - ON

6 Maintain starter operation for 10 - 20 seconds for the burning time of the cartridge starter.

7 Engine Starter Switch - OFF

8 Fuel Boost Pump Switch - OFF

9 Allow a 30 second fuel drainage period before attempting another start.

(7) Engine Shutdown Procedure

(a) Set the N1 lever to provide 75% N1 rpm for 30 seconds to provide the proper residual oil scavenging; then slowly return the N1 lever to OFF.

CAUTION: WHEN THE ENGINE HAS BEEN OPERATING AT HIGH SETTINGS FOR AN APPRECIABLE LENGTH OF TIME, OPERATE THE ENGINE IN IDLE FOR APPROXIMATELY 5 MINUTES PRIOR TO SHUTDOWN TO PREVENT SEIZURE OF THE ROTOR AND/OR OVERHEATING OF THE NO. 3 BEARING DUE TO RESIDUAL HEAT IN THE TURBINE ROTOR.

CAUTION: DO NOT USE VALVES UPSTREAM OF FUEL CONTROL (SUCH AS FIREWALL SHUTOFF VALVES OR TEST STAND FUEL SUPPLY SHUTOFF VALVES), OR TURN OFF FUEL BOOST PUMPS TO SHUT DOWN THE ENGINE. DOING SO ALLOWS THE ENGINE FUEL PUMP TO OPERATE IN A DRY STATE THAT CAN RESULT IN PUMP FAILURE. IF THE ENGINE IS SHUT DOWN IN THIS MANNER FOR ANY REASON, THEN INSPECT ALL FUEL SYSTEM FILTERS AND STRAINERS FOR EVIDENCE OF FUEL PUMP DAMAGE.

(b) Fuel Boost Pump Switch - OFF

NOTE: To prevent air from getting into fuel lines, set the N1 lever to OFF before the fuel boost pump is turned OFF.

(c) Engine Fuel Shutoff Switch - CLOSED

(d) Engine Master Switch - OFF

NOTE: Please see the TEMPORARY REVISION that revises this page

(e) Ascertain whether the compressor decelerates freely.

NOTE: In the event of inadvertent, or emergency shutdown, rotor rotational freedom must be checked before attempting another start.

(8) Limits For Test Instruments And Equipment

(a) Engine Check Chart For JFTD12A-4A: See Table 911.

(b) Engine Check Chart For JFTD12A-5A: See Table 912.

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1) RPM (1)	FREE TURB (N1) RPM (2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP (3)	TIME LMTS (MIN)
Take-off	4500	16530	9000	2.130 to 2.185	0.690	Must be below line of Fig 928	5
30 MIN	4500	16530	"	2.130 to 2.185	0.690	"	30
Max Cont	4000	16055	"	2.039 to 2.095	0.695	See Fig 928	Cont
80% Max Cont	3200	-	"	1.884 to 1.942	-	-	"
50% Max Cont	2000	-	"	1.643 to 1.696	-	-	"
Flt Idle (no load)	-	-	-	-	-	-	"
Strtng	-	-	-	-	-	525°C (977°F)	Momentary

NOTE: Please see the TEMPORARY REVISION that revises this page

Engine Check Chart (JFTD12A-4A)
Table 911 (Sheet 1)

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1) RPM (1)	FREE TURB (N1) RPM (2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP (3)	TIME LMTS (MIN)
Accl-rtn	-	-	-	-	-	688°C (1270°F)	2

Notes:

(1) Vibration Limits (Single Amplitude) (4) - 15,500 rpm N1 and above limits for all pickups are 1.7 mils; below 15,500 rpm is 1.9 mils; and limit for free turbine case pickup with free turbine driveshaft uncoupled and above 8000 rpm N2 is 0.8 mil; coupled is 1.5 mils.

(2) Maximum permissible N1 rotor observed speed is 16,700 rpm.

(3) Maximum permissible N2 rotor indicated speed is 9,500 rpm for steady power operation.

Maximum permissible N2 rotor operating indicated speed is 9600 rpm.

(4) During and just after acceleration, the above stabilized limits may be exceeded to a maximum of 688°C (1270°F) for a period of not more than 2 minutes. Prior to establishing final trim setting line, the indicated TAKEOFF limits must not be exceeded.

(5) If the vibration reading of the free turbine is above 1.5 mils when coupled to dynamometer and below 0.8 mils when uncoupled, then the coupling must be reindexed to minimize the coupled vibration readings.

If the vibration readings continue to be unacceptable when coupled and do not exceed 0.8 mil uncoupled, then it is permissible to run the acceptance test coupled to the dynamometer and accept free turbine vibration not exceeding 2.5 mils.

NOTE: Please see the TEMPORARY REVISION that revises this page

Engine Check Chart (JFTD12A-4A)
Table 911 (Sheet 1) (Continued)

PWR RATNG	OIL PRSSR PSIG	OIL TEMP INLT	OIL BRTHR PRSSR	OIL CONSMP	FUEL TEMP INLT	FUEL PRSSR INLT	FUEL LEAKAGE P&D VALV	FUEL LEAKAGE CNTRL & PMP	IGNTN SYSTM
Take-off	45-55	15°-121°C 59°-250°F	2.5in Hg stdy state	0.11gph max dur accpt	43°C 110°F max	5-50 psig	300cc per hour dur eng run	20cc per hour (12cc per hour for F'C speed sense unit)	24vdc nom (14vdc with 5 amp load at input term)
30 MIN	"	"	"	"	"	"	"	"	"
Max Cont	"	"	"	"	"	"	"	"	"
80% Max Cont	"	"	"	"	"	"	"	"	"
50% Max Cont	"	"	"	"	"	"	"	"	"
Flt Idle (no load)	40 Min	10°-121°C 50°-250°F	"	"	"	"	"	"	"
Strtng	-	-	-	"	"	"	"	"	"
Accl-rtn	45-55	15°to 121°C 59°-250°F	4in. Hg max	"	"	"	"	"	"

NOTE: Please see the TEMPORARY REVISION that revises this page

Engine Check Chart (JFTD12A-4A)
Table 911 (Sheet 2)

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1) RPM (1)	FREE TURB (N1) RPM (2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP (3)	TIME LMTS (MIN)
Take-off	4800	16350	9000	2.195 to 2.253	0.655	Must be below line of Fig 928	5
30 MIN	4800	16350	"	2.198 to 2.253	0.655	"	30
Max Cont	4430	16050	"	2.130 to 2.183	0.665	See Fig 928	Cont
80% Max Cont	3200	-	"	1.893 to 1.938	-	"	"
60% Max Cont	2000	-	"	1.643 to 1.688	-	"	"
Idle (no load)	-	-	-	-	-	-	"
Strtng	-	-	-	-	-	525°C (977°F)	Momen tary
Accl-rtn	-	-	-	-	-	720°C (1328°F)	2

Notes:

(1) Vibration Limits (Single Amplitude) (4) - 15,500 rpm N1 and above limits for all pickups are 1.7 mils; below 15,500 rpm is 1.9 mils; and limit for free turbine case pickup with free turbine drive disconnected and above 8000 rpm N2 is 0.8 mil; coupled is 1.5 mils.

(2) Maximum permissible N1 rotor observed speed is 16,700 rpm.

NOTE: Please see the TEMPORARY REVISION that revises this page

Engine Check Chart (JFTD12A-5A)
Table 912 (Sheet 1)

PWR RATNG	CORRECTED SHAFT H.P.	CORRECTED COMPRSSR (N1)RPM(1)	FREE TURB (N1)RPM(2)	ENG PRSSR RATIO (EPR)	CORR BSFC LB 'SHP' HR	MAX IND TURB DISCHRG TEMP(3)	TIME LMTS (MIN)

(3) Maximum permissible N2 rotor indicated speed is 9,500 rpm for steady power operation.

Maximum permissible N2 rotor operating indicated speed is 9,600 rpm.

(4) During and just after acceleration, the above stabilized limits may be exceeded to a maximum of 720°C (1328°F) for a period of not more than 2 minutes. Prior to establishing final trim setting line, the indicated TAKEOFF limits must not be exceeded.

(5) If the vibration reading of the free turbine is above 1.5 mils when coupled to dynamometer and below 0.8 mils when uncoupled, then the coupling must be reindexed to minimize the coupled vibration readings.

If the vibration readings continue to be unacceptable when coupled and do not exceed 0.8 mil uncoupled, then it is permissible to run the acceptance test coupled to the dynamometer and accept free turbine vibration not exceeding 2.5 mils.

Engine Check Chart (JFTD12A-5A)
Table 912 (Sheet 1) (Continued)

NOTE: Please see the
TEMPORARY REVISION
that revises this page

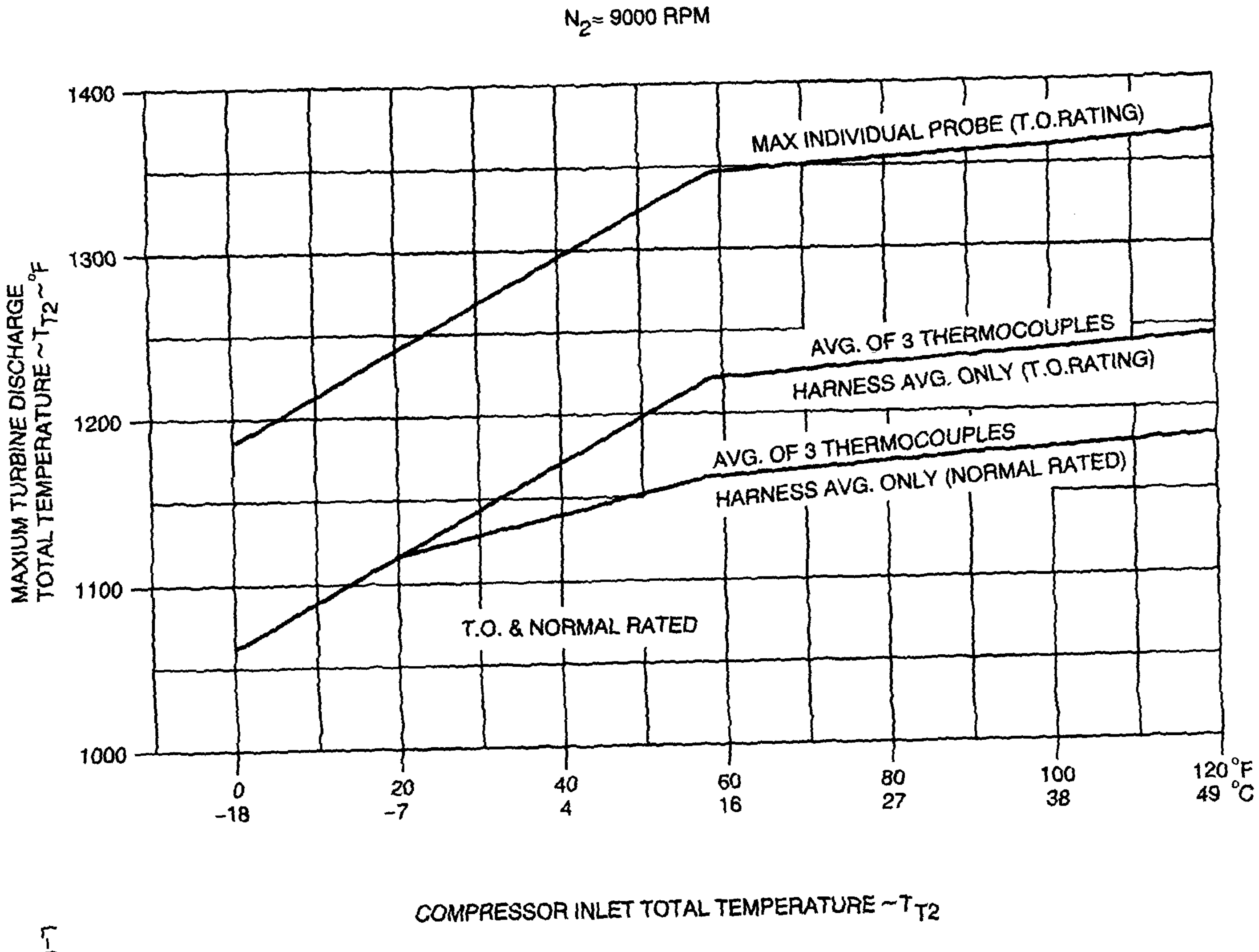
R
R

PWR RATNG	OIL PRSSR PSIG	OIL TEMP INLT	OIL BRTHR PRSSR	OIL CONSMP	FUEL TEMP INLT	FUEL PSSR INLT	FUEL LEAKAGE P&D VALV	FUEL LEAKAGE CNTRL & PMP	IGNTN SYSTM
Take-off	45-55	121°C 250°F max	2 in Hg stdy state	0.11gph during accpt	43°C 110°F max	5-50 psig	300cc per hour dur eng run	20cc per hour (12cc per hour for F'C speed sense unit)	24vdc nom (14vdc with 5 amp load at input term)
30 MIN	"	"	"	"	"	"	"	"	"
Max Cont	"	"	"	"	"	"	"	"	"
80% Max Cont	"	"	"	"	"	"	"	"	"
60% Max Cont	40 Min	-	"	"	"	"	"	"	"
Flt Idle (no load)	40 Min	-	"	"	"	"	"	"	"
Strtng	-	-	"	"	"	"	"	"	"
Accl-rtn	-	-	4in. Hg max	"	"	"	"	"	"

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Engine Check Chart (JFTD12A-5A)
Table 912 (Sheet 2)



R
R

NOTE: please see the TEMPORARY REVISION that revises this page

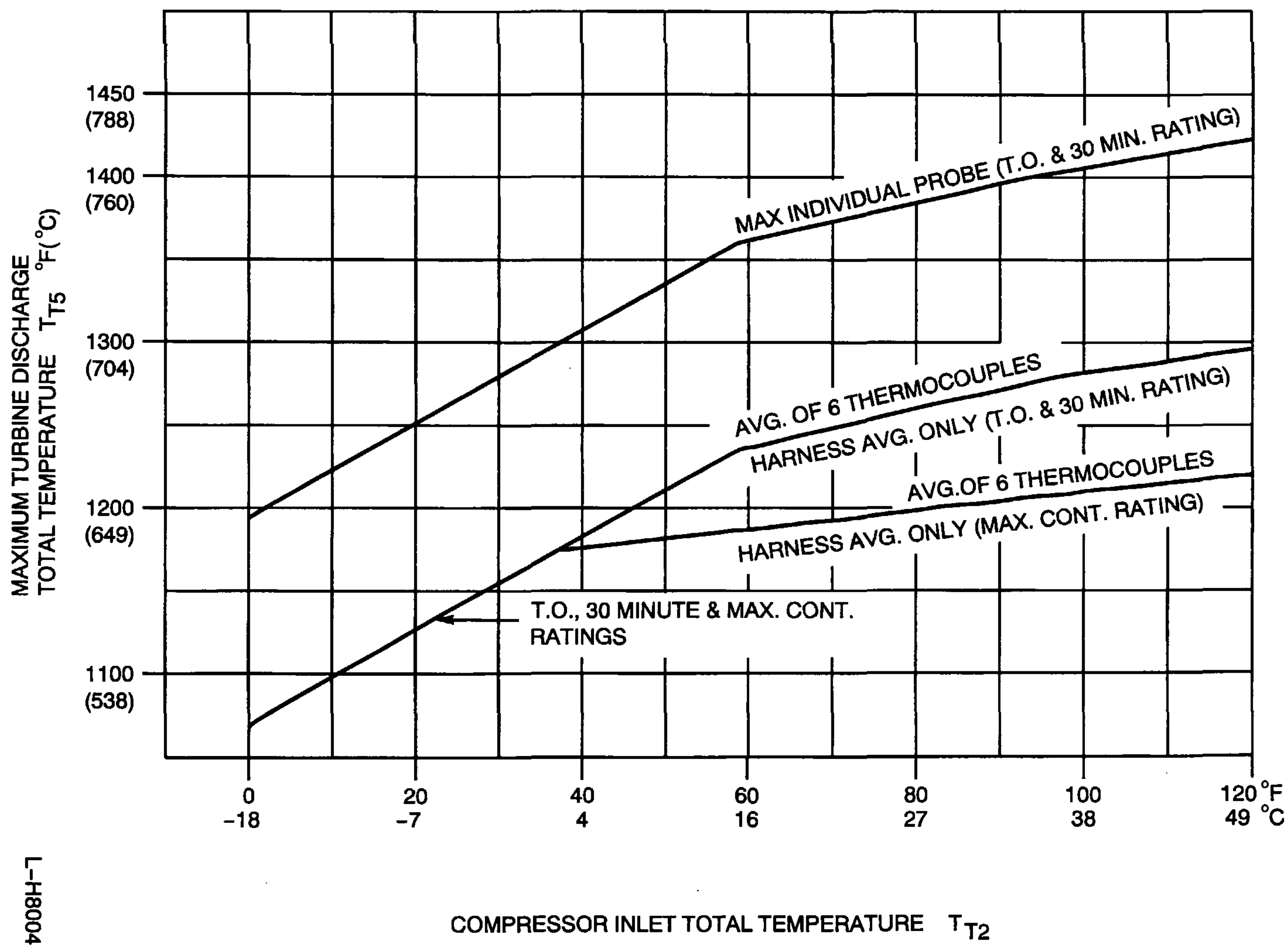
Maximum Turbine Discharge Temperature (Tt5) (JFTD12A-4A)
Figure 928 (Sheet 1)

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

TAKEOFF, 30 MINUTE MAXIMUM CONTINUOUS RATINGS

N_2= 9000 RPM



L-H8004 (0107)
PW/V

Maximum Turbine Discharge Temperature (Tt5) (JFTD12A-5A)
Figure 928 (Sheet 2)

(c) The TAKEOFF rating for this engine can be obtained above 15°C (59°F) without attaining maximum gas generator speed, and below 15°C (59°F) at maximum gas generator speed equivalent to the constant gas generator power lever setting. Take care not to run engine above conditions required to meet corrected TAKEOFF horsepower requirements for the inlet temperature time indicated in Figures 929 (Sheets 1 or 2).

(d) Fuel System (Refer to Engine Check Chart For JFTD12A-4A or Engine Check Chart For JFTD12A-5A)

(e) Oil System (Refer to Engine Check Chart For JFTD12A-4A or Engine Check Chart For JFTD12A-5A)

(f) Electrical System (Refer to Engine Check Chart For JFTD12A-4A or Engine Check Chart for JFTD12A-5A)

(g) Instrumentation

1 All instruments and equipment should be calibrated often enough to ensure reported data has a static accuracy within the limits listed below for values obtained at the TAKEOFF SHP rating.

a	Pam	Ambient Pressure	±0.01 inch Hg
b	Pt2	Compressor Inlet Total Pressure	±0.10 inch H2O
c	Ps3	Compressor Discharge Static Pressure	±0.25%
d	Pt5	Turbine Discharge Total Pressure	±0.10 inch Hg
e	Ps8	Exhaust Duct Exit Static Pressure	±0.10 inch Hg
f	Tt2	Compressor Inlet Total Temperature	±2°F (±1.1°C)
g	Tt5	Turbine Discharge Total Temperature (Exhaust Gas Temperature) Average and Individual	±5°F (±2.8°C)

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

h	OBT	Control Room Temperature	±1°F (±.5°C)
i	Tf	Inlet Fuel Temperature	±1°F (±.5°C)
j	Wf	Fuel Flow	±0.75%
k	N1	Compressor Rotor Speed	±0.10%
l	N2	Free Turbine Rotor Speed	±0.10%
m	DL	Dynamometer Load	±0.50%

(h) Engine Vibration Limits

1 Vibration monitoring is used in overhaul of gas turbine engines to provide an indication of correct assembly. Unless the main engine rotor assembly is correctly assembled and balanced, vibration limits will be exceeded.

2 Vibration amplitude must be observed at steady state running at all speeds in the operating range, and must not exceed the limits referenced in Section 7.

NOTE: Momentary vibration peaks during transient operating conditions in excess of limits listed are not cause for rejections as long as steady state readings are within limits.

(i) Engine Test Vibration Equipment

1 The following combination of suitably calibrated vibration measuring equipment, or equivalent combination, must be used to monitor vibration during the engine test:

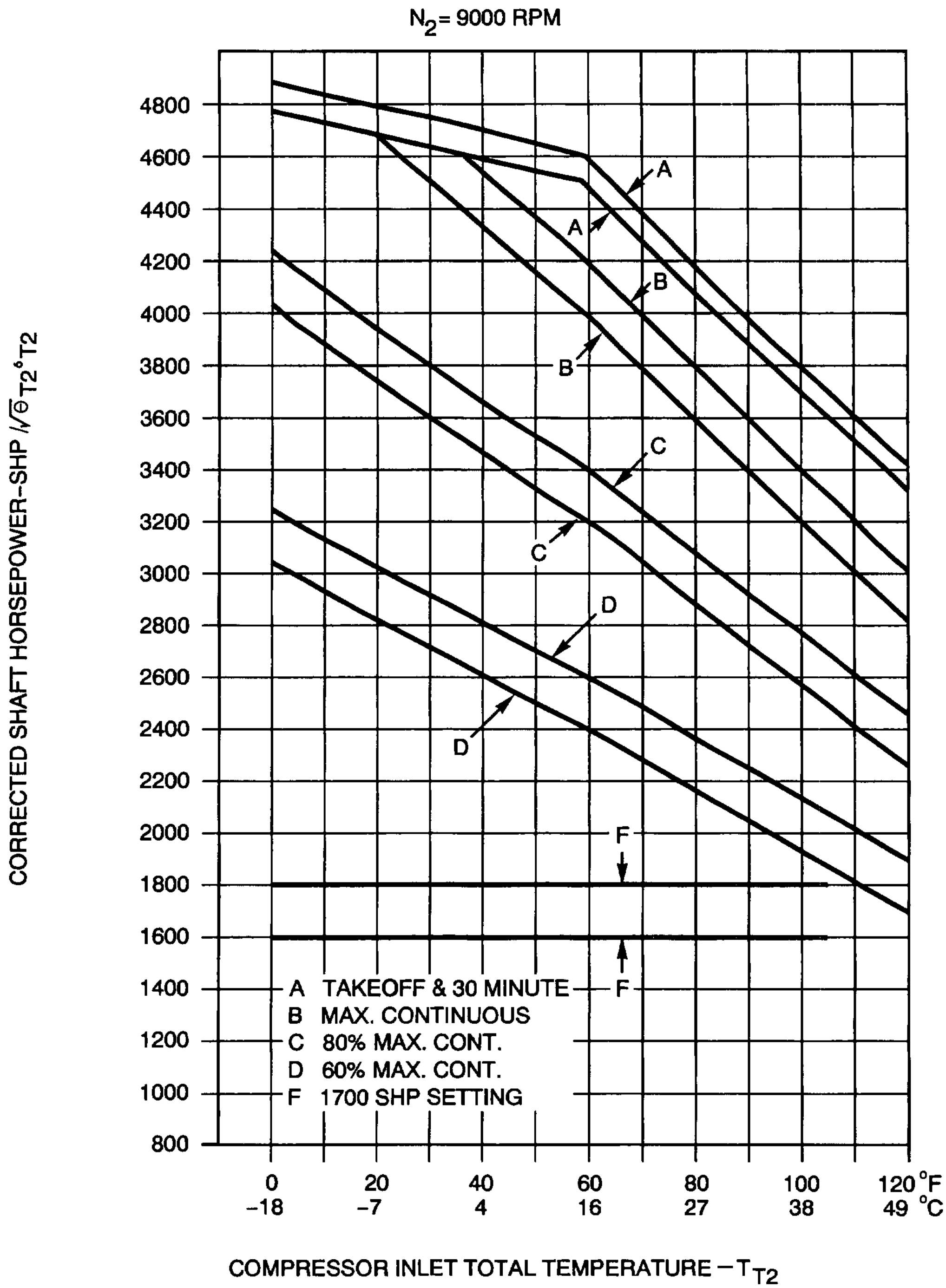
a Model ED-156-4 Vibration Meter (or equivalent).

NOTE: This vibration meter was formerly available from Glenn Hathaway Electronics of Canaan, CT.

b Compatible 40 cps filter for vibration meter.

R
R

OTE: Please see the
PORARY REVISION
revises this page

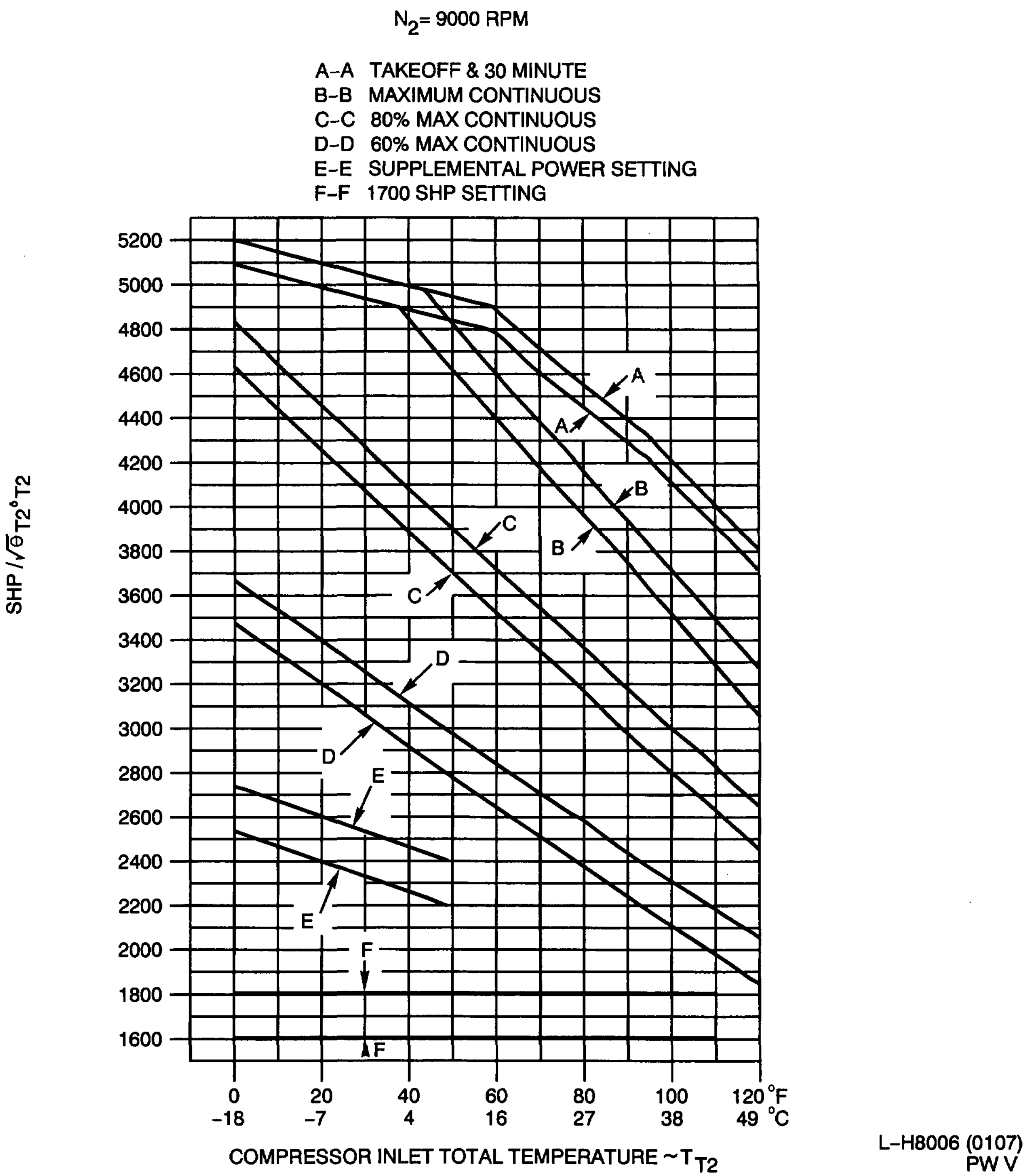


L-H8005 (0107)
PW V

NOTE: Please see the **TEMPORARY REVISION** that revises this page

R
R

Power Setting Curve (JFTD12A-4A)
Figure 929 (Sheet 1)



NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Power Setting Curve (JFTD12A-5A)
Figure 929 (Sheet 2)

c Model 4-103 or 4-123 vibration pickups (or equivalent).

NOTE: These vibration pickups were formerly available from Consolidated Electrodynamics Corp. of Pasadena, CA.

d The vibration indicator and filter used to monitor vibration during the test must be calibrated often enough to ensure the accuracy and frequency in cps vs. relative frequency response in percent fall within the band in Figure 909.

(9) Drain Leakage Check of Fuel System

(a) During an engine run, the overboard drain seal leakage from the main engine fuel control, fuel pump, and pressurizing and dump valve must be collected in individual containers.

(b) Individual leakage of the listed controls must not exceed the limits referenced above.

(c) Record leakage obtained from the Fuel Control Speed Sense Unit.

(10) Maximum Indicated N1 Speed: Refer to Paragraph 7.

(11) Maximum Indicated N2 RPM: Refer to Paragraph 7.

(12) Correction of Observed Readings

(a) Observed data taken during engine operation at each power setting in the bands in Figure 929 for horsepower, fuel consumption, compressor rpm, and turbine discharge temperature, must be corrected as described below and checked against ratings.

(b) First correct the indicated horsepower for the test stand exit pressure loss in accordance with the correction curve, before any other corrections are made. See Figure 929. Observed horsepower must be corrected for gearbox horsepower loss.

(c) Obtain the corrected values with the formulae in Figure 909A.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(d) Engine breather pressure in inches Hg must be converted to psi (in. Hg x 0.49) and subtracted from the observed main oil pressure gage reading to obtain the true main oil pressure.

(e) All engine idle trimming must be done by measuring the gas generator rotor speed in relation to the inlet temperature (Tt2). See Figure 931.

(13) Compressor Inlet Total Pressure (Pt2) Conversion

(a) Convert Pt2 inches water (gage) to inches mercury (gage): multiply inches water by 0.07355.

(b) To obtain P5t2 inches mercury absolute: subtract Pt2 inches mercury from the barometer, taken at the time of the test.

(14) Turbine Discharge Pressure (Pt5) Manometer Test

(a) All engine trimming must be done by measuring Pt5 with a precision bore manometer.

(b) Leak test the manometer by applying air pressure, equal to 2/3 capacity of the manometer, to the tube connection from the engine.

(c) The manometer must remain constant for 2 minutes minimum.

(d) All Pt5 readings must be made to the nearest 0.1 inch mercury and added, to the nearest 0.01 inch, to the observed true barometer reading.

(e) Correct Pt5 manometer readings for temperature effect according to Figure 911.

(15) Belting-In (Dynamometer Not Connected)

(a) Ignition OFF, or grounded

(b) Fuel ON

(c) N1 lever CLOSED

(d) Motor the engine by using external power; the speed must be sufficiently high to ensure the oil system is fully primed and the oil pump maintains steady pressure.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(e) Check for external oil leaks.

(f) Check the operation of the fuel drain valve by briefly exercising the N1 lever to pressurize the fuel system.

(g) Dry out the engine by performing the Clear Engine Procedure, after satisfactorily completing the above steps and before startup.

(16) Engine Test Log Sheet

(a) Before beginning the engine test, record the data listed below in the appropriate place at the top of the log sheets:

1 Date of test

2 Test cell number

3 Building number

4 Dynamometer serial number

5 Sheet number

6 Fuel pump serial number

7 Fuel control serial number

8 Bellmouth assembly number

9 Screen assembly number

10 Oil type

11 Fuel type

12 Turbine and free turbine nozzle guide vane area

13 Engine model and type taken from the data plate

14 Engine serial number taken from the data plate

15 Work order number

16 Contract number

17 Nature of test

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

18 Exhaust re-enforcing ring assembly number.

(b) During startup, record the following data on the log sheet:

1 Time the engine is started

2 Maximum average turbine temperature encountered

3 Fuel flow

4 N1 rpm

5 Main oil pressure.

(c) During engine operation, record the following data on the log sheet:

1 Time of day

2 Total hours of engine operation

3 True barometric pressure

NOTE: During erratic weather conditions, record the pressure every half hour.

4 Control room temperature

5 Fuel specific gravity

6 Fuel specific gravity at temperature

7 Observed and corrected main oil pressure

8 Oil tank breather pressure

9 Main oil pump corrected oil scale level

10 Oil temperature

11 Vibration amplitude

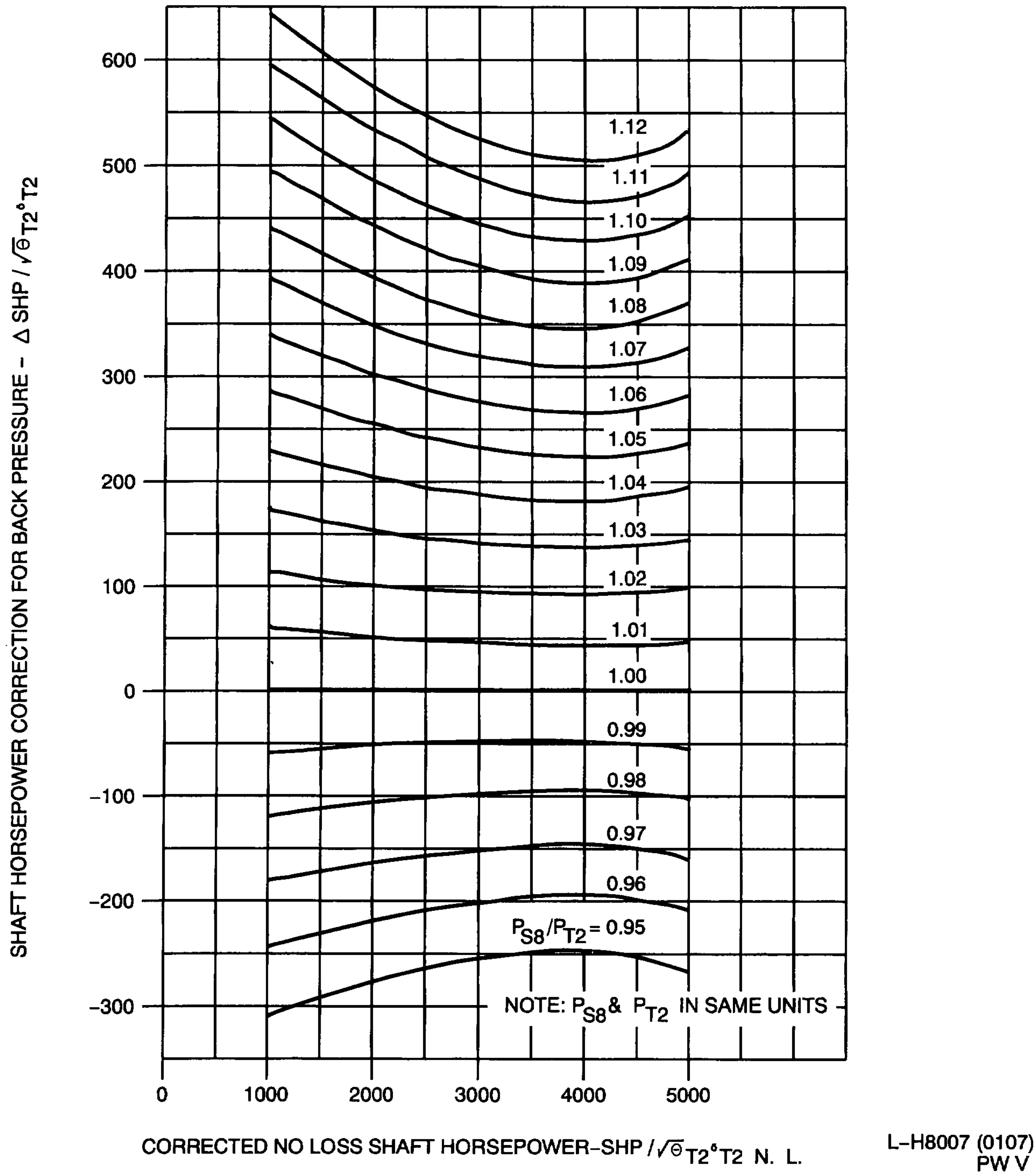
12 Compressor inlet differential pressure

13 Compressor inlet total pressure

14 Observed and corrected turbine discharge temperature

R
R

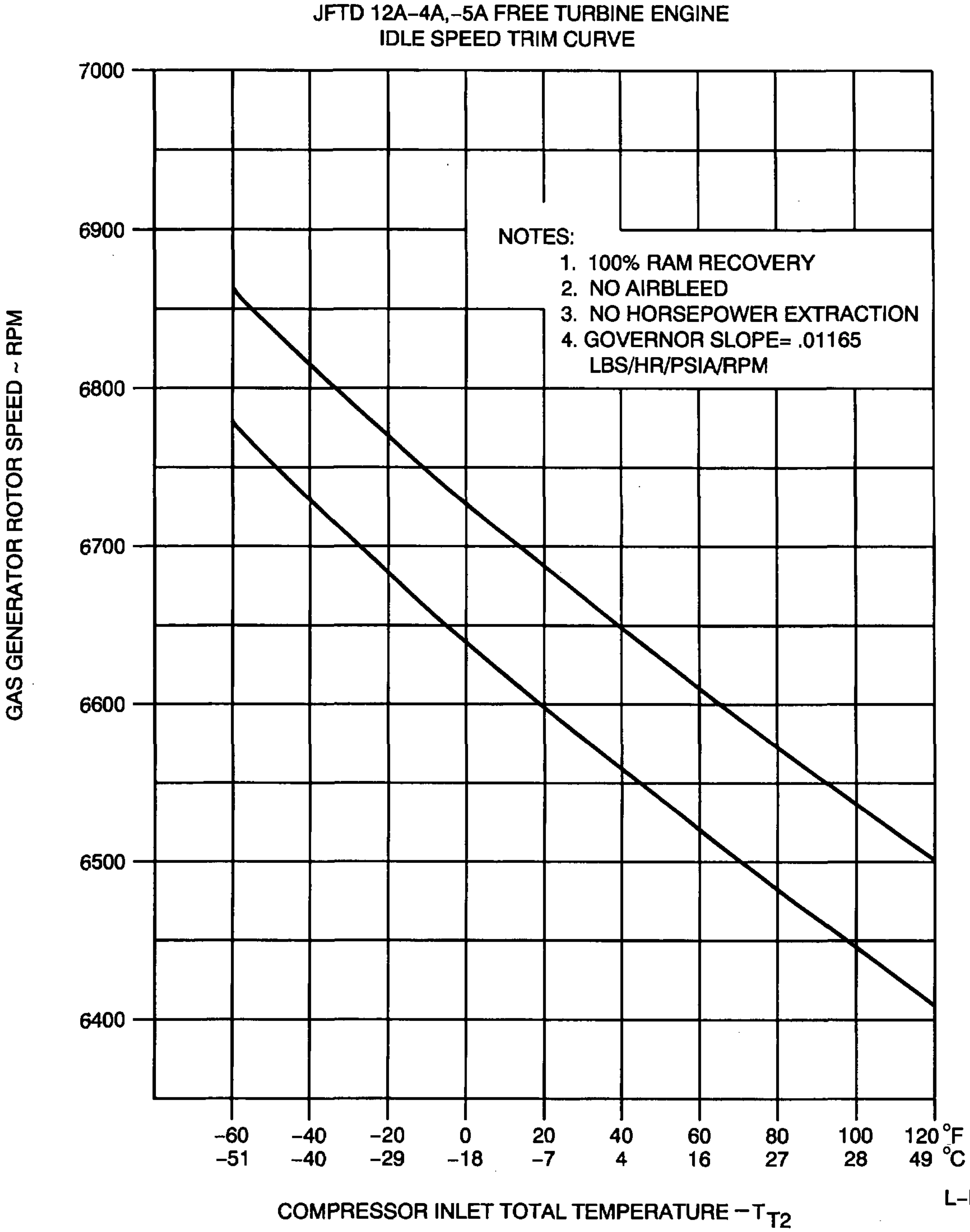
NOTE: Please see the TEMPORARY REVISION that revises this page



NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Estimated Shaft Horsepower
Correction For Back
Pressure Effect
Figure 930



NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Idle Speed Trim Curve
(JFTD12A-4A, -5A)
Figure 931

15 Dynamometer load

16 Observed and corrected compressor rpm

17 Observed free turbine rotor rpm

18 Fuel flow - observed and corrected

19 Fuel flow specific gravity correction

20 Oil consumption

21 Fuel pressure stack temperature

22 Brake specific fuel consumption

23 Fuel flow temperature

24 Free Turbine exhaust gas static pressure

25 Compressor static discharge pressure

26 Compressor inlet temperature

27 Record the following times:

a Time to ignition and N1 at ignition

b Time to starter cutout and N1 at cutout

c Time to stabilized idle and N1 at idle.

28 Observed and corrected turbine discharge pressure

29 Corrected indicated shaft horsepower

30 Engine pressure ratio

31 Compressor bleed system operation

32 Miscellaneous data:

a Reason for any nonscheduled engine shutdown

b Reason for any engine rejection

c Performance of any penalty tests

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

d Time in seconds that Tt5 exceeds specific limits

e Repairs made to the engine during the test.

(d) Record the engine coast-down time. This time is defined as the time lapse between the moment the N1 lever is placed in the full closed position and the moment the engine N1 rotor comes to a complete stop.

NOTE: Coast-down time has no absolute value: however, all the engine records combined will determine the expected coast-down time. Any engine with an abnormally short coast-down time should be thoroughly checked to determine the cause.

(17) Engine Trim Procedures (JFTD12A-4A And -5A)

(O)OPERATION/(C&R)CHECKS AND REMARKS

1. (O) Belting-in

(C&R) Refer to Paragraph 14.

2. (O) Engine startup (dynamometer not connected)

(C&R) a. Refer to Paragraph 4.

b. Determine and record:
the time from start cycle initiation to idle speed; the times to ignition and rpm, starter cutout and rpm, maximum exhaust gas temperature, and noticeable flat spots in acceleration.

CAUTION: DO NOT ADVANCE THE N1 LEVER BEYOND IDLE UNTIL 38°C (100°F) OIL-IN TEMPERATURE IS REACHED. CHECK FOR FUEL AND OIL LEAKS AND CORRECT AS NECESSARY BEFORE CONTINUING THE RUN.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(O)OPERATION/(C&R)CHECKS AND REMARKS

3. (O) Accelerate free turbine 8000 to 9500 rpm.

(C&R) Run a vibration survey on the free turbine from 8000 N2 to 9500 N2. Read all generator and free turbine pickups at 9000 N2, 9500 N2, and at peak vibration points. Refer to Paragraph B.(8), Limits For Test Instruments And Equipment.

NOTE: The maximum allowable N2 operating speed for this test is 9600 rpm.

4. (O) Engine shutdown

(C&R) Refer to Paragraph 6.

5. (O) Connect dynamometer to engine.

6. (O) Install part power trim stop.

(C&R) See Figure 902.

7. (O) Engine startup

(C&R) Refer to Paragraph 4. Determine and record the overall time from start cycle initiation to idle speed.

8. (O) Run at ground IDLE

(C&R) a. N1 lever at IDLE

b. N2 and pitch levers at minimum positions

c. Adjust IDLE trimmer to obtain the limits in Figure 931.

d. After a 5 minute stabilization, record the following data:

N1, N2, load, Tt2, Pt2, Pt5, Wf, Ps3
oil and breather pressure
oil temperature
vibration.

e. Advance the N2 lever and pitch lever to the maximum position.

CAUTION: THIS POSITION WILL BE CONSIDERABLY LESS THAN

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(O)OPERATION/(C&R)CHECKS AND REMARKS

(CONTINUED)

FULL N1 LEVER TRAVEL. DO NOT APPLY EXCESSIVE FORCE TO THE N1 LEVER.

9. (O) Move the N1 lever to part power trim stop, then back to ground idle position.

NOTE: Adjust the dynamometer load to limit N2 to maximum 9000 rpm.

(C&R) a. During acceleration, the automatic modulated bleed 1 fuel control arm must start to close at N1 between 10,450 and 11,000 rpm and be fully closed at 13,000 rpm.

b. During deceleration, the arm must be:
fully closed at N1 of 13,000 rpm
start to open between 13,000 and 12,400 rpm
and
fully open between 11,000 and 10,450 rpm.

c. Record N1 prior to initiating bleed actuation on acceleration and deceleration.

NOTE: The arm position during bleed opening and closing should vary smoothly with engine speed.

CAUTION: DO NOT OPERATE ENGINES ABOVE 12,000 RPM FOR EXTENDED PERIODS WITH THE BLEED VALVE OPEN. EXCESSIVE STRESS TO 5TH STAGE STEEL BLADES REQUIRES REPLACING THEM. TITANIUM BLADES DO NOT NEED TO BE REPLACED.

10. (O) Move N1 lever to part power trim stop.

CAUTION: THIS POSITION WILL BE CONSIDERABLY LESS THAN FULL N1 LEVER TRAVEL. DO NOT APPLY EXCESSIVE FORCE TO THE N1 LEVER.

(C&R) a. While maintaining N2 at 9,000 rpm by adjusting the load, adjust the MAX trim screw on the fuel control To obtain the proper engine pressure ratio (EPR) from Figure 932 and check the corrected shaft horse-power from Figure 933.

CAUTION: ADJUSTING FUEL CONTROL MAX TRIM SCREW TO EITHER EXTREME POSITION CAN RESULT IN

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(O)OPERATION/(C&R)CHECKS AND REMARKS

(CONTINUED)

BINDING OF THE GOVERNOR LEVER, WHICH WILL CAUSE N1 LEVER BINDING. IF THIS CONDITION IS ENCOUNTERED, THE TRIM SCREW MUST BE TURNED 1/2 - 2 1/2 TURNS IN THE DIRECTION OPPOSITE FROM THE EXTREME TO FREE THE N1 LEVER. FULL TRIM SCREW TRAVEL SHOULD NOT BE REQUIRED TO TRIM THE ENGINE TO ALLOWABLE LIMITS.

b. Record all data after a 5 minute stabilization.

11. (O) Decelerate to GROUND IDLE

(C&R) a. Recheck N1 idle speed from Figure 931.

b. Adjust the idle trimmer, if necessary, and repeat the operation.

c. Record all data after a 5 minute stabilization.

CAUTION: IDLE AND MAX TRIMMERS AFFECT EACH OTHER. THEREFORE, IT MAY BE NECESSARY TO REPEAT OPERATIONS 10 AND 11 UNTIL THE PREFERRED SETTINGS ARE OBTAINED WITHOUT INTERMEDIATE ADJUSTMENT.

12. (O) Remove the part power trim stop, and replace it on the fuel control.

NOTE: PN 579313 stop must remain with the same control at all times. PN 706392-1 stops are interchangeable with each other.

13. (O) Accelerate to TAKEOFF position

(C&R) a. Adjust N1 lever and the load to develop TAKEOFF power by Figure 927A or Figure 927B, while maintaining N2 at 9000 rpm.

b. Record all data after a 5 minute stabilization.

14. (O) Decelerate to IDLE (JFTD12A-5A only)

(C&R) Place the overspeed system test switch in the TEST position.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(O)OPERATION/(C&R)CHECKS AND REMARKS

15. (O) Accelerate slowly to dropoff point (JFTD12A-5A only)

(C&R) a. N2 speed will increase and then drop off sharply.

b. Record N2 speed prior to the dropoff (speed must be between 8590 and 8990 rpm.)

c. After at least 2 cycles, place the test switch in the RUN position during acceleration. Continue to cycle.

16. (O) Add more acceleration (JFTD12A-5A only)

(C&R) N2 speed must increase above the dropoff noted speed.

CAUTION: DO NOT EXCEED 9500 RPM N2.

17. (O) Engine shutdown

(C&R) a. Refer to Paragraph 6.

b. Inspect for oil and fuel leaks. Correct as needed.

(18) Engine Acceptance Test Procedures (JFTD12A-4A And -5A)
(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

1. (O) Engine startup

(C&R) a. Refer to Paragraph 4.

b. Determine and record the overall time from start cycle initiation to idle speed.

CAUTION: DO NOT ADVANCE THE N1 LEVER BEYOND GROUND IDLE UNTIL 38°C (100°F) OIL-IN TEMPERATURE IS REACHED. CHECK FOR FUEL AND OIL LEAKS AND CORRECT, AS NEEDED, BEFORE CONTINUING RUN.

2. (O) Minimal load

(D) 5 minutes

(C&R) Record the oil level and oil inlet temperature when the temperature stabilizes after 5 minutes.

NOTE: During the operation at no-load and all subsequent power settings, maintain N2 at 9000 rpm.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

(CONTINUED)

NOTE: During Operations 3, 5, or 7, actuate the anti-icing controls at least twice. The anti-icing air temperature, downstream of the valve, must increase at least 55°C (100°F) when the valve is open. The indicator light must be ON when the valve is open. Record the temperature and the indicator light operation.

3. (O) TAKEOFF load

   (D) 5 minutes

   (C&R) Adjust the control levers and the dynamometer load to the corrected horsepower in Band A of Figure 929.

4. (O) Minimal load

   (D) 5 minutes

5. (O) TAKEOFF load

   (D) 5 minutes

   (C&R) Refer to Operation 3.

6. (O) No-load

   (D) 5 minutes

7. (O) TAKEOFF load

   (D) 5 minutes

   (C&R) Refer to Operation 3.

8. (O) 1700 HP load

   (D) 10 minutes

   (C&R) Adjust control levers and dynamometer load to 1700 HP by Band F in Figure 929. Record all data when the engine is stabilized.

NOTE: Please see the
TEMPORARY REVISION
that revises this page

R
R

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

R 9. (O) Supplemental power load (required only if Tt2 is 10°C (50°F) or lower for JFTD12A-5A only)

(D) 10 minutes

(C&R) Adjust control levers and dynamometer load by Band E in Figure 929 (Sheet 2). Record all data when the engine is stabilized.

10. (O) 60% MAXIMUM CONTINUOUS HP load

(D) 10 minutes

(C&R) Adjust control levers and dynamometer load by Band D in Figure 929. Record all data when the engine is stabilized.

11. (O) 80% MAXIMUM CONTINUOUS HP load

(D) 10 minutes

(C&R) Adjust control levers and dynamometer load by Band C in Figure 929. Record all data when the engine is stabilized.

12. (O) MAXIMUM CONTINUOUS HP load

(D) 10 minutes

(C&R) a. Adjust control levers and dynamometer load by Band B in Figure 929. Record all data when the engine is stabilized.

b. Check the operation of the fuel de-icing system during this time. With the air valve open, the fuel-out temperature of the heat exchanger must increase at least 44°C (80°F) in 1 minute.

<u>NOTE</u>: Do not adjust control levers for resultant loss of power. Do not record data while the valve is open.

NOTE: Please see the TEMPORARY REVISION that revises this page

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

13. (O) TAKEOFF HP load

(D) 10 minutes

(C&R) a. Adjust control levers and dynamometer load to the corrected TAKEOFF horsepower requirements for the inlet temperature by Band A in Figure 929. Record all data when the engine is stabilized.

b. Check the dual junction exhaust gas measurement system. Take readings from individual reading thermocouple circuits and compute the average, which should fall within ± 11°C (± 20°F) of readings taken with the averaging harness. If an individual thermocouple reading is above the line in Figure 929 and the thermocouple and gage are accurate, then make a fuel nozzle flow check. Refer to the instructions in Section 73-00-00, Accessories.

14. (O) Minimal load

(D) 5 minutes

(C&R) Record the oil level and temperature after stabilization. Determine the oil consumption (gallons per hour) since Operation 2 and record.

15. (O) Engine shutdown

(C&R) Refer to Paragraph 6.

16. (O) Plot the graph

(C&R) a. Use data previously recorded to plot the graph for standard sea level evaluation. Determine the corrected data plate check speed at Pt5/Pt2 of 1.65 in rpm and as a percent of 16,030 rpm to 2 decimal places. Refer to Paragraph 11. and Figure 921, using 0.262:1 tachometer drive ratio.

b. The value of EPR at corrected power settings must conform to the limits in Paragraph 7.

<u>NOTE</u>: If the EPR at corrected TAKEOFF thrust is not within the limits, then check the test stand instrumentation and repeat Operations 9 thru 13.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(O)OPERATION/(D)DURATION(minutes)/(C&R)CHECKS AND REMARKS

17. (O) Inspect filters and strainer

(C&R) a. Remove and inspect the main oil strainer, fuel control filter, and fuel pump filter for contamination.

b. Reinstall the uncontaminated strainer and filters.

c. Perform a leak check during preservation cycle.

(19) Marking Data Plate

(a) The value of the corrected N1 determined as Pt5/Pt2 of 1.65 and established in Engine Acceptance Test must be expressed in both rpm and a percent of 16,030 rpm to 2 decimal places, then stamped on the data plate as follows:

Data plate check speed at 59°F: 00000 rpm, 00.00%

NOTE: Replacing parts that affect the gaspath, such as the compressor and turbine rotors, diffuser case and turbine nozzle, requires recomputing the data plate speed.

(20) Operating Limits

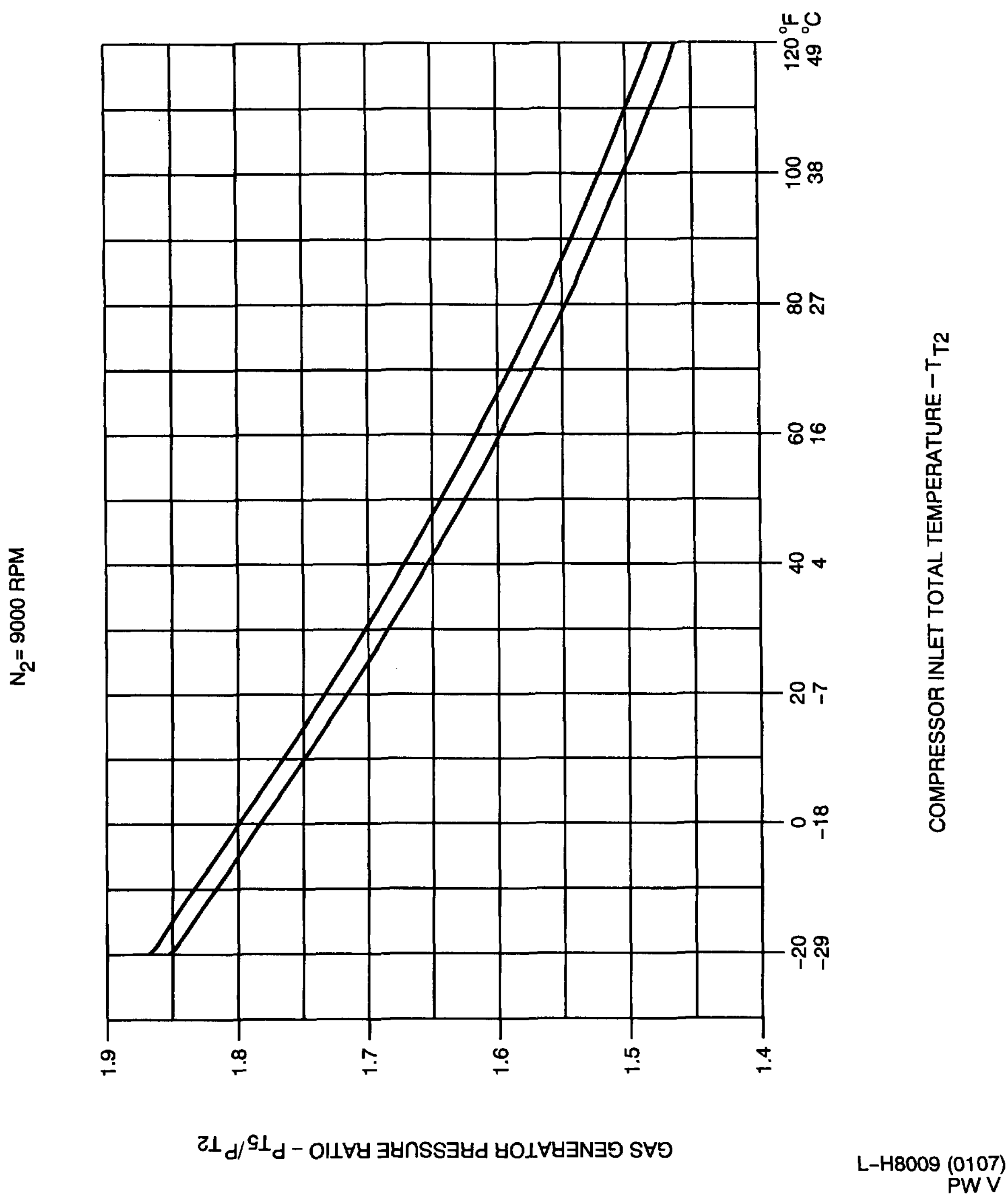
(a) Overtemperature

1 Overtemperature conditions are usually preceded by an excessively rapid rise in fuel flow, compressor speed, and/or temperature. Several momentarily high overtemperatures affect engine service life as seriously as a single prolonged overtemperature condition. The higher the temperature, the greater the threat of serious engine damage, resulting in more extensive inspections.

2 When an overtemperature condition is anticipated or has occurred, perform engine shutdown by Paragraph 6. Avoid emergency shutdown unless it becomes obvious that continued operation will result in more than overtemperature damage.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page



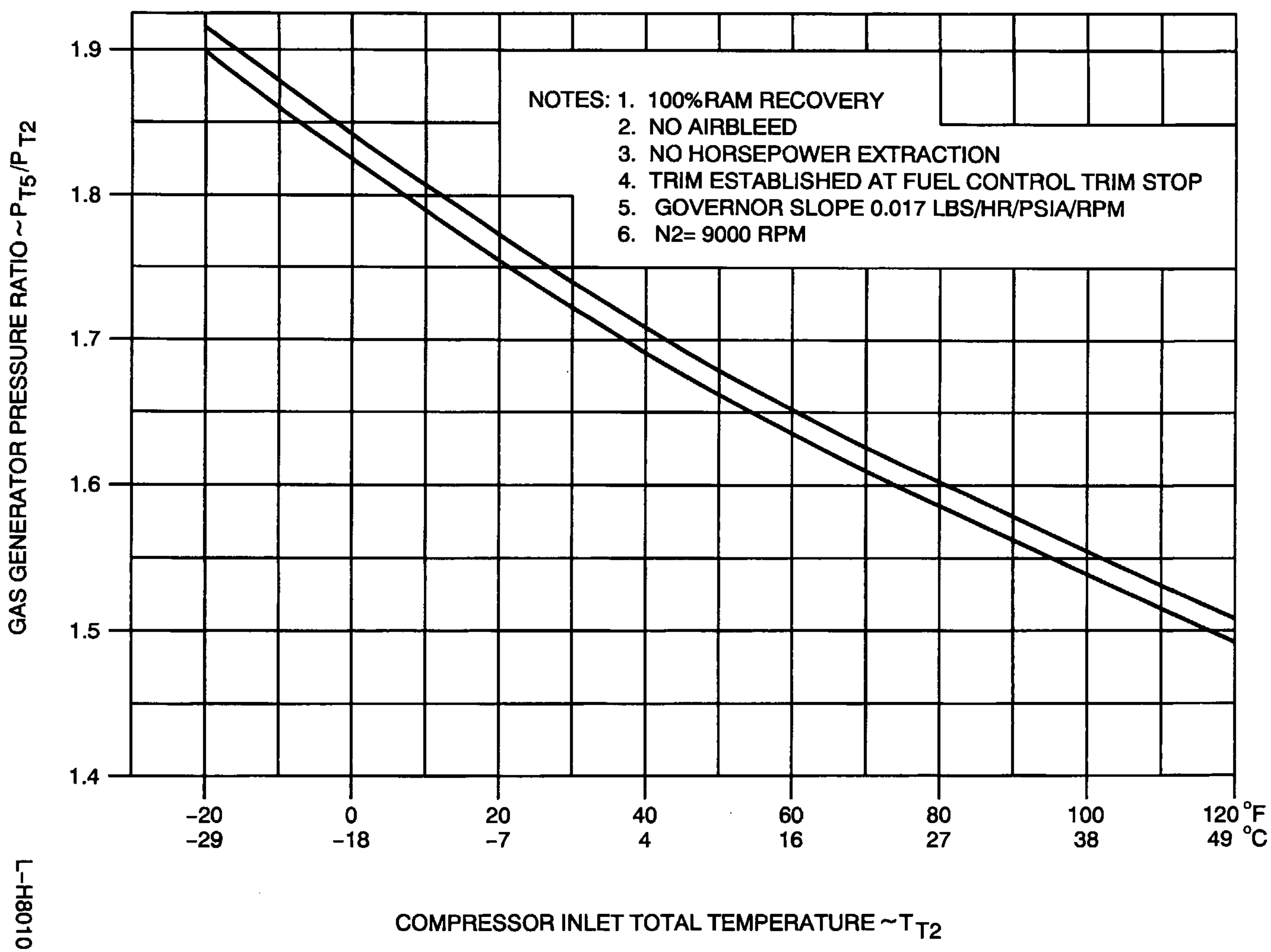
NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Part Power Trim Curve (JFTD12A-4A)
Figure 932 (Sheet 1)

R
R

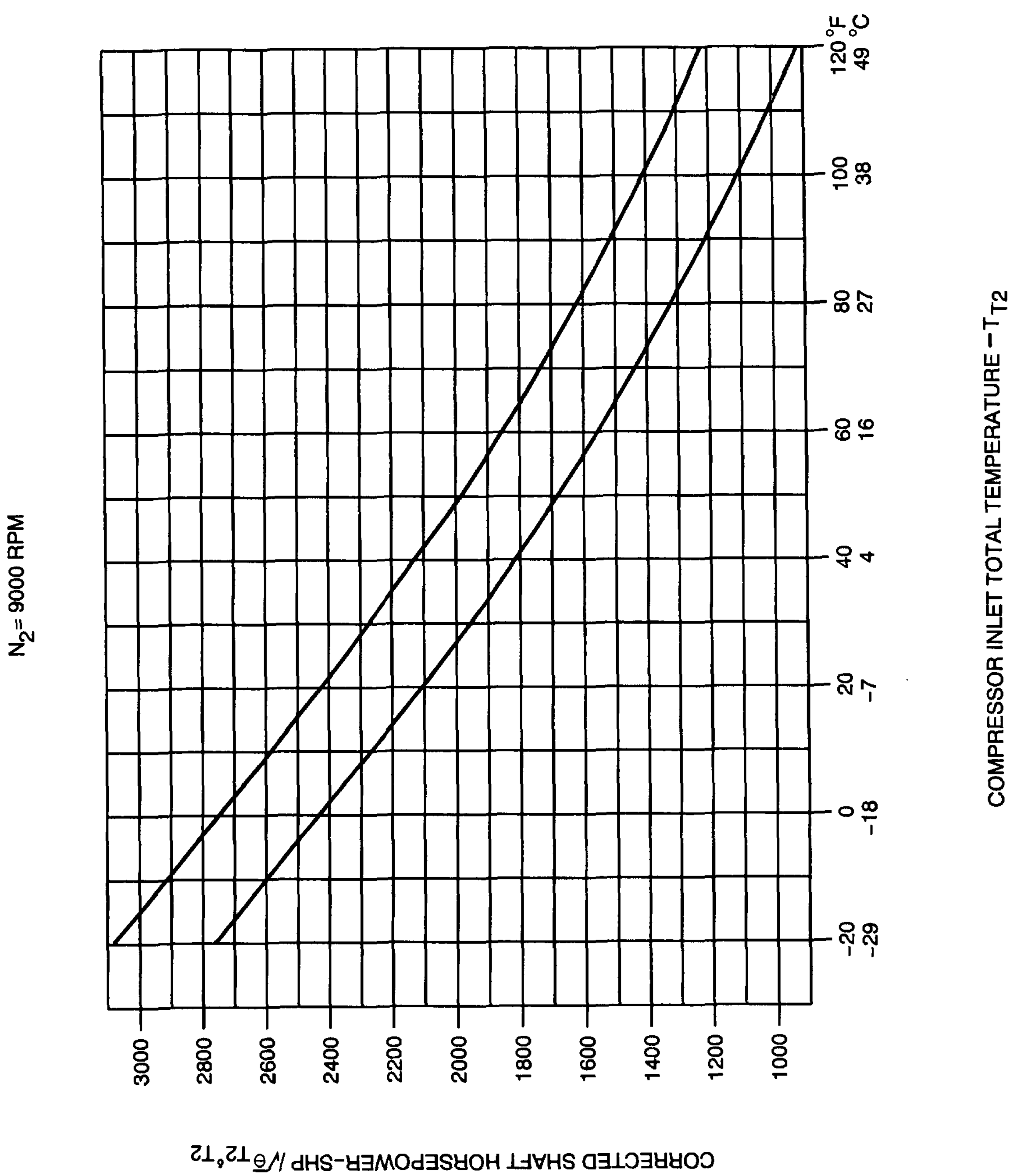
JFTD12A-5A FREE TURBINE DRIVE ENGINE
ESTIMATED REDUCED SHAFT HORSEPOWER TRIM CURVE



L-H8010 (0107)
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

Part Power Trim Curve (JFTD12A-5A)
Figure 932 (Sheet 2)

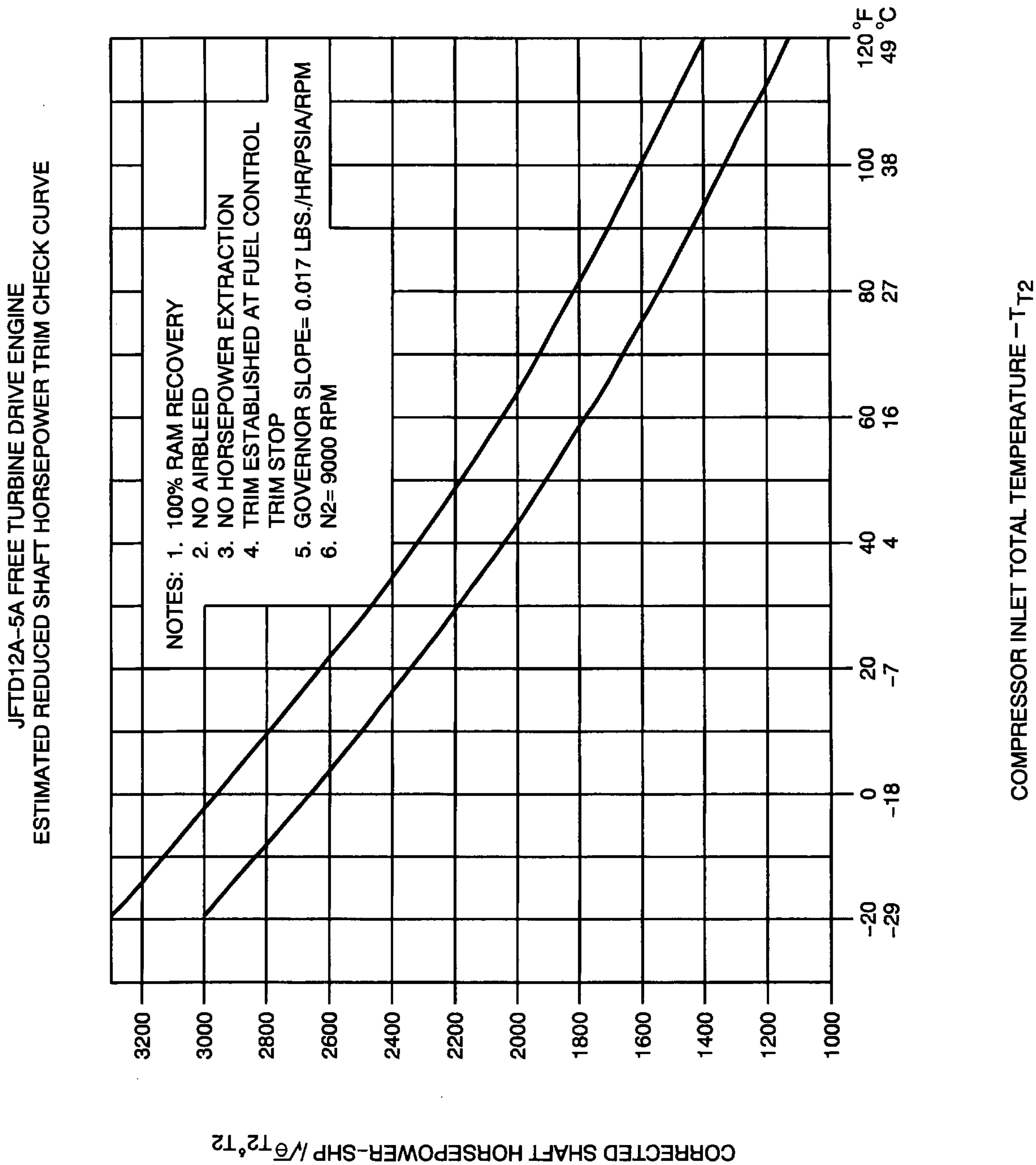


L-H8011 (0107)
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Part Power Corrected Shaft
Horsepower Check Curve
(JFTD12A-4A)
Figure 933 (Sheet 1)



L-H8012 (0107)
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Part Power Corrected Shaft
Horsepower Check Curve
(JFTD12A-5A)
Figure 933 (Sheet 2)

3 Overtemperature limits and corresponding inspection procedures are presented in Table 913 and Table 914, and in Figure 934, Figure 935 (Sheet 1), and Figure 935 (Sheet 2).

4 The charts list overtemperature conditions in the left-hand column and the action to take in the right-hand column. For example, if Tt5 is observed for a given length of time and falls within a category listed in the left-hand column, then refer to the applicable instructions in the right-hand column.

5 In Figure 934, Figure 935 (Sheet 1), and Figure 935 (Sheet 2) the left margin contains the temperature (Tt5°C/°F) and the bottom margin contains the time in seconds. The temperature and time lines intersect within coded blocks in the graph. Plot the temperature and time on the graph to the point where they intersect. The letter code in the block indicates the procedure to follow in the legend.

(21) Overspeed
See Table 915 and Table 916.

(a) Overspeed Cutout System

1 This system (incorporated in the fuel control), which is set to cut out at 10,350 (N2) rpm, automatically shuts off the fuel flow. In the event the fuel flow shuts off, proceed as follows:

a Slowly return the N1 lever to OFF.

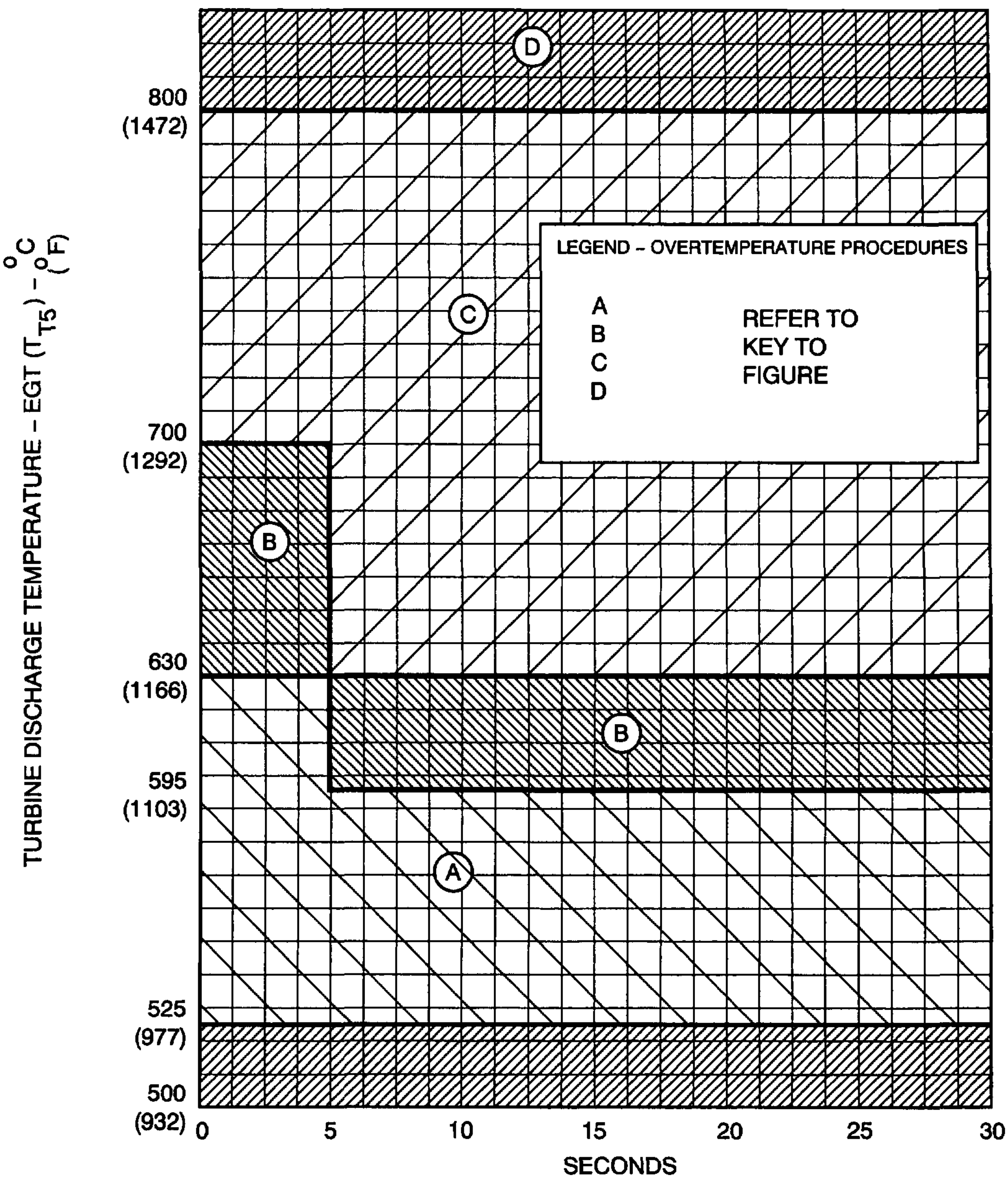
b Decrease the pitch lever to the minimum position.

c Apply the maximum dynamometer load.

d Restart the engine by using the standard startup procedure.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page



L-50815 (0107)
PW V

ORIGINAL
As Received By
ATP

NOTE: Please see the
TEMPORARY REVISION
that revises this page

R
R

Engine Startup Overtemperature
(JFTD12A-4A, And -5A)
Figure 934

Notes For Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

   (1) Examine the exhaust duct for foreign material.

   (2) Examine the rear of the turbine for apparent damage.

   (3) Do inspections of the combustion section and turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

   (1) FPI all turbine and free turbine blades and vanes.

   (2) Examine all turbine vanes for bow, bend and twist.

   (3) Examine all free turbine vanes for bow.

   (4) Do stretch inspections of all turbine and free turbine blades.

   (5) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

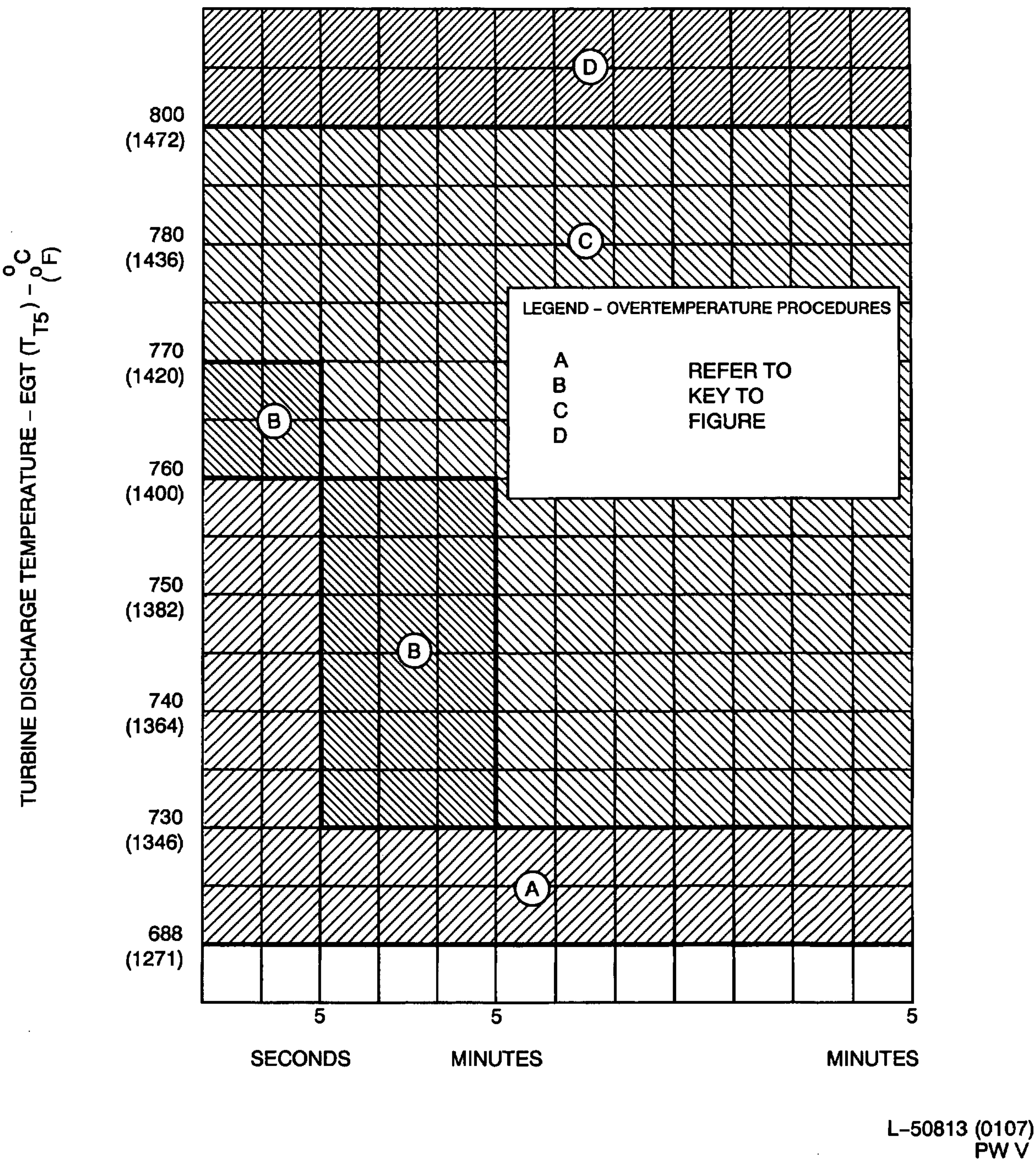
   (1) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to find the temperature at
R which they operated. Refer to the Standard Practices
R Manual, Section 70-36-00. Blades that do not have indica-
R tions that they got to 1094°C (2000°F) can return to service
R if they are in all inspection limits. Scrap blades that
R have indications that they got to 1094°C (2000°F) or more.

   (2) FPI all turbine vanes and all free turbine blades and vanes. Refer to Section 72-00-00, Inspection.

   (3) Examine all turbine vanes for bow, bend, and twist.

Key to Figure 934

NOTE: Please see the TEMPORARY REVISION that revises this page



ORIGINAL
As Received By
ATP

NOTE: Please see the
TEMPORARY REVISION
that revises this page

R
R

Engine Operation Overtemperature
Limits (JTFD12A-4A)
Figure 935 (Sheet 1)

(4) Examine all free turbine vanes for bow.

(5) Examine all free turbine blades for stretch.

(6) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 934 (Continued)

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

NOTES For Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Do inspections of the combustion section and turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine and free turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend and twist.

(3) Examine all free turbine vanes for bow.

(4) Do stretch inspections of all turbine and free turbine blades.

(5) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to find the temperature at which they operate. Refer to the Standard Practices Manual, Section 70-36-00. Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that do not reach 1094°C (2000°F) or more.

(2) FPI all turbine vanes and all free turbine blades and vanes. Refer to Section 72-00-00, Inspection.

R Key to Figure 935 (Sheet 1)

NOTE: Please see the TEMPORARY REVISION that revises this page

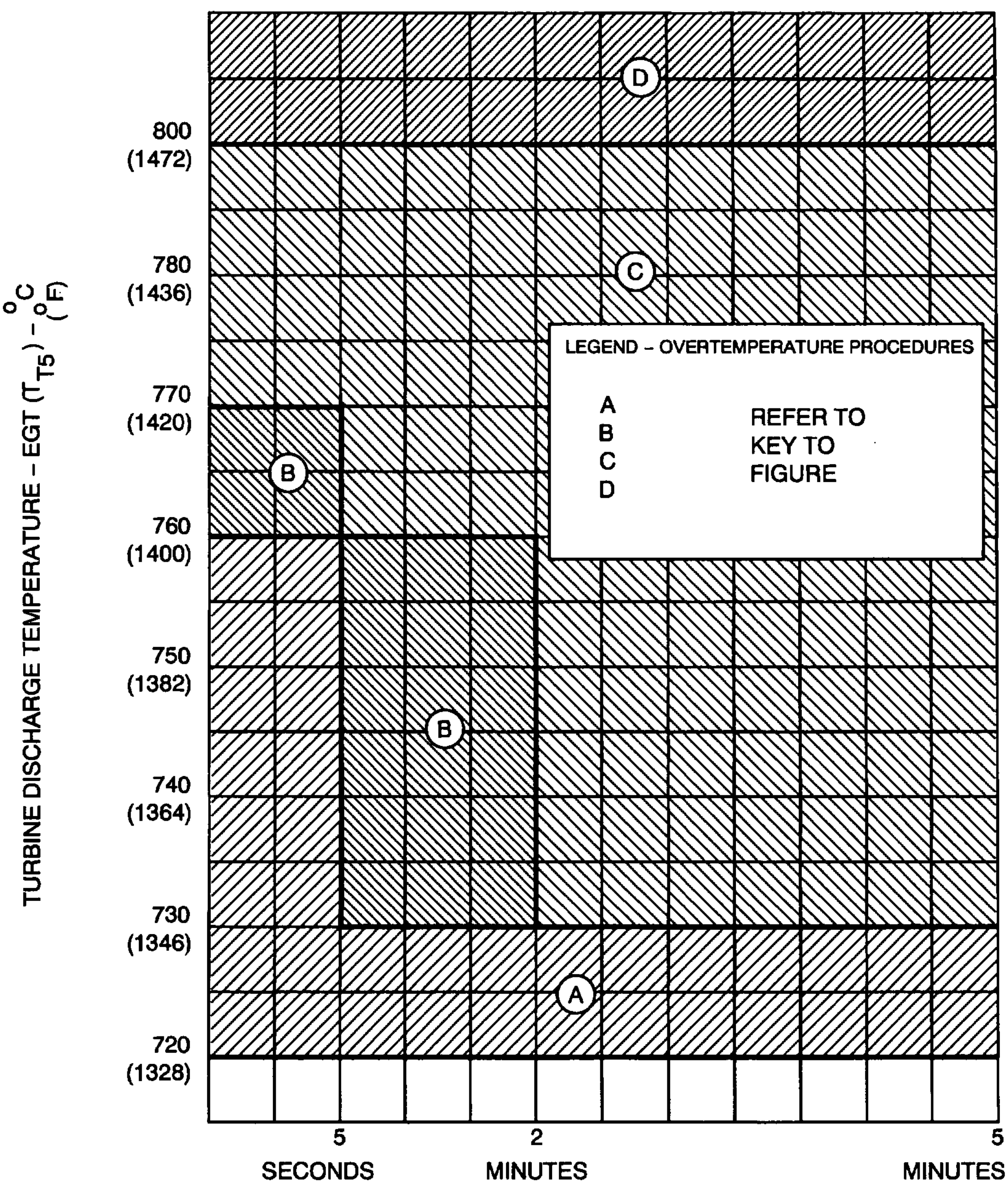
(3) Examine all turbine vanes for bow, bend, and twist.

(4) Examine all free turbine vanes for bow.

(5) Examine all free turbine blades for stretch.

(6) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 935 (Sheet 1) (Continued)



L-50817 (0107)
PW V

ORIGINAL
As Received By
ATP

NOTE: Please see the
TEMPORARY REVISION
that revises this page

R
R

Engine Operation Overtemperature
Limits (JFTD12A-5A)
Figure 935 (Sheet 2)

NOTEs For Overtemperature Procedures:

A. Find and correct the cause of the overtemperature.

B. Visually inspect all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Examine the exhaust duct for foreign material.

(2) Examine the rear of the turbine for apparent damage.

(3) Do inspections of the combustion section and turbine vanes.

C. Do teardown inspections of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) FPI all turbine and free turbine blades and vanes.

(2) Examine all turbine vanes for bow, bend and twist.

(3) Examine all free turbine vanes for bow.

(4) Do stretch inspections of all turbine and free turbine blades.

(5) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

D. Do full overhaul inspection of all hot section parts. Refer to Section 72-40-00 and 72-50-00, Inspection.

(1) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to find the temperature at which they operate. Refer to the Standard Practices Manual, Section 70-36-00. Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that do not reach 1094°C (2000°F) or more.

(2) FPI all turbine vanes and all free turbine blades and vanes. Refer to Section 72-00-00, Inspection.

(3) Examine all turbine vanes for bow, bend, and twist.

Key to Figure 935 (Sheet 2)

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(4) Examine all free turbine vanes for bow.

(5) Examine all free turbine blades for stretch.

(6) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

Key to Figure 935 (Sheet 2) (Continued)

	Tt5 CONDITION	Tt5 ACTION REQUIRED
A	●Exceeds 688°C (1271°F) ●Does not exceed 730°C (1346°F) for more than 5 seconds ●Does not exceed 760°C (1400°F)	Determine the cause of overtemperature. Correct the overtemperature.
B(1)	●Exceeds 760°C (1400°F) for 5 seconds or less ●Does not exceed 770°C (1420°F)	Perform a visual inspection of hot section parts:
(2)	●Exceeds 730°C (1346°F) for more than 5 seconds but less than 2 minutes ●Does not exceed 760°C (1400°F)	(a) Inspect exhaust duct for foreign particles. (b) Inspect turbine rear for apparent damage (c) Inspect combustion section, turbine vanes, and turbine section front for excessive distortion or damage.
C(1)	●Exceeds 730°C (1346°F) for more than 2 minutes ●Does not exceed 800°C (1472°F)	Perform a teardown inspection of hot section parts: (Refer to Section 72-40-00, Inspection)
(2)	●Exceeds 760°C (1400°F) for more than 5 seconds but less than 5 minutes ●Does not exceed 800°C (1472°F)	(a) FPI turbine and free turbine blades and vanes. (b) Inspect turbine vanes for bow, bend, and twist. (c) Inspect turbine vanes for bow. (d) Inspect turbine and free turbine disks for growth and hardness. Hardness must be at least Rockwell A66.
(3)	●Exceeds 770°C (1420°F) for 5 seconds or less ●Does not exceed 800°C (1472°F)	

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Overtemperature Limits
(Engine Operating - JFTD12A-4A)
Table 913

	Tt5 CONDITION	Tt5 ACTION REQUIRED
D	•Exceeds 800°C (1472°F) for any length of time	Perform a complete overhaul inspection of hot section parts: (Refer to Section 72-40-00, Inspection) (a) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that reach 1094°C (2000°F) or more. (b) FPI all turbine vanes and free turbine blades and vanes. Refer to Section 72-00-00, Inspection. (c) Examine turbine vanes for bow, bend and twist. Refer to Section 72-50-00, Inspection. (d) Examine free turbine vanes for bow. Refer to Section 72-50-00, Inspection. (e) Inspect free turbine blades for stretch. Refer to Section 72-50-00, Inspection. (f) Do growth and hardness checks of all turbine and free turbine disks.

NOTE: Please see the TEMPORARY REVISION that revises this page

Tt5 CONDITION	Tt5 ACTION REQUIRED
	Hardness must be Rockwell A66 or more.

Overtemperature Limits
(Engine Operating - JFTD12A-4A)
Table 913 (Continued)

	Tt5 CONDITION	Tt5 ACTION REQUIRED
A	●Exceeds 720°C (1328°F) ●Does not exceed 730°C (1346°F) for more than 5 seconds ●Does not exceed 760°C (1400°F)	Determine the cause of overtemperature. Correct the overtemperature.
B(1)	●Exceeds 760°C (1400°F) for 5 seconds or less ●Does not exceed 770°C (1420°F)	Perform a visual inspection of hot section parts: (a) Inspect exhaust duct for foreign particles. (b) Inspect turbine rear for apparent damage (c) Inspect combustion section, turbine vanes, and turbine section front for excessive distortion or damage.
(2)	●Exceeds 730°C (1346°F) for more than 5 seconds but less than 2 minutes ●Does not exceed 760°C (1400°F)	
C(1)	●Exceeds 730°C (1346°F) for more than 2 minutes ●Does not exceed 800°C (1472°F)	Perform a teardown inspection of hot section parts: (Refer to Section 72-40-00, Inspection) (a) FPI turbine and free turbine blades and vanes. (b) Inspect turbine vanes for bow, bend, and twist. (c) Inspect free turbine vanes for bow. (d) Inspect turbine and free turbine blades for stretch. (e) Inspect turbine and free turbine disks for growth and hardness. Hardness must be at least Rockwell
(2)	●Exceeds 760°C (1400°F) for more than 5 seconds but less than 5 minutes ●Does not exceed 800°C (1472°F)	
(3)	●Exceeds 770°C (1420°F) for 5 seconds or less ●Does not exceed 800°C (1472°F)	

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Overtemperature Limits
(Engine Operating - JFTD12A-5A)
Table 914

	Tt5 CONDITION	Tt5 ACTION REQUIRED
(CONTINUED)		A66.
D	•Exceeds 800°C (1472°F) for any length of time	Perform a complete overhaul inspection of hot section parts: (Refer to Section 72-40-00, Inspection) (a) Scrap all turbine blades (not free turbine) except those made of PWA 663 or PWA 655 material. Do a metallurgical analysis of the remaining blades to reveal the temperature at which they operate (refer to the Standard Practices Manual, Section 70-36-00). Blades that do not reach 1094°C (2000°F) can return to service if they are within all inspection limits. Scrap blades that reach 1094°C (2000°F) or more. (b) FPI all turbine vanes and free turbine blades and vanes. Refer to Section 72-00-00, Inspection. (c) Examine turbine vanes for bow, bend and twist. Refer to Section 72-50-00, Inspection. (d) Examine free turbine vanes for bow. Refer to Section 72-50-00, Inspection. (e) Inspect free turbine blades for stretch. Refer to Section 72-50-00, Inspection.

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Overtemperature Limits
(Engine Operating - JFTD12A-5A)
Table 914 (Continued)

Tt5 CONDITION	Tt5 ACTION REQUIRED
(CONTINUED)	(f) Do growth and hardness checks of all turbine and free turbine disks. Hardness must be Rockwell A66 or more.

Overtemperature Limits
(Engine Operating - JFTD12A-5A)
Table 914 (Continued)

OBSERVED N1 CONDITION	OBSERVED N1 ACTION REQUIRED
A ●Rotor speed exceeds 16,700 rpm (104.2%) ●Does not exceed 16,900 rpm (105.4%)	(a) Check N1 rotor for free rotation and visually inspect inlet and exhaust ducts for foreign particles or evidence of rubbing. (b) Check compressor and turbine vanes and blades for damage. (c) Check free turbine blades and vanes for damage. If satisfactory, continue the engine in service. (d) If an abnormal condition is evident, then perform the teardown inspection.
B ●Rotor speed exceeds 16,900 rpm (105.4%)	Shut down the engine and send the engine to overhaul for a complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).

Overspeed Procedures
Table 915

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

OBSERVED N2 CONDITION	OBSERVED N2 ACTION REQUIRED
A ●Rotor speed exceeds 10,350 rpm ●Does not exceed 10,800 rpm	(a) Remove and inspect N2 speed cable. (b) Inspect N2 gearbox for positive rotation of cable drive output shaft during free turbine rotation. (c) Check the free turbine for free rotation. (d) Visually inspect exhaust ducts for particles or evidence of rubbing. (e) Check turbine blades for damage. If satisfactory, continue the engine in service. (f) If an abnormal condition is evident, then remove the free turbine and send it to overhaul.
B ●Rotor speed exceeds 10,800 rpm	Shut down the free turbine and perform a complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).

Free Turbine Overspeed Procedures
Table 916

29. Engine Trim Balance Procedure
(Refer to Tool Group 95B)

A. Engines with rotating parts that are balanced, as specified in Subassembly, will usually have some residual unbalance resulting in detectable vibration during engine operation. This vibration may be minimized by trim balancing, a procedure that installs counterweights positioned to offset compressor or turbine residual unbalance. Engines that exceed vibration limits during standard testing, but qualify per Paragraph B. may be trim balanced. This procedure is performed in the test cell.

NOTE: Trim balance can be done only on turbojet and free turbine engines that incorporate a removable front compressor hub plug.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

B. Engine Qualification For Trim Balance

(1) Trim balancing is limited by the following conditions:

(a) Only overhauled engines and repaired engines (light overhaul) that have had compressor and turbine rotors disassembled, inspected, reassembled, and balanced, can be trim balanced.

NOTE: Engines that develop a vibration while in service must not be trim balanced prior to rotor subassembly balance at overhaul or light overhaul.

(b) Engines with a vibration at any pickup point that exceeds the limit specified in Table 917 do not qualify for trim balancing.

NOTE: Table 917 allows for relaxing the vibration amplitude during trim balance runs. To be acceptable, a vibration must fall within the limits in Table 921 at the completion of the trim balance.

C. Engine Classification

(1) The engine must be classified by comparing results of the prebalance vibration survey with Figure 936 and Table 918 (turbojet engines), or with Figure 937 and Table 919 (free turbine engines). It is possible for an engine to have vibration characteristics that place it in more than one class. When this happens, place the engine in a class where the highest amplitude occurs. Trim balance the vibration within limits and proceed to the next class.

D. Equipment Required For Trim Balancing
See Figure 938.

(1) The following recommended equipment is used to measure the parameters required to perform trim balance, such as vibration amplitude, rotor speed, and phase angle.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(a) Vibration Pickups - Phased velocity type, CEC 4-123A, or equivalent. Accelerometers can be used, however, if the readout is in velocity, then phase angle lags are affected and trim balance displacement limits require conversion to velocity.

NOTE: Vibration pickups can be obtained from Consolidated Electrodynamics Corporation, or another manufacturer with equivalent equipment.

VIBRATION PICKUP	ABOVE 15,500 RPM	BELOW 15,500 RPM
	TURBOJET ENGINES	
No. 1 Inlet Case-Flange A Vertical	.0020 inch (2.0 mils)	.0024 inch (2.4 mils)
No. 2 Inlet Case-Flange A Horizontal	.0020 inch (2.0 mils)	.0024 inch (2.4 mils)
No. 3 Combustion Chamber Outer Case-Flange E Horizontal	.0020 inch (2.0 mils)	.0020 inch (2.0 mils)
No. 4 Gearbox-Vertical	.0020 inch (2.0 mils)	.0024 inch (2.4 mils)
	FREE TURBINE ENGINES	
No. 1 Inlet Case-Flange A Vertical	.0023 inch (2.3 mils)	.0025 inch (2.5 mils)
No. 2 Inlet Case-Flange A Horizontal	.0023 inch (2.3 mils)	.0025 inch (2.5 mils)
No. 3 Combustion Chamber Outer Case-Flange E Horizontal	.0023 inch (2.3 mils)	.0025 inch (2.5 mils)
No. 4 Gearbox-Vertical	.0023 inch (2.3 mils)	.0025 inch (2.5 mils)

NOTE: During the trim balance run, vibration amplitudes at rotor frequency up to 0.0030 inch (single amplitude) are allowable on all vibration pickups.

Maximum Vibration Limits (Single Amplitude) (Trim Balance
R Qualification)
R Table 917

NOTE: Please see the TEMPORARY REVISION that revises this page

(b) Speed And Reference Signal Generator - Generator (pip), Model ET-207 (or equivalent), one triangular tooth 1/16 inch flat.

NOTE: This signal generator was formerly available from Standard Electric Company of Springfield, MA.

(c) Narrow Band Filter - All portions of a vibration signal, other than rotor frequency component, are filtered out of the signal input to phase meter. The filter can be either manual or automatic tracking. If a manual filter is used, exercise caution when tuning the filters to eliminate phase errors.

(d) Pip To Sine Converter - This converter accepts the speed pip and produces a sine wave the exact frequency of, as well as locked with, the speed pip.

(e) Phase Meter - The phase angle between the filtered vibration signal and the sine wave reference signal determines the angular location of the residual unbalance.

(f) Frequency Counter - A frequency counter with a 10 second time base that determines rotor speed to 1 part in 1000.

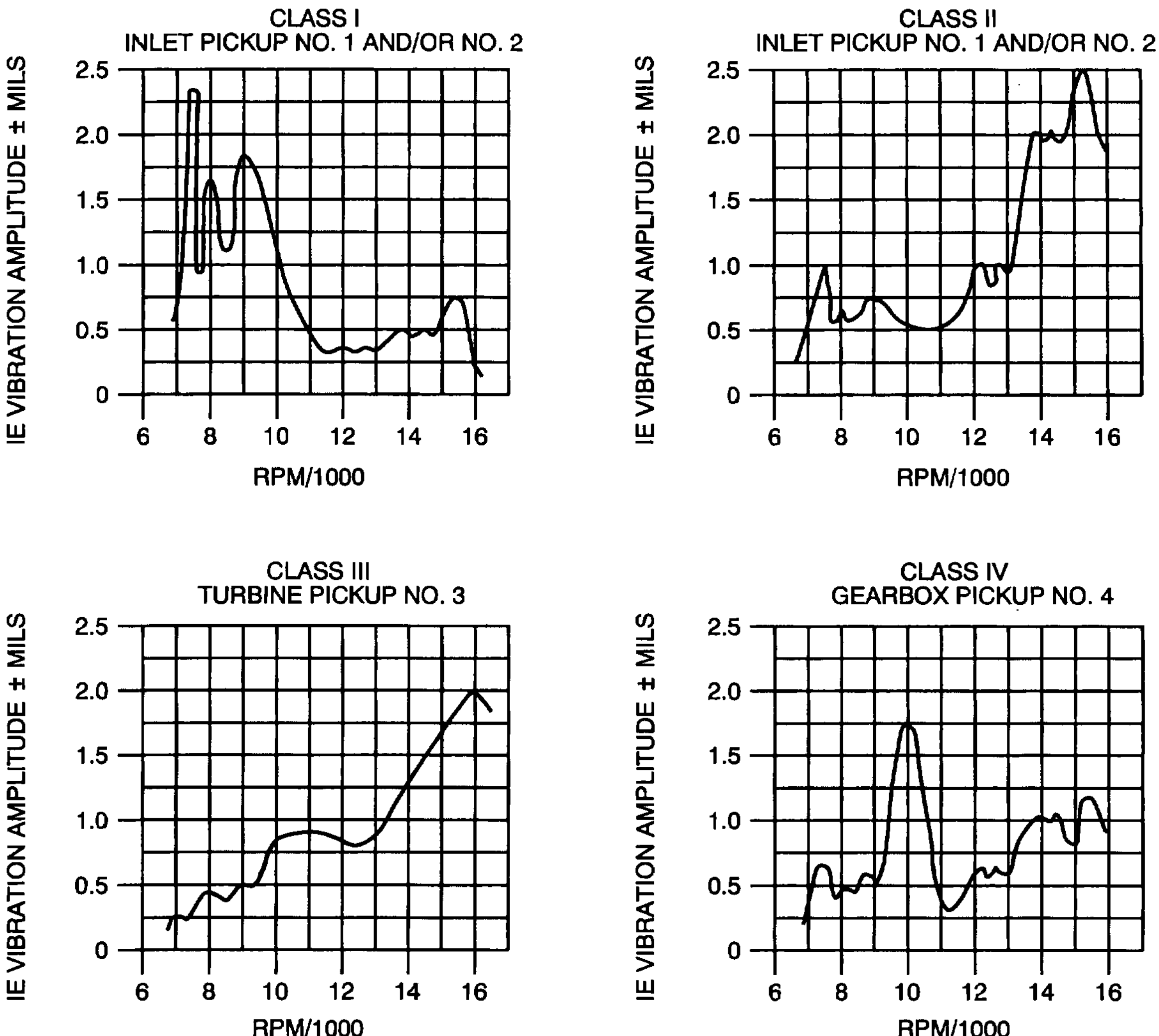
(g) Vibration Meter Integrator - This system accepts the input signal from a vibration pickup mounted on the engine. The signal is integrated to convert it from velocity proportional to displacement proportional.

(h) Sine Wave Oscillator - The oscillator is used to calibrate the trim balance console.

(i) Oscilloscope - A dual display oscilloscope monitors the vibration and reference signals to ensure proper equipment setup and operation.

(j) X-Y Plotter (optional) - The plotter can show a plot of amplitude vs. speed, which is very helpful in classifying engine vibrations.

E. Trim Balance Equipment Setup



L–34865
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Turbojet Engine Trim Balance Classification
Figure 936

(1) Check vibration pickups to ensure they are in phase (positive outward displacement provides positive voltage output).

(2) Install vibration pickups by Paragraph 2.

(3) Perform the following steps to install the tachometer and reference signal generator by using tachometer adapter PWA-13950 and hydraulic pump pad adapter PWA-13949:

(a) Remove nuts and washers that secure the hydraulic pump drive pad cover to the gearbox. Remove the cover.

(b) Install tachometer mount adapter PWA-13950 onto the pad and secure by using previously removed nuts and washers. Torque to 275 - 300 lb-in.

(c) Install hydraulic pump drive support adapter PWA-13949 onto the tachometer mount adapter and secure with capscrews. Connect the reference signal generator to the adapter.

(4) Index the rotor to determine the 0 position for phase angle measurement. Align the single tooth of the pulse generator with the tip of the impulse pickup, which can be seen through the small window in the pulse generator. 0° points to 12:00 with the rotor in this position. Mark the blade and case with layout dye so that the rotor can be reindexed without realigning the tooth with the impulse pickup.

<u>NOTE</u>: Turn the rotor in the direction of engine rotation (counterclockwise facing the engine inlet) to pick up the backlash of the tachometer drive.

(5) Calibrate the trim balance console per the equipment manufacturer's instructions by applying an oscillator signal of known amplitude and frequency to the vibration pickup and the tachometer inputs.

(6) Set the selected speed points and allow the engine to stabilize.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

(7) On automatic consoles, actuate the phase check switch to ensure that phase errors do not exist due to improper calibrating or to a tracking filter malfunction. Release the switch and read the amplitude and phase.

(8) On manual consoles, tune to the rotor frequency and read the amplitude. Actuate the phase check switch to ensure that phase errors do not exist due to improper tuning of the filter. Release the switch and read the phase.

SYMPTOM	CORRECTIVE ACTION
	CLASS I
Vibration is above limits on No. 1 and/or No. 2 pickups below 10,000 rpm.	2nd to 3rd stage spacer balance - Use No. 1 and 2 pickups. Take data at all peaks in speed range below 10,000 rpm. Determine the size and location of the first trial weight by performing trim balance at maximum vibration peak using sensitivity and phase angle lag data from Table 917. If counterweight 1 does not reduce vibration within limits, then repeat trim balance by using calculated sensitivity and phase angle lags for the specific engine.
	CLASS II
Vibration is above limits on No. 1 and/or No. 2 pickups above 10,000 rpm.	8th to 9th stage spacer balance - Use No. 1 and 2 pickups. Take data at all peaks in speed range above 10,000 rpm. Determine the size and location of the first trial weight by performing trim balance at maximum vibration peak using sensitivity and phase angle lag data from Table 917. If counterweight 1 does not reduce vibration within limits, then repeat trim balance by using calculated sensitivity and phase angle lags for the specific engine.
	CLASS III

NOTE: Please see the TEMPORARY REVISION that revises this page

R Vibration Classification And
R Corrective Action For
Turbojet Engines
Table 918

SYMPTOM	CORRECTIVE ACTION
Vibration is above limits on No. 3 pickup generally above 10,000 rpm.	Turbine balance - Use No. 3 pickup. Take data at all peaks in speed range. Determine the size and location of the first trial weight by performing trim balance at maximum vibration peak using sensitivity and phase angle lag data from Table 917. If counterweight 1 does not reduce vibration within limits, repeat trim balance by using calculated sensitivity and phase angle lags for the specific engine.
	CLASS IV
Vibration is above limits on No. 4 pickup but within limits at all other pickups.	Review the vibration survey and determine where the highest vibration amplitude is present on the No. 1 and No. 2 pickups. If below 10,000 rpm, then use the 2nd to 3rd stage spacer balance in Class I. If above 10,000 rpm, then use the 8th to 9th stage spacer balance in Class II.

Vibration Classification And
Corrective Action For
Turbojet Engines
Table 918 (Continued)

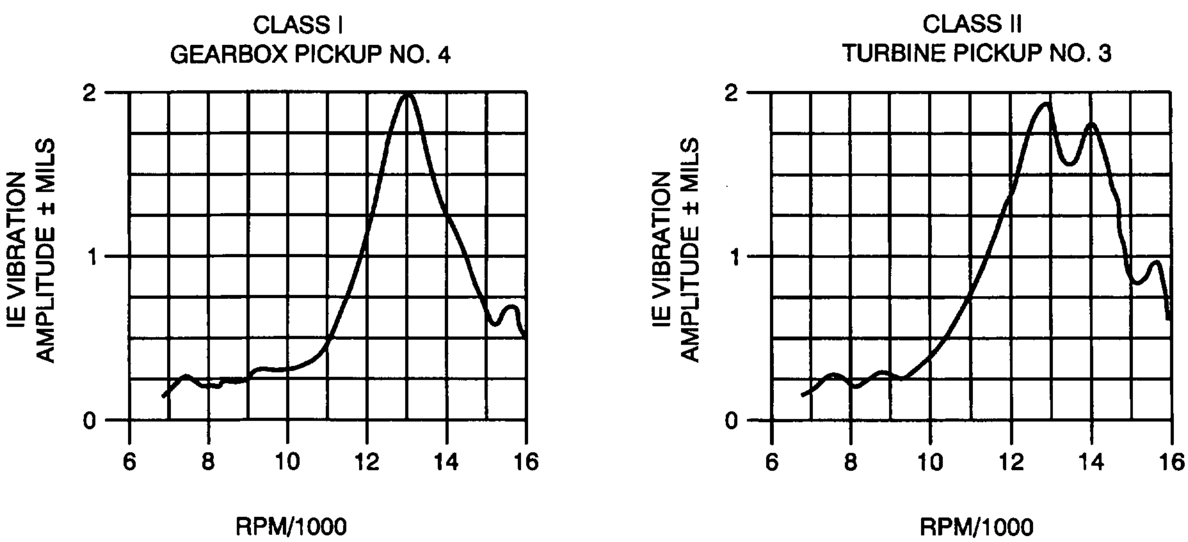
SYMPTOM	CORRECTIVE ACTION
	CLASS I
Vibration is above limits at No. 4 pickup (sometimes No. 1 and No. 2) generally above 12,000 rpm.	8th to 9th stage spacer balance - Use No. 1, 2 and 4 pickups. Take data at all peaks in speed range. Install 1 Class 3 weight (.44 oz-in.) at any known angular location. Calculate sensitivity and phase angle lag for the engine, and repeat balance. If success is limited, then repeat on 2nd to 3rd stage spacer.
NOTE: Please see the TEMPORARY REVISION that revises this page	CLASS II

R Vibration Classification And
R Corrective Action For
Free Turbine Engines
Table 919

SYMPTOM	CORRECTIVE ACTION
Vibration is above limits at No. 3 pickup generally above 12,000 rpm.	Turbine balance - Use No. 3 pickup. Take data at all peaks in speed range. Determine the size and location of first trial weight by performing trim balance at maximum vibration peak using sensitivity and phase angle lag data from Table 917. If counterweight 1 does not reduce vibration within limits, then repeat trim balance by using calculated sensitivity and phase angle lags for the specific engine.

Vibration Classification And
Corrective Action For
Free Turbine Engines
Table 919 (Continued)

NOTE: Please see the
TEMPORARY REVISION
that revises this page

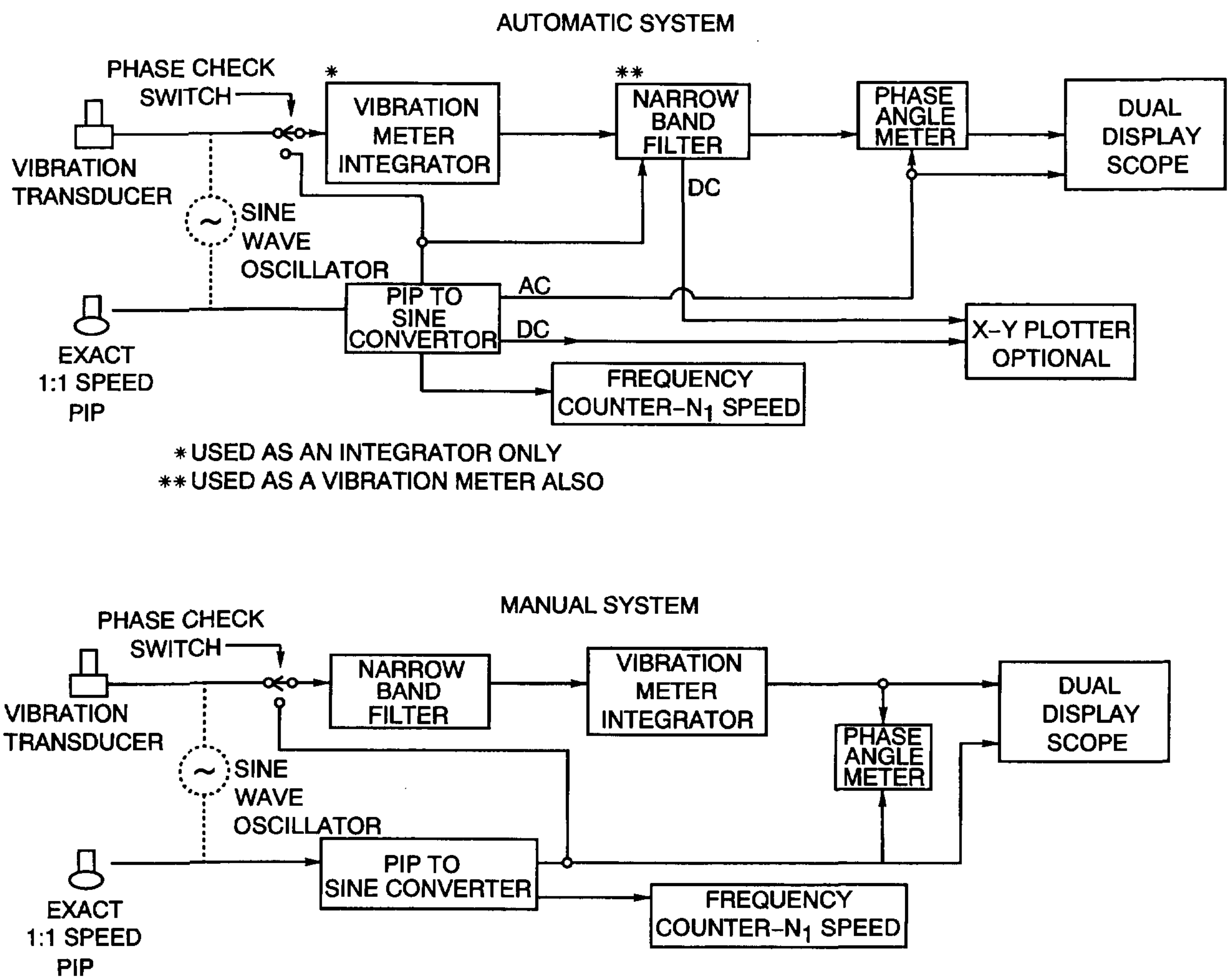


L-34864
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Free Turbine Engine Trim Balance
Classification
Figure 937



TRIM BALANCE SYSTEMS

L-29929
PW V

NOTE: Please see the
TEMPORARY REVISION
that revises this page

R
R

Trim Balance Systems
Figure 938

F. Detailed Trim Balance Procedure

(1) Definition Of Terms:

(a) 1E - Rotor fundamental vibration amplitude.

(b) CW - Counterweights (CW1, CW2, etc.) used to balance the engine.

(c) Phase Angle - Phase meter reading of angle that integrated vibration signal lags use to reference signal.

(d) Phase Angle Lag - Calculated angle indicating the lag between passing of unbalance weight and response signal.

(e) Assumed Phase Angle Lag - The average of phase angle lags determined during the previous balance attempts with an emphasis on current data.

(f) Sensitivity To Unbalance - Number of mils vibration produced by 1 oz-in. unbalance, stated in ±mils/oz.-in. However, it is more convenient to use the reciprocal (oz-in./± mil) throughout this procedure.

(g) Assumed Sensitivity - The average of sensitivities determined during the previous balance attempts with an emphasis on current data.

(2) Trim Balance Sequence:

(a) Conduct the prebalance vibration survey to determine suitability of the engine for trim balance and to provide the basis for classification. The survey should include the measurement of 1E and overall vibration amplitudes.

(b) Install a tachometer by Paragraph E. and run and run AS IS speed points by Table 915 or Table 916 for the model and class engine being balanced. Record 1E amplitudes and phase angles.

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

(c) From the AS IS data, plot the 1E amplitude and phase angle of the relevant location pickup at the relevant speed on polar coordinate graph paper. Lay out the angle counter to engine rotation direction from the 12 o'clock position, which is the A vector. Draw the R vector equal and opposite the A vector. Refer to Paragraph G.

(d) Obtain assumed phase angle lag from Table 917 for the class balance being done. The assumed phase angle lag is laid off from R vector in the direction of rotation and indicates the angular location of Counterweight 1. Refer to Paragraph G.

(e) Obtain assumed sensitivity from Table 917 for the class balance being done. Multiply the amplitude of A vector by assumed sensitivity to determine oz-in. value of Counterweight 1. Refer to Paragraph G.

(f) Reindex the rotor by aligning dye marks on the blade and case. Install counterweight 1 at the correct location by Paragraph D.

(g) Rerun the engine as in step (b) above, repeating each speed point within ±.20 rev/sec (±12 rpm) on the counter at a time base of 10 seconds. Record 1E amplitudes.

(h) If 1E amplitudes are above limits in Table 918, then the engine is still unacceptable. Calculate and install counterweight 2 by steps (d) and (f) and rerun. All weights and locations (Counterweights 1, 2, etc.) are calculated with respect to the AS IS data.

NOTE: Maximum correction (all counterweights) for trim balancing the compressor must not exceed a total vector sum of 2.5 oz-in. Maximum correction (all counterweights) for trim balancing the turbine must not exceed a total vector sum of 1.0 oz-in. Prior installed weights used for balancing rotor components on the balance machine may be moved or replaced. The total number of weights used on the final rotor assembly must not exceed 4 bill of material weights per balance flange, and 6 compressor spacer clip-on weights per spacer.

(i) If the engine is acceptable, then repeat the vibration survey to ensure that 1E amplitudes repeat within ± 0.3 mils.

(j) Calculate phase angle lags and sensitivities by using AS IS and final balance weight data. Compile this information for future balances.

(3) Test Equipment And Inlet Case Cover Removal

(a) Remove the test equipment (pressure hoses, bellmouth, Tt2 lead, etc.) to gain access to the front of the inlet case.

(b) Remove the inlet cone assembly as follows:

1 Remove the front cone assembly followed by the outer cone assembly.

2 Remove the support assembly from the center cover of the inlet case.

(c) Remove wire, nuts and washers that secure the inlet case cover to the inlet case. Remove the cover.

(d) Protect the oil scavenge tube with a suitable cover, and remove wire, nuts and washers that secure the No. 1 bearing oil jet. Remove the oil jet and strainer.

NOTE: Be careful not to lose the strainer. Make sure that the oil jet location is suitably covered.

(4) Installation Of Compressor And Turbine Weights

(a) Perform the following steps to install the compressor counterweights:

1 Remove the rivet that secures the No. 1 bearing inner race retaining nut to the front compressor hub by using remover PWA 13963.

2 Remove 3 bolts and key washers that secure the plug in the front compressor hub.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

3 Remove the front hub plug by using puller PWA 13974 or equivalent. Position the jaw ends of the puller into 11/32 inch diameter holes in the plug, and secure in place by adjusting the screw nut. Use knocker hammer action to remove the plug. Remove the packing from the rear groove in the plug.

4 Rotate the compressor so that the counterweight installation location is in the 6 o'clock position.

5 Install tierod sleeve clip-on counterweights (See Table 919) with compressor rotor trim balance counterweight inserter PWA 13964 and observation periscope PWA 13952A, or equivalents.

a Position the periscope mirror and light assembly to line up with the spacer that requires counterweight installation. Insert the full length of the periscope through the opening in the hub.

b Place the counterweight between the holding clips on the inserter. Pass the inserter through the periscope, the periscope side slot, and into the compressor.

Pickup	Speed RPM	Sensitivity oz-in/±MIL	Phase Angle Lag	Balance Plane
Inlet Pickup-Vertical No. 1	7,500	0.61	135°	2nd to 3rd Stage Spacer
	8,000	0.85	155°	2nd to 3rd Stage Spacer
	9,000	0.78	170°	2nd to 3rd Stage Spacer
	12,250	0.75	220°	2nd to 3rd Stage Spacer
	12,250	0.99	225°	8th to 9th Stage Spacer
	13,000	1.03	225°	8th to 9th Stage Spacer
	14,000	0.51	245°	8th to 9th Stage Spacer

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R Trim Balance Data (Class I, II, And IV Turbojet And Class I Free Turbine Engines
Table 920

Pickup	Speed RPM	Sensitivity oz-in/±MIL	Phase Angle Lag	Balance Plane
(CONTINUED)	14,500	0.47	260°	8th to 9th Stage Spacer
	15,600	0.35	320°	8th to 9th Stage Spacer
	16,000	0.48	340°	8th to 9th Stage Spacer
Inlet Pickup-Horizontal No. 2	7,500	1.37	155°	2nd to 3rd Stage Spacer
	8,000	0.98	190°	2nd to 3rd Stage Spacer
	9,000	0.83	215°	2nd to 3rd Stage Spacer
	12,250	0.84	285°	2nd to 3rd Stage Spacer
	12,250	0.94	300°	8th to 9th Stage Spacer
	13,000	0.67	325°	8th to 9th Stage Spacer
	14,000	0.59	345°	8th to 9th Stage Spacer
	14,500	0.46	350°	8th to 9th Stage Spacer
	15,600	0.39	10°	8th to 9th Stage Spacer
	16,000	0.45	30°	8th to 9th Stage Spacer
	Turbine Balance - Class II Free Turbine Engines			
Turbine Pickup-No. 3	12,250	0.41	5°	Turbine Balance Ring
	13,000	0.33	5°	Turbine Balance Ring
	14,000	0.42	40°	Turbine Balance Ring
	14,500	0.74	55°	Turbine Balance Ring
	15,600	0.93	85°	Turbine Balance Ring
	Turbine Balance - Class III Turbojet Engines			

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Trim Balance Data (Class I, II, And IV Turbojet And Class I Free Turbine Engines
Table 920 (Continued)

Pickup	Speed RPM	Sensitivity oz-in/±MIL	Phase Angle Lag	Balance Plane
Turbine Pickup-No. 3	14,000	1.51	280°	Turbine Balance Ring
	14,500	1.13	280°	Turbine Balance Ring
	15,600	1.00	315°	Turbine Balance Ring
	16,000	0.89	315°	Turbine Balance Ring

NOTE: Keep records of Sensitivity and Phase angle Lag on the runs made, because in the future it may be necessary to make changes to the table. Refer to Paragraph K.

Trim Balance Data (Class I, II, And IV Turbojet And Class I Free Turbine Engines
Table 920 (Continued)

Vibration Pickup Location	Below 15,500 RPM	Above 15,500 RPM
Turbojet Engine		
No. 1 Inlet Case Flange A Vertical	.0016 in.(1.6 mils)	.0012 in.(1.2 mils)
No. 2 Inlet Case Flange A Horizontal	.0016 in.(1.6 mils)	.0012 in.(1.2 mils)
No. 3 Combustion Chamber Outer Case Flange E Horizontal	.0012 in.(1.2 mils)	.0012 in.(1.2 mils)
No. 4 Gearbox Vertical	.0016 in.(1.6 mils)	.0012 in.(1.2 mils)
Free Turbine Engine		
No. 1 Inlet Case Flange A Vertical	.0017 in.(1.7 mils)	.0015 in.(1.5 mils)
No. 2 Inlet Case Flange A Horizontal	.0017 in.(1.7 mils)	.0015 in.(1.5 mils)

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R Maximum Vibration Limits (Single Amplitude) After Trim Balance
Table 921

Vibration Pickup Location	Below 15,500 RPM	Above 15,500 RPM
No. 3 Combustion Chamber Outer Case Flange E Horizontal	.0017 in.(1.7 mils)	.0015 in.(1.5 mils)
No. 4 Gearbox Vertical	.0017 in.(1.7 mils)	.0015 in.(1.5 mils)

NOTE: After the trim balance, vibration amplitudes must be observed at steady state, running at all speeds in the operating range, and must not exceed the limits in the table above. A second vibration survey must be made to demonstrate repeatability. Variations between runs must not exceed 0.0003 inch (0.3 mils) single amplitude.

Maximum Vibration Limits (Single Amplitude) After Trim Balance
Table 921 (Continued)

c Position the inserter over the spacer sleeve that requires the counterweight. Exert pressure on the inserter in the direction of the spacer sleeve (radially outward) until the counterweight snaps into place.

d Remove the inserter by exerting pressure in the opposite direction until holder clips are released from the counterweight. Slowly remove the inserter from the periscope. Remove the periscope.

6 Remove the trim balance counterweights by using counterweight remover PWA 13969 and observation periscope PWA 13952A, or equivalents.

NOTE: Please see the TEMPORARY REVISION that revises this page

a Position the periscope mirror and light assembly so they line up with the spacer that requires counterweight removal. Insert the full length of the periscope through the opening in the hub.

		Moment (oz-in)	
Class	Weight(oz)	2nd to 3rd Stage Spacer	8th to 9th Stage Spacer
1	.061	.21	.28
2	.082	.29	.38

R
R

Compressor Counterweights
Table 922

Class	Weight(oz)	Moment (oz-in) 2nd to 3rd Stage Spacer	Moment (oz-in) 8th to 9th Stage Spacer
3	.095	.33	.44

NOTE: There are 16 tiebolt sleeves at 22.5° intervals in the 2nd to 3rd stage spacer. There are 12 tiebolt sleeves at 30.0° intervals in the 8th to 9th stage spacer.

Compressor Counterweights
Table 922 (Continued)

b Insert the counterweight remover through the periscope, the periscope side slot, and into the compressor, positioning it on the counterweight to be removed. Turn the knurled knob at the end of the remover to engage the jaws under the counterweight. Continue turning the knob until the counterweight is off the spacer sleeve.

c Slowly remove the tool from the periscope. Remove the periscope. Remove the counterweight from the tool by retracting the knurled knob.

7 Install packing on the front hub plug. Reinstall the plug in the front hub by using guide PWA 13946 or equivalent. Align the 3 tapped holes in the plug with the three 3/16 inch diameter holes in the hub.

NOTE: For engines that incorporate SB 4110, classified plug (PN 733514) has been machined to fit the hub ID and does not require packing. If the plug needs replacing, then a new plug (PN 735369) must be machined to the appropriate class and identified by SB 4110.

8 Install bolts and key washers at 3 tapped hole locations. Torque and bend key washers to secure.

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

9 Install a rivet to secure the No. 1 bearing inner race retaining nut to the front compressor hub. The head of the rivet sits inside the larger hole in the plug. Flare the rivet by using riveter PWA 13975 or equivalent.

10 Reinstall the oil jet, inlet case cover, inlet cone assembly, and the previously removed test equipment.

(b) Perform the following steps to install the turbine counterweights:

1 Remove the free turbine and/or exhaust case.

2 Install counterweights (See Table 924) on the rear balance flange by using turbine weight riveter PWA 13277 or equivalent.

3 Replace the free turbine and/or exhaust case.

G. Example Of Trim Balance Procedure - Hypothetical

(1) This example of a turbojet engine trim balance demonstrates the procedure step by step.

(a) A vibration survey indicates that an engine is above limits throughout the speed range on the No. 1 and 2 pickups. Figure 939 shows the pre-trim balance survey transient data. Table 921 lists the maximum amplitude readings.

(b) The engine has vibration characteristics that place it in Classes I and II. (See Table 915) However, the engine is placed first in the class where the highest amplitude vibration occurs: Class I that requires 2nd to 3rd stage spacer balance. Refer to Run No. 1 in Table 921.

(c) Plot Vector A (±1.9 mils at 330°). Lay out the angle counter to engine rotation from the 12 o'clock location. Draw Vector R (vector required to balance the engine) equal and opposite to Vector A. See Figure 942.

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

(d) Apply the assumed phase angle lag (135 degrees from Table 925) laying it off from R in the direction of engine rotation. Therefore, Counterweight 1 should be installed at 15 degrees, measured from the 12 o'clock reference location indicated in Paragraph.

Class	Weight (oz)	Moment (oz-in)
A (2 holes)	.220	.60
B (3 holes)	.346	.96
C (4 holes)	.467	1.29

NOTE: The rivet weight, .00044 oz., is included in the calculation of the turbine weight moment.

NOTE: There are 36 holes at 10° intervals on the turbine balance ring.

Turbine Counterweights
Table 923

Run No.	Speed (RPM)	Frequency (Hz)	Vibration Amplitude (±MIL) 1E	Overall	Phase Angle	Pickup No.
Pre-trim Balance Survey	7560	126.1	1.9	2.1		1
	15620	260.3	1.8	1.8		1
1	7560	126.0	1.9		330°	1
2	7560	126.0	1.5		250°	1
3	7570	126.1	0.25		220°	1
High Speed Run Vibration Survey	15620	260.3	2.0	2.1		1
4	15620	260.3	2.0		50°	1
5	7560	126.0	0.4		210°	1
	15620	260.3	0.3		340°	1

R
R

Trim Balance Vibration Surveys
Table 924

Run No.	Speed (RPM)	Frequency (Hz)	Vibration Amplitude (±MIL) 1E	Overall	Phase Angle	Pickup No.
6	7560	126.0	0.4	0.5		1
	15620	260.3	0.4	0.5		1

Trim Balance Vibration Surveys
Table 924 (Continued)

(e) Apply the assumed sensitivity from Table 917. Multiply the amplitude of A vector (±1.9 mil) by the assumed sensitivity (.61 oz-in./±mil). The magnitude of counterweight 1 should be 1.16 oz-in.

(f) Install Counterweight 1. Counterweight locations are restricted to spacer sleeve locations. Install 1 Class I weight and 1 Class III weight (.54 oz-in. each) at 0° and 22.5° on the 2nd to 3rd stage spacer sleeves, for a vector sum of 1.07 oz-in. at 11 degrees. Use Figure 941 to calculate the vector sum as follows:

1 Plot Points B and C. These points represent the angular location and magnitude of each selected counterweight.

2 Construct Lines AB and AC followed by BD parallel to AC, and CD parallel to AB.

3 Determine vector sum AD by using the intersecting point between Lines BD and CD.

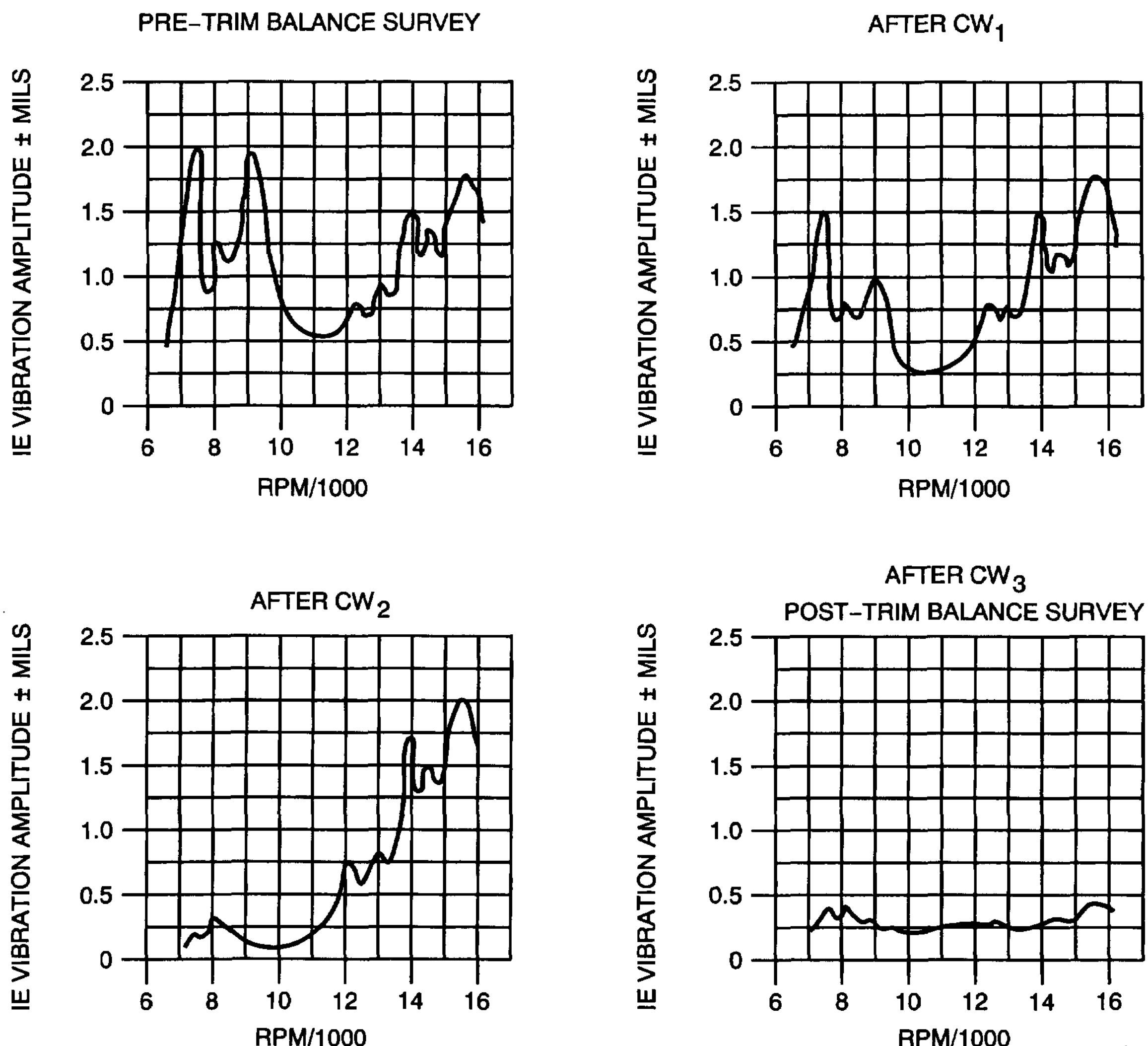
(g) The balance point is rerun. Refer to Run No. 2 in Table 924. Refer to After CW1 (Counterweight 1) in Figure 939 for transient data.

(h) Plot Vector C (±1.5 mils at 250°) shown in Figure 940. Plot the vector difference (VD):

1 Subtract Vector A from Vector C; Draw VD from A to C with the arrow pointing to C; Translate VD to the origin; and maintain parallelism with AC.

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R



L-34866
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Trim Balance Surveys Of
Hypothetical Example
Figure 939

2 VD represents the effect of Counterweight 1 alone, both in magnitude and direction, to eliminate unbalance. VD must be rotated and adjusted in length to coincide with R vector.

(i) Calculate the amount and location of 2 counterweight:

1 $$CW2 = CW1 \times \frac{A(mils)}{VD(mils)} - 1.07 \times \frac{1.9}{2.2} = .92 \text{ oz-in.}$$

2 Determine the location of counterweight 2 as follows: The angle between VD (at 192°) and R

3 Remove counterweight 1, and install Counterweight 2 (.92 oz-in.) 42 degrees from Counterweight 1 in the direction of rotation, which is 329 degrees. See Figure 944.

(j) Install 1 Class I weight (.54 oz-in.) at 337.5° and 1 Class III weight (.33 oz-in.) at 315° on 2nd to 3rd stage spacer sleeves, for a vector sum of .86 oz-in. at 329°.

NOTE: Perform the vector sum calculation by constructing lines AB', AC', B'D', and C'D' (See Figure 941) by using the procedures in step (g) above.

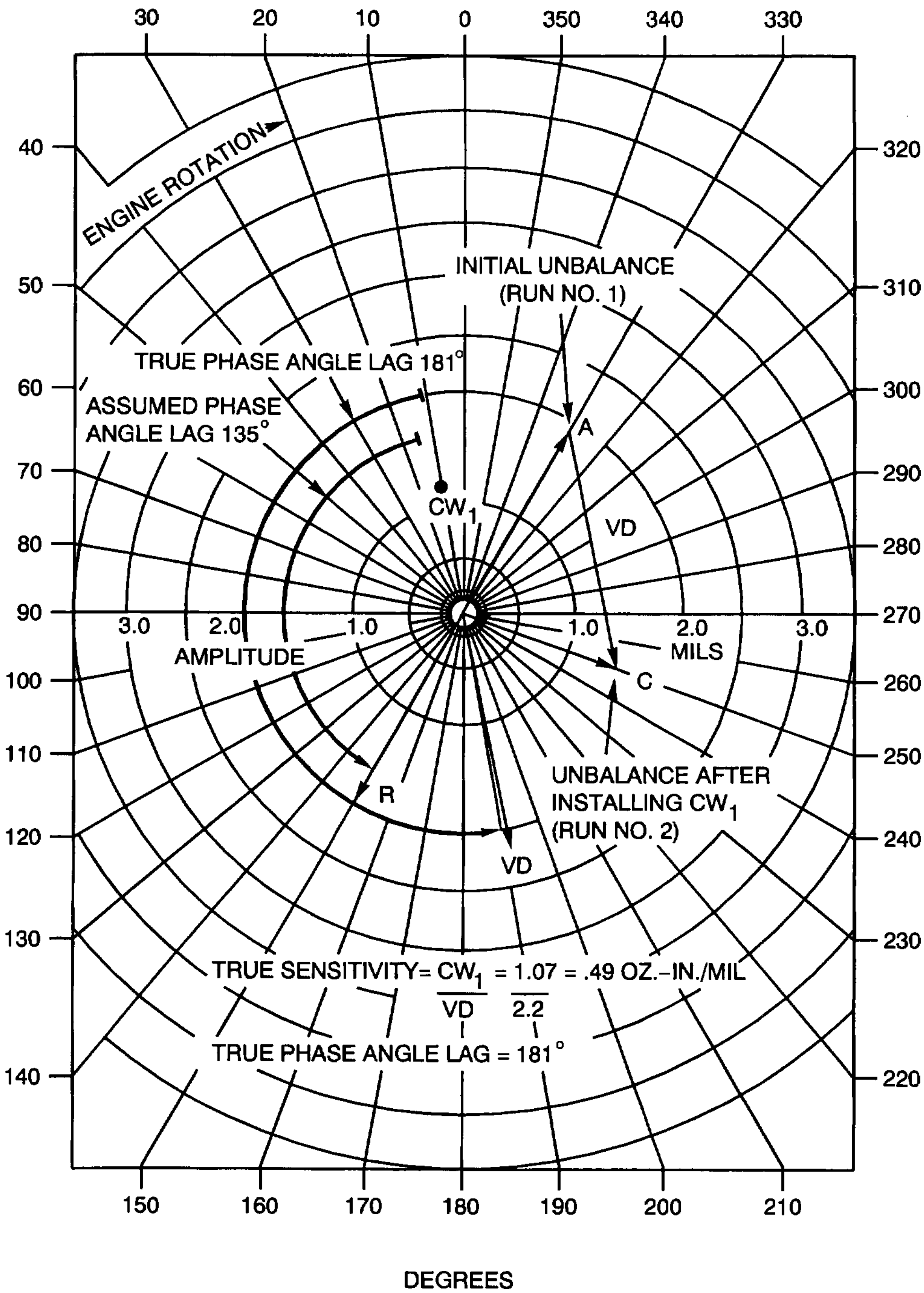
(k) The balance point is rerun, indicating low speed points brought within limits. Refer to Run No. 3 in Table 924 and Figure 939, After CW2 (Counterweight 2).

(l) Actual sensitivities and phase angle lags are calculated as shown in Figure 942 to provide information for future balances. The average of the data from a number of balances provide assumed phase angle lags and sensitivities (Table 920), which are used for future balances.

(m) A repeat vibration survey shows the engine is still above limits on the No. 1 and 2 pickups in the high speed range. See Table 921. Note the 2nd to 3rd stage spacer weights have slightly affected the high speed vibration on the No. 1 pickup.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

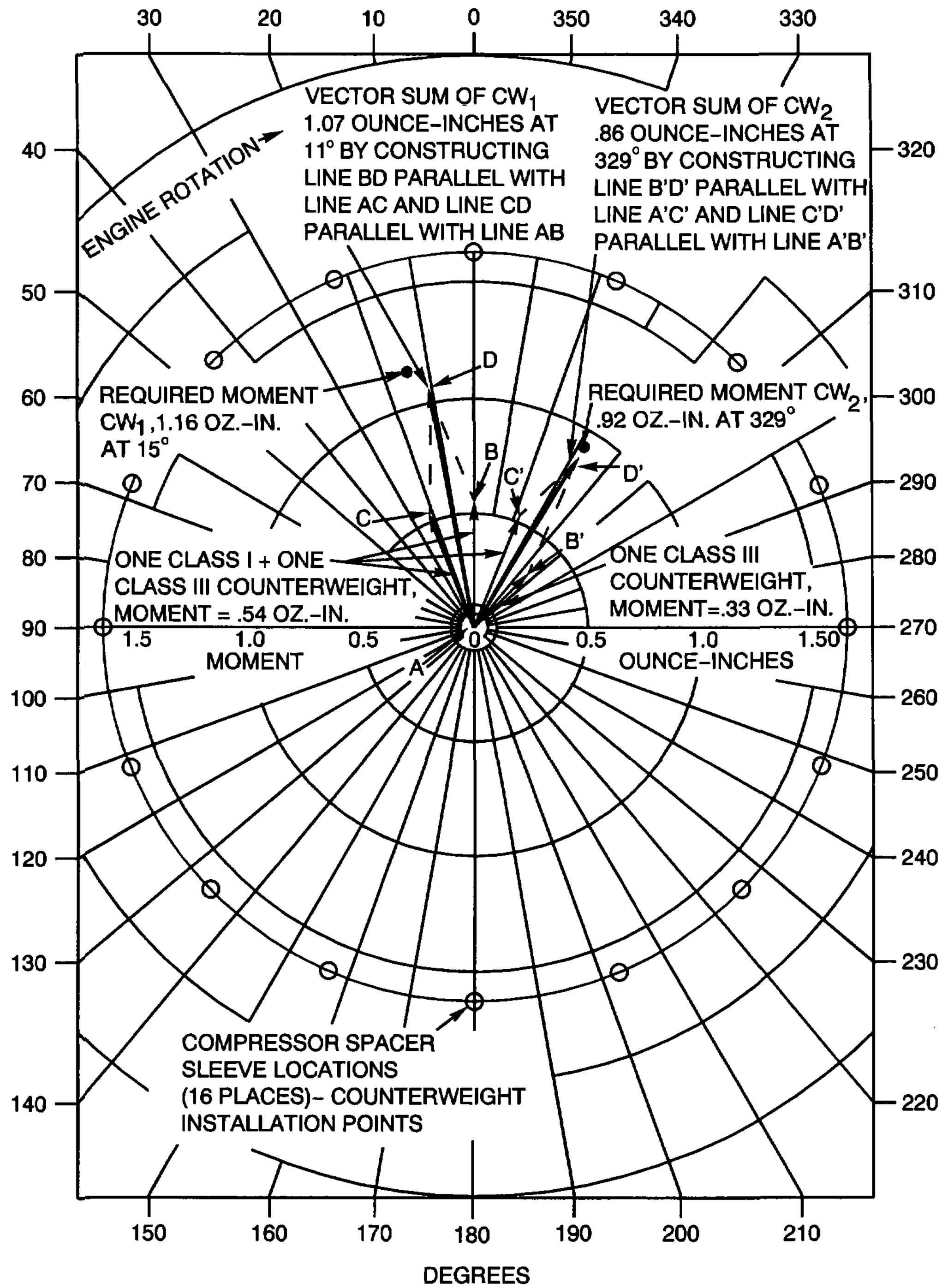


L-34905
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Balance Effect Of Counterweight 1
Hypothetical Example
Figure 940



L-34906
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Vector Summation Method
Hypothetical Example
Figure 941

(n) As in step (2), the engine is classified as Class II, requiring 8th to 9th stage spacer balance. Refer to Run 4 in Table 924.

(o) Plot Vector A (±2.0 mils at 50°). Lay out the angle counter to engine rotation from the 12 o'clock position. Draw Vector R (vector required to balance engine) equal and opposite Vector A. See Figure 943.

(p) Apply the assumed phase angle lag (320° from Table 920), laying it off from R in the direction of engine rotation. Therefore, counterweight 3 should be applied at 270 degrees measured from the 12 o'clock reference location, indicated in Paragraph E.(4), counter to engine rotation. See Figure 943.

(q) Apply assumed sensitivity. Multiply the amplitudes of A vector (± 2.0 mils) by the assumed sensitivity (.35 oz-in./±mil from Table 920) (the magnitude of Counterweight 3 should be .70 oz-in.).

R (r) Install one Class III weight (.44 oz-in.) at
R 300 degrees and one Class III weight (.44 oz-in.) at 40 degrees, for a vector sum of .76 oz-in. at 270 degrees.

(s) The balance point is rerun, indicating high speed points brought within limits, while low speed points remain within limits. Refer to Run No. 5 in Table 924 and Figure 941, Post-trim Balance Survey.

(t) Actual sensitivities and phase angle lags are calculated as shown in Figure 945 to provide information for future balances. The average of the data from a number of balances provide the assumed phase angle lags and sensitivities (Table 920), which are used for future balances.

(u) A second vibration survey is run to demonstrate repeatability. Variations between runs may not exceed 0.0003 inch (0.3 mils) single amplitude. 1E and overall amplitude was repeatable and within limits. Refer to Run No. 6 in Table 924.

NOTE: Please see the TEMPORARY REVISION that revises this page

30. Preservation And Depreservation Of Engine

A. The following procedures cover the steps to preserve or depreserve lubrication and fuel systems. They may be done while the engine is in the aircraft or installed in a test stand. Check engine records before following these procedures. Make the appropriate entries in the applicable engine records when the work is complete.

CAUTION: UNDER NO CIRCUMSTANCES MUST PRESERVATIVE OIL BE SPRAYED INTO THE COMPRESSOR OR ENGINE TURBINE. DIRT PARTICLES THAT DEPOSIT ON BLADES AND VANES DURING ENGINE OPERATION WILL ALTER AIRFOIL SHAPE AND HAVE AN ADVERSE AFFECT ON COMPRESSOR EFFICIENCY.

B. Engine Preservation-Short Term Inactivity

NOTE: The following procedure must be followed for preservation of engines with a compressor that can be rotated, and that expect to be in operation within 2 months. This procedure should be repeated weekly after the first 2 weeks.

NOTE: Engines incorporating the intent of SB 4178 have no fuel pressure signal tube, and the signal port and overboard drain port are plugged. When preserving these engines, remove the plugs from the signal and overboard drain ports and collect the discharge.

(1) Rotate the engine with the starter or auxiliary power source at the starter pad until the oil pressure and compressor rotor speed are indicated.

(2) Continue this rotation for 5 minutes or an allowable starter operating period, whichever is less.

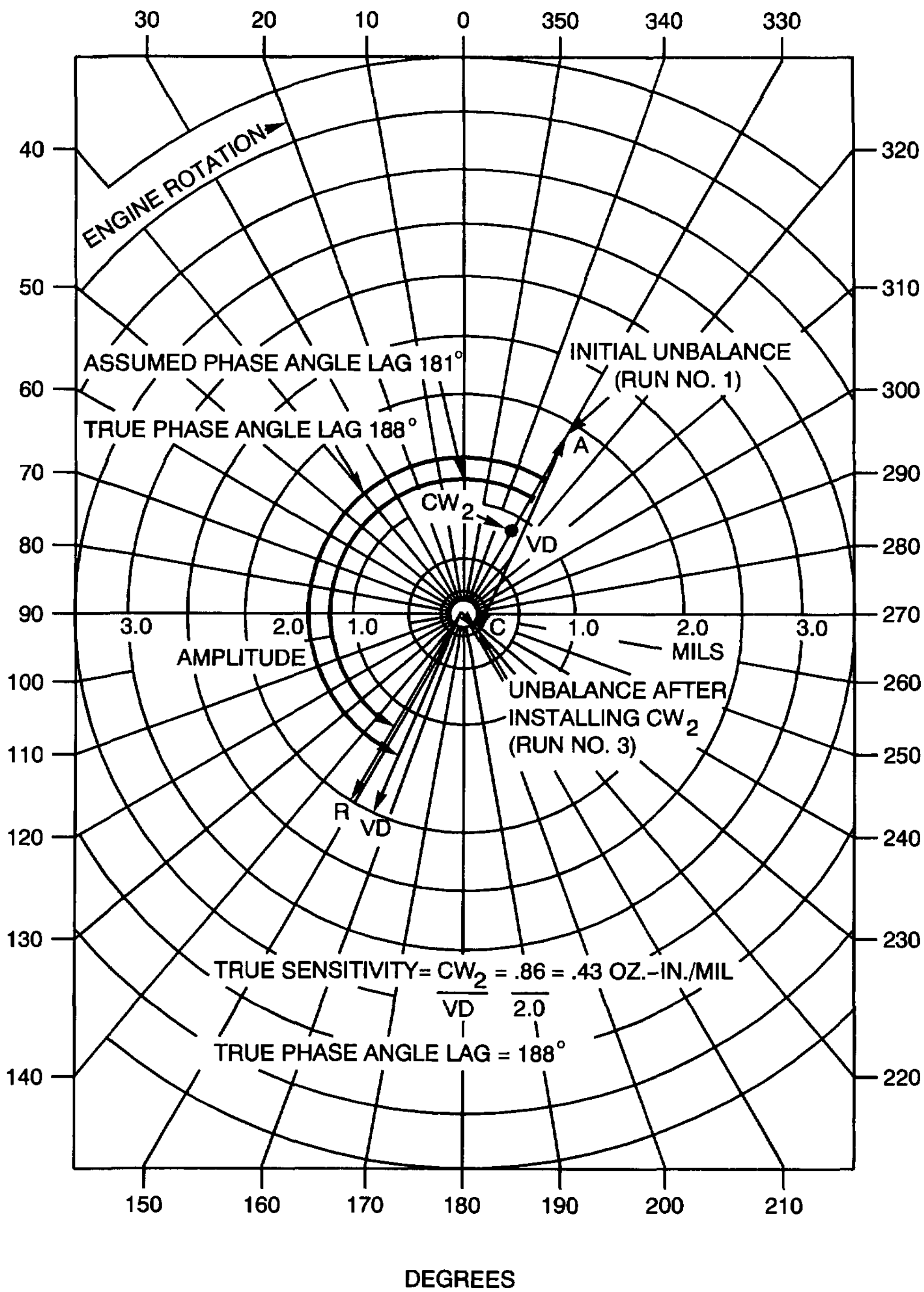
(3) During this period, actuate the N1 lever from OFF to IDLE (engine ignition switch OFF), and check whether the dump valve closes, indicated by cessation of the overboard fuel drainage.

(4) Return the N1 lever to OFF and check whether the dump valve opens, indicated by fuel draining overboard.

NOTE: For engines incorporating the intent of SB 4178, reinstall the plugs in the signal and overboard drain ports.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page

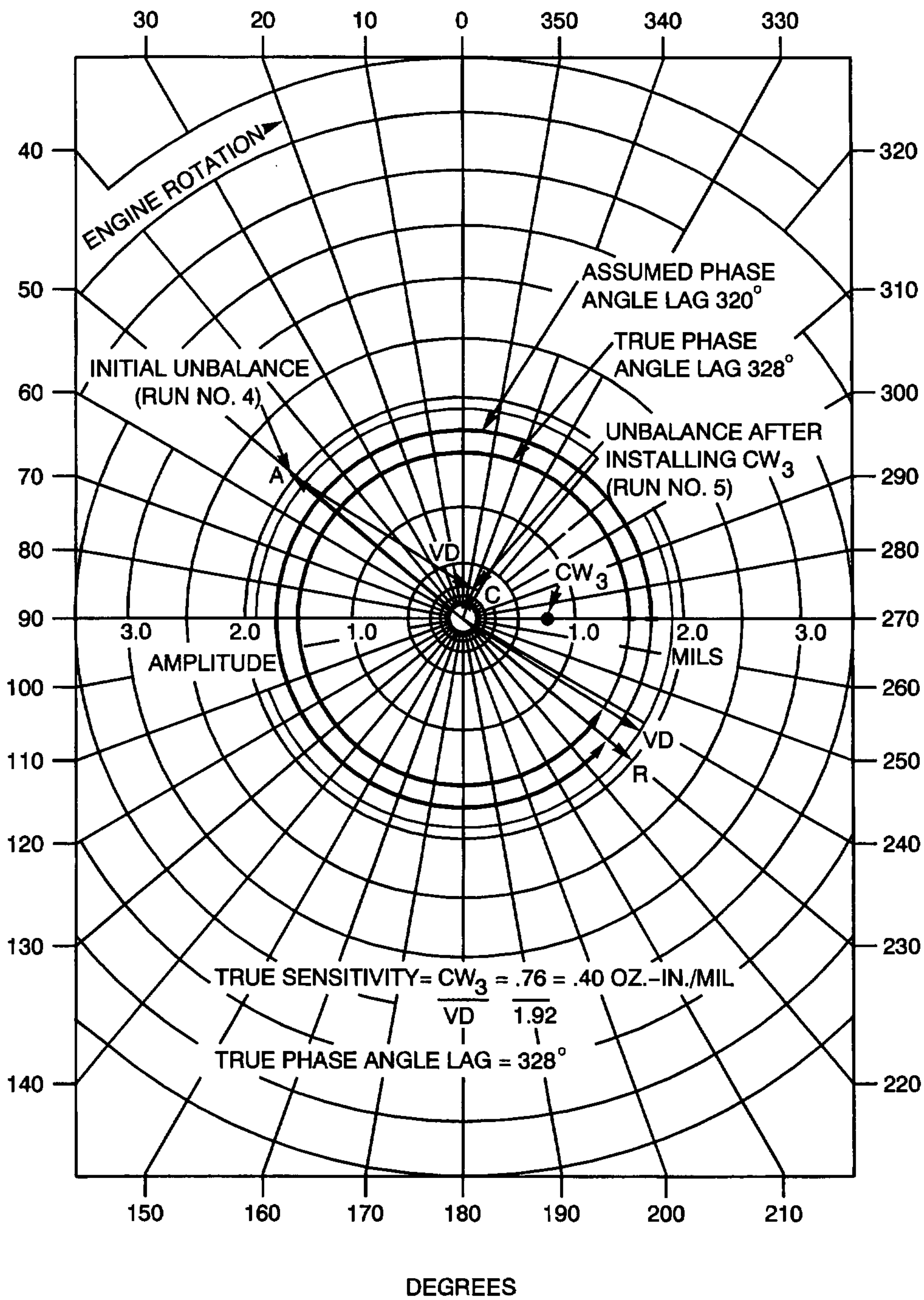


L-34907
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Balance Effect Of Counterweight 2
Hypothetical Example
Figure 942



L-34900
PW V

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

Balance Effect Of Counterweight 3
Hypothetical Example
Figure 943

C. Engine Depreservation-Short Term Inactivity

(1) The only required reactivation treatment for these engines consists of starting the engine and operating it for 15 minutes at 75 percent normal rated thrust.

D. Engine Preservation-Long Term Inactivity

NOTE: The following procedures must be followed for preservation of engines that are inactive for periods that exceed 2 months.

E. Lubrication System

NOTE: If the engine has been tested by using PWA 521B, Type II lubricating oil, then additional preservation of the lubricating system is unnecessary.

(1) Drain the oil from the oil tank and accessory and component drives gearbox into suitable containers.

(2) Coat the drain plugs with PWA 521B, Type II oil. Reinstall the plugs.

NOTE: Do not drain the oil until the fuel system preservation is complete.

(3) Remove and rinse the oil strainer in petroleum solvent.

(4) Inspect the strainer and slush it in PWA 521B, Type II oil. Reinstall the strainer.

F. Fuel System

NOTE: Engines incorporating the intent of SB 4178 have no fuel pressure signal tube, and the signal port and overboard drain port are plugged. When preserving these engines, remove the plugs from the signal and overboard drain ports and collect the discharge.

(1) Remove the large hex plug located just under the dump valve inlet connection. Remove the inlet screen. Place a suitable container under the dump valve to catch the preservative discharge from the dump valve screen boss.

NOTE: Do not insert a fitting or hose.

(2) Disconnect the fuel-in line and connect it to the supply of flushing oil at an inlet pressure of 5 to 25 psi and a minimum temperature of 15°C (60°F). Take extreme care to prevent foreign material from being drawn into the engine fuel system. Provide equipment with suitable filters and/or strainers that have mesh no coarser than is used in the engine.

(3) With the ignition off and all control levers in the maximum position, motor the engine with the starter at 1500 to 2100 rpm. During motor startup, move the N1 lever from OPEN to CLOSED to OPEN. This sequence must be timed so that the lever is in the CLOSED position at least half the time during motor startup.

(4) When not less than 3 but no more than 4 gallons of fluid has been obtained from the dump valve inlet screen boss, close the N1 lever and discontinue engine rotation.

(5) Thoroughly clean the dump valve screen and slush it with preservation oil. Reinstall the screen and hex plug in the dump valve. Torque the hex plug to 125 - 175 lb-in.

(6) Remove the oil filter and thoroughly clean and slush it with preservative oil. Reinstall the oil filter.

<u>NOTE</u>: For engines incorporating the intent of SB 4178, reinstall the plugs in the signal and overboard drain ports.

31. <u>Miscellaneous Preservation Procedures</u>
(Refer to Tool Group 47A)

A. Remove cover plates from unused accessory drives and spray the exposed surfaces with preservative oil. Replace the cover plates.

B. Plugs, caps and covers must be installed over all the openings to prevent foreign material access and moisture accumulation.

C. For engines that remain in the aircraft, dispense a sufficient amount of dehydrating agent in the engine compartment. Distribute half this amount around the engine, and distribute the remaining half in equal amounts in the aircraft inlet and exhaust ducts.

CAUTION: OPEN THE DEHYDRATING AGENT CONTAINER AS LITTLE AS POSSIBLE TO PREVENT EXCESSIVE EXPOSURE TO THE ATMOSPHERE. ALSO, REMOVE THE DEHYDRATING AGENT FROM THE STORAGE CONTAINER AND SEAL THE ENGINE COMPARTMENT IN THE SHORTEST TIME POSSIBLE.

D. The N1 lever and the oil filler cap should be tagged with the preservative used and the preservation date.

E. Place an airtight moisture barrier or other suitable cover over the air inlet and exhaust end of the engine compartment.

F. Install a humidity indicator at each end of the engine compartment.

NOTE: Provide inspection windows in each cover for viewing the humidity indicators.

G. Inspect the engine every 2 weeks when the aircraft is stored outside, and every 30 days when the aircraft is stored inside.

H. The entire engine must be depreserved and then represerved when the relative humidity exceeds 40 percent within the compartment.

32. Engine Depreservation - Long Term Inactivity

NOTE: The following procedure must be followed for depreservation of engines that have been preserved for long term inactivity.

A. Check all oil passages for possible obstructions before installing accessories that are dependent on engine oil. Remove all covers, plugs and the dehydrating agent.

B. Fill the oil tank with engine oil specification PWA-521B, Type II.

C. Connect the fuel supply line to the fuel inlet pad on the fuel pump.

NOTE: Engines incorporating the intent of SB 4178 have no fuel pressure signal tube, and the signal port and overboard drain port are plugged. When depreserving these engines remove the plugs from the signal and overboard drain ports and collect the discharge. Disregard Paragraphs E. and F.

D. Place a suitable container (with a minimum capacity of 5 gallons) under the dump valve overboard drain.

E. Disconnect the fuel pressurizing and dump valve-to-fuel control signal tube at either the dump valve or the fuel control.

F. Leave the dump valve connection open to the atmosphere, and plug the fuel control with a suitable plugged fitting to prevent dumping out fuel.

G. With the ignition switch OFF, the fuel shutoff valve OPEN, and all fuel control levers in the maximum position, motor the engine with the starter at 1500 - 2100 rpm.

H. When at least 1 gallon of fuel is obtained from the overboard drain, close the N1 lever and disengage the starter.

<u>CAUTION</u>: LIMIT ENGINE ROTATION TO THE SHORTEST TIME POSSIBLE. DO NOT EXCEED THE STARTER OPERATING LIMIT.

I. Remove the plugged fitting from the fuel pressurizing and dump valve signal tube, and reconnect the tube to the dump valve.

<u>NOTE</u>: For engines incorporating the intent of SB 4178, reinstall the plugs in the signal and overboard drain ports.

J. Remove the preservation tags and make the applicable entry in the engine records.

NOTE: Please see the TEMPORARY REVISION that revises this page

R
R

ENGINE GENERAL - TABLE OF LIMITS

1. General

A. General

(1) Reference Numbers

(a) Reference numbers for the fits, clearances, backlashes, torques, and spring pressures are found in Clearance Charts and in the Tables contained in this section. Use the figures to find the area or parts relationship to which a number entry refers. The Tables will show what dimensions or limits are necessary for each parts relationship.

(b) There will be a figure reference adjacent to each fits and clearances entry. Because the fits and clearances information for each JT12 model is much the same, the information for all models is combined where possible. However different models of the engine will possibly use a Reference Number for different fits or clearances. Be careful to refer to the Clearance Chart which is applicable to the applicable model of the engine.

NOTE: Number codes in a circle or in parentheses are P&W blueprint codes and are not important in these sections. Letters connected to numbers with hyphens ("C-8") (if found) are blueprint location coordinates which were formerly used to help find data on the figures.

(2) Dimensions

(a) The Minimum and Maximum columns under "Dimensions" contain the dimensions for new or as-manufactured parts.

(3) Limits

(a) The Minimum and Maximum columns Under "Limits" contain the necessary fits and clearances between new or as-manufactured parts. The Replace If Over column contains the limit to which a part is permitted to wear before part repair or replacement becomes necessary.

(4) Terms And Symbols

R
R

(a) A "T" symbol in the Minimum or Maximum or Replace If Over column shows that a fit is tight.

(b) An asterisk (*) in the Replace If Over column shows that it will be necessary to replace or repair parts if they are loose.

(c) "By Selection" means that it will be necessary to choose a part that will have a specified fit or clearance. "Fit to" means that a machining operation can be necessary to get a specified fit or clearance.

(d) The symbol "#" means that it will be necessary to replace a gear when service use causes scuffing,
R pitting, galling, or wear more than limits.

(5) Units

(a) Unless otherwise specified, all fits are diametrical (except for spline fits, which are calculated from chordal dimensions).

(b) Dimensions are specified in inches, torques in pound-inches, and spring pressures are in pounds.

(6) Torques

(a) Torques which are under P&W Engineering control are in the Table of Limits with Reference Numbers.

(b) For standard torques, refer to Section 70-52-00 in the Standard Practices Manual.

(7) Disk Service Life

(a) Disk hours and cycles are now in Section 5-10-01, Time Limits.

B. Tables Of Limits

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
2	1001,	Compressor Rotor					
	1004,	Front Hub	2.9544	2.9549			
	1007,	Bearing	2.9525	2.9528	.0016T	.0024T	.0016T

Accessory Section Limits
Table 1101

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
3	1001,	Compressor Rotor					
	1004,	Front Hub	2.9544	2.9549			
	1007	Spacer	2.9554	2.9567	.005	.0023	.0033
4	1001,	Compressor Rotor					
	1004,	Front Hub	6.397	6.399			
	1007	Disk, 2nd Stage	6.399	6.401	.000	.0045T	.000
		Compressor Rotor					
		Front Hub (PN					
		667901A or Later)	6.3965	6.3985			
		Disk, 2nd Stage	6.3995	6.4010	.001T	.005T	.000
		(PN 670802A or					
		Later)					
5	1001,	Compressor Rotor					
	1004,	Disk Spacer	9.771	9.773			
	1007	Disks	9.769	9.771	.004T	.000	
		Compressor Rotor					
		Disk Spacer (PN					
		668974A, 668975A,					
		668976A, 668977A,					
		668978A or Later					
		Change Letter)	9.772	9.774			
		Disks (PN 448804N,	9.769	9.7705	.001T	.005T	.0005
		496705E, 496706E,					
		448807N, 541908J					
		or Later)					
6	1001,	Compressor Rotor					
	1004	Disk Spacer	8.497	8.499			
		Disk, 4th Stage	8.499	8.501	.000	.0045T	.0005
		Compressor Rotor					
		Disk Spacer					
		Disk, 4th Stage (PN	8.4965	8.4985			
		448804N or Later)	8.4995	8.5010	.001T	.005T	.000
	1007	Disk, 4th Stage	8.499	8.501			
		Compressor Rotor					
		Airseal	8.501	8.503	.0005T	.004	.004
7	1001,	Compressor Rotor					
	1004,	Disk Spacer	.3815	.3825			
R	1007	Liner (Front End)	.3810	.3815	.000	.0015	.0015

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
8	1001,	Compressor Rotor					
	1004,	Disk Spacer	.3800	.3810			
	1007	Liner (Rear End)	.3810	.3815	.000	.0015T	.000
9	1001,	Compressor 1st And					
	1004,	2nd Stage Blade					
	1007	Clearance					
		1st Stage Compressor					
		Blade (FWD)	.726	.736			
		Front Hub (FWD)	.737	.747	.001	.021	.021
		1st Stage Compressor					
		Blade (AFT)	.460	.470			
		Front Hub (AFT)	.471	.481	.001	.021	.021
		2nd Stage Compressor					
		Blade (FWD)	.381	.391			
		Disk (FWD)	.392	.402	.001	.021	.021
		2nd Stage Compressor					
		Blade (AFT)	.245	.255			
		Disk (AFT)	.256	.266	.001	.021	.021
10	1001,	Compressor Rotor					
	1004,	Rear Hub	8.629	8.631			
	1007	9th Stage Disk	8.631	8.633	.000	.0045T	.000
		Compressor Rotor Rear Hub (PN 668985A, 668273A or Later)	8.6285	8.6305			
		9th Stage Disk (PN 541909J or Later)	8.6315	8.6330	.001T	.005T	.000
		Compressor Rotor Rear Hub (PWA 110 Coated)	8.6265	8.6300			
		9th Stage Disk (PWA 110 Coated)	8.6307	8.6350	.0007T	.009T	.000
11	1001,	9th Stage Disk@	12.488	12.492			
	1004,	9th Stage Airseal	12.492	12.496	.000	.008T	.000
	1007						

@ Disk dimensions are before plate.

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
12	1001, 1004, 1007	Turbine Shaft Lockring Spline	.0444	.0460			
		Compressor Rotor Rear Hub Spline (This clearance need not be taken at overhaul. Evidence of spline wear so as to produce a clearance over maximum would be the controlling criteria)	.0479	.0505	.0019	.0061	.009
14	1001, 1004, 1007	Turbine Shaft Lockbolt	1.819	1.821			
		Compressor Rotor Rear Hub	1.823	1.825	.002	.006	.010
		Turbine Shaft Coupling PN 419406A, 473723C or Later)	1.813	1.815			
		Compressor Rotor Rear Hub	1.823	1.8250	.008	.012	
15	1007	Turbine Shaft Lock Splines	.0444	.0460			
		Turbine Shaft Lockring Splines	.0479	.0495	.0019	.0051	.008
16	1001, 1004, 1007	Compressor Rotor Rear Hub	2.8990	2.9000			
		Rear Bearing Oil Distributing Sleeve	2.8995	2.9005	.0005T	.0015	.0015
		Compressor Rotor Rear Hub	2.8995	2.9000			
		Compressor Rear Bearing Oil Distributing Sleeve	2.8992	2.8997	.0008T	.0002	

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
17	1001, 1004, 1007	Compressor Rear Bearing Oil Distributing Sleeve	3.1497	3.1502			
		Seal Face Plate	3.1507	3.1542	.0005	.0045	.0055
18	1001, 1004, 1007	Compressor Rear Bearing Oil Distributing Sleeve	3.1497	3.1502			
		Bearing	3.1494	3.1496	.0001T	.0008T	.0001T
19	1001, 1004, 1007	Compressor Rotor Rear Hub Spline	.0977	.0987			
		Rear Bearing Oil Distributing Sleeve Spline (This clearance need not be taken at overhaul. Evidence of spline wear as to produce a clearance over maximum would be the controlling criteria)	.1007	.1017	.002	.004	.006
20	1001, 1004	Clearance at Bolt End Before Tightening Rear Nut			.000	.030	
	1007	Turbine Shaft Lock Splines	.0444	.0460			
		Turbine Shaft Coupling Splines	.0479	.0495	.0019	.0051	.008
21	1007	Compressor 1st Stage Vane and Shroud	17.2180	17.2224			
		Compressor 2nd Stage Vane and Shroud	17.219	17.223	.0050T	.0034	.007

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
22	1001,	Side Clearance,					
	1007	Front Compressor:					
		Outer 1st Stage					
		Shroud Lug	.4896	.4940			
		Outer 2nd Stage					
		Shroud Slot	.498	.502	.0040	.0124	.040
23	1007	Side Clearance,					
		Compressor Vane:					
		Outer 5th Stage					
		Shroud Lug	.4876	.4920			
		Outer 6th Stage					
		Vane Shroud Slot	.4970	.5014	.0050	.0138	.017
24	1001,	Axial Gap - Inlet					
	1004	Case Rear Flange	.099	.101			
		4th Stage Vane and					
		Shroud Support	.096	.098	.001	.005	.005
	1007	Compressor Vane Outer					
		3rd Stage Shroud	16.738	16.742			
		4th Stage Vane and					
		Shroud Support	16.738	16.740	.004T	.002	.004
25	1007	4th Stage Shroud					
		Compressor Stator	16.7476	16.7520			
		Spacer	16.747	16.749	.0050T	.0014	.002
26	1001,	Bushing Sleeve					
	1004	Manifold Bolt	.224	.228			
		Bracket - Fuel					
		Manifold	.219	.221	.003	.009	
27	1007	Compressor Vane					
		Outer 1st Stage					
		Shroud	17.7230	17.7274			
		Inlet Vane Outer					
		Shroud Rear					
R		Flange	17.718	17.722	.0010	.0094	.011
28	1001,	Compressor Front					
	1004,	Bearing Housing	4.221	4.222			
	1007	Inlet Vane Inner					
		Shroud Rear					
		Flange	4.219	4.221	.000	.003T	.001

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
29	1001,	Compressor Front					
	1004,	Bearing	4.1329	4.1339			
	1007	Housing	4.1339	4.1346	.000	.0017	.0017
30	1001,	Compressor Front					
	1004,	Bearing Oil Seal					
	1007	Gap At 3.875 Inch	.018	.028			
		Housing	3.874	3.876	.015	.031	.031
31	1001,	Compressor Inlet					
	1004,	Case	18.238	18.242			
	1007	Stator Spacer	18.246	18.248	.004T	.010T	.004T
32	1001,	Compressor Inlet					
	1004,	Case Rear Flange	19.479	19.481			
	1007	Diffuser Case Front					
		Front Flange	19.479	19.481	.002	.002T	.002
33	1001,	4th Stage Vane					
	1004,	And Shroud					
	1007	Support Ring	18.262	18.266			
		Diffuser Case					
		Front Flange	18.258	18.262	.000	.008T	.000
34	1001,	Turbine Shaft					
	1004	Lockring Spline	.0479	.0495			
		Turbine Shaft Lock					
		Spline	.0444	.0460	.0019	.0051	.008
35	1001,	Turbine Shaft					
	1004	Lock Spline	.0444	.0460			
		Turbine Shaft					
		Coupling Spline	.0479	.0495	.0019	.0051	.008
	1007	5th Stage Shroud	16.5336	16.5380			
		4th Stage Shroud	16.5320	16.5364	.0060T	.0028	.004
36	1001	Compressor Outer					
		1st Stage Shroud	17.724	17.728			
		Inlet Vane Outer					
		Shroud Front					
		Flange (Steel					
		Stator)	17.718	17.722	.002	.010	.013
	1007	Axial Gap -					
		Inlet Case Rear					

R
R

Accessory Section Limits
Table 1101 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
(CONTINUED)							
		Flange	.099	.101			
		4th Vane And Shroud Support	.096	.098	.001	.005	.005
37	1001	Compressor Shroud 1st Stage	17.219	17.223			
		Compressor Shroud 2nd Stage	17.219	17.223	.004T	.004	.007
	1007	Bushing Sleeve Manifold Bolt	.224	.228			
		Bracket - Fuel Manifold	.219	.221	.003	.009	
38	1001	Compressor 4th Stage Disk	8.499	8.501			
		Compressor 4th Stage Air Seal	8.501	8.503	.000	.004	.006
	1007	1st Stage Turbine Blade Outer Airseal 1. Install Seal On Rotor With Rear Knife-Edge Engaged on Spoiler At One Position. 2. Move Seal Until All Radial Clearance Is On Side Opposite Engaged Position. 3. Move Seal Rearward (Start At Engaged Position And Go All Around Until Seal Is Correctly in Position).					
41	1001, 1004	Main Component Drive Bearing Housing	1.6535	1.6541			
		Bearing	1.6533	1.6535	.000	.0008	.001

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
42	1001,	Compressor Vane					
	1004	Outer 3rd Stage					
		Shroud	16.738	16.742			
		Stator Spacer	16.738	16.740	.004T	.002	.004
43	1001,	Side Clearance -					
	1004	Compressor Stator					
		Spacer	.747	.753			
		3rd Stage Vane					
		and Shroud Lug	.739	.745	.002	.014	.017
45	1007	Compressor Vane					
		Outer 9th Stage					
		and Exit Stator					
		Shroud	16.3396	16.3442			
		Compressor Vane					
		8th Stage					
		Shroud	16.3378	16.3424	.0064T	.0028	.004
46	1007	Compressor Vane					
		Outer 9th Stage					
		and Exit Stator					
		Shroud	16.7596	16.7642			
		Diffuser Outer					
		Case Front					
		Flange Shroud	16.758	16.762	.0062T	.0024	.003
47	1004	Axial Clearance -					
		Compressor Vane					
		Outer 9th Stage					
		and Exit Stator				.010	.010
48	1007	Diffuser Inner Case					
		Front Flange	13.916	13.922			
		Compressor 9th					
		Stage Vane Outer					
		and Exit Stator					
		Shroud Support	13.9228	13.9274	.0008	.0114	.012
49	1001,	Compressor Rear					
	1004,	Bearing Housing	5.1191	5.1201			
	1007	Bearing	5.1177	5.1181	.001	.0024	.0024

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
50	1001, 1004, 1007	Compressor Rear Bearing Support Flange	4.959	4.962			
		Bearing Seal Housing	4.956	4.958	.001	.006	.007
51	1001, 1004, 1007	Side Clearance - Compressor Rear Bearing Seal Housing	.127	.130			
		Seal Ring (PN 370362)	.1225	.1240	.003	.0075	.0095
		Compressor Rear Bearing Seal Housing	.132	.135			
		(PN 370362P5)	.1275	.1290	.003	.0075	
		Compressor Rear Bearing Seal Housing	.137	.140			
		(PN 370362P10)	.1325	.1340	.003	.0075	
52	1001, 1004, 1007	Gap - Compressor Rear Bearing Seal Ring Gap at 3.749 Gage	.015	.020			
		Housing	3.749	3.751	.015	.026	.031
53	1001, 1004, 1007	Height of Step - Compressor Rear Bearing Seal			.075	.085	.063
54	1001, 1004, 1007	Main Component Drive Bearing Housing	1.8504	1.8510			
		Bearing Housing	1.8502	1.8504	.000	.0008	.001
55	1001, 1004, 1007	Main Component Drive Shaft Coupling	.7875	.7878			
		Bearing	.7872	.7874	.0001T	.0006T	.0001T
56	1001, 1004, 1007	Main Component Drive Shaft Coupling	.7875	.7878			
		Bearing Spacer	.7895	.7915	.0017	.004	.004

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
57	1001,	Main Component Drive					
	1004,	Bearing Housing	1.6535	1.6541			
	1007	Bearing Spacer	1.6500	1.6516	.0019	.0041	.0041
58	1001,	End Clearance -					
	1004,	Main Component Drive					
	1007	Bearings					
		Bearing Housing and					
		Snapring			.0034	.0290	.029
59	1001,	Main Component Drive					
	1004,	Tower Shaft	.0392	.0407			
	1007	Coupling Splines	.0367	.0377	.0015	.004	.006
60	1001,	Main Component Drive					
	1004,	Coupling Splines	.0486	.0496			
	1007	Gear Splines	.0491	.0501	.0005T	.0015	.0022
		(This clearance need not be taken at overhaul. Evidence of spline wear so as to produce a clearance over maximum would be the controlling criteria.)					
61	1001,	Diffuser Case Outer					
R	1004	Rear Flange (with Nickel-Cadmium Plate or Aluminum Coat)	20.4426	20.4480			
		Combustion Chamber					
		Case Front Flange	20.436	20.442	.0006T	.0120T	.002
62	1007	Main Component Drive					
		Gear Bearing	1.6533	1.6535			
		Housing	1.6535	1.6541	.000	.0008	.001

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
63	1001	Radial Clearance (JT12A-8(L) Model Only)					
		9th Stage Compressor Rotor Airseal			.038	.042	.050
	1007	Diffuser Case Outer Rear Flange (With Nickel-Cadmium Plate Or Aluminum Coat)	20.4426	20.4480			
		Combustion Chamber Case Front Flange	20.436	20.442	.0006T	.0120T	.002
64	1001, 1004, 1007	Inner Combustion Chamber Rear Flange	7.858	7.860			
		Turbine Vane Inner Shroud Support Flange	7.860	7.864	.000	.006	.008
65	1001, 1004, 1007	Combustion Chamber Outer Duct Diaphragm	20.281	20.287			
		Outer Support Front Flange	20.289	20.295	.002	.014	.040
66	1001, 1004, 1007	Turbine Case	19.142	19.146			
		Combustion Chamber Case Rear Flange	19.136	19.142	.000	.010T	.002
67	1001, 1004, 1007	Outlet Duct Outer Support Rear Flange	18.871	18.873			
		Turbine Case	18.871	18.873	.002T	.002	.004
68	1001, 1004, 1007	Turbine Case	18.002	18.006			
		2nd Stage Rotor Outer Seal	17.998	18.002	.008T	.000	.013T
69	1001, 1004, 1007	Axial Clearance - Turbine Case	.199	.201			
		2nd Stage Vane End	.195	.199	.000	.006	.009
70	1001, 1004, 1007	Turbine Bearing Support	6.227	6.228			
		Seal Support Flange	6.229	6.231	.001	.004	.006

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
71	1001,	Turbine Bearing					
	1004,	Support	4.3317	4.3324			
	1007	Bearing	4.3297	4.3307	.001	.0027	.0027
72	1001,	Turbine Bearing	3.1493	3.1496			
	1004,	Turbine Shaft	3.1500	3.1505	.0004T	.0012T	.0004T
	1007						
73	1001,	Bearing Seal Support					
	1004,	Oil Scoop					
	1007	(PN 369312 Pre-					
		Change Letter D)	3.1515	3.1540			
		Turbine Shaft	3.1500	3.1505	.001	.004	.004
		Bearing Seal Support					
		Oil Scoop					
		(PN 369312 Change					
		Letter D)	3.1515	3.1525			
		Turbine Shaft	3.1500	3.1505	.001	.0025	.004
74	1001,	Height of Step -					
	1004,	Turbine Bearing Seal			.055	.065	.043
	1007						
75	1001,	Side Clearance -					
	1004,	Housing	.127	.130			
	1007	Seal Ring	.1225	.1240	.003	.0075	.0093
76	1001,	Gap - Turbine Bearing					
	1004,	Seal Ring At					
	1007	3.749 Gage Diameter	.015	.020			
		Housing	3.749	3.751	.015	.026	.031
77	1001,	Radial Clearance -					
	1004,	Inner Turbine Rotor					
	1007	Seal	3.277	3.279			
		1st Stage Disk	3.249	3.251	.026	.030	.036
78	1001,	Radial Clearance -					
	1004,	Inner Turbine Rotor					
	1007	Seal	4.220	4.222			
		2nd Stage Sealing					
		Ring	4.249	4.251	.027	.031	.035

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	79	1001,	1st Stage Disk	6.103	6.105			
		1004,	Turbine Shaft	6.105	6.107	.000	.004T	.000
		1007	1st Stage Turbine Disk	6.103	6.105			
			Turbine Shaft (PN 405251N or Later But Pre-PN 802420)	6.106	6.108	.001T	.005T	.000
			1st Stage Turbine Disk	6.103	6.105			
			Turbine Shaft (PN 802420)	6.1067	6.1102	.0017T	.0072T	.000
	80	1001,	2nd Stage Disk	5.899	5.901			
		1004, 1007	Turbine Shaft	5.897	5.899	.000	.0045T	.000
R R			2nd Stage Turbine Disk (PN 405802U or later)	5.8995	5.9010			
R			Turbine Shaft (PN 405251N or Later But Pre-PN 802420)	5.8965	5.8985	.001T	.005T	.000
R R R			2nd Stage Turbine Disk (PN 405802U or later)	5.8995	5.8985			
R R			Turbine Shaft (PN 802420)	5.8943	45.8978	.0017T	.0067T	.000
	81	1004	Compressor Outer 1st Stage Shroud	17.7230	17.7274			
			Inlet Vane Outer Shroud Front Flange	17.718	17.722	.001	.0094	
		1007	Turbine Bearing Oil Transfer Tube	.234	.235			
			Oil Nozzle Adapter	.2355	.2365	.0005	.0025	.0025
	82	1001,	Turbine Exhaust Case Front Flange	18.098	18.102			
		1004	Turbine Rotor 2nd Stage Seal	18.092	18.096	.002	.010	.012

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
83	1001,	Select Spacer for					
	1004,	1st Stage Turbine					
	1007	Disk Locating					
		Dimension			1.407	1.417	
84	1001,	Turbine Exhaust Case	17.845	17.855			
	1004	Turbine Rotor 2nd					
		Stage Seal	17.855	17.865	.000	.020	.020
85	1001,	Compressor Blade Lock					
	1004,	Total End Clearance -					
	1007	3rd Stage				.020	
86	1001,	Compressor Rotor Rear					
	1004,	Hub Spline	.0977	.0987			
	1007	Component Drivegear					
		Spline	.0982	.0992	.0005T	.0015	.0022
		(This clearance need not be taken at overhaul. Evidence of spline wear so as to produce a clearance over maximum would be the controlling criteria.)					
87	1007	Diffuser Inner Case					
		Front Flange	12.990	12.993			
		Compressor 9th					
		Airsealing Ring					
		(JFTD12A-4A and					
		-5A)	12.9884	12.9910	.0010T	.0046	.006
88	1001,	Turbine Rotor Inner					
	1004,	Seal	8.149	8.151			
	1007	1st Stage Disk	8.147	8.149	.004T	.0005	.002
89	1001,	Turbine Rotor Inner					
	1004,	Seal	7.949	7.951			
	1007	2nd Stage Disk	7.951	7.953	.000	.004T	.000
90	1001,	Diffuser Inner Case					
	1004,	Rear Flange	7.075	7.079			
	1007	Combustion Chamber					
		Inner Case Front					
		Flange	7.077	7.079	.000	.004T	.000

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	91	1001,	Fuel Nozzle Air Swirl					
		1004,	Guide	1.480	1.484			
		1007	Fuel Nozzle Cup					
			Adapter	1.486	1.490	.002	.010	.010
			Fuel Nozzle Nut					
			(PN 695847)	1.526	1.530			
			Combustion Chamber					
			Flange (PN 695857,					
			695858, 695859,					
			659860)	1.532	1.536	.002	.010	
R	92 -		Fuel Manifold/Nozzle					
R	95		Limits - Refer to					
R			73-00-00, Fuel					
	96	1001,	Compressor Rear Bearing					
		1004,	Oil Nozzle Connector	.437	.439			
		1007	Oil Strainer Ferrule	.432	.436	.001	.007	.007
	97	1001,	Compressor Rotor Disk					
		1004,	Spacer	6.467	6.469			
			Disk	6.469	6.471	.000	.0045T	.000
			2nd to 3rd Stage					
			Compressor Disk					
			Spacer	6.4665	6.4685			
			2nd and 3rd Stage					
			Compressor Disks					
			PN 670802A, 670403A,					
			or later	6.4695	6.4710	.001T	.005T	.000
	98	1001,	Compressor Rotor Front					
R		1004	Hub	7.474	7.476			
			2nd Stage Airseal	7.472	7.474	.000	.004T	.001
	99	1001,	Compressor Rotor 3rd					
		1004	Stage Disk	6.549	6.551			
			Spacer	6.547	6.549	.000	.0045T	.000
			3rd Stage Compressor					
			Disk (PN 670403A or					
			later)	6.5495	6.5510			
			3rd to 4th Stage					
			Disk Spacer	6.5465	6.5485	.001T	.004T	.007

Accessory Section Limits
Table 1101 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
100	1001,	Compressor 2nd Stage					
	1004	Vane and Shroud	16.988	16.992			
		3rd Stage Vane and					
		Shroud	16.988	16.992	.004	.004T	.007
102	1001,	Turbine Bearing Oil					
	1004,	Strainer Ferrule					
	1007	(PN 397088 Pre-Change					
		Letter B)	.340	.341			
		Turbine Bearing Oil					
		Pressure Tube					
		Connector	.343	.344	.002	.004	.004
		Turbine Bearing Oil					
		Strainer Ferrule					
		(PN 397088 Change					
		Letter B)	.337	.341			
		Turbine Bearing Oil					
		Pressure Tube					
		Connector	.343	.344	.002	.007	.007
		Turbine Bearing Oil					
		Strainer Ferrule					
		(PN 397088 Change					
		Letter C)	.333	.339			
		Turbine Bearing Oil					
		Pressure Tube					
		Connector	.343	.344	.004	.011	.011
104	1001,	Compressor Inlet					
	1004	Pressure Probe Elbow	.4975	.4985			
		Sensing Boss	.499	.501	.0005	.0035	.0035
105	1001,	Compressor Inlet					
	1004	Pressure Probe Elbow	.620	.622			
		Sensing Boss	.624	.626	.002	.006	.006
106	1001,	Gearbox Mounting					
	1004	Shoulder Bolt	.366	.368			
		Mounting Lug Sleeve					
		Bushing and Diffuser					
		Case Mounting Lugs	.374	.376	.006	.010	.010
107	1007	Compressor Blade Lock					
		Total End Clearance					
		Stage 4			.010	.020	
		Stage 5 thru 9				.015	

R
R

Accessory Section Limits
Table 1101 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
108	1007	Compressor 4th Stage Vane/Shroud Support Ring Axial			.0006T	.0110T	.000
109	1007	Compressor 4th Stage Vane/Shroud Support Ring	17.1646 17.168	17.1690 17.172	.0010T	.0074	.010
110	1001	Compressor Blade Lock Total End Clearance Stage 5 thru 9				.015	
	1004	Axial Clearance - 4th Stage Vane and Shroud Support - 4th Stage Outer Shroud Support Ring			.0006T	.0110T	.000
111	1001, 1004	1st Stage Turbine Blade Outer Airseal 1. Install Seal On Rotor With Rear Knife-Edge Engaged on Spoiler At One Position. 2. Move Seal Until All Radial Clearance Is On Side Opposite Engaged Position. 3. Move Seal Rearward (Start At Engaged Position And Go All Around Until Seal Is Correctly in Position).					
	1007	5th Stage Disk@ 5th Stage Airseal	10.328 10.334	10.332 10.345	.002T	.017T	.002T

@ Disk dimensions are before plate.

R
R

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	112	1004	Compressor 4th Stage					
			Vane/Shroud	17.1646	17.1690			
			Support Ring	17.168	17.172	.0010T	.0074	.010
	113	1004	Compressor Blade Lock					
			Total End Clearance					
			Stages 5 thru 9				.015	
		1007	2nd Stage Turbine Rotor					
			Disk	5.911	5.913			
			Free Turbine Inlet					
			Airsealing Ring	5.909	5.911	.000	.004T	.000
R	115	1007	Compressor Rotor Front					
			Hub	7.474	7.478			
			2nd Stage Airseal	7.472	7.474	.000	.004T	.001
	116	1001, 1004	Bleed Valve Linkage					
			Rod End	.990	.994			
			Spring Housing	.998	1.002	.004	.012	.012
			Compressor Rotor Disk					
			Spacer	6.4665	6.4685			
			Disk	6.4695	6.4710	.001T	.005T	
	117	1001, 1004	Side Clearance - Compressor Stator					
			Spacer	.747	.753			
			Compressor Inlet Case					
			Lugs	.739	.745	.002	.014	.017
		1007	6th Stage Disk@	10.888	10.892			
			6th Stage Airseal	10.894	10.905	.002T	.017T	.002T
			@ Disk dimensions are before plate.					
	118	1007	Compressor Rotor 4th					
			Stage Disk	8.4995	8.501			
			Spacer	8.4965	8.4985	.001T	.005T	.000

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	119	1001,	Housing - Compressor					
		1004	Bleed Valve	.606	.610			
R			Rod	.598	.602	.004	.012	.015
R		1007	Compressor Rotor 3rd					
R			Stage Disk	6.5495	6.551			
R			Spacer	6.5465	6.5485	.001T	.005T	.001
	120	1004	Radial Clearance (JT12A-8(N) Model Only)					
			9th Stage Compressor Rotor Airseal			.038	.042	.050
		1007	Clearance at Bolt End Before Tightening Rear Nut, Compressor Rotor Stator			.000	.030	
	121	1007	7th Stage Disk	11.448	10.452			
			7th Stage Airseal	11.454	10.465	.002T	.017T	.002T
	122	1007	8th Stage Disk	12.008	12.012			
			8th Stage Airseal	12.014	12.025	.002T	.017T	.002T
	123	1001,	Flanged Sleeve					
		1004,	Bushing	.5320	.5326			
		1007	Compressor Inlet Case	.5305	.5315	.0005T	.0021T	.0005T
	124	1001, 1004, 1007	Radial Clearance (Reference Only) - 1st Stage Compressor Blade			.020	.040	
	125	1001, 1004, 1007	Radial Clearance (Reference Only) - 2nd Stage Compressor Blade			.020	.040	
	126	1001, 1004, 1007	Radial Clearance (Reference Only) - 3rd Stage Compressor Blade			.020	.040	

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
127	1001, 1004, 1007	Radial Clearance (Reference Only) - 4th Stage Compressor Blade			.020	.040	
128	1001, 1004, 1007	Radial Clearance (Reference Only) - 5th Stage Compressor Blade					
		Stainless Steel			.035	.055	
		Titanium (PN 457805)			.0345	.0525	
129	1001, 1004, 1007	Radial Clearance (Reference Only) - 6th Stage Compressor Blade			.030	.050	
130	1001, 1004, 1007	Radial Clearance (Reference Only) - 7th Stage Compressor Blade			.025	.045	
131	1001, 1004, 1007	Radial Clearance (Reference Only) - 8th Stage Compressor Blade			.025	.045	
132	1001, 1004, 1007	Radial Clearance (Reference Only) - 9th Stage Compressor Blade					
		For JT12A-6 and -6A Pre-SB 1533			.025	.045	
		For JT12A-6 and -6A Post-SB 1533 and All JT12A-8, and JFTD12A-4A and -5A			.034	.054	
133	1001, 1004, 1007	Radial Clearance 2nd Stage Compressor Rotor Airseal			.020	.030	.040

NOTE: References 124 thru 132 are for reference only and are not mandatory for overhaul.

R
R

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
134	1001, 1004, 1007	Radial Clearance 3rd Stage Compressor Rotor Airseal			.020	.030	.040
135	1001, 1004, 1007	Radial Clearance 4th Stage Compressor Rotor Airseal			.020	.030	.040
136	1001, 1004, 1007	Radial Clearance 4th to 5th Stage Compressor Rotor Airseal			.010	.020	.030
137	1001, 1004, 1007	Radial Clearance 5th Stage Compressor Rotor Airseal			.010	.020	.030
138	1001, 1004, 1007	Radial Clearance 6th Stage Compressor Rotor Airseal			.013	.023	.033
139	1001, 1004, 1007	Radial Clearance 7th Stage Compressor Rotor Airseal			.013	.023	.033
140	1001, 1004, 1007	Radial Clearance 8th Stage Compressor Rotor Airseal			.025	.035	.045
141	1001, 1004	Radial Clearance 9th Stage Compressor Rotor Airseal			.028	.032	.040
142	1001, 1004, 1007	Radial Clearance 1st Stage Turbine Blade Outer Airseal					
		PN 394808 Pre-Change Letter B			.060	.085	
		PN 394808 Change Letter B			.060	.085	
		PN 394808C and 560890C			.0165	.0415	.0495
		PN 394808E and 560890E			.022	.047	.055

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
143	1001, 1004, 1007	Radial Clearance 2nd Stage Turbine Blade Outer Airseal			.023	.055	
		Blade Outer Airseal (Front)			.030	.045	
144	1001, 1004	Compressor Disk - 5th Stage	10.328	10.332			
		Compressor Rotor Seal - 5th Stage	10.334	10.345	.002T	.017T	.002T
145	1001, 1004	Compressor Disk - 3rd Stage	8.688	8.692			
		Compressor Rotor Seal - 3rd Stage	8.694	8.705	.002T	.017T	.002T
	1007	Side Clearance Compressor Stator Spacer	.747	.753			
		Compressor Inlet Case Lugs	.739	.745	.002	.014	.017
146	1001, 1004	Area, Total All Vanes (JT12A-8) This area is from a selection of 58 vanes (PN 569551) to give a numerical class average of 4.40 - 4.44. When vanes area classified in tenths, the average class limit is 4.40 - 5.44.			54.52	55.08	

NOTE: At 100 percent vane replacement, engines which did not have the above class average must be in the limits specified.

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
		Area, Total All Vanes (JT12A-8) This area is from a selection of 58 vanes (PN 566051) to give a numerical class average of 6.28 - 6.34. When			55.52	56.08	

R
R

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	(CONTINUED)							
			vanes area classified in tenths, the average class limit is 6.28 - 6.34.					
		1007	Side Clearance					
			Compressor Stator Spacer	.747	.753			
			Compressor Inlet Case Lugs	.739	.745	.002	.014	.017
	147	1004	Bolt	.2935	.2945			
R			Case - Compressor Inlet	.2945	.2955	.000	.002	.004
		1007	Side Clearance					
			Diffuser Case Support Ring	.498	.504			
			6th Stage Vane and Shroud Lug	.4896	.4940	.0040	.0144	.020
	148	1001	Tierod (PN 669845, 668984, or Subsequent)	.246	.247			
			Compressor Rotor Disk Spacers	.249	.251	.002	.005	
		1004	Bolt	.2935	.2945			
			Cross Shaft Support	.2965	.2975	.002	.004	.004
	149	1001	Tierod (PN 669845, 668984, or Subsequent)	.246	.247			
			Compressor Rotor Disk and Front Hub	.249	.252	.002	.006	
		1004	Cross Shaft Lever	.6557	.6562			
			Bearings	.6557	.6562	.0005	.0005T	
		1007	Engine Lifting Pin	.343	.347			
			Engine Lifting Pin Bolt	.339	.342	.001	.008	.008

Accessory Section Limits
Table 1101 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
150	1001	Tierod (PN 668984 or Subsequent)	.246	.247			
		Compressor Rotor Rear Hub	.250	.252	.003	.006	
	1004	Cross Shaft Lever Bearing	.2495	.2500			
		Bearing Insert	.2480	.2495	.000	.002	
	1007	Flanged Sleeve Bushing ID	.3425	.3435			
		Engine Lifting Pin Bolt	.339	.342	.0005	.0045	.0045
151	1001	Tierod (PN 668984 or Subsequent)	.246	.247			
		Compressor Rotor Seal - 4th Stage	.249	.251	.002	.005	
	1004	Fuel Control Lever	.6557	.6562			
		Bearing	.6557	.6562	.0005	.0005T	
	1007	Compressor Disk - 9th Stage	12.408	12.412			
		Seal - 9th Stage	12.414	12.425	.002T	.017T	.002T
152	1004	Fuel Control Lever Bearing	.2495	.2500			
		Bearing Insert	.2480	.2495	.000	.002	
	1007	Compressor 2nd Stage Vane and Shroud	16.988	16.992			
		3rd Stage Vane and Shroud	16.988	16.992	.004	.004T	.007
153	1004	Cross Shaft Spline	.0457	.0467			
		Cross Shaft Lever Spring	.049	.0500	.0023	.0043	.009
R 153A	1007	2nd Stage Inner Airseal Ring to Turbine Case Dimension			.005	.081	

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
154	1004	Cross Shaft Spline	.0457	.0467			
		Spacer Spline	.0490	.0500	.0023	.0043	.009
	1007	Compressor 5th Stage Vane and Shroud	16.3680	16.3724			
		6th Stage Vane and Shroud	16.3696	16.3740	.0060T	.0028	.004
155	1007	Compressor 6th Stage Vane and Shroud	16.3120	16.3164			
		7th Stage Vane and Shroud	16.3136	16.3182	.0062T	.0028	.004
156	1007	Compressor 7th Stage Vane and Shroud	16.2958	16.3004			
		8th Stage Vane and Shroud	16.2976	16.3022	.0064T	.0028	.004
157	1001, 1004	Area, Total All Vanes (JT12A-6/6A) This area is from a selection of 58 vanes (PN 702051) to give a numerical class average of 6.69 - 6.72. When vanes area classified in tenths, the average class limit is 6.69 - 7.72.			52.62	53.18	
		Or					
		This area is from a selection of 58 vanes (PN 512751) to give a numerical class average of 8.69 - 8.72. When vanes are classified in tenths, the average class limit is 8.69 - 9.72.			52.62	53.18	
	1007	Area, Total All Vanes (JFTD12A-5A) This area is from a selection of 58 vanes (PN 512751) to give a			53.92	54.48	

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	(CONTINUED)		numerical class average of 11.12 - 11.19. When vanes are classified in tenths, the average class limit is 11.04 - 12.19.					
	158	1001, 1004, 1007	Area, Total All Vanes (JT12A-6/6A), PN 562752 (JT12A-8), PN 567152/ 648752 (JFTD12A-4A,-5A), PN 648752/567152 This area is from a selection of 96 vanes to give a numerical class average of 4.98 - 5.24. When vanes are classified in tenths, the average class limit is 4.98 - 6.24 (4.88 - 6.24 for JFTD12A-5A).			79.70	80.70	
	159	1001, 1004	2nd Stage Inner Airseal Ring to Turbine Case Dimension			.005	.081	
R		1007	Checking Dimensions Only - Main Accessory Drive Shaftgear Backlash, 0.011 - 0.019 with Compressor Rotor Assembly To Front of Engine, 0.003 Minimum with Compressor Rotor to Rear of Engine					
R	159A	1001	2nd Stage Inner Airseal Ring to Turbine Case Dimension			.005	.081	
	160	1007	Compressor Disk - 3rd Stage	8.688	8.692			
			Compressor Seal - 3rd Stage	8.694	8.705	.002T	.017T	

Accessory Section Limits
Table 1101 (Continued)

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	161	1001, 1004	Compressor Disk - 6th Stage	10.888	10.892			
			Compressor Seal - 6th Stage	10.894	10.905	.002T	.017T	.002T
R			NOTE: Disk dimensions are before plate.					
	162	1001, 1004	Compressor Disk - 7th Stage	11.448	11.452			
			Compressor Seal - 7th Stage	11.454	11.465	.002T	.017T	.002T
		1007	Radial Clearance 9th Stage Compressor Airseal			.038	.042	.050
	163	1001, 1004	Compressor Disk - 8th Stage	12.008	12.012			
			Compressor Seal - 8th Stage	12.014	12.025	.002T	.017T	.002T
R			NOTE: Disk dimensions are before plate.					
R		1007	Area (Total - All vanes, JFTD12A-4A) This area is from a selection of 58 vanes (PN 512751) to give a numerical class average of 8.68 - 8.73. When vanes area classified in tenths, the average class limit is 8.68 - 9.73.			52.62	53.18	
	164	1001, 1004	Compressor Disk - 9th Stage	12.408	12.412			
			Compressor Seal - 9th Stage	12.414	12.425	.002T	.017T	.002T
			NOTE: Disk dimensions are after plate.					
		1007	Side Clearance:					

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
(CONTINUED)							
		Compressor Outer 2nd Stage Shroud Lug	.489	.493			
		Outer 3rd Stage Shroud Slot	.498	.502	.005	.013	.040
165	1001, 1004	Checking Dimensions Only - Main Accessory Drive Shaftgear Backlash, 0.011 - 0.019 with Compressor Rotor Assembly To Front of Engine, 0.003 Minimum with Compressor Rotor to Rear of Engine					
	1007	Side Clearance: Compressor Outer 4th Stage Shroud Lug	.4896	.494			
		Outer 5th Stage Shroud Slot	.497	.5014	.003	.0118	.040
166	1001	Gap - Dual Drain Valve			.023	.050	
	1007	Side Clearance: Compressor Outer 6th Stage Shroud Lug	.489	.493			
		Outer 7th Stage Shroud Slot	.4968	.5014	.0038	.0124	.040
		NOTE: Lug dimensions are after plate.					
167	1007	Side Clearance, Compressor Outer 7th Stage Shroud Lug	.489	.493			
		Outer 8th Stage Shroud Slot	.4968	.5014	.0038	.0124	.040
168	1007	Side Clearance 1st Stage Turbine Blade Airseal Lug	.1860	.1880			
		Turbine Case Slot	.1970	.2030	.0090	.0170	.027

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
169	1007	Radial Clearance 2nd Stage Turbine Blade Outer Airseal (Rear)			.032	.047	
171	1001,	Strap	.093	.095			
	1004	Pin	.0905	.0925	.0005	.0045	.0085
172	1001	Clevis	.248	.252			
		Strap	.242	.246	.002	.010	
	1004	Axial Clearance					
		Clevis	.248	.252			
		Strap	.242	.246	.002	.010	
173	1001,	Clevis	.093	.095			
	1004	Pin	.0905	.0925	.0005	.0045	.0085
174	1001,	Guide	.5010	.5028			
	1004	Clevis	.4953	.4975	.0035	.0075	
175	1001,	Bearing	.1872	.1875			
	1004	Pin	.1866	.1871	.0001	.0009	
	1007	Tierod	.246	.247			
		Compressor Rotor Disk Spacers and Seal	.249	.251	.002	.006	
176	1001,	Clevis	.1872	.1875			
	1004	Pin	.1866	.1871	.0001	.0009	
	1007	Tierod	.246	.247			
		Compressor Rotor Disk Spacers and Seal	.249	.252	.002	.006	
177	1001,	Guide	.5010	.5028			
	1004	Pin	.4996	.5000	.001	.0032	
178	1001,	Connecting Link	.299	.301			
	1004	Clevis	.2965	.2985	.0005	.0045	
179	1001,	Connecting Link	.3730	.3735			
	1004	Clevis	.3745	.3755	.001	.0025	

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
180	1001,	Ball Bearing	.1872	.1875			
	1004	Connecting Link	.1866	.1871	.0001	.0009	
181	1001,	Ball Bearing	.4996	.5000			
	1004	Guide	.5010	.5028	.001	.032	
182	1001,	Guide	1.1819	1.1829			
	1004	Ball Bearing	1.1807	1.1811	.0008	.0022	
183	1001,	Arm	.3902	.3923			
	1004	Ball Bearing	.3934	.3937	.0011	.0035	
184	1001,	Valve Arm Spline	.0302	.0312			
	1004	Linkage Arm Spline	.0327	.0337	.0015	.0035	
185	1001,	Linkage Arm	.2485	.2490			
	1004	Bolt	.2475	.2480	.0005	.0015	
		Linkage Arm	.184	.186			
		Pin (JT12A-6 and -6A Pre-SB 1291)	.181	.183	.001	.005	
186	1001,	Linkage Arm	.185	.195			
	1004	Connector	.167	.169	.016	.028	
		Linkage Arm Connector	.120	.130			
		Pin (JT12A-6 and -6A Pre-SB 1291)	.105	.115	.005	.025	
187	1001,	Connector	.2495	.2505			
	1004	Bolt	.2475	.2480	.0015	.0030	
		Connector	.184	.186			
		Pin (JT12A-6 and -6A Pre-SB 1291)	.181	.183	.001	.005	
188	1001,	Arm	.2475	.2480			
	1004	Connecting Link	.2495	.2505	.0015	.0030	
		Arm	.245	.247			
		Connecting Link (JT12A-6 and -6A Pre-SB 1291)	.249	.251	.002	.006	
189	1001,	Connector	.1905	.1910			
	1004	Bolt	.1895	.1900	.0005	.0015	

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
190	1001,	Radial Clearance					
	1004	1st Stage Turbine					
		Blade Outer Airseal					
		(Front)					
		PN 394808 Pre-					
		Change Letter B			.060	.085	
		PN 394808 Change					
		Letter B			.0165	.0415	
		PN 394808C and					
		560890C			.0165	.0415	.0495
		PN 394808E and					
		560890E			.022	.047	.055
191	1001,	Plug - Compressor					
	1004	Rotor Front Hub	2.5910	2.5915			
		Hub	2.5920	2.5925	.0005	.0015	
192	1001	Compressor Blade Lock					
		Total End Clearance -					
		4th Stage			.010	.020	
193	1001	Compressor Rotor					
		Disk Spacer	9.7718	9.7764			
		Disk	9.7690	9.7705	.0008T	.0074T	
195	1004	Side Clearance,					
		Front Compressor					
		Outer 1st Stage					
		Shroud Lug	.4896	.4940			
		Outer 2nd Stage					
		Shroud Slot	.498	.502	.0040	.0124	
196	1004	Side Clearance,					
		Compressor Vane					
		Outer 5th Stage					
		Shroud Lug	.4876	.4920			
		Outer 6nd Stage					
		Vane Shroud Slot	.4970	.5014	.0050	.0138	.020
197	1004	4th Stage Shroud					
		Compressor Stator	16.7476	16.7520			
		Spacer	16.747	16.749	.0050T	.0014	.002
198	1004	5th Stage Shroud	16.5336	16.5380			
		4th Stage Shroud	16.5320	16.5364	.0060T	.0028	.004

R
R

Accessory Section Limits
Table 1101 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
199	1004	Side Clearance					
		Diffuser Case Support Ring	.498	.504			
		6th Stage Vane and Shroud Lug	.4896	.4940	.0040	.0144	.020
200	1004	Side Clearance (JT12A-8(N) Only)					
		Diffuser Case Support Ring	.503	.509			
		6th Stage Vane and Shroud Lug	.4896	.4940	.0094	.0194	
205	1004	Compressor Vane 9th Stage Shroud	16.3396	16.3442			
		Compressor Vane 8th Stage Shroud	16.3378	16.3424	.0064T	.0028	.006
206	1004	Compressor Vane 9th Stage Outer Shroud	16.7596	16.7642			
		Diffuser Outer Case Front Flange	16.758	16.762	.0062T	.0024	.003
207	1004	Diffuser Inner Case Front Flange	13.916	13.922			
		Compressor 9th Stage Inner Shroud	13.9228	13.9274	.0008	.0114	.012
208	1004,	Diffuser Inner Case Front Flange	12.991	12.994			
		Compressor 9th Airsealing Ring	12.9884	12.9910	.000	.0056	.006
209	1004	Compressor 5th Stage Vane and Shroud	16.3680	16.3724			
		6th Stage Vane and Shroud	16.3696	16.3740	.0060T	.0028	.004
210	1004	Compressor 6th Stage Vane and Shroud	16.3120	16.3164			
		7th Stage Vane and Shroud	16.3136	16.3182	.0062T	.0028	.004

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
211	1004	Compressor 7th Stage Vane and Shroud	16.2958	16.3004			
		8th Stage Vane and Shroud	16.2976	16.3022	.0064T	.0028	.004
212	1004	Compressor Shroud 1st Stage	17.2180	17.2224			
		Compressor Shroud 2nd Stage	17.219	17.223	.0050T	.0034	.007
213	1004	Side Clearance, Compressor 2nd Stage Outer Shroud Lug	.489	.493			
		3rd Stage Outer Shroud Slot	.498	.502	.005	.013	.020
214	1004	Side Clearance, Compressor 4th Stage Outer Shroud Lug	.4896	.4940			
		5th Stage Outer Shroud Slot	.4970	.5014	.003	.0118	.020
216	1004	Side Clearance, Compressor 6th Stage Outer Shroud Lug	.4890	.4930			
		7th Stage Outer Shroud Slot	.4970	.5014	.004	.0124	.020
		NOTE: Lug dimensions are after plate.					
218	1004	Side Clearance, Compressor 6th Stage Outer Shroud Lug	.4890	.4930			
		7th Stage Outer Shroud Slot	.4970	.5014	.004	.0124	.020
220	1004	Gap Fuel Drain Valve				.023	.050
221	1004	Side Clearance 1st Stage Turbine Airseal Lug	.1860	.1880			
		Turbine Case Slot	.1970	.2030	.0090	.0170	.027

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
222	1004	Tierod (PN 669845, 668984, or Subsequent)	.246	.247			
		Compressor Rotor Disk Spacers	.249	.251	.002	.005	
223	1004	Tierod (PN 669845, 668984, or Subsequent)	.246	.247			
		Compressor Rotor Disk and Front Hub	.249	.252	.002	.006	
224	1004	Tierod (PN 668984 or Subsequent)	.246	.247			
		Compressor Rotor Rear Hub	.250	.252	.003	.006	
225	1004	Tierod (PN 668984 or Subsequent)	.246	.247			
		Compressor Rotor Seal - 4th Stage	.249	.251	.002	.005	
226	1004	Radial Clearance 2nd Stage Turbine Blade Outer Airseal (Rear)			.032	.047	
227	1004	Compressor Blade Lock Total End Clearance Stage 4			.010	.020	
228	1004	Compressor Rotor Disk Spacer	9.7718	9.7764			
		Disk	9.7690	9.7705	.0008T	.0074T	
272	1007	Arm	.2475	.2480			
		Connecting Link	.2495	.2505	.0015	.0030	
273	1007	Arm	.3902	.3923			
		Ball Bearing	.3934	.3937	.0011	.0035	
274	1007	Guide	1.1819	1.1829			
		Ball Bearing	1.1807	1.1811	.0008	.0022	
275	1007	Connecting Link	.299	.301			
		Clevis	.2965	.2985	.0005	.0045	

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	276	1007	Linkage Arm	.185	.195			
			Connector	.167	.169	.016	.028	
	277	1007	Connector	.1905	.1910			
			Bolt	.1895	.1900	.0005	.0015	
	278	1007	Linkage Arm	.2485	.2490			
			Bolt	.2475	.2480	.0005	.0015	
	279	1007	Valve Arm Spline	.0302	.0312			
			Linkage Arm Spline	.0321	.0337	.0009	.0035	
	280	1007	Ball Bearing	.1872	.1875			
			Connecting Link	.1866	.1871	.0001	.0009	
	281	1007	Ball Bearing	.4996	.5000			
			Guide	.5010	.5028	.001	.032	
	282	1007	Clevis	.093	.095			
			Pin	.0905	.0925	.0005	.0045	.0085
	283	1007	Clevis	.248	.252			
			Strap	.242	.246	.002	.010	
	284	1007	Strap	.093	.095			
			Pin	.0905	.0925	.0005	.0045	.0085
R	286	1007	Guide	.5010	.5028			
			Clevis	.4953	.4975	.0035	.0075	
	287	1007	Bearing	.1872	.1875			
			Pin	.1866	.1871	.0001	.0009	
	288	1007	Clevis	.1872	.1875			
			Pin	.1866	.1871	.0001	.0009	
	289	1007	Guide	.5010	.5028			
			Bearing	.4996	.5000	.001	.0032	
	290	1007	Connector	.2495	.2505			
			Bolt	.2475	.2480	.0015	.0030	
	291	1007	Connecting Link	.3730	.3735			
			Clevis	.3745	.3755	.001	.0025	

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	292	1007	Gap					
			Fuel Drain Valve			.023	.050	
R	293	1007	JFTD12A-5A:					
			Connector - Tube	.185	.186			
			Bushing - Sleeve	.183	.185	.000	.003T	
R		1007	JFTD12A-4A:					
			Plug - Compressor Rotor Front Hub	2.5910	2.5915			
			Hub	2.5920	2.5925	.0005	.0015	

351 — 1001, 1004, 1007 — Compressor Front Bearing Inner Race Retaining Nut

1. Tighten nut to 1300 lb-in, turn nut through angle of 10° minimum to 14° maximum, loosen nut to 0 lb-in.
2. Tighten nut to 1300 lb-in.
3. Mark location of nut with reference to mating part.
4. Turn nut through angle of 10° minimum to 14° maximum.
5. Loosen nut to 0 lb-in. and repeat step 2.
6. If nut mark is in line with or beyond mating part reference mark 0.050 inch maximum, apply final angle of turn (step 4).
7. If marks are not in limits, repeat steps 3, 4, and 5 in order until marks are in limits, then do step 6.

352 — 1001, 1004, 1007 — Compressor Front Bearing Outer Race Retaining Nut

1. Tighten nut to 2000 lb-in.
2. Mark location of nut with reference to mating part.
3. Turn nut through angle of 5° minimum to 8° maximum.
4. Loosen nut to 0 lb-in. and repeat step 1.
5. If nut mark is in line with or beyond mating part reference mark 0.050 inch maximum, apply final angle of turn (step 3).
6. If marks are not in limits, repeat steps 2, 3, and 4 in order until marks are in limits, then do step 5.

353 — 1001, 1004, 1007 — Compressor Rear Bearing Outer Race Retaining Nut

1. Tighten nut to 2000 lb-in.
2. Mark location of nut with reference to mating part.
3. Turn nut through angle of 12° minimum to 17° maximum.
4. Loosen nut to 0 lb-in. and repeat step 1.
5. If nut mark is in line with or beyond mating part reference mark 0.050 inch maximum, apply final angle of turn (step 3).
6. If marks are not in limits, repeat steps 2, 3, and 4 in order until marks are in limits, then do step 5.

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
354	1001, 1004, 1007	Compressor Rear Bearing Oil Scoop 1. Tighten nut to 1300 lb-in. 2. Mark location of scoop with reference to mating part. 3. Turn nut through angle of 8° minimum to 20° maximum. 4. Loosen nut to 0 lb-in. and repeat step 1. 5. If nut mark is in line with or beyond mating part reference mark 0.050 inch maximum, apply final angle of turn (step 3). 6. If marks are not in limits, repeat steps 2, 3, and 4 in order until marks are in limits, then do step 5.					
355	1001, 1004, 1007	Turbine Shaft Locking Bolt 1. Tighten bolt to 800 lb-in. 2. Loosen bolt to 0 lb-in. 3. Tighten bolt again to 800 lb-in., then turn bolt through angle of 16° minimum to 24° maximum.					
356	1001, 1004, 1007	Main Component Drivegear Retaining Nut 1. Tighten bolt to 400 lb-in. 2. Loosen bolt to 0 lb-in. R 3. Tighten bolt again to 400 lb-in., then turn nut to next locking position.					
358	1001, 1004	Compressor Rotor Tierod Extension 1. Tighten all tierod nuts simultaneously in pairs 180° apart in increments of 25 lb-in. to 75 lb-in., then farther to 85 lb-in. in sequence shown in schematic view. 2. Loosen nuts simultaneously in pairs 180° apart to 0 lb-in. and retighten to 81b-in. torque. Then further tighten to required minimum stretch. Loosening and retightening to be done simultaneously in pairs of 180° apart in sequence shown in schematic view. 3. Repeat this procedure until all tierods have been tightened to minimum tierod extension. 4. Secure all nuts by bending tablocks but do not reposition nuts during this process. Tierod extension is measured from Rear Face of Front Flange of Bearing Sleeve or (Optional) to shoulder on Hub provided to retain Bearing Sleeve. 5. Tierod must be held from turning at same end at which stretch is being set.	.025	.025			

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
359	1001, 1004, 1007	Turbine Bearing Outer Race Retaining Nut 1. Tighten nut to 2000 lb-in. 2. Mark location of nut with reference to mating part. 3. Turn nut through angle of 5° minimum to 8° maximum. 4. Loosen nut to 0 lb-in. and repeat step 1. 5. If nut mark is in line with or beyond mating part reference mark within 0.050 maximum, apply final angle of turn per step 3. 6. If marks are not within limits, repeat steps 2, 3, and 4 in order until marks are within limits. Then perform step 5.					
360	1001, 1004, 1007	Turbine Bearing Inner Race Retaining Nut 1. Tighten nut to 1500 lb-in. Turn nut through angle of 20° minimum to 24° maximum and loosen nut to 0 lb-in. 2. Tighten nut to 1500 lb-in. 3. Mark location of nut with reference to mating part. 4. Turn nut through angle of 20° minimum to 24° maximum. 5. Loosen nut to 0 lb-in. and repeat step 2. 6. If nut mark is in line with or beyond mating part reference mark within 0.050 maximum, apply final angle of turn per step 4. 7. If marks are not within limits, repeat steps 3, 4, and 5 in order, until marks are within limits. Then perform step 6.					
361	1001, 1004, 1007	Turbine Disks Nut, tighten all turbine disk nuts simultaneously in pairs 180° apart in sequence shown in schematic view to specified limits. Loosen nuts simultaneously in pairs 180° apart to 0 lb-in. then retighten to specified limits, loosening and retightening to be done simultaneously in pairs 180° apart in sequence shown in schematic view.			175.0	200.0	
362	1001, 1004, 1007	Turbine Bearing Support Bolts			65.0	72.0	

R
R

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
365	1001, 1004	Compressor Rotor Front Tierod Stretch. Procedure for tightening rear nut on front tierod:			.008	.008	
		1. Tierod must be held from turning at all times. 2. Required tierod stretch is measured from rear face of tierod to rear inner face of front hub. 3. With nuts set, tighten rear nuts simultaneously in pairs 180° apart by increments of 25 lb-in. to torque of 75 lb-in. in sequence shown in schematic view. 4. Loosen nuts simultaneously in pairs 180° apart to 0 lb-in. and retighten to 8 lb-in. torque. Then, further tighten to required minimum stretch, loosening and retightening to be done simultaneously in pairs 180° apart in sequence shown in schematic view. Secure nuts by bending tablocks but do not reposition nuts during this process.					
366	1001, 1004	Tail Cone Mounting Bolts			45.0	51.0	
	1007	Diffuser Case Rear Flange Locknuts			35.0	40.0	
367	1001, 1004	Compressor Rotor Rear Tierod Tightening Procedure when hydraulic loading method is used:					
		1. Starting with initial tight rotor stack with 50 - 85 lb-in. torque on tierod nut, assemble hydraulic load fixture on tierods. Turn ram thimbles down on tierod threads until secured. 2. Apply hydraulic pressure, loading tierods to break away load of 2230 - 2270 lbs. (or equivalent on pressure gage). Back tierod nuts off so at baseline load of 146 lbs. nuts do not contact stack. 3. Reduce hydraulic pressure to baseline load of 136 - 156 lbs. (or equivalent on pressure gage). Adjust dial indicators so as to allow 0.040 inch min. free travel. Insure that nuts are free of stack. Set dial indicators to zero. 4. Increase hydraulic pressure to load tierods to check load of 1980 - 2020 lbs. (or equivalent on pressure gage). Observe proper functioning of hydraulic					

R
R

Accessory Section Limits
Table 1101 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER

(CONTINUED)

fixture and dial indicators.

5. Increase hydraulic pressure to load tierods to initial load of 2965 - 3005 lbs. (or equivalent on pressure gage) observing dial indicator readings. All indicators must agree within specified tolerance range of 0.003 inch.
6. If dial indicator difference exceeds 0.003 inch, a check should be made for malfunction of hydraulic fixture or tierod material defect. Make necessary corrections and repeat loading procedure.
7. Release hydraulic pressure to baseline load of 136 - 156 lbs. Reset dial indicators to zero.
8. Increase hydraulic pressure to load tierods to final load of 2685 - 2705 lbs. (or equivalent on pressure gage), ensuring all dial indicators read within specified tolerance range of 0.003 inch. If dial indicator difference exceeds 0.003 inch, make necessary corrections and repeat loading procedure steps 7 and 8.
9. Tighten tierod nuts to 15 - 18 lb-in. torque in sequence shown in diagram of tierods. Further tighten tierod nuts to 24 - 26 lb-in. torque in sequence shown in diagram of tierods. Hydraulic pressure will decrease slightly while nuts are being torqued, but do not reset.
10. After all nuts have been tightened, recheck dial indicator to ensure all indicators read within specified tolerance range of 0.004 inch.
11. Decrease hydraulic pressure to baseline load of 136 - 146 lbs, (or equivalent on pressure gage), ensuring all indicators read within the specified tolerance range of 0.004 inch.

<u>NOTE</u>: A very low dial indicator reading indicates an untorqued nut at pressure release and loading of all tierods must be repeated.

12. Reduce hydraulic pressure to zero and remove fixture.
13. Secure all nuts by bending tablocks but do not reposition nuts during process.

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
368	1001,	Gearbox Drive Bearing Nozzle			7	10	
R	1004, 1007	Fuel Nozzle Air Swirl Guide			250	275	

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
R	369	1001	For Front Tierod Hydraulic Loading Procedure, See Assembly of Subassemblies					
R	370	1004	For Front Tierod Hydraulic Loading Procedure, See Assembly of Subassemblies					
	371	1007	Compressor Rotor Tierod Extension Procedures for Manual Tightening of Nuts on Tierods. 1. Tighten all tierod nuts simultaneously in pairs 180° apart by increments of 25 - 75 lb-in. Then further to a torque of 85 lb-in. in sequence shown in schematic view. 2. Loosen nuts simultaneously in pairs 180° apart to 0 lb. and retighten to 8 lb-in. torque. Then further tighten to required minimum stretch. Loosening and retightening to be done simultaneously in pairs 180° apart in sequence shown in schematic view. 3. Repeat this process until all tierods have been stretched to minimum tierod extension. 4. Secure all nuts by bending tablocks but do not reposition nuts during this process. Tierod extension is measured from threaded end of tierod to rear face of front flange of bearing sleeve or (optional) to shoulder on hub provided to retain the bearing sleeve. 5. Tierod must be held from turning at same end at which stretch is being set.			.025	.025	
	372	1007	Compressor Rotor Front Tierod Extension Procedure for Tightening Rear Nut on Front Tierod. 1. Tierods must be held from turning at all times. 2. Required tierod stretch is measured from rear face of tierod to rear inner face of front hub. 3. With front nuts set, tighten rear nuts simultaneously in pairs 180° apart by increments of 25 - 75 lb-in. in sequence shown in schematic view. 4. Loosen nuts simultaneously in pairs 180° apart to 0 lb. and retighten to 8 lb-in. torque. Then further tighten to required minimum stretch. Loosening and retightening to be done simultaneously in pairs 180° apart in sequence shown in schematic view. Secure nuts by bending tablocks but do not reposition nuts during this process.			.008	.008	

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
375	1007	Compressor Rotor Rear Tierod-- Tightening procedure when hydraulic loading method is used: 1. Starting with initial tight rotor stack with 50 - 85 lb-in. torque on tierod nut, assemble hydraulic load fixture on tierods. Turn ram thimbles down on tierod threads until secured. 2. Apply hydraulic pressure, loading tierods to break away load of 2250 ± 20 lbs. (or equivalent on pressure gage). Back tierod nuts off so at baseline load of 146 lbs. nuts do not contact stack. 3. Reduce hydraulic pressure to baseline load of 146 ± 10 lbs. (or equivalent on pressure gage). Adjust dial indicators so as to allow 0.040 inch min. free travel. Ensure that nuts are free of stack. Set dial indicators to zero. 4. Increase hydraulic pressure to load tierods to check load of 2000 ± 20 lbs. (or equivalent on pressure gage). Observe proper functioning of hydraulic fixture and dial indicators. 5. Increase hydraulic pressure to load tierods to initial load of 2985 ± 20 lbs. (or equivalent on pressure gage) observing dial indicator readings. All indicators must agree within specified tolerance range of 0.003 inch. 6. If dial indicator difference exceeds 0.003 inch check should be made for malfunction of hydraulic fixture or tierod material defect. Make necessary corrections and repeat loading procedure. 7. Release hydraulic pressure to baseline of 146 ± 10 lbs. Reset dial indicators to zero. 8. Increase hydraulic pressure to load tierods to final load of 2695 ± 10 lbs. (or equivalent on pressure gage), ensuring all dial indicators read within specified tolerance range of 0.003 inch. If dial indicator difference exceeds 0.003 inch, make necessary corrections and repeat loading procedure steps 7 and 8. 9. Tighten tierod nuts to 15 - 18 lb-in. torque in sequence shown in diagram of tierods. Further tighten tierod nuts to 24 - 26 lb-in. torque in sequence shown in diagram of tierods. Hydraulic pressure will decrease slightly while nuts are being torqued, but do not reset. 10. After all nuts have been tightened, recheck dial indicator to ensure all indicators read within					

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
		specified tolerance range of 0.004 inch. 11. Decrease hydraulic pressure to baseline load of 146 ± 10 lbs. (or equivalent on pressure gage), ensuring all indicators read within specified tolerance range of 0.004 inch. NOTE: Very low dial indicator reading indicates untorqued nut at pressure release, and loading of all tierods must be repeated. 12. Reduce hydraulic pressure to zero, and remove fixture. 13. Secure all nuts by bending tablocks, but do not reposition nuts during process.					
376	1007	Gearbox Drive Bearing Nozzle			7	10	
378	1007	For Front Tierod Hydraulic Loading Procedure, Refer to Assembly of Subassemblies.					
381	1001, 1004, 1007	Tierod (Pre-SB 2564)	.242	.243			
		Compressor Rotor Disk Spacers	.249	.251	.006	.009	
		Tierod (Post-SB 2564)	.246	.247			
		Compressor Rotor Disk Spacers	.249	.251	.002	.005	
382	1001, 1004, 1007	Tierod (Pre-SB 2564)	.242	.243			
		Compressor Rotor Disk and Front Hub	.249	.252	.006	.010	
		Tierod (Post-SB 2564)	.246	.247			
		Compressor Rotor Disk Spacers	.249	.252	.002	.006	
383	1001, 1004, 1007	Tierod (Pre-SB 2451)	.242	.243			
		Compressor Rotor Disk Spacers	.249	.251	.006	.009	
		Tierod (Post-SB 2451)	.246	.247			
		Compressor Rotor Disk Spacers	.249	.251	.002	.005	

R
R

Accessory Section Limits
Table 1101 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
384	1001,	Tierod (Pre-SB 2451)	.242	.243			
	1004,	Compressor Rotor Seal-					
	1007	4th Stage	.249	.251	.006	.009	
		Tierod (Post-SB 2451)	.246	.247			
		Compressor Rotor Seal-					
		4th Stage	.249	.251	.002	.005	
385	1001,	Tierod (Pre-SB 2451)	.242	.243			
	1004,	Compressor Rotor Rear					
	1007	Hub	.250	.252	.007	.010	
		Tierod (Post-SB 2451)	.246	.247			
		Compressor Rotor Rear					
		Hub	.250	.252	.003	.006	
386	1001,	Tierod (Pre-SB 2451)	.242	.243			
	1004,	Compressor Rotor Disk	.249	.252	.006	.010	
	1007						
		Tierod (Post-SB 2451)	.246	.247			
		Compressor Rotor Disk	.249	.252	.002	.006	
1000	1001	4th Stage					
		Outer Shroud	16.7476	16.7520			
		Stator Spacer	16.747	16.749	.0050T	.0014	.002
1001	1001	4th Stage Vane					
		and Shroud Support	17.1646	17.1690			
		4th Stage Outer					
		Shroud Support					
		Ring	17.168	17.172	.0010T	.0074	.010
1002	1001	Axial Clearance					
		4th Stage Vane					
		and Shroud					
		4th Stage Outer					
		Shroud Support					
		Ring			.0006T	.0110T	.000
1003	1001	Side Clearance					
		Compressor 5th Stage					
		Outer Shroud Lug	.4876	.4920			
		6th Stage Outer					
		Shroud Slot	.4970	.5014	.0050	.0138	.017

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
R	1004	1001	Compressor Stator					
R			7th Stage Vane and					
R			Shroud	16.3136	16.3182			
R			6th Stage Vane and					
R			Shroud	16.3120	16.3164	.0062T	.0028	.004
R	1005	1001	Compressor Stator					
R			9th Stage Outer					
R			Shroud	16.3396	16.3442			
R			8th Stage Outer					
R			Shroud	16.3378	16.3424	.0064T	.0028	.006
R	1006	1001	Compressor Stator					
R			9th Stage Air					
R			Sealing Ring	12.9884	12.9910			
R			Diffuser Inner					
R			Case Front Flange	12.991	12.994	.0000	.0056	.006
	1007	1001	Diffuser Inner Case					
			Front Flange	13.916	13.922			
			Compressor 9th Stage					
			Inner Shroud	13.9228	13.9274	.0008	.0014	.012
	1008	1001	Compressor 9th Stage					
			Outer Shroud	16.7596	16.7642			
			Diffuser Outer Case					
			Front Flange	16.758	16.762	.0062T	.0024	.003
	1009	1001	Compressor 6th Stage					
			Vane and Shroud	16.3696	16.3740			
			5th Stage Vane					
			and Shroud	16.3680	16.3724	.0060T	.0028	.004
	1010	1001	Compressor 8th Stage					
			Vane and Shroud	16.2976	16.3022			
			7th Stage Vane					
			and Shroud	16.2958	16.3004	.0064T	.0028	.004
	1011	1001	Compressor 5th Stage					
			Shroud	16.5336	16.5380			
			4th Stage Shroud	16.5320	16.5364	.0060T	.0028	.004

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1012	1001	Side Clearance					
		Compressor 6th Stage Outer Shroud Lug	.4896	.4940			
		7th Stage Outer Shroud Slot	.4970	.5014	.0030	.0118	.020
1013	1001	Side Clearance					
		Compressor 4th Stage Outer Shroud Lug	.4896	.4940			
		5th Stage Outer Shroud Slot	.4970	.5014	.0030	.0118	.020
1014	1001	Side Clearance					
		Compressor 7th Stage Outer Shroud Lug	.4890	.4930			
		8th Stage Outer Shroud Slot	.4968	.5014	.0038	.0124	.020
1015	1001	Side Clearance					
	@	6th Stage Vane and Shroud Lug	.4890	.4930			
		Diffuser Case Support Ring Slot	.4980	.5040	.0050	.0150	.020
1016	1001	Side Clearance					
		1st Stage Turbine Airseal Lug	.1860	.1880			
		Turbine Case Slot	.1970	.2030	.0090	.0170	.027
5016	1001	Side Clearance [JT12A-8 (LD) Only]					
		6th State Vane and Shroud Lug	.4896	.4940			
		Diffuser Case Support Ring Slot	.503	.509	.0090	.0194	
5017	1001	Radial Clearance					
		2nd Stage Turbine Blade Outer Airseal (Rear)			.032	.047	

@ Lug dimensions after plate

Accessory Section Limits
Table 1101 (Continued)

R
R

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	LIMITS MIN	LIMITS MAX	REPLACE IF UNDER
401	1001, 1004, 1007	Turbine Shaft Lock Spring at 1.250 inches	9.125	10.875	8.625
402	1001, 1004, 1007	Compressor Rear Bearing Seal Spring at 0.575 inch	1.625	1.750	1.563
403	1001, 1004, 1007	Turbine Bearing Seal Spring at 0.600 inch	1.5625	1.6875	1.500
405	1001, 1004	Compressor Bleed Valve Linkage Spring at 1.539 inches	227.687	236.312	223.375
407	1001, 1004	Spring-Helical, Compressor at 0.880 inch	33.687	36.687	
		Spring-Helical, Compressor at 1.080 inches	24.000	26.000	

Compressor And Turbine Section
Spring Pressures (All Models)
Table 1002

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
501	1002, 1005, 1009	Hydraulic Pump Drive Front Oil Seal	1.251	1.253			
		Housing	1.247	1.249	.002T	.006T	.002T
502	1002, 1005, 1009	Hydraulic Pump Drive Gearshaft Front Bearing	1.8502	1.8504			
		Liner	1.8504	1.8510	.0000	.0008	.001
		Liner (Free Turbine Engines)	1.8505	1.8511	.0001	.0009	.0010
503	1002, 1005, 1009	Hydraulic Pump Drive Gearshaft	1.1813	1.1817			
		Front Bearing	1.1809	1.1811	.0002T	.0008T	*

R
R

Accessory Section (All Models)
Table 1003

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
504	1002,	Hydraulic Pump Drive					
	1005,	Gearshaft Rear					
	1009	Bearing	2.1651	2.1654			
		Liner	2.1649	2.1656	.0005T	.0005	.0007
505	1002,	Hydraulic Pump Drive					
	1005,	Gearshaft	1.1813	1.1817			
	1009	Rear Bearing	1.1809	1.1811	.0002T	.0008T	*
506	1002,	Hydraulic Pump Drive					
	1005,	Rear Oil Seal	1.501	1.505			
	1009	Pad	1.498	1.500	.001T	.007T	.001T
508	1002,	Fuel Control Drive					
	1005,	Oil Seal	1.501	1.505			
	1009	Boss	1.498	1.500	.001T	.007T	.001T
509	1002,	Fuel Control Drive					
	1005,	Gearshaft Front					
	1009	Bearing	2.0469	2.0472			
		Bushing	2.0470	2.0475	.0002T	.0006	.0008
510	1002,	Fuel Control Drive					
	1005,	Gearshaft	.9845	.9849			
	1009	Front Bearing	.9841	.9843	.0002T	.0008T	*
511	1002,	Fuel Control Drive					
	1005,	Gearshaft Rear					
	1009	Bearing	1.8502	1.8504			
		Bushing	1.8502	1.8508	.0002T	.0006	.0008
512	1002,	Fuel Control Drive					
	1005,	Gearshaft	.7876	.7880			
	1009	Rear Bearing	.7872	.7874	.0002T	.0008T	*
513	1002,	Component Drive Gear-					
	1005,	box Main Gearshaft					
	1009	Front Bearing	1.8502	1.8504			
		Bushing	1.8502	1.8508	.0002T	.0006	.0008
514	1002,	Component Drive					
	1005,	Gearbox Main					
	1009	Gearshaft	.6695	.6699			
		Front Bearing	.6691	.6693	.0002T	.0008T	*

R
R

Accessory Section (All Models)
Table 1003 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
515	1002,	Component Drive					
	1005,	Gearbox Main					
	1009	Gearshaft Splines	.0486	.0496			
		Fuel Control					
		Drivegear Splines	.0491	.0501	.0005T	.0015	.0035
516	1002,	Component Drive					
	1005,	Gearbox Main					
	1009	Gearshaft Splines	.0486	.0496			
		Gear Splines	.0491	.0501	.0005T	.0015	.0035
517	1002,	Component Drive					
	1005,	Gearbox Main					
	1009	Gear Bearings	2.4406	2.4409			
		Bushing	2.4410	2.4415	.0001	.0009	.0011
518	1002,	Component Drive					
	1005,	Gearbox Gear	.9845	.9849			
	1009	Bearing	.9841	.9843	.0002T	.0008T	*
519	1002,	Starter-Generator					
	1005,	Drive Oil Seal					
	1009	(Rubber)	1.501	1.505			
		Support	1.498	1.500	.001T	.007T	.001T
		Starter-Generator					
		Drive Oil Seal					
		(Carbon)	1.626	1.628			
		Support	1.621	1.622	.004T	.007T	.001T
520	1002	Starter-Generator					
	1005	Drive Gearshaft					
	1009	Outer Bearing	2.1651	2.1654			
		Bushing	2.1655	2.1660	.0001	.0009	.0011
521	1002,	Starter-Generator					
	1005,	Drive Gearshaft	1.3782	1.3786			
	1009	Outer Bearing	1.3778	1.3780	.0002T	.0008T	*
522	1002,	Starter-Generator					
	1005,	Driveshaft	1.028	1.029			
	1009	Gearshaft	1.0295	1.0305	.0005	.0025	.0030
523	1002,	Starter-Generator					
	1005,	Driveshaft Splines	.0466	.0476			
	1009,	Gearshaft Splines	.0491	.0501	.0015	.0035	.0055

R
R

Accessory Section (All Models)
Table 1003 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
524	1002,	Starter-Generator					
	1005,	Drive Gearshaft					
	1009	Inner Bearing	2.1651	2.1654			
		Liner	2.1649	2.1656	.0005T	.0005	.0007
525	1002,	Starter-Generator					
	1005,	Drive Gearshaft	1.1813	1.1817			
	1009	Inner Bearing	1.1809	1.1811	.0002T	.0008T	*
526	1002,	Main Oil Pump					
	1005,	Drive Gearshaft					
	1009	Splines	.0485	.0495			
		Starter-Generator					
		Driveshaft Splines	.0490	.0500	.0005T	.0015	.0035
527	1002	Main Oil Pump					
	1005	Drive Gearshaft	.580	.581			
	1009	Starter-Generator					
		Drive Gearshaft	.578	.579	.001T	.003T	*
528	1002,	Main Oil Pump Bodies	3.398	3.399			
	1005	Component Drives					
		Gearbox housing	3.3995	3.4005	.0005	.0025	.0035

R **NOTE**: For de-icing shutoff valve
R spline limits formerly
R with Ref. No. 528, refer
R to 73-00-00, Fuel.

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
529	1002,	Main Oil Pump Drive					
	1005,	Gearshaft	.5605	.5610			
	1009	Inner Cover	.562	.563	.001	.0025	.0035
530	1002,	Main Oil Pump Drive					
	1005	Gearshaft	.5605	.5610			
		Pressure Gear	.5615	.5635	.0005	.003	.004
	1009	Pressure Gear (Free					
		Turbine Engines)	.5615	.5625	.0005	.002	.003
531	1002,	Main Oil Pump Gears	.6855	.6860			
	1005,	Bodies, Covers and					
	1009	Supports	.687	.688	.001	.0025	.0035
532	1002,	Main Oil Pump Drive					
	1005,	Gearshaft spline	.0465	.0475			
	1009	Gear Spline	.0490	.0505	.0015	.004	.006

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
533	1002	Main Oil Pump Gears	1.499	1.501			
	1005	Bodies, Covers and					
	1009	Supports	1.504	1.506	.003	.007	.008
534	1002,	Main Oil Pump Drive					
	1005	Gear Shaft	.4090	.4095			
		Drivegear	.410	.411	.0005	.002	.003

R NOTE: For de-icing shutoff valve
R spline limits formerly
R with Ref. No. 534, refer
R to 73-00-00, Fuel.

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
535	1002,	Main Oil Pump Gear	.6865	.6875			
	1005,	Gear	.6855	.6860	.0005	.002	.003
	1009						
536	1002,	Main Oil Pump Idler					
	1005,	Shaft	.6038	.6043			
	1009	Inner Cover	.6018	.6028	.001T	.0025T	*
538	1002,	Main Oil Pump Idler					
	1005,	Shaft	.6015	.6020			
	1009	Body Plate	.6025	.6035	.0005	.002	.003
539	1002,	Main Oil Pump Pressure					
	1005,	Gear	.6855	.6860			
	1009	Body Plate	.689	.690	.003	.0045	.0055
540	1002,	Main Oil Pump Idler					
	1005,	Shaft	.6015	.6020			
	1009	Bodies and Outer					
		Cover (All Stages)	.6025	.6035	.0005	.002	.003
541	1002,	Main Oil Pump Idler					
	1005,	Gears	.6030	.6040			
	1009	Straight Shaft	.6015	.6020	.001	.0025	.0035
542	1002,	End Clearance					
	1005	Main Oil Pump Idler					
		Gear	.3745	.375			
		Outer Bodies	.378	.380	.003	.0055	.0060
	1009	Main Oil Pump					
		No. 1 and 2	.503	.505			
		Gear-End Clearance	.4995	.5000	.003	.0055	.0055

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
543	1002,	End Clearance					
	1005	Main Oil Pump Idler					
		Gear	.3115	.312			
		Inner Body	.315	.317	.003	.0055	.0060
544	1002,	Component Drive Gearbox					
	1005,	Main Gearshaft Upper					
	1009	Bearing	1.8502	1.8504			
		Support	1.8505	1.8511	.0001	.0009	.0011
545	1002,	Component Drive Gearbox					
	1005,	Main Gearshaft	.7876	.7880			
	1009	Upper Bearing	.7872	.7874	.0002T	.0008T	*
546	1002,	Component Drive Gearbox					
	1005,	Main Gearshaft Lower					
	1009	Bearing	1.6533	1.6535			
		Liner	1.6527	1.6533	.0000	.0008T	.0002
		Housing (PN 566467					
		and PN 585642)	1.6536	1.6542	.0001	.0009	
547	1002,	Component Drive Gearbox					
	1005,	Main Gearshaft	.7876	.7880			
R	1009	Lower Bearing	.7872	.7874	.0002T	.0008T	*
548	1002,	Starter-Generator					
	1005,	Drive Bearing Bushing	2.351	2.352			
	1009	Support	2.345	2.346	.005T	.007T	.0044T
549	1005,	Tachometer Drive					
	1009	Bearing Support	2.029	2.030			
		Component Drive					
		Gearbox Housing	2.030	2.031	.000	.002	.0025
550	1005,	Tachometer Drive					
	1009	Bearing	.9447	.9449			
		Support	.9450	.9456	.0001	.0009	.0011
551	1005,	Tachometer Drive					
	1009	Gearshaft	.4723	.4727			
		Inner Bearing	.4722	.4724	.0005T	.0001	.0001
552	1005,	Tachometer Drive					
	1009	Gearshaft	.4723	.4727			
		Spacer (Inner End)	.474	.480	.0013	.0077	.0107

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
553	1005	Tachometer Drive Gear-shaft End Clearance			.0101	.0281	.0281
	1009	Tachometer Drive Gear-shaft End Clearance			.0061	.0281	.0281
554	1005, 1009	Tachometer Drive Oil Seal	1.126	1.130			
		Housing	1.123	1.125	.001T	.007T	.010T
555	1005, 1009,	Tachometer Drive Gearshaft	.4716	.4720			
		Outer Bearing	.4722	.4724	.0002	.0008	.0010
556	1005, 1009	Tachometer Drive Gearshaft	.4716	.4720			
		Spacer (Outer End)	.474	.480	.002	.0084	.0114
557	1002, 1005	End Clearance Main Oil Pump Idler Gear	.4995	.500			
		Inner Cover	.503	.505	.003	.0055	.0060
	1009,	Housing Oil Pump No. 1 and 2	3.058	3.059			
		Cover	3.0595	3.0605	.0005	.0025	.0035
558	1002, 1005, 1009	End Clearance Main Oil Pump Drivegear	.4993	.500			
		Inner Cover	.503	.505	.003	.0057	.0062
		Housing Oil Pump No. 3, 4, and 5 and Outer Cover	3.398	3.399			
		Housing	3.3995	3.4005	.0005	.0025	.0035
559	1002, 1005	End Clearance Main Oil Pump Drivegear	.3113	.312			
		Inner Body	.315	.317	.003	.0057	.0062
	1009	Housing Oil Pump	3.338	3.339			
		No. 5 Housing	3.3395	3.4005	.0005	.0025	.0035

R
R

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	560	1002,	End Clearance					
		1005,	Main Oil Pump Gears	.3743	.375			
		1009	Outer Bodies	.378	.380	.003	.0057	.0062
			Cover Oil Pump Inner	3.338	3.339			
			Housing	3.3395	3.3405	.0005	.0025	.0035
	561	1009	Cover Oil Pump Inner	3.278	3.279			
			Housing	3.2795	3.2805	.0005	.0025	.0035
	562	1009	Main Oil Pump,					
			No. 3 and 4	.378	.380			
			Gear-End Clearance	.3745	.3750	.003	.0055	.0055
	563	1009	Main Oil Pump No. 5	.315	.317			
			Gear-End Clearance	.3115	.3120	.003	.0055	.0055
	564	1009	Main Oil Pump Cover,					
			Inner	.943	.945			
			Gear-End Clearance	.9395	.940	.003	.0055	.0055
	565	1002,	Bearing Support	1.833	1.834			
		1005	Bushing (PN 432542)	1.839	1.840	.005T	.007T	.0045T
		1009	Bearing Support	1.8555	1.8565			
			Housing (PN 566467					
			or PN 585642)	1.8555	1.8565	.001T	.001	
	566	1002,	Relief Valve					
		1005,	Cylinders	.537	.538			
		1009	Valve Housing	.540	.541	.002	.004	.0045
	568	1002,	Hydraulic Pump Drive					
		1005,	Bearing					
		1009	Bushing	2.351	2.352			
			Support	2.345	2.346	.005T	.007T	.0044T
	569	1002,	Hydraulic Pump Drive					
		1005,	Bearing					
		1009	Bushing	2.036	2.037			
			Housing	2.030	2.031	.005T	.007T	.0044T
R	570		Fuel Pressurizing and					
R			Dump Valve Limits -					
R			Refer to 73-00-00,					
R			Fuel					

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	571	1002,	Hydraulic Pump Pad					
		1005,	Front					
		1009	Seal Housing Liner	1.348	1.349			
			Housing	1.342	1.343	.005T	.007T	.0046T
	572	1002,	Main Gearshaft Front					
		1005,	Bearing					
		1009	Liner	2.036	2.037			
			Housing	2.030	2.031	.005T	.007T	.0044T
R	573,		Fuel Pressurizing and					
R	574		Dump Valve Limits -					
R			Refer to 73-00-00,					
R			Fuel					
	575	1002,	Fuel Control Drive					
		1005,	Bearing					
		1009	Bushing	2.2345	2.235			
			Boss	2.2285	2.280	.005T	.007	.0043
R	576 -		Fuel Pressurizing and					
R	578		Dump Valve Limits -					
R			Refer to 73-00-00,					
R			Fuel					
	579	1002,	Main Gearshaft Bearing					
		1005,	Rear					
		1009	Liner	2.629	2.630			
			Gearbox Cover	2.623	2.624	.005T	.007T	.0043T
R	580		Fuel Pressurizing and					
R			Dump Valve Limits -					
R			Refer to 73-00-00,					
R			Fuel					
	581	1002,	Gearbox Mounting					
		1005,	Lug Bushing	.5015	.5030			
		1009	Housing	.499	.500	.0015	.004T	.0012T
	582	1002,	Fuel Control Drive					
		1005,	Bearing					
		1009	Bushing	2.036	2.037			
			Gearbox Housing	2.030	2.031	.005T	.007T	.0044T

Accessory Section (All Models)
Table 1003 (Continued)

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	583	1002,	Starter-Generator					
		1005	Drive Bearing Liner	2.289	2.290			
			Gearbox Housing	2.283	2.284	.005T	.007T	.0044T
		1009	Starter and Generator					
			Drive Bearing Liner	2.351	2.352			
			Housing	2.345	2.346	.005T	.007T	.0044T
R	584 -		Fuel Deicing Air					
R	596		Shutoff Valve Limits -					
R			Refer to 73-00-00,					
R			Fuel.					
R		NOTE:	For anti-icing air					
R			valve limits formerly					
R			with Ref. No. 584, refer					
R			to 75-00-00, Air,					
R			Ref. 156.					
	597	1009	Fuel Anti-Icing					
			Heater Sleeve					
			Spacer	.249	.251			
			Housing Lug	.252	.256	.001	.007	.0085
R		NOTE:	For fuel heater bypass					
R			valve limits formerly					
R			with Ref. No. 597, refer					
R			to 73-00-00, Fuel,					
R			Ref. 596.					
	598	1002	Sleeve Spacer	.249	.251			
			Fuel Heater Mounting					
			Lugs	.252	.256	.018	.030	.033
		1009	Fuel Anti-Icing					
			Heater Sleeve					
			Spacer	.192	.194			
			Bolt	.164	.174	.018	.030	.033

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
599	1002, 1005	Main Oil Pump Housing and Cover	3.3380	3.3390			
		Component Drive Gearbox Housing	3.3395	3.3405	.0005	.0025	.0035
	1009	Fuel Anti-Icing Heater Support					
		Expansion Joint Sleeve	.365	.367			
		Rod	.359	.363	.002	.008	.0095
600	1002	Main Oil Pump Cover	3.278	3.279			
		Component Drive Gearbox Housing	3.2795	3.2805	.0005	.0025	.0035
	1005	Sleeve Spacer	.279	.281			
		Fuel Heater Mounting Lugs	.282	.286	.001	.007	.0085
	1009	Fuel Anti-Icing Heater Sleeve					
		Spacer	.279	.281			
		Housing Lug	.282	.286	.001	.007	.0085
601	1002	Tachometer Drive Housing	.6025	.6035			
		Main Oil Pump Straight Shaft	.6015	.6020	.0005	.002	.0025
	1005	Main Oil Pump Cover Component					
		Drive Gearbox	3.2780	3.2790			
		Housing	3.2795	3.2805	.0005	.0025	.0035
	1009	Fuel Anti-Icing Heater Sleeve					
		Spacer	.192	.194			
		Bolt	.164	.174	.018	.030	.033
602	1002	Tachometer Drive Housing	1.125	1.126			
		Main Oil Pump GearShaft Support	1.1235	1.1245	.0005	.0025	.0035

R
R

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
603	1002	Splines					
		Main Oil Pump Gear	.0485	.0495			
		Tachometer Drive Shaftgear	.0490	.0500	.0005T	.0015	.0035
604	1002	Seal	1.126	1.130			
		Tachometer Drive Bearing Housing	1.123	1.125	.001T	.007T	.001T
605	1002	Tachometer Drive Housing	1.250	1.251			
		Tachometer Drive Bearing Housing	1.2485	1.2495	.0005	.0025	.003
606	1002	Tachometer Drive Bevel Gearshaft	.4723	.4727			
		Tachometer Drive Bearing Spacer	.475	.477	.0023	.0047	.0053
607	1002	Tachometer Drive Bearing Housing	.9450	.9456			
		Bearing	.9447	.9449	.0001	.0009	.0011
608	1002	Tachometer Drive Shaftgear	.4723	.4727			
R		Bearing	.4722	.4724	.0001	.0005T	*
609	1002	Tachometer Drive Housing	1.639	1.641			
		Tachometer Drive Bearing Housing	1.635	1.637	.002	.006	.008
	1009	Accessory and Component Drives					
		Gearbox Housing	4.375	4.376			
		Hydraulic Pump Drive Bearing Support	4.374	4.375	.000	.002	.003

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
610	1002	Main Oil Pump Shaft	.6015	.6020			
		Main Oil Pump Support	.6060	.6085	.004	.007	.008
	1009	Accessory and Component Drives Gearbox Housing	6.599	6.600			
		Component Drive Gearbox Housing Cover Assembly	6.598	6.599	.000	.002	.003
611	1005, 1009	Accessory and Component Drives Gearbox Housing	4.375	4.376			
		Hydraulic Pump Drive Bearing Support	4.374	4.375	.000	.002	.003
612	1005	Accessory and Component Drives Gearbox Housing	6.599	6.600			
		Component Drive Gearbox Housing Cover Assembly	6.598	6.599	.000	.002	.003
	1009	Accessory and Component Drives Gearbox Housing	4.375	4.376			
		Starter and Generator Drive Bearing Support	4.374	4.375	.000	.002	.003
613	1005	Accessory and Component Drives Gearbox Housing	4.375	4.376			
		Fuel Control Boss	4.374	4.375	.000	.002	.003
	1009	Accessory and Component Drives Gearbox Housing	2.670	2.671			
		Component Drive Gearbox Main Bearing Support	2.669	2.670	.000	.002	.003

R
R

Accessory Section (All Models)
Table 1003 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
614	1005	Accessory and Component Drives Gearbox Housing	4.375	4.376			
		Starter-Generator Drive Bearing Support	4.374	4.375	.000	.002	.003
	1009	Accessory and Component Drives Gearbox Housing	3.3995	3.4005			
		Main Oil Pump Left Cover	3.398	3.399	.0005	.0025	.0035
615	1005	Accessory and Component Drives Gearbox Housing	2.670	2.671			
		Component Drive Gearbox Main Bearing Support	2.669	2.670	.000	.002	.003
	1009	Gearbox Drive Bearing Upper Housing	2.3196	2.3204			
		Gearbox Drive Bearing Lower Housing	2.3196	2.3204	.0008	.0008T	
616	1005	Gearbox Drive Bearing Upper Housing	2.3196	2.3204			
		Gearbox Drive Bearing Lower Housing	2.3196	2.3204	.0008	.0008T	
801	1002, 1005, 1009	Backlash All Stages Main Oil Pump Spur Gearshaft - Main Oil Pump Spur Idler Gear			.0045	.0195	
802	1002, 1005, 1009	Backlash Fuel Control Drive Spur Gearshaft - Hydraulic Pump Drive Spur Gearshaft			.004	.020	

R
R

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
803	1002, 1005,	Backlash Fuel Control Drive Spur Gear - Fuel Control Drive Spur Gearshaft			.004	.020	
804	1002, 1005	Backlash Starter-Generator Drive Spur Gearshaft - Main Component Drive Gearbox Gearshaft			.004	.020	
805	1005, 1009	Backlash Tachometer Drive Bevel Gearshaft - Main Component Drive Gearbox Gearshaft			.007	.025	
806	1002, 1005, 1009	Backlash Main Component Drive Gearbox Gear - Main Component Drive Gearbox Gearshaft			.007		
807	1002	Backlash Tachometer Drive Bevel Gearshaft - Tachometer Drive Bevel Gear			.011	.037	
	1004, 1009	Mounting Distance Component Drive Gearbox Gear			2.1110	2.1290	
808	1002	Gearbox Drive Bearing Upper Housing	2.3196	2.3204			
		Gearbox Drive Bearing Lower Housing	2.3196	2.3204	.0008	.0008T	
	1009	Mounting Distance Component Drive Gearshaft			4.152	2.168	

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
809	1002	Backlash Main Oil Pump Drive Gearshaft Gearshaft			.009	.031	
811	1002	Accessory and Component Drives Gearbox Housing	4.375	4.376			
		Hydraulic Pump Drive Bearing Support	4.374	4.375	.000	.002	.003
812	1002	Accessory and Component Drives Gearbox Housing	6.599	6.600			
		Component Drive Gearbox Housing Cover Assembly	6.598	6.599	.000	.002	.003
813	1002	Accessory and Component Drives Gearbox Housing (R)	4.375	4.376			
		Fuel Control Boss	4.374	4.375	.000	.002	.003
814	1002	Accessory and Component Drives Gearbox Housing	4.375	4.375			
		Starter-Generator Drive Bearing Support	4.374	4.375	.000	.002	.003
815	1002	Accessory and Component Drives Gearbox Housing	2.670	2.671			
		Component Drive Gearbox Main Bearing Support	2.669	2.670	.000	.002	.003
818	1005, 1009	Backlash Main Oil Pump Drive Gearshaft - Gearshaft			.009	.031	
819	1009	Main Oil Pump Cover, Inner	.943	.945			
		Gear-End Clearance	.9393	.940	.003	.0057	.0062

Accessory Section (All Models)
Table 1003 (Continued)

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	820	1009	Main Oil Pump No. 5	.315	.317			
R			Gear-End Clearance	.3113	.312	.003	.0057	.0062
	821	1009	Main Oil Pump No. 3 and 4	.378	.380			
R			Gear-End Clearance	.3743	.375	.033	.0057	.0062
	822	1009	Main Oil Pump No. 1 and 2	.503	.505			
			Gear-End Clearance	.4993	.500	.003	.0057	.0062

Accessory Section (All Models)
Table 1003 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
828	1002, 1005, 1009	Component Drive Gearbox Housing Bushing			275	300	
829	1002, 1005, 1009	Component Drive Gearbox Housing Plug			120	130	
830	1002, 1005, 1090	Component Drive Gearbox Main Gearshaft Nut (Tighten to specified limits, loosen to zero torque, then tighten to specified limits)			250		
831	1002, 1005, 1009	Component Drive Gearbox Main Gearshaft Nut (Tighten to specified limits, loosen to zero torque, then tighten to specified limits)			500		
833	1002, 1005, 1009	Oil Pressure Transmitter Connector Insert			700	750	

Accessory Section Torque Limits
(All Models)
Table 1004

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
834	1002, 1005, 1009	Oil Filter Cover Retaining Nuts (Locknuts Only)			55	60	

Accessory Section Torque Limits
(All Models)
Table 1004 (Continued)

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF UNDER
	862	1002, 1005	Compensating Relief Valve Spring Pressure at 1.600 Inches			6.0625	7.0625	5.750
	864	1002, 1005, 1009	Main Oil Strainer Bypass Valve Spring Pressure at 1.470 Inches			13.375	14.625	12.750
	865	1002, 1005, 1009	Main Oil Strainer Support Spring Pressure at 0.650 Inch			40.875	45.125	38.750
R	870		For fuel deicing air valve limits, refer to 73-00-00, Fuel, Ref. 871.					
R			NOTE: For spring limits formerly found in Ref. 870, refer to 73-00-00, Fuel, Ref. 406.					
R	871		For fuel deicing air valve limits, refer to 73-00-00, Fuel.					
	872	1009	Helical Compression Spring					
			Pressure at 1.620 Inches			15.625	16.125	14.875
			Pressure at 1.420 inches			20.375	21.375	19.312

Accessory Section Spring Pressures
(All Models)
Table 1005

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
876	1002,	Component Drive					
	1005	Gearbox Gear			2.110	2.1290	
880	1002,	Component Drive					
	1005	Gearshaft			4.152	4.168	

Accessory Section Mounting Distances
Table 1006

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1001	1010	Housing - Compressor					
		Bleed Valve Linkage					
		Spring	.998	1.002			
		Seat - Spring	.990	.994	.004	.012	.012
1002	1010	Adjuster - Intern-					
		ally Threaded	.598	.602			
		Housing - Compressor					
		Bleed Valve Linkage					
		Spring	.606	.610	.004	.012	
1003	1010	Case - Free Turbine					
		Inlet, Assembly of					
		Nut - Plane D			.050		
		After Tightening					
		14 Places			Gap		
1004	1010	Fuel Control Flexible					
		Shaft Flange	.8661	.8667			
		Bearing	.8659	.8661	.0000	.0008	
1005	1010	Flexible Shaft Fuel					
		Control Core	.3152	.3156			
		Bearing	.3148	.3150	.0002T	.0008T	
1006	1010	Flexible Shaft Fuel					
		Control Core	.409	.411			
		Bearing	.412	.414	.001	.005	
1007	1010	Flexible Shaft Fuel					
		Control Core	.2475	.2485			
		Gearshaft	.2520	.2560	.0035	.0085	

R
R External Parts Torques and Stretch
Table 1007

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1008	1010	Fuel Control Flexible					
		Shaft Flange	.998	1.000			
		Seal	1.001	1.005	.001T	.007T	
1009	1010	Flexible Shaft Fuel					
		Control Core					
		Rivet Hole					
		Diameter	.138	.144			.156
1020	1006	Fuel Heater Sleeve					
		Spacer	.279	.281			
		Fuel Heater					
		Housing Bushing	.283	.285	.002	.006	
1022	1006	Oil Cooler Mounting					
		Bolt	.284	.286			
		Oil Cooler Bracket					
		(SB 4171)	.288	.290	.002	.006	.016
1030	1003,	Immersion Thermo-					
	1006,	couple Lead Nut					
	1010	(0.164-32 Reference)			8	12	
1031	1003	Immersion Thermo-					
	1006	couple Lead Nut					
	1010	(0.190-32 Reference)			10	15	
1032	1003,	Fuel Heater Valve					
	1010	Actuator Assembly					
		Screw (0.164-32					
		Reference)			12	15	
	1006	Torque to 15 - 19 lb-in.					
		(four places)					
1033	1003,	Torque to 15 - 18 lb-in.					
	1010	(four places)					
	1006	Ignition Exciter					
		Mounting Bolts			50	60	
1034	1003,	Ignition Exciter					
	1010	Mounting Bolts			50	60	

R
R
External Parts Torques and Stretch
Table 1007 (Continued)

EFFECTIVITY -ALL

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1035	1003	Oil Cooler Mounting Bolt	.284	.286			
		Oil Cooler Bracket (SB 4171)	.288	.290	.002	.006	.016
	1005, 101	Nut, Fuel Control Flexible Shaft			.120	.150	
1036	1010	Fuel Heater Sleeve Spacer	.279	.281			
		Fuel Heater Housing Bushing	.283	.285	.002	.006	
1050	1003	Fuel Heater Sleeve Spacer	.279	.281			
		Fuel Heater Housing Bushing	.283	.185	.002	.006	
1051	1003, 1006, 1010	Igniter Plug			300	360	
1052	1003, 1006, 1010,	Oil Tank Mounting Strap Turnbuckle			4	6	
1053	1003, 1006	Oil Cooler Thermostat			900	1080	
	1010	Pressurizing and Dump					
1054	1003, 1006	P and D Valve Mounting Bolts			65	85	
	1010	Solenoid Adjustment Instructions: With solenoid in energized position and ball seated in PN 451274 seat, adjust air gap between solenoid plunger and PN 451272 pin to 0.005 - 0.007 inch.					
		Switch Assembly Instructions: (Refer to adjustment schematic on sheet 1 of clearance chart.)					

R
R

External Parts Torques and Stretch
Table 1007 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
(CONTINUED)							
		(a) Measure depth inside of PN 432424 bellows and add washers PN 432412, 432413, and/or 432414 to provide a gap of 0.007 - 0.010 inch between PN 432420 cap and inside bellows when PN 451275 piston is fully closed.					
		(b) Adjust PN 432418 pin by shortening end nearest the bellows until the switch off point is 0.007 - 0.010 inch from the assembled bellows free length. Check that the bellows mechanical travel with PN 451275 piston fully depressed overrides the switch point by 0.004 inch minimum.					
		(c) Install PN 432421 spacers if and as required, to limit bellows extension to maximum of 0.035 inch from free length end to provide a minimum gap of 0.002 inch beyond the limit of mechanical bellows travel when PN 451275 piston is fully depressed.					
		Solenoid Adjustment Instructions: For PN 693027 Valve Assemblies Only:					
		With solenoid in energized position and ball seated in PN 451274 seat, adjust air gap between solenoid plunger and PN 451272 pin to 0.005 - 0.007 inch.					
		Switch Assembly Instructions: (Refer to adjustment schematic on (Sheet 2) of clearance chart).					
		(a) Measure depth inside of PN 432424 bellows and add washer PN 432412, 432413					

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
(CONTINUED)		and/or PN 432414 to provide a gap of 0.005 - 0.008 inch between PN 432420 cap and inside bellows when PN 693029 piston is fully closed. (b) Adjust PN 432418 pin by shortening end nearest the bellows until the switch off point is 0.003 - 0.006 inch from the assembled bellows free length. Check that the bellows mechanical travel with PN 693029 piston fully depressed overrides the switch point by 0.004 inch minimum. (c) Install PN 432421 spacers if and as required to limit bellows extension to maximum of 0.035 inch from free length end to provide a minimum gap of 0.002 inch beyond the limit of mechanical bellows travel when PN 693029 piston is fully depressed.					
1055	1003, 1006	Pressure Switch Mounting Bolts			30	40	
1056	1003, 1006 1010	Solenoid Adjustment Instructions: With solenoid in energized position and ball seated in PN 451274 seat, adjust air gap between solenoid plunger and PN 451272 pin to 0.005 - 0.007 inch. Switch Assembly Instructions: (Refer to adjustment schematic on sheet 1 of clearance chart). (a) Measure depth inside of					

R
R

External Parts Torques and Stretch
Table 1007 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER

(CONTINUED)

PN 432424 bellows and add washers PN 432412, 432413, and/or 432414 to provide a gap of 0.007 - 0.010 inch between PN 432420 cap and inside of bellows when PN 451275 piston is fully closed.

(b) Adjust PN 432418 pin by shortening end nearest bellows until the switch off point is 0.007 - 0.010 inch from assembled bellows free length. Check that bellows mechanical travel, with PN 451275 piston fully depressed, overrides switch point by 0.004 inch minimum.

(c) Install PN 432421 spacers as required to limit bellows extension to maximum of 0.035 inch from free length and to provide a minimum gap of 0.002 inch beyond the limit of mechanical bellows travel when PN 451275 piston is fully depressed.

Solenoid Adjustment Instructions For PN 693027 Valve Assemblies Only:
With solenoid in energized position and ball seated in PN 451274 seat, adjust air gap between solenoid plunger and PN 451272 pin to 0.005 - 0.007 inch.

Switch Assembly Instructions:
(Refer to adjustment schematic on sheet 2 of clearance chart).

(a) Measure depth inside of PN 432424 bellows and add

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
(CONTINUED)							
		washers PN 432412, 432413, and/or 432414 to provide a gap of 0.005 - 0.008 inch between PN 432420 cap and inside of bellows when PN 693029 piston is fully closed.					
		(b) Adjust PN 432418 pin by shortening end nearest bellows until the switch off point is 0.003 - 0.006 inch from assembled bellows free length. Check that bellows mechanical travel, with PN 693029 piston fully depressed, overrides switch point by 0.004 inch minimum.					
		(c) Install PN 432421 spacers as required to limit bellows extension to maximum of 0.035 inch from free length and to provide a minimum gap of 0.002 inch beyond the limit of mechanical bellows travel when PN 693029 piston is fully depressed.					

External Parts Torques and Stretch
Table 1007 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1057	1003	Oil Tank Cap Spring at 0.375 inch			17.000	24.000	
	1006	Fuel Heater Valve Actuator Assembly Screw (0.164-32)			12	15	

R
R
External Parts Spring Pressures
All Models
Table 1008

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1100	1006	Oil Tank Cap Spring at 0.375 inch			17.000	24.000	
1101	1010	Compressor Bleed Valve Linkage Spring at 1.539 inches			227.687	236.312	223.375
1102	1010	Spring - Helical Compressor					
		at 0.880 inch			33.687	36.687	
		at 1.080 inches			24.000	26.000	
1104	1010	Oil Tank Cap Spring at 0.375 inch			17.000	24.000	

External Parts Spring Pressures
All Models
Table 1008 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1301	1008	Free Turbine Air Inlet Seal	7.732	7.736			
		Sealing Ring (Radial Clearance Based on Size Tolerance)	7.678	7.682	.025	.029	.035
1302	1008	Free Turbine Inlet Duct	8.161	8.163			
		Inlet Seal	8.159	8.161	.000	.004	
1303	1008	Free Turbine Inlet Duct	8.461	8.463			
		1st Stage Airseal	8.459	8.461	.000	.004	.006
1304	1008	Free Turbine Inlet Case	17.845	17.855			
		Airsealing Ring	17.855	17.865	.000	.020	.023
1305	1008	Free Turbine Inlet Case	18.104	18.108			
		Airsealing Ring	18.092	18.096	.008	.016	.020

R
R

Free Turbine Section
(All Free Turbine Models)
Table 1009

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1307	1008	Free Turbine Shaft	.446	.447			
		Tierod	.441	.442	.004	.006	.008
1308	1008	Free Turbine 1st and 2nd Stage Disk	.446	.448			
		Tierod	.441	.442	.004	.007	.009
1309	1008	Free Turbine Case	27.437	27.443			
		Airsealing Ring	27.443	27.449	.000	.012T	.003
1310	1008	Free Turbine 1st Stage Airseal	7.976	7.980			
		Airsealing Ring (Radial Clearance Based on Size Tolerance Only)	7.928	7.932	.022	.026	.040
1311	1008	Free Turbine 1st Stage Disk	5.699	5.701			
		Airsealing Ring	5.697	5.699	.000	.004T	.002
R 1312	1008	Free Turbine 1st Stage Disk	5.199	5.201			
		Free Turbine Shaft	5.197	5.199	.000	.004T	.000
1313	1008	Free Turbine 2nd Stage Disk	5.879	5.881			
		Free Turbine Shaft	5.881	5.883	.000	.004T	.000
1314	1008	Free Turbine 1st Stage Disk	7.898	7.902			
		Airseal (Radial Clearance Based on Size Tolerance Only)	7.948	7.952	.023	.027	.040
1315	1008	Free Turbine Rotor 2nd Stage Seal Flange	8.399	8.401			
		Airseal	8.401	8.403	.000	.004T	.002

Free Turbine Section
(All Free Turbine Models)
Table 1009 (Continued)

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1316	1008	Free Turbine 2nd					
		Stage Disk	7.398	7.402			
		Airseal	7.448	7.452	.023	.027	.040
		(Radial Clearance Based on Size Tolerance Only)					
1317	1008	Side Clearance					
		Turbine Bearing Seal Assembly	.127	.130			
		Seal Ring	.1225	.1240	.003	.0075	.0095
1318	1008	Gap:					
		Seal Ring Gap at 3.749 Inch Gage	.005	.020			
		Free Turbine Front Bearing Seal Support	3.749	3.751	.005	.0269	.031
1319	1008	Height of Step Turbine Bearing Seal	.055	.065			
1320	1008	Free Turbine Shaft	3.1497	3.1502			
		Front Bearing Seal Plate	3.1507	3.1542	.0005	.0045	.0045
1321	1008	Free Turbine Shaft	3.1497	3.1502			
		Bearing	3.1494	3.1496	.0001T	.0008T	.0001T
1322	1008	Free Turbine Case	5.9055	5.9070			
		Bearing	5.9051	5.9055	.000	.0019	.0019
1323	1008	Free Turbine Case	7.499	7.501			
		Front Bearing Seal Support	7.502	7.504	.001	.005	.007
1324	1008	Free Turbine Case	7.499	7.501			
		Accessory Drive Support	7.497	7.499	.000	.004T	.000

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1325	1008	First Stage Free					
		Turbine Blade	24.392	24.408			
		Ring	24.495	24.505	.0435	.0565	.065
		(Radial Clearance Based on Size Tolerance Only)					
1326	1008	Second Stage Free					
		Turbine Blade	26.892	26.908			
		Ring	27.000	27.010	.046	.059	
		(Radial Clearance Based on Size Tolerance Only)					
1327	1008	End Clearance: Free Turbine 1st Stage Vane - Free Turbine Inlet Case			.000	.010	.012
1328	1008	End Clearance:					
		Free Turbine 2nd Stage Vane	.209	.211			
		Free Turbine Inlet Case	.211	.213	.000	.004	.004
1329	1008	Free Turbine					
		Inlet Case	27.297	27.303			
		Ring	27.291	27.297	.000	.012T	.020T
1330	1008	Side Clearance:					
		Free Turbine Inlet Case	.314	.318			
		Ring Segment Lugs	.300	.304	.010	.018	.020
1331	1008	Free Turbine Inlet					
		Case	.0625	.0635			
		Pin	.06125	.06175	.00075	.00225	.00250
1332	1008	Free Turbine First					
		Stage Vane Lock	.069	.071			
		Pin	.06125	.06175	.00725	.00975	.01050

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	1333	1008	Side Clearance					
			Free Turbine					
R			Inlet Case	.314	.318			
R			Inlet Duct Lugs	.300	.304	.010	.018	.020
	1334	1008	Free Turbine Case	9.106	9.108			
			Heat Shield	9.104	9.105	.001	.004	.006
	1335	1008	Free Turbine					
			Shaft Splines	.0977	.0987			
			Accessory Gear					
			Spline	.0982	.0992	.0005T	.0015	.0022
	1336	1008	JFTD12A-4A:					
			Free Turbine					
			Inlet Case	18.138	18.142			
			Inlet Duct	18.123	18.127	.011	.019	.022
			JFTD12A-5A:					
			Free Turbine					
			Inlet Case	18.138	18.148			
			Inlet Duct	18.109	18.119	.019	.039	
	1337	1008	Free Turbine					
			Accessory Drive					
			Shaft Bearing					
			Housing	1.1024	1.1031			
			Bearing	1.1022	1.1024	.000	.0009	.0009
	1338	1008	Free Turbine					
			Accessory Drive					
			Shaft Coupling					
			Spline	.0387	.0397			
			Gear Spline	.0392	.0402	.0005T	.0015	.0022
	1339	1008	Free Turbine					
			Accessory Drive-					
			shaft Coupling					
			Spline	.0391	.0401			
			Accessory Drive-					
			shaft Spline	.0356	.0376	.0015	.0045	.0055

Free Turbine Section
(All Free Turbine Models)
Table 1009 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1340	1008	Free Turbine Accessory Drive-shaft Coupling	.5905	.5909			
		Spacer	.5904	.5906	.0005T	.0001	.0001
1341	1008	Free Turbine Accessory Drive-shaft Coupling	.5905	.5909			
		Spacer	.591	.595	.0001	.0045	.0045
1342	1008	Free Turbine Accessory Drive Housing	1.152	1.158			
		Oil Sump	1.158	1.162	.000	.010	.012
1343	1008	Gearshaft	.4718	.4722			
		Bearing	.4722	.4722	.000	.0006	.0006
1344	1008	Accessory Drive-shaft Splines	.0356	.0376			
		Gearshaft Splines	.0391	.0401	.0015	.0045	.0053
1345	1009	Gearshaft	.4723	.4727			
		Bearing	.4722	.4724	.0005T	.0001	.0001
1346	1008	Free Turbine Accessory Drive Housing	.9443	.9449			
		Bearing	.9447	.9449	.0006T	.0002	.0002
1347	1008	Free Turbine Accessory Drive Housing	.9447	.9453			
		Bearing	.9447	.9449	.0002T	.0006	.0006
1348	1008	Free Turbine Accessory Drive Housing	1.3425	1.3435			
		Boss	1.344	1.345	.0005	.0025	.0030
1349	1008	Free Turbine Accessory Drive Housing	1.750	1.751			
		Bearing Housing	1.7485	1.7495	.0005	.0025	.0030

R
R

ENGINE GENERAL - TABLE OF LIMITS

	REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
	1350	1008	Free Turbine					
			Bearing Housing	1.123	1.125			
			Seal	1.126	1.130	.001T	.007T	.001T
	1351	1008	Free Turbine					
			Gearshaft	.4723	.4727			
			Bearing	.4722	.4724	.0005T	.0001	.0001
	1352	1008	Free Turbine					
			Bearing Housing	.9450	.9456			
			Bearing	.9447	.9449	.0001	.0009	.0009
	1353	1008	Free Turbine Case	11.624	11.626			
R			Exhaust Duct	11.624	11.626	.002T	.002	.004
	1354	1008	Free Turbine Case	27.594	27.598			
			Exhaust Duct	27.598	27.602	.000	.008	
	1355	1008	Free Turbine Shaft					
			Inner Case	6.449	6.451			
			Accessory Drive					
			Support	6.447	6.449	.000	.004	.006
	1356	1008	Free Turbine Case	10.281	10.283			
			Outer Shaft Case	10.279	10.281	.000	.004T	.000
	1357	1008	Free Turbine Shaft					
			Spline	.0957	.0967			
R			Coupling Spline	.0982	.0992	.0015	.0035	.006
	1358	1008	Free Turbine Shaft					
			Coupling	3.1500	3.1505			
			Bearing	3.1493	3.1496	.0004T	.0012T	.0004T
	1359	1008	Free Turbine Rear					
			Bearing Housing	4.3317	4.3324			
			Bearing	4.3297	4.3307	.001	.0027	.0027
	1360	1008	Free Turbine Shaft					
			Inner Case	5.761	5.763			
			Seals Support					
			Assembly	5.759	5.761	.000	.004T	.001

Free Turbine Section
(All Free Turbine Models)
Table 1009 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1361	1008	Free Turbine Shaft					
		Coupling	3.1500	3.1505			
		Oil Scoop	3.1515	3.1525	.001	.0025	.003
1362	1008	Free Turbine Shaft					
		Outer Case	10.249	10.251			
		Seal Support Assembly	10.251	10.253	.000	.004T	.001
1363	1008	Height of Step Turbine Bearing Seal	.075	.085			.063
1364	1008	Gap:					
		Seal Ring Gap at 3.749 Inch Gage	.005	.020			
		Compressor Rear Bearing Seal	3.749	3.751	.005	.0263	.031
1365	1008	Side Clearance					
		Turbine Bearing Seal Ring	.1225	.1240			
		Free Turbine Seal Support	.125	.1265	.001	.004	.0055
1366	1008	Free Turbine Shaft					
		Coupling Nut Spline	.0436	.0452			
		Lockring Spline	.0479	.0495	.0027	.0059	.0080
1367	1008	Free Turbine Shaft					
		Coupling Spline	.0479	.0505			
		Lockring Spline	.0444	.0460	.0019	.0061	.0079
1369	1008	Free Turbine Oil Pressure Tube					
		Connector	.5605	.5615			
		Oil Pressure Boss	.562	.563	.0005	.0025	.0035
1370	1008	Free Turbine Air					
		Inlet Seal	7.786	7.790			
		Sealing Ring (Radial Clearance Based on Size Tolerance Only)	7.678	7.682	.052	.056	

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1372	1008	Free Turbine 2nd State Vane Set Ring (Radial Clearance)			.000	.018	
1373	1008	Free Turbine 2nd Stage Vane Set Inlet Case (Radial Clearance)	.119 .123	.122 .126	.001	.007	
1374	1008	Free Turbine Rear Bearing Seal Housing Assembly Seal Support	4.959 4.956	4.961 4.958	.001	.005	.007
1375	1008	Free Turbine 1st Stage Vane Lock Ring Segments Radial Clearance)	.085 .075	.093 .085	.000	.018	
1376	1008	Free Turbine 1st Stage Vane Set Inlet Case (Radial Clearance)	.124 .128	.127 .131	.001	.007	
1377	1008	First Stage Free Turbine Blade Ring (Radial Clearance Based on Size Tolerance Only)	24.592 24.695	24.608 24.705	.0435	.0565	.065
1378	1008	Second Stage Free Turbine Blade Ring (Radial Clearance Based on Size Tolerance Only)	27.094 27.202	27.110 27.212	.046	.059	
1379	1008	Free Turbine 2nd Stage Disk Airseal (Radial Clearance Based on Size Tolerance Only)	7.898 7.958	7.902 7.962	.028	.032	.040

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1380	1008	Area (Total All Vanes, JFTD12A-4A) (This area is produced by selecting 49 vanes, PN 572951, to give numerical class average of 3.17 - 3.19) when vanes are classified in TENTHS, average class limit of 3.17 - 4.19 applies.			141.30	142.70	
		Area (Total All Vanes, JFTD12A-5A) (This area is produced by selecting 49 vanes, PN 653651, to give numerical class average to 100.25 - 100.27) when vanes are classified in Tenths, average class limit of 100.25 - 101.27 applies.			137.30	138.70	
1390	1008	Free Turbine Accessory Drive Gear Backlash (Measure with End Play Removed In Directions A and B)			.007		
1391	1008	Free Turbine Gearbox Gearshaft Backlash (Measured with End Play Removed in Directions C and D)			.0055	.0215	
1392	1008	Area (total All Vanes, JFTD12A-4A and 5A) (this area is produced by selecting 77 vanes, PN 572952, to give numerical class average of 5.00 - 5.70) when vanes are classified in Tenths, average class limit of 5.00 - 6.70 applies.			238.00	242.00	
1393	1008	Side Clearance: Free Turbine Inlet					
		Case	.368	.372			
		Ring Segment Lugs	.354	.358	.010	.018	.020

ENGINE GENERAL - TABLE OF LIMITS

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1394	1008	Side Clearance: Free Turbine Inlet					
		Case	.368	.372			
		Inlet Duct Lugs	.354	.358	.010	.018	.020
1395	1008	Free Turbine Case					
		Stabilizing Ring	.5380	.5390			
		Bushing	.5395	.5405	.0005	.0025T	
1396	1008	Free Turbine Case	27.594	27.598			
		Stabilizing Ring	27.586	27.594	.000	.012T	

Free Turbine Section
(All Free Turbine Models)
Table 1009 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1401	1008	Turbine Disk Nut Tighten in 100 lb-in. increments to Specified Limits. Loosen to 0 lb-in. Then retighten to Specified Limits. Loosening and all tightening to be done simultaneously in groups of three, 120 degrees apart in sequence shown in schematic view.			440	500	
1402	1008	Free Turbine Bearing Oil Scoop. Tighten to 1800 lb-in. then turn through angle of 1° minimum to 3° maximum. Tighten to Specified Limits. Loosen to 0 lb-in. then retighten to Specified Limits.					

R
R

Free Turbine Section
Torque Limits
(All Free Turbine Models)
Table 1010

REF. NO.	FIG. NO.	DESCRIPTION	DIMENSIONS MIN	DIMENSIONS MAX	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1403	1008	Free Turbine Bearing Outer Race Retaining Nut Tighten to 2000 lb-in. then turn through angle of 12° minimum to 16° maximum.					
1404	1008	Free Turbine Rear Bearing Outer Race Retaining Nut (Tighten to 2000 lb-in. then turn through angle of 6° minimum to 9° maximum)					
1405	1008	Free Turbine Rear Bearing Inner Race Retaining Nut Tighten to specified limits, loosen to 0 lb-in. then retighten to specified limits. (Tighten to 1500 lb-in. then turn through angle of 20° minimum to 24° maximum)					
1406	1008	Free Turbine Shaft Coupling Nut, Tighten to 2500 lb-in. then turn through angle of 3° maximum					
1407	1008	Free Turbine Towershaft Bearing Nut. Tighten to 200 lb-in. then turn through angle of 0° minimum to 30° maximum.					

