OVERHAUL MANUAL
FOR
IO-360 AND TSIO-360 SERIES
AIRCRAFT ENGINES

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SECTION I
INTRODUCTION

1-1. SCOPE. This publication contains overhaul instruction for Models IO-360-A, C & D, and TSIO-360-A, B, C and D Aircraft Engines.

1-2. RELATED PUBLICATIONS. Detail part numbers and service assemblies for these engines are contained in the Service Parts Catalog, Form X-30031A. Operating instructions for the IO-360 Series will be found in Operator's Manual, Form X-30032 and for the TSIO-360 Series in Operator's Manual, Form X-30069.

a. Service instructions for Bendix-Scintilla Magneto Models S6LN-25, S6LN-201 or S6LN-205 may be obtained from Scintilla Magneto Division, Bendix Aviation Corporation, Sidney, New York 13838.

b. Service instructions for Delco-Remy starter, Model 1108234 or 1109514 may be obtained from any United Delco Parts and Service Distributor.

c. Service instructions for the Prestolite Alternator may be obtained from Prestolite Company, 15705 Meyers Road, Detroit, Michigan 48227.

d. Service instructions for the Ford Alternator may be obtained from Ford Motor Company, General Parts Division, McKean and Textile Roads, P. O. Box 412, Ypsilanti, Michigan 48197.

1-3. SERVICE BULLETINS. Important changes and product improvements are covered by factory service bulletins available for study at all Approved Distributors. These bulletins are also available to owners, operators and maintenance personnel on an annual subscription basis.

1-4. SERVICE REPORTS AND INQUIRIES. It is the policy of Teledyne Continental Motors to handle all reports of service difficulties and requests for information through Approved Distributors. Requests for further copies of this or any other Continenal Aircraft Engine Service Publications should be made through these facilities. There is an Approved Distributor at every major airport.

1-5. DEFINITION OF TERMS. Front, rear, left and right, as used in this manual refer to the engine as viewed by the mechanic in a normal position, facing the accessory end.

1-6. CYLINDER ARRANGEMENT. Cylinders are numbered starting from the rear, with odd numbers on the right and even numbers on the left.

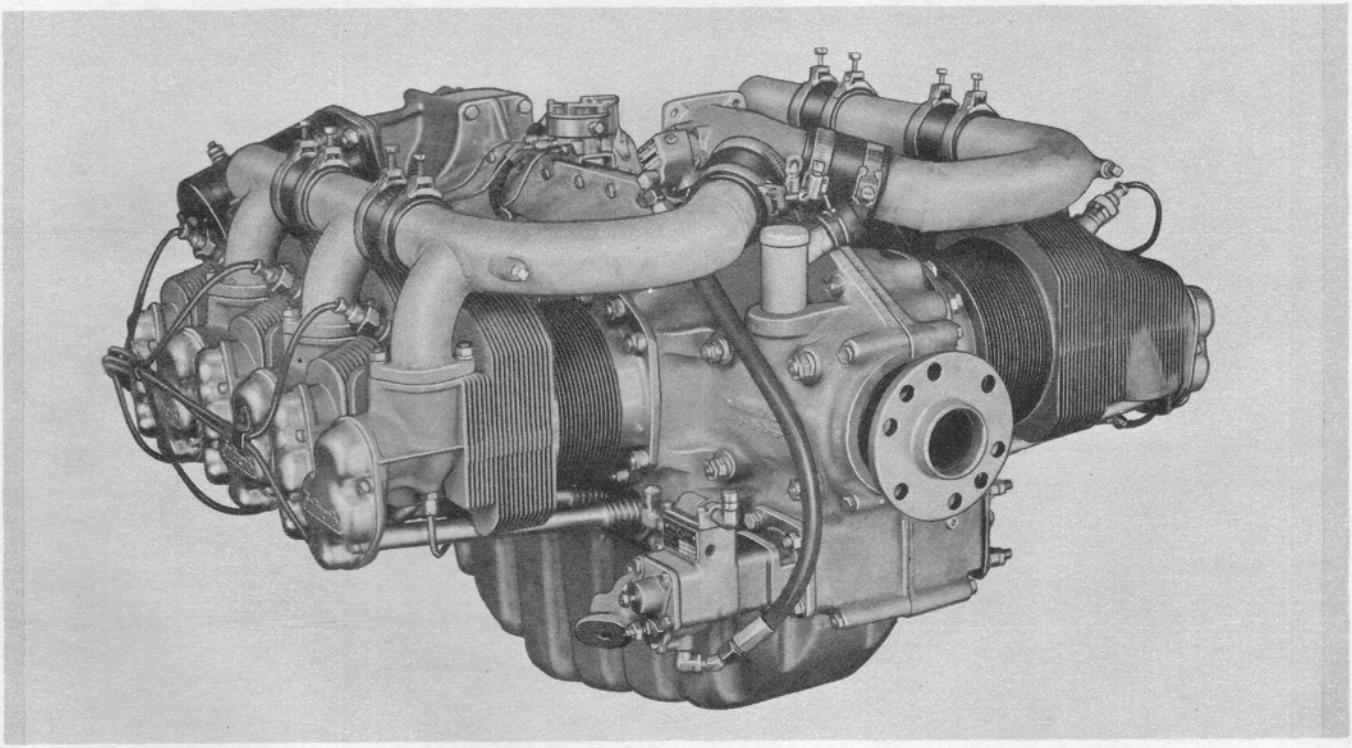


Figure 1-1. Three-Quarter Right Front View of the IO-360

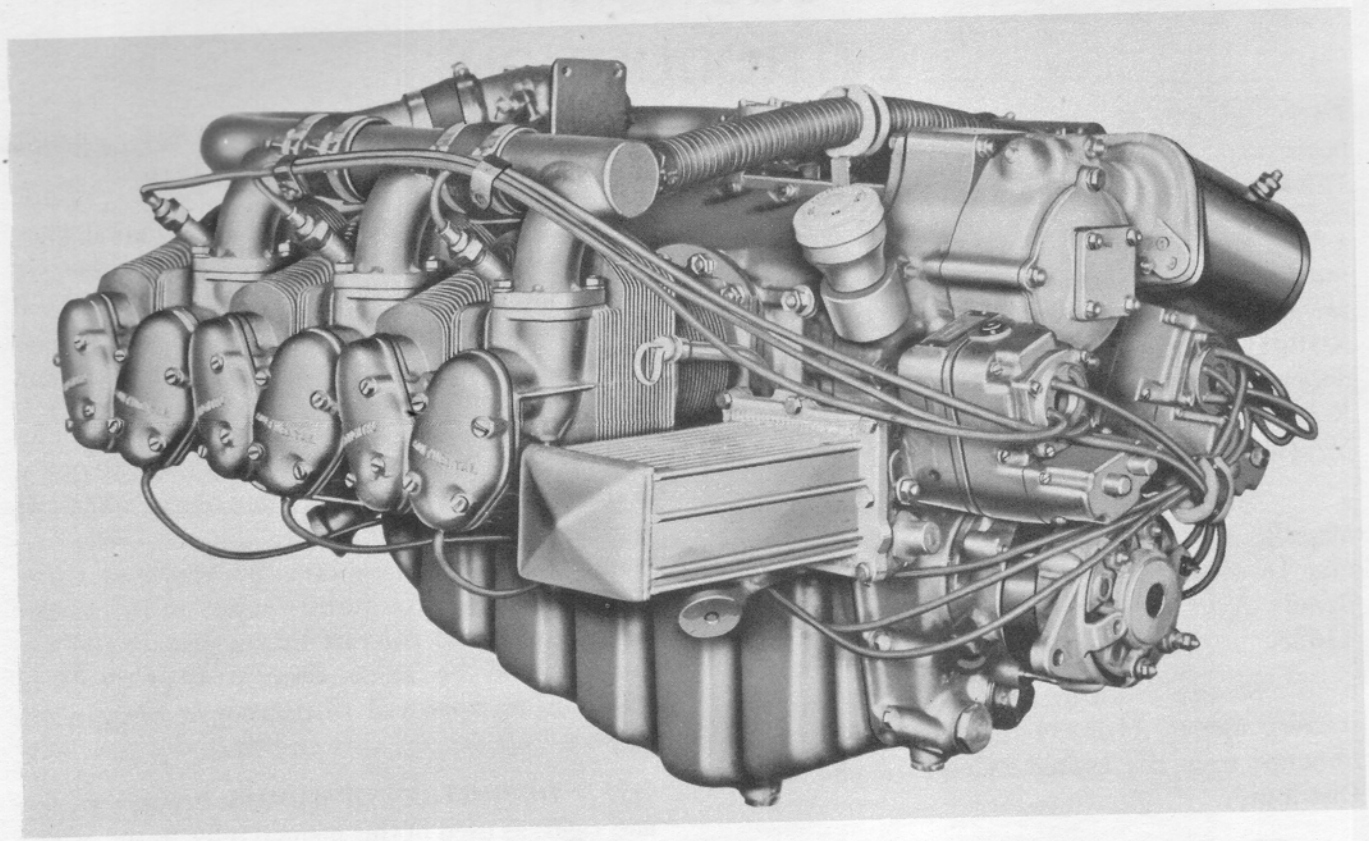


Figure 1-2. Three-Quarter Left Rear View of the IO-360A.

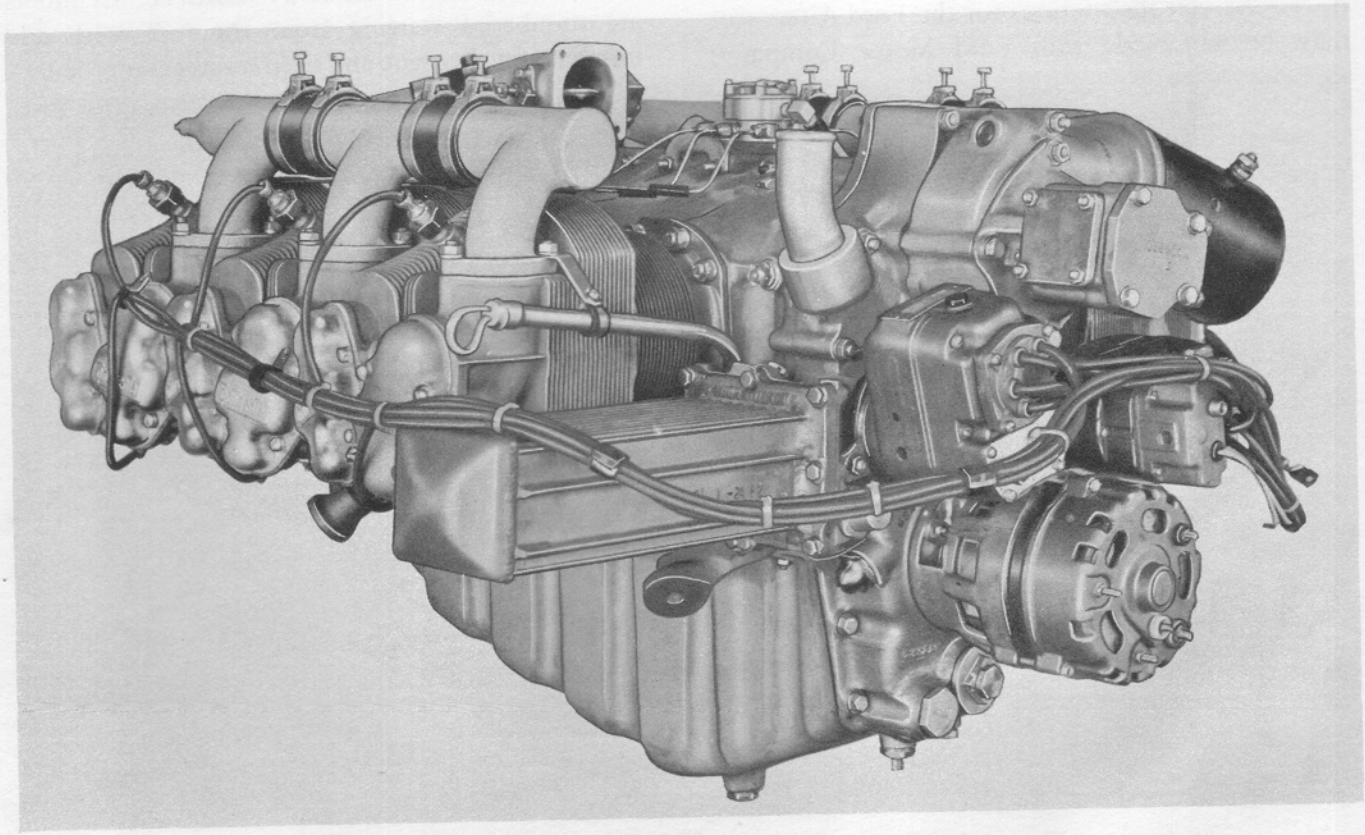


Figure 1-3. Three-Quarter Left Rear View of the IO-360C and G.

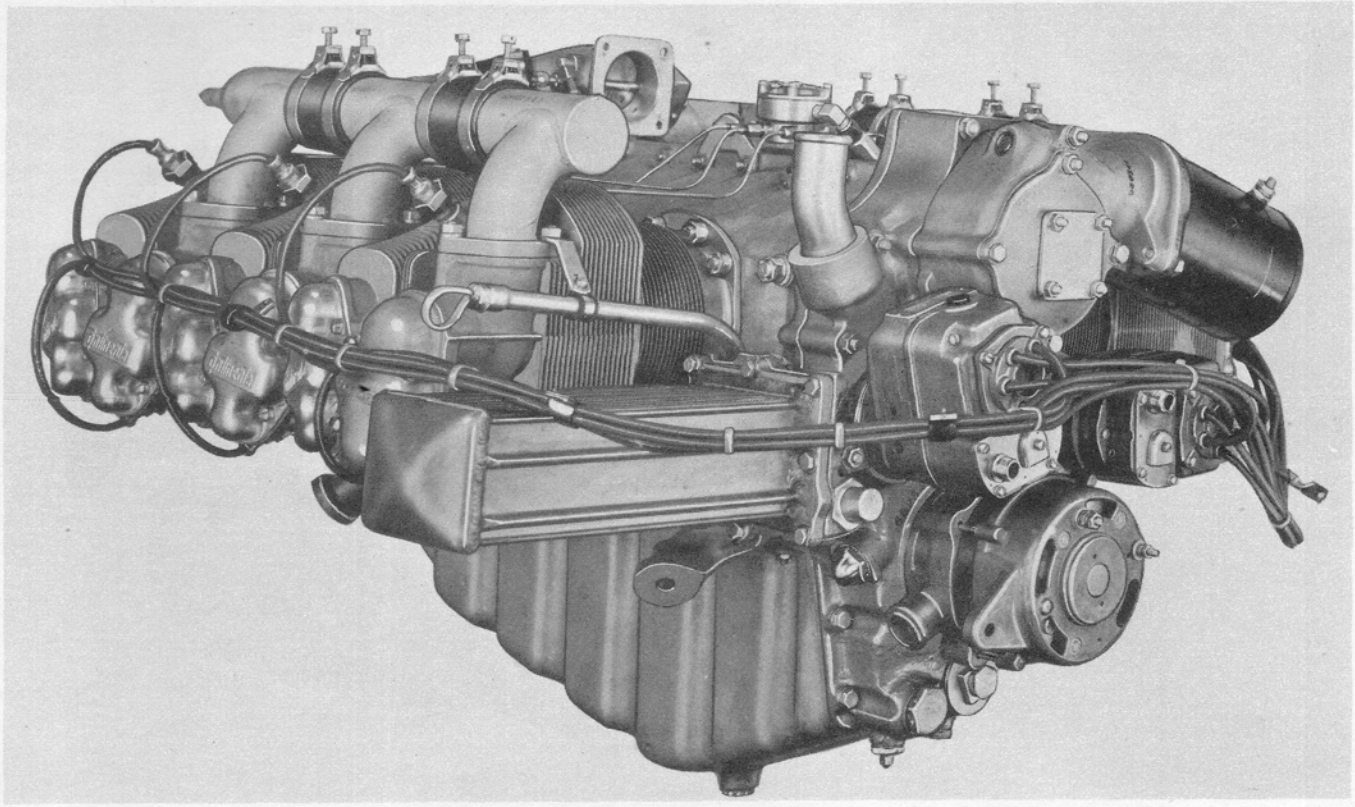


Figure 1-4. Three-Quarter Left Rear View of the IO-360D and H.

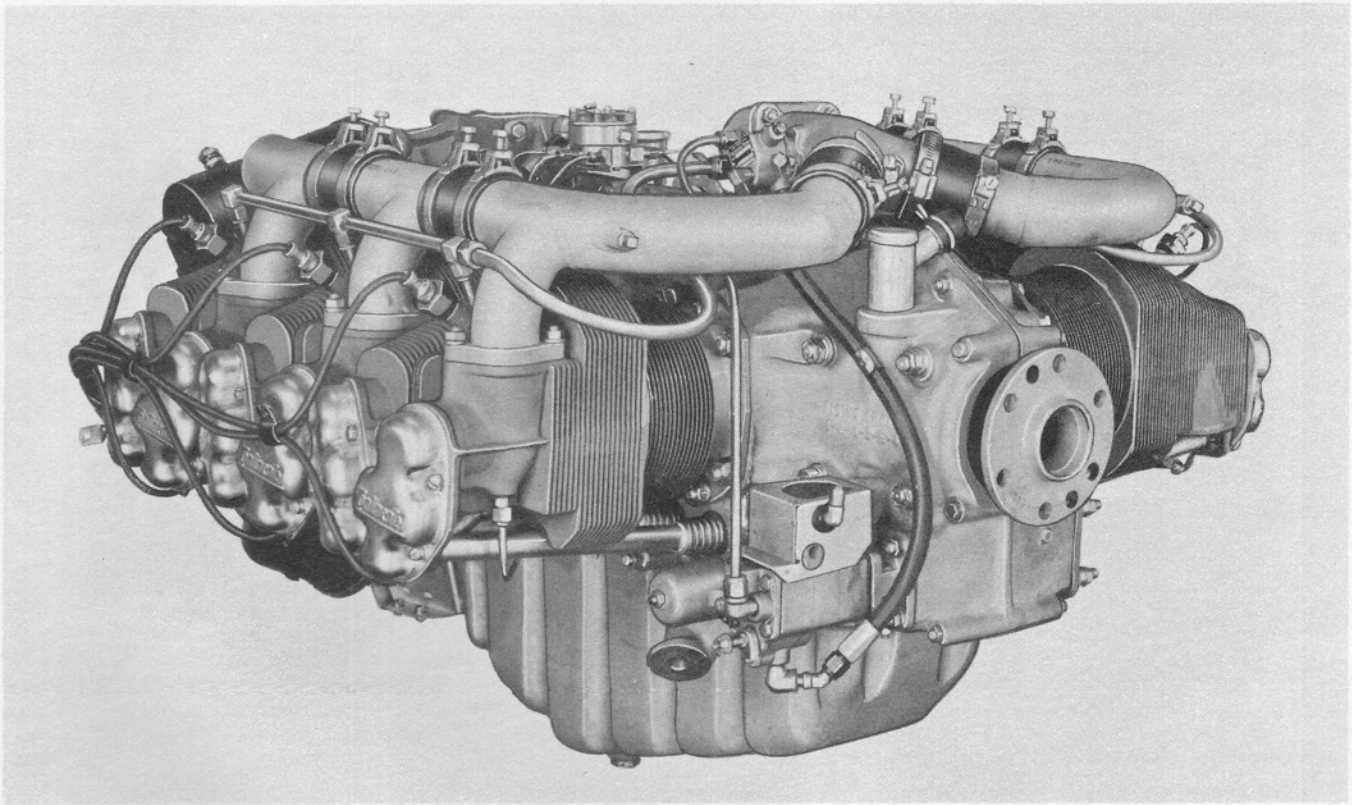


Figure 1-5. Three-Quarter Right Front View of the TSIO-360A and B.

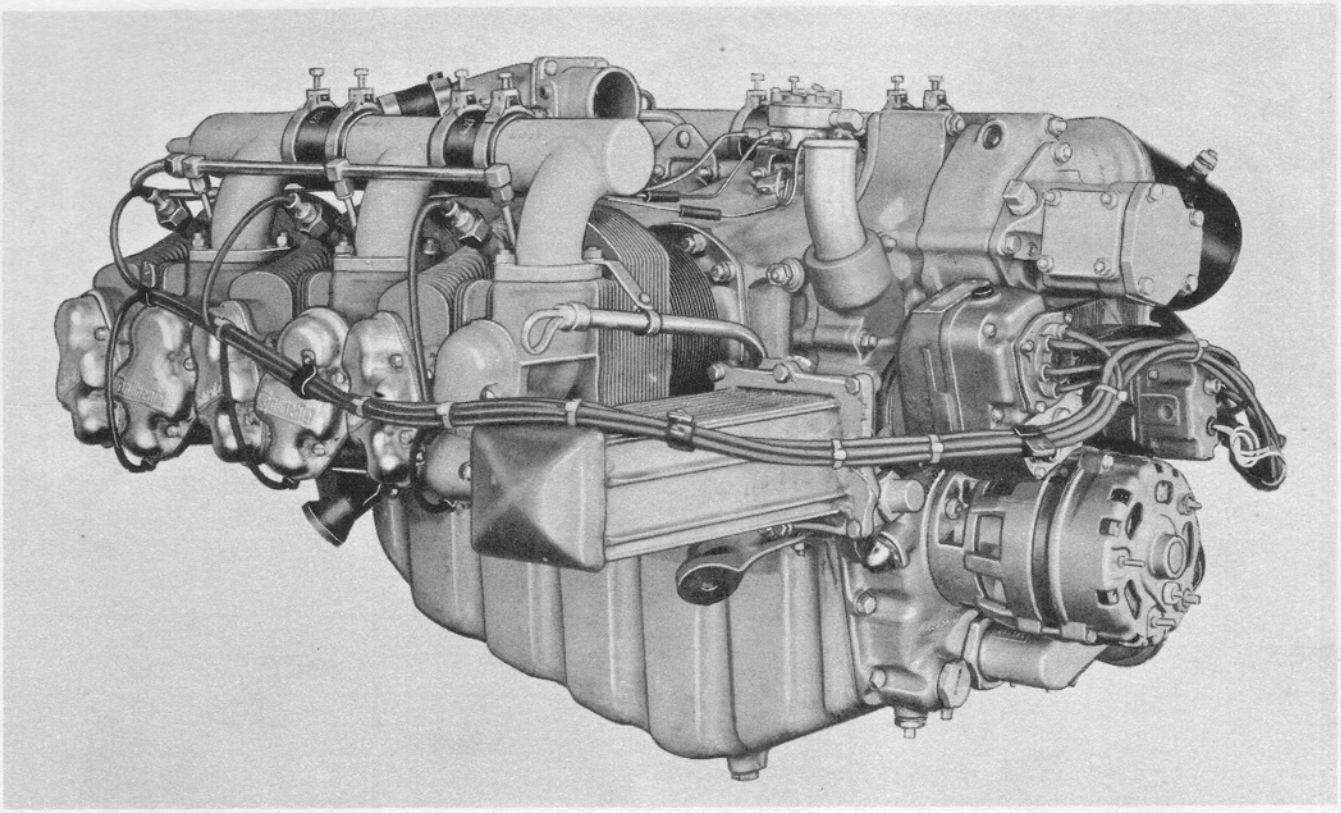


Figure 1-6. Three-Quarter Left Rear View of the TSIO-360A.

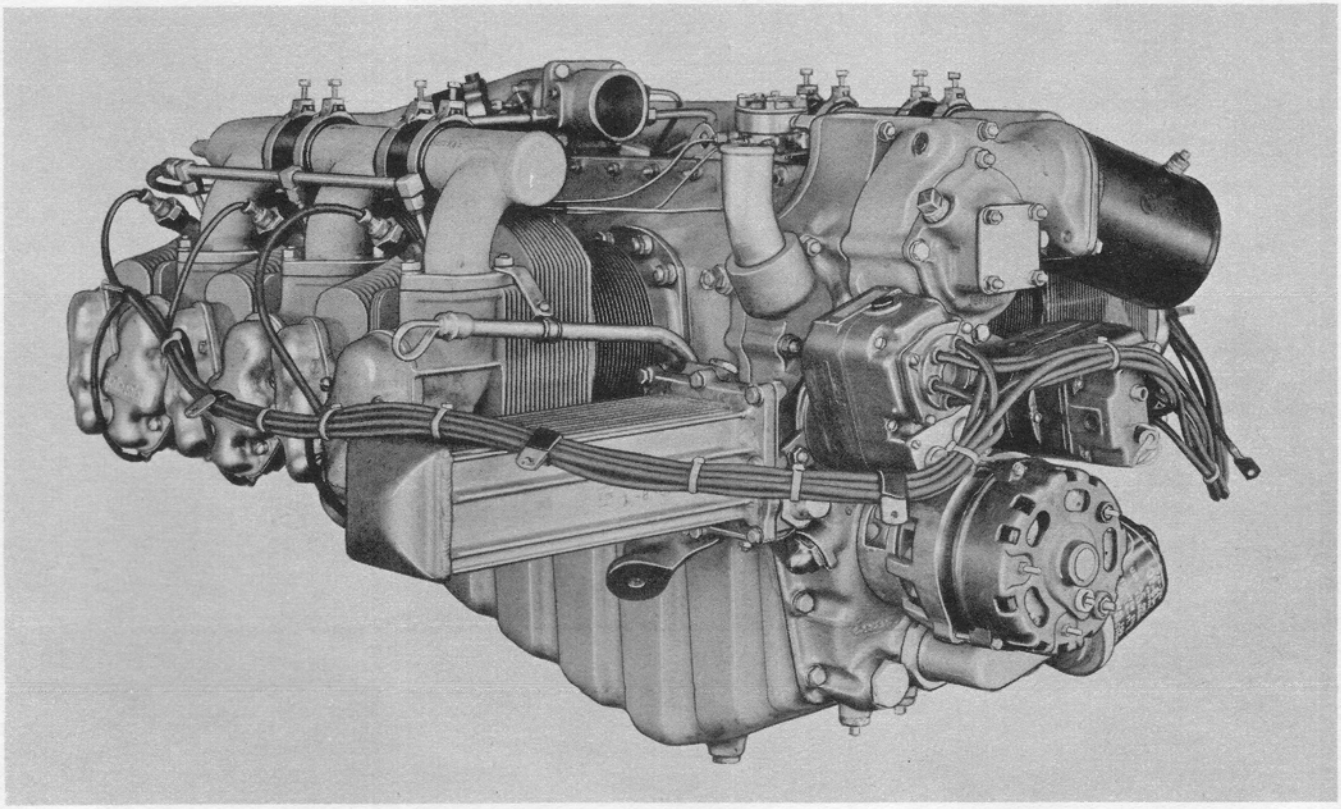


Figure 1-7. Three-Quarter Left Rear View of the TSIO-360B.

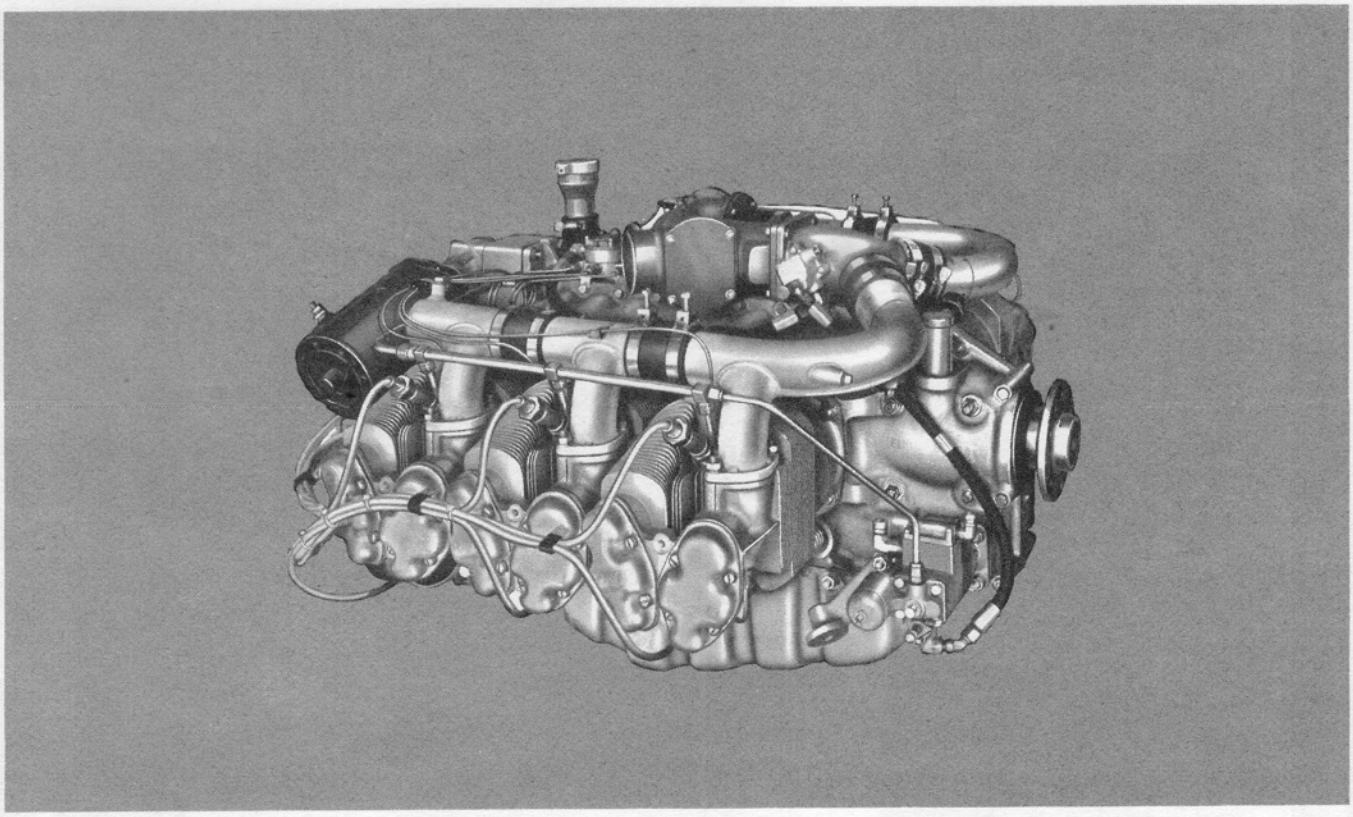
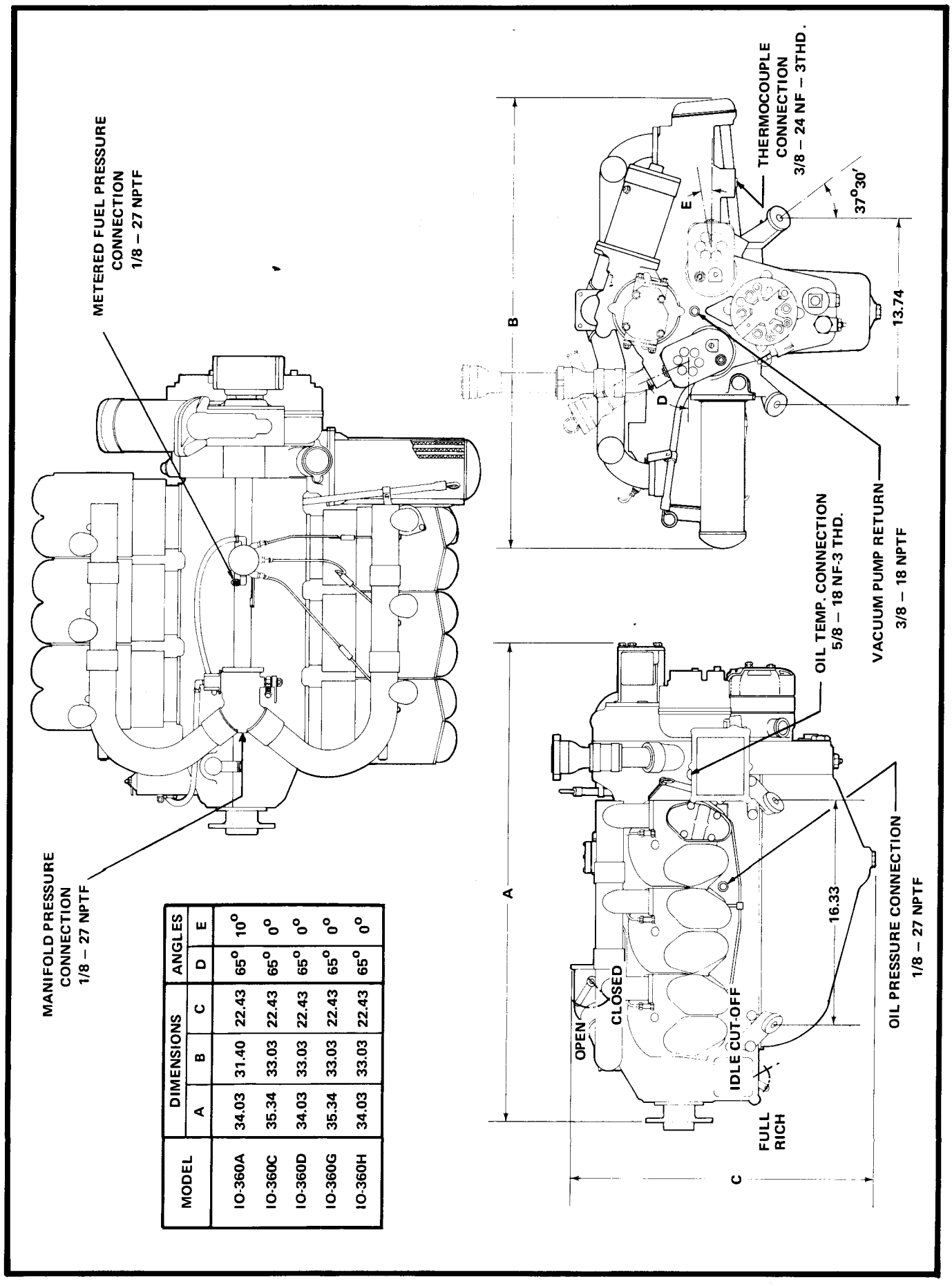
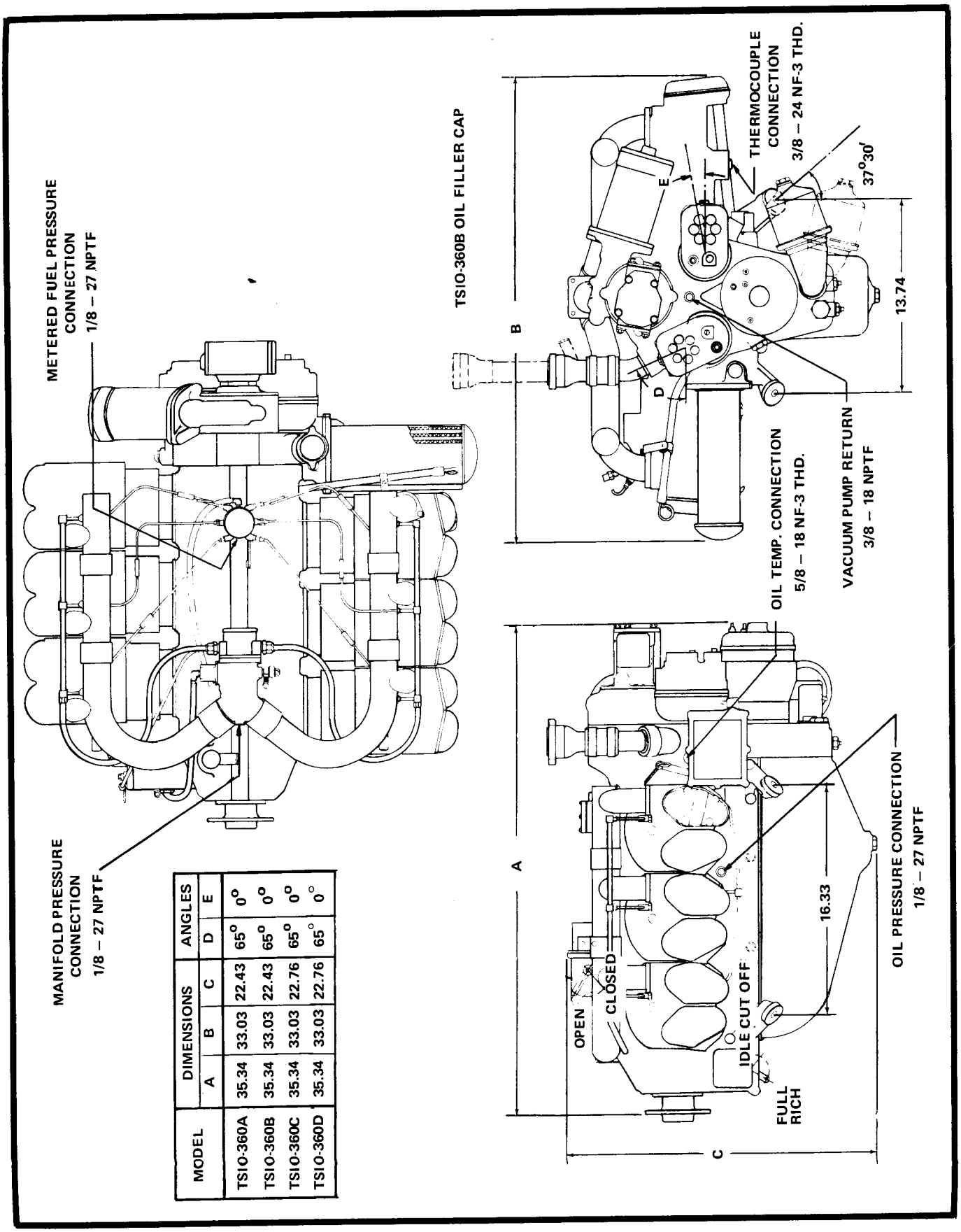


Figure 1-8. Three-Quarter Right Front View of the TSIO-360 C & D.



MODEL	DIMENSIONS			ANGLES	
	A	B	C	D	E
IO-360A	34.03	31.40	22.43	65°	10°
IO-360C	35.34	33.03	22.43	65°	0°
IO-360D	34.03	33.03	22.43	65°	0°
IO-360G	35.34	33.03	22.43	65°	0°
IO-360H	34.03	33.03	22.43	65°	0°

Figure 1-9. Installation Drawing for the IO-360 Series.



MODEL	DIMENSIONS			ANGLES	
	A	B	C	D	E
TSIO-360A	35.34	33.03	22.43	65°	0°
TSIO-360B	35.34	33.03	22.43	65°	0°
TSIO-360C	35.34	33.03	22.76	65°	0°
TSIO-360D	35.34	33.03	22.76	65°	0°

Figure 1-10. Installation Drawing for the TSIO-360 Series.

