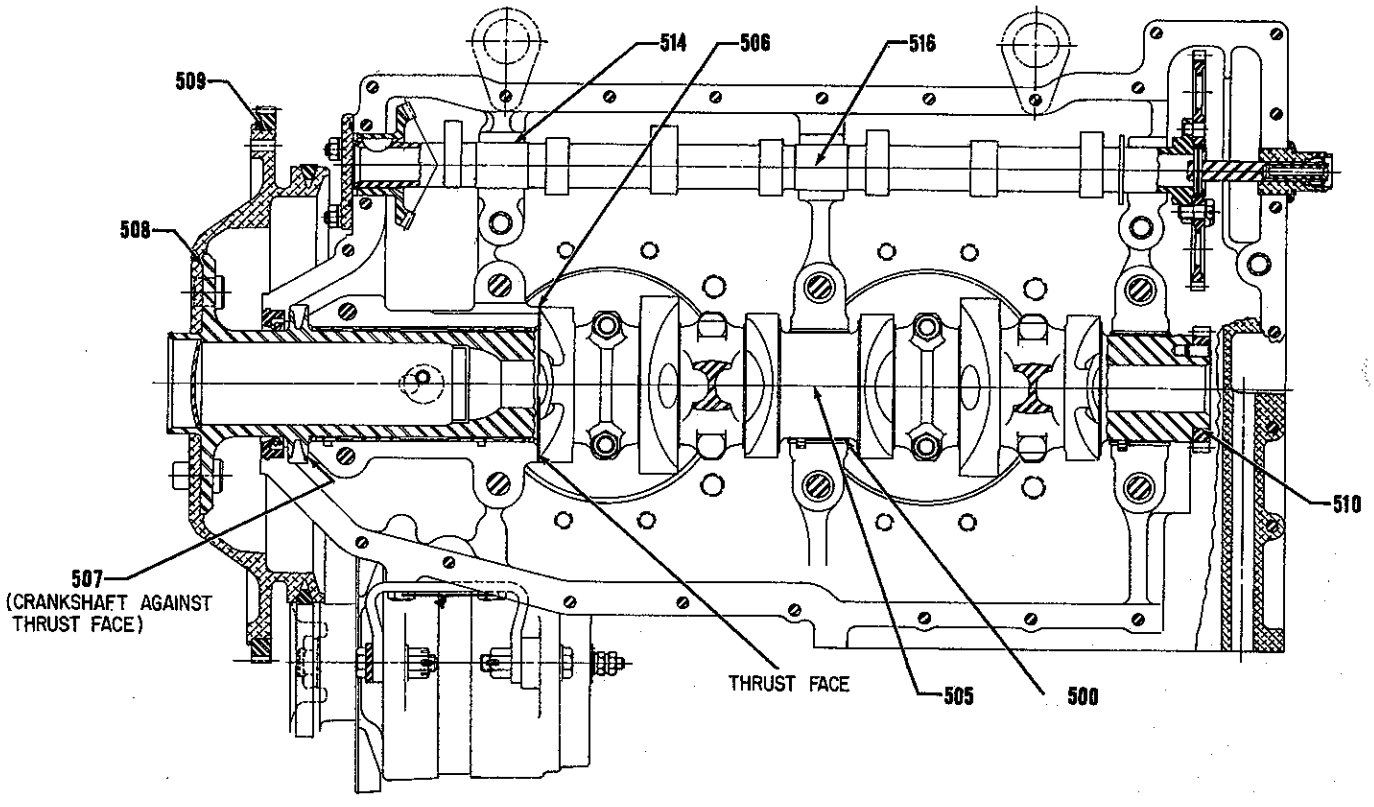
SERVICE TABLE OF LIMITS

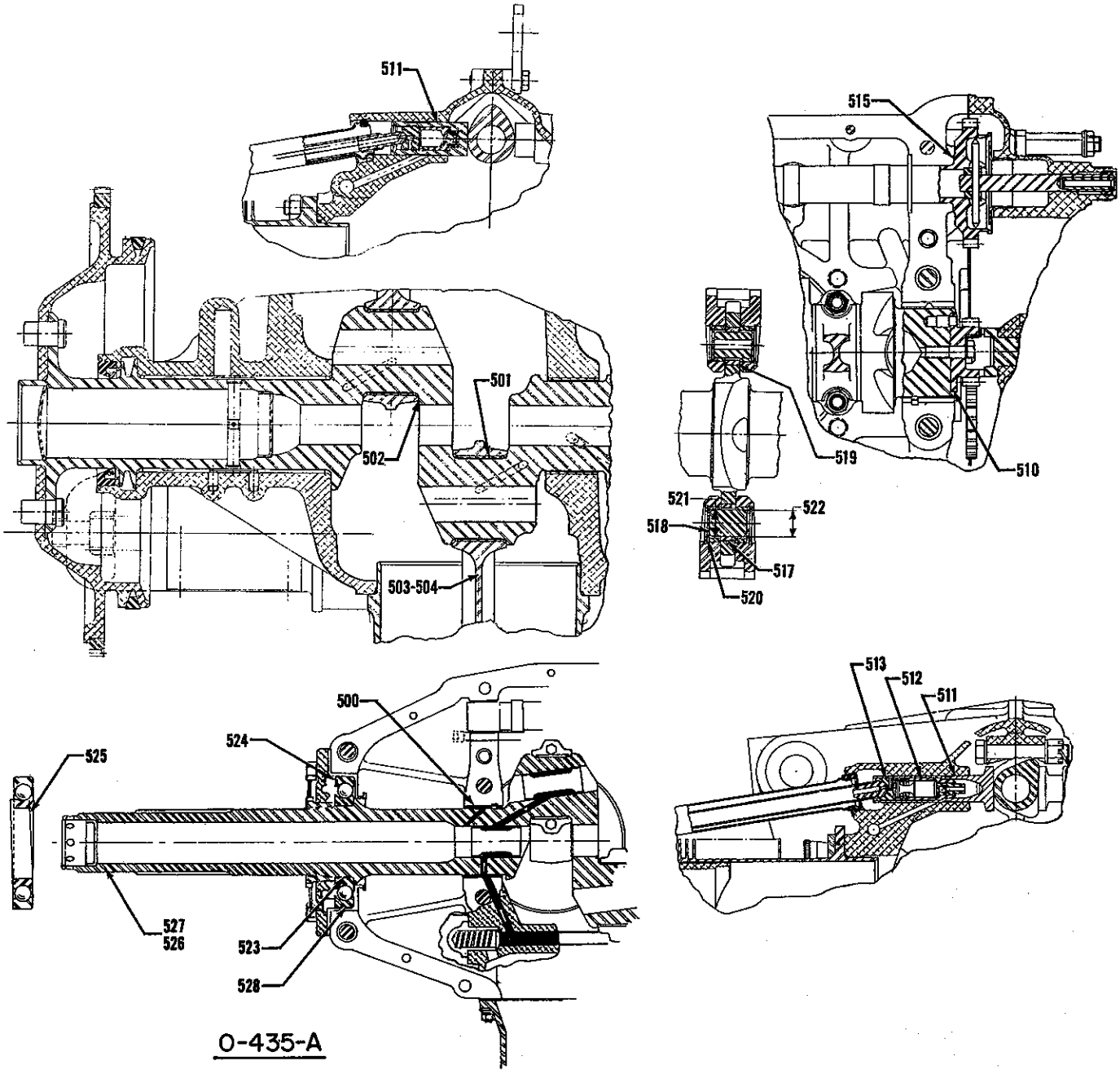
PART 1 DIRECT DRIVE ENGINES

SECTION I CRANKCASE, CRANKSHAFT, CAMSHAFT

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
522	774	ALL (AS APPLICABLE)	O.D. of Counterweight Roller (See latest edition of Service Instruction No. 1012)				
523	503	D	Thrust Bearing and Propeller Shaft			.0000 / .0012L	.002L
524	509	D	Thrust Bearing and Thrust Bearing Cap Clamp Fit (Shim to this Fit)			.003T / .005T	(A)
525	565	D	Thrust Bearing Tilt		.027 Tilt		
526	505	D	Crankshaft Run-Out - Rear Cone Location				.003
527	506	D	Crankshaft Run-Out - Front Cone Location				.007
528	508	D	Thrust Bearing and Thrust Bearing Cage			.0016L / .0034L	.0045L



Longitudinal Section Thru Engine



Crankcase, Crankshaft, Camshaft and Related Parts

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions Mfr. Min. & Max.	Dimensions Serv. Max.	Clearances Mfr. Min. & Max.	Clearances Serv. Max.
600	510	ALL	Connecting Rod and Connecting Rod Bushing	Bushing To Be Burnished in Place			
		ALL	Finished I.D. of Connecting Rod Bushing	1.1254 / 1.1262			
601	510	A-B-D-G-J-BD	Length Between Connecting Rod Bearing Centers	6.4985 / 6.5015			
		S-T-Y-AF-BE	Length Between Connecting Rod Bearing Centers	6.7485 / 6.7515			
602	511	ALL	Connecting Rod Bushing and Piston Pin			.0008L / .0021L	.0025L
603	512	ALL	Piston Pin and Piston			.0003L / .0014L	.0018L
		ALL	Diameter of Piston Pin Hole in Piston	1.1249 / 1.1254			
		ALL	Diameter of Piston Pin	1.1241 / 1.1246			
604	513	A-G-J-S-T-AF-BD-BE	Piston and Piston Pin Plug			.0002L / .0010L	.002L
		A-G-J-S-T-AF-BD-BE	*Diameter of Piston Pin Plug	1.1242 / 1.1247			
605	513	B-D-G-J-S-T-Y-AF	Piston Pin and Piston Pin Plug (Optional)			.0005L / .0025L	.005L
		G-J-S-T-Y-AF	*Diameter of Piston Pin Plug	.5655 / .5665			
		B-D	Diameter of Piston Pin Plug (Thin Wall Pin)	.8405 / .8415			
		*See latest edition of Service Instruction No. 1267.					
606	514	A-B	Piston Ring and Piston - Side Clearance (Top Ring Comp.) (Plain) Full Wedge			.000 / .004L	.006L(B)
		B-D	Piston Ring and Piston - Side Clearance (Top Ring Comp.) (Chrome) Full Wedge			.0025L / .0065L	.008L(B)
		G-J-S-T-Y-AF-BD-BE	Piston Ring and Piston - Side Clearance (Top Ring Comp.) Half Wedge			.0025L / .0055L	.008L(B)
606	515	B	Piston Ring and Piston - Side Clearance (2nd Ring Comp.) (Chrome) Full Wedge			.0025L / .0065L	.008L(B)
		A-B-D-G-J-S-T-Y-AF-BD-BE	Piston Ring and Piston - Side Clearance (2nd Ring Comp.) Full or Half Wedge			.000 / .004L	.006L(B)
		J	Piston Ring and Piston - Side Clearance (3rd Ring Comp.) Half Wedge			.000 / .004L	.006L(B)
606	516	ALL	Piston Ring and Piston - Side Clearance (Oil Regulating)			.002L / .004L	.006L(B)

SERVICE TABLE OF LIMITS

PART 1 DIRECT DRIVE ENGINES

SECTION II CYLINDERS

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions Mfr. Min. & Max.	Dimensions Serv. Max.	Clearances Mfr. Min. & Max.	Clearances Serv. Max.
606	617	A	Piston Ring and Piston - Side Clearance (Bottom)			.003L / .0055L	.007L(B)
607	615	ALL	Piston Ring Gap (Compression) Plain and Chrome Cylinders (Straight Barrels)			.020 / .030	.047
		ALL	Piston Ring Gap (Compression) Nitrided and Chrome Cylinders (Choke Barrels)			.045 / .055	.067
		ALL	Piston Ring Gap (Oil Regulating) (All Barrels)			.015 / .030	.047
		A-T2	Piston Ring Gap (Oil Scraper) (All Barrels)			.015 / .030	.047

For Choke Barrels - Ring gap is measured within 4 inches from bottom. Ring gap at top of travel must not be less than .0075.

For all Other Barrels - Ring gap is measured at top limit of ring travel.

		Engine and Piston Application		Min. Piston Diameter			Cylinder Barrel		
		Engine Chart Code Letter	Piston Number	Top	Bottom	Type of Piston	Type of Surface	Maximum Diameter	Max. Clearance Piston Skirt & Cyl.
608	619	A	61147, 73851	4.3470	4.3555	Cast-Round	P	4.3795	.021L
608	622		61333	4.3470	4.3555	Forged-Round	P	4.3795	.021L
609	620		LW-11621*, LW-13623*	4.3290	4.3605	Cast-Cam	N	4.3805	.018L
610	621	B	69841*, 69958, 70396	4.8290	4.8620	Cast-Cam	P - C	4.8805	.018L
		D	69958	4.8290	4.8620	Cast-Cam	P	4.8805	.018L
		G,S,T	73196, 74059, 75413	5.0790	5.1090	Cast-Cam	P-C-N	5.1305	.018L
		G	69337	5.0790	5.1090	Forged-Cam	P - C	5.1305	.018L
		J,S,Y,T	71594*, 72967*, 74530*, 75089*	5.0790	5.1090	Cast-Cam	P-C-N	5.1305	.018L
		B D	LW-15357*	5.0790	5.1090	Cast-Cam	N	5.1305	.018L
		S,T,AF	73264*, 75617*, 76966, 78203*, LW-10207*, LW-13358*, LW-14610*, LW-11487*, LW-10545	5.0790	5.1090	Forged-Cam	N - C	5.1305	.018L
		T	LW-13396*	5.0790	5.1090	Cast-Cam	N	5.1305	.018L

NOTES:

To find the average diameter of cylinder in an area 4" above bottom of barrel: First, measure diameter at right angles from plane in which valves are located. Second, measure diameter through the plane in which valves are located. Add both diameters; this sum, divided by 2, represents the average diameter of the cylinder.

*=High Compression.

Cylinder Barrel: P=plain steel, N=nitride hardened, C=chrome plated.

To find the average out-of-round, measure diameter of cylinder in an area 4" above bottom of barrel: First, measure diameter at right angles from plane in which valves are located. Second, measure diameter through the plane in which valves are located. Difference between diameters must not exceed .0045 inch.

Maximum taper and out-of-round permitted for cylinder in service is .0045 inch.

See Service Instruction No. 1243 for identification of cast and forged pistons. The suffix "S" that will be found with the part number on 76966, 78203, LW-10207, LW-10545, LW-11487, LW-13358, LW-14610 pistons indicates the piston weight is within the limits specified for any group of pistons and may be substituted for any like piston on a particular engine. Other pistons are manufactured within weight limits that do not require any weight controlled piston for replacement.

Piston diameter at top is measured at top ring land (between top and second compression ring grooves) at right angle to piston pin hole; diameter at bottom of piston is measured at the bottom of the piston skirt at right angles to the piston pin. See Service Instruction No. 1243 for illustration.

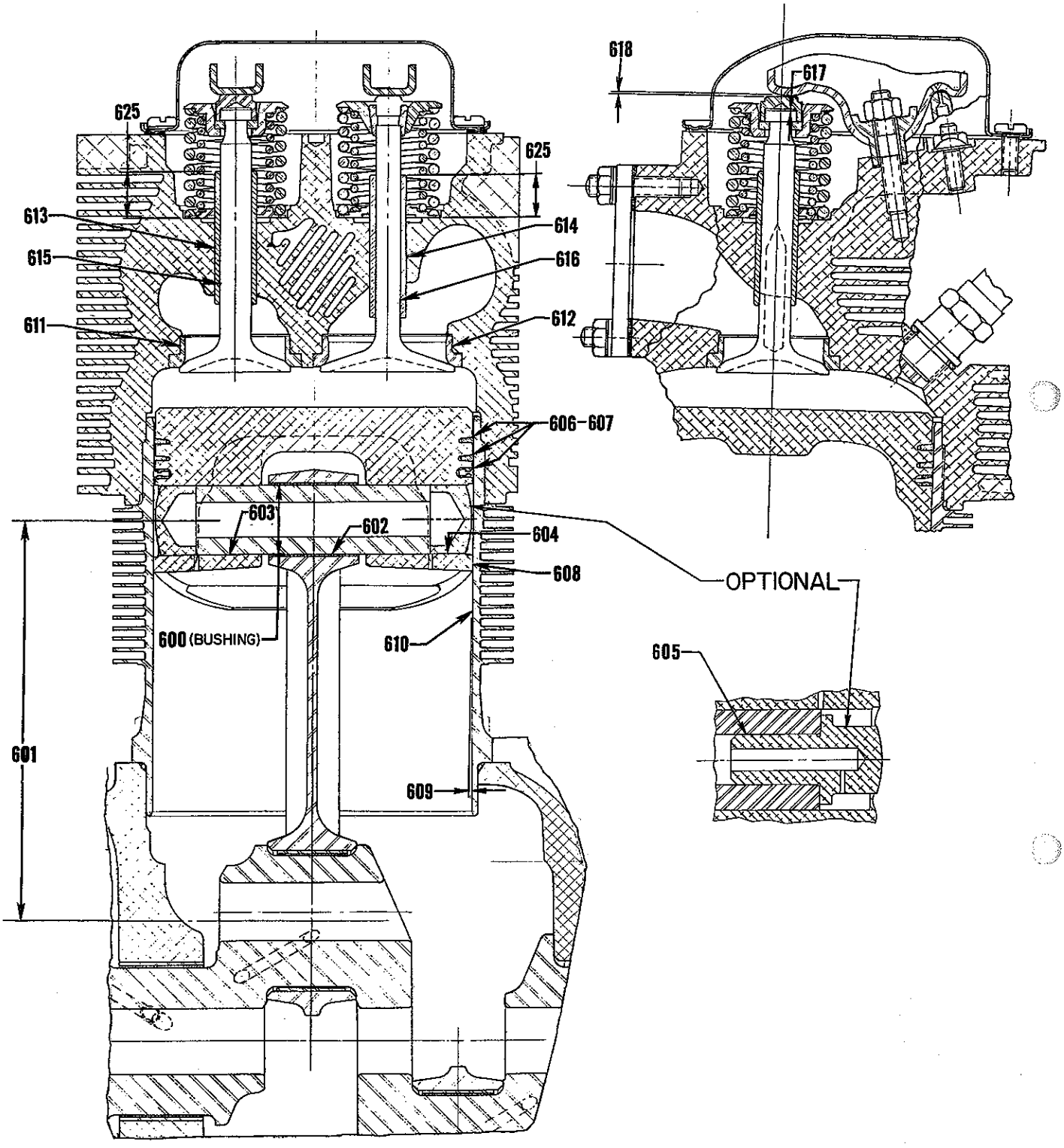
Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
611	523	A	Exhaust Valve Seat and Cylinder Head			.0065T / .010T	(A)
		B-D-G-J-S-T-Y-BD-BE	Exhaust Valve Seat and Cylinder Head			.0045T / .008T	(A)
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Exhaust Valve Seat and Cylinder Head			.0075T / .011T	(A)
		A	O.D. Exhaust Seat	2.0025 / 2.004			
		B-D-G-J-S-T-Y-BD-BE	O.D. Exhaust Seat	1.7395 / 1.741			
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	O.D. Exhaust Seat	1.9355 / 1.937			
		A	I.D. Exhaust Seat Hole in Cylinder Head	1.994 / 1.996			
		B-D-G-J-S-T-Y-BD-BE	I.D. Exhaust Seat Hole in Cylinder Head	1.733 / 1.735			
611	523	S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Exhaust Seat Hole in Cylinder Head	1.926 / 1.928			
612	524	A	Intake Valve Seat and Cylinder Head			.0070T / .0105T	(A)
		B-D-G-J-S-T-Y-AF-BD-BE	Intake Valve Seat and Cylinder Head			.0065T / .010T	(A)
		A	O.D. Intake Seat	2.0965 / 2.0975			
		A1-B-D	O.D. Intake Seat	1.9265 / 1.928			
		B1-C-J-S-T-Y-BD-BE	O.D. Intake Seat	2.0815 / 2.083			
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	O.D. Intake Seat	2.2885 / 2.290			
		A	I.D. Intake Seat Hole in Cylinder Head	2.087 / 2.089			
		A1-B-D	I.D. Intake Seat Hole in Cylinder Head	1.918 / 1.920			
		B1-G-J-S-T-Y-BD-BE	I.D. Intake Seat Hole in Cylinder Head	2.073 / 2.075			
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	I.D. Intake Seat Hole in Cylinder Head	2.280 / 2.282			
613	526	ALL	Exhaust Valve Guide and Cylinder Head			.001T / .0025T	(A)
613	527	A-B-D-G-J	O.D. Exhaust Valve Guide	.5933 / .5938			