Free Turbine Section
Torque Limits
(All Free Turbine Models)
Table 1010 (Continued)

REF. NO.	FIG. NO.	DESCRIPTION	LIMITS MIN	LIMITS MAX	REPLACE IF OVER
1451	1008	Free Turbine Bearing Seal Spring at 0.450 inch	1.8125	1.9375	1.7500

R
R

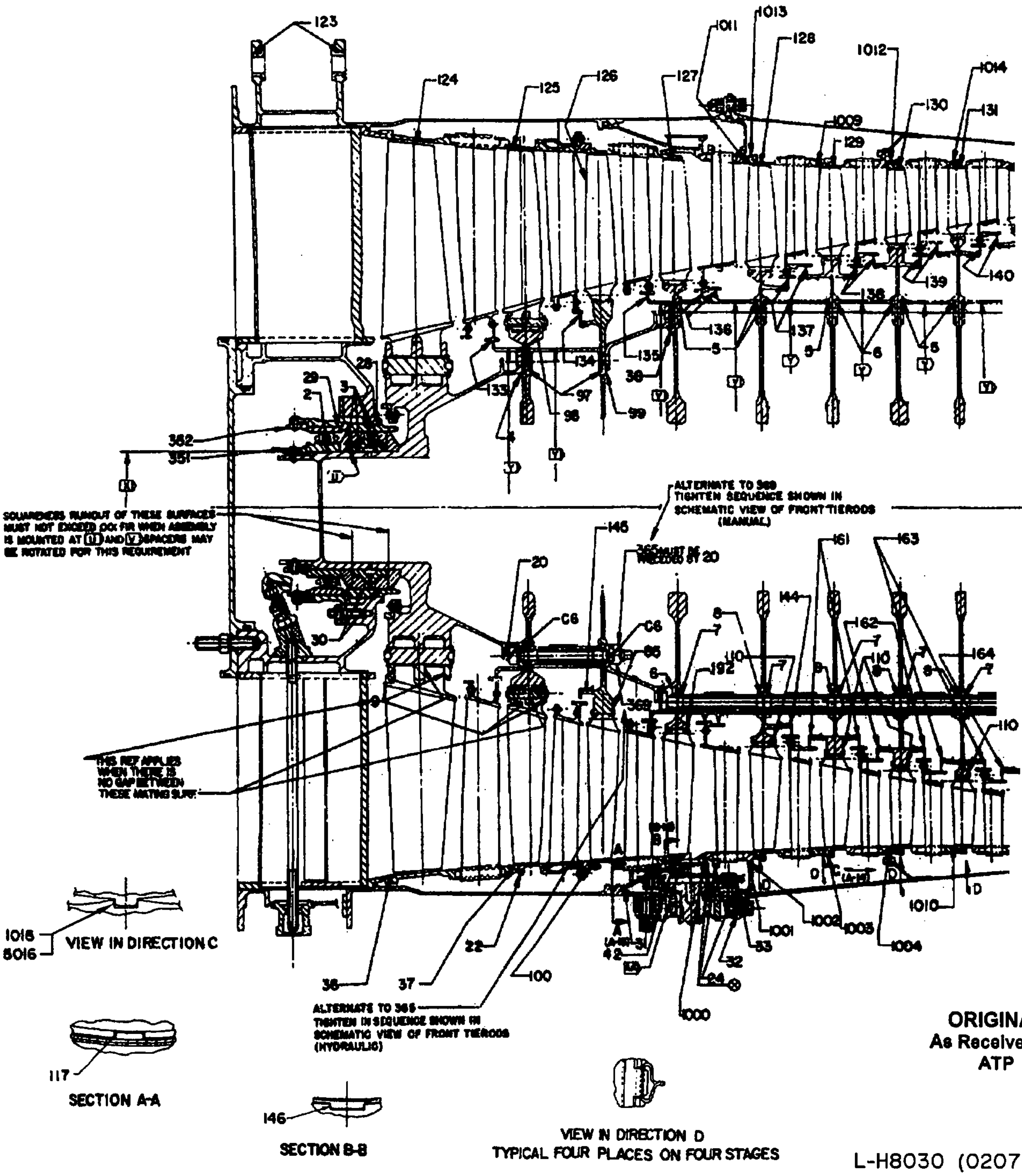
Free Turbine Section
Spring Pressures
(All Free Turbine Models)
Table 1011

	REF. NO.	FIG. NO.	DESCRIPTION	LIMITS MIN	MAX	REPLACE IF OVER
	1452	1008	Free Turbine Bearing Seal Spring at 0.575 inch	1.625	1.750	1.563

Free Turbine Section
Spring Pressures
(All Free Turbine Models)
Table 1011 (Continued)

	REF. NO.	FIG. NO.	DESCRIPTION	LIMITS MIN	MAX	REPLACE IF OVER
R	2000	1008	1st Stage Inner Airseal Ring to Turbine Case Rear Face	3.488	3.582	3.595
R	2001	1008	2nd Stage Inner Airseal Ring to Turbine Case Front Face	1.038	1.116	1.131
R	2002	1008	1st Stage Disk to Turbine Case Front Face	10.413	10.491	
R	2003	1008	2nd Stage Vane to Turbine Case Rear Face	1.423	1.451	
R	2004	1008	2nd Stage Vane to 2nd Stage Inner Airseal Ring	1.470	1.510	

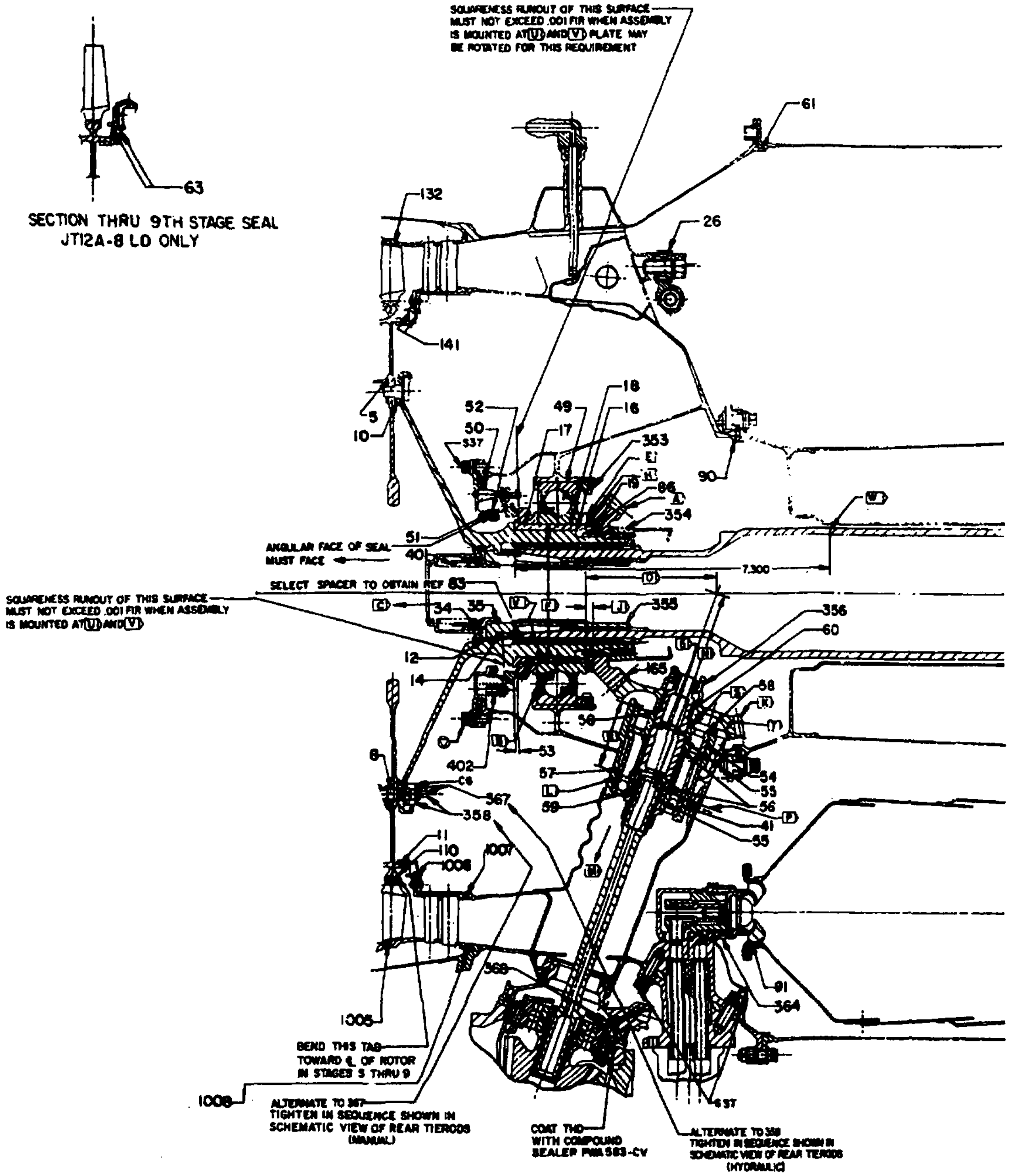
Free Turbine Vane Loading
Dimensions (JFTD12A-4A,-5A)
Table 1012



L-H8030 (0207)

R
R

Engine Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1001 (Sheet 1)



L-H8031 (0207)

ORIGINAL
As Received By
ATP

R
R

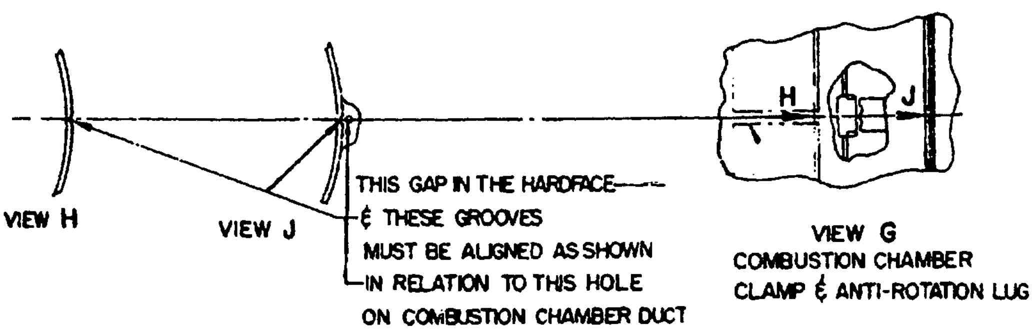
Engine Clearance Chart
(JT12A-6, -6A, -8 [L])
Figure 1001 (Sheet 2)

FOR MOUNTING GEAR A

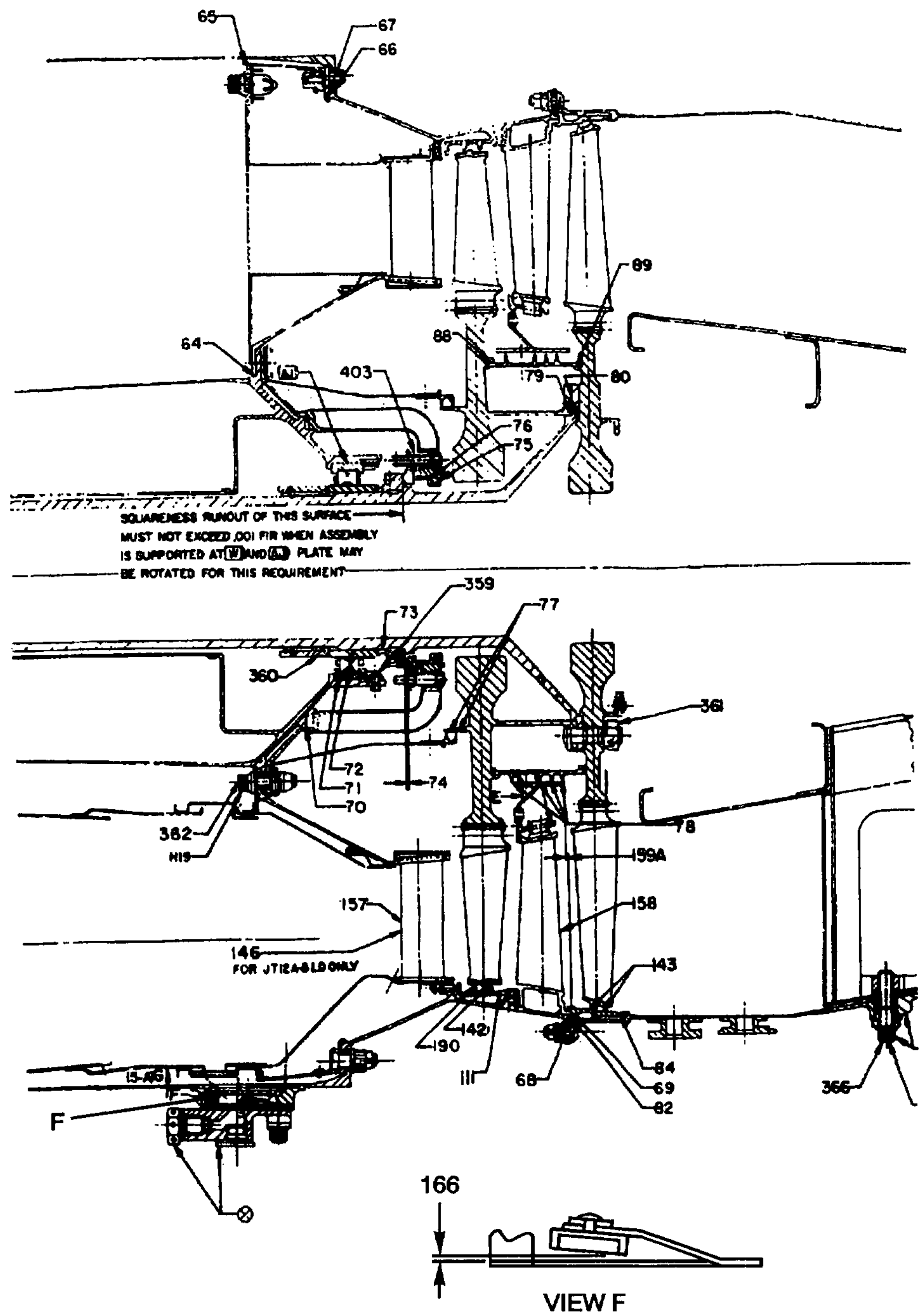
1. END PLAY OF BEARING B MUST BE TAKEN UP IN DIRECTION OF THRUST C TO OBTAIN DIM. D
2. MEASURE DISTANCE D IN RELATION TO FACE E AND INTERSECTION OF ℄ OF DIA F & DIA G
3. GRIND SPACER H WITH DIM. J ±.0005 EQUAL TO D - 2.890
4. SPACER FACES MUST BE PARALLEL WITHIN .0005 FIR. AFTER GRINDING

FOR MOUNTING GEAR K

1. END PLAY OF BEARING L MUST BE TAKEN UP IN DIRECTION OF THRUST M TO OBTAIN DIM. N
2. MEASURE DISTANCE N IN RELATION TO FACE P AND INTERSECTION OF ℄ OF DIA F & DIA G
3. MEASURE DISTANCE R
4. GRIND SPACER S WITH DIM. T ±.0005 EQUAL TO (N - 2.990) - R
5. SPACER FACES MUST BE PARALLEL WITHIN .0005 FIR. AFTER GRINDING



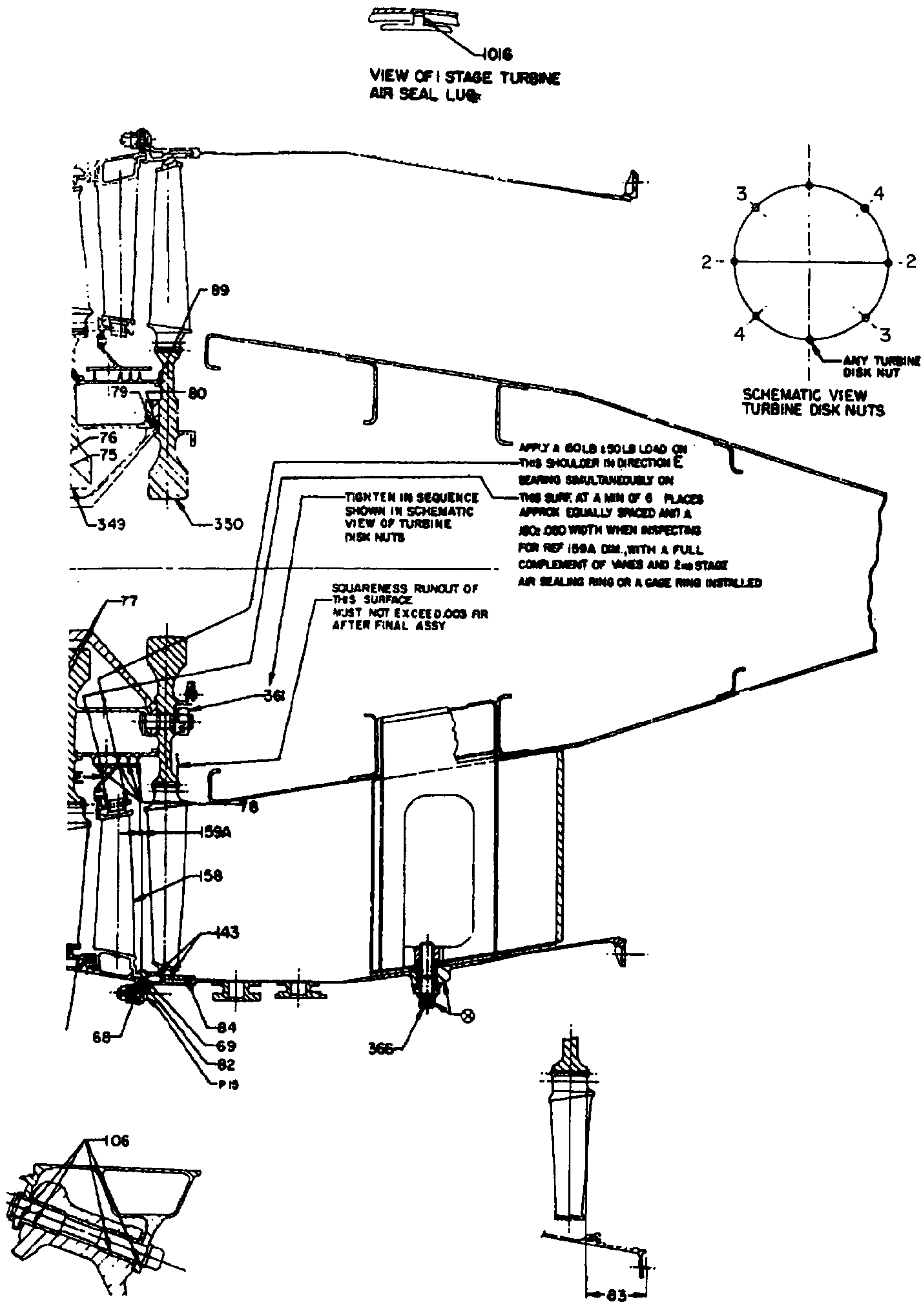
L-H8067 (0307)



L-H8032 (1107)
PW C

ORIGINAL
As Received By
ATP

Engine Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1001 (Sheet 3)



SECTION THRU GEARBOX MOUNT LUGS

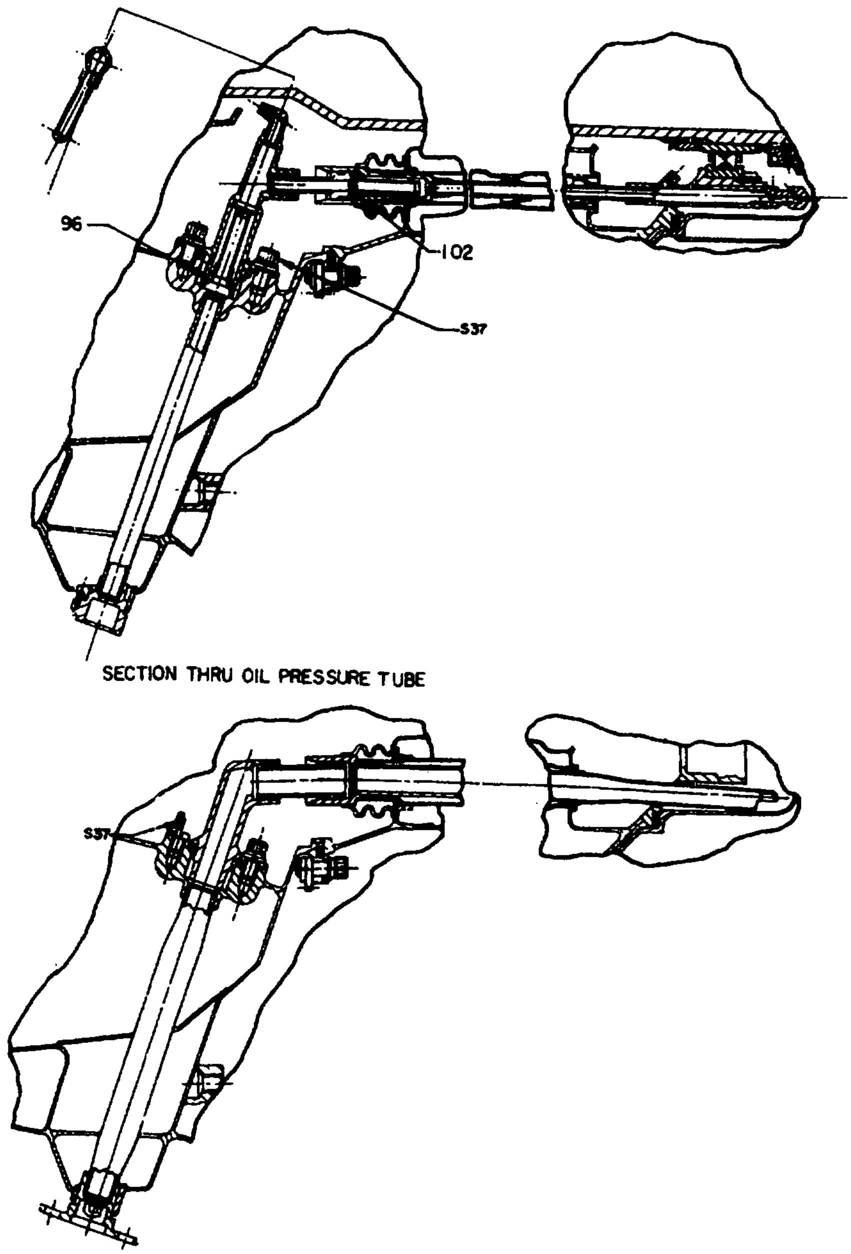
IST STAGE TURBINE DISK LOCATING DIMENSION

L-H8033 (0207)

ORIGINAL
As Received By
ATP

R
R

Engine Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1001 (Sheet 4)

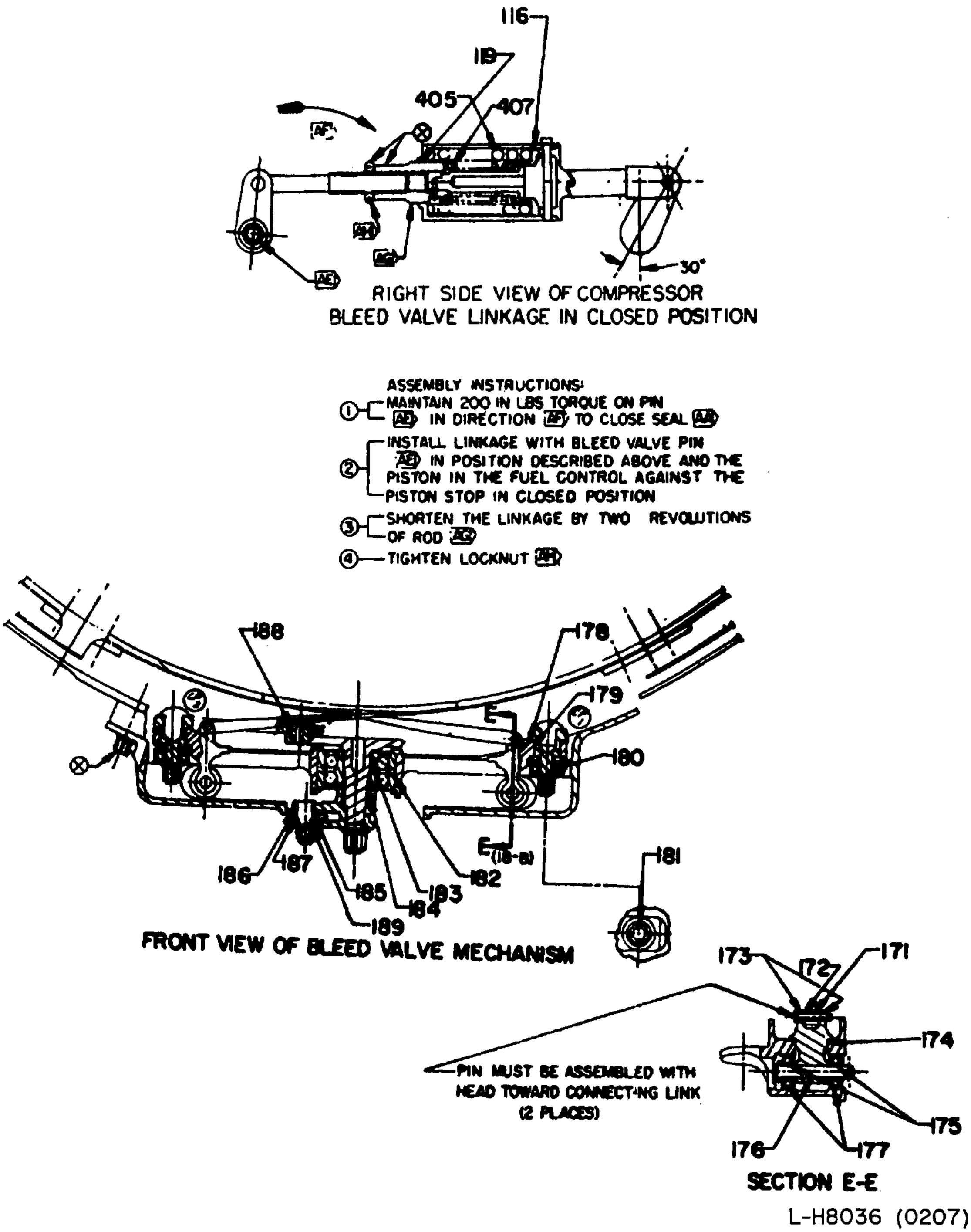


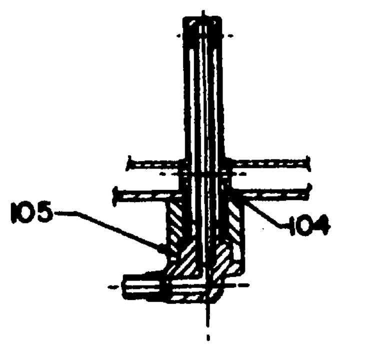
L-H8035 (0207)

ORIGINAL
As Received By
ATP

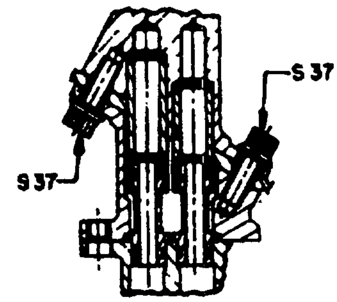
R
R

Engine Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1001 (Sheet 5)

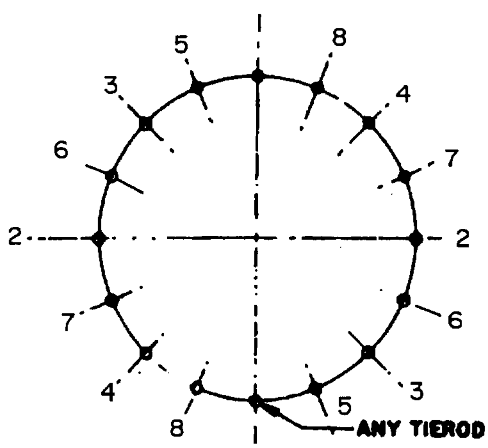

116
119
405
407
30°
RIGHT SIDE VIEW OF COMPRESSOR
BLEED VALVE LINKAGE IN CLOSED POSITION
ASSEMBLY INSTRUCTIONS:
① MAINTAIN 200 IN LBS TORQUE ON PIN AE IN DIRECTION AF TO CLOSE SEAL AA
② INSTALL LINKAGE WITH BLEED VALVE PIN AE IN POSITION DESCRIBED ABOVE AND THE PISTON IN THE FUEL CONTROL AGAINST THE PISTON STOP IN CLOSED POSITION
③ SHORTEN THE LINKAGE BY TWO REVOLUTIONS OF ROD AG
④ TIGHTEN LOCKNUT AH
188
178
179
180
181
182
183
184
185
186
187
189
E
FRONT VIEW OF BLEED VALVE MECHANISM
171
172
173
174
175
176
177
PIN MUST BE ASSEMBLED WITH HEAD TOWARD CONNECTING LINK (2 PLACES)
SECTION E-E
L-H8036 (0207)



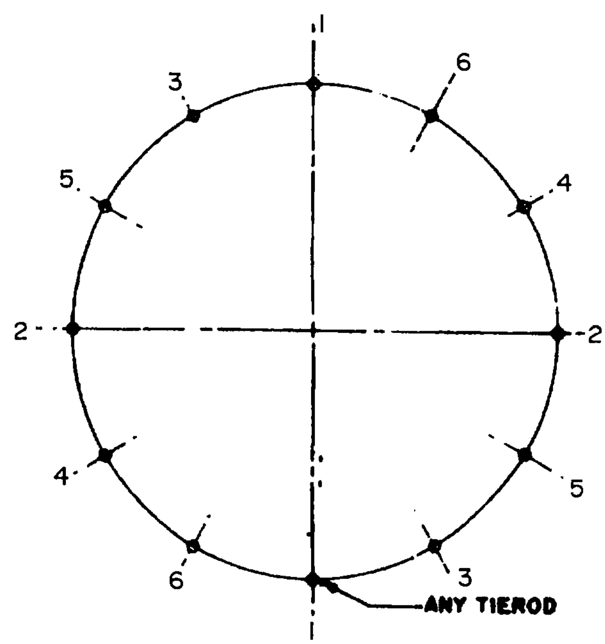
SECTION THRU INLET PRESSURE SENSING PROBE



SECTION THRU FUEL TRANSFER TUBES
JT12-8 L ONLY



SCHEMATIC VIEW
FRONT TIERODS

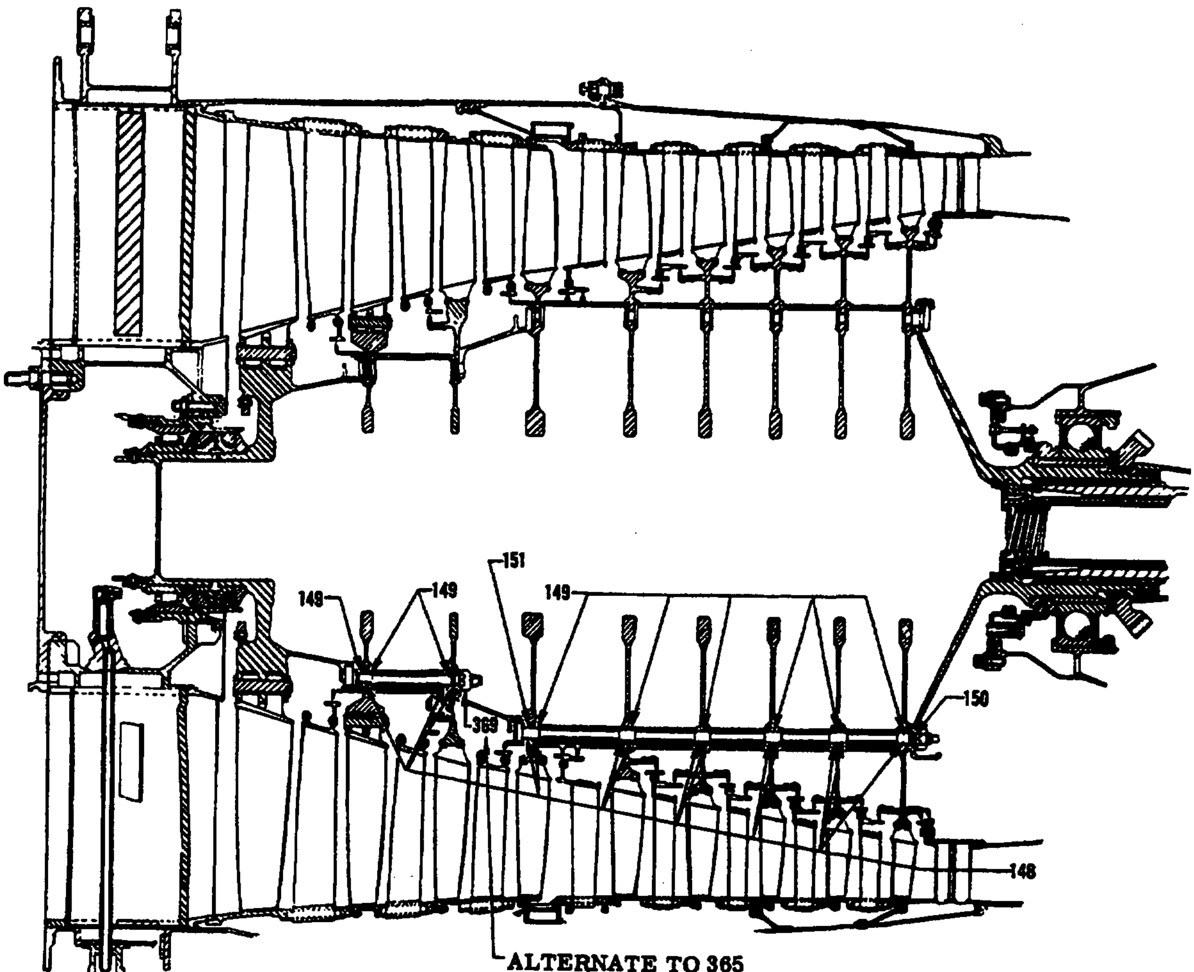


SCHEMATIC VIEW
REAR TIERODS
HYDRAULIC OR MANUAL

L-H8037 (0207)

R
R

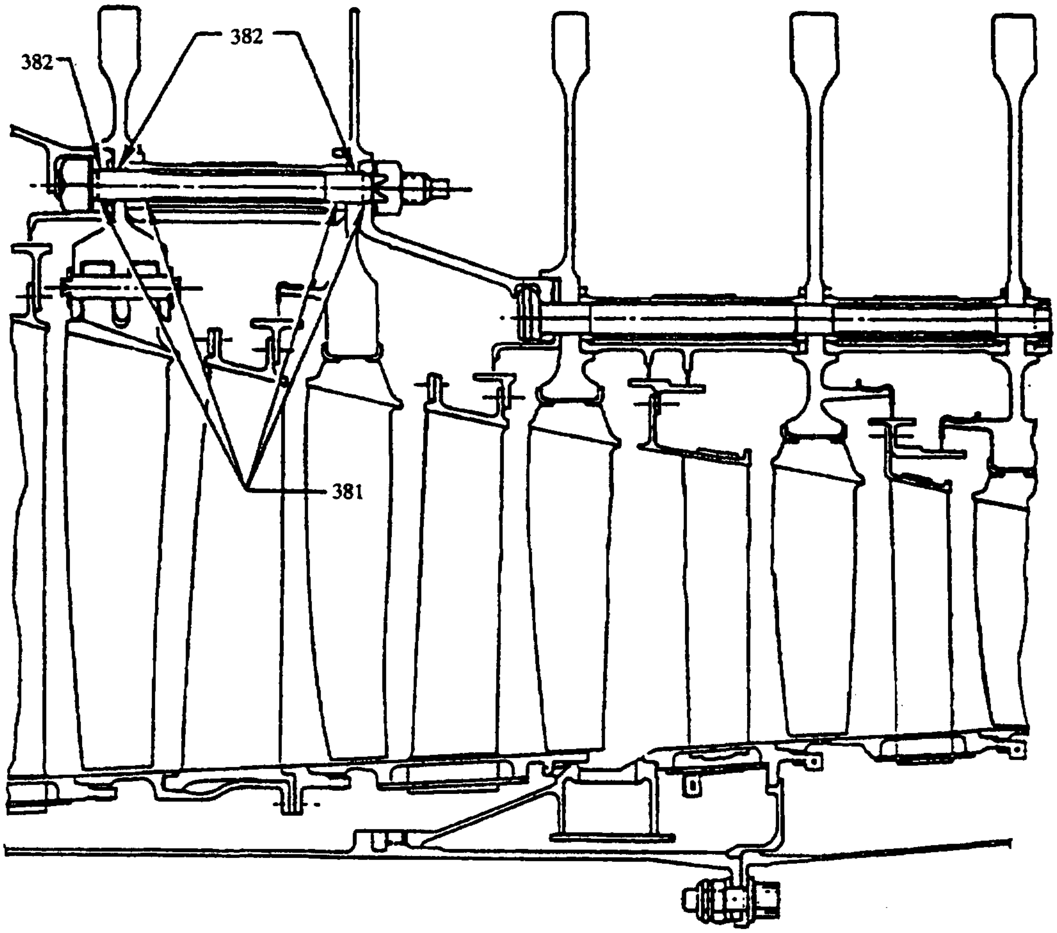
Engine Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1001 (Sheet 7)



L-29327 (0207)

R
R

Engine Clearance Chart
(JT12A-6, -6A, -8 [L])
Figure 1001 (Sheet 8)



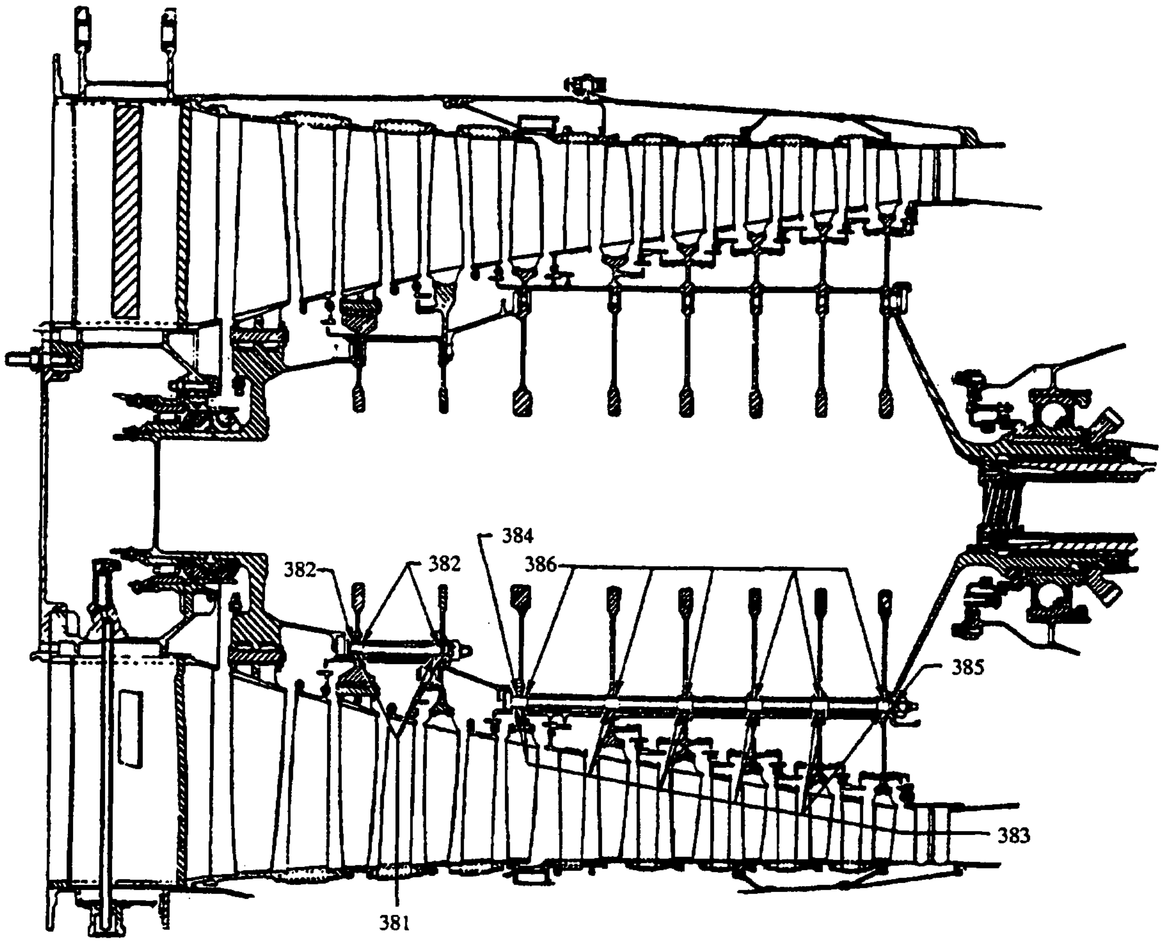
PRE SB 2564 FOR THE FRONT COMPRESSOR AND
PRE SBs 2451, 5363 AND 6229 FOR THE REAR COMPRESSOR

L-H4503 (0307)

ORIGINAL
As Received By
ATP

R
R

Engine Clearance Chart
(JT12A-6, -6A, -8 [L])
Figure 1001 (Sheet 9)



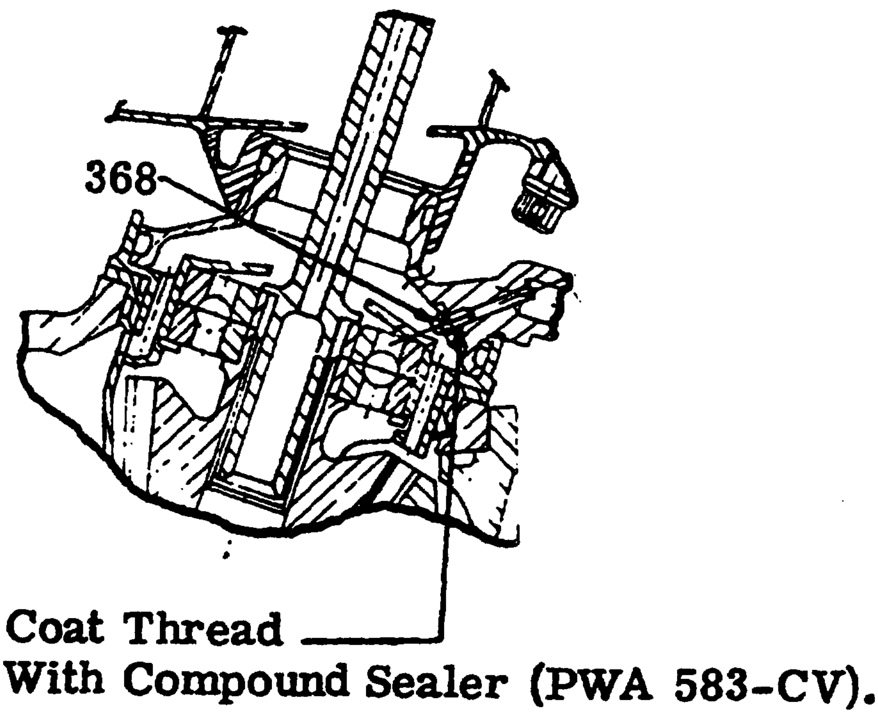
PRE SB 2564 FOR THE FRONT COMPRESSOR AND
PRE SBs 2451, 5363 AND 6229 FOR THE REAR COMPRESSOR

L-H4501 (0307)

ORIGINAL
As Received By
ATP

R
R

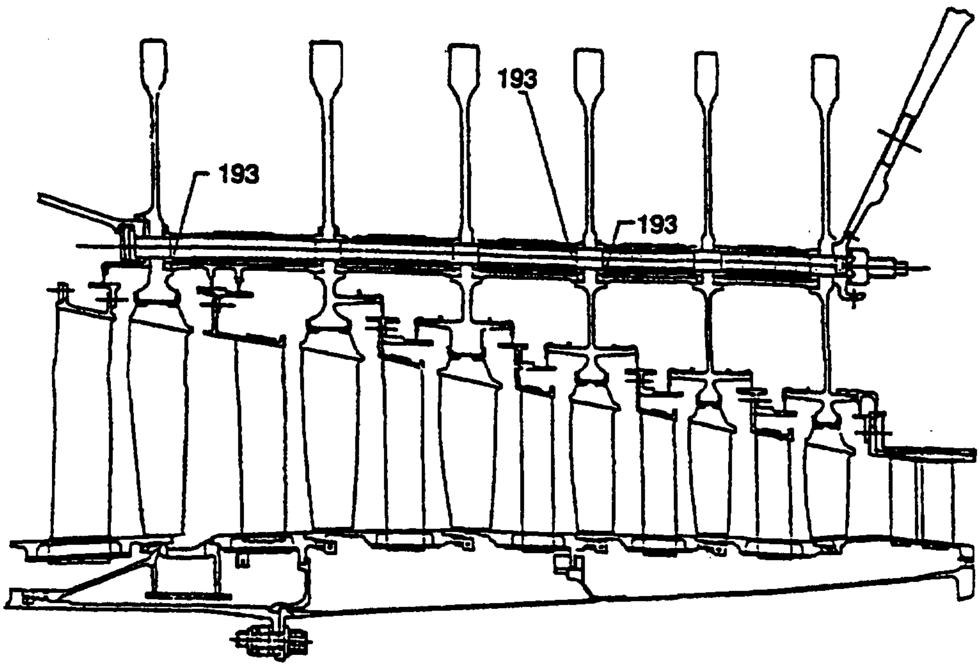
Engine Clearance Chart
(JT12A-6, -6A, -8 [L])
Figure 1001 (Sheet 10)



MAIN COMPONENT DRIVEGEAR UPPER BEARING OIL NOZZLE INSTALLATION

L-29337 (0207)

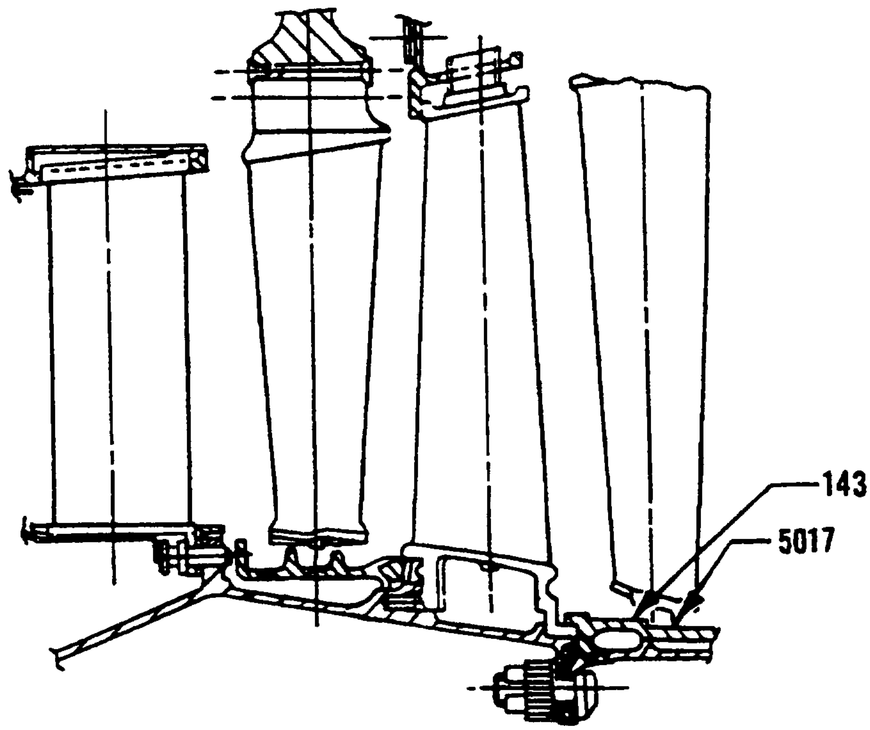
ORIGINAL
As Received By
ATP



L-H8034 (0207)

R
R

Engine Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1001 (Sheet 12)

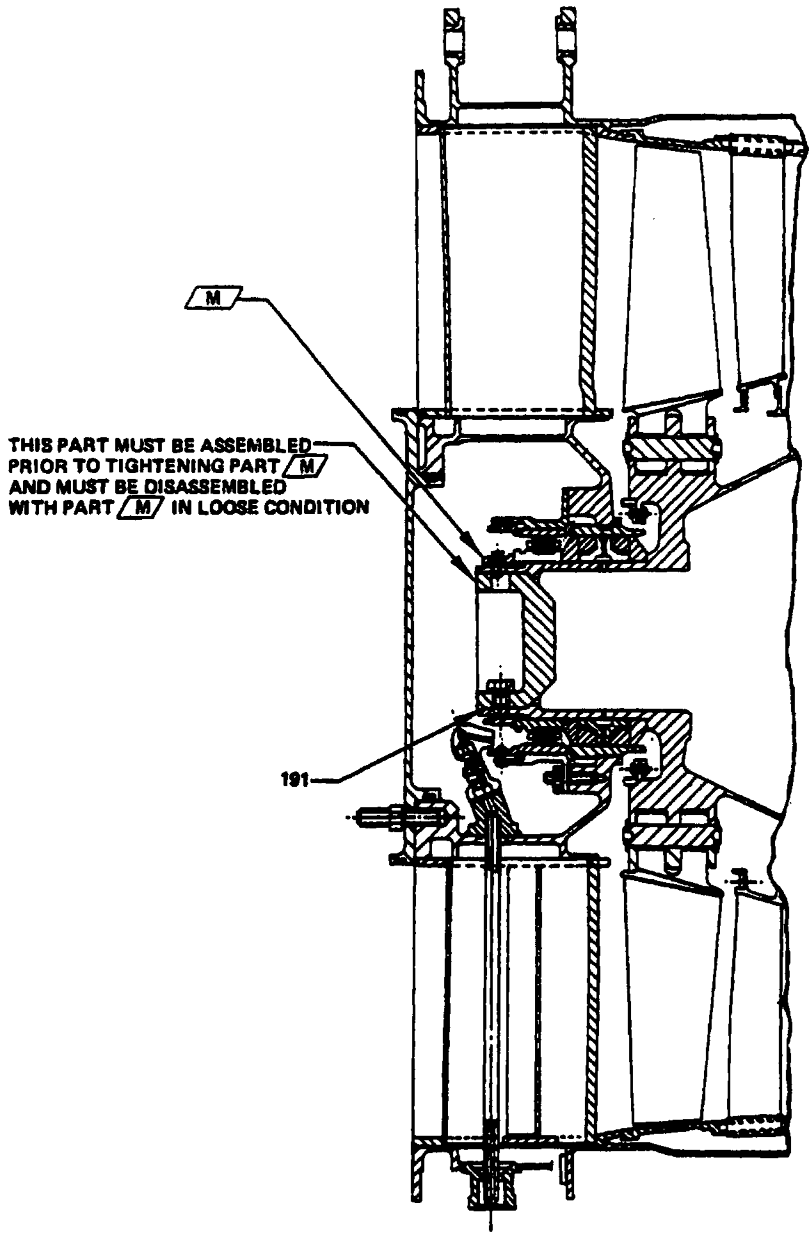


L-37079 (0207)

ORIGINAL
As Received By
ATP

R
R

Engine Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1001 (Sheet 13)

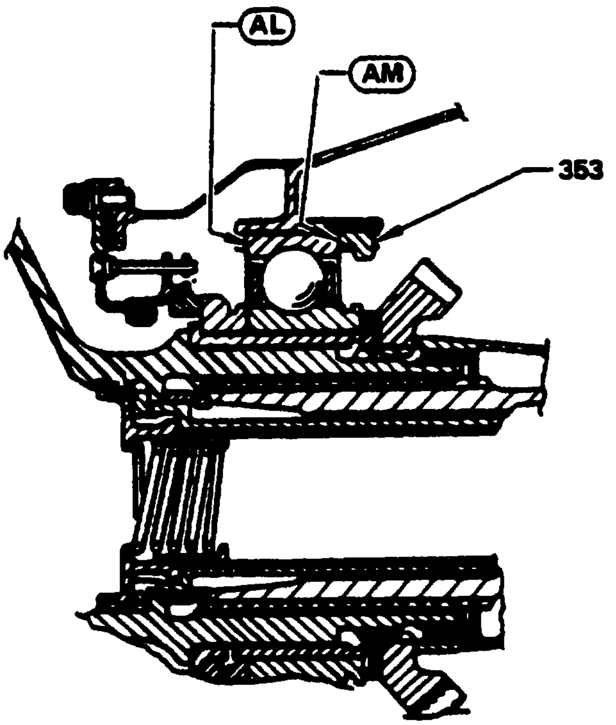


L-42835 (0207)

ORIGINAL
As Received By
ATP

R
R

Engine Clearance Chart
(JT12A-6, -6A, -8 [L])
Figure 1001 (Sheet 14)



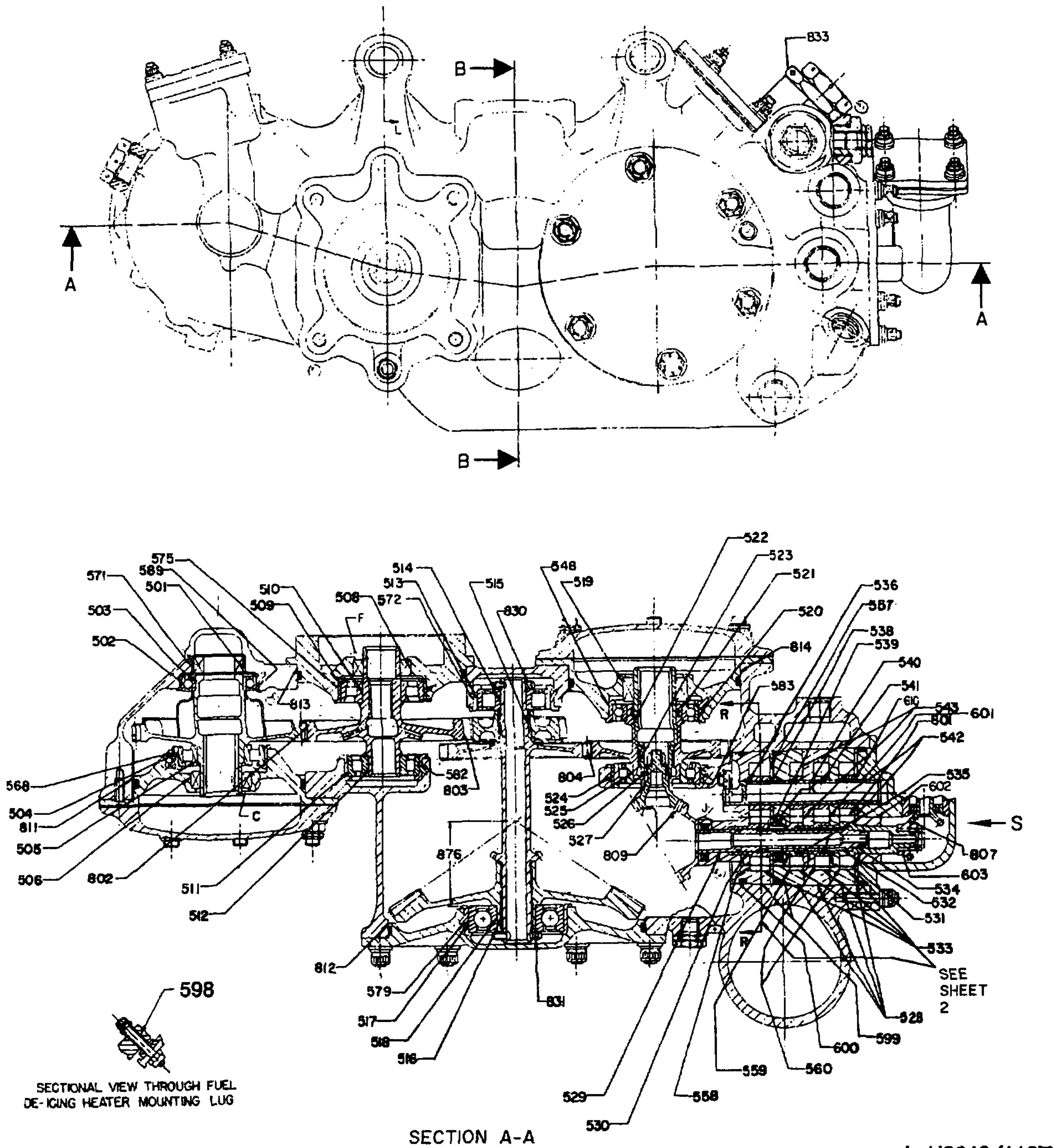
9 AM .007 MAX. GAP PERMISSIBLE IN LOCAL AREA AFTER APPLICATION OF TORQUE.

8 AL .001 MAX. GAP PERMISSIBLE IN LOCAL AREA AFTER APPLICATION OF TORQUE.

L-59050 (0207)

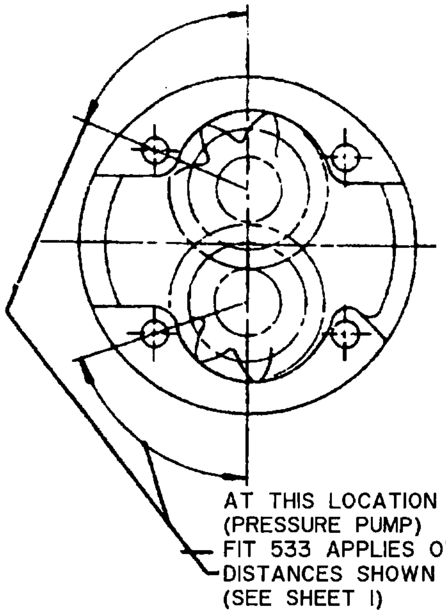
R
R

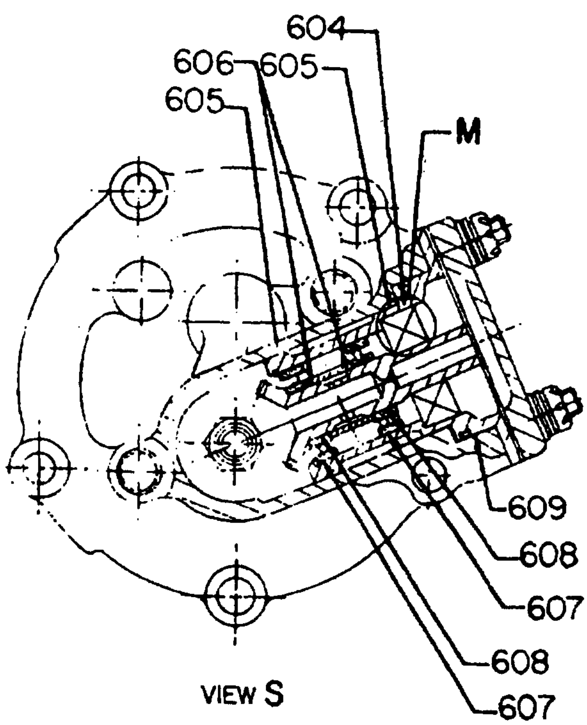
Engine Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1001 (Sheet 15)



L-H8043 (1107)
PWC

Accessory Section Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1002 (Sheet 1)



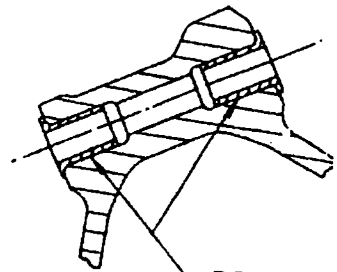


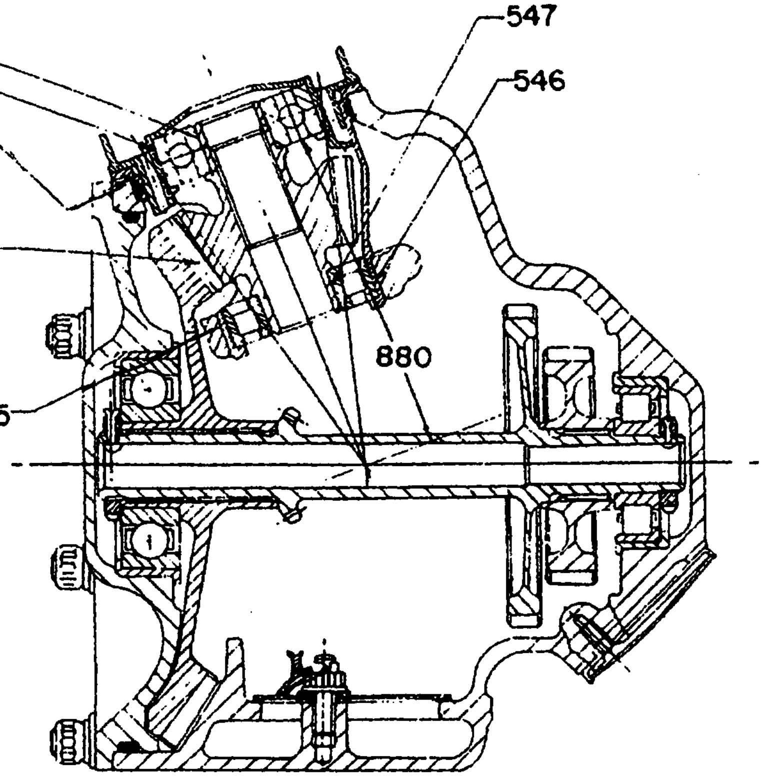
L-H8044 (0207)

ORIGINAL
As Received By
ATP

R
R

Accessory Section Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1002 (Sheet 2)

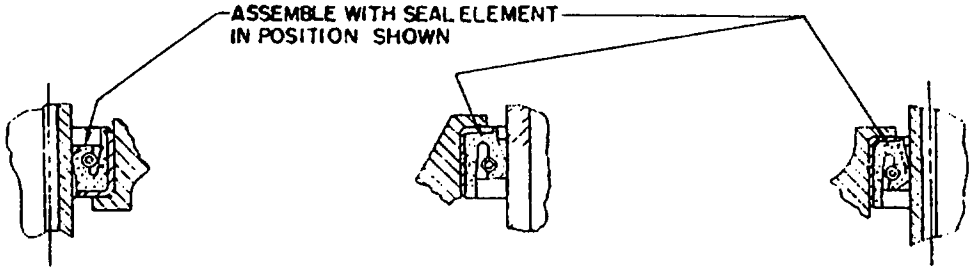




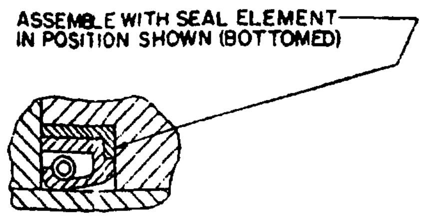
L-H8045 (0207)

R
R

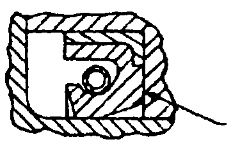
Accessory Section Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1002 (Sheet 3)



VIEW C (10-B)   VIEW F (9-C)   VIEW G (8-C)



VIEW K (7-B)

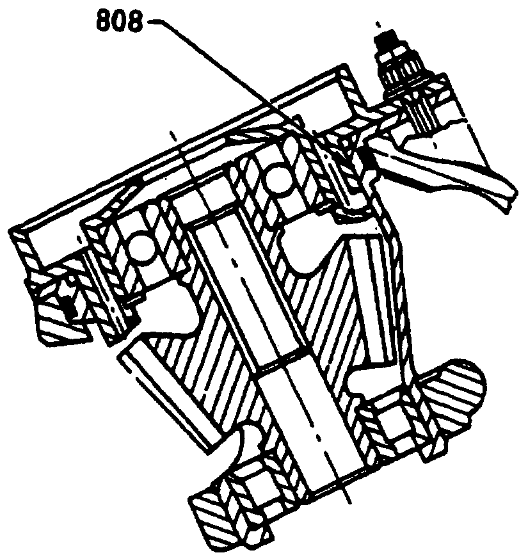


VIEW J (8-B)

L-H8046 (0207)

R
R

Accessory Section Clearance Chart
(JT12A-6,-6A,-8 [L])
Figure 1002 (Sheet 4)



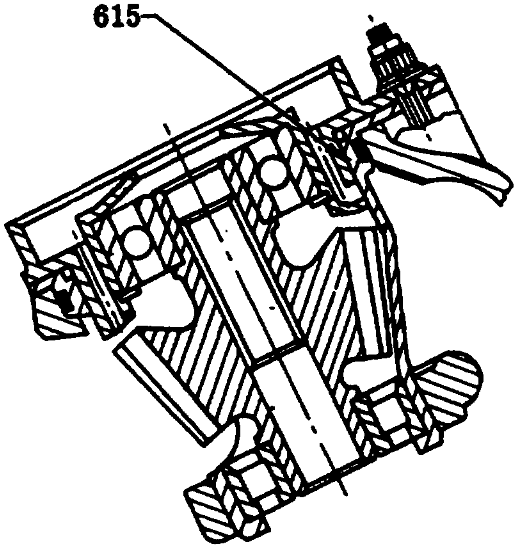
MAIN COMPONENT DRIVEGEAR UPPER BEARING HOUSING FIT

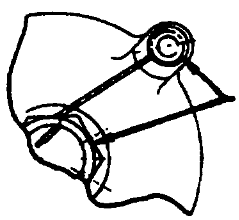
L-29333 (0307)

ORIGINAL
As Received By
ATP

R
R

Accessory Section Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1002 (Sheet 5)





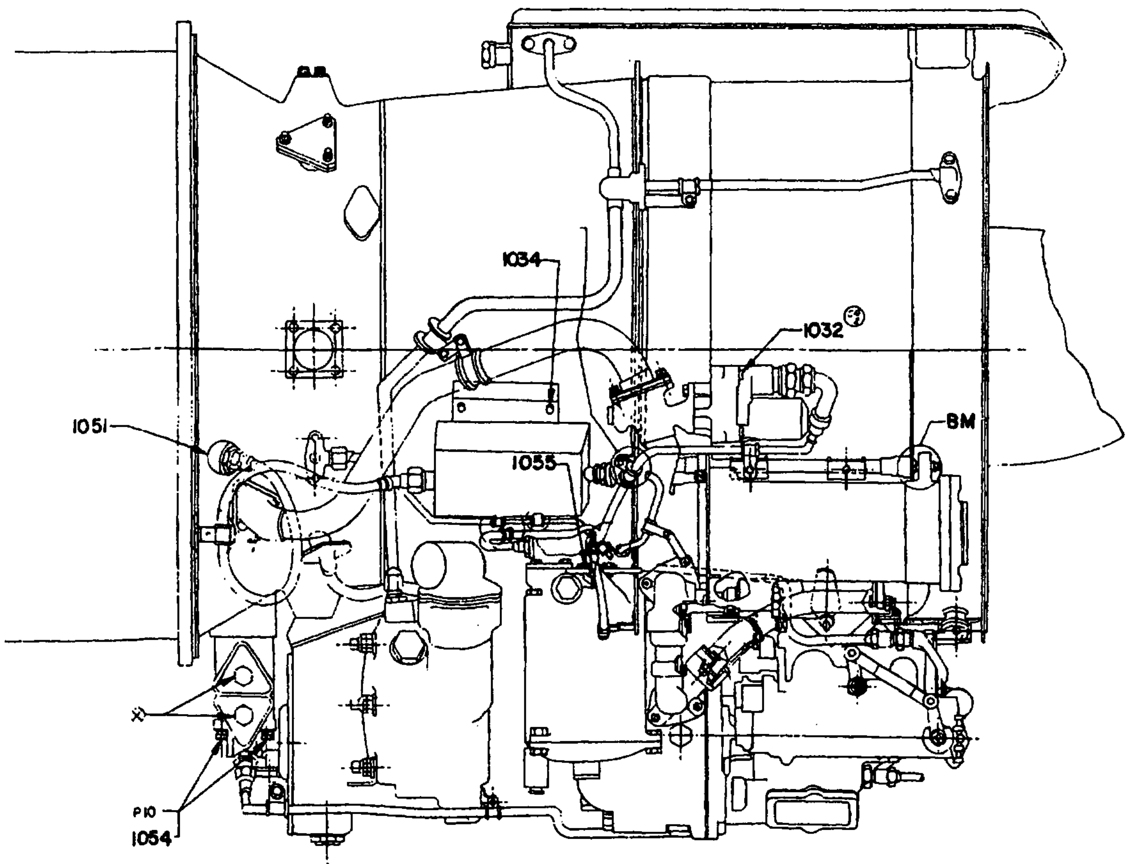
MAIN OIL STRAINER COVER RETAINING NUTS AND DRAIN PLUG LOCKWIRING

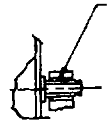
L-29492 (0000)

ORIGINAL
As Received By
ATP

R
R

Accessory Section Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1002 (Sheet 6)



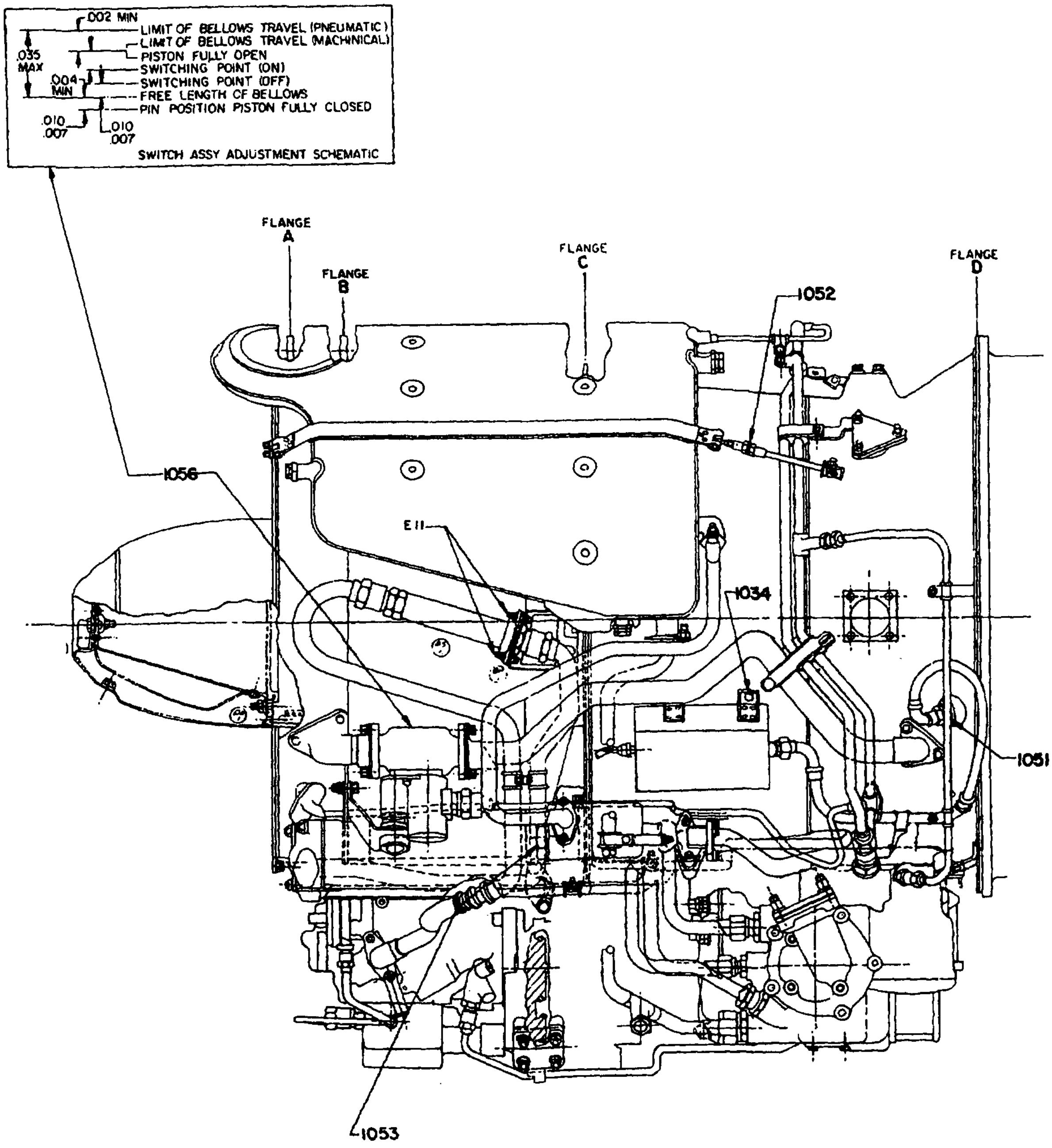


L-H8048 (0307)

ORIGINAL
As Received By
ATP

R
R

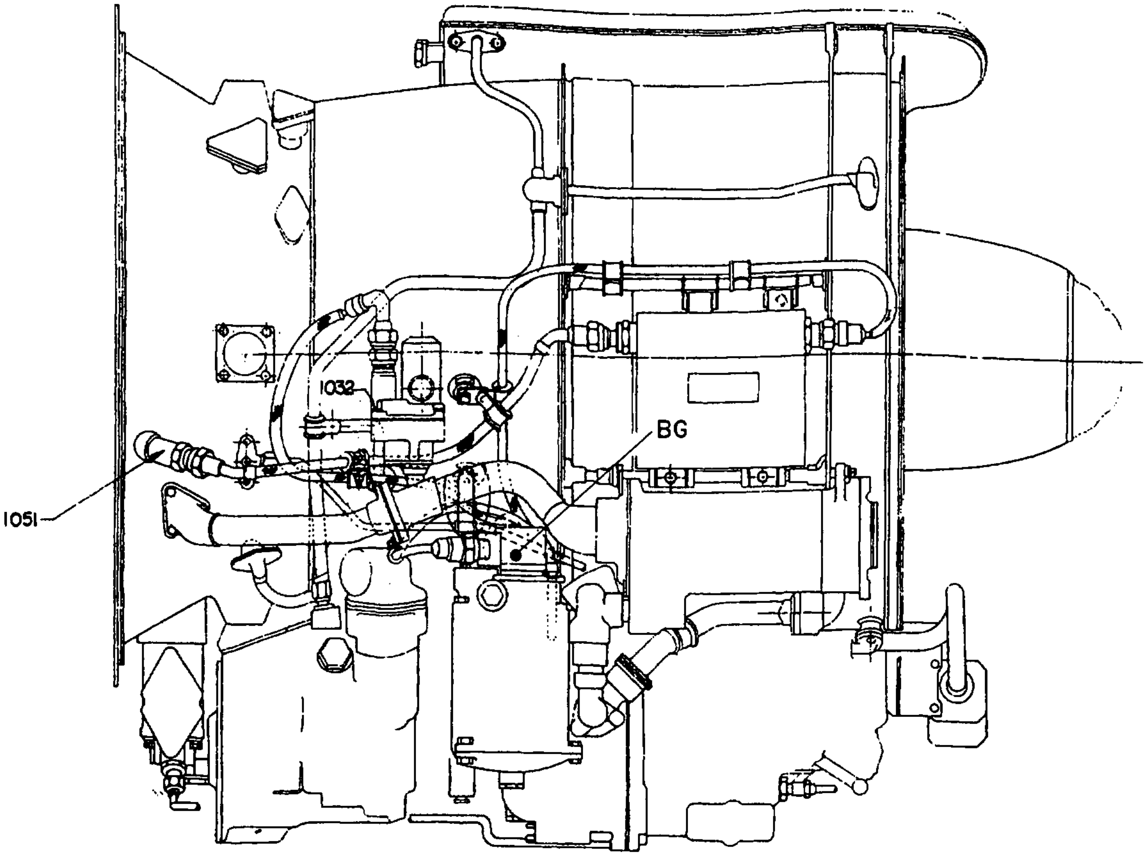
External Parts Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1003 (Sheet 1)

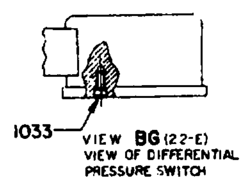


ORIGINAL
As Received By
ATP

R
R

External Parts Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1003 (Sheet 2)



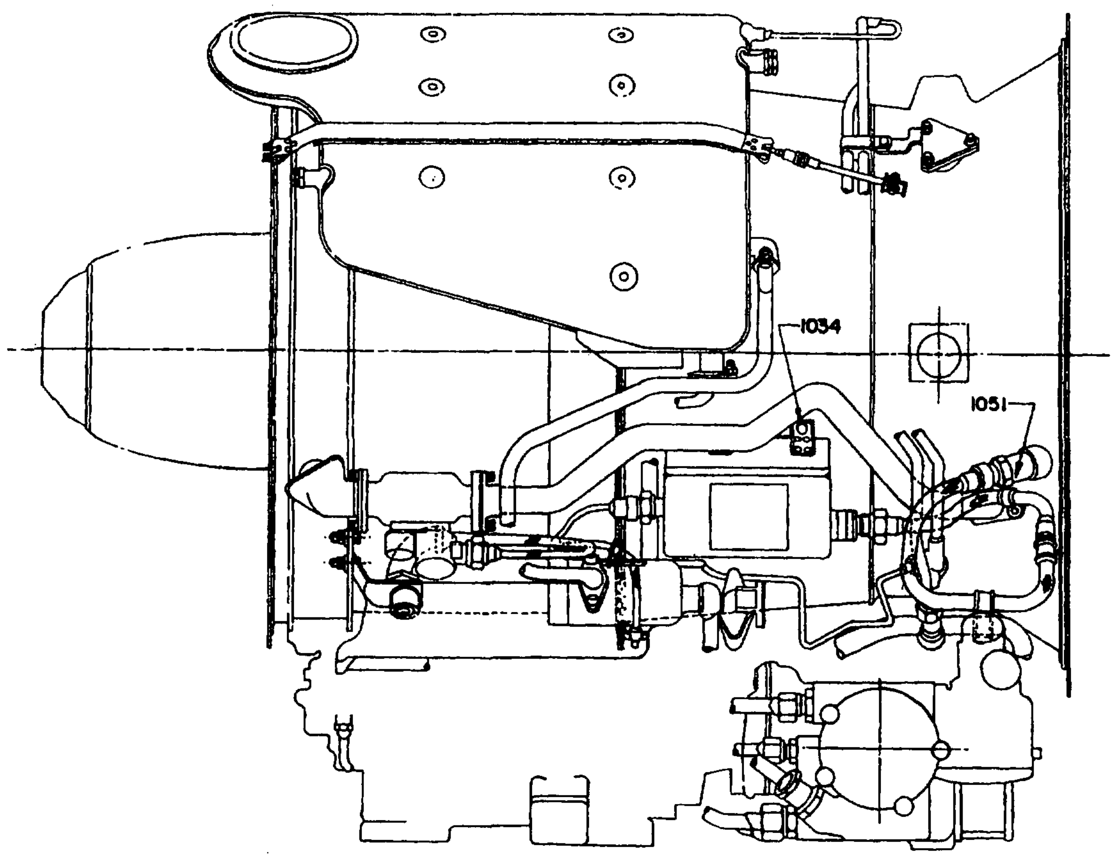


ORIGINAL
As Received By
ATP

L-H8050 (0307)

R
R

External Parts Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1003 (Sheet 3)

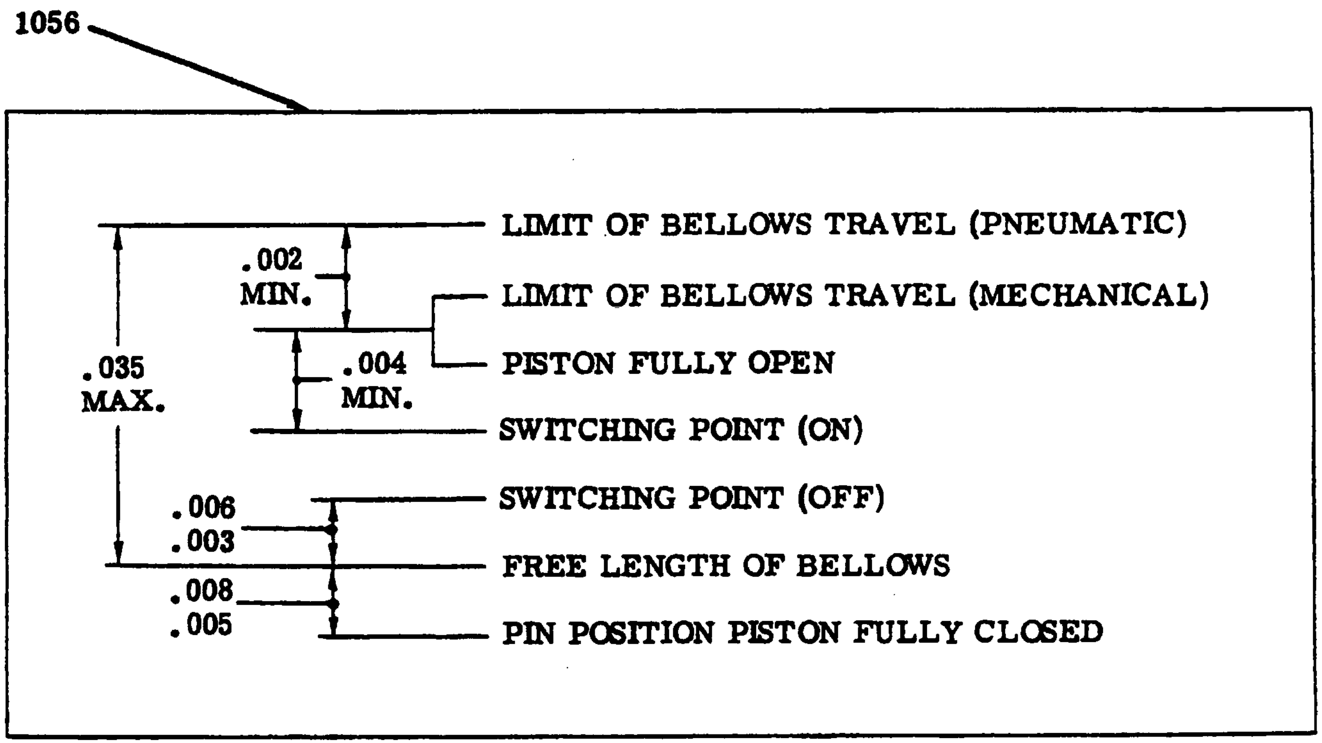


LEFT SIDE
ALTERNATE IGNITION
(CONTINUOUS)

L-H8051 (0307)

R
R

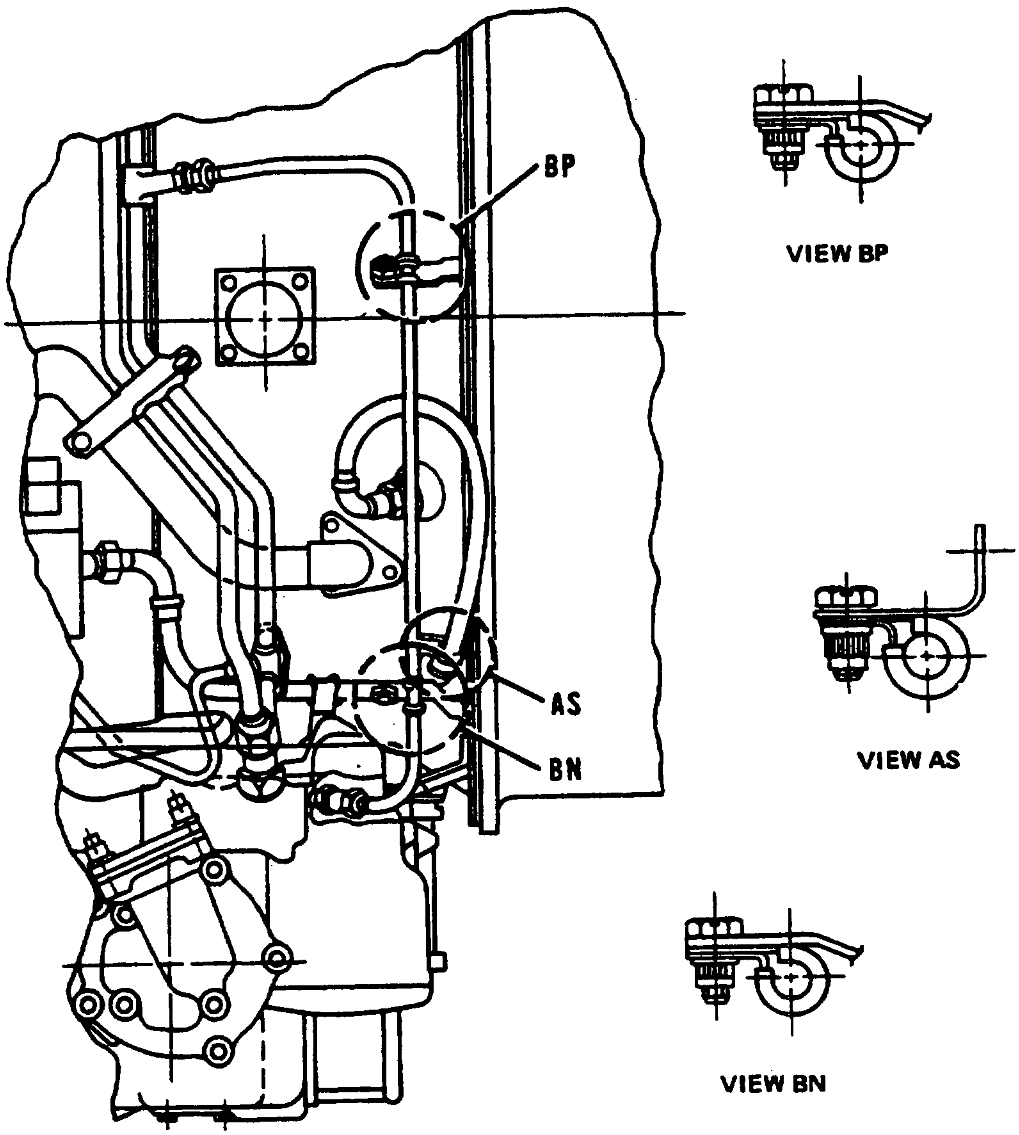
External Parts Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1003 (Sheet 4)



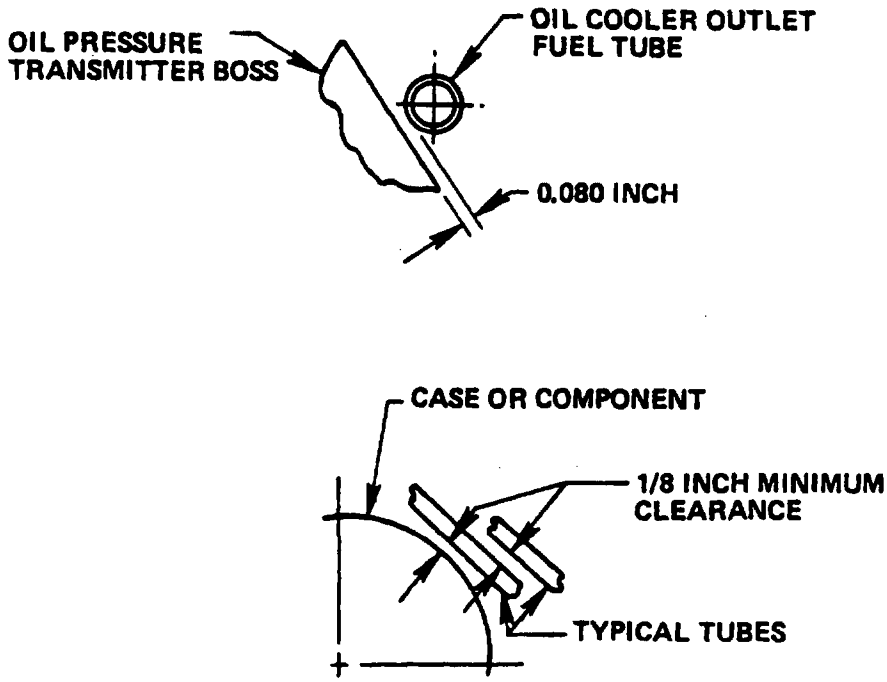
SWITCH ASSEMBLY ADJUSTMENT SCHEMATIC
(P/N 693027 VALVE ASSEMBLY ONLY)

L-29384 (0307)

External Parts Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1003 (Sheet 5)



R
R
External Parts Clearance Chart
(JT12A-6,-6A,-8 [L])
Figure 1003 (Sheet 6)

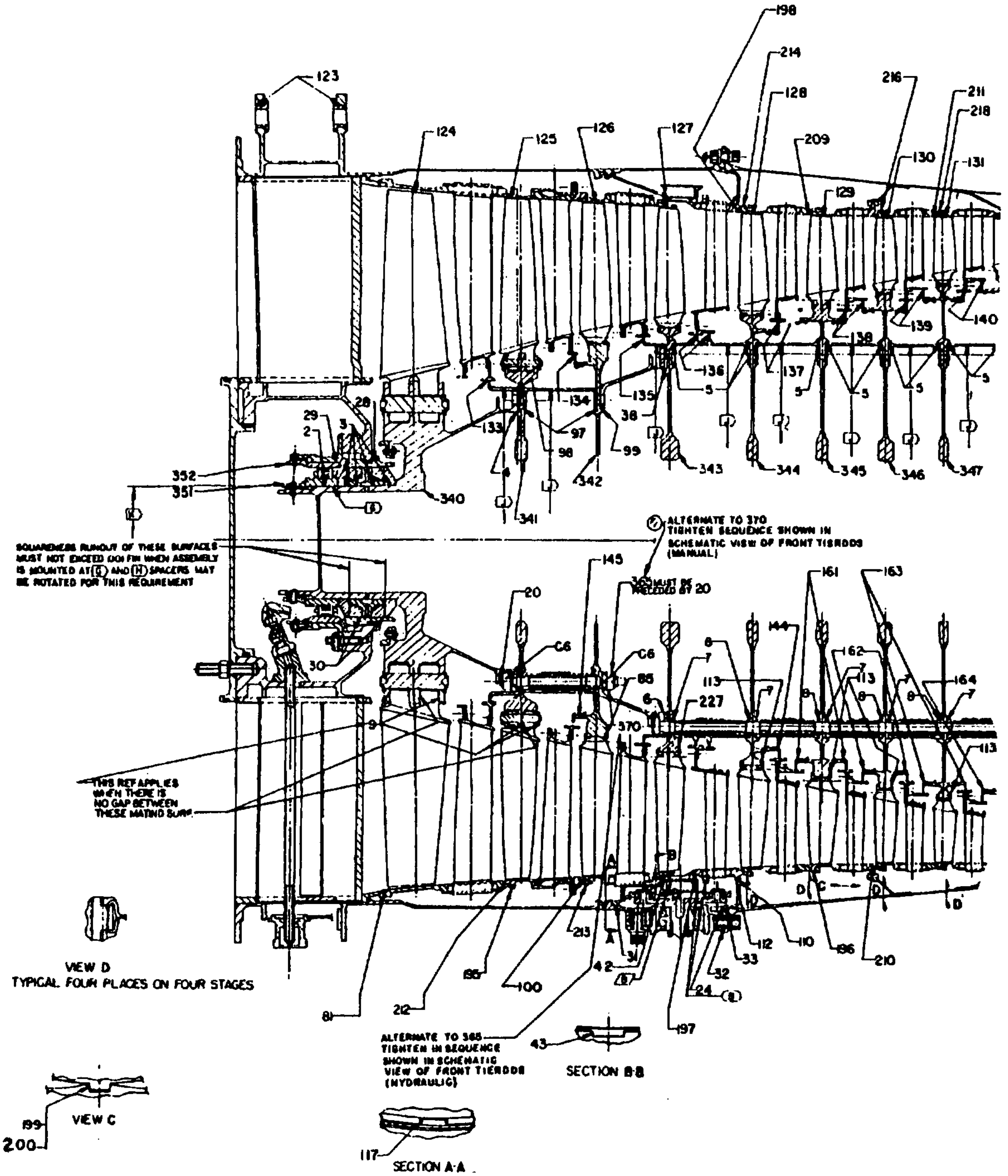


NOTE: Unless otherwise specified, clearance between tubes (except where clipped together) and between tubes and other external engine parts must be 0.125 inch minimum.

L-65299 (0307)

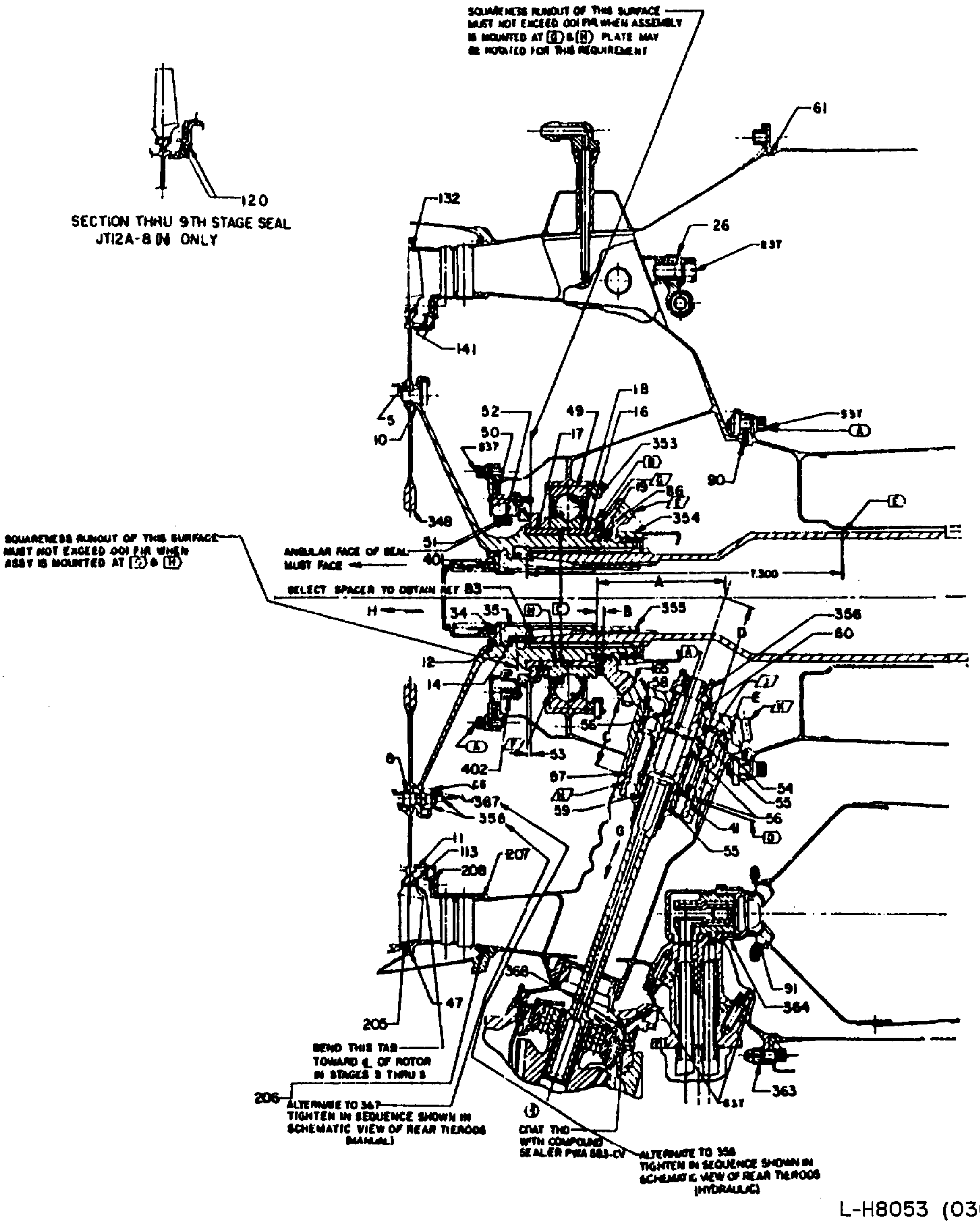
R
R

External Parts Clearance Chart
(JT12A-6,-6A,-8[L])
Figure 1003 (Sheet 7)



L-H8052 (0307)

Engine Clearance Chart
(JT12A-6A, -8 [N])
Figure 1004 (Sheet 1)



ORIGINAL
As Received By
ATP

R
R

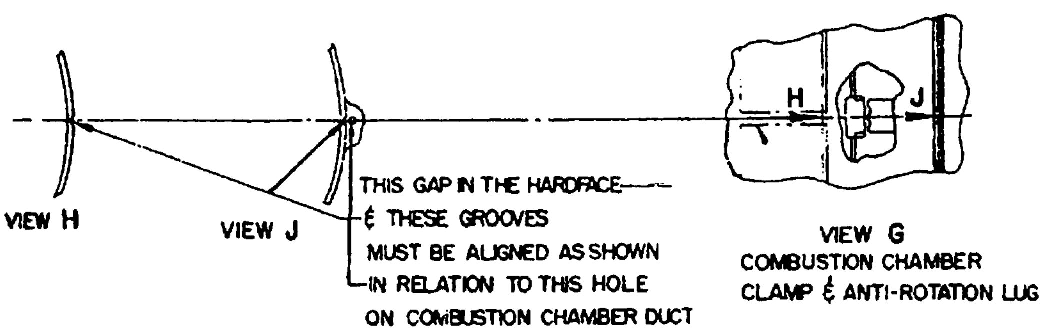
Engine Clearance Chart
(JT12A-6A,-8 [N])
Figure 1004 (Sheet 2)

FOR MOUNTING GEAR A

1. END PLAY OF BEARING B MUST BE TAKEN UP IN DIRECTION OF THRUST C TO OBTAIN DIM. D
2. MEASURE DISTANCE D IN RELATION TO FACE E AND INTERSECTION OF ℄ OF DIA F ₵ DIA G
3. GRIND SPACER H WITH DIM. J ±.0005 EQUAL TO D - 2.890
4. SPACER FACES MUST BE PARALLEL WITHIN .0005 FIR. AFTER GRINDING

FOR MOUNTING GEAR K

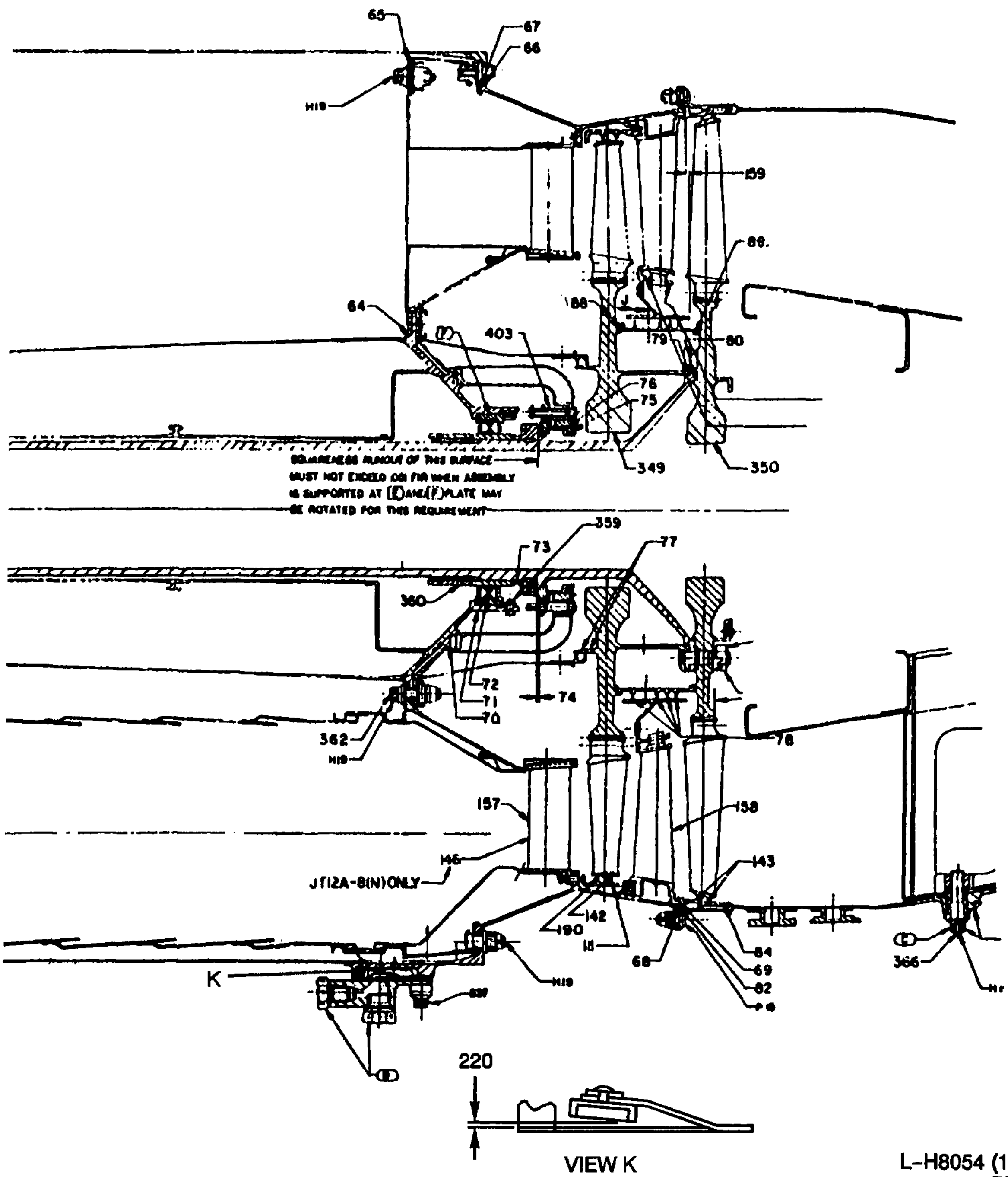
1. END PLAY OF BEARING L MUST BE TAKEN UP IN DIRECTION OF THRUST M TO OBTAIN DIM. N
2. MEASURE DISTANCE N IN RELATION TO FACE P AND INTERSECTION OF ℄ OF DIA F ₵ DIA G
3. MEASURE DISTANCE R
4. GRIND SPACER S WITH DIM. T ±.0005 EQUAL TO (N - 2.990) - R
5. SPACER FACES MUST BE PARALLEL WITHIN .0005 FIR. AFTER GRINDING



L-H8067 (0307)

R
R

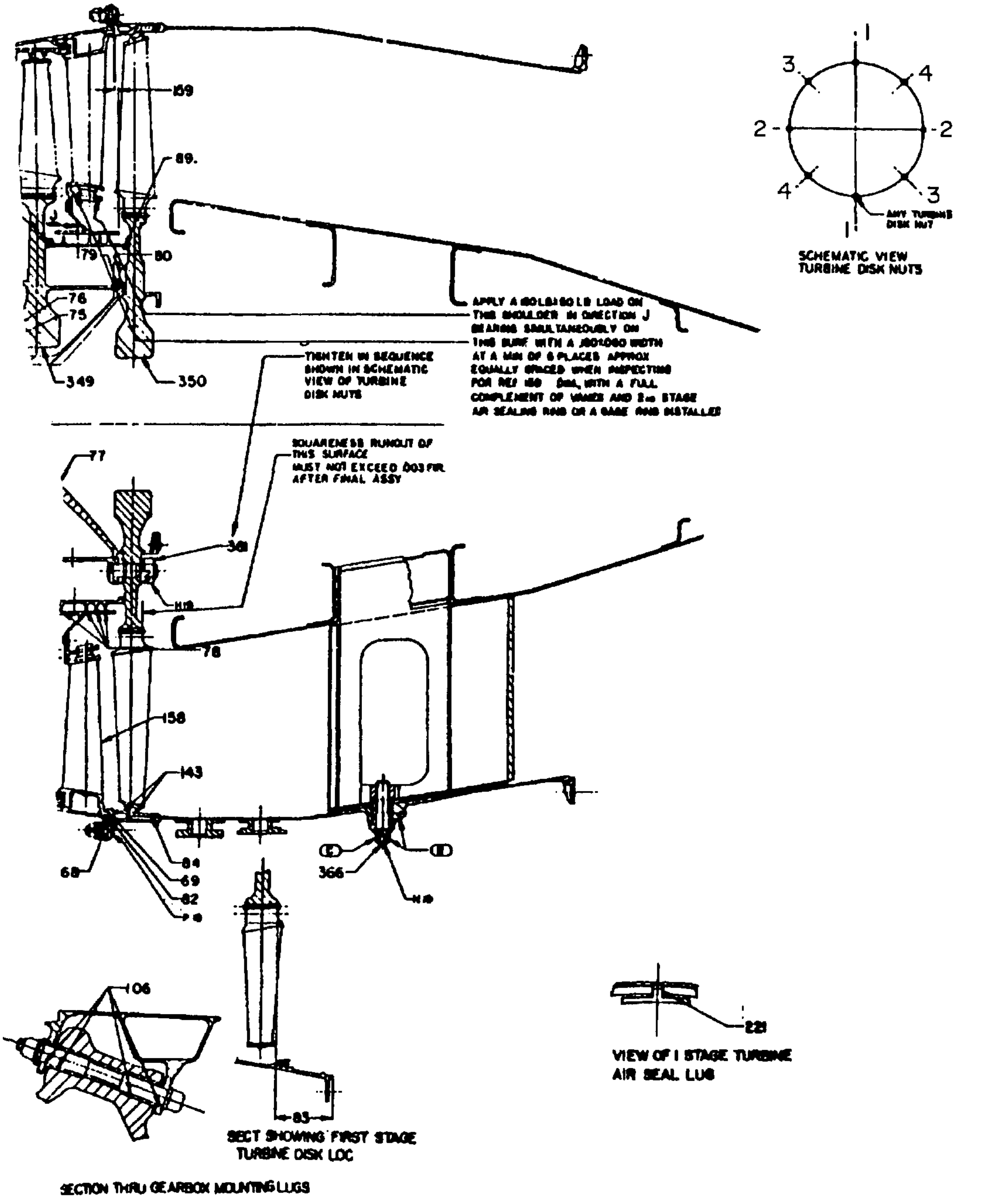
Engine Clearance Chart
(JT12A-A, -8 [N])
Figure 1004 (Sheet 2A)



L-H8054 (1107)
PW C

ORIGINAL
As Received By
ATP

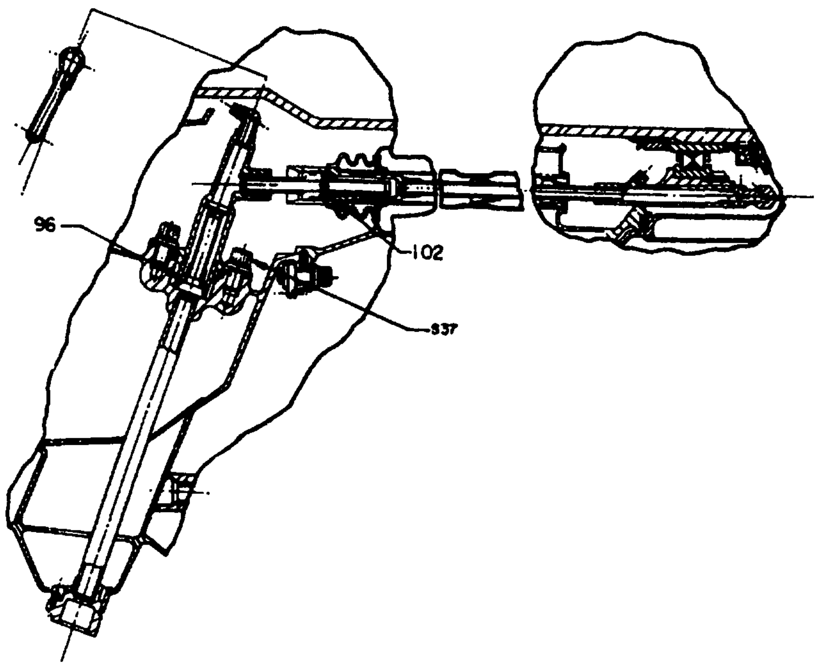
Engine Clearance Chart
(JT12A-6A,-8[N])
Figure 1004 (Sheet 3)



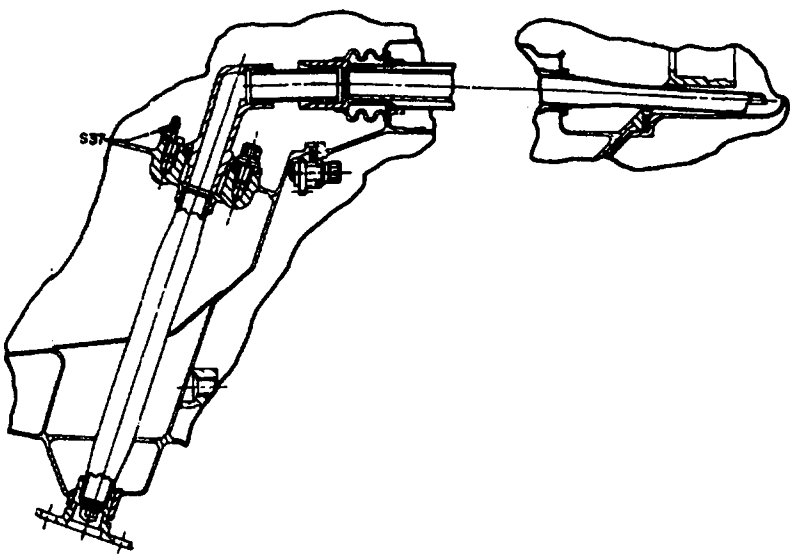
L-H8055 (0307)

R
R

Engine Clearance Chart
(JT12A-6A,-8[N])
Figure 1004 (Sheet 4)



SECTION THRU OIL PRESSURE TUBE

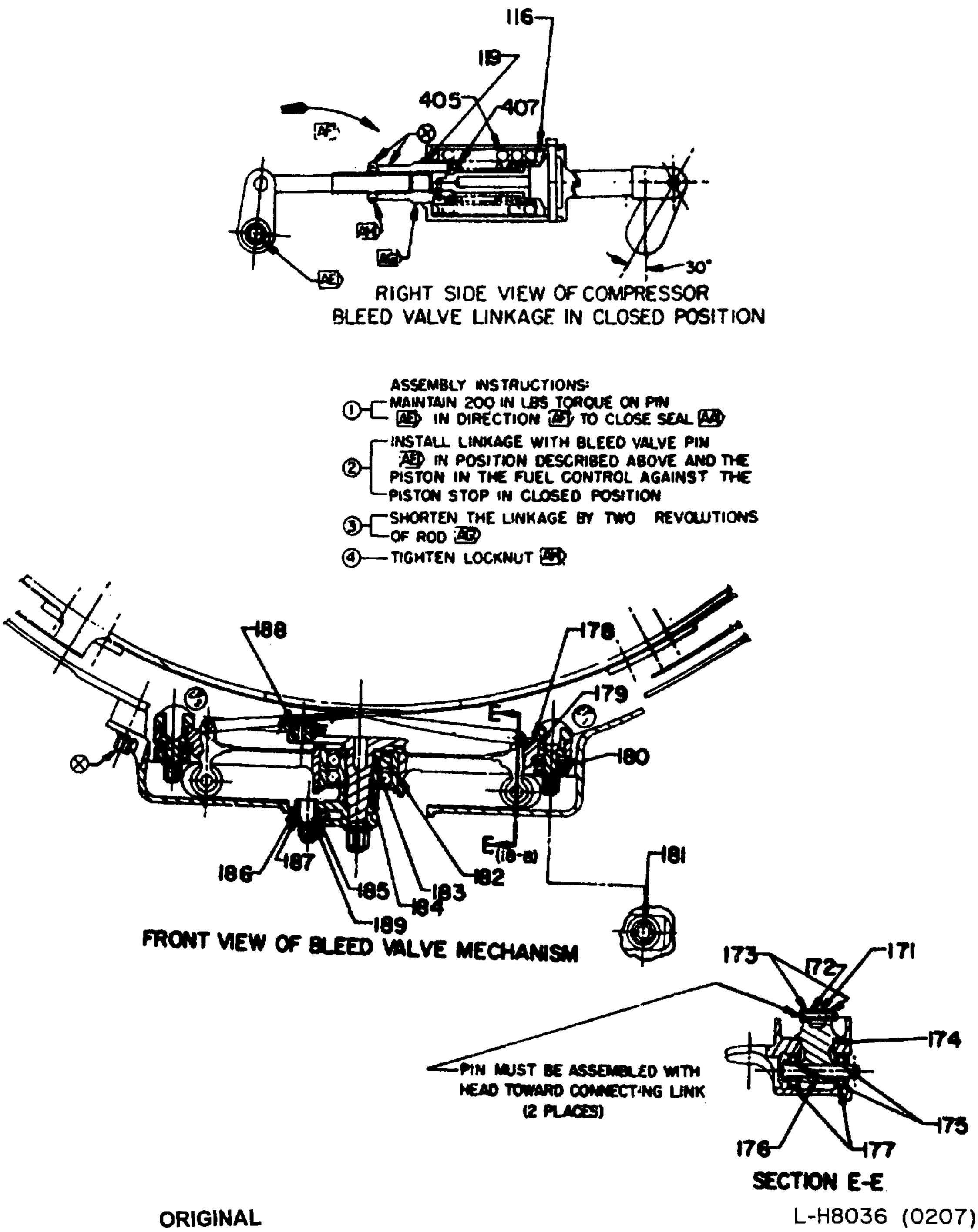


SECTION THRU OIL SUCTION TUBE

L-H8035 (0207)

R
R

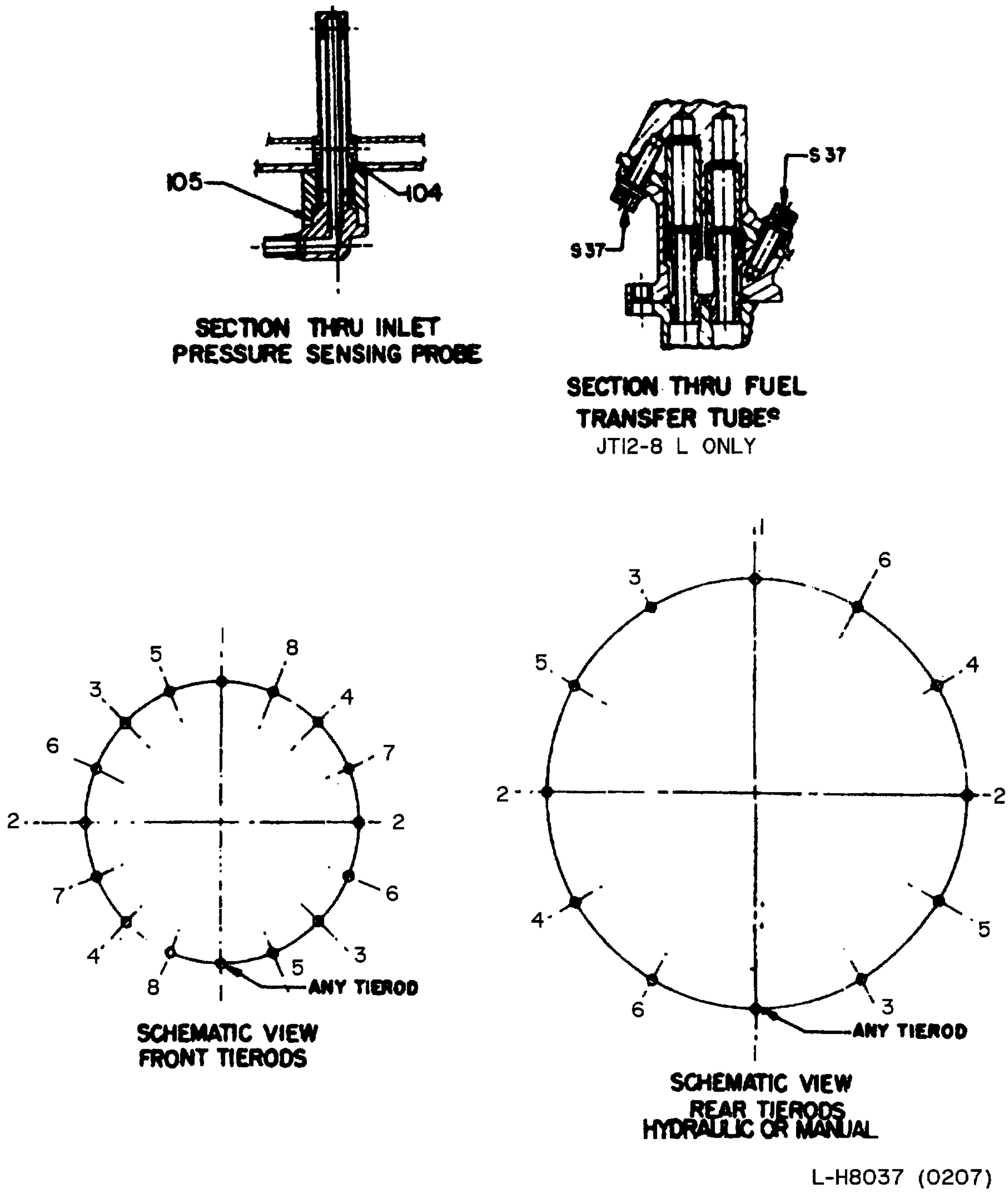
Engine Clearance Chart
(JT12A-6A,-8[N])
Figure 1004 (Sheet 5)



ORIGINAL
As Received By
ATP

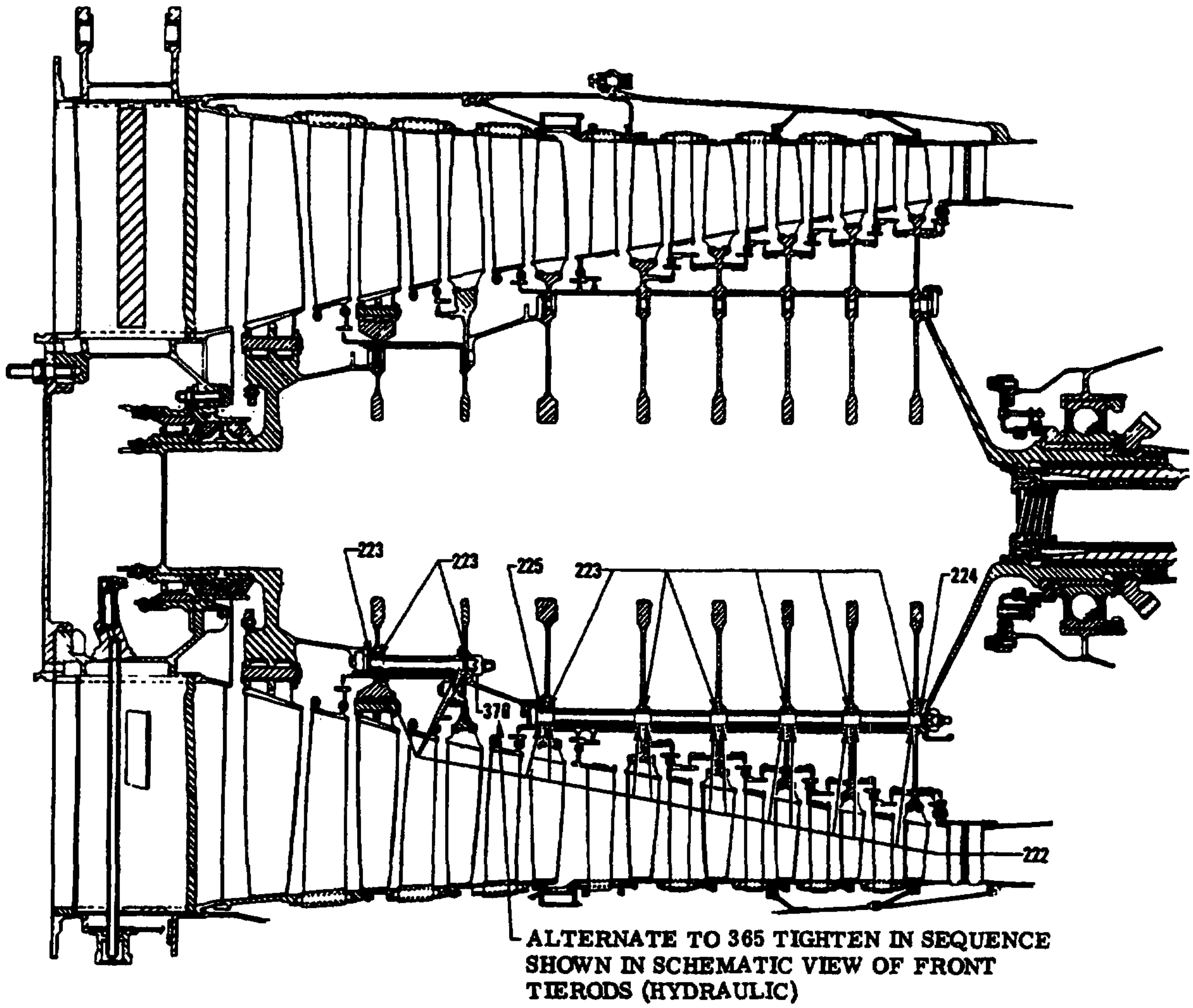
R
R

Engine Clearance Chart
(JT12A-6A,-8 [N])
Figure 1004 (Sheet 6)



R
R

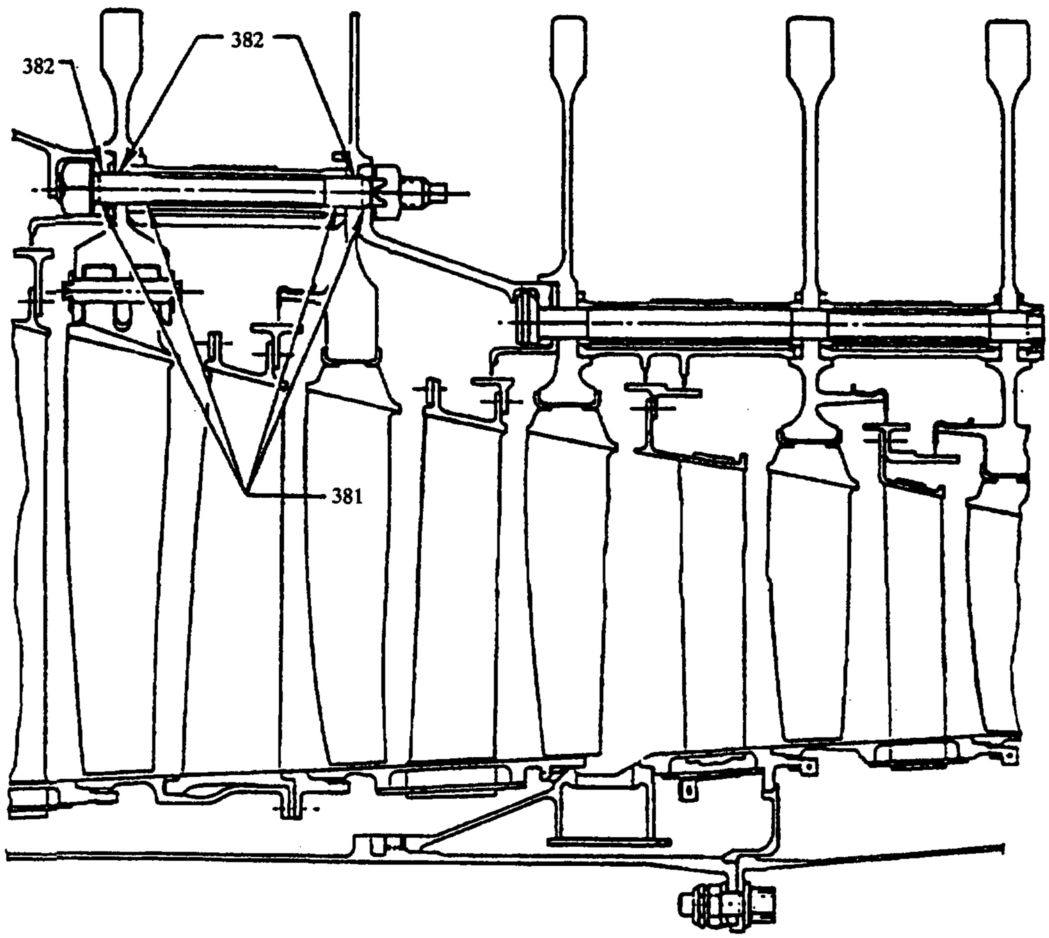
Engine Clearance Chart
(JT12A-6A,-8[N])
Figure 1004 (Sheet 7)



L-29328 (0307)

R
R

Engine Clearance Chart
(JT12A-6A,-8 [N])
Figure 1004 (Sheet 8)

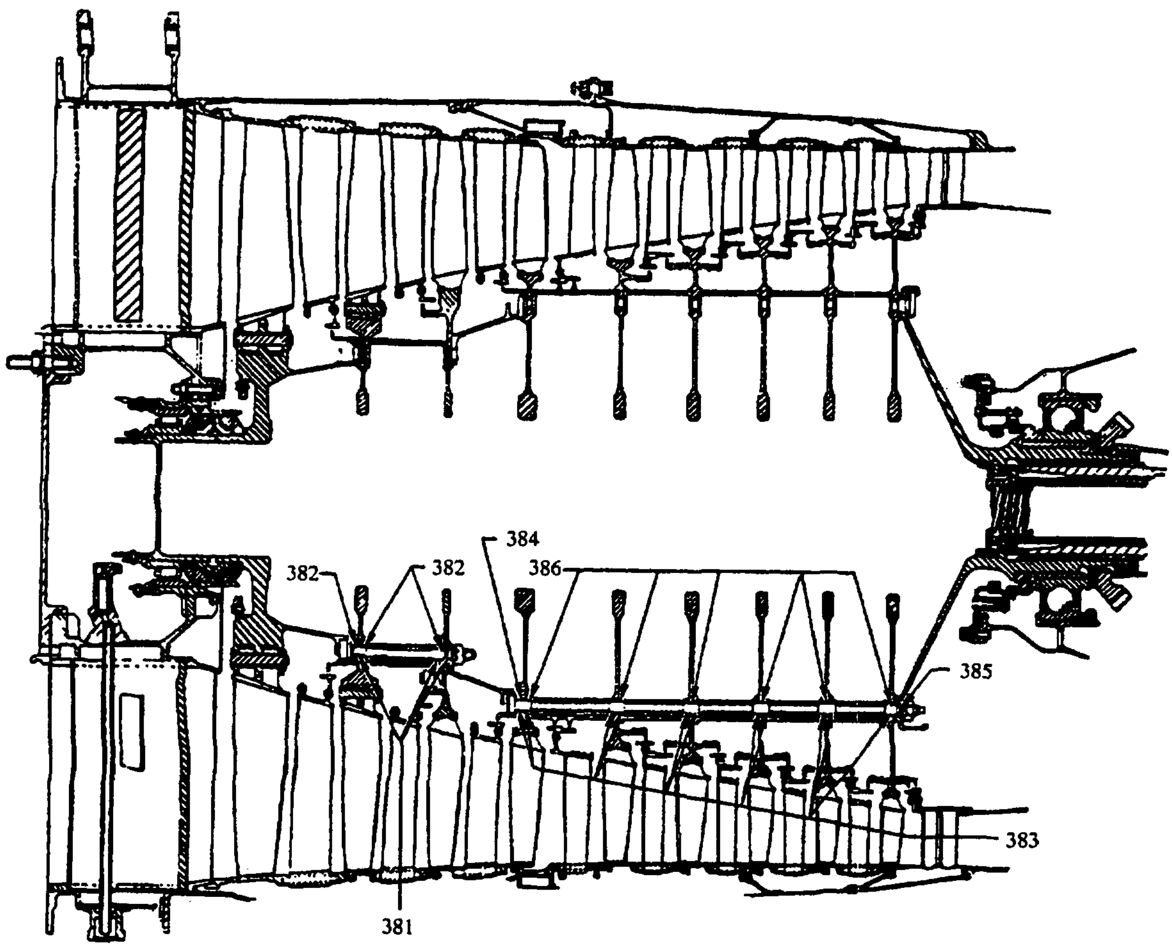


PRE SB 2564 FOR THE FRONT COMPRESSOR AND
PRE SBs 2451, 5363 AND 6229 FOR THE REAR COMPRESSOR

L-H4503 (0307)

R
R

Engine Clearance Chart
(JT12A-6A,-8[N])
Figure 1004 (Sheet 9)

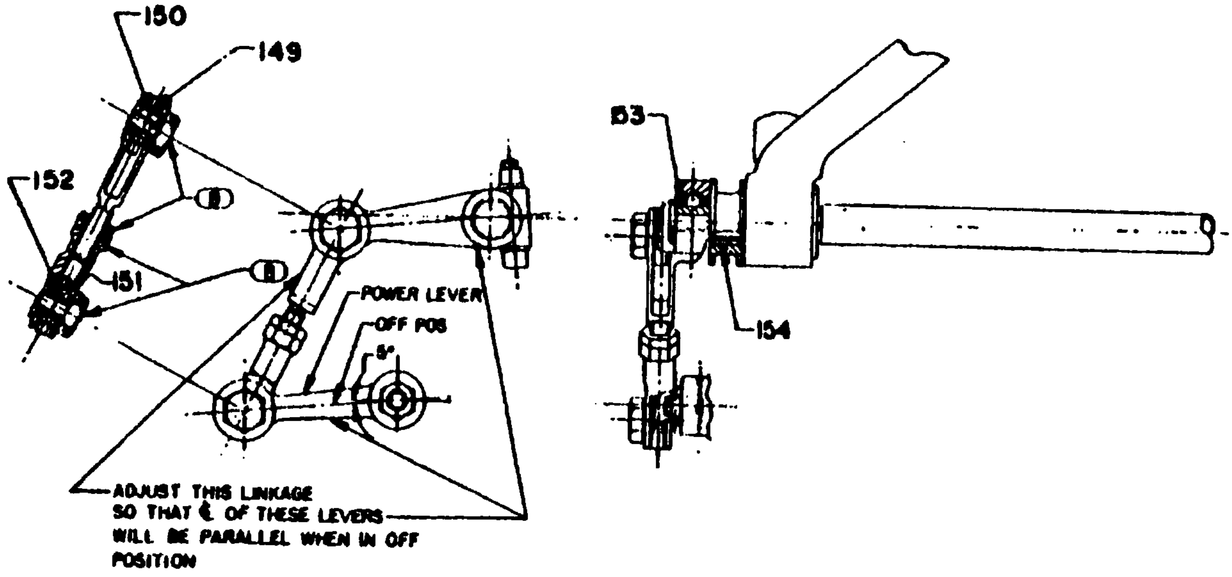


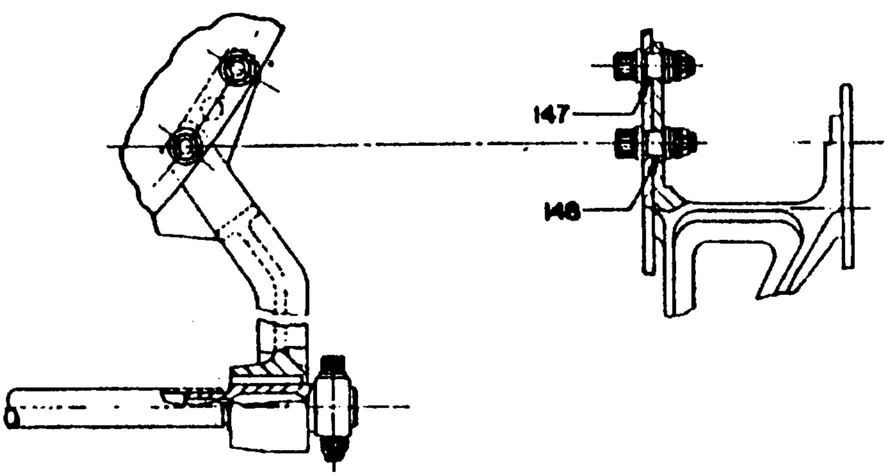
PRE SB 2564 FOR THE FRONT COMPRESSOR AND
PRE SBs 2451, 5363 AND 6229 FOR THE REAR COMPRESSOR

L-H4501 (0307)

R
R

Engine Clearance Chart
(JT12A-6A, -8 [N])
Figure 1004 (Sheet 10)



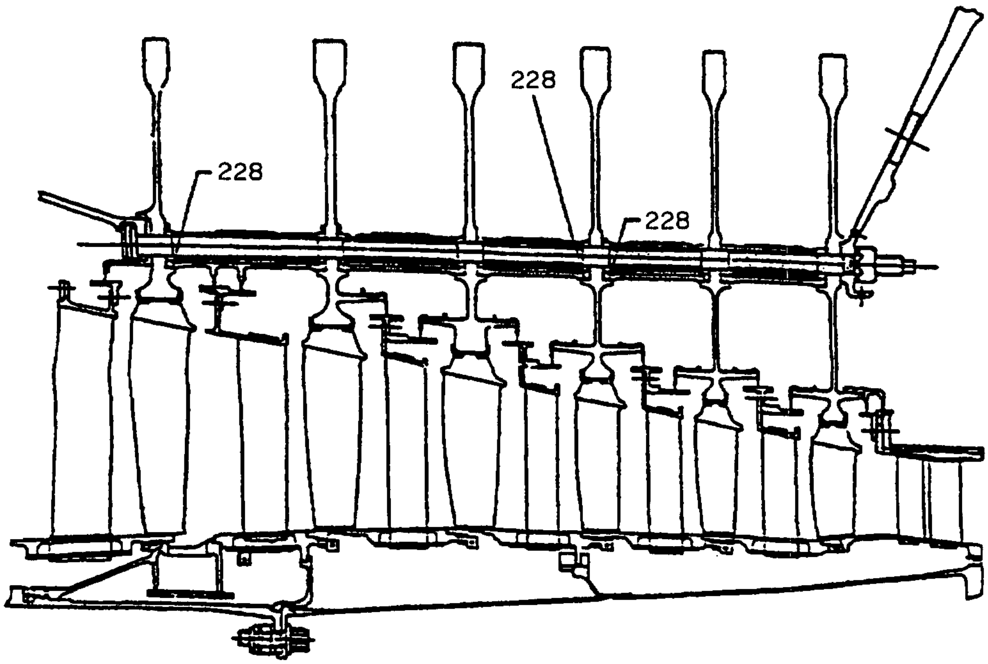


VIEW OF POWER LEVER CROSS SHAFT

L-H8056 (0307)

R
R

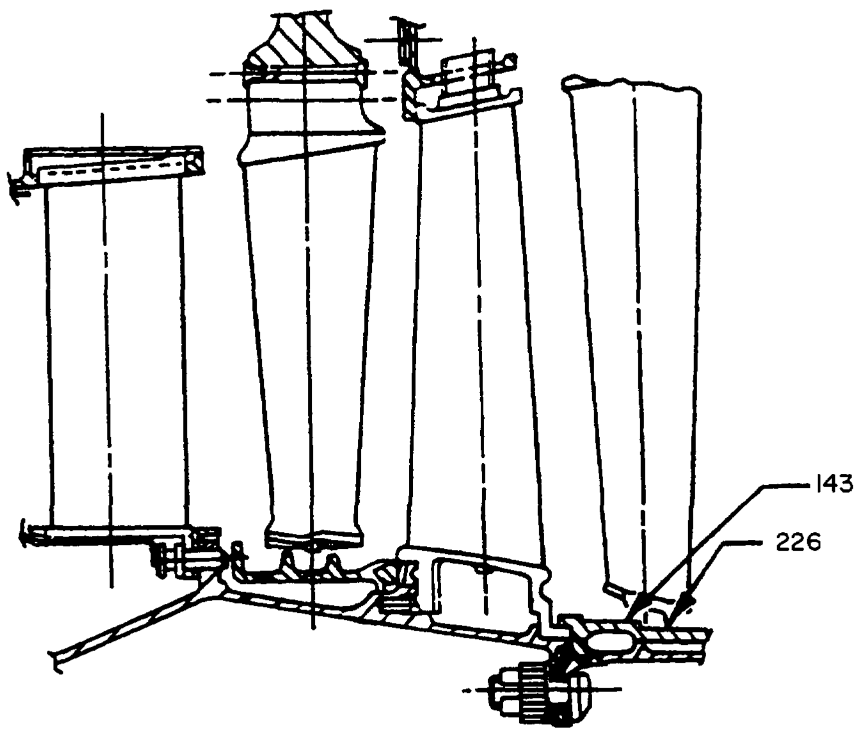
Engine Clearance Chart
(JT12A-6A,-8[N])
Figure 1004 (Sheet 11)



L-H8057 (0307)

R
R

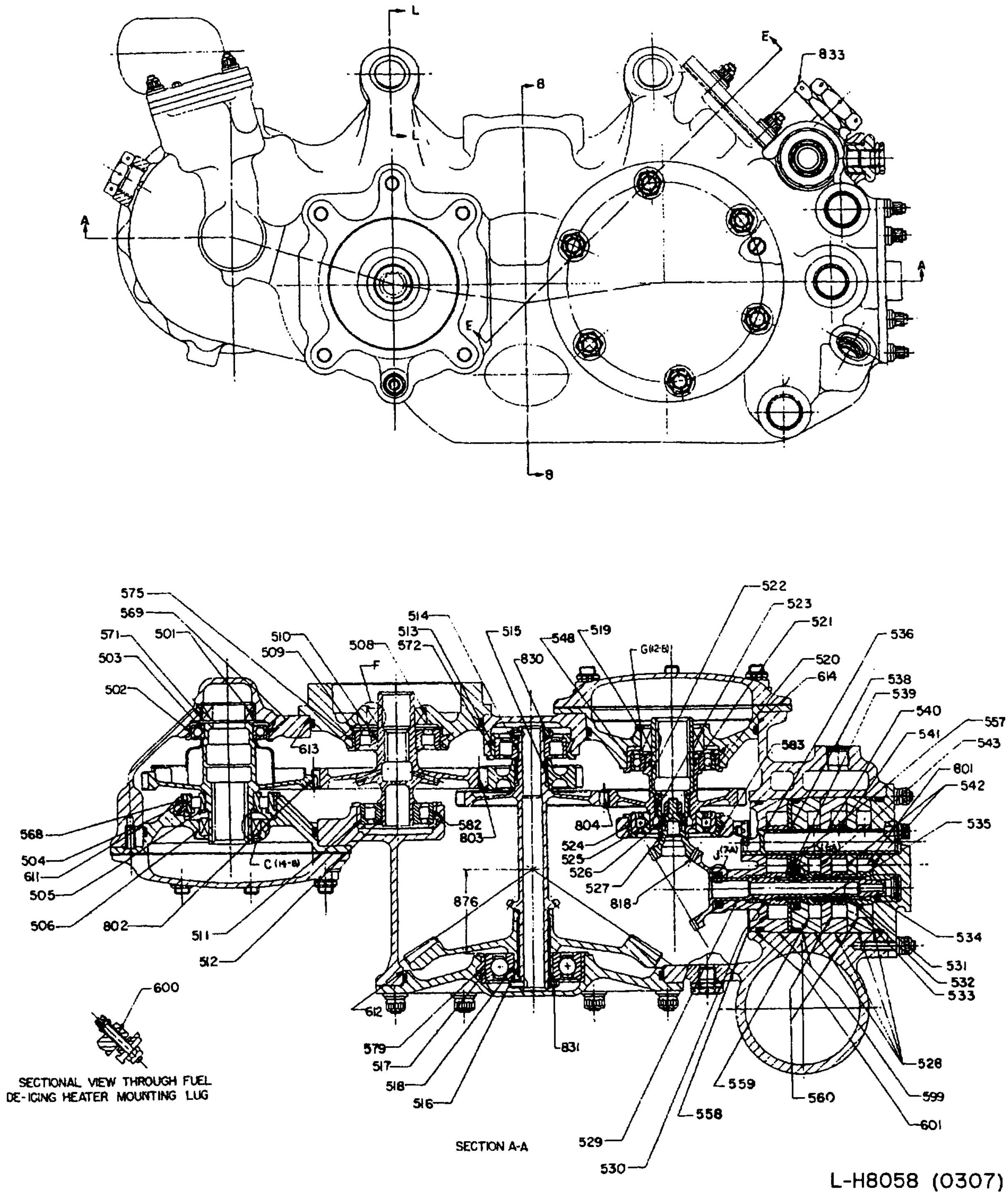
Engine Clearance Chart
(JT12A-6A,-8[N])
Figure 1004 (Sheet 12)



L-37080 (0307)

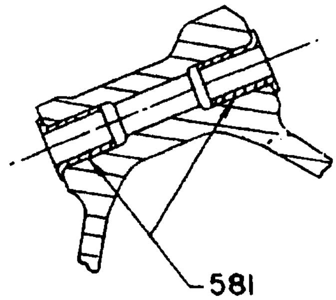
R
R

Engine Clearance Chart
(JT12A-6A,-8 [N])
Figure 1004 (Sheet 13)

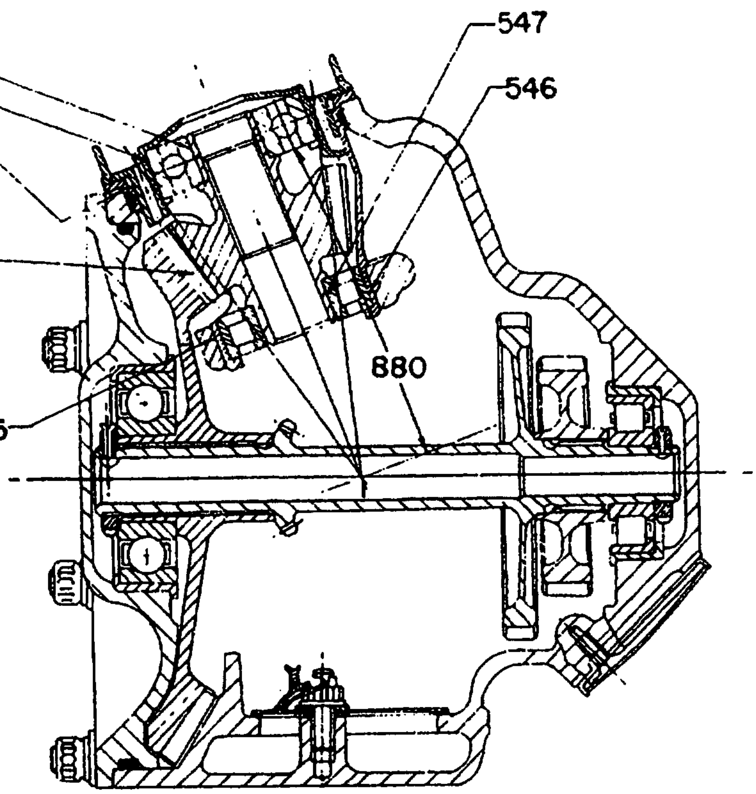


R
R

Accessory Section Clearance Chart
(JT12A-6A, -8 [N])
Figure 1005 (Sheet 1)



SECTION L-L

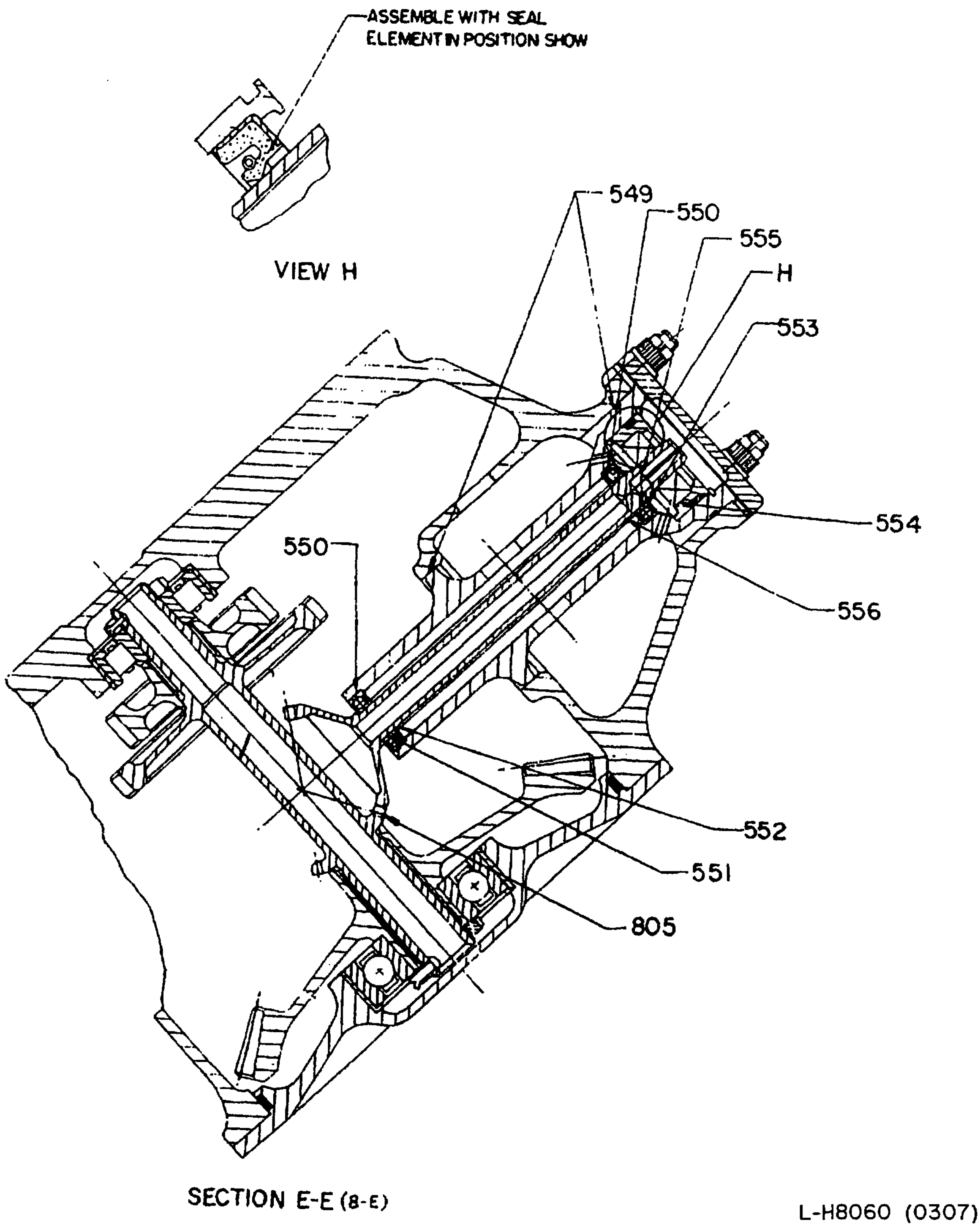


SECTION B-B

L-H8059 (0307)

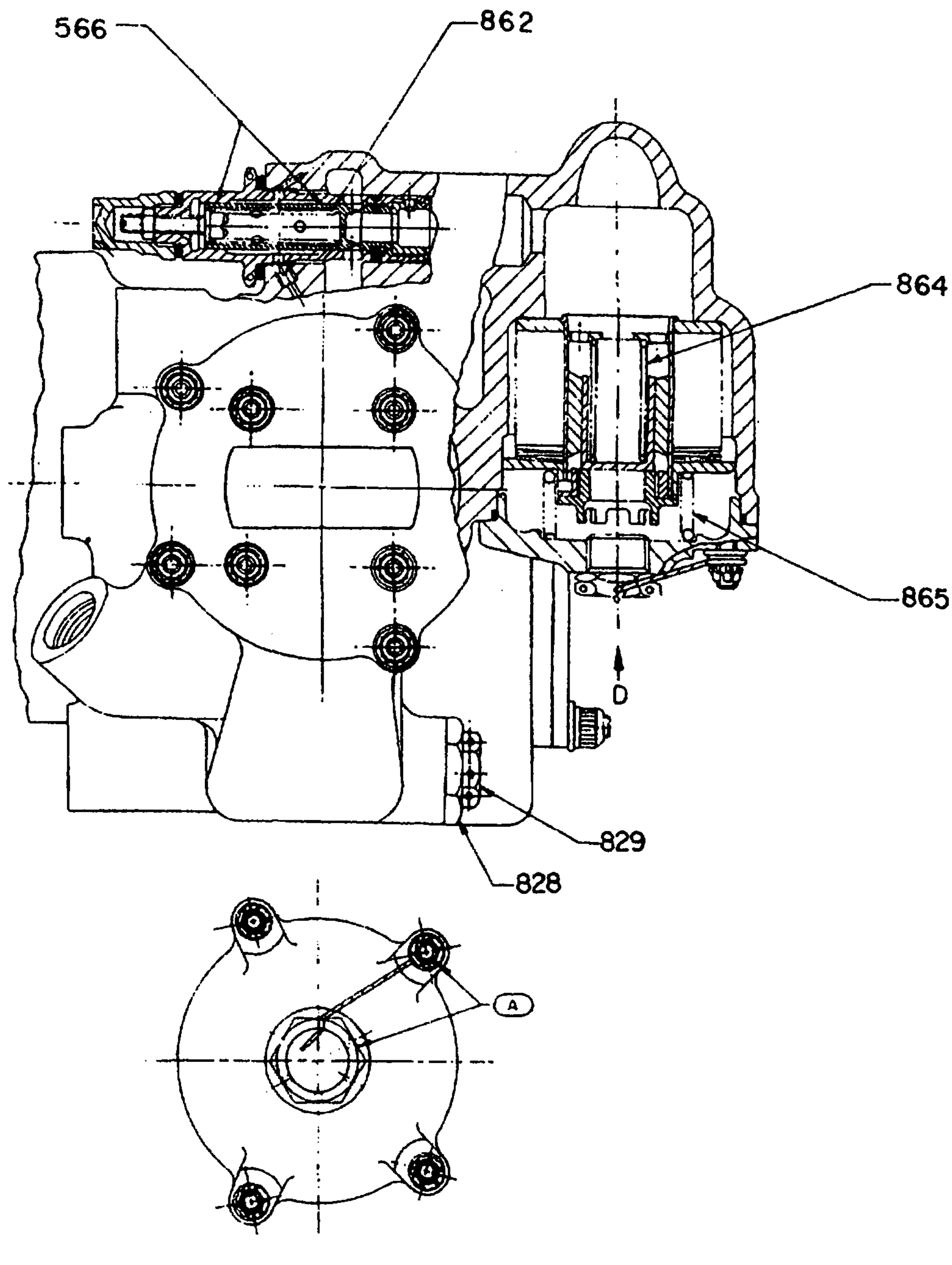
R
R

Accessory Section Clearance Chart
(JT12A-6A,-8[N])
Figure 1005 (Sheet 2)



R
R

Accessory Section Clearance Chart
(JT12A-6A,-8[N])
Figure 1005 (Sheet 3)

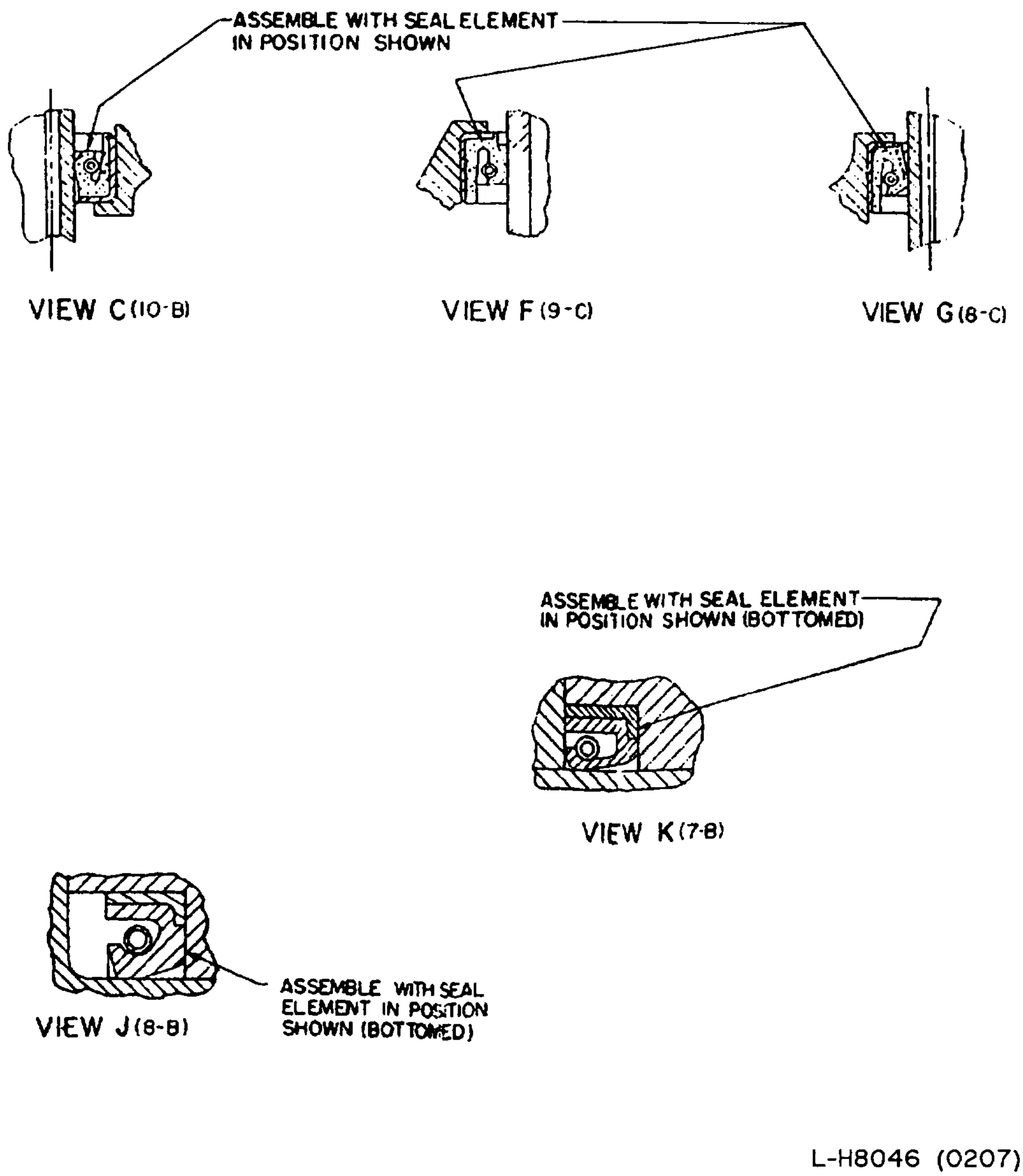


VIEW D

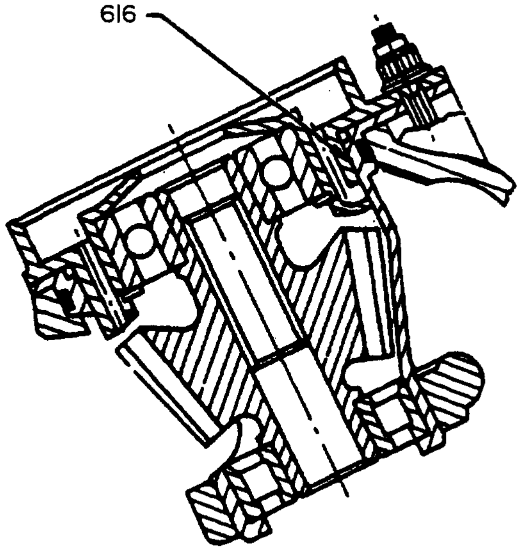
L-H806I (0307)

R
R

Accessory Section Clearance Chart
(JT12A-6A, -8 [N])
Figure 1005 (Sheet 4)

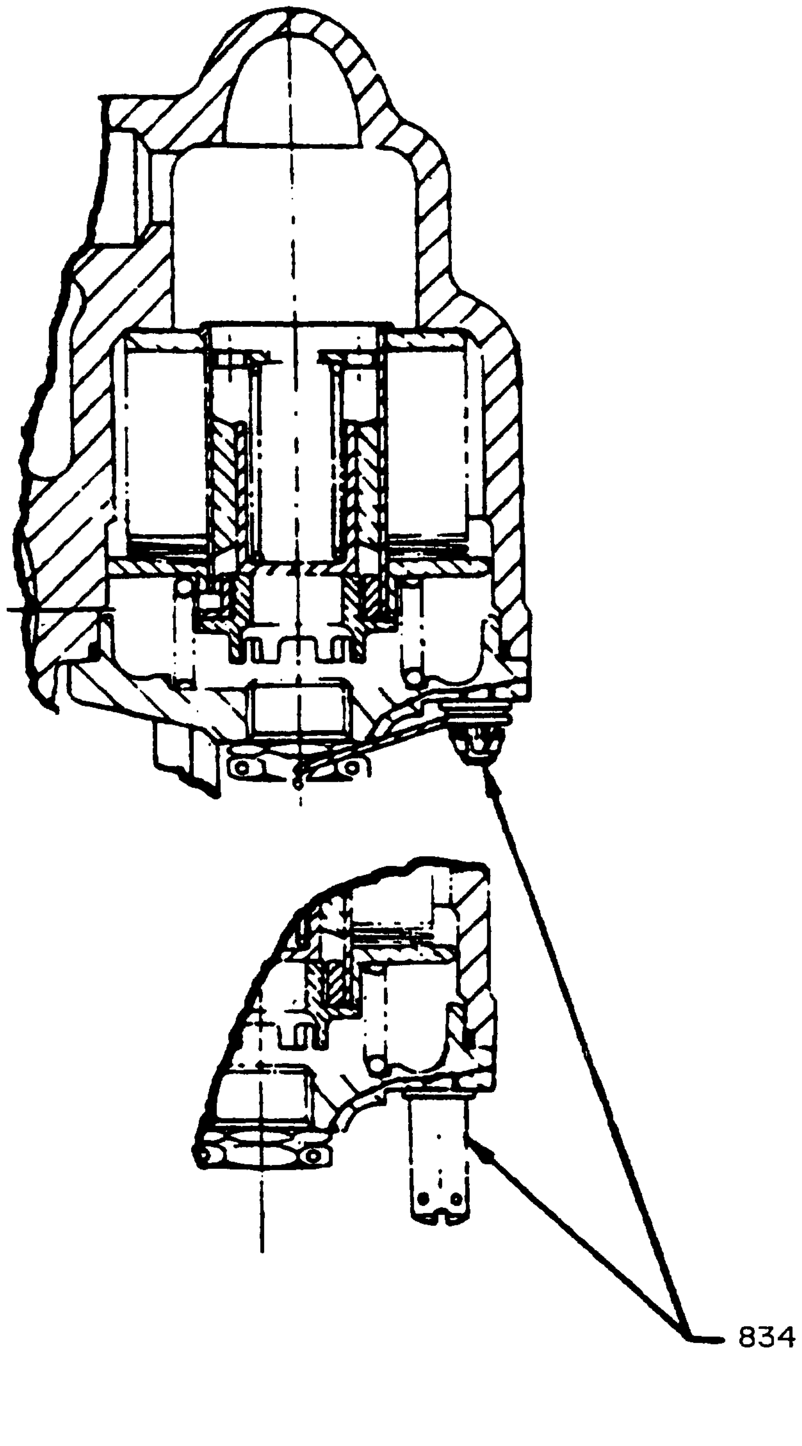


R
R
Accessory Section Clearance Chart
(JT12A-6A,-8[N])
Figure 1005 (Sheet 5)



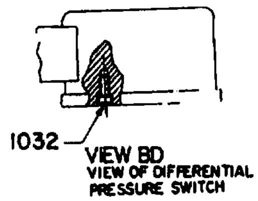
MAIN COMPONENT DRIVEGEAR UPPER BEARING HOUSING FIT

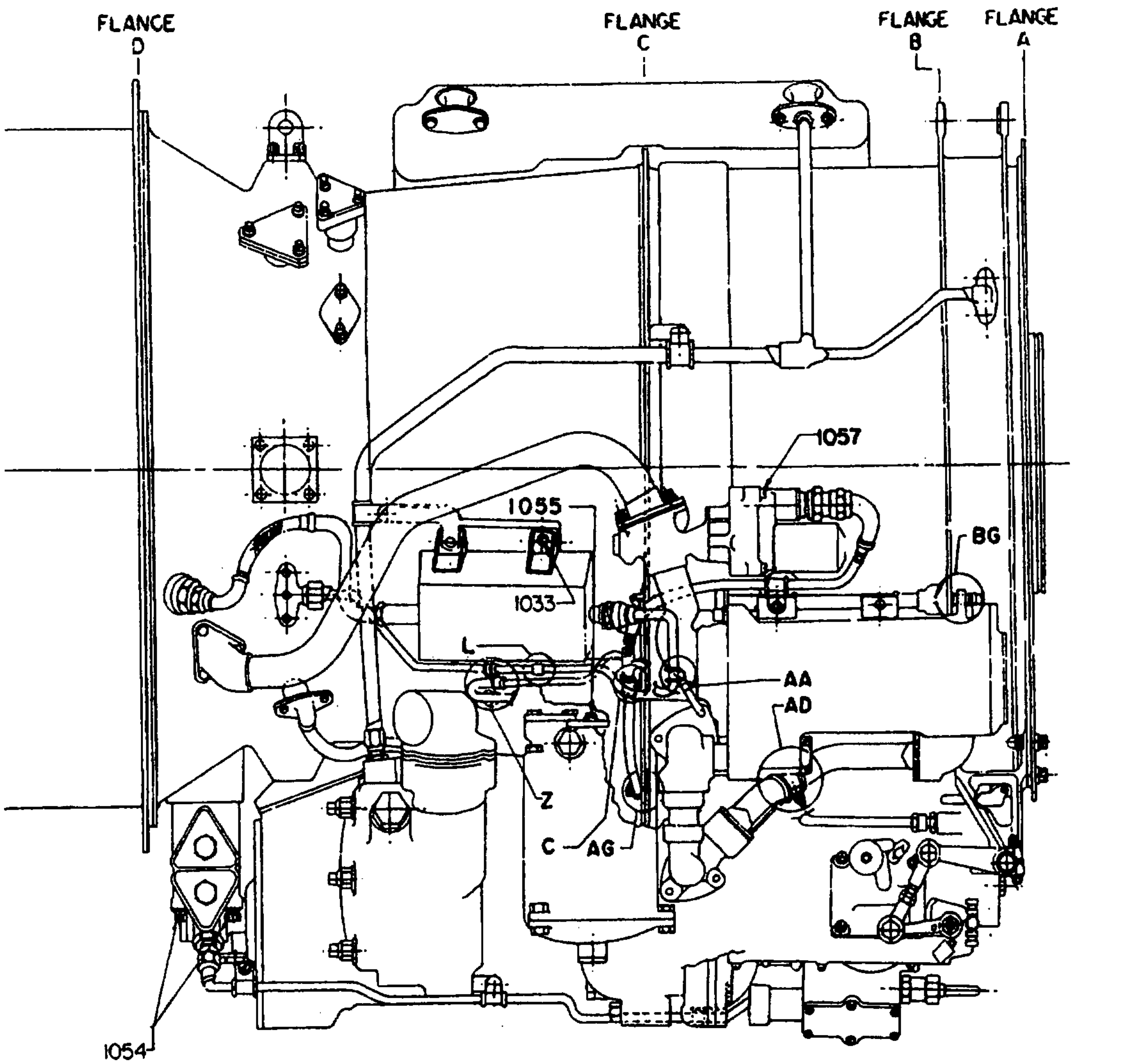
L-H8062 (0307)



R
R

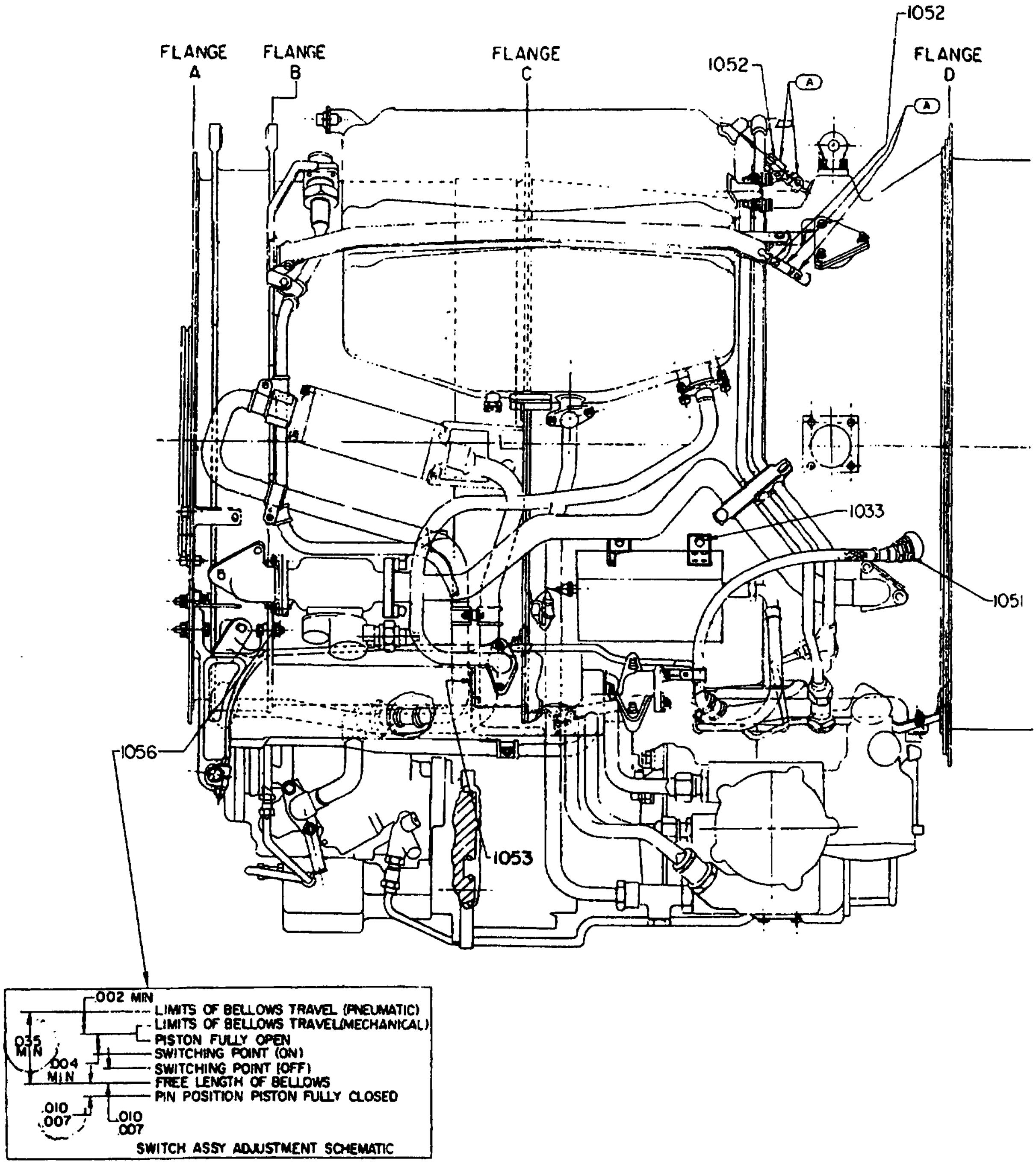
Accessory Section Clearance Chart
(JT12A-6A,-8[N])
Figure 1005 (Sheet 7)





R
R

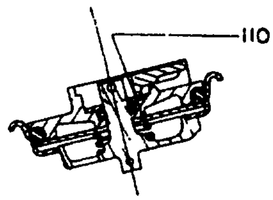
External Parts Clearance Chart
(JT12A-6A,-8 [N])
Figure 1006 (Sheet 1)



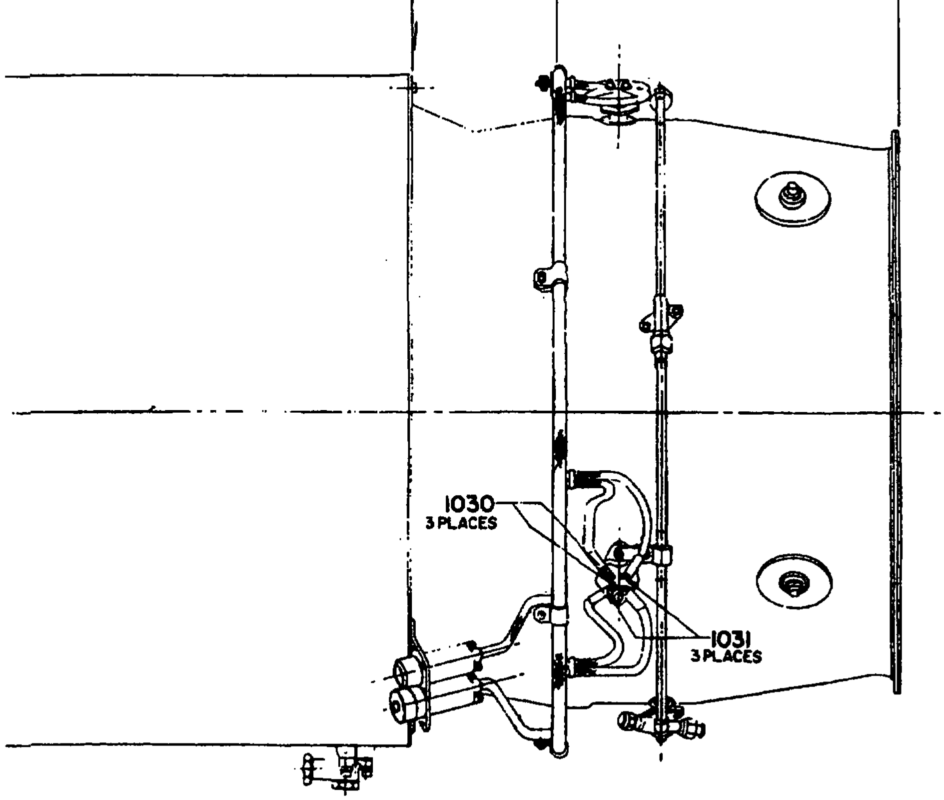
L-H8064 (0307)

R
R

External Parts Clearance Chart
(JT12A-6A,-8[N])
Figure 1006 (Sheet 2)



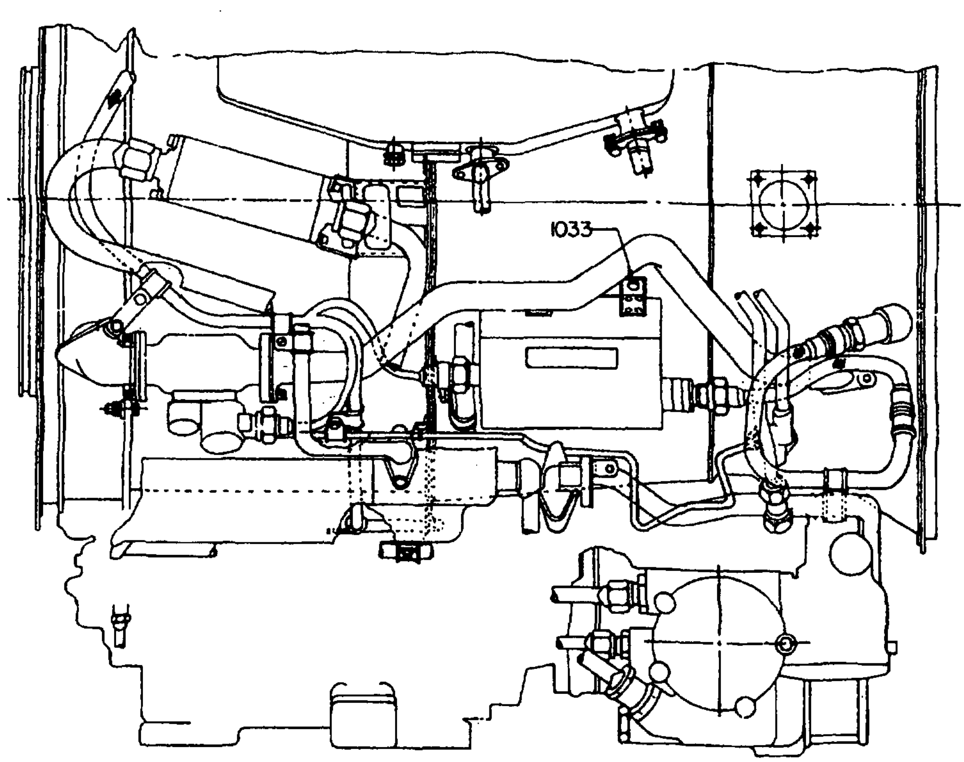
SECT. VIEW OF OIL TANK CAP



L-H8065 (0307)

R
R

External Parts Clearance Chart
(JT12A-6A,-8 [N])
Figure 1006 (Sheet 3)

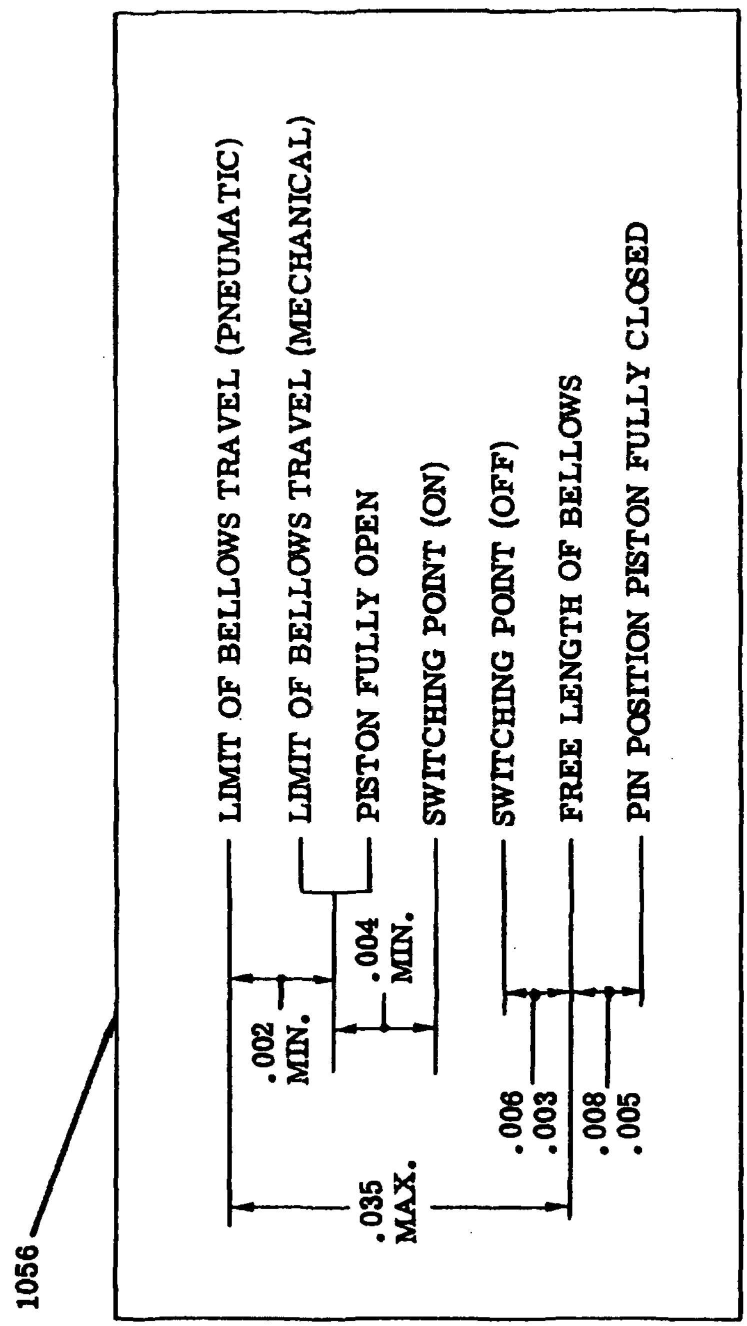


LEFT SIDE
ALTERNATE IGNITION (CONTINUOUS)

L-H8066 (0307)

R
R

External Parts Clearance Chart
(JT12A-6A, -8 [N])
Figure 1006 (Sheet 4)

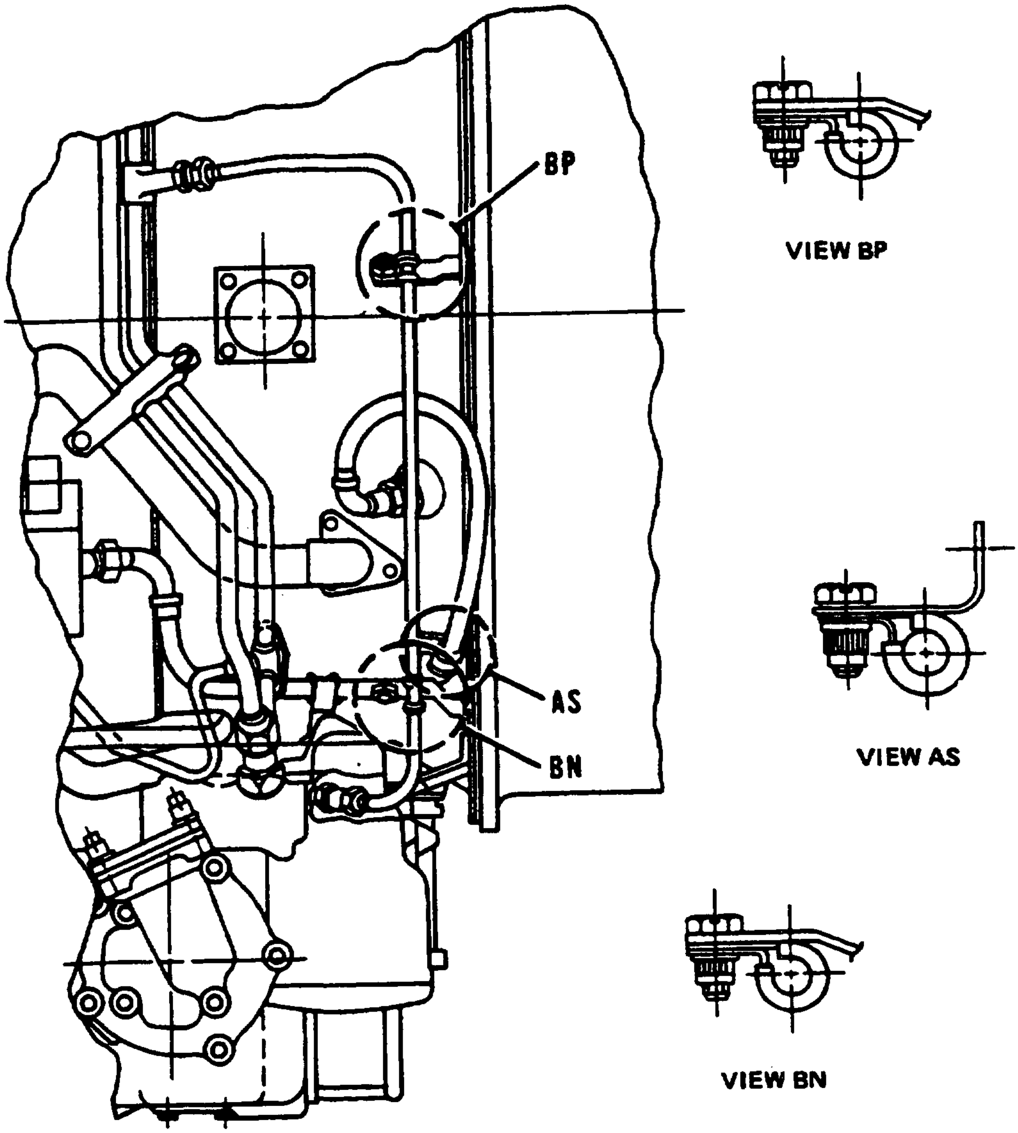


SWITCH ASSEMBLY ADJUSTMENT SCHEMATIC
(P/N 693027 VALVE ASSEMBLY ONLY)

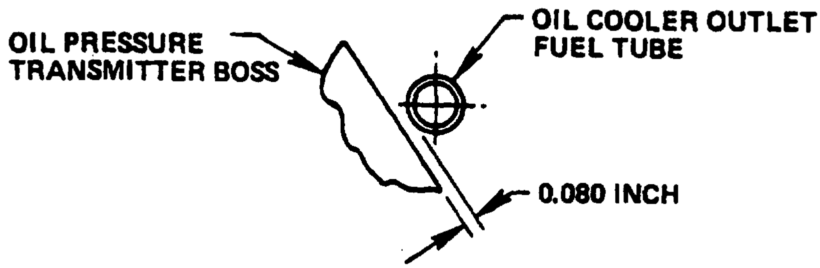
L-29384 (0307)

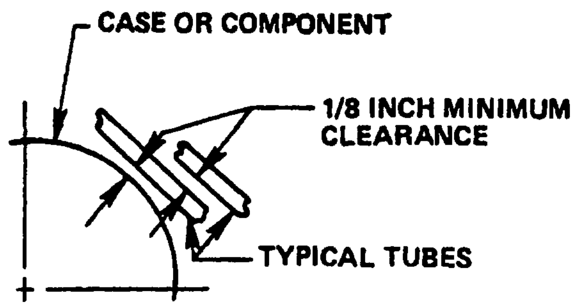
R
R

External Parts Clearance Chart
(JT12A-6A, -8 [N])
Figure 1006 (Sheet 5)



R
R
External Parts Clearance Chart
(JT12A-6A,-8[N])
Figure 1006 (Sheet 6)



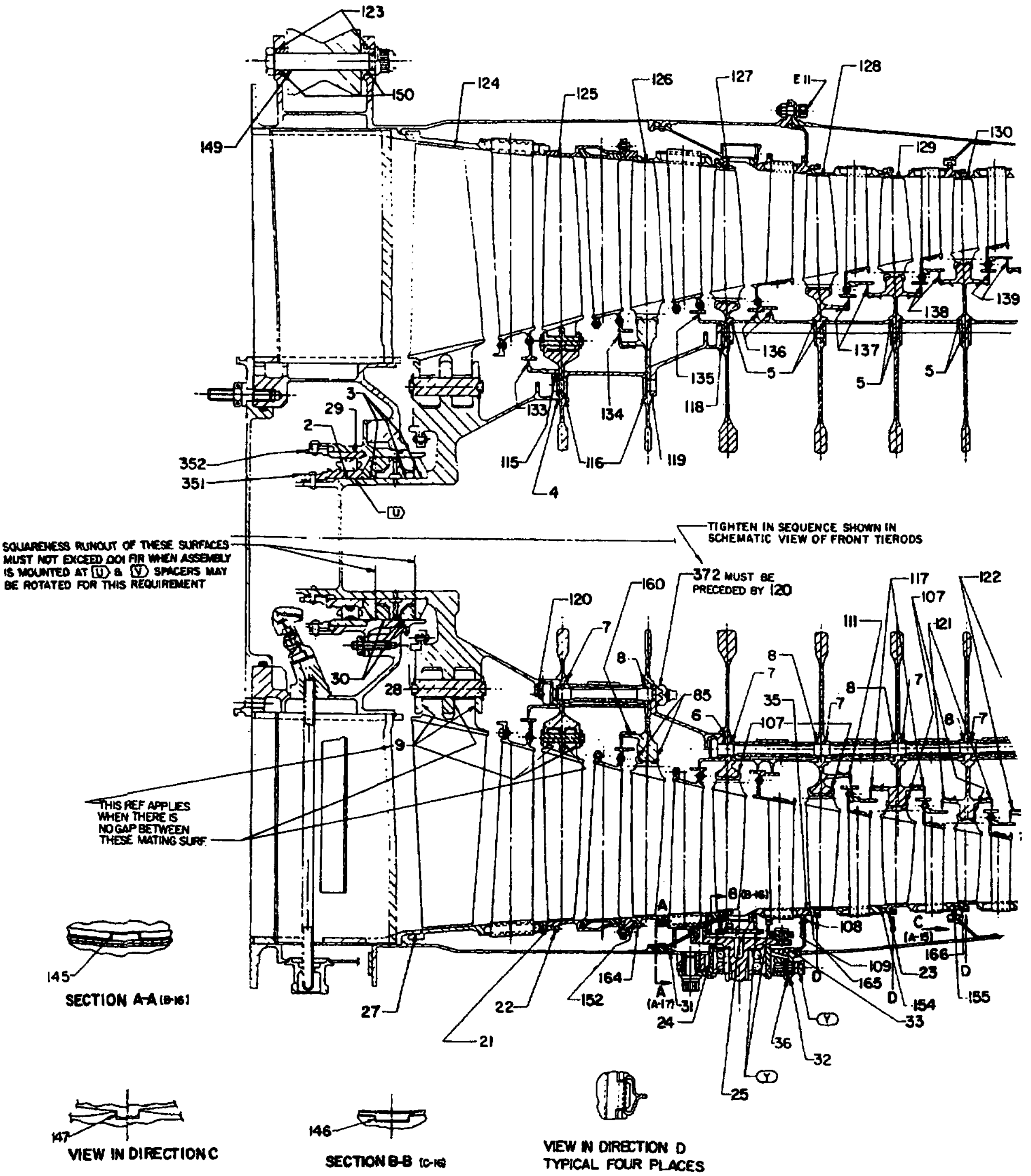


NOTE: Unless otherwise specified, clearance between tubes (except where clipped together) and between tubes and other external engine parts must be 0.125 inch minimum.

L-65299 (0307)

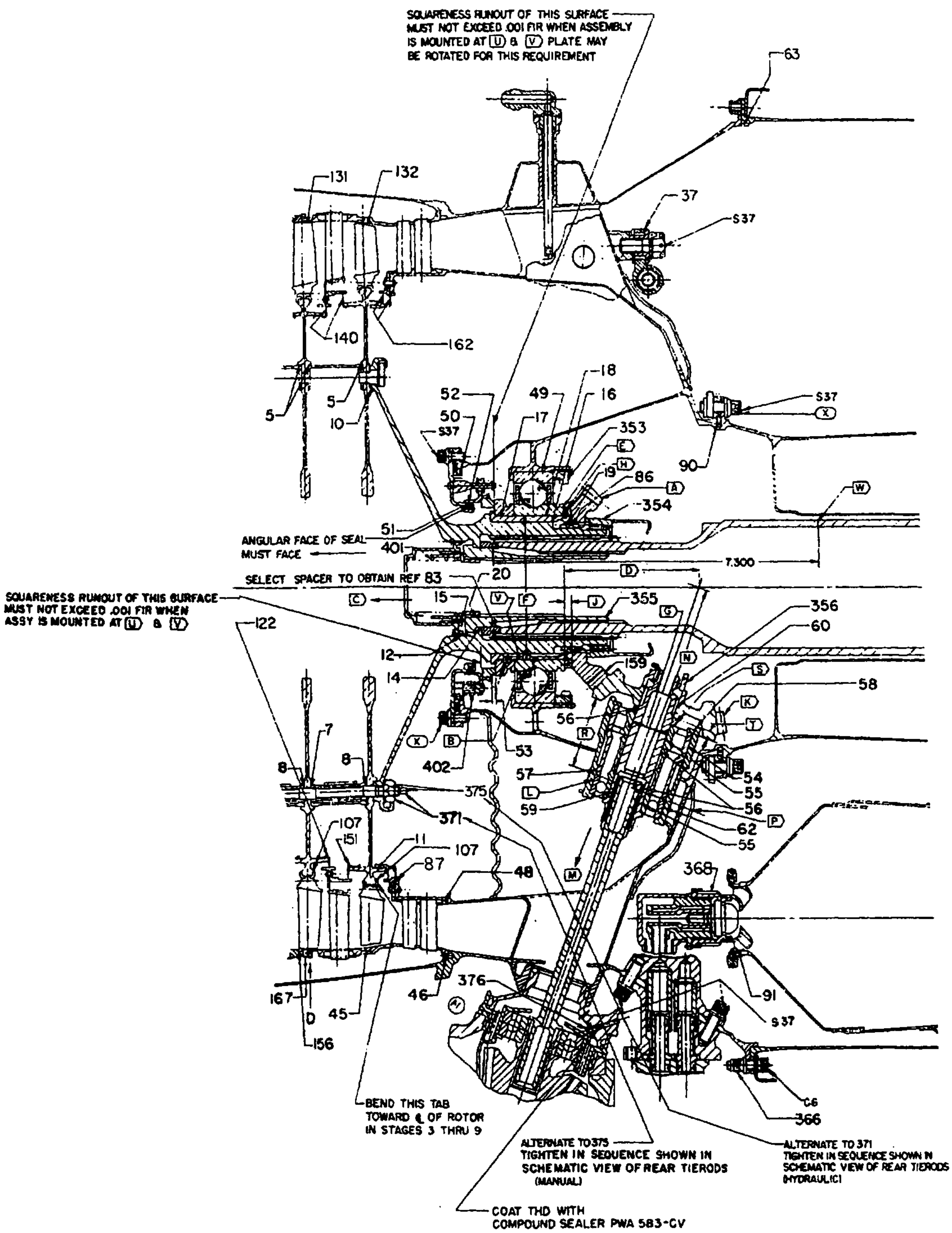
R
R

External Parts Clearance Chart
(JT12A-6A, -8 [N])
Figure 1006 (Sheet 7)



L-H8068 (0307)

ORIGINAL
As Received By
ATP

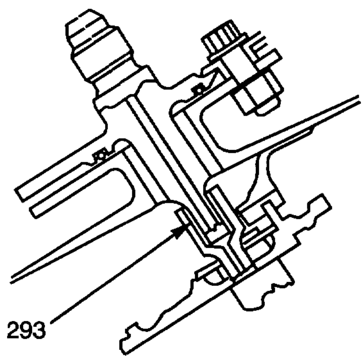


L-H8069 (0307)

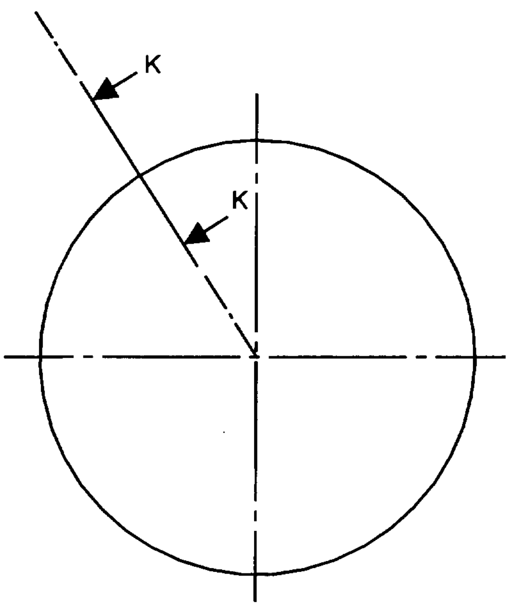
ORIGINAL
As Received By
ATP

R
R

Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 2)



SECTION K-K



SCHEMATIC FRONT VIEW OF 6TH STAGE
COMPRESSOR STATOR PRESSURE PICK UP
JFTD12A -5A ONLY

L-H8368 (1107)
PW V

Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 2A)

FOR MOUNTING GEAR [A]

① END PLAY OF BEARING [B] MUST BE TAKEN UP IN DIRECTION OF THRUST [C] TO OBTAIN DIM. [D]

② MEASURE DISTANCE [D] IN RELATION TO FACE [E] AND INTERSECTION OF ℄ OF DIA [F] & DIA [G]

③ GRIND SPACER [H] WITH DIM. [J] ±.0005 EQUAL TO [D] - 2.890

④ SPACER FACES MUST BE PARALLEL WITHIN .0005 FIR. AFTER GRINDING

FOR MOUNTING GEAR [K]

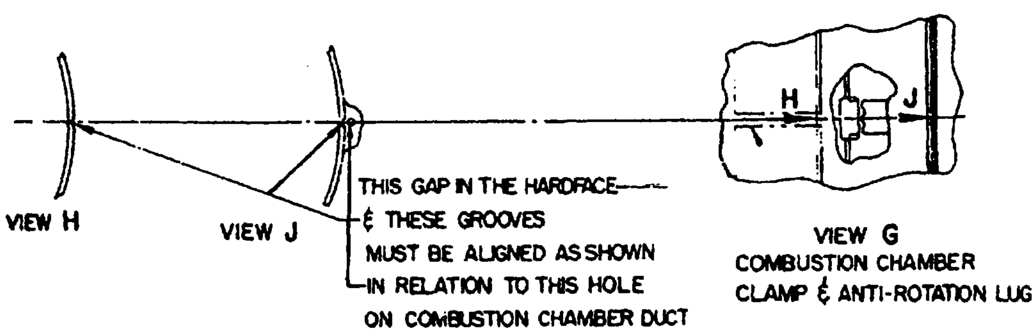
① END PLAY OF BEARING [L] MUST BE TAKEN UP IN DIRECTION OF THRUST [M] TO OBTAIN DIM. [N]

② MEASURE DISTANCE [N] IN RELATION TO FACE [P] AND INTERSECTION OF ℄ OF DIA [F] & DIA [G]

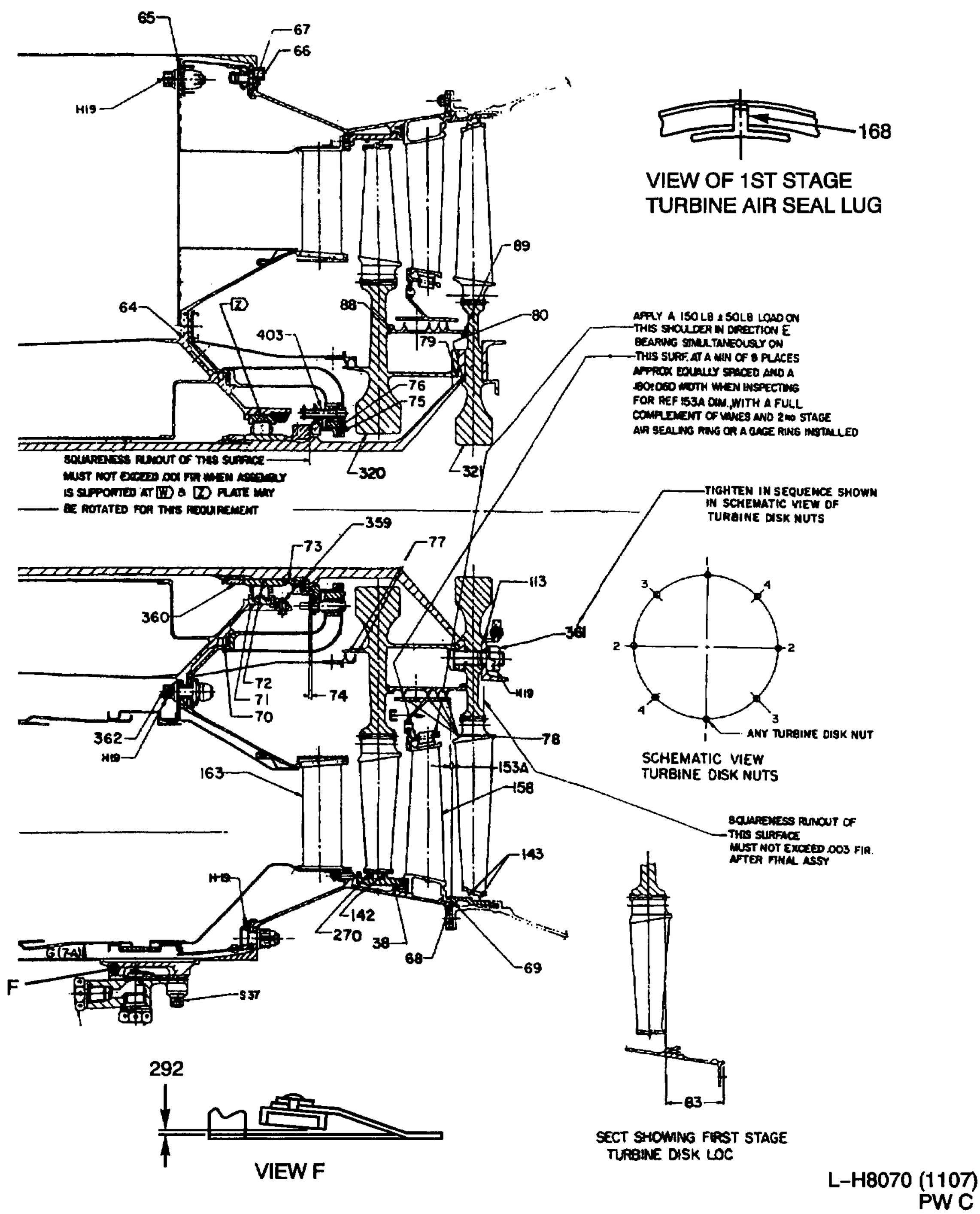
③ MEASURE DISTANCE [R]

④ GRIND SPACER [S] WITH DIM. [T] ±.0005 EQUAL TO ([N] - 2.990) - [R]

⑤ SPACER FACES MUST BE PARALLEL WITHIN .0005 FIR. AFTER GRINDING

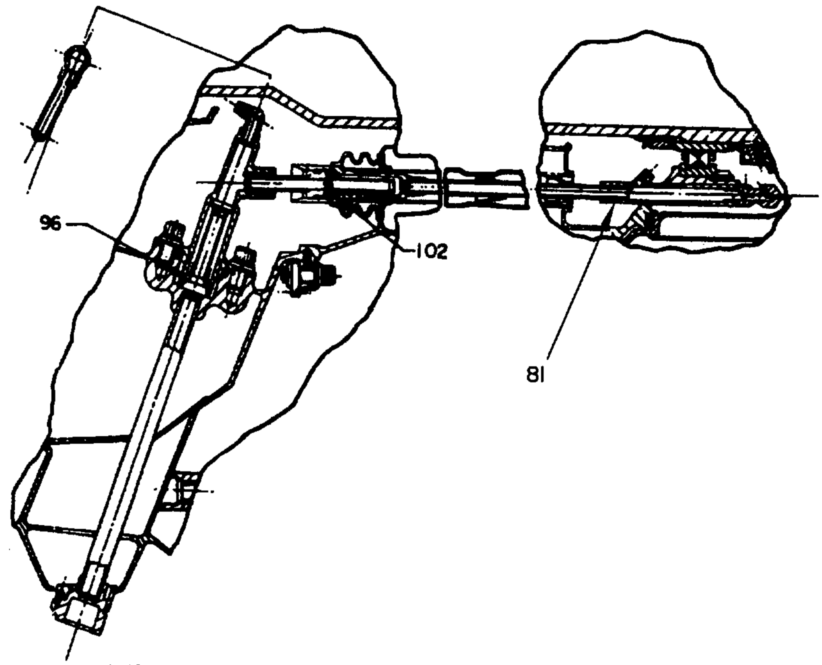


L-H8067 (0307)

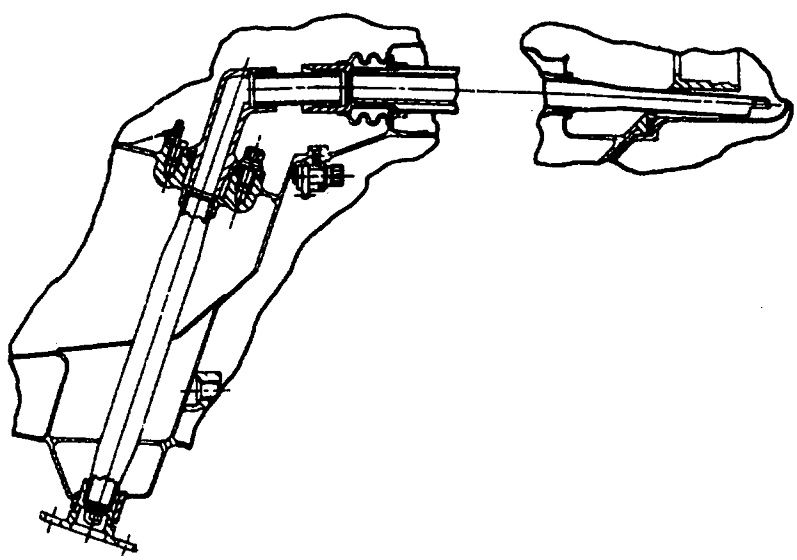


ORIGINAL
As Received By
ATP

Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 3)



SECTION THRU OIL PRESSURE TUBE

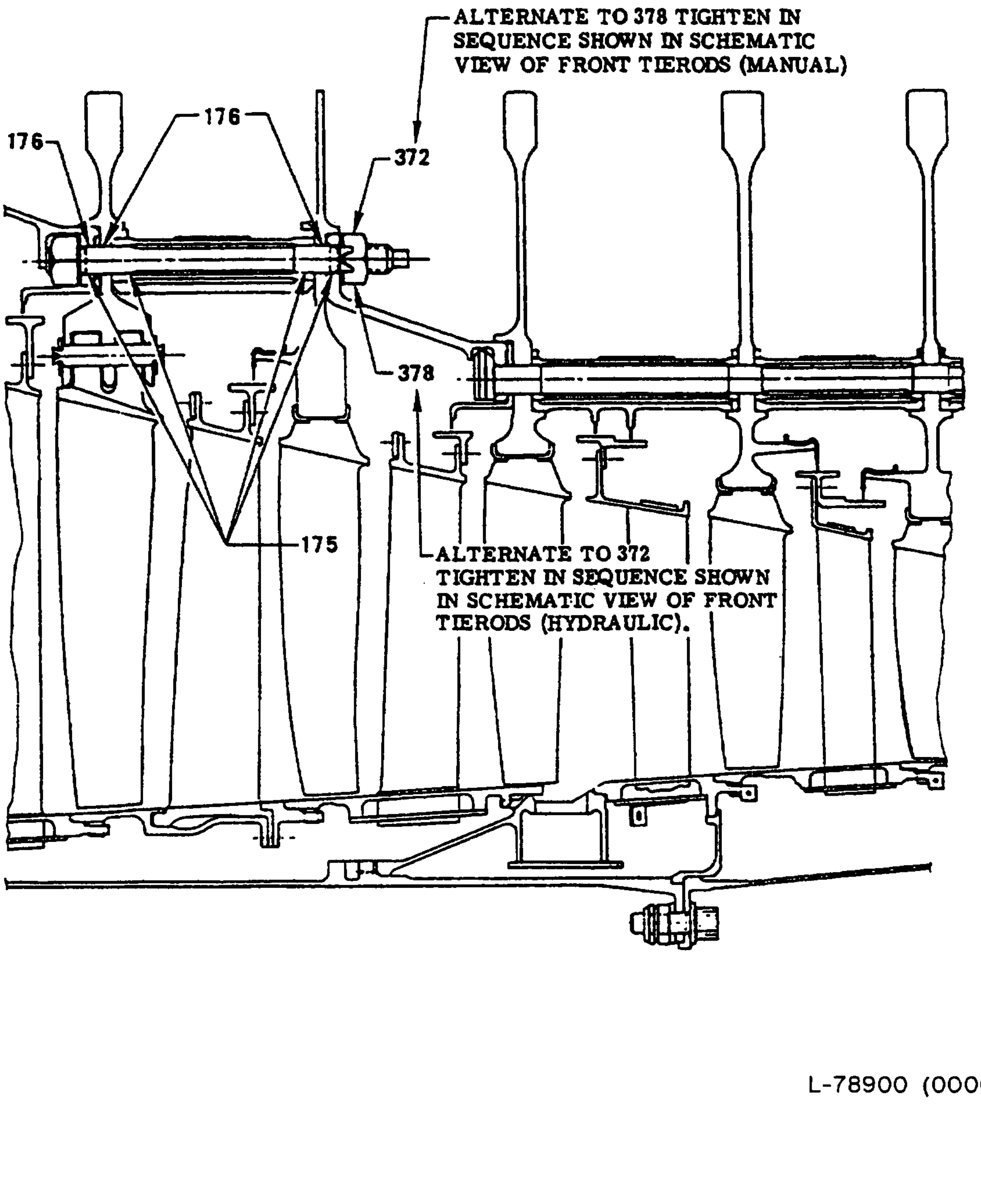


SECTION THRU OIL SUCTION TUBE

L-H8071 (0307)

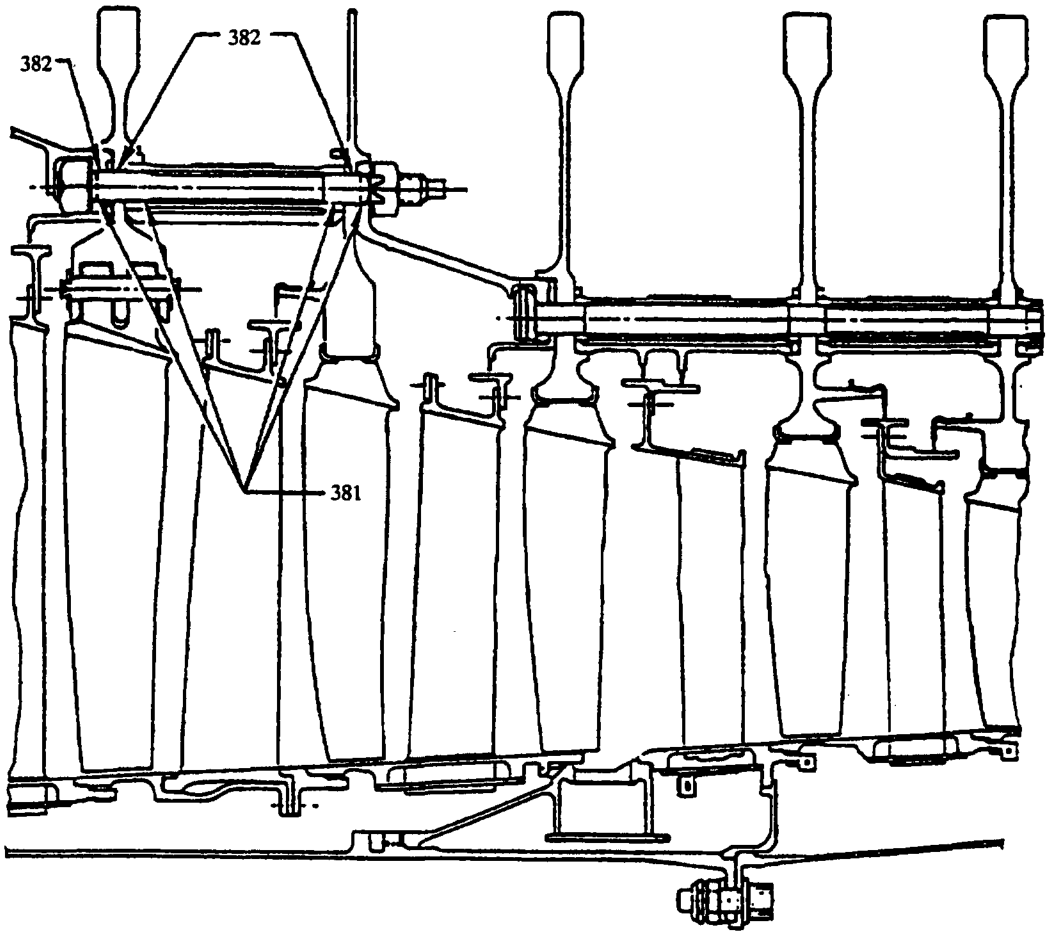
R
R

Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 4)



R
R

Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 5)

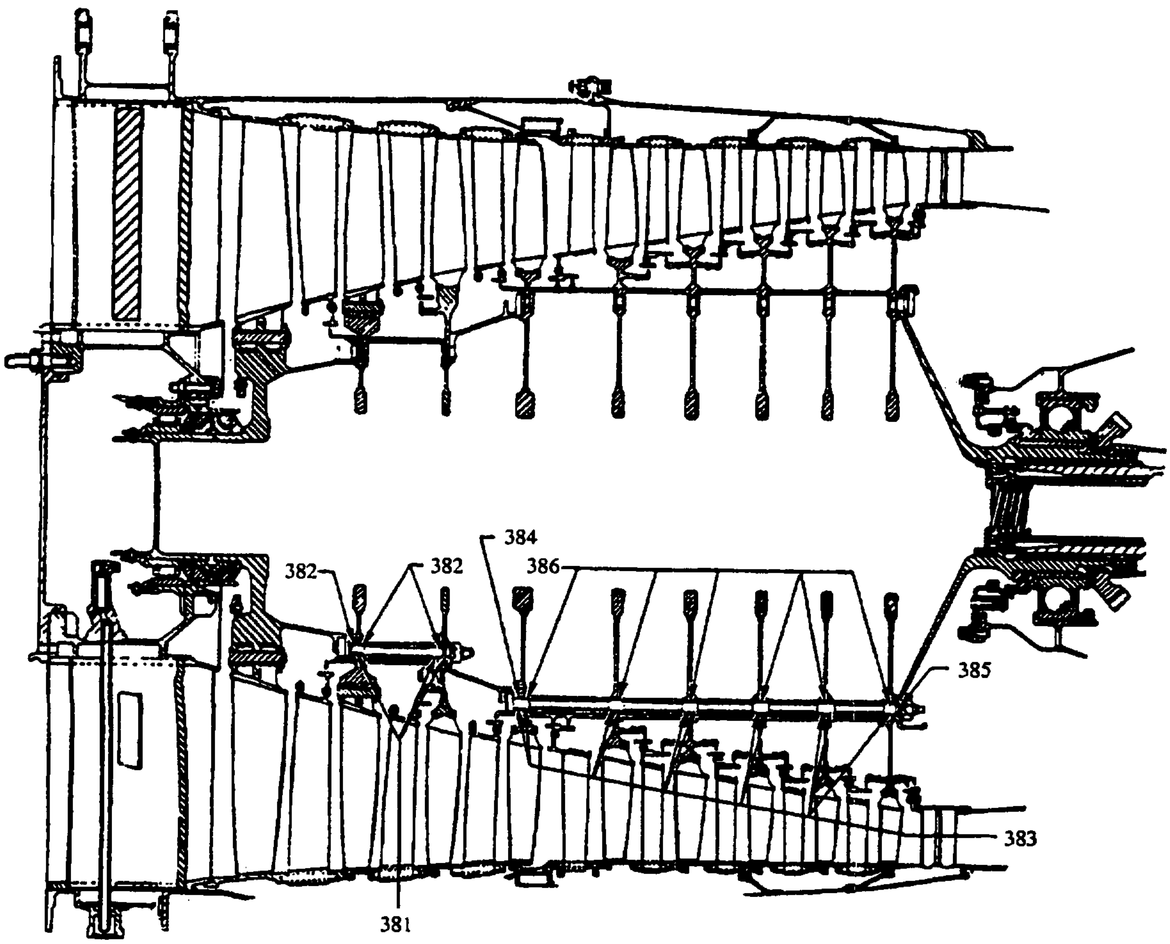


PRE SB 2564 FOR THE FRONT COMPRESSOR AND
PRE SBs 2451, 5363 AND 6229 FOR THE REAR COMPRESSOR

L-H4503 (0307)

R
R

Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 6)

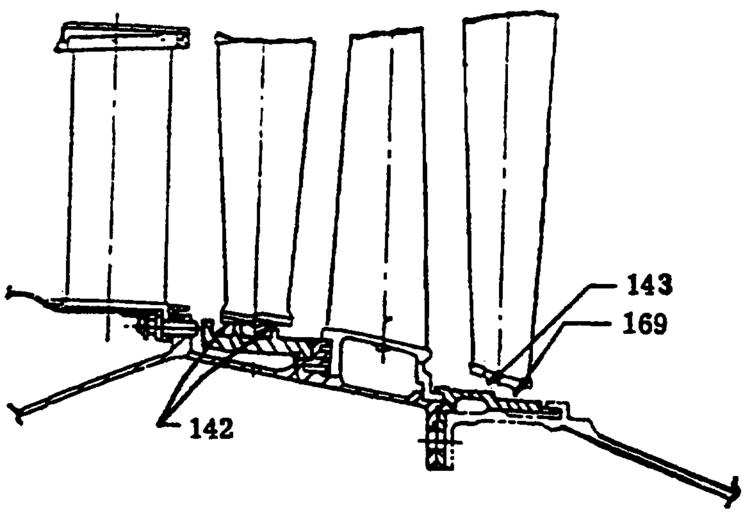


PRE SB 2564 FOR THE FRONT COMPRESSOR AND
PRE SBs 2451, 5363 AND 6229 FOR THE REAR COMPRESSOR

L-H4501 (0307)

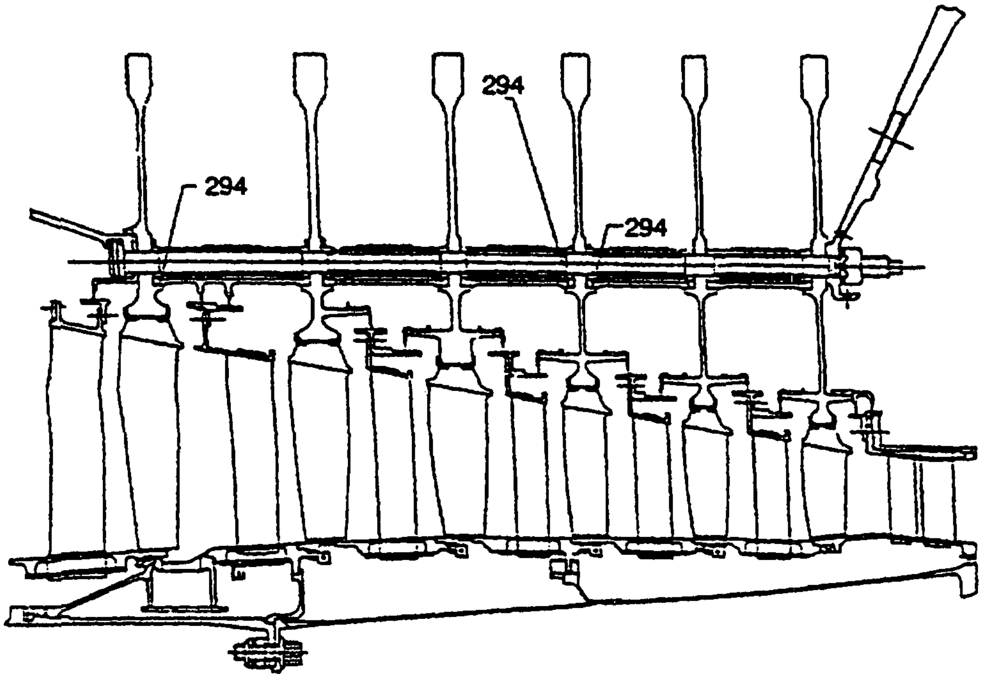
R
R

Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 7)



TURBINE BLADE TIP CLEARANCE

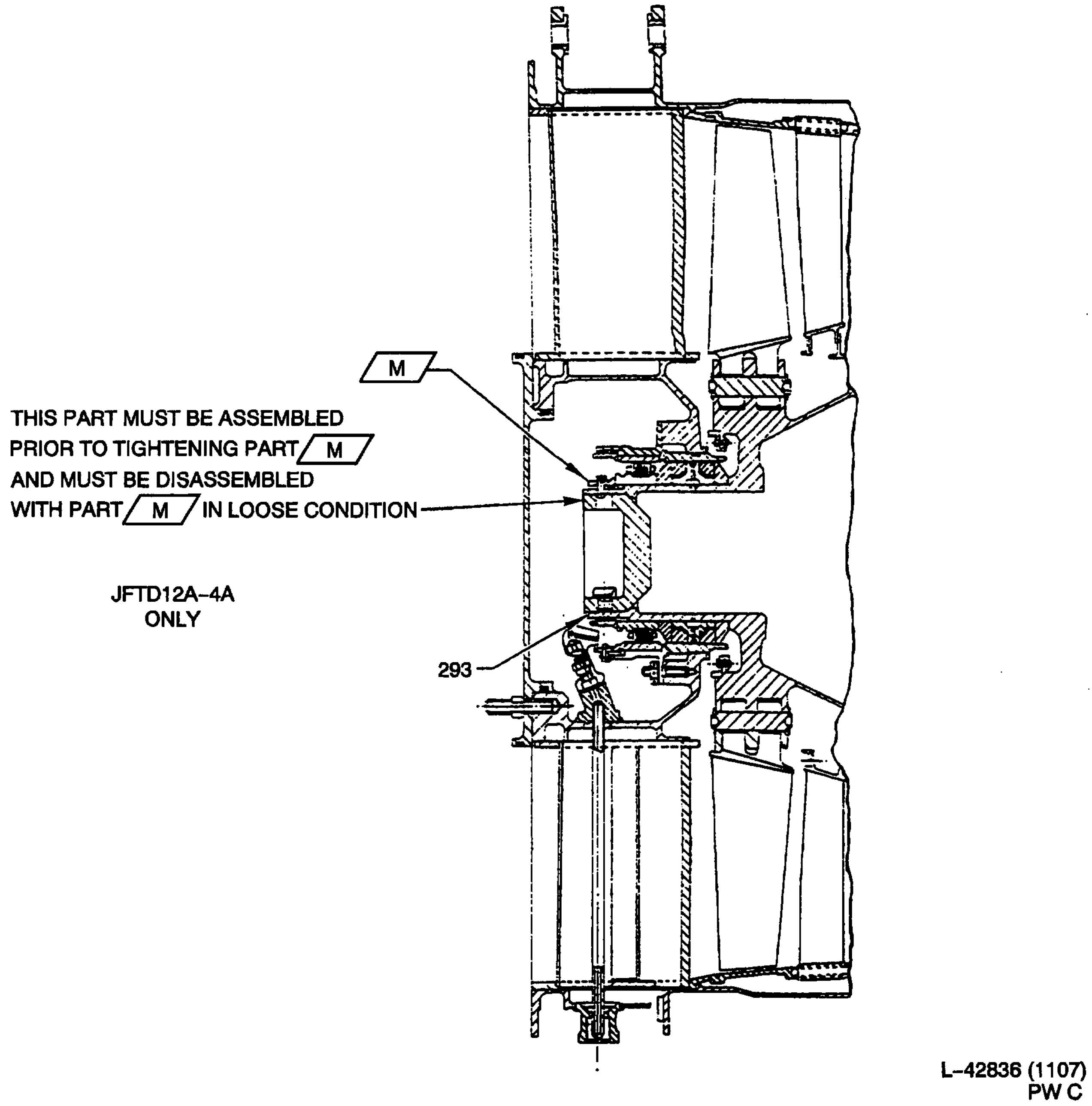
L-29336 (0000)



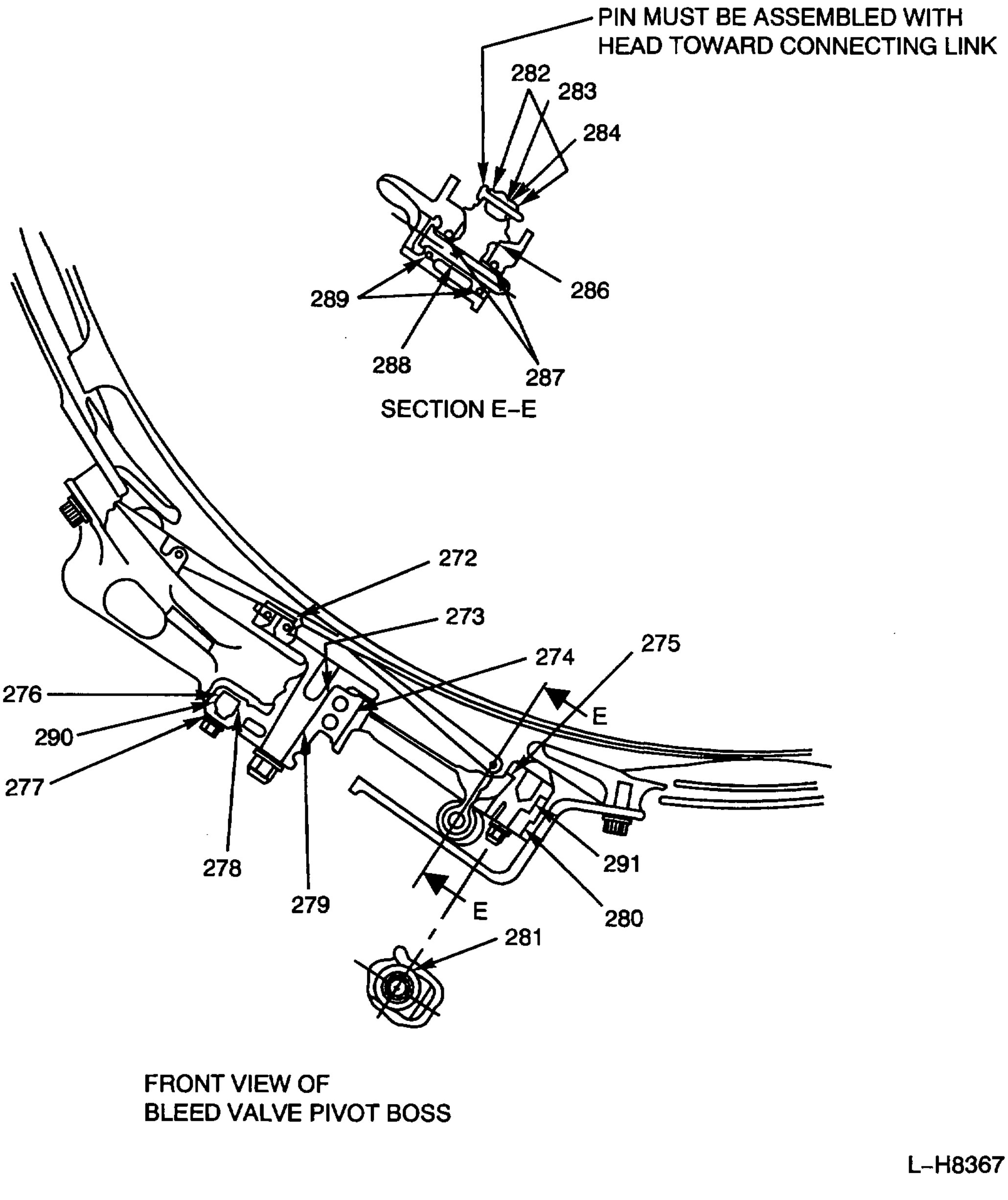
L-H8072 (0307)

R
R

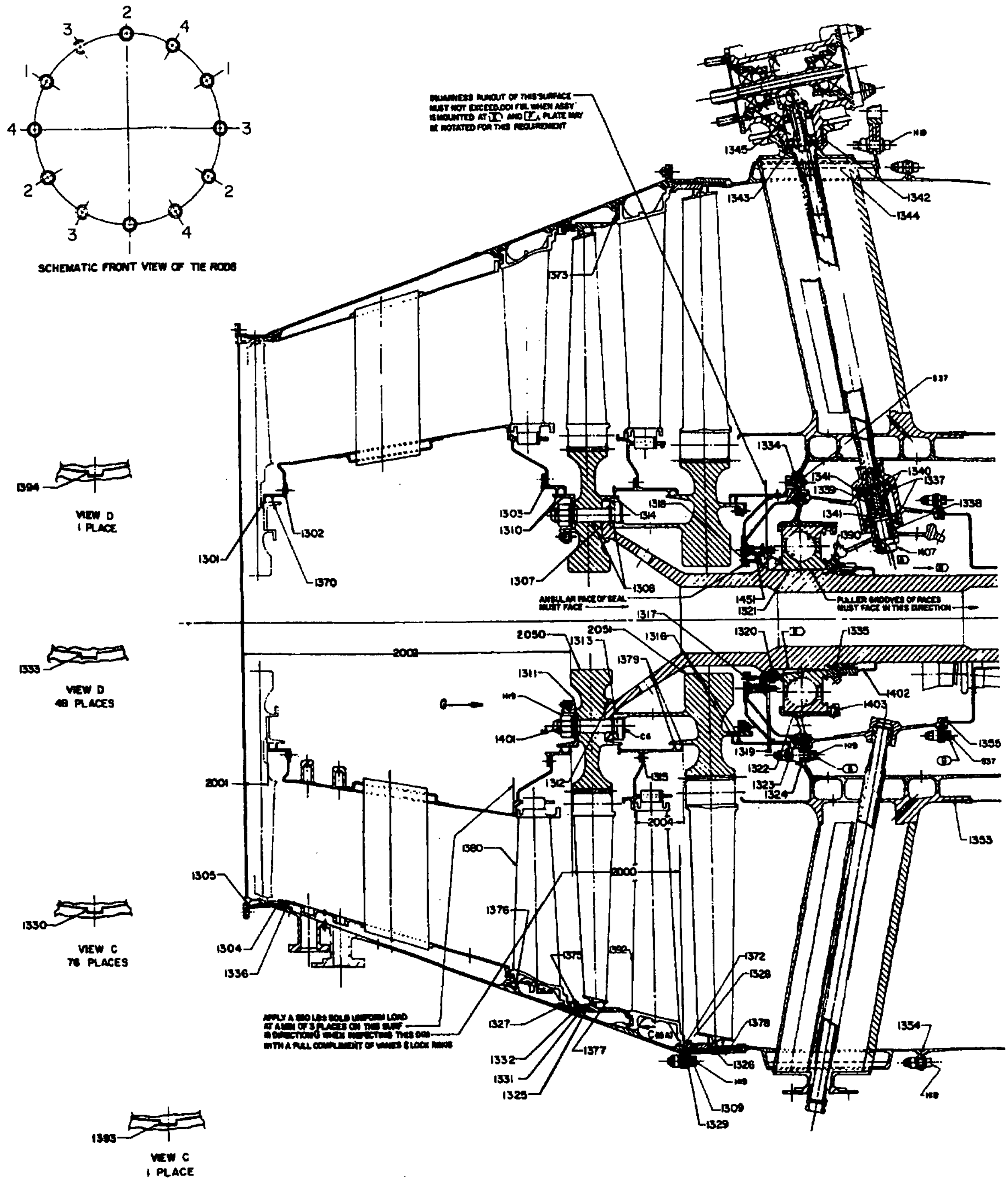
Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 9)



Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 10)



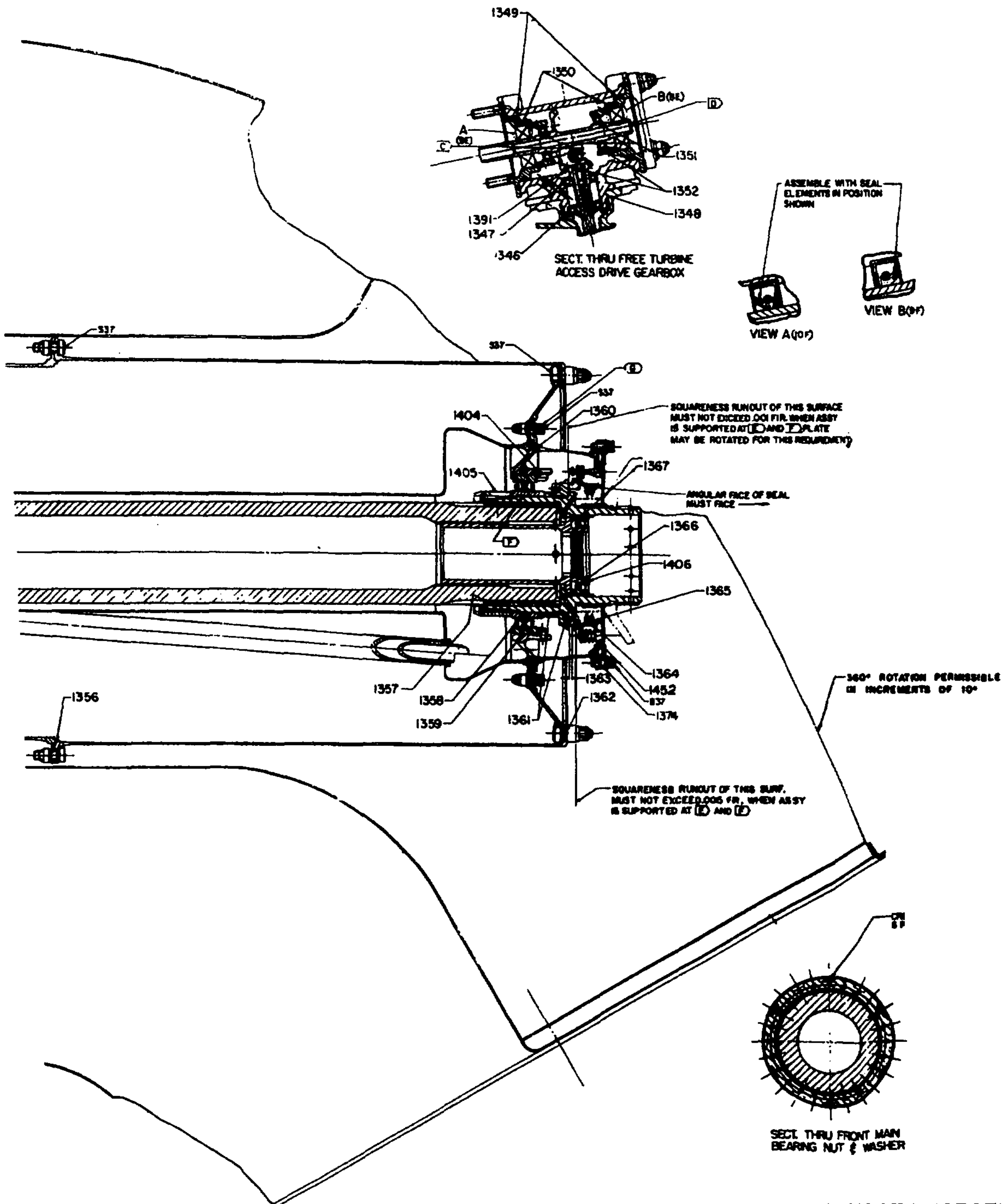
Engine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1007 (Sheet 11)



L-H8073 (0307)

R
R

Free Turbine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1008 (Sheet 1)

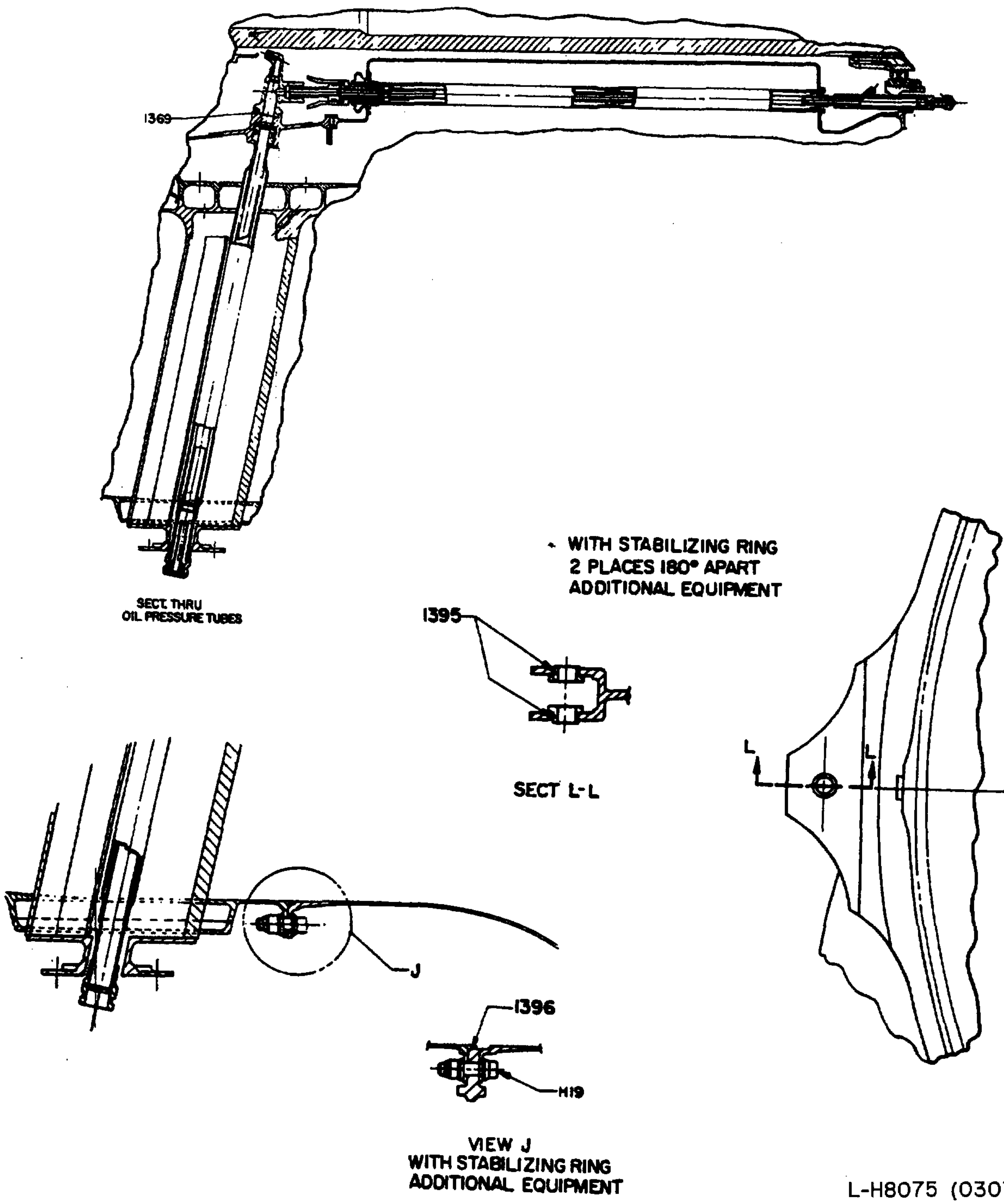


L-H8074 (0307)

ORIGINAL
As Received By
ATP

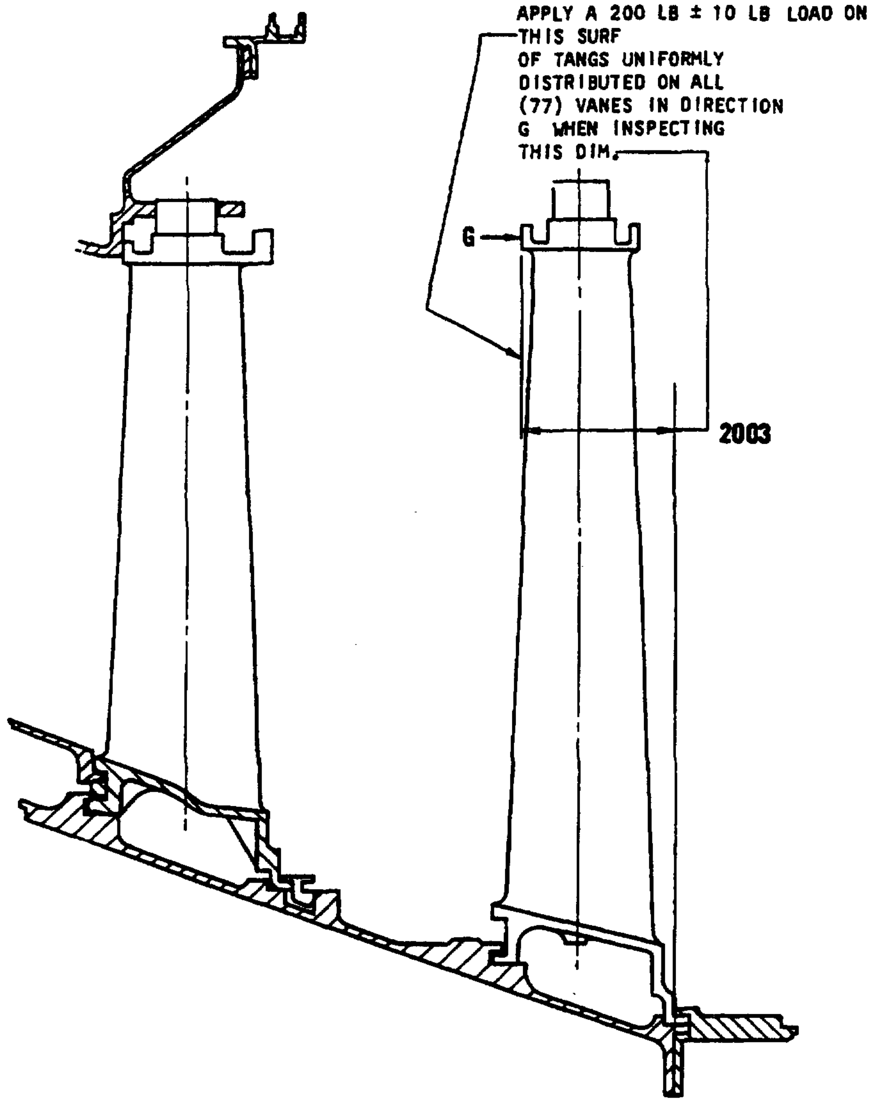
R
R

Free Turbine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1008 (Sheet 2)



R
R

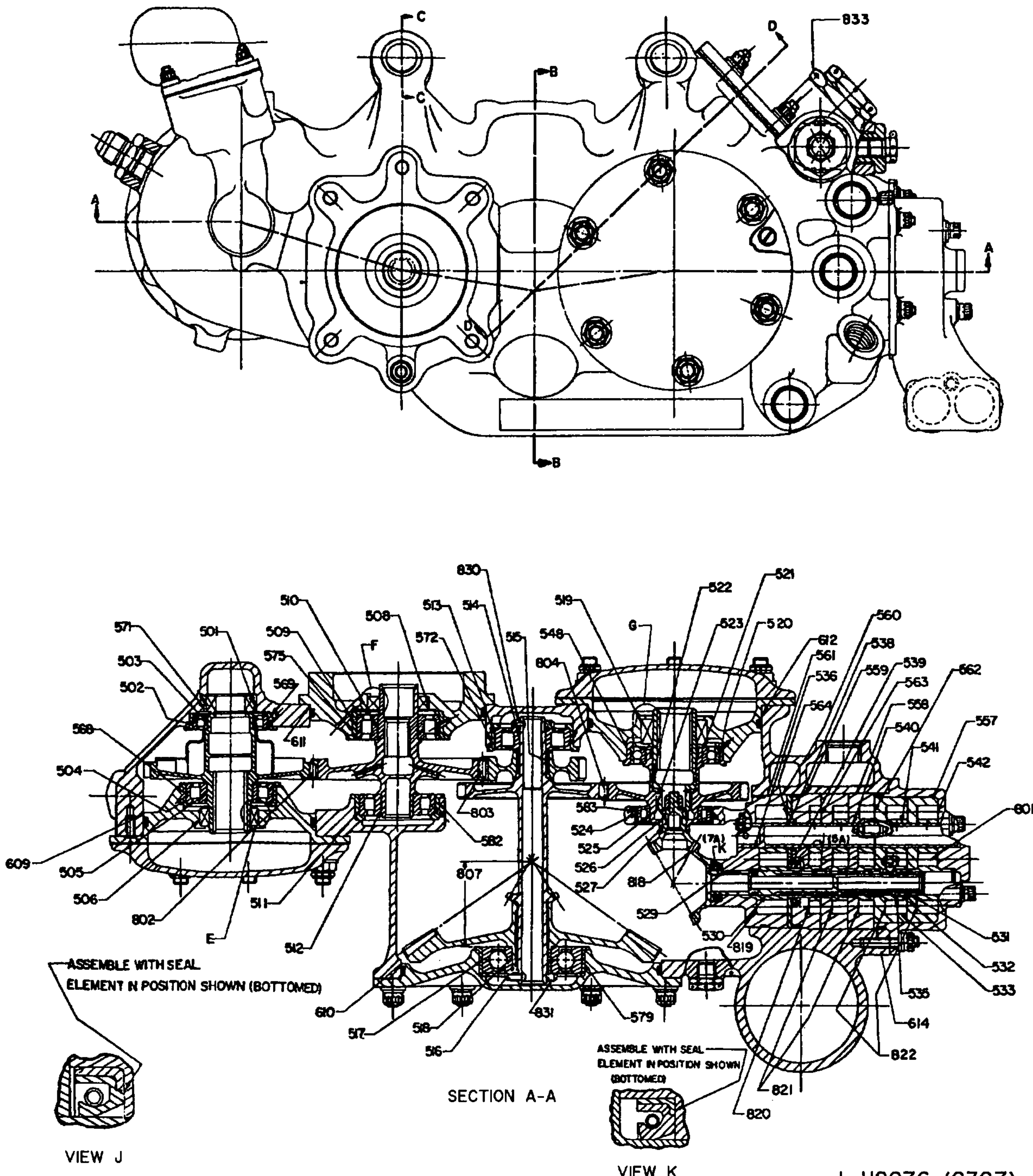
Free Turbine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1008 (Sheet 3)



L-37129 (0000)

R
R

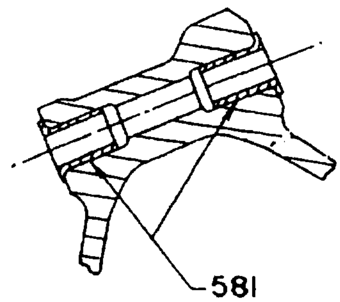
Free Turbine Clearance Chart
(JFTD12A-4A,-5A)
Figure 1008 (Sheet 4)



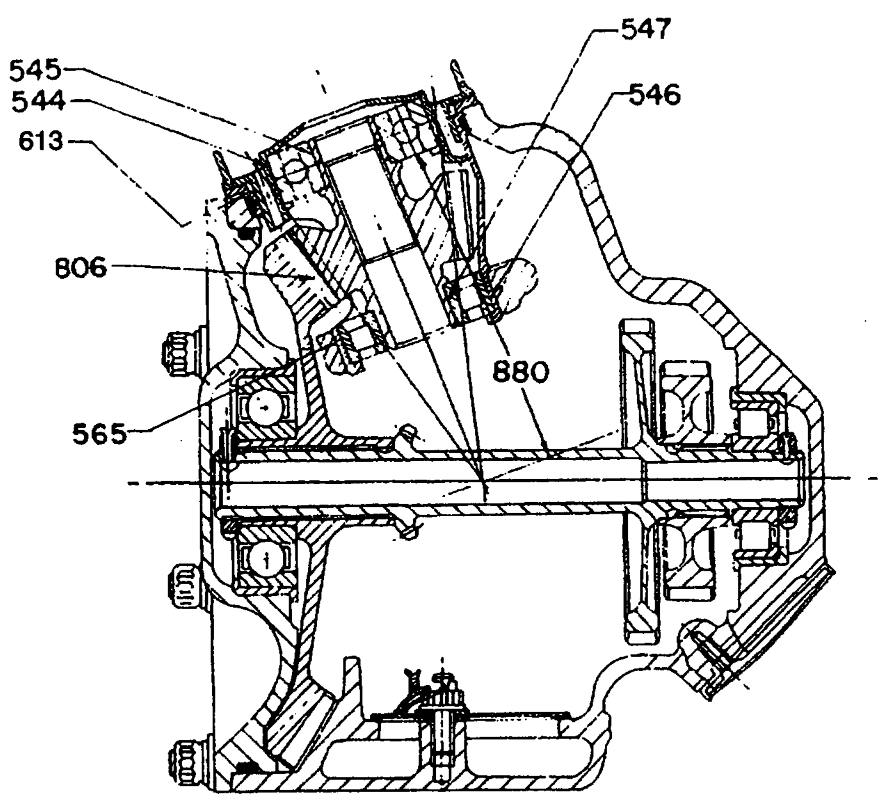
L-H8076 (0307)

R
R

Accessory Section Clearance Chart
(JFTD12A-4A,-5A)
Figure 1009 (Sheet 1)



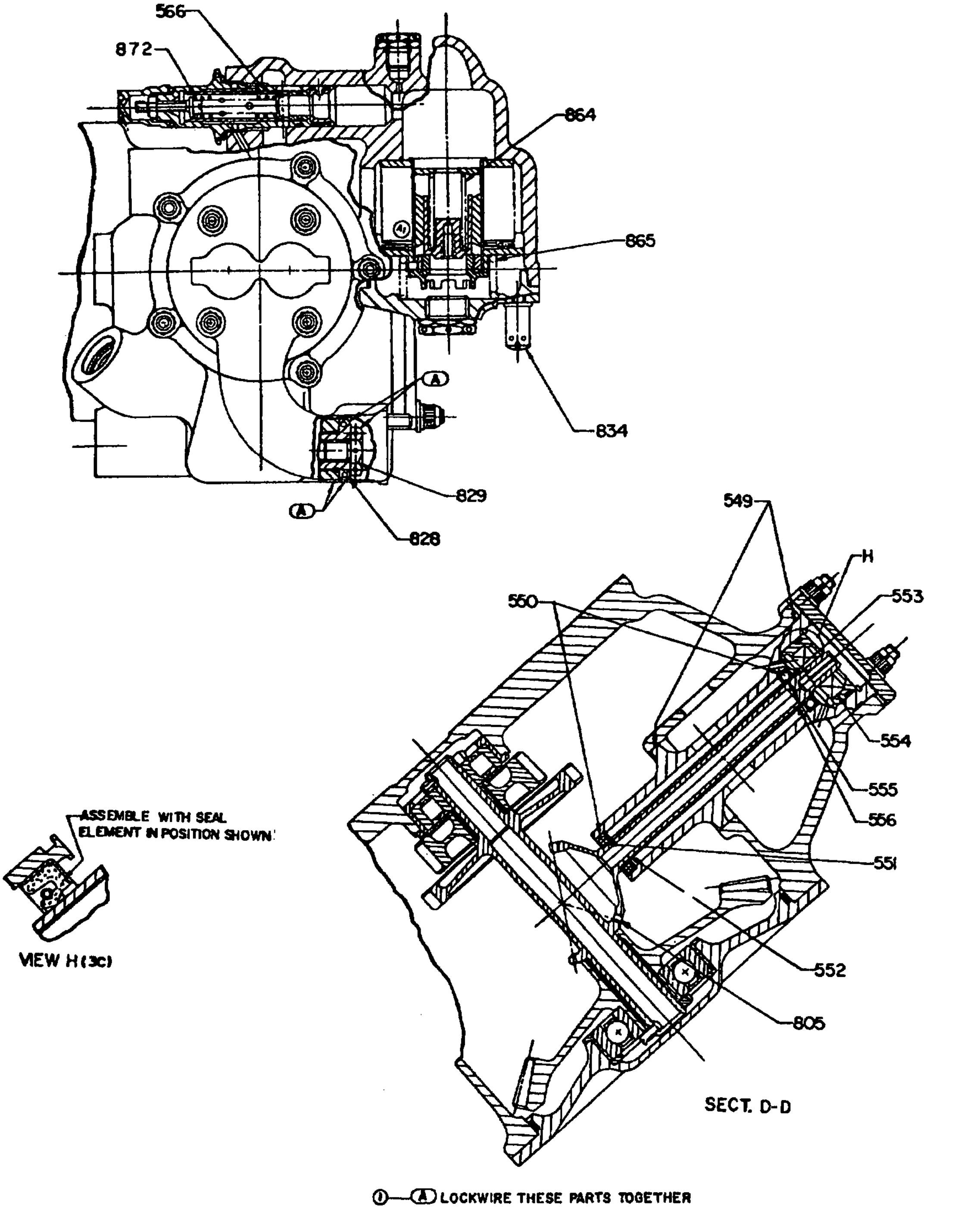
SECTION L-L



SECTION B-B

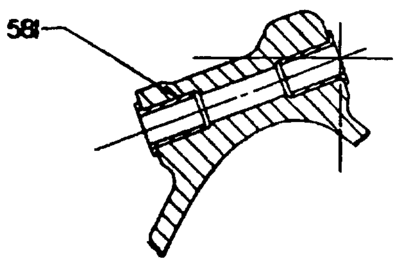
L-H8369 (1107)
PW C

Accessory Section Clearance Chart
(JFTD12A-4A,-5A)
Figure 1009 (Sheet 2)

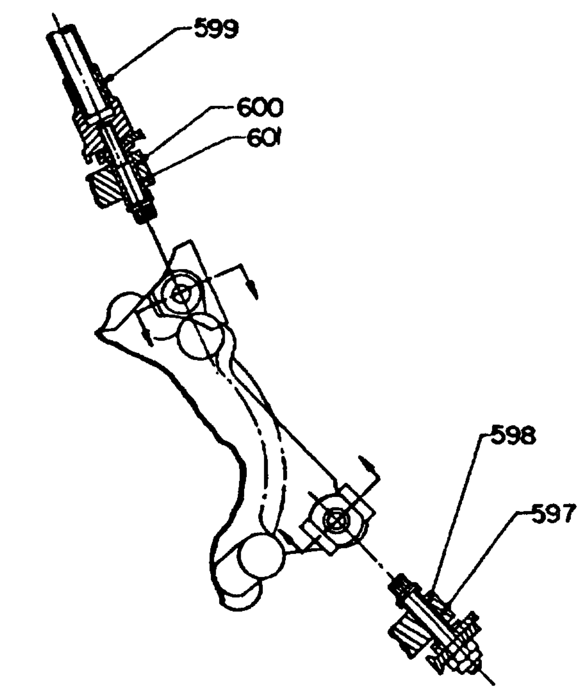


L-H8077 (0307)

Accessory Section Clearance Chart
(JFTD12A-4A, -5A)
Figure 1009 (Sheet 3)



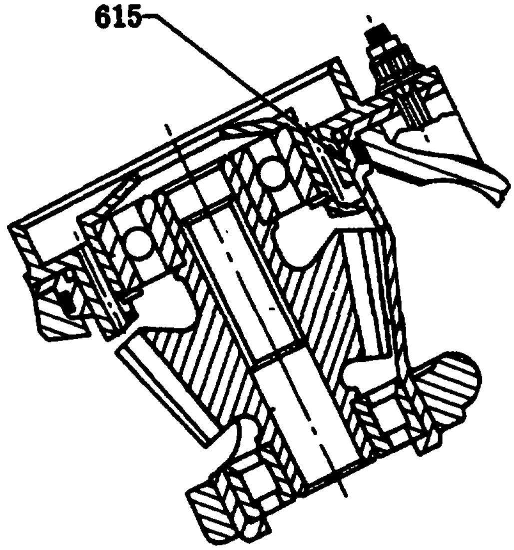
SECTION C-C

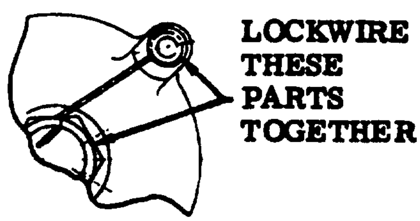


SECTIONAL VIEW THRU FUEL
DE-ICING HEATER MOUNTING LUGS

L-H8078 (0307)

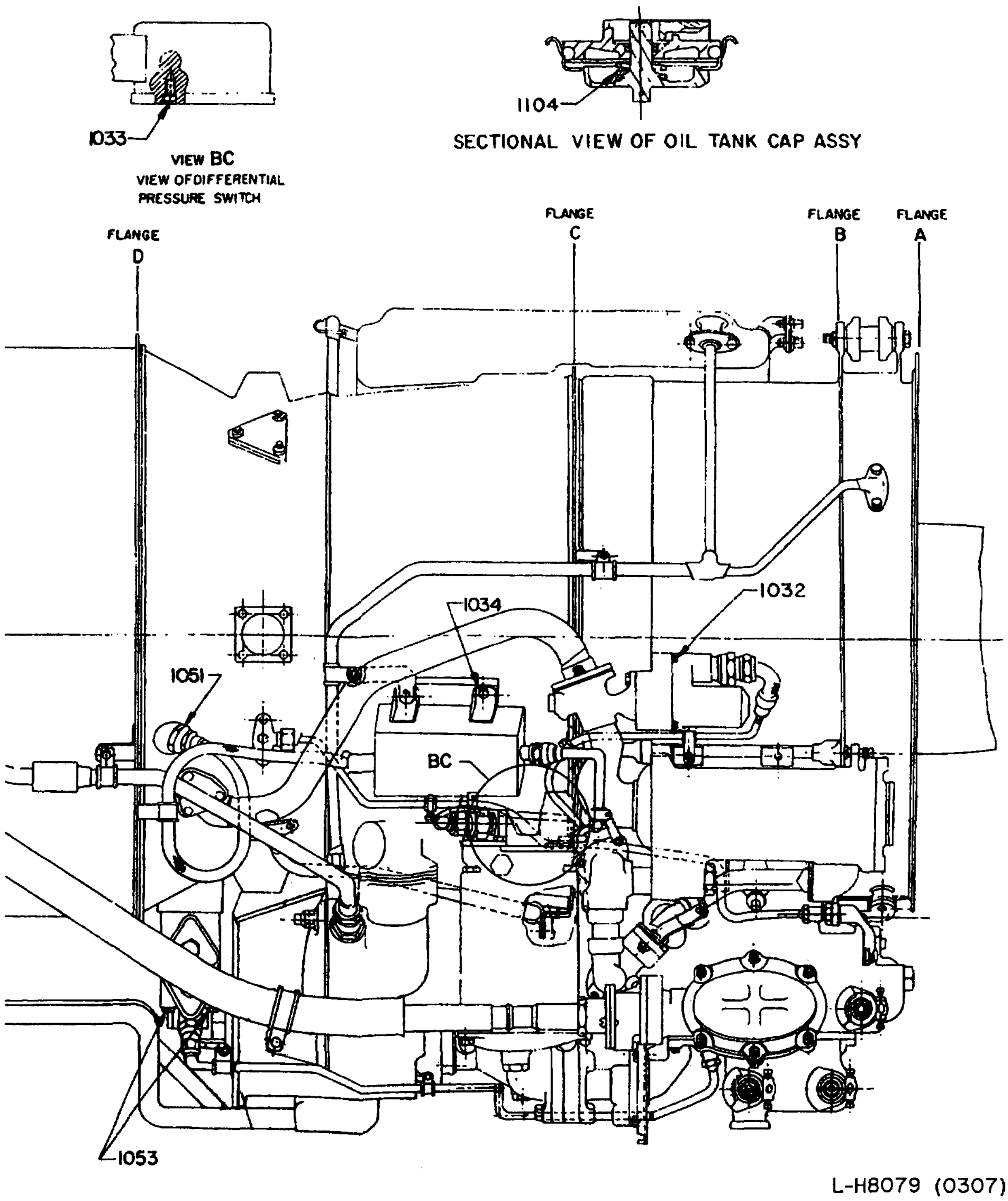
Accessory Section Clearance Chart
(JFTD12A-4A,-5A)
Figure 1009 (Sheet 4)





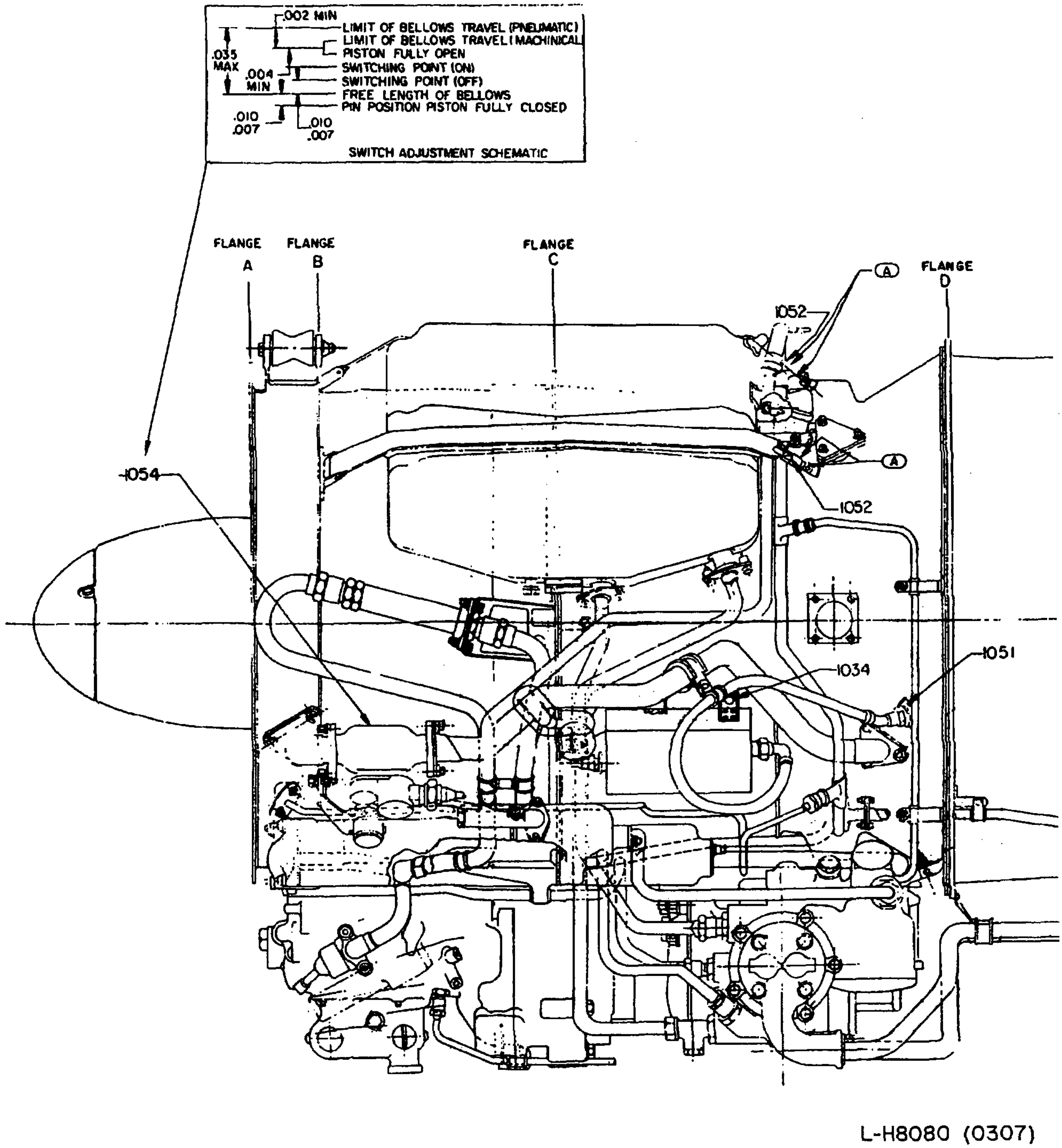
MAIN OIL STRAINER COVER RETAINING NUTS AND DRAIN PLUG LOCKWIRING

L-29492 (0000)



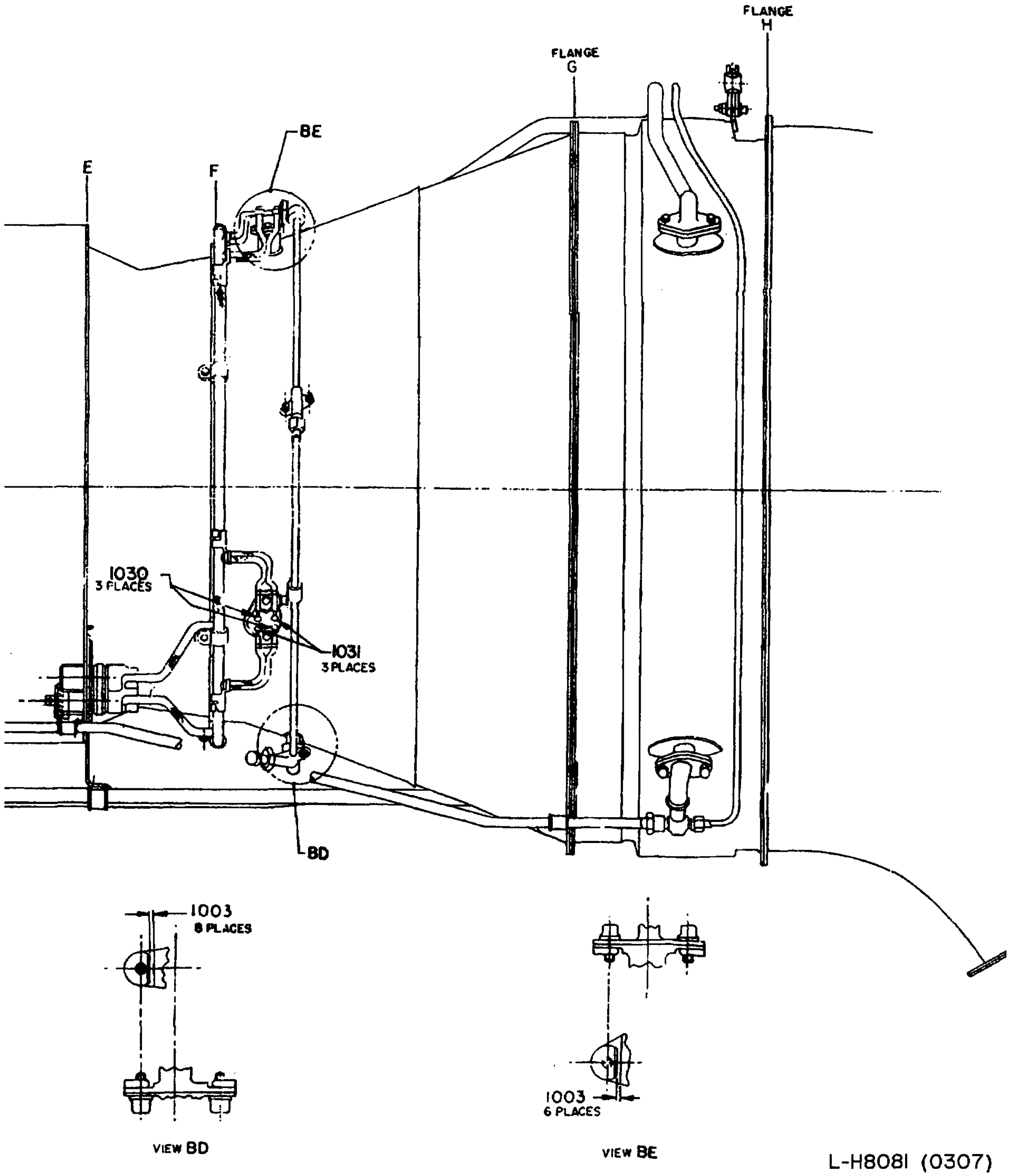
R
R

External Parts Clearance Chart
(JFTD12A-4A,-5A)
Figure 1010 (Sheet 1)



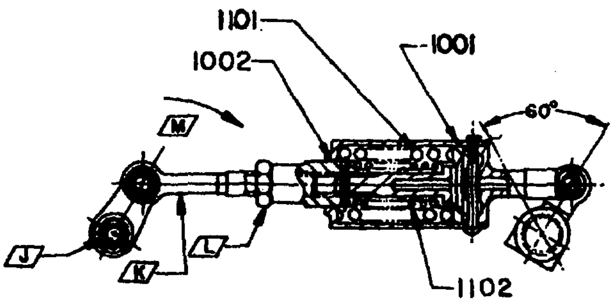
R
R

External Parts Clearance Chart
(JFTD12A-4A,-5A)
Figure 1010 (Sheet 2)



R
R

External Parts Clearance Chart
(JFTD12A-4A,-5A)
Figure 1010 (Sheet 3)



RIGHT SIDE VIEW OF
COMPRESSOR BLEED VALVE LINKAGE
IN CLOSED POSITION

ASSY INSTRUCTIONS:

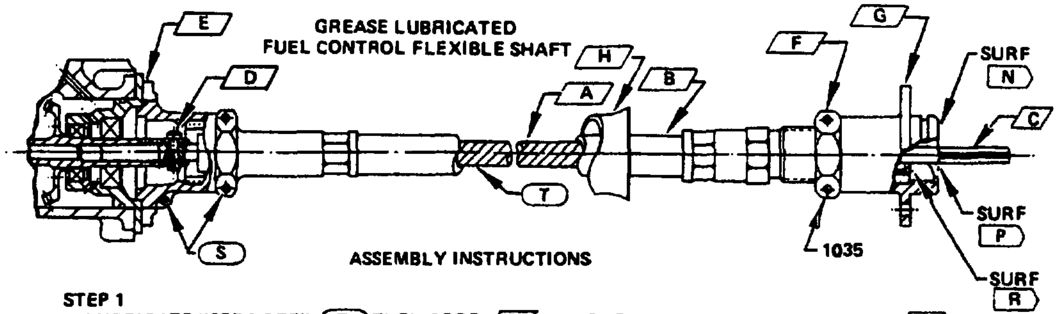
STEP 1
MAINTAIN 200 IN-LBS TORQUE ON LEVER J IN DIRECTION M
TO CLOSE COMPRESSOR BLEED STRAP VALVE
STEP 2
INSTALL LINKAGE WITH BLEED VALVE LEVER J
IN POSITION DESCRIBED ABOVE AND THE PISTON
IN THE FUEL CONTROL AGAINST THE PISTON STOP
IN CLOSED POSITION
STEP 3
SHORTEN THE LINKAGE OF ROD K BY 3 1/2 REVOLUTIONS
STEP 4
TIGHTEN LOCKNUT L

L-H8082 (0307)

R
R

External Parts Clearance Chart
(JFTD12A-4A,-5A)
Figure 1010 (Sheet 4)

CAUTION
SQUARE DRIVE /C/ MUST LINE UP WITH FUEL CONTROL INTERNAL SPLINE BEFORE INSTALLING TO PREVENT BENDING



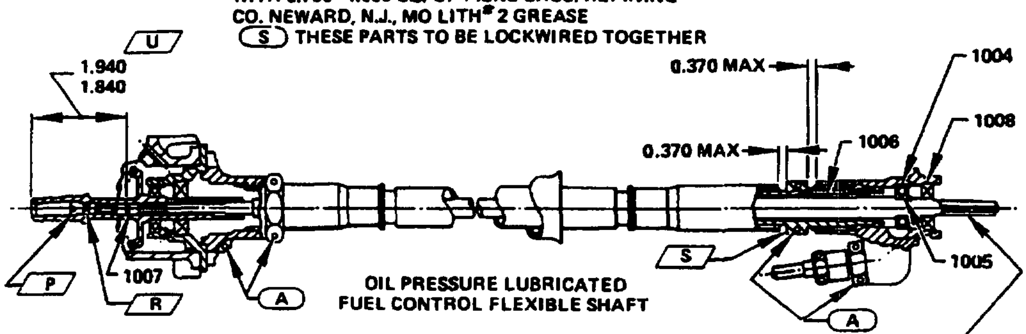
ASSEMBLY INSTRUCTIONS

STEP 1
LUBRICATE "SEE NOTE" (T) THEN CORE /A/ MUST BE WITHDRAWN FROM CASING /B/ UNTIL THE SQUARE DRIVE /C/ ON CORE /A/ FALLS INSIDE SURFACE (R) (THIS PROCEDURE MUST BE PERFORMED AT DISASSEMBLY BEFORE REMOVING CASING /B/ FROM SHIELD /H/). INSERT CASING /B/ THROUGH SHIELD /H/ . REPLACE NUT /F/ AND FLANGE /G/ TO CASING /B/ .

STEP 2
WITH ACCESSORY DRIVE GEARBOX INSTALLED ON THE FREE TURBINE, ATTACH CORE /A/ BY WITHDRAWING FROM CASING /B/ AND ASSEMBLING INTO GEARSHAFT. SECURE BY CRIMPING RIVET /D/ ATTACH FLANGE /E/

STEP 3
LOCATE SHIELD /H/ IN ENGINE POSITION BY LOOSELY INSTALLING BOLT /N/ (SEE SHEET 2) SECURING SHIELD /H/ TO BRACKET /F/ . ADJUST FLANGE /G/ TO LINE UP SURFACE (N) WITH SURFACE (P) WITHIN 0.060 INCH WHEN FLANGE /G/ IS HELD IN LINE WITH THE FUEL CONTROL FLANGE. HAND TIGHTEN CHECK NUT /F/ AGAINST FLANGE /G/ . REMOVE BOLT /N/ AND SLIDE SHIELD /H/ REARWARD. INSERT SQUARE DRIVE /C/ INTO FUEL CONTROL. BOLT DOWN FLANGE /G/ . TIGHTEN NUT /F/ TO RECOMMENDED TORQUE AND LOCKWIRE. CLIP AND BRACKET CABLE ASSY.

(T) LUBRICATE ENTIRE PART UNIFORMLY WITH 0.700–1.000 OZ. OF FISKE BROS. REFINING CO. NEWARD, N.J., MO LITH* 2 GREASE
(S) THESE PARTS TO BE LOCKWIRED TOGETHER



CABLE LENGTH ADJUSTMENT INSTRUCTIONS

STEP 1
REMOVE BOLT /P/ AND PACKING /R/

STEP 2
ADJUST BEARING ASSEMBLY /S/ TO MAINTAIN DIM /U/

STEP 3
REINSTALL BOLT /P/ AND PACKING /R/

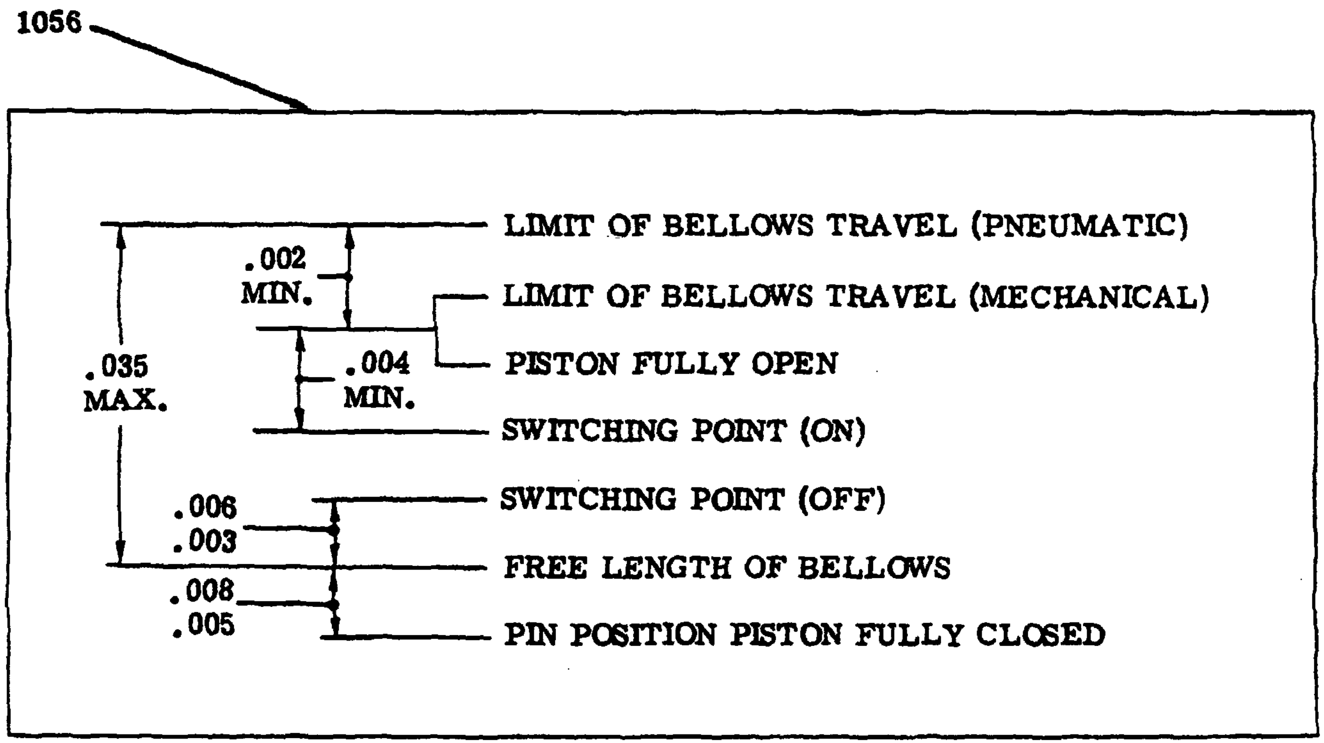
CAUTION
SQUARE DRIVE MUST LINE UP WITH FUEL CONTROL INTERNAL SPLINE BEFORE INSTALLING TO PREVENT BENDING

(A) LOCKWIRE THESE PARTS TOGETHER PER SPEC PWA 318

L-51271 (1075)

R
R

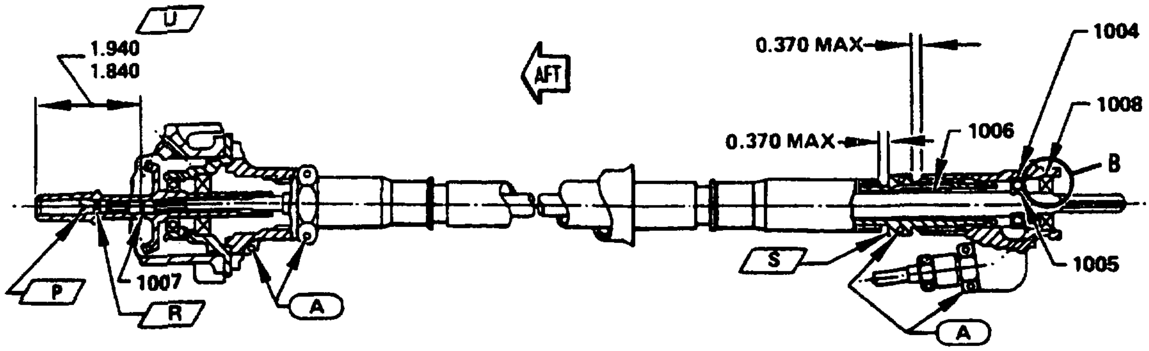
External Parts Clearance Chart
(JFTD12A-4A,-5A)
Figure 1010 (Sheet 5)

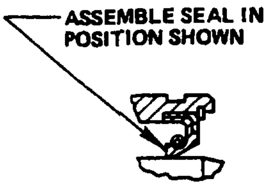


SWITCH ASSEMBLY ADJUSTMENT SCHEMATIC
(P/N 693027 VALVE ASSEMBLY ONLY)

L-29384 (0307)

External Parts Clearance Chart
(JFTD12A-4A, -5A)
Figure 1010 (Sheet 6)





VIEW B

(A) LOCKWIRE THESE PARTS TOGETHER

CAUTION: SQUARE DRIVE MUST LINE UP WITH FUEL CONTROL INTERNAL SPLINE BEFORE INSTALLING TO PREVENT BENDING.

CABLE LENGTH ADJUSTMENT INSTRUCTIONS

(1) Remove Bolt P and Packing R.

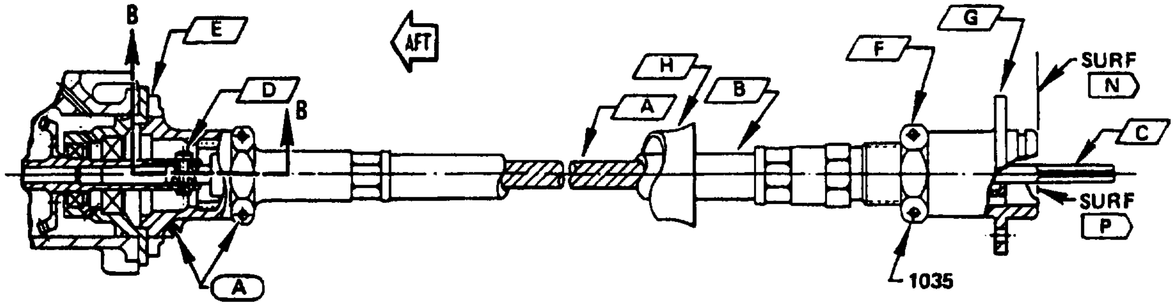
(2) Adjust Bearing Assembly S to maintain Dimension U.

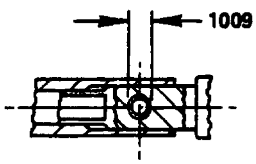
(3) Install Bolt P and Packing R.

L-65298 (0000)

R
R

External Parts Clearance Chart
(JFTD12A-4A, -5A)
Figure 1010 (Sheet 7)





SECTION B-B

(A) LOCKWIRE THESE PARTS TOGETHER.

CAUTION: SQUARE DRIVE MUST LINE UP WITH FUEL CONTROL INTERNAL SPLINE BEFORE INSTALLING TO PREVENT BENDING.

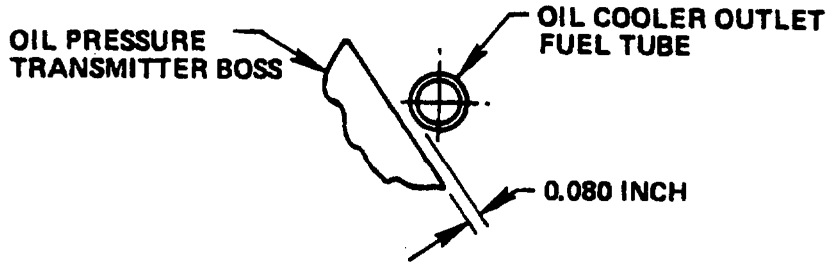
ASSEMBLY INSTRUCTIONS

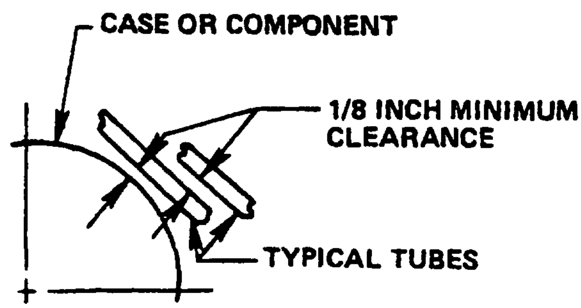
(1) Thread flanged Fitting E onto aft end of Casing B.
(2) Insert casing into Shield H. Install Locknut F and flanged Fitting G on forward end of casing.
(3) Inspect rivet hole in Core A for compliance with Reference No. 1009.
(4) Lubricate core uniformly using 0.700 to 1.000 ounce Mo LITH No. 2 Grease available from Fiske Brothers Refining Company, Newark, New Jersey 07105.
(5) Insert core into casing. Remove excess grease.
(6) Install gasket on rear Fitting E.
(7) Partially withdraw core from casing and insert core into gear-shaft. Install and flare securing Rivet D.
(8) Secure rear Fitting E to free turbine gearbox.
(9) Secure shield using clips and brackets.
(10) Adjust position of Fitting G on casing to align Surface N of fitting with Surface P of core within 0.060 inch when cable assembly is in line with fuel control N2 speed sense boss.
(11) Handtighten Locknut F to secure Fitting G. Lubricate and install packing on fitting.
(12) Remove bolts securing shield.
(13) Align square drive of cable assembly with adapter in fuel control.
(14) Pull cable assembly rearward until square drive of cable assembly clears boss of fuel control. Engage cable with adapter in fuel control.
(15) Secure Fitting G to fuel control. Tighten Locknut F to recommended torque and lockwire.
(16) Secure shaft assembly using clips and brackets.

L-65297 (0000)

R
R

External Parts Clearance Chart
(JFTD12A-4A, -5A)
Figure 1010 (Sheet 8)





NOTE: Unless otherwise specified, clearance between tubes (except where clipped together) and between tubes and other external engine parts must be 0.125 inch minimum.

L-65299 (0307)

R
R

External Parts Clearance Chart
(JFTD12A-4A, -5A)
Figure 1010 (Sheet 9)

ENGINE INLET

TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

Please insert the revised pages into this manual and delete obsoleted pages in accordance with the following List of Effective Pages. Revised pages are indicated by the letter "R", added pages by the letter "A", and deleted pages by the letter "D". Superseded pages shall be removed and destroyed.

The List of Effective Pages records not only each page of subject revision but also each previously issued page which is still current. Blank pages and pages which are no longer current do not appear on this list. If there is any question about the currency of the maintained copy, it is recommended that each page of the manual be checked off against this List of Effective Pages. Any page which does not check out with this list, either by number or by date, shall be discarded. This list is reissued in its entirety whenever this manual section is revised.

TO: RECIPIENTS OF JT12 OVERHAUL MANUAL, PART NUMBER 435108

REVISION NO. 74 DATED APRIL 1, 2007

HIGHLIGHTS - ENGINE INLET

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-20-00 INSP/REP-00	602 608	Added inlet repair section.	-ALL
	618 -620	Revised No. 1 bearing housing plate repair requirements. (EAC 10-7-02)	

ENGINE INLET - INSPECTION, REPAIR, AND REPLACEMENT

1. Engine Inlet Section

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Compressor Inlet Outer Front Cone.

A. Weld Repair of Cracks in Lockwire Hole

(1) Rout out the crack.

(2) Weld the crack and the lockwire hole by PWA 16-4, Item No. 2. Refer to Section 70-42-01 in the Standard Practices Manual.

(3) Stress-relieve as follows:

(a) Put the cone in a cold oven (air is a satisfactory atmosphere).

(b) Heat to 162.8° ± 9.44°C (325° ± 15°F) and hold for two hours.

(c) Air cool the part.

(4) Machine the weld flush with the adjacent surface.

(5) Do a fluorescent penetrant inspection by SPOP 70 (normal intensity). No remaining crack indications are permitted (repair of these will be necessary). Refer to Section 70-33-00 in the Standard Practices Manual.

(6) Coat each side of the repaired tab by SPOP 42 (Task 70-44-01-330-012). Refer to Section 70-44-01 in the Standard Practices Manual.

(7) Drill a new lockwire hole at its initial position. See Figure 601 for location and dimensions.

(8) Apply SPOP 42 to the surface of the repaired hole.

(9) Coat PN 670386 eyelet with wet zinc chromate primer by SPOP 157 (Task 70-41-03-380-013) where its external surface will touch the aluminum tab surface. Refer to Section 70-41-03 in the Standard Practices Manual.

(10) Install an eyelet as shown in the figure. A pneumatic rivet gun is recommended (manual tools do not do this operation correctly).

NOTE: It is recommended to install eyelets in all holes, whether the holes are in good condition or not.

3. Compressor Inlet Outer Rear Cone

A. Inspection

R (1) Examine the cone for worn areas or cracks. Use SPOP 70, normal sensitivity.

(2) Wear of less than 0.003 inch depth is permitted.

(3) Repair wear of 0.003 inch depth or more.

B. Repair

(1) Weld a cone with cracks or wear, with AMS 4190 welding wire.

(2) Blend the weld to the approximate contour and finish of the adjacent surface.

(3) Stress-relieve the part for four hours at 157° - 168°C (315° - 335°F).

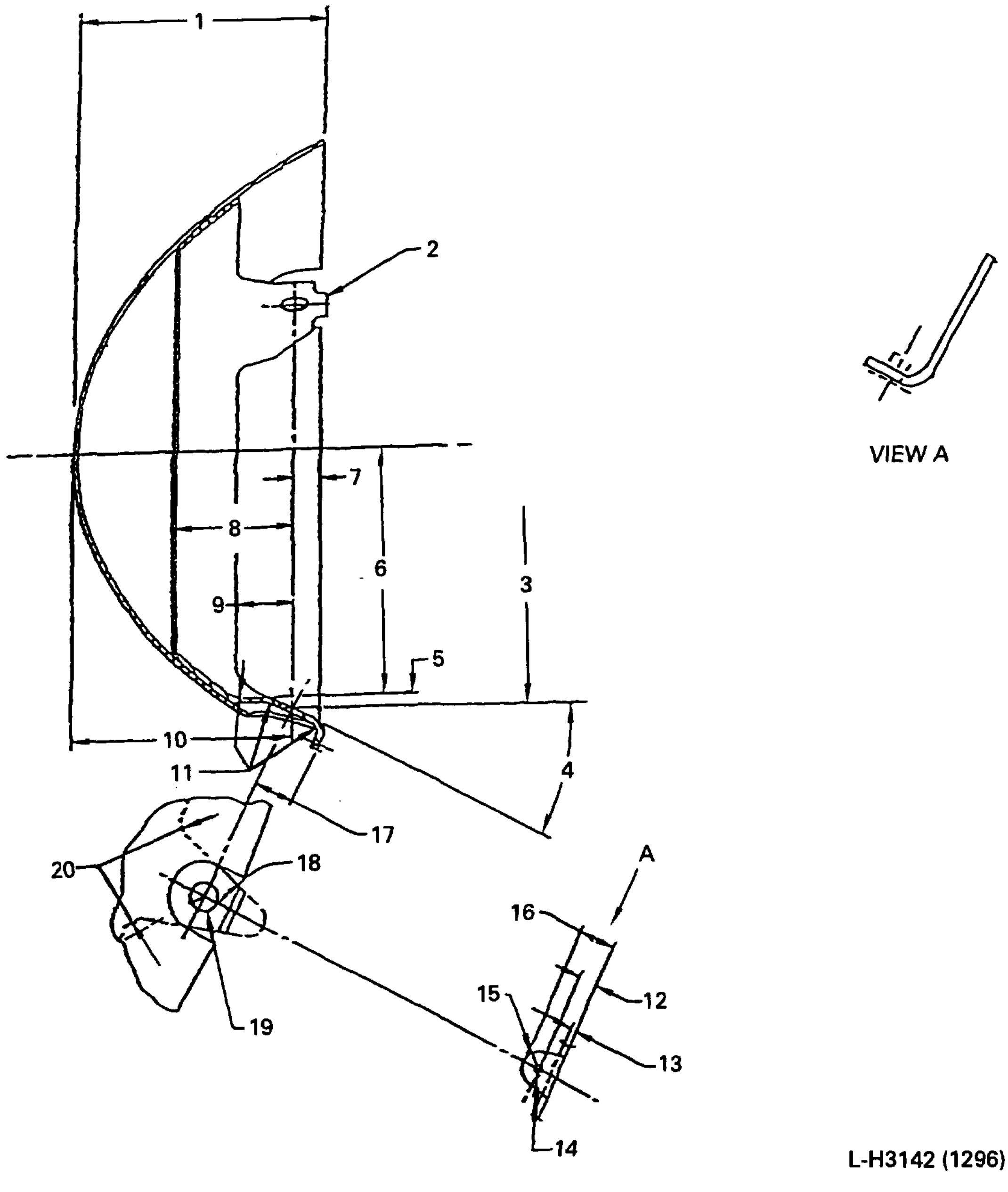
(4) Do a SPOP 62 fluorescent penetrant inspection of the part.

4. Compressor Inlet Case

A. Inspection

(1) Pinholes, pits, porosity, and voids in braze material are permitted if they are in the fillet but do not extend into the joint.

(2) Coarse pits on the surface of aluminum braze material are permitted if they are in the fillet and do not extend into the joint.



Outer Front Cone Lockwire
Hole Weld Repair
Figure 601

1. 2.450 - 2.490 Inches
2. Three Tabs Equally Spaced And Located 0.010 Inch Maximum Of True Position
3. 4.810 - 4.830 Inch Diameter
4. 30° ± 0° 30'
5. ± 0.030 Inch
6. 2.245 Inch Radius
7. 0.270 - 0.330 Inch
8. 1.220 - 1.280 Inch
9. 0.690 - 0.750 Inch
10. 2.170 Inches
11. 0.062 - 0.125 Inch Radius
12. 0.185 Inch
13. 0.043 - 0.057 Inch
14. 0.070 Inch Initial Diameter (Make Larger, To 0.124 - 0.129 Inch Diameter)
15. 0.140 - 0.200 Inch Radius
16. 0.340 - 0.370 Inch
17. 0.390 - 0.410 Inch
18. 15° ± 2° Each Side
19. 0.276 - 0.286 Inch Diameter, Three Holes Equally Spaced, 0.005 Inch Maximum Of True Position.
20. 0.156 - 0.219 Inch Radius

Key To Figure 601

(3) Cracks in the braze material at either end of a vane or in the parent material of the vane or case are not permitted. Fluorescent penetrant inspection crack indications in the resistance weld along the trailing edge of a vane are permitted.

B. Repair

(1) Crack weld repair

(a) Rout out cracks with a cone-shape routing tool.

(b) Clean the repair area with aluminum wool.

NOTE: If a crack is in the fillet braze area, clean the area with heat and a wire brush until bubbles are not seen.

CAUTION: KEEP WATER FLOW CONTINUOUSLY THROUGH THE CASE TUBES DURING WELD OPERATIONS TO PREVENT TUBE DAMAGE. BLOW TUBES OUT WITH AIR AND FLUSH THEM WITH SPOP 208 CLEANING FLUID BEFORE THE HEAT-TREAT OPERATION.

MAKE SURE THAT NO WATER OR SOLVENT IS REMAINING IN THE CASE ASSEMBLY BEFORE IT GOES IN THE STRESS-RELIEF FURNACE.

(c) Weld the parent metal and brazed fillet area with AMS 4190 welding wire in an argon gas gun. Adjust the current as necessary.

(d) After weld repair, stress-relieve the case assembly at 160° - 165°C (320° - 330°F) for four hours.

NOTE: Put the case in a cold oven, bring it up to temperature, and let it become cool in the oven.

(e) Wear cavities where the fuel-deicing heater rubbed on the case can get puddle weld repair with AMS 4190 welding wire if the cavity is not more than 0.020 inch depth before repair.

NOTE: Stress-relief is not necessary after this cavity puddle weld repair.

(2) Inlet case flange repair. See Figure 602.

(a) Repair cracks at the dip-brazed boss flanges by inert gas fusion welding.

(b) For cracks in the braze or in the parent metal of dip-brazed flanges (for example anti-icing air flanges), breather flanges, and oil tube flanges), repair as follows:

1 Rout out the crack with a rotary file to a depth of 10 - 20 percent of the stock.

2 Fully clean the weld area. Degrease the area by SPOP 208 solvent wipe and clean with steel wool.

3 Weld the routed area with an argon gas gun and AMS 4190 welding wire. Adjust the current when necessary.

(c) Repair cracks at major case flanges as follows:

1 On narrow flanges, make a narrow cut through the crack area.

2 At thick flanges, rout out the crack to 60 percent depth of stock make a deep V-groove.

3 Put a locally fabricated steel block in back of the damaged flange area and attach it against the case with two clamps.

4 Weld the crack area with an argon gas gun and AMS 4190 welding wire (adjust the current when necessary).

5 Do steps 2 thru 4 on the opposite side of the flange.

NOTE: If there is not sufficient access to each side of the flange, rout out the crack on one side to 80 - 90 percent depth of the stock, then do the weld.

6 Remove unwanted weld material with a hand file and finish polish with fine emery cloth.

(d) Stress-relieve a repaired case in an oven for 163°C (325°F) for four hours.

NOTE: Put the case in a cold oven, bring it up to temperature, and let it become cool in the oven.

(3) Inlet case No. 1 bearing oil pressure tube and boss assembly replacement (refer to Tool Group 34-1). See Figure 603 and Figure 604.

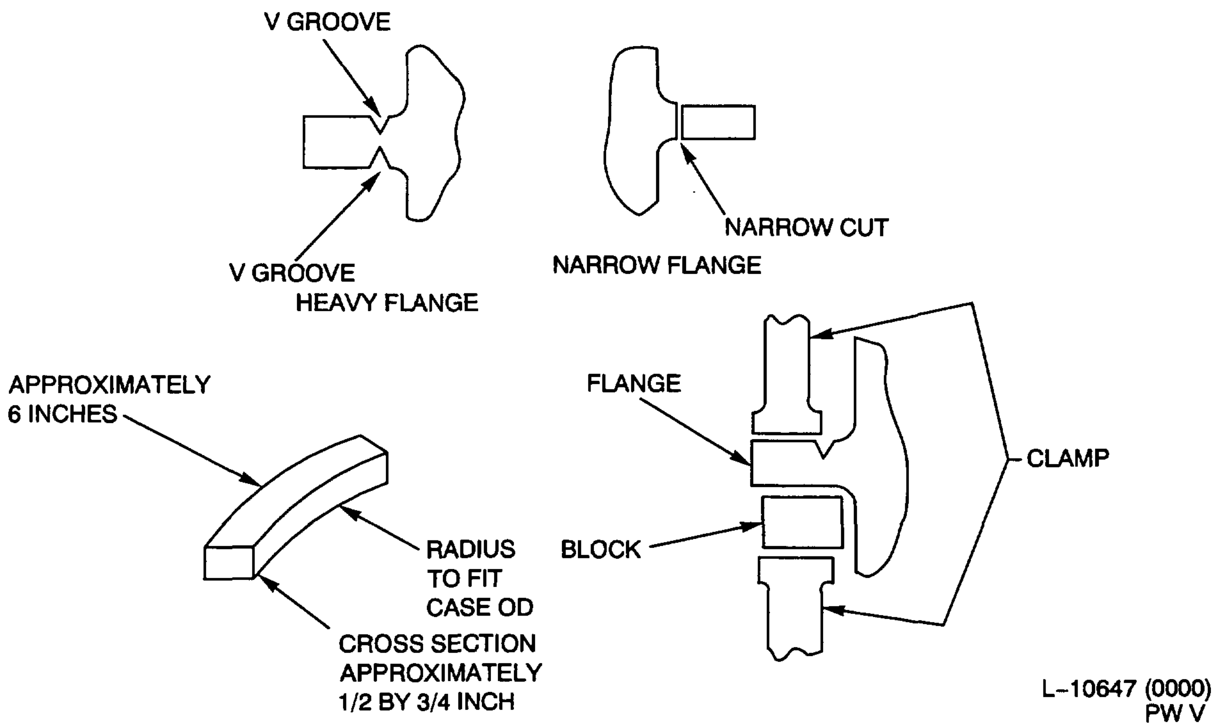
(a) Machine out the weld around the oil nozzle boss.

(b) Remove the boss and tube assembly from the inlet case.

(c) Machine the inner case as shown to prepare for installation of a replacement boss and tube assembly.

(d) Install the boss and tube assembly in the inlet case and weld as shown (make sure that all anodize film is removed from the weld area).

(e) Stress-relieve the case at 157° - 168°C (315° - 335°F) for four hours.



R
R

Inlet Case Flange Repair
Figure 602

(f) To make sure that the case repair is satisfactory, do an air pressure check:

1 Install covers on the outer openings of the No. 1 bearing oil pressure, scavenge, and breather tubes.

2 Put each half of the breather area Pressure Test Adapter on the front and rear openings of the bearing area and attach them.

3 With the case in fluid, do an air pressure check at 25 psi.

(g) Install studs in the boss.

(4) Compressor inlet Case No. 1 bearing oil scavenge tube and boss replacement

(a) Remove boss and tube from inlet case by machining.

(b) Strip anodize coating locally around area to be welded with crocus cloth.

(c) Assemble and weld tube and boss, maintaining tube length as shown. See Figure 604.

(d) Install tube and boss in inlet case and weld. See Figure 604.

(e) Stress-relieve at 157° - 168°C (315° - 335°F) for four hours.

(f) Pressure test repaired inlet case per step (3)(f).

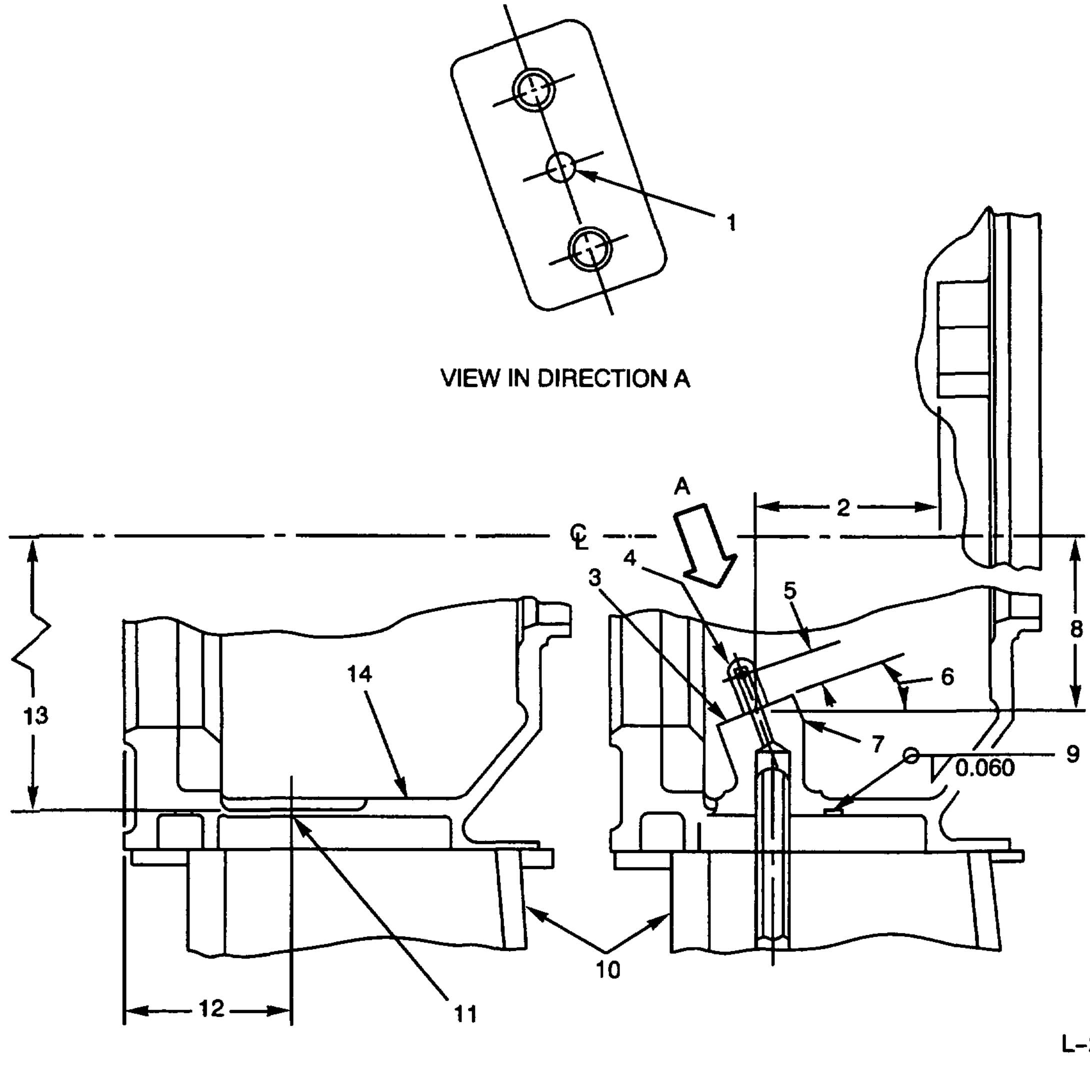
(4) Inlet case No. 1 bearing support stud replacement

(a) Replace studs which are stretched, loose, or have damaged threads. Use oversize replacement studs.

1 Compressor inlet case cover studs must extend 0.990 - 1.010 inch above the adjacent surface.

2 No. 1 bearing oil nozzle studs must extend 0.305 - 0.325 inch above the adjacent surface.

R 3 No. 1 bearing housing studs must extend 0.310 - 0.330 inch above the adjacent surface.



Inlet Case No. 1 Bearing
Oil Pressure Tube Replacement
Figure 603

1. 42° from Horizontal For Centerline of Oil Passage, Reference 0.110 - 0.120 Inch Diameter Through, 0.060 Inch Maximum Of True Position
2. 1.435 Inch
3. This Surface Must Be 0.005 Inch Maximum of True Position.
4. PN 94692 Stud (2)
5. 0.305 - 0.325 Inch
6. 20°
7. Boss And Tube Assembly, 0.060 Inch Maximum Of True Position
8. 2.813 Inches
9. Weld Area (See Text)
10. Inlet Case Vane (4 O'Clock Position As Seen From Front of Case)
11. 0.842 - 0.846 Inch Diameter Hole, 1.115 - 1.135 Inch Diameter Recess With 0.047 - 0.078 Inch Corner Radius
12. 1.300 Inch
13. 3.510 - 3.520 Inches
14. Machine to 0.000 - 0.005 Inch Below This Surface To Remove Damaged Boss And Tube Assembly

Key To Figure 603

(5) Inlet case vane

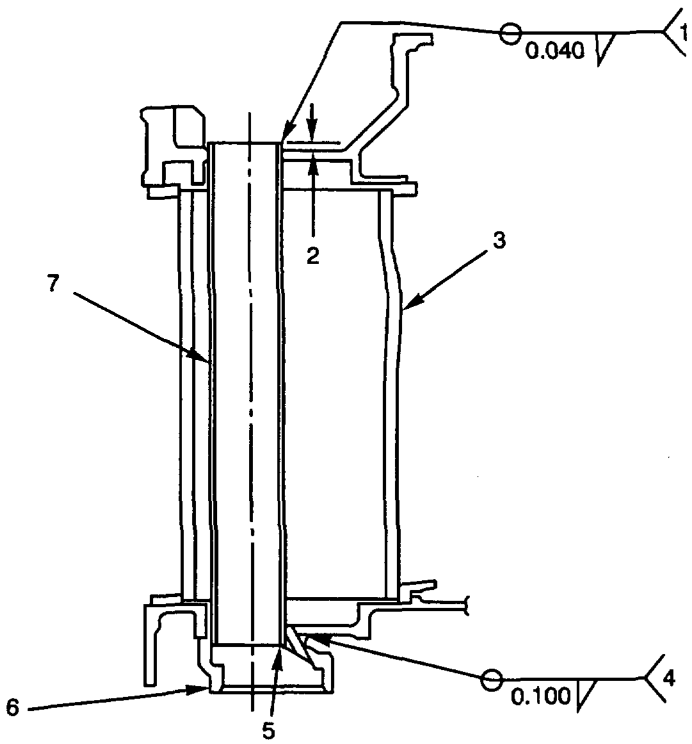
(a) Inspection

1 Examine inlet vanes for damage. Pits and corrosion are not bad damage. Fluorescent penetrant indications in the resistance weld along the vane trailing edge are permitted.

2 Round-bottom dents that do not have cracks or tears are permitted without repair to a maximum diameter of 0.500 inch and a depth of 0.125 inch.

CAUTION: BE VERY CAREFUL DURING BLEND REPAIRS WHEN DAMAGE IS NEAR INNER OR OUTER FILLET WELDS OF VANES.

3 Damage that does not decrease part thickness by more than 0.020 inch and which does not cause cracks or tears in the vanes is permitted without repair if the damage has a gradual contour shape and is not sharp or with a V-shape. To remove surface stress concentrations, do blend repairs of sharp indentations.



1. Weld (See Text)
2. 0.050 - 0.090 Inch
3. Inlet Case Vane (6 O'Clock Position)
4. Weld (See Text)
5. Weld (see Text)
6. Boss PN 402604
7. Tube PN 391973

Inlet Case No. 1 Bearing
Oil Scavenge Tube Replacement
Figure 604

4 Local removal of vane material after blend repair must not be more than 0.032 inch on the leading edge convex, and concave surfaces.

5 Remove trailing edge cracks and tears by blend repair. Blend repair must not decrease vane chordal length by more than 0.187 inch.

6 Surface finish on repaired vanes must be approximately the same as a new vane.

(b) Repair

CAUTION: BE VERY CAREFUL DURING BLEND REPAIRS WHEN DAMAGE IS NEAR INNER OR OUTER FILLET WELDS OF VANES.

1 Remove sharp indentations by blend repair. Removal of vane material must not be more than 0.032 inch on the leading edge concave and convex sides.

2 Remove trailing edge cracks and tears by blend repair. Chordal length after blend repair must not decrease by more than 0.187 inch.

CAUTION: DURING WELD REPAIR (WHEN VANE CRACKS ARE STOP-DRILLED), MAKE SURE THAT THE OIL SYSTEM TUBES IN THE 4 AND 6 O'CLOCK POSITION STRUTS ARE NOT DAMAGED. TO MAKE SURE OF THIS, PUT A STOP OF THE CORRECT SIZE ON THE DRILL BIT TO KEEP THE DRILL DEPTH TO 1/32 INCH.

3 Repair cracks in vanes by weld as specified in Inlet Case Weld Repair above.

4 Surface finish on repaired vanes must be approximately the same as a new vane.

(c) Inlet vane replacement

1 It is permitted to replace vanes if:

a No more than five vanes are replaced

b No more than two adjacent vanes are replaced.

c Each vane is fully replaced before a subsequent vane is replaced.

d No more than three vanes are replaced in a 180-degree arc.

2 If the thick vanes (4 and/or 6 o'clock positions as seen from the front) will get replacement, remove No. 1 bearing internal oil tubes as specified above.

3 Remove damaged vanes and bring the vane slots in the outer and inner shrouds back to their initial dimensions.

4 Cut the new vane to have the correct fit with the case slot and weld it in position as shown (make sure that anodize coat is removed from the weld area). See Figure 605. Put wet ceramic fiber insulation around the weld areas to prevent heat damage to adjacent surfaces.

5 If applicable (if the replaced vane had tubes in it), replace the No. 1 bearing oil tubes as specified above.

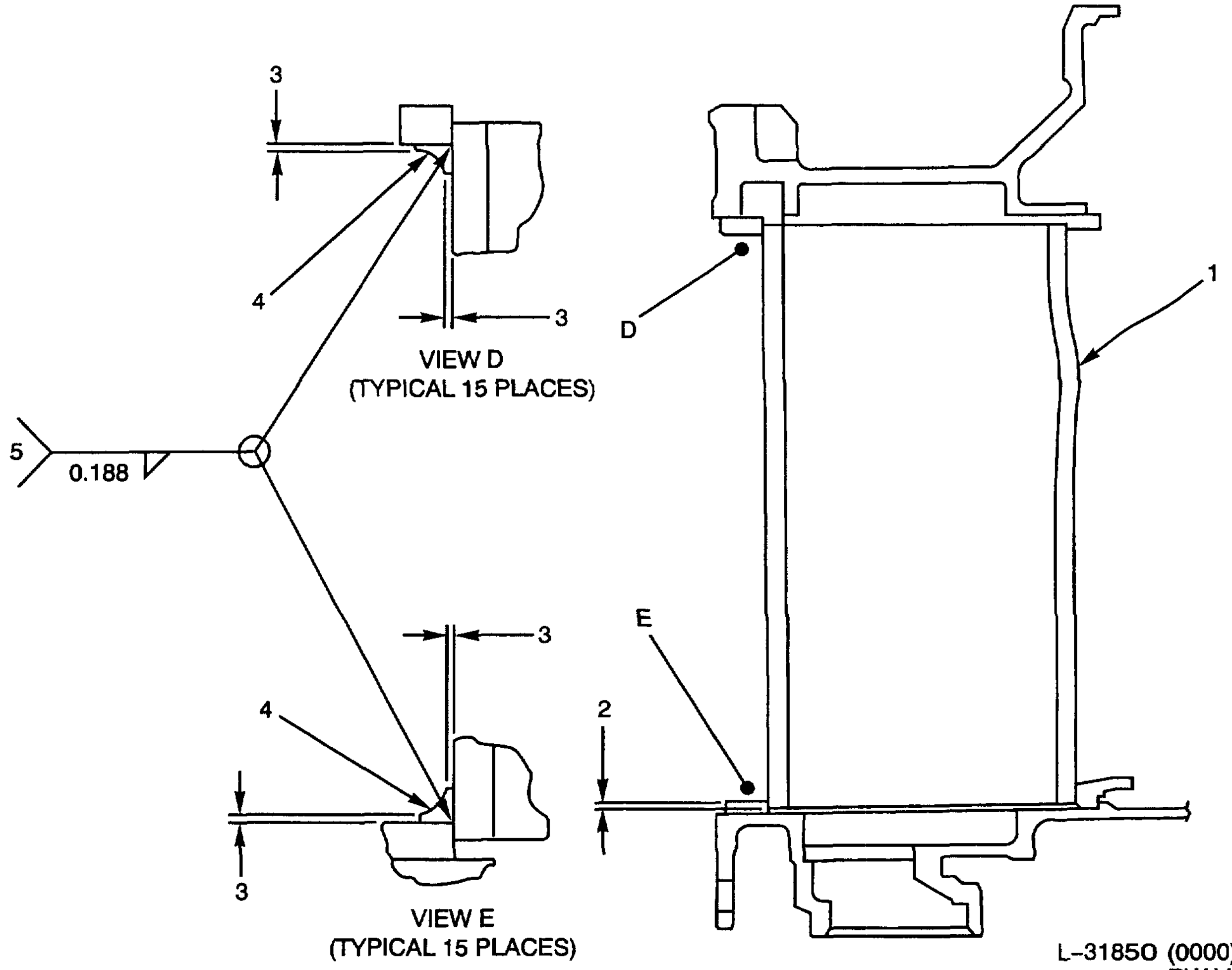
6 Stress-relieve the case at 157° - 168°C (315° - 335°F) for four hours.

7 Coat the local area with aluminized epoxy paint by SPOP 148 (Task 7-41-03-380-06). Refer to Section 70-41-03 in the Standard Practices Manual.

8 Do a pressure check of the case assembly as specified above.

(d) Inlet case vane junction repair

1 Weld repair cracks at the junction of the compressor vanes and outer shrouds as shown in Figure 605, Indexes 3 and 4, with stress-relief, pressure check, and coating as specified in steps (c) 6 thru 8 above.



1. Compressor Inlet Case Vane
2. 0.020 Inch Minimum Each End
3. 0.000 - 0.010 Inch All Around
4. 0.156 Inch Radius Minimum, Blended Smoothly All Around
5. Weld (See Text)

Inlet Case Vane Replacement
Figure 605

C. Compressor Inlet Case Air Pressure Check (See Tool Group 30A)

NOTE: This check is used to find leakage which is more than limits in the inlet case braze areas, specifically the bearing compartment, pressure oil tubes, and hollow vanes.

(1) Attach the No. 1 bearing area Plug to the No. 1 bearing compartment on the front face of the inlet case.

(2) Install the probe hole Plug in the pressure probe hole flange on the outer surface of the inlet case.

(3) Attach the anti-icing air Plug to the anti-icing air flange on the outer surface of the inlet case.

(4) Install the oil pressure tube Plug in the pressure oil tube flange on the outer surface of the inlet case.

(5) Put the inlet case fully into clean water and gradually apply air pressure at five psi.

(6) No leakage is permitted in tubes or in the bearing compartment. Pinhole-type leaks (not cracks) are permitted in the braze around vanes, if the leakage at an individual leak is not more than 150 cc of air per minute.

(7) Remove the case from the water tank and remove the tool plugs.

(8) Install the pressure tube Adapter to the inner and outer end of the oil pressure tube (round) and put the case in the water tank.

(9) Gradually apply air pressure to 25 psi. No leakage is permitted.

(10) Remove the case from the water tank and remove the test adapter.

(11) Install the scavenge tube Adapter to the inner and outer end of the oil scavenge tube and put the case in the water tank.

(12) Gradually apply air pressure to 5 psi. No leakage is permitted.

(13) Remove the case from the water tank and remove the test adapter.

(14) Dry the case fully with hot dry air (be sure to remove water from cavities and internal passages to which there is not easy access).

D. Inlet case mount bushing replacement (refer to Tool Group 46). See Figure 606.

(1) Install the bolt detail of the Puller through the bushing.

(2) Put the body of the puller on the bolt and bushing flange and attach the body to the bolt with the nut.

(3) Turn the nut until the bushing is free of the case. Hold the nut (do not let it turn) with the flat on the nut.

(4) Start the new mount bushing into the inlet case flange.

NOTE: Oversize bushings are available (see Table 601). If an oversize bushing is necessary, machine the flange holes to get the specified fit. Refer to Table of Limits, Reference 123.

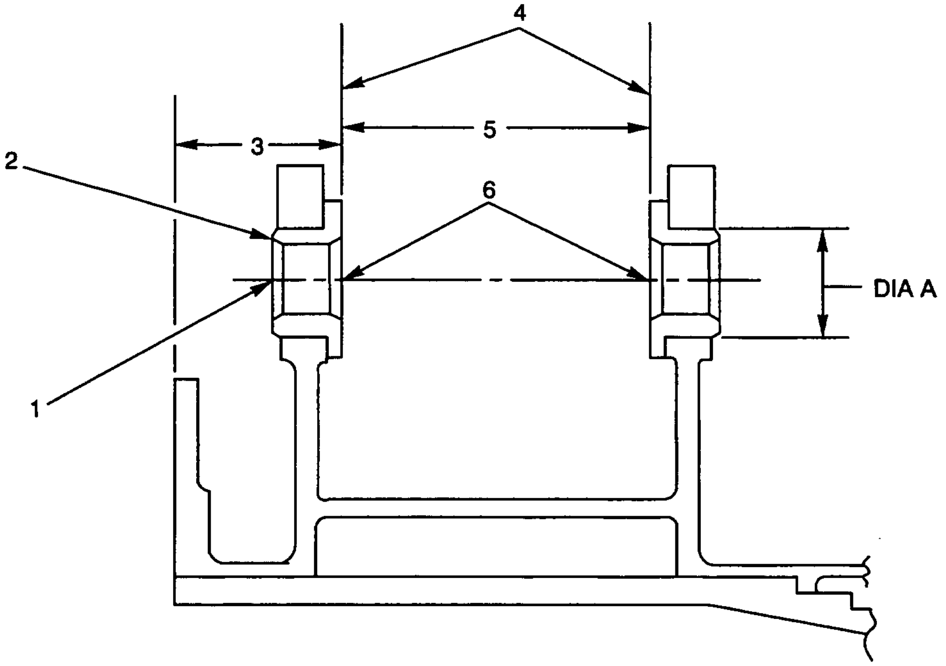
BUSHING PN	DIAMETER A (SEE FIGURE 606)
370162	0.5320 - 0.5326
370162-3	0.5350 - 0.5356
370162-5	0.5370 - 0.5376
370162-10	0.5420 - 0.5426
370162-15	0.5470 - 0.5476

Mount Bushing Oversizes
Table 601

(5) Install the bolt detail of the Puller through the bushing and case flange (put the body of the puller on the bolt until it is against the case).

(6) Attach the puller body in position with the nut, and turn the nut until the bushing is tightly installed in the case flange.

(7) If necessary machine faces and ID of the bushings to the limits shown in the figure.



L-12017 (0000)
PW V

1. Two Holes, In-Line To 0.001 Inch Maximum. Finish If Necessary To 0.3425 - 0.3435 Inch Diameter
2. PN 370162 Bushing (2)
3. 0.8326 - 0.8420 Inch
4. These Surfaces Must Be Parallel With The Front Flange Of The Inlet Case 0.001 Inch FIR Maximum
5. 1.623 - 1.627 Inch
6. Chamfer 0.020 - 0.040 Inch By 45° Approximately

R
R

Inlet Case Vane Replacement
Figure 606

5. No. 1 Bearing Housing

A. Inspection

(1) Refer to Table of Limits for housing dimensions and limits.

B. Repair

(1) Plating repair. See Figure 607.

R R R (a) Remove plate (chromium or cadmium) from the rear OD. Refer to SPOP 21 (Task 70-44-01-330-001) or SPOP 22 (Task 70-44-01-330-002). Refer to Section 70-44-01 in the Standard Practices Manual.

(b) Machine the bearing journal to prepare it for chromium plate as shown in the figure.

R (c) If necessary, remove and replace the chromium plate at the rear ID and OD, to a thickness of 0.004 - 0.006 inch as shown by SPOP 22 (Task 70-44-01-330-002). Refer to Section 70-44-01 in the Standard Practices Manual.

(d) Apply chromium plate to the bearing journal area by SPOP 22.

R (e) Do one of these procedures after plate:

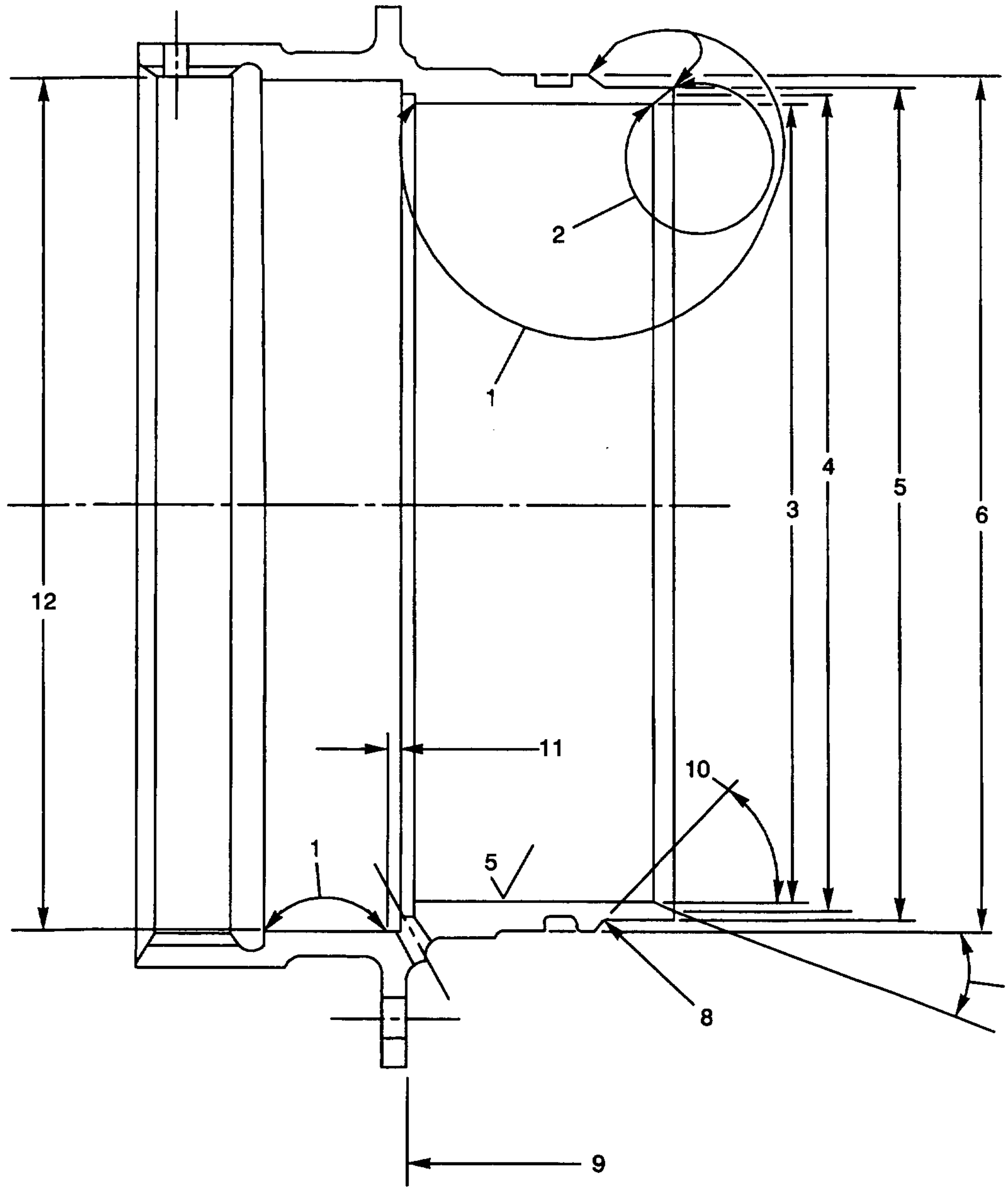
R R NOTE: The housing has a Rockwell hardness of C32 - C38 or equivalent.

R R 1 Bake the housing at 399° - 427°C (750° - 800°F) for two hours.

R or

R 2 Shotpeen the repair area (refer to SPOP 22).

(f) Finish grind to the dimensions shown in the figure.



No. 1 Bearing Housing
Plate Repair
Figure 607

ENGINE INLET - INSPECTION, REPAIR, AND REPLACEMENT

R 1. Chromium Plate Area. Plate Out Of Journal Area Shown Is
R Permitted But Remove Unwanted Plate.
R 2. Minimum Plate Thickness Limits Waived In This Area
R 3. 3.874 - 3.876 Inch Diameter After Plate And Finish Machining,
R Concentric With Index 6 Diameter 0.001 Inch Maximum FIR And
R Square with Index 9 Face 0.001 Inch Maximum FIR
R 4. 3.970 - 3.990 Inch Diameter
R 5. 4.050 - 4.070 Inch Diameter (After Plate)
R 6. Reference Diameter
R 7. 18° - 22° Chamfer
R 8. 0.047 - 0.078 Inch Radius
R 9. Reference Face
R 10. 43° - 47°
R 11. 0.035 Inch Minimum
R 12. 4.1396 - 4.1546 Inch Diameter After Machining (Hold To Minimum),
4.123 Inch Maximum Diameter After Plate, 4.1339 - 4.1346 Inch
Diameter Finish Dimension, Concentric With Index 7 Diameter
0.001 Inch Maximum FIR And Square With Index 9 Face 0.001 Inch
Maximum FIR.

Key To Figure 607

ENGINE COMPRESSOR

TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

Please insert the revised pages into this manual and delete obsoleted pages in accordance with the following List of Effective Pages. Revised pages are indicated by the letter "R", added pages by the letter "A", and deleted pages by the letter "D". Superseded pages shall be removed and destroyed.

The List of Effective Pages records not only each page of subject revision but also each previously issued page which is still current. Blank pages and pages which are no longer current do not appear on this list. If there is any question about the currency of the maintained copy, it is recommended that each page of the manual be checked off against this List of Effective Pages. Any page which does not check out with this list, either by number or by date, shall be discarded. This list is reissued in its entirety whenever this manual section is revised.

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
Tab Separator - Engine Compressor				
List of Effective Pages - Engine Compressor See end of list.				
Table of Contents - Engine Compressor				
72-30-00		01	A	APR 1/07
		02	A	APR 1/07
72-30-00 INSP/REP-01		601	-ALL	APR 1/07
		602		APR 1/07
	R	603		MAY 1/08
	R	604		MAY 1/08
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
		613		APR 1/07
		614		APR 1/07
		615		APR 1/07
		616		APR 1/07
		617		APR 1/07
		618		APR 1/07
		619		APR 1/07
		620		APR 1/07
72-30-00 INSP/REP-02		601	-ALL	APR 1/07
		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
		613		APR 1/07
		614		APR 1/07
		615		APR 1/07
		616		APR 1/07
	R	617		MAY 1/08
	R	618		MAY 1/08
	R	619		MAY 1/08
	R	620		MAY 1/08
	R	621		MAY 1/08
	R	622		MAY 1/08
	R	623		MAY 1/08
	R	624		MAY 1/08
	R	625		MAY 1/08
	R	626		MAY 1/08
		627		APR 1/07
		628		APR 1/07

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-30-00			(CONTINUED)	
INSP/REP-02	R	629		MAY 1/08
	R	630		MAY 1/08
	R	631		MAY 1/08
	R	632		MAY 1/08
	R	633		MAY 1/08
	R	634		MAY 1/08
	R	635		MAY 1/08
	R	636		MAY 1/08
	R	637		MAY 1/08
	R	638		MAY 1/08
	R	639		MAY 1/08
	R	640		MAY 1/08
	R	641		MAY 1/08
	R	642		MAY 1/08
	R	643		MAY 1/08
	R	644		MAY 1/08
	R	645		MAY 1/08
	R	646		MAY 1/08
	R	647		MAY 1/08
	R	648		MAY 1/08
	R	649		MAY 1/08
	R	650		MAY 1/08
	R	651		MAY 1/08
	R	652		MAY 1/08
	R	653		MAY 1/08
	R	654		MAY 1/08
	R	655		MAY 1/08
	R	656		MAY 1/08
	R	657		MAY 1/08
	R	658		MAY 1/08
	R	659		MAY 1/08
	R	660		MAY 1/08
	R	661		MAY 1/08
	R	662		MAY 1/08
	R	663		MAY 1/08
	R	664		MAY 1/08
	R	665		MAY 1/08
	R	666		MAY 1/08
	R	667		MAY 1/08
	R	668		MAY 1/08
	R	669		MAY 1/08
	R	670		MAY 1/08
	R	671		MAY 1/08
	R	672		MAY 1/08
		673		APR 1/07
		674		APR 1/07
	R	675		MAY 1/08
	R	676		MAY 1/08
	R	677		MAY 1/08
	R	678		MAY 1/08
	R	679		MAY 1/08
	R	680		MAY 1/08
	R	681		MAY 1/08
	R	682		MAY 1/08
	R	683		MAY 1/08
	R	684		MAY 1/08
		685		APR 1/07
		686		APR 1/07

LIST OF EFFECTIVE PAGES

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-30-00			(CONTINUED)	
INSP/REP-02	R	687		MAY 1/08
	R	688		MAY 1/08
		689/690		APR 1/07
72-30-00		601	-ALL	APR 1/07
INSP/REP-03		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
	R	607		MAY 1/08
	R	608		MAY 1/08
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
	R	613		MAY 1/08
	R	614		MAY 1/08
	R	615		MAY 1/08
	R	616		MAY 1/08
		617		APR 1/07
		618		APR 1/07
	R	619		MAY 1/08
	R	620		MAY 1/08
	R	621		MAY 1/08
	R	622		MAY 1/08
	R	623		MAY 1/08
	R	624		MAY 1/08
		625		APR 1/07
		626		APR 1/07
	R	627		MAY 1/08
	R	628		MAY 1/08
	R	629		MAY 1/08
	R	630		MAY 1/08
	R	631		MAY 1/08
	R	632		MAY 1/08
	R	633		MAY 1/08
	R	634		MAY 1/08
	R	635		MAY 1/08
	R	636		MAY 1/08
	R	637		MAY 1/08
	R	638		MAY 1/08
	R	639		MAY 1/08
	R	640		MAY 1/08
	R	641		MAY 1/08
	R	642		MAY 1/08
	R	643		MAY 1/08
	R	644		MAY 1/08
	R	645		MAY 1/08
	R	646		MAY 1/08
	R	647		MAY 1/08
	R	648		MAY 1/08
	R	649		MAY 1/08
	R	650		MAY 1/08
	R	651		MAY 1/08
	R	652		MAY 1/08
	R	653		MAY 1/08
	R	654		MAY 1/08
	R	655		MAY 1/08
	R	656		MAY 1/08
		657		APR 1/07
		658		APR 1/07
	R	659		MAY 1/08
	R	660		MAY 1/08
	R	661		MAY 1/08
	R	662		MAY 1/08
	R	663		MAY 1/08
	R	664		MAY 1/08
	R	665		MAY 1/08
	R	666		MAY 1/08
	R	667		MAY 1/08
	R	668		MAY 1/08
	R	669		MAY 1/08
	R	670		MAY 1/08
72-30-00			(CONTINUED)	
INSP/REP-03		671		APR 1/07
		672		APR 1/07
		673		APR 1/07
		674		APR 1/07
	R	675		MAY 1/08
	R	676		MAY 1/08
	R	677/678		MAY 1/08
72-30-00		601	-ALL	APR 1/07
INSP/REP-04		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
	R	605		MAY 1/08
	R	606		MAY 1/08
		607		APR 1/07
		608		APR 1/07
	R	609		MAY 1/08
	R	610		MAY 1/08
	R	611		MAY 1/08
	R	612		MAY 1/08
		613		APR 1/07
		614		APR 1/07
	R	615		MAY 1/08
	R	616		MAY 1/08
	R	617		MAY 1/08
	R	618		MAY 1/08
		619		APR 1/07
		620		APR 1/07
		621		APR 1/07
		622		APR 1/07
	R	623		MAY 1/08
	R	624		MAY 1/08
		625		APR 1/07
		626		APR 1/07
		627		APR 1/07
		628		APR 1/07
		629		APR 1/07
		630		APR 1/07
		631		APR 1/07
		632		APR 1/07
72-30-00		601	-ALL	APR 1/07
INSP/REP-05		602		APR 1/07
		603/604		APR 1/07
72-30-00		601	-ALL	APR 1/07
INSP/REP-06		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
		613/614		APR 1/07
72-30-00		601	-ALL	APR 1/07
INSP/REP-07		602		APR 1/07
	R	603		MAY 1/08
	R	604		MAY 1/08
		605		APR 1/07
		606		APR 1/07
	R	607		MAY 1/08
	R	608		MAY 1/08
		609		APR 1/07
		610		APR 1/07
	R	611		MAY 1/08
	R	612		MAY 1/08
		613		APR 1/07
		614		APR 1/07

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-30-00		601	-ALL	APR 1/07
INSP/REP-08		602		APR 1/07
	R	603		MAY 1/08
	R	604		MAY 1/08
		605		APR 1/07
		606		APR 1/07
	R	607		MAY 1/08
	R	608		MAY 1/08
	R	609		MAY 1/08
	R	610		MAY 1/08
	R	611		MAY 1/08
	R	612		MAY 1/08
	R	613		MAY 1/08
	R	614		MAY 1/08
		615		APR 1/07
		616		APR 1/07
	R	617		MAY 1/08
	R	618		MAY 1/08
	R	619		MAY 1/08
	R	620		MAY 1/08
	R	621		MAY 1/08
	R	622		MAY 1/08
		623		APR 1/07
		624		APR 1/07
	R	625		MAY 1/08
	R	626		MAY 1/08
	R	627		MAY 1/08
	R	628		MAY 1/08
		629		APR 1/07
		630		APR 1/07
		631		APR 1/07
		632		APR 1/07
	R	633		MAY 1/08
	R	634		MAY 1/08
	R	635		MAY 1/08
	R	636		MAY 1/08
	R	637		MAY 1/08
	R	638		MAY 1/08
	R	639		MAY 1/08
	R	640		MAY 1/08
	R	641		MAY 1/08
	R	642		MAY 1/08
	R	643		MAY 1/08
	R	644		MAY 1/08
	R	645		MAY 1/08
	R	646		MAY 1/08
	R	647		MAY 1/08
	R	648		MAY 1/08
	R	649		MAY 1/08
	R	650		MAY 1/08
	R	651		MAY 1/08
	A	652		MAY 1/08
LIST OF EFFECTIVE PAGES				
		A		MAY 1/08
		B		MAY 1/08
		C		MAY 1/08

TEMPORARY REVISION NO. 72-0002

PURPOSE: This Temporary Revision adds category classifications for used compressor blades at inspection.

APPLICABLE MANUAL REVISION: Revision Number 075.

TR FILING INSTRUCTIONS: For a printed manual, put this Temporary Revision in the manual location specified below. Write the Temporary Revision Number on the Record of Temporary Revisions, which is adjacent to the Volume 1 Title Page. For a CD-ROM version of the manual, put this Temporary Revision in the reference file in sequence by Chapter/Section to show that this Temporary Revision is added to the manual.

MANUAL LOCATION:

CHAPTER/SECTION	PROCEDURE	LOCATION
72-30-00	INSPECTION, REPAIR, AND REPLACEMENT-01	Page 612

CHANGED DATA:

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-30-00 INSP/REP-01	612 -617 619 621 -624	Added categories for JFTD12A compressor blade condition, (EA 08JC003)	-ALL

TEMPORARY REVISION NO. 72-0003

PURPOSE: This Temporary Revision adds inspection and classification of JFTD12A compressor stator vane chord width.

APPLICABLE MANUAL REVISION: Revision Number 075.

TR FILING INSTRUCTIONS: For a printed manual, put this Temporary Revision in the manual location specified below. Write the Temporary Revision Number on the Record of Temporary Revisions, which is adjacent to the Volume 1 Title Page. For a CD-ROM version of this manual, put this Temporary Revision in the reference file in sequence by Chapter/Section to show that this Temporary Revision is added to the manual.

