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FOR  
TS10-520 SERIES  
AIRCRAFT ENGINES**

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# SECTION I

## INTRODUCTION

### 1-1. SCOPE.

This publication comprises overhaul instructions for Model TSIO-520 aircraft engines manufactured by Teledyne Continental Motors, Aircraft Products Division, Mobile, Alabama 36601.

### 1-2. RELATED PUBLICATIONS.

Detail part numbers and service assemblies for these engine models are contained in Parts Catalog X-30043A. Operating instructions are contained in Operator's Manual X30044. TSIO520-L, LB & WB operating instructions are contained in Operators Manual X30505.

a. Service instructions for Slick Magneto Model No. 662 may be obtained from Slick Electro, Inc., Rockford, Illinois 61101.

b. Service instructions for Bendix Magnets may be obtained from the Bendix Corporation, Electrical Components Division, Sidney, New York.

c. Service instructions for Delco-Remy Starter and Alternator may be obtained from Delco-Remy Division, General Motors Corporation, Anderson, Indiana.

### 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.

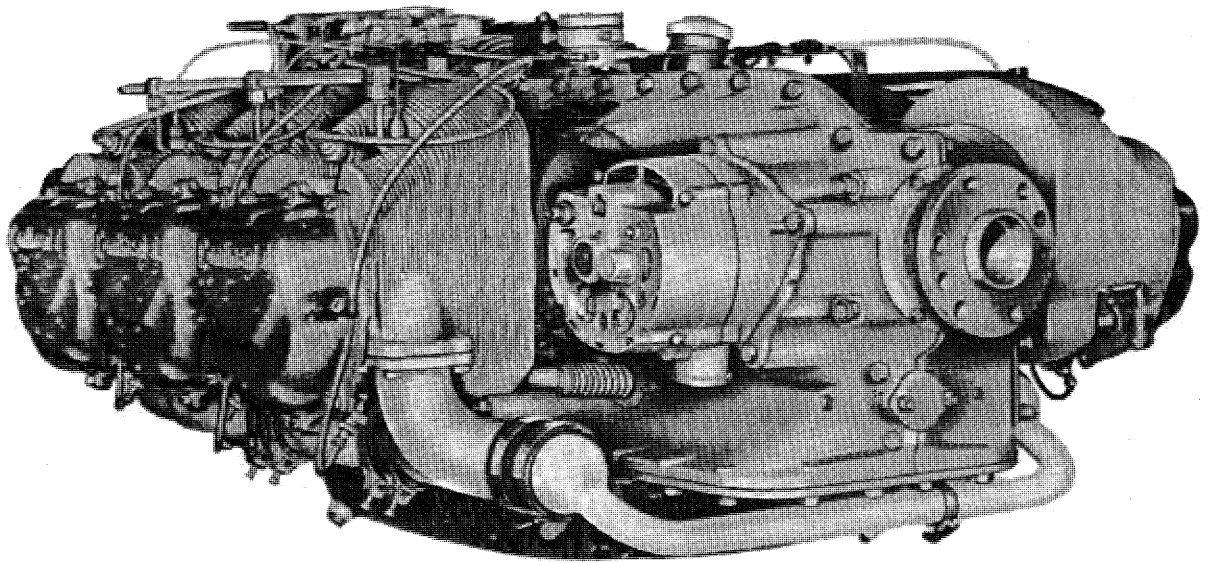
It is the policy of Teledyne Continental Motors to handle all reports of service difficulty and requests for information through Approved Distributors. Requests for further copies of this or any other Teledyne Continental Aircraft Engine Service Publication should be made through these facilities. There is an Approved Distributor at most major airports.

### 1-5. DEFINITION OF TERMS.

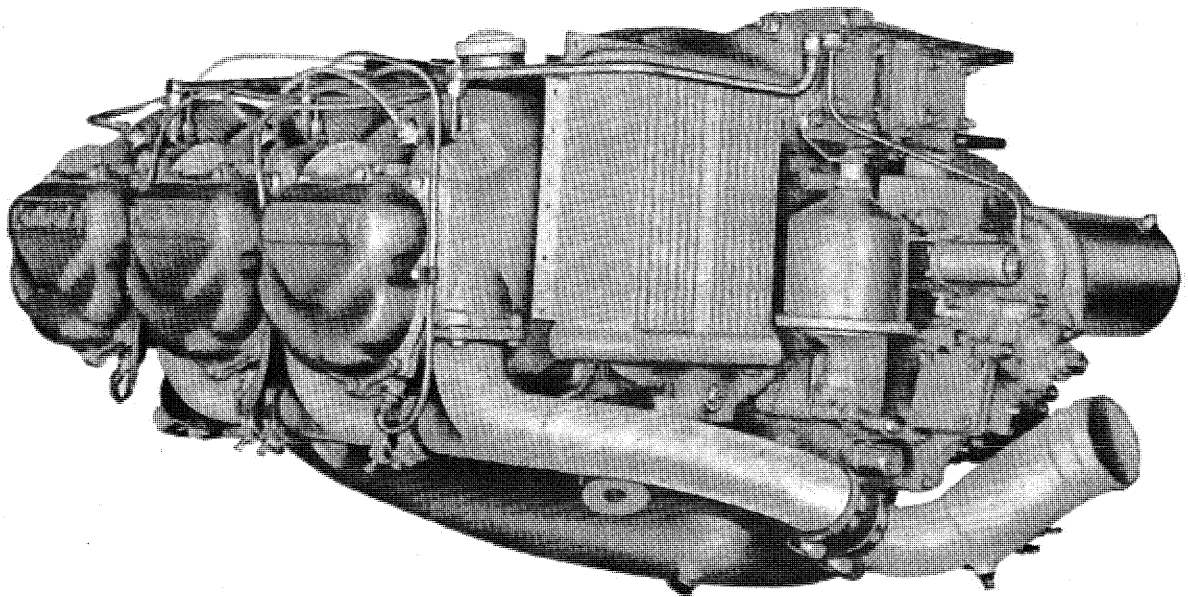
Front, rear, left and right, as used in this manual, refer to the engine as viewed by the mechanic in a normal position, facing the accessory end.

### 1-6. CYLINDER ARRANGEMENT.

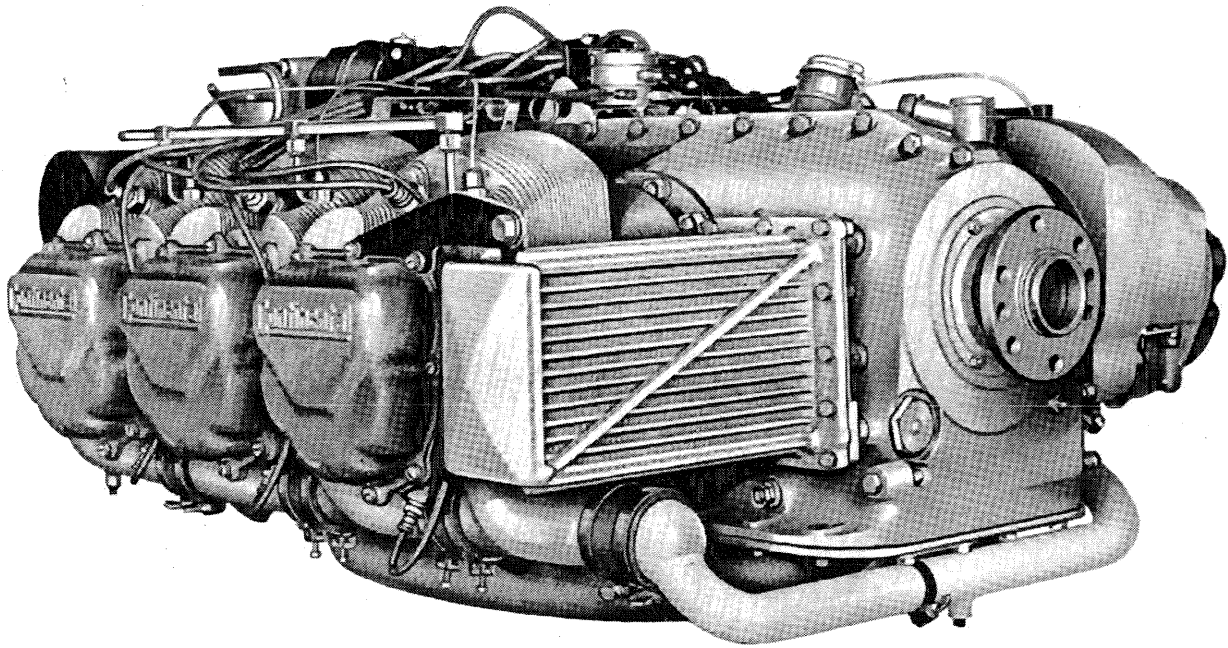
Cylinders are numbered starting from the rear, with odd numbers on the right and even numbers on the left.



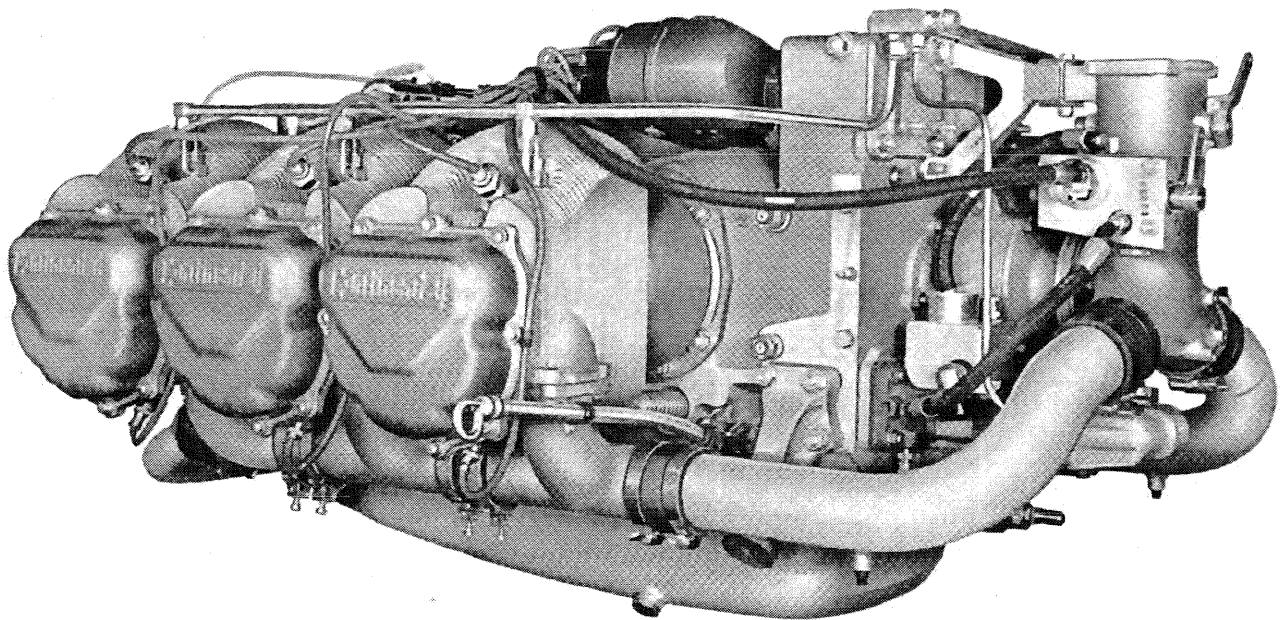
*FIGURE 1-1. THREE-QUARTER RIGHT FRONT VIEW OF THE TS10-520-B & K.*



*FIGURE 1-2. THREE-QUARTER LEFT REAR VIEW OF THE TS10-520-B.*



*FIGURE 1-3. THREE-QUARTER RIGHT FRONT VIEW OF THE TSIO-520-C*



*FIGURE 1-4. THREE-QUARTER LEFT REAR VIEW OF THE TSIO-520-C.*

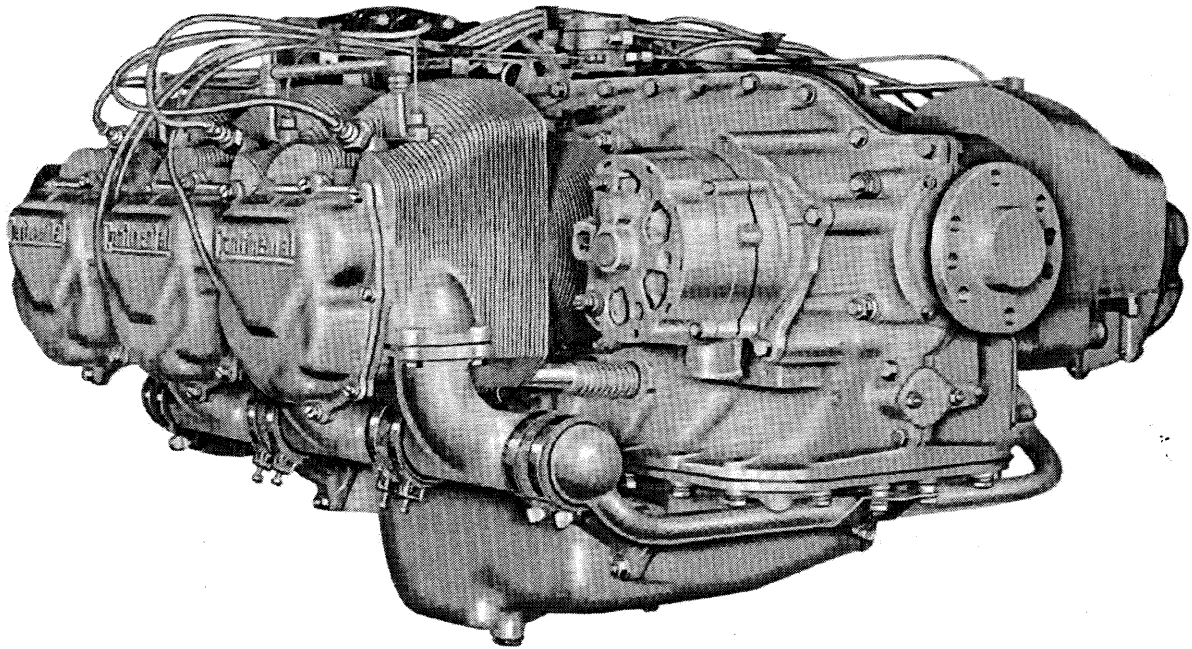


FIGURE 1-5. THREE-QUARTER RIGHT FRONT VIEW OF THE TS10-520-D.