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions Mfr. Min. & Max.	Dimensions Serv. Max.	Clearances Mfr. Min. & Max.	Clearances Serv. Max.
613	527	Y	O.D. Exhaust Valve Guide	.6267 / .6272			
		G-J-S-T-AF-BD-BE	O.D. Exhaust Valve Guide	.6633 / .6638			
		S1	O.D. Exhaust Valve Guide	.6953 / .6958			
		A-B-D-J	I.D. Exhaust Valve Guide Hole in Cylinder Head	.5913 / .5923			
613	527	Y	I.D. Exhaust Valve Guide Hole in Cylinder Head	.6247 / .6257			
		G-J-S-T-AF-BD	I.D. Exhaust Valve Guide Hole in Cylinder Head	.6613 / .6623			
		S1	I.D. Exhaust Valve Guide Hole in Cylinder Head	.6933 / .6943			
614	527	ALL	Intake Valve Guide and Cylinder Head			.0010T / .0025T	
		ALL	O.D. Intake Valve Guide	.5933 / .5938			
		ALL	I.D. Intake Valve Guide Hole in Cylinder Head	.5913 / .5923			
615	528	A-B-D	Exhaust Valve Stem and Valve Guide			.0020L / .0038L	(A)
		A1-G-J-S-T-BD-BE	Exhaust Valve Stem and Valve Guide (Parallel Valve Heads)			.0040L / .0060L	(A)
		Y	Exhaust Valve Stem and Valve Guide			.0035L / .0053L	(A)
		S1-S2-S3-S5-S6-T2-T3-AF	Exhaust Valve Stem and Valve Guide (Angle Valve Heads)			.0037L / .0050L	(A)
		S7-S9-S10	Exhaust Valve Stem and Valve Guide (Angle Valve Heads - Helicopter)			.0035L / .0055L	(A)
		A-B-D	O.D. Exhaust Valve Stem	.4012 / .4020			
		A1	O.D. Exhaust Valve Stem	.4320 / .4333			
		G-J-Y	O.D. Exhaust Valve Stem	.4332 / .4340			
		G-J-S-T-BD-BE	O.D. Exhaust Valve Stem (Parallel Valve Heads)	.4935 / .4945	.4915		
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	O.D. Exhaust Valve Stem (Angle Valve Heads)	.4955 / .4965	.4937		

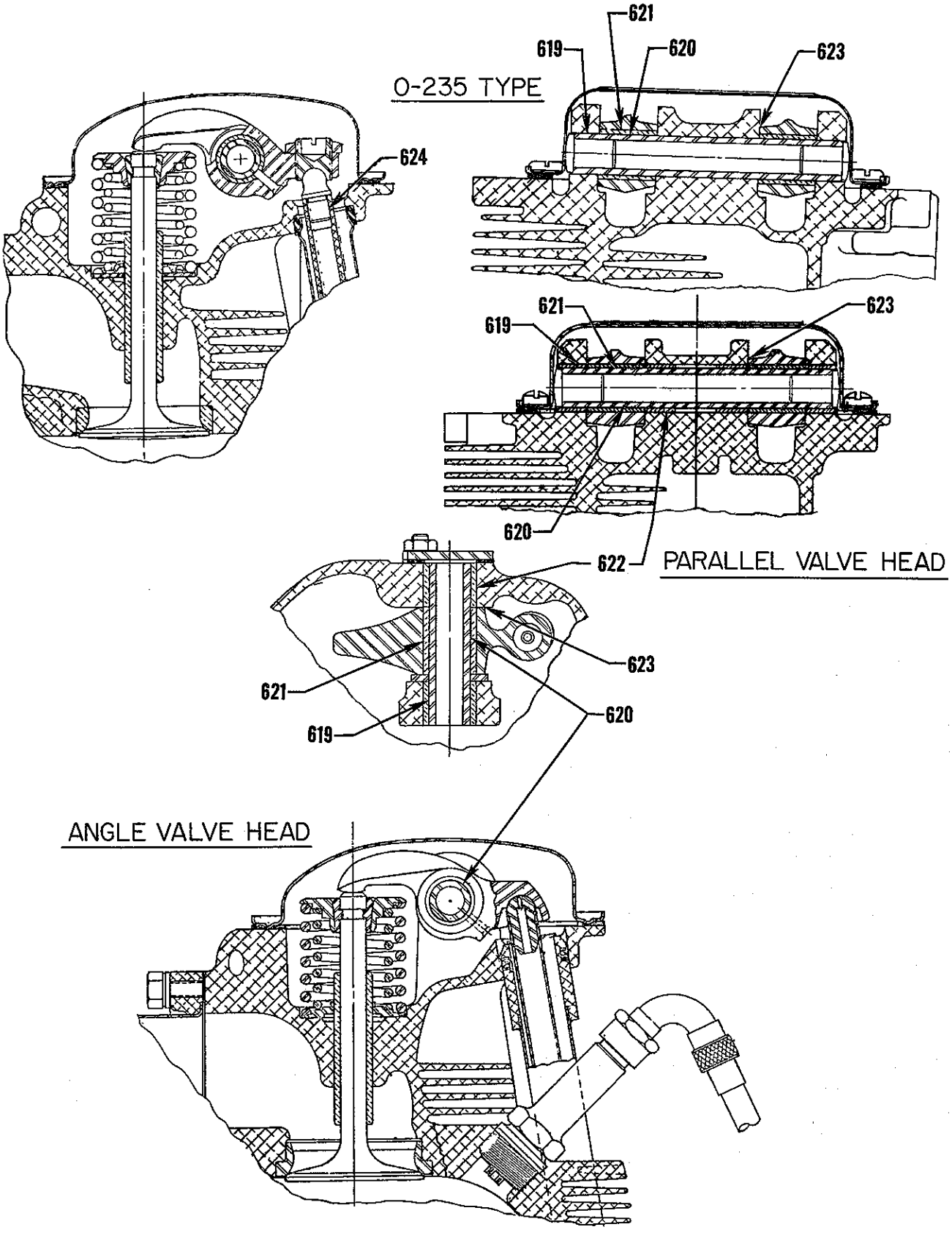
Service allowable limits of .4937 or .4915 is applicable only to inconel or nimonic valves.

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
615	527	A-B-D	Finished I.D. Exhaust Valve Guide	.4040 / .4050			
		A1-G-J	Finished I.D. Exhaust Valve Guide	.4370 / .4380			
		Y	Finished I.D. Exhaust Valve Guide	.4375 / .4385			
		G-J-S-T-BD-BE	Finished I.D. Exhaust Valve Guide (Parallel Valve Heads)	.4985 / .4995			
		S1-S2-S3-S5-S6-T2-T3-AF	Finished I.D. Exhaust Valve Guide (Angle Valve Heads)	.4995 / .5005			
		S7-S9-S10	Finished I.D. Exhaust Valve Guide (Angle Valve Heads - Helicopter)	.5000 / .5010			
		1/2 inch diameter exhaust valves may have exhaust valve guides that are .003 in. over the maximum inside diameter limit, anytime up to 300 hours of service. After 300 hours of service, inside diameter of exhaust valve guide may increase .001 in. during each 100 hours of operation up to the recommended overhaul time for the engine, or not to exceed .015 inch over the basic I.D. See latest edition of Service Instruction No. 1009 for recommended overhaul time.					
616	529	ALL	Intake Valve Stem and Valve Guide			.0010L / .0028L	.006L
		ALL	O.D. Intake Valve Stem	.4022 / .4030	.4010		
616	527	ALL	Finished I.D. Intake Valve Guide	.4040 / .4050			
617	951	ALL	Intake and Exhaust Valve and Valve Cap Clearance (Rotator Type Small Dia. Head)			.000 / .004L	.005L
618	952	A-B	Solid Tappet Clearance (After Engine in Run)			.006 / .012	
		G-D-J-S-T-Y-AF-BD-BE	Dry Tappet Clearance			.028 / .080	
619	530	A	Valve Rocker Shaft and Cylinder Head (No Bushing)			.0001L / .0013L	.0025L
619	611	B-D-J-S-T-Y	Valve Rocker Shaft and Valve Rocker Bushing (Parallel Valve Heads)			.0001L / .0013L	.0025L
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Valve Rocker Shaft and Valve Rocker Bushing (Angle Valve Heads)			.0001L / .0013L	.0025L
619	530	A	Finished I.D. of Valve Rocker Shaft Bores in Cylinder Head (No Bushings)	.6246 / .6261	.6270		
619	611	B-D-G-J-S-T-Y	Finished I.D. of Valve Rocker Shaft (Bushing) in Cylinder Head (Parallel Valve Heads)	.6246 / .6261	.6270		

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
619	611	S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Finished I.D. of Valve Rocker Shaft (Bushing) in Cylinder Head (Angle Valve Heads)	.6246 / .6261	.6270		
620	531	ALL	Valve Rocker Shaft and Valve Rocker Bushing			.0007L / .0017L	.004L
		ALL	Finished I.D. of Rocker Arm Bushing	.6252 / .6263	.6270		
		ALL	O.D. Valve Rocker Shaft	.6241 / .6245	.6231		
621	532	ALL	Valve Rocker Bushing and Valve Rocker	Bushing Must Be Burnished In Place			
622	612	ALL	Valve Rocker Shaft Bushing and Cylinder Head			.0022T / .0038T	(A)
		ALL	Valve Rocker Shaft Bushing Hole in Cylinder Head	.7380 / .7388			
623	533	A-B-D-G-J-Y-S-T	Valve Rocker and Cylinder Head - Side Clearance (Parallel Valve Heads)			.005L / .013L	.016L
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Valve Rocker and Cylinder Head - Side Clearance (Angle Valve Heads)			.002L / .020L	.024L
624	535	A-B-J	Push Rod and Ball End			.0005T / .0025T	(A)
625	971	A	Intake and Exhaust Valve Guide Height	.705 / .725			
		ALL	Intake Valve Guide Height (Parallel Valve Heads)	.705 / .725			
		ALL EXCEPT 0-235	Exhaust Valve Guide Height (Parallel Valve Heads)	.765 / .785			
		ALL	Intake and Exhaust Valve Guide Height (Angle Valve Heads)	.914 / .954			
			MEASURE VALVE GUIDE HEIGHT FROM THE VALVE SPRING SEAT COUNTERBORE IN THE CYLINDER HEAD TO THE TOP OF VALVE GUIDE.				



Cylinder, Piston and Valve Components



Cylinder, Piston and Valve Components

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
700	545	ALL	Oil Pump Drive Shaft and Oil Pump Body or Cover			.0010L / .0025L	.004L
701	601	A-B-D-G-J-S-T-AF	Oil Pump Drive Shaft and and Accessory Housing			.0015L / .0030L	.006L
		Y	Oil Pump Drive Shaft and Accessory Case			.0015L / .0030L	.006L
		BD-BE	Oil Pump Drive Shaft and Crankcase			.0010L / .0025L	.004L
702	980	S-T-AF (DUAL MAGNETO)	Oil Pump Drive Shaft - End Clearance			.015L / .050L	.065L
		BD-BE	Oil Pump Drive Shaft - End Clearance			.017L / .037L	.047L
703	542	A-B-D-G-J-S-T-Y-AF	Oil Pump Impellers - Diameter Clearance			.002L / .006L	.008L
		BD-BE	Oil Pump Impellers - Diameter Clearance			.0035L / .0075L	.009L
704	543	ALL (Except BD-BE)	Oil Pump Impeller - Side Clearance			.002L / .0045L	.005L
		BD-BE	Oil Pump Impeller - Side Clearance			.003L / .005L	.006L
		AS APPLICABLE	Width of Oil Pump Impellers	.622 / .624	.621		
		AS APPLICABLE	Width of Oil Pump Impellers	.747 / .749	.746		
		AS APPLICABLE	Width of Oil Pump Impellers	.995 / .997	.994		
		BD-BE	Width of Oil Pump Impellers	.622 / .623	.620		
705	544	S-T-AF (DUAL MAGNETO)	Oil Pump Impeller and Idler Shaft			.0010L / .0025L	.004L
		A-B-D-G-J-S-T-Y-AF	Oil Pump Impeller and Idler Shaft			.001T / .003T	(A)
		BD-BE	Oil Pump Impeller and Idler Shaft			.002T / .004T	(A)
706	558	A-B-D-G-J-S-T-Y-AF	Oil Pump Idler Shaft and Oil Pump Body			.0005L / .0020L	.003L
		BD-BE	Oil Pump Idler Shaft and Oil Pump Body			.0010L / .0025L	.003L
		S-T-AF (DUAL MAGNETO)	Oil Pump Idler Shaft and Oil Pump Body			.0000 / .0015T	(A)
707	602	A-B-D-G-J-S-T-Y-AF	Oil Pump Idler Shaft and Accessory Housing			.0010L / .0025L	.0035L
		BD-BE	Oil Pump Idler Shaft and Crankcase			.0010L / .0025L	.0035L

SECTION III GEAR TRAIN SECTION - SCAVENGE PUMP

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
708	545	G2-S2	Scavenge Pump Drive Shaft and Adapter			.0010L / .0025L	.004L
709	546	G2-S2	Scavenge Pump - End Clearance			.000 / .045L	.060L
710	542	G2-S2	Scavenge Pump Impellers - Diameter Clearance			.007L / .011L	.014L
711	543	G2-S2	Scavenge Pump Impellers - Side Clearance			.003L / .005L	.006L
		G2-S2	Width of Impellers	1.496 / 1.498	1.495		
712	544	G2-S2	Scavenge Pump Impellers and Idler Shaft			.0010L / .0025L	.004L
713	544	G2-S2	Scavenge Pump Body and Idler Shaft			.0000 / .0015T	(A)
714	772	S3-T4-AF (WIDE DECK)	Turbocharger Scavenge Pump Drive and Adapter			.0010L / .0025L	.004L
715	986	S3-T4-AF (WIDE DECK)	Turbocharger Scavenge Pump Shaft and Adapter			.0010L / .0020L	.0035L
716	949	S3-T4-AF (WIDE DECK)	Gerotor Pump - Rotor - Side Clearance			.0015L / .003L	.004L
717	950	S3-T4-AF (WIDE DECK)	Gerotor Pump Housing and Adapter			.0005L / .0020L	(A)
718	985	S3-T4-AF (WIDE DECK)	Turbocharger Scavenge Pump - End Clearance			.0055L / .0365L	.0415L
		T4 (DUAL MAGNETO)	Turbocharger Scavenge Pump - End Clearance			.0105L / .0395L	.0445L
		SECTION III GEAR TRAIN SECTION - FUEL PUMP					
719	629	A-B-D-G-J-S-T	AC Fuel Pump Plunger and Accessory Housing			.0015L / .003L	.005L
720	619	J-S-T-AF	Crankshaft Idler Gear and Crankshaft Idler Gear Shaft			.001L / .003L	.005L
721	983	S-T-AF (DUAL MAGNETO)	Crankshaft Idler Gear Shaft and Accessory Housing			.0020L / .0035L	.0065L
		S-T-AF (DUAL MAGNETO)	Crankshaft Idler Gear Shaft and Crankcase			.0020L / .0035L	.0065L
722	767	S-T-AF	AN Fuel Pump Idler Gear and Shaft			.001L / .003L	.005L
723	984	S-T-AF (DUAL MAGNETO)	AN Fuel Pump Idler Gear Shaft and Accessory Housing and Crankcase			.0020L / .0035L	.0065L
		S-T-AF (DUAL MAGNETO)	AN Fuel Pump Idler Shaft and Crankcase			.0020L / .0035L	.0065L

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions Mfr. Min. & Max.	Dimensions Serv. Max.	Clearances Mfr. Min. & Max.	Clearances Serv. Max.
724	620	A-B	Crankshaft Idler Gear - End Clearance			.003L / .043L	.058L
		G-J-S-Y	Crankshaft Idler Gear - End Clearance			.005L / .040L	.055L
		T-AF	Crankshaft Idler Gear - End Clearance			.007L / .037L	.052L
		S (DUAL MAGNETO)	Crankshaft Idler Gear - End Clearance			.020L / .030L	.040L
		T (DUAL MAGNETO)	Crankshaft Idler Gear - End Clearance			.015L / .038L	.046L
725	768	S	AN Fuel Pump Idler Gear - End Clearance			.010L / .045L	.055L
		T-AF	AN Fuel Pump Idler Gear - End Clearance			.002L / .018L	.024L
		S-T-AF (DUAL MAGNETO)	AN Fuel Pump Idler Gear - End Clearance			.015L / .038L	.045L
726	769	S-T-AF-Y	AN Fuel Pump Drive Shaft Gear and Adapter			.0010L / .0025L	.004L
727	770	S	AN Fuel Pump Drive Shaft Gear - End Clearance			.035L / .069L	.079L
		T-AF	AN Fuel Pump Drive Shaft Gear - End Clearance			.044L / .081L	.091L
		T-AF (DUAL MAGNETO)	AN Fuel Pump Drive Shaft Gear - End Clearance			.035L / .073L	.083L
		Y	AN Fuel Pump Drive Shaft Gear - End Clearance			.000L / .067L	.075L
		SECTION III GEAR TRAIN SECTION - GOVERNOR & HYDRAULIC PUMP					
728	668	T-AF (NARROW DECK)	Front Governor Drive Idler Shaft (Both Ends) and Crankcase			.0010L / .0025L	.004L
729	668	G1-G2-S2-S4-S6-T-AF (WIDE DECK)	Front Governor Idler Gear and Shaft			.0010L / .0025L	.004L
730	668	BD-BE	Front Governor Drive Gear and Crankcase			.0010L / .0025L	.004L
		BD-BE	Front Governor Drive Gear and and Camshaft			.0005L / .0025L	.004L
731	670	G1-G2-S-T-AF	Front Governor Gear and Crankcase			.0010L / .0025L	.004L
		BD	Front Governor Gear and Crankcase			.0010L / .0030L	.004L
732	674	G1-G2-S-T-AF	Front Governor Gear - End Clearance			.008L / .016L	.021L
		BD-BE	Front Governor Gear - End Clearance			.0045L / .0165L	.021L

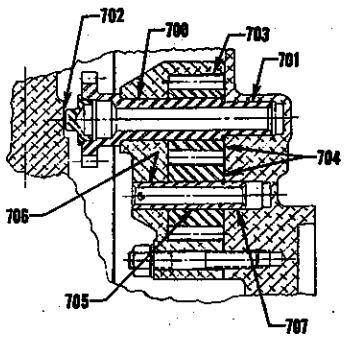
SECTION III GEAR TRAIN SECTION - GOVERNOR & HYDRAULIC PUMP (CONT.)

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
733	675	G-J-S	Rear Governor Gear and Adapter			.0010L / .0025L	.005L
		G-S (DUAL MAGNETO)	Rear Governor Gear and Accessory Housing			.0010L / .0025L	.005L
734	674	G-J-S	Rear Governor Gear - End Clearance			.002L / .024L	.034L
		G-S (DUAL MAGNETO)	Rear Governor Gear - End Clearance			.002L / .037L	.044L
735	772	T-AF	Hydraulic Pump Gear and Adapter			.0010L / .0025L	.004L
		T-AF (DUAL MAGNETO)	Hydraulic Pump Gear and Accessory Housing			.0010L / .0025L	.004L
736	773	T-AF	Hydraulic Pump Gear - End Clearance			.010L / .066L	.076L
		T-AF (DUAL MAGNETO)	Hydraulic Pump Gear - End Clearance			.007L / .032L	.039L
		SECTION III GEAR TRAIN SECTION - VACUUM & TACHOMETER					
737	622	A-B-G-J-S-T-Y-AF	Vacuum Pump Gear and Adapter			.0010L / .0030L	.0045L
737	989	S-T-AF (DUAL MAGNETO)	Vacuum Pump Gear and Accessory Housing			.0010L / .0025L	.004L
737	589	D	Vacuum Pump Gear and Accessory Housing			.0010L / .0025L	.006L
738	590	A-B-G-J-S-T-AF	Vacuum Pump Gear - End Clearance			.010L / .057L	.075L
		D	Vacuum Pump Gear - End Clearance			.003L / .020L	.030L
		Y	Vacuum Pump Gear - End Clearance			.000 / .067L	.075L
		S (DUAL MAGNETO)	Vacuum Pump Gear - End Clearance			.012L / .044L	.055L
		T-AF (DUAL MAGNETO)	Vacuum Pump Gear - End Clearance			.017L / .039L	.050L
739	625	A-B-Y	Tachometer Drive Shaft and Adapter			.0015L / .0035L	.006L
		BD-BE	Tachometer Drive Shaft and Adapter			.0010L / .0050L	.0065L
739	540	D-G-J-S-T-AF	Tachometer Drive Shaft and Accessory Housing			.0015L / .0035L	.006L
740		G-J-S (DUAL DRIVE)	Vacuum Pump Gear and Adapter			.0010L / .0025L	.004L
741	789	G-J-S (DUAL DRIVE)	Vacuum Pump Gear - End Clearance			.000 / .017L	.027L

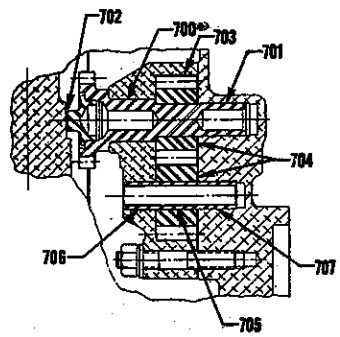
SECTION III GEAR TRAIN SECTION - VACUUM & TACHOMETER (CONT.)