MANUAL LOCATION:

CHAPTER/SECTION	PROCEDURE	LOCATION
72-30-00	INSPECTION, REPAIR, AND REPLACEMENT-02	Page 601

CHANGED DATA:

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-30-00 INSP/REP-02	601 -612 614 -617 619 621 -648 650 -686 688 -693	Added compressor vane chord width inspection and classification (JFTD12A) (EA 08JC004, 08JC005)	-ALL

TO: RECIPIENTS OF JT12 OVERHAUL MANUAL, PART NUMBER 435108

REVISION NO. 75 DATED MAY 1, 2008

HIGHLIGHTS - ENGINE COMPRESSOR

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-30-00 INSP/REP-01	604	Added compressor blade pitting limits. (Editorial)	-ALL
72-30-00 INSP/REP-02	618 620 -622 624 626 629 632 642 644 -645 647 -648 651 663 666 668 675 677 682 -683 688	Added post-SB 1168 stator rivet hole dimensions. (SB 1168)	-ALL
72-30-00 INSP/REP-03	608 613 615	Revised compressor disk/hub repair text. (Editorial)	-ALL

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-30-00 INSP/REP-03 (CONTINUED)	619 621 627 629 631 633 635 637 639 644 646 652 654 656 659 -669 675 -677/ 678	Added steel compressor disk part numbers. (CTS req 11-21-07)	-ALL
72-30-00 INSP/REP-04	606 609 615 618 624	Revised compressor spacer repair text. (Editorial) Added 4th thru 9th stage spacer pitting repair procedures. (IEN 03JC009)	-ALL
72-30-00 INSP/REP-07	604 607 612	Revised No. 2 bearing oil sleeve repair. (Editorial)	-ALL
72-30-00 INSP/REP-08	603 608 -609 611 617 619 -620 634 636	Revised diffuser area parts text. (Editorial)	-ALL

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-01

1. Engine Compressor Section (Blades)

   A. General

      (1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Compressor Blades

   A. Inspection
   See Tool Group 27A.

      CAUTION: DISCARD ALL 5TH STAGE STEEL BLADES FROM ENGINES OPERATED TO MORE THAN 12,600 RPM FOR AN EXTENDED PERIOD WITH THE BLEED VALVE OPEN.

      (1) Do fluorescent magnetic particle inspection or fluorescent penetrant inspection of steel compressor blades. All cracks are cause to reject the blade.

      NOTE: Compressor blade blend limits as specified in this manual are evaluated from the standpoint of structural integrity only, and the use of a substantial number or blades repaired at or near the maximum limits, or blades with many repaired areas may adversely affect compressor efficiency and engine performance.

      (2) Do fluorescent penetrant inspection of titanium blades. All cracks are cause to reject the blade.

      CAUTION: THE LIMITS IN FIGURE 601 IN AREAS C AND E ARE APPLICABLE TO LOCAL ISOLATED DAMAGED AREAS ONLY AND ARE NOT AN AUTHORITY TO REMOVE MATERIAL ALL ACROSS THE TIP OR LEADING OR TRAILING EDGE (AS A SINGLE MACHINING CUT WILL DO), EXCEPT FOR THE TAPER CUT PERMITTED ON 1ST STAGE BLADES ONLY.

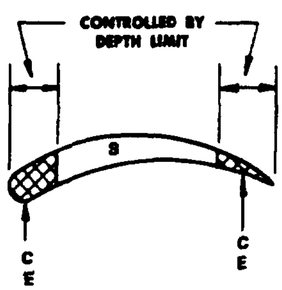
      (3) Repair minor damage to blades if it is possible to remove the damage in the limits in Figure 601.

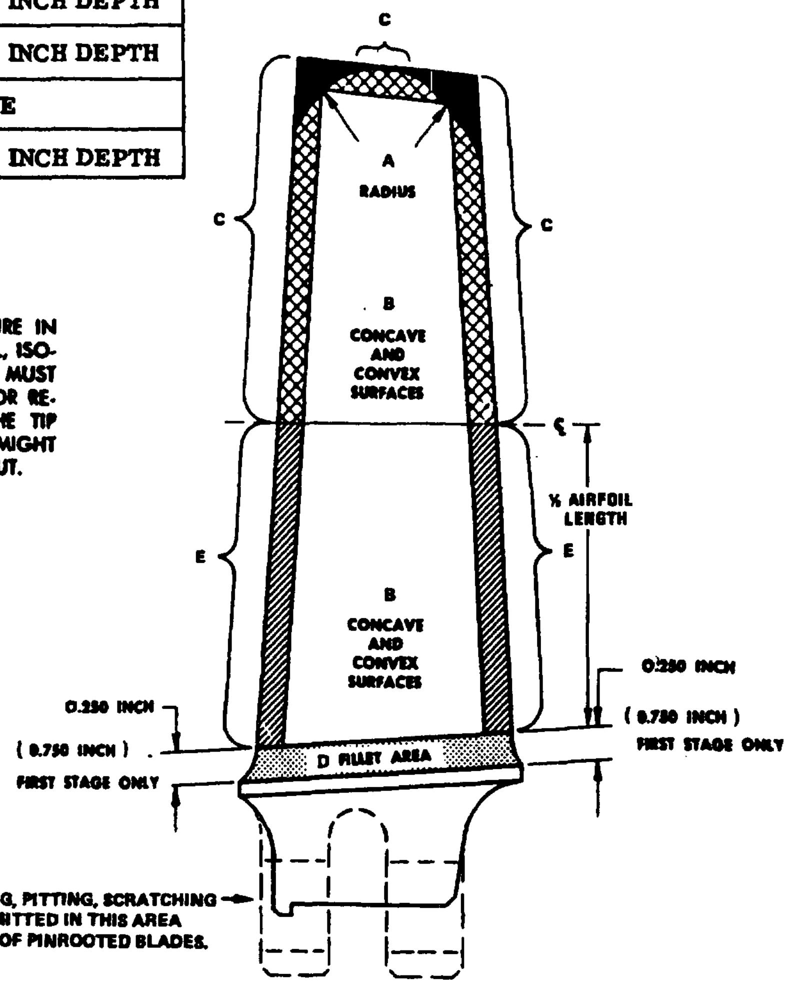
      (4) Portions of a blade which have sustained indentation, with blade material compressed and edges raised, and damage with small radii or ragged edges are not serviceable.

BLADE AREA	1ST STAGE	STAGES 2 THROUGH 9
A	1/4 INCH RADIUS	3/16 INCH RADIUS
B	1/32 INCH DEPTH	1/32 INCH DEPTH
C	1/8 INCH DEPTH	3/32 INCH DEPTH
D	NONE	NONE
E	1/32 INCH DEPTH	1/32 INCH DEPTH

CAUTION

THE LIMITS REFERRED TO IN THIS FIGURE IN AREAS "C" AND "E" PERTAIN TO LOCAL, ISOLATED, DAMAGED AREAS ONLY AND MUST NOT BE INTERPRETED AS AUTHORITY FOR REMOVAL OF MATERIAL ALL ACROSS THE TIP AND LEADING OR TRAILING EDGES AS MIGHT BE DONE IN A SINGLE MACHINING CUT.





L-50978 (I075)

R
R

Compressor Blade Limits
Figure 601

(5) To repair relatively smooth and round-bottom indentations, remove only the edges of the damage.

(6) Well-rounded damage to leading and trailing edges which can be seen on opposite side of blade are acceptable without rework provided damage is in outer half of blade and indentation does not exceed 0.010 inch.

(7) In inner half of airfoil, any damage must be treated with extreme caution. No attempt shall be made to remove any damage by straightening.

(8) Following requirements and Figure 602 and Figure 603 provide the maximum reparable pit limits for compressor blades. This includes both minor impact and corrosion pitting.

(a) Pitting within the limits shown in Figure 602 is acceptable with repair. No compressor blades exhibiting pitting on airfoil are acceptable without repair in accordance with Paragraph F.

(b) Any pitting or galling in blade root Area F is cause for rejection.

(c) Inspect blade root platform. See Figure 603.

(9) Inspect dovetail or pin joint blade roots of titanium blades to be sure of complete coverage of antigalling compound.

(10) Examine a 1st stage compressor blade tip for damage due to blade tip rub. Slight discoloration due to rubbing is permissible. There must not be any sign of blade tip curl.

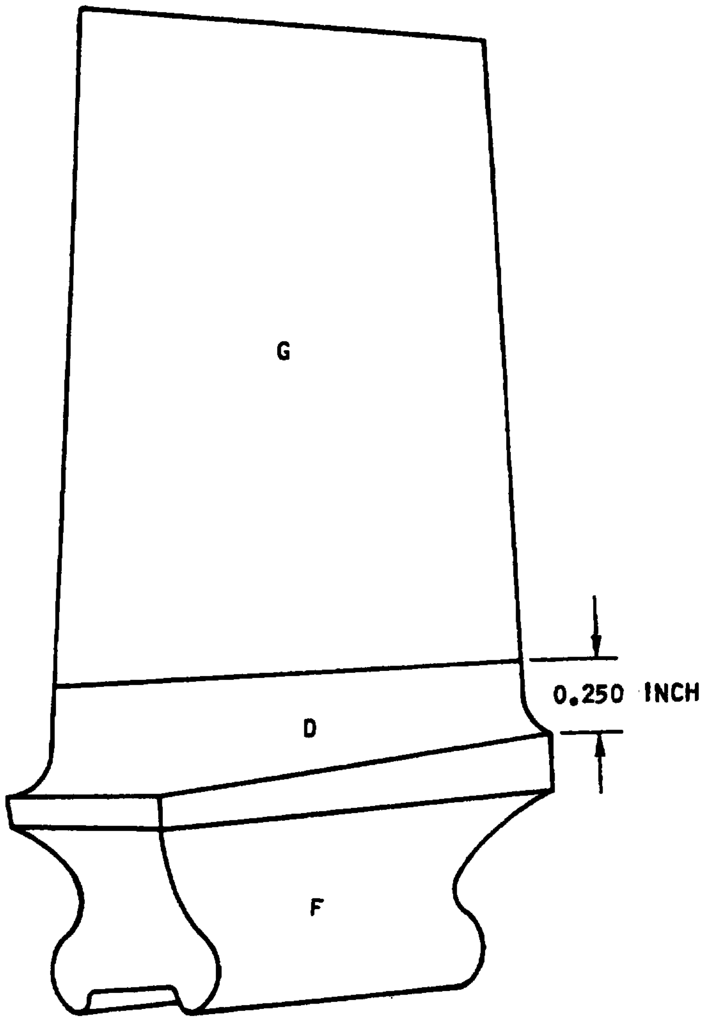
(11) Inspect blade root chamfers by Figure 604.

(12) First stage blades acceptable to Figure 605 with damaged leading edges may be repaired by a taper cut in accordance with Paragraph D. Blades must be acceptable to limits in Figure 602 after repair.

B. Compressor Blade Trailing Edge Erosion Measurement (JFTD12A Only)
See Tool Group 28 and Figure 606 and Figure 607.

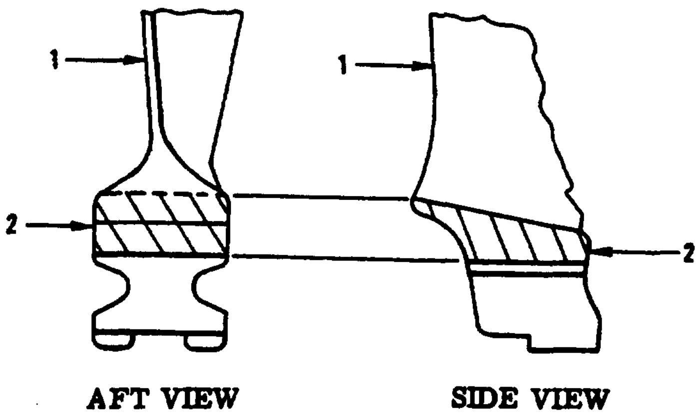
(1) Select random sample consisting of ten percent of blades used in each disk and blade assembly.

R
R



R	AREA	DEPTH LIMIT
R	G	0.010 Inch
R	D	0.003 Inch
R	F	No Pits Permitted

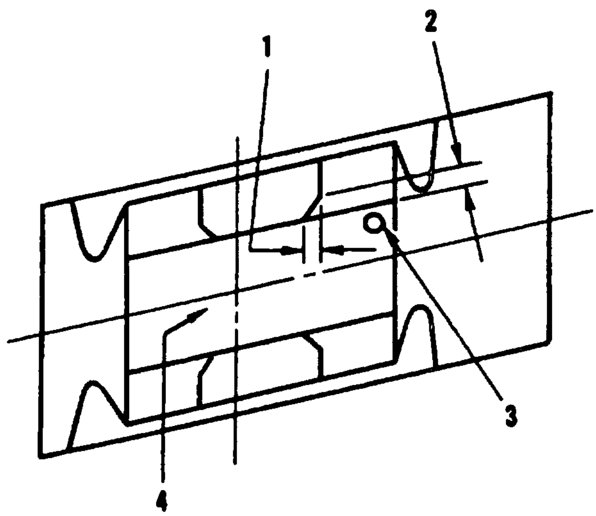
Pitting Limits
Figure 602



L-21874 (0000)

1. Compressor Blade Trailing Edge
2. Shaded Area - Pitting Allowed Provided Depth Does Not Exceed 0.032 Inch

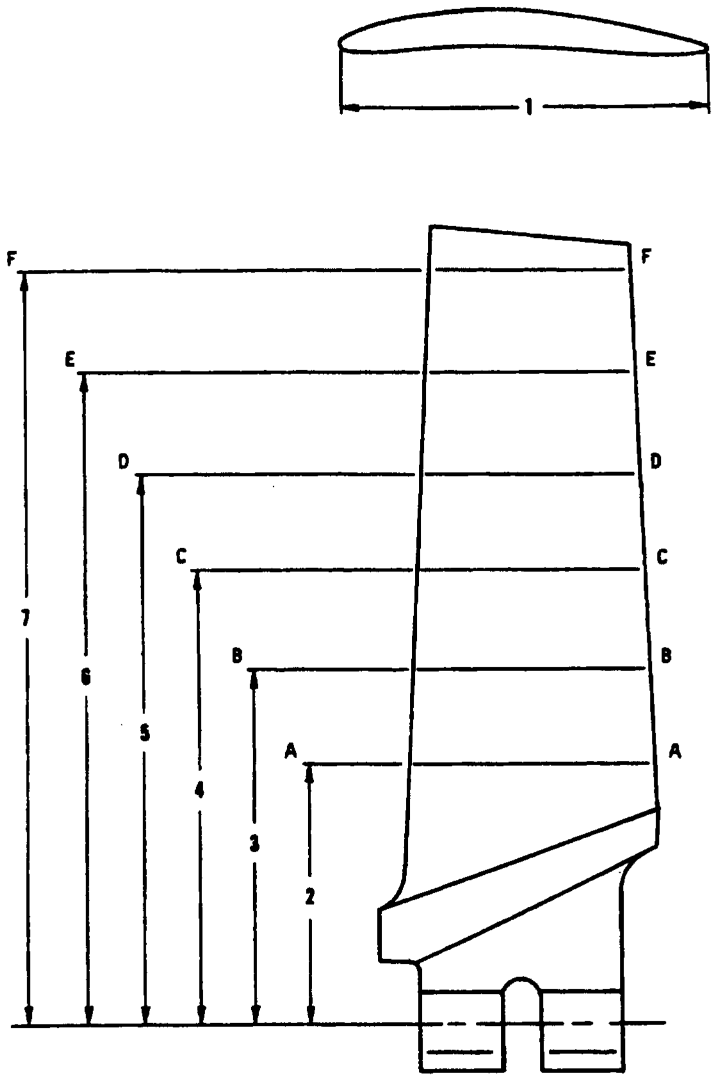
Steel Compressor Blade
Root Pitting Limits
Figure 603



L-I8678 (0000)

1. 0.065 Inch Maximum Acceptable Chamfer (Four Places)
2. 0.045 Inch Maximum Acceptable Chamfer (Four Places)
3. Two Spherical Indentations Are Acceptable
4. Part Number Area

Compressor Blade Root
Lugs Inspection
Figure 604



L-37128 (0000)

Chord Length Inspection
(PN 445301)
Figure 605

1. Minimum Chord Length:

   1.865 Inches At Section A-A
   1.915 Inches at Section B-B
   1.974 Inches at Section C-C
   2.032 Inches at Section D-D
   2.092 Inches at Section E-E
   2.151 Inches at Section F-F

2. 1.344 Inch Gage Length
3. 2.009 Inch Gage Length
4. 2.762 Inch Gage Length
5. 3.514 Inch Gage Length
6. 4.268 Inch Gage Length
7. 5.019 Inch Gage Length

Key to Figure 605

(2) Using erosion gage (Figure 606) as follows, check for erosion of compressor blade trailing edges at points indicated in Figure 607, Indexes 1 and 2.

(3) Select random sample consisting of ten percent of blades used in each disk and blade assembly.

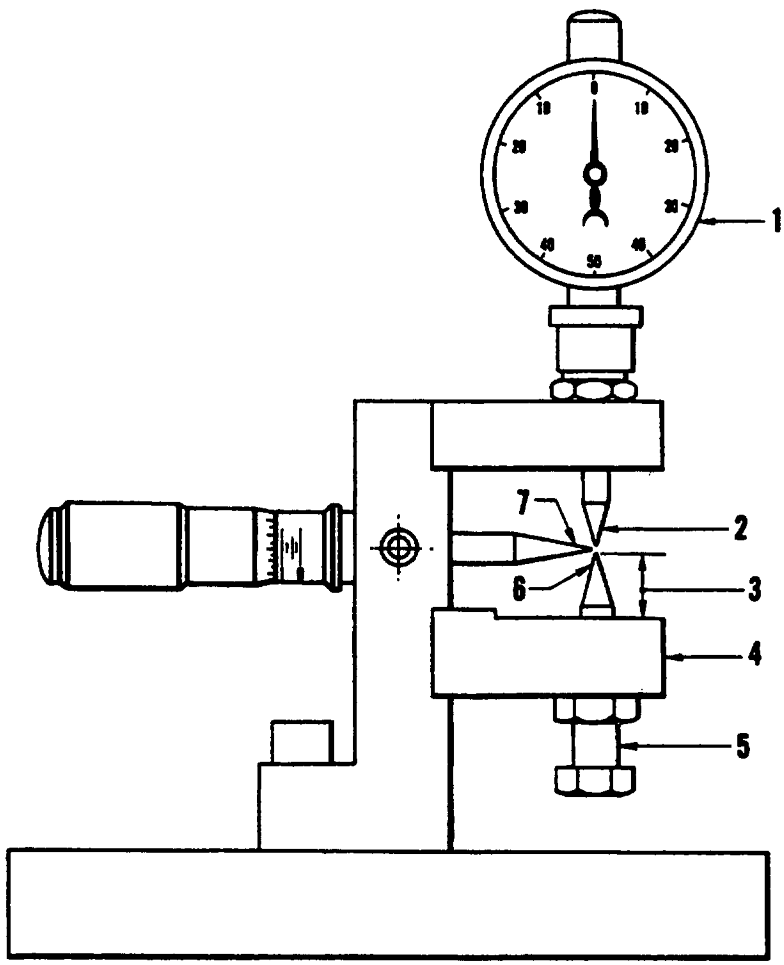
(4) Using erosion gage (Figure 606) as follows, check for erosion of compressor blade trailing edges at points indicated in Figure 607, Indexes 1 and 2.

(a) Zero micrometer depth control. Back off 0.0075 inch for 1st stage blades. For 2nd through 9th stages, back off 0.002 inch.

(b) Set adjustable stop so that contact point is at correct height above top surface of adjustable stop holding block. To obtain this dimension, when checking first stage blades, subtract 0.0075 inch from dimension marked on tool. For all other blades subtract 0.002 inch from dimension marked on tool.

(c) Zero dial indicator against contact point of adjustable stop.

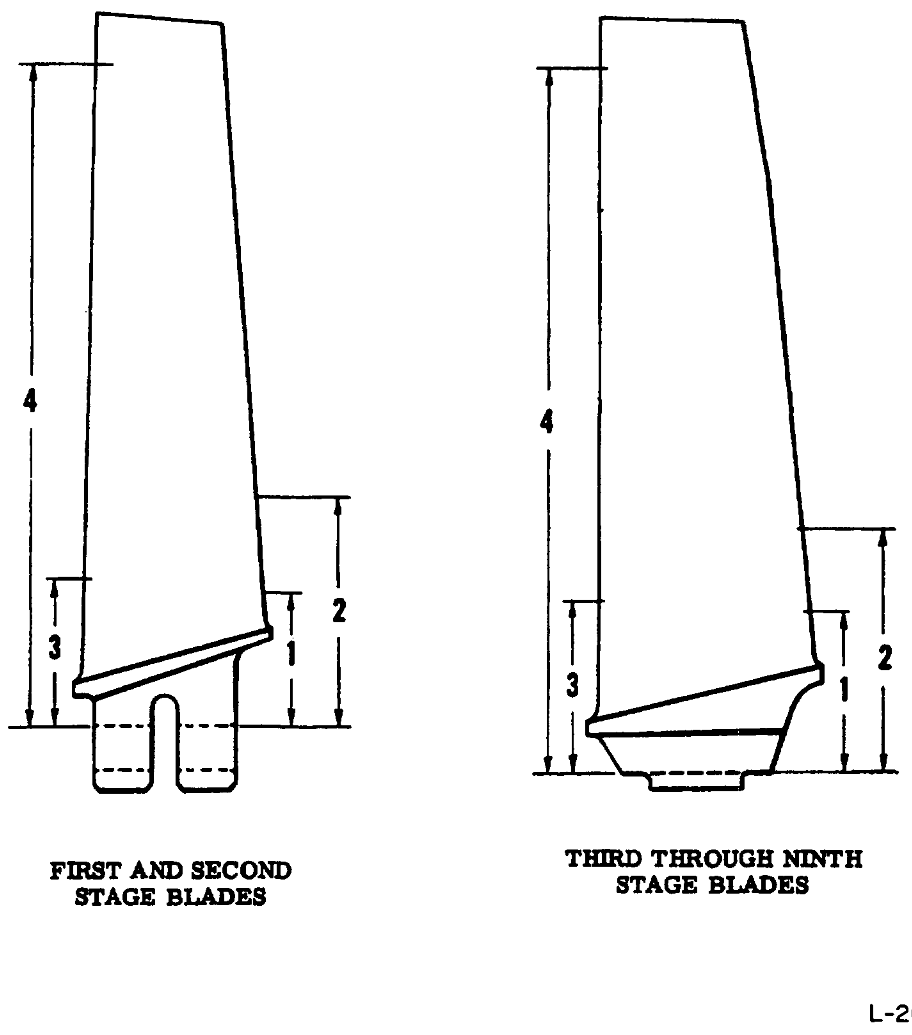
(d) Place blade in gage so that trailing edge maintains contact with all three points: adjustable stop contact point, micrometer type depth control, and dial indicator probe.



L-20429 (0000)

1. Dial Indicator
2. Dial Indicator Probe
3. Adjustable Stop Positioning Dimension
4. Adjustable Stop Holding Block
5. Adjustable Stop
6. Adjustable Stop Contact Point
7. Depth Control

Compressor Blade Trailing Edge
Erosion Checking Gage
Figure 606



Compressor Blade Erosion
Inspection
Figure 607

Minimum Acceptable Trailing Edge Dimensions

STAGE	DIM. 1	DIM. 2	MIN. TRAILING EDGE THICKNESS
1	1.124	1.789	0.015
2	0.820	1.845	0.004
3	0.684	1.331	0.004
4	0.663	1.176	0.004
5	0.663	1.176	0.004
6	0.663	1.176	0.004
7	0.440	0.643	0.004
8	0.440	0.643	0.004
9	0.440	0.643	0.004

Minimum Acceptable Airfoil Thickness Dimensions

	STAGE	DIM. 3	MAX. AIRFOIL THICKNESS	DIM. 4	MAX. AIRFOIL THICKNESS
	1	1.124	0.150	4.799	0.085
	2	0.820	0.080	3.895	0.045
	3	0.684	0.068	3.274	0.036
	4	0.663	0.064	2.715	0.037
	5	0.663	0.064	2.437	0.041
R	5*	0.663	0.064	2.083	0.045
	6	0.663	0.064	2.083	0.045
	7	0.440	0.055	1.785	0.035
	8	0.440	0.055	1.538	0.040
	9	0.440	0.055	1.337	0.042

R *PN 457805 only

Key to Figure 607

(e) Keeping blade trailing edge perpendicular to dial indicator probe, slightly rotate blade so that trailing edge radius rolls on depth control. Record minimum indicated reading.

(5) If any blades in sample are unacceptable per limits in Figure 607, all blades in that disk and blade assembly must be checked.

NOTE: Care shall be taken to avoid erosion checks in blended areas, since results from such checks will not reflect true condition of blade. If permissible blend has been performed, Figure 601, at erosion checking point, perform check at point immediately adjacent to blended area.

C. Compressor Blade Airfoil Thickness Check

(1) Using standard measuring equipment, check maximum airfoil thickness at locations indicated in Figure 607, Indexes 3 and 4.

(2) Reject all blades having maximum airfoil thickness below limits shown in Figure 607.

D. Blade Airfoil Chord Inspection And Classification (JFTD12A)

(1) General

(a) The tools in Table 601 are a steel bar with two gage slots with convergent angles. Each gage slot has two dowel pins in the slot as stops.

(b) The gages are used to find if the 1st thru 9th stage blade chordal width dimensions are in the limits of one of two permitted inspection categories, Category A or Category B, at a specified distance from the tip of the blade. Refer to Table 601 for the compressor blade part numbers and their applicable PWA tools, and the chord width limits specified for Category A and Category B.

(c) Blade Disposition:

1 An erosion section is identified near the blade tips. Limits for Category A and Category B blades are specified in these areas.

72-0002

2 There is a limit to how many lower-quality Category B blades are permitted per disk/hub stage (maximum 20 percent per stage).

3 Category B blades must be in random positions around the circumference of a disk or hub.

4 Blade chord limits are applicable if blades get all sufficent leading edge repairs before they go back into service.

5 Blades cannot be Category A if they have blend repairs. A blade with blend repairs that is in Category A limits must get a Category B classification.

6 A maximum of 10 percent of blades with blend repairs (half of the Category B limit) are permitted per disk/hub stage.

Blade/ Stage	PN	Ref. SB	PWA Tool Number	Category A Minimum Chord (Inches)	Category B Minimum Chord (Inches)
1st	445301	519	107501	2.169	2.146
2nd	407402		107502	1.121	1.110
3rd	536203	884	107503	0.880	0.872
	536203-001	6387	107503	0.880	0.872
	822103	6387	107503	0.880	0.872
4th	392104		107504	0.847	0.839
	536204	884	107504	0.847	0.839
5th	387705		107505	0.833	0.825
	457805	1665	107505	0.833	0.825
	536205	884	107505	0.833	0.825
	537405	1192	107505	0.833	0.825
6th	387706		107506	0.820	0.813
	536206	884	107506	0.820	0.813
	537406	1192	107506	0.820	0.813
7th	387707		107507	0.647	0.641
	536207	884	107507	0.647	0.641

Blade Chord Width Inspection Tools
And Limits
Table 601

72-0002

Blade/ Stage	PN	Ref. SB	PWA Tool Number	Category A Minimum Chord (Inches)	Category B Minimum Chord (Inches)
8th	387708		107508	0.638	0.632
	536208	884	107508	0.638	0.632
	537408	1192	107508	0.638	0.632
9th	406309		107509	0.628	0.622
	536209	884	107509	0.628	0.622
	537409	1192	107509	0.628	0.622
	569109	1533	107509	0.628	0.622

Blade Chord Width Inspection Tools
And Limits
Table 601 (Continued)

(2) Blade Chord Width Inspection

See Figure 608.

(a) Put the gage on a bench with the narrow part of the Category A gage slot to the operator.

(b) Install the blade in the Category A gage slot with the blade concave side to the gage face.

(c) Put the blade leading edge against the part of the gage slot that is adjacent to the middle of the gage as shown in the figure.

(d) Lift the trailing edge of the blade up to get it out of the gage slot. Move the blade tip in against the two gage dowel pins.

(e) Move the blade trailing edge down to the gage slot (keep the leading edge against the gage slot and the blade tip against the dowel pins).

(f) If the blade trailing edge does not go in the gage slot ("No Go" condition), then the blade is Category A.

(g) If the blade trailing edge does go in the gage slot ("Go" condition), then the blade is not in Category A minimum chord width limits.

R (h) Turn the gage 180 degrees to get the Category B
R side to the operator.

R (i) Install the blade in the Category B gage slot with
R the blade concave side to the gage face.

R (j) Do steps (c) thru (e).

R (k) If the blade trailing edge does not go in the gage
R slot ("No Go" condition), then the blade is a
R Category B blade.

R (l) If the blade trailing edge does go in the gage
R slot ("Go" condition), the blade is not in
R Category B minimum chord width limits and is not
R serviceable.

R (m) Refer to 72-00-00, Assembly of Subassemblies for
R procedures specified for Category A and Category B
R blades at compressor assembly.

R E. Repair

(1) Rework damage to blades to limits shown in Figure 601.

<u>CAUTION</u>: LIMITS REFERRED TO IN FIGURE 601 AT AREAS C AND E PERTAIN TO LOCAL, ISOLATED DAMAGED AREAS ONLY, AND MUST NOT BE INTERPRETED AS AUTHORITY FOR REMOVAL OF MATERIAL ALL ACROSS TIP AND LEADING OR TRAILING EDGE AS MIGHT BE DONE IN SINGLE MACHINING CUT, (EXCEPT FOR TAPER CUT WHICH IS ALLOWED ON 1ST STAGE BLADES ONLY). SEE PARAGRAPH E.

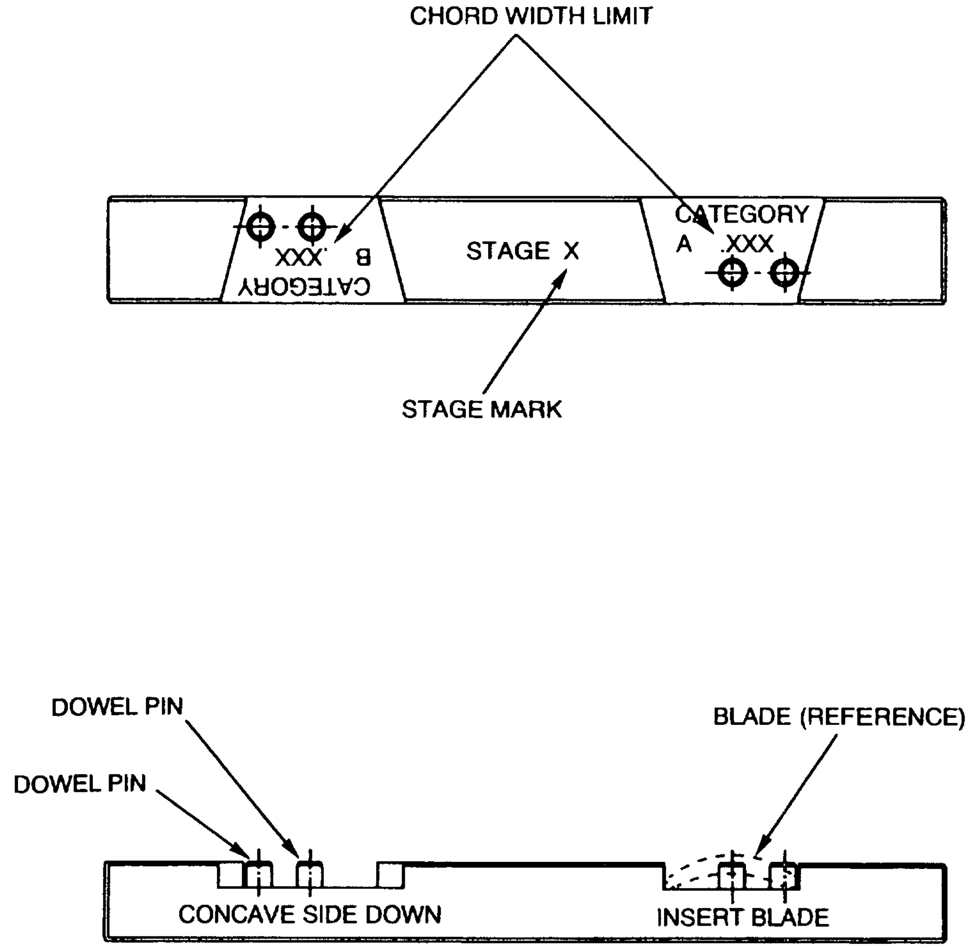
(2) Number of blends that may be performed on any one blade are as follows:

(a) Stages 1 thru 5 - two blends per blade if:

1 The blends are on leading or trailing edge (not both)

2 One blend is on the leading edge and one is on the trailing edge provided they are not closer than 1/4 length of blade from being opposite one another.

72-0002



L-H8387 (0408)
PW V

Blade Chord Width Inspection Tool
Figure 608

(b) Stages 6 thru 9 - one blend per blade.

NOTE: Limits in steps (a) and (b) do not apply to Areas A and D. Limits for these areas are governed by Figure 601.

(3) Stoning and blending of compressor blades should be done lengthwise to blade, never across it. This is to ensure that no scratches, however minute, run across blade edge. (See Blending, Grinding and Lapping, Standard Practices Manual).

NOTE: No belt sanding of blades is permitted.

(4) Elimination of damaged area in blade should be performed by local blending of damaged area only. Length of blend should be four times depth.

(5) Repaired compressor blades must be inspected by either fluorescent magnetic particle inspection or fluorescent penetrant methods to ensure that all trace of damage has been removed. All surfaces must be smooth and all repairs well blended. No cracks of any extent will be tolerated in any area.

(6) Blades which are bowed or bent shall not be considered for reuse. If gages are not available for rechecking this condition, blade in question shall be aligned and compared with new blades of the same stage.

(7) Surface finish that is desired in repaired area should be comparable to new blade. No buffing of entire area of blade shall be performed.

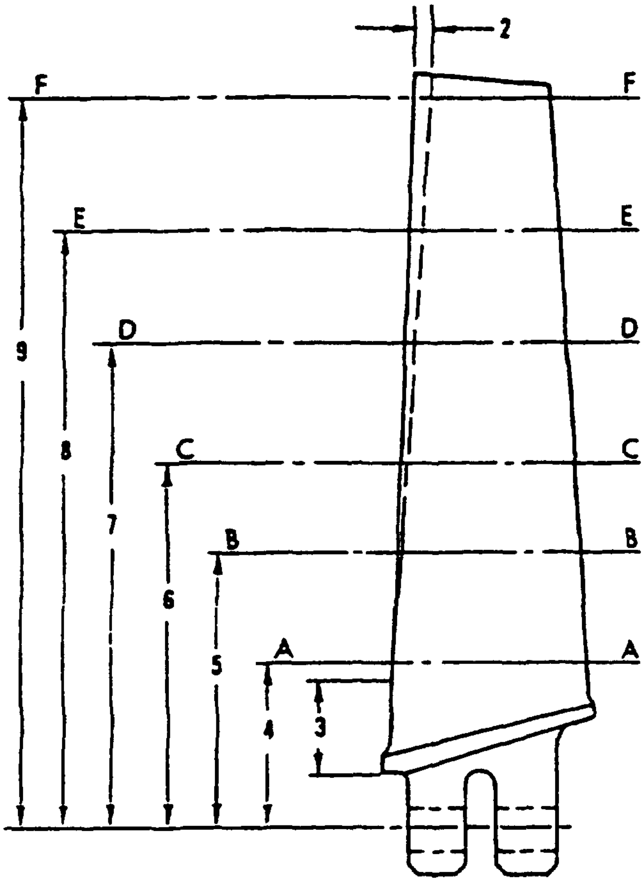
(8) Remove and replace antigalling compound on the dovetail or pin root of titanium blades. Refer to SPOP 160 (if PWA 474 antigalling compound is used) or SPOP 139 (if PWA 36545-3 is used). Refer to Section 70-41-03 in the Standard Practices Manual.

R F. First Stage Compressor Blade Repair
R See Figure 609.

(1) Leading Edge

(a) First stage compressor blades acceptable to Figure 605 with damaged leading edges may be
R repaired by a taper cut as shown in Figure 609.

TYPICAL VIEW
AIRFOIL LEADING EDGE



L-2575I (0572)

R
R

First Stage Compressor Blade
Leading Edge Repair
Figure 609

1. 0.026 - 0.038 Inch at Section A-A
   0.024 - 0.036 Inch at Section B-B
   0.022 - 0.034 Inch at Section C-C
   0.018 - 0.030 Inch at Section D-D
   0.012 - 0.024 Inch at Section E-E
   0.006 - 0.018 Inch at Section F-F
2. 0.030 Inch
3. 0.500 Inch
4. 1.344 Inches
5. 2.009 Inches
6. 2.762 Inches
7. 3.514 Inches
8. 4.268 Inches
9. 5.019 Inches

R Key to Figure 609

NOTE: Amount of material removed from leading edge shall decrease from 0.030 inch at blade tip to no removal one half inch above blade root platform. See Figure 609, (2) and (3). Chord must not be reduced less than shown in Figure 604.

(b) Restore radius of leading edge to limits in Figure 609. This shall be accomplished with hand files, abrasive cloth, or by SPOP 532. Refer to Section 70-45-00 in the Standard Practices Manual. Ensure that radius is smooth.

R G. Pitting Repair

(1) All steel compressor blades with pitting acceptable to Figure 602 shall be repaired as follows:

NOTE: For titanium blades, see step (2).

(a) Remove corrosion oxides from pitted areas.

1 Clean corroded or pitted areas by SPOP 218.

2 Immerse blade in inhibited muriatic acid (PS 47) at room temperature (or SPOP 203) for 15 minutes. Refer to the Standard Practices Manual, Section 70-21-00 for SPOP 203 and Section 70-44-02 for the make-up of PS 47.

72-0002

CAUTION: OTHER PROCEDURES USING THIS SOLUTION SPECIFY A HIGHER TEMPERATURE RANGE WHICH IS NOT ACCEPTABLE FOR THIS APPLICATION.

(b) If there are still corrosion oxides present on the blade when removed from solution, step (2) may be repeated.

CAUTION: TOTAL IMMERSION TIME IN SOLUTION MUST NOT EXCEED TWO HOURS.

(c) Thoroughly rinse part in cold water.

(d) Remove black or gray carbon residue by immersing in PS 211, alkali smut removal solution. See Standard Practices Manual, Section 70-44-02 for the make-up of PS 211.

(e) Inspect all blades for removal of oxides. If oxides are still present, repeat steps (b) thru (d).

(f) Bead peen entire airfoil section of blade by SPOP 500 (Refer to the Standard Practices Manual, Section 70-41-01 to an intensity of 10N-0+2 except minimum intensity is waived for 0.125 inch maximum from leading and trailing edges, both sides. Refer to SPOP 501 in Standard Practices Manual, 70-41-02 for taper peening procedures.

NOTE: Any deformation or distortion of blade, waviness or rolling of leading or trailing edge is not acceptable.

(2) All titanium compressor blades with pitting acceptable to Figure 602 shall be repaired as follows:

(a) Bead peen all of the airfoil section of a blade by SPOP 500 (refer to Section 70-41-01 in the Standard Practices Manual) to an intensity of 10N -0 +2 (minimum intensity is waived for a distance of 0.125 inch maximum from the leading or trailing edges on each side). Refer to the Standard Practices Manual for procedures to decrease the intensity in these areas.

R
R

(b) Grit blast (PMC 3052-8) same area for 60 seconds at 50 psi employing taper peening technique.

NOTE: Any deformation or distortion of blade, or waviness or rolling of leading or trailing edge is not acceptable.

R H. Mechanical Blade Finishing (Stages 1 thru 9)

(1) Clean all blades (refer to Section 72-00-00, Cleaning).

(2) Remove nickel-cadmium plate from blades that have it by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual.

(3) Do non-destructive tests of the blades by FPI (titanium blades) or FMPI (steel blades). Refer to Section 72-00-00, Inspection.

(4) Do all visual and dimensional inspections of blades as specified in this section.

(5) Do all necessary repairs to blades (but do not apply root antigallant coatings to titanium blades and do not apply nickel-cadmium plate to steel blades at this time).

(6) After all inspections and repairs are completed, use the a procedures in SPOP 182 and SPOP 186 to increase the blade surface finish on the leading and trailing edges and on the blade airfoil. Refer to Section 70-41-05 in the Standard Practices Manual.

(7) After the finishing procedures are completed, do the visual and dimensional inspection again to be sure that the blades continue to be in limits.

(8) Apply antigalling compound to the roots of titanium blades and apply nickel-cadmium plate to steel blades as specified in this section.

R I. Nickel-Cadmium Plating of 5th, 6th, 8th, and 9th Stage Steel Blades (When Required)
R See Tool Group 27A and Figure 610.

NOTE: Plating facilities not previously approved for nickel-cadmium plating of blades must submit samples of plated blades to Pratt & Whitney. Refer to Repair Source Approval (RSA) Requirements - Nickel-Cadmium

72-0002

(Ni-Cd) Plating in the Standard Practices Manual, Section 70-40-01, Repair-06. If approval has already been granted for nickel-cadmium plating of blades from other engines no further approval is necessary. Plated blades can be identified either by three x's marked through first two to four digits of part number or by PN 537405, 537406, 537408, 537409 and 569109.

(1) For steel blades not requiring pitting refurbishment in accordance with Paragraph F. bead peen the entire airfoil section of blade by SPOP 500. Refer to Section 70-41-01 in the Standard Practices Manual, to an intensity of 6N-0+2 except minimum intensity is waived for 0.125 inch maximum from leading and trailing edges, both sides. Steel blades refurbished in accordance with Paragraph F. do not require additional treatment prior to plating.

NOTE: Any deformation or distortion of blade or waviness or rolling of leading or trailing edge is not acceptable.

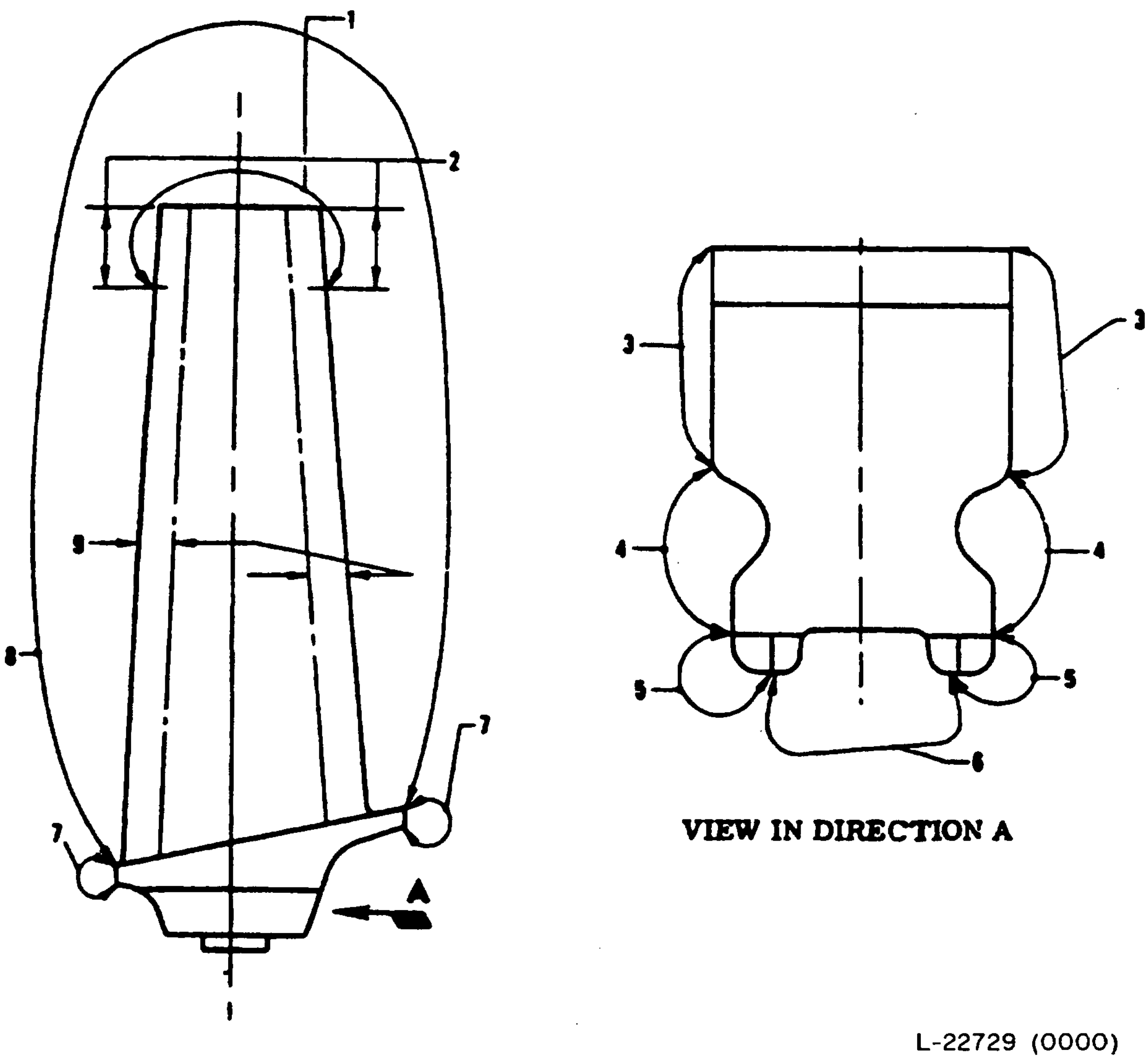
(2) Nickel-cadmium plate all steel blades all over except for optional areas and electrical contact areas by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual. For surface plating area, see
R Table 602.

NOTE: No burning, pitting, or selective attack is permitted.

STAGE	DIMENSION IN SQUARE INCHES
5	4.3
6	3.4
8	1.9
9	1.7

Fifth, 6th, 8th, and 9th
Stage Blade Plating
R Table 602

(3) Prior to baking, paint electrical contact areas and unplated root areas with high-baking, heat-resistant, aluminum enamel by SPOP 142. Refer to Section 70-41-03 in the Standard Practices Manual.



Stages Five, Six, Eight, And Nine
Compressor Blades Plating
Figure 610

72-0002

1. Unplated Area Within This Enclosure Must Not Exceed 0.125 Square Inch
2. 0.250 Inch Maximum
3. Bead Peen Optional. Maximum Plating Thickness Requirement Waived
4. Shotpeen Enclosed Area Per AMS 2430 With Intensity Equivalent To 6A, Using SAE 110 Cast Steel Shot
5. Paint Overspray Permissible In This Area
6. Paint By SPOP 142. Plating Optional, And May Be Incomplete
7. Bead Peen Optional. Maximum Plating Thickness Requirement Waived. Paint By SPOP 142.
8. Bead Peen Area
9. 0.125 Inch Maximum. Minimum Intensity Requirement Waived In This Area

R Key to Figure 610

(4) Bake by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual.

(e) Keeping blade trailing edge perpendicular to dial indicator probe, slightly rotate blade so that trailing edge radius rolls on depth control. Record minimum indicated reading.

(5) If any blades in sample are unacceptable per limits in Figure 607, all blades in that disk and blade assembly must be checked.

NOTE: Care shall be taken to avoid erosion checks in blended areas, since results from such checks will not reflect true condition of blade. If permissible blend has been performed, Figure 601, at erosion checking point, perform check at point immediately adjacent to blended area.

C. Compressor Blade Airfoil Thickness Check

(1) Using standard measuring equipment, check maximum airfoil thickness at locations indicated in Figure 607, Indexes 3 and 4.

(2) Reject all blades having maximum airfoil thickness below limits shown in Figure 607.

D. Repair

(1) Rework damage to blades to limits shown in Figure 601.

CAUTION: LIMITS REFERRED TO IN FIGURE 601 AT AREAS C AND E PERTAIN TO LOCAL, ISOLATED DAMAGED AREAS ONLY, AND MUST NOT BE INTERPRETED AS AUTHORITY FOR REMOVAL OF MATERIAL ALL ACROSS TIP AND LEADING OR TRAILING EDGE AS MIGHT BE DONE IN SINGLE MACHINING CUT, (EXCEPT FOR TAPER CUT WHICH IS ALLOWED ON 1ST STAGE BLADES ONLY). SEE PARAGRAPH E.

(2) Number of blends that may be performed on any one blade are as follows:

(a) Stages 1 thru 5 - two blends per blade if:

1 The blends are on leading or trailing edge (not both)

2 One blend is on the leading edge and one is on the trailing edge provided they are not closer than 1/4 length of blade from being opposite one another.

(b) Stages 6 thru 9 - one blend per blade.

NOTE: Limits in steps (a) and (b) do not apply to Areas A and D. Limits for these areas are governed by Figure 601.

(3) Stoning and blending of compressor blades should be done lengthwise to blade, never across it. This is to ensure that no scratches, however minute, run across blade edge. (See Blending, Grinding and Lapping, Standard Practices Manual).

NOTE: No belt sanding of blades is permitted.

(4) Elimination of damaged area in blade should be performed by local blending of damaged area only. Length of blend should be four times depth.

(5) Repaired compressor blades must be inspected by either fluorescent magnetic particle inspection or fluorescent penetrant methods to ensure that all trace of damage has been removed. All surfaces must be smooth and all repairs well blended. No cracks of any extent will be tolerated in any area.

(6) Blades which are bowed or bent shall not be considered for reuse. If gages are not available for rechecking this condition, blade in question shall be aligned and compared with new blades of the same stage.

(7) Surface finish that is desired in repaired area should be comparable to new blade. No buffing of entire area of blade shall be performed.

R (8) Remove and replace antigalling compound on the dovetail
R or pin root of titanium blades. Refer to SPOP 160 (if
R PWA 474 antigalling compound is used) or SPOP 139 (if
R PWA 36545-3 is used). Refer to Section 70-41-03 in the
R Standard Practices Manual.

E. First Stage Compressor Blade Repair
See Figure 608.

(1) Leading Edge

(a) First stage compressor blades acceptable to Figure 605 with damaged leading edges may be repaired by a taper cut as shown in Figure 608.

NOTE: Amount of material removed from leading edge shall decrease from 0.030 inch at blade tip to no removal one half inch above blade root platform. See Figure 608, (2) and (3). Chord must not be reduced less than shown in Figure 604.

(b) Restore radius of leading edge to limits in Figure 608. This shall be accomplished with hand files, abrasive cloth, or by SPOP 532. Refer to Section 70-45-00 in the Standard Practices Manual. Ensure that radius is smooth.

F. Pitting Repair

(1) All steel compressor blades with pitting acceptable to Figure 602 shall be repaired as follows:

NOTE: For titanium blades, see step (2).

(a) Remove corrosion oxides from pitted areas.

1 Clean corroded or pitted areas by SPOP 218.

2 Immerse blade in inhibited muriatic acid (PS 47) at room temperature (or SPOP 203) for 15 minutes. Refer to the Standard Practices Manual, Section 70-21-00 for SPOP 203 and Section 70-44-02 for the make-up of PS 47.

CAUTION: OTHER PROCEDURES USING THIS SOLUTION SPECIFY A HIGHER TEMPERATURE RANGE WHICH IS NOT ACCEPTABLE FOR THIS APPLICATION.

(b) If there are still corrosion oxides present on the blade when removed from solution, step (2) may be repeated.

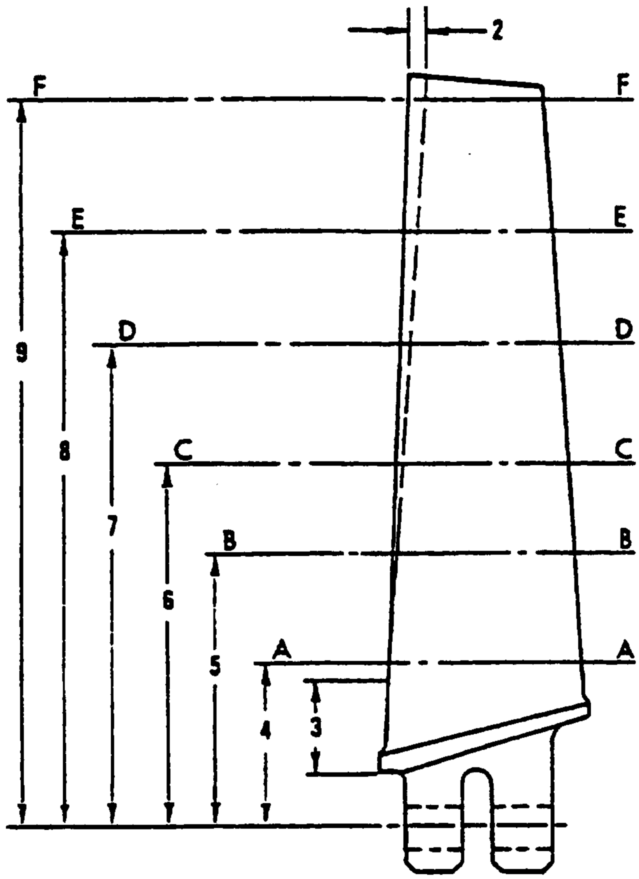
CAUTION: TOTAL IMMERSION TIME IN SOLUTION MUST NOT EXCEED TWO HOURS.

(c) Thoroughly rinse part in cold water.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page.

TYPICAL VIEW
AIRFOIL LEADING EDGE



L-25751 (0572)

R
R

First Stage Compressor Blade
Leading Edge Repair
Figure 608

1. 0.026 - 0.038 Inch at Section A-A
   0.024 - 0.036 Inch at Section B-B
   0.022 - 0.034 Inch at Section C-C
   0.018 - 0.030 Inch at Section D-D
   0.012 - 0.024 Inch at Section E-E
   0.006 - 0.018 Inch at Section F-F
2. 0.030 Inch
3. 0.500 Inch
4. 1.344 Inches
5. 2.009 Inches
6. 2.762 Inches
7. 3.514 Inches
8. 4.268 Inches
9. 5.019 Inches

Key to Figure 608

(d) Remove black or gray carbon residue by immersing in PS 211, alkali smut removal solution. See Standard Practices Manual, Section 70-44-02 for the make-up of PS 211.

(e) Inspect all blades for removal of oxides. If oxides are still present, repeat steps (b) thru (d).

(f) Bead peen entire airfoil section of blade by SPOP 500 (Refer to the Standard Practices Manual, Section 70-41-01 to an intensity of 10N-0+2 except minimum intensity is waived for 0.125 inch maximum from leading and trailing edges, both sides. Refer to SPOP 501 in Standard Practices Manual, 70-41-02 for taper peening procedures.

<u>NOTE</u>: Any deformation or distortion of blade, waviness or rolling of leading or trailing edge is not acceptable.

(2) All titanium compressor blades with pitting acceptable to Figure 602 shall be repaired as follows:

R (a) Bead peen all of the airfoil section of a blade
R by SPOP 500 (refer to Section 70-41-01 in the
R Standard Practices Manual) to an intensity of
R 10N -0 +2 (minimum intensity is waived for a
R distance of 0.125 inch maximum from the leading
R or trailing edges on each side). Refer to the
R Standard Practices Manual for procedures to
R decrease the intensity in these areas.

NOTE: Please see the TEMPORARY REVISION that revises this page.

(b) Grit blast (PMC 3052-8) same area for 60 seconds at 50 psi employing taper peening technique.

NOTE: Any deformation or distortion of blade, or waviness or rolling of leading or trailing edge is not acceptable.

G. Mechanical Blade Finishing (Stages 1 thru 9)

(1) Clean all blades (refer to Section 72-00-00, Cleaning).

(2) Remove nickel-cadmium plate from blades that have it by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual.

(3) Do non-destructive tests of the blades by FPI (titanium blades) or FMPI (steel blades). Refer to Section 72-00-00, Inspection.

(4) Do all visual and dimensional inspections of blades as specified in this section.

(5) Do all necessary repairs to blades (but do not apply root antigallant coatings to titanium blades and do not apply nickel-cadmium plate to steel blades at this time).

(6) After all inspections and repairs are completed, use the a procedures in SPOP 182 and SPOP 186 to increase the blade surface finish on the leading and trailing edges and on the blade airfoil. Refer to Section 70-41-05 in the Standard Practices Manual.

(7) After the finishing procedures are completed, do the visual and dimensional inspection again to be sure that the blades continue to be in limits.

(8) Apply antigalling compound to the roots of titanium blades and apply nickel-cadmium plate to steel blades as specified in this section.

H. Nickel-Cadmium Plating of 5th, 6th, 8th, and 9th Stage Steel Blades (When Required)
See Tool Group 27A and Figure 609.

NOTE: Plating facilities not previously approved for nickel-cadmium plating of blades must submit samples of plated blades to Pratt & Whitney. Refer to Repair Source Approval (RSA) Requirements - Nickel-Cadmium

(Ni-Cd) Plating in the Standard Practices Manual, Section 70-40-01, Repair-06. If approval has already been granted for nickel-cadmium plating of blades from other engines no further approval is necessary. Plated blades can be identified either by three x's marked through first two to four digits of part number or by PN 537405, 537406, 537408, 537409 and 569109.

(1) For steel blades not requiring pitting refurbishment in accordance with Paragraph F. bead peen the entire airfoil section of blade by SPOP 500. Refer to Section 70-41-01 in the Standard Practices Manual, to an intensity of 6N-0+2 except minimum intensity is waived for 0.125 inch maximum from leading and trailing edges, both sides. Steel blades refurbished in accordance with Paragraph F. do not require additional treatment prior to plating.

NOTE: Any deformation or distortion of blade or waviness or rolling of leading or trailing edge is not acceptable.

(2) Nickel-cadmium plate all steel blades all over except for optional areas and electrical contact areas by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual. For surface plating area, see Table 601.

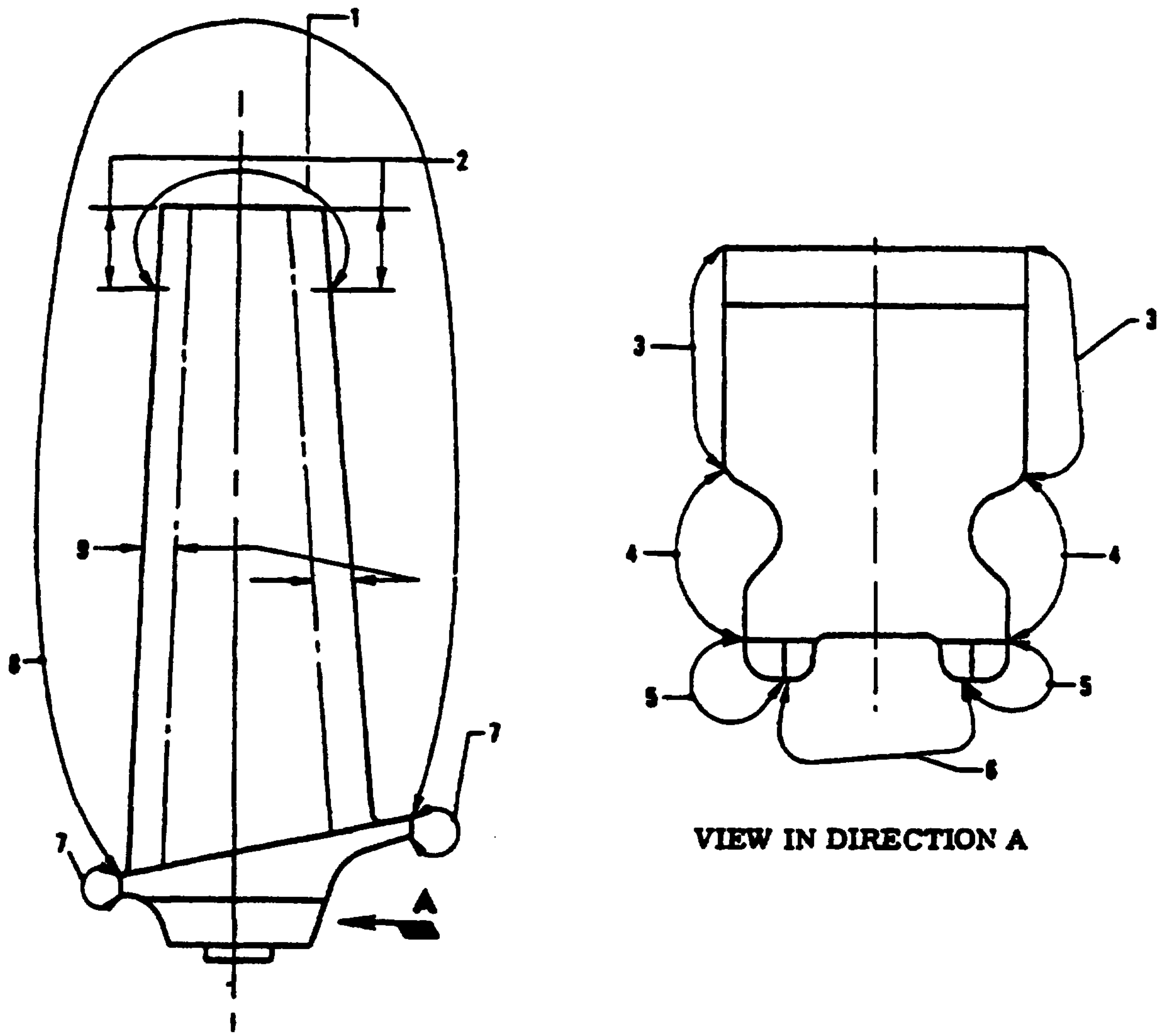
NOTE: No burning, pitting, or selective attack is permitted.

STAGE	DIMENSION IN SQUARE INCHES
5	4.3
6	3.4
8	1.9
9	1.7

Fifth, 6th, 8th, and 9th
Stage Blade Plating
Table 601

(3) Prior to baking, paint electrical contact areas and unplated root areas with high-baking, heat-resistant, aluminum enamel by SPOP 142. Refer to Section 70-41-03 in the Standard Practices Manual.

R
R



L-22729 (0000)

NOTE: Please see the
TEMPORARY REVISION
that revises this page.

Stages Five, Six, Eight, And Nine
Compressor Blades Plating
Figure 609

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-01

1. Unplated Area Within This Enclosure Must Not Exceed 0.125 Square Inch
2. 0.250 Inch Maximum
3. Bead Peen Optional. Maximum Plating Thickness Requirement Waived
4. Shotpeen Enclosed Area Per AMS 2430 With Intensity Equivalent To 6A, Using SAE 110 Cast Steel Shot
5. Paint Overspray Permissible In This Area
6. Paint By SPOP 142. Plating Optional, And May Be Incomplete
7. Bead Peen Optional. Maximum Plating Thickness Requirement Waived. Paint By SPOP 142.
8. Bead Peen Area
9. 0.125 Inch Maximum. Minimum Intensity Requirement Waived In This Area

Key to Figure 609

(4) Bake by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual.

1. Engine Compressor Section (Vanes/Stators)

   A. General

      (1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Compressor Vanes - All Stages

   A. Inspection

      (1) Pitting and corrosion are not considered serious on compressor stator vanes, provided pitting does not exceed 0.005 inch depth. Refer to Paragraphs B. and L.

      (2) If more than 50 percent of all vanes in one stator assembly are damaged in same location to approximately maximum blend-out limit, replace assembly.

      NOTE: For riveted 2nd stage vanes, any number may be replaced without replacing vane and shroud assembly.

      (3) If all vanes in any 60-degree sector of one stage are damaged to approximately maximum blend-out limits, replace assembly except as indicated in preceding note.

      (4) Round-bottom dents up to 0.030 inch deep are considered acceptable without blending.

      (5) No cracks in vane are allowed.

      (6) Cracks in attaching weld or braze are acceptable provided they are less than 0.250 inch long.

      (7) Inspect steel first-stage vanes, using fluorescent magnetic particle method. Refer to Section 70-32-00 in the Standard Practices Manual.

      NOTE: If fluorescent magnetic particle method is unavailable, fluorescent penetrant inspection may be used as interim measure.

R B. Vane Chord Width Inspection and Classification (JFTD12A)

R   (1) First thru 3rd Stage Vanes

72-0003

(a) During each engine overhaul, do a check of 12 vanes in a stator assembly for minimum chord width.

NOTE: It will be necessary to make a tool locally to measure the vane chord dimensions at the specified radial positions.

1 The vanes measured must be an equal distance (30 degrees) apart and must not have blend repairs.

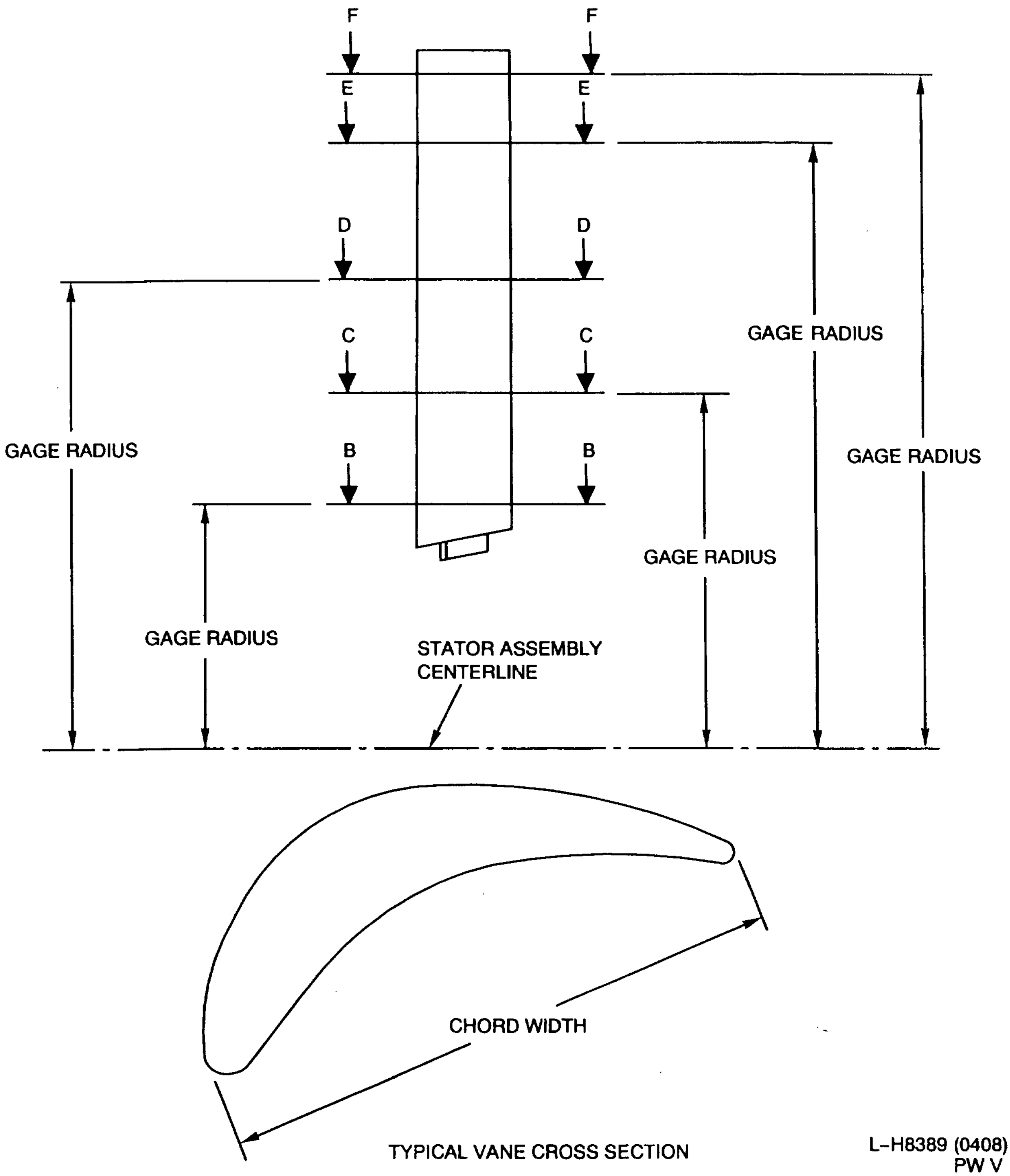
2 If a vane has erosion which is more than limits (refer to Table 601), do a chord width check of all vanes in the stator assembly.

3 Figure 601 shows how the vane airfoil sections are identified. The gage radius for each section is given in Table 601, with the minimum chord limits at that section.

NOTE: The gage radius for each section is the distance from that section to the center-line of the stator assembly as shown in the figure.

Stage	Section	Gage Radius (Inches)	Minimum Chord Limit (Inches)
1	B-B	5.044	0.795
1	C-C	5.797	0.857
1	D-D	6.550	0.917
1	E-E	7.303	0.980
1	F-F	8.056	1.042
2	B-B	5.479	0.659
2	C-C	6.094	0.725
2	D-D	6.710	0.790
2	E-E	7.326	0.857
2	F-F	7.941	0.924
3	B-B	5.809	0.663
3	C-C	6.314	0.704
3	D-D	6.820	0.744
3	E-E	7.326	0.783
3	F-F	7.831	0.825

Compressor Vane Chord Width Limits
Table 601



First Thru 3rd Stage Compressor
Stator Vane Chord Inspection
Figure 601

72-0003

(2) Fourth thru 8th Stage Vanes

(a) During each engine overhaul, do a check of 12 vanes in a stator assembly for minimum chord width.

1 The vanes measured must be an equal distance (30 degrees) apart and must not have blend repairs.

2 If a vane has erosion which is more than limits (refer to Table 602), do a chord width check of all vanes in the stator assembly.

(b) Inspection Procedure

1 Put a compressor stator assembly on a bench with the lugs on the outer case down. The leading edges of the vanes will be to the operator.

2 At a specified gage radius position, install the applicable gage (see Table 602) on a vane with the gage face against the vane concave side. See Figure 602.

3 Put the side of the gage slot adjacent to the middle of the gage against the vane leading edge.

4 Move the gage to touch the trailing edge of the vane with the gage slot (keep the leading edge of the vane against the gage slot surface at the other side).

5 If the vane trailing edge does not go in the gage slot ("No Go" condition), then the vane is in minimum permitted chord width limits at this gage radius position.

6 Do the chord width check at one or two other positions on the vane (do steps 1 thru 5 again).

7 If the vane trailing edge does go in the gage slot ("Go" condition), the vane is not in minimum chord width limits and the stator assembly is not serviceable.

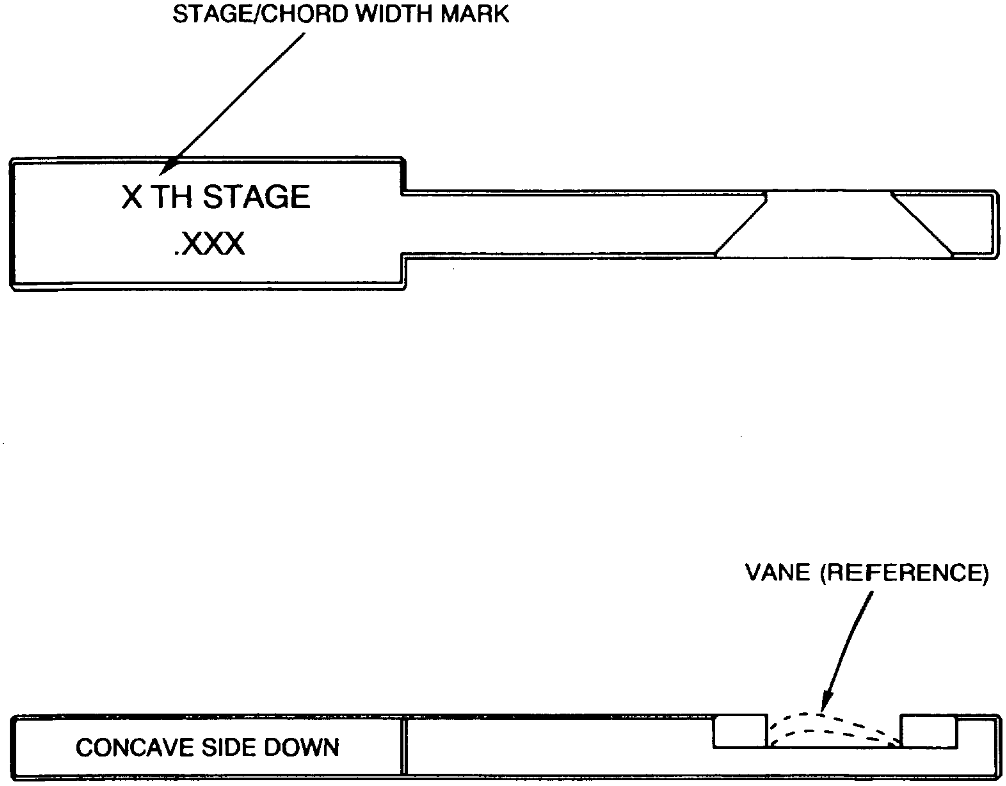
	Vane/ Stage	Stator PN	Ref. SB	PWA Tool Number	Minimum Chord Limit (Inches)
R	4th	542274		107513	0.598
R		580294	1611	107513	0.598
R		804594	6211	107513	0.598
R	5th	542275		107514	0.537
R		580295	1611	107514	0.537
R		804595	6211	107514	0.537
R	JFTD12A-4A:				
R	6th	542276		107515	0.479
R		580296	1611	107515	0.479
R		804596	6211	107515	0.479
R	JFTD12A-5A:				
R	6th	542276		107515	0.479
R		580296	1611	107515	0.479
R		656376	1612	107515	0.479
R		804576	6211, 6212	107515	0.479
R	7th	542277		107516	0.482
R		591567	1611	107516	0.482
R		804067	6211	107516	0.482
R	8th	542278		107517	0.484
R		804578	6211	107517	0.484

R Compressor Stator Vane Chord Width
R Inspection Tools And Limits
R Table 602

R C. Repair

(1) Do not attempt to repair any vane by brazing, welding, or soldering.

(2) Crocus cloth, fine files, and stones should be used to blend out injuries by removing minimum amount of material and leaving surface finish comparable to that of new part. Refer to Blending, Grinding, and Lapping, in the Standard Practices Manual, Section 70-45-00.



L-H8388 (0408)
PW V

Vane Chord Width Inspection Tool
Figure 602

(3) Rework leading and trailing edges of vanes by blending so that maximum reduction to vane chord does not exceed 0.062 inch. One leading edge and one trailing edge repair may be accomplished on same vane provided repairs are not opposite each other.

NOTE: Dimension between repairs must not be less than chord dimension.

(4) Blend out injuries to concave and convex surfaces so that depth of removal does not exceed 0.010 inch.

R D. Replace Second Stage Vanes (For JFTD12A-4A, -5A With PN 567352 Vanes)
R See Figure 603.

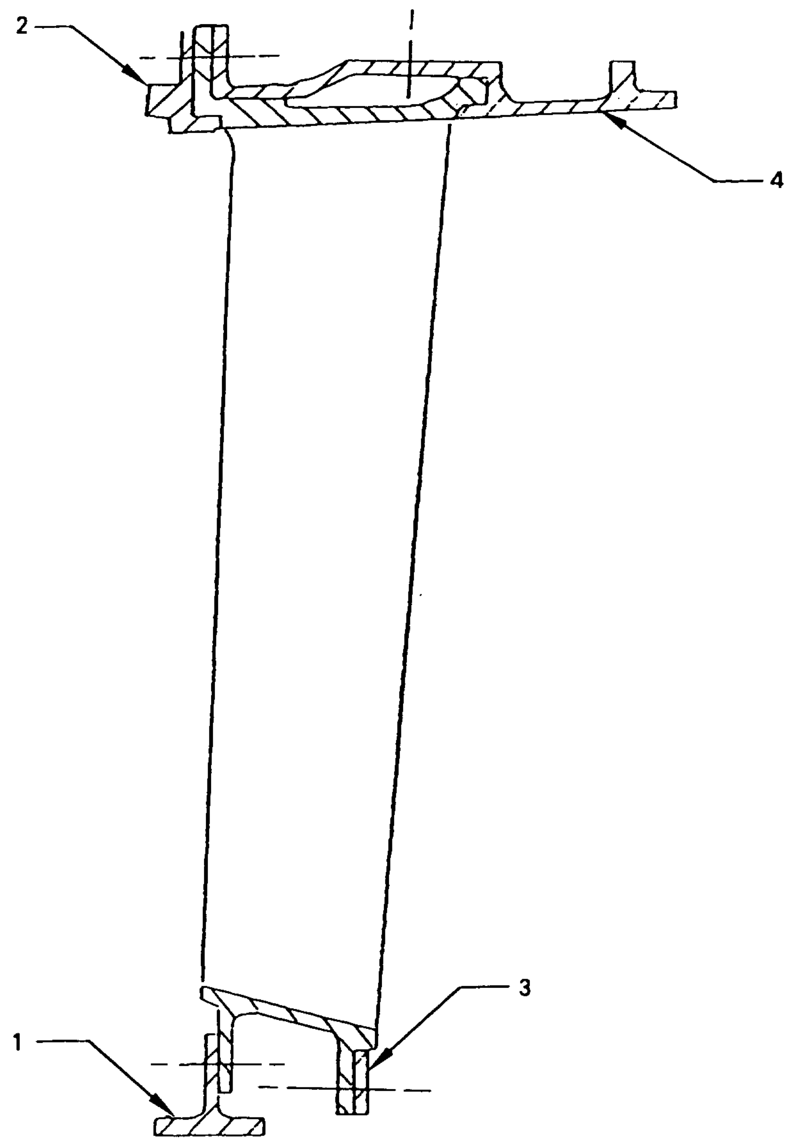
(1) Procedure for partial vane replacement up to and including 100 percent of the vanes.

(a) Chart the vane shroud squareness and concentricity.

(b) Remove the rivets that secure the air sealing ring to the vane tabs and remove the air sealing ring relative to tabs prior to removal for reinstallation in the same location.

NOTE: All dimensional controls must be maintained after the vanes have been replaced. If necessary, fixture assembly when removing the vanes to maintain dimensional control.

(c) Remove the rivets that secure the flange to the outer shroud and remove the flange. Mark the flange



Second Stage Compressor
Vane Assembly
Figure 603

1. Air Sealing Ring
2. Flange
3. Positioning Plate
4. Shroud

R Key to Figure 603

relative to the shroud prior to removal for reinstallation in the same location.

(d) Remove the rivets that secure the damaged vanes to the positioning plate (two per vane).

(e) Remove the damaged vanes.

(f) Assemble the replacement vanes into the shroud.

(g) Secure the vanes to the positioning plate with rivets.

(h) Install previously removed flange in its proper location as determined in step (c) and secure with rivets.

(i) Install previously removed air sealing ring in its proper location as determined in step (b) and secure with rivets.

(j) Dimensionally inspect the compressor stator assembly. A 0.010 inch out-of-concentricity is permissible after vane replacement.

(k) Check and correct (if required) vane angles for the following vanes. See Paragraph H.

1 All replaced vanes.

2 Two original vanes adjacent to the replaced vane(s).

3 Ten percent of the remaining original vanes, equally spaced around the assembly.

NOTE: If the vane angle of any vane checked is outside limits, vane angles of all the vanes in the assembly must be checked at all locations.

R E. Replace Third State Vanes (For JFTD12A-4A, -5A with PN 370553 Vanes)
R See Figure 604.

(1) Procedure for partial vane replacement up to and including 100 percent of the vanes.

(a) Chart the vane shroud squareness and concentricity.

(b) Remove the rivets that secure the air sealing ring to the vane tabs and remove the air sealing ring. Mark inner air sealing ring relative to tabs prior to removal for reinstallation in the same location.

(c) Remove the rivets that secure the damaged vanes to the plate (two per vane).

NOTE: All dimensional controls must be maintained after the vanes have been replaced. If necessary, fixture assembly when removing the vanes to maintain dimensional control.

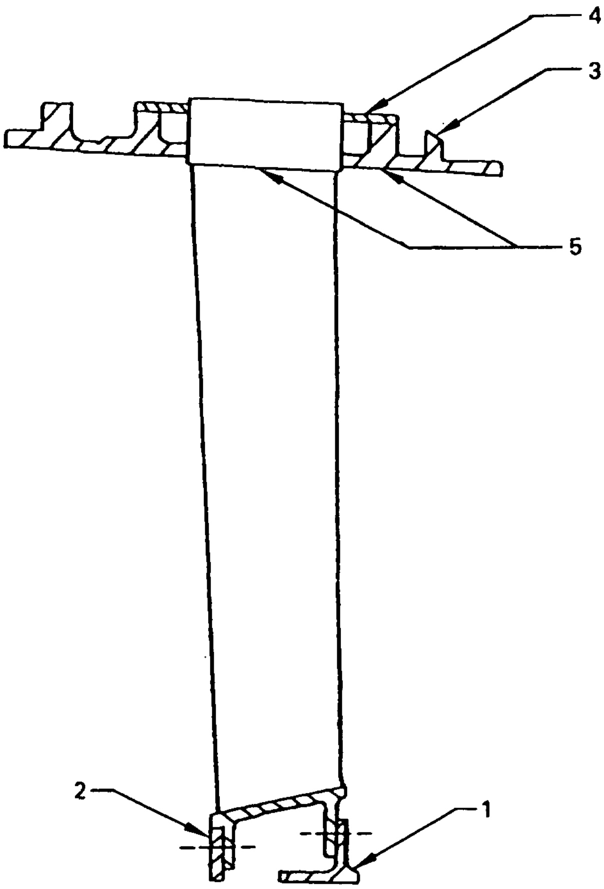
(d) Remove the damaged vanes from the assembly.

1 Remove the majority of the damaged vane airfoil center sections by cutting the vanes in two places approximately 1/16 inch from the inner and outer shrouds. Use a saw, heliarc cutting torch, or any other suitable cutting equipment.

NOTE: When using a heliarc cutting torch, make two "U" shaped sheet metal copper strips to place over the edges of the adjacent under damaged vanes to prevent burning them. Use pliers to handle the hot copper strips.

2 Use Electro-Discharge Machine (EDM) to remove vane stubs from the inner and outer shrouds and the outer ring. Refer to Standard Practices Manual, Section 70-47-00. Do not damage open up the vane slots with the EDM process.

(e) Remove any residual braze on both the ring and the shroud using a silicon carbide grit polishing bob. Use extreme caution not to open up the vane slots.



L-H3136 (1296)

Third Stage Compressor
Stator Assembly
Figure 604

72-0003

1. Air Sealing Ring
2. Positioning Plate
3. Shroud
4. Ring
5. Edge of Lug Must Be Flush With Surface Or Extend Into Airstream

R Key to Figure 604

(f) Inspect the outer shroud and the ring for cracks and repair if required.

(g) Clean around the vane slots fully using vapor blast by SPOP 9. Refer to the Standard Practices Manual, Section 70-21-00.

(h) Clean the replacement vanes by SPOP 209. Refer to the Standard Practices Manual, Section 70-21-00.

(i) Test fit the replacement vane by inserting the outer lug of the vane into the outer shroud and ring.

<u>NOTE</u>: The inner edge of the lug must be flush with the inner shroud surface, or extend into the air stream. The gap between the shroud and the lug is to be opened up as much as 0.080 inch.

(j) Epoxy the replacement vanes to the outer shroud and ring as follows:

<u>1</u> Wet all contact surfaces with Epoxy Adhesive (PN 492227).

<u>2</u> Install the replacement vane into the outer shroud vane slot and position it correctly.

<u>3</u> Fill the joints or gaps over 0.020 inch with epoxy adhesive.

<u>4</u> Cure the Adhesive as follows:

<u>a</u> For 5412B Resin, cure at room temperature for four hours. Follow with post-cure and stress-relief at 177°C (350°F) for four hours.

b For EC 2214 or EC 2214 NMF, cure and stress-relieve at 177°C (350°F) for four hours. No Post-cure is necessary.

NOTE: Epoxy Information

Tradename	Source
Scotch Weld Structural Adhesive EC 2214 Regular - or - Scotch Weld Structural Adhesive EC 2054A&B	Refer to Source Code 04963 in Section 70-12-01 in the Standard Practices Manual.
EA 929	Refer to Source Code 33564 in Section 70-12-01 in the Standard Practices Manual.
5412B Resin 5412C Hardener	Local Purchase

If you use 5412B resin, mix it with 5412C Hardener, 25 parts by weight of Resin with one part by weight of Hardener. The working potlife of the hardener this mix is approximately 45 minutes at 24°C (75°F). If you use Scotch Weld EC 2186, it must be kept refrigerated until you need it and you can use it directly from the can.

(k) Dimensionally inspect the compressor stator assembly. A 0.010 inch out-of-concentricity is permissible after vane replacement.

(l) Install previously removed air sealing ring in its proper location as determined in step (1)b and secure with rivets.

(m) Check and correct (if required) vane angles for the following vanes. See Paragraph H.

1 All replaced vanes.

2 Two original vanes adjacent to the replaced vane(s)

R
R

72-0003

3 Ten percent of the remaining original vanes, equally spaced around the assembly.

NOTE: If the vane angle of any vane checked is outside limits, vane angles of all the vanes in the assembly must be checked at all locations.

R F. Replace Fourth Stage Vanes (For JFTD12A-4A, -5A with PN 579354 Vanes)
R See Figure 605.

(1) Procedure for partial vane replacement up to and including 100 percent of the vanes.

(a) Chart the vane shroud squareness and concentricity.

(b) Remove cadmium plate from the assembly by SPOP 59. See Standard Practices Manual, Section 70-44-01.

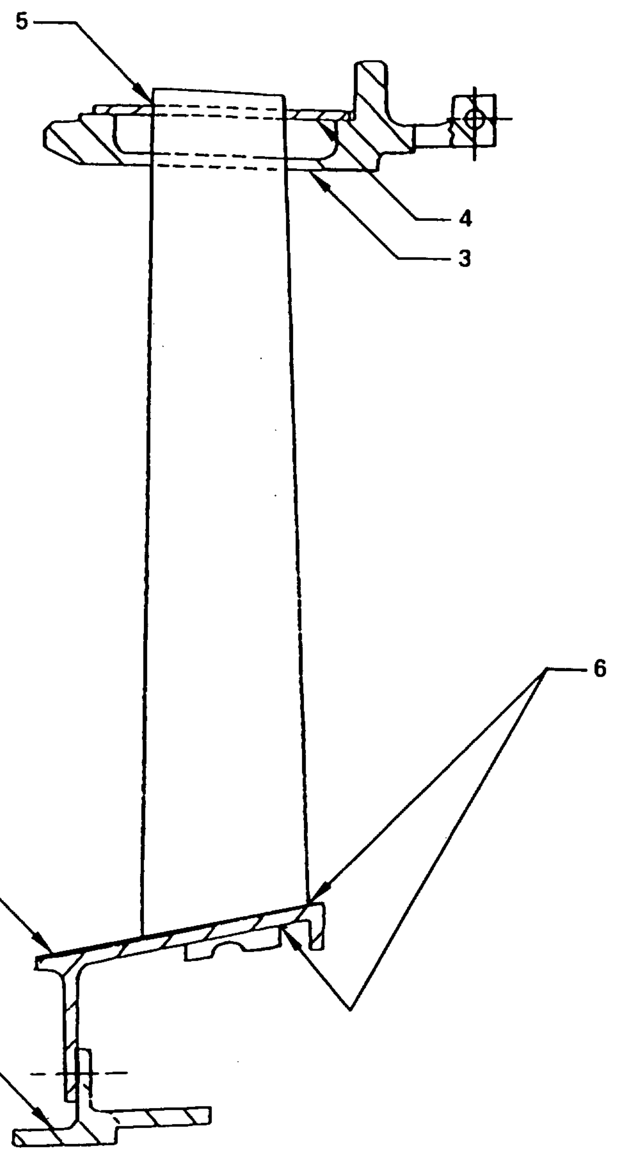
(c) Remove the rivets that secure the air sealing ring to the inner shroud and remove the air sealing ring. Mark inner air sealing ring relative to tabs prior to removal for reinstallation in the same location.

NOTE: All dimensional controls must be maintained after the vanes have been replaced. If necessary, fixture assembly when removing the vanes to maintain dimensional control.

(d) Remove the damaged vanes from the assembly.

1 Remove the majority of the damaged vane airfoil center sections by cutting the vanes in two places approximately 1/16 inch from the inner and outer shrouds. Use a saw, heliarc cutting torch, or any other suitable cutting equipment.

2 Use Electro-Discharge Machine (EDM) to remove vane stubs from the inner and outer shrouds and the outer ring. Refer to the Standard Practices Manual, Section 70-47-00. Do not damage or open up the vane slots with the EDM process.



Fourth Stage Compressor
Stator Assembly
Figure 605

1. Air Sealing Ring
2. Inner Shroud
3. Outer Shroud
4. Ring
5. Braze Around All Vanes, 0.010 Min. Fillet Radius To Cover A Minimum of 80 Percent Of Length Of Intersecting Surface
6. Braze Around All Vanes, 0.010 Min. Fillet Radius To Cover A Minimum of 90 Percent Of Length Of Intersecting Surfaces

R Key to Figure 604

(e) Clean up inner shroud vane slots by removing all burrs and remove any residual braze on both shrouds using a silicon carbide grit polishing bob. Use extreme caution not to open up the vane slots.

(f) Inspect the outer shroud and the ring for cracks and repair if requested.

(g) Clean around the inner and outer vane slots using vapor blast by SPOP 9. Refer to the Standard Practices Manual, Section 70-21-00.

(h) Clean the replacement vanes by SPOP 209. Refer to the Standard Practices Manual, Section 70-21-00.

NOTE: Use white gloves for all handling operations after cleaning and before brazing.

(i) Insert replacement vanes through the OD ring and shroud until inner portion seats in shroud. Gap must be 0.000 - 0.006 inch.

(j) High temperature braze replacement vanes by AMS 2664. Refer to the Standard Practices Manual, Section 70-42-03. Remove excess braze material from braze area.

(k) Visually inspect braze joints. A smooth continuous fillet is required.

(l) Fluorescent penetrant inspect by SPOP 62. Refer to the Standard Practices Manual, Section 70-33-00.

(m) Hold assembly flat and concentric, and stress-relieve by SPOP 460-2. Refer to the Standard Practices Manual, Section 70-42-04.

(n) Dimensionally inspect the compressor stator assembly. A 0.010 inch out-of-concentricity is permissible after vane replacement.

(o) Install previously removed air sealing ring in its proper location as determined in step (b) and secure with rivets.

(p) Check and correct (if required) vane angles for the following vanes. See Paragraph H.

1 All replaced vanes.

2 Two original vanes adjacent to the replaced vane(s).

3 Ten percent of the remaining original vanes, equally spaced around the assembly.

NOTE: If the vane angle of any vane checked is outside limits, vane angles of all the vanes in the assembly must be checked at all locations.

(q) Restore the protective coat to the assembly by either PWA 110-21 or AMS 2416. Refer to the Standard Practices Manual, Section 70-41-04.

R G. Replacement (Steel)
See Tool Group 40A.

(1) Chart vane shroud squareness and concentricity.

(2) Etch position of seal ring, and remove seal ring.

(3) Using hacksaw, cut off damaged vane, 1/16 inch from inner and outer shrouds.

(4) Wrap adjacent vanes and shroud area with watersoaked ceramic fiber tape.

(5) Using oxyacetylene torch, heat vane tab (using, circular motion for uniform heating). While heating, tap vane stub until it is free of shroud.

72-0003

(6) Repeat for outer end of vanes; then clean shroud area.

NOTE: For replacement of damaged vanes with ones having no leading edge notches and longer chordal dimension, enlarge vane slot in shroud by grinding, using replacement vane as template.

NOTE: For replacement and stress-relief of 9th stage vanes, install vane and shroud assembly in brazing and stress-relief fixture so that fixture cutouts leave accessibility to work area. In replacement of 9th stage vanes and exit vanes, install square ended vanes only in shrouds with straight outer surface, and install vanes with angled outer ends only in shrouds with ramped outer surface. For concentricity check following repair, see Paragraph L.

(7) Insert replacement vane through OD shroud until inner portion seats in inner shroud.

(8) High-temperature braze replacement vane in accordance with AMS 2666. Remove excess material from braze area.

NOTE: Install vanes at 180 degree intervals, allowing assembly to cool before attempting to weld next vane into place.

(9) Install previously removed seal ring in its proper location as determined in step (2).

CAUTION: INSTALL ALUMINUM AIRSEALING RING AFTER STRESS-RELIEVING ASSEMBLY.

(10) Holding assembly flat and concentric, stress-relieve by SPOP 460-2. Refer to the Standard Practices Manual, Section 70-42-04.

(11) Check assembly for distortion, as determined in step (1). A 0.010 inch out-of-concentricity is permissible.

(12) Check vane angles as prescribed in Paragraph H. Angle Checking, for following vanes:

(a) All replaced vanes.

(b) Two original vanes adjacent to replaced vane(s).

R
R

(c) Ten percent of remaining original vanes equally spaced around assembly.

NOTE: If vane angle of any vane checked is outside limits, vane angles of all vanes in assembly must be checked at all locations indicated in Table 602.

(13) If necessary, descale assembly, and immerse in slushing oil. Allow assembly to drain.

(14) Inspect vane and shroud assembly. See Paragraph A.

R H. Replacement (Aluminum) (JFTD12A-4A, -5A)
See Tool Group 40A.

(1) Welded Vane Tip

(a) Chart vane shroud squareness and concentricity.

(b) Etch position of seal ring, and remove seal ring.

(c) Using hacksaw, cut out airfoil portion in gaspath. Outer stub may be removed by drilling through it, using a steel template with a slightly smaller airfoil shape than vane stub. After rough vane stub is removed, grind to contour of replacement vane.

NOTE: Anodize coating can be removed from outer shroud, using abrasive cloth.

(d) Wrap adjacent vane and shroud area with water-soaked ceramic fiber tape.

(e) Install replacement vane through OD shroud until inner portion seats in inner shroud.

(f) Weld shroud assembly, using AMS 4190 filler rod. When welding 3rd stage vanes to outer shroud, weld entirely around vane airfoil at outer shroud ID. On OD of shroud, vanes need only be tack welded.

NOTE: Install vanes at 180 degree intervals, allowing assembly to cool before attempting to weld next vane into place.

72-0003

(g) Remove and/or contour excess weld material, as required.

NOTE: Slight deformation of shroud outer box surface is not cause for rejection.

(h) Install previously removed seal ring in its proper location, as determined in step (b).

(i) Holding assembly flat and concentric, stress-relieve at 160°- 165°C (320° - 330°F) for four hours. Place in cold furnace and allow to cool.

CAUTION: INSTALL ALUMINUM AIRSEALING RING AFTER STRESS-RELIEVING ASSEMBLY.

(j) Inspect vane and shroud assembly. Refer to Paragraph A. and Fluorescent Penetrant Inspection, in the Standard Practices Manual, Section 70-33-00.

(k) Check assembly for distortion as determined in step (a). A 0.010 inch out-of-concentricity is acceptable.

(l) Check vane angles, as prescribed in Paragraph H. Angle Checking, for following vanes:

1 All replaced vanes.

2 Two original vanes adjacent to replaced vane(s).

3 Ten percent of remaining original vanes equally spaced around assembly.

NOTE: Initial check of ten percent of original vanes shall be performed at two vane section locations only, those adjacent to inner and outer shrouds (for example, Sections B-B and E-E, shown in Figure 613).

4 If vane angle of any vane checked is outside limits, vane angles of all vanes in the assembly must be checked at all locations indicated in Table 602.

(2) Riveted Vane Tip

(a) Mark position of compressor shroud flange.

(b) Remove rivets securing shroud flange to vane and shroud assembly and remove flange

(c) Mark position of airsealing ring.

(d) Remove rivets securing airsealing ring to vane and shroud assembly and remove ring.

(e) Remove two rivets per vane that secure vane to front inner stiffening ring.

(f) Remove damaged vane and replace with new part.

(g) Reinstall seal ring and shroud flange in original locations.

(h) Check vane angles. See Paragraph H. Angle Checking.

(i) Inspect diameter concentricities as indicated in Paragraph C.

R I. Angle Checking

(1) Position vane and shroud assembly (front face up) on smooth level surface.

CAUTION: CHECK SURFACE FREQUENTLY TO MAKE SURE THAT IT IS LEVEL AND SMOOTH.

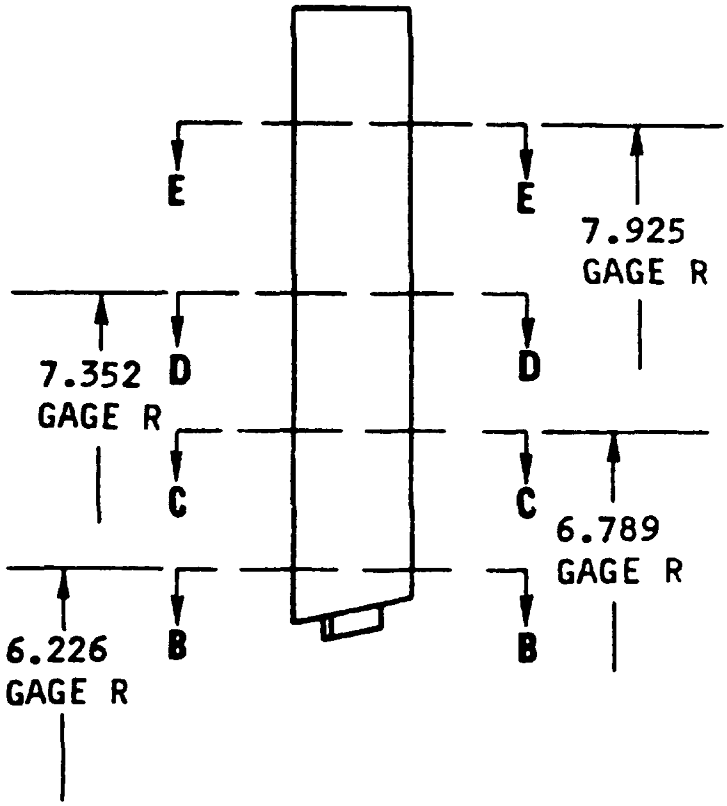
(2) Determine location of each vane section, using gage
R radius specified in Table 603 and illustrated in
R Figure 606. Mark locations.

(3) Check leading edge sections of each vane, using following procedure:

R (a) See Table 603, and determine proper leading edge angle for section to be checked. Adjust master gage to this angle.

1 Shake master gage to ensure even oil distribution on bearing races to prevent drag.

2 Place master gage on surface plate, making certain surface plate and master gage are clean to ensure full bearing on surface plate.



NOTE: Gage Radius is the Distance, in Inches, From a Vane Section to Center of Vane and Shroud Assembly. This Example Indicates The Proper Gage Radius For Locating Sections BB, CC, DD, and EE of a 5th Stage Vane.

Vane Section Locations
Figure 606

3 Turn thumbscrew clockwise until drum is free. If resistance to drum rotation is desired, thumbscrew may be tightened slightly to create a drag.

4 When drum has come to rest, lock by turning thumbscrew counterclockwise. During locking procedure care shall be taken to avoid jarring. Instrument may be removed from plate for reading.

5 Whole degrees (figures on rotating drum) are read by means of index mark on vernier scale which coincides with scribed white lines on master gage case. If index mark falls between two degree marks the lower shall be used.

6 To read minutes on vernier scale, find point at which vernier minute line and degree line on rotating scale coincide. If index mark is on black figures of rotating drum, black vernier figures shall be read; if on red, red vernier figures shall be read.

7 Vernier adjustment. If master gage reads inaccurately rotate it 180 degrees on surface plate. If it gives equal error in opposite direction, vernier needs adjustment. Loosen three acorn nuts, adjust vernier to give accurate readings and tighten nuts.

NOTE: Before adjusting vernier, repeat step (1) and determine proper vane angle checking gage.

R (b) See Table 603, and determine proper vane angle checking gage for section to be checked.

(c) Secure vial gage to angle checking gage.

Stage (PN)	Section	Gage Radius	LE Angle	Gage	Bar
1st (566281)	B-B	5.044	64°10′	PWA 13580	PWA 13576
	C-C	5.797	61°49′	PWA 13580	PWA 13576
	D-D	6.550	58°12′	PWA 13580	PWA 13576
	E-E	7.303	53° 7′	PWA 13580	PWA 13577
	F-F	8.056	47° 9′	PWA 13580	PWA 13775

Compressor Vane Bending
(Leading Edge)
R Table 603

72-0003

Stage (PN)	Section	Gage Radius	LE Angle	Gage	Bar
(568881)	B-B	5.044	62°41'	PWA 13580	PWA 13576
	C-C	5.797	60°48'	PWA 13580	PWA 13576
	D-D	6.550	57° 3'	PWA 13580	PWA 13576
	E-E	7.303	52°31'	PWA 13580	PWA 13577
	F-F	8.056	46°44'	PWA 13580	PWA 13577
(568891)	B-B	5.044	62°41'	PWA 13580	PWA 13576
	C-C	5.797	60°48'	PWA 13580	PWA 13576
	D-D	6.550	57° 3'	PWA 13580	PWA 13576
	E-E	7.303	52°31'	PWA 13580	PWA 13577
	F-F	8.056	46°44'	PWA 13580	PWA 13577
2nd (422882)	B-B	5.479	61°32'	PWA 13397	#
	C-C	6.094	55°58'	PWA 13397	#
	D-D	6.710	50°56'	PWA 13397	#
	E-E	7.326	46°50'	PWA 13397	#
	F-F	7.941	41°13'	PWA 13397	#
(566282)	B-B	5.479	60°30'	PWA 13397	#
	C-C	6.094	56°35'	PWA 13397	#
	D-D	6.710	51°24'	PWA 13397	#
	E-E	7.326	46°18'	PWA 13397	#
	F-F	7.941	41°00'	PWA 13397	#
3rd (385503)	B-B	5.809	55°38'	PWA 13397	PWA 13665
	C-C	6.314	49°45'	PWA 13397	PWA 13665
	D-D	6.820	45°14'	PWA 13397	PWA 13665
	E-E	7.326	41° 2'	PWA 13397	PWA 13665
	F-F	7.831	36°49'	PWA 13397	PWA 13665
4th (542274)	B-B	5.945	54°17'	PWA 13397	PWA 13398
	C-C	6.605	48°11'	PWA 13397	PWA 13398
	D-D	7.265	43°39'	PWA 13397	PWA 13398
	E-E	7.995	38°17'	PWA 13397	PWA 13398
(580294)	B-B	5.945	54°17'	PWA 13397	PWA 13398
	C-C	6.605	48°11'	PWA 13397	PWA 13398
	D-D	7.265	43°39'	PWA 13397	PWA 13398
	E-E	7.995	39° 5'	PWA 13397	PWA 13398

Compressor Vane Bending
(Leading Edge)
Table 603 (Continued)

Stage (PN)	Section	Gage Radius	LE Angle	Gage	Bar
5th (542275)	B-B	6.226	45°26'	PWA 13399	PWA 13401
	C-C	6.789	42°54'	PWA 13399	PWA 13401
	D-D	7.352	39° 9'	PWA 13399	PWA 13401
	E-E	7.925	34°35'	PWA 13399	PWA 13401
(580295)	B-B	6.226	45°26'	PWA 13399	PWA 13401
	C-C	6.789	42°54'	PWA 13399	PWA 13401
	D-D	7.352	39° 9'	PWA 13399	PWA 13401
	E-E	7.975	34°44'	PWA 13399	PWA 13401
6th (542276)	B-B	6.502	45° 2'	PWA 13560	PWA 13404
	C-C	6.978	42°50'	PWA 13560	PWA 13404
	D-D	7.454	38°35'	PWA 13560	PWA 13404
	E-E	7.895	34°16'	PWA 13560	PWA 13404
(580296)	B-B	6.502	45° 2'	PWA 13560	PWA 13404
	C-C	6.978	42°50'	PWA 13560	PWA 13404
	D-D	7.454	38°35'	PWA 13560	PWA 13404
	E-E	7.895	35°42'	PWA 13560	PWA 13404
7TH 542277	B-B	6.745	44°19'	PWA 13399	PWA 13407
	C-C	7.140	41°44'	PWA 13399	PWA 13407
	D-D	7.535	38°15'	PWA 13399	PWA 13407
	E-E	7.880	34°28'	PWA 13399	PWA 13407
591277	B-B	6.745	44°19'	PWA 13399	PWA 13407
	C-C	7.140	41°44'	PWA 13399	PWA 13407
	D-D	7.535	38°15'	PWA 13399	PWA 13407
	E-E	7.880	34°28'	PWA 13399	PWA 13407
591567	B-B	6.745	44°19'	PWA 13399	PWA 13407
	C-C	7.140	41°44'	PWA 13399	PWA 13407
	D-D	7.535	38°15'	PWA 13399	PWA 13407
	E-E	7.950	35° 6'	PWA 13399	PWA 13407
8TH (479238)	B-B	7.105	45°29'	PWA 13560	PWA 13536
	C-C	7.293	43°49'	PWA 13560	PWA 13536
	D-D	7.619	40°51'	PWA 13560	PWA 13536
	E-E	7.850	39°32'	PWA 13560	PWA 13536

Compressor Vane Bending
(Leading Edge)
Table 603 (Continued)

72-0003

Stage (PN)	Section	Gage Radius	LE Angle	Gage	Bar
(542278)	B-B	6.967	46°33'	PWA 13560	PWA 13536
	C-C	7.293	43°49'	PWA 13560	PWA 13536
	D-D	7.619	40°51'	PWA 13560	PWA 13536
	E-E	7.905	39°17'	PWA 13560	PWA 13536
(591278)	B-B	6.967	46°33'	PWA 13560	PWA 13536
	C-C	7.293	43°49'	PWA 13560	PWA 13536
	D-D	7.619	40°51'	PWA 13560	PWA 13536
	E-E	7.905	39°17'	PWA 13560	PWA 13536
9TH (568869) (Primary)	B-B	7.160	40° 8'	PWA 13412	PWA 13756
	C-C	7.488	37°43'	PWA 13412	PWA 13756
	D-D	7.708	36°24'	PWA 13412	PWA 13756
	E-E	7.7930	34°24'	PWA 13412	PWA 13756
(568869) (Secondary)	F-F	7.160	53°47'	*	*
	G-G	7.592	53°47'	*	*
	H-H	7.930	53°47'	*	*

No Bending Permissible
* Not Available

Compressor Vane Bending
(Leading Edge)
R Table 603 (Continued)

Stage (PN)	Section	Gage Radius	TE Angle	Gage	Bar
1st (566281)	B-B	5.044	82°42'	PWA 13581	PWA 13776
	C-C	5.797	77°34'	PWA 13581	PWA 13776
	D-D	6.550	73°16'	PWA 13581	PWA 13776
	E-E	7.303	68°51'	PWA 13581	PWA 13579
	F-F	8.056	64°17'	PWA 13581	PWA 13579
(568881)	B-B	5.044	81°10'	PWA 13581	PWA 13578
	C-C	5.797	76° 5'	PWA 13581	PWA 13578
	D-D	6.550	71°25'	PWA 13581	PWA 13578
	E-E	7.303	67°20'	PWA 13581	PWA 13579
	F-F	8.056	63°3'13"	PWA 13581	PWA 13579

Compressor Vane Bending
(Trailing Edge)
R Table 603A

Stage (PN)	Section	Gage Radius	TE Angle	Gage	Bar
(568891)	B-B	5.044	81°10'	PWA 13581	PWA 13578
	C-C	5.797	76° 5'	PWA 13581	PWA 13578
	D-D	6.550	71°25'	PWA 13581	PWA 13578
	E-E	7.303	67°20'	PWA 13581	PWA 13579
	F-F	8.056	63°3'13"	PWA 13581	PWA 13579
2nd (422882)	B-B	5.479	79°58'	PWA 13399	PWA 13664
	C-C	6.094	71°51'	PWA 13399	PWA 13664
	D-D	6.710	66°45'	PWA 13399	PWA 13802
	E-E	7.326	63°37'	PWA 13399	PWA 13802
	F-F	7.941	61°14'	PWA 13399	PWA 13802
(566282)	B-B	5.479	80°35'	PWA 13399	PWA 13664
	C-C	6.094	72°46'	PWA 13399	PWA 13664
	D-D	6.710	67°55'	PWA 13399	PWA 13802
	E-E	7.326	64°50'	PWA 13399	PWA 13802
	F-F	7.941	62° 7'	PWA 13399	PWA 13802
3rd (385503)	B-B	5.809	74°55'	PWA 13399	PWA 13666
	C-C	6.314	66°54'	PWA 13399	PWA 13666
	D-D	6.820	62°42'	PWA 13399	PWA 13666
	E-E	7.326	60°19'	PWA 13399	PWA 13666
	F-F	7.831	58°38'	PWA 13399	PWA 13666
4th (542274)	B-B	5.945	67° 3'	PWA 13399	PWA 13400
	C-C	6.605	61°10'	PWA 13399	PWA 13400
	D-D	7.265	58°26'	PWA 13399	PWA 13400
	E-E	7.995	55°35'	PWA 13399	PWA 13400
(580294)	B-B	5.945	67° 3'	PWA 13399	PWA 13400
	C-C	6.605	61°10'	PWA 13399	PWA 13400
	D-D	7.265	58°26'	PWA 13399	PWA 13400
	E-E	7.995	63°11'	PWA 13399	PWA 13400
5th (542275)	B-B	6.226	60°53'	PWA 13399	PWA 13403
	C-C	6.789	58°55'	PWA 13399	PWA 13403
	D-D	7.352	56°23'	PWA 13399	PWA 13403
	E-E	7.925	53°38'	PWA 13399	PWA 13403

Compressor Vane Bending
(Trailing Edge)
Table 603A (Continued)

72-0003

Stage (PN)	Section	Gage Radius	TE Angle	Gage	Bar
(580295)	B-B	6.226	60°53'	PWA 13399	PWA 13403
	C-C	6.789	58°55'	PWA 13399	PWA 13403
	D-D	7.352	56°23'	PWA 13399	PWA 13403
	E-E	7.975	63°33'	PWA 13399	PWA 13403
6th (542276)	B-B	6.502	64°26'	PWA 13406	PWA 13405
	C-C	6.978	62°57'	PWA 13406	PWA 13405
	D-D	7.454	60°54'	PWA 13406	PWA 13405
	E-E	7.895	59°12'	PWA 13406	PWA 13405
(580296)	B-B	6.502	64°26'	PWA 13406	PWA 13405
	C-C	6.978	62°57'	PWA 13406	PWA 13405
	D-D	7.454	60°54'	PWA 13406	PWA 13405
	E-E	7.895	68°18'	PWA 13406	PWA 13820
7TH 542277	B-B	6.745	65°48'	PWA 13406	PWA 13408
	C-C	7.140	64°20'	PWA 13406	PWA 13408
	D-D	7.535	62°45'	PWA 13406	PWA 13408
	E-E	7.880	61°33'	PWA 13406	PWA 13408
591277	B-B	6.745	65°48'	PWA 13406	PWA 13408
	C-C	7.140	64°20'	PWA 13406	PWA 13408
	D-D	7.535	62°45'	PWA 13406	PWA 13408
	E-E	7.880	61°33'	PWA 13406	PWA 13408
591567	B-B	6.745	65°48'	PWA 13406	PWA 13408
	C-C	7.140	64°20'	PWA 13406	PWA 13408
	D-D	7.535	62°45'	PWA 13406	PWA 13408
	E-E	7.950	69°42'	PWA 13406	PWA 13408
8TH (479238)	B-B	7.105	66°10'	PWA 13406	PWA 13410
	C-C	7.293	65°25'	PWA 13406	PWA 13410
	D-D	7.619	64°23'	PWA 13406	PWA 13410
	E-E	7.850	63°26'	PWA 13406	PWA 13410
(542278)	B-B	6.967	66°47'	PWA 13406	PWA 13410
	C-C	7.293	65°25'	PWA 13406	PWA 13410
	D-D	7.619	64°23'	PWA 13406	PWA 13410
	E-E	7.905	63° 9'	PWA 13406	PWA 13410

Compressor Vane Bending
(Trailing Edge)
Table 603A (Continued)

Stage (PN)	Section	Gage Radius	TE Angle	Gage	Bar
(591278)	B-B	6.967	66°47'	PWA 13406	PWA 13410
	C-C	7.293	65°25'	PWA 13406	PWA 13410
	D-D	7.619	64°23'	PWA 13406	PWA 13406
	E-E	7.905	63° 9'	PWA 13406	PWA 13406
9TH					
(568869)	B-B	7.160	55°35'	*	*
(Primary)	C-C	7.488	56°38'	*	*
	D-D	7.708	56°59'	*	*
	E-E	7.7930	57°28'	*	*
(568869)	F-F	7.160	89°39'	PWA 13414	PWA 13413
(Secondary)	G-G	7.592	89°39'	PWA 13414	PWA 13413
	H-H	7.930	89°39'	PWA 13414	PWA 13413

*Not Available

Compressor Vane Bending
(Trailing Edge)
R Table 603A (Continued)

(d) Secure vane angle checking gage to lug on master gage.

(e) Adjust vial gage until edge of bubble coincides with scribe mark on glass tube. Remove vane angle checking gage from master gage.

(f) Secure vane angle checking gage on leading edge
R section to be checked, as shown in Figure 606.

(g) If edge of bubble coincides with scribe mark on glass tube, angel is correct. If bubble does not coincide with scribe mark, vane must be bent to correct angle.

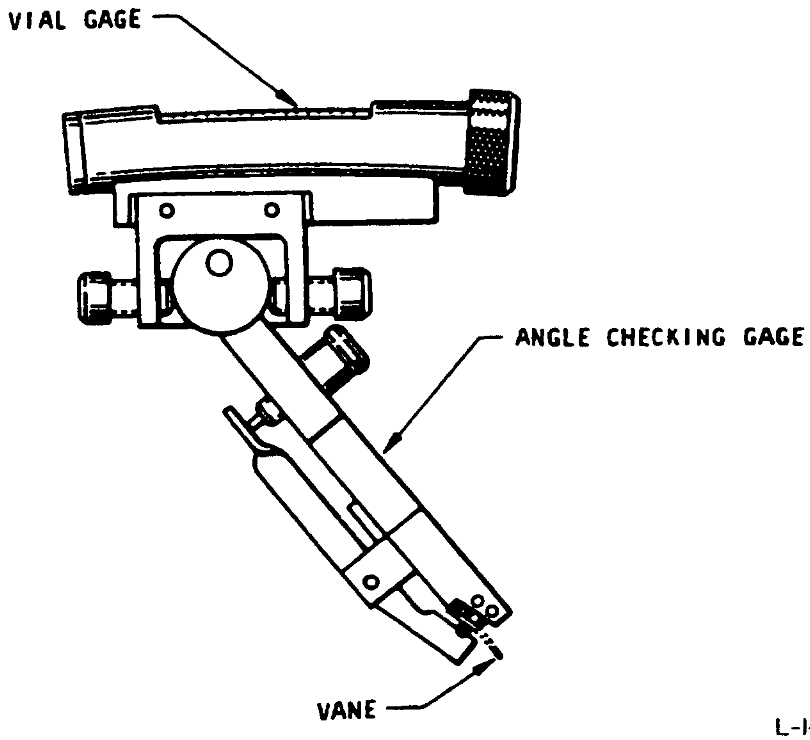
NOTE: Angles must be within 1°30' of specified angle. Average of all vanes must be within 0°45' of specified vane angle.

R J. Bending

R (1) Bend vanes to angle specified in Table 603, as necessary, using following procedure:

R (a) See Table 603 and determine proper bending bar for section to be bent.

72-0003



L-14283 (0000)

Vane Angle Checking
Figure 606

(b) Position slot of bar over leading edge section of vane and bend the vane section to correct angle.
R See Figure 608.

(2) Position vane and shroud assembly (rear face up) on level, smooth surface. Using procedures used for leading edges, check vane trailing edge angle for each
R vane and bend as necessary. Refer to Table 603A for the applicable angles, gages, and bending bars for each section.

3. Compressor Vane And Shroud Assemblies
R See Figure 609.

A. First Stage
See Tool Group 29A-1.

(1) Inspection

(a) Inspect 1st stage vane and shroud assemblies for blade tip rub on shroud. Depth of rub must not exceed 0.010 inch.

(b) Maximum out-of-round of 0.020 inch is permissible for 1st stage shroud. Clearance may be approximated using vernier tape measure or by quadrant diametrical comparison of parts.

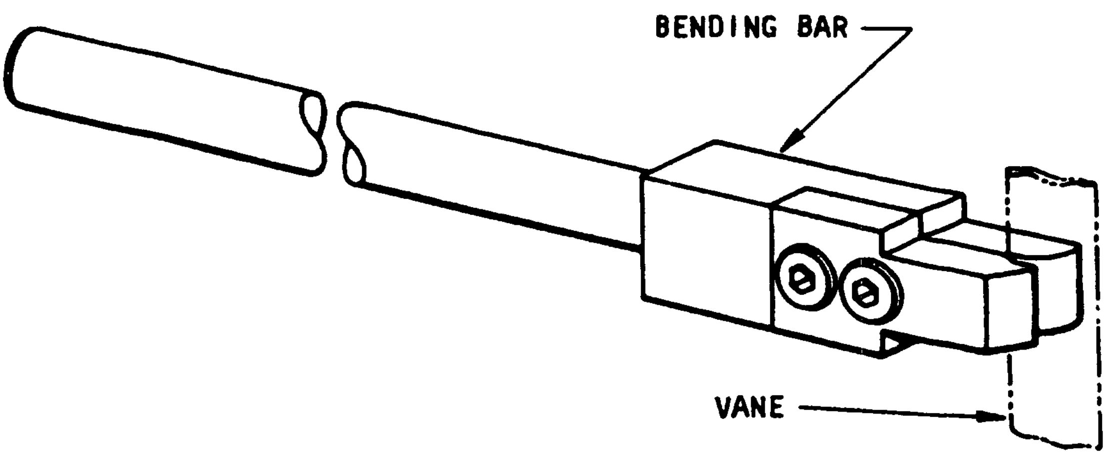
(c) Visually inspect all areas of each vane for pitting, galling, or other defects.

(d) Inspect aluminum vane and shroud assemblies, using fluorescent penetrant method. Refer to the Standard Practices Manual, Section 70-33-00. For steel parts, use fluorescent magnetic particle inspection. Refer to the Standard Practices Manual, Section 70-32-00.

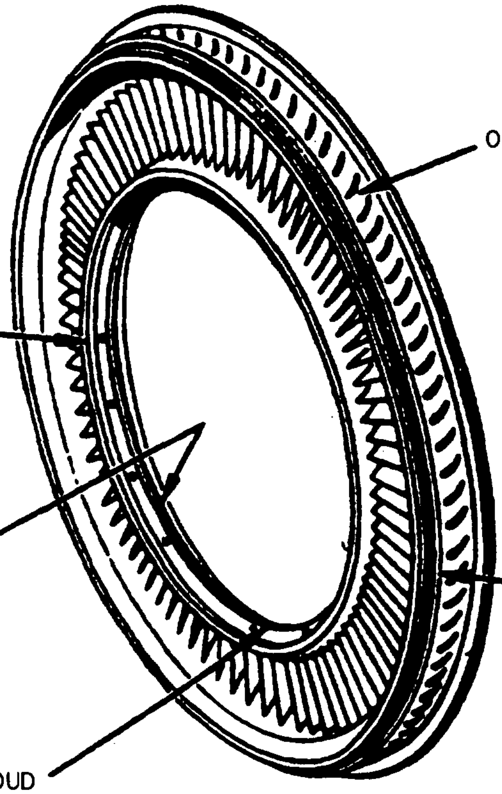
NOTE: If indication of defects is discovered, strip assembly and reinspect, using same procedure.

(2) Plating (When Required)

72-0003



Vane Bending Bar
Figure 608



Vane And Shroud Assembly
(Stages 1 Thru 3)
Figure 609

72-1003

(a) Remove rivets securing airsealing ring to vane and shroud assembly.

NOTE: Before removing rivets, mark ring opposite offset lug to ensure that ring is reinstalled in same position.

(b) Prepare vane and shroud assembly for plating procedure by attaching fixture. Remove wing nuts and separate fixture details. Position stator, rear face down, with outer shroud in stepped fixture locators. Reassemble fixture, and secure with wing nuts.

NOTE: Electrical contact points are permissible
R only in area shown in Figure 610. No burning, pitting, or selective attack is permitted.

(c) Strip and cadmium plate vane and shroud assembly. Plate to thickness of 0.0003 - 0.005 inch. Refer to SPOP 21 in the Standard Practices Manual, Section 70-44-01.

NOTE: Surface area of stator assembly is 5.7 square feet. Current requirements are 195 - 420 amperes for nickel strike and 140 amperes for cadmium plate.

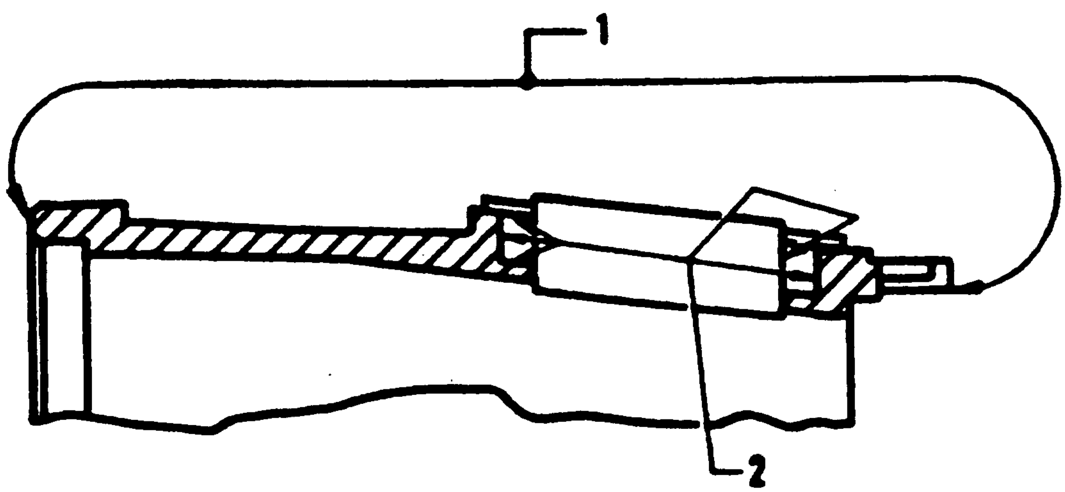
(d) Inspect assembly to ensure that plate is complete and uniform in thickness. Plating inbox shroud area and in two, one-eighth-inch peripheral holes is optional, and may be incomplete.

(e) Paint with high-baking, heat-resistant, aluminum
R enamel those areas specified in Figure 611, as well as all fixture contact points, and any other abrasions or scratches penetrating through plating to bare metal as a result of fixturing. Refer to SPOP 142 in the Standard Practices Manual, Section 70-41-03.

(f) Bake assembly at 185° - 196°C (365° - 385°F) for three hours.

(3) PWA 110-21/110-9 Coating (Alternate Coating Procedure)

NOTE: Coating is required for vane and shroud assemblies post-SB 6211.

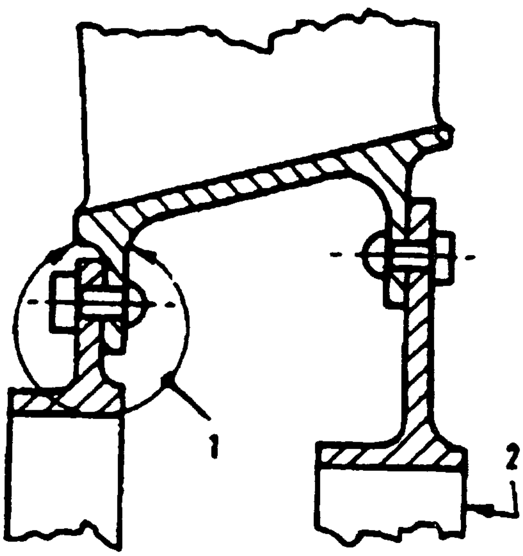


L-I7948 (0000)

1. Electrical Contact Points
2. Optional Plate Area

First Stage Vane And
Shroud Plating
Figure 610

72-0003



L-17947 (0000)

1. Paint Area
2. "Rear" Marked This Side

First Stage Vane And Shroud
Painting And Airsealing
Ring Replacement
Figure 611

(a) Remove all the coating and plating from all surfaces.

(b) Apply PWA 110-21/110-9 Coating, 0.0005 - 0.0020 inch thick.

(4) Airsealing Ring Replacement

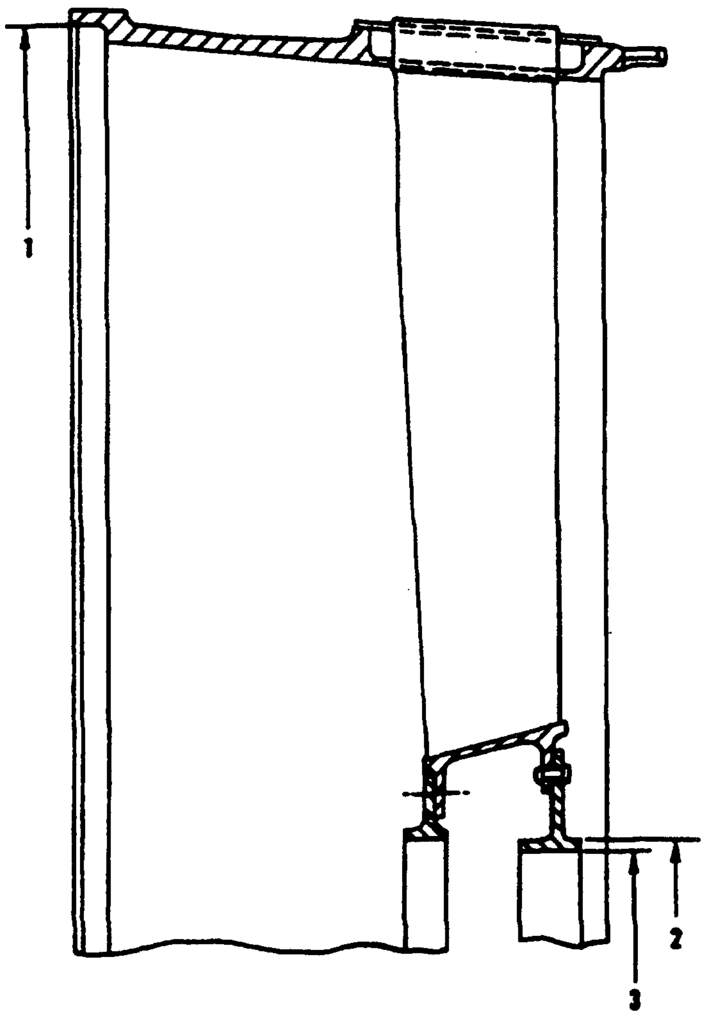
(a) For a new replacement ring, transfer drill 108 0.046 - 0.052 inch (0.094 - 0.096 inch post-SB 1168) diameter rivet holes (use the old ring as a template). Put the used or replacement airsealing ring on the rivet flange as shown in
R Figure 612 (make sure that the face with the REAR mark is in its correct position). For old rings, align the mark on the airsealing ring with the offset lug assembly.

(b) Using riveter, rivet ring to vane and shroud assembly with manufactured rivet heads forward.

NOTE: To preclude rivet bending which may result in aluminum airsealing ring deformation, PN 125571 rivets shall be used. If material to be riveted (airsealing ring and inner shroud flanges) is below nominal thickness, rivets shall be shortened so that length of rivet shank is equal to material thickness plus 1.5 times shank diameter. These guidelines for determining rivet length shall be used when replacing airsealing rings on all vane and shroud assemblies. Refer to the Standard Practices Manual, Section 70-43-00.

(c) For replacement airsealing rings, machine to
R dimensions in Figure 621. Concentricity checks shall be performed on used and replacement rings to ensure that ring is positioned properly and that machined ID surface of ring is concentric with vane outer shroud.

(d) Degrease assembly and dry.



L-22355 (0000)

First Stage Compressor
Vane And Shroud Assembly
Airsealing Ring Replacement
Figure 612

1. Reference Diameter
2. This Diameter Must Be Concentric With Reference Diameter Within 0.010 Inch FIR To Ensure That Ring Is Properly Positioned On Rivet Flange Prior to Machining or Ring ID Concentricity Check
3. This Machined Diameter (7.995 - 8.005 Inches) Must Be Concentric With Reference Diameter Within 0.002 Inch FIR.

R Key to Figure 612

(5) First Stage Vane and Shroud Assembly Outer Box Shroud Crack Repair

NOTE: Do not repair a 1st stage compressor stator assembly, PN 568891 with the procedure that follows:

(a) Remove the protective coating as necessary. See Paragraph A.(2).

(b) Remove and replace the airsealing ring. See Paragraph A.(2) and (3).

R (c) Use a No. 60 drill bit (0.040 inch diameter) to stop drill cracks. See Figure 613.

NOTE: Stop drill holes must be free of weld protuberances to avoid stress risers, and therefore could require reaming or polishing after the crack has been welded.

(d) Rout the cracks completely in the area to be welded. Keeping the width of the cut to a minimum.

(e) Weld the crack with AMS 5776 (410 bare) or AM 363 (PWA 791) filler metal.

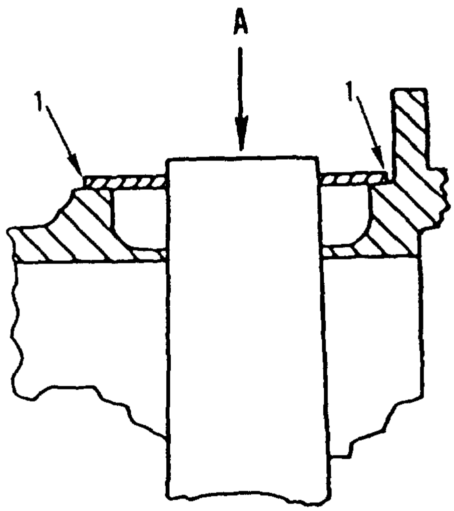
CAUTION: BE CAREFUL WITH THE PARTS UNTIL STRESS-RELIEF IS ACCOMPLISHED.

(f) Stress-relieve as follows:

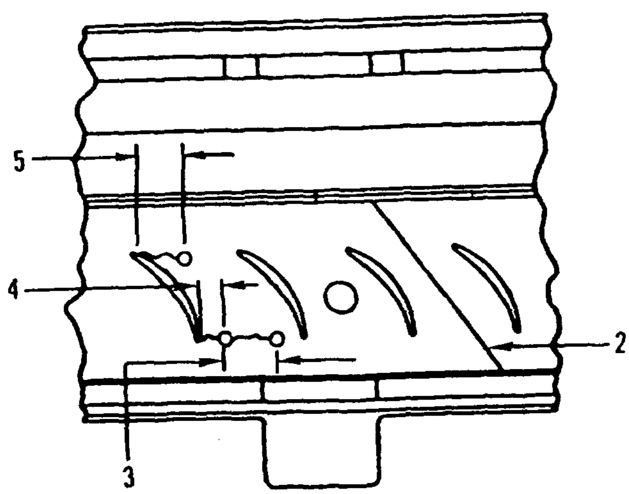
1 Place the assembly on a flat plate in a cold furnace.

2 Support the inner shroud in relation to the outer shroud.

3 Place the flat plate on top of the assembly.



TYPICAL STATOR ASSEMBLY



L-88506

VIEW IN DIRECTION A

First Stage Compressor Vane
And Shroud Crack Repair
Figure 613

1. Cracks In Circumferential Weld Area: Do Not Stop Drill Cracks. Weld Cracks With AMS 5776 (410 bare) Or AM 363 PWA 7910 Filler Metal
2. It Is Permitted To Weld Cracks In This Weld Again
3. Stop Drill Cracks (Longer Than 0.125 Inch) 0.050 Inch From The Braze And At The End Of The Crack. Rout And Weld The Crack Between The Holes
4. 0.050 Inch
5. Stop Drill Cracks Less Than 0.125 Inch long Which Come From The Brazed Area At The End Of The Crack And Not Let Them Stay Welded

R Key to Figure 613

4 Stress-relieve with SPOP 455-2 in Section 70-42-04 in the Standard Practices Manual.

(g) Fluorescent penetrant inspect the welded areas. See Paragraph A.

(h) Blend the weld flush to 0.010 inch above the surface. Do not remove any parent metal.

(i) Fluorescent penetrant inspect the welded areas. See Paragraph A.

(j) Make a dimensional inspection of the repaired mating diameters as necessary. See Paragraph A.

R (6) Mating Diameter Repair. See Figure 61.

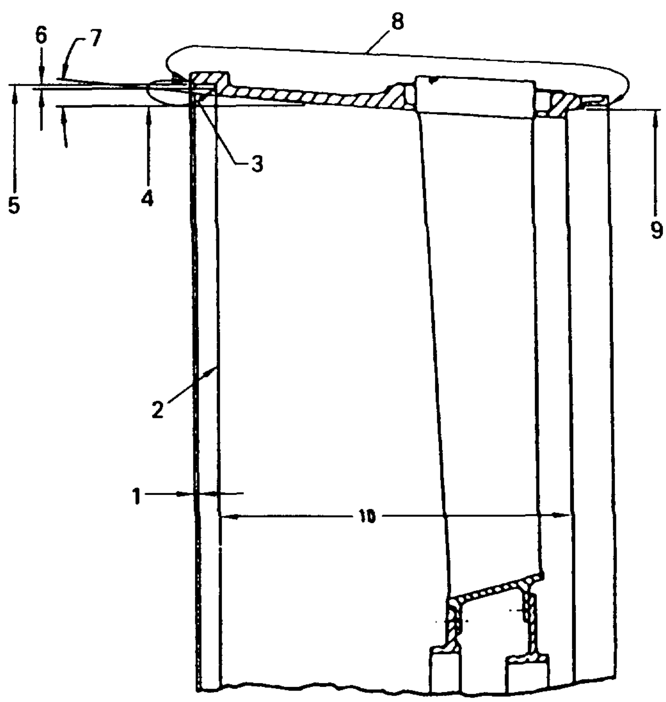
(a) Remove protective coatings as necessary as instructed In this section.

(b) Machine damaged or worn front and/or rear mating diameter as shown in figure.

(c) Nickel plate machined areas by SPOP 26. Refer to Section 70-44-01 in the Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

NOTE: Plasma coat by PWA 53-37 or PWA 53-80 may be used as an option to nickel plate. Refer to Section 70-46-01 in the Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but

72-0003



L-H3124 (1296)

First Stage Compressor Vane
And Shroud Assembly Mating
Diameter Repair
Figure 614

1. Chamfer 0.020 - 0.030 Inch By 43 - 47 degrees
2. Reference Surface
3. Nickel Plate Or Plasma Coat Area

NOTE: For PN 568891 Stage 1 Vane and Shroud Assemblies, Nickel Plate per SPOP 43 or Plasma Coat per PWA 53-37 or PWA 53-80

4. 17.344 - 17.54 Inch Diameter; Must Be Concentric With Index 5 Within 0.004 Inch FIR;
5. 17.344 - 17.748 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 17.714 Inch Diameter Maximum After Nickel Plate Or Plasma Coat. 17.724 - 17.728 Inch Diameter After Finish Machining; Diameter Must Be Concentric With Index 4 Within 0.004 Inch FIR, And Index 9 Within 0.002 Inch FIR.

NOTE: For PN 568891 Assemblies, Finish Machine Front Mating Diameter; 17.722 - 17.726 Inch After Plate or Coat

6. 0.020 - 0.035 Inch
7. 5 Degrees 6 Minutes - 5 degrees 26 Minutes
8. Electrical Contact Area
9. 17.219 - 17.223 Inch Diameter; Must Be Concentric With Index 5 Within 0.002 Inch FIR
10. 2.913 - 2.915 Inches

R Key to Figure 614

extra plasma coat must be removed at final machining.

(d) For nickel plate only, bake vane and shroud assembly at 185 - 196°C (365 - 385°F) for three hours.

(e) Finish machine diameter(s) to dimensions shown, maintaining all radii and concentricity requirements.

(f) Replace protective coat by this section.

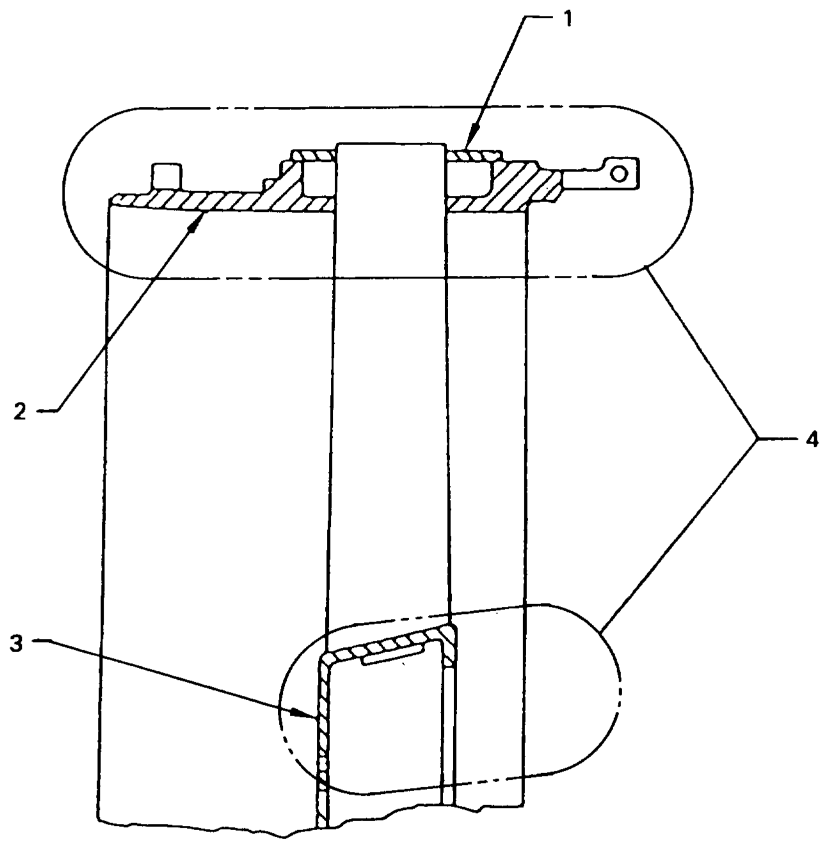
B. First And 4th Thru 8th Stage

R (1) Corrosion Pitting. See Figure 615.

(a) Inspection

1 Remove protective coatings as necessary as instructed in this section.

72-0003



Typical First And Fourth
Through Eighth Stage Stator
Pitting Inspection And Repair
Figure 615

1. Outer Box Shroud
2. Outer Shroud
3. Inner Shroud
4. Pitting And Corrosion Are Repairable In These Areas To A Depth Of 0.005 Inch.

R Key to Figure 615

2 Measure the pit depth by the replicating tape method in SPOP 127 or equivalent method. Refer to Section 70-30-00 in the Standard Practices Manual.

3 Pits on outer, inner and box shrouds are repairable to a depth of 0.005 inch.

(b) Repair

1 Complete all other necessary repairs (including removal of the air sealing ring) before you repair corrosion pits.

CAUTION: ENSURE THAT MATING DIAMETERS AND CRITICAL DIMENSIONS ARE NOT ALTERED BY THE BLAST CLEANING PROCEDURE IN PWA 110.

2 Coat the stator by the PWA 110-21 process in Section 70-41-04 in the Standard Practices Manual.

C. Second And 3rd Stages

(1) Coating Repair

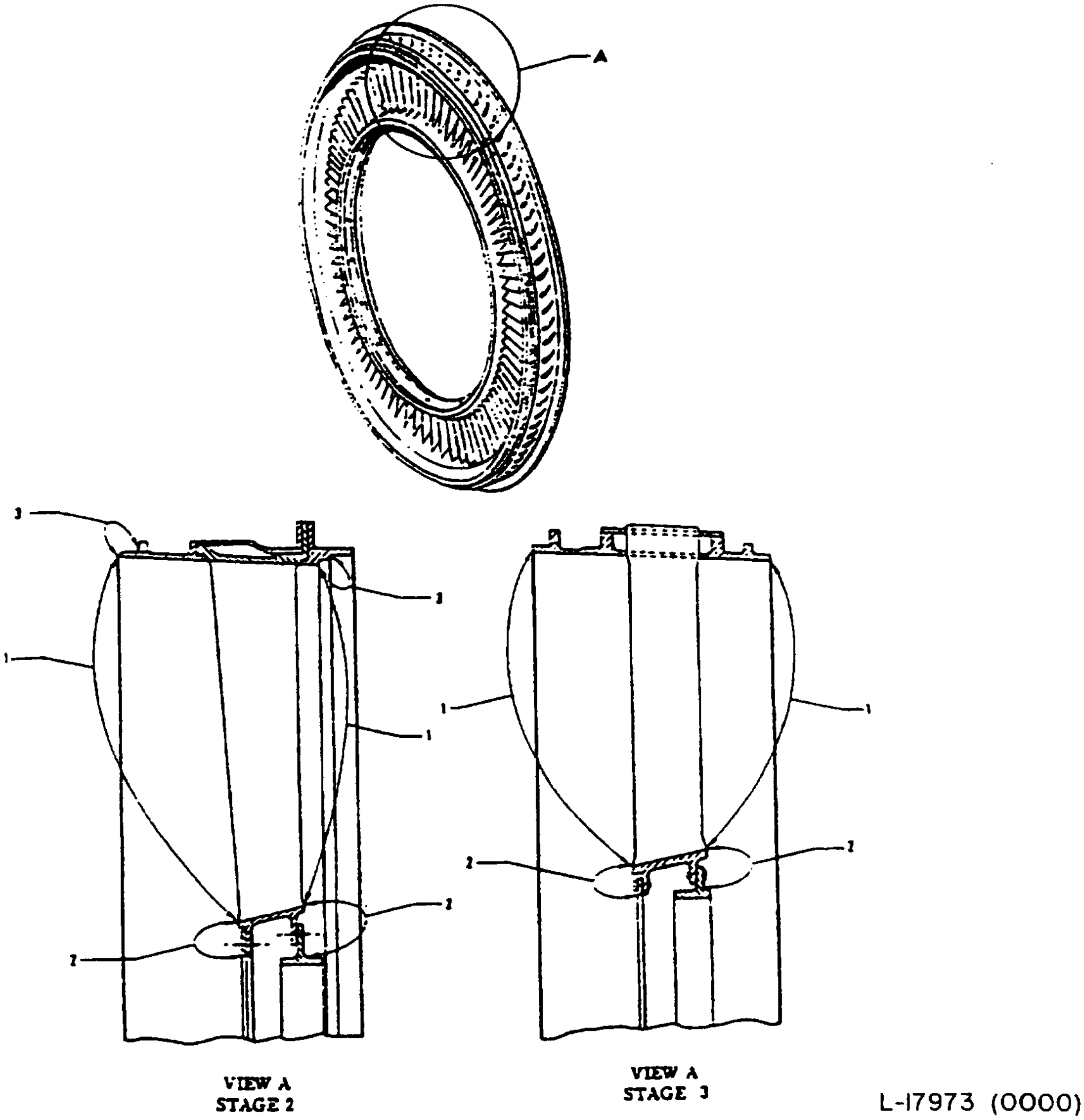
(a) Apply, or renew, coating of clear, polyurethane compound on gaspath surfaces of vanes. See
R Figure 616.

NOTE: When necessary, remove polyurethane coating with solvent.

(b) Cover areas shown with two coats.

1 Apply preliminary coat and air dry for 20 - 30 minutes.

2 Apply final coat and bake at 91° - 118°C (195° - 245°F) for 30 minutes.



1. Coat Enclosed Area
2. Overspray Permissible
3. Uncoated Area

Vane And Shroud 2nd And
3rd Stage Coating
Figure 616

(2) PWA 110-21/110-9 Coating (Alternate Coating Procedure) .

(a) Remove all coat and plate from all surfaces.

(b) Apply PWA 110-21/110-9 coating, 0.0005 - 0.0020 inch thickness. Refer to 70-41-04 in the Standard Practices Manual.

(3) Second Stage Compressor Rotor Airsealing Ring-Replacement
R See Tool Group 34A and Figure 617.

(a) Mark old airsealing ring and shroud for location.

(b) Machine off rivet heads and seal land so only flat ring remains.

(c) Remove rivet shanks and old seal ring.

(d) Using old ring as template, transfer drill 140, 0.066 - 0.071 inch diameter, holes.

(e) Transfer locating mark from old ring to new ring.

(f) Align mark on new ring with mark on vane and shroud assembly.

(g) Rivet ring to vane and shroud assembly as follows:

1 Insert rivet, manufactured head against vane root.

2 Install punch into plunger of riveter.

3 Secure anvil to yoke of riveter.

4 Position cupped head of punch on manufactured head of rivet.

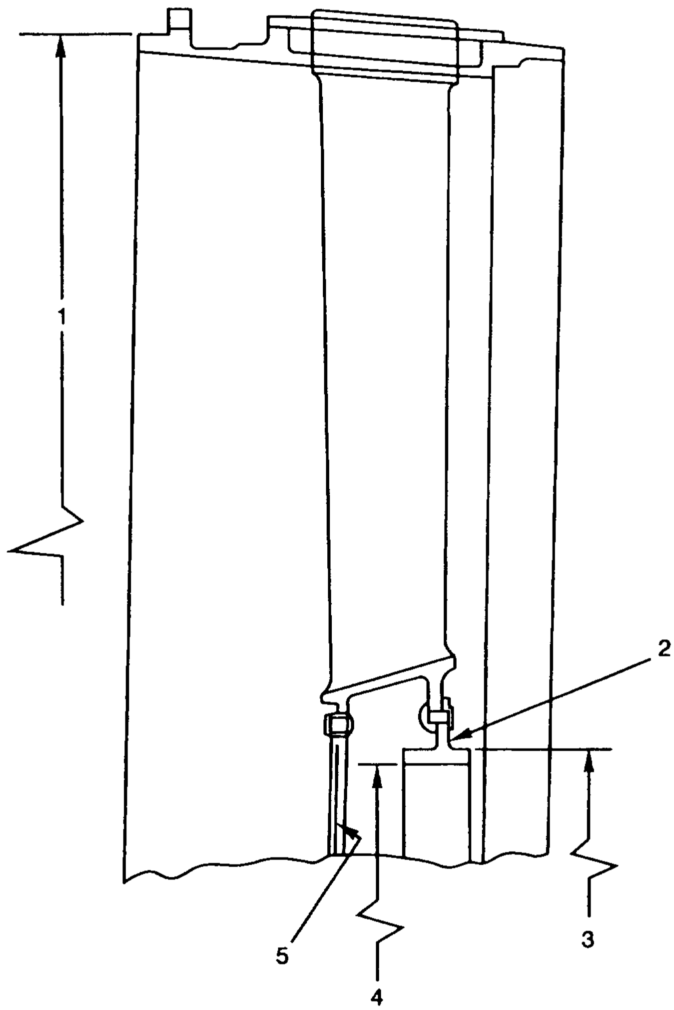
5 Squeeze handles of riveter to upset rivets.

(h) Machine ring ID, as shown.

(i) After machining, treat ID with AMS 2473.

(4) Third Stage Compressor Rotor Airsealing Ring Replacement
R See Tool Group 34A and Figure 617.

72-0003



1. Reference Mating Diameter
2. REAR marked here On 3rd State Airsealing Ring
3. This Diameter Shall Be Concentric With Reference Diameter Within 0.010 Inch FIR Prior To Machining Of Airsealing Ring ID For Stage 2 Only
4. 9.255 - 9.265 Inch Diameter For 2nd Stage Airsealing Ring. Diameter Must Be Concentric With Diameter (1) Within 0.002 Inch FIR. 10.135 - 10.145 Inch Diameter For 3rd Stage Airsealing Ring. Diameter Must Be Concentric With Mating Diameters Within 0.002 Inch FIR.
5. Vane Stiffening Ring (Positioning Plate) Chamfer Installed This Side.

Second And 3rd Stage
Compressor Airsealing Ring And
Vane Stiffening Ring Replacement
Figure 617

(a) Remove rivets securing ring to vane and shroud assembly and remove ring.

CAUTION: DURING RIVET REMOVAL CARE SHALL BE TAKEN TO PREVENT DAMAGE TO RIVET HOLES IN SUPPORT RING OR VANES.

(b) Position new ring, as shown, and transfer drill 140 holes, 0.066 - 0.071 inch diameter.

NOTE: Ensure that side of ring marked REAR is so installed for 3rd stage.

(c) Rivet ring to vane and shroud assembly. For riveting procedure, see step (2)(g).

(d) Machine ring ID, as shown.

(e) After machining, treat ID with AMS 2473.

(5) Compressor Vane Stiffening Ring - Replacement See Tool Group 34A.

(a) Remove rivets securing ring to vane and shroud assembly and remove ring.

(b) Treat new 3rd stage ring with AMS 2470.

(c) Install new ring with chamfer against vanes.

(d) Align ring and drill holes to 0.066 - 0.071 inch diameter.

(e) Rivet ring to vane and shroud assembly as follows:

1 Insert rivet, manufactured head against vane root.

2 Position cupped head of riveter on manufacturing head of rivet.

3 Squeeze handles of riveter to upset rivet.

(6) Compressor Vane, Second Stage - Replacement

(a) Mark position of compressor shroud flange.

R
R

(b) Remove rivets securing flange to vane and shroud assembly and remove flange.

(c) Mark position of airsealing ring.

(d) Remove rivets securing ring to vane and shroud assembly and remove ring.

(e) Remove two rivets per vane that secure vane to front inner stiffening ring.

(f) Remove damaged vane and replace with new part.

CAUTION: VANES FOR JFTD12A-4A, JFTD12A-5A, JT12A-8 (L), AND JT12-8 (N) ENGINES ARE NOT TO BE INTERMIXED WITH VANES OF OTHER ENGINE MODELS.

(g) Reinstall seal ring and shroud flange in original locations.

(h) Check vane angles. See paragraph Vane Bending.

R (i) Inspect diameter concentricities. See Figure 617.

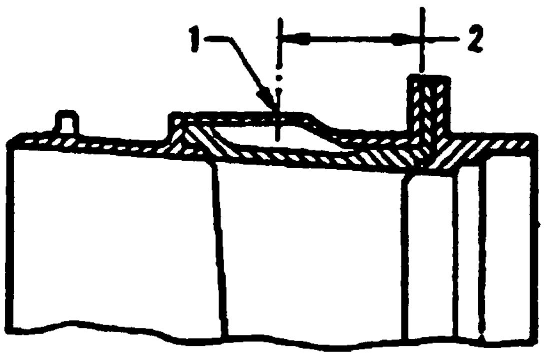
(7) Second Stage Vane and Shroud Assembly - Fluid Drainholes. To enable fluid drainage from between
R vanes and outer shroud, drill holes. See Figure 618.

(8) Second Stage Outer Shroud Front Mating Diameter Repair.
R See Figure 619.

(a) Machine damaged or worn front mating diameter as shown in figure.

(b) Nickel plate diameter by SPOP 43. Refer to Section 70-44-01 in the Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

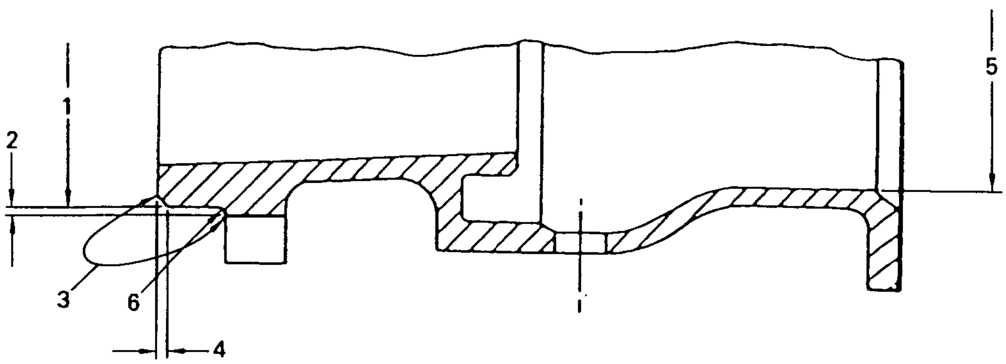
NOTE: Plasma coat by PWA 53-37 or PWA 53-80 is permitted as an option to nickel plate. Refer to 70-46-01 in the Standard Practices Manual. If plasma coat is used, do not do a bake operation. Plasma coat out of the area shown is permitted, but it will be necessary to remove this unwanted plasma coat during the finish machining operation.



L-2528I (0000)

1. Four Holes, 0.115 - 0.135 Inch Diameter, Equally Spaced And Located Within 0.020 Inch Radius Of True Position; Angular Relation To Other Features Unimportant.
2. 0.720 Inch

Second Stage Vane And Shroud Assembly - Fluid Drainholes
Figure 618



1. 17.199 - 17.213 Inch Diameter For Cleanup Machining. Hold To Maximum Value. 17.233 Inch Minimum Diameter After Plating Or Coating. 17.219 - 17.223 Inch Finish Diameter.

   NOTE: Index 1 diameter must be concentric with Index 5 diameter 0.002 inch FIR maximum.

2. 0.020 - 0.035 Inch
3. Nickel Plate Or Plasma Coat Area
4. Chamfer 0.020 - 0.030 Inch By 43 - 47 degrees
5. 17.138 - 17.142 Inch Diameter
6. 0.010 - 0.020 Inch Radius

Second Stage Vane And Shroud Assembly Front Diameter Repair
Figure 619

(c) Finish machine diameter to dimensions shown, maintaining radius and concentricity requirements.

(d) Treat any bare surfaces by the surfaces by the AMS 2473 procedure in SPOP 42. Refer to Section 70-44-01 in the Standard Practices Manual.

(9) Third Stage Vane and Shroud Mating Diameter Repair.
R See Figure 620.

(a) Machine damaged or worn front and/or rear mating diameter as shown in figure.

(b) Nickel plate the diameter(s) by SPOP 43. Refer to Section 70-44-01 in the Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

NOTE: Plasma coat per PWA 53-37 or PWA 53-80 may be used as an option to nickel plate. Refer to Section 70-46-01 in the Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but extra plasma coat must be removed at final machining.

(c) Finish machine diameter(s) to dimensions shown, maintaining radius and concentricity requirements.

(d) Treat any bare surfaces by the AMS 2473 procedure in SPOP 42. Refer to Section 70-44-01 in the Standard Practices Manual.

D. Fourth Through Eighth Stages Lockwire Lugs

(1) Broken or mutilated lockwire lugs may be removed and replaced.

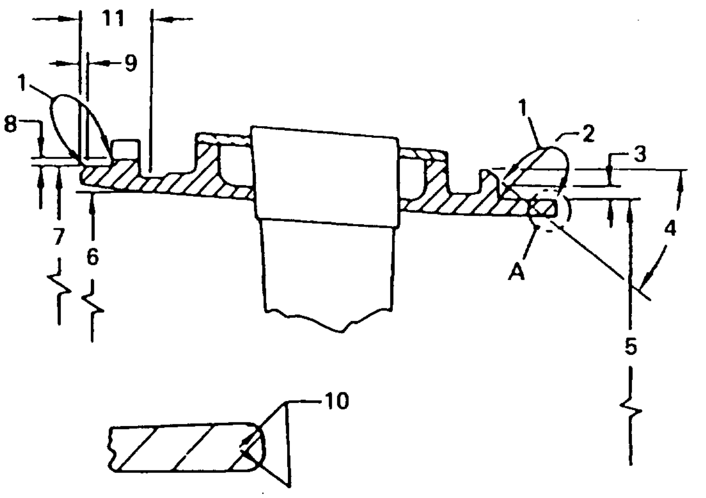
(2) Braze on fabricated lug using AMS 2665. Refer to Section 70-42-03, Repair-05 in the Standard Practices Manual. Stress-relief is not necessary.

E. Fourth Thru Eighth Stage Vane and Shroud

(1) Inner Shroud Rivet Hole Repair.

(a) Remove air sealing ring as instructed in this section.

72-0003



Third Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 620

1. Nickel Plate Or Plasma Coat Area

NOTE: Front mating diameter may be nickel plated only.

2. 0.010 - 0.020 Inch Radius
3. 0.015 - 0.030 Inch
4. Chamfer 33 - 37 Degrees
5. 16.718 - 16.732 Inch Diameter After Cleanup Machining
   16.572 Inch Minimum Diameter After Plating Or Coating
   16.738 - 16.742 Inch Finish Diameter

NOTE: Index (5) diameter must be concentric with Index 7 diameter within 0.002 inch FIR.

6. Reference Diameter
7. 16.968 - 16.982 Inch Diameter After Cleanup Machining
   17.002 Inch Minimum Diameter After Plating Or Coating
   16.988 - 16.992 Inch Finish Diameter

NOTE: Index 7 Diameter Must Be Concentric With Index 6 Diameter Within 0.004 Inch FIR and With Index 5 Diameter Within 0.002 Inch FIR.

8. 0.015 - 0.030 Inch
9. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
10. 0.020 - 0.040 Inch Radius
11. 0.345 Inch Gage Dimension

R Key To Figure 620

(b) Remove protective coatings as necessary as instructed in this section.

(c) Fill rivet holes and cracks up to 0.050 inch in length by the weld process using AMS 5776 filler metal.

NOTE: AM 363 (PWA 793) filler metal may be used as an option to AMS 5776.

CAUTION: TO AVOID CRACKS, PARTS MUST BE HANDLED WITH CARE UNTIL STRESS-RELIEF PROCESS IS ENDED.

(d) Stress-relieve as follows:

1 Place vane and shroud on a flat plate in a cold furnace.

2 Support inner shroud in relation to outer shroud.

3 Place flat plate on top of assembly.

4 Stress-relieve by SPOP 455-2 in Section 70-42-04 in the Standard Practices Manual.

(e) Do a fluorescent penetrant inspection of the welded area. Refer to 72-00-00, Table 605.

(f) Grind the weld repair flush with the rear face of the inner shroud to ensure that the air sealing ring seats properly.

(g) Do a fluorescent penetrant inspection of the welded area. Refer to 72-00-00, Table 605.

(h) Install air sealing ring.

1 If optional slot is present, rotate the airseal 2.25 degrees. If slot is not present, rotate airsealing ring 4.5 degrees.

2 Transfer drill twenty 0.064 - 0.068 inch diameter holes into the inner shroud.

3 Break edges of rivet holes to ensure proper seating of rivet heads.

4 Install air sealing ring as instructed in this section.

(i) Replace protective coat per this section.

F. Air Sealing Ring Lands

(1) Wear Limits

(a) First and 2nd stages are repairable to a maximum depth of 0.020 inch.

(b) Third thru 5th and 8th and 9th stages are repairable to a maximum depth of 0.015 inch.

R (2) Repair of Air Sealing Lands. See Figure 621, Figure 622
R and Figure 623.

CAUTION: TAKE CARE WHEN YOU REMOVE THE RIVETS TO PREVENT DAMAGE TO THE RIVET HOLES.

(a) Remove the air sealing ring as instructed in this section.

(b) Remove the protective coat as necessary as instructed in this section.

(c) Clean up only to the full depth of wear. Hold to the minimum dimension. Allow for 0.003 - 0.025 inch plate or coat after finishing machining.

NOTE: Minimum wall thickness of 0.035 inch must be maintained on all seal lands for
R 360 degrees. See Figure 621, Index 3 to
R Index 4; Figure 622, Index 4 to Index 2,
R and Index 5 to Index 3; and Figure 623, Index 2 to Index 5, and Index 3 to Index 6.

(d) Post Clean-Up Coating/Plating

1 For aluminum air sealing rings, 1st thru 6th stages, refer to SPOP 43 in Section 70-44-01 in the Standard Practices Manual.

2 For steel air sealing rings, 7th thru 9th stages, refer to SPOP 26 in Section 70-44-01 in the Standard Practices Manual.

NOTE: As an option to nickel plate, you can plasma coat all part by the PWA 53-37 or PWA 53-80 process. Refer to Section 70-46-01 in the Standard Practices Manual.

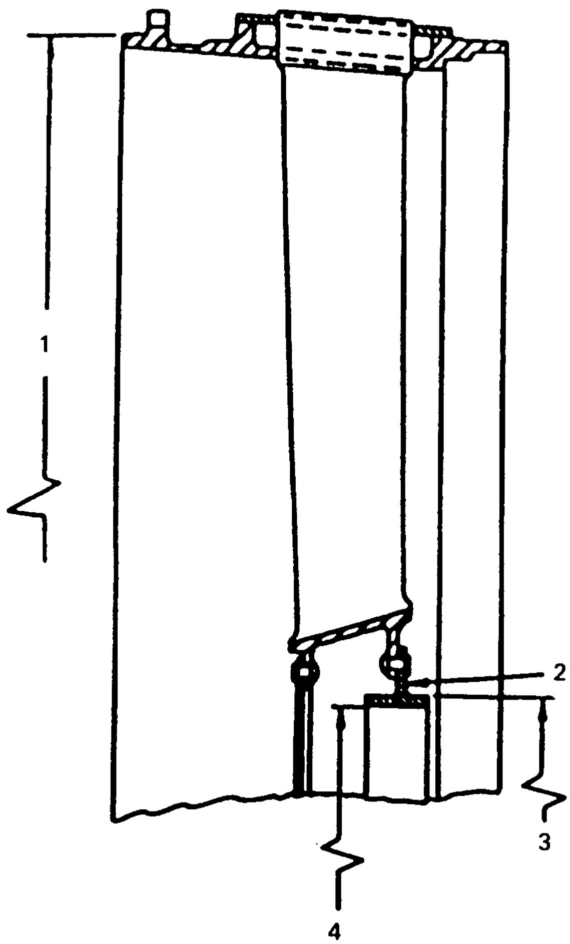
3 Coat/plate must be complete for 360 degrees. Partial coating/plating is not permitted.

(e) Install the air sealing ring as instructed in this section.

(f) Machine to the finished dimensions given in
R Figure 621 thru Figure 623.

(g) Replace the protective coat as instructed in this section.

72-0003



Typical Stator Assembly
1st Through 3rd Stages
Figure 621

1. Reference Mating Diameter
2. Rear Marked Here On 1st And 3rd Stages
3. Air Sealing Ring Outer Diameter Must Be Concentric With Reference Diameter Within 0.010 Inch FIR Prior To Machining Of Air Sealing Ring ID.
4. Air Sealing Ring Inner Diameter Shall Be Concentric With Reference Snap Diameter Within 0.002 Inch FIR.

1st Stage	7.995 - 8.005 Inch Diameter
2nd Stage	9.255 - 9.265 Inch Diameter
3rd Stage	10.135 - 10.145 Inch diameter

R Key to Figure 621

G. Fourth Thru 6th Stage Air Sealing Rivet Hole Repair

(1) You are permitted to repair worn or elongated rivet holes by drilling twenty (20) 0.064 - 0.068 inch diameter holes midway between existing holes.

(2) You can use the inner shroud as a template.

(3) A maximum of three such repairs is permitted.

(4) Post Requisites.

(a) Break the edges of the new rivet holes so that the rivet heads will seat properly.

(b) Stress-relieve by SPOP 455-2. Refer to Section 70-42-04 in the Standard Practices Manual.

(c) Fluorescent penetrant inspect as instructed in this section.

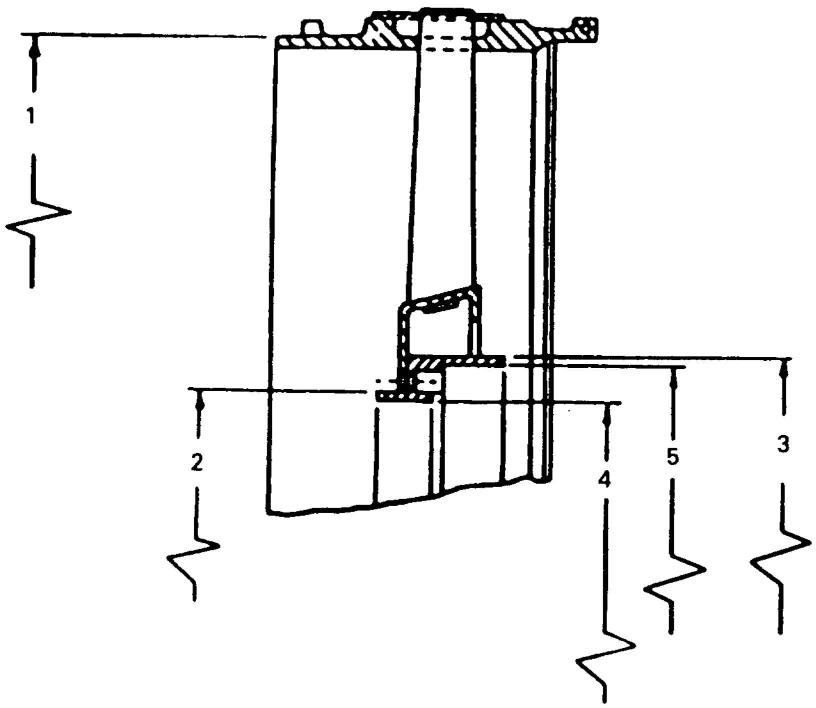
(d) Grind the weld repairs flush with the front face to ensure proper seating with the shroud.

(e) Fluorescent penetrant inspect the weld repairs as instructed in this section.

H. Compressor Vane and Shroud Assembly Lug and Slot Repair
R See Figure 624 and Figure 625.

(1) Steel vane and shroud assemblies

72-1003



Typical Stator
Stages 4, 5, And 8
Figure 622

1. Reference Mating Diameter
2. Air Sealing Ring Forward Outer Diameter Shall Be Concentric With Index 1 Diameter Within 0.010 Inch To Machining Air Sealing Ring ID.
3. Air Sealing Ring Aft Outer Diameter Shall Be Concentric With Index 1 Diameter Within 0.010 Prior To Machining Air Sealing Ring ID.
4. Air Sealing Ring Forward Inner Diameter Must Be Concentric With Index 1 Diameter Within 0.002 Inch FIR. Finish Machine As Follows:

Fourth Stage	10.205 - 10.215 Inch Diameter
Fifth Stage	10.875 - 10.885 Inch Diameter
Eight Stage	12.425 - 12.435 Inch Diameter

5. Air Sealing Ring Aft Diameter Must Be Concentric With Index 1 Diameter Within 0.002 Inch FIR. Finish Machine As Follows:

Fourth Stage	10.305 - 10.315
Fifth Stage	11.435 - 11.445
Eight Stage	12.985 - 12.995

R Key to Figure 622

(a) Grind or machine area to be repaired only enough to clean up.

NOTE: Cracks in lugs shall be removed prior to weld buildup.

(b) Wrap area adjacent to area to be welded with water-soaked ceramic fiber rope.

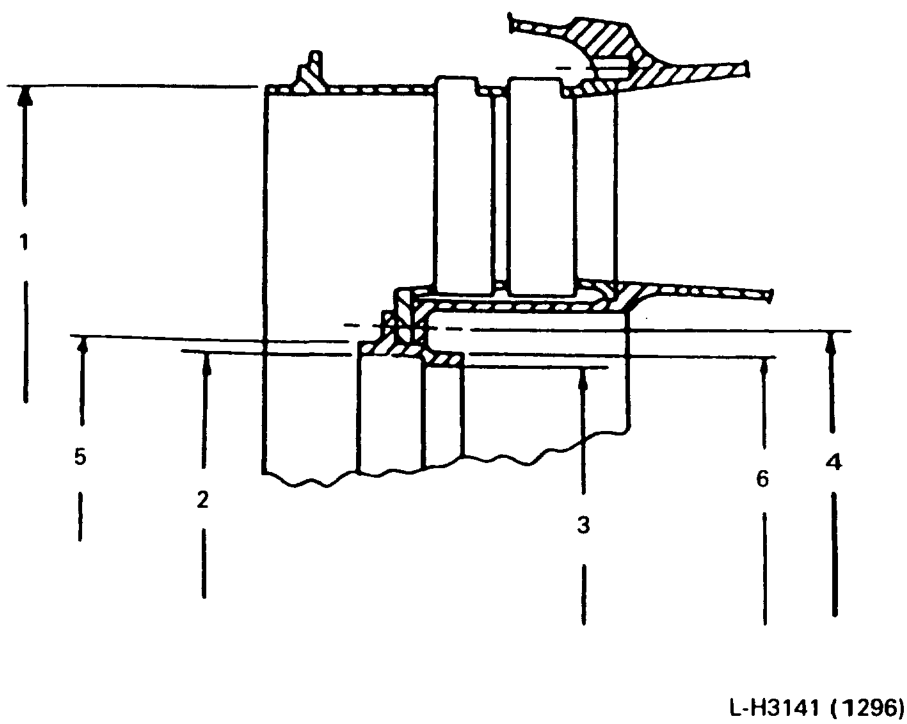
(c) Build up lugs or slots by welding, using AMS 5776 rod.

NOTE: Build up one side and drill through from opposite side. Repeat procedure for other side.

(d) Hold the assembly flat and concentric and stress-relieve by SPOP 460-2. Refer to Welding in the Standard Practices Manual, Section 70-42-00.

(e) Machine to dimensions shown.

72-0003



Case And 9th Stator Assembly
Figure 623

1. Reference Mating Diameter
2. Air Sealing Ring Forward Inner Diameter - Finish Machine As Follows:

572958	13.008 - 13.012
618813	12.988 - 12.992
656320	13.008 - 13.012
659299 (735849)	12.988 - 12.992

3. Air Sealing Ring Rear Inner Diameter. Finish Machine As Follows:

572958	12.908 - 12.912
618813	12.888 - 12.892
656320	12.908 - 12.912
659299 (735849)	12.888 - 12.892

4. 13.470 Inch Diameter To Centerline of Rivet Holes
5. Air Sealing Ring Forward Outer Diameter
6. Air Sealing Ring Rear Outer Diameter

NOTE: Prior to Machining Air Sealing Ring, Indexes 2 and 3 Must Be Concentric to Index 4 within 0.010 Inch FIR. After Machining, Indexes 2 and 3 Must Be Concentric to Index 1 Within 0.002 Inch FIR.

R Key To Figure 623

(f) Inspect vane and shroud assembly. Refer to Fluorescent Penetrant Inspection in the Standard Practices Manual, Section 70-33-00.

<u>NOTE</u>: Lugs and mating slots having less than 0.040 inch wear are acceptable without repair, provided they are not cracked or broken.

(2) Aluminum Vane and Shroud Assemblies

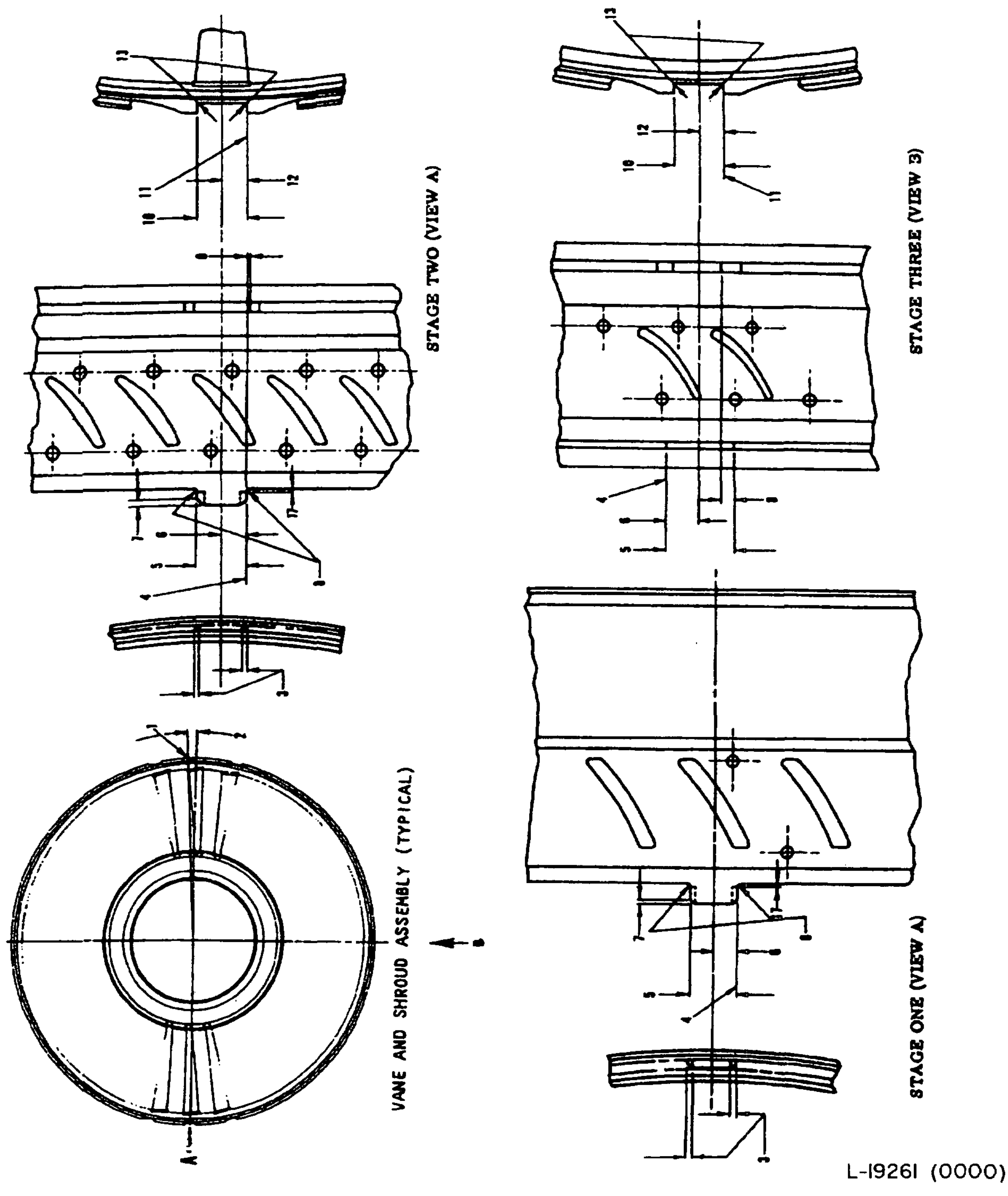
(a) Grind or machine area to be repaired only enough to clean up.

<u>NOTE</u>: Cracks in lugs shall be removed prior to weld buildup.

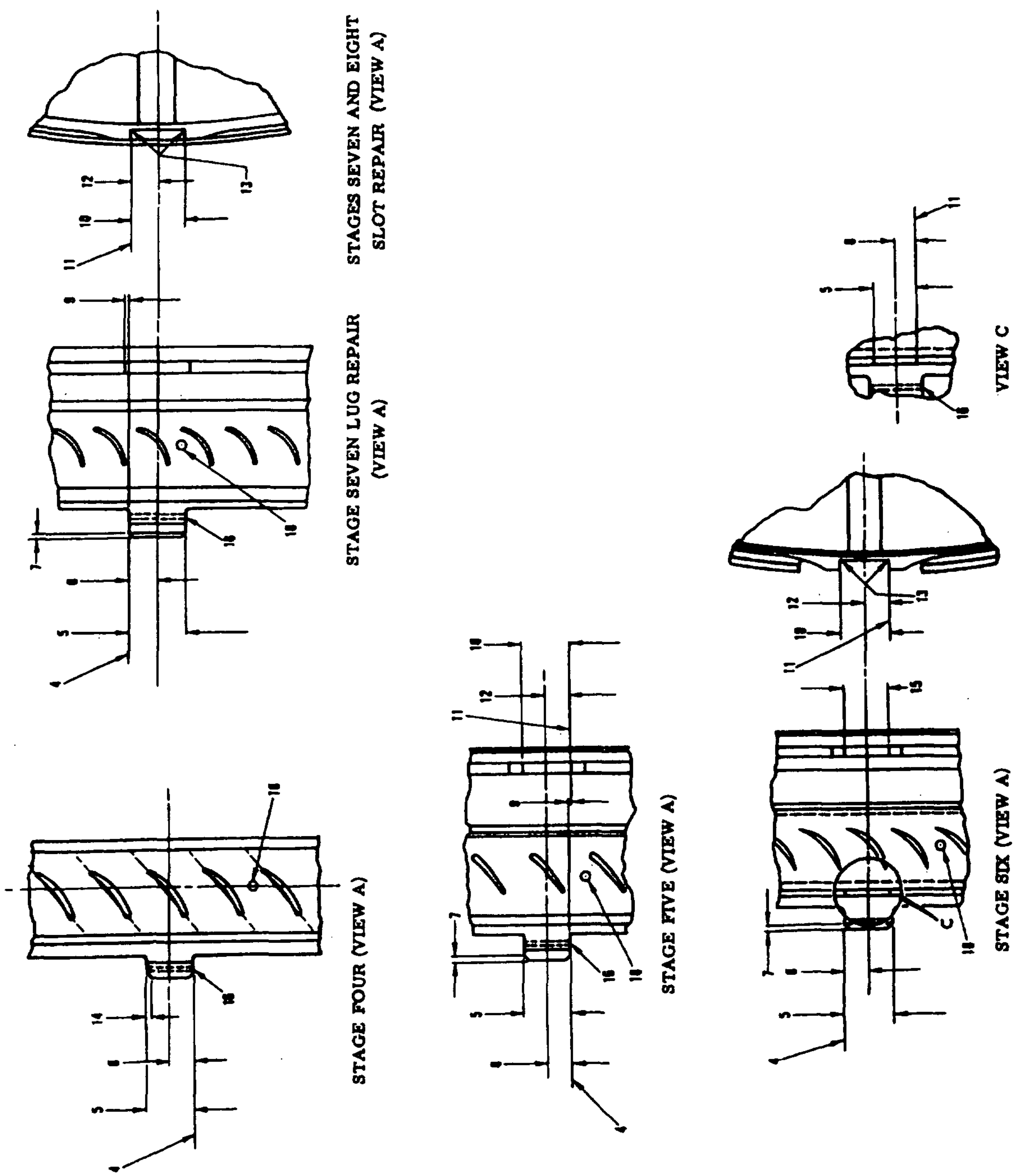
(b) Wrap area adjacent to area to be welded with water-soaked ceramic fiber rope.

(c) Build up lugs and slots and repair shroud cracks by welding using AMS 4190 rod.

72-0003



Stages One Thru Three
Vane And Shroud Assembly
Lug And Slot Repair
Figure 624



Stages Four Thru Eight
Vane And Shroud Assembly
Lug And Slot Repair
Figure 625

1. Centerline of Offset Lug And Slot
2. Lug And Slot Offset Three Degrees
3. 0.025 -0.035 Inch By 43° - 47° Chamfer
4. This Face On Each Lug Must Be Located Within 0.002 Inch Of True Angular Position In Relation To Rear Snap ID (See Section XI)
5. 0.489 - 0.493 Inch (0.739 - 0.745 Inch For 3rd Stage And 0.487 - 0.491 Inch For 5th Stage)
6. 0.2455 Inch (0.371 Inch For 3rd Stage And 0.2445 Inch For 5th Stage)
7. 0.010 - 0.030 Inch By 43° - 47° Chamfer (Both Sides). 0.020 - 0.030 Inch By 43° - 47° Chamfer For 1st And 2nd Stages
8. 0.016 - 0.031 Inch Radius

   NOTE: Third stage lug corner radius is 0.016 - 0.031 inch.

9. This Dimension Is For One Lug And One Slot At View A Only. See Table 603.

   NOTE: For 3rd stage, this dimension is located at six o'clock position (View B), as shown.

10. 0.498 - 0.502 Inch
11. This Face On Each Slot (And On 20 Lugs Of 6th stage) Must Be Located Within 0.002 Inch Of True Angular Position In Relation To Front Snap OD.
12. 0.250 Inch (See Section XI)
13. Slot Radius. (See Table 603)
14. 0.010 - 0.030 Inch by 43° - 47° Chamfer (Both Sides)
15. 0.4935 - 0.4975 Inch For One Lug And One Slot Only (At View A)
16. 0.055 - 0.065 Inch Diameter Hole Through Four Lugs
17. 0.000 - 0.030 Inch
18. 0.120 - 0.130 Inch Diameter

R Key to Figure 624 and Figure 625

(d) Stress-relieve at 157° - 168°C (315° - 335°F) for four hours.

(e) Machine to dimensions shown.

NOTE: Ensure that any buildup of weld material on shroud ID is removed to preclude possibility of blade rub during engine operation.

(f) Inspect vane and shroud assembly. See Fluorescent Penetrant Inspection, Standard Practices Manual.

NOTE: Lugs and mating slots having less than 0.040 inch wear are acceptable without repair, provided they are not cracked or broken.

I. Stages 4 thru 6

(1) Inspection

(a) Remove rivets securing airsealing ring to vane and shroud assembly and remove ring.

(b) Inspect assembly for lack of or worn, cadmium plate.

(c) Inspect condition of paint for flaking and chipping.

(2) Plating. Plate, serviceable or new unplated assembly, as follows:
R See Tool Group 29A-1 and Figure 626.

NOTE: For shroud assemblies incorporating plug rivets or adhesive in outer shroud, remove rivets or adhesives to facilitate draining after cleaning and plating. Rivet shanks need not be removed from within shroud. For vane and shroud assemblies not previously plated, drill 0.120 - 0.130 inch diameter drain holes in outer shroud outer surface. Drill only as far as box area. For Stages 4 thru 6, drill eight, ten, and six holes respectively. Holes shall be equally spaced between vanes and around vane outer shroud. Seal holes completely with adhesive after plating. Maximum permissible adhesive projection into box area is 0.050 inch. Use

72-0003

General Electric RTV 156 adhesive, and cure at room temperature for 24 hours.

(a) Clean and cadmium plate vane and shroud assembly when necessary, using fixture. Refer to SPOP 21 in the Standard Practices Manual, Section 70-44-01.
R For surface area plating, see Table 604.

NOTE: Plate is optional and may be incomplete in box shroud area (as shown) and in 1/8 inch diameter holes on outer shroud periphery. Electrical contact is permitted only in area shown.

Stage	Vane and Shroud	Airsealing Ring
4	6.0 sq. ft.	-
5	3.7 sq. ft.	-
6	3.2 sq. ft.	-
7	3.0 sq. ft.	95.0 sq. in.
8	2.8 sq. ft.	105.0 sq. in.

Stages 4 thru 8
Stator Assembly - Plating Area
R Table 604

(b) Bake assembly by SPOP 21. Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: Assembly has Rockwell hardness of C30 - C38, or equivalent.

(3) PWA 110-21/110-9 Coating (Alternate Coating Procedure).

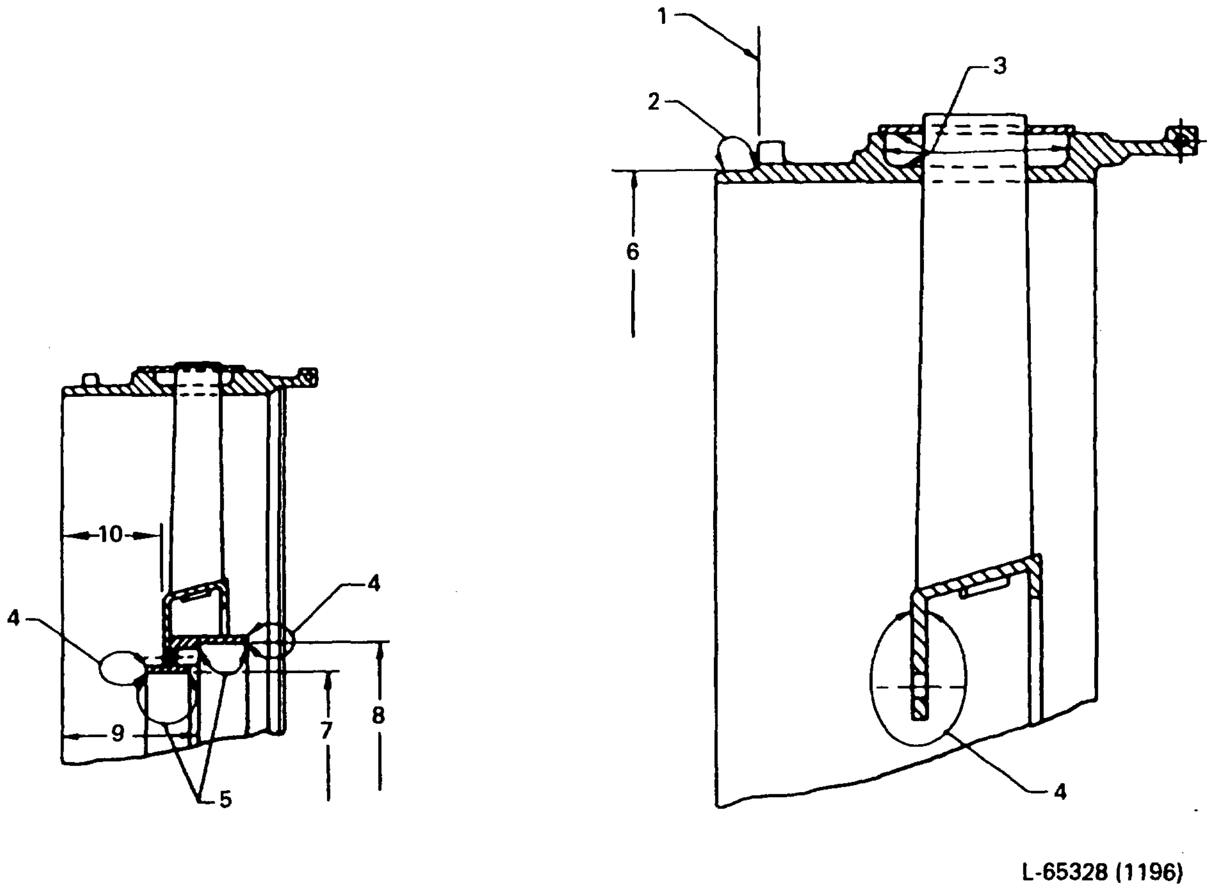
NOTE: Coating is required for vane and shroud assemblies post-SB 6211.

(a) Remove all the coating and plating from all surfaces.

(b) Apply PWA 110-21/110-9 coating, 0.0005 - 0.0020 inch thick. Refer to Section 70-41-04 in the Standard Practices Manual.

(4) Airsealing Ring Installation.

(a) Position serviceable or new airsealing ring on assembly, and, if necessary, transfer drill 20 holes in ring, 0.064 - 0.068 inch diameter.



Stages 4 Thru 8 Vane And Shroud
Plating Repair
Figure 626

72-0003

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-02

1. Overspray Permissible On This Surface
2. Aluminum Paint Area
3. Optional Plate Area
4. Electrical Contact Area
5. Paint Area. Treat Stages 4 Thru 6 By The AMS 2473 Procedure In SPOP 42. See Section 70-44-01, Standard Practices Manual.

Stage	Index 6 (Inches)	Index 7 (Inches)	Index 8 (Inches)	Index 9 (Inches)	Index 10 (Inches)
4	16.747 - 16.751	10.205 - 10.215	10.305 - 10.315	.213 - .238	.035 - .045
5	16.533 - 16.537	10.875 - 10.885	11.435 - 11.445	1.231 - 1.256	.950 - .960
6	16.369 - 16.373	11.441 - 11.451	12.001 - 12.011	1.144 - 1.169	.934 - .944
7	16.313 - 16.317	12.001 - 12.011	12.561 - 12.571	.946 - .971	.745 - .757
8	16.297 - 16.301	12.425 - 12.435	12.985 - 12.995	.976 - 1.001	.726 - .736

NOTE: Indexes 7 and 8 must be concentric with Index 5 Diameter within 0.010 inch FIR.

NOTE: No burning, pitting, or selective attack is permitted. Completely cover electrical contact point with high-baking, heat-resistant, aluminum enamel.

NOTE: Drop dimension from outer shroud to face of inner shroud (Index 10) for Stage 4 is forward of snap.

R Key to Figure 626

(b) Rivet ring to vane and shroud assembly.

(c) Machine ring front and rear inside diameters to dimensions shown.

(d) Treat ring inside diameters by AMS 2473 (SPOP 42) as shown. Refer to Section 70-44-01 in the Standard Practices Manual.

R (e) Paint with high-baking, heat-resistant, aluminum enamel those areas specified in Figure 626, as well as all fixture contact points, and any other abrasions or scratches penetrating through plating to bare metal as a result of fixturing. Refer to SPOP 142 in Section 70-41-03 in the Standard Practices Manual. Finished paint thickness shall be 0.0015 - 0.0025 inch.

NOTE: Aluminum enamel shall be applied, using lower bake temperature for cadmium-plated parts. Do not abrasive blast before applying aluminum enamel.

(5) Four thru 6 Stage Vane and Shroud Assembly Outer Box Shroud Crack Repair

(a) Remove the protective coating as necessary. See Paragraph I.(2).

(b) Remove and replace the airsealing ring. See Paragraph I.(4).

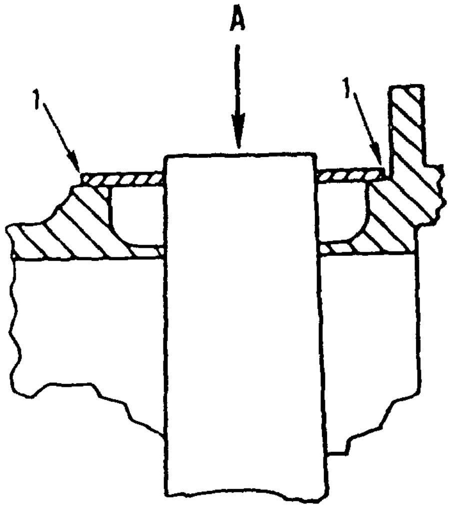
R (c) Use a No. 60 drill bit (0.040 inch diameter) to stop drill cracks. See Figure 627.

NOTE: Stop drill holes must be free of weld protuberances to avoid stress risers, and therefore, could require reaming of polishing after the crack has been welded.

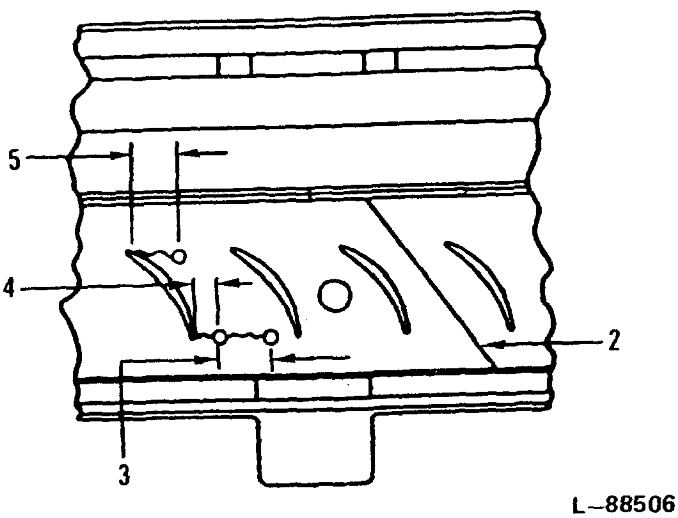
(d) Rout the cracks completely in the area to be welded, keeping the width of the cut to a minimum.

(e) Weld the crack with AMS 5776 (410 bare) or AM 363 (PWA 791) filler metal.

72-0003



TYPICAL STATOR ASSEMBLY



VIEW IN DIRECTION A

Stages 4 And 8 Compressor
Vane and Shroud Crack Repair
Figure 627

1. Cracks In The Circumferential Weld Area: Do Not Stop Drill Cracks. Weld The Cracks Using AMS 5776 (410 Bare) Or AM 363 (PWA 791) Filler Metal
2. It Is Permitted To Weld Cracks In This Weld Again
3. It Is permitted To Weld Cracks (Longer Than 0.025 Inch) 0.050 Inch From The Braze And At The End Of The Crack. Rout And Weld The Crack Between Holes.
4. 0.050 Inch
5. Stop Drill Cracks Less Than 0.125 Inch Long Which Come From The Brazed Area At The End Of The Crack And Let Them Stay Not Welded.

R Key to Figure 627

CAUTION: BE CAREFUL WITH THE PARTS UNTIL STRESS-RELIEF IS ACCOMPLISHED.

(f) Stress-relieve as follows:

1 Place the assembly on a flat plate in a cold furnace.

2 Support the inner shroud in relation to the outer shroud.

3 Place the flat plate on top of assembly.

4 Stress-relieve by SPOP 455-2 in Section 70-42-04 in the Standard Practices Manual.

(g) Fluorescent penetrant inspect welded area. See Paragraph I.

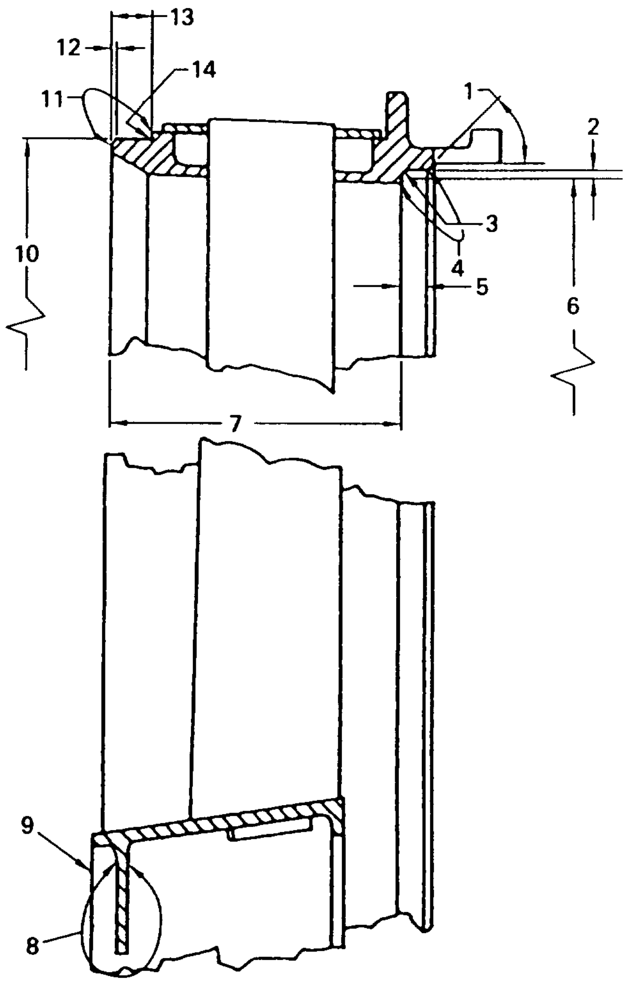
(h) Blend the weld flush to 0.010 inch above the surface. Do not remove any parent metal.

(i) Fluorescent penetrant inspect the welded area. See Paragraph I.

(j) Make a dimensional inspection of the repaired diameters as required. See Paragraph I.(4).

(6) Four Thru 6 Stage and Mating Diameter Repair. See
R Figure 628, Figure 629, and Figure 630.

(a) Remove protective coatings as necessary as instructed in this section.



L-H3125 (1296)

Fourth Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 628

1. Chamfer 43 - 47 Degrees
2. 0.020 - 0.035 Inch
3. 0.010 - 0.020 Inch Radius
4. Nickel Plate Or Plasma Coat Area
5. 0.095 - 0.105 Inch To Sharp Corner
6. 16.543 - 16.557 Inch Minimum Diameter For Cleanup Machining; Hold To Minimum Value. 16.523 Inch Diameter Maximum After Plate Or Coat. 16.533 - 16.537 Inch Diameter After Finish Machining; 0.020 Inch Out-Of-Round In Excess Of This Tolerance Permissible. Diameter Must Be Concentric With Index (10) Within 0.002 Inch FIR
7. 1.118 - 1.120 Inches
8. Electrical Contact Area
9. Reference Surface
10. 16.729 - 16.741 Inch Diameter For Cleanup Machining; Hold To Maximum Value. 16.760 Inch Diameter Minimum After Plate Or Coat. 16.747 - 16.751 Inch Diameter After Finish Machining. Diameter Must Be Concentric With Index 6 within 0.002 Inch FIR
11. Nickel Plate Or Plasma Coat Area
12. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
13. 0.115 - 0.125 Inch
14. 0.010 - 0.020 Inch Radius

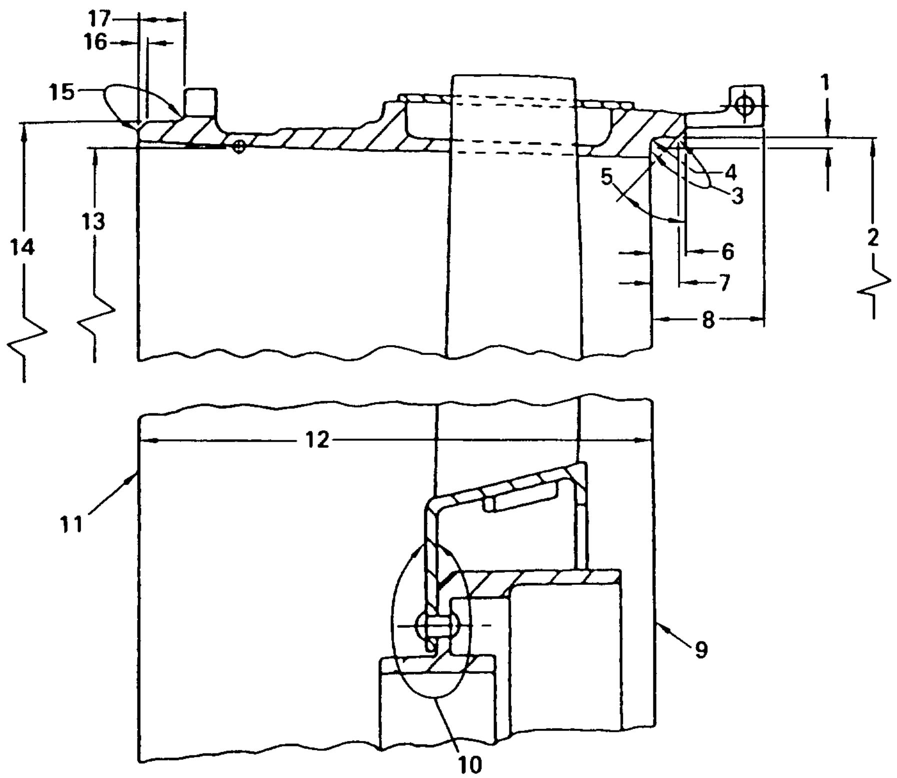
R Key to Figure 628

(b) Machine damaged or worn front and/or rear mating diameter as shown in figure.

(c) Nickel plate machined areas by SPOP 26. Refer to Section 70-44-01, Standard Practice Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

NOTE: Plasma coat by PWA 53-37 or PWA 53-80 may be used as an option to nickel plate. Refer to Section 70-46-01 in Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but extra plasma coat must be removed at final machining. Prepare the machined surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(d) For nickel plate only, bake vane and shroud assembly at 185 - 196°C (365 - 385°F) for three hours.



Fifth Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 629

1. 0.030 - 0.040 Inch
2. 16.379 - 16.393 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 16.360 Inch Diameter Maximum After Plating And Coating. 16.369 - 16.373 Inch Diameter After Finish Machining; 0.020 Inch Out-Of-Round In Excess Of This Tolerance Is Permissible. Diameter Must Be Concentric With Index 14 Within 0.002 Inch FIR
3. Nickel Plate Or Plasma Coat Area
4. 0.010 - 0.020 Inch Radius
5. Chamfer 43 - 47 Degrees
6. 0.115 - 0.125 Inch
7. 0.095 - 0.105 Inch
8. 0.385 - 0.395 Inch
9. Reference Surface
10. Electrical Contact Area
11. Reference Surface
12. 1.711 - 1.713 Inches
13. 16.377 - 16.387 Inch Diameter. Diameter Must Be Concentric With Index 14 Within 0.004 Inch
14. 16.513 - 16.527 Inch Diameter For Cleanup Machining. Hold To Maximum Value. 16.547 Inch Minimum Diameter After Plating Or Coating. 16.533 - 16.377 Inch Diameter After Finish Machining; Diameter Must Be Concentric With Index 13 Within 0.004 Inch FIR
15. Nickel Plate Or Plasma Coat Area
16. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
17. 0.145 - 0.155 inch

R Key to Figure 629

(e) Finish machine diameter(s) to dimensions shown, maintaining all radii and concentricity requirements.

(f) Replace protective coat by this section.

J. Seventh And Eighth Stages

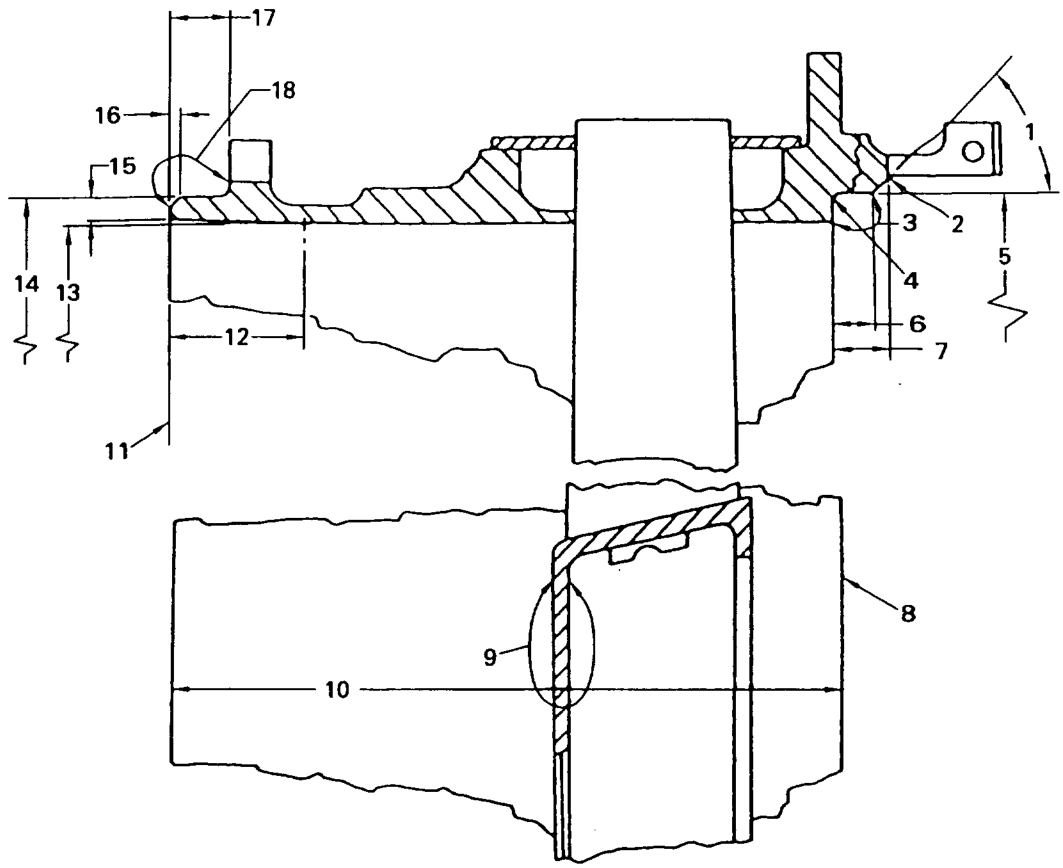
(1) Inspection

(a) Remove rivets securing airsealing ring to vane and shroud assembly, and remove ring.

NOTE: Discard aluminum ring.

(b) Inspect for worn nickel-cadmium plate or unplated ring and assembly.

72-0003



Sixth Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 630

1. 43 - 47 Degrees
2. 0.005 - 0.020 Inch Radius
3. Nickel Plate Or Plasma Coat Area
4. 0.010 - 0.020 Inch Radius
5. 16.323 - 16.337 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 16.303 Inch Maximum Diameter After Plating Or Coating. 16.313 - 16.317 Inch Diameter After Finish Machining; 0.020 Out-Of-Round Excess Of Finish Dimension Permissible. Diameter Must Be Concentric With Index 14 Diameter Within 0.002 Inch FIR.
6. 0.095 - 0.105 Inch
7. 0.115 - 0.125 Inch
8. Reference Surface
9. Electrical Contact Area
10. 1.647 - 1.649 Inch
11. Reference Surface
12. 0.320 Inch Gage
13. 16.234 - 16.244 Inch Diameter; Must Be Concentric With Index (14) Within 0.004 Inch FIR
14. 16.349 - 16.363 Inch Diameter For Cleanup Machining; Hold To Maximum Value. 16.383 Inch Minimum Diameter After Plating Or Coating. 16.369 - 16.373 Inch Diameter After Finish Machining. Diameter Must be Concentric with Index 13 Diameter Within 0.004 Inch FIR And Concentric With Index (5) Within 0.002 Inch FIR
15. 0.052 Inch Minimum Thickness
16. Chamfer 0.020 - 0.030 by 43 - 47 Degrees
17. 0.145 - 0.155 Inch
18. Nickel Plate Or Plasma Coat Area

R Key to Figure 630

(c) If old ring is serviceable, plate and reinstall. Otherwise install new plated ring.

(2) Plating
R See Tool Group 29A-1 and Figure 626.

NOTE: For 7th stage shroud assemblies with plug rivets in outer shroud, remove rivets to facilitate draining after cleaning and plating. For vane and shroud assemblies not previously plated, drill 0.120 - 0.130 inch diameter drain holes in outer shroud outer surface. Drill only as far as box area. For 7th and 8th stages, drill eight drain holes, equally spaced between vanes and around vane shroud.

(a) Airsealing Ring

1 Nickel-cadmium plate new or serviceable ring, if necessary, using fixture. Refer to SPOP 25 in the Standard Practices Manual, Section 70-44-01.
R For surface area plating, see Table 604.

NOTE: Electrical contact is permitted only in area shown.

2 Bake ring by SPOP 25. Refer to the Standard Practices Manual, Section 70-44-01.

(b) Vane and Shroud Assembly

1 Clean and nickel-cadmium plate vane and shroud assembly, when necessary, using fixture. Refer to SPOP 40 in the Standard Practices Manual, Section 70-44-01. For surface area plating, see Table 603.

NOTE: Nickel-plate is optional, and may be incomplete in box shroud area (as shown) and in eight, 1/8 inch diameter holes on outer shroud periphery. No cadmium plate is permitted at these locations. Electrical contact is permissible only in area shown.

2 Bake assembly by SPOP 25. Refer to the Standard Practices Manual, Section 70-44-01.

(3) PWA 110-21/110-9 Coating (Alternate Coating Procedure).

NOTE: Coating is required for vane and shroud assemblies post-SB 6211.

(a) Remove all the coating and plating from all surfaces.

(b) Recoat with PWA 110-21/110-9 to 0.0005 - 0.0020 inch thick. Refer to the Standard Practices Manual, Section 70-41-00.

(4) Airsealing Ring Installation.
R See Figure 626.

(a) Position plated airsealing ring on assembly, and if necessary, transfer drill 20 holes in ring, 0.064 - 0.068 inch diameter.

(b) Rivet ring to vane and shroud assembly.

(c) Machine ring front and rear inside diameters to dimensions shown.

(d) Paint ring inside diameters and front snap diameter of outer shroud with high-baking, heating-resistant, aluminum enamel, as shown. Paint on front snap diameter shall be 0.0015 - 0.0025 inch thick. Refer to Surface Treatments in the Standard Practices Manual, Section 70-41-00.

NOTE: Do not abrasive blast before applying aluminum enamel.

(e) Bake assembly.

(5) Seventh and Eighth Stage Vane and Shroud Assembly Outer Box Shroud Crack Repair.

(a) Remove the protective coating as necessary. See Paragraph J.(2).

(b) Remove and replace airsealing ring. See Paragraph J. steps (2) and (4).

(c) Use a No. 60 drill bit (0.040 inch diameter) for
R stop drilling. See Figure 626.

NOTE: Stop drill holes must be free of weld protuberances to void stress risers, and therefore, could require reaming or polishing after the crack has been welded.

(d) Rout the cracks completely in area to be welded, keeping the width of the cut to a minimum.

(e) Weld the crack with AMS 5776 (410 bare) or AM 363 (PWA 791) filler metal.

CAUTION: BE CAREFUL WITH THE PARTS UNTIL STRESS-RELIEF IS ACCOMPLISHED.

(f) Stress-relieve as follows:

1 Place the assembly on a flat plate in a cold furnace.

2 Support the inner shroud in a relation to the outer shroud.

3 Place the flat plate on top of assembly.

4 Stress-relieve by SPOP 455-2. Refer to the Standard Practices Manual, Section 70-42-04.

(g) Fluorescent penetrant inspect welded areas. See Paragraph J.

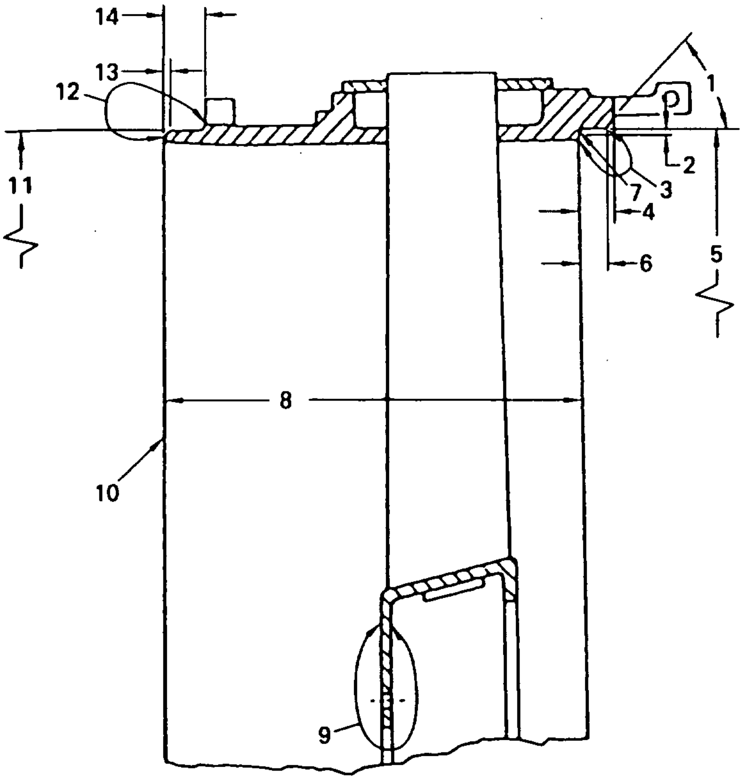
(h) Blend weld flush to 0.010 inch. Do not remove any parent metal.

(i) Fluorescent penetrant inspect welded areas. See Paragraph J.

(j) Do a dimensional inspection of the repaired mating diameters as required. See Paragraph J. step (4).

(6) Seventh and Eighth Stage Mating Diameter Repair. See
R Figure 631 and Figure 632.

(a) Remove protective coatings as necessary as instructed in this section.



L-H3128 (1296)

Seventh Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 631

72-0003

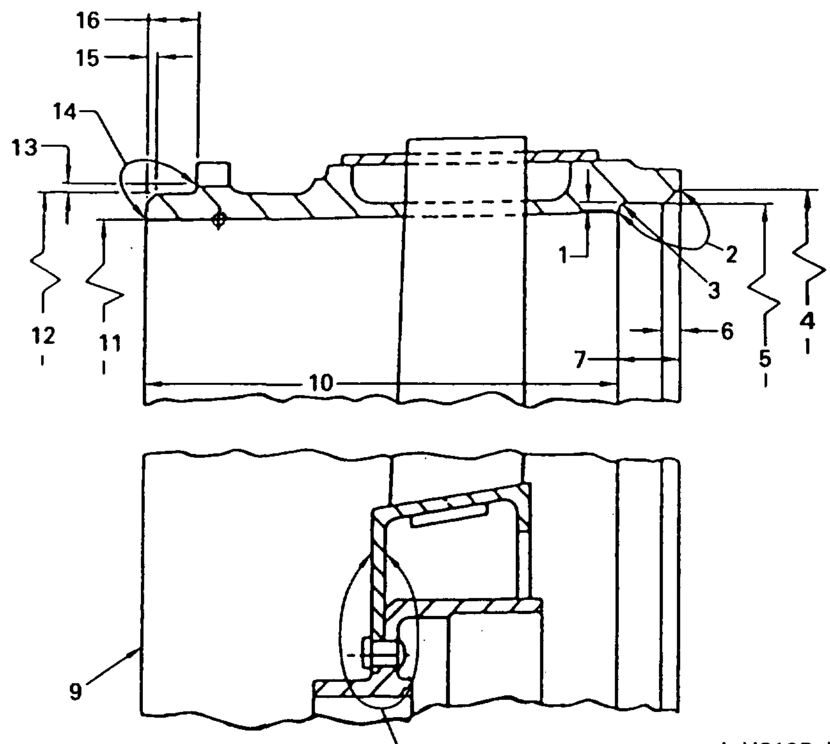
1. Chamfer 43 - 47 Degrees
2. 0.030 - 0.040 Inch
3. Nickel Plate Or Plasma Coat Area
4. 0.115 - 0.125 Inch
5. 16.307 - 16.321 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 16.288 Inch Diameter Maximum After Plating Or Coating. 16.297 - 16.301 Inch Diameter After Finish Machining; 0.020 Inch Out-Of-Round In Excess Of This Tolerance Is Permissible. Diameter Must Be Concentric With Index 11 Diameter Within 0.002 Inch FIR
6. 0.095 - 0.105 Inch
7. 0.010 - 0.020 Inch Radius
8. 1.464 - 1.466 Inches
9. Electrical Contact Area
10. Reference Face
11. 16.295 - 16.307 Inch Diameter For Cleanup Machining; Hold To Maximum Value. 16.327 Inch Minimum Diameter After Nickel Plating Or Plasma Coating. 16.313 - 16.317 Inch Diameter After Finish Machining; Diameter Must Be Concentric With Index 5 Diameter Within 0.002 Inch FIR
12. Nickel Plate or Plasma Coat Area
13. Chamfer 0.020 - 0.030 Inch by 43 - 47 Degrees
14. 0.145 - 0.155 Inch

R Key to Figure 631

(b) Machine damaged or worn front and/or rear mating diameter as shown in figure.

(c) Nickel plate machined areas by SPOP 26. Refer to Section 70-44-01 in the Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

<u>NOTE</u>: Plasma coat by PWA 53-37 or PWA 53-80 may be used as an option to nickel plate. See Section 70-46-01 in Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but extra plasma coat must be removed at final machining. Prepare the machined surface for plasma coat by SPOP 170 (refer to Section 70-46-01 in the Standard Practices Manual).



Eighth Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 632

72- 0003

1. 0.020 - 0.035 Inch
2. Nickel Plate Or Plasma Coat Area
3. 0.010 - 0.020 Inch Radius
4. 16.285 - 16.305 Inch Diameter; Must Be Concentric With Index 12 Diameter Within 0.004 Inch FIR
5. 16.349 - 16.363 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 16.329 Inch Maximum Diameter After Nickel Plating Or Plasma Coating. 16.339 - 16.343 Inch Diameter After Finish Machining; 0.020 Inch Out-of-round In Excess Of This Tolerance Permissible. Diameter Must Be Concentric With Index 12 Diameter Within 0.002 Inch FIR
6. Chamfer 0.050 - 0.060 Inch by 43 - 47 Degrees.
7. 0.194 - 0.204 Inch
8. Electrical Contact Area
9. Reference Face
10. 1.456 - 1.458 Inches
11. 16.179 - 16.189 Inch Diameter; Must Be Concentric With Index 12 Diameter Within 0.004 Inch FIR
12. 16.277 -16.291 Inch Diameter For Cleanup Machining; Hold To Maximum Value. 16.311 Inch Minimum Diameter After Plating Or Coating. 16.297 - 16.301 Inch Diameter After Finish Machining; Must Be Concentric With Index 11 Diameter With 0.004 Inch FIR, And Index 5 Diameter Within 0.002 Inch FIR
13. 0.020 - 0.035 Inch
14 Nickel Plate or Plasma Coat Area
15. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
16. 0.145 - 0.155 Inch

R Key to Figure 632

(d) For nickel plate only, bake vane and shroud assembly at 185 - 196°C (365 - 385°F) for three hours.

(e) Finish machine diameter(s) to dimensions shown, maintaining all radii and concentricity requirements.

(f) Replace protective coat by the procedure in this section.

K. Seventh, Eighth and Ninth Stage Air Sealing Ring Elongated Rivet Hole Repair

NOTE: The use of oversize rivets is not recommended for repair of elongated rivet holes in the airseals for these reasons:

1 The minimum edge distance of the rivet is excessively violated

2 There is insufficient standard installation tool clearance

3 There is insufficient clearance for the rivet head on 7th and 8th stage airseals

4 The rivet head overhangs the OD of the airseal flange on the 9th stage airseal

(1) Remove the air sealing ring as instructed in this section.

(2) Strip the protective nickel-cadmium coating from the air sealing ring by SPOP 25. Remove the protective aluminum paint from the air sealing ring by SPOP 19 or SPOP 258. Refer to Section 70-44-01, Standard Practices Manual.

(3) Degrease by SPOP 209 in Section 70-21-00, Standard Practices Manual and plug weld the enlarged and/or worn rivet holes. Use AMS 5776 filler rod.

(4) Stress-relieve by SPOP 455-2. Refer to Section 70-42-04, Standard Practices Manual.

(5) Machine the surface to the initial dimension. Flange thickness is 0.035 - 0.045 inch. Blend flush to the parent metal at the weld areas.

(6) Restore the protective coating to the air sealing ring by one of the procedures that follow:

(a) Apply nickel-cadmium plate:

1 Nickel-cadmium plate by AMS 2416. Dimensions are before plating. See SPOP 25 in Section 70-44-01, Standard Practices Manual.

R
R

72-0003

2 Electrical contact is only permitted at the extreme fore and aft axial surfaces of the seal lands.

3 Fully cover the electrical contact points with PWA 578 paint after plating, but before AMS 2416 baking. Refer to SPOP 142 in Section 70-41-03, Standard Practices Manual.

(b) Apply aluminum paint:

1 Apply the coating all over by the PWA 110-21 or PWA 110-31 process to a thickness of 0.0005 - 0.003 inch. Dimensions are before coating. Refer to Section 70-41-04, Standard Practices Manual.

(7) Transfer drill the holes from the stators/diffuser case into the welded hole area of the air sealing rings.

(8) Install the air sealing ring to the vane assembly by attaching with rivets by PWA 357, Section 70-43-00, Standard Practices Manual. See the Illustrated Parts Catalog (IPC), PN 435109 for the applicable rivets as follows:

(a) For 7th stage, see Figure 4, Item 32A/33

(b) For 8th stage, see Figure 4, Item 37/38

(c) For 9th stage, see Figure 7, Item 21 of the IPC

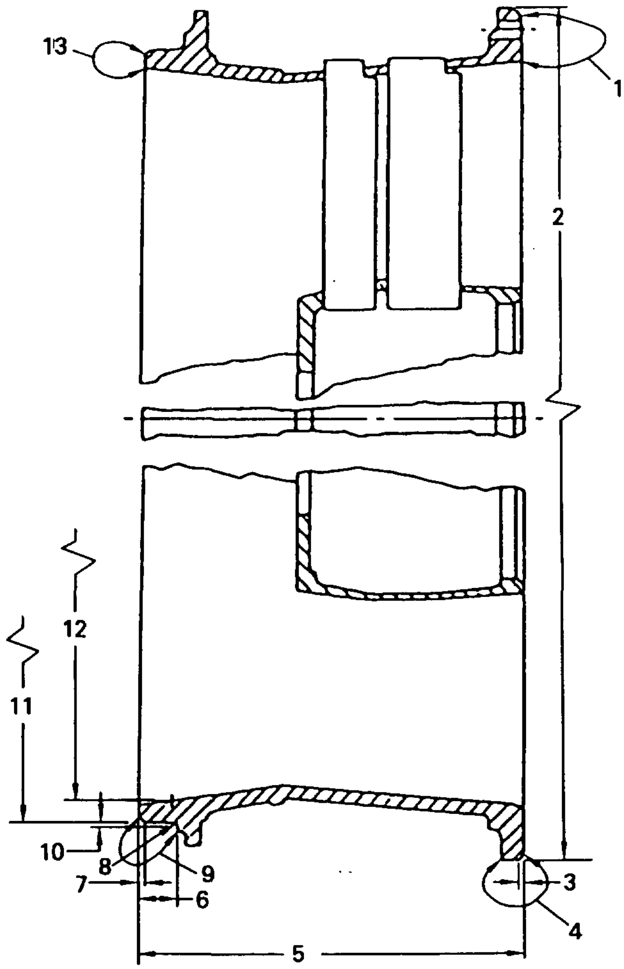
(9) After you rivet the air sealing ring to the stator assembly, if additional machining is done which would remove the plate or paint, treat that area with two coats of PWA 578 Heat Resistant Aluminum Enamel. See SPOP 142 in Section 70-41-03, Standard Practices Manual.

(10) Install the air sealing ring as instructed in this section.

L. Ninth Stage Vane and Shroud Assembly

R (1) Ninth Stage Snap Diameter Repair. See Figure 633.

(a) Remove protective coatings as necessary as instructed in this section.



L-H3130 (1296)

Ninth Stage Vane And Shroud
Assembly Snap Diameter Repair
Figure 633

72-0003

1. Electrical Contact Area
2. 16.739 - 16.753 Inch Diameter for Cleanup Machining; Hold to Maximum Value. 16.773 Inch Diameter Minimum After Plating or Coating. 16.759 - 16.763 Inch Diameter After Finish Machining; Must Be Concentric with Index Diameter 11 Within 0.004 Inch FIR
3. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
4. Nickel Plate or Plasma Coat Area
5. 1.929 Inches
6. 0.205 - 0.215
7. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
8. 0.010 - 0.020 Inch Radius
9. Nickel Plate or Plasma Coat Area
10. 0.020 - 0.035 Inch
11. 16.319 - 16.333 Inch Diameter for Cleanup Machining; Hold to Maximum Value. 16.353 Inch Minimum Diameter After Plating or Coating. 16.339 - 16.343 Inch Diameter After Finish Machining; Must be Concentric With Index 2 Diameter Within 0.002 Inch FIR
12. 16.174 - 16.184 Inch Diameter; Must Be Concentric With Index 11 Diameter Within 0.004 Inch FIR

NOTE: For PN 542069 assemblies, Index 12; 16.225 - 16.235 inch diameter.

13. Electrical Contact Area

R Key to Figure 633

(b) Machine damaged or worn front and/or rear snap diameter as shown in figure.

(c) Nickel plate machined areas by SPOP 26. See Section 70-44-01, Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

NOTE: Plasma coat per PWA 53-57 or PWA 53-80 may be used as an option to nickel plate. See Section 70-46-01 in Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but extra plasma coat must be removed at final machining. Prepare the machined surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(d) For nickel plate only, bake vane and shroud assembly at 185 - 196°C (365 - 385°F) for three hours.

(e) Finish machine diameter(s) to dimensions shown, maintaining all radii and concentricity requirements.

(f) Replace protective coat per this section.

R (2) Corrosion Pitting. See Figure 634.

(a) Inspection

1 Remove protective coatings as necessary as instructed in this section.

2 Measure the pit depth by the replica tape method in SPOP 127 or equivalent method. Refer to Section 70-30-00 in the Standard Practices Manual.

3 Pits on outer, inner and box shrouds are repairable to a depth of 0.005 inch.

(b) Repair

1 Complete all other necessary repairs (including removal of the air sealing ring) before you repair the corrosion pits.

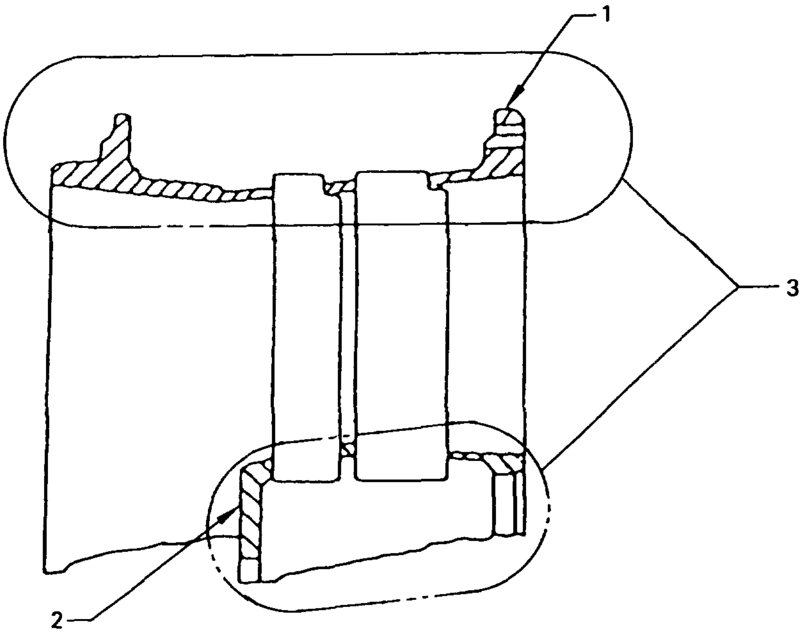
CAUTION: ENSURE THAT MATING DIAMETERS AND CRITICAL DIMENSIONS ARE NOT ALTERED BY THE BLAST CLEANING PROCEDURE IN PWA 110.

2 Coat the stator by the PWA 110-21 process in Section 70-41-04, Standard Practices Manual.

(3) Inner Shroud Rivet Hole Repair

(a) Remove air sealing ring as instructed in this section.

(b) Remove protective coatings as necessary as instructed in this section.



Ninth Stage Stator Pitting
Inspection and Repair
Figure 634

1. Outer Shroud
2. Inner shroud
3. Pitting And Corrosion Is Repairable In These Areas To A Depth Of 0.005 Inch

R Key to Figure 634

(c) Fill rivet holes and cracks up to 0.050 inch in length by the weld process using AMS 5776 filler metal.

NOTE: AM 363 (PWA 792) filler metal may be used as an option to AMS 5776.

CAUTION: TO AVOID CRACKS, PARTS MUST BE HANDLED WITH CARE UNTIL STRESS-RELIEF PROCESS IS ENDED.

(d) Stress-relieve as follows:

1 Place vane and shroud on a flat plate in a cold furnace.

2 Support inner shroud in relation to outer shroud.

3 Place flat plate on top of assembly.

4 Stress-relieve by SPOP 455-2 in Section 70-42-04, Standard Practices Manual.

(e) Fluorescent penetrant inspect the welded areas. Refer to Section 72-00-00.

(f) Grind the weld repair with the front face of the inner shroud that the air sealing ring seats properly.

(g) Fluorescent penetrant inspect the welded areas. Refer to Section 72-00-00.

(h) Install air sealing ring.

1 Transfer drill twenty 0.094 - 0.096 inch diameter holes into the inner shroud. Maintain the original position.

2 Break edges of rivet holes to ensure proper seating of rivet heads.

3 Install air sealing ring as instructed in this section.

(i) Replace protective coating by this section.

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-02

1. Engine Compressor Section (Vanes/Stators)

   A. General

      (1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Compressor Vanes - All Stages

   A. Inspection

      (1) Pitting and corrosion are not considered serious on compressor stator vanes, provided pitting does not
R exceed 0.005 inch depth. Refer to Paragraphs B. and L.

      (2) If more than 50 percent of all vanes in one stator assembly are damaged in same location to approximately maximum blend-out limit, replace assembly.

         NOTE: For riveted 2nd stage vanes, any number may be replaced without replacing vane and shroud assembly.

      (3) If all vanes in any 60-degree sector of one stage are damaged to approximately maximum blend-out limits, replace assembly except as indicated in preceding note.

      (4) Round-bottom dents up to 0.030 inch deep are considered acceptable without blending.

      (5) No cracks in vane are allowed.

      (6) Cracks in attaching weld or braze are acceptable provided they are less than 0.250 inch long.

      (7) Inspect steel first-stage vanes, using fluorescent magnetic particle method. Refer to Section 70-32-00 in the Standard Practices Manual.

         NOTE: If fluorescent magnetic particle method is unavailable, fluorescent penetrant inspection may be used as interim measure.

   B. Repair

(1) Do not attempt to repair any vane by brazing, welding, or soldering.

(2) Crocus cloth, fine files, and stones should be used to blend out injuries by removing minimum amount of material and leaving surface finish comparable to that of new part. Refer to Blending, Grinding, and Lapping, in the Standard Practices Manual, Section 70-45-00.

(3) Rework leading and trailing edges of vanes by blending so that maximum reduction to vane chord does not exceed 0.062 inch. One leading edge and one trailing edge repair may be accomplished on same vane provided repairs are not opposite each other.

NOTE: Dimension between repairs must not be less than chord dimension.

(4) Blend out injuries to concave and convex surfaces so that depth of removal does not exceed 0.010 inch.

C. Replace Second Stage Vanes (For JFTD12A-4A, -5A With PN 567352 Vanes)
See Figure 601.

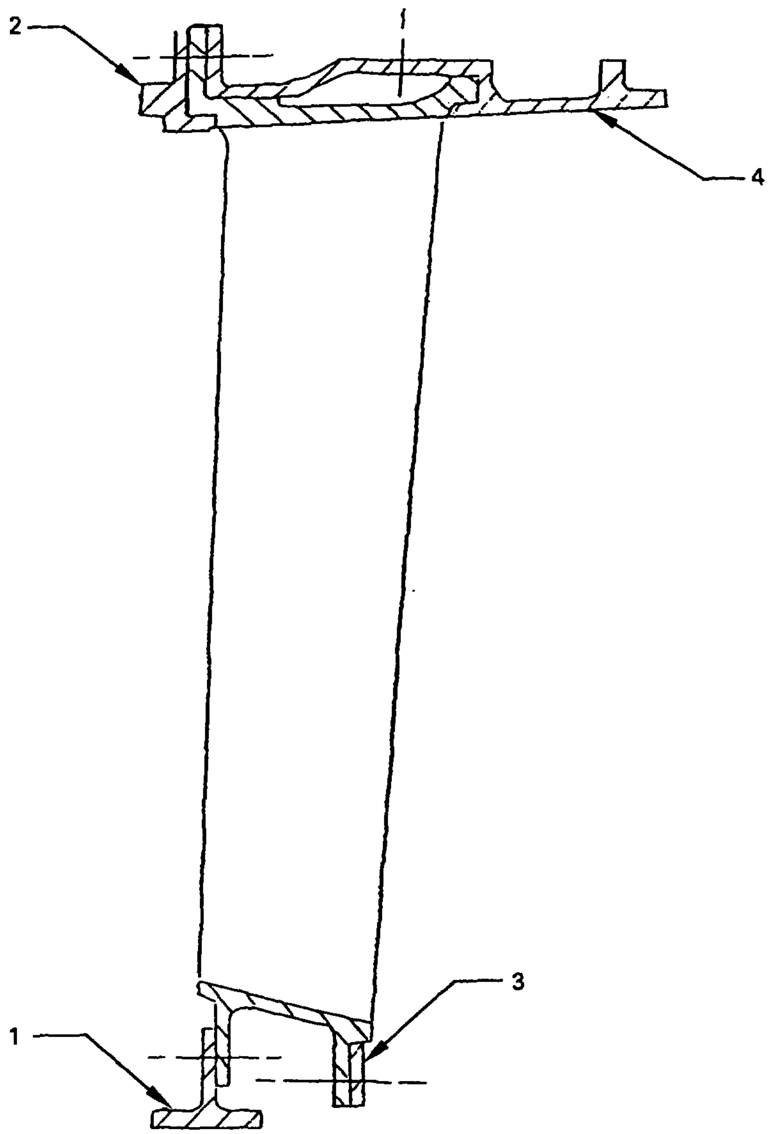
(1) Procedure for partial vane replacement up to and including 100 percent of the vanes.

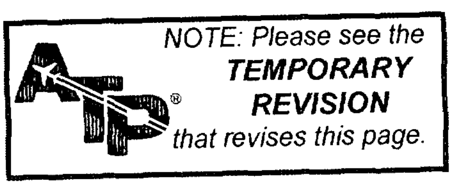
(a) Chart the vane shroud squareness and concentricity.

(b) Remove the rivets that secure the air sealing ring to the vane tabs and remove the air sealing ring relative to tabs prior to removal for reinstallation in the same location.

NOTE: All dimensional controls must be maintained after the vanes have been replaced. If necessary, fixture assembly when removing the vanes to maintain dimensional control.

(c) Remove the rivets that secure the flange to the outer shroud and remove the flange. Mark the flange





Second Stage Compressor
Vane Assembly
Figure 601

1. Air Sealing Ring
2. Flange
3. Positioning Plate
4. Shroud

Key to Figure 601

relative to the shroud prior to removal for reinstallation in the same location.

(d) Remove the rivets that secure the damaged vanes to the positioning plate (two per vane).

(e) Remove the damaged vanes.

(f) Assemble the replacement vanes into the shroud.

(g) Secure the vanes to the positioning plate with rivets.

(h) Install previously removed flange in its proper location as determined in step (c) and secure with rivets.

(i) Install previously removed air sealing ring in its proper location as determined in step (b) and secure with rivets.

(j) Dimensionally inspect the compressor stator assembly. A 0.010 inch out-of-concentricity is permissible after vane replacement.

(k) Check and correct (if required) vane angles for the following vanes. See Paragraph H.

1 All replaced vanes.

2 Two original vanes adjacent to the replaced vane(s).

3 Ten percent of the remaining original vanes, equally spaced around the assembly.

NOTE: If the vane angle of any vane checked is outside limits, vane angles of all the vanes in the assembly must be checked at all locations.

D. Replace Third State Vanes (For JFTD12A-4A, -5A with PN 370553 Vanes)
See Figure 602.

(1) Procedure for partial vane replacement up to and including 100 percent of the vanes.

(a) Chart the vane shroud squareness and concentricity.

(b) Remove the rivets that secure the air sealing ring to the vane tabs and remove the air sealing ring. Mark inner air sealing ring relative to tabs prior to removal for reinstallation in the same location.

(c) Remove the rivets that secure the damaged vanes to the plate (two per vane).

NOTE: All dimensional controls must be maintained after the vanes have been replaced. If necessary, fixture assembly when removing the vanes to maintain dimensional control.

(d) Remove the damaged vanes from the assembly.

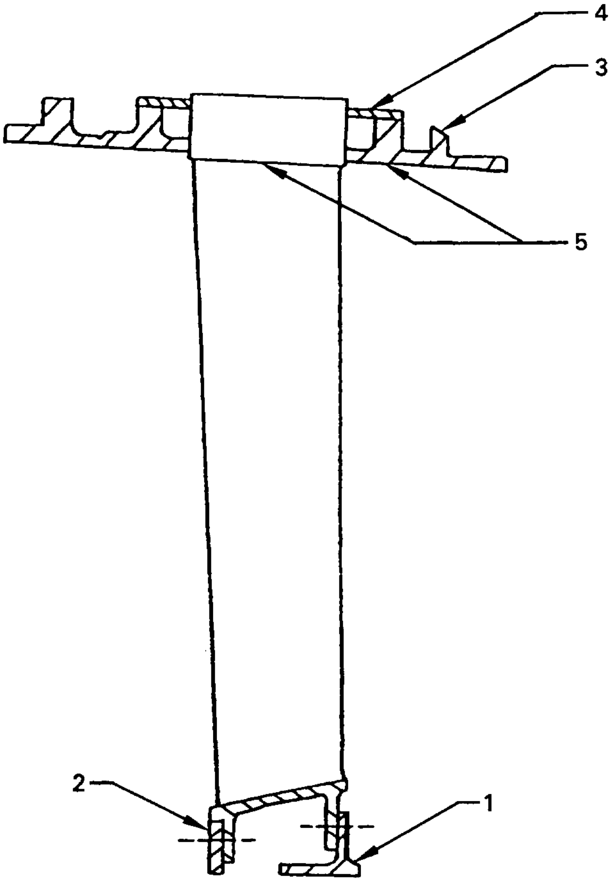
1 Remove the majority of the damaged vane airfoil center sections by cutting the vanes in two places approximately 1/16 inch from the inner and outer shrouds. Use a saw, heliarc cutting torch, or any other suitable cutting equipment.

NOTE: When using a heliarc cutting torch, make two "U" shaped sheet metal copper strips to place over the edges of the adjacent under damaged vanes to prevent burning them. Use pliers to handle the hot copper strips.

2 Use Electro-Discharge Machine (EDM) to remove vane stubs from the inner and outer shrouds and the outer ring. Refer to Standard Practices Manual, Section 70-47-00. Do not damage open up the vane slots with the EDM process.

(e) Remove any residual braze on both the ring and the shroud using a silicon carbide grit polishing bob. Use extreme caution not to open up the vane slots.

NOTE: Please see the TEMPORARY REVISION that revises this page.



NOTE: Please see the TEMPORARY REVISION that revises this page.

Third Stage Compressor
Stator Assembly
Figure 602

1. Air Sealing Ring
2. Positioning Plate
3. Shroud
4. Ring
5. Edge of Lug Must Be Flush With Surface Or Extend Into Airstream

Key to Figure 602

(f) Inspect the outer shroud and the ring for cracks and repair if required.

(g) Clean around the vane slots fully using vapor blast by SPOP 9. Refer to the Standard Practices Manual, Section 70-21-00.

(h) Clean the replacement vanes by SPOP 209. Refer to the Standard Practices Manual, Section 70-21-00.

(i) Test fit the replacement vane by inserting the outer lug of the vane into the outer shroud and ring.

NOTE: The inner edge of the lug must be flush with the inner shroud surface, or extend into the air stream. The gap between the shroud and the lug is to be opened up as much as 0.080 inch.

(j) Epoxy the replacement vanes to the outer shroud and ring as follows:

1 Wet all contact surfaces with Epoxy Adhesive (PN 492227).

2 Install the replacement vane into the outer shroud vane slot and position it correctly.

3 Fill the joints or gaps over 0.020 inch with epoxy adhesive.

4 Cure the Adhesive as follows:

a For 5412B Resin, cure at room temperature for four hours. Follow with post-cure and stress-relief at 177°C (350°F) for four hours.

b For EC 2214 or EC 2214 NMF, cure and stress-relieve at 177°C (350°F) for four hours. No Post-cure is necessary.

NOTE: Epoxy Information

Tradename	Source
Scotch Weld Structural Adhesive EC 2214 Regular - or - Scotch Weld Structural Adhesive EC 2054A&B	Refer to Source Code 04963 in Section 70-12-01 in the Standard Practices Manual.
EA 929	Refer to Source Code 33564 in Section 70-12-01 in the Standard Practices Manual.
5412B Resin 5412C Hardener	Local Purchase

If you use 5412B resin, mix it with 5412C Hardener, 25 parts by weight of Resin with one part by weight of Hardener. The working potlife of the hardener this mix is approximately 45 minutes at 24°C (75°F). If you use Scotch Weld EC 2186, it must be kept refrigerated until you need it and you can use it directly from the can.

(k) Dimensionally inspect the compressor stator assembly. A 0.010 inch out-of-concentricity is permissible after vane replacement.

(l) Install previously removed air sealing ring in its proper location as determined in step (1)b and secure with rivets.

(m) Check and correct (if required) vane angles for the following vanes. See Paragraph H.

1 All replaced vanes.

2 Two original vanes adjacent to the replaced vane(s)

NOTE: Please see the TEMPORARY REVISION that revises this page.

3 Ten percent of the remaining original vanes, equally spaced around the assembly.

NOTE: If the vane angle of any vane checked is outside limits, vane angles of all the vanes in the assembly must be checked at all locations.

E. Replace Fourth Stage Vanes (For JFTD12A-4A, -5A with PN 579354 Vanes)
See Figure 603.

(1) Procedure for partial vane replacement up to and including 100 percent of the vanes.

(a) Chart the vane shroud squareness and concentricity.

(b) Remove cadmium plate from the assembly by SPOP 59. See Standard Practices Manual, Section 70-44-01.

(c) Remove the rivets that secure the air sealing ring to the inner shroud and remove the air sealing ring. Mark inner air sealing ring relative to tabs prior to removal for reinstallation in the same location.

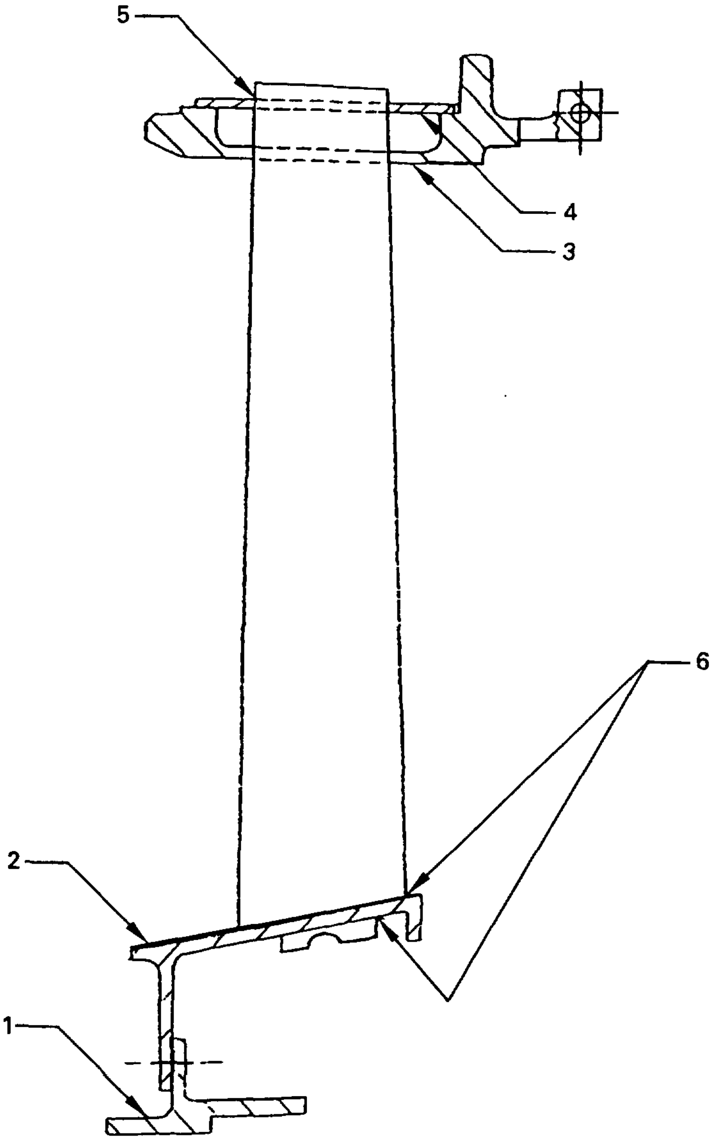
NOTE: All dimensional controls must be maintained after the vanes have been replaced. If necessary, fixture assembly when removing the vanes to maintain dimensional control.

(d) Remove the damaged vanes from the assembly.

1 Remove the majority of the damaged vane airfoil center sections by cutting the vanes in two places approximately 1/16 inch from the inner and outer shrouds. Use a saw, heliarc cutting torch, or any other suitable cutting equipment.

2 Use Electro-Discharge Machine (EDM) to remove vane stubs from the inner and outer shrouds and the outer ring. Refer to the Standard Practices Manual, Section 70-47-00. Do not damage or open up the vane slots with the EDM process.

NOTE: Please see the TEMPORARY REVISION that revises this page.



Fourth Stage Compressor
Stator Assembly
Figure 603

1. Air Sealing Ring
2. Inner Shroud
3. Outer Shroud
4. Ring
5. Braze Around All Vanes, 0.010 Min. Fillet Radius To Cover A Minimum of 80 Percent Of Length Of Intersecting Surface
6. Braze Around All Vanes, 0.010 Min. Fillet Radius To Cover A Minimum of 90 Percent Of Length Of Intersecting Surfaces

Key to Figure 603

(e) Clean up inner shroud vane slots by removing all burrs and remove any residual braze on both shrouds using a silicon carbide grit polishing bob. Use extreme caution not to open up the vane slots.

(f) Inspect the outer shroud and the ring for cracks and repair if requested.

(g) Clean around the inner and outer vane slots using vapor blast by SPOP 9. Refer to the Standard Practices Manual, Section 70-21-00.

(h) Clean the replacement vanes by SPOP 209. Refer to the Standard Practices Manual, Section 70-21-00.

NOTE: Use white gloves for all handling operations after cleaning and before brazing.

(i) Insert replacement vanes through the OD ring and shroud until inner portion seats in shroud. Gap must be 0.000 - 0.006 inch.

(j) High temperature braze replacement vanes by AMS 2664. Refer to the Standard Practices Manual, Section 70-42-03. Remove excess braze material from braze area.

(k) Visually inspect braze joints. A smooth continuous fillet is required.

(l) Fluorescent penetrant inspect by SPOP 62. Refer to the Standard Practices Manual, Section 70-33-00.

(m) Hold assembly flat and concentric, and stress-relieve by SPOP 460-2. Refer to the Standard Practices Manual, Section 70-42-04.

(n) Dimensionally inspect the compressor stator assembly. A 0.010 inch out-of-concentricity is permissible after vane replacement.

(o) Install previously removed air sealing ring in its proper location as determined in step (b) and secure with rivets.

(p) Check and correct (if required) vane angles for the following vanes. See Paragraph H.

1 All replaced vanes.

2 Two original vanes adjacent to the replaced vane(s).

3 Ten percent of the remaining original vanes, equally spaced around the assembly.

NOTE: If the vane angle of any vane checked is outside limits, vane angles of all the vanes in the assembly must be checked at all locations.

(q) Restore the protective coat to the assembly by either PWA 110-21 or AMS 2416. Refer to the Standard Practices Manual, Section 70-41-04.

F. Replacement (Steel)
See Tool Group 40A.

(1) Chart vane shroud squareness and concentricity.

(2) Etch position of seal ring, and remove seal ring.

(3) Using hacksaw, cut off damaged vane, 1/16 inch from inner and outer shrouds.

(4) Wrap adjacent vanes and shroud area with watersoaked ceramic fiber tape.

(5) Using oxyacetylene torch, heat vane tab (using, circular motion for uniform heating). While heating, tap vane stub until it is free of shroud.

(6) Repeat for outer end of vanes; then clean shroud area.

NOTE: For replacement of damaged vanes with ones having no leading edge notches and longer chordal dimension, enlarge vane slot in shroud by grinding, using replacement vane as template.

NOTE: For replacement and stress-relief of 9th stage vanes, install vane and shroud assembly in brazing and stress-relief fixture so that fixture cutouts leave accessibility to work area. In replacement of 9th stage vanes and exit vanes, install square ended vanes only in shrouds with straight outer surface, and install vanes with angled outer ends only in shrouds with ramped outer surface. For concentricity check following repair, see Paragraph L.

(7) Insert replacement vane through OD shroud until inner portion seats in inner shroud.

(8) High-temperature braze replacement vane in accordance with AMS 2666. Remove excess material from braze area.

NOTE: Install vanes at 180 degree intervals, allowing assembly to cool before attempting to weld next vane into place.

(9) Install previously removed seal ring in its proper location as determined in step (2).

CAUTION: INSTALL ALUMINUM AIRSEALING RING AFTER STRESS-RELIEVING ASSEMBLY.

(10) Holding assembly flat and concentric, stress-relieve by SPOP 460-2. Refer to the Standard Practices Manual, Section 70-42-04.

(11) Check assembly for distortion, as determined in step (1). A 0.010 inch out-of-concentricity is permissible.

(12) Check vane angles as prescribed in Paragraph H. Angle Checking, for following vanes:

(a) All replaced vanes.

(b) Two original vanes adjacent to replaced vane(s).

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page.

(c) Ten percent of remaining original vanes equally spaced around assembly.

NOTE: If vane angle of any vane checked is outside limits, vane angles of all vanes in assembly must be checked at all locations indicated in Table 602.

(13) If necessary, descale assembly, and immerse in slushing oil. Allow assembly to drain.

(14) Inspect vane and shroud assembly. See Paragraph A.

R G. Replacement (Aluminum) (JFTD12A-4A, -5A) See Tool Group 40A.

(1) Welded Vane Tip

(a) Chart vane shroud squareness and concentricity.

(b) Etch position of seal ring, and remove seal ring.

(c) Using hacksaw, cut out airfoil portion in gaspath. Outer stub may be removed by drilling through it, using a steel template with a slightly smaller airfoil shape than vane stub. After rough vane stub is removed, grind to contour of replacement vane.

NOTE: Anodize coating can be removed from outer shroud, using abrasive cloth.

(d) Wrap adjacent vane and shroud area with water-soaked ceramic fiber tape.

(e) Install replacement vane through OD shroud until inner portion seats in inner shroud.

(f) Weld shroud assembly, using AMS 4190 filler rod. When welding 3rd stage vanes to outer shroud, weld entirely around vane airfoil at outer shroud ID. On OD of shroud, vanes need only be tack welded.

NOTE: Install vanes at 180 degree intervals, allowing assembly to cool before attempting to weld next vane into place.

(g) Remove and/or contour excess weld material, as required.

NOTE: Slight deformation of shroud outer box surface is not cause for rejection.

(h) Install previously removed seal ring in its proper location, as determined in step (b).

(i) Holding assembly flat and concentric, stress-relieve at 160°- 165°C (320° - 330°F) for four hours. Place in cold furnace and allow to cool.

CAUTION: INSTALL ALUMINUM AIRSEALING RING AFTER STRESS-RELIEVING ASSEMBLY.

(j) Inspect vane and shroud assembly. Refer to Paragraph A. and Fluorescent Penetrant Inspection, in the Standard Practices Manual, Section 70-33-00.

(k) Check assembly for distortion as determined in step (a). A 0.010 inch out-of-concentricity is acceptable.

(l) Check vane angles, as prescribed in Paragraph H. Angle Checking, for following vanes:

1 All replaced vanes.

2 Two original vanes adjacent to replaced vane(s).

3 Ten percent of remaining original vanes equally spaced around assembly.

NOTE: Initial check of ten percent of original vanes shall be performed at two vane section locations only, those adjacent to inner and outer shrouds (for example, Sections B-B and E-E, shown in Figure 613).

4 If vane angle of any vane checked is outside limits, vane angles of all vanes in the assembly must be checked at all locations indicated in Table 602.

(2) Riveted Vane Tip

NOTE: Please see the TEMPORARY REVISION that revises this page.

(a) Mark position of compressor shroud flange.

(b) Remove rivets securing shroud flange to vane and shroud assembly and remove flange

(c) Mark position of airsealing ring.

(d) Remove rivets securing airsealing ring to vane and shroud assembly and remove ring.

(e) Remove two rivets per vane that secure vane to front inner stiffening ring.

(f) Remove damaged vane and replace with new part.

(g) Reinstall seal ring and shroud flange in original locations.

(h) Check vane angles. See Paragraph H. Angle Checking.

(i) Inspect diameter concentricities as indicated in Paragraph C.

H. Angle Checking

(1) Position vane and shroud assembly (front face up) on smooth level surface.

CAUTION: CHECK SURFACE FREQUENTLY TO MAKE SURE THAT IT IS LEVEL AND SMOOTH.

(2) Determine location of each vane section, using gage radius specified in Table 602 and illustrated in Figure 604. Mark locations.

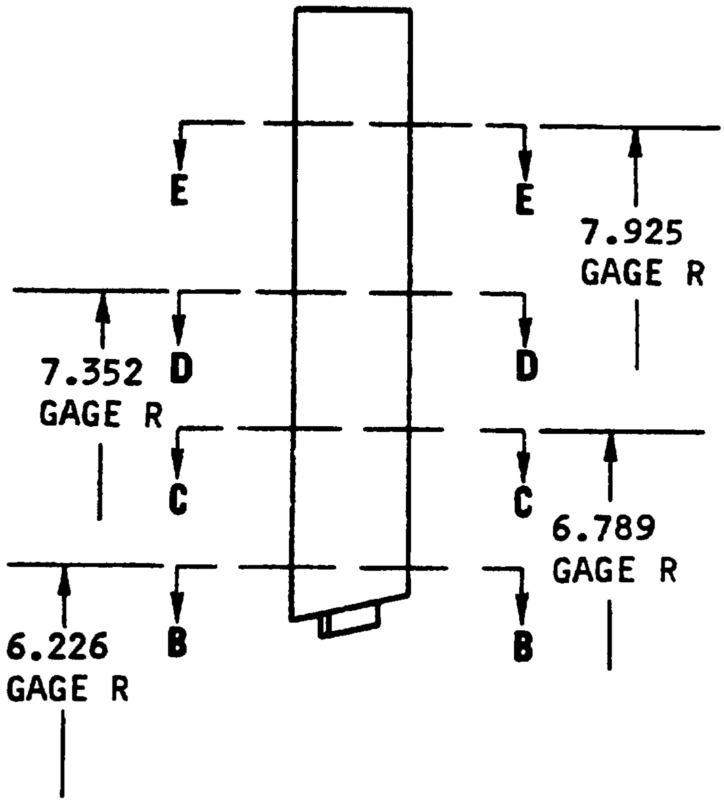
(3) Check leading edge sections of each vane, using following procedure:

(a) See Table 602, and determine proper leading edge angle for section to be checked. Adjust master gage to this angle.

1 Shake master gage to ensure even oil distribution on bearing races to prevent drag.

2 Place master gage on surface plate, making certain surface plate and master gage are clean to ensure full bearing on surface plate.

NOTE: Please see the TEMPORARY REVISION that revises this page.



NOTE: Gage Radius is the Distance, in Inches, From a Vane Section to Center of Vane and Shroud Assembly. This Example Indicates The Proper Gage Radius For Locating Sections BB, CC, DD, and EE of a 5th Stage Vane.

NOTE: Please see the TEMPORARY REVISION that revises this page.

R
R

Vane Section Locations
Figure 604

3 Turn thumbscrew clockwise until drum is free. If resistance to drum rotation is desired, thumbscrew may be tightened slightly to create a drag.

4 When drum has come to rest, lock by turning thumbscrew counterclockwise. During locking procedure care shall be taken to avoid jarring. Instrument may be removed from plate for reading.

5 Whole degrees (figures on rotating drum) are read by means of index mark on vernier scale which coincides with scribed white lines on master gage case. If index mark falls between two degree marks the lower shall be used.

NOTE: Please see the TEMPORARY REVISION that revises this page.

6 To read minutes on vernier scale, find point at which vernier minute line and degree line on rotating scale coincide. If index mark is on black figures of rotating drum, black vernier figures shall be read; if on red, red vernier figures shall be read.

R 7 Vernier adjustment. If master gage reads inaccurately rotate it 180 degrees on surface plate. If it gives equal error in opposite direction, vernier needs adjustment. Loosen three acorn nuts, adjust vernier to give accurate readings and tighten nuts.

NOTE: Before adjusting vernier, repeat step (1) and determine proper vane angle checking gage.

(b) See Table 602, and determine proper vane angle checking gage for section to be checked.

(c) Secure vial gage to angle checking gage.

Stage (PN)	Section	Gage Radius	LE Angle	Gage	Bar
1st (566281)	B-B	5.044	64°10′	PWA 13580	PWA 13576
	C-C	5.797	61°49′	PWA 13580	PWA 13576
	D-D	6.550	58°12′	PWA 13580	PWA 13576
	E-E	7.303	53° 7′	PWA 13580	PWA 13577
	F-F	8.056	47° 9′	PWA 13580	PWA 13775

Compressor Vane Bending
(Leading Edge)
Table 602

Stage (PN)	Section	Gage Radius	LE Angle	Gage	Bar
(568881)	B-B	5.044	62°41'	PWA 13580	PWA 13576
	C-C	5.797	60°48'	PWA 13580	PWA 13576
	D-D	6.550	57° 3'	PWA 13580	PWA 13576
	E-E	7.303	52°31'	PWA 13580	PWA 13577
	F-F	8.056	46°44'	PWA 13580	PWA 13577
(568891)	B-B	5.044	62°41'	PWA 13580	PWA 13576
	C-C	5.797	60°48'	PWA 13580	PWA 13576
	D-D	6.550	57° 3'	PWA 13580	PWA 13576
	E-E	7.303	52°31'	PWA 13580	PWA 13577
	F-F	8.056	46°44'	PWA 13580	PWA 13577
2nd (422882)	B-B	5.479	61°32'	PWA 13397	#
	C-C	6.094	55°58'	PWA 13397	#
	D-D	6.710	50°56'	PWA 13397	#
	E-E	7.326	46°50'	PWA 13397	#
	F-F	7.941	41°13'	PWA 13397	#
(566282)	B-B	5.479	60°30'	PWA 13397	#
	C-C	6.094	56°35'	PWA 13397	#
	D-D	6.710	51°24'	PWA 13397	#
	E-E	7.326	46°18'	PWA 13397	#
	F-F	7.941	41°00'	PWA 13397	#
3rd (385503)	B-B	5.809	55°38'	PWA 13397	PWA 13665
	C-C	6.314	49°45'	PWA 13397	PWA 13665
	D-D	6.820	45°14'	PWA 13397	PWA 13665
	E-E	7.326	41° 2'	PWA 13397	PWA 13665
	F-F	7.831	36°49'	PWA 13397	PWA 13665
4th (542274)	B-B	5.945	54°17'	PWA 13397	PWA 13398
	C-C	6.605	48°11'	PWA 13397	PWA 13398
	D-D	7.265	43°39'	PWA 13397	PWA 13398
	E-E	7.995	38°17'	PWA 13397	PWA 13398
(580294)	B-B	5.945	54°17'	PWA 13397	PWA 13398
	C-C	6.605	48°11'	PWA 13397	PWA 13398
	D-D	7.265	43°39'	PWA 13397	PWA 13398
	E-E	7.995	39° 5'	PWA 13397	PWA 13398

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

R
R

Compressor Vane Bending
(Leading Edge)
Table 602 (Continued)

Stage (PN)	Section	Gage Radius	LE Angle	Gage	Bar
5th					
(542275)	B-B	6.226	45°26′	PWA 13399	PWA 13401
	C-C	6.789	42°54′	PWA 13399	PWA 13401
	D-D	7.352	39° 9′	PWA 13399	PWA 13401
	E-E	7.925	34°35′	PWA 13399	PWA 13401
(580295)	B-B	6.226	45°26′	PWA 13399	PWA 13401
	C-C	6.789	42°54′	PWA 13399	PWA 13401
	D-D	7.352	39° 9′	PWA 13399	PWA 13401
	E-E	7.975	34°44′	PWA 13399	PWA 13401
6th					
(542276)	B-B	6.502	45° 2′	PWA 13560	PWA 13404
	C-C	6.978	42°50′	PWA 13560	PWA 13404
	D-D	7.454	38°35′	PWA 13560	PWA 13404
	E-E	7.895	34°16′	PWA 13560	PWA 13404
(580296)	B-B	6.502	45° 2′	PWA 13560	PWA 13404
	C-C	6.978	42°50′	PWA 13560	PWA 13404
	D-D	7.454	38°35′	PWA 13560	PWA 13404
	E-E	7.895	35°42′	PWA 13560	PWA 13404
7TH					
542277	B-B	6.745	44°19′	PWA 13399	PWA 13407
	C-C	7.140	41°44′	PWA 13399	PWA 13407
	D-D	7.535	38°15′	PWA 13399	PWA 13407
	E-E	7.880	34°28′	PWA 13399	PWA 13407
591277	B-B	6.745	44°19′	PWA 13399	PWA 13407
	C-C	7.140	41°44′	PWA 13399	PWA 13407
	D-D	7.535	38°15′	PWA 13399	PWA 13407
	E-E	7.880	34°28′	PWA 13399	PWA 13407
591567	B-B	6.745	44°19′	PWA 13399	PWA 13407
	C-C	7.140	41°44′	PWA 13399	PWA 13407
	D-D	7.535	38°15′	PWA 13399	PWA 13407
	E-E	7.950	35° 6′	PWA 13399	PWA 13407
R 8TH	B-B	7.105	45°29′	PWA 13560	PWA 13536
(479238)	C-C	7.293	43°49′	PWA 13560	PWA 13536
	D-D	7.619	40°51′	PWA 13560	PWA 13536
	E-E	7.850	39°32′	PWA 13560	PWA 13536

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

Compressor Vane Bending
(Leading Edge)
Table 602 (Continued)

Stage (PN)	Section	Gage Radius	LE Angle	Gage	Bar
(542278)	B-B	6.967	46°33′	PWA 13560	PWA 13536
	C-C	7.293	43°49′	PWA 13560	PWA 13536
	D-D	7.619	40°51′	PWA 13560	PWA 13536
	E-E	7.905	39°17′	PWA 13560	PWA 13536
(591278)	B-B	6.967	46°33′	PWA 13560	PWA 13536
	C-C	7.293	43°49′	PWA 13560	PWA 13536
	D-D	7.619	40°51′	PWA 13560	PWA 13536
	E-E	7.905	39°17′	PWA 13560	PWA 13536
9TH (568869) (Primary)	B-B	7.160	40° 8′	PWA 13412	PWA 13756
	C-C	7.488	37°43′	PWA 13412	PWA 13756
	D-D	7.708	36°24′	PWA 13412	PWA 13756
	E-E	7.7930	34°24′	PWA 13412	PWA 13756
R (568869)	F-F	7.160	53°47′	*	*
R (Secondary)	G-G	7.592	53°47′	*	*
	H-H	7.930	53°47′	*	*

No Bending Permissible
* Not Available

Compressor Vane Bending
(Leading Edge)
Table 602 (Continued)

Stage (PN)	Section	Gage Radius	TE Angle	Gage	Bar
1st (566281)	B-B	5.044	82°42′	PWA 13581	PWA 13776
	C-C	5.797	77°34′	PWA 13581	PWA 13776
	D-D	6.550	73°16′	PWA 13581	PWA 13776
	E-E	7.303	68°51′	PWA 13581	PWA 13579
	F-F	8.056	64°17′	PWA 13581	PWA 13579
(568881)	B-B	5.044	81°10′	PWA 13581	PWA 13578
	C-C	5.797	76° 5′	PWA 13581	PWA 13578
	D-D	6.550	71°25′	PWA 13581	PWA 13578
	E-E	7.303	67°20′	PWA 13581	PWA 13579
	F-F	8.056	63°3′13"	PWA 13581	PWA 13579

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

Compressor Vane Bending
(Trailing Edge)
Table 602A

Stage (PN)	Section	Gage Radius	TE Angle	Gage	Bar
(568891)	B-B	5.044	81°10′	PWA 13581	PWA 13578
	C-C	5.797	76° 5′	PWA 13581	PWA 13578
	D-D	6.550	71°25′	PWA 13581	PWA 13578
	E-E	7.303	67°20′	PWA 13581	PWA 13579
	F-F	8.056	63°3′13"	PWA 13581	PWA 13579
2nd (422882)	B-B	5.479	79°58′	PWA 13399	PWA 13664
	C-C	6.094	71°51′	PWA 13399	PWA 13664
	D-D	6.710	66°45′	PWA 13399	PWA 13802
	E-E	7.326	63°37′	PWA 13399	PWA 13802
	F-F	7.941	61°14′	PWA 13399	PWA 13802
(566282)	B-B	5.479	80°35′	PWA 13399	PWA 13664
	C-C	6.094	72°46′	PWA 13399	PWA 13664
	D-D	6.710	67°55′	PWA 13399	PWA 13802
	E-E	7.326	64°50′	PWA 13399	PWA 13802
	F-F	7.941	62° 7′	PWA 13399	PWA 13802
3rd (385503)	B-B	5.809	74°55′	PWA 13399	PWA 13666
	C-C	6.314	66°54′	PWA 13399	PWA 13666
	D-D	6.820	62°42′	PWA 13399	PWA 13666
	E-E	7.326	60°19′	PWA 13399	PWA 13666
	F-F	7.831	58°38′	PWA 13399	PWA 13666
4th (542274)	B-B	5.945	67° 3′	PWA 13399	PWA 13400
	C-C	6.605	61°10′	PWA 13399	PWA 13400
	D-D	7.265	58°26′	PWA 13399	PWA 13400
	E-E	7.995	55°35′	PWA 13399	PWA 13400
(580294)	B-B	5.945	67° 3′	PWA 13399	PWA 13400
R	C-C	6.605	61°10′	PWA 13399	PWA 13400
	D-D	7.265	58°26′	PWA 13399	PWA 13400
	E-E	7.995	63°11′	PWA 13399	PWA 13400
5th (542275)	B-B	6.226	60°53′	PWA 13399	PWA 13403
	C-C	6.789	58°55′	PWA 13399	PWA 13403
	D-D	7.352	56°23′	PWA 13399	PWA 13403
	E-E	7.925	53°38′	PWA 13399	PWA 13403

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

Compressor Vane Bending
(Trailing Edge)
Table 602A (Continued)

Stage (PN)	Section	Gage Radius	TE Angle	Gage	Bar
(580295)	B-B	6.226	60°53'	PWA 13399	PWA 13403
	C-C	6.789	58°55'	PWA 13399	PWA 13403
	D-D	7.352	56°23'	PWA 13399	PWA 13403
	E-E	7.975	63°33'	PWA 13399	PWA 13403
6th					
(542276)	B-B	6.502	64°26'	PWA 13406	PWA 13405
	C-C	6.978	62°57'	PWA 13406	PWA 13405
	D-D	7.454	60°54'	PWA 13406	PWA 13405
	E-E	7.895	59°12'	PWA 13406	PWA 13405
(580296)	B-B	6.502	64°26'	PWA 13406	PWA 13405
	C-C	6.978	62°57'	PWA 13406	PWA 13405
	D-D	7.454	60°54'	PWA 13406	PWA 13405
	E-E	7.895	68°18'	PWA 13406	PWA 13820
7TH					
542277	B-B	6.745	65°48'	PWA 13406	PWA 13408
	C-C	7.140	64°20'	PWA 13406	PWA 13408
	D-D	7.535	62°45'	PWA 13406	PWA 13408
	E-E	7.880	61°33'	PWA 13406	PWA 13408
591277	B-B	6.745	65°48'	PWA 13406	PWA 13408
	C-C	7.140	64°20'	PWA 13406	PWA 13408
	D-D	7.535	62°45'	PWA 13406	PWA 13408
	E-E	7.880	61°33'	PWA 13406	PWA 13408
591567	B-B	6.745	65°48'	PWA 13406	PWA 13408
	C-C	7.140	64°20'	PWA 13406	PWA 13408
	D-D	7.535	62°45'	PWA 13406	PWA 13408
	E-E	7.950	69°42'	PWA 13406	PWA 13408
8TH	B-B	7.105	66°10'	PWA 13406	PWA 13410
(479238)	C-C	7.293	65°25'	PWA 13406	PWA 13410
	D-D	7.619	64°23'	PWA 13406	PWA 13410
	E-E	7.850	63°26'	PWA 13406	PWA 13410
(542278)	B-B	6.967	66°47'	PWA 13406	PWA 13410
	C-C	7.293	65°25'	PWA 13406	PWA 13410
	D-D	7.619	64°23'	PWA 13406	PWA 13410
	E-E	7.905	63° 9'	PWA 13406	PWA 13410

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

R
R

Compressor Vane Bending
(Trailing Edge)
Table 602A (Continued)

Stage (PN)	Section	Gage Radius	TE Angle	Gage	Bar
(591278)	B-B	6.967	66°47′	PWA 13406	PWA 13410
	C-C	7.293	65°25′	PWA 13406	PWA 13410
	D-D	7.619	64°23′	PWA 13406	PWA 13406
	E-E	7.905	63° 9′	PWA 13406	PWA 13406
9TH					
(568869)	B-B	7.160	55°35′	*	*
(Primary)	C-C	7.488	56°38′	*	*
	D-D	7.708	56°59′	*	*
	E-E	7.7930	57°28′	*	*
(568869)	F-F	7.160	89°39′	PWA 13414	PWA 13413
R (Secondary)	G-G	7.592	89°39′	PWA 13414	PWA 13413
	H-H	7.930	89°39′	PWA 13414	PWA 13413

*Not Available

Compressor Vane Bending
(Trailing Edge)
Table 602A (Continued)

(d) Secure vane angle checking gage to lug on master gage.

(e) Adjust vial gage until edge of bubble coincides with scribe mark on glass tube. Remove vane angle checking gage from master gage.

(f) Secure vane angle checking gage on leading edge section to be checked, as shown in Figure 614.

(g) If edge of bubble coincides with scribe mark on glass tube, angel is correct. If bubble does not coincide with scribe mark, vane must be bent to correct angle.

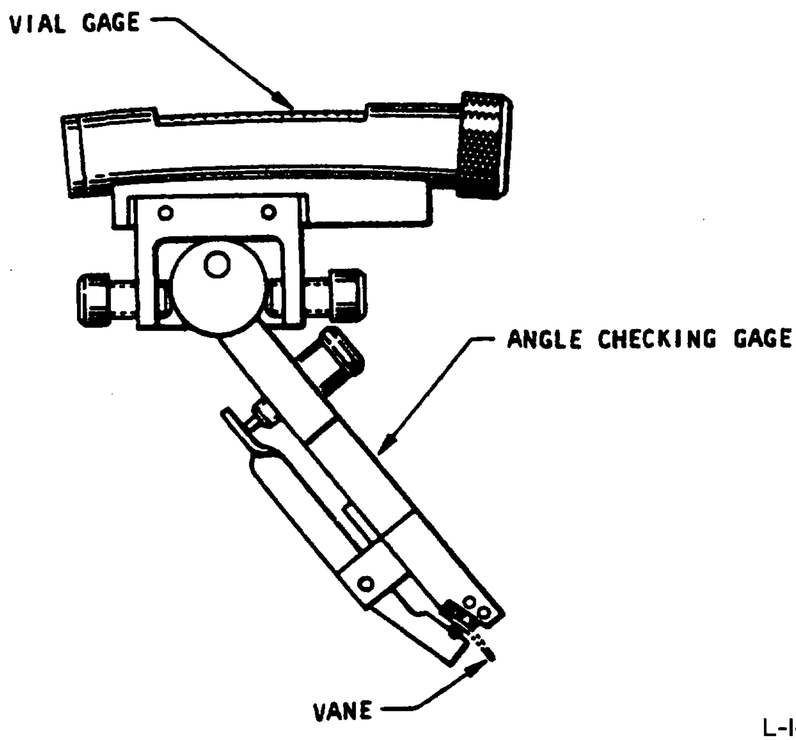
R NOTE: Angles must be within 1°30′ of specified angle. Average of all vanes must be within 0°45′ of specified vane angle.

I. Bending

(1) Bend vanes to angle specified in Table 602, as necessary, using following procedure:

(a) See Table 602 and determine proper bending bar for section to be bent.

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-14283 (0000)

R
R

Vane Angle Checking
Figure 605

(b) Position slot of bar over leading edge section of vane and bend the vane section to correct angle. See Figure 606.

(2) Position vane and shroud assembly (rear face up) on level, smooth surface. Using procedures used for leading edges, check vane trailing edge angle for each
R vane and bend as necessary. Refer to Table 602A for
R the applicable angles, gages, and bending bars for each
section.

3. Compressor Vane And Shroud Assemblies
See Figure 607

A. First Stage
See Tool Group 29A-1.

(1) Inspection

(a) Inspect 1st stage vane and shroud assemblies for blade tip rub on shroud. Depth of rub must not exceed 0.010 inch.

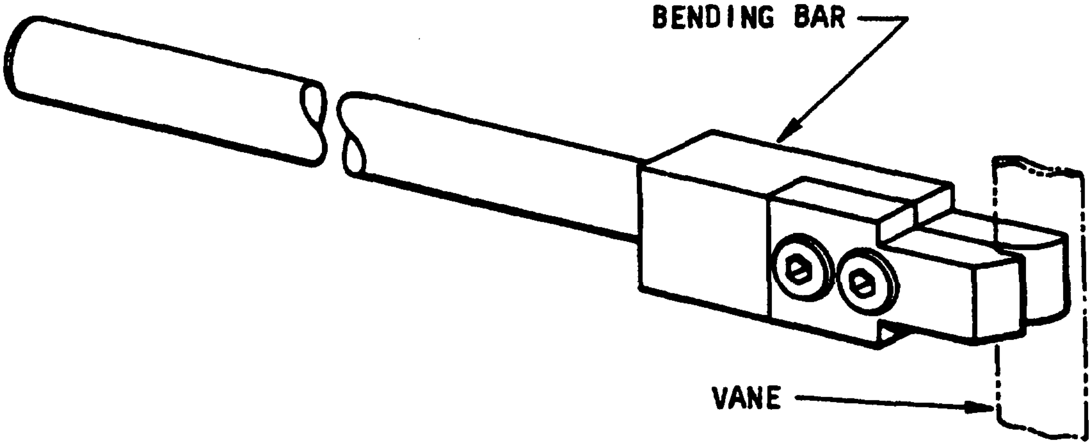
(b) Maximum out-of-round of 0.020 inch is permissible for 1st stage shroud. Clearance may be approximated using vernier tape measure or by quadrant diametrical comparison of parts.

(c) Visually inspect all areas of each vane for pitting, galling, or other defects.

(d) Inspect aluminum vane and shroud assemblies, using fluorescent penetrant method. Refer to the Standard Practices Manual, Section 70-33-00. For steel parts, use fluorescent magnetic particle inspection. Refer to the Standard Practices Manual, Section 70-32-00.

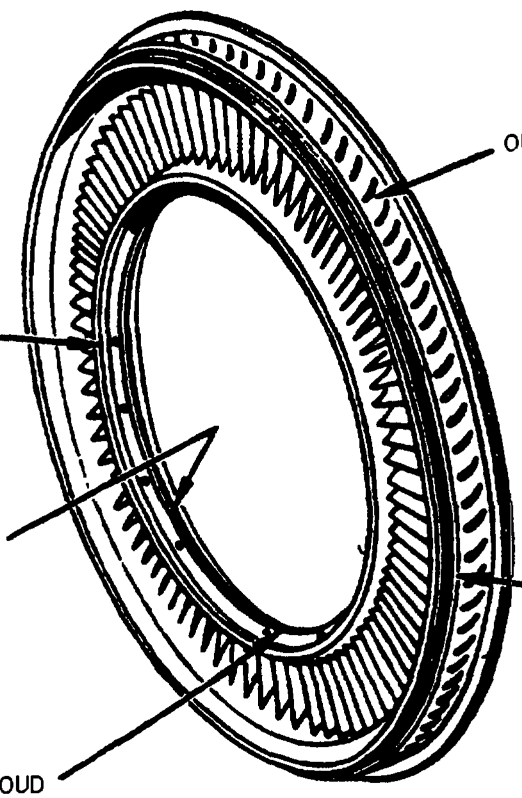
NOTE: If indication of defects is discovered, strip assembly and reinspect, using same procedure.

(2) Plating (When Required)



L-14284 (0000)

Vane Bending Bar
Figure 606



L-17971 (0000)

Vane And Shroud Assembly
(Stages 1 Thru 3)
Figure 607

(a) Remove rivets securing airsealing ring to vane and shroud assembly.

NOTE: Before removing rivets, mark ring opposite offset lug to ensure that ring is reinstalled in same position.

(b) Prepare vane and shroud assembly for plating procedure by attaching fixture. Remove wing nuts and separate fixture details. Position stator, rear face down, with outer shroud in stepped fixture locators. Reassemble fixture, and secure with wing nuts.

NOTE: Electrical contact points are permissible only in area shown in Figure 608. No burning, pitting, or selective attack is permitted.

(c) Strip and cadmium plate vane and shroud assembly. Plate to thickness of 0.0003 - 0.005 inch. Refer to SPOP 21 in the Standard Practices Manual, Section 70-44-01.

NOTE: Surface area of stator assembly is 5.7 square feet. Current requirements are
R 195 - 420 amperes for nickel strike and
R 140 amperes for cadmium plate.

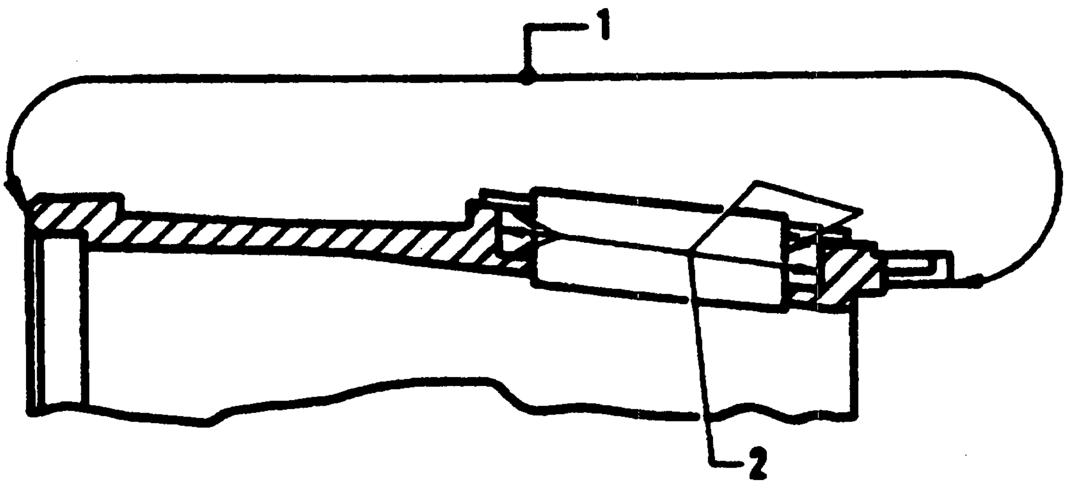
(d) Inspect assembly to ensure that plate is complete and uniform in thickness. Plating inbox shroud area and in two, one-eighth-inch peripheral holes is optional, and may be incomplete.

(e) Paint with high-baking, heat-resistant, aluminum enamel those areas specified in Figure 609, as well as all fixture contact points, and any other abrasions or scratches penetrating through plating to bare metal as a result of fixturing. Refer to SPOP 142 in the Standard Practices Manual, Section 70-41-03.

(f) Bake assembly at 185° - 196°C (365° - 385°F) for three hours.

(3) PWA 110-21/110-9 Coating (Alternate Coating Procedure)

NOTE: Coating is required for vane and shroud assemblies post-SB 6211.

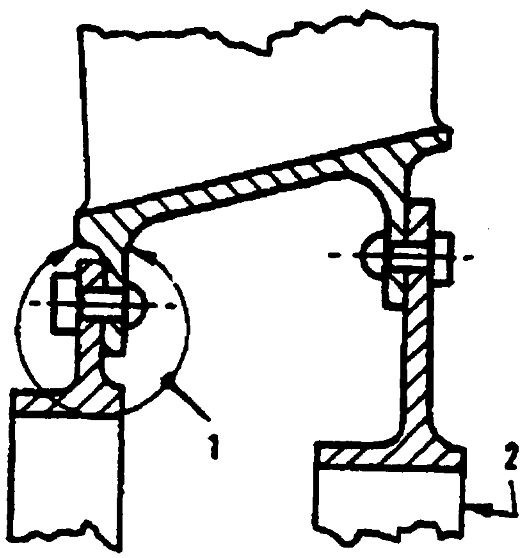


L-17948 (0000)

1. Electrical Contact Points
2. Optional Plate Area

R
R

First Stage Vane And
Shroud Plating
Figure 608



L-17947 (0000)

1. Paint Area
2. "Rear" Marked This Side

R
R

First Stage Vane And Shroud
Painting And Airsealing
Ring Replacement
Figure 609

(a) Remove all the coating and plating from all surfaces.

(b) Apply PWA 110-21/110-9 Coating, 0.0005 - 0.0020 inch thick.

(4) Airsealing Ring Replacement

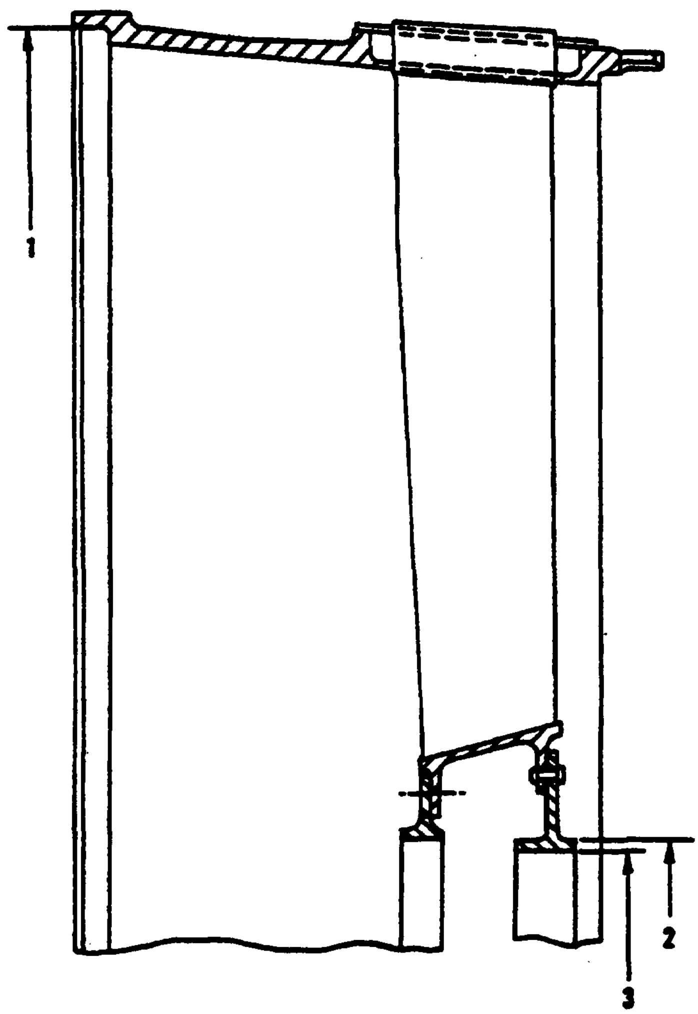
R (a) For a new replacement ring, transfer drill 108
R 0.046 - 0.052 inch (0.094 - 0.096 inch post-
R SB 1168) diameter rivet holes (use the old
R ring as a template). Put the used or replacement
R airsealing ring on the rivet flange as shown in
R Figure 610 (make sure that the face with the REAR
R mark is in its correct position). For old rings,
R align the mark on the airsealing ring with the
offset lug assembly.

(b) Using riveter, rivet ring to vane and shroud assembly with manufactured rivet heads forward.

NOTE: To preclude rivet bending which may result in aluminum airsealing ring deformation, PN 125571 rivets shall be used. If material to be riveted (airsealing ring and inner shroud flanges) is below nominal thickness, rivets shall be shortened so that length of rivet shank is equal to material thickness plus 1.5 times shank diameter. These guidelines for determining rivet length shall be used when replacing airsealing rings on all vane and shroud assemblies. Refer to the Standard Practices Manual, Section 70-43-00.

(c) For replacement airsealing rings, machine to dimensions in Figure 619. Concentricity checks shall be performed on used and replacement rings to ensure that ring is positioned properly and that machined ID surface of ring is concentric with vane outer shroud.

(d) Degrease assembly and dry.



L-22355 (0000)

NOTE: Please see the **TEMPORARY REVISION** that revises this page.

R
R

First Stage Compressor
Vane And Shroud Assembly
Airsealing Ring Replacement
Figure 610

1. Reference Diameter
2. This Diameter Must Be Concentric With Reference Diameter Within 0.010 Inch FIR To Ensure That Ring Is Properly Positioned On Rivet Flange Prior to Machining or Ring ID Concentricity Check
3. This Machined Diameter (7.995 - 8.005 Inches) Must Be Concentric With Reference Diameter Within 0.002 Inch FIR.

Key to Figure 610

(5) First Stage Vane and Shroud Assembly Outer Box Shroud Crack Repair

NOTE: Do not repair a 1st stage compressor stator assembly, PN 568891 with the procedure that follows:

(a) Remove the protective coating as necessary. See Paragraph A.(2).

(b) Remove and replace the airsealing ring. See Paragraph A.(2) and (3).

(c) Use a No. 60 drill bit (0.040 inch diameter) to stop drill cracks. See Figure 611.

NOTE: Stop drill holes must be free of weld protuberances to avoid stress risers, and therefore could require reaming or polishing after the crack has been welded.

(d) Rout the cracks completely in the area to be welded. Keeping the width of the cut to a minimum.

(e) Weld the crack with AMS 5776 (410 bare) or AM 363 (PWA 791) filler metal.

CAUTION: BE CAREFUL WITH THE PARTS UNTIL STRESS-RELIEF IS ACCOMPLISHED.

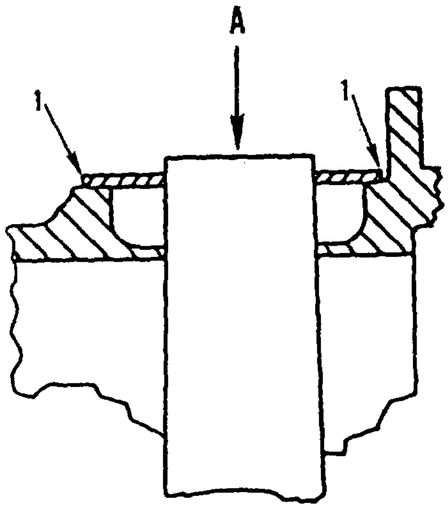
(f) Stress-relieve as follows:

1 Place the assembly on a flat plate in a cold furnace.

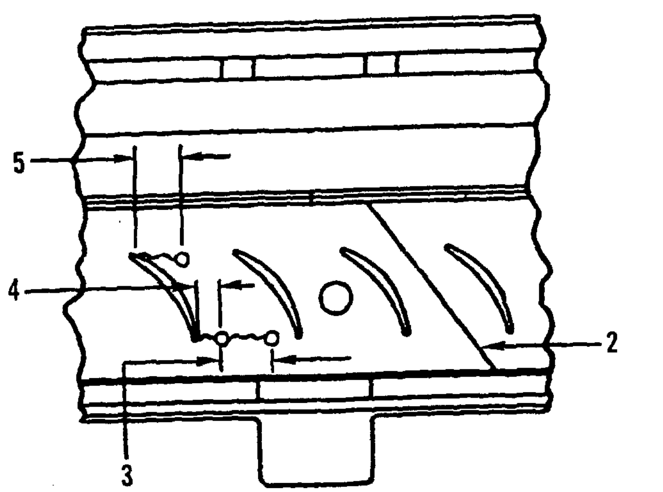
2 Support the inner shroud in relation to the outer shroud.

3 Place the flat plate on top of the assembly.

R
R



TYPICAL STATOR ASSEMBLY



VIEW IN DIRECTION A

NOTE: Please see the *TEMPORARY REVISION* that revises this page.

R
R

First Stage Compressor Vane
And Shroud Crack Repair
Figure 611

1. Cracks In Circumferential Weld Area: Do Not Stop Drill Cracks. Weld Cracks With AMS 5776 (410 bare) Or AM 363 PWA 7910 Filler Metal
2. It Is Permitted To Weld Cracks In This Weld Again
3. Stop Drill Cracks (Longer Than 0.125 Inch) 0.050 Inch From The Braze And At The End Of The Crack. Rout And Weld The Crack Between The Holes
4. 0.050 Inch
5. Stop Drill Cracks Less Than 0.125 Inch long Which Come From The Brazed Area At The End Of The Crack And Not Let Them Stay Welded

Key to Figure 611

4 Stress-relieve with SPOP 455-2 in Section 70-42-04 in the Standard Practices Manual.

(g) Fluorescent penetrant inspect the welded areas. See Paragraph A.

(h) Blend the weld flush to 0.010 inch above the surface. Do not remove any parent metal.

(i) Fluorescent penetrant inspect the welded areas. See Paragraph A.

(j) Make a dimensional inspection of the repaired mating diameters as necessary. See Paragraph A.

(6) Mating Diameter Repair. See Figure 612.

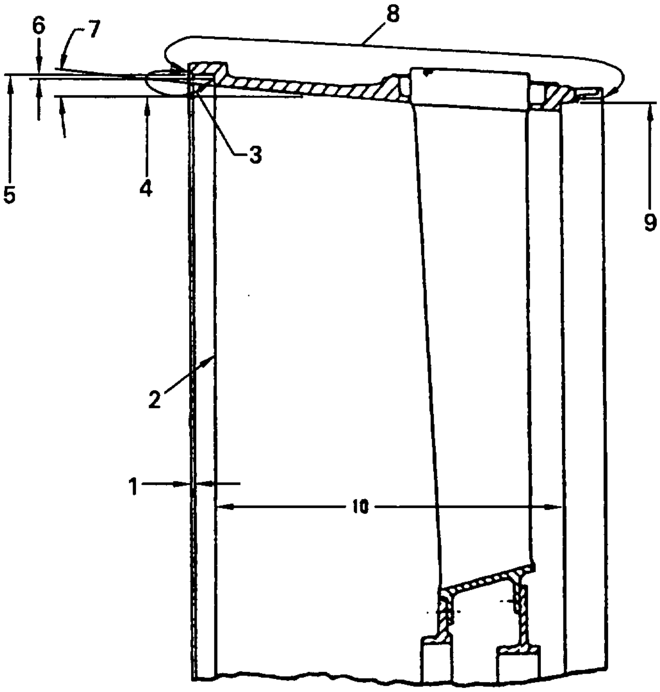
(a) Remove protective coatings as necessary as instructed In this section.

(b) Machine damaged or worn front and/or rear mating diameter as shown in figure.

(c) Nickel plate machined areas by SPOP 26. Refer to Section 70-44-01 in the Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

NOTE: Plasma coat by PWA 53-37 or PWA 53-80 may be used as an option to nickel plate. Refer to Section 70-46-01 in the Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but

R
R



L-H3124 (1296)

R
R

First Stage Compressor Vane
And Shroud Assembly Mating
Diameter Repair
Figure 612

1. Chamfer 0.020 - 0.030 Inch By 43 - 47 degrees
2. Reference Surface
3. Nickel Plate Or Plasma Coat Area

   NOTE: For PN 568891 Stage 1 Vane and Shroud Assemblies, Nickel Plate per SPOP 43 or Plasma Coat per PWA 53-37 or PWA 53-80

4. 17.344 - 17.54 Inch Diameter; Must Be Concentric With Index 5 Within 0.004 Inch FIR;
5. 17.344 - 17.748 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 17.714 Inch Diameter Maximum After Nickel Plate Or Plasma Coat. 17.724 - 17.728 Inch Diameter After Finish Machining; Diameter Must Be Concentric With Index 4 Within 0.004 Inch FIR, And Index 9 Within 0.002 Inch FIR.

   NOTE: For PN 568891 Assemblies, Finish Machine Front Mating Diameter; 17.722 - 17.726 Inch After Plate or Coat

6. 0.020 - 0.035 Inch
7. 5 Degrees 6 Minutes - 5 degrees 26 Minutes
8. Electrical Contact Area
9. 17.219 - 17.223 Inch Diameter; Must Be Concentric With Index 5 Within 0.002 Inch FIR
10. 2.913 - 2.915 Inches

Key to Figure 612

extra plasma coat must be removed at final machining.

(d) For nickel plate only, bake vane and shroud assembly at 185 - 196°C (365 - 385°F) for three hours.

(e) Finish machine diameter(s) to dimensions shown, maintaining all radii and concentricity requirements.

(f) Replace protective coat by this section.

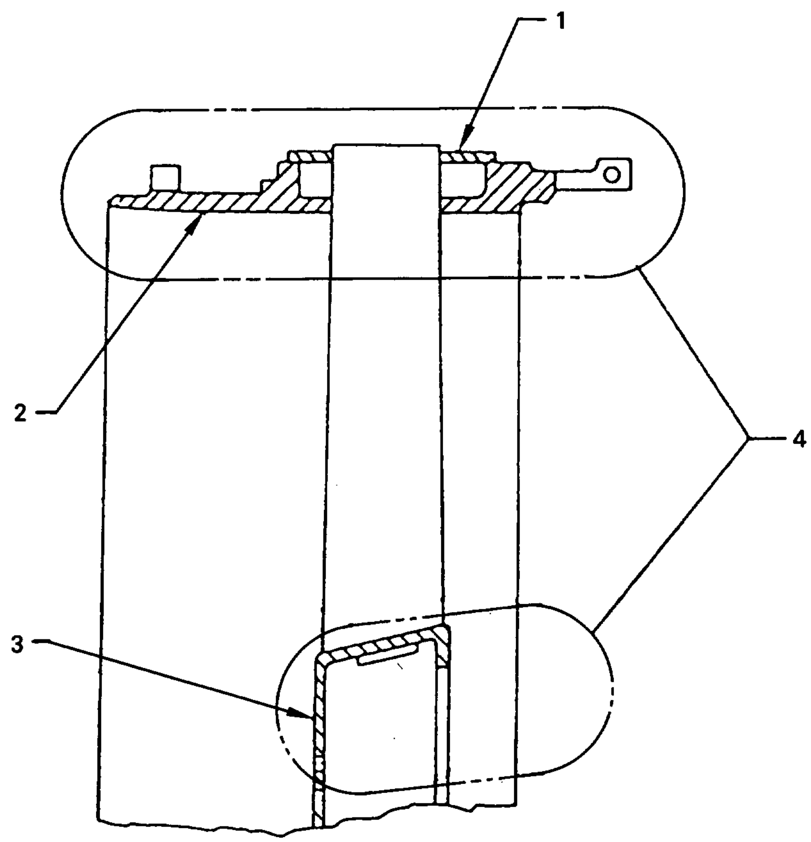
B. First And 4th Thru 8th Stage

(1) Corrosion Pitting. See Figure 613.

(a) Inspection

1 Remove protective coatings as necessary as instructed in this section.

R
R



L-H3133 (1296)

R
R

Typical First And Fourth
Through Eighth Stage Stator
Pitting Inspection And Repair
Figure 613

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-02

1. Outer Box Shroud
2. Outer Shroud
3. Inner Shroud
4. Pitting And Corrosion Are Repairable In These Areas To A Depth Of 0.005 Inch.

Key to Figure 613

2 Measure the pit depth by the replicating tape method in SPOP 127 or equivalent method. Refer to Section 70-30-00 in the Standard Practices Manual.

3 Pits on outer, inner and box shrouds are repairable to a depth of 0.005 inch.

(b) Repair

1 Complete all other necessary repairs (including removal of the air sealing ring) before you repair corrosion pits.

CAUTION: ENSURE THAT MATING DIAMETERS AND CRITICAL DIMENSIONS ARE NOT ALTERED BY THE BLAST CLEANING PROCEDURE IN PWA 110.

2 Coat the stator by the PWA 110-21 process in Section 70-41-04 in the Standard Practices Manual.

C. Second And 3rd Stages

(1) Coating Repair

(a) Apply, or renew, coating of clear, polyurethane compound on gaspath surfaces of vanes. See Figure 614.

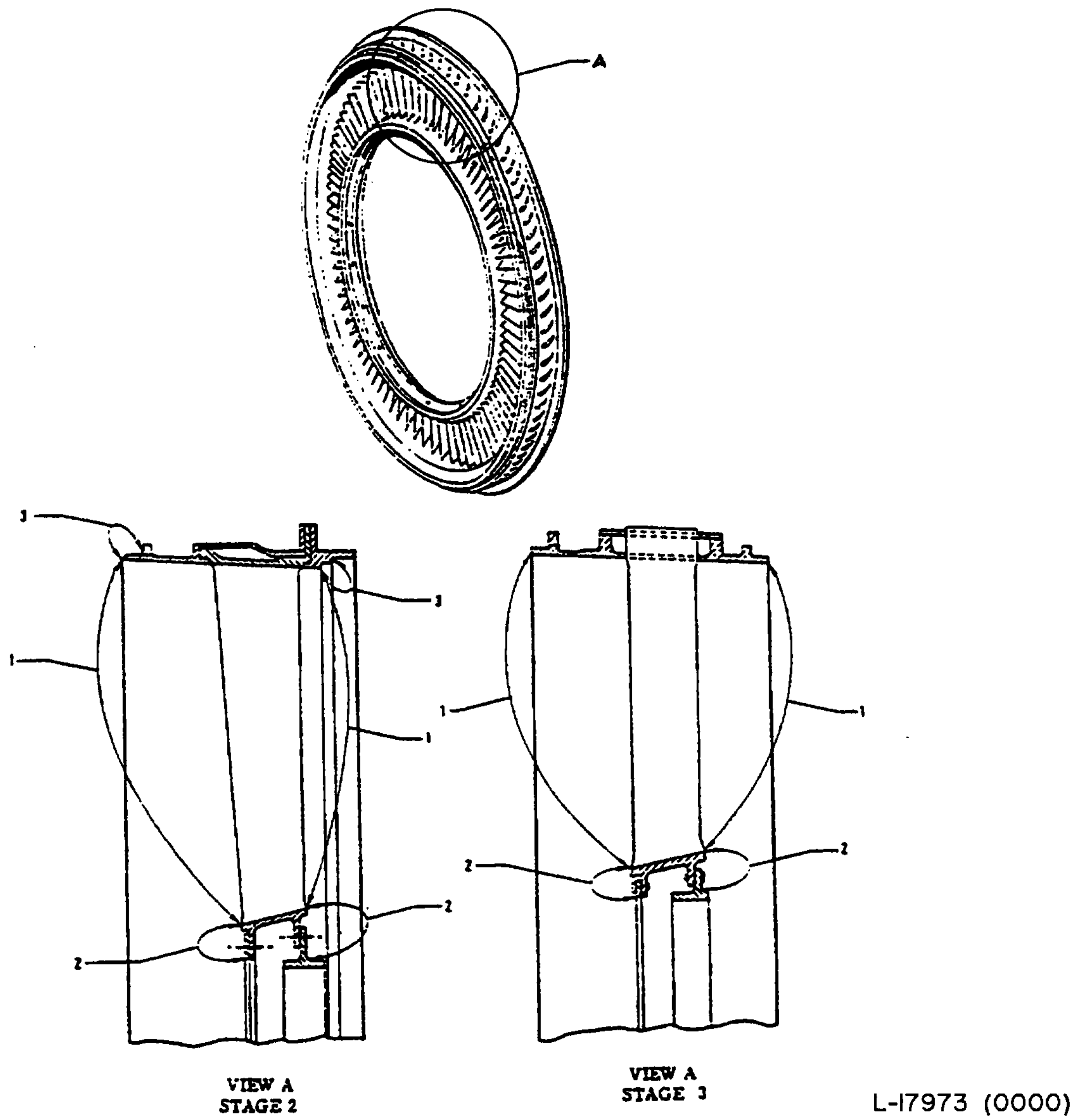
NOTE: When necessary, remove polyurethane coating with solvent.

(b) Cover areas shown with two coats.

1 Apply preliminary coat and air dry for 20 - 30 minutes.

2 Apply final coat and bake at 91° - 118°C (195° - 245°F) for 30 minutes.

R
R



1. Coat Enclosed Area
2. Overspray Permissible
3. Uncoated Area

NOTE: Please see the **TEMPORARY REVISION** that revises this page.

R
R

Vane And Shroud 2nd And
3rd Stage Coating
Figure 614

R (2) PWA 110-21/110-9 Coating (Alternate Coating Procedure)

R (a) Remove all coat and plate from all surfaces.

R (b) Apply PWA 110-21/110-9 coating, 0.0005 -
R 0.0020 inch thickness. Refer to 70-41-04 in the
R Standard Practices Manual.

R (3) Second Stage Compressor Rotor Airsealing Ring-Replacement
See Tool Group 34A and Figure 615.

(a) Mark old airsealing ring and shroud for location.

(b) Machine off rivet heads and seal land so only flat ring remains.

(c) Remove rivet shanks and old seal ring.

(d) Using old ring as template, transfer drill 140, 0.066 - 0.071 inch diameter, holes.

(e) Transfer locating mark from old ring to new ring.

(f) Align mark on new ring with mark on vane and shroud assembly.

(g) Rivet ring to vane and shroud assembly as follows:

1 Insert rivet, manufactured head against vane root.

2 Install punch into plunger of riveter.

3 Secure anvil to yoke of riveter.

4 Position cupped head of punch on manufactured head of rivet.

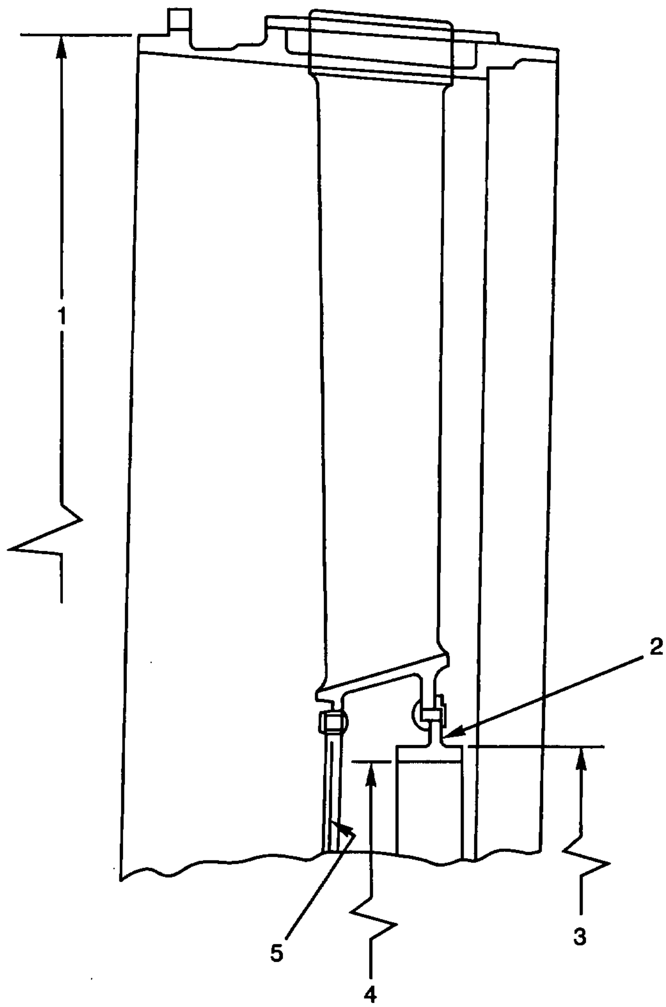
5 Squeeze handles of riveter to upset rivets.

(h) Machine ring ID, as shown.

(i) After machining, treat ID with AMS 2473.

R (4) Third Stage Compressor Rotor Airsealing Ring Replacement
See Tool Group 34A and Figure 624.

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-18292 (0000)
PW V

1. Reference Mating Diameter
2. REAR marked here On 3rd State Airsealing Ring
3. This Diameter Shall Be Concentric With Reference Diameter Within 0.010 Inch FIR Prior To Machining Of Airsealing Ring ID For Stage 2 Only
4. 9.255 - 9.265 Inch Diameter For 2nd Stage Airsealing Ring. Diameter Must Be Concentric With Diameter (1) Within 0.002 Inch FIR. 10.135 - 10.145 Inch Diameter For 3rd Stage Airsealing Ring. Diameter Must Be Concentric With Mating Diameters Within 0.002 Inch FIR.
5. Vane Stiffening Ring (Positioning Plate) Chamfer Installed This Side.

R
R

Second And 3rd Stage
Compressor Airsealing Ring And
Vane Stiffening Ring Replacement
Figure 615

(a) Remove rivets securing ring to vane and shroud assembly and remove ring.

CAUTION: DURING RIVET REMOVAL CARE SHALL BE TAKEN TO PREVENT DAMAGE TO RIVET HOLES IN SUPPORT RING OR VANES.

(b) Position new ring, as shown, and transfer drill 140 holes, 0.066 - 0.071 inch diameter.

NOTE: Ensure that side of ring marked REAR is so installed for 3rd stage.

(c) Rivet ring to vane and shroud assembly. For riveting procedure, see step (2)(g).

(d) Machine ring ID, as shown.

(e) After machining, treat ID with AMS 2473.

R (5) Compressor Vane Stiffening Ring - Replacement See Tool Group 34A.

(a) Remove rivets securing ring to vane and shroud assembly and remove ring.

(b) Treat new 3rd stage ring with AMS 2470.

(c) Install new ring with chamfer against vanes.

(d) Align ring and drill holes to 0.066 - 0.071 inch diameter.

(e) Rivet ring to vane and shroud assembly as follows:

1 Insert rivet, manufactured head against vane root.

2 Position cupped head of riveter on manufacturing head of rivet.

3 Squeeze handles of riveter to upset rivet.

R (6) Compressor Vane, Second Stage - Replacement

(a) Mark position of compressor shroud flange.

(b) Remove rivets securing flange to vane and shroud assembly and remove flange.

(c) Mark position of airsealing ring.

(d) Remove rivets securing ring to vane and shroud assembly and remove ring.

(e) Remove two rivets per vane that secure vane to front inner stiffening ring.

(f) Remove damaged vane and replace with new part.

<u>CAUTION</u>: VANES FOR JFTD12A-4A, JFTD12A-5A, JT12A-8 (L), AND JT12-8 (N) ENGINES ARE NOT TO BE INTERMIXED WITH VANES OF OTHER ENGINE MODELS.

(g) Reinstall seal ring and shroud flange in original locations.

(h) Check vane angles. See paragraph Vane Bending.