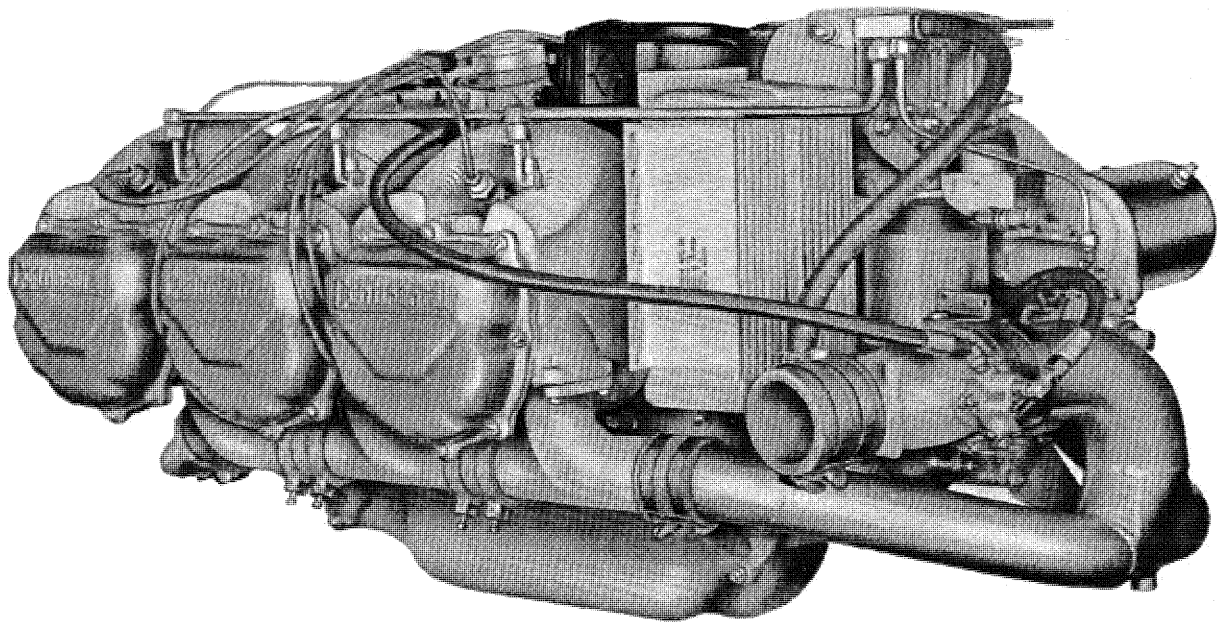
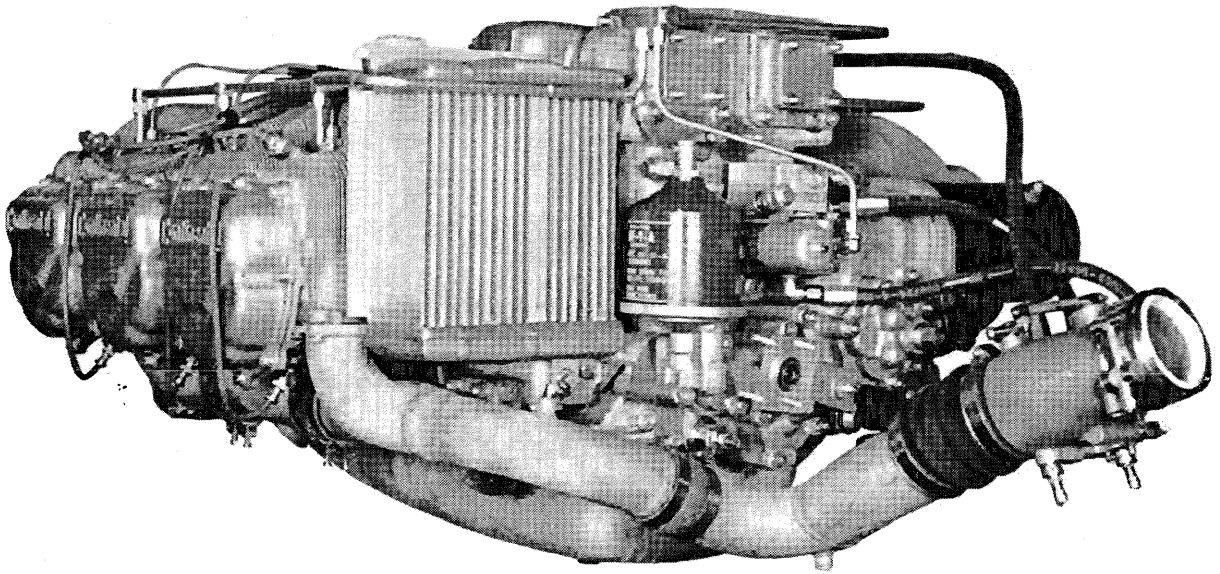
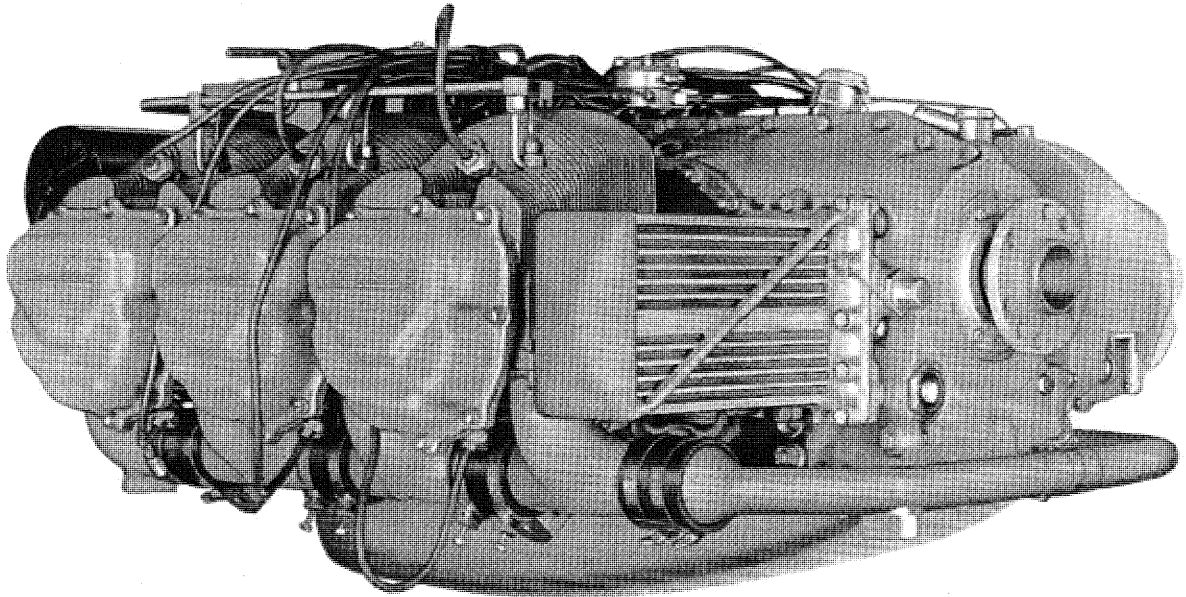


FIGURE 1-6. THREE-QUARTER LEFT REAR VIEW OF THE TS10-520-D.



*FIGURE 1-7. THREE-QUARTER LEFT REAR VIEW OF THE TS10-520-E.*



*FIGURE 1-8. THREE-QUARTER RIGHT FRONT VIEW OF THE TS10-520-G.*

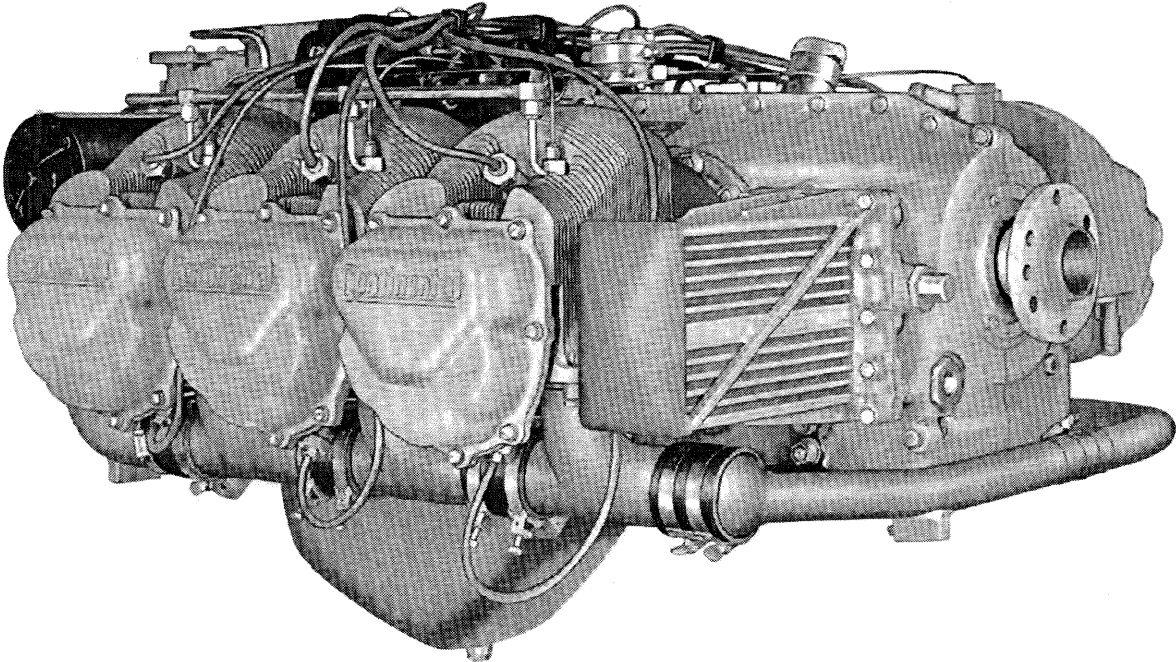


FIGURE 1-9. THREE-QUARTER RIGHT FRONT VIEW OF THE TS10-520-H.

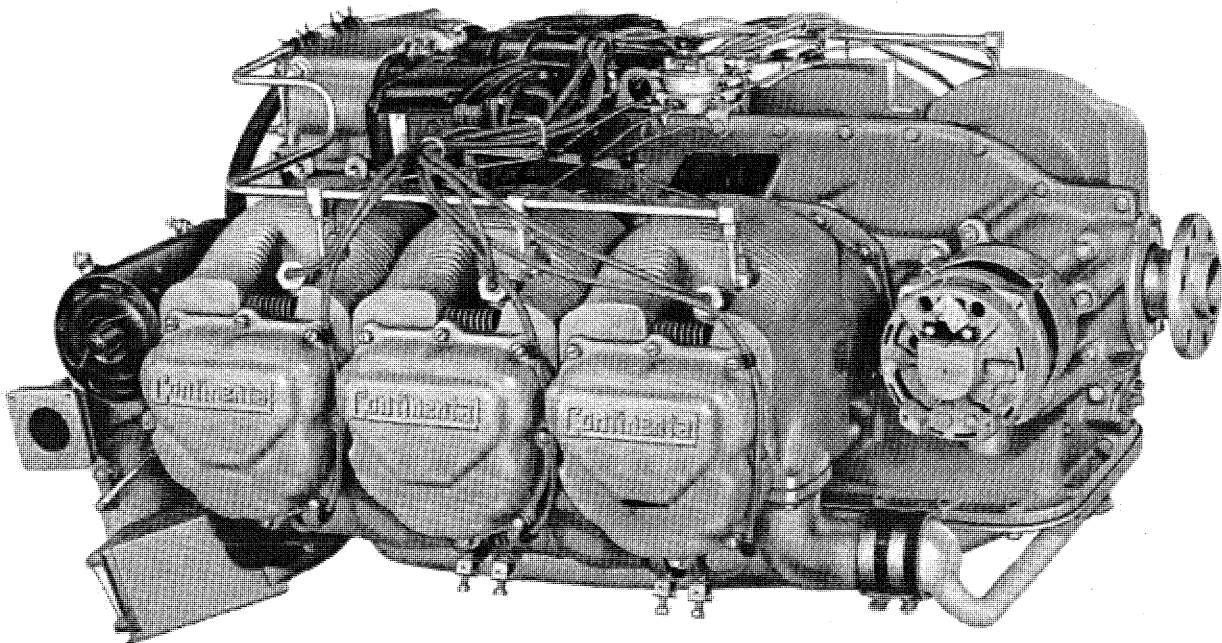


FIGURE 1-10. THREE-QUARTER RIGHT FRONT VIEW OF THE TS10-520-J.