SECTION II
GENERAL DISCRIPTION

2-1. SIGNIFICANT DIFFERENCES. Specific detail parts differences between the models covered herein will be noted in the parts catalog. The only visual difference between the IO-360 Models is the starter and accessory drive adapter on the IO-360-C and G. The TSIO-360 Series also has a starter and accessory drive adapter in addition to a scavenge pump and full flow oil cooler. The TSIO-360 Series also features a pressurized induction system, including the fuel system.

2-2. GENERAL. The arrangement of components and location of accessories will be noted in Figures 1-1 through 1-8. It will be observed that the engine package has been shortened by the use of a right angle starter drive. Full focalized engine mounts reduce vibration to a minimum.

2-3. CRANKCASE. Two aluminum alloy castings are joined along the vertical center plane to form the complete crankcase. The individual castings will be referred to as the "right crankcase" and "left crankcase" throughout this publication.

a. Bosses molded in the crankcase castings are line bored in the assembled castings to form bearings for the camshaft and seats for precision, steel-backed, lead alloy lined crankshaft main bearing inserts. Guides are bored through lateral bosses for valve lifters and the governor drive shaft.

b. Cylinder mounting pads on the left crankcase are farther forward than the corresponding pads on the right crankcase to permit each connecting rod to work on a separate crankpin. Each pad has six studs and two through bolts for attaching cylinder base flanges. The governor pad is located on the left crankcase at the lower front corner. A fuel pump pad is located on the lower front corner of the right crankcase.

c. The crankcase interior is ventilated by a breather consisting of a tube and baffle assembly with a side extension for hose attachment. The breather assembly is pressed into the upper right crankcase.

2-4. CRANKSHAFT. The six throw, steel alloy forging is machined all over except some surfaces of the crankcheeks. The main bearing journals and crankpins are nitrided after grinding. A flange is formed at the front for attaching the propeller. Side blades projecting from the crankcheeks are machined for the installation of counterweights. Oscillation of the counterweights on their pins dampen crankshaft torsional vibration.

a. The crankshaft gear is a critical fit and positive location is obtained by a dowel of uniform diameter, extending from the crankshaft.

b. A rubber oil seal is seated between crankcase castings at the front shaft exit. It is sealed to the shaft by a helical spring inside the seal cavity. A felt dust shield is installed in front of the oil seal to prevent abrasive material working under the seal

and scoring the crankshaft.

2-5. CAMSHAFT. The camshaft is a steel alloy forging machined on four journals, nine cam lobes and the gear flange. The journals and lobes are hardened and ground. The camshaft gear is attached by four unequally spaced bolts to locate its timing mark in relation to the lobes. The inner teeth of the camshaft gear drive the alternator.

2-6. TAPPETS. The barrel type hydraulic tappets may be removed and replaced without complete disassembly of the engine. The construction and operation of the tappets are described in paragraph 2-12 and Figure 2-4.

2-7. CONNECTING RODS. The "I" beam type connecting rods have split bronze piston pin bushings and two identical presicion inserts (of the same type as the main bearings) at the crankpin end. Weight variation of rods is limited to 1/2 ounce per pair in opposite bays.

2-8. PISTONS. Pistons are aluminum alloy forgings. Three grooves above the pin bore and one below accomodate two compression rings in the top two grooves, one oil control ring in the third groove and an oil scraper ring in the fourth groove. Piston pins are full floating, ground steel tubes with pressed in aluminum end plugs. Weight variation of pistons is limited to 1/2 ounce per pair in opposite bays.

2-9. CYLINDERS. The aluminum alloy heads are heated and the valve seats installed before the head is screwed and shrunk onto the steel alloy barrel to make the permanent head and barrel assembly. Aluminum-bronze valve guides are pressed into the cold cylinder assembly and reamed to correct diameters. Special 18 mm helical coil thread inserts are installed in the upper and lower spark plug holes. Exhaust valves are faced with Stellite "F". The solid valve stem tips are hardened. The outer valve spring retainers are locked to the stems by tapered, semi-circular keys which engage the stem grooves. Valve rocker covers are aluminum alloy stamped. Rocker shafts are fully machined, chrome plated steel. The rocker shafts are held in place by studs in the cylinder rocker boxes. Valve rockers are steel forgings with pressed in bronze bushings, harderned pushrod sockets and rocker faces. The rockers are drilled for lubricating oil transfer. Pushrods are composed of steel tubes and pressed in, hardened, forged steel ball ends which are center drilled for oil passages. The pushrod housings are beaded steel tubes. The bead at the cylinder end retains a washer and seal ring. The bead at the crankcase end retains a heavy spring, washer, seal ring and a second washer.

2-10. FUNCTIONAL SYSTEMS.

2-11. GEAR TRAIN (See Figure 2-1).

a. When starting the engine, torque is transmitted from the starter (13) through the adapter components (14 thru 22) depending on the adapter configuration. As worm wheel (16) is turned, the spring mounted on its hub is tightened to grip the knurled drum of the shaft gear (17). After the engine is started, the spring returns to its normal position, thus disengaging the starter. The IO-360-C and G and TSIO-360-A starter adapters incorporate an additional housing which provides for two additional accessory drive pads. Gears (19, 20) provide the torque for these drives. In addition, all turbocharged engines incorporate a scavenge pump in the starter adapter cover. Gears (21, 22) are driven by the starter shaft gear (17). The scavenge pump drive gear (21) is keyed to the starter shaft gear (17).

b. Torque from the crankshaft gear (1) is transmitted directly to the camshaft gear (3).

c. The camshaft gear (3) drives the magneto gears (11, 12). The alternator drive gear (23) meshes with the inner camshaft gear and turns the alternator shaft through a rubber bushing drive coupling. The splined end of the oil pump drive gear (9) mates with the internal spline of the camshaft gear and transmits torque to the oil pump driven gear (10).

d. The governor drive bevel gear (6) is keyed to the camshaft (4) and meshes with and drives the governor bevel gear (7).

e. The splined end of the fuel pump drive shaft (8) mates with the internal spline of the governor driven gear.

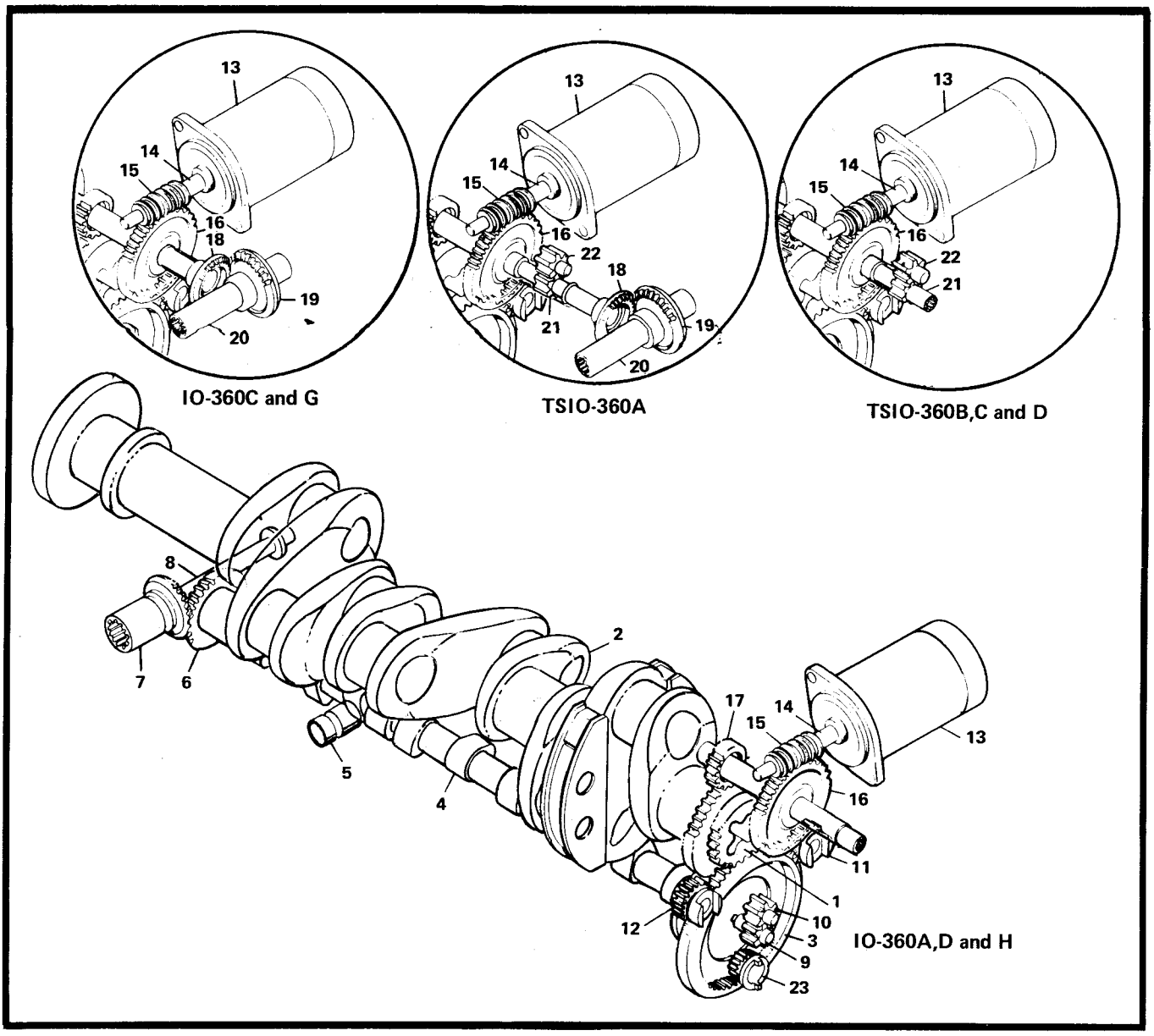


Figure 2-1. Gear Train Diagram.

1. Crankshaft gear
2. Crankshaft
3. Camshaft gear
4. Camshaft
5. Hydraulic tappet
6. Governor drive gear
7. Governor driven gear
8. Fuel pump drive shaft
9. Oil pump drive gear
10. Oil pump driven gear
11. Right magneto drive gear
12. Left magneto drive gear
13. Starter
14. Worm drive shaft
15. Starter worm gear
16. Starter worm wheel
17. Starter shaft gear
18. Accessory drive gear
19. Accessory driven gear
20. Accessory driven shaft
21. Scavenge pump drive gear
22. Scavenge pump driven gear
23. Alternator drive gear

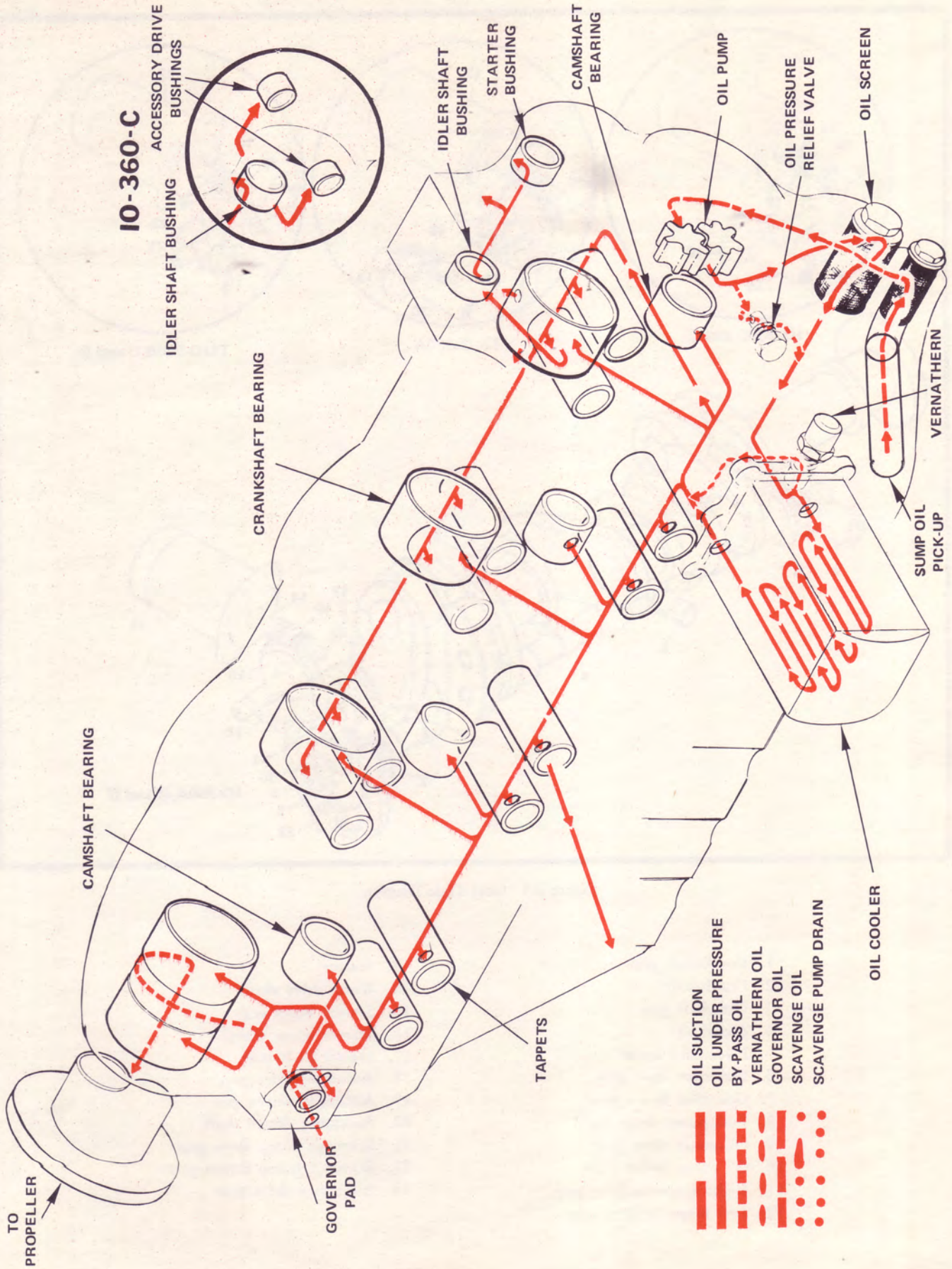


Figure 2-2. Lubrication System for the IO-360 Series.

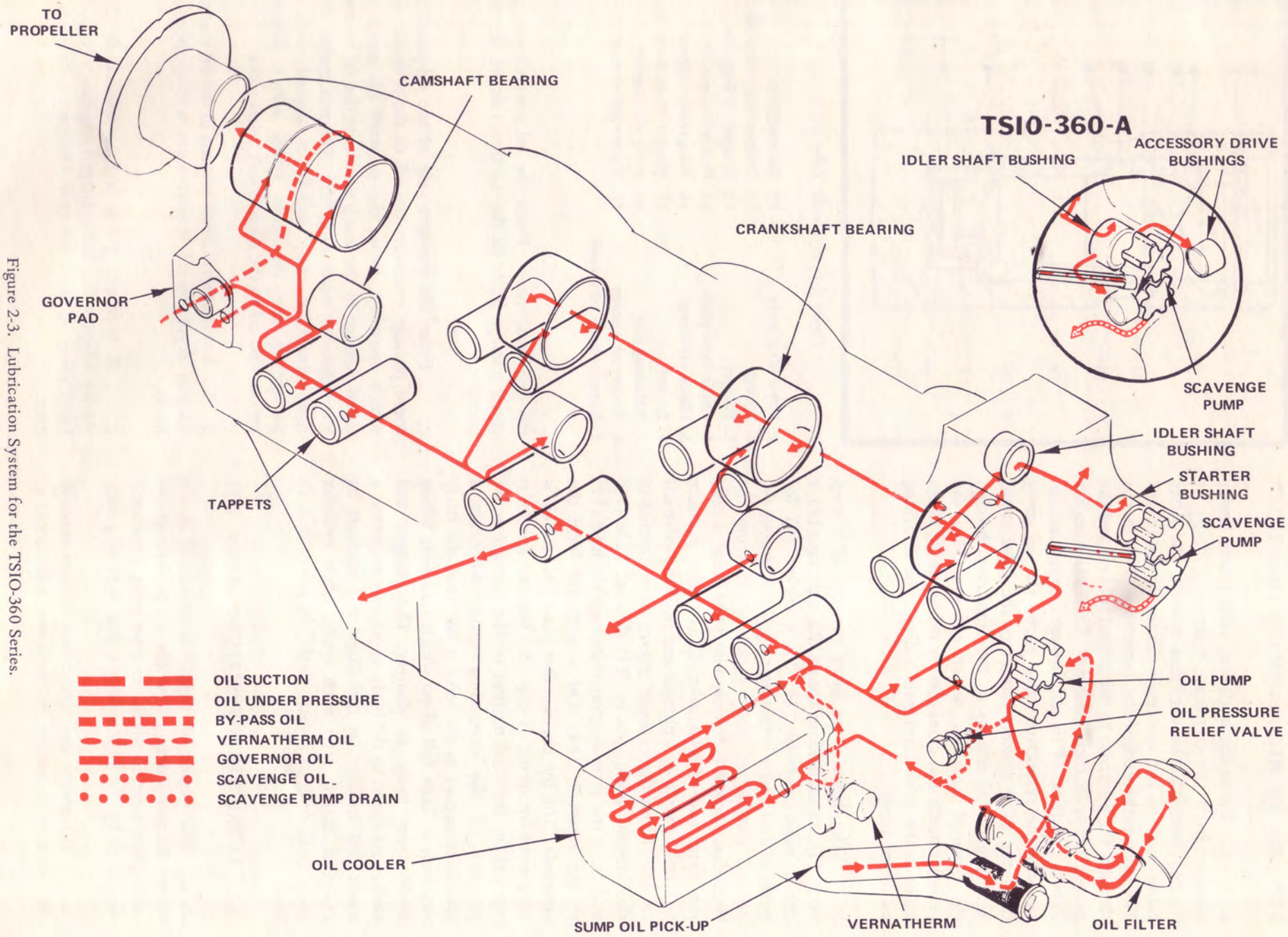


Figure 2-3. Lubrication System for the TSIO-360 Series.

2-12. VALVE MECHANISM (See Figure 2-2).

a. Oil fed to the hydraulic valve lifters, under pressure from the crankcase main oil galleries, is divided between the overhead system, the lifter guide surfaces and the reservoirs inside the lifters. The oil which reaches the pushrod ends is forced through the pushrods to the drilled rockers and the groove between their bushings. Each valve rocker directs a portion of its oil, through a squirt nozzle, towards the respective valve stem. The oil spray from the valve rockers lubricates the valve stems and springs. Oil returns to the crankcase through the pushrod housings, which are sealed to the cylinder heads and crankcase by rubber seals. Drain holes in the valve lifter guides direct the returning oil to the sump.

b. The barrel type lifter consists of a steel body (1), an expanding spring (2), a plunger (3), a check valve assembly (4, 5), a socket (6) for pushrod end and a retaining ring (7). A groove (9) around outside of body picks up oil from the crankcase supply hole only when the lifter is near the outer end of its stroke. Thus engine pressure will not "pump up" plunger and hold the valve off its seat. From the exterior groove oil is directed to the interior body groove (11) through hole (10) and from the interior groove through the hole (12) to the reservoir (14). Oil is withheld from the reservoir (16) by check valve plate (4), which is supported by spring of cage (5). The check valve is opened by outward motion of the plunger under pressure of the expanding spring whenever a clearance occurs in the valve train. Thus the body reservoir is kept full of oil which transmits lifting force from body to plunger. The plunger and socket are fitted to the body selectively to permit a calibrated leakage so the lifter will readjust its effective length after each cycle, while cylinder valve is closed, to return "lash" in valve train to zero.

2-13. LUBRICATION SYSTEM (See Figure 2-3).

a. The engine oil supply is contained in the sump. The oil is drawn from the sump, through the oil suction tube, to fill the volume being constantly displaced by the engine driven, gear type oil pump.

b. Oil enters the lubrication system through the oil suction screen in the lower left corner of the crankcase cover. From the oil screen cavity a cored passage leads to the suction side of the oil pump.

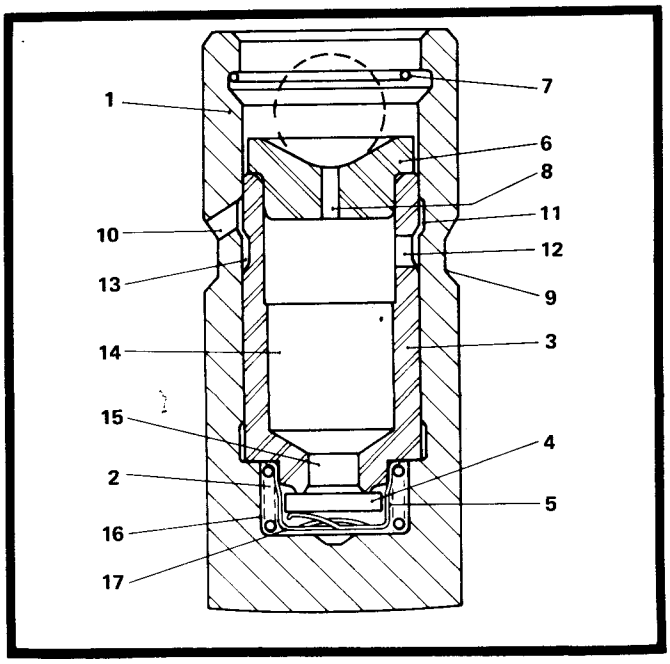


Figure 2-4. Hydraulic Valve Lifter.

1. Valve lifter body
2. Spring
3. Plunger
4. Check valve plate
5. Check valve cage
6. Socket
7. Retaining ring
8. Socket oil passage
9. Exterior body oil groove
10. Oil inlet hole
11. Interior body oil groove
12. Plunger oil inlet hole
13. Plunger oil groove
14. Plunger oil reservoir
15. Plunger oil discharge hole
16. Body oil reservoir
17. Valve cage oil outlet hole

c. From the pressure side of the oil pump a cored passage conducts the oil to the pressure oil screen assembly. From the pressure oil screen a cored passage in the sump conducts the oil to the left crankcase main oil gallery. The rear end of the right crankcase main gallery is aligned with a passage in the crankcase cover which directs pressurized oil to the oil pressure relief valve.

d. A vernatherm valve located in the oil cooler adapter regulates oil temperatures within specific limits.

e. A scavenge pump is incorporated in the starter adapter for turbocharged engines to return lubrication oil from the turbocharger to the crankcase.

2-14. INDUCTION SYSTEM.

a. The induction on the IO-360 Series consists of intake tubes, an air throttle assembly and connecting hoses and clamps.

b. Intake air is directed to the air throttle body which controls the quantity of air to be inducted in accordance with the setting of the injector system fuel control unit. From the air throttle body the induction air is directed through the intake tubes to the cylinder intake ports. A boss for connection to a manifold pressure line is incorporated on the air throttle body.

c. The TSIO-360 Series includes, in addition to the above, provisions for pressurized cylinder air induction.

2-15. FUEL INJECTION SYSTEM.

a. The continuous flow fuel injection system consists of a combination fuel pump and fuel mixture control, a combination air throttle and fuel metering control, a manifold valve, injector nozzles, connecting hoses and tube assemblies.

b. The fuel pump is mounted on the right crankcase ahead of the right front engine mount. The pump is an engine driven, rotary vane type. Fuel is introduced to the pump inlet port from the aircraft tank and auxiliary pump. Upon entering the pump, fuel passes through the vapor separating chamber from which the liquid fuel is directed to the pump impeller, while the vaporized fuel is routed back to the aircraft tank. From the pressure side of the pump impeller, fuel is directed to the fuel mixture control and from there to the fuel metering unit on the air throttle body.

c. The fuel metering unit determines and controls the amount of fuel required by the engine in accordance with the throttle setting. Fuel from the metering unit outlet port is routed, through a connecting hose, to the manifold valve inlet port.

d. The manifold valve incorporates a spring-loaded, diaphragm operated plunger valve. As demands for fuel occur, the plunger valve opens to admit fuel into the distribution chamber from where it is routed, through the discharge tubes, to the injector nozzles. The injector nozzles are installed so they inject the fuel directly into the cylinder intake valve chamber.

e. In addition to the above, the fuel injection nozzles and fuel pump are provided with turbo-charger discharge air pressurization lines on the TSIO-360 engines.

2-16. IGNITION SYSTEM.

a. Torque from the engine crankshaft is transmitted through the camshaft gear to the magneto drive gears, which in turn drives the magneto drive coupling. The magneto coupling incorporates an impulse coupling. As the rubber bushings in the drive gear turns the coupling drive lugs, counter-weighted latch pawls, inside the coupling cover, engage pins on the magneto case and hold back the latch plate until forced inward by the coupling cover. When the latch plate is released, the coupling spring spins the magnet shaft through its neutral position and the breaker opens to produce a high voltage surge in the secondary coil. The spring action permits the latch plate, magnet and breaker to be delayed through a lag angle of 30 degrees of drive gear rotation during the engine cranking period. Two stop pins on the case and two lobes on the breaker cam produce two sparks per revolution of the drive shaft. After engine is started, counter weights hold the latch pawls clear of the stop pins and the magnet shaft is driven at full advance.

b. Engine firing order is 1-6-3-2-5-4. Notice the position of the No. 1 cable terminal in the magneto outlet plate in relation to the magneto case. As viewed from the distributor end, the magneto rotor turns counterclockwise, passing in succession the terminals of spark plug cables in engine firing order. Cables are connected to the magnetos so that the right magneto fires the upper plugs on the right side and lower plugs on the left. The left magneto fires the upper plugs on the left and the lower plugs on the right. The magneto cases, spark plugs, cables and connections are shielded to prevent radio interference.

SECTION III
SPECIAL TOOLS AND EQUIPMENT

3-1. GENERAL.

3-2. For most overhaul operations, tools in general use in aircraft engine overhaul shops will be sufficient. Certain operations, however, are more easily accomplished with the tools listed herein.

3-3. It is advisable to have an engine transportation stand with a bed that can be inverted so certain parts can be removed or installed easily. A typical engine stand is shown in Figure 3-1.

3-4. Use a Thomas & Betts Crimping Tool, No. WT-217 for replacing a new outer sleeve on the ignition harness.

3-5. The tool in Figure 3-2 is used for installing the needle bearing in the starter adapter. This tool can be manufactured locally in accordance with the dimentions specified.

3-6. Figures 3-3 through 3-6 depict special tools manufactured and sold by Borroughs Tool and Equipment Corp., Kalamazoo, Michigan. Figure 3-3 shows a Crankshaft Blade and Dampener Bushing Remover and Replacer, Borroughs Part No. 4965. Figure 3-4 depicts a Piston Ring Gauge, Borroughs Part No. 3601, used in checking ring gaps. Figure 3-5 is a Valve Spring Compressor, Borroughs Part No. 3602, used to compress the valve springs while removing or replacing valves. Figure 3-6 is a Pushrod Housing Spring Compressor, Borroughs Part No. BT68-2, designed to enable the mechanic to install the pushrod housings more easily.

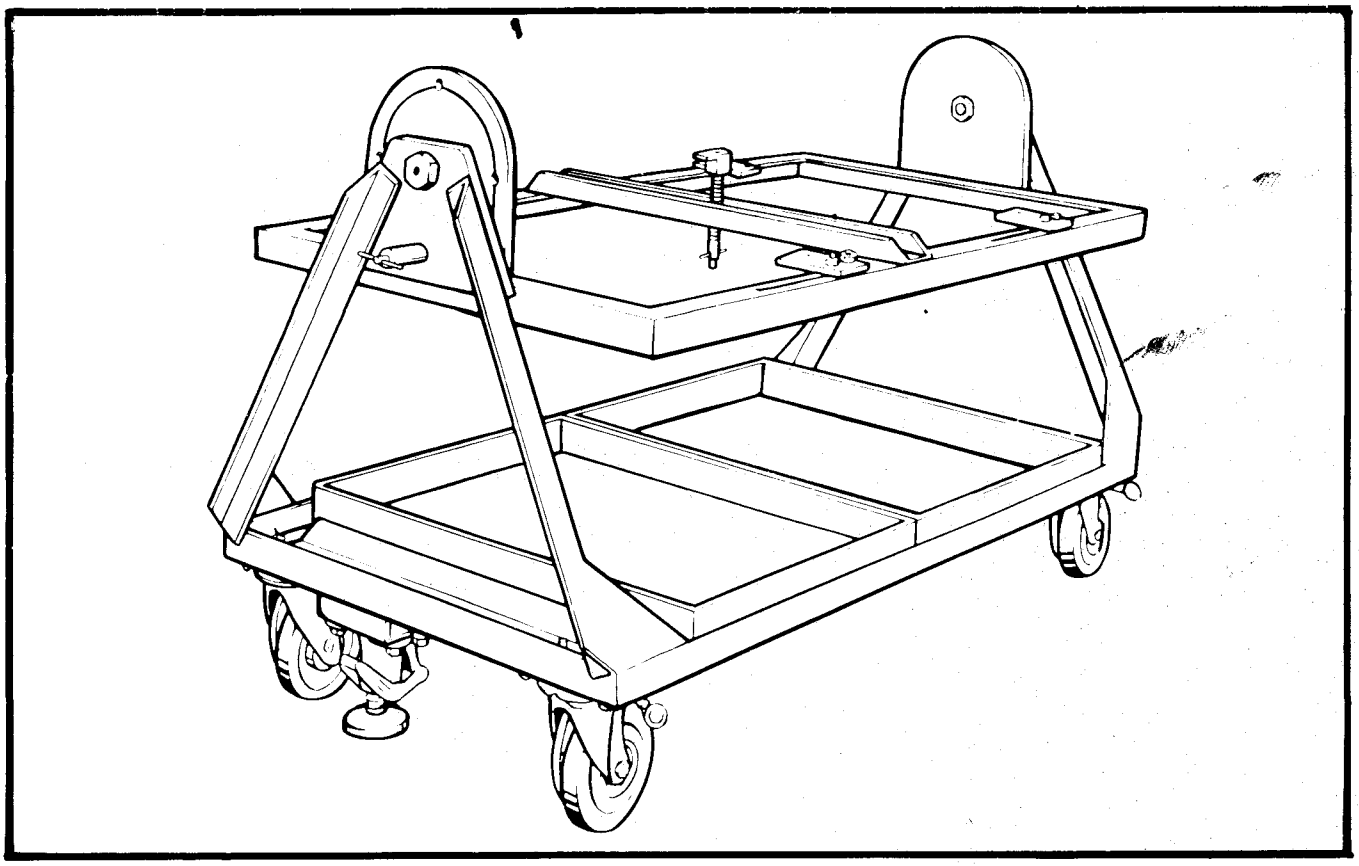


Figure 3-1. Engine Transportation Stand.

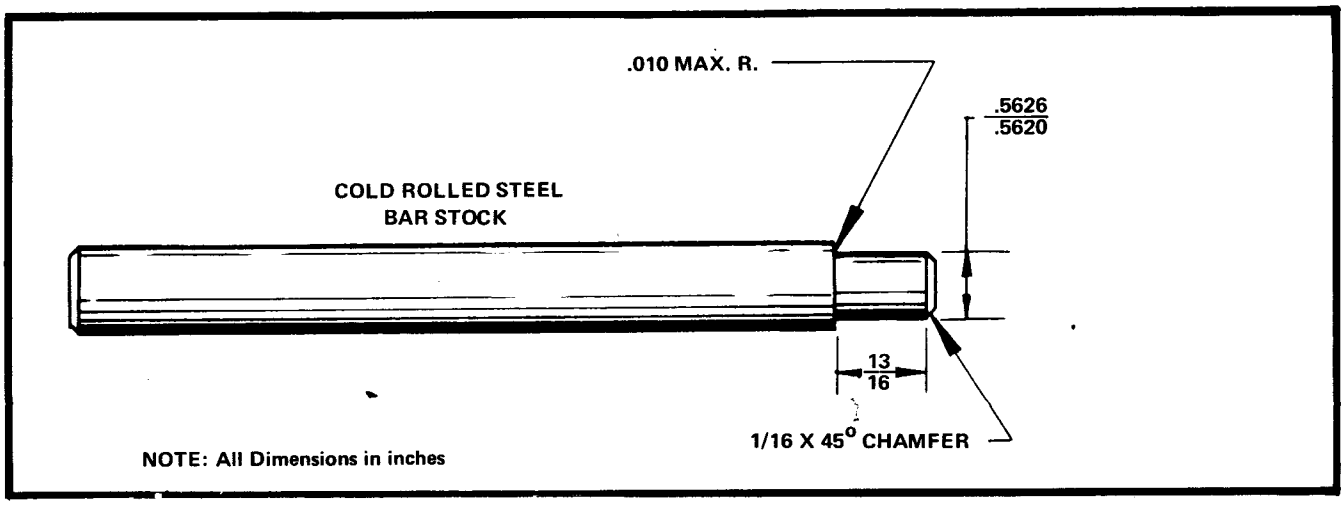


Figure 3-2. Starter Adapter Bearing Installer.

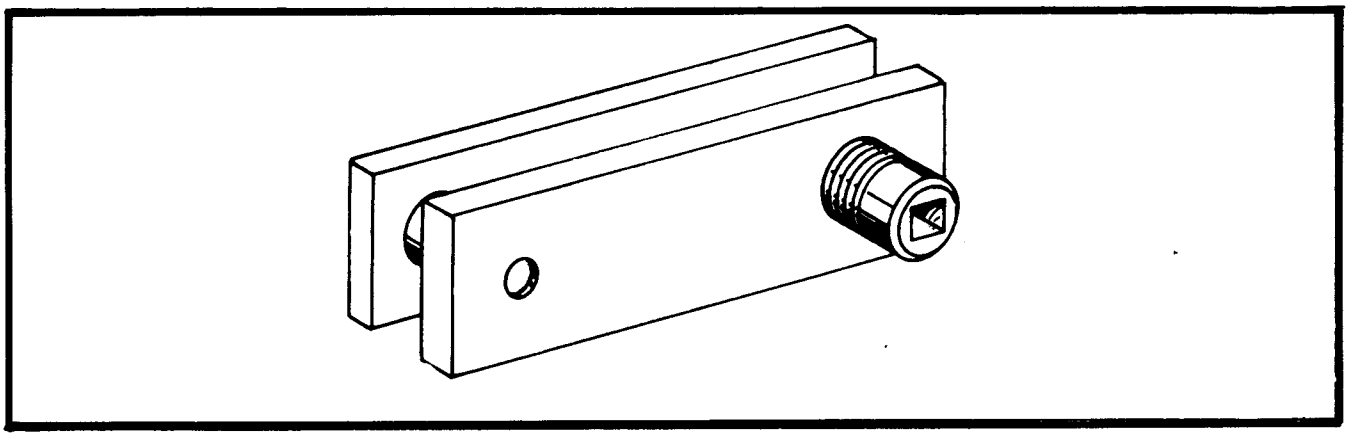


Figure 3-3. Crankshaft Blade and Dampener Bushing Remover and Replacer.

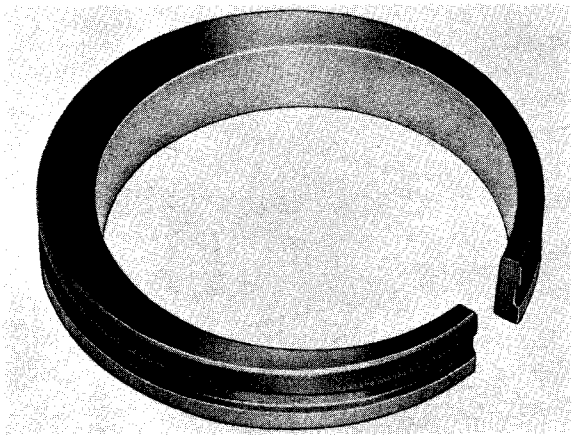


Figure 3-4. Ring Gauge.

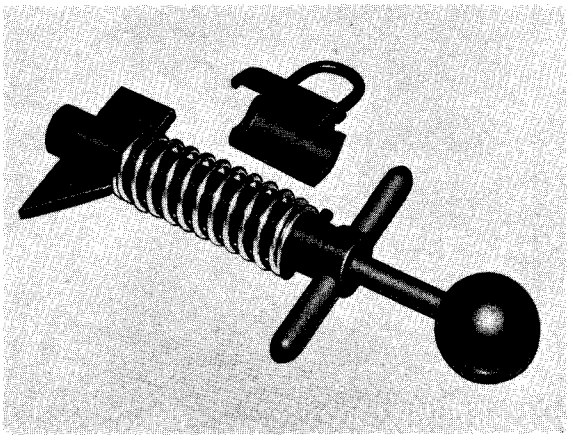


Figure 3-6. Pushrod Spring Compressor.

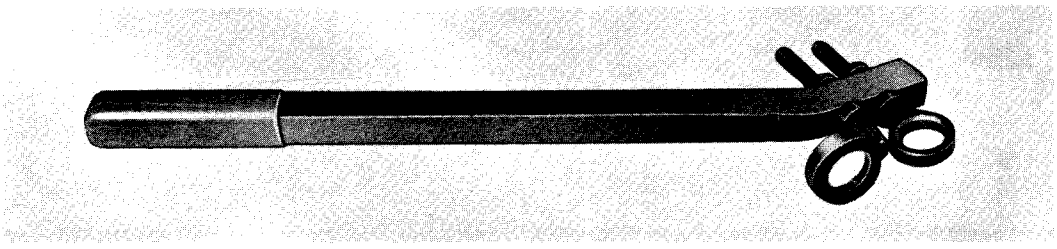


Figure 3-5. Valve Spring Compressor.

SECTION IV
DISASSEMBLY

4-1 GENERAL

a. Instructions in this section are based on the assumption that all parts attached by the aircraft manufacturer, except optional pumps, have been removed.

b. Accessories supplied by the engine manufacturer may be serviced according to instructions furnished by the applicable accessory manufacturer. (See paragraph 1-2).

c. Line drawings reproduced in this section are, in most cases, similar to those used in the parts catalog, except for order of index numbers assigned to components. Index numbers as assigned herein indicate the most convenient order of disassembly. In many instances, the location of the components and attaching parts in the illustration will be sufficient to enable personnel to accomplish disassembly. In such instances, disassembly is to be done even though there are no printed instructions to that effect. The exception to this includes bushings, inserts, and studs which need to be removed only for replacement. The identity of these parts will be obvious.

4-2 PARTS TO BE DISCARDED: Discard all palnuts (if used), lockwashers, tab washers, lockwire, rubber seal rings, oil seals, gaskets, cotter pins, hose connectors and magneto coupling (rubber) bushings in such a manner that they will not inadvertantly be used again. Care should be used in removing gaskets from aluminum by scraping. Such removal should be delayed until the part is to be cleaned.