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
742	791	G-J-S (DUAL DRIVE)	Idler Gear and Shaft			.0010L / .0030L	.005L
743		G-J-S (DUAL DRIVE)	Idler Gear - End Clearance			.021L / .041L	.060L
744	764	G-J-S (DUAL DRIVE)	Propeller Governor Gear and Adapter			.0013L / .0028L	.005L
		G-J-S (DUAL DRIVE)	Hydraulic Pump Gear and Adapter			.0013L / .0028L	.005L
745	794	G-J-S (DUAL DRIVE)	Propeller Governor or Hydraulic Pump - End Clearance			.000 / .054L	.074L
		SECTION III GEAR TRAIN SECTION - MAGNETO, GENERATOR, STARTER					
746	677	T	Magneto Bearing and Gear			.0005T / .0001L	.0005L
746	549	D	Magneto Bearing and Gear			.0008T / .0001L	.0005L
747	677	T	Magneto Bearing and Crankcase			.0002T / .0007L	(A)
747	561	D	Magneto Drive Bearing and Adapter			.0006T / .0008T	(A)
748		S7	Magneto Bearing and Gear			.0001T / .0010T	(A)
749		S7	Magneto Bearing and Adapter			.000 / .0012L	.0015L
750	987	S-T-AF (DUAL MAGNETO)	Magneto Drive Gear and Crankcase			.0010L / .0025L	.003L
751	988	S-T-AF (DUAL MAGNETO)	Magneto Drive Gear - End Clearance			.005L / .073L	.083L
752		AF	Magneto Drive Gear and Shaft			.001L / .003L	.005L
753		BD-BE	Magneto Drive Gear and Crankcase			.001L / .003L	.005L
754	784	Y	Magneto Shaft Gear and Magneto Case			.001L / .003L	.005L
755	786	Y	Magneto Shaft Gear and Support Assembly			.001L / .003L	.005L
756		Y	Magneto Shaft Gear and Accessory Drive Shaft Gear - End Play			.0075 / .0125	.015
757	787	Y	Accessory Drive Shaft Gear and Support Assembly			.001L / .003L	.005L
758		S	Magneto Gear and Bushing (S4LN-21 and S4LN-1227)			.0005L / .0020L	.0035L
		T	Magneto Gear and Bushing (S6LN-21 and S6LN-1227)			.0015L / .0035L	.0055L

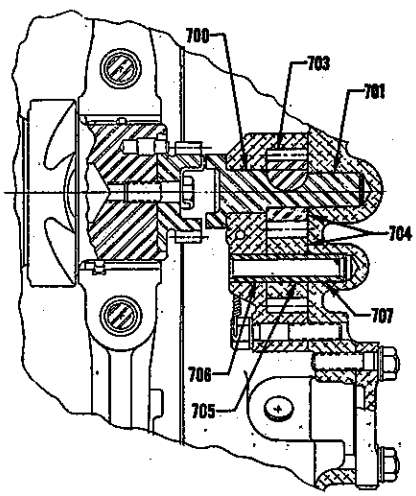
Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
758		T-AF (DUAL MAGNETO)	Magneto Gear and Bushing			.0015L / .0035L	.0055L
7095		BD, BE	Bushing - Magneto Drive and Crankcase			.0025T / .0045T	(A)
759	627	D	Generator Gear Bushing and Generator Gear			.0020T / .0035T	(A)
760	628	D	Generator Gear Bushing and Generator Drive Coupling Adapter			.001L / .0028L	.005L
761	632	D	Bendix Drive Gear Bushing and Crankcase			.0005T / .0025T	(A)
762	633	D	Bendix Drive Gear and Bendix Drive Gear Bushing			.0010L / .0025L	.005L
763	634	D	Bendix Drive Shaft and Bendix Drive Housing			.003L / .005L	.010L
764	637	D	Bendix Drive Shaft - End Clearance			.000 / .0059L	.080L



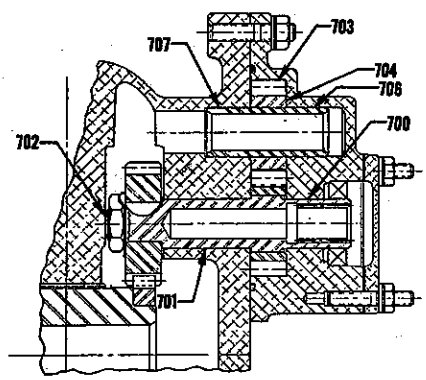
6 CYL–DUAL MAG



4 CYL–DUAL MAG

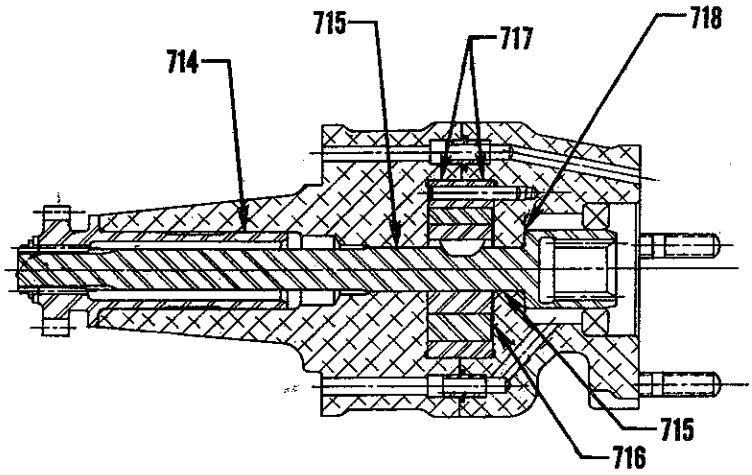


STANDARD TYPE

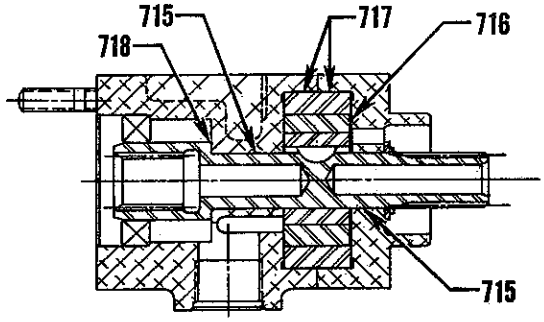


O-320-H,O,LO-360-E

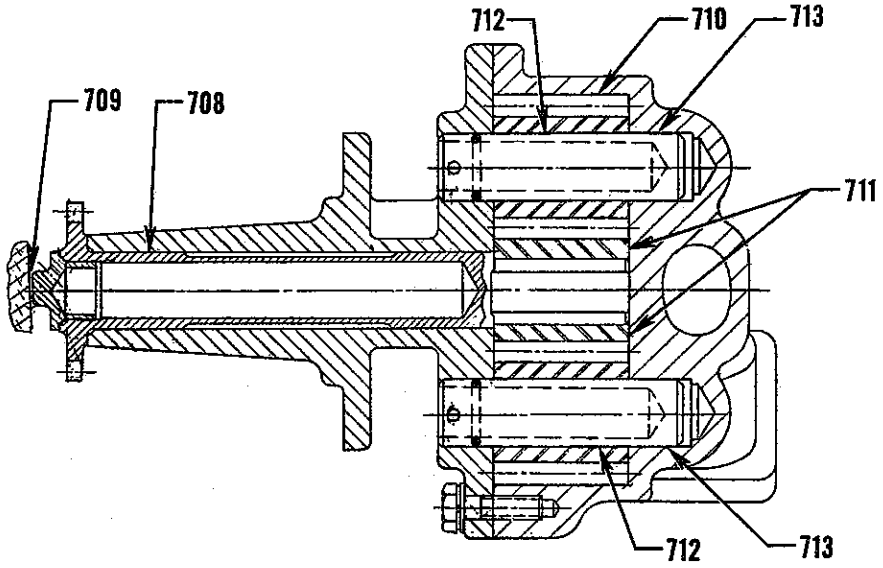
Oil Pumps



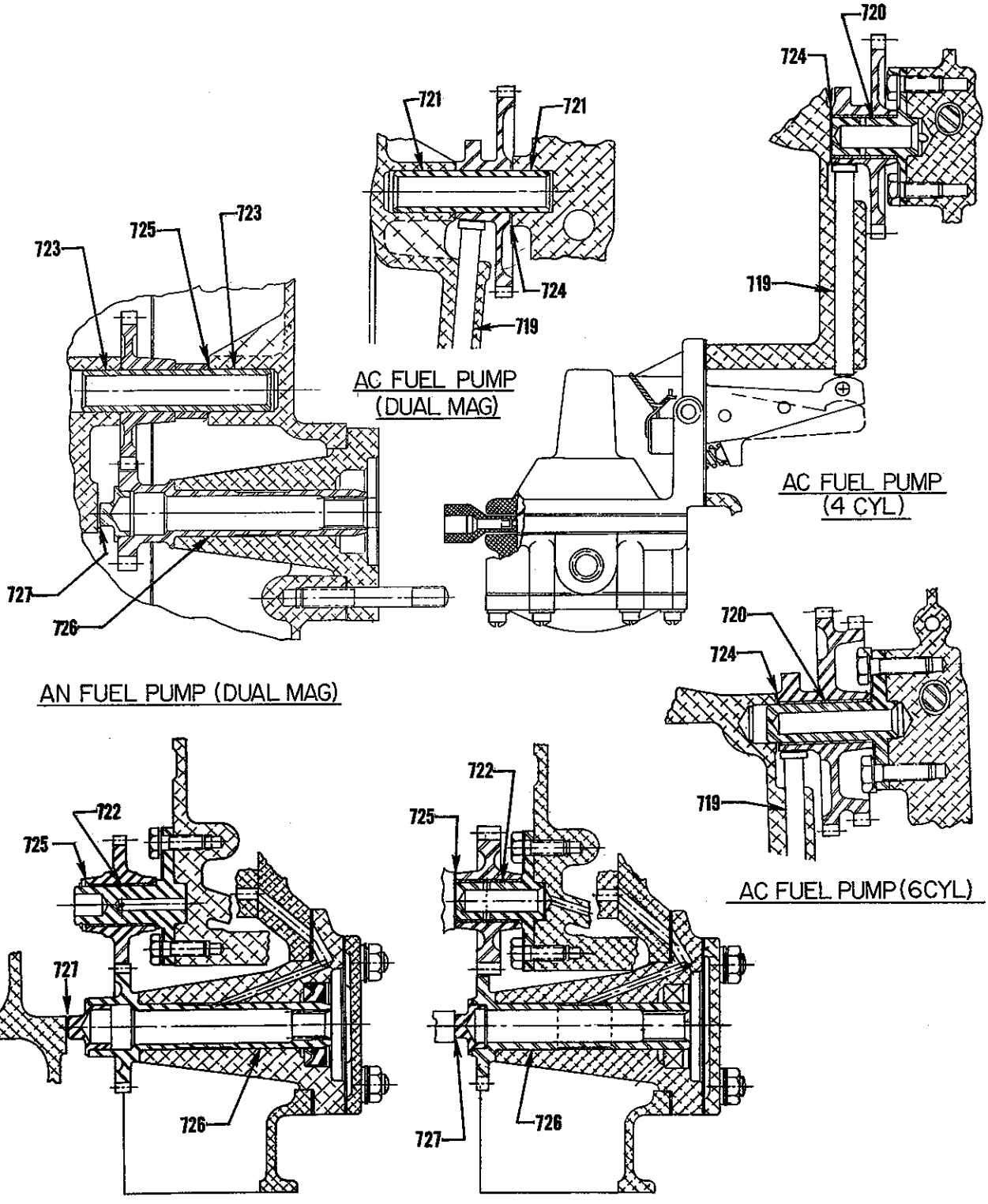
TURBO SCAVENGE PUMP & HYD PUMP (TIO-540-C)
TURBO SCAVENGE PUMP & GOV. (TIO-360)



DUAL MAG: TURBO SCAVENGE PUMP & HYD. PUMP



SCAVENGE PUMP AIO 320 & AIO-360



AC FUEL PUMP (DUAL MAG)

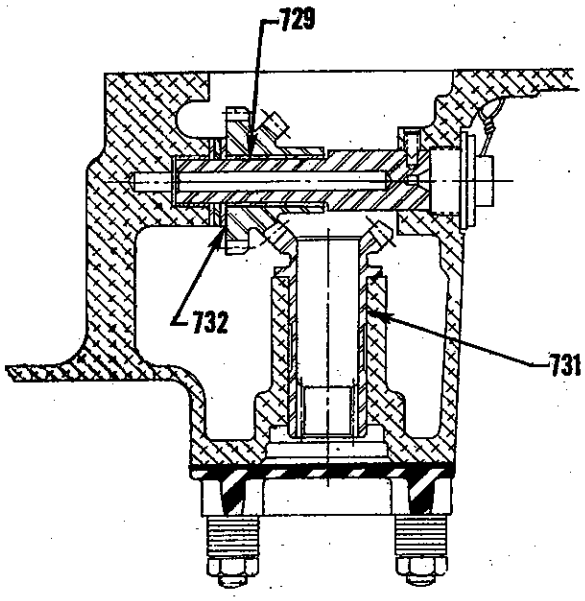
AC FUEL PUMP (4 CYL)

AN FUEL PUMP (DUAL MAG)

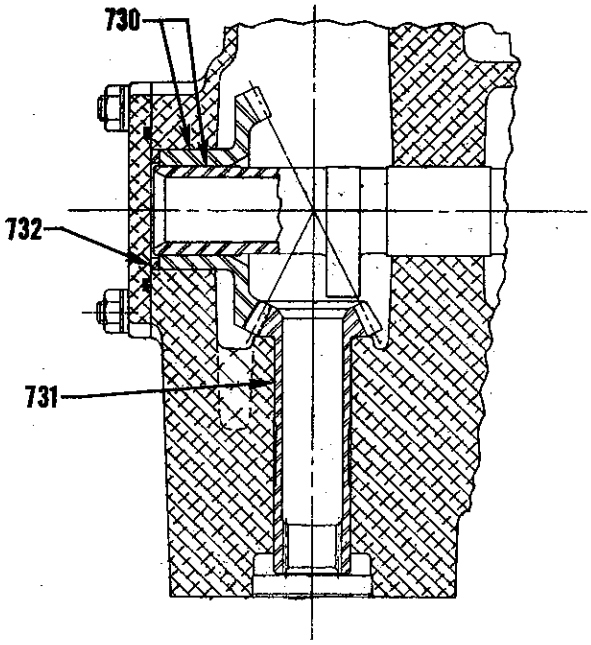
AC FUEL PUMP (6CYL)

AN FUEL PUMP (6&8 CYL)

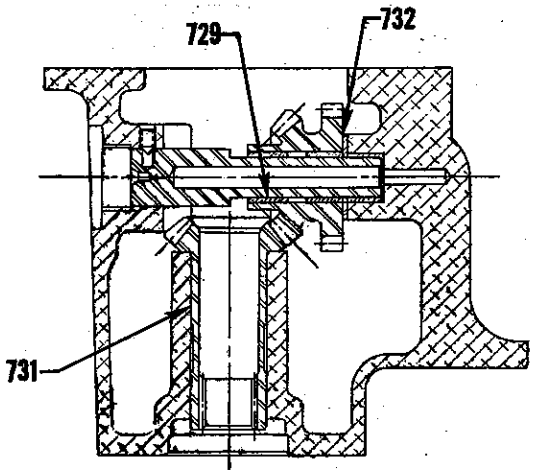
AN FUEL PUMP (4CYL)



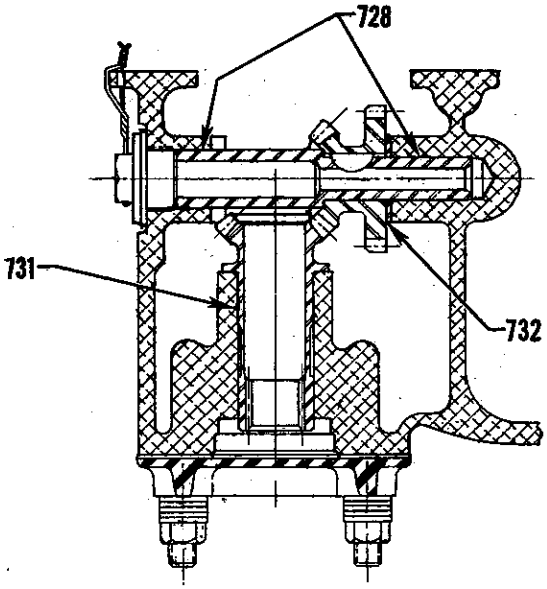
4 & 8 (WIDE DECK)



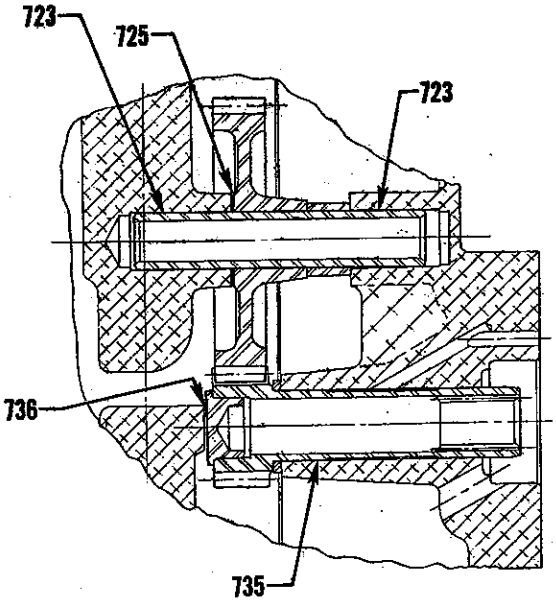
O-320-H O,LO-360-E



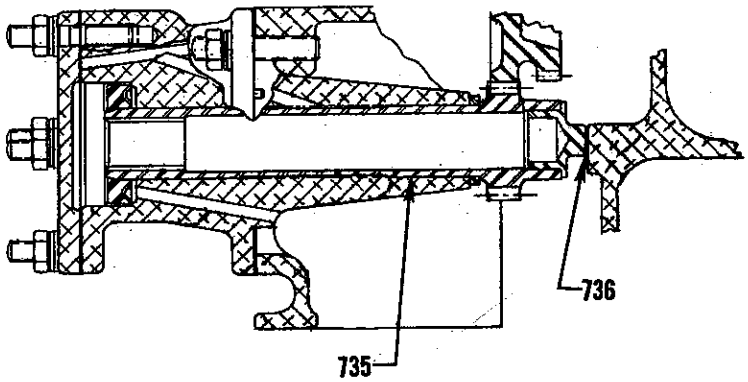
6 CYL. (WIDE DECK) (2200 LB)



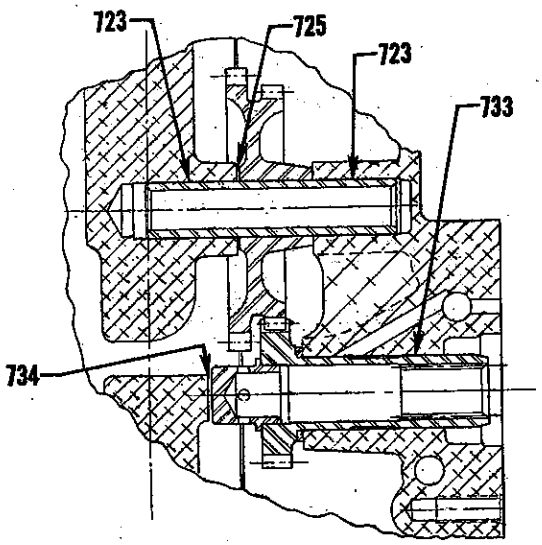
NARROW DECK (6 & 8 CYL.



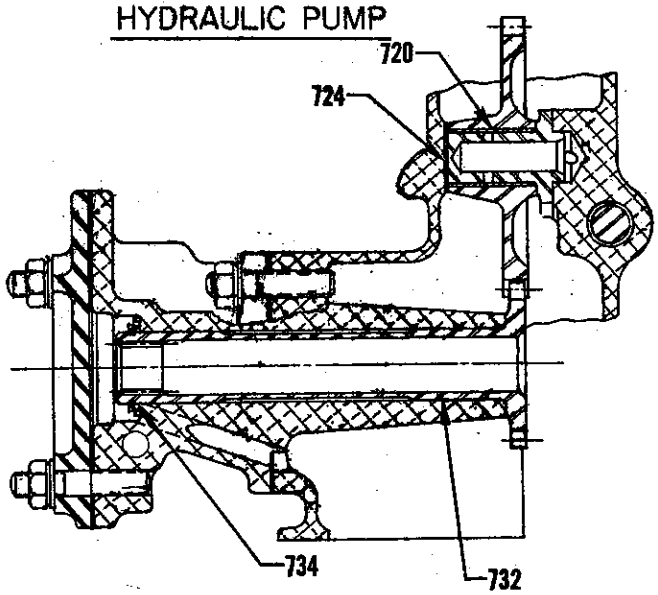
HYDRAULIC PUMP-DUAL MAG



HYDRAULIC PUMP

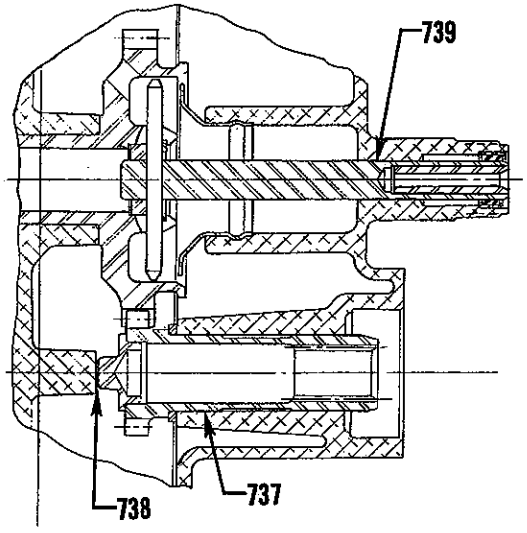


REAR PROP. GOV. (4 CYL.)
(DUAL MAG.)