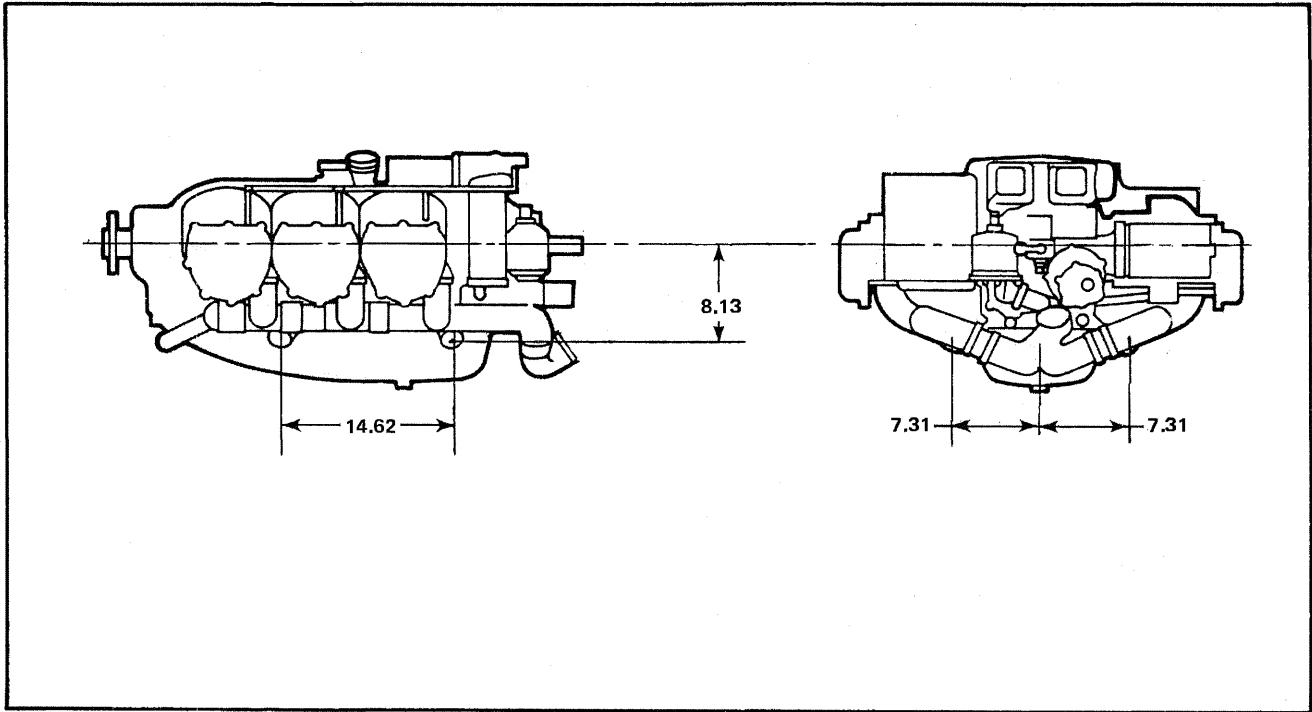


FIGURE 1-11. INSTALLATION DRAWING FOR TSIO-520-B, E, J & K.

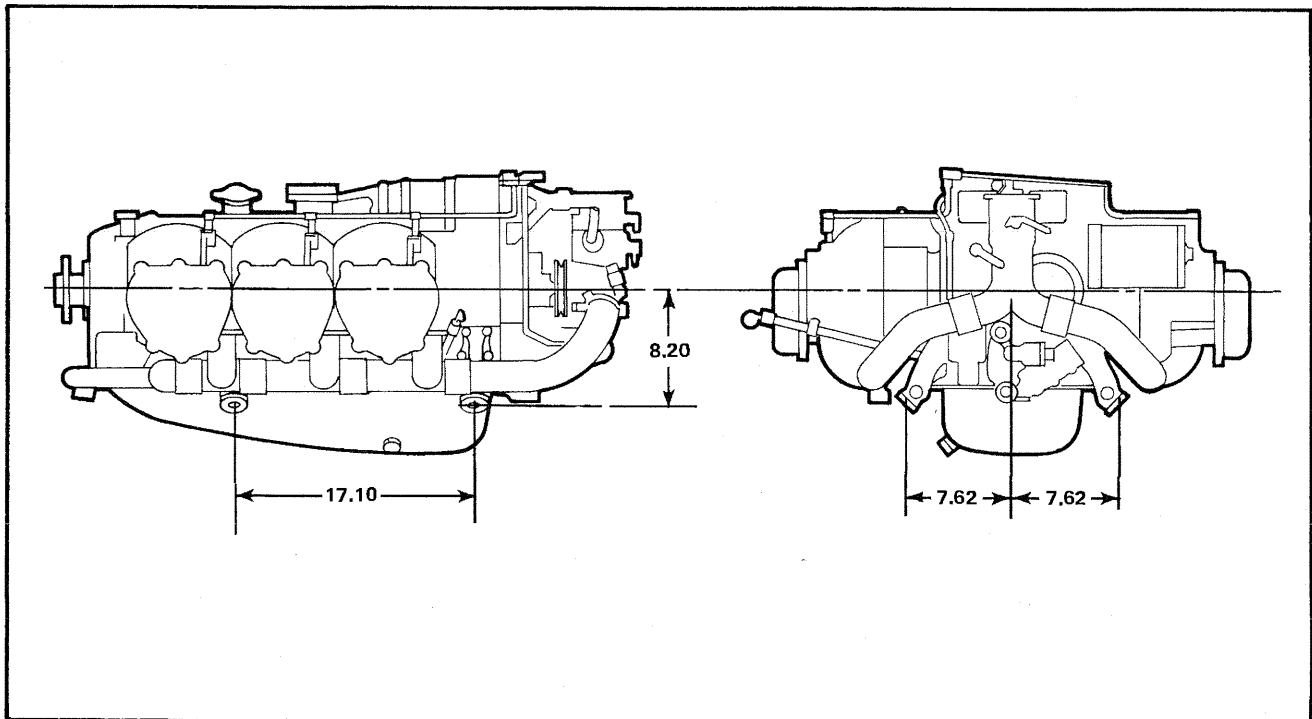


FIGURE 1-12. INSTALLATION DRAWING FOR TSIO-520-C, G & H.

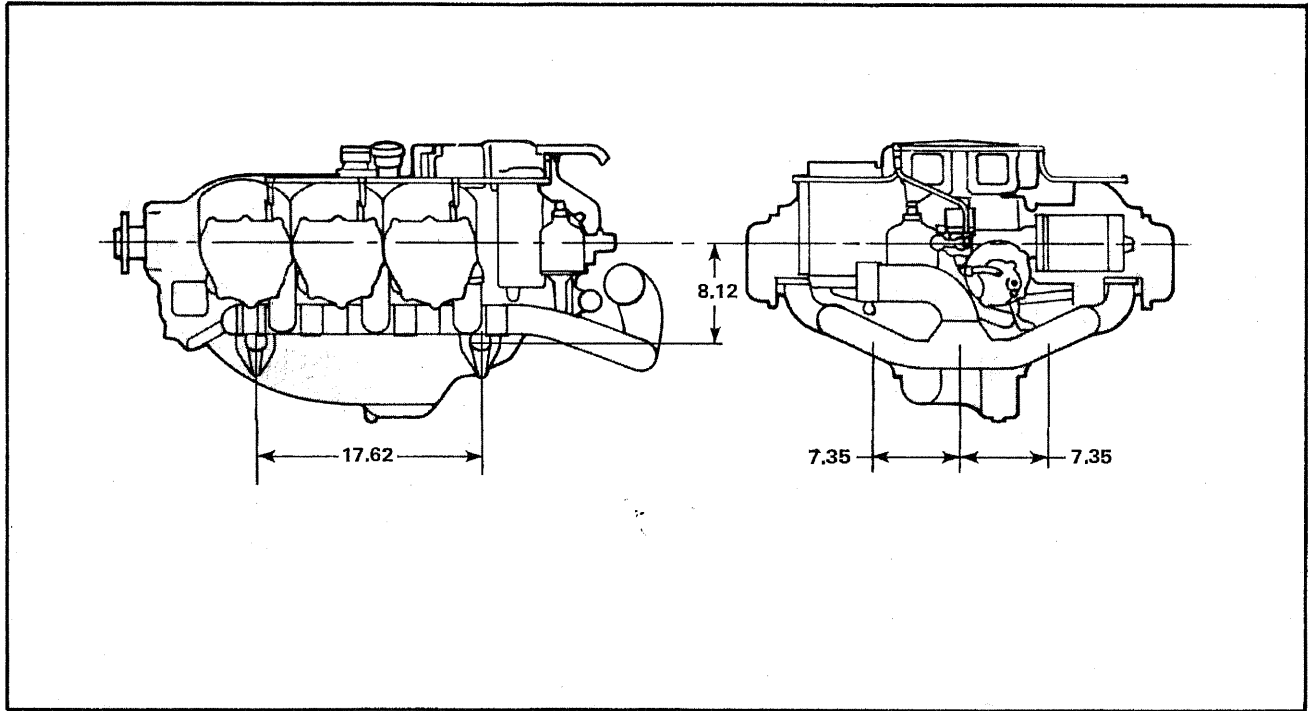


FIGURE 1-13. INSTALLATION DRAWING FOR TSIO-520-D.



## SECTION II

### GENERAL DESCRIPTION

#### 2-1. SIGNIFICANT DIFFERENCES.

Specific detail part differences between the TSIO-520 Models will be noted in the Parts Catalog. Visual differences mainly concern the location of accessories. The oil cooler is located on the right front of the C, G and H and on the left rear of the B, D, E, J & K. The B, D, E, J & K have a gear driven alternator mounted at the right front while the C, G & H have a belt driven generator or alternator mounted on the left rear. The D also has a cast aluminum sump while the others all have stamped sumps.

#### 2-2. GENERAL.

The arrangement and appearance of engine components are indicated in Figures 1-1 through 1-10. It will be observed that minimum length has been achieved by mounting the starter at a right angle and by mounting the magnetos in the forward side of the accessory gear compartment formed by the crankcase castings at the rear. This magneto arrangement also serves to shorten the high tension cables as much as possible.

#### 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 "left crankcase" and "right 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, special alloy lined crankshaft main bearing inserts. Guides are bored through lateral bosses for valve lifters and the governor drive shaft. A needle bearing is pressed into the right crankcase, to the right of the rear main bearing, to support the front of the starter shaftgear.

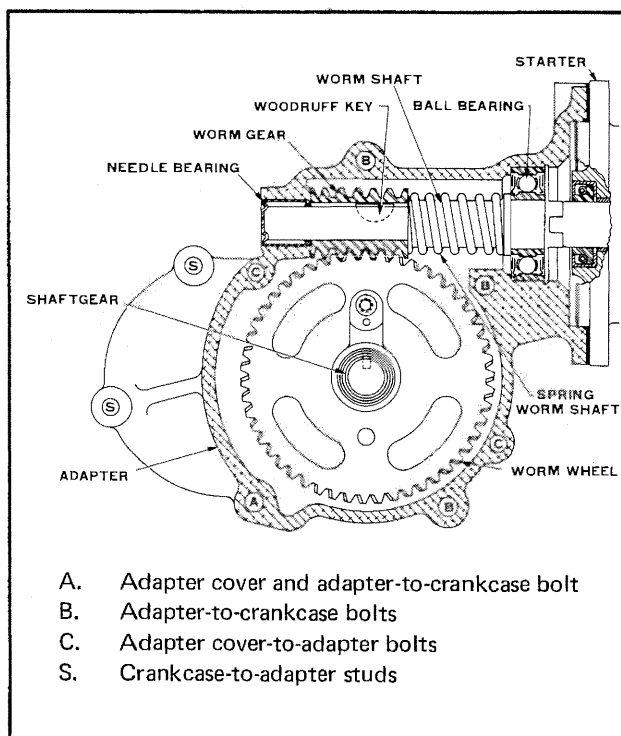


FIGURE 2-1. CROSS-SECTION OF STARTER DRIVE.