4-3 DISASSEMBLY STAND. For greatest ease in disassembly, the engine should be mounted on a stand with a tilting bed. (See Figure 3-1).

4-4 PRELIMINARY CLEANING. Spray or apply with a brush, a solvent used for general cleaning of engine parts. Remove caked dirt on bolt heads and nuts especially. At the same time, the oil drain plugs should be removed to drain any remaining oil.

CAUTION - - - Do not use a caustic or even mild alkaline cleaning solution for external precleaning as these solutions will also remove the "alodized" finish of certain aluminum parts.

4-5 IGNITION SYSTEM (See Figure 4-1)

a. Disconnect cables from spark plugs (1).

b. Remove four sets of attaching parts (2, 3) to detach cable outlet plates and lift off cable and plate assemblies.

c. Remove two sets of attaching parts (4, 5, 6) and withdraw magnetos (7) and gaskets (8).

d. Reach into the accessory case openings and withdraw the magneto drive gear and bearing assemblies. Remove cotter pin (9) and nut (10). Withdraw magneto gear support shaft assembly (11, 12). Nut (10) and cotter pin (9) have been replaced by a special conelok nut on current production engines.

4-6 FUEL INJECTION SYSTEM (See Figure 4-2)

a. Disconnect fuel discharge tubes (1) from elbows (7), nipples (8) and nozzles (2). Remove nozzles.

b. Disconnect hose assembly (3) from elbows (5) and (10). Disconnect hose assembly (4) from elbow (13) and tee (9). Loosen, but do not remove, all fittings.

c. Remove two sets of attaching parts (21 thru 24) and lift off fuel manifold valve (25 thru 30). The fuel manifold valve may be disassembled to the extent shown for cleaning only. Any further disassembly will disturb the calibration, and should be accomplished only in accordance with the instructions contained in the Fuel Injection Manual, Form X30091.

d. Remove four sets of attaching parts (34, 35, 36) and remove fuel pump (37) and gasket (38).

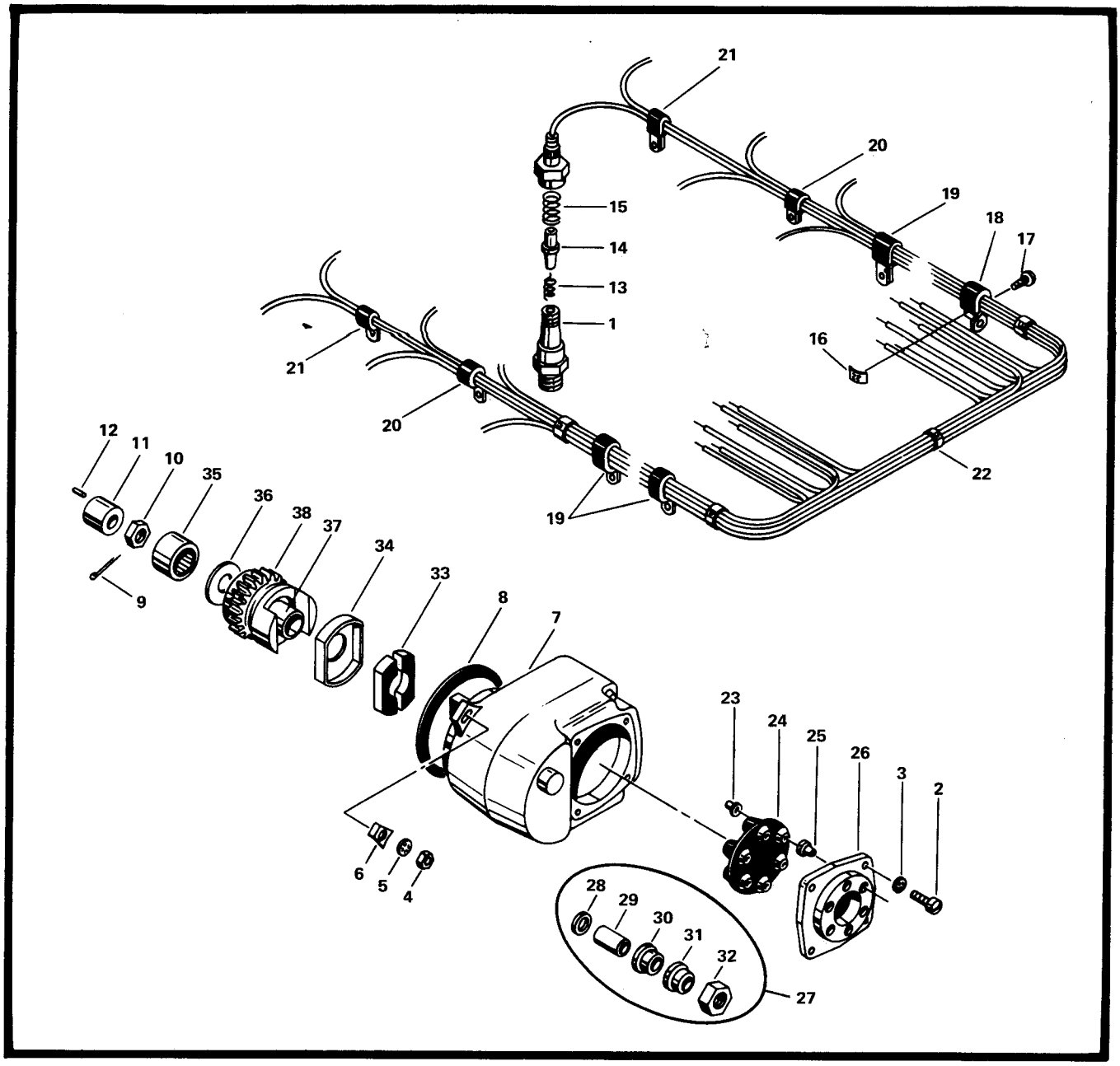


Figure 4-1. Ignition System.

1. Spark plug
2. Screw
3. Lockwasher
4. Nut
5. Lockwasher
6. Hold down washer
7. Magneto
8. Gasket
9. Cotter pin
10. Nut
11. Gear support shaft
12. Pin
13. Spring
14. Sleeve
15. Spring assembly
16. Speed nut
17. Screw
18. Bracket clamp
19. Six wire clamp
20. Four wire clamp
21. Two wire clamp
22. Strap
23. Ignition cable eyelet
24. Distributor cable grommet
25. Ignition cable ferrule
26. Distributor cable plate
27. Ground terminal kit
28. Washer
29. Insulating sleeve
30. Inner ferrule
31. Outer ferrule
32. Coupling nut
33. Coupling bushings
34. Retainer
35. Needle bearing
36. Washer
37. Pilot sleeve bushing
38. Magneto drive gear

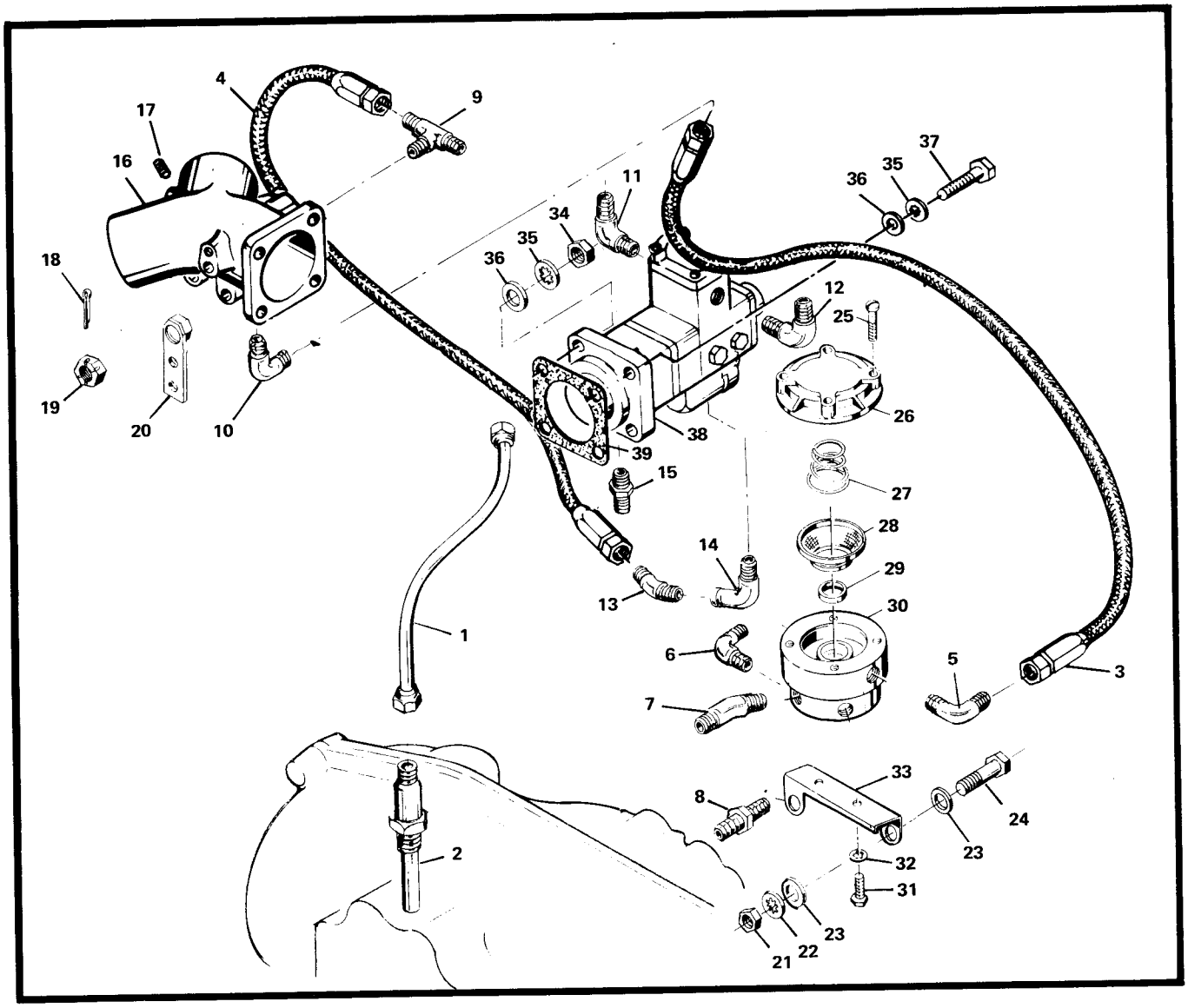


Figure 4-2. Fuel Injection System.

1. Fuel discharge tube
2. Injection nozzle
3. Hose assembly
4. Hose assembly
5. Elbow
6. Elbow
7. Elbow
8. Nipple
9. Tee
10. Elbow
11. Elbow
12. Elbow
13. Elbow
14. Elbow
15. Nipple
16. Air throttle body
17. Plug
18. Cotter pin
19. Nut
20. Lever
21. Nut
22. Lockwasher
23. Plain washer
24. Bolt
25. Screw
26. Cover
27. Spring
28. Screen
29. Seal
30. Fuel manifold valve
31. Screw
32. Washer
33. Bracket
34. Nut
35. Lockwasher
36. Plain washer
37. Bolt
38. Fuel Pump
39. Gasket

4-7 INDUCTION SYSTEM (See Figure 4-3)

a. Loosen hose clamps (1, 2) and remove hoses (3).

b. Remove attaching parts (4, 5, 6) and lift off intake tubes (7, 8, 9, 10, 11). Remove gasket (12).

c. On naturally aspirated engines, remove two sets of attaching parts (26 thru 29) and remove air throttle body (22). Remove tube (13).

d. On turbocharged engines, remove tube assemblies (13 thru 17), grommet (18), sleeves (19), washers (20, 21) as applicable. Remove attaching parts (26 thru 29) and lift off air throttle body (22) and adapter (24 or 25). On TSIO-360-C & D engines, tube (13) attaches to the air manifold tube assembly (16).

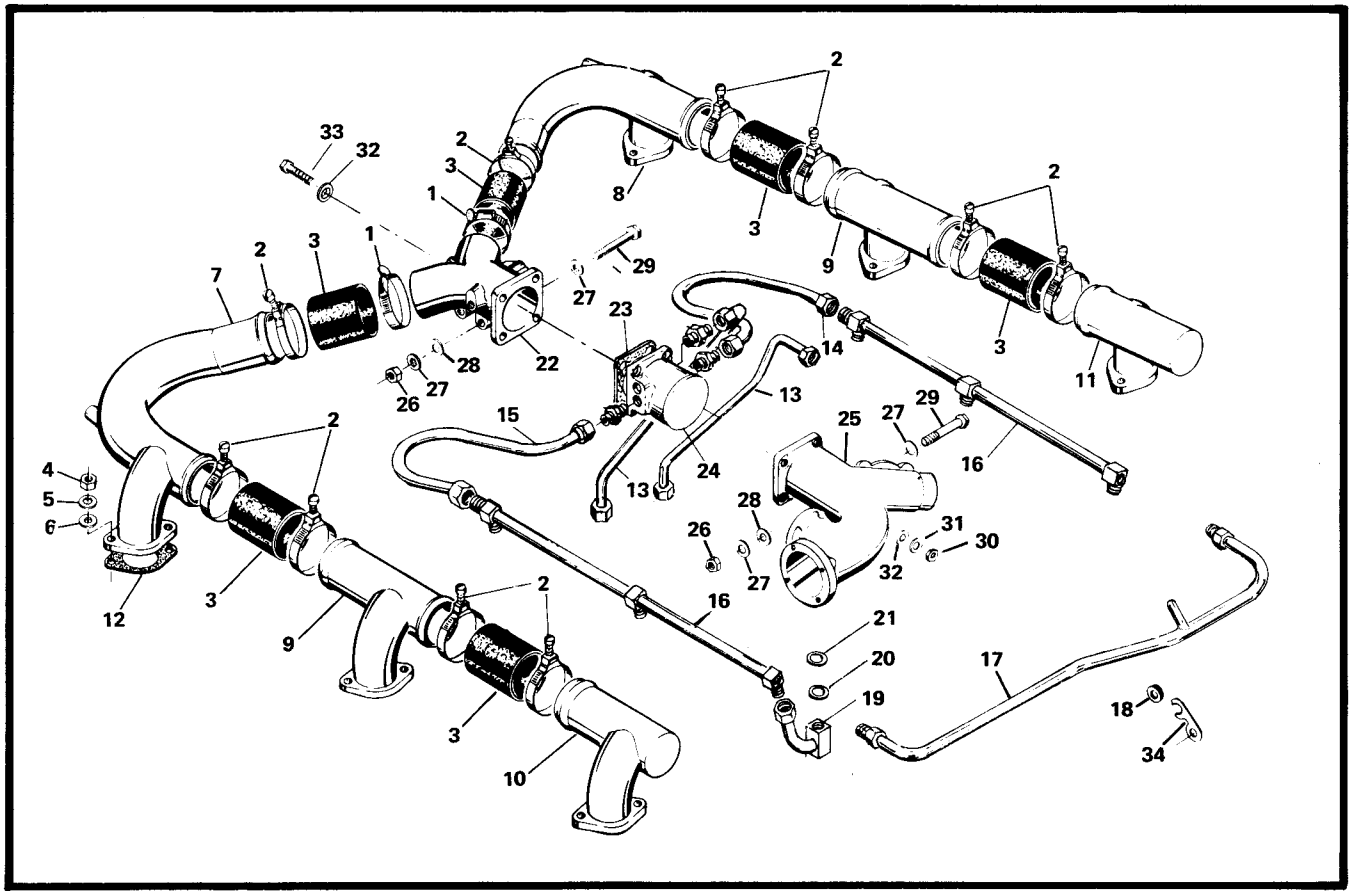


Figure 4-3. Induction System.

1. Clamp
2. Clamp
3. Hose
4. Nut
5. Lockwasher
6. Plain washer
7. Tube assembly
8. Tube assembly
9. Tube assembly
10. Tube assembly
11. Tube assembly
12. Gasket
13. Tube assembly
14. Tube assembly
15. Tube assembly
16. Tube assembly
17. Tube assembly
18. Grommet
19. Sleeve assembly
20. Washer, rubber
21. Washer, plain
22. Air throttle body
23. Gasket
24. Adapter
25. Adapter
26. Nut
27. Lockwasher
28. Plain washer
29. Bolt
30. Nut
31. Lockwasher
32. Plain washer
33. Bolt
34. Clamp

4-8. STARTER AND ADAPTER, IO-360 A, D, H and TSIO-360-B, C & D (See Figure 4-4)

a. Remove two sets of attaching parts (1, 2, 3) and pull starter (4) from adapter studs. Remove gasket (5).

b. Remove attaching parts (6 thru 13) and pull starter adapter from crankcase cover. Remove gasket (14).

c. Remove attaching parts (15, 16, 17) and lift off cover (18) and gasket (19).

d. Detach nut (20), lockwasher (21) and plain washer (22) and lift off cover assembly (27). On turbocharged engines, the cover contains the scavenge pump. Remove oil seal (24). Bushing (25) is flanged and pinned on non-turbocharged engines. In both cases they are pressed in and need only be removed if necessary for replacement.

e. Where applicable, cut lockwire and remove bolt (28) and washers (29). Lift off scavenge pump cover (31). If necessary, remove bushing (30). Remove woodruff key (32), drive gear (33) and driven gear (35). Remove gasket (23).

f. To remove worm wheel (37) and clutch spring (38) from adapter (50), support accessory drive end of adapter on wood blocks and tap around the front end of the spring with a brass drift. Pull shaftgear (41) from adapter.

g. Clamp worm wheel (37) in shielded vise jaws and bend ears of tab washers (40) away from bolt (39). Remove bolt and tab washer. Turn clutch spring (38) until its depressed rear end lies across the 1/4-inch hole in the worm wheel hub. Insert a narrow screw driver blade into the hole and pry spring outward clear of the drum groove. Hold spring end out while pulling spring from drum.

h. Remove retaining ring (42), ball bearing (43), and worm gear and shaft assembly. Separate worm gear (44), spring (45) and woodruff key (46) from shaft (47).

4-9 STARTER AND STARTER ADAPTER, IO-360 C, G AND TSIO-360 A (See Figure 4-5)

a. Remove two sets of attaching parts (1, 2, 3) and pull starter (4) from starter adapter. Remove gasket (5).

b. Remove attaching parts (6 thru 12) and pull starter adapter assembly from crankcase cover. Remove gasket (13).

c. Remove bolt (14), lockwasher (15) and plain washer (16) and lift cover (17) from adapter. Remove gasket (18). Remove attaching parts (19, 20, 21) and lift off covers (22). Remove gaskets (23).

d. Remove attaching parts (24, 25, 26) and separate accessory drive adapter (47) from starter adapter (63). On turbocharged engines, the accessory drive adapter also contains the scavenge pump. Remove "O"- ring (27).

e. Use Truarc pliers to release retaining ring (28) and slide it back on shaft (29). Press shaft out through left accessory drive pad. As shaft is pressed out, driven gear (31) and retaining ring (28) will fall free inside the accessory drive adapter. Key (30) will be removed with shaft (29). Drive gear (32) can now be removed.

f. Remove oil seals (33, 34). Use arbor press to remove bushings (35, 36, 37).

g. Where applicable, cut lockwire and remove bolts (38) and washers (39). Remove scavenge pump cover (41) and lift out scavenge pump gears (42, 44).

h. Remove plug (45) and ball (46) only if required for cleaning. Ball is staked in place.

i. To remove worm wheel (49) and clutch spring (50) from starter adapter (63), support accessory drive end of adapter on wood blocks and tap around front end of spring (50) with a brass drift. Remove shaftgear (53) from adapter.

j. Clamp worm wheel (49) in shielded vise jaws and bend ears of tab washer (51) away from bolt (52). Remove tab washer and bolt. Turn clutch spring (50) until its' depressed rear end lies across the 1/4-inch hole in the worm wheel hub. Insert a narrow bladed screw driver into the hole and pry spring outward clear of drum groove. Hold spring end out while pulling spring from drum.

k. Remove retaining ring (55), ball bearing (56) and worm gear and shaft assembly. Remove worm gear (57), spring (58) and woodruff key (59) from shaft (60).

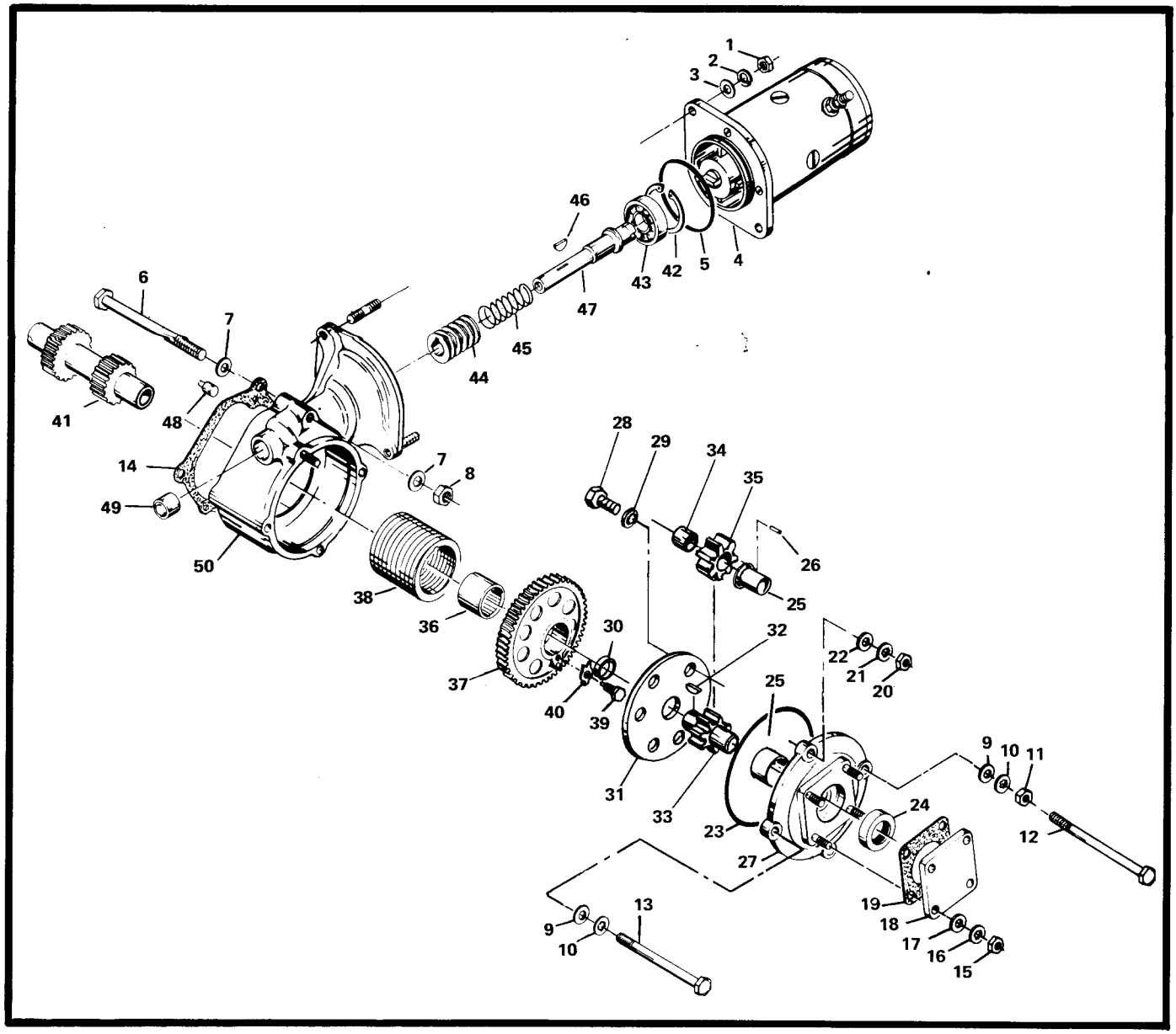


Figure 4-4. Starter Adapter for IO-360A, D and H & TSIO-360B, C & D.

1. Nut	11. Nut	21. Lockwasher	31. Cover	41. Shaftgear
2. Lockwasher	12. Bolt	22. Plain washer	32. Woodruff Key	42. Retaining ring
3. Plain washer	13. Bolt	23. Gasket	33. Drive gear	43. Ball bearing
4. Starter	14. Gasket	24. Oil seal	34. Bushing	44. Worm gear
5. Gasket	15. Nut	25. Bushing	35. Driven gear	45. Spring
6. Bolt	16. Lockwasher	26. Pin	36. Needle bearing	46. Woodruff Key
7. Plain washer	17. Plain washer	27. Cover	37. Worm wheel	47. Shaft
8. Nut	18. Cover	28. Bolt	38. Clutch spring	48. Dowel
9. Plain washer	19. Gasket	29. Washer	39. Bolt	49. Needle bearing
10. Lockwasher	20. Nut	30. Bushing	40. Tab washer	50. Adapter

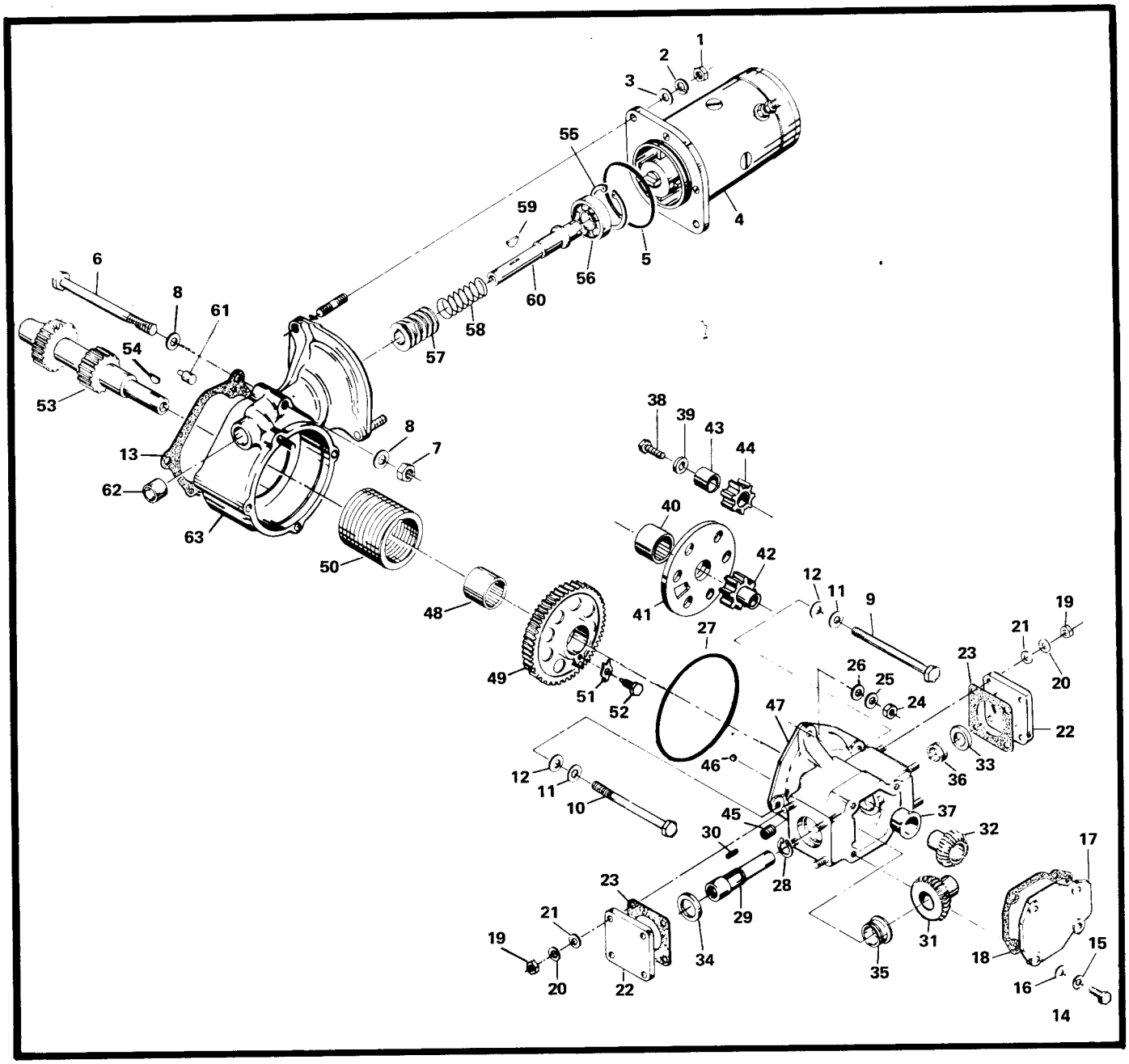


Figure 4-5. Starter Adapter for IO-360C and G & TSIO-360A.

1. Nut
2. Lockwasher
3. Plain washer
4. Starter
5. Gasket
6. Bolt
7. Nut
8. Washer
9. Bolt
10. Bolt
11. Lockwasher
12. Plain washer
13. Gasket
14. Bolt
15. Lockwasher
16. Plain washer
17. Cover
18. Gasket
19. Nut
20. Lockwasher
21. Plain washer
22. Cover
23. Gasket
24. Nut
25. Lockwasher
26. Plain washer
27. Gasket
28. Retaining ring
29. Shaft
30. Key
31. Gear
32. Gear
33. Oil seal
34. Oil seal
35. Bushing
36. Bushing
37. Bushing
38. Bolt
39. Washer
40. Needle bearing
41. Cover
42. Drive gear
43. Bushing
44. Driven gear
45. Plug
46. Ball
47. Adapter
48. Needle bearing
49. Worm wheel
50. Clutch spring
51. Tab washer
52. Bolt
53. Shaftgear
54. Woodruff Key
55. Retaining ring
56. Ball bearing
57. Worm gear
58. Spring
59. Woodruff Key
60. Shaft
61. Dowel
62. Needle bearing
63. Adapter

4-10 ALTERNATOR ASSEMBLY (See Figure 4-6)

a. Remove attaching parts (1, 2) and pull alternator assembly from crankcase cover studs.

b. Remove cotter pin (3) and nut (4). Remove as applicable, gear (5), sleeve (6), bushings (7), retainer (8) and hub (9). If installed, remove oil seal (10) and "O"-ring (11). Where heavy duty coupling (12) is used, only the sleeve (13) can be removed for replacement.

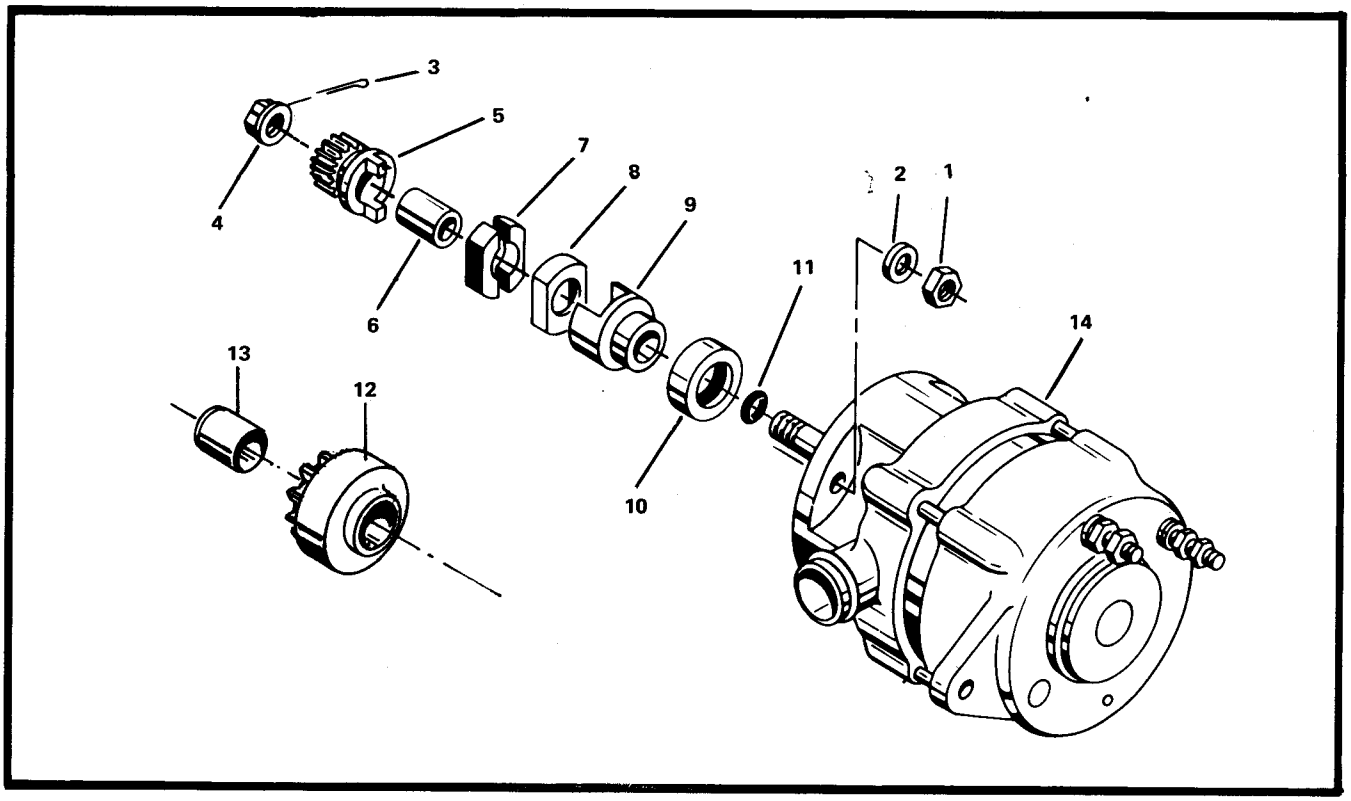


Figure 4-6. Alternator Assembly.

1. Nut
2. Washer
3. Cotter pin
4. Nut
5. Drive gear
6. Sleeve
7. Coupling bushings
8. Retainer
9. Coupling hub
10. Oil seal
11. "O" ring
12. Hub assembly
13. Sleeve
14. Alternator

4-11 CRANKCASE COVER, IO-360 ENGINES (See Figure 4-7)

a. Remove attaching parts (1 thru 6) and carefully remove crankcase cover from crankcase studs. Remove gasket (7).

b. Remove plug (8), gasket (9), pressure oil screen (10), and gasket (11). Remove suction oil screen (12) and gasket (13). Remove, as applicable, plugs (14, 15) and gaskets (16).

c. Remove nut (17) lockwasher (18), and plain washer (19) and lift off cover (20) and gasket (21).

d. Remove oil pressure relief valve (22), gasket (23), spring (24) and plunger (25).

e. On engines other than the IO-360-A, remove nut (26) or the tach drive shaft which threads onto shaft (27). Remove shaft (27) and woodruff key (28). Bend down ears of tab washers (29) and remove bolts (30) and washers (29). Lift off oil pump cover and pull gears (32, 33) or (34, 35) from oil pump cavity.

f. Remove bushing (36), studs (37 thru 40), inserts (41, 42) or plug (43) only as required.

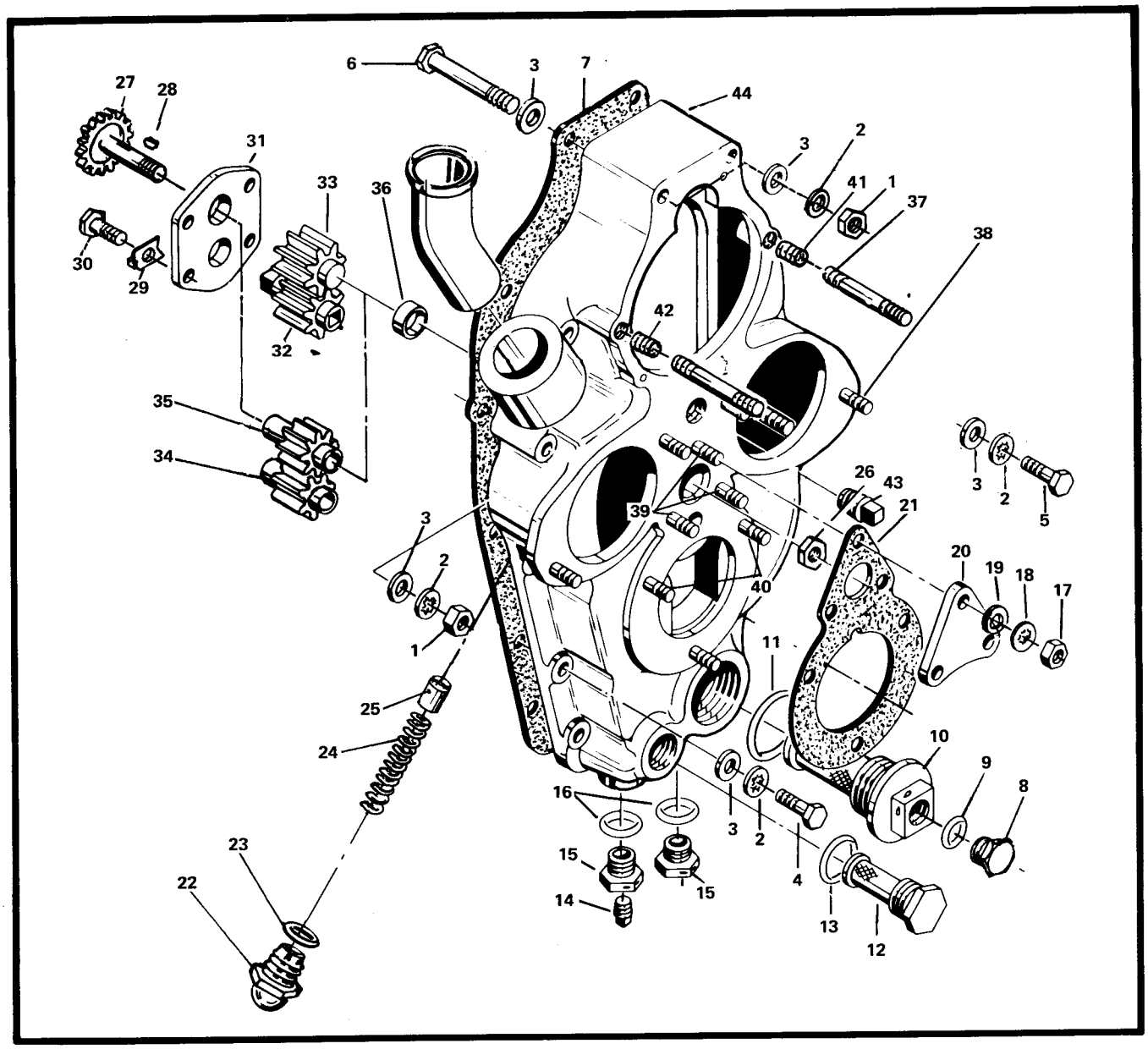


Figure 4-7. Crankcase Cover for IO-360 Series.