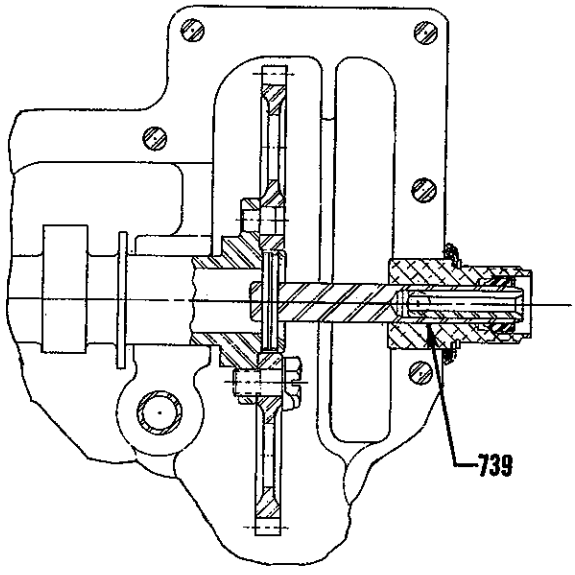


REAR PROP. GOV. (4 CYL.)
(STANDARD)

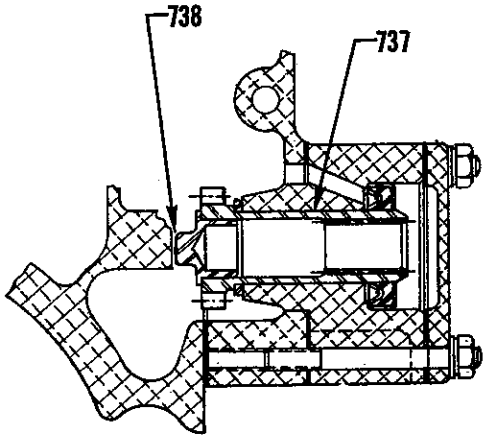
Rear Governor and Hydraulic Pumps



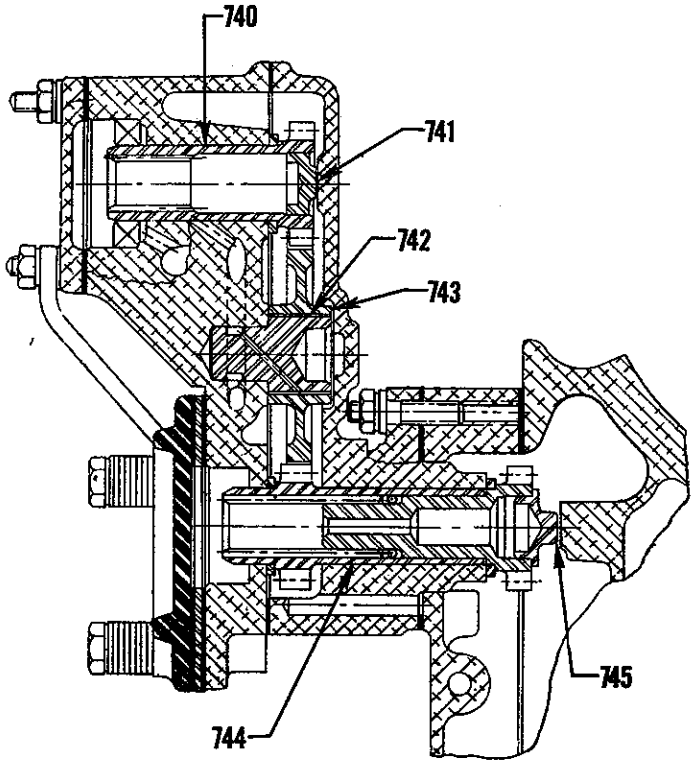
VACUUM PUMP & TACHOMETER



TACHOMETER DRIVE

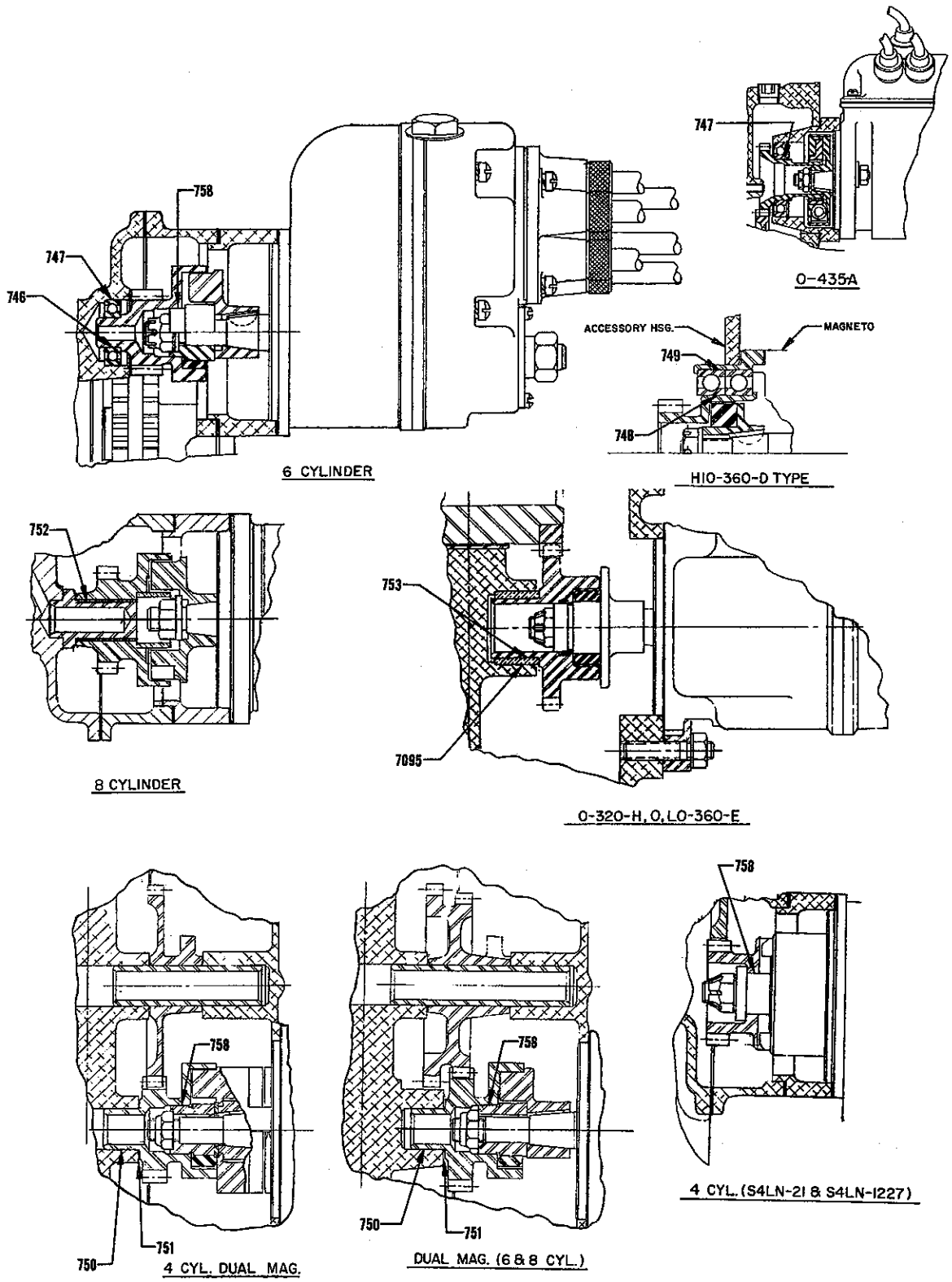


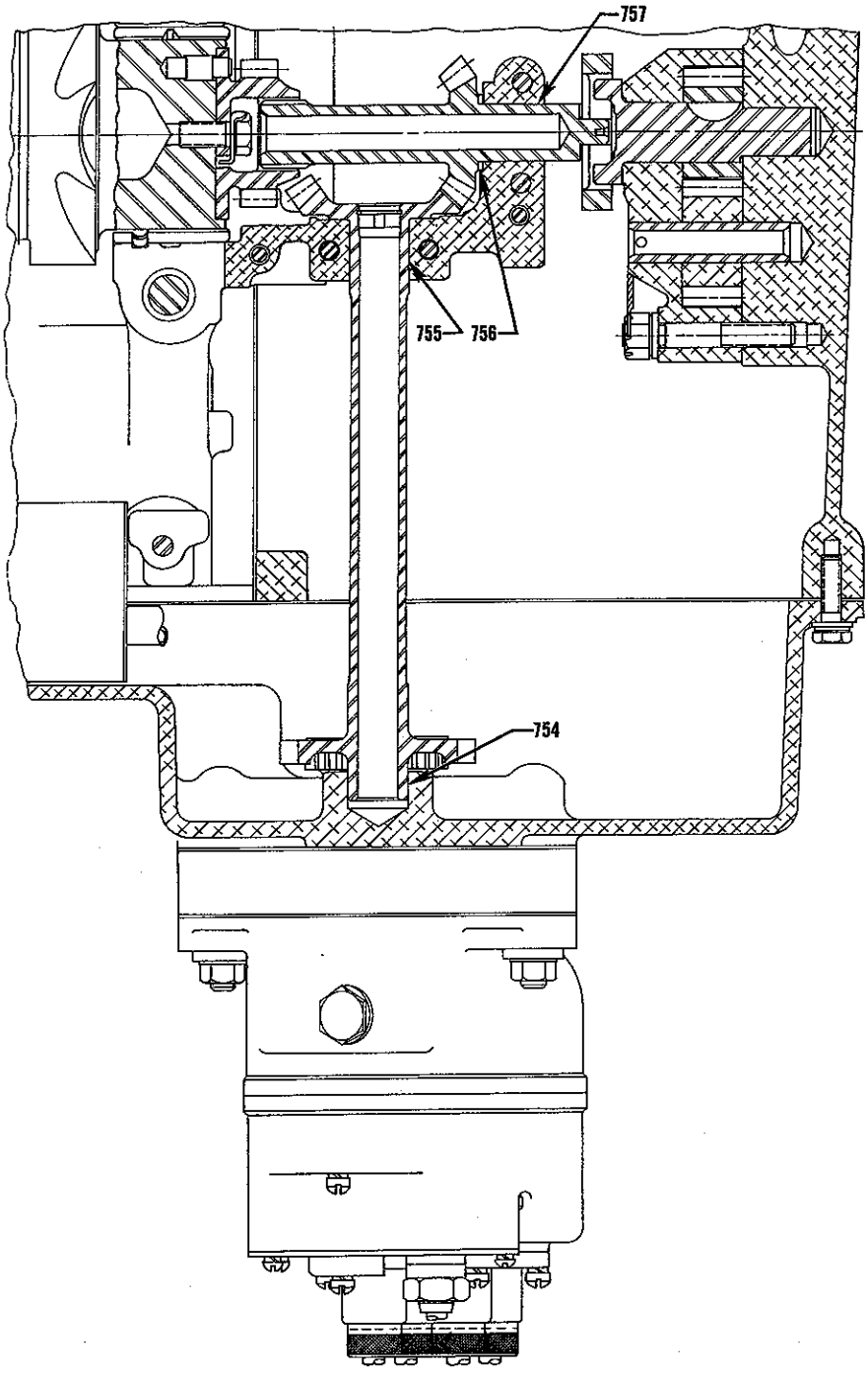
VACUUM PUMP



DUAL DRIVE (VACUUM PUMP & PROP. GOV.)
OR (VACUUM PUMP & HYD. PUMP)

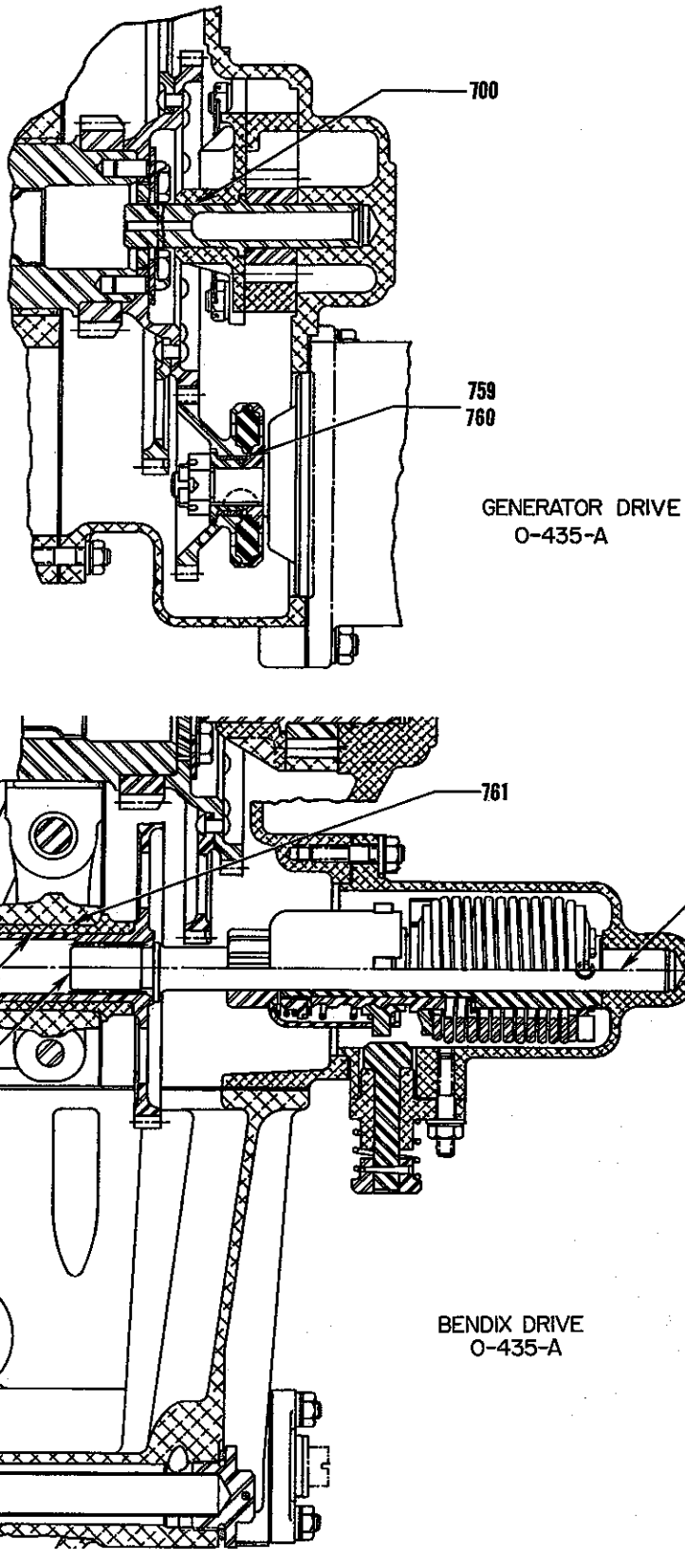
Tachometer Drives, Vacuum and Hydraulic Pumps


747
O-435A
758
747
746
6 CYLINDER
ACCESSORY HSG.
MAGNETO
749
748
HIO-360-D TYPE
752
8 CYLINDER
753
7095
O-320-H, O, LO-360-E
758
758
758
4 CYL. (S4LN-21 & S4LN-1227)
750
751
4 CYL. DUAL MAG.
750
751
DUAL MAG. (6 & 8 CYL.)



VO, IVO-360

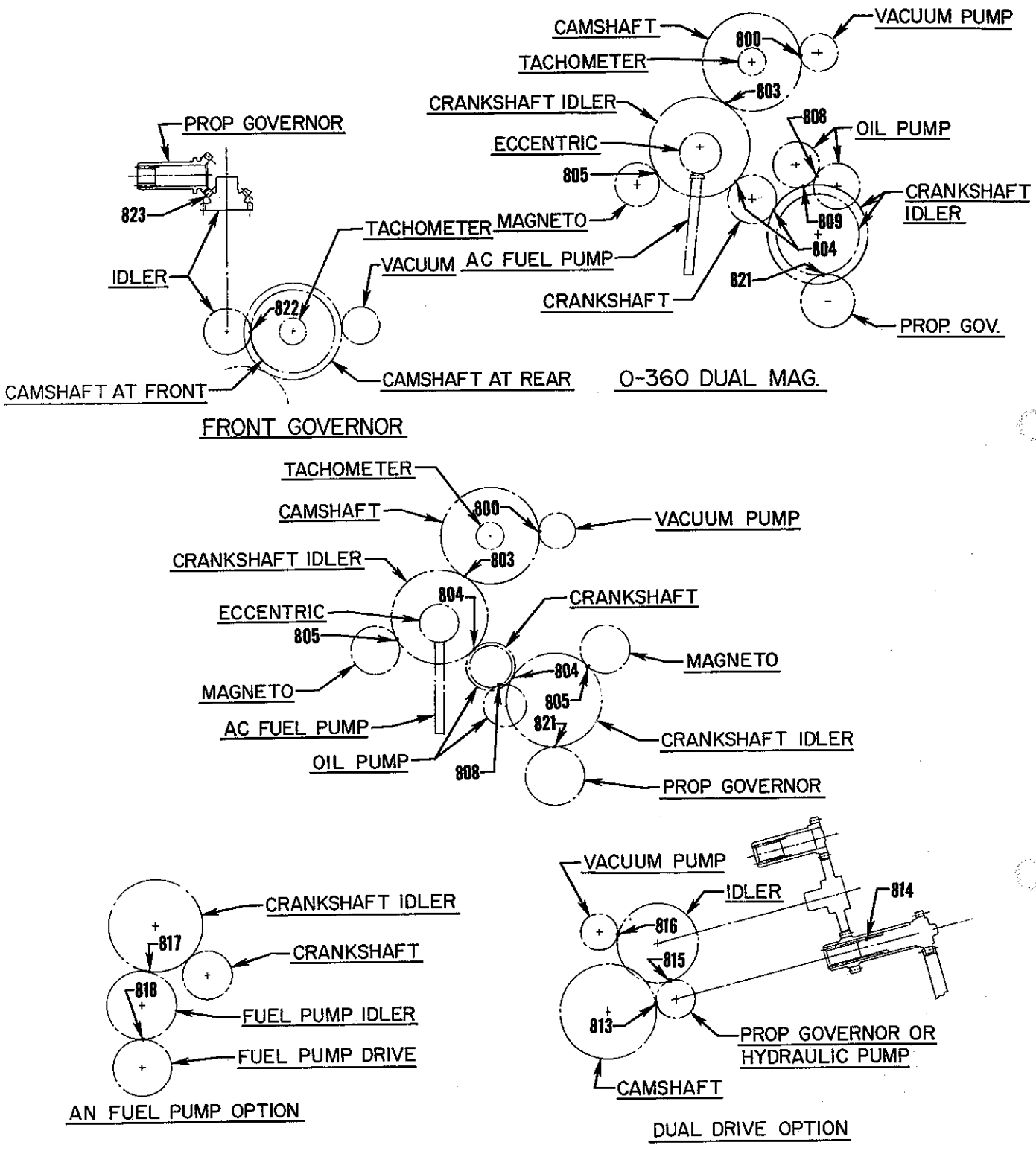
Accessory Drives: Magnetos



Generator and Bendix Drive

Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
800	623 979	A-B-G-J-S-T-Y-AF	Camshaft and Vacuum Pump - Backlash			.004 .015	.020
801	1002	BD-BE	Camshaft and Vacuum and Oil Pump Drive - Backlash			.006 .014	.020
802	623	Y	Camshaft and Fuel Pump - Backlash			.004 .015	.020
803	616 978	A-B-G-J-S-T-Y-AF	Camshaft and Crankshaft Idler - Backlash			.004 .015	.020
804	617 972	A-B-G-J-S-T-Y-AF	Crankshaft and Crankshaft Idler - Backlash			.004 .015	.020
805	618 977	A-B-G-J-S-T-AF	Magneto Drive and Crankshaft Idler - Backlash			.004 .015	.020
806	1004	BD-BE	Magneto Drive and Crankshaft Gear - Backlash			.006 .014	.020
807	1003	BD-BE	Crankshaft Gear and Vacuum and Oil Pump Drive - Backlash			.006 .014	.020
808	553	A-B-D-G-J-S-T-Y-AF	Oil Pump Impellers - Backlash			.008 .015	.020
		BD-BE	Oil Pump Impellers - Backlash			.008 .012	.020
809	975	S-T-AF (DUAL MAGNETO)	Oil Pump Drive and Crankshaft Idler - Backlash			.004 .015	.020
810	783	Y	Magneto and Magneto Shaft Gear - Backlash			.004 .015	.020
811	785	Y	Accessory Drive Shaft Gear and Magneto Driven Shaft Gear - Backlash			.003 .005	.012
812	788	Y	Crankshaft Gear and Accessory Drive Shaft Gear - Spline Backlash			.002 .005	.015
813		G-J-S (DUAL DRIVE)	Camshaft and Propeller Governor or Hydraulic Pump - Backlash			.004 .015	.020
814	793	G-J-S (DUAL DRIVE)	Governor or Hydraulic Pump Drive and Drive Gear - Spline Backlash			.0013 .0073	.010
815	792	G-J-S (DUAL DRIVE)	Governor or Hydraulic Pump and Idler - Backlash			.004 .015	.020
816	790	G-J-S (DUAL DRIVE)	Vacuum Pump and Idler - Backlash			.004 .015	.020
817	765	S-T-AF	AN Fuel Pump Idler and Crankshaft Idler - Backlash			.004 .015	.020
818	766 976	S-T-AF	AN Fuel Pump Idler and Fuel Pump Drive - Backlash			.004 .015	.020