R (i) Inspect diameter concentricities. See Figure 615.

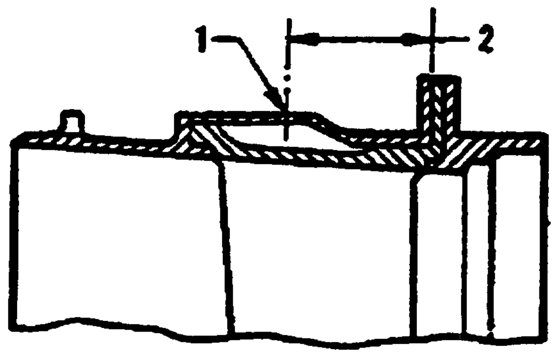
R (7) Second Stage Vane and Shroud Assembly - Fluid Drainholes. To enable fluid drainage from between vanes and outer shroud, drill holes. See Figure 616.

R (8) Second Stage Outer Shroud Front Mating Diameter Repair. See Figure 617.

(a) Machine damaged or worn front mating diameter as shown in figure.

(b) Nickel plate diameter by SPOP 43. Refer to Section 70-44-01 in the Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

R <u>NOTE</u>: Plasma coat by PWA 53-37 or PWA 53-80 is
R permitted as an option to nickel plate.
R Refer to 70-46-01 in the Standard Practices
R Manual. If plasma coat is used, do not
R do a bake operation. Plasma coat out of
R the area shown is permitted, but it will be
R necessary to remove this unwanted plasma
R coat during the finish machining operation.



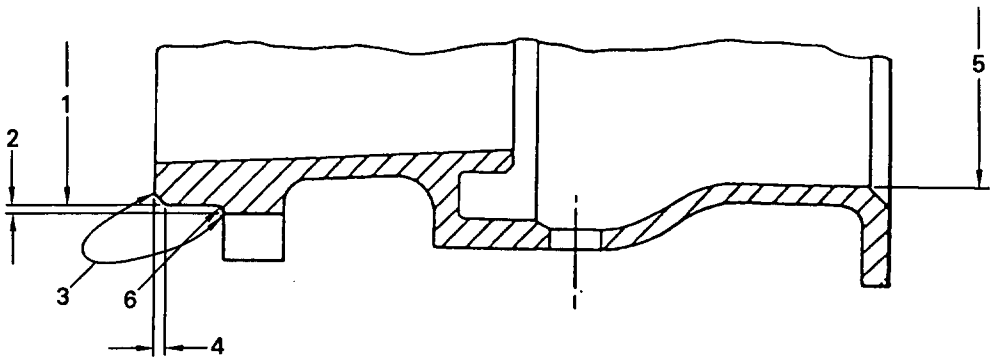
L-2528I (0000)

1. Four Holes, 0.115 - 0.135 Inch Diameter, Equally Spaced And Located Within 0.020 Inch Radius Of True Position; Angular Relation To Other Features Unimportant.
2. 0.720 Inch

NOTE: Please see the ***TEMPORARY REVISION*** *that revises this page.*

R
R

Second Stage Vane And Shroud
Assembly - Fluid Drainholes
Figure 616



L-H3131 (1296)

1. 17.199 - 17.213 Inch Diameter For Cleanup Machining. Hold To Maximum Value. 17.233 Inch Minimum Diameter After Plating Or Coating. 17.219 - 17.223 Inch Finish Diameter.

R NOTE: Index 1 diameter must be concentric with Index 5 diameter
R 0.002 inch FIR maximum.

2. 0.020 - 0.035 Inch
3. Nickel Plate Or Plasma Coat Area
4. Chamfer 0.020 - 0.030 Inch By 43 - 47 degrees
5. 17.138 - 17.142 Inch Diameter
6. 0.010 - 0.020 Inch Radius

Second Stage Vane And Shroud
Assembly Front Diameter Repair
Figure 617

(c) Finish machine diameter to dimensions shown, maintaining radius and concentricity requirements.

(d) Treat any bare surfaces by the surfaces by the AMS 2473 procedure in SPOP 42. Refer to Section 70-44-01 in the Standard Practices Manual.

R (9) Third Stage Vane and Shroud Mating Diameter Repair. See Figure 618.

(a) Machine damaged or worn front and/or rear mating diameter as shown in figure.

(b) Nickel plate the diameter(s) by SPOP 43. Refer to Section 70-44-01 in the Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

NOTE: Plasma coat per PWA 53-37 or PWA 53-80 may be used as an option to nickel plate. Refer to Section 70-46-01 in the Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but extra plasma coat must be removed at final machining.

(c) Finish machine diameter(s) to dimensions shown, maintaining radius and concentricity requirements.

(d) Treat any bare surfaces by the AMS 2473 procedure in SPOP 42. Refer to Section 70-44-01 in the Standard Practices Manual.

D. Fourth Through Eighth Stages Lockwire Lugs

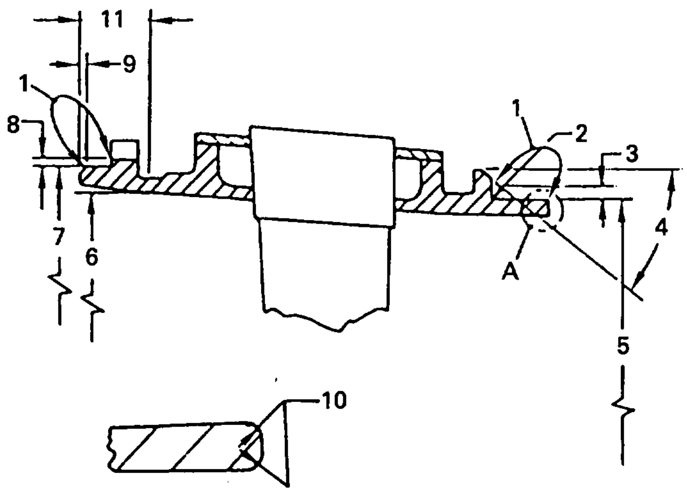
(1) Broken or mutilated lockwire lugs may be removed and replaced.

(2) Braze on fabricated lug using AMS 2665. Refer to Section 70-42-03, Repair-05 in the Standard Practices Manual. Stress-relief is not necessary.

E. Fourth Thru Eighth Stage Vane and Shroud

(1) Inner Shroud Rivet Hole Repair.

(a) Remove air sealing ring as instructed in this section.



R
R

Third Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 618

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-02

1. Nickel Plate Or Plasma Coat Area

   NOTE: Front mating diameter may be nickel plated only.

2. 0.010 - 0.020 Inch Radius
3. 0.015 - 0.030 Inch
4. Chamfer 33 - 37 Degrees
5. 16.718 - 16.732 Inch Diameter After Cleanup Machining
   16.572 Inch Minimum Diameter After Plating Or Coating
   16.738 - 16.742 Inch Finish Diameter

   NOTE: Index (5) diameter must be concentric with Index 7 diameter within 0.002 inch FIR

6. Reference Diameter
7. 16.968 - 16.982 Inch Diameter After Cleanup Machining
   17.002 Inch Minimum Diameter After Plating Or Coating
   16.988 - 16.992 Inch Finish Diameter

   NOTE: Index 7 Diameter Must Be Concentric With Index 6 Diameter Within 0.004 Inch FIR and With Index 5 Diameter Within 0.002 Inch FIR

8. 0.015 - 0.030 Inch
9. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
10. 0.020 - 0.040 Inch Radius
11. 0.345 Inch Gage Dimension

Key To Figure 618

(b) Remove protective coatings as necessary as instructed in this section.

(c) Fill rivet holes and cracks up to 0.050 inch in length by the weld process using AMS 5776 filler metal.

   NOTE: AM 363 (PWA 793) filler metal may be used as an option to AMS 5776.

   CAUTION: TO AVOID CRACKS, PARTS MUST BE HANDLED WITH CARE UNTIL STRESS-RELIEF PROCESS IS ENDED.

(d) Stress-relieve as follows:

   1 Place vane and shroud on a flat plate in a cold furnace.

R
R

2 Support inner shroud in relation to outer shroud.

3 Place flat plate on top of assembly.

4 Stress-relieve by SPOP 455-2 in Section 70-42-04 in the Standard Practices Manual.

R (e) Do a fluorescent penetrant inspection of the welded
R area. Refer to 72-00-00, Table 605.

(f) Grind the weld repair flush with the rear face of the inner shroud to ensure that the air sealing ring seats properly.

R (g) Do a fluorescent penetrant inspection of the welded
R area. Refer to 72-00-00, Table 605.

(h) Install air sealing ring.

1 If optional slot is present, rotate the airseal 2.25 degrees. If slot is not present, rotate airsealing ring 4.5 degrees.

2 Transfer drill twenty 0.064 - 0.068 inch diameter holes into the inner shroud.

3 Break edges of rivet holes to ensure proper seating of rivet heads.

4 Install air sealing ring as instructed in this section.

(i) Replace protective coat per this section.

F. Air Sealing Ring Lands

(1) Wear Limits

R (a) First and 2nd stages are repairable to a maximum depth of 0.020 inch.

(b) Third thru 5th and 8th and 9th stages are repairable to a maximum depth of 0.015 inch.

(2) Repair of Air Sealing Lands. See Figure 619, Figure 620 and Figure 621.

CAUTION: TAKE CARE WHEN YOU REMOVE THE RIVETS TO PREVENT DAMAGE TO THE RIVET HOLES.

(a) Remove the air sealing ring as instructed in this section.

(b) Remove the protective coat as necessary as instructed in this section.

(c) Clean up only to the full depth of wear. Hold to the minimum dimension. Allow for 0.003 - 0.025 inch plate or coat after finishing machining.

NOTE: Minimum wall thickness of 0.035 inch must be maintained on all seal lands for 360 degrees. See Figure 619, Index 3 to Index 4; Figure 620, Index 4 to Index 2, and Index 5 to Index 3; and Figure 621, Index 2 to Index 5, and Index 3 to Index 6.

(d) Post Clean-Up Coating/Plating

1 For aluminum air sealing rings, 1st thru 6th stages, refer to SPOP 43 in Section 70-44-01 in the Standard Practices Manual.

2 For steel air sealing rings, 7th thru 9th stages, refer to SPOP 26 in Section 70-44-01 in the Standard Practices Manual.

NOTE: As an option to nickel plate, you can plasma coat all part by the PWA 53-37 or PWA 53-80 process. Refer to Section 70-46-01 in the Standard Practices Manual.

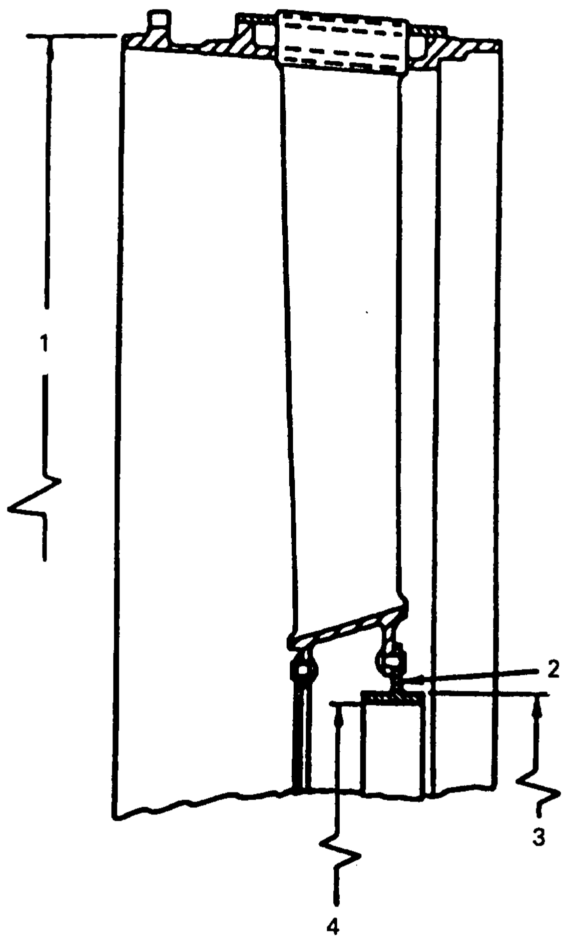
3 Coat/plate must be complete for 360 degrees. Partial coating/plating is not permitted.

(e) Install the air sealing ring as instructed in this section.

(f) Machine to the finished dimensions given in Figure 619 thru Figure 621.

(g) Replace the protective coat as instructed in this section.

R
R



NOTE: Please see the **TEMPORARY REVISION** that revises this page.

R
R

Typical Stator Assembly
1st Through 3rd Stages
Figure 619

1. Reference Mating Diameter
2. Rear Marked Here On 1st And 3rd Stages
3. Air Sealing Ring Outer Diameter Must Be Concentric With Reference Diameter Within 0.010 Inch FIR Prior To Machining Of Air Sealing Ring ID.
4. Air Sealing Ring Inner Diameter Shall Be Concentric With Reference Snap Diameter Within 0.002 Inch FIR.

1st Stage	7.995 - 8.005 Inch Diameter
2nd Stage	9.255 - 9.265 Inch Diameter
3rd Stage	10.135 - 10.145 Inch diameter

Key to Figure 619

G. Fourth Thru 6th Stage Air Sealing Rivet Hole Repair

(1) You are permitted to repair worn or elongated rivet holes by drilling twenty (20) 0.064 - 0.068 inch diameter holes midway between existing holes.

(2) You can use the inner shroud as a template.

(3) A maximum of three such repairs is permitted.

(4) Post Requisites.

(a) Break the edges of the new rivet holes so that the rivet heads will seat properly.

(b) Stress-relieve by SPOP 455-2. Refer to Section 70-42-04 in the Standard Practices Manual.

(c) Fluorescent penetrant inspect as instructed in this section.

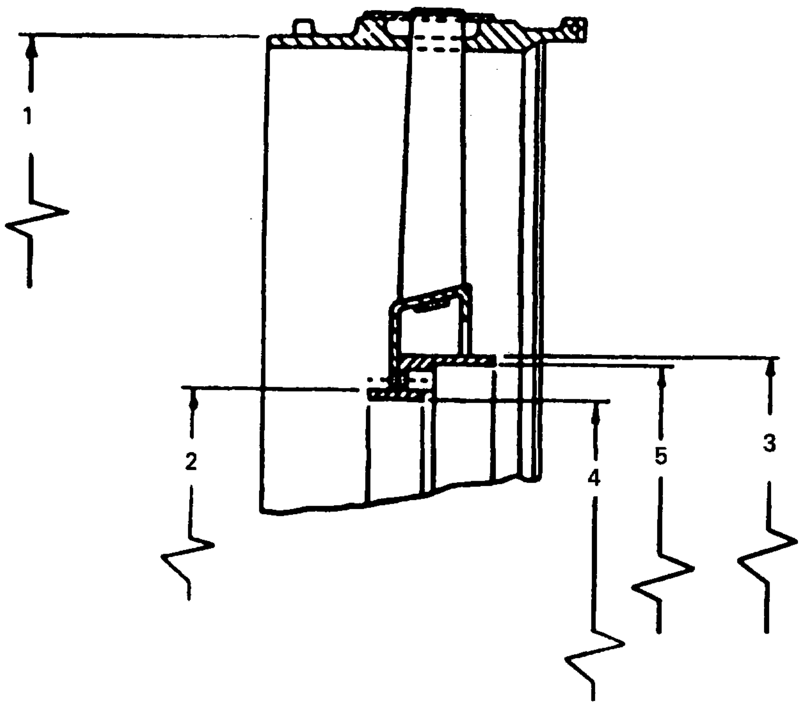
(d) Grind the weld repairs flush with the front face to ensure proper seating with the shroud.

(e) Fluorescent penetrant inspect the weld repairs as instructed in this section.

H. Compressor Vane and Shroud Assembly Lug and Slot Repair See Figure 622 and Figure 623.

(1) Steel vane and shroud assemblies

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-H3140 (1296)

R
R

Typical Stator
Stages 4, 5, And 8
Figure 620

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-02

1. Reference Mating Diameter
2. Air Sealing Ring Forward Outer Diameter Shall Be Concentric With Index 1 Diameter Within 0.010 Inch To Machining Air Sealing Ring ID.
3. Air Sealing Ring Aft Outer Diameter Shall Be Concentric With Index 1 Diameter Within 0.010 Prior To Machining Air Sealing Ring ID.
4. Air Sealing Ring Forward Inner Diameter Must Be Concentric With Index 1 Diameter Within 0.002 Inch FIR. Finish Machine As Follows:

Fourth Stage	10.205 - 10.215 Inch Diameter
Fifth Stage	10.875 - 10.885 Inch Diameter
Eight Stage	12.425 - 12.435 Inch Diameter

5. Air Sealing Ring Aft Diameter Must Be Concentric With Index 1 Diameter Within 0.002 Inch FIR. Finish Machine As Follows:

Fourth Stage	10.305 - 10.315
Fifth Stage	11.435 - 11.445
Eight Stage	12.985 - 12.995

Key to Figure 620

(a) Grind or machine area to be repaired only enough to clean up.

NOTE: Cracks in lugs shall be removed prior to weld buildup.

(b) Wrap area adjacent to area to be welded with water-soaked ceramic fiber rope.

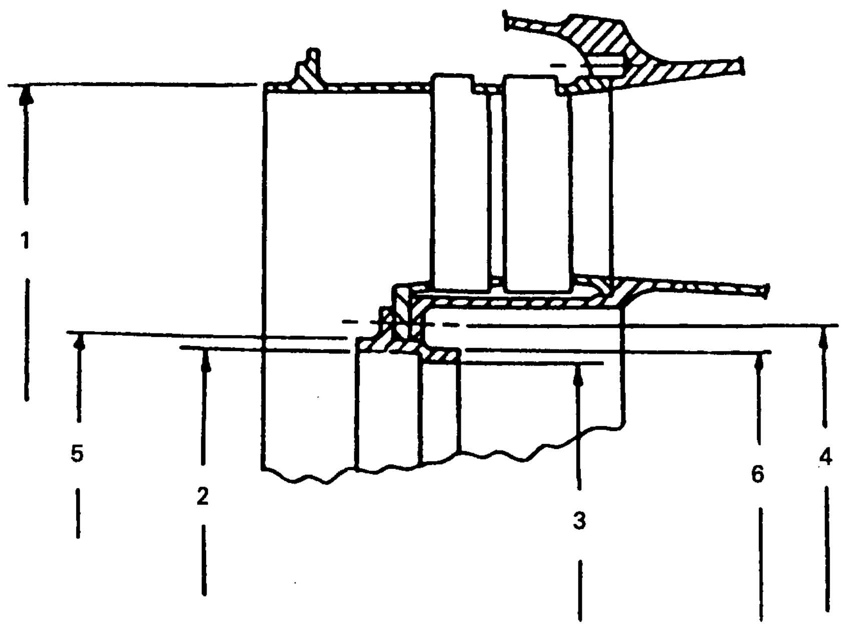
(c) Build up lugs or slots by welding, using AMS 5776 rod.

NOTE: Build up one side and drill through from opposite side. Repeat procedure for other side.

(d) Hold the assembly flat and concentric and stress-relieve by SPOP 460-2. Refer to Welding in the Standard Practices Manual, Section 70-42-00.

(e) Machine to dimensions shown.

R
R



L-H3141 (1296)

NOTE: Please see the **TEMPORARY REVISION** that revises this page.

R
R

Case And 9th Stator Assembly
Figure 621

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-02

1. Reference Mating Diameter
2. Air Sealing Ring Forward Inner Diameter - Finish Machine As Follows:

572958	13.008 - 13.012
618813	12.988 - 12.992
656320	13.008 - 13.012
659299 (735849)	12.988 - 12.992

3. Air Sealing Ring Rear Inner Diameter. Finish Machine As Follows:

572958	12.908 - 12.912
618813	12.888 - 12.892
656320	12.908 - 12.912
659299 (735849)	12.888 - 12.892

4. 13.470 Inch Diameter To Centerline of Rivet Holes
5. Air Sealing Ring Forward Outer Diameter
6. Air Sealing Ring Rear Outer Diameter

NOTE: Prior to Machining Air Sealing Ring, Indexes 2 and 3 Must Be Concentric to Index 4 within 0.010 Inch FIR. After Machining, Indexes 2 and 3 Must Be Concentric to Index 1 Within 0.002 Inch FIR

Key To Figure 621

(f) Inspect vane and shroud assembly. Refer to Fluorescent Penetrant Inspection in the Standard Practices Manual, Section 70-33-00.

NOTE: Lugs and mating slots having less than 0.040 inch wear are acceptable without repair, provided they are not cracked or broken.

(2) Aluminum Vane and Shroud Assemblies

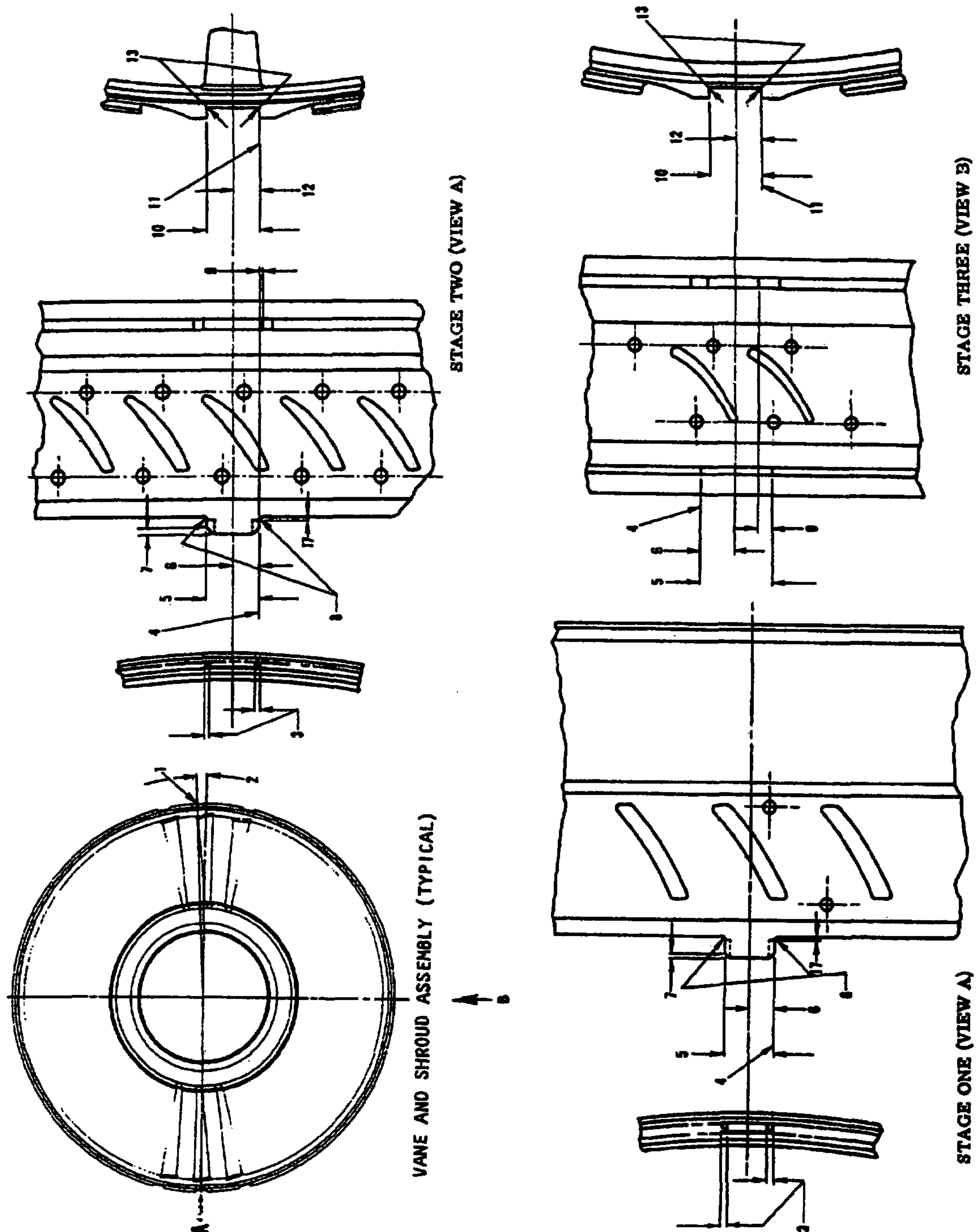
(a) Grind or machine area to be repaired only enough to clean up.

NOTE: Cracks in lugs shall be removed prior to weld buildup.

(b) Wrap area adjacent to area to be welded with water-soaked ceramic fiber rope.

(c) Build up lugs and slots and repair shroud cracks by welding using AMS 4190 rod.

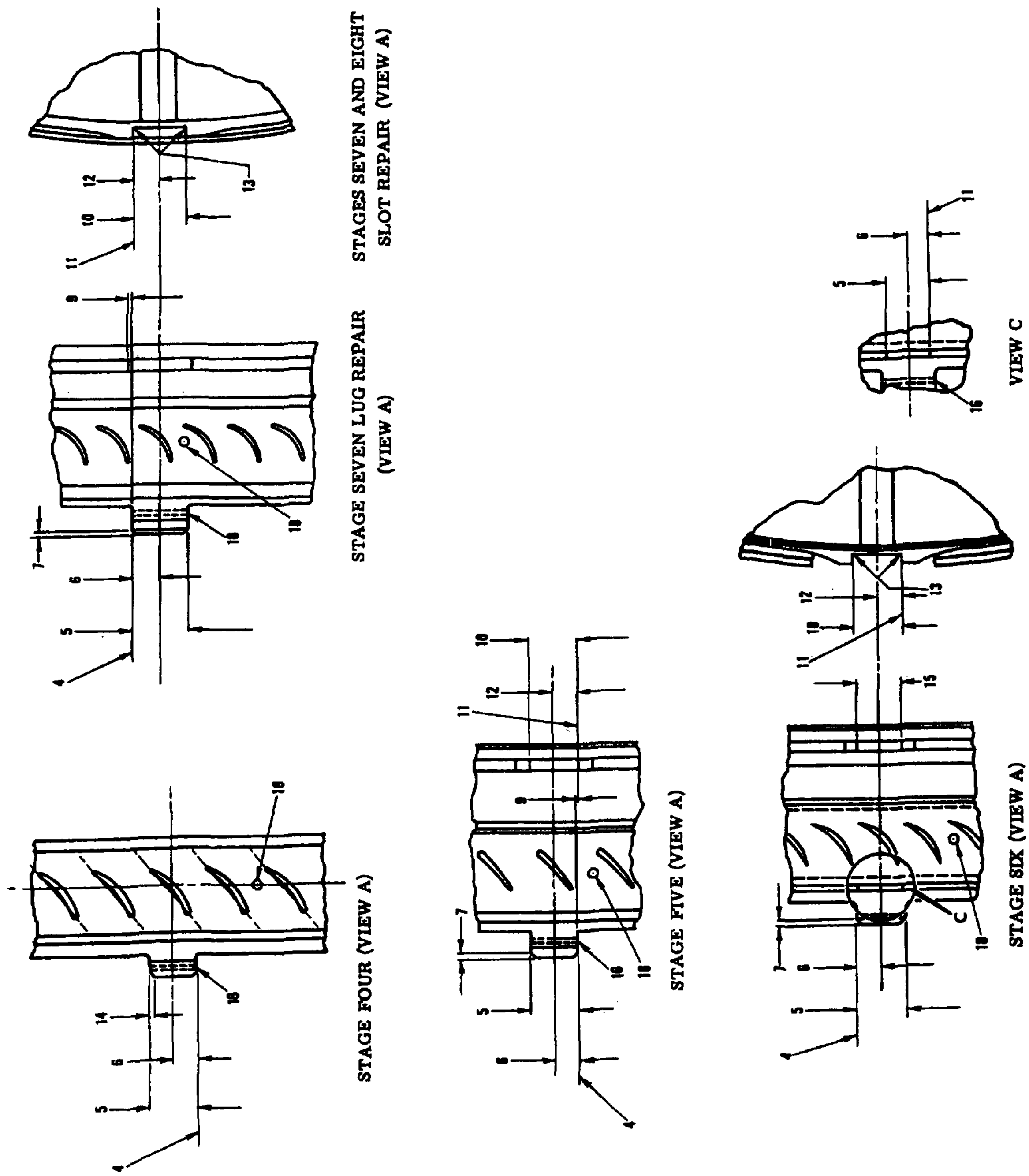
R
R



L-19261 (0000)

R
R

Stages One Thru Three
Vane And Shroud Assembly
Lug And Slot Repair
Figure 622



L-21946 (0000)

R
R

Stages Four Thru Eight
Vane And Shroud Assembly
Lug And Slot Repair
Figure 623

1. Centerline of Offset Lug And Slot
2. Lug And Slot Offset Three Degrees
3. 0.025 -0.035 Inch By 43° - 47° Chamfer
4. This Face On Each Lug Must Be Located Within 0.002 Inch Of True Angular Position In Relation To Rear Snap ID (See Section XI)
5. 0.489 - 0.493 Inch (0.739 - 0.745 Inch For 3rd Stage And 0.487 - 0.491 Inch For 5th Stage)
6. 0.2455 Inch (0.371 Inch For 3rd Stage And 0.2445 Inch For 5th Stage)
7. 0.010 - 0.030 Inch By 43° - 47° Chamfer (Both Sides).
   0.020 - 0.030 Inch By 43° - 47° Chamfer For 1st And 2nd Stages
8. 0.016 - 0.031 Inch Radius

   NOTE: Third stage lug corner radius is 0.016 - 0.031 inch.

9. This Dimension Is For One Lug And One Slot At View A Only. See Table 603.

   NOTE: For 3rd stage, this dimension is located at six o'clock position (View B), as shown.

10. 0.498 - 0.502 Inch
11. This Face On Each Slot (And On 20 Lugs Of 6th stage) Must Be Located Within 0.002 Inch Of True Angular Position In Relation To Front Snap OD.
12. 0.250 Inch (See Section XI)
13. Slot Radius. (See Table 603)
14. 0.010 - 0.030 Inch by 43° - 47° Chamfer (Both Sides)
15. 0.4935 - 0.4975 Inch For One Lug And One Slot Only (At View A)
16. 0.055 - 0.065 Inch Diameter Hole Through Four Lugs
17. 0.000 - 0.030 Inch
18. 0.120 - 0.130 Inch Diameter

Key to Figure 622 and Figure 623

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page.

(d) Stress-relieve at 157° - 168°C (315° - 335°F) for four hours.

(e) Machine to dimensions shown.

NOTE: Ensure that any buildup of weld material on shroud ID is removed to preclude possibility of blade rub during engine operation.

(f) Inspect vane and shroud assembly. See Fluorescent Penetrant Inspection, Standard Practices Manual.

NOTE: Lugs and mating slots having less than 0.040 inch wear are acceptable without repair, provided they are not cracked or broken.

I. Stages 4 thru 6

(1) Inspection

(a) Remove rivets securing airsealing ring to vane and shroud assembly and remove ring.

(b) Inspect assembly for lack of or worn, cadmium plate.

(c) Inspect condition of paint for flaking and chipping.

(2) Plating. Plate, serviceable or new unplated assembly, as follows:
See Tool Group 29A-1 and Figure 624.

NOTE: For shroud assemblies incorporating plug rivets or adhesive in outer shroud, remove rivets or adhesives to facilitate draining after cleaning and plating. Rivet shanks need not be removed from within shroud. For vane and shroud assemblies not previously plated, drill 0.120 - 0.130 inch diameter drain holes in outer shroud outer surface. Drill only as far as box area. For Stages 4 thru 6, drill eight, ten, and six holes respectively. Holes shall be equally spaced between vanes and around vane outer shroud. Seal holes completely with adhesive after plating. Maximum permissible adhesive projection into box area is 0.050 inch. Use

General Electric RTV 156 adhesive, and cure at room temperature for 24 hours.

(a) Clean and cadmium plate vane and shroud assembly when necessary, using fixture. Refer to SPOP 21 in the Standard Practices Manual, Section 70-44-01. For surface area plating, see Table 603.

NOTE: Plate is optional and may be incomplete in box shroud area (as shown) and in 1/8 inch diameter holes on outer shroud periphery. Electrical contact is permitted only in area shown.

Stage	Vane and Shroud	Airsealing Ring
4	6.0 sq. ft.	-
5	3.7 sq. ft.	-
6	3.2 sq. ft.	-
7	3.0 sq. ft.	95.0 sq. in.
8	2.8 sq. ft.	105.0 sq. in.

Stages 4 thru 8
Stator Assembly - Plating Area
Table 603

(b) Bake assembly by SPOP 21. Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: Assembly has Rockwell hardness of C30 - C38, or equivalent.

(3) PWA 110-21/110-9 Coating (Alternate Coating Procedure).

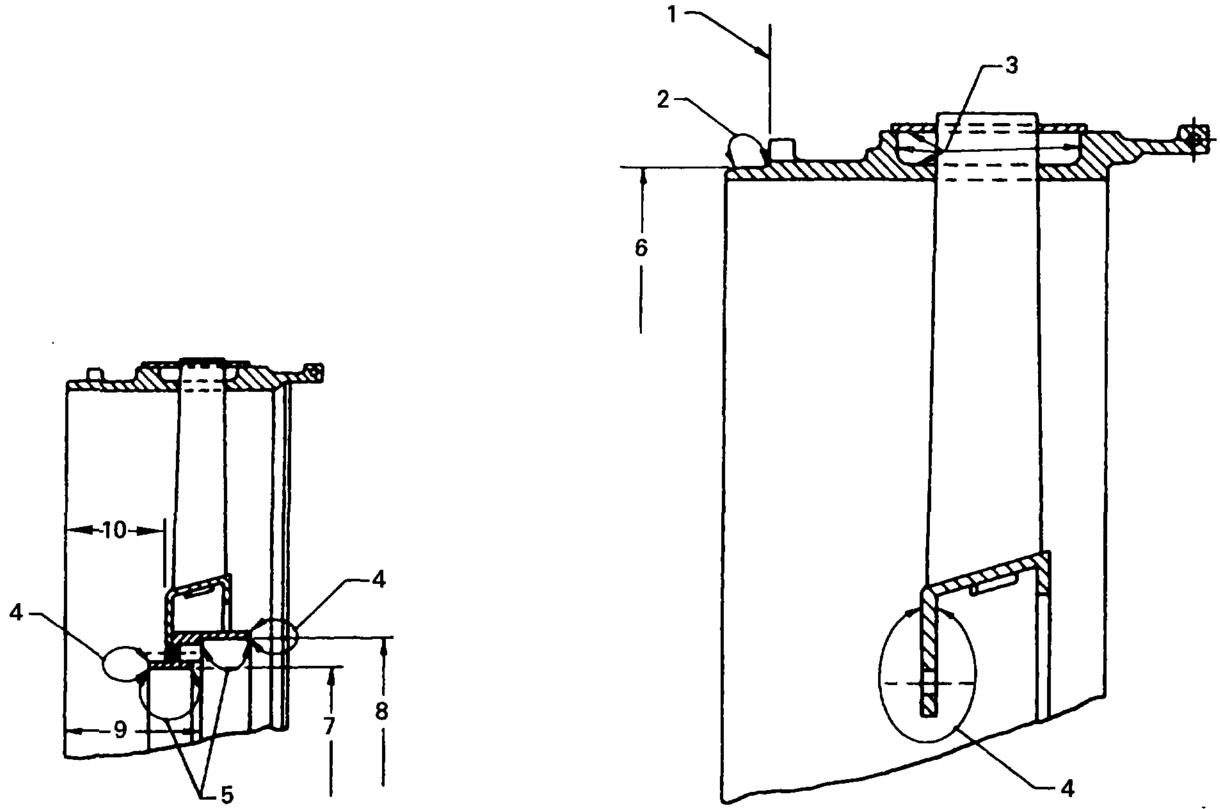
NOTE: Coating is required for vane and shroud assemblies post-SB 6211.

(a) Remove all the coating and plating from all surfaces.

(b) Apply PWA 110-21/110-9 coating, 0.0005 - 0.0020 inch thick. Refer to Section 70-41-04 in the Standard Practices Manual.

R (4) Airsealing Ring Installation.

(a) Position serviceable or new airsealing ring on assembly, and, if necessary, transfer drill 20 holes in ring, 0.064 - 0.068 inch diameter.



R
R

Stages 4 Thru 8 Vane And Shroud
Plating Repair
Figure 624

1. Overspray Permissible On This Surface
2. Aluminum Paint Area
3. Optional Plate Area
4. Electrical Contact Area
5. Paint Area. Treat Stages 4 Thru 6 By The AMS 2473 Procedure In SPOP 42. See Section 70-44-01, Standard Practices Manual.

Stage	Index 6 (Inches)	Index 7 (Inches)	Index 8 (Inches)	Index 9 (Inches)	Index 10 (Inches)
4	16.747 - 16.751	10.205 - 10.215	10.305 - 10.315	.213 - .238	.035 - .045
5	16.533 - 16.537	10.875 - 10.885	11.435 - 11.445	1.231 - 1.256	.950 - .960
6	16.369 - 16.373	11.441 - 11.451	12.001 - 12.011	1.144 - 1.169	.934 - .944
7	16.313 - 16.317	12.001 - 12.011	12.561 - 12.571	.946 - .971	.745 - .757
8	16.297 - 16.301	12.425 - 12.435	12.985 - 12.995	.976 - 1.001	.726 - .736

NOTE: Indexes 7 and 8 must be concentric with Index 5 Diameter within 0.010 inch FIR.

NOTE: No burning, pitting, or selective attack is permitted. Completely cover electrical contact point with high-baking, heat-resistant, aluminum enamel.

NOTE: Drop dimension from outer shroud to face of inner shroud (Index 10) for Stage 4 is forward of snap.

Key to Figure 624

NOTE: Please see the TEMPORARY REVISION that revises this page.

(b) Rivet ring to vane and shroud assembly.

(c) Machine ring front and rear inside diameters to dimensions shown.

(d) Treat ring inside diameters by AMS 2473 (SPOP 42) as shown. Refer to Section 70-44-01 in the Standard Practices Manual.

(e) Paint with high-baking, heat-resistant, aluminum enamel those areas specified in Figure 625, as well as all fixture contact points, and any other abrasions or scratches penetrating through plating to bare metal as a result of fixturing. Refer to SPOP 142 in Section 70-41-03 in the Standard Practices Manual. Finished paint thickness shall be 0.0015 - 0.0025 inch.

NOTE: Aluminum enamel shall be applied, using lower bake temperature for cadmium-plated parts. Do not abrasive blast before applying aluminum enamel.

(5) Four thru 6 Stage Vane and Shroud Assembly Outer Box Shroud Crack Repair

(a) Remove the protective coating as necessary. See Paragraph I.(2).

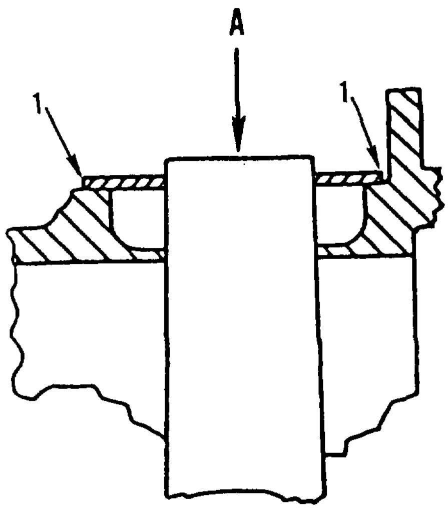
(b) Remove and replace the airsealing ring. See Paragraph I.(4).

(c) Use a No. 60 drill bit (0.040 inch diameter) to
R stop drill cracks. See Figure 625.

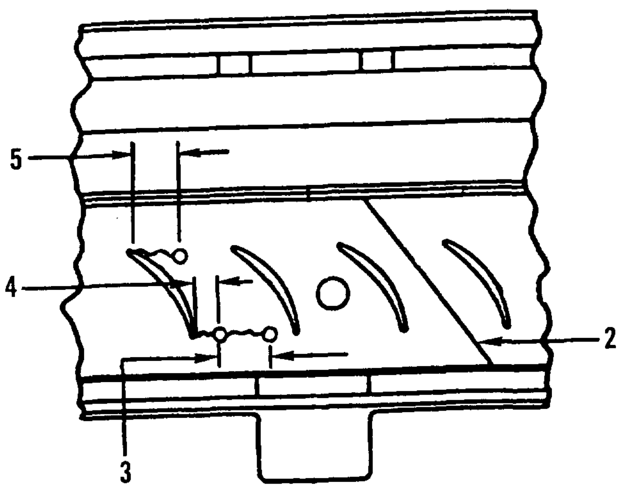
NOTE: Stop drill holes must be free of weld protuberances to avoid stress risers, and therefore, could require reaming of polishing after the crack has been welded.

(d) Rout the cracks completely in the area to be welded, keeping the width of the cut to a minimum.

(e) Weld the crack with AMS 5776 (410 bare) or AM 363 (PWA 791) filler metal.



TYPICAL STATOR ASSEMBLY



L–88506

VIEW IN DIRECTION A

NOTE: Please see the
TEMPORARY
REVISION
that revises this page.

1. Cracks In The Circumferential Weld Area: Do Not Stop Drill Cracks. Weld The Cracks Using AMS 5776 (410 Bare) Or AM 363 (PWA 791) Filler Metal
2. It Is Permitted To Weld Cracks In This Weld Again
3. It Is permitted To Weld Cracks (Longer Than 0.025 Inch) 0.050 Inch From The Braze And At The End Of The Crack. Rout And Weld The Crack Between Holes.
4. 0.050 Inch
5. Stop Drill Cracks Less Than 0.125 Inch Long Which Come From The Brazed Area At The End Of The Crack And Let Them Stay Not Welded.

Key to Figure 625

CAUTION: BE CAREFUL WITH THE PARTS UNTIL STRESS-RELIEF IS ACCOMPLISHED.

(f) Stress-relieve as follows:

1 Place the assembly on a flat plate in a cold furnace.

2 Support the inner shroud in relation to the outer shroud.

3 Place the flat plate on top of assembly.

4 Stress-relieve by SPOP 455-2 in Section 70-42-04 in the Standard Practices Manual.

(g) Fluorescent penetrant inspect welded area. See Paragraph I.

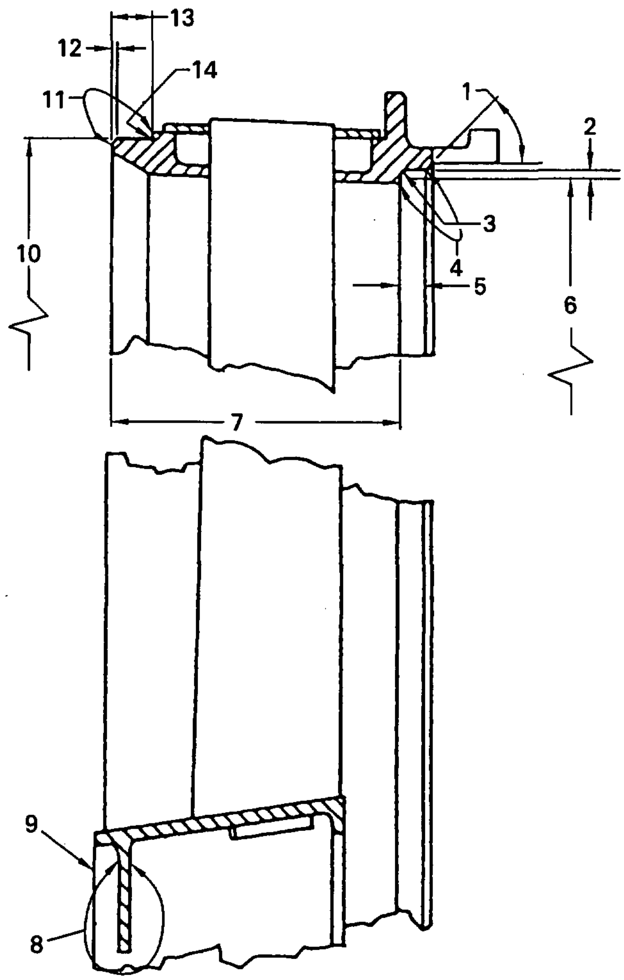
(h) Blend the weld flush to 0.010 inch above the surface. Do not remove any parent metal.

(i) Fluorescent penetrant inspect the welded area. See Paragraph I.

(j) Make a dimensional inspection of the repaired diameters as required. See Paragraph I.(4).

(6) Four Thru 6 Stage and Mating Diameter Repair. See
R Figure 626, Figure 627, and Figure 628.

(a) Remove protective coatings as necessary as instructed in this section.



L-H3125 (1296)

R
R

Fourth Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 626

1. Chamfer 43 - 47 Degrees
2. 0.020 - 0.035 Inch
3. 0.010 - 0.020 Inch Radius
4. Nickel Plate Or Plasma Coat Area
5. 0.095 - 0.105 Inch To Sharp Corner
6. 16.543 - 16.557 Inch Minimum Diameter For Cleanup Machining; Hold To Minimum Value. 16.523 Inch Diameter Maximum After Plate Or Coat. 16.533 - 16.537 Inch Diameter After Finish Machining; 0.020 Inch Out-Of-Round In Excess Of This Tolerance Permissible. Diameter Must Be Concentric With Index (10) Within 0.002 Inch FIR
7. 1.118 - 1.120 Inches
8. Electrical Contact Area
9. Reference Surface
10. 16.729 - 16.741 Inch Diameter For Cleanup Machining; Hold To Maximum Value. 16.760 Inch Diameter Minimum After Plate Or Coat. 16.747 - 16.751 Inch Diameter After Finish Machining. Diameter Must Be Concentric With Index 6 within 0.002 Inch FIR
11. Nickel Plate Or Plasma Coat Area
12. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
13. 0.115 - 0.125 Inch
14. 0.010 - 0.020 Inch Radius

Key to Figure 626

(b) Machine damaged or worn front and/or rear mating diameter as shown in figure.

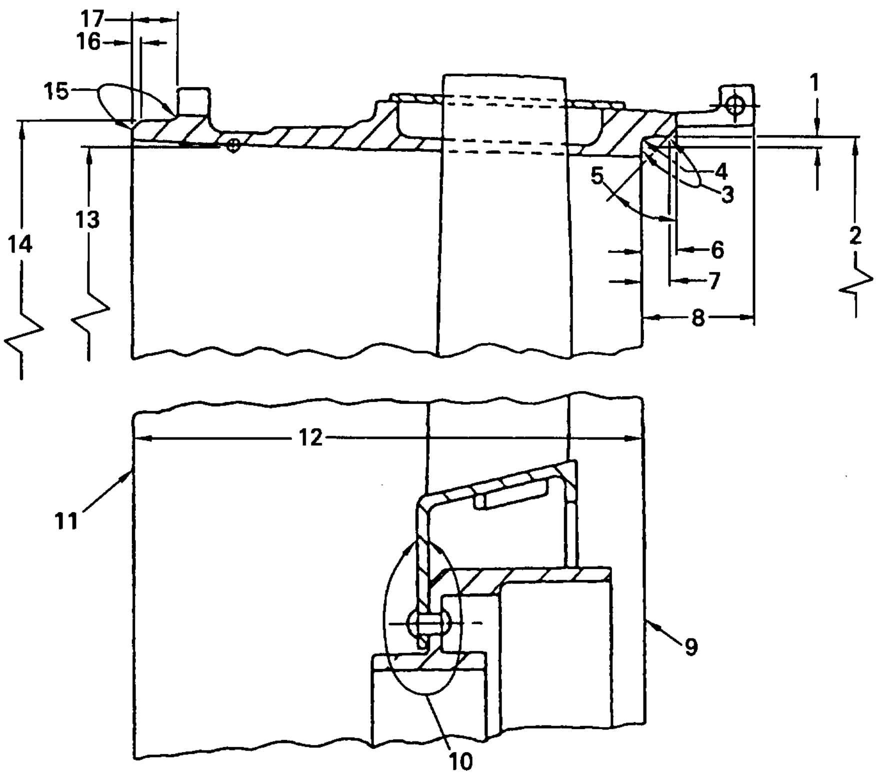
(c) Nickel plate machined areas by SPOP 26. Refer to Section 70-44-01, Standard Practice Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

<u>NOTE</u>: Plasma coat by PWA 53-37 or PWA 53-80 may be used as an option to nickel plate. Refer to Section 70-46-01 in Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but extra plasma coat must be removed at final machining. Prepare the machined surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(d) For nickel plate only, bake vane and shroud assembly at 185 - 196°C (365 - 385°F) for three hours.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page.



NOTE: Please see the
TEMPORARY REVISION
that revises this page.

R
R

Fifth Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 627

1. 0.030 - 0.040 Inch
2. 16.379 - 16.393 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 16.360 Inch Diameter Maximum After Plating And Coating. 16.369 - 16.373 Inch Diameter After Finish Machining; 0.020 Inch Out-Of-Round In Excess Of This Tolerance Is Permissible. Diameter Must Be Concentric With Index 14 Within 0.002 Inch FIR
3. Nickel Plate Or Plasma Coat Area
4. 0.010 - 0.020 Inch Radius
5. Chamfer 43 - 47 Degrees
6. 0.115 - 0.125 Inch
7. 0.095 - 0.105 Inch
8. 0.385 - 0.395 Inch
9. Reference Surface
10. Electrical Contact Area
11. Reference Surface
12. 1.711 - 1.713 Inches
13. 16.377 - 16.387 Inch Diameter. Diameter Must Be Concentric With Index 14 Within 0.004 Inch
14. 16.513 - 16.527 Inch Diameter For Cleanup Machining. Hold To Maximum Value. 16.547 Inch Minimum Diameter After Plating Or Coating. 16.533 - 16.377 Inch Diameter After Finish Machining; Diameter Must Be Concentric With Index 13 Within 0.004 Inch FIR
15. Nickel Plate Or Plasma Coat Area
16. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
17. 0.145 - 0.155 inch

Key to Figure 627

(e) Finish machine diameter(s) to dimensions shown, maintaining all radii and concentricity requirements.

(f) Replace protective coat by this section.

J. Seventh And Eighth Stages

(1) Inspection

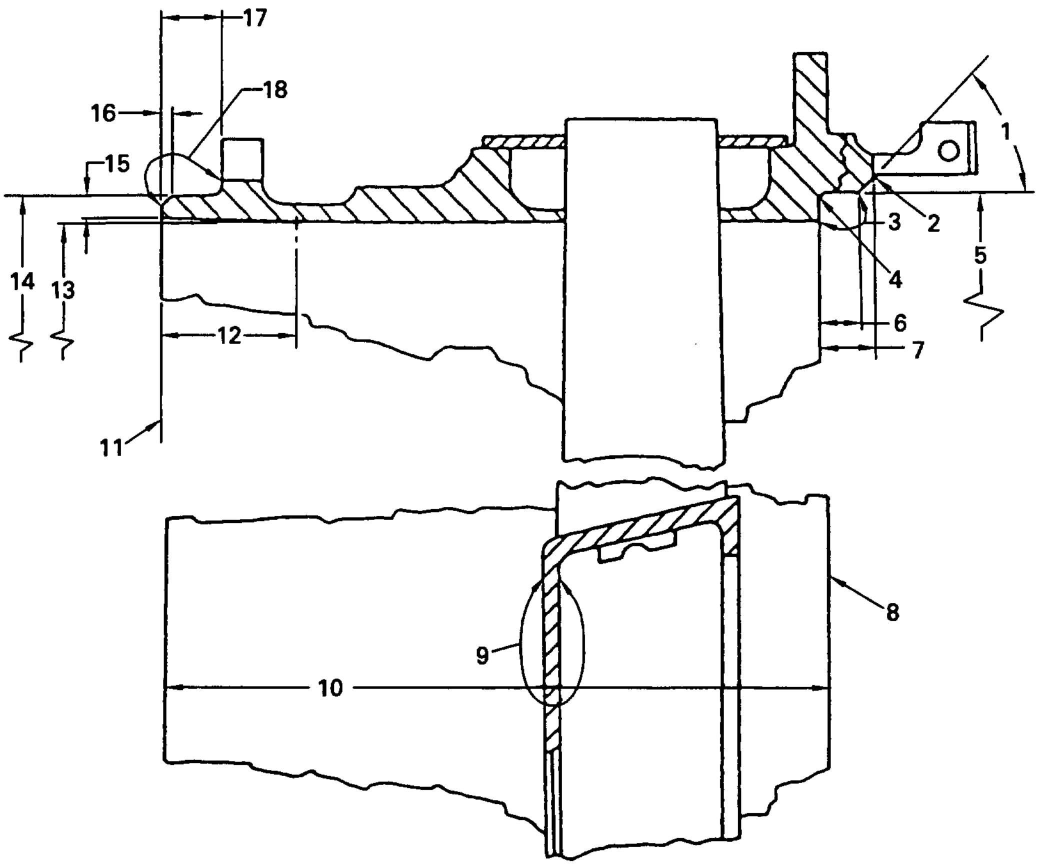
(a) Remove rivets securing airsealing ring to vane and shroud assembly, and remove ring.

NOTE: Discard aluminum ring.

(b) Inspect for worn nickel-cadmium plate or unplated ring and assembly.

R
R

NOTE: Please see the TEMPORARY REVISION that revises this page.



NOTE: Please see the TEMPORARY REVISION that revises this page.

Sixth Stage Vane And Shroud Assembly Mating Diameter Repair
Figure 628

1. 43 - 47 Degrees
2. 0.005 - 0.020 Inch Radius
3. Nickel Plate Or Plasma Coat Area
4. 0.010 - 0.020 Inch Radius
5. 16.323 - 16.337 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 16.303 Inch Maximum Diameter After Plating Or Coating. 16.313 - 16.317 Inch Diameter After Finish Machining; 0.020 Out-Of-Round Excess Of Finish Dimension Permissible. Diameter Must Be Concentric With Index 14 Diameter Within 0.002 Inch FIR.
6. 0.095 - 0.105 Inch
7. 0.115 - 0.125 Inch
8. Reference Surface
9. Electrical Contact Area
10. 1.647 - 1.649 Inch
11. Reference Surface
12. 0.320 Inch Gage
13. 16.234 - 16.244 Inch Diameter; Must Be Concentric With Index (14) Within 0.004 Inch FIR
14. 16.349 - 16.363 Inch Diameter For Cleanup Machining; Hold To Maximum Value. 16.383 Inch Minimum Diameter After Plating Or Coating. 16.369 - 16.373 Inch Diameter After Finish Machining. Diameter Must be Concentric with Index 13 Diameter Within 0.004 Inch FIR And Concentric With Index (5) Within 0.002 Inch FIR
15. 0.052 Inch Minimum Thickness
16. Chamfer 0.020 - 0.030 by 43 - 47 Degrees
17. 0.145 - 0.155 Inch
18. Nickel Plate Or Plasma Coat Area

Key to Figure 628

(c) If old ring is serviceable, plate and reinstall. Otherwise install new plated ring.

(2) Plating
R See Tool Group 29A-1 and Figure 624.

NOTE: For 7th stage shroud assemblies with plug rivets in outer shroud, remove rivets to facilitate draining after cleaning and plating. For vane and shroud assemblies not previously plated, drill 0.120 - 0.130 inch diameter drain holes in outer shroud outer surface. Drill only as far as box area. For 7th and 8th stages, drill eight drain holes, equally spaced between vanes and around vane shroud.

(a) Airsealing Ring

1 Nickel-cadmium plate new or serviceable ring, if necessary, using fixture. Refer to SPOP 25 in the Standard Practices Manual, Section 70-44-01. For surface area plating, see Table 603.

NOTE: Electrical contact is permitted only in area shown.

2 Bake ring by SPOP 25. Refer to the Standard Practices Manual, Section 70-44-01.

(b) Vane and Shroud Assembly

1 Clean and nickel-cadmium plate vane and shroud assembly, when necessary, using fixture. Refer to SPOP 40 in the Standard Practices Manual, Section 70-44-01. For surface area plating, see Table 603.

NOTE: Nickel-plate is optional, and may be incomplete in box shroud area (as shown) and in eight, 1/8 inch diameter holes on outer shroud periphery. No cadmium plate is permitted at these locations. Electrical contact is permissible only in area shown.

2 Bake assembly by SPOP 25. Refer to the Standard Practices Manual, Section 70-44-01.

(3) PWA 110-21/110-9 Coating (Alternate Coating Procedure).

NOTE: Coating is required for vane and shroud assemblies post-SB 6211.

(a) Remove all the coating and plating from all surfaces.

(b) Recoat with PWA 110-21/110-9 to 0.0005 - 0.0020 inch thick. Refer to the Standard Practices Manual, Section 70-41-00.

(4) Airsealing Ring Installation.
See Figure 633.

(a) Position plated airsealing ring on assembly, and if necessary, transfer drill 20 holes in ring, 0.064 - 0.068 inch diameter.

(b) Rivet ring to vane and shroud assembly.

(c) Machine ring front and rear inside diameters to dimensions shown.

(d) Paint ring inside diameters and front snap diameter of outer shroud with high-baking, heating-resistant, aluminum enamel, as shown. Paint on front snap diameter shall be 0.0015 - 0.0025 inch thick. Refer to Surface Treatments in the Standard Practices Manual, Section 70-41-00.

NOTE: Do not abrasive blast before applying aluminum enamel.

(e) Bake assembly.

(5) Seventh and Eighth Stage Vane and Shroud Assembly Outer Box Shroud Crack Repair.

(a) Remove the protective coating as necessary. See Paragraph J.(2).

(b) Remove and replace airsealing ring. See Paragraph J. steps (2) and (4).

R
R

(c) Use a No. 60 drill bit (0.040 inch diameter) for
R stop drilling. See Figure 625.

NOTE: Stop drill holes must be free of weld protuberances to void stress risers, and therefore, could require reaming or polishing after the crack has been welded.

(d) Rout the cracks completely in area to be welded, keeping the width of the cut to a minimum.

(e) Weld the crack with AMS 5776 (410 bare) or AM 363 (PWA 791) filler metal.

CAUTION: BE CAREFUL WITH THE PARTS UNTIL STRESS-RELIEF IS ACCOMPLISHED.

(f) Stress-relieve as follows:

1 Place the assembly on a flat plate in a cold furnace.

2 Support the inner shroud in a relation to the outer shroud.

3 Place the flat plate on top of assembly.

4 Stress-relieve by SPOP 455-2. Refer to the Standard Practices Manual, Section 70-42-04.

(g) Fluorescent penetrant inspect welded areas. See Paragraph J.

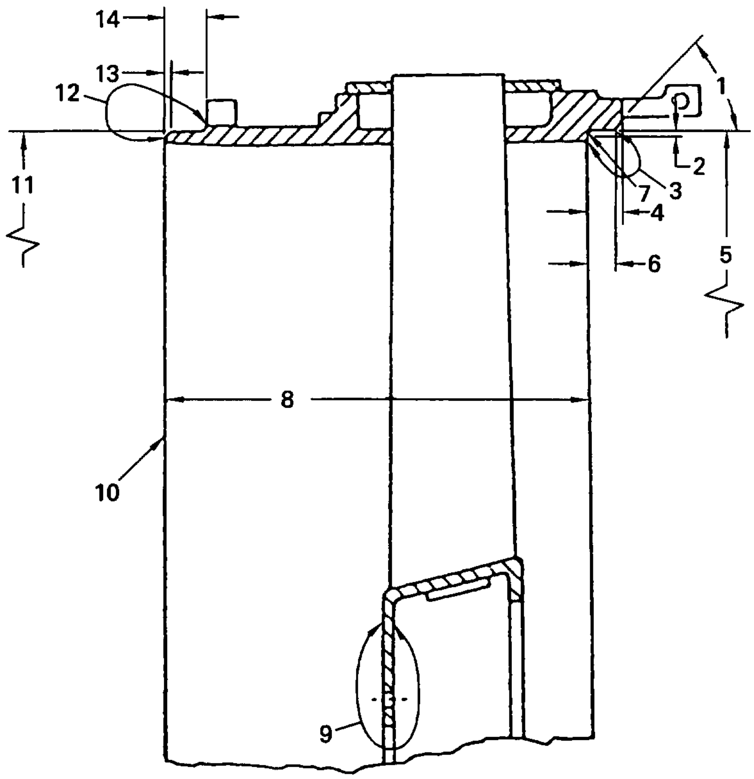
(h) Blend weld flush to 0.010 inch. Do not remove any parent metal.

(i) Fluorescent penetrant inspect welded areas. See Paragraph J.

(j) Do a dimensional inspection of the repaired mating diameters as required. See Paragraph J. step (4).

(6) Seventh and Eighth Stage Mating Diameter Repair. See
R Figure 629 and Figure 630.

(a) Remove protective coatings as necessary as instructed in this section.



L-H3128 (1296)

NOTE: Please see the **TEMPORARY REVISION** that revises this page.

R
R

Seventh Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 629

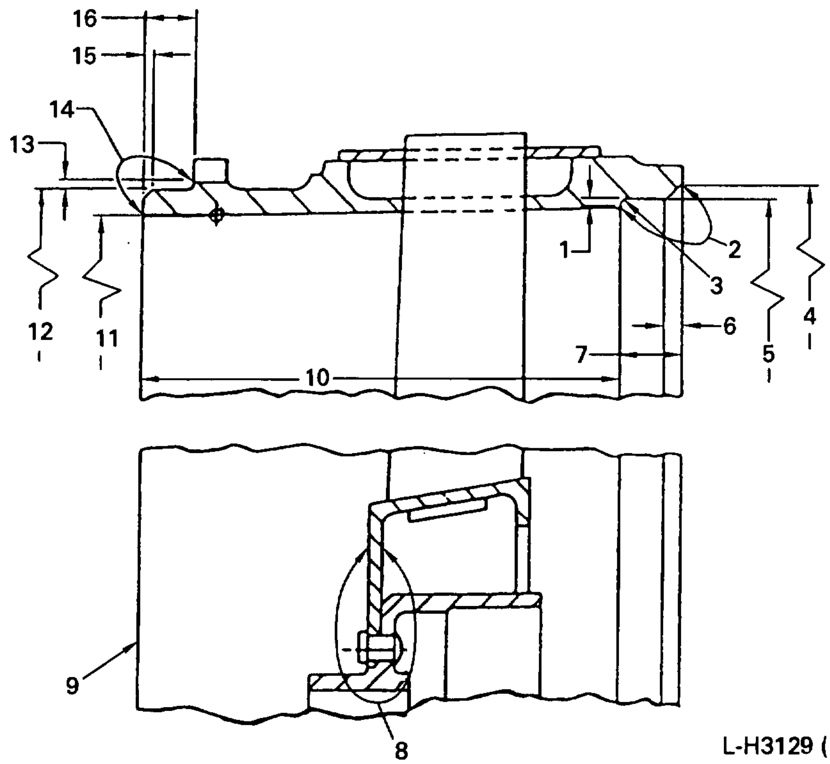
1. Chamfer 43 - 47 Degrees
2. 0.030 - 0.040 Inch
3. Nickel Plate Or Plasma Coat Area
4. 0.115 - 0.125 Inch
5. 16.307 - 16.321 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 16.288 Inch Diameter Maximum After Plating Or Coating. 16.297 - 16.301 Inch Diameter After Finish Machining; 0.020 Inch Out-Of-Round In Excess Of This Tolerance Is Permissible. Diameter Must Be Concentric With Index 11 Diameter Within 0.002 Inch FIR
6. 0.095 - 0.105 Inch
7. 0.010 - 0.020 Inch Radius
8. 1.464 - 1.466 Inches
9. Electrical Contact Area
10. Reference Face
11. 16.295 - 16.307 Inch Diameter For Cleanup Machining; Hold To Maximum Value. 16.327 Inch Minimum Diameter After Nickel Plating Or Plasma Coating. 16.313 - 16.317 Inch Diameter After Finish Machining; Diameter Must Be Concentric With Index 5 Diameter Within 0.002 Inch FIR
12. Nickel Plate or Plasma Coat Area
13. Chamfer 0.020 - 0.030 Inch by 43 - 47 Degrees
14. 0.145 - 0.155 Inch

Key to Figure 629

(b) Machine damaged or worn front and/or rear mating diameter as shown in figure.

(c) Nickel plate machined areas by SPOP 26. Refer to Section 70-44-01 in the Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

<u>NOTE</u>: Plasma coat by PWA 53-37 or PWA 53-80 may be used as an option to nickel plate. See Section 70-46-01 in Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but extra plasma coat must be removed at final machining. Prepare the machined surface for plasma coat by SPOP 170 (refer to Section 70-46-01 in the Standard Practices Manual).



L-H3129 (1296)

R
R

Eighth Stage Vane And Shroud
Assembly Mating Diameter Repair
Figure 630

1. 0.020 - 0.035 Inch
2. Nickel Plate Or Plasma Coat Area
3. 0.010 - 0.020 Inch Radius
4. 16.285 - 16.305 Inch Diameter; Must Be Concentric With Index 12 Diameter Within 0.004 Inch FIR
5. 16.349 - 16.363 Inch Diameter For Cleanup Machining; Hold To Minimum Value. 16.329 Inch Maximum Diameter After Nickel Plating Or Plasma Coating. 16.339 - 16.343 Inch Diameter After Finish Machining; 0.020 Inch Out-of-round In Excess Of This Tolerance Permissible. Diameter Must Be Concentric With Index 12 Diameter Within 0.002 Inch FIR
6. Chamfer 0.050 - 0.060 Inch by 43 - 47 Degrees.
7. 0.194 - 0.204 Inch
8. Electrical Contact Area
9. Reference Face
10. 1.456 - 1.458 Inches
11. 16.179 - 16.189 Inch Diameter; Must Be Concentric With Index 12 Diameter Within 0.004 Inch FIR
12. 16.277 -16.291 Inch Diameter For Cleanup Machining; Hold To Maximum Value. 16.311 Inch Minimum Diameter After Plating Or Coating. 16.297 - 16.301 Inch Diameter After Finish Machining; Must Be Concentric With Index 11 Diameter With 0.004 Inch FIR, And Index 5 Diameter Within 0.002 Inch FIR
13. 0.020 - 0.035 Inch
14 Nickel Plate or Plasma Coat Area
15. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
16. 0.145 - 0.155 Inch

Key to Figure 630

(d) For nickel plate only, bake vane and shroud assembly at 185 - 196°C (365 - 385°F) for three hours.

(e) Finish machine diameter(s) to dimensions shown, maintaining all radii and concentricity requirements.

(f) Replace protective coat by the procedure in this section.

R
R

R K. Seventh, Eighth and Ninth Stage Air Sealing Ring Elongated Rivet Hole Repair

NOTE: The use of oversize rivets is not recommended for
R repair of elongated rivet holes in the airseals for
R these reasons:

1 The minimum edge distance of the rivet is excessively violated

2 There is insufficient standard installation tool clearance

3 There is insufficient clearance for the rivet head on 7th and 8th stage airseals

4 The rivet head overhangs the OD of the airseal flange on the 9th stage airseal

(1) Remove the air sealing ring as instructed in this section.

(2) Strip the protective nickel-cadmium coating from the air sealing ring by SPOP 25. Remove the protective aluminum paint from the air sealing ring by SPOP 19 or SPOP 258. Refer to Section 70-44-01, Standard Practices Manual.

(3) Degrease by SPOP 209 in Section 70-21-00, Standard Practices Manual and plug weld the enlarged and/or worn rivet holes. Use AMS 5776 filler rod.

(4) Stress-relieve by SPOP 455-2. Refer to Section 70-42-04, Standard Practices Manual.

(5) Machine the surface to the initial dimension. Flange thickness is 0.035 - 0.045 inch. Blend flush to the parent metal at the weld areas.

(6) Restore the protective coating to the air sealing ring by one of the procedures that follow:

(a) Apply nickel-cadmium plate:

1 Nickel-cadmium plate by AMS 2416. Dimensions are before plating. See SPOP 25 in Section 70-44-01, Standard Practices Manual.

2 Electrical contact is only permitted at the extreme fore and aft axial surfaces of the seal lands.

3 Fully cover the electrical contact points with PWA 578 paint after plating, but before AMS 2416 baking. Refer to SPOP 142 in Section 70-41-03, Standard Practices Manual.

(b) Apply aluminum paint:

1 Apply the coating all over by the PWA 110-21 or PWA 110-31 process to a thickness of 0.0005 - 0.003 inch. Dimensions are before coating. Refer to Section 70-41-04, Standard Practices Manual.

(7) Transfer drill the holes from the stators/diffuser case into the welded hole area of the air sealing rings.

(8) Install the air sealing ring to the vane assembly by attaching with rivets by PWA 357, Section 70-43-00, Standard Practices Manual. See the Illustrated Parts Catalog (IPC), PN 435109 for the applicable rivets as follows:

R (a) For 7th stage, see Figure 4, Item 32A/33

R (b) For 8th stage, see Figure 4, Item 37/38

(c) For 9th stage, see Figure 7, Item 21 of the IPC

(9) After you rivet the air sealing ring to the stator assembly, if additional machining is done which would remove the plate or paint, treat that area with two coats of PWA 578 Heat Resistant Aluminum Enamel. See SPOP 142 in Section 70-41-03, Standard Practices Manual.

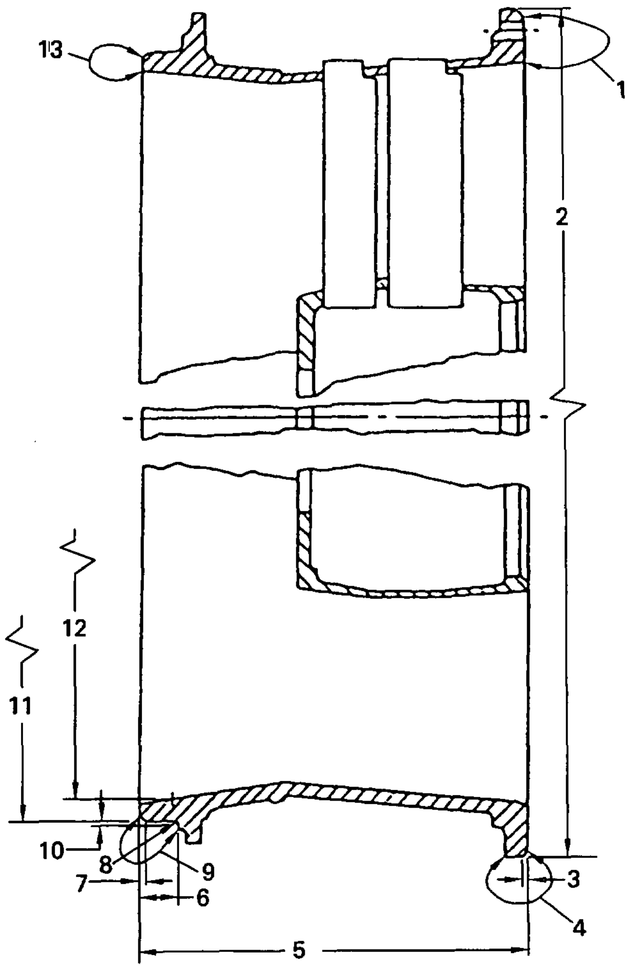
(10) Install the air sealing ring as instructed in this section.

L. Ninth Stage Vane and Shroud Assembly

(1) Ninth Stage Snap Diameter Repair. See Figure 631.

(a) Remove protective coatings as necessary as instructed in this section.

NOTE: Please see the TEMPORARY REVISION that revises this page.



L-H3130 (1296)

NOTE: Please see the
TEMPORARY REVISION
that revises this page.

R
R

Ninth Stage Vane And Shroud
Assembly Snap Diameter Repair
Figure 631

1. Electrical Contact Area
2. 16.739 - 16.753 Inch Diameter for Cleanup Machining; Hold to Maximum Value. 16.773 Inch Diameter Minimum After Plating or Coating. 16.759 - 16.763 Inch Diameter After Finish Machining; Must Be Concentric with Index Diameter 11 Within 0.004 Inch FIR
3. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
4. Nickel Plate or Plasma Coat Area
5. 1.929 Inches
6. 0.205 - 0.215
7. Chamfer 0.020 - 0.030 Inch By 43 - 47 Degrees
8. 0.010 - 0.020 Inch Radius
9. Nickel Plate or Plasma Coat Area
10. 0.020 - 0.035 Inch
11. 16.319 - 16.333 Inch Diameter for Cleanup Machining; Hold to Maximum Value. 16.353 Inch Minimum Diameter After Plating or Coating. 16.339 - 16.343 Inch Diameter After Finish Machining; Must be Concentric With Index 2 Diameter Within 0.002 Inch FIR
12. 16.174 - 16.184 Inch Diameter; Must Be Concentric With Index 11 Diameter Within 0.004 Inch FIR

    NOTE: For PN 542069 assemblies, Index 12; 16.225 - 16.235 inch diameter.

13. Electrical Contact Area

Key to Figure 631

(b) Machine damaged or worn front and/or rear snap diameter as shown in figure.

(c) Nickel plate machined areas by SPOP 26. See Section 70-44-01, Standard Practices Manual. Plating outside of enclosed area is allowed, but extra plate must be removed at final machining.

<u>NOTE</u>: Plasma coat per PWA 53-57 or PWA 53-80 may be used as an option to nickel plate. See Section 70-46-01 in Standard Practices Manual. If plasma coat is used, omit the following bake. Plasma coat outside of enclosed area is permitted, but extra plasma
R coat must be removed at final machining.
R Prepare the machined surface for plasma coat
R by SPOP 170. Refer to Section 70-46-01 in
R the Standard Practices Manual.

(d) For nickel plate only, bake vane and shroud assembly at 185 - 196°C (365 - 385°F) for three hours.

(e) Finish machine diameter(s) to dimensions shown, maintaining all radii and concentricity requirements.

(f) Replace protective coat per this section.

(2) Corrosion Pitting. See Figure 632.

(a) Inspection

1 Remove protective coatings as necessary as instructed in this section.

2 Measure the pit depth by the replica tape method in SPOP 127 or equivalent method. Refer to Section 70-30-00 in the Standard Practices Manual.

3 Pits on outer, inner and box shrouds are repairable to a depth of 0.005 inch.

(b) Repair

1 Complete all other necessary repairs (including removal of the air sealing ring) before you repair the corrosion pits.

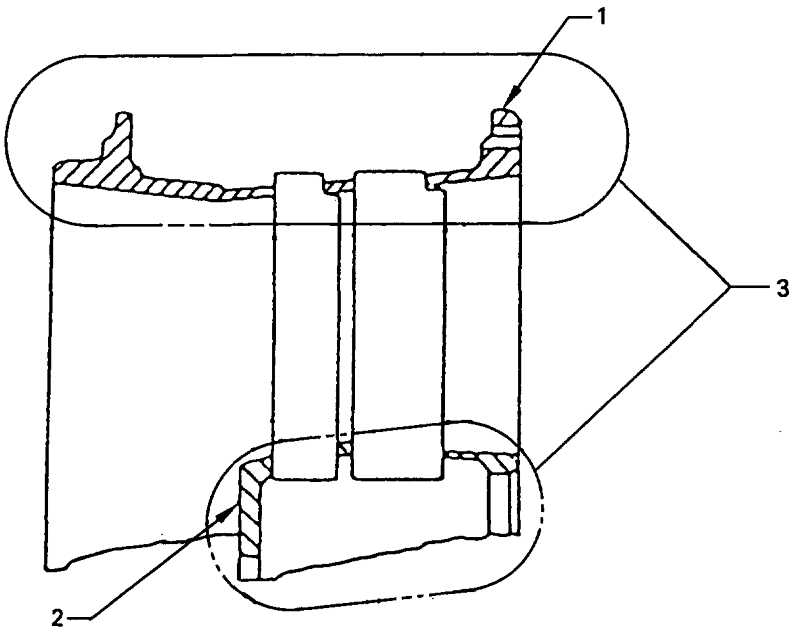
CAUTION: ENSURE THAT MATING DIAMETERS AND CRITICAL DIMENSIONS ARE NOT ALTERED BY THE BLAST CLEANING PROCEDURE IN PWA 110.

2 Coat the stator by the PWA 110-21 process in Section 70-41-04, Standard Practices Manual.

(3) Inner Shroud Rivet Hole Repair

(a) Remove air sealing ring as instructed in this section.

(b) Remove protective coatings as necessary as instructed in this section.



L-H3134 (1296)

R
R

Ninth Stage Stator Pitting
Inspection and Repair
Figure 632

1. Outer Shroud
2. Inner shroud
3. Pitting And Corrosion Is Repairable In These Areas To A Depth Of 0.005 Inch

Key to Figure 632

(c) Fill rivet holes and cracks up to 0.050 inch in length by the weld process using AMS 5776 filler metal.

NOTE: AM 363 (PWA 792) filler metal may be used as an option to AMS 5776.

CAUTION: TO AVOID CRACKS, PARTS MUST BE HANDLED WITH CARE UNTIL STRESS-RELIEF PROCESS IS ENDED.

(d) Stress-relieve as follows:

1 Place vane and shroud on a flat plate in a cold furnace.

2 Support inner shroud in relation to outer shroud.

3 Place flat plate on top of assembly.

4 Stress-relieve by SPOP 455-2 in Section 70-42-04, Standard Practices Manual.

(e) Fluorescent penetrant inspect the welded areas. Refer to Section 72-00-00.

(f) Grind the weld repair with the front face of the inner shroud that the air sealing ring seats properly.

(g) Fluorescent penetrant inspect the welded areas. Refer to Section 72-00-00.

(h) Install air sealing ring.

R 1 Transfer drill twenty 0.094 - 0.096 inch diameter holes into the inner shroud. Maintain the original position.

2 Break edges of rivet holes to ensure proper seating of rivet heads.

3 Install air sealing ring as instructed in this section.

(i) Replace protective coating by this section.

NOTE: Please see the **TEMPORARY REVISION** that revises this page.

1. Engine Compressor Section (Disks/Hubs)

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Compressor Disks/Hubs

A. Life Limits

(1) Flight cycles as well as operating time determine disk life. This information must be recorded at each overhaul.

(2) Replace disk if either flight cycle or operating time
R limit is reached. Refer to Section 5.

(3) Following definitions and regulations apply to use of new limits.

(a) Cycle is defined as any flight (i.e. take-off and landing) regardless of duration and whether or not reservers are used on landing. Touch-and-go landing and take-off operation, is of course, included in this definition. Cyclic records must be recorded for each disk for all operations.

(b) This definition of cycle applies to engines in normal aircraft usage including moderate amount of routine pilot training. Any extended special usage as might be incurred by assignment of aircraft to exclusive pilot-training use for several months required that any power change, equal to or greater than idle-to-maximum continuous, be recorded as a cycle.

(c) For JFTD12A engines, a cycle is defined as any flight regardless of duration which is terminated by an engine shutdown.

(d) Operators who can obtain cyclic histories of disks currently in service from available records shall use this method to establish current total numbers of cycles on each disk. When such records are not available, hours accumulated to date on disks currently in service must be converted to cycles. The number of cycles on in-service disks my be calculated by dividing disk total operating time in hours by average flight lengths (in hours) experienced by disks in operation to date.

Cycles = Total disk hrs. / Average flight length (hrs.)

(e) Operating hours must continue to be recorded for each disk as it has been in past.

(f) Operating hours are defined as that accumulated time from the moment an aircraft leaves the surface of the earth until it touches it at the next point of landing (flight time).

(g) The marking of hours and cycles by engine model on the engine parts is optional to maintaining accurate accumulated service life (hours and cycle by engine model) in the form of permanent records, paper documents or computer data base records. Refer to Standard Practices Manual, Section 70-30-00. For disks currently in service whose past cyclic history was obtained by converting current hours, the total cycles will be sum of cycles obtained by conversion and cycles recorded thereafter.

B. Compressor Disk/Hub Growth Limits

(1) Reject compressor disks that have stretched beyond maximum allowable limits given in Figure 601. Measure at several locations around disk to obtain average diameter.

NOTE: Compressor disk mating diameters are not to be machined or plated in order to regain correct fit with mating spacer or hub. Altered disks adversely affect growth limits.

R (2) Reject compressor hubs that have growth more than the
R limits in the figure. Measure at sufficient positions
R around the diameter to get an average diameter reading.

R NOTE: If a hub has had the mating diameter alteration
R repair in this section, it will be necessary to
R use the Px or Mx values during an inspection for
R growth. Subtract a Px value to, or add an Mx
R value from, a hub mating diameter measured during
R inspection. Multiple Px and Mx values are
R cumulative.

NOTE: For example: A hub as-received mating diameter has a measured dimension of 8.636 and the part has P6 and M3 marks. Thus 8.636 minus 0.006 plus 0.003 equals 8.633. The part is serviceable because the result is not more than the 8.638 inch growth limit.

C. Inspection

CAUTION: DO NOT REWORK ANY DISK THAT HAS CRACK OR ANY INDICATION NOT CLEARLY RESULT OF LOCALIZED SURFACE DAMAGE (SUCH AS NICKS, DENTS, SCRATCHES, AND CORROSION PITS). PRESENCE OF CRACKS OR OTHER UNUSUAL CONDITIONS CONFIRMED BY FLUORESCENT PENETRANT, MAGNETIC PARTICLE, OR VISUAL EXAMINATION IS CAUSE FOR REJECTION. CLOSE ATTENTION MUST BE GIVEN TO TIEBOLT HOLES, COUNTERWEIGHT HOLES, LIGHTENING HOLES, BLADE SLOTS, AND BORE.

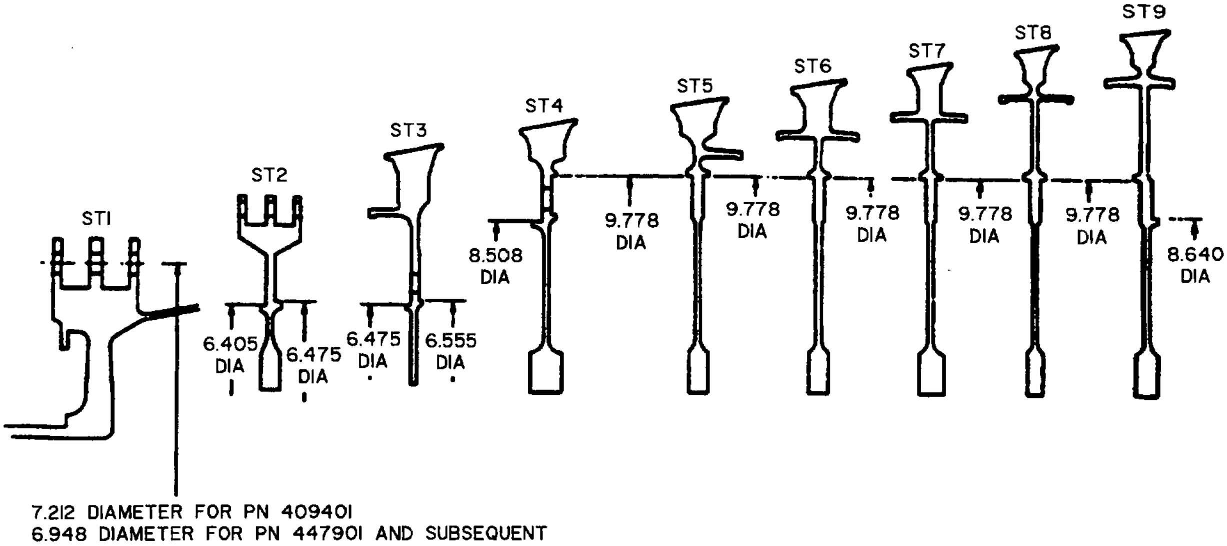
(1) Inspection - General. See Figure 602 thru Figure 611.

NOTE: Prior to inspection of steel disks and the rear hub, remove the nickel-cadmium plating or aluminum coating. Before and after removal of the plate or coat, measure the diameter of each tierod hole; of lip-seal flange(s); of snap diameters used to measure/record growth. Enclosures in referenced figures are to tangent points, sharp corners, 0.030 inch from holes, blade slots, and snap diameters or spacer mating surfaces. Reference dimensions given in Table of Limits are after nickel-cadmium plating or aluminum coating.

Although some areas have specific damage limits acceptable without repair, it is preferable to have these areas blended.

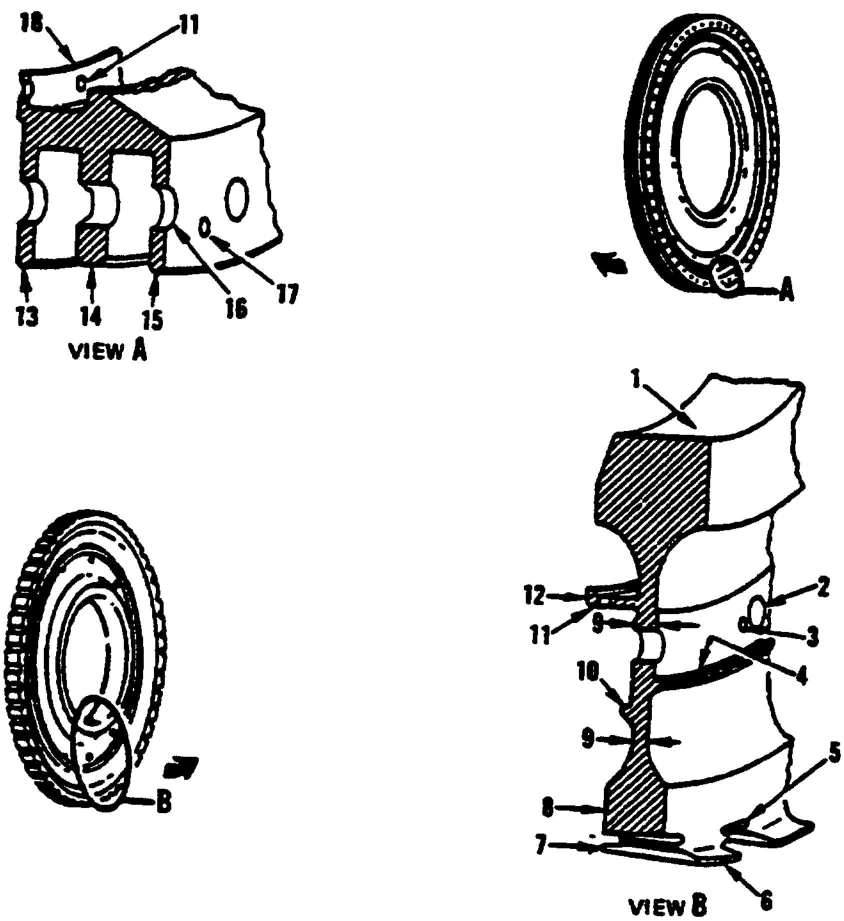
(a) Inspect front hub bearing journal for minor scoring or wear. See Reference No. 2, Table of Limits.

(b) Inspect tierod holes, balance holes, snap diameters, and blade slots visually for surface damage (nicks, dents, scratches, corrosion, pitting, galling, and other defects), using white light and three-power magnification.



L-12378 (0307)

Compressor Disk/Hub
Growth Limits
Figure 601



L-62311 (0000)

Compressor Disk Nomenclature
Figure 602

1. Bore
2. Tierod Hole
3. Key Washer Keyhole
4. Rear Spacer Mating ID
5. Blade (Dovetail) Slot
6. Rear Windage Tab
7. Front Windage Tab
8. Front Face
9. Web
10. Front Spacer Mating ID
11. Counterweight Rivet Hole
12. Counterweight Flange
13. Front Rim
14. Middle Rim
15. Rear Rim
16. Blade Pinhole
17. Spherical Indent (Dimple)
18. Counterweight Rim

Key to Figure 602

(c) Inspect 1st and 2nd stage compressor disk rims (front and rear) for surface damage caused by rocking compressor blades.

(d) Smooth impressions from parts such as spacers or tierods are acceptable, and do not require repair.

(e) During inspection, segregate disks to be repaired, as follows:

1 Disks with no corrosion.

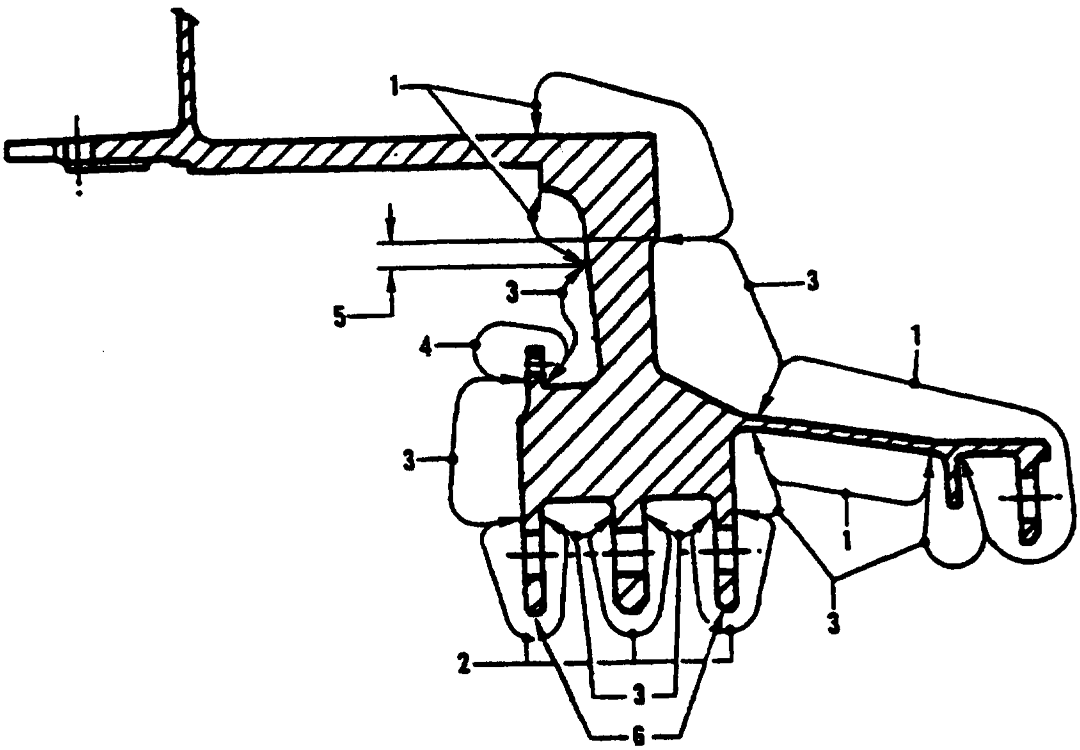
2 Disks with corrosion or galling in blade slots.

3 Disks with corrosion on airseal rim ID.

4 Combinations of above.

C. Repair
See Tool Group 29A and Figure 612 thru Figure 619.

NOTE: OPTIONAL - Rear Hub (PN 627597, 597588, 669273, 668985) can be balanced after repair to no more than 0.2 ounce-inch at no less than 600 RPM by removal of material from the balance ring. See Figure 620. The balance ring height must be at least 0.005 inch greater than the thickness of the cone section. The surface of the balance ring, after

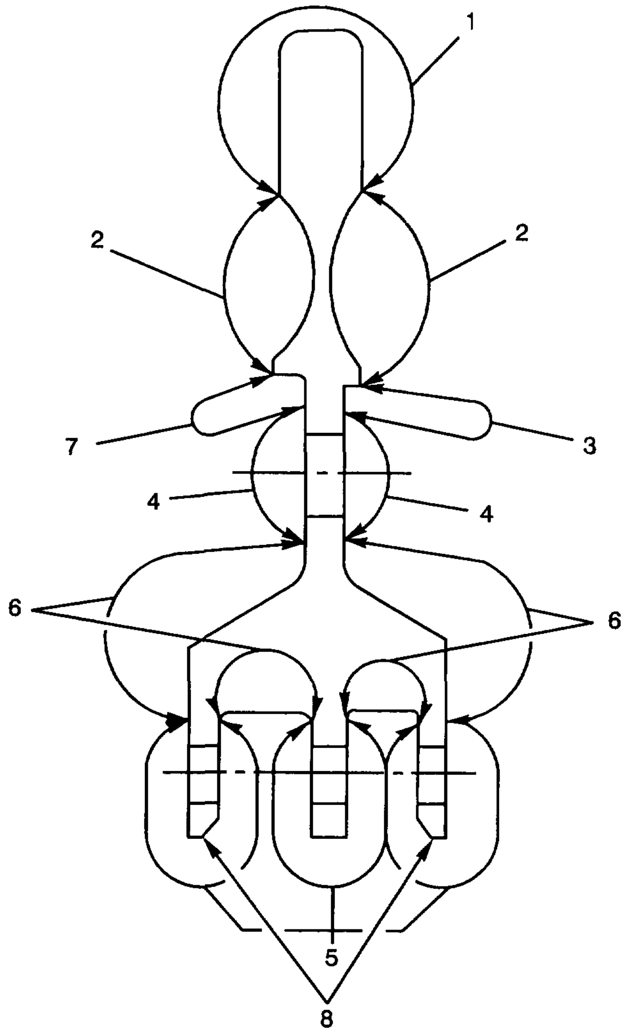


L-62310 (0000)

1. No Surface Damage Allowable
2. No Surface Damage Allowable In Hole Or Within 0.125 Inch On Adjacent Surface Except Wear Indication On Rear Face Of Center Rim Up To 0.0005 Inch Deep As Noted In Index 6
3. Scattered Surface Damage Up To 0.002 Inch Deep Allowable
4. Scattered Surface Damage Up To 0.003 Inch Deep
5. 0.125 Inch
6. 0.030 Inch Maximum Depth On Chamfers.

R
R

Compressor Rotor Front
Hub Inspection
Figure 603



L-14510 (1107)
PW V

Second Stage Compressor
Disk Inspection
Figure 604

1. No Surface Damage Allowable
2. Scattered Surface Damage Up To 0.003 Inch Deep Allowable
3. No Surface Damage Allowable
4. No Surface Damage Allowable In Tierod Holes Or Within 0.125 Inch On Adjacent Surfaces
5. No Surface Damage Allowable Except:
   1) Wear Indications On Rear Face Of Center Rim Up To 0.007 Inch Deep;
   2) Wear Indications On Outer Surfaces Of Front And Rear Rims Due To Blade Retaining Pin Washer Contact, Up To 0.0005 Inch Deep And
   3) As Noted In Index 8.
6. Scattered Surface Damage Up To 0.003 Inch Deep Allowable
7. No Surface Damage Allowable
8. 0.020 Inch Maximum Depth On Chamfers

Key to Figure 604

the material removal, must be at least as good as the original hub.

CAUTION: DO NOT REWORK ANY HUB/DISK THAT HAS CRACK OR ANY INDICATION WHICH IS NOT CLEARLY THE RESULT OF SUCH LOCALIZED SURFACE DAMAGE AS NICKS, DENTS, SCRATCHES, OR CORROSION PITS. CRACKS, OR OTHER UNUSUAL CONDITIONS CONFIRMED BY FLUORESCENT PENETRANT, MAGNETIC PARTICLE, OR VISUAL INSPECTION ARE CAUSE FOR REJECTION.

R (1) Prerequisites

R (a) Nickel-cadmium plated parts

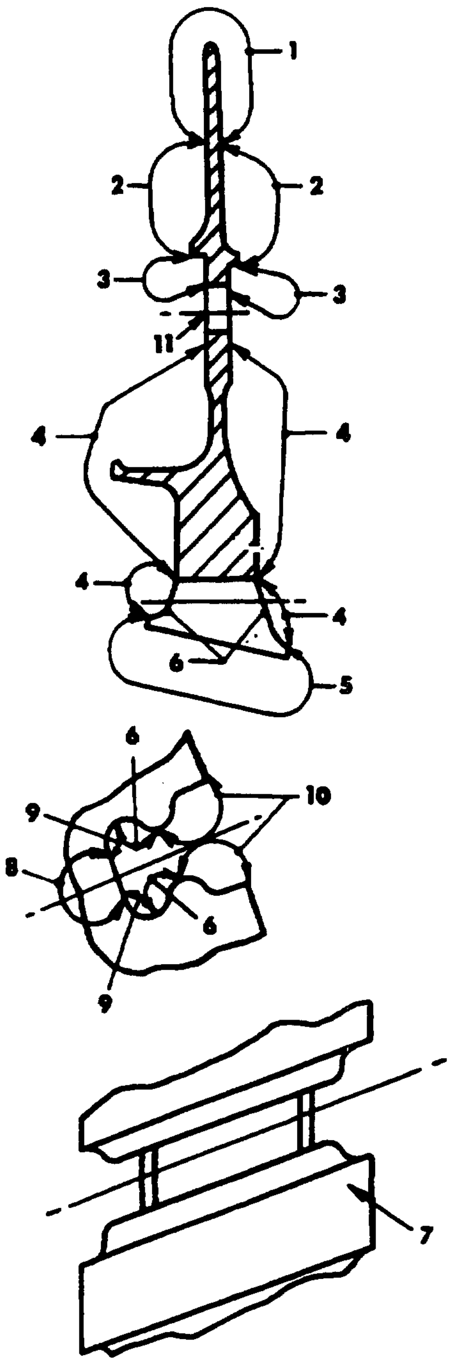
R 1 Clean by SPOP 203. Refer to Section 70-21-00 in the Standard Practices Manual.

R R 2 Remove antigalling compound from blade slots by SPOP 19. Refer to Section 70-21-00 in the Standard Practices Manual.

R 3 Remove nickel-cadmium plate by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual.

R R R 4 Do a fluorescent magnetic particle inspection of disks. Refer to Section 72-00-00, Inspection.

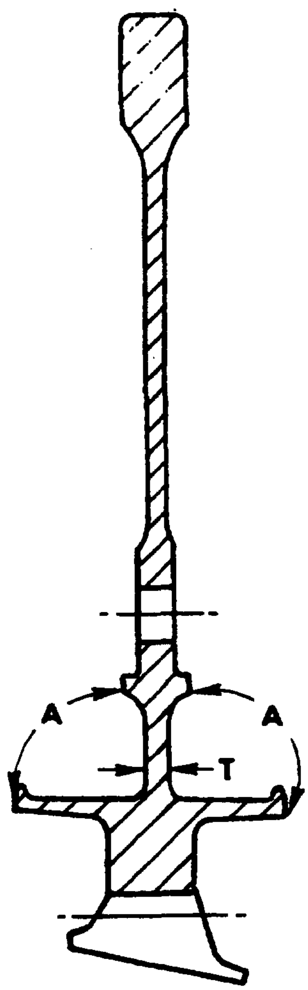
R (b) Aluminum coated parts



R
R
Third Stage Compressor
Disk Inspection
Figure 605

1. No Surface Damage Acceptable Without Repair. If In Excess Of 0.003 Inch Deep, Scrap Disk
2. Scattered Surface Damage Up To 0.003 Inch Deep Shall Be Repaired. If In excess of 0.003 Inch Deep Scrap Disk.
3. No Surface Damage Allowable
4. Scattered Surface Damage Up To 0.003 Inch Deep Acceptable Without Repair. For Steel Disks, See Disk Web Corrosion Limits
5. Scattered Surface Damage Up To 0.005 Inch Deep Shall Be Repaired. If In Excess Of 0.005 Inch Deep, Scrap Disk
6. Scattered Surface Damage Acceptable Without Repair Up To 0.001 Inch Deep On Blade Contact Area And Within 0.125 Inch Of Slot On Front And Rear Faces. Four Locations On Each Slot. For Steel Disks, See Blade Slot Corrosion Limits.
7. Scattered Surface Damage Up To 0.005 Inch Deep Shall Be Repaired
8. Scattered Surface Damage Up To 0.003 Inch Deep On Bottom Of Slot Acceptable Without Repair. If In Excess Of 0.005 Inch Deep, Scrap Disk. For Steel Disks, See Blade Slot Corrosion Limits.
9. No Surface Damage Acceptable Without Repair. If In Excess Of 0.005 Inch Deep, Scrap Disk. For Steel Disks, See Blade Slot Corrosion Limits.
10. Scattered Surface Damage Up To 0.003 Inch Deep in Slot And On Faces Of Disk. For Steel Disks, See Blade Slot Corrosion Limits.
11. No Surface Damage Allowable in Any Hole or within 0.125 Inch On Adjacent Surface

Key to Figure 605



L-16476 (0000)

Disk Web Corrosion Limits
For Steel Compressor Disks
Figure 606

	Stage	PN	Area A Allowable Damage	Area A Allowable Repair	Dim. T Minimum Web Thickness (Inches)
	3	406203	Scattered	Damage	0.075
R	5	406205,	surface	0.010 inch	0.047
R		496705,	damage	maximum	
R		541905,	0.003 inch		
R		701505,	maximum		
R		797305			
	6	417806			0.047
	7	426107			0.036
R	8	406208,			0.036
R		541908,			
R		701108,			
R		725008,			
R		796708,			
R		803108			
R	9	406209,			0.046
R		541909,			
R		701409,			
R		797309			

Key to Figure 606

1 Clean by SPOP 203. Refer to Section 70-21-00 in the Standard Practices Manual.

2 Removal antigalling compound from blade slots by SPOP 19. Refer to Section 70-21-00 in the Standard Practices Manual.

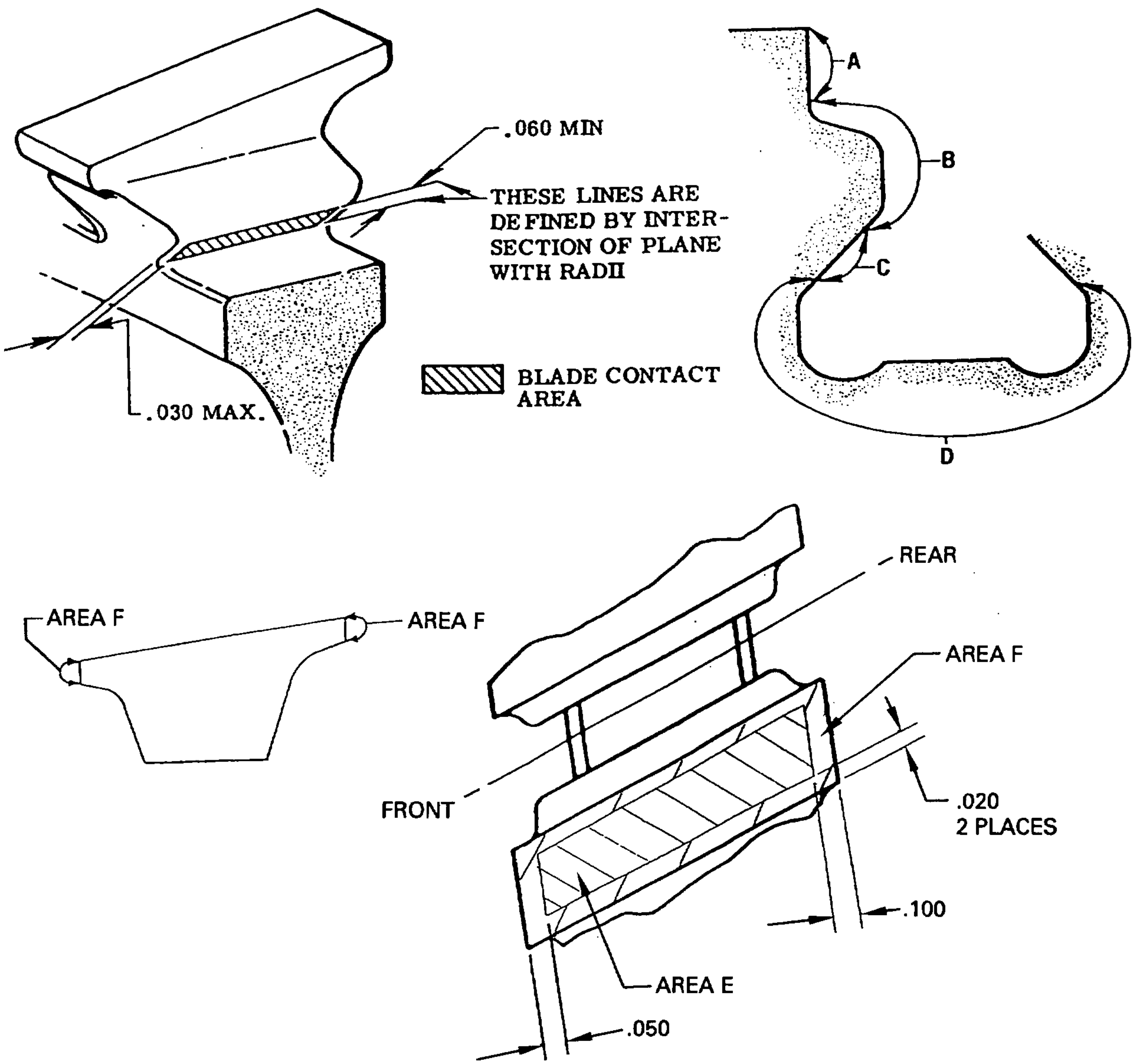
3 Remove aluminum coating by SPOP 258. Refer to Section 70-21-00 in the Standard Practices Manual.

4 Do a fluorescent magnetic particle inspection of steel disks or a fluorescent penetrant inspection of titanium disks. Refer to Section 72-00-00, Inspection.

(2) Surface Damage Repair.

(a) Blend round bottom dents by removing sharp edges only.

(b) Break all sharp edges 0.005 - 0.015 inch radius.



L-25979 (1296)

R
R

Blade Slot Corrosion Limits
For Steel Compressor Disks
Figure 607

R Maximum Depth of Repairable Pitting in Areas A through F and Galling at Area C

Area	By Shotpeening	By Grit Blasting and Shotpeening
A	0.005 Inch	0.015 Inch
B	0.003 Inch	0.010 Inch
C	0.003 Inch	0.010 Inch
D	0.005 Inch	0.015 Inch
E	--	0.030 Inch
F	--	0.015 Inch

R Maximum Depth of Repairable Pitting Edge Radii

Area	By Shotpeening	By Grit Blasting and Shotpeening
A	0.005 Inch	0.015 Inch
B	0.003 Inch	0.010 Inch
C	0.002 Inch	0.005 Inch
D	0.005 Inch	0.010 Inch
E	--	--
F	--	--

Key to Figure 607

(c) Blend repairs shall taper-out in all directions at ratio of 15 times depth.

(d) Finish-blend as smooth or smoother than original surface following lay of original tool marks.

(e) Repair scattered pitting by local blending. Use grit blast to repair generalized or concentrated pitting.

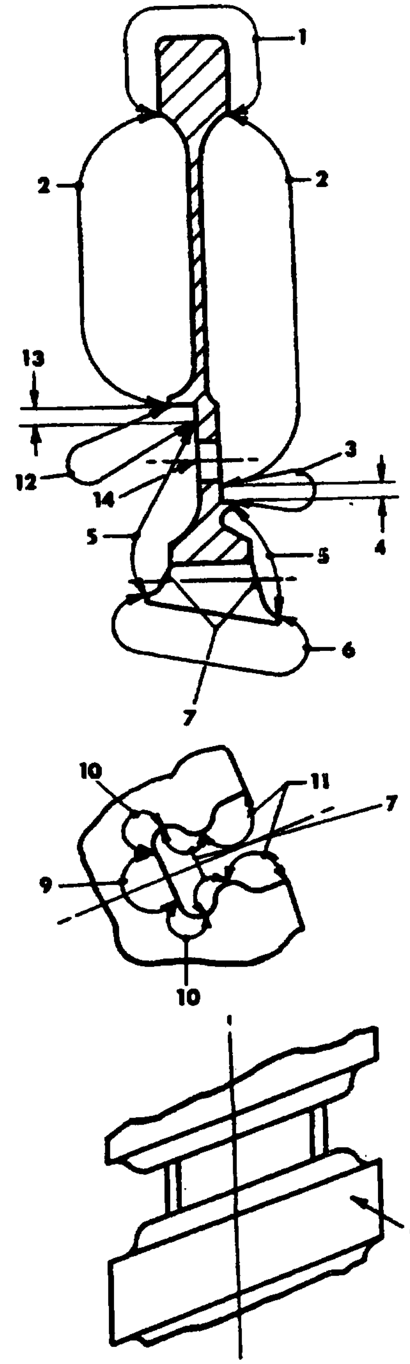
(f) Repair snap diameters and spacer mating surfaces by machining and plating.

(3) Liquid Buffing of 5th, 6th, 8th and 9th stage disks

R (a) Application:

R R 1 Disks prior to 700 Series part numbers (for example PN 701505)

R R 2 Disks not yet identified as having been liquid buffed



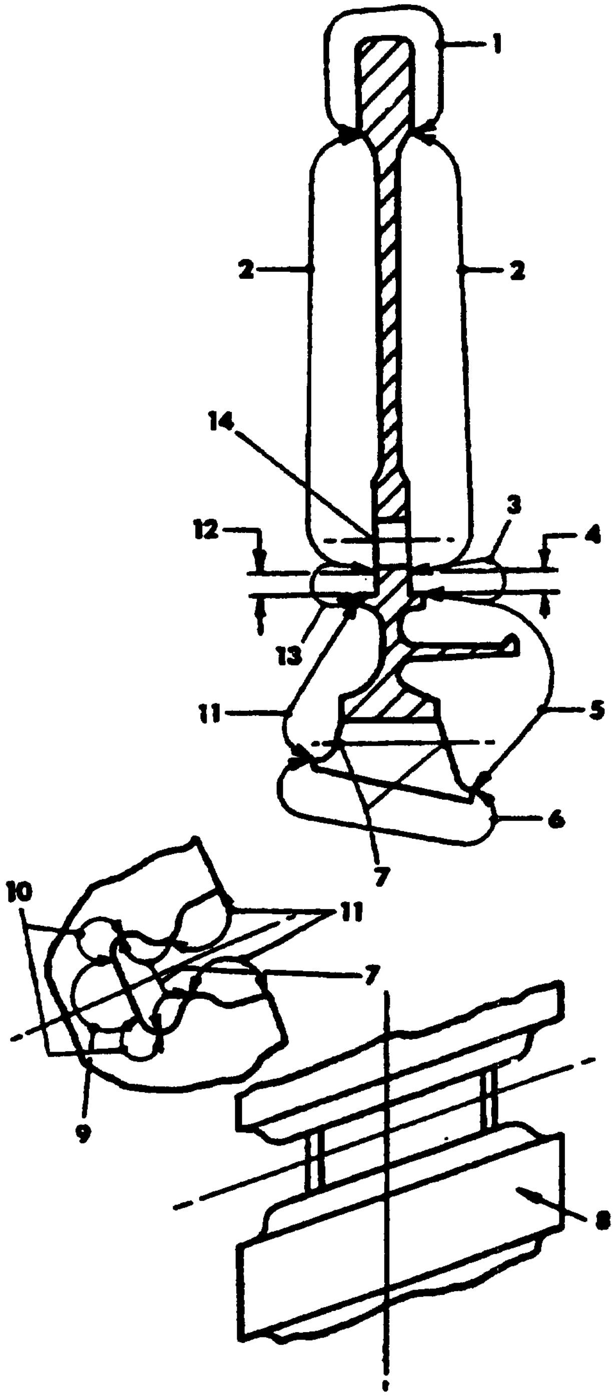
L-14512 (0000)

R
R

Fourth Stage Compressor
Disk - Inspection
Figure 608

1. No Surface Damage Acceptable Without Repair. If In Excess Of 0.010 Inch, Scrap Disk.
2. Surface Damage Up To 0.003 Inch Deep Except As Noted. See Repair.
3. No Surface Damage Allowable
4. 0.125 Inch
5. Scattered Surface Damage Up To 0.003 Inch Deep Allowable Except As Noted. See Repair. If In Excess Of 0.005 Inch Deep, Scrap Disk.
6. Scattered Surface Damage Up To 0.005 Inch Deep Shall Be Repaired. If In Excess Of 0.005 Inch, Scrap Disk.
7. Scattered Surface Damage is Acceptable Without Repair Up To 0.001 Inch Deep on Blade Contact Area and 0.125 Inch Of Slot Of These Faces. Four Locations On Each Slot. For Steel Disks, See Blade Slot Corrosion Limits.
8. Scattered Surface Damage Up To 0.005 Inch Deep Acceptable Without Repair.
9. Scattered Surface Damage Up To 0.003 Inch Deep is Acceptable Without Repair On Bottom Of Slot. If In Excess Of 0.005 Inch, Scrap. For Steel Disks, See Blade Slot Corrosion Limits.
10. No Surface Damage Acceptable Without Repair. If In Excess Of 0.005 Inch Deep, Scrap Disk. For Steel Disks, See Blade Slot Corrosion Limits.
11. Scattered Surface Damage Up To 0.003 Inch Deep In Slot and On Faces Of Disk Acceptable Without Repair. For Steel Disks, See Blade Slot Corrosion Limits.
12. No Surface Damage Allowable.
13. 0.125 Inch.
14. No Surface Damage Allowable In Any Hole Or Within 0.125 Inch On Adjacent Surface.

Key to Figure 608

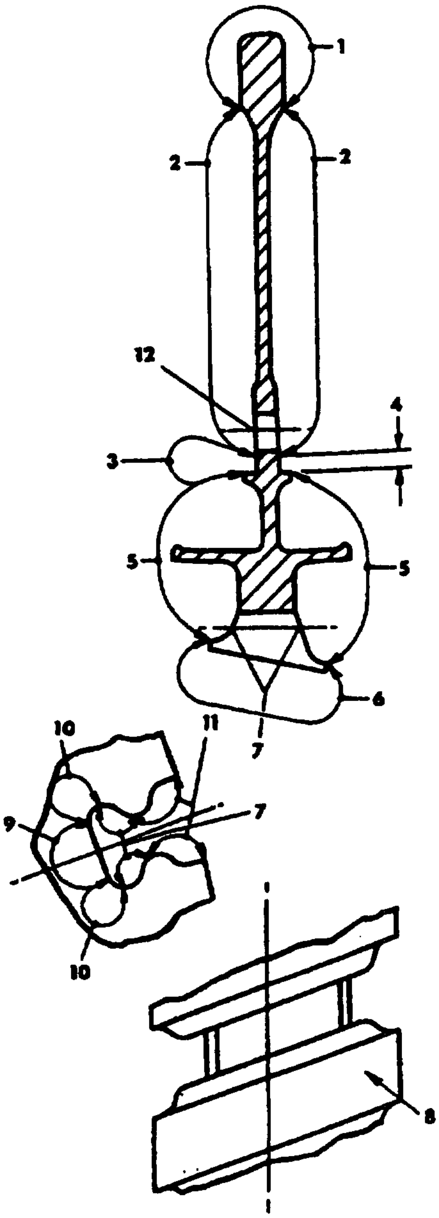


L-14523 (0000)

Fifth Stage Compressor
Disk - Inspection
Figure 609

1. No Surface Damage Acceptable Without Repair. If In Excess Of 0.010 Inch Deep, Scrap Disk.
2. Scattered Surface Damage Up To 0.003 Inch Deep Shall Be Repaired.
3. No Surface Damage Acceptable Without Repair. See Repair For Minimum Dimensions On Spacer Mating Surfaces.
4. 0.125 Inch.
5. Scattered Surface Damage Up To 0.003 Inch Deep Acceptable without Repair. For Steel Disks, See Disk Web Corrosion Limits.
6. Scattered Surface Damage Up To 0.008 Inch Deep Acceptable Without Repair. For Steel Disks With Corrosion, See
R Figure 607, Blade Slot Corrosion Limits.
7. Scattered Surface Damage Up To 0.003 Deep On Blade Contact Area and Within 0.030 Inch Of Slot On These Faces (front And Rear) acceptable Without Repair. For Steel Disks, See Blade Slot Corrosion Limits.
8. Scattered Surface Damage Up To 0.008 Inch Deep (Other Than Corrosion) Acceptable Without Repair. For Steel Disks With
R Corrosion, See Figure 607, Blade Slot Corrosion Limits.
9. Scattered Surface Damage Up To 0.005 Inch Deep On Bottom Of Slot. If In Excess Of 0.008 Inch Deep, Scrap disk. For Steel Disks, See Blade Slot Corrosion Limits.
10. No Surface Damage Acceptable Without Repair. For Steel Disks, See Blade Slot Corrosion Limits.
11. Scattered Surface Damage Up To 0.003 Inch Deep Acceptable Without Repair. For Steel Disks, See Blade Slot Corrosion Limits.
12. 0.125 Inch
13. No Surface Damage Acceptable Without Repair.
14. No Surface Damage In Any Hole Or Within 0.030 Inch Of Adjacent Surfaces Acceptable.

Key to Figure 609



L-14518 (0000)

R
R

Sixth, Seventh, Eighth,
And Ninth Stage Compressor
Disks - Inspection
Figure 610

1. No Surface Damage Acceptable Without Repair.
2. Scattered Surface Damage Up To 0.003 Inch Deep Acceptable Without Repair.
3. No Surface Damage Allowable.
4. 0.125 Inch
5. Scattered Surface Damage Allowable Up To 0.003 Inch Deep. For Steel Disks, See Disk Web Corrosion Limits.
6. Scattered Surface Damage Up To 0.008 Deep. If In Excess Of 0.008 Inch, Scrap. For Steel Disks With Corrosion, See
R Figure 607, Blade Slot Corrosion Limits.
7. Scattered Surface Damage Up To 0.003 Inch Deep On Blade Contact Area Within 0.125 Inch Of Slot On Front And Rear Faces Is Acceptable Without Repair. For Steel Disks, See Blade Slot Corrosion Limits.
8. Scattered Surface Damage Up To 0.008 Inch Deep Is Allowable. If In Excess Of 0.008 Inch Deep, Scrap Disk. For Steel Disks With
R Corrosion, See Figure 607, Blade Slot Corrosion Limits.
9. Scattered Surface Damage Up To 0.005 Inch Deep On Bottom Of Slot Shall Be Repaired. For Steel Disks With Corrosion, See Blade Slot Corrosion Limits.
10. No Surface Damage Acceptable Without Repair. For Steel Disks, See Blade Slot Corrosion Limits.
11. Scattered Surface Damage Up To 0.005 Inch Deep Acceptable Without Repair. For Steel Disks, See Blade Slot Corrosion Limits.
12. No Surface Damage In Any Hole Or Within 0.030 Inch On Adjacent Surface Acceptable.

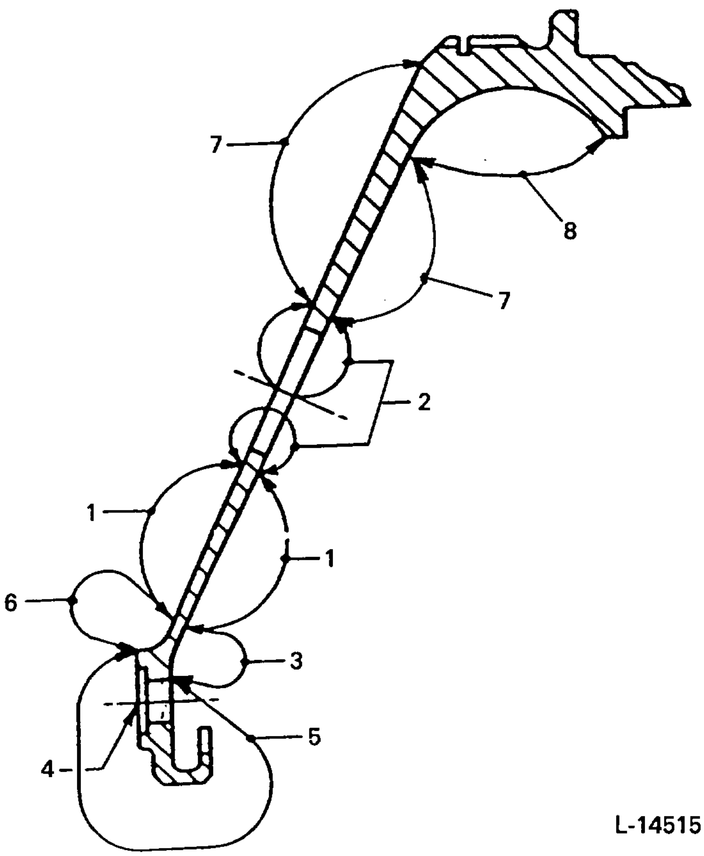
Key to Figure 610

R 3 Disks with repairable damage in blade slot
R leading edges.

R (b) Liquid buff all disk slot radii with an Osborn Metal Finishing Machine, Model 52-2M1A or equivalent. Refer to Source Code 45092 in the Standard Practices Manual, Section 70-12-01 for the source of this machine.

(c) Add letters LB, by roll or drag impressions method (Standard Practices Manual), after part number of disks that have been liquid buffed. See Section 70-11-00, Marking of Parts, Standard Practices Manual for these Permanent marking methods.

NOTE: Parts repaired using this procedure shall be in strict accordance with samples approved by P&W Engineering. Repair Vendor 02403 in the Repair Vendors List has such approval.



R
R

Compressor Rotor Rear
Hub Inspection
Figure 611

1. Scattered Surface Damage Up To 0.002 Inch Deep Allowable.
2. No Surface Damage Allowable In Air Balance Holes And Within 0.125 Inch On Adjacent Surfaces.
3. No Surface Damage Allowable.
4. No Surface Damage Allowable In Bolt Holes Or Within 0.125 Inch On Adjacent Surfaces.
5. Scattered Surface Damage Up To 0.003 Inch Deep Allowable.
6. No Surface Damage Allowable.
7. Scattered Surface Damage Up To 0.003 Inch Deep Allowable.
8. Scattered Surface Damage Up To 0.002 Inch Deep Allowable.

Key to Figure 611

Refer to the Standard Practices Manual, Section 70-40-00 for contact information.

(4) Shotpeening of 3rd stage disk tierod holes.

(a) Inspect disk by this section.

(b) Shotpeen by SPOP 501. Refer to the Standard Practices Manual, Section 70-41-02. Repair Vendor 3H711 in the Repair Vendors List has demonstrated capability to do this repair. Refer to the Standard Practices Manual, Section 70-40-00 for contact information. Vendor FAA License No. is ZF3R022M; Process No. is 390.

(c) Reinspect mating diameters by this section.

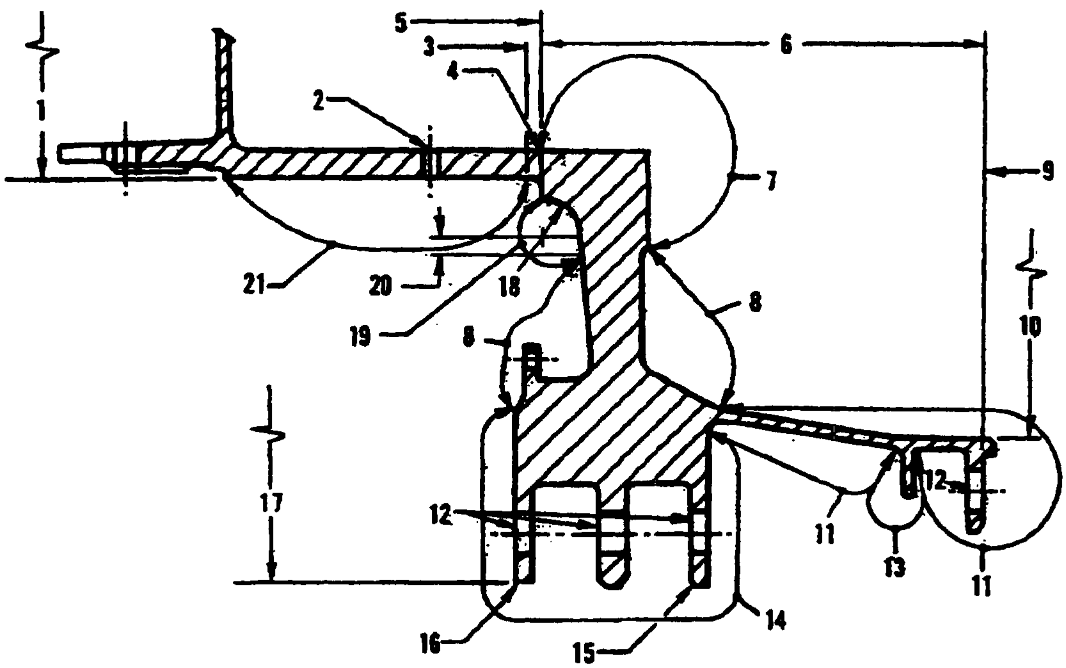
(d) Reidentify disk as follows by the vibration peening process. See Standard Practices Manual, Section 70-11-00. Marking is permitted on the circumference between any two blade slots except at the locations with growth measuring dimples. The -001 may be added to the existing part number if there is space available. Reidentify PN 406203 as 406203-001, 410703 as 410703-001 and 726403 as 726403-001.

(5) Shotpeening of 5th, 6th and 8th Stage Disks

(a) Application: Any 5th, 6th, or 8th stage disks that are discovered during inspection, not to have been shotpeened previously, shall be shotpeened per Blade Slot Corrosion Pitting Repair.

(6) Repair of Mating Diameters

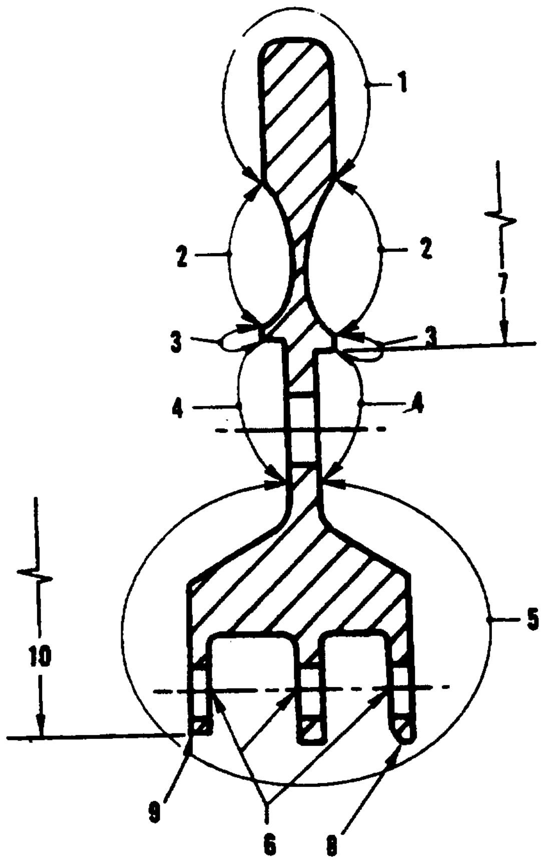
R
R



Compressor Rotor
Front Hub Repair
Figure 612

1. 2.9544 - 2.9549 Inch Diameter. This Diameter Must Be Square With Face 9 And Concentric With Diameter 10 Within 0.001 Inch FIR
2. Hardfacing Not Permitted In Holes (Two Places)
3. 0.047 - 0.062 Inch
4. Blended Step Must Taper At Rate Of 15 Times Depth Of Step.
5. This Face Must Be Square With Diameter 1 Within 0.0005 Inch FIR
6. 2.970 - 2.975 Inches (PN 447901 And 596901)
7. Repair Damage To 0.010 Inch.
8. Repair Damage To 0.005 Inch. No Blend Repairs On Opposite Areas.
9. Reference Face
10. Reference Diameter
11. No Repair Area.
12. No Repair In Holes Or Within 0.125 Inch Of Holes
13. Repair Damage To 0.005 Inch. No repair In Radius
14. Isolated Surface Damage May Be Blended Up To 0.003 Inch. Damage On Chamfers May Be Repaired As Noted In Indexes 15 And 16
15. Repair Damage To 0.030 Inch Maximum Depth On Inner Chamfer.
16. Machine Front Rim Only As Much As Is Required To Clean Up Damage, But Not To Be Less than Diameter 17. Do Not Reinstate Chamfer
17. 7.975 Inch Minimum Diameter. This Diameter Must Be Concentric With Diameter 1 Within 0.002 Inch FIR.
18. 0.234 - 0.266 Inch Radius
19. Repair Damage To 0.003 Inch
20. 0.125 Inch
21. Machine Bearing Journal And Face To Depth Necessary To Produce Hardface Thickness Of 0.002 - 0.004 Inch After Final Machining. Shotpeen And Hardface Enclosed Area.

Key to Figure 612



L-22576 (0000)

Second Stage Compressor
Disk - Repair
Figure 613

1. Repair Damage To 0.010 Inch
2. Isolated Surface Damage May Be Blended To 0.002 Inch
3. Repair Damage To 0.005 Inch
4. No Repair
5. Isolated Surface Damage May Be Blended
6. No Repair In Holes or Within 0.125 Inch Of Holes
7. Reference Diameter
8. Repair Damage To 0.020 Inch Maximum Depth On Inner Chamfer.
9. Reoperate Front Rim Only As Much As Is Required To Clean Up Damage, But Not To Exceed Diameter 10. Do Not Reinstate Chamfer.
10. 9.223 Inch Minimum Diameter. This Diameter Must Be Concentric
R With Diameter 7 0.002 Inch FIR Maximum.

Key to Figure 613

(a) Application. If mating diameters do not meet concentricity requirements, remove up to 0.002 inch of material to bring mating diameters within concentricity limits provided such removal does not violate fit requirements between disks and mating parts. See Table of Limits. For steel disks and rear hubs with damaged mating diameters and/or spacer mating surfaces, repair these areas by plating.

(b) Measure the diameter before machining.

NOTE: This repair is intended to remove surface damage only and not to correct fit of parts.

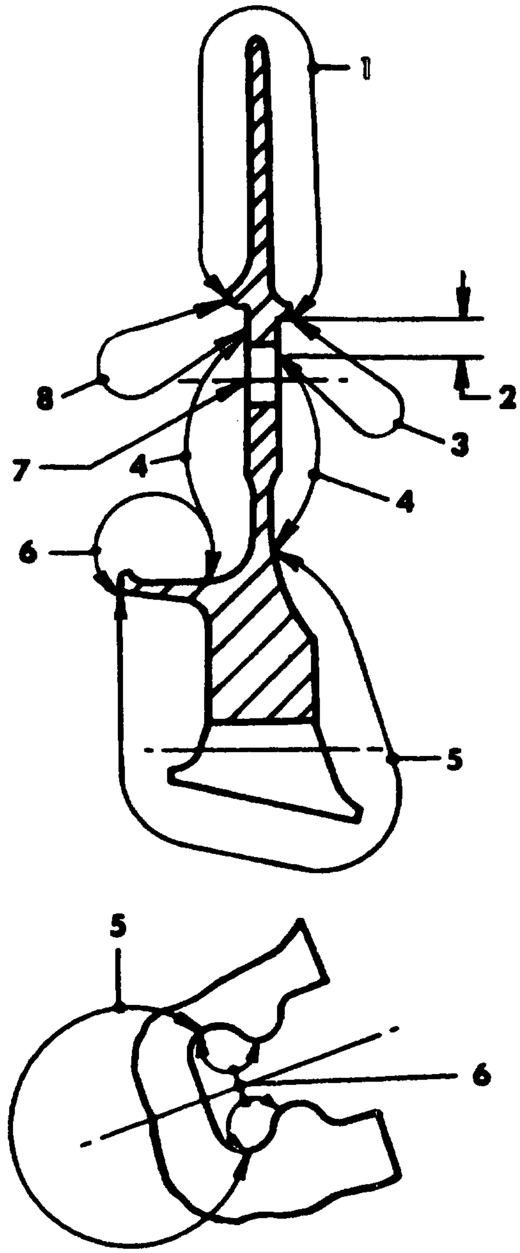
(c) Machine the diameter to remove damage.

(d) Nickel plate diameter by SPOP 29. See Section 70-44-01, Standard Practices Manual.

(e) Machine to dimensions measured prior to machining and plating.

CAUTION: IT IS IMPERATIVE THAT MATING DIAMETER BE MACHINED BACK TO DIMENSIONS PRIOR TO REPAIR AND NOT TO BLUEPRINT DIMENSIONS IN ORDER TO MAINTAIN HISTORY OF HUB GROWTH. ALLOWANCE MUST BE MADE FOR THICKNESS OF PLATE.

(f) Machine spacer mating surface to clean up.



L-14521 (0000)

R
R

Third Stage Compressor
Disk - Repair
Figure 614

1. Repair Surface Damage Up To 0.003 Inch.
2. 0.125 Inch
3. No Repair In This Area.
4. No Repair In This Area.
5. Repair damage Up To 0.005 Inch. For Steel Disks With Corrosion, See Blade Slot Corrosion Pitting Repair.
6. No Repair. For Steel Disks With Corrosion, See Blade Slot Corrosion Pitting Repair.
7. No Repair In Holes Or Within 0.125 Inch Of Holes.
8. No Repair.

Key to Figure 614

(g) Nickel plate spacer mating surface by SPOP 29. See Section 70-44-01, Standard Practices Manual.

(h) Machine to dimensions, allowing for nickel-cadmium plate.

(7) Rear Hub Front Mating Diameter Alteration Repair

(a) If the hub is in the growth limits in Figure 601, repair a hub with this procedure if the fit with the mating parts is not as specified in the Table of Limits:

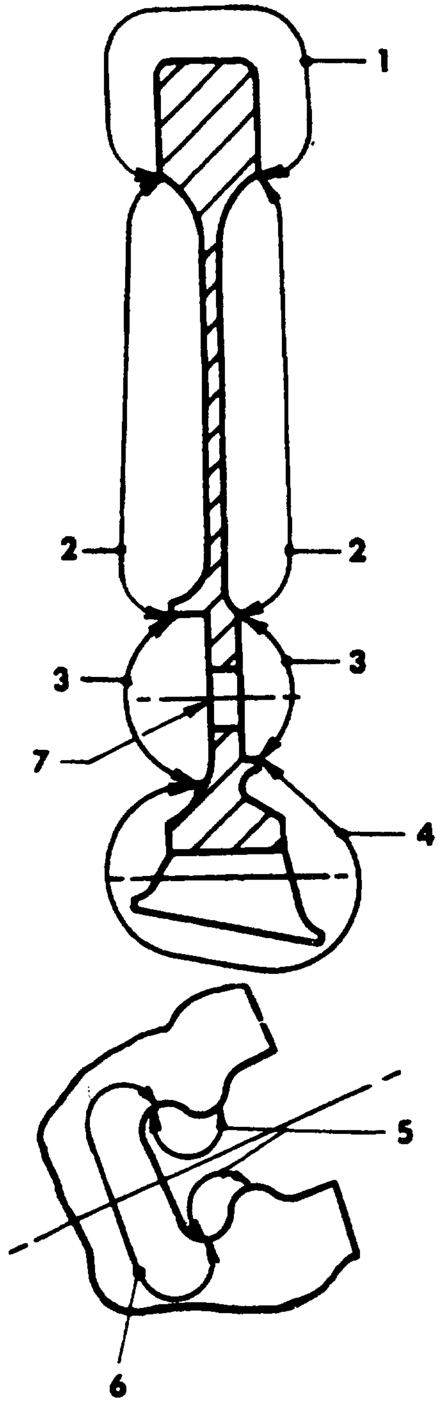
1 Measure and record the mating diameters of the 9th stage disk (Figure 618, Index 6) and the
R hub (Figure 619, Index 7).

NOTE: It is necessary to measure these mating diameters during inspection or mating diameter repair, and it is important to record these diameters if a repair changes the diameter.

2 One of these repairs will be necessary to repair the hub:

a Machine the hub diameter to bring the mating part fit in limits (see step 3 in this paragraph).

b Machine the diameter and apply nickel plate to repair local damage (see step 4 in this paragraph).



R
R

Fourth Stage Compressor
Disk - Repair
Figure 615

1. Repair Damage Up To 0.010 Inch
2. Minor Surface Damage May Be Blended
3. No Repair
4. Repair Damage Up To 0.005 Inch. For Steel disks With Corrosion, See Blade Slot Corrosion Pitting Repair.
5. No. Repair. For Steel Disks With Corrosion, See Blade Slot Corrosion Pitting Repair.
6. Repair Damage Up To 0.005 Inch. For Steel Disks With Corrosion, See Blade Slot Corrosion Pitting Repair.
7. No Repair In Holes Or Within 0.125 Inch Of Holes.

Key to Figure 615

c Machine the diameter and apply nickel plate to bring the mating part fit in limits (see steps 5 and 6 in this paragraph).

R 3 Machine the mating diameter to the pre-nickel plate dimension (see Figure 619, Index 7) or as necessary to be in mating part fit limits (Reference 10 in the Table of Limits).

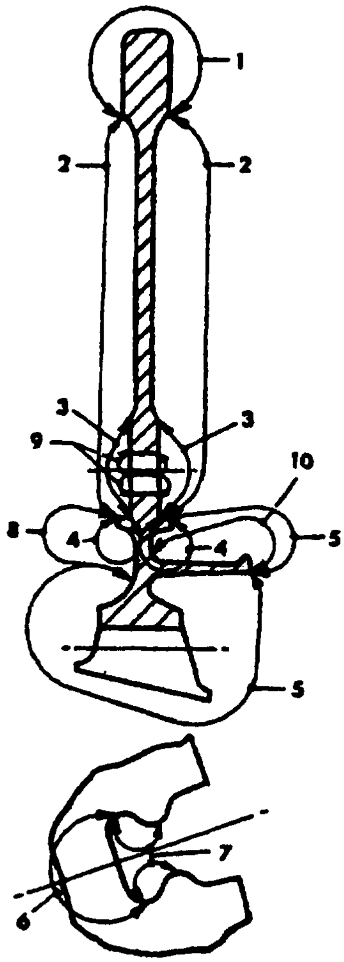
4 Apply nickel plate by SPOP 29. Refer to Section 70-44-01 in the Standard Practices Manual.

5 After plate is applied, machine the diameter to the dimension measured (see step 1) or to a dimension sufficient to get the specified fit from Table of Limits.

6 Measure the repaired diameter and compare this dimension with the measured diameter from step 1. Record the changed diameter on the hub adjacent to the part number as specified in paragraph B. of this section (refer to Section 70-11-00 of the Standard Practices Manual for marking procedures).

NOTE: After all inspections and repairs are completed, it will be necessary to do all plate repairs done before again and to apply protective coatings by the applicable procedure in this section. All machined hub dimensions must be in limits after this protective coating is applied.

(b) Hub Mating Diameter Alteration Marking



L-14522 (0000)

R
R

Fifth Stage Compressor
Disk - Repair
Figure 616

1. Repair Damage Up To 0.010 Inch.
2. Minor Surface Damage May Be Blended. Do Not Reduce Web Thickness By More Than 0.008 Inch.
3. Finish Machine Spacer Mating Surfaces To 0.140 - 0.144 Inch Thick And Parallel Within 0.001 Inch FIR
4. Repair Damage Up To 0.005 Inch. Finish Machine Snap Diameter To Dimensions Measured Prior To Machining And Plating Plus 0.000 - Minus 0.002 Inch. ID Snaps Must Be Concentric Within 0.001 Inch FIR And Front Snap Diameter Square With Front Spacer Mating Surface Within 0.0005 Inch FIR.
5. Repair Corrosion Pitting Within Disk Web Corrosion Limits. For Steel Disks With Corrosion That Is Within Limits Of Figure 648 (Blade Slot Limits) Repair Slots And Rim Lands as Instructed In Paragraph P. step (6).
6. Repair Damage Up To 0.008 Inch. For Steel Disks With
R Corrosion, See Blade Slot Corrosion Pitting/Galling Repair.
7. For Steel Disks With Corrosion, Or Galling, See Blade Slot Corrosion Pitting/Galling Repair.
8. Repair Corrosion Pitting Within Disk Web Corrosion Limits.
9. No Repair In Holes Within 0.125 Inch Of Holes.
10. After Rework, Restore Surface Finish.

Key to Figure 616

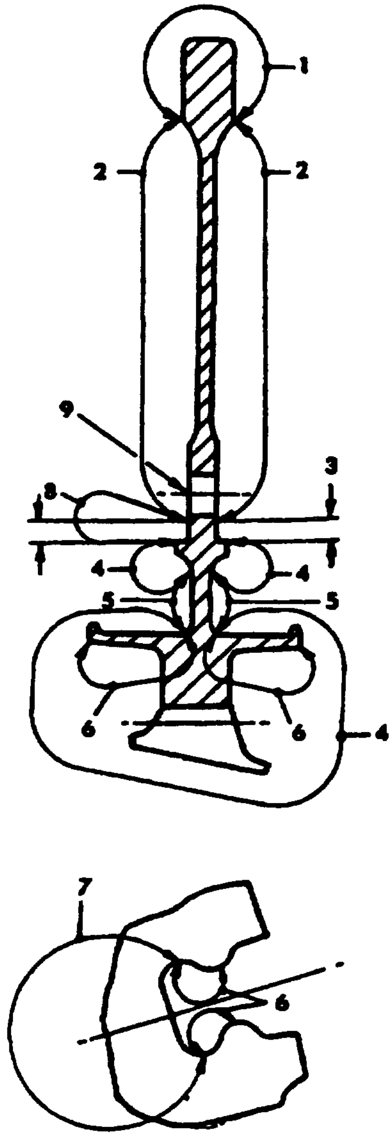
1 General

a To get the correct fit with the mating disk, it is possible to add or remove material from the hub front mating diameter (refer to the repair procedure above). It will be necessary to record these changes to the mating diameter as a code added to the hub adjacent to the part number. Refer to the Compressor Disk/Hub Growth Limits paragraph in this section.

2 Procedure

a Measure and record the base dimension (the diameter measured before repair is started) for which changes will be necessary.

b After repair, compare the changed dimension with the base dimension to find how the diameter was changed.



L-14520 (0000)

R
R

Seventh Stage Compressor
Disk - Repair
Figure 617

1. Repair Damage Up To 0.010 Inch
2. Minor Damage May Be Blended.
3. 0.125 Inch
4. Repair Damage Up To 0.005 Inch. For Steel Disks With Corrosion
R That Is Within Limits Of Figure 607 (Blade Slot Limits) Repair Slots And Rim Lands As Instructed In Paragraph P.(6).
5. Minor Damage May Be Blended.
6. No Repair Except For Steel Disks With Corrosion. For Steel Disks With Corrosion, Or Galling, See Blade Slot Corrosion Pitting/Galling Repair.
7. Repair Damage Up To 0.005 Inch. For Steel Disks With Corrosion,
R or Galling, See Blade Slot Corrosion Pitting/Galling Repair.
8. No Repair, Both Sides.
9. No Repair In Holes Or Within 0.125 Inch Of Holes.

Key to Figure 617

c Record this change as a code: If the diameter increased, record the change in thousands of an inch with a P symbol. If the diameter decreased, record the change with a M symbol.

NOTE: For example, if a hub diameter increased 0.005 inch by a machining repair, the hub mark will be P5.

d Refer to Section 70-11-00 in the Standard Practices Manual for marking procedures.

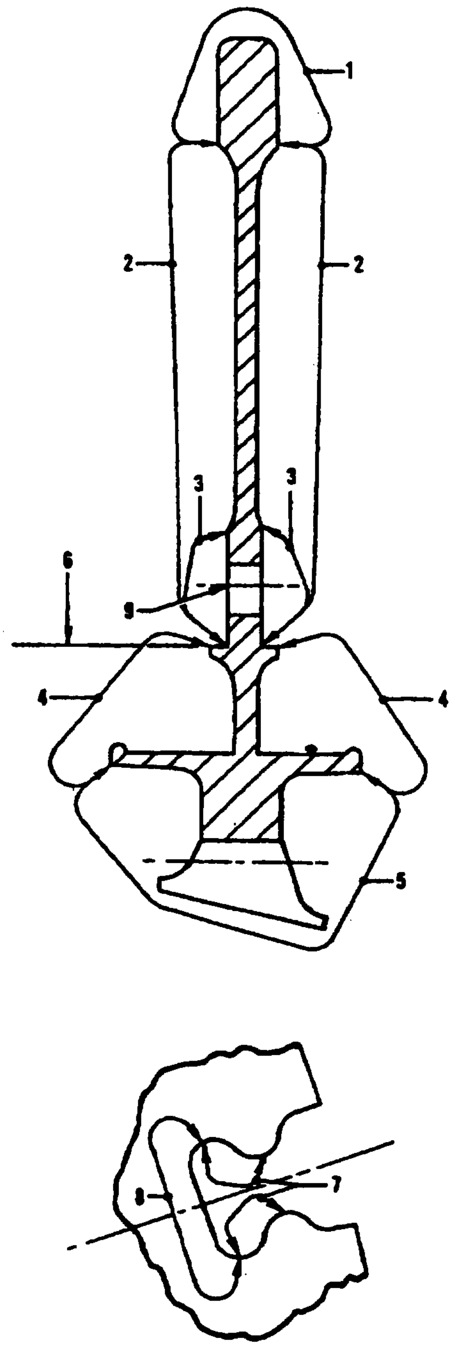
(8) Blade Slot Corrosion Pitting/Galling Repair. See Figure 607.

(a) Grit blast corroded areas by SPOP 218. Refer to Section 70-21-00 in the Standard Practices Manual.

(b) Clean by SPOP 203. Refer to Section 70-21-00 in the Standard Practices Manual. If there are oxides remaining on disk surfaces after removal from the solution, do step (a) again.

(c) Examine all blade slots for remaining oxides, do step (b) again if necessary.

(d) Do a fluorescent magnetic particle or fluorescent penetrant inspection method (as applicable).



R
R

Sixth, Eighth, And Ninth Stage
Compressor Disks - Repair
Figure 618

1. Repair Damage Up To 0.010 Inch.
2. Minor Surface Damage May Be Blended
3. Nickel Plate per SPOP 29. See Section 70-44-01, Standard Practices Manual. Dimensions Between Mating Surfaces Must Be: 6th Stage - 0.146 - 0.150 Inch, 8th Stage - 0.142 - 0.146 Inch, And 9th Stage - 0.168 - 0.172 Inch. Mating Surfaces Must Be Parallel Within 0.001 Inch FIR.
4. Scattered Damage Allowable Up To 0.003 Inch Deep And Reparable Within Disk Web Corrosion Limits. See Inspection.
5. Scattered Damage Allowable Up To 0.003 Inch Deep. For Steel Disks With Corrosion That Is Within Limits Of Figure 648 (Blade Slot Limits) Repair Slots And Rim Lands As Instructed In Paragraph P. step (6).
6. Repair Damage Up To 0.005 Inch. Surface Finish To Be Restored Per SPOP 29 To Dimensions Measured Prior To Machining And Plating Plus 0.000 To Minus 0.002 Inch For ID Snaps And Plus 0.002 To Minus 0.000 Inch On OD Snap. Snap Diameters Must Be Concentric Within 0.001 Inch FIR And Front Snap Diameter Square With Front Spacer Mating Surfaces Within 0.0005 Inch FIR.
7. See, Blade Slot Corrosion Pitting/Galling Repair.
8. Repair Damage Up To 0.008 Inch. For Corrosion pitting, See Blade Slot Corrosion Pitting/Galling Repair.
9. No Repair In Holes Or Within 0.125 Inch Of Holes.

Key to Figure 618

(e) Visually inspect each blade slot, using magnifying glass of 3X power, or greater, and sufficient lighting.

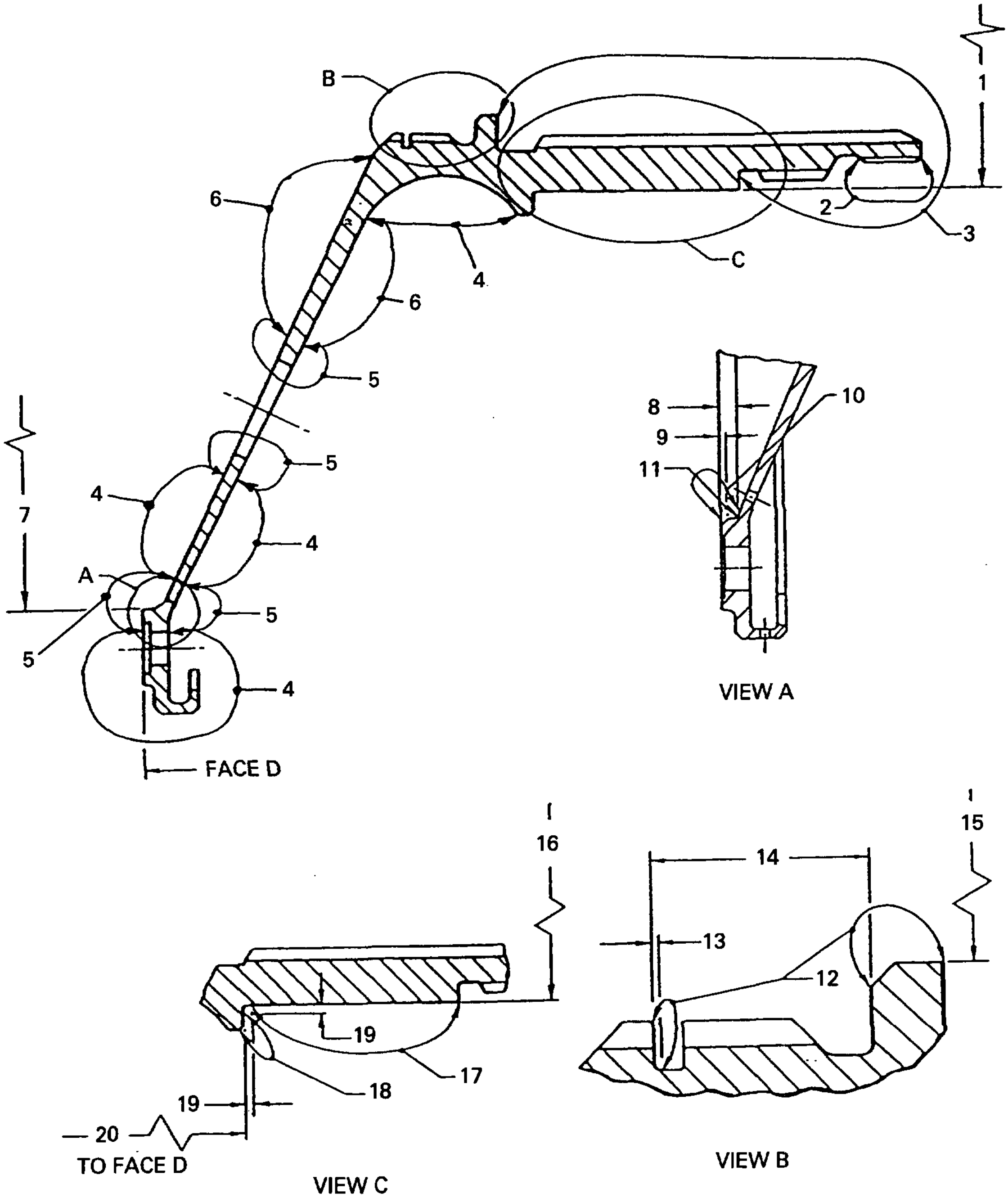
<u>NOTE</u>: It is recommended that light be placed in back of disk directed toward viewer to show up texture and pattern of surface. Magnifying dental mirrors may also be used.

(f) When slot shows significant pitting, galling or wear on blade surface determine contact area as follows:

R <u>1</u> Using cotton tipped swab, lightly coat blade slot with solution of 20 grams copper sulfate, two grams sulfuric acid and enough water to make one liter of solution.

<u>NOTE</u>: Disk must be free of oil so that solution will take properly.

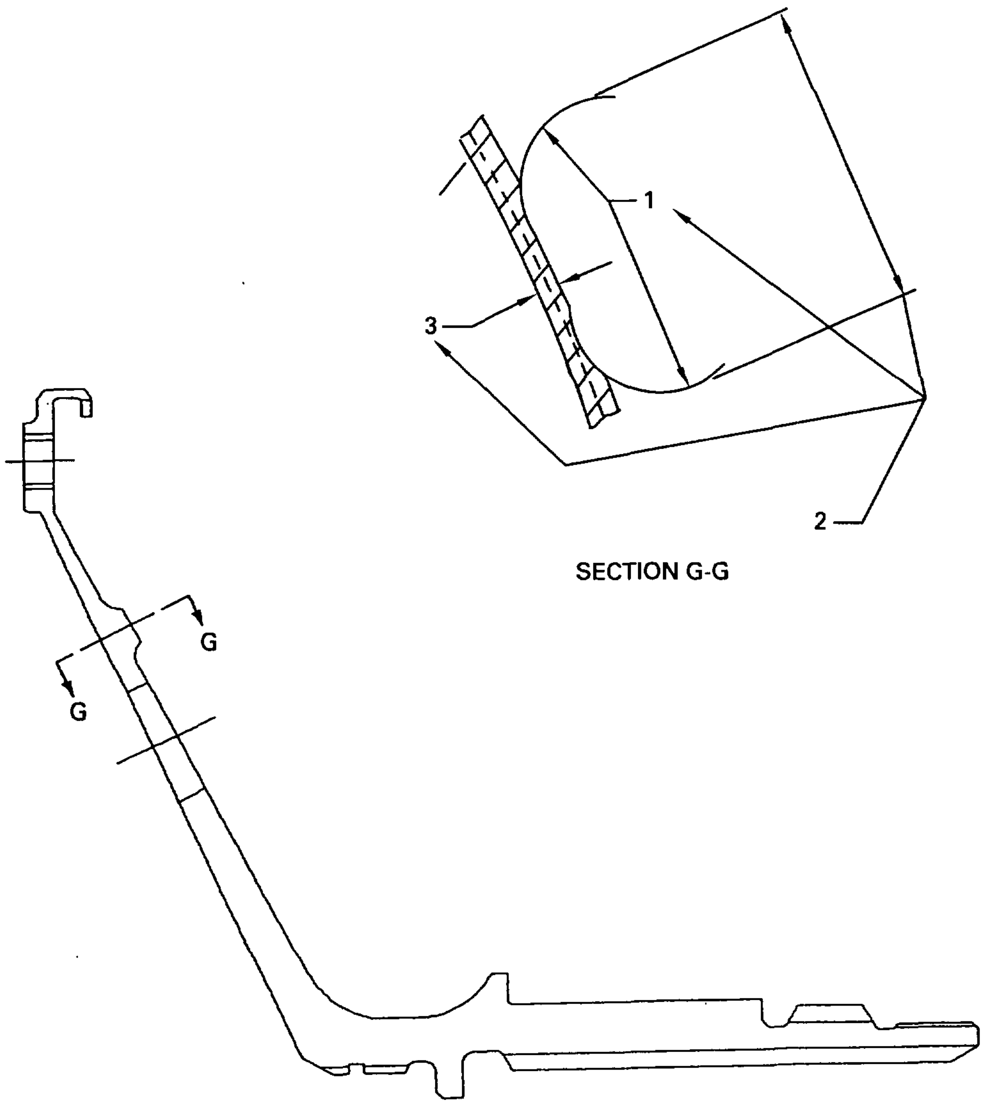
<u>2</u> Wipe dry with clean swab.


B
1
6
2
3
C
4
6
5
8
10
9
11
5
4
7
4
A
5
5
4
VIEW A
FACE D
16
15
14
13
12
19
17
18
19
20
TO FACE D
VIEW C
VIEW B

L-62390 (0207)

1. Reference Diameter
2. Electrical Contact Area
3. Nonplated Area
4. Repair Damage To 0.005 Inch Depth.
R 5. Repair Damage To 0.003 Inch Depth.
R Repair Damage To 0.005 Inch On Mating Diameter
6. Repair Damage To 0.006 Inch Depth.
7. Mating Diameter, 8.651 - 8.636 Inch Diameter Before Nickel Plate (Hold To Minimum Value), 8.624 Inch Diameter Maximum After Nickel Plate. Finish Machine To Dimension Measured Before Plate Removal (Unless Other Dimensions are Necessary To Give the Hub the Specified Fit In the Table Of Limits). The Diameter Must Be Concentric With Index 1 Diameter 0.003 Inch Maximum FIR.
8. 0.105 - 0.110 Inch Machine Dimension Before Plating For Index 7.
9. Chamfer 0.015 - 0.025 Inch By 43° - 47°.
10. Nickel-plate Enclosed Area Per SPOP 29. Plating Outside Enclosed Area Is Permissible Provided Such Excess Is Removed.
11. 0.016 - 0.031 Inch Radius. Must Be Tangent To Adjacent Surfaces.
12. Nickel-plate Enclosed Area Per SPOP 29. Plating Outside Enclosed Area Is Permissible Provided Such Excess Is Removed.
13. 0.010 Inch Minimum.
14. 0.495 - 0.507 Inch Machine Dimension Before Nickel-plate. Hold To Minimum Value. 0.483 Inch Maximum Dimension After Nickel-plate Buildup. Finish Machine Dimension Of 0.488 - 0.492 Inch
15. 1.830 - 1.845 Inch Diameter Machine Dimension Before Nickel-plate. Hold To Minimum Value. 1.813 Inch Maximum Diameter After Nickel-plate Buildup. Finish Machine To Dimension Of 1.823 - 1.825 Inch Diameter. Restore Chamfer Of 0.030 - 0.040 Inch By 43°- 47°.
16. 2.879 - 2.894 Inch Diameter Machine Dimension Before Chromium Plate. Hold To Maximum Value. 2.910 Inch Minimum Diameter After Chromium Plate buildup. Finish Machine To Dimension Of 2.899 - 2.900 Inch Diameter.
17. Chromium Plate Enclosed Area Per SPOP 22. Plate Outside Enclosed Area Is Permissible Provided Such Excess Is Removed.
18. Chromium Plate Enclosed Area Per SPOP 22. Plate Outside Enclosed Area Is Permissible Provided Such Excess Is Removed.
19. 0.020 Inch Minimum
20. From Face D To Shoulder, 2.672 - 2.684 Inch Machine Dimension Before Chromium Plate. Hold To Maximum Value. 2.694 Inch Minimum Dimension After Chromium Plate Buildup. Finish Machine To Dimension Of 2.687 - 2.689 Inches. Face Of Shoulder Must Be Square With Index 16 within 0.005 Inch FIR.

Key to Figure 619



R
R

Flange Material Removal
Technique for Balancing
Figure 620

1. 0.500 Inch Radius Minimum
2. Remove Material To these Limits As Required To Obtain Balance
3. 0.005 Inch Minimum

Key to Figure 620

3 Insert blade into slot, loading blade toward root to avoid contact with normal blade contact area until blade is properly centered.

NOTE: Use a 3rd stage blade for 3rd stage disk and 4th stage blade for remaining disks.

4 Apply outward radial load to blade and rock blade slightly. This will remove copper from high spots and indicate bearing area.

NOTE: Remainder of copper will be removed during normal cleaning process prior to nickel-cadmium plating.

5 Inspect contact area on both sides of slot. Pattern must show contact for at least 50 percent of length of slot on each side as defined in referenced figure.

6 For disks within limits of referenced figure, shotpeen each slot and rim per SPOP 501 to an steel intensity equivalent to 6A using SAE 110 cast shot or grit blasts slots using No. 90 aluminum oxide grit and shotpeen each slot and rim to an intensity equivalent to 10A using SAE 170 cast steel shot.

NOTE: Parts repaired using this procedure shall be in strict accordance with samples approved by P&W Engineering. Procedure No. 5111 of Repair Vendor 4A245 has such approval. Refer to the Repair Vendors List in Section 70-40-00 in the Standard Practices Manual for contact information.

(9) Lipseal Flange Corrosion Pitting Repair (Stage 3 And Stages 5 Thru 9).

(a) Application. For disks within corrosion pitting limits specified in Inspection - Disk Web Corrosion Limits.

R
R

(b) Clean all of a disk by grit blasting by SPOP 218 (refer to Section 70-21-00 in the Standard Practices Manual).

(c) Measure the depth of pitting damage. Pitting must not be more than repairable surface damage limits.

(d) Clean the disk by SPOP 203. Refer to Section 70-21-00 in the Standard Practices Manual.

(e) Blend heavy, irregular and/or sharp bottom pitting, within limits. Repaired area shall not exceed three inches in length, measured circumferentially. Scrap disks when Dimension "T" is less than minimum allowable.

(10) Butterfly-finish of Tierod Holes.

(a) If not already accomplished, butterfly finish tierod holes of all steel disks by SPOP 502. Refer to Section 70-45-00 in the Standard Practices Manual.

(11) Disk Bore Repair.

(a) The maximum bore clean up diameter for all compressor disks is 4.030 inches.

(b) After machining, carefully restore bounding radii, maintaining circumferential lay of tool marks.

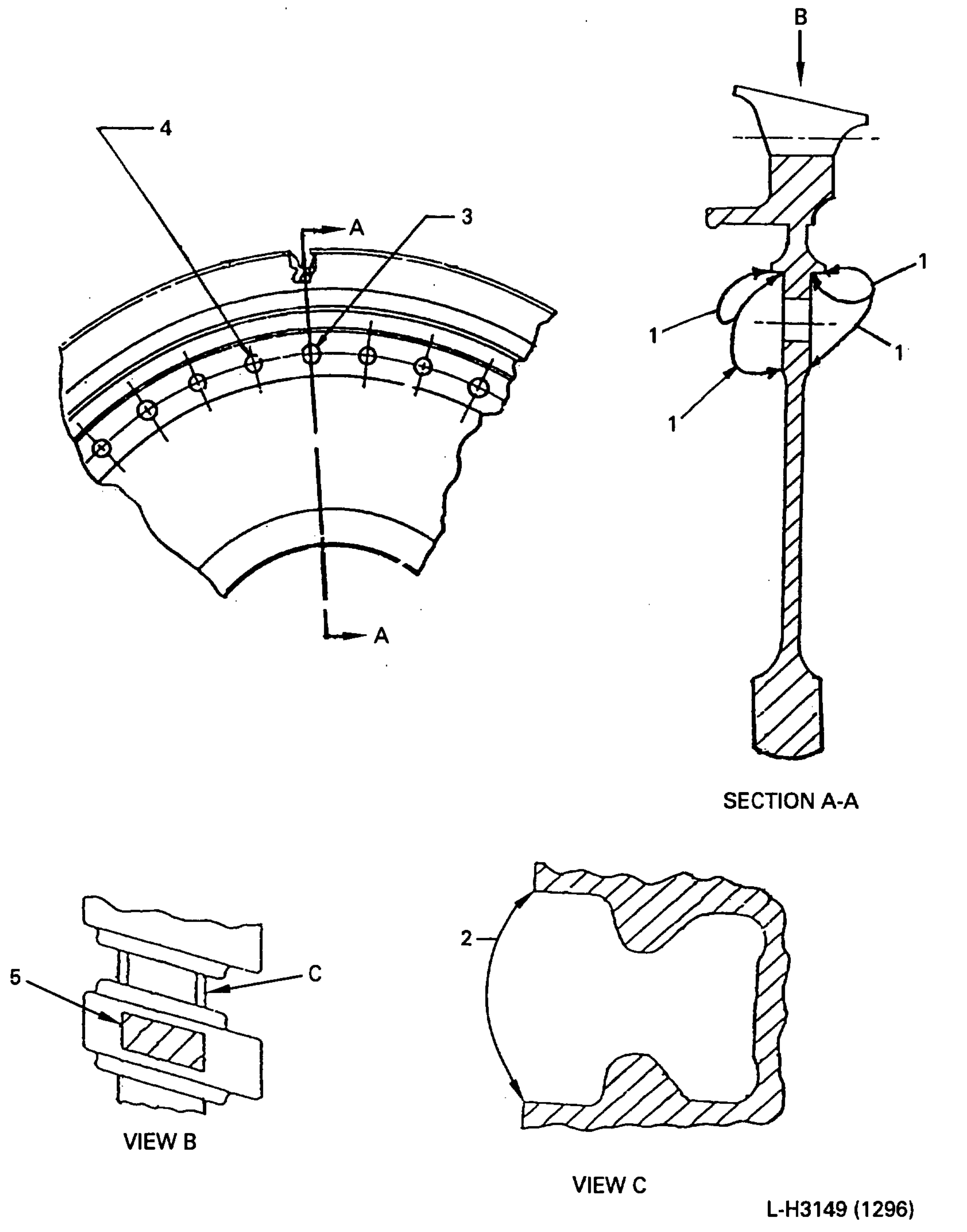
(12) Optional PWA 110-21 coating of 5th, 6th, 8th, and 9th stage disks. See Figure 621 thru Figure 624.

(a) Inspect and repair corrosion pits as instructed in this section.

(b) Strip nickel cadmium plate by SPOP 25, Standard Practices Manual, Section 70-44-01.

R (c) Apply inorganic aluminum coat and top coat by PWA 110-21 in the Standard Practices Manual, Section 70-41-04. Coat must be 0.001 - 0.003 inch thick all over except as shown in the applicable figures.

R (d) Mark part number information where shown in figures. Use a non-etching ink. Refer to Section 70-11-00, Standard Practices Manual.



R
R

Fifth Stage Disk
Optional Coating
Figure 621

1. Coat Must Be 0.0005 - 0.0015 Inch Thick With 0.0004 Inch Maximum Variation
2. Coat Must Be 0.0005 Inch Thick Minimum
3. 0.249 - 0.252 Inch Diameter, 12 Holes Equally Spaced. Coat To Be 0.0005 Inch Thick Minimum, But Minimum Hole Diameter Must Be Maintained.
4. 0.209 - 0.229 Inch Diameter, 24 Holes On Basis of 36 Holes Equally Spaced. Coat To Be 0.0005 Inch Thick Minimum, But Minimum Hole Diameter Must Be Maintained.
5. Coat Must Be 0.0005 Inch Thick Minimum. Mark Part Number In This Area.

Key to Figure 621

(e) If touchup or recoat are required before or after disk and blade assembly, refer to recoating of PWA 595 and touchup of top coat in Section 70-41-04, Standard Practices Manual.

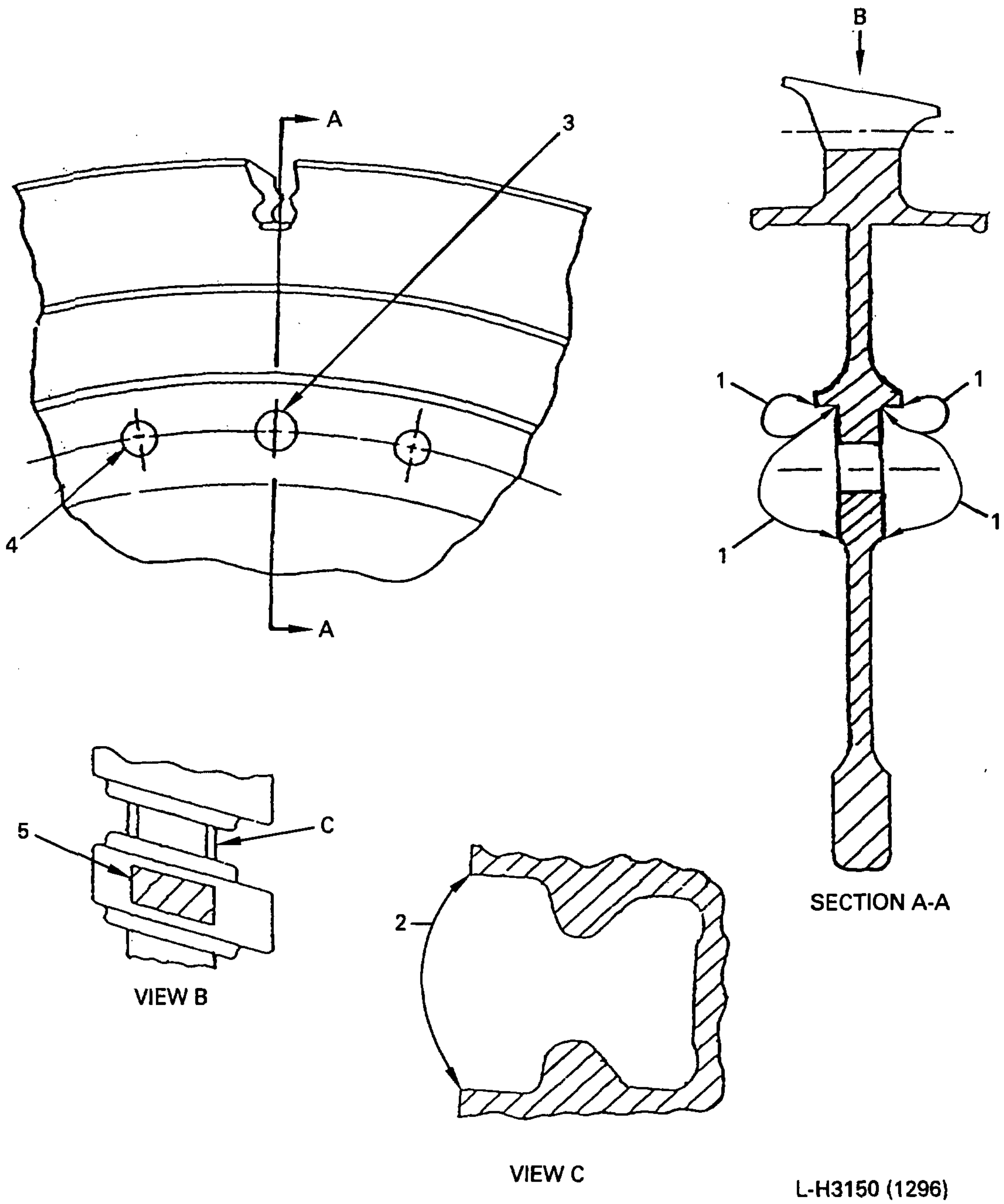
(13) Compressor Front Hub Bearing Journal Plasma Coat Repair. See Figure 612.

(a) Grind journal to remove enough material to maintain 0.002 - 0.004 inch thick Linde Tungsten Carbide Coating after finish grind.

NOTE: Use four inch diameter aluminum oxide wheel (Grit 32A 1002 18 UBE). Dress wheel prior to each grind. Maintain wheel speed of 2200 - 2400 surface feet per minute. Hold to lower limit. Work speed to be 24 rpm with feed of 0.0002 inch per revolution. Use PMC 9398 synthetic cutting and grinding coolant compound mixed to 20 to one ratio. Refer to 70-12-00, Standard Practices Manual for the source and trade name of this compound.

NOTE: Do not use too much tool force on the work during the grinding operation. During calculation of the finished diameter, allow for effect of temperature increase. Temperature increase of one degree Fahrenheit increases journal diameter 0.00005 inch. Work piece temperature shall be carefully monitored before, during and after grinding to ensure rework results

R in the exact diameter desired.



R
R

Sixth Stage Disk
Optional Coating
Figure 622

1. Coat Must Be 0.0005 - 0.0015 Inch Thick With 0.0004 Inch Maximum Variation
2. Coat Must Be 0.0005 Inch thick Minimum
3. 0.249 - 0.252 Inch Diameter, 12 Holes Equally Spaced. Coat To Be 0.0005 Inch Thick Minimum, But Minimum Hole Diameter Must Be Maintained.
4. 0.209 - 0.229 Inch Diameter, 24 Holes On Basis Of 36 Holes Equally Spaced. Coat To Be 0.0005 Inch Thick Minimum, But Minimum Hole Diameter Must Be Maintained.
5. Coat Must Be 0.0005 Inch Thick Minimum. Mark Part Number In This Area.

Key to Figure 622

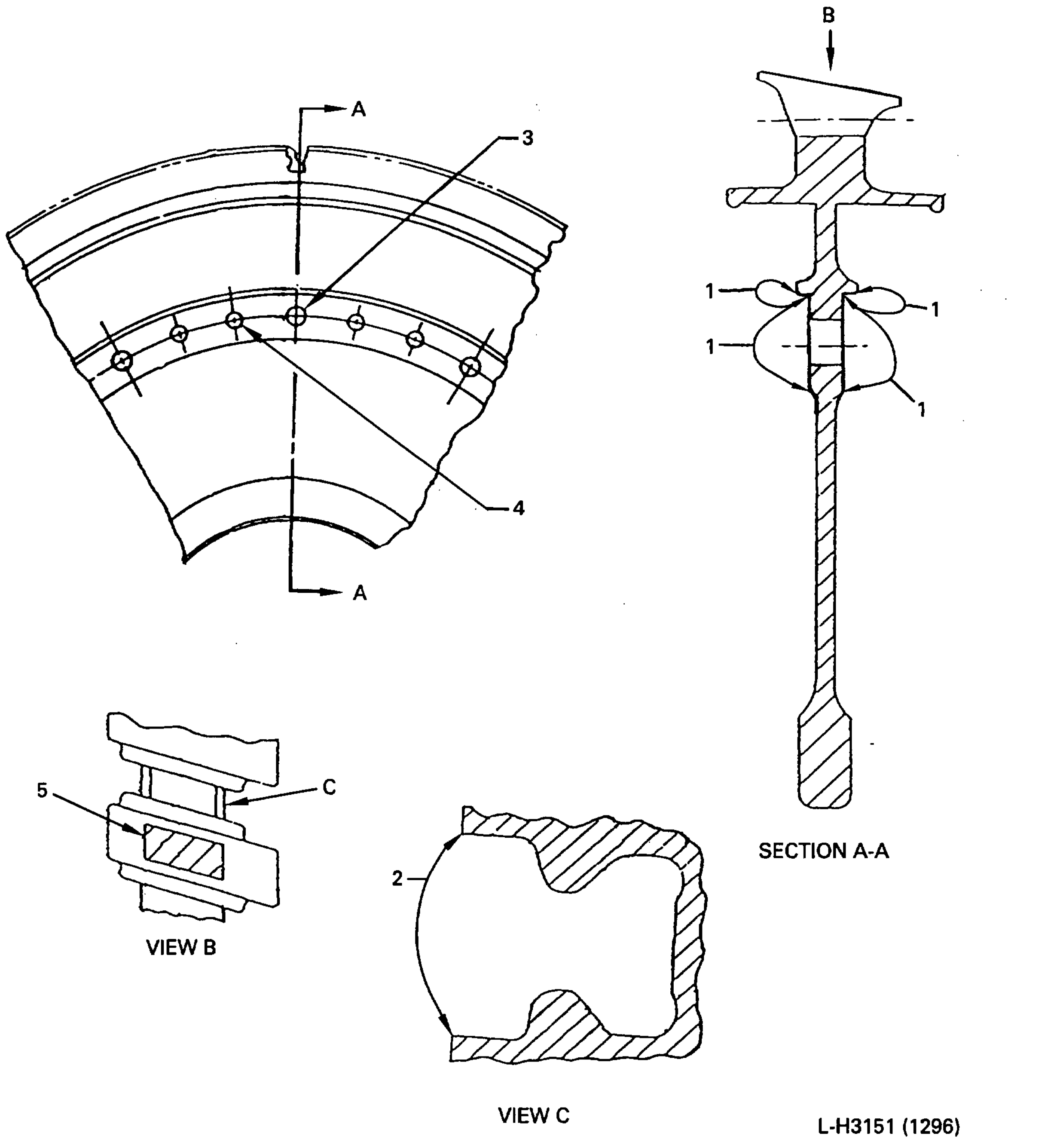
(b) Shotpeen journal by SPOP 501 to intensity equivalent to 6A with SAE 110 cast steel shot. Refer to Section 70-41-02 in the Standard Practices Manual.

(c) Send hub to an approved source for PWA 46 coating (refer to Section 70-40-02 in the Standard Practices Manual). Minimum thickness of coating is 0.007 inch.

(d) Finish-grind journal using specially formed or straight 220 grit diamond wheel having 100 percent concentration of diamond, L or N hardness and resinoid bond. Maintain requirements of referenced figure. Finish journal to roughness value of 16AA.

<u>NOTE</u>: Balance and true wheel on its own wheel mount for maximum runout of 0.0003 inch.

Wheel size should be determined by manufacturer's recommendation. Wheel should be mounted for its entire life. Dress wheel frequently with silicon carbide stick (37C 4001 7V) to ensure clean wheel and free cutting. Wheel speed should be approximately 6000 surface feet per minute and work speed should be approximately 40 surface feet per minute. Infeed should be 0.0002 inch per pass for rough cuts and reduced to 0.0001 inch per pass for removal of final
R 0.0003 - 0.0005 inch of material. Cross-



R
R

Eighth Stage Disk
Optional Coating
Figure 623

1. Coat Must Be 0.0005 - 0.0015 Inch Thick With 0.0004 Inch Maximum Variation
2. Coat Must Be 0.0005 Inch Thick Minimum
3. 0.249 - 0.252 Inch diameter, 12 Holes Equally Spaced. Coat To Be 0.0005 Inch Thick Minimum, But Minimum Hole Diameter Must Be Maintained.
4. 0.209 - 0.230 Inch Diameter, 24 Holes On Basis Of 36 Holes Equally Spaced. Coat To Be 0.0005 Inch Thick Minimum, But Minimum Hole Diameter Must Be Maintained.
5. Coat Must Be 0.0005 Inch Thick Minimum. Mark Part Number In This Area.

Key to Figure 623

feed of 0.040 - 0.080 inch per revolution of the workpiece is recommended.

Flood coolant is necessary. Use mixture of water and one to two percent rust inhibitor oil for best results.

(14) Front hub repair for elongated bearing retaining nut rivet holes. See Figure 625.

(a) Application. Hubs having holes elongated beyond limits of Index 1.

(b) Machine set of new holes as shown

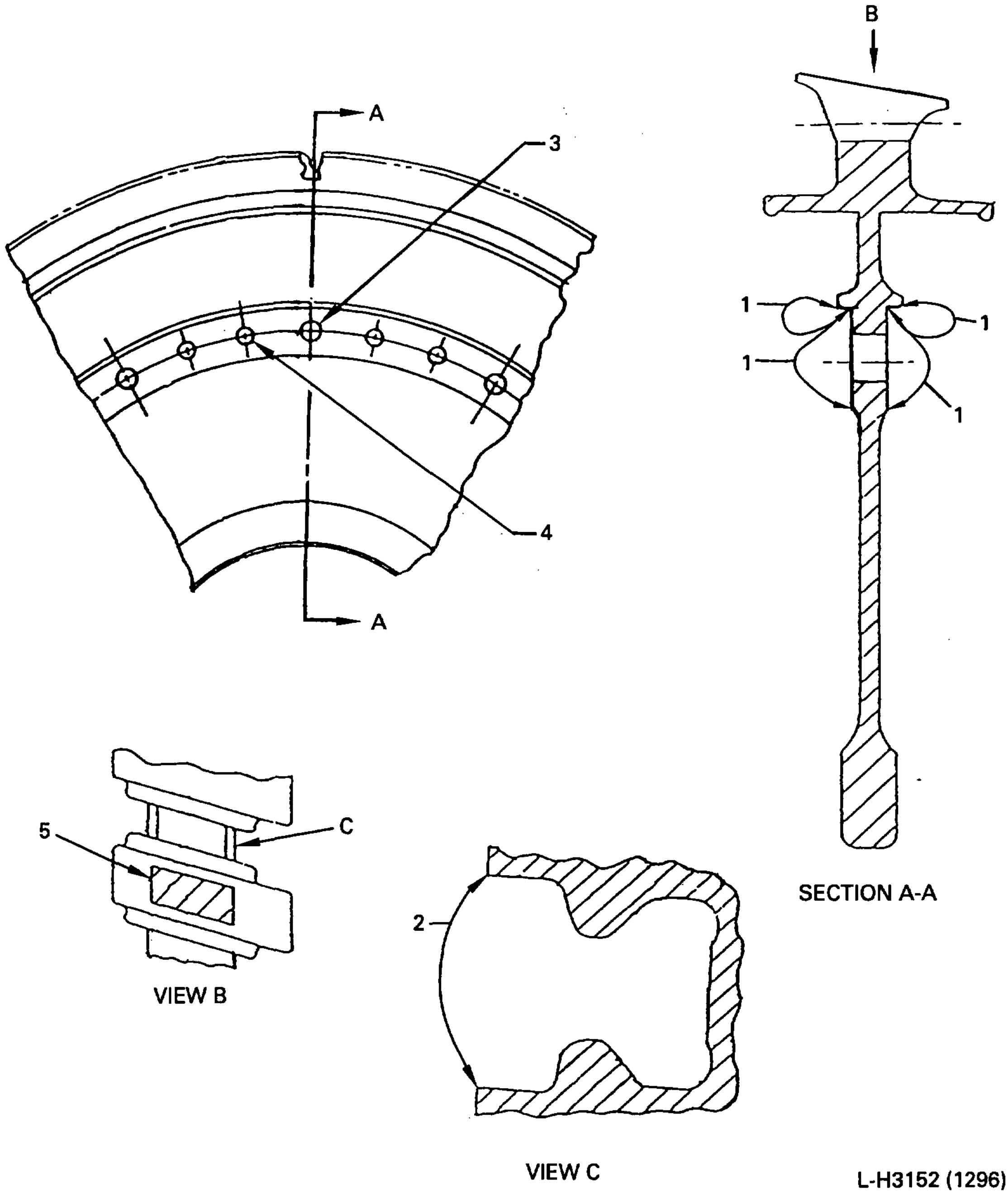
(c) Clean holes to be plugged by PWA 83-7. Refer to Section 70-48-00 in the Standard Practices Manual.

(d) Plug elongated holes with PWA 36003 adhesive/ sealant. Refer to Section 70-12-00 in the Standard Practices Manual. Cure sealant for 24 hours minimum.

(15) Front Hub Rear Mating Diameter Plasma Coat. See Figure 626 and Figure 627.

(a) Machine the worn inner mating diameter of the hub to a maximum diameter of 6.413 inches before plasma coating. If you grind the diameter, grind by SPOP 530 in Section 70-45-00, Standard Practices Manual. Remove a minimum of parent metal when you clean up machine while you maintain the recommended plasma thickness of 0.003 - 0.010 inch by PWA 53.

R
R



R
R

Ninth Stage Disk
Optional Coating
Figure 624

1. Coat Must Be 0.0005 - 0.0015 Inch Thick With 0.0004 Inch Maximum Variation
2. Coat Must Be 0.0005 Inch Thick Minimum
3. 0.249 - 0.252 Inch Diameter, 12 Holes Equally Spaced. Coat To Be 0.0005 Inch Thick Minimum, But Minimum Hole Diameter Must Be Maintained.
4. 0.229 - 0.234 Inch Diameter, 24 Holes On Basis Of 36 Holes Equally Spaced. Coat To Be 0.0005 Inch Thick Minimum, But Minimum Hole Diameter Must Be Maintained.
5. Coat Must Be 0.0005 Inch Thick Minimum. Mark Part Number In This Area.

Key to Figure 624

(b) Degrease the part by SPOP 209 in Section 70-21-00, Standard Practices Manual. See SPOP 170 in Section 70-46-01, Standard Practices Manual.

(c) Fluorescent penetrant inspect the prepared area by SPOP 84 in Section 70-33-00, Standard Practices Manual.

(d) Prepare the machined mating diameter (see View A in Figure 626) by SPOP 170. Refer to 70-46-01 in the Standard Practices Manual.

(e) Mask the fillet machined in step (a). The masking can extend rearward to with 0.135 inch of the rear of the hub.

(f) Plasma coat the prepared area by the procedure in Section 70-46-01, Standard Practices Manual. See View B in Figure 626. Use one of the materials that follow:

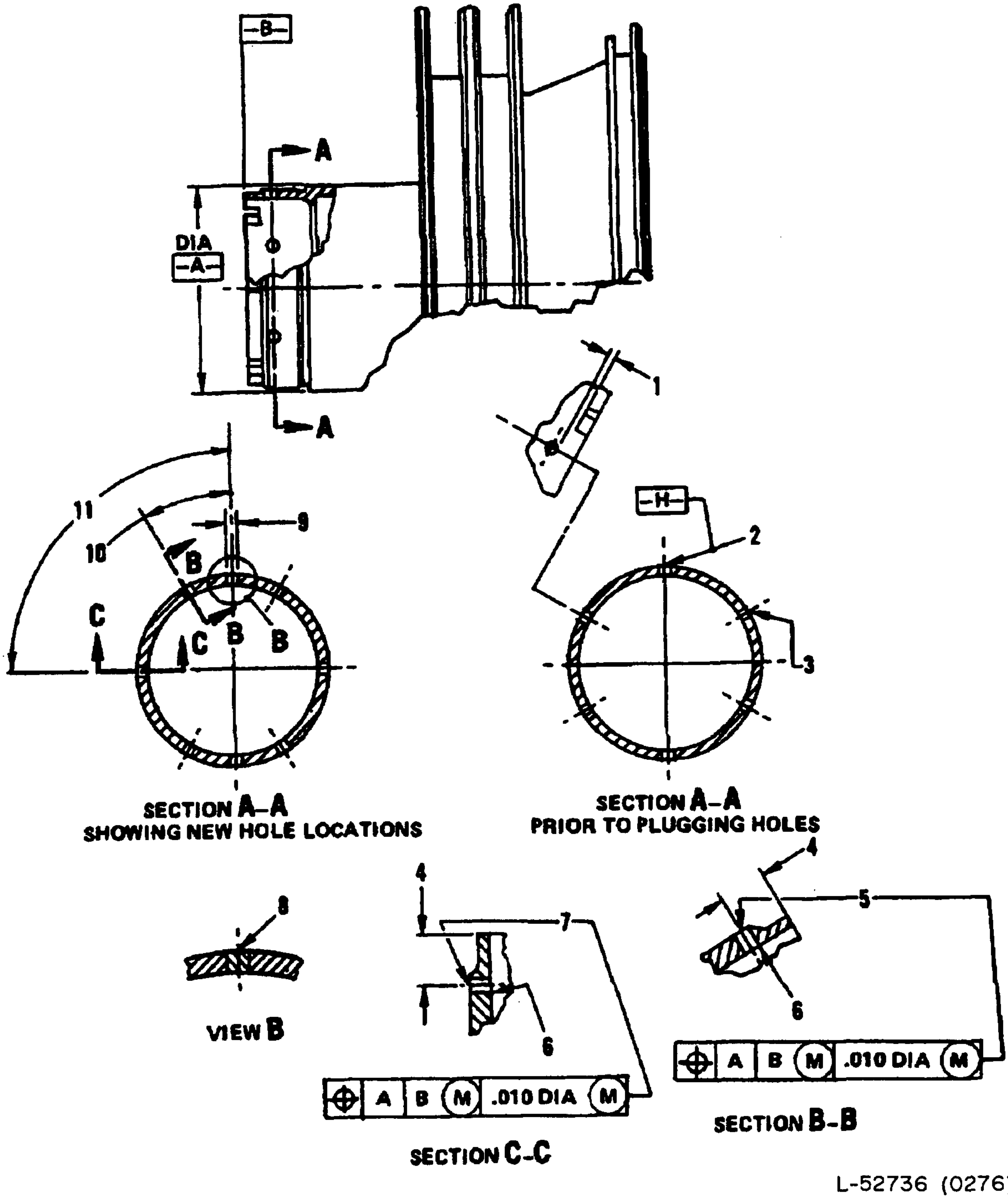
PWA 53, PWA 1313 Powder (PWA 53-13)
PWA 53, PWA 1337 Powder (PWA 53-37)
(This is recommended)
PWA 53, PWA 1338 Powder (PWA 53-38)

(g) Plasma coat within two hours after grit blasting.

(h) Finish machine the plasma coated area. See View C in Figure 627.

NOTE: Plasma coating PWA 53-13 or PWA 53-38 must be machine ground to size. Scratching or scoring of the parent metal is prohibited.

R
R


-B-
A
DIA
-A-
A
1
11
10
9
B
C
C
B
B
-H-
2
3
SECTION A-A
SHOWING NEW HOLE LOCATIONS
SECTION A-A
PRIOR TO PLUGGING HOLES
4
8
4
7
5
6
6
VIEW B
A
B
M
.010 DIA
M
SECTION C-C
SECTION B-B
L-52736 (0276)

1. 0.050 Inch Minimum. This Dimension From Bottom Of Nearest Slot To Edge Of Index 3 Hole Must Be Maintained Three Places.
2. Holes To Be Plugged. Reference 0.1595 Inch Diameter, Three Holes Equally Spaced.
3. Holes To Be Plugged. Reference 0.1885 Inch Diameter, Three Holes Equally Spaced.
4. 0.380 Inch.
5. New Holes. 0.186 - 0.192 Inch Diameter, Three Holes Equally Spaced. Basic Hole Pattern Located Within 0.020 Inch Either Side Of Basic Angular Location Maximum Material Condition, In Relation To Any One Diameter H Maximum Material Condition.
6. Break Edge 0.010 - 0.020 Inch, Three Places.
7. New Holes. 0.157 - 0.162 Inch Diameter, Three Holes Equally Spaced. Basic Hole Pattern Located Within 0.020 Inch Either Side Of Basic Angular Location Maximum Material Condition, In Relation To Any One Diameter H Maximum Material Condition.
8. Holes To Be Plugged And Sealed, Six Places. See Indexes 2 and 3.
9. Reference Diameter H, Prior To Plugging.
10. 30°
11. 90°

Key to Figure 625

(16) Front Hub Rear Flange OD Plasma Coat. See Figure 628.

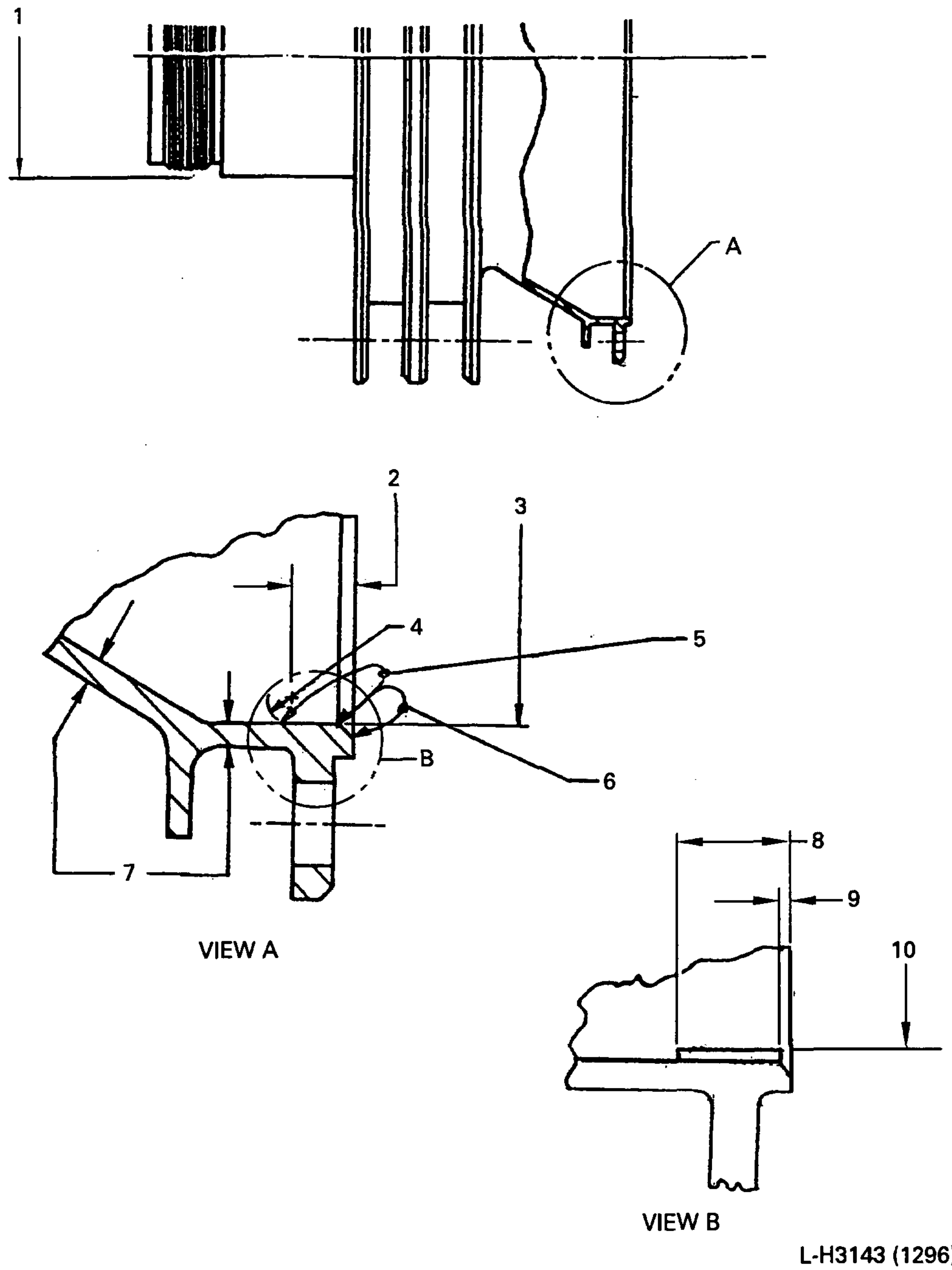
(a) Machine the rear flange mating OD before plasma coat. Machine as required to remove damaged material (but hold to maximum value).

(b) Prepare the surface for plasma coat by SPOP 170. Refer to Index 4 in the figure and Section 70-46-01, Standard Practices Manual.

(c) Plasma coat the rear flange OD with PW 53-37 plasma powder. Refer to Section 70-46-01, Standard Practices Manual. Build up the plasma coat thickness to a minimum of 0.010 inch. See View A (plasma coat area) of the flange.

(d) Finish machine the rear OD. See View A of the figure. Restore the chamfer and the face.

(17) Front Hub ID (Heavy Wear) (PN 748001 Hub) Plasma Coat.
R See Figure 629.



R
R

Rear Mating Diameter
Machine and Plasma Coat
Figure 626

1. Reference Diameter
2. 0.140 - 0.150
3. 6.407 - 6.413 Inch Diameter Before Plasma Coat. Must Be Concentric With Index 1 Diameter Within 0.001 Inch FIR
4. 0.016 - 0.047 Inch Radius
5. Shotpeen Minimum Intensity Waived, But Complete Coverage Is Required
6. Peen Is Optional And May Be Incomplete
7. 0.050 - 0.060 Inch (reference)
8. 0.125 - 0.135 Inch
9. 0.030 - 0.040 Inch
10. 6.390 - 6.395 Inch Diameter After Plasma Coat

Key to Figure 626

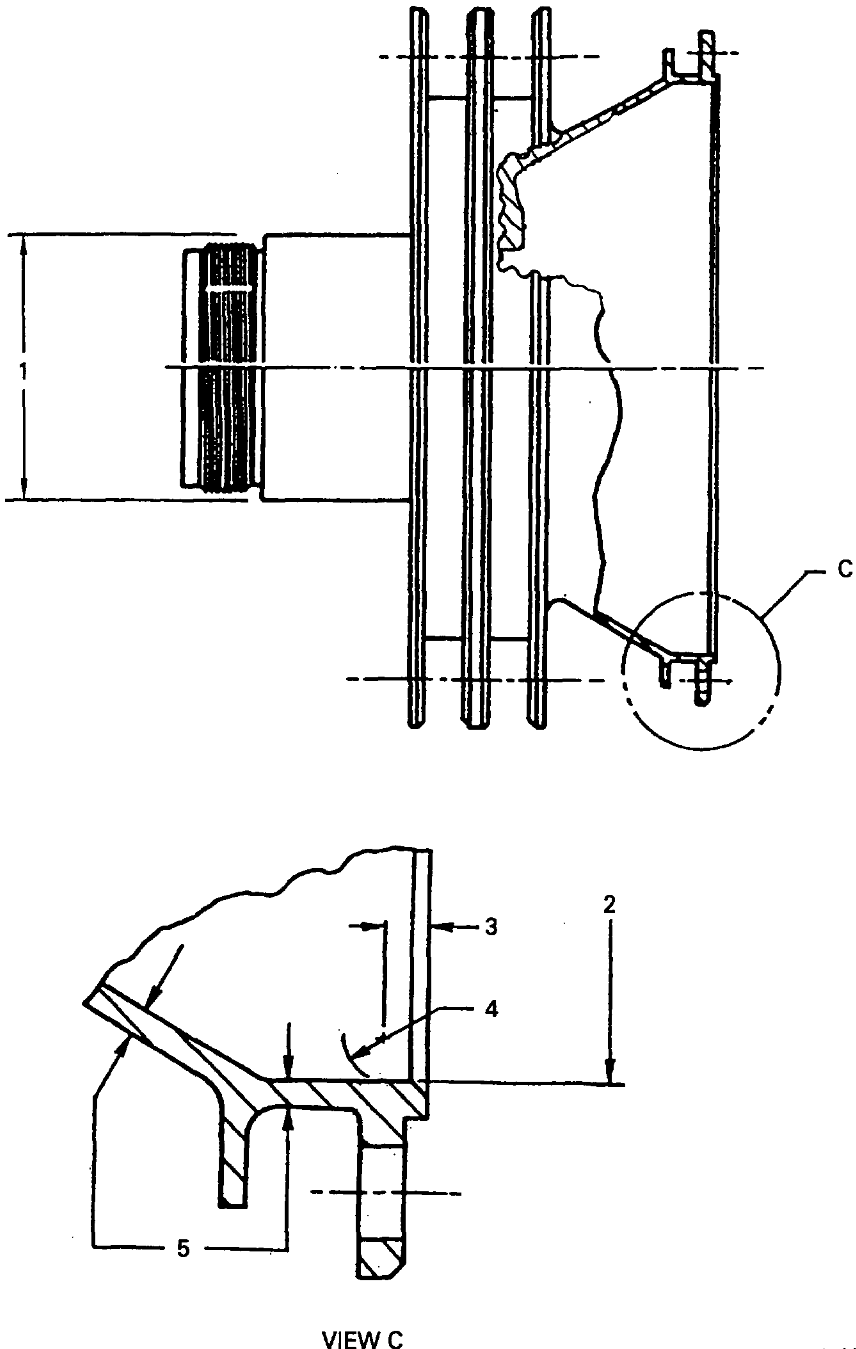
(a) Machine the worn ID of the hub to a maximum diameter of 2.604 inches. If it is necessary to grind the titanium material, follow the information given in SPOP 530 Machine Grinding of Titanium (PWA 106) in Section 70-45-00, Standard Practices Manual. Remove a minimum of parent metal when you clean up machine. See Figure 629.

(b) Prepare the surface for plasma spray or dual wire electric arc deposition by SPOP 170 in Section 70-46-01, Standard Practices Manual.

(c) Apply coating to this area by plasma coating process PWA 53-37 or PWA 53-80 in Section 70-46-01, Standard Practices Manual or by the dual wire electric arc deposition process PWA 271-37 in Section 70-46-07, Standard Practices Manual.

(d) Plasma spray or dual wire electric arc deposition material is undesirable in the holes and at their edges. You must mask the holes. The masking can extend from the holes concentrically to a maximum diameter which is 0.100 inch larger than the largest diameter called out for that hole. See Figure 630 for the hole diameters.

(e) Machine the plasma spray or dual wire electric arc
R deposition material to 2.5920 - 2.5925 inch diameter for a diametral fit of 0.0005 - 0.0015 inch loose with the nominal diameter plug PN 735369. You can grind the coating to get the tightly toleranced ID specified. The required surface texture is 32AA.



R
R

Rear Mating Diameter
Finish Machining
Figure 627

1. Reference Diameter
2. 6.3965 - 6.3985 Inch Diameter for Index 3 Distance. Remainder Must Be 6.389 - 6.399 Inch Diameter. No Step Permitted For Index 3 Distance. Must Be Concentric With Index 1 Diameter Within 0.001 Inch FIR.
3. 0.125 - 0.0135 Inch
4. 0.016 - 0.047 Inch Radius
5. 0.050 - 0.060 Inch (Reference)

Key to Figure 627

(f) Break all sharp edges 0.010 - 0.020 inch.

(g) The recommended after-coat finished thickness for this repair is 0.003 - 0.006 inch.

(h) Make the repair identification mark in the location shown in (Sheet 2) of the figure adjacent to the existing part number mark. See Section 70-11-00, Standard Practices Manual, for marking information.

(18) Front Hub ID Plasma Coat Repair (Light Wear)
R (PN 748001 Hub). See Figure 630.

(a) Machine to the before-plasma coat dimensions in the figure.

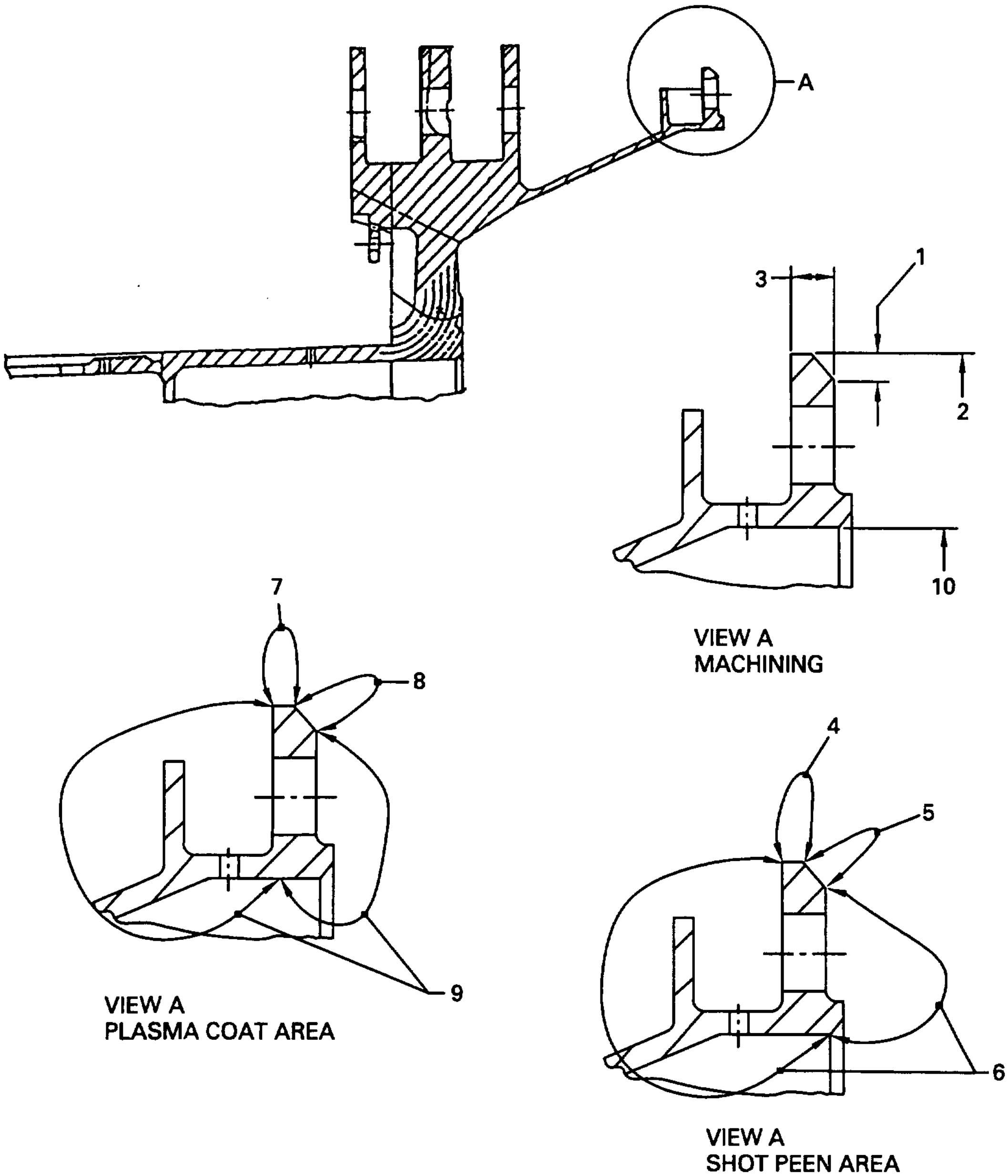
(b) Prepare the machined surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(c) Plasma coat the area shown by PWA 53-38, allowing sufficient material for machining to finished dimensions. Refer to Section 70-46-01, Repair-01 in the Standard Practices Manual.

(d) Machine to finished dimensions.

(19) Nickel-Cadmium Plate Repair of Compressor Disks and Rear Hub.
R See Tool Group 29A, Figure 631 thru Figure 633 and Table 604.

NOTE: At every overhaul, strip and replace nickel-cadmium plate. Before and after plate removal, measure diameter of each tierod hole, of lip seal flange(s), of mating diameters used to measure/record growth. Reference dimensions given in Table of Limits are after nickel-cadmium plating.

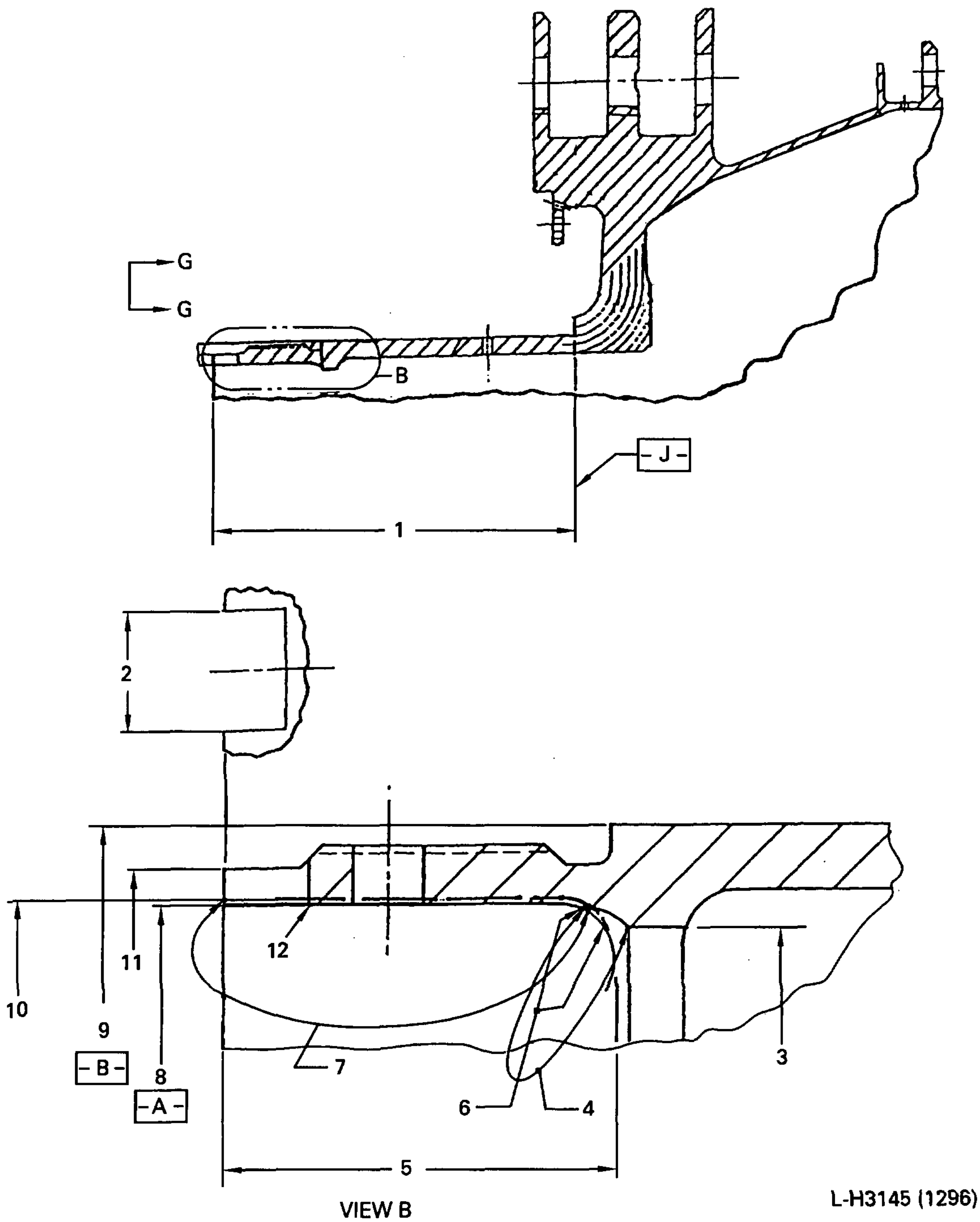


L-H3148 (1296)

Front Hub Rear Flange
OD Plasma Coat Repair
Figure 628

1. Chamfer 0.060 - 0.070 x 45° ± 2°
2. 7.466 - 7.468 Inch Diameter Before Plasma Coat. 7.474 - 7.476 Inch Diameter finished. Must Be Concentric With Index 10 Diameter Within 0.001 Inch FIR
3. 0.119 - 0.130 Inch
4. Shotpeen And Grit Blast Area
5. Shotpeen Overspray Permitted In This Area. No Grit Blast Is Permitted.
6. No Shotpeen Or Grit Blast Is Permitted.
7. Plasma Coat Area
8. Optional Plasma Coat Area.
9. Plasma Overspray is Not Permitted.
10. Reference Diameter.

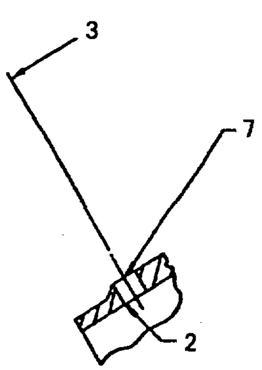
Key to Figure 628



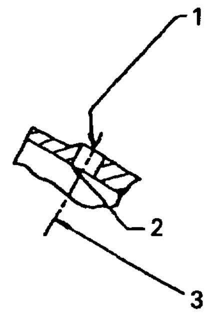
Front Hub ID (Heavy Wear)
Figure 629 (Sheet 1)

1. 2.900 - 2.920 Inches (Reference)
2. 0.370 - 0.380 Inch (Reference). Six Slots Equally Spaced.
3. 2.490 - 2.510 Inch Diameter (Reference).
4. Shotpeen Enclosed Area. Minimum Intensity Is Waived, But Complete Coverage Is Required.
5. 0.900 - 0.920 Inch
6. 0.109 - 0.141 Inch Radius. Two Places
7. Shotpeen And Coat Area
8. 2.590 - 2.5925 Inch Diameter. Must Be Concentric With Diameter B (Index 9) Within 0.005 Inch FIR
9. 2.9544 - 2.9549 Inch Diameter (Reference)
10. 2.604 Inch Diameter Maximum To Clean Up.
11. 2.760 - 2.780 Inch Diameter (Reference)
12. Break Sharp Edges 0.010 - 0.020 Inch. Six Places.

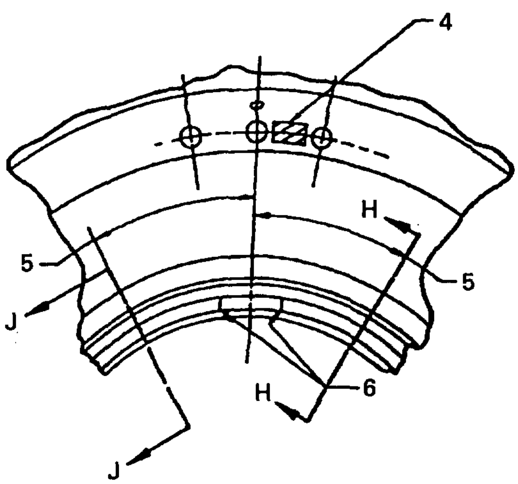
R Key to Figure 629 (Sheet 1)



SECTION J-J



SECTION H-H



VIEW G-G

L-H3146 (1296)

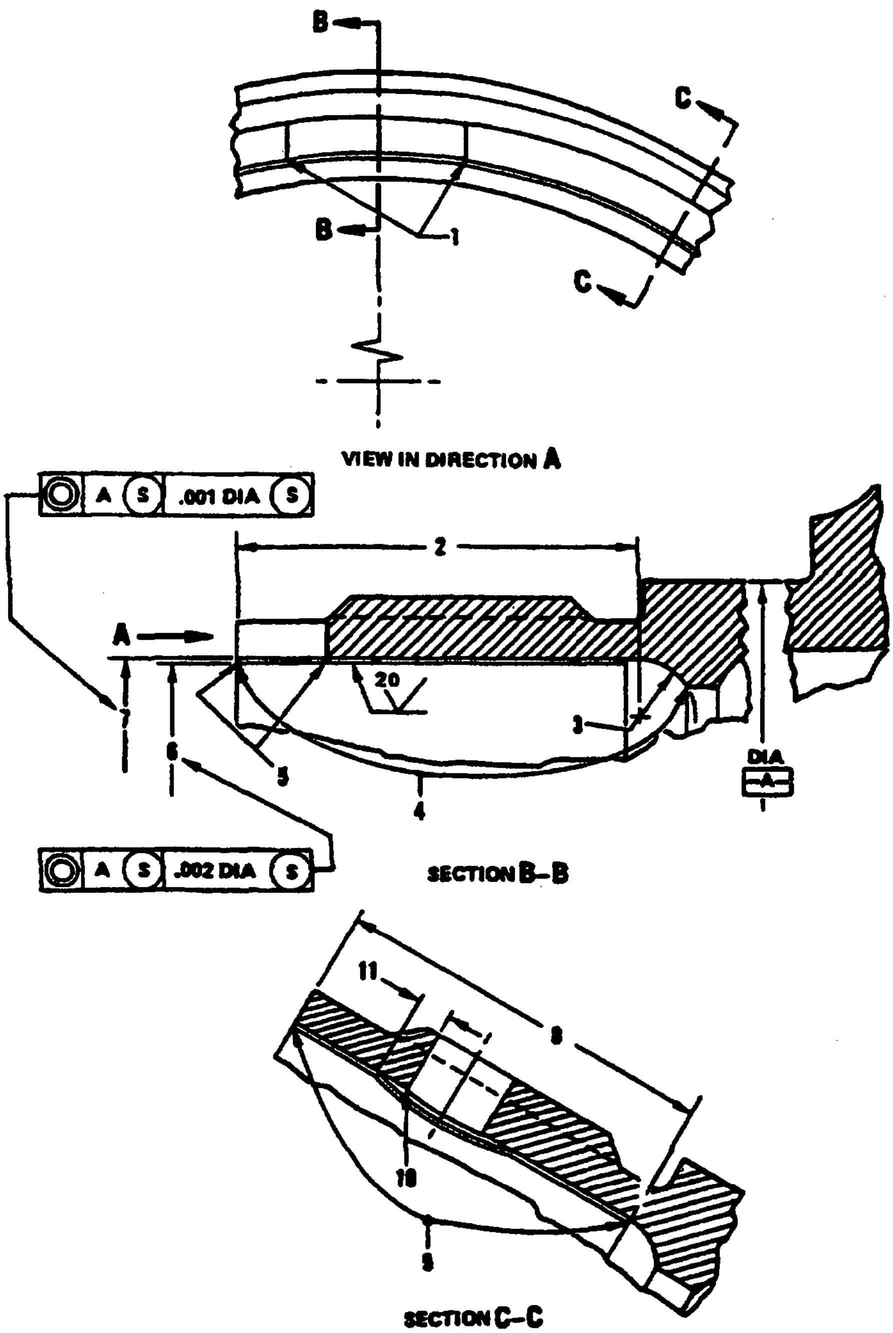
Front Hub ID (Heavy Wear)
Figure 629 (Sheet 2)

1. 0.186 - 0.192 Inch Diameter. Three Holes Equally Spaced.
2. Break Sharp Edge 0.010 - 0.020 Inch Six Places.
3. 2.530 Inches To Surface J.

R 4. Marking Area Between Any Two Holes As Shown

5. 30 degrees
6. Break Sharp Edges 0.010 - 0.020 Inch. Six Places.
7. 0.151 - 0.162 Inch Diameter. Three Holes Equally Spaced.

R Key to Figure 629 (Sheet 2)

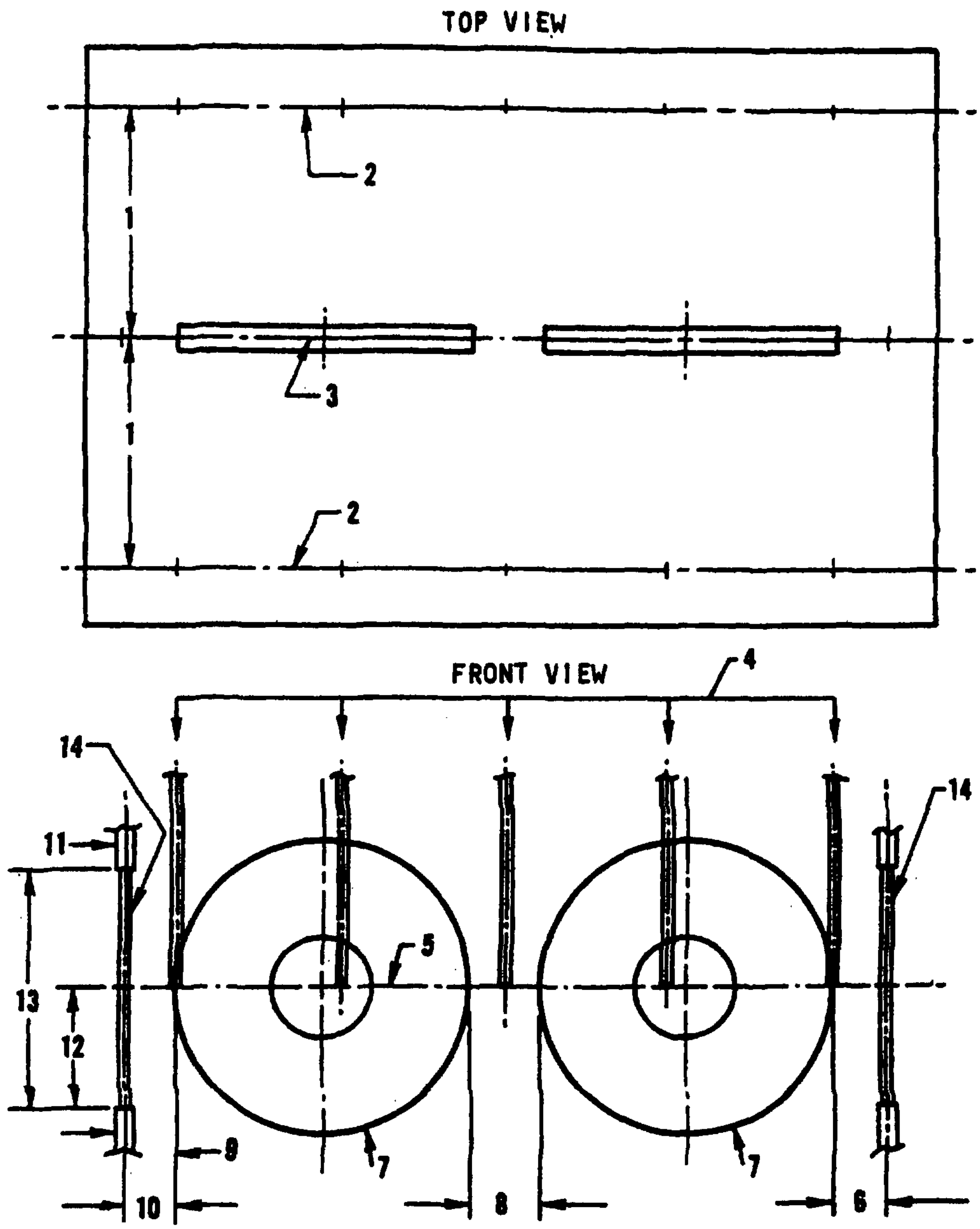


L-52738 (0276)

Plasma Coating Of Compressor
Front Hub ID (Light Wear)
Figure 630

1. Break Edge 0.010 - 0.020 Inch Six Places.
2. 0.860 - 0.880 Inch
3. 0.109 - 0.141 Inch Radius
4. After Machining, And Prior To Plasma Coat, No Cracks Or Wear Marks Permitted In This Area.
5. Break Edge 0.010 - 0.020 Inch Six Places After Plasma Coat.
6. 2.5920 - 2.5925 Inch Diameter Finished.
7. 2.608 - 2.609 Inch Diameter Before Plasma Coat
8. 0.820 - 0.850 Inch
9. Plasma Coat Area
10. Break Edge 0.010 - 0.020 Inch Six Holes
11. 0.060 - 0.090 Inch. No Plasma Coat All Around Six Holes.

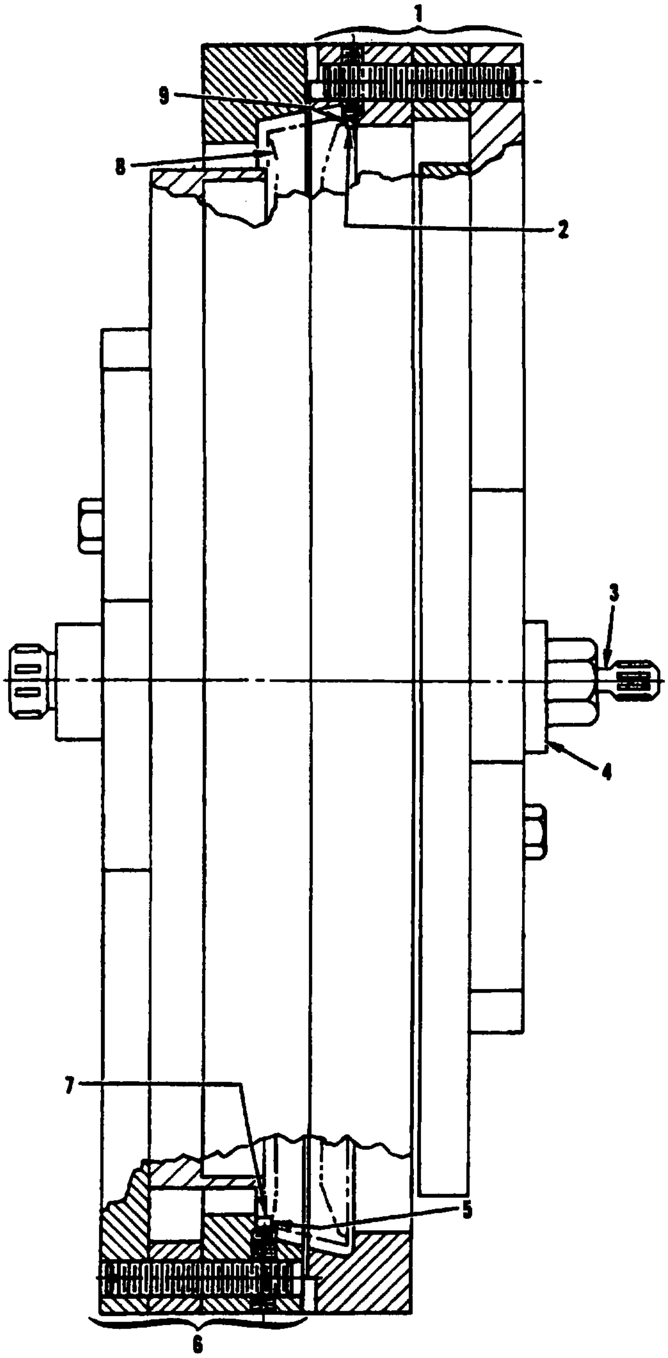
R Key to Figure 630



Anode And Thieving Arrangement
For Nickel Plating (AMS 2416-4)
Figure 631

1. 12 Inches
2. Workbar (anode) Centerline
3. Workbar (cathode) Centerline
4. Five Anodes Equally Spaced (Six To Seven Inches Apart)
5. Disks Centerline
6. Two Inches
7. Disk
8. Two To Three Inches
9. Edge Of Disk
10. Two Inches
11. Masked Portion
12. Five Inches
13. 10 Inches Exposed Thief
14. 3/8 Inch Diameter Thief

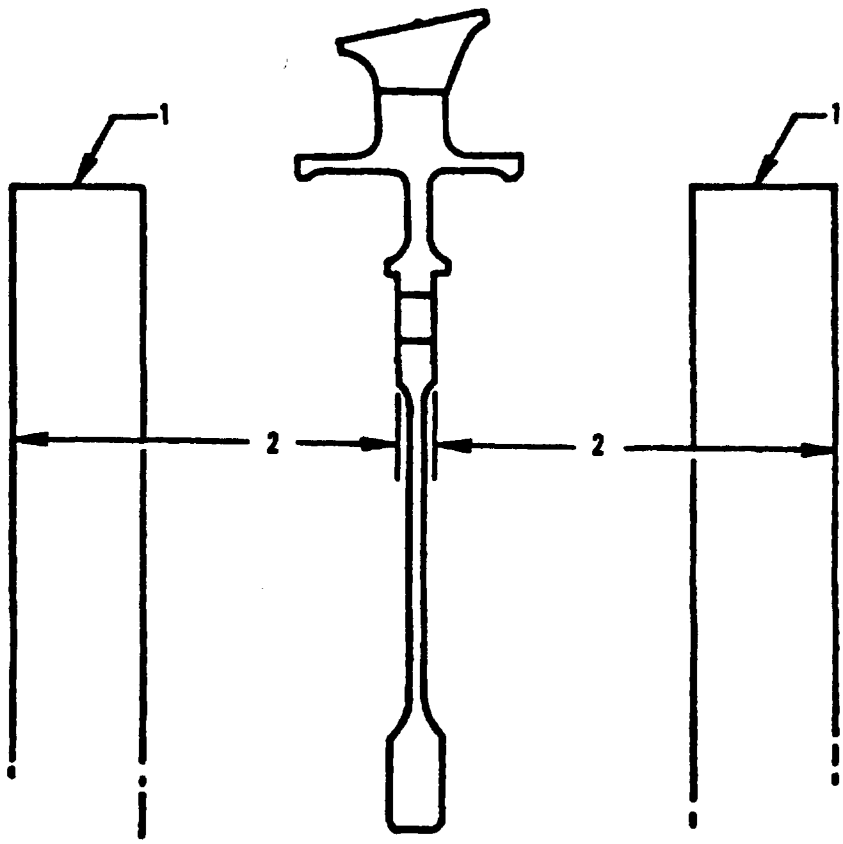
R Key to Figure 631



Compressor Disk Controlled
Distribution Plating Fixture
Figure 632

1. Fixture Rear Half
2. Rear Electrical Contact Pin (3 Places)
3. Center Post
4. C-washer
5. Electrical Contact With Front Of Disk Tang
6. Fixture Front Half
7. Front Electrical Contact Pin (3 Places)
8. Compressor Disk
9. Electrical Contact With Rear Of Disk Tang

R Key to Figure 632



L-62301 (0000)

1. Fixture Shield
2. 1.728 ± 0.025 Inches for Stages 5 and 6
   1.631 ± 0.025 Inches for Stage 8
   1.622 ± 0.025 Inches for Stage 9

Compressor Disk Controlled
Distribution Plating Fixture
Disk/Shield Position Check
Figure 633

Stage	PN	Stripping Fixture	Plating Fixture
2nd	406302	PWA 13423	PWA 13423
3rd	406203	PWA 13424	PWA 13424
4th	406204	PWA 13425	PWA 13425
5th	406205 496705	PWA 13426	PWA 13925*
6th	417806 496706	PWA 13427	PWA 13926*
7th	426107	PWA 13428	PWA 13428
8th	406208 541908	PWA 13429	PWA 13928*
9th	406209 541909	PWA 13430	PWA 13929*
Rear Hub	414063	PWA 13704	PWA 13704

*Controlled distribution plating fixture. Stripping fixtures may be used for plating until controlled distribution fixtures are made available.

Compressor Disk
Plating Fixtures
Table 604 (Sheet 1)

Stage	PN	Area (sq. in.)	Plating Current (amperes) Nickel	Cadmium	Nickel Time** (Minutes)
2nd	406302	190	40	30	22
3rd	406203	200	40	33	22
4th	406204	210	42	36	22
5th	406205 496705	295	65	55	48(22)
6th	417806 496706	355	75	62	36(22)
7th	426107	350	70	58	22
8th	406208 541908	385	80	67	36(22)
9th	406209 541909	390	80	68	36(22)
Rear Hub	414063	240	50	42	

**For 5th, 6th, 8th, and 9th stages, plating times shown apply only when controlled distribution fixtures are used. Nickel plating time contained in parentheses shall be used if controlled distribution plating fixtures have not been made available.

Compressor Disk
Plating Currents
Table 604 (Sheet 2)

R
R

(a) Before nickel-cadmium plate removal, carefully measure and record with proper identification:

1 Front and rear mating diameters.

2 Web thickness in spacer mating areas.

NOTE: These measurements are necessary to make sure that all plate repairs in areas measured can be renewed and restored to the same dimensions.

CAUTION: UNDER NO CIRCUMSTANCES SHALL CONTROLLED DISTRIBUTION PLATING FIXTURES BE USED FOR PLATE REMOVAL.

(b) Remove nickel-cadmium plate with the SPOP 25 stripping fixtures listed in referenced table. Refer to the Standard Practices Manual, Section 70-44-01.

(c) During plate removal note and record presence of plating repairs. All such repair plating must be removed to expose clear smooth base metal.

(d) If necessary, clean residual rust remaining after plate removal. Refer to SPOP 9 in the Standard Practices Manual, Section 70-21-00.

CAUTION: UNDER NO CIRCUMSTANCES IS IT PERMITTED TO REPLACE ONLY CADMIUM PORTION OF DIFFUSED NICKEL-CADMIUM PLATE.

(e) Plate all of the disk or rear hub with diffused nickel-cadmium by SPOP 25. Refer to the Standard Practices Manual, Section 70-44-01.

1 Nickel-plate must be 0.0004 - 0.0007 inch thick on fully exposed surfaces and not less than 0.0001 inch in blade slots, boltholes, and radii surfaces not touched by a 0.750 inch diameter sphere on disks.

2 Nickel-plate must be 0.0002 - 0.0004 inch thick on fully exposed surfaces of rear hub.

NOTE: Plating facilities not previously approved for nickel-cadmium plating of JT12 compressor disks and rear hubs must submit samples of plated parts to Pratt & Whitney for approval. Refer to Repair Source Approval (RSA) Requirements - Nickel-Cadmium (Ni-Cd) Plating in the Standard Practices Manual, Section 70-40-01, Repair-06. In addition, a sample disk (any 5th, 6th, 8th, or 9th stage) plated with a controlled distribution plating fixture shall be submitted for destructive analysis regardless of prior approval for plating with standard fixtures. This sample shall be nickel plated only. Once approved for both types of fixtures additional submission of samples is not required.

NOTE: No burning, pitting, or selective attack is permitted at electrical contact points.

(f) When plating 5th, 6th, 8th, and 9th stage disks, use controlled distribution plating fixtures as follows:

NOTE: These fixtures were developed to provide the minimum specified plate thickness of 0.0003 inch in blade slots of 5th, 6th, 8th, and 9th stage disks.

NOTE: When SPOP 25 calls for alkali clean, clean-water rinse and water-break examination, disk must be mounted on stripping fixture rather than controlled distribution plating fixture to permit proper examination for water breaks. Upon completion of examination mount disk in plating fixture and repeat alkali clean and clean-water rinse operations before continuing with acid-etch operation, omitting water-break examination.

1 With front half of plating fixture (center post up) on bench, position disk (front face down) in fixture, ensuring that disk rests on electrical contact pins. Disk tangs shall be centered in fixture ring and butt against shoulder of threaded portion of contact pin.

2 Place rear half of fixture on rear of disk, engaging aligning pins. Secure halves with C-washer and center post nut.

NOTE: Aligning pins will ensure correct electrical contact between disk and rear half of fixture provided disk is not allowed to shift during joining of both fixture halves. Ensure that electrical contact pins are shouldered against disk tangs as indicated in step 1.

3 Shield warpage or incorrect disk positioning will result in uneven plate thickness. To check this condition, measure distance from shield surface to disk face through plate thickness measuring holes. See referenced figure for controlling dimensions.

NOTE: Rubber plugs must be secured in holes except when access is required for specified measurements.

NOTE: Ensure that all exposed steel details of fixture (except contact surface, center post, C-washer, and center post nut) are masked.

4 Install fixture in hanger, and plate by SPOP 25. Refer to the Standard Practices Manual, Section 70-44-01. During plating, turn the fixture 350 degrees in the hanger, at increments of 60 degrees at a time. The six electrical contact pin locations (located at the end of each spider arm on fixture) will serve as a guide for fixture rotations since they are 60 degrees apart. Starting with one pin location at the 12 o'clock position, turn the fixture in the hanger until each successive location is at the 12 o'clock position for the prescribed time. Each position shall be held for six minutes except for the 5th stage which shall be held for eight minutes. Part shall be agitated and current monitored to each individual disk. Ensure that current is held within ± 2 amperes of value specified. If the designated amperage cannot be obtained due to equipment limitations, lower amperage may be used provided plating time is increased to

maintain the same amperage-minutes (amperage x minutes) and plating time is divided equally among the six plating-fixture positions.

NOTE: No thieves are permitted with these fixtures, and no specific anode arrangement is required. Under no circumstances shall fixtures be immersed in solutions above 54°C (130°F).

5 Once amperages and plating times have been complied with, nickel plate shall be 0.0004 - 0.0007 inch thick on disk and not less than 0.0003 inch thick in blade slots, boltholes, and radii surfaces not touched by 0.750 inch diameter sphere. Inspect plate as follows:

a Plate thickness is to be measured on disk bolt circle with a magnetic gage. (See Standard Practices Manual, Plating Procedures). Holes with rubber plugs in fixture permit measurement of plate thickness with disk in fixture.

b When magnetic gage shows plate thickness at bolt circle to be as specified below, disk will have plate of required thickness on all surfaces.

Stage	Nickel Thickness
5	0.0006 - 0.0007 inch
6	0.0006 - 0.0007 inch
8	0.0005 - 0.0007 inch
9	0.0005 - 0.0007 inch

c These plate thicknesses will ensure compliance with the plating requirements of 0.0003 inch thick for recessed areas.

NOTE: Since plate build-up in disk blade slots is monitored by checking plate thickness at bolthole circle, one is cautioned that simple compliance with minimum plating thickness of 0.0004 inch at bolthole circle may not yield acceptable plate thickness at blade slot.

Controlled distribution plating fixtures must be stripped of excess plate build-up after each plating cycle.

(20) Diffused-Aluminum Coating of Rear Hub (Alternate to
R Nickel-Cadmium Plating). See Figure 634.

(a) Apply internal masks to the turbine shaft mating splines and mating diameters. Apply external masks to the hub bearing journal, splines, and threads.

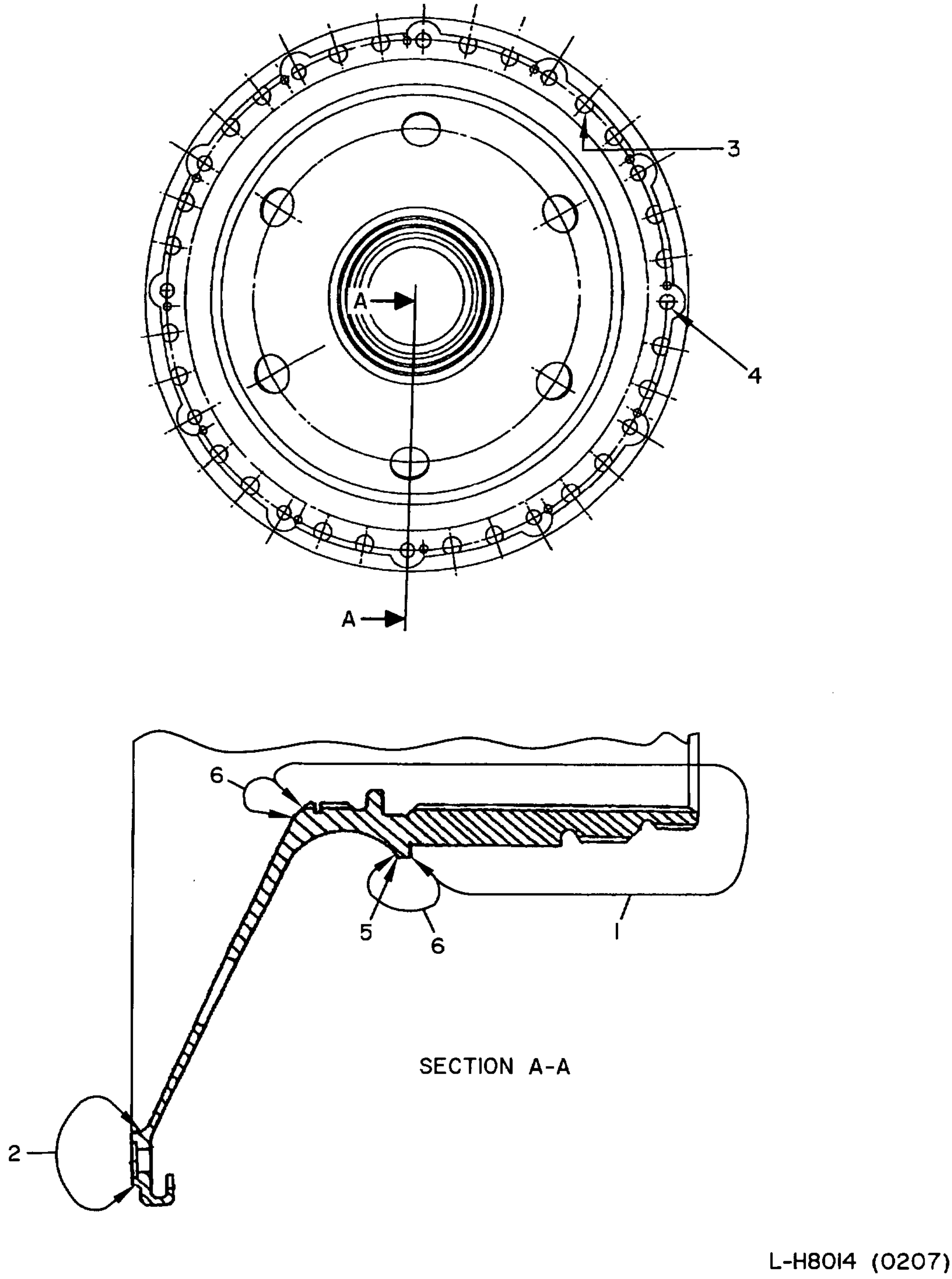
(b) Apply inorganic aluminum coating and topcoat by PWA 110-1, -2, or -3. Refer to Section 70-41-04 in the Standard Practices Manual.

(c) Apply the coating and topcoat to the hub as specified in PWA 110-21 and the figure as follows:

1 Coat by PWA 110-1, -2, or -3 (Section 70-41-04 in the Standard Practices Manual) on all hub surfaces (but not the area shown in Index 1 in the figure). The coating must be 0.001 - 0.003 inch thickness (but 0.0005 - 0.0015 inch thickness in Index 2 Area, with a 0.0004 inch variation).

2 In Index 3 and 4 areas the thickness is 0.0005 inch minimum (but make sure that the hole diameters stay in limits).

3 Coating in Index 5 area can be 0.0005 inch thickness maximum (and in Index 6 areas the coating is permitted to be not completed). Touchup is permitted.



Compressor Hub Aluminum Coating
Figure 634

1. No Coating Area
2. Flange Coating Area (See Text)
3. 0.311 - 0.313 Inch Diameter (24 Holes)
4. 0.246 - 0.248 Inch Diameter With 85 - 95 Degree Chamfer To 0.270 - 0.290 Inch Diameter Opposite Side, 12 Holes
5. Alternate Coating Area (See Text)
6. Coating Is Permitted To Be Not Completed in This Area

R Key To Figure 634

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-04

1. Engine Compressor Section (Spacers)

   A. General

      (1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Compressor Spacers

   A. Inspection

      (1) Measure the mating diameters of compressor spacers to be sure that the fit with mating parts will be in limits as specified in the Table of Limits. Refer to the Mating Diameter Alteration repair in this section for procedures to keep spacer and disk fits in limits.

      (2) Check parallelism of front and rear mating surfaces. Parallelism must not exceed 0.001 inch. Spacers that fail to meet parallelism check shall be checked for concentricity. With front mating diameter restrained, front and rear diameters must be within 0.001 inch FIR. For 3rd-to-4th stage spacer, concentricity check is required at each overhaul. See following note.

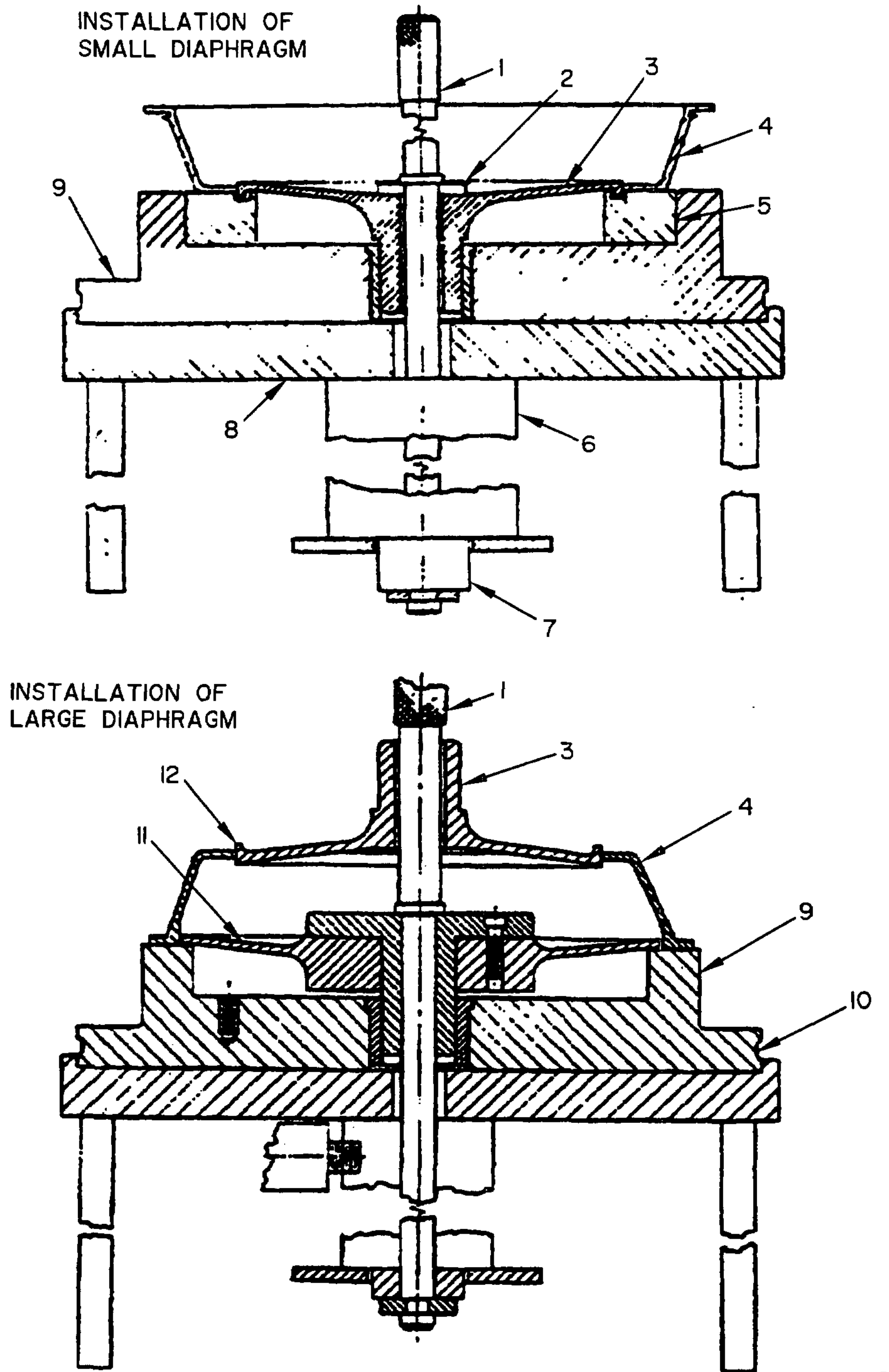
      NOTE: Third-to-4th stage compressor spacer shall be measured with a suitable restraining plate installed on the forward and rear mating diameters (0.0001T fit between the plate and the diameters). This procedure may be performed in accordance with Paragraph B.

   B. Third-to-Fourth Stage Compressor Disk Spacer Concentricity Check
      See Tool Group 29-1 and Figure 601.

      (1) To make sure that the concentricity check is accurate, install a compressor disk spacer and do a concentricity check in a fixture designed to simulate the spacer's installed condition as part of the compressor rotor assembly. Do the check as follows:

         (a) Install ring detail (Index 5 in the figure) on the fixture and secure with cap screws.

         (b) Position small diaphragm, concave side up, on fixture.



Third To 4th Stage Compressor
Disk Spacer Concentricity
And Flatness Check
Figure 601

1. Shaft
2. Shaft Spacer
3. Small Diaphragm
4. Compressor Disk Spacer
5. Ring Detail (For Small Diaphragm Installation Only)
6. Ram Unit
7. C-washer
8. Base
9. Detail Ring
R 10. Runout Track
11. Large Diaphragm
R 12. Maximum Runout On This Surface Must Be 0.001 Inch FIR

Key to Figure 601

(c) Slide shaft spacers onto shaft, and insert shaft through center of diaphragm, fixture and ram unit. Then hold the parts together with the C-washer.

(d) Using pump, actuate ram to flex diaphragm. Ensure that diaphragm contacts stop.

(e) Position compressor disk spacer, small ID down, on fixture so that spacer encloses diaphragm. Then, release pressure. Diaphragm will expand resulting in contact with small ID of spacer.

(f) Remove C-washer, shaft, and shaft spacer from fixture. Then remove compressor disk spacer with small diaphragm attached.

(g) Remove cap screws and ring detail from fixture.

(h) Position large diaphragm, concave side up, on fixture.

(i) With shaft inserted through small diaphragm and spacer assembly, position assembly (spacer large ID down) on fixture and secure shaft with C-washer as before.

NOTE: Shaft spacer is not used during this operation.

(j) Flex large diaphragm so that spacer large ID slips over diaphragm. Then release pressure to bring diaphragm in contact with spacer ID.

(k) Remove the C-washer and shaft as before, then remove the spacer with the diaphragms from the detail ring (Index 9 in the figure). Install the spacer washer under the large diaphragm (Index 11 in the figure) and put the assembly back in the detail ring (make sure that the washer does not come off when the assembly is turned around).

(l) Use the applicable indicators to do a concentricity check at the locations shown in the figure, Index 12.

<u>NOTE</u>: Due to tool design, measuring runout of the small diaphragm OD will accomplish the concentricity check for both spacer IDs.

C. Compressor Disk Spacer Sleeve Replacement
See Tool Group 29-1A and Figure 602.

(1) Remove counterweights

(2) Position spacer on base engaging appropriate snap diameter. Ensure that spacer sleeve interference fits are up.

(3) Using drift and small fiber mallet, drive sleeve out of spacer, working from end with tight fit and out through hole with loose fit.

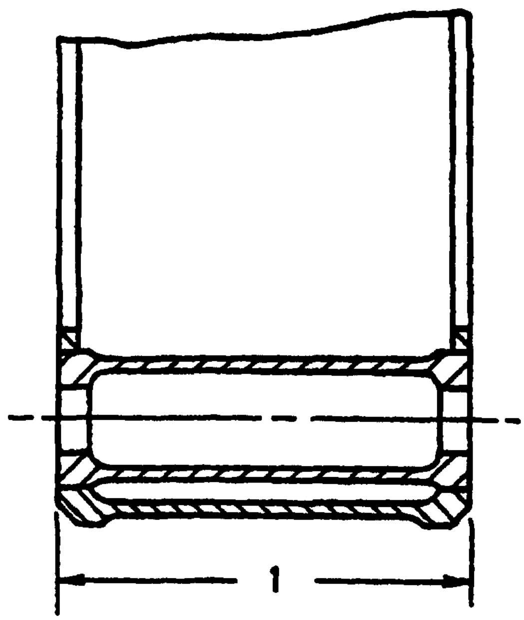
<u>NOTE</u>: Check old sleeve part number to ensure that sleeve with appropriate inside diameter will be installed

(4) Position spacer on base so that larger sleeve holes are up.

(5) While installed on base, heat spacer to 93.3°C (200°F), and install replacement sleeve through hole with loose fit and into hole with tight fit using drift and small fiber mallet. Sleeve is properly positioned when both ends extend out from spacer approximately 0.010 inch.

(6) Machine both ends of sleeve to dimensions shown.

(7) Inspect repaired spacer for concentricity and parallelism as indicated in Paragraph A.



L-24421 (0000)

1. 1.848 - 1.853 Inches (2nd - 3rd Stage)
   1.929 - 1.934 Inches (4th - 5th Stage)
   1.554 - 1.559 Inches (5th - 6th Stage)
   1.406 - 1.411 Inches (6th - 7th Stage)
   1.302 - 1.307 Inches (7th - 8th Stage)
   1.287 - 1.292 Inches (8th - 9th Stage)

R
R

Compressor Disk Spacer
Sleeve Replacement
Figure 602

D. Compressor Rotor Spacer Assembly Corrosion Pitting Repair (Steel Only)
See Figure 603 thru Figure 605.

(1) Spacers which exhibit corrosion in the area shown in Figure 603 but do not need refurbishment of nickel-cadmium plate must be repaired as follows:

(a) Inspect for corrosion pitting in the area shown in Figure 603. Pitting limit is 0.006 inch maximum depth except for the flange ID (Index 2 in the figure. Pitting limit is 0.015 inch maximum depth for the flange ID.

<u>NOTE</u>: You can measure the depth of corrosion pitting with PN 65P-40 push-down point gage. This gage is available from Source Code 21938 in the Tool and Equipment Supplier List in Section 70-91-00 in the Standard Practices Manual. You can use an equivalent gage instead of the push-down point gage.

(b) Remove old plating by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual.

<u>NOTE</u>: It is not necessary to remove nickel-cadmium plate from parts if the nickel or base metal is not pitted or corroded. You can apply PWA 595 aluminum coating over nickel plating. (you must blend pitted areas before you apply PWA 595 coating).

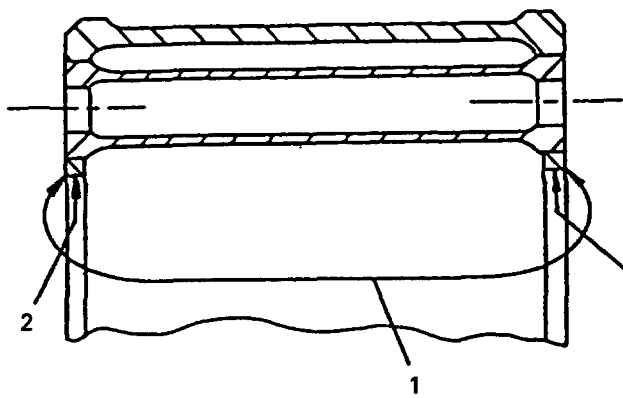
(c) Apply PWA 595 Coating by the process in Section 70-41-04, Standard Practices Manual.

(d) Coating requirements. See Figure 604.

(2) Pitting limits for replacement of nickel-cadmium plate or PWA 110 coating. See Figure 605.

E. Fourth Thru 9th Stage Space Corrosion Pitting Inspection/Repair
See Figure 606.

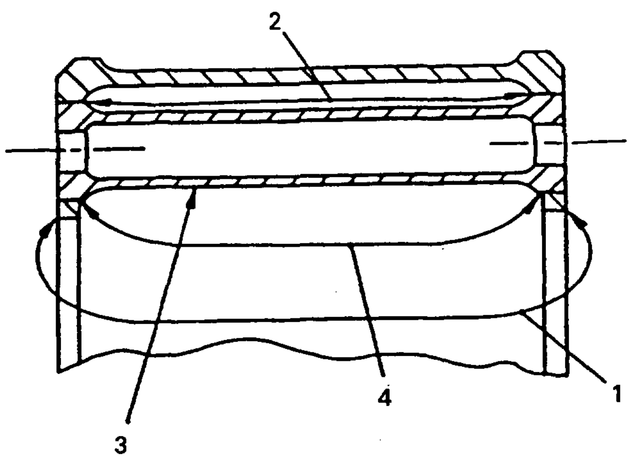
(1) Inspect for corrosion pitting in area shown in figure (ID and OD).



L-29440 (1296)

1. Corrosion Repair Area
2. Flange ID

Compressor Disk Spacer
Corrosion Pitting
Repair Limits
Figure 603



L-H3153 (1296)

Spacer Assembly Coating Requirements
Figure 604

1. Coating Must Be 0.0005 - 0.003 Inch Thick In Enclosed Area.
2. Minimum Coating Requirements Waived For 0.200 Inch Maximum Width In Areas Opposite Tubes (Twelve Places).
3. Tube Coating Must Be 0.0005 - 0.0014 Inch Thick In this Area; Mark Identification By PWA 310, Class 40.
4. Coating Required All Around Tube (Twelve Places) But Minimum Coating Requirements Waived.

Key to Figure 604

(a) Spacers with pits up to 0.003 inch deep may be continued in service.

(b) Spacers with pits over 0.003 inch up to 0.010 inch deep repair as follows:

1 Blend pits, but maintain a minimum wall thickness of 0.040 inch. See SPOP 533, Standard Practices Manual, Section 70-45-00.

R 2 Apply aluminum coating. Refer to Paragraph L.

R 3 Reidentify coated spacers with an R mark in
R front of the part number (for example PN R796143).

(c) Spacers with pits over 0.010 inch deep or minimum wall thickness of less than 0.040 inch must be scrapped.

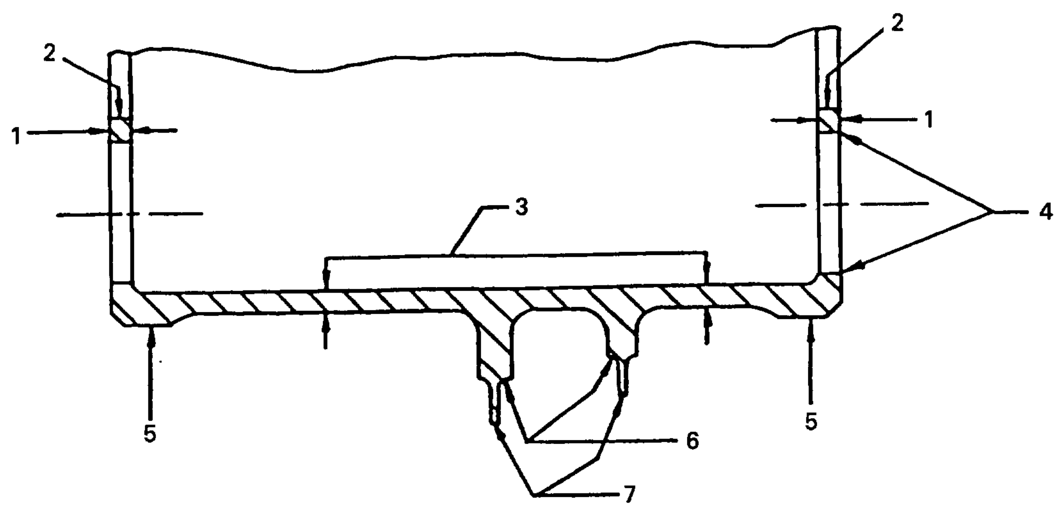
F. Second-to-Third and 4th thru 9th Stage Spacer ID Surface Blend Repair
See Figure 607.

NOTE: The repair is only for these spacers which have been damaged due to clip-on counterweight edge contact.

(1) Scattered denting or fretting due to counterweight edge contact, in Index 2 area in the figure, to a depth of 0.010 inch maximum must get blend repair.

(2) Additional limitations:

(a) This repair and corrosion pit repair combined are restricted to 0.010 inch deep. A minimum wall thickness of 0.040 inch must be maintained.



R
R

Compressor Disk Spacer
Corrosion Pitting Repair Limits
Figure 605

1. Pitting On Flange That Is Not More Than 0.006 Inch In Depth On One Side Only Is Acceptable For Repair. A Combination Of Inner And Outer Flange Surface Pitting that Is not More Than 0.006 Inch In Depth Is Acceptable For Repair.
2. Pitting On The Flange ID That Is Not More Than 0.015 Inch In Depth Is Acceptable For Repair. The Full 0.006 Inch Is Acceptable On One Side If The Other Side Is Free Of Pits.
3. A Combination Of ID And OD Pitting that Is Not More than 0.006 In Depth Is Acceptable For Repair. The Full 0.006 Inch Is Acceptable On One Side If The Other Side Is Free Of Pits.
4. Corrosion Around Lightening Holes That Is Not More Than 0.015 Inch In Depth And Is Confined To 0.075 Inch From The Edge Of the Hole Is Acceptable For Repair.
5. If The Snap Diameter Is Pitted And Machined per The Snap Diameter Nickel Plate Repair, Machining Must Remove All Pitting. If not, Reject The Spacer.
6. Pitting Depth Of Knife-Edge Land that Is Not More Than 0.010 Inch In Depth Is Acceptable For Repair.
7. A Combination Of Pitting On Both Sides Of The Knife-Edge That Is Not More Than 0.003 Inch In Depth Is Acceptable. The Full 0.003 Inch Is Acceptable On One Side If The Other Side Is Free Of Pits.

Key to Figure 605

(b) Refer to Standard Practices Manual, Section 70-45-00, SPOP 532 for 2nd-to-3rd stage and SPOP 533 for 4th thru 9th stage spacer blending.

(3) Recoat or replate after blending as instructed in this section.

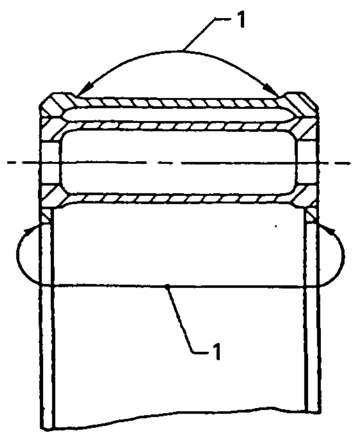
G. Third-to-Fourth Stage Spacer Front Flange Rear Face Blend Repair
See Figure 608.

(1) Scratches and tool marks, in Index 6 area of the figure, up to 0.005 inch deep must be blended, See SPOP 532 Standard Practices Manual, Section 70-45-00.

(a) Blending radial direction must be confined within Index 6 area.

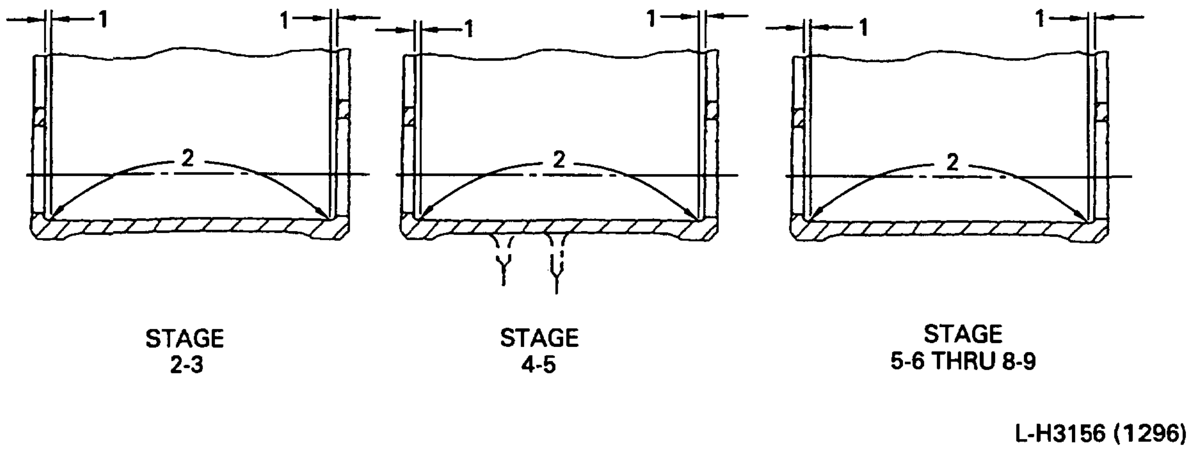
(b) Blend aspect ratio as measured (width/depth) must be greater than ten.

(2) Scratches/tool marks greater than 0.005 inch deep shall be rejected.



L-H3155 (1296)

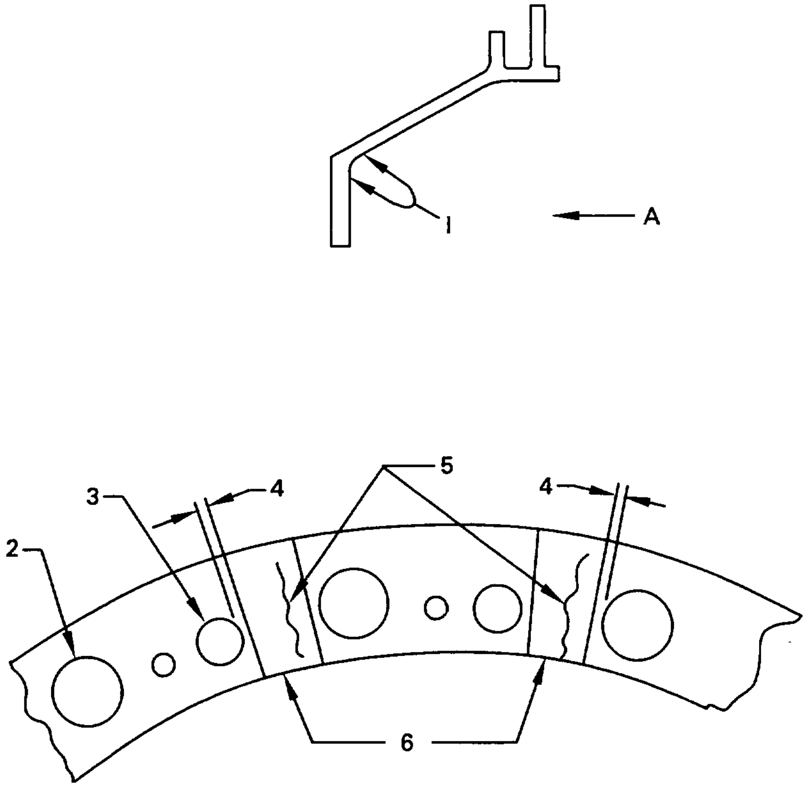
1. Corrosion Repair Area



1. 0.250 Inch
2. Blend Repair Within This Area

R
R

Spacer ID Blend Repair
Figure 607



L-H3157 (0207)

1. No Damage Allowed Inside Flange Fillet.
2. Low Cycle Fatigue Hole
3. Tiebolt Hole
4. 0.030 Inch Minimum
5. Typical Scratch/Tool Mark
6. Blending Confined To This Area

Third-to-Fourth Stage Spacer
Front Flange Rear Face Blending
Figure 608

H. Steel Compressor Spacer Sleeve Hole Nickel Plate Repair
See Figure 609.

NOTE: This plating repair is used to restore the sleeve hole diameter. This repair can be combined with the sleeve plating repair in Paragraph I. to get the spacer and sleeve diameters back to their initial condition. Refer to Paragraph J. for a repair in which the spacer sleeve holes are machined oversize and only the spacer sleeve diameters get plate.

(1) Strip the spacer by SPOP 310 in Section 70-44-01, Standard Practices Manual.

(2) Do other repairs as necessary.

(3) Machine the front and rear diameters as shown in the figure.

(4) Fluorescent magnetic particle inspect the spacer hole by SPOP 115 in Section 70-32-00, Standard Practices Manual.

(5) Mask the areas not to be nickel plated.

(6) Nickel plate the machined areas by SPOP 29 or SPOP 321 to a maximum dimension of 0.372 inch. Refer to Section 70-44-01, Standard Practices Manual.

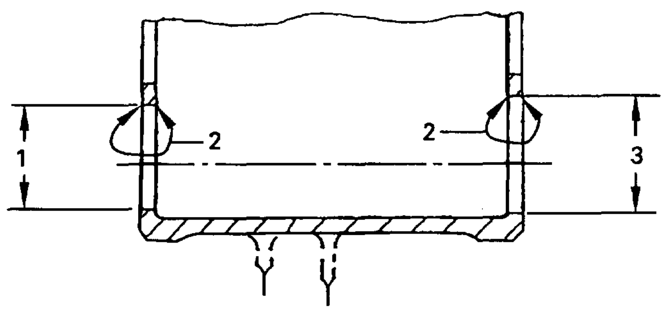
(7) Bake after plating at 190.6° ± 5.6°C (375° ± 10°F) for three hours.

(8) Finish machine the front and rear diameters as shown in the figure. Maintain concentricity and squareness
R requirements as instructed in Paragraph A.

(9) Install the spacer sleeves as instructed in Paragraph C.

I. Steel Compressor Spacer Sleeve Nickel Plate Repair
See Figure 610.

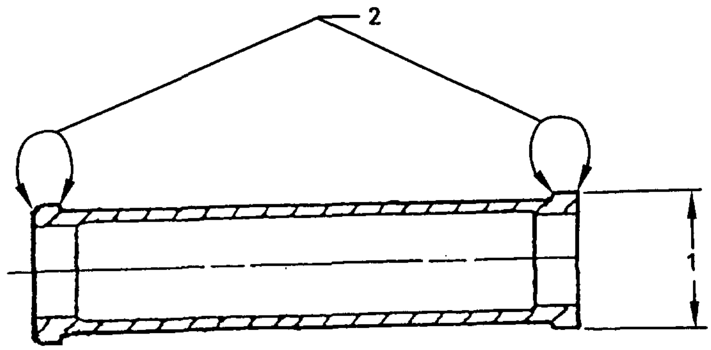
NOTE: This plating repair is used to restore the sleeve snap diameter. This repair can be combined with the plating repair in Paragraph H. to get the spacer and sleeve diameters back to their initial condition. Refer to Paragraph J. for a repair in which the spacer sleeve holes are machined oversize and only the spacer sleeve diameters get plate.



1. 0.388 - 0.393 Inch Diameter Before Plate. Hold to Minimum Value. 0.372 Inch Diameter After Plate. Finish To 0.3815 - 0.3825 Diameter.
2. Nickel Plate Enclosed Area
3. 0.386 - 0.391 Inch Diameter Before Plate. Hold To Minimum Value. 0.372 Inch Diameter After Plate. Finish To 0.3800 - 0.3810 Diameter.

R
R

Steel Compressor Spacer Sleeve
Hole Nickel Plate Repair
Figure 609



L-H3159 (1296)

1. 0.361 - 0.375 Inch Diameter Before Plate. Hold To Maximum Value.
   0.384 Inch Diameter After Plate. Finish To 0.3810 - 0.3815 Inch Diameter.
2. Nickel Plate Enclosed Area

R
R

Steel Compressor Spacer Sleeve
Nickel Plate Repair
Figure 610

(1) Strip the sleeve by SPOP 40 in Section 70-44-01, Standard Practices Manual.

(2) Do other repairs as necessary.

(3) Machine the front and rear diameters as shown in figure. Hold to maximum value.

(4) Fluorescent penetrant inspect the sleeve by SPOP 82 in Section 70-33-00, Standard Practices Manual.

(5) Mask the areas not to be nickel plated.

(6) Nickel plate the machined areas by SPOP 29 or SPOP 321 to a maximum dimension of 0.384 inch. See Section 70-44-01, Standard Practices Manual.

(7) Bake after plating at 190.6° ± 5.6°C (375° ± 10°F) for three hours.

(8) Finish machine the front and rear sleeve diameters as shown in the figure. Maintain concentricity and
R squareness requirements as instructed in Paragraph A.

(9) Install the spacer sleeves as instructed in Paragraph C.

J. Steel Compressor Spacer Sleeve Hole Machining and Spacer Sleeve Nickel Plate Repair
See Figure 611.

NOTE: This plating repair is used to restore the fit of the sleeves in the spacer holes. This repair is a substitute for the individual plating repairs of the spacer hole IDs and sleeve ODs in Paragraphs H. and I.

This repair machines the sleeve holes in the spacer and applies nickel plate to the outer diameters or the sleeves. This will give the sleeves the fit in the spacer that is specified in the Table of Limits.

(1) Machine the worn sleeve holes in the spacer as shown in (Sheet 1) of the figure.

(2) Clean the spacer by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

(3) Machine and plate the sleeve as follows:

(a) Remove all coat and plate:

1 Remove nickel-cadmium plate from the sleeve by SPOP 40. Refer to Section 70-44-01 in the Standard Practices Manual.

2 If there is no nickel-cadmium plate on the sleeve, remove nickel plate by SPOP 258. Refer to Section 70-21-00 in the Standard Practices Manual.

3 Remove PWA 110 aluminum coating from the sleeve by SPOP 258. Refer to Section 70-21-00 in the Standard Practices Manual.

(b) Machine the front and rear diameters as shown in (Sheet 2) of the figure. Remove only the minimum material necessary to remove damage or plate.

(c) Clean the sleeve by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

(d) Do a fluorescent penetrant inspection of the sleeve as specified in Section 72-00-00, Inspection.

(e) Apply masks to sleeve areas which will not get plate.

(f) Apply nickel plate to the machined diameters by SPOP 29 to a maximum diameter of 0.397 inch. Refer to Section 70-44-01 in the Standard Practices Manual. Nickel plate thickness after final machining must be 0.003 - 0.015 inch.

NOTE: The sleeve material is AMS 6304 with a hardness of HRC 30 - 38.

(g) Finish machine the front and rear sleeve diameters as shown in (Sheet 2) of the figure.

(4) Install the sleeves in the spacer holes by Paragraph C.

(5) If coating or plate is removed by spacer sleeve installation:

(a) Apply nickel-cadmium plate to the spacer by Paragraph K.

(b) Apply aluminum coat to the spacer assembly by Paragraph L.

R (6) Make sure that the spacer assembly is in all limits for
R condition and dimensions before it goes back into
R service.

R K. Compressor Disk Spacer Mating Diameter Nickel Repair -
Stages 4 - 9
See Figure 612.

R (1) Repair spacers as necessary with this procedure to
R remove local damage or to keep spacer mating diameters
R and fits with adjacent disks in limits (refer to the
R Table of Limits):

(a) Measure and record both mating diameters.

<u>NOTE</u>: Either or both diameters may have been nickel repaired previously. Since such repairs may be stripped in following step, recording of original diameter dimensions becomes necessary in order to restore mating diameter alteration, if necessary. See Paragraph M.

(b) Strip nickel-cadmium plate by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual.

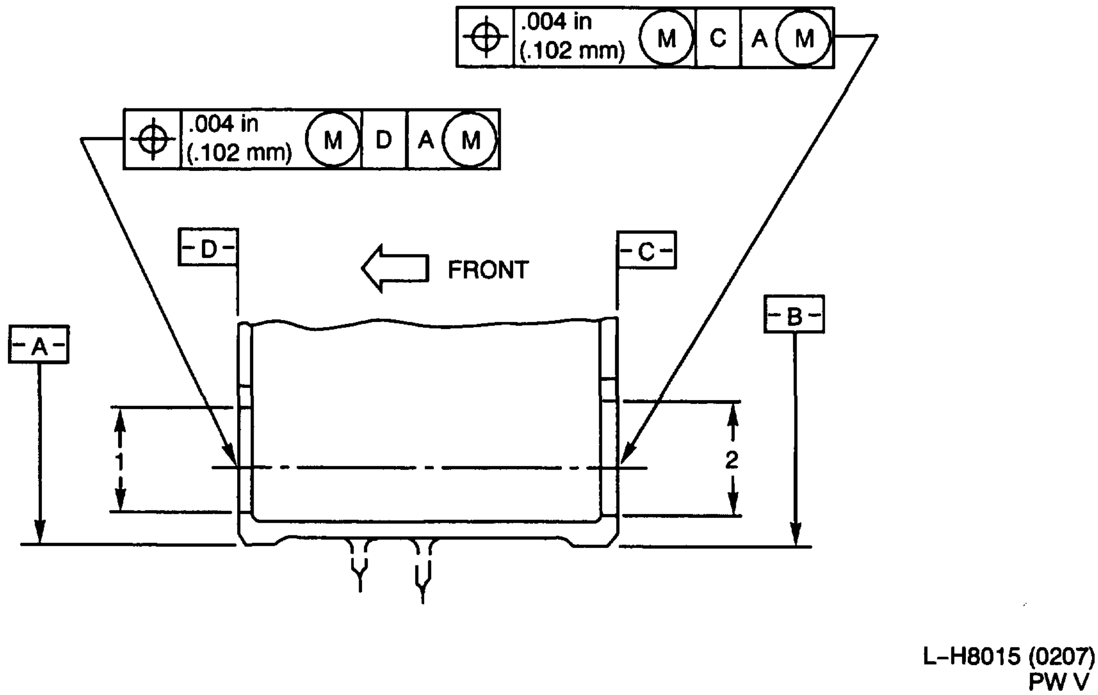
(c) Machine mating diameter to be repaired to dimension shown.

(d) Nickel plate diameter by AMS 2424, ensuring that plate buildup reaches minimum diameter requirements shown.

(e) Stress-relieve at 185° - 196°C (365° - 385°F) for three hours.

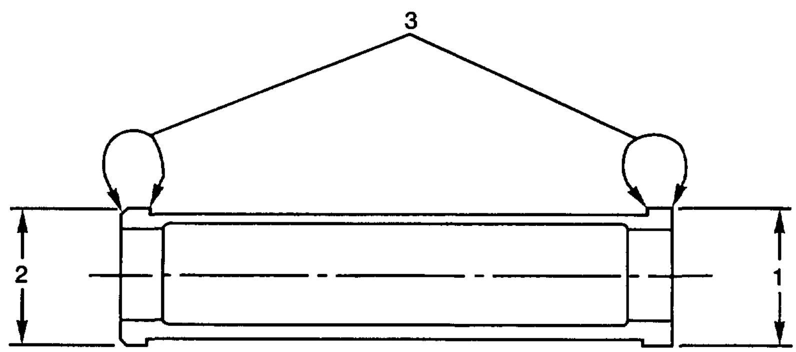
(f) Machine the diameter to dimension measures and recorded in step (a) unless alterations to diameter are necessary to comply with fit requirement in the Table of Limits.

(g) Measure repaired mating diameters(s), and compare with measurements taken in step (a) unless alterations to a mating diameter are marked adjacent to part number as indicated in Paragraph M.



R 1. Front Sleeve Hole: Machine To Diameter 0.0005 - 0.0025 inch
R Larger Than Rear Hole On Opposite Surface
R 2. Rear Sleeve Hole: Machine To 0.380 - 0.391 Inch Diameter
R (Hold Minimum Value To Remove Damage).

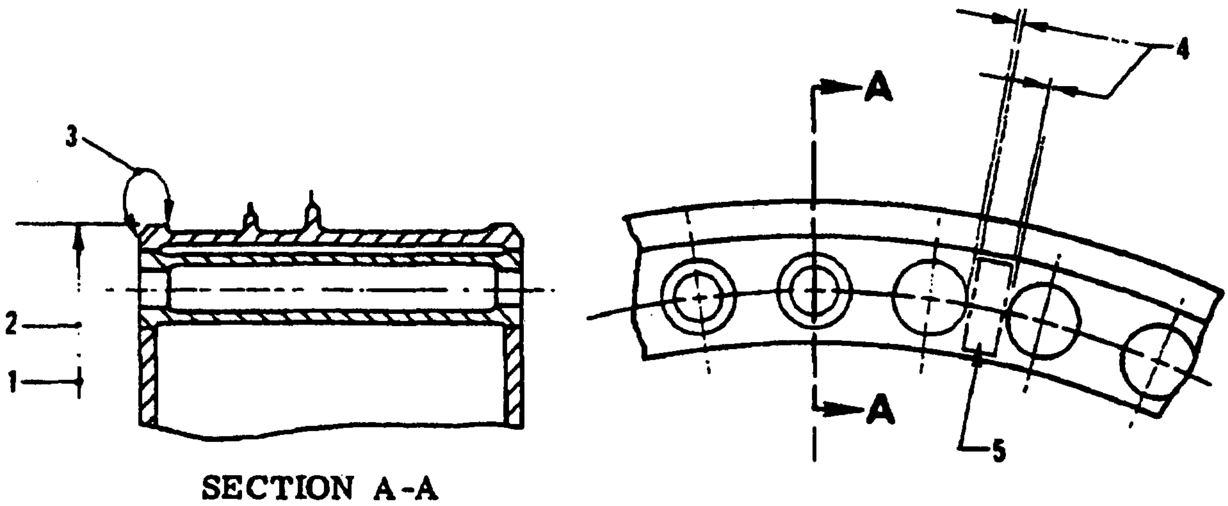
R Spacer And Sleeve
Plate/Machining Repair
R Figure 611 (Sheet 1)



L-H8016 (0207)
PW V

R 1. Rear Diameter: 0.361 Inch Minimum Before Plate. 0.397 Inch
R After Plate. Finish To Dimension Necessary For 0.000 -
R 0.0015 Inch Tight Fit With Rear Spacer Hole. This Dimension
R Cannot Be More Than Index 1 Of (Sheet 2) Of Figure.
R 2. Front Diameter: 0.361 Inch Minimum Before Plate. 0.397 Inch
R After Plate. Finish To Dimension Necessary For 0.000 -
R 0.0015 Inch Tight Fit With Front Spacer Hole.
R 3. Plating Areas (See Text)

R Spacer And Sleeve
R Plate/Machining Repair
R Figure 611 (Sheet 2)



L-26180 (0000)

1. 9.783 Inch Minimum Diameter After Nickel Plate Buildup. Finish Machine To Dimension Measured Prior To Repair Unless Altered Dimensions Are Required For Spacer Mating Diameter To Meet Fit Specified In Table Of Limits. Restore Chamfer Of 0.030 - 0.040 inch By 43 - 47 Degrees. Front And Rear Mating Diameters Must Be Concentric Within 0.0005 Inch FIR.
2. 9.756 - 9.766 Inch Diameter Before Nickel Plate. Hold To Maximum Value.
3. Nickel Plate Enclosed Area By AMS 2424. Plating Outside Enclosed Area Is Permissible Provided Such Excess Is Removed.
4. 0.030 Inch Minimum
5. Electrical Contact Area. Six Places Maximum, Both Flanges; Angular Relation Not Important. No Burning, Pitting, Or Selective Attack Permitted.

R
R

Front And Rear Mating Diameter
Repair - Compressor Disk
Spacers (Stages 4 Thru 9)
Figure 612

(h) Restore nickel-cadmium plate by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual. Nickel-cadmium surface plating area is 144 square inches.

L. Fourth Thru Ninth Stage Spacers Aluminum Coating For Spacers
R Post-SB 6135
See Figure 613.

(1) Remove all the coating and plating from all surfaces.

(2) Apply PWA 110-21 or PWA 110-31 Coating 0.001 - 0.003 inch thick except shown in figure. Refer to Section 70-41-04, Standard Practices Manual.

M. Compressor Disk Spacer Mating Diameter Alteration Marking

(1) General

(a) To get the correct fits with adjacent disks, material can be added to or removed from spacer mating diameters. Alterations to diameters must be carefully measured and recorded on the part adjacent to part number. This information is used to keep a record of changes to the initial mating diameter.

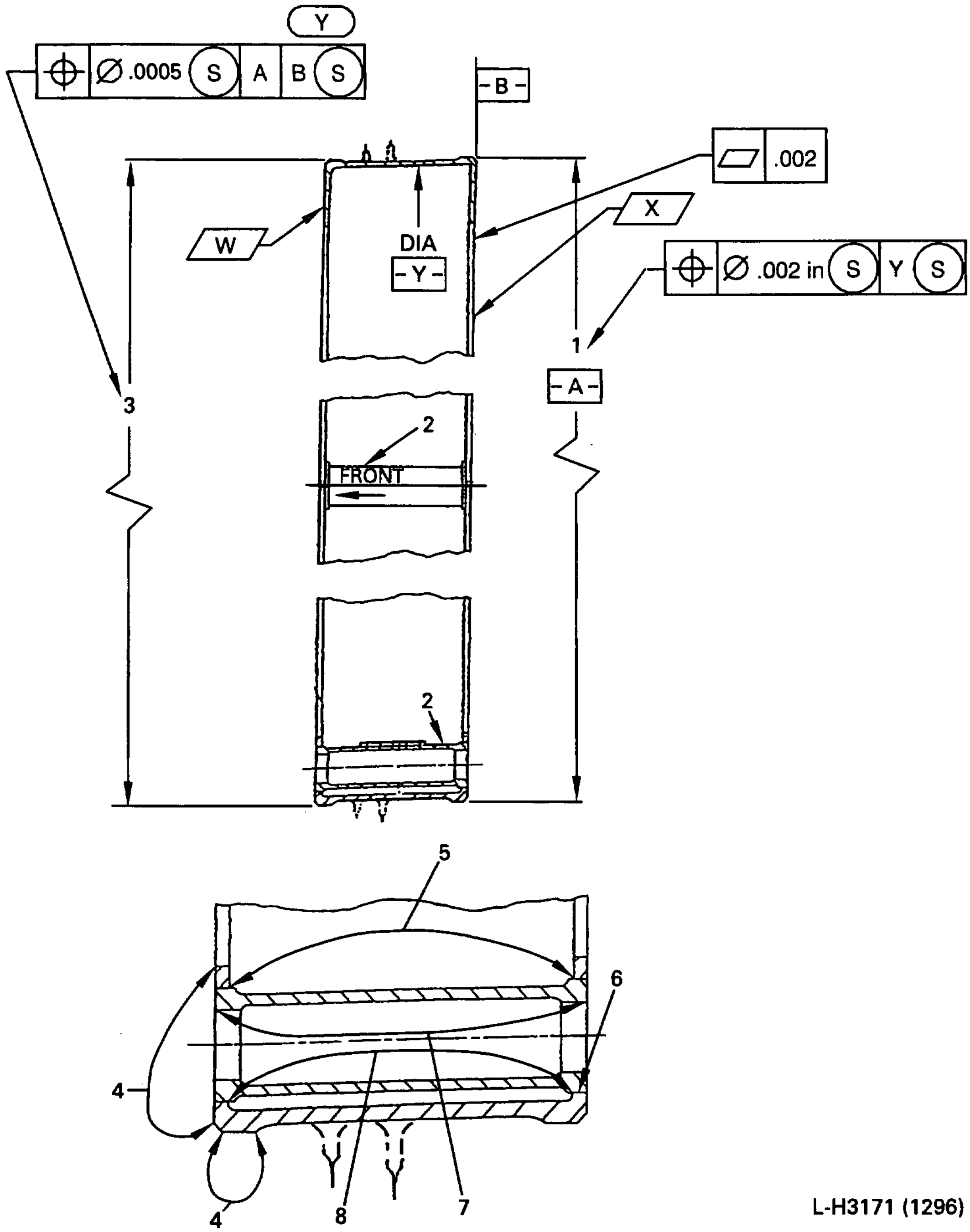
(2) Recording procedure.

(a) Measure and record base dimension which is that dimension (measured prior to each repair) which will be altered to achieve required fit.

(b) Following repair, compare altered dimension with base dimension to determine extent of alteration. Then, record change adjacent to part number, using the following symbols.

1 Dimensional increases shall be marked using "P" (plus) and dimensional decreases shall use "M" (minus).

2 Following "P" or "M" (depending upon whether the dimensions increased or decreased) record dimensional change in thousands of an inch followed by "F" (front) or "R" (rear) to



Fourth Thru 9th Stage
Spacer Aluminum Coating
Figure 613

1. 9.7708 - 9.7734 Inch Average Diameter Before Coating.
   9.7718 - 9.7764 Inch Diameter After Coating.
2. Mark On Any Sleeve Not Requiring A Counterweight. Marking Must Be Visible After Coating.
3. 9.7708 - 9.7734 Inch Average Diameter Before Coating.
   9.7718 - 9.7764 Inch Diameter After Coating.
4. Coat To be 0.0005 - 0.0015 Inch Thick with 0.0004 Inch Maximum Variation. Both Sides.
5. Must be Coated, but Maximum Thickness Requirement Is Waived. All Around Tube, 12 Places.
6. Omit Coating.
7. Coating May Be Incomplete, But Minimum Tierod Hole Diameter Must Be Maintained. Touch-up Is Allowed.
8. Must Be Coated, But Minimum Thickness Requirement Is Waived. In Area Opposite Tube, 12 Places.

Key to Figure 613

indicate the mating diameter to which markings apply.

<u>NOTE</u>: For example, if the front mating diameter of a spacer is increased 0.006 inch by plating and the rear mating diameter is decreased 0.003 inch by grinding, the spacer must get marks "P6F" and "M3R". For acceptable repair procedures, refer to the individual spacer repairs.

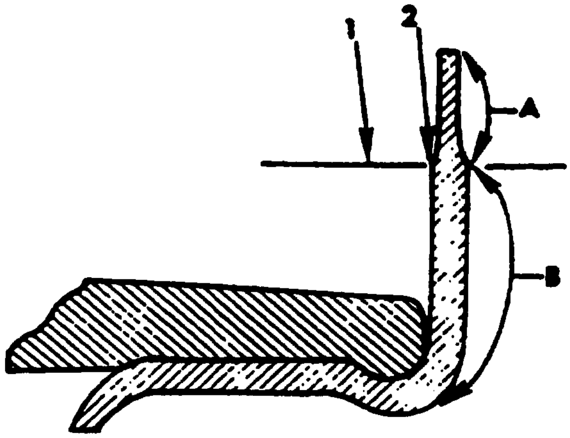
N. Compressor Disk and Spacer Knife-Edge Seal Repair
   See Figure 614 and Figure 615.

   (1) Blend damaged seals in Area A by profiling, provided depth on blend does not extend into Area B.

   (2) Removal of material from single knife-edge seal must not exceed 0.500 linear inch total (measured circumferential around seal).

   (3) For double-edge knife seals of 4th - 5th stage rotor disk spacer and 9th stage rotor air seal, removal of material must not exceed one linear inch total from one knife-edge or cumulative total of one linear inch from both knife-edges.

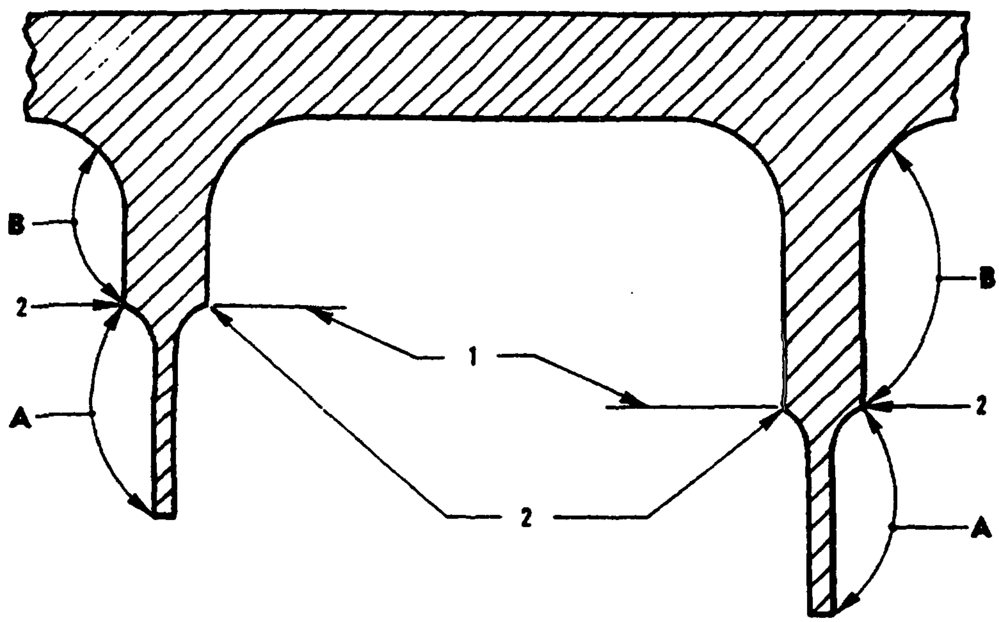
   (4) Bent seals may be straightened, provided such straightening does not result in seal cracking.



L-13665 (0000)

1. Maximum Depth of Blend
2. Break Sharp Edges

Compressor Disk Knife-Edge
Seal Blend Repair
Figure 614



1. *Maximum Depth of Blend*
2. Break Sharp Edges

Fourth To Fifth Stage And
Ninth Stage Rotor Airseal Repair
Figure 615

NOTE: Suggested method of straightening is to use block of hardwood, slotted and formed to fit seal. Slide block over bent arc of seal to straighten.

(5) Radial cracks in Area A are acceptable, provided they do not extend into Area B.

(6) Inspect repaired seals, using fluorescent penetrant method. Reject seals exhibiting cracks in Area B. Refer to Standard Practices Manual, Section 70-33-00.

O. Compressor Third to Fourth Stage Stator Spacer
See Figure 616.

(1) Inspection.

(a) Inspect spacer visually and using fluorescent penetrant method of inspection. Refer to Standard Practices Manual, Section 70-33-00. Give particular attention to cover, bleed valve strap seat band, and lugs.

(2) Lug Repair

(a) Damage up to 0.025 inch may be repaired by blending.

(b) Damage in excess of 0.025 shall be repaired as follows:

1 Weld lugs (AMS 5613 material) with AMS 5776 filler rod.

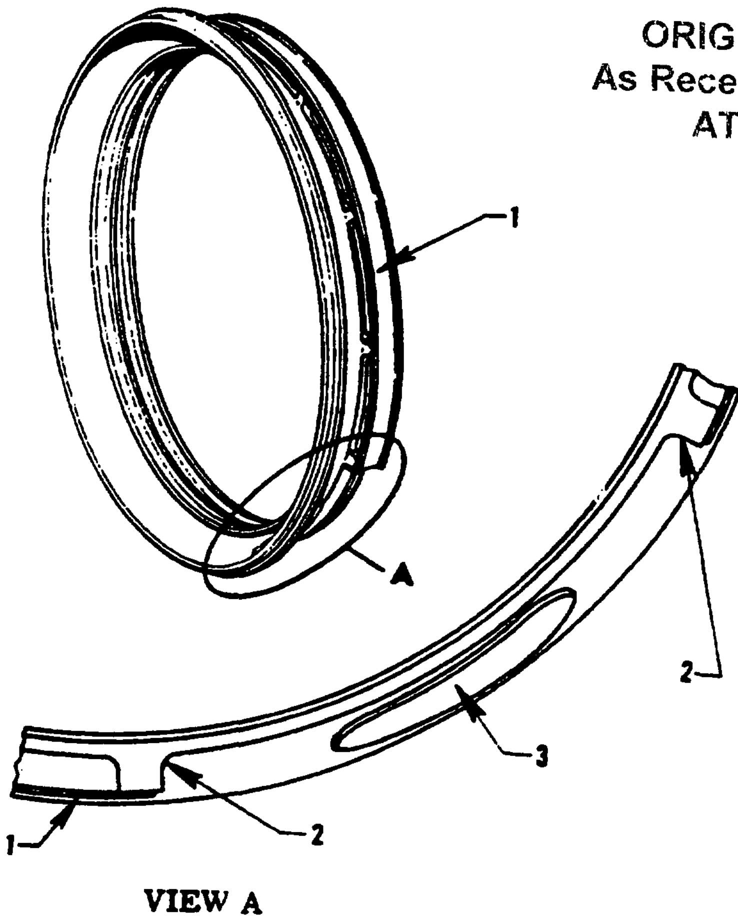
2 Hand blend welded area smooth and flush with surrounding area.

3 Stress-relieve by SPOP 455-2. Refer to Standard Practices Manual, Section 70-42-04.

(3) Cover Repair

(a) Cracks shall be weld repaired using AMS 5776 filler rod. Stress-relieve by SPOP 455-2. Refer to Standard Practices Manual, Section 70-42-04.

NOTE: Cover is made of AMS 5504 material.



L-22977 (0000)

1. Bleed Valve Strap Seat Band
2. Lug
3. Compressor Stator Spacer Cover

Compressor 3rd-to-4th Stage
Stator Spacer
Figure 616

P. Third-to-Fourth Stage Spacer Rear Mating Diameter Repair
See Figure 617 and Tool Group 29-1B.

(1) Procedure

R R **NOTE**: Record diameter to maintain a reference for future repair. See Paragraph B. for dimensional and positional requirements.

(a) Position spacer in fixture with small ID end down on movable segments.

(b) Turn hand knob (detail-7) to expand segments.

(c) Secure spacer to fixture using (detail-3).

(d) Position fixture on face chuck of grinding machine and indicate to zero on OD surface of segments and secure with standard hold-down bolts.

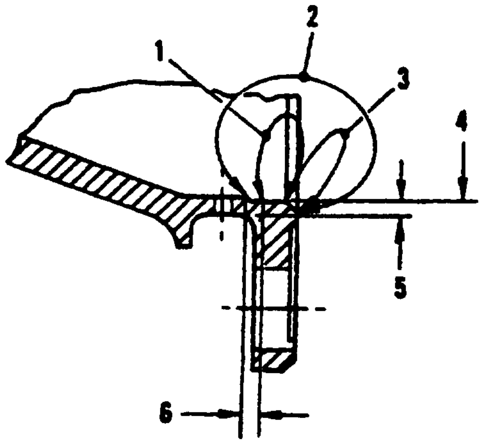
NOTE: Large ID and small ID must be concentric within 0.0005 inch.

(e) Using internal grinder, proceed to grind large ID to before-plasma coat dimensions indicated.

R R R (f) Prepare the surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(g) Plasma coat by PWA 53-13 to after-plasma coat dimensions shown. Refer to Section 70-46-01 in the Standard Practices Manual.

(h) With spacer installed in fixture, machine to finish dimensions.



L-52740 (0376)

1. Plasma Coat Area. Coating Outside Enclosed Area Not Permissible
2. Shotpeen Area
3. Plasma Coat Optional And May Be Incomplete
4. 8.5045 - 8.5185 Inch Diameter Before Plasma Coat; Hold To Minimum Value. 8.4865 Inch Diameter Maximum After Plasma Coat. 8.4965 - 8.4985 Inch Diameter Finished.
5. 0.045 Inch Minimum Parent Material
6. 0.062 - 0.077 Inch

R
R

Third-to-Fourth Stage Spacer
Rear Mating Diameter Repair
Figure 617

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-05

1. Engine Compressor Section (Tierods)

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Compressor Front Tierod

A Inspection

(1) Give tierods these inspections:

(a) Measure runout. Maximum acceptable runout of necked-down portion is 0.005 inch FIR.

NOTE: During runout check, use vee blocks at each land to either side of necked-down portion being checked.

(b) Measure length of tierod. Maximum acceptable
R length is 3.291 inches for PN 589786 and 744252 and 3.170 inches for PN 468243.

3. Compressor Rear Tierod

A. Inspection

(1) Give tierods these inspections:

(a) Measure runout. Maximum acceptable runout of necked-down portion is 0.005 inch FIR.

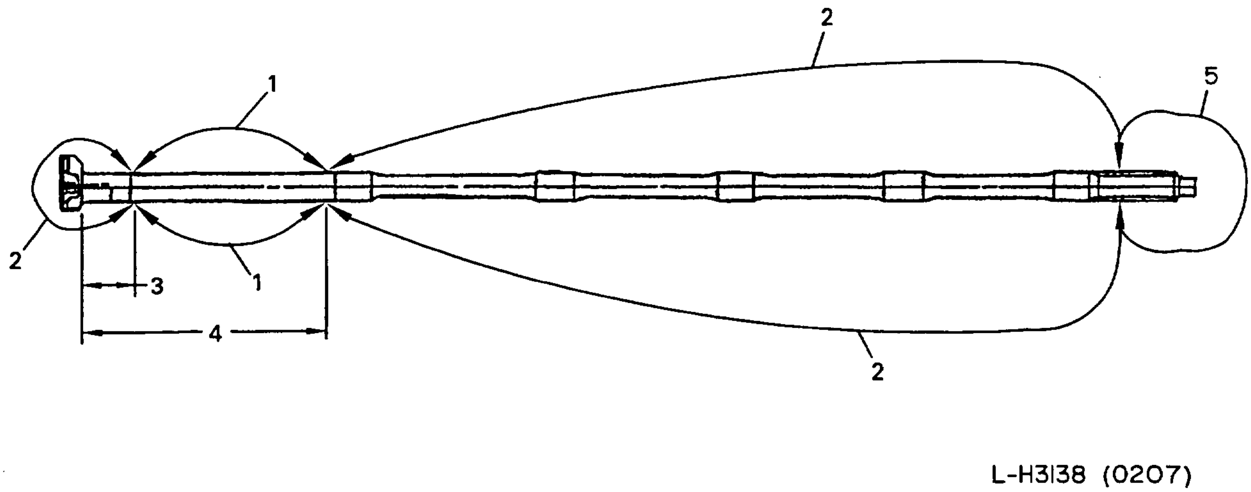
NOTE: During runout check, use vee blocks at each land to either side of necked-down portion being checked.

(b) Measure length of tierod. Maximum acceptable tierod length is 9.475 inches for PN 572252 and 9.270 inches for PN 409227.

B. Repair

(1) Blend Repair. See Figure 601.

(a) If the tierod diameter is larger than 0.238 inch at the location of the damage, blend surface damage to a depth of 0.002 inch. Otherwise, blend damage no deeper than the tierod diameter at the location of the damage minus 0.236 inch.



1. Blend Area
2. No Damage or Blend Allowed
3. 1.375 Inches
4. 1.480 Inches
5. Threads Out Of Nut Contact Area (12 Threads Maximum) (Refer To Text For Repair)

Rear Tierod Blend Repair
Figure 601

1 Damage that is circumferentially oriented may not be more than 180 degrees.

2 Blend length should be approximately 1.5 times the maximum length of the damage. Blend width should be approximately one third the blend length.

3 Blend must not extend into the radius between the necked-down section and the tierod land or onto tierod land itself.

4 Surface finish after blending should be as good or better than the original finish.

(b) No surface damage blending is allowed in Index 2 area. Surface damage in Index 2 area will make it necessary to reject the tierod.

(c) The rear part of the tierod thread does not hold the load of the tierod (only the forward threads are the mating surface for the tierod nut threads). If there is damage to this non-contact area (see Index 5 in the figure), remove it by SPOP 9. Refer to Section 70-21-00 in the Standard Practices Manual.

(d) After blend repair, recoat tierod by nickel-cadmium by SPOP 25. Refer to Section 70-44-01 in the Standard Practices Manual.

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-06

1. Engine Compressor Section (Bleed Valve Parts)

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Bleed Valve Strap Seat Band

A. Inspection

(1) Axial cracks across band are cause for band replacement.

(2) Other cracks shall be weld repaired.

B. Repair

(1) Weld Repair

(a) Weld band (AMS 5504 material) with AMS 5776 filler rod.

(b) Hand blend welded area smooth and flush with surrounding area.

(c) Stress-relieve by SPOP 455-2. Refer to Section 70-42-04 in the Standard Practices Manual.

(2) Replacement. See Figure 601.

CAUTION: ENSURE WHEN MACHINING TO AVOID REMOVAL OF PARENT MATERIAL OF LUGS.

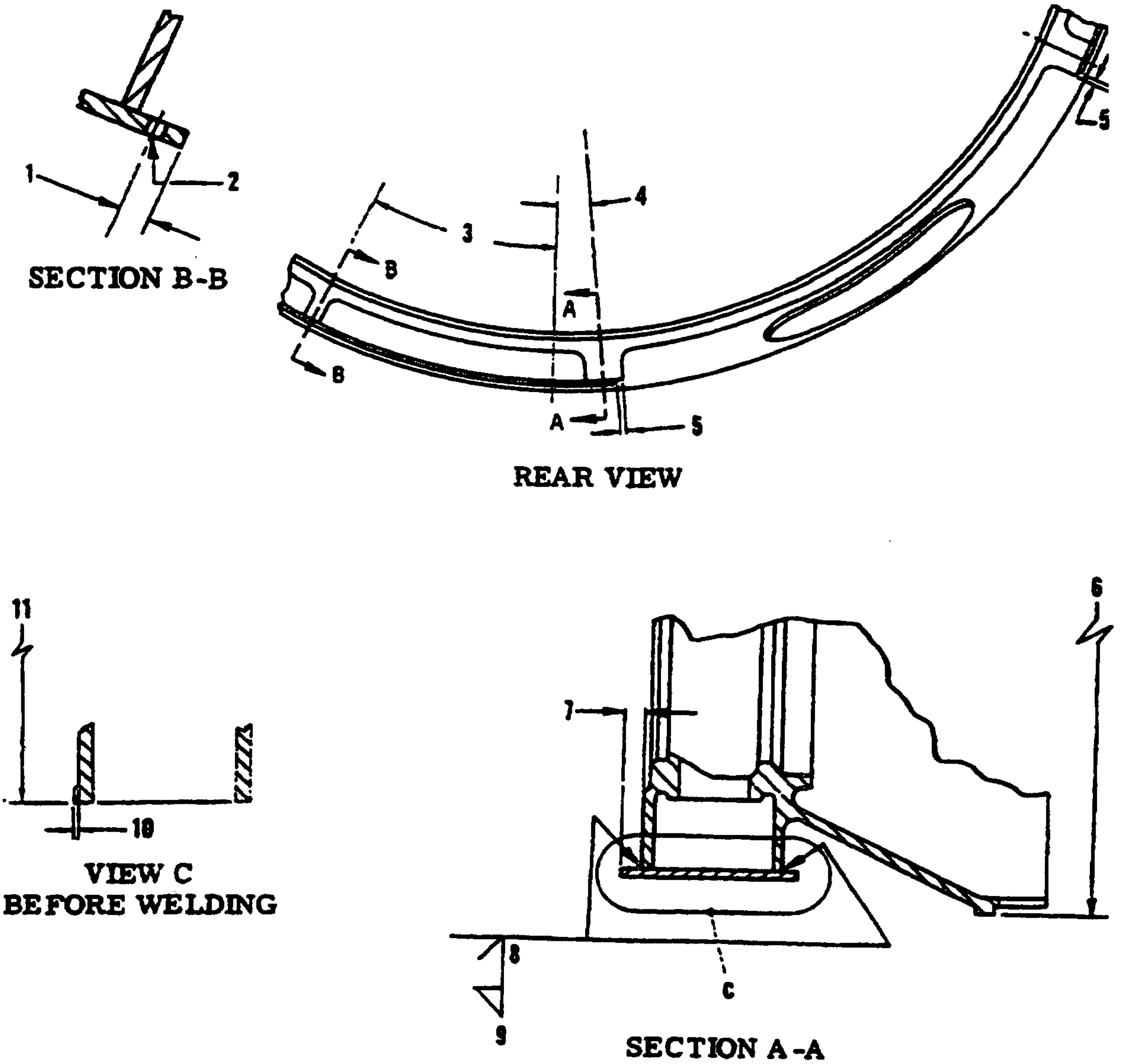
(a) Machine off existing band where welded at 11 pairs of support lugs.

(b) Position new band on lugs as shown.

(c) Weld band in place using AMS 5776 filler rod.

(d) Stress-relieve by SPOP 455-2. Refer to Section 70-42-04 in the Standard Practices Manual.

(e) Drill lockwiring holes through rear lip of band as shown.



L-24340 (0000)

Compressor Bleed Valve Strap
Seat Band Replacement
Figure 601

1. 0.075 - 0.085 Inch
2. 0.060 - 0.080 Inch Diameter Through Four Holes Equally Spaced and Located Within 0.030 Inch Either Side Of True Position
3. 25 Degrees
4. 5 Degrees (reference)
5. This Dimension (After Welding) Must Be Within 0.030 Inch Of Corresponding Dimension At Other End Of Band.
6. Reference Diameter
7. 0.120 - 0.140 Inch
8. 0.040 Inch
9. 11 Places
10. 0.005 Inch Maximum Permissible Step, 11 Places
11. 17.995 - 18.005 Inch Diameter. This Diameter Must Be Concentric with Diameter Within 0.010 Inch FIR

Key to Figure 601

3. Compressor Bleed Valve Strap
See Figure 602.

A. Inspection

(1) Non-Destructive Inspection

(a) Remove chromium plate from the strap. Refer to SPOP 22 in the Standard Practices Manual, Section 70-44-01.