1. Nut
2. Lockwasher
3. Plain washer
4. Bolt
5. Bolt
6. Bolt
7. Gasket
8. Plug
9. Gasket
10. Pressure oil screen
11. Gasket
12. Suction oil screen
13. Gasket
14. Plug
15. Plug
16. Gasket
17. Nut
18. Lockwasher
19. Plain washer
20. Cover
21. Gasket
*22. Cap, oil pressure relief valve
*23. Gasket
*24. Spring
*25. Plunger
26. Nut
27. Gear
28. Woodruff Key
29. Tab washer
30. Bolt
31. Cover, oil pump
32. Drive gear
33. Driven gear
34. Driven gear
35. Drive gear
36. Bushing
37. Stud
38. Stud
39. Stud
40. Stud
41. Insert
42. Insert
43. Plug
44. Accessory case

*These parts installed on opposite side on IO-360-A.

4-12 CRANKCASE COVER TSIO-360 ENGINES (See Figure 4-8)

a. Remove filter assembly, or spin on filter (8). Remove attaching parts (1 thru 6) and carefully pull crankcase cover assembly from crankcase studs. Remove gasket (7).

NOTE . . . Only spin on filter should be used as replacement part.

b. Remove screws (10, 13), nuts (12) and washers (11) and separate brackets (19, 20). Loosen adapter nut (14) and remove adapter (18). Remove gaskets (15, 16).

c. Remove oil screen (21) and gasket (22). Remove plugs (23), plugs (24) and gaskets (25).

d. Remove nut (26), lockwasher (27) and plain washer (28) and lift off cover (29) and gasket (30).

e. Remove oil pressure relief valve cap (31), gasket (32), spring (33), spring (34) and plunger (35).

f. Remove nut (36), or tach drive shaft on engines so equipped, and pull out gear (37) and woodruff key (38). Bend down ears of tab washers (39) and remove bolts (40) and washers. Lift off cover (41) and extract gears (42, 43) from the oil pump cavity.

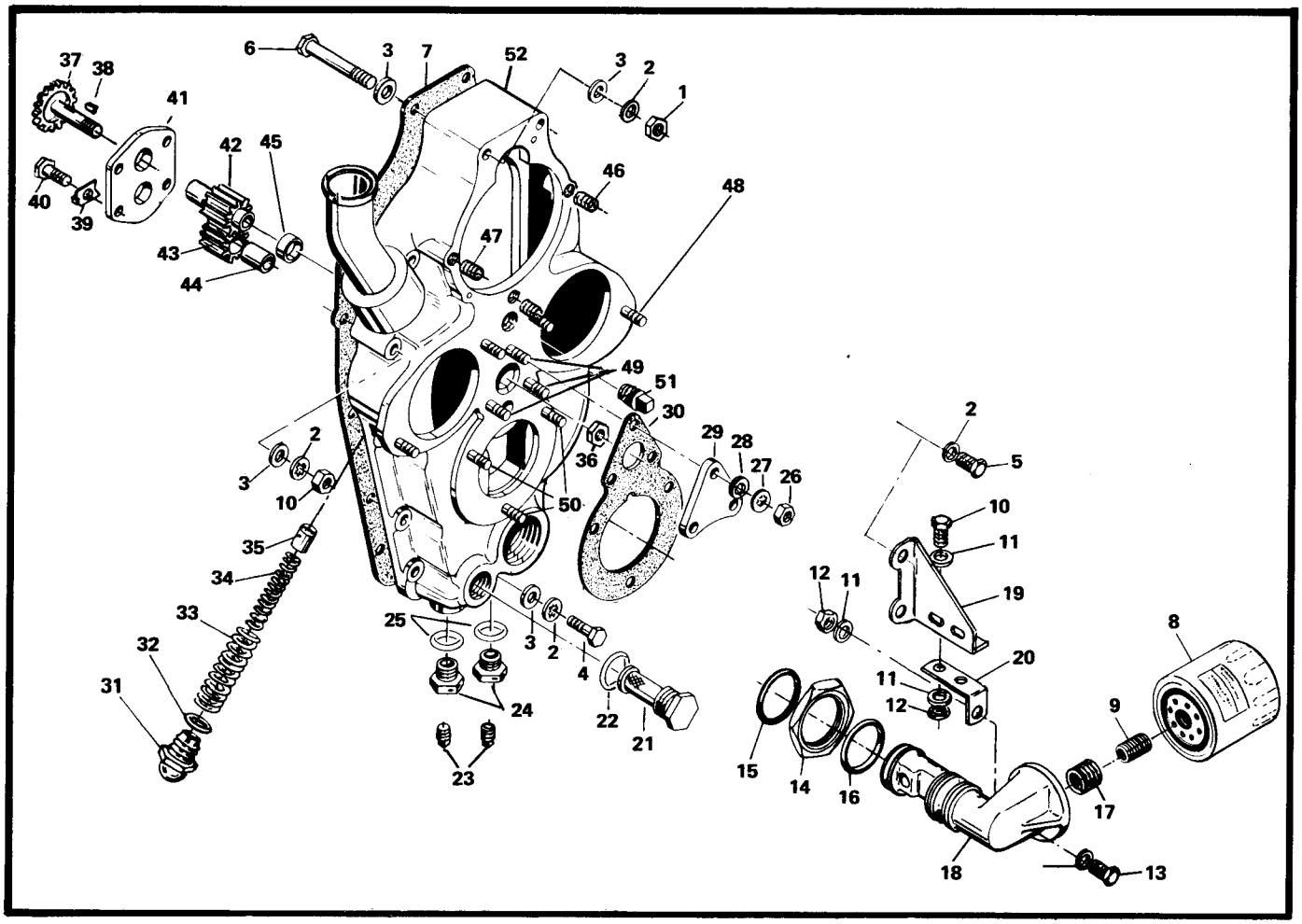


Figure 4-8. Crankcase Cover for TSIO-360 Series.

1. Nut
2. Lockwasher
3. Plain washer
4. Bolt
5. Bolt
6. Bolt
7. Gasket
8. Filter assembly
9. Stud
10. Screw
11. Lockwasher
12. Nut
13. Screw
14. Nut
15. "O" ring
16. "O" ring
17. Stud, adapter
18. Adapter
19. Bracket
20. Bracket
21. Screen assembly
22. Gasket
23. Plug
24. Plug
25. Gasket
26. Nut
27. Lockwasher
28. Plain washer
29. Cover
30. Gasket
31. Cap, oil pressure relief valve
32. Gasket
33. Spring
34. Spring
35. Plunger
36. Nut
37. Gear
38. Woodruff Key
39. Tab washer
40. Bolt
41. Cover
42. Drive gear
43. Driven gear
44. Bushing
45. Bushing
46. Insert
47. Insert
48. Stud
49. Stud
50. Stud
51. Plug
52. Crankcase cover

4-13 CRANKCASE COVER (OPTIONAL) (See Figure 4-9)

a. Remove attaching parts (1 thru 6) and carefully remove crankcase cover from crankcase studs. Remove gasket (7).

b. Remove filter (45). Remove attaching parts (8, 9, 10) and pull adapter (11 or 12) from studs. Remove "O"-ring (14) and gasket (15). Remove oil screen (16) and gasket (17). Remove plugs (18), plugs (19) and gaskets (20).

c. Remove nut (21), lockwasher (22), and plain washer (23) and pull cover (24) from crankcase cover studs. Remove gasket (25).

d. Unscrew oil pressure relief valve cap (26) and remove relief valve (26 thru 30)

e. Remove nut (31) and withdraw gear (34). Remove woodruff key (35). If engine is equipped with a tachometer, the shaft serves the same purpose as nut (31), and must be removed before gear (34) can be removed.

f. Bend down ears of tab washers (32) and remove with screws (33). Lift off cover (36) and pull gears (37, 38) from oil pump cavity.

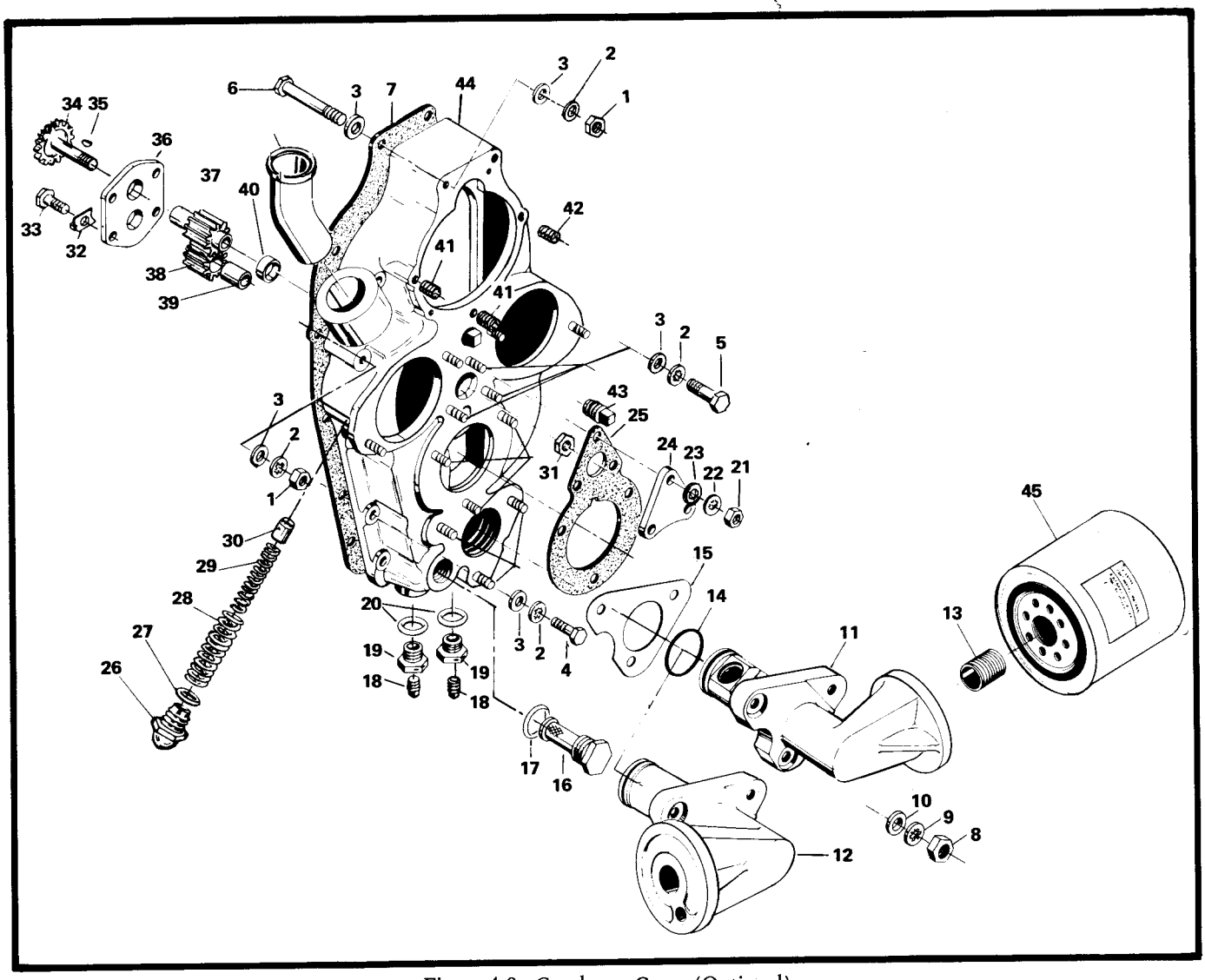


Figure 4-9. Crankcase Cover (Optional).

1. Nut
2. Lockwasher
3. Plain washer
4. Screw
5. Screw
6. Screw
7. Gasket
8. Nut
9. Lockwasher
10. Plain washer
11. Adapter (front engine)
12. Adapter (rear engine)
13. Stud, adapter
14. "O" ring
15. Gasket
16. Screen assembly
17. Gasket
18. Plug
19. Plug
20. Gasket
21. Nut
22. Lockwasher
23. Plain washer
24. Cover
25. Gasket
26. Cap, oil pressure relief valve
27. Gasket
28. Spring
29. Spring
30. Plunger
31. Nut
32. Tab washer
33. Screw
34. Gear
35. Woodruff Key
36. Cover, oil pump
37. Gear, drive
38. Gear, driven
39. Bushing
40. Bushing
41. Helical coil
42. Helical coil
43. Plug
44. Crankcase cover
45. Filter

4-14 OIL SUMP (See Figure 4-10)

a. Remove drain plug (1) and gasket (2) if this has not been accomplished.

b. Place engine in inverted position. Remove nut (3), lockwasher (4) and plain washer (5) and lift off sump (8). Remove suction tube (6) and gasket (7).

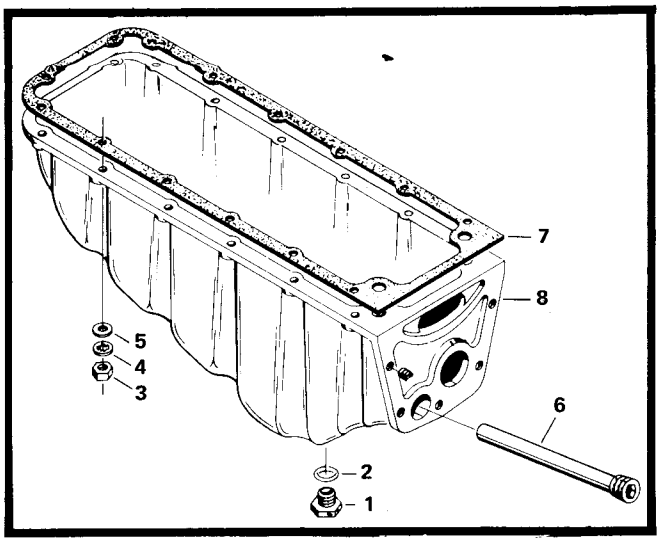


Figure 4-10. Oil Sump.

1. Plug
2. Gasket
3. Nut
4. Lockwasher
5. Washer
6. Suction tube
7. Gasket
8. Sump

4-15 CYLINDER ASSEMBLY (See Figure 4-11)

a. With engine in the inverted position, remove attaching parts (1, 2, 3), covers (4, 5) and gaskets (7). Position crankshaft so valve lifters of cylinder to be removed are on heels of cam lobes and both valves are fully closed. Bend down ears of tab washers (9) clear of nut (8). Remove nut and washer (8, 9), rocker retainer (10), shafts (11) and rocker assemblies (15, 16, 17). Withdraw pushrods (18). Repeat these steps on the remaining cylinders. Retainers (13) and shafts (14) are used on IO-360-A engines in places of (10 and 11).

b. Push the pushrod housings (23) in towards the crankcase until the cylinder flange end is clear. Lift the cylinder end of the housing and withdraw from the crankcase. Disconnect and remove drain tube assembly (24, 25).

c. Rotate engine stand so engine is in upright position. Make certain piston in cylinder to be removed is in top dead center position. Remove flange nuts (26, 27). Cradle cylinder in either arm and withdraw it straight outward. Catch piston with free hand as it clears the cylinder to prevent damage to the crankcase.

d. Remove piston pin (28) and piston and rings assembly (29 thru 33) immediately after removing the cylinder. Remove hydraulic lifters (44).

e. Remove cylinder base packing (34). Use of a cylindrical wood block and a lever type valve spring compressor is recommended to facilitate removal of valve springs (38, 39) and to prevent dropping valves (41, 42).

f. Compress valve springs (38, 39) and remove keys (35). Be careful not to cock the retainers (36) or the roto coil (37), and score the valve stems. Remove outer retainer (36), roto coil (37), springs (38, 39) and inner retainers (40). Hold the valve stems while lifting the cylinder from its support. Lay the cylinder on its side and stone any nicks on valve stems before removing valves (41, 42).

g. Remove piston rings (29 thru 32) from piston (33). Be careful not to score piston lands with ring ends.

h. Hydraulic lifters (44) are to be disassembled only for cleaning. (See paragraph 6-30.)

4-16 CRANKCASE (See Figure 4-12)

a. If not previously accomplished, remove oil gauge rod (1), packing (2), bracket assembly (6, 7) and gauge housing assembly (8, 9). Remove eight sets of attaching parts (10, 11, 12), oil cooler (13) and gasket (14). Loosen plug (15) and temperature control valve (17).

b. Rotate engine stand to place left crankcase downward. Place a length of pipe or wood under the left crankcase of sufficient length to help support it during disassembly. Disconnect the right mount brackets from the engine stand.

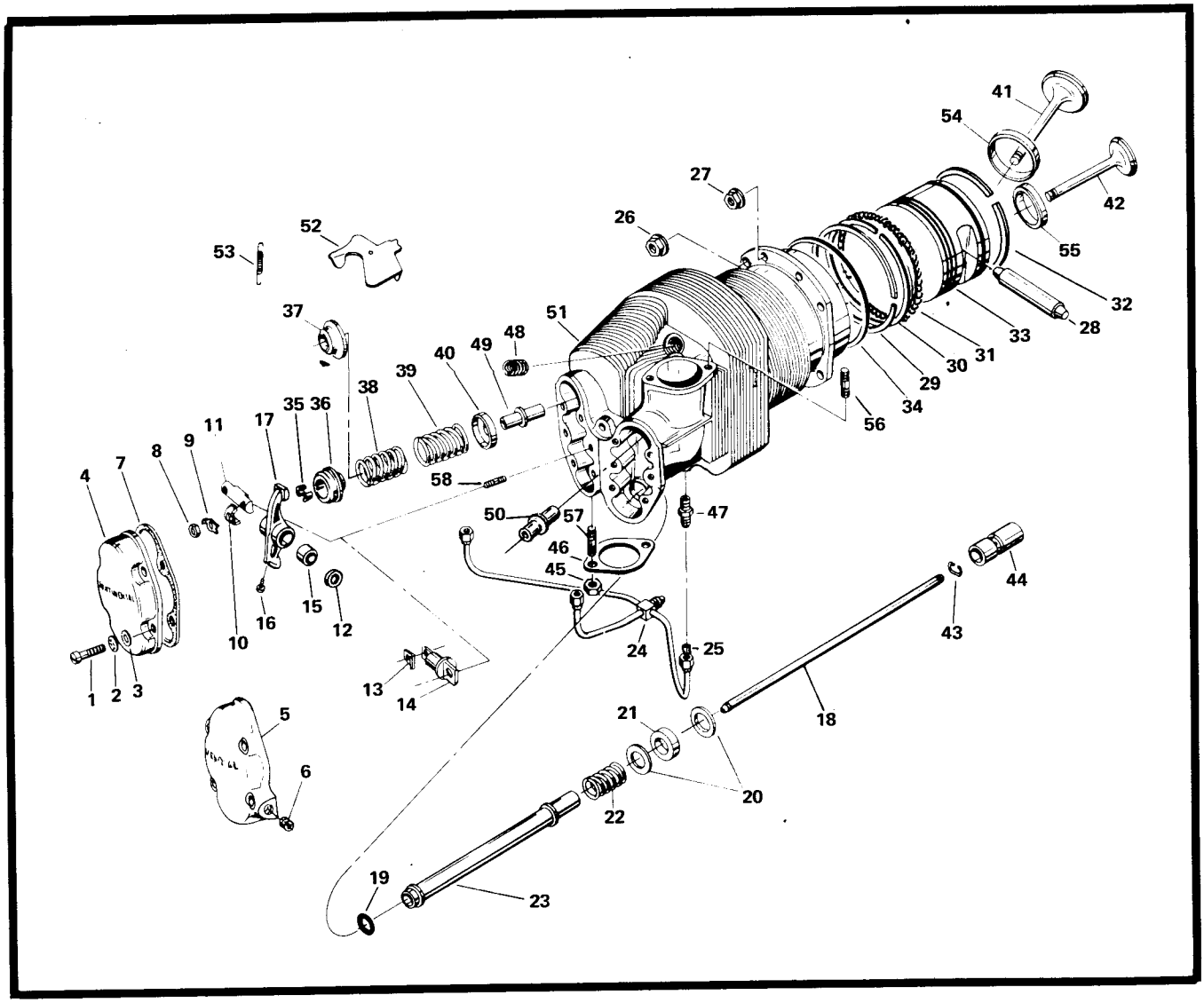


Figure 4-11. Cylinder Assembly.

1. Screw
2. Lockwasher
3. Washer
4. Rocker cover
5. Rocker cover
6. Insert
7. Gasket
8. Nut
9. Tab washer
10. Retainer
11. Shaft
12. Retainer
13. Shaft
14. Bushing
15. Plug
16. Rocker
17. Pushrod
18. "O" ring
19. Washer
20. Packing
21. Spring
22. Housing
23. Tube assembly
24. Palnut
25. Flanged nut
26. Palnut
27. Flanged nut
28. Piston pin
29. Top piston ring
30. Second piston ring
31. Oil control ring
32. Scraper ring
33. Piston
34. Cylinder base packing
35. Keys
36. Roto coil
37. Seat
38. Inner spring
39. Outer spring
40. Retainer
41. Intake valve
42. Exhaust valve
43. Retaining ring
44. Lifter socket
45. Lifter body
46. Spring
47. Valve cage
48. Valve plate
49. Lifter plunger
50. Nut
51. Exhaust gasket
52. Nipple
53. Insert
54. Valve guide
55. Cylinder
56. Baffle
57. Spring
58. Insert, intake
59. Insert, exhaust

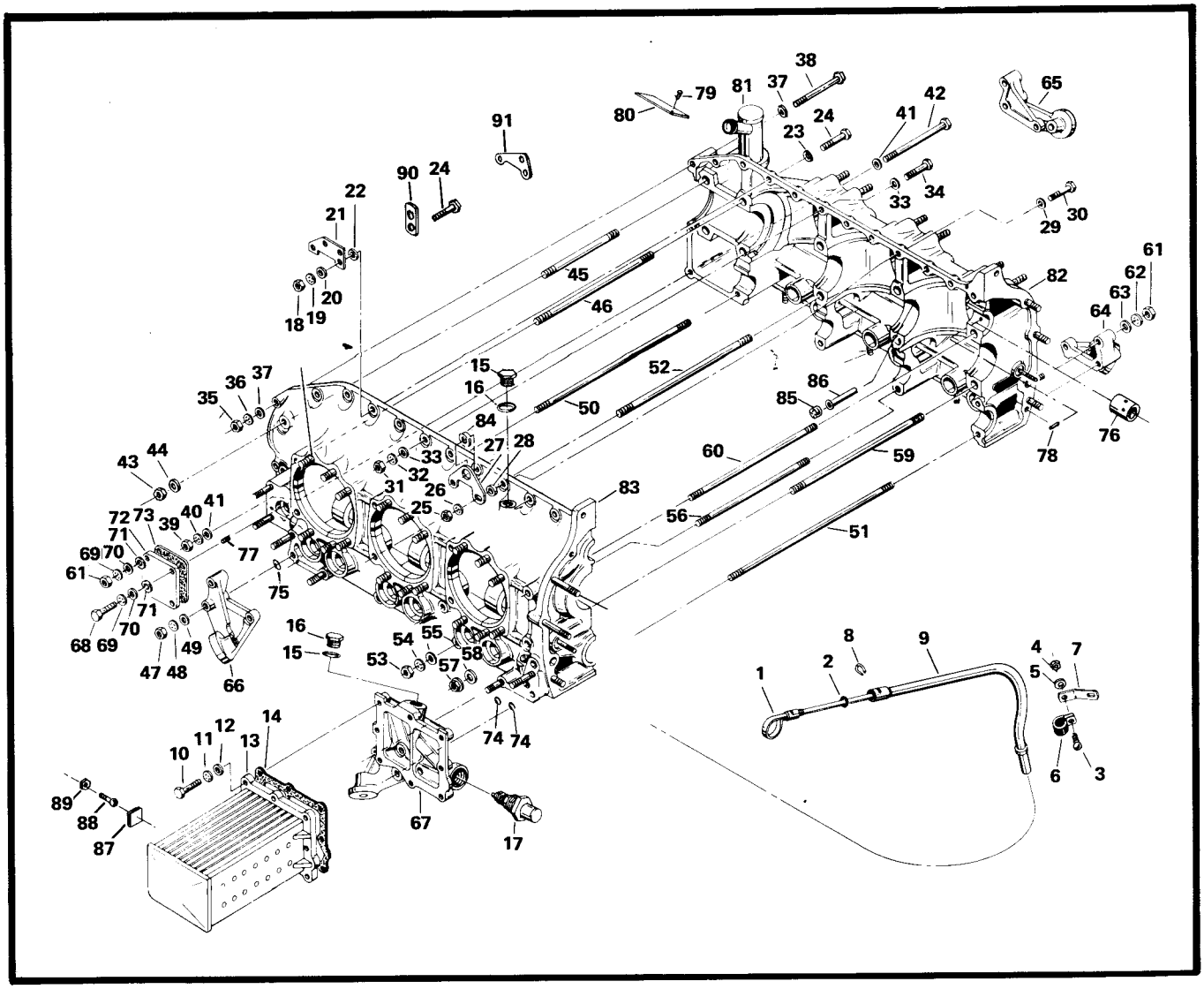


Figure 4-12. Crankcase.

1. Oil gauge rod
2. "O" ring
3. Screw
4. Locknut
5. Washer
6. Clamp
7. Bracket
8. Circlip
9. Oil gauge housing
10. Screw
11. Lockwasher
12. Washer
13. Oil cooler
14. Gasket
15. Plug, machine thread
16. Gasket
17. Temperature control valve
18. Nut
19. Lockwasher
20. Washer
21. Air throttle bracket
22. Washer
23. Washer
24. Bolt
25. Nut
26. Lockwasher
27. Lifting eye
28. Spacer
29. Washer
30. Bolt
31. Nut
32. Lockwasher
33. Washer
34. Bolt
35. Nut
36. Lockwasher
37. Washer
38. Bolt
39. Nut
40. Lockwasher
41. Washer
42. Bolt
43. Nut
44. Washer
45. Thru bolt
46. Thru bolt
47. Nut
48. Lockwasher
49. Washer
50. Thru bolt
51. Thru bolt
52. Thru bolt
53. Nut
54. Lockwasher
55. Washer
56. Thru bolt
57. Flanged nut
58. Washer
59. Thru bolt
60. Thru bolt
61. Nut
62. Lockwasher
63. Washer
64. Right rear mount bracket
65. Right front mount bracket
66. Left front mount bracket
67. Left rear mount bracket
68. Bolt
69. Lockwasher
70. Washer
71. Spacer
72. Cover
73. Gasket
74. "O" ring
75. "O" ring
76. Bushing
77. Helical coil
78. Dowel
79. Drive screw
80. Nameplate
81. Breather
82. Right crankcase
83. Left crankcase
84. Spacer
85. Screen
86. Squirt nozzle
87. Shoe
88. Bolt
89. Nut
90. Bracket, air throttle
91. Bracket, adapter

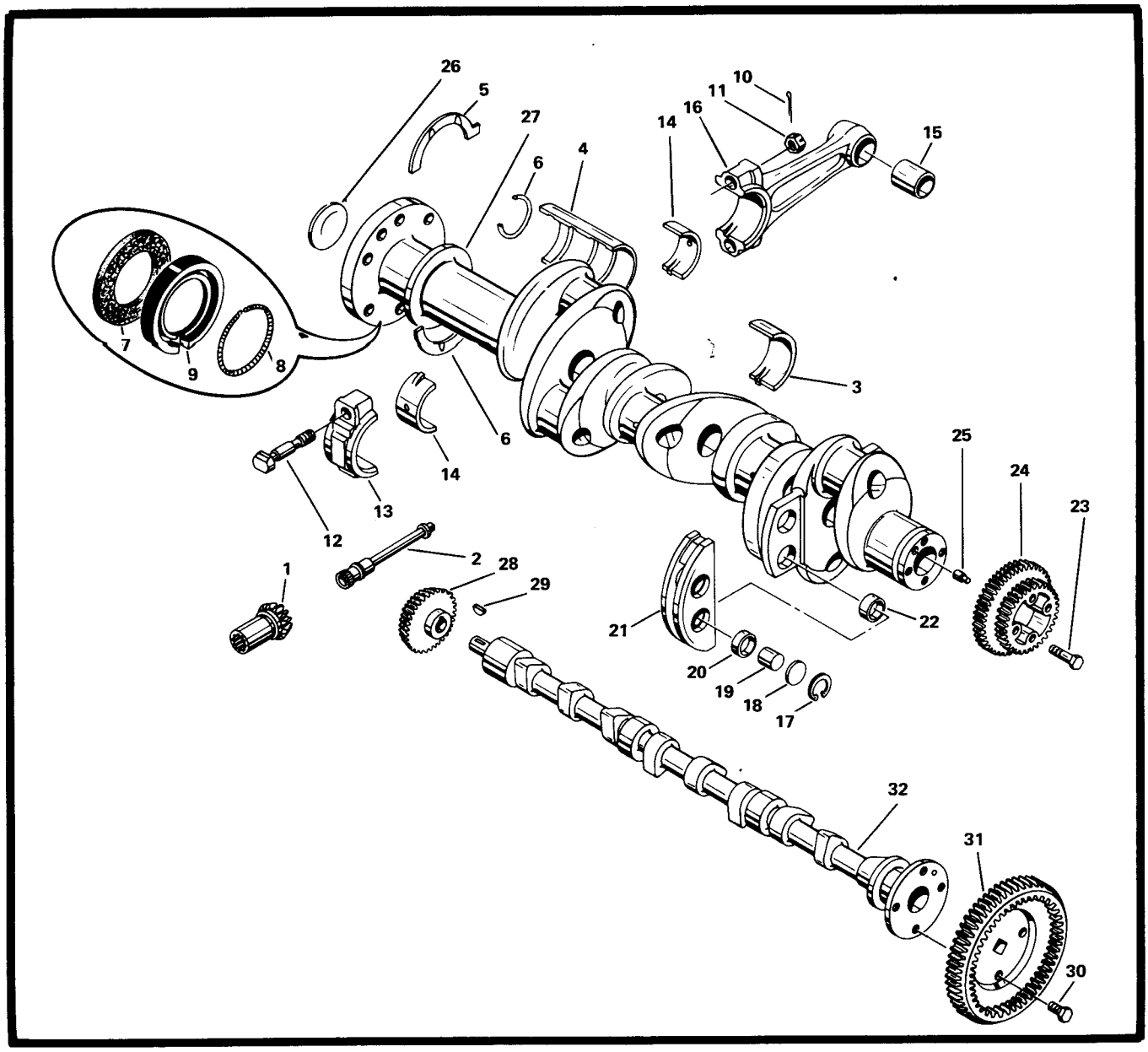


Figure 4-13. Crankshaft.

1. Governor driven gear
2. Fuel pump drive
3. Intermediate and rear main bearing
4. Front main bearing
5. Thrust washer
6. Packing, crankshaft bearing
7. Oil seal felt
8. Oil seal spring
9. Oil seal
10. Cotter pin
11. Nut
12. Rod bolt
13. Rod cap
14. Rod bearing
15. Rod bushing
16. Connecting rod
17. Retaining ring
18. Retaining plate
19. Counterweight pin
20. Counterweight bushing
21. Counterweight
22. Crankshaft bushing
23. Bolt
24. Crankshaft gear
25. Dowel
26. Plug
27. Crankshaft
28. Governor drive gear
29. Woodruff key
30. Bolt
31. Camshaft gear
32. Camshaft

c. Remove attaching parts (18 thru 20, 23 thru 26 and 28 thru 30). Lift off bracket (21 or 92) and lifting eye (27) or bracket (93). Remove attaching parts (31 thru 42).

d. Remove a set of attaching parts (43, 44, 45) from each end of two thru bolts (46) and from the right crankcase side of two thru bolts (47). Remove a set of attaching parts (48, 49, 50) from each end of thru bolts (51, 52). Remove a set of attaching parts (54, 55, 56) from each end of thru bolt (57). Remove a set of attaching parts (58, 59, 60) from each end of thru bolts (61, 62). Very carefully, with a brass or fiber drift, drive the thru bolts downward and out of the crankcase. Catch each thru bolt as it leaves the crankcase to prevent damage to the threads.

e. Stand numbers (1, 3 and 5) connecting rods upright and lift off the right crankcase half. Lift out camshaft assembly, fuel pump drive shaft, and governor drive gear. Remove crankshaft assembly with connecting rods, thrust washers and main bearings. Remove left crankcase from stand.

f. Remove eight sets of attaching parts (63, 64, 65) and mount brackets (66 thru 69). Remove one set of attaching parts (70, 71, 72, 73), three sets of attaching parts (63, 71, 72, 73), cover (74) and gasket (75). Remove and discard packings (76, 77). Remove plugs (79). Lift out starter bushing (78).

4-17 CRANKSHAFT AND CAMSHAFT GROUP (See Figure 4-13)

a. Use wooden support blocks under front and rear main journals during disassembly of crankshaft.

b. Twist and remove oil seal felt (7) from shaft. Work oil seal spring (8) from its groove. Remove oil seal (9) from shaft.

c. Remove cotter pins (10), nuts (11) and bolts (12). Remove connecting rod caps (13) and rods (16). Remove and discard all inserts (14). Loosely reassemble rods, caps, bolts and nuts with position numbers matched.

d. Use Truarc pliers to remove retaining rings (17). Remove plates (18), pins (19) and counterweights (21). Remove lockwire, bolts (23) and gear (24).

e. Remove gear (28) and woodruff key (29) from camshaft (32). Remove lockwire, four bolts (30) and gear (31).

SECTION V
CLEANING PARTS

5-1. MATERIALS AND PROCESSES.

5-2. Equipment, processes and material in general use in aircraft engine overhaul shops will be satisfactory for cleaning IO-360 or TSIO-360 engine parts.

5-3. Aluminum alloy parts can be degreased by spraying with any fortified mineral spirit solvent or by brush application of the same liquid. Fortified mineral spirits are more effective when the parts are immersed in them and allowed to remain for a short time to permit solvent action to loosen caked deposits. Carbon deposits and gum (oil varnish) may be removed most easily by immersing these parts in a hot bath of an inhibited mild alkaline cleaning compound. Immersion time should be held to the minimum time necessary to remove the deposits. Carbon solvent should be employed only when the carbon deposits are too hard and thick for removal by other solvents. Give special attention to cleaning studs, tapped holes and drilled holes. Caution must be exercised in cleaning all aluminum alloy parts. Do not use any strong alkaline solutions to clean aluminum alloy or wrought aluminum alloy parts, because strong solutions will attack and cause destruction to machined surfaces. Immediately after removing soaking parts from a caustic or inhibited, mild alkaline bath, remove all traces of the alkali by spraying the parts with a jet of wet steam or by brushing vigorously with a mineral spirit solvent. Cleaned parts may be dried by use of a jet of dry compressed air to remove all solvent liquids.

CAUTION . . . All alkaline residues must be removed from crevices, recesses and holes, as well as from other surfaces, to prevent the formation of foaming emulsion in the engine lubricating oil after reassembly.

5-4. No polishing compound, abrasive paste or powder should be employed for cleaning engine parts. Scraping, abrasion with wire brushes, sandpaper or abrasive cloth and buffing wheels are dangerous methods for use on soft metal such as aluminum. Scratches resulting from such methods allow a concentration of stress at the scratch and may cause fatigue failure.

5-5. Various blasting techniques can be employed to remove hard carbon deposits if suitable equipment is available. The most suitable types of grit for dry blasting are plastic pellets and processed natural materials, such as wheat grains and crushed fruit pits or shells. Air pressure should be the lowest that will produce the required cleaning action. Small holes and finished surfaces which do not require cleaning should be protected from the blasts by seals and covers particularly if the grit is sharp. Sand, shot and metal grit are too abrasive and too heavy to use on soft metals as aluminum. After any blasting process, blow off all dust with dry compressed air and make sure that no grit has lodged in any hole, crevice or recess.

5-6. SPECIFIC PARTS.

5-7. CYLINDERS. Precautions applicable to both aluminum and steel must be exercised in cleaning and storing these assemblies. Remove oil and loose material with a mild alkaline cleaner by spraying or brushing. If stubborn deposits of carbon still remain, the areas affected may be vapor blasted. All machined surfaces must be protected from abrasive action during the blasting operation.

5-8. PISTONS. Do not use wire brushes or scrapers of any kind. Soft and moderately hard carbon deposits may yield to solvent action. If deposits remain, blast the heads with soft grit or by the vapor grit method, first having installed tight fitting skirt protectors. Ring grooves may be cleaned by pulling through them lengths of binder twine or narrow strips of crocus cloth. Do not use automotive type ring groove scrapers, since the corner radius at the bottom of the ring groove must not be altered, nor any metal removed from the sides. Discoloration or light scoring need not be

removed from piston skirts. The use of abrasive cloth on piston skirts is not recommended because the diameter and cam ground contour must not be altered. Heavily burned or scored pistons should be discarded.

5-9. VALVES. After degreasing valves, inspect them and discard any with excessively warped head, insufficient stock to permit refacing within specified limits or scored, nicked, burned or eroded stem. Carbon deposits may be loosened by solvent action or scraped off while valve is rotated in polishing head or lathe collet. Apply crocus cloth moistened in mineral spirit, and polish the stems with dry crocus cloth.

5-10. ROCKER SHAFTS. Degrease these parts by brushing on any mineral spirit solvent. Prior to magnetic inspection, polish the steel bearing surfaces with crocus cloth moistened with kerosene, followed by dry crocus cloth.

5-11. PUSHRODS, VALVE ROCKERS AND OTHER SMALL STEEL PARTS. Degrease these parts with mineral spirit solvent, paying special attention to removal of sludge from all oil passages.

5-12. CAMSHAFT AND CRANKSHAFT. All parts may be degreased by spraying with mineral spirit solvent. Pay particular attention to threads, oil holes and recesses. Before magnetic inspection, the crankpins, main journals, oil seal race of the crankshaft and all journals, cam lobes and gear mount flange of the camshaft must be smoothed with crocus cloth, moistened in a mineral spirit. If possible this should be accomplished while shaft is rotated in a lathe at about 100 RPM. All gum (varnish) deposits should be removed to allow reliable magnetic indications.

5-13. CRANKCASE. The oil passages should be pressure-flushed with mineral spirit solvent and checked with a flashlight. If the castings are immersed in an alkaline bath, it is strongly recommended that such treatment be followed by spraying with a jet of wet steam and this followed by flushing of all passages with a solvent. After the castings are dry, inspect them thoroughly for alkaline residues, and remove any traces of scum.

5-14. GEARS. Gears without bushings may be freed of hard deposits by immersion in a caustic stripping bath, when cold solvents are not effective. Bushings are discolored by such methods, therefore, bushed gears should be cleaned by other methods, such as spraying and/or brushing with a mineral spirit solvent and brushing with a brass wire brush.

5-15. SHEETMETAL PARTS. Clean these parts with a mineral spirit spray or by brushing with the same liquid, or use a cold emulsion type cleaner and flush with water to rinse.