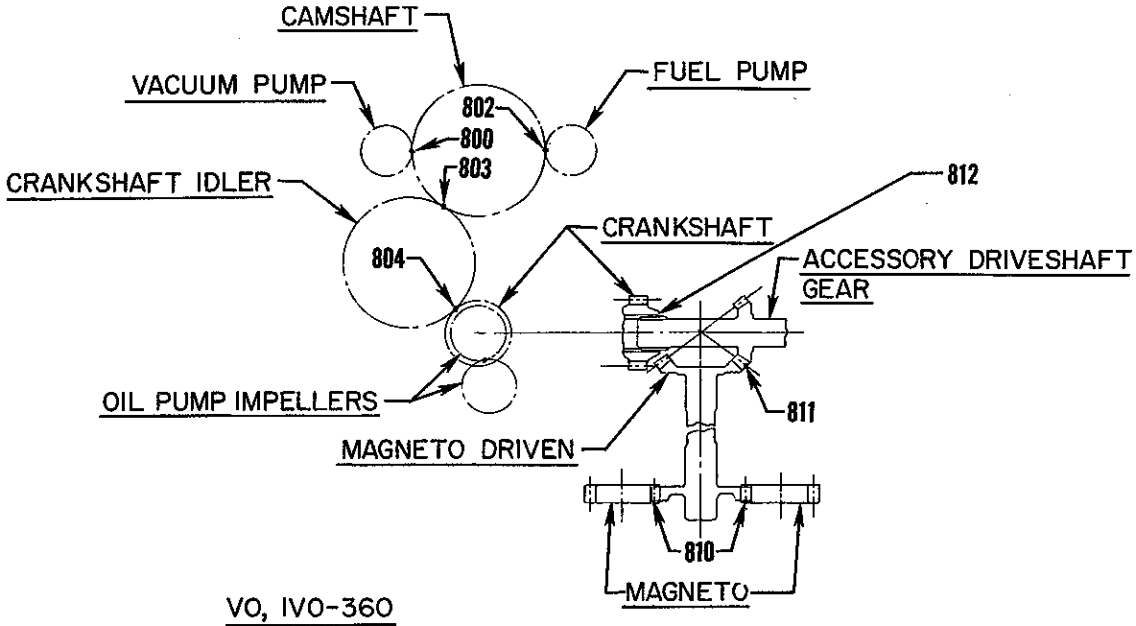
Ref. New	Ref. Old	Chart	Nomenclature	Dimensions		Clearances	
				Mfr. Min. & Max.	Serv. Max.	Mfr. Min. & Max.	Serv. Max.
819	973	S-T-AF (DUAL MAGNETO)	Crankshaft Gear and AN Fuel Pump Idler - Backlash			.004 / .015	.020
820	974	T-AF	Hydraulic Pump and Crankshaft Idler - Backlash			.004 / .015	.020
821	676	G-J-S	Propeller Governor Drive and Crankshaft Idler - Backlash (Rear Governor)			.004 / .015	.020
822		G1-G2-S2-S4-S6-T-AF	Propeller Governor Idler and Camshaft - Backlash (Front Governor)			.004 / .015	.020
823	669	G1-G2-S2-S4-S6-T-AF	Propeller Governor Drive and Idler - Backlash (Bevel Gears) (Front Governor)			.004 / .008	.015
824	669	BD-BE	Propeller Governor Drive and Camshaft - Backlash (Bevel Gears) (Front Governor)			.003 / .011	.015
825	550	D	Crankshaft Timing Gear and Camshaft Gear - Backlash			.004 / .015	.020
826	551	D	Camshaft Gear and Generator Gear - Backlash			.004 / .015	.020
827	552	D	Crankshaft Gear and Generator Gear - Backlash			.004 / .015	.020
828	562	D	Magneto Coupling Spline - Backlash			.001 / .005	.0075
829	621	D	Vacuum Pump Gear and Vacuum Pump Drive Gear - Backlash			.004 / .015	.020
830	635	D	Starter Drive and Bendix Drive Gear - Backlash			.004 / .015	.020
831	636	D	Bendix Drive Shaft Spline and Bendix Drive Gear Spline - Backlash			.001 / .006	.015
832	766	S	Injector Pump Idler Gear and Injector Pump Drive Shaft Gear - Backlash			.004 / .015	.020



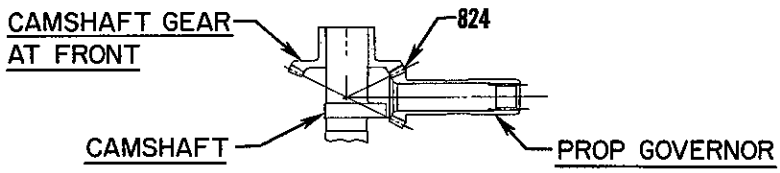
O-235, O-320, O-340 & O-360

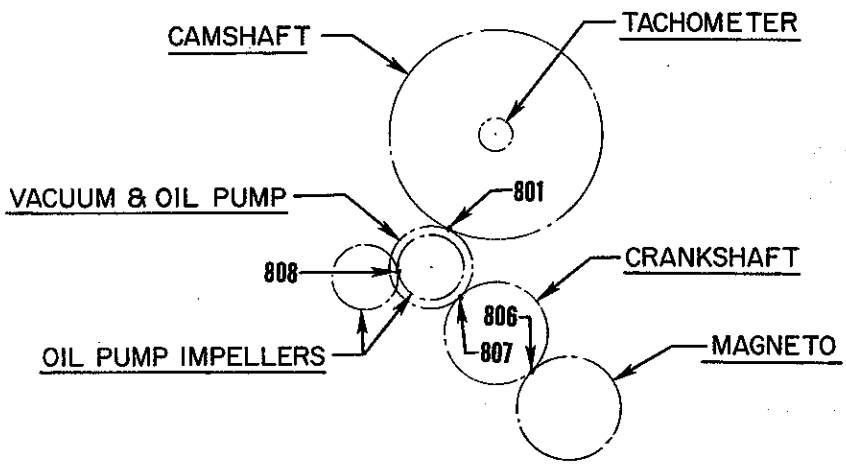
ALL VIEWS SHOWN FROM REAR OF ENGINE

Backlash (Accessory Drives)



VO, IVO-360

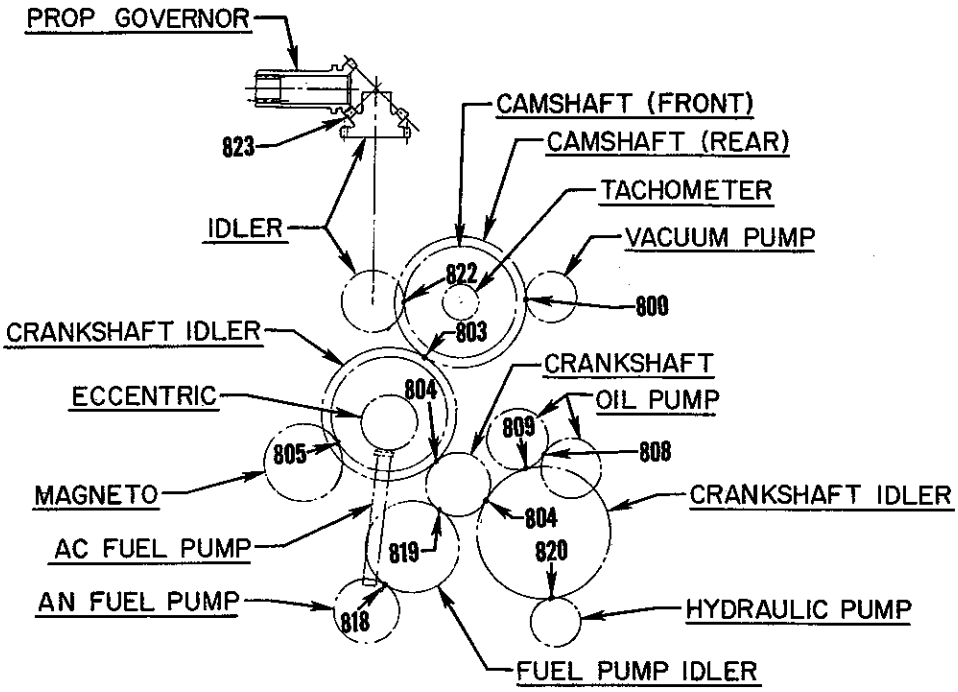




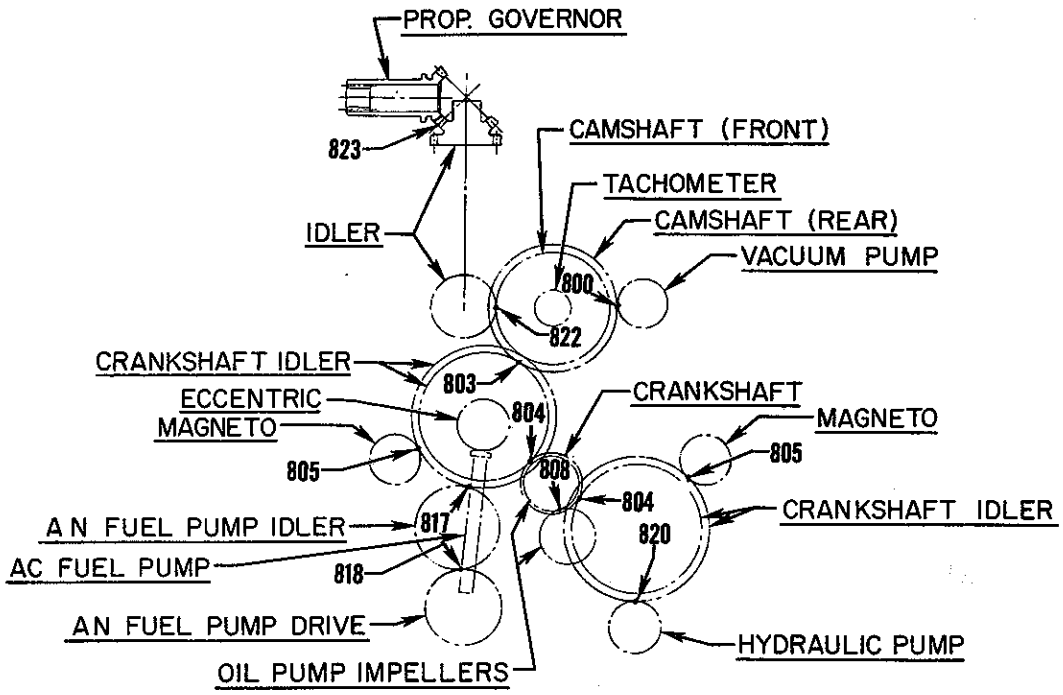
O-320-H, O, LO-360-E

ALL VIEWS SHOWN FROM REAR OF ENGINE

Backlash (Accessory Drives)



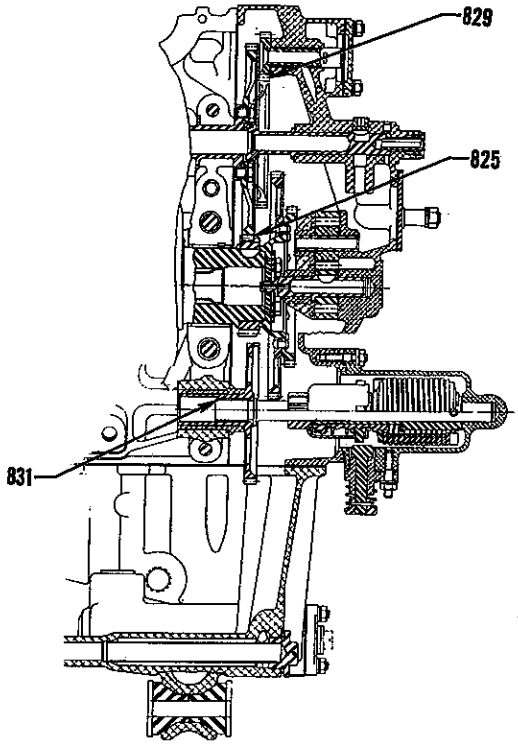
O-540 & IO-720 DUAL MAG.



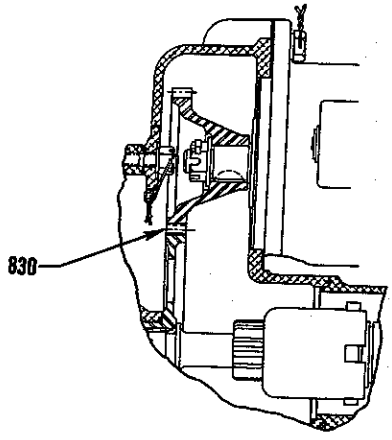
O-540 & IO-720

ALL VIEWS FROM REAR OF ENGINE

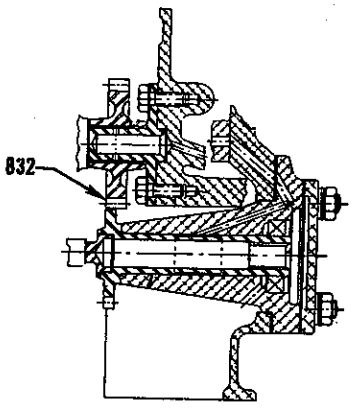
Backlash (Accessory Drives)

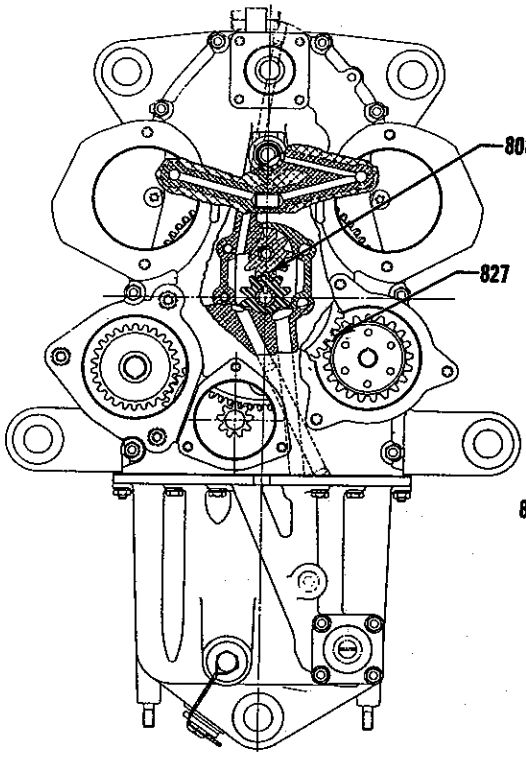


ACCESSORY HOUSING
O-435-A

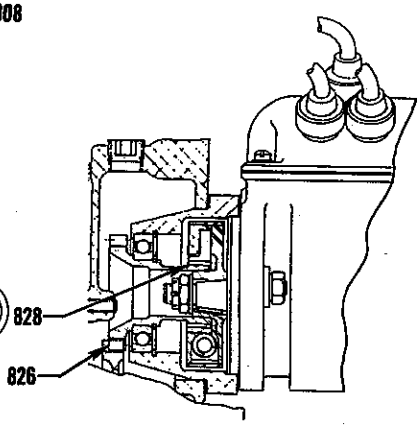


STARTER DRIVE
O-435-A





SECTION THRU REAR
OF ENGINE



MAGNETO DRIVE
O-435-A

Backlash (Accessory Drives)

Ref. New	Ref. Old	Chart	Thread Size	Nomenclature	Torque Limits
900	829	A-B-D-G-Y-S-T-BD-BE	3/8-24	Connecting Rod Nuts	480 in. lbs.
		J	3/8-24	Connecting Rod Nuts	360 in. lbs.
		S1-S3-S5-S6-S7-S9-T3-AF	3/8-24	Connecting Rod Bolts - Tighten to Length	2.255 - 2.256
901	878	BD-BE	9/16-18	Oil Pump Shaft Nut	660 in. lbs.
902	877	BD-BE	5/16-24	Rocker Stud Nut	150 in. lbs.
903	840	ALL (AS APPLICABLE) (EXCEPT S7)	3/8-24	Magneto Nut (To attach drive member to magneto) - Bendix - Sintered Bushing - Gray	120 - 150 in. lbs.
				Magneto Nut (To attach drive member to magneto) - Bendix - Steel Bushing	170 - 300 in. lbs.
				Magneto Nut (To attach drive member to magneto) - Slick	120 - 300 in. lbs.
		S7	1/2-20	Magneto Nut (To attach drive member to magneto)	170 - 300 in. lbs.
904	839	ALL	10-32	Magneto Plate Screws (To attach ignition cable outlet plate to magneto)	15 in. lbs.
905	853	ALL	1/4-20	Rocker Box Screws	50 in. lbs.
906	852	ALL	5/16-18	Exhaust Port Studs	40 in. lbs. min.
907	830	ALL	18MM	Spark Plugs	420 in. lbs.
908	860	ALL	1/8-27 NPT	Fuel Pump Vent Fitting (Approximately two turns beyond finger tight)	96 in. lbs.
909	862	ALL	5/8-32	Alternator Pulley Nut	450 in. lbs.
910	864	ALL	1/4-28	Alternator Output Terminal Nut	85 in. lbs.
911	865	ALL	10-32	Alternator Auxiliary Terminal Nut	30 in. lbs.
912		ALL	5/16-24	Starter Terminal Nut	24 in. lbs.
913	857	ALL (AS APPLICABLE)	1/16-27 NPT	Piston Cooling Nozzle in Crankcase	100 in. lbs.
914	854	Y-S-T-AF	1/8-27 NPT	Injector Nozzle in Cylinder Head	60 in. lbs.
915	869	ALL (AS APPLICABLE)	3/4-16	Oil Filter Bolt (AC Can and Element Type)	300 in. lbs.
		ALL (AS APPLICABLE)	13/16-16	Oil Filter (Throw Away Type)	240 in. lbs.
	874	ALL (AS APPLICABLE)	3/4-16	Converter Stud	720 in. lbs.
916		ALL (AS APPLICABLE)	3/4-18 NPT	Carburetor Drain Plug	144 in. lbs.
917		ALL (AS APPLICABLE)	1.00-14	Oil Cooler Bypass Valve	300 in. lbs.
918		ALL (AS APPLICABLE)	1 1/4-12	Oil Pressure Relief Valve	300 in. lbs.

Ref. New	Ref. Old	Chart	Thread Size	Nomenclature	Torque Limits
919	871	ALL	1/4 Hex Head and Below	Hose Clamps (Worm Type)	20 in. lbs.
			5/16 Hex Head and Above	Hose Clamps (Worm Type)	45 in. lbs.
920	875	ALL		Cylinder Head Drain Back Hose Clamps	10 in. lbs.

921 — S-T — Exhaust V-Band Coupling Torque Data

Coupling Size Tube OD	Avco Lycoming Part No.	Vendor Part No.	T-Bolt Split Type Locknut Torque In. Lbs.	1/4 In. Drilled Hex Nut With Safety Wire Torque In. Lbs.
1.75 in.	LW-12093-4	MVT69183-175	65	75
2.00 in.	LW-12093-5	MVT69183-200	85	75
2.25 in.	LW-12093-6	MVT69183-225	85	75
2.25 in.	LW-12125-3	MVT69197-225	85	
3.69 in.	LW-13464	U4204-55-369M	70	
3.69 in.	LW-14985	ANH1000902-10	70	

922 — ALL — Turbocharger V-Band Torque Data

Turbocharger Model No.	V-Clamp Part No.	V-Clamp Diameter	Torque In. Lbs.
TO-473*	400500-600	6.00 in.	40-80
TEO659*	400500-685	6.85 in.	40-50
THO8A60*	400500-775	7.75 in.	40-60
THO8A69*	400500-775	7.75 in.	40-60
301E10-2**	TC-6-15	6.50 in.	15-20

* - AiResearch turbocharger.
** - Rajay turbocharger.

See latest edition of Service Instruction No. 1238 for assembly procedure.

Ref. New	Ref. Old	Chart	Thread Size	Nomenclature	Torque Limits
927	863	ALL DUAL MAGNETO MODELS	1/2-20	Crankshaft Gear Bolt	660 in. lbs.
		BD	1/4	Crankshaft Gear Bolts	96 - 120 in. lbs.
928		ALL	3/8-16	Cylinder Hold Down Studs (Crankcase Driving Torque)	100 in. lbs.
			7/16-14	Cylinder Hold Down Studs (Crankcase Driving Torque)	200 in. lbs.
			1/2-13	Cylinder Hold Down Studs (Crankcase Driving Torque)	250 in. lbs.
929	858	A-B-D-BD-BE-J-G-Y-S-T-AF	3/8	Cylinder Hold Down Nuts	3,4 300 in. lbs.
		A1	7/16	Cylinder Hold Down Nuts	420 in. lbs.
		B-D-BD-BE-J-G-Y-S-T-AF	1/2	Cylinder Hold Down Nuts	6,8 600 in. lbs.
		Cylinder Hold Down and Crankcase Parting Flange Nuts' Tightening Procedures - See latest edition of Service Instruction No. 1029.			