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 mount pad is located on the left crankcase at the lower front corner. The permold crankcase has an alternator pad on the right crankcase at the front.

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

#### 2-4. CRANKSHAFT.

The six-throw, steel-alloy forging is machined all over except for portions of the crankcheeks. The main bearing journals and crankpins are ground to close tolerances and nitrided for longer wear. A flange is formed at the front for attaching a propeller. An oil transfer collar, encompassing the crankshaft between the front and rear halves of the main thrust bearing, transfers the governor controlled oil from the crankcase passage to the crankshaft interior. Side blades projecting from crankcheeks 1 and 2 plus 3 and 4 are machined for the installation of one 4th, one 5th and two 6th order counterweights. Oscillation of the counterweights on their pins dampen crankshaft torsional vibration.

a. The crankshaft gear is heated prior to installation to obtain a shrink fit. The gear is driven by a dowel of uniform diameter. A cluster gear, typical of permold engines, provides for direct drive of the fuel pump.

b. The accessory drive gear, typical of permold engines, is heated and shrunk onto a flange just behind the oil transfer collar and retained by four bolts.

c. A rubber oil seal, which is stretched over the crankshaft flange and a split retainer ring are seated between crankcase castings in front shaft exit, and are sealed to the crankshaft by a helical spring inside the seal's cavity.

#### 2-5. CAMSHAFT.

A steel-alloy forging is machined on four journals, nine cam lobes and the gear mount flange at the rear end. The governor drive gear is mounted on the front of the cam with a Woodruff key. The lobes and journals are hardened and ground. A groove around the front journal passes oil from the right crankcase cross passage to the left crankcase passage. The camshaft gear is attached by four unequally spaced bolts to locate its timing mark in relation to the cam lobes. On the sandcast engine, a cluster gear is bolted with the camshaft gear, and drives the fuel pump gear.

#### 2-6. HYDRAULIC LIFTER.

The barrel-type hydraulic lifter may be removed and replaced without complete disassembly of the engine as described in Section IV. The construction and operation of the tappets are described in paragraph 2-15 and Figure 2-6.

#### 2-7. CONNECTING RODS.

The "I" beam-type connecting rods have split bronze piston pin bushings and two identical precision inserts (of the same type as the main bearings) at the crankpin end. Weight variation of two rods in any one bay is limited to 1/2 ounce.

#### 2-8. PISTONS.

Pistons are aluminum alloy forgings. The skirts are solid and have cylindrical relief cuts at the bottom to clear the crankshaft counterweights. Pistons have three ring grooves above the pin hole and one ring groove below. An oil control ring is installed in the third groove. Also the oil drain holes are provided in the third groove. The groove below the pin hole accommodates a scraper ring. Piston pins are full floating, ground steel tubes with permanently forged-in aluminum end plugs. Weight variation of two pistons in any one bay is limited to 1/2 ounce.

#### 2-9. CYLINDERS.

The externally-finned aluminum alloy head castings are heated, and valve seat inserts installed, before the head is screwed and shrunk onto an externally-finned steel alloy barrel to make the permanent head and barrel assembly. Bronze valve guides are pressed into the cold cylinder assembly and reamed to slightly different diameters. Special 18 mm helical coil inserts are installed in the upper and lower spark plug holes. Smaller inserts are installed in the exhaust manifold stud holes. Both intake and exhaust ports are on the bottom when the cylinder is installed. Exhaust valves are Stellite faced and stem tips are hardened. Upper retainers of the two concentric springs surrounding each valve are locked to the stems by tapered semi-circular keys, which engage grooves around the stems. Roto caps are installed on the exhaust valves only. The rotating action of this type of retainer helps to prevent burning and eroding of the valve and valve seat. Lower spring retainers are pressed steel. Valve rocker covers are aluminum alloy castings. Rocker shafts are ground steel tubes with a hole drilled in one end at a 90° angle to the longitudinal axis. This drilled hole is for retaining the rocker shaft and preventing axial movement. The two inside rocker shaft bosses are drilled and tapped for the rocker shaft retaining screws. Valve rockers are steel forgings with hardened sockets, rocker faces and pressed-in bronze bearings. They are drilled for lubrication. Pushrods are constructed of steel tubes and pressed-in, hardened, forged steel ball

ends, which are center drilled for oil passages. The bead at the cylinder end of the pushrod housing retains a washer and packing ring. The bead at the crankcase end retains a heavy spring, washer, packing ring and second washer.

## 2-10. FUNCTIONAL SYSTEMS.

### 2-11 GEAR TRAIN, PERMOLD ENGINE (See Figure 2-3).

When starting engine, torque is transmitted from the starter (15) through adapter components (16 thru 23) to crankshaft gear (1). As wormwheel (21) is turned, spring mounted on its hub is tightened to grip knurled drum of shaftgear (22). After engine is started, spring returns to its normal position, thus disengaging starter. Torque is transmitted to the alternator (23) by a face gear (25) mounted on the crankshaft (2).

a. Torque from the crankshaft (2) is transmitted by the small cluster gear (1) directly to the idler gear (12) and the camshaft gear (3).

b. The idler gear rotating in a counterclockwise direction, drives the magneto drive gears (13 and 14). Optional accessories mounted on the crankcase upper rear are driven by internal splines of magneto drive gears.

c. The fuel pump coupling is driven directly from the crankshaft gear. The splined end of the oil pump and tachometer drive gear (8) mates with the internal splines of the camshaft gear (3) and transmits torque to the oil pump driven gear (9) and the tachometer drive gear (10). The scavenge pump forces oil back to the sump after the turbocharger is lubricated. The governor drive bevel gear (6) is keyed to the camshaft (4) and meshes with and drives the governor bevel gear (7).

### 2-12. GEAR TRAIN, SANDCAST ENGINE (See Figure 2-2).

When starting engine, torque is transmitted from the starter (18) through adapter components (19 thru 24) to crankshaft gear (1). As wormwheel (22) is turned, clutch spring (23) mounted on its hub, is tightened to grip knurled drum of shaftgear (24). This design eliminates wear and stress encountered in direct drive starter systems. After engine is started, spring returns to its normal position, thus disengaging starter. The shaftgear (24) is now used to transmit torque from the crankshaft gear to the generator drive pulley.

a. Torque from the crankshaft (2) is transmitted by the crankshaft gear (1) directly to the idler gear (14) and camshaft gear (3).

b. The idler gear, rotating in a counterclockwise direction, drives magneto drive gears (16 and 17). Optional accessories mounted on crankcase upper rear are driven by internal splines of magneto drive gears.

c. The fuel pump drive gear (25) is driven by the camshaft cluster gear (3). The splined end of the oil pump and tachometer drive gear (8) mates with the internal splines of the camshaft gear and transmits torque to the oil pump driven gear (9) and tachometer drive gear (10). The scavenge pump forces oil back to the sump after the turbocharger is lubricated. The governor drive bevel gear (6) on the front of the camshaft (4) drives the governor driven bevel gear (7).

### 2-13. LUBRICATION SYSTEM, PERMOLD ENGINE (See Figure 2-4).

a. Oil is drawn from the sump through the suction tube to the intake side of the engine driven, gear-type oil pump. From the outlet side of the pump oil is directed to the full flow replaceable element oil filter. A by-pass valve is incorporated in the filter in the event that the element becomes clogged. Lubrication reaches the tachometer drive gears through passages drilled in the oil pump cover. An oil pressure relief valve is incorporated in the oil pump housing.

b. From the filter discharge port, oil is directed through a crankcase passage to the oil cooler. The oil cooler incorporates an oil temperature control valve. Oil passing through the control valve cavity is directed either through the cooler or directly to the crankcase passage to the rear of the camshaft, depending on the oil temperature. In this manner, engine oil temperature is maintained at 175° F.

c. Oil entering the engine is directed to the hollow camshaft, which serves as the main engine oil gallery. Grooves and drilled holes in the camshaft are located so as to afford proper lubrication through a system of orifices to the main bearings, lifters, idler gear bushing, accessory drive gear bushings and the starter drive gear bearing.

d. Oil leaving the camshaft interior at the front of the crankcase is directed to the left main crankcase gallery. From there it is directed to the main thrust bearing and the governor drive gear.

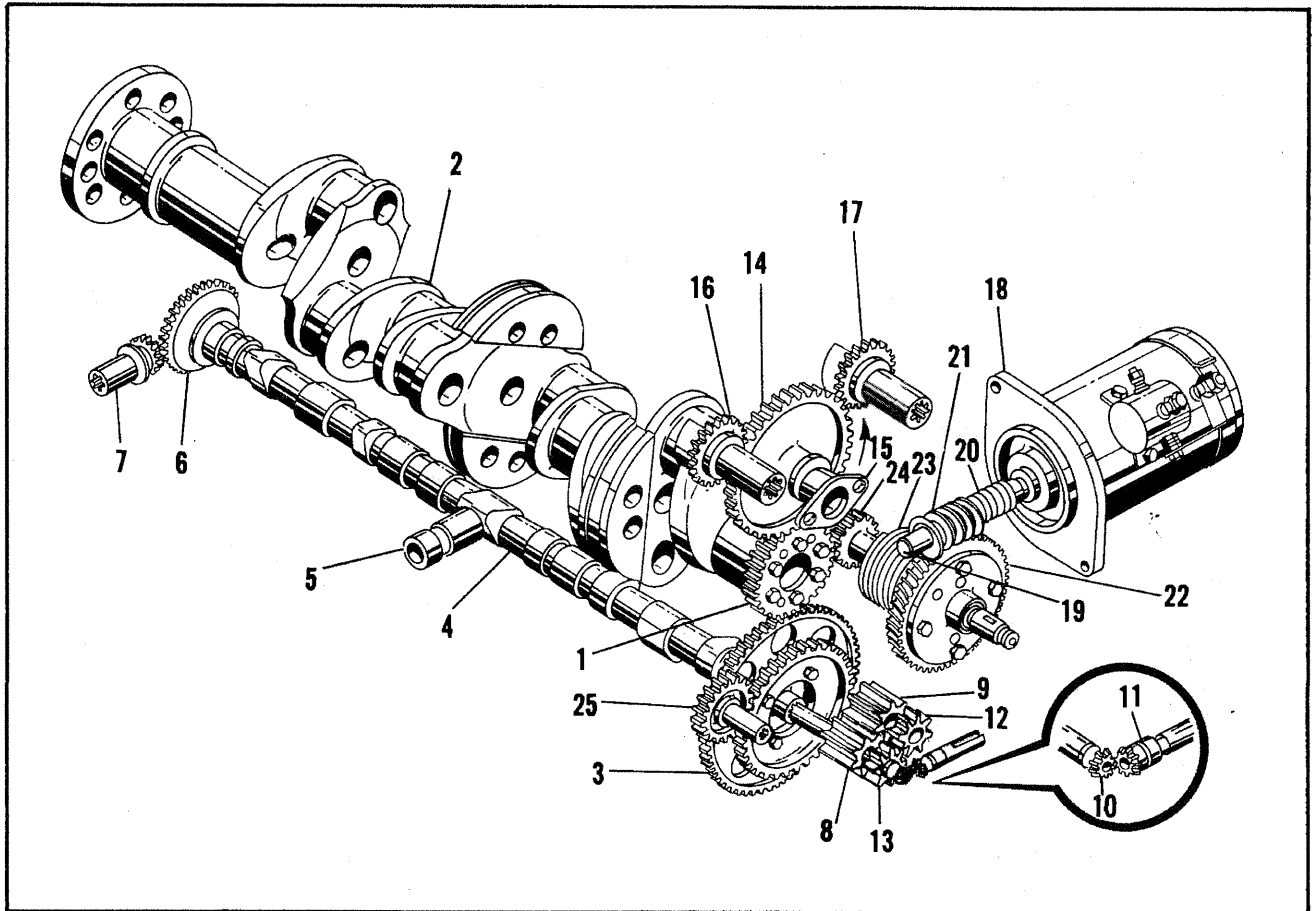


FIGURE 2-2. GEAR TRAIN DIAGRAM, SANDCAST ENGINE.