5-16. Immediately after cleaning bare steel parts spray them with, or dip them in clean engine oil or, for larger storage, in a corrosion preventive oil mixture. Wrap ball bearings in wax paper. Wrap or cover other clean parts to protect them from abrasive dust in the air.

SECTION VI
INSPECTION

6-1. DEFINITION OF TERMS.

6-2. The following definitions apply to terms used to describe kinds of damage for which parts should be inspected.

a. ABRASION: Scratching of a surface, either by motion while in contact with another surface or by mechanical cleaning or resurfacing with abrasive cloth or lapping compound.

b. BURNING: As applied to valve heads, this term indicates roughening or erosion due to high temperature gases escaping past valve faces. In other instances it indicates drawing the temper of steel to a soft (blue) condition as a result of overheating in absence of lubrication on moving surfaces, such as gear teeth, subject to high loading.

c. BURR: A sharp projection of metal from an edge, usually the result of drilling, honing, counter-sinking, etc. May also be caused by excessive wear of one or both surfaces adjacent to the burred edge.

d. CORROSION: Deterioration of a surface usually caused by oxidation of metal.

e. ELONGATION: Stretching or increase of length.

f. FRETTING: Scuffing or deterioration of a metal surface caused by vibration or chattering of/or against another part. A fretted steel surface may appear dull, scuffed or corroded, depending on length of time subjected to the action, dissimilarity and link of contacting metal and presence or absence of moisture.

g. GALLING: Excessive friction between two metals resulting in particles of the softer metal being torn away and "welded" to the harder metal.

h. INDENTATION: Dents of depressions in a surface caused by severe blows.

i. OXIDATIONS: Chemical combining of a metal with atmospheric oxygen. Aluminum oxide forms a tough, hard film and protects the surface from further decomposition. Iron oxides, however, do not form continuous cover or protect underlying metal. Thus oxidation of steel parts is progressive and destructive.

j. PITTING (or Spalling): Small, deep cavities with sharp edges may be caused in hardened steel surfaces by high impacts or in any smooth steel part by oxidation.

k. RUNOUT: Eccentricity or wobble of a rotating part. Eccentricity of two bored holes or two shaft diameters. A hole or bushing out-of-square with a flat surface. Usually measured with a dial indicator, and limits stated indicated full deflection of indicator needle in one revolution of part or indicator support.

l. SCORING: Deep grooves in a surface caused by abrasion when fine, hard particles are forced between moving surfaces, as in a bearing and journal, or by galling when a moving part is not supplied with lubrication.

6-3. PROTECTION FROM CORROSION. Bare steel parts should be coated with oil or a corrosion preventive oil mixture except during the actual inspection operations. Since inspection involves handling of dry steel parts, it is advisable to apply a finger print remover solution after such handling, particularly since perspiration and skin oils have a high acid content. Application of lubricating oil or corrosion preventive oil will not necessarily stop corrosion from this cause.

6-4. VISUAL INSPECTION. Parts without critical dimensions and small parts, as well as running parts and others of major importance should be inspected visually under good light for surface damage such as nicks, dents, deep scratches, visible cracks, distortion, burned areas, pitting, pick-up of foreign metal and removal of enamel coating. Visual inspection may also reveal the need for further cleaning of obscure areas. Inspect all studs for possible bending, looseness or backing out. Inspect all threaded parts for nicks or other damage to screw threads. After inspection the parts should be in three groups as apparently serviceable parts, repairable parts and parts to be discarded.

6-5. MAGNETIC PARTICAL INSPECTION. Inspection by the Magnaflux method should be conducted on all ferrous parts listed in Table IV, and in accordance with the methods and data in the table before dimensional inspection. The Magnaglow method is recommended whenever the necessary equipment is available. This method employs magnetic particles coated with a fluorescent organic material which may be illuminated with "black light" as in the Zyglo process to amplify weak conditions. If a crankshaft if doubtful after circular magnetization and inspection, demagnetize and magnetize it longitudinally for further inspection.

NOTE . . . Before magnetic partical inspection, piston pins and valve rocker shafts must be polished with crocus cloth.

CAUTION . . . Before magnetic particle inspection of any part, plug small holes leading to obscure cavities with tight wood plugs or with a hard grease which is soluble in lubricating oil to prevent particles from lodging in places from which they would be difficult to remove and which places are not subject to visual inspection. After magnetic particle inspection remove all such parts and clean parts in solvent and dry with compressed air. Check for complete demagnetization.

6-6. FLUORESCENT PARTICLE INSPECTION. This process, commonly known under the trade name of "Zyglo", is recommended for inspecting aluminum alloy parts for invisible cracks. The standard operating techniques for this process is applicable.

6-7. DIMENSIONAL INSPECTION.

6-8. INSTRUMENTS. Areas of running parts and bushings subjected to wear should be inspected for serviceable fit with mating parts by comparative linear measurements and alignment measurements, using standard pattern precision measuring instruments such as micrometers, telescoping gauges and dial indicators. The use of a dial-type cylinder bore gauge is recommended in preference to other tools not specifically designed for this purpose.

6-9. DIMENSIONAL LIMITS. After comparative measurements of mating parts and determination of running clearences, refer to the Table of Limits to locate the reference number of each fit and the acceptable limits assigned to it. Limits under the column heading "New Parts" are manufacturing limits. All running clearances in this column apply to mating parts, both of which are new. Such clearances, however, are allowed to increase with wear to, but not beyond, the values in the column headed "Serviceable Limits". The absence of any value in this column indicates that the clearance must be maintained at the new part value. Oversize parts are available, in some instances, to permit conformity to this requirement.

6-10. ORIGINAL DIMENSIONS. Although comparative measurements of mating parts will determine the serviceability of the fit, it is not always easy to determine which part has worn the most, and in some instances (e.g., main journals in bearing inserts) accurate measurements of fit are not possible. While no limits of wear on critical dimensions have been assigned to specific parts in most instances, it is helpful in estimating wear to know the original dimensions. The list of manufacturing limits in Table I on important dimensions of new parts should be consulted when the serviceability of a specific part is in doubt.

6-11. GENERAL REPAIR AND REPLACEMENT PROCEDURES.

6-12. CASTINGS. Remove raised edges of nicks in machined surfaces with a hard Arkansas stone. Unobstructed flat surfaces, such as valve rocker cover flanges, may be returned to true flatness by lapping on a true lapping plate. Use a fine grade lapping compound and move the casting in a figure 8 movement without rocking it.

TABLE 1
CRITICAL NEW PART DIMENSIONS

Part Name	Feature	New Dimension (Inches)
Cylinder head	Intake valve guide bore	0.3745 - 0.3755
	Exhaust valve guide bore	0.3745 - 0.3755
Valve rocker shaft	Outside diameter	0.593 - 0.594
Valve rocker bushings	Inside diameter	0.5945 - 0.5955
Intake valve	Stem diameter	0.3730 - 0.3735
Exhaust valve	Stem diameter	0.3720 - 0.3725
Piston (Std)	* Diameter at top	4.390 - 4.392
	* Diameter below 2nd groove	4.405 - 4.407
	* Diameter at bottom	4.4265 - 4.4275
	Pin bore diameter	0.9988 - 0.9990
	Third ring groove width	0.1585 - 0.1595
	Fourth ring groove width	0.097 - 0.098
Piston pin assembly	Diameter	0.9984 - 0.9986
	Length (including plugs)	4.410 - 4.430
Connecting rod	Bushing bore diameter	1.0000 - 1.0005
	Bushing center to crankpin center	6.373 - 6.377
Crankshaft assembly	Damper pin bushing I.D. P/N 626566	0.604 - 0.607
	P/N 639580	0.730 - 0.732
Camshaft	Journal diameter	1.3725 - 1.3735
Hydraulic valve tappets	Outside diameter	0.9990 - 0.9995
Crankcase	Camshaft bearings diameter	1.3745 - 1.3755
	Tappet guides diameter	1.0005 - 1.0015
	Governor driven gear bearing diameter	0.875 - 0.876
Starter worm drive shaft	Small end diameter	0.5615 - 0.5625
Starter shaftgear	Front journal diameter	1.059 - 1.060
	Knurled drum diameter	1.931 - 1.932
Starter clutch drum	Inside diameter	1.3115 - 1.3125
Starter clutch spring	Outside diameter	2.374 - 2.376
	Inside diameter	1.938 - 1.940
Starter drive adapter	Sleeve front end I.D.	2.338 - 2.343

TABLE 1 (Continued)
CRITICAL NEW PART DIMENSIONS

Part Name	Feature	New Dimension (Inches)
Oil pump driver gear	Shaft diameter	0.7180 - 0.7185
Oil pump driven gear	Shaft diameter (IO-360)	0.3745 - 0.3755
	Bushing I.D. (TSIO-360)	0.3745 - 0.3755
Oil pump housing	Bushing inside diameter	0.719 - 0.720
	Gear chamber depth (IO-360-A)	1.002 - 1.004
	Gear chamber depth (IO-360-C-D-G-H)	0.658 - 0.660
	Gear chamber depth (TSIO-360)	0.745 - 0.747
Magneto drive gears	Shaft support diameter	0.8745 - 0.8750

* Measure piston diameters at right angles to pin bore.

6-13. STUD REPLACEMENT. Remove damaged whole studs with a standard pattern stud remover or a small pipe wrench. Turn slowly to avoid heating the casting. Remove broken studs which cannot be gripped, by drilling in center to proper diameter for unscrewing with a splined stud extractor. Examine coarse thread end of damaged stud, before discarding it, to determine its pitch diameter size. Standard studs have no markings. For oversize stud identification reter to Table II.

Clean casting tapped hole with solvent and blow dry with compressed air. Examine thread condition. If it is not damaged install next larger oversize stud. If the removed stud was of maximum oversize, or if thread was damaged, the hole may be retapped and a helical coil insert installed to permit the use of a standard size stud. Coat coarse thread of new stud with Alcoa thread lube if hole is blind or with National Oil Seal Compound if hole is through to a cavity subject to oil spray. It is

TABLE II

Typical Part No.	Oversize on Pitch Dia. of Coarse Thread (inches)	Optional Identification Mark on Coarse Thread End		Identification Color Code
		Stamped	Machined	
XXXXXX	Standard	None		None
XXXXXXP003	.003			Red
XXXXXXP006	.006			Blue
XXXXXXP009	.009			Green
XXXXXXP007	.007			Blue
XXXXXXP012	.012			Green

recommended that the new stud be installed with a "T" handle stud driver. Drive stud in slowly until it projects a distance equal to that listed in Table III.

6-14. HELICAL COIL INSERT INSTALLATION.

a. Helical coil thread inserts are factory installed at various locations. These inserts may be replaced, if damaged, with the aid of special tools procurable from any Authorized Distributor of the "Heli Coil" Corporation.

b. Inserts are helical coils of wire with a diamond shaped cross section forming both a male and female thread. Drilling and tapping depths for inserts, being installed in blind holes, should be equal to twice the nominal diameter of the insert.

TABLE III. STUD SETTING HEIGHTS

Location	Thread Sizes	Setting Height	IO-360			TSIO-360		
			A	C-G	D-H	A	B	C & D
CRANKCASE								
Cylinder mount pads	3/8-16 X 3/8-24	25/32	36	36	36	36	36	36
Engine mount pads	3/8-16 X 3/8-24	1.00	4	4	4	4	4	4
	3/8-16 X 3/8-24	1-1/2	3	3	3	3	3	3
Governor mount pads	5/16-18 X 5/16-24	1-3/8	3	3	3	3	3	3
Fuel pump pad	5/16-18 X 5/16-24	1-1/4	3	3	3	3	3	3
Oil sump pad	1/4-20 X 1/4-28	3/4	14	14	14	14	14	14
Crankcase cover pad	5/16-18 X 5/16-24	27/32	4	3	3	3	3	3
	5/16-18 X 5/16-24	2.00	2	3	3	3	3	3
Shaftgear support	5/16-18 X 5/16-24	1-17/64	2	2	2	2	2	2
	5/16-18 X 5/16-24	1-3/8						2
Oil cooler adapter	3/8-16 X 3/8-24	1-1/2	1	1	1	1	1	1
CYLINDER								
Intake flange	5/16-18 X 5/16-24	53/64	2	2	2	2	2	2
Rocker pin	1/4-20 X 1/4-24	3/4	4	4	4	4	4	4
Exhaust flange	5/16-18 X 5/16-24	25/32	2	2	2	2	2	4
CRANKCASE COVER								
Generator pad	5/16-18 X 5/16-24	13/16	3	3	3	3	3	3
Oil pump cover	1/4-20 X 1/4-28	19/32	-	3	3	3	3	3
Starter adapter pad	5/16-18 X 5/16-24	3-1/4	3	-	-	-	-	-
Magneto pad	5/16-18 X 5/16-24	43/64	4	4	4	4	4	4
Filter adapter pad	5/16-18 X 5/16-24	1.00	-	-	-	-	-	-
STARTER ADAPTER								
Starter pad	3/8-16 X 3/8-24	1.00	2	2	2	2	2	2
Cover pad	5/16-18 X 5/16-24	25/32	1	1	1	1	1	1
STARTER ADAPTER COVER								
Acc drive cover pad	1/4-20 X 1/4-28	5/8	4	-	4	-	4	4
ACCESSORY DRIVE ADAPTER								
Cover pads	1/4-20 X 1/4-28	5/8	-	8	-	8	-	8

Consult the manufacturer's bulletin No. 650-R. The helical coil drills and taps must be absolutely perpendicular to the machined surface of the casting. Drilling should be accomplished in a drill press after the casting is firmly supported, clamped and alignment checked. For drilling and tapping aluminum alloy castings, use a lubricant made of one part lard oil and two parts kerosene to prevent overheating the metal and tearing the thread.

c. To remove a damaged helical coil, use the proper size extracting tool specified for the nominal thread size. Tap the tool into the insert so the sharp edges get a good "bite". Turn the tool to the left and back the insert out. To install a new insert, blow out all chips and liquid, slide the insert over the slotted end of the mandrel, and engage the driving tang in the mandrel slot. Wind the insert into the tapped hole slowly (See Figure 6-1). The outer end of the insert should lie within the first full thread of the hole. Break off the driving tang with long nose pliers.

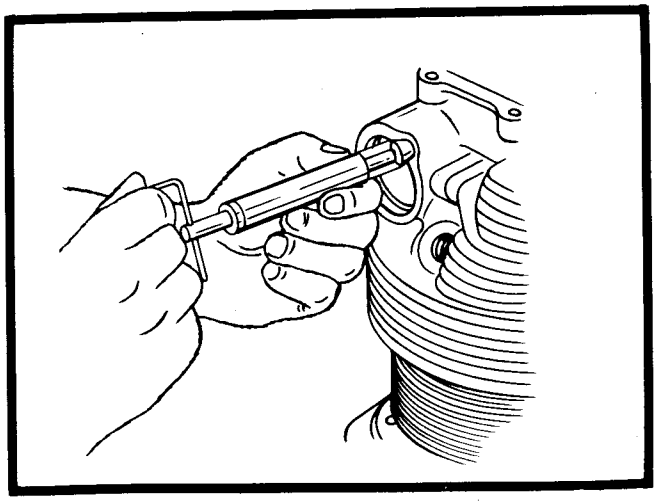


Figure 6-1. Installing Helical Coil Insert.

6-15. BUSHING REPLACEMENT.

a. Use an arbor press and piloted drift to remove worn bushings. The large outside diameter of the drift should be only slightly less than the O.D. of the bushing. Make certain the part which houses the bushing is firmly supported above the arbor press table, and adequate bushing clearance is provided for between the part and arbor press table. Press the bushing out with slow but even pressure.

b. Make certain that the bore wall is without burrs or metal pickup from old bushing. Dip new bushing in clean lubricating oil. Position the bushing in place and carefully align bushing housing, bushing and installing drift. Carefully press bushing in place. Watch for peeling of bushing surface which would indicate misalignment.

6-16. OIL SEAL REPLACEMENT.

a. In most instances oil seals may be removed by driving out with a drift or pulling with a standard expanding type puller. If the seal is too tight for either of the above methods, drill and tap two machine screw holes in the exposed end of the case, opposite each other. Make a plate that will extend across the oil seal bore and drill two holes that will align with those drilled in the oil seal case. Obtain two long screws that will fit the tapped holes and run a nut onto each screw. Place the plate in position, insert the screws through the plate and turn into the oil seal case. Pull the seal by tightening the nuts against the plate slowly and evenly.

b. Inspect housing bore for scores and burrs. Smooth any disfiguration with crocus cloth. Coat the periphery of the new seal with Lubriplate No. 707 grease. Position the oil seal in the bore with its lip toward the oil source. Press the oil seal squarely into the bore with a flat end block of wood and an arbor press.

6-17. PROTECTIVE COATING. The manufacturer protects all alluminum alloy castings, sheet metal and tubing from corrosion by treating all surfaces of the parts with "Alodine 1200" (American Paint and Chemical Company, Ambler, Pennsylvania).

6-18. APPLICATION OF "ALODINE 1200". In the event the original finish of an aluminum part has deteriorated or has been removed, the part may be "Alodized" as described in "Alodine Manufacturer's Technical Service Data Sheet No. AL-1200-D." Wrought or die cast (smooth surface) parts, such as valve rocker covers and intake tubes, are tumble blasted prior to machining, if any, to roughen surface before treatment. Such treatment should not be employed in overhaul work shops on parts with machined surfaces. "Alodine", unlike enamel or primer, will not flake or peel off to contaminate engine lubricating oil. Corrosion protection can therefore be afforded to all interior

aluminum surfaces and parts. If enamel coating is required for a part previously treated with "Alodine", application of a primer before painting is not necessary. "Alodizing" will be performed after all machining and/or repair operations have been completed. The surface color of an "Alodized" part may vary from light gold to dark brown. When a part is treated with "Alodine 1200", the thickness of the film, or build-up, on the mating or bearing surfaces is so small that the effect on dimensional tolerances is negligible.

6-19. REPAIR OF "ALODIZED" SURFACES. If "Alodized" parts have been remachined, rubbed with abrasives or scratched in handling so as to expose areas of bare aluminum, the surface may be repaired by local application of "Alodine" solution in the following steps:

a. Clean bare area thoroughly with carbon tetrachloride. Do not, under any circumstances, use an oil base solvent or strong alkaline cleaner.

b. Mix a small quantity of hot water (180° F.) with 1-1/2 to 2 ounces of "Alodine 1200" powder to form a paste, then gradually dilute with hot water until one gallon of solution is attained. This solution is to be adjusted by addition of nitric acid to a PH value of 1.5 to 1.7.

c. Apply solution with rubber set paint brush in such a manner that solution flows over bare area. Allow solution to remain on area from one to five minutes, or until color of new film is approximately that of the original.

d. Flush part with clear water and dry with warm air current. Do not air blast or rub with cloth to dry new film area. If color it too light, repeat step "c" until desired color is attained.

NOTE . . . If "Alodine" does not adhere to a metal, a more severe cleaning method must be used. A solution of 12 to 16 ounces of Oakite No. 61, or equal, per one gallon of water is preferred. Apply and remove the solution with caution, because an alkaline cleaner of this type will remove any "Alodine" film previously applied. Remove cleaning solution thoroughly, using plenty of hot water and brushing vigorously.

6-20. ENAMEL COATINGS. Ferrous parts, when baked with gold enamel, will be baked with infra-red equipment for 15 minutes at 275-285° F. following application of each coat.

NOTE . . . If a part which was originally "Alodized" is to be refinished with enamel, it will not be necessary to apply zinc chromate primer except to surfaces completely stripped of "Alodine".

CAUTION . . . Before application of primer and enamel to a part, carefully mask all connection joints and mating surfaces. No primer or enamel is permissible on interior surfaces of any parts contacted by engine lubricating oil after assembly.

6-21. SPECIFIC INSPECTIONS.

6-22. CRANKCASE. If any cylinder base nut was loose at disassembly, or if any of the cylinder attaching studs are bent, even slightly, or if there is definite evidence that a cylinder was loose at any time, it is possible that a reversal of stress has fatigued the studs and through bolts on that cylinder pad, in which case all of them should be replaced. Test for bent studs with a toolmaker's square. When inspecting for casting cracks pay particular attention to areas on and adjacent to the cylinder mount pads, tappet guides, bottom flange and bearing bosses. Look for nicks on machined surfaces and scoring in shaft bearings. The castings must be slave-bolted together before inspection of the camshaft bearings.

NOTE . . . If camshaft bearings are excessively worn, the crankcase may be line bored for a 0.020 inch oversize camshaft.

6-23. CRANKSHAFT. In addition to magnetic particle, visual and dimensional inspection, the crankshaft should be mounted in matched vee blocks on a surface plate (supporting the front and rear main journals), and rotated under a dial indicator placed to bear on the center main journal in order to detect excessive bending. This is of particular importance if the aircraft has been in an accident resulting in a broken or bent propeller. (Refer to Table of Limits for run-out at center main journal.)

6-24. CRANKSHAFT AND COUNTERWEIGHT BUSHINGS.

a. Excessive localized brinelling of the crank-

shaft dampener pin bushings can affect propeller blade tip stresses. It is therefore recommended that at each major overhaul the pin bushings be inspected and replaced as required. This applies to both the dampener bushings and the crankshaft blade bushings.

b. Inspect in the following manner: Measure the inside diameter of the bushing across points A, B and C. Take the average of A and B and deduct this from C. If the difference exceeds 0.001 inch, the bushing should be replaced.

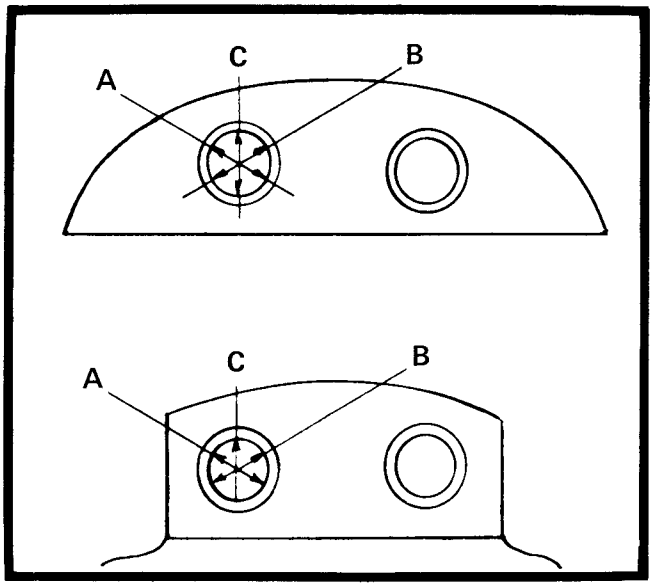


Figure 6-2. Measurement of Dampener Bushings.

1. The C measurement should be the point of maximum diameter, which is generally a point perpendicular to the lengthwise centerline of the crankshaft.

2. Measurements A and B should be taken at points approximately 60° either side of point C.

3. After removing the bushings from the dampeners or the crankshaft blades, measure the inside diameter of the holes. Select a replacement bushing which will give an interference fit of 0.001 to 0.002 inch.

c. Replacement bushings are available in standard, 0.0015, 0.003 and 0.005 inch oversize on the outside diameter.

d. A special tool for removing and replacing these bushings has been developed by Borrough's Tool and Equipment Corporation, 2429 North Burdick Street, Kalamazoo, Michigan (See Section III). It is recommended that this tool only be used for these operations. Removing and replacing bushings with makeshift tools and methods can result in irreparable damage to the crankshaft and/or dampeners. Order tool direct from Borrough's Tool and Equipment Corporation.

6-25. CAMSHAFT. Inspect the journals for scoring, corrosion and overheating. Inspect the lobes for pitting at the toes and evidence of overheating and usual wear.

6-26. CONNECTING RODS. Use a telescoping gauge and micrometer to measure all worn bushings and locally replaced bushings. If a bushing was replaced locally, it is also necessary to check the alignment with a big end bearing seat. The simplest method of making alignment measurements requires a push fit arbor, preferably at least eight inches long, for the bushing bore and another for the bearing seat, a surface plate, two matched vee blocks and two blocks of ground flat, steel stock of equal height. To measure twist, insert the arbors into the rod bores and place the big end arbor in the vee blocks on the surface plate. Next, place the ground steel blocks under the bushing arbor at a measured distance apart. A feeler gauge may be used to detect any clearance at either end under the bushing arbor. This, divided by the separation of the blocks in inches, will give the twist per inch of length (See Table of Limits). To measure bushing and bearing convergence, mount dial indicator on a surface gauge, and swing the rod around the big end arbor to the vertical position against a firm stop. Pass the indicator over the bushing arbor at points an exact number of inches apart. The difference in readings at the two ends, divided by the distance between points of measurements, again gives the misalignment per inch, as specified in the Table of Limits.

6-27. GEARS. Inspect gear teeth for signs of overheating and excessive wear. Normal wear produces a fine polish on the tooth thrust faces. Alteration of the tooth profiles, score marks and pitting are sufficient cause for rejection.

6-28. PISTONS AND RINGS. Inspect the skirt for long, deep scores which indicate overheating

and are sufficient cause for rejection. If a telescoping gauge is used to measure the pin bore, do not allow the spring to expand rapidly so as to strike the wall hard. Inspect visually for thorough cleaning, including the oil relief holes in the oil ring grooves. If the piston is dimensionally serviceable and apparently sound, measure side clearance of new rings (after measuring their gaps while squared in the cylinder barrel) by installing the slotted oil control ring assembly in the third groove, the two compression rings in the two top grooves and the oil scraper ring in the fourth groove, with the part numbers toward the piston head, and inserting various thickness gauges on either side of each ring (See Figure 6-3). The gaps of rings should be measured in the barrel first so those selected may be left in the piston grooves, if the grooves are not excessively worn or distorted. When installing rings, take care not to allow the sharp ends to scratch the piston lands. If the cylinder barrel has not been ground oversize and fits the piston within the allowable clearance limit, it is permissible to install standard or 0.005 inch oversize rings, whichever have the specified gap.

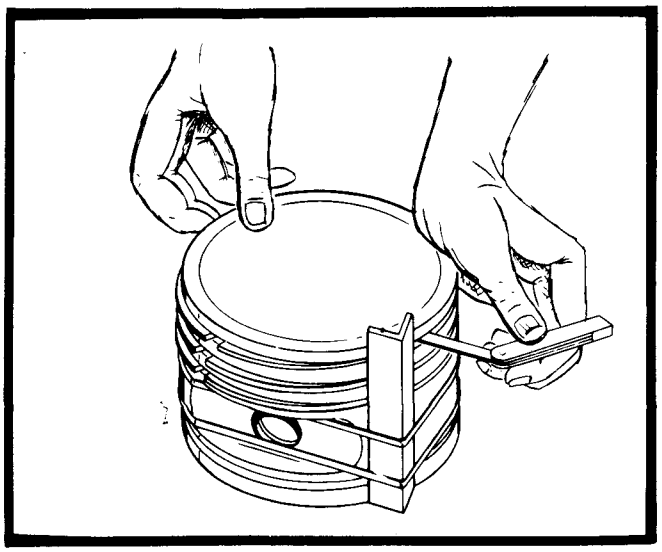


Figure 6-3. Inspecting Ring Side Clearance.

6-29. CYLINDERS. Measure cylinder barrel bore at the locations specified in the Table of Limits, and at right angles in order to detect out-of-roundness and wear in taper. There should be little or no wear at open end. Look for bent barrel fins and broken head fins. Barrel fins can be straight-

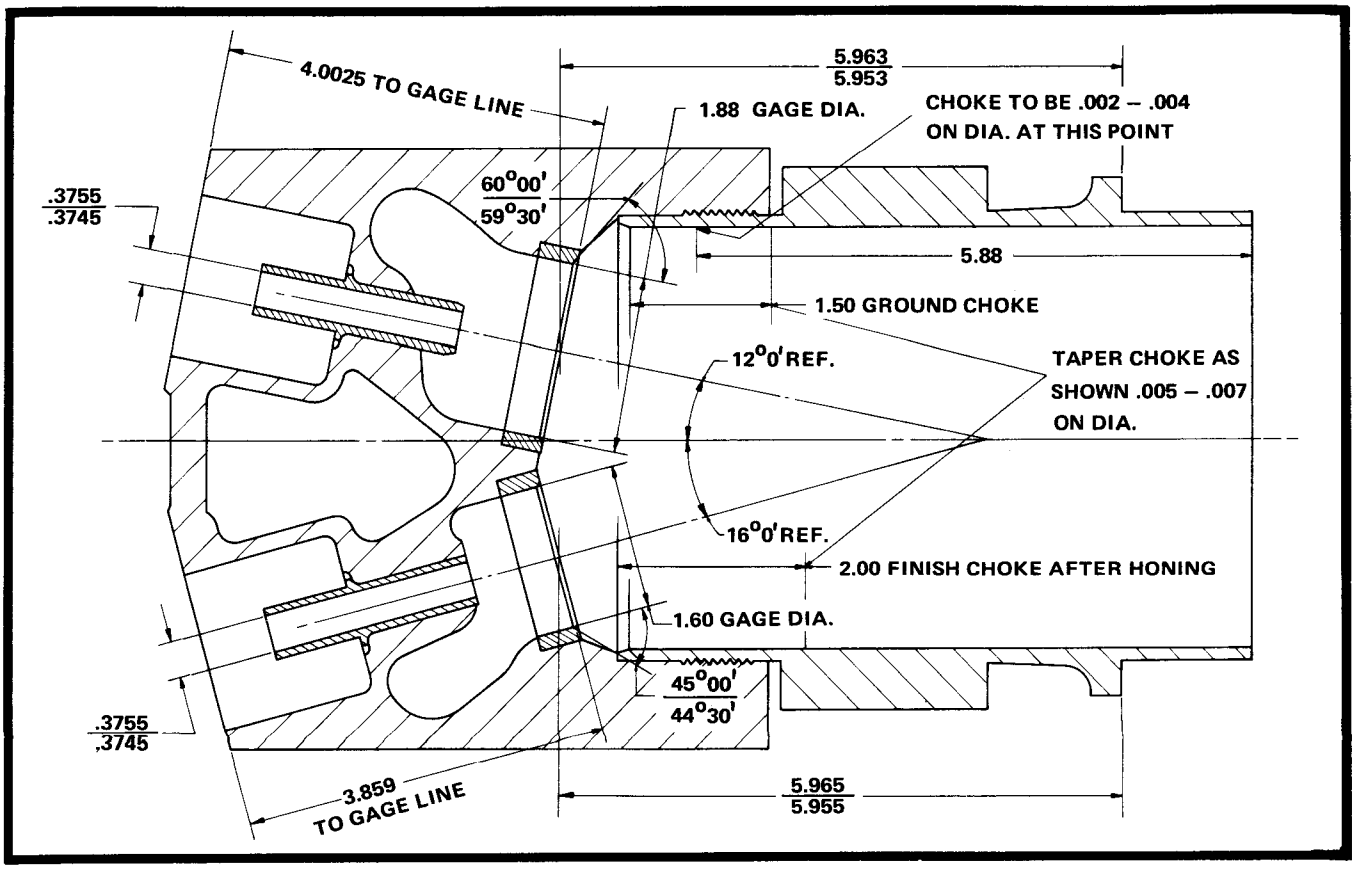


Figure 6-4. Cylinder Machining Dimensions.

ened if not badly bent or cracked. A reduction of not over ten percent in area of head fins due to breakage is allowable. Look for cracked head fins, and specify repair of any radial crack by drilling vee notch to remove it. If radial crack extends to the root of a fin, it may have penetrated the wall. Cylinders with this condition should be rejected. If cylinder base nuts were loose or bent, inspect machined side of cylinder base flange for bending. If this condition exists, reject the cylinder. Measure valve guides for wear and inspect their bores for scoring. Inspect valve seats after refacing to make sure their outside diameters are still less than valve head diameters. Exhaust valves should be checked for warpage before refacing, and all valves should be measured in length if stem tips were ground. Inspect helical coil inserts for looseness, deformation and position. Outer ends should lie in first full thread of tapped hole in which they are installed. Spark plug helical coil has teeth at outer end which are forced into head metal and should not be visible.

CAUTION. . . During the removal and installation of valve guides and/or seats, it is extremely important that the cylinder head to barrel relation not be disturbed while the assembly is at the elevated temperature. It is recommended that a line be scribed from head to barrel at the joint prior to prehead and inspected after the cooling period. If the scribe line has been displaced, the assembly should be scrapped.

6-30. HYDRAULIC VALVE LIFTERS. During examination of each part, look for sludge and carbon residues. Also check for obstructed oil holes. Inspect face of cam follower on body for any type of damage. Look for deep scoring and corrosion on exterior of tubular portion. Discard any lifter body that exhibits any of these defects. To test roughly for excessive diametrical clearance between hydraulic unit plunger and cylinder and to check valve wear in cylinder, start dry plunger into dry cylinder. While holding cylinder between thumb and middle finger, depress plunger with index finger and release it quickly. Compression of air in cylinder should make plunger kick back instantly. If plunger does not return fully, either it is excessively worn or check valve is leaking. To check for a leaking valve, repeat compression test while plugging end of oil inlet tube with other hand. If plunger still does not kick back promptly, both the cylinder and plunger are excessively worn. If plunger does kick back on the second test, either the check valve seat is worn and leaking or it is dirty. Clean cylinder again and repeat, first test (tube open). If plunger still does not kick back, valve is defective. Any unit failing to pass this rough test must be discarded. Discard both plunger and cylinder, since these parts are selectively-fitted and are not interchangeable.

6-31. INTAKE TUBES. Inspect intake tubes for distortion, cracks and out-of-roundness. The only practical repairs possible would be removal of dents, lapping of flanges and repainting tubes. Any other type of damage will require replacement of part.

6-32. LUBRICATION SYSTEM. Visually inspect all parts of the system in accordance with the instructions in paragraphs 6-4, 6-8, 6-9 and 6-10.

6-33. FUEL INJECTION SYSTEM. Inspection of the components and parts of this system is limited strictly to visual for evidence of deterioration. Unless proper test facilities are available, Teledyne Continental Motors does not recommend any disassembly and repair of the fuel pump and/or fuel control unit. When such equipment is available, repairs are to be made in accordance with the applicable Fuel Injection System Manual (See Form X-30091).

6-34. IGNITION SYSTEM. Teledyne Continental Motors recommends replacement of the complete ignition harness at every engine overhaul.

TABLE IV. INSPECTION CHART

Subassembly and Part	Inspect	Nature of Inspection	Special Considerations
CYLINDER ASSEMBLY Head & Barrel	Interior walls	Corrosion, pitting, scoring.	Defects not permissible after removal of glaze.
	Bore diameters	Wear in ring traversed area and step at top. Use dial-type gauge set to zero near open end of bore.	Refer to Table of Limits for standard size bore or for oversize bore.
	Bore walls	After honing or roughening of glaze measure bore diameters, out-of-roundness and taper.	Dimensional honing should remove ring step of more than 0.002 in. dia. Taper limit (Table of Limits) must not be exceeded by honing.
	Stem holes in valve guides	After roughening or honing, inspect scratch pattern and, if possible, measure surface roughness in micro inches RMS of 10% of cylinders as a quality check.	Refer to Table of Limits.
	Valve seats	Scoring, diameter, flare at ends.	Diameters of stem holes in new guides must be within limits for new parts and free of tool marks.
	Cooling fins	Roughness caused by burning.	Replace valve seats which cannot be ground within service limits.
	Base flange	Cracks and broken areas.	Cracked and/or broken cylinder head fins may be repaired, providing a total of not more than five square inches is, or has been removed.
	Base flange	If attaching nuts were found loose at disassembly, test for flatness of mounting face.	Allow not over 0.001 in. out-of-flat on machined surface.

TABLE IV. INSPECTION CHART (Continued)

Subassembly and Part	Inspect	Nature of Inspection	Special Considerations
CYLINDER ASSEMBLY (continued)	Pilot	Out-of-roundness of pilot below face flange.	
	Spark plug thread insert	Distortion or improper fit in cylinder head hole.	
	Pushrod housing stems	Looseness, leakage.	
	Stems	Scoring, nicks in grooves, wear on tips.	Polishing must not reduce diameter below minimum for new parts.
	Heads	Use dial indicator to determine warp. Make sure that grinding has not cut through Stellite face of exhaust valve or entered rounded edge on intake valve head.	
	Length	Use height gauge to detect stretch and check for reduction due to tip grinding.	Stretched valves may fail. Shortened valve may exceed ability of hydraulic lifters to take up lash.
Valve rockers	Contact foot	Scoring, diameter.	
	Oil passages	Obstruction.	
Rocker shaft	Outside surface	Diameter, Scoring.	
CONNECTING ROD ASSEMBLY			
Bushings	Inside diameter	Measure with telescoping gauge and micrometer caliper.	New bushings must be reamed within diameter limits for new parts. Sharp edges must be broken slightly. (Refer to Table of Limits, for wear limit, for new bushing limits and new bushing alignment limits.)

TABLE IV. INSPECTION CHART (Continued)

Subassembly and Part	Inspector	Nature of Inspection	Special Considerations
CRANKSHAFT ASSEMBLY Crankshaft	Main journals	Diameters, scoring, burning.	Must be polished before magnetic inspection.
	Crankpins	Diameters, scoring, burning.	Must be polished before magnetic inspection.
	Oil seal race	Scoring.	Must be polished.
	Screw holes	Damaged or dirty threads.	
	Oil Holes	Obstructions..	
	Bending	Measure run-out at center journal and wobble on face of flange.	Required only if shaft has been subject to shock.
Gear dowel	Tight fit	Attempt to pull out by hand only.	
Oil control plug	Presence	Obstruction of oil hole, tight fit.	
Gear	Teeth, screw thread	Burning, scoring, wear enough to alter profile. Damaged or dirty threads.	
CAMSHAFT ASSEMBLY Camshaft	Journals	Diameter and fit in crankcase bearings. Scoring, pitting and corrosion.	Excessive bearing wear may be compensated by enlarging bearing and installing oversize shaft. Refer to "Crankcase".
	Lobes	Pitting along toe line, loss of slope along toe line, width across heal and toe at center of length.	Serious pitting not permissible. Toe line must taper in relation of axis to rotate valve lifters.
	Flange screw holes	Distortion of threads	
	Edge and rear face of flange	Nicks, peening, other irregularities.	Must be smooth to align gear.