Ref. New	Ref. Old	Chart	Thread Size	Nomenclature	Torque Limits
930	849	ALL	3/8	Allen Head Screw (Diaphragm Fuel Pump)	225 - 250 in. lbs.
931		A	9/16	Locking Nut (Valve Adjusting Screw)	450 in. lbs.
932	858	ALL	5/16-18	Exhaust Transitions - Studs (Driving Torque)	100 in. lbs.
		ALL	3/8-16	Exhaust Transitions - Studs (Driving Torque)	200 in. lbs.

SECTION V SPRINGS

		Chart	Nomenclature	Avco Lyc. Part No.	Wire Dia.	Length At Comp. Length	COMP. LOAD Mfr. Min.	COMP. LOAD Mfr. Max.	COMP. LOAD Serv. Max.
950	800	A-B-D-G-J-S-T-Y-BD-BE	Outer Valve Springs (Parallel)	76994 LW-11800	.177	1.30 in.	112 lb.	122 lb.	109 lb. min.
		A-B-D-G-J-S-T-Y-BD-BE	Outer Valve Springs (Parallel)	65427	.162	1.30 in.	82 lb.	89 lb.	79 lb. min.
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3	Outer Valve Springs (Angle)	68326	.177	1.46 in.	103 lb.	111 lb.	100 lb. min.
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3	Outer Valve Springs (Angle)	LW-11796	.182	1.43 in.	116 lb.	124 lb.	113 lb. min.
951	801	A-B-D-G-J-S-T-Y-BD-BE	Auxilliary Valve Spring (Parallel)	65567 LW-11795	.135	1.17 in.	61 lb.	67 lb.	58 lb. min.
		S1-S2-S3-S5-S6-S7-S9-S10-T2-T3-AF	Auxilliary Valve Spring (Angle)	68328 LW-11797	.142	1.33 in.	75 lb.	83 lb.	72 lb. min.
952	802 803	ALL (AS APPLICABLE)	Oil Pressure Relief Valve Spring						
		Avco Lycoming Part Numbers	Identification: Dye	Free Length					
		61084	None	2.18	.054	1.30 in.	8.5 lb.	9.5 lb.	8.3 lb. min.
		65703	None	2.16	.063	1.47 in.	17.8 lb.	19.4 lb.	18.0 lb. min.
		68668	Purple	2.04	.054	1.30 in.	7.1 lb.	7.8 lb.	6.9 lb. min.
		77467	Yellow	1.90	.054	1.30 in.	6.4 lb.	7.1 lb.	6.2 lb. min.
		LW-11713	White	2.12	.059	1.44 in.	10.79 lb.	11.92 lb.	10.5 lb. min.
953	811	A-B-G-J-S-T-Y-AF	Oil Cooler Bypass Spring		.0465	1.94 in.	6.50 lb.	7.25 lb.	6.41 lb. min.
954		BD-BE	Oil Filter Bypass Spring		.047	1.00 in.	3.05 lb.	3.55 lb.	3.0 lb. min.
955	806	D	Magneto Coupling Spring		.091	.603 in.	20 lb.	22 lb.	19 lb. min.

SERVICE TABLE OF LIMITS

STANDARD TORQUE
UNLESS OTHERWISE LISTED

Torque limits for propeller attaching bolts to be supplied by propeller or airframe manufacturer.

TABLE I

BOLTS, SCREWS AND NUTS

Thread	Torque In. Lb.	Torque Ft. Lb.	Thread	Torque In. Lb.	Torque Ft. Lb.
10	49	------	1/2	900	75
1/4	96	------	9/16	1320	110
5/16	204	17	5/8	1800	150
3/8	360	30	3/4	3240	270
7/16	600	50			

THIN NUTS (1/2 DIA OF BOLT) - 1/2 LISTED TORQUE

TABLE II

PIPE PLUGS

Thread	Torque In. Lbs.
1/16-27 NPT	40
1/8-27 NPT	40
1/4-18 NPT	85
3/8-18 NPT	110
1/2-14 NPT	160
3/4-14 NPT	230
1-11 1/2 NPT	315

TABLE III

CRUSH TYPE ASBESTOS GASKETS

Thd. Pitch On Part To Be Tightened Threads Per Inch	ANGLE OF TURN Aluminum Asbestos	Copper Asbestos
8	135°	67°
10	135°	67°
12	180°	90°
14	180°	90°
16	270°	135°
18	270°	135°
20	270°	135°
24	360°	180°
28	360°	180°

NOTE

Install all crush type gaskets except the self centering type, with the unbroken surface against the flange of the plug or part being tightened against the seal. Turn the part until the sealing surfaces are in contact and then tighten to the angle of turn listed for the appropriate thread size.

NOTE: Lubricate Threads Unless Otherwise Specified.

TABLE IV

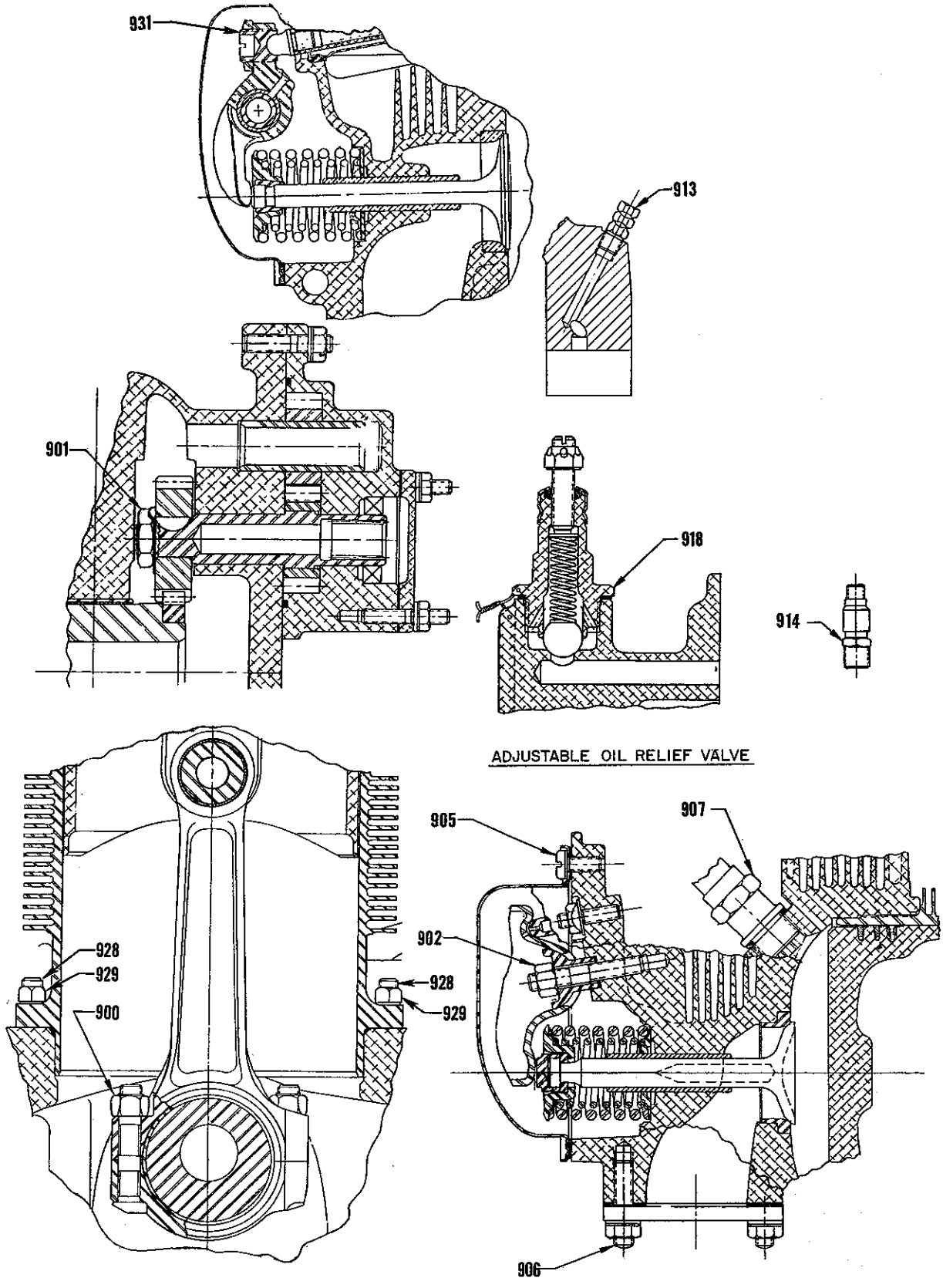
FLEXIBLE HOSE OR TUBE FITTINGS

Tube Size	Thread	Torque In. Lbs.
(-3) 3/16	3/8-24	30
(-4) 1/4	7/16-20	30
(-5) 5/16	1/2-20	35
(-6) 3/8	9/16-18	35
(-8) 1/2	3/4-16	60
(-10) 5/8	7/8-14	70

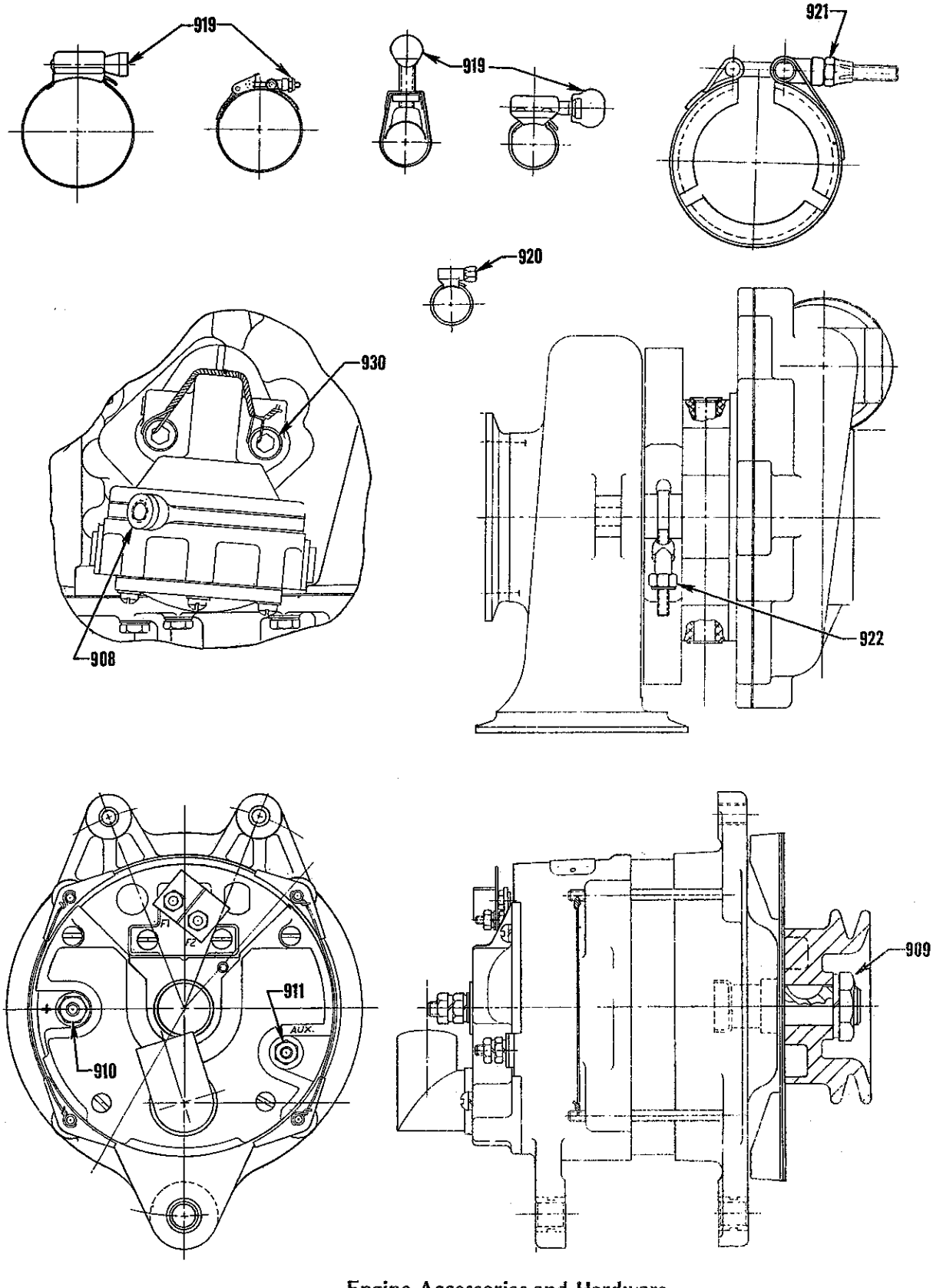
TABLE V

STUDS MIN. DRIVING TORQUE

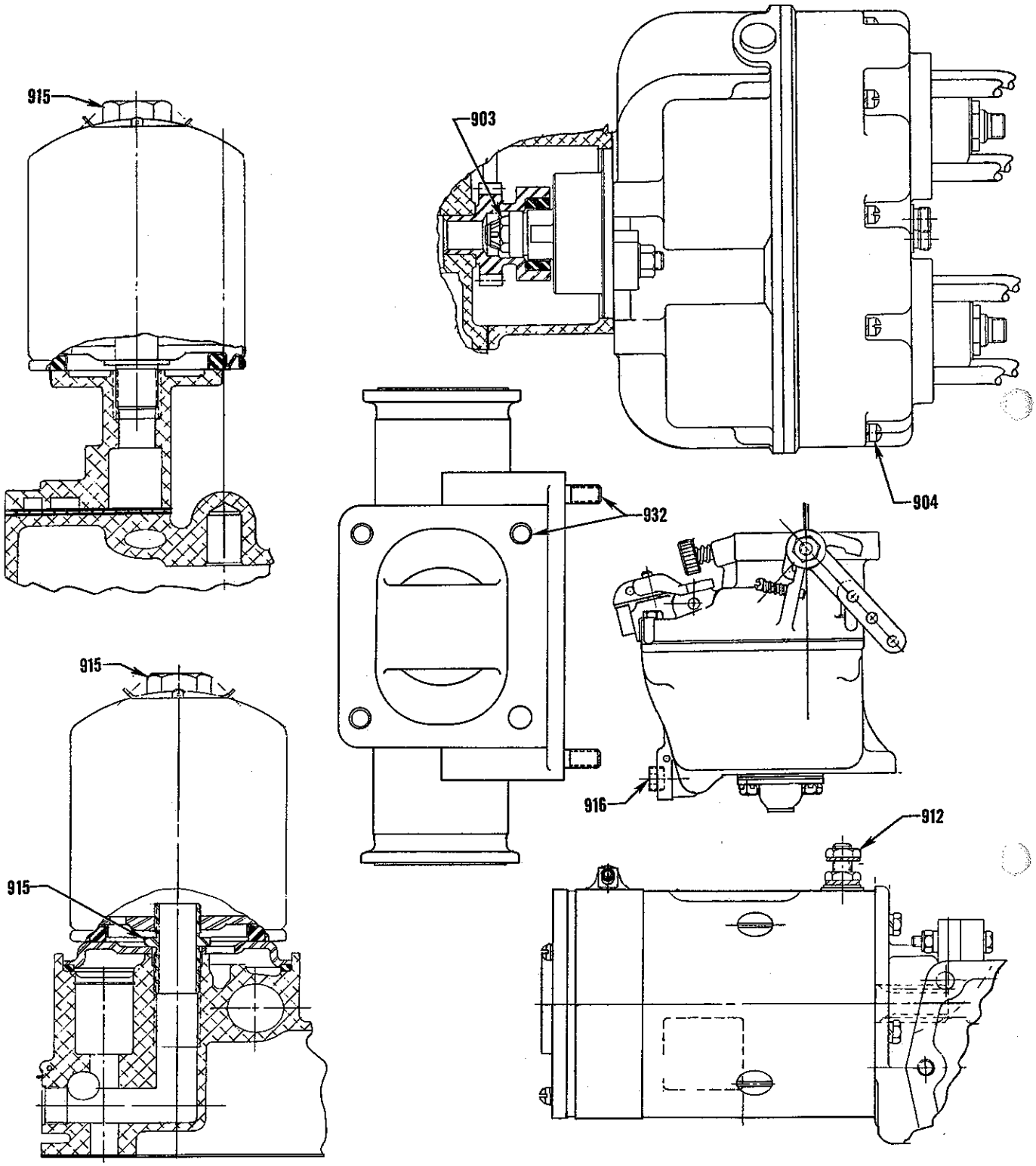
Threads	Torque In. Lb s.
1/4-20	15
5/16-18	25
3/8-16	50



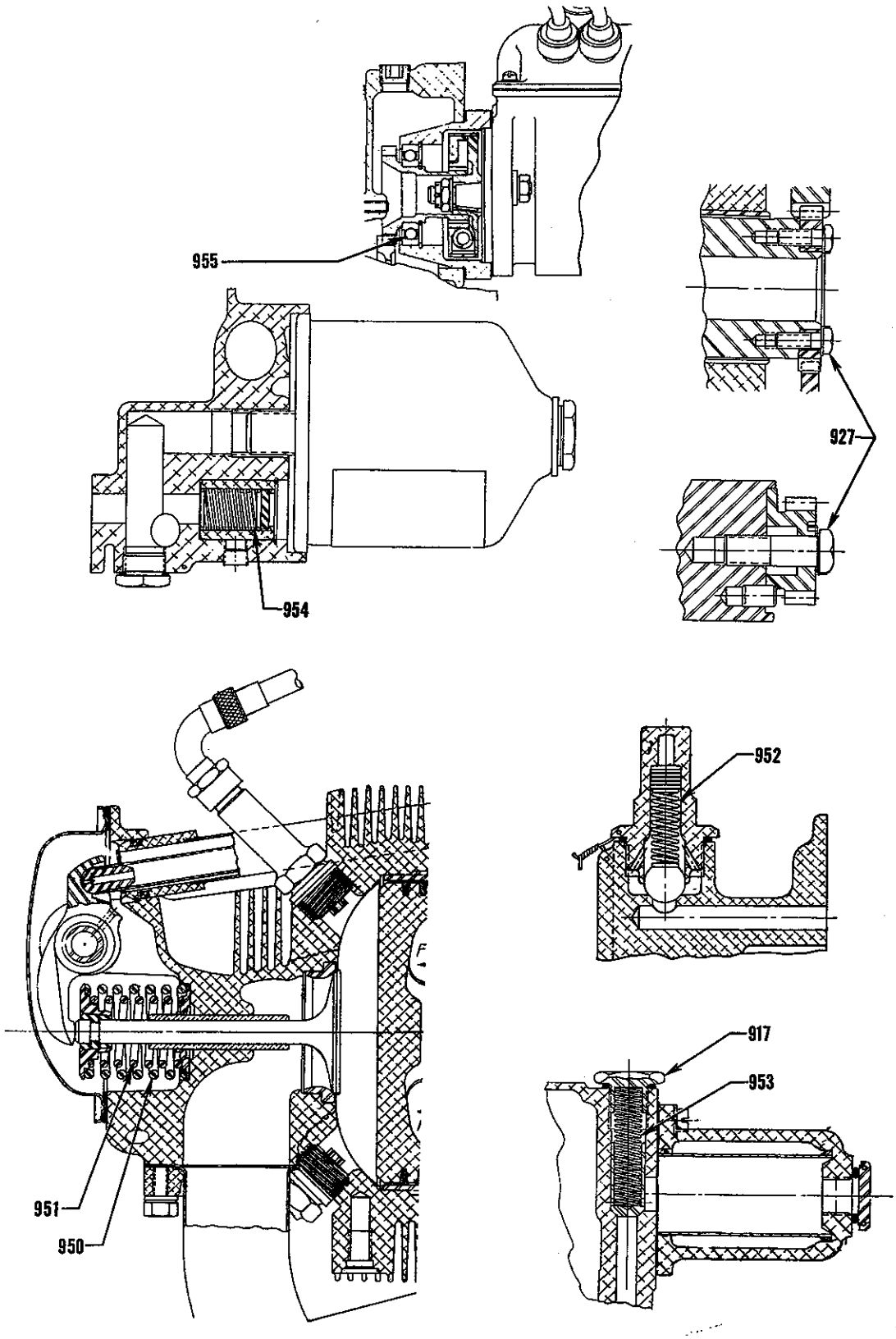
Engine Accessories and Hardware



Engine Accessories and Hardware



Engine Accessories and Hardware



Engine Springs and Hardware

TEXTRON Lycoming

Reciprocating Engine Division/
Subsidiary of Textron Inc.

652 Oliver Street
Williamsport, PA 17701 U.S.A.
717/323-6181

TECHNICAL PUBLICATION REVISION

REVISION No.	PUBLICATION	PUBLICATION No.	PUBLICATION DATE
60294-7-6	Direct Drive Overhaul Manual	60294-7	February, 1971

The page(s) furnished herewith are intended to replace the corresponding page(s) of the publication indicated above.