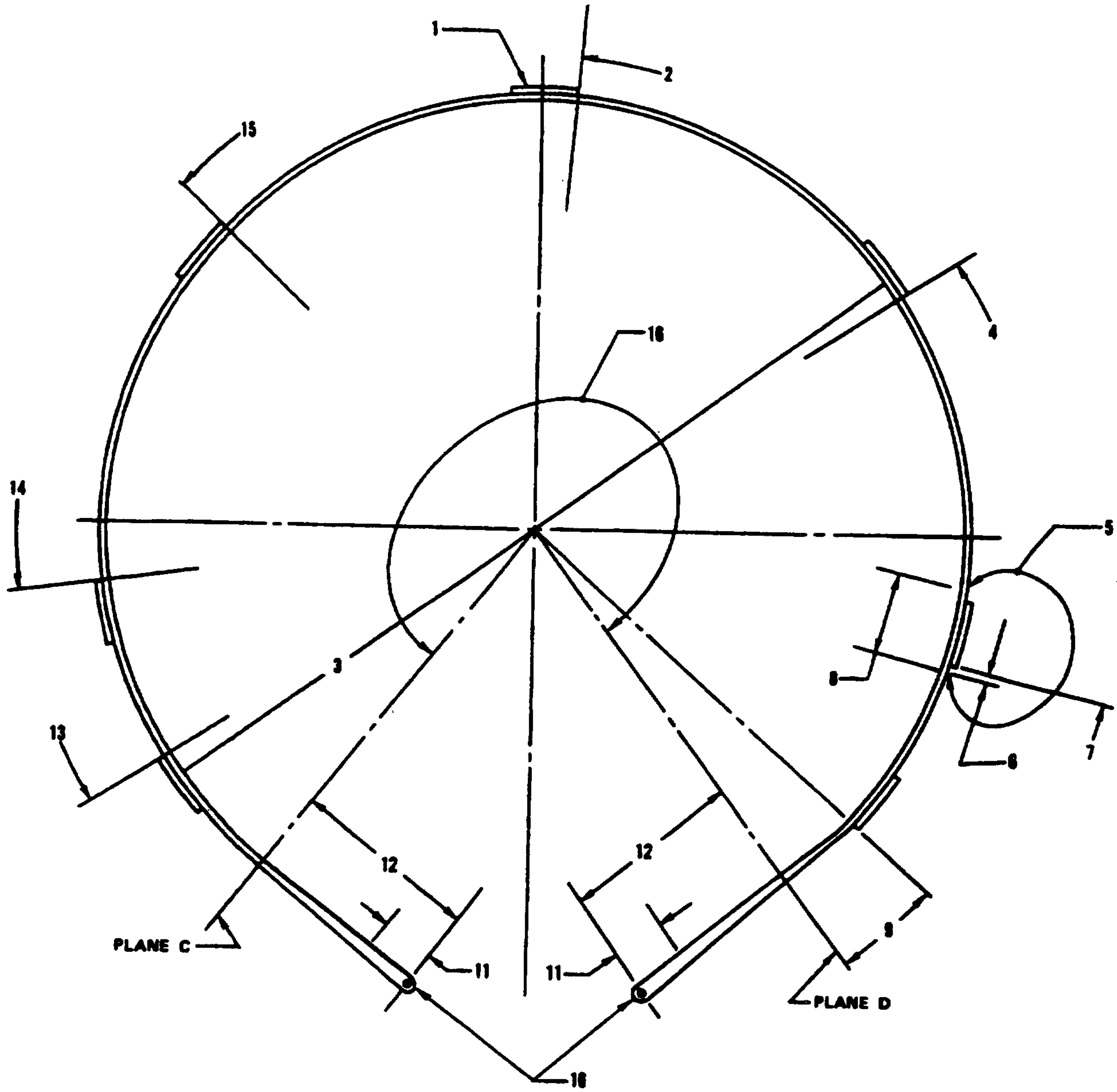
(b) Inspect strap for cracks by fluorescent penetrant method. Refer to Section 70-33-00 in the Standard Practices Manual.

NOTE: Pay particular attention to weld areas and former rivet holes.

B. Repair

(1) Corrosion Protection

(a) Bead peen, using 0.0015 - 0.0029 inch diameter beads with intensity equivalent to 6N to 8N. Refer to SPOP 500 in the Standard Practices Manual, Section 70-41-01.



L-61594 (0000)

Compressor Bleed Strap
Chromium Plate And
Cushion Replacement
Figure 602

NOTE: Dimensions apply when diameter (3) from Plane C to Plane D is round within 0.010 inch FIR.

1. Cushion, Located 0.125 Inch Either Side Of True Position And Centered On Strap Within 0.010 Inch (Seven Places).
2. 139°22′ From Plane D
3. 19.995 - 20.005 Inch Diameter
4. 88°3′ From Plane D
5. Do Not Plate Enclosed Area (Seven Places)
6. 0.290 - 0.310 Inch (Seven Places)
7. 36°44′ from Plane D
8. 1.940 - 2.060 Inches (Seven Places)
9. 11°5′
10. Plating Not Permitted In Holes
11. 1.000 Inch Maximum. Plate Is Optional, And May Be Incomplete On Both Sides. Electrical Contact Permissible In This Area.
12. 4.130 - 4.136 Inches. Reference
13. 267°39′ From Plane D
14. 242° From Plane D
15. 190°41′ From Plane D
16. 287°17′

Key to Figure 602

(b) Chromium plate bleed valve strap. Refer to SPOP 22 Standard Practices Manual, Section 70-44-01. Plate to thickness of 0.0006 - 0.001 inch, and bake at 391°- 407°C (735°- 765°F) for two hours.

<u>NOTE</u>: Plating to minimum thickness of 0.0006 inch will tend to hold plate buildup on edge of strap to minimum. Do not plate clevis pinholes or areas where cushions are to be installed.

(c) Install new cushions.

(2) Installing/Replacing Bleed Strap Cushions. See Figure 602 and Table 601.

Epoxy Adhesive Film	Primer	Primer Requirements Thickness (inches)	Cure Requirements
PWA 626	PWA 496	0.0002 - 0.0003	At room temperature for 30 - 60 minutes followed by 176° ± 5.5°C (350° ± 10°F) for 60 - 90 minutes

Bonding Materials
Table 601

Epoxy Adhesive Film	Primer	Primer Requirements Thickness (inches)	Cure Requirements
PWA 627	PWA 497	0.0002 - 0.0003	At room temperature for 60 - 90 minutes
PWA 633	PWA 498	0.0002 - 0.0003	At room temperature for 15 - 30 minutes followed by 93° ± 5.5°C (200° ± 10°F) for 30 - 60 minutes

NOTE: Primer, if refrigerated, shall be allowed to warm to room temperature. Application shall be accomplished within 30 minutes of completion of cleaning. Bonding shall be conducted within 24 hours following the application of primer. Primed surfaces prior to bonding shall be kept free of contamination either by packaging or storage in a controlled environment area with relative humidity not lower than 50 percent.

Bonding Materials
Table 601 (Continued)

(a) Remove worn or damaged cushions using sharp knife.

(b) Dry abrasive blast bond area on strap using nonmetallic No. 80 - 100 grit at a pressure of 40 - 50 psig to provide a uniform matte finish.

(c) Remove abrasive residue by vacuuming.

CAUTION: DO NOT VAPOR DEGREASE.

(d) Clean the bond area by SPOP 208. Refer to Standard Practices Manual, Section 70-21-00.

(e) Air dry for 10 - 15 minutes. Avoid contact with cleaned surface.

(f) Apply appropriate primer to bond area. Cure primer as specified.

(g) Trip epoxy adhesive film to conform with replacement bleed strap cushion.

(h) Abrade and clean bond area on fluorocarbon cushion as specified in steps (b) thru (e) above. Use a separate booth to prevent fluorocarbon contamination of booth.

(i) Strip protective liner from one surface of adhesive. Place unprotected surface of adhesive on strap.

(j) Remove air entrapped between adhesive and strap using a suitable roller.

(k) Strip remaining protective liner from adhesive and place abraded surface of cushion on adhesive. Remove entrapped air using suitable roller.

(l) Cure adhesive under positive pressure of 25 - 50 psi at 176.7°C (350°F) for 1 - 1.5 hours.

4. Compressor Bleed Valve Linkage Spring Assembly
See Tool Group 14 and Figure 603.

(1) Remove flared rivet securing compressor bleed valve linkage spring cover to housing, and withdraw cover, pusher, and springs.

(2) Check spring tension, References 405 thru 408 in Table of Limits. Replace spring if it is below acceptable limits.

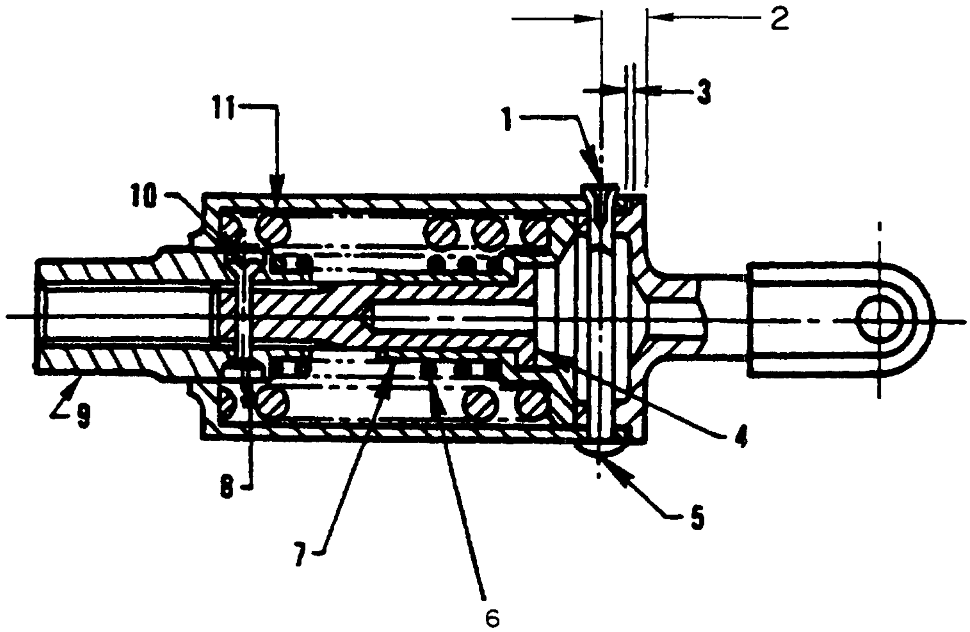
(3) Place the compressor bleed valve linkage spring housing cover on the housing and position them on the bleed valve jig.

(4) Drill the 0.127 - 0.132 inch rivet hole as shown in referenced figure.

(5) Position the linkage spring compressor on the bench. Install the housing spring and rod end in the compressor with the housing in the counterbored end of the compressor.

(6) Install the housing cover in the pusher of the compressor.

(7) Turn the knurled pin into the pusher until the pilot is in the shank of the housing cover, and the face of the rod end contacts the face of the cover. The spring and rod end will extend out beyond the housing.



L-19355 (0000)

1. Secure By Flaring
2. 0.205 - 0.215 Inch
3. 0.000 - 0.010 Inch
4. Rod
5. Rivet
6. Small Spring
7. Seat
8. Rivet
9. Adjuster
10. Stake Securely
11. Large Spring

ORIGINAL
As Received By
ATP

Compressor Bleed Valve
Linkage-Spring Assembly
Figure 603

(8) Turn the screw until the cover enters the housing, and the rivet holes are lined up.

(9) With the assembly held in this position, install the rivet. Turn the assembly until the rivet head can be supported by the support in the base of the compressor, and flare the rivet with a standard punch.

NOTE: The knurled pin on the pusher can be turned to line up the rivet holes, if necessary.

5. Compressor Bleed Valve Strap Guide Assembly
See Figure 604.

A. Inspection

(1) Wear up to 0.008 inch in track area (Index 6) is acceptable without repair.

B. Repair

(1) Wear up to 0.015 inch in track area (Index 6) shall be repaired as follows:

(a) Strip chromium plate by SPOP 22. Refer to Standard Practices Manual, Section 70-44-01.

(b) Clean up worn surface as necessary to allow for minimum plate thickness of 0.005 inch after final machining.

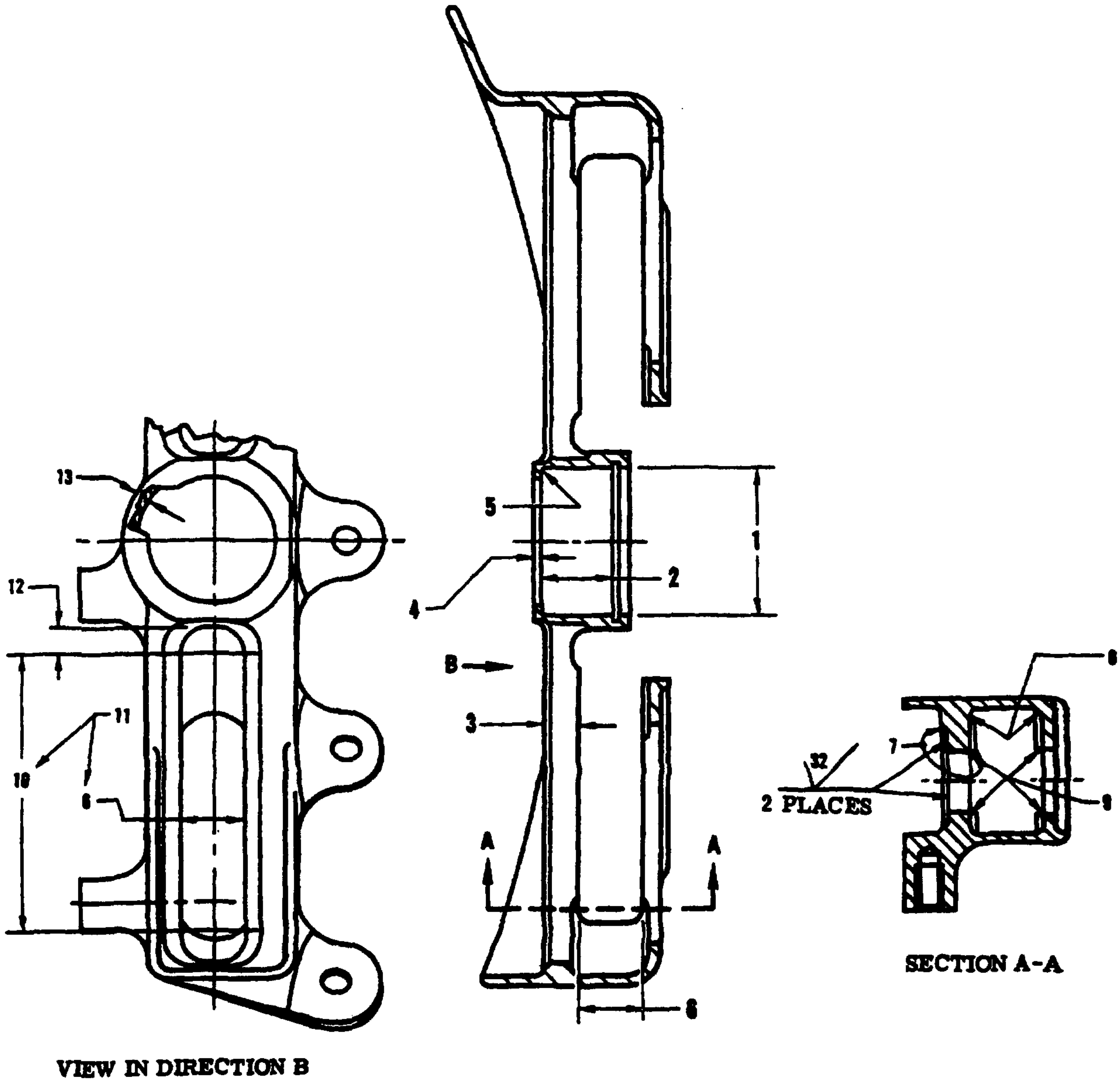
(c) Nickel-plate worn track areas by SPOP 26 ensuring that plate buildup will allow for final machining to dimensions shown. Refer to Standard Practices Manual, Section 70-44-01.

(d) Machine to dimensions shown.

(e) Restore chromium flash of 0.0004 - 0.0008 inch by SPOP 22. Refer to Standard Practices Manual, Section 70-44-01.

(2) Minor wear in ID of bearing bore which can be restored with chromium flash shall be repaired as follows:

(a) Clean up bore as necessary to accommodate chromium flash.



L-29692 (0000)

Compressor Bleed Valve
Strap Guide Repair
Figure 604

1. 1.1819 - 1.1829 Inch Diameter
2. 0.6155 - 0.6195 Inch
3. 0.219 - 0.221 Inch In Two Places
4. 0.050 - 0.060 Inch
5. 0.015 - 0.025 Inch Radius
6. 0.5010 - 0.5028 Inch In Two Places
7. Chromium Plate (SPOP 22) 0.0004 - 0.0008 Inch Thick, All Around Two Places. Dimensions Shown Are After Plating
8. 0.047 - 0.078 Inch Radius In Two Places
9. 0.047 - 0.078 Inch Radius In Two Places
10. Distance For Finish Machined Surface.
11. Machine To Dimension Shown In Index 6 For Distance Shown In Index 10.
12. 0.240 Inch Maximum. Both Ends, Two Places.
13. 0.040 Inch Minimum Wall Thickness.

NOTE: All machined diameters about a common center must be concentric within 0.010 inch FIR. All unspecified cast wall thickness, 0.060 - 0.080 inch

Key to Figure 604

(b) Chromium flash by SPOP 22 to dimensions shown. Refer to Standard Practices Manual, Section 70-44-01.

(c) Fluorescent penetrant inspect by SPOP 62. Refer to Standard Practices Manual, Section 70-33-00.

6. <u>Compressor Bleed Valve Linkage Shaft Lever Assembly</u>
See Figure 605.

A. Repair

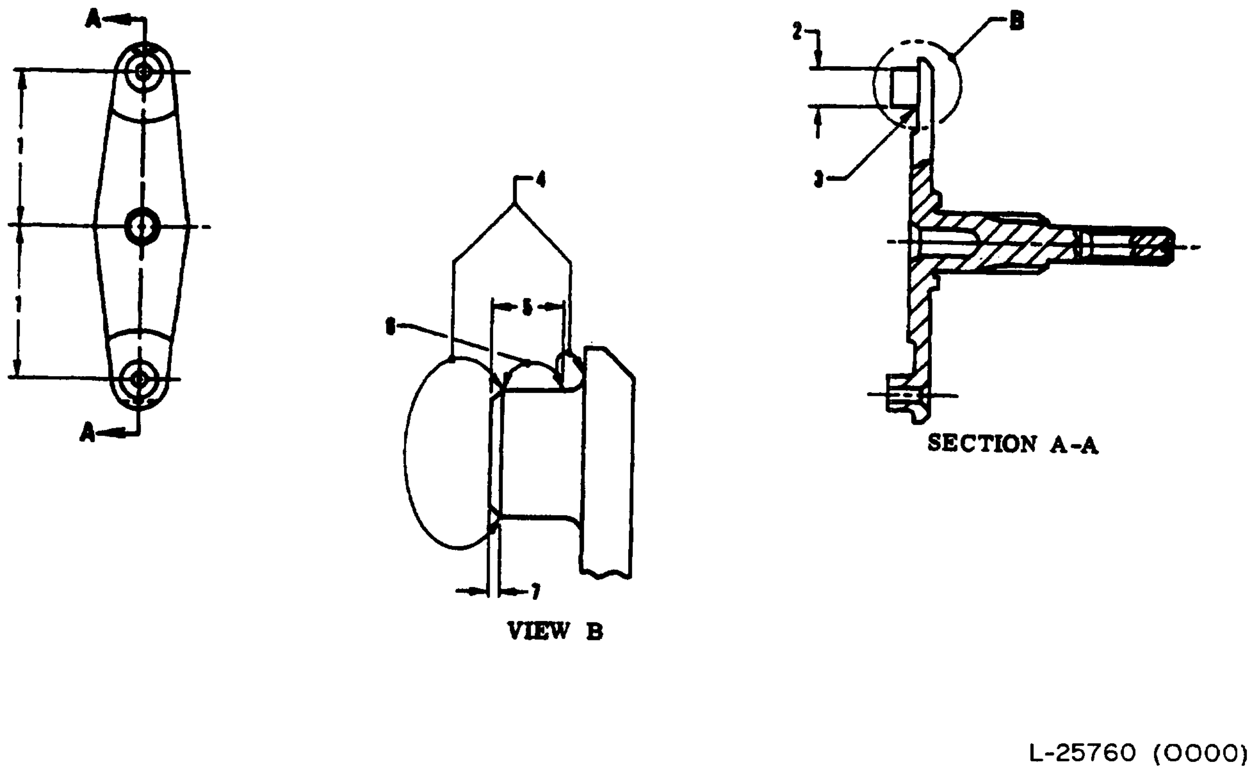
(1) Remove rivets securing links to shaft and remove links.

(2) Weld repair a worn link bearing area:

(a) Build up worn area with AMS 5776 filler rod.

(b) Harden by heating at 996° - 1024°C (1825° - 1875°F) for one hour and air cool.

(c) Temper by heating at 502° - 518°C (935° - 965°F) for one hour and air cool.



1. 1.098 - 1.102 Inches
2. 0.2475 - 0.2480 Inch Diameter After Plating With Surface Roughness of 32AA (Both Ends)
3. 0.015 - 0.030 Inch Radius (Both Ends)
4. Plate Optional And May Be Incomplete (Both Ends)
5. 0.130 - 0.150 Inch (Both Ends)
6. Chromium Plate Area 0.0002 - 0.0004 Inch Thick (Both Ends)
7. 0.010 - 0.020 Inch By 43 - 47 Degree Chamfer (Both Ends)

Compressor Bleed Valve
Linkage Shaft
Figure 605

(3) Chromium plate to 0.0002 - 0.0004 Inch thickness by SPOP 22 except bake at 385° - 413°C (725° - 775°F) for two hours after plating. Refer to Standard Practices Manual, Section 70-44-01.

(4) Machine plated surface to dimensions shown.

(5) Install and secure serviceable links with rivets locating upset end of rivet flush to 0.010 inch below surface.

1. Engine Compressor Section (No. 2 Bearing Parts)

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. No. 2 Bearing Oil Distributing Sleeve

A. Inspection

(1) Inspection - General

(a) Clean the sleeve before inspection (refer to Section 72-00-00, Cleaning).

(b) Make sure that all oil holes and passages are free from unwanted material.

(c) Sleeve condition limits are applicable to damaged areas after blend repair and not to the size of the damage area before blend repair is started. Keep material removal to a minimum for the longest part life and service.

(d) During inspection be sure that all limits are correct and applicable for the surfaces examined (some conditions are permitted without repair). It is usually best to do blend repairs on all surface damage found on the part. The sharper the edges of the surface damage, the more important it is to do blend repair.

(e) Be sure to include in inspection internal surfaces, slots, and holes. When damage is found, it will be easier to know how much damage there is with some magnification.

(2) Non-destructive inspection

1 Do a fluorescent magnetic particle inspection of the part (refer to Section 72-00-00, Inspection).

2 If cracks are found during this inspection, it will not be possible to put the part back in an engine.

(3) Visual inspection

(a) Refer to Table 601 for inspection areas and limits. See Figure 601.

(b) Examine the sleeve for cracks and damage (for example; nicks, dents, pitting, galling, or scoring).

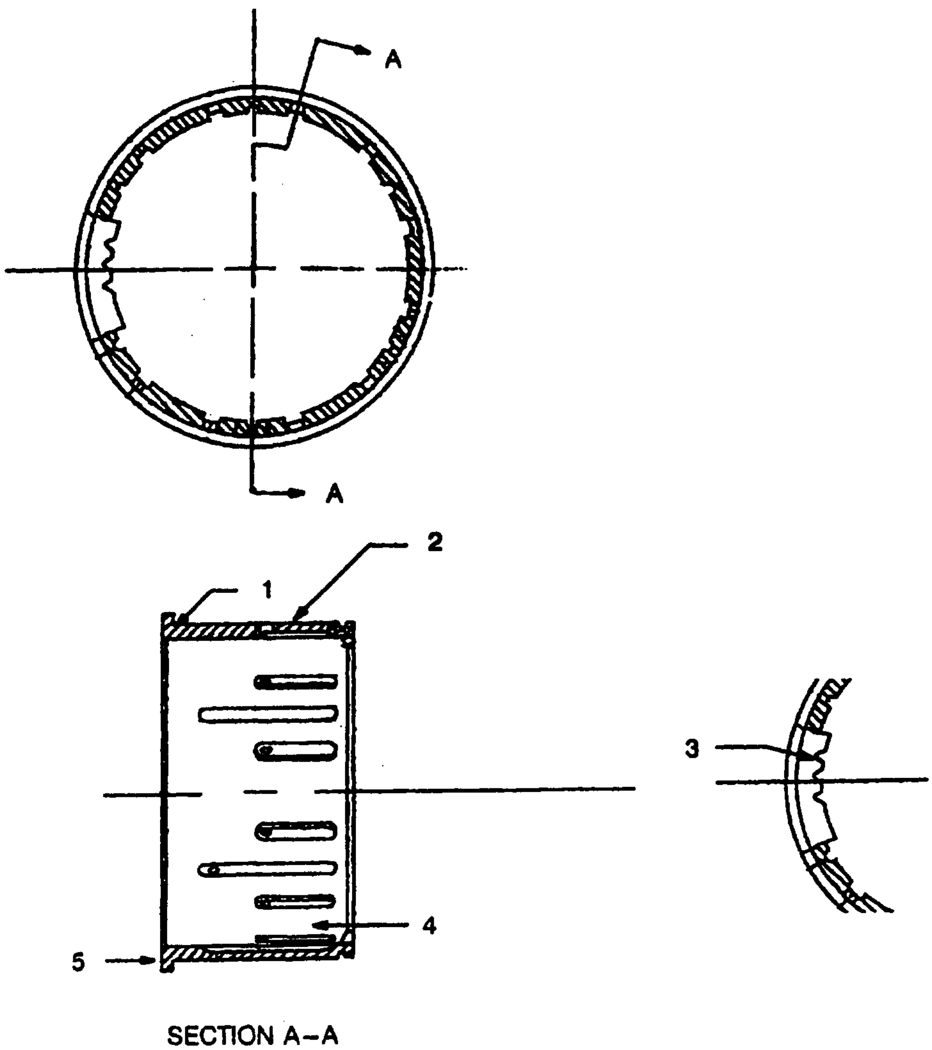
(c) Remove all sharp ridges and raised metal to be sure of a smooth surface that is the same as adjacent (not-damaged) surfaces.

CONDITION	SERVICEABLE LIMITS	REPAIRABLE LIMITS	REPAIR BY:
Cracks	No cracks permitted	Not repairable	None
Index 1, 5 Area Damage	All nicks, dents, scratches to 0.003 inch depth permitted	To 0.010 inch depth	See text
Index 2 area scoring	Circumferential scoring in bearing seat are to 0.005 inch depth permitted. Axial scoring of full length of sleeve to 0.005 inch depth is permitted.	Scoring to 0.010 inch depth permitted	See text
Index 3 spline wear	Wear of spline to 0.002 inch on loaded side of one tooth	None	None
Index 4 wear	Wear to 0.001 inch is permitted		See text

Visual Inspection of No. 2 Bearing Sleeve
Table 601

(4) Dimensional inspection

(a) Reference numbers are included where applicable to identify fit or clearance checks necessary before or during assembly with mating parts. Refer to the Table of Limits section for the data related to these reference numbers.



1. Nicks, Dents, And Scratches to 0.003 Inch Deep Permitted
2. Circumferential Scoring in Bearing Seat Area to 0.005 Inch Depth Permitted
3. Spline Wear to 0.002 Inch Maximum on Loaded Side of Spline Tooth
4. Wear to Maximum of 0.001 Inch
5. All Nicks, Dents, or Scratches to 0.003 Inch Maximum Depth

R
R

No. 2 Bearing Oil Distributing Sleeve Inspection
Figure 601

(b) Measure the sleeve dimensions shown in Table 602 and Figure 602.

DIMENSION	SERVICEABLE LIMITS	REPAIRABLE LIMITS	REPAIR BY:
1	1.809 Inch Minimum	1.807 Inch Minimum	See text
2	0.097 Inch Minimum	0.095 Inch Minimum	See text
3	3.1487 Inch Diameter Minimum	3.144 Inch Diameter Minimum	See text
4	2.9007 Inch Diameter Maximum	2.904 Inch Diameter Maximum	See text

Dimensional Inspection of No. 2 Bearing Sleeve
Table 602

A. Repair

(1) Plate Repair

(a) Sleeve ID electroless nickel plate repair (Index 4) in Figure 602. See Figure 603.

1 Examine the sleeve repair surface for damage. Do a blend repair to remove damage (raised material and sharp edges). Refer to Section 70-45-00 in the Standard Practices Manual.

2 Machine the ID of the sleeve to 2.904 inch diameter maximum.

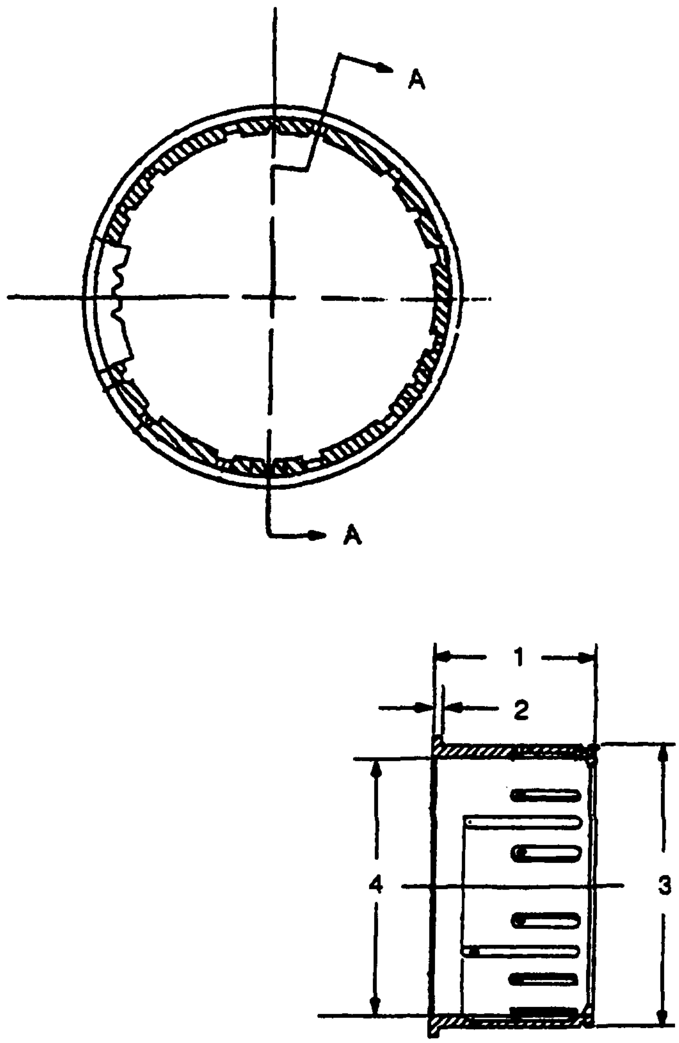
CAUTION: NO PLATE IS PERMITTED IN THE OIL HOLES, GROOVE, SLOTS, OR ON THE SPLINES. APPLY MASKS AS NECESSARY.

3 Apply electroless nickel plate to the surface by SPOP 320. Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: Sleeve hardness is 35 - 40 HRC.

4 Finish machine the ID surface to the dimensions in the figure. Surface finish must be 16AA or better. It is permitted to break sharp edges to 0.003 - 0.015 inch.

(b) Sleeve OD electroless nickel plate repair (Index 3) in Figure 602. See Figure 604.

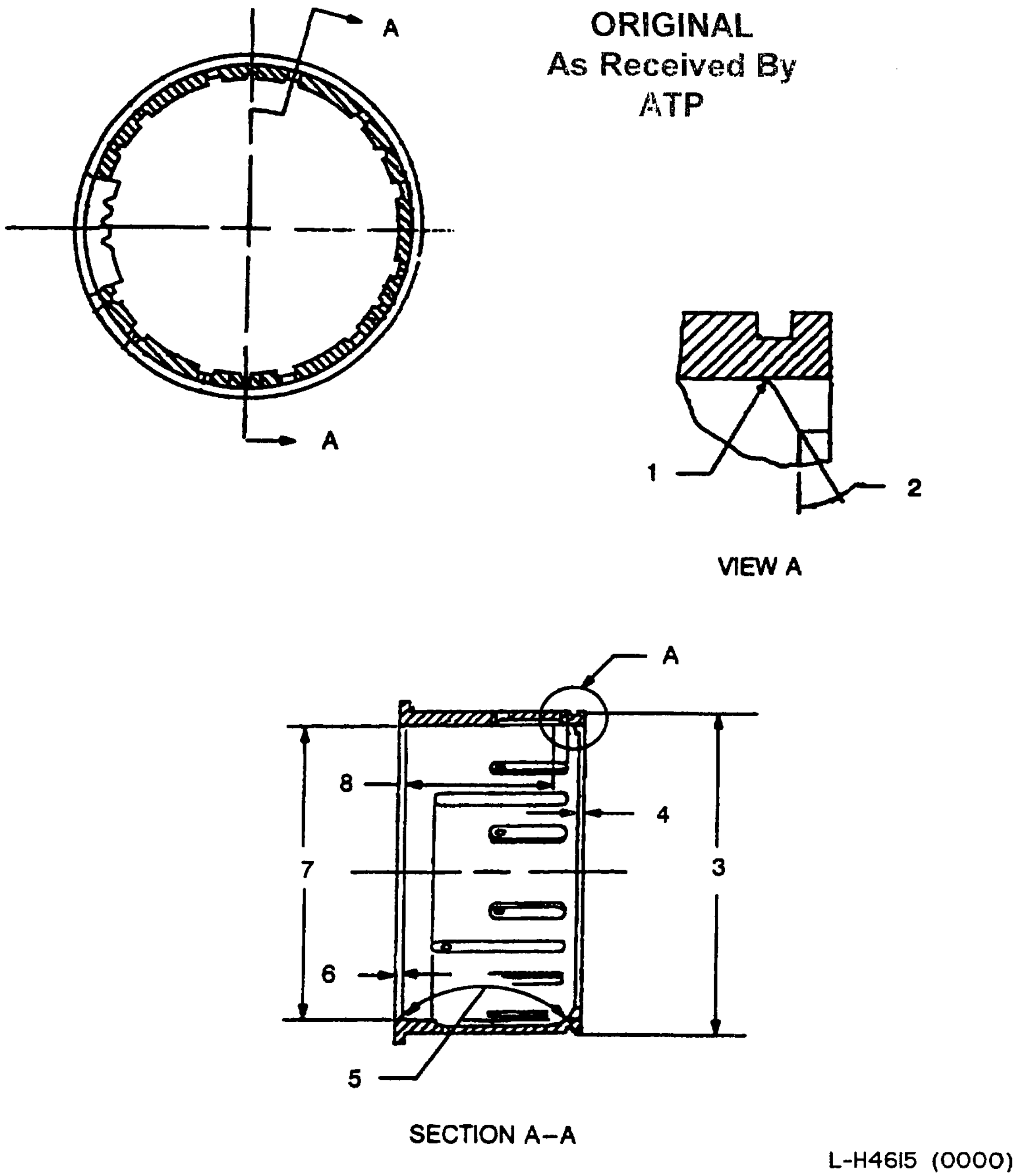


SECTION A–A

L-H4614 (0000)

1. 1.809 Inch Minimum
2. 0.097 Inch Minimum
3. 3.1487 Inch Diameter Minimum
4. 2.9007 Inch Diameter Maximum

No. 2 Bearing Oil Distributing
Sleeve Dimensions
Figure 602



No. 2 Bearing Oil Distributing
ID Plate Repair
Figure 603

1. 0.031 - 0.062 Inch Radius
2. 30° ± 2°
3. 3.1497 - 3.1502 Inch Diameter, Concentric with Index 7 Diameter 0.0005 Inch FIR Maximum
4. 0.050 - 0.070 Inch
5. Plate Area (to Edge of Index 1 Radius)
6. 0.020 - 0.040 Inch by 45° ± 2° Chamfer
7. 2.8992 - 2.8997 Inch Diameter Across Index 8 Distance (Remaining Diameter Can Be 2.89 - 2.9005 Inches)
8. 1.500 Inches

Key to Figure 603

1 Examine the sleeve repair surface for damage. Do a blend repair to remove damage (raised material and sharp edges). Refer to Section 70-45-00 in the Standard Practices Manual.

2 Machine the OD of the sleeve to 3.144 inch diameter minimum.

CAUTION: NO PLATE IS PERMITTED IN THE OIL HOLES, GROOVE, SLOTS, OR ON THE SPLINES. APPLY MASKS AS NECESSARY.

3 Apply electroless nickel plate to the surface by SPOP 320. Refer to Section 70-44-01 in the Standard Practices Manual.

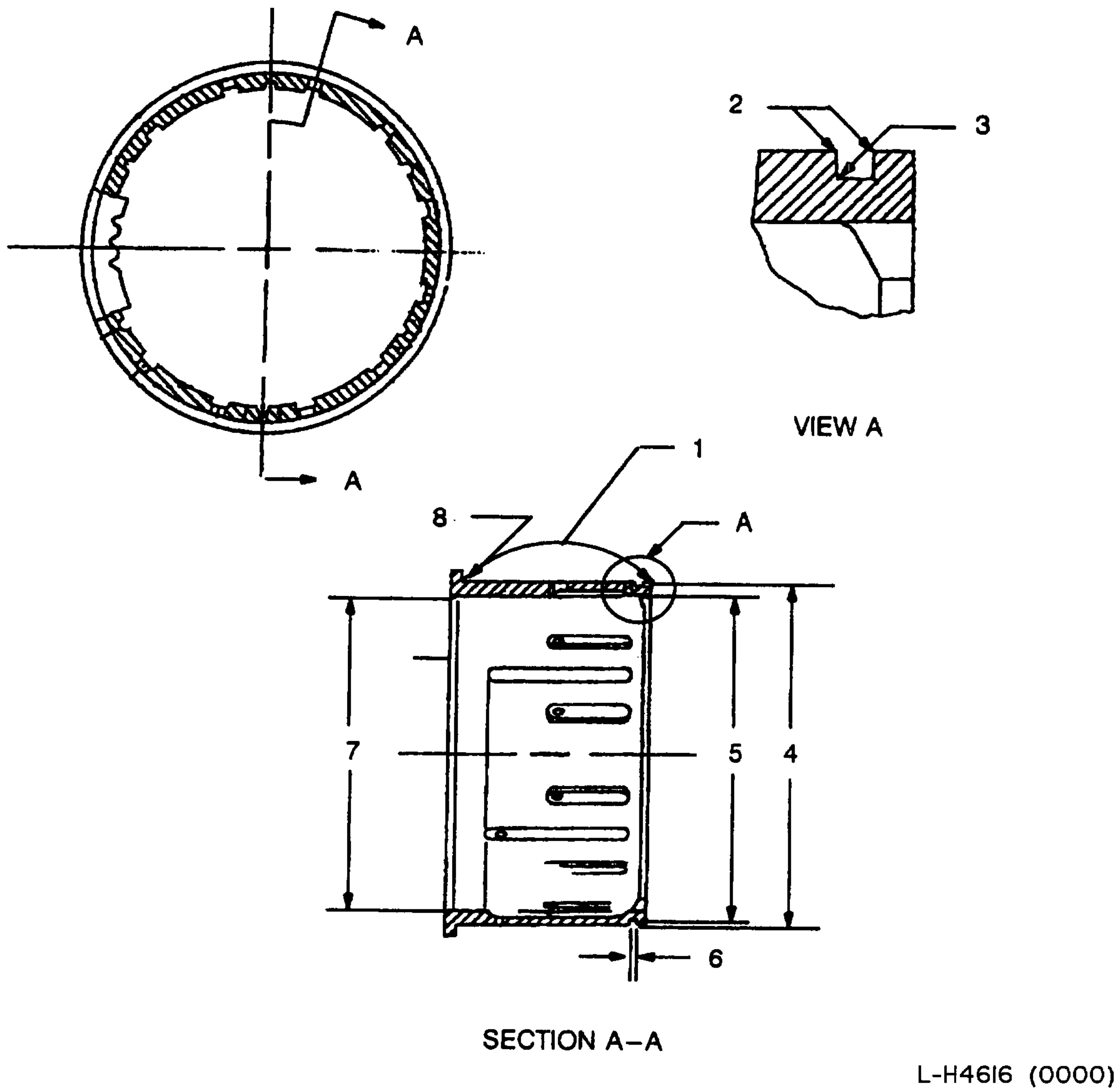
NOTE: Sleeve hardness is 35 - 40 HRC.

R 4 Finish machine the OD surface to the dimensions
R in the figure. Surface finish must be 16AA or
R better. It is permitted to break sharp edges
R to 0.003 - 0.015 inch.

(c) Sleeve flange electroless nickel plate repair (Index 1) and (Index 2) in Figure 602. See Figure 605.

1 Examine the sleeve repair surface for damage. Do a blend repair to remove damage (raised material and sharp edges). Refer to Section 70-45-00 in the Standard Practices Manual.

2 Machine the flange face(s) to remove damage and distortion, to 1.807 inches (Index 1) and 0.095 inch (Index 5).



1. Plate Repair Area
2. 0.003 Inch Radius Maximum
3. 0.010 Inch Radius Maximum Each Side
4. 3.1497 - 3.1502 Inch Finish Diameter, Concentric With Index 7 Diameter 0.0005 Inch FIR Maximum and Index 5 Diameter 0.005 Inch FIR Maximum
5. 3.045 - 3.052 Inch Diameter, Concentric With Index 4 Diameter 0.005 Inch FIR Maximum
6. 0.020 - 0.040 Inch by 45° ± 2° Chamfer
7. 2.8992 - 2.8997 Inch Diameter
8. 0.020 Inch Radius Maximum (Must Have Smooth Transition To OD And Flange Surfaces)

R
R

No. 2 Bearing Oil Distributing
OD Plate Repair
Figure 604

<u>CAUTION</u>: NO PLATE IS PERMITTED IN THE OIL HOLES, GROOVE, SLOTS, OR ON THE SPLINES. APPLY MASKS AS NECESSARY.

<u>3</u> Apply electroless nickel plate to the surface by SPOP 320. Refer to Section 70-44-01 in the Standard Practices Manual.

<u>NOTE</u>: Sleeve hardness is 35 - 40 HRC.

<u>4</u> Finish machine to the flange dimensions in the figure. Surface finish must be 16AA or better.

3. <u>No. 2 Bearing Seal Assembly</u>

A. Inspection/Repair

(1) Seal ring holder. See Figure 606.

(a) Inspect riveted anti-rotation pins for wear and security. As required, replace pins.

(b) Inspect seal ring groove for wear and scoring. Remove wear indications by machining groove to accept oversize seal ring.

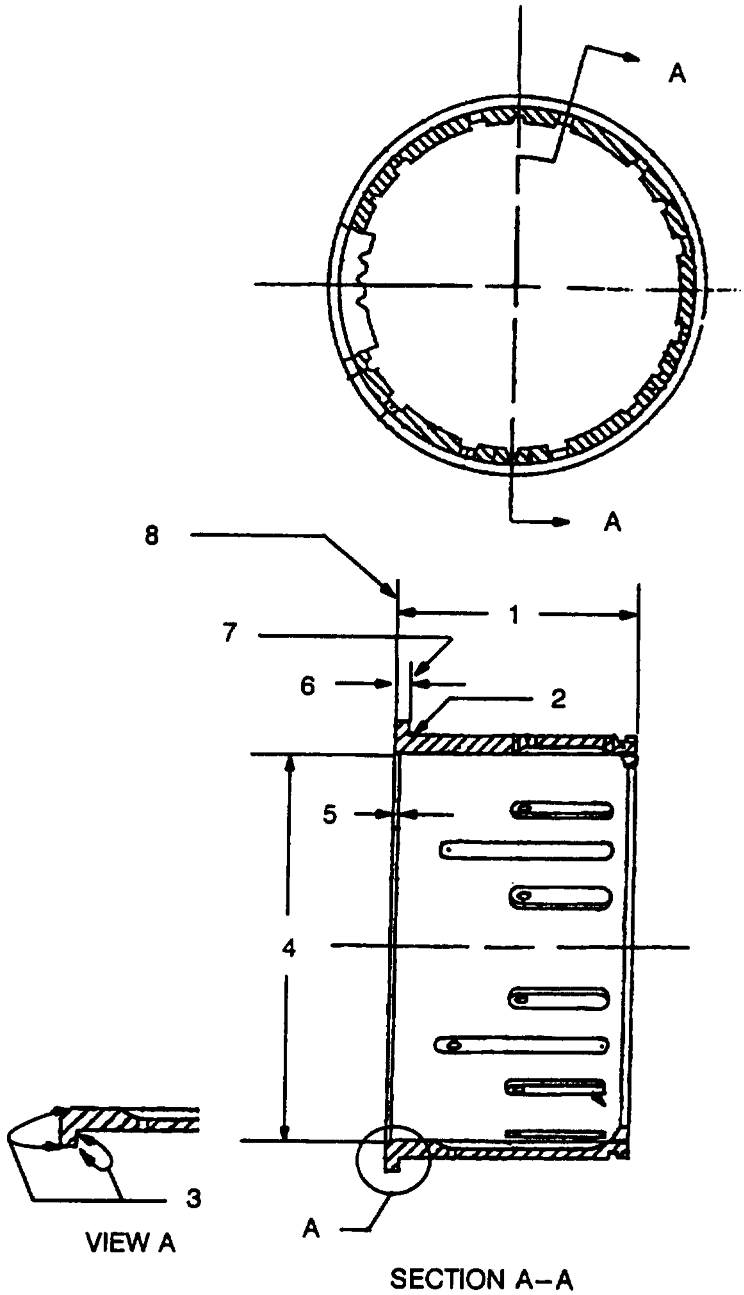
<u>NOTE</u>: Machining of groove requires prior removal of anti-rotation pins.

If extensive wear necessitates machining to width in excess of 0.140 inch but not more than 0.155 inch, chromium plate machined surface by SPOP 22 (AMS 2406) in the Standard Practices Manual, Section 70-44-01 and grind back to 0.140 inch. Parts requiring machining in excess of 0.155 inch in order to clean up shall be scrapped.

(2) Carbon Seal Housing. See Figure 607.

(a) Examine Index 5 diameter for wear. Repair if wear is more than 3.751 inches.

(b) Strip previously plated ID. Refer to SPOP 22 in the Standard Practices Manual, Section 70-44-01, or grind non-plated ID to 3.759 - 3.765 inches.



L-H4659 (0000)

No. 2 Bearing Oil Distributing
Sleeve Flange Plate Repair
Figure 605

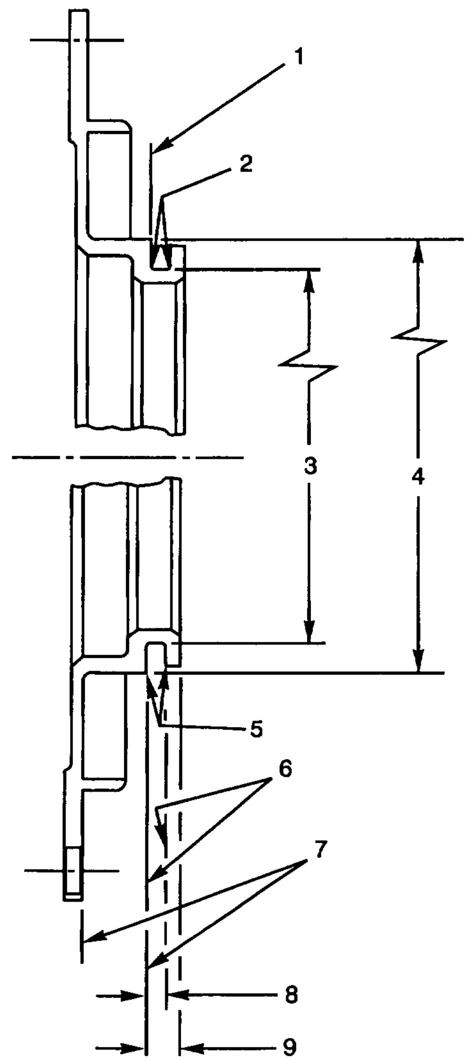
1. 1. 811 - 1.815 Inch Finish Dimension
2. 0.020 Inch Radius Maximum (Must Have Smooth Transition To OD And Flange Surfaces)
3. Plate Repair Area
4. 2.8992 - 2.8997 Inch Diameter
5. 0.020 - 0.040 Inch by 45° ± 2° Chamfer
6. 0.099 - 0.101 Inch Finish Dimension
7. This Face Must Be Square With Index 4 Diameter 0.001 Inch FIR Maximum
8. This Face Must Be Parallel With Index 7 Face 0.0005 Inch FIR Maximum

Key to Figure 605

(c) Chromium plate, where shown, by SPOP 22. Refer to the Standard Practices Manual, Section 70-44-01.

NOTE: Part hardness is Rockwell C30 - C38, or equivalent.

(d) Grind plated surface to dimensions shown.

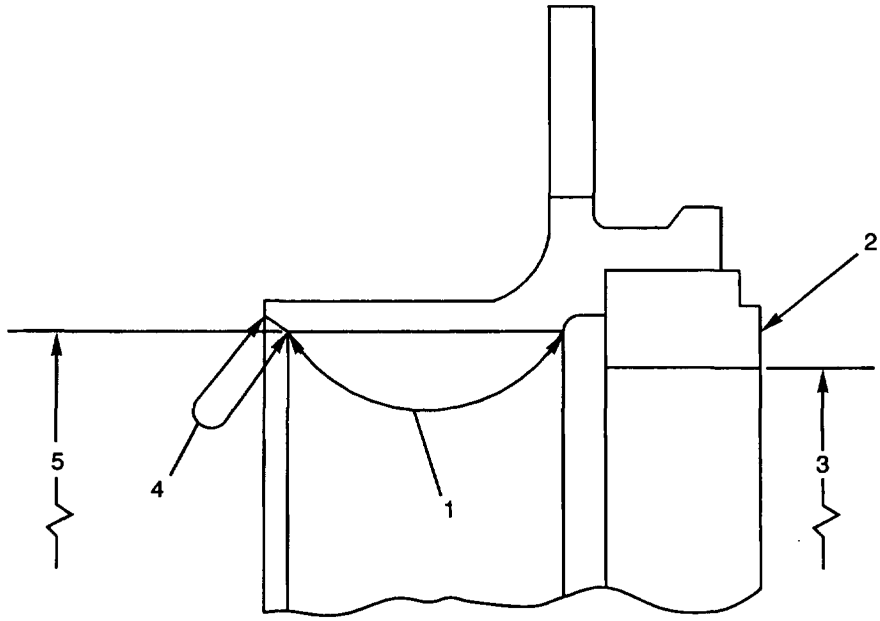


L-22919 (1107)
PW V

No. 2 Bearing Seal
Assembly - Ring Holder
Figure 606

1. Machine Surface
2. 0.020 Inch Radius
3. 3.450 - 3.460 Inch Diameter
4. Reference Diameter
5. 0.005 Inch Radius
6. 10 Micro Finish M
7. These Surfaces Must Be Square With Diameter (4) within 0.004 Inch FIR
8. 0.127 - 0.130 Inch for PN 370362 Seal
   0.132 - 0.135 Inch for PN 370362P5 Seal
   0.137 - 0.140 Inch for PN 370362P10 Seal
9. 0.170 - 0.180 Inch for PN 370362 Seal
   0.175 - 0.185 Inch for PN 370362P5 Seal
   0.180 - 0.190 Inch for PN 370362P10 Seal

Key to Figure 606



1. Chromium Plate Area
2. Reference Surface
3. Reference Diameter
4. Optional Plate Area
5. 3.749 - 3.751 Inch Diameter Square with Surface (2) Within 0.001 Inch FIR and Concentric with Diameter (3) Within 0.004 Inch FIR. Surface Finish Shall be 10 Microinch

No. 2 Bearing Seal Assembly
Plate Repair
Figure 607

ENGINE COMPRESSOR - INSPECTION, REPAIR, AND REPLACEMENT-08

1. Engine Compressor Section (Diffuser)

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Ninth Stage Compressor Exit Vanes

A. Inspection

(1) Damage to leading and trailing edges of vanes is acceptable provided blend-out does not exceed 0.125 inch. One leading edge and one trailing edge repair may be accomplished on same vane provided repairs are not opposite each other.

NOTE: Dimension between repairs must not be less than chord dimension. For JFTD12A, maintenance limit for exit vane erosion is 0.060 inch loss of material (5/16 inch remaining) at rear vane trailing edge at outer vane ends.

(2) Nicks, scoring, or scratches on the concave and convex surfaces of the vanes are acceptable provided the blend-out does not exceed 0.010 inch in depth.

(3) The surface finish of repaired vanes must be comparable to that of a new vane.

A. Repair

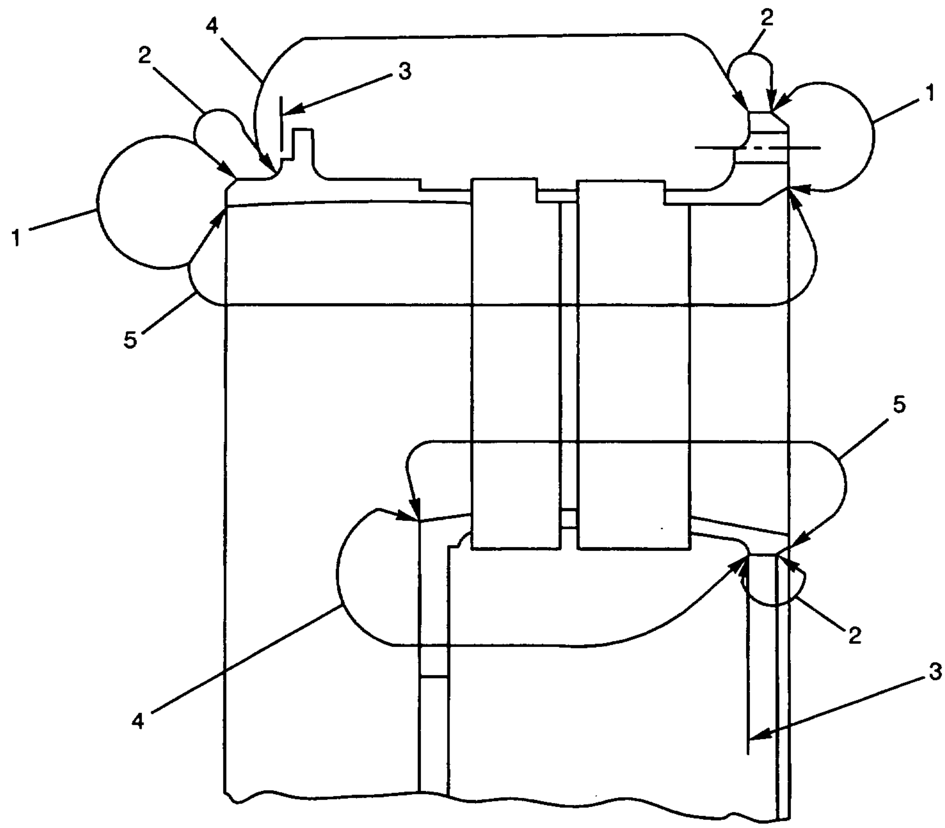
(1) Nickel-Cadmium Plating. See Figure 601 and Figure 602.

(a) Nickel-cadmium plate assembly, when necessary, using fixture. Refer to SPOP 25 and SPOP 40 in the Standard Practices Manual, Section 70-44-01.

NOTE: Plating area is 3.2 square feet. No plate is permitted in twenty anti-rotation pinholes on rear flange. Electrical contact permitted only in area shown.

(b) Paint shroud with high-baking, heat resistant, aluminum enamel. Paint shall be 0.0015 - 0.0025 inch thick.

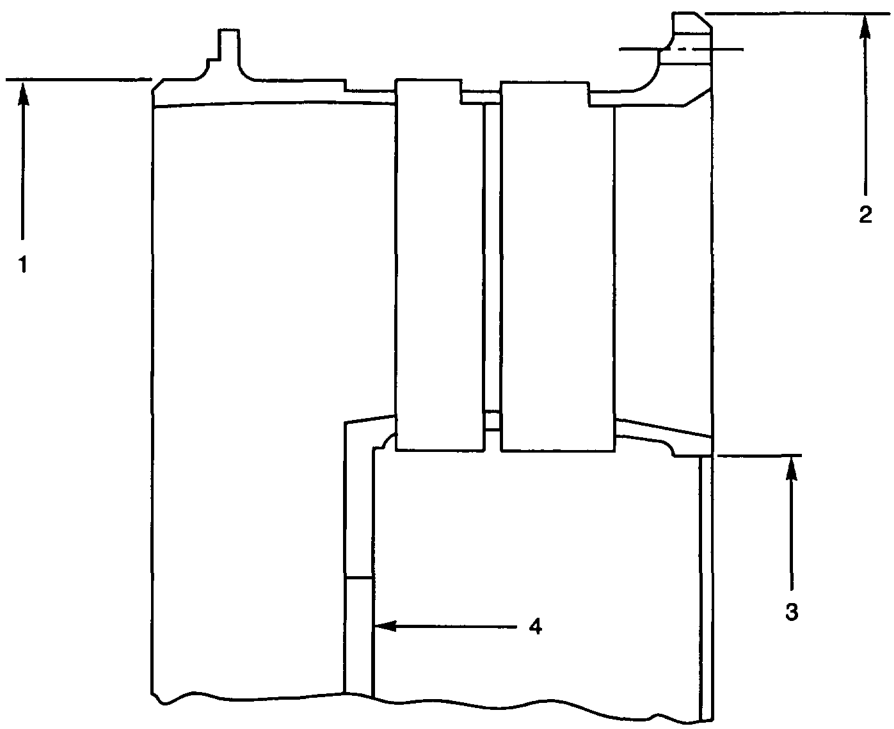
(c) Bake assembly by SPOP 25. Refer to Standard Practices Manual, Section 70-44-01.



L-22920 (0000)
PW V

1. Electrical Contact Area. No Burning, Pitting, Or Selective Attack Is Permitted. Completely Cover Electrical Contact Points With High-baking, Heat-resistant, Aluminum Enamel After Plating, But Before Baking.
2. Paint Enclosed Area
3. Overspray Permitted On This Surface
4. Abrasion And Scratches On Plating, Due To Fixturing, Permissible In This Area. Abrasion And Scratches Penetrating To Bare Metal Shall Be Painted. Dry Paint And Bake At 246° - 274°C (475° - 525°F) For 1 1/2 hours.
5. No Paint Area

Ninth Stage Compressor Exit
Vanes-Plating And Painting Of
Figure 601



L-65324 (0000)
PW V

NOTE: Dimensions apply when Diameter (2) and Surface (4), in free state or constrained, are round within 0.005 inch and flat within 0.001 inch total respectively.

NOTE: Dimensions specified are before plating and painting.

1. 16.339 - 16.348 Inch Diameter Concentric With Diameter (2) Within 0.002 Inch FIR.
R 2. 16.759 - 17.763 Inch Diameter
3. 13.924 - 13.928 Inch Diameter Concentric With Diameter (1) Within 0.002 Inch FIR.
4. Reference Surface

Ninth Stage Compressor Exit Vanes-Inspection Of
Figure 602

(2) Repair of Inner Shroud Rivet Holes

(a) Strip protective coating from stator assembly.

(b) Clean up and plug weld enlarged rivet hole(s) with AMS 5776 filler rod.

(c) Stress-relieve by SPOP 455-2. Refer to Standard Practices Manual, Section 70-42-04.

(d) Dress welds.

(e) Restore protective coating.

(f) When installing stator assembly in diffuser case, transfer-drill rivet holes into stator flange using mating air sealing ring as a guide. See Diffuser Case Repair.

(3) Repair of Outer Shroud Anti-Rotation Pin Holes. See Figure 603.

(a) Strip protective coating from stator assembly.

(b) Clean-up and plug-weld holes with AMS 5680 rod.

(c) Stress-relieve by SPOP 455-2. Refer to Standard Practices Manual, Section 70-42-04.

(d) Dress welds.

(e) Drill holes as specified.

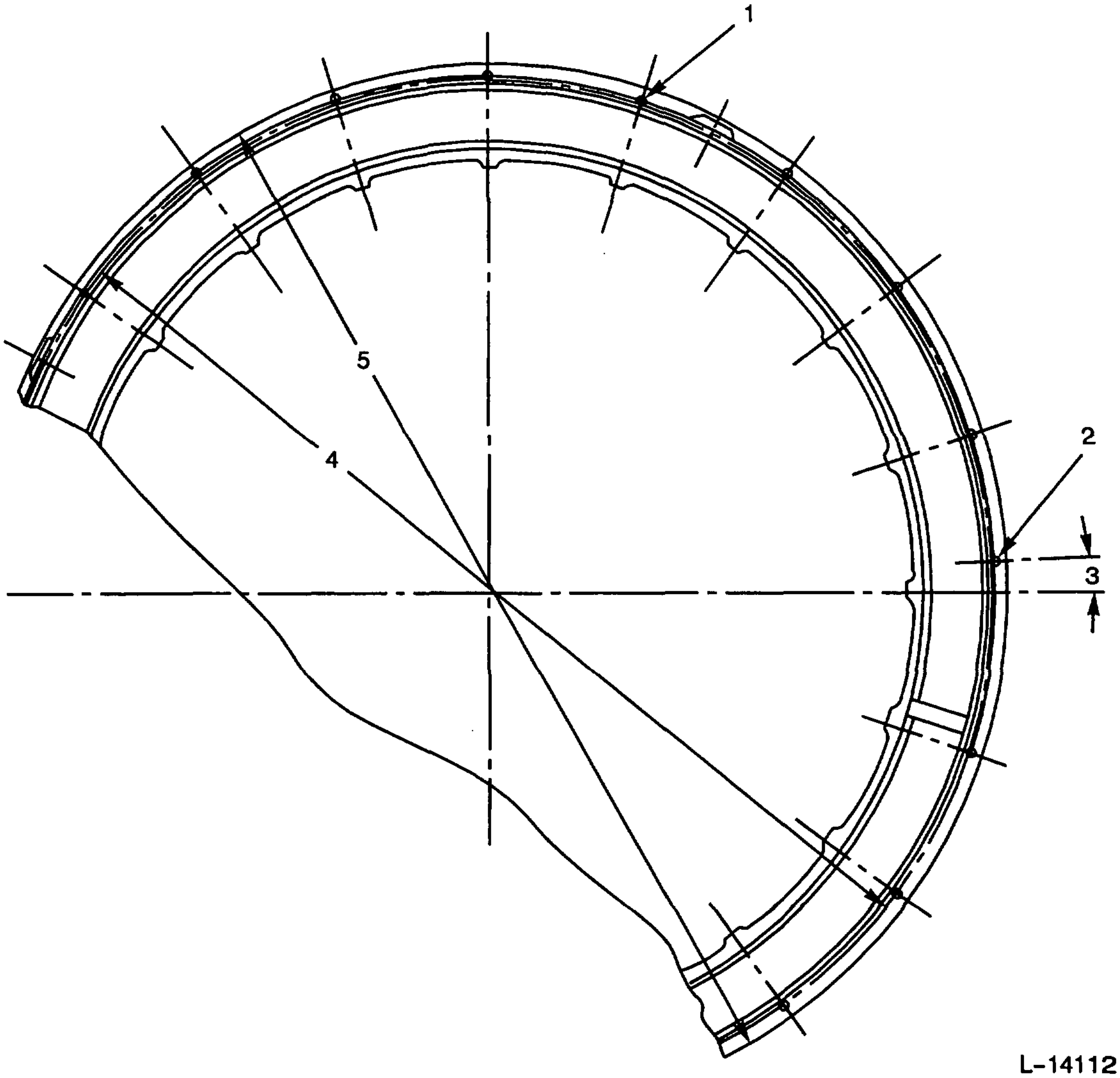
(f) Restore protective coating.

(4) Vane Replacement of 9th Stage Compressor Exit Stator Assembly (Up to 100 Percent)

NOTE: This procedure provides a repair for nickel brazed vane stator assemblies and can also be used to restore gold-nickel brazed vane stator assemblies.

(a) Make a note of the vane shroud squareness and concentricity.

R
R



1. 0.134 - 0.138 Inch Diameter Through, 20 Holes, 19 Holes On The Basis Of 20 Holes Equally Spaced with One Hole Offset As Shown, Located within 0.002 Inch Radius Of True Position In Relation To Diameter (5).
2. Offset Hole
3. 3 Degrees
4. 16.560 Inch Diameter
5. Reference Diameter

Ninth Stage Stator Outer Shroud - Pin Hole Repair
Figure 603

(b) Remove the rivets that secure the airsealing ring to the inner shroud and remove the airsealing ring. Mark the position of the inner ring to the shroud before removal.

CAUTION: KEEP ALL DIMENSIONAL CONTROLS AFTER THE VANES HAVE BEEN REPLACED. KEEP THE ASSEMBLIES IN THE FIXTURE WHEN REMOVING THE VANES TO KEEP DIMENSIONAL CONTROL.

(c) Remove the nickel or nickel-cadmium with SPOP 40. Refer to Standard Practices Manual, Section 70-44-01.

NOTE: Install the vane and shroud assembly in the applicable brazing and stress-relief fixture to keep dimensional control. Install the square ended vanes only in the shrouds with straight outer surface for vane replacement; install the vanes with angled outer ends only in shroud with ramped outer surface.

(d) Remove the vanes by chemical or by electrical discharge machining.

NOTE: Identify the 9th stage exit compressor stator assemblies that incorporate (AMS 2675) nickel braze as follows:

PN 542069 Change F
PN 568679 Change F
PN 568869 Change K

(e) Remove the vanes by chemical strip procedure.

1 Manually grind the vane tabs flush to +0.005 inch at the OD of the outer shroud to remove any possible vane staking. Do not remove any shroud material.

(f) Remove the nickel braze with SPOP 316. Refer to Standard Practices Manual, Section 70-44-01.

(g) Remove the silver braze with SPOP 305. Refer to Standard Practices Manual, Section 70-44-01.

(h) Remove the gold nickel braze with SPOP 313. Refer to Standard Practices Manual, Section 70-44-01.

(i) Remove the vanes towards the ID with pliers and/or drift. Do not damage or open up the vane slots.

CAUTION: EXCEPT FOR WORK OR SUPPLIES TO BE PERFORMED OR FURNISHED BY PRATT & WHITNEY, PRATT & WHITNEY DOES NOT ENDORSE THE WORK PERFORMED BY THE COMPANY OR COMPANIES IDENTIFIED HEREIN OR ANY OTHER COMPANY AND DOES NOT ACCEPT RESPONSIBILITY TO ANY DEGREE FOR THE SELECTION OF SUCH COMPANY OR COMPANIES FOR THE PERFORMANCE OF ANY WORK OR PROCUREMENT OF SUPPLIES.

(j) Electrical discharge machining procedure.

NOTE: Send repairable parts to an approved source licensed to remove vanes by PWA 996. The list that follows identifies sources approved and licensed for this repair by source code number. Refer to the source code list in Section 70-40-00, General-01 (Task 70-40-00-990-001) in the Standard Practices Manual, PN 585005 for the company name, address, and contact information identified by each source code.

8N802 9A587

1 Cut the vanes in two places to remove most of the damaged vane airfoil center section. Cut the vane approximately 1/8 inch from the inner and the outer shrouds. Use a saw, heliarc torch or any other applicable equipment.

NOTE: Make two "U"-shaped sheet metal copper strips to place over the edges of the adjacent undamaged vanes to prevent burning.

2 Use electrical discharge machine (EDM) to remove the vane stubs from the inner and the outer shrouds. Do not damage or open up the vane slots with the EDM procedure.

(k) Clean the inner shroud vane with a silicon grit polishing bob to remove the braze on both shrouds. Do not open up the vane slots.

R
R

(l) Make an inspection of the shrouds for crack and repair as necessary.

(m) Clean around the inner and the outer shroud vane slots with SPOP 9. Refer to Standard Practices Manual, Section 70-21-00.

(n) Clean the replacement vanes with SPOP 209. Refer to the Standard Practices Manual, Section 70-21-00.

NOTE: Use white gloves for all handling procedures after cleaning and before you braze.

(o) Assemble the replacement vanes into shroud as follows:

1 Place the vane outer bob end through the inner shroud vane slot toward the outer shroud. Align the vane outer tab with the outer shroud slot. Carefully tap the vane inner end out until the vane airfoil section is against the shroud. The gap must be 0.000 - 0.006 inch.

2 It is permitted to stack the vanes at the outer end approximately at the middle position. Make sure the vane is seated against the outer shroud with a gap within 0.000 - 0.006 inch.

(p) Partial vane replacement (up to 50 percent) (gold-nickel brazed stator vane assemblies).

R 1 Follow procedure in step (4).

(q) Vane replacement of nickel brazed stator vane assemblies (up to 100 percent).

1 Apply PWA 996 Braze Paste around the vanes at the OD of the inner shroud and the ID of the outer shroud. Put the paste into the joint with a nozzle type applicator. Do not use too much paste.

2 Put the assembly in the applicable braze fixture. Braze by AMS 2675 in a vacuum furnace. Refer to Section 70-42-03, Repair-09 in the Standard Practices Manual. Use PWA 996. Braze and harden with PWA 11-22 as follows:

CAUTION: DO NOT PUT PARTS WHICH ARE OF HARDENABLE MATERIAL ONLY THROUGH THE HIGH-TEMPERATURE PART OF A FURNACE BRAZE CYCLE. THESE PARTS MUST GET THE REMAINING PART OF A COMPLETE HEAT TREATMENT CYCLE AFTER THE BRAZE CYCLE, BECAUSE THESE PARTS MUST CHANGE INTO THE DESIRED CONDITION.

3 The chamber must be at a vacuum level below 5x10 to the minus 4 TORR.

4 Increase the temperature to 1200° ± 25°F and stabilize the work thermocouples until a vacuum of 5x10 to the minus 4 TORR is established again.

5 Increase the temperature 1650° ± 25°F and stabilize the work thermocouples until a vacuum of 5x10 to the minus 4 TORR is established again.

CAUTION: DO NOT GO ABOVE THE TEMPERATURE LIMIT.

6 Increase the temperature to 2075° ± 15°F as rapidly as possible.

NOTE: Use a manual cycle at 100 percent output to rapidly increase temperature. Use an automatic cycle if necessary.

7 Hold the temperature to 2075° ± 15°F for 20 -
R 30 minutes. Turn off the power.

8 Let the temperature decrease to 1800°F and hold for 15 - 30 minutes.

9 Let the argon flow to cool to less than 300°F.

10 Close the argon system and remove argon to 5x10 to the minus 4 TORR.

11 Increase the temperature to 1500° ± 25°F and stabilize the work thermocouples until a vacuum 5x10 to the minus 4 TORR is established again.

12 Increase the temperature to 1800° ± 25°F and hold for 15 - 30 minutes. Turn the power off and air cool to less than 300°F.

13 Increase the temperature to 1060° ± 15°F for 1.5 hours to obtain hardness of Rockwell 25 - 33.

14 Turn off the power and decrease the temperature to less than 300°F. Open the furnace and remove parts.

15 Do a check for hardness. Impressions on the gas path are not permitted.

(r) Make an inspection of the braze joints. Make the fillets smooth. The fillet radius must be 0.040 inch maximum on each surface. Remove the excess material from the braze area.

NOTE: If the braze quality is not satisfactory, it is permitted to:

NOTE: Do the furnace procedure again.

NOTE: Make an inspection and heat treat after part is brazed.

(s) Make a dimensional inspection of the compressor stator assembly.

(t) Fluorescent penetrant inspect with SPOP 62. Refer to Section 70-33-00, Standard Practices Manual. It is permitted to have these defects in 20 percent of the brazed joint (visible portion):

1 Isolated shrinkage

2 Voids

3 Porosity.

(u) Repair all vanes above these limits. Use AMS 2675 but use braze alloy PWA 996.

(v) Stress-relieve the stator assembly by SPOP 455-2 with an applicable fixture. Refer to Standard Practices Manual, Section 70-42-04.

(w) Make a dimensional inspection of the compressor stator assembly. The concentricity must be 0.010 inch or less for the compressor stator after the vanes are replaced.

R
R

R (x) Install the air sealing ring. Refer to
R step 3.B(3).

(y) Examine and correct the vane angles on these vanes:

1 All the replaced vanes.

2 Two original vanes adjacent to the replaced vanes.

3 Ten percent of the remaining original vanes equally spaced around the assembly.

NOTE: If any vane angle is not in limits, examine all vane angles at all vane locations in the stator.

NOTE: After a vane is bent to correct the angle, make an inspection for cracked braze. Repair the braze if necessary.

(z) Coat the compressor stator assembly. See step (5).

(5) PWA 110-31 Coating (for stators post-SB 6211).

(a) Remove all the coating and plating from all surfaces.

(b) Coat all over with PWA 110-31 coating. Refer to Section 70-41-04, Standard Practices Manual.

3. Diffuser Case

A. Inspection

(1) Inspect case for cracks. Refer to Limits for Repairable Cracks below.

(2) Inspect rear outer flange mating diameter for wear. Mating diameter worn to less than 20.442 inches but not less than 20.422 inches must be repaired.

(3) Inspect rear inner flange for pits. See Figure 604. Maximum serviceable pit depth is 0.003 inch. To prevent further pit growth, coat diffuser case as specified below.

(a) Remove protective coatings before case inspection or repair.

(b) Clean the diffuser case to make sure that all rust and oxides are removed. Refer to Section 72-00-00, Cleaning.

(c) White light visual inspection:

1 Visually examine all of the case for pits that became through holes.

2 Record areas with through holes with a mark for repair.

(d) Fluorescent penetrant inspection:

1 Apply penetrant oil to the outer surface of the diffuser case and look at the inner surface for leakage at holes that are through the case wall but are not possible to see.

2 Record areas with through holes with a mark for repair.

(4) For diffuser case areas with cracks or pitting damage more than limits, refer to the patch repair below.

B. Repair

(1) Diffuser Case Pitting Repair

(a) If necessary remove protective coatings before repair.

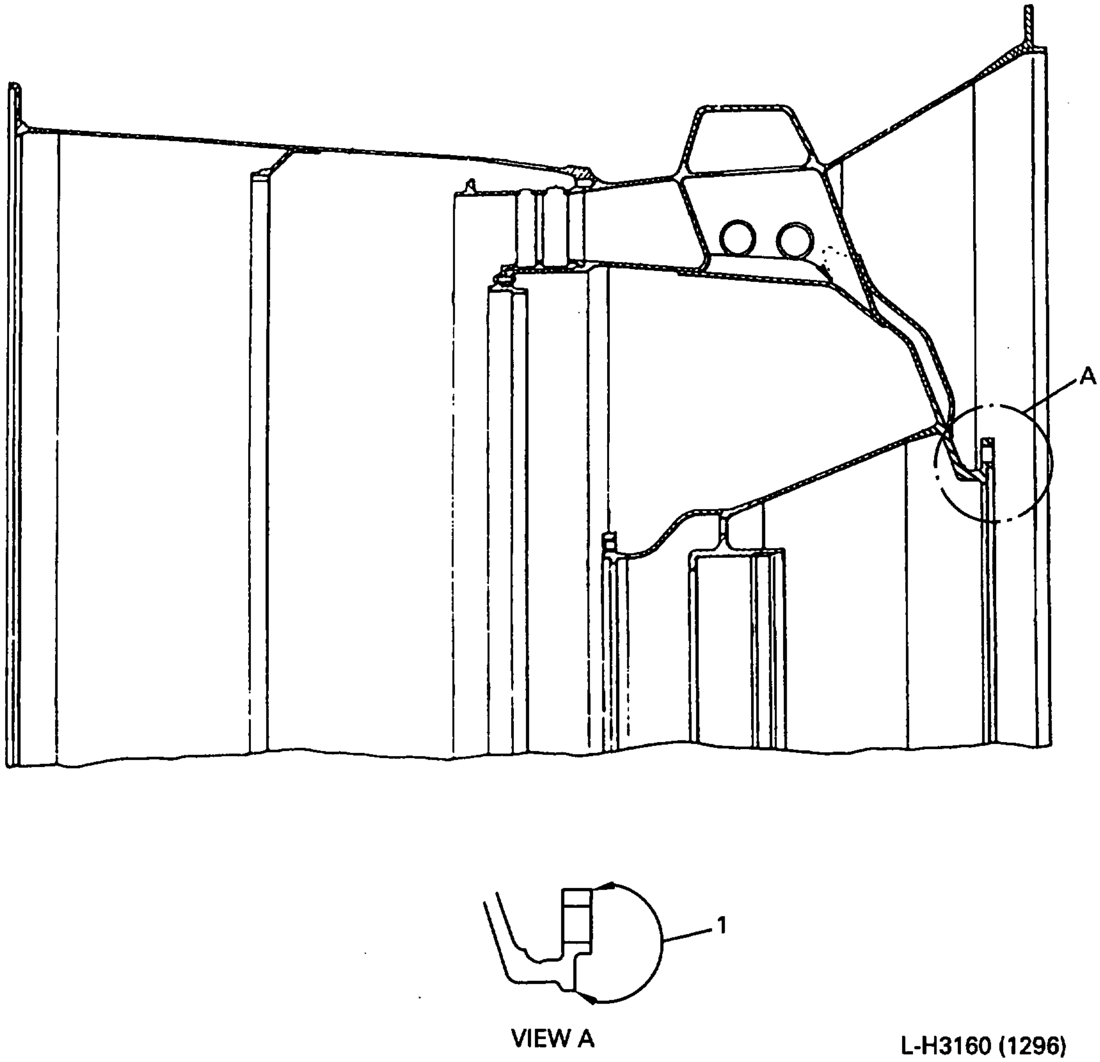
(b) Remove pitting by blend repair and make repaired areas smooth and continuous with adjacent areas.

(c) Minimum case thickness in case blend repair areas is 0.023 inch (this thickness is for base metal only and does not include paint, oxides, or other unwanted material).

(d) If an area is less than 0.023 inch thickness after blend repair, refer to the patch repair below.

(e) Apply protective coatings to areas where necessary after repair.

R
R



1. 0.003 Inch Maximum Pit Depth Limit In This Area.

R
R

Diffuser Case Rear Inner Flange
Figure 604

(2) Diffuser Case Patch Repair. See Figure 605.

(a) If necessary remove protective coatings before repair.

CAUTION: DURING REMOVAL OF CASE SEGMENTS FOR REPLACEMENT, BE CAREFUL TO PREVENT DAMAGE TO THE FRONT AND REAR FLANGES AND ANTI-TORQUE RING. CASE SURFACES ADJACENT TO REPAIR WELDS MUST HAVE NO BLEND MARKS FOR A 0.250 INCH WIDE MINIMUM BAND TO PREVENT STRESS CONCENTRATIONS IN THE HEAT-AFFECTED ZONE OF THE WELD.

(b) If there is damage that extends to the rear from the cutoff plane in the figure, do the repair shown in View K.

(c) If there is damage that extends forward from the the cutoff plane in the figure, do the repair in View L.

(d) Cut out damaged areas to prepare for a patch repair.

(e) Make patches from scrap cases for which there is no economical repair, or use AMS 5504 material 0.027 - 0.035 inch thickness heat treated to hardness of Rockwell C30 - 38.

(f) Weld patches with AMS 5776 filler metal and inert gas tungsten arc method.

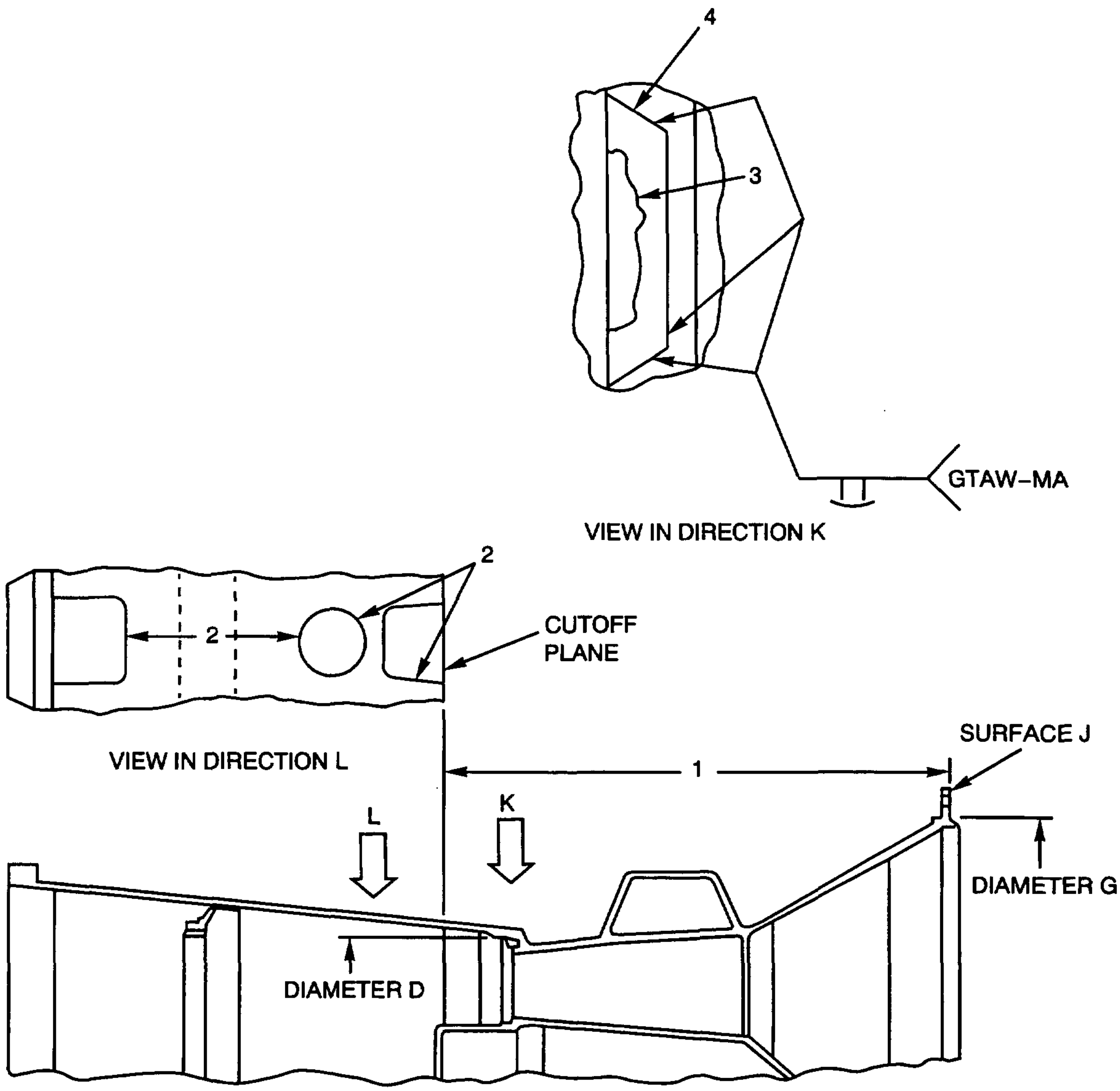
NOTE: To decrease warpage during welding and stress-relief, use heat-dissipating copper plates.

(g) Stress-relieve all of the case 24 hours or less after welding by SPOP 455-2. Refer to Section 70-42-04 in the Standard Practices Manual.

(h) Do a crack inspection by fluorescent penetrant inspection. No cracks are permitted.

(i) Apply protective coatings to areas where necessary after repair.

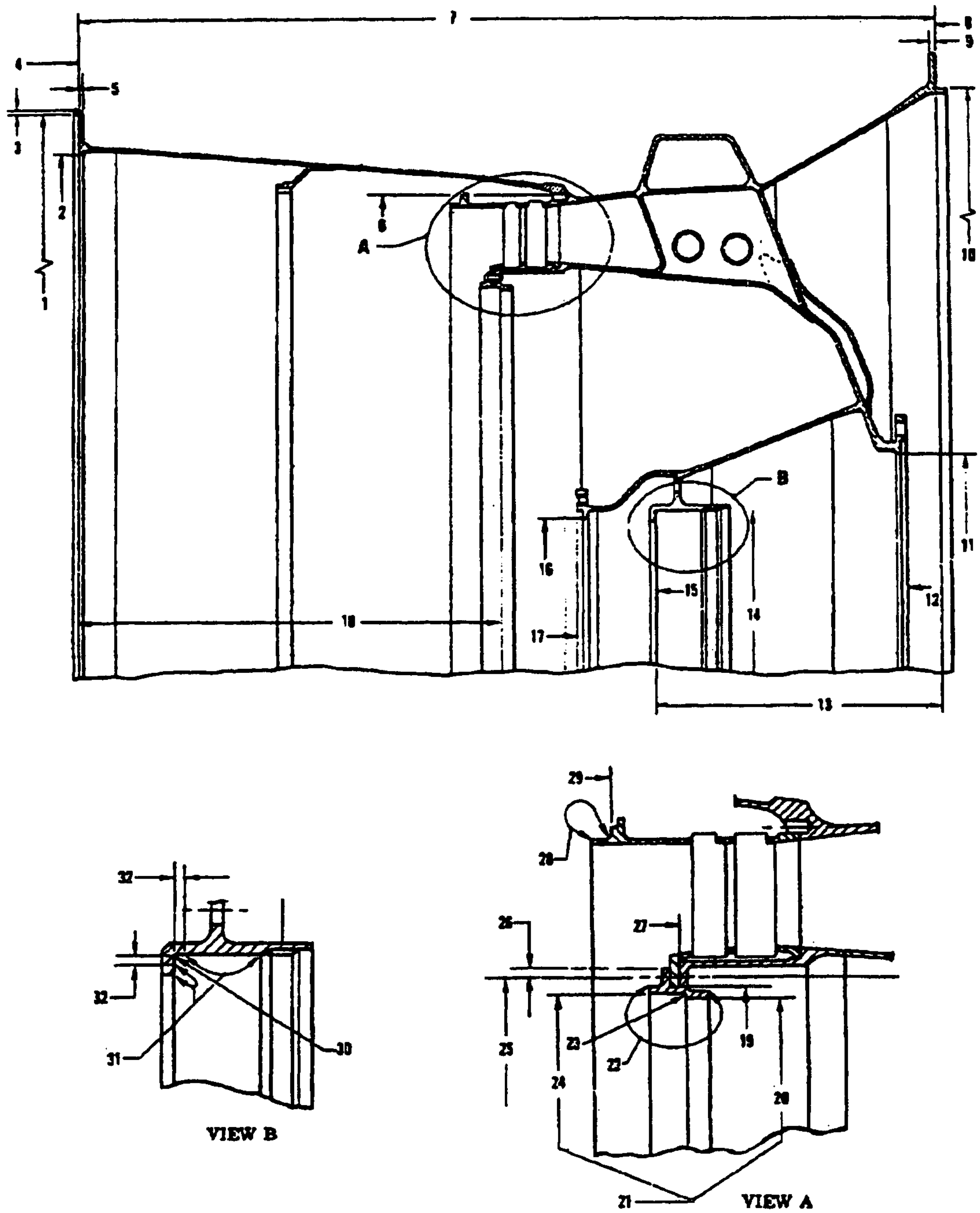
(3) Replacement of 9th Stage Compressor Airsealing Ring. See Figure 606.



L-H8107 (0407)
PW V

1. 7.840 - 7.860 Inches To Cutoff Plane
2. Typical Patches
3. Damage or Hole Aft Of Cutoff Plane
4. Patch From Removed Portion Of Case

Diffuser Case Patch Repair
Figure 605



L-25898 (0000)

Diffuser Case Repair Dimensions
Figure 606

1. Reference Diameter
2. Reference Diameter
3. 0.045 - 0.055 Inch
4. Reference Face
5. 0.035 - 0.045
6. Reference Diameter
7. 15.314 - 15.320 Inches
8. Reference Face
9. 0.055 - 0.065 Inch
10. 20.4420 - 20.4468 Inch Diameter
11. Reference Diameter
12. Reference Face
13. 5.187 - 5.193 Inches
14. 5.1191 - 5.1201 Inch Diameter
15. Reference Surface
16. Reference Diameter
17. Reference Face
18. 7.286 - 7.296 Inches
19. Reference Diameter
20. 12.908 - 12.912 Inch Diameter, (For JT12A-6 Only)
    12.888 - 12.892 Inch Diameter
21. These Diameters Must Be Concentric With Diameter (14) Within 0.002 Inch FIR And Diameter (25) Within 0.010 Inch FIR.
22. Aluminum Enamel Paint Area
R 23. 0.005 - 0.020 Inch Radius
24. 13.008 - 13.012 (For JT12A-6 Only) 12.988 - 12.992 Inch Diameter
25. Reference Diameter
26. 0.100 Inch Minimum
27. Reference Surface
28. Aluminum Enamel Paint Area. Overspray Permissible On Surface (29)
29. Reference Surface
30. 0.005 - 0.020 Inch Radius
31. Chromium Plate Enclosed Area
32. 0.054 Inch Maximum

Key to Figure 606

NOTE: Dimensions given are before plating and painting.

NOTE: Listed diameters shall be concentric within limits specified when part is supported on Surface (8) and Diameter (10).

Index No.	*Inspection Limit (inch FIR)	Repair Limit (inch FIR)
1	0.005	0.002
2	0.006	0.002
6	0.005	0.002
11	0.006	0.002
14	0.002	0.002
16	0.004	0.002
19	0.004	0.002

*Relaxed requirements are for general inspection rather than repair.

Surfaces (4), (12), (15), (17) and (27) shall be parallel with Surface (8) within 0.002 inch FIR (0.005 inch FIR *Inspection Limit).

Key to Figure 606 (Continued)

(a) Remove rivets securing airsealing ring and remove ring.

NOTE: If ring appears serviceable, index ring to flange to ensure installation in original position.

(b) Transfer drill 20 rivet holes into replacement ring. Burr holes.

(c) Rivet ring in place.

(d) Machine ring to dimensions shown.

(e) Paint ring inside diameters and front snap diameter of stator shroud with high-baking, heat-resistant, aluminum enamel. Paint thickness of front mating diameter shall be 0.0015 - 0.0025 inch thick.

NOTE: Do not abrasive blast before applying aluminum enamel.

(4) Limits for Repairable Cracks.

(a) Cracks in welds in outer portion of case shall not exceed 13 inches in length.

(b) Circumferential cracks in non-welded areas of outer portion of case shall not exceed 10 inches in length.

(c) Axial cracks in outer portion of case shall not exceed four inches in length.

(d) Cracks in mounting flange areas shall not exceed 10 inches in length.

(e) Circumferential cracks in No. 2 bearing rear support shall not exceed five inches in length.

(f) Axial cracks in No. 2 bearing support shall not exceed one inch in length.

(g) Circumferential cracks around bosses shall not exceed more than 225 degrees around any boss.

(5) Crack Repair - General

(a) Remove old weld with a rotary file in the repair area.

(b) Clean the weld area by SPOP 208 wipe method (Task 70-21-00-110-040). Refer to 70-21-00 in the Standard Practices Manual.

(c) Use the applicable weld fixture to hold the case tightly during the weld and stress-relief operations.

(d) Use heat-dissipating copper plates. Refer to 70-42-01 in the Standard Practices Manual.

(e) Use the lowest heat range possible to get satisfactory fusion. Keep backup gas flow equivalent to the gas flow of the welding torch.

(f) Keep weld passes to one inch length maximum (longer passes will go backwards and each pass will end where where the pass that was done before started).

(g) Use AMS 5776 filler rod.

R (h) Furnace stress-relieve at 316°C ± 8° (600°F ±15°)
R for 30 minutes, 472°C ± 8° (800°F ±15°) for
R 30 minutes, and 538°C ± 8° (1000°F ±15°) for two
R hours. Furnace cool the case.

R (i) Do a fluorescent penetrant inspection of the case
R for cracks. Refer to 72-00-00, Table 605.

C. Diffuser Case Plating Repairs

(1) Chromium Plating of No. 2 Bearing Housing. See Figure 606.

(a) Grind bearing area and/or shoulder area to clean for plating. Do not remove more material than is permitted to be replaced by plating. After grinding, chromium plate must not be less than 0.003 inch thick nor more than 0.010 inch thick.

(b) Fluorescent magnetic particle inspect part. See Section 70-32-00, Standard Practices Manual.

(c) Chromium plate bearing housing by SPOP 22. See Section 70-44-01, Standard Practices Manual.

<u>NOTE</u>: No bake required prior to plating. Threads adjacent to bearing are not to be plated.

(d) Bake part at 384° - 400°C (725° - 755°F) for two hours.

(e) Finish grind plated area to dimensions shown.

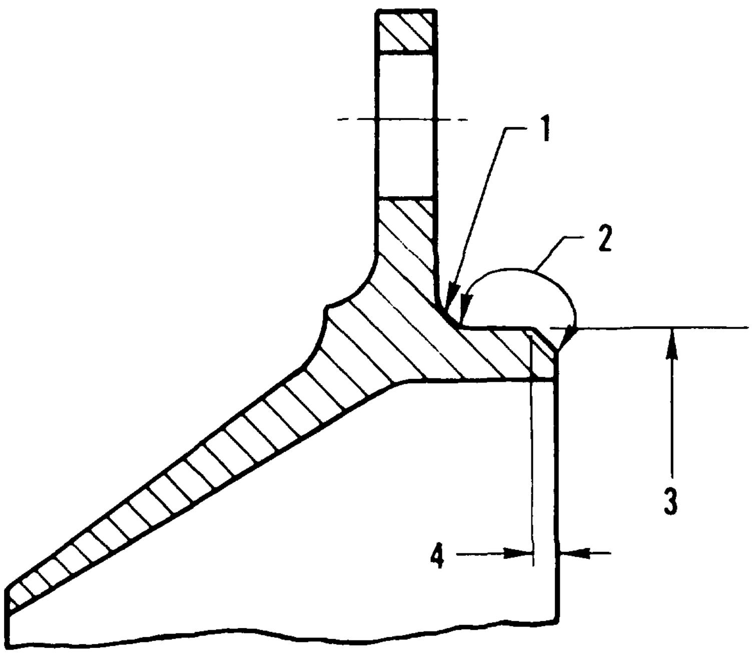
(f) Fluorescent magnetic particle inspect part. See Section 70-32-00, Standard Practices Manual.

(2) Nickel Plate Repair of Diffuser Case Outer Rear Flange Mating Diameter. See Figure 607.

(a) Machine mating diameter to clean-up wear indications.

(b) Bead peen flange. See Diffuser Case Nickel-Cadmium Plating.

(c) Nickel plate mating diameter by SPOP 26 or SPOP 321. See Section 70-44-01, Standard Practices Manual.



L 18921

R
R
Nickel Plating Diffuser Case Outer
Rear Flange Mating Diameter
Figure 607

NOTE: Dimensions given are prior to nickel-cadmium plating.

1. 0.020 Inch Radius
2. Nickel Plate Area
3. 20.422 Inch Minimum Diameter (Remove Only Enough Material To Clean Up)
   20.456 Inch Diameter After Nickel Plate.
   20.4420 - 20.4468 Inch Diameter After Finish Machining, Concentric With Front Flange ID Within 0.002 inch FIR When Assembly Is Fixtured On Front Face.
4. 0.020 - 0.040 Inch By 40° - 50° Chamfer

Key to Figure 607

(d) Bake part at 185° - 196°C (365° - 385°F) for three hours.

(e) Finish machine the diameters to dimensions shown.

(3) Nickel Plate Repair of Diffuser Case Inner Rear Flange Mating Diameter. See Figure 608.

(a) Machine diameter to dimensions shown.

(b) Nickel-plate by SPOP 26 or SPOP 321. Refer to Section 70-44-01, Standard Practices Manual.

(c) Bake part at 185° - 196°C (365° - 385°F) for three hours. Plating outside of enclosed area shown is permissible provided such excess plating is removed.

(d) Finish machine diameter maintaining concentricity requirements specified.

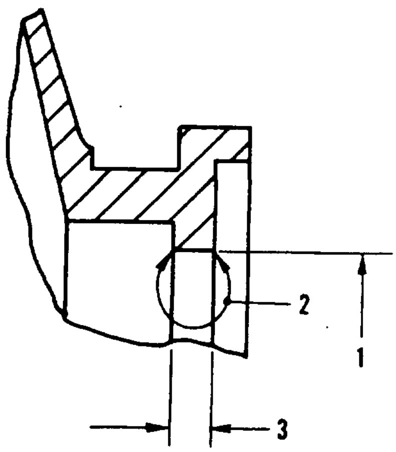
(4) Nickel-Cadmium Plating of Diffuser Case. See Figure 609.

(a) Strip nickel-cadmium plate from rear flange by SPOP 25. Refer to Standard Practices Manual, Section 70-44-01.

(b) Dimensionally inspect part for any removed nickel plate repairs. Restore removed nickel plate repairs.

(c) Unless accomplished as part of mating diameter restoration, bead peen flange as specified in referenced figure.

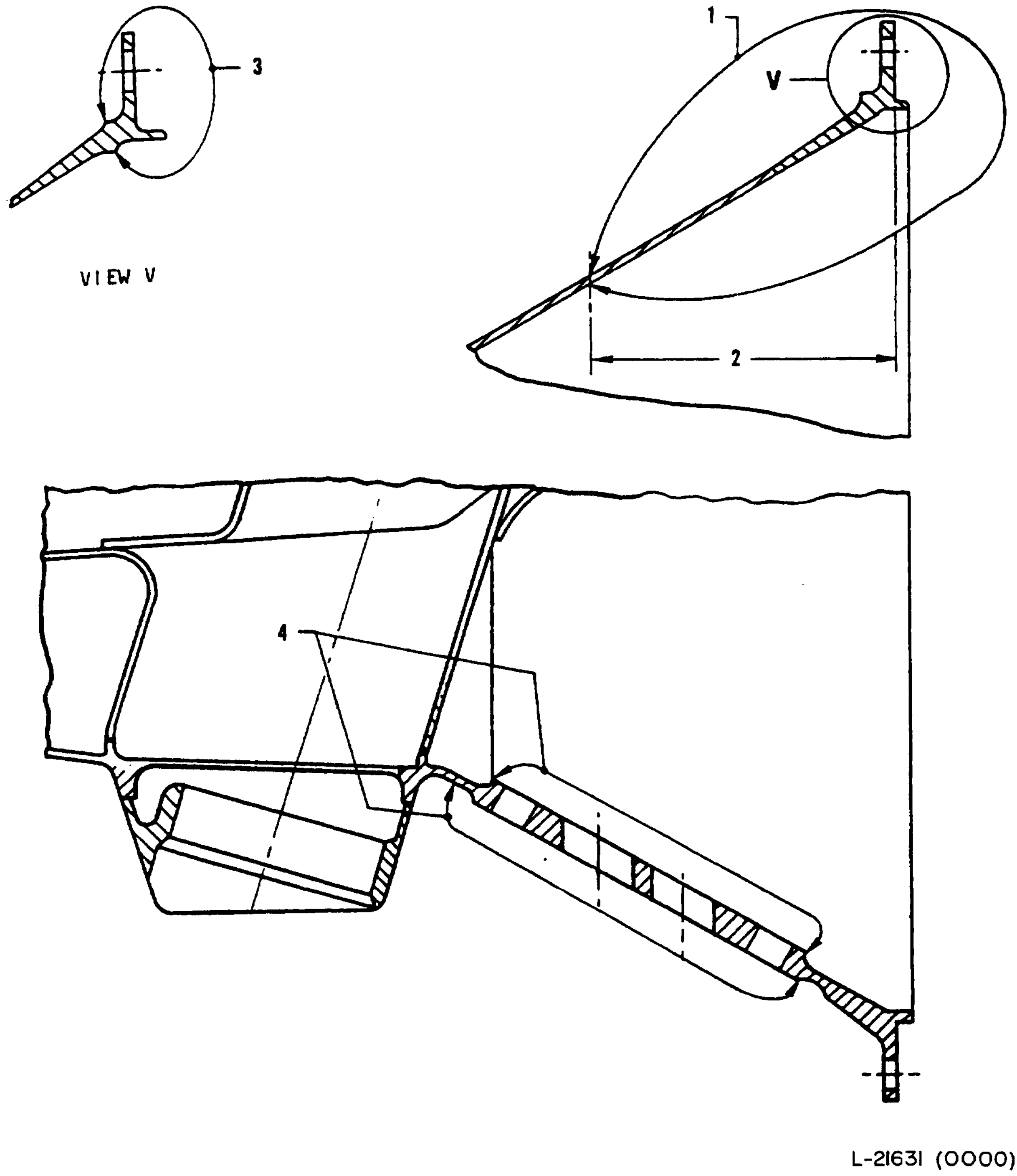
R
R



L-29614

1. Machine To 7.082 - 7.097 Inch Diameter, Holding To Minimum Value. Plate To 7.065 Inch Diameter Maximum. Finish Machine Diameter To 7.075 - 7.077 Inches.
2. Nickel Plate Area
3. 0.060 - 0.080 Inch

Nickel Plating Diffuser Case
Inner Rear Flange Mating Diameter
Figure 608



Nickel-Cadmium Plating
Of Diffuser Case
Figure 609 (Sheet 1)

1. Nickel-cadmium Plate And High-baking, Heat-resistant, Aluminum Enamel Area. Paint Is Optional And May Be Incomplete On Remainder Of Case
2. 2.000 Inches
3. Bead Peen Area By SPOP 500 With Intensity Of 10N-2. Overspray Permitted. Peening Of Holes In Flange Optional
4. No Nickel-Cadmium Plate Or Aluminum Paint Allowed In This Area

Key to Figure 609 (Sheet 1)

(d) Nickel-cadmium plate flange area by SPOP 25. Refer to the Standard Practices Manual, Section 70-44-01. Total surface area is 360 square inches.

NOTE: Incomplete nickel plate is permissible in flange holes. Cadmium plate is not permitted in any area where nickel plate is incomplete.

(e) Treat area, as shown, with two coats of high baking, heat-resistant, aluminum enamel after plating and baking. Refer to SPOP 142 in the Standard Practices Manual, Section 70-41-03.

(5) Nickel or Chromium Plating of Diffuser Case Towershaft Bearing Housing. See Figure 610.

(a) Machine bearing bore 1 shoulder within limits shown to clean-up wear indications.

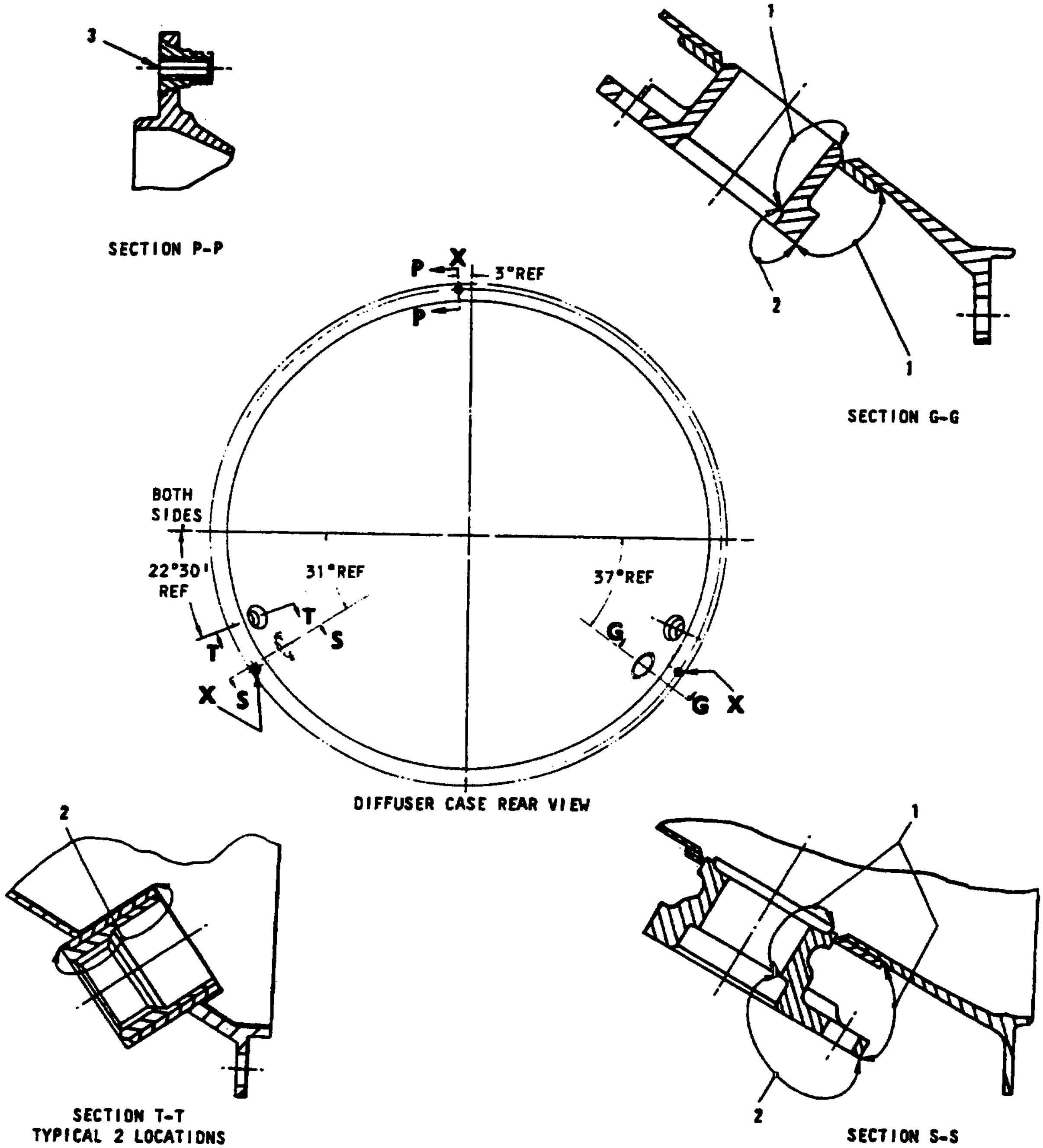
(b) Fluorescent-penetrant-inspect machined area by SPOP 70 Ultra high sensitivity. Refer to Section 70-33-00, Standard Practices Manual.

(c) Chromium plate by SPOP 22, or nickel-plate by SPOP 26. Refer to Standard Practices Manual, Section 70-44-01.

(d) Bake chromium plate at 391° - 407°C (735° - 765°F) for two hours. Bake nickel-plate at 185° - 196°C (365° - 385°F) for three hours.

(e) Finish-machine plated areas. Remove excess plate outside enclosed area.

(f) Fluorescent-penetrant-inspect entire diffuser case by SPOP 62. Refer to Section 70-33-00, Standard Practices Manual.



L-21900 (0000)

R
R

Nickel-Cadmium Plating
Of Diffuser Case
Figure 609 (Sheet 2)

1. No Nickel-Cadmium Plate; Aluminum Paint Optional In This Area
2. No Nickel-Cadmium Plate Or Aluminum Paint Allowed In This Area
3. No Nickel-Cadmium Plate Or Aluminum Paint Permitted On Threads Of Diffuser Case Rear Flange Holes Located At Three Locations Marked X

Key to Figure 609 (Sheet 2)

(6) Nickel Plate Repair of Diffuser Case Gearbox Mount Lugs. See Figure 611.

(a) Machine lug faces to clean-up wear indications in minimum wall thickness requirements specified.

(b) Nickel-plate enclosed area in accordance with SPOP 26 or SPOP 321 as shown in referenced figure. See Section 70-44-01, Standards Practices Manual.

(c) Bake at 185° - 196°C (365° - 385°F) for three hours.

(d) Finish machine as shown in figure.

(7) PWA 110-31 Coating of Diffuser Case (Alternate Coating Procedure).

NOTE: Coating is required for diffuser cases post-SB 6211.

(a) Remove all coatings and plating from all surfaces of the case.

NOTE: Do not let the strip solutions stay between the riveted flanges.

(b) Apply coating to the diffuser case assembly as shown in Figure 612.

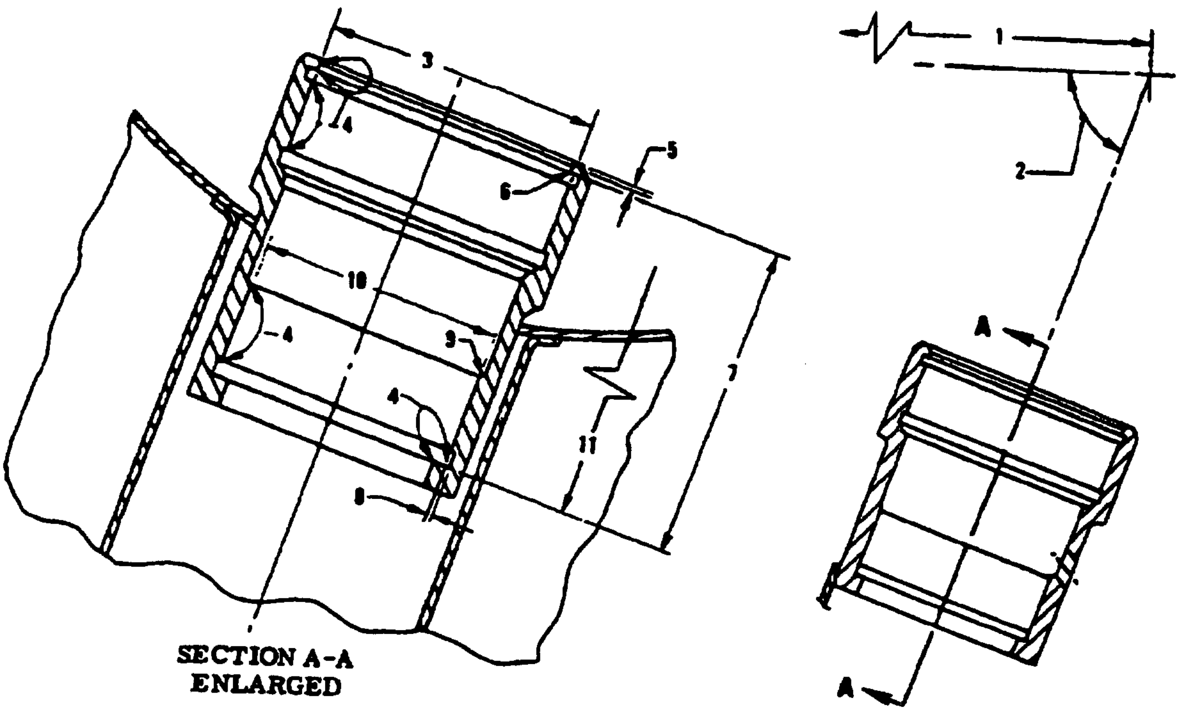
D. Replacement of Diffuser Case Front Flange See Tool Group 41A and Figure 613.

(1) Flange Removal

(a) Strip plate and paint. See Nickel-Cadmium Plating of Diffuser Case.

(b) Install diffuser case, front flange up, in machining fixture installed on vertical turret lathe.

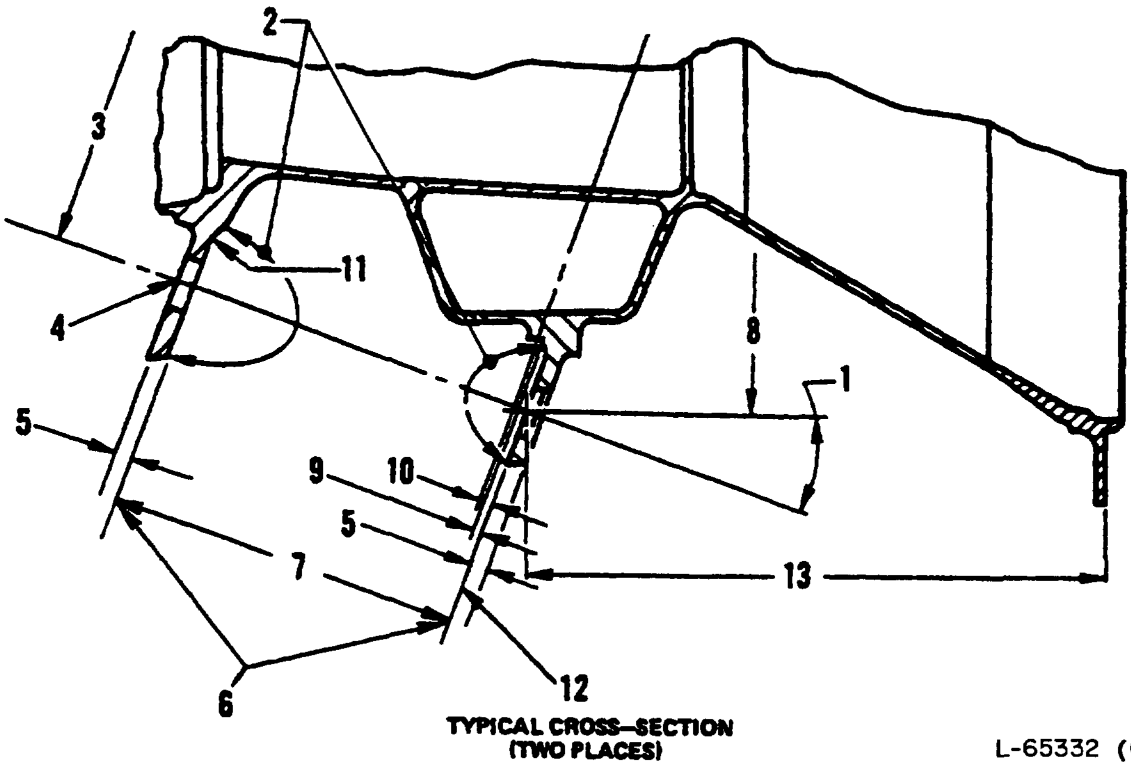
R
R



1. 4.167 - 4.173 Inches To Shoulder Of No. 2 Bearing Housing.
2. 70°0′ ± 0°5′ From Case Centerline
3. 1.856 - 1.871 Inch ID Before Plate. 1.840 Inch Maximum ID After Plate. 1.8504 - 1.8510 Inch Finish ID
4. Plate Area
5. Chamfer 0.010 - 0.030 Inch By 45°± 5°
6. 0.005 Inch Maximum Radius
7. 2.063 - 2.072 Inches Before Plate. 2.050 Inch Maximum After Plate. 2.0550 - 2.0596 Finish Dimension
8. 0.020 - 0.35 Inch
9. 0.047 - 0.078 Inch Radius
10. 1.659 - 1.674 Inch ID Before Plate 1.644 Inch Maximum ID After Plate. 1.6535 - 1.6541 Inch Finish ID
11. 5.137 - 5.143 Inches From Intersection Of Case Axis And Axis Of Bearing Bores (3) And (10)

R
R

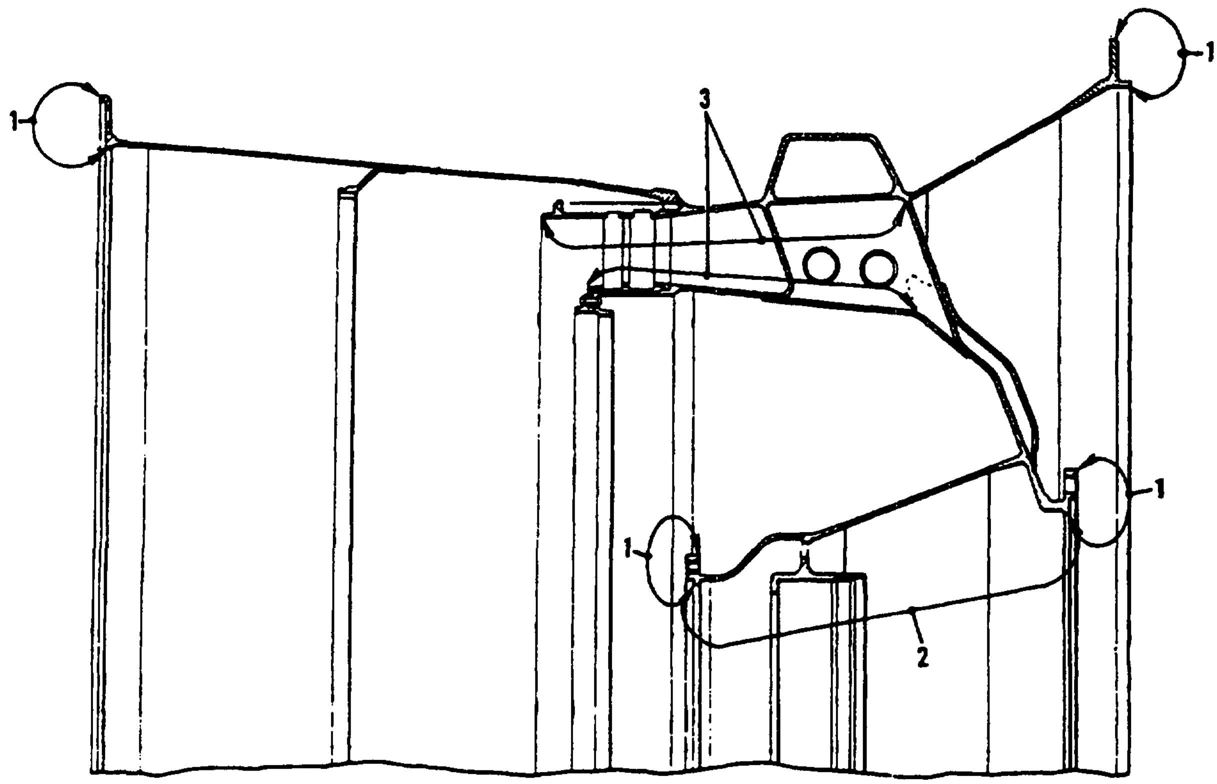
Plating Repair Of Diffuser
Case Towershaft Bearing Housing
Figure 610



1. 20 Degrees
2. Nickel-plate Area. Plating Outside Enclosed Area Is Permissible But Such Excess Plate Must Be Removed
3. 10.052 Inches To Intersection Of Centerlines Of No. 2 Bearing Housing And Towershaft Bearing Housing.
4. 0.374 - 0.376 Inch Diameter Through Both Flanges
5. 0.100 Inch Minimum Before Plating.
6. References Faces
7. 2.765 - 2.777 Inches Before Plating. Hold To Minimum Value. 2.753 Inches Maximum After Plating. Finish Machine To 2.758 - 2.762 Inches.
8. 9.477 Inches To Centerline
9. 0.078 - 0.093 Inch
10. 0.091 Inch. Centerline Of Towershaft Bearing Housing.
11. 0.047 - 0.078 Inch Radius (Each Face)
12. Reference Face
13. 4.373 Inches

NOTE: Lug faces (6) must be square with Diameter (4) 0.002 inch FIR maximum. Face (12) must be 0.002 inch FIR maximum of true position.

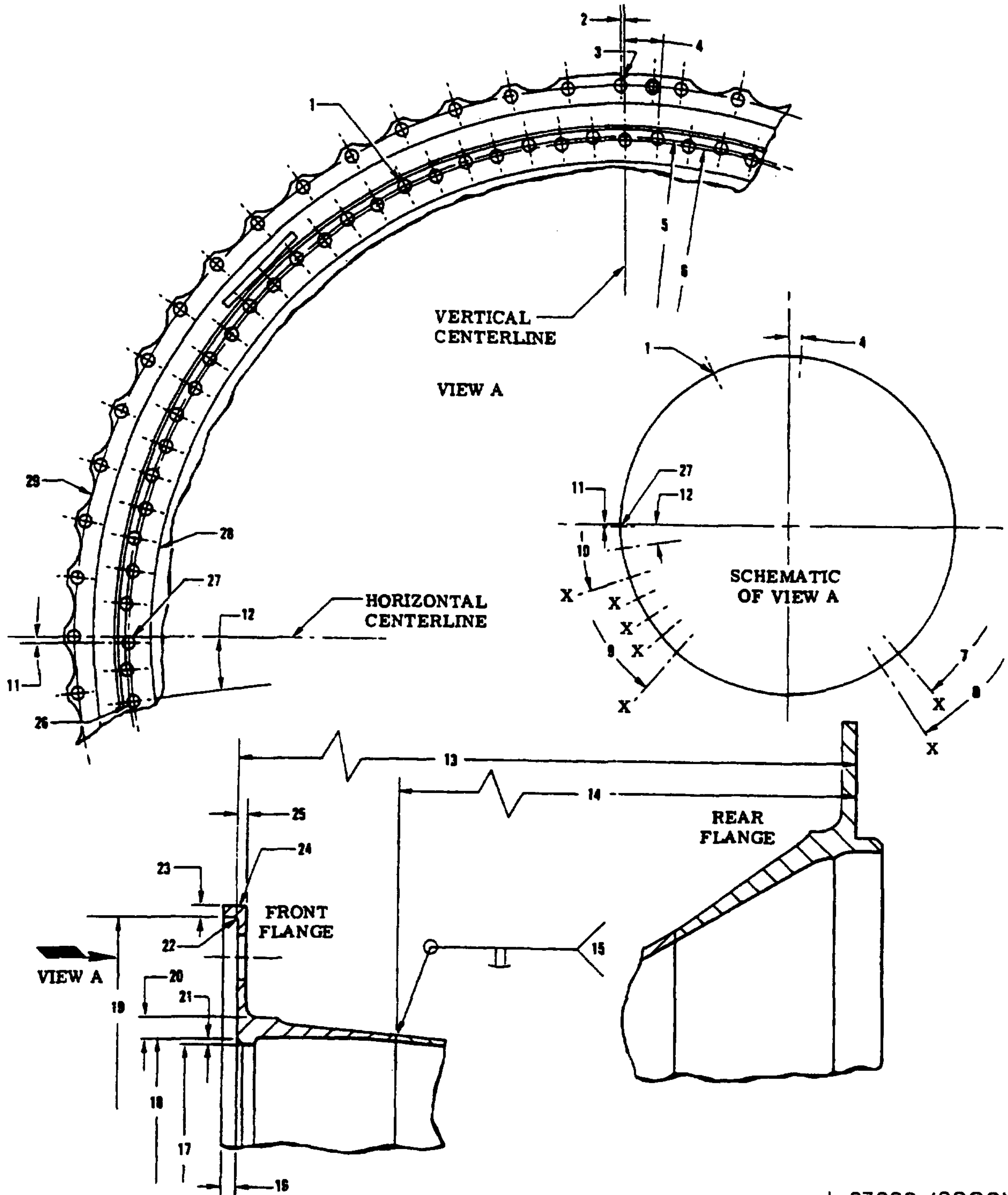
Nickel Plate Repair Of Diffuser
Case Gearbox Mount Lugs
Figure 611



1. Coat This Area And All Boss Faces 0.0005 - 0.0015 Inch Thick With PWA 110-31
2. No Coat Area And On All Threads
3. Surface Texture Must Not Be Above 35AA In This Area

NOTE: Unless otherwise specified coat all over 0.0015 - 0.0030 inch thick with PWA 110-31.

PWA 110-31 Coating Of Diffuser Case
(Alternate Coating Procedure)
Figure 612



Replacement Of Diffuser Case
Front Flange
Figure 613

1. 0.245 - 0.255 Inch Diameter; 41 Holes On The Basis Of 48 Holes Equally Spaced And Located Within 0.005 Inch Radius Of True Position In Relation To Index 19. Holes Shall Be Omitted At Locations Marked X.
2. Hole Offset 0.060 Inch From Vertical Centerline
3. Machine Mark Identifying Vertical Centerline
4. 3°45'
5. 19.220 Inch Diameter
6. 19.100 Inch Diameter
7. 48°45' From Horizontal Centerline
8. 56°15' From Horizontal Centerline
9. 48°45' From Horizontal Centerline
10. 18°45' From Horizontal Centerline
11. 0.100 Inch
12. 7°30'
13. 15.314 - 15.320 Inches
14. 14.540 - 14.560 Inches. Cut And Trim To This Dimension For Flange Replacement.
15. Weld With AMS 5776 Welding Rod Using Machine Gas Tungsten-Arc Welding Method (ME-GTAW)
16. 0.065 - 0.075 Inch
17. 18.258 - 18.262 Inch Diameter
18. 18.340 Inch Diameter
19. 19.479 - 19.481 Inch Diameter
20. 18.495 - 18.505 Inch Diameter With 0.047 - 0.078 Inch Corner Radius
21. 0.010 Inch Minimum
22. 0.010 Inch Maximum Radius
23. 0.045 - 0.055 Inch
24. Replacement Flange
25. 0.035 - 0.045 Inch
26. 0.216 - 0.226 Inch Diameter; 48 Holes - 47 Holes On Basis Of 48 Holes Equally Spaced And One Offset Hole As Shown; All Located Within 0.010 Inch Radius Of True Position In Relation To Index 19.
27. Offset Hole
28. Front Flange
29. Rear Flange

Key to Figure 613

(c) Cut-off flange to dimensions shown.

(d) Trim to required dimension by machining vertically, while checking fit with replacement flange.

(2) Welding Replacement Flange

(a) With welding fixture secured to welding positioner, place diffuser case on fixture and secure rear flange with clamps.

(b) With gas backup support in retracted position, install support in case.

(c) Position new flange on case and install hold-down plate detail.

(d) Alternately tighten gas backup support detail and hold-down plate detail to obtain uniform alignment between case and replacement flange.

(e) Weld AMS 5504 flange to AMS 5613 case using AMS 5776 welding rod and machine gas tungsten-arc procedure. Refer to Section 70-42-01, Repair-00 in the Standard Practices Manual.

(3) Stress-Relief

(a) Place case with rear flange down on stress-relief fixture and secure.

(b) Insert stress-relief ring into No. 2 bearing support front segment ID; then, install stress-relief plate on top of replacement flange and secure.

(c) Stress-relieve by SPOP 455-2. Refer to Standard Practices Manual, Section 70-42-04.

(4) Finish-machining Replacement Flange

(a) With machining fixture installed on vertical turret lathe, position case on fixture aligning offset hole in rear flange with pin.

(b) Secure case to fixture and machine flange to dimensions shown.

(5) Drilling Front Flange Hole Pattern

R
R

(a) With machining fixture mounted on jig borer, establish relationship between guide pin in fixture and position of spindle, so that spindle will be aligned with offset hole location on replacement flange when case is installed.

(b) Secure case to fixture aligning pin with rear flange offset hole and machine 0.2182 - 0.2192 inch diameter offset hole in front flange.

(c) For remaining holes, position machining fixture on base of radial drill; then position case with rear flange down on fixture, and secure.

(d) Install drill plate on replacement flange aligning pin with offset hole jib-bored previously. Drill plate may be secured with C-clamps.

(e) Drill hole pattern using plate as guide.

(f) Restore nickel-cadmium plate. See Nickel-Cadmium Plating of Diffuser Case.

E. Replacement of Diffuser Case Forward Section
R See Tool Group 41A and Figure 606 and Figure 614.

(1) Removal of Forward Section

(a) Mount diffuser case in machining fixture on a vertical turret lathe, front flange up.

(b) Using slow rpm and hand feed, cut-off front section of diffuser case to dimensions shown.

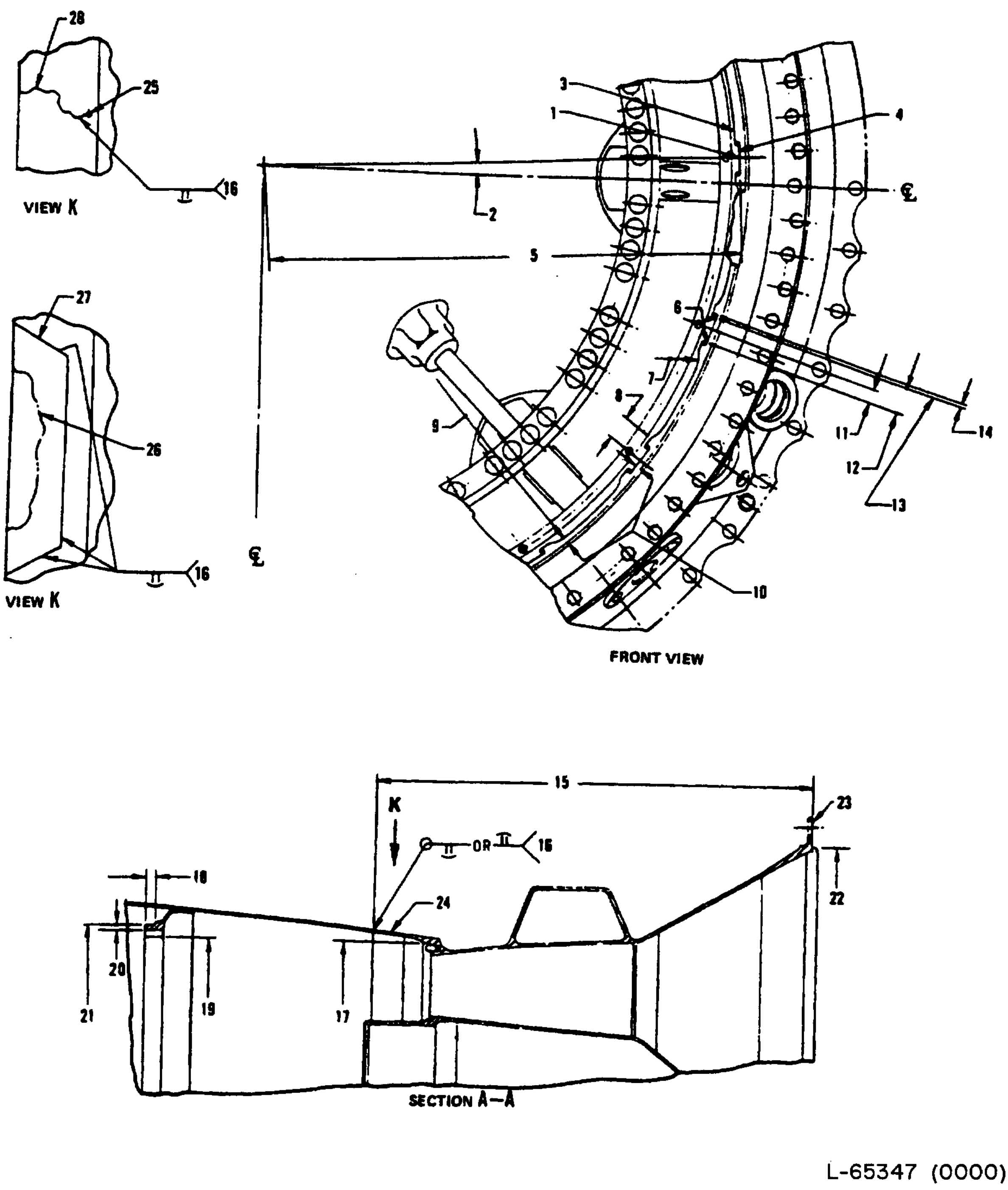
(c) Trim to required dimension.

(2) Welding Replacement Section in Place

(a) Strip paint and plating from rear section of diffuser case by SPOP 25. Refer to Standard Practices Manual, Section 70-44-01.

(b) Weld repair cracks in area of cut-off plane as shown in View K.

(c) Size mating diameter to match replacement section.

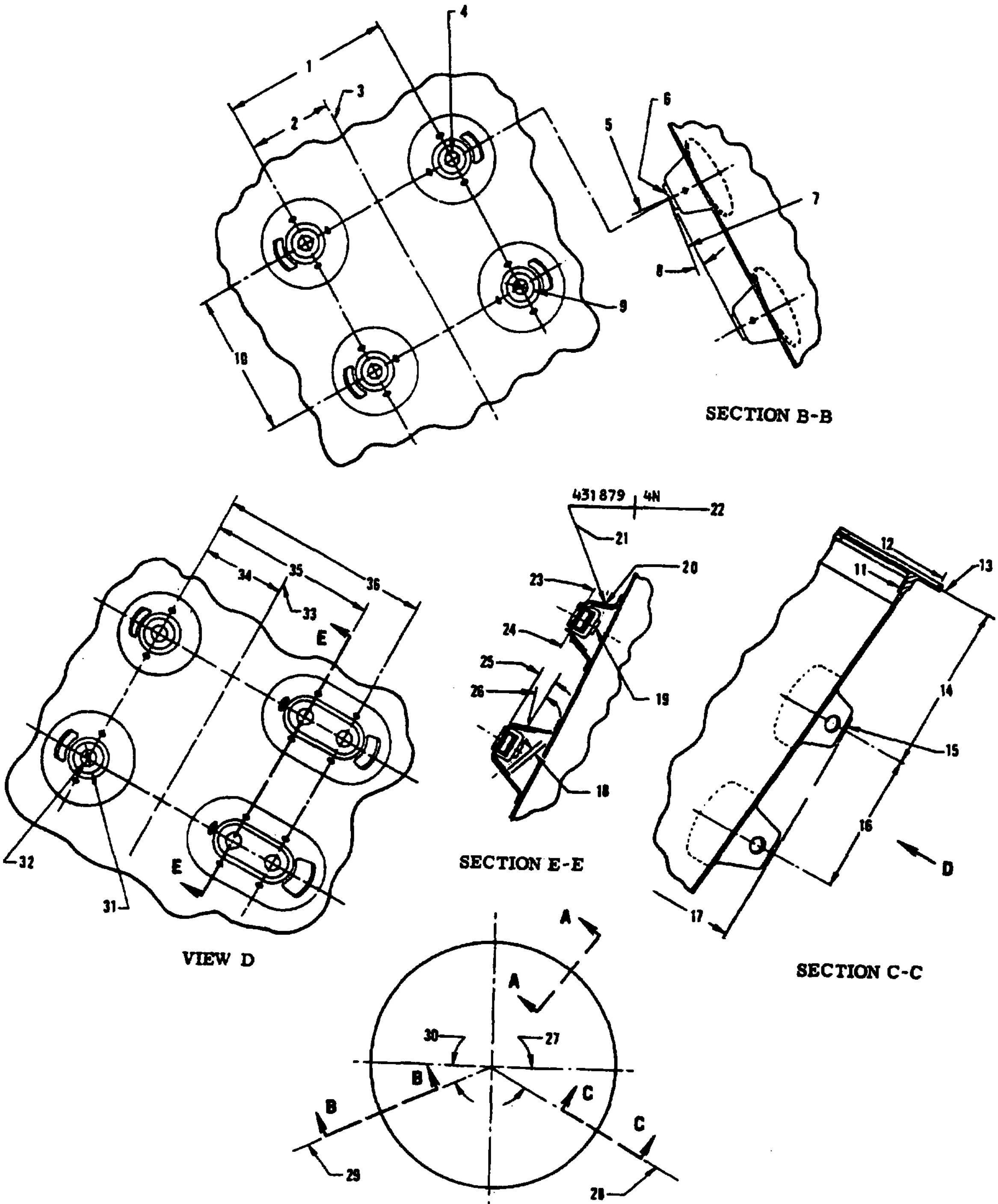


R
R

Replacement Of Diffuser Case
Forward Section
Figure 614 (Sheet 1)

1. Offset Slot
2. Three Degrees
3. Omit Scallop At This Location
4. Twenty Slots. Nineteen Slots On The Basis Of 20 Slots Equally Spaced And One Slot Offset As Shown.
5. 8.530 - 8.540 Inches
6. 0.003 - 0.010 Inch Radius
7. 0.500 - 0.750 Inch Radius, 38 Places
8. 0.340 - 0.400 Inch, 38 Places
9. R 8.540 - 8.550 Inch Radius
10. 0.030 Inch Minimum Wall
11. 0.250 Inch
12. 0.495 - 0.504 Inch
13. This Face Of Each Slot Shall Be located Within 0.002 Inch Of True Angular Position
14. Chamfer 0.002 - 0.030 Inch By 43° - 47° On Both Sides Of Slot In 20 Places
15. 7.840 - 7.860 Inch Cut-off Dimension
16. Weld With AMS 5776 Welding Rod Using Tungsten Inert Gas (TIG) Method
17. Reference Diameter
18. 0.155 - 0.175 Inch
19. 16.785 - 16.795 Inch Diameter
20. 0.020 Inch Minimum
21. 17.180 - 17.200 Inches
22. Reference Diameter
23. Reference Surface
24. Area To Be Resized If Necessary
25. Stop Drill 0.055 - 0.095 Inch Diameter Hole At End Of Crack
26. Broken Piece
27. Patch
28. Crack Extending Rearward

Key to Figure 614 (Sheet 1)



L-31510 (0000)

R
R

Replacement Of Diffuser Case
Forward Section
Figure 614 (Sheet 2)

1. 3.218 Inches
2. 1.609 Inches
3. Plane S
4. 0.276 - 0.286 Inch Diameter Through, Four Holes Located Within 0.010 Inch Radius Of True Position
5. 3.284 Inches To Front Flange Front Face (13)
6. This Surface, Four Places, Located Within 0.010 Inch Of True Position In Same Plane Within 0.005 Inch FIR
7. 9.530 Inches To Centerline
8. Four Degrees 45 Minutes
9. 0.070 Inch Minimum In Four Places
10. 2.750 Inches
11. Reference Diameter
12. Reference Diameter
13. Reference Surface
14. 3.284 Inches
15. This Surface, In Four Places, May Vary By Limits Shown But Must Lie In Same Plane Within 0.005 Inch FIR
16. 2.750 Inches
17. 9.520 - 9.540 Inches To Centerline, Two Places
18. 0.030 Inch Minimum, Four Places
19. Self Locking Nut PN 616727
20. 0.129 - 0.132 Inch Diameter Through Holes In Two Locations Within 0.010 Inch Radius Of True Position
21. Twenty Required
22. Blind Rivet, PN 431879
23. This Surface Shall Be Flush To 0.010 Inch Below Surface (24) While Lugs Are Drilled And Riveted. A 0.010 Inch Maximum Gap Is Permissible After Riveting In Two Places
24. Reference Surface
25. 0.320 Inch, Four Places
26. 16°30' - 20°30' In Four Places
27. 29 Degrees
28. Plane R
29. Plane S
30. 22°30'
31. 0.070 Inch Minimum In Six Places
32. 0.276 - 0.286 Inch Diameter Through Holes In Six Locations Within 0.005 Inch Radius of True position
33. Plane R
34. 1.609 Inches
35. 3.218 Inches
36. 4.093 Inches

Key to Figure 614 (Sheet 2)

R
R

(d) With the diffuser case rear section in welding fixture, position forward section, PN 650784, such that the exciter bosses are located within 0.020 inch radius of true position in relation to outer rear flange mating diameter and rear face.

(e) Weld segment as shown.

CAUTION: HANDLE PART WITH CARE BEFORE STRESS-RELIEF. FAILURE TO DO SO MAY RESULT IN CRACKING AT WELD BEAD OR IN HEAT-AFFECTED AREA.

(f) Stress-relieve by SPOP 455-2. Refer to Standard Practices Manual, Section 70-42-04.

(3) Finish Machining of Forward Section.

(a) Finish machine front flange as specified elsewhere.

(b) Finish machine torque ring and exciter bosses as shown in referenced figure.

(c) Restore nickel-cadmium plate. Refer to Nickel-Cadmium Plating of Diffuser Case.

(d) Install locknuts on diffuser case ignition exciter mount bosses as shown in referenced figure.

F. Diffuser Case Pressure and Scavenge Oil Tube Replacement. See Figure 615.

(1) Heat boss at inner end of tube being replaced.

(2) Pull tube from case.

(3) Clean tube boss to remove old braze.

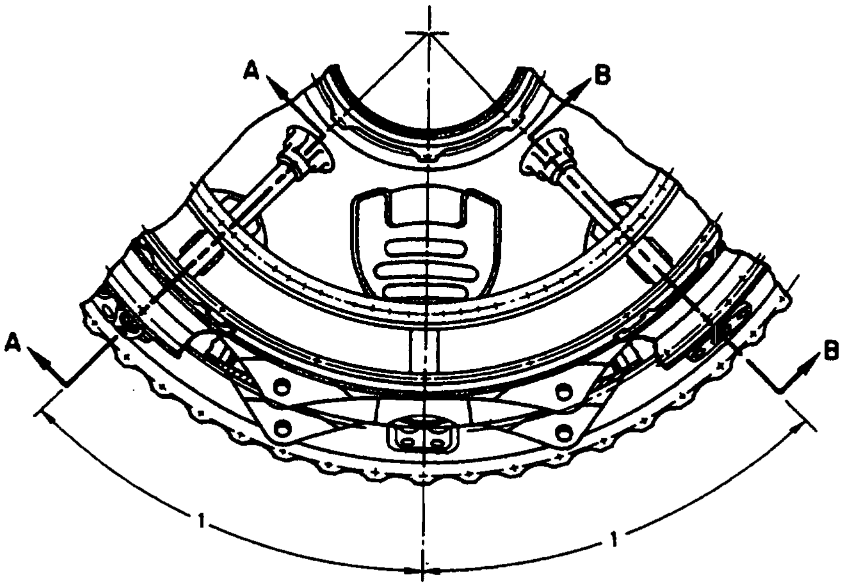
(4) Install replacement tube assembly.

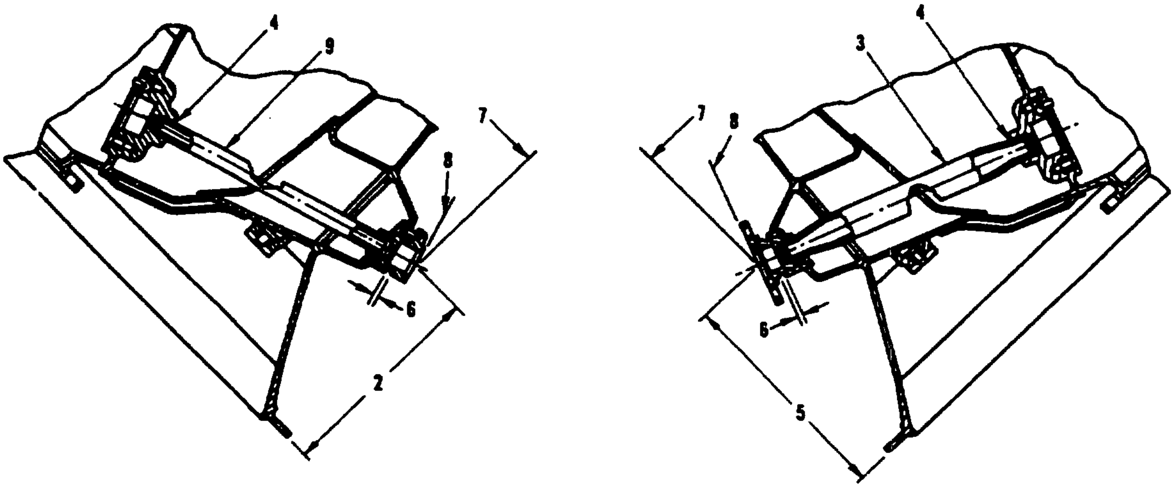
(5) Install temporary shim between diffuser case boss and tube assembly.

(6) Braze tube to inner boss by AMS 2664. Refer to Section 70-42-03, Repair-03 in the Standard Practices Manual. Remove temporary shims.

(7) Stress-relieve at 265° - 282°C (510° - 540°F) for three hours.

R
R





SECTION B-B

SECTION A-A

L-65331 (0000)

R
R

Diffuser Case Pressure And
Scavenge Oil Tube Replacement
Figure 615

1. 45 Degrees
2. 4.305 Inches
3. No. 2 Bearing Oil Scavenge Tube
4. Braze Per AMS 2666
5. 4.650 Inches
6. 0.040 - 0.080 Inch
7. 9.973 Inches To Case Centerline
8. Surface Shall Be Located Within 0.030 Inch Of True Position
9. No. 2 Bearing Oil Pressure Tube

Key to Figure 615

(8) Clean tube assembly.

G. Diffuser Case Strut Brace Installation
See Figure 616.

(1) Strip plate and paint. Refer to Nickel-Cadmium Plating of Diffuser Case.

(2) Weld-repair diffuser case strut cracks.

(3) Install braces (as needed) on three lower struts only.

NOTE: All strut welds in the area under the brace must be finished flush.

(4) Weld braces and finish machine brace per referenced figure.

NOTE: Brace and case material is AMS 5504.

CAUTION: HANDLE PART WITH CARE BEFORE STRESS-RELIEF. FAILURE TO DO SO MAY RESULT IN CRACKING AT WELD BEAD OR IN HEAT-AFFECTED AREA.

(5) Furnace stress-relieve by SPOP 455-2. Refer to Standard Practices Manual, Section 70-42-04.

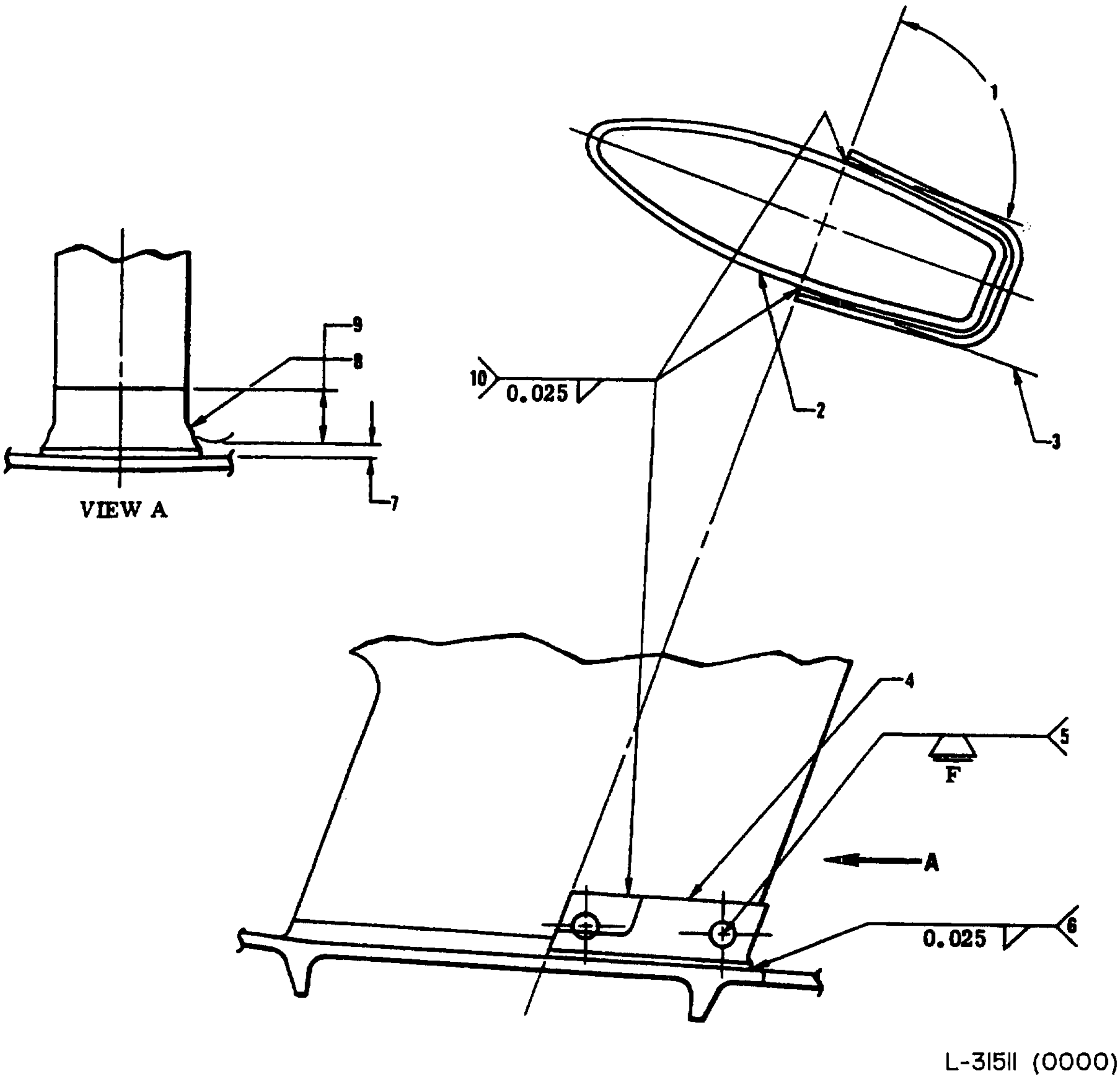
(6) Restore plate and paint. Refer to Nickel-Cadmium Plating of Diffuser Case.

H. Diffuser Case-Ignition Exciter Supports - Repair of

(1) Cracks around exciter supports may be weld repaired as follows:

(a) Vee-out crack.

R
R



R
R

Installation Of Diffuser
Case Strut Braces
Figure 616

1. 90 Degrees, Two Places
2. Reference Surface
3. Finish In This Plane, Flush To 0.005 Inch Above Surface (2) For Distance (9). Both Sides.
4. Brace, PN 644619
5. Fusion Plug Weld, GTAW Method, In Four Places With AMS 5776 Rod
6. Fillet Weld, GTAW Method, In Three Places With AMS 5776 Rod
7. 0.050 - 0.070 Inch, Both Sides
8. 0.109 - 0.141 Inch Radius, Both Sides
9. Reference Distance
10. Fillet Weld, GTAW Method, With AMS 5776 Rod

Key to Figure 616

(b) Strip plate and paint. Refer to Nickel-Cadmium Plating of Diffuser Case.

(c) Weld case using AMS 5680 rod. Complete weld penetration on exciter boss is not required.

<u>CAUTION</u>: HANDLE PART WITH CARE BEFORE STRESS-RELIEF. FAILURE TO DO SO MAY RESULT IN CRACKING AT WELD BEAD OR IN HEAT-AFFECTED AREA.

(d) Stress-relieve by SPOP 455-2. Refer to Standard Practices Manual, Section 70-42-04.

(e) Fluorescent penetrant inspect case.

<u>NOTE</u>: If stress-relief is accomplished with the exit guide vanes installed, stress-relieve at 316°C (600°F) for 30 minutes and 427°C (800°F) for three hours.

(f) Restore nickel-cadmium plate.

(2) Boss Mis-match.

(a) Check for flatness by placing flat piece of stock on four supports.

(b) Using feeler gage, ensure that all support surfaces are level within 0.020 inch.

(c) Braze washer onto support by AMS 2665, if required. Refer to Section 70-42-03, Repair-05 in the Standard Practices manual.

R
R

I. Diffuser Case Igniter Plug Bosses
See Tool Group 85A.

(1) Inspect igniter plug boss threads for damage.

(2) Damaged threads may be dressed with igniter plug boss tap.

J. Diffuser Case Engine Mount Boss
See Figure 617.

(1) Inspect tapped boltholes in boss for damage.

(2) Repair damaged hole.

NOTE: Maximum of any two damaged boltholes per boss may be repaired with helical coil inserts.

(a) Drill hole as shown.

(b) Tap hole.

(c) Install insert 1/4 to 1/2 pitch below outer surface of boss.

K. Diffuser Case Ninth Stage Vane and Shroud Elongated Rivet Hole Repair
See Figure 618.

(1) Inspect rivet hole for worn or elongated condition.

(2) Weld worn rivet holes by PWA 16-2 in Section 70-42-01, Standard Practices Manual. Use AMS 5776 filler metal. Avoid excessive heat to prevent distortion.

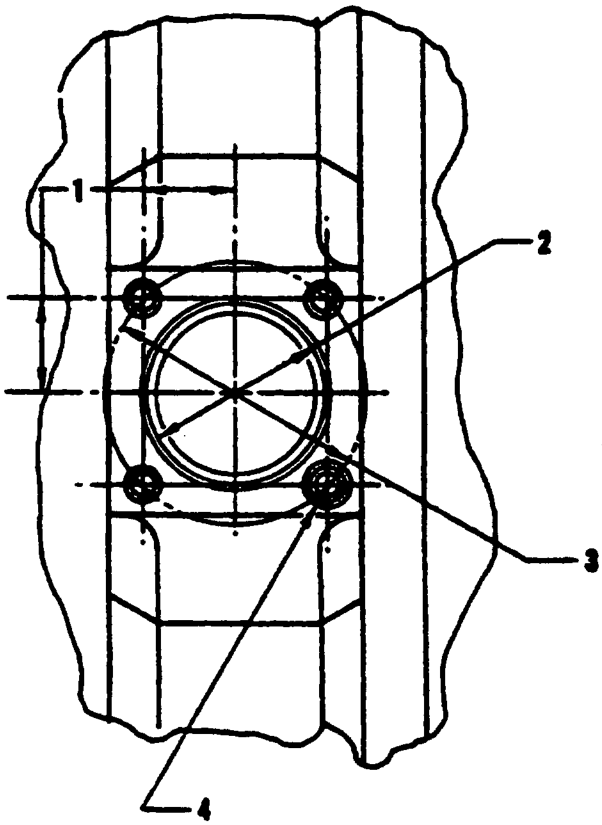
(3) Blend weld to restore surfaces.

(4) Stress-relieve by SPOP 455-2 in Section 70-42-04, Standard Practices Manual.

(5) Fluorescent penetrant inspect repaired area by SPOP 70 (high sensitivity). See Section 70-33-00, Standard Practices Manual. Repair as required.

(6) Transfer drill repaired rivet holes (twenty places) using a ninth stage compressor air sealing ring.

L. Ninth Stage Air Sealing Ring

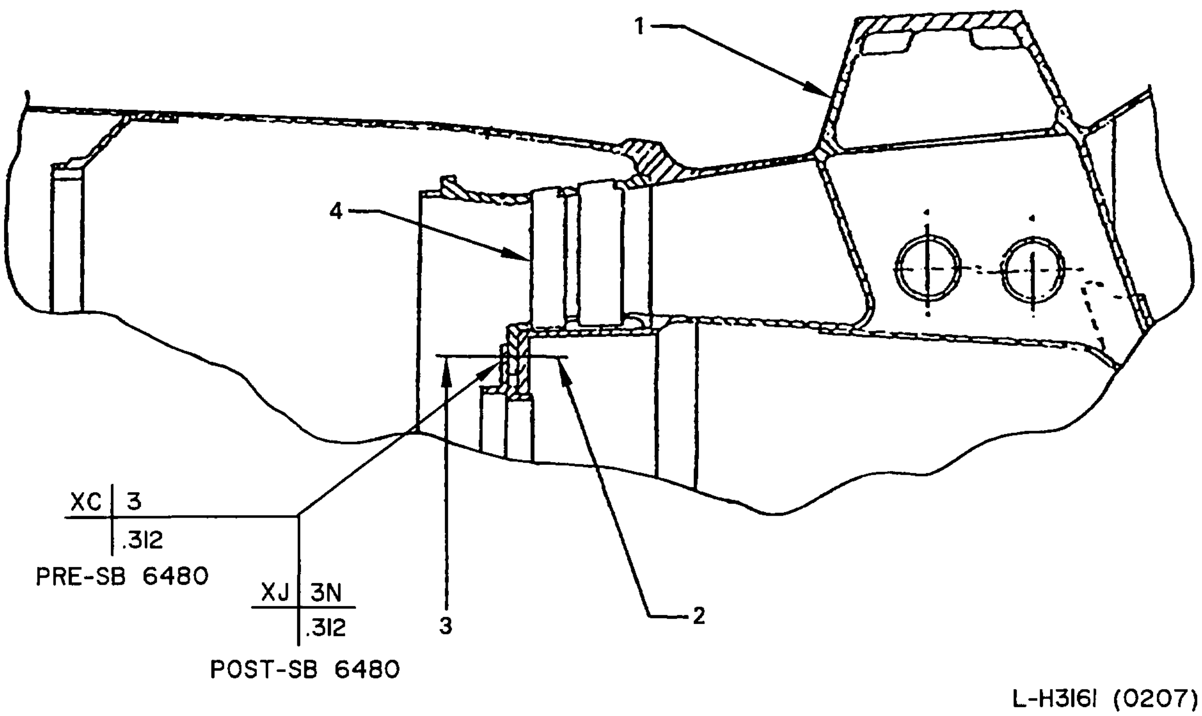


L-21167 (0000)

1. 0.735 Inch
2. Reference Diameter
3. 2.080 Inch Diameter
4. MS 124657 Helical Coil Insert (0.3125-24). Chamfer 115 - 125 Degrees Included Angle To 0.360 - 0.400 Inch Diameter, Located Within 0.005 Inch Radius Of True Position In Relation To Diameter (2)

R
R

Helical Coil Insert
Repair Of Diffuser Case
Engine Mount Boss
Figure 617



1. Diffuser Case Assembly
2. Rivet Hole Centerline
3. 13.470 Inch Diameter (Reference)
4. Ninth Stage Compressor Exit Stator

R
R

Diffuser Case Elongated
Rivet Hole Weld Repair
Figure 618

(1) PWA 110-21 or PWA 110-31 Coating (For Stators post-SB 6211)

(a) Remove all coat and plate from all surfaces.

(b) Coat all over with PWA 110-21 or PWA 110-31. See Standard Practices Manual, Section 70-41-04.

(2) Air sealing ring weld repair. See Figure 619, Figure 620 and Figure 621.

(a) Remove the rivets which secure the air sealing ring and remove the ring.

(b) Index the ring to flange to make sure that you install the ring again in the initial position.

(c) Clean the ring fully by SPOP 203 in Section 70-21-00, Standard Practices Manual.

(d) Strip the nickel-cadmium plate by SPOP 25 in Section 70-44-01, Standard Practices Manual.

(e) Remove cracks with a vee-groove.

(f) Fluorescent penetrant inspect by SPOP 70 (high sensitivity) in Section 70-33-00, Standard Practices Manual, to make sure that the crack is removed.

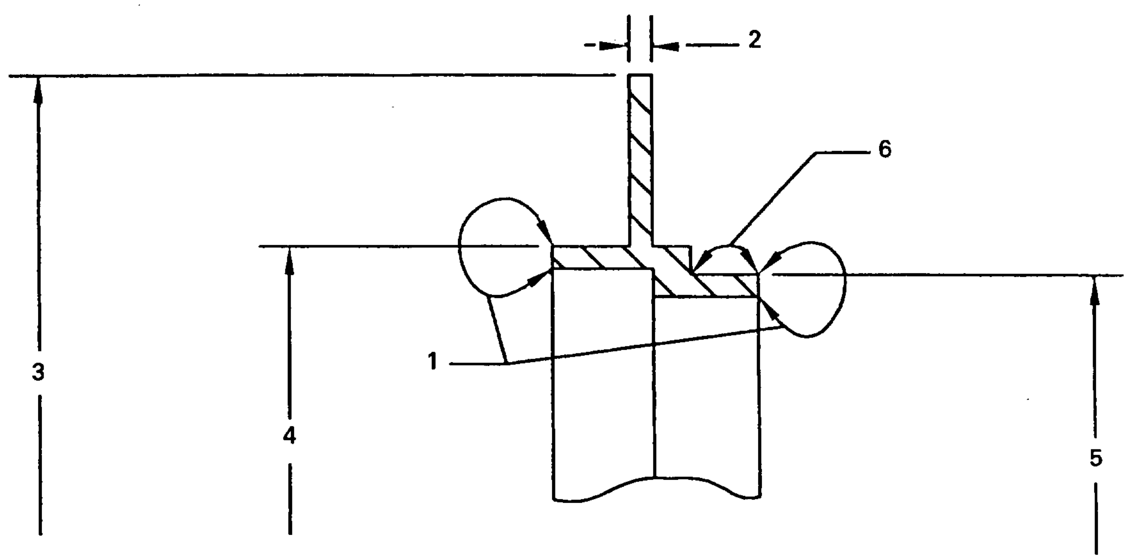
(g) Weld by PWA 16-2 code A. Use AMS 5776 Filler metal. See Section 70-42-01, Standard Practices Manual.

<u>NOTE</u>: Rings that need several weld repairs must be welded by alternately shifting weld positions, 180 degrees from the first weld, 90 degrees from the second weld, 180 degrees from the third weld, 90 degrees from the fourth weld, etc. This procedure is to make sure there is a minimum distortion

(h) Stress-relieve the ring by PWA 11-15 at 732°C (1350°F) for one hours.

(i) Blend the ring so that it is flush to the parent metal at the weld areas.

R
R



L-H3172 (1296)

R
R

Ninth Stage Air Sealing Ring
Figure 619

1. Electrical Contact Permissible Only In This Area. No Burning, Pitting Or Selective Attack Permitted. Completely Cover Contact Points Within This Area With PWA 578 Paint After Plating But Before AMS 2416 Baking.
2. 0.035 - 0.045 Inch
3. 13.680 - 13.700 Inch Average Diameter
4. 13.080 - 13.100 Inch Average Diameter
5. 12.9878 - 12.9898 Inch Average Diameter
6. If PWA 110 (Task 70-41-04-380-100) Is Performed, Refer To Section 70-41-04 In The Standard Practices Manual, Thickness Of Paint Must Not Exceed 0.0006 Inch In This Area.

NOTE: Average diameter in free state may be out of round 0.030 inch in excess of tolerance shown.

NOTE: All dimensions apply when Index 5 average diameter (in free state or constrained) is round within 0.003 inch.

NOTE: Dimensions shown are before plating.

Key to Figure 619

(j) Fluorescent penetrant inspect by SPOP 70 (high Sensitivity) in Section 70-33-00, Standard Practices Manual.

(k) Inspect by Figure 619.

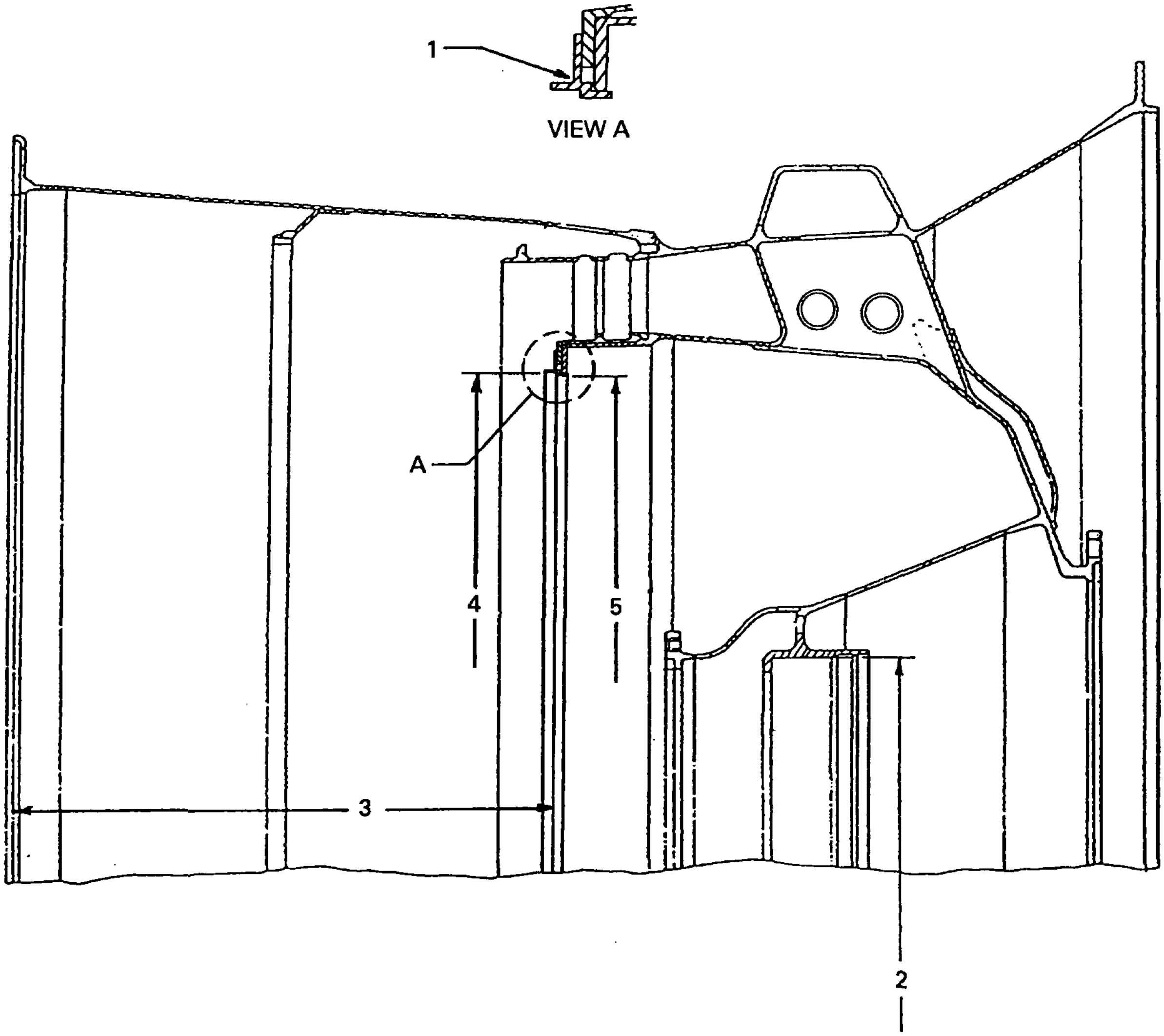
(l) Apply new coating by one of the methods that follow:

1 Apply nickel-cadmium plating by SPOP 25 in Section 70-44-01, Standard Practices Manual. See Figure 619, (Index 1).

2 Paint the ring by PWA 110 (Task 70-41-04-380-100). Refer to Section 70-41-04 in the Standard Practices Manual. The paint thickness must be 0.0005 - 0.0015 inch except where otherwise specified. See Figure 619 (Index 6).

(m) Put the ring in the diffuser case in the initial position. Transfer drill the rivet holes to the appropriate diameter at repaired areas. Rivet the ring in the initial location by PWA 357-21 in Section 70-43-00, Standard Practices Manual. Use

R
R



R
R

Diffuser Case Airsealing
Ring Repair
Figure 620

1. PN 517559
2. Reference Diameter
3. 7.286 - 7.296 Inches
4. 13.008 - 13.012 Inch Diameter
5. 12/908 - 12.912 Inch Diameter

NOTE: Indexes 4 and 5 diameters must be concentric with Index 2 diameter within 0.002 inch FIR.

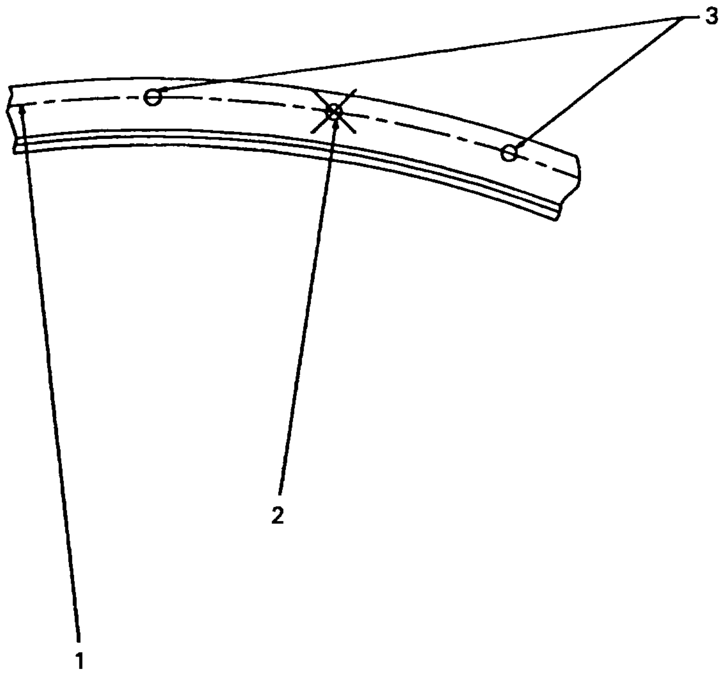
NOTE: Dimensions specified are before painting.

Key to Figure 620

the initial rivet holes. See the dimensions and concentricity requirements shown in Figure 617. Rivets: PN AN125423 (rivet, universal head, 0.094 inch diameter by 0.375 inch long).

NOTE: You can rotate the ring relative to the diffuser case and transfer drill 20 new rivet holes so that the new rivet holes are halfway between the initial rivet holes. See Figure 621 for the new rivet hole locations.

R
R



L-H3174 (0207)

1. 6.7350 Inch Radius
2. New Rivet Holes, 20 Places Equally Spaced, Located Within 0.003 Inch Radius Of True Position
3. Original Rivet Holes

R
R

New Rivet Hole Locations
(If Required)
Figure 621

ENGINE COMBUSTION

TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

Please insert the revised pages into this manual and delete obsoleted pages in accordance with the following List of Effective Pages. Revised pages are indicated by the letter "R", added pages by the letter "A", and deleted pages by the letter "D". Superseded pages shall be removed and destroyed.

The List of Effective Pages records not only each page of subject revision but also each previously issued page which is still current. Blank pages and pages which are no longer current do not appear on this list. If there is any question about the currency of the maintained copy, it is recommended that each page of the manual be checked off against this List of Effective Pages. Any page which does not check out with this list, either by number or by date, shall be discarded. This list is reissued in its entirety whenever this manual section is revised.

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
Tab Separator - Engine Combustion				
List of Effective Pages - Engine Combustion See end of list.				
Table of Contents - Engine Combustion				
72-40-00	R	01/ 02		MAY 1/08
72-40-00 INSP/REP-00		601	-ALL	APR 1/07
		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
		613		APR 1/07
		614		APR 1/07
		615		APR 1/07
		616		APR 1/07
		617		APR 1/07
		618		APR 1/07
		619		APR 1/07
		620		APR 1/07
		621		APR 1/07
		622		APR 1/07
		623		APR 1/07
		624		APR 1/07
	R	625		MAY 1/08
	R	626		MAY 1/08
		627		APR 1/07
		628		APR 1/07
		629		APR 1/07
		630		APR 1/07
		631		APR 1/07
		632		APR 1/07
	R	633		MAY 1/08
	R	634		MAY 1/08
	R	635		MAY 1/08
	R	636		MAY 1/08
	R	637		MAY 1/08
	R	638		MAY 1/08
	R	639		MAY 1/08
	R	640		MAY 1/08
	R	641		MAY 1/08
	R	642		MAY 1/08
	R	643		MAY 1/08
	R	644		MAY 1/08
	R	645		MAY 1/08
	R	646		MAY 1/08
	R	647		MAY 1/08
	R	648		MAY 1/08
	R	649		MAY 1/08
	R	650		MAY 1/08
72-40-00			(CONTINUED)	
INSP/REP-00	R	651		MAY 1/08
	R	652		MAY 1/08
	R	653		MAY 1/08
	R	654		MAY 1/08
	R	655		MAY 1/08
	R	656		MAY 1/08
	R	657		MAY 1/08
	R	658		MAY 1/08
	R	659		MAY 1/08
	R	660		MAY 1/08
	R	661		MAY 1/08
	R	662		MAY 1/08
	R	663		MAY 1/08
	R	664		MAY 1/08
	R	665		MAY 1/08
	R	666		MAY 1/08
	R	667		MAY 1/08
	R	668		MAY 1/08
	R	669		MAY 1/08
	R	670		MAY 1/08
	R	671		MAY 1/08
	R	672		MAY 1/08
	R	673		MAY 1/08
	R	674		MAY 1/08
	R	675		MAY 1/08
	R	676		MAY 1/08
	R	677		MAY 1/08
	R	678		MAY 1/08
	R	679		MAY 1/08
	R	680		MAY 1/08
	R	681		MAY 1/08
	R	682		MAY 1/08
	A	683		MAY 1/08
	A	684		MAY 1/08
LIST OF EFFECTIVE PAGES				
		A		MAY 1/08

TO: RECIPIENTS OF JT12 OVERHAUL MANUAL, PART NUMBER 435108

REVISION NO. 75 DATED MAY 1, 2008

HIGHLIGHTS - ENGINE COMBUSTION

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-40-00 INSP/REP-00	626 633 -684	Corrected combustion section text. (Editorial) Added combustion chamber cross-over tube baffle replacement repair. (IEN 02JC027) Added optional duct plasma coat. (IEN 99JC045A)	-ALL

ENGINE COMBUSTION - INSPECTION, REPAIR, AND REPLACEMENT

1. General

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Combustion Chamber Inner Case (See Tool Group 18A). See Figure 601.

A. Inspection

(1) Do inspections of the combustion chamber inner case by visual and fluorescent penetrant methods.

(a) No cracks in machined surfaces are acceptable.

(b) All cracks on rear flange shall be repaired.

(c) All other cracks up to one inch long shall be repaired.

(2) Inner case front and rear snap diameters must be concentric within 0.004 inch FIR. Rear mating diameter must be concentric within 0.001 inch FIR with bearing housing diameter. Bearing housing diameter must be square with bearing seat within 0.003 inch FIR. Individual mating diameters (front and rear) must not be out-of-round in excess of 0.004 inch FIR.

(3) Inspect oil tube bellows-type seals for cracking. Cracked seals must be replaced.

(4) Inspect oil tube connectors for wear indications. Worn connectors may be repaired by plating.

(5) Pressure check case.

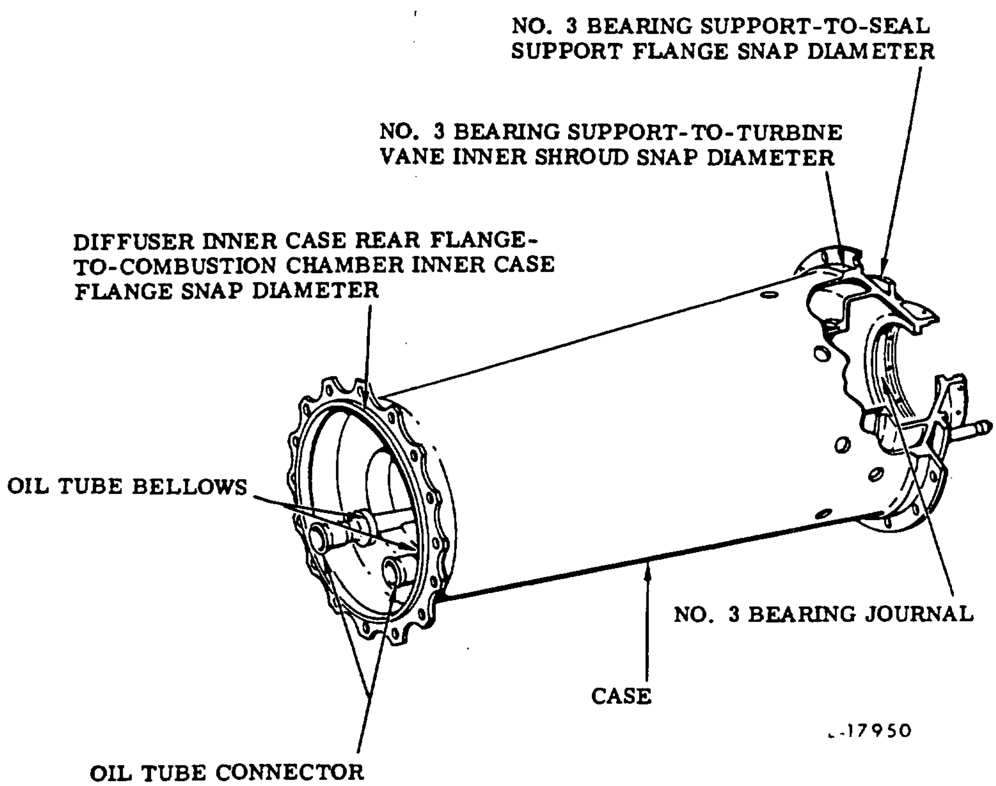
B. Repairs

(1) Combustion Chamber Inner Case Crack Repairs. See Figure 602.

(a) Clean circumferential cracks shown in referenced figure by SPOP 208.

(b) Rout crack.

(c) Weld crack with AMS 5776 welding wire.



Combustion Chamber Inner Case
Figure 601

(d) Fluorescent penetrant inspect repair.

(e) Stress-relieve by Cycle No. 1A. (See Heat Treatments, Standard Practices Manual)

(f) Inspect front and rear snap diameters.

(2) Combustion Chamber Inner Case Oil Tube Replacement (See Tool Group 17). See Figure 603.

(a) Machine bellows from front flange as shown (Indexes 18 or 27).

(b) Heat braze, attaching tube assembly to turbine shaft heat shield front flange, and remove tube assembly and old braze from inner case.

(c) Position replacement tube assembly in inner case and secure for welding using locator.

(d) Braze tube to oil tube heat shield per AMS 2666 as shown in Index 6. Ensure that brazing does not affect the previous braze.

(e) Machine tube connector to finished dimensions shown.

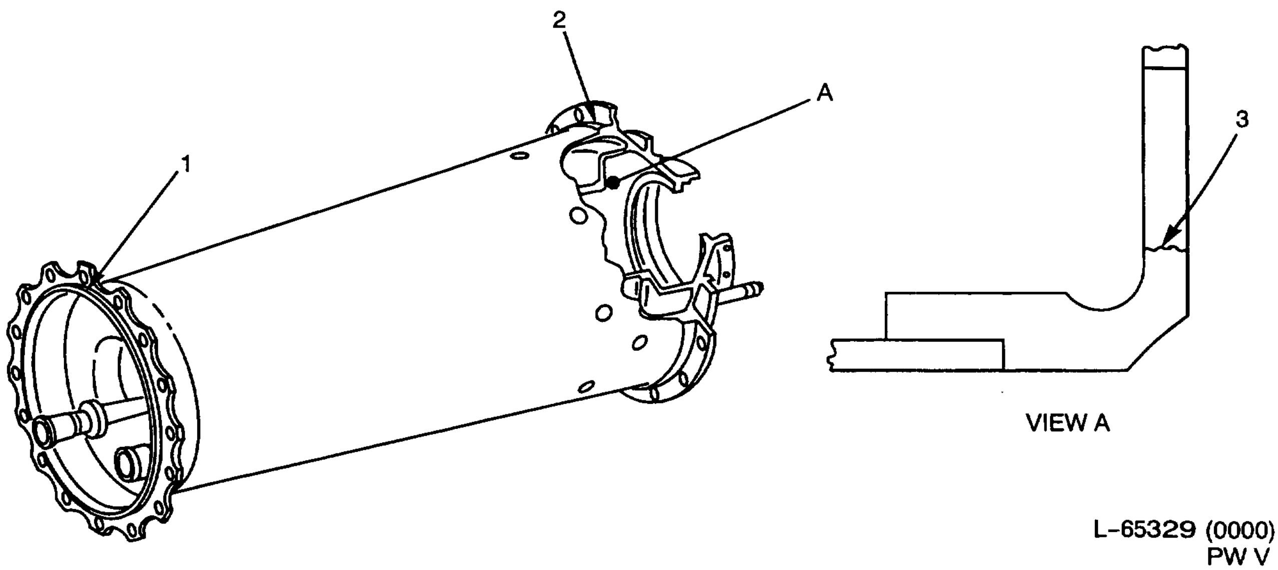
(f) Install new bellows, stress-relieve assembly, pressure test, and final inspect as described in steps (3)(d) thru (i).

(3) Combustion Chamber Inner Case Oil Tube Bellows Seal Replacement (See Tool Group 18A).

(a) Replace cracked scavenge and/or pressure oil tube bellows-type seals with new seals.

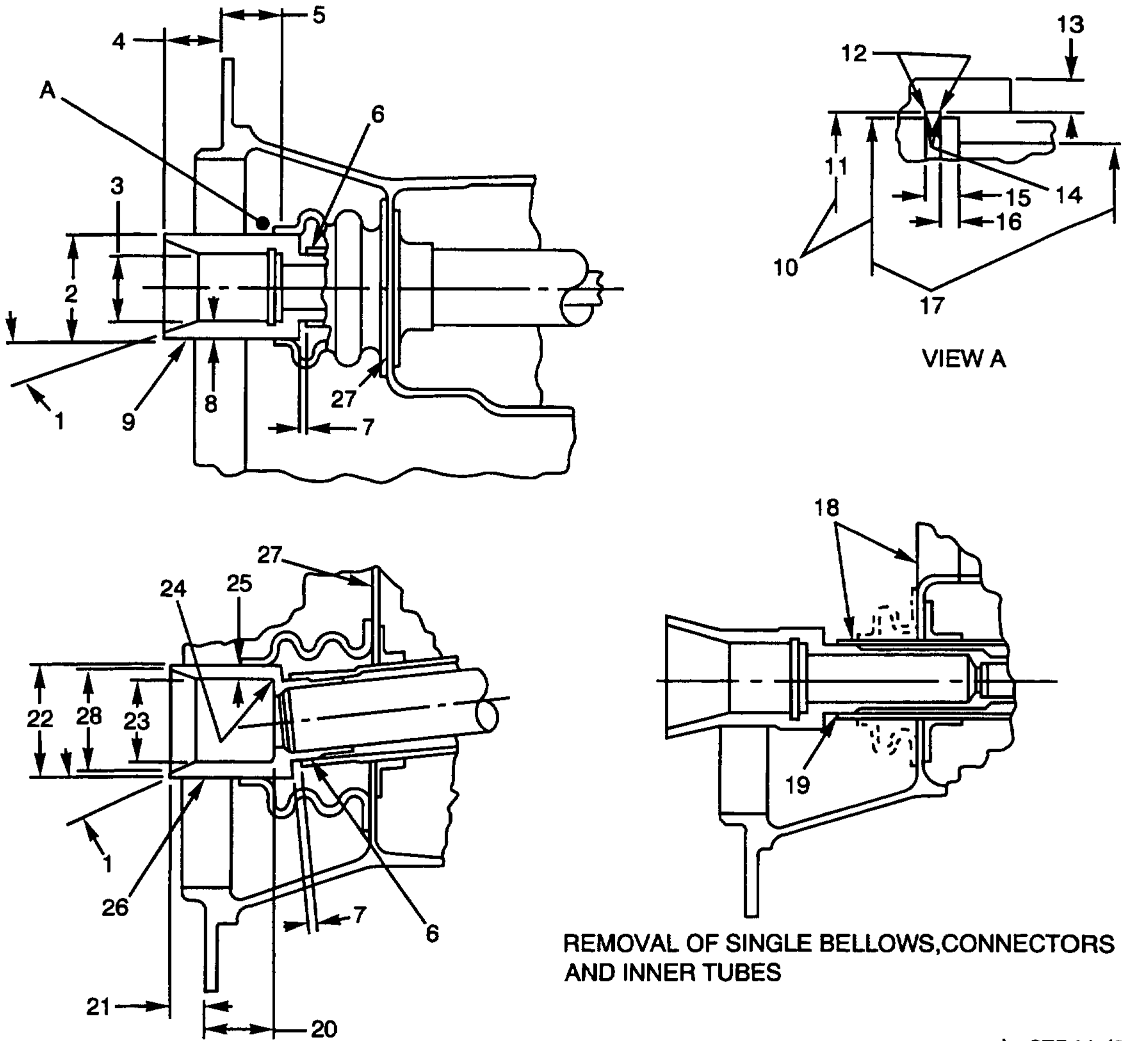
(b) If oil tube incorporates connector housing flared lead-in, it will be necessary to machine to configuration as follows: See Figure 604 and Figure 605.

1 Machine pressure tube connector flared lead-in from 0.880 - 0.900 inch diameter to 0.700 - 0.720 inch diameter.



1. Front Mating Diameter
2. Rear Mating Diameter
3. Heat Shield Rear Flange Cracking

Combustion Chamber Inner Case
Rear Flange Crack Repair
Figure 602



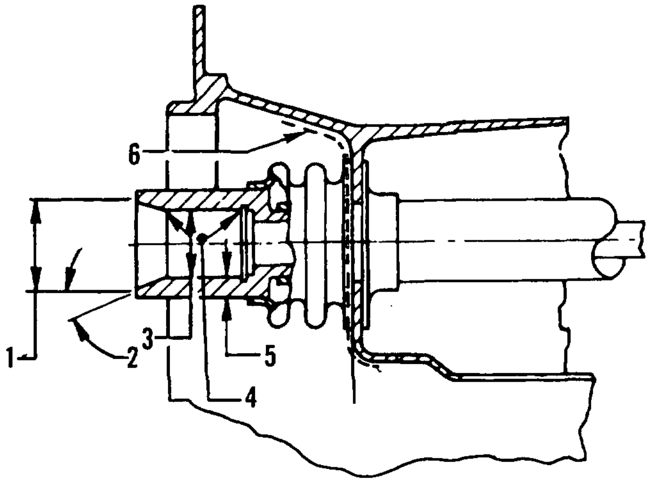
L-27541 (0900)
PW V

R
R

Combustion Chamber Inner Case
Oil Tube Replacement
Figure 603

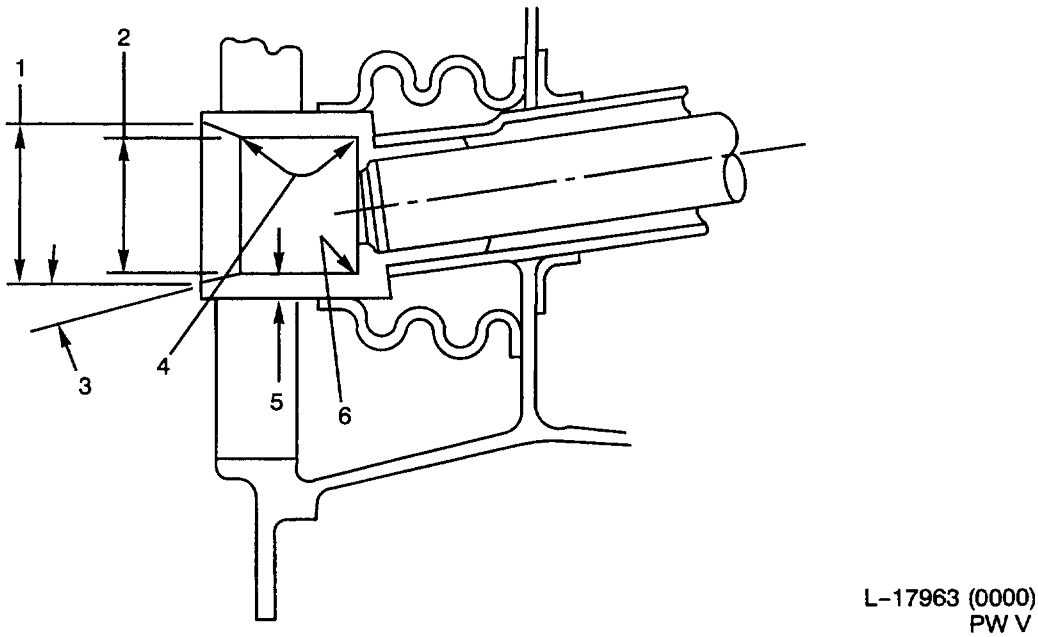
1. Chamfer 20° ± 1°
2. 0.660 - 0.680 Inch Diameter
3. 0.499 - 0.501 Inch Diameter
4. 0.440 - 0.480 Inch
5. 0.420 - 0.440 Inch
6. Braze Area (See Text)
7. 0.060 Inch Minimum
8. 0.040 Inch Minimum
9. Pressure Oil Tube Assembly, PN 637990
10. These Diameters Must Be Concentric 0.003 Inch FIR Maximum
11. 0.520 - 0.532 Inch Diameter
12. 0.005 Inch Maximum Radius
13. 0.030 Inch Minimum
14 0.003 Inch Maximum Radius
15. 0.039 - 0.042 Inch
16. 0.045 - 0.065 Inch
17. These Diameters Must Be Concentric 0.060 Inch FIR Maximum
18. Machine Bellows Flush To 0.010 Inch Above These Surfaces All Around
19. Apply Heat Locally To Remove Connector And Inner Tube
20. 0.460 - 0.480 Inch
21. 0.250 - 0.290 Inch
R 22. 0.770 - 0.790 Inch Diameter
23. 0.604 - 0.608 Inch Diameter
24. 0.010 - 0.020 Inch Radius
25. 0.030 Inch Minimum
26. Scavenge Oil Tube Assembly, PN 637991
27. Machine Bellows Flush To 0.010 Inch Above These Surfaces All Around
R 28. 0.730 - 0.750 Inch Diameter

Key To Figure 603



1. 0.660 - 0.680 Inch Diameter
2. 19 - 21 degrees
3. 0.499 - 0.501 Inch Diameter
4. Nickel Plate Area
5. 0.040 Inch Minimum
6. Fabricated Patch (Alternate Installation)

Pressure Oil Tube Connector
Figure 604



1. 0.730 - 0.750 Inch Diameter
2. 0.604 - 0.608 Inch Diameter
3. 19 - 21 Degrees
4. Nickel Plate Area
5. 0.030 Inch Minimum
6. 0.010 - 0.020 Inch Radius

Scavenge Oil Tube Connector
Figure 605

2 Machine scavenge connector flared lead-in from 1.020 - 1.040 Inch diameter to 0.770 - 0.790 Inch diameter.

NOTE: Pressure tube connectors cannot get this repair if the rear shoulder OD where the bellows mates is less than 0.700 inch. Scavenge tube connector cannot get this repair if the OD mating with the bellows is less than 0.770 inch.

(c) Remove old bellows by hand grinding.

NOTE: Remove excess weld, but do not cut into parent metal.

(d) Install new bellows seals. See Figure 606.

1 Without Fabricated Patch (See step 2 for alternate method.)

a Position seals on pressure tube connector and scavenge tube connector.

b Position locator on case front flange and install locating pins in tube connectors.

c Ensure that seals are flush against case and weld with AMS 5680 filler rod.

2 Using Fabricated Patch. (Alternate method).

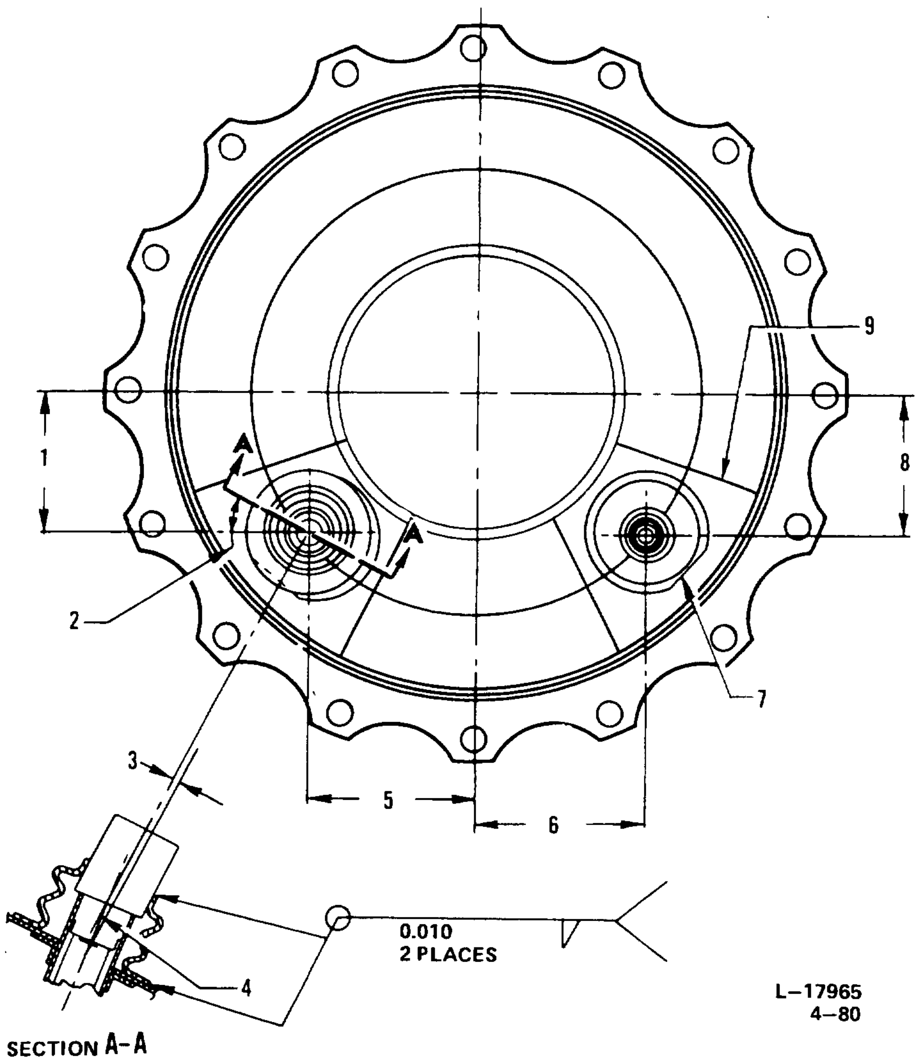
a Locally fabricate a patch from AMS 5504 steel plate 0.032 inch thick. See Figure 607. Cut hole and shape to contour of case assembly. See Figure 604 and Figure 606.

b Position bellows over fitted patch on pressure tube connector and scavenge tube connector.

c Position locator on case front flange and install locating pins in tube connectors.

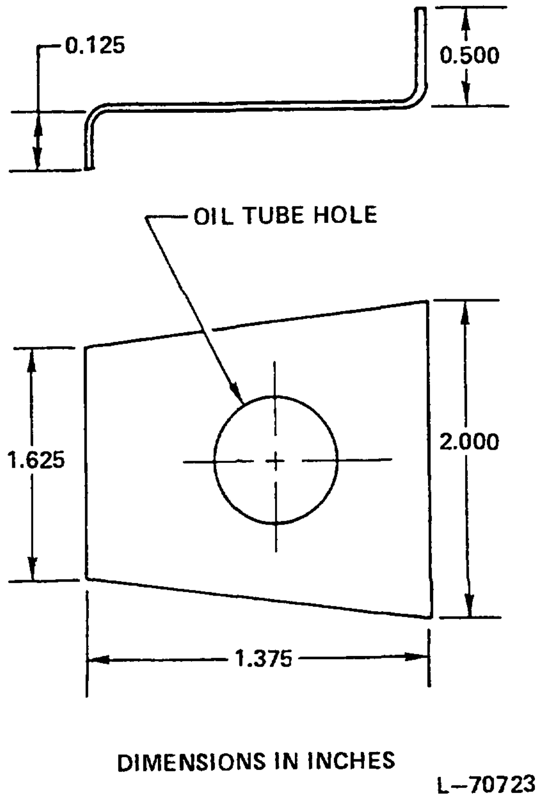
d Tack weld bellows in position to patch.

e Remove patch complete with bellows and weld flush against patch with AMS 5776 filler rod.



1. 1.598 - 1.602 Inches
2. 28°- 29°
3. 0.052 Inch
4. Centerline For This Diameter of Bellows Must Be In This Plane As Shown And Located Within 0.010 Inch Of True Position
5. 1.898 - 1.902 Inches
6. 1.941 - 1.945 Inches
7. This Flat Must Be Positioned As Shown: Two Places
8. 1.571 - 1.575 Inches
9. Fabricated Patch (Alternate Installation)

Oil Tube Positioning
Figure 606



Maximum Allowable
Fabricated Patch
Figure 607

f Re-install bellows and patch assembly to case, preload flange at weld location approximately 0.015 inch by placing shims between the restraining fixture and the flange in order to prevent flange distortion.

g Pack ceramic fiber insulation around outside wall of case in repair area of weld. In-sulation is a Fiberfrax product that can be obtained from the Carborundum Co., Refractories and Insulation Division; Fiberfrax Branch, P.O. Box 808, Niagara Falls, NY 14302.

h Weld bellows patch assembly to case with AMS 5776 filler rod ensuring that patch assembly is flush against case.

NOTE: Use caution during welding (because there are two different thicknesses on the support).

(e) Stress-relieve part by Cycle No. 1A. (See Welding, Standard Practices Manual.)

(f) Inspect welds, using fluorescent penetrant method. (See Standard Practices Manual.)

(g) Pressure check case, using fixture and ten psi air pressure. No leakage is permissible.

NOTE: Due to low air pressure used, rubber plugs may be used in case holes. If desired cover plugs with band to ensure integrity.

(h) Degrease and dry fully.

(i) Reinspect front and rear mating diameters to assure concentricity within 0.014 inch FIR and circularity of individual mating diameters 0.004 inch FIR maximum.

(4) Combustion Chamber Inner Case Oil Tube Connector Plating Repair

(a) Pressure oil tube connector.

1 Machine to clean up connector to 0.511 inch maximum diameter. See Figure 604.

2 Nickel plate machined area 0.483 - 0.489 inch diameter by SPOP 26. See the Standard Practices Manual.

3 Bake at 180° - 196°C (365° - 385°F) for three hours.

4 Machine plated area to dimensions shown.

(b) Scavenge oil tube connector.

1 Machine to clean up connector to 0.618 inch maximum diameter. See Figure 605.

2 Nickel plate machined area to 0.591 - 0.594 inch diameter by SPOP 26.

3 Bake at 180° - 196°C (365° - 385°F) for three hours.

4 Machine plated area to dimensions shown.

(5) No. 3 Bearing Journal Repair. See Figure 608.

(a) Machine worn journal to dimensions shown.

(b) Nickel plate area shown by SPOP 29. Refer to Plating in the Standard Practices Manual.

(c) Finish grind to dimensions, maintaining concentricity and squareness.

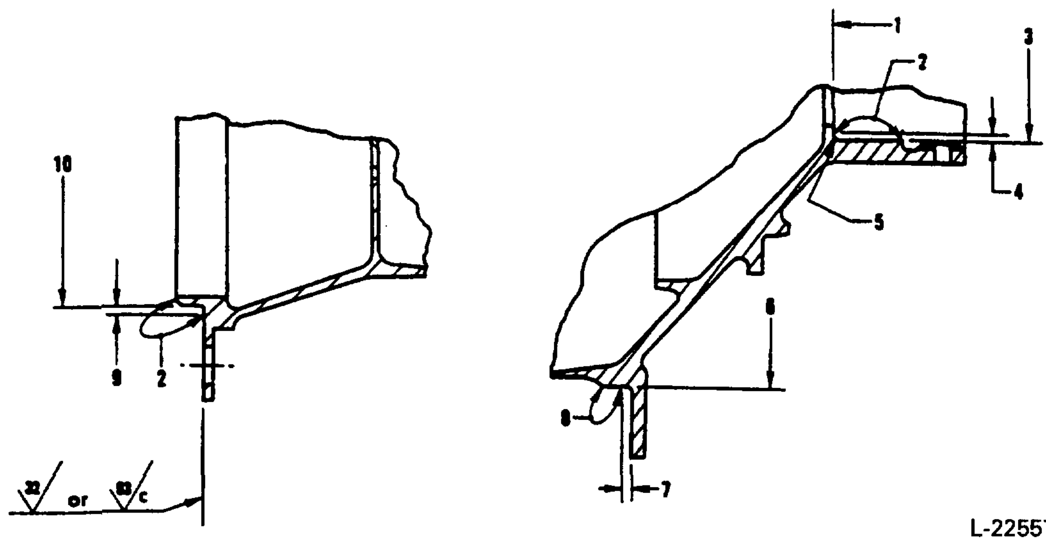
(d) Stress-relieve at 184° - 196°C (365° - 385°F) for three hours.

(6) Diffuser Inner Case Rear Flange-to-Combustion Chamber Inner Case Flange Mating Diameter Repair. See Figure 608.

(a) Machine diameter to dimensions shown.

(b) Nickel plate area shown (see SPOP 26, Plating, Overhaul Standard Practices Manual).

(c) Bake at 185° - 196°C (365° - 385°F) for three hours.



L-22557 (0000)

1. Reference Face
2. Nickel Plate Area. Plating Outside This Area Is Permissible, But Such Excess Plating Must Be Removed.
3. 4.3374 - 4.3524 Inch Diameter Before Plate, Hold To Minimum Value. 4.321 Inch Diameter, Maximum, After Plate 4.3317 - 4.3324 Inch Diameter Finish Dimension. This Diameter Must Be Square With Face 1 Within 0.002 Inch FIR; And Concentric With Pitch Diameter Of Retaining Nut Threads Within 0.002 Inch FIR, And Diameter 6 Within 0.0005 Inch FIR.
4. 0.040 - 0.055 Inch
5. 0.020 - 0.040 Inch Radius
6. 7.838 - 7.853 Inch Diameter Before Plate, Hold To Maximum Value. 7.870 Inch Minimum Diameter After Plating. 7.858 - 7.860 Inch Diameter Finish Dimension. This Diameter Must Be Concentric With Diameter 10 Within 0.002 Inch FIR.
7. 0.035 Inch Minimum
8. Chromium Plate Area. Plating Outside This Area Is Permitted But Such Excess Plating Must Be Removed.
9. 0.045 - 0.060 Inch
10. 7.062 - 7.072 Inch Diameter Before Plating, Hold To Maximum Value. 7.089 Inch Minimum Diameter After Plate. 7.077 - 7.079 Inch Diameter Finish Dimension. This Diameter Must Be Concentric With Diameter 6 Within 0.002 Inch FIR.

Combustion Chamber Inner Case
Flange/Journal Repair
Figure 608

(d) Finish grind to dimensions shown, maintaining concentricity.

(7) No. 3 Bearing Support-to-Turbine Vane Inner Shroud Mating Diameter Repair. See Figure 608.

(a) Machine mating diameter to dimensions shown.

(b) Chromium plate area shown by SPOP 22 (see Plating, Standard Practices Manual).

(c) Bake at 399° - 427°C (750° - 800°F) for two hours.

(d) Finish grind to dimensions shown, maintaining concentricity.

3. Combustion Chamber Outer Case

A. Inspection

(1) Isolated chafing or scratches on case shall be blended, provided minimum wall thickness or 0.021 inch is maintained.

(2) Smooth, round-bottom dents up to 1/32 inch deep are permissible. Any dents having raised material, sharp corners, or depth within 1/32 inch shall be lightly blended.

(3) Only cracks in the drain boss or adjacent weld shall be welded.

(4) Minor damaged and/or worn front flange diameter that is more than 20.442 inches but less than 20.447 inches shall be repaired.

(5) Minor damaged and/or worn rear flange diameter that is more than 19.142 inches but less than 19.147 inches shall be repaired.

(6) Worn or damaged jackscrew bosses shall be replaced.

(7) Worn, chipped, or flaking paint shall be retouched.

B. Repair

(1) Blending of chafing or scratches.

(a) Blend repairs to skin shall be performed provided the following conditions are met:

1 There is no evidence of corrosive pitting or corrosive attack.

2 Repairs must be as shown. See Figure 609 and Figure 610.

3 Each blend repair must result in smooth round-bottom depressions having blend ratio of at least ten-to-one and maintaining at least 0.021 inch wall thickness.

(b) Do a magnetic particle inspection for cracks (refer to Section 72-00-00, Inspection).

(c) Reapply coatings by steps (6) or (7) as appropriate.

(2) Front Flange Mating Diameter

(a) Machine the diameter as shown. See Figure 610.

(b) Bead peen area shown to intensity of 10N-2 by SPOP 500. (See Surface Treatments in the Standard Practices Manual.)

(c) Nickel plate the diameter in area shown by SPOP 26 (refer to the Standard Practices Manual.) See Figure 611 for nickel plate test sample description.

(d) Bake at 185° - 196°C (365° - 385°F) for three hours.

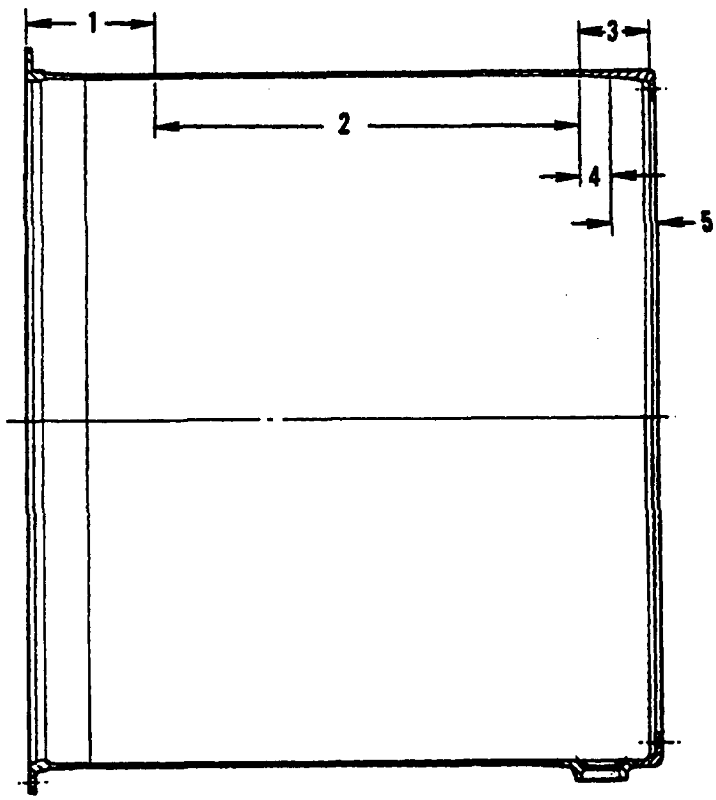
(e) Finish machine the diameter to dimensions shown.

(3) Rear Flange Mating Diameter

(a) Machine mating diameter as shown. See Figure 610.

(b) Bead peen the area shown to intensity of 10N-2 by SPOP 500.

(c) Nickel plate the diameter in area shown by SPOP 26 (see Figure 611 for nickel plate test sample description).



L-42813 (0000)

1. 3.320 Inches. No Repairs Permitted Within This Dimension.
R 2. 14.323 - 14.327 Inches
3. 1.000 Inch. No Repairs Permitted Within This Dimension.
4. Blending To A Minimum Wall Thickness of 0.021 Inch Permitted Within This Area. Maximum Blend Depth Of 0.006 Inch Permitted On Drain Boss.
5. Blending To A Depth of 0.006 Inch Permitted Within This Area.

Combustion Chamber Outer Case
Blend Repair Areas
Figure 609

(d) Bake at 185° - 196°C (365° - 385°F), for three hours.

(e) Finish machine the diameter to dimensions shown.

(4) Drain Boss Crack Repair

R (a) Locally remove nickel-cadmium plating (if found) by SPOP 25 (refer to Section 70-44-01 in the Standard Practices Manual.)

R (b) Locally remove aluminum coating by SPOP 258 (refer to Section 70-21-00 in the Standard Practices Manual).

R (c) Weld by manual gas tungsten arc method with AMS 5680 welding rod. See Figure 610.

R (d) Do a magnetic particle inspection (refer to Section 72-00-00, Inspection).

(e) Locally stress-relieve at 538° - 566°C (1000° - 1050°F) for two hours immediately after welding.

NOTE: Material adjacent to welds and including welds must not be reduced below actual parent metal thickness.

(5) Jackscrew Boss Replacement

(a) Locally apply heat to damaged or worn boss and adjacent braze joint using torch or burner until boss can be separated from flange without distortion or damage to flange.

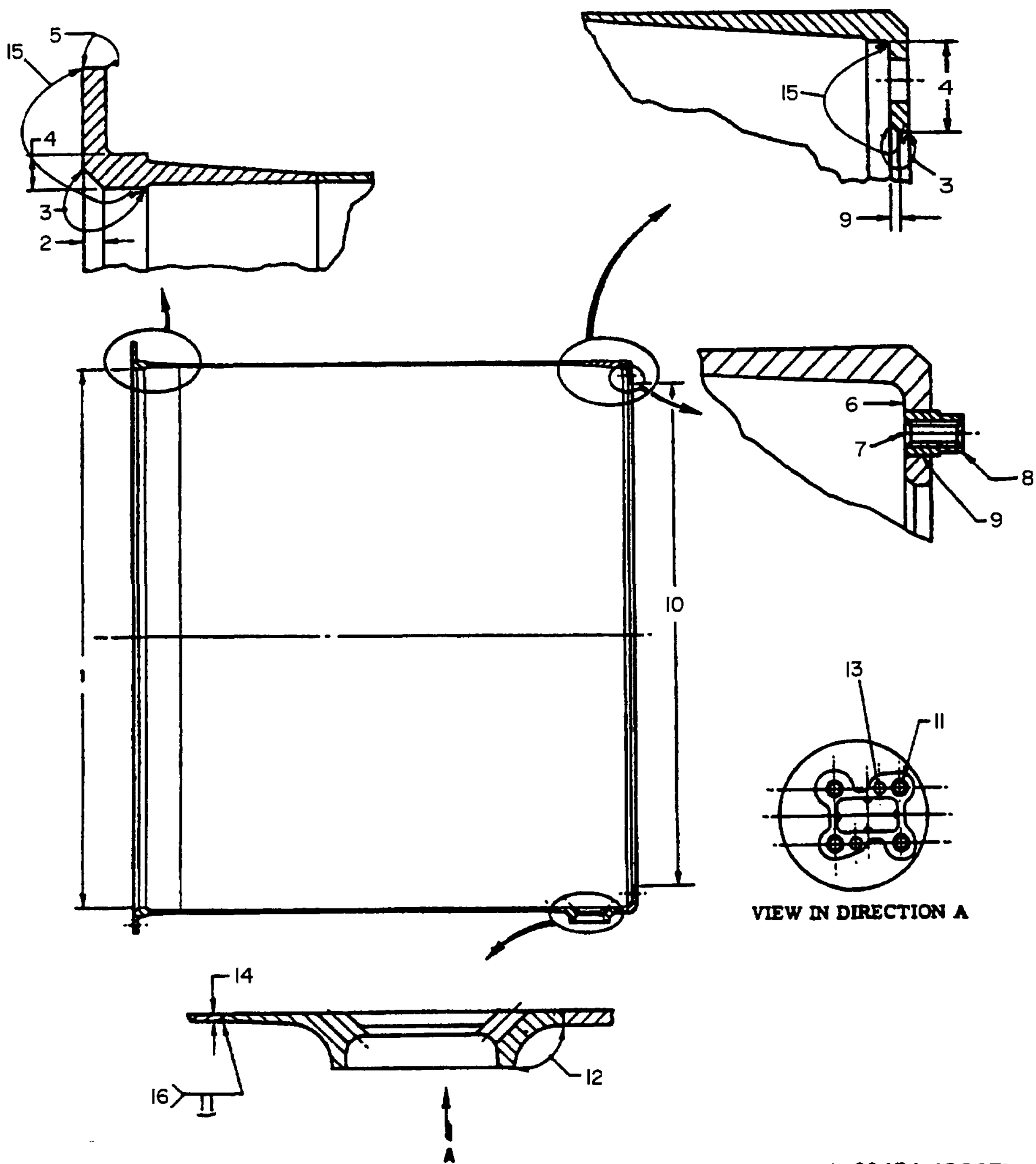
R (b) Locally remove plate (if found) by SPOP 25 or remove aluminum coat by SPOP 258.

(c) Install new boss as shown in Figure 610 (braze by AMS 2665).

NOTE: Eighty percent joining requirements in AMS 2665 are waived. Joint must withstand 60 pound-inches minimum torque.

R (d) Apply protective coat to the repair area as specified below.

R (6) Aluminum Coating Replacement. See Figure 610.



Combustion Chamber
Outer Case Repair
Figure 610

1. 20.447 Inch Maximum Diameter After Clean Up Machining, Hold To Minimum. 20.426 Inch Diameter After Nickel Plating 20.436 - 20.442 Inch Average Diameter After Finish Machining
2. 0.020 - 0.040 inches At 40° - 50° Chamfer
3. Nickel Plate and Bead Peen Area

   NOTE: Hardness: Rockwell C30 - C38 or equivalent

4. This Dimension Must Be Uniform Written 0.010 Inch Total

R 5. Electrical Contact Area (No Burning, Pitting, Or Selective Attack Is Permitted)

R 6. Boss Must Be Flush To Below This Surface

R 7. No Paint Or Plate Area (Jackscrew Boss Hole)

R 8. Relationship Of Flats On This Part To Other Features Is
R Unimportant

R 9. Braze

R 10. 19.147 Inch Maximum Diameter After Cleanup Machining (Hold To Minimum 19.126 Inches After Nickel Plating). 19.136 - 19.142 Inch Average Diameter After Finish Machining

R NOTE: Diameters (1) and (10) must be concentric 0.010 inch FIR maximum. Average diameter in free state can be out of round 0.100 inch more than the tolerances shown.

R 11. No Paint Or Plate Area (4 Drain Boss Boltholes)

R 12. Drain Boss Weld Repair Area

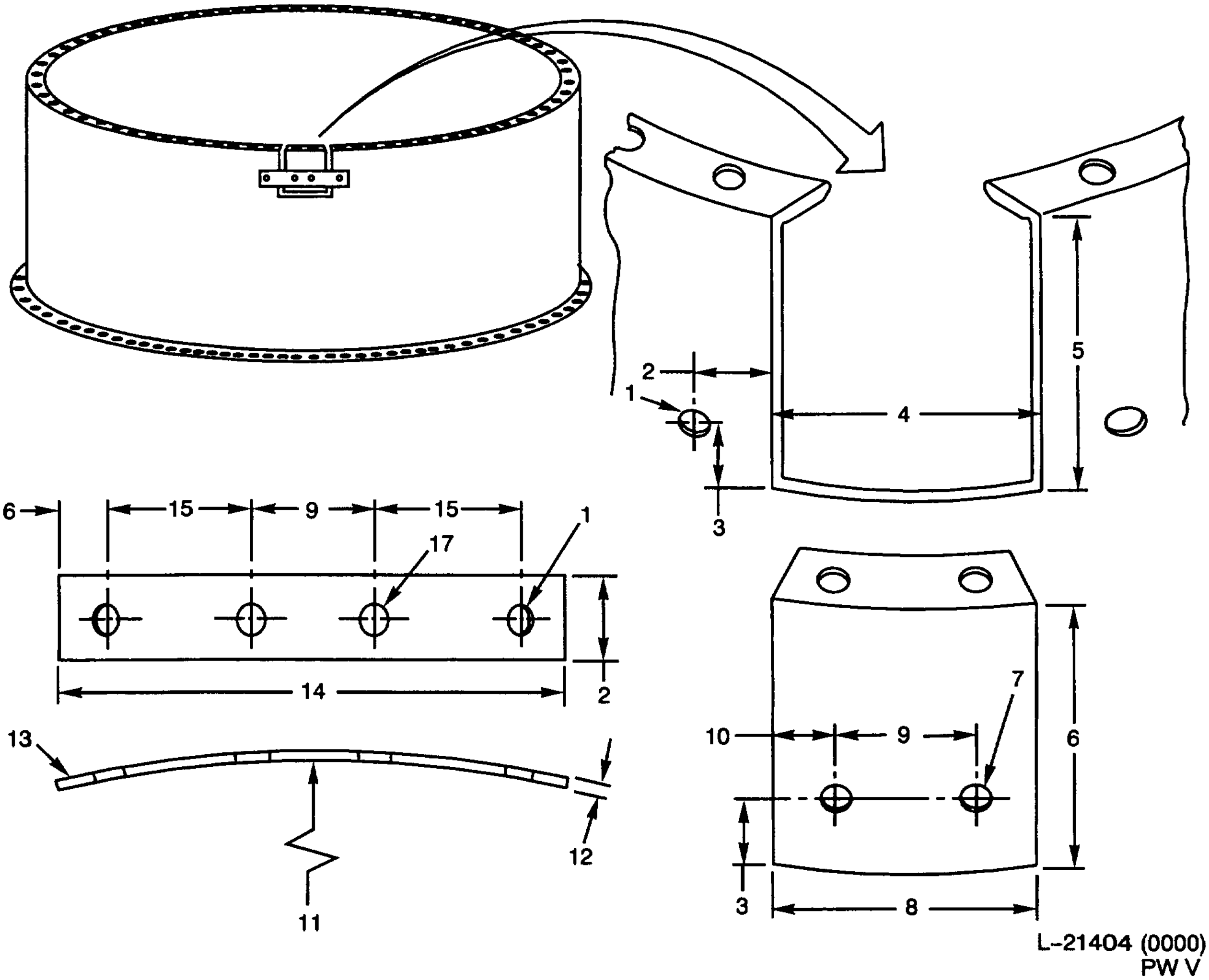
R 13. No Paint Area (Dowel Pin Holes).

R 14. 0.027 - 0.032 Inch

R 15. Paint Area (Flange Mating Surfaces) (PWA 110-21 Top Coat Only)
R (Approximately 0.0001 Inch Thickness)

R 16. Drain Boss Weld Repair Area

Key To Figure 610



R Test Segment And Holder
R For Combustion Chamber
Outer Case Nickel Plating
Figure 611

ENGINE COMBUSTION - INSPECTION, REPAIR, AND REPLACEMENT

1. 1/4 Inch Diameter Holes (2)
2. One Inch
3. 1 1/4 Inches
4. 3.000 - 3.010 Inches
5. 3.620 - 3.630 Inches
6. 3.610 - 3.620 Inches
7. 1/4-20 Tapped Holes (2)
8. 2.990 - 3.000 Inches
9. 1 1/2 Inches
10. 3/4 Inch
11. 10.260 - 10.300 Inches Radius
12. 1/8 Inch
13. Strap Detail AMS 5504 Or Equivalent
14. Six Inches
15. 1 3/4 Inch
16. 1/2 Inch
17. 9/32 x 3/8 Inch Holes (2)

Key To Figure 611

R (a) Remove protective coat from the case with either of
R these methods as applicable:

R 1 Method 1 (PN 506809)

R a Remove aluminum enamel (PWA 578) by SPOP 16
R or SPOP 260.

R b Remove nickel-cadmium plate by SPOP 25.

R 2 Method 2 (PN 819035)

R a Remove PWA 561 top coat by SPOP 258.

R b Remove aluminum paint (PWA 595) by SPOP 258.

R (b) Coat the combustion chamber outer case by
R PWA 110-21, 0.0005 - 0.002 inch thickness (but not
R in areas specified in Figure 610). Refer to
R (Task 70-41-04-380-101-001) Section 70-41-04 in the
Standard Practices Manual.

R NOTE: Nickel-cadmium plate is no longer permitted
R as a protective coating for the combustion
R chamber outer case. Refer to SB 6444.

(7) Localized painting

R (a) When the condition of case paint or coating makes
R it necessary, replace coating locally or on all
R of the case (do not include areas identified in
R Figure 610 as no coat areas). Apply two coats
R of high-baking, heat-resistant aluminum coating
R (Task 70-41-04-380-101-001). Refer to Section
R 70-41-04 in the Standard Practices Manual.

4. Combustion Chambers
See Figure 612.

A. General

(1) Inspect combustion chambers visually and by fluorescent penetrant method. See Overhaul Standard Practices Manual.

(2) Certain types of cracking and burning deterioration resulting from thermal stresses may occur after periods of operation. Majority of cracking and burning deterioration occurs in early stages of engine operation, and further progression may be expected to proceed at greatly reduced rate.

(3) Progress of such determination with further engine operation is usually negligible, since deterioration, that has been produced by thermal stresses in effect relieves original stress conditions.

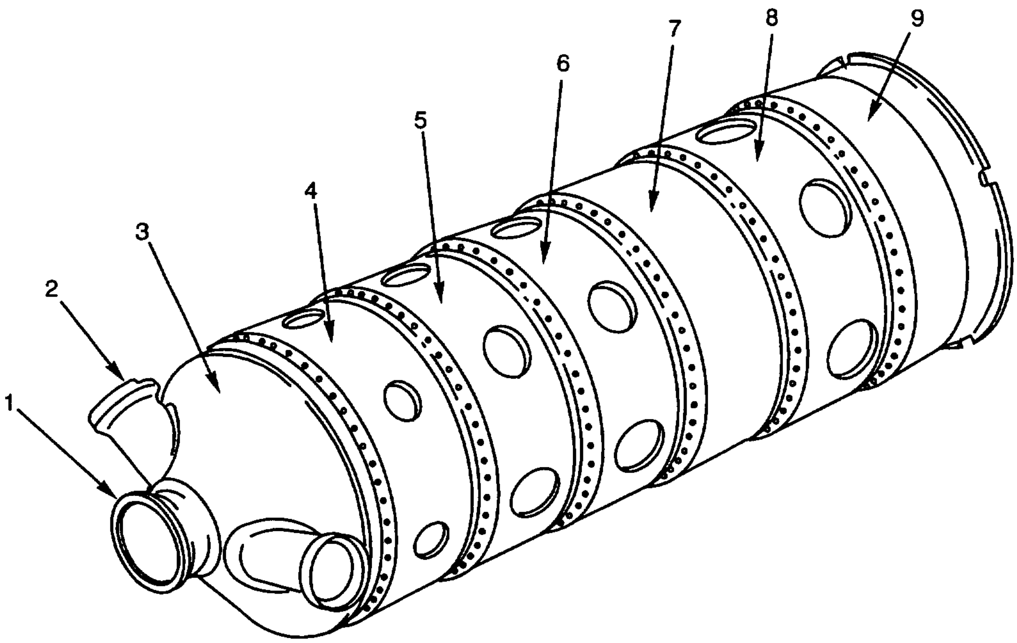
B. Burning

(1) Burning or erosion through sidewalls or front cone is unacceptable without repair. Only damage falling in limits of patch repair, Paragraph F.(3), may be repaired.

(2) Burning of first and second row of tabs inside chambers is acceptable if it meets the following requirements: See Figure 613.

(a) Burning of one, or both, corners of each tab is acceptable provided burning has not progressed into weld seams and total burned area on each tab does not exceed 25 percent of total area of tab.

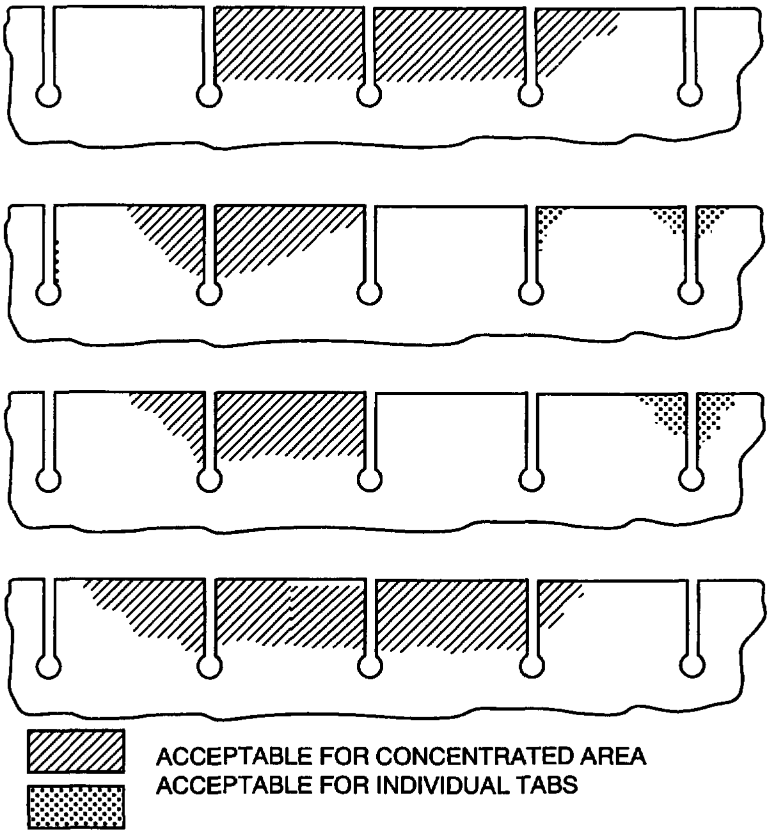
NOTE: References to tab burning limits apply to only JT12A-6 and -6A combustion chambers.



1. Fuel Nozzle Cup Adapter
2. Flame Tube
3. Fuel Nozzle Cup
4. No. 1 Liner
5. No. 2 Liner
6. No. 3 Liner
7. No. 4 Liner
8. No. 5 Liner
9. No. 6 Liner

R
R

Combustion Chamber
Figure 612



R
R

Tab Burning Limits
(JT12A-6 And -6A Only)
Figure 613

(b) Burning in excess of above requirement is acceptable in concentrated area provided total burned area of tabs involved is not greater than area of three complete tabs, and provided no more than two adjacent tabs are completely burned away.

(c) If tab burning in excess of above limits occurs in first (forward) row of tabs, all of first row tabs may be removed and chamber continued in service.
R Remove tabs to depth shown in Figure 614. Use hand tool with rotary type carbide cutter operating at 16,000 - 22,000 rpm, or any other suitable method that will not cause damage to combustion chamber liner wall. Under no circumstances are tabs of second row to be so machined.

<u>CAUTION</u>: IF FIRST ROW TABS WERE REMOVED AT PREVIOUS OVERHAUL, SECOND ROW TABS CANNOT BE CONSIDERED AS FIRST ROW OF TABS. SECOND ROW TABS MUST REMAIN IN THE LIMITS SPECIFIED IN STEP B.(2)(b).

(d) Burning of combustion chamber segments without slots (not divided into tabs) is limited to 3/8 inch in depth and one inch circumferentially. Burning in excess of this limit shall be repaired per Paragraph F.(b).

<u>NOTE</u>: Use a stone to smooth any rough edges remaining after cutting off tabs.

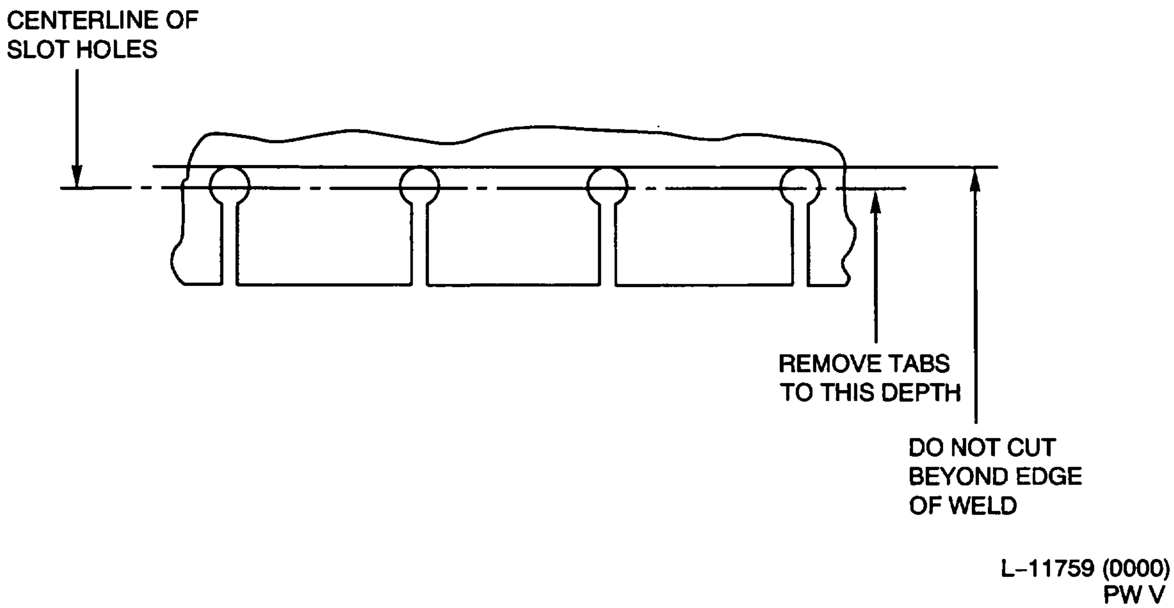
(1) Burning of cone within boundary of crossover tube welds is acceptable provided welded area is not structurally affected.

A. Cracking

(1) Minor axial cracks in seam welds are acceptable provided they are not accompanied by extreme buckling. Such cracks should be stop drilled and welded if they are visible from outside.

(2) Cracks in seam welds circumferentially around combustion chambers are not acceptable.

(3) Cracks at combustion air holes are not acceptable.



Tab Removal Limits
Figure 614

(4) Any cracks originating from keyhole slots which might subsequently result in metal breaking loose are not acceptable.

(5) Prior to weld repair, solution heat treat combustion chamber assembly at 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at the rate of air cool or faster. See Standard Practices Manual for general information.

(6) Weld the cracks using AMS 5798 (Hastelloy X) weld rod. See Section 70-42-04, Standard Practices Manual.

(7) Stress-relieve combustion chamber assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04 Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

(8) Fluorescent penetrant inspect welded by SPOP 70 (local application) (normal sensitivity). Refer to Section Section 70-33-00, Standard Practices Manual.

B. Buckling: Sidewall buckling is acceptable if:

(1) It does not include an adjacent welded area.

(2) It does not weaken the part structurally.

(3) It does not affect the part length.

C. Distortion: If rear liner of combustion chamber is Out-of-round in excess of 1/16 inch, it must be brought within 0.025 inch round. This may be accomplished by rolling or through use of suitable mandrel.

D. Wear on combustion chamber:

(1) Area that contacts retaining clamp must not exceed 0.010 inch. Minimum wall thickness in same area shall be 0.010 inch.

(2) Plasma coating: Worn plasma coating be replaced as follows:

(a) Mask areas not to be coated.

R R R (b) Prepare the surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(c) Plasma coat worn area within limits specified by Figure 615 with PWA 1318 powder. (See Plasma Coatings, Overhaul Standard Practices Manual) Bring coating back to the initial 0.002 - 0.004 inch thickness. Dimensions shown are after plasma coating.

(3) Combustion Chamber Patch Repair

(a) Cracks, buckling, or burning may be repaired by this procedure provided damage complies with the following constraints:

1 Maximum permissible patch area is two inches (axially) by three inches (circumferentially).

2 No more than 30 square inches may be patched in any one combustion chamber.

3 Only one seam weld may be included in each patch.

4 Patches may not extend into hardfaced or PWA-581 treated area at rear of can.

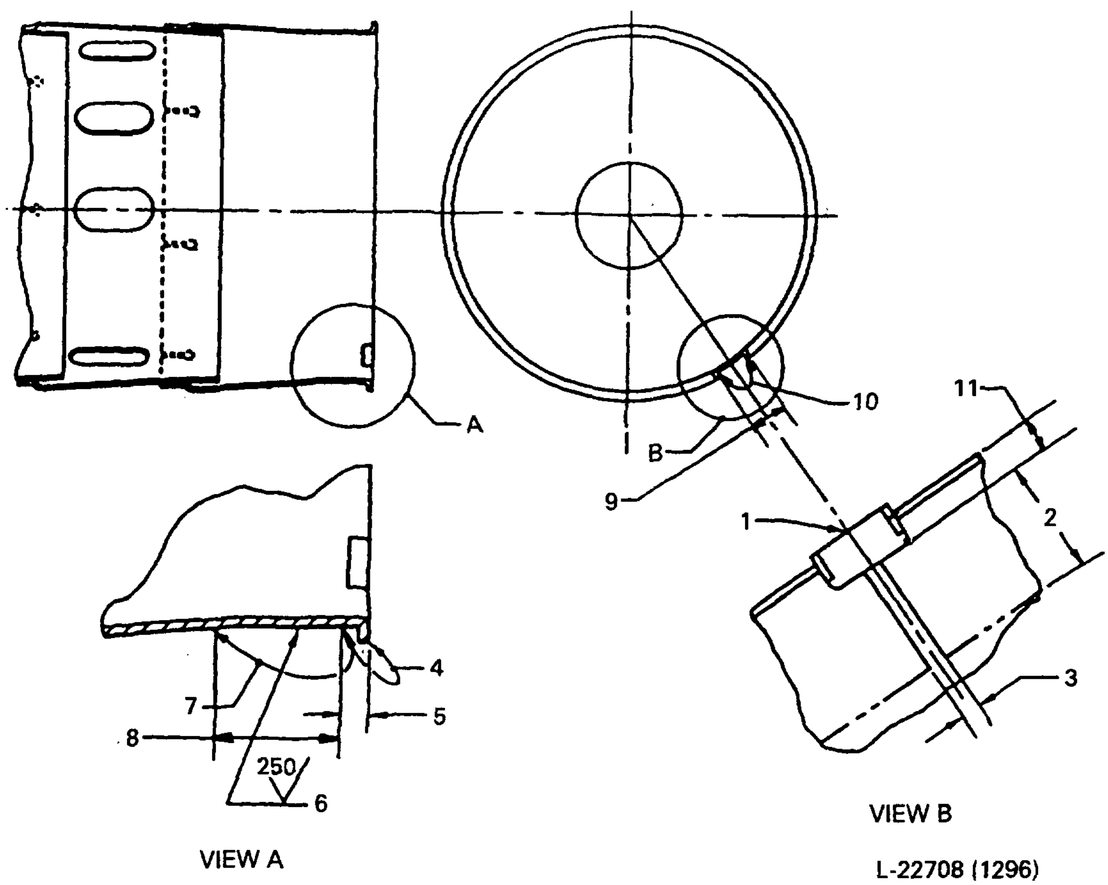
5 Patches may not extend more than 1/2 inch into dome section at front of can.

6 Minimum of 1/4 inch sound undamaged material must lie between damage and any point on boundary of patch area. This will ensure that patch weld is made in sound material.

7 Patch repairs shall be no closer than 1 1/2 inches from each other.

(b) If damaged combustion chamber falls within above limits, perform patch repair as follows:

1 Prior to patch repair, solution heat treat combustion chamber assembly at 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at rate of air cool or faster. See Standard Practices Manual for general information.



R
R

Combustion Chamber Plasma
Coat Repair
Figure 615

1. Centerline Of Guide
2. Extremity Of Coating
3. 0.125 Inch Centered In Relation To Index 1 Within 0.030 Inch. Omit This Area From Plasma Coat Over Distance 2.
4. No Plasma Coat Permitted
5. 0.055 - 0.120 Inch
6. Surface Roughness Is After Plasma Coating. Wire Brush Coating To Eliminate Abrasive Surface, Maintaining Plasma Coating Thickness And Surface Roughness Requirements. Grinding Of Coating Is Not Permitted.
7. Plasma Coat Area
8. 1.030 Inches
9. 0.049 Inch Minimum
10. Coating Optional And May Be Incomplete
11. 0.240 Inch

Key To Figure 615

2 Layout and scribe lines which define area to be patched.

3 If air holes lie within patch area carefully fabricate template indicating position of holes to be restored following installation of new patch.

4 Cut out and remove section to be replaced.

CAUTION: ENSURE THAT CUTTING TOOL IS KEPT JUST INSIDE SCRIBE LINES TO ENSURE THAT MINIMUM GAP (0.030 INCH MAXIMUM ALLOWED) WILL BE ACHIEVED WHEN PATCH IS FITTED TO CHAMBER.

5 Burr and lightly bevel edges of patch area.

6 Fabricate patch from extra combustion chamber by repeating steps (1), (2) and (4) from above. cutting tool shall be kept just outside scribe lines in order to minimize gap. Then burr and lightly bevel edges of patch.

NOTE: Patch for flat section of louvre not extending into cooling hole or seam weld area may be fabricated from AMS 5536 sheet stock, 0.027 - 0.031 inch thick.

7 Fit patch into hole in chamber so that maximum gap is 0.030 inch, and tack weld into place.

8 Weld the patch in place with AMS 5798 (Hastelloy X) weld rod. See Section 70-42-01, Standard Practices Manual.

9 Stress-relieve combustion chamber assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04, Standards Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

10 Fluorescent penetrant inspect welded areas by SPOP 70 (local application). Use normal sensitivity inspection fluid. See Section 70-33-00, Standard Practices Manual.

11 Blend welds to within 0.020 inch of parent metal surface without attempting to dress welds absolutely flush with parent material.

12 Repeat fluorescent penetrant inspection of welded areas by SPOP 70 (local application) (normal sensitivity). See Section 70-33-00, Standard Practices Manual.

13 Blend welds to within 0.020 inch of parent metal surface without attempting to dress welds absolutely flush with parent material.

14 Drill air holes, if applicable, in accordance with template fabricated in step 3 above.

(4) Combustion Chamber Flame Tube

(a) Prior to weld repair, solution heat treat combustion assembly at 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at the rate of air cool or faster. See Standard Practices Manual for general information.

(b) Weld repair using AMS 5798 (Hastelloy X) weld rod. See Section 70-42-01, Standard Practices Manual.

(c) Hand blend down weld.

(d) Stress-relieve combustion chamber assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

(e) Fluorescent penetrant inspect welded areas by SPOP 70 (local application) (normal sensitivity). See Section 70-33-00, Standard Practices Manual.

(5) Combustion Chamber Crossover Tube Baffle Replacement See Figure 616.

NOTE: The crossover tube baffle is found in combustion chambers at the No. 2, 4, and 8 positions.

(a) Before weld repair, solution heat treat the combustion chamber assembly at 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at the rate of air cool or faster. Refer to the Standard Practices Manual for general information.

(b) Grind out the damaged baffle. Do not remove crossover tube material.

(c) Make a new baffle from AMS 5536 to the limits shown in the figure.

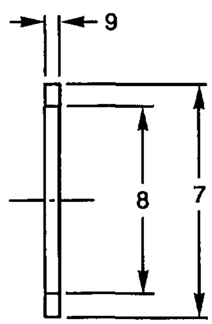
(d) Weld the new baffle in position with AMS 5798 (Hastelloy X) weld rod. Refer to 70-42-01 in the Standard Practices Manual.

(e) Decrease weld bead heights to 0.020 inch maximum by hand grinding.

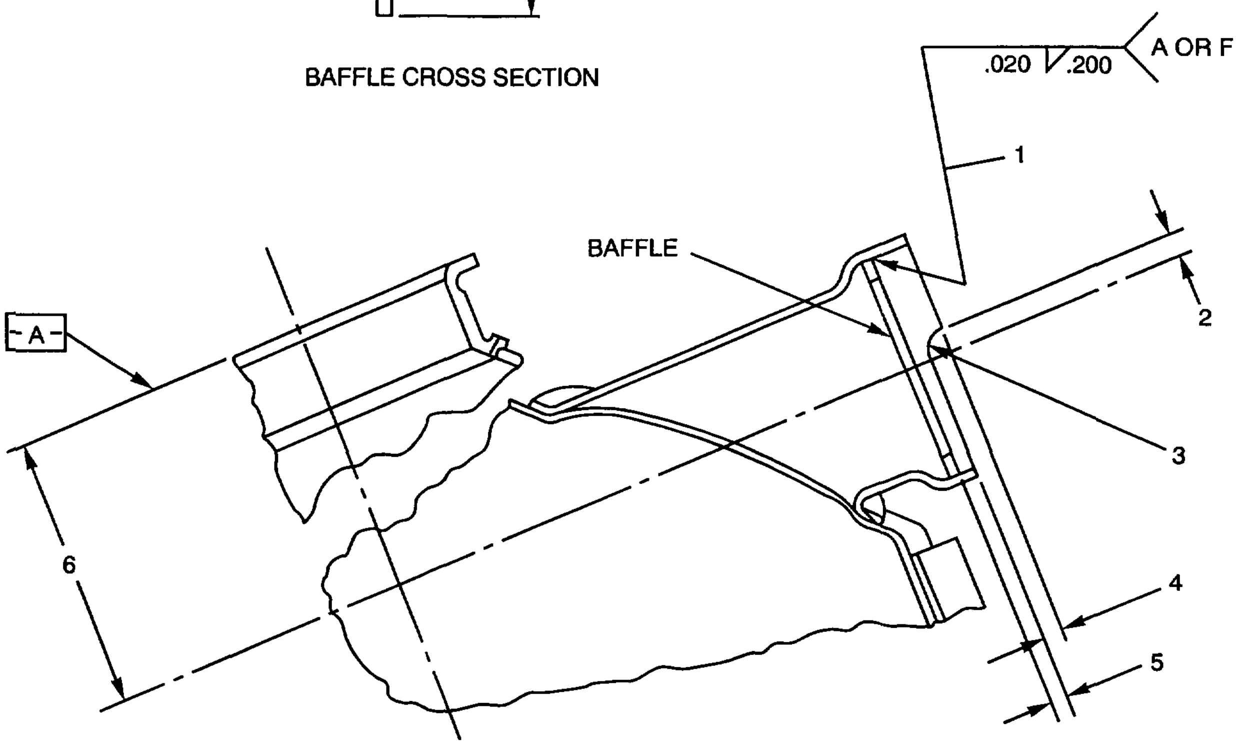
(f) Stress-relieve the combustion chamber assembly by SPOP 463 (Cycle No. 10). Refer to 70-42-04 in the Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

(g) Do a fluorescent penetrant inspection of welded areas by SPOP 70 (local application) (normal sensitivity). Refer to 70-33-00 in the Standard Practices Manual.



BAFFLE CROSS SECTION



CROSS SECTION THROUGH CROSSOVER TUBE (EITHER SIDE)

L-H8371 (1207)
PW V

R 1. Weld The Baffle As Shown, 4 Places Approximately
R Equal Distance Apart.
R 2. 0.100 - 0.120 Inch
R 3. 0.076 - 0.109 Inch Modified Radius
R 4. 0.110 - 0.130 Inch
R 5. 0.060 - 0.080 Inch
R 6. 1.225 Inch (Reference)
R 7. 1.132 - 1.136 Inch Diameter
R 8. 0.910 - 0.930 Inch Diameter
R 9. 0.045 - 0.050 Inch

R Key To Figure 616

R (6) Combustion Chamber No. 6 Liner Replacement. See Figure 617.

(a) Repair damaged No. 6 liners by installing replacement part (PN 758589) as follows:

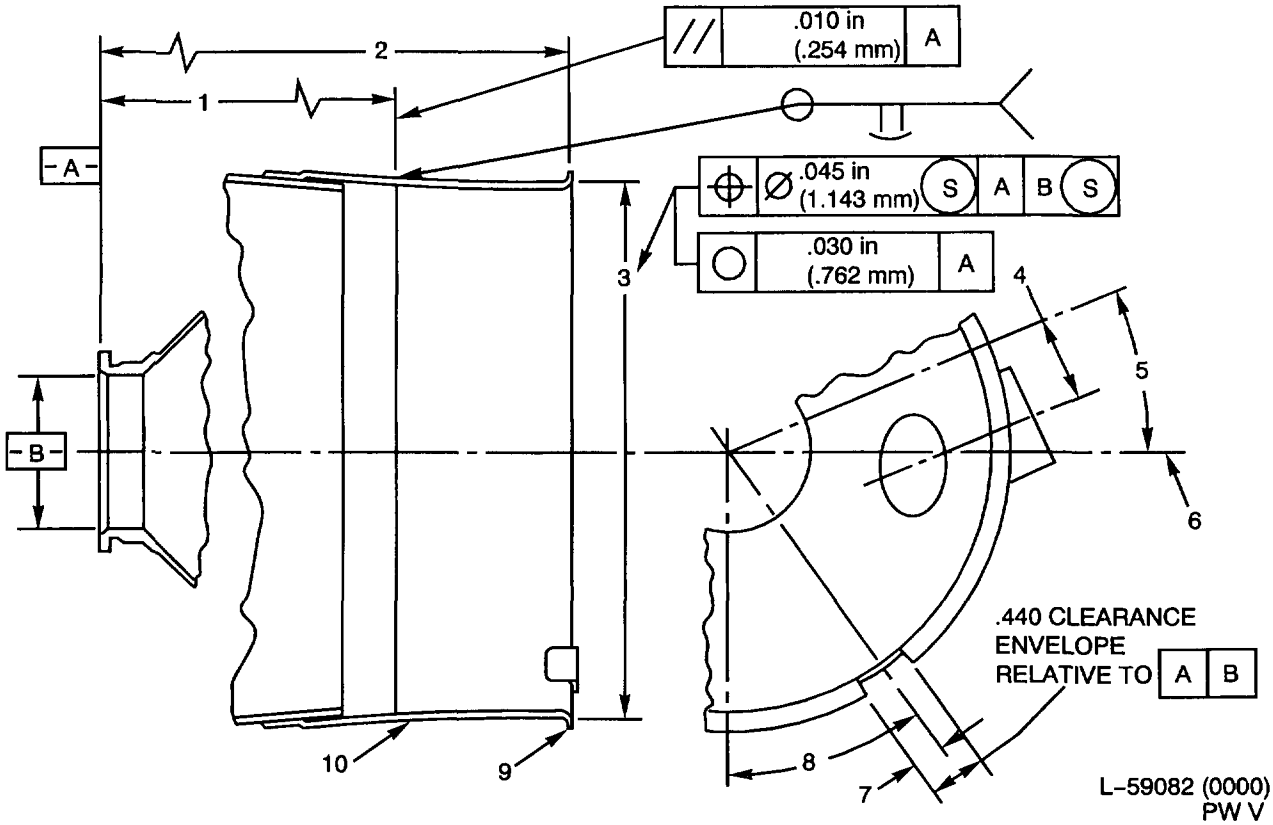
NOTE: Replacement part may be locally produced by using combustion chambers which have been discarded for reasons other than damaged No. 6 liners. Cutoff replacement part at Index 1 dimension of figure.

(b) Prior to No. 6 liner repair, solution heat treat combustion chamber assembly at 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at the rate of air cool or faster. See Standard Practices Manual for general information.

(c) Cut off damaged liner to indicated dimension.

(d) Weld on replacement part as shown. Weld replacement liner with AMS 5798 (Hastelloy X) weld rod. See Section 70-42-01 in the Standard Practices Manual.

(e) Blend welds to within 0.020 inch or parent metal surface without attempting to dress welds absolutely flush with parent material.



1. 14.300 - 14.800 Inches. Cut Damaged And/Or Replacement Part Off To This Dimension
2. 16.185 - 16.245 Inches
3. 5.101 - 5.115 Inch Average Diameter
4. 0.800 Inch Reference
5. 22° 30' Reference
6. Horizontal Axis Of Diameter B
7. 0.220 Inch
8. 35°
9. PN 758589 Liner Assembly
10. Permissible To Finish This End Of Index 9 Part To Maintain Index 2 Dimension

Combustion Chamber
Liner Repair
Figure 617

(f) After weld repairs are made, stress-relieve combustion chamber assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

R (g) Fluorescent penetrant inspect welded areas by SPOP 70 (local application) (normal sensitivity). See Section 70-33-00, Standard Practices Manual.

R (7) Combustion Chamber No. 4 - 6 Liners Replacement. See
R Figure 618.

(a) Repair the damaged 4th - 6th stage combustion chamber liners. Install a repair part from the list below:

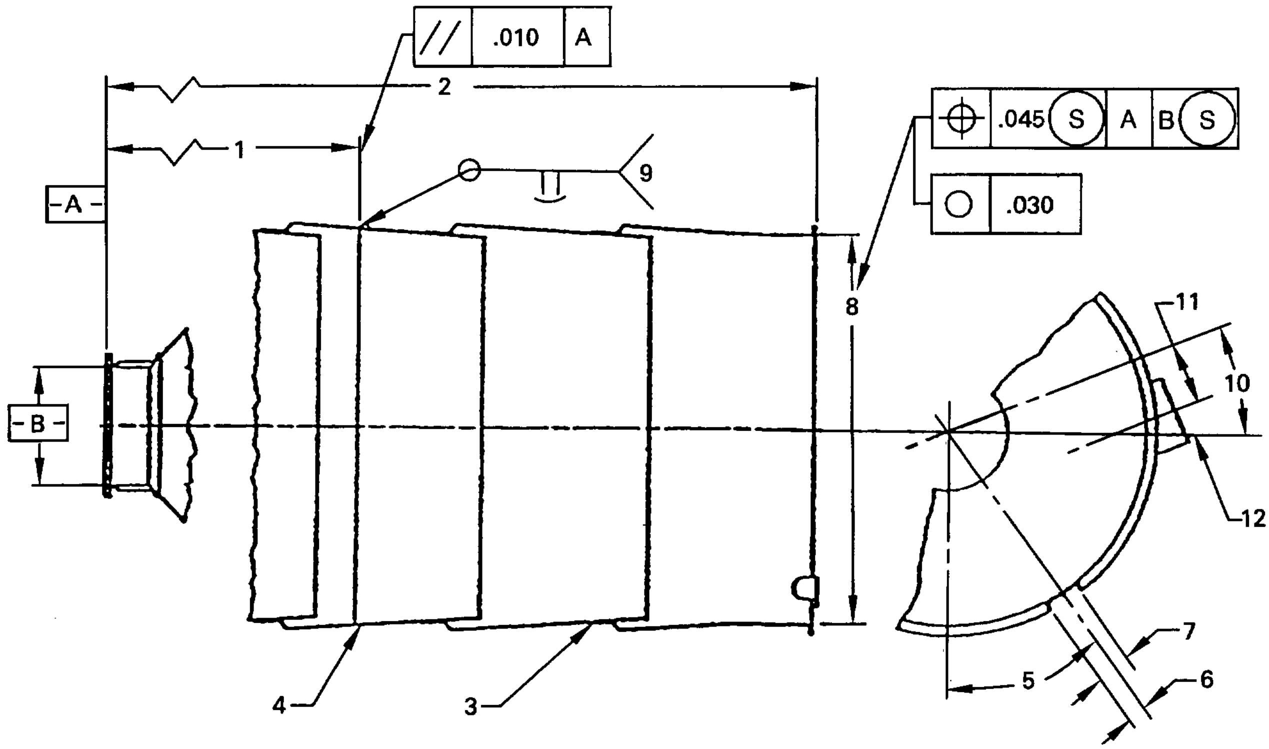
Chamber	PN	Repair Part PN
1	769242	813092
2, 4	769243	813093
3	769244	813093
5, 7	769245	813093
6	769246	813093
8	769247	813094

NOTE: The replacement part can be made locally by using combustion chambers which have been discarded for reasons other than damaged
R liners. Cut off to Index 1, Figure 618.

1 Prior to No. 4 - 6 liner repair, solution heat treat combustion chamber assembly at 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at the rate of air cool or faster. See Standard Practices Manual.

2 Cut off damaged liner to indicated dimension.

3 Weld on replacement part as shown. Thermal barrier coating should be removed before welding. Weld replacement liner using AMS 5798 (Hastelloy X) weld rod. See Section 70-24-01, Standard Practices Manual.



L-H3167 (1296)

Combustion Chamber Liner Repair
Figure 618

1. 9.900 - 10.400 Inches. Cut Damaged And/Or Replacement Part Off To This Dimension
2. 16.185 - 16.245 Inches
3. PN 813092, 813093, Or 813094 Liner Assembly
4. Permissible To Finish This End Of Index 3 Part To Maintain Index 2 Dimension
5. 35 Degrees
6. 0.220 Inch
7. 0.440 Clearance Envelope Relative To Datums A And B
8. 5.101 - 5.115 Inch Average Diameter
9. Weld By PWA 16-3, A Or J. See Standard Practices Manual, Section 72-42-01.
10. 22.5 Degrees Reference
11. 0.800 Inch Reference
12. Horizontal Axis of Diameter B

R Key To Figure 618

4 After weld repairs are made, stress-relieve combustion chamber assembly by SPOP 463 (Cycle No. 10). See Section 70-24-04, Standard Practices Manual.

5 Fluorescent penetrant inspect welded areas by SPOP 70 (high sensitivity). See Section 70-33-00, Standard Practices Manual. Rework as required.

6 Dimensionally inspect the combustion chamber assembly as instructed in this section.

7 Replace the combustion chamber coatings/plating as required as instructed in this section.

R (8) Combustion Chamber Dome Flange Replacement. See
R Figure 619 thru Figure 622.

NOTE: See Table 601 for applicable repair combustion chamber assembly part numbers.

Part Number	Description
695857	Chamber-Combustion, 3, Assembly, Of
695858	Chamber-Combustion, 1, 5, and 7, Assembly, Of
695859	Chamber-Combustion, 2, 4, and 8, Assembly, Of
695860	Chamber-Combustion, 6, Assembly, Of
754146	Chamber-Combustion, 3, Assembly, Of
754147	Chamber-Combustion, 5, and 7, Assembly, Of
754148	Chamber-Combustion, 2, and 4, Assembly, Of

Applicable Combustion Chambers
Table 601

Part Number	Description
(CONTINUED)	
754149	Chamber-Combustion, 6, Assembly, Of
754151	Chamber-Combustion, 8, Assembly, Of
754153	Chamber-Combustion, 1, Assembly, Of
755864	Chamber-Combustion, 8, Assembly, Of
755865	Chamber-Combustion, 1, Assembly, Of
769242	Chamber-Combustion, 1, Assembly, Of
769243	Chamber-Combustion, 1, 5, and 7, Assembly, Of
769244	Chamber-Combustion, 2, and 4, Assembly, Of
769245	Chamber-Combustion, 5, and 7, Assembly, Of
769246	Chamber-Combustion, 6, Assembly, Of
769247	Chamber-Combustion, 8, Assembly, Of

Applicable Combustion Chambers
Table 601 (Continued)

(a) Remove the coating or plating (PWA 53-18 coating, for example) if present, from the combustion chamber assembly surfaces.

(b) Solution heat treat the combustion chamber assembly by SPOP 480 (Cycle No. 20). Refer to Section 70-42-04, Standard Practices Manual.

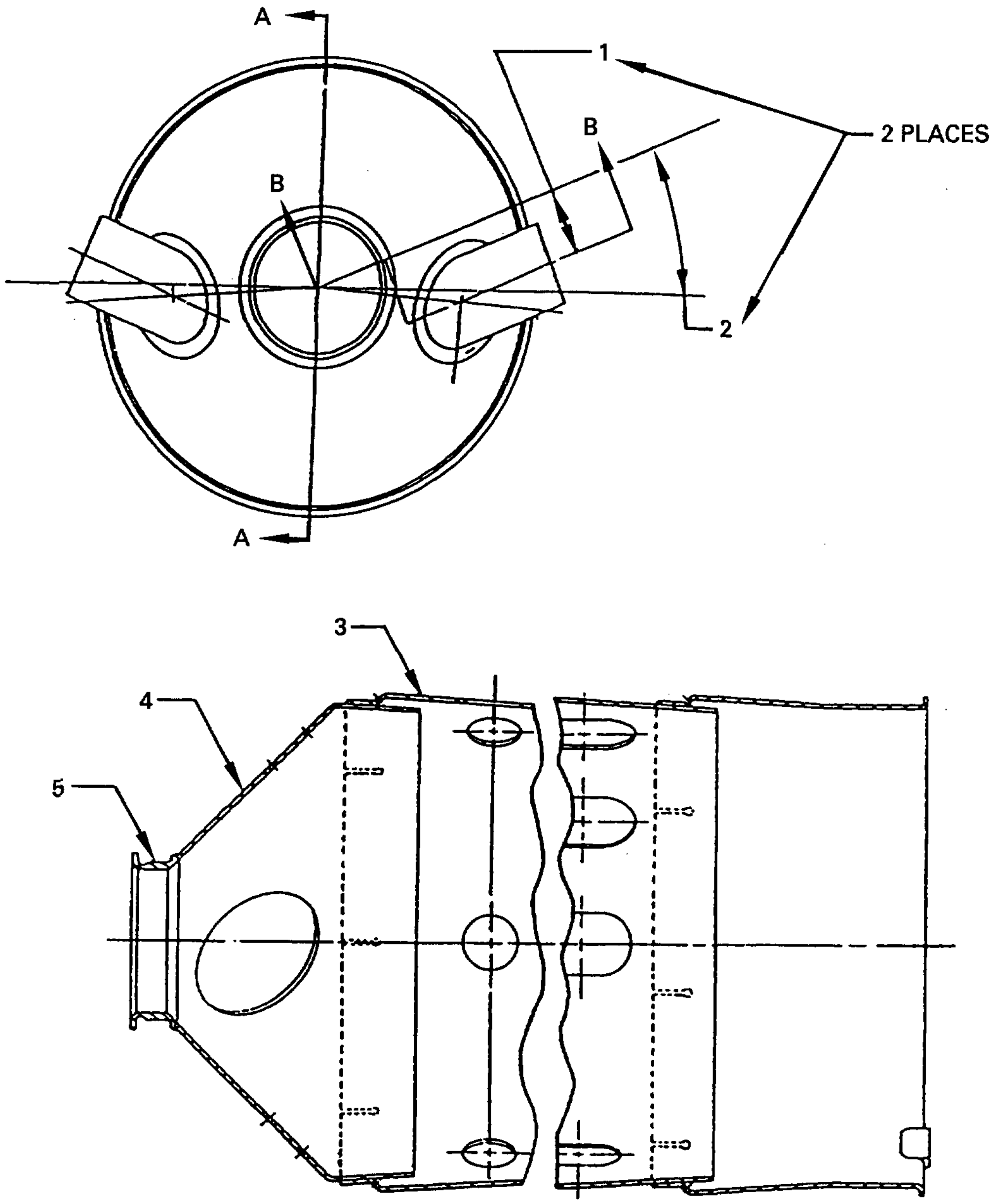
<u>NOTE</u>: Air cool or faster is a cooling rate of not less than 19°C (35°F) per minute to 593°C (1100°F) and not less than 8°C (15°F) per minute from 593°C (1100°F) to 538°C (1000°F).

R (c) Machine to remove the combustion chamber front flange (PN 695861) at Dimension E. See Figure 620.

<u>NOTE</u>: You can use PWA 39016 Fixture to do this repair, but minor modifications to the fixture can be necessary to make sure there is sufficient machining clearance.

R (d) Rework the remaining combustion chamber forward liner front edge to make it easier to do the new front flange weld procedure. See Figure 620 (Sheet 1).

(e) Degrease by SPOP 209 (refer to Section 70-21-00, Standard Practices Manual).



Combustion Chamber Dome
Flange Replacement
Figure 619

1. 0.800 Inch (Reference), Two Places
2. 22.5 Degrees (Reference), Two Places
3. PN 695854 Liner
4. PN 695852 Liner
5. PN 695681 Liner

R Key To Figure 619

(f) Put the combustion chamber replacement front flange (PN 695861) on the remaining forward liner front edge. Flange detail Diameter G must be concentric with combustion chamber assembly center line Diameter H within 0.005 inch FIR.

(g) Weld the flange to the liner by manual gas tungsten-arc (TIG) or machine gas tungsten-arc by PWA 16-23. Weld filler wire is not required, but if you want to use weld filler wire, use AMS 5680. The mating parts can be fitted at assembly. See
R Figure 620 (Sheet 2) and Section 70-24-01, Standard Practices Manual.

(h) Stress-relieve the combustion chamber assembly by SPOP 463 (Cycle No. 10) at 982° ± 13.8°C (1800° ± 25°F) for one hour, then air cool.

(i) Fluorescent penetrant inspect the repaired area by SPOP 70 (high sensitivity). Rework as necessary.

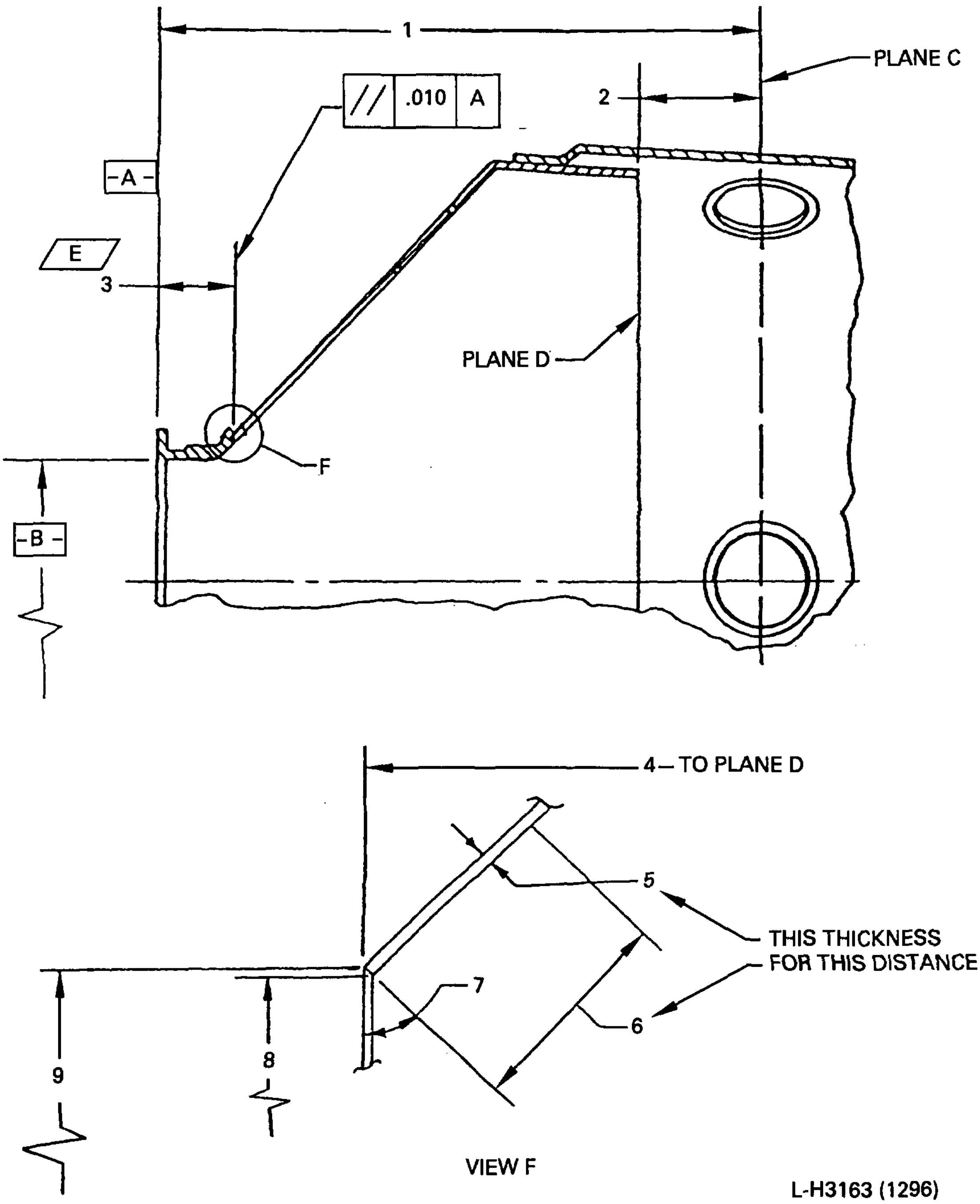
(j) From Plane J, finish machine Face K of the flange. Face K must be square to combustion chamber center line Diameter H within 0.005 inch FIR. See
R Figure 621.

<u>CAUTION</u>: BE CAREFUL TO MAKE SURE THAT THE COMBUSTION CHAMBER OVERALL LENGTH, CROSSOVER TUBE AXIAL POSITION AND IGNITER ASSEMBLY AXIAL POSITION (AS APPLICABLE) FROM FACE K ARE MAINTAINED. SEE FIGURE 621.

(k) Finish machine the remainder of the flange. See
R Figure 621.

(l) Degrease by SPOP 209 in Section 70-21-00, Standard Practices Manual.

(m) Dimensional inspect the combustion chamber assembly as required as instructed in this section.



Front Flange Removal
Requirements
Figure 620 (Sheet 1)

1. 3.820 Inches (Reference)
2. 0.790 Inch (Reference)
3. 0.479 - 0.489 Inch
4. 2.527 Inches
5. 0.027 - 0.031 Inch
6. 0.840 Inch Maximum
7. 45° ± 5°
8. 1.800 - 1.810 Inch Average Diameter
9. 1.846 Inch Diameter (Reference)

R Key To Figure 620 (Sheet 1)

(n) Replace the combustion chamber coating or plating as required as instructed in this section.

(o) Reoperated combustion chamber assemblies will keep their initial part number identification.

5. Combustion Chamber Clamp

A. Inspection

(1) Retaining clamps worn to wall thickness below 0.015 inch shall be scrapped.

(2) Worn clamps which do not exceed this limit can get plate
R repair. See Figure 623.

NOTE: Plate repair procedure is applicable only to clamps which did not get plasma coat repair.

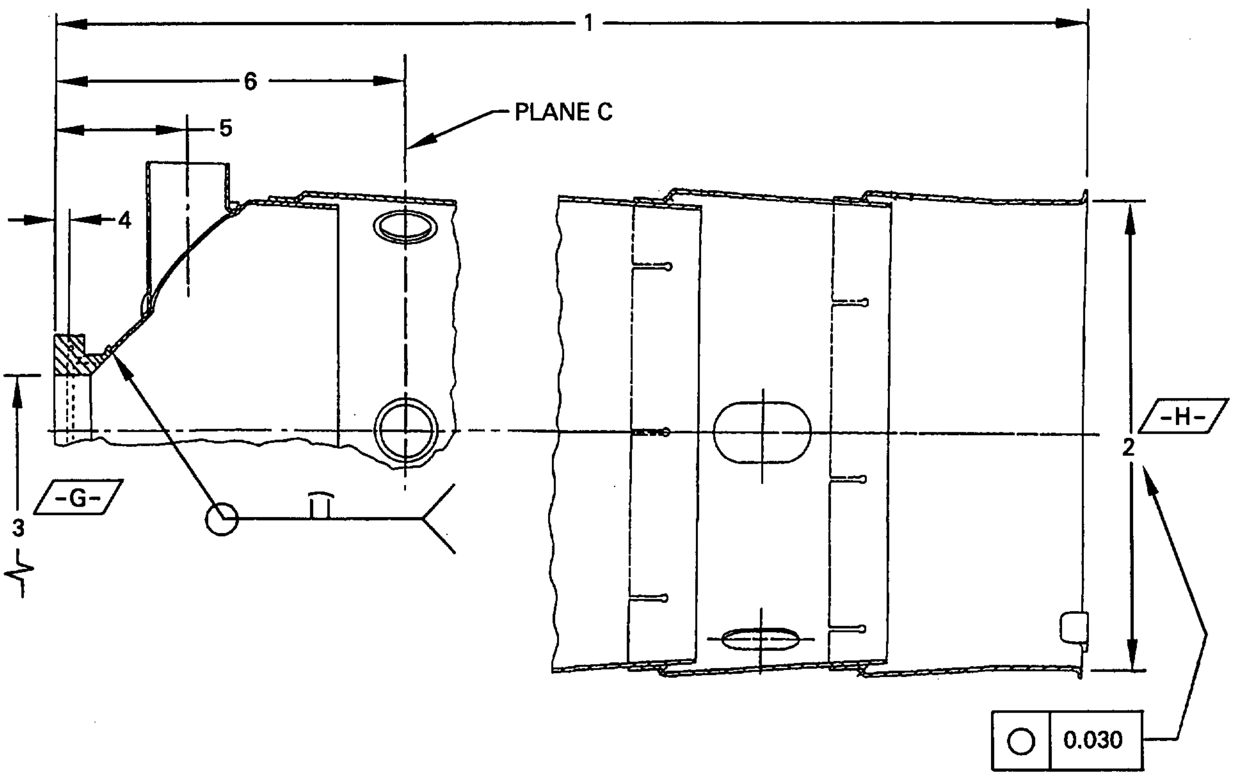
(3) Cracks up to 3/8 inch long at corners of lock area (see
R Figure 624), or cracks through both front and rear channels at junction of band and lock assembly
R (Figure 625) may be repaired.

(4) Worn plasma coating shall be replaced.

(5) If there is wear to the clamp mating area (key surface) from the outlet duct antirotation lug, do the weld repair below.

B. Repair

(1) Clamps with Cracks up to 3/8 Inch Long at Corners of
R Lock Area. See Figure 624.



SECTION B-B

L-H3164 (1296)

New Front Flange Weld And
Location Requirements
Figure 620 (Sheet 2)

1. 16.318 Inches (Reference)
2. 5.101 - 5.115 Inch Average Diameter
3. 1.350 - 1.353 Inch Diameter, Concentric With Index 2 Diameter 0.005 Inch FIR Maximum
4. 0.084 Inch (Reference)
5. 1.419 Inch (Reference)
6. 3.904 Inches (Reference)

R Key To Figure 620 (Sheet 2)

(a) Weld cracks with AMS 5694 (310 SST) weld rod. Refer to Section 70-42-01, Standard Practices Manual.

(b) After weld repairs are made, stress-relieve combustion chamber retaining clamp assembly by SPOP 459-2 (Cycle No. 5A) or SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

(c) Fluorescent penetrant inspect welded areas by SPOP 70 (local application) (normal sensitivity). Refer to Section 70-33-00, Standard Practices Manual.

(2) Clamps with Cracks Through Both Front and Rear Channels
R at Junction of Band and Lock Assembly. See Figure 625.

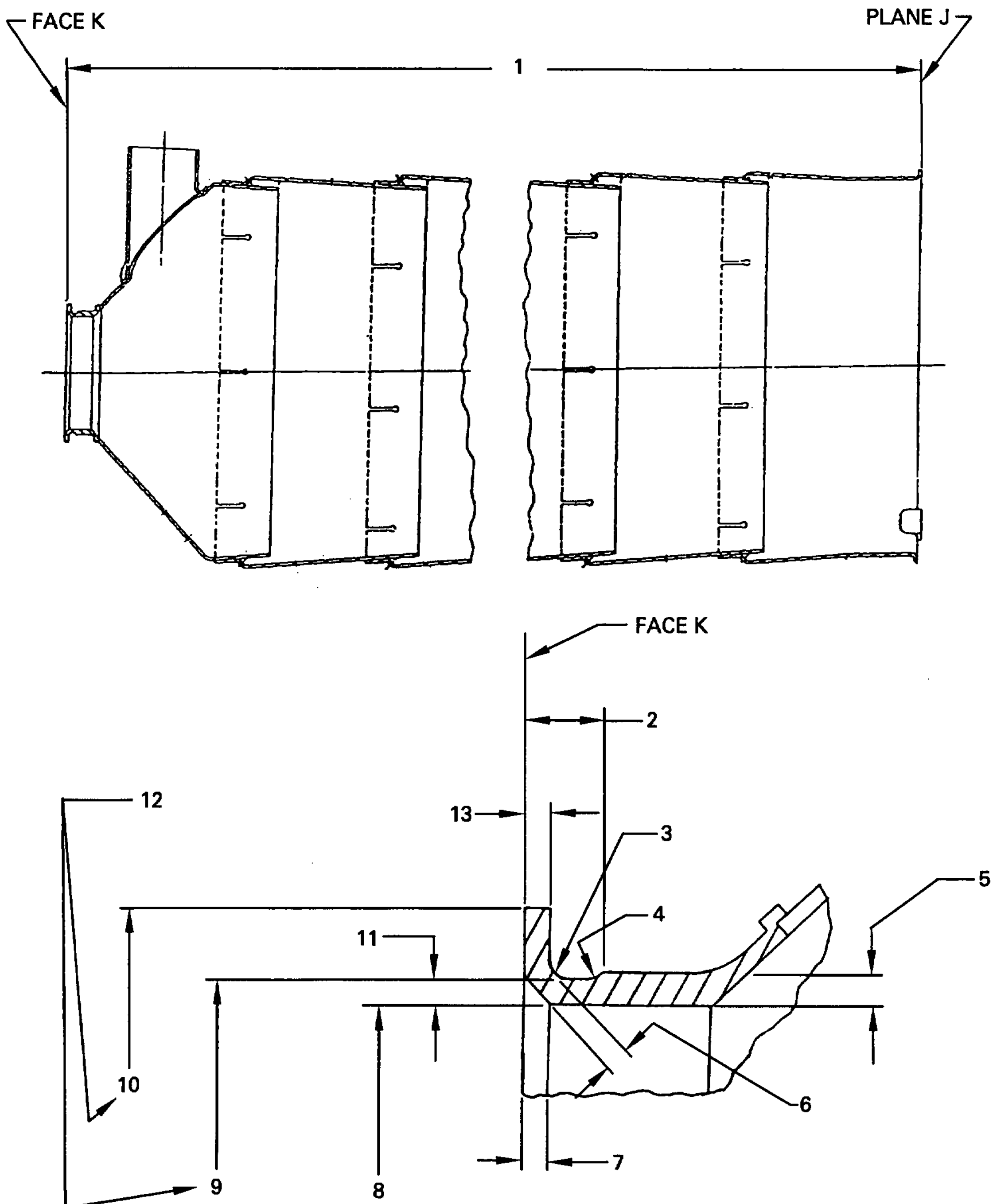
(a) Weld cracks using AMS 5694 (310 SST) weld rod. See Section 70-42-01, Standard Practices Manual.

(b) After weld repairs are made, stress-relieve combustion chamber retaining clamp assembly by SPOP 459-2 (Cycle No. 5A) or SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

(c) Fluorescent penetrant inspect welded areas by SPOP 70 (local application) (normal sensitivity). See Section 70-33-00, Standard Practices Manual.

(3) Clamps Which Were Not Plasma Coated



New Front Flange
Machine Requirements
Figure 621

1. 16.185 - 16.245 Inches
2. 0.150 - 0.170 Inch
3. 0.020 - 0.030 Inch Radius
4. 0.030 - 0.050 Inch Radius
5. 0.042 Inch Minimum
6. 0.035 Inch Minimum
7. Chamfer 0.040 - 0.060 Inch by 45° ± 2°
8. 1.532 - 1.536 Inch Diameter
9. 1.610 - 1.630 Inch Diameter
10. 1.870 - 1.890 Inch diameter
11. 0.035 Inch Minimum
12. These Diameters Must Be Concentric With Index 8 Diameter Within 0.005 Inch FIR
13. 0.046 - 0.048 Inch

R Key To Figure 621

(a) With abrasive wheel, remove any high spots or roughness.

(b) Weld cracks with AMS 5694 (310 SST) weld rod. See Section 70-42-01, Standard Practices Manual.

(c) After weld repairs are made, stress-relieve combustion chamber retain clamp assembly by SPOP 459-2 (Cycle No. 5A) or SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

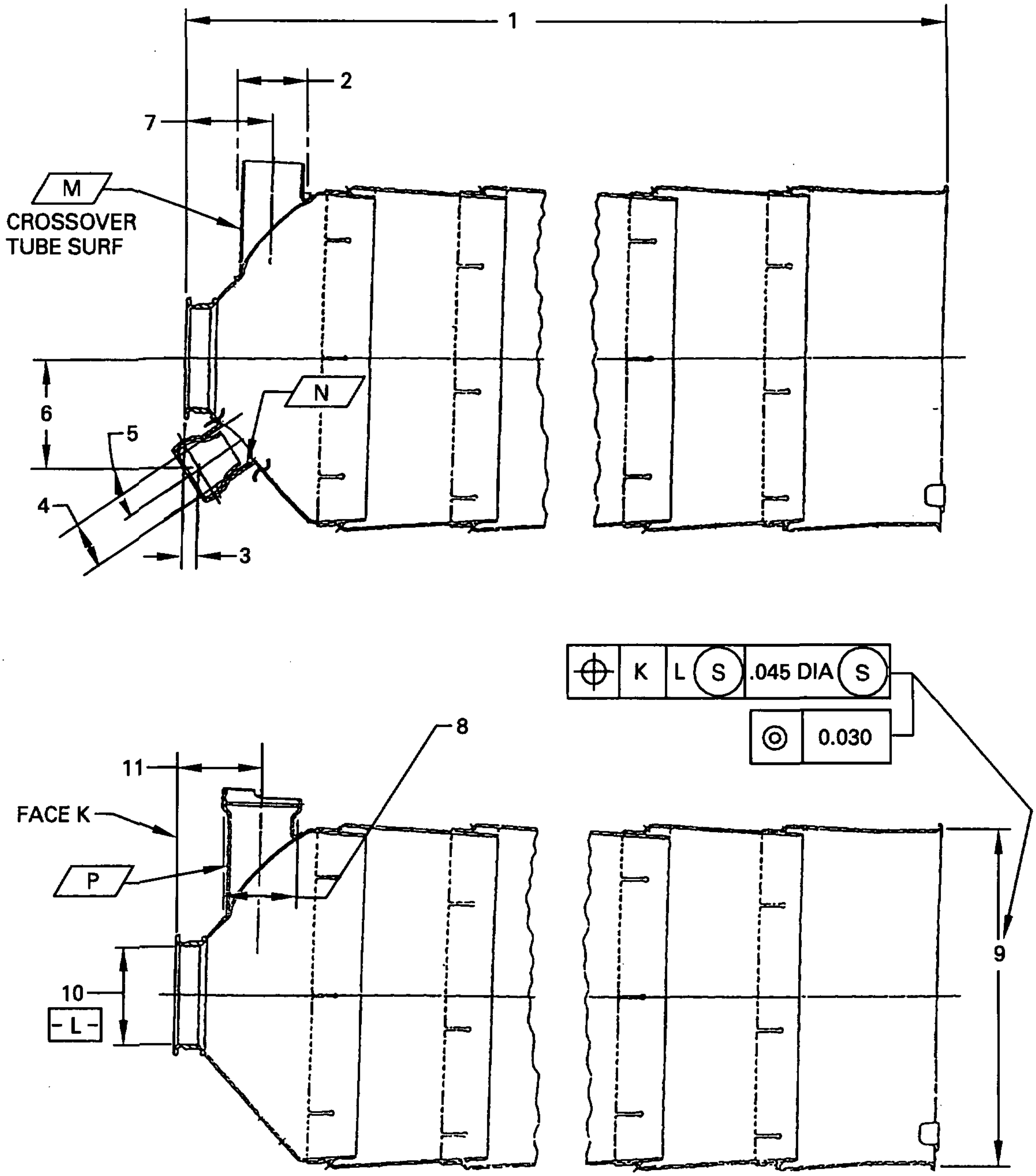
<u>NOTE</u>: Stress-relief is optional based on operator's experience

(d) Fluorescent penetrant inspect welded areas by SPOP 70 (local application) (normal sensitivity). See Section 70-33-00, Standard Practices Manual.

(e) Nickel plate designated areas 0.002 - 0.005 inch thick by SPOP 26. Refer to Plating in the Standard Practices Manual. Dimensions in
R Figure 623 are after plating except where noted.

(4) Plasma Coated Clamps

(a) Weld cracks with AMS 5694 (310 SST) weld rod. See Section 70-42-01, Standard Practices Manual.



Combustion Chamber
Assembly Key Dimensions
Figure 622

1. 16.185 - 16.245 Inches
2. 1.065 Inch Basic Diameter. Clearance Envelope For Surface M In Relation To Face K And Diameter L, Maximum Material Condition.
3. 0.426 - 0.436 Inch
4. 0.753 Inch Basic Diameter. Clearance Envelope For Surface N In Relation To Face K And Diameter L, Maximum Material Condition.
5. 35°
6. 1.725 - 1.755 Inch
7. 1.335 Inch
8. 1.065 Inch Basic Diameter. Clearance Envelope For Surface P In Relation To Face K And Diameter L, Maximum Material Condition.
9. 5.101 - 5.115 Inch Average Diameter
10. 1.532 - 1.536 Inch Diameter
11. 1.335 Inch

R Key To Figure 622

(b) After weld repairs are made stress-relieve combustion chamber retaining clamp assembly by SPOP 459-2 (Cycle No. 5A) or SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

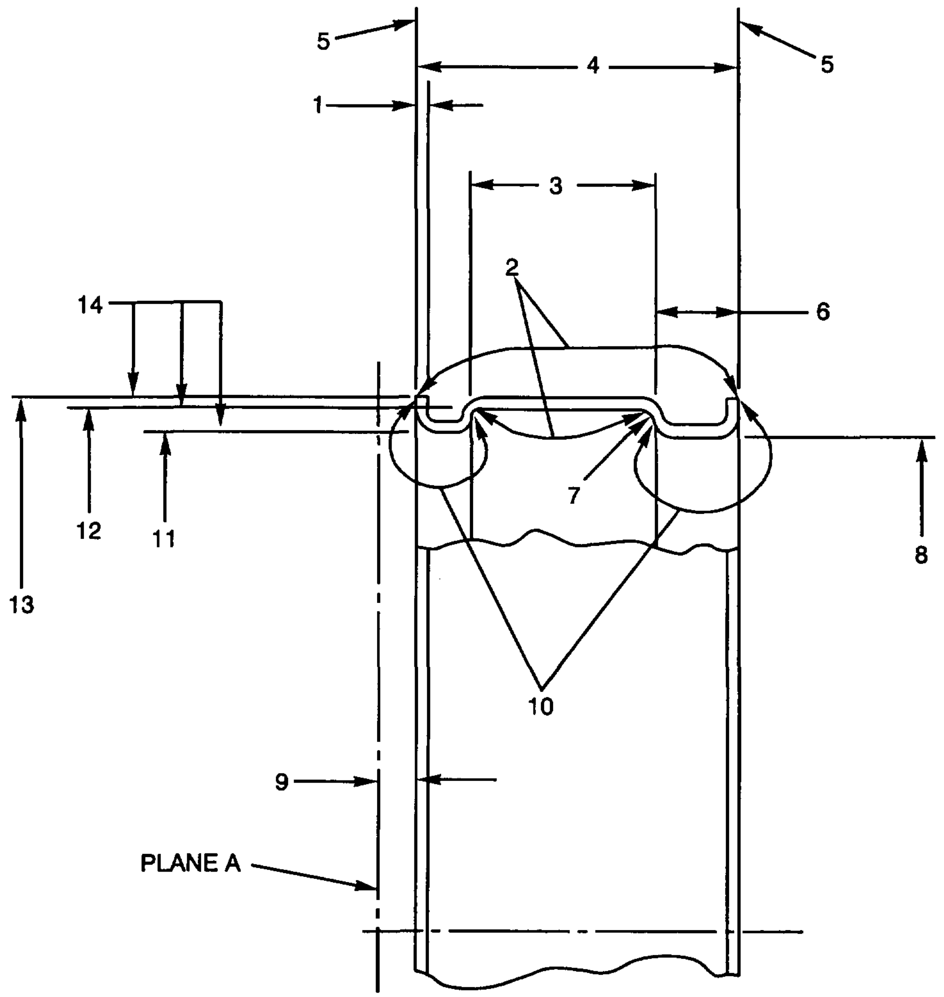
(c) Fluorescent penetrant inspect welded areas by SPOP 70 (local application) (normal sensitivity). See Section 70-33-00, Standard Practices Manual.

(d) Mask areas not to be plasma coated.

(e) Prepare the surface for plasma coat by SPOP 170. Refer to the Standard Practices Manual, Section 70-46-00.

(f) Plasma coat worn area in the limits specified by
R Figure 626 with PWA-1318 powder (refer to Plasma Coatings in the Standard Practices Manual). Bring the coating back to the original 0.002 - 0.004 inch thickness. Dimensions shown are after plasma coating.

R (5) Clamp Key Surface Weld Repair. See Figure 627.



Combustion Chamber
Retaining Clamp Plating
Figure 623

1. 0.022 - 0.025 Inch (Before Plating)
2. Plating Optional And May Be Incomplete In Enclosed Areas
3. 0.890 - 0.910 Inch
4. 1.580 Inch
5. ± 0.020 Inch
6. 0.400 - 0.420 Inch
7. 0.020 - 0.040 Inch (6 Places)
8. 5.090 - 5.100 Inch Diameter
9. 0.200 Inch
10. Nickel Plate Area
11. 5.120 - 5.140 Inch Diameter
12. 5.390 - 5.410 Inch Diameter
13. 5.450 Inch Diameter Both Ends
14. ± 0.010 Inch

NOTE: Tolerances 5 And 14 Define Zone Which Includes All Deviations From Basic Surface In Relation To Index 8 Diameter And Plane A.

R Key To Figure 623

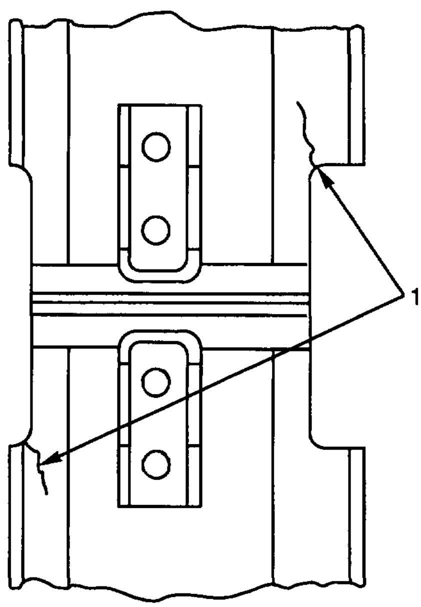
(a) Do a manual blend of the weld area to remove surface oxides or scale.

(b) Apply weld buildup (with AMS 5796 weld wire) by manual gas tungsten arc method to worn areas of the clamp key as shown in the figure. Apply sufficient material to make it possible to fully remove damage to the finish size.

(c) After weld repairs are made, stress-relieve combustion chamber retaining clamp assembly by SPOP 459-2 (Cycle No. 5A) or SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

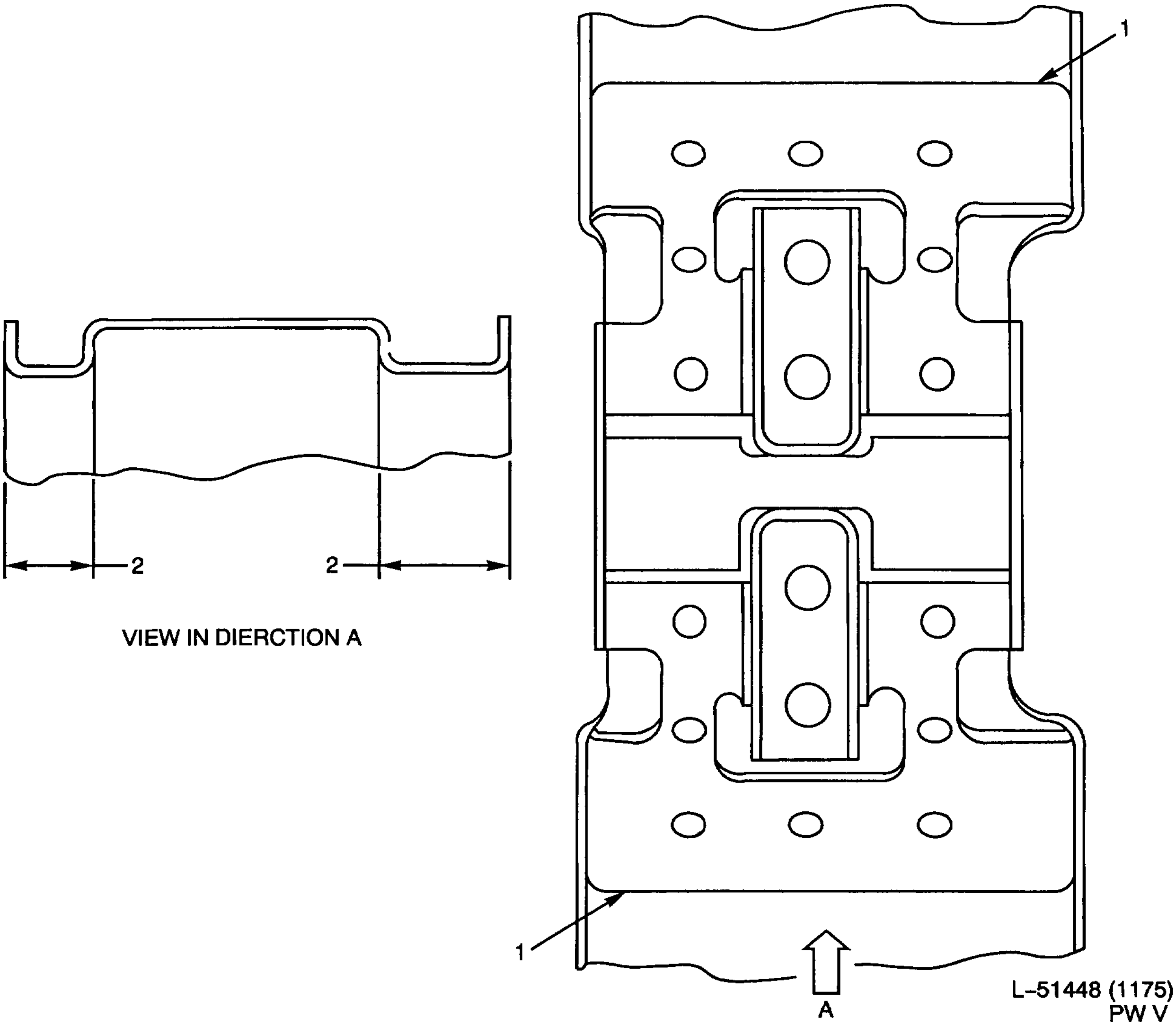
(d) Do a fluorescent penetrant inspection of the welded areas by SPOP 62 or by SPOP 70 (normal sensitivity). See Section 70-33-00, Standard Practices Manual. No cracks are permitted.



L-13672 (0000)
PW V

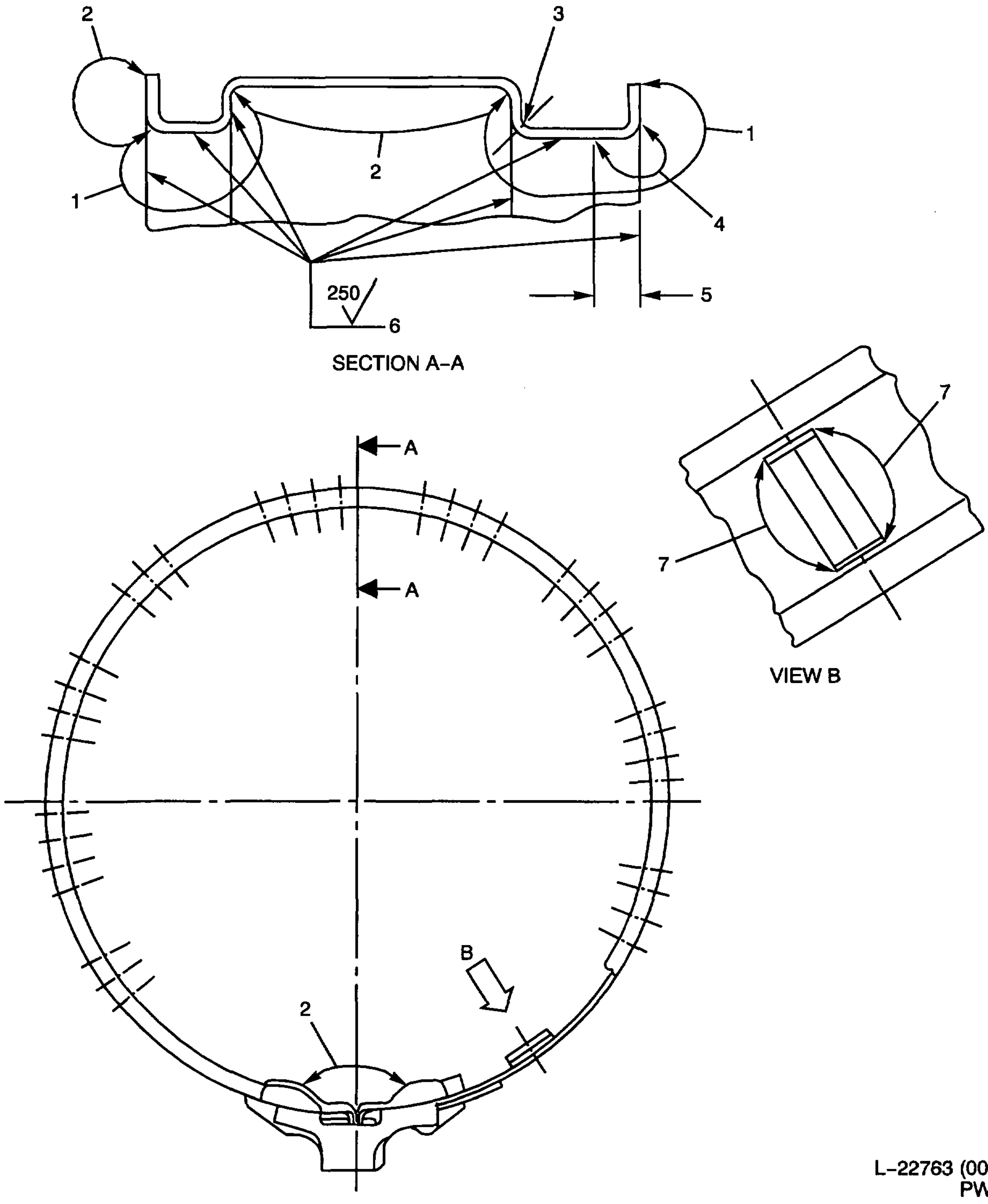
1. Weld Repair These Cracks (See Text)

Combustion Chamber Clamp
Crack Repair
Figure 624



1. Weld Repair Cracks (See Text)
2. Weld Repair Is Confined to Front and Rear Channels

Combustion Chamber Clamp
Crack Repair
Figure 625



Combustion Chamber Retaining
Clamp Plasma Coat Repair
Figure 626

1. Plasma Coat Area
2. Plasma Coat Optional And May Be Incomplete
3. Plasma Coat Not Permitted In 38 (0.088 - 0.098 Inch Diameter) Holes.
4. 0.002 - 0.004 Inch Minimum Coating Thickness Requirement Waived
5. 0.030 - 0.150 Inch
6. Wire Brush Coating To Eliminate Abrasive Surface Maintaining Coating And Surface Roughness
7. Coating Not Permitted On This Surface

R Key To Figure 626

6. Combustion Chamber Outlet Duct Assembly

A. Inspection

(1) Burning or erosion through any part of combustion chamber outlet duct assembly is not acceptable.

(2) Burning or erosion to depth not more than 1/4 of thickness of parent metal is acceptable without repair.

(3) Minor warping or buckling is acceptable without repair if:

(a) Alignment of duct with combustion chamber outlet duct outer support is not affected.

(b) Alignment of duct with turbine vane shroud bolt holes is not affected.

(c) Alignment of part liners with combustion chambers is acceptable.

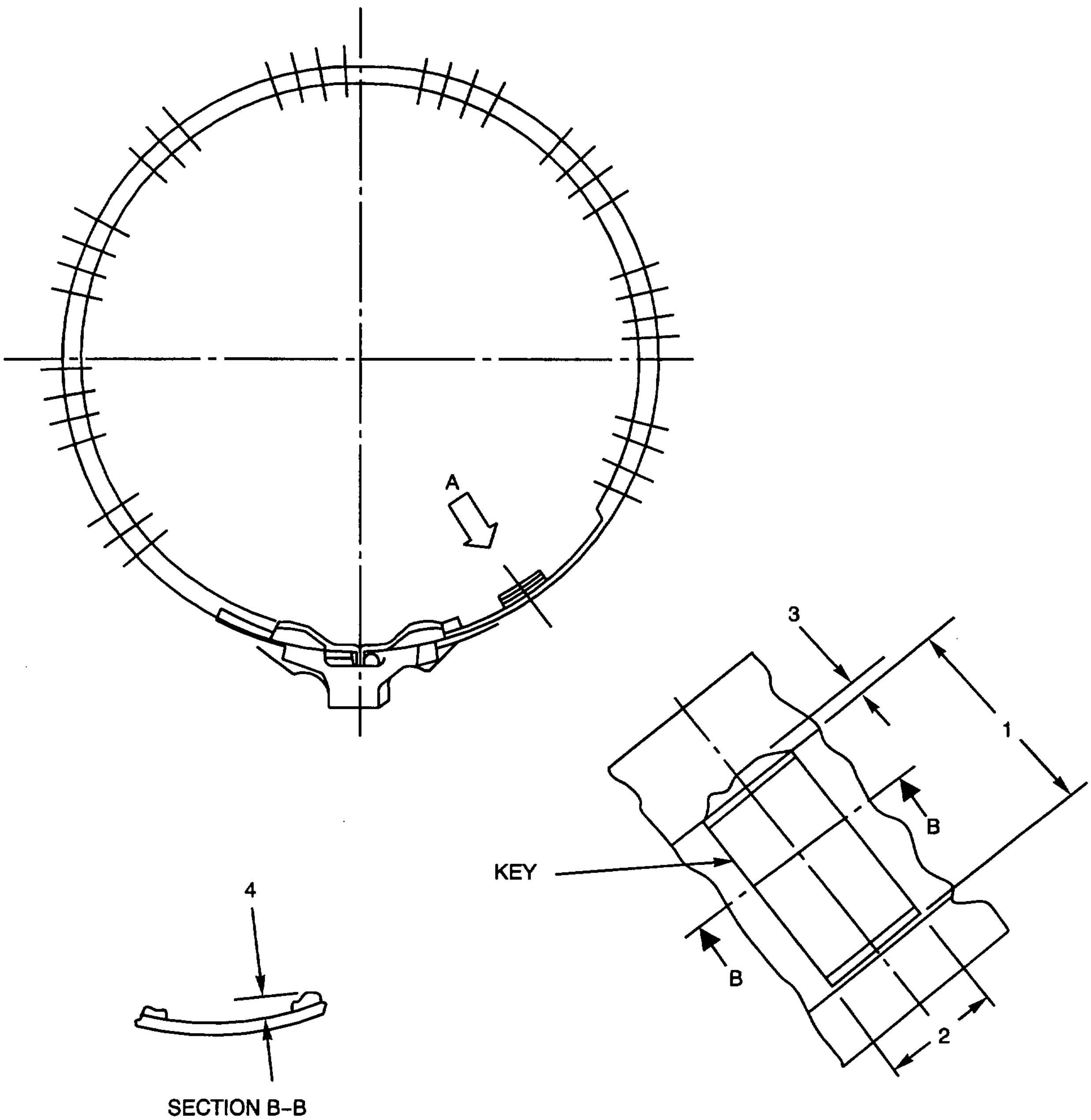
(4) Wear on rear lip of duct assembly cannot be more than 0.012 inch.

(5) Three loose spot welds are permissible per port, with a maximum of 16 per duct.

(6) Cracks (from the keyhole slots) to a maximum of 0.125 inch are permitted on the rear seal. No cracks can extend into the seal seam weld.

(7) Replace worn plasma coat.

R B. Repair



L-H7973 (0107)
PW V

Combustion Chamber Clamp
Key Weld Repair
Figure 627

1. 0.870 - 0.890 Inch
2. 0.470 - 0.480 Inch
3. 0.000 - 0.040 Inch
4. Machine Or Blend Weld Bead To 0.000 - 0.010 Inch Of Parent Metal

R Key To Figure 627

(1) Outlet Duct and Seal Crack Weld Repair (PN 404362 and
R 506274). See Figure 628.

(a) Before repair, stress-relieve the duct assembly by SPOP 463. Refer to Section 70-42-04 in the Standard Practices Manual.

(b) Do a fluorescent penetrant inspection by SPOP 62. Refer to Section 70-33-00 in the Standard Practices Manuals.

(c) Visually examine the duct with 3X magnification for cracks in the outer duct and seal. Refer to the figure for typical crack locations.

(d) Rout out cracks fully (remove a minimum of material).

(e) Solvent wipe the repair area by SPOP 208. Refer to Section 70-21-00 in the Standard Practices Manual.

(f) Weld cracks in the outer duct (with manual gas tungsten arc) by PWA 16-3. Use AMS 5579 or AMS 5684 weld wire. Weld cracks in the seal area (with manual gas tungsten arc) by PWA 16-33. Use AMS 5778 or AMS 5832 weld wire. Refer to Section 70-42-01 in the Standard Practices Manual.

(g) Solution and precipitation heat treat the assembly by SPOP 478-1. Refer to Section 70-42-04 in the Standard Practices Manual.

(h) Do a fluorescent penetrant inspection by SPOP 62.

(i) Do a blend of the weld to make the surface smooth, with continuous contour between the parent material and the repaired surface. Keep a seal wall thickness as shown in Index 6 in (Sheet 1) of the figure. Keep an outer duct thickness as shown in (Sheet 1) of the figure (Index 7).

(j) Machine all seal holes and slots filled by weld to their initial dimensions (see the figure).

(k) Bend the seal lip gap to the limits in the Index 5 of (Sheet 1) of the figure if there is distortion.

(l) Do a fluorescent penetrant inspection by SPOP 62.

(m) Apply antigalling compound on the seal by SPOP 146 (PWA 586-1) to the area shown in (Sheet 3) of the figure.

(2) Outlet Duct and Seal Crack Weld Repair (PN 562008,
R 562012, 579924, and 769251). See Figure 628.

(a) Remove plasma coat from the outer duct (refer to the repair in this section). See (Sheet 3) of the figure for plasma coat locations.

(b) Before repair, solution heat treat the duct assembly by SPOP 482. Refer to Section 70-42-04 in the Standard Practices Manual.

(c) Do a fluorescent penetrant inspection by SPOP 62. Refer to Section 70-33-00 in the Standard Practices Manuals.

(d) Visually examine the duct with 3X magnification for cracks in the outer duct and seal. Refer to the figure for typical crack locations.

(e) Rout out cracks fully (remove a minimum of material).

(f) Solvent wipe the repair area by SPOP 208. Refer to Section 70-21-00 in the Standard Practices Manual.

(g) Weld cracks in the outer duct and seal (with manual gas tungsten arc) by PWA 16-3. Use AMS 5798 weld wire. Refer to Section 70-42-01 in the Standard Practices Manual.

(h) Stress-relieve the assembly by SPOP 463. Refer to Section 70-42-04 in the Standard Practices Manual.

(i) Do a fluorescent penetrant inspection by SPOP 62.

(j) Do a blend of the weld to make the surface smooth, with continuous contour between the parent material and the repaired surface. Keep a seal wall thickness as shown in the figure (Index 6 in Sheet 2). Keep an outer duct thickness as shown in Index 7 of (Sheet 2) to the figure.

(k) Machine all seal holes and slots filled by weld to
R their initial dimensions. See Figure 628 (Sheet 1) and (Sheet 3).

(l) Bend the seal lip gap to the limits in Index 5 of (Sheet 2) of the figure if there is distortion.

(m) Do a fluorescent penetrant inspection by SPOP 62.

(n) Apply antigalling compound on the seal by SPOP 146 (PWA 586-1) to the area shown in (Sheet 3) of the figure.

(o) Apply plasma coat on the outer duct (see the repair in this section).

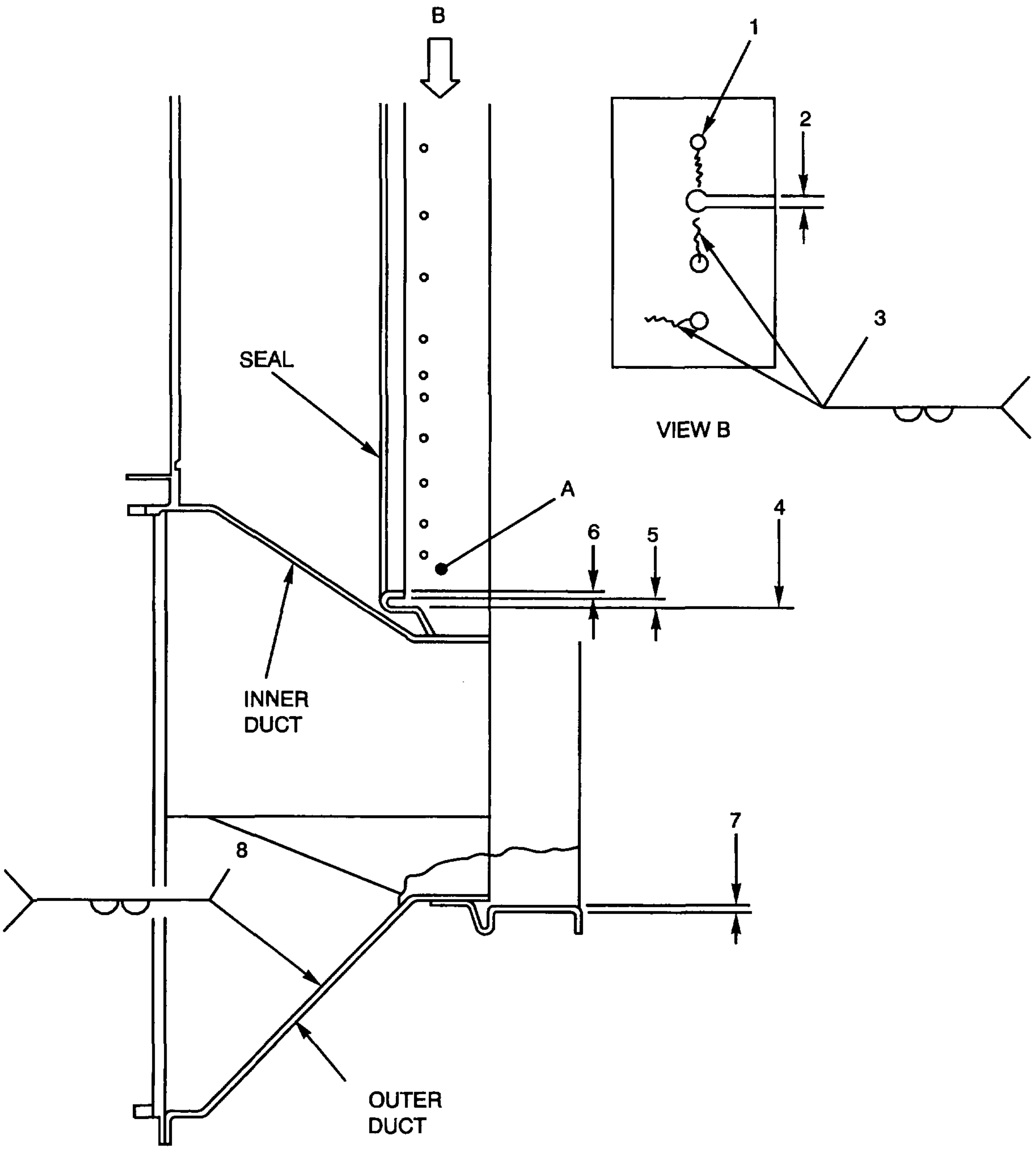
(3) Outlet Duct Diaphragm Crack Weld Repair

(a) Before weld repair, solution heat treat the duct assembly by 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at a rate of air cool or faster. Refer to the Standard Practices Manual for general information.

(b) Weld cracks in the outlet duct diaphragm in the
R limits in Figure 629 with AMS 5679 weld wire (for steel diaphragms) or AMS 5798 weld wire (for nickel alloy diaphragms). Refer to Section 70-42-01 in the Standard Practices Manual.