1.	Crankshaft gear . . . . .	1:1
2.	Crankshaft . . . . .	1
3.	Camshaft cluster gear . . . . .	1:0.5
4.	Camshaft . . . . .	1:0.5
5.	Hydraulic tappet . . . . .	—
6.	Governor drive bevel gear . . . . .	1:0.5
7.	Governor driven bevel gear . . . . .	1:1
8.	Oil pump and tachometer drive shaft gear . . . . .	1:0.5
9.	Oil pump driven gear . . . . .	1:0.5
10.	Tachometer drive bevel gear . . . . .	1:0.5
11.	Tachometer shaft gear . . . . .	1:0.5
12.	Scavenge pump driven gear . . . . .	1:0.5
13.	Scavenge pump driver gear . . . . .	1:0.5
14.	Idler gear assembly . . . . .	1:0.652
15.	Idler gear support pin . . . . .	—
16.	Left magneto drive gear . . . . .	1:1.5
17.	Right magneto drive gear . . . . .	1:1.5
18.	Starter, 12 volt . . . . .	32:1
19.	Worm drive shaft . . . . .	32:1
20.	Worm shaft spring . . . . .	—
21.	Starter worm gear . . . . .	32:1
22.	Starter worm wheel . . . . .	2:1
23.	Clutch spring . . . . .	2:1
24.	Starter shaft gear . . . . .	1:2
25.	Fuel pump drive gear . . . . .	1:1

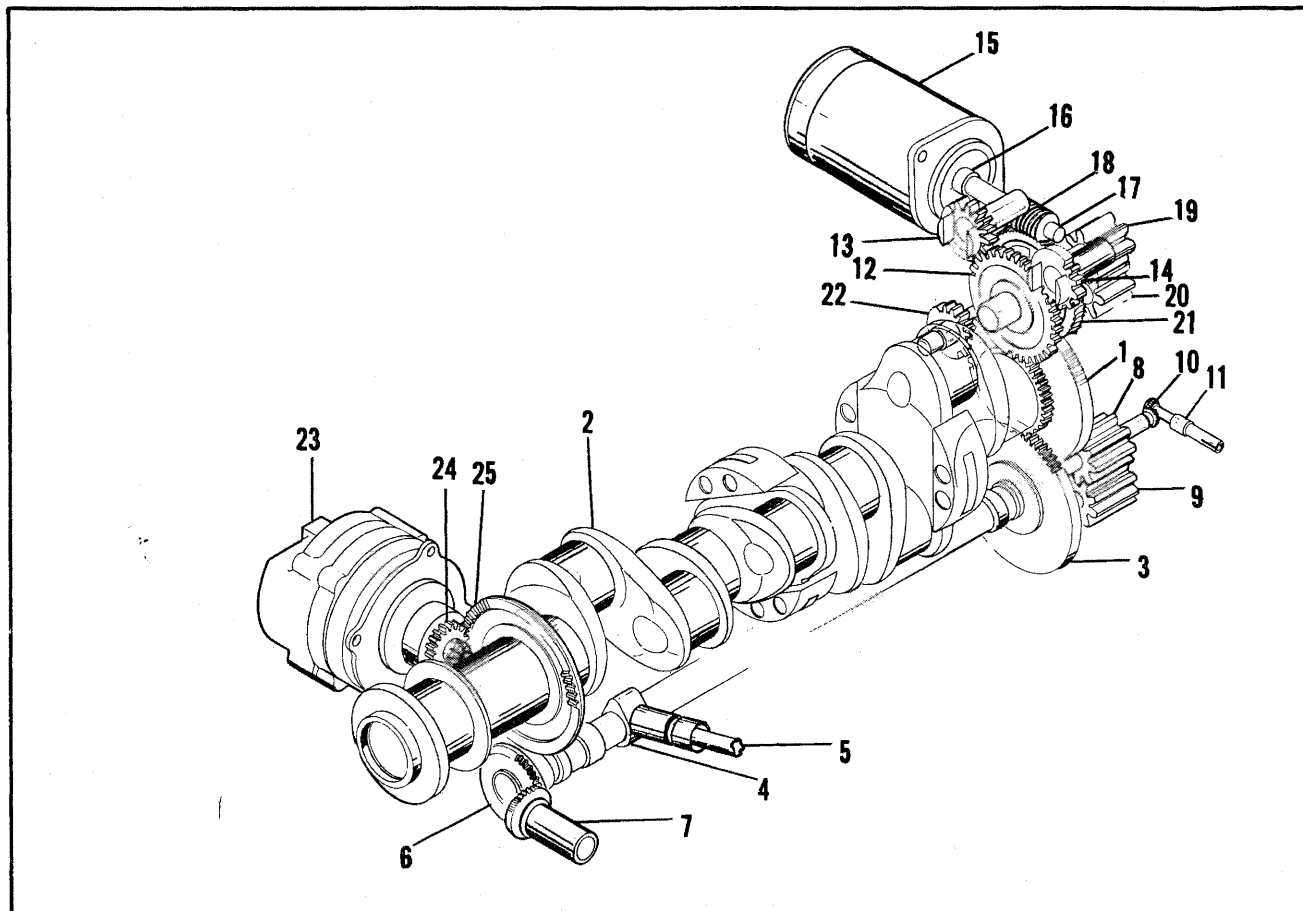


FIGURE 2-3. GEAR TRAIN DIAGRAM, PERMOLD ENGINE.

1.	Crankshaft gear .....	1:1
2.	Crankshaft .....	1
3.	Camshaft gear .....	1:0.5
4.	Camshaft .....	1:0.5
5.	Hydraulic lifter .....	—
6.	Governor drive bevel gear .....	1:0.5
7.	Governor driven bevel gear .....	1:1
8.	Oil pump and tachometer drive shaft gear .....	1:0.5
9.	Oil pump driven gear .....	1:0.5
10.	Tachometer drive bevel gear .....	1:0.5
11.	Tachometer drive bevel gear shaft .....	1:0.5
12.	Idler gear assembly .....	1:0.652
13.	Right magneto drive gear .....	1:1.5
14.	Left magneto drive gear .....	1:1.5
15.	Starter .....	48:1
16.	Starter coupling .....	—
17.	Worm drive shaft .....	48:1
18.	Starter worm gear .....	48:1
19.	Scavenge pump driven gear .....	1:0.5
20.	Scavenge pump driver gear .....	1:0.5
21.	Starter worm wheel .....	2:1
22.	Starter shaft gear .....	1:3
23.	Alternator .....	3:1
24.	Alternator driven gear .....	3:1
25.	Alternator drive gear .....	1:1

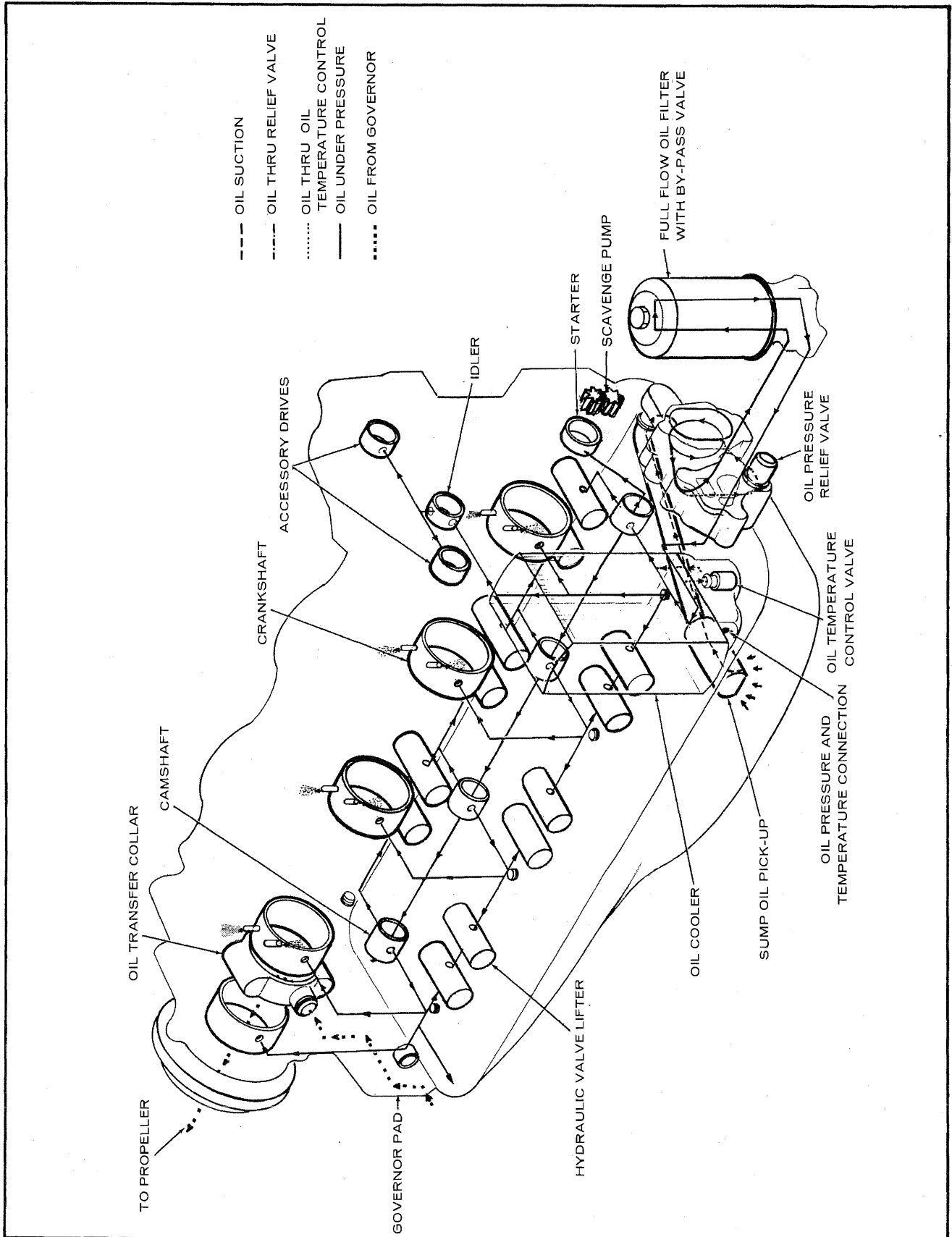


FIGURE 2-4. SCHEMATIC OF THE LUBRICATION SYSTEM, PERMOLD ENGINE.

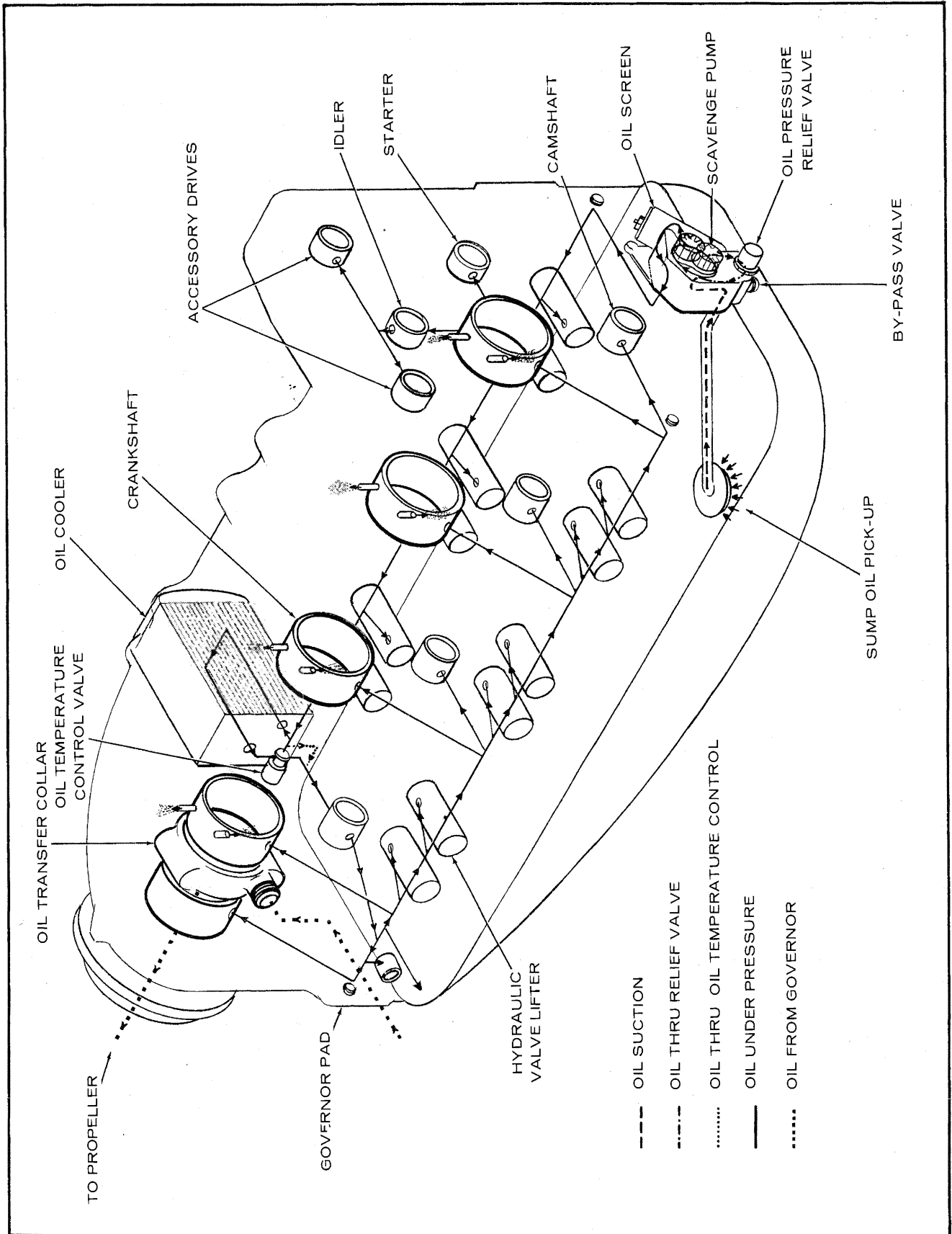


FIGURE 2-5. SCHEMATIC OF THE LUBRICATION SYSTEM, SANDCAST ENGINE.

e. By action of the governor drive gear, lubricating oil is increased in pressure and directed to the crankshaft oil transfer collar. The oil transfer collar directs it to the interior of the crankshaft and then to the propeller hub where it controls the pump blade angle.

f. Each cylinder wall and piston is lubricated by individual oil squirt nozzles. These nozzles direct a continuous stream of oil at the piston inner dome.

g. Oil is returned to the sump through a system of oil transfer tubes and drain holes.