Previous revisions to this publication		This revision consists of: -	
April, 1966	5-3, 5-6; 8-5	June, 1993	7-10, adds pages 7-10A, 7-10B, 7-10C, 7-10D; 7-12, adds page 7-12A/B
July, 1967	5-8, 6-1 thru 6-18, 6-23, deleted pages 6-25 thru 6-32		
April, 1968	4-2 thru 4-8		
Dec., 1968	Section 11 replaces Special Service Tool Catalog		
Jan., 1970	i, ii, deleted pages iv and v 1-1, 1-2, deleted page 1-3; 2-1 thru 2-6; deleted pages 2-7 thru 2-12; 3-1 thru 3-5; 4-1; 9-1, 9-2, 9-4, deleted page 9-7; 10-1 thru 10-36; deleted pages 10-37 thru 10-47		
Jan., 1971	iii, 6-19 thru 6-24; 7-1 thru 7-19; 9-3, 9-5, 9-6		
May, 1972	Added page 2-7; 3-1, 3-5; 5-1, 5-2, 5-3, 5-4, 5-5, 5-6, 5-7, 5-8, 5-9, 5-10, 5-11, deleted pages 5-12, 5-13, 5-14; 6-1, 6-17, 6-18, 6-22,		

TEXTRON Lycoming

Reciprocating Engine Division/
Subsidiary of Textron Inc.

652 Oliver Street
Williamsport, PA 17701 U.S.A.
717/323-6181

TECHNICAL PUBLICATION REVISION

REVISION No.	PUBLICATION	PUBLICATION No.	PUBLICATION DATE
60294-7-6	Direct Drive Overhaul Manual	60294-7	February, 1971

The page(s) furnished herewith are intended to replace the corresponding page(s) of the publication indicated above.

Previous revisions to this publication		This revision consists of: -
May, 1972 (Cont.)	6-23; 8-1, 8-2, 8-3, 8-4, 8-5, 8-6, deleted pages 8-7, 8-8; 9-3	
Oct., 1974	i, ii, iii 1-1; 3-3, 3-4, 3-5; 4-1, 4-3, 4-4, 4-5, 4-6, 4-7, 4-8; 5-1, 5-5, 5-6, 5-7, 5-9, 5-10; 6-2, 6-7, 6-10, 6-11, 6-12, 6-13, 6-17, 6-20, 6-21, 6-22, 6-23; 7-4, 7-16, 7-17, 7-18, 7-19; 9-1, 9-2	
Feb., 1992	i	

6. Polish the oil seal area of the shaft with crocus cloth while the shaft is rotated counter-clockwise when viewed from the flange (front) end of shaft. Do not move the cloth while polishing because the area must be free of spiral marks.

7. Clean the shaft to remove all traces of grinding dust and mask the bushing holes in the flange.

8. Cadmium plate (in accordance with AMS 2400) the flange and oil seal area of the crankshaft as indicated in figure 7-13. Do not plate beyond the 0.13 inch radius.

9. After plating, bake the crankshaft at 275° F. ± 10° F. for 5 hours to eliminate possibility of surface embrittlement.

10. See the applicable Avco Lycoming Parts Catalog for the particular engine model for correct propeller flange bushings and install new plated service bushings in the flange. Chill the bushings by refrigeration and install with Avco Lycoming Service Tool No. ST-115.

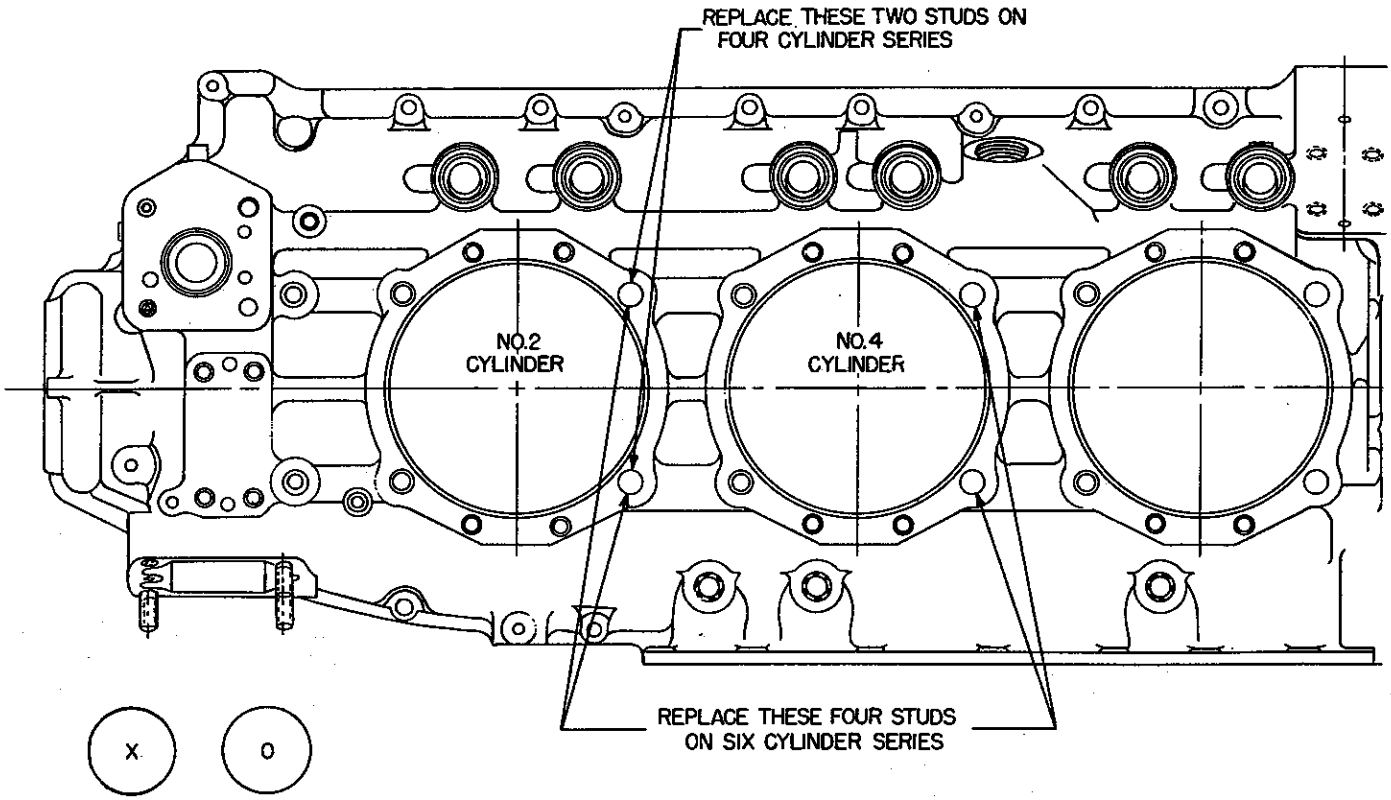
11. Support crankshaft in vee-blocks at the end journals and measure run-out at refinished area. Total indicated run-out must not exceed 0.002 inch.

12. Examine crankshaft by magnetic particle method.

7-50. Crankshaft, Counterweight Bushing Replacement (Where applicable). Wear or damage to the crankshaft counterweight bushings located in the crankshaft counterweight lugs, is almost impossible to detect by normal inspection procedures. Because of this situation and as damage to the crankshaft counterweight bushings could cause failure of the counterweight and/or the crankshaft, it is mandatory that these bushings be replaced at overhaul. The procedure for removal and replacement of the crankshaft counterweight bushings follows.

1. Thread the bolt of the counterweight bushing puller through the puller plate, positioning the plate so that the recess in it will be next to the crankshaft when the puller bolt is inserted through the bushing in the crankshaft. Install the small puller bushing over the end of the bolt and then place the puller nut over the end of the bolt and tighten. As the nut is tightened on the bolt the counterweight bushing will be pushed out of its recess in the crankshaft counterweight mounting ear and into the recess in the puller plate. See figure 7-14.

2. Measure the ID of the roller bushing hole in the crankshaft. If the hole measures 0.9369 - 0.9377 inch, no reaming of the hole is necessary and a standard bushing may be installed. If the roller bushing hole measures more than 0.9377 inch, the next oversize bushing must be installed and the hole reamed accordingly. See Table 7-2.



NOTE: ENGINES WHICH INCORPORATE BODY FIT THRU-STUDS AS INDICATED BY ARROWS WILL BE STAMPED "X" OR "O" AS SHOWN ABOVE. ENGINES WITH STUDS SO IDENTIFIED NEED NOT BE REWORKED

Figure 7-11. Location of Thru-Studs to be Modified

TABLE 7-2	
Hole Size	Reamer No.
.9369/.9377	None
.9420/.9425	64874
.9445/.9450	ST-210
.9470/.9475	64875
.9495/.9500	ST-211
.9520/.9525	64876

3. Determine the oversize reamer needed and assemble the reaming fixture over the crankshaft lug. Select the two openings in the fixture to line up with bushing holes and install the plugs provided to line up the holes in the fixture with the holes in the crankshaft lugs. Secure the fixture by tightening the set screw. Assemble the reamer to a suitable brace and proceed to hand ream the hole in the crankshaft lug to proper size.

4. Assemble the puller to the crankshaft in the same manner as described in "Step 1" except that the large puller bushing is used instead of small puller bushing. Place the correct size crankshaft bushing on the puller bolt, between the crankshaft lug and the large puller bushing. When the puller nut is tightened, the bushing will be forced into place in the crankshaft.

CAUTION

The inside diameter of these bushings is finished at the factory and no further machining of the bushing is necessary. Caution must be exercised when installing the bushings so that this finished ID is not damaged. Because of possible damage to the crankshaft, never, under any circumstances, remove or install the roller bushings by use of a drift.

5. After the bushing is installed, check its alignment with the main bearings by placing the crankshaft in vee blocks on a surface plate. Install the wedge blocks, Tool No. ST-212, in the bushing and compare parallelism of the wedge blocks with that of the main journals. Bushing must be parallel with .002 per inch. Support the crankshaft in the vee blocks at journals adjacent to the bushing location.

7-51. Counterweight Bushing Replacement - Consult the latest edition of Servie Instruction No. 1143 for information relative to rebushing counterweights and subsequent inspection.

7-52. Connecting Rod Bushings. If the bushing in the small end of the connecting rod is worn beyond service limits, it can be removed and replaced by accomplishing the following procedure:

1. Clamp the connecting rod on the connecting rod bushing replacement block (P/N 64597) in such a manner that the small bushing in the rod is in alignment with the hole stamped "Remove Bushing". Use the connecting rod bushing removal drift (P/N 64535) and drive the bushing out of the rod. Move the connecting rod to the "Install and Burnish" position and clamp it securely in place. Using the replacement drift (P/N 64536) drive a new bushing in place in the rod. Be sure the split in the bushing is located so that it is toward the piston end of rod and 45° off the centerline.

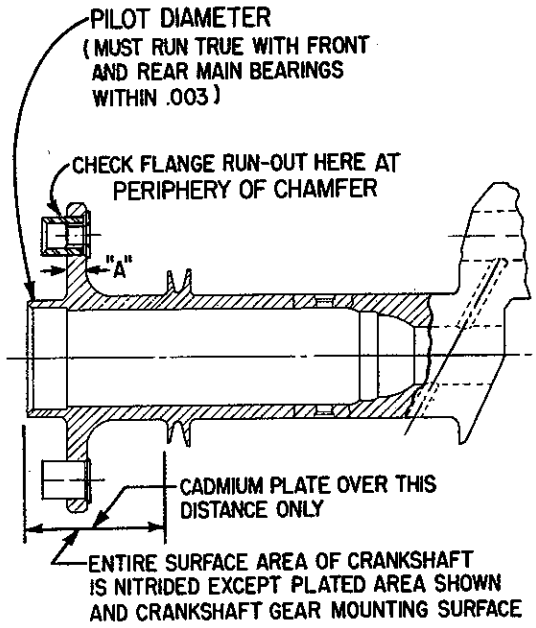


Figure 7-12. Limits for Straightening Bent Flange

2. Use a suitable arbor press and the connecting rod bushing burnisher (P/N 64580) to burnish bushing in place. Pass the burnisher completely through the bushing. Remove the rod from the holding block and finish bore the bushing to diameter shown in Table of Limits, SSP1776, Ref. 600. Check the bushing ID with finish ID gage (P/N 64767). Check alignment of the hole in the bushing with connecting rod parallelism and squareness gage (P/N 64530) as described in paragraphs 7-39 and 7-40. If the assembly does not meet the requirements shown in references 503 and 504, Table of Limits, SSP1776, the entire assembly must be replaced.

7-53. Crankshaft and Gear Assembly. Damage to the crankshaft gear and the counterbored recess in the rear of the crankshaft, as well as badly worn or broken gear alignment dowels are the result of improper assembly techniques or the reuse of worn or damaged parts during reassembly. Since a failure of the gear or the gear attaching parts would result in complete engine stoppage, the proper inspection and reassembly of these parts is very important. The procedures described in the following steps are mandatory.

CAUTION

Prior to making any repairs to the crankshaft, insure that the counterbored gear mounting face of the crankshaft is undamaged by fretting or galling. Damage of this nature is unrepairable.

1. Examine the threads in the gear retaining bolt hole of the crankshaft. Insure that the tapped hole is clean and

the threads are undamaged. The threads can be cleaned by running a tap through them. Use a standard .3125-24NF3 (P.D. .2854/.2878) tap for 5/16 inch threads. Use a standard .500-20NF3 (P.D. .4675/.4701) tap for 1/2 inch threads. Check the depth of the thread by threading a gear retaining bolt to the bottom of the hole and comparing the exposed length of the bolt with the thickness of the gear and lockplate.

CAUTION

Use extreme care when cleaning threads with tap.

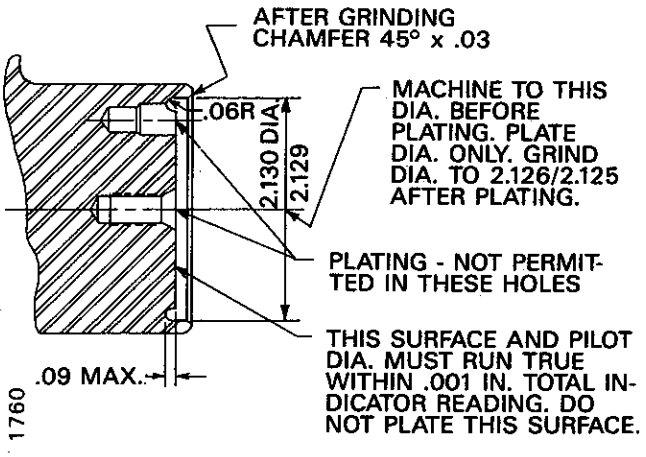


Figure 7-12A. Details for Repairing Pilot Diameter of Crankshaft

2. Check the condition of the dowel in the end of the crankshaft. It should be perfectly smooth with no indication of nicks or deformation. If it is out-of-round, it should be removed and replaced with a new one. Replacement instructions are in step 4. If dowel condition is acceptable, insure that it is installed as shown in Figure 7-12B. or Figure 7-12C.

CAUTION

If the dowel must be removed, it is very important to do so without damaging the hole in the crankshaft. A satisfactory method consists of drilling a 1/8 in. dia. hole through the center of the dowel; then fill the hole with oil and insert a piece of 1/8 in. dia. drill rod in the hole. Strike the end of the drill rod a sharp blow with a hammer. Hydraulic pressure of the oil will force the dowel from the crankshaft.

3. Check the pilot diameter of the counterbore on the end of the crankshaft for size and evidence of damage. The diameter should not exceed 2.1262 inches when measured at any location. If found to be oversize, the crankshaft may be repaired as described in the following steps. Do not attempt to reuse a crankshaft with an oversize pilot diameter.

a. After removing the dowel, machine the pilot diameter in the end of the crankshaft to 2.129/2.130 inch as shown in the illustration. See Figure 7-12A. Also, cut the .09 deep x .06R undercut as shown.

b. Chrome or nickel plate the surface of the pilot diameter with a firmly bonded deposit that is free of pin holes, blisters and any other imperfections that could impair the function of the parts.

c. After plating, stress relieve the shaft by baking at 390° to 410°F. for 3 to 5 hours.

d. Grind the plated pilot diameter surface to 2.125/2.126 inch. Note that the diameter must run true with rear main journal within .001 inch total indicator reading.

CAUTION

The crankshaft counterbored gear mounting face should be checked for damage. If the surface face requires repair other than specified in CAUTION following paragraph 7-53, the crankshaft should first be measured as shown in Figure 7-12G. If the crankshaft measures more than the minimum dimension shown in Figure 7-12G, the surface may be reworked down to the dimensions shown. (Do not plate the surface.) The surface must be true within .001 in. total indicator reading to rear main bearing and the surface finish must be held to 45 to 90 microinches.

e. Chamfer edge of pilot diameter 45° x .03 as shown in Figure 7-12A.

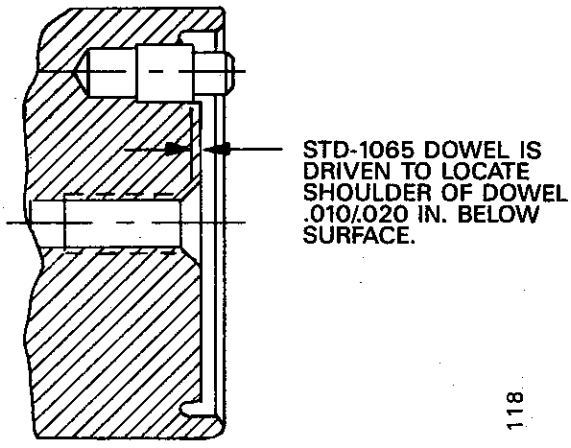


Figure 7-12B. Section Thru End of Crankshaft Showing Driven Height of STD-1065 Dowel

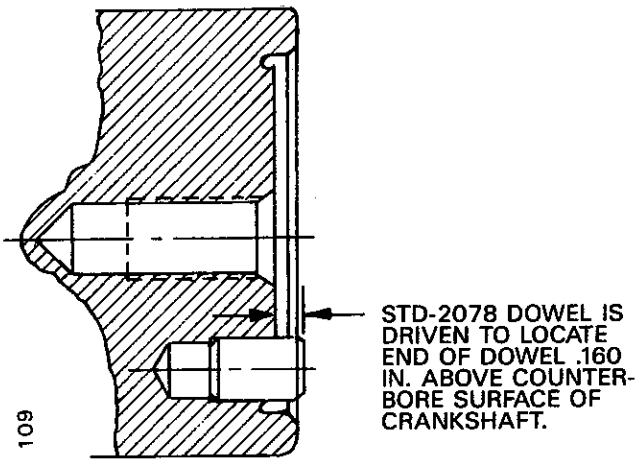


Figure 7-12D. Details of Crankshaft Dowels

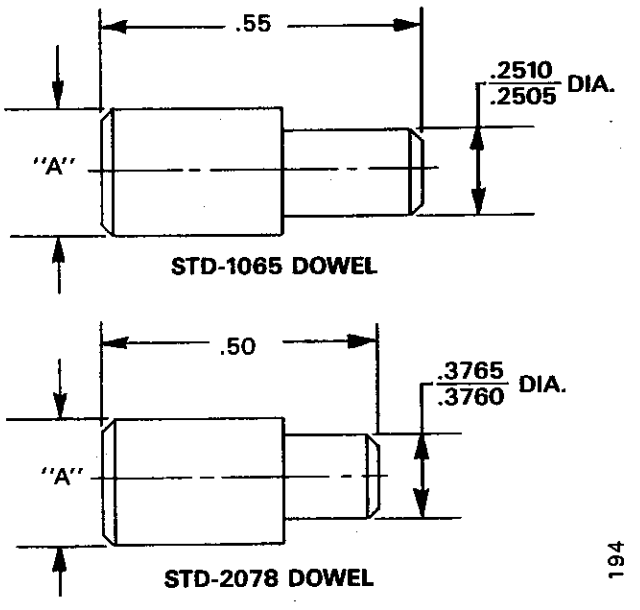


Figure 7-12C. Section Thru End of Crankshaft Showing Driven Height of STD-2078 Dowel

4. If the dowel has been removed, check the condition of the dowel hole in the crankshaft. If out-of-round or oversize, ream as required for installation of an oversize dowel. Available oversize dowels and the corresponding reamed holes are shown in Table 7-3.

TABLE 7-3. DOWELS & DOWEL HOLES

Dowel Part No.	Size Code on Dowel	Diameter of Dowel "A" (Fig. 7-12D)	Diameter of Dowel Hole in Crankshaft
STD-1065	None	.3095/.3100	.3085/.3095
STD-1065-P02	P02	.3115/.3120	.3105/.3115
STD-1065-P05	P05	.3145/.3150	.3135/.3145
STD-1065-P10	P10	.3195/.3200	.3185/.3195
STD-1065-P15	P15	.3245/.3250	.3235/.3245
STD-2078	None	.3760/.3765	.3750/.3760
STD-2078-P02	P02	.3780/.3785	.3770/.3780
STD-2078-P05	P05	.3810/.3815	.3800/.3810
STD-2078-P10	P10	.3860/.3865	.3850/.3860
STD-2078-P15	P15	.3910/.3915	.3900/.3910

CAUTION

Crankshaft gears for applicable engines are now manufactured with three 3/4 inch radius scallops cut into the OD of the pilot flange and a counterbore on the back side of the gear. These enlarged scallops have been added to allow inspection of the gear and crankshaft assembly. Serviceable gears must be modified as shown in Figure 7-12E, prior to being reassembled on the crankshaft, or a new gear that has been manufactured to this configuration must be installed. Before modifying the gear, measure the diameter of the pilot flange. If it is less than 2.1245 inch, it should not be reused. The original 2.1250/2.1255 dimension of the crankshaft gear must be restored with a flash copper plate of up to .0005 inch max.