<u>NOTE</u>: Identify diaphragm alloy by the outlet duct part number. Steel duct assemblies are PN 404362A thru D. Hastelloy duct assemblies are PN 404362E or subsequent.

<u>NOTE</u>: To make sure that there will be no blockage of the combustion chamber clamp during installation, keep weld height of circumferential welds that go fully around the periphery of the duct clamp flange to 0.010 inch maximum.



L-H7984 (0107)
PW V

Combustion Chamber Outlet Duct
Seal And Outer Duct Weld Repair
(PN 404362 And 506274)
Figure 628 (Sheet 1)

1. 0.071 - 0.081 Inch Diameter Hole (12 In Each Quadrant Of The Seal)
2. 0.050 - 0.070 Inch (Every Fourth Hole In Seal)
3. Weld Cracks In Seal Holes As Shown
4. 11.330 - 11.380 Inch Diameter
5. 0.120 - 0.140 inch
6. 0.0150 - 0.0195 Inch
7. 0.023 - 0.026 Inch
8. Weld Cracks In The Outer Duct As Shown (See Text)

R Key To Figure 628 (Sheet 1)

(c) After repairs are made, stress-relieve assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

(d) Do a fluorescent penetrant inspection of welded areas by SPOP 70 (normal sensitivity). Refer to Section 70-33-00, Standard Practices Manual.

1 A crack more than four inches in length or 0.030 inch in width is cause for rejection.

2 Finished repair must not result in excessive buckling or change of contour in surface.

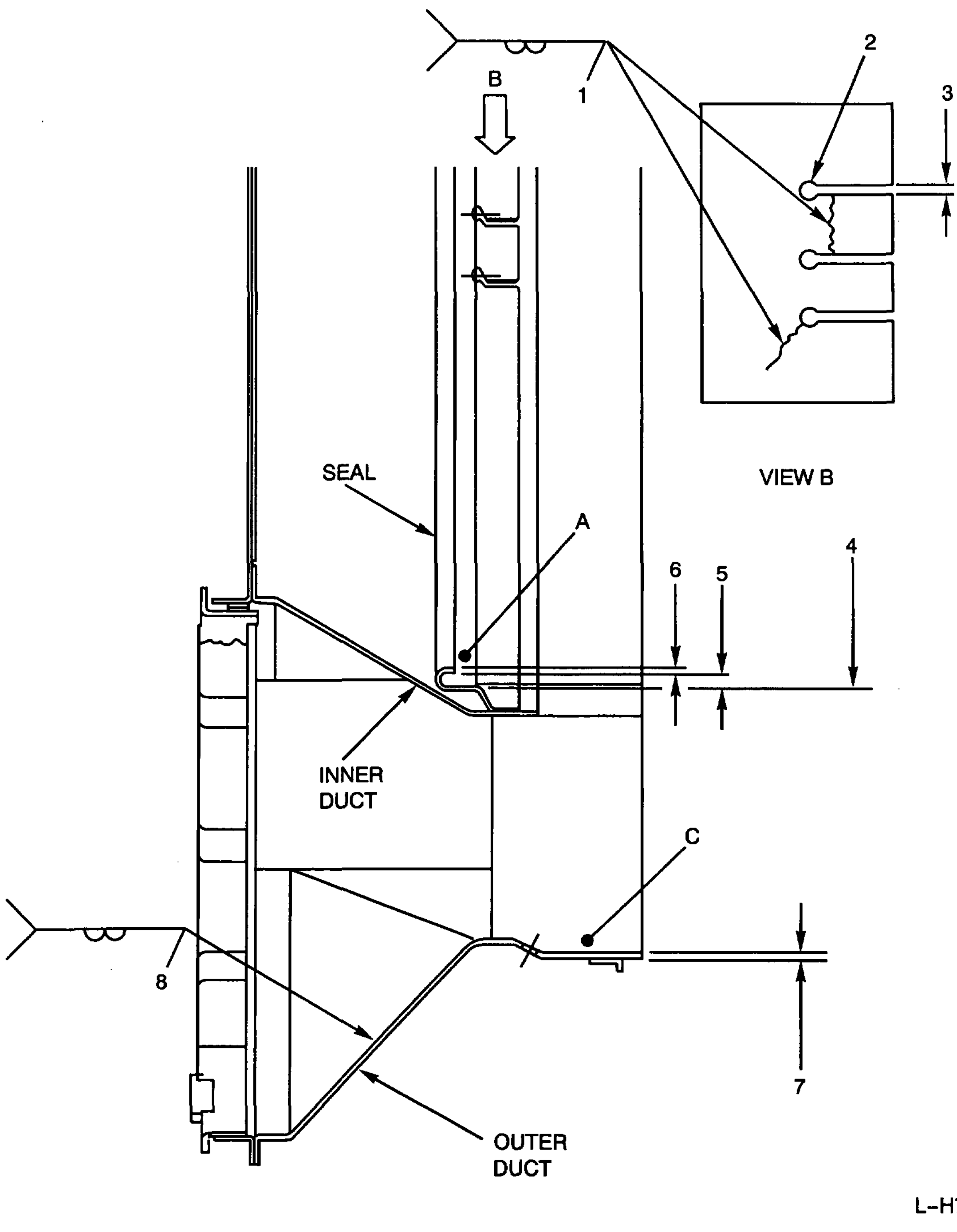
3 If complete removal of flux is not possible after welding, assembly must be suitably treated to prevent corrosion by residual flux.

(4) Rear ring area grooving repair

(a) Before weld repair, solution heat treat the duct assembly by 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at a rate of air cool or faster. Refer to the Standard Practices Manual for general information.

(b) Use AMS 5778 weld wire to fill grooves that are more than 0.008 inch deep on the rear ring (mating area with the 1st stage turbine vanes).

NOTE: For JT12A-8 transition duct repairs, use AMS 5798 (Hastelloy X) weld rod.



Combustion Chamber Outlet Duct
Seal And Outer Duct Weld Repair
(PN 562008, 562012,
579924, And 769251)
Figure 628 (Sheet 2)

1. Weld Cracks In Keyhole Slots And Holes As Shown
2. 0.071 - 0.081 Inch Diameter Hole (12 In Each Quadrant Of The Seal)
3. 0.050 - 0.070 Inch
4. 11.330 - 11.380 Inch Diameter
5. 0.120 - 0.140 Inch
6. 0.013 - 0.018 Inch
7. 0.023 - 0.026 Inch
8. Weld Cracks In The Outer Duct As Shown (See Text)

R Key To Figure 628 (Sheet 2)

(c) Hand grind the welded area to be continuous with the adjacent surface.

(d) After weld repairs are made, stress-relieve the duct assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

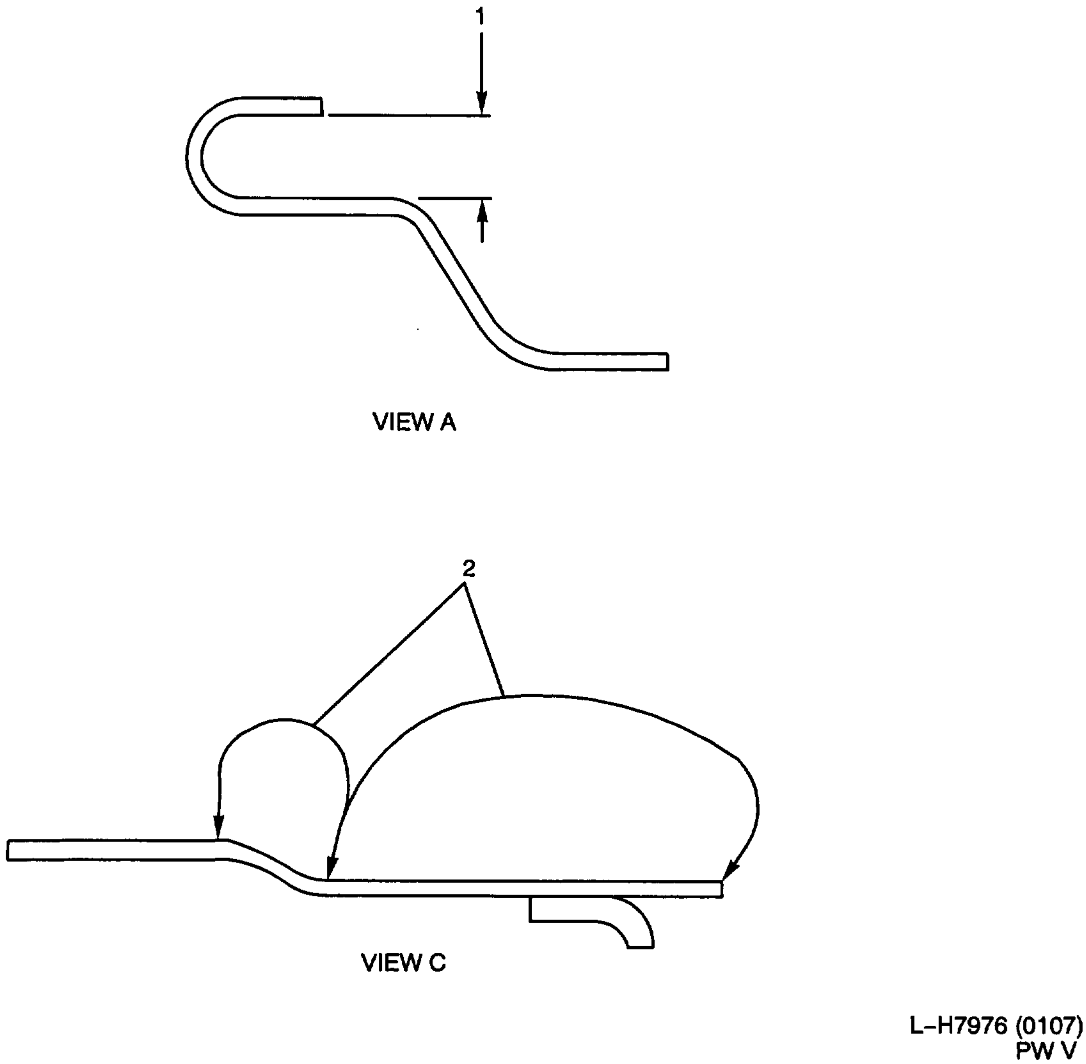
(e) Do a fluorescent penetrant inspection of welded areas by SPOP 70 (normal sensitivity). Refer to Section 70-33-00, Standard Practices Manual.

(5) Broken-Through Surface Patch Repair

(a) Before weld repair, solution heat treat the duct assembly by 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at a rate of air cool or faster. Refer to the Standard Practices Manual for general information.

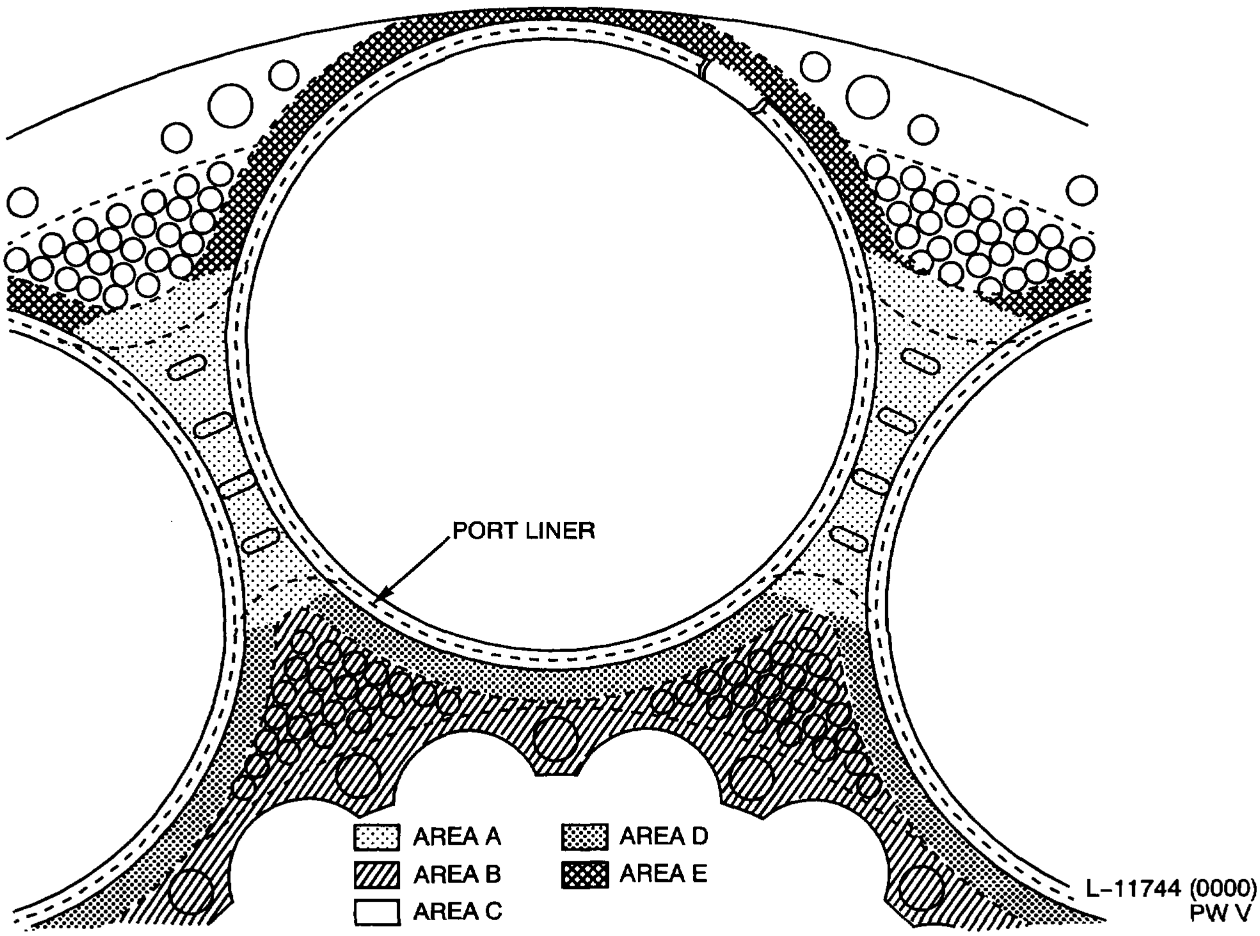
(b) For broken-through surfaces that are too large to weld, butt-weld a patch in position. Remove all weld beads that extend into the inner side of the ring.

NOTE: Ring material is AMS 5542 (Inco X-750) except for JT12A-8 rear seal rings which are AMS 5536 (Hastelloy X).



1. Antigalling Compound Application Area (See Text)
2. Plasma Coat Area (Coat Is Optional In All Other Areas)

Combustion Chamber Outlet Duct
Seal And Outer Duct Weld Repair
(All Duct Part Numbers)
Figure 628 (Sheet 3)



Combustion Chamber Outlet
Duct Diaphragm and
Port Liner Repair
Figure 629

Area A - Not More Than One Circumferential Crack, One Inch Or Less In Length, Shall Be Weld Repaired. Welding Is Not Permitted If Crack Exists In Corresponding Area On Other Side Of Port. L or U Shaped Cracks Are Not Acceptable in This Area.

Area B And C - Any Number Of Cracks, Four Inches Or Less In Length, On Flat Surface Of Diaphragm Shall Be Weld Repaired.

Areas D And E - Any Number Of Cracks, Six Inches Or Less In Length Shall Be Weld Repaired, Provided No Crack Has Progressed More Than One Inch Into Area A.

Port Liners - Any Number Of Cracks Shall Be Weld Repaired In Liner Areas Adjacent To Areas D And E. One Crack On Each Side Of Liner Shall Be Weld Repaired In Areas Adjacent To Area A.

R Key To Figure 629

(c) After weld repairs are completed, stress-relieve the duct assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

(d) Do a fluorescent penetrant inspection of welded areas by SPOP 70 (normal sensitivity). Refer to Section 70-33-00, Standard Practices Manual.

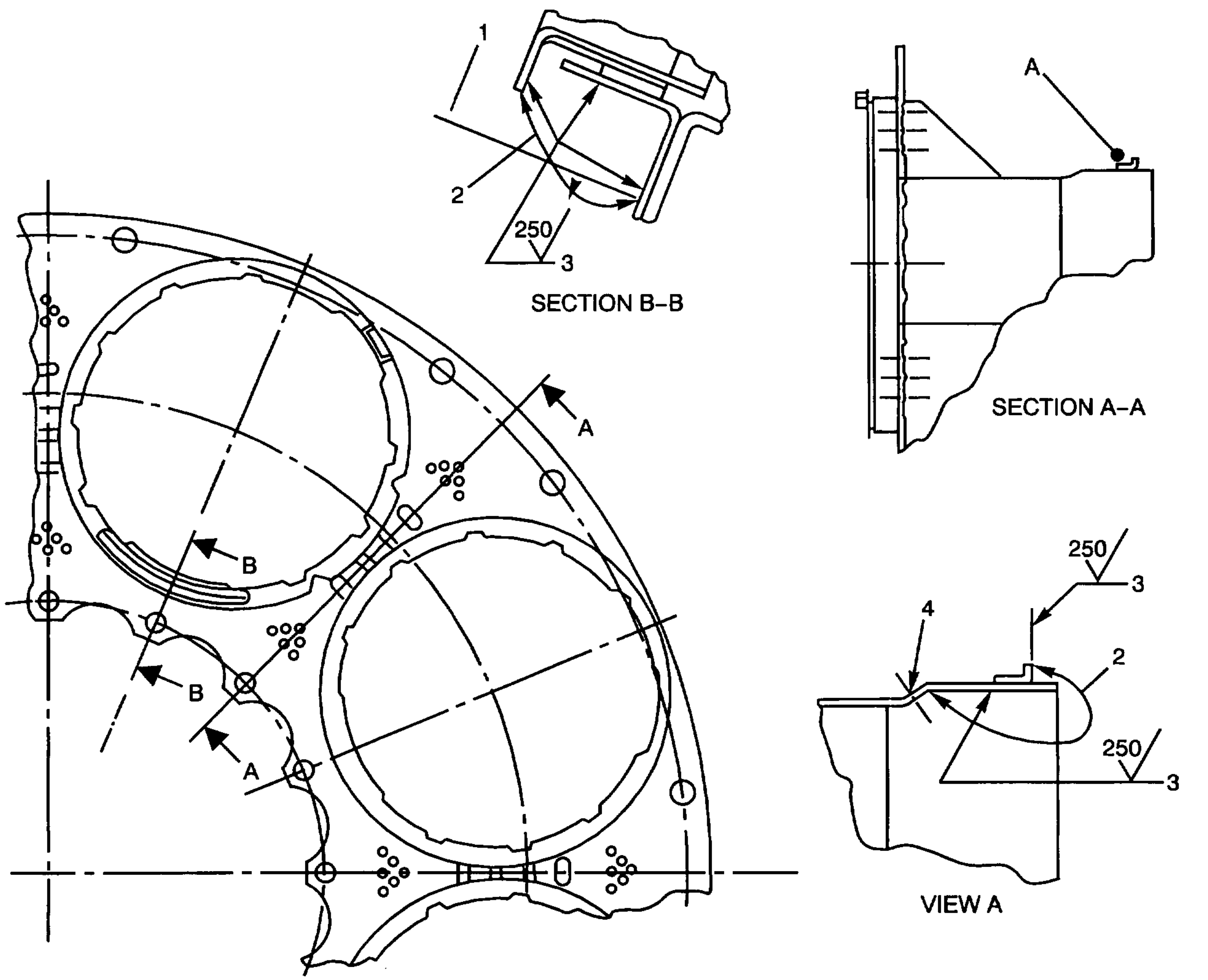
(6) Duct Plasma Coat Replacement

(a) Mask areas not to be coated.

(b) Prepare the coat area by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(c) Plasma coat worn area in the limits specified in
R Figure 630 with PWA 1316 or PWA-1318 powder. Refer
R to 70-46-01, Plasma Coatings in the Standard Practices Manual. Apply coating to the original 0.002 - 0.004 inch thickness.

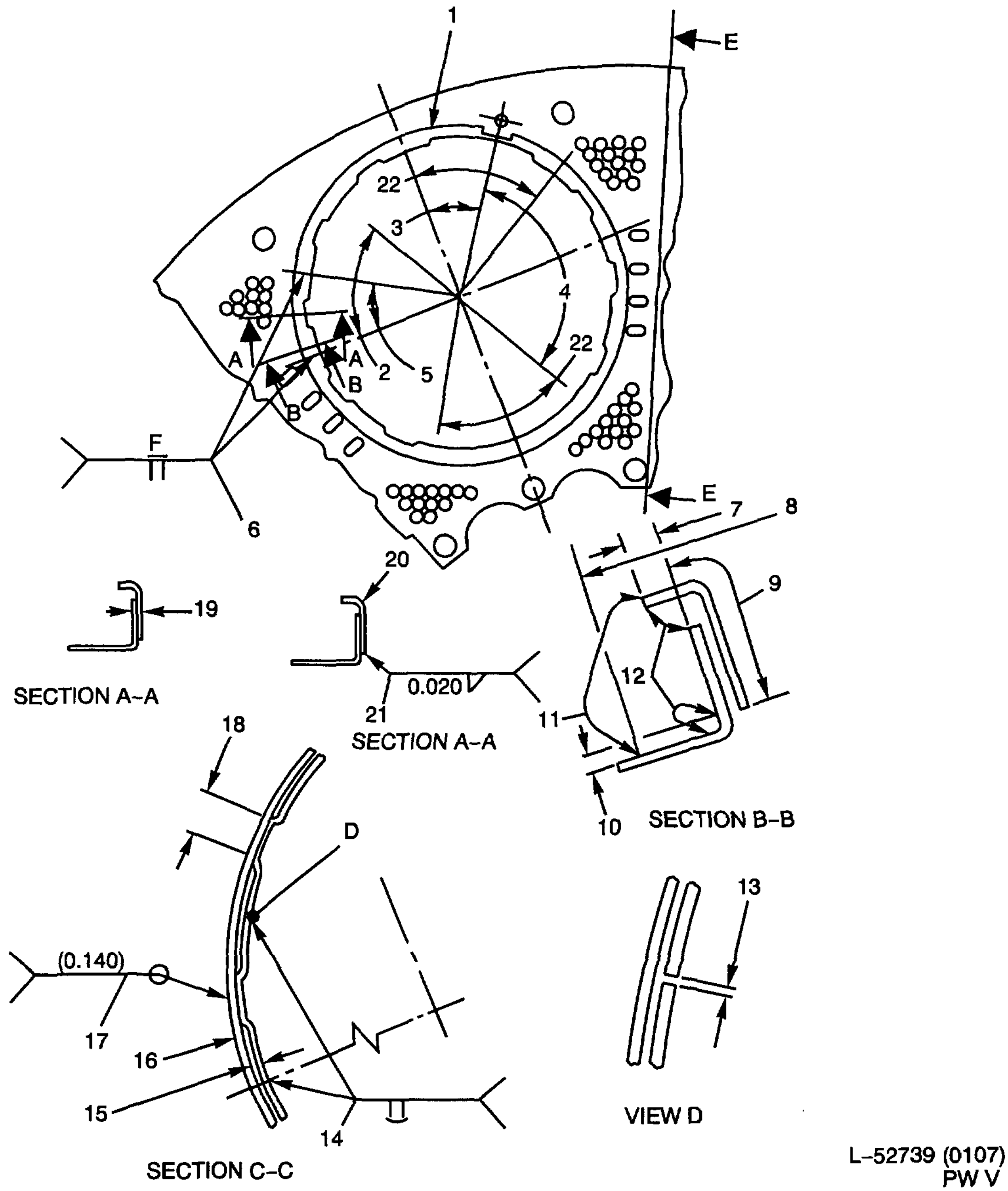
(7) Combustion Chamber Outlet Duct Flange Repair. See
R Figure 631.



L-22727 (0000)
PW V

1. 5.686 Inch Minimum Diameter
2. Plasma Coat Area
3. Surface Roughness Is After Plasma Coating. Wire Brush Coat To Eliminate Abrasive Surface, Maintaining Hardface Thickness And Surface Roughness Requirement. Grinding Of Coating Is Not Permitted.
4. Plasma Coat Is Not Permitted in 136 (0.083 - 0.089 Inch Diameter) Holes.

Combustion Chamber Outlet Duct
Plasma Coat Repair
Figure 630



Combustion Chamber Duct
Flange Repair
Figure 631 (Sheet 1)

1. Flange. Remove Damaged Portion Where Necessary
2. Patch Areas Must Extend Into Raised Areas On Either Side Of Dimple Areas
3. 35°
4. 115°
5. 30° (Area To Be Removed Must Not Be Less Than This Dimension)
6. Fusion Weld (This Weld For Index 7 Distance)
7. Reference Distance
8. 5.686 Inch Diameter Minimum
9. Reference Distance
10. 0.030 - 0.150 Inch
11. Plasma Coat Area
12. Minimum Coat Thickness Requirement Waived In This Area
13. 0.030 Inch Maximum (This Gap Must Stay In Limits). See Text.
14. This (Fusion) Weld For Index 9 Distance
15. 0.035 - 0.045 Inch (PN 562012 Duct Assembly), 0.045 - 0.055 Inch (PN 769251 Duct Assembly). This Dimension Must Be Maintained After Welding
16. Remove Plasma Coat From Weld Area Before Welding
17. Resistance Weld As Shown
18. Reference Distance
19. 0.020 Inch Minimum
20. PN 759924 Lug (Or Serviceable Scrap Section)
21. This (Fusion) Weld For Index 18 Distance For Each Dimple
22. If Patch Repair Is Necessary In This Area, Patch Must Extend Into The Next Raised Area On Either Side Of Dimple Areas

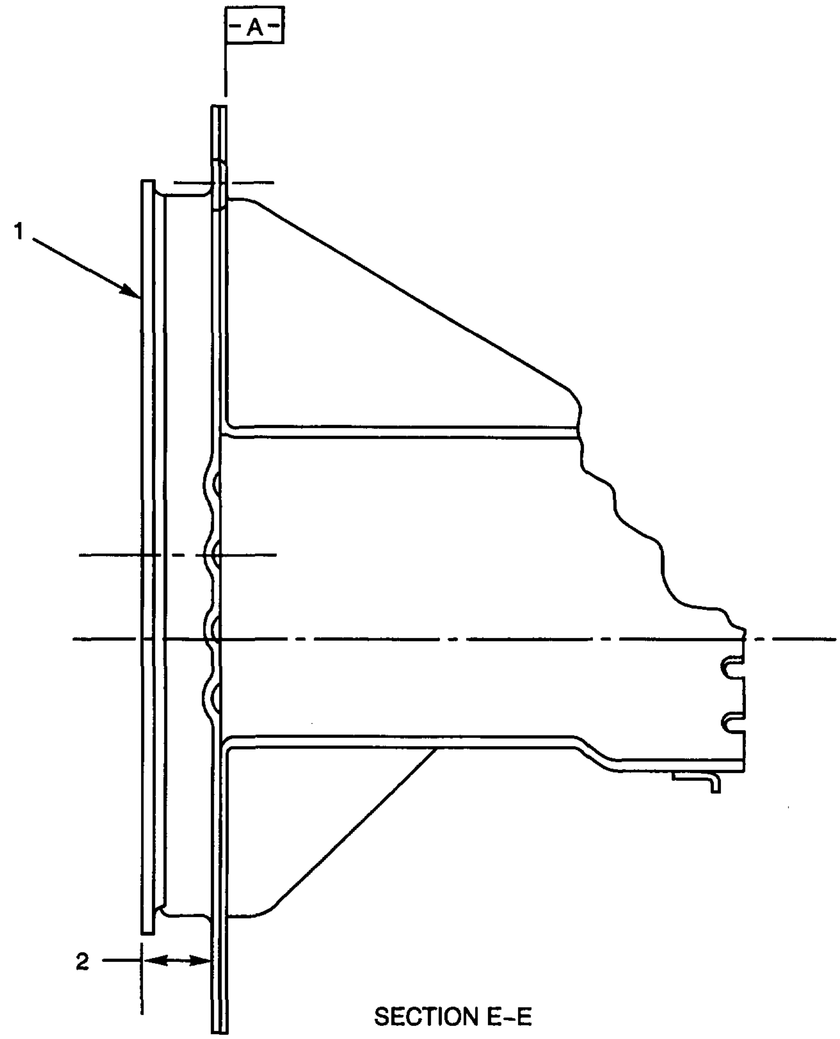
R Key To Figure 631 (Sheet 1)

(a) Machine to remove damaged portion of flange (or the full flange) where necessary.

<u>NOTE</u>: Area to be removed must not be less than 30 degrees or more than 60 degrees for all damaged area, and must be more than the damaged area by 0.250 inch minimum each side. During removal, keep 0.020 inch minimum thickness (Index 19) as shown in the figure. It is permitted to use part of a flange or a full flange from a scrap duct support.

(b) Trim the replacement material to have the correct fit with the support as a result of damage removal. Keep the Index 13 gap (0.030 inch) in limits.

(c) Remove plasma coat from the Index 16 part as shown before welding.



L-H7977 (0107)
PW V

1. This Surface Of A Replaced Flange Must Be Parallel With Surface A 0.020 Inch FIR Maximum. All Points Of This Surface Must Be In Index 2 Limits When Surface A Is Held Flat 0.010 Inch Maximum
2. 0.450 - 0.490 Inch

Combustion Chamber Duct
Flange Repair
Figure 631 (Sheet 2)

(d) Before weld repair, solution heat treat the duct assembly and replacement section at 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at a rate of air cool or faster. Refer to the Standard Practices Manual for general information.

(e) Weld repair with AMS 5798 (Hastelloy X) weld wire. Refer to Section 70-42-01, Standard Practices Manual.

(f) After weld repairs are completed, stress-relieve duct assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

(g) Do a fluorescent penetrant inspection of welded areas by SPOP 70 (normal sensitivity). Refer to Section 70-33-00, Standard Practices Manual.

R (h) Plasma coat indicated area by PWA 53-16 or
R PWA 53-18, 0.002 - 0.004 inch thick (prepare the surface before plasma coat by SPOP 170).

(8) Combustion Chamber Guide Spacer Replacement

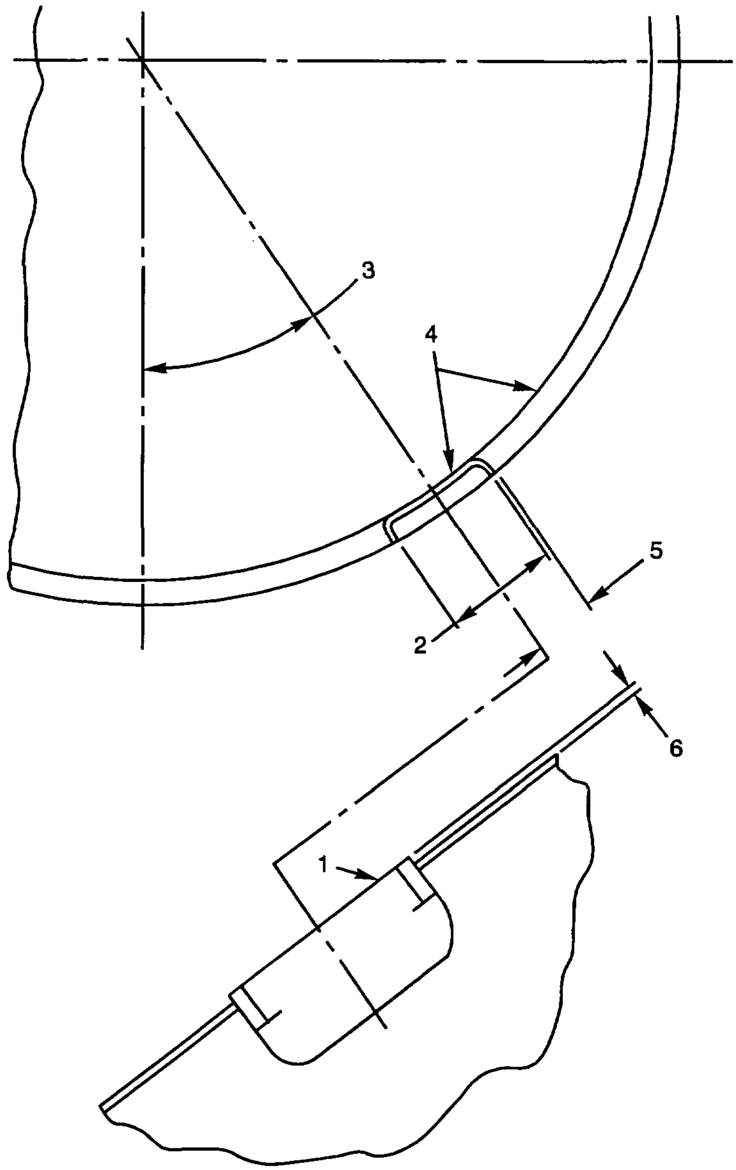
(a) Remove worn combustion chamber guide spacers and replace them with new spacers:

1 Machine anti-rotation slot in combustion chamber as necessary to facilitate installation of
R spacer, as shown. See Figure 632.

2 Locate spacer by tack welding.

3 Before weld repair, solution heat treat the duct assembly by 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at a rate of air cool or faster. Refer to the Standard Practices Manual for general information.

4 Weld repair with AMS 5798 (Hastelloy X) weld wire. Refer to Section 70-42-01, Standard Practices Manual.



L-16477 (0000)
PW V

1. Spacer PN 467002
2. 0.490 Inch Minimum
3. 35° ± 1°
4. These Surfaces Must Be Flush Within 0.010 Inch
5. 0.270 - 0.290 Inch
6. 0.015 Inch Maximum

Combustion Chamber Guide
Spacer Replacement
Figure 632

5 After weld repairs are completed, stress-relieve duct assembly by SPOP 463 (Cycle No. 10). Refer to Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

6 Do a fluorescent penetrant inspection of welded areas by SPOP 70 (normal sensitivity). Refer to Section 70-33-00, Standard Practices Manual.

(9) Combustion Chamber Outlet Duct Guide Assembly
R Replacement. See Tool Group 18C. See Figure 633.

(a) Guide Removal

1 With Machining Fixture installed on horizontal or vertical lathe, position and secure combustion chamber duct on fixture (front of duct assembly toward fixture).

2 Install jaw assembly on fixture post, ensuring that assembly is properly seated.

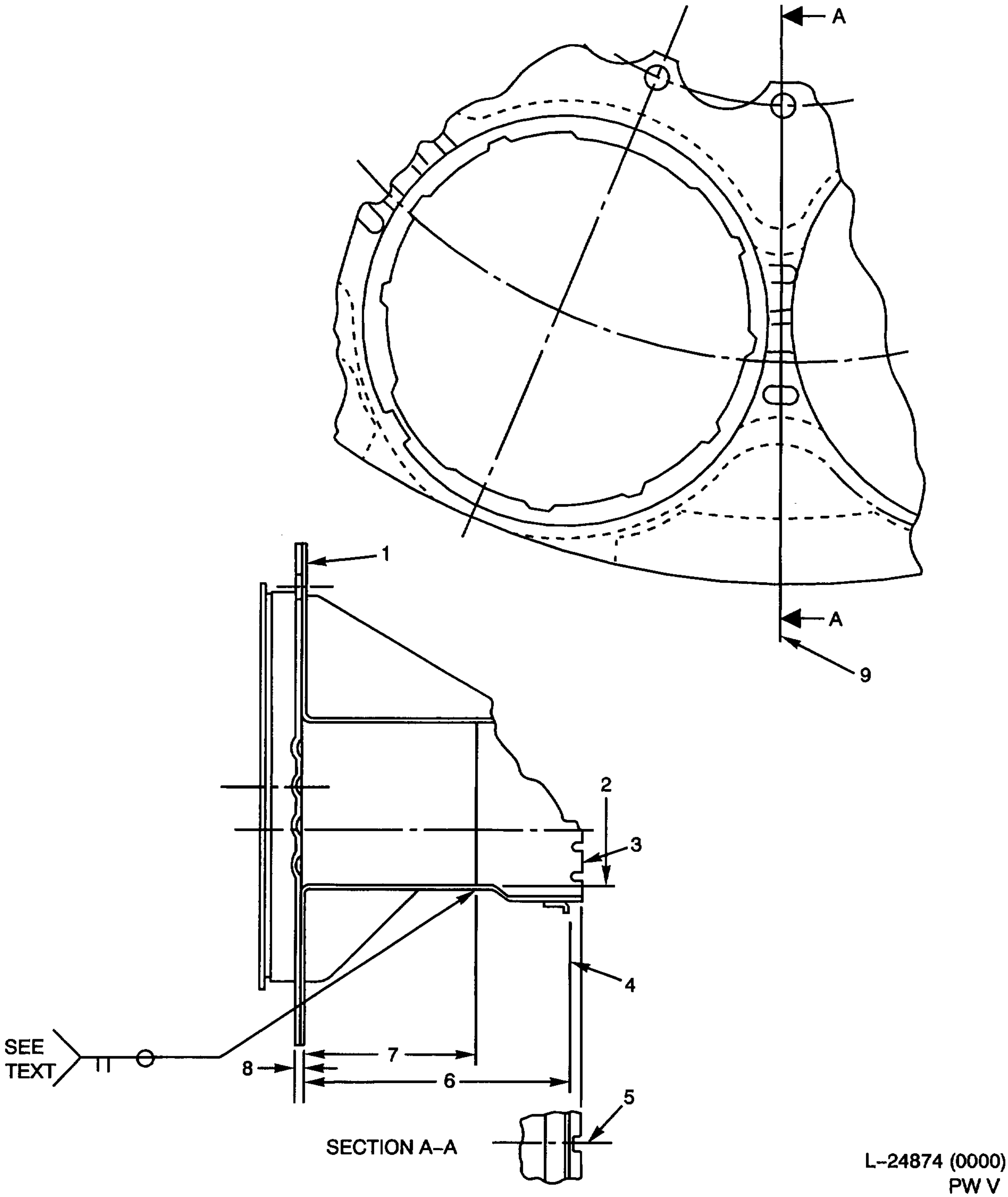
3 Expand jaws of fixture detail to support duct ID at cut-off point. Remove damaged portion of guide by machining through guide at dimension shown in the figure, Index 7. Then remove duct from fixture.

(b) Replacement Guide Welding Procedure

1 With Welding Fixture mounted on power driven welding positioner, secure duct assembly to fixture with front of assembly down.

NOTE: Position duct assembly on fixture so that 0.031 - 0.047 inch radius notch on OD lines up with scribe line on fixture and 0.276 - 0.286 inch diameter hole on same centerline as above notch engages spring loaded tapered pin on fixture.

2 Position replacement guide assembly on rear of duct assembly, and push plunger to engage 0.220 - 0.240 inch slot on guide. Expand segmented gas backup support so that contact with duct and replacement guide assembly is made.



Combustion Chamber Outlet
Duct Guide Assembly
Replacement
Figure 633

1. Reference Surface
2. 16.195 - 16.205 Inch Diameter
3. Guide Assembly (PN 642195)
4. This Surface Must be Parallel With Reference Surface within 0.040 Inch
5. Any One Slot To Be Located Within 0.010 Inch Either Side of True Position In Relation To Centerline
6. 3.520 - 3.580 Inches
7. 2.270 - 2.330 Inches
8. 0.015 - 0.018 Inch
9. Centerline

R Key To Figure 633

3 Fasten clamp to OD of parts to secure guide assembly for tack welding.

4 With gas backup, tack weld two mating surfaces at several equally spaced locations.

5 Before weld repair, solution heat treat the duct assembly by 1024° - 1051°C (1875° - 1925°F) for one hour in argon or hydrogen atmosphere or in a vacuum. Cool at a rate of air cool or faster. Refer to the Standard Practices Manual for general information.

6 Remove the clamp and fusion weld the AMS 5536 (Hastelloy X) guide assembly to the AMS 5536 duct with AMS 5798 (Hastelloy X weld rod. Refer to Section 70-42-01, Standard Practices Manual.

7 After weld repairs are completed, stress-relieve duct assembly by SPOP 463 (Cycle No. 10). See Section 70-42-04, Standard Practices Manual.

NOTE: Stress-relief is optional based on operator's experience.

8 Do a fluorescent penetrant inspection of welded areas by SPOP 70 (normal sensitivity). Refer to Section 70-33-00, Standard Practices Manual.

9 Remachine ID of guide, if necessary, to keep Index 2 dimension in limits.

10 Do a parallelism check as shown in Index 4 of the figure. For repair, straighten or replace the guide assembly by the above procedure.

7. Combustion Chamber Outlet Duct Support Assembly (PN 449262)
R See Figure 634 and Figure 635.

A. Repair

(1) Nut-plate Rivet Hole Repair

NOTE: Elongated rivet holes, and/or cracks that extend from rivet holes may be repaired as follows:

(a) Remove PN 314106 nut plates from the support assembly.

(b) Prepare cracks for weld repair by Section 70-42-01, Standard Practices Manual.

(c) Weld rivet hole cracks with AMS 5786 weld rod. Keep heat to a minimum.

(d) Blend weld flush with parent metal surfaces.

(e) Stress-relieve in furnace or locally by SPOP 468 (Cycle No. 15). See Section 70-42-04, Standard Practices Manual.

R (f) Re-drill holes as shown in Figure 634 and deburr.

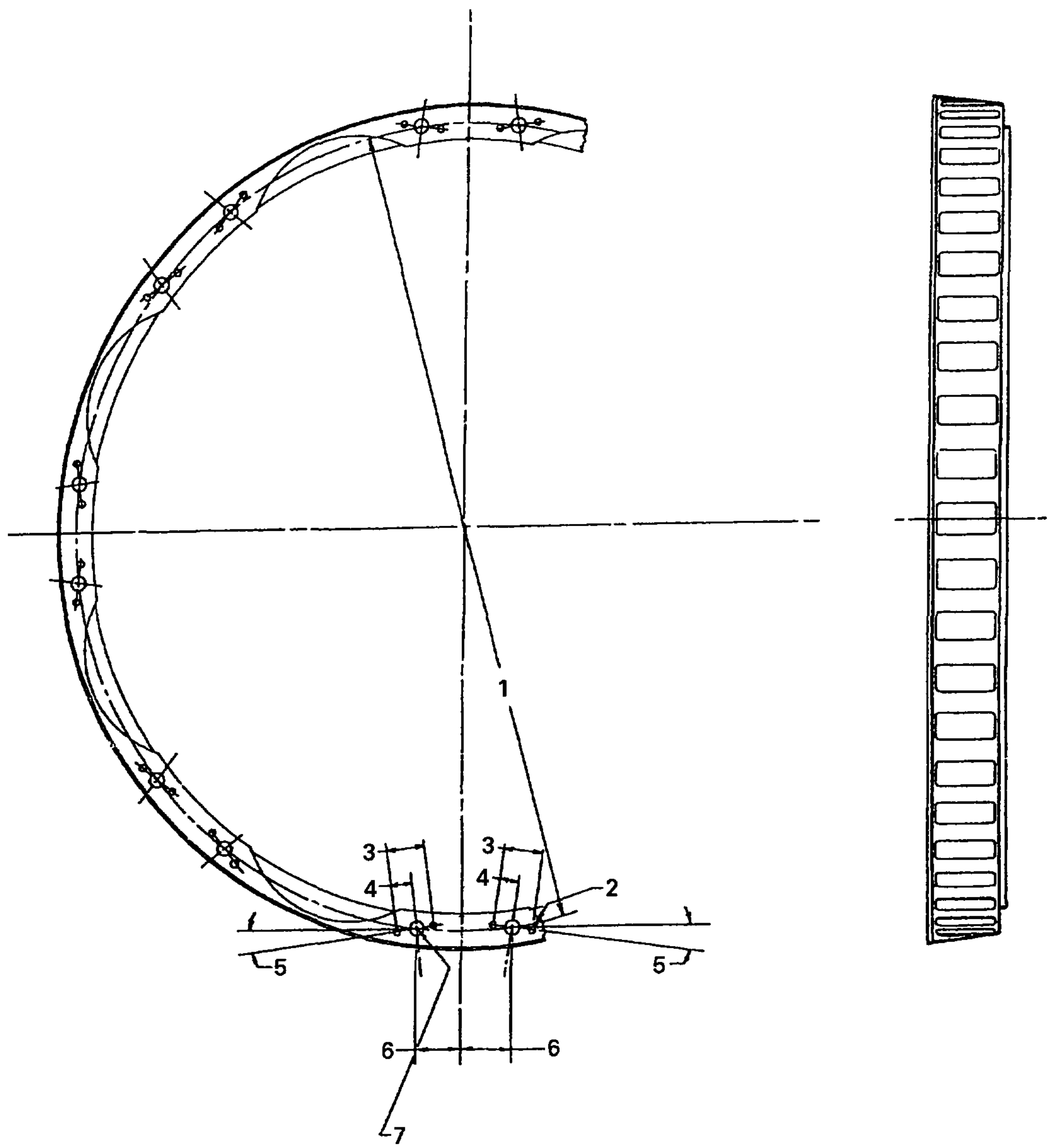
(g) Reassemble with removed nut plates (if threads are acceptable) or with new ones, and rivet with
R AN 123318 Rivets. See Figure 635. Rivet by Section 70-43-00, Standard Practices Manual.

R (2) T-bolt Hole Repair. See Figure 636 and Figure 637.

NOTE: Cracks that extend from T-bolt holes on the rear side of the detail support may be repaired as follows:

(a) Remove bolt support ring segment(s) (PN 427060) as required by removing rivets.

(b) Retain removed details (segments, nuts and T-bolts) for reassembling.



Rivet Hole Locations
Figure 634

1. 19.460 Inch Diameter
2. 0.096 - 0.101 Inch Diameter. 32 Holes, 8 Groups Of 4 Holes Located As Shown
3. 0.998 - 1.002 Inch
4. 0.495 - 0.505 Inch
5. 7°30′ ± 0°30′
6. 1.200 Inch
7. 0.307 - 0.317 Inch Diameter (reference)

R Key To Figure 634

(c) Prepare cracks for weld repair by Section 70-42-01, Standard Practices Manual.

(d) Weld T-bolt hole cracks with AMS 5786 weld rod. Keep heat to a minimum.

(e) Blend weld flush with parent metal surfaces.

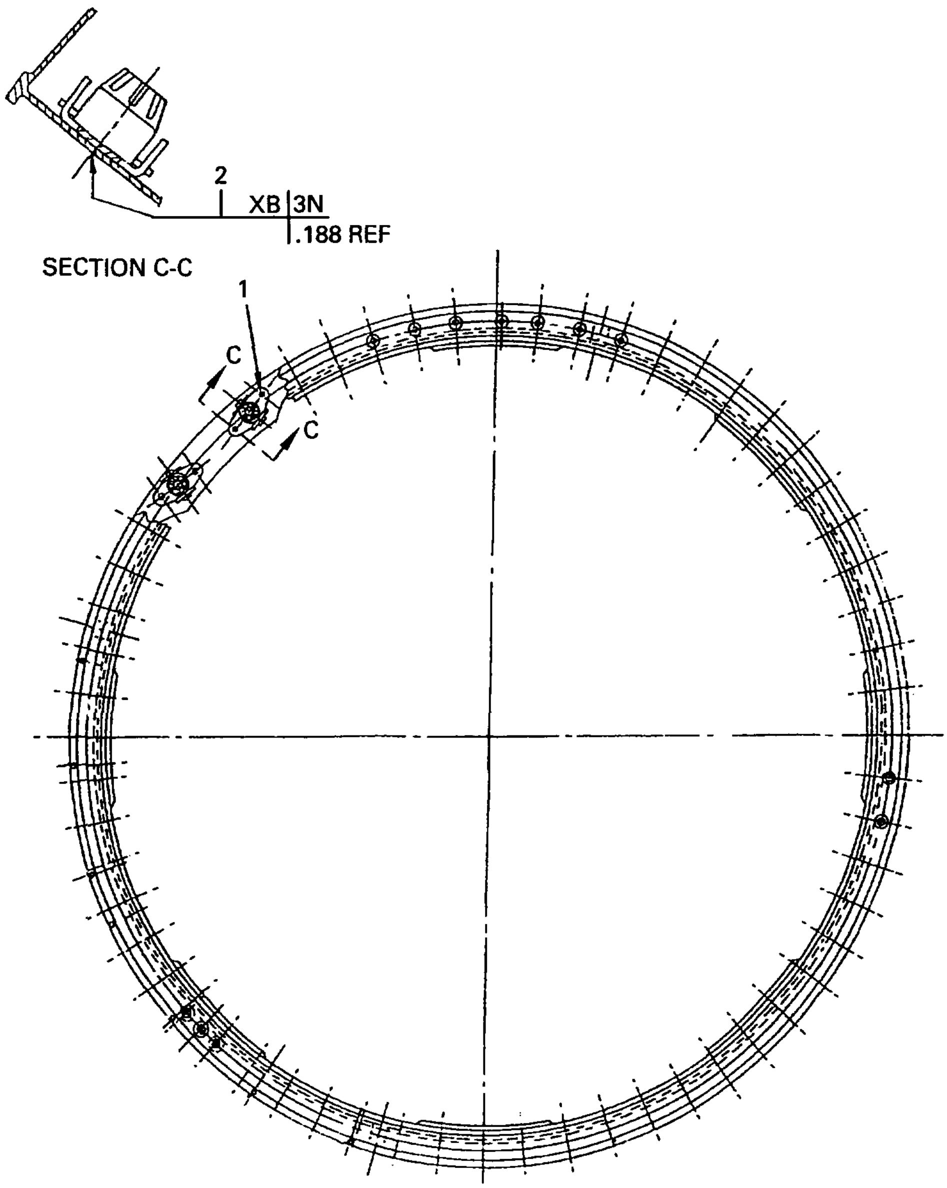
(f) Stress-relieve in furnace or locally by SPOP 468 (Cycle No. 15). See Section 70-42-04, Standard Practices Manual.

R (g) Re-drill holes as shown in Figure 636 and deburr.

(h) Inspect T-bolts for reuse (refer to the Standard Practices Manual.

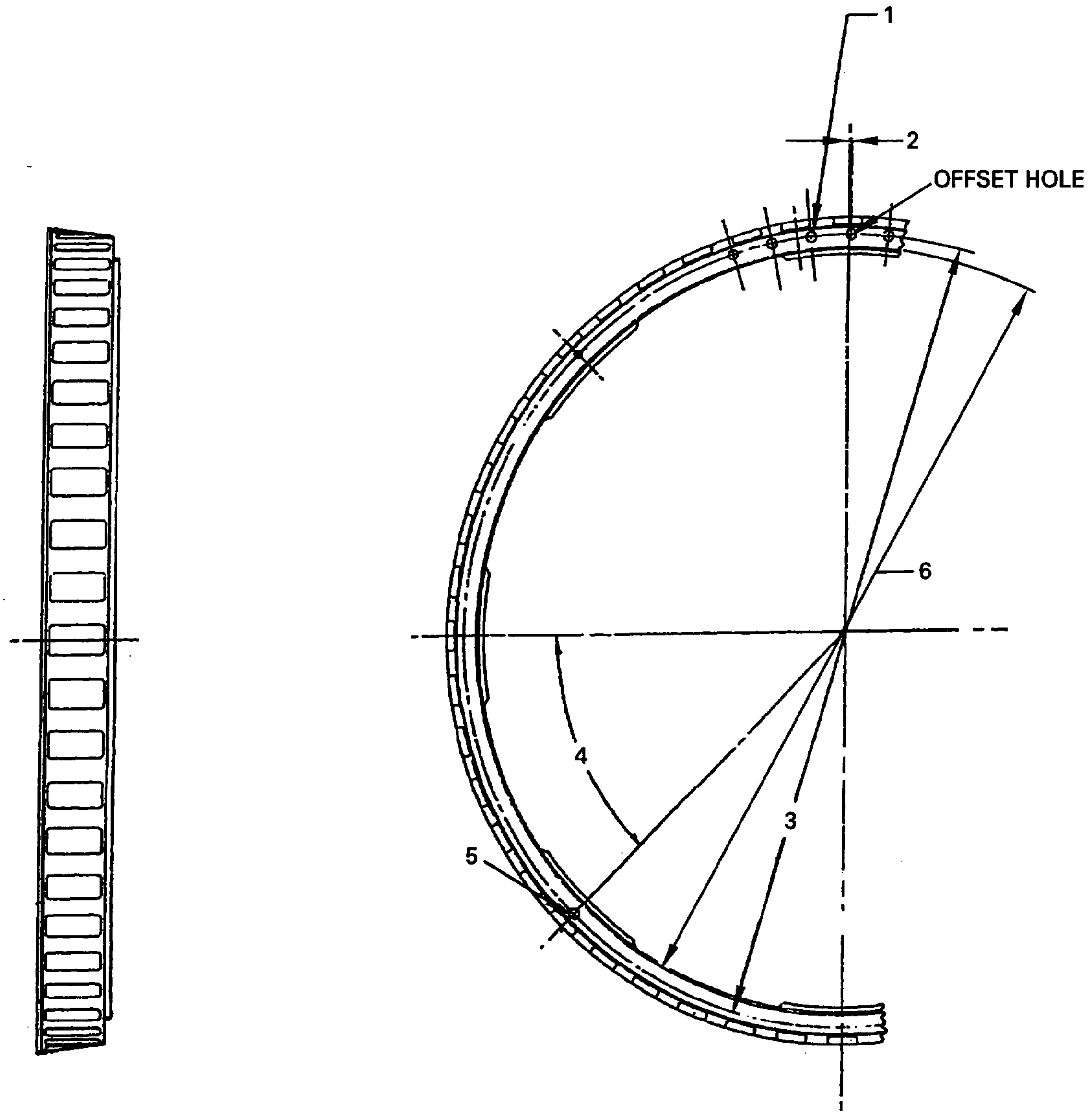
(i) Reassemble with removed T-bolts (if serviceable)
R or new ones as shown. See Figure 637.

(j) Reassemble with removed retaining screw nut(s), and ring segment(s). Rivet with AN 123318 rivets by PWA 357-21 (that is, hard solid shank rivet,
R cold upset heading). See Figure 637 and Section 70-43-00, Standard Practices Manual.



1. PN 314106 Nut Plate (1 - 16)
2. Two Places, Each Location

Nut Plate Riveting
Figure 635

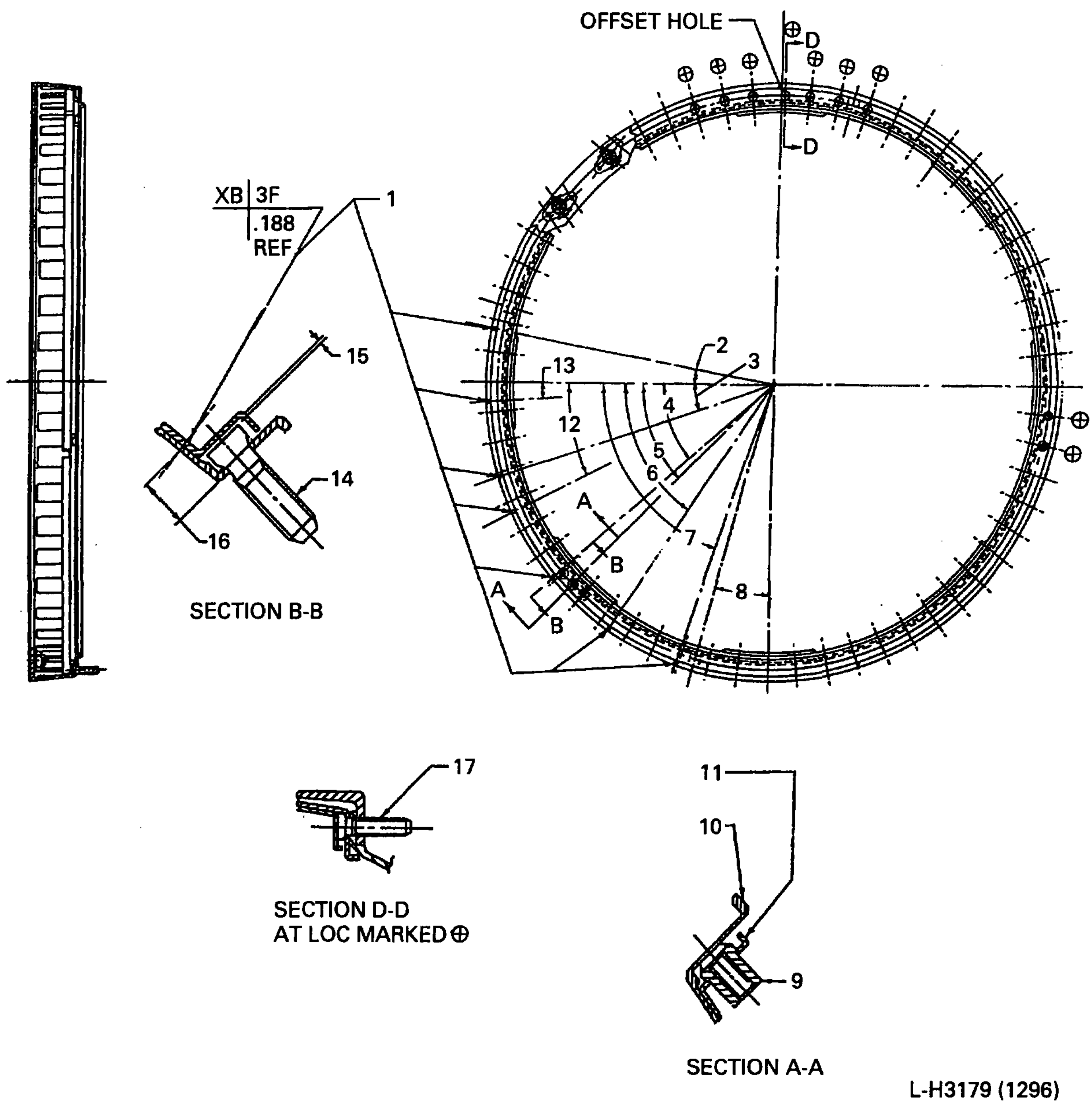


L-H3178 (1296)

Bolt Hole Locations
Figure 636

1. 0.307 - 0.317 Inch Diameter. 60 Holes (59 Holes On The Basis Of 60 Holes Equally Spaced And One Hole Offset As Shown). All Located Within 0.005 Inch Of True Position In Relation To Index 6 Diameter
2. 0.060 Inch
3. 19.640 Inch Diameter
4. 45°
5. 0.229 - 0.239 Inch Diameter. Four Holes Equally Spaced And Located Within 0.005 Inch Of True Position In Relation To Index 6 Diameter
6. Reference Diameter

R Key To Figure 636



Outer Outlet Duct Support
Assembly - Reassembly
Figure 637

1. 28 Places, Four Equally Spaced Groups of Seven as shown.
2. 11°15'
3. 18°45'
4. 41°15'
5. 45° (Reference)
6. 56°15'
7. 71°15'
8. 15°
9. PN 427059 (4)
10. PN 407824 Outer Support
11. PN 427060 Ring Segment (4). Diameter of Hole in This Part Must be Concentric with Diameter of Hole in Index 10 Support 0.030 Inch FIR Maximum (4 Places).
12. 26°15'
13. 3°45'
14. PN 407825 Bolt (51)
15. 0.010 Inch Maximum Gap After Riveting
16. 0.0360 Inch
17. PN 407826 Bolt (9)

R Key To Figure 637

ENGINE TURBINE

TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

Please insert the revised pages into this manual and delete obsoleted pages in accordance with the following List of Effective Pages. Revised pages are indicated by the letter "R", added pages by the letter "A", and deleted pages by the letter "D". Superseded pages shall be removed and destroyed.

The List of Effective Pages records not only each page of subject revision but also each previously issued page which is still current. Blank pages and pages which are no longer current do not appear on this list. If there is any question about the currency of the maintained copy, it is recommended that each page of the manual be checked off against this List of Effective Pages. Any page which does not check out with this list, either by number or by date, shall be discarded. This list is reissued in its entirety whenever this manual section is revised.

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
Tab Separator - Engine Turbine				
List of Effective Pages - Engine Turbine See end of list.				
Table of Contents - Engine Turbine				
72-50-00	R	01	A	MAY 1/08
	R	02	A	MAY 1/08
72-50-00 INSP/REP-01		601	-ALL	APR 1/07
		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
72-50-00 INSP/REP-02		601	-ALL	APR 1/07
		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
	R	609		MAY 1/08
	R	610		MAY 1/08
		611		APR 1/07
		612		APR 1/07
		613		APR 1/07
		614		APR 1/07
		615		APR 1/07
		616		APR 1/07
	R	617		MAY 1/08
	R	618		MAY 1/08
	R	619		MAY 1/08
	R	620		MAY 1/08
	R	621		MAY 1/08
	R	622		MAY 1/08
	R	623		MAY 1/08
	R	624		MAY 1/08
		625		APR 1/07
		626		APR 1/07
		627		APR 1/07
		628		APR 1/07
	R	629		MAY 1/08
	R	630		MAY 1/08
	R	631		MAY 1/08
	R	632		MAY 1/08
		633		APR 1/07
		634		APR 1/07
		635		APR 1/07
		636		APR 1/07
		637		APR 1/07
		638		APR 1/07
72-50-00 INSP/REP-02			(CONTINUED)	
		639		APR 1/07
		640		APR 1/07
	R	641		MAY 1/08
	R	642		MAY 1/08
	R	643		MAY 1/08
	R	644		MAY 1/08
		645		APR 1/07
		646		APR 1/07
		647		APR 1/07
		648		APR 1/07
		649/650		APR 1/07
72-50-00 INSP/REP-03	R	601	-ALL	MAY 1/08
	R	602		MAY 1/08
	R	603		MAY 1/08
	R	604		MAY 1/08
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
		613		APR 1/07
		614		APR 1/07
	R	615		MAY 1/08
	R	616		MAY 1/08
	R	617		MAY 1/08
	R	618		MAY 1/08
		619		APR 1/07
		620		APR 1/07
		621		APR 1/07
		622		APR 1/07
		623		APR 1/07
		624		APR 1/07
		625		APR 1/07
		626		APR 1/07
		627		APR 1/07
		628		APR 1/07
		629		APR 1/07
		630		APR 1/07
		631		APR 1/07
		632		APR 1/07
		633		APR 1/07
		634		APR 1/07
		635		APR 1/07
		636		APR 1/07
		637		APR 1/07
		638		APR 1/07
		639		APR 1/07
		640		APR 1/07
		641		APR 1/07
		642		APR 1/07
		643		APR 1/07
		644		APR 1/07
		645		APR 1/07
		646		APR 1/07

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-50-00			(CONTINUED)	
INSP/REP-03	R	647		MAY 1/08
	R	648		MAY 1/08
		649		APR 1/07
		650		APR 1/07
		651		APR 1/07
		652		APR 1/07
		653		APR 1/07
		654		APR 1/07
		655		APR 1/07
		656		APR 1/07
		657		APR 1/07
		658		APR 1/07
		659		APR 1/07
		660		APR 1/07
	R	661		MAY 1/08
	R	662		MAY 1/08
	R	663		MAY 1/08
	R	664		MAY 1/08
	R	665		MAY 1/08
	R	666		MAY 1/08
	R	667		MAY 1/08
	R	668		MAY 1/08
	R	669		MAY 1/08
	R	670		MAY 1/08
	R	671		MAY 1/08
	R	672		MAY 1/08
	R	673		MAY 1/08
	R	674		MAY 1/08
	R	675		MAY 1/08
	R	676		MAY 1/08
	R	677		MAY 1/08
	R	678		MAY 1/08
	A	679		MAY 1/08
	A	680		MAY 1/08
	A	681		MAY 1/08
	A	682		MAY 1/08
72-50-00		601	-ALL	APR 1/07
INSP/REP-04		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
		613		APR 1/07
		614		APR 1/07
		615		APR 1/07
		616		APR 1/07
		617		APR 1/07
		618		APR 1/07
		619		APR 1/07
		620		APR 1/07
		621		APR 1/07
		622		APR 1/07
		623		APR 1/07
		624		APR 1/07
		625		APR 1/07
		626		APR 1/07
		627/628		APR 1/07
72-50-00		601	-ALL	APR 1/07
INSP/REP-05		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
72-50-00			(CONTINUED)	
INSP/REP-05		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
		613		APR 1/07
		614		APR 1/07
		615		APR 1/07
		616		APR 1/07
		617		APR 1/07
		618		APR 1/07
	R	619		MAY 1/08
	R	620		MAY 1/08
		621		APR 1/07
		622		APR 1/07
		623		APR 1/07
		624		APR 1/07
		625		APR 1/07
		626		APR 1/07
		627		APR 1/07
		628		APR 1/07
		629		APR 1/07
		630		APR 1/07
		631		APR 1/07
		632		APR 1/07
		633		APR 1/07
		634		APR 1/07
		635		APR 1/07
		636		APR 1/07
		637		APR 1/07
		638		APR 1/07
72-50-00		601	-ALL	APR 1/07
INSP/REP-06		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
	R	605		MAY 1/08
	R	606		MAY 1/08
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
	R	611		MAY 1/08
	R	612		MAY 1/08
	R	613		MAY 1/08
	R	614		MAY 1/08
	R	615		MAY 1/08
	R	616		MAY 1/08
	R	617		MAY 1/08
	R	618		MAY 1/08
	R	619		MAY 1/08
	R	620		MAY 1/08
	R	621		MAY 1/08
	R	622		MAY 1/08
	R	623		MAY 1/08
	R	624		MAY 1/08
	R	625		MAY 1/08
	R	626		MAY 1/08
	R	627		MAY 1/08
	R	628		MAY 1/08
	R	629		MAY 1/08
	R	630		MAY 1/08
	A	631		MAY 1/08
	A	632		MAY 1/08
72-50-00		601	-ALL	APR 1/07
INSP/REP-07		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-50-00	R	601	-ALL	MAY 1/08
INSP/REP-08	R	602		MAY 1/08
	R	603		MAY 1/08
	R	604		MAY 1/08
	R	605		MAY 1/08
	R	606		MAY 1/08
	R	607		MAY 1/08
	R	608		MAY 1/08
	R	609		MAY 1/08
	R	610		MAY 1/08
	R	611		MAY 1/08
	R	612		MAY 1/08
	R	613		MAY 1/08
	R	614		MAY 1/08
	R	615		MAY 1/08
	R	616		MAY 1/08
	R	617		MAY 1/08
	R	618		MAY 1/08
	R	619		MAY 1/08
	R	620		MAY 1/08
	R	621		MAY 1/08
	R	622		MAY 1/08
	R	623		MAY 1/08
	R	624		MAY 1/08
	R	625		MAY 1/08
	R	626		MAY 1/08
	R	627		MAY 1/08
	R	628		MAY 1/08
	R	629		MAY 1/08
	R	630		MAY 1/08
	R	631		MAY 1/08
	R	632		MAY 1/08
	R	633		MAY 1/08
	R	634		MAY 1/08
	R	635		MAY 1/08
	R	636		MAY 1/08
	R	637		MAY 1/08
	R	638		MAY 1/08
	R	639		MAY 1/08
	R	640		MAY 1/08
	R	641		MAY 1/08
	R	642		MAY 1/08
	A	643		MAY 1/08
	A	644		MAY 1/08
	A	645		MAY 1/08
	A	646		MAY 1/08
	A	647		MAY 1/08
	A	648		MAY 1/08
LIST OF EFFECTIVE PAGES				
		A		MAY 1/08
		B		MAY 1/08
		C		MAY 1/08

TEMPORARY REVISION NO. 72-0004

PURPOSE: This Temporary Revision corrects dimensions for 1st and 2nd stage free turbine repair.

APPLICABLE MANUAL REVISION: Revision Number 075.

TR FILING INSTRUCTIONS: For a printed manual, put this Temporary Revision in the manual location specified below. Write the Temporary Revision Number on the Record of Temporary Revisions, which is adjacent to the Volume 1 Title Page. For a CD-ROM version of this manual, put this Temporary Revision in the reference file in sequence by Chapter/Section to show that this Temporary Revision is added to the manual.

MANUAL LOCATION:

CHAPTER/SECTION	PROCEDURE	LOCATION
72-50-00	INSPECTION, REPAIR, AND REPLACEMENT-03	Page 665

CHANGED DATA:

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-50-00 INSP/REP-03	665 -666	Revised turbine vane repair figure. (Editorial)	-ALL

TO: RECIPIENTS OF JT12 OVERHAUL MANUAL, PART NUMBER 435108

REVISION NO. 75 DATED MAY 1, 2008

HIGHLIGHTS - ENGINE TURBINE

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-50-00 INSP/REP-02	609 618 -619 622 624 629 631 641 644	Revised turbine blade repair text. (Editorial)	-ALL
72-50-00 INSP/REP-03	601 -602 604 615 617 647 661 663 -664 666 668 -679 681 -682	Revised turbine vane repair text. (Editorial)	-ALL
72-50-00 INSP/REP-05	619	Revised turbine shaft repair text.	-ALL
72-50-00 INSP/REP-06	605 611 -621 623 -626	Added turbine repair section for turbine disks and seals. Revised free turbine disk damage limits. (IEN 01JC039A)	-ALL
72-50-00 INSP/REP-08	601 -605 607	Updated free turbine case and static structure texts.	-ALL

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-50-00 INSP/REP-08 (CONTINUED)	609 611 613 616 -619 630 632 636 -637 641 645 -646	Added free turbine inlet case flange repair. (IEN 90JC028)	-ALL

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-01

1. Engine Turbine Section - No. 3 Bearing Parts

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. No. 3 Bearing Seal Support

A. Inspection

(1) Examine the walls of the seal ring groove for wear. Groove width must be in 1 of 3 sets of dimensions (those for standard seal rings and 2 available for oversize rings).

(2) Machine to remove damage to bring the groove width within limits for seal ring installation when groove wear makes the seal support unserviceable. Refer to Paragraph B. Repair.

B. Repair
See Figure 601.

(1) Seal Ring Groove Machining

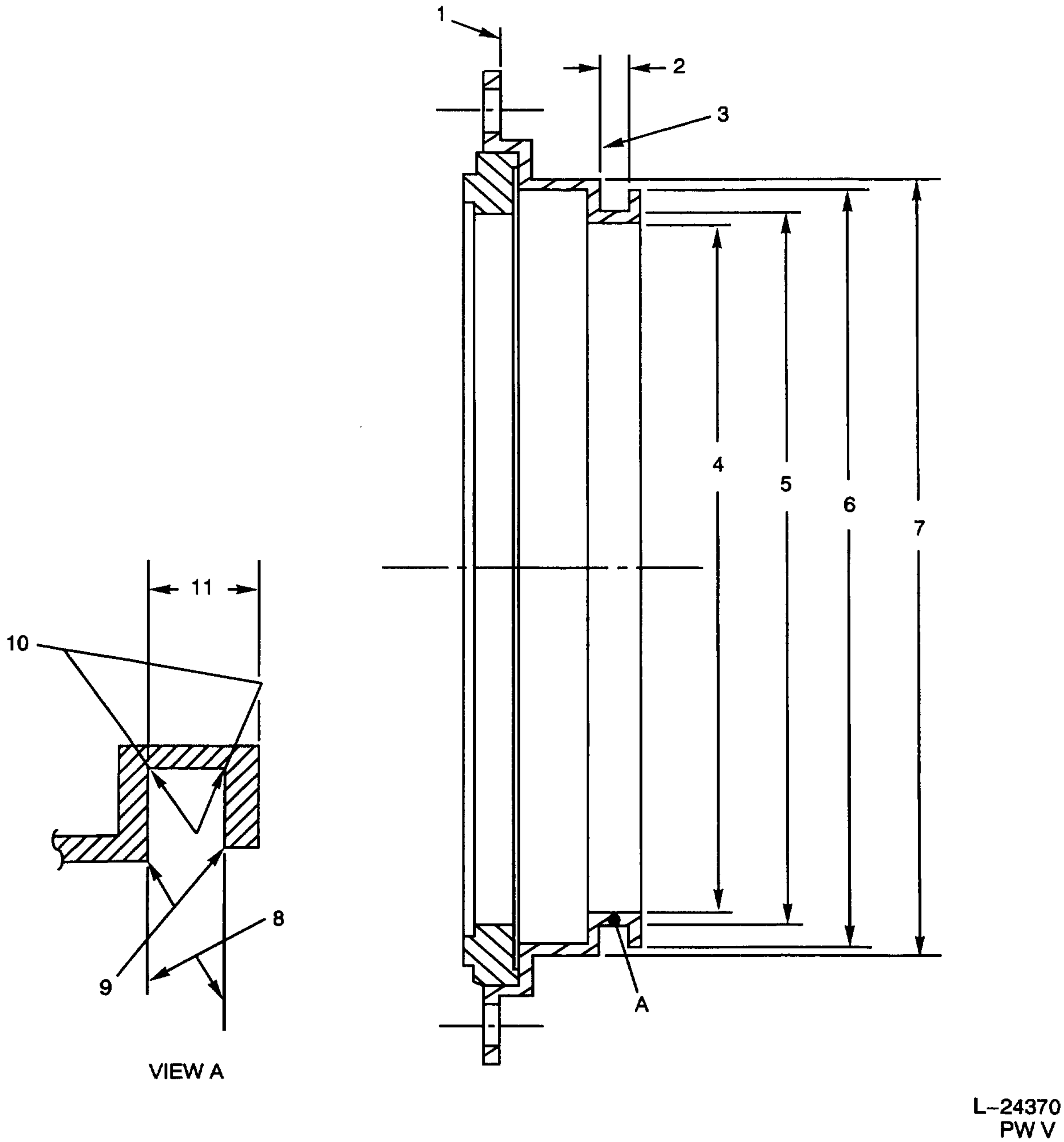
(a) Machine grooves as necessary to remove damage and restore the groove to the correct width to fit a sealing ring. Keep machining to the area shown in the figure.

(2) Seal Ring Groove Chromium Plate Repair

(a) If too much wear makes it necessary to machine the slot to 0.140 inch (but not more than 0.155 inch), then apply chromium plate by SPOP 22. Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: The part is not serviceable when machining is required to obtain a width of more than 0.155 inch to remove damage.

(b) Machine the groove to 0.140 inch width.



No. 3 Bearing Seal Support
Sealing Groove Repair
Figure 601

1. Reference Surface
2. 0.127 - 0.130 Inch (PN 370362)
   0.132 - 0.135 Inch (PN 370362 P5)
   0.137 - 0.140 Inch (PN 370362 P10)
3. Machining Surface, Parallel With Index 1 Surface 0.002 Inch FIR Maximum
4. 3.340 - 3.350 Inch Diameter
5. 3.450 - 3.460 Inch Diameter
6. 3.670 - 3.680 Inch Diameter
7. 3.737 - 3.741 Inch Diameter, Square With Machining And Reference Surfaces 0.004 Inch FIR Maximum (Refer To Indexes 1 And 3 Surfaces)
8. 10 Micro Surface Finish (M) In This Area
9. 0.005 Inch Radius Maximum
10. 0.020 Inch Radius Maximum
11. 0.170 - 0.180 Inch (PN 370362)
    0.175 - 0.185 Inch (PN 370362 P5)
    0.180 - 0.190 Inch (PN 370362 P10)

NOTE: Unless otherwise specified, diameters shown must be concentric 0.005 inch FIR maximum.

Key to Figure 601

(3) Sealing ID Chromium Plate Repair
See Figure 602.

NOTE: This repair applies to worn chromium plate on the seal ID. If the chromium plate and parent metal are worn, then perform the repair in step (4).

(a) Inspect the seal ID diameter (Index 1). If the diameter is more than 3.751 inches, then repair as follows:

1 Strip the ID by SPOP 22 (refer to Section 70-44-01 in the Standard Practices Manual), or machine to the pre-plating dimension. Refer to Index 3.

2 Chromium plate (see Index 4) by SPOP 22. Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: The part hardness is Rockwell C30 - C38.

3 Machine the plated surface to dimensions given in Indexes 3 and 4.

(4) Sealing ID Chromium Plate Repair
See Figure 603.

NOTE: This repair applies to worn chromium plate and parent metal on the seal ID. When only the chromium plate is worn, perform the repair in step (3).

(a) Inspect the seal ID diameter (Index 1).

(b) Machine the seal ID to the pre-plating dimension specified in Index 3.

NOTE: If the seal ID requires more machining after attaining the pre-plating dimension, then perform the repair in step (5).

(c) Chromium plate per Index 4 by SPOP 22. Refer to Section 70-44-01 in the Standard Practices Manual.

(d) Machine the plated surface to the dimension specified in Index 3.

(5) Sealing ID Chromium Plate Repair
See Figure 604.

NOTE: Do this repair when the seal ID cannot be cleaned up sufficiently, as described in Paragraph 4.

(a) Inspect the seal ID diameter (Index 1).

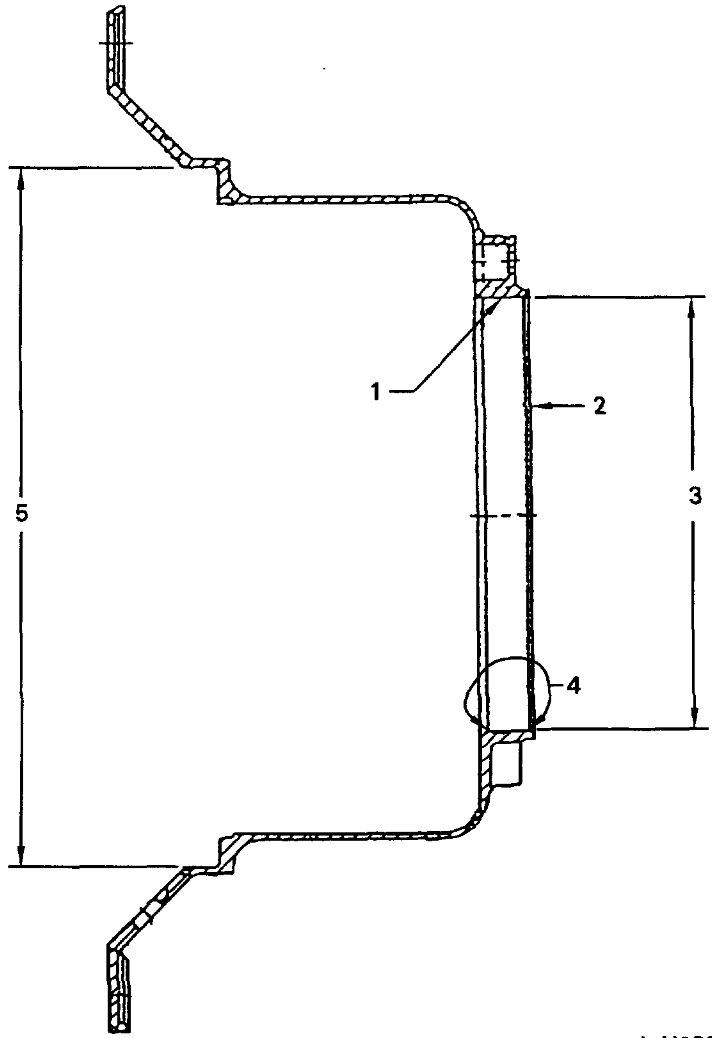
(b) Machine the seal ID to the pre-plating dimension specified in Index 3.

(c) Apply nickel plating underlay on the seal ID per Index 4 by SPOP 26. Refer to Section 70-44-01 in the Standard Practices Manual.

(d) Chromium plate over the nickel plate (see Index 4) by SPOP 22. Refer to Section 70-44-01 in the Standard Practices Manual.

(e) Machine the chromium plated surface to the dimension specified in Index 3.

NOTE: The part hardness is Rockwell C30 - C38.

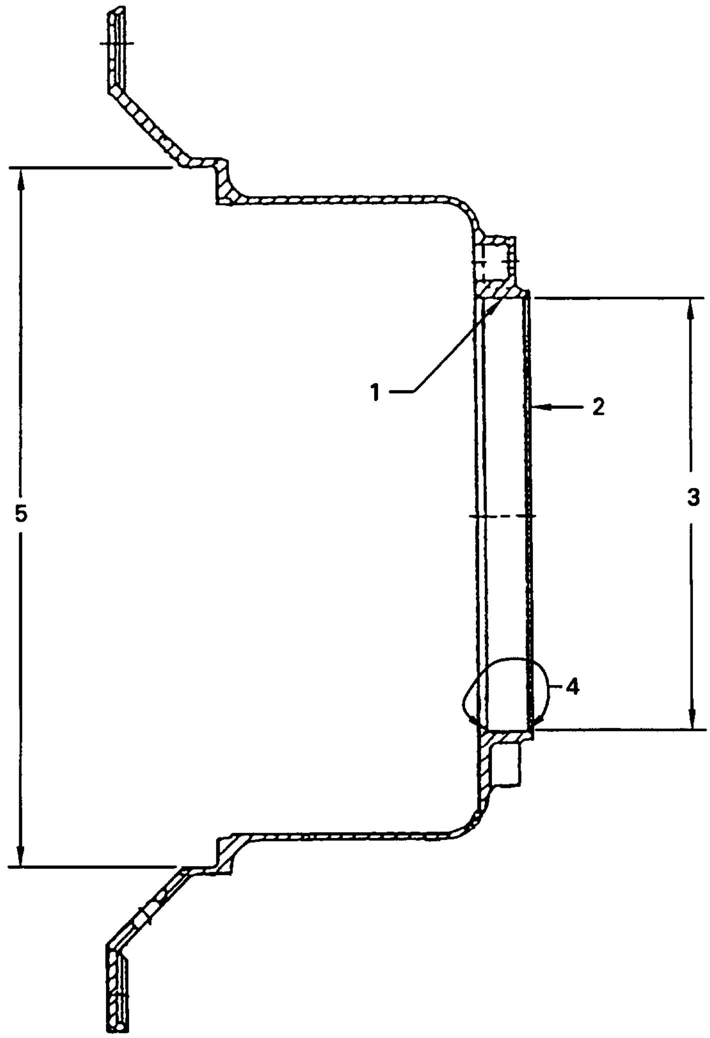


No. 3 Bearing Seal and Support
Assembly Chromium Plate Repair
Figure 602

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-01

1. Seal ID
2. Surface B
3. 3.755 - 3.757 Inch Pre-machining Diameter
   3.749 - 3.751 Inch Diameter After Plating and Finish Machining, Concentric With Diameter (Index 5) 0.002 Inch FIR Maximum, Square With Surface B (Index 2) 0.002 Inch FIR Maximum
4. Chromium Plate By SPOP 22 To 0.004 - 0.006 Inch Thick, Surface Finish 10AA
5. 6.229 - 6.231 Inch Diameter

Key to Figure 602

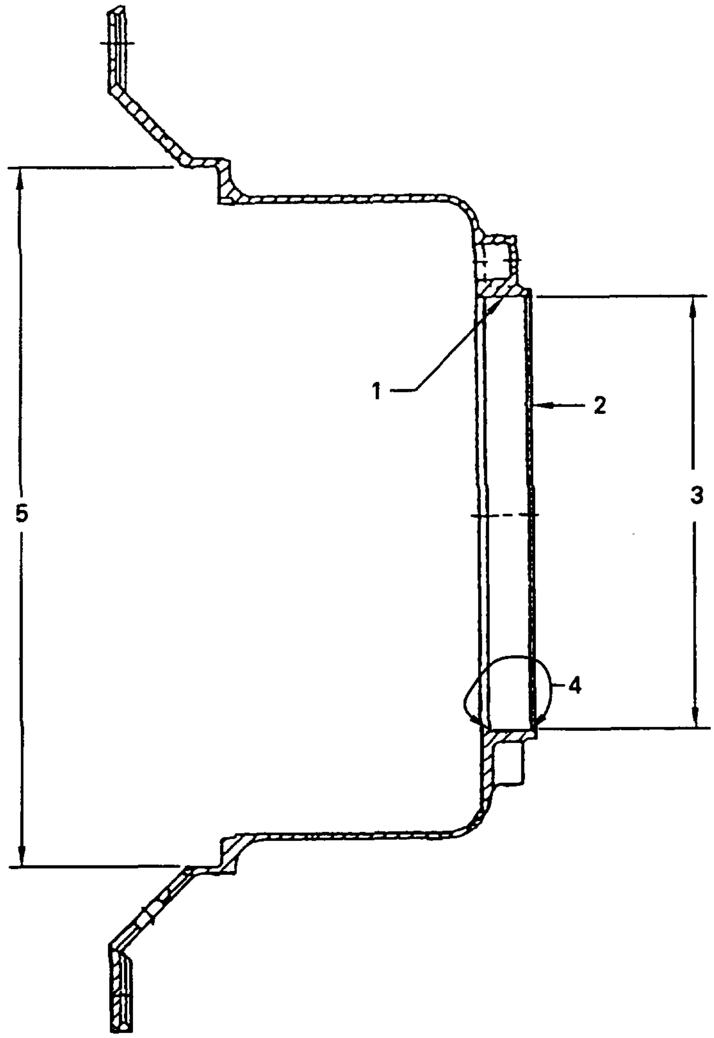


L-H3202 (1296)

No. 3 Bearing Seal and Support
Assembly Chromium Plate Repair
Figure 603

1. Seal ID
2. Surface B
3. 3.767 - 3.769 Inch Pre-Machining Diameter
   3.749 - 3.751 Inch Diameter After Plating And Finish Machining, Concentric With Diameter (Index 5) 0.002 Inch FIR Maximum, Square With Surface B (Index 2) 0.002 Inch FIR Maximum
4. Chromium Plate To 0.010 Inch Thick, Surface Finish 10AA
5. 6.229 - 6.231 Inch Diameter

Key to Figure 603



L-H3203 (1296)

No. 3 Bearing Seal and Support
Assembly Chromium Plate Repair
Figure 604

1. Seal ID
2. Surface B
3. 3.771 - 3.773 Inch Pre-Machining Diameter
   3.749 - 3.751 Inch Diameter After Plating And Finish Machining, Concentric With Diameter (Index 5) 0.002 Inch FIR Maximum, Square With Surface B (Index 2) 0.002 Inch FIR Maximum
4. Nickel Plate To 0.005 Inch Thick, Chromium Plate To 0.009 Inch Over Nickel Plate, Surface Finish 10AA
5. 6.229 - 6.231 Inch Diameter

Key to Figure 604

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-02

1. Engine Turbine Section - Turbine Blades

   A. General

   (1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Turbine Blades

   NOTE: It is recommended that individual 1st and 2nd stage gas generator turbine blades and individual 1st and 2nd stage free turbine blades be fully inspected before continued use, as described in the following paragraphs.

   A. Inspection
   (Refer to Tool Group 96A)

   (1) Use the appropriate stretch gage to check blades for excessive stretch.

   NOTE: Position the 2nd stage blade gage so that the pin at the inner end contacts the side of the blade root.

   (2) Inspect blades visually; then reinspect the visually acceptable blades by using fluorescent penetrant inspection (FPI). See Figure 601, Table 601 and Table 602.

   NOTE: FPI cast 1st stage turbine blades (PN 566101) used in JT12A-8 (N and L) and JFTD12A-4A and -5A by referring to Table 602.

   (3) Gas generator turbine blades exposed to temperatures in excess of 800°C (1472°F) are unacceptable. Refer to the Testing Section for overtemperature procedures.

   (4) First stage turbine blades that exhibit leading edge erosion must be inspected and repaired by Paragraph C.

INSPECTION AREA	VISUAL LIMITS	FPI LIMITS
Area 1-Fillet Areas	No surface damage	3 pinpoint pitting indications 1/16 in. dia. for each 4 areas and well dispersed. No indications on adjacent portion of leading or trailing edge radii.
NOTE: Fillet inspection areas extend 1/16 in. beyond point where fillet blends with airfoil and shroud or blade root platform.		

Maximum Visual And FPI Limits
Table 601

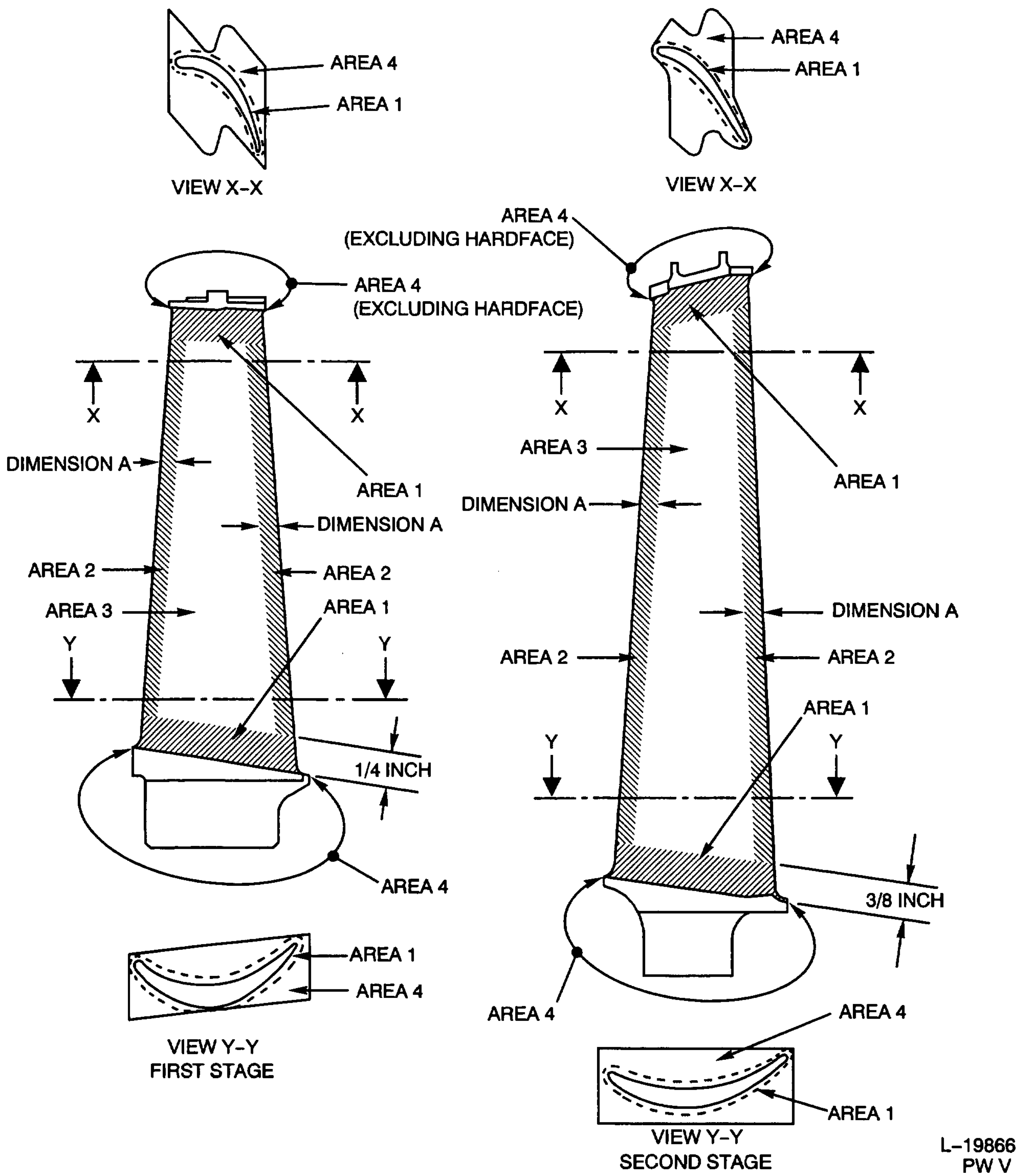
ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-02

INSPECTION AREA	VISUAL LIMITS	FPI LIMITS
Area 2-Leading and Trailing Edge Radii (Excluding Area 1)	On leading edge-3 pits 1/64 in. dia. 0.003 in. deep and 1/8 in. apart for forged blades; no surface damage for cast blades. On trailing edge-no surface damage.	3 pinpoint pitting indications 1/64 in. dia. and well dispersed per in. of area length. No indication on trailing edge radius.

NOTE: Dimension A visual inspection is 1/8 in.; FPI is 1/4 in.

INSPECTION AREA	VISUAL LIMITS	FPI LIMITS
Area 3-Airfoil (Excluding Areas 1 and 2)	Pits 1/32 in. dia. 0.006 in. deep and 1/8 in. apart for forged blades; 1/4 in. apart for cast blades.	6 pinpoint pitting indications 1/32 in. dia. per in. of area length and well dispersed.
Area 4-Shroud and Blade Root Platform (Excluding Shroud Notch and Area 1) and Blade Root	Pits 1/32 in. dia. 0.006 in. deep. Unjoined dents free of foreign material and no longer than area equivalent to 1/16 in. circle.	No indications in excess of 1/32 in. dia. and well dispersed. No indications on radii of blade root serrations. On shroud surface no linear indication exceeding 1/8 in. length neither in notch radius nor extending over edge.
Area 5-Blade Notch Hardfacing	2 pits 1/32 in. dia. and 0.005 in. deep but not closer than 3/32 in. and not breaking edge.	Linear crack indications, and lack of fusion or hot tears on side of shroud not reaching edge and not in notch radius. No hot tear indications exceeding 1/16 in. long on airfoil side of shroud in heat affected zone of hardfacing.

Maximum Visual And FPI Limits
Table 601 (Continued)



First and 2nd Stage Turbine
Blade Inspection
Figure 601

INSPECTION AREA	LIMITS
Area 1-Fillet Areas	6 pinpoint inclusions or gas porosity indications 1/64 in. dia., except in fillet area within 1/8 in. of edge radii where no indications are allowed.
Area 2-Leading and Trailing Edge Radii	4 pinpoint indications 1/4 in. apart. NOTE: Dimension A is 1/4 in.
Area 3-Airfoil (Excluding Areas 1 and 2)	12 pinpoint inclusion or gas porosity indications 1/32 in. dia. and well dispersed per in. of area length.
Area 4-Shroud and Blade Root Platform (Excluding Notch and Area)	12 pinpoint inclusion or porosity indications 1/32 in. wide and well dispersed. On blade root-faint indications except when 3 or more form a line parallel to root serrations.
Area 5-Blade Notch Hardfacing	1/8 in. crack indications, lack of fusion or hot tears not extending over edge.

Maximum Acceptable FPI Limits
For Cast Turbine Blades
Table 602

B. Repair - This repair applies to 1st and 2nd stage turbine blades, diffused aluminum with silicon coating replacement (for JT12A-8N, -8L, JFTD12A-4A and -5A only)

NOTE: Any reusable blades that exhibit coating chips, blistering or blendable foreign object damage on the airfoil must be stripped, reworked, and re-coated.

(1) Strip the coating from the blade.

(a) Remove surface grease from the blade by SPOP 209.

(b) Mask the uncoated areas.

NOTE: 1st stage turbine blades that come after PN 566101, Change Letter G, will have a tip shroud coating, which can extend into the shroud notch hardface area.

(c) Lightly grit blast the coated area by SPOP 218 using 55 - 65 psi air pressure to remove oxides. Refer to Cleaning in the Overhaul Standard Practices Manual.

(d) Place the blade in a suitable stainless steel mesh container and immerse it in air-agitated PS 316 at 60° - 66°C (140° - 150°F) for a minimum of 20 minutes.

WARNING: HYDROGEN CYANIDE VAPORS ARE EXTREMELY DANGEROUS AND MAY BE FATAL IF INHALED IN SUFFICIENT QUANTITIES. ALL OPERATIONS THAT MAY RESULT IN FORMATION OF THIS CHEMICAL MUST BE DONE IN A HOOD AREA.

CAUTION: THE TEMPERATURE OF STRIP SOLUTION MUST NOT EXCEED 66°C (150°F). EXTREME TEMPERATURES CAUSE CYANIDE BREAKDOWN AND MAY RESULT IN PARENT METAL ATTACK.

NOTE: The stripping solution must be checked daily before use to ensure that cyanide content is at least 16 oz. per gallon. The minimum operation proportion during use is 12 oz. per gallon.

(e) Scrub the coated areas with a stiff bristle brush paste of pumice and water to remove smut. Alternately, lightly vapor blast smut by SPOP 9. Refer to Cleaning in the Overhaul Standard Practices Manual.

(f) Rinse off the pumice.

(g) Immerse the part in PS 316 for 1 - 2 minutes.

(h) Rinse the part in clean water and visually check for residual coating, which will appear as a black area. Remove residual coating by repeating steps (d) through (h), as needed, for a maximum of 5 cycles.

(2) Inspect the turbine blade by Table 602 and Figure 601.

R
R

(3) Return blades to an approved source for PWA-47 coating. Refer to Section 70-40-02 in the Standard Practices Manual.

NOTE: On 1st stage turbine blades, PWA-73 diffused aluminum coating may be used as an alternate to PWA-47. Refer to Section 70-40-02 in the Standard Practices Manual for the application procedure.

(4) After the blades are re-coated (by either PWA-47 or PWA-73), shotpeen the entire root area by SPOP 501 to an intensity of 6A by using SAE 110 cast shot.

R (5) Reclassify the blades (refer to Paragraph J.).

C. First Stage Turbine Blade Leading Edge Erosion Inspection And Repair
See Figure 602 and Figure 603.

(1) Visually inspect the blade leading edge for erosion.

NOTE: Erosion is defined as flattening of the convex side of the airfoil near the leading edge radius, as shown in Figure 602. This condition is most prevalent on the edge radius near the blade outer shroud.

(2) Measure the blade chord width M-dimension at Station A-A of Figure 602. Reject blades that are below limits and hold them pending possible future repair.

NOTE: All dimensions apply to the blade before re-coating.

(3) Blend the leading edge at the eroded area to incorporate a radius of 0.008 - 0.012 inch on the concave and convex sides. Remove the minimum amount of material. Use a 240 grit aluminum oxide wheel for all machining.

(4) Machine material from the leading edge of the shroud parallel to the shroud trailing edge to provide a shroud overhang of 0.010 inch minimum to 0.020 inch maximum. The minimum allowable shroud leading edge thickness after cutback is 0.015 inch. The shroud width following re-operation must not be less than 0.450 inch.

(5) For all JT12A-8 blades PN 566101, use a 240 grit aluminum oxide wheel to polish the entire leading edge area the full length of the blade, not blended by step (3), in preparation for the re-coating operation. Polishing cleans and removes the existing coating while minimizing removal of blade parent material.

NOTE: Steps (3) and (5) may be combined, provided a 0.008 - 0.012 inch radius is established on the eroded edges and most of the existing coating on the length of the blade is removed. Preferably, perform trial runs to establish the technique for removing the leading edge coating.

(6) Inspect for the presence or absence of coating as follows:

(a) Power flush with water, rinse in hot water, and dry with air blast.

(b) Heat tint blades by heating in an air furnace at 524° - 552°C (975° - 1025°F) for 1 hour.

(c) Inspect coated area for color. Golden color indicates the presence of coating. Blue or purple color indicates a lack of coating.

NOTE: First stage turbine blades that come after PN 566101 Change Letter G have a tip shroud coating that can extend into the shroud notch hardface area.

(7) Inspect blades for cracks by using FPI. Refer to the Standard Practices Manual.

(8) Perform the following steps for JT12A-8 blades PN 566101:

NOTE: JT12A-6/A-6A blades PN 405701 must not be coated.

(a) Fully clean the blades by SPOP 209.

(b) Use masking tape to mask areas that will not be coated. Refer to Figure 603.

(c) Grit blast the blade shroud ID and the leading edge affected area with No. 90 mesh aluminum oxide grit at 20 psi line pressure and 1 foot nozzle-to-work distance. Do not exceed 5 seconds on any area.

(d) Remove the masking tape and clean the blades by power flushing (water blast). Rinse all surfaces with acetone. Inspect to ensure all blasting grit and residual tape adhesive is gone.

(e) Re-mask unaffected areas, allowing approximately 0.010 inch overlap of coating beyond the area to be coated.

(f) Brush SermeTel J, aluminum-silicon coating, onto the exposed area and cure under heat lamps or in an electric oven set at 65° - 93°C (150° - 200°F) for 15 minutes.

NOTE: SermeTel J is manufactured by:
Teleflex Corp.
SermeTel Division
P.O. Box 187
North Wales, PA 19454

WARNING: COMPOUNDS THAT CONTAIN FINELY DIVIDED ALUMINUM METAL CAN INTRODUCE AN EXPLOSIVE HAZARD WHEN A DUST CLOUD OF DRY PARTICLES FORMS. RESIDUE OF COATING SLURRIES MAY REACT WITH ALKALIES OR ACIDS TO PRODUCE HYDROGEN GAS, WHICH IS EXPLOSIVE. AVOID ACCUMULATING COATING RESIDUE IN THE SPRAY BOOTH AND ON EQUIPMENT.

(g) Apply aluminum-silicon coating 2 or more times for a total coating thickness of 0.005 - 0.007 inch. After curing each coat, allow blades to cool to room temperature before applying the succeeding coat.

(h) Remove the masking tape. Inspect the new coating for cracks or voids. If any indications appear, then scrub off the coating with a soft brush and water. Repeat the sequence for cleaning and applying the coating.

(i) If the new coating is satisfactory, then place the blades in a rack for diffusion cycle, ensuring that the newly coated surfaces do not contact the rack.

CAUTION: DO NOT HANDLE NEWLY COATED SURFACES PRIOR TO DIFFUSE CYCLE.

(j) Diffuse the coating at:

857° - 885°C (1575° - 1625°F) in Argon or Hydrogen atmosphere for 15 - 20 minutes;

followed by:

Four hours at 1066° - 1094°C (1950° - 2000°F) in Argon or Hydrogen atmosphere.

Take extreme care when handling blades. Air cool blades, then:

Heat treat at 885° - 913°C (1625° - 1675°F) for 10 hours. Air cool blades to room temperature.

(k) Shotpeen the entire root area with an intensity of 6A by using SAE 110 cast shot. Refer to the Standard Practices Manual.

D. Second Stage Turbine Blade Leading Edge Erosion Inspection And Repair
See Figure 604.

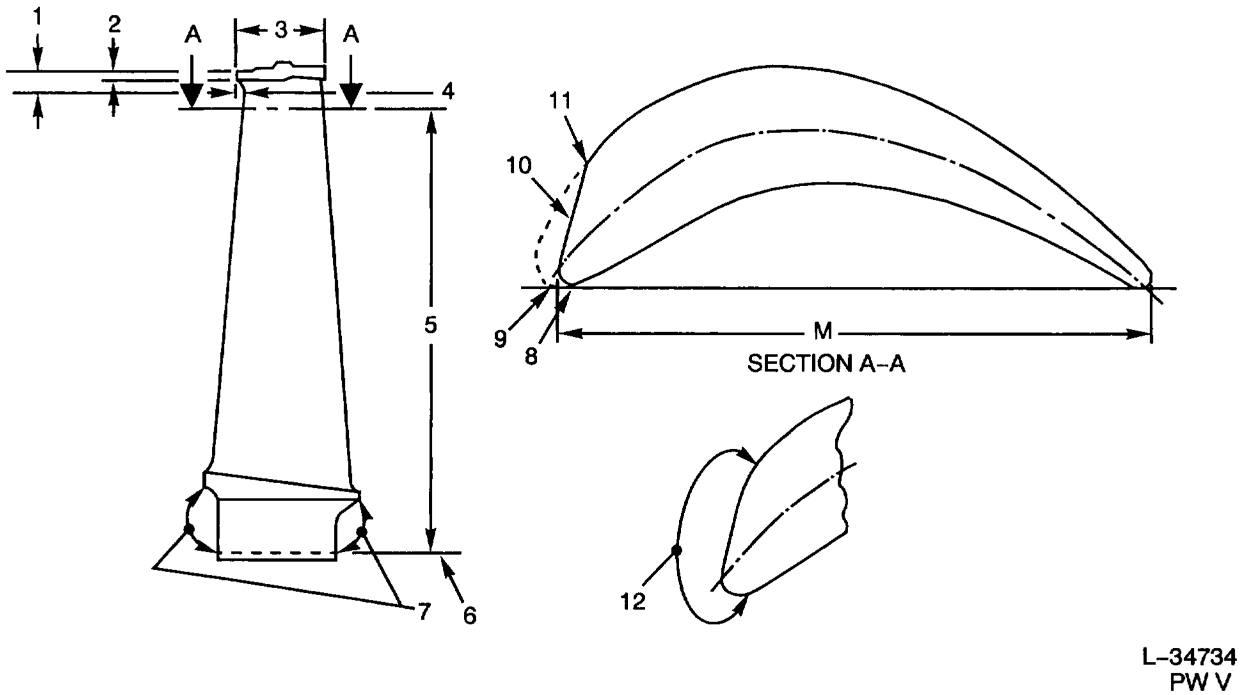
(1) Visually inspect the blade leading edge for erosion.

NOTE: Erosion is defined as flattening of the convex side of the airfoil near the leading edge radius, as shown in Figure 605. This condition is most prevalent on the edge radius near the blade outer shroud.

(2) Measure the blade chord width M-dimension at Section A-A
R in Figure 604. Reject blades that are below limits and hold them pending possible future repair.

NOTE: All dimensions apply to the blade before re-coating.

(3) Blend the leading edge at the eroded area to incorporate a radius of 0.008 - 0.012 inch on the concave and convex sides. Remove the minimum amount of material. Use a 240 grit aluminum oxide wheel for all machining.

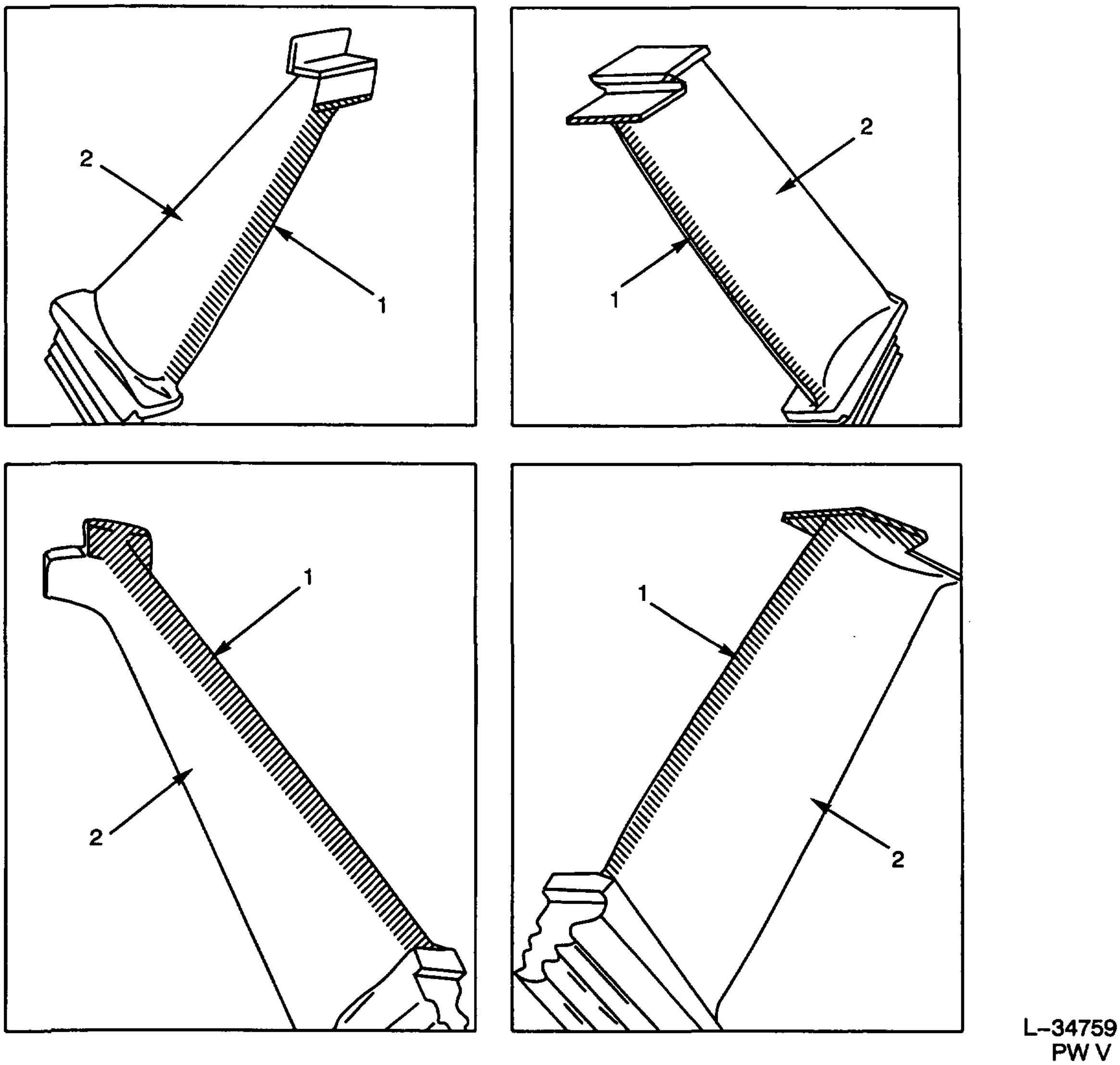


1. 0.100 Approximately
2. Minimum Shroud Leading Edge Thickness 0.015 Inch
3. Minimum Shroud Width After Machining 0.450 Inch
4. Shroud Overhang 0.010 Inch Minimum To 0.020 Inch Maximum
5. Section A-A Is Located At Point Of Maximum Erosion. The Minimum Allowable M-Dimension At This Section Is 0.637 Inch
6. Rivet Radius
7. Shotpeen Area
8. Concave Side Leading Edge Radius
9. Original Leading Edge Contour
10. Eroded Leading Edge Contour
11. Convex Side Leading Edge Radius
12. Leading Edge To Polish To Remove Most Of Coating

NOTE: It is recommended that a blade type micrometer be used for shroud thickness and M-dimension measurement, similar to L.S. Starrett Co., Athol MA, No. 486-P (1 inch) micrometer.

R
R

First Stage Turbine Blade Erosion
Inspection And Repair
Figure 602



1. Area Of Blade To Coat Is Indicated By Cross-Hatch
2. Remainder Of Blade To Mask

First Stage Turbine Blade Leading Edge Coating Repair
Figure 603

(4) For turbine blade PN 597602, use a 240 grit aluminum oxide wheel to polish the entire leading edge area the full length of the blade, not blended by step (3), in preparation for the re-coating operation. Polishing cleans and removes the existing coating while minimizing removal of blade parent material.

NOTE: Steps (3) and (4) may be combined, provided a 0.008 - 0.012 inch radius is established on the eroded edges and most of the existing coating on the length of the blade is removed. Preferably, perform trial runs to establish the technique for removing the leading edge coating.

(5) Inspect for the presence or absence of coating by following the procedure in Paragraph C. step (6).

(6) Inspect for cracks by using FPI. Refer to the Standard Practices Manual. Scrap all blades with cracks.

(7) For turbine blades PN 597602, restore the coating to the polished leading edge area by following the procedure in Paragraph C. step (8).

NOTE: Turbine blades PN 428802 must not be re-coated.

E. Turbine Blade Seals - 2nd Stage

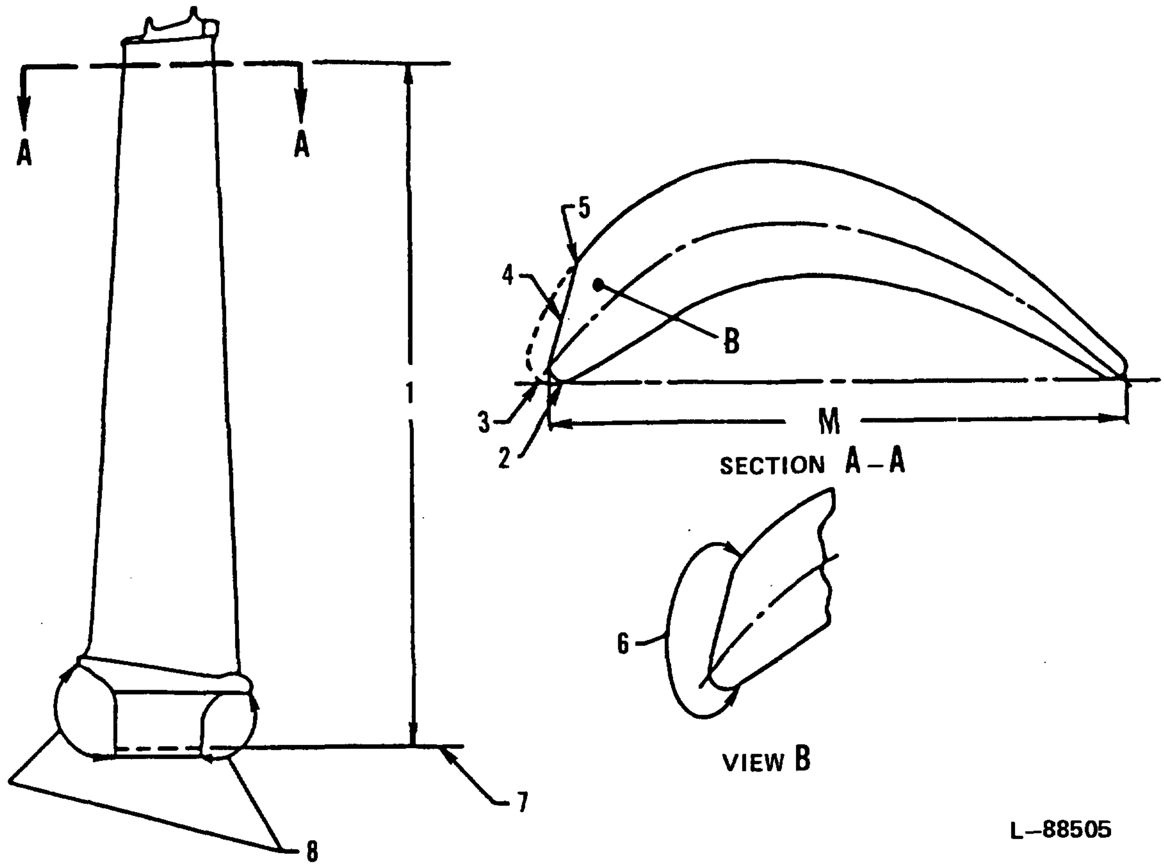
CAUTION: DO NOT USE POWER TOOLS ON THESE GAS SEALS. AVOID EXCESSIVE REMOVAL OF MATERIAL, WHICH WILL RESULT IN EXCESSIVE SEAL CLEARANCE OR DAMAGE TO BLADE SHROUD. SLIGHTLY BENT GAS SEALS ARE SERVICEABLE WITHOUT REWORK PROVIDED CRACKING DOES NOT EXIST. DO NOT ATTEMPT TO STRAIGHTEN BENT GAS SEALS.

(1) Material may be removed 3/32 inch circumstantially to full depth of seal on 1 of 2 seals, provided cracks do not extend into the shroud.

F. First And 2nd Stage Turbine Blade Shroud Notch Repair See Figure 605.

(1) Examine the base of the shroud notch.

(a) Minor cracks in the area shown are permitted to get repair.



1. 3.540 Inches From Rivet radius. The Minimum Allowable M-Dimension At Section A-A Is 0.702 Inch. Do Not Exceed Blend More Than 0.250 Inch Inboard Of Section A-A.
2. Concave Side Leading Edge Radius
3. Original Leading Edge Contour
4. Eroded Leading Edge Contour
5. Convex Side Leading Edge Radius
6. Leading Edge To Polish To Remove Most Of Coating
7. Rivet Radius
8. Shotpeen Area

NOTE: It is recommended that a blade type micrometer be used for shroud thickness and M-dimension measurement, similar to L.S. Starrett Co., Athol MA, No. 486-P (1 inch) micrometer.

Second Stage Turbine Blade Erosion
Inspection And Repair
Figure 604

(b) Blades with cracks that extend out of the material removal area are not serviceable and are scrap.

(2) To repair the shroud notch, remove material from the base of the notch in the area shown with a small hand file. Make sure that there is a smooth transition between the notch wall and the repair area. Do not remove material more than the dimensions specified.

(3) Repair procedure

CAUTION: THE REPAIR MUST NOT DECREASE THE AIRFOIL THICKNESS BY MORE THAN 0.005 INCH OR THE CHORD LENGTH BY MORE THAN 0.007 INCH.

(a) Blend nicks or dents in the airfoil to no nearer than 3/8 inch from either the outer shroud or the root platform. It must not be possible to see the damage on the opposite side of the airfoil.

CAUTION: THE REPAIR MUST NOT DECREASE THE AIRFOIL THICKNESS BY MORE THAN 0.005 INCH OR THE CHORD LENGTH BY MORE THAN 0.007 INCH.

(b) Blend nicks or dents in the airfoil (but not in the above areas) if it is not possible to see damage from the opposite side of the airfoil.

(c) Remove shroud knife-edge seals to 1/4 of the length of one seal, or a total on the two seals which (added together) will not be more than 1/4 of the length of one seal.

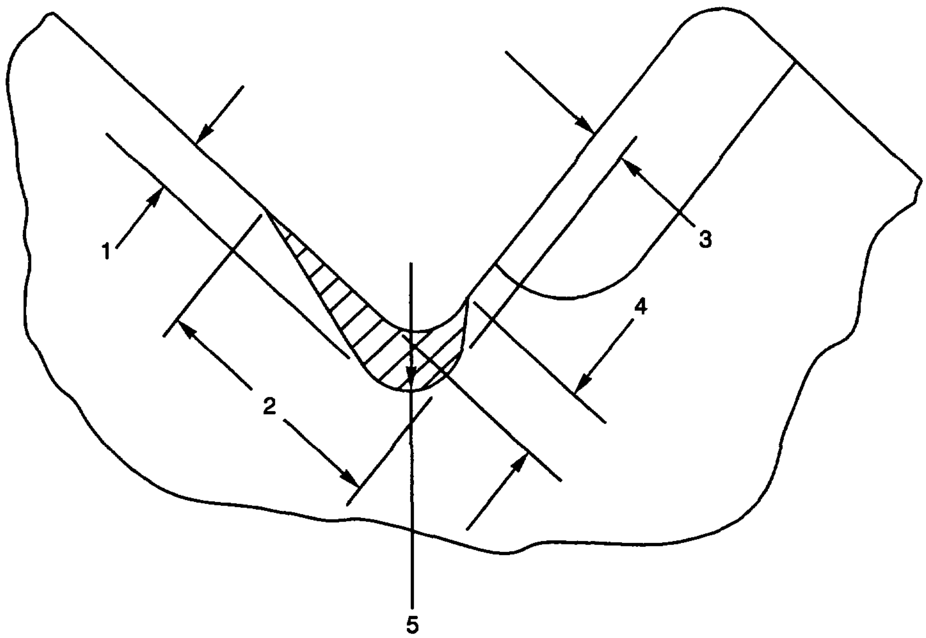
NOTE: If it is necessary to repair the two seals, it is not permitted to have two seal repair areas opposite each other. Keep a 1/16 inch overlap limit for repairs on adjacent seals.

G. Turbine Blade Shroud Pretwist Inspection And Repair See Tool Group 96A-3, Table 603 and Table 604.

NOTE: This procedure is not applicable to PN 392702 turbine blade.

(1) Inspection

(a) With a blade installed in a Pretwist Checking Fixture, find the amount of pretwist with an optical comparator.



1. 0.020 Inch Maximum
2. 0.100 Inch Maximum
3. 0.012 Inch Maximum
4. 0.035 Inch Maximum
5. 0.025 - 0.035 Inch Radius

NOTE: These dimensions apply to both notches.

Turbine Blade Shroud Notch
Limits For Repair
Figure 605

(b) See Table 603 and Table 604 for acceptable twist conditions. Record the pretwist for each blade to find the permitted extent of notch wear. Refer to Paragraph H.

AMOUNT OF PRETWIST (SHROUD ROTATION)	DISPOSITION OF BLADE
5° 45' - 6° 00'	Acceptable without repair when notch wear is 0.004 inch or less
5° 20' - 5° 45'	Retwist to 5° 55' - 6° 05'
Less than 5° 20'	Scrap, unacceptable for service or repair

Pretwist Inspection - 1st Stage
Table 603

AMOUNT OF PRETWIST (SHROUD ROTATION)	DISPOSITION OF BLADE
0° 15' - 1° 00'	Acceptable without repair when notch wear is 0.008 inch or less
0° 15' to -0° 30'	Retwist to 0° 55' - 1° 5'
Less than -0° 30'	Scrap, unacceptable for service or repair

Pretwist Inspection - 2nd Stage
Table 604

(2) Repair

(a) Blades within reparable limits must be retwisted as follows:

1 Secure the blade in a vise ensuring that the vise jaw contacts the root platform rather than the blade root.

2 Position the wrench (with the appropriate Insert installed) on the blade shroud and twist in the appropriate direction. Check the pretwist by using the pretwist Checking Fixture and the optical comparator.

CAUTION: DURING TWISTING, ENSURE THAT THE SHROUD AND AIRFOIL ARE NOT OVERTWISTED OR BENT EITHER AXIALLY OR CIRCUMFERENTIALLY. TO ENSURE THAT AXIAL OR CIRCUMFERENTIAL BENDING HAS NOT OCCURRED, CHECK THE BLADE WITH A STRETCH GAGE PER PARAGRAPH A.

H. Turbine Blade Shroud Notch Inspection (Refer to Tool Groups 96A-1 and 96A-2)

NOTE: This procedure does not apply to PN 392702 blades.

(1) Visually inspect the blade for point to point contact wear, high or low spots, and upset or displaced material on notch surfaces. Blades with obvious notch wear or displaced material on notch surfaces can be either scrapped as unacceptable or inspected for acceptability according to the following procedure.

(2) Perform the following steps to inspect blade notches:

(a) Install the dial indicator holder on the cross notch checking fixture and mount the dial indicator on the holder. Center the indicator probe on the end surface of the flush pin. With the master installed in the checking fixture, zero the dial indicator. Ensure that the holding fixture has full bearing on the surface of the gage body; then, slide the holder so that the dial indicator probe contacts the gage body. Remove the master.

(b) Install the blade in the checking fixture.

NOTE: The blade is mounted in the fixture with the wedge engaging the blade root rivet radius and the shroud notch on the convex side engaging the shroud support. The shroud end of the blade must rest securely on gage surfaces.

(c) Slide the holder so that the dial indicator probe first bears on the gage body, then on the flush pin.

NOTE: The dial indicator reading at the flush pin indicates the present dimension of the blade compared to the original mean dimension. A zero reading represents the original mean dimension across notches (no notch wear).

R
R

(d) Blades with notch wear (reduction in cross notch dimension) must be handled according to Table 605 and Table 606.

	NOTCH WEAR	DISPOSITION OF BLADE
	0.004 inch or less	Acceptable when pretwist is between 5° 45′ and 6° 00′
R	0.004 - 0.006 inch	Replace hardface by Paragraph I.
R	0.006 - 0.009 inch	Scrap, when associated with a pretwist of 5° 35′ or less. Replace hardface by Paragraph I. when pretwist is between 5° 35′ and 6° 00′.
	In excess of 0.009 inch	Scrap, unacceptable for service or repair.

Notch Wear Inspection - 1st Stage
Table 605

	NOTCH WEAR	DISPOSITION OF BLADE
	0.008 inch or less	Acceptable when pretwist is between 0° 15′ and 1° 00′
R	0.008 - 0.014 inch	Replace hardface by Paragraph I.
R	0.014 - 0.020 inch	Scrap, when associated with a pretwist of less than 0° 00′. Replace hardface by Paragraph I. when pretwist is between 0° 00′ and 1° 00′.
	In excess of 0.020 inch	Scrap, unacceptable for service or repair.

Notch Wear Inspection - 2nd Stage
Table 606

I. Turbine Blade Shroud Notch Repair
(Refer to Tool Groups 96A-1 and 96A-2)

<u>NOTE</u>: This procedure does not apply to PN 392702 turbine blades.

NOTE: First weld and machine the convex notch. Due to fixture setup, the notch repairs cannot be done simultaneously.

(1) Weld the hardface material on the worn surface of the blade notch with coating alloy PWA-694. Use 15 - 30 amperes (maximum) alternating current. Keep hardface buildup to a minimum.

NOTE: Preferably, maintain a 0.050 inch gap between the notch and the electrode tip.

(2) Grind the weld bead to get a smooth surface for the hardness check. Rockwell C42 - C50, or equivalent, is required. Perform the hardness check on at least 10 percent of a quantity of blades.

R (3) Grind excess hardface from the inner and outer sides of the shroud, maintaining the contour of the shroud and shroud spoiler.

(4) Visually inspect the hardface material for defects. If cracks are present, then completely replace the hardface.

R (5) Grind the hardface notch on the airfoil convex side as follows:

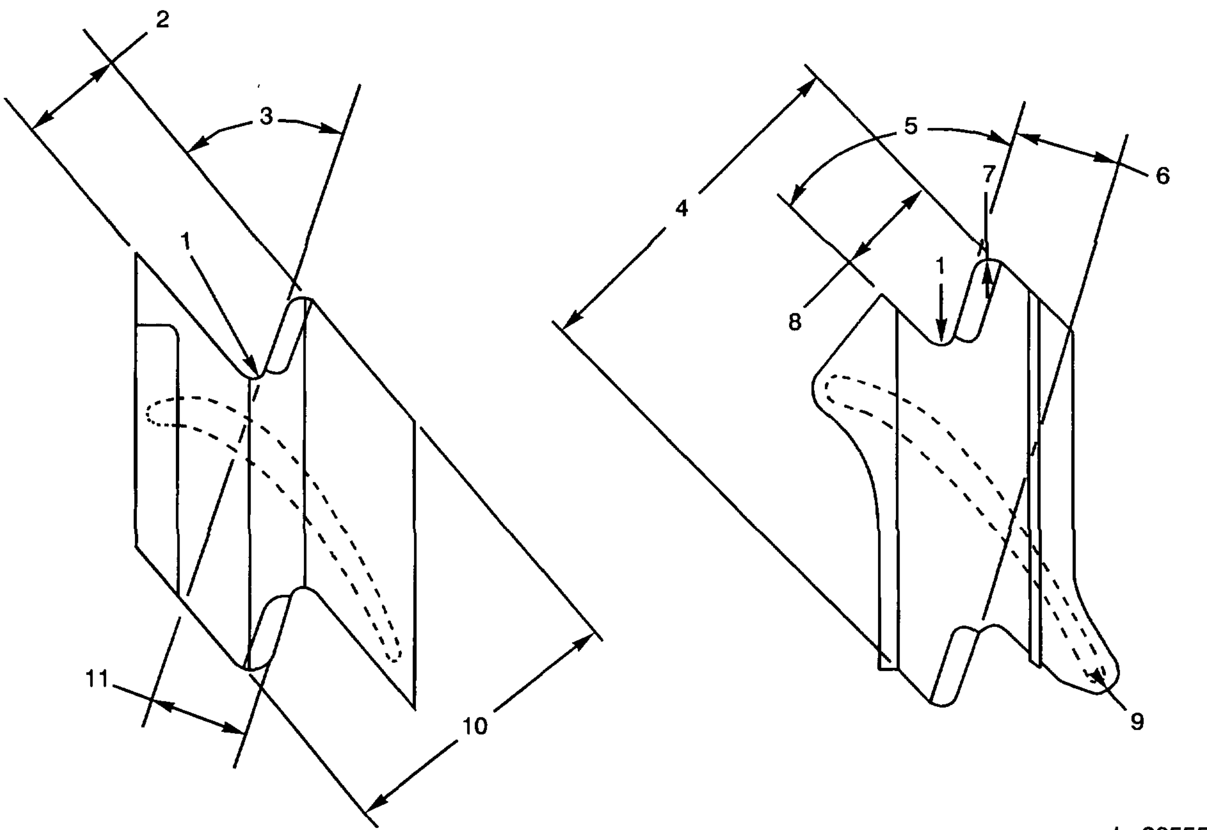
(a) Dress the grinding wheel by using a template and a 5:1 ratio wheel dresser.

(b) Attach the grinding fixture (convex) to the grinder table.

(6) Place the blade, convex side up, in the fixture with the wedge radius engaging the blade root rivet radius, and with the fixture clamping screw against the shroud. Shim stock, 0.001 inch thick, must not extend between the notch face and the locating blocks.

(7) Remove the correct amount of material to obtain the original dimensions. See Figure 606.

NOTE: Use a 10 x 1 x 3 inch, FMR-JA-802-J7-V10 grinding wheel or equivalent at 41 - 55 sfm, and use coolant.



1. 0.020 - 0.030 Inch Notch Radius
2. 0.198 - 0.202 Inch Notch Depth
3. 58° 55′ - 59° 5′ Notch Angle
4. 0.675 - 0.679 Inch
5. 62° 25′ - 62° 35′ Notch Angle
6. 0.204 - 0.208 Inch Cross Notch Dimension
7. 0.030 - 0.040 Inch Radius
8. 0.198 - 0.202 Inch Notch Depth
9. 0.040 Inch Radius
10. 0.556 - 0.560 Inch
11. 0.182 - 0.186 Inch Cross Notch Dimension

R
R

Turbine Blade Shroud Notch Dimensions
Figure 606

(8) Determine the cross notch dimension for the convex side by using a notch depth gage, dial indicator, and dial indicator holder. Place the gage on the gaging surface of the grinding fixture with the gage pin in the shroud notch. Zero the dial indicator with the probe against the gage body. Then, move the dial indicator to the gage flush pin. A ±0.002 inch reading is acceptable.

(9) Blend sharp edges and radii to original surface where necessary.

(10) Weld the notch hardface on the airfoil concave side as described in step (1), and machine as follows:

(a) Check the wheel shape. If it is properly shaped and convex side dimensions are within limits, then additional dressing is not required.

(b) Attach the grinding fixture (concave) to the grinder table.

(c) Place the blade in the fixture with the root radius contacting the wedge and with the convex side notch contacting the locating block. Clamp in place with the clamp screw, engaging the shroud and securing the airfoil section. Shim stock, 0.001 inch thick, must not extend between the notch face and the locating blocks.

(11) Machine the notch on the concave side as described in step (7).

(12) Stress-relieve the blade at 816°C (1500°F) for 4 hours, then perform a final FPI. Refer to the Overhaul Standard Practices Manual.

J. Free Turbine Blade (1st And 2nd Stages) Inspection And Repair

(1) Inspection
(Refer to Tool Group 56E-1)

(a) Preinspection Preparation

1 Limits are evaluated from the standpoint of structural integrity, gross performance deficiencies, and dimensional requirements for assembly. The use of a substantial number of airfoils at or near the maximum limits or having many repaired areas can adversely affect engine efficiency and performance.

2 Limits apply to damaged areas after blend repair and not to the size of the damage measured before blend repair. Keep material removal to a minimum for maximum part life and function.

3 Evaluation of surfaces for which blend repair is necessary must take into consideration the need for blend repair and the limits of the blend repair. Some conditions are acceptable without repair. Hover it is usually better to do blend repair of surface damage. The sharper the surface damage, the better it is to repair the damage.

4 During visual inspection pay particular attention to areas where defects are difficult to find, for example shroud notches, root firtree fillet radii, and pockets. Use a strong white light and mirrors (as well as the fingernails) to find damaged areas. When an indication (nick, dent, scratch, corrosion pit, etc.) is found, use magnification to find the size of the defect (or compare it to samples with known damage depths).

(b) Non-destructive Inspection

1 Do a fluorescent penetrant inspection of the 1st and 2nd stage blades. Refer to Section
R 72-00-00, Inspection. See Figure 607 for special attention areas and Table 607 for inspection limits.

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area A	One indication per area, not more than 0.015 inch diameter	Permitted without repair

Free Turbine Blade FPI Limits
Table 607

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area B - Leading and Trailing Edge	No cracks permitted, four indications per side, not back to back, minimum separation 0.250 inch	Refer to Repair. Finish blend limits must not be more than 0.015 inch in depth and must not decrease chord width more than 0.020 inch.
Area C - Airfoil, concave and convex sides (not fillet area)	No cracks permitted, six indications per inch of length with minimum separation of 0.125 inch	Refer to Repair. Finish blend limits must not be more than 0.007 inch in depth.
Area D - Two positions (not in the fillet)	Six indications per side or two clusters per side, clusters not to be more than 0.125 inch in diameter and no nearer than 0.250 inch	Refer to blend repair
Area E - Blade root, front and rear faces and platform	Six pinpoint indications 0.031 inch diameter and well dispersed. Indications 0.005 inch deep maximum are permitted without repair.	Refer to Repair. Finish blend must not be more than 0.015 inch depth.
Area F - Blade root, firtree faces and platform	Six pinpoint indications 0.031 inch diameter and well dispersed. Indications must not be more than 0.003 inch depth and not nearer to edge or load surface than 0.063 inch.	Refer to Repair.
	No unblended damage permitted 0.063 or less from edge or load surface. NOTE: No blend repair is permitted on load surfaces.	Refer to Repair.

R
R

Free Turbine Blade FPI Limits
Table 607 (Continued)

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area G - Knife-edge Seal and shroud	No cracks permitted in knife-edge seal	Refer to Repair.
	Indications on shroud not more than 0.031 inch diameter and well dispersed, and not more than 12 in number	Refer to Repair. Blend must not be more than 0.015 inch depth
1st stage - Blade notch area	No crack indications permitted in notch radius	Refer to Repair for limits
2nd Stage - Blade shroud notch hardface area	No cracks permitted in notch radius. Chip or crack indications that break on edge of hardface area must have blend repair. Cracks that extend into base material are not permitted.	Refer to Repair. 10 percent maximum of contact surface permitted to remove. No limit to number of blends on contact face.

Free Turbine Blade FPI Limits
Table 607 (Continued)

(c) Visual Inspection

1 Examine the blades for surface damage. See
R Figure 608 and Table 608 for inspection areas and damage limits.

2 Examine blades for overtemperature condition and metal splatter.

a Parts with overtemperature condition are not serviceable or repairable and are scrap.

b Parts with metal splatter in area where no blend repair is permitted are not serviceable or repairable and are scrap.

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area A	Smooth round-bottom dents 0.003 inch maximum depth. No cracks permitted in dents. No damage permitted in fillet area.	Remove damage 0.005 inch depth maximum.

Free Turbine Blade Visual
Inspection Limits
Table 608

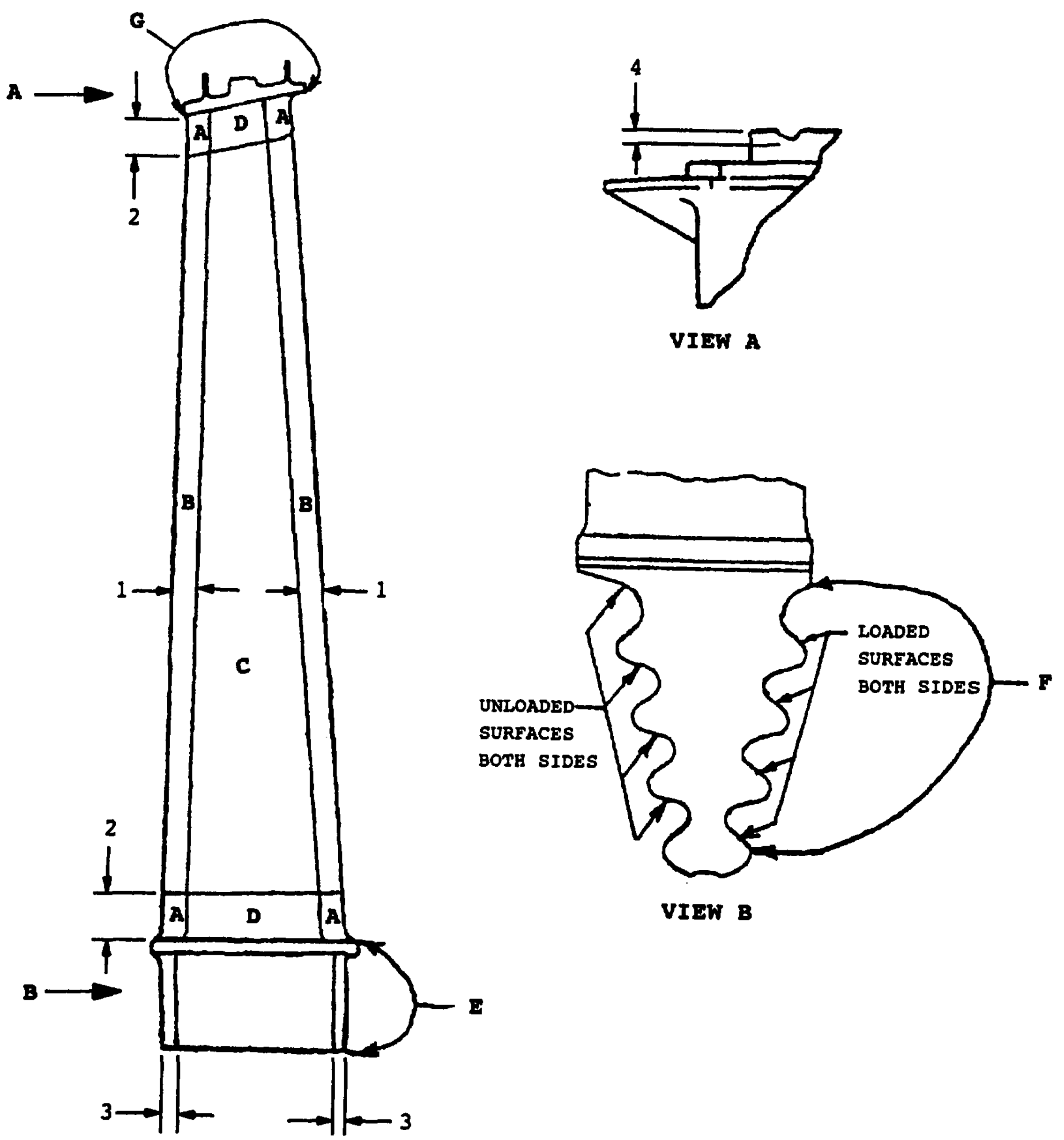
INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area B - Leading and Trailing Edge	No cracks permitted. Smooth round bottom dents can be 0.010 inch depth maximum. Dents must not be detectable on opposite side of airfoil. No cracks are permitted in dents.	Blend of edge must not decrease leading and trailing edge chord length by more than 0.020 inch total.
Area C - Airfoil, concave and convex sides (not fillet area)	No cracks permitted. Smooth round bottom dents must be 0.005 inch depth maximum. Dents must not be detectable on opposite side of airfoil.	Finish blend must not be more than 0.007 inch depth.
Area D - Two positions (not in the fillet)	Smooth round bottom dents 0.003 inch depth maximum. No cracks permitted in dents. No damage permitted in fillet area.	Blend 0.007 inch depth maximum.
Area E - Blade root, front and rear faces	Nicks, dents, corrosion and pits permitted to 0.015 inch maximum depth.	Maximum depth of blend 0.015 inch
Area F - Blade root firtree	No unblended damage is permitted 0.063 inch or less from load surface or blade root serrations.	Maximum depth of blend 0.010 inch
	NOTE: No blend repair is permitted on load surfaces.	
	Nicks, dents, corrosion, and pits that are not at the edge and are not more than 0.003 inch depth are permitted.	

Free Turbine Blade Visual Inspection Limits
Table 608 (Continued)

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area G - Knife-edge	Nicks, dents, and corrosion pits can be 0.010 inch maximum depth	Maximum blend axial length 0.025 inch
	All cracks must get blend repair.	Maximum blend must not be more than 0.025 inch depth or 25 percent of knife-edge length
		Knife-edge damage more than limits can get weld repair
Area G - Shroud surface (not fillet area)	Nicks, dents, and corrosion pits 0.010 inch maximum depth	Maximum finish blend no more than 0.015 inch depth
1st stage - Blade notch area	Two pits 0.031 inch diameter and 0.005 inch depth maximum with distinct separations and which do not break edge. No cracks permitted.	Refer to Repair.
2nd stage - Blade notch and hardface area	Two pits 0.031 inch diameter and 0.005 inch depth maximum with distinct separations and which do not break edge.	10 percent removal of contact surface permitted
	Chip cracks that break an edge in hardface must get blend repair. No cracks permitted which extend into parent material. No cracks permitted in notch radius.	

Free Turbine Blade Visual Inspection Limits
Table 608 (Continued)

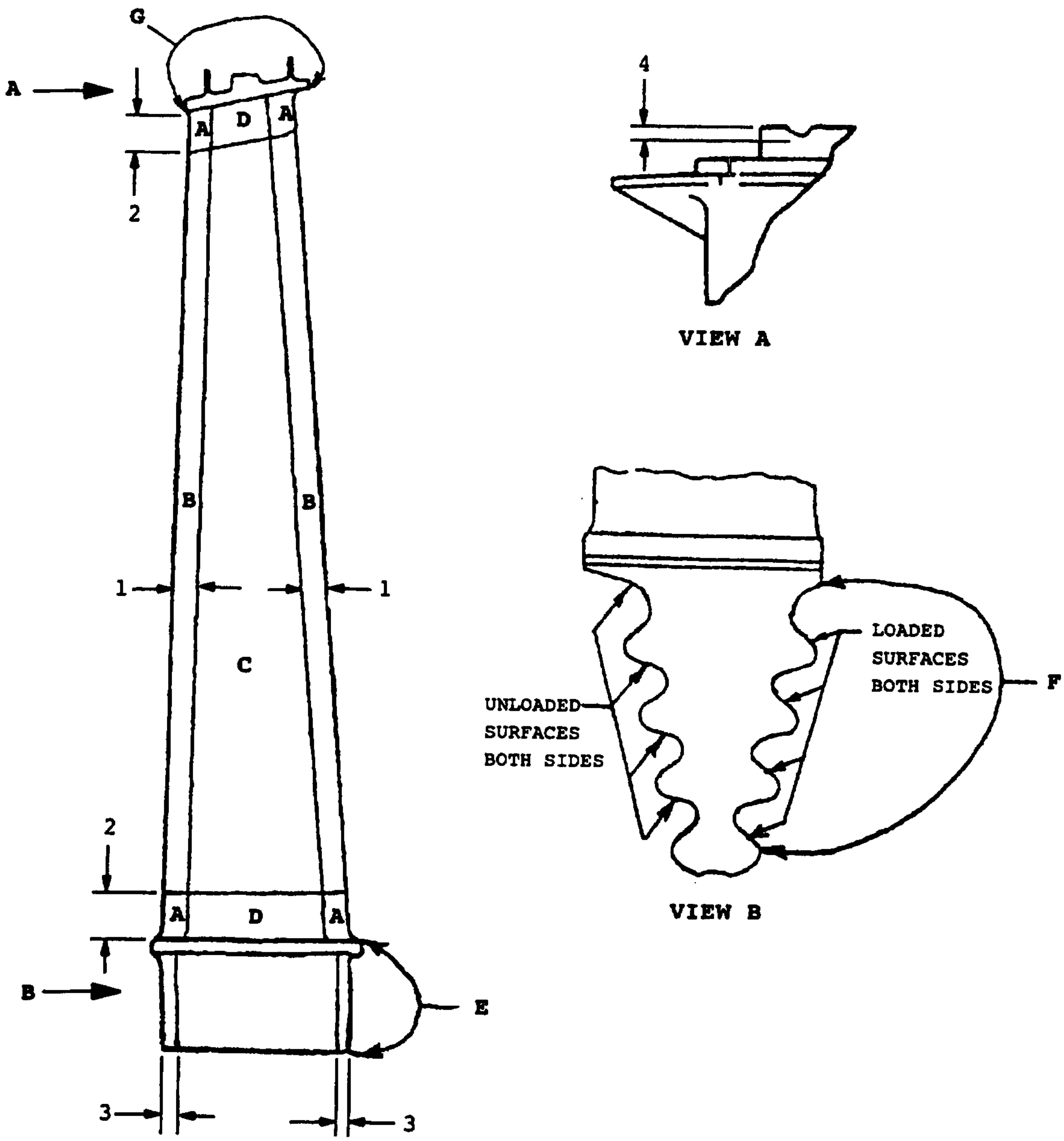
(d) Dimensional Inspection (1st stage free turbine blade). See Tool Group 56E-2.



L-H4579 (0207)

R 1. 0.125 Inch
R 2. 0.500 Inch
R 3. 0.063 Inch
R 4. 0.025 Inch Maximum

R Free Turbine Blade Fluorescent
R Penetrant Inspection Limits
R Figure 607



L-H4579 (0207)

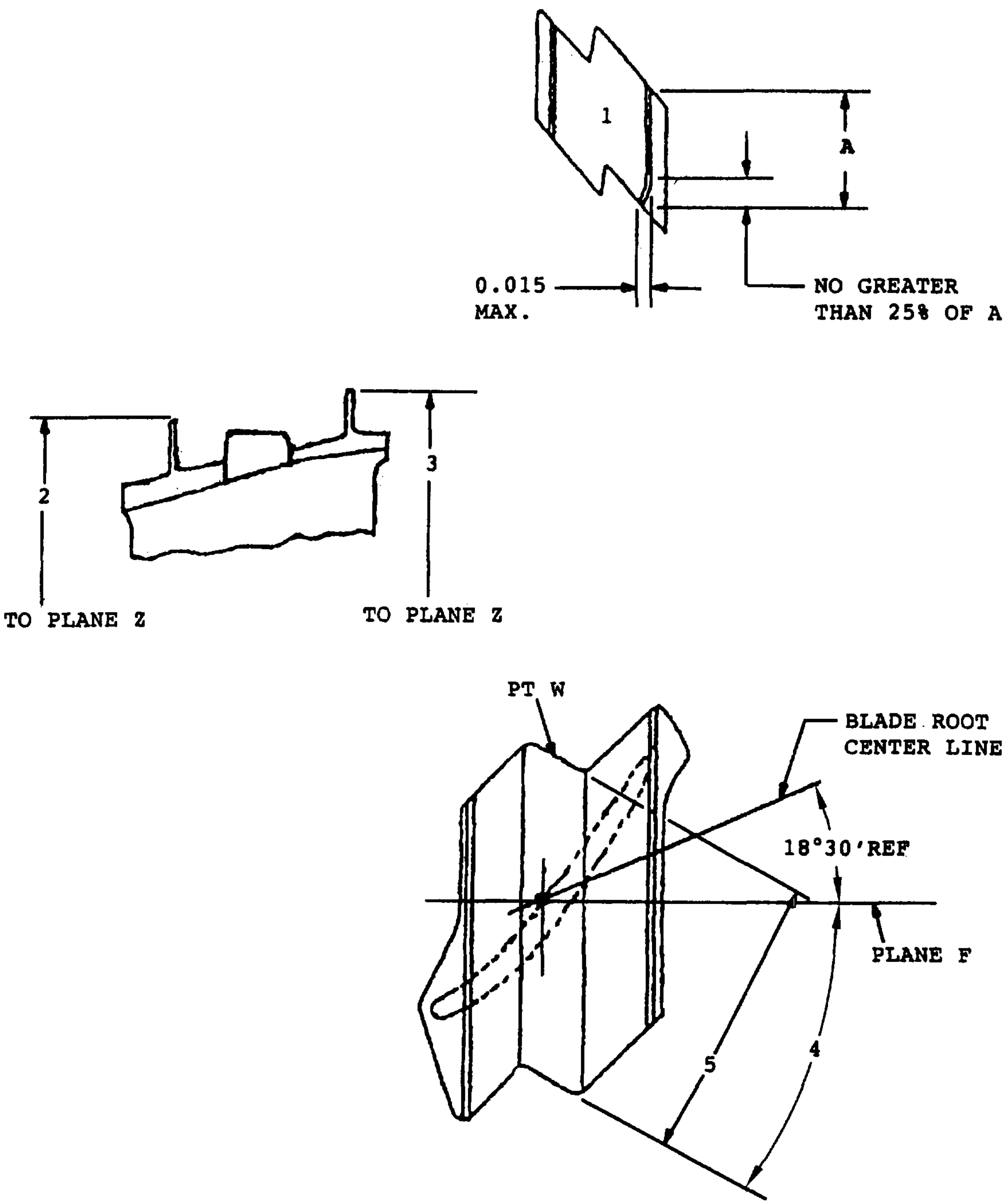
R 1. 0.125 Inch
R 2. 0.500 Inch
R 3. 0.063 Inch
R 4. 0.025 Inch Maximum

R Free Turbine Blade Visual
R Inspection Limits
R Figure 608

R 1 Measure the blade shroud and notch features. Refer to Figure 609 and Table 609 for limits.

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
(1) Knife-edge seal	One bent seal per blade, displaced not more than 0.015 inch and not more than 25 percent of knife-edge per blade	Knife-edge seal damage more than limits can get weld repair.
(2) Front knife-edge	6.357 inch minimum	Knife-edge seal damage more than limits can get weld repair. Cut back to 6.302 inch minimum.
(3) Rear knife-edge	6.457 inch minimum NOTE: Remove all sharp edges.	Knife-edge seal damage more than limits can get weld repair. Cut back to 6.402 inch minimum.
(4) Shroud angle	30°5′ - 29°50′ (notch wear must be 0.004 inch or less) NOTE: Blades with shroud angle less than 29°30′ are not serviceable and are scrap.	29°50′ - 29°30′
(5) Cross notch	0.837 inch (shroud angle must be between 30°5′ - 29°50′) NOTE: Blades with cross notch wear more than 0.020 inch are not serviceable and are scrap.	0.837 - 0.821 inch (shroud angle must be between 30°5′ - 29°50′)

First Stage Free Turbine Blade
Dimensional Limits
Table 609



L-H4580 (0207)

R
R

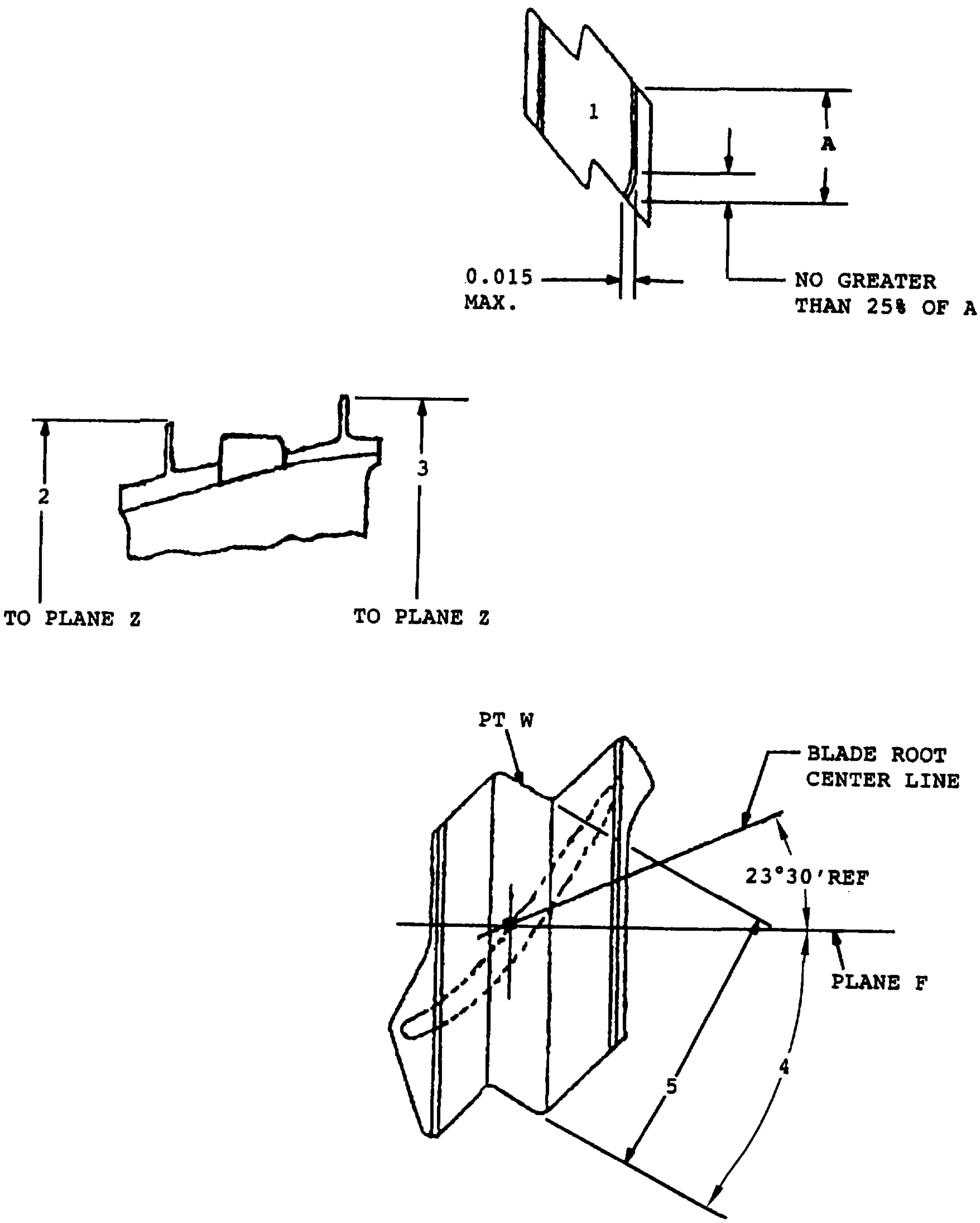
First Stage Free Turbine Blade
Dimensional Inspection Limits
Figure 609

(e) Dimensional Inspection (2nd stage free turbine blade) (See Tool Group 56E-3).

1 Measure the blade shroud and notch features. Refer to Figure 610 and Table 610 for limits.
R

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
(1) Knife-edge seal	One bent seal per blade, displaced not more than 0.015 inch and not more than 25 percent of knife-edge per blade	Knife-edge seal damage more than limits can get weld repair.
(2) Front knife-edge	7.916 inch minimum	Knife-edge seal damage more than limits can get weld repair. Cut back to 7.861 inch minimum.
(3) Rear knife-edge	8.017 inch minimum NOTE: Remove all sharp edges.	Knife-edge seal damage more than limits can get weld repair. Cut back to 7.962 inch minimum.
(4) Shroud angle	30°5′ - 29°50′ (notch wear must be 0.004 inch or less) NOTE: Blades with shroud angle less than 29°5′ are not serviceable and are scrap.	29°50′ - 29°5′
(5) Cross notch	1.445 inch (shroud angle must be between 30°5′ - 29°50′) NOTE: Blades with cross notch wear more than 0.020 inch are not serviceable and are scrap.	1.445 - 1.429 inch (shroud angle must be between 30°5′ - 29°50′)

Second Stage Free Turbine Blade
Dimensional Limits
Table 610



L-H458I (0207)

R
R

Second Stage Free Turbine Blade
Dimensional Inspection Limits
Figure 610

(2) Repair (1st and 2nd stage free turbine blades) (see Tool Group 56E-4, 56E-5, 56E-6, and 56E-7). See Figure 607 and Figure 608.

(a) Surface Damage Blend Repair

1 Do blend repairs of the 1st or 2nd stage blades as specified in SPOP 533. Refer to Section 70-45-00 in the Standard Practices Manual.

2 Individual blends must be 0.250 inch minimum apart. Damage to 0.005 inch maximum depth can get blend repair unless otherwise specified. Total cumulative blend area must not be more than 10 percent of the individual area or span length.

3 Blend limits for Area A: Keep minimum length to depth ratio of 6:1. Do not decrease chord width more than 0.010 inch (except in fillet areas where no blend repair is permitted).

4 Blend limits for Area B: Keep minimum length to depth ratio of 4:1. Do not decrease chord width more than 0.020 inch.

5 Blend limits for Area C: Keep minimum length to depth ratio of 10:1. Do blend repair to maximum depth of 0.007 inch.

6 Blend limits for Area D: Keep minimum length to depth ratio of 10:1.

7 Blend limits for Area E: Keep minimum length to depth ratio of 10:1. Damage to 0.005 inch maximum is permitted without repair.

<u>NOTE</u>: No unrepaired damage is permitted in the 0.063 inch band at the edge of a blade root serration or load surface. Nicks, round-bottom dents, corrosion, and pits are permitted without repair if damage is not in this band at an edge and is not more than 0.003 inch depth.

8 Blend limits for Area F:

a No unrepaired damage is permitted in the 0.063 inch band at an edge of a blade root serration or load surface. Nicks, round-bottom dents, corrosion and pits are permitted without repair if the damage is not in this band at an edge and is not more than 0.003 inch depth.

b If damage is either in the band at an edge or on load surfaces, or is on an unloaded surface but out of limits, remove damage with a length to depth ratio of 10:1 to a maximum depth of 0.010 inch. No blend repair is permitted on load surfaces.

9 Blend limits for Area G (knife-edge seal):

a Do not straighten a bent knife-edge seal.

b Remove knife-edge seal damage to the limit specified to remove all damage indications.

c Remove damage to 0.025 inch maximum depth.

d Keep length to depth ratio of 4:1.

e Remove a damaged knife-edge seal to 25 percent maximum of the length of the seal or to a cumulative length of 25 percent of the front and rear seals. If repair to the front and rear seals is necessary, it is not permitted to have repaired areas opposite each other. Overlap separation of 0.063 inch is necessary.

f If there is knife-edge seal damage more than limits, do a weld repair.

10 Blend limits for Area G (shroud surface):

a Keep minimum length to depth ratio of blends to 6:1.

R b Remove damage to 0.015 inch maximum depth.

R NOTE: During free turbine rotor assembly it is recommended that blades with knife-edge seal repairs be installed at intervals around the circumference of the disk (not installed together in one position).

R (b) Notch Radius Crack Damage Blend Repair (1st Stage Free Turbine Blade). See Figure 611.

R CAUTION: DO BLEND REPAIRS IN THE NOTCH RADIUS BY ONE OF THE TWO OPTIONS IN THE FIGURE. ONLY ONE OF THE TWO OPTIONS IS APPLICABLE TO AN INDIVIDUAL NOTCH RADIUS. DURING NOTCH RADIUS REPAIR. DO NOT CHANGE THE SHROUD ANGLE OR OTHER SHROUD DIMENSIONS, AND DO NOT REMOVE MORE THAN THE SPECIFIED MATERIAL.

R 1 Remove cracks in the shroud notch. Break edges of the blend area 0.005 - 0.020 inch as shown in the figure.

R (c) Notch Radius Crack Damage Blend Repair (2nd Stage Free Turbine Blade). See Figure 612.

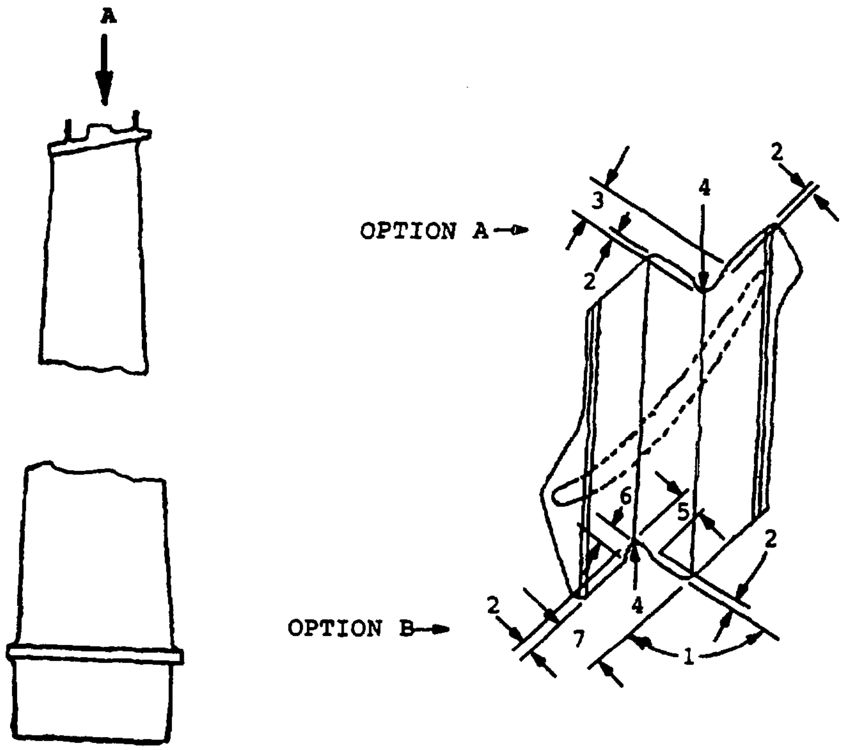
R CAUTION: DO BLEND REPAIRS IN THE NOTCH RADIUS BY ONE OF THE TWO OPTIONS IN THE FIGURE. ONLY ONE OF THE TWO OPTIONS IS APPLICABLE TO AN INDIVIDUAL NOTCH RADIUS. DURING NOTCH RADIUS REPAIR. DO NOT CHANGE THE SHROUD ANGLE OR OTHER SHROUD DIMENSIONS, AND DO NOT REMOVE MORE THAN THE SPECIFIED MATERIAL.

R 1 Remove cracks in the shroud notch. Break edges of the blend area 0.005 - 0.020 inch as shown in the figure.

R 2 Repair a chip or crack indication that breaks an edge to these limits:

R a Keep a length to depth ration of 3:1.

R b Do not remove more than 10 percent of the contact surface. There is no limit to the number of blends on a contact surface.



L-H4582 (0207)

1. 105° ± 0° 5′
2. 0.020 Inch Maximum
3. 0.100 Inch Maximum
4. 0.025 - 0.035 Inch Radius
5. 0.090 Inch Maximum
6. 0.035 Inch Maximum
7. 0.186 - 0.190 Inch

First Stage Free Turbine Blade
Shroud Notch Radius Blend Repair
Figure 611

c The length of a blend must not be more than 50 percent of the contact surface. On the inner and outer shroud surfaces, cracks can extend to but not in to the base material.

d Inner and outer shroud surface blends can go a maximum of 0.020 inch into the base material.

3 The blend area in the hardface surface contact area must not be more than 10 percent of the contact surface. The hardface contact surface is equal to Area A multiplied by Area B (see the figure).

(d) Knife Edge Seal Weld Repair (1st Stage Free Turbine Blade) (See Tool Group 56E-4). See Figure 613.

CAUTION: BLEND REPAIR OF BLADES WHICH HAVE SEAL CRACKS THAT EXTEND INTO THE SHROUD AREA IS NOT PERMITTED.

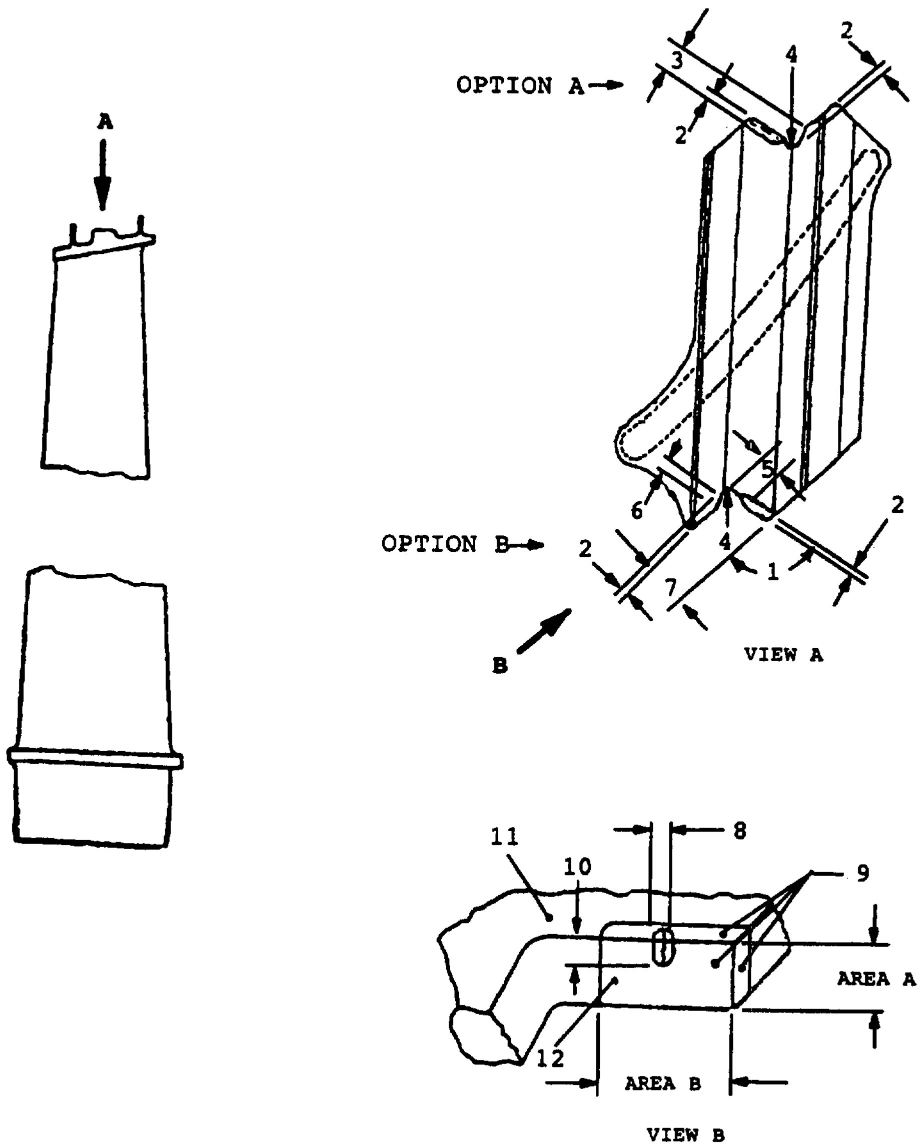
1 Grind a damaged knife-edge seal to the dimensions shown in the figure before weld repair. Remove the minimum material necessary to remove damage.

2 Clean the blade by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

3 Clean the repair area immediately before weld repair by SPOP 208 (refer to Section 70-21-00 in the Standard Practices Manual).

4 Apply weld buildup to the knife-edge seal to make it possible to machine the seal to the dimensions in the figure. Refer to PWA 16-7 in Section 70-42-01 in the Standard Practices Manual. Use a manual TIG method with AMS 5789 weld wire.

NOTE: During the weld operation use a small-diameter weld wire to keep heat to a minimum. This will decrease distortion and cracks in the heat-affected zone.



L-H4583 (0207)

Second Stage Free Turbine Blade
Shroud Notch Radius Blend Repair
Figure 612

R 1. 105° ± 0° 5′
R 2. 0.020 Inch Maximum
R 3. 0.100 Inch Maximum
R 4. 0.025 - 0.035 Inch Radius
R 5. 0.100 Inch Maximum
R 6. 0.035 Inch Maximum
R 7. 0.198 - 0.202 Inch
R 8. Width Of Blend Must Be Equal To 3 Times Crack Depth. Shortest
R Leg Of Crack Is Always The Depth Of The Crack.
R 9 Hardface Surface
R 10. Length Of Crack Must Not Be More Than 50 Percent Of Contact
R Surface Or Go Into The Base Material Of Other Surfaces
R 11. Base Material Area
R 12. Contact Surface Area

R Key to Figure 612

R 5 Stress-relieve the blade after weld by
R SPOP 459-2. Refer to Section 70-42-04 in the
R Standard Practices Manual.

R 6 Do a fluorescent penetrant inspection of the
R blade by SPOP 82. Refer to Section 70-33-00 in
R the Standard Practices Manual.

R CAUTION: DO NOT REMOVE AIRFOIL BASE MATERIAL
R OR DAMAGE TO THE BLADE CAN OCCUR.

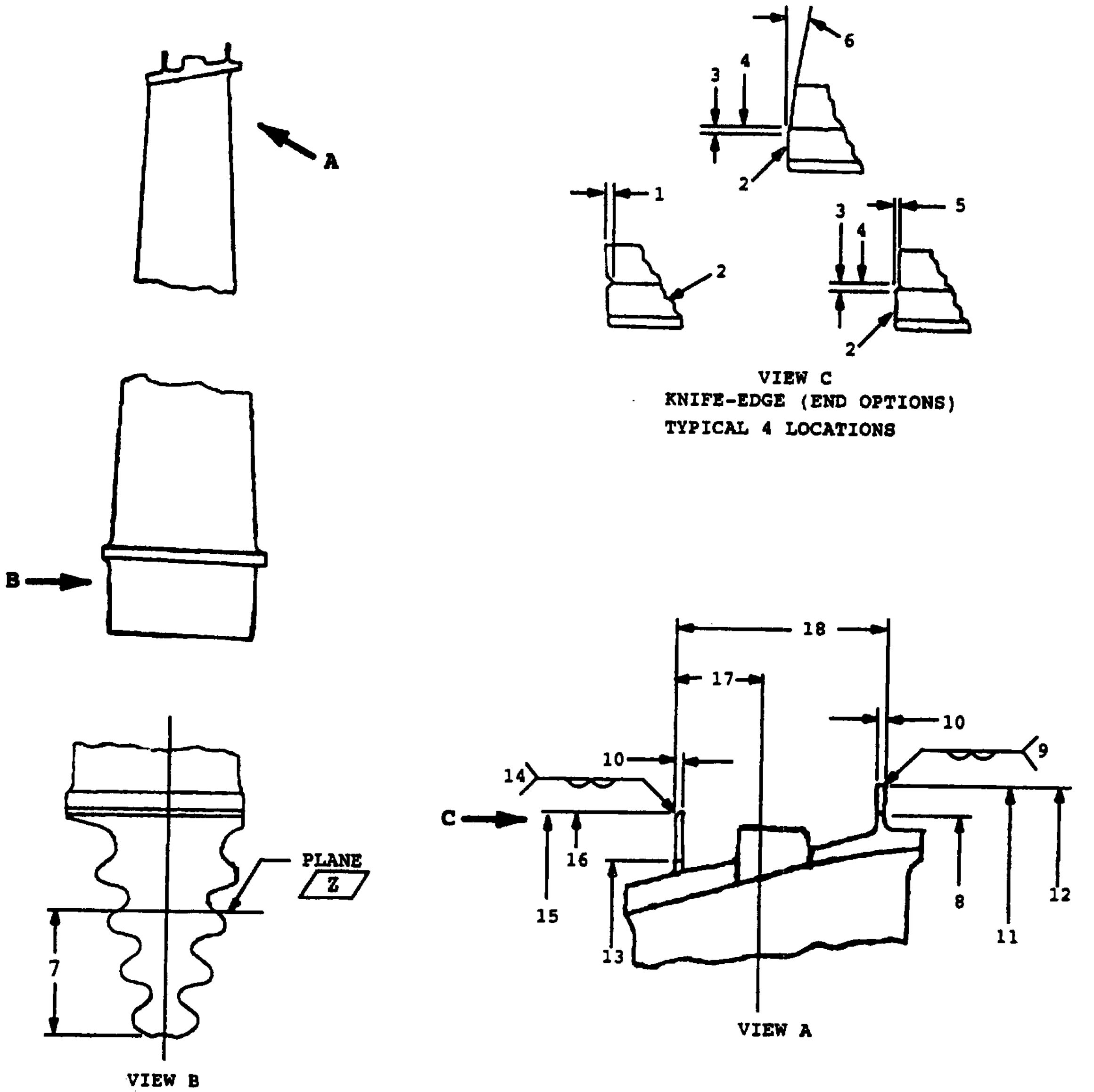
R 7 Grind the knife-edge seal to the dimensions
R in the figure.

R a Blend the weld material 0.005 inch above the
R surface to flush.

R b Blend where necessary to get the knife-edge
R seal thickness to limits.

R c Break sharp edges 0.003 - 0.015 inch.

R (e) Knife-Edge Seal Weld Repair (2nd Stage Free Turbine
R Blade) (See Tool Group 56E-5).
R See Figure 614 and Figure 615.



L-H4584 (0207)

First Stage Free Turbine Blade
Knife-Edge Seal Weld Repair
Figure 613

1. 0.020 Inch Maximum Meltback Permitted
2. No Weld Material Permitted On This Surface
3. 0.000 - 0.020 Inch
4. Weld Joint
5. 0.000 - 0.005 Inch
6. 2° 30′ ± 2° 30′
7. 0.336 - 0.340 Inch Reference
8. 6.402 Inches Minimum to Plane Z (Cut Back Before Weld)
9. Weld Buildup Area (See Text)
10. 0.015 - 0.025 Inch
11. 6.462 - 6.466 Inches To Plane Z
12. 12.050 - 12.550 Inch Radius
13. 6.302 Inches Minimum To Plane Z (Cut Back Before Weld)
R 14. Weld Buildup Area (See Text)
15. 6.362 - 6.366 Inches To Plane Z
16. 11.950 - 12.540 Inch Radius
17. 0.233 - 0.243 Inch From Average Blade Stacking Line
18. 0.565 - 0.575 Inch

Key to Figure 613

CAUTION: BLEND REPAIR OF BLADES WHICH HAVE SEAL CRACKS THAT EXTEND INTO THE SHROUD AREA IS NOT PERMITTED.

1 Grind a damaged knife-edge seal to the dimensions shown in Figure 614 before weld repair. Remove the minimum material necessary to remove damage.

2 Clean the blade by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

3 Clean the repair area immediately before weld repair by SPOP 208 (refer to Section 70-21-00 in the Standard Practices Manual).

4 Apply weld buildup to the knife-edge seal to make it possible to machine the seal to the
R dimensions in Figure 614. Refer to PWA 16-33 in Section 70-42-01 in the Standard Practices
R Manual. Use a manual TIG method with AMS 5828 weld wire.

NOTE: During the weld operation use a small-diameter weld wire to keep heat to a minimum. This will decrease distortion and cracks in the heat-affected zone.

5 Stress-relieve the blade after weld by SPOP 461. Refer to Section 70-42-04 in the Standard Practices Manual.

6 Do a fluorescent penetrant inspection of the blade by SPOP 82. Refer to Section 70-33-00 in the Standard Practices Manual.

CAUTION: DO NOT REMOVE AIRFOIL BASE MATERIAL OR DAMAGE TO THE BLADE CAN OCCUR.

7 Grind the knife-edge seal to the dimensions in Figure 614.

a Blend the weld material 0.005 inch above the surface to flush.

b Blend where necessary to get the knife-edge seal thickness to limits.

c Break sharp edges 0.003 - 0.015 inch.

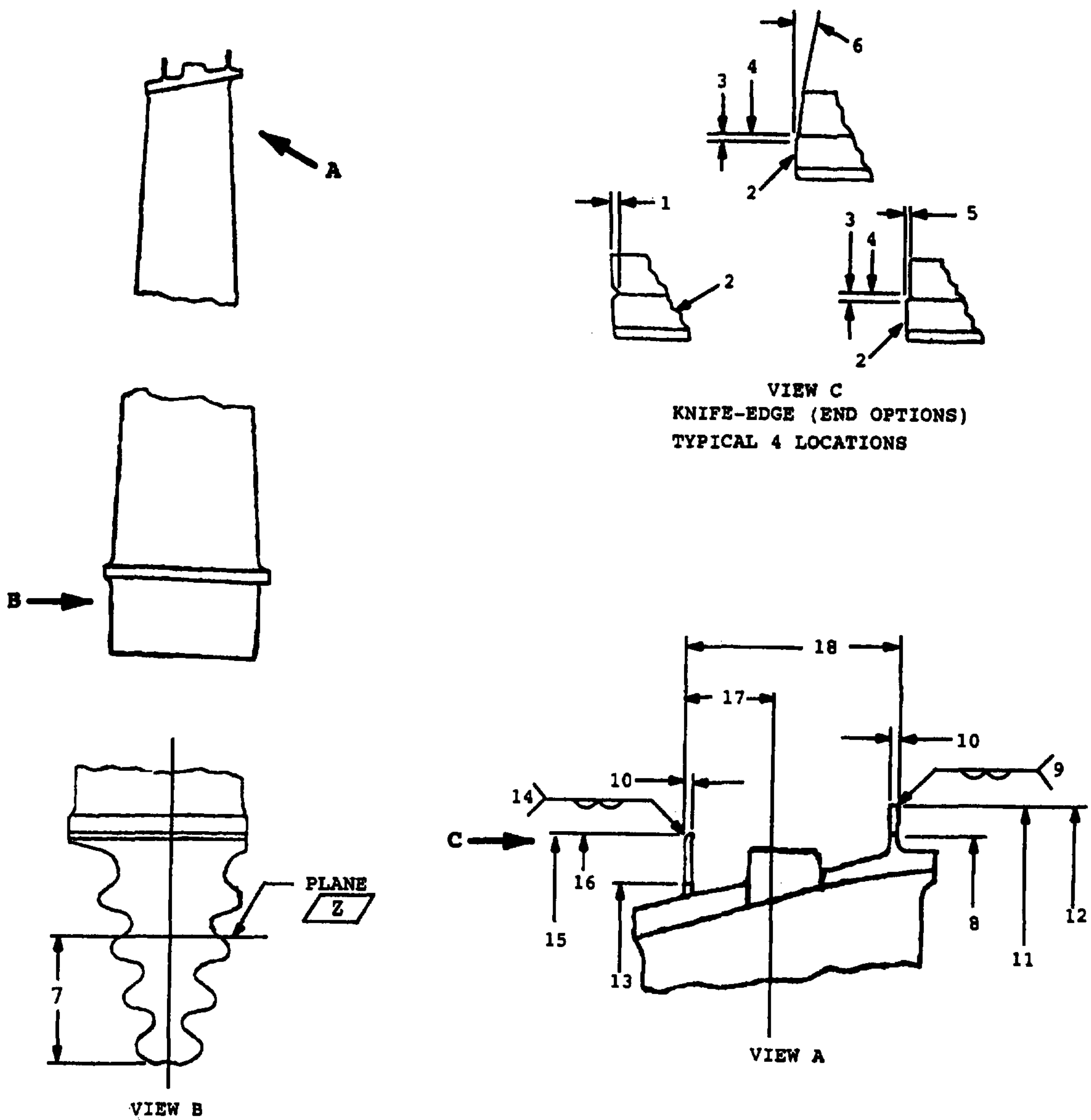
8 Dry abrasive blast the blade airfoil by SPOP 218.

9 Bead peen the blade root by SPOP 500 to an intensity of 15N. Refer to Section 70-41-00 in the Standard Practices Manual.

(f) Shroud Notch Weld Repair (1st and 2nd Stage Free Turbine Blade).

CAUTION: EXCEPT FOR WORK OR SUPPLIES PERFORMED OR FURNISHED BY PRATT & WHITNEY, IT IS TO BE UNDERSTOOD THAT PRATT & WHITNEY DOES NOT ENDORSE THE WORK PERFORMED BY THE COMPANY OR COMPANIES APPROVED TO DO THIS REPAIR AND DOES NOT ACCEPT RESPONSIBILITY TO ANY DEGREE FOR THE SELECTION OF SUCH A COMPANY OR COMPANIES FOR THE PERFORMANCE OF WORK OR PROCUREMENT OF SUPPLIES.

1 This is a Source Demonstration repair. Send blades that are in repair limits to a source with a license for this repair. The list that follows identifies sources approved and licensed


A
6
3
4
2
1
2
3
5
4
2
VIEW C
KNIFE-EDGE (END OPTIONS)
TYPICAL 4 LOCATIONS
B
18
17
10
14
10
9
C
16
15
13
8
12
11
PLANE
Z
7
VIEW A
VIEW B

L-H4584 (0207)

1. 0.020 Inch Maximum Meltback Permitted
2. No Weld Material Permitted On This Surface
3. 0.000 - 0.020 Inch
4. Weld Joint
5. 0.000 - 0.005 Inch
6. 2° 30′ ± 2° 30′
7. 0.425 - 0.429 Inch Reference
8. 7.962 Inches Minimum To Plane Z (Cut Back Before Weld)
9. Weld Buildup Area (See Text)
10. 0.015 - 0.025 Inch
11. 8.022 - 8.026 Inches To Plane Z
12. 13.301 - 13.801 Inch Radius
13. 7.861 Inches Minimum To Plane Z (Cut Back Before Weld)
R 14. Weld Buildup Area (See Text)
15. 7.921 - 7.925 Inches To Plane Z
16. 13.200 - 13.700 Inch Radius
17. 0.214 - 0.224 Inch From Average Blade Stacking Line
18. 0.475 - 0.485 Inch

Key to Figure 614

for this repair by source code number. Refer to the Source Code list in Section 70-40-00, General-01 in the Standard Practices Manual for the company name, address, and contact information for the companies identified by these codes.

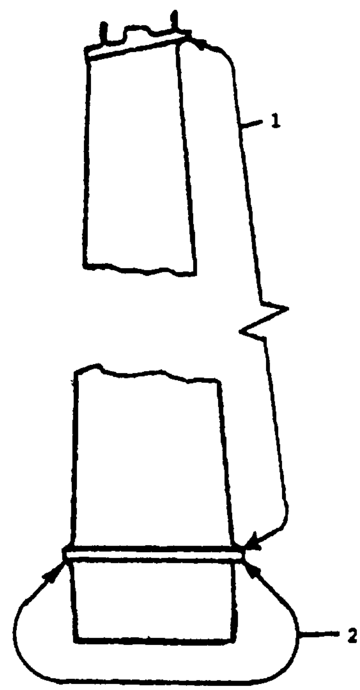
No Sources Approved at this Time

2 Because this repair is critical, sources must show Pratt & Whitney that they can do this repair and must get a license for this repair from Pratt & Whitney. Write to the address in the Introduction section of this manual or in Section 70-40-00, General-01 of the Standard Practices Manual for information about the qualification program to become an approved and licensed source.

(g) Shroud Pretwist Restoration (1st and 2nd Stage Free Turbine Blade) (See Tool Group 56E-6 and 56E-7). See Figure 616.

1 Install the Gage and Jaws in the Fixture.

NOTE: The gage is set to zero with a known right angle on the surface plate.



L-H4585 (0207)

R 1. Grit Blast Area (See Text)
R 2. Bead Peen Area (See Text)

R Second Stage Free Turbine Blade
R Knife-Edge Seal Weld Repair
R Figure 615

2 Measure the blade twist to find how much correction will be necessary.

a One degree of rotation is equal to 0.017 inch on the dial indicator.

NOTE: Blades with pretwist angles that are in repair limits can get twist repair to the limits in Figure 616. If shroud weld repair is necessary, do the twist repair first. For this repair to be done correctly, operator experience and skill will be necessary.

b Attach the blade root in a soft-jaw bench vise.

c Install the Insert in the Wrench. Twist the blade with the wrench to correct the shroud angle to the limit in the figure.

3 Clean the blade by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

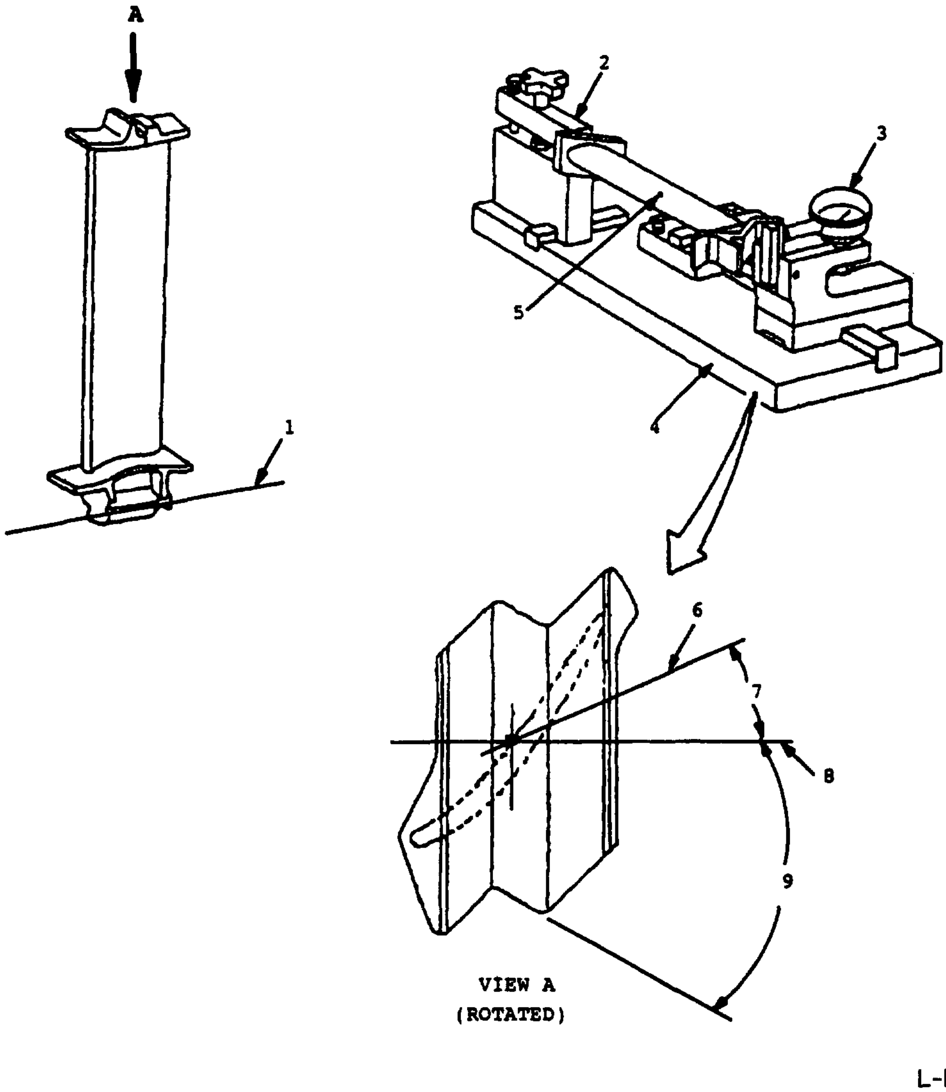
4 Do a fluorescent penetrant inspection of the blade for cracks in the base material by SPOP 82. Refer to Section 70-33-00 in the Standard Practices Manual. No cracks are permitted.

5 If blades will not get shroud notch or mating surface repair, stress-relieve the blade by SPOP 459-2. Refer to Section 70-42-04 in the Standard Practices Manual.

K. Turbine Blade Weight Classification (Refer to Tool Group 96)

NOTE: Omit the following steps if turbine blades are assembled in the disk with the optional mass weight procedure.

(1) All serviceable blades are classified on a moment (weight x distance) basis. Blade moment is expressed in ounce-inches and classified in 0.05 oz-in. increments.



Free Turbine Blade Shroud
Pretwist Restoration
Figure 616

R 1. Blade Root Centerplane
R 2. Jaws (See Tool Group)
R 3. Gage (See Tool Group)
R 4. Twist Fixture (See Tool Group)
R 5. Blade (Typical)
R 6. Blade Root Centerline
R 7. First Stage Blade: 18° 30′ Reference
R Second Stage Blade: 23° 30′ Reference
R 8. Plane F
R 9. 30° ± 5′

R Key to Figure 616

(2) Classification NA designates the mean class of a blade. Blades heavier than mean class are designated MB, MC through MZ; then, NA, NB, etc., as required. Blades lighter than mean class are designated LZ, LY, through LA; then, KZ, KY, etc., as required. Do not use Letters I, O, and Q. Mark the correct class with a rubber ink stamp or electrolytic etch on the concave side inward from the shroud tip.

(3) The mean class (MA) of PN 405701 1st stage turbine blades is 15.20 - 15.25 oz-in. The mean class of 2nd stage blades PN 392702 is 15.88 - 15.93 oz-in.

(4) Complete Table 611 by adding the remaining classes and moments for turbine blades. Mark the blade part number at the top of the table.

	MOMENT (OUNCE-INCHES)	
CLASS	FIRST STAGE	SECOND STAGE
LY	15.10 - 15.15	15.78 - 15.83
LZ	15.15 - 15.20	15.83 - 15.88
MA	15.20 - 15.25	15.88 - 15.93
MB	15.25 - 15.30	15.93 - 15.98
MC	15.30 - 15.35	15.98 - 16.03

Moment Weight Classification
Table 611

(5) Check the blade moment weight scale for accuracy.

(6) Place zero weight on the counterweight pan. Install the applicable adapter and counterweight.

(7) Align the basic (MA) letter row of the backup plate with the holes in the chart. Install the corresponding counterweight.

NOTE: Tool counterweights and tare beam are used to provide moment weight equal to the blade MA less 5 oz-in.

(8) Place individual blades on their designated adapters, and classify each blade within the chart range. Segregate the blades that are above or below chart range for further classification.

CAUTION: MAKE SURE THAT THE PART NUMBER ON THE BLADE CORRESPONDS TO THE PART NUMBER ON THE CHART.

(9) Classify segregated blades by moving the backup plate to expose the next row of letters and by changing the chart counterweight to correspond.

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-03

1. Engine Turbine Section - Turbine Vanes

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Turbine Vanes

A. Inspection

(1) General

(a) Scrap all JT12A-6 and -6A gas generator turbine vanes that have been subjected to temperatures in excess of 800°C (1472°F).

NOTE: For inspection procedures associated with overtemperature conditions, refer to overtemperature tables and figures in Section 72-00-00, Testing.

(b) Visually inspect all vanes suspected of being subjected to temperatures in excess of 800°C (1472°F) for signs of material flow (dribbling, blistering, etc.), particularly on the leading edge. Reject the entire set when any vane has indication of material flow.

(c) All visually acceptable vanes not scrapped according to steps (a) and (b) must have FPI by SPOP 82 described in the Overhaul Standard Practices Manual.

NOTE: All coated vanes that have fluorescent
R penetrant indications of repairable damage must be stripped and reinspected by SPOP 82.

1 Inspect for nicks, dents, and trailing edge
R cracks. These forms of damage are repairable through blending, provided the blends do not reduce airfoil thickness or chordal dimension by more than the limits shown in Table 601.

CAUTION: BLENDING IS PERMITTED ON THE TRAILING EDGE PROVIDED THAT A MULTI-CONTACT GAGE IS USED TO DETERMINE VANE CLASSIFICATION. WHEN A LIMITED CONTACT GAGE IS USED, REPAIRS MAY NOT

BE PERFORMED ON THE GAGE CONTACT POINTS UNLESS THE ORIGINAL AIRFOIL CONTOUR IS RESTORED. SEE FIGURE 601 AND FIGURE 602.

2 Organize vanes that have damage in excess of the blend limits shown in Table 601 according to the 1st and 2nd stage crack repair limits. Vanes with airfoil nicks and dents detectable on the opposite side of the airfoil must be replaced or repaired by Paragraph F.

(2) First Stage Vanes

(a) Vanes of AMS 5385 material (PN 419851) that exhibit oxidation on the airfoil surface may be
R refurbished, as indicated in Paragraph D.

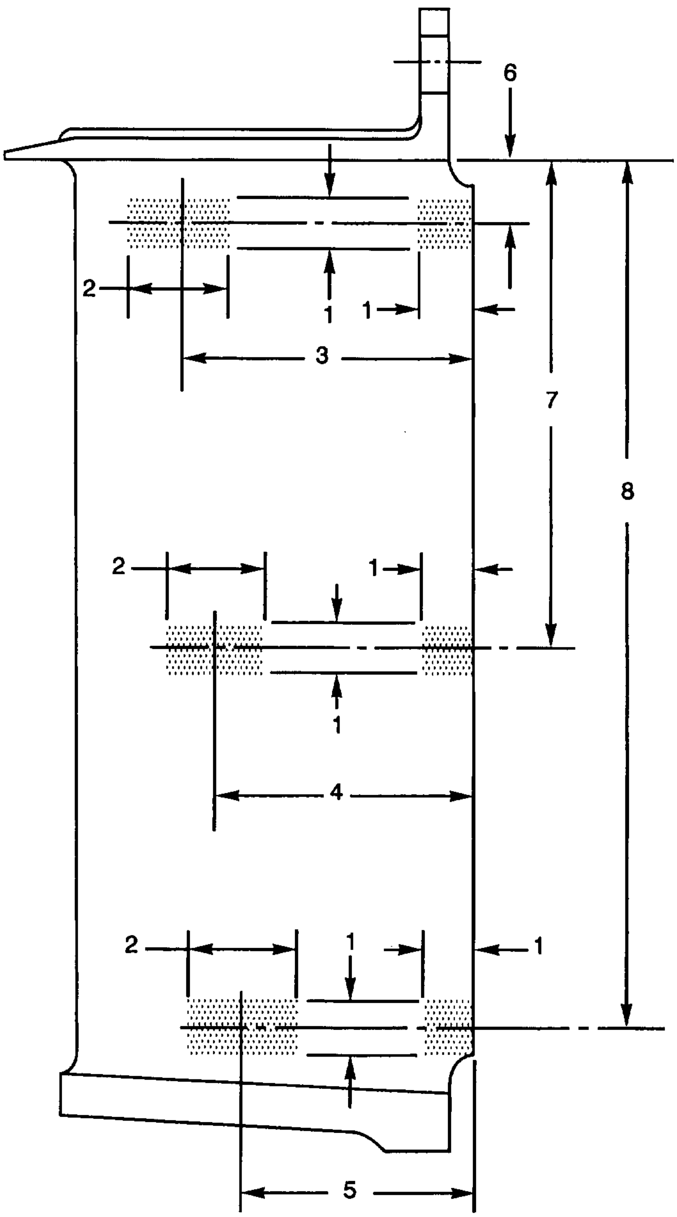
(b) Vanes with visual signs of bowing must be placed (concave side down) on a flat block, as shown in Figure 603. Measure the extent of bowing by inserting a round feeler stock between the trailing edge and the block surface. Vanes that bow in excess of 0.050 inch are unacceptable unless straightened. Refer to Paragraph H.

NOTE: The block width must be approximately 2 1/8 inches so that the ends of the airfoil and the adjacent radii slightly overhang the block edges enabling the vane to rest on the trailing edge.

VANE STAGE	MAXIMUM AIRFOIL THICKNESS REDUCTION	MAXIMUM CHORDAL DIMENSION REDUCTION
1st Stage	0.010 inch	0.020 inch
2nd Stage	0.005 inch	0.015 inch

Turbine Vane Airfoil Blend Limits
Table 601

(c) Inspect vane outer buttress. Scrap vanes with evidence of bent and deformed tabs. Wear on the outer buttress face, shown in Figure 604, is acceptable provided the depth does not exceed 0.020 inch. Replace all vanes with wear above this limit.



R
R

First Stage Vane Limited Contact
Classification Gage Contact Points
Figure 601

1. 0.125 Inch
2. 0.250 Inch
3. 0.6819 Inch
4. 0.6140 Inch
5. 0.5445 Inch
6. 0.162 Inch
7. 1.142 Inches
8. 2.122 Inches

NOTE: Shading on the airfoil surface indicates gage contact point areas. To identify these areas, fabricate a template to mask the convex side of the airfoil, excluding contact areas.

Key to Figure 601

(d) Examine the 1st stage turbine vane locating pin hole for wear.

1 Wear to the locating pin hole, Index 5 in
R Figure 608, 0.132 inch diameter maximum in a radial direction or 0.130 inch diameter maximum in a circumferential direction is permitted without repair. If a vane hole is worn more than these limits, then the vane is not serviceable. Repair the hole with the weld repair below.

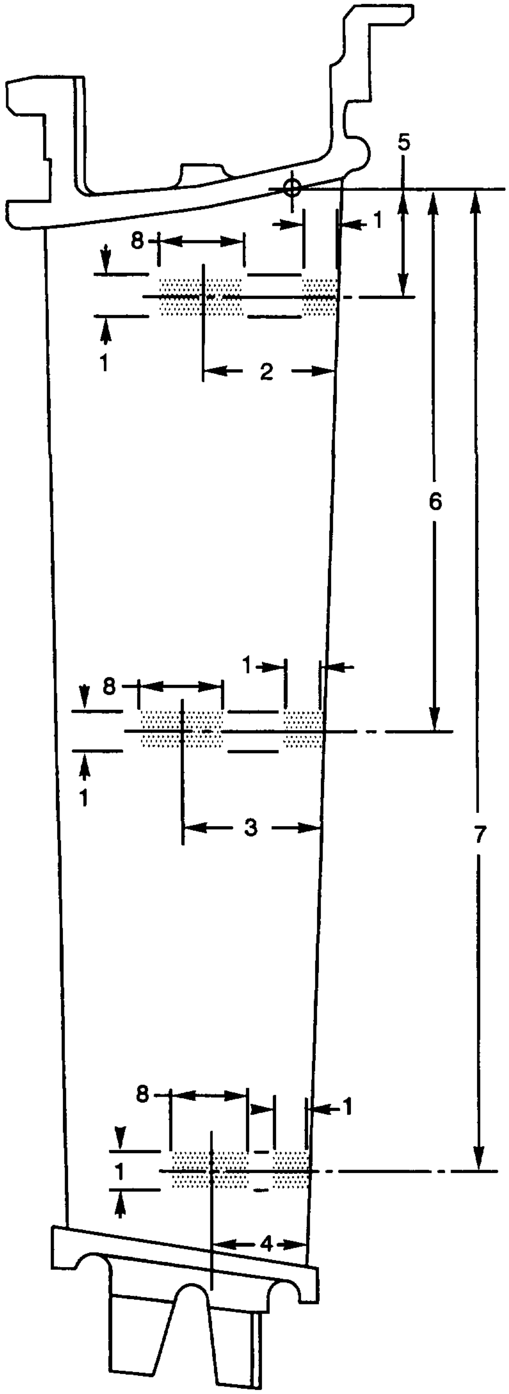
(e) If the vane is coated, then inspect the vane coating by using the following limits:

1 Any irregularity or loss of coating on the concave side of the airfoil that is visible to the naked eye must be repaired.

2 Presence of oxide emission is unacceptable without repair.

3 Any number of minute cracks in the coating is acceptable provided the cracks are visible only under 10 power magnification or higher. There must be no evidence of oxide emission.

4 Coating discrepancies on the outer ends are acceptable. Any loss of coating must not extend beyond the fillet area. Evidence of oxide emission is unacceptable without repair.



R
R

Second Stage Vane Limited Contact
Classification Gage Contact Points
Figure 602

1. 0.125 Inch
2. 0.3485 Inch
3. 0.3673 Inch
4. 0.2700 Inch
5. 0.301 Inch
6. 1.533 Inches
7. 2.765 Inches
8. 0.250 Inch

NOTE: Shading on the airfoil surface indicates gage contact point areas. To identify these areas, fabricate a template to mask the convex side of the airfoil, excluding contact areas.

Key to Figure 602

5 Use the following limits to FPI visually acceptable vanes for cracks in excess of the blend limits. Refer to SPOP 82 in the Overhaul Standard Practices Manual. R

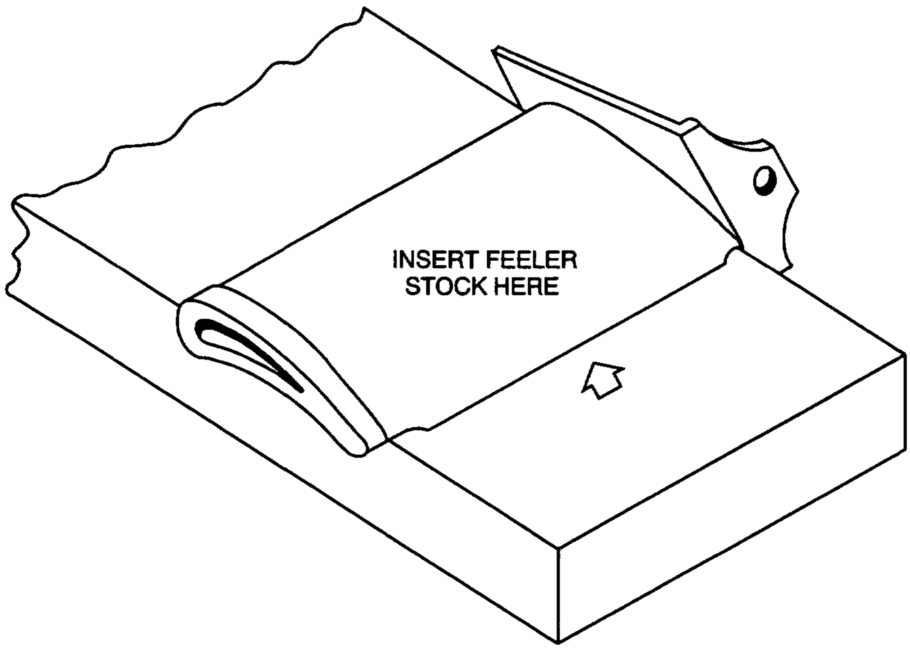
a Leading edge cracks up to 0.060 inch deep (measured chordwise) must be repaired.

b Trailing edge cracks up to 0.375 inch deep (measured chordwise) may be repaired provided they do not appear in clusters. However, clusters of minor trailing edge cracks with deteriorated metal in adjacent areas may be repaired if the depth of damage does not exceed 0.187 inch.

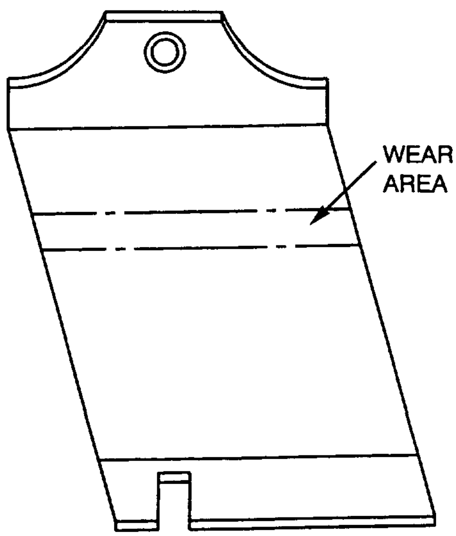
c Cracks up to 0.375 inch deep in trailing edge fillet radii also may be repaired.

d Single cracks in the concave airfoil section leading in any direction and into fillet radii at either end of the airfoil are reparable by welding provided they are not longer than 0.500 inch.

e Areas of extensive burning or deterioration of base metal, except as indicated in step 2, are not reparable.



First Stage Turbine Vane
Bow Measurement
Figure 603



First Stage Turbine Vane Outer
Buttress Face Wear Limit
Figure 604

(3) Second Stage Vanes (Pre-SB 6133)

R NOTE: Vanes pre-SB 6133 are made from AMS 5382
R (PN 370252) or PWA 653 (PN 567152). Refer to the
R subsequent paragraph for inspection and repair of
R PWA 655 vanes (post-SB 6133).

(a) Inspect vane inner foot tangs for wear. Replace or repair (see below) a vane with tang wear more than 0.005 inch as shown in Figure 605.

(b) Measure 2nd stage vanes for twist: put each vane on a surface plate and measure the shroud position as shown in Figure 606.

(c) Examine the vane inner buttress front face. Wear in excess of 0.010 inch is unacceptable without repair. See Figure 609, Index 14.

(d) Inspect vanes for bend according to Figure 606. The minimum acceptable dimension shown allows for 0.080 inch bend without straightening.

(e) Use the following limits to FPI vanes for cracks in excess of blend limits. Refer to SPOP 82 in the Standard Practices Manual.

1 Replace any vanes that have non-blendable damage on the airfoil within 0.250 inch of the inner or outer buttress.

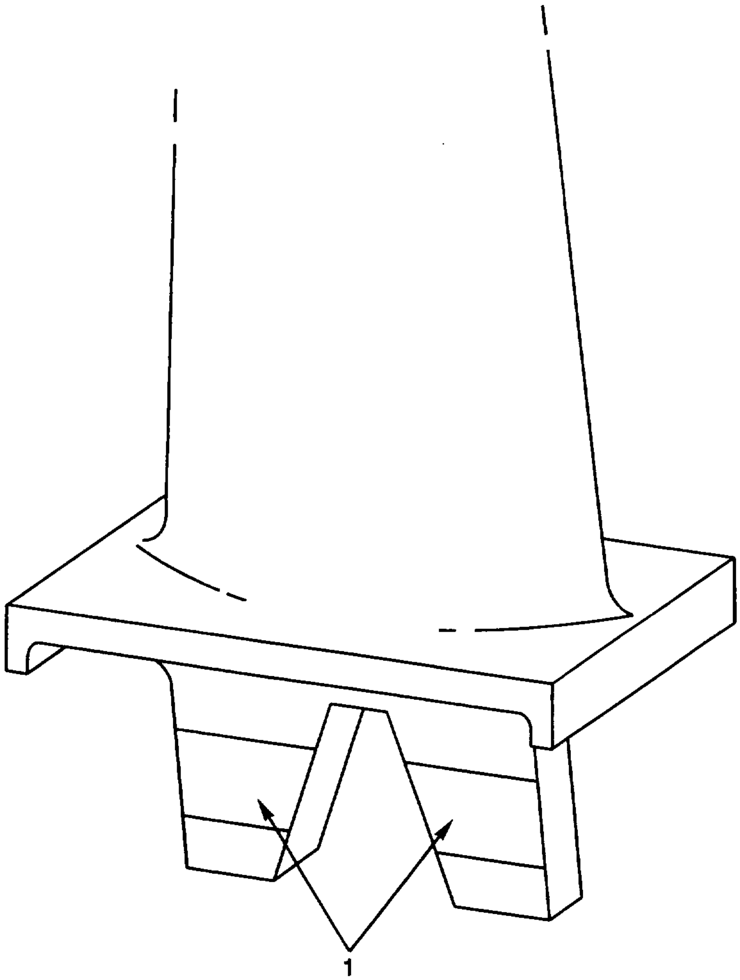
2 Leading and trailing edge cracks up to 0.100 inch depth, measured chordwise, may be repaired provided a minimum of 0.500 inch of undamaged material remains between crack repair areas.

3 Replace any vanes that have non-blendable cracks on both leading and trailing edges.

4 Up to 3 edge crack repairs per vane may be performed provided the limits in steps 1, 2, and 3 are met.

R (4) Second Stage Vanes (Post-SB 6133)

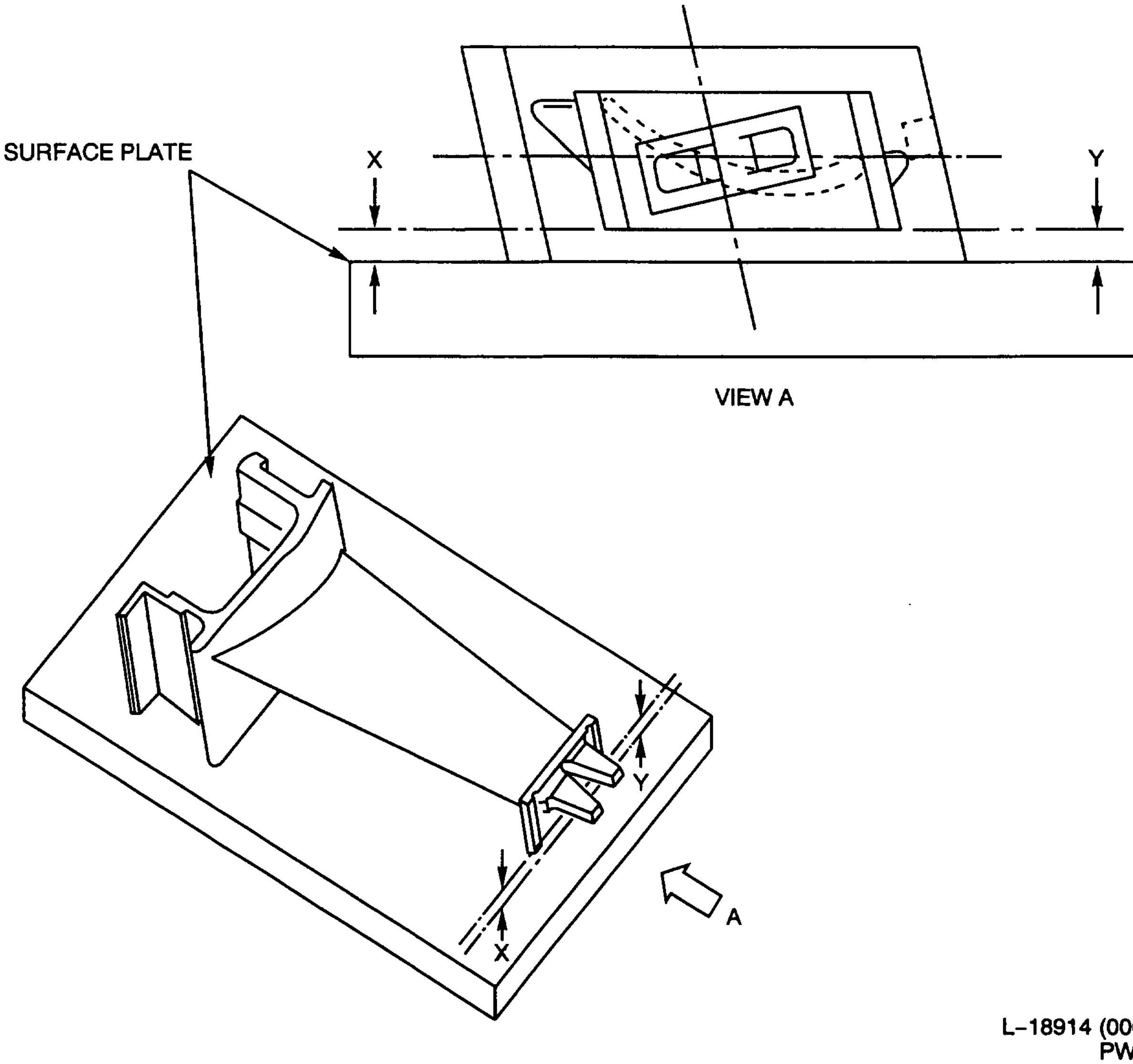
R (a) Non-Destructive Inspection



1. 0.005 Inch Maximum

R
R

Vane Inner Tang Wear Limit
Figure 605



Vane Bend Check - 0.001 Inch Minimum At Dimensions X And Y And At Any Point Between

Vane Twist Check - X And Y Differential - 0.008 Inch (Maximum)

R
R

Second Stage Vane Twist
And Bend Inspection
Figure 606

1 Do a fluorescent penetrant inspection of the vane. Refer to Section 72-00-00, Inspection.

2 A vane with a crack is not serviceable. Refer to crack weld repairs in this section.

3 Pinpoint indications with sufficient separation are permitted (but not in a fillet area).

4 Indications in groups can get the repair specified in this section.

(b) Coating Inspection

1 Do the heat tint inspection in SPOP 90. Refer to Section 70-21-00 in the Standard Practices Manual.

2 Examine the coated area for color. A gold color is an indication of coating. A blue or purple is an indication of missing coating.

(c) Visual Inspection

1 Examine all vanes for overtemperature condition. Refer to Testing for overtemperature conditions and specified inspection actions. Vanes which were in overtemperature conditions more than the specified limits are not serviceable.

2 Examine all vanes for metal splatter. Vanes with this condition are not serviceable if the damage is in no-blend areas.

3 Examine vane surfaces for cracks, burning, impact, wear damage, or damaged or missing coating.

4 Refer to Figure 607 and Table 602 for vane condition limits.

VANE AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Coating	No worn or missing coating permitted	Touch-up or replace coating
Sulfidation	None permitted	0.005 inch depth (see Repair)

Second Stage Vane Condition Limits
(Post-SB 6133)
Table 602

VANE AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Leading and Trailing Edge Cracks	None permitted	0.100 chordwise with 0.500 inch separation
Nicks/Dents:		
Area A	No visible damage permitted	None
Area B	Round-bottom indications to depth of 0.002 inch maximum, not more than 3 per area, with 0.125 inch minimum separation	See Repair
Area C	No cracks permitted. Round-bottom indications to depth of 0.002 inch maximum with 0.250 inch minimum separation	None See Repair
Area D	0.002 inch maximum depth	0.005 inch maximum depth after blend repair, total area less than 10 percent
Plasma Coat Area	Worn coating to 0.005 inch maximum permitted	See Repair
Tang	Wear to 0.005 inch maximum permitted	See Repair

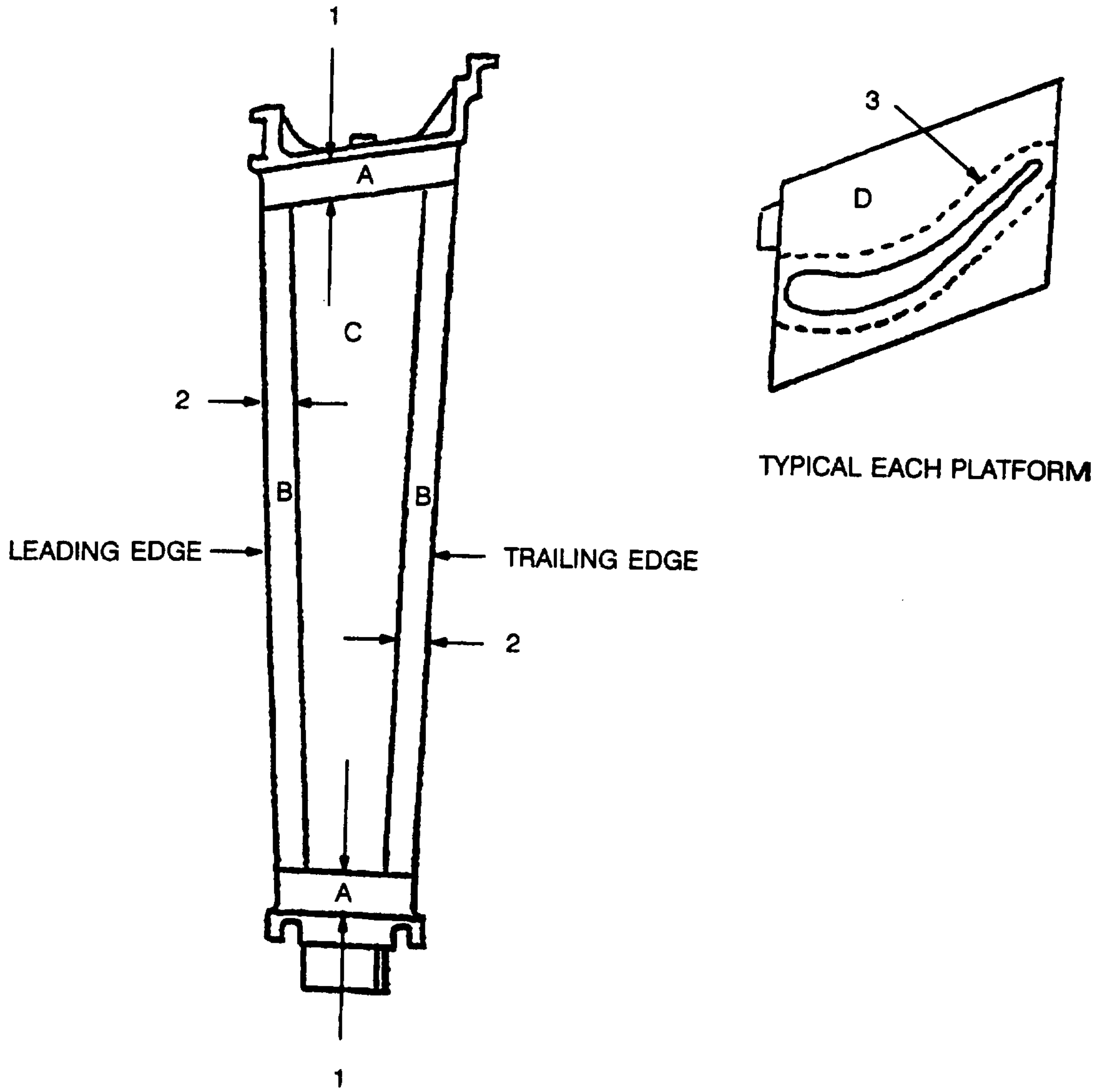
Second Stage Vane Condition Limits
(Post-SB 6133)
Table 602 (Continued)

B. First Stage Vane Repair

(1) Locating pin hole weld repair. See Figure 608.

(a) Remove the coating (necessary when airfoil repairs are done together with this repair, otherwise coating removal is not necessary).

(b) Clean all areas around the locating pin hole for a 1/4 inch radius with a wire brush.



L-H4660 (0207)

R 1. 0.500 Inch
R 2. 0.250 Inch
R 3. 0.125 Inch From Platform/Fillet Radius Tangent Line

R Second Stage Turbine Vane
R Blend Limits
R Figure 607

(c) Clean the repair area by SPOP 208. Refer to Section 70-21-00 in the Standard Practices Manual.

(d) Heat the vane to 524° - 552°C (975° - 1025°F) before repair and keep the vane at this temperature during the weld repair (this step is optional).

(e) Puddle weld the locating pin hole with the weld wire specified for the vane. See Table 603.

(f) Stress-relieve the vane by SPOP 459-1. Refer to Section 70-42-04 in the Standard Practices Manual.

(g) FPI the vane by SPOP 82. Refer to Section 70-33-00 in the Standard Practices Manual.

(h) Machine the welded vane pin hole to the dimensions in the figure (be sure to blend down the weld flush with the adjacent surface at the front or rear face around each repaired hole).

(i) Apply coating to the vane if it was removed after other vane repairs are completed.

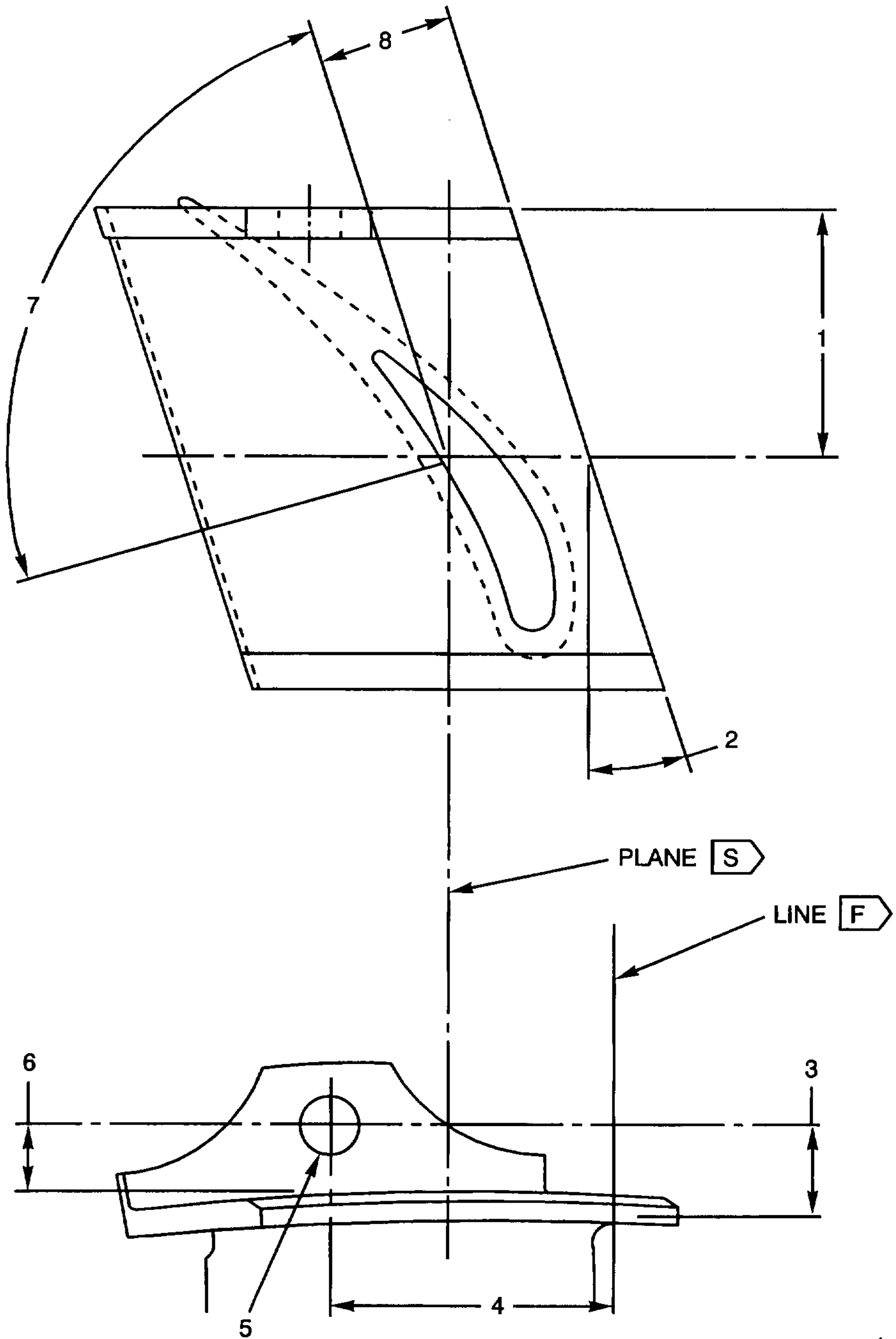
(2) Coating Repair - Applicable to 1st stage vane chromalized coating replacement (JT12A-8N, -8L, and JFTD12A-4A only)

(a) Any reusable vanes that exhibit coating chips, blistering, or blendable foreign object damage on the airfoil must be stripped, reworked, and re-coated. Inspect vanes for bow and class (refer to Paragraphs A. and I. to ensure serviceability prior to rework.

(b) Remove chromalloy coating by abrasive blasting or, preferably, by chemical stripping by SPOP 55. Refer to Plating Procedures in the Standard Practices Manual.

R (c) Repair nicks and dents by Paragraph D.

(d) Inspect vanes according to limits in Paragraphs A.
R and J. If acceptable, then send the vanes to an approved source for PWA 252 coating. Refer to Section 70-40-02 in the Standard Practices Manual.



R
R

First Stage Turbine Vane
Locating Pin Hole Weld Repair
Figure 608

1. 0.536 Inch ± 0.001 Inch
2. 16° 0′ ± 0° 5′
3. 0.203 - 0.213 Inch
4. 0.589 - 0.593 Inch
5. 0.126 - 0.128 Inch Diameter Through, Chamfer 90° ± 5° Included To 0.150 - 0.170 Inch Diameter (Refer to Text for Wear Limits)
6. 0.149 - 0.155 Inch
7. 90° Reference
8. 0.278 - 0.298 Inch

Key to Figure 608

(e) Inspect and classify re-coated vanes. Refer to Paragraphs A. and I.

NOTE: No rework on the airfoil is permitted after re-coating.

C. Second Stage Vane Repair

NOTE: Refer to the subsequent paragraph for repairs applicable to PWA 655 vanes (post-SB 6133).

(1) Vane Inner Foot Tang Weld Repair
Refer to Tool Group 85-1 and Figure 609.

R (a) Vane tangs worn below limits in Figure 605 must be repaired.

(b) Install the vane in the Welding Fixture.

(c) Weld vane tang (refer to Table 603 for the applicable weld wire). Weld buildup must close notch in a vane with a double tang. See Figure 609.

CAUTION: AVOID EXCESSIVE OR PROLONGED HEAT (WHICH CAN CAUSE HEAT DISTORTION). WELDING MUST BE CONFINED TO WORN AREAS WHENEVER POSSIBLE, EXCEPT WHEN ENCLOSING NOTCH IN DOUBLE TANG VANES.

(d) Stress-relieve by Cycle No. 5A. Refer to Heat Treatment in the Standard Practices Manual.

CAUTION: POSITION A SUITABLE SHIM BETWEEN THE SETSCREWS AND THE OUTER BUTTRESS TO PREVENT MARRING THE OUTER BUTTRESS.

(e) Install the vane in the Grinding Fixture by securing the inner buttress clamp and tightening the outer buttress set-screws.

(f) Machine tang to dimensions shown in Figure 609.

(g) Remove the vane from the fixture and position the checking gage over the re-operated tang. Vane tang dimensions are acceptable when the gage accepts the tang.

(h) FPI the welded machine areas.

(i) When necessary, reweld defective areas.

(2) Vane Inner Buttress Front Face Repair (PN 562752) Refer to Tool Group 84B and Figure 610.

(a) Vane inner buttress front faces worn below limits in Figure 608 must be repaired provided they meet the 0.543 inch minimum dimension prior to coating. See Figure 609, Index 1.

(b) Mask areas not to be coated.

(c) Prepare the surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(d) Plasma coat worn area with PWA-1318 powder to sufficient thickness to allow for final machining. Refer to Section 70-46-01 in the Standard Practices Manual.

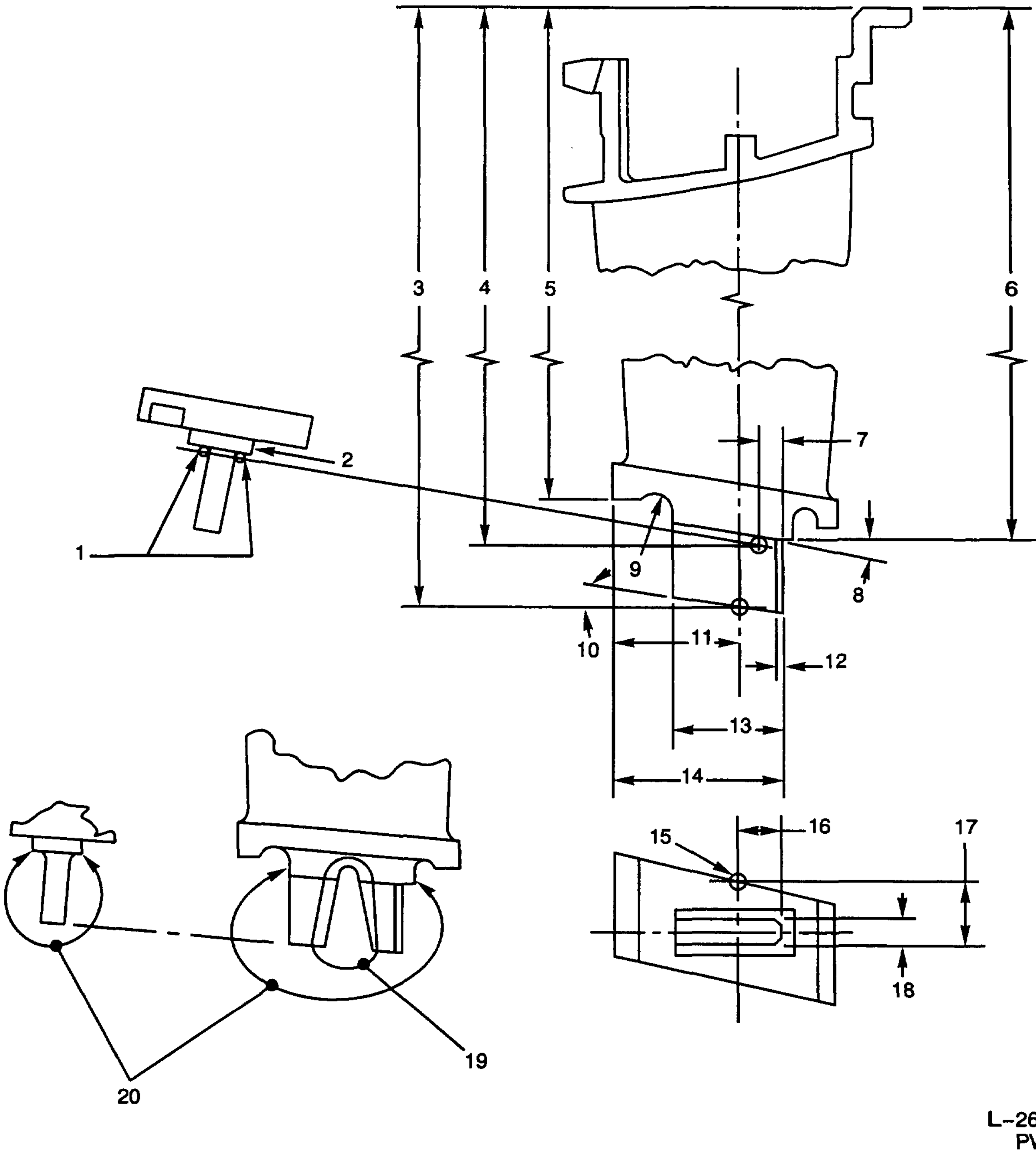
(e) Install the vane in the Machining Fixture.

(f) Finish machine to dimensions shown in Figure 610.

D. Turbine Vane Blend Repair (1st and 2nd Stage Vanes)

NOTE: Refer to the subsequent paragraph for repairs applicable to PWA 655 2nd stage vanes (post-SB 6133).

R
R



Second Stage Turbine Vane Tang Repair
Figure 609

1. 0.010 - 0.030 Inch Radius
2. Blend Excess Weld
3. 3.859 - 3.899 Inches
4. 3.662 - 3.682 Inches To Centerline Of Radius (Index 1)
5. 3.565 - 3.605 Inches
6. 3.652 - 3.692 Inches
7. 0.070 Inch Gage
8. 9° 3′ ± 0° 30′ (Both Sides)
9. 0.010 - 0.070 Inch Radius
10. 7° - 11°
11. 0.413 Inch Gage
12. Chamfer 0.020 - 0.030 Inch x 43° - 47° (Both Sides)
13. 0.355 - 0.375 Inch
14. 0.557 - 0.563 Inch
15. Gage Point
16. 0.147 Inch
17. 0.205 - 0.209 Inch
18. 0.077 - 0.083 Inch
19. Enclose Notch Completely
20. Weld Area (Excluding Index 19). Limit Welding To Worn Areas When Possible

Key to Figure 609

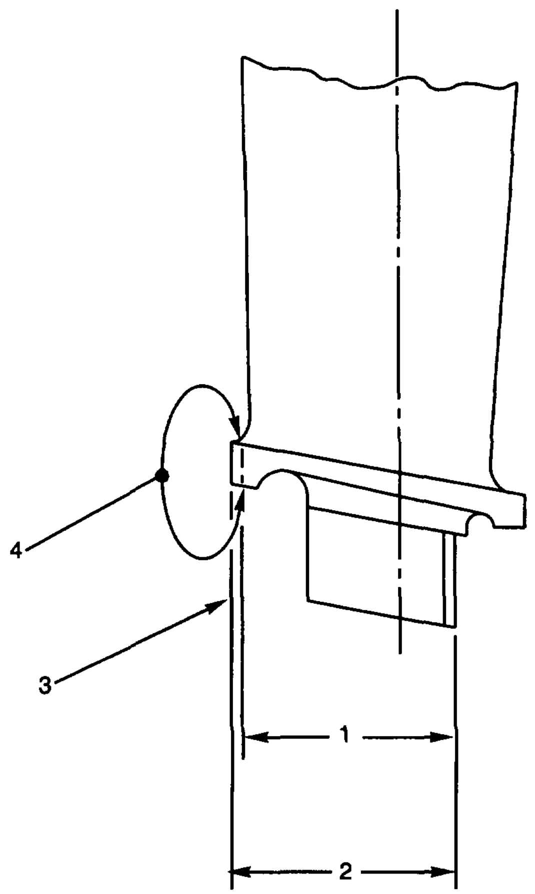
CAUTION: FOR 1ST STAGE VANES: THE AIRFOIL THICKNESS AFTER BLENDING MUST NOT BE REDUCED BY MORE THAN 0.010 INCH OR CHORD BY 0.020 INCH.

FOR 2ND STAGE VANES: THE AIRFOIL THICKNESS AFTER BLENDING MUST NOT BE REDUCED BY MORE THAN 0.005 INCH OR CHORD BY 0.015 INCH.

FOR FREE TURBINE VANES: THE AIRFOIL THICKNESS MUST NOT BE REDUCED BY MORE THAN 0.004 INCH OR CHORDAL DIMENSION BY MORE THAN 0.011 INCH.

(1) Remove deep nicks by grinding with a carborundum wheel (Carborundum No. A36-I-BFX2 or equivalent). The wheel must not be operated at an arbor speed of more than 3000 rpm.

CAUTION: BLENDING IS PERMITTED ON GAGE CONTACT POINTS SHOWN IN FIGURE 601 AND FIGURE 602 PROVIDED A MULTI-CONTACT GAGE IS USED TO DETERMINE VANE CLASSIFICATION. IF A LIMITED CONTACT GAGE IS USED, THEN REPAIRS MUST NOT BE



1. 0.543 Inch Minimum Permissible Prior To Coat
2. 0.557 - 0.563 Inch Finish Dimension
3. Maximum Surface roughness 80AA After Finish Machining
4. Plasma Coat Area

Second Stage Vane Inner Buttress
Front Face Repair
Figure 610

PERFORMED ON GAGE CONTACT POINTS UNLESS THE ORIGINAL AIRFOIL CONTOUR IS RESTORED.

(2) Blend out wheel marks, light nicks, scratches, pits, and radius sharp edges on the damaged surface with a cloth wheel (2 required) coated with wheel conditioner Ad-Lea-Siv and buffing compound Lea Grade A or equivalent.

CAUTION: ALL POLISHING MUST BE DONE IN THE DIRECTION PARALLEL TO THE LENGTH OF THE AIRFOIL. WIPE THE VANE WITH A SOFT CLOTH TO REMOVE ANY RESIDUAL POLISHING COMPOUND OR OTHER FOREIGN MATERIAL.

NOTE: An alternate procedure to blend nicks and dents in turbine vanes consists of files and stones, finishing with fine stones. Reworked turbine blades and vanes must be inspected by FPI (post-emulsification).

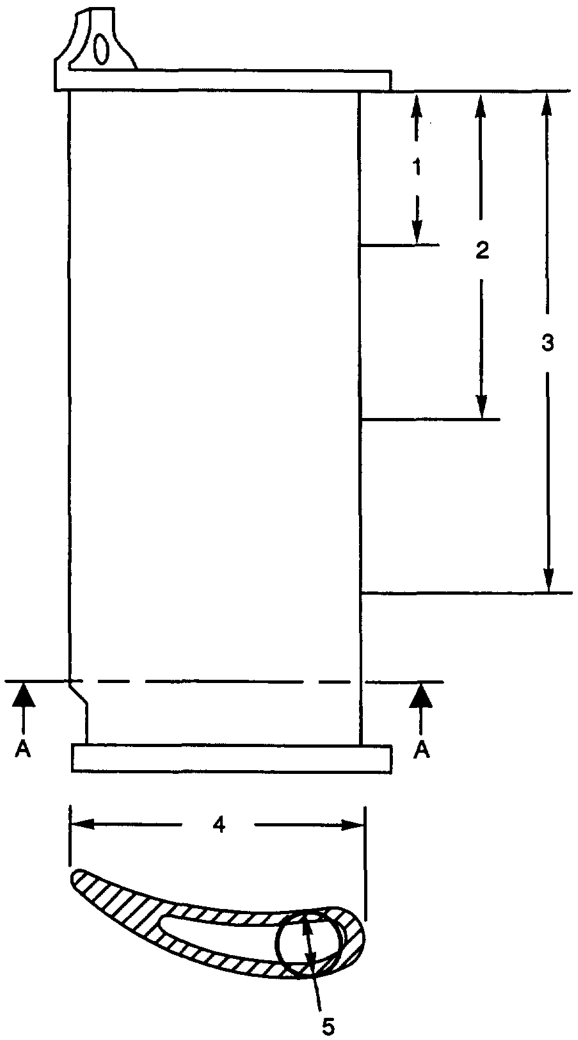
(3) Vanes of AMS 5385 material (PN 419851) that exhibit oxidation of airfoil surfaces may be refurbished by lightly polishing the airfoil surface on a polishing lathe as follows:

(a) Use a cloth wheel (2 sections) coated with adhesive precoat PMC 3091 and polishing compound PMC 3023. Refer to SPOP 533 Blending, Lapping and Grinding in the Overhaul Standard Practices Manual.

(b) Perform the final buffing by using a 12 inch Tampico brush and PMC 3061 polishing compound.

NOTE: The intent of refurbishing is to remove the obvious roughness from the airfoil, which should present a comparatively smooth surface. It is not necessary to remove all of the oxidation, and any remaining pits are not considered detrimental to part function. Typically, 0.002 inch per side stock removal will provide an acceptable surface.

Confirmation of excessive stock removal may be accomplished by measurements before and after polishing per Figure 611. The maximum stock removal allowed is 0.010 inch from airfoil thickness and 0.020 inch from overall chord length.



L-26272
PW V

R First Stage Turbine Vane Airfoil
R Thickness Check Following Oxidized
Airfoil Refurbishment
Figure 611

1. 0.375 Inch
2. 1.125 Inches
3. 1.875 Inches
4. Maximum Reduction Of Vane Chordal Dimension At Indexes 1, 2 And 3 is 0.020 Inch
5. Maximum Airfoil Thickness At Indexes 1, 2 And 3 Must Not Be Reduced By More Than 0.010 Inch

Key to Figure 611

E. Turbine Vane Weld Repair (1st And 2nd Stage Vanes)

R NOTE: Refer to the subsequent paragraph for repairs
R applicable to PWA 655 2nd stage vanes (post-SB 6133).

NOTE: This repair applies to coated and uncoated vanes. The coating must be stripped prior to FPI. Refer to Paragraphs A. and B.

(1) 1st Stage Vanes - Repair cracks that exceed blend limits as follows:

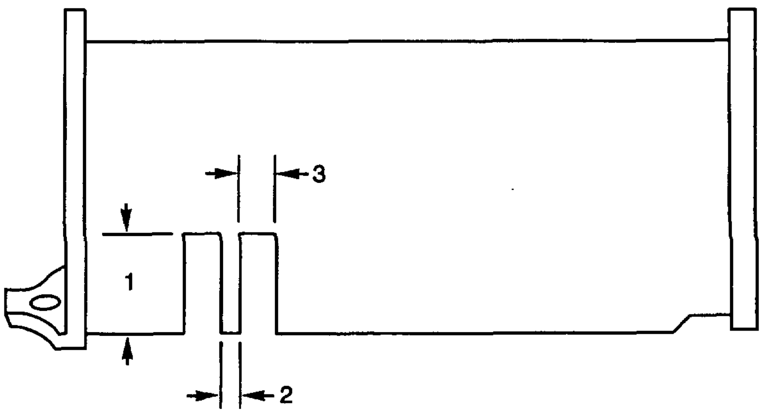
(a) Prepare trailing edge cracks for welding by machining out all deteriorated metal inside and on either side of the cracked area.

1 Machine 0.125 inch wide slots up to a maximum depth of 0.375 inch as shown in Figure 612. Sound material of at least 0.062 inch should remain between slots unless cracking warrants use of alternate slots. When machining each slot, machine additional slots on either side.

2 Closely grouped cracks may be machined out by cutting alternate slots as shown in Figure 613, Indexes 1 and 3.

NOTE: Alternate slots must also have adjacent cuts of lesser depths to ensure a smooth repair. Patterns for adjacent slots, either standard or alternate, do not need to be symmetrical.

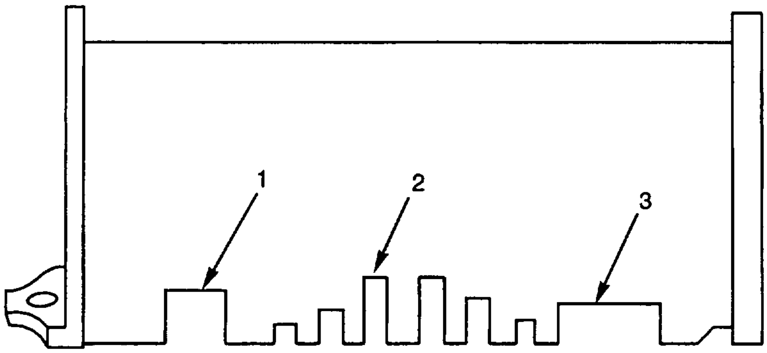
(b) Machine leading edge cracks as necessary provided that slot width and depth do not exceed 0.062 inch. See Figure 614.



L-24483 (0000)
PW V

1. Maximum Depth Of Reparable Crack And Slot Is 0.375 Inch
2. 0.062 Inch Of Sound Metal Between Slots
3. Width Of Slots 0.125 Inch Maximum

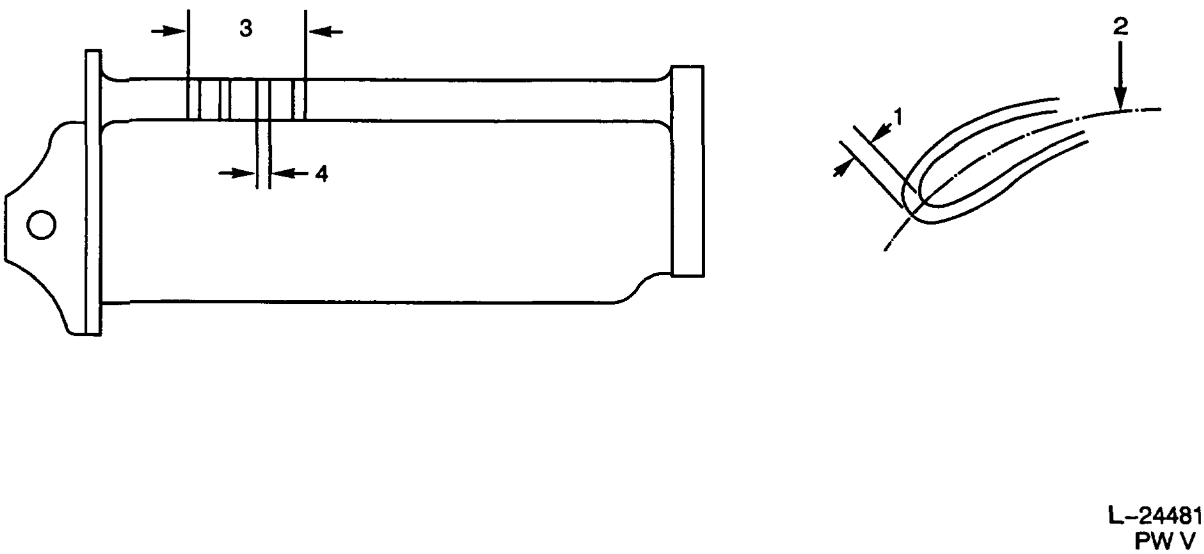
First Stage Vane Trailing
Edge Repair
Figure 612



1. Alternate Slot - 0.250 Inch Deep By 0.250 Inch Wide Maximum
2. Normal Slotting Pattern
3. Alternate Slot - 0.187 Inch Deep By 0.500 Inch Wide Maximum

NOTE: Location of these slots is not necessarily indicative of actual conditions. Alternate slots may be combined with normal slotting pattern in order to accomplish repair.

First Stage Vane Trailing Edge Repair
(Using Normal and Alternate
Slotting Pattern)
Figure 613



1. Maximum Depth Of Cut 0.062 Inch, Perpendicular To Mean Chord Line
2. Mean Chord Line
3. Maximum Length Of Repair 0.500 Inch
4. Maximum Slot Width 0.062 Inch

R
R

First Stage Turbine Vane Leading Edge Repair
Figure 614

(c) Single cracks up to 0.500 inch in length in concave airfoil section, leading in any direction and into radii at either end, may be repaired by machining out a rectangular area with borders 0.050 inch from the crack. Remove the loose material through the vane cavity.

(d) Wire brush or sand blast all areas to be welded at least 1/4 inch beyond machined area.

(e) Preheat the vane to 524° - 552°C (975° - 1025°F) by using a temperature indicating crayon. Weld with the material specified in Table 603.

	VANE (PN)	VANE MATERIAL	WELDING WIRE
	1st Stage		
R	(419851)	AMS 5385	AMS 5789
R	(512751)	PWA 653	AMS 5801
R	(566051)	PWA 647	AMS 5801
R	(569551)	PWA 653	AMS 5801
R	(702051)	AMS 5385	AMS 5789
R	(821551)	PWA 663	AMS 5837
	2nd Stage		
R	(370252)	AMS 5382	AMS 5789
R	(567152)	PWA 653	AMS 5801

Turbine Vane Welding Material
Table 603

(f) Dress weld to conform with surrounding area. Use care to ensure that the airfoil contour and both trailing edge radii are maintained.

<u>NOTE</u>: Do not attempt to alter the vane classification during the course of the repair.

(g) FPI each vane by SPOP 82 in the Standard Practices Manual.

(h) Reapply the coating to previously coated vanes.

(i) Stress-relieve uncoated vanes by Cycle No. 5 in the Overhaul Standard Practices Manual.

(j) Determine the vane classification per Paragraph I. steps (1) through (5).

R (2) Second Stage Vanes (Pre-SB 6133)

(a) Vanes with leading or trailing edge minor damage and/or dents that exceed established blend limits may be repaired as follows:

1 Machine out the damaged area within limits in Figure 615. Up to 3 weld repairs can be performed on either the leading or the trailing edge, but all edge repairs must be confined to the same edge on a single vane.

2 Weld slots by using the welding material specified in Table 603.

3 Stress-relieve by Cycle No. 5 in the Overhaul Standard Practices Manual.

4 Dress welds flush with adjacent surfaces. The final finish must be equal to the original, and performed parallel to the vane edge to prevent chordwise finishing marks.

(b) Following the repair of the vane edge, permanently mark the vane by vibration Peening W on the vane buttress as shown in the figure.

(c) Determine the vane classification by Paragraph I. steps (1) through (5).

R F. Second Stage Turbine Vane Repair (PWA 653 Vanes Post-
R SB 6133)

R (1) General

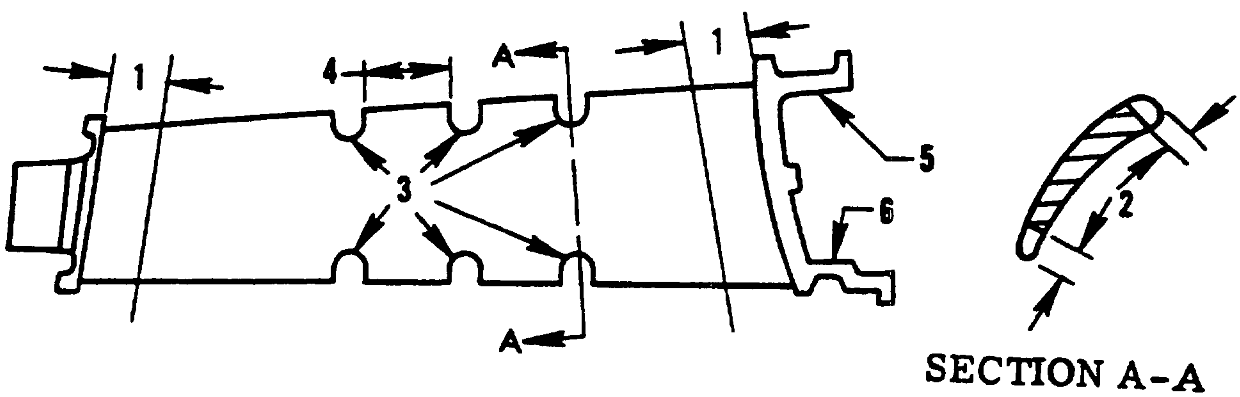
R (a) Repair all vanes to the limits in this section.

R (b) After surface damage blend repair the vane area
R must get PWA 73 coat as specified in this section.

R (2) Surface Damage Blend Repair

R (a) Use a SPOP 533 blend repair procedure to remove
R surface damage. Refer to Section 70-45-00 in the
R Standard Practices Manual.

R (b) Blend areas must be smooth and uniform with no
R sharp edges or corners. Keep material removal to
R a minimum.



1. 0.250 Inch (No Repair Permitted in This Area)
2. 0.100 Inch Maximum Depth Of Repair Welds
3. 0.125 Inch Maximum Slot Width. Maximum Of 3 Slot Repairs Permitted On Either Leading Or Trailing Edge. Weld Repairs Not Permitted On Leading And Trailing Edges Of Vane At Same Time
4. 0.500 Inch Minimum Undamaged Material Between Repair Welds (Leading And Trailing Edges)
5. Leading Edge Weld Repair Identification Area
6. Trailing Edge Weld Repair Identification Area

R
R

First Stage Turbine Vane
Leading Edge Repair
Figure 615

(c) Surface finish of blend repair areas must be the equal to that of areas without repair.

(d) Vanes must get fluorescent penetrant inspection (refer to Section 72-00-00, Inspection).

(3) Blend Limits. See Figure 607.

(a) Area A

1 No blend repair is permitted in the radius between the airfoil and the inner and outer platforms.

(b) Area B

1 Leading and trailing edges can get repair to a maximum depth of 0.005 inch.

2 Total chordal blend depth cannot be more than 0.010 inch.

3 Total blend length of either edge must not be more than 10 percent of the airfoil length.

4 Keep a minimum length to depth ratio of 10:1.

(c) Area C

1 Airfoil blends must not decrease the airfoil thickness by more than 0.015 inch either as a single repair or with two repairs opposite each other.

2 Total blend area must not be more than 10 percent of Area C.

3 Keep a minimum length to depth ratio of 10:1.

(d) Area D

1 Maximum depth of a blend is 0.005 inch.

2 Keep a minimum length to depth ratio of 10:1.

3 Total blend area must not be more than 10 percent of surface area.

(4) Airfoil Leading and Trailing Edge Weld Repair. See Figure 616.

(a) Vanes with leading or trailing edge damage or cracks which are more than the limits for blend repair can get this weld repair (which cuts slots in the vane surface to remove defects, fills the slots with weld, and finishes the vane surface to the initial contour. Refer to the figure for the limits of this repair.

<u>NOTE</u>: It will be necessary to remove the vane coating either fully or in local areas before this weld repair.

(b) Grit blast the repair area by SPOP 218 if necessary to remove oxides. Refer to Section 70-21-00 in the Standard Practices Manual.

(c) Removed damaged areas to the limits in the figure.

(d) Clean the vanes by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

(e) Clean the repair area by solvent wipe (SPOP 208) before the weld operation. Refer to Section 70-21-00 in the Standard Practices Manual.

(f) Fill the slots with AMS 5837 weld material by GTAW-MA process (refer to Section 70-42-01 in the Standard Practices Manual).

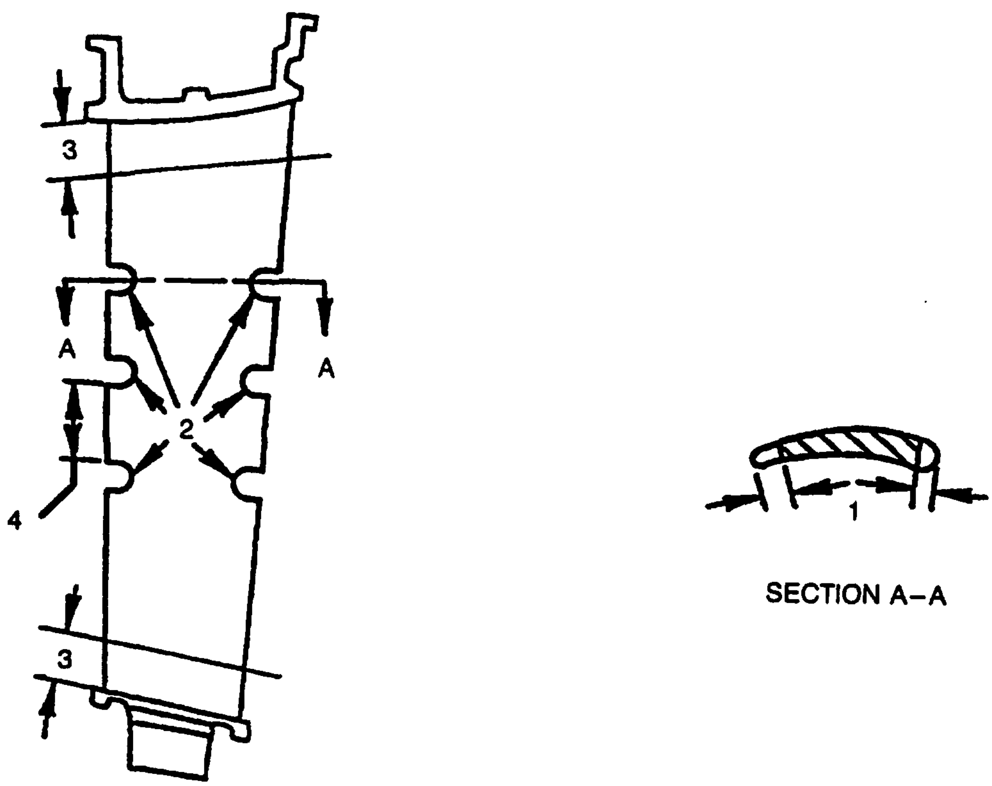
(g) Finish the welds flush with adjacent surfaces with a finish equal to that of areas without repair.

(h) Stress-relieve the vane by SPOP 459-2. Refer to Section 70-42-01 in the Standard Practices Manual.

(i) Do a fluorescent penetrant inspection of the vane. Refer to Section 72-00-00, Inspection.

(i) Apply coating to the vane as specified in this section.

(5) Vane Inner Foot Tang Weld Repair
Refer to Tool Group 85-1 and Figure 617.



L-H4662 (0207)

1. 0.100 Inch Maximum Depth Of Repair
2. 0.125 Inch Maximum Slot Width. Three Repairs Permitted Per Edge But Not Permitted on Both Edges of a Vane.
3. 0.250 Inch (No Repair Permitted)
4. 0.500 Inch Minimum Separation of Repairs on Either Edge

Second Stage Turbine Vane
Leading And Trailing Edge
Weld Repair
Figure 616

(a) Vane tangs worn below plasma coat limits must get weld repair.

(b) Install the vane in the Welding Fixture.

(c) Machine the vane tang surfaces to remove plasma coat and remove damaged vane material.

(d) Grit blast the repair area by SPOP 218 if necessary to remove oxides. Refer to Section 70-21-00 in the Standard Practices Manual.

(e) Clean the vanes by SPOP 209, followed by SPOP 208 solvent wipe. Refer to Section 70-21-00 in the Standard Practices Manual.

(f) Weld the vane tang with AMS 5837 filler rod. Refer to Section 70-42-01 in the Standard Practices Manual.

(g) Finish machine the repair area to the limits in the figure.

(h) Stress-relieve by SPOP 459-1. Refer to Section 70-41-01 in the Standard Practices Manual.

(i) Do a fluorescent penetrant inspection of the vane. No cracks are permitted. Refer to Section 72-00-00, Inspection.

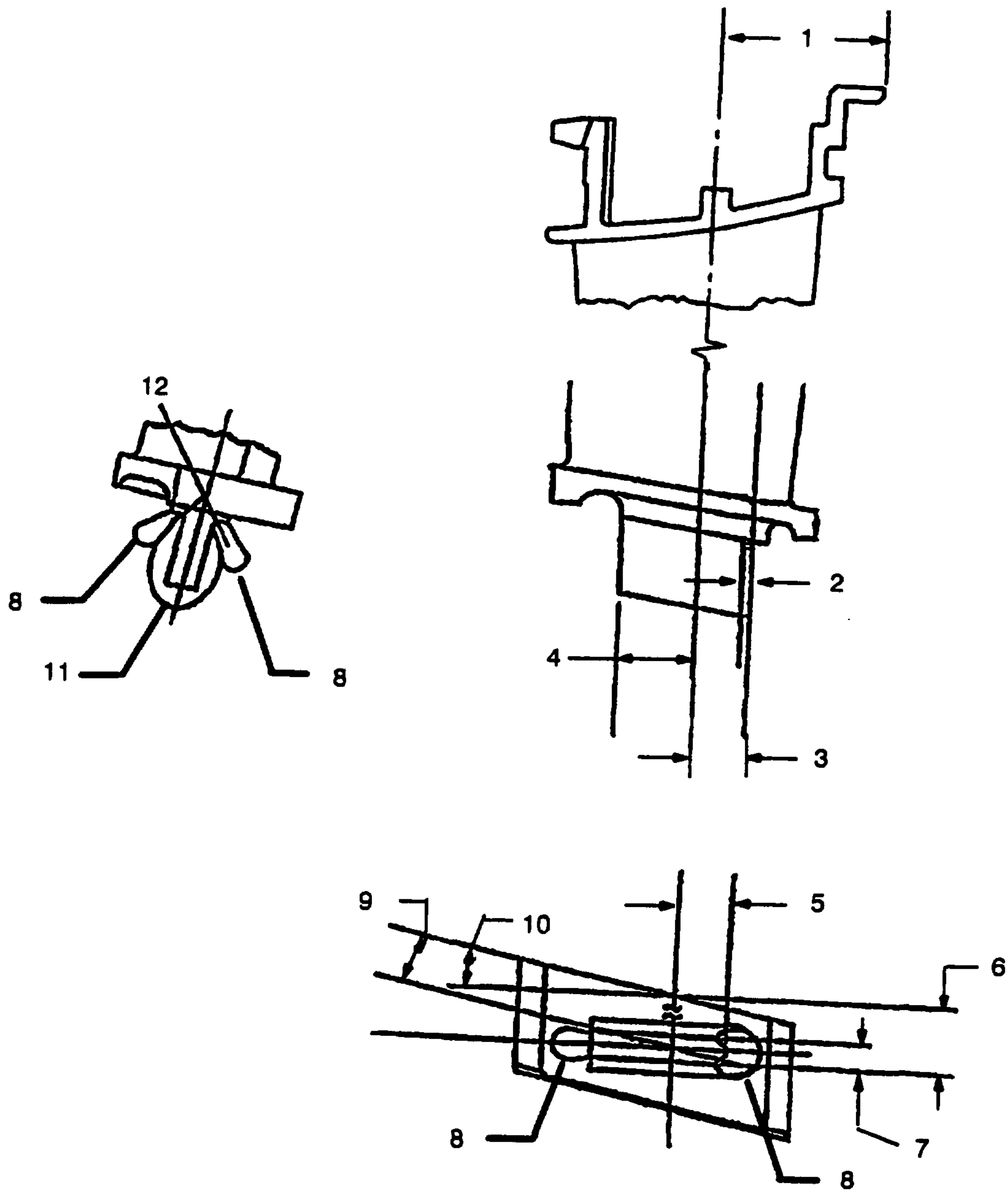
(j) Prepare the surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(k) Apply PWA 53-16 plasma coat to the tang surfaces as shown in the figure. Refer to Section 70-46-01 in the Standard Practices Manual.

(l) Finish machine the surface to the limits in the figure. Keep the coating thickness to 0.003 - 0.006 inch.

(6) Vane Inner Foot Front Face Plasma Coat Repair See Figure 618.

(a) Machine the front face to remove coating and damaged vane material (remove a minimum of material).



Second Stage Turbine Vane Tang Repair
Figure 617

1. 0.570 - 0.590 Inch
2. Chamfer 0.020 - 0.030 Inch x 43° - 47° (Both Sides)
3. 0.137 - 0.157 Inch
4. 0.213 - 0.233 Inch
5. 0.147 Inch Gage Dimension
6. 0.205 - 0.209 Inch (Reference)
7. 0.077 - 0.083 Inch
8. Plasma Coat Optional In This Area and May be Incomplete
9. 0.153 - 0.173 Inch (Reference)
10. 13° 0′ ± 5′ (Reference)
11. Plasma Coat Area
12. 0.010 - 0.030 Inch Modified Radius

Key to Figure 617

(b) Prepare the surface for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

(c) Measure the front face dimension (Index 3 in the figure) to get the necessary plasma coat thickness.

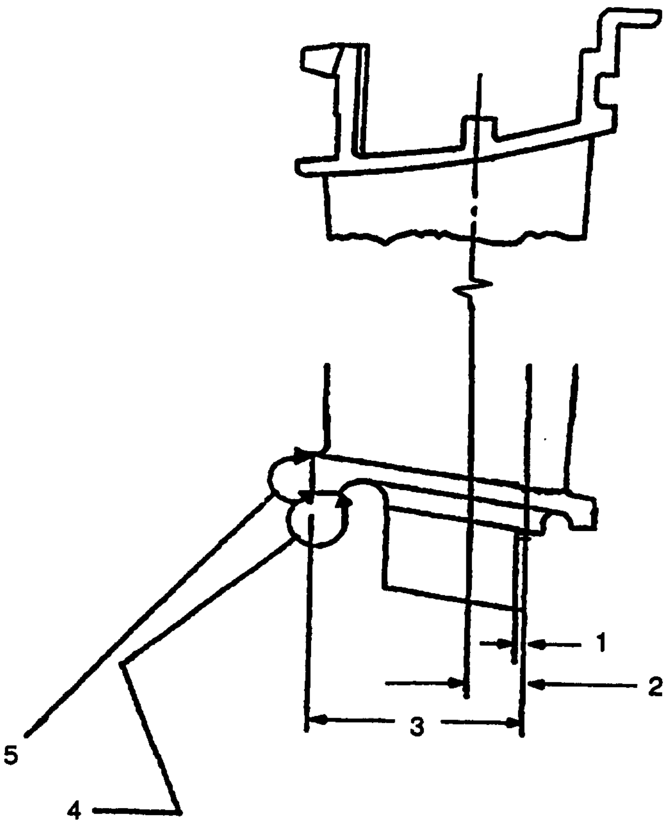
(d) Apply PWA 53-16 plasma coat to the tang surfaces as shown in the figure to a maximum of 0.006 inch thickness. Refer to Section 70-46-01 in the Standard Practices Manual.

(e) Finish machine the surface to the limits in the figure. Keep the coating thickness to 0.003 - 0.006 inch.

(7) PWA 73 Coating Replacement

<u>CAUTION</u>: EXCEPT FOR WORK OR SUPPLIES TO BE PERFORMED OR FURNISHED BY PRATT & WHITNEY, IT IS TO BE UNDERSTOOD THAT PRATT & WHITNEY DOES NOT ENDORSE THE WORK PERFORMED BY THE COMPANY OR COMPANIES NAMED HEREIN OR ANY OTHER COMPANY AND DOES NOT ACCEPT RESPONSIBILITY TO ANY DEGREE FOR THE SELECTION OF SUCH COMPANY OR COMPANIES FOR THE PERFORMANCE OF ANY WORK OR PROCUREMENT OF SUPPLIES.

(a) This is a Source Demonstration repair. Send vanes that are in repair limits to an approved source which has a license for this repair. The list that follows identifies sources approved and licensed for this repair by source code number. Refer to



L-H4665 (O207)

1. Chamfer 0.020 - 0.030 Inch x 43° - 47° (Both Sides)
2. 0.137 - 0.157 Inch (Reference)
3. 0.557 - 0.563 Inch After Plasma Coat
4. Plasma Coat Optional In This Area And May Be Incomplete
5. Plasma Coat Area

Second Stage Turbine Vane Inner Foot
Plasma Coat Repair
Figure 618

the source code list in Section 70-40-00, General-01 in the Standard Practices Manual for the company name, address, and contact information for the companies identified by each source code.

C0032 C0033 C0034 C0035 C0045

0AH76 0C162 33586 1M141 3A367

(b) Because this repair is critical, repair sources must show Pratt & Whitney that they can do this repair and must get a license for this repair from Pratt & Whitney. Write to the address in this manual's Introduction section or in Section 70-40-00 of the Standard Practices Manual for information about the qualification program to become an approved and licensed source.

(8) PWA 73 Coating Touch-up Repair. See Figure 617.

NOTE: Before this coating touch-up repair, do a general coating inspection for corrosion, sulfidation, and damage. If the coating condition makes necessary a full coating repair, refer to the coating replacement repair above.

(a) Use PWA 545 cobalt-aluminum slurry or PWA 596 aluminum-silicon slurry to do a touch-up repair of the vane coating as shown in the figure. Refer to SPOP 158 in Section 70-41-03 in the Standard Practices Manual.

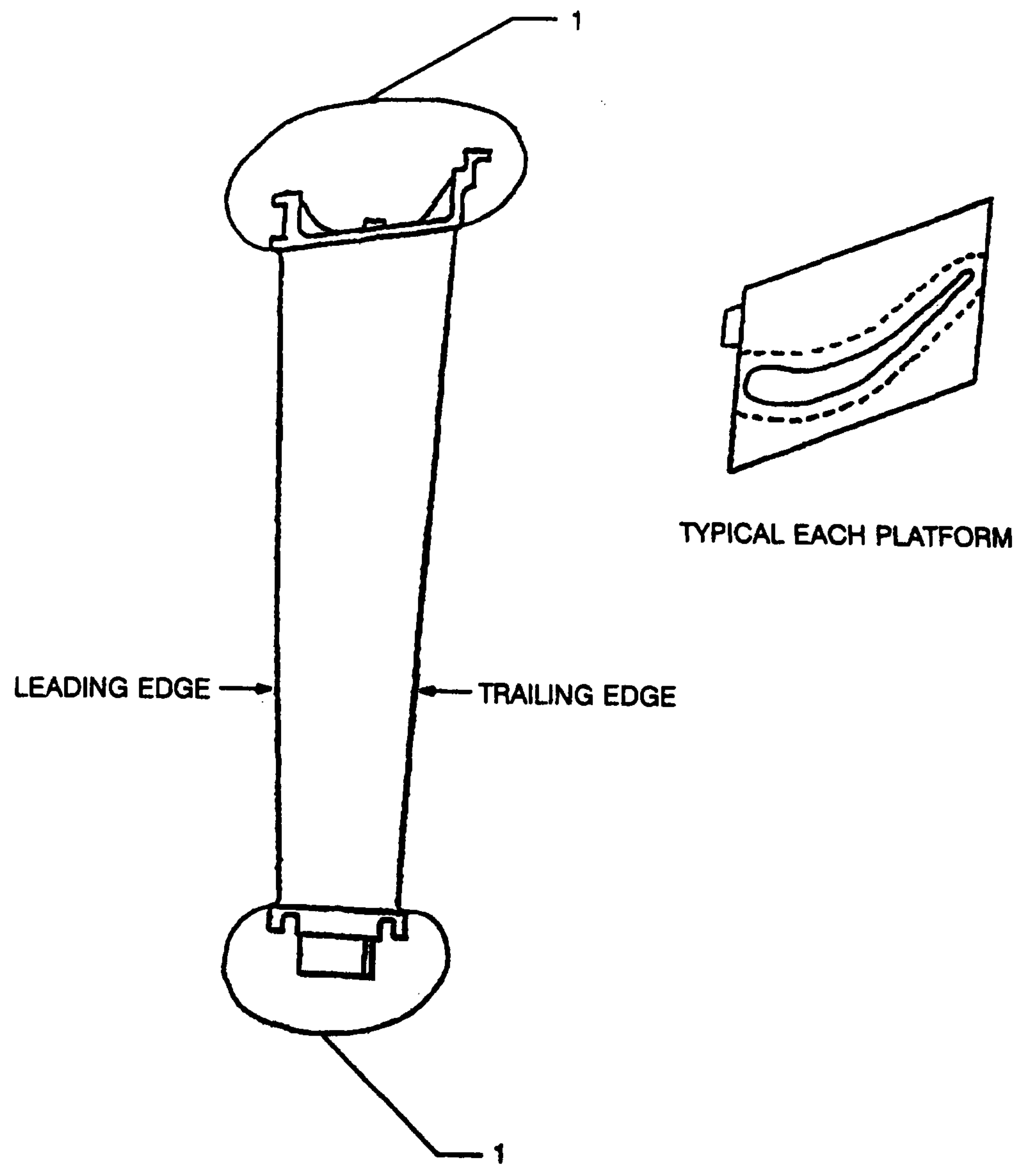
(b) An optional diffusion heat-treatment by SPOP 459-1 in an argon atmosphere is permitted.

NOTE: The optional diffusion heat treatment will give a vane slightly less corrosion protection.

G. Free Turbine Vane (1st And 2nd Stages) Inspection And Repair

(1) Inspection

(a) Preinspection Preparation



L-H4663 (0207)

1. No Coat Areas (All Around the Areas Shown)

Second Stage Turbine Vane
Coating Touch-up Repair
Figure 619

1 Limits are evaluated from the standpoint of structural integrity, gross performance deficiencies, and dimensional requirements for assembly. The use of a substantial number of airfoils at or near the maximum limits or with many repaired areas can adversely affect engine efficiency and performance.

2 Limits apply to damaged areas after blend repair and not to the size of the damage measured before blend repair. Keep material removal to a minimum for maximum part life and function

3 Evaluation of surfaces for which blend repair is necessary must take into consideration the need for blend repair and the limits of the blend repair. Some conditions are acceptable without repair. However it is usually better to do blend repair of surface damage. The sharper the surface damage, the better it is to repair the damage.

4 During visual inspection pay particular attention to areas where defects are difficult to find, for example corners and fillet radii. Use white light and mirrors (as well as the fingernails) to find damaged areas. When an indication (nick, dent, scratch, corrosion pit, etc.) is found, use magnification to find the size of the defect (or compare it to samples with known damage depths).

5 No cracks are permitted in any area of the free turbine vanes.

6 Bowing is not usually encountered in free turbine vanes. Vanes may become permanently bent as cantilever beams and the inner lug of a new vane may not mate with the slot in the inner shroud. When this situation occurs, replace all vanes and/or the inner shroud.

7 Inspect all free turbine vanes suspected of being subjected to temperatures in excess of 1472°C (800°F) for signs of material flow (dribbling, blistering, etc.), particularly on the leading edge. Reject the entire set if any vane has an indication of material flow.

(b) Non-destructive Inspection

1 Do a fluorescent penetrant inspection of the 1st and 2nd stage vanes. Refer to Section 72-00-00, Inspection. See Figure 620 for special attention areas and Table 604 for inspection limits.

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area A		
Fillet Areas	Six point inclusions or gas porosity indications, 0.015 inch diameter maximum except nearer than 0.125 inch to fillets radius tangent line (no cracks or indications permitted in this area)	None
Area B		Refer to Repair. Finish blend must not be more than 0.010 inch in depth and must not decrease chord width more than 0.020 inch.
Leading and Trailing Edges	Four pinpoint indications 0.250 inch apart	Blend Repair
Area C		
Airfoil (Concave and Convex sides)	12 pinpoint inclusions or gas porosity indications, 0.031 inch diameter maximum, well-dispersed, per inch of area length	Blend Repair
	No cracks permitted	
Area D		

Free Turbine Vane FPI Limits
Table 604

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Platforms (not in fillet areas)	12 pinpoint inclusions or gas porosity indications, 0.031 inch diameter maximum, well-dispersed	Blend Repair

Free Turbine Vane FPI Limits
Table 604 (Continued)

(c) Visual Inspection

1 Examine the vanes for surface damage. See Figure 621 and Table 605 for inspection areas and damage limits.

2 Examine vanes for overtemperature condition and metal splatter.

a Parts with overtemperature condition are not serviceable or repairable and are scrap.

b Parts with metal splatter in area where no blend repair is permitted are not serviceable or repairable and are scrap.

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area A	No visible damage or cracks permitted	None
Area B		
Leading and Trailing Edge	Round bottom dents to 0.010 inch maximum depth, not more than three on leading edge and trailing edge with 0.125 inch minimum separation	Leading edge 0.025 inch maximum depth, trailing edge 0.015 inch maximum depth. Combined LE and TE repairs must not decrease chord length more than 0.030 inch
	No leading or trailing edge cracks permitted	

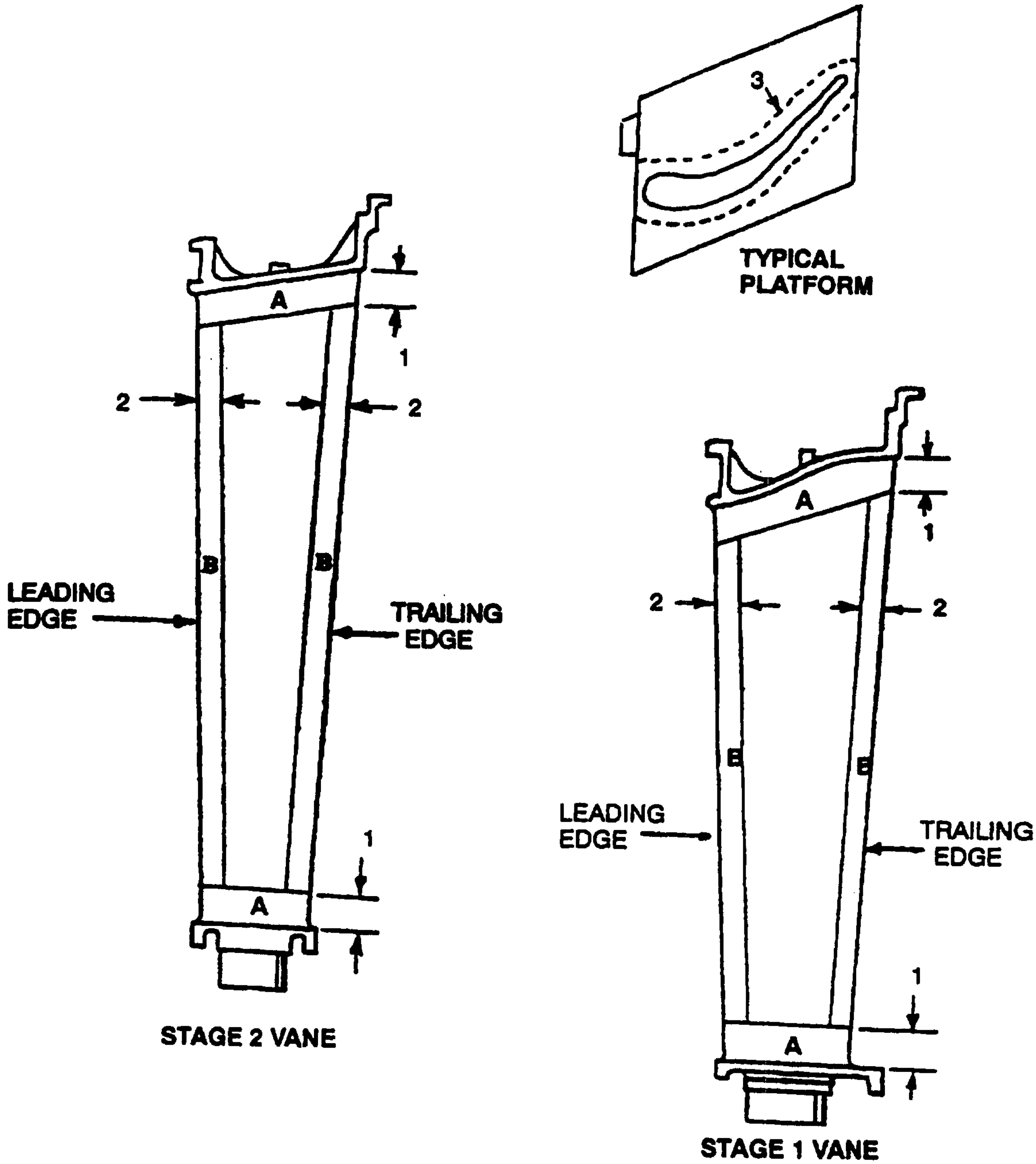
Free Turbine Vane Visual
Inspection Limits
Table 605

INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
Area C		
Airfoil, concave and convex sides	No cracks permitted	None
	No dents that protrude through to the opposite side of the airfoil. Round bottom dents to 0.015 inch depth maximum, with 0.250 inch minimum separation.	Airfoil blends must not decrease decrease airfoil thickness more than 0.030 inch.
	No cracks permitted in dents	
Area D		
Platforms (not in the fillet)	Pits 0.015 inch maximum diameter, to 0.006 inch maximum. No connected dents or dents with foreign material, no dents larger than area of 0.162 inch circle.	No blend repair in fillet area. For non-fillet areas, maximum blend depth of 0.025 inch.
	No cracks permitted	For cracks 0.100 inch maximum length not removed by blend repair to 0.025 inch limit above, refer to weld repair.

Free Turbine Vane Visual
Inspection Limits
Table 605 (Continued)

(d) Dimensional Inspection (1st stage free turbine vane)

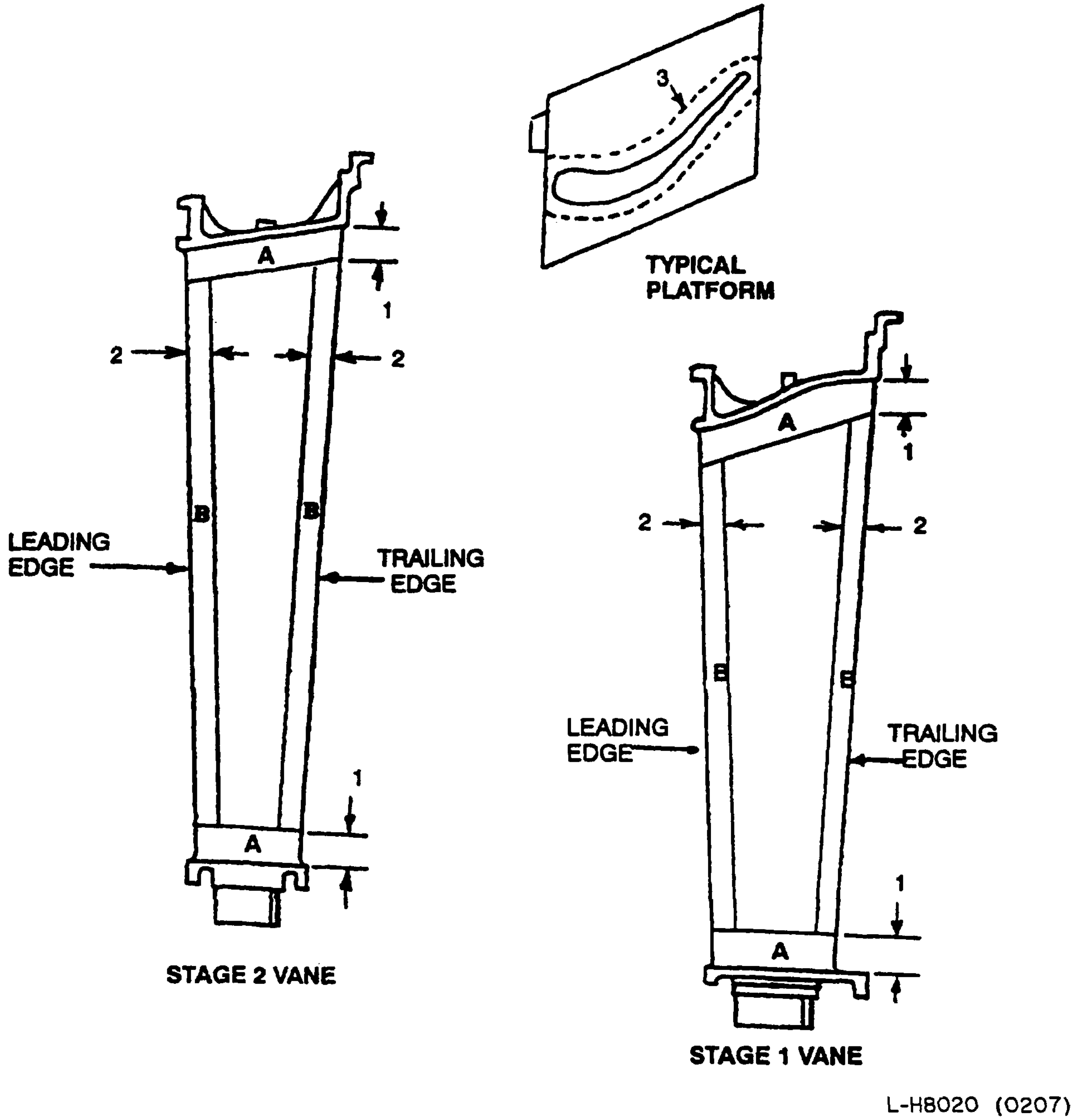
1 Measure the vane features shown in Figure 622 and see Table 606 for limits.



L-H4588 (0207)

1. 0.500 Inch
2. 0.250 Inch
3. 0.125 Inch From Platform/Fillet Line

Free Turbine Vane Fluorescent
Penetrant Inspection Limits
Figure 620

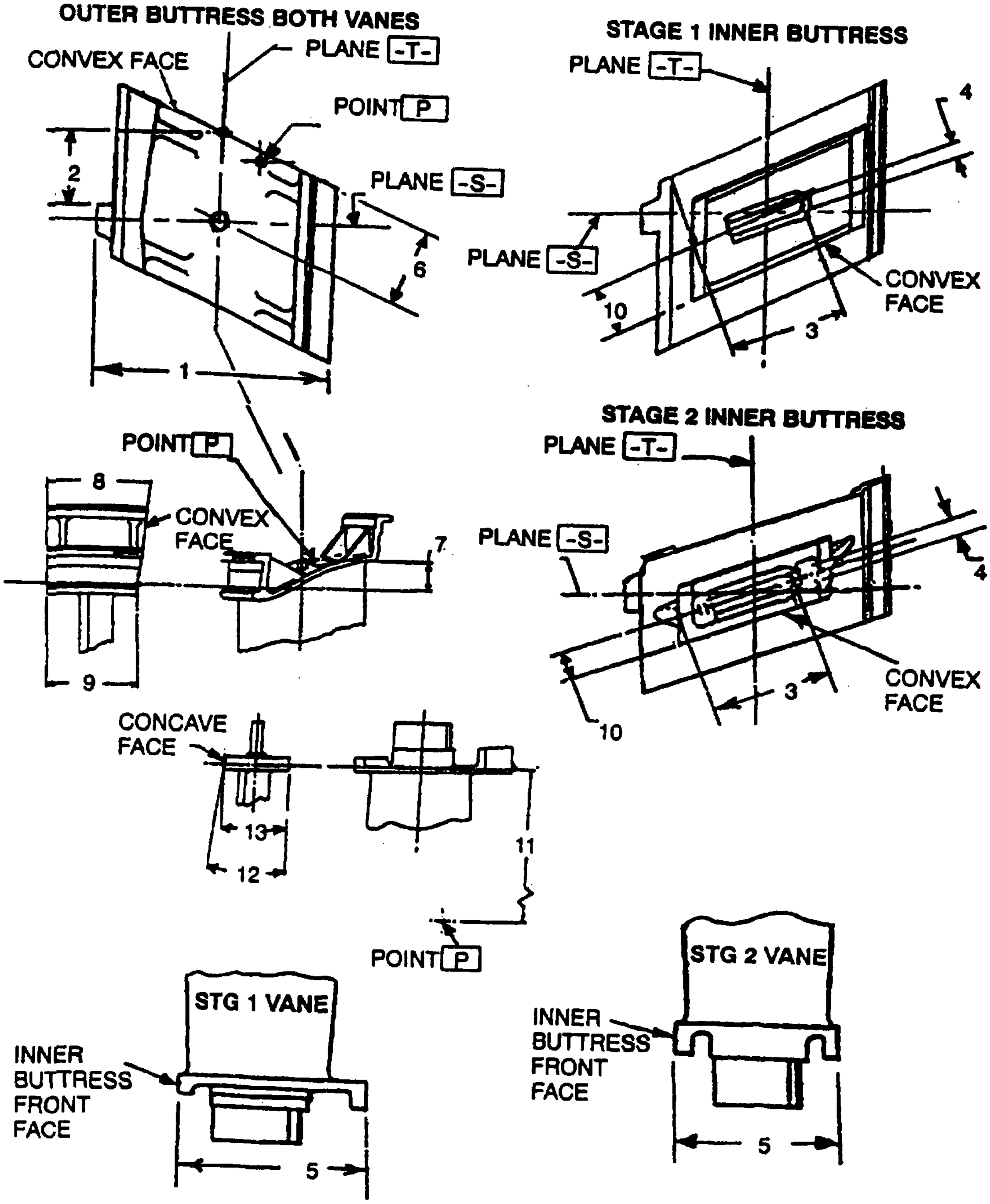


R 1. 0.500 Inch
R 2. 0.250 Inch
R 3. 0.125 Inch From Platform/Fillet Line

R Free Turbine Vane Visual
R Inspection Limits
R Figure 621

R	INSPECTION AREA	SERVICEABLE LIMIT	REPAIRABLE LIMIT
R	Outer Buttress: Antirotation Lug	No bent, missing, or cracked lugs permitted	
R		1. 2.020 inches minimum	1.995 inches minimum
R		2. 0.616 inch maximum	0.647 inch maximum
R	Inner Buttress: Tang	3. 0.928 inch minimum	0.899 inch minimum
R		4. 0.112 inch minimum	0.098 inch minimum, wear on one side only
R	Front Face	5. 1.365 inches minimum	1.350 inches minimum
R	Outer Buttress: Convex sideface, Concave sideface	6. 0.655 inch minimum	0.640 inch minimum
R		7. 0.383 inch reference	
R		8. 6° 30′ ± 0° 10′ reference	
R		9. 1.291 inches minimum	1.268 inches minimum
R	Inner Buttress: Convex sideface, Concave sideface	10. 0.377 inch minimum	0.362 inch minimum
R		11. 5.385 inch reference	
R		12. 4° 40′ ± 0° 10′ reference	
R		13. 1.709 inches minimum	0.686 inch minimum

R Free Turbine 1st Stage Vane
R Dimensional Inspection Limits
R Table 606



L-H802I (0207)

R

First and 2nd Stage Free Turbine Vane
Dimensional Inspection Limits
Figure 622

(e) Dimensional Inspection (2nd stage free turbine vane)

1 Measure the vane features shown in Figure 622 and refer to Table 607 for limits.

INSPECTION AREA	SERVICEABLE LIMIT	REPARABLE LIMIT
Outer Buttress: Antirotation Lug	No bent, missing, or cracked lugs permitted	
	1. 1.960 inches minimum	1.935 inches minimum
	2. 0.391 inch maximum	0.422 inch maximum
Inner Buttress: Tang	3. 0.882 inch minimum	0.847 inch minimum
	4. 0.112 inch minimum	0.098 inch minimum, wear on one side only
Front Face	5. 1.112 inches minimum	1.093 inches minimum
Outer Buttress: Convex sideface, Concave sideface	6. 0.475 inch minimum	0.460 inch minimum
	7. 0.197 inch reference	
	8. 4° 18′ ± 0° 10′ reference	
	9. 0.966 inch minimum	0.943 inch minimum

R
R
Free Turbine 2nd Stage Vane
Dimensional Inspection Limits
Table 607

INSPECTION AREA		SERVICEABLE LIMIT	REPARABLE LIMIT
Inner Buttress: Convex sideface, Concave sideface	10.	0.225 inch minimum	0.210 inch minimum
	11.	6.738 inches reference	
	12.	4° 28′ ± 0° 10′ reference	
	13.	0.457 inch minimum	0.434 inch minimum

Free Turbine 2nd Stage Vane
Dimensional Inspection Limits
Table 607 (Continued)

(2) Repair (1st and 2nd stage free turbine vanes) See Figure 623.

(a) Surface Damage Blend Repair

1 Do blend repairs of the 1st or 2nd vanes as specified in SPOP 533. Refer to Section 70-45-00 in the Standard Practices Manual.

2 Area A blend limits: No blend repair is permitted in the radii between the airfoil and the inner and outer platforms.

3 In Area B do blend repair of nicks, cracks, and dents to these limits:

a Do not decrease the leading edge by more than 0.025 inch.

b Do not decrease the trailing edge by more than 0.015 inch.

c Total depth of leading and trailing edge blends when combined must not decrease the chord width by more than 0.030 inch.

d Cumulative length of all leading and trailing edge blends must not be more than 10 percent of the respective airfoil span length.

e A blend in Area B can extend into Area A.

f Keep a minimum length-to-depth ratio of 5:1.

4 In Area C do blend repair of nicks and dents to these limits:

a Airfoil blends must not decrease the airfoil thickness by more than 0.030 inch.

b Total area of blends must not be more than 10 percent of Area C.

c Keep a minimum length-to-depth ratio of 4:1.

d Maximum depth of a blend is 0.030 inch.

e A blend in Area C can extend into Area A or Area B.

5 In Area D do blend repairs (but not in the airfoil fillet radius) to these limits:

a Maximum blend depth is 0.030 inch.

b Keep minimum diameter-to-depth ratio of 4:1.

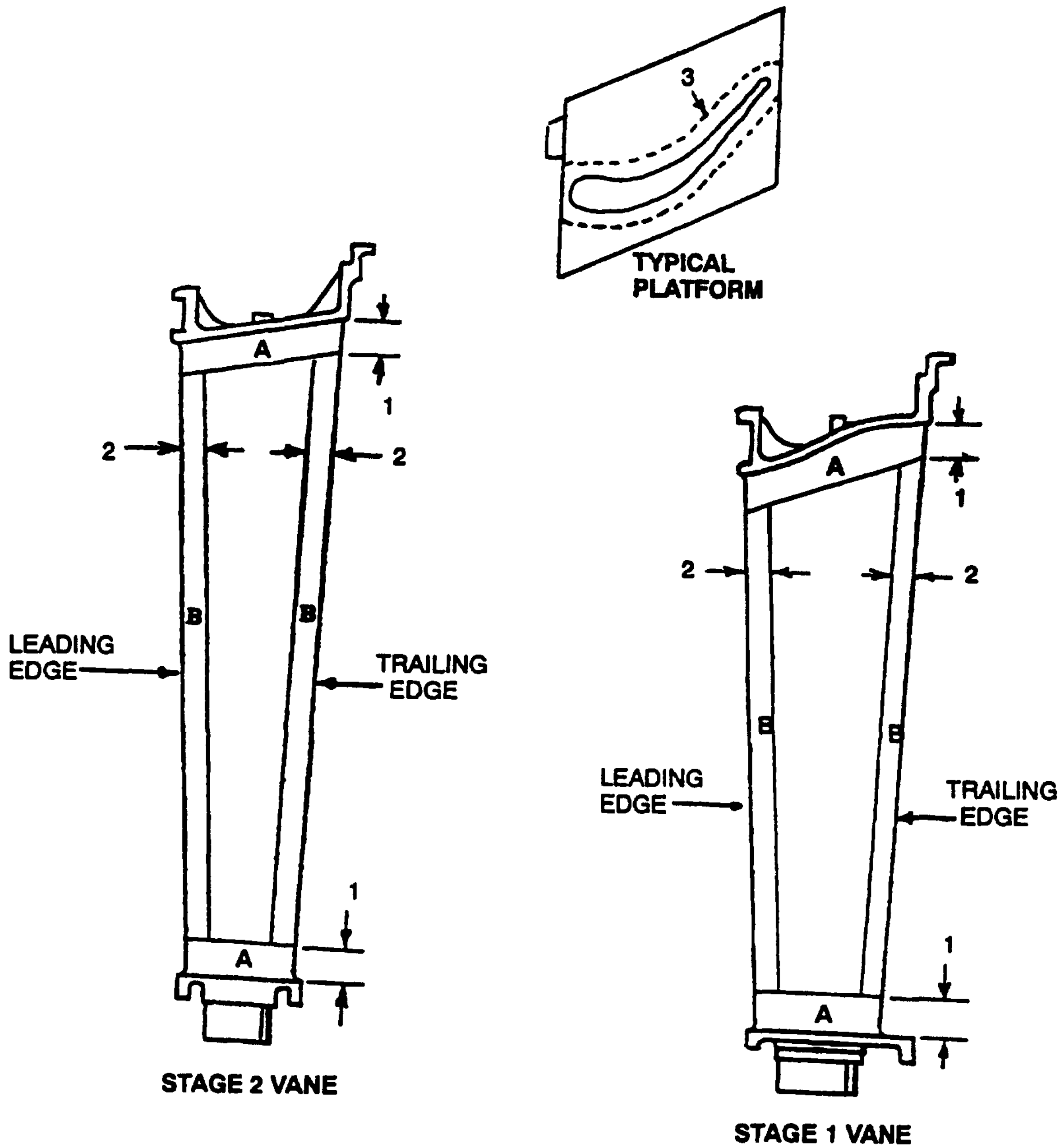
c Total area of blends must not be more than 10 percent of Area C.

d If cracks are not removed to the specified blend limits, do a weld repair.

(b) Airfoil and Platform Weld Repair. See Figure 624.

NOTE: The total quantities of the span weld repair must not be more than 50 percent of the span on the leading or trailing edge of the vane. A leading edge weld opposite a trailing edge weld must have the radial separation shown in the figure.

1 Grit blast the repair area by SPOP 218. Refer to Section 70-21-00 in the Standard Practices Manual.



L-H8022 (0207)

R 1. 0.500 Inch
R 2. 0.250 Inch
R 3. 0.125 Inch From Platform/Fillet Line

R First And 2nd Stage Free Turbine Vane
R Surface Damage Repair
R Figure 623

2 Hand grind a notch in the leading edge of the airfoil, not more than the limits shown in the figure. Rout out cracks in the platform to the limits shown.

3 Clean the vanes by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

4 Clean the repair area by solvent wipe (SPOP 208). Refer to Section 70-21-00 in the Standard Practices Manual.

5 Weld the repair area on the vane by PWA 16-7 with AMS 5789 welding wire. Refer to Section 70-42-01 in the Standard Practice Manual.

CAUTION: DO NOT USE WORN ABRASIVE BELTS OR WHEELS TO REMOVE WELD MATERIAL FROM A VANE. THIS CAN CAUSE TOO MUCH HEAT IN THE VANE AND CAN CAUSE CRACKS IN THE VANE MATERIAL.

6 Make the repair area smooth to the original vane surface and contour. It is permitted to use abrasive belts to sand the airfoil surface to the adjacent contour.

7 Stress-relieve the vane after weld by SPOP 459-2. Refer to Section 70-42-04 in the Standard Practices Manual.

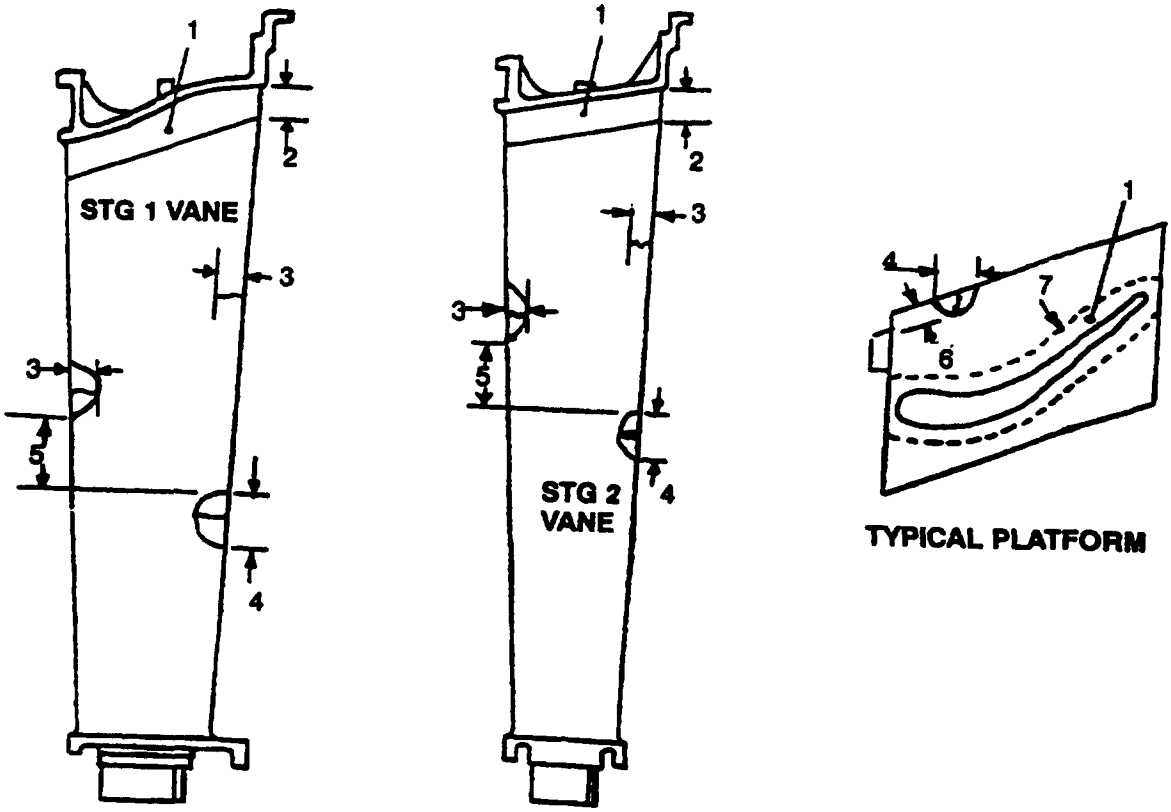
8 Give the vane one of these inspections to be sure that there are no cracks, undercuts, or porosity in the weld area:

a Fluorescent penetrant inspection by SPOP 82. Refer to Section 70-33-00 in the Standard Practices Manual.

b X-ray inspection (refer to Section 70-37-01 in the Standard Practices Manual).

(c) Inner Buttress Tang Weld Repair. See Figure 625 and Figure 626.

1 Grit blast the repair area by SPOP 218. Refer to Section 70-21-00 in the Standard Practices Manual.



First And 2nd Stage Free Turbine
Vane Airfoil/Platform Weld Repair
Figure 624

1. Weld Repair Not Permitted In This Area
2. 0.500 Inch Minimum All Around
3. First Stage Vane: 0.275 Inch Maximum Depth Of Pre-Weld Notch
   Second Stage Vane: 0.250 Inch Maximum Depth Of Pre-Weld Notch
4. Pre-Weld Notch Must Have Minimum Of 2:1 Width-To-Depth Ratio
5. First Stage Vane: 1.350 Inch Minimum Radial Space Between Leading Edge And Trailing Edge Welds
   Second Stage Vane: 1.060 Inch Minimum Radial Space Between Leading Edge And Trailing Edge Welds
6. 0.100 Inch Maximum
7. 0.125 Inch From Platform/Fillet Line

Key to Figure 624

2 Clean the vanes by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

3 Clean the repair area by solvent wipe (SPOP 208). Refer to Section 70-21-00 in the Standard Practices Manual.

4 Weld the repair area on the vane by PWA 16-7 with AMS 5789 welding wire. Refer to Section 70-42-01 in the Standard Practice Manual.

NOTE: During the weld operation use small-diameter weld wire to keep heat on the vane to a minimum and decrease possible cracks in the heat affected zone.

5 Stress-relieve the vane after weld by SPOP 459-2. Refer to Section 70-42-04 in the Standard Practices Manual.

6 Do a fluorescent penetrant inspection by SPOP 82. Refer to Section 70-33-00 in the Standard Practices Manual. No cracks, undercuts, or porosity in the weld area are permitted.

7 Finish machine the repair area to the dimensions in the applicable figure by one of these methods:

a For repairs to only one surface, blend the weld material 0.005 inch above the surface to flush with adjacent surfaces. Blend as necessary to get back to initial tang dimensions. Break sharp edges to 0.003 - 0.015 inch.

b For repairs to two or more surfaces, machine the weld material to the dimensions shown in the applicable figure.

(d) Antirotation Lug Weld Repair. See Figure 627 and Figure 628.

1 Grit blast the repair area by SPOP 218. Refer to Section 70-21-00 in the Standard Practices Manual.

2 Clean the vanes by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

3 Clean the repair area by solvent wipe (SPOP 208). Refer to Section 70-21-00 in the Standard Practices Manual.

4 Weld the repair area on the vane by PWA 16-7 with AMS 5789 welding wire. Refer to Section 70-42-01 in the Standard Practice Manual.

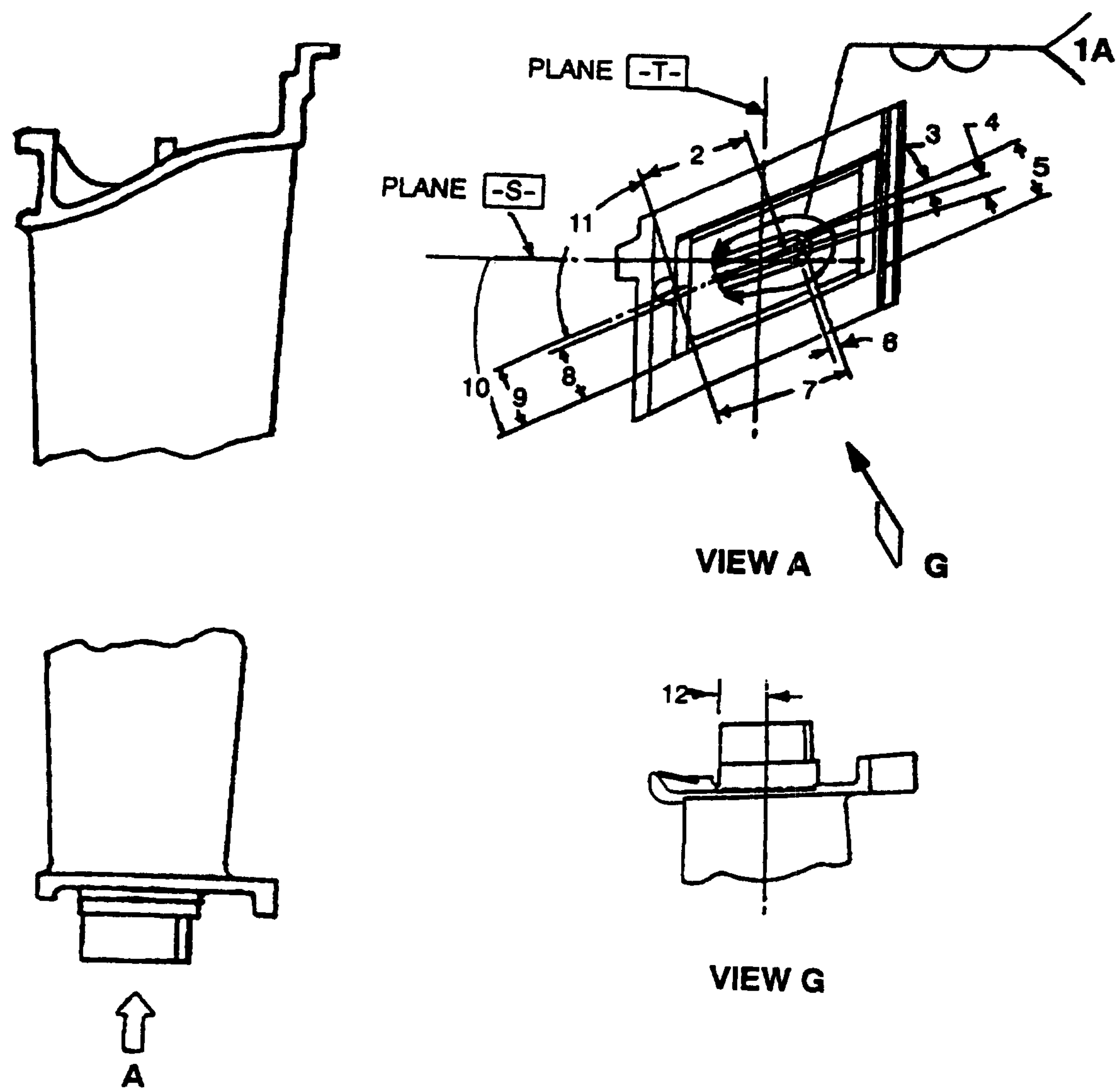
NOTE: During the weld operation use small-diameter weld wire to keep heat on the vane to a minimum and decrease possible cracks in the heat affected zone.

5 Stress-relieve the vane after weld by SPOP 459-2. Refer to Section 70-42-04 in the Standard Practices Manual.

6 Do a fluorescent penetrant inspection by SPOP 82. Refer to Section 70-33-00 in the Standard Practices Manual. No cracks, undercuts, or porosity in the weld area are permitted.

7 Finish machine the repair area to the dimensions shown in the applicable figure.

(e) Inner Buttress Front Face Plasma Coat Repair See Figure 629.



First Stage Free Turbine Vane
Inner Buttress Tang Weld Repair
Figure 625

1. Weld Repair Area (See Text)
2. 0.800 Inch Gage Dimension (Reference)
3. 5° ± 0° 5′
4. 0.117 - 0.123 Inch
5. 0.430 - 0.434 Inch
6. Chamfer 0.030 - 0.050 Inch At 45° ± 2° Each Side
7. 0.933 - 0.939 Inch
8. 0.382 - 0.392 Inch
9. 0.442 Inch Gage Dimension (Reference)
10. 25° ± 0° 30′
11. 95° Gage (Reference)
12. 0.305 - 0.315 Inch

Key to Figure 625

1 Machine the repair area to remove all damage and wear. Remove the minimum material necessary to remove the damage. If the surface was repaired before, remove this coating from the repair area.