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g. Oil is returned to the sump through a system of oil transfer tubes and drain holes.

#### 2-14. LUBRICATION SYSTEM, SANDCAST ENGINE (See Figure 2-5).

a. The engine driven gear-type oil pump draws oil from the sump through the oil suction tube and crankcase oil passage. From the gear chamber oil is directed to the oil filter chamber and tachometer drive gear. A filter by-pass valve is incorporated in the pump housing in the event that the filter becomes clogged.

b. After leaving the pump oil is directed through passages to the right crankcase oil gallery. Right side valve lifters and guides are lubricated by passages leading off this gallery. An oil temperature control valve is located at the front end of the right oil gallery to regulate oil temperature within specific limits. When oil reaches a temperature high enough to require cooling, the control valve expands and blocks passage, directing oil to the cooler. From the control valve cavity, oil is directed to the camshaft passage. A groove around the front of the camshaft directs oil to the front camshaft bearing and left crankcase oil gallery.

c. Lubricating oil is directed to the governor drive bearing and propeller governor through passages off the left oil gallery. Oil is channeled through a discharge port to the crankshaft oil transfer collar, which directs it to the crankshaft interior.

d. Passageways from the left oil gallery direct oil to the main bearings and left side valve lifters.

e. Four drilled passages, radiating from the rear main bearing, conduct lubricating oil to the adapter ports of the fuel pump drive, right and left magneto and accessory drives and to starter shaftgear bearing. An intersecting passage directs oil to the idler gear support.

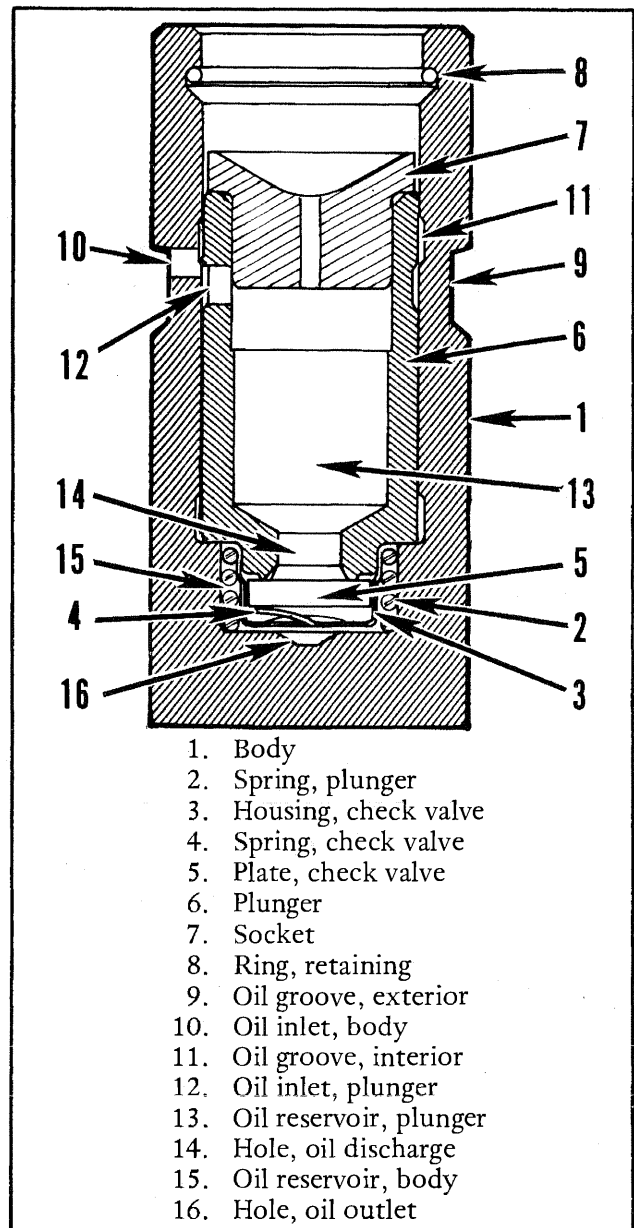


FIGURE 2-6. CUTAWAY VIEW OF HYDRAULIC VALVE LIFTER.



## 2-15. VALVE MECHANISM (See Figure 2-6).

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

b. The barrel-type hydraulic lifter (See Figure 2-6) consists of a steel body (1), an expanding spring (2), and a check valve assembly (3,4 and 5), a plunger (6), a socket (7) for pushrod end, and a retaining ring (8). A groove (9), around outside of body picks up oil under pressure from crankcase supply hole only when lifter is near outer end of its stroke so engine pressure will not "pump up" plunger and hold the valve off its seat. From the exterior groove oil is directed to interior body groove (11) through hole (10) and from the interior groove through the hole (12) to the reservoir (13). Oil is withheld from reservoir (15) by check valve plate (5) which is supported by spring (4) of housing (3). 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 of 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. This also permits contraction of the valve train length when the engine cools. Tappet bodies, plunger, and socket assemblies are not interchangeable, because of the narrow limits of permissible diametrical clearance, but retaining rings and expanding springs may be interchanged without ill effect.

## 2-16. INDUCTION SYSTEM.

a. The air induction system consists of intake tubes, a balance tube, connecting hoses, clamp assemblies, an air throttle body, a fuel metering control unit and a turbocharger. On the sandcast engine the air throttle body and fuel metering control unit is located at the rear of the engine

and supported by a bracket assembly that is attached to the crankcase cover at the accessory drive pads. The throttle assembly is connected by elbows to the rear cylinder intake tubes by connector hoses and clamps. The permold engine rear elbows are joined by a manifold riser connected by hoses and clamps. On both models the rear elbows are attached to the center intake tubes and in turn the center intake tubes are connected to the front intake tubes by means of connector hoses and clamps. The front cylinder intake tubes are connected by a balance tube assembly. A boss on the balance tube is provided for fuel drain provisions to prevent hydrostatic lock. The balance tube is supported by a bracket assembly attached to the front of the sump.

b. The TSIO-520-J has an intercooler capable of 45% effectivity with a static cooling air pressure drop of 4.0 in. H<sub>2</sub>O across the cooler. Both the TSIO-520-J & K turbochargers provide turbo-bleed air through a sonic venturi which limits the amount to approximately 6 lb./min.

## 2-17. IGNITION SYSTEM.

a. High voltage current is generated and distributed to the upper spark plugs of the right side cylinders and lower spark plugs of the left side cylinders by a magneto mounted on the right side of the crankcase. An identical magneto mounted on the left side of the crankcase produces the current for the upper spark plugs of the left side cylinders and lower spark plugs of the right side cylinders. The high tension cables pass through braided flexible, shielded conduit assemblies which are connected to the magnetos by coupling nuts and to the spark plugs by elbows. The magnetos are driven through impulse couplings which incorporate springs and counterweighted latches. When cranking the engine, the latches engage magneto body stops to retard the rotors and ignition spark. Retarding the magneto rotors serves to retard ignition spark until the piston reaches top center at the beginning of the power stroke and to attain full secondary coil voltage as the rotor is spun rapidly through the breaker opening position at which the spark occurs. As engine speed increases, centrifugal force disengages the latches, and the magnetos are driven at full advance.

b. In engine models which employ the retard breaker system, the left magneto incorporates dual breakers which retard ignition spark during engine cranking. During the engine cranking period the right magneto is grounded and inoperative. The

retard breaker, in the left magneto, is actuated by the same cam as the main breaker, and is so located that its contacts will open at a predetermined number of degrees after the main breaker contacts open. A battery-operated starting vibrator furnishes electrical current to the magneto for retarded ignition starting, regardless of engine cranking speed. The retarded ignition is in the form of a "shower" of sparks instead of a single spark as obtained from the impulse coupling magneto. When the engine starts and the ignition start switch is released to return to its "BOTH" position, the vibrator circuit and the retard breaker circuit becomes inoperative. Simultaneously the right magneto circuit becomes operative and both magnetos are firing at full advance position.

## SECTION III

### SPECIAL TOOLS AND EQUIPMENT

3-1. It is advisable to have an engine transportation stand (Figure 3-4) on which the engine can be inverted so certain parts can be removed or installed easily.

3-2. The tool in Figure 3-1 is used for installing the needle bearing in the starter adapter. This tool can be manufactured locally in accordance with the dimensions specified.

3-3. For replacing an outer sleeve on the ignition harness, use a Thomas and Betts Crimping Tool, No. WT-217.

3-4. For removing and replacing crankshaft blade and counterweight bushings use Borrough's Tool No. 4965.

#### NOTE

Special tools for Aircraft Engines in general and the TSIO-520 in particular can be purchased from the Borrough's Tool and Equipment Corporation, 2429 North Burdick Street, Kalamazoo, Michigan 49007.

3-5. Special tools for disassembly of the starter adapter are shown in Figures 3-7 and 3-8.

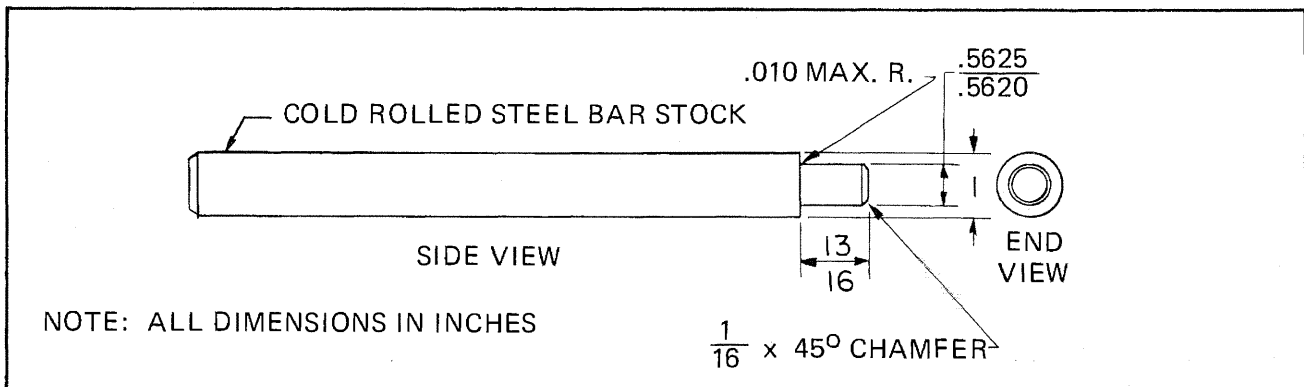


FIGURE 3-1. STARTER ADAPTER BEARING INSTALLER.

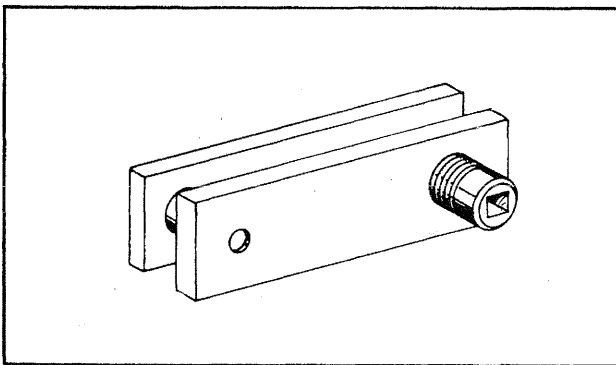


FIGURE 3-2. CRANKSHAFT BLADE AND DAMPENER BUSHING REMOVER AND REPLACER.