TABLE 7-4. CRANKSHAFT GEAR & ATTACHING PARTS

New Crankshaft Gear Part No.	Superseded Crankshaft Gear Part No.	Lockplate Part No.	Bolt Part No.	Dowel Part No.
13S19646 13S19647 13S19648	61155 67514 76786	LW-18639 LW-18638 LW-18638	STD-2213 STD-2209 STD-2209	STD-1065 (5/16 in. dia.)
13S19649	LW-10284	LW-10332	AN8-14A	STD-2078 (3/8 in. dia.)

CAUTION

Some old crankshaft gears are carborized all over. If carborized, they will not nick when a file is used on scallop. If carborized all over, gear should not be reworked.

7-54. Starter Ring Gear. The latest edition of Service Instruction No. 1141 contains all the information necessary to accomplish the replacement of the starter ring gear.

7-55. Crankcase - Modification of Center Main Bearing Supports to Incorporate Body Fit Thru-Studs. This modification to be performed on the following listed engines only.

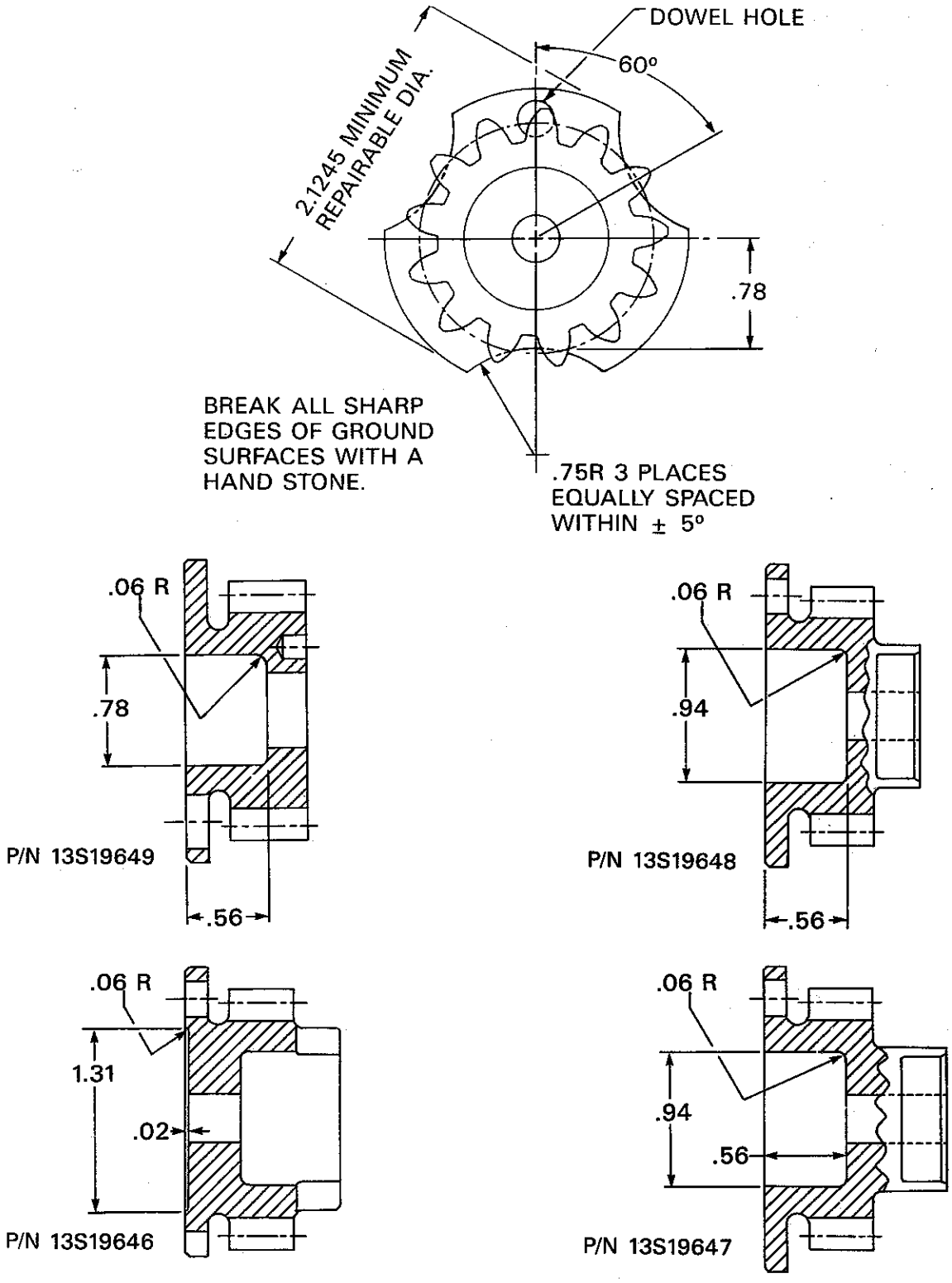


Figure 7-12E. Details for Rework of Crankshaft Gears to Current Configuration

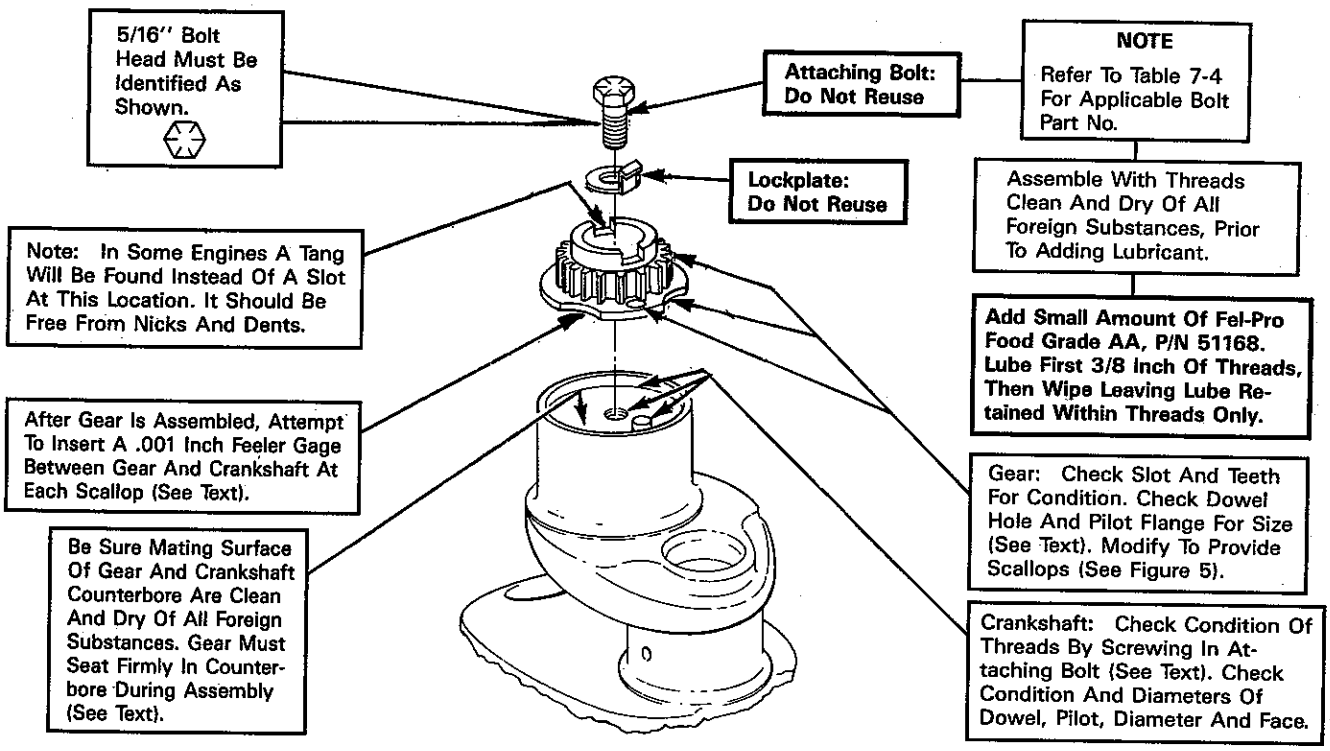
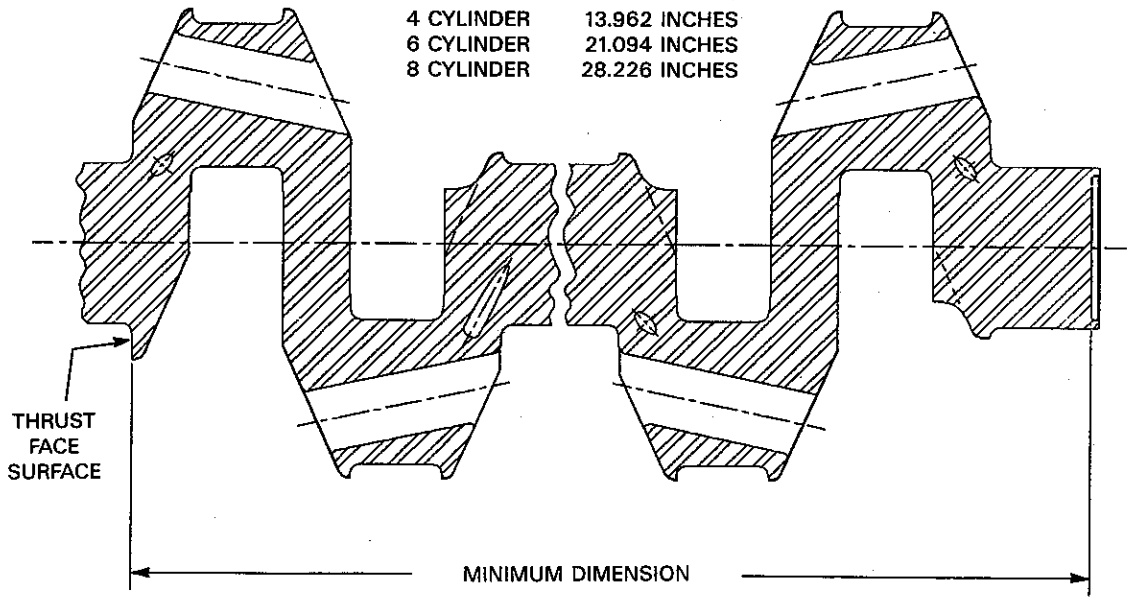


Figure 7-12F. Rear End View of Crankshaft Showing Associated Parts

CAUTION

No field repair of crankshaft gear attaching threads is permitted. Crankshafts requiring this type of repair **must be** returned to the factory through an authorized Textron Lycoming Distributor.



CAUTION

Insure minimum dimension is measured between thrust face surface and pilot.

Figure 7-12G. Minimum Dimension of Crankshaft

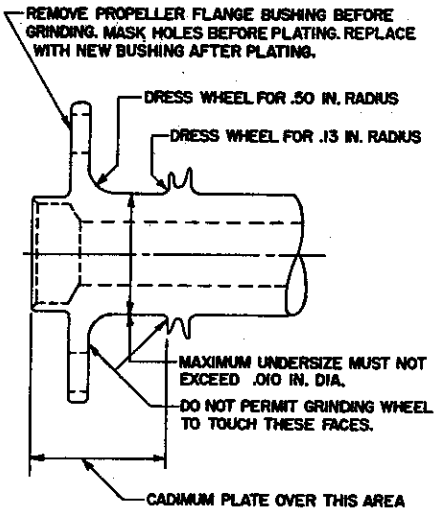


Figure 7-13. Reconditioning Crankshaft Oil Seal Surface

O-320-B Series	Engines prior to 3815-39
O-340 Series	Engines prior to 405-30
O-360-A, -C Series	Engines prior to 3042-36
O-540 Series	Engines prior to 2790-40

1. With the crankcase assembled as directed in paragraphs 7-34 and 7-35, loosen and remove the thru-studs from the locations shown in figure 7-11.

2. Place the crankcase with the odd numbered cylinder side down on eight inch parallel blocks.

3. Set the stop collar (P/N 64905) 5.75 inches above the cutting edge of special piloted reamer (P/N 64902).

4. Assemble the universal (P/N 64908) to a 1/2 inch electric drill motor, the reamer to the universal and proceed to ream 0.547 inch through thru-stud holes from the even cylinder number side. Continue reaming until the reamer reaches the collar. Make sure the drill and reamer has stopped before removal from the stud hole.

CAUTION

A liberal amount of kerosene must be constantly flowing into the hole as the reamer is passing through. This will prevent overheating and scoring.

5. Remove the stop collar from the 0.547 inch diameter reamer and assemble the collar 5.50 inches from the cutting edge of the 0.563 inch diameter finish reamer (P/N 64903).

6. Assemble reamer to universal and proceed to finish ream the holes, once again paying attention to the preceding "caution" note.

7. Disassemble crankcase halves and hand tap the anchor threads 0.007 inch oversize using tap (P/N 64907).

8. Use a 3/4 inch counterbore (P/N 64904) and standard tap handle to resize the oil seal counterbore hole. Exercise caution so as not to go deeper than the present depth. See figure 7-10.

9. Burr to clean up all rough edges caused by the reaming operations. Wash and clean the crankcase thoroughly.

10. Assemble new body fit thru-studs (P/N 72698-P07) in the threaded half of the crankcase. The same size "O" ring seal is used with the 9/16 inch thru-studs as was previously used.

7-56. Oil Relief Valve Sleeve (Non-adjustable oil relief valve). If the sleeve is badly scored or otherwise damaged, remove and replace the sleeve in the following manner.

1. Apply a liberal coating of heavy grease to the threads of a standard 1/2-20 bottoming hand tap. This will aid in subsequent cleaning of the relief valve bore, since loose metal particles resulting from the action of the tap will tend to adhere to the tap when it is withdrawn from the bore. Insert the tap into the relief valve bore, making sure that the tap is centered in the ball seat of the sleeve. Screw the tap into the sleeve a maximum of four full turns.

CAUTION

Do not rotate tap in excess of four full turns because the tap may damage the crankcase if it is inserted too far beyond the sleeve.

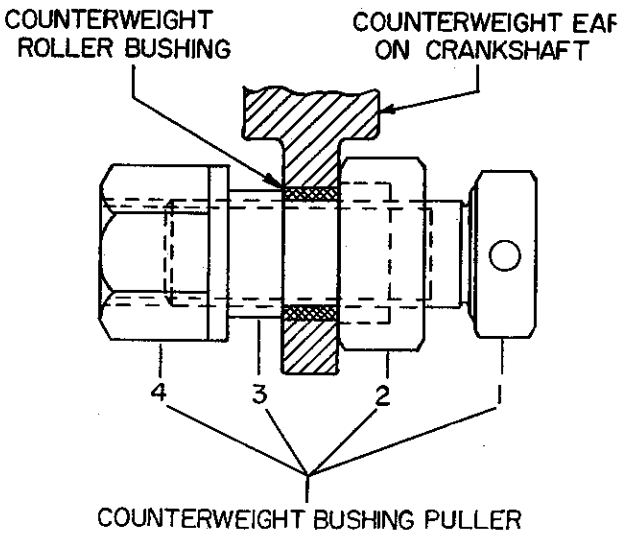


Figure 7-14. Removal of Crankshaft Counterweight Bushing

2. Draw the tap and sleeve straight out of the bore with a sharp quick pull.

3. Clean the relief valve bore thoroughly with petroleum solvent and a suitable bristle brush, taking care to see that all metal particles are removed. The sleeve seat in particular must be entirely free from foreign matter, or new sleeve will not seat properly.

4. Place a new relief valve sleeve into the crankcase bore with the seat end of the sleeve toward the crankcase. Make sure that the sleeve is centered in the bore, insert sleeve driver (ST-215) in the sleeve and drive sleeve into place with light hammer blows on the driver.

5. If the sleeve does not make a 0.001 press fit with the crankcase, but is loose, remove the standard size sleeve and install an 0.003 inch oversize sleeve exactly as described in Step "4" above.

CAUTION

In the event the hole in the crankcase is too small for installation of the 0.003 inch oversize sleeve, place the sleeve in a lathe and lap it sufficiently to fit the hole in the crankcase. Never ream the oil relief valve sleeve hole in the crankcase.

7-57. Oil Pressure Relief Valve (adjustable). The latest edition of Service Instruction No. 1172 contains the information relative to replacing the non-adjustable oil pressure relief valve assembly with the adjustable oil pressure relief valve assembly if required.

7-58. Crankcase - Fretting. Consult the latest edition of Service Instruction No. 1112 for information relative to inspection and repair of crankcases damaged by fretting.

7-59. Crankcase - Fretting. The latest edition of Service Instruction No. 1123 contains all the requirements necessary to modify the crankcase to prevent fretting.

7-60. Crankshaft Idler Gear Shaft Recess. Damaged or worn idler gear shaft recesses in the crankcase can be repaired as described in Service Instruction No. 1197.

REASSEMBLY

7-61. Crankshaft Sludge Tube Assembly (Where applicable). Support the crankshaft in a nearly vertical position and install new sludge tubes. Place a new sludge tube on the applicable drift, P/N 64547 for six and eight cylinder engines and P/N 64548 for four cylinder engines, and drive sludge tube to its correct depth. See figure 7-17 for four cylinder engines and figure 7-18 for six and eight cylinder engines.

NOTE

Sludge tubes are not employed in later model crankshafts. However, this is not to imply that sludge tubes can be removed and not replaced in those crankshafts originally using sludge tubes.

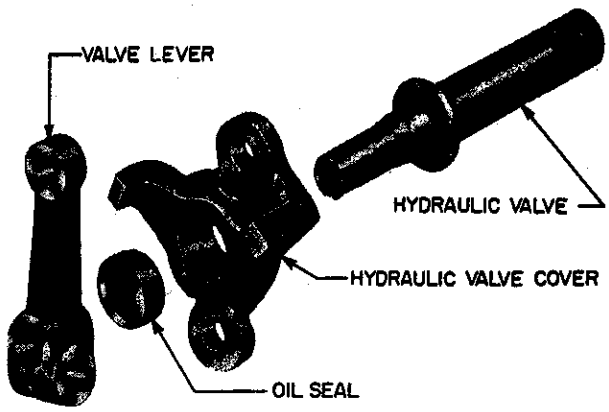


Figure 7-15. Hydraulic Valve Assembly

7-62. Expansion Plug. On engines equipped for fixed pitch propeller use the expansion plug installation drift (P/N 64681) to install a new expansion plug in place in the front of the crankshaft (see figure 7-17) with the convex side toward the front. Be sure the plug fits firmly against the shoulder provided for it on the inside diameter of the crankshaft.

7-63. Plug. On engines equipped for controllable pitch propeller, a plug is installed at the rear of the bore in the front of the crankshaft. If this plug has been removed during overhaul, install a new plug by sliding it sideways past the crankshaft propeller oil tube (see figure 7-17). When the plug is properly positioned in the rear of the bore (flange forward) insert the oil plug drift (P/N 64770 for 1-3/4 inch plug, P/N ST-46 for 1-3/8 inch plug) and seat the plug with several sharp hammer blows on the drift.

NOTE

Some crankshaft employ a 1-1/4 inch plug. This size plug cannot be replaced in the field. The crankshaft must be returned to Textron Lycoming for repair.

7-64. Propeller Flange Bushings. If the propeller flange bushings have been removed from the crankshaft, new bushings must be installed. Use the crankshaft flange bushing replacement tool (ST-115) to install new bushings. Consult the applicable Parts Catalog for proper location of the bushings.

7-65. Crankshaft Gear. Assemble the gear to the crankshaft **using both a new lockplate and bolt.** Refer to Figure 7-12F. The correct bolt, lockplate and dowel for each gear are shown in Table 7-4. Tighten the bolt to 125 inch lbs. torque, then with a hammer and brass drift, tap lightly around the pilot flange of the gear and listen for sharp solid sounds from the hammer blows that would indicate that the gear is seated against the crankshaft. As a check on seating against the crankshaft, attempt to insert a pointed .001 inch thick feeler gage or shim stock between the gear and crankshaft at each of the three scallops. The .001 feeler gage, or any smaller feeler gage, must **NOT** fit between the two sur-

faces at any location. (.001 feeler gage is used as an indicator, however there must be no clearance between crankshaft and gear.) Retighten the gear attaching bolt to the proper torque. Tighten the 5/16 inch bolt to 204 inch-pound torque or the 1/2 inch bolt to 660 inch-pound torque. Measure the clearance between the O.D. of the gear flange and the pilot I.D. of the crankshaft. There should not be more than .0005 inch clearance at any point. Bend the lockplate against the bolt head.

7-66. Counterweight Assembly. When assembling counterweights which have previously been installed on the engine, use the identifying marks, made on the various parts during disassembly, to enable matching each washer with the proper seat on the counterweight from which it was removed. Install washer (10) and retaining ring (11) on one side of the counterweight (8), place the counterweight on its proper ear on the crankshaft, insert the roller (9) and secure the assembly by installing the washer and retaining ring on the second