2 Prepare the area for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

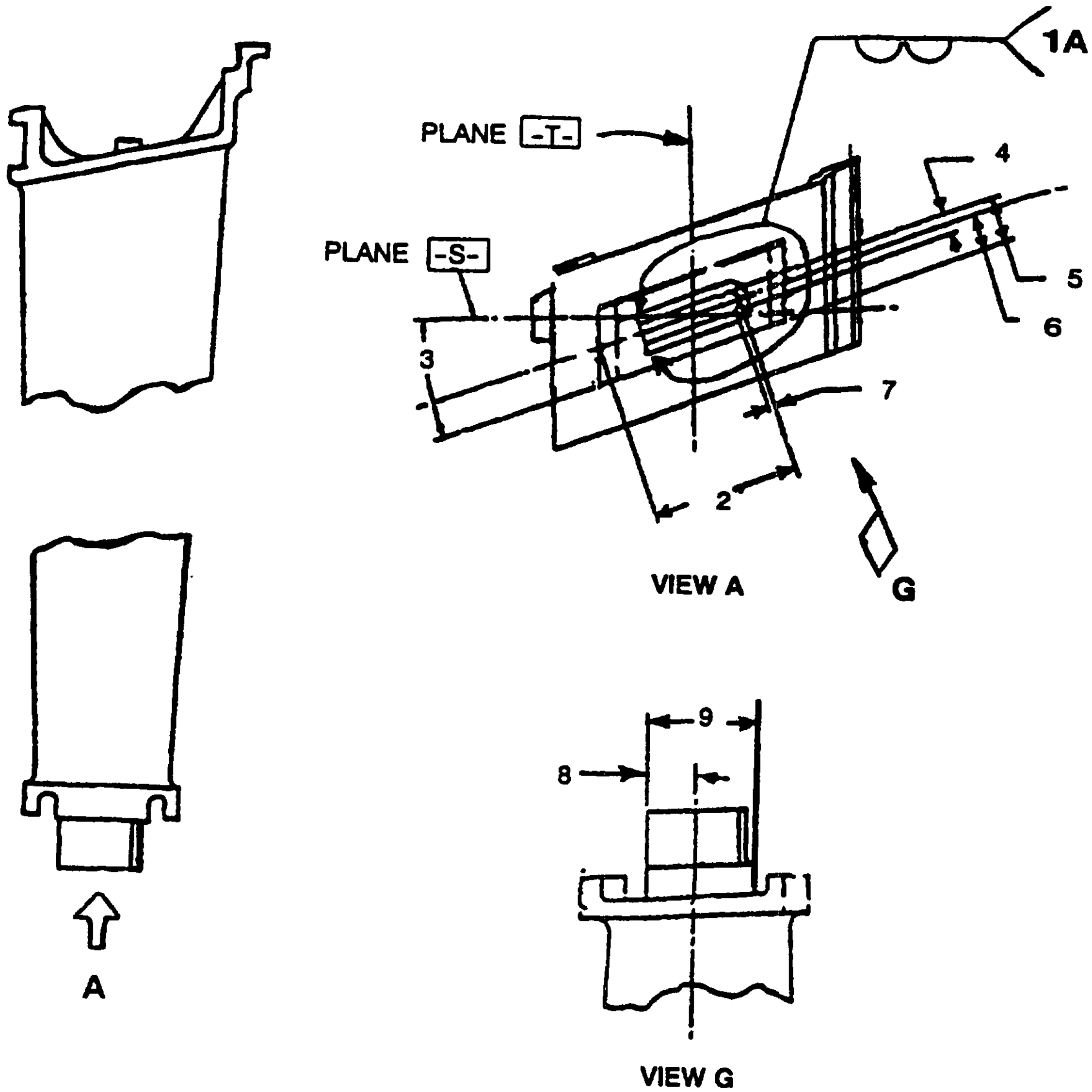
3 Apply plasma coat by PWA 53-18 to a thickness sufficient for finish machining to the dimensions in the applicable figure. Refer to Section 70-46-01 in the Standard Practices Manual.

4 Finish machine the repair area to the dimensions specified.

(f) Outer Buttress Side Face Plasma Coat Repair. See Figure 630.

CAUTION: MAKE SURE THAT THE CONVEX SIDE FACE SURFACE OF A VANE IS MACHINED AND REPAIRED BEFORE THE CONCAVE SURFACE, OR THE DIMENSIONAL FEATURES OF THE VANE BUTTRESS WILL NOT STAY IN LIMITS.

1 Machine the convex side repair area to remove all damage and wear. Remove the minimum material necessary to remove the damage. If the surface was repaired before, remove this coating from the repair area.



L-H8026 (0207)

Second Stage Free Turbine Vane
Inner Buttress Tang Weld Repair
Figure 626

R 1. Weld Repair Area (See Text)
R 2. 0.887 - 0.893 Inch
R 3. 17° 30′ ± 0° 5′
R 4. 0.117 - 0.123 Inch
R 5. 0.293 - 0.297 Inch
R 6. 0.230 - 0.240 Inch
R 7. Chamfer 0.030 - 0.050 Inch At 45° ± 2° Each Side
R 8. 0.295 - 0.305 Inch
R 9. 0.655 - 0.665 Inch

R Key to Figure 626

2 Prepare the area for plasma coat by SPOP 170. Refer to Section 70-46-01 in the Standard Practices Manual.

3 Apply plasma coat by PWA 53-18 to a thickness sufficient for finish machining to the dimensions in the applicable figure. Refer to Section 70-46-01 in the Standard Practices Manual.

4 Finish machine the repair area to the dimensions specified.

H. Straightening Turbine Nozzle Guide Vanes (See Tool Group 96D)

(1) General

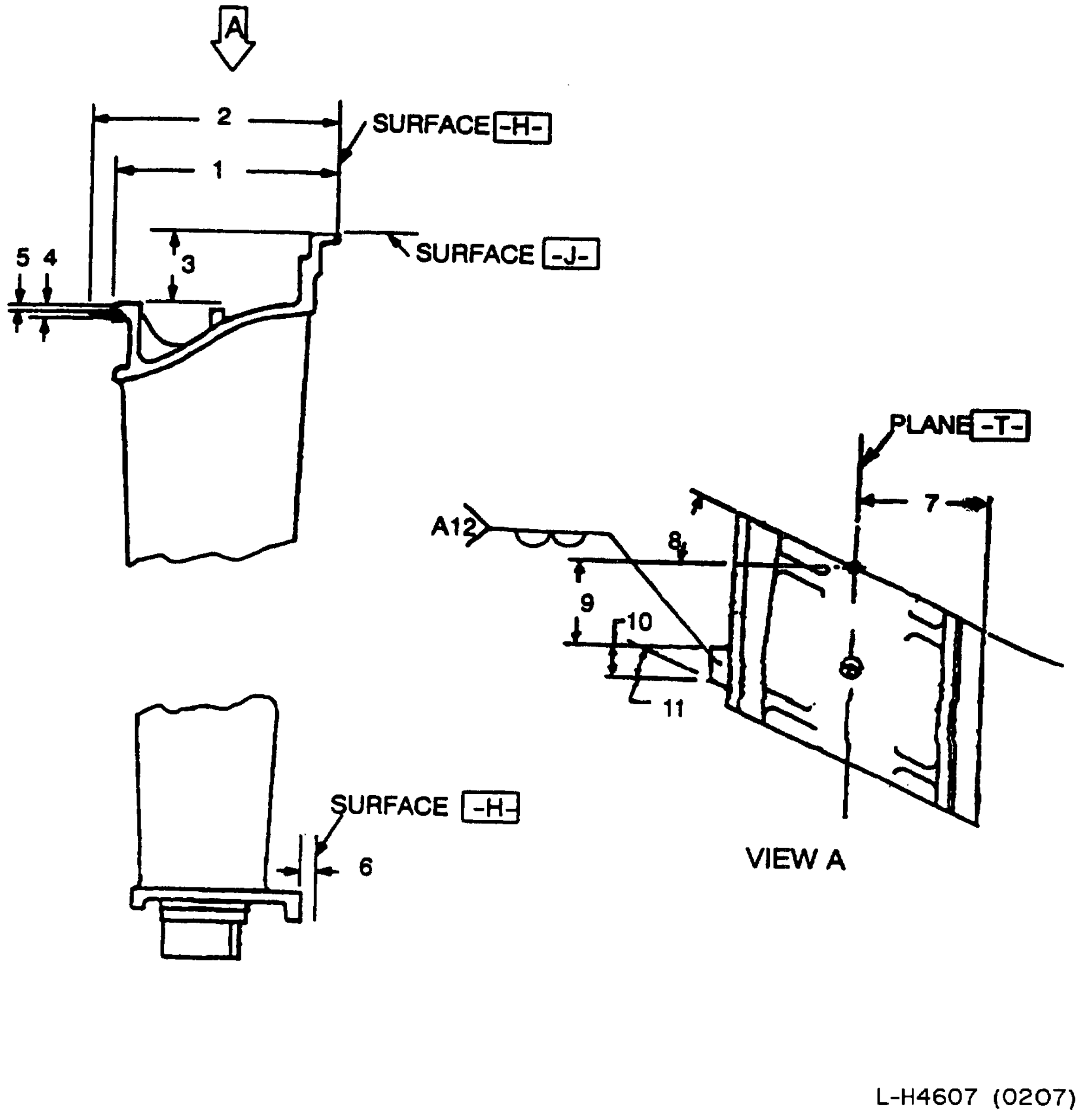
(a) Turbine nozzle guide vanes that are deformed beyond the serviceable limit must be straightened to their original class with the turbine vane straightening press and related equipment. After straightening, the vanes must be heat-treated, when applicable, and cleaned, inspected and remarked.

NOTE: Vanes to be straightened or reclassified may be processed through:

Pratt & Whitney Aftermarket Services
Cheshire Engine Center
500 Knotter Drive
Cheshire, CT 06410

I. Preparation Prior To Straightening

(1) Clean the vanes.



First Stage Free Turbine Vane
Antirotation Lug Weld Repair
Figure 627

1. 1.885 - 1.895 Inches
2. 2.025 - 2.035 Inches
3. 0.623 - 0.626 Inch
4. 0.124 - 0.127 Inch
5. 0.070 - 0.080 Inch
6. 0.245 Inch Gage Dimension to Surface H (Reference)
7. 1.030 Inch Gage Dimension (Reference)
8. 25° ± 0° 30′
9. 0.607 - 0.611 Inch
10. 0.230 - 0.240 Inch
11. 25° ± 0° 30′
12. Weld Repair Area (See Text)

Key to Figure 627

(2) Inspect vanes for bow (1st stage) or bend (2nd stage). First stage vanes that exhibit bow of 0.100 inch or more can be difficult to straighten if the bow is abrupt. The vane condition after straightening must be functionally equal to a new vane, with no evidence of collapse of the hollow vane, cracking, or buckling. Cracks may be repaired per Paragraph E. Second stage vanes may be straightened if the bend exceeds reusable limits in Paragraph 4.A. The finished product must be functionally equal to a new vane.

(3) Strip and clean coated vanes.

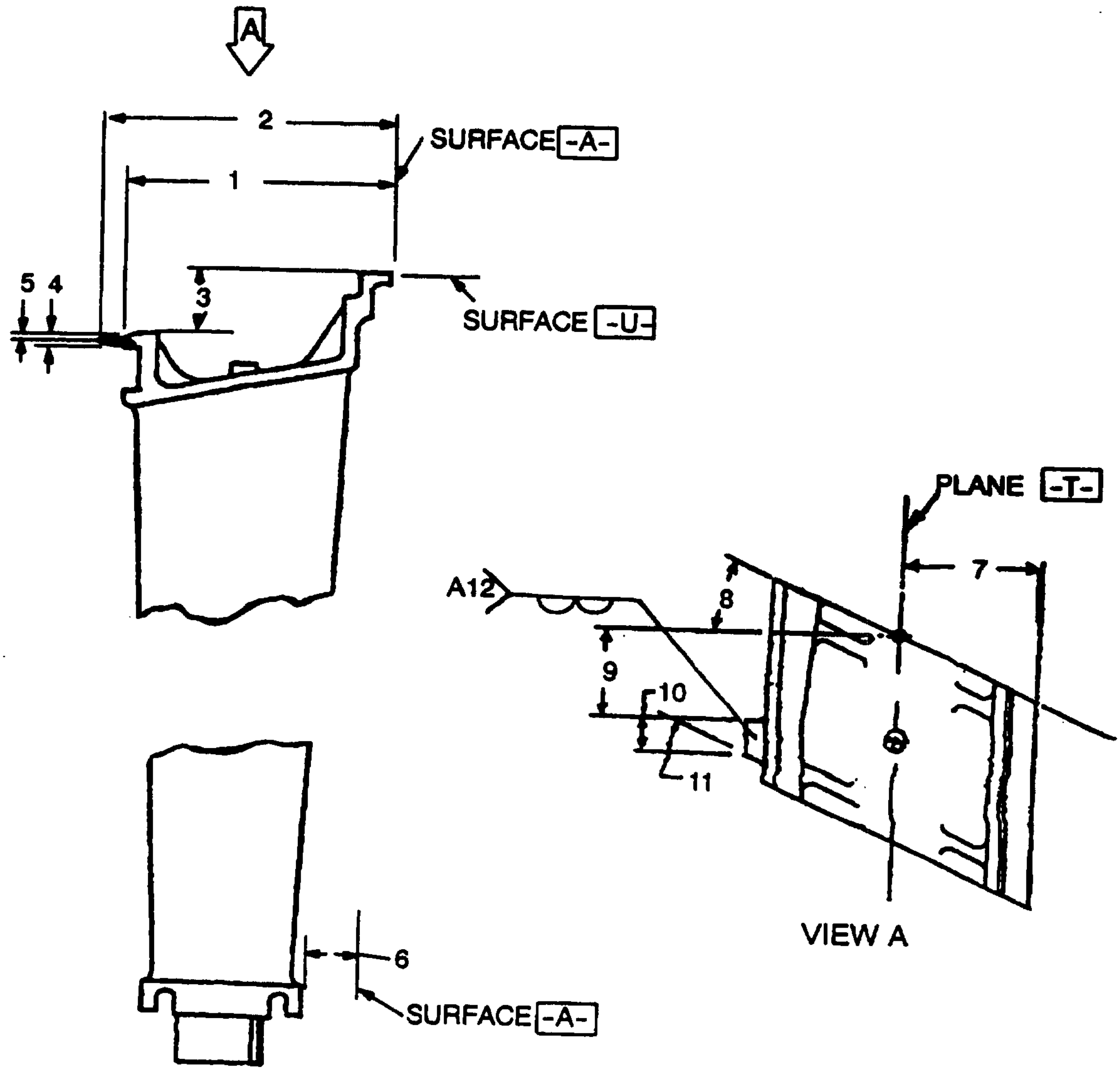
(4) Visually inspect and FPI vanes.

NOTE: Coated vanes with damage or cracks must be repaired prior to straightening or reclassifying.

(5) Before the straightening repair, polish the trailing edge of the vane to remove intergranular oxidation. Use a 10-inch diameter cloth wheel with Seely No. 2316 compound or equivalent, to polish the vane where necessary to get down to the bare, bright natural finish of the vane material.

(6) Find the initial (as-manufactured) class of each vane and keep the vanes in groups by class.

NOTE: Vanes for which no initial as-manufactured class number is available, but which have a class mark from gage classification, can get the straightening repair with the tools applicable to the class for which there is a mark on the vane (the



L-H4612 (0207)

R
R Second Stage Free Turbine Vane
Antirotation Lug Weld Repair
Figure 628

1. 1.840 - 1.850 Inches
2. 1.965 - 1.975 Inches
3. 0.533 - 0.536 Inch
4. 0.119 - 0.122 Inch
5. 0.065 - 0.075 Inch
6. 0.445 Inch Gage Dimension to Surface A (Reference)
7. 1.000 Inch Gage Dimension (Reference)
8. 17° 30′ ± 0° 30′
9. 0.382 - 0.386 Inch
10. 0.245 - 0.250 Inch
11. 17° 30′ ± 0° 30′
12. Weld Repair Area (See Text)

Key to Figure 628

vanes must not have an HF mark). Refer to the paragraph below, Determining Classification of Straightened Vanes.

(7) Straighten vanes with the Vane Straightening Press and safety blocks and heat shields, and the related tools in Table 608.

NOTE: Because of inherent design tolerances in each turbine nozzle vane, you cannot be sure that a vane will go back to its as-manufactured class. Approximately 80 percent of a specified lot of vanes will be in a range one class more or less than the manufactured class. The remaining 20 percent can be in a range two classes more or or two classes less than the initial as-manufactured class. Percentage rules are applicable to vanes of which the initial manufactured class is known. When the initial class number is not known, the spread of classes that is the result can be more than the above estimate.

VANE PN	CLASSES	VANE MATERIAL	RESTRIKE DIE (PWA-)	DIE INSERT (PWA-)	INSERT CLASS	LOCATOR (PWA-)	ADAPTER (PWA-)
419851	5 thru 8	AMS 5385	15669	15672	5	15671	15676
				15673	8	15671	15676

Turbine Vane Straightening
And Classification Tools
Table 608

VANE PN	CLASSES	VANE MATERIAL	RESTRIKE DIE (PWA-)	DIE INSERT (PWA-)	INSERT CLASS	LOCATOR (PWA-)	ADAPTER (PWA-)
370252	3 thru 8	AMS 5382	15595	15598	4	15670	15596
				15599	7	15670	15596
				15597 (Preliminary)			

Turbine Vane Straightening
And Classification Tools
Table 608 (Continued)

J. Vane Handling after Straightening or Reclassifying

(1) Clean vanes and do fluorescent penetrant inspection. Refer to 72-00-00, Inspection, Table 605.

K. Determining Classification of Straightened Vanes
See Figure 631.

(1) Put a mark on each vane to record the work done.

<u>NOTE</u>: Do not remove initial classification marks. These numbers can be necessary for future reference.

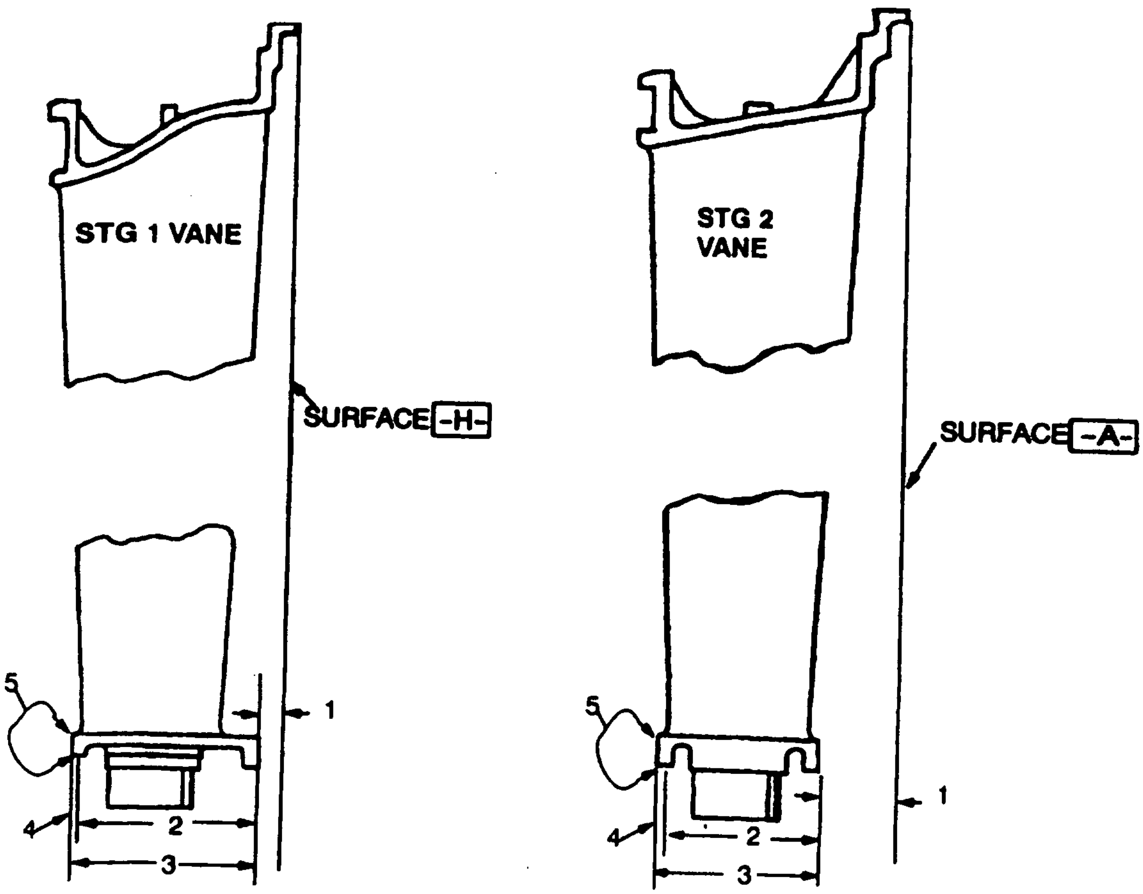
(2) Identify straightened vanes with a triangular symbol or symbols to show the number of times the vane was straightened. Refer to Figure 631 (Example 1).

<u>NOTE</u>: Put identification marks on the vane surface where the initial class mark is found.

(3) Show the class of the vane as follows:

(a) If the initial class number is known and the class of the vane was changed by the straightening repair, put a new class number after the straightening symbol (see Example 2 in the figure).

(b) If the initial class number is not available, put a straightening mark followed by the letters HF and the new class number (see Example 3 in the figure).



First And 2nd Stage Free Turbine Vane
Inner Buttress Front Face
Plasma Coat Repair
Figure 629

72-0004

R 1. First Stage Vane: 0.245 Inch Gage Dimension To Surface H
R (Reference). Second Stage Vane: 0.445 Inch Gage Dimension
R To Surface A (Reference).
2. First Stage Vane: 1.002 Inches Minimum Before Coat. Second Stage Vane: 1.350 Inches Minimum Before Coat.
3. First Stage Vane: 1.117 - 1.123 Inch Finish Dimension After Coat. Second Stage Vane: 1.370 - 1.380 Inch Finish Dimension After Coat.
4. Maximum Surface Roughness 80AA After Finish Machining
5. Repair Area (See Text)

Key to Figure 629

NOTE: The letters HF show that the airfoil contour of the vane was changed with a hot form procedure. Do not try to change the airfoil contour again on vanes with an HF mark. A vane with an HF class mark can get the straightening procedure to the same class only.

(4) Identify straightened vanes that get a new class after the straightening repair with the letters HF and the class number (see Example 4 in the figure).

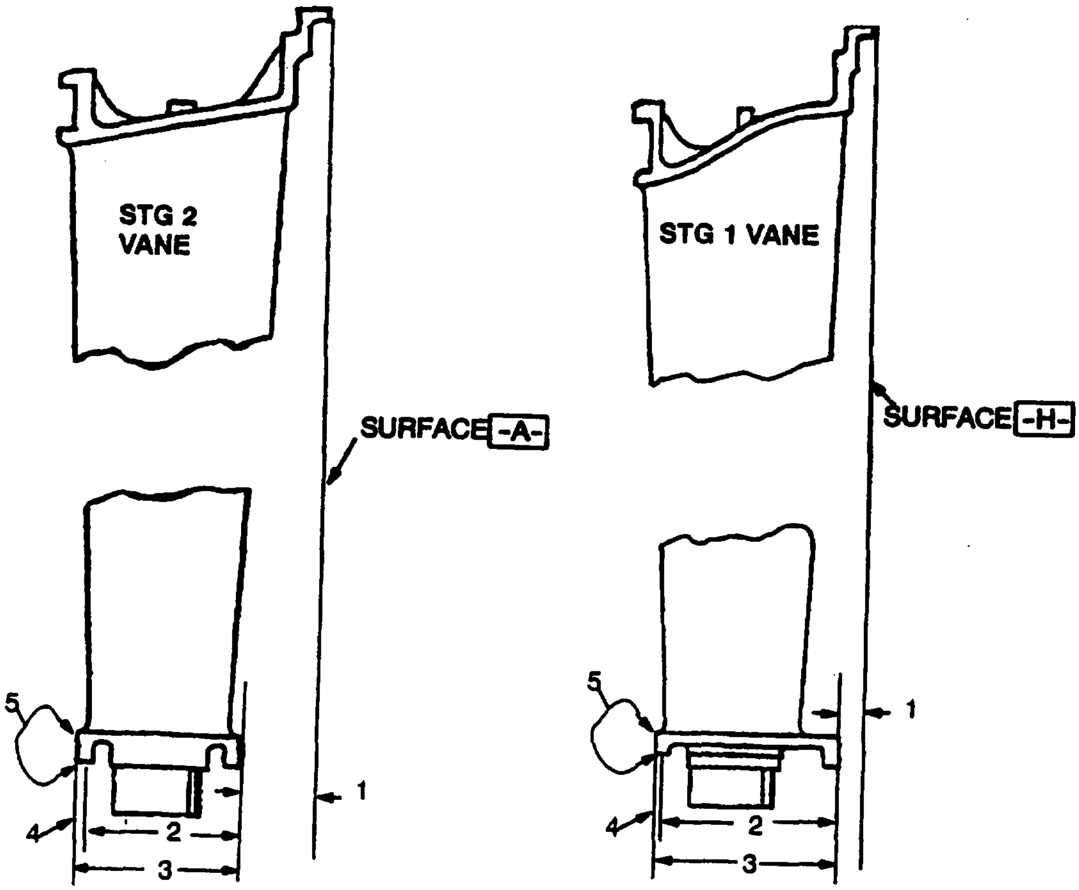
(5) During vane storage use separators to prevent damage to vanes.

L. Classification
(Refer to Tool Group 106)

(1) General

(a) At overhaul, all stages of turbine vanes must be individually classified. A complete set of vanes for each stage must be selected so that the average class for each nozzle assembly is within the average class limits specified in the Table of Limits. An assembly of vanes within the average class limit provides the correct flow area requirements.

(b) Two types of Compair gages are suitable for determining vane classification. First, master calibration and gage usage for limited contact gage (Type I) is described, then similar procedures for the multi-contact gages (Type II) and their appropriate masters is described.



L-H4608 (0207)

R
R

First And 2nd Stage Free Turbine Vane
Inner Buttress Front Face
Plasma Coat Repair
Figure 629

1. First Stage Vane: 0.445 Inch Gage Dimension To Surface A (Reference). Second Stage Vane: 0.245 Inch Gage Dimension To Surface H (Reference).
2. First Stage Vane: 1.002 Inches Minimum Before Coat. Second Stage Vane: 1.350 Inches Minimum Before Coat.
3. First Stage Vane: 1.117 - 1.123 Inch Finish Dimension After Coat. Second Stage Vane: 1.370 - 1.380 Inch Finish Dimension After Coat.
4. Maximum Surface Roughness 80AA After Finish Machining
5. Repair Area (See Text)

Key to Figure 629

NOTE: The letters HF show that the airfoil contour of the vane was changed with a hot form procedure. Do not try to change the airfoil contour again on vanes with an HF mark. A vane with an HF class mark can get the straightening procedure to the same class only.

(4) Identify straightened vanes that get a new class after the straightening repair with the letters HF and the class number (see Example 4 in the figure).

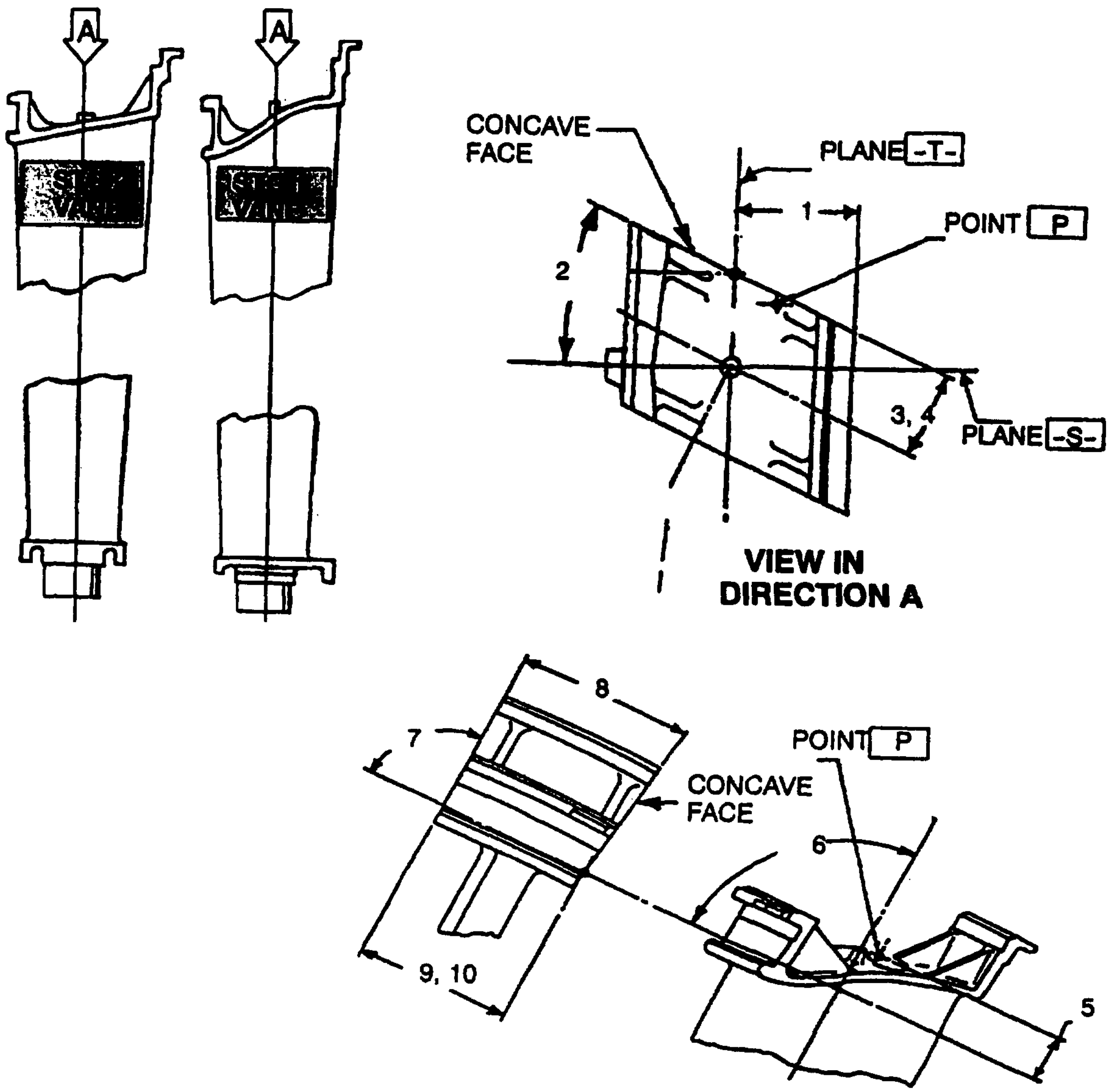
(5) During vane storage use separators to prevent damage to vanes.

L. Classification
(Refer to Tool Group 106)

(1) General

(a) At overhaul, all stages of turbine vanes must be individually classified. A complete set of vanes for each stage must be selected so that the average class for each nozzle assembly is within the average class limits specified in the Table of Limits. An assembly of vanes within the average class limit provides the correct flow area requirements.

(b) Two types of Compair gages are suitable for determining vane classification. First, master calibration and gage usage for limited contact gage (Type I) is described, then similar procedures for the multi-contact gages (Type II) and their appropriate masters is described.



L-H4609 (0207)

R First And 2nd Stage Free Turbine Vane
R Outer Buttress Side Face
Plasma Coat Repair
Figure 630

Stage 1 Free Turbine Vanes

1. 1.030 Inch Gage, Reference.
2. 25° ± 0° 5′
3. 0.640 Inch Minimum Before Plasma Coat
4. 0.660 - 0.670 Inch Finish Dimension After Repair Of Convex Face.
5. 0.383 Inch Gage, Reference To Point P.
6. 88° 27′ ± 0° 5′
7. 90° Reference
8. 6° 30′ ± 0° 10′
9. 1.268 Inch Minimum, Refer to Plasma Coat.
10. 1.296 - 1.298 Inch Finish Dimension After Repair Of Convcave Face.

Stage 2 Free Turbine Vanes

1. 1.005 Inch Gage, Reference.
2. 17° 30′ ± 0° 30′
3. 0.460 Inch Minimum Before Plasma Coat
4. 0.480 - 0.490 Inch Finish Dimension After Repair Of Convex Face.
5. 0.197 Inch Gage, Reference To Point P.
6. 89° 18′ ± 0° 5′
7. 90° Reference
8. 4° 18′ ± 0° 10′
9. 1.943268 Inch Minimum, Refer to Plasma Coat.
10. 0.971 - 0.973 Inch Finish Dimension After Repair Of Convcave Face.

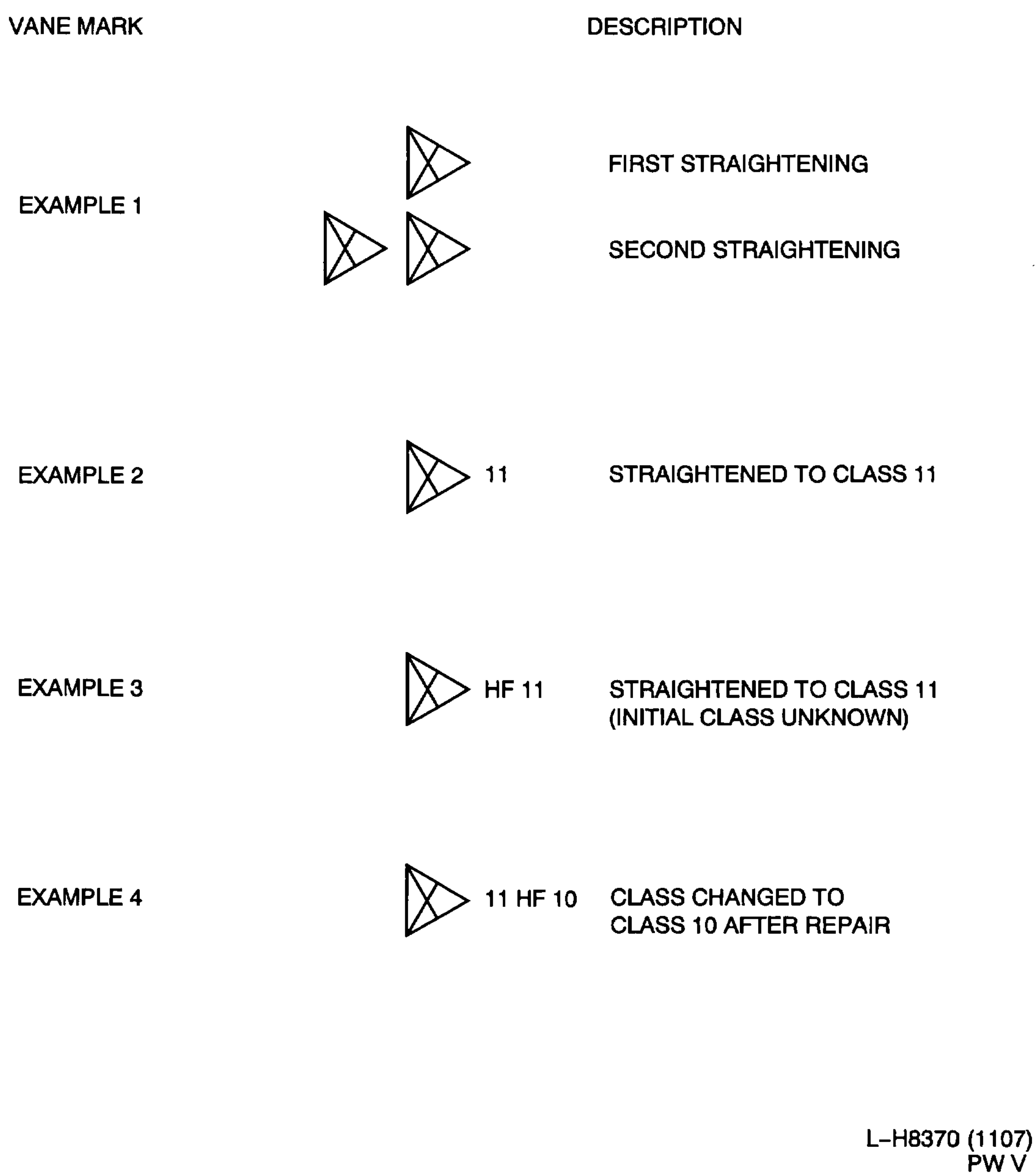
Key to Figure 630

R (2) See Figure 632, and Tools in the Standard Practices Manual for Nozzle Guide Vane Classification Gage - (Compair) Master Calibration Type I (Limited Contact Gage)

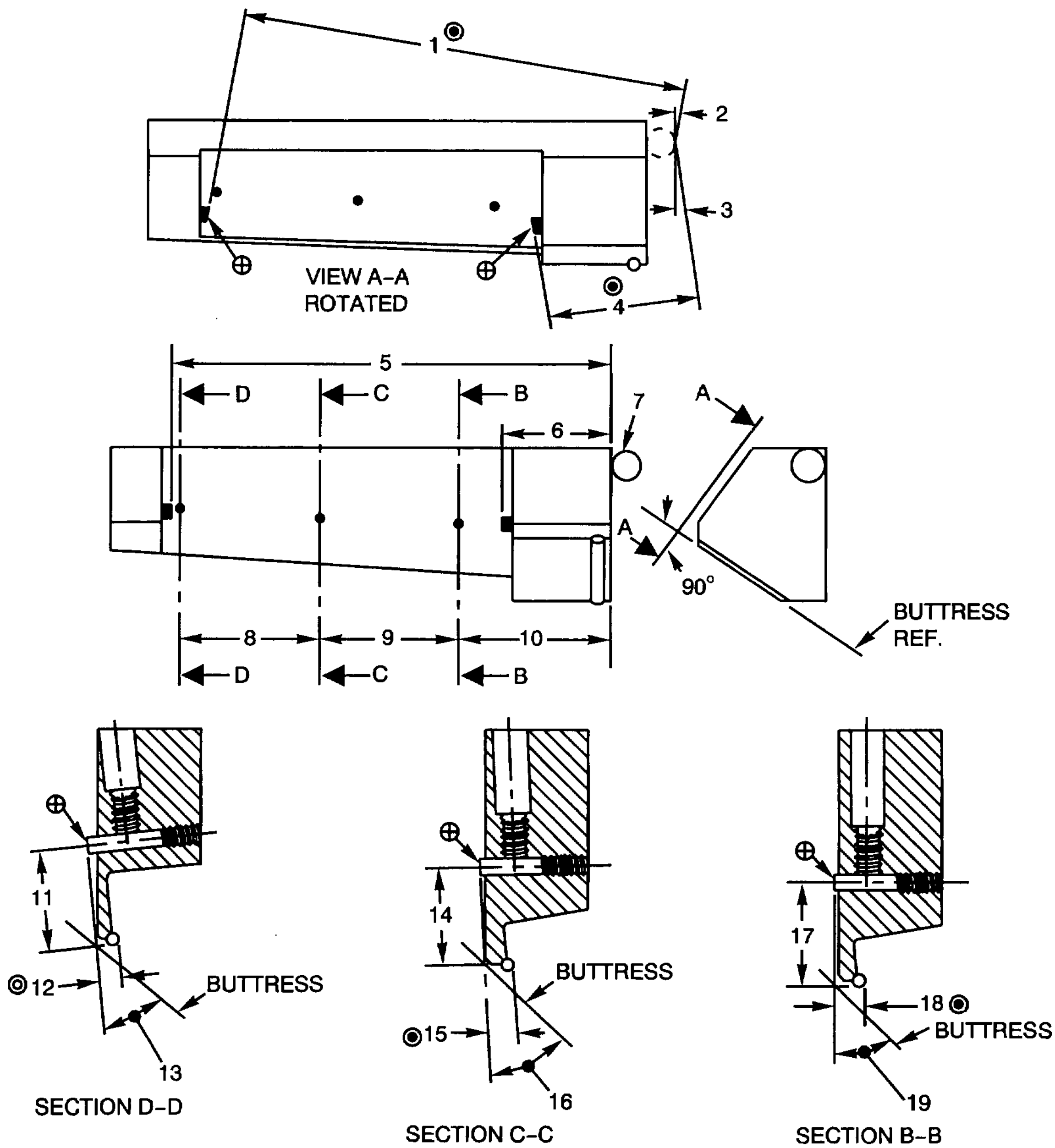
(3) Turbine Vane Classification (Using Type I Limited Contact Gage)

(a) First Stage Vanes

1 Position the master setting block into the 1st stage vane classification gage. While holding the master firmly in place, set the large dial indicator to the red set line. Set the small indicator to zero. Remove the master setting block from the gage.



Turbine Vane Straightening
Repair Marks
Figure 631



FACE RUNOUT OF ⊕ CARBIDE INSERTS SHALL BE WITHIN 0.001 INCH FIR
WHEN HELD ON BASIC ANGLES.
◎ SET AT MEAN OF FACE RUNOUT.
SET GAGE POINTS TO AVERAGE OUT TO A MAXIMUM OF 0.0003 INCH EACH,
WITH ANY ONE TO BE WITHIN 0.002 INCH FROM BASIC.
SPECIFIED BASIC ANGLE TOLERANCE ±0.002 INCH IN 10 INCHES.

L-14876
PW V

Nozzle Guide Vane Classification
Gage Master Setting Dimensions
Figure 632

First Stage
1 - 5. Not Required
6. Set 5400 Inch
7. 0.375 Inch Diameter Grinding Ball
8. 0.980 Inch Reference
9. 0.980 Inch Reference
10. 0.702 Inch Reference
11. 0.5445 Inch Reference
12. Set 0.0600 Inch
13. 35° 37′ 34″
14. Set 0.6137 Inch Reference
15. Set 0.0820 Inch
16. 37° 45′ 29″
17. 0.6819 Inch Reference
18. Set 0.1006 Inch
19. 39° 24′ 36″

Second Stage
1. 3.8580 Inch
2. 9° 3′
3. 13°
4. Set 1.0965 Inches
5 - 6. Not Required
7. 0.375 Inch Diameter Grinding Ball
8. 1.232 Inch Reference
9. 1.232 Inch Reference
10. 0.893 Inch Reference
11. 0.2700 Inch Reference
12. Set 0.0525 Inch
13. 45° 39′ 14″
14. 0.3086 Inch Reference
15. Set 0.0636 Inch
16. 48° 50′ 58″
17. 0.3485 Inch Reference
18. Set 0.0719 Inch
19. 50° 49′ 8″

R Key to Figure 632

2 Place the trailing edge of the vane, concave side down, into the gage. Pick up the HM lever of the gage. Exert slight pressure to the left to push the vane in over the carbide ball. See
R Figure 633.

3 While holding the vane at the center of its leading edge, roll the vane upward against the roller stop on the gage. While holding the vane firmly against the roller stop, position the vane firmly against the back stop and the carbide rod at the left of the gage.

NOTE: Position the vane firmly in the gage, but do not shock the dial indicators.

4 Read the vane class number on the large dial indicator.

5 Compare the class number, determined in step (4) with the class number marked on the vane. If the class numbers do not correspond, then strike out the class number on the vane, and mark the vane with the new classification number.

NOTE: Use the vibration peening method of marking to strike out the old number and mark a new class on the vane.

6 Use steps 2 thru 4 to classify all the 1st stage vanes.

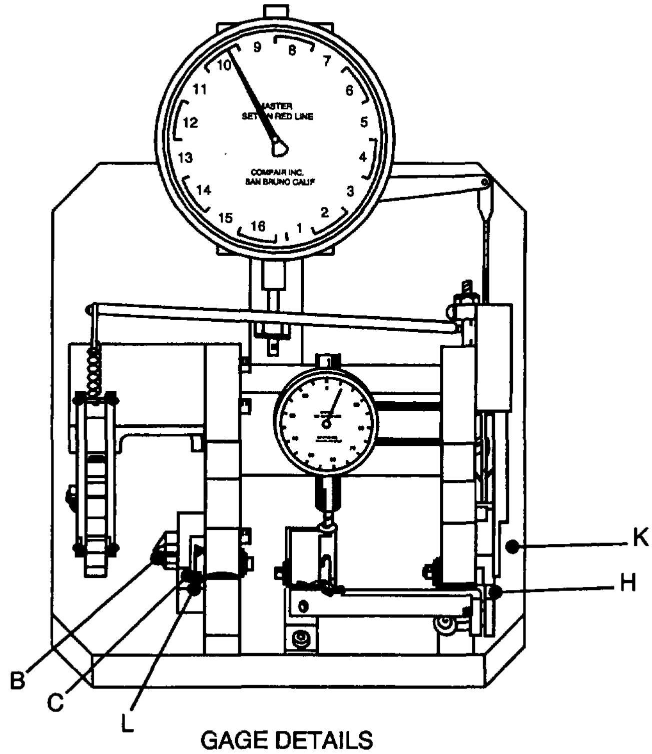
NOTE: Periodically, repeat step 1 as often as necessary to ensure correct gage readings. If dial indicator settings are disturbed, then repeat step 1.

(b) Second Stage Vanes

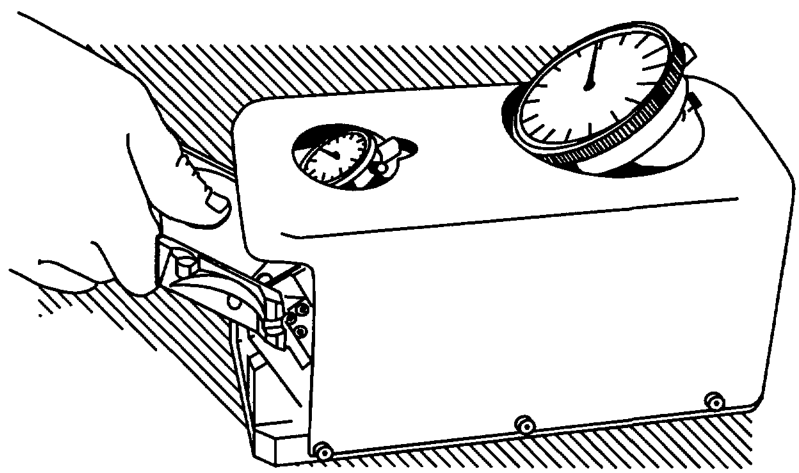
1 Use the 2nd stage turbine nozzle guide vane classification gage.

2 Refer to (a) 1st Stage Vanes to use the master setting block to set each dial indicator of the gage.

3 Refer to (a) 1st Stage Vanes to classify and mark all 2nd stage vanes.



GAGE DETAILS



GAGING GUIDE VANE

L-09606
PW V

Turbine Vane Classification
Figure 633

Gaging Procedure

1. Place The Trailing Edge Of The Vane, Concave Side Down, Into The Gage. Pick Up HM Lever K; Then, Exert Slight Pressure To The Left To Push The Vane In Over The Carbide Ball B.
2. Roll The Vane Upward Holding The Vane At The Center Of The Leading Edge Against Roller Stop C.
3. Hold The Vane Firmly Against Back Stop L, Carbide Rod H And Roller Contact C.

NOTE: Place vanes in the gage firmly, but do not shock the dial indicators.

4. The Large Indicator Gage Displays The Class Number Of The Vane.
5. The Small Gage Displays The Amount Of The Vane Bow.

R Key to Figure 633

R (4) Refer to Tool Group 108, Table 609, Figure 634 and
R Figure 635 for Turbine Vane Classification Gage Master Calibration - Type II (For Multi-Contact Gage).

Use the following procedure to calibrate Type II masters. It is recommended that each operator maintain 2 masters, 1 for gage calibration before and during use, and 1 as a master checking device.

(a) Equipment Required:

1 Precision surface plate approximately 2 feet square (minimum) with an accuracy of 0.0001 inch

2 Dial test indicator (graduated in tenths of an inch)

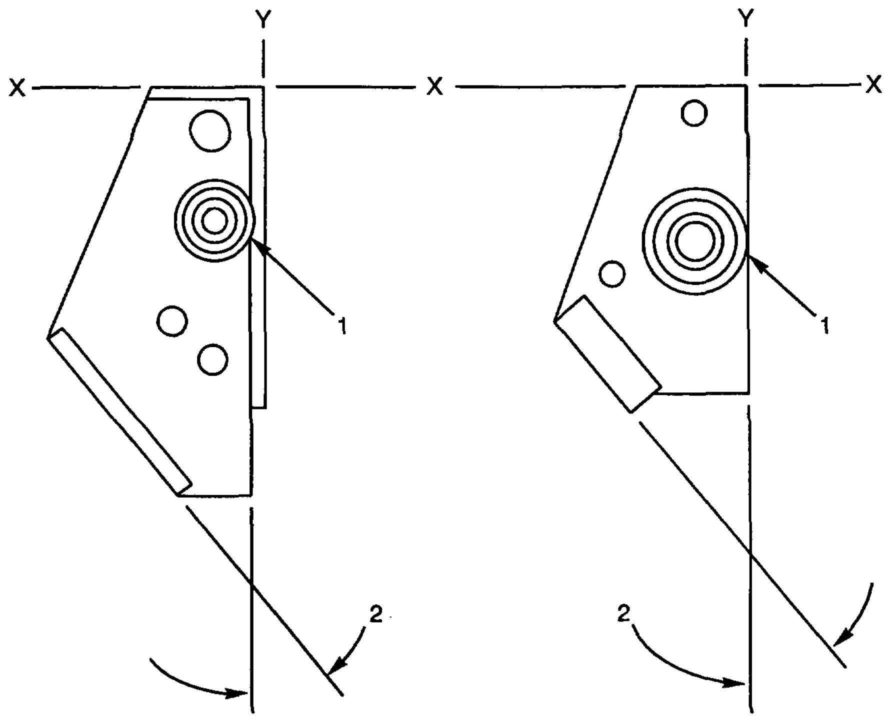
3 Set of gage blocks

4 Surface gage

5 Sine plate (5 inches minimum)

(b) Calibration Procedure:

1 Position the sine plate on the surface plate. Use the dial indicator check parallelism between the surface plate and sine plate with the sine plate in the collapsed position.



L-22907
PW V

1. Cap Screw(s)
2. Buttress Angle

Turbine Vane Classification Gage
(Type II) Masters
Typical End Views For Buttress
Angle Settings
Figure 634

2 Place the master on the sine plate with Plane Y down so that Plane X is true with the sine plate hinge. Adjust the sine plate to the correct buttress angle.

NOTE: Obtain the buttress angle by corresponding the angle code marked on the master to the applicable angle in
R Table 609.

BUTTRESS ANGLE CODES	BUTTRESS ANGLES 1ST STAGE TURBINE	1ST STAGE TURBINE	2ND STAGE TURBINE	1ST STAGE FREE TURBINE	2ND STAGE FREE TURBINE
	JT12A-6,-6A JFTD12A-1, -4A	JT12A-8N, -8L	ALL MODELS	JFTD12A-1, -4A	JFTD12A-1, -4A
A	39°16'36"	32°20'9"	50°41'8"	42°0'32"	51°54'6"
B	39°17'36"	32°21'9"	50°42'8"	42°1'32"	51°55'6"
C	39°18'36"	32°22'9"	50°43'8"	42°2'32"	51°56'6"
D	39°19'36"	32°23'9"	50°44'8"	42°3'32"	51°57'6"
E	39°20'36"	32°24'9"	50°45'8"	42°4'32"	51°58'6"
F	39°21'36"	32°25'9"	50°46'8"	42°5'32"	51°59'6"
G	39°22'36"	32°26'9"	50°47'8"	42°6'32"	52°0'6"
H	39°23'36"	32°27'9"	50°48'8"	42°7'32"	52°1'6"
I	39°24'36"	32°28'9"	50°49'8"	42°8'32"	52°2'6"
J	39°25'36"	32°29'9"	50°50'8"	42°9'32"	52°3'6"
K	39°26'36"	32°30'9"	50°51'8"	42°10'32"	52°4'6"
L	39°27'36"	32°31'9"	50°52'8"	42°11'32"	52°5'6"
M	39°28'36"	32°32'9"	50°53'8"	42°12'32"	52°6'6"
N	39°29'36"	32°33'9"	50°54'8"	42°13'32"	52°7'6"
O	39°30'36"	32°34'9"	50°55'8"	42°14'32"	52°8'6"
P	39°31'36"	32°35'9"	50°56'8"	42°15'32"	52°9'6"
Q	39°32'36"	32°36'9"	50°57'8"	42°16'32"	52°10'6"
R	39°33'36"	32°37'9"	50°58'8"	42°17'32"	52°11'6"

Turbine Vane Classification Gage
Master Calibration
R Table 609

(c) Use the dial indicator and surface gage, shown in
R Figure 635, to check the carbide gage contact surface on the master buttress to ensure that the carbide surface is parallel within 0.0002 inch FIR to the surface plate.

(d) If buttress angle adjustments are necessary, then loosen the cap screws and adjust the set-screws to alter the angle. Once the carbide surface is within limits, tighten the cap screws and recheck the carbide surface for parallelism to the surface plate.

(5) Turbine and Free Turbine Vane Classification
(Using Multi-Contact Gage, Type II)
(Refer to Tool Group 107)

(a) Prior to vane classification, perform the following steps to calibrate the multi-contact gage:

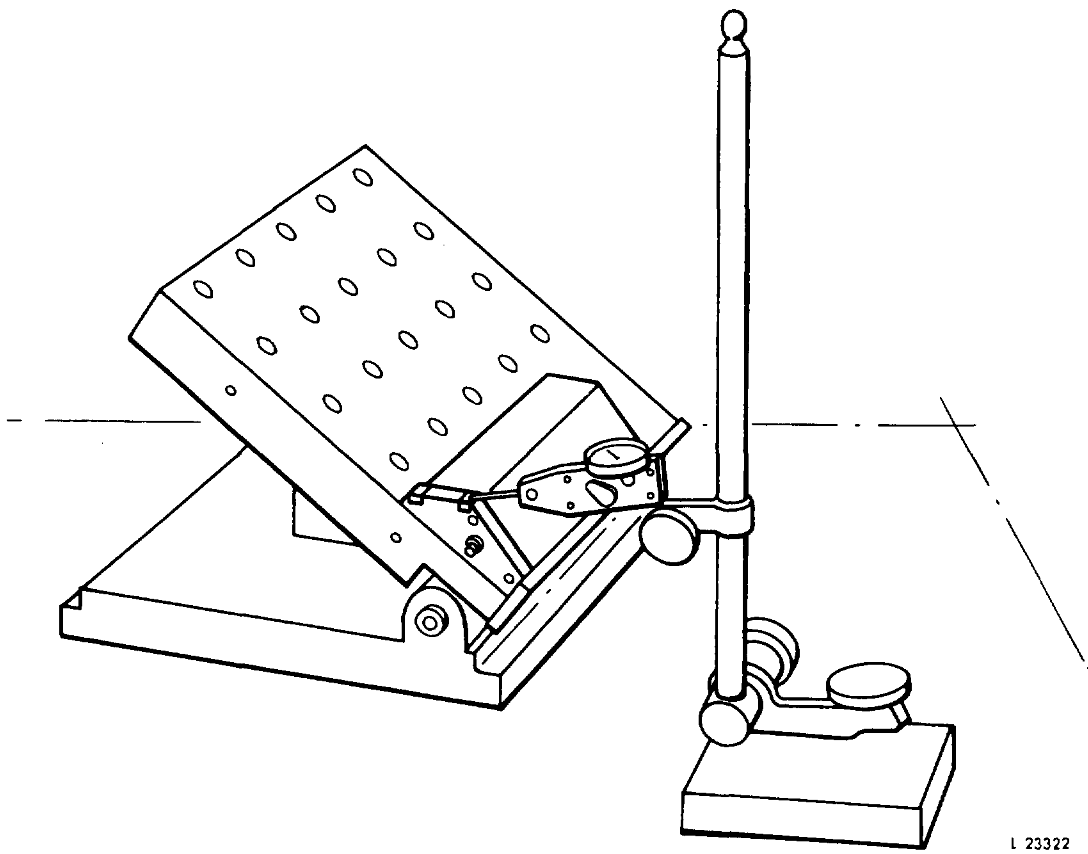
1 Install the master (tool number up) in the gage. The carbide strip on the bottom of the master must rest on the gage stops so that the strip surface facing the operator has uniform contact with the row of trailing edge probes. Ensure that the master is positioned to the extreme left against the stop.

NOTE: When installing masters that have 2 end blocks (buttresses), ensure that both hinged gage probes (designed to measure the dimension between end blocks) are contacting the inner surfaces of the end blocks.

2 Position the weight on the master with the handle away from the operator. Ensure that weights without the pin feature are centered on the master.

3 Adjust the red set line to coincide with the indicated reading. Remove the weight and master.

(b) Classify vanes as follows:



Classification Gage (Type II)
Master Calibration
Figure 635

1 Position the vane in the gage with the trailing edge down and the concave side of the airfoil pointing toward the operator. With the vane positioned to the extreme left and the trailing edge resting on the stops, ensure that the concave side of the trailing edge uniformly contacts the trailing edge probes. Hinged probes, which are designed to measure airfoil length, should contact the inner surfaces of both buttresses.

2 Position the weight on the vane so that the slot in the weight accepts the vane leading edge, with the handle away from the operator and the weight centered on the vane.

3 If the indicated classification differs from the recorded class on the turbine vane, then strike out the old record and record the new class by using vibration peening.

(6) Selection of Vanes to Meet Nozzle Flow Area Requirements

(a) The numerical class average of vanes for each nozzle assembly must conform to the values specified in the Table of Limits. The following example illustrates computing the numerical class average of a 1st stage complete assembly.

Example:

Select 58 vanes (total number of vanes in the assembly) to obtain a numerical class average of 6.69 - 6.72.

5 Class No. 4 Vanes	5 x 4 = 20
5 Class No. 5 Vanes	5 x 5 = 25
10 Class No. 6 Vanes	10 x 6 = 60
20 Class No. 7 Vanes	20 x 7 = 140
18 Class No. 8 Vanes	18 x 8 = 144

Add the total No. of Vanes = 58
Add the total Numerical Class = 389

Divide 389/58 = 6.70 Class Average

6.70 is within the 6.69 - 6.72 limit, therefore, the assembly will provide the correct flow area requirement.

(b) When the average is too high, substitute a sufficient number of vanes of a lower classification to bring the average within limits.

(c) When the average is too low, substitute a sufficient number of vanes of a higher classification to bring the average within limits.

R (d) Table 610 and Table 611 indicate the maximum usability of various vane classes in 1st and 2nd stage nozzles. Enter the chart horizontally from a specific class to find the maximum number of the class to use. Read the vertical column to determine the additional vane classes required to bring the nozzle within specified limits.

Example:

In the 1st stage nozzle, a maximum of 37 Class No. 8 vanes can be used within:

16 Class No. 4 vanes
1 Class No. 5 vane
4 Class No. 6 vanes

1ST STAGE

CLASS				
3	2			
4		16		
5	4	1	31	
6	1	4		45
7	51		4	1
8		37	1	4
9			22	
10				8

2ND STAGE

CLASS								
2	22				17			
3		46				41		
4	4		70		4		65	
5		4		96		4		89
6	70		4		75		4	
7		46				51		4
8			22				27	
9								3

First And 2nd Stage Turbine Vane
Utilization Chart
R Table 610

1ST STAGE VANES

CLASS				
3	7			
4	1	20		
5	4	3	36	
6		4	1	51
7	46		4	
8		31		4
9			17	1
10				2

First Stage Turbine Vane
Utilization Chart (JT12A-8 Only)
R Table 611

(e) A maximum of 5 consecutive classes can be used in 1 nozzle assembly when more than 1 classification of vane is used in a single assembly, provided the spread between adjacent vanes is not more than 3 classes. Vanes in the same class must be distributed as equally as possible around the nozzle assembly.

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-04

1. Engine Turbine Section - Turbine Case And Stators

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Turbine Vane Inner Shroud Assembly - 1st Stage

A. Blend Limits
See Figure 601 and Figure 602.

(1) Inspect shroud for wear and erosion. Blend within limits given.

(2) Check shroud guide for cracks and broken pieces. Cracks or pieces missing from outer half of rolled portion of guide are acceptable, after blending, if within limits shown. Edges of damaged area are to be blended using a ratio of 4 to 1.

B. Weld-repair of Vane Slot

(1) Weld slot wall using AMS 5786 filler rod. To minimize local overheating, weld repair on slot at a time per 120 degree arc.

(2) Stress-relieve by Cycle No. 4A.

(3) Machine slots to original contour using a new vane as a template. With vane installed against leading edge of slot, total side and rear clearance should be 0.005 - 0.015 inch. Use of automatically controlled contour machine is preferred.

(4) Fluorescent penetrant inspect per SPOP 62 to ensure satisfactory repair.

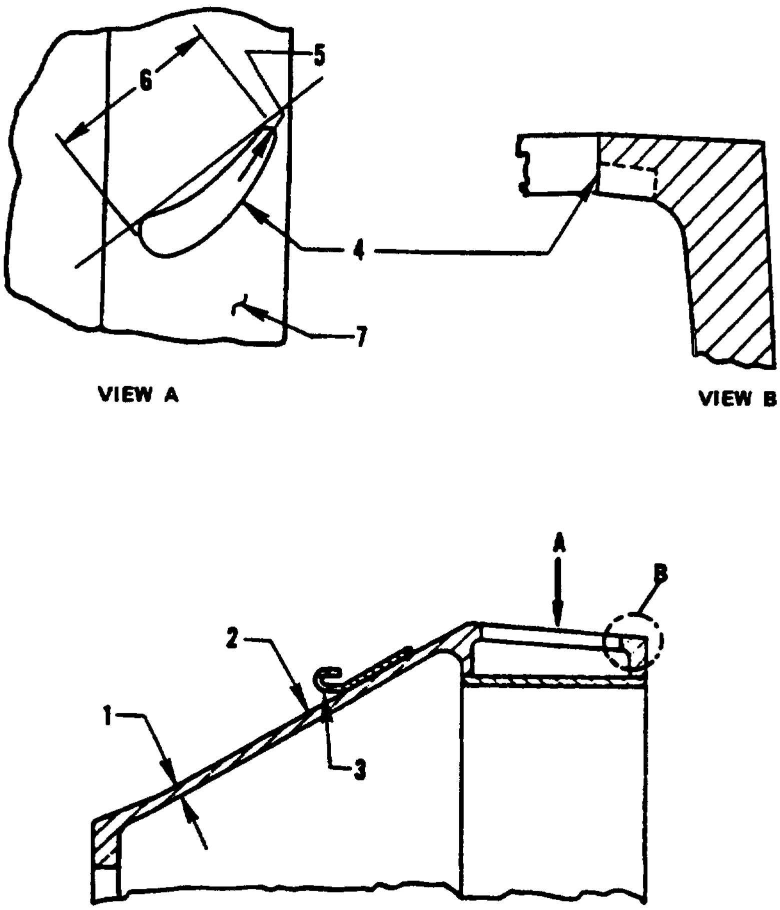
(5) Apply antigalling compound to slot wall.

C. Surface Treatment of Vane Slot

(1) Wet abrasive blast slots by SPOP 9A.

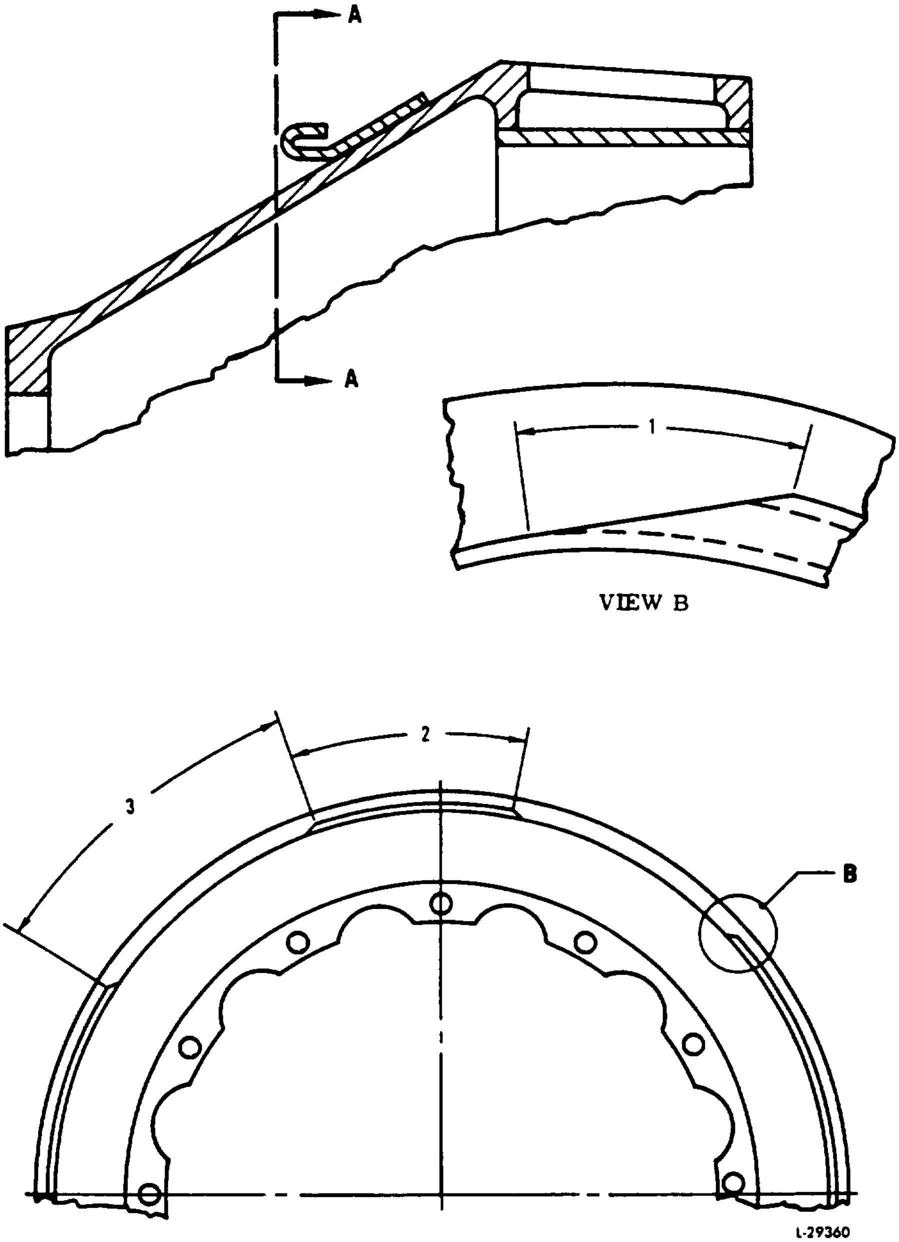
(2) Apply antiseize-antigalling compound by SPOP 146 all around slots.

D. Vane Inner Shroud Section Replacement Repair



1. 0.038 Inch Minimum Wall Thickness; Wear Up To 0.005 Inch Below This Dimension Acceptable Without Repair.
2. Local Wear Up To 0.015 Inch Deep Acceptable Without Repair.
3. Local Wear Up To 0.004 Inch Acceptable Without Repair. Cracked Guide Is To Be Blended Within Limits Shown In Referenced Figure.
4. No Step Wear Permitted.
5. Maximum Trailing Edge Radius 0.092 Inch Acceptable Without Repair.
6. Maximum Allowable Slot Wear 0.030 Inch Acceptable Without Repair.
7. Minor Erosion Of Outer Diameter Between Vane Slots May Be Blend-Repaired Using A Blend Ratio Of Not Less Than 5 To 1 Provided Wall Thickness Is Not Reduced Below 0.070 Inch.

First Stage Turbine Vane
Inner Shroud Blend
Limits/Repair
Figure 601



SECTION A-A

1. Minimum Blend Distance: 0.320 - 0.360 Inch
2. Minimum Separation Of Damaged Areas: 3 Inches Of Sound Material
3. Maximum Length Of Damaged Area: 4 Inches, Three Places Maximum

First Stage Turbine Vane
Inner Shroud - Blend Repair
Of Cracked Guide
Figure 602

(1) Damage to vane slots and/or between slots which exceed established repair limits above can be repaired as follows:

NOTE: Only six repair segments are permitted on an assembly.

(2) Cut out the damaged area as shown in Figure 603. The removed segment can contain no more than three vane slots as shown.

(3) If the damage is adjacent to a previously repaired area, cut out must include the adjacent weld. See Figure 603, Index 3.

NOTE: Fabricate a replacement segment (free of any defects) with one from a previously condemned inner shroud assembly which is beyond economical repair.

(4) Weld the replacement segment in place as shown in figure.

(5) Stress-relieve the entire shroud assembly cycle No. 15A within 24 hours of repair.

(6) Make an inspection for cracks with fluorescent penetrant inspect. No cracks are permitted.

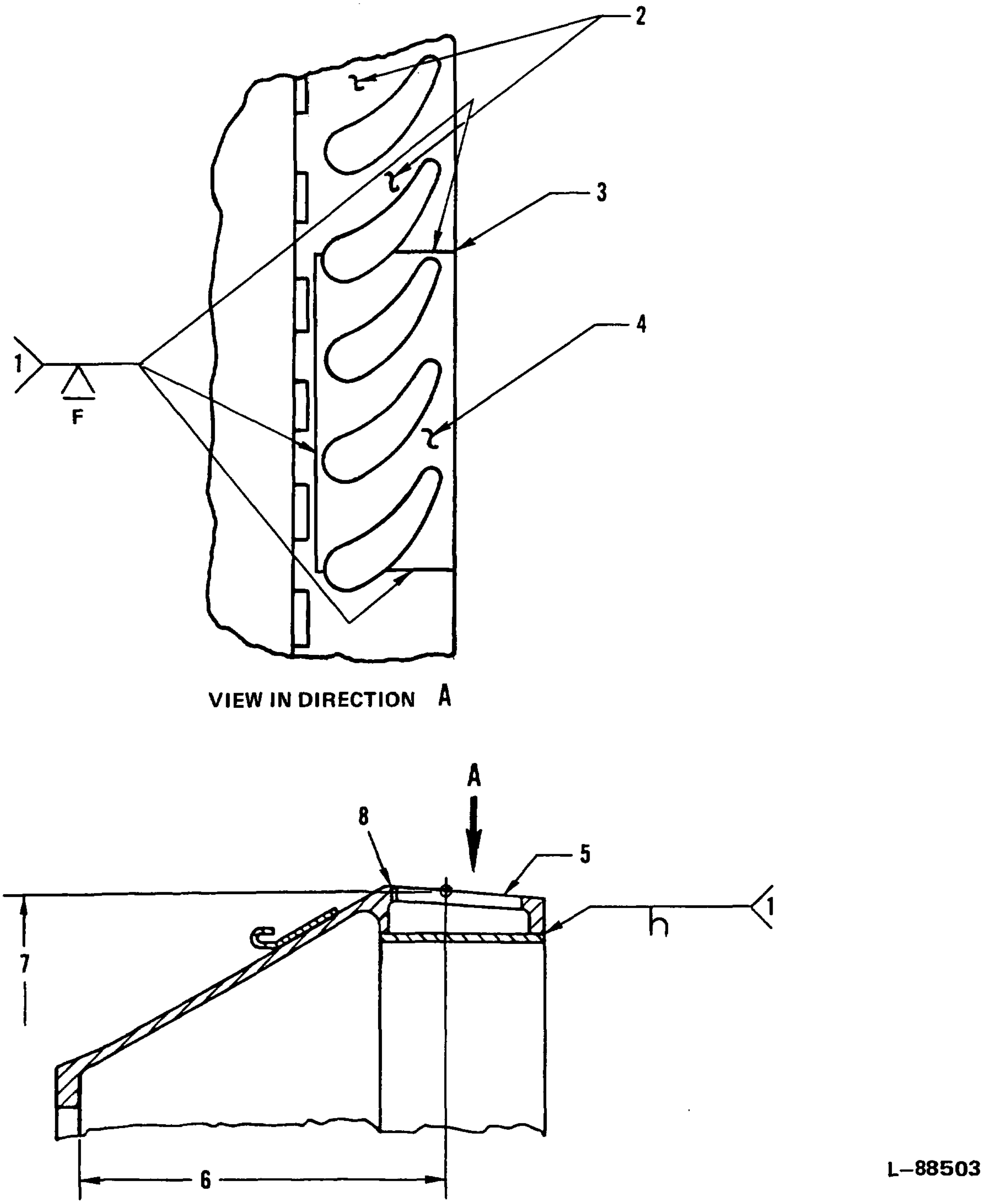
(7) Make an inspection of the flowpath diameter. See Figure 603, Index 7.

3. Second Stage Turbine Stator

A. Airsealing Ring Inspection

(1) Raised metal caused by contact with knife-edges of outer airseal must be blended. For a cumulative arc of 120 degrees, grooves are permitted to a depth of 0.012 inch provided that the wall thickness is not reduced below 0.035 inch. For the remainder of the circumference, grooves are permitted to a depth of 0.010 inch provided that the wall thickness is not reduced below 0.040 inch.

NOTE: Wall thickness must be measured from the bottom of grooves to the OD of the ring.



R
R

First Stage Turbine Vane Inner
Shroud Section Replacement
Figure 603

1. Weld By PWA 16-22 As Shown
2. Damage Adjacent To Previous Repair
3. Adjacent Weld
4. Typical Segment For Replacement: Not To Include More Than Three Vane Slots As Shown.
5. Wall Thickness: 0.070 Inch Minimum
6. 3.177 Inch Gage
7. 11.720 ± 0.005 Inch Diameter
8. Vertical Section Cut Forward To Leading Edge Of Vane Slots

Key to Figure 603

(2) Check security of ring and integrity of riveted bushings.

B. Stator Shroud Inspection

(1) Inspect flange rear face for wear. Flange worn less than 0.005 inch is acceptable without repair. Flange worn more than 0.005 inch may be repaired by plasma coat if thickness of parent metal exceeds 0.060 inch.

(2) Inspect slot width for wear. Shroud with slots worn to 0.105 inch width is acceptable without repair.

C. Second Stage Stator Shroud Plasma Coat Repair
See Figure 604 and Figure 605.

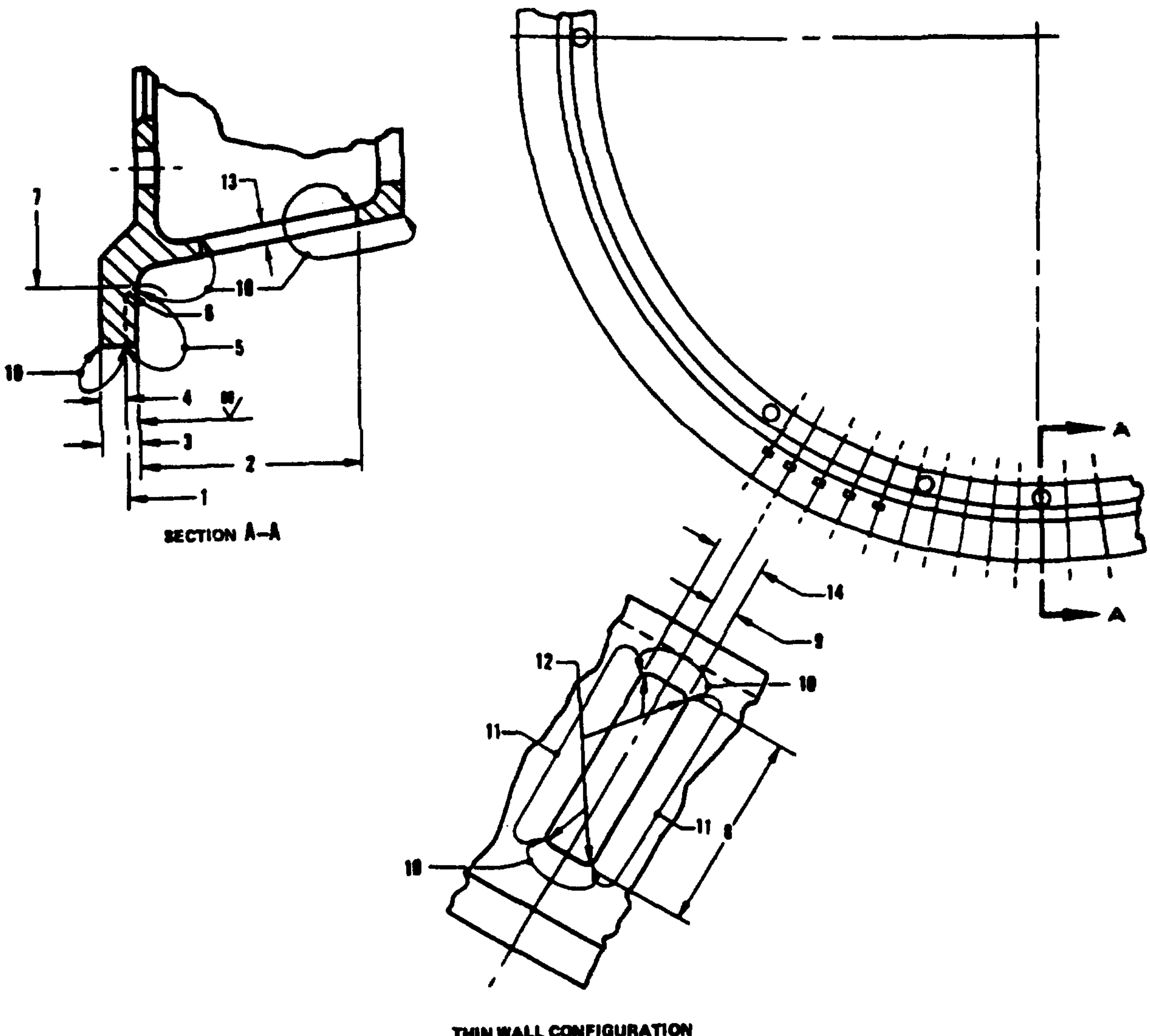
(1) Remove airsealing ring.

(2) Machine flange rear face 0.002 - 0.004 inch for distance shown to remove wear indications, contamination and old coating.

NOTE: Additional machining permitted provided minimum wall thickness requirement is not violated.

(3) For thin-wall configurations. As required, machine slots to remove wear indications and old coating.

R (4) Prepare the repair area for plasma coat by SPOP 170.
R Refer to Section 70-46-01 in the Standard Practices
R Manual.



L-65343 (0000)

R
R

Plasma Coat Repair Of 2nd Stage
Turbine Stator Shroud
Figure 604

1. Reference Surface, Prior To Hardfacing
2. 0.565 - 0.575 Inch
3. 0.080 - 0.090 Inch
4. 0.060 Inch Minimum Wall Thickness
5. Plasma Coat Area (See Text)
6. 0.030 - 0.050 Inch Radius
7. 10.600 - 10.640 Inch Diameter
8. 0.425 - 0.435 Inch
9. 0.044 Inch
10. Plasma Coat Optional In This Area
11. Plasma Coat Sides Of Slots For Distance Shown, 0.003 - 0.006 Inch Thickness
12. 0.005 - 0.020 Inch Radius
13. 0.050 - 0.060 Inch
14. 0.085 - 0.095 Inch After Plasma Coat

NOTE: Ninety Six slots must be equally spaced and located 0° 2′ of true angular position maximum. Slots must be parallel to their respective axial planes within 0° 15′. Sides of slots must be parallel to radial plane 0.004 inch maximum.

Key to Figure 604

R CAUTION: SLOT AREA OF THICK-WALL CONFIGURATIONS MUST
R NOT GET PLASMA COAT. FAILURE TO COMPLY WITH
R THE ABOVE MAY RESULT IN EXCESSIVE WEAR OF
R MATING NON-COATED VANE TANG.

R (5) Apply plasma coat to the shroud by PWA 53-18. Refer to the Standard Practices Manual, Section 70-46-01.

(6) As required, machine the plasma coat and make sure that the surface finish is in limits.

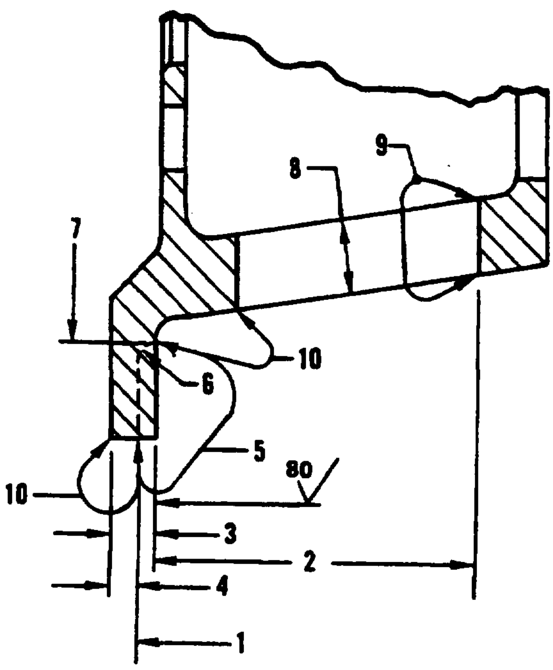
(7) Replace airsealing ring.

D. Weld Build-up Of 2nd Stage Turbine Stator Shroud Slots See Figure 606.

(1) Remove airsealing ring.

(2) Machine slots to remove wear indications and any old surface coating.

(3) Fusion weld build-up slot using AMS 5786 weld rod. See Standard Practices Manual, Section 70-42-01.



L-65344 (0000)

Plasma Coat Repair Of 2nd Stage
Turbine Stator Shroud Flange
Figure 605

1. Reference Surface (Before Plasma Coat)
2. 0.565 - 0.575 Inch
3. 0.080 - 0.090
4. 0.060 Inch Minimum Wall Thickness
5. Plasma Coat Area (See Text)
6. 0.030 - 0.050 Inch Radius
7. 10.600 - 10.640 Inch Diameter
8. 0.110 - 0.120 Inch
9. Treat By PWA 586-3 All Around Slots
10. Overspray Permissible

Key to Figure 605

(4) Stress-relieve by SPOP 458-2 (Cycle 4A). See Standard Practices Manual, Section 70-42-04.

(5) Finish machine slots as shown.

(6) Fluorescent penetrant inspect shroud and check for cracks. See Standard Practices Manual, Section 70-33-00.

(7) Treat slots as specified.

(8) Replace airsealing ring.

E. Airsealing Ring-Replacement Of
See Figure 607.

(9) Remove rivets and bushings securing airsealing ring to shroud.

(10) Remove ring.

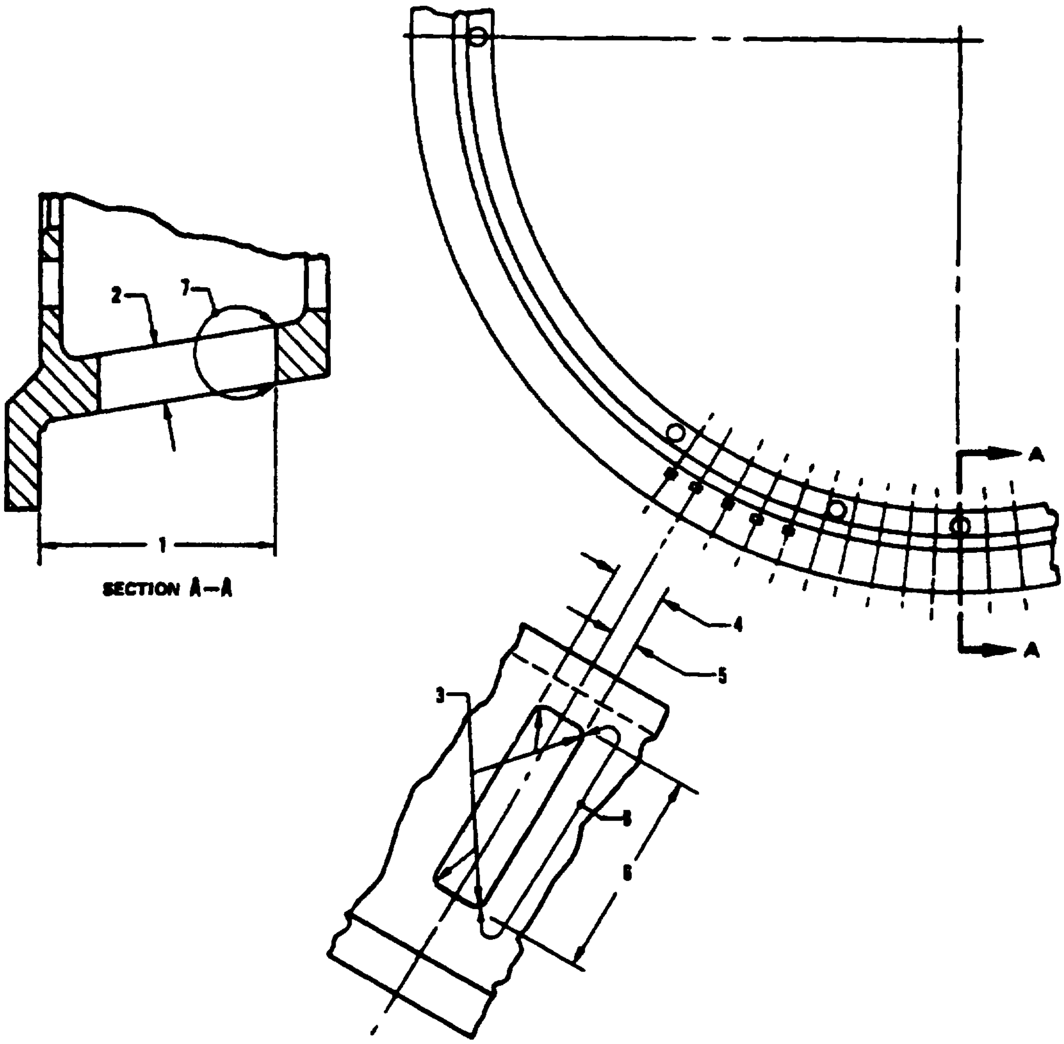
(11) Position new airsealing ring on shroud and rivet as shown.

(12) Machine ring ID as shown.

4. Turbine Case Inner Seal

A. Inspection

(1) No circumferential cracking is allowed.



L-65345 (0000)

R
R

Weld Build-Up Of 2nd Stage
Turbine Stator Shroud Slots
Figure 606

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-04

1. 0.565 - 0.575 Inch
2. Thick-Wall Configuration: 0.110 - 0.120 Inch
   Thin-Wall Configuration: 0.050 - 0.060 Inch
3. 0.005 - 0.020 Inch Radius
4. 0.085 - 0.095 Inch Finish Dimension
5. 0.044 Inch
6. 0.425 - 0.435 Inch Finish Dimension
7. For Thick-wall Configuration Only: Treat By PWA 586-3, All Around Slots
8. For Thin-Wall Configuration Only: Allow For Plasma Coat Of Slot Sides, Each Side.

NOTE: 96 slots must be equally spaced and located within 0° 2′ of true angular position. Slots must be parallel to their respective axial planes within 0° 15′. Sides of slots must be parallel to radial plane 0.004 inch maximum.

Key to Figure 606

(2) Only one radial crack emanating from vane retaining pin hole and extending inward is allowed and only if crack is situated in center section of seal.

NOTE: Since each of four seals covers 90 degrees of turbine case inner flange, center section of each seal is defined as middle 30 degrees of the seal.

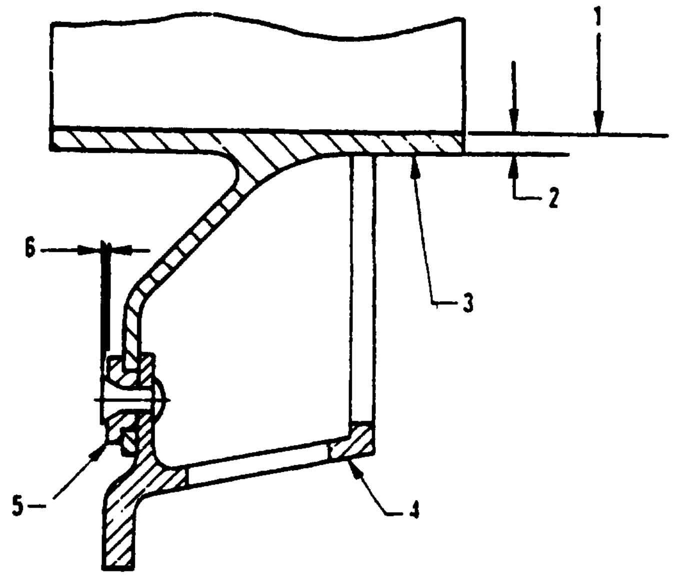
B. Replacement: Damaged inner seals exceeding inspection requirements shall be removed and replaced with new seals as follows:

R CAUTION: DURING RIVET REMOVAL BE CAREFUL NOT TO MAKE
R THE RIVET HOLES LARGER. IF A RIVET HOLE IS
R MADE LARGER OR OVAL DURING RIVET REMOVAL, IT
R IS PERMITTED TO INSTALL A NEW RIVET, BUT THE
R HOLE DIAMETER MUST NOT BE MORE THAN 0.105 INCH
R FOR A MAXIMUM OF 50 PERCENT OF THE HOLE DEPTH,
R AND A LONGER RIVET WILL BE NECESSARY AS SHOWN
R IN THE FIGURE.

(1) Remove retaining rivets, spacers, and damaged seal(s) from case.

(2) Mark locations of six spacers for reinstallation at same locations.

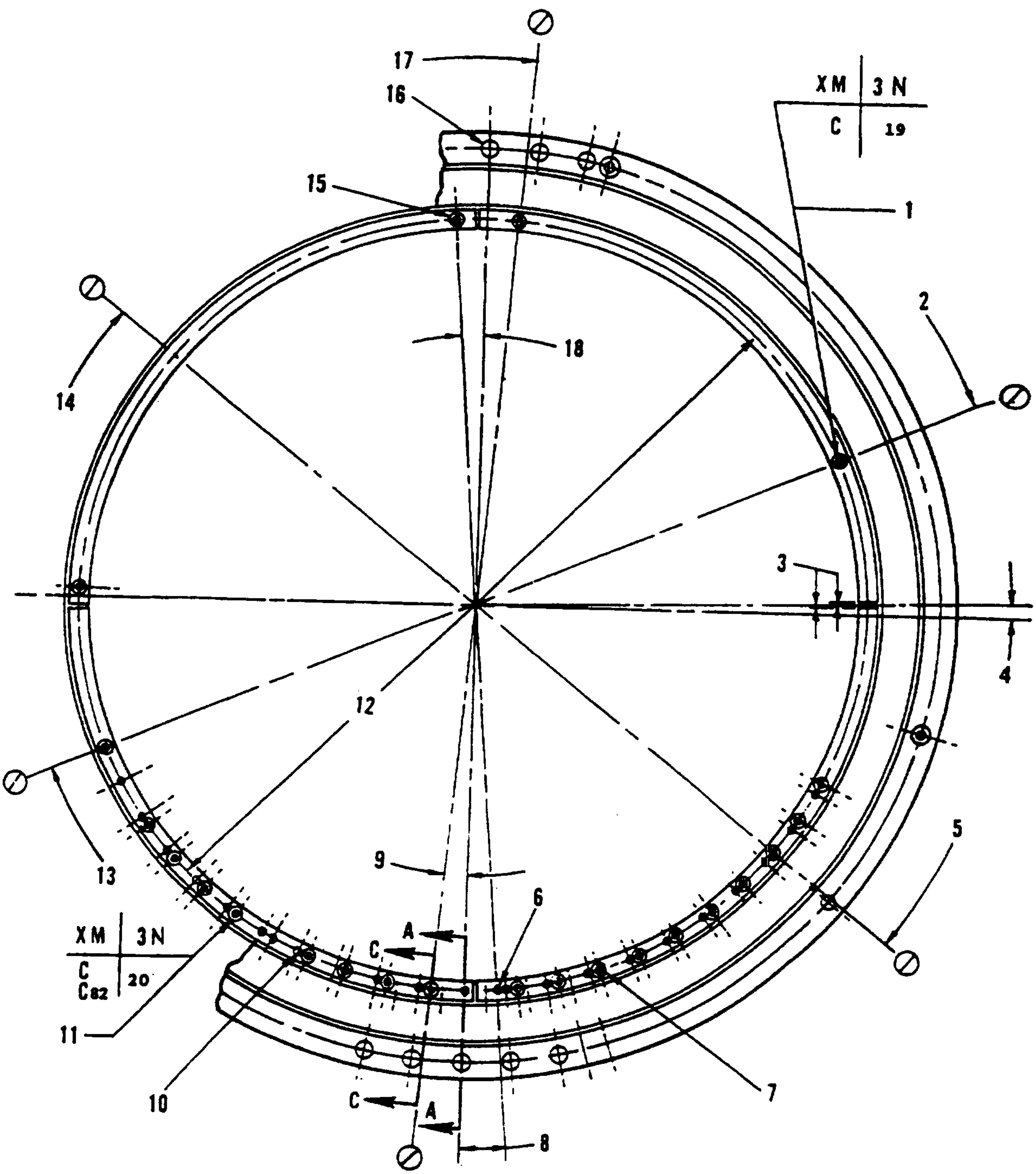
(3) Place replacement seal in case and temporarily secure. Maintain end gaps as specified in Figure 608.



L-22979 (0000)

1. 8.498 - 8.502 Inch Diameter. Concentric With Average Diameter Of Conical Surface (4) Within 0.010 Inch FIR When Seal Radial Float, If Present, Is Centralized.
2. 0.040 Inch Minimum Wall
3. Airsealing Ring
4. Reference Conical Surface
5. Bushing
6. 0.000 - 0.015 Inch

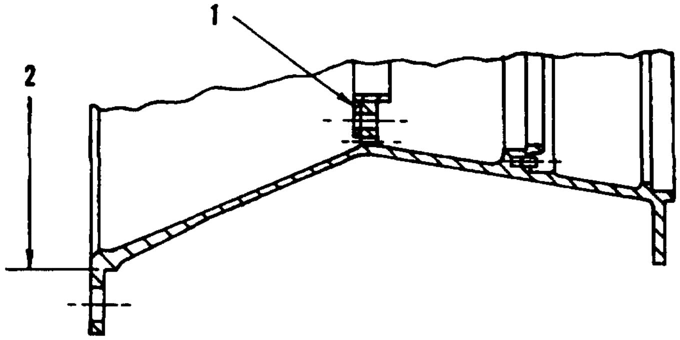
Second Stage Turbine Stator
Airsealing Ring Replacement
Figure 607



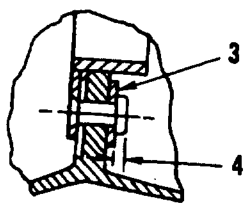
Turbine Case Inner Seal
Replacement
Figure 608 (Sheet 1)

1. Six Places As Marked. Rivets Must Be Flush To 0.010 Inch Below
R Flange Face. For Oversize Hole (See Text), Rivet Length Must
R Be 0.500 Inch.
2. 246° 43′
3. 0.015 - 0.025 Inch
4. 1° 33′ ± 0° 30′ Four Places
5. 308° 47′
6. Offset Hole
7. 58 Rivets - 56 Rivets On Basis Of 58 Rivets Equally Spaced And Two Rivets Offset As Shown Located Within 0.010 Inch Radius Of True Position In Relation To Diameter B
8. 4° 39′
9. 4° 39′
10. 0.126 - 0.127 Inch Diameter Through 58 Holes Equally Spaced And Located Within 0.002 Inch Of True Angular Position And 0.004 Inch of True Radial Position in Relation to Diameter B. Hole Pattern Must Be Within 0.010 Inch Of True Angular Position In Relation To Hole N.
11. 52 Places. Rivets Must Be Flush To 0.010 Inch Below Flange
R Face. For Oversize Hole (See Text), Rivet Length Must Be
R 0.375 Inch.
12. 16.750 Inch Diameter
13. 66° 43′
14. 128° 47′
15. Offset Hole
16. Hole N
17. 184° 39′
18. 4° 39′

Key to Figure 608 (Sheet 1)



SECTION A-A



SECTION C-C
TYPICAL 6 PLACES
MARKED ∅

L-67614 (0000)

1. Turbine Case Inner Seal
2. Diameter B Reference
3. Rivet Spacer
4. 0.075 Inch Maximum

R
R

Turbine Case Inner Seal
Replacement
Figure 608 (Sheet 2)

(4) Using locating dimensions given in figure to transfer drilling through existing rivet holes in case, drill all necessary new holes in replacement seal.

(5) Deburr holes as necessary.

(6) Install six spacers in locations indicated at removal.

(7) Install rivets and secure replacement seal to case.

R NOTE: If a longer rivet is used in an oversize rivet
R hole (see the Caution above), make sure that
R the upset head thickness Index 4 in (Sheet 2)
R of the figure is in limits.

C. Weld Repair of Turbine Case
See Figure 609.

(1) Turbine case (AMS 5735) outer airseal positioning slots worn 0.010 inch over maximum limit shown (Index 22) shall be weld repaired using AMS 5786 filler material. any variation in widths of different slots in excess of 0.006 inch shall also be cause for repair.

(2) Following weld repair, stress-relieve by SPOP 458-2 (Cycle 4A). See Section 70-42-04, Standard Practices Manual.

(3) Machine to dimensions shown.

5. First Stage Turbine Outer Airseal
See Figure 610.

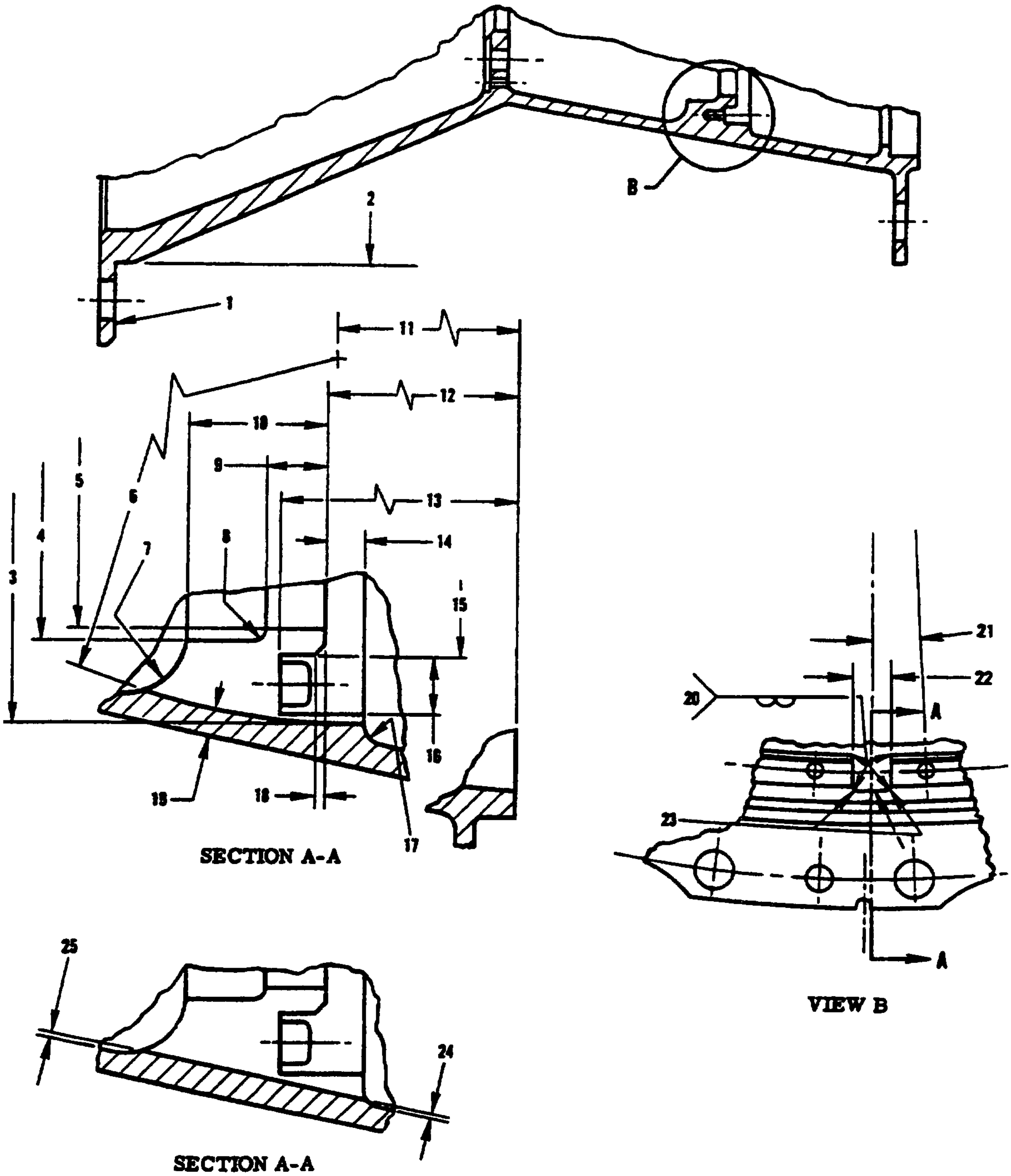
A. Inspection

(1) Reject a seal whose wall thickness, at any point is less than 0.025 inch (0.070 inch for JT12A-8 models).

(2) Blade Rub Limits for Truncated Airseals:

(a) Local wear up to 0.010 inch deep, over 30 degree arc, in three or less locations, is acceptable.

B. Repair



L-20176 (0000)

R
R

Turbine Case Repair
Figure 609

1. Turbine Case Flange Rear Surface
2. Diameters (Index 5 and Index 15) Must Be Concentric With This Diameter Within 0.002 Inch When Supported On Index 1 Surface
3. 8.765 - 8.775 Inches
4. 17.200 - 17.220 Inches
5. 17.140 - 17.150 Inches
6. 1.470 - 1.530 Inches
7. 0.141 - 0.172 Inch Radius
8. 0.047 - 0.078 Inch Radius
9. 0.120 - 0.140 Inch
10. 0.300 - 0.320 Inch
11. 1.030 - 1.070 Inches
12. 1.060 - 1.070 Inches
13. 1.170 - 1.180 Inches
14. 0.080 - 0.100 Inch
15. 17.225 - 17.265 Inches
16. 0.122 - 0.125 Inch
17. 0.047 - 0.078 Inch
18. Chamfer 0.020 - 0.078 Inch 43° - 47°
19. 0.050 Inch Minimum
20. Weld With AMS 5786 Filler Rod
21. 1° 52′ 30"
22. 0.197 - 0.203 Inch
23. 0.020 - 0.040 Radius
24. 0.000 - 0.010 Inch
25. 0.000 - 0.010 Inch

Key to Figure 609

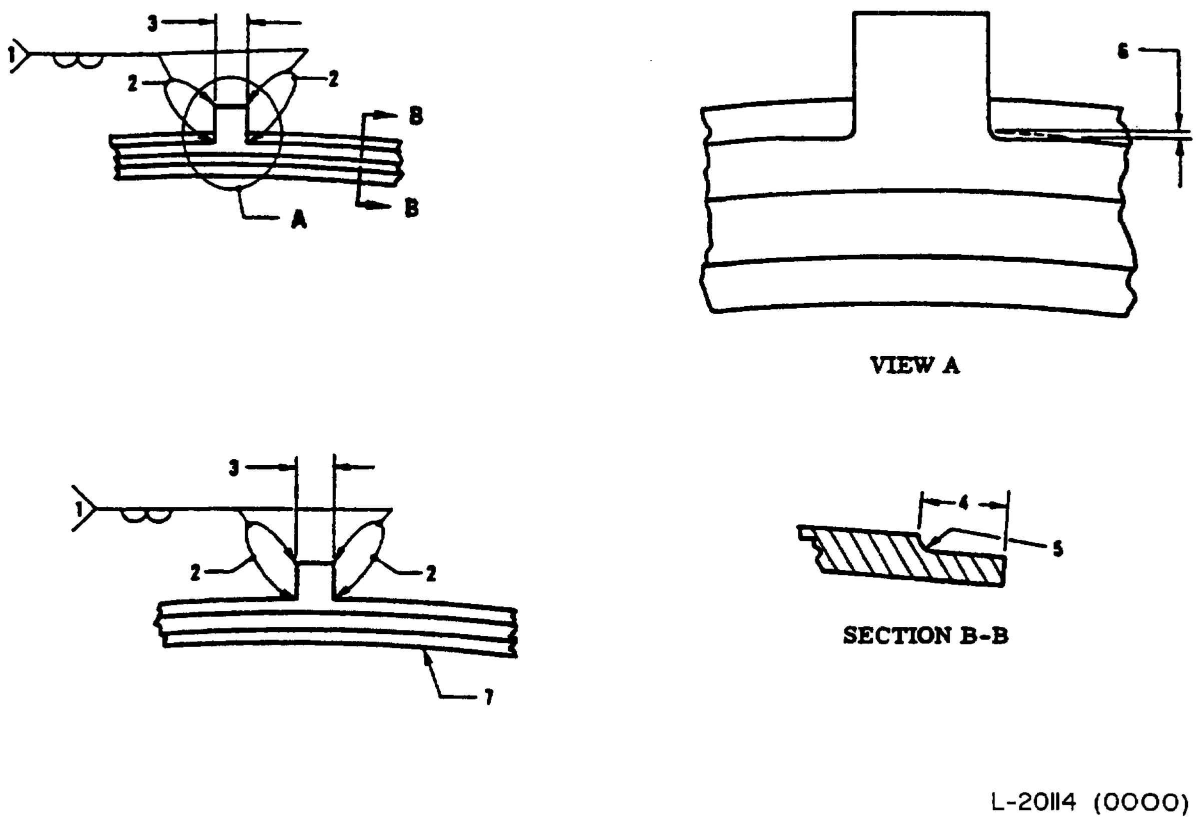
(1) Lug repair: If lug width is worn 0.010 inch below minimum dimension shown (Index 3), airseal lugs shall be repaired by welding with AMS 5798 filler rod, machining to dimensions shown and applying antigalling compound by SPOP 146 at locations shown.

NOTE: Stress-relief is not required after repair.

(2) Knife-edge repair: Otherwise acceptable airseals with worn knife edges are repaired as follows:

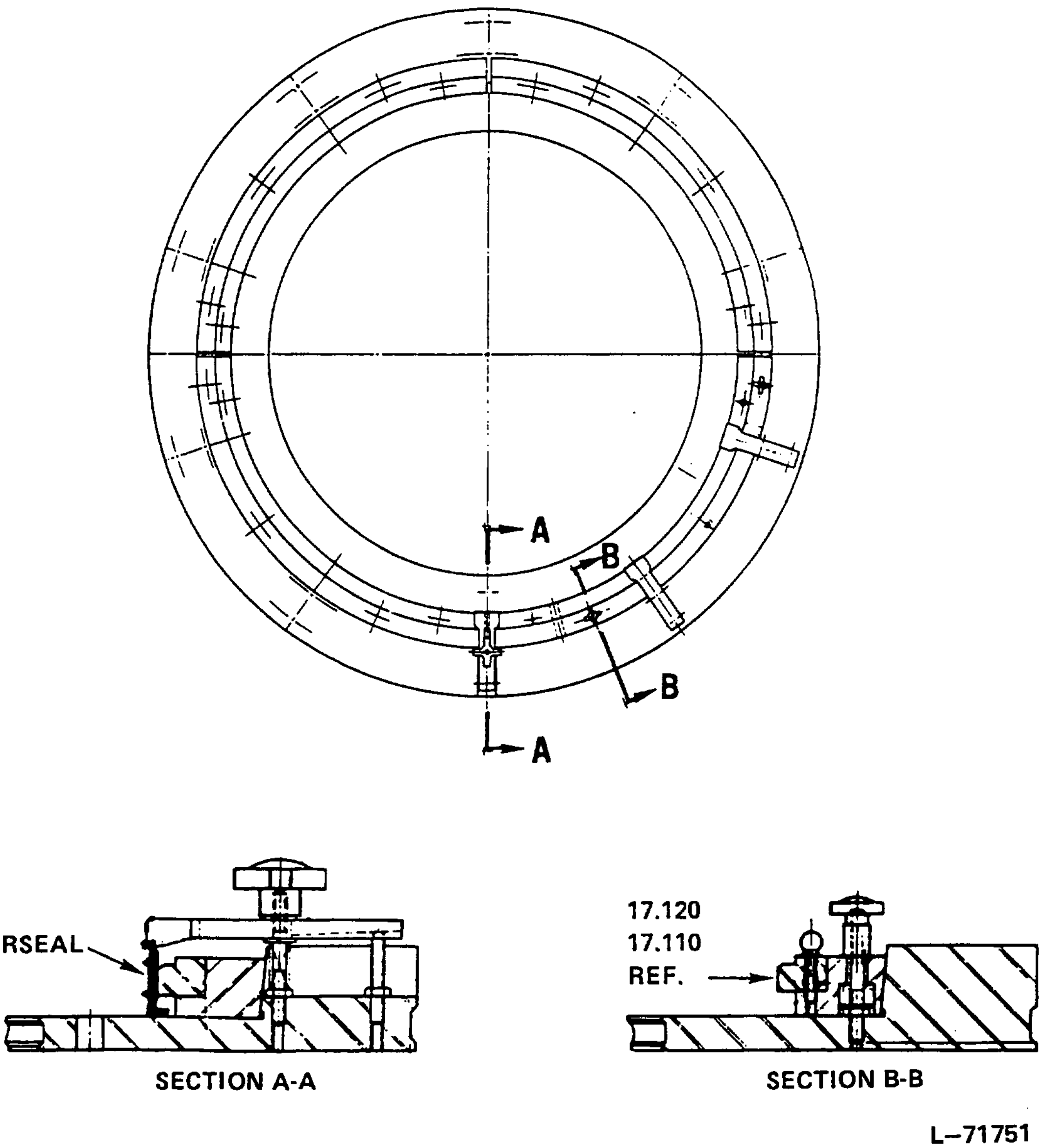
(a) Clean airseal of any foreign material making certain that airseal is free of oxides in area to be repair welded.

(b) Using Figure 611 as a reference, locally fabricate an airseal holding fixture. Position holding fixture on a vertical turret lathe or equivalent. Indicate and secure fixture to run true.



1. Weld Using AMS 5798 Filler Rod
2. Treat By SPOP 146
3. 0.186 - 0.188 Inch
4. 0.280 - 0.300 Inch
5. 0.031 - 0.062 Inch Radius
6. 0.010 Inch Finish Machine
7. First Stage Turbine Outer Airseal

First Stage Turbine
Outer Airseal Repair
Figure 610



Typical Airseal Holding Fixture
Figure 611

(c) Install airseal in holding fixture.

(d) Machine knife edges of airseal, removing minimum stock to clean up wear. See Figure 612. Airseals requiring stock removal beyond limits given are not repairable.

(e) Position and secure holding fixture, with airseal still installed, on an automatic welding machine and proceed with weld build up.

1 To improve ductility of Hastelloy X Airseals requiring extensive repairs, it is recommended that a solution heat treat by SPOP 480 (Cycle No. 20) be accomplished prior to welding. See Section 70-42-04, Standard Practices Manual.

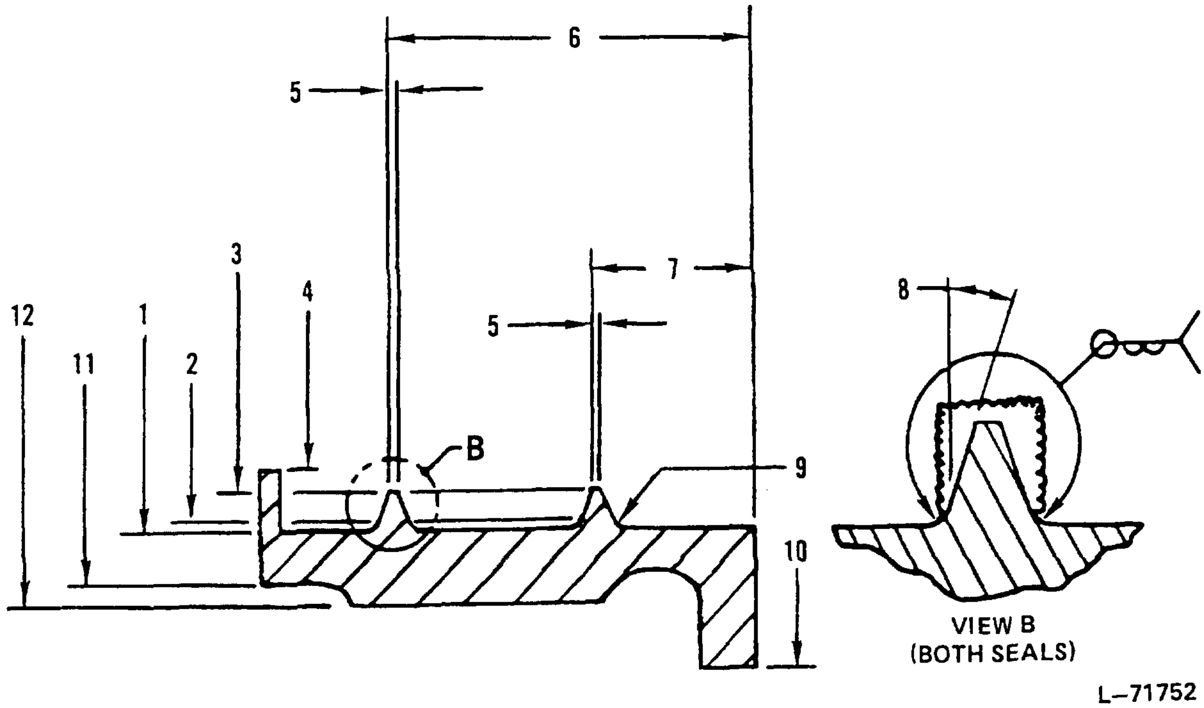
CAUTION: HOLD HEAT TO MINIMUM.

(f) Using AMS 5798 filler material, build up knife-edges using multiple passes of welding machine. Each pass shall add a maximum of 0.020 inch of material. Welding may be facilitated by welding approximately six inches along knife-edge and then rotating fixture 180 degrees until weld build up is completed. Mark angular position of airseal in holding fixture.

(g) Remove airseal from holding fixture and stress-relieve at 982°C (1800°F) for one hour. Sandwich airseal between two flat plates during stress-relief (top plate must be approximately 100 pounds). Air cool after stress-relief.

(h) Before final machining of knife-edges, check airseal for shrinkage. If resizing of airseal is required, this may be accomplished on locally fabricated resizing fixture. See Figure 613 for fixture reference.

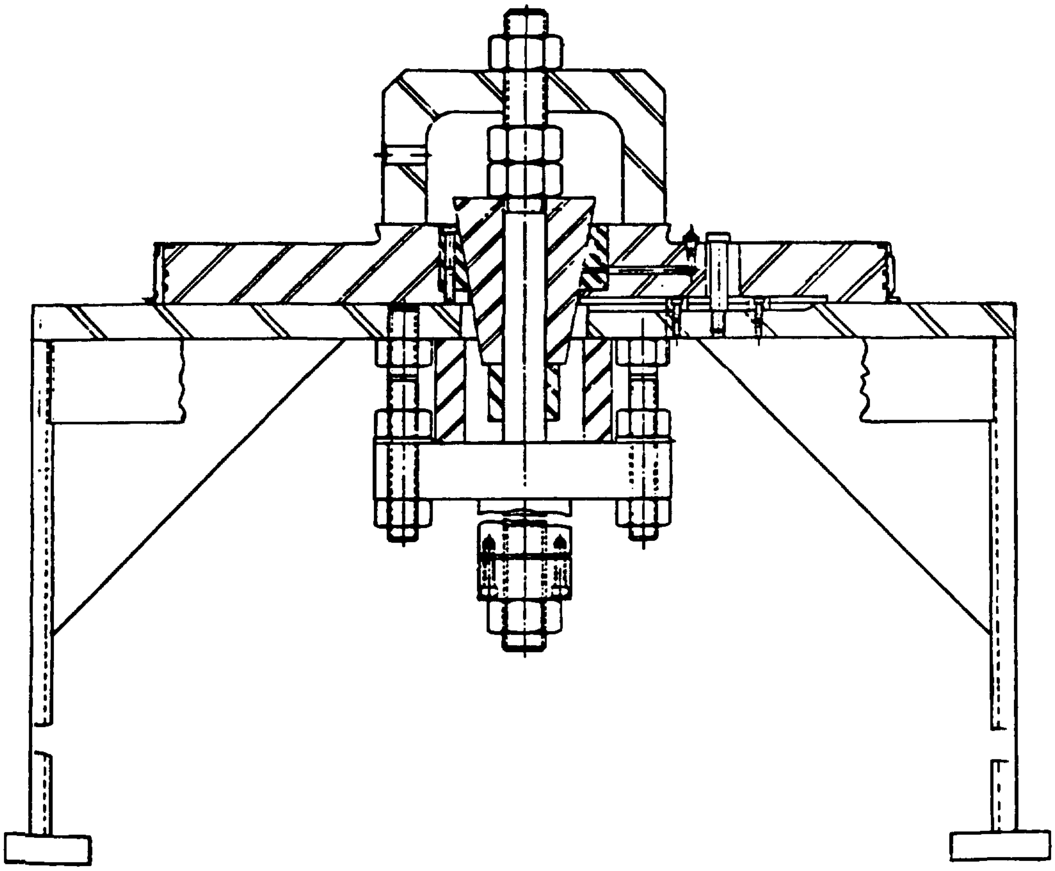
(i) Reinstall airseal in holding fixture as indexed in step (f). Machine welded knife edges to dimensions given in Figure 612.



1. 16.820 - 16.830 Inch Average Diameter
2. 16.790 - 16.800 Inch Average Diameter. Airseals with Crack Or Blend Exceeding This Dimension Are Not Reparable.
3. 16.633 - 16.643 Inch Average Diameter. This Diameter Must Be Concentric With Diameter At Index 12 Within 0.002 Inch FIR.
4. 16.490 - 16.500 Inch Average Diameter
5. 0.038 - 0.042 Inch
6. 0.740 - 0.750 Inch
7. 0.418 - 0.428 Inch
8. 15° ± 2°
9. 0.016 - 0.047 Inch Radius
10. 17.345 - 17.355 Inch Average Diameter
11. 16.995 - 17.005 Inch Average Diameter
12. 17.110 - 17.120 Inch Average Diameter

NOTE: All dimensions apply when Diameter 12 (in free state or constrained) is round within 0.003 inch. Free state out-of-roundness may be 0.030 inch in excess of tolerance shown.

First Stage Turbine Outer
Airseal Knife Edge Weld Repair
Figure 612



Typical Airseal Resizing Fixture
Figure 613

6. First Stage Turbine Inner Airseal
See Figure 614.

A. Replacement

(1) Remove 12 retaining rivets.

(2) Remove seal.

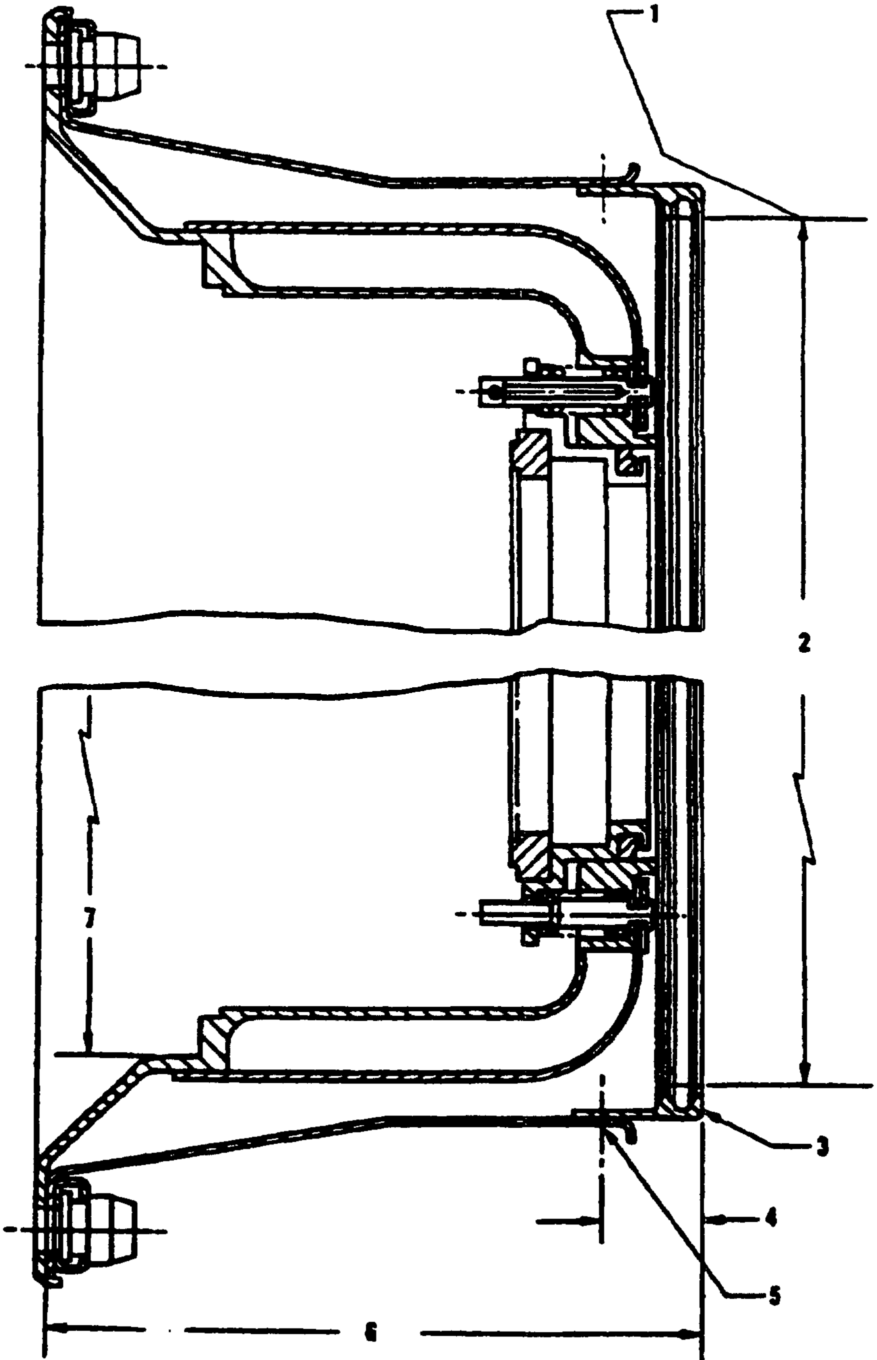
(3) Install replacement seal and clamp in position.

(4) Transfer drill 12 rivet holes.

(5) Break sharp edges.

(6) Install appropriate size seal retaining rivets.

(7) Machine new seal to proper dimensions.



First Stage Turbine Rotor
Inner Airseal - Replacement
Figure 614

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-04

1. Diameter must Be Concentric With Reference Diameter (Index 7) Within 0.002 Inch FIR.
2. 6.554 - 6.558 Inches
3. First Stage Turbine Rotor Inner Airseal
4. 0.557 Inch
5. Rivet Location - 12 Rivets Required
6. 3.842 - 3.852 Inches
7. Reference Diameter

Key to Figure 614

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-05

1. Engine Turbine Section - Turbine Shafts

   A. General

      (1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Turbine Shaft
   See Tool Group 105B-1, and Figure 601 thru Figure 604.

   A. Inspection

      (1) Strip graphited, antiscuffing varnish from front OD splines. See SPOP 203 Cleaning, in Section 70-21-00, Standard Practices Manual, and inspect splines.

         CAUTION: PROTECT NICKEL-CADMIUM SURFACES WHEN STRIPPING VARNISH.

      (2) Inspect turbine shaft rear outside and inside mating diameters. Wear and/or corrosion pitting to 0.005 inch maximum depth shall be repaired.

      (3) Perform hardness check as follows:

         (a) Clean shaft surface of any scale or foreign matter.

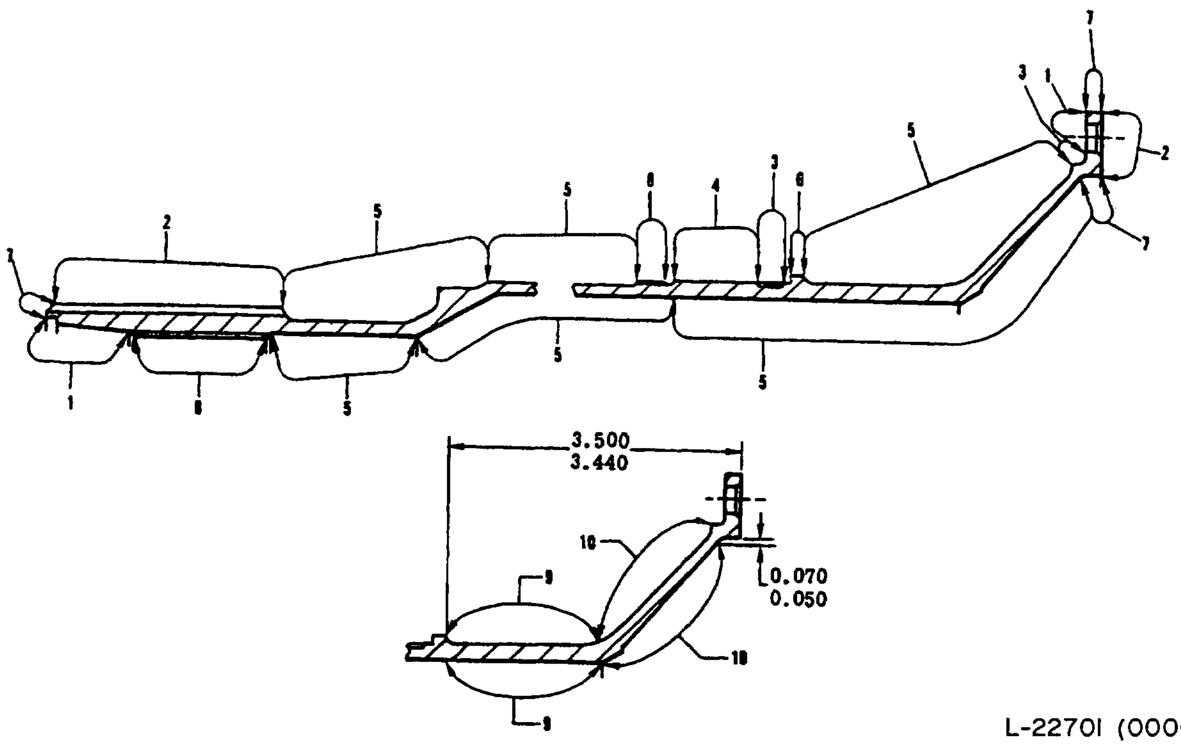
         (b) Support shaft in suitable stationary Rockwell A hardness checking machine. Ensure that surface to be checked is perpendicular to hardness machine scroll and that shaft is supported in manner to prevent shaft deflection under loads.

         (c) Check hardness at minimum of three points on area shown (Index 33). Points shall be equally spaced axially and radially 120 degrees apart. For example one point may be located at front of checking area 12 o'clock position, second point at center of checking area at four o'clock and third point at rear of checking area at eight o'clock.

         (d) Minimum acceptable hardness shall be Rockwell A66.

         (e) Stone down displaced metal flush with surface at three check points.

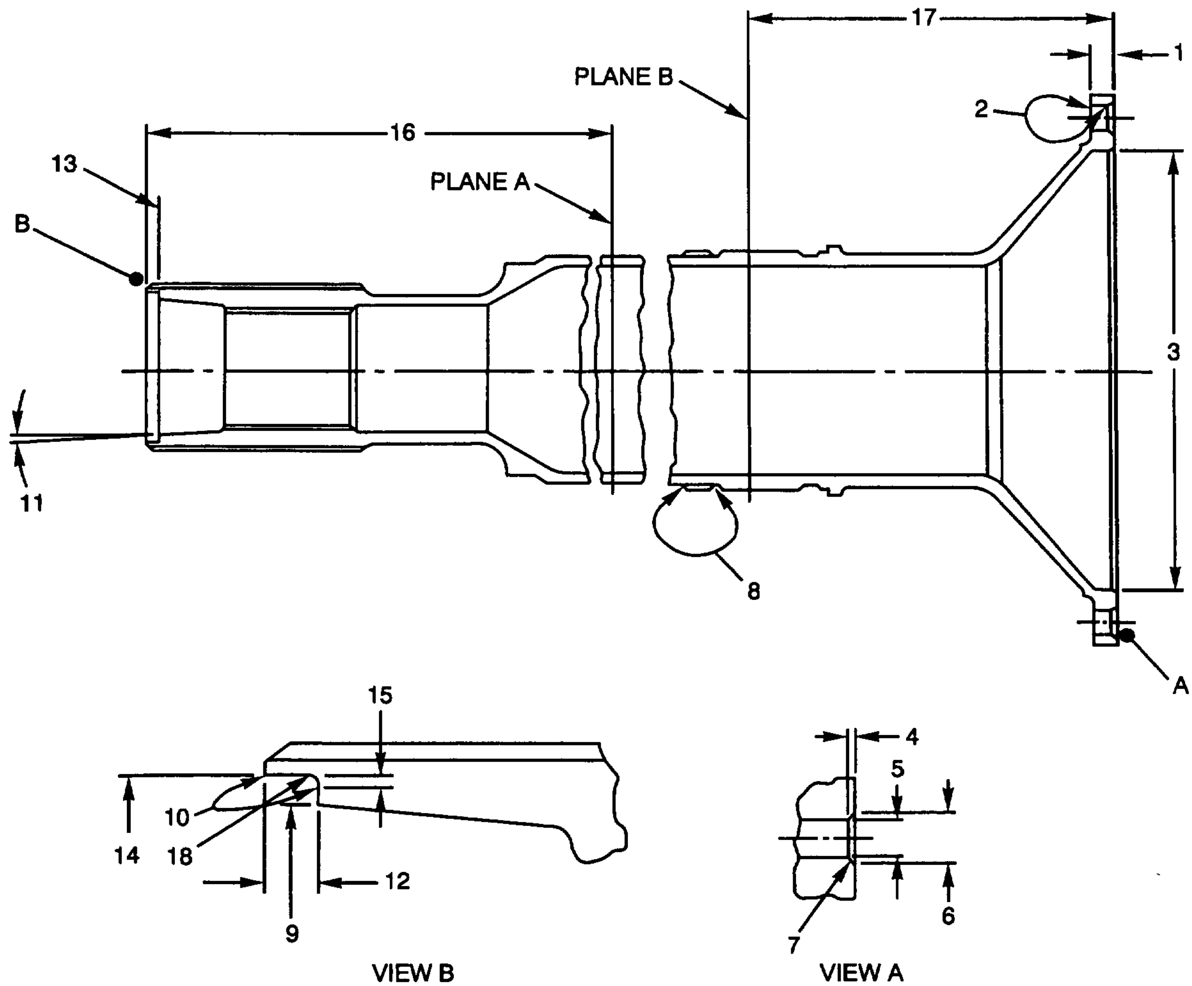
      (4) Fluorescent magnetic particle inspect turbine shaft by Figure 601, Figure 603 and Table 601.



L-22701 (0000)

NOTE: For limits associated with areas shown see Table 601.

Turbine Shaft Inspection
Figure 601



L-29326 (0407)
PW V

Turbine Shaft Spacer Area
And Tierod Hole Repair
Figure 602

1. 0.168 - 0.172 Inch
2. Nickel Plate Area
3. Reference Diameter
4. 0.030 - 0.050 Inch
5. 0.328 - 0.348 Inch Diameter For Clean-up Machining (Hold To Minimum Value). 0.311 Inch Diameter Maximum After Plating. 0.321 - 0.323 Inch Diameter After Finish Machining.

   NOTE: Tierod holes are located within 0.001 inch of true position in relation to Index 3.

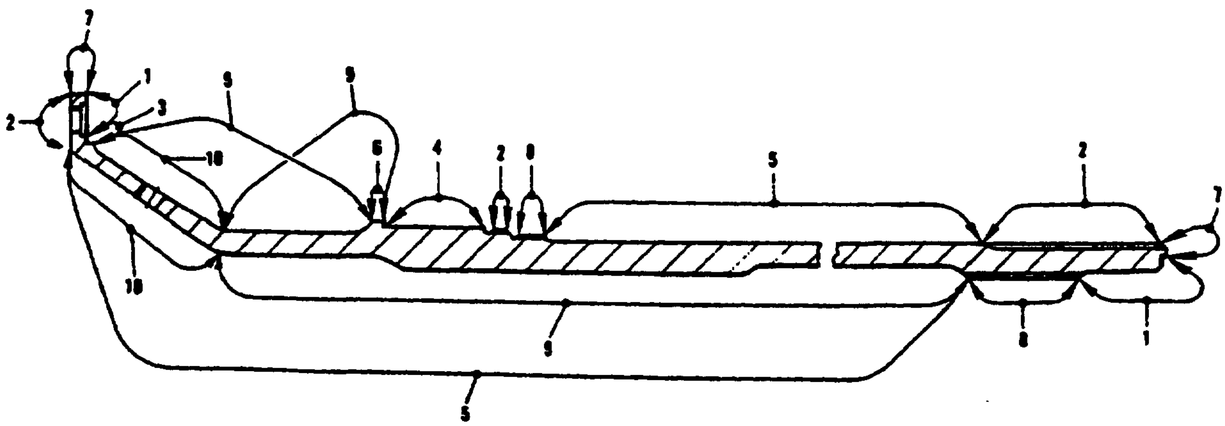
6. 0.355 - 0.375 Inch
7. 0.010 - 0.020 Inch Radius

   NOTE: Radius must be maintained for finish machining.

8. Electrical Contact Area
9. 1.755 - 1.775 Inch Diameter
10. Nickel Plate Area
11. 2 Degrees And 20 Minutes - 4 Degrees And 20 Minutes.
12. 0.128 - 0.132 Inch
13. Surface Must Be Square Within 0.0003 Inch FIR, And Have A Surface Finish Of 15 Microinches
14. 1.9745 - 1.9895 Inch Diameter For Clean-up Machining; Hold To Minimum Value. 1.9585 Inch Diameter After Plate. 1.9685 - 1.9695 Inch Diameter After Finish Machining; Diameter Must Be Concentric Within 0.001 Inch FIR When Shaft Is Mounted At Planes A And B.
15. 0.010 - 0.025 Inch
16. 7.050 - 7.550 Inches
17. 4.450 - 4.950 Inches

R 18. 0.005 - 0.020 Inch Radius

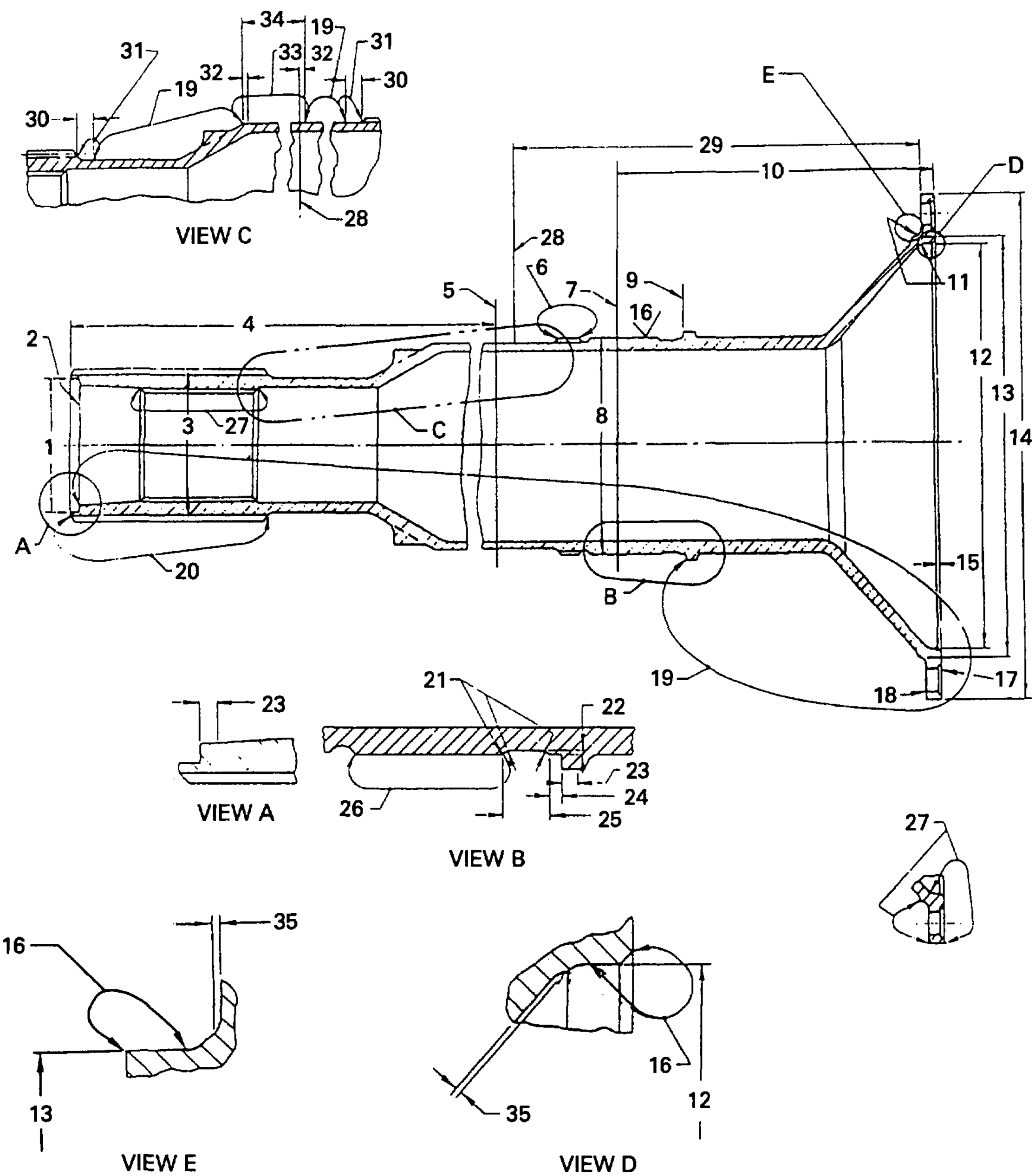
Key to Figure 602



L-22183 (0207)

NOTE: For limits associated with area shown, See Table 601.

Free Turbine Shaft Inspection
Figure 603



L-35141 (1296)

Turbine Shaft Repair
Figure 604

1. Reference Diameter
2. Reference Face
3. Reference Diameter
4. 7.050 - 7.550 Inches
5. Reference Plane
6. Electrical Contact Area
7. Reference Plane
8. 3.130 - 3.145 Inch Diameter After Machining (Hold to Maximum), 3.160 Inch Diameter Minimum After Plating, 3.1500 - 3.1505 Inch Diameter After Finish Machining.

   NOTE: Diameter 8 must be concentric with Diameters 1, 3, 12, 13 and 14 with 0.001 inch FIR, and must be square with Faces 9, 17 and 18 within 0.001 Inch Fir, when shaft is mounted on Planes 5 and 7. Diameter must be square with Face 2 within 0.0003 Inch FIR. Taper must not exceed 0.0002 inch FIR, and out-of-roundness must not exceed 0.0003 inch FIR.

9. Reference Face
10. 4.450 - 4.950 Inches
11. 0.030 - 0.050 Inch Radius
12. Machine ID To 5.904 - 5.927 Inches; Hold To Minimum To Clean Up. Nickel-plate Machined Surface To 5.887 Inch Maximum Diameter *5.8965 - 5.8985 Inch Diameter After Machining And Nickel-Cadmium Plating. Plating In Fillet Is Not Allowed.

    NOTE: Diameter Must Be Concentric with Diameters 1, 3, 8, 13 and 14 Within 0.001 Inch FIR When Shaft Is Mounted in Planes 5 and 7.

13. Machine OD To 6.077 - 6.100 Inches; Hold To Maximum To Clean Up. Nickel-Plate Machined Surface To 6.117 Inch Minimum Diameter
    *6.1067 - 6.1102 Inch Diameter After Machining And Nickel-Cadmium Plating. Plating In Fillet Is Not Allowed.

    NOTE: Diameter Must be Concentric with Diameters 1, 3, 8, 12 and 14 Within 0.001 Inch FIR When Shaft Is Mounted In Planes 5 And 7.

Key to Figure 604

14. Reference Diameter
15. 0.020 - 0.040 Inch By 43° - 47° Chamfer
16. Nickel-Plate Areas (When Necessary)
17. Reference Face
18. Reference Face
19. Nickel-Cadmium Plate Area. After Baking Per SPOP 25, Cover Area With High-Baking, Heat-Resistant Aluminum Enamel Per SPOP 142. (See Surface Treatments, Overhaul Standard Practices Manual).

NOTE: Do not paint nickel-cadmium plated areas shown in View C with aluminum enamel. Also, see Index 27.

20. Graphited, Antiscuffing Varnish Area
21. 0.109 - 0.141 Inch Radius
22. 0.015 - 0.025 Inch
23. 0.125 Inch Optional Plate Area
24. 0.060 - 0.080 Inch
25. 0.290 - 0.310 Inch
26. Chromium Plate Area
27. No Paint Area
28. Reference Plane
29. 19.770 - 19.830 Inches
30. 0.125 Inch Maximum
31. Optional Plate Area
32. 0.040 Inch Maximum
33. Hardness Checking Area, Do Not Plate
34. 4.000 Inches (Approximate)
35. 0.010 - 0.000 Inch Before Plating

*PN 405251 Shafts Following Mating Diameter Repair Will Now Be Equivalent To PN 4055251N Or Later But Pre-PN 802420.

Key to Figure 604 (Continued)

Area	Maximum number of sub-surface inclusions in area, all well disbursed, and maximum length of each A	Maximum length of combination of separate sub-surface inclusions in same axial plane B
1*	One-1/4 or three-1/8 - 3/16 or six-3/32	1/4
2*	Two-1/4 or four-1/8 - 3/16 or six-3/32	1/4
3	None	None
4*	One-3/8 - 1/2 or three-3/16 - 1/4 or six-3/32 - 1/8	1/2
5*	One-5/8 or two-7/16 or 1/2 or six-1/4 - 3/8 or nine-3/32 - 3/16	5/8
6***	Four-1/8 - 3/16 or six-1/16 or less	3/16
7	Four pinpoints per inch of diameter - no more than six pinpoints in any one concentration	
8**	Five-running through six threads or less	
9	Pitting not exceeding 0.005 inch shall be repaired.	
10	Pitting not exceeding 0.010 inch shall be repaired.	

NOTE* - Inclusions 1/16 inch or less shall be disregarded in this area. In and adjacent to thread areas inclusions must be centered on thread lands or grooves, except surface inclusions are restricted to threads lands.

** Inclusions may extend into lead thread radius or undercut.

*** Inclusions 1/16 inch or less shall be disregarded in fillet radii adjacent to Area 6.

Turbine and Free Turbine
Shaft Inspection Limits
Table 601 (Sheet 1)

Area	Total number of surface inclusions well dispersed in area and maximum length of each C	Total length of combinations of sub-surface and surface inclusions in same axial plane D
1*	Two-3/16 or four-3/32 - 1/8	3/16
2*	Two-1/4 or four-1/8 - 3/16 or six-3/32	1/4
3	None	None
4*	Two-3/32 - 1/8	1/8
5*	One-1/2 or two-3/8 or six-3/16 - 5/16 or nine-3/32 - 1/8	1/2
6***	Three-1/8 or five-1/16 or less	1/8
7	Four pinpoints per inch of diameter - no more than six pinpoints in any one concentration	
8**	Five-running through six threads or less	
9	Pitting not exceeding 0.005 inch shall be repaired.	
10	Pitting not exceeding 0.010 inch shall be repaired.	

NOTE* - Inclusions 1/16 inch or less shall be disregarded in this area. In and adjacent to thread areas inclusions must be centered on thread lands or grooves, except surface inclusions are restricted to thread lands.

** Inclusions may extend into lead thread radius or undercut.

*** Inclusions 1/16 inch or less shall be disregarded in Fillet Radii adjacent to Area 6.

Turbine and Free Turbine
Shaft Inspection Limits
Table 601 (Sheet 2)

Area	Maximum depth of low spot permissible to stone to remove or relieve surface inclusions E	Total number of indication from A, B, C, and D Combinations not to exceed: F
1*	0	6
2*	.005	6
3	0	None
4*	.005	6
5*	.002	9
6***	.0002	8
7	Four pinpoints per inch of diameter - no more than six pinpoints in any one concentration	
8**	Five-running through six threads or less	
9	Pitting not exceeding 0.005 inch shall be repaired.	
10	Pitting not exceeding 0.010 inch shall be repaired.	

NOTE* - Inclusions 1/16 inch or less shall be disregarded in this area. In and adjacent to thread areas inclusions must be centered on thread lands or grooves, except surface inclusions are restricted to thread lands.

** Inclusions may extend into lead thread radius or undercut.

*** Inclusions 1/16 inch or less shall be disregarded in Fillet Radii adjacent to Area 6.

Turbine and Free Turbine
Shaft Inspection Limits
Table 601 (Sheet 3)

B. Repair
See Tool Group 105B-1 and Figure 604.

(1) Rear inside and outside mating diameter wear.

R
R

(a) Grind worn diameters to remove damage and prepare for plate repair as shown.

NOTE: Corner radius of 0.030 - 0.050 inch must be maintained during rework.

(b) Mount shaft in applicable Plating Fixture.

NOTE: Electrical contact points are permitted only in area shown. No burning, pitting, or selective attack is permitted.

(c) Nickel-plate machined area, as shown. See SPOP 29 or SPOP 321 Plating, in Section 70-44-01, Standard Practices Manual.

(d) Bake part at 185° - 196°C (365° - 385°F) for three hours.

(e) Finish-grind to dimensions shown.

(2) Rear inside and outside mating diameter corrosion pitting to 0.005 inch maximum depth.

(a) Clean corroded area with a wire brush.

(b) Grit-blast corroded and surrounding areas with dry, 320-mesh, aluminum oxide at pressure of 90 psi.

(c) Shotpeen area, using SAE-S-110 cast steel shot, to arc heights of 6 - 8A-2.

(3) No. 3 bearing journal plate repair.

(a) Grind bearing journal to dimensions shown.

R (b) Remove the nickel-cadmium plate by SPOP 25. Refer
R to Section 70-44-01 in the Standard Practices
R Manual.

R (c) Mount shaft in the applicable Plating Fixture.

R (d) Chromium-plate bearing journal as shown by SPOP 22 (non-stainless steel). Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: Plating outside enclosed area is permissible, but excess must be removed to dimensions given in View B.

(e) Bake part at 396° - 427°C (750° - 800°F) for two hours.

(f) Finish-grind bearing journal, maintaining indicated tolerances, as shown.

(4) Pitting of Areas 9 and 10 (Figure 601).

NOTE: See alternate repair scheme below for this area.

(a) Mask adjacent areas.

(b) Clean with aluminum oxide No. 320 grit.

(c) Clean in 32° - 46°C (90° - 115°F) PS47, inhibited muriatic acid solution, for 15 minutes. Repeat, if necessary, up to maximum total immersion time of two hours. Rinse in cold water. (See Plating Solutions, Section 70-44-02, Standard Practices Manual).

(d) Grit blast by SPOP 218. See Section 70-21-00, Standard Practices Manual.

(e) Shotpeen with S-170 steel shot with intensity of 10A. (See SPOP 501 Surface Treatments, Section 70-41-02, Standard Practices Manual).

(f) Nickel-cadmium plate as specified below (if applicable).

(g) Apply two coats of high-baking, heat-resistant, aluminum enamel by step (g).

R (5) No. 3 bearing shoulder wear chromium plate repair.

R (a) Machine the No. 3 bearing shoulder to the dimension
R shown in Figure 604. Keep removal of material to a
R minimum while damage is removed.

R NOTE: If the surface is ground to remove damage,
R local fluorescent penetrant inspection by
R SPOP 70 (ultra-high sensitivity) will be
R necessary. Refer to Section 70-33-00 in the
R Standard Practices Manual.

(b) Remove grease from the machined area by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

NOTE: The steps (c) thru (f) that follow are necessary only if the final machined dimension is less than the limits shown.

(c) Install the shaft in the applicable Plating Fixture.

NOTE: Electrical contact is permitted only in the area shown. No burning, pitting, or selective attack is permitted.

(d) Apply chromium plate to the bearing shoulder to the dimension shown. by SPOP 22 (non-stainless steel). Refer to Section 70-44-01 in the Standard Practices Manual.

(e) Bake part at 396° - 427°C (750° - 800°F) for two hours.

(f) Finish grind the bearing shoulder (keep the dimensions shown in the figure in limits). Break sharp edges 0.003 - 0.013 inch.

(6) No. 3 bearing shoulder wear nickel plate repair.

(a) Machine the No. 3 bearing shoulder to the dimension shown in Figure 604 (Index 36). Keep removal of material to a minimum while damage is removed.

NOTE: If the surface is ground to remove damage, local fluorescent penetrant inspection by SPOP 70 (ultra-high sensitivity) will be necessary. Refer to Section 70-33-00 in the Standard Practices Manual.

(b) Remove grease from the machined area by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

NOTE: The steps (c) thru (f) that follow are necessary only if the final machined dimension is less than the limits shown.

R (c) Install the shaft in the applicable Plating
R Fixture.

R NOTE: Electrical contact is permitted only in the
R area shown. No burning, pitting, or
R selective attack is permitted.

R (d) Apply nickel plate to the bearing shoulder to
R the dimension shown. by SPOP 29. Refer to Section
R 70-44-01 in the Standard Practices Manual.

R (e) Bake part at 185° - 196°C (365° - 385°F) for
R two hours.

R (f) Finish grind the bearing shoulder (keep the
R dimensions shown in the figure in limits). Break
R sharp edges 0.003 - 0.013 inch.

(7) Alternate Conical Surfaces Repair. See Figure 605.

(a) Machine surfaces as shown in figure.

1 Break edge 0.003 - 0.015 inch unless otherwise specified. Machine runout step is permitted anywhere on conical surface.

2 Machine surface and blend areas to be 63AA.

3 Local blending is permitted. Blend areas must be smooth and continuous in all directions with a twenty-to-one length to depth ratio. Blends on opposite sides of the conical elements are permitted if the minimum wall thickness is maintained.

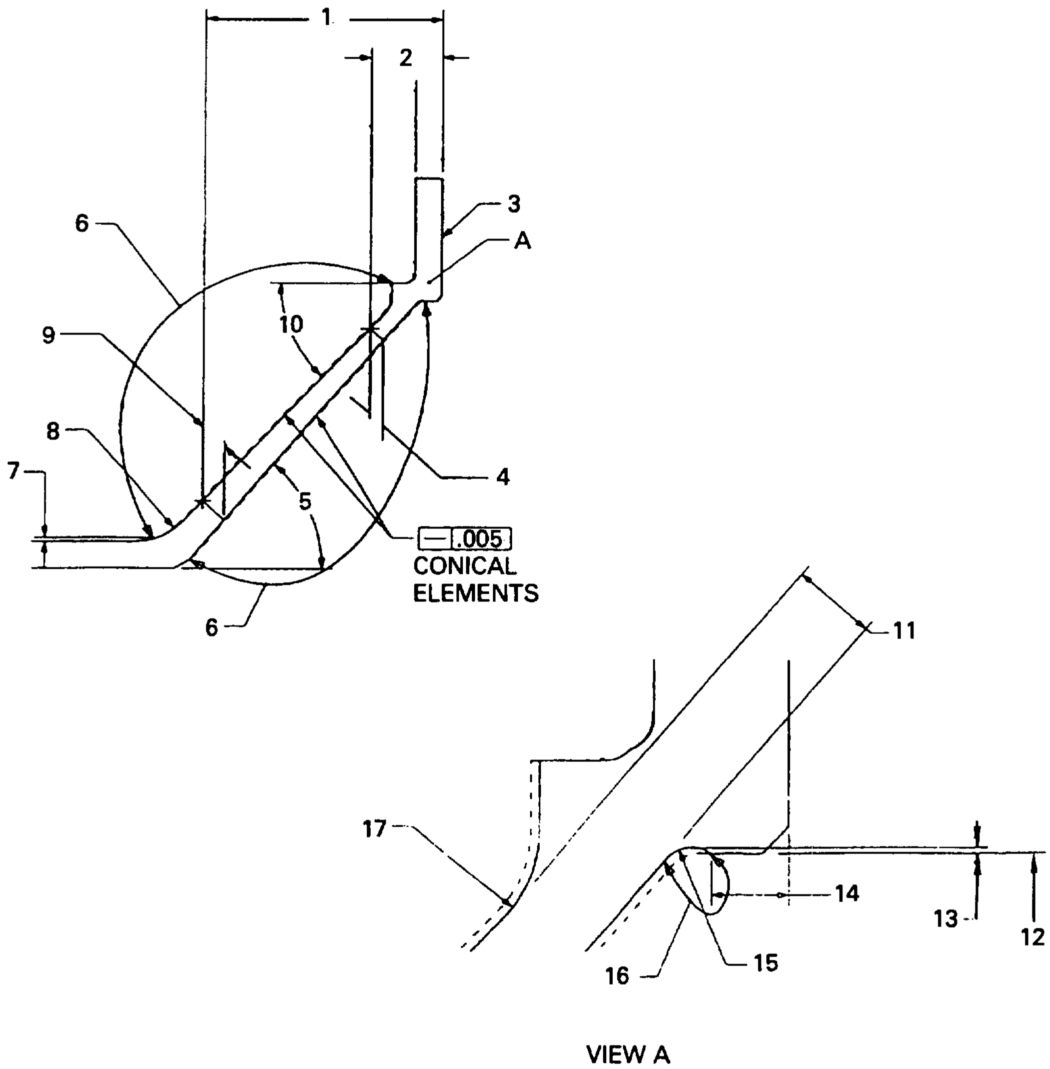
(b) Apply paint to repaired surfaces as specified in this section.

(8) Rear Flange Front Face Repair. See Figure 606.

(a) Machine front face of flange as required to remove pitting. Hold to minimum value.

1 Break edge 0.003 - 0.015 inch unless otherwise specified.

2 Machine surface and blend areas to be 63AA.



Alternate Conical Surfaces Repair
Figure 605

1. 1.350 Inches
2. 0.410 Inch
3. PN 405251 (Reference)
4. 0.096 Inch Minimum
5. 49°21' (Reference)
6. 0.010 Inch Maximum Material Removal Is Permissible Within This Area
7. 0.020 Inch Minimum
8. 0.296 - 0.398 Inch Radius
9. 0.158 Inch Minimum
10. 46°46' (Reference)
11. 0.082 Inch Minimum
12. 5.896 - 5.898 Inch Diameter
13. 0.007 Inch. Undercut Applies Only When Index 12 Diameter Is Within Tolerance Shown.
14. 0.088 Inch Minimum
15. 0.030 - 0.050 Inch Radius
16. No Plate in Enclosed Area
17. 0.109 - 0.141 Inch Radius

Key to Figure 605

3 Local blending is permissible. Blend areas must be smooth and continuous in all directions, with a twenty-to-one length to depth ratio.

(b) Nickel plate by SPOP 29. See Section 70-44-01, Standard Practices Manual.

(c) Finish machine as shown in the figure.

(d) Apply paint to repaired surfaces as specified in this section.

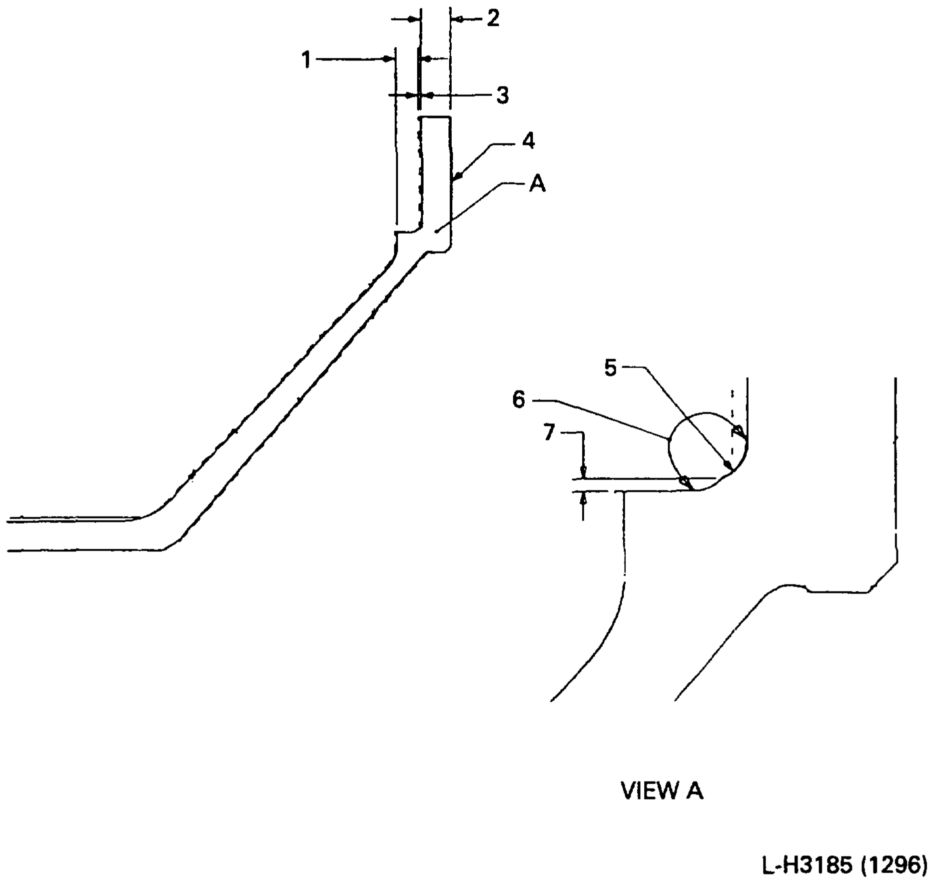
NOTE: All areas with nickel plating must be masked.

(9) Turbine shaft spacer area wear repair. See Figure 602.

(a) Machine spacer area to dimensions shown, keeping machining to minimum.

(b) Mount turbine shaft in Plating Fixture.

NOTE: Electrical contact points are permitted only in the area shown. No burning, pitting, or selective attack is permitted.



1. 0.115 Inch Minimum. Applies Only When Flange Thickness Is 0.168 - 0.172 Inch
2. 0.155 Inch Minimum
3. 0.015 Inch Maximum Material Removal
4. PN 405251 (Reference)
5. 0.030- 0.050 Inch Radius
6. No Plate in Enclosed Area
7. 0.013 Inch Minimum.

Rear Flange Front Face Repair
Figure 606

(c) Nickel plate machined area, as shown. See SPOP 29 or SPOP 321 in Section 70-44-01, Standard Practices Manual.

NOTE: Plating outside of enclosed area is permitted, but excess plate must be removed to dimensions shown.

(d) Bake part at 185° - 196°C (365° - 385°F) for three hours.

(e) Finish machine to dimensions shown, maintaining concentricity and squareness requirement.

(10) Turbine shaft tierod hole repair. See Figure 602.

(a) Machine worn tierod holes to dimensions shown, keeping machining to minimum.

R (b) Complete repair with steps (9) (b) thru (e).

(11) Nickel cadmium plate, aluminum enamel paint, and antiscuffing varnish replacement (optional to PWA 110)

(a) For nickel-cadmium plating (when required) refer to Section 70-44-01, Standard Practices Manual.

NOTE: Plating facilities not previously approved for nickel-cadmium plating of JT12 turbine shafts must submit samples of these plated shafts to Pratt & Whitney (refer to Special Plating Tests, Section 70-44-04, Standard Practices Manual).

(b) Place shaft in PWA 13703 Plating Fixture, ensuring that O-ring is in proper position. Then attach the anode to the fixture.

NOTE: Four-inch ring portion of inner anode must extend 1/4 inch to rear of turbine shaft flange rear face.

(c) Nickel-cadmium plate turbine shaft, as shown (refer to Table 602 and SPOP 25). Nickel-plate to thickness of 0.0002 - 0.0004 inch. Cadmium plate to thickness of 0.0001 - 0.0002 inch.

NOTE: Shaft has Rockwell hardness of C35 - 40 or equivalent.

Description	Surface Area (square inches)	Amperes Nickel	Amperes Cadmium
(1) Inside Surface	275	55	50
(2) Outside Surface	225	50	40

NOTE: (1) Conforming anode
(2) Boxed tank anodes

Use separate rectifiers for (1) and (2) anode

Plating Currents
Table 602

(d) Paint shaft with high-baking, heat resistant, aluminum as shown in Indexes 19 and 27. Refer to SPOP 142, Surface Treatments, Standard Practices Manual.

(e) Graphited, Antiscuffing Varnish: Treat front OD of shaft as shown. Refer to Surface Treatments, Standard Practices Manual.

(12) PWA 110 Coating Replacement (Optional to Nickel-Cadmium Plate. See Figure 607.

<u>NOTE</u>: Refer to SB 6276 for part numbers for which PWA 110 coat is applicable. Shafts which get PWA 110 coat do not get nickel-cadmium plate, paint, or varnish.

(a) Clean the shaft as specified in Section 72-00-00, Cleaning.

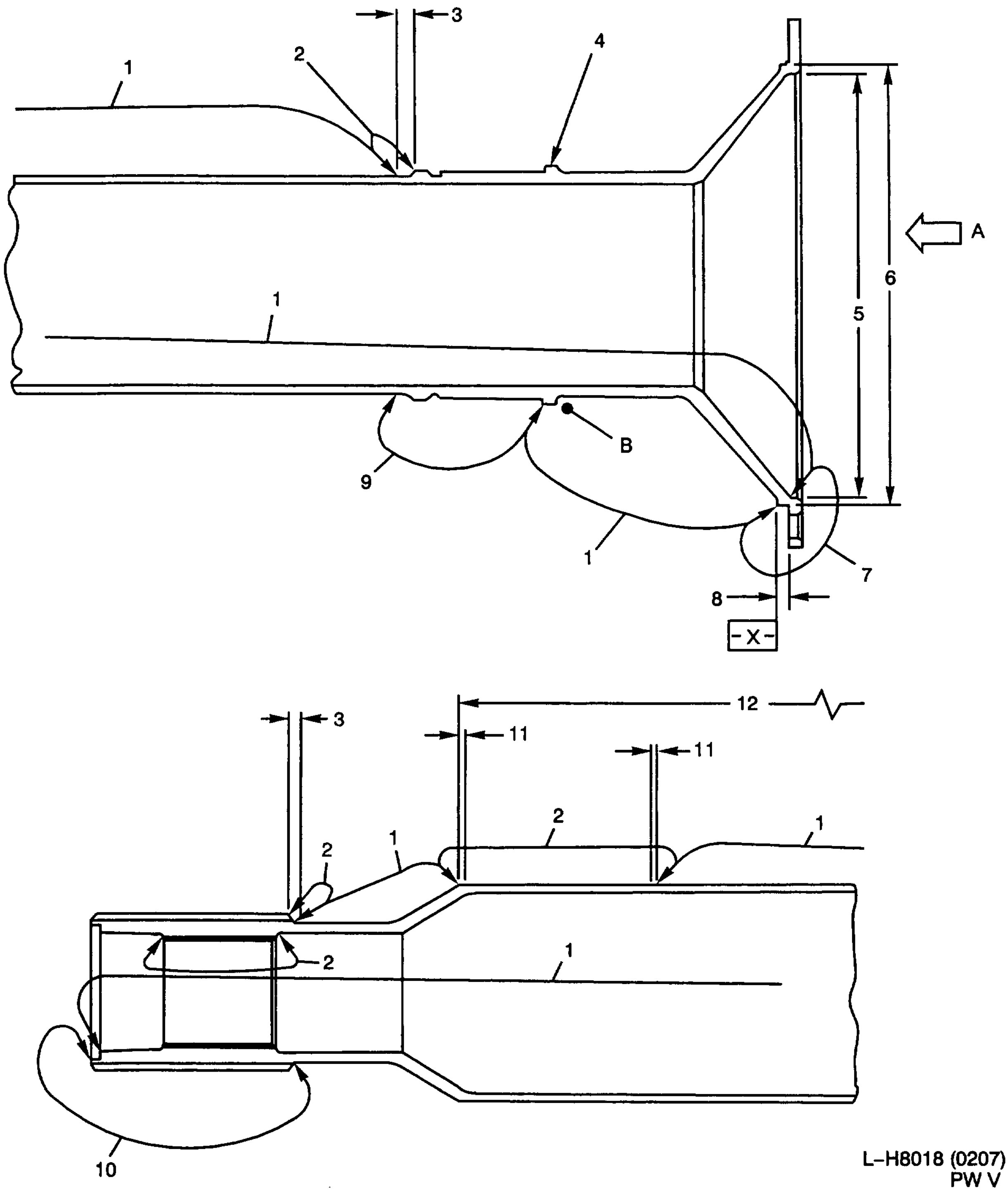
(b) If there is nickel-cadmium plate on the shaft, remove it by SPOP 25 (refer to Section 70-44-01 in the Standard Practices Manual.

(c) Do a fluorescent penetrant inspection of the shaft (refer to Section 72-00-00, Inspection)

(d) Do all necessary repairs to the shaft.

(e) On a PN 405251 shaft, measure the rear flange mating diameters and bolt holes to be sure that they are in the limits shown in the figure. Machine the diameters or holes as necessary to get them in limits.

R
R



L-H8018 (0207)
PW V

Turbine Shaft PWA 110
Coating Repair
Figure 607 (Sheet 1)

R 1. Coating thickness In This Area Must Be 0.001 - 0.003 Inch
R 2. Coating Is Optional In This Area and Full Coverage Is Not
R Necessary) (It Must Be Possible To See Part Markings In This
R Area If Coated)
R 3. 0.125 Inch Maximum
R 4. Coating Thickness In This Area Must Be 0.0005 Inch Minimum
R 5. 5.8973 - 5.8988 Inch Diameter Before Coat, 5.8943 - 5.8978 Inch
R Diameter After Coat
R 6. 6.1057 - 6.1072 Inch Diameter Before Coat
R 7. Coating Thickness In This Area Must Be 0.0005 - 0.0015 Inch With
R 0.0004 Inch Maximum Variation Permitted
R 8. 0.120 - 0.130 Inch
R 9. No Coat Area
R 10. Antigalling Compound Area
R 11. 0.040 Inch Maximum
R 12. 23.790 - 23.810 Inches To Surface X

R Key to Figure 607 (Sheet 1)

R (f) Apply PWA 110 coat (Task 70-41-04-380-101-001). Refer to Section 70-41-04 in the Standard Practices
R Manual to the areas shown in the figure.

R <u>NOTE</u>: For PN 405251 shaft, refer to SB 6276 for
R part re-identification.

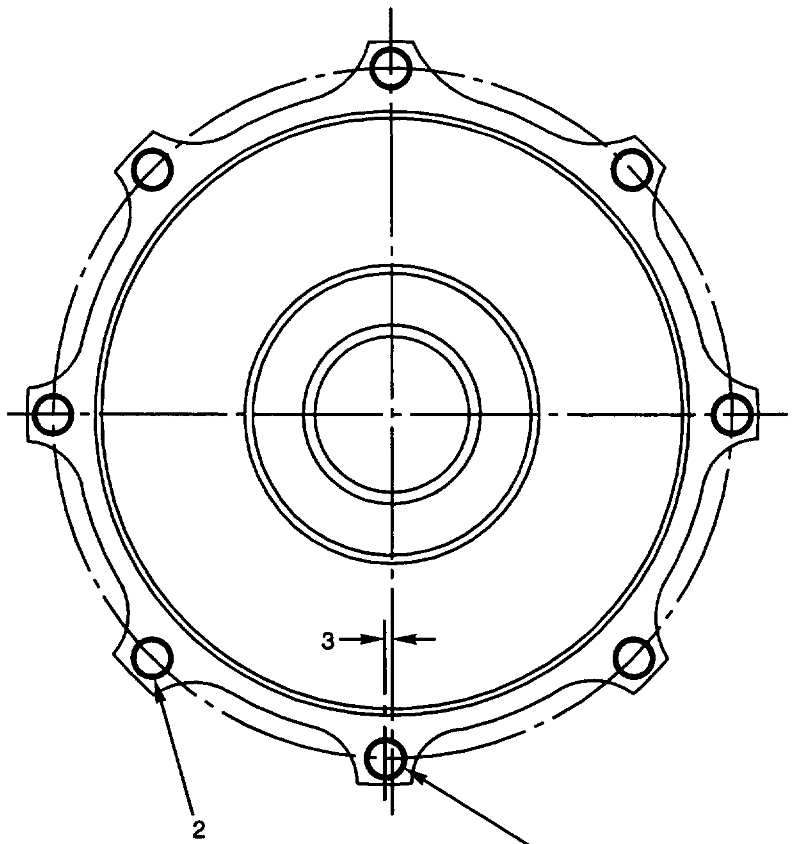
R (g) Apply antigalling compound to the area shown in
R the figure by SPOP 146. Refer to Section 70-41-03
R in the Standard Practices Manual.

3. <u>Turbine Shaft Coupling</u>
(See Tool Group 105B)

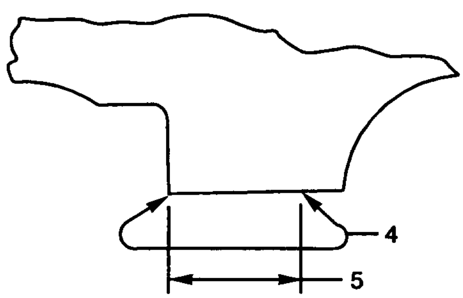
A. Plating Repair

(1) When necessary, strip and replate nickel-cadmium with the Fixture. Refer to SPOP 25 Plating, Section 70-44-01, Standard Practices Manual. Total surface area is 36 square inches.

<u>NOTE</u>: Electrical contact points are permitted in all areas but splines and threads. No burning, pitting, or selective attack is permitted. Paint electrical contact points with heat-resistant, high-baking, aluminum enamel after plating, but before baking.



VIEW A



VIEW B

L-H8019 (0207)
PW V

Turbine Shaft PWA 110
Coating Repair
Figure 607 (Sheet 2)

R 1. Offset Hole (Make X-Mark For Reference By Vibropeen). Coating Thickness In Hole Must Be 0.0005 Inch Minimum
R 2. Bolt Hole, 0.321 - 0.323 Inch Diameter, 8 Holes (7 On Basis Of 8 Holes An Equal Distance Apart And One Hole Offset As Shown (Index 1). Coating Thickness In Holes Must Be 0.0005 Inch Minimum But Hole Diameters Must Be In Limits
R 3. 0.050 Inch (Reference)
R 4. Coating Is Optional In This Area And Full Coverage is Not Necessary
R 5. 0.125 Inch Maximum

R Key to Figure 607 (Sheet 2)

(2) Apply PWA 586 antigalling compound to splines, threads, and rear side of front flange. See SPOP 146 Surface Treatments, Section 70-41-03, Standard Practices Manual.

4. Turbine Shaft Splined Lockring
(See Tool Group 105C)

A. Plating Repair

(1) When necessary to replate, refer to Turbine Shaft Coupling Plating, above. Total surface area is 16 square inches.

5. Turbine Shaft Lock
(See Tool Group 105D)

A. Plating Repair

(1) When necessary to replate, refer to Turbine Shaft Coupling Plating, above. Total surface area is 15 square inches.

6. Turbine Shaft Retaining Ring

A. Plating Repair

(1) When necessary, strip and replace nickel-cadmium, (with the applicable Fixture). Refer to SPOP 25 Plating, Section 70-44-01, Standard Practices Manual.

NOTE: Electrical contact points are permitted only in two holes. No burning, pitting, or selective attack is permitted.

7. Free Turbine Shaft
See Figure 608.

A. Repair

(1) Repair worn or damaged front and rear mating diameters of free turbine shaft front flange as follows:

(a) Machine to clean up damage on diameters, holding clean-up of front diameter (Index 2) to minimum value and clean-up of rear diameter (Index 1) to maximum.

(b) Nickel plate machined areas by SPOP 29 or SPOP 321. (See Section 70-44-01, Standard Practices Manual)

NOTE: Plating outside of enclosed area is permitted if excess plating is removed at finish machining. Electrical contact must be limited to area shown with no burning, pitting, or selective attack.

(c) Bake part at 185° - 196°C (365° - 385°F) for three hours.

(d) Finish machine to dimensions shown, maintaining radius and concentricity requirements.

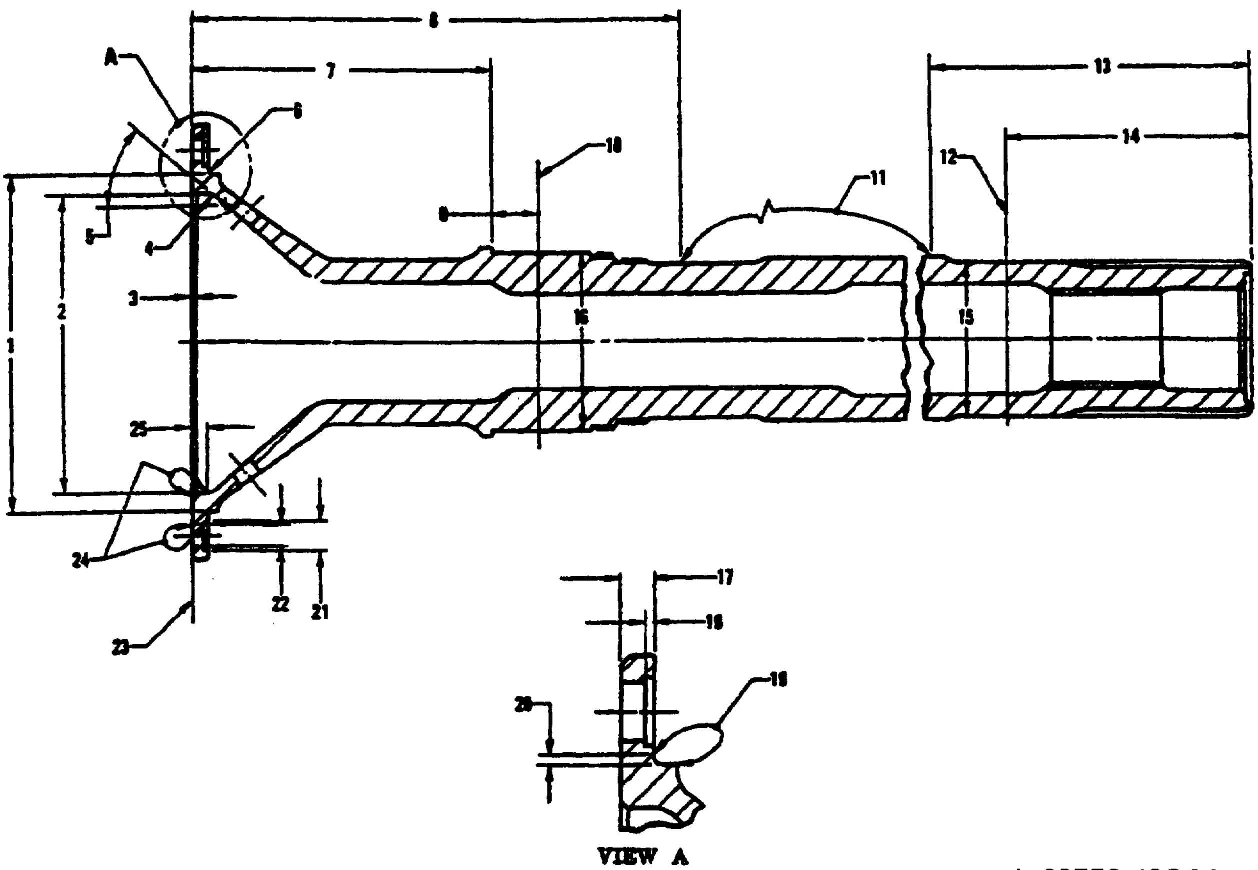
NOTE: All concentricity requirements shown are based upon shaft being mounted on Indexes 15 and 16 of Figure 606.

(e) Apply paint and antigalling compound in accordance with procedure above.

(2) Repair damaged tierod holes as follows:

(a) Machine bore of tierod hole to clean up for plating. Hold material removal to a minimum.

R NOTE: Tierod hole counterbore of shaft (Index 21
R in the figure) is permitted to be more than
R the manufactured maximum if related surface
R features are in limits. Use fluorescent
R penetrant inspection (refer to Section
R 72-00-00) to be sure that there are no
R tierod hole cracks.



R
R

Free Turbine Shaft Repair
Figure 608

1. 5.849 - 5.876 Inch Diameter After Cleanup Machining; Hold To Maximum Value. 5.893 Inch Minimum Diameter After Plate. 5.881 - 5.883 Inch Diameter After Finish Machining; Must Be Concentric Within 0.001 Inch FIR.
2. 5.214 - 5.232 Inch Diameter After Cleanup Machining; Hold To Minimum Value. 5.187 Inch Diameter Maximum After Plate. 5.197 - 5.199 Inches After Finish Machining; Must Be Concentric Within 0.001 Inch FIR.
3. 0.040 - 0.060 Inch by 43 - 47 Degrees Chamfer.
4. 0.130 - 0.150 Inch Radius
5. 41 Degrees, 29 Minutes Reference
6. 0.030 - 0.050 Inch Radius
7. 5.348 - 5.352 Inches
8. 8.720 Inches Minimum
9. 0.635 - 1.135 Inches
10. Reference Plane
11. Electrical Contact Area
12. Reference Plane
13. 5.620 Inches Minimum
14. 4.000 - 4.500 Inches
15. 2.7500 - 2.7505 Inches Diameter, Concentric Within 0.001 Inch FIR.
16. 3.1497 - 3.1502 Inches Diameter, Concentric Within 0.001 Inch FIR
17. 0.248 - 0.252 Inch
18. 0.060 - 0.080 Inch
19. Nickel Plate Area
20. 0.055 - 0.065 Inch
R 21. 0.505 - 0.525 Inch Diameter (Permitted To Increase To 0.555 Inch
R Maximum If Flange Thickness is Not Decreased) Maintain 0.010 - 0.020 Inch Corner Radius.
22. 0.452 - 0.467 Inch Diameter for Cleanup Machining, Hold To Minimum Value. 0.436 Inch Maximum Diameter After Plate. 0.446 - 0.447 Inch Diameter After Finish Machining. Each Hole Shall Be Positioned On The Basis Of 12 Holes Equally Spaced And Located Within 0.001 Inch Radius Of True Position In Relation To Index 1.
23. Reference Surface
24. Nickel Plate Area
25. 0.200 Inch

Key to Figure 608

(b) Nickel plate machined area by SPOP 29 or SPOP 321 (refer to Section 70-44-01, Standard Practices Manual). Plate buildup must conform with dimensions shown.

NOTE: Plating outside of enclosed area is permitted if excess plating is removed at finish machining. Electrical contact must be limited to area shown with no burning, pitting, or selective attack.

(c) Bake part at 185° - 196°C (365° - 385°F) for three hours.

(d) Finish machine nickel plated area to dimensions shown.

NOTE: All concentricity requirements given are based upon shaft being mounted on Indexes 15 and 16 of Figure 606.

(e) Apply paint and antigalling compound in accordance with the procedure above.

(3) Repair a worn or damaged No. 4 bearing journal as follows: See Figure 609.

NOTE: Base Metal: AMS 6304
Hardness: Rockwell C35-40 or equivalent

(a) Clean-up machine the bearing journal area to the dimensions given in the figure.

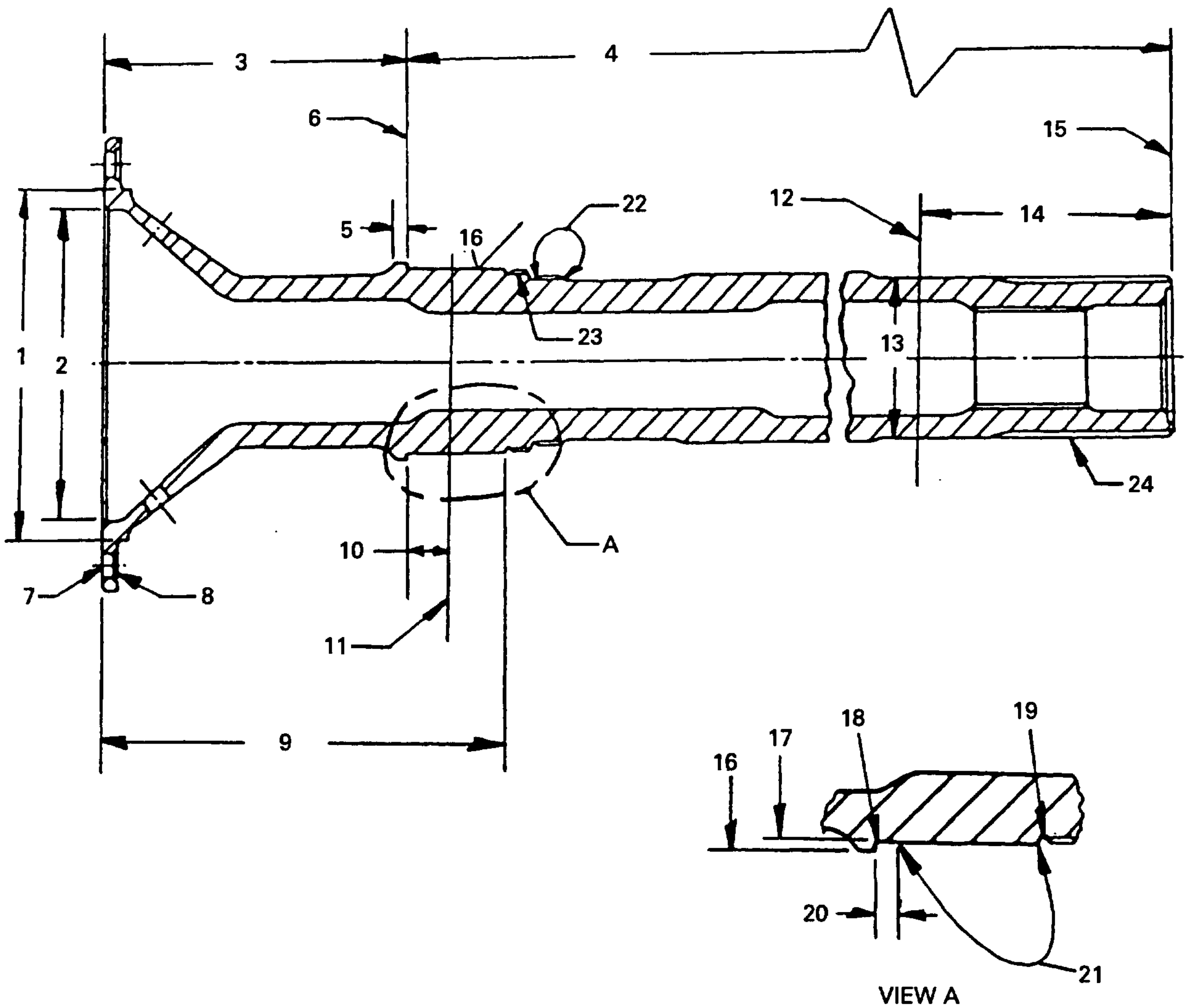
R (b) Remove the nickel-cadmium plate by SPOP 25. Refer
R to Section 70-44-01 in the Standard Practices
R Manual.

(c) Chromium plate the bearing journal by SPOP 22 (non-stainless steel). Refer to Section 70-44-01, Standard Practices Manual.

(d) Bake part at 396° - 427°C (750° - 800°F) for three hours.

(e) Finish machine to the dimensions given in the figure.

(4) Free Turbine Shaft Painting. See Figure 610.



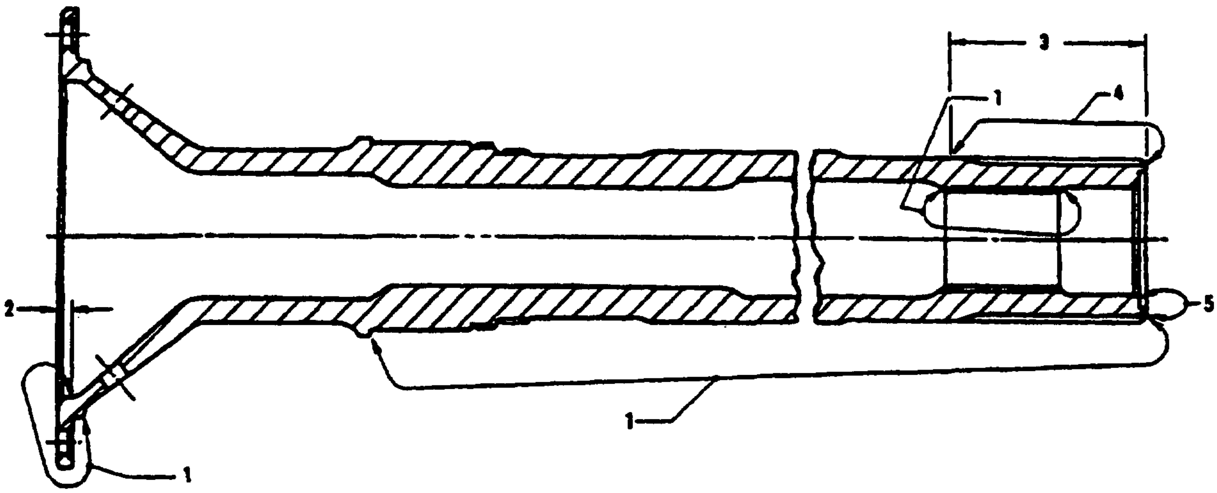
Free Turbine Shaft
Bearing Journal Repair
Figure 609

1. Reference Diameter
2. Reference Diameter
3. 5.348 - 5.352 Inches
4. 22.113 - 22.123 Inches
5. 0.190 - 0.210 Inch
6. Reference Face
7. Reference Face
8. Reference Face
9. 7.100 - 7.120 Inches
10. 0.635 - 1.135 Inches
11. Reference Plane
12. Reference Plane
13. Reference Diameter
14. 4.000 - 4.500 Inches
15. Reference Face
16. 3.325 - 3.335 Inch Diameter
17. 3.1342 - 3.1457 Inch Diameter After Clean-up Machining; Hold To Maximum. 3.1642 Inch Diameter Minimum After Plating. 3.1497 - 3.1502 Inch Diameter After Finish Machining.

    NOTE: When mounted on Indexes 11 and 12 planes, Index 17 diameter must be concentric with Indexes 1, 2, and 13 diameters within 0.001 inch FIR, with PD of Indexes 23 and 24 splines within 0.002 inch FIR. Diameter must be square with Index 6 face within 0.0005 inch FIR and Indexes 7, 8, and 15 faces within 0.001 inch FIR. Taper must not exceed 0.0002 inch FIR and out-of-roundness must not exceed 0.0003 inch FIR.

18. 0.005 - 0.020 Inch Radius
19. No Plating Allowed
20. 0.035 - 0.060 Inch. No Machining or Plating Allowed.
21. Chromium Plate Area
22. Electrical Contact Area
23. Reference Spline
24. Reference Spline

Key to Figure 609



1. Do Not Paint Enclosed Areas Except For PN 675615 Free Turbine Shaft Which Requires One Coat Of Aluminum Enamel, by PWA 110 (Task 70-41-04-380-100) Within Enclosure On Front Flange Area. Refer to Section 70-41-04 in the Standard Practices Manual.
2. 0.200 Inch
3. 3.300 Inches
4. Apply Antiseize, Antigalling Compound To Area Shown, Per SPOP 146
5. Paint With One Coat Of Aluminum Enamel by PWA 110 (Task 70-41-04-380-100). Refer to Section 70-41-04 in the Standard Pracices Manual.

R
R

Free Turbine Shaft Painting
Figure 610

(a) Apply PWA 586 antiseize, antigalling compound to free turbine splines by SPOP 146. Refer to Section 70-41-03 in the Standard Practices Manual.

(b) Paint shaft with two coats of high baking, heat-resistant PWA 595 aluminum coating by PWA 110 (Task 70-41-04-380-100). Refer to Section 70-41-04 in the Standard Practices Manual. except in areas shown. Rear face of shaft (aft of splines) must be limited to one coat.

(5) Free Turbine Shaft Corrosion Repair. See Figure 611.

(a) Machine or blend pitting (see the figure).

R **NOTE**: Blend areas must be smooth and continuous in
R all directions with a 20:1 length to depth
R ratio. Blends on opposite sides of the
R conical area are permitted but the wall
R thickness must be in the limits specified
R in the figure.

(b) Apply paint and antigalling compound (refer to the procedure above).

8. Free Turbine Shaft Coupling

A. Inspection

(1) Examine the coupling for worn or damaged nickel-cadmium plate.

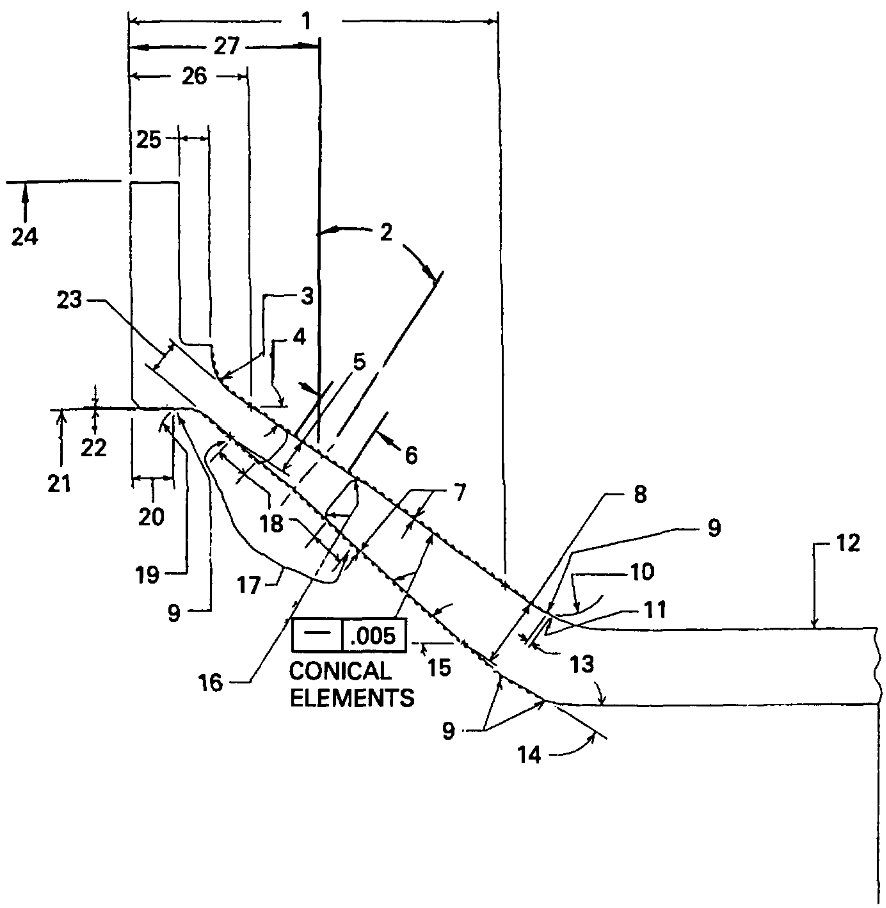
(2) Do a dimensional inspection of the coupling. See Figure 612.

B. Repair

(1) If either the plate or the runout surface does not meet requirements, repair as follows:

(a) Remove the remaining plate with SPOP 25.

(b) Restore the runout surface, if required, by removing a minimum amount of material. See Figure 613.



L-H3187 (1296)

R
R

Free Turbine Shaft
Corrosion Repair
Figure 611

1. 1.940 Inches
2. 41° 30′ (Reference)
3. 0.234 - 0.266 Inch Radius
4. 35° 4′ (Reference)
5. 0.192 Inch Minimum
6. 0.420 Inch Diameter Maximum. Eight Places.
7. 0.010 Inch Maximum (Reference)
8. 0.374 Inch Minimum
9. Break Edge 0.003 - 0.015 Inch
10. 0.234 - 0.266 Inch Modified Radius
11. Existing Tangency

R 12. PN 575130 or 675615 Shaft (Reference)

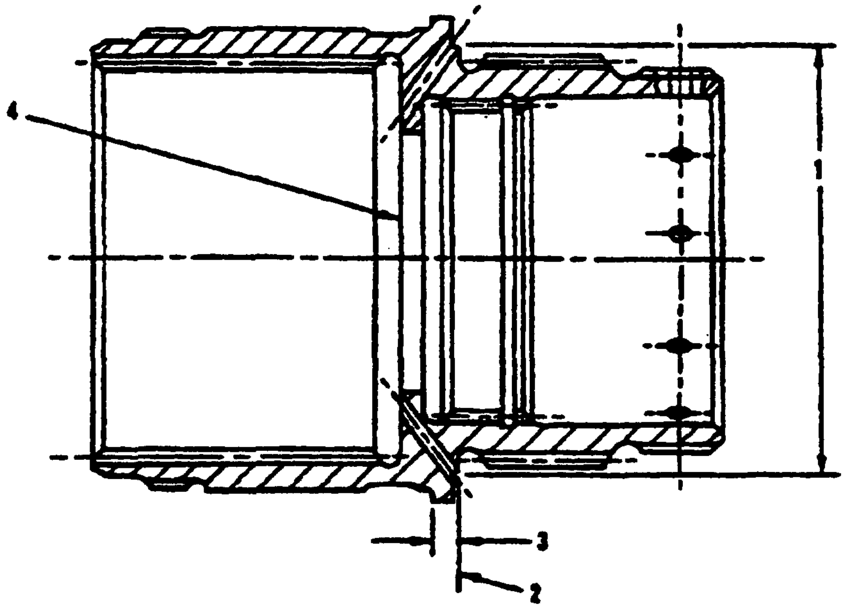
13. 0.025 Inch Minimum
14. 30° (Reference)
15. 41° 25′ (Reference)
16. 0.031 - 0.094 Inch Radius. Eight Places. Blend Smooth And Continuous With Existing Radius.
17. No Step Or Local Blends Are Permitted In This Area All Around On Each Side.
18. 0.250 Inch
19. 0.130 - 0.150 Inch Radius
20. 0.200 Inch Minimum
21. 5.197 - 5.199 Inch Diameter
22. 0.017 Inch Maximum. Undercut Applies Only When Index 21 Diameter Is Within Tolerance Shown
23. 0.180 Inch Minimum

R 24. 7.533 Inch Diameter Minimum For Removal Of Corrosion Material

25. 0.140 Inch Minimum
26. 0.615 Inch
27. 1.000 Inch (Reference)

R NOTE: Material removal is permitted in the area shown by a
R dashed line.

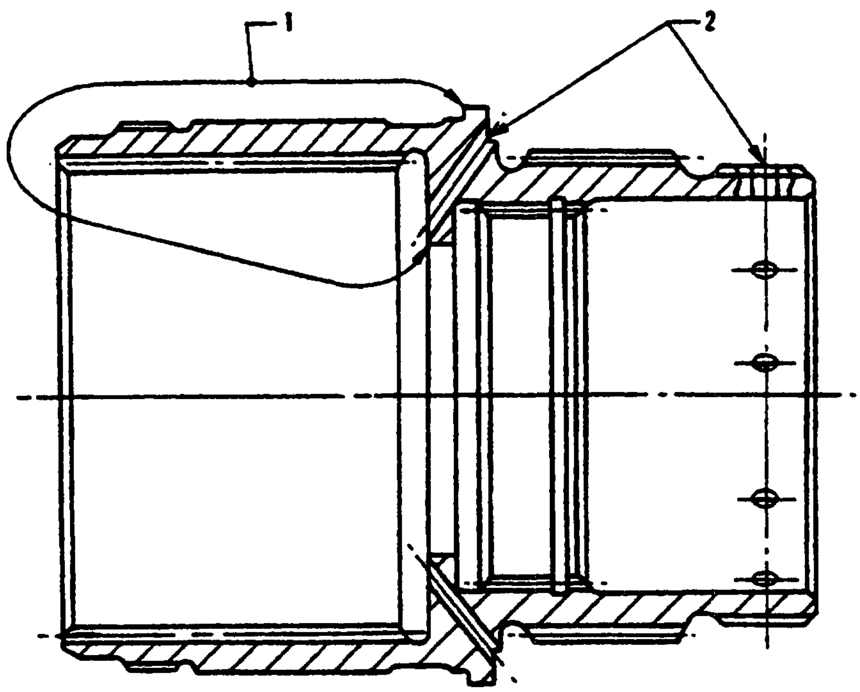
Key to Figure 611



L-88507 (0000)

1. 2.825 - 2.855 Inch Diameter
2. Runout Surface. This surface Must Be Parallel To Index 4 Surface 0.0015 Inch FIR Maximum. Remove Minimum Material.
3. 0.123 Inch minimum Before Plate
4. Reference Surface

Free Turbine Shaft Coupling
Runout Surface Check
Figure 612



1. No Plate Area
2. Nickel Plate In These Holes Is Optional And May Be Incomplete (No Cadmium Plate Allowed)

Free Turbine Shaft
Coupling Repair
Figure 613

9. Free Turbine Shaft Coupling Nut
See Figure 614.

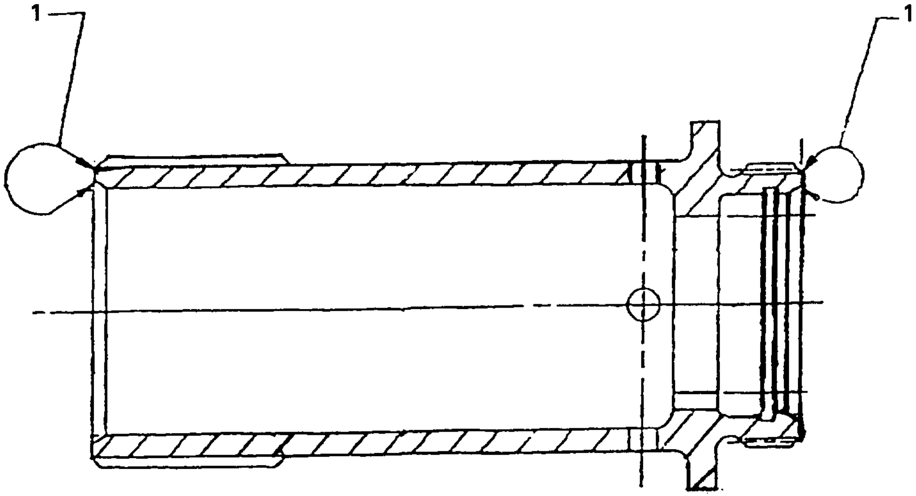
A. Corrosion Restoration - Superficial Condition

(1) Strip all nickel-cadmium coating to SPOP 25. See Section 70-44-01, Standard Practices Manual.

(2) Clean the part by SPOP 9 or SPOP 10. See Section 70-21-01, Standard Practices Manual.

(3) Coat the part with nickel-cadmium by SPOP 25. See Section 70-44-01, Standard Practices Manual.

(4) Fully cover the contact points (Index 1 of the figure) by SPOP 142 after plate but before SPOP bake. See Section 70-41-03, Standard Practices Manual.



L-H3180 (1296)

1. Electrical Contact Permitted Only In This Area. No Burning, Pitting Or Selective Attack Permitted.

Free Turbine Shaft Coupling Nut
Corrosion Restoration
Figure 614

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-06

1. Engine Turbine Section - Turbine Disks And Seals

   A. General

      (1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Turbine Disks

   A. Turbine Disk Life Limits

      (1) Flight cycles as well as operating time determine disk life. This information must be recorded.

      (2) Replace disk if either flight cycle or operation time limit is reached. Refer to Section 5.

      NOTE: For definition and regulations concerning flight cycle limits, refer to Section 5, Compressor Disk Life Limits.

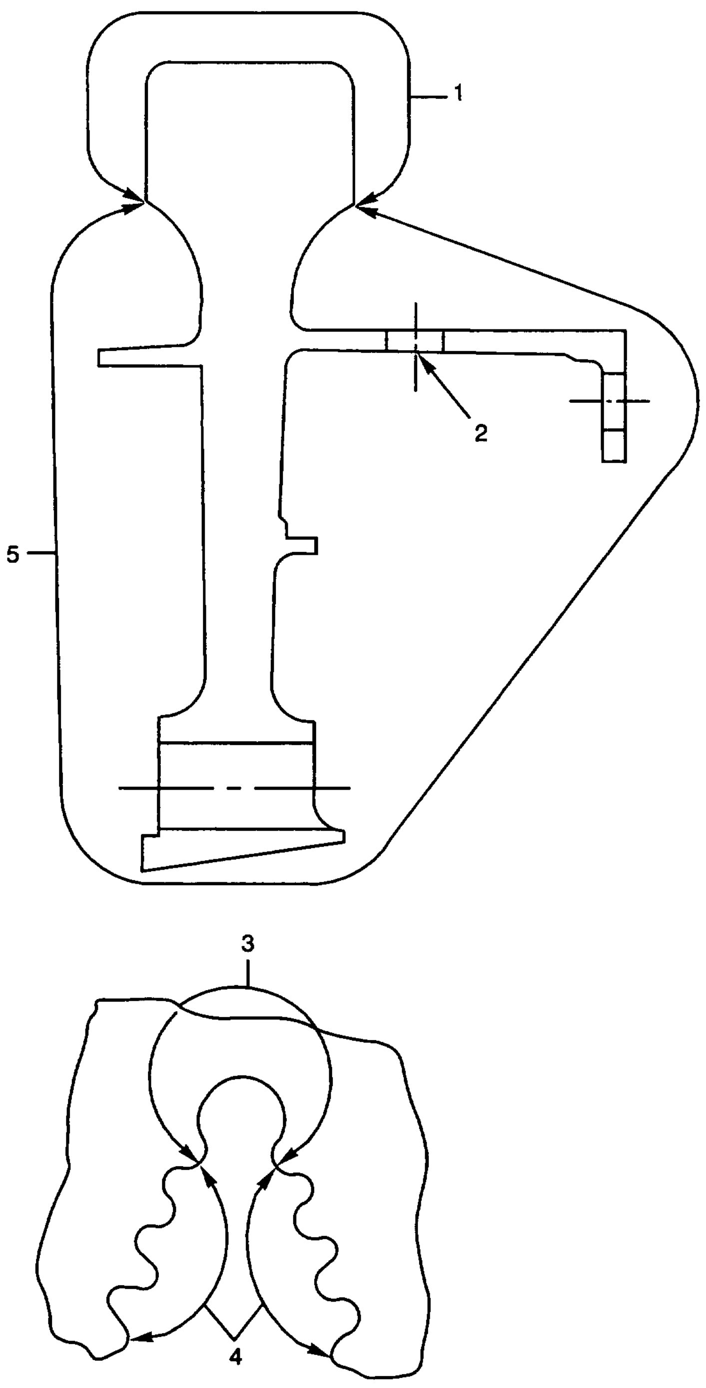
   B. Inspection
   See Figure 601 and Figure 602.

      (1) Inspect tierod holes, mating diameters, and blade slots visually for surface damage (nicks, dents, scratches, and corrosion) with white light and three power magnification.

      WARNING: DO NOT REWORK ANY DISK THAT HAS CRACK OR ANY INDICATION NOT CLEARLY RESULT OF LOCALIZED SURFACE DAMAGE (SUCH AS NICKS, DENTS, SCRATCHES, AND CORROSION PITS). PRESENCE OF CRACKS OR OTHER UNUSUAL CONDITIONS CONFIRMED BY FLUORESCENT PENETRANT, MAGNETIC PARTICLE, OR VISUAL EXAMINATION IS CAUSE FOR REJECTION. CLOSE ATTENTION MUST BE GIVEN TO TIEBOLT HOLES, COUNTERWEIGHT HOLES, LIGHTENING HOLES, BLADE SLOTS, AND BORE.

      (2) Smooth impressions from parts, such as spacers or tierods, are acceptable, and do not require repair.

      NOTE: Enclosures on Figure 601 and Figure 602 are to tangent points, sharp corners, 0.125 inch from holes, blade slots, and mating diameters or spacer mating surfaces.



R
R

First Stage Turbine
Disk Inspection
Figure 601

1. No Surface Damage Allowable
2. No Surface Damage Allowable In Any Hole Or Within 0.125 Inch On Adjacent Surface
3. No Surface Damage Allowable On Enclosed Slot Area, Chamfer, Or Within 0.125 Inch On Adjacent Surface
4. Scattered Surface Damage Up To 0.003 Inch Deep Allowable
5. Scattered Surface Damage Up To 0.005 Inch Deep Allowable

Key to Figure 601

(3) Punch Marks
See Figure 603.

(a) Examine 1st and 2nd stage disks for punch marks.

(b) Repairable punch marks may be blended, using fine-cut hand-files, stones, and abrasive cloth. Refer to SPOP 533 in the Standard Practices Manual.

(4) Gas Generator and Free Turbine Disk Hardness Check Dimple/Impression Acceptability on Bore Front and Rear Surfaces. See Figure 604.

(a) Continued service use limitations:

1 Hardness dimples are shallow, round-bottomed impressions and are acceptable without repair if:

a There are no more than three impressions per surface (front and rear) (Index 1).

b There are no other marks or imperfections in this area.

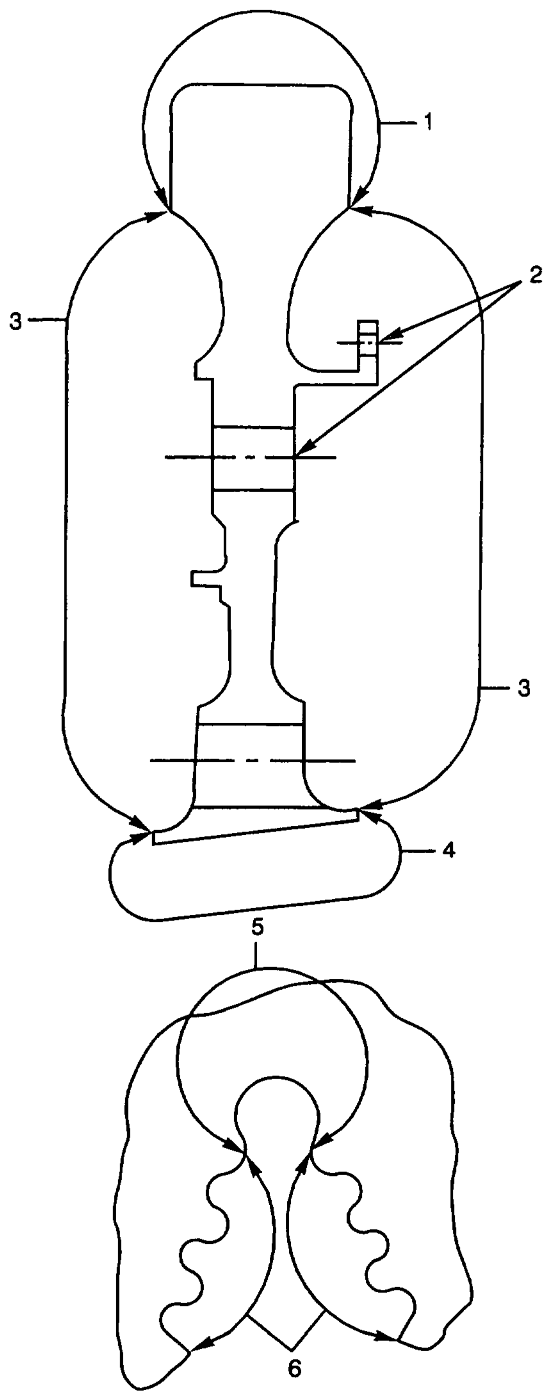
c There is no surface damage on the bore ID surface.

(b) Future hardness checks are not permitted in this area.

(5) Hardness check

(a) Measure hardness of 1st and 2nd stage turbine disks and 1st and 2nd stage free turbine disks.

(b) Minimum hardness is 66, Rockwell A scale.



Second Stage Turbine
Disk Inspection
Figure 602

1. No Surface Damage Allowable
2. No Surface Damage Allowable In Tiebolt Holes, Balance Weight Holes, Chamfers, Or Within 0.125 Inch On Adjacent Surface
3. Scattered Surface Damage Up To 0.005 Inch Deep Allowable
4. Scattered Surface Damage Up To 0.005 Inch Deep Allowable
5. No Surface Damage Allowable On Enclosed Slot Area, Chamfer, Or Within 0.125 Inch On Adjacent Face.
6. Scattered Surface Damage Up To 0.003 Inch Deep Allowable

Key to Figure 602

(6) Growth Limits
See Tool Group 96C.

(a) Measure turbine disks as follows:

1 For turbine disks featuring machine-stepped OD on outer periphery of fir-tree slots, use following procedure:

a Measure diameter on step of disk in at least four places, equally spaced, with standard measuring equipment.

R b Compute average dimension.

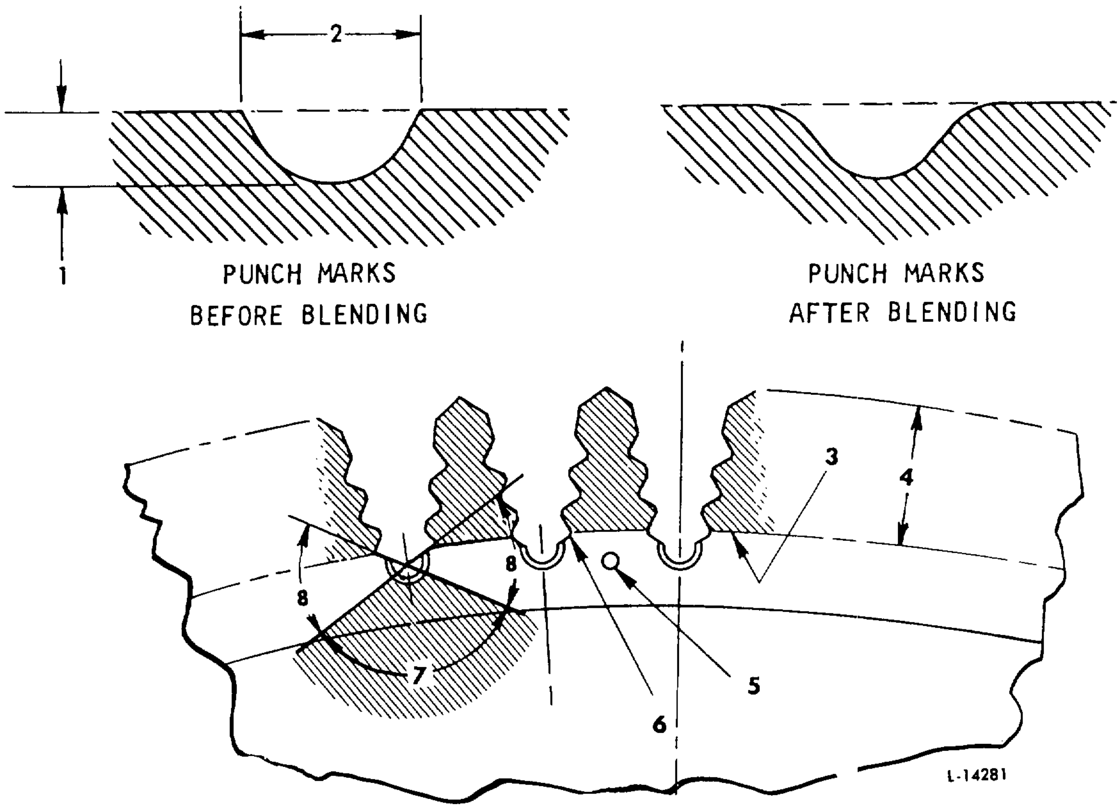
c Subtract dimension marked at manufacture on face adjacent to fir-tree slot from average measured dimension to obtain disk growth.

d Replace disks having growth in excess of 0.006 inch.

2 For turbine disks not having machine-stepped OD, determine growth in accordance with either or both of these procedures:

a Measure disk at several locations around each diameter indicated in Figure 605. Replace all disks with a diameter larger than the limits shown.

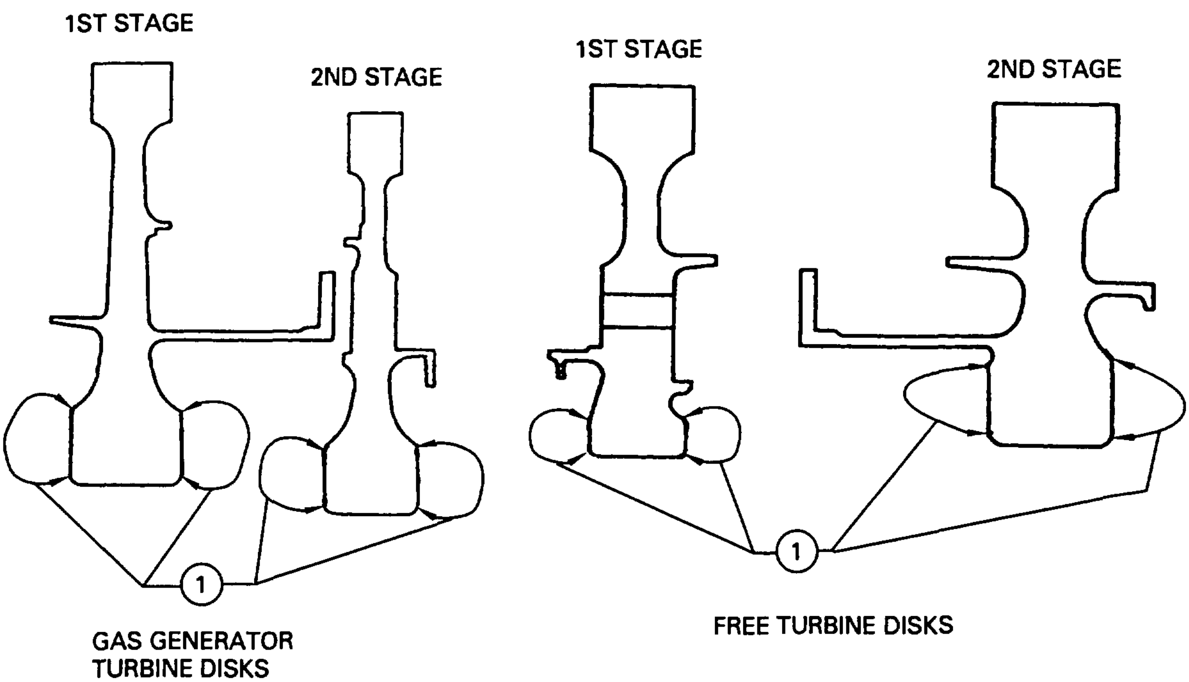
b Install two plugs, 180 degrees apart, in the fir-tree serrations of disk. Using vernier caliper, measure across gaging balls, and subtract dimension marked on tool (distance from gaging ball to reference plane) from measurement. Repeat measurement at several locations around disk to obtain average



1. Maximum Depth Of Punch Marks Is 0.0461 Inch
2. Maximum Width Of Punch Marks Is 3/32 Inch (0.0937 Inch)
3. Radius Line Through Center Of Bottom Broached Groove. No Punch Mark Damage Permitted Outboard
4. No Punch Mark Damage Permitted In This Area
5. Punch Marks Are Limited To One Between Any Two Rivet Holes (Slots).
6. Bottom Broached Groove
7. 120 Degrees. No Damage Permitted. No Repair Permitted. Surface Must Be Smooth (This Is A Critical Stress Area)
8. 60 Degrees

R
R

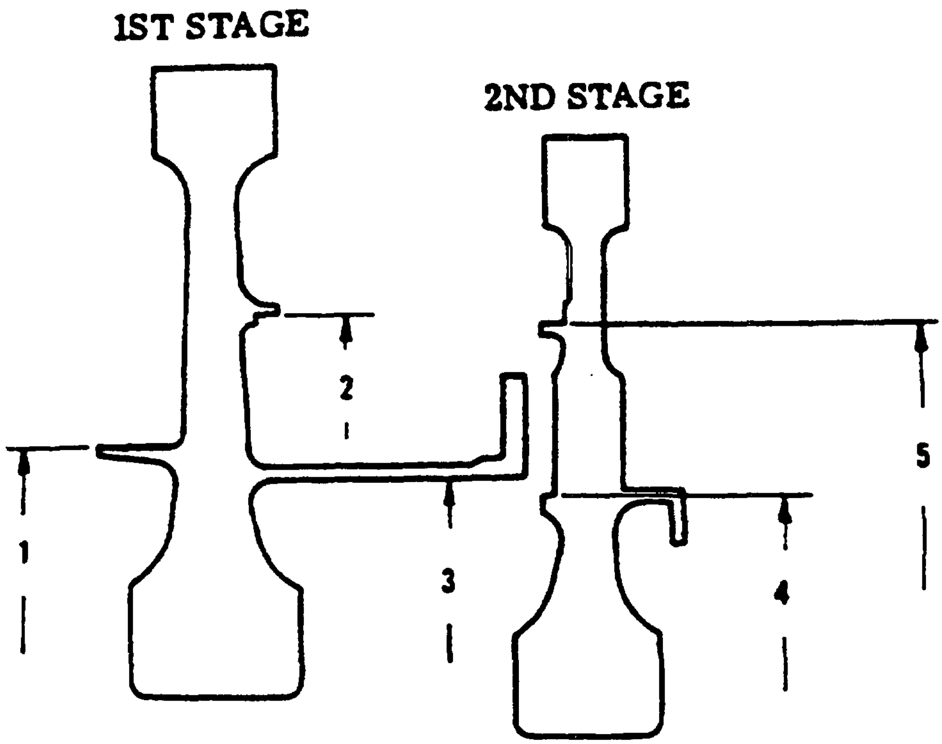
Punch Mark Repair
Figure 603



L-H3194 (1296)

1. Hardness Dimple Area

Hardness Dimple Inspection
Figure 604



L-23036 (0000)

1. 6.506 Inch Diameter
2. 8.153 Inch Diameter
3. 6.109 Inch Diameter
4. 5.905 Inch Diameter
5. 7.957 Inch Diameter

Turbine Disk Growth Limits
Figure 605

diameter. Replace a disk with a diameter larger than:

1st Stage	10.696 Inches
2nd Stage	9.786 Inches

(b) Measure free turbine disks with the above procedures:

1 Replace disks with stepped OD having growth in excess of 0.006 inch.

2 Replace disks without stepped OD that have stretched beyond allowable limits shown in Figure 606. Measure at several locations around disks to obtain average diameters.

NOTE: Gaging ball measurement procedure is optional to this method.

3 Replace, when using gaging ball measurement method, a disk with a diameter greater than:

1st Stage	11.682 Inches
2nd Stage	11.064 Inches

R (c) Repair free turbine surface damage with the blend
R and machining repairs below.

C. Repair

(1) Mating Diameters, Boltholes, and Mating Surfaces. See Figure 607 and Figure 608.

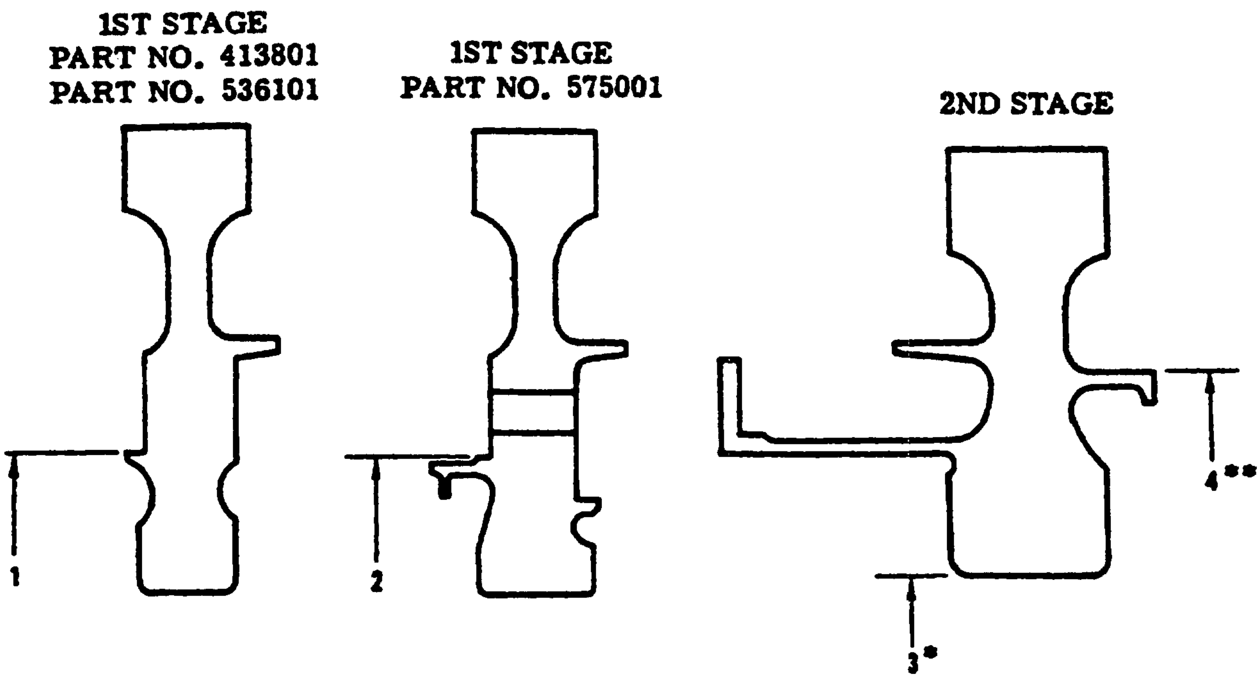
(a) Worn or damaged turbine disk mating diameters may be repaired as follows:

1 Measure a mating diameter before machining to remove damage.

NOTE: This repair is intended to remove surface damage only and not to correct fit of parts.

2 Machine mating diameter up to 0.005 inch (radially) to remove damage.

3 Nickel plate by SPOP 26 (refer to the Standard Practices Manual.



L-23033 (0000)

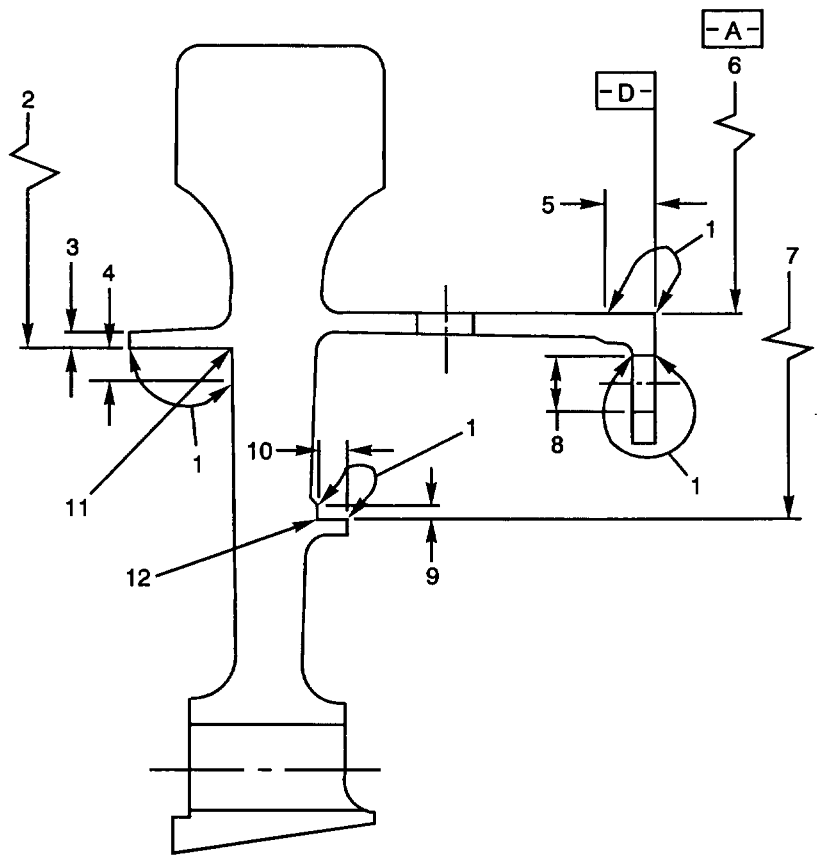
*Growth limit is based on as machined bore diameter which should be stamped on disk.

**This growth limit is to apply to disks which do not have machined bore diameter stamped on them.

1. 5.847 Inch Diameter
2. 5.705 Inch Diameter
3. 0.014 Inch Growth (Diameter)
4. 7.407 Inch Diameter

R
R

Free Turbine Disk
Growth Limits
Figure 606



L-15366 (0108)
PW V

First Stage Turbine
Disk-Plating
Figure 607

1. Plate Enclosed Area
2. 6.480 - 6.493 Inches Diameter Before Plate (Hold To Maximum Value). 6.510 Inch Diameter Minimum After Plate.
R 6.498 - 6.502 Inch Diameter Finish Dimension. This Diameter Must Be Concentric With Diameter A, Index 6 Within 0.002 Inch FIR.
3. 0.038 Inch Minimum Wall Thickness Before Plate
4. 0.047 - 0.062 Inch
5. 0.200 - 0.240 Inch
6. 6.110 - 6.125 Inch Diameter Before Plate; Hold To Minimum Value. 6.093 Inch Diameter Maximum After Plate. 6.103 - 6.105 Inch Diameter Finish Dimension. This Diameter A Must Be Square With Face D Within 0.002 Inch FIR.
7. 8.154 - 8.169 Inch Diameter Before Plate; Hold To Minimum Value. 8.137 Inch Diameter Maximum After Plate. 8.147 - 8.149 Inch Diameter Finish Dimension. This Diameter Must be Concentric with Diameter A, Index 6 Within 0.002 Inch FIR.
8. 0.327 - 0.336 Inch Diameter Before Plate; Hold To Minimum Value. 0.311 Inch Diameter Maximum After Plate. 0.321 - 0.322 Inch Diameter Finish Dimensions. Back Chamfer 90° ± 5° to 0.360 - 0.380 Inch Diameter. Locate Holes Within 0.001 Inch Of True Position In Relation To Diameter A, Index 6.
9. 0.020 - 0.035 Inch
10. 0.160 - 0.170 Inch
11. 0.016 - 0.047 Inch Radius
12. 0.005 - 0.020 Inch Radius

Key to Figure 607

4 Machine to dimensions obtained in step 1.

(b) Damaged turbine tiebolt holes may be repaired as follows:

1 Machine to clean up damage up to 0.005 inch radially (0.010 inch from hole diameter).

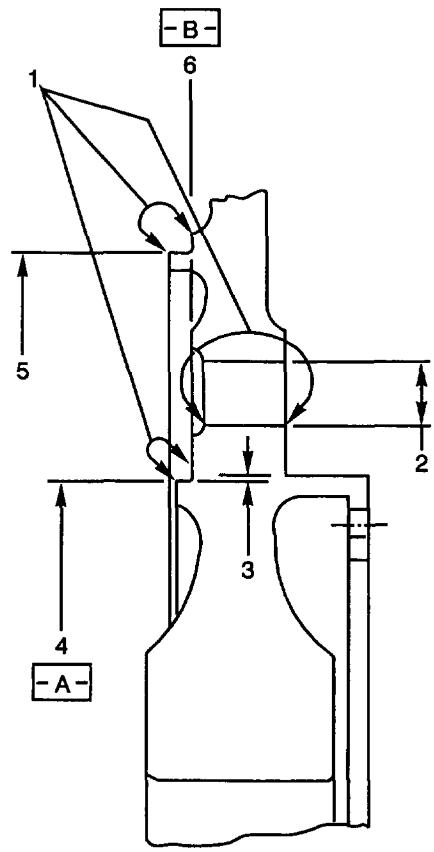
2 Nickel plate by SPOP 26.

3 Finish machine to dimensions shown.

(c) Repair damaged turbine disk mating surfaces as follows:

1 Machine up to 0.005 inch per side to remove surface damage.

2 Nickel plate by SPOP 26.



L-16031 (0108)
PW V

Second Stage Turbine
Disk-Plating
Figure 608

1. Plate Enclosed Area
2. 0.325 - 0.340 Inch Diameter Before Plating, Hold To Minimum Value. 0.309 Inch Diameter After Plating. 0.319 - 0.321 Inch Finish Dimension Located Within 0.002 Inch Of True Position In Relation To Diameter A.
3. 0.020 - 0.035 Inch
4. Diameter A 5.879 - 5.894 Inch Diameter Before Plating, Hold To Maximum Value. 5.911 Inch Diameter After Plating. 5.899 - 5.901 Inch Diameter Finish Dimension. This Diameter Must Be Square With Face B Within 0.002 Inch FIR.
5. 7.931 - 7.946 Inch Diameter Before Plate, Hold To Maximum
R Value. 7.963 Inch Diameter After Plate. 7.951 - 7.953 Inch Diameter Finish Dimension. This Diameter Must Be Concentric With Diameter A Within 0.002 Inch FIR.
6. Face B

Key To Figure 608

3 Finish machine to dimensions shown.

(d) Bore Repair

1 Maximum bore clean-up diameter is 3.530 inches for 1st stage turbine disks and 3.030 inches for 2nd stage disks.

2 After machining, carefully restore bounding radii, maintaining circumferential lay of tool marks.

(e) Turbine Disk Bolt Surface Blend Repair

1 Damage to rear face flat of turbine disk at bolt area may be blend-repaired.

NOTE: Blend-repair applies only to bolt area of turbine disk.

2 Hand-stone face to remove high spots and burrs. Nicks and dents may be round-bottom blended to maximum depth of 0.005 inch to remove sharp stress risers.

3 Face under nut and tab washer must be free of any damage.

(f) Rivet Slot and Slot Chamfer Repair

1 Damage caused by scoring in rivet slot may be repaired by blending to depth of 0.005 inch, using ten to one width to depth blend ratio.

a Up to 1/2 length of rivet slot may be repaired if damage extends to edge of disk.

b If material from edges of disk to 1/8 inch depth into slot remains undamaged, remainder of slot may be blended.

NOTE: Adequate rivet flare is required after this repair.

2 Damage at rivet groove chamfer is repairable, provided damage does not extend 1/16 inch beyond ID surface of groove, does not encompass more than 120 degrees of chamfer and does not exceed 0.010 inch in depth.

NOTE: Repairable rivet groove damage shall be blended with fine files and/or stones. Use No. 500 grit abrasive tape (1/8 - 3/16 inch wide) to polish area. All marks must be removed from chamfer.

R (g) Free Turbine Disk Mating Diameter Surface Damage Repair. See Figure 609 and Figure 611.

1 Worn or damaged turbine disk diameter can be repaired by the procedure that follows:

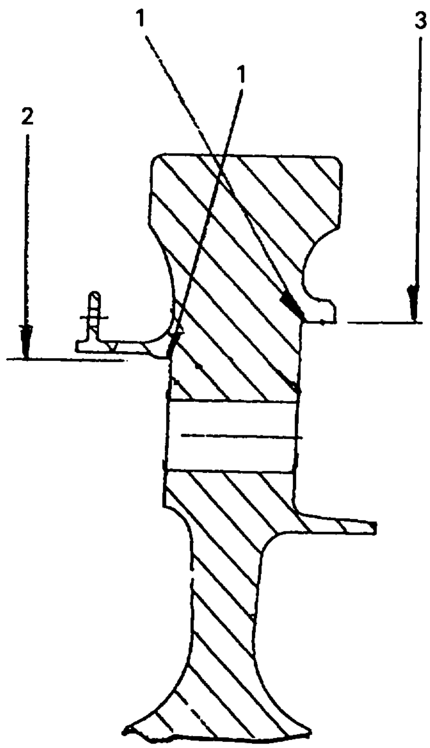
a Fluorescent penetrant inspect affected areas by SPOP 84. Refer to Section 70-33-00, Standard Practices Manual.

b Measure mating diameters before they are machined to remove damage.

NOTE: This repair is intended to remove surface damage only and not to correct the fit of parts.

c Machine the mating diameters up to 0.010 inch radially to remove damage.

d Fluorescent penetrant inspect affected areas by SPOP 84. Refer to Section 70-33-00, Standard Practices Manual.

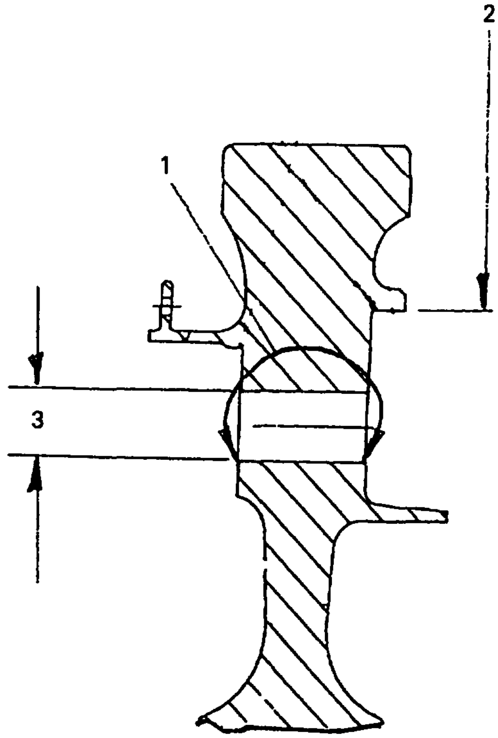


L-H3190 (1296)

1. 0.010 - 0.030 Inch Radius
2. 5.680 - 5.694 Inch Diameter Before Plate; Hold To Maximum Value.
   5.710 Inch Diameter Minimum After Plate
   5.699 - 5.701 Inch Diameter Finish Dimension. This Diameter Must Be Concentric With Diameter A Index 3 Within 0.002 Inch FIR.
3. Diameter A
   5.180 - 5.194 Inch Diameter Before Plate; Hold Maximum Value.
   5.210 Inch Diameter Minimum After Plate
   5.199 - 5.201 Inch Diameter Finish Dimension

R

First Stage Free Turbine Disk
Mating Diameters Plating
Figure 609



1. Plate Enclosed Area
2. Diameter A
   5.180 - 5.194 Inch Diameter Before Plate; Hold To Maximum Value
   5.210 Inch Diameter Minimum After Plate
   5.199 - 5.201 Inch Diameter Finish Dimension
3. 0.453 - 0.467 Inch Diameter Before Plate; Hold To Minimum Value
   0.436 Inch Diameter Maximum After Plate
   0.446 - 0.448 Inch Diameter Finish Dimension Located Within
   0.002 Inch Of True Position In Relation To Diameter A, Index 2

R

First Stage Free Turbine Disk
Tierod Hole Plating
Figure 610

e Nickel plate by SPOP 26. Refer to Section 70-44-01, Standard Practices Manual.

f Machine to dimensions in Index 2 of the figure.

g Break all sharp edges to 0.003 - 0.015 inch.

h Fluorescent penetrant inspect affected areas by SPOP 84. Refer to Section 70-33-00, Standard Practices Manual.

R (2) Free Turbine Disk Tierod Hole Repair. See Figure 610 and Figure 612.

(a) Damaged turbine tierod holes can be repaired by this procedure:

1 Fluorescent penetrant inspect affected area by SPOP 84. Refer to Section 70-33-00, Standard Practices Manual.

2 Machine to clean up damage up to 0.010 inch radially (0.020 inch from the hole diameter).

3 Fluorescent penetrant inspect by SPOP 84. Refer to Section 70-33-00, Standard Practices Manual.

4 Nickel plate by SPOP 26. Refer to Section 70-44-01, Standard Practices Manual.

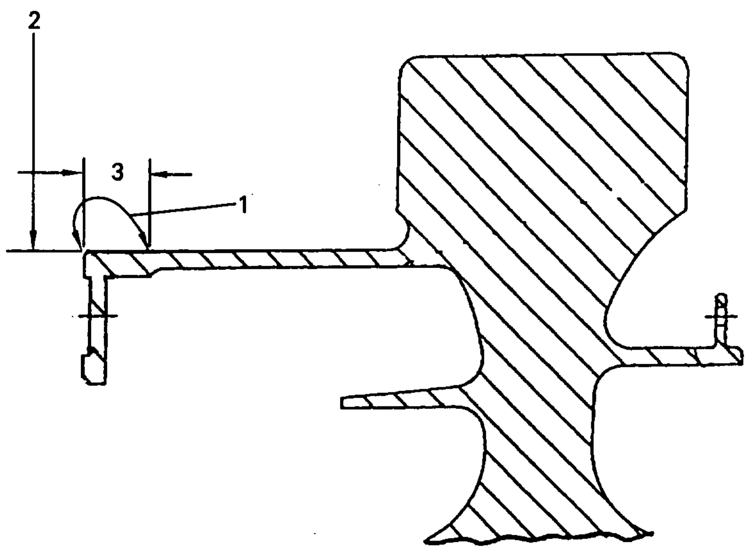
5 Finish machine to dimensions in the figure.

6 Break all sharp edges to 0.003 - 0.015 inch.

7 Fluorescent penetrant inspect affected areas by SPOP 84. Refer to Section 70-33-00, Standard Practices Manual.

(3) Free Turbine Disk Rim Impact Mark Repair. See Figure 613.

NOTE: Before repair, make sure that a disk has no cracks. Refer to the fluorescent penetrant specifications in Section 72-00-00.

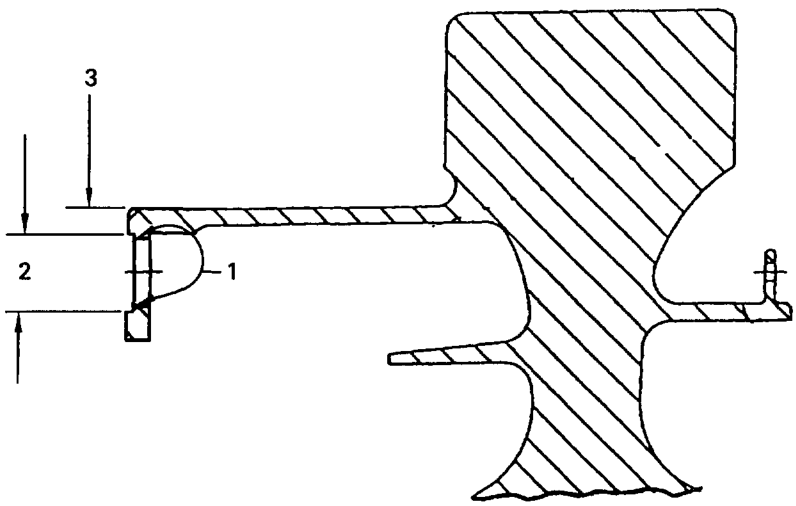


L-H3192 (1296)

1. Plate Enclosed Area
2. Diameter A
   5.886 - 5.900 Inch Diameter Before Plate; Hold Minimum Value.
   5.869 Inch Diameter Maximum After Plate.
   5.879 - 5.881 Inch Diameter Finish Dimension.
3. 0.310 Minimum

R

Second Stage Free Turbine Disk
Mating Diameter Plating
Figure 611



L-H3193 (1296)

1. Plate Enclosed Area.
2. 0.453 - 0.467 Inch Diameter Before Plate; Hold To Minimum Value.
   0.436 Inch Diameter Maximum After Plate.
   0.446 - 0.448 Inch Diameter Finish Dimension.
   0.480 - 0.501 Inch Diameter By 0.030 - 0.050 Inch Deep Spotface.
   0.010 - 0.020 Inch Corner Radius
   Back Chamfer 85 - 95 Degrees Included, To 0.480 - 0.501 Inch Diameter Locate Holes Within 0.002 Inch Of True Position In Relation To Diameter A, Index 3
3. Diameter A (Reference)

R

Second Stage Free Turbine Disk
Tierod Hole Plating
Figure 612

(a) Remove damage to rim and fir-tree slot areas at the front or rear of a free turbine disk. Axial width
R (Index 3) must not decrease to less than:

1 First Stage (PN 575001): 1.217 inch minimum

2 Second Stage (PN 575002): 1.597 inch minimum

(b) Keep all chamfers, edge breaks, and fillet radius in limits.

(c) Refer to SPOP 533 in the Standard Practices Manual for procedures.

(4) Free Turbine Disk Surface Damage Repair. See Figure 614.

NOTE: Before repair, make sure that a disk has no cracks. Refer to the fluorescent penetrant specifications in Section 72-00-00.

(a) Disk air seal land areas:

1 Scoring to depth of 0.010 inch maximum is permitted in the disk air seal land area (see the figure for applicable areas).

2 Remove all raised material.

(b) Outboard disk face:

1 Dents or pits to depth of 0.005 inch maximum on the outboard disk face (see the figure) can get blend repair but taper ratio must be not less than 20:1 in all directions.

(c) Disk bore:

1 Damage to depth of 0.010 inch maximum in the disk bore can get repair in which the bore is machined to a larger diameter. See Table 601 for bore limits.

Disk Feature	Letter (See Figure 614)	Dimensional Limit (Inches) 1st Stage	2nd Stage
Bore	A	3.125 Max	3.425 Max
Bore Width	B	1.256 Min	1.880 Min
Bore Edge Radius	C	0.062 - 0.094	0.109 - 0.141

Free Turbine Disk Surface Damage Limits
Table 601

(d) Refer to SPOP 533 in the Standard Practices Manual for procedures.

(e) Make corner radius to the limits specified. No sharp corners are permitted.

(f) The outer blend radius of the bore area face must be in limits after the repair (see Sheet 2 of the figure). No sharp edges are permitted.

(g) Blend repairs are not permitted in the disk bore area. Repair must fully remove all dents and pits.

3. Turbine Rotor And Free Turbine Rotor Inner Seal

A. Repair

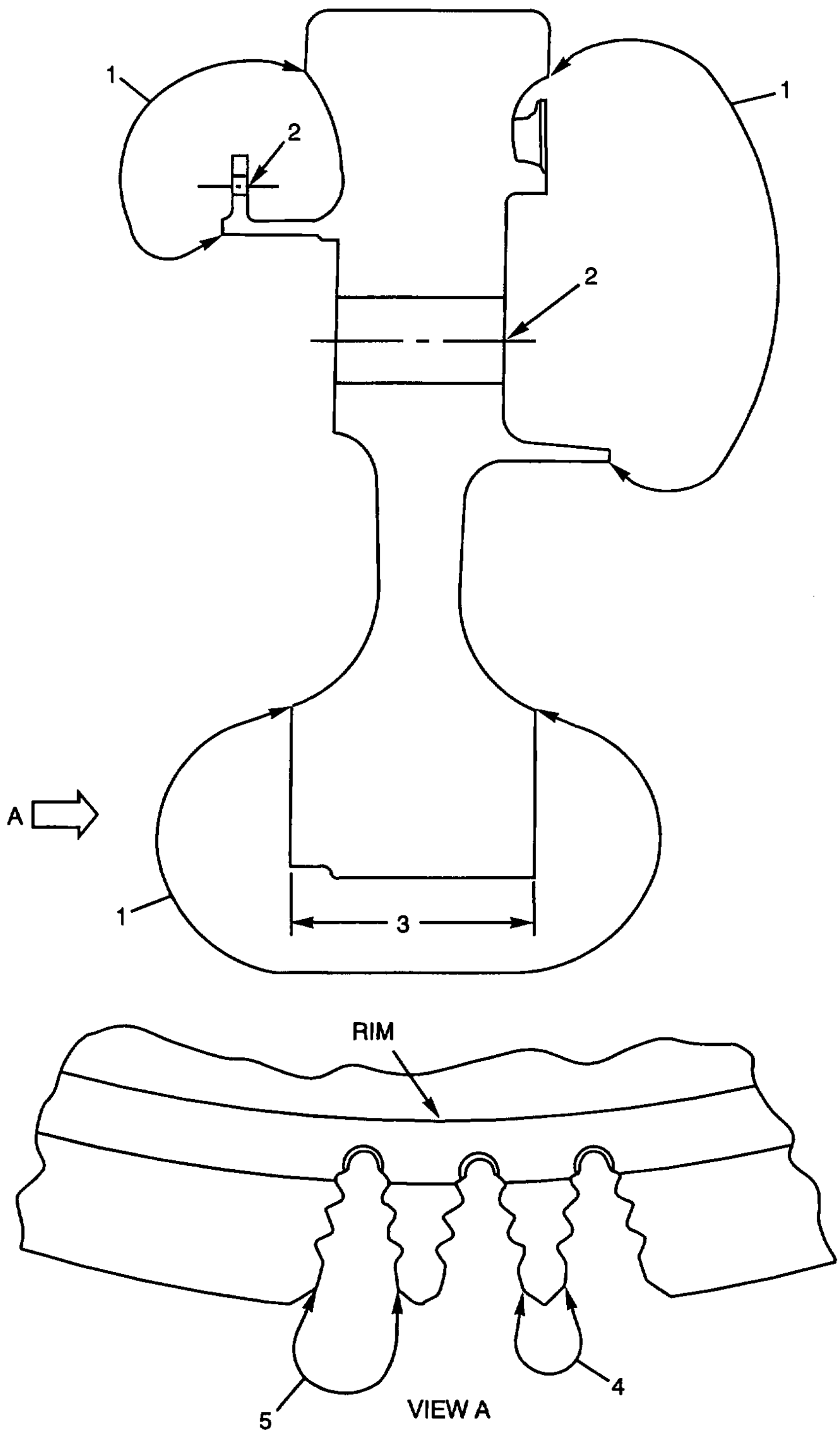
(1) Blend damaged seals in Area A by profiling provided depth of blend does not extend into Area B.

(2) Removal of material from 1st stage turbine rotor and free turbine knife-edge (Figure 615 and Figure 616) must not exceed one linear inch total (measured circumferentially around seal) from one knife-edge or cumulated total of one linear inch from both knife-edges.

NOTE: For turbine rotor outer 1st stage seal spacer surface treatment (by SPOP 146), see Figure 617.

(3) Total material removed from front seal of turbine rotor and free turbine inner seal (Figure 618) shall not exceed 0.500 linear inch. Total material removed from rear three seals must not exceed cumulated total of one linear inch.

R
R



L-H4587 (0108)
PW V

Free Turbine Disk Blend Limits
(First Stage)
Figure 613 (Sheet 1)

R 1. Scattered Surface Damage 0.005 Inch Depth Maximum
R Permitted
R 2. No Surface Damage Permitted In Tiebolt Holes, Counter-
R Weight Holes, Chamfers, Or 0.125 Inch Minimum From
R Adjacent Surfaces
R 3. See Text
R 4. Scattered Damage In Fir-Tree Root Area Is Permitted To
0.003 Inch Maximum. No Repair Is Permitted.
R 5. Remove Damage In This Area by Blend Repair To 0.010 Inch
Maximum.

R Key to Figure 613 (Sheet 1)

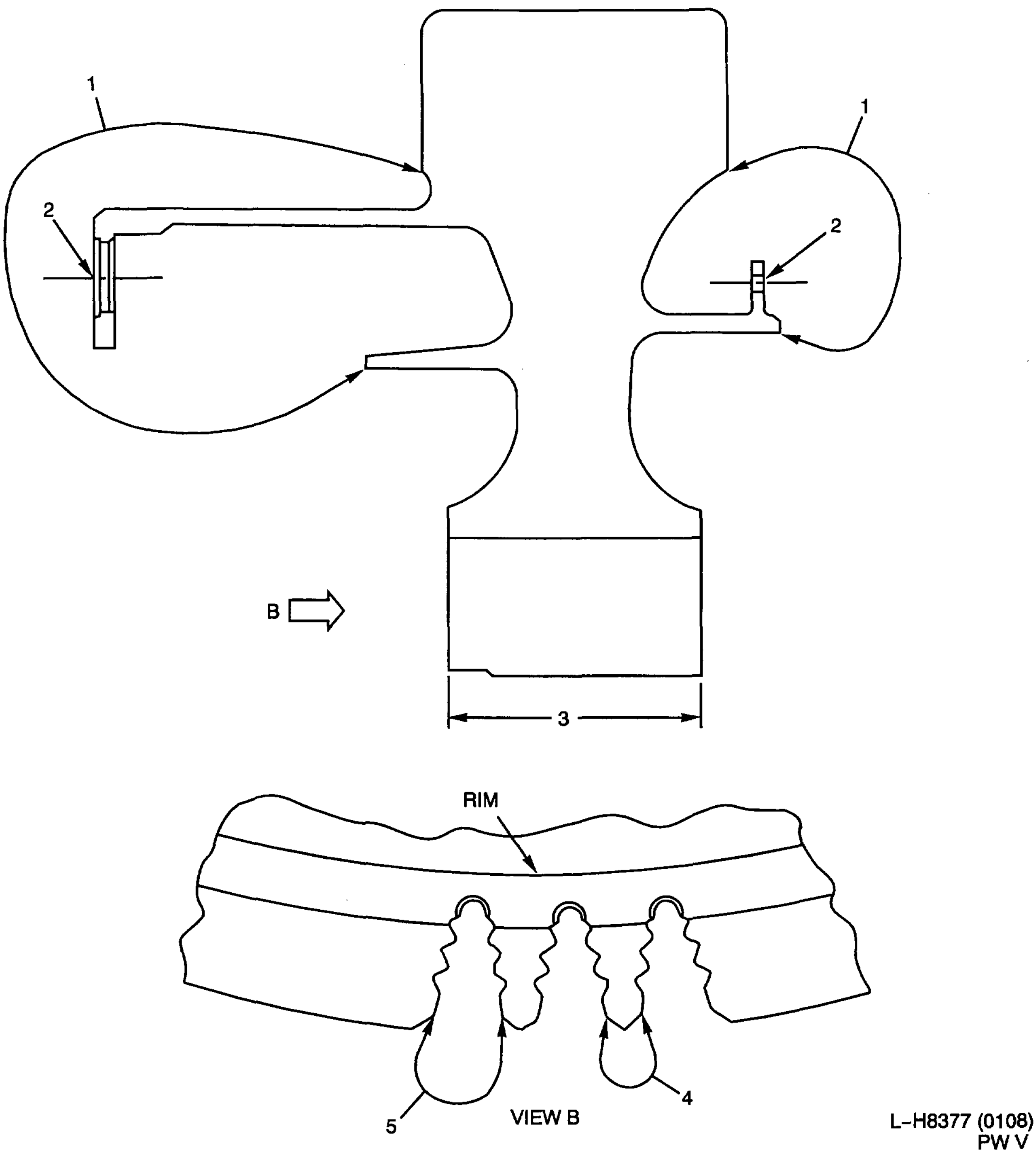
(4) Where blending is required in adjacent knife-edges, minimum of three inches must separate blended areas between seals.

(5) Bent seals may be straightened, provided such straightening does not result in cracking seal.

<u>NOTE</u>: Suggested method of straightening is to use block of hardwood, slotted and formed to fit seal. Slide block over bent arc of seal to straighten.

(6) Radial cracks in Area A are acceptable, provided they do not extend into Area B.

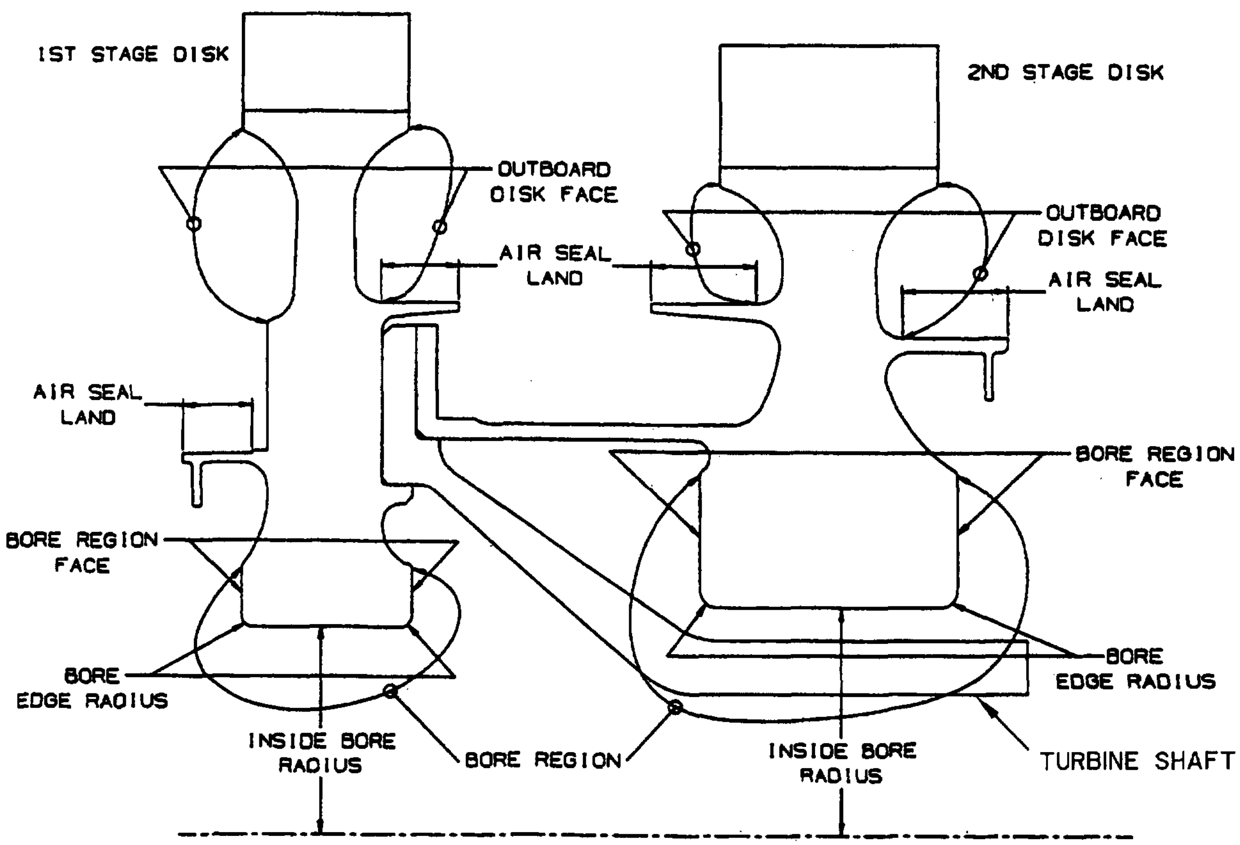
(7) Inspect repaired seals, using fluorescent penetrant method. Reject seals exhibiting cracks in Area B. See Standard Practices Manual.



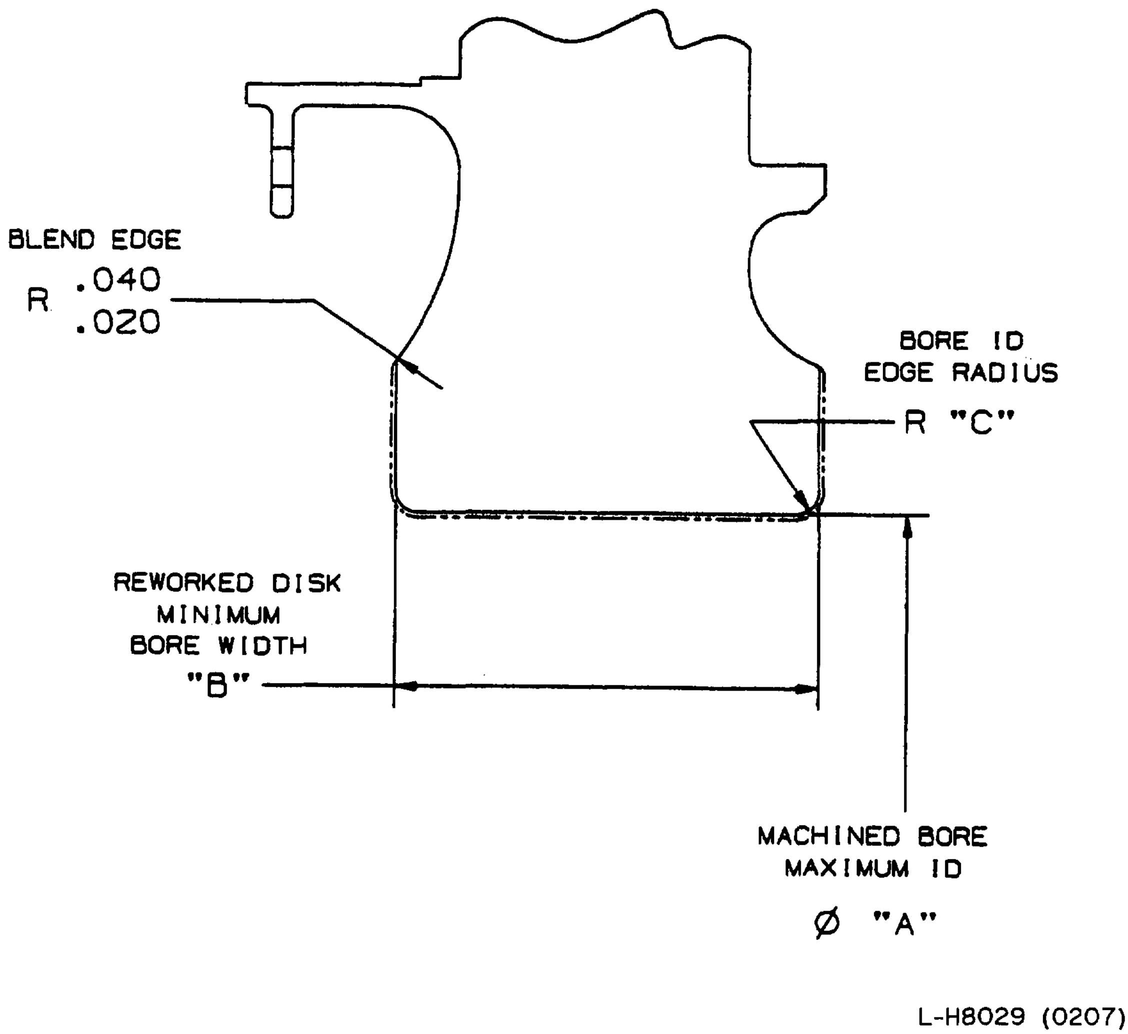
Free Turbine Disk Blend Limits
(Second Stage)
Figure 613 (Sheet 2)

R 1. Scattered Surface Damage 0.005 Inch Depth Maximum
R Permitted
R 2. No Surface Damage Permitted In Tiebolt Holes, Counter-
R Weight Holes, Chamfers, Or 0.125 Inch Minimum From
R Adjacent Surfaces
R 3. See Text
R 4. Scattered Damage In Fir-Tree Root Area Is Permitted To
R 0.003 Inch Maximum. No Repair Is Permitted.
R 5. Remove Damage In This Area by Blend Repair To 0.010 Inch
R Maximum.

R Key to Figure 613 (Sheet 2)

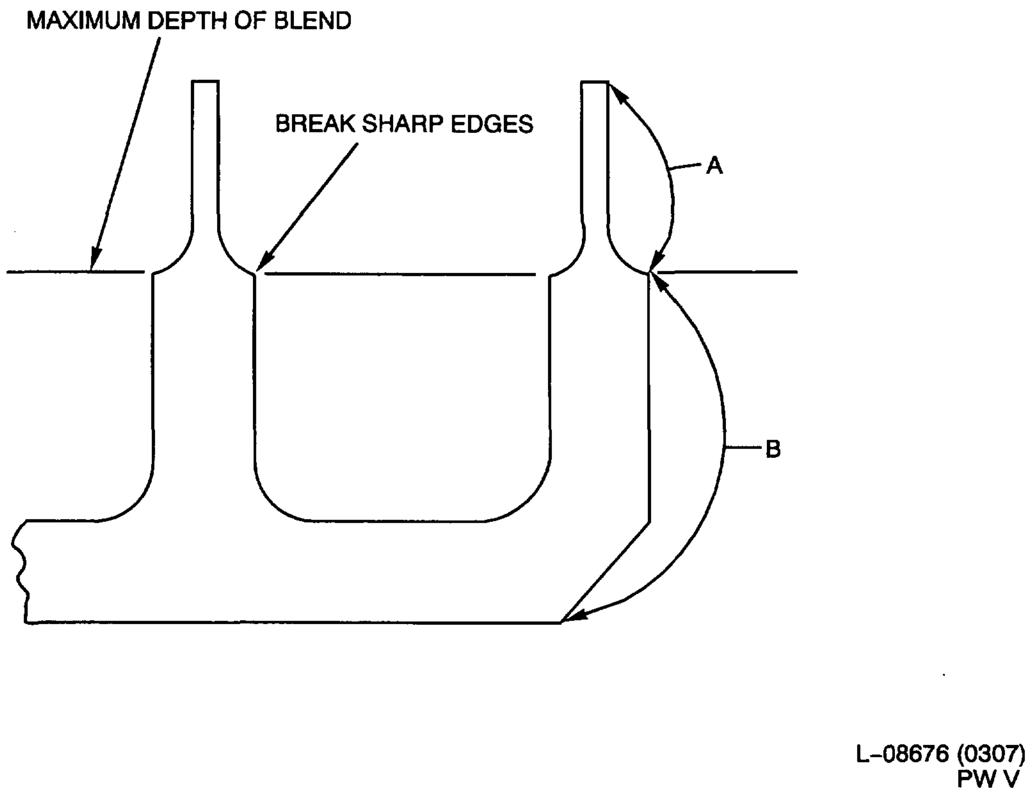

1ST STAGE DISK
2ND STAGE DISK
OUTBOARD DISK FACE
OUTBOARD DISK FACE
AIR SEAL LAND
AIR SEAL LAND
AIR SEAL LAND
BORE REGION FACE
BORE REGION FACE
BORE EDGE RADIUS
BORE EDGE RADIUS
INSIDE BORE RADIUS
BORE REGION
INSIDE BORE RADIUS
TURBINE SHAFT

L-H8028 (0207)



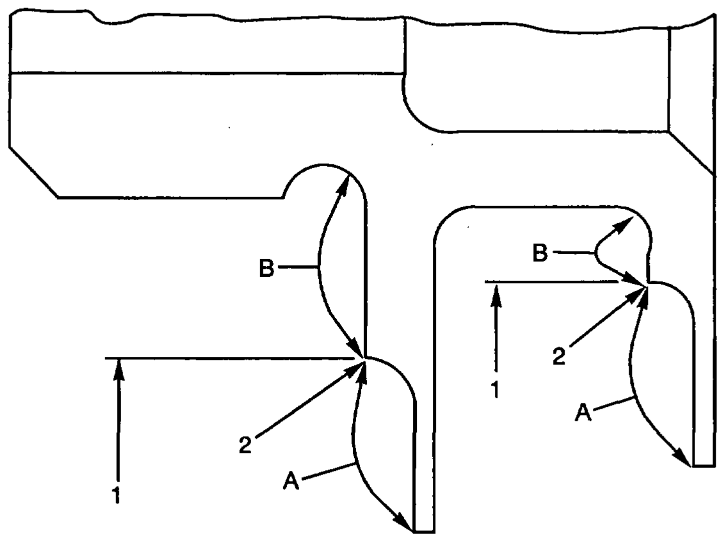
R
R

Free Turbine Disk Surface
Damage Repair
Figure 614 (Sheet 2)



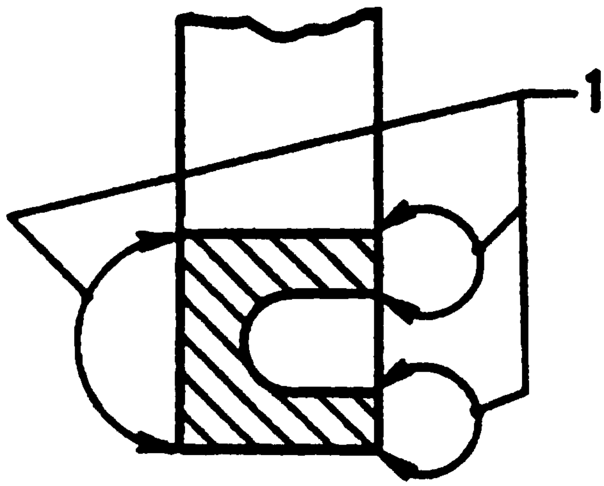
R
R

Turbine Rotor Seal
Blend Limits 1st Stage
Figure 615



L-16281 (0307)
PW V

1. Maximum Depth Of Blend
2. Break Sharp Edges

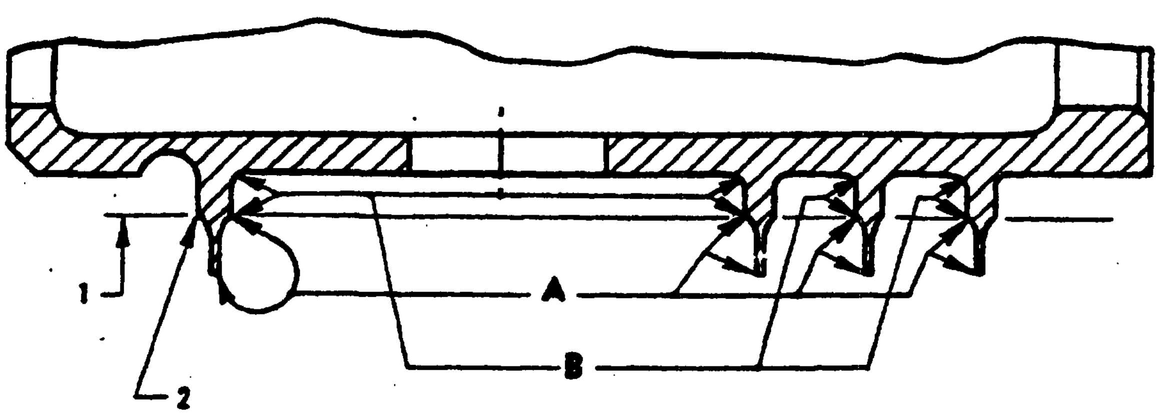


L-I9708 (0000)

1. Treat Where Shown With Antigalling Compound (See Text). Compound On Remaining Surfaces Optional.

R
R

Turbine Rotor Outer
1st Stage Seal Spacer
Surface Treatment
Figure 617



L-16283 (0000)

1. Maximum Depth Of Blend
2. Break Sharp Edges

Turbine Rotor Inner Seal
Figure 618

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-07

1. Engine Turbine Section - Turbine Exhaust Case

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Turbine Exhaust Case

A. Inspection

(1) Inspect case for cracks. Cracks which extend more than 270 degrees around temperature and pressure probe bosses, circumferential cracks which extend more than 14 inches (approximately 90 degrees) in our immediately adjacent to front flange to case weldment and those resulting in broken out material are unacceptable and non-repairable.

(2) All cracks are unacceptable without repair.

B. Repair

(1) Case Crack Repair (See Tool Group 96C-2)

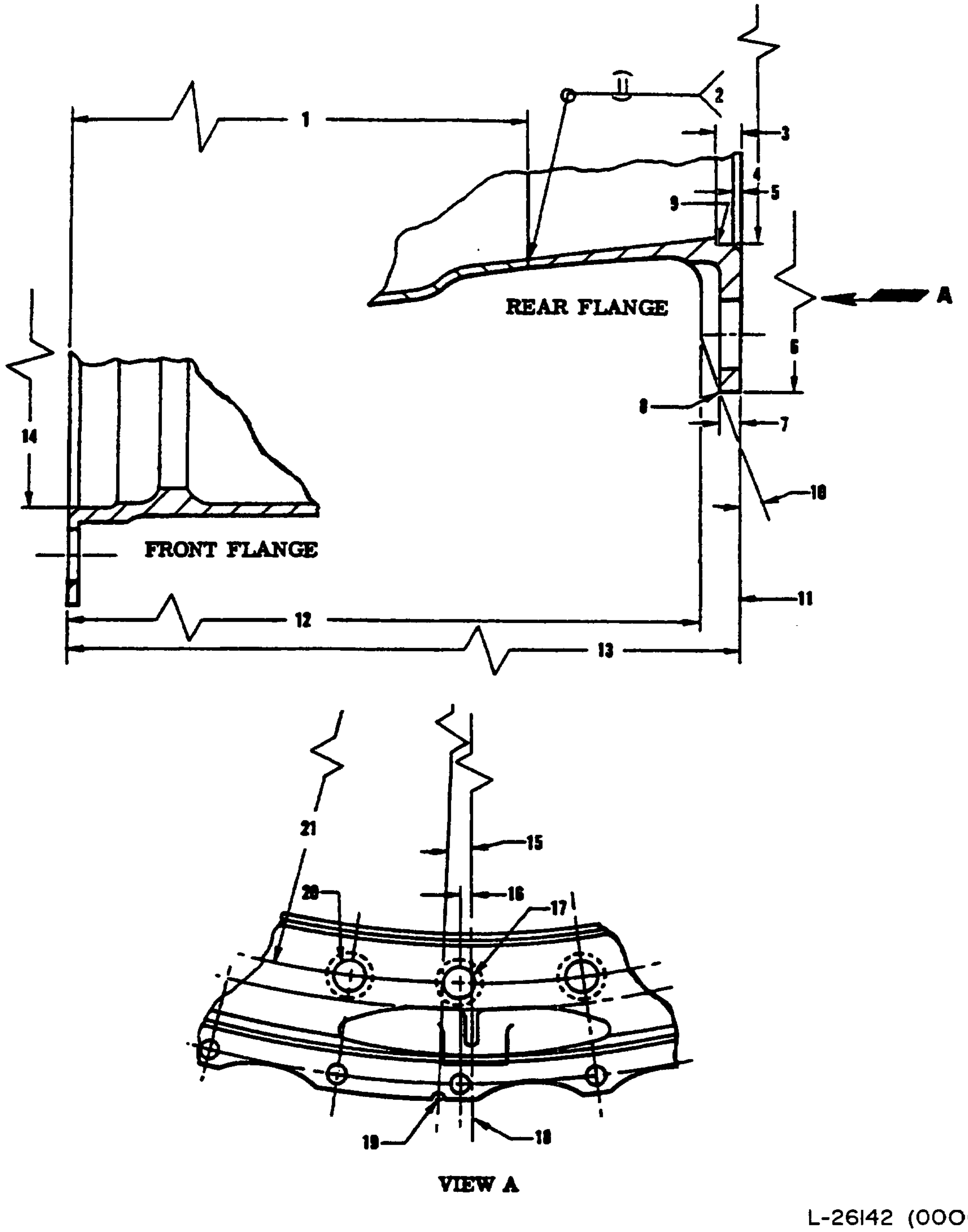
(a) Repairable cracks in or immediately adjacent to front flange to case weldment shall be repaired as follows:

1 Stop drill crack extremities and vee out crack to ensure weld penetration.

2 Secure case in Machining Fixture and clamp, ensuring front flange flatness is kept to minimum (reference Figure 601) Install exhaust case welding fixture to prevent case collapse during welding and stress-relief operations.

3 Weld, using Hastelloy W rod (AMS 5786) and machine gas metalarc (MIG), keeping weld bead to minimum height. Argon gas backup shall be used where possible as well as chill blocks, copper water chill or wet bulk ceramic fiber for extensive welds. Refer to Standard Practices Manual, Section 70-42-05, for material source.

NOTE: To minimize parent metal distortion, use thin welding wire and only sufficient heat to ensure proper weld fusion and penetration.



Turbine Exhaust Case Rear
Flange Replacement
Figure 601

1. 9.850 - 9.870 Inches
2. Weld PN 648036 Flange To Case Using Machine Gas Tungsten-Arc (TIG) Or Machine Gas Metal-Arc (MIG)
3. 0.095 - 0.105 Inch
4. 16.018 - 16.022 Inch Diameter
5. 0.020 - 0.040 Inch By 43 - 47 Degrees Chamfer
6. 17.180 - 17.200 Inch Diameter
7. 0.075 - 0.085 Inch
8. 0.031 - 0.062 Inch Radius
9. 0.010 - 0.030 Inch Radius
10. 20° - 21°
11. Rear Flange Rear Face Must Be Square With Common Axis Of Indexes 14 And 3 Within 0.002 Inch FIR.
12. 10.540 - 10.660 Inches
13. 10.790 - 10.810 Inches
14. Reference Diameter
15. 1°30′ - 2°30′
16. 0.100 Inch
17. Offset Hole
18. Reference Plane
19. Machined Mark (Front Flange)
20. 0.276 - 0.286 Inch Diameter Hole Through 0.520 - 0.540 Inch Diameter Recess (Having 0.010 - 0.030 Inch Corner Radius) On Front Face Of Rear Flange. 47 Holes Equally Spaced On Basis Of 48 Holes Located In 7°30′ Increments From Reference Plane And One Offset Hole, As Shown. Holes Shall Be Located Within 0.005 Inch Radius Of True Position In Relation To Index 3.
21. 16.750 Inch Diameter

Key to Figure 601

4 Blend weld bead to 0.020 inch maximum height, flaring weld bead blend toward parent material.

5 Stress-relieve by Cycle No. 4A, except hold at 1275° - 1325°F (689° - 719°C) for four hours.

NOTE: Ensure fixturing retains front flange tightly to prevent warpage.

6 Remove fixturing from case.

7 Fluorescent penetrant inspect by SPOP 62.

(2) Turbine Exhaust Case Rear Flange Replacement (Pre-SB 6079)
See Tool Group 96C-1 and Figure 601.

(a) Rear Flange Removal

1 With Machining Fixture mounted on vertical turret lathe and spider detail removed, install case on fixture with front flange down.

2 Secure case with clamps ensuring that run-out at machining area is kept to minimum. Then, secure spider detail to fixture post, and in turn support rear of case by securing flange to spider detail with nuts and bolts.

3 Cut off rear flange at location rearward of 9.870 inch dimension, then trim to required dimension (use the replacement flange to check for fit).

(b) Welding Procedure

1 Position case on welding fixture, front flange down, and secure with clamps.

2 Position gas backup support (in retracted position) inside case, and position replacement flange on rear of case, securing with hold-down detail.

3 Alternately tighten gas backup support and hold-down detail to obtain uniform alignment between case and replacement flange.

4 Weld AMS 5754 Flange to AMS 5754 case with AMS 5798 welding wire and machine gas tungsten arc or machine gas metal arc procedure. Flange shall be tack welded to case at equally-spaced intervals. Relieve hold-down pressure and complete welding procedure.

5 After welding, remove from fixture and stress-relieve by Cycle No. 4A. Refer to Standard Practices Manual.

(c) Replacement Flange Finish Machining

1 With machining fixture mounted on vertical turret lathe, install case and machine replacement flange to dimensions shown.

2 Install case on drill fixture ensuring that offset hole in front flange is aligned with guide pin.

3 Install keyed drill plate on fixture post so that plate rests on replacement flange, and drill 48 0.281 inch diameter holes.

NOTE: The 0.212 inch diameter hole shall not be drilled for this repair. This hole is provided for reinforced rear flanges only, to prevent thrust reverse installation on standard rear flanges.

(3) Turbine Exhaust Case Boss Repair
See Tool Group 14A.

(a) Cracks in exhaust case bosses may be weld-repaired without stress-relief.

(b) Position case (rear end) on retaining ring hold-down bar of Fixture. Install retaining ring in ID of case. Assemble nut and torque until ring is in position behind strut locating bosses.

(c) Vee out crack.

(d) Weld bosses (AMS 5754) with AMS 5798 welding wire.

NOTE: To prevent collapse of exhaust case during welding, leave retaining ring in position until all welding is completed.

(e) Hand file weld and lap boss face flat.

(4) Turbine Exhaust Case (Post-SB 1150) Helical Coil Insert Replacement.
See Figure 602.

(a) Remove the PN 581177 bolt from the stripped threads.

(b) Drill the boss hole. See Index 4 of the figure.

(c) Chamfer the hole. See Index 5 of the figure.

(d) Maintain the pitch diameter and major diameter as shown in the figure.

(e) Install the PN 124656 helical coil insert until it bottoms out.

(f) Break off the tang at the notch.

(g) Install PN 581177 bolt again.

3. Turbine Exhaust Cone And Strut Assembly

A. Inspection

(1) Inspect cone and strut assembly for cracks, dents, and buckling.

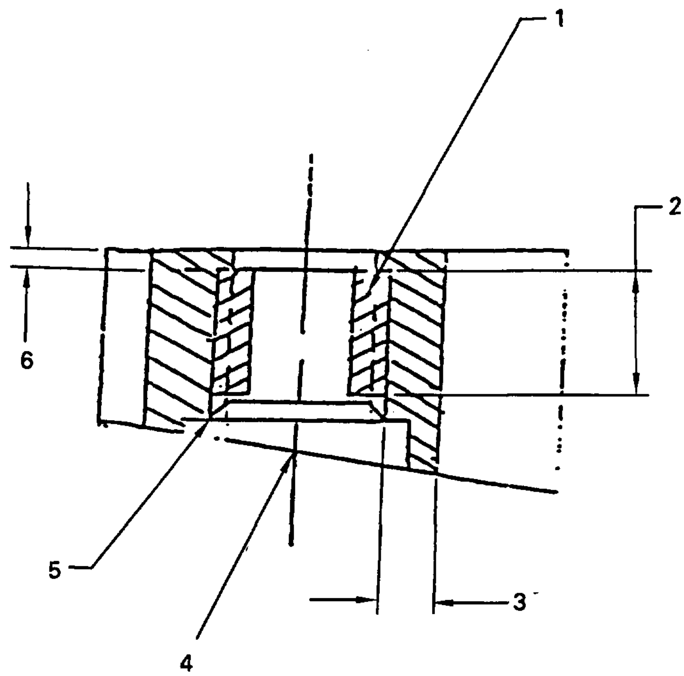
(2) Dents and buckling is acceptable, provided there are not sharp angles which could develop into cracks and over-all general contour of part is not disturbed.

(3) All cracks shall be repaired.

B. Repair

(1) All cracks shall be welded using AMS 5680 filler metal except those with pieces of material broken out. Weld bead shall not be higher than 0.020 inch. Argon gas backup shall be used, where possible. Stress-relief is not required after welding.

(2) It is permissible to patch repair tail cone skin using AMS 5680 filler metal and argon gas backup where possible. Maintain contour as close to original as possible.



L-H3184 (1296)

1. Thread Requirements For The Helical Coil Inserts:
   Pitch Diameter Is 0.2732 - 0.2754 Inch.
   Minimum Thread Length Is 0.200.
   Major Diameter Is 2.995 Inches For Minimum Wall Conditions.
2. 0.200 Inch Minimum Thread Lengths.
3. 0.090 Inch Minimum Edge Distance (All Around) To Major Diameter
4. Drill The Boss Hole To 0.2577 - 0.2646 Inch Diameter
5. Chamfer 115 - 125 Degrees Included By 0.280 - 0.310 Inch Diameter
6. No Thread For 0.036 Inch

Turbine Exhaust Case
Helical Coil Insert Replacement
Figure 602

(3) Exhaust Cone and Strut Assembly Mounting Bolts and Bushings - Replacement
See Tool Group 50A.

(a) Inspect exhaust strut bolt (Figure 603) for wear. If minor diameter is worn below 0.181 inch in any area reject bolt.

(b) For engines incorporating mounting configuration in Figure 604, remove bolt and inspect for thread wear. Reject bolt if worn.

(c) Remove bushing from boss and inspect for wear on ID at tapered end. If wear has occurred replacement is required.

NOTE: To eliminate recurrence of thread or bushing wear, replace bolt with improved bolt having necked-down shank. See Figure 604, Index 4.

1 Position puller bolt from inside case through bushing. Place sleeve over bolt with washer and nut on threaded end.

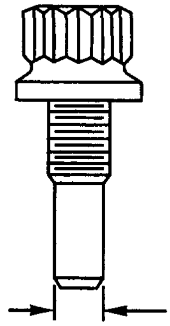
2 Securing bolt head with appropriate wrench, remove bushing from case with a wrench on the nut.

3 To install new bushing, insert bolt with flat washer through bushing with bolt head at flanged end.

NOTE: Chill bushings to facilitate installation.

4 Position bolt/bushing assembly on exhaust case from outside with a tapered washer and nut on the inside.

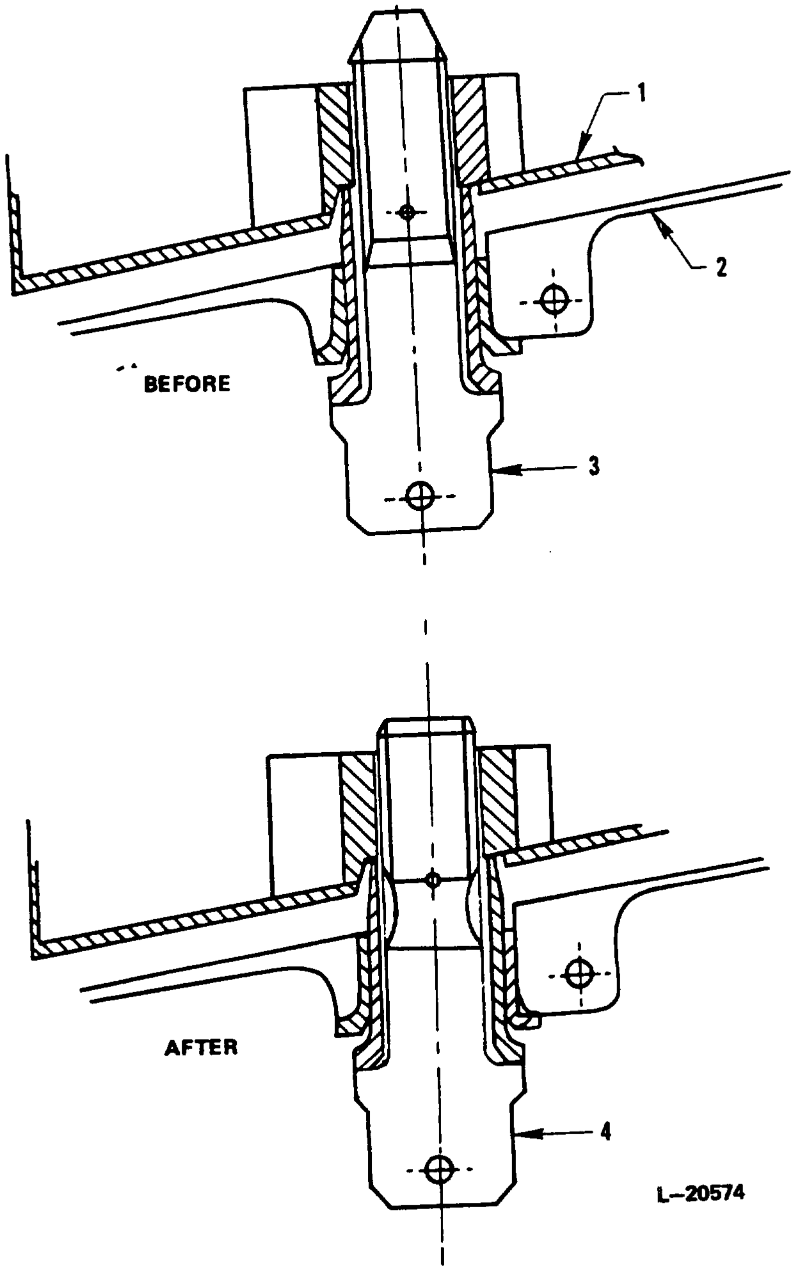
5 Secure bolt head and turn nut to pull bushing into case.



L-13373 (0307)
PW V

1. 0.181 Inch Minimum

Exhaust Strut Bolt
Wear Limits
Figure 603



1. Exhaust Strut
2. Exhaust Case
3. Bolt Without Necked Down Shank
4. Bolt With Necked Down Shank

Exhaust Cone And Strut
Assembly Mounting Bolt
And Bushing Replacement
Figure 604

ENGINE TURBINE - INSPECTION, REPAIR, AND REPLACEMENT-08

1. Engine Turbine Section - Free Turbine Cases And Static Structures

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

2. Free Turbine Inlet Case

A. Inspection

(1) Refer to Section 72-00-00 for fluorescent penetrant inspection procedures.

NOTE: Cracks are possible in the scallops of the front flange. Refer to Repair.

B. Repair

(1) Front Flange Crack Weld Repair (see Figure 600)

(a) Clean the repair area by SPOP 208 (Task 70-21-00-110-040). Refer to 70-21-00 in the Standard Practices Manual.

(b) Weld flange cracks with AMS 5786 weld wire. Refer to 70-42-01 in the Standard Practices Manual.

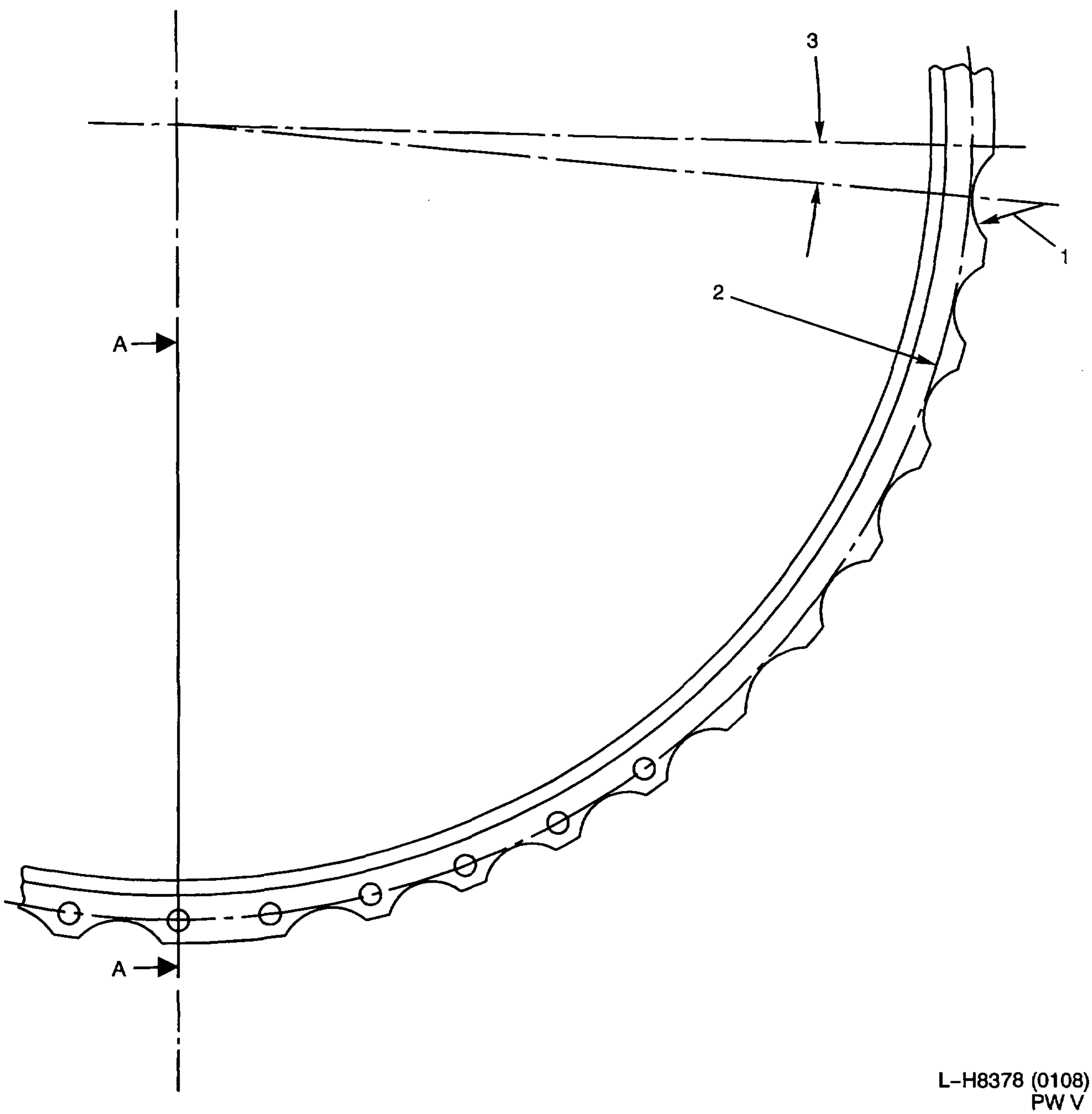
NOTE: Keep weld heat to a minimum to prevent distortion during the weld operation.

(c) Do a local stress-relief of the repair area at 1350°F ± 25° for four hours.

(d) Machine the flange to the dimensions shown in the figure.

(e) Do a dimensional inspection of the areas shown in the figure.

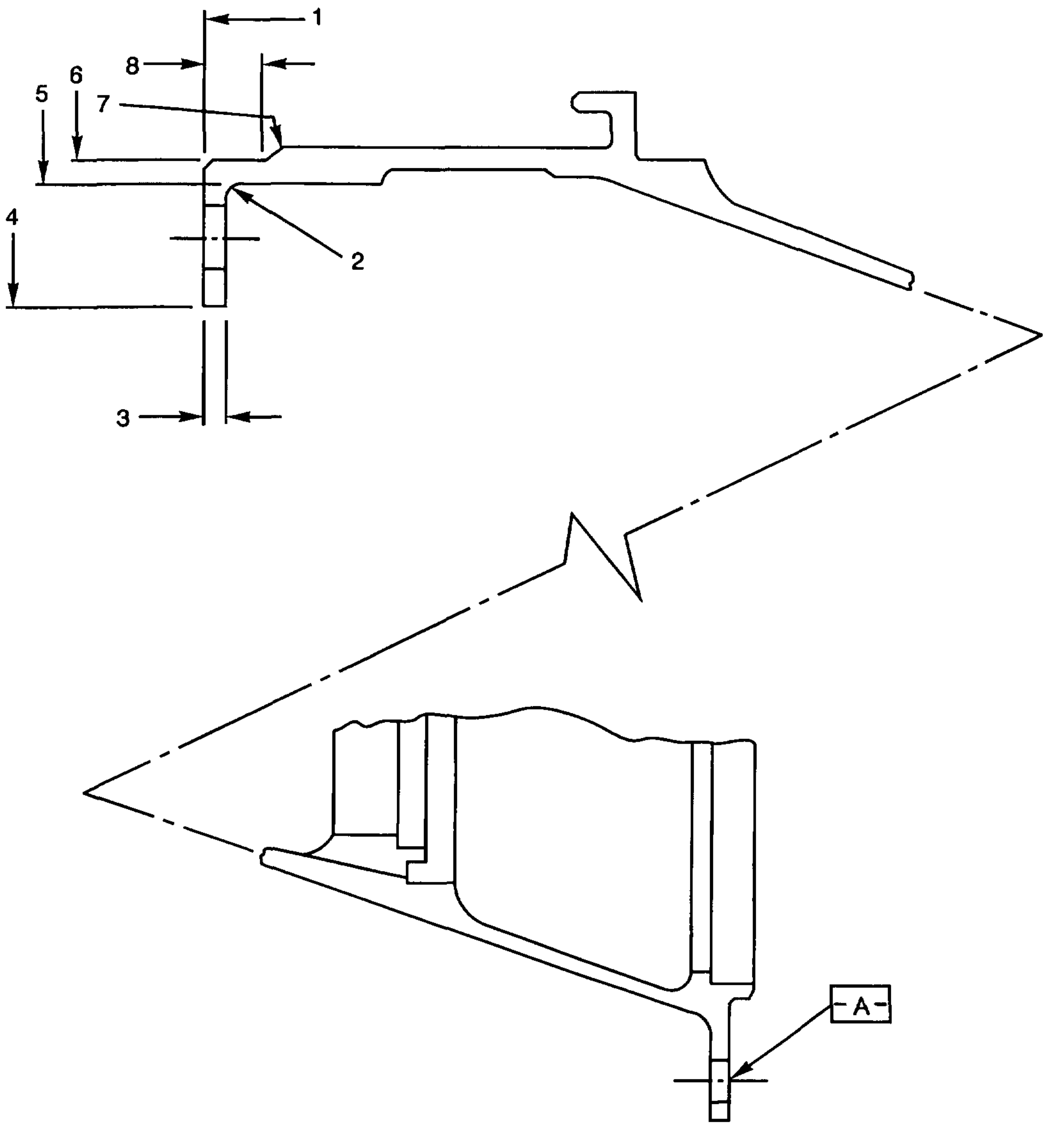
(f) Do a fluorescent penetrant inspection of all welds by SPOP 62 (Task 70-33-00-230-001). Refer to 70-33-00 in the Standard Practices Manual.



R 1. 0.922 - 0.937 Inch Radius, 47 Scallops On The Basis Of
48 Scallops An Equal Distance Apart and One Omitted, All
0.020 Inch Maximum Of True Position.
R 2. 18.480 - 18.520 Inch Diameter (Scallops)

R 3. 3° 45′

R Free Turbine Inlet Case
R Front Flange Crack Repair
R Figure 600 (Sheet 1)



SECTION A–A

L–H8379 (0108)
PW V

Free Turbine Inlet Case
Front Flange Crack Repair
Figure 600 (Sheet 2)

R 1. 13.863 - 18.867 Inches To Face A
R 2. 0.109 - 0.141 Inch Radius
R 3. 0.065 - 0.075 Inch
R 4. 18.875 - 18.885 Inch Diameter
R 5. 18.225 - 18.235 Inch Diameter
R 6. 18.104 - 18.108 Inch Diameter
R 7. 0.109 - 0.141 Inch Radius
R 8. 0.130 - 0.150 Inch

R Key to Figure 600 (Sheet 2)

R 3. Free Turbine Inlet Duct

A. Repair

(1) Free Turbine Inlet Duct Lug Repair. See Figure 601.

(a) Lugs found dimensionally unacceptable by Figure 601 must be repaired as follows:

1 Weld lugs (AMS 5645) with AMS 5680 welding wire.

2 Stress-relieve by Cycle No. 1A (refer to Welding, Standard Practices Manual).

3 Machine to dimensions, shown in Figure 601, and flush with flange surfaces.

4 Fluorescent penetrant inspect lugs by SPOP 62. (Refer to Standard Practices Manual).

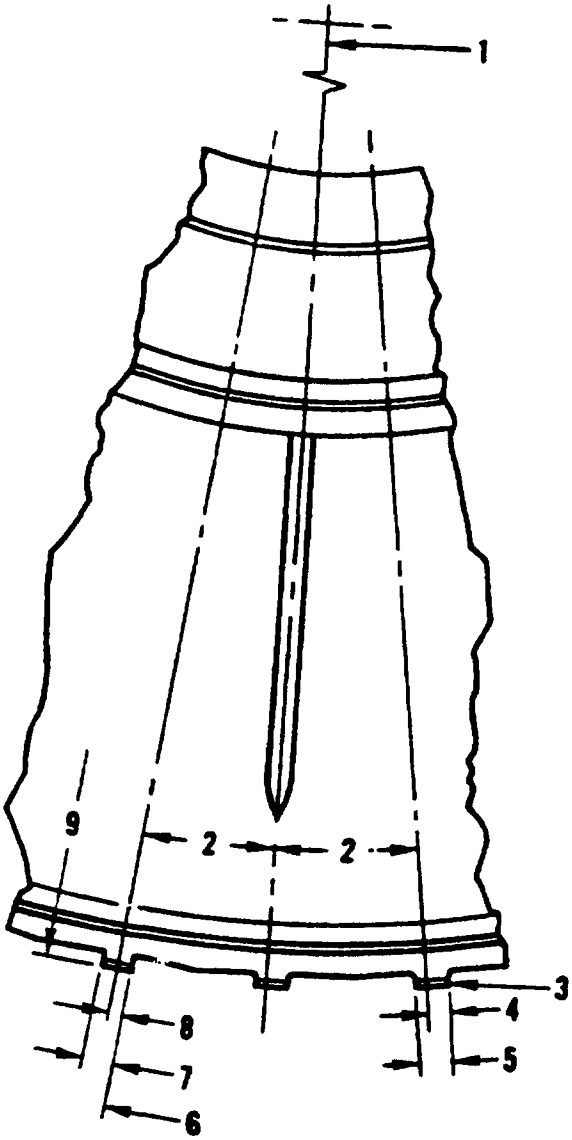
(2) Free Turbine Inlet Duct Crack Repair. See Figure 602.

(a) Fluorescent penetrant inspect for cracks by SPOP 62 (refer to the Standard Practice Manual). All cracks must be repaired.

(b) Scribe seals and their mating flanges to ensure proper indexing at reinstallation. Drill out retaining rivets and remove seal.

(c) If necessary vee out crack; otherwise stop-drill crack extremities. Ensure that cracked area is clean before welding.

(d) Weld AMS 5645 duct with AMS 5786 welding wire. Welds must be blended on air stream side only.



L-25741 (0000)

R
R

Free Turbine Inlet Duct
Lug Repair
Figure 601

1. Vertical Centerline
2. 7°20'49"
3. Chamfer 0.020 - 0.040 inch at 40° - 50°
4. 0.231 Inch
5. 0.354 - 0.358 Inch (One Lug Only)
6. This Face On Each Lug Must Be located Within 0.002 Inch Of True Position In Relation To Index 9.
7. 0.300 - 0.304 Inch. 48 Lugs On Basis Of 49 Lugs Equally Spaced And Located As Shown.
8. 0.177 Inch
9. 23.045 - 23.055 Inch Diameter

Key to Figure 601

(e) Stress-relieve by Cycle No. 4A, however, in lieu of 704°C (1300°F), use maximum heat of 635° - 649°C (1175° - 1200°F).

R (f) Inspect duct both visually and with fluorescent penetrant by SPOP 62 to ensure satisfactory repair.

(g) Replace or reinstall seals removed prior to repair. If rivet holes are worn or enlarged due to rivet removal, drill 16 new rivet holes situating each one midway between two existing oversize holes. For dimensions of rivet hole circle. See Figure 602.

(h) Deburr all rivet holes and fluorescent penetrant inspect seal by SPOP 62 then, reinstall seal.

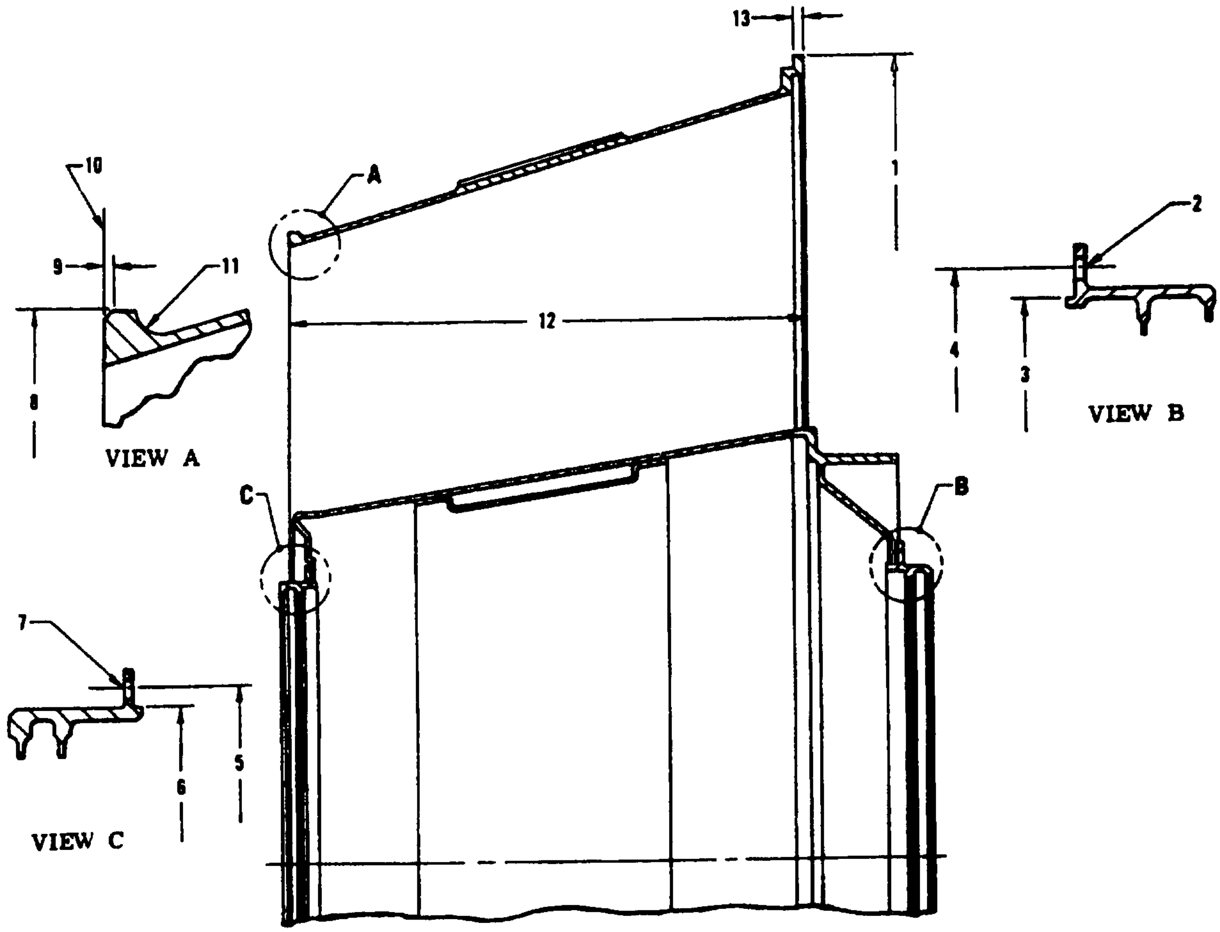
(i) Final inspect inlet duct.

(3) Free Turbine Inlet Duct Front Outside Diameter Repair. See Figure 602.

(a) Inspect front face and outside diameter for localized damage, general wear, concentricity, and squareness. See Figure 603.

(b) Machine diameter and front face sufficiently to remove damage. Avoid excessive material removal.

(c) Determine amount of plate buildup necessary to restore acceptable dimensions by performing measurements to outside diameter and front face.



L-26577 (0000)

R
R

Free Turbine Inlet Duct Repair
Figure 602

1. Reference Diameter (Rear Flange)
2. 0.118 - 0.122 Inch Diameter Holes, Equally Spaced And Located Within 0.002 Inch Of True Position In Relation To Reference Diameter (Index 3)
3. Reference Diameter (Rear Seal)
4. 8.600 Inches Average Diameter
5. 8.400 Inches Average Diameter
6. Reference Diameter (Front seal)
7. 0.118 - 0.122 Inch Diameter Holes, Equally Spaced And Located Within 0.002 Inch Of True Position In Relation To Reference Diameter (Index 6)
8. 18.123 - 18.127 Inches Diameter
9. 0.020 - 0.040 Inch Chamfer At 40° - 50°
10. This Face Must Be Square With Reference Diameter (Index 1) Within 0.002 Inch FIR
11. 0.078 - 0.109 Inch Radius
12. 7.293 - 7.297 Inches
13. 0.120 - 0.130 Inch

Key to Figure 602

(d) Nickel plate by SPOP 26 (refer to the Standard Practices Manual). Ensure that plate buildup is sufficient to machine to dimensions in Figure 602 then, machine to dimensions shown.

(e) Fluorescent penetrant inspect by SPOP 62, followed by dimensional inspection of outside diameter, concentricity check, and squareness of front face.

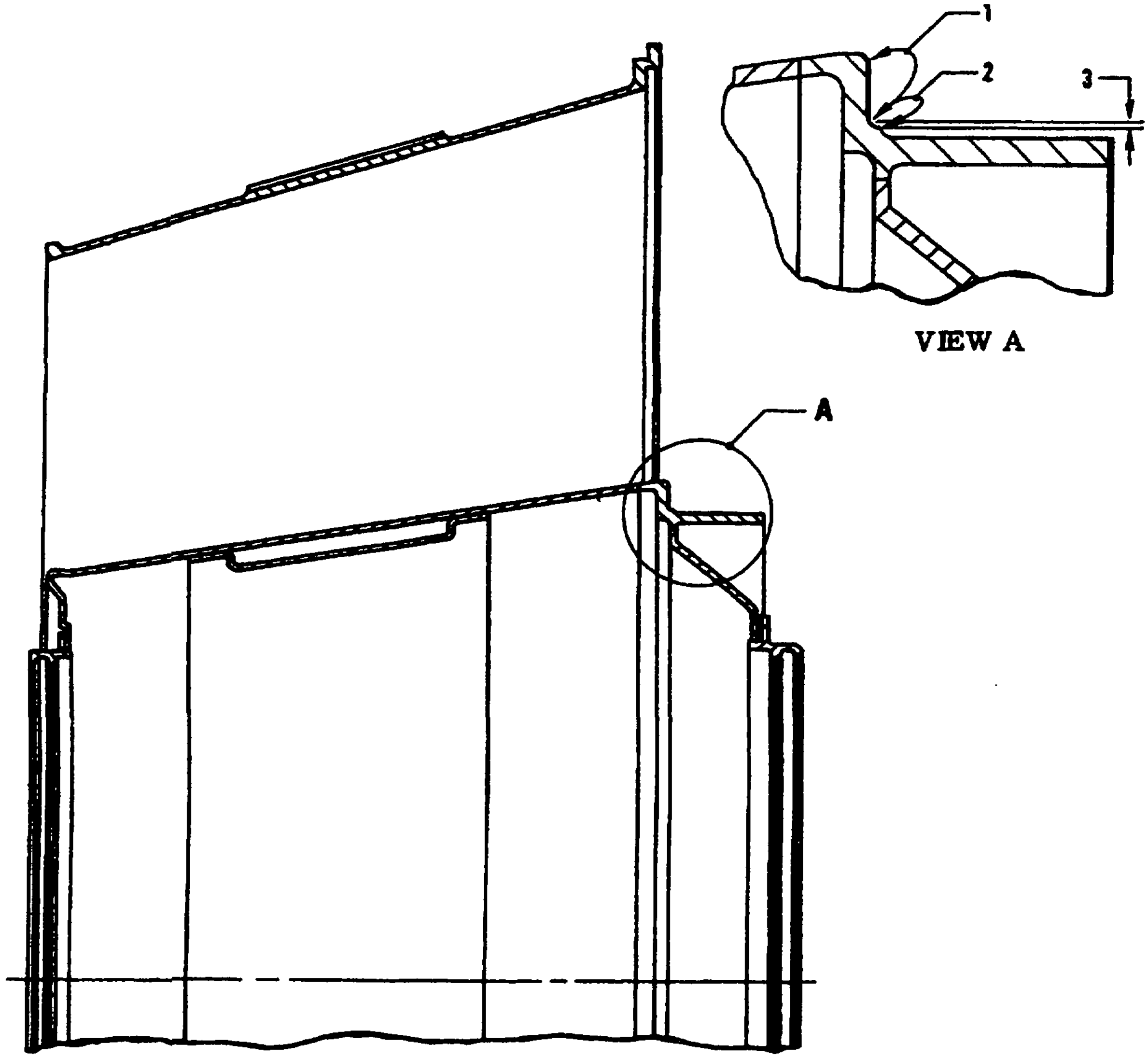
R (4) Free Turbine Inlet Duct Plasma Coating Replacement
R See Figure 603.