TABLE IV. INSPECTION CHART (Continued)

Subassembly and Part	Inspect	Nature of Inspection	Special Considerations
Gear	Teeth	Scoring, burning, pitting, wear enough to alter profile.	
CRANKCASE ASSEMBLY			
Crankcase castings	Valve lifter guides	Diameter, scoring.	
	Bearing seats	Roughness, wear in tang notches.	Refer to Table of Limits.
	Camshaft bearings	Diameter, scoring, fit of rear bearing between camshaft flanges.	Note: See para. 6-22.
	Oil passages	Visually inspect galleries, main and camshaft bearing supply holes, using flashlight to illuminate. Probe other holes with brass rod.	
	Tapped holes	Deformed or dirty threads.	
Studs	Threads	Distortion.	
	Height	Check for backing out.	Refer to Stud Height Table.
	Squareness	Use toolmaker's square to check studs.	
Oil gauge rod	Distortion	Look for bent blade, obliterated "FULL" and "LOW" marks, loose collar.	
Engine mounting brackets	Machined surfaces	Warpage and scratches.	
	All areas	Cracks.	
Plugs	Threads	Look for distortion.	
CRANKCASE COVER			
Casting	Pilot holes	Cracks, corrosion, burrs, scratches and flatness.	

TABLE IV. INSPECTION CHART (Continued)

Subassembly and Part	Inspect	Nature of Inspection	Special Considerations
CRANKCASE COVER (Continued)	All areas	Cracks.	
	Tapped holes	Deformed or dirty threads.	
	Oil pump cavity	Depth, diameter, scoring.	
	Bushing	Bore diameter, burning, scoring, concentricity.	Refer to Table of Limits.
Studs	Threads	Distortion.	
	Height	Check for backing out.	Refer to Stud Height Table.
	Squareness	Use toolmaker's square to check studs.	
Oil pump	Gears	Scoring, burning or wear enough to alter the tooth profile. Diameter of shaft.	Refer to Table of Limits.
	Cover plate	Surface wear, scoring, and wear in shaft hole. Deformed or dirty threads.	
OIL COOLER ASSEMBLY Oil cooler	Headers, fins, core	Inspect visually for dents, deformed fins, punctures, stripped plug hole threads, cracks and scratches.	
	Machined surfaces	Warpage and scratches.	
	All areas	Cracks.	
Temperature control valve	Seat	Roughness.	

TABLE IV. INSPECTION CHART (Continued)

Subassembly and Part	Inspect	Nature of Inspection	Special Considerations
OIL SUMP ASSEMBLY			
Sump	Tapped holes	Damaged threads, cracks around holes.	
	Mounting surfaces	Scratches, warpage, cracks.	
	All areas	Cracks.	
Plugs	Threads	Look for distortion.	
	Wrench flats	Look for damaged corners.	
Oil suction tube	Threads, tube, filter	Damaged threads, dented tube, cracks in tube, distorted or plugged filter.	
STARTER ADAPTER ASSEMBLY			
Adapter	All areas	Cracks, scratches on machined surface, damaged tapped holes.	
Needle bearing	Rollers	Roughness or excessive play.	
Studs	Threads	Distortion or stripping.	
	Height	Check for backout.	Refer to Stud Height Table.
	Alignment	Check studs suspected of bending with toolmaker's square.	
Gears	Shafts	Measure diameters and compare with bushing diameters.	Refer to Table of Limits.
	Gear teeth	Scoring, burning or wear enough to alter tooth profile.	
Ball bearing	Balls, cage	Surface roughness, out-of-round, excessive depth and looseness.	

TABLE IV. INSPECTION CHART (Continued)

Subassembly and Part	Inspect	Nature of Inspection	Special Considerations
STARTER ADAPTER ASSEMBLY (Continued)			
Adapter cover	All areas	Cracks, scratches on machined surfaces, damaged mounting holes.	
	Shaft bearing	Look for scoring.	
	Bore	Measure diameter.	
	Oil Seal	See that old seal was removed without damage to casting.	
Accessory drive adapter and/or scavenge pump	Gears	Scoring, burning or wear enough to alter tooth profile. Shaft diameter.	
	Bushings	Inside diameter. Compare with shaft diameter.	Refer to Table of Limits.
	Oil seal	Observe that old seal was removed without damage to adapter bore.	
	Studs	Damaged threads, looseness or bending.	Refer to Stud Height Table.
	Covers	Flatness and cracks.	
ALTERNATOR HUB ASSEMBLY			
Hub	All areas	Scored or undersize bearing surfaces.	Refer to Table of Limits.
	Spring	Damaged or broken.	
	Gear	Look for chipped, cracked and broken teeth, scoring, burning and wear enough to alter tooth profile.	
	Gear bushing	Measure bore diameter.	Refer to Table of Limits.

TABLE IV. INSPECTION CHART (Continued)

Subassembly and Part	Inspect	Nature of Inspection	Special Considerations
ALTERNATOR HUB ASSEMBLY (continued)			
Intake manifold	Flanges	Check for warping by placing flanges on surface plate. Look for cracks.	
	Tubes	Look for dents, out-of-round ends, cracks.	
	Plug bosses	Damaged threads, cracks around bosses.	
Clamps	Shape	Look for distortion such as out-of-roundness and lugs converging.	
FUEL INJECTION SYSTEM			
Fuel pump adapter	All areas	Cracks, damaged mounting holes, inspect tapped holes. Measure bore diameter.	
Fuel pump drive spline shaft	Teeth	Look for chipped, cracked and broken teeth, scoring, burning and wear enough to alter tooth profile.	
Fuel pump and vapor separator assy.	Outside area	Inspection is limited strictly to visual for evidences of damage or deterioration.	(See paragraph 6-33).
Air throttle assembly	Tapped holes	Damaged threads, cracks, around holes.	
	Studs	Bent or stripped stud threads.	
	All areas	Cracks.	

TABLE IV. INSPECTION CHART (Continued)

Subassembly and Part	Inspect	Nature of Inspection	Special Considerations
FUEL INJECTION SYSTEM (Continued)	Shaft	Check alignment. Measure diameter.	No wear limits established.
	Plate	Check for warpage.	
Fuel discharge tubes	All areas	Look for cracks, flat spots, out-of-round ends.	
Pipe fittings	Threads	distortion or stripping.	
	Wrench flats	Look for damaged corners.	
MAGNETO DRIVE ASSEMBLY	Support shaft	Outside diameter, nicks, evidence of overheating.	Refer to Table of Limits.
	Gear	Look for chipped, cracked or broken teeth, scoring, burning and wear enough to alter tooth profile.	
	Thrust washer	Measure thickness, look for scoring, scratches and flatness.	
	Needle bearing	Inspect rollers for roughness or excessive play.	
	Sleeve	Nicks, scoring and tight in drive gear.	

TABLE V MAGNETIC PARTICLE INSPECTION

FLUORESCENT METHOD PREFERRED, WET CONTINUOUS PROCEDURE REQUIRED

Part	*Method of Magnetization	D. C. Amperes	Critical Areas	Possible Defects
Crankshaft	Circular and Longitudinal	2500	Journals, fillets, oil holes, thrust flanges, prop flange.	Fatigue cracks, heat cracks.
Connecting Rod	Circular and Longitudinal	1800	All areas.	Fatigue cracks.
Camshaft	Circular and Longitudinal	1500	Lobes, journals.	Heat cracks.
Piston Pin	Circular and Longitudinal	1000	Shear planes, ends, center.	Fatigue cracks.
Rocker Arms	Circular and Longitudinal	800	Pad, socket under side arms and boss.	Fatigue cracks.
Gears to 6 Inch Diameter	Circular or on Center Conductor	1000 to 1500	Teeth, Splines, Keyways.	Fatigue cracks.
Gears over 6 Inch	Shaft Circular Teeth Between Heads Two Times 90°.	1000 to 1500	Teeth, Splines.	Fatigue cracks.
Shafts	Circular and Longitudinal	1000 to 1500	Splines, Keyways, Change of Section.	Fatigue cracks, heat cracks.
Thru Bolts	Circular and Longitudinal	500	Threads Under Head.	Fatigue cracks.

NOTE: (*)

LONGITUDINAL MAGNETISM: *Current applied to solenoid coil surrounding the work.*

CIRCULAR MAGNETISM: *Current passed through work or through non-magnetic conductor bar inserted through work.*

TABLE VI. MAGNETO DRIVE ASSEMBLY LIMITS

(Refer to Figure 6-5)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
1	Deleted			
2	Magneto gear support shaft-to-bearing ..... dia:	0.002 L	0.0003L	0.0012L
3	Sleeve in drive gear ..... dia:		0.0015T	0.0036T
4	Washer in drive gear ..... dia:		0.0000	0.0021T
5	Deleted			
6	Magneto coupling retainer on gear sleeve ..... dia:	0.055 L	0.025 L	0.045 L
7	Magneto coupling retainer in drive gear slot ..... side clear:	0.040 L	0.008 T	0.034 L
8	Magneto coupling rubber bushings on magneto drive lugs (replace if worn) ..... side clear:		0.052 T	0.010 L
	Magneto pilot in crankcase cover ..... dia:		0.001 L	0.005 L
9	Magneto gear-to-camshaft gear ..... backlash:	0.016	0.012	0.014

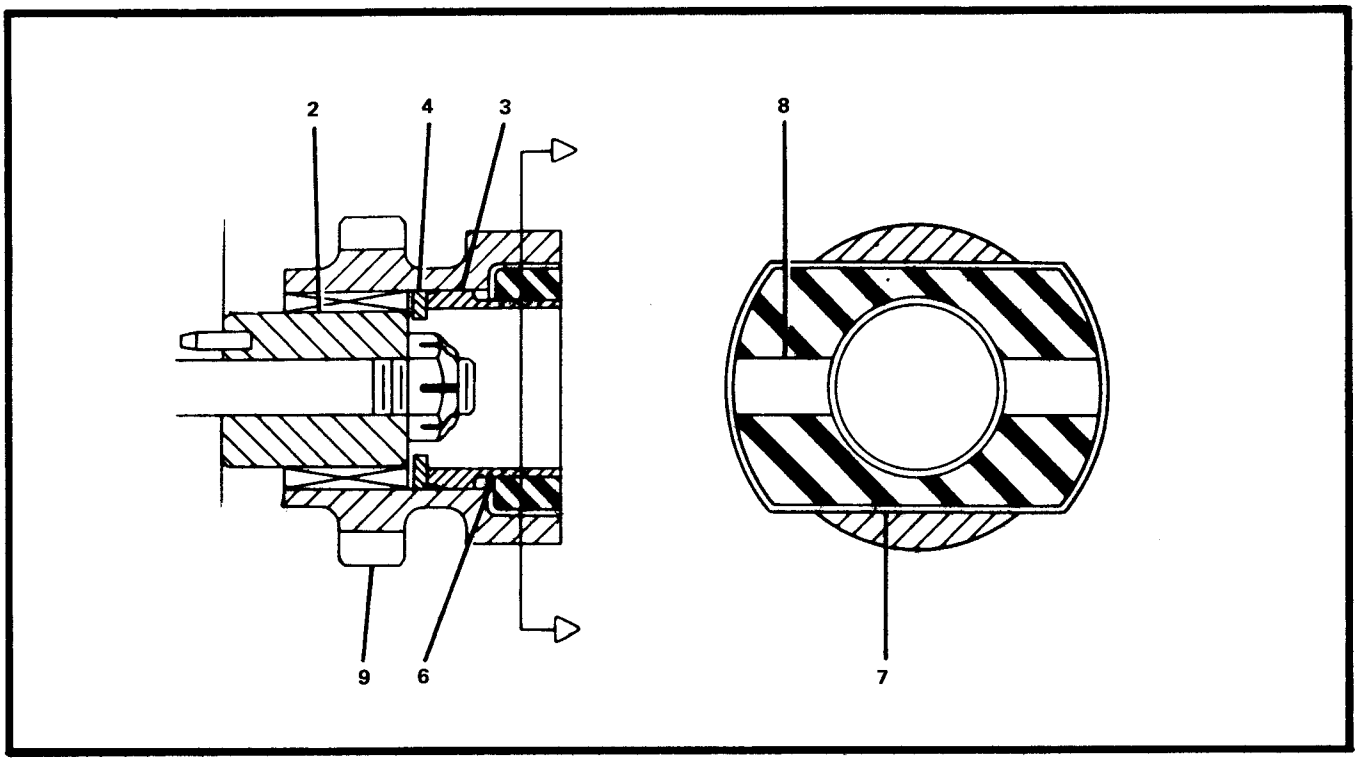


Figure 6-5. Magneto Drive Assembly Limits (Refer to Table VI).

TABLE VII. STARTER ADAPTER LIMITS

(Refer to Figure 6-6)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
1	Starter shaftgear in bushing ..... dia:	0.0045L	0.001 L	0.003 L
2.	Starter shaftgear front journal ..... dia:	1.058	1.059	1.060
3.	Starter shaftgear in needle bearing ..... dia:	0.0031L	0.0005L	0.0029L
4.	Starter shaftgear in cover bushing ..... dia:	0.0035L	0.0010L	0.0025L
5.	Bushing in Adapter cover ..... dia:		0.001 T	0.003 T

TABLE VII. STARTER ADAPTER LIMITS

(Refer to Figure 6-6)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
6	Oil seal in adapter cover ..... dia:		0.001 T	0.007 T
7	Cover pilot in adapter ..... dia:		0.001 L	0.003 L
8	Worm wheel gear ..... end clear:	0.015	0.0025L	0.0115L
9	Clutch spring on clutch drum ..... dia:	0.012 T	0.015 T	0.022 T
10	Clutch spring on starter shaftgear drum ..... dia:	0.013 L	0.006 L	0.009 L
11	Clutch spring to sleeve (Sand blasted finish) when sand blasted finish is worn to 75 RMS replace sleeve ..... dia:			
12	From centerline of worm gear shaft to starter adapter thrust pads ..... :	0.252	0.246	0.248
13	Needle bearing in starter adapter ..... dia:		0.001 L	0.001 T
14	Ball bearing in starter adapter ..... dia:		0.001 L	0.0001T
15	Worm gearshaft in needle bearing ..... shaft dia:	0.5600	0.5615	0.5625
16	Worm gear shaft in ball bearing ..... dia:		0.0001L	0.0007T
17	Starter worm gear on shaft ..... dia:	0.004 L	0.0005L	0.0025L
18	Starter spring on worm drive shaft ..... dia:		0.005 L	0.025 L
19	Starter pilot to starter drive adapter ..... dia:		0.001 L	0.0065L
20	Starter drive tongue to worm shaft drive slot ..... side clear:	0.030 L	0.010 L	0.021 L
21	Needle bearing to shaft worm gear ..... dia:	0.0031L	0.0005L	0.0029L
22	Starter gear-to-crankshaft gear ..... backlash:	0.016	0.008	0.012
23	Starter wormwheel-to-worm gear ..... backlash:	0.020	0.009	0.013

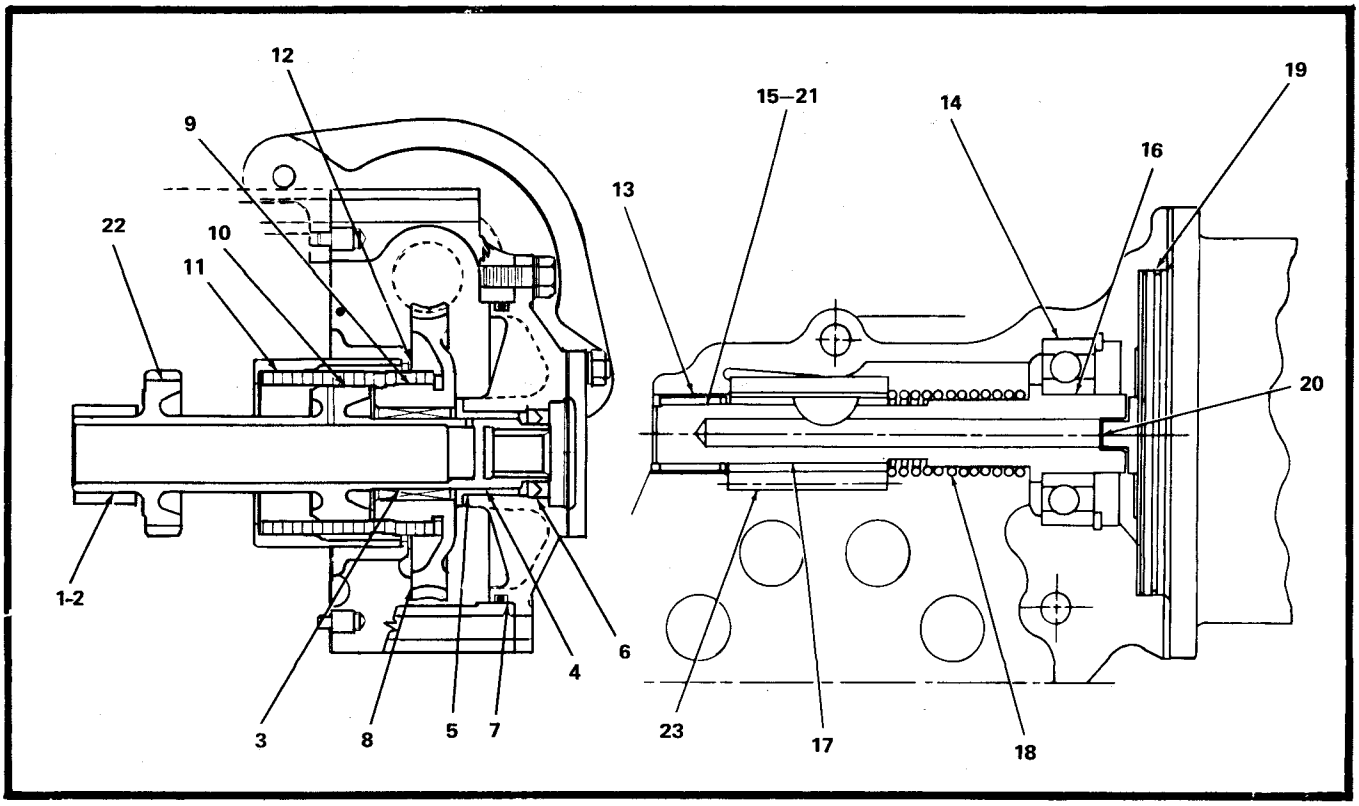


Figure 6-6. Starter Adapter Limits (IO-360A, D and H) (Refer to Table VII).

TABLE VIII. STARTER ADAPTER AND ACCESSORY DRIVE LIMITS

(Refer to Figure 6-7)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
1	Starter shaftgear bushing in adapter ..... dia:		0.002 T	0.004 T
2	Accessory driver gear in bushing ..... dia:	0.0045L	0.001 L	0.003 L
3	Driver gear on starter shaftgear ..... dia:	0.004 L	0.0002L	0.002 L
4	R. H. side accessory drive bushing in adapter ..... dia:		0.002 T	0.004 T
5	R. H. accessory drive shaft end in bushing ..... dia:	0.0045L	0.001 L	0.003 L
6	L. H. side accessory drive bushing in adapter ..... dia:		0.002 T	0.004 T
7	L. H. accessory drive shaft end in bushing ..... dia:	0.0045L	0.001 L	0.003 L
8	Driven gear on accessory drive shaft ..... dia:	0.004 L	0.000	0.002 L
9	R. H. seal in adapter ..... dia:		0.001 T	0.007 T
10	L. H. seal in adapter ..... dia:		0.001 T	0.007 T
11	Accessory adapter in starter drive adapter (pilot) ..... dia:		0.001 L	0.003 L
12	Driven and driver gear ..... backlash:	0.016	0.008	0.012

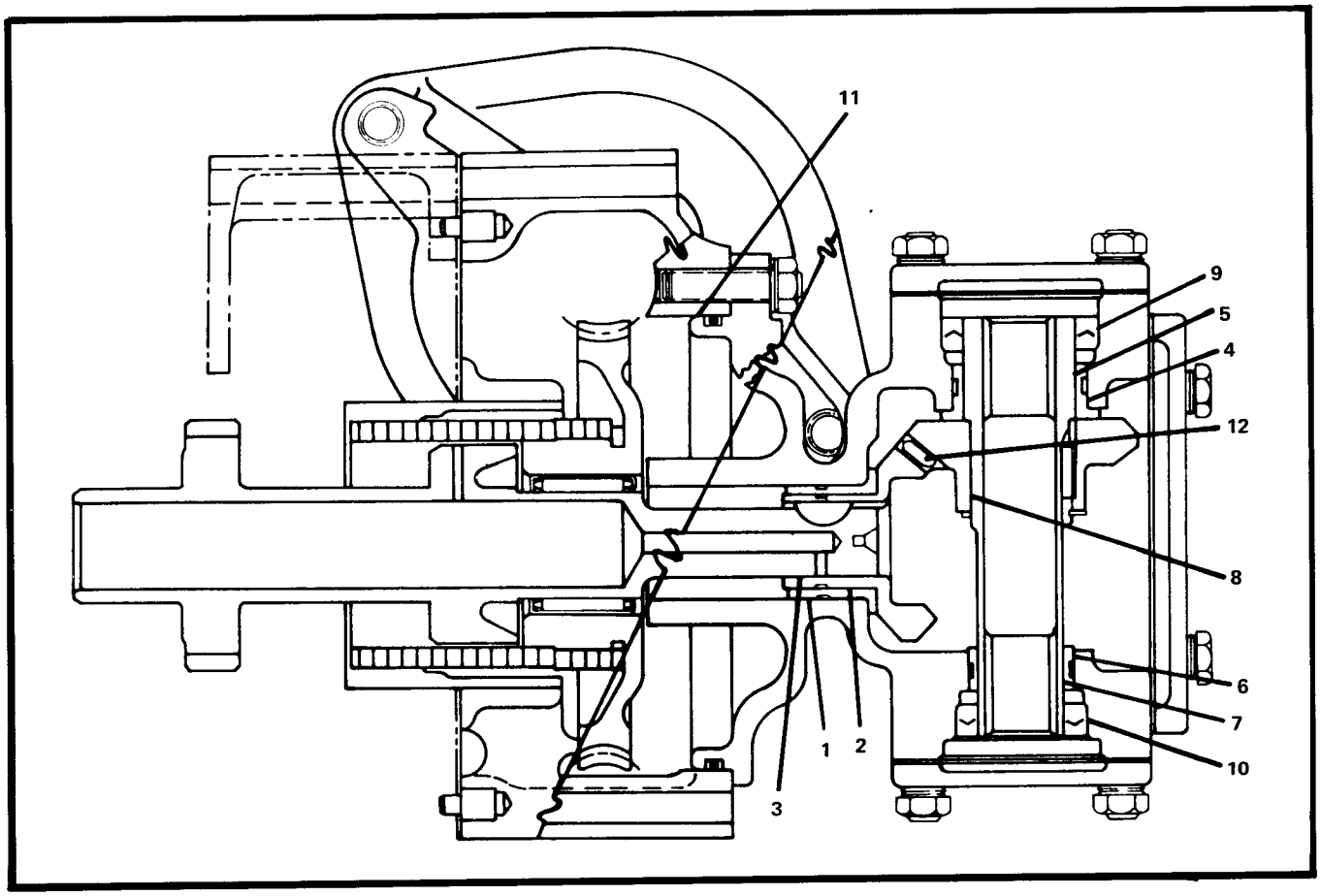


Figure 6-7. Starter Adapter & Accessory Drive Limits (IO-360C & G) (Refer to Table VIII).

TABLE IX. STARTER ADAPTER AND ACCESSORY DRIVE LIMITS

(Refer to Figure 6-8)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
1	Scavenge pump driven gear on shaft ..... dia:	0.004 L	0.0005L	0.0025L
2	Starter shaftgear in scavenge pump drive gear ..... dia:	0.0025L	0.0002L	0.0017L
3	Scavenge pump gears in adapter ..... dia:	0.010 L	0.0055L	0.0080L
4	Scavenge pump gears in adapter ..... end clear:	0.005	0.001	0.0035
5	Starter shaftgear in adapter ..... dia:	0.003 L	0.0005L	0.0020L
6	Scavenge pump driven gear to driver gear ..... backlash:	0.027	0.0140	0.0218

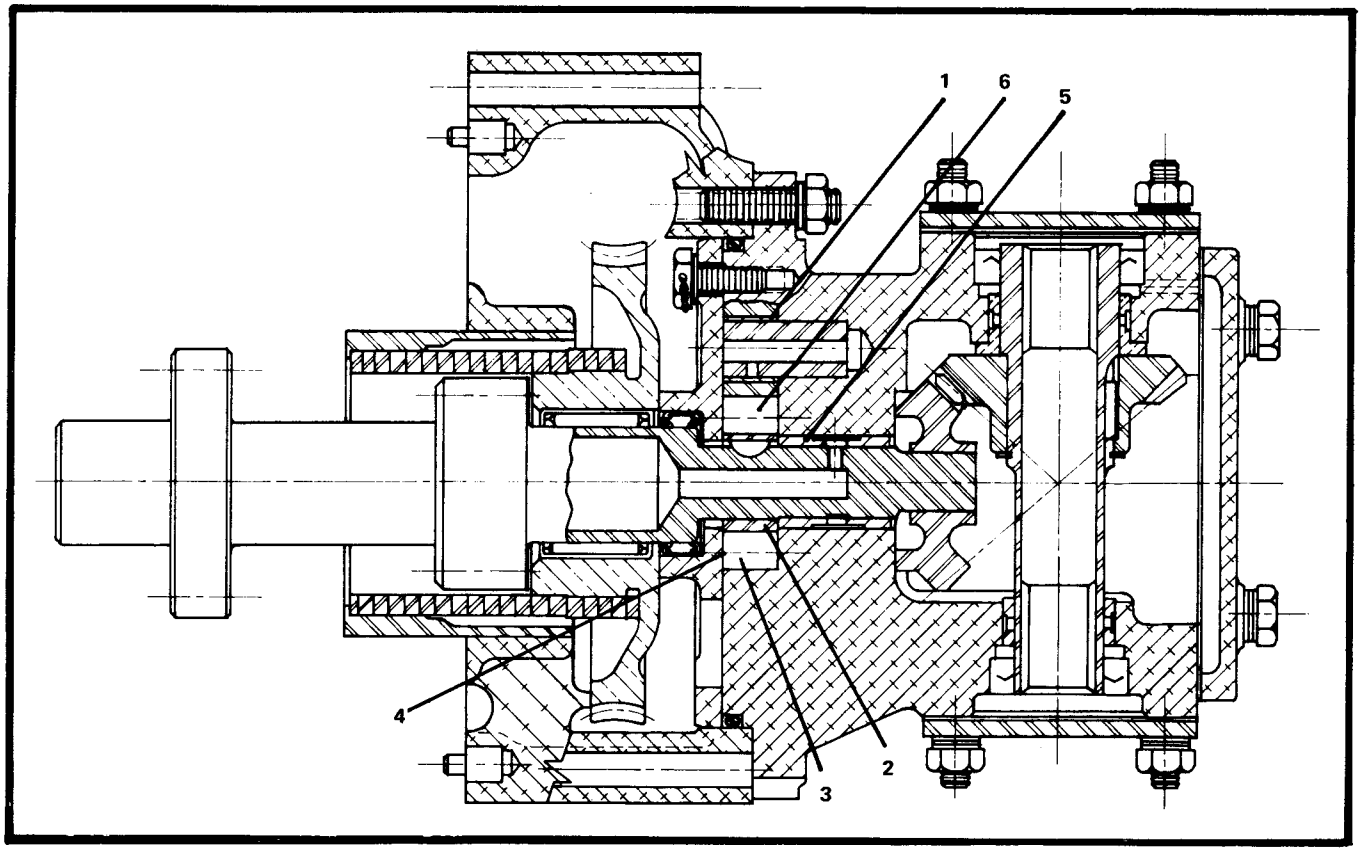


Figure 6-8. Starter Adapter & Accessory Drive Limits (TSIO-360A) (Refer to Table IX).

TABLE X. STARTER ADAPTER AND ACCESSORY DRIVE LIMITS

(Refer to Figure 6-9)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
1	Scavenge pump driven gear on shaft ..... dia:	0.004 L	0.0005L	0.0025L
2	Scavenge pump drive gear in adapter ..... dia:	0.004 L	0.0005L	0.0025L
3	Scavenge pump gears in adapter ..... dia:	0.010 L	0.0055L	0.0080L
4	Scavenge pump gears in adapter ..... end clear:	0.005	0.0010	0.0035
5	Scavenge pump drive gear in starter shaftgear ..... dia:	0.004	0.0010L	0.0030L
6	Starter shaftgear in scavenge pump cover ..... dia:	0.004 L	0.0005L	0.0025L
7	Scavenge pump driven gear to drive gear ..... backlash:	0.027	0.0140	0.0218

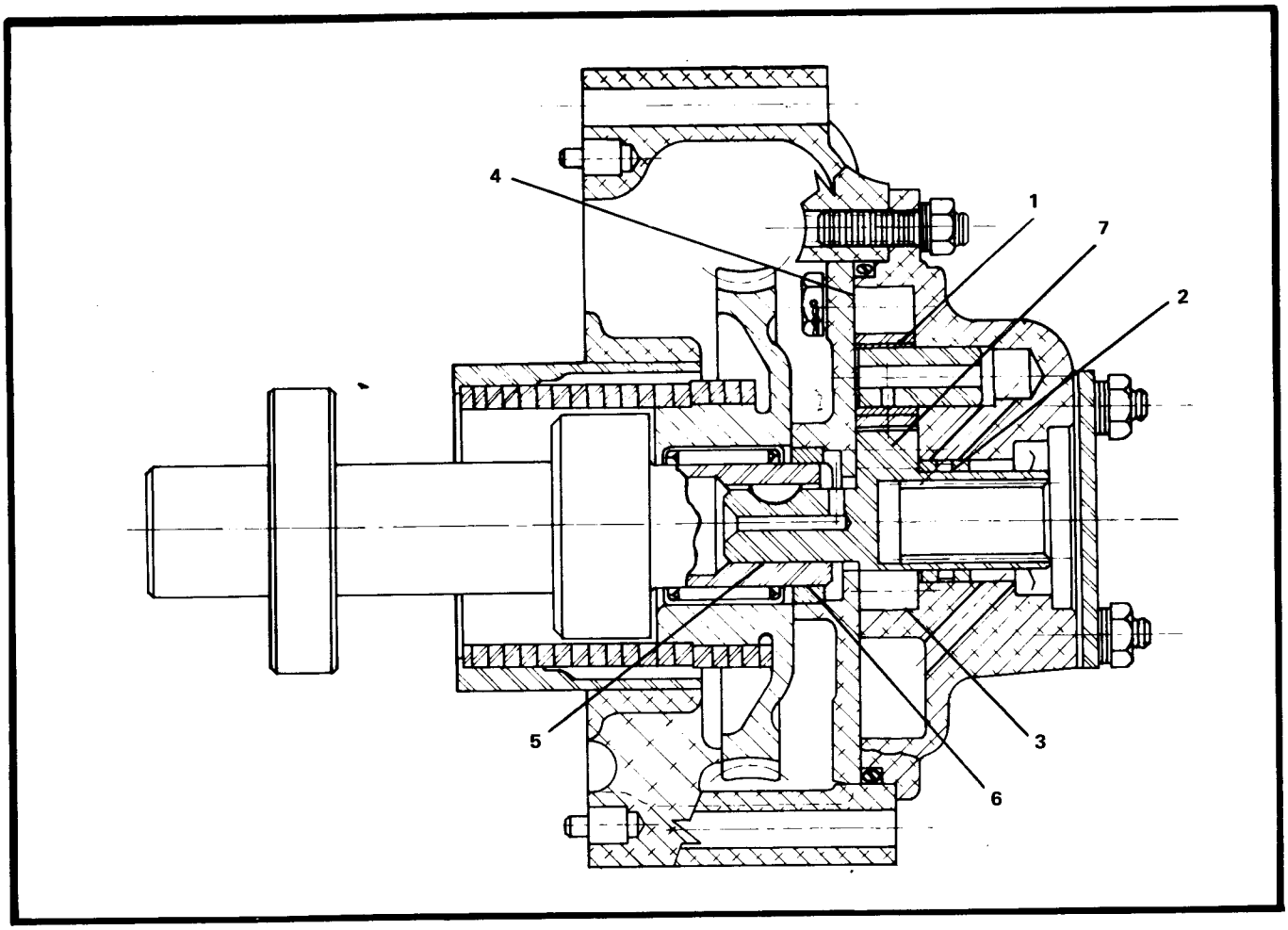


Figure 6-9. Starter Adapter & Accessory Drive Limits (TSIO-360B, C & D) (Refer to Table X).

TABLE XI. CRANKCASE COVER LIMITS

(Refer to Figure 6-10)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
1	Oil pump gears in housing ..... end clear:	0.006	0.001	0.004
2	Oil pump gears in housing ..... dia:	0.006 L	0.0015L	0.004 L
3	Oil pump gear shafts in housing ..... dia:	0.004 L	0.0005L	0.002 L
4	Oil pump gear shafts in cover ..... dia:	0.004 L	0.0005L	0.002 L
5	Oil pump driver gear in camshaft gear (IO-360-A) ..... dia:	0.015 L	0.0055L	0.0115L
6	Oil pump driven gear on shaft (TSIO-360) ..... dia:	0.004 L	0.0020L	0.0005L
7	Alternator pilot in cover ..... dia:		0.001 L	0.005 L
8	Oil seal in alternator ..... dia:		0.002 T	0.008 T
9	Alternator coupling retainer on sleeve ..... dia:	0.032 L	0.016 L	0.026 L
10	Coupling retainer in coupling hub slot ..... side clear:	0.020 L	0.005 T	0.015 L
11	Coupling bushings on drive gear lugs (replace if worn) ..... side clear:		0.043 T	0.039 L
12	Oil pump driver-to-driven gear ..... backlash:	0.027	0.014	0.0218
13	Alternator gear-to-camshaft gear ..... backlash	0.019	0.010	0.014
14	Driver gear shaft in oil pump drive gear ..... dia:	0.003 L	0.0005L	0.002 L

TABLE XI. CRANKCASE COVER LIMITS

(Refer to Figure 6-10)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
15	Driver gear-to-camshaft gear* ..... Backlash:	0.019	0.010	0.014
	Oil pressure relief valve spring No. 534885 compressed to 1.56" length ..... load:	7.35 lbs.	7.48 lbs.	7.72 lbs.
	Oil pressure relief valve spring No. 539619 compressed to 1.49" length ..... **load:	4.50 lbs.	4.75 lbs.	5.25 lbs.
	Oil temperature control valve 0.090 inch minimum travel at ..... temperature:		120°F.	170°F.
	Valve must be fully closed against seat at ..... temperature:		168°F.	172°F.
	Valve must crack open at 180°F ..... PSI:		18 lbs.	
	TIGHTENING TORQUES	Thread Size	Torque In./Lbs.	Torque Ft./Lbs.
16	Alternator shaft nut	5/16-24	175-200	14.6-16.7

* Except IO-360-A

** Outer spring, TSIO-360-A & B

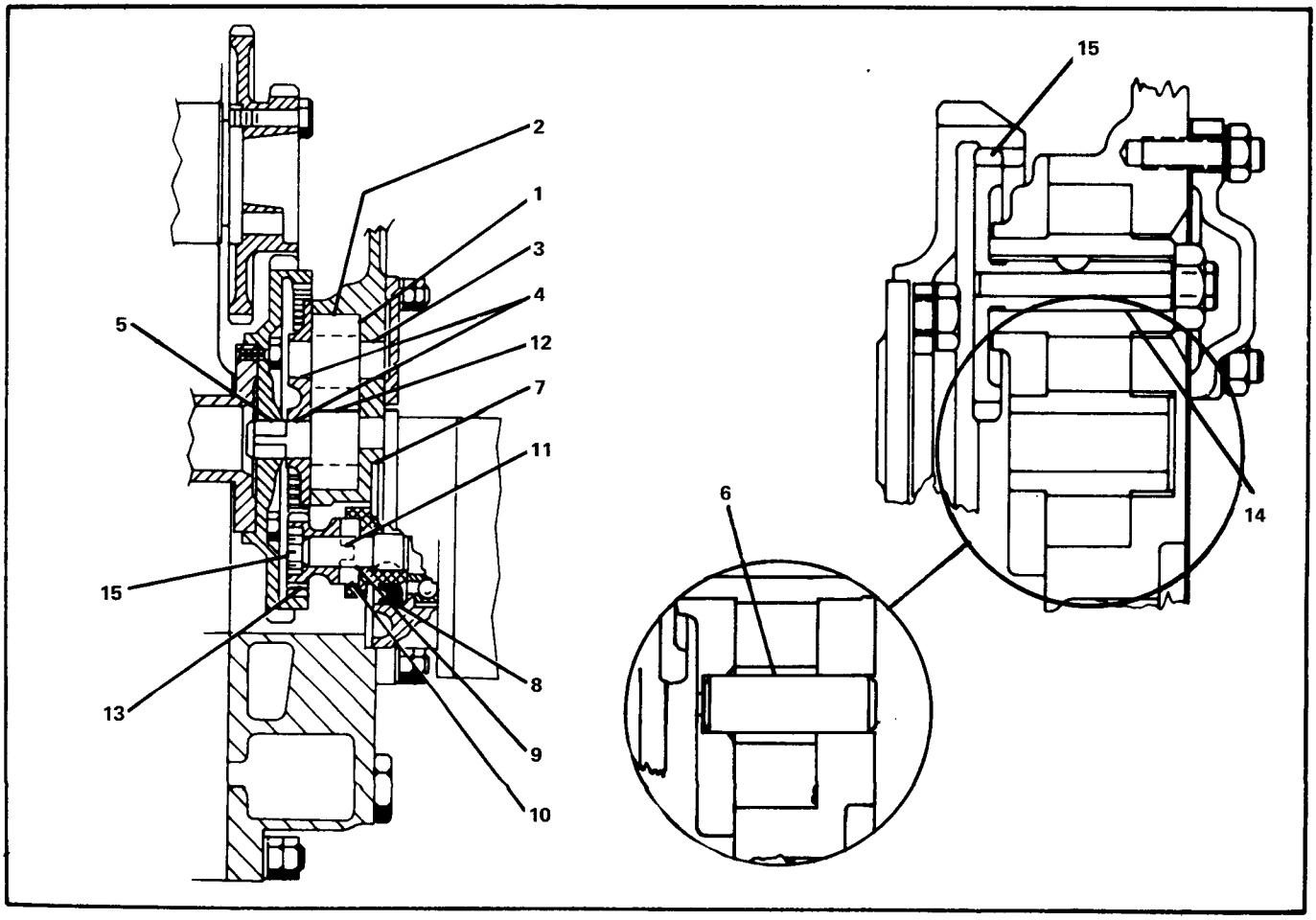


Figure 6-10. Crankcase Cover Limits (Refer to Table XI).