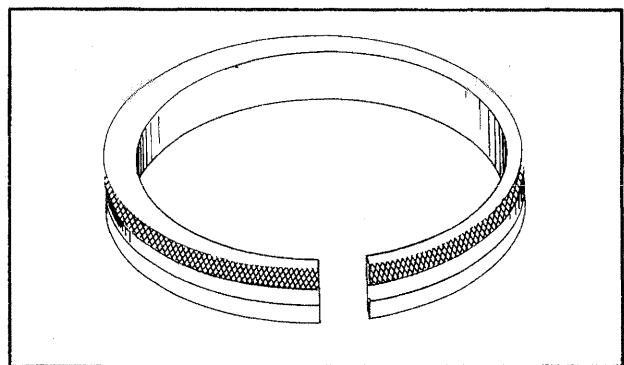


FIGURE 3-3. PISTON RING COMPRESSOR, BORROUGHS NO. 5201.

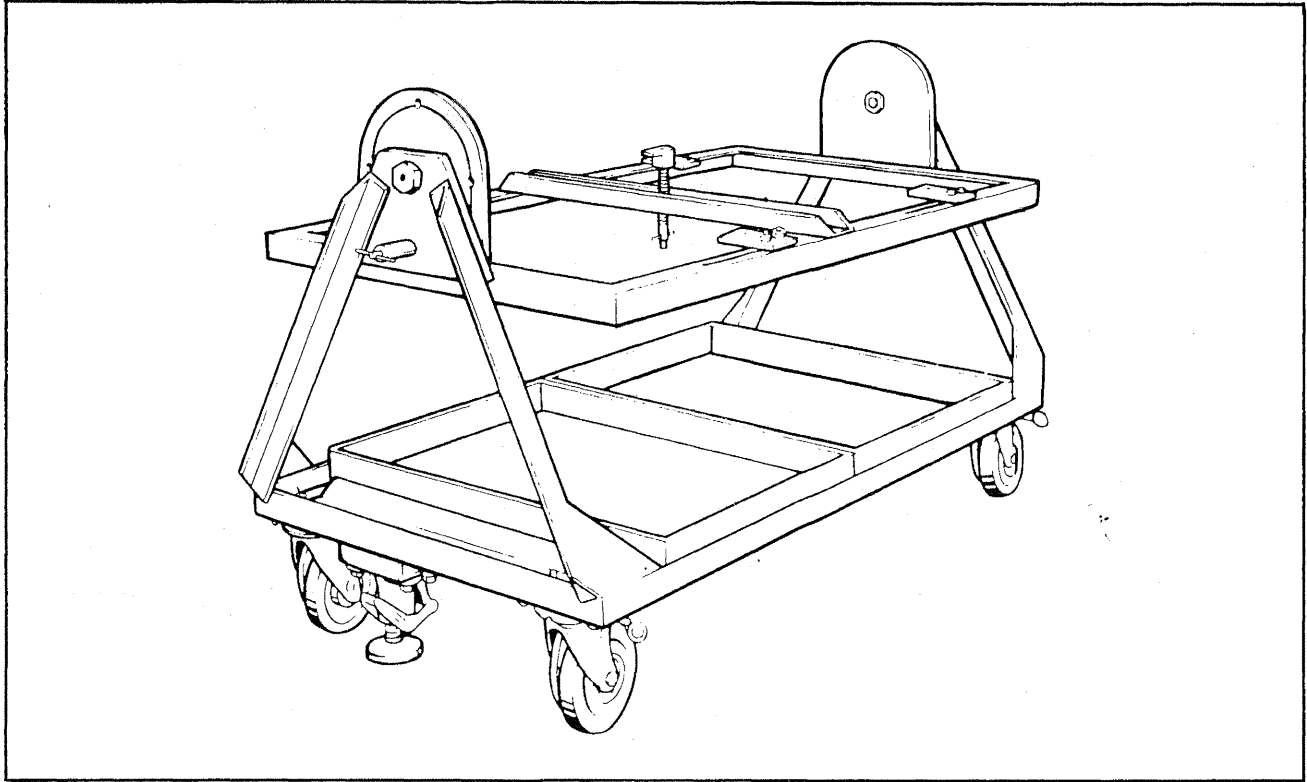


FIGURE 3-4. ENGINE TRANSPORTATION STAND.

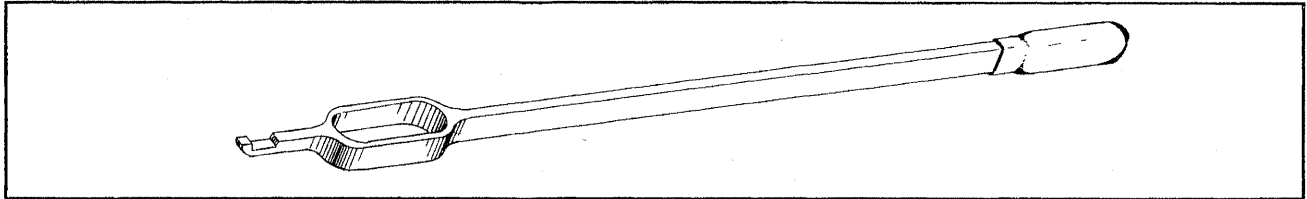
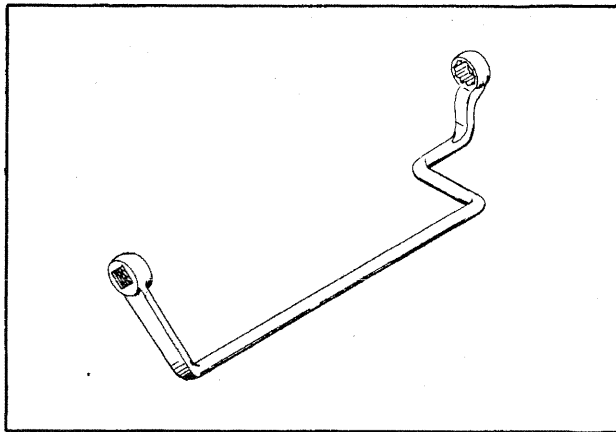
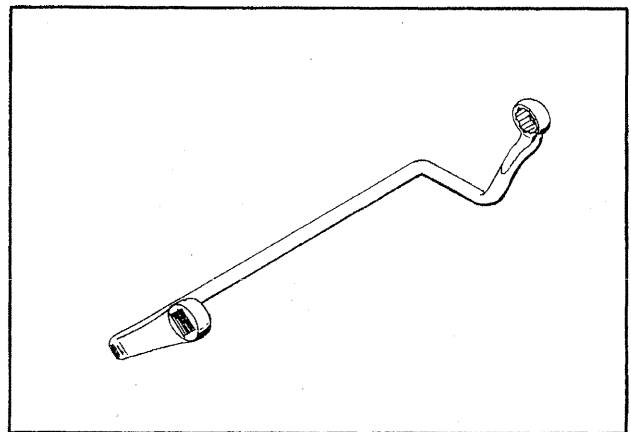


FIGURE 3-5. VALVE SPRING COMPRESSOR, BORROUGH'S NO. 3602.

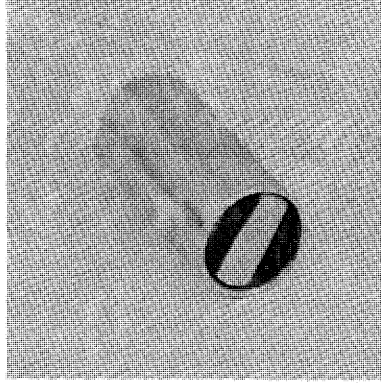


BORROUGHS NO. 5204 RIGHT HAND

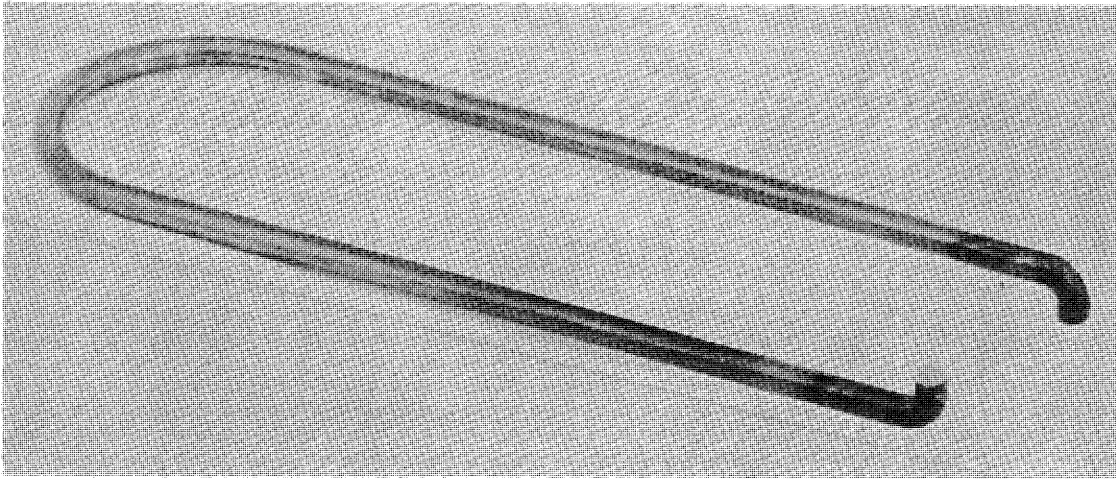


BORROUGHS NO. 5203 LEFT HAND

FIGURE 3-6. CYLINDER BASE NUT WRENCHES.



*FIGURE 3-7. WORM SHAFT  
TURNING TOOL.*



*FIGURE 3-8. WORM GEAR REMOVER.*



## SECTION IV

# DISASSEMBLY

### 4-1. GENERAL.

### 4-2. AIRCRAFT PARTS AND ACCESSORIES.

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 supplied by the applicable accessory manufacturer.

c. Instructions for the maintenance and overhaul of the turbocharger is supplied in Turbocharger Manual, Form TP020 from AiResearch, Inc.

### 4-3. EXTENT OF DISASSEMBLY.

Line drawings reproduced in this section are identical to those used in the parts catalog, except for the order of index numbers assigned to components. Index numbers herein indicate the approximate order of disassembly. In many instances the location of components and attaching parts in the illustration will be sufficient to enable personnel to accomplish disassembly operations. In these instances such disassembly is to be accomplished, even though there are no printed instructions to that effect, excepting those parts which need to be removed only for replacement. Such parts include studs, bushings and other tight fit inserts. The identity of these will be obvious.

### 4-4. PARTS TO BE DISCARDED.

Discard all shakeproof washers, lockwires, tab washers, rubber seal rings, oil seals, gaskets, cotter pins, hose connectors and magneto coupling (rubber) bushings in such a manner that they will not be used again inadvertently. Care should be taken in removing gaskets from aluminum parts by scraping. Such removal should be delayed until the part is to be cleaned.

### 4-5. DISASSEMBLY STAND.

For greatest ease of disassembly, this engine should be mounted on an engine stand with a tilting bed and oil drip pan. See the installation drawings for necessary dimensions for mounting engine on stand.

### 4-6. 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 sump 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.*

### 4-7. DISMANTLING.

### 4-8. IGNITION SYSTEM.

a. Disconnect cables from spark plugs.

b. Remove one screw from each of the six valve rocker covers that attaches the lower spark plug cable clamps.

c. Detach ignition cable retaining clamps from fuel discharge brackets.

d. Detach clip from cable bracket on top of crankcase. Disengage band clamps.

e. Detach high tension cable outlet plates from magnetos and withdraw them to free cable assemblies.

f. Remove two attaching nuts, lockwashers and holding washers from each magneto. Withdraw magnetos forward from the crankcase.

#### 4-9. INDUCTION SYSTEM, TSIO-520-B & E (See Figure 4-1).

a. Loosen clamps (1) and remove hose (2) from junction block (4) and air throttle body (15). Remove tube assembly (3) from junction block and pump. Disconnect the injection nozzle tube sleeve assemblies (7,8,9,10) from air fuel tubes (5,6). Separate tubes (5,6) from junction block (4).

b. Loosen clamps (18) and remove air throttle body (15) and convoluted bellows (16) from manifold riser (28).

c. Remove attaching parts (19,20) and loosen hose clamps (22,23). Lift off balance tube bracket (21) and balance tube (24).

d. Loosen clamps (25,27) from hoses (26) and remove riser (28). Remove attaching parts (29, 30,31) and separate intake cylinder head manifold tubes (32,33), elbows (34,35) and gaskets (36).

#### 4-10. INDUCTION SYSTEM, TSIO-520-C, G & H (See Figure 4-2).

a. Disconnect tube (1) from junction block (2). Disconnect the 1-3-5 side air fuel nozzle tube (3) and the 2-4-6 side air fuel nozzle tube (4) from the junction block (2). Remove the junction block.

b. Disconnect six injection nozzle sleeve assemblies (5,6,7,8) from air fuel nozzle tubes (3,4) and remove tubes.

c. Remove attaching parts (9,10). Loosen hose clamps (12,13). Remove balance tube bracket (11) and balance tube (14).

d. Loosen clamps (15) from hoses (16). Remove attaching parts (17,18,19). Remove intake manifold elbows (20,21) and gasket (22). Loosen clamps (23) from hoses (24) and remove intake manifold tubes (25,26).

e. Remove attaching parts (28,29). Remove screw (32) and nut (31). Remove the air throttle assembly (27).