(a) To ensure optimum protection for parent metal, all plasma-coated areas with wear shall be recoated as follows:

1 Mask areas not to be coated.

2 Prepare the surface for plasma coat by SPOP 170 (refer to the Standard Practices Manual).

3 Plasma coat worn area within limits specified by Figure 603 with PWA 1318 powder (refer to Plasma Coatings in the Standard Practices Manual). Coating must be to the original 0.003 - 0.006 inch thickness.



L-22737 (0000)

1. Plasma Coat Area. No Grinding Of Coating Permitted.
2. Plasma Coating Optional And May Be Incomplete
3. 0.060 Inch Maximum

R
R

Free Turbine Inlet Duct
Assembly Plasma Coat Repair
Figure 603

(5) Free Turbine Inlet Duct 1st Stage Vane Tang Slots. See Figure 604.

(a) Inspection

1 Inspect slot walls for wear. Slot wear causing an increase to length or width in excess of 0.005 inch is unacceptable without repair.

(b) Repair

1 Weld worn slots (PN 427204 is AMS 5645 material requiring AMS 5680 welding wire, PN 575219 is AMS 5736 material requiring AMS 5786 welding wire) taking precautions to prevent heat distortion.

2 Machine slots to dimensions shown in Figure 604.

NOTE: Correct location of each slot is derived from reference plane in Figure 604. Locate reference plane by angular measurement from oversize lug on rear flange of inlet duct. All 49 slots must be equally spaced and with 0°2′ of true angular position in relation to reference plane.

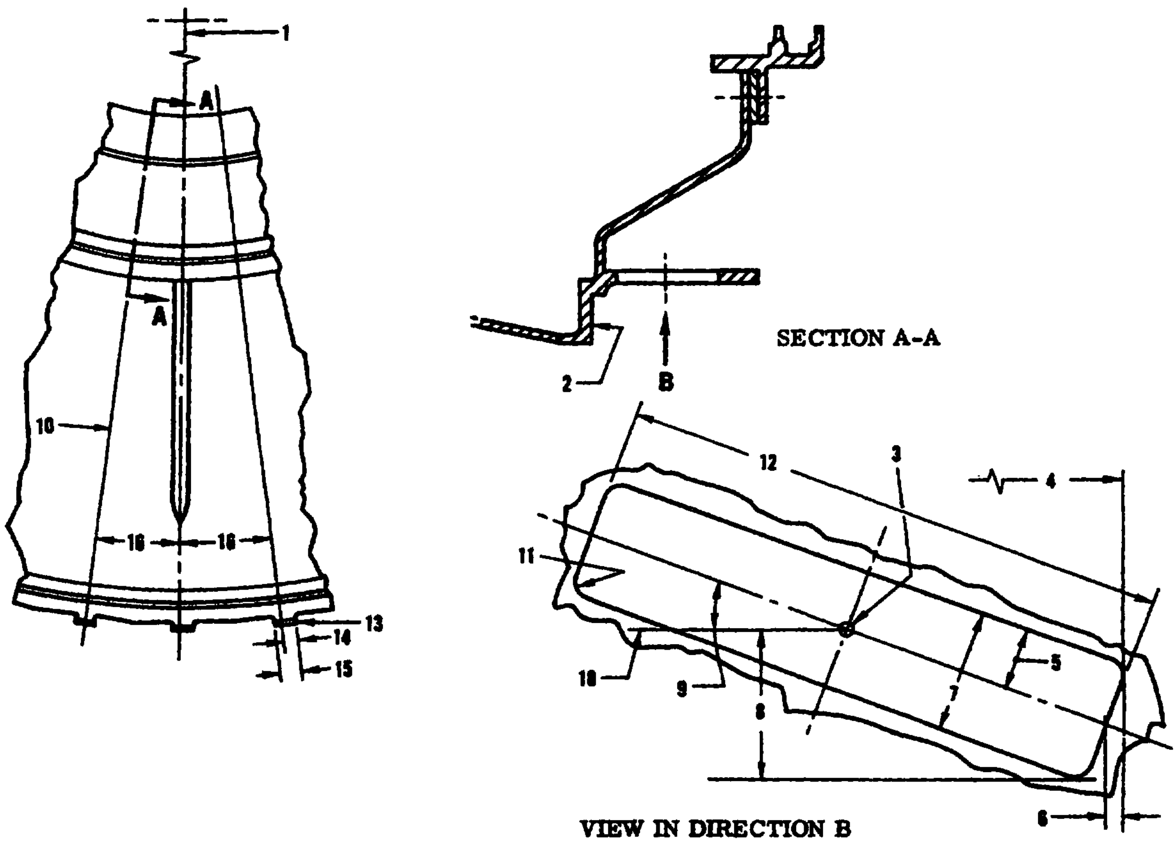
3 Hand file to remove excess weld and to break sharp edges

4 Clean and degrease.

R 5 Do fluorescent penetrant inspection on the part
R by SPOP 62 (Task 70-33-00-230-001) to make sure
R that the repair is satisfactory.

6 Aluminize walls of slot (PN 427204 and 590764 only) (refer to Surface Treatments, Standard Practices Manual).

7 Apply antiseize, antigalling compound (SPOP 146) all around slots (refer to Surface Treatments, Standard Practices Manual).



L-22202 (0000)

R
R
First Stage Free Turbine
Inlet Duct Vane Tang
Slot Repair
Figure 604

1. Vertical Centerline
2. Reference Face
3. Axis Of Rotation
4. 0.902 - 0.910 Inch To Reference Face
5. 0.064 Inch (Reference)
6. 0.016 Inch (Reference)
7. 0.125 - 0.131 Inch
8. 0.159 - 0.169 Inch
9. 19°45' - 20°15'
10. Reference Plane
11. 0.010 - 0.030 Inch Radius (Four Places)
12. 0.730 - 0.740 Inch
13. Oversize Lug
14. 0.231 Inch
15. 0.354 - 0.358 Inch
16. 7° 20' 49"

Key to Figure 604

R 4. Free Turbine 2nd Stage Vane Shroud
See Figure 605.

A. Inspection

(1) Wear up to 0.005 inch greater than dimensions shown in slots of shroud is acceptable without repair.

(2) Wear up to 0.005 inch on flange face (contacted by inner buttress of 2nd stage free turbine vane) of shroud is acceptable without repair.

(a) Wear in excess of 0.005 inch for PN 423701 may be repaired provided parent metal minimum wall thickness of 0.085 inch is maintained prior to plating.

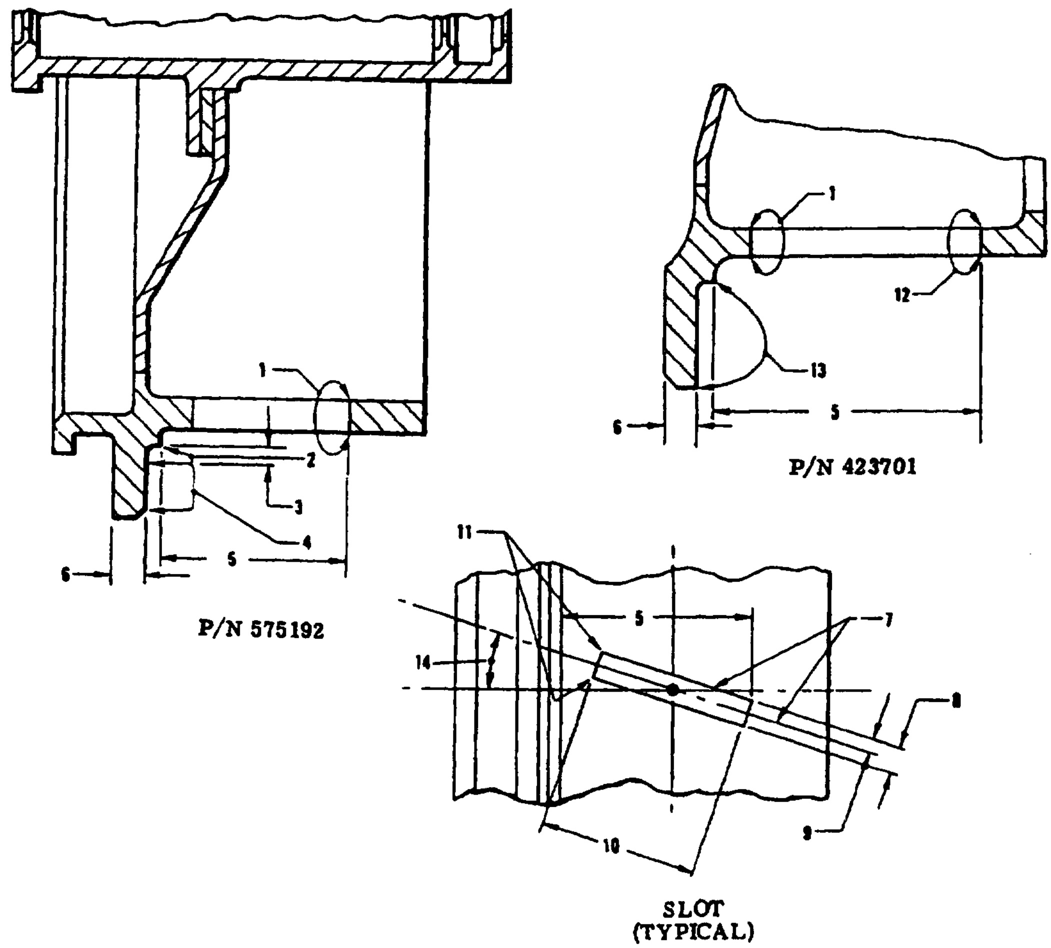
(b) Wear in excess of 0.005 inch for PN 575192 may be repaired by plasma spray coating, provided final thickness of coating does not exceed 0.008 inch.

(3) Worn plasma coating shall be replaced.

B. Repair

(1) Slot repair: Slot wear in excess of 0.005 inch shall be repaired by either of the following methods:

(a) Nickel Plating Method


1
2
3
4
5
6
P/N 575192
1
12
13
5
6
P/N 423701
11
5
7
14
8
9
10
SLOT
(TYPICAL)

L-22897 (0769)

1. Apply Antigalling Compound To Enclosed Area All Around Slots.
2. Optional Plasma Coat Area. Coating May Be Incomplete.
3. 0.060 Inch Maximum
4. Plasma Coat Area
5. 0.808 - 0.818 Inch
6. 0.095 - 0.105 Inch
7. Sides of Slots Must Be Parallel To Radial Line Within 0° 15' (PN 575192 Only). Slots Must Be Parallel To Their Respective Axial Planes Within 0° 15' (PN 423701 only).
8. 0.125 - 0.131 Inch
9. 0.064 Inch
10. 0.715 - 0.725 Inch
11. 0.010 - 0.030 Inch Radius (Both Ends)
12. Aluminize Enclosed Area All Around Slots (Only After Weld Repair)
13. Nickel-plate Repair Area.
14. 17° 15' - 17° 45'

Key to Figure 605

1 Nickel plate by SPOP 26 (refer to the Standard Practices Manual).

2 Hand file slots to dimensions shown.

(b) Welding Method

1 Weld slots, (AMS 5736 material) with AMS 5786 filler rod, taking precautions to prevent excessive heat distortion.

2 Hand file slots to dimensions shown.

NOTE: For PN 423701 only, dimensions shown are after aluminizing.

3 Fluorescent penetrant inspect to ensure satisfactory weld.

4 Aluminize slots, (PN 423701 only) (refer to Surface Treatments, Standard Practices Manual).

(c) Apply antigalling compound (PWA 586) all around the slots.

(2) Flange face repair (PN 423701). Flange face wear shall be repaired as follows:

(a) Machine flange to 0.085 inch minimum thickness. Hold to maximum value.

R
R

(b) Nickel plate by SPOP 26.

(c) Machine to dimensions shown.

(3) Flange face repair (PN 575192). Worn plasma coating on flange face shall be repaired as follows:

(a) Mask areas not to be coated.

(b) Prepare the surface for plasma coat by SPOP 170 (refer to Section 70-46-01 in the Standard Practices Manual)

(c) Plasma coat worn area with PWA 1318 powder (refer to Plasma Coatings, Standard Practices Manual). Coating must be to original 0.003 - 0.006 inch thickness. Dimensions shown are after plasma coating.

NOTE: Plasma coating up to 0.008 Inch thickness is permitted if required to restore flange to dimensions shown.

R 5. Free Turbine 1st Stage Outer Duct Segment
See Figure 606.

A. Inspection

(1) Do a fluorescent penetrant inspection of the part by
R SPOP 82 (refer to Section 70-33-00 in the Standard Practices Manual). A segment with cracks can get the weld repair below if the cracks do not extend more than
R 25.310 inch diameter (refer to Index 3 area in the figure).

B. Repair

(1) Remove cracks with a vee-groove before welding.

(2) Do a fluorescent penetrant inspection of the part by
R SPOP 82 (refer to Section 70-33-00 in the Standard Practices Manual) to make sure that all cracks were removed.

(3) Weld by TGAW with AMS 5798 weld wire. Refer to Section 70-42-01 in the Standard Practices Manual.

(4) Stress-relieve by SPOP 482 (Cycle 22). Refer to Section 70-42-04 in the Standard Practices Manual.

(5) Machine to the finish dimensions shown in the figure.

(6) Do a fluorescent penetrant inspection of the part by
R SPOP 82 (refer to Section 70-33-00 in the Standard Practices Manual) to make sure that all cracks were removed.

R 6. No. 4 Bearing Seal Assembly
See Figure 607.

A. Inspection

(1) Measure Index 1 diameter of the seal. If the diameter is more than 3.751 inches, repair by the Repair procedure.

B. Repair

(1) Chromium Plate Repair

(a) Strip the ID by SPOP 22 in Section 70-44-01, Standard Practices Manual or grind to the dimension given before plate (Index 3).

(b) Chromium plate at Index 4 by SPOP 22 (refer to Section 70-44-01, Standard Practices Manual.

NOTE: The hardness of the part is Rockwell C30 - C38.

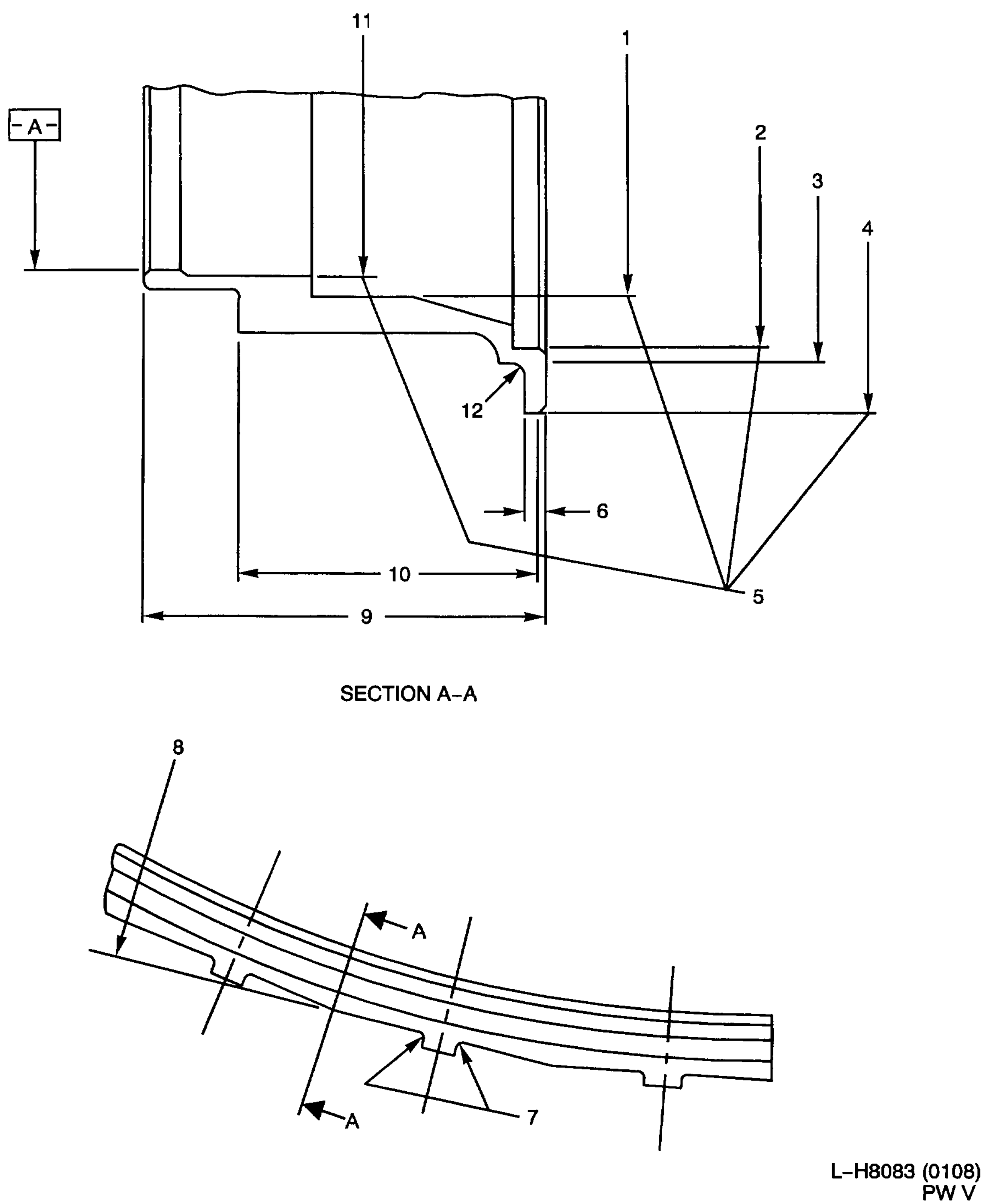
(c) Grind the plated surface to dimensions given in Indexes 3 and 4.

R 7. Free Turbine Case

A. Inspection

(1) Inspect turbine case skin and struts for cracks. Cracks in excess of one inch should be repaired by Pratt & Whitney. Less severe cracking may be repaired locally.

(2) Measure the No. 4 bearing support mating diameter of the case. If the diameter is undersize and the fit with the support will not be in limits (see Reference 1323 in the Table of Limits section), repair the diameter as specified below.



Free Turbine 1st Stage
Outer Duct Segment
Crack Weld Repair
Figure 606

1. 24.695 - 24.705 Inch Diameter
2. 25.190 - 25.200 Inch Diameter
3. 25.300 - 25.320 Inch Diameter
4. 25.795 - 25.805 Inch Diameter
5. These Diameters Must Be Concentric With Diameter A 0.002 Inch FIR Maximum
6. 0.095 - 0.105 Inch
7. 0.031 - 0.062 Inch Radius
8. 12.750 - 12.760 Inches (To Centerline Of Segment ID) (Typical)
9. 1.868 - 1.872 Inch
10. 1.410 - 1.430 Inch
11. 24.495 - 24.505 Inch Diameter

R 12. 0.047 - 0.078 Inch Radius

Key to Figure 606

(3) Measure and examine the rear inner air seal area of the case. If the seal is worn or undersize (see Reference 1353 in the Table of Limits), repair the diameter as specified below.

B. Repair

(1) Strut (AMS 5754) and Case Ring (AMS 5536, 5754) Cracks. See Figure 608.

(a) Stop drill and vee out cracks, removing minimum amount of material.

(b) Pack areas adjacent to crack with wet bulk ceramic fiber.

(c) Weld repair with AMS 5798 filler rod, keeping heat and weld bead height to a minimum.

(d) No stress-relief is required.

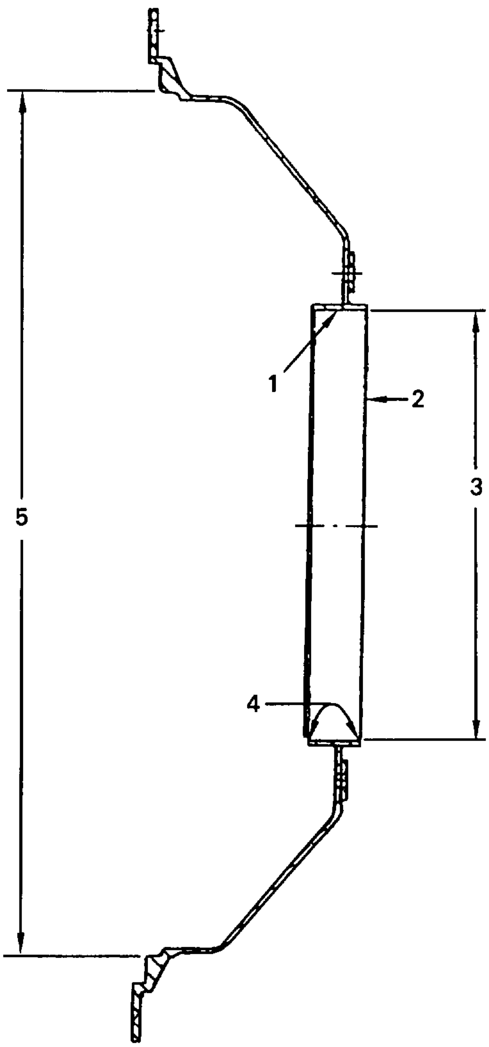
(e) Fluorescent penetrant inspect by SPOP 62 to ensure satisfactory repair.

(2) Skin Cracks (AMS 5736). See Figure 608.

(a) Stop drill and vee out cracks, removing minimum amount of material.

(b) Pack areas adjacent to crack with wet bulk ceramic fiber. See Standard Practices Manual. Section 70-42-05, for material source.

(c) Weld repair with AMS 5786 filler rod.



L-H3204 (1296)

R
R

No. 4 Bearing Seal Assembly
Chromium Plate Repair
Figure 607

1. Seal ID
2. Surface B
3. 3.755 - 3.767 Inch Pre-machining Diameter
   3.749 - 3.751 Inch Diameter After Plating And Finish Machining
   This Diameter Must Be Concentric With The Diameter At Index 5 Within 0.002 Inch FIR And Square With Surface B (Index 2) Within 0.002 Inch FIR.
4. Chromium Plate By AMS 2406 To Thickness Of 0.010 - 0.012 Inch. Surface Finish Must Be 10AA.
5. 6.229 - 6.231 Inch Diameter

Key to Figure 607

(d) After welding, perform local dye penetrant inspection.

(e) If cracks exist, blend out to parent material and reweld.

(f) Stress-relieve according to Cycle 4A (SPOP 458-2) (refer to the Standard Practices Manual).

(g) Reinspect for cracks.

(3) Free Turbine Case No. 4 Bearing Support Front Mating Diameter Repair. See Figure 609.

(a) Machine diameter to allow for at least 0.003 inch of finish plate.

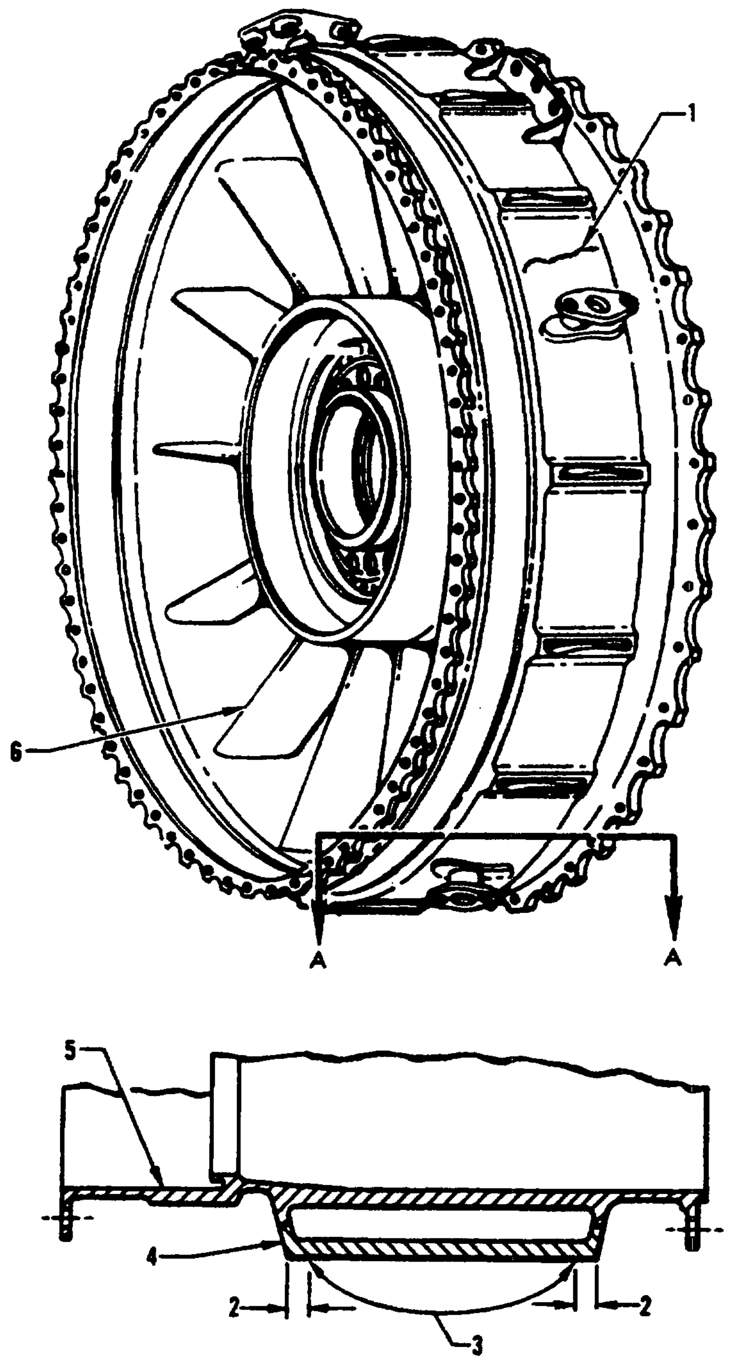
(b) Do a fluorescent penetrant inspection of the repair area (refer to Section 72-00-00).

(c) Nickel plate the area by SPOP 29 to a diameter sufficient to give a diameter in limits after finish machining.

(d) Machine the diameter to the dimensions in the figure.

(e) Do a fluorescent penetrant inspection of the repair area (refer to Section 72-00-00) to be sure that the repair is satisfactory.

(f) Treat the case area shown in the figure by SPOP 146 (refer to Section 70-41-03 in the Standard Practices Manual).



SECTION A-A

L-29816 (0000)

R
R

Free Turbine Case
Crack Repair
Figure 608

1. Case Ring Crack
2. 0.250 Inch Minimum
3. Permissible Crack Repair Area
4. Free Turbine Case Ring
5. Free Turbine Case
6. Strut

Key to Figure 608

(4) Free Turbine Case Rear Inner Flange Replacement. See Figure 610 and Figure 611 (Sheet 1) and (Sheet 2).

(a) Replacement Flange Assembly

1 Weld PN 417099 case to PN 417100 flange as shown in the figure.

2 Stress-relieve the weld at 1800° ± 50°F for one hour.

3 Machine the replacement flange assembly as shown in the figure.

(b) Rear Inner Flange Installation

1 Machine off the damaged flange as shown in the figure.

2 Remove burrs and break sharp edges.

3 Install the replacement flange in position as shown in the figure and hold it in place with clamps.

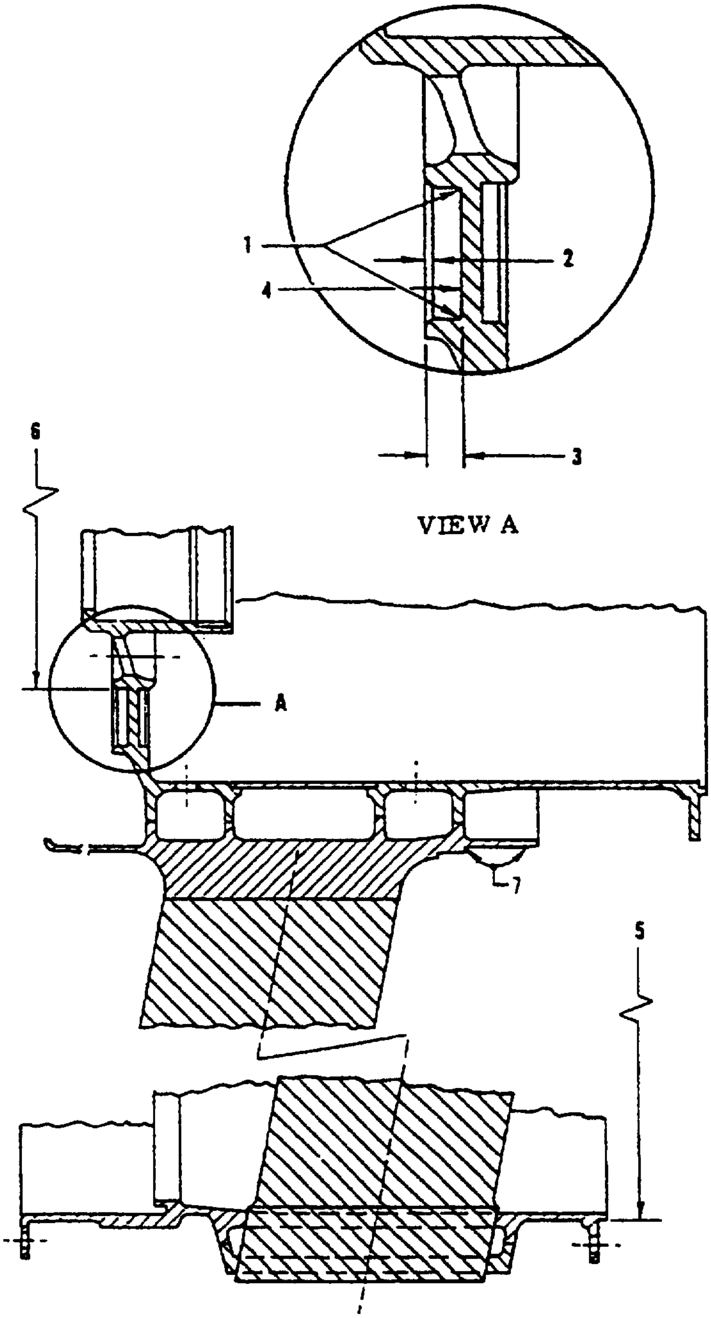
4 Weld the replacement flange to the case. Use a machine gas tungsten arc (TGAW) procedure with AMS 5798 filler metal.

NOTE: It is not necessary to stress-relieve this weld.

5 Machine the flange to the finish dimensions shown in the figure.

6 Apply antiseize compound (SPOP 146, PWA 586-1) as shown in the figure.

R
R



L-22386 (0170)

R
R

Free Turbine Case Front
Inner Mating Diameter Repair
Figure 609

1. 0.016 - 0.031 Inch Radius
2. 0.020 - 0.040 Inch by 43° - 47° Chamfer
3. 0.180 - 0.200 Inch
4. Surface Roughness Of 32 Microinch Or 63 Microinch And Circular Lay
5. 27.594 - 27.598 Inches
6. 7.499 - 7.501 Inches. This Diameter Must Be Concentric With Index 5 Within 0.002 Inch FIR.
7. Antigalling Compound Area

Key to Figure 609

(5) Free Turbine Case Rear Inner Air Seal Plasma Coat Repair.
See Figure 612.

(a) If the rear inner mating diameter of the case is worn or undersized, repair as follows:

1 Machine to clean up and remove wear. Keep parent metal removal to a minimum.

2 Measure the mating diameters before they are machined to remove damage.

3 Maintain the minimum diameter after pre-machining given (Index 3 in figure). If the diameter is not in minimum limits or if the wall thickness is less than 0.050 inch, do the replacement ring weld repair below.

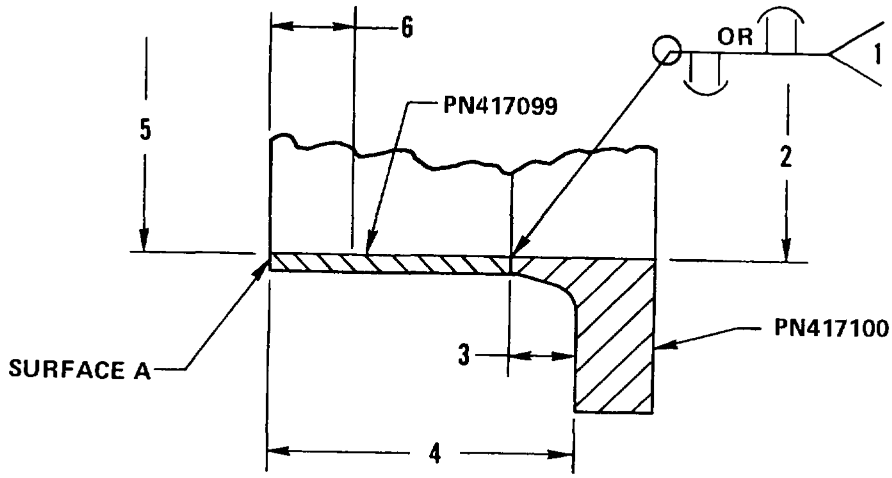
4 Fluorescent penetrant inspect affected areas by SPOP 82 (refer to Section 70-33-00, Standard Practices Manual).

5 Prepare the surface for plasma coat by SPOP 170 (refer to Section 70-46-01 in the Standard Practices Manual).

6 Apply coating to the prepared area by PWA 53-47 plasma coating process or by PWA 271-47 dual wire electric arc deposition process. If the coating will be more than 0.015 inch on each side, use the PWA 271-47 process.

7 Machine the coated areas to the dimensions given in the figure.

R
R



L—89310

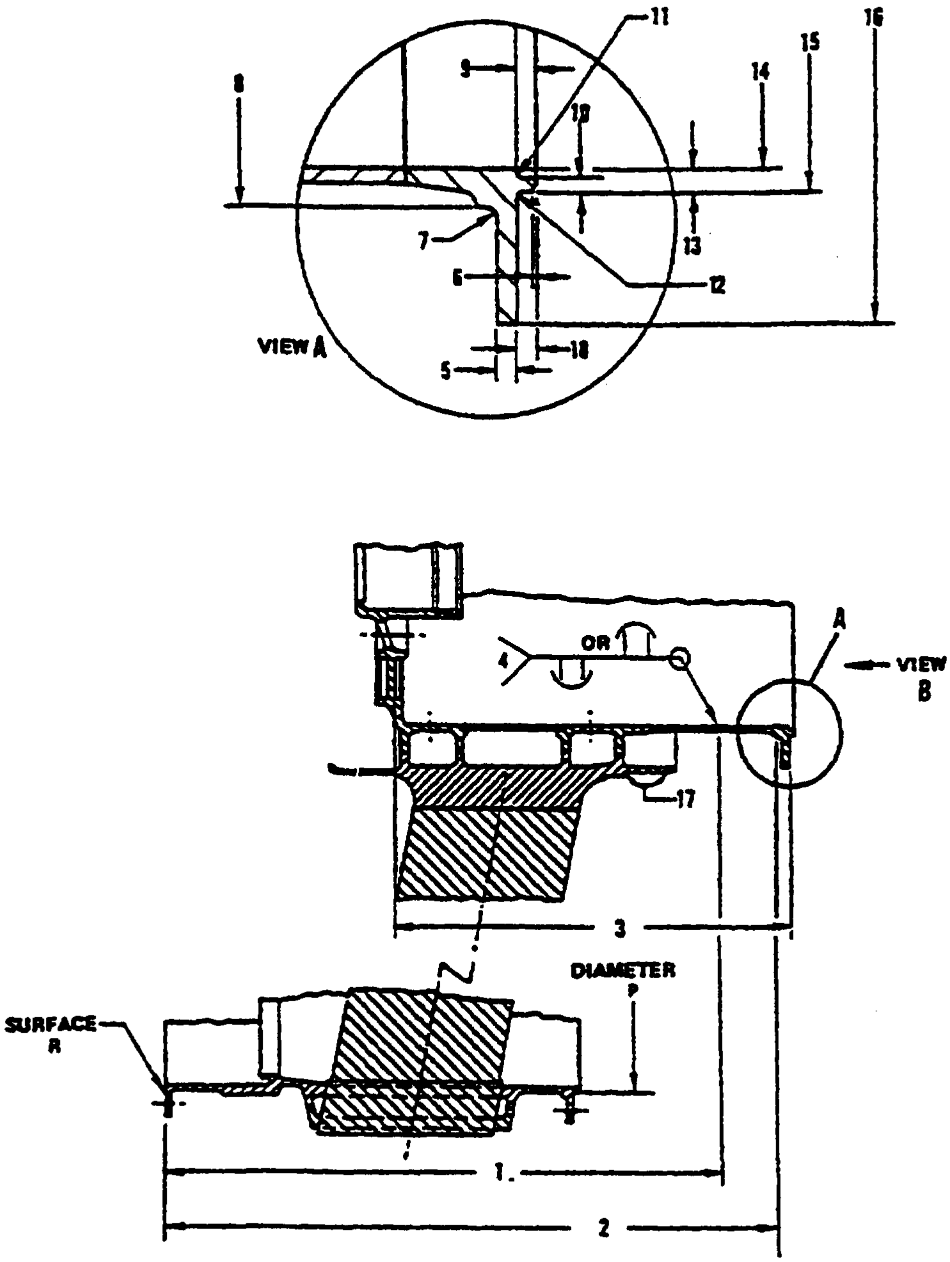
1. Weld PN 417099 (AMS 5536) To PN 417100 (AMS 5754). Use AMS 5798 Weld Wire And TGAW Procedure. The Weld Location Has Tolerance Of ± 0.060 Inch.
2. 10.020 - 10.060 Inches Diameter
3. 0.360 Inch
4. 1.560 - 1.570 Inch. Machine At Surface A.
5. 10.035 - 10.045 Inch Diameter. It Is Permitted To Size This Diameter As Necessary For Index 6 Distance.

   NOTE: Index 5 Diameter for the remaining distance can be to Index 2 limits (the limits are not applicable in the weld area).

6. 0.500 Inch Minimum

R
R

Free Turbine Case Rear
Inner Replacement
Flange Assembly
Figure 610



L-89311 (0000)

R
R

Free Turbine Case Rear
Inner Flange Replacement
Figure 611 (Sheet 1)

1. 9.505 - 9.515 Inches, Flange Removal Dimension From Surface R.
2. 11.000 - 11.120 Inches From Surface B.
3. 7.208 - 7.212 Inches
4. Weld The Replacement Flange (AMS 5536) To The Case (AMS 5536)
5. Weld
6. 0.010 - 0.030 Inch By 45° ± 2° Chamfer
7. 0.031 - 0.062 Inch Radius
8. 10.380 - 10.420 Inch Diameter
9. 0.080 - 0.120 Inch
10. 0.055 - 0.065 Inch
11. 0.016 - 0.047 Inch Radius
12. 0.010 - 0.020 Inch Radius
13. 0.095 Inch Minimum
14. 10.040 Inch Diameter
15. 10.281 - 10.283 Inch Diameter, Must Be Concentric With Diameter P In 0.002 Inch Or Less FIR.
16. 11.470 - 11.490 Inch Diameter
17. Apply PWA 586-1 As Specified In SPOP 146 And As Shown In The Figure.
18. 0.080 - 0.100 Inch

Key To Figure 611 (Sheet 1)

8 Apply PWA 586 antiseize, antigalling compound by SPOP 146 (refer to Section 70-41-03, Standard Practices Manual.

(6) Free Turbine Case Replacement Ring Weld Repair. See Figure 613.

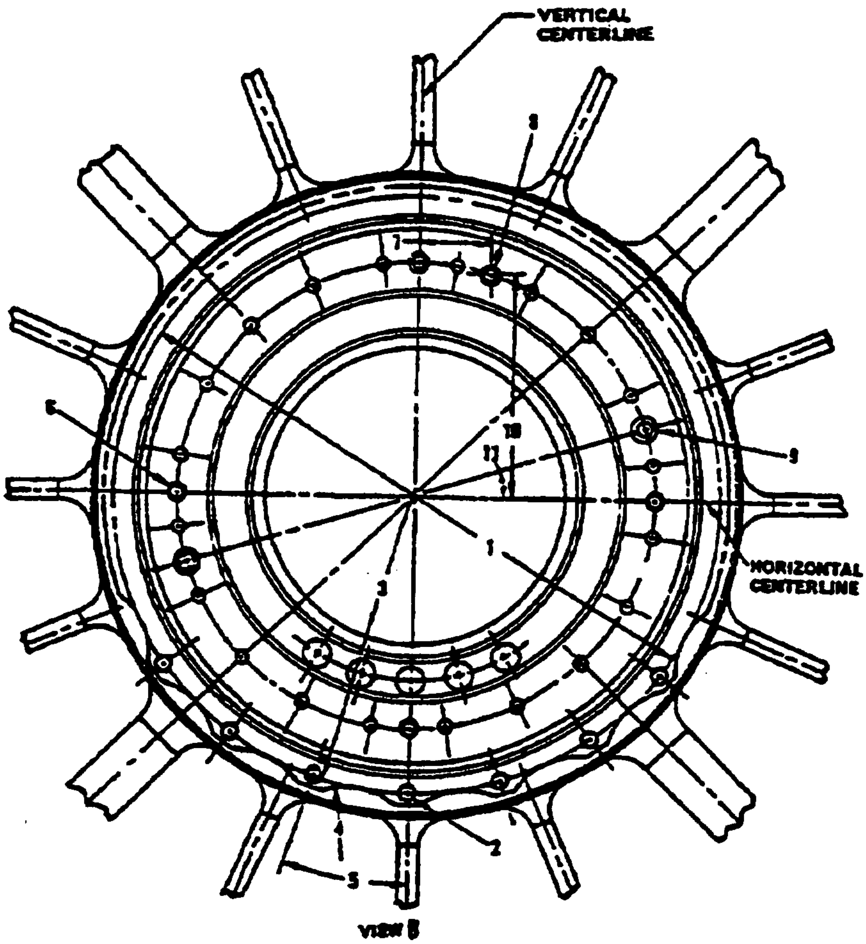
(a) Machine off the worn area (Sheet 1 of the figure).

(b) Fluorescent penetrant inspect affected area by SPOP 82 (refer to Section 70-33-00, Standard Practices Manual).

(c) Surface weld as shown in the figure. Use a GTAW procedure with AMS 5798 filler metal. Build up the weld to get the necessary dimension (Index 1, Sheet 1).

(d) Machine the welded area to the dimension given in Index 1 (Sheet 1).

R
R



L-89312 (0000)

R
R

Free Turbine Case Rear
Inner Flange Replacement
Figure 611 (Sheet 2)

1. 11.040 Inch Diameter
2. 0.276 - 0.286 Inch Diameter, 20 Holes An Equal Distance Apart and in 0.010 Inch Radius Of True Position In Relation To Index 15 (Sheet 1 Of 2)
3. 5.510 - 5.530 Inch Radius Scallops
4. 1.469 - 1.531 Inch Radius, 20 Scallops An Equal Distance Apart And In 0.020 Inch From One To The Other Side Of True Position.
5. 18° (Reference)
6. Reference Holes, 0.190-32NF2B through, 90° ± 5° Included Chamfer To 0.190 - 0.220 Inch Diameter, Four Holes And Equal Distance Apart.
7. 1.333 Inch Reference
8. Reference Hole, 0.186 - 0.187 Inch Diameter Through 90° ± 5° Included Chamfer To 0.210 - 0.230 Inch Diameter.
9. Reference Holes, 0.276 - 0.286 Inch Diameter, 82° - 84° Included Chamfer To 0.420 - 0.440 Inch Diameter, Two Holes An Equal Distance Apart.
10. 4.113 Inches (Reference)
11. 18° (Reference)

Key to Figure 611 (Sheet 2)

(e) Weld a AMS 5754 replacement ring to the AMS 5754 case (Sheet 2). Weld by the PWA 16-3 process (refer to Section 70-42-01, Standard Practices Manual. Use a GTAW process with AMS 5798 filler metal.

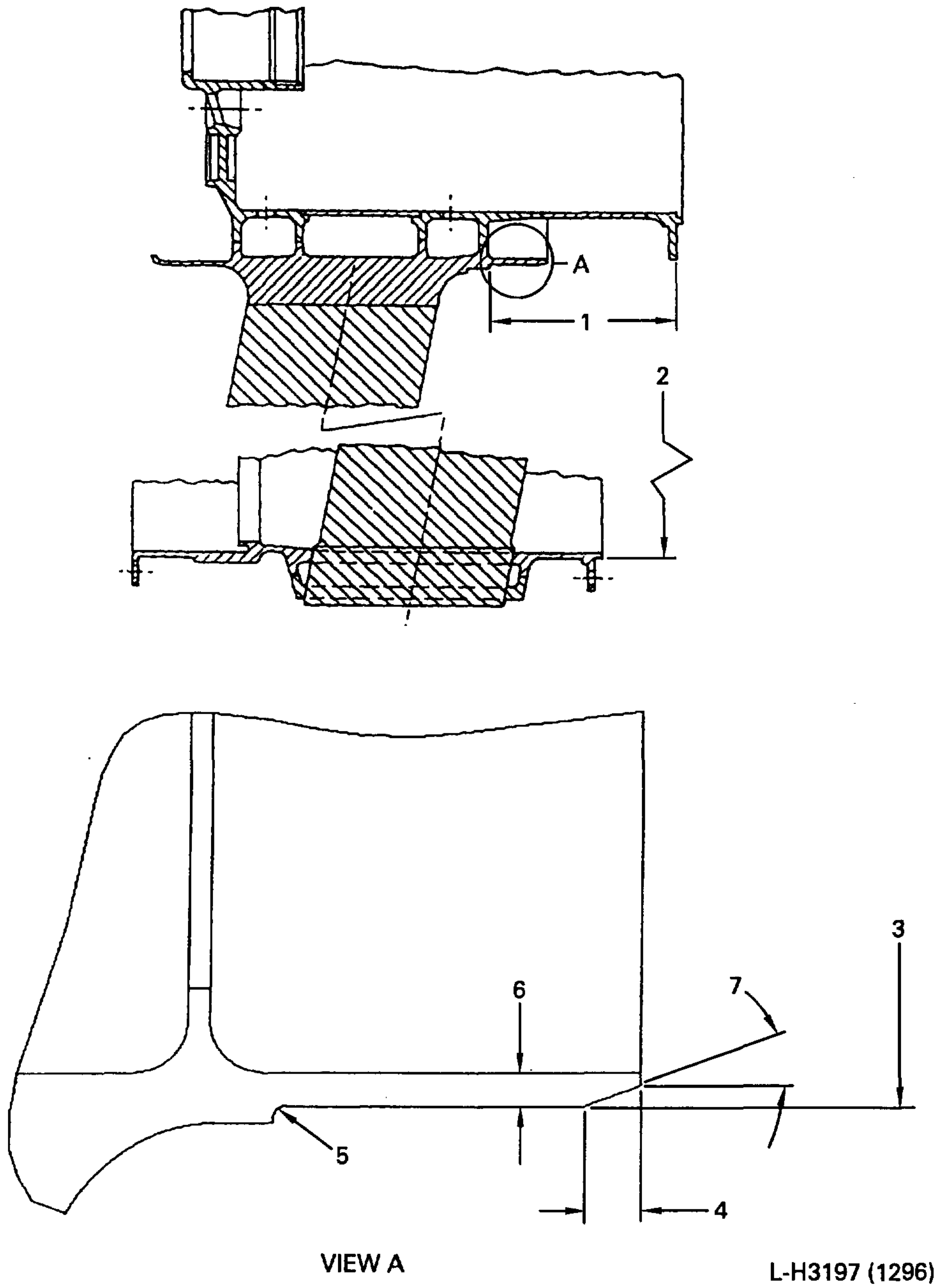
__NOTE__: Construction by AMS 7490 is permitted.

R (f) Stress-relieve by SPOP 482 (Cycle No. 22). Locally
R stress-relieve a zone that is 0.375 inch minimum
R from the edge of the weld. Refer to 70-42-04 in
R the Standard Practices Manual.

R (g) Finish machine to the dimensions given in Sheet 3
R of the figure.

R (h) Do a fluorescent penetrant inspection of affected
R areas by SPOP 82 (refer to 70-33-00 in the Standard
Practices Manual).

R (i) Apply PWA 586 antiseize, antigalling compound by
R SPOP 146 (refer to 70-41-03 in the Standard
Practices Manual).



R
R
Free Turbine Case Rear
Inner Air Seal Plasma Coating
Figure 612

1. 3.020 - 3.040 Inches
2. Reference Diameter
3. 11.585 Inch Diameter Minimum After Premachining. 11.650 Inch Diameter Minimum After Plasma Coat. 11.624 - 11.626 Inch Diameter Finished. Must Be Concentric With Index 2 Diameter Within 0.005 Inch FIR
4. 0.120 - 0.150 Inch
5. 0.020 - 0.040 Inch Radius
6. 0.050 Inch Minimum After Premachining
7. 20 Degrees ± 1 Degree

Key to Figure 612

R 8. Free Turbine Shaft Inner Case Assembly
See Tool Group 56Q-1.

A. Inspection

(1) Inspect case visually and with fluorescent penetrant method (refer to Section 72-00-00 and the Standard Practices Manual).

(2) Case front and rear mating diameters shall be concentric with 0.015 inch FIR; rear mating diameter shall be concentric within 0.004 inch FIR with bearing journal; bearing journal shall be square with bearing seat with 0.003 inch FIR; and individual diameters shall not be out-of-round in excess of 0.004 inch FIR.

(3) Inspect oil tube connectors for wear. Worn connectors may be repaired by plating.

(4) Pressure test case as follows:

(a) Secure adapter to front flange and plate to rear flange.

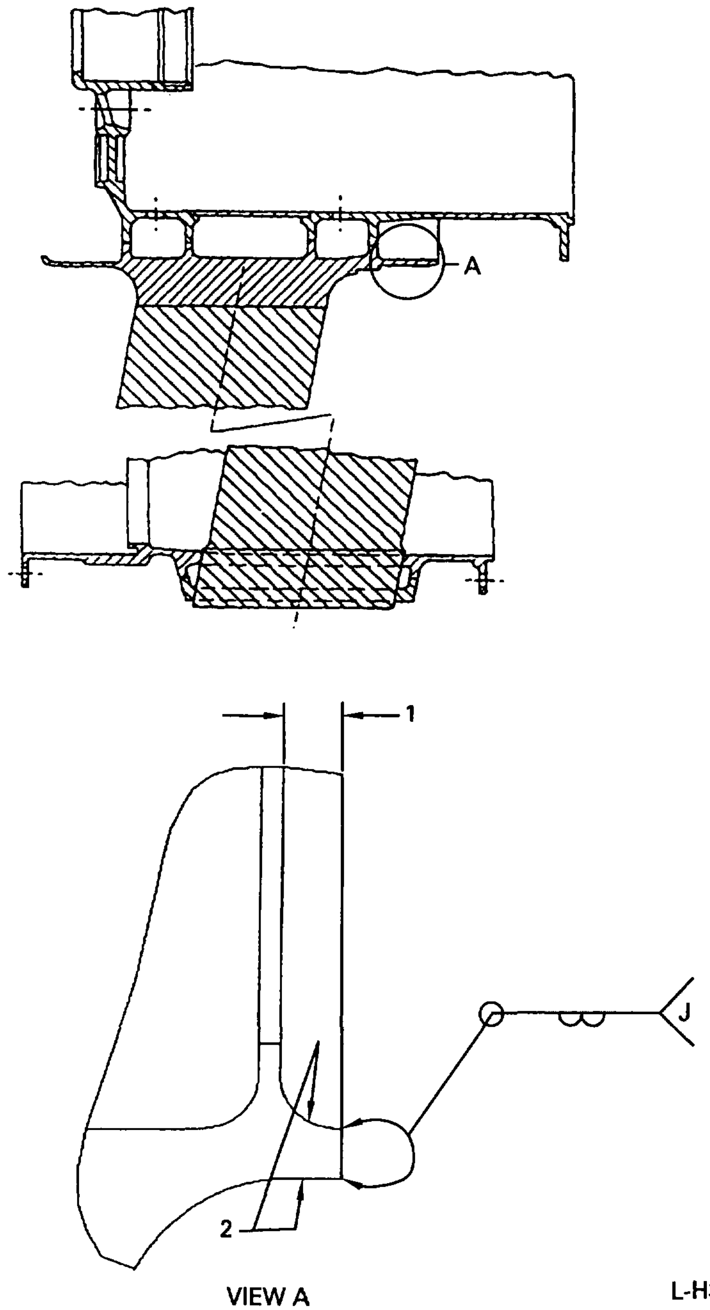
(b) Plug all holes on outside of case, using appropriate rubber plugs.

(c) Submerge case in PMC-9002 oil. (See Overhaul Standard Practices Manual).

(d) Pressurize case with ten psi air pressure. No leakage is permissible.

B. Repair

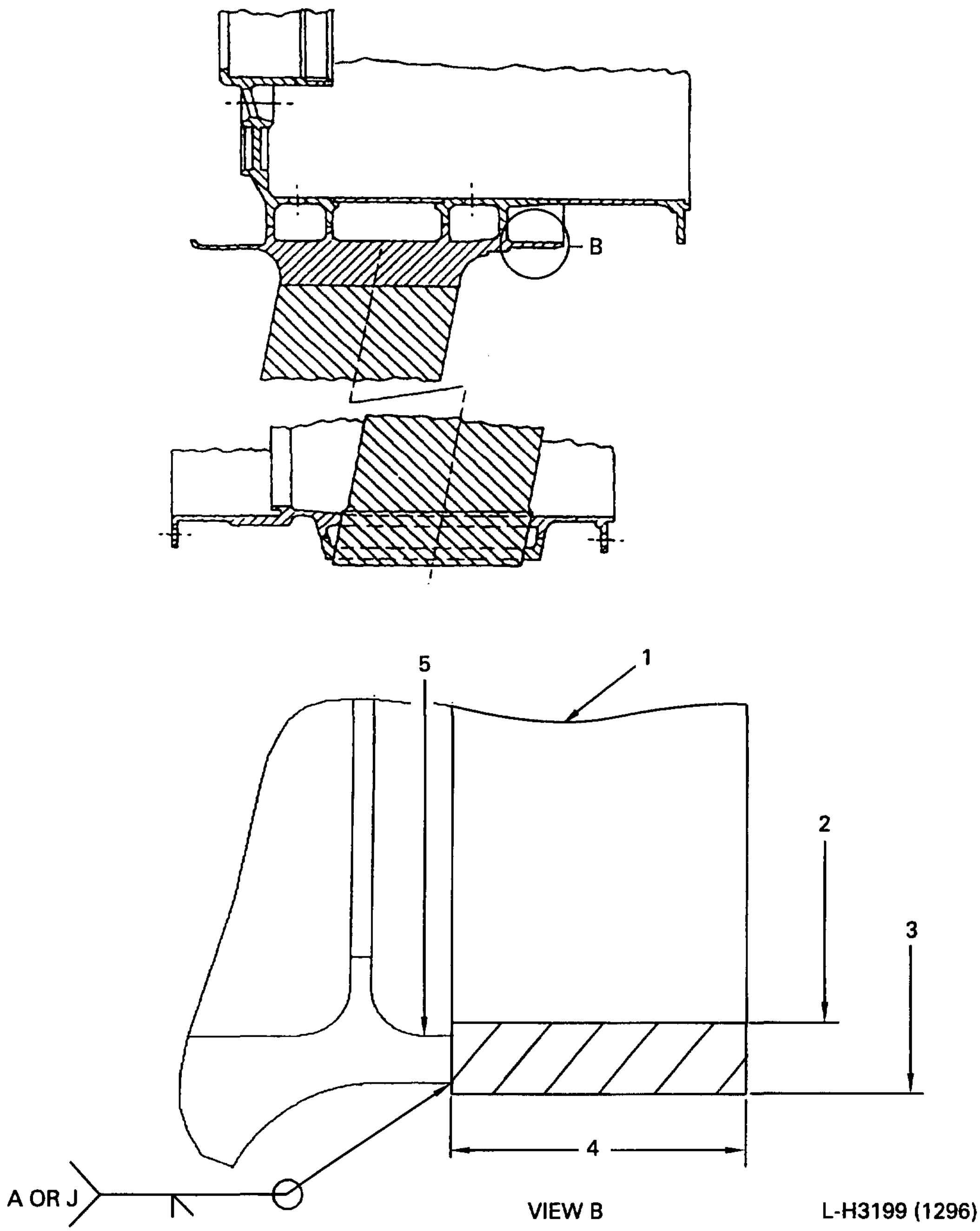
(1) Crack Repair



1. 0.300 Inch Minimum After Machining
2. All Steps Or Mismatched Areas Must Be Machined And Blended Smoothly With Parent Material

R
R

Free Turbine Case Replacement
Ring Weld Repair
Figure 613 (Sheet 1)



R
R

Free Turbine Case Replacement
Ring Weld Repair
Figure 613 (Sheet 2)

1. Replacement ring
2. 11.360 - 11.380 Inch Diameter. Must Be Machined To Index 5 Diameter Prior To Welding. Any Step Or Mismatched Area Must Be Blended Smooth
3. 11.815 - 11.835 Inch Diameter
4. 0.870 - 0.890 Inch
5. Existing Diameter (Reference)

Key to Figure 613 (Sheet 2)

(a) Cracks up to one inch may be repaired if cracks do not extend into bellows or machined surfaces.

(b) Clean area to be welded.

(c) Weld with AMS 5776 filler rod. Keep weld bead height to a minimum.

(d) Stress-relieve by Cycle No. 1A (refer to Heat Treatment in the Standard Practices Manual). Clean and descale as required.

(5) Reinspect (see above, Step A).

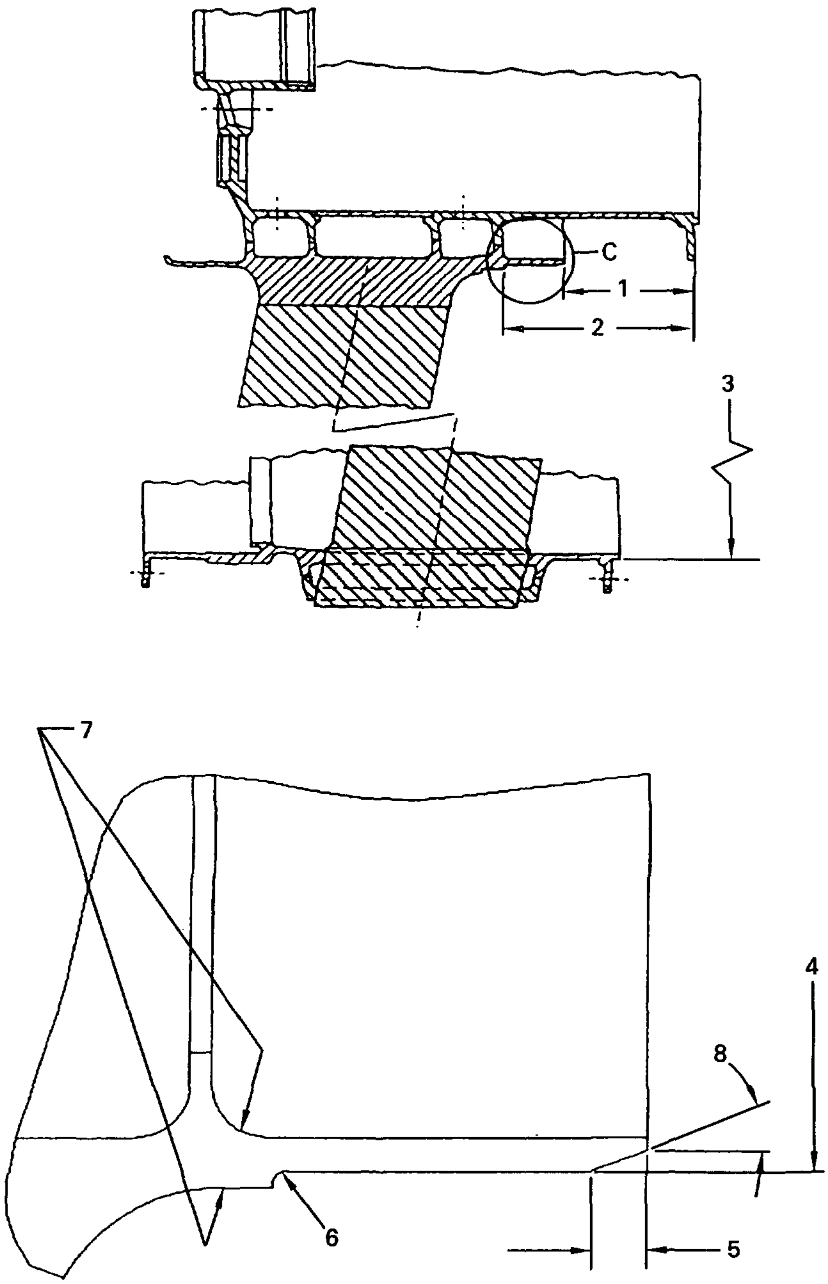
(2) Free Turbine Shaft Inner Case Oil Tube and Oil Tube Heat Shield Replacement.
See Tool Group 56Q-1 and Figure 614 and Figure 615.

(a) Free turbine shaft inner cases with damaged No. 5 bearing pressure or scavenge oil tubes and/or damaged oil tube heat shields must get this repair:

1 No. 5 bearing pressure and scavenge oil tube replacement

a Apply heat locally at Index 8 and/or 27 (Figure 614) to loosen braze and slide connector and inner tube assembly forward and out of case.

R
R



VIEW C

L-H3200 (1296)

Free Turbine Case Replacement
Ring Weld Repair
Figure 613 (Sheet 3)

R 1. 2.150 - 2.170 Inches
R 2. 3.020 - 3.040 Inches
R 3. Reference Diameter
R 4. 11.624 - 11.626 Inch Diameter, Concentric With Index 3
R Diameter 0.005 Inch FIR Maximum
R 5. 0.120 - 0.150 Inch
R 6. 0.020 - 0.040 Inch Radius
R 7. Blend All Steps, Welds, Or Mismatched Areas Smooth
R 8. 20 Degrees ± 1 Degree

R Key to Figure 613 (Sheet 3)

b Position replacement tube assembly in inner case. Position locator on case front flange so that locator aligning pin engages flange hole. Then insert tapered pin into flange offset hole at approximately 6 o'clock position. If pin will not engage, locator is improperly indexed on flange and must be repositioned. Insert locating plugs in oil tube connectors, and secure locator to case flange with detail clamps.

c Braze tube assembly to oil tube heat shield by AMS 2666 as shown in Index 8 and/or 27 (Figure 614).

NOTE: Ensure that brazing does not affect previous braze.

d Stress-relieve case at 538° - 554°C (1000° - 1030°F) for two hours.

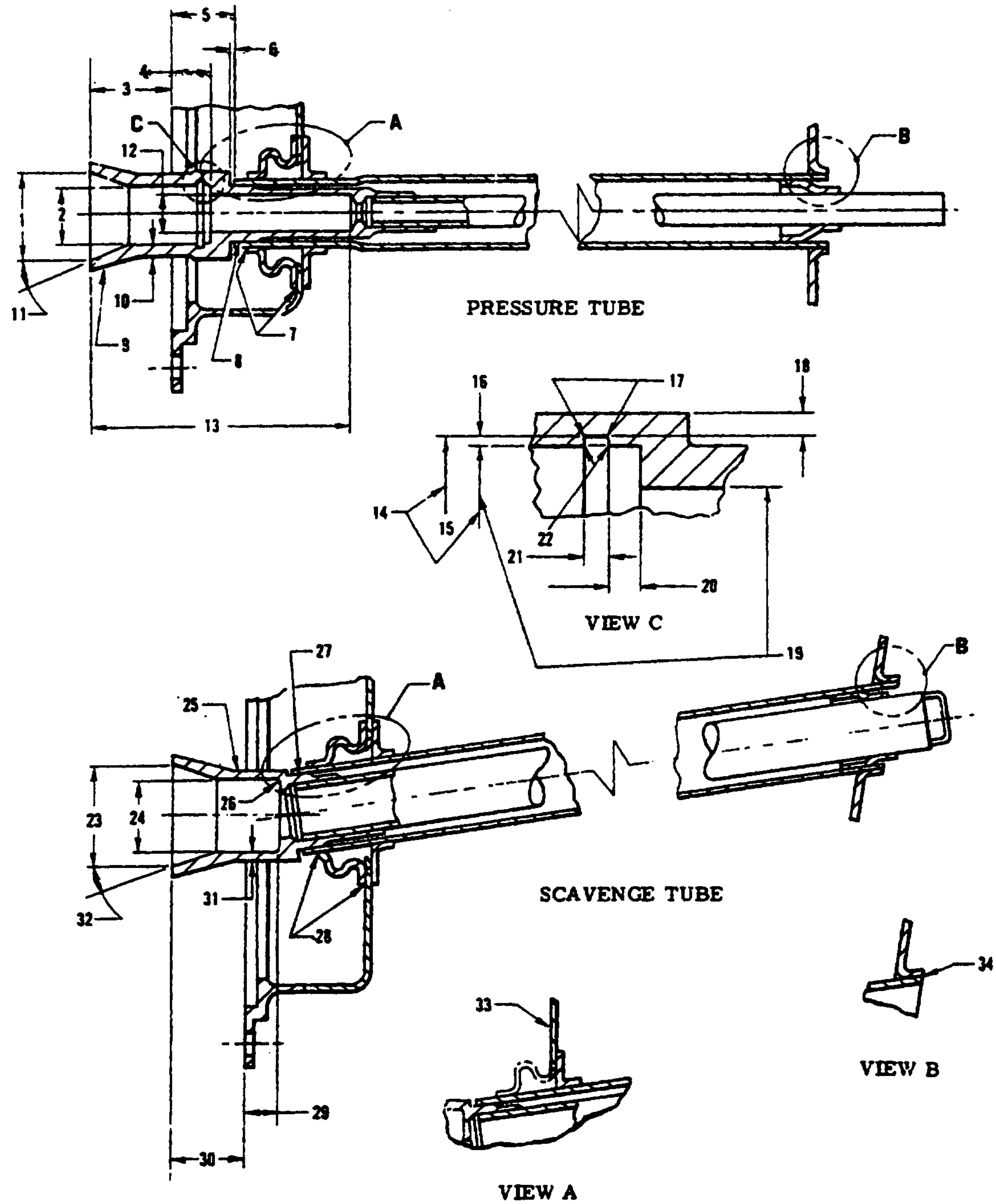
e Finish machine connectors to dimensions shown in figure.

f Ensure that oil tubes are positioned in accordance with dimensions shown in Figure 615.

g Pressure check case as specified in Inspection above.

2 No. 5 bearing pressure and scavenge oil tube heat shield replacement.

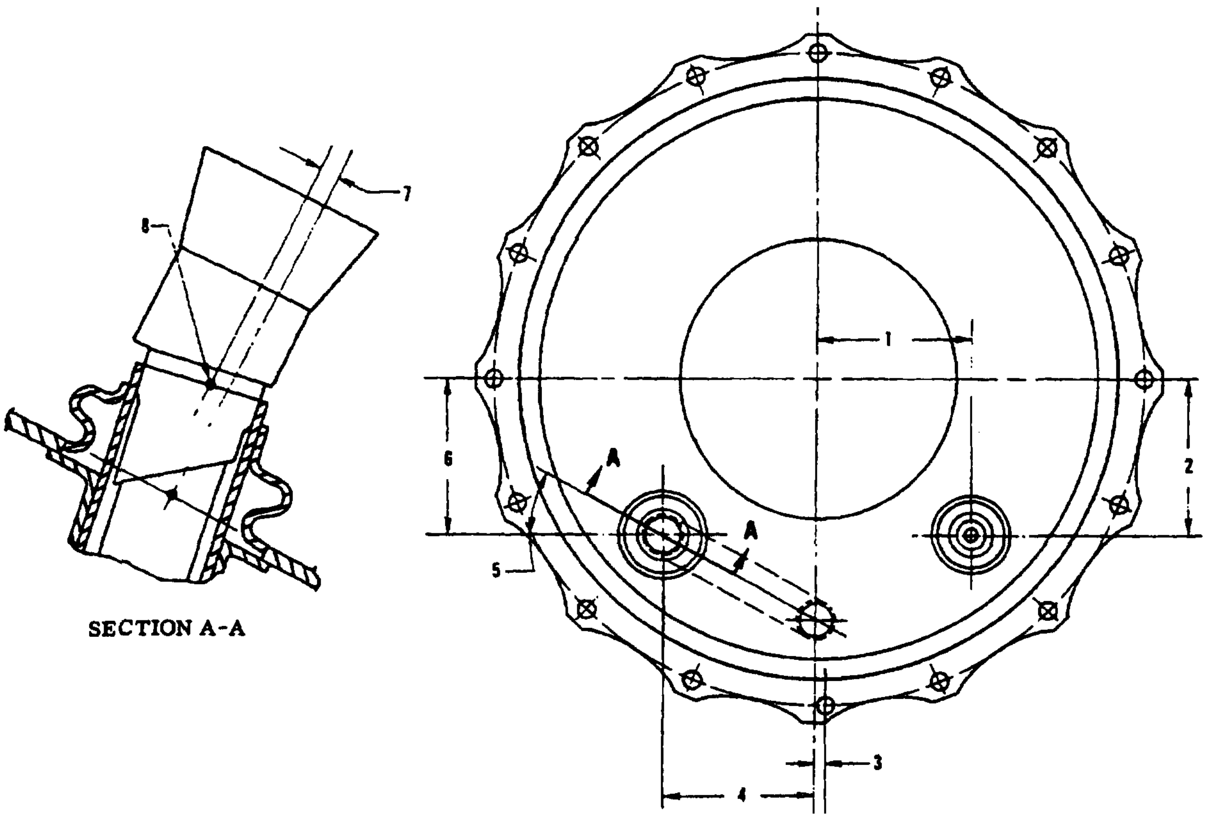
a Remove oil tube assembly as in step (a)1 above.


PRESSURE TUBE
VIEW C
SCAVENGE TUBE
VIEW B
VIEW A
A
B
C
L-29230 (0370)

1. 0.740 -0.760 Inch Diameter
2. 0.499 - 0.501 Inch Diameter
3. 0.640 - 680 Inch
4. 0.330 - 0.350 Inch
5. 0.550 - 0.570 Inch
6. 0.060 Inch Minimum
7. Weld Area
8. Braze
9. PN 658610 Tube Assembly
10. 0.040 Inch Minimum
11. 19 - 21 Degrees
12. 0.343 - 0.344 Inch Diameter For Minimum Distance Of 1.180 Inches From Front Of Connector; 0.320 - 0.344 Inch Diameter For Remainder Of Distance In Index 13.
13. 2.150 - 2.160 Inches
14. These Diameters Must Be Concentric Within 0.003 Inch FIR.
15. 0.528 - 0.532 Inch Diameter
16. 0.014 Inch Minimum
17. 0.005 Inch Maximum Radius
18. 0.030 Inch Minimum
19. These Diameters Must Be Concentric Within 0.060 Inch FIR.
20. 0.045 - 0.065 Inch
21. 0.039 - 0.042 Inch
22. 0.003 Inch Maximum Radius
23. 0.860 - 0.880 Inch
24. 0.604 - 0.608 Inch
25. PN 658609 Tube Assembly
26. 0.010 - 0.020 Inch Radius
27. Braze
28. Weld Area
29. 0.330 - 0.350 Inch
30. 0.550 - 0.590 Inch
31. 0.030 Inch Minimum
32. 19 - 21 Degrees
33. Machine Bellows Flush To 0.010 Inch Above This Surface
34. Weld Area

Key to Figure 614

R
R



L-29264 (0000)

1. 1.780 - 1.784 Inches
2. 1.780 - 1.784 Inches
3. 0.100 Inch
4. 1.794 - 1.798 Inches
5. 27°29′ - 28°29′
6. 1.794 - 1.798 Inches
7. 0.074 Inch
8. Centerline For This Diameter Of Bellows Must Be In This Plane As Shown And Located Within 0.030 Inch Of True Position

R
R

Free Turbine Shaft Inner Case
Oil Tube Positioning
Figure 615

b Machine bellows from case heat shield front flange.

NOTE: Bellows must be machined flush or to within 0.010 inch of heat shield flange (Index 33, Figure 614).

c Grind weld securing rear of oil tube heat shield to case (see Index 34, Figure 614).

d Slide oil tube heat shield out of case.

e Position replacement heat shield in case.

f Weld heat shield to rear of case with AMS 5680 welding wire.

g Weld (AMS 5504 or AMS 5591) replacement bellows to case heat shield flange and to oil tube heat shield with AMS 5680 welding wire.

h Complete repair by replacing tube assembly by steps 1 c thru g above.

R (3) Free Turbine Shaft Inner Case Oil Tube Connector Plating
R Repair

R NOTE: For this repair refer to 72-40-00 Inspection/
R Repair/Replacement-00, 2.B.(4).

R 9. Free Turbine Shaft Outer Case

A. Repair

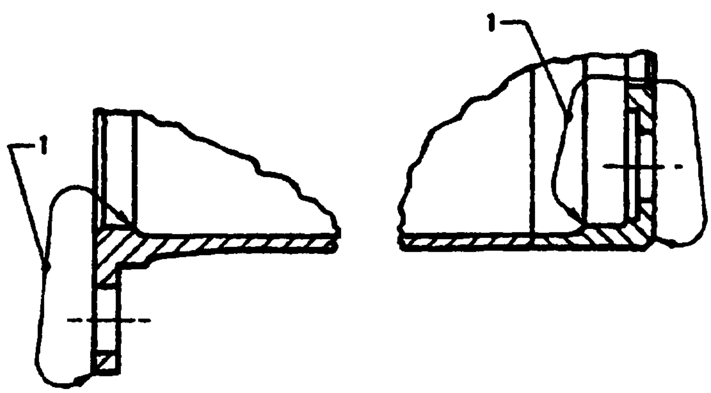
(1) Aluminum coating. See Figure 616.

(a) Apply two coats of aluminum finish (PWA 595) all over by PWA 110 (Task 70-41-04-380-100). Refer to Section 70-41-03 in the Standard Practices Manual except where indicated in figure.

(2) Front Flange Bolt Hole Crack Repair. See Figure 617.

NOTE: The base material is AMS 5613

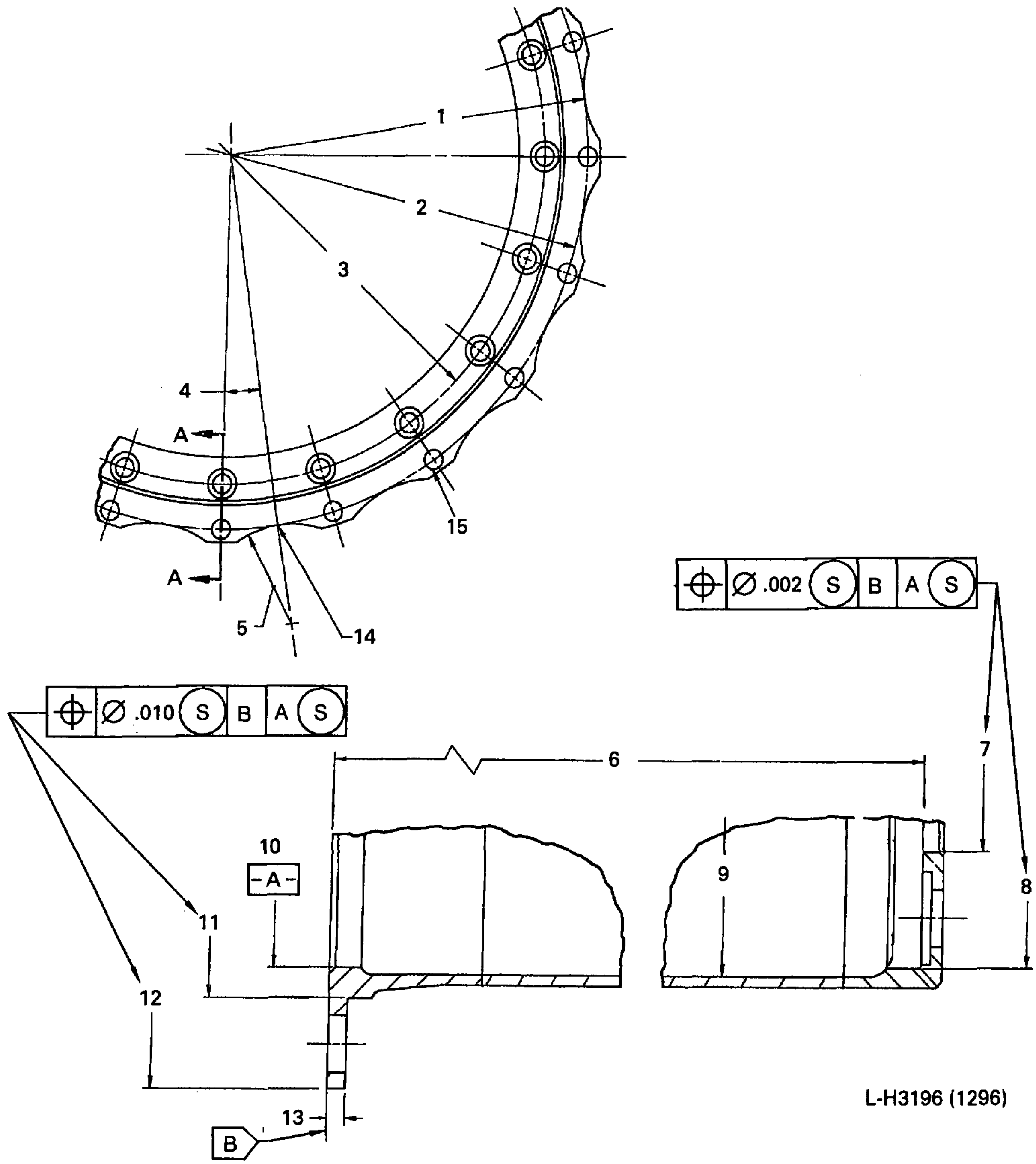
(a) Clean the area to be repaired. Refer to Section 70-20-00, Standard Practices Manual.



L-29595 (0000)

1. Apply Only One Coat Aluminum Finish by PWA 110 (Task 70-41-04-380-100) In Enclosed Areas. Refer To Section 70-41-04 In The Standard Practices Manual.

R
R
Free Turbine Shaft Outer Case
Front and Rear Flange
Aluminum Finish Application
Figure 616



R
R

Free Turbine Shaft Outer Case
Front Flange Bolt Hole
Crack Repair
Figure 617

1. 11.030 - 11.050 Inch Diameter
2. 11.040 Inch Diameter
3. 9.750 Inch Diameter
4. 9°
5. 1.469 - 1.531 Inch Radius
6. 13.841 - 13.845 Inches
7. 9.099 - 9.101 Inch Diameter
8. 10.249 - 19.251 Inch Diameter
9. 10.340 Inch Diameter
10. 10.279 - 10.281 Inch Diameter
11. 10.575 - 10.585 Inch Diameter
12. 11.475 - 11.485 Inch Diameter
13. 0.090 - 0.100 Inch
14. Twenty Scallops Equally Spaced And Located Within 0.020 Inch Of True Position
15. 0.276 - 0.286 Inch Diameter. Twenty Holes Equally Spaced And Located Within 0.101 Inch Radius Of True Position

Key to Figure 617

CAUTION: KEEP HEAT TO A MINIMUM TO PREVENT DISTORTION DURING THE WELD OPERATION. A CHILL BLOCK MAY BE NECESSARY.

(b) Weld the cracked flanges and build up the ID of the hole with AMS 5776 weld wire. Refer to Section 70-42-01, Standard Practices Manual.

(c) Fluorescent penetrant inspect all cracks by SPOP 62 (refer to Section 70-33-00, Standard Practices Manual).

(d) Stress-relieve by SPOP 455-2 (Cycle No. 1A) (refer to Section 70-42-04, Standard Practices Manual).

(e) Dimensionally inspect Indexes 6, 7, 8, 10, 11, 12 and 13 of the figure to check for distortion.

(f) Fluorescent penetrant inspect all cracks by SPOP 62 (refer to Section 70-33-00, Standard Practices Manual).

NOTE: It is recommended that the case be put in a "hold" category if it is rejected after fluorescent penetrant and dimensional inspection for future front flange replacement consideration.

R 10. Free Turbine Exhaust Duct Assembly

A. Inspection

(1) Inspect for cracks. All cracks may be repaired.

(2) Inspect for holes. All holes less than 36 square inches in area shall be repaired.

B. Crack Repair

(1) Stop drill crack extremities.

(2) Vee out cracks to ensure weld penetration.

(3) Weld using AMS 5680 filler rod, keeping weld bead to minimum height. To minimize parent material distortion, use thin welding wire and only sufficient heat to ensure proper weld fusion and penetration.

(4) Blend weld bead only to 0.020 inch above surface of parent material.

NOTE: Cracks in doubler area (rear flange) may be repaired without welding by performing blend up to and including weld. Leave edges smooth.

C. Hole Repair

(1) Blend holes to eliminate notches and sharp corners. Keep as round as possible.

(2) Fabricate patch from AMS 5510 material with thickness equal to duct thickness, not to exceed 36 square inches in area.

(3) Rework patch to original duct configuration. Fit patch 0.000 - 0.010 inch on a side.

(4) Weld patch, using small diameter AMS 5680 filler rod. (See Patch Type Repair, Fusion Welding, Overhaul Standard Practices Manual).

(5) Stress relief is not required.

(6) Blending of weld is not necessary; however, if done, blend only to 0.020 inch above surface of parent material.

D. Inspection after repair: Fluorescent penetrant inspect all weld repairs by SPOP 62 (refer to the Standard Practices Manual).

NOTE: Materials used in construction of duct assembly are AMS 5510 and AMS 5645.

E. Surface Treatment

(1) Treat by SPOP 146 as shown in Figure 618.

R 11. Free Turbine No. 4 Bearing Key Washer

A. Inspection

(1) Fluorescent penetrant inspect washer for cracks, particularly around straightened tabs (refer to Section 72-00-00 in this manual and Section 70-33-00 in the Standard Practices Manual).

(2) Any crack is unacceptable.

R 12. Free Turbine Oil Line and Flexible Shaft Shield

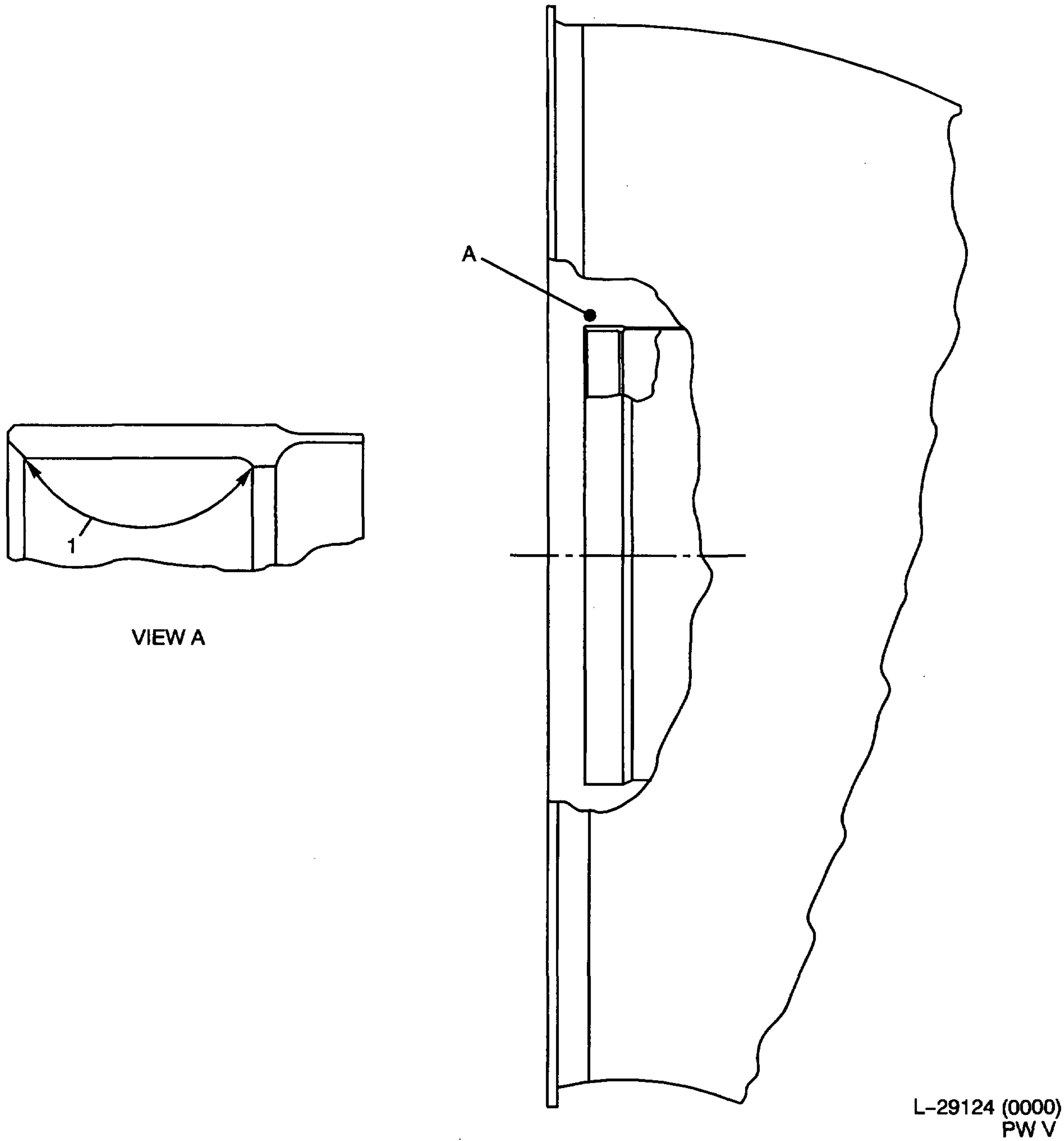
A. Repair

(1) Shield Marking

(a) The JFTD12A engine No. 4 and 5 bearing oil and breather tube assemblies and speed sense flexible shaft shield are marked NO STEP - NO HOLD at several locations. These markings shall be reapplied if removed during service use or cleaning. Size and location of markings shall be approximately the same as originally on tubes. Either of the following paints may be used. Apply by the manufacturer's instructions.

1 Red Polyurethane
E 2069 JRJ Red Enamel Component A (one part)
E 2477 JRJ Catalyst Component B (two parts)
T-78A JRJ Thinner

NOTE: The above paint is available from Miller Protective Coatings, Inc.
P.O. Box 358, South Norwalk, CT



1. Antigalling Compound Area

R
R

Free Turbine Exhaust Duct
Antigalling Compound Application
Figure 618

2 Red Epoxy Enamel E-4624 (Components A and B)

NOTE: The above paint is available from Voltex Company, Bridgeport, CT

ENGINE GEARBOX

TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

Please insert the revised pages into this manual and delete obsoleted pages in accordance with the following List of Effective Pages. Revised pages are indicated by the letter "R", added pages by the letter "A", and deleted pages by the letter "D". Superseded pages shall be removed and destroyed.

The List of Effective Pages records not only each page of subject revision but also each previously issued page which is still current. Blank pages and pages which are no longer current do not appear on this list. If there is any question about the currency of the maintained copy, it is recommended that each page of the manual be checked off against this List of Effective Pages. Any page which does not check out with this list, either by number or by date, shall be discarded. This list is reissued in its entirety whenever this manual section is revised.

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
Tab Separator - Engine Gearbox				
List of Effective Pages - Engine Gearbox See end of list.				
Table of Contents - Engine Gearbox				
72-60-00	R	01/ 02		MAY 1/08
72-60-00 INSP/REP-00		601	-ALL	APR 1/07
		602		APR 1/07
		603		APR 1/07
		604		APR 1/07
		605		APR 1/07
		606		APR 1/07
		607		APR 1/07
		608		APR 1/07
		609		APR 1/07
		610		APR 1/07
		611		APR 1/07
		612		APR 1/07
		613		APR 1/07
		614		APR 1/07
	R	615		MAY 1/08
	R	616		MAY 1/08
		617		APR 1/07
		618		APR 1/07
		619		APR 1/07
		620		APR 1/07
	R	621		MAY 1/08
	R	622		MAY 1/08
		623		APR 1/07
		624		APR 1/07
		625		APR 1/07
		626		APR 1/07
		627		APR 1/07
		628		APR 1/07
		629		APR 1/07
		630		APR 1/07
		631		APR 1/07
		632		APR 1/07
		633		APR 1/07
		634		APR 1/07
		635		APR 1/07
		636		APR 1/07
		637		APR 1/07
		638		APR 1/07
		639		APR 1/07
		640		APR 1/07
		641		APR 1/07
		642		APR 1/07
		643		APR 1/07
		644		APR 1/07
		645		APR 1/07
		646		APR 1/07
	R	647		MAY 1/08
	R	648		MAY 1/08
		649		APR 1/07
		650		APR 1/07

CHAPTER/ SECTION		PAGE	EFFECTIVITY	DATE
72-60-00			(CONTINUED)	
INSP/REP-00		651		APR 1/07
		652		APR 1/07
	R	653		MAY 1/08
	R	654		MAY 1/08
		655		APR 1/07
		656		APR 1/07
	R	657		MAY 1/08
	R	658		MAY 1/08
		659		APR 1/07
		660		APR 1/07
	R	661		MAY 1/08
	R	662		MAY 1/08
	R	663		MAY 1/08
	R	664		MAY 1/08
	R	665		MAY 1/08
	R	666		MAY 1/08
	R	667		MAY 1/08
	R	668		MAY 1/08
	R	669		MAY 1/08
	R	670		MAY 1/08
	R	671		MAY 1/08
	R	672		MAY 1/08
	R	673		MAY 1/08
	R	674		MAY 1/08
	R	675		MAY 1/08
	R	676		MAY 1/08
	R	677		MAY 1/08
	R	678		MAY 1/08
	R	679		MAY 1/08
	R	680		MAY 1/08
	R	681		MAY 1/08
	R	682		MAY 1/08
	R	683		MAY 1/08
	R	684		MAY 1/08
	R	685		MAY 1/08
	R	686		MAY 1/08
	R	687		MAY 1/08
	R	688		MAY 1/08
	R	689		MAY 1/08
	R	690		MAY 1/08
	R	691		MAY 1/08
	R	692		MAY 1/08
	R	693		MAY 1/08
	R	694		MAY 1/08
	A	695/696		MAY 1/08
LIST OF EFFECTIVE PAGES				
		A		MAY 1/08

TO: RECIPIENTS OF JT12 OVERHAUL MANUAL, PART NUMBER 435108

REVISION NO. 75 DATED MAY 1, 2008

HIGHLIGHTS - ENGINE GEARBOX

CHAPTER/ SECTION	PAGE NO	DESCRIPTION OF CHANGE	EFFECT OF CHANGE
72-60-00 INSP/REP-00	615 621 647 654 658 662 -694	Revised gearbox repair text.	-ALL

ENGINE GEARBOX - INSPECTION, REPAIR, AND REPLACEMENT

1. Engine Gearbox Section

A. General

(1) Refer to Section 72-00-00 for general procedures related to inspection, repair, and replacement.

(2) This section contains inspection, repair, and replacement procedures for the engine gearbox and for other related engine control parts and supports.

2. Power Lever Cross Shaft

A. Bearing Replacement
(Refer to Tool Group 83C)

(1) Put the Base, DISASSEMBLY end up, in a vise and install the arm assembly on the base.

(2) Use the Drift to push the drive bearing out of the arm assembly.

(3) Put the Base, ASSEMBLY end up, in a vise and install the arm assembly on the base.

(4) Put the bearing in the Drift and install the bearing in the arm.

(5) With the arm assembly on the Base, stake the bearing in position.

B. Inspection

(1) Examine the bearing journals for wear or damage. Repair a journal worn to less than 0.6242 inch diameter.

C. Bearing Journal Repair
See Figure 601.

(1) Machine the worn bearing journal to remove chromium plate (keep the journal diameter to a minimum diameter of 0.620 inch).

(2) Apply chromium plate to the area shown in the figure by SPOP 22 (Task 70-44-01-330-002). Refer to Section 70-44-01 in the Standard Practices Manual.

(3) Examine the chromium plate to be sure that it is in good condition (no cracks, other than crazing or "alligatoring").

(4) Bake the part at 385° - 413°C (725° - 775°F) for one hour.

(5) Machine the journal diameter to the dimensions shown (keep concentricities in limits).

3. Power Lever Cross Shaft Support

A. Inspection

(1) Measure the support mounting bolt holes for wear.

(2) Repair holes worn more than 0.2980 inch diameter.

B. Repair

See Figure 602.

(1) Drill out worn holes to the dimension shown (keep the holes to 0.002 inch maximum radius of true position).

(2) Chamfer each end of the holes as shown.

(3) Treat the machined areas where shown by SPOP 42 (Task 70-44-01-330-012) (AMS 2473). Refer to Section 70-44-01 in the Standard Practices Manual.

(4) Install PN 629715 bushing in a machined hole.

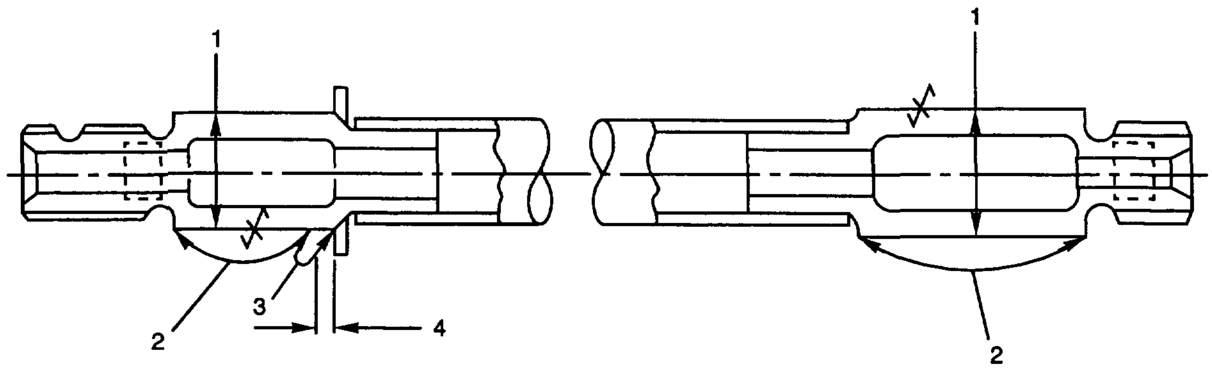
(5) Flare each end of a bushing (make sure that the flared ends are flush with or below the surface of the support as shown).

4. Main Oil Pressure Relief Valve

A. Inspection

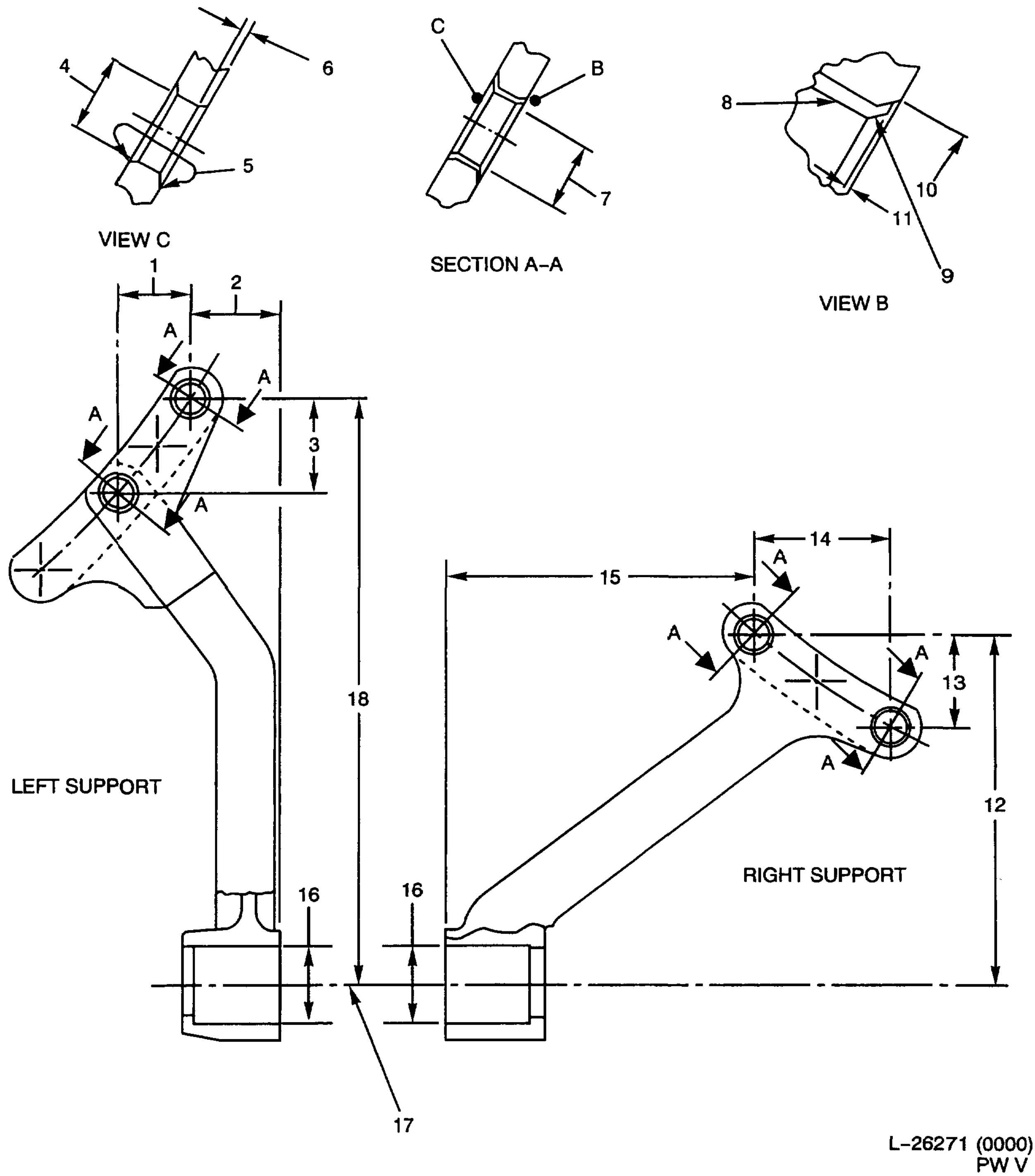
(1) Examine the detail parts of the relief valve (refer to the Table of Limits for dimensions and fit limits).

(2) Examine part mating surfaces for grooves, scores, or steps. Replace worn parts.



1. 0.6242 - 0.6255 Inch Diameter, Concentric With Their Respective Spline Pitch Diameters 0.002 Inch Maximum FIR. Journal End Faces Adjacent To Splines Must Be Square With Spline Pitch Diameters 0.002 Inch Maximum FIR.
2. Bearing Journal Repair Area
3. Optional Plate Area
4. 0.120 Inch Minimum

Power Lever Cross Shaft
Bearing Journal Repair
Figure 601



Power Lever Cross Shaft
Support Bolt Hole Repair
Figure 602

1. 0.688 Inch
2. 0.920 Inch
3. 0.983 Inch
4. 0.3265 - 0.3275 Inch Diameter, 0.001 Inch Radius Maximum Of True Position
5. Anodize Touch-Up Area (See Text)
6. 0.015 - 0.030 Inch by 43 - 47 Degrees Chamfer
7. 0.2965 - 0.2975 Inch Diameter, 0.001 Inch Radius Maximum Of True Position
8. Bushing (See Text)
9. Flare to Attach (Each Side)
10. 0.390 - 0.400 Inch Diameter
11. 0.000 - 0.005 Inch
12. 3.673 Inches
13. 0.976 Inch
14. 1.394 Inch
15. 3.058 Inches
16. Diameter A
17. Centerline Of Index 16 Diameter (Diameter A)
18. 6.054 Inches

Key To Figure 602

(3) All mating surfaces of the valve parts (that move against each other) must have a surface finish of 10 RMS minimum.

B. Repair

(1) If the parts do not have the necessary finish (see Inspection above), polish the mating surfaces of the valve housing and cylinder with No. 400 crocus cloth soaked in oil. After parts are polished, remove the
R oil by SPOP 209 (Task 70-21-00-110-041). Refer to
R Section 70-21-00 in the Standard Practices Manual.

5. Main Oil Pump

A. Pump Bodies and Cover

(1) Inspection

(a) Examine the pump bodies and cover for erosion indications. It is permitted to do a blend repair of eroded areas in the inlet and outlet areas to a depth of 0.125 inch.

(b) If erosion extends into the drive or idler shaft holes or if it is apparent that erosion will cause the inlet and outlet areas to connect, replace the pump body and/or cover.

(c) Depth of isolated circumferential grooves and/or scores on either body faces or the ID of gear pockets must not be more than 0.008 inch, and the width must not be more than 10 percent of the geartooth.

(d) No blend repair of scores or grooves is permitted unless it is to remove raised material.

(2) Repair

(a) Remove erosion or raised material by blend repair to a depth of 0.125 inch maximum.

NOTE: Blend repair must remove all erosion indications and all sharp edges. Do not cause internal clearances to be more than specified in the Table of Limits.

B. Pump Gears

(1) Inspection

(a) Blend repair of meshing surfaces of gears is not permitted (blends in these areas will decrease the efficiency of the pump in which the gear is used).

(b) The surfaces of gear teeth mating with the housing or cover must not have a round radius of more than 0.005 inch.

NOTE: The sharp corners on gear teeth are the result of pump design.

C. Main Oil Pump Straight Shaft

(1) Shaft Replacement (refer to Tool Group 79B)

(a) Remove the pin that attaches the main oil pump straight shaft to the inner cover.

(b) Put the cover assembly under an arbor press.

(c) Use the Drift to push the shaft out of the cover.

(d) Install a new shaft in the cover with an arbor press. Install a pin to hold the shaft in position.

D. Main Oil Pump Idler Shaft (JFTD12 Free Turbine Engines)

(1) Shaft Replacement (refer to Tool Group 79B) and Figure 603.

(a) Remove the pin that attaches the main oil pump straight shaft to the inner cover.

(b) Put the cover assembly under an arbor press.

(c) Use the Drift to push the shaft out of the cover.

(d) Install a new shaft in the cover with an arbor press. Make sure that the shaft is in the correct axial position as shown in the figure (Index 6) and that the idler shaft flats are in the correct position (Index 7).

(e) Use the cover as a guide and drill a retaining pin hole in the new idler shaft.

(f) Install a new retaining pin and stake it tightly at each end.

6. <u>Accessory And Component Drive Gearshafts</u>

A. Inspection

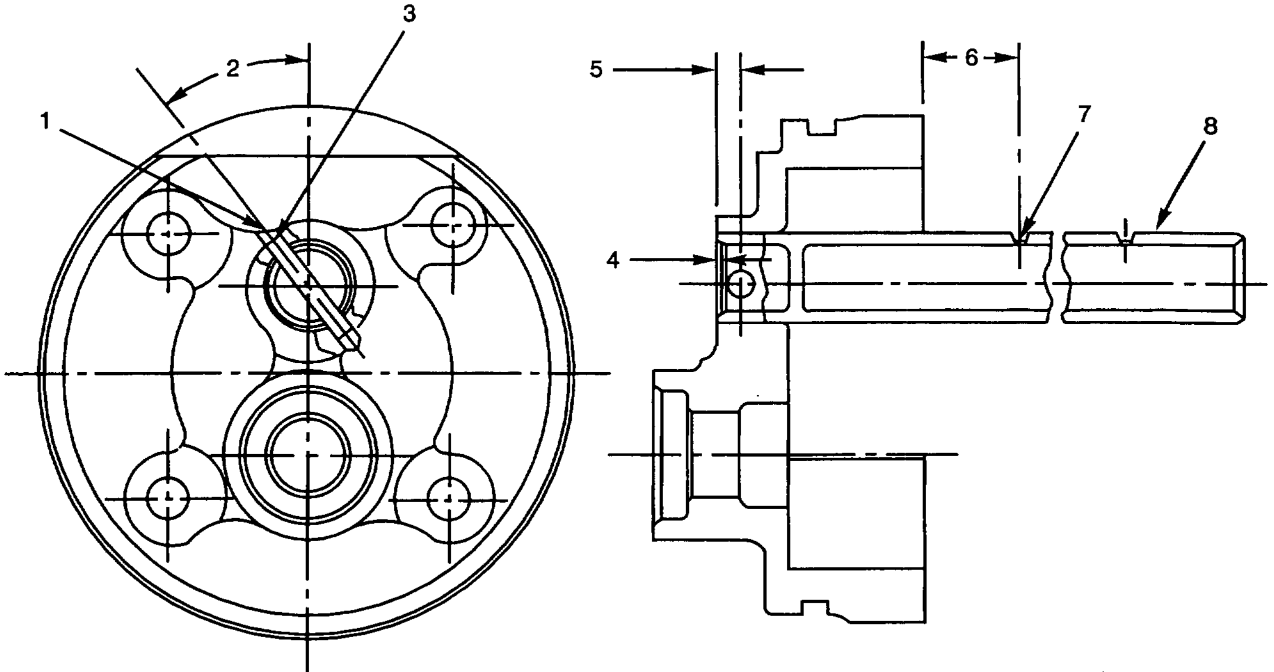
(1) Refer to the Table of Limits for dimensions and fit limits.

B. Repair
R See Figure 604 thru Figure 612.

(1) Chromium Plate Repair

(a) Grind gearshaft bearing journals sufficiently to prepare the surface for chromium plate.

<u>NOTE</u>: Do not decrease diameters to more than 0.010 inch less than the finish dimensions.



1. 0.1225 - 0.1245 Inch Diameter Hole To Depth Of 0.950 - 0.990 Inch, Plus/Minus 2 Degrees Of True Angular Position
2. 38 Degrees
3. AN150262 Pin (Stake Tightly At Each End)
4. 0.000 - 0.020 Inch
5. 0.130 - 0.150 Inch
6. 0.644 Inch (Reference Dimension)
7. Install Shaft With Flats In Position Shown, Plus/Minus 5 Degrees Of True Angular Position
8. PN 450871

R
R

Main Oil Pump Idler Shaft
Replacement (JFTD12)
Figure 603

(b) Do a fluorescent magnetic particle inspection of the machined area. Refer to Section 72-00-00, Inspection/Repair/Replacement and Section 70-32-00 in the Standard Practices Manual.

(c) Shotpeen the plate area by SPOP 501 to an intensity of 12A2. Refer to Section 70-41-02 in the Standard Practices Manual.

(d) Apply chromium plate to the machined area by SPOP 22 (Task 70-44-01-330-002). Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: No bake is necessary.

(e) Finish grind to the dimension shown in the applicable figure.

(2) Hydraulic Pump Drive Gearshaft Seal Face Chromium Plate Repair

(a) Grind gearshaft seal face sufficiently to prepare the surface for chromium plate Grind to 1.716 - 1.729 inch dimension (see Figure 608, Index 9) (hold to minimum dimension when possible).

(b) Do a fluorescent magnetic particle inspection of the machined area. Refer to Section 72-00-00, Inspection/Repair/Replacement and Section 70-32-00 in the Standard Practices Manual.

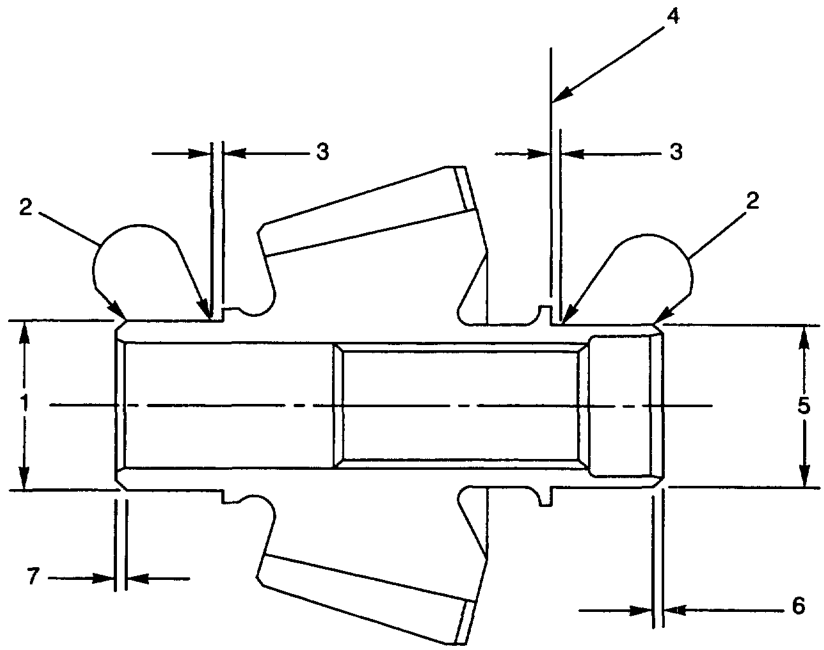
(c) Shotpeen the plate area by SPOP 501 to an intensity equivalent to 10A. Refer to Section 70-41-02 in the Standard Practices Manual.

(d) Apply chromium plate to the machined area by SPOP 22 (Task 70-44-01-330-002). Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: No bake is necessary before or after plate.

(e) Finish grind to the dimension shown. See Figure 608.

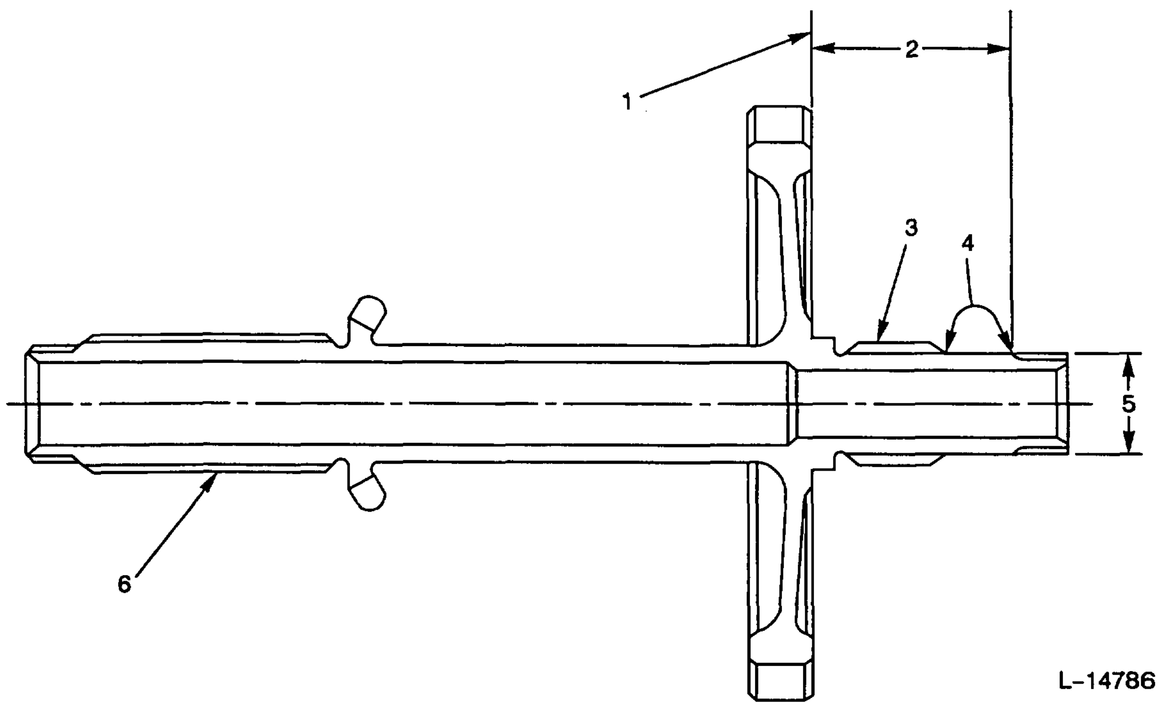
(3) Starter and Generator Drive Gearshaft Seal Face Chromium Plate Repair



L-14685 (0000)
PW V

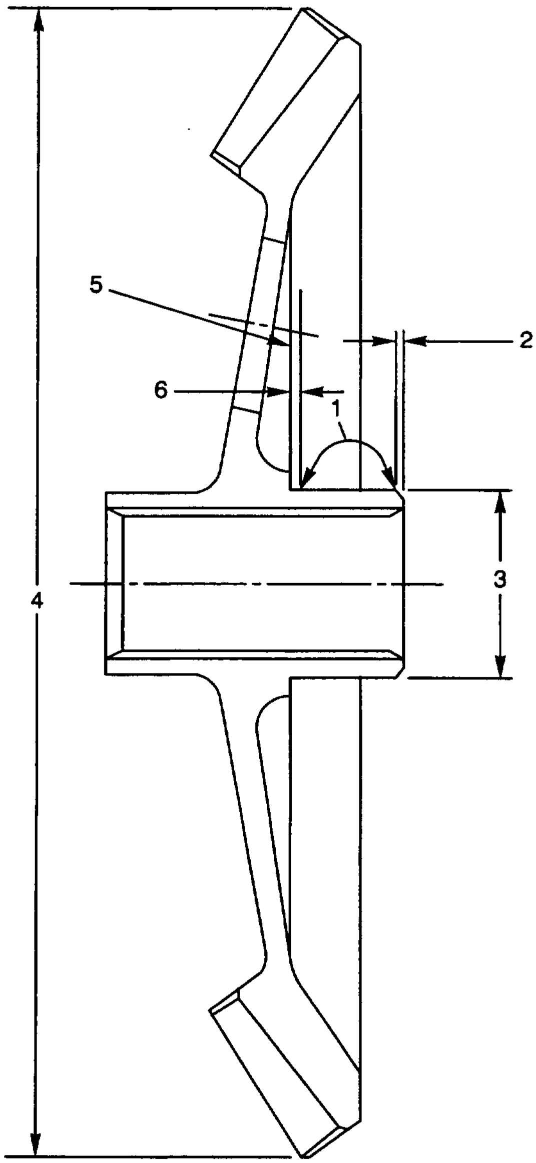
1. 0.7876 - 0.7880 Inch Diameter, Concentric With Diameter A (Index 5) 0.001 Inch Maximum FIR And All Other Diameters 0.010 Inch Maximum FIR
2. Plate Area (See Text)
3. 0.039 Inch
4. Diameter A (Index 5) Must Be Square With This Face 0.001 Inch Maximum FIR
5. Diameter A, 0.7876 - 0.7880 Inch, Concentric With Axis Of Pitch Cone And Axis Of PD Of Spline 0.002 Inch Maximum FIR And With All Other Diameters 0.010 Inch Maximum FIR
6. Chamfer 0.010 - 0.020 Inch by 43 - 47 Degrees
7. Chamfer 0.010 - 0.030 Inch by 43 - 47 Degrees

Component Drive Gearshaft
Plate Repair
Figure 604



1. Face E
2. 1.260 - 1.280 Inch
3. Spline B
4. Plate Area (See Text)
5. 0.6695 - 0.6699 Inch Diameter A, Square With Face E (Index 1) 0.001 Inch Maximum FIR, Concentric With PD Of Spur Gear, Spline B, Spline C 0.002 Inch Maximum FIR, And All Other Diameters 0.010 Inch Maximum FIR. Centerline Of Diameter A And Axis Of Pitch Cone Must Be Concentric 0.002 Inch Maximum FIR.
6. Spline C

Gearbox Bevel Spur Gearshaft
Plate Repair
Figure 605



Component Drive Gearbox
Bevel Gear Plate Repair
Figure 606

1. Plate Area (See Text)
2. Chamfer 0.020 - 0.040 Inch By 43 - 47 Degrees
3. 0.9845 - 0.9849 Inch, Diameter A, Concentric With PD Of Spline 0.002 Inch Maximum FIR And All Other Diameters 0.010 Inch Maximum FIR Unless Otherwise Specified. Axis Of Diameter A And Axis Of Pitch Cone Must Be Concentric 0.001 Inch Maximum FIR.
4. This Diameter Must Be Concentric With Diameter A 0.002 Inch Maximum FIR
5. This Face Must Be Square With Diameter A 0.0005 Inch Maximum FIR
6. 0.035 Inch

Key To Figure 606

(a) Grind gearshaft seal face sufficiently to prepare the surface for chromium plate Grind to the pre-plate dimension (see Figure 609, Index 15) (hold to minimum dimension when possible).

(b) Do a fluorescent magnetic particle inspection of the machined area. Refer to Section 72-00-00, Inspection/Repair/Replacement and Section 70-32-00 in the Standard Practices Manual.

(c) Shotpeen the plate area by SPOP 501 to an intensity equivalent to 10A. Refer to Section 70-41-02 in the Standard Practices Manual.

(d) Apply chromium plate to the machined area by SPOP 22 (Task 70-44-01-330-002). Refer to Section 70-44-01 in the Standard Practices Manual.

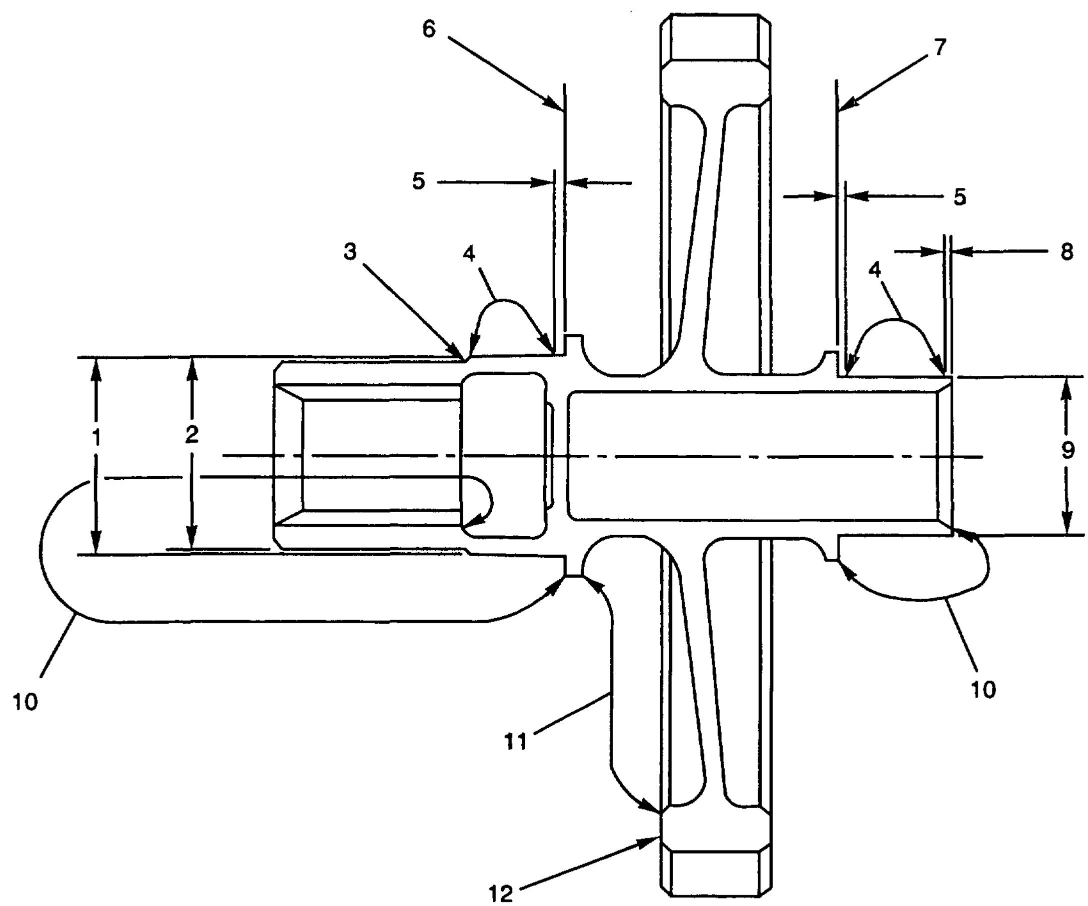
<u>NOTE</u>: No bake is necessary before or after plate.

(e) Finish grind to the dimension shown. See Figure 609.

(4) Starter and Generator Driveshaft Chromium And Silver Plate Repair. See Figure 611.

(a) Grind the front OD of the driveshaft (pre-PN 449114) (if worn) sufficiently to prepare the surface for chromium plate.

<u>NOTE</u>: Remove only sufficient material to remove old plate and damage. The chromium plate thickness after finished machining must be 0.002 - 0.010 inch.



Fuel Control Drive Gearshaft
Plate Repair
Figure 607

1. 0.9845 - 0.9849 Inch, Diameter A
2. This Diameter Must Be Concentric With Diameter (Index 1) 0.001 Inch Maximum FIR
3. 0.031 - 0.062 Inch Radius
4. Plate Area (See Text)
5. 0.039 Inch
6. Diameter A (Index 1) Must Be Concentric With This Diameter 0.002 Inch Maximum FIR
7. Diameter B Must Be Square With This Face 0.002 Inch Maximum FIR

R 8. Chamfer 0.010 - 0.030 Inch By 43 - 47 Degrees
9. 0.7876 - 0.7880 Inch, Diameter B, Concentric With Diameter A (Index 1) 0.002 Inch Maximum FIR
10. No Paint Area (Refer to Gear Tooth Surface Treatment Repair For Gear Tooth Areas)
11. Paint Area (Refer To SPOP 152 In Standard Practices Manual)
12. Overspray Permitted In This Area

Key To Figure 607

(b) Remove silver plate from the driveshaft (refer to SPOP 23 in Section 70-44-01 in the Standard Practices Manual).

(c) Do a fluorescent magnetic particle inspection of the machined area. Refer to Section 72-00-00, Inspection/Repair/Replacement and Section 70-32-00 in the Standard Practices Manual.

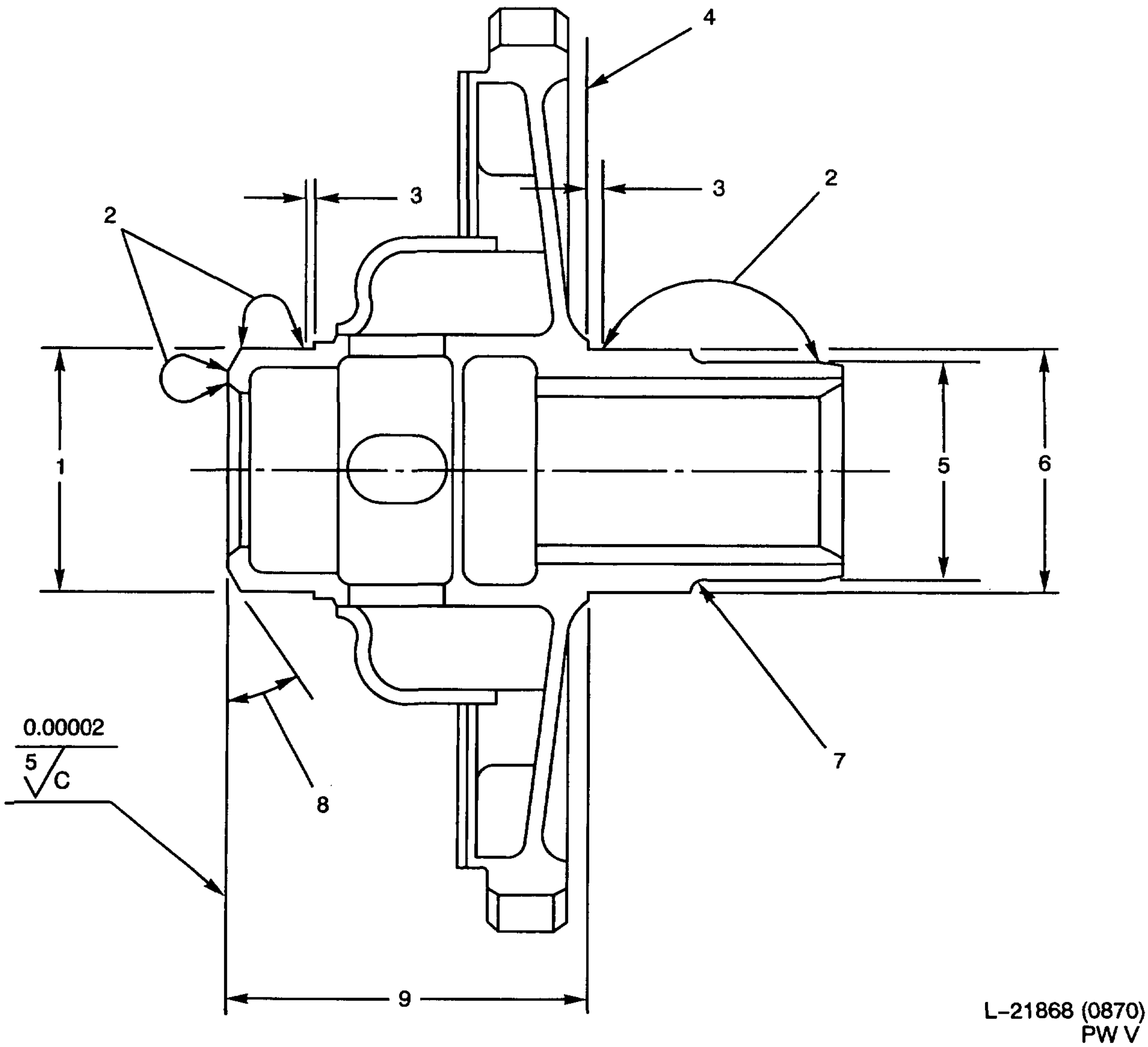
(d) Shotpeen the chromium plate area by SPOP 501 to an intensity equivalent to 6A2. Refer to Section 70-41-02 in the Standard Practices Manual.

(e) Apply chromium plate to the machined area of the front OD by SPOP 22 (Task 70-44-01-330-002). Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: The driveshaft is case-hardened to Rockwell A79 - A85 or equivalent.

(f) Apply silver plate to the area shown by SPOP 23 (Task 70-44-01-330-003), 0.002 - 0.004 inch thickness. Refer to Section 70-44-01 in the Standard Practices Manual.

(g) Finish grind the chromium plate area to the dimension shown. See Figure 611.



R
R

Hydraulic Pump Drive Gearshaft
Plate Repair
Figure 608

1. 1.1813 - 1.1817 Inch, Diameter B
2. Plate Area (See Text)
3. 0.025 Inch
R 4. This Face Must Be Square With Diameter A (Index 6) 0.002 Inch Maximum FIR
5. This Diameter And Diameter B (Index 1) Must Be Concentric With Diameter A (Index 6) 0.002 Inch Maximum FIR
6. Diameter A, 1.1813 - 1.1817 Inch, Concentric With PD Of Spline And PD Of Gear 0.002 Inch Maximum FIR And All Other Diameters 0.010 Inch Maximum FIR Unless Otherwise Specified
7. 0.094 - 0.125 Inch Radius
8. 30 degrees Plus/Minus 2 Degrees
9. 1.731 - 1.733 Inch

Key To Figure 608

(5) Accessory Component Drive Splines

(a) Inspection

NOTE: To measure spline wear, use the inner area of a spline that is not worn to be an area with zero wear.

NOTE: Apply chromium flash to the splines of a fuel control drive gearshaft and a starter-generator driveshaft before installation in a gearbox (whether there is wear or not). See Figure 611 for chromium flash areas on the driveshaft.

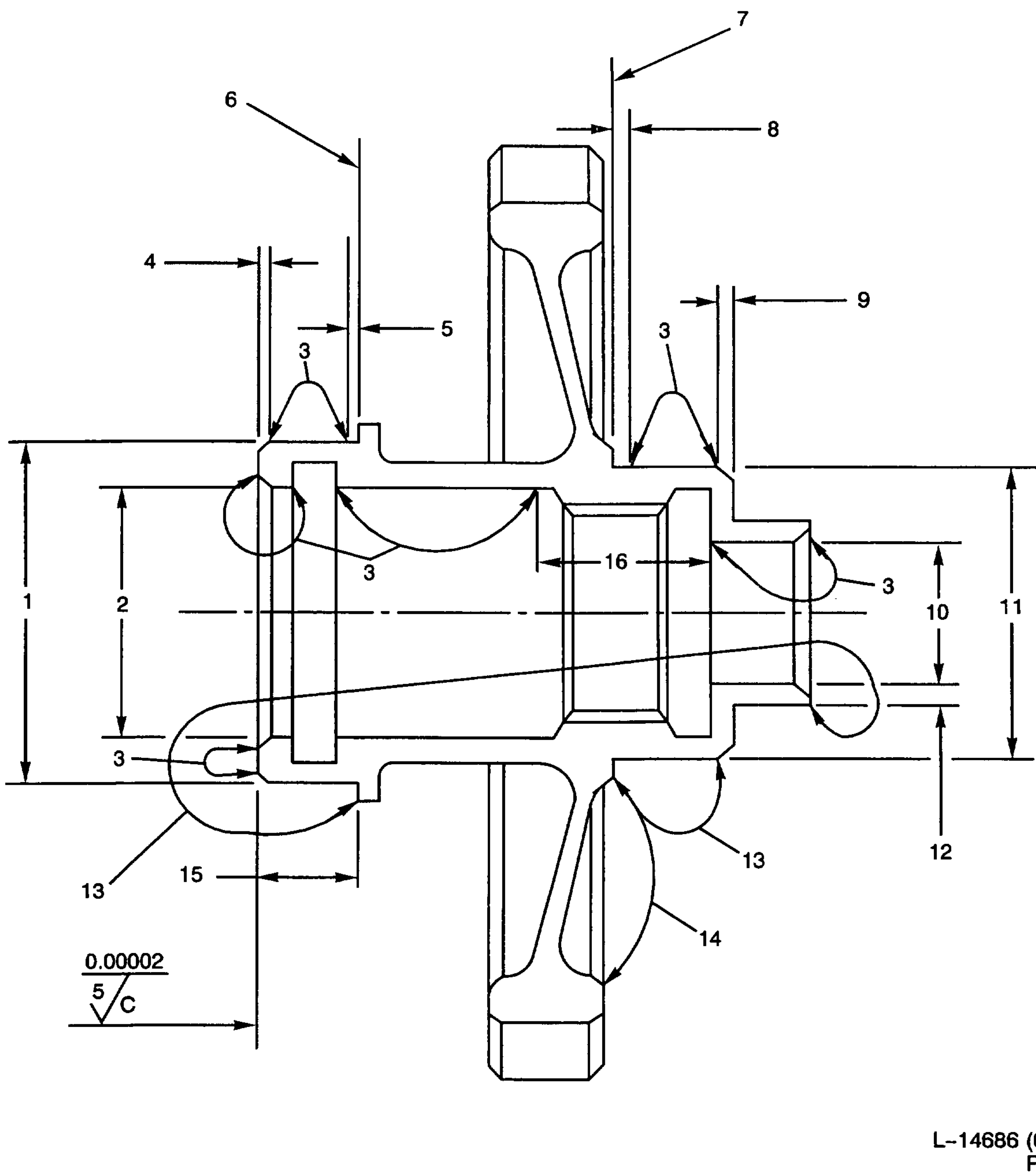
1 Splines worn less than 0.002 inch are serviceable without repair.

2 Splines worn a maximum of 0.005 inch can get a chromium flash repair.

3 Splines worn more than 0.005 inch are not approved for repair.

(b) Repair

1 Use a stone to remove sharp edges on splines worn 0.002 - 0.005 inch.

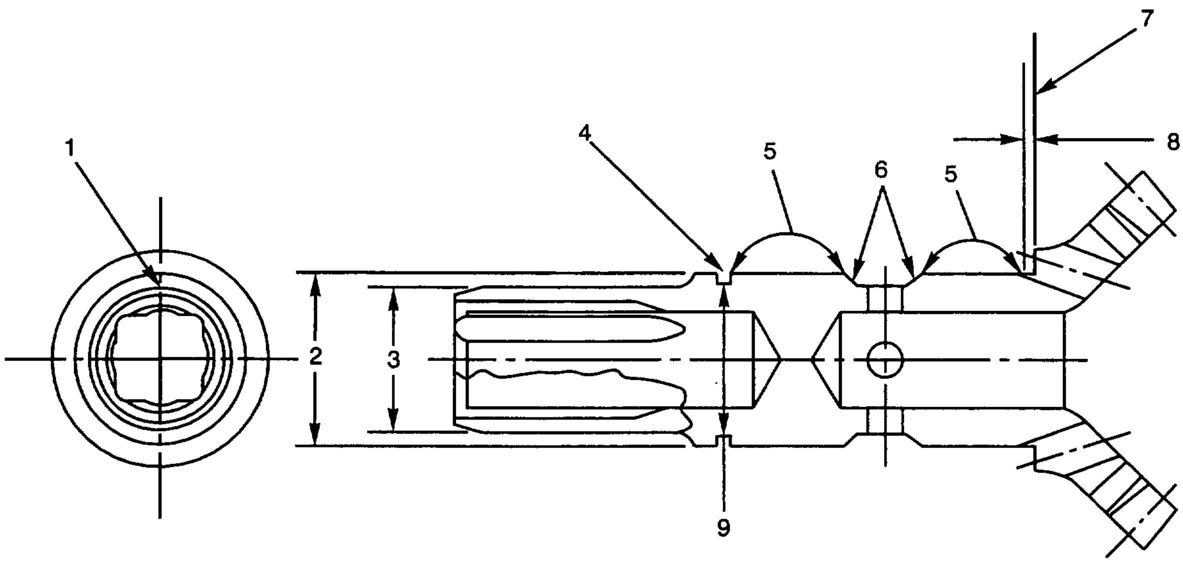


R
R

Starter And Generator Drive
Gearshaft Plate Repair
Figure 609

1. 1.3782 - 1.3786 Inch Diameter, Square With Index 6 Face 0.001 Inch Maximum FIR And Concentric With PD Of Gear And Spline 0.002 Inch Maximum FIR When Gear Is Held On Indexes 2 And 11 Diameters
2. 1.0295 - 1.0305 Inch Diameter To 1.120 Inch Minimum Depth And 1.015 - 1.0305 Inch Diameter For Remaining Distance, Concentric With Gear And Spline PD 0.002 Inch Maximum FIR When Gear Is Held On Indexes 1 and 11 Diameters. Before Plate Machine To 1.0355 - 1.0505 Inch Diameter (Hold To Minimum Dimension), Plate To 1.0195 Inch Diameter Maximum.
3. Plate Area (See Text)
4. 0.020 - 0.040 Inch At 43 - 47 Degrees Chamfer
5. 0.039 Inch Minimum
6. Front Reference Face
7. Rear Reference Face
8. 0.027 Inch Minimum
9. 0.040 - 0.060 Inch Minimum By 43 - 47 Degrees Chamfer
10. 0.578 - 0.579 Inch Diameter, Concentric With Index 11 Diameter 0.001 Inch Maximum FIR. Before Plate Machine to 0.584 - 0.599 Inch Diameter (Hold To Minimum Dimension), Plate To 0.568 Inch Diameter Maximum.
11. 1.1813 - 1.1817 Inch Diameter, Concentric With Index 10 Diameter 0.001 Inch Maximum FIR And Square With Index 7 Face 0.001 Inch Maximum FIR, And Concentric With PD Of Gear And Spline 0.002 Inch Maximum FIR When Gear Is Held On Indexes 1 And 2 Diameters.
12. 0.065 Inch Minimum Before Plate
R 13. No Paint Area (refer to Gear Tooth Surface Treatment Repair
R For Gear Tooth Areas)
14. Paint Area (Refer To SPOP 152 In Standard Practices Manual)
15. 0.388 - 0.392 Inch. Before Plate Machine To 0.373 - 0.385 Inch (Hold To Maximum Dimension), Plate To 0.397 Inch Minimum.
16. 0.695 - 0.715 Inch

Key To Figure 609

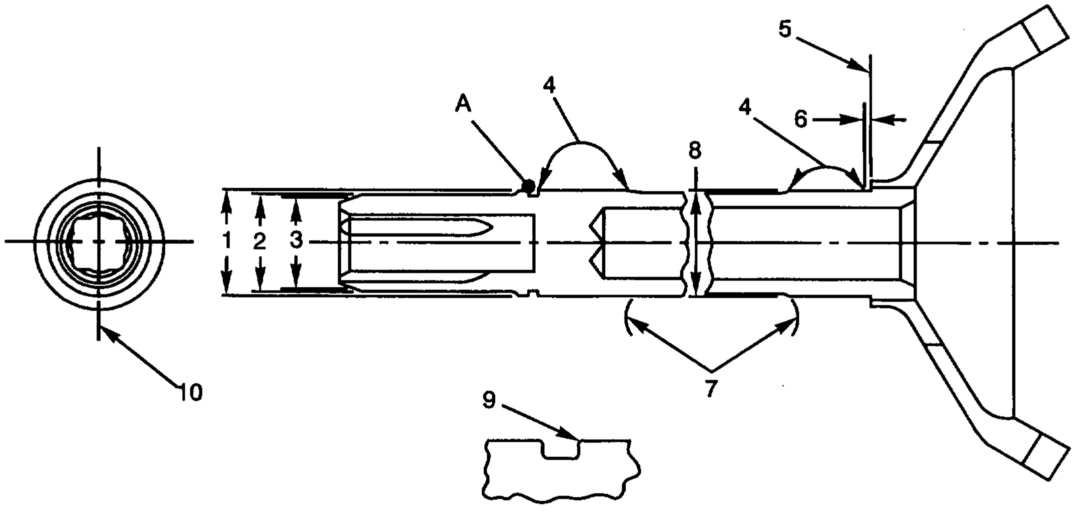


L-15584 (0000)
PW V

1. Centerline Of This Square Must Coincide With Axis Of Diameter A (Index 2) 0.004 Inch Maximum FIR
2. 0.4723 - 0.4727 Inch Diameter A, Concentric With All Diameters 0.010 Inch Maximum FIR And With Axis Of Pitch Cone 0.002 Inch Maximum FIR
3. This Diameter Must Be Concentric With Diameter A (Index 2) 0.002 Inch Maximum FIR
4. 0.003 Inch Maximum Radius
5. Plate Area (See Text)
6. 0.047 - 0.078 Inch Radius
7. Diameter A Must Be Square With This Face 0.001 Inch Maximum FIR
8. 0.027 Inch
9. This Diameter Must Be Concentric With Diameter A 0.002 Inch Maximum FIR

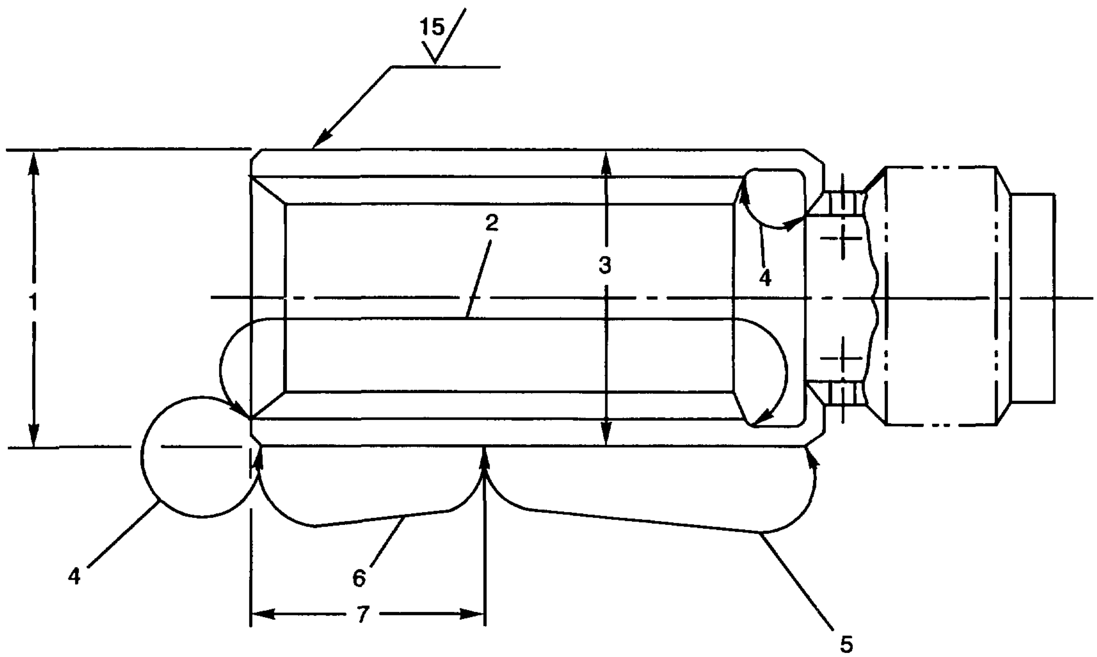
R
R

Tachometer Drive Gearshaft
(JT12A-6, -6A (L), -8 (L)
Plate Repair
Figure 610 (Sheet 1)



1. 0.4716 - 0.4720 Inch Diameter A, Square With Face B 0.001 Inch Maximum FIR And Concentric With Diameters E And F (Indexes 2 And 3) 0.002 Inch Maximum FIR
2. 0.441 - 0.445 Inch Diameter E
3. Diameter F
4. Plate Area (See Text)
5. Face B
6. 0.027 Inch
7. 0.047 - 0.078 Inch Radius
8. 0.4723 - 0.4727 Inch Diameter D, Concentric With Diameter A 0.0005 Inch Maximum FIR And With All Other Diameters 0.010 Inch Maximum FIR. Diameter D Must Be Concentric With Axis Of Pitch Cone 0.001 Inch Maximum FIR.
9. 0.003 Inch Maximum Radius
10. Centerline Of This Square Must Be Concentric With Axis Of Diameter A (Index 1) 0.004 Inch Maximum FIR

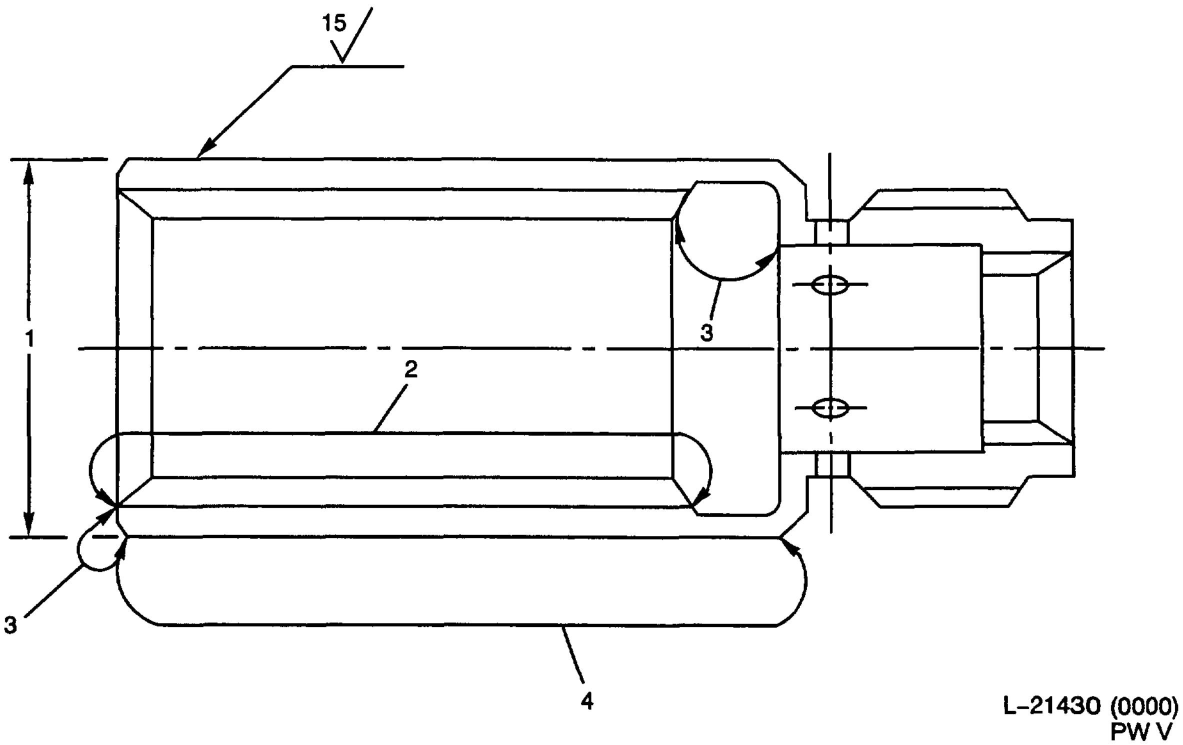
Tachometer Drive Gearshaft
(JT12A-6 (N), -8 (N),
JFTD12A-1, 4A)
Plate Repair
Figure 610 (Sheet 2)



1. 1.031 - 1.032 Inch Diameter For Index 7 Distance, Concentric With Other Diameters 0.010 Inch Maximum FIR
2. Chromium Flash Area (Spline) (See Text)
3. 1.028 - 1.029 Inch Diameter, Concentric With PD Of Each Spline 0.002 Inch Maximum FIR
4. Optional Chromium Flash Area
5. Silver Plate Area (See Text)
6. Chromium Plate Area
7. 0.850 - 0.890 Inch

R
R

Starter and Generator Driveshaft
(Pre-PN 449114) Plate Repair
Figure 611 (Sheet 1)



1. 1.028 - 1.029 Inch Diameter, Concentric With Other Diameters
   0.010 Inch Maximum FIR And Concentric With PD Of Each Spline
   0.002 Inch Maximum FIR
2. Chromium Flash Area (Spline) (See Text)
3. Optional Chromium Flash Area
4. Silver Plate Area (See Text)

R
R

Starter and Generator Driveshaft
(PN 449114) Plate Repair
Figure 611 (Sheet 2)

2 Apply a chromium flash to splines, 0.00005 - 0.0004 inch thickness by SPOP 22. Refer to Section 70-44-01 in the Standard Practices Manual.

NOTE: Bake is not necessary during the plating procedure.

(6) Gear Tooth Surface Treatment (See Figure 612)

NOTE: Gear tooth surface treatment is applicable to gear and gearshaft PN 385427, 385428, 385432, 387837, 390940, 410592, 410593, 449117, and 500438.

(a) After all other gear or gearshaft repairs are completed, apply surface treatment to the gear teeth by one of these methods:

1 SPOP 150 Graphite varnish (refer to Section 70-41-00 in the Standard Practices Manual).

2 SPOP 23 Silver plate (refer to Section 70-44-01 in the Standard Practices Manual).

NOTE: After plate bake the part at 148.9°C (300°F) for two hours minimum.

7. Accessory And Component Drive Gearbox Housing

A. Inspection

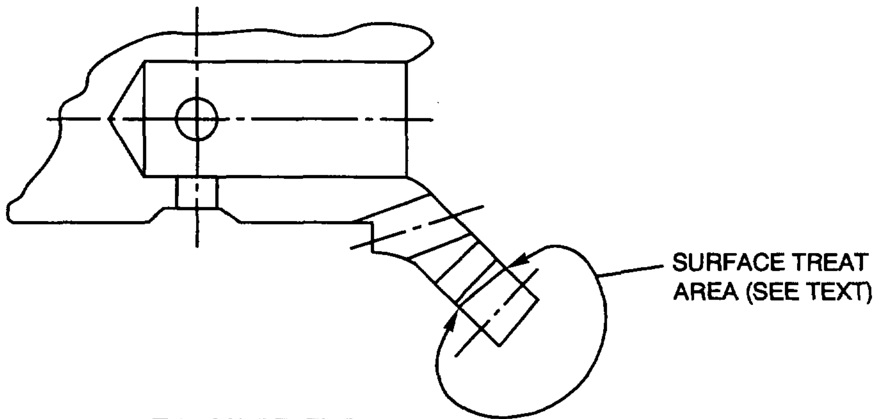
(1) Refer to the Table of Limits for dimensions and fit limits.

(2) Examine the housing for cracks in the area of bosses, studs, and boltholes and repair where necessary.

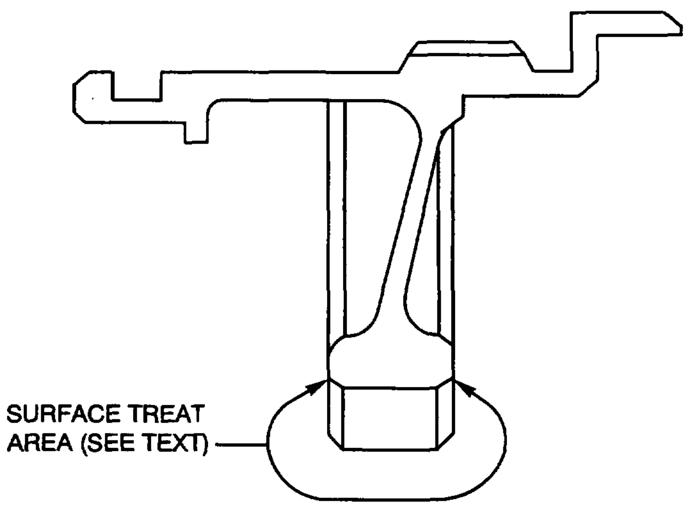
(3) Measure the distance (see Figure 613, Index 9) from the gearbox mating face to the edge of the nearest oil port. Repair as specified if this dimension is less than 0.350 inch.

B. Gearbox Crack Repair

(1) If cracks are found in the area of bosses, studs, and boltholes, remove the crack with a V-groove (remove a minimum of material).



TYPICAL BEVEL GEAR



TYPICAL STRAIGHT-CUT GEAR

L-H8131 (0407)
PW V

Gear And Gearshaft Tooth
Surface Treatment
Figure 612

(2) Do a Spotcheck inspection of the repair area to be sure that all cracks are removed:

(a) Remove grease from the housing by SPOP 209 and apply Spotcheck Penetrant (red) or equivalent.

(b) Remove visible penetrant with degreasing solvent.

(c) Apply Spotcheck Developer (white) or equivalent and let it dry. Look for crack indications.

(3) Heat the housing to 177° - 204°C (350° - 400°F).

(4) Put a ceramic fiber blanket around the part (let there be access to the repair area).

(5) Weld with AMS 4395 welding wire. If a boss has stripped threads, use plug weld to fill the hole.

NOTE: If the time to weld is more than five minutes, do the heat step (3) again to keep the part temperature up.

(6) Stress-relieve the housing to 177° - 204°C (350° - 400°F) for one hour, then let it become cool to 66°C (150°F) before the blanket is removed.

(7) Do a fluorescent penetrant inspection of the part. Refer to Section 70-33-00 in the Standard Practices Manual for FPI and Section 70-37-00 for X-ray inspection procedures.

(8) Machine, drill, and tap where necessary to bring housing features back to their initial dimensions.

C. Gearbox Housing Oil Port Repair
See Figure 613.

NOTE: If the dimension from the gearbox mating face at the mouth of the oil pump bore to the edge of either of the nearest oil ports is less than 0.350 inch, do the repair that follows.

(1) Remove the housing protective treatment. Refer to the Standard Practices Manual, SPOP 19 or SPOP 260.

(2) Surface weld the housing (AMS 4434) with AMS 4395 welding wire. Refer to Section 70-42-01 in the Standard Practices Manual. Weld the larger port at the top of the oil pump bore first, followed by the smaller scavenge oil port at the 6 o'clock position.

(3) Stress-relieve the housing to 196° - 213°C (385° - 415°F) for one hour. Heat applied before or after the weld operation must not get the housing to more than 213°C (415°F).

(4) Finish machine the weld on the edges of the oil ports to the dimensions shown, then machine the oil pump bore to the specified diameter (be sure to keep concentricity in limits).

NOTE: Make sure that all gearbox coating is fully removed (see step (1) above).

(5) Remove surface grease by SPOP 209 (Task 70-21-00-110-041). Refer to Section 70-21-00 in the Standard Practices Manual.

(6) Apply masks to all the NO PAINT areas and to the bushing or housing bores (if the bushings were removed).

(7) Put plugs in all openings and masks or plugs in all threaded holes and studs.

(8) Bead peen the housing (with 270 mesh beads) at the lowest possible pressure by SPOP 500 (Task 70-41-01-380-018). Refer to Section 70-41-01 in the Standard Practices Manual.

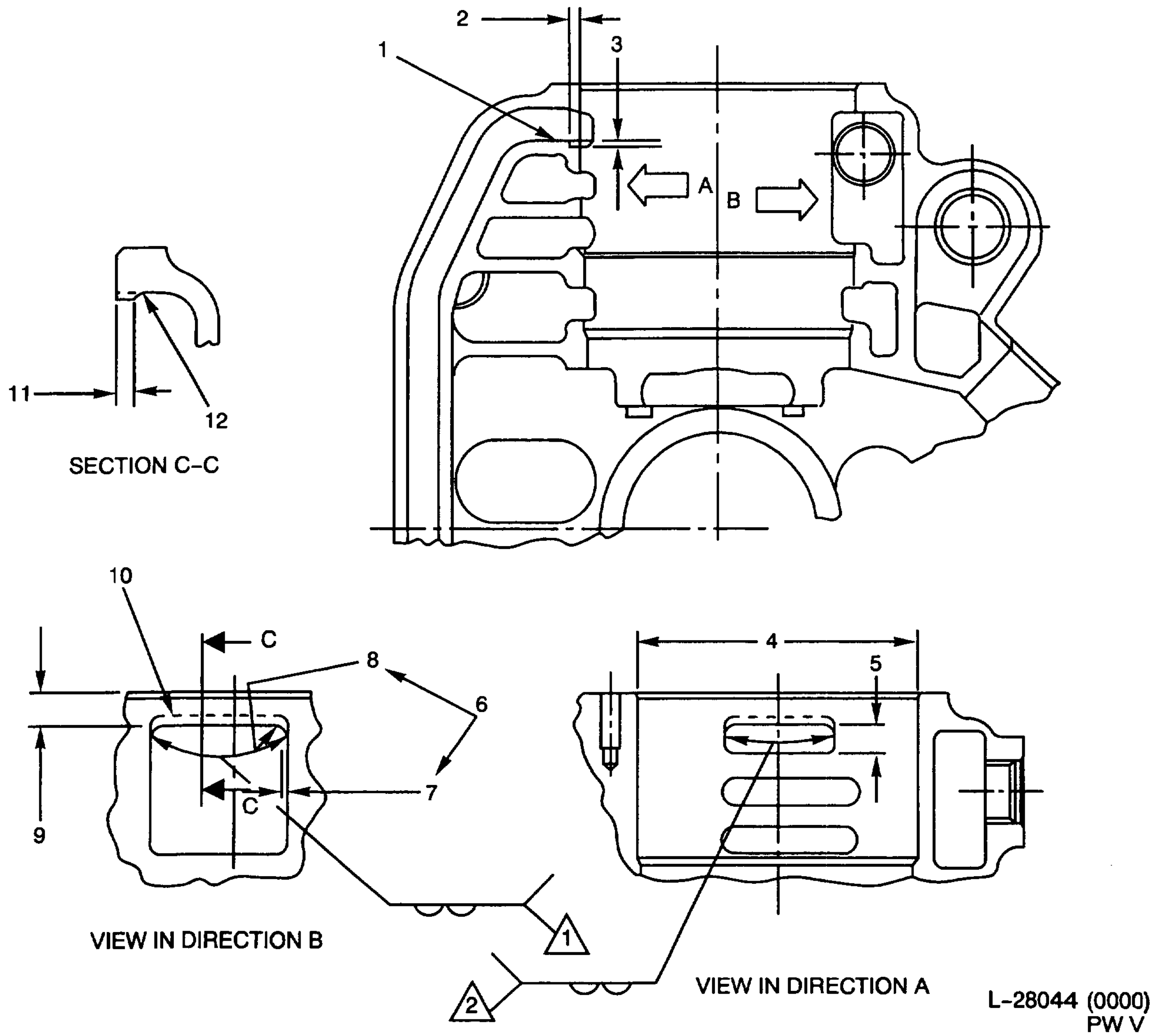
(9) Blow off the beads and remaining blast material from the housing. Clean all passages with compressed air.

(10) Power flush the housing with water.

(11) Blow the housing dry with hot air.

(12) Prepare the housing for surface treatment by SPOP 41 (Task 70-44-01-330-011). Refer to Section 70-44-01 in the Standard Practices Manual.

(13) Apply enamel coating to the housing by SPOP 155 (Task 70-41-03-380-011). Refer to Section 70-41-03 in the Standard Practices Manual.



R
R

Gearbox Main Oil Pump Bore
Oil Port Repair
Figure 613

1. Nicks From Machining Are Permitted In This Area During Repair.
2. 0.160 Inch Minimum
3. 0.060 Inch Maximum
4. 3.401 - 3.402 Inch Diameter. Machine To This Diameter To Remove All Weld Expulsion In The Repair Area. Depth Into Bore Must Not Be More Than 0.700 Inch And Diameter Must Be Concentric With Adjacent Diameter 0.0015 Inch Maximum FIR.
5. 0.280 Inch Minimum
6. Typical 4 Locations
7. 0.000 - 0.010 Inch
8. 0.093 - 0.219 Inch Radius
9. 0.360 - 0.380 Inch
10. Contour of Part Before Repair
11. 0.100 - 0.150 Inch 2 Locations
12. 0.093 - 0.219 Inch Radius, 2 Locations

Key To Figure 613

D. Main Component Drive Gearbox Gearshaft Lower Bearing Support Replacement
(See Tool Group 75A) and Figure 614.

(1) Strip protective treatment by SPOP 19 or SPOP 260. See Standard Practices Manual.

(2) Remove bearing support by machining as shown in Sections A-A and B-B of Figure 614 (Sheet 1).

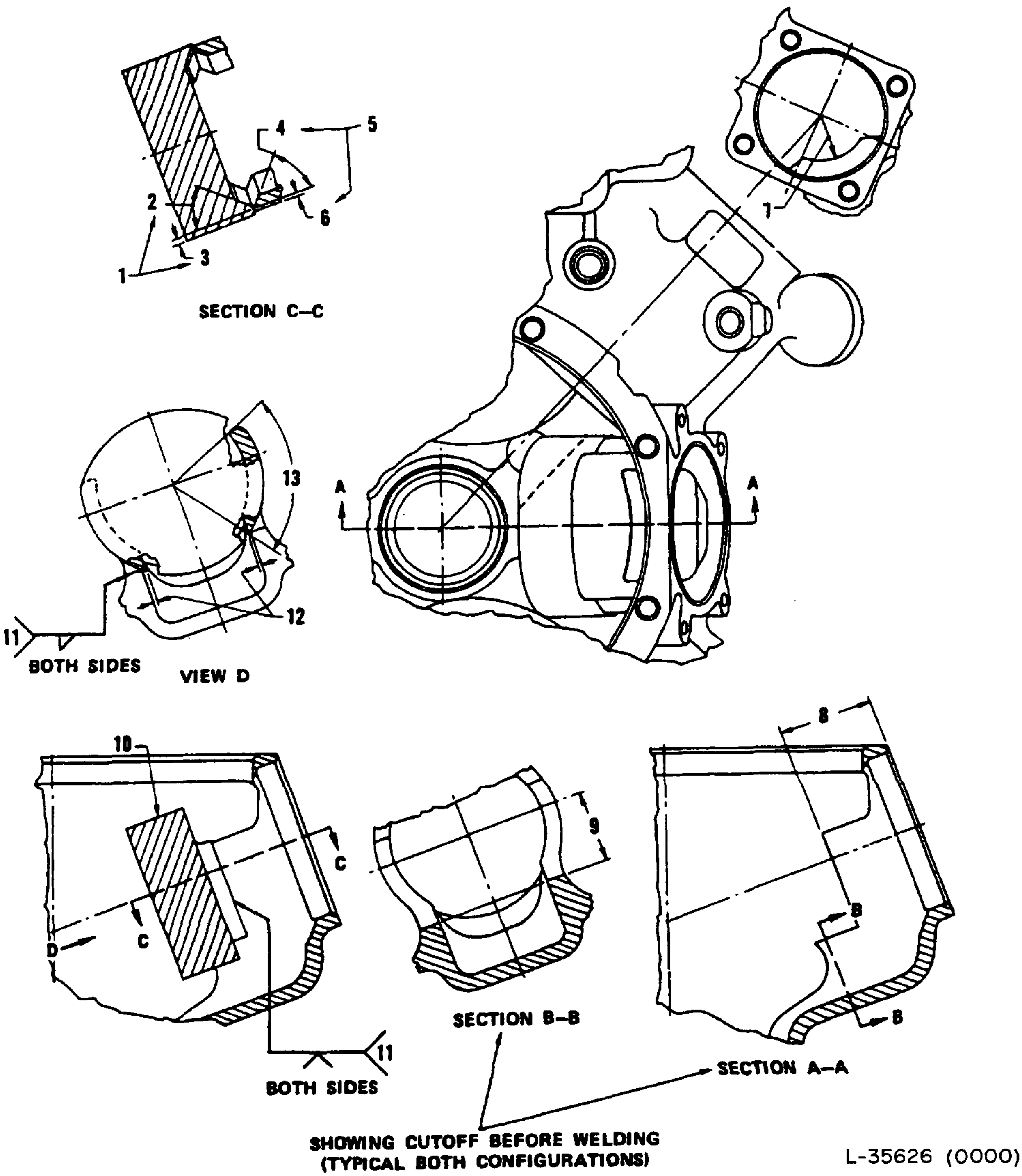
(3) Using rotary file, remove all PWA-591 sealing compound impregnation on area to be welded. Ensure that grinding away of excessive material is avoided.

(4) Preheat gearbox to 196° - 213°C (385° - 414°F) for one hour. Ensure that maximum temperature is not exceeded.

(5) Upon removal from oven, immediately wrap gearbox in ceramic fiber blanket to ensure that heat is retained.

(6) Weld AMS 4350 magnesium insert into AMS 4434 gearbox housing using AMS 4395 welding wire. Casting temperature shall be maintained at 196°C (385°F) higher during welding operations.

<u>NOTE</u>: Magnesium insert may be procured from Pratt & Whitney or fabricated to the dimensions shown. See Figure 614 (Sheet 2).



Gearbox Gearshaft Lower Bearing
Support Replacement,
Support Removal,
Welding, and Initial Machining
Figure 614 (Sheet 1)

1. Two Places Over Arc, Index 13
2. 40° - 50°
3. 0.080 - 0.100 Inch
4. 40° - 50°
5. Two Places Over Arc, Index 13
6. 0.040 - 0.060 Inch
7. 0.740 - 0.760 Inch. This Dimension After Welding.
8. 1.485 - 1.515 Inches
9. 1.165 - 1.195 Inches
10. PN 660662
11. Weld, Using AMS 4395 Welding Wire.
12. These Distances To Be Approximately Equal.
13. Arc, Two Places

Key To Figure 614 (Sheet 1)

(7) Heat-treat gearbox at 196° - 213°C (385° - 415°F) for one hour.

(8) Remove gearbox from oven, wrap in ceramic fiber blanket, and allow to cool for 12 - 14 hours.

(9) Clean up weld with rotary file, and dye penetrant inspect to ensure satisfactory repair.

(10) Perform preliminary machining in accordance with Sheet 1 of Figure 614; then, depending upon which configuration is required (either dual housing, bolted, or pinned-in liner) final machine to dimensions shown in either (Sheet 3), (Sheet 4), or (Sheet 5) of Figure 614.

(11) Final inspect following machining with dye penetrant.

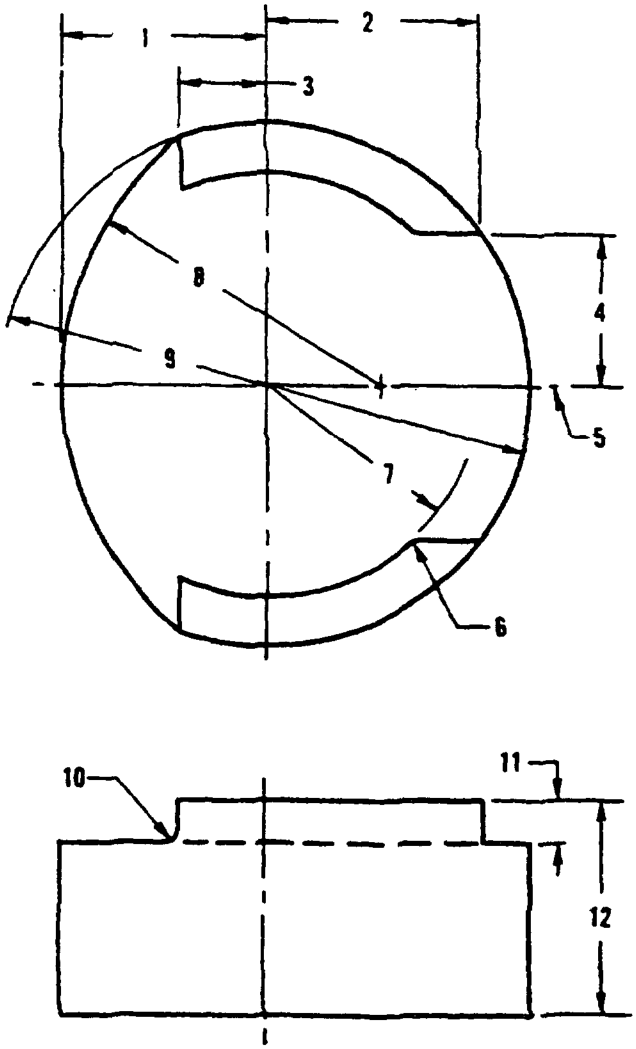
<u>NOTE</u>: The coating that is on the gearbox housing must be stripped with SPOP 19 or 260.

(12) Degrease by SPOP 209. Refer to Section 70-21-00 in the Standard Practices Manual.

(13) Mask all the no paint areas. Mask all the bushing

(14) Plug all the openings and mask or plug all the threaded holes and studs.

(15) Dry bead (270 mesh beads) blast with the lowest possible pressure (refer to SPOP 500 in the Standard Practices Manual). Do not exceed 30 psig.



L-26162 (0000)

Fabrication of Magnesium Insert
for Gearbox Repair
Figure 614 (Sheet 2)

1. 1.150 - 1.170 Inches
2. 1.2074 Inches (Reference)
3. 0.520 - 0.540 Inch (Includes Allowance For Final Finishing At Assembly)
4. 0.880 - 0.900 Inch
5. Symmetric About This Centerline
6. 0.219 - 0.281 Inch Radius
7. 1.210 - 1.230 Inches Radius
8. 1.797 - 1.827 Inches Radius
9. 2.990 - 3.010 Inch Diameter
10. 0.047 - 0.078 Inch Radius
11. 0.200 - 0.220 Inch (Includes Allowance For Final Finishing At Assembly)
12. 1.240 - 1.260 Inches (Includes Allowance For Final Finishing At Assembly)

Key To Figure 614 (Sheet 2)

(16) Blow off the beads and the residual blasting material from the housing.

(17) Clean all the passages with compressed air.

(18) Power flush the housing with water.

(19) Blow the housing dry with hot air.

(20) Prepare the surface for recoating with SPOP 41. (See Standard Practices Manual).

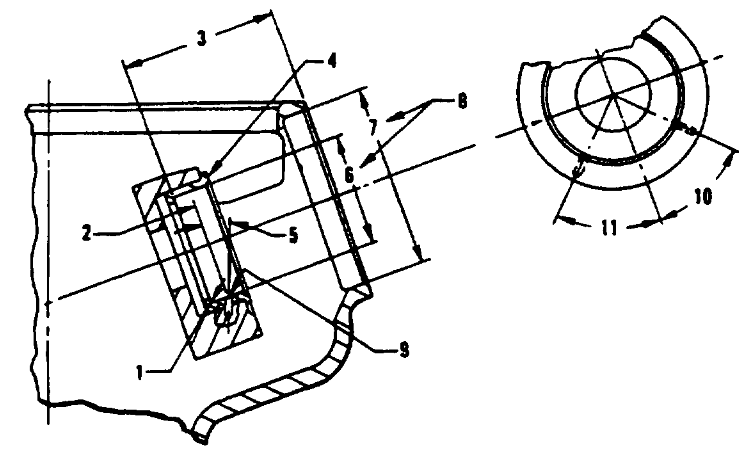
(21) Apply protective coating by SPOP 155 (refer to Standard Practices Manual).

(22) For installation of pinned-in liners, proceed as follows:

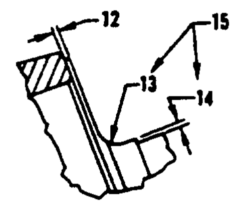
(a) Heat gearbox and chill liner. Then install liner in bore of bearing support using drift. Ensure that liner is properly seated.

(b) Install drill jig in liner and secure with tightening screw. The jig shall be indexed so that the holes when drilled will be positioned as shown. See Figure 613 (Sheet 3).

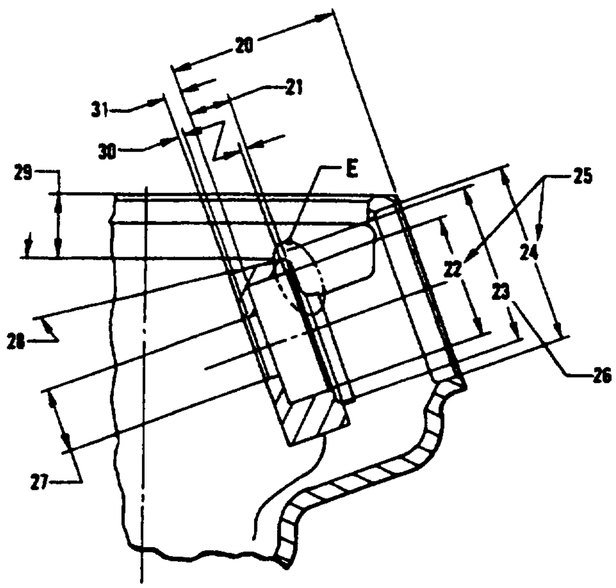
(c) Drill liner pin holes to depth shown in Figure 614 (Sheet 3) using 2.35 mm (0.0925 inch) diameter drill.



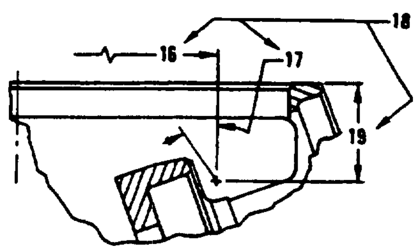
MACHINING FOLLOWING
LINER INSTALLATION



VIEW E



MACHINING BEFORE
LINER INSTALLATION



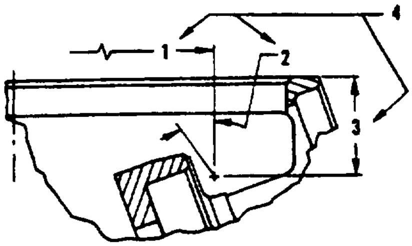
CLEARANCE CHECK

L-27602 (0000)

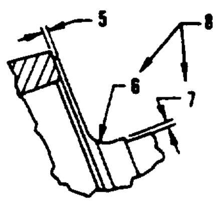
Gearbox Gearshaft Lower Bearing
Support Replacement (Final Machining
For Pinned-in Liner)
Figure 614 (Sheet 3)

1. 0.024 Inch Maximum Radius
2. 0.270 - 0.330 Inch
3. 2.243 - 2.247 Inches
4. PN 432542 Liner
5. 18° - 22°
6. 1.6527 - 1.6533 Inch Diameter.
7. 2.670 - 2.671 Inch Diameter
8. Diameter (Index 6) Shall Be Concentric With Diameter (Index 7) Within 0.001 Inch FIR.
9. 0.0913 - 0.0933 Inch Diameter Hole To Depth Of 0.260 - 0.300 inch (Two Places) For AN150233 Pin.
10. 43° - 47°
11. 43° - 47°
12. 0.000 - 0.020 Inch (Two Places)
13. 0.109 - 0.141 Inch Radius
14. 0.000 - 0.030 Inch
15. Two Places
16. 4.857 - 4.867 Inch Diameter
17. 34° 29' - 34° 31'
18. Maintain Clearance To This Dimension. Machine If Required All Around
19. 1.224 - 1.228 Inches
20. 2.495 - 2.499 Inches
21. 0.690 - 0.696 Inches
22. 1.833 - 1.835 Inch Diameter With Bottom Corner Radius Of 0.016 - 0.047 Inch.
23. 2.340 - 2.360 Inch Diameter
24. 2.670 - 2.671 Inch Diameter
25. Diameter (Index 22) Shall Be Concentric With Diameter (Index 24) Within 0.001 Inch FIR.
26. 0.030 - 0.060 Inch Blend Radius Required On Sharp Edges Created By Machining Diameter (Index 23).
27. 0.970 - 0.990 Inch Diameter
28. 13° - 15°
29. 0.930 - 0.940 Inch
30. 0.020 - 0.040 Inch Chamfer At 43° - 47°
31. 0.170 - 0.190 Inch

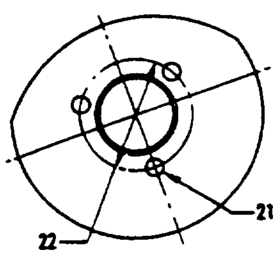
Key To Figure 614 (Sheet 3)



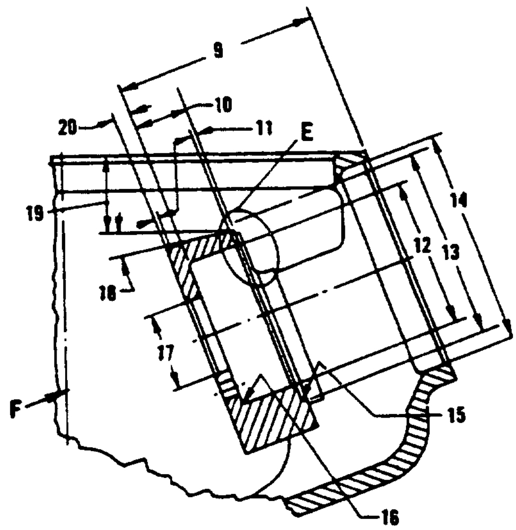
CLEARANCE CHECK



VIEW E



VIEW F



L-27601 (0000)

Gearbox Gearshaft Lower Bearing
Support Replacement (Final Machining
For Bolted-in Liner)
Figure 614 (Sheet 4)

1. 4.857 - 4.867 Inch Diameter
2. 33° 30" - 35° 30'
3. 1.224 - 1.228 Inches.
4. Maintain Clearance To These Dimensions (Indexes 1, 2, And 3) And Machine If Required All Around.
5. 0.000 - 0.020 Inch (Two Pieces)
6 0.109 - 0.141 Inch
7. 0.000 - 0.030 Inch
8, Two Places (Indexes 6 And 7)
9. 2.495 - 2.499 Inches
10. 0.690 - 0.696 Inch
11. 0.020 - 0.040 Inch Chamfer At 43° - 47°
12. 1.833 - 1.834 Inch Diameter
13. 2.340 - 2.360 Inch Diameter
14. 2.670 - 2.671 Inch Diameter
15. 0.047 - 0.078 Inch Radius
16. 0.016 - 0.047 Inch Radius
17. 0.970 - 0.990 Inch Diameter
18. 13° - 15°
19. 0.930 - 0.940 Inch
20. 0.170 - 0.190 Inch
21. 0.216 - 0.226 Inch Diameter Through Three Holes Equally Spaced And Located Within 0.005 Inch Radius Of True Position In Relation To Index 12.
22. 1.380 Inch Diameter

Key To Figure 614 (Sheet 4)

(d) Install pins and machine liner ID to dimensions while gearbox is mounted on holding adapter.

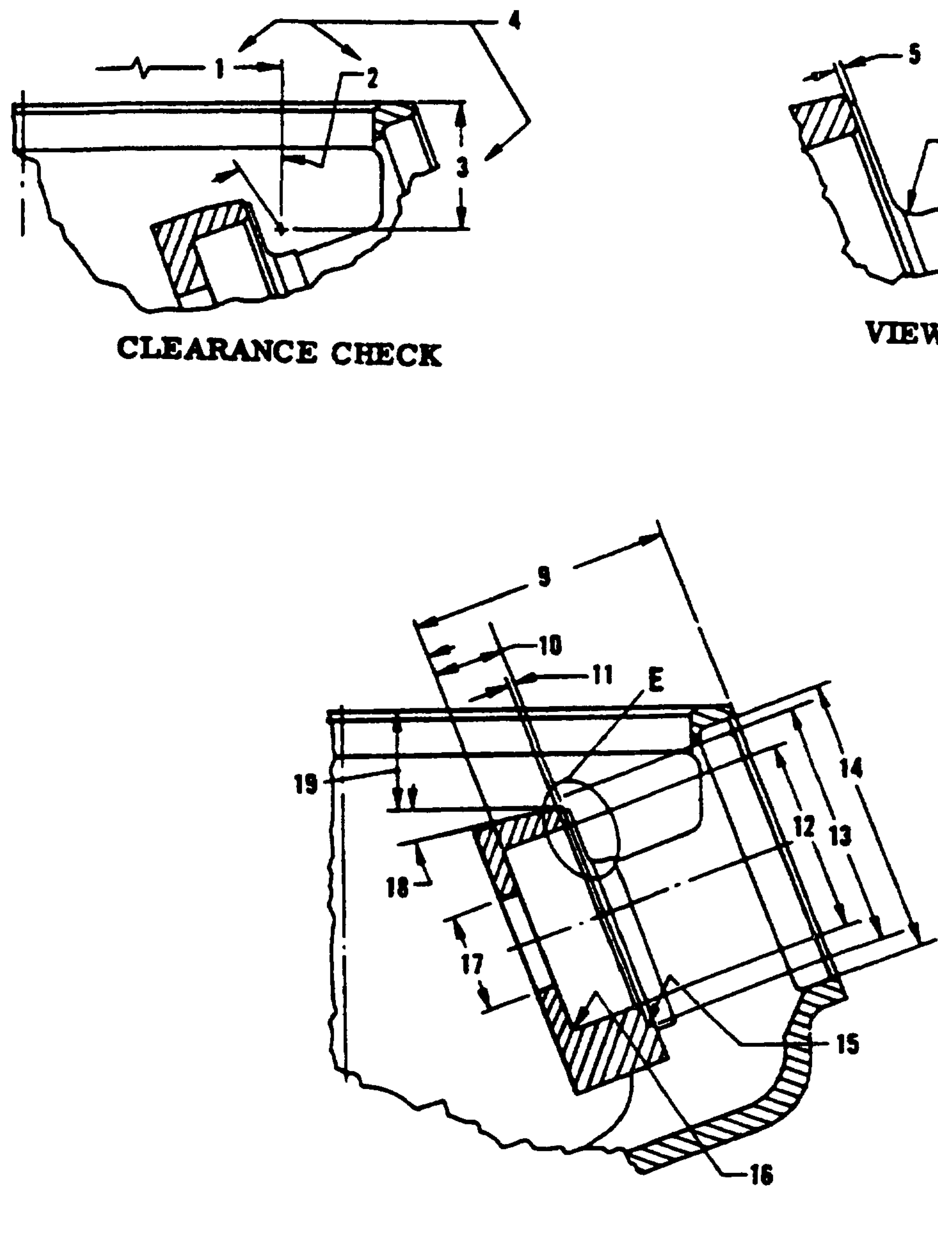
E. Main Oil Pressure Relief Valve Port Repair
See Figure 615 (Sheet 1).

(1) Clean by SPOP 18 or SPOP 360.

(2) Fluorescent penetrant inspect.

(3) For sleeve, bore 0.860 - 0.880 inch ID 3.000 ± 0.010 inch deep, as required, using jig bore. Locate from existing bore (unworn area) with 0.002 inch FIR.

(4) For plug, bore, tap, and counterbore 1.125-18 and 1.125 - 1.135 inch diameters. Recess 0.050 - 0.070 inch deep, as required. Locate from existing bore (unworn area) within 0.002 inch FIR.



Main Component Drive Gearbox
Gearshaft Lower Bearing Support
Replacement (Final Machining
For Upper and Lower Bearing
Dual Housing Configuration)
Figure 614 (Sheet 5)

1. 4.857 - 4.867 Inch Diameter
2. 33° 30′ - 35° 30′
3. 1.224 - 1.228 inches
4. Maintain Clearance To These Dimensions, And Machine If Required All Around.
5. 0.000 - 0.020 Inch (Two Places)
6. 0.109 - 0.141 Inch
7. 0.000 - 0.030 Inch
8. Two Places
9. 2.410 - 2.430 Inches
10. 0.590 - 0.610 Inch
11. 0.020 - 0.040 Inch Chamfer To 43 - 47 Degrees
12. 1.8555 - 1.8565 Inch Diameter
13. 2.340 - 2.360 Inch Diameter
14. 2.670 - 2.671 Inch Reference Diameter
15. 0.047 - 0.078 Inch Radius
16. 0.016 - 0.047 Inch
17. 0.970 - 0.990 Inch
18. 13° - 15°
19. 0.930 - 0.940 Inch

Key To Figure 614 (Sheet 5)

(5) Inspect repair. Measure and record bore size(s) for plug and/or sleeve manufacture. Specify finish OD size required for sleeve and/or plug.

(6) Fabricate plug and/or sleeve, as required, using AMS 4119 or 4120 aluminum material.

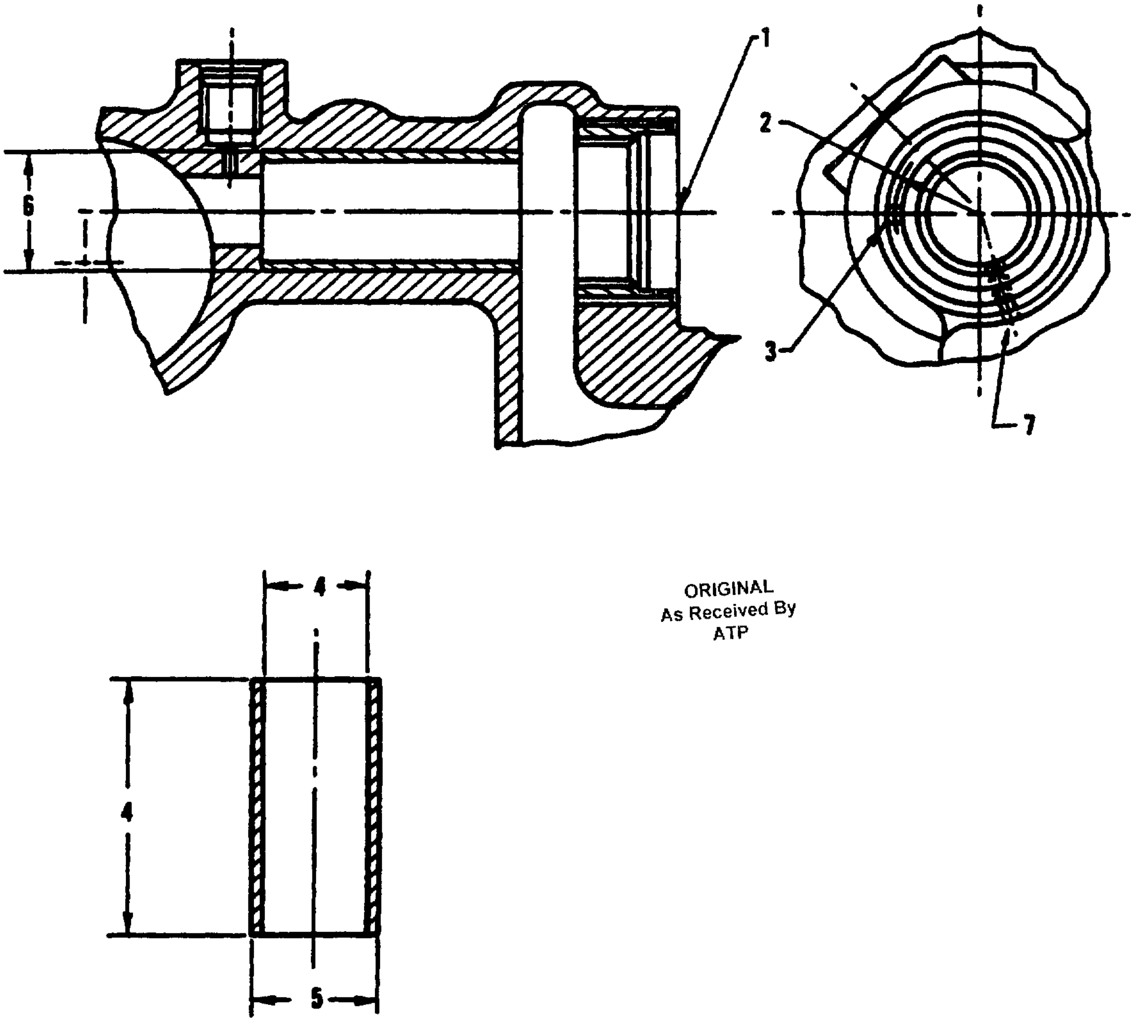
(7) Fluorescent penetrant inspect finished sleeve and/or plug. See Standard Practices Manual.

(8) Heat Housing and chill sleeve and/or plug to install. Coat plug and/or sleeve with Permatex #2 at installation.

(9) Stake sleeve, after installing, by prick punching.

(10) Stake plug, after installing, with a #5-40 x 5/6 inch long aluminum threaded pin; cut and peen flush.

(11) Finish bore, thread, counterbore and face flush for 0.875-14UNF-3B x 0.935 - 0945 inch diameter counterbore, as required.



L-55946 (0676)

Main Oil Pressure Relief
Valve Port Repair
Figure 615 (Sheet 1)

1. 1.125-18UNEF-3B. 1.125 - 1.135 Inch Diameter Depth 0.050 - 0.070 Inch. Insert AMS 4119 Or 4120 Aluminum Plug As Shown. Finish Flush. Plug Must Fit 0.001T - 0.002T Inch In Housing.
2. 0.592 - 0.602 Inch Radius.
3. 0.125-40NC-3B Minor Diameter Depth 0.288 Inch Maximum. Minimum Full Thread Depth 0.250 Inch. Insert AMS 4119 Or 4120 Aluminum Pin As Shown. Finish Flush. Pin Must Fit 0.001T - 0.002T Inch In Housing.
4. Finish At Assembly To Dimensions Shown In Sheet 2.
5. This Diameter Must Fit 0.001T - 0.003T Inch In Housing.
6. 0.860 - 0.880 Inch Diameter.
7. Metering Jet Hole. See Text And Sheet 2.

Key To Figure 615 (Sheet 1)

(12) Finish bore, chamfer, and face flush 0.769 - 0.771 inch diameter bore, as required.

NOTE: If threaded plug has been installed, drill a 5/32 inch diameter hole through plug wall to intersect opening for metering jet. See Figure.

CAUTION: DO NOT REMOVE THE PAINT. DO THE DEGREASING PROCEDURE ABOVE A TANK.

(13) Use degreaser hose to flush out chips from inside gearbox housing, and blow out with air.

(14) Touch up paint, as required. See Standard Practices Manual.

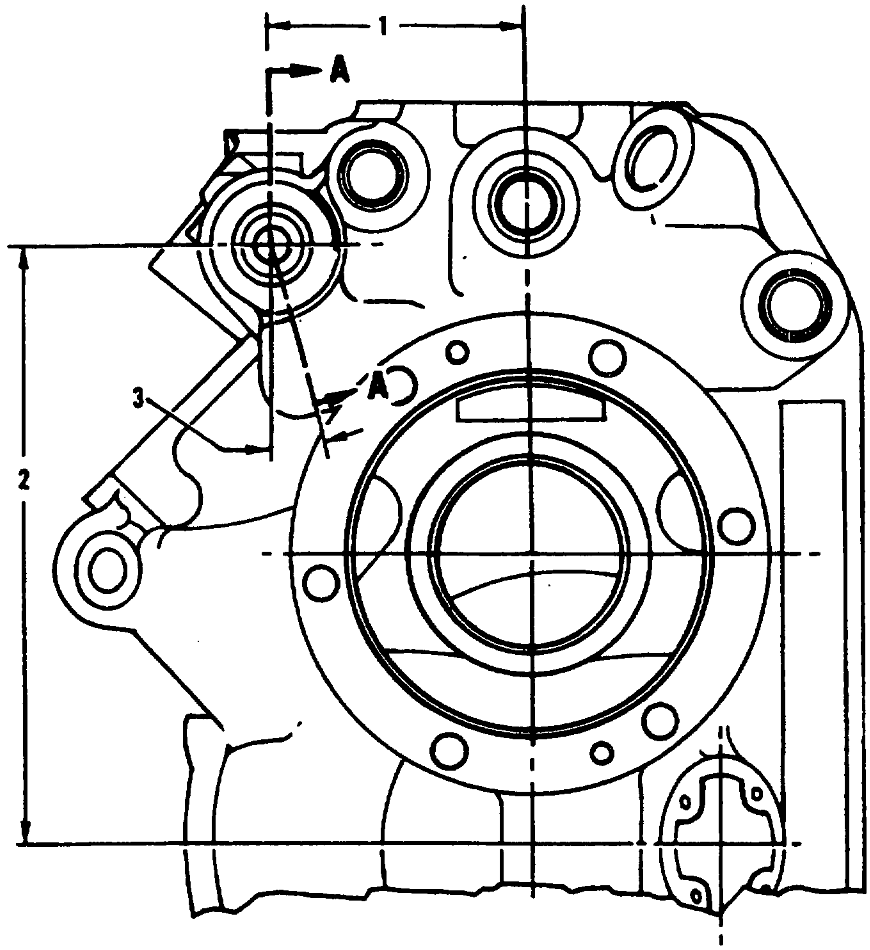
CAUTION: OBSERVE NORMAL SAFETY PRECAUTIONS WHEN PRESSURE TESTING.

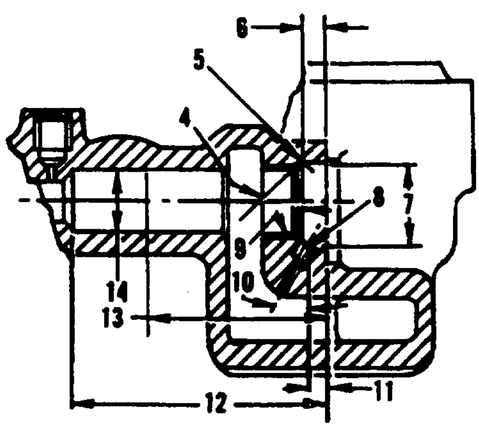
(15) Pressure test repaired bore at 150 psi.

F. Main Oil Strainer Housing Stud Hole Repair

(1) Repair stud holes with stripped threads by boring and retapping the holes and installing PN AN155050 studs. See Figure 616.

G. Oil Pressure Transmitter Boss Weld Repair for Threaded Steel Insert
See Figure 617.





SECTION A-A

L-56834 (0000)

Main Oil Pressure Relief
Valve Port Repair
Figure 615 (Sheet 2)

1. 3.080 - 3.100 Inches
2. 7.220 - 7.240 Inches
3. 15° ± 2°
4. 45° ± 2°
5. 0.006 - 0.026 Inch Radius
6. 0.300 - 0.320 Inch To Centerline Of Index 5 Radius
7. 0.935 - 0.945 Inch Diameter
8. Metering Jet Hole. 0.164-36NF-3B Minor Diameter Through; Full Thread Depth 0.220 - 0.320 Inch Hole Located Within 0.010 Inch Radius Of True Position.
9. 0.875-14UNF-3B
10. 30° ± 2°
11. 0.200 Inch
12. 2.900 - 3.010 Inches
13. 2.170 Inch Minimum
14. 0.769 - 0.771 Inch Diameter. This Diameter For Index 13 Distance; Remainder To Be 0.745 - 0.771 Inch Diameter. This Diameter And Pitch Diameter Of Index 9 Thread Must Be Concentric Within 0.003 FIR Per Inch Of Thread.

Key To Figure 615 (Sheet 2)

(1) Remove all corrosion using power-driven wire brush. Ensure that only clean case material is exposed in weld area. Rout out corroded areas, threads, or overhanging material using rotary file.

(2) Degrease and dry gearbox housing.

(3) Preheat entire housing to 177° - 204°C (350° - 400°F).

(4) If welding time is more than three minutes, return housing to oven and reheat to temperature in step (3).

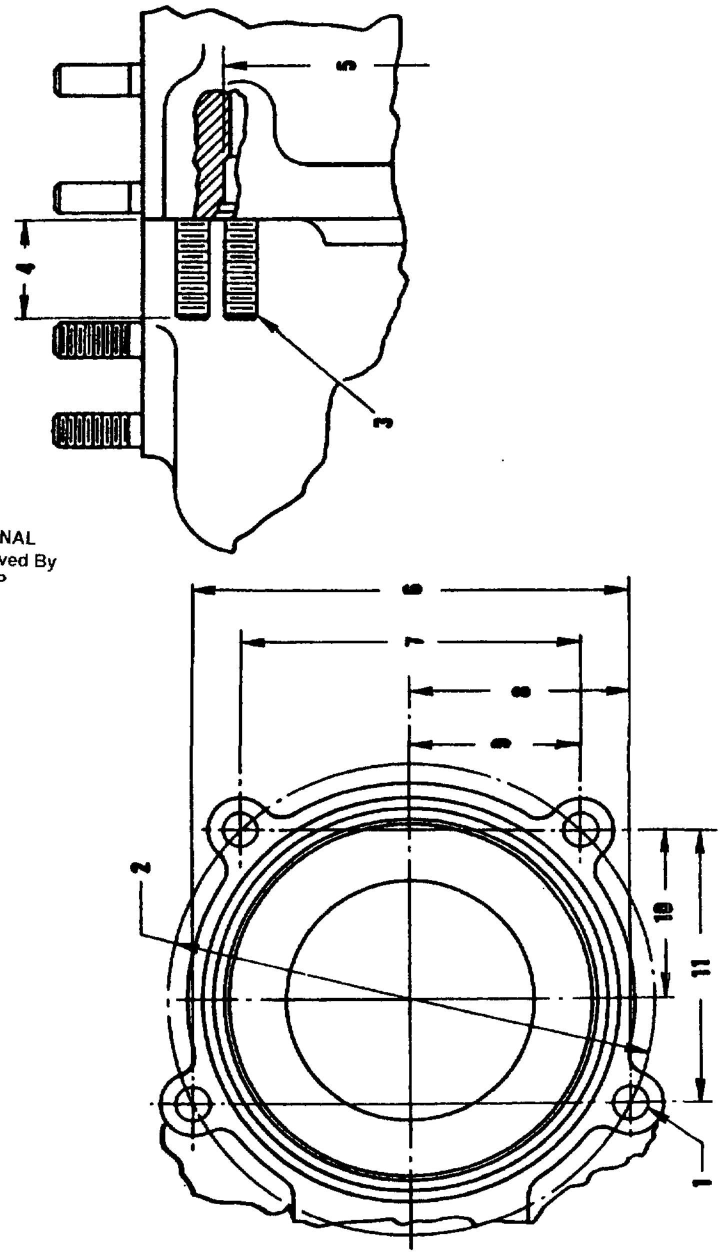
(5) Puddle weld, as shown in figure, with AMS 4395 (AZ 92A) 1/32, 1/16, or 1/8 inch diameter filler rod. See Welding, Standard Practices Manual.

(6) Stress-relieve after welding for one hour at 191° - 218°C (375° - 425°F).

(7) Remove housing from oven and cover with ceramic fiber blanket, or pack in box of loose ceramic fiber, to prevent rapid cooling to 66°C (150°F) before removing insulator.

(8) Inspect by fluorescent penetrant method.

(9) Machine to dimensions shown.



L-I5465 (0000)

Main Oil Strainer Housing
Stud Hole Repair
Figure 616

1. Minor Diameter Depth 0.080 Inch Maximum, Chamfer 60 Degrees Plus Or Minus 5 Degrees Included Angle To 0.312 - 0.342 Inch Diameter. Tap 0.3125-18NC-3 To Minimum Full Thread Depth Of 0.710 Inch. One To Four Holes Located Within 0.005 Inch Radially Of True Position In Relation To Diameter P.
2. 3.677 Inch Diameter
3. AN155050 Stud
4. 0.800 - 0.820 Inch
5. Diameter P
6. 3.310 Inches
7. 2.600 Inches
8. 1.655 Inch
9. 1.300 Inch
10. 1.300 Inch
11. 2.100 Inches

Key To Figure 616

(10) Restore protective finish. See Surface Treatments, Standard Practices Manual.

(11) Restore "OIL PRESSURE" as shown. Mark 0.090 inch deep, using press or roll method. See Marking of Parts, Standard Practices Manual.

H. Oil Pressure Transmitter Boss - Helical Coil Insert Repair (See Tool Group 83-1) and Figure 618.

(1) Counterbore boss as shown.

(a) Thread fixture post into antisiphon line elbow hole. Do not tighten jamnut.

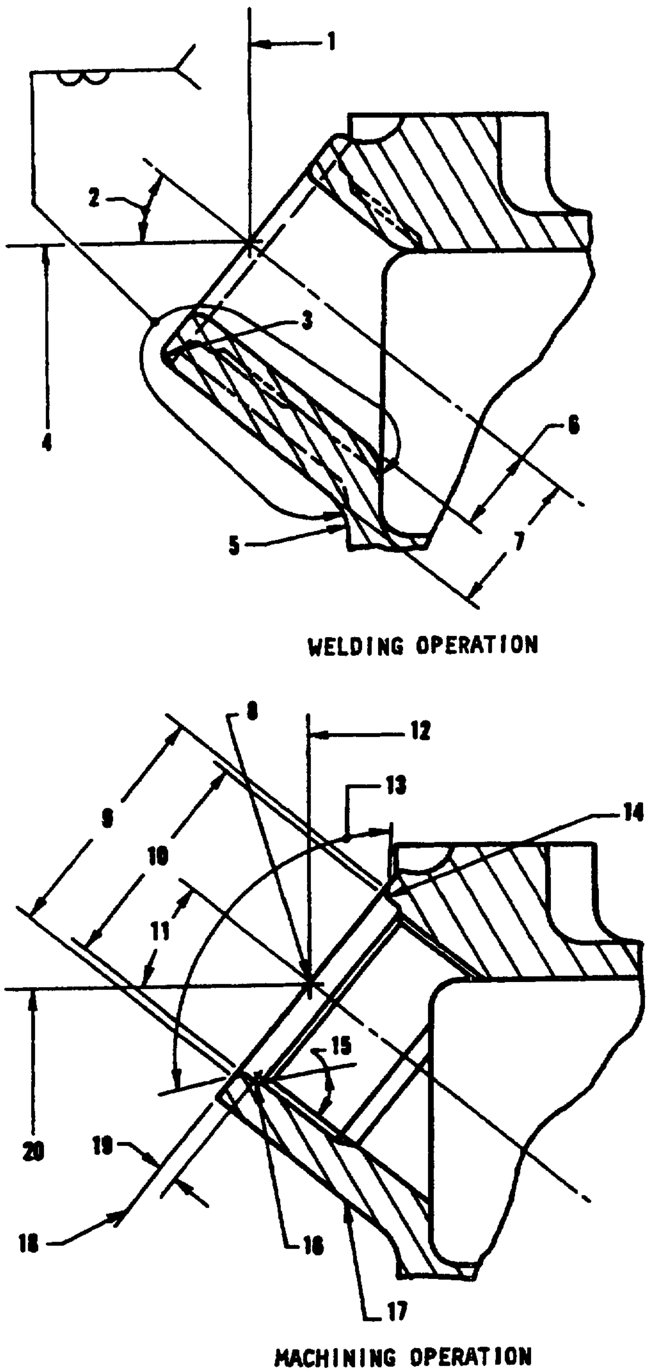
(b) Place counterbore pilot in transmitter boss hole.

(c) Place fixture bushing holder over counterbore shank, fitting holder slot over post key.

(d) Install fixture cap screw and washer to secure holder to post. Do not tighten.

(e) Position holder so counterbore rotates freely. Tighten jamnut and cap screw.

NOTE: Maintain fixture position for all subsequent operations. Do not loosen nut or screw until entire procedure has been completed.



L-17839 (0000)

Oil Pressure Transmitter Boss
Weld Repair
Figure 617

1. 4.165 - 4.205 Inches, Starter And Generator Pad To Centerline
2. 38 - 40 degrees
3. 0.094 Inch Maximum Radius, Three Places
4. 7.735 - 7.775 Inches To Main Component Drive Centerline
5. 0.188 - 0.312 Inch Radius
6. 0.531 - 0.594 Inch Radius
R 7. 0.875 - 0.938 Inch Radius
8. 1.3125-12N-3 Minor Diameter Through One Side, 0.734 Inch Minimum Full Thread Depth
9. 1.487 - 1.502 Inch Diameter. Must Be Concentric With Thread Pitch Diameter Within 0.005 Inch FIR.
10. 1.333 - 1.338 Inch Diameter. Must Be Concentric With Thread Pitch Diameter Within 0.005 Inch FIR
11. 38 - 40 Degrees
12. 4.096 - 4.116 Inches To Starter And Generator Pad Centerline.
13. 119° 30′ - 120° 30′
14. 0.010 - 0.040 Inch Radius
15. 40 - 50 Degrees
16. 0.020 Inch Maximum
17. Mark "OIL PRESSURE" Here.
18. This Surface Must Be Square With Thread Pitch Diameter 0.008 Inch FIR Maximum
19. 0.125 - 0.140 Inch
20. 7.683 - 7.703 Inches To Main Component Drive Centerline.

Key To Figure 617

(f) Counterbore to dimensions shown, using suitable socket extension and Tee handle.

(2) Remove existing threads, tap, and install helical coil insert.

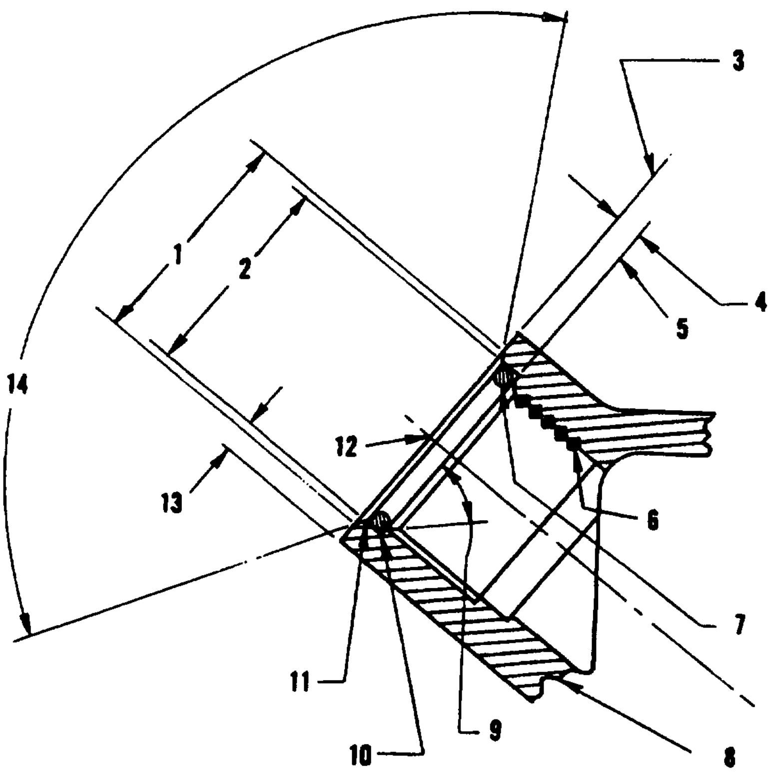
(a) Install fixture bushing in holder. Using end mill, 1.082 - 1.101 inch diameter by six to seven inches long, remove threads.

(b) Tap hole for helical coil insert to depth shown.

(c) Install insert (Helicoil No. 364-17 CNX, 636, or equivalent).

I. Accessory Components Drive Housing, Pads and Cover Liners Replacement
See Figure 619.

J. Starter-Generator Gearshaft Bearing Liner Replacement (See Tool Group 93)



R
R

Oil Pressure Transmitter Boss
Helical Coil Repair
Figure 618

1. 1.234 - 1.249 Inch Diameter. Must Be Concentric With Thread PD Within 0.005 Inch FIR
2. 1.170 - 1.175 Inch Diameter. Must Be Concentric With Thread PD Within 0.005 Inch FIR
3. This Surface Must Be Square With Thread PD Within 0.008 Inch FIR
4. 0.148 - 0.153 Inch
5. Helical Coil Insert To Be 1/4 - 1/2 Pitch Below This Surface After Installation
6. Helical Coil Insert
7. Packing
8. Oil Pressure Transmitter Boss
9. 43 - 47 degrees
10. 0.010 Inch Maximum Radius
11. 0.010 - 0.040 Inch Radius
12. Thread For 1.062-12 Helical Coil Insert
    1.1167 - 1.1212 Inch Minor Diameter PD
    1.1562 Inch Minimum Major Diameter
    1.082 - 1.101 Inch Minor Diameter
    0.997 Inch Minimum Minor Diameter Depth
    0.789 Inch Minimum Full Thread Depth
13. 0.090 Inch Minimum Wall
14. 119° 30′ - 120° 30′

Key To Figure 618

(1) Drill out retaining pin, using liner jig. Pull out liner jig. Pull out liner with the Liner Puller.

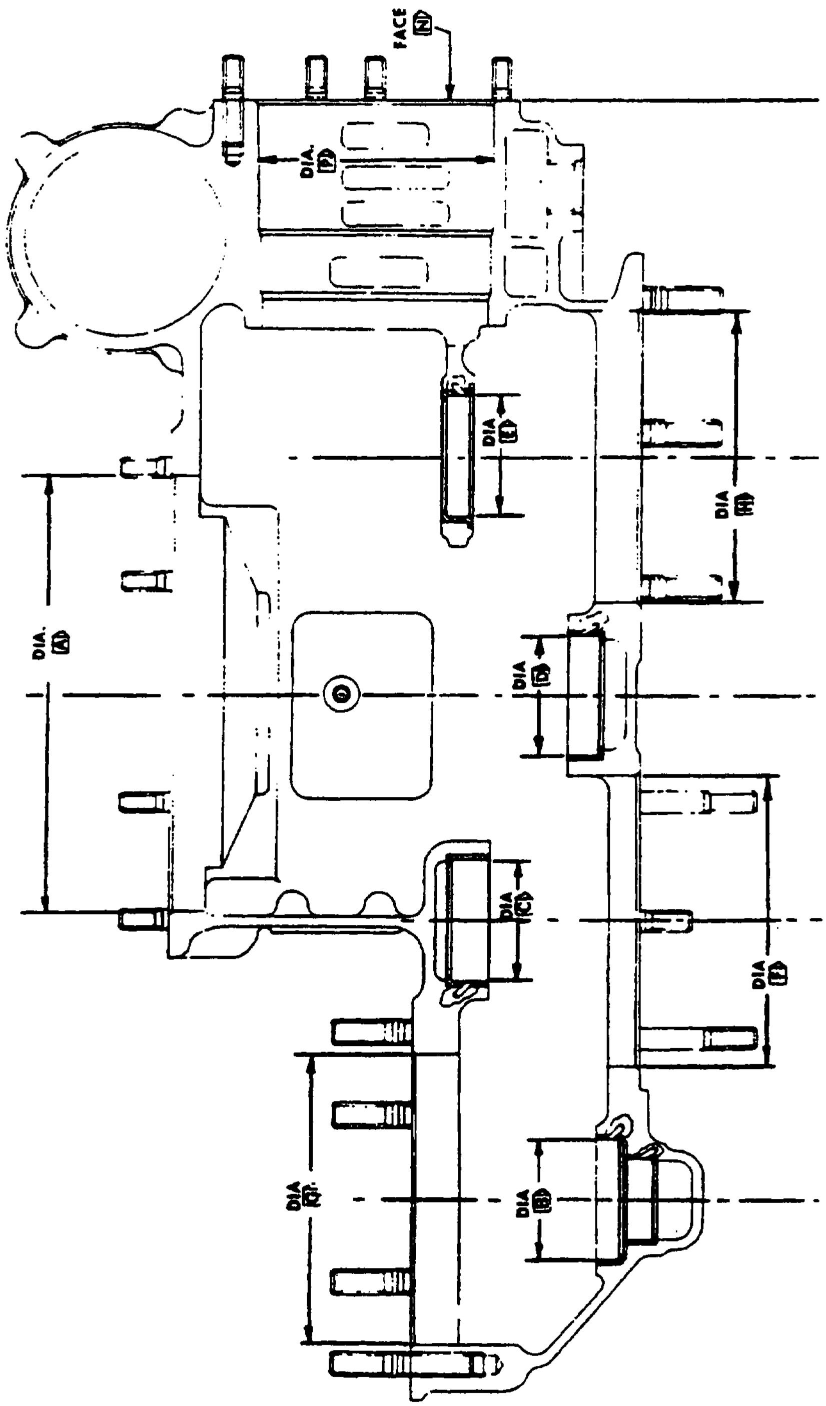
(2) Heat housing, and chill new liner; then drift in liner with the Bearing Liner Drift and pin in place.

NOTE: Oversize liners are available in accordance with Table 601. If oversize liner is required, machine housing to obtain a fit in Requirements in Figure 620 must be maintained.

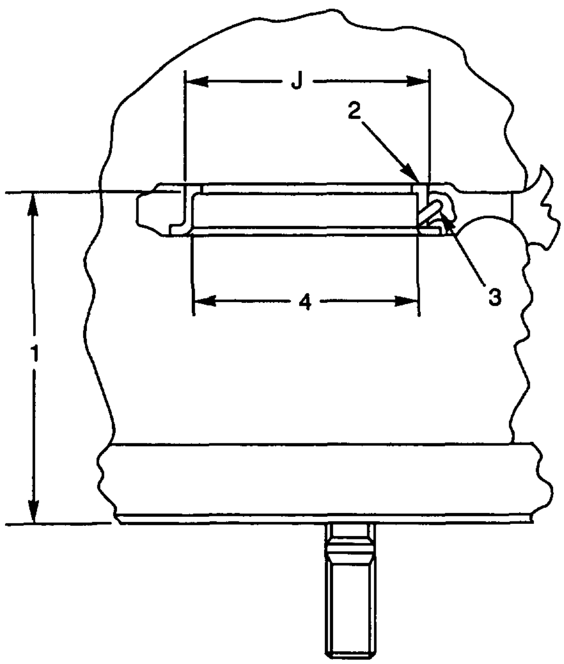
Part No.	Diameter J
434008	2.351 - 2.352
434008-3	2.354 - 2.355
434008-5	2.356 - 2.357

Starter-Generator Bearing Liner
Table 601

(3) With gearbox housing mounted on holding adapter, machine liner to dimensions. See Figure 620.



Accessory Drives Housing
Figure 619



1. 2.943 - 2.947 Inches
2. PN 434008 Liner
3. AN150232 Pin (3). Drill 0.0913 - 0.0933 Inch Diameter Holes To 0.200 - 0.240 Inch Depth.
4. 2.1649 - 2.1656 Inch Diameter. This Diameter Must Be Located Within 0.001 Inch Of True Position In Relation To Diameter A, Diameter P And Face N Of Figure 619.

R
R

Starter-Generator
Liner Replacement
Figure 620

K. Fuel Pump and Fuel Control Bearing Liner Bushing Replacement (See Tool Group 57) and Figure 621.

(1) Liner (Bushing) Removal

(a) Use the Bearing Liner Jig to drill out the bushing retaining pin.

(b) Remove the bushing with the Bearing Liner Puller.

(c) Machine the gearbox housing ID where necessary to remove worn areas (if the diameter is made larger than the as-manufactured limits, it will be necessary to use a larger class of bushing or to make the bushing OD larger with plate to get the specified fit). Refer to step (2).

NOTE: It can be necessary to machine other gearbox pads or bearing bushing diameters to keep these features in the specified concentricity and position.

(2) Bushing Selection

(a) Measure Index 5 in the figure (housing inner ID).

(b) If the housing ID is more than the limits (refer to Table of Limits, Reference 582), but not more than 2.046 inch diameter, get a bushing (PN 432828) which will have the necessary 0.005 - 0.007 inch tight fit with the ID in the gearbox housing.

NOTE: PN 432828 is available in these standard and oversize OD classes (See Sheet 2 of the figure):

PN	Diameter A (Inches)
432828	2.036 - 2.037
432828P3	2.039 - 2.040
432828P5	2.041 - 2.042
432828P15	2.051 - 2.052

(c) It is permitted to machine the OD of a bushing which is larger than necessary, or to make a bushing OD larger by plate as follows if it is too small:

1 Apply nickel plate to the OD of the bushing by SPOP 29. Refer to Section 70-44-01 in the Standard Practices Manual. Nickel plate thickness must be 0.002 - 0.010 inch after finish machining to a dimension which will give the specified fit with the gearbox housing ID.

2 Machine the plated surface to a diameter which will give the specified fit with the housing ID

(3) Bushing installation

(a) Treat the gearbox ID by SPOP 41. Refer to Section 70-44-01 in the Standard Practices Manual.

(b) Heat the housing and chill the replacement bushing.

(c) Install the bushing with the Liner Drift.

(d) Use the Liner Jig to drill new pin holes for the bushing retaining pin (keep away from the previous locations).

(e) Install retaining pins (AN150233) as shown in the figure.

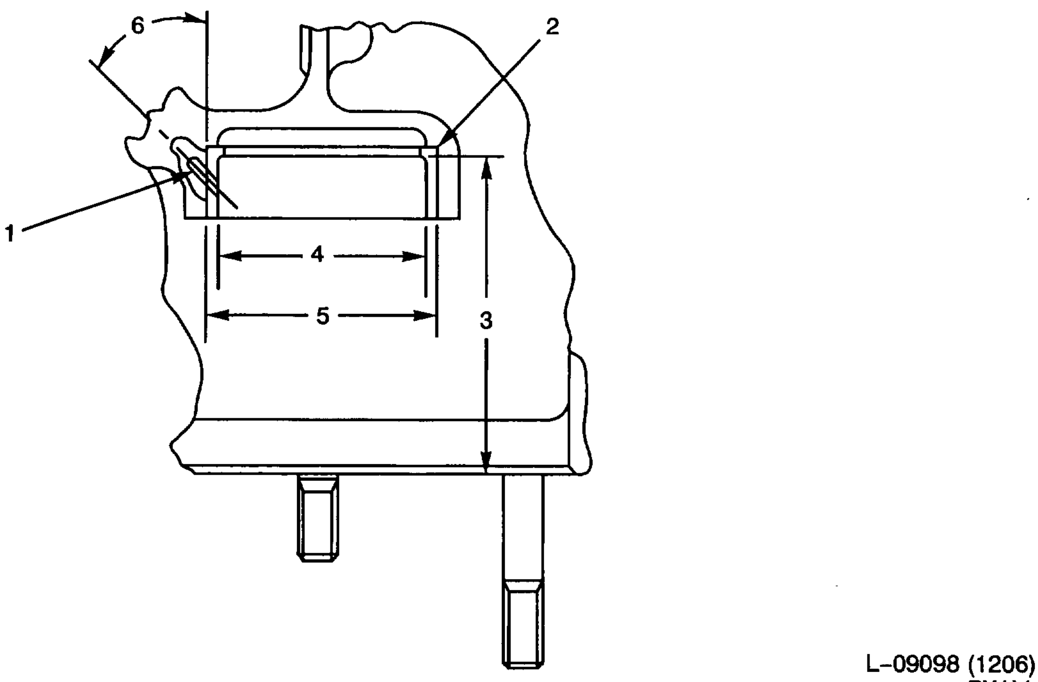
(f) Machine the bushing ID to the diameter specified in the figure.

L. Main Component Driveshaft Lower Bearing Liner Replacement (See Tool Group 75)

NOTE: Retaining pins for liners in reinforced lower bearing supports, as shown in Figure 614 (Sheet 3), are installed at a different angle than that shown in Figure 624. When replacing these liners, use tooling indicated in Paragraph D.

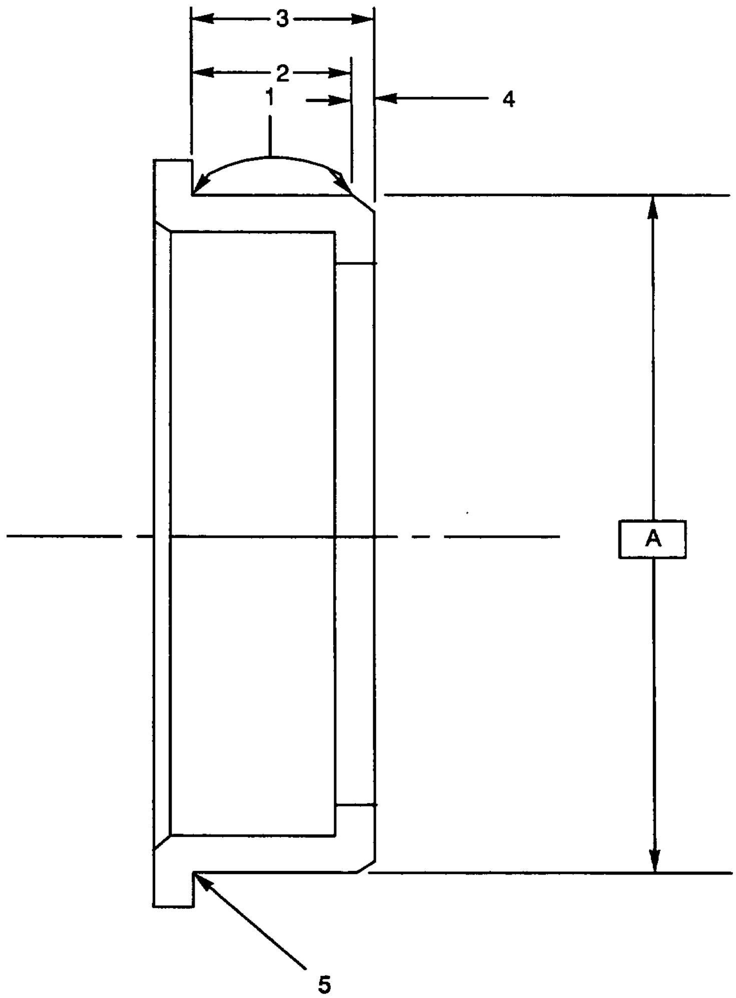
(1) Drill out the retaining pin with the Drill Jig, and remove the liner with the Liner Puller.

R
R



1. Retaining Pin (3). Drill 0.0913 - 0.0933 Inch Diameter Holes To 0.260 - 0.300 Inch Depth
2. Bushing (See Text)
3. 2.796 - 2.800 inches
4. 1.8502 - 1.8508 Inch Diameter, 0.001 Inch Maximum Of True
R Position In Relation To Diameter F. See Figure 619.
5. 2.046 Inch Maximum Diameter (See Text)
6. 45 Degrees Plus/Minus 2 Degrees

Fuel Control Drive
Gearshaft Rear Bearing Liner
(Bushing) Replacement
Figure 621 (Sheet 1)



L-H7965 (1206)
PW V

1. Nickel Plate Area (Refer To Limits In Index 5)
2. 0.442 - 0.446 Inch
3. 0.555 - 0.565 Inch (Reference)
4. 45 degrees ± 2 Degrees Chamfer, 0.030 - 0.045 Inch
5. 0.010 - 0.020 Inch Modified Radius (Keep Plate Out Of Radius)

Fuel Control Drive
Gearshaft Rear Bearing Liner
(Bushing) Replacement
Figure 621 (Sheet 2)

(2) Heat housing and chill new liner. Use the Bearing Liner Drift to install the liner and install a pin to hold the liner in position.

NOTE: Oversize bearing liners are available in accordance with Table 602. If an oversize liner is required, machine housing to obtain fit in accordance with Reference 565 Table of Limits. The requirements in Figure 623 must be maintained.

Part No.	Diameter K
432542	1.839 - 1.840
432542-3	1.842 - 1.843
432542-5	1.844 - 1.845

Component Driveshaft
Lower Bearing Liner
Table 602

(3) With gearbox housing mounted on holding adapter, machine liner to dimensions. See Figure 624.

M. Gearbox Housing Assembly Bushing Installation For Worn Gearbox Housing
See Figure 622.

(1) Machine the housing to Dimension A, Index 6.

(2) Install the bushing, Index 4, to the bottom in the housing.

(a) Heat the housing to a maximum of 93.3°C (200°F) and cool the bushing (Index 4) to a maximum of -87.2°C (-125°F).

(b) Let the parts return to room temperature.

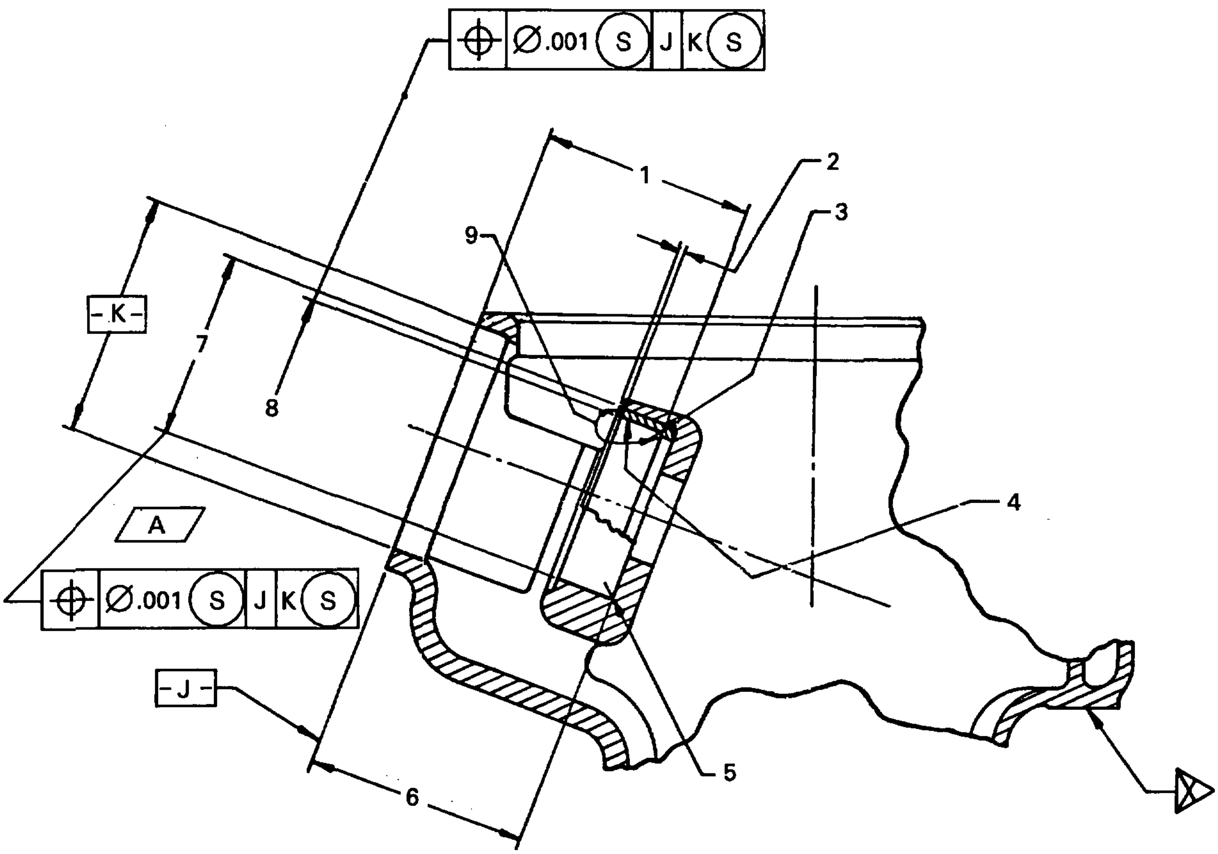
(3) Machine the housing to Dimension C (Index 1).

(4) Treat the surface (Index 9) by AMS 2473 (SPOP 42). Refer to Section 70-44-01 in the Standard Practices Manual.

N. Lower Gearbox Drive Bearing Housing Chromium Plate Repair
See Figure 623.

(1) Inspect Diameter E, Index 4

R
R



L-H3122 (1296)

1. 2.350 - 2.370 Inches After Bushing Installation
2. Chamfer 0.020 - 0.040 Inch By 40° - 50° After Bushing Installation
3. 0.016 - 0.047 Inch Modified Radius After Bushing Installation
4. PN 795388 Bushing
5. 0.016 - 0.047 Inch Modified Radius After Bushing Installation
6. 2.440 - 2.450 Inches Before Bushing Installation
7. 1.976 - 1.978 Inch Diameter Before Bushing Installation
8. 1.8555 - 1.8565 Inch Diameter After Bushing Installation
9. Treat This Surface By AMS 2473 (SPOP 42).

Key To Figure 622

(a) If the part is over the maximum dimension, machine the part to Diameter E, Index 4.

(b) If the part is less than the minimum dimension, repair as follows:

1 Machine the worn diameter. Hold to the minimum diameter, Index 5.

2 Do a magnetic particle inspection. See Standard Practices Manual.

3 Shotpeen at Index 9 by SPOP 501 to an intensity of 12A.

4 Chromium plate at Index 10 per SPOP 22. Plate must be 0.002 - 0.010 inch thick after Diameter E (Index 4) is machined. Do not bake before or after plate.

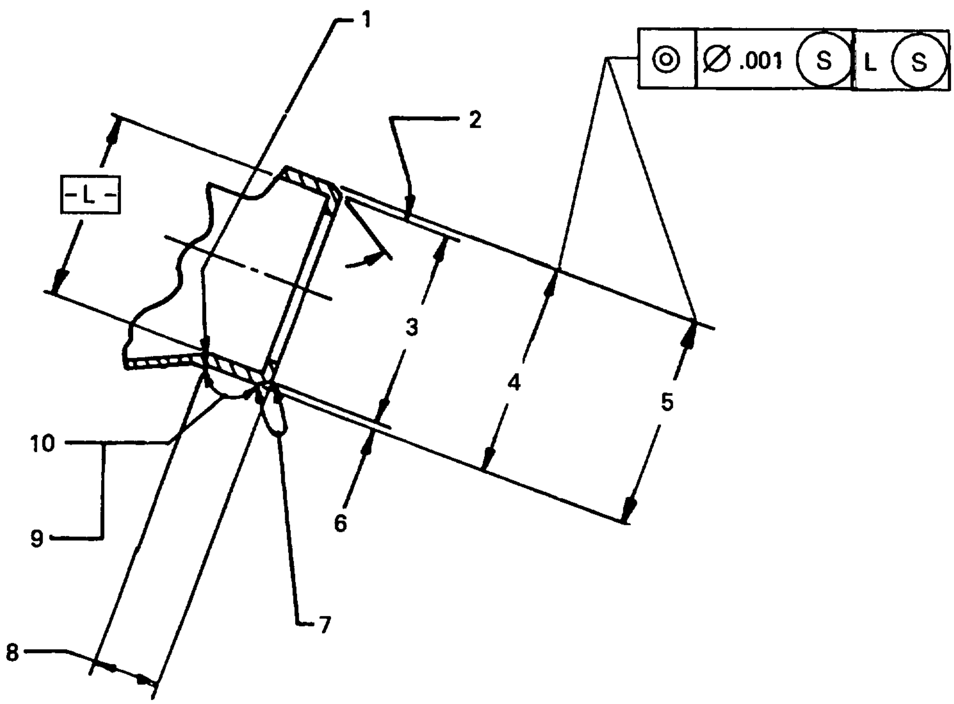
5 Machine to Diameter E (Index 4).

R O. Main Component Gearshaft Drive Front Bearing Liner (Bushing) Replacement
R (See Tool Group 76) and Figure 625.

(1) Liner (Bushing) Removal

(a) Use the Bearing Liner Jig to drill out the bushing retaining pins.

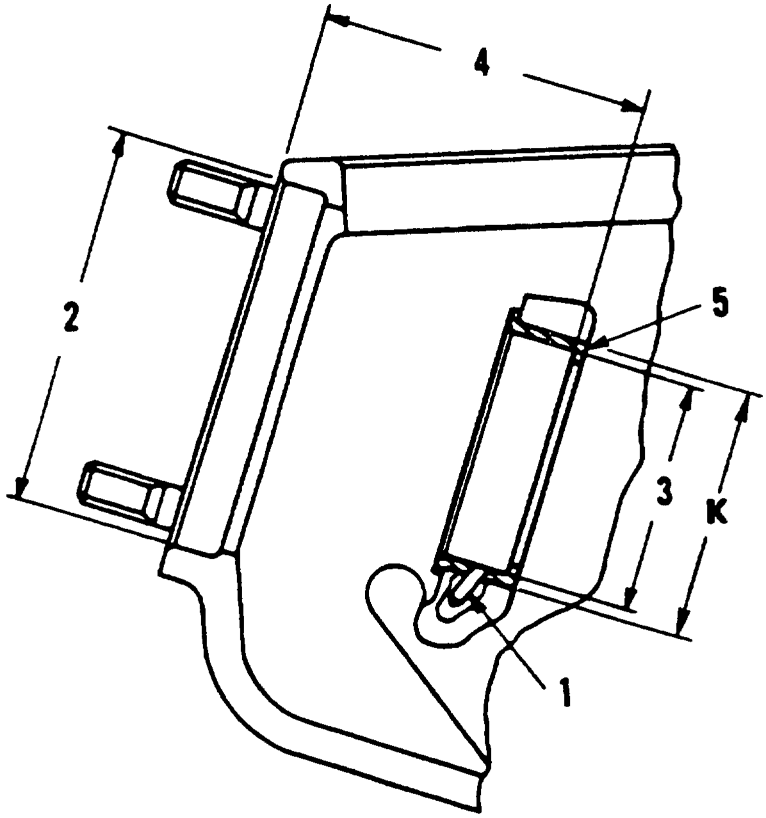
(b) Remove the bushing with the Bearing Liner Puller.



L-H3123 (1296)

1. 0.016 - 0.047 Inch Modified Radius
2. 28 degrees - 32 degrees
3. 1.740 - 1.760 Inch Diameter
4. 1.8555 - 1.8565 Inch Diameter, Diameter E
5. 1.837 Inch Diameter Minimum
6. 0.043 Inch Minimum
7. Shotpeen And Chromium Plate In This Area Is Optional And Does Not Have To Be Complete
8. 0.575 or 0.615 Inch
9. Shotpeen By SPOP 501 To An Intensity Of 12A
10. Chromium Plate By SPOP 22

Lower Gearbox Drive
Bearing Housing
Chromium Plate Repair
Figure 623



L-08779 (0000)

1. AN150233 Pin (Two Required); Drill 0.0913 - 0.0933 Inch Diameter Holes To 0.260 - 0.300 Inch Depth
2. 2.670 - 2.671 Inch Diameter. Diameter A, Figure 618, Must Pass Through The Centerline Of This Diameter Within 0.001 Inch
3. 1.6527 - 1.6533 Inches. This Diameter Must Be Concentric With Diameter (2) Within 0.002 Inch FIR And Be Located Within 0.001 Inch Of True Position In Relation To Diameter A, Figure 618.
4. 2.243 - 2.247 Inches
5. PN 432542 Liner

Main Component Driveshaft
Lower Liner Replacement
Figure 624

(c) Install the gearbox in the Holding Adapter and machine the gearbox housing ID where necessary to remove worn areas (remove only the minimum material necessary). If the diameter is made larger than the as-manufactured limits, it will be necessary to use a larger class of bushing or to make the bushing OD larger with plate to get the specified. Refer to step (2).

NOTE: It can be necessary to machine other gearbox pads or bearing bushing diameters to keep these features in the specified concentricity and position.

(2) Bushing Selection

(a) Measure Index 5 (housing inner ID) as shown in the figure.

(b) If the housing is more than specified in Table of Limits Reference 572, get a bushing (PN 432828) which will have the necessary 0.005 - 0.007 inch tight fit in the gearbox housing.

NOTE: PN 432828 is available in these standard and oversize OD classes (see Sheet 2 of the figure):

PN	Diameter A (Inches)
432828	2.036 - 2.037
432828P3	2.039 - 2.040
432828P5	2.041 - 2.042
432828P15	2.051 - 2.052

(c) It is permitted to machine the OD of a bushing which is larger than necessary, or to make a bushing OD larger by plate as follows if it is too small:

1 Apply nickel plate to the OD of the bushing by SPOP 29. Refer to Section 70-44-01 in the Standard Practices Manual. Nickel plate thickness must be 0.002 - 0.010 inch after finish machining to a dimension which will give the specified fit with the gearbox housing ID.

(3) Bushing Installation

R
R

(a) Treat housing inner ID by SPOP 41. Refer to Section 70-44-01 in the Standard Practices Manual.

(b) Heat the housing and chill the replacement bushing.

(c) Install the bushing with the Liner Drift.

(d) Use the Liner Drill Jig to drill new pin holes for the bushing retaining pin (keep away from the previous pin locations).

(e) Install retaining pins (AN150233) as shown in the figure).

(f) With the gearbox housing installed in the Holding Adapter, machine the bushing ID to the diameter specified in the figure.

R P. Hydraulic Pump Drive Front Oil Seal Housing Liner Replacement
R (See Tool Group 70) and Figure 626.

(1) Drill out the pin with the Drill jig. Remove liner, using oil seal liner puller.

(2) Heat housing, and chill new liner. Drift in liner, using seal housing drift.

(3) Using the gearbox housing holding adapter, machine liner to dimensions. See Figure 628. Check liner ID after machining using liner gage.

R Q. Hydraulic Pump Drive Gearshaft Front Bearing Liner Replacement (see Tool Group 71)

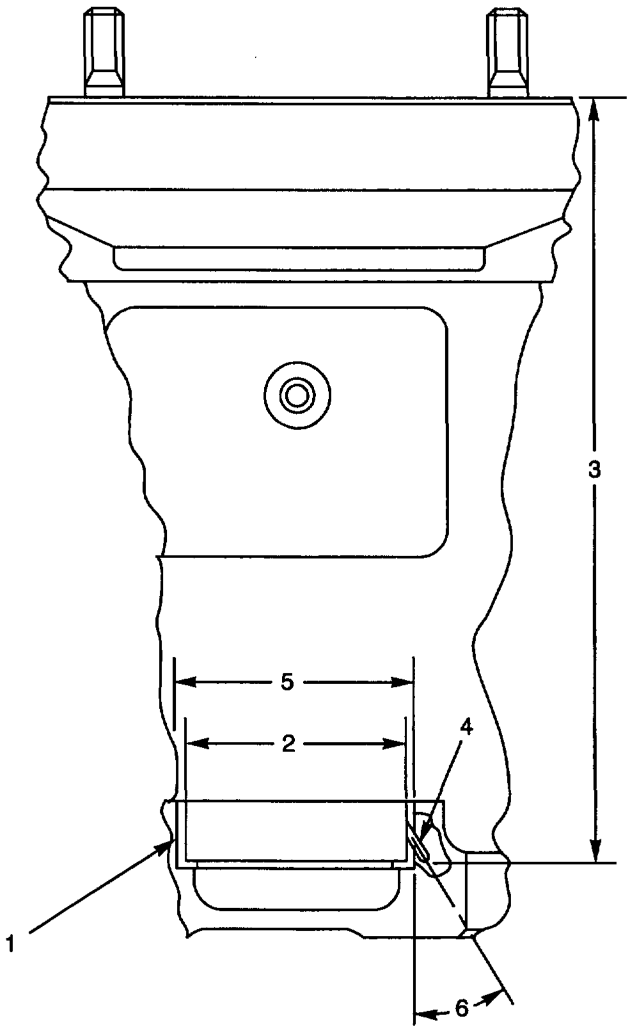
(1) Drill out pin and remove liner, using bearing liner puller.

(2) Heat housing and chill new liner. Install liner using bearing liner drift.

(3) Using gearbox housing holding adapter, machine
R liner to dimensions. See Figure 626.

R R. Component Drives Gearbox Mounting Lug Bushing Replacement (See Tool Group 25)

(1) Remove four bushings from mounting lugs using bushing puller.

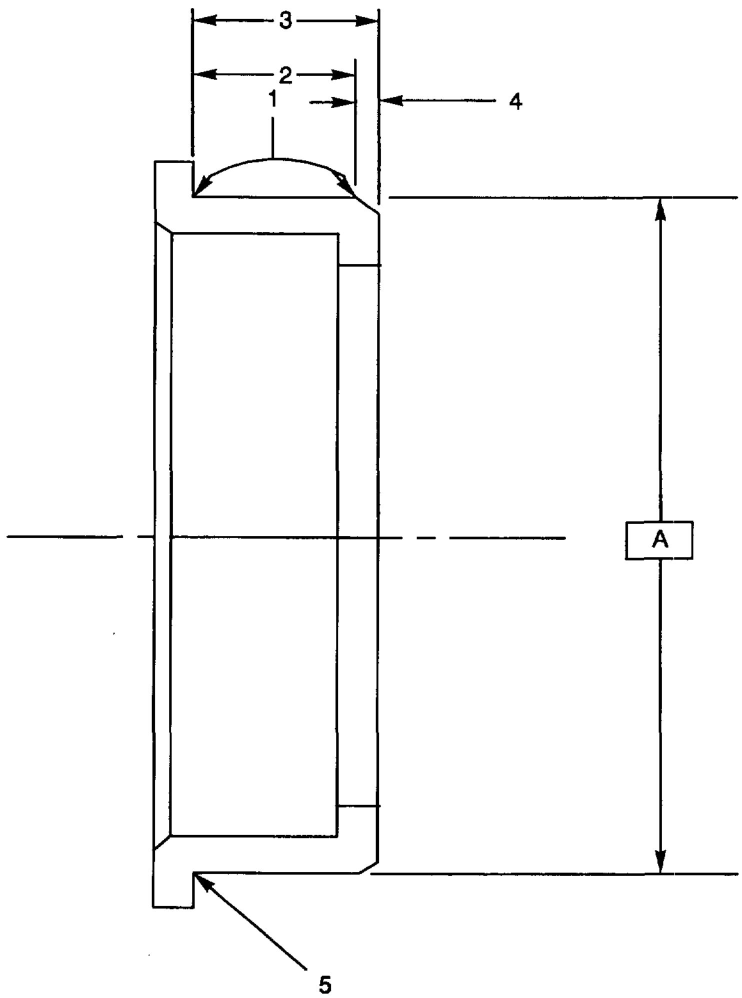


1. Bushing (See Text)
2. 1.8502 - 1.8508 Inch Diameter. This Diameter Must Be Located Within 0.001 Inch Of True Position In Relation To Diameter A, Figure 618
3. 6.248 - 6.252 Inches
4. PN 150233 Retaining Pin (3). Drill 0.0913 - 0.0933 Inch Diameter Holes To Depth Of 0.260 - 0.300 Inch

R 5. 2.046 Inch Diameter Maximum

6. 30 Degrees ± 2 Degrees

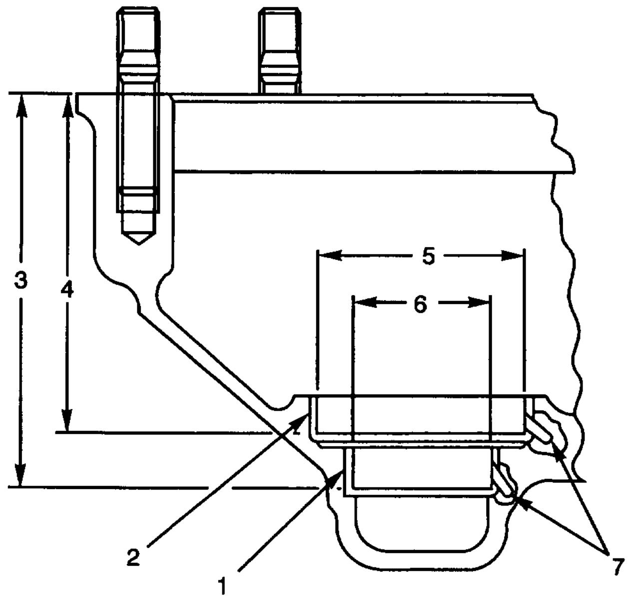
Component Gearshaft Front Liner
(Bushing) Replacement
R Figure 625 (Sheet 1)



L-H7965 (1206)
PW V

1. Nickel Plate Area (Refer To Limits In Index 5)
2. 0.442 - 0.446 Inch
3. 0.555 - 0.565 Inch (Reference)
4. 45 Degrees Plus/Minus 2 Degrees Chamfer, 0.030 - 0.045 Inch
5. 0.010 - 0.020 Inch Modified Radius (Keep Plate Out Of The Radius)

Component Gearshaft Front Liner
(Bushing) Replacement
Figure 625 (Sheet 2)



1. PN 365419 Liner
2. PN 432821 Liner
3. 3.509 - 3.511 Inches
4. 3.019 - 3.022 Inches
5. 1.8504 - 1.8510 Inches. This Diameter Must Be Within 0.001 Inch
R Of True Position In Relation To Diameter A, Figure 619.
6. 1.247 - 1.249 Inches. This Diameter Must Be Within 0.001 Inch
R Of True Position In Relation To Diameter A, Figure 619, And Concentric With The Diameter Of Index 5 Within 0.001 Inch FIR
7. AN150233 Pin (Two Required); Drill 0.0913 - 0.0933 Inch Diameter Holes To 0.260 - 0.300 Inch Depth.

Hydraulic Pump Housing
Liner Replacement And
Hydraulic Pump Gearshaft
Liner Replacement
Figure 626

(2) Drift in replacement bushings using mounting lug drift.

R (3) Machine bushings to dimensions. See Figure 627.

(4) Check bushing ID after machining, using bushing gage.

R S. Gearbox Housing Mount Lug Faces Repair
R See Figure 628.

NOTE: This repair is only for removing corrosion on the mount lug faces and to replace the bushings.

(1) Remove the four bushings from the mount lugs as instructed in this section.

(2) Machine the casting as shown in the figure.

(3) Drift in the new PN 387847 bushings as instructed in this section. If necessary, use the oversized bushings PN 387847+3 or PN 387847+5.

(4) Use the SPOP 41 chemical chromate conversion treatment, Method A touch-up process on the machined areas to prevent corrosion. See Section 70-44-01, Standard Practices Manual.

(5) Machine the bushings down to get the dimensions given in the figure.

R T. Gearbox Housing Mount Lug Holes Bore Repair
R See Figure 629.

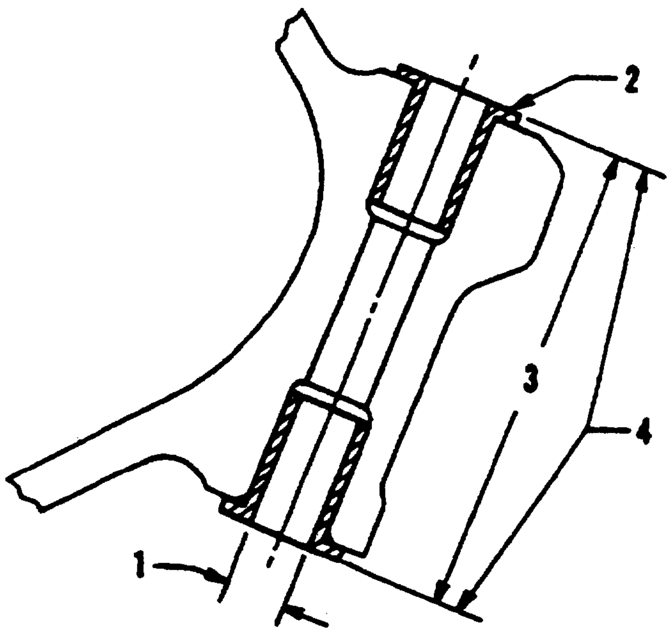
(1) Remove the four bushings from the mount lugs as instructed in this section.

(2) Machine the casting as shown in the figure.

(3) Use the SPOP 41 chemical chromate treatment, Method A touch-up process on the machined areas to prevent corrosion. See Section 70-44-01, Standard Practices Manual.

(4) Strip the cadmium plate from the PN 387847 bushings by SPOP 21 in Section 70-44-01. Standard Practices Manual.

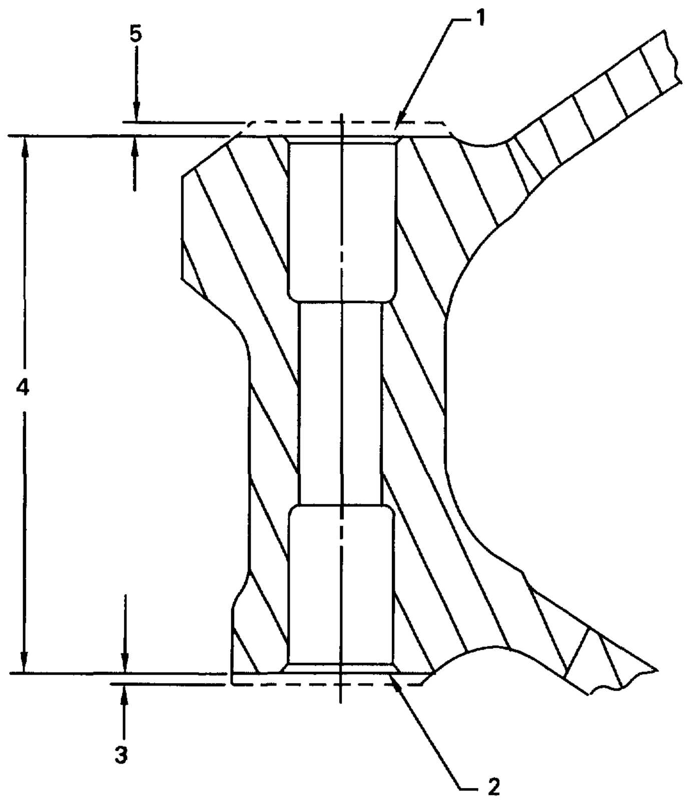
(5) Apply nickel plate by SPOP 26 on the bushing ODs as shown in the figure. See Section 70-44-01 Standard Practices Manual.



L-08777 (0000)

1. 0.374 - 0.376 Inch
2. PN 387847 Bushing: (Four Required)
3. 2.752 - 2.756 Inches
4. These Surfaces Must Be Square With The Bore Within 0.002 Inch FIR

Mounting Lug Bushing Replacement
Figure 627



L-H3205 (1296)

Gearbox Housing Mount Lug Faces Repair
Figure 628

1. Chamfer 0.030 - 0.050 Inch By 45 - 47 Degrees Both Ends. This End Must Be Located Within 0.004 Inch Radius Of True Position.
2. Treat Both Sides. See Text.
3. 0.019 Inch Maximum (Both Sides Equally)
4. 2.590 - 2.594 Inches
5. 0.019 Inch Maximum Removal From Original Surfaces (Both Sides Equally)

R Key To Figure 628

(6) Machine the bushings to the dimensions given in the figure.

(7) Apply cadmium plate on the bushings by SPOP 21 in Section 70-44-01, Standards Practices Manual. No baking is necessary for hardness.

(8) Dimensionally inspect the bushings as given in the figure.

(9) Drift in the new PN 387847 bushings as instructed in this section

(10) Machine the bushings down to get the dimensions given to the figure.

R U. Gearbox Housing Stud Replacement

(1) Replace studs in accordance with Table 603.

PN	Projection Length (Inches)	Location	No. Reqd.
AN126012	0.950 - 0.970	Breather Valve Pad	3
206443	0.830 - 0.850	Tachometer Drive Pad	4
AN125970	0.490 - 0.510	Main Bearing Support	4
AN125982*	0.560 - 0.580	Main Bearing Support	4
359333	1.700 - 1.720	Fuel Control Pad	5
AN126312	0.730 - 0.750	Fuel Control Pad	1

Gearbox Stud Replacement
Table 603

PN	Projection Length (Inches)	Location	No. Reqd.
(CONTINUED)			
AN126312	0.685 - 0.705	Gearbox Housing Cover	8
AN126324** AN126325 AN126326 AN126327 AN126328	0.810 - 0.830	Gearbox Housing Cover	1
232499	1.170 - 1.190	Starter-Generator Pad	6
		Fluid Power Pump Pad	6
709699**	1.295 - 1.315	Starter-Generator Pad	1
		Fluid Power Pump Pad	1
AN125988	0.650 - 0.670	Oil Pump Pad	5
AN126000 547344	0.800 - 0.820	Oil Strainer Cover Pad	4

* Refer to SB 2005
** Refer to SB 6312

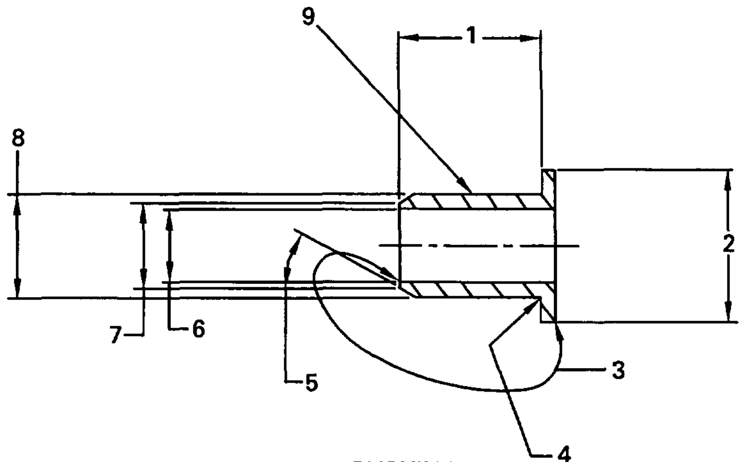
Gearbox Stud Replacement
Table 603 (Continued)

R V. Helical Coil Insert Repair of Gearbox Bosses
R See Figure 630 and Table 604.

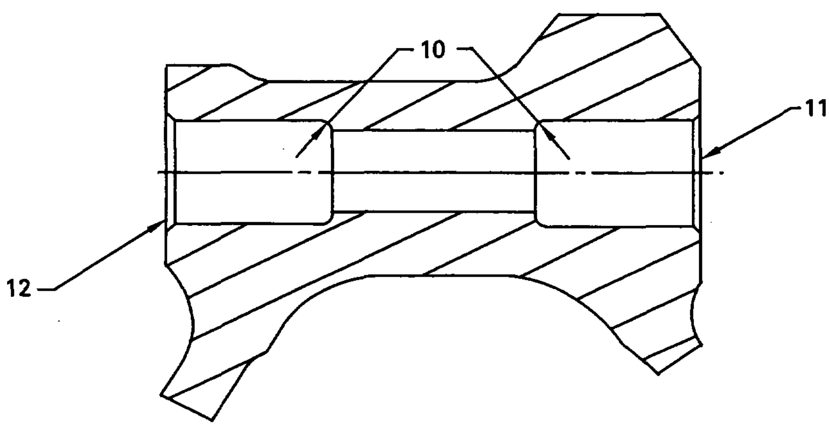
(1) Locate gearbox housing on boring mill and align hole under spindle maintaining concentricity and squareness.

(2) Fabricate plug for installation in boss to prevent chips from entering gearbox. Install plug.

(3) Bore or ream out damaged threads to specified diameter and depth. Also counterbore by the referenced figure. See Overhaul Standard Practices Manual for surface texture requirements of machined surfaces.



BUSHING



CASTING

L-H3206 (1296)

Gearbox Housing Mount Lug Holes
Bore Repairs
Figure 629

1. 0.690 - 0.710 Inch Diameter (Reference)
2. 0.740 - 0.760 Inch Diameter (Reference)
3. Cadmium Plate Area
4. 0.010 - 0.030 Inch Radius
5. 28 - 32 Degrees
6. 0.350 - 0.355 Inch Diameter (Reference)
7. 0.430 - 0.045 Inch Diameter (Reference)
8. 0.517 - 0.518 Inch Diameter After Nickel And Cadmium Plate.
9. Nickel Plate Area (OD Only)
10. 0.047 - 0.078 Inch Radius
11. 0.514 - 0.515 Inch
    0.770 - 0.870 Inch Depth
    0.030 - 0.050 Inch by 45° ± 2° Chamfer Both Ends
12. Treat Both Sides (See Text)

R Key To Figure 629

(4) Tap hole for 0.750-16 helical coil insert. See referenced figure and thread data table. The following Heli-Coil Corporation tools (or equivalent) may be used: Tap No. 10193-12-1, Gage No. 1694-12, Insert Tool No. 2729-12.

(5) Clean chips and remove plug.

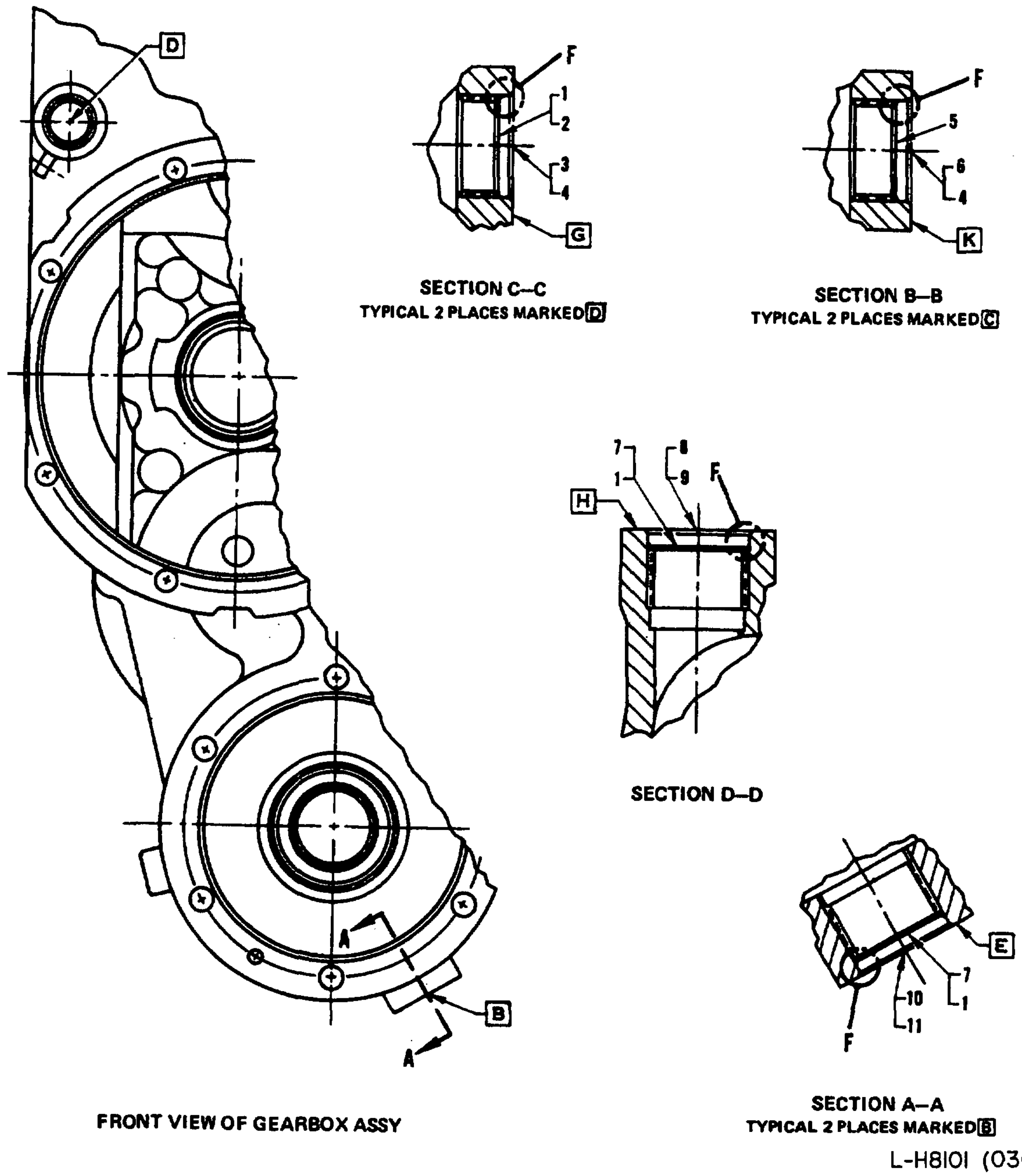
(6) Coat threads of reworked bosses by SPOP 157 before installing helical coil insert.

(7) Install helical coil insert. Break off tang at notch with pliers.

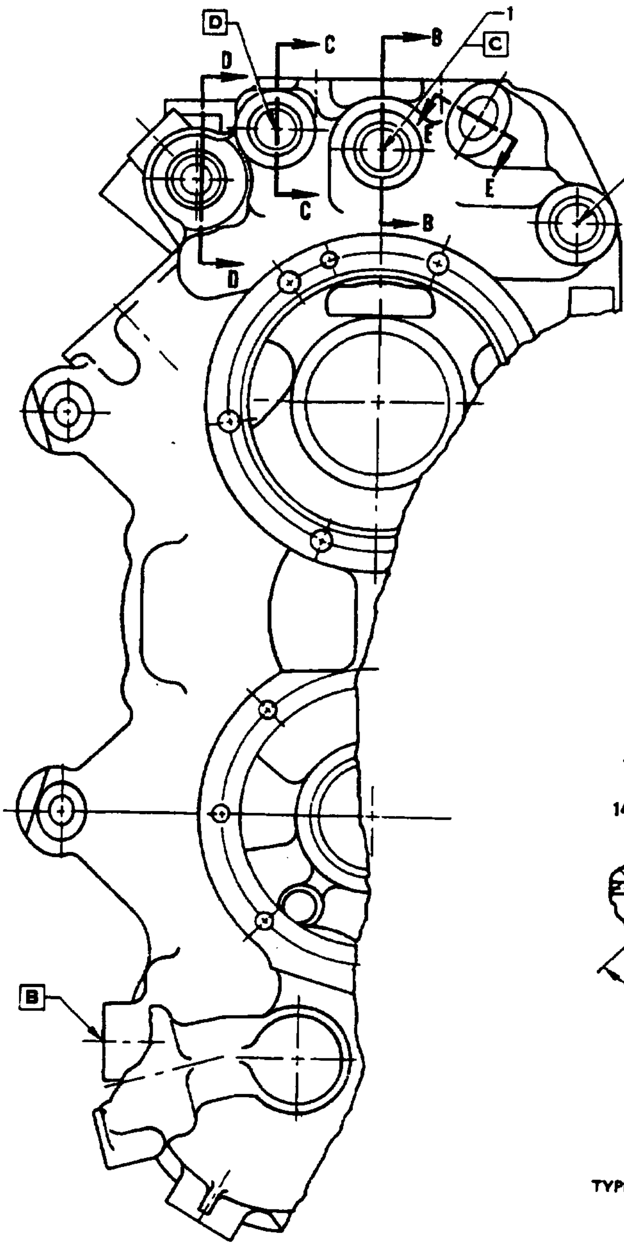
(8) Use specified packing when connectors are attached.

Section	PD (Inches)	Major Diameter (Inches)	Minor Diameter (Inches)	Minor Diameter Depth (Inches)	Minimum Full Thread Depth (Inches)
	0.7945	0.8204	0.775		
A-A	0.7906	Minimum	0.765	Through	0.632
B-B, C-C	0.7945	0.8204	0.775		
E-E	0.7906	Minimum	0.765	Through	
D-D	0.7945	0.8204	0.775	0.820	
	0.7906	Minimum	0.765	0.780	0.632

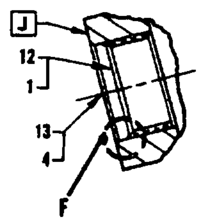
Thread Data For Helical Coil
Insert Repair of Bosses
Table 604



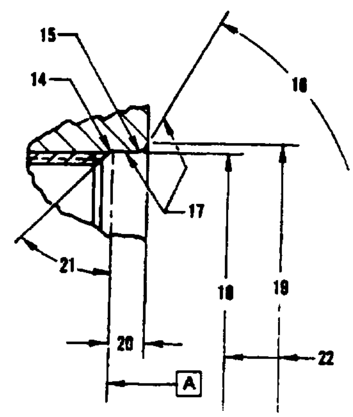
Helical Coil Insert
Repair of Bosses
Figure 630 (Sheet 1)



REAR VIEW OF GEARBOX ASSY



SECTION E–E



VIEW F
TYPICAL 8 PLACES

L-H8102 (0307)

Helical Coil Insert
Repair of Bosses
Figure 630 (Sheet 2)

1. Packing MS9388-114
2. Insert PN 719269. Top Face Of First Coil To Be From One-Fourth To One-half Pitch Below Surface A.
3. Pitch Diameter Of Thread Must Be Square With Surface G Within 0.005 Inch FIR And Must Be located Within 0.005 Inch Radius Of True Position.
4. See Table 604 For Thread Data.
5. Insert PN 719270. Top Face Of First Coil To Be From One-Fourth To One-half Pitch Below Surface A.
6. Pitch Diameter Of Thread Must Be Square With Surface K Within 0.005 Inch FIR And Must Be located Within 0.005 Inch Radius Of True Position.
7. Insert PN 494824. Top Face Of First Coil To Be From One-Fourth To One-half Pitch Below Surface A.
8. Pitch Diameter Of Thread Must Be Square With Surface H Within 0.005 Inch FIR And Must Be located Within 0.005 Radius Of True Position.
9. See Table 604 For Thread Data.
10. Pitch Diameter Of Thread Must Be Square With Surface E Within 0.005 Inch FIR And Must Be located Within 0.005 Inch Radius Of True Position.
11. See Table 604 For Thread Data.
12. Insert PN 719275. Top Face Of First Coil To Be 0.25 - 0.5 Pitch Below Surface A.
13. Pitch Diameter Of Thread Must Be Square With Surface J Within 0.005 Inch FIR And Must Be located Within 0.005 Inch Radius Of True Position.
14. 0.020 Inch Radius Maximum.
15. 0.010 - 0.040 Inch Radius.
16. 120°0′ ± 0°30′ Included Angle.
17. These Surfaces Must Be Free From Nicks, And Scratches.
18. 0.833 - 0.838 Inch Diameter.
19. 0.875 - 0.890 Inch Diameter.
20. 0.111 - 0.116 Inch.
21. 45° ± 5° Angle.
22. These Diameters Must Be Concentric With PD Of Thread Within 0.005 Inch FIR.

R Key To Figure 630 (Sheets 1 And 2)

R 8. Main Component Drive Gearshaft Upper Bearing Support (PN 417613)

R A. Inspection

R (1) Examine the main component drive gearshaft upper bearing
R support for wear or damage.

R (2) If the bore is not in limits (refer to the Table of
R Limits), repair the ID by plating (refer to Repair).

R (3) Examine the end faces for wear. Repair wear more than
R 0.003 inch by Repair (if the wall thickness before plate
R will not be less than 0.040 inch).

R B. Repair
R See Figure 631.

(1) Bearing Outer Race Support Bore Repair

(a) Grind out bearing outer race support sufficiently to clean up bore of outer race support (Index 12). Ensure that minimum wall thickness (Index 7) is observed.

(b) Fluorescent penetrant inspect machined area (refer to Section 70-33-00 in the Standard Practices Manual).

(c) Chromium plate by SPOP 22, ensuring that plate build up will be sufficient to obtain finish dimensions.

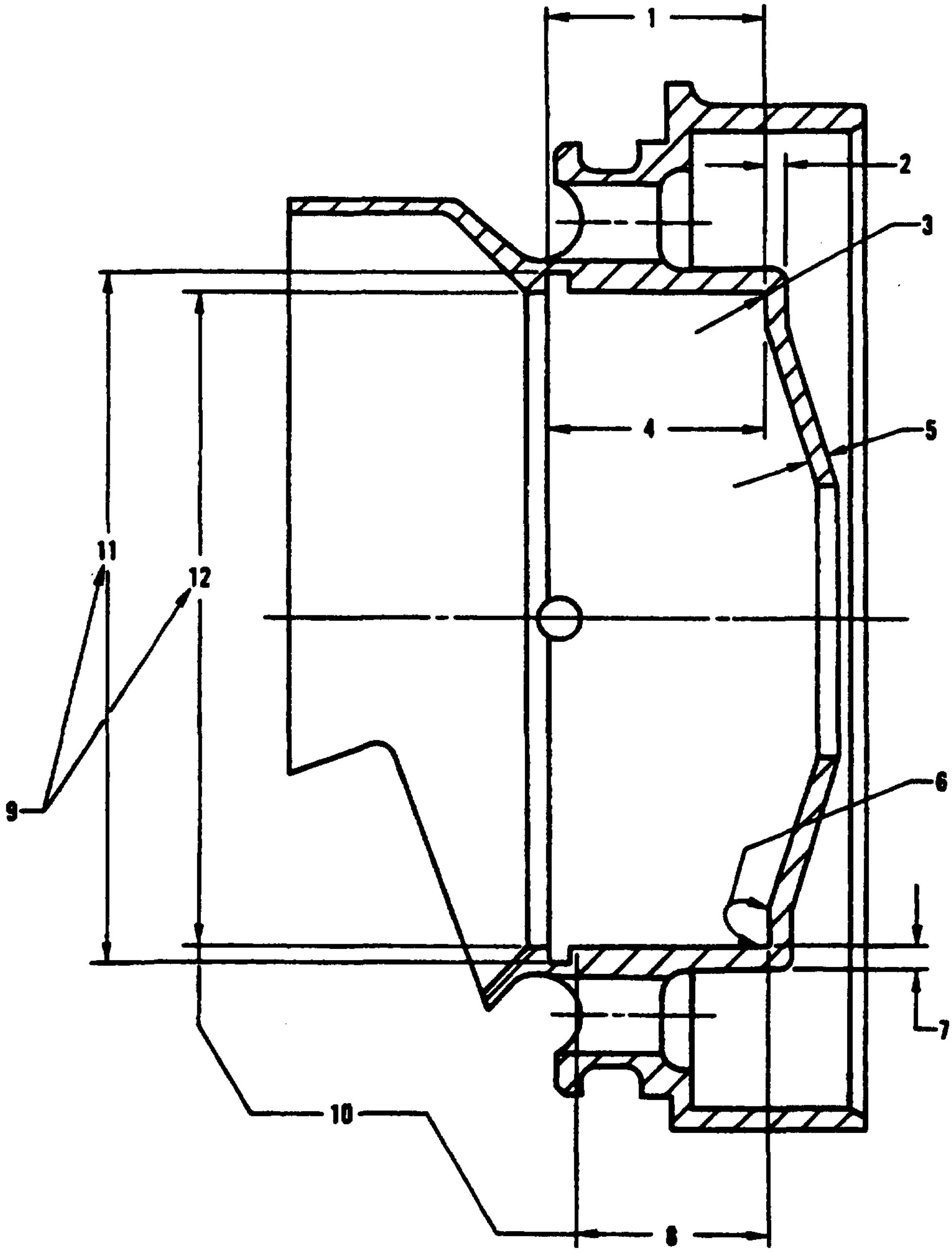
(d) Finish grind to 1.8505 - 1.8511 inch diameter on outer race contact area as indicated by Index 8.

(e) Inspect entire support by fluorescent penetrant.

(2) Bearing Outer Race Support End Face Repair (Index 6)

R (a) Repair as follows:

1 For wear of 0.015 inch or less, chromium plate by SPOP 22 and finish grind as shown.



L-29798 (0000)

Main Component Drive Gearshaft
Upper Bearing Support Plating
Figure 631

1. 0.614 - 0.618 Inch After Plate
2. 0.040 Inch Minimum Wall Thickness
3. 0.040 Inch Maximum Radius
4. 0.620 - 0.622 Inch Finished Dimension After Plating
5. 0.050 - 0.070 Inch Thickness (Reference)
6. Surface C
7. 0.040 Inch Minimum Wall Thickness Before Plating
8. 0.520 Inch Minimum
9. These Diameters (Indexes 11 And 12) Shall Be Concentric With Each Other Within 0.003 Inch FIR
10. This Diameter For The Distance Shown In Index 8. Remainder To be 1.8505 - 1.8600 Inch Diameter
11. 1.944 - 1.954 Inch Diameter
12. 1.8505 - 1.8511 Inch Diameter

R Key To Figure 631

2 Wear in excess of 0.015 inch shall be nickel plated by SPOP 26 and ground to 0.620 - 0.622 inch axial dimension. Then chromium plate by SPOP 22 ensuring a buildup of 0.006 - 0.008 inch followed by a finish grind to 0.614 - 0.618 inch axial dimension.

R 3 For either repair (step 1 or 2), fluorescent penetrant inspect entire support at completion.

R 9. Main Component Drive Gearshaft Upper Bearing Housing (PN 566466
R And 659465)

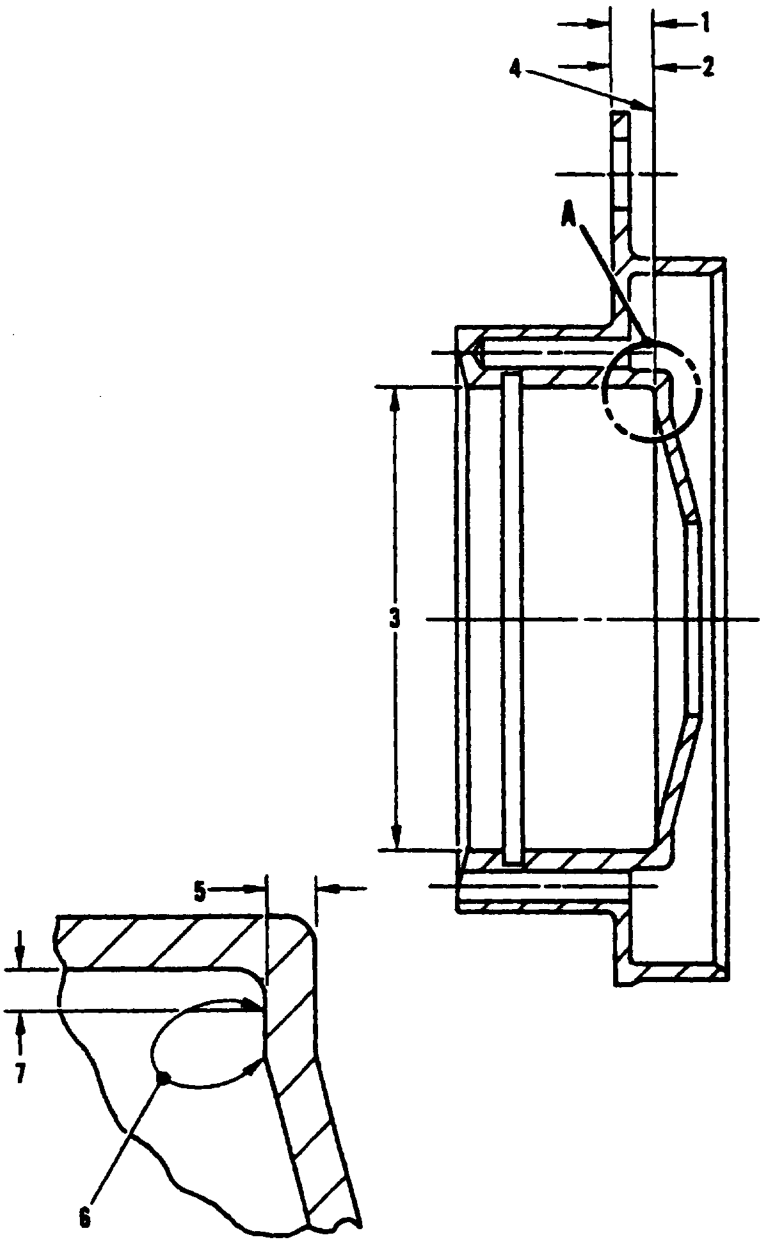
R A. Inspection

R (1) Examine the end faces for wear. Repair wear more than
R 0.003 inch by Repair (if the wall thickness before plate
R will not be less than 0.040 inch).

R B. Repair
R See Figure 632.
(1) Bearing Outer Race Housing End Face Repair

(a) Repair as follows:

1 For wear of 0.015 inch or less, chromium plate by SPOP 22 and bake at 185° - 196°C (365° - 385°F).



Main Component Drive Gearshaft
Upper Bearing Housing
End Face Repair
Figure 632

1. 0.179 - 0.181 Inch Finish Dimension
2. 0.1745 - 0.1755 Inch Finish Dimension After Plate
3. Reference Diameter
4. Surface Must Be Square With Index 3 Diameter 0.002 Inch FIR Maximum
5. 0.040 Inch Minimum Before Plating
6. Plating Area
7. 0.040 - 0.050 Inch

R Key to Figure 632

2 Wear in excess of 0.015 inch shall be nickel-plated in accordance with SPOP 26 and ground to Figure 625, Index 2. Then chromium plate by SPOP 22, 0.006 - 0.008 inch thick and bake at 185°- 196°C (365° - 385°F) for three hours. Finish grind as shown. See Figure 626.

R 3 For either repair (step 1 or 2), do a fluorescent penetrant inspection of the full housing at completion.

R 10. Generator And Starter Bearing Support

A. Bushing Replacement
R (See Tool Group 69) and Figure 633 and Figure 634.

(1) Bore out bushing.

(2) Heat bushing housing and chill bushing. Position on Bearing Bushing Drift and drift into position. Pin bushing in place.

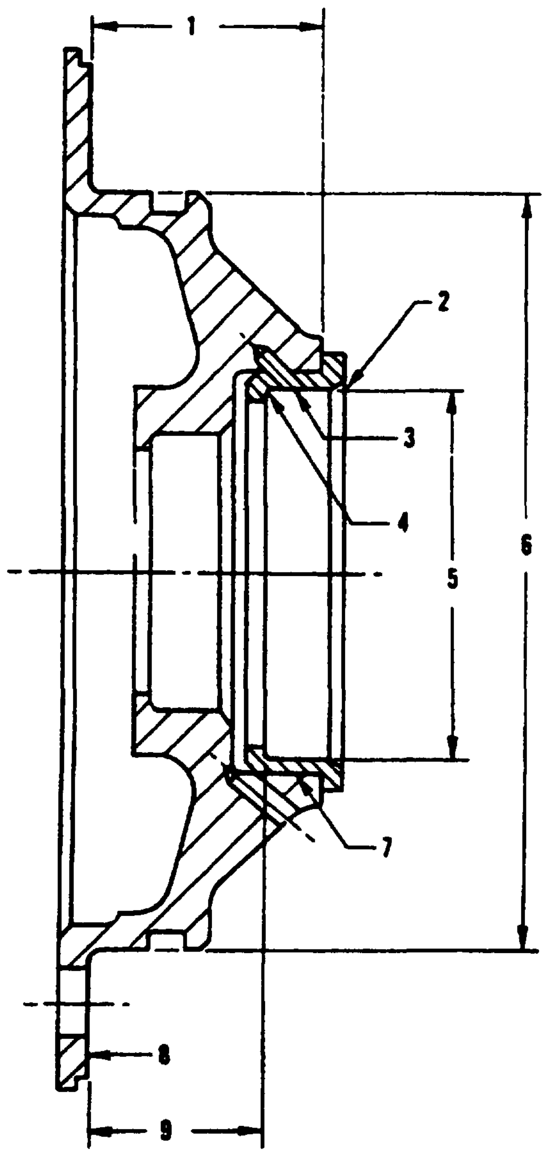
NOTE: Positioning of bushing in housing should be done quickly so that bushing will be seated correctly before temperature change in parts.

(3) Machine bushing to dimensions shown.

R 11. Fuel Control Drive Boss Assembly

A. Bushing Replacement
R (See Tool Group 57) and Figure 635.

(1) Bore out bearing bushing



L-21782 (0000)

Generator and Starter Bearing
Support Assembly
Bushing Replacement
Figure 633

1. 1.358 - 1.362 Inch
2. Chamfer 0.020 - 0.040 Inch x 43° - 47°
3. AN150233 Pin (3). Drill 0.0913 - 0.0933 Inch Diameter Holes To 0.260 - 0.300 Inch Depth
4. 0.015 - 0.024 Inch Radius
5. 2.1655 - 2.1660 Inches. This Diameter Must Be Concentric With Index 6 Diameter 0.001 Inch FIR Maximum And Square With Index 8 Face 0.002 Inch FIR Maximum
6. Reference Diameter
7. PN 432833 Bushing
8. Reference Face
9. 0.998 - 1.002 Inch

R Key to Figure 633

(2) Heat bearing bushing housing, and chill bushing. Position bushing on bushing drift and drift into position. Pin bushing in place.

<u>NOTE</u>: Positioning of bushing in housing should be done quickly so that bushing will be seated correctly before temperature change in parts.

R (3) Machine the bushing to the dimensions shown in the
R figure.

R 12. <u>Component Drive Main Gearbox Housing Cover Assembly</u>
R (See Tool Group 26) and Figure 636.

A. Bushing Replacement

(1) Bore out bearing bushing.

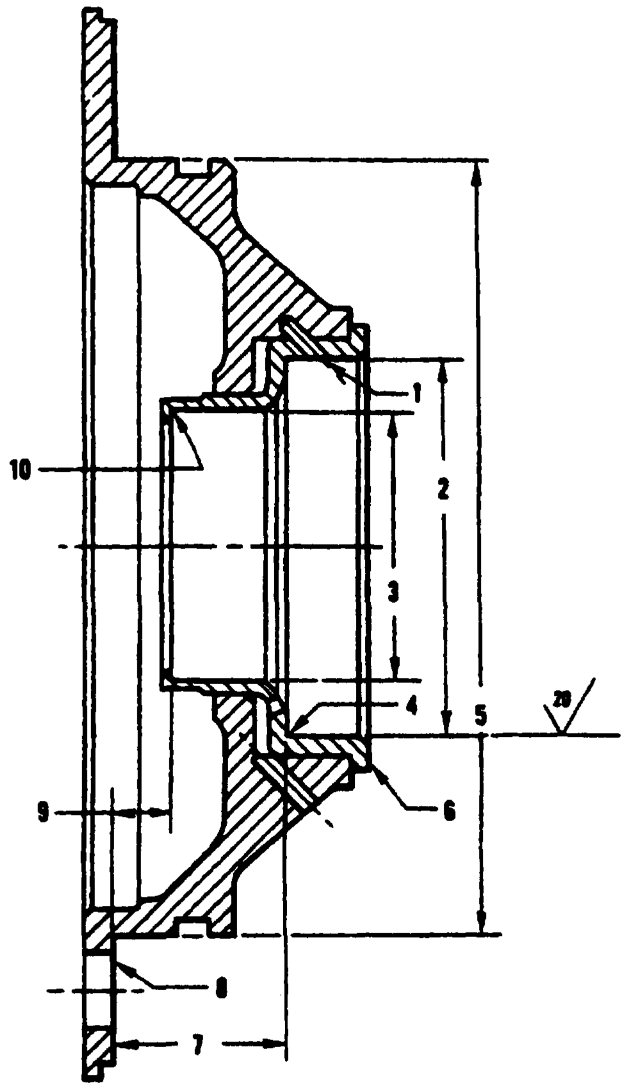
(2) Heat bearing bushing housing, and chill bushing. Position bushing on rear bushing drift and drift into position. Pin bushing in place.

<u>NOTE</u>: Positioning of bushing in housing should be done quickly so that bushing will be seated correctly before temperature change in parts.

R (3) Machine to the dimensions shown in the figure.

B. Corrosion Pitting Epoxy Repair
R See Figure 637.

(1) General



L-23083 (0000)

Generator and Starter
Bearing Support Assembly
Bushing Replacement
(Post-SB 1179)
Figure 634

1. AN150233 Pin (3). Drill 0.0913 - 0.0933 Inch Diameter Holes To 0.260 - 0.300 Inch Depth
2. 2.1655 - 2.1660 Inch Diameter
3. 1.622 - 1.624 Inch Diameter
4. 0.015 - 0.024 Inch Radius
5. Reference Diameter
6. PN 449118 Bushing
7. 0.998 - 1.002 Inch
8. Reference Face
9. 0.349 - 0.357 Inch
10. 0.020 - 0.040 Inch Radius

NOTE: Indexes 2 And 3 Diameters Must Be Concentric With Index 5 Diameter 0.001 Inch FIR Maximum And Square With Index 8 Face 0.002 Inch FIR Maximum.

R Key to Figure 634

(a) For areas of the parent magnesium material that are bare, apply protective treatment as specified in step (2) below.

(b) For minor pitting and corrosion to a maximum depth of 0.010 inch on as-cast surfaces, do the blend repair in step (3) (for light corrosion).

(c) For pitting corrosion to a maximum depth of 0.060 inch on as-cast surfaces, do the epoxy repair in step (4) (heavy corrosion).

(2) Surface Protective Treatment (Local or Full)

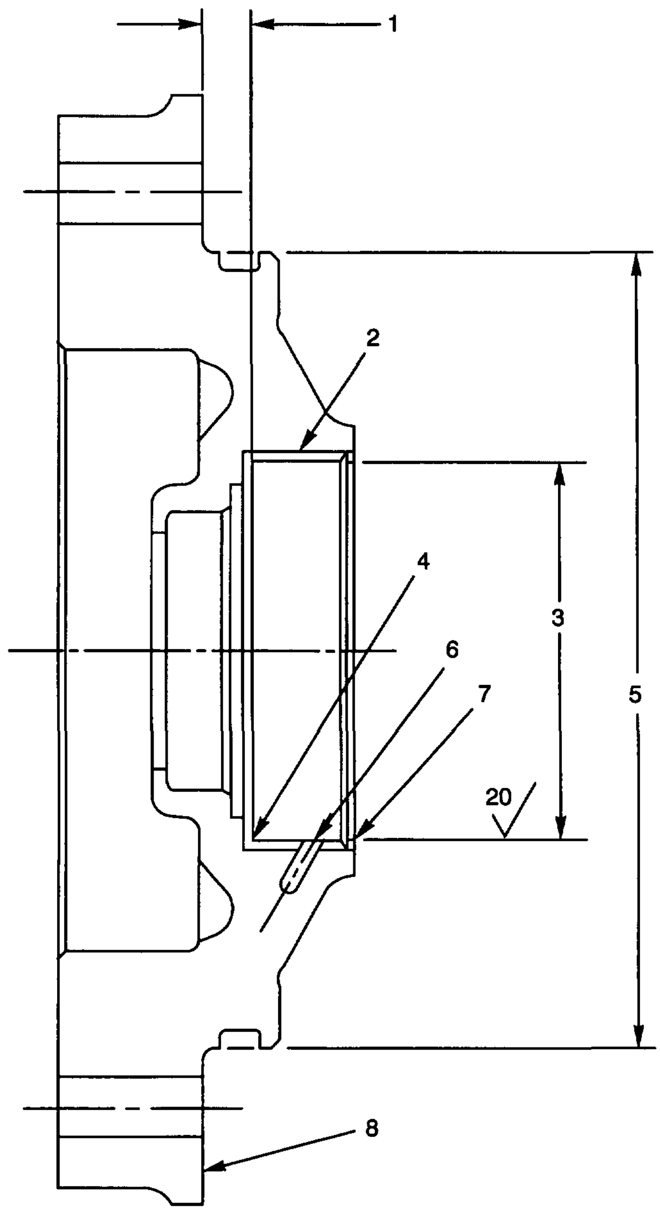
(a) Remove all the old protective treatment by one of these procedures:

1 Remove all paint from the cover by SPOP 260. Refer to Section 70-21-00 in the Standard Practices Manual.

2 Dry plastic blast local or full-part surfaces by SPOP 19. Refer to Section 70-21-00 in the Standard Practices Manual.

NOTE: It will be necessary to remove all blast material from the passages and holes in the cover after the blast procedure.

3 Clean local areas with fine crocus cloth.



L-21779 (0000)
PW V

Fuel Control Drive
Boss Assembly
Bushing Replacement
Figure 635

1. 0.252 - 0.256 Inch
2. PN 432827 Bushing
3. 2.0470 - 2.0475 Inches. This Diameter Must Be Concentric With Diameter 5 Within 0.001 Inch FIR And Square With Face 8.
4. Radius 0.020 - 0.030 Inch Maximum
5. Reference Diameter
6. AN150233 Pin (Three Required); Drill 0.0913 - 0.0933 Inch Diameter Holes To 0.300 - 0.340 Inch Depth
7. Chamfer 0.020 - 0.040 Inch x 43° - 47°
8. Reference Face

R Key To Figure 635

(b) Apply chemical chromate conversion treatment by SPOP 41. Refer to Section 70-44-01 in the Standard Practices Manual.

(c) Apply masks to areas where protective treatment is not permitted (see the figure). Apply the masks immediately before the primer/enamel is applied.

(d) Apply protective treatment to bare metal areas by SPOP 155. Refer to Section 70-41-03 in the Standard Practices Manual.

(3) Minor Blend Repair

(a) Remove minor pitting to a maximum depth of 0.010 inch by SPOP 533. Refer to Section 70-45-00 in the Standard Practices Manual.

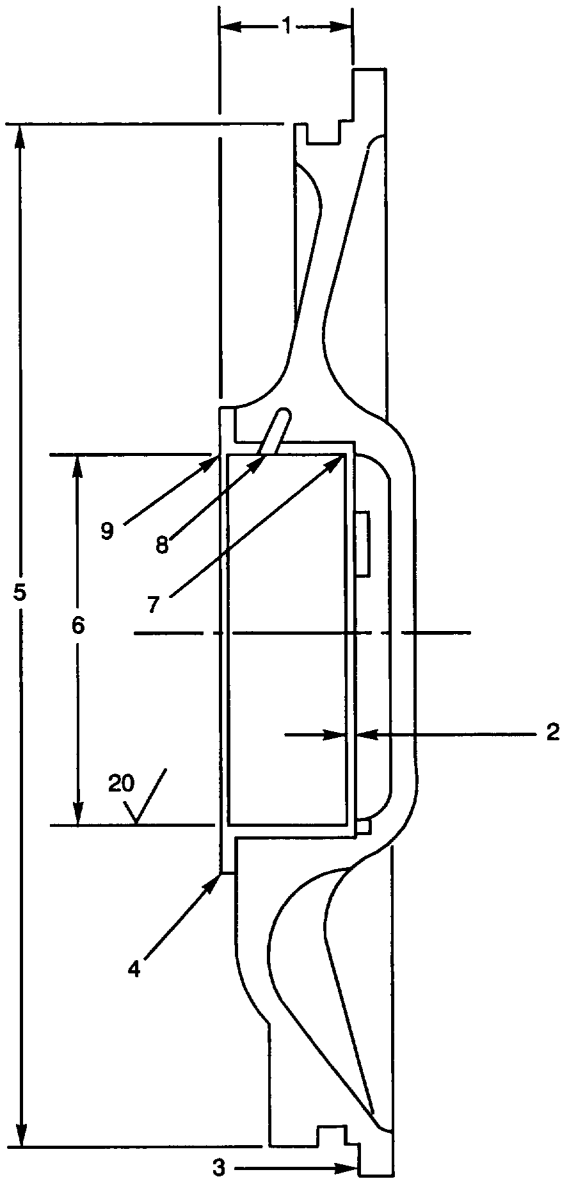
(b) Apply protective treatment to repaired areas as specified in step (1) above.

(4) Epoxy Fill Repair

(a) Repair of pitting and corrosion to a maximum depth of 0.060 inch is permitted if the wall thickness is in limits (refer to the figure). Each repair area must not be more than one square inch.

(b) Apply chromate conversion treatment to the cover by SPOP 41. Refer to Section 70-44-01 in the Standard Practices Manual.

(c) Apply PWA 457 adhesive as follows:



Component Drive Main Gearbox
Housing Cover Assembly
Bushing Replacement
Figure 636

1. 0.745 - 0.755 Inch
2. 0.090 - 0.092 Inch
3. Reference Face
4. PN 432830
5. Reference Diameter
6. 2.4410 - 2.4415 Inches. This Diameter Must Be Concentric With Diameter 5 Within 0.001 Inch FIR And Square With Face 3 Within 0.002 Inch FIR.
7. 0.024 - 0.039 Inch Radius

R 8. AN150233 Pin (3). Drill 0.0913 - 0.933 Inch Diameter Holes To 0.024 - 0.280 Inch Depth

9. Chamfer 0.020 - 0.040 Inch x 43° - 47°

R Key To Figure 636

1 Mix components of PWA 457 as follows:

PWA	Part A	Part B
457-1	100	33
457-2	100	17
457-3	100	17

2 Mix the components fully to a uniform consistency at room temperature.

3 Apply marks to a minimum of three small areas of approximately one-half square inch, in locations without pitting damage. Use these areas during the machining operation below as reference surfaces. If there is pitting all around the cover circumference, apply marks to areas above or below the pitting as applicable.

4 Apply the adhesive to the repair surface with a metal spatula. Apply all of the coating at one time. Move the spatula in one direction only, with sufficient pressure to make sure that all pits are filled. Use the circular sides of a clean rod (one-quarter to one-half inch diameter) to get the same effect in curved cover areas. Do not apply adhesive to areas with reference marks.

5 Cure at 121°C (250°F) for one and one-half hours.

(d) Machine the repaired area back to the initial surface (refer to the reference marks). Apply chromate conversion to machined areas where necessary by step (b) above.

(e) Apply protective treatment as specified in step (2).

R 13. Hydraulic Pump Drive Bearing Support Assembly
R (See Tool Group 70A) and Figure 638.

A. Bushing Replacement

(1) Drill out retaining pin and bore out bushing.

(2) Heat bearing housing and chill housing. Position on drift and drift into position. Drill and pin in place, using the drill jig.

NOTE: Positioning of bushing in housing should be done quickly so that bushing will be seated correctly before temperature change in parts.

R (3) Machine bushing to the dimensions shown in the figure.

R 14. Free Turbine Speed Sensing Flexible Shaft Assembly

A. Inspection

(1) Examine the flexible shaft casing for cut, broken, or torn braids. Scrap casing if any of these conditions exist.

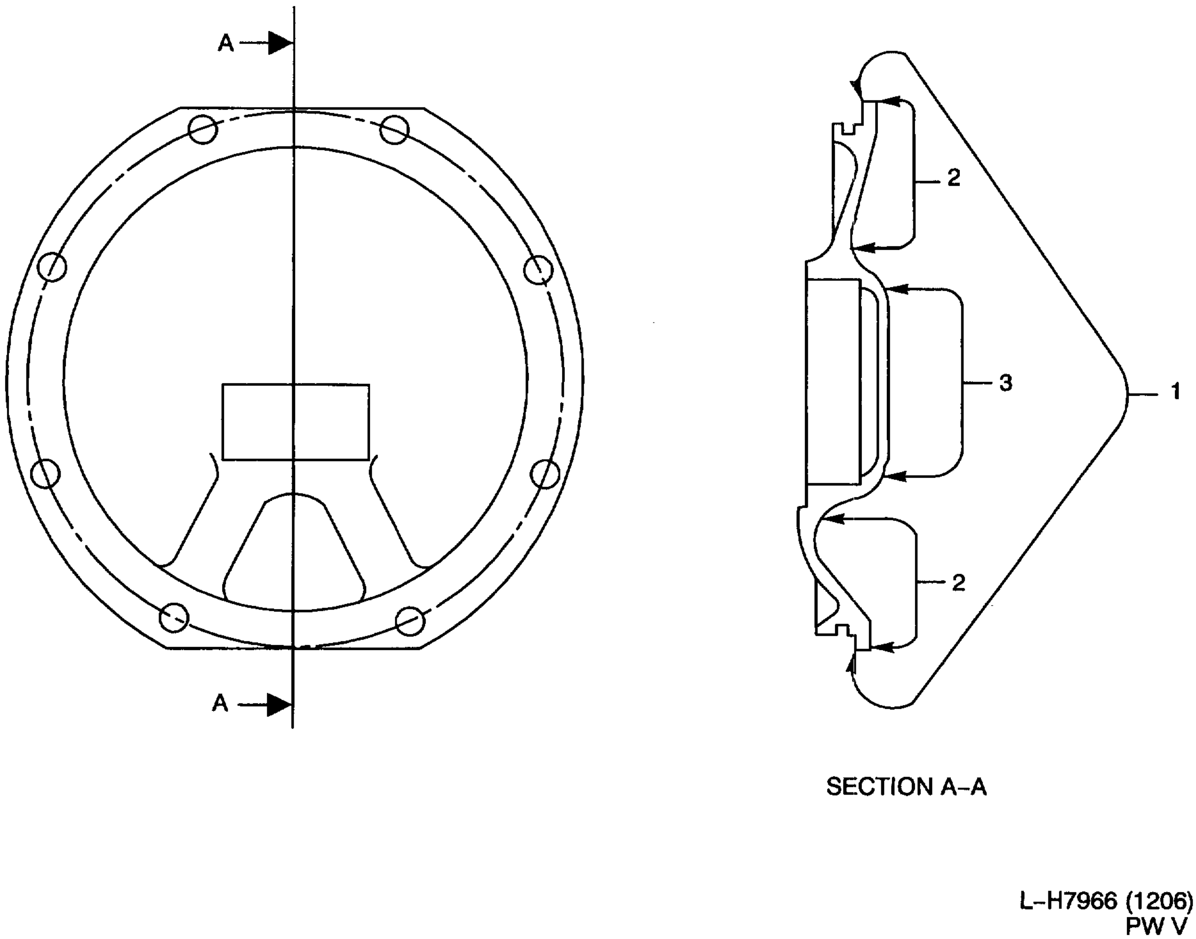
(2) Examine the rivet attaching core to gearbox gearshaft to ensure there is no obvious severe wear of rivet or rivet hole. Inspect rivet for proper crimping.

(3) Examine the core for:

(a) Severe twisting or unwinding of core.

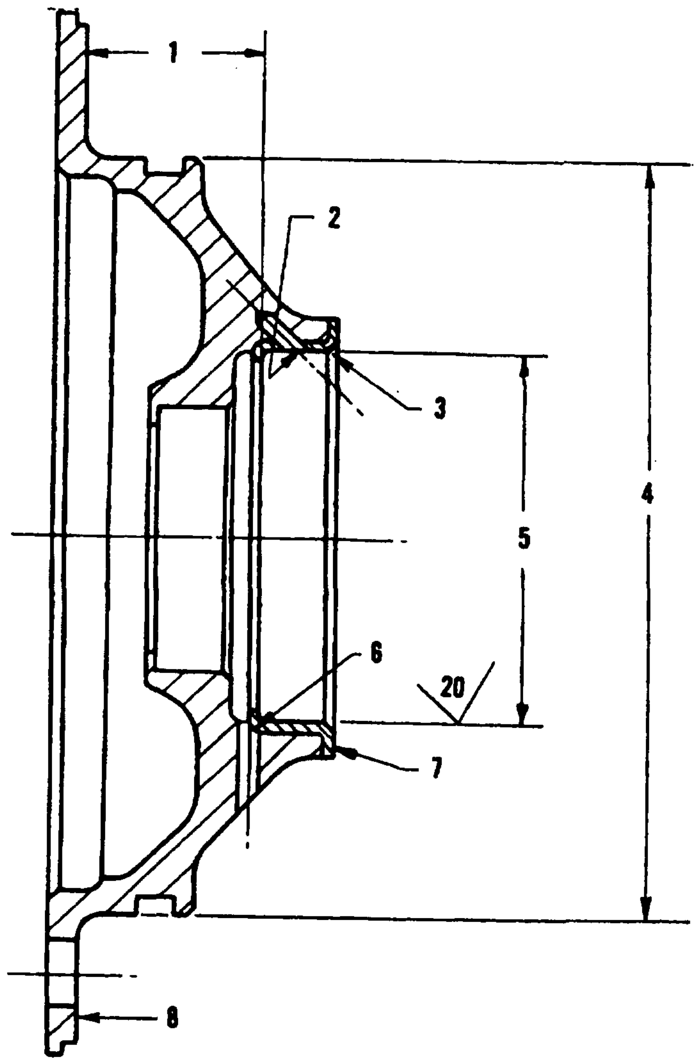
1 Separations or gaps at every 12 - 15 turns is acceptable.

(b) Flat or worn spots on outer surface of core must not be more than 0.030 inch width on one strand.



1. Apply Protective Treatment To This Area
2. Wall Thickness At All Locations In This Area Must Be More Than 0.130 Inch Before Repair
3. Wall Thickness At All Locations In This Area Must Be More Than 0.094 Inch Before Repair

Main Gearbox Cover
Protective Treatment
Figure 637



L-21785 (0000)

Hydraulic Pump Drive
Bearing Support Assembly
Bushing Replacement
Figure 638

1. 0.815 - 0.819 Inch Depth
2. AN150233 Pin (3). Drill 0.0913 - 0.0933 Inch Diameter Pin Holes To 0.0260 - 0.300 Inch Depth
3. Chamfer 0.020 To 0.040 Inch x 43° - 47°
4. Reference Diameter
5. 2.1649 - 2.1656 Inch Diameter. Must Be Concentric With Index 4 Diameter 0.001 Inch FIR Maximum And Square With Index 8 Face 8 0.002 Inch FIR Maximum
6. 0.024 - 0.039 Inch Radius
7. PN 432822 Bushing
8. Reference Face

R Key to Figure 638

1 Wear on individual strands of core can also be measured by determining wear depth (this must not be more than 0.0165 inch).

NOTE: While measuring this core strand wear, be sure that the wires are not worn below maximum flat width (radius).

(c) Maximum square drive end wear limits are 0.090 inch at gearbox end (0.250 inch square) and 0.100 inch at control end (0.200 inch square). See
R Figure 639.

(d) Examine the square drive of the core for bend as
R follows (see Figure 640):

1 Position shaft as shown in illustration.

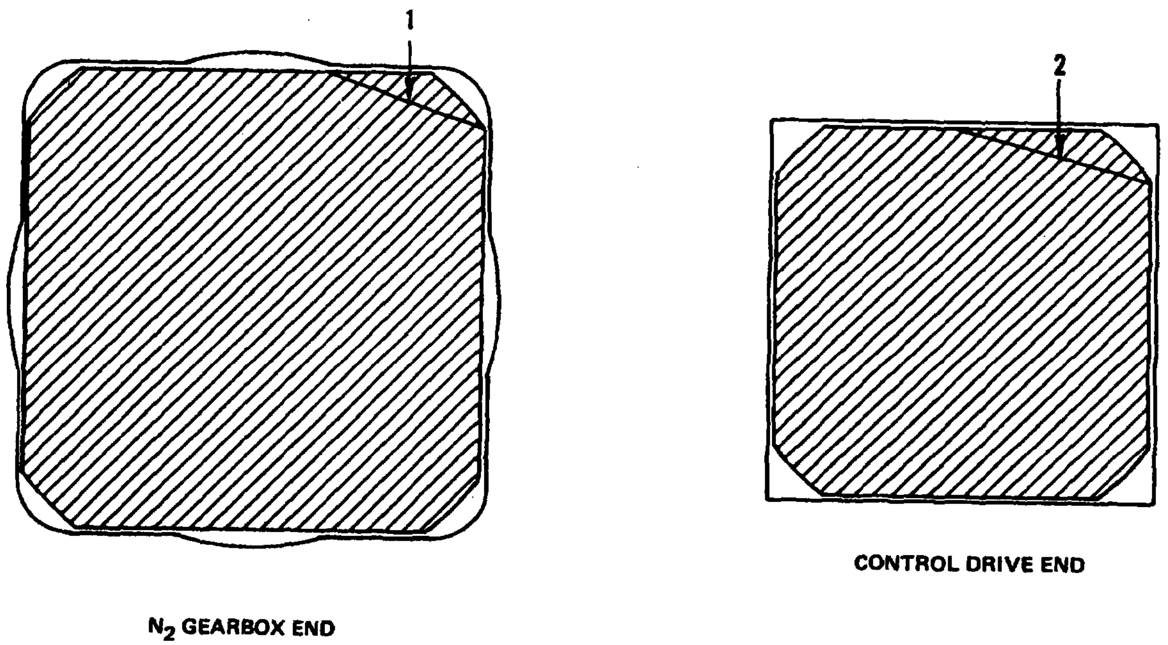
2 Measure Distances 1 and 2 and record.

3 Subtract smaller distance from larger. Maximum allowable bend is 0.031 inch. If core end is in excess of limit, core shall be scrapped.

4 Rotate square drive end 90 degrees. Repeat steps 2 and 3.

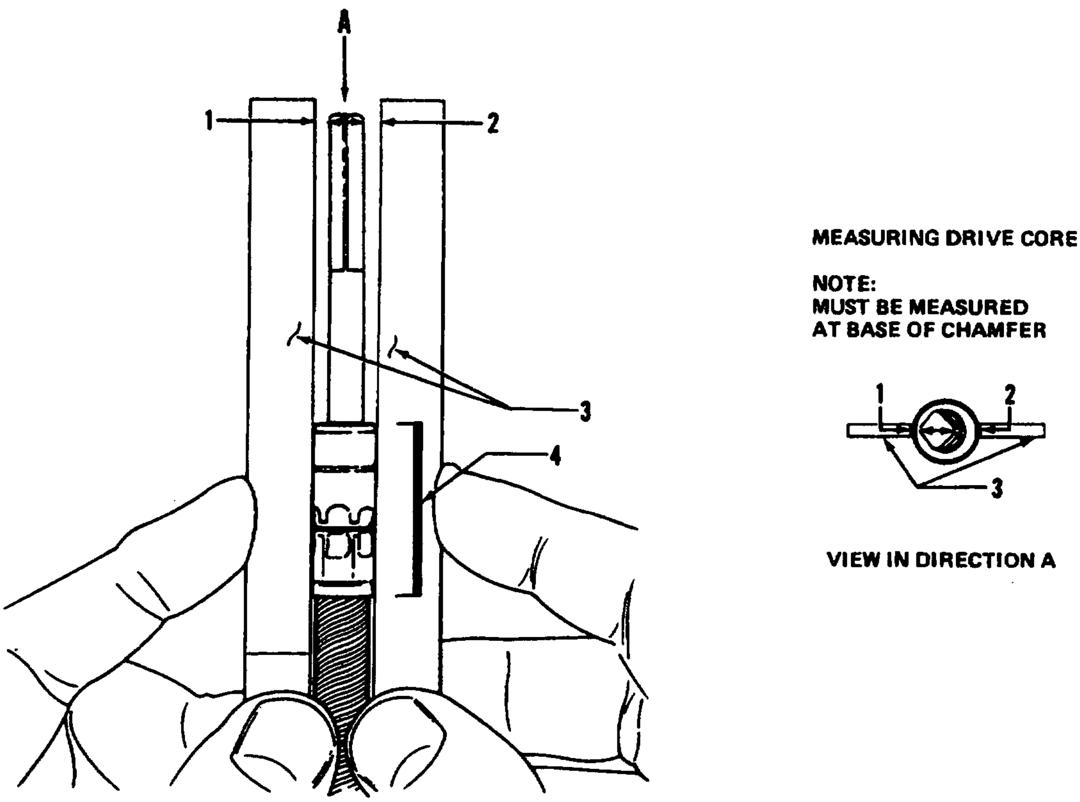
(4) A casing can be reused once after its core is rejected. Make a mark on a casing to show that it has a second core. If this second core is rejected, reject the casing. Make casing marks as follows:

(a) New casing with acceptable core: mark as Cycle No. 1.



1. Flat, 0.090 Inch
2. Flat, 0.100 Inch

Free Turbine Speed Sensing
Flexible Shaft Inspection
Figure 639



L-35633 (0000)

1. 0.031 Inch Maximum Bend From Centerline Of Square Drive
2. 0.031 Inch Maximum Bend From Centerline Of Square Drive
3. Straight Edge
4. Straight Edges Contacting End Fitting At 2 Maximum Diameter Sections Of Fitting, Each Side

Free Turbine Speed Sensing
Flexible Shaft Inspection
Figure 640

(b) Casing with Cycle No. 1 mark with first unacceptable core: mark as Cycle No. 2.

(c) Casing with Cycle No. 2 mark with unacceptable core: replace the casing.