TABLE XII. CYLINDER AND PISTON LIMITS

(Refer to Figure 6-11)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
	CYLINDER AND HEAD ASSEMBLY			
1	Cylinder bore (lower 4-1/4" of barrel) ..... dia:	4.442	4.437	4.439
2	Cylinder bore (3/4" from top of barrel) ..... dia:	4.438	4.4335	4.4365
3	Cylinder bore choke (see Figure 6-4) ..... taper:	0.003	0.005	0.007
4	Cylinder bore out-of-round ..... :	0.002	0.000	0.001
5	Cylinder bore (reground 0.015") ..... allowable oversize:	4.457	4.452	4.454
6	Cylinder bore surface roughness (micro in. RMS) ..... :		20	30
7	Cylinder barrel in crankcase ..... dia:		0.003 L	0.011 L
8	Intake valve guide in cylinder head ..... dia:		0.0011T	0.0026T
9	Exhaust valve guide in cylinder head ..... dia:		0.0011T	0.0026T
10	Intake valve seat ..... width:		0.107	0.156
11	Exhaust valve seat ..... width:		0.120	0.171
12	Exhaust valve seat (to valve guide axis) ..... angle:		44°30'	45°00'
13	Intake valve seat (to valve guide axis) ..... angle:		59°30'	60°00'
	VALVES, ROCKER ARMS AND SHAFTS			
14	Rocker shaft in rocker arm bearing ..... dia:	0.004 L	0.0005L	0.0025L
15	Rocker arm bearing in rocker arm ..... dia:		0.002 T	0.0045T
16	Intake valve in guide ..... dia:	0.005 L	0.0010L	0.0025L
17	Exhaust valve in guide ..... dia:	0.006 L	0.002 L	0.0035L
18	Intake valve face (to stem axis) ..... angle:		59°45'	60°15'
19	Exhaust valve face (to stem axis) ..... angle:		45°45'	46°15'
20	Intake valve (max. tip regrind 0.015") ..... length:	4.337	4.352	4.368
21	Exhaust valve (max. tip regrind 0.015") ..... length:	4.1825	4.1975	4.2135
22	Intake and exhaust valve (full indicator reading) .... warpage:	0.004	0.000	0.002
	Value Rocker toe to valve stem (dry lifter)		0.060	0.200
	PISTONS, RINGS AND PINS			
23	Top of piston in cylinder ..... dia:		0.045 L	0.049 L
24	Piston (2nd & 3rd lands) in cylinder ..... dia:		0.030 L	0.034 L
25	Piston (below 3rd ring groove) in cylinder ..... dia:	0.027 L	0.0195L	0.0235L
26	Piston (bottom of skirt) in cylinder ..... dia:	0.0155L	0.0095L	0.0125L
27	Deleted			
28	Top and second piston ring (semi-keystone) in groove ..... side clear:	0.005	0.001	0.003
29	Third piston ring in groove ..... side clear:	0.0065	0.003	0.005
30	Fourth piston ring in groove ..... side clear:	0.0065	0.003	0.005
31	First piston ring in cylinder ..... gap:	0.054	0.028	0.045
	First piston ring (std. gap) ..... tension:	11 lbs.	12 lbs.	16 lbs.
32	Fourth piston ring in cylinder ..... gap:	0.044	0.018	0.035
	Fourth piston ring (std. gap) ..... tension:	6 lbs.	6.75 lbs.	10.75 lbs.

TABLE XII. CYLINDER AND PISTON LIMITS

(Refer to Figure 6-11)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
33	Second piston ring in cylinder ..... gap:	0.054	0.028	0.045
	Second piston ring (std. gap) ..... tension:	11 lbs.	12 lbs.	16 lbs.
34	Third piston ring in cylinder ..... gap:	0.054	0.028	0.045
	Third piston ring (std. gap) ..... tension:	6 lbs.	6.75 lbs.	10.75 lbs.
35	Deleted			
36	Piston pin in piston (std. or 0.005" oversize) ..... dia:	0.0013L	0.0002L	0.0006L
37	Deleted			
38	Piston pin in cylinder ..... end clear:	0.050	0.007	0.029
39	Piston pin in connecting rod bushing ..... dia:	0.004 L	0.0014L	0.0021L
40	Bushing in connecting rod ..... dia:		0.002 T	0.0045T
41	Inner valve spring (625957) compressed to 1.100 in. length ..... load:	59 lbs.	62 lbs.	68 lbs.
	Inner valve spring (625957) compressed to 1.500 in. length ..... load:	30 lbs.	33 lbs.	37 lbs.
42	Outer valve spring (625958) compressed to 1.168 in. length ..... load:	74 lbs.	77 lbs.	83 lbs.
	Outer valve spring (625958) compressed to 1.559 in. length ..... load:	40 lbs.	43 lbs.	47 lbs.
	TIGHTENING TORQUES	Thread Size	Torque In./Lbs.	Torque Ft./Lbs.
43	Cylinder hold down nuts	3/8-24	410-430	34.2-35.8
44	Cylinder hold down nuts	7/16-20	490-510	40.8-42.5
45	Spark plugs	18 mm	300-360	25.0-30.0

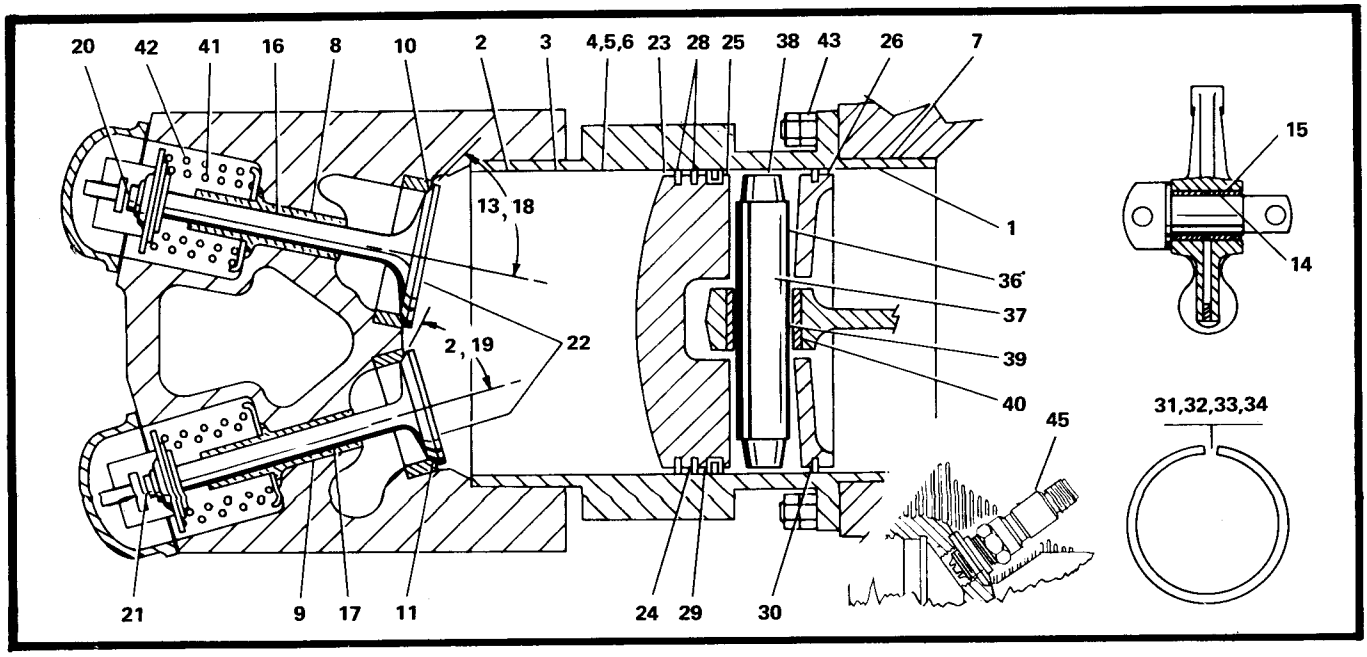


Figure 6-11. Cylinder and Piston Limits (Refer to Table XII).

TABLE XIII. CRANKCASE LIMITS

(Refer to Figure 6-12)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
1	Through bolt in crankcase ..... dia:		0.0007T	0.0011L
2	Hydraulic valve lifter in crankcase ..... dia:	0.0035L	0.001 L	0.0025L
3	Hydraulic valve lifter bore in crankcase ..... dia:		1.0005	1.0015
4	Governor driven gear in crankcase ..... dia:	0.005 L	0.0014L	0.0034L
5	Governor driven gear bore in crankcase ..... dia:		0.875	0.876
6	Starter shaft bushing in crankcase ..... dia:		0.0005L	0.0015T
7	Crankcase main bearing journals ..... dia:		2.437	2.438
8	Crankcase camshaft bearing journals ..... dia:		1.3745	1.3755
9	Fuel pump adapter pilot in crankcase ..... dia:		0.001 L	0.005 L
10	Fuel pump body pilot in adapter ..... dia:		0.0005L	0.0045L
11	Oil seal in adapter ..... dia:		0.003 T	0.009 T
12	Fuel pump drive shaft in impeller shaft ..... dia:	0.011 L	0.002 L	0.008 L
13	Fuel pump drive shaft in governor gear ..... tooth clear:	0.0055	0.0015	0.0039
14	Deleted			
15	Deleted			
	TIGHTENING TORQUES	Thread Size	Torque In./Lbs.	Torque Ft./Lbs.
16	Crankcase through bolts	3/8-24	370-390	30.8-32.5
17	Crankcase flange bolt	1/4-28	100-124	8.3-10.3
18	Crankcase through bolts at nose	1/4-28	90-110	7.5-9.2
19	Sump-to-crankcase nuts	1/4-28	90-110	7.5-9.2

TABLE XIV. CRANKSHAFT, CONNECTING ROD, BEARINGS AND CAMSHAFT LIMITS

(Refer to Figure 6-12)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
20	Crankshaft in thrust bearing ..... end clear:	0.023	0.006	0.016
21	Crankshaft in main bearings ..... dia:	0.006 L	0.001 L	0.004 L
22	Crankpin ..... out-of-round:	*0.0015	0.000	0.0005
23	Main journals ..... out-of-round:	*0.0015	0.000	0.0005
24	Crankshaft main and thrust journals ..... dia:	*2.2445	2.247	2.248
25	Crankpin journals ..... dia:	*1.9335	1.936	1.937
26	Crankshaft run-out at center main journals (shaft supported at thrust and rear journals) ..... full indicator reading:	*0.015	0.000	0.015
	Taper over full crankshaft bearing length ..... :	*0.0015	0.000	0.0005
27	Crankshaft run-out at propeller flange when supported at front and rear main journals ..... full indicator reading:	0.005	0.000	0.005
28	Damper pin bushing in crankcheek ..... dia:		0.0015T	0.003 T
29	Damper pin bushing in counterweight ..... dia:		0.001 T	0.0025T
30	Bushing in counterweight ..... bore dia:		0.604	0.607†

TABLE XIV. CRANKSHAFT, CONNECTING ROD, BEARINGS AND CAMSHAFT LIMITS

(Refer to Figure 6-12)

Ref. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
31	Bushing in crankshaft ..... bore dia:		0.604	0.607†
32	Damper pin			
	630261-41 ..... dia:		0.545	0.546
	630261-43 ..... dia:		0.499	0.498
	630261-44 ..... dia:		0.552	0.553
33	Damper pin ..... length:		0.819	0.821
34	Damper pin ..... end clear:	0.040	0.011	0.037
35	Counterweight on crankcheek ..... side clear:	0.020	0.004	0.014
36	Crankshaft gear on crankshaft ..... dia:		0.000	0.0025T
37	Connecting rod bearing and bushing twist or convergence per inch length ..... :	0.001	0.000	0.0005
38	Connecting rod bearing on crankpin ..... dia:	0.006 L	0.0005L	0.003 L
39	Connecting rod bolt in connecting rod ..... dia:		0.0005L	0.0023L
40	Camshaft in crankcase ..... dia:	0.005 L	0.001 L	0.003 L
41	Camshaft in crankcase ..... end clear:	0.012	0.004	0.008
42	Camshaft run-out at center journals (shaft supported at end journals) ..... full indicator reading:	0.003††	0.000	0.001††
43	Camshaft gear in camshaft counterbore (IO-360-A) ..... dia:		0.0005T	0.0015L
44	Camshaft gear on camshaft ..... dia:		0.0005T	0.0015L
45	Governor drive gear on camshaft ..... dia:	0.004 L	0.0002L	0.002 L
46	Crankshaft gear-to-camshaft gear ..... backlash:	0.013	0.006	0.009
47	Governor drive gear-to-governor driven gear ..... backlash:	0.012	0.004	0.008
	TIGHTENING TORQUES	Thread Size	Torque In./Lbs.	Torque Ft./Lbs.
48	Crankshaft gear screw	5/16-24	240-260	20.0-21.7
49	Connecting rod nuts #	3/8-24	400-475	33.3-39.5
50	Camshaft gear screw	5/16-24	240-260	20.0-21.7

*If crankshafts are worn beyond these limits they may be repaired by grinding journals to 0.010 inch under new shaft limits and renitriding journals.

†If bushing in either counterweight or crankshaft blades are brinelled in excess of 0.001 inch, the bushings should be replaced. (See Section VI, page 6-6)

††Straightening of the camshaft is permissible if run-out does not exceed 0.005 inch.

#TORQUE TO LOW LIMIT - IF COTTER PIN WILL NOT ENTER INCREASE TORQUE GRADUALLY UP TO HIGH LIMIT ONLY. IF COTTER PIN WILL NOT ENTER IN THIS RANGE REPLACE NUT AND REPEAT. IN NO CASE SHALL NUTS BE TORQUED BELOW LOW LIMIT OR OVER HIGH LIMIT.

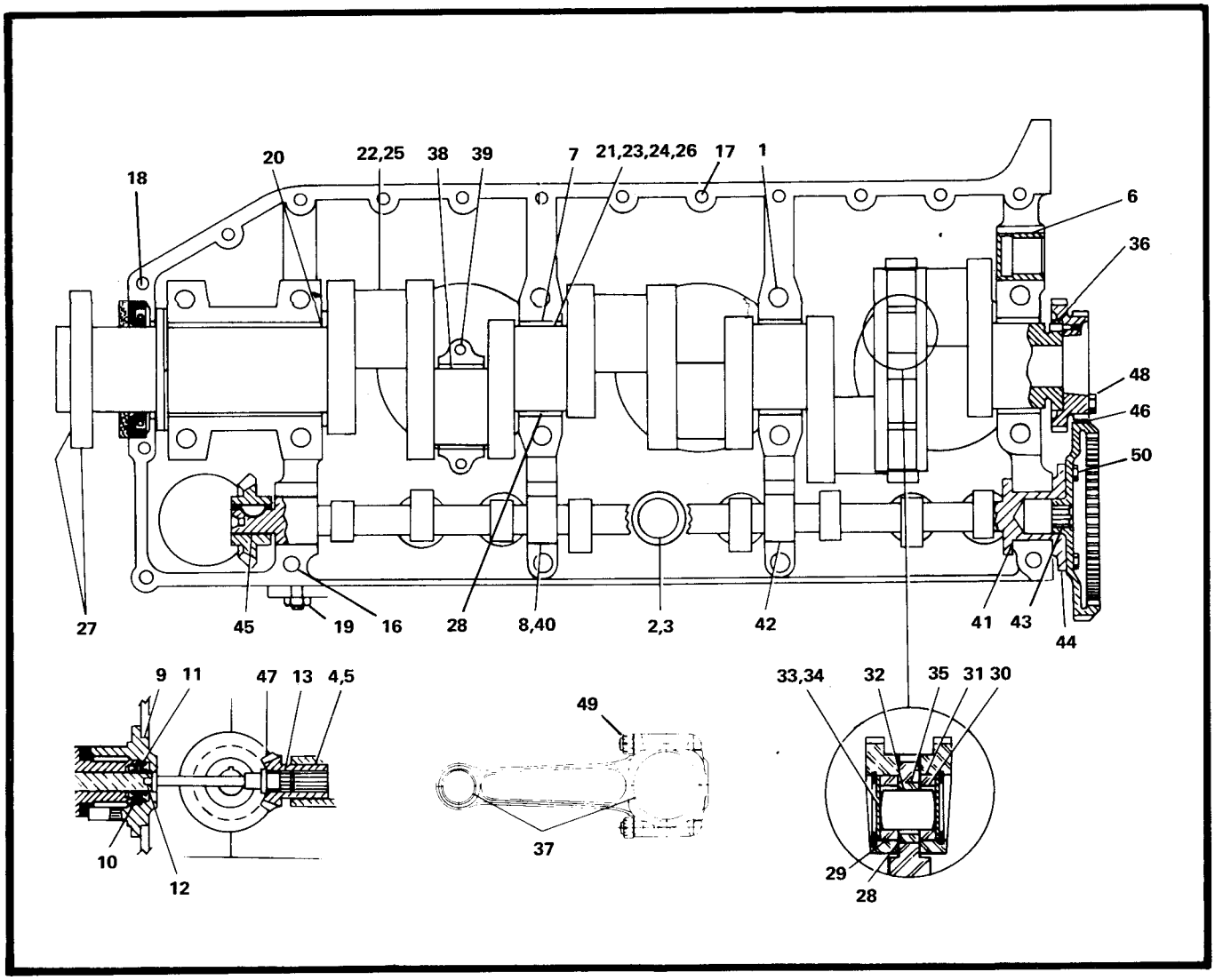


Figure 6-12. Crankcase Limits (Refer to Table XIII & XIV).

SECTION VII
ASSEMBLY OF SUBASSEMBLIES

7-1. NEW PARTS. Parts which require protection from atmospheric dust and moisture are wrapped or boxed individually or in sets. These should not be unpacked until they are ready to be installed. This is especially true of precision bearing inserts and anti-friction bearings. Check other parts on receipt for damage done in transit. Refer to Section IV of the parts catalog, Form X-30031A for part numbers of the complete gasket set, the main bearing set, the piston ring set and tubes of light weight Tite-Seal gasket paste, all of which should be on hand when work is started. Use only new shakeproof or split lockwashers, tab washers, elastic stop nuts, cotter pins and annealed, corrosion-resistant lockwire.

7-2. TIGHTENING TORQUES. The Table of Limits in Section VI contains tightening torques for bolts, nuts and plugs installed without special thread lubricant. The accuracy of any torque indicating wrench depends on a smooth application of force. Do not back up a nut or bolt and leave it in that position. If a part is accidentally tightened beyond specified limits, loosen it and retighten to correct limits. If a nut slot cannot be aligned with a cotter pin hole within specified limits, substitute another serviceable nut. If the cotter pin hole in a stud lies beyond the nut slots when the nut has been properly tightened, the stud has been improperly installed or has backed out, or the attached part has been reduced in thickness, or either nut or washer is incorrect part for that application. The situation must be corrected by whatever replacement is indicated by inspection.

7-3. FINAL CLEANING. Immediately before assembling a group of parts they should be washed in, or sprayed with, a clean solvent and dried with dehydrated compressed air.

7-4. LUBRICATION. Immediately after final cleaning and before installation, coat all bare steel surfaces and journals with clean engine lubricating oil, except where special lubricants are mentioned in the text. In some instances, where gears and other running parts are not accessible after assembly in a housing, additional oil should be applied to assure full coverage. Before installing tapered pipe plugs or straight thread plugs, to prevent seizure and oil leakage, coat the male threads with Rite anti-seize compound, RT-4, Rite Products Co. Coat both sides of gaskets with lightweight tightseal compound to assure a perfect seal and to counteract the permanent "set" caused by compression.

7-5. SPECIFIC ASSEMBLY OPERATIONS.

7-6 CRANKCASE COVER ASSEMBLY IO-360 (See Figure 4-7)

a. Lubricate oil pump gears (32, 33 or 34, 35) with clean lubricating oil and install them in the oil pump cavity. Install the pump cover (31) and secure it with four sets of attaching parts (29, 30). After tightening screws bend up ears of tab washers (29) to secure. On IO-360-A engines, drive gear (32) is driven by means of a square drive by the camshaft gear. On all other engines in this series, insert the oil pump drive gear (27) with woodruff key (28) in place through cover (31) and aligned with keyway in drive gear (35). Secure with nut (26).

b. Install plunger (25), spring (24), new gasket (23) and cap(22). Secure cap to crankcase with lockwire. (Items 22 through 25 are installed on opposite side of the IO-360-A accessory case.)

c. Install gaskets (16), plugs (15) and plug (14).

d. Install gasket (13) and suction oil screen (12). Install gasket (11) and pressure oil screen (10), gasket (9) and plug (8).

7-7. CRANKCASE COVER, TSIO-360 (See Figure 4-8).

a. Lubricate oil pump gears (42, 43) with clean engine oil and insert in pump cavity in housing (52). Install cover and secure with tab washer (39) and bolt (40). Insert oil pump drive gear (37) with woodruff key aligned with slot in oil pump drive gear. Secure with nut (36) or tach drive shaft as applicable.

b. Install plunger (35), springs (34, 33), new gasket (32) and cap (31). Secure cap with lockwire.

c. Install gaskets (25), plugs (24) and plugs (23).

d. Install gasket (22) and suction oil screen assembly (21).

e. Install gasket (16), nut (14) and gasket (12) on adapter (18). Install adapter in crankcase cover. Lock in place by turning nut (14) against crankcase cover. Attach bracket (20) to adapter with attaching parts (11, 12, 13).

NOTE . . . It is highly recommended that the spin-on oil filter be used. To do this, it will be necessary to install stud (9) in adapter (18). Screw stud into adapter by hand until it bottoms.

7-8. CRANKCASE COVER, OPTIONAL (See Figure 4-9).

NOTE . . . Cover shown in Figure 4-9 is used on current production TSIO-360-C, D engines.

a. Lubricate oil pump gears (37, 38) with clean engine oil and install in oil pump cavity. Insert oil pump drive gear (34) through top hole of oil pump cover (36) and insert woodruff key (35) in slot. Carefully insert shaft of gear with woodruff key aligned with slot of drive gear (37). Secure cover (36) with tab washers (32) and screws (33).

b. Install plunger (30), springs (29, 28), gasket (27) and cap (26). Secure relief valve assembly with lockwire.

c. Install gasket (17) and suction oil screen (16).

d. Install gaskets (20), plugs (19) and plugs (18) as applicable.

e. Install gasket (15) on crankcase studs. Install "O"-ring (14) on adapter (11 or 12) and install adapter in crankcase. Secure with attaching parts (8, 9, 10).

7-9. STARTER AND ACCESSORY DRIVE ADAPTER (See Figure 4-6)

a. Install needle bearing (49). Installing tool may be manufactured in accordance with dimensions shown in Figure 3-2.

b. Press ball bearing (43) on shaft (47) until it bottoms against flange. Install spring (45), woodruff key (46) and gear (44) on shaft. Install assembly in adapter housing (50). Install retaining ring (42).

c. Press bearing (36) into wormwheel (37). Install clutch spring (38) on hub of wormwheel (37). Turn spring in unwinding direction until the offset end drops into the gear hub groove. Position spring so notch is aligned with screw hole and secure with screw (39) and tab washer (40). Bend up ears of tab washer.

d. Lubricate spring, sleeve and shaftgear (41) liberally with clean engine oil. Press wormwheel, bearing and spring assembly onto shaftgear. Insert shaftgear and wormwheel assembly into adapter. Make certain wormwheel and wormgear teeth are aligned.

e. On turbocharged engines, cover (27) is also the scavenge pump housing. In assembling starter adapter for such engines, lubricate scavenge pump gears (33, 35) with clean engine oil and install in pump cavity. Install cover (31) and secure with attaching parts (28, 29). Install woodruff key (32).

f. Install new "O"-ring (25) and oil seal (24) on cover (27). Replace bushing (25) only if necessary. Secure cover to adapter with one set of attaching parts (20, 21, 22). Install gasket (19), cover (18) and secure with attaching parts (15, 16, 17).

7-10. STARTER AND ACCESSORY DRIVE ADAPTER (See Figure 4-5).

a. Install needle bearing (62) using installer such as that described in Figure 3-2.

b. Press ball bearing (56) onto shaft (60) until it bottoms against flange. Install spring (58), woodruff key (59) and wormgear (57) on shaft. Install assembly in adapter housing (63) and secure with retaining ring (55).

c. Install clutch spring (50) on wormwheel hub by turning in an unwinding direction until the offset end drops into the gear hub groove. Align the notch in the spring with the screw hole in the worm wheel web and secure spring with screw (52) and tab washer (51). Install bearing (48).

d. Lubricate spring, shaftgear (53) and sleeve with engine oil and press worm wheel assembly on shaftgear. Install entire assembly in adapter housing.

e. On Turbocharged engines, install scavenge pump gears (42, 44) in adapter (47). Install cover (41) and secure with attaching parts (38, 39). Install new "O"-ring (37) on adapter (47).

f. Install woodruff key (54) in shaftgear and slide accessory drive adapter over shaftgear end and secure with one set of attaching parts (24, 25, 26).

g. Install driven gear (32) on end of shaftgear (53). Hold driven gear (31) in place and slide shaft (29) and key (30), small end first, into left side of accessory drive pad through driven gear (31). Push far enough to slide retaining ring (28) over end of shaft. Push shaft into place in accessory adapter. Install retaining ring in groove in shaft. Lubricate seals (34, 33) with clean engine oil so as not to damage them while installing shaft.

h. Apply a thin film of Tite Seal compound to both sides of gaskets (23, 18) and install on adapter studs. Install cover (22, 17) on pad. Secure with attaching parts (19, 20, 21) and (14, 15, 16).

NOTE . . . Test for free turning of gears.

7-11 CYLINDER ASSEMBLY (See Figure 4-11)

a. Spread a film of Gredag No. 44 grease on valve stems (42, 41) and insert them into the cylinders to which they have been lapped. Grasp valve stems and lift cylinder onto a post which will support valve heads. Clamp cylinder base flange to prevent it from rising. Again apply Gredag No. 44 to valve stems.

b. Temporarily install rocker shaft (11) and secure with attaching parts (10, 9, 8). Install retainers (40), two sets of springs (38, 39), intake valve seats (36) and exhaust valve rotator (37). Compress springs (see Figure 7-1) and install keys (35). Make certain keys are properly seated before releasing pressure on springs. Remove cylinder from fixture and stand it upright on a bench. Strike each valve stem sharply with a rawhide mallet to seat the valve stem keys.

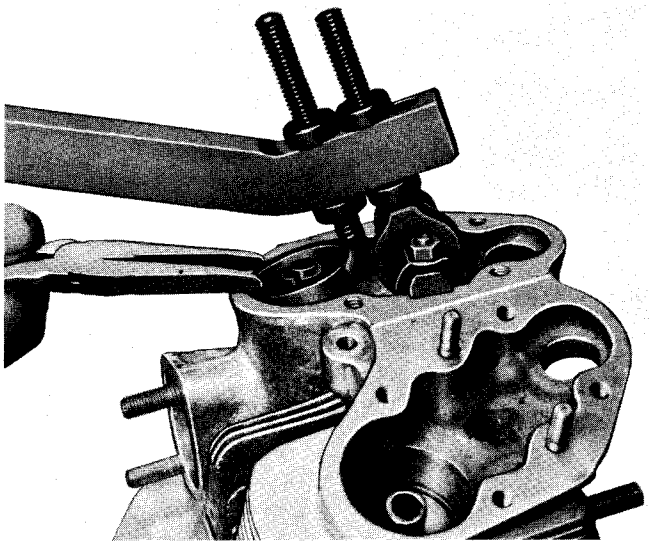


Figure 7-1. Compressing Valve Springs.

c. Install new cylinder base packing (34) on the skirt of each cylinder and push it against the flange. Make certain none are twisted. Coat the cylinder bore walls with Cities Service No Scuff Oil. No. 9028 or castor oil.

d. Lubricate pistons (33) and rings (29 through 32) liberally with Cities Service CMS No. 50. Position first and third ring gaps so they are on bottom when piston is installed. Stagger gap of second and fourth ring so they are 180° from that of the first and third.

e. Insert spring (53) in holes in baffles (56) so the hook end opens toward outer end of cylinder. Using another spring, or a piece of thin stiff wire with a hook bent into it, install baffle on bottom

of cylinder head and fish spring (53) through fins. Hook spring in groove provided in cylinder head (see Figure 7-2).

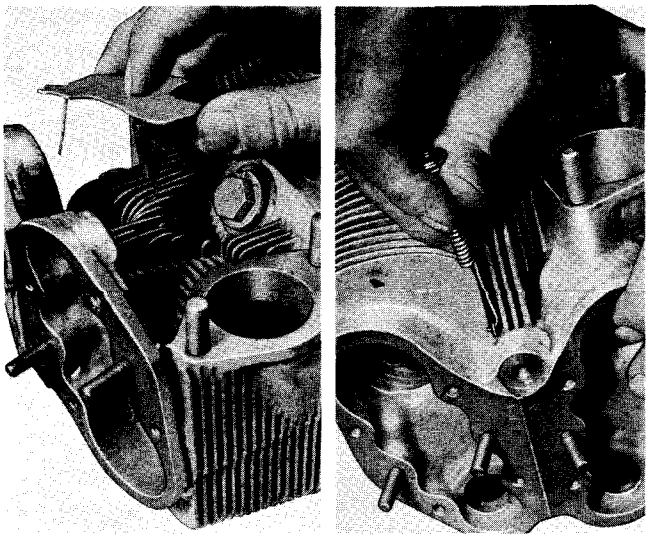


Figure 7-2. Installing Cylinder Baffle.

7-12. CRANKSHAFT AND CONNECTING RODS (See Figure 4-13)

a. Lay crankshaft (27) on bench with wooden support blocks under front and rear main journals. Lay out connecting rod assemblies (10 through 16) opposite crankpins according to position numbers stamped on bolt bosses. Install a new bearing insert (14) in each rod and cap so their ends project equal distances. Lubricate and install each rod and cap with position numbers on top when odd numbered rods are extended to the right and even numbered to the left. Secure rods and caps with rod bolts (12) and slotted nuts (11). Tighten nuts to torque specified in Table of Limits, Section VI and install cotter pins (10).

b. Place counterweights (21) on crankshaft blades and install pins (19). Secure pins with plates (18) and retaining rings (17). See parts catalog, Form X-30031A for correct pin application.

c. Heat crankshaft gear (24) to 300°F., align gear dowel hole with crankshaft dowel and tap gear onto shaft. Attach gear to shaft with four bolts (23). Tighten bolts to specified torque and secure with lockwire.

d. Remove spring (8) from crankshaft oil seal assembly and unhook its ends. Coat the lip of the seal with molyshield grease. Twist the seal and slide it over the crankshaft with the felt side toward the flange (see Figure 7-3). Bring the ends back together. Wrap the spring around the crankshaft in the seal areas. Turn the spring ends in an unwinding direction, then join and allow one end to wind into the other end. With hooked ends opposite the seal split, lift the spring into the seal recess. Work the remainder in by moving the fingers in both directions from the starting point (see Figure 7-4). Make sure the spring is in the deepest part of the recess all around.

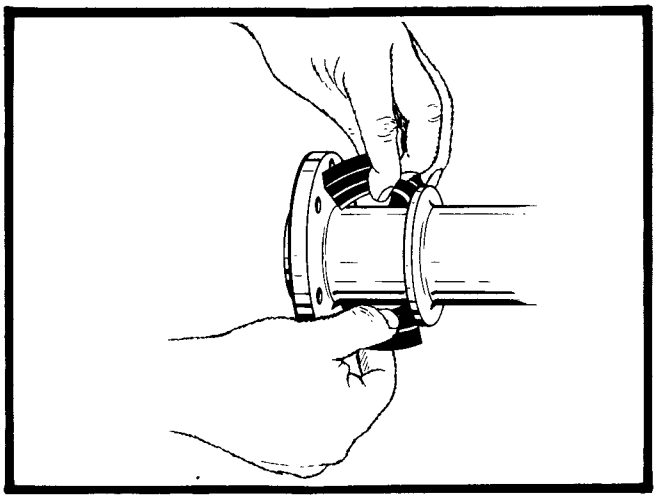


Figure 7-3. Installing Crankshaft Oil Seal.

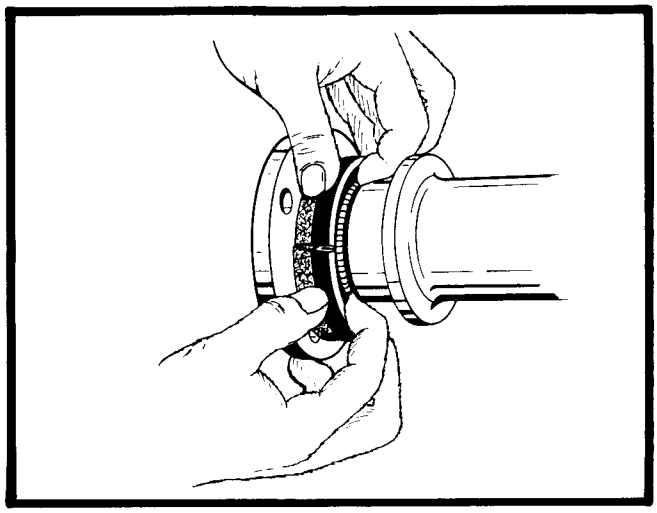


Figure 7-4. Installing Crankshaft Oil Seal Spring.

7-13. CAMSHAFT (See Figure 4-13).

a. Install key (29) and gear (28) on camshaft (32).

b. Install gear (31) on camshaft and secure with four bolts (30). Tighten bolts to specified torque and secure heads together with lockwire.

7-14. CRANKCASE (See Figure 4-12).

a. Replace any pipe plugs which may have been removed for cleaning and inspection of galleries. Install new gaskets on machine thread plugs.

b. Spread a film of Tite Seal compound on both sides of gasket (73) and install on governor pad studs. Install cover (72) on governor and secure with four spacers (71), plain washers (72), lockwashers (69), three nuts (61) and one bolt (68). Bolt (68) has been replaced on current production engines by a stud and nut (61).

c. Install "O"-ring (74, 75) and mounting legs (64, 65, 66, 67). Secure with attaching parts (49, 48, 47 and 63, 62, 61).

d. Turn both crankcase halves open side up. Make sure all squirt nozzles (86) and screens (85) are in place. Lubricate all cam bearings and main bearings. Install intermediate and rear main bearing inserts (3, Figure 4-13) and front main bearing inserts (4, Figure 4-13). Insert bearings in seats so that edges project equally.

7-15 ALTERNATOR ASSEMBLY (See Figure 4-6)

a. Where applicable, install new "O"-ring (11) on shaft of alternator (14). Lubricate lip of oil seal (10) and the polished surface of coupling hub (9) with Gredag No. 44 grease. Slide hub onto shaft, over the woodruff key and through the seal lip until seated against inner race of ball bearing.

b. Install sleeve (6), retainer (8) and two bushings (7). Slide gear (6) onto shaft so its drive lugs are inserted in the rubber bushings.

c. When heavy duty coupling is used, only sleeve (13) is a serviceable item. Install coupling assembly (12) with sleeve (13) in place.

d. Install nut (4) and tighten to 175 in. lbs. torque. If necessary, the nut may be tightened further to align the cotter pin hole with the nut slots, but do not exceed 200 in. lbs. Install cotter pin (3).

7-16 INDUCTION SYSTEM (See Figure 4-3)

a. Place a clamp (2) loosely over two hoses (3). Insert an intake tube (7) into each of the hoses. Assemble the remaining hoses (3), clamps (2) and intake tubes (8, 9, 10, 11) in a like manner. Do not tighten clamps at this time.

b. Place a clamp (1) loosely on the hoses installed on the front intake tubes (7, 8).

SECTION VIII
FINAL ASSEMBLY AND TESTING

8-1. GENERAL INSTRUCTION

8-2. LUBRICATION. Apply clean engine lubricating oil to all bare steel surfaces, journals, bearings and bushings, before and/or after installation, depending on accessibility, except where special lubricants are mentioned.

8-3. TIGHTENING TORQUES. See Table of Limits, Section VI and instructions in paragraph 7-2.

8-4. CLEARANCES. Wherever possible, measure clearances of running parts as they are installed. When end clearances, side clearances and backlashes cannot be measured with normal thickness gauges due to inaccessible position of parts, test for binding or excessive looseness as well as possible by moving the running part.

8-5. COVERS. Unless the atmosphere is unusually free of dirt and airborne grit, it is advisable to cover openings as soon as possible and to cover subassemblies and partial engine assemblies whenever they are not in the process of being assembled. Cover all openings into which small parts may be dropped.

8-6. CRANKCASE.

a. Attach mounting legs of left crankcase to engine assembly stand and support it as shown in Figure 8-1.

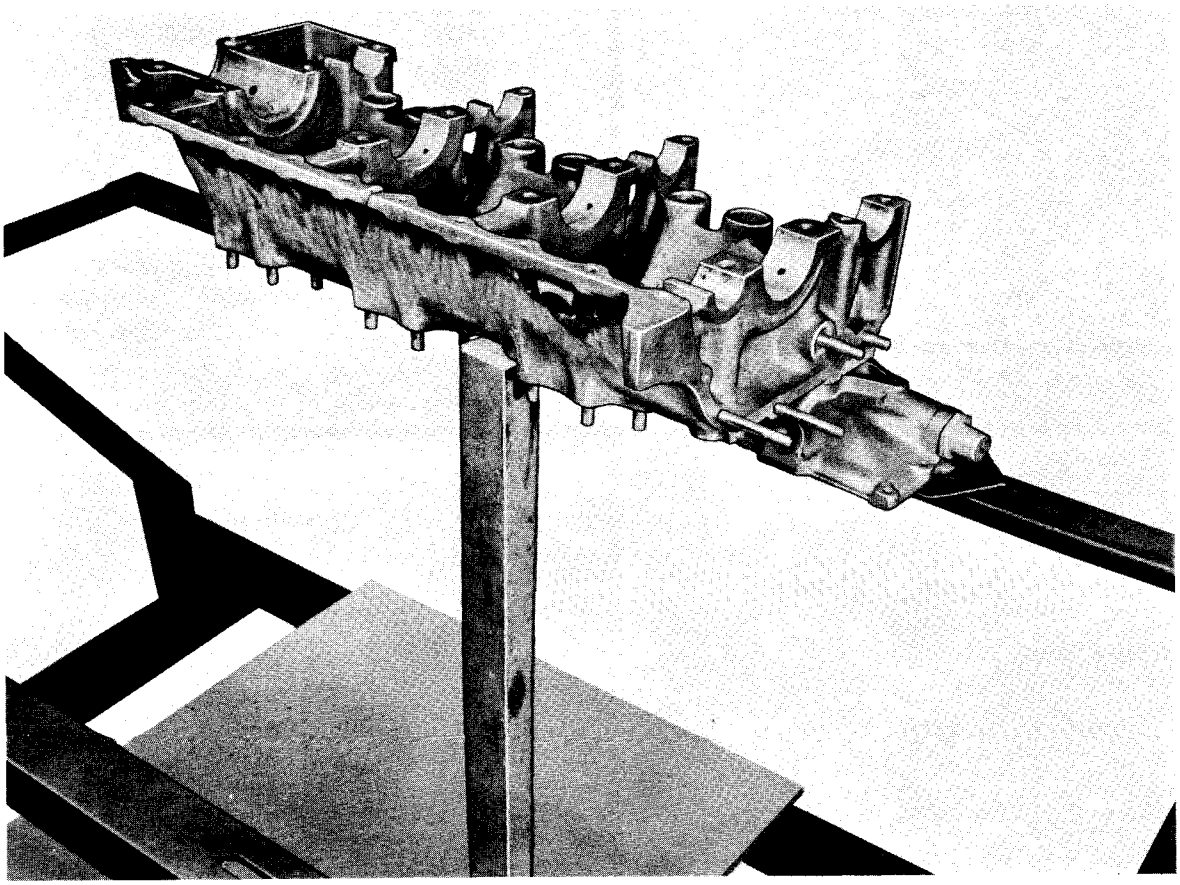


Figure 8-1. Left Crankcase on Stand, Supported.

b. Lubricate all main bearing inserts and crankshaft journals. Lubricate both thrust washer halves with molyshield grease and install.

c. Lift crankshaft assembly by No. 1 connecting rod and propeller flange while an assistant holds No.'s 3 and 5 rods. Carefully lower the assembly into the left crankcase bearings. Make certain the oil seal enters the oil seal cavity. If properly installed, the connecting rod position numbers will be toward the upper crankcase flange.

d. Lubricate governor driven gear with clean engine lubricating oil and insert it into the crankcase bore. Lay camshaft assembly in crankcase bearings, meshing spur gear teeth with crankshaft gear so that timing marks are aligned and turning governor driven gear so it meshes with governor drive gear (see Figure 8-2).

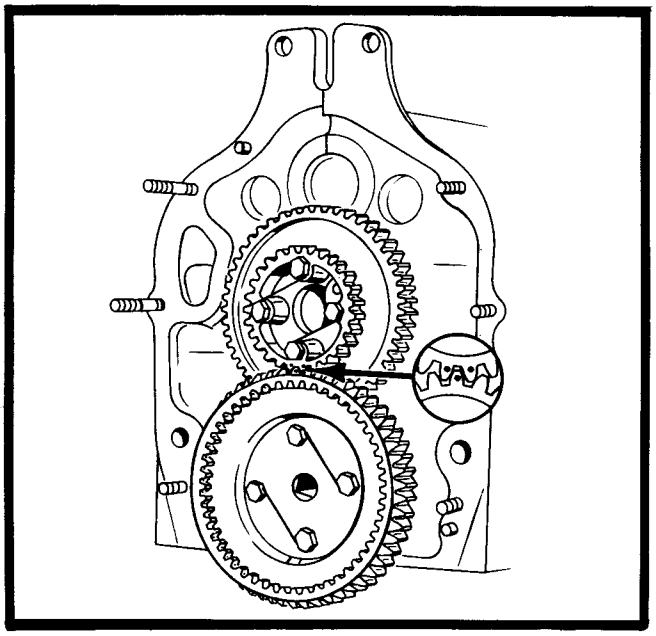


Figure 8-2. Alignment of Timing Marks.

e. With a feeler gauge, measure crankshaft and camshaft end clearance. See Table of Limits, Section VI for allowable tolerances.

f. Position starter shaft bushing (76, Figure 4-12) in place with dowel hole upward. Install two new packings (75, Figure 4-12).

g. Spread a thin continuous film of No. 3 Aviation Permatex on the left crankcase parting flange. Take care that the Permatex does not get on any other part. Lay lengths of No. 50 silk thread on parting flange. Thread should be on inside of bolt holes but never on the flange edge (see Figure 8-3). Stand No. 1, 3 and 5 rods upright. Carefully lower the right crankcase onto the left crankcase. Rotate the starter shaft bushing as necessary to align the hole with the dowel in the crankcase.

h. Insert two thru bolts (45, Figure 4-12) through the crankcase halves at the nose, two thru bolts (46) in front of No. 5 cylinder pad, one thru bolt (50) through lower corner of front mount brackers, one thru bolt (51) at the lower corner of the rear mount brackets, four thru bolts (52) through No. 3 and 5 cylinder mount pads, two thru bolts (56) below camshaft level, one thru bolt (59) in lower hole of No. 1 cylinder pad and one thru bolt (60) in upper hole of No. 1 cylinder mount pad. Tap all thru bolts to a centered position with a non-marring hammer. These bolts align the crankcase castings and bearings.

i. Install, but do not tighten, two sets of attaching parts (35 through 38), a washer (44) and nut (43) on each end of two thru bolts (45), one

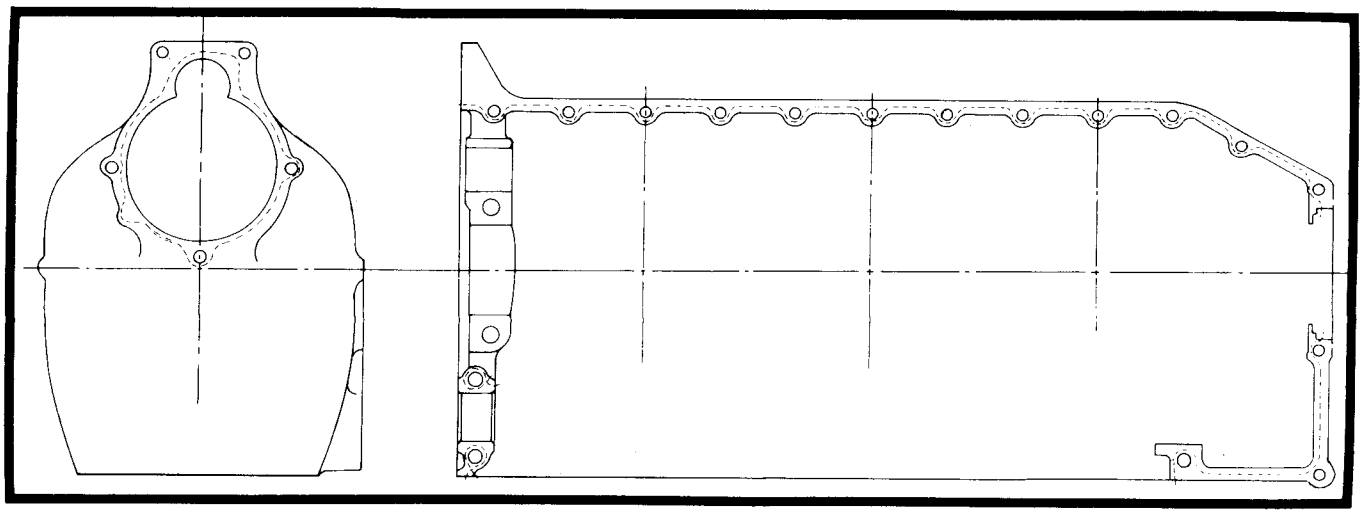


Figure 8-3. Threading Instructions.

set of attaching parts (39 through 42), a washer (49), lockwasher (48) and a nut (47) on each end of thru bolts (50, 51), a washer (55), lockwasher (54) and nut (53) on each end of two thru bolts (56), a washer (58) and a nut (57) on the right crankcase side of two thru bolts (46) and a washer (58) and nut (57) on the left crankcase side of thru bolts (59, 60).

j. Attach the manifold valve and bracket assembly (25 through 33, Figure 4-2) to the backbone at hole position (47, 45, Figure 8-4). Install lifting eye (27, Figure 4-12) at the (45, 43) hole position. Secure finger tight with spacers (28, 84), washer (29), bolts (30), lockwashers (26) and nuts (25). Attach throttle body bracket (21) to backbone at hole position (48, 46, Figure 8-4) with attaching parts (24, 23, 22, 20, 19, 18). On TSIO-360-C & D engines, install bracket (90) in place of bracket (21) and install bracket (91) in hole position (43, 41) on backbone. Install attaching parts (31 through 34) in remaining holes of upper parting flange. Attach right mount brackets to the overhaul stand bed. Rotate the stand to place the engine in an upright position.

8-7 CYLINDERS AND PISTONS.

a. Rotate crankshaft until No. 4 connecting rod is at the outermost position. Install piston with the position number towards the propeller flange. Dip piston pin in castor oil before installing in piston and connecting rod.

b. Lubricate pistons and rings liberally with Cities Service No Scuff Oil, No. 9028. Hang a ring compressor on the piston skirt. Cradle the cylinder in one arm, center the compressor over the rings and compress fully. Push cylinder onto piston, forcing compressor off piston.

c. Remove ring compressor and place cylinder base flange onto hold down studs. Make sure packing is in place and not twisted and seat the cylinder on the crankcase cylinder pad. Install, but do not tighten attaching parts.

d. Rotate crankshaft until No. 5 connecting rod is at its outermost position. Install No. 5 piston and cylinder as described above. Tighten stud nuts and thru bolts to the torque specified in Table of Limits, Section VI. Tighten in sequence shown in Figure 8-4.

e. Install cylinders 2, 3 and 1, 6 in a like manner.

f. Turn overhaul stand so engine is in the inverted position. Lubricate the exterior surface of valve lifter with clean lubricating oil and install in crankcase bores.

g. Install washer (19, Figure 4-11) on cylinder end of pushrod housing (23). Compress spring in cage of pushrod housing installer (see Figure 8-5)

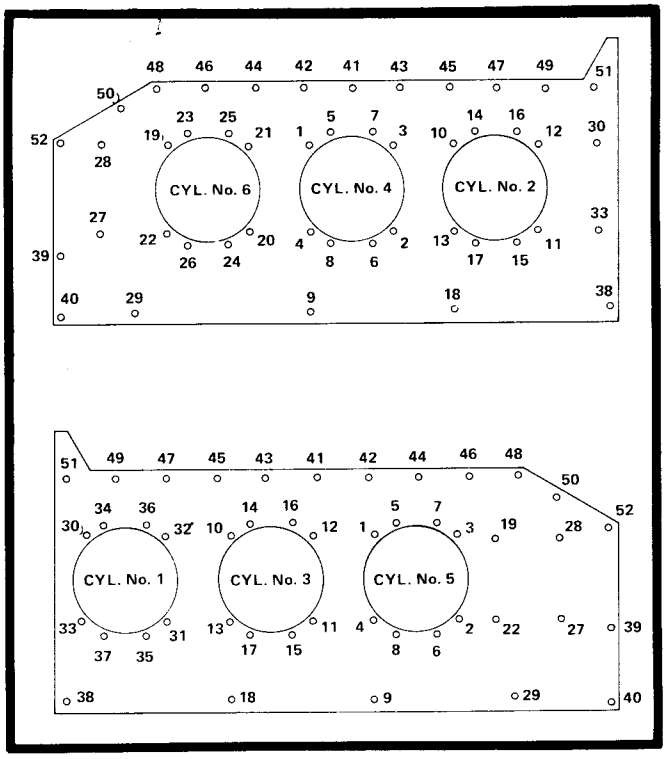


Figure 8-4. Torquing Sequence.

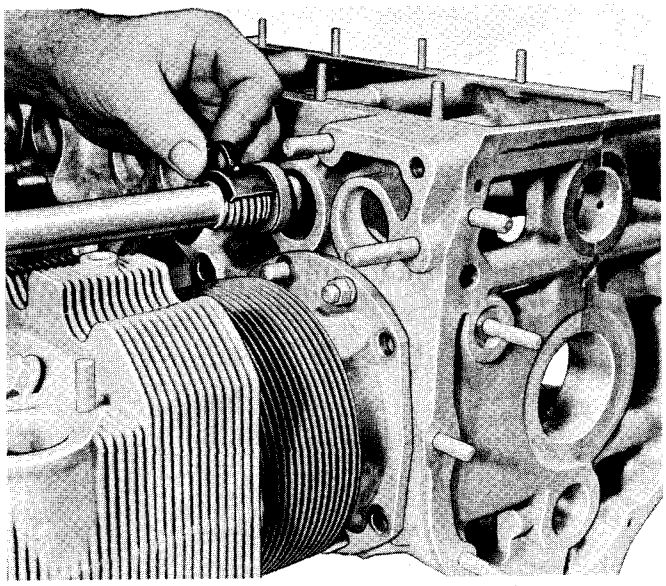


Figure 8-5. Installing Pushrod Housing.

and install spring on pushrod housing. Install one washer (20, Figure 4-11), packing (21) and a second washer (20). Insert spring loaded end of assembly into crankcase bore and align opposite end with cylinder head flange hole. Remove spring compressor cage and allow housing to snap in place.

h. Insert pushrods (18 , Figure 4-11) for one cylinder into their housings. Turn crankshaft until both pushrods are at their lowest position. Lubricate the rocker shafts (11) with clean lubricating oil and insert in rocker assembly (15, 16, 17). Install thrust washers (12). Install rocker and shaft on cylinder rocker studs. On IO-360-A, engines, make sure the wide end of shaft (14) is over the inner studs. Install retainers (10) on both ends of shaft, or, on the IO-360-A, install retainer (13) on the narrow end of the shaft. Secure each shaft with two sets of attaching parts (9, 8). After tightening the nuts, bend ears of tab washers up against wrench flats of nuts. Install pushrods and rockers on remaining cylinders in a like manner.

i. Coat both sides of gasket (7) with Tite Seal compound. Install gaskets and covers (4, 5). Cover (5) is used on cylinder No. 2 toward the engine rear. Secure with attaching parts (1, 2, 3).

j. Apply a film of Led Plate No. 250 compound to pipe threads of nipples (47) and install in cylinder intake chamber drain hole. Install a cylinder drain manifold (24) on each bank of cylinders.

8-8 OIL SUMP.

a. Make certain the suction tube (6, Figure 4-10) is firmly installed. Rotate the engine stand to place the engine in the inverted position. Apply a film of Tite Seal compound to both sides of gasket (7) and lay gasket in position on the crankcase-to-sump parting flange. Install sump (8) on crankcase studs and secure with fourteen sets of attaching parts (5, 4, 3).

b. Install a new gasket (2) and plug (l).

8-9. CRANKCASE COVER.

a. Rotate engine stand to place engine in upright position. Apply a film of Tite Seal compound to both sides of gasket (7, Figure 4-7, 4-8 or 4-9). Install gasket on crankcase studs.

b. Install crankcase cover over gasket. On IO-360-A models, turn oil pump gear (32, Figure 4-7) so square drive aligns with cam gear. On all other engines, turn oil pump drive gear (27, Figure 4-7; 37, Figure 4-8 or 34, Figure 4-9) to mesh with cam gear. Secure the cover to the crankcase with attaching parts (1 through 6).

8-10. ALTERNATOR ASSEMBLY.

a. Apply a film of Tite Seal compound to both sides of gasket (21, Figure 4-7 or 30, Figure 4-8 or 25, Figure 4-9) and install on crankcase cover studs.

b. Install alternator and secure with three sets of attaching parts (2, 1, Figure 4-6).

c. Install cover (20, Figure 4-7 or 29, Figure 4-8 or 24, Figure 4-9) and secure with attaching parts (l9, l8, l7, Figure 4-7; 28, 27, 26, Figure 4-8 or 23, 22, 21, Figure 4-9).

8-11. STARTER ADAPTER AND STARTER.

a. Coat a new gasket (14, Figure 4-4 or 13, Figure 4-5) with a film of Tite Seal compound and install it on the crankcase studs.

NOTE . . . All current production engines have a gasket between the starter adapter and the crankcase cover. Certain models built prior to 1973 used silk thread. Either method is appropriate. When using thread, apply a thin coat of No. 3 Aviation Permatex evenly on the crankcase cover starter adapter flange surface and apply No. 50 black silk thread as shown on crankcase threading diagram (Figure 8-3).

b. Place adapter on crankcase cover and secure with three sets of attaching parts (9, 10, 11, Figure 4-4 or 9, 10, 12, 13, Figure 4-4 as applicable or 9, 10, 11, 12, Figure 4-5 and one set of attaching parts (6, 7, 8, Figure 4-4 and 4-5).

8-12. OIL COOLER.

a. On all engines covered herein except the IO-360-A, install the carriage bolt (88, Figure 4-12) and nut (89) in the rear rocker cover of No. 2 cylinder.

b. Apply a film of Tite Seal compound to both sides of gasket (14). Install gasket and oil cooler (13) and secure with eight sets of attaching parts (12, 11, 10).

c. Install a new gasket (16), plug (15) and temperature control valve (17). Secure valve and plug with lockwire.

d. Install shoe (87) in groove in oil cooler. Adjust bolt by backing it into shoe until shoe just contacts cooler (see Figure 8-6). Preload by adjusting bolt 2/3 turn further toward cooler and lock in place. After engine run-in, readjust to above setting.

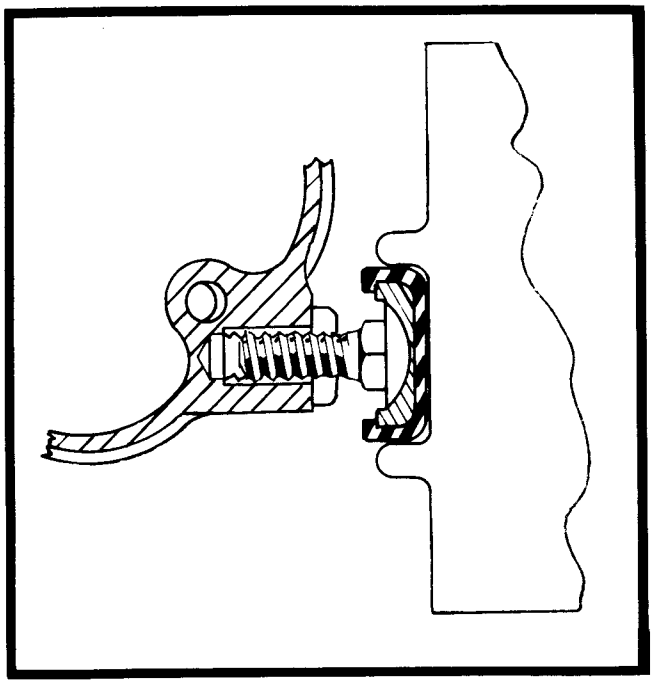


Figure 8-6. Installing Oil Cooler Support.

8-13. INJECTION SYSTEM.

a. Install nozzles (2, Figure 4-2) in cylinders. Connect discharge tubes (1) to nozzles and nipples (8) or elbows (5, 6, 7). Turbocharged engines incorporate a sleeve (19, Figure 4-3) over the nozzle which must be installed before the fuel discharge tubes.

CAUTION . . . Fuel injection equipments are tested and flowed with fittings installed. Any necessary turning to install hoses and tubes must be done very carefully to avoid the possibility of brass chips entering the fuel stream.

b. Install fuel pump drive gear (2, Figure 4-13) so spline meshes with spline of governor driven gear (1, Figure 4-13).

c. Apply a film of Tite Seal compound to both sides of gasket (38, Figure 4-2) and install it on crankcase fuel pump pad studs. Mesh square drive end of fuel pump gear with fuel pump (37) and mount fuel pump on crankcase studs. Secure with attaching parts (34, 35, 36).

d. Install air throttle body (22, Figure 4-3) on bracket and secure with attaching parts (26 through 29, Figure 4-3). On turbocharged engines, apply a film of Tite Seal compound to both sides of gasket (23, Figure 4-3). Secure gasket and adapter (24 or 25, Figure 4-3) to air throttle body with attaching parts (30 through 33). Secure adapter (25) to bracket (91, Figure 4-12) with attaching parts (26 through 29, Figure 4-3).

e. Install fuel metering-to-fuel manifold valve hose (3) and fuel metering-to-fuel pump hose (4).

8-14. INDUCTION SYSTEM.

a. Place a new gasket (12, Figure 4-3) on each of the cylinder intake flanges.

b. Install the intake manifold assembly on the cylinders. Secure each intake tube to its cylinder with two sets of attaching parts (6, 5, 4). Center hoses (3) and clamps (2) on intake tubes and tighten clamps snugly.

c. Position hose and clamp on air throttle body and tighten snugly.

d. Install oil gauge housing assembly (9, 8, Figure 4-12). Install clamp (6, Figure 4-12) on housing and secure to bracket (7, Figure 4-12) with attaching parts (3, 5, 4). Secure bracket to rear stud No. 2 cylinder intake manifold flange with intake manifold attaching parts. Install oil gauge rod (1, Figure 4-12). Make certain a new packing (2) is installed on rod.

8-15. IGNITION SYSTEM.

a. Plug one spark plug hole of No. 1 Cylinder, and place a thumb over the other plug hole. Have a second person stand at the front of the engine and turn the crankshaft, in a counterclockwise direction, until pressure is felt on the thumb. No. 1

piston is coming up on the compression stroke. Hold a machinist square so its base is along the crankcase vertical parting line below the crankshaft and the arm of the square is pointing outward past the crankshaft propeller flange. Turn the crankshaft, counterclockwise, until the 20 degree Before Top Center mark, on the flange, is aligned with the crankcase parting line. The engine is now in the advanced ignition firing position.

b. Remove inspection hole plug from magneto. Turn magneto coupling until painted chamfered tooth on the distributor gear is approximately centered in the inspection hole. Hold magneto in its approximate installed position. Note carefully the position of the coupling drive lugs.

c. Lubricate the gear support shaft with clean lubricating oil, and install drive gear assembly (35 through 38, Figure 4-1) so the slots of the drive bushings will be in the approximate position for aligning with drive coupling lugs. Insert retainer (34) into gear hub slot. Apply a film of Lubriplate grease to each of the new rubber bushings (33). Insert the bushings into the retainers, rounded long edges first.

d. Place a new gasket (8) on flange of magneto. Install magneto carefully so drive coupling lugs mate with slots of drive bushings. Install and snug down but do not tighten, two sets of attaching parts (6, 5, 4).

e. Install the ignition harness assemblies. Secure each outlet plate (26) with four sets of attaching parts (3, 2).

f. Connect a timing light to spark plug end of No. 1 cylinder ignition cable. Tap magneto case with a non-marring hammer, counterclockwise (from the rear) to make certain the points are closed. After timing light indicates points are closed, tap the magneto lightly clockwise until the points are open. Tighten magneto attaching nuts.

g. Check timing by backing up crankshaft approximately five degrees and tapping gently forward until timing light indicates opening of breaker points. If timing is correct, the 20 degree mark (midway between the 16 and 24 stamped on the crankshaft) will appear in the center of the inspection hole. The crankshaft has punch marks in two degree increments with 16 and 24 at each extreme.

h. Apply BG mica thread lubricant to first three threads of spark plugs (1). Install plugs and gaskets in cylinders. Insert ignition cable terminals into plugs and screw cable coupling nuts onto plugs. Make certain conduits are not kinked or interferring with some other part. Attach brackets and tighten all coupling nuts.

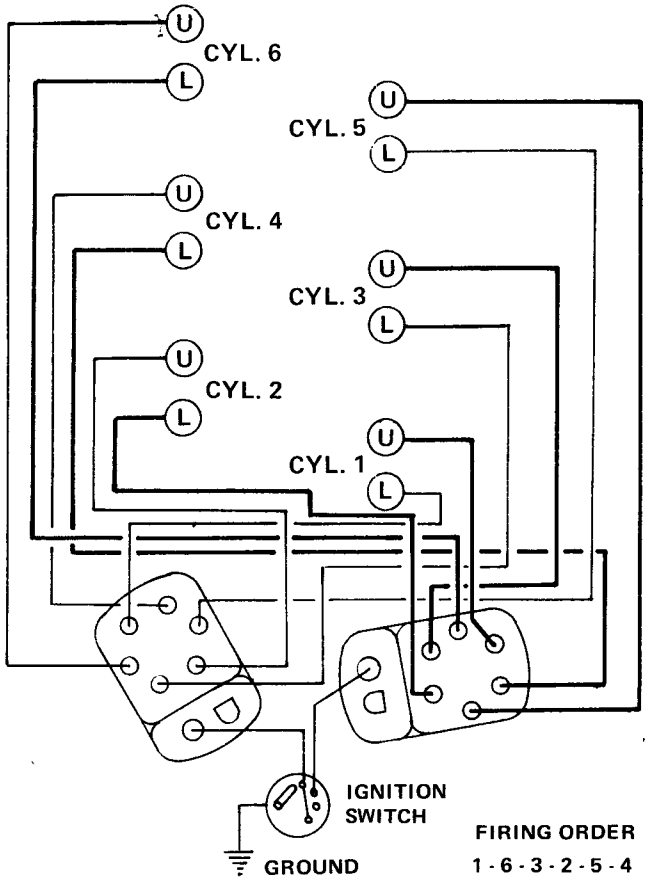


Figure 8-7. Wiring Diagram.

8-16. TESTING AFTER OVERHAUL.

NOTE . . . To assure the accuracy of test data and an adequate flow of cooling air over the cylinders, it is recommended that the run-in test be performed in a test cell. If a test cell is not available, the air-frame can be used for running in overhauled engines contingent on the use of a test propeller and suitable shroud or scoop to gather and direct cooling air over the cylinders. The engine must be equipped with cylinder head temperature pick-ups on all cylinders and other instrumentation as indicated.

8-17. TEST EQUIPMENT.

8-18. TEST CLUB. Unless a dynamometer is used to apply controlled loads to the crankshaft, it will be necessary to install a wood test club such as those supplied by the Hartzell Propeller Co. of Piqua, Ohio. Test clubs are customarily supplied in standard diameters, so that the blade length must be reduced by the 'cut and try' method until the club will absorb the BHP at the RPM specified in Table XV for the model on test when used in the cell, stand and engine combination for which it was calibrated.

8-19. TEST STAND. Any rigid supporting stand of adequate strength and suitable shape and dimensions may be fitted with adapters to accept the engine mount bracket locations and shear rubber mount bushing. The crankshaft should be at least five feet above the cell floor so that the test club will not cause excessive disturbance in the air at floor level. If the cell does not have a paved floor, the ground beneath the stand and for a reasonable distance around it should be treated so as to hold the soil in place.

8-20. COOLING. It will be necessary to construct a scoop of heavy-gauge sheet metal to fit over the tops of all cylinders, with pads to seal it to the rear cylinders and to all valve rocker covers, in order to direct an adequate flow of air downward through the cylinder fins. Vanes may be necessary to direct a portion of the cooling air to the center cylinder and the oil cooler; therefore the temperatures of all cylinder heads should be measured until a uniformity of temperature not exceeding a 50°F. spread has been obtained between coolest and hottest cylinder. It is advisable to provide a duct from the cylinder scoop to the governor vent tube or to provide a separate scoop for it.

8-21 INDUCTION AIR INTAKE. An air filter and housing should be attached to air throttle body inlet glange. The filter area must be sufficient to avoid restriction of air flow. Filter should be cleaned before each test. Calculations of filter area should be based on 300 c.f.m., of air required by the engine at full throttle and on the filter capacity per unit of area. The calculated area of a clean filter should be increased by at least 50% to allow for dirt accumulation.

8-22. EXHAUST MANIFOLDS. For the purpose of testing, the engine exhaust system should be installed.

8-23. CONTROLS. The only controls required are a mixture control and throttle control capable of operating the fuel control and metering shafts through their complete ranges, and a standard twin magneto switch connected to the magneto grounding terminals.

8-24. ELECTRICAL WIRING. A storage battery of the proper voltage, depending on starter voltage, must be connected by a No. 0 stranded copper cable from its positive terminal to the power terminal of the starter or starter solenoid. The battery negative terminal must be connected to the engine or both battery terminal and engine may be grounded. A small insulated wire should connect the starter solenoid coil terminal to a 5 amp. push-button switch. The other switch terminal must be connected to the engine or both to a common ground.

8-25. INSTRUMENTS. (Calibrated Gauges are Recommended). The control panel should be equipped with the following engine instruments:

a. A mechanically driven (counterclockwise, 1/2 engine rpm) tachometer and flexible shaft assembly.

b. A fuel flow gauge connected between the fuel metering unit and the fuel injector manifold valve.

c. A fuel pump pressure gauge at the fuel pump.

d. A metered fuel pressure gauge at the fuel injector manifold valve (see installation drawing).

e. A manifold pressure gauge at top provided on intake manifold (or throttle body). (see installation drawing.)

f. A water manometer gauge to record crankcase pressure connected at rear of crankcase in vacuum pump return hole (see installation drawing).

g. An oil temperature gauge at base of oil cooler (see installation drawing).

h. A temperature and a pressure gauge located between the air filter and throttle body to record inlet air pressure and temperature.

i. An oil pressure gauge at the port provided in the crankcase (see installation drawing).

j. Bayonet thermocouples at location provided in cylinder (see installation drawing).

k. Ammeter connected in the generator circuit.

8-26. BREATHER. A substantial hose of 3/4 inch I.D. should be securely clamped over crankcase breather elbow and supported so as to lead to a point above and to the rear of engine.

8-27. FUEL SYSTEM. The test stand fuel system is to incorporate an auxiliary pump capable of delivering fuel to and through engine system at a pressure of 2 to 2-1/2 p.s.i. indication on fuel pressure gauge. Means of determining, by weight, fuel consumption for given periods of time and at specific percentages of power should also be included. Connect test stand fuel supply line to upper elbow projection from left side of fuel pump. Connect the fuel pump-to-supply tank vapor return line to upper elbow projecting from right side of fuel pump. Connect fuel pressure gauge line to the fitting projecting from the center rear of fuel control unit.

8-28. ENGINE TEST AFTER OVERHAUL.

a. After a partial or complete disassembly and repair of an engine, the engine will be tested in accordance with Tables XV and XVI (or XV and XVII for TSIO-360).

b. Extend the second period of each test schedule, if necessary, to raise the oil temperature to 100° F.

NOTE . . . If tests must be conducted in extremely cold weather, it may be necessary to shield the crankcase from the cooling air stream, since it takes some heat from the oil.

c. Take instrument readings at the beginning, in the middle, and at the end of the full throttle period. Take one reading during each of the other periods as soon as conditions have stabilized.

d. Make one check on performance of each magneto alone. (Refer to Table XV and XVI or XV and XVII.) Clear spark plugs by operating with both magnetos on for a few seconds between checks.

NOTE . . . The maximum allowable cylinder head temperature and the maximum allowable oil temperature (Table XV) must not be exceeded at any time during the test.

8-29. STARTING PROCEDURE.

a. Open throttle to approximately 1000 to 1200 RPM position.

b. Turn magneto switch to "BOTH" position.

c. Press boost pump button and hold in until 2.5-3.0 psi nozzle pressure is obtained; then release boost pump button and press starter button.

NOTE . . . During operation of the starter, the boost pump may be used intermittently to maintain 2.5 to 3.0 psi nozzle pressure. DO NOT use boost pump after engine is running smoothly.

8-30. PRESERVATION. If the engine is not to be installed in an aircraft and placed in service immediately, the last 15 minutes of operation should be used to circulate a corrosion-preventive oil mixture (suitable for flight operation). This will be an additional period, since the engine must be stopped to change oil. Install dehydrater plugs in the spark plug holes which are in the top position when the engine is mounted in the shipping base. Seal all other openings leading to the interior of the engine with shipping covers, suitable plugs or non-hydroscopic tape.

TABLE XV - TEST OPERATING LIMITS

Feature	IO-360 Value	TSIO-360 A&B Value	TSIO-360 C&D Value
Rated maximum B.H.P.	*210 at 2800 RPM	210 at 2800 RPM	225 at 2800 RPM
Full throttle speed	2775-2825 RPM	2775-2825 RPM	2775-2825 RPM
Idling speed	575-625 RPM	575-625 RPM	575-625 RPM
Fuel grade	100/130 Octane	100/130 Octane	100/130 Octane
Fuel consumption at full throttle	100/106 lbs./hr.	116/124 lbs./hr.	135/145 lbs./hr.
Fuel pump pressure at full throttle	25.5-27.0 PSI	29.7-31.6 PSI	34-37 PSI
Fuel pump pressure at idle	7.0-9.0 PSI	6.5-7.5 PSI	6.5-7.5 PSI
Metered fuel pressure at full throttle	16.5-17.5 PSI	15.8-16.7 PSI	16.75-17.25 PSI
Metered fuel pressure at idle	3.5-4.0 PSI	3.2-3.7 PSI	3.5-4.0 PSI
Engine intake air temperature	ambient air temp.	70° to 100°F. (T/C inlet)	70° to 100°F.
Engine intake air pressure (max.)	1.0" H_2O max.	1.0" H_2O max.	1.0" H_2O
Manifold pressure at full throttle	25.5" to 27.0" Hg.	31.7" to 32.2" Hg.	36.8 to 37.2" Hg. (C only) 35.8 to 36.2" Hg. (D only)
Manifold pressure at idle	12.5" to 14.5" Hg.	16.5 to 17.5" Hg.	17.0 to 21.0" Hg. (C only) 16.5 to 17.5" Hg. (D only)
Oil grade	SAE #50 Above 40°F. SAE #30 Below 40°F.	SAE #50 Above 40°F. SAE #30 Below 40°F.	SAE #50 Above 40°F. SAE #30 Below 40°F
Oil consumption at full throttle	2.72 lbs./hr. max.	3.15 lbs./hr. max.	3.15 lbs./hr. max.
Oil temperature (desired range)	150° - 200°F.	150° - 200°F.	150° - 200°F.
Oil temperature (max.)	240°F.	240°F.	240°F.
Oil pressure at full throttle (oil temperature 175° - 185°F.)	30-60 PSI	30-60 PSI	30-60 PSI
Oil pressure at idle (min.) (oil temperature 140° - 150°F.)	10 PSI	10 PSI	10 PSI
Ignition timing	Left 19° - 21° BTC Right 19° - 21° BTC	Left 19° - 21° BTC Right 19° - 21°BTC	Left 19° - 21° BTC Right 19°- 21°BTC
Magneto spread	50 RPM max. (at full throttle)	50 RPM (at 1800 RPM)	50 RPM (at 1800 RPM)
Cylinder head temperature (with bayonet thermocouple)	460°F. max.	460°F. max.	460°F. max.
**Crankcase pressure	1.0" H_2O max.	1.0" H_2O max.	1.0" H_2O max.

*IO-360-A has max. BHP of 195 with take-off BHP of 210.

**A sudden increase in crankcase pressure, during which the liquid in the manometer fluctuates rapidly, is usually an indication of rings beginning to stick. However, before removing cylinders, investigate the breather and manometer.

NOTE

Turbocharger inlet air may be regulated to provide engine operation within test limits.

TABLE XVI

STANDARD ACCEPTANCE TEST IO-360

Period	Time-Minutes	RPM	
1	15	Warm-up to 2400	
2	10	2600	
3	5	600 ± 25	Cooling Period

Stop engine, drain oil, weight oil in for oil consumption determination.

START OIL CONSUMPTION DETERMINATION

Period	Time-Minutes	RPM	
4	5	Warm-up to 2400	
5	5	2500	(See Item A)
6	5	2600	
7	10	2700	
8	10	2775-2525 Full Throttle	100% Power Check Magnetos (See Item B)
9	5	600 ± 25	Idle Cooling Period

Stop engine, drain oil, clean screen (or replace filter), weight oil and record engine oil consumption. (See Item C.)

Item A. Readings must be recorded after completion of each 10 minute interval during oil consumption run.

Item B. Magneto spread to be taken after completion of oil consumption run.

Item C. Oil consumption at a rate of 1.36 lbs./per 1/2 hr. maximum is acceptable. If value in excess of 1.36 lbs./per 1/2 hr. is determined, re-run 1 hour. If consumption is still excessive, return engine to assembly for complete recheck of construction.

TABLE XVII

STANDARD ACCEPTANCE TEST FOR TSIO-360-A, B

Period	Time	RPM		T/C Dis. PR "Hg. (Ref.)
1	5	1200		
2	5	1600		
3	5	2400		
4	10	2600		
5	10	2800 ± 25	100% Power	33.8 - 34.3
6	5	2360	60% Power	29.0 - 29.6
7	5	600 ± 25	Idle-Cooling Period	

Stop engine, drain oil, weight in oil for oil consumption determination and replace in engine.

START OIL CONSUMPTION DETERMINATION

Period	Time	RPM		T/C Dis. Pr. "Hg. (Ref.)
8	5	Warm-up to 2400		
9	5	2500		
10	5	2600		
11	10	2700		
12	10	2800 ± 25	100% Power - See item A	
13	5	1800	Check magnetos See item B	
14	5	Stop engine, drain oil, weight oil and record oil consumption. See item C.		

TABLE XVIII

STANDARD ACCEPTANCE TEST FOR TSIO-360-C

Period	Time	RPM	ADMP " Hg.	T/C Dis. Pr. "Hg. ± .5
1	5	1200		29.5
2	5	1600		29.6
3	5	2400		30.5
4	10	2600		33.9
5	10	2800 ± 25	100% Power 36.8-37.2	38.5
6	5	2545	75% Power 30.2-30.6	32.0
7	5	2360	60% Power 27.8-28.2	29.8
		Full Rich Fuel Flow #/hr.	Metered Fuel Pr. (vented psi)	
8	5	135	16.75-17.25	38.5
9	5	110	12.35-12.85	35.2
10	5	80	8.65- 9.15	31.3
11	5	50	5.95- 6.45	29.7
12	5	600 ± 25	Idle - Cooling Period	
		Stop engine, drain oil, weigh in oil for oil consumption determination and replace in engine.		
13	5	Warm-up to 2400		30.5
14	5	2500		32.0
15	5	2600		33.9
16	10	2700		36.0
17	10	2800 ± 25	100% Power, See item A	38.5
18	5	1800	Check Magnetos, See item B	29.7
19	5	600 ± 25	Idle, Cooling Period	
		Stop engine, drain oil, weigh oil and record oil consumption. See item C.		

TABLE XIX

STANDARD ACCEPTANCE TEST FOR TSIO-360-D

Period	Time	RPM	ADMP "Hg.	T/C Dis. Pr. "Hg. ± .3
1	5	1200		29.7
2	5	1600		29.7
3	5	2400		30.3
4	10	2600		33.1
5	10	2800 ± 25	100% Power 35.8-36.2	38.0
6	5	2545	75% Power 30.5-30.9	32.2
7	5	2360	60% Power 27.6-28.0	29.7
		Full Rich Fuel Flow #/hr.	Metered Fuel Pr. (vented psi)	
8	5	140	17.60-18.10	38.0
9	5	110	12.35-12.85	34.0
10	5	80	8.65- 9.15	29.6
11	5	50	5.95- 6.45	29.6
12	5	600 ± 25	Idle - Cooling Period	
		Stop engine, drain oil, weight in oil for oil consumpiton determination and replace in engine.		
13	5	Warm-up to 2400		30.0
14	5	2500		31.3
15	5	2600		33.1
16	10	2700		35.2
17	10	2800 ± 25	100% Power, See item A	38.0
18	5	1800	Check Magnetos, See item B	29.7
19	5	600 ± 25	Idle, Cooling Period	
		Stop engine, drain oil, weight oil and record oil consumption. See item C.		