#### 4-11. INDUCTION SYSTEM, TSIO-520-D (See Figure 4-3).

a. Loosen hose clamps (1) on hose (2), remove hose. Disconnect coupling and tee fitting (3,4)

from air manifold tube assemblies (5,7). Remove coupling and tee fitting. Disconnect the six injection nozzle sleeve assemblies (10,11,12,13) from the air fuel nozzle tubes (6). Remove tubes (5,6,7).

b. Remove attaching parts (14,15,16). Loosen hose clamps (18,19). Remove balance tube bracket (17) and balance tube (20).

c. Loosen clamps (19,29) from hoses (22,30) and remove riser (31).

d. Loosen clamps (21) from hoses (22). Remove attaching parts (23,24,25). Remove intake manifold elbows (26,27) and gasket (28).

#### 4-12. INDUCTION SYSTEM, TSIO-520-J (See Figure 4-4).

a. Loosen clamps (1) and remove hose (2) from junction block (3). Disconnect the injection nozzle sleeve assemblies (8,9,10,11) from air fuel tubes (6,7). Loosen clamps (4) from hoses (5) and separate tubes (6,7), hoses (5) and junction block (3).

b. Loosen junction block (3) when the accessory adapter (Figure 4-11) is disassembled.

c. Remove attaching parts (12,13) and loosen hose clamps (15,17). Remove balance tube bracket (14) and balance tube (16).

d. Air throttle assembly (27) and intercooler (28) should have been removed when engine was removed from airframe. Loosen clamps (20) and remove flexible elbows (29).

e. Loosen clamps (19) from hoses (18) and remove attaching parts (21,22,23). Remove and separate intake manifold elbows (24,25), hoses (18), clamps (19) and gaskets (26).

#### 4-13. INDUCTION SYSTEM, TSIO-520-K (See Figure 4-5).

a. Loosen clamps (1) and remove hose (2) from junction block (3). Disconnect the injection nozzle sleeve assemblies (8,9,10,11) from air fuel tubes (6,7). Loosen clamps (4) from hoses (5) and separate tubes (6,7), hoses (5) and junction block (3).

b. Remove junction block (3) when the accessory adapter (Figure 4-11) is disassembled.

c. Remove attaching parts (12,13) and loosen hose clamps (15,17). Remove balance tube bracket (14) and balance tube (16).



d. Turbocharger (38) and air throttle assembly (37) should have been removed when engine was removed from airframe.

e. Loosen clamps (34) to remove elbow (35) and convoluted bellows (33). Loosen clamps (32)

from hoses (31) and remove riser (29).

f. Loosen clamps (19) from hoses (18) and remove attaching parts (20,21,22). Remove and separate clamps (19), intake manifold tube assemblies (23,24), elbows (25,26) and gaskets (27).

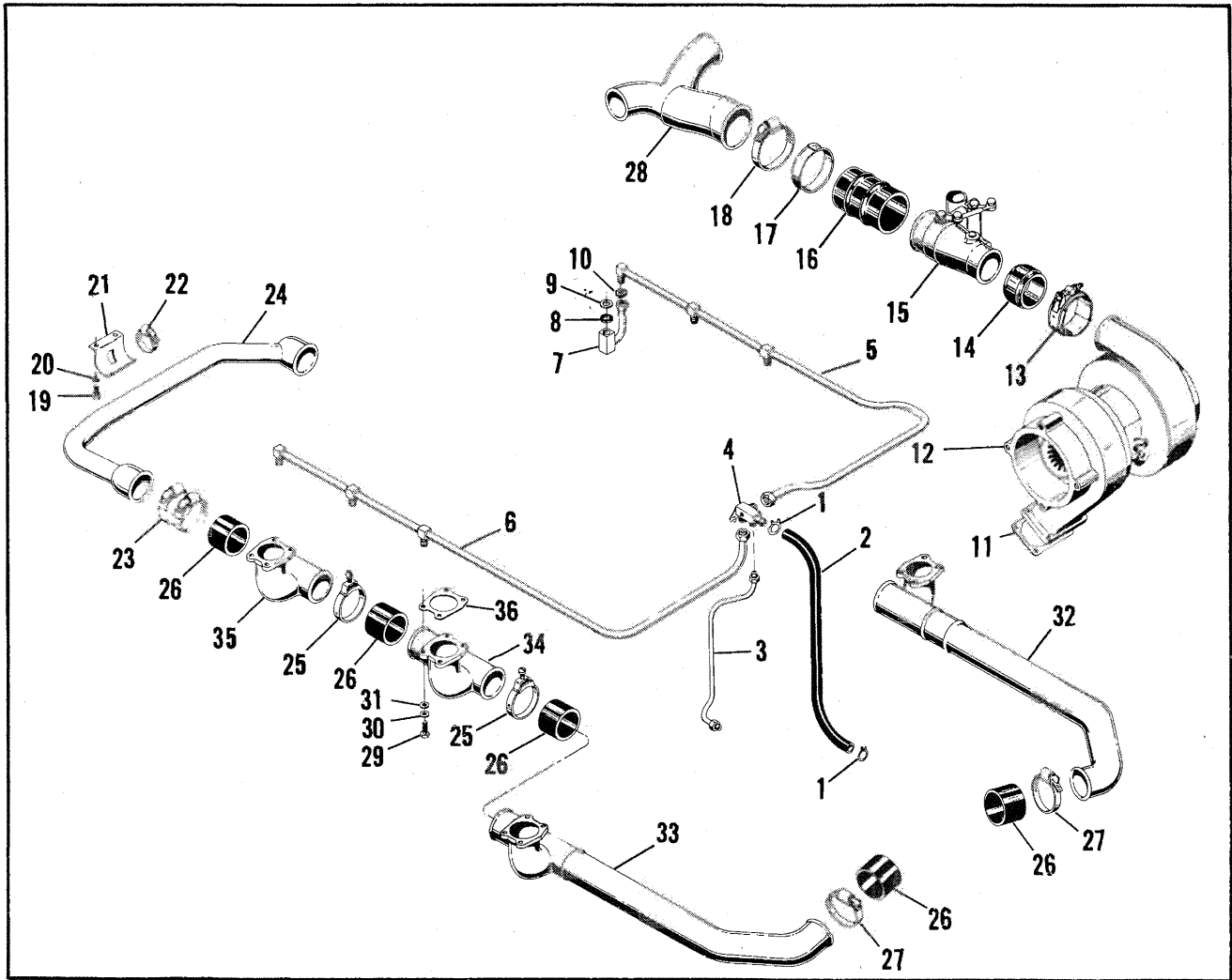


FIGURE 4-1. INDUCTION SYSTEM, TSIO-520-B & E.

- |                                 |                            |                             |
|---------------------------------|----------------------------|-----------------------------|
| 1. Clamp, Hose                  | 12. Turbocharger           | 25. Clamp, Hose             |
| 2. Hose                         | 13. Coupling, Channel Band | 26. Hose                    |
| 3. Tube Assembly                | 14. Sleeve, Coupling       | 27. Clamp, Hose             |
| 4. Junction Block               | 15. Air Throttle Assembly  | 28. Manifold Riser          |
| 5. Tube Assembly                | 16. Convoluted Bellows     | 29. Screw                   |
| 6. Tube Assembly                | 17. Sleeve, Clamp          | 30. Washer, Lock            |
| 7. Sleeve Assembly              | 18. Clamp                  | 31. Washer, Plain           |
| 8. Washer, Rubber               | 19. Screw                  | 32. Tube Assembly           |
| 9. Washer, Plain                | 20. Washer                 | 33. Tube Assembly           |
| 10. Seal, Compression           | 21. Bracket                | 34. Elbow, Intake Manifold  |
| 11. Gasket, Turbo Exhaust Inlet | 22. Clamp, Hose            | 35. Elbow, Intake Manifold  |
|                                 | 23. Clamp, Hose            | 36. Gasket, Intake Manifold |
|                                 | 24. Tube Assembly, Balance |                             |

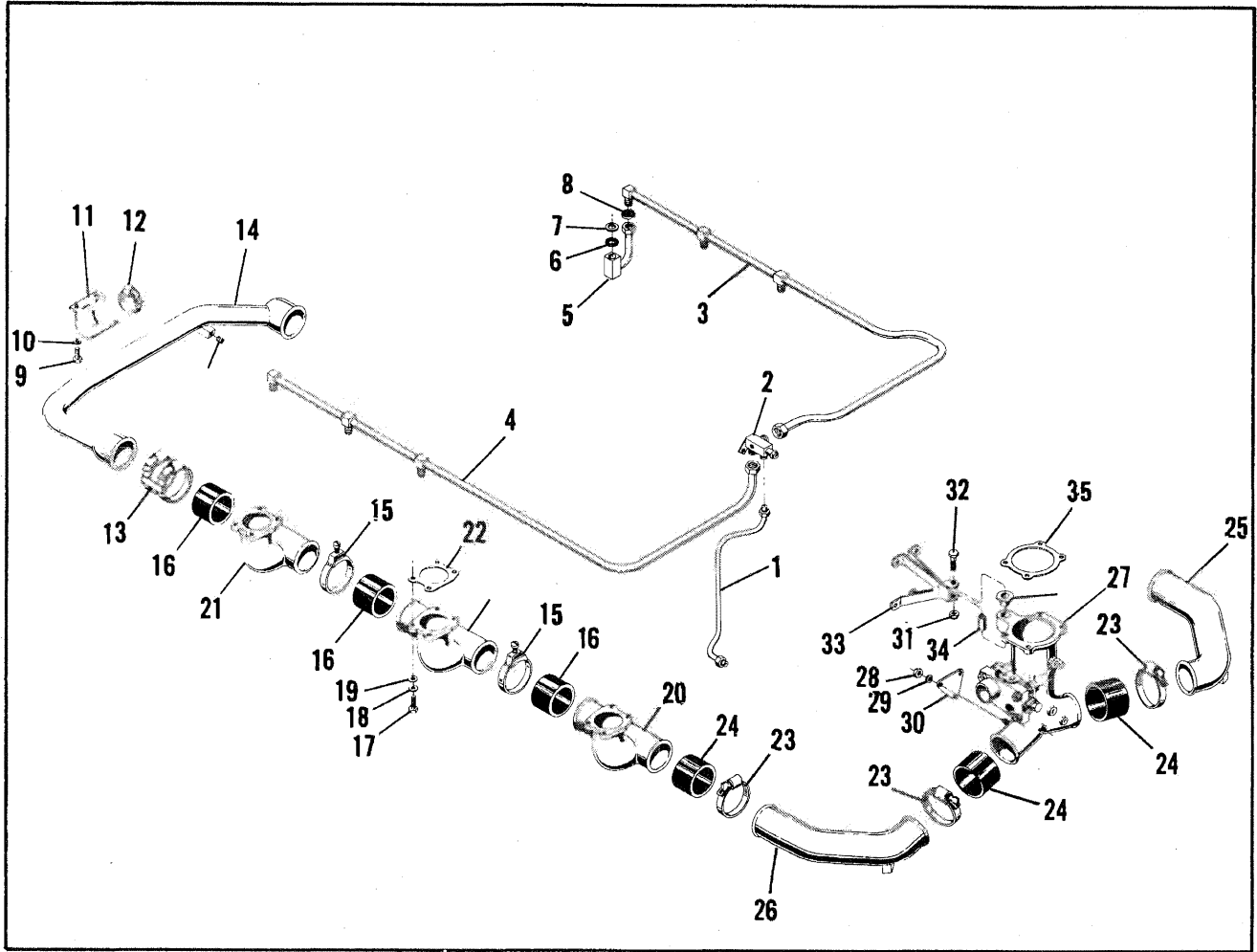


FIGURE 4-2. INDUCTION SYSTEM, TSIO-520-C, G & H.

- |                      |                             |                            |
|----------------------|-----------------------------|----------------------------|
| 1. Tube Assembly     | 13. Clamp, Hose             | 24. Hose                   |
| 2. Junction Block    | 14. Tube Assembly, Balance  | 25. Elbow Assembly, Intake |
| 3. Tube Assembly     | 15. Clamp, Hose             | 26. Elbow Assembly, Intake |
| 4. Tube Assembly     | 16. Hose                    | 27. Air Throttle Assembly  |
| 5. Sleeve Assembly   | 17. Screw                   | 28. Nut                    |
| 6. Washer, Rubber    | 18. Washer, Lock            | 29. Washer                 |
| 7. Washer, Plain     | 19. Washer, Plain           | 30. Bracket                |
| 8. Seal, Compression | 20. Elbow, Intake Manifold  | 31. Nut                    |
| 9. Screw             | 21. Elbow, Intake Manifold  | 32. Screw                  |
| 10. Washer           | 22. Gasket, Intake Manifold | 33. Bracket                |
| 11. Bracket          | 23. Clamp, Hose             | 34. Sleeve                 |
| 12. Clamp, Hose      |                             | 35. Bolt                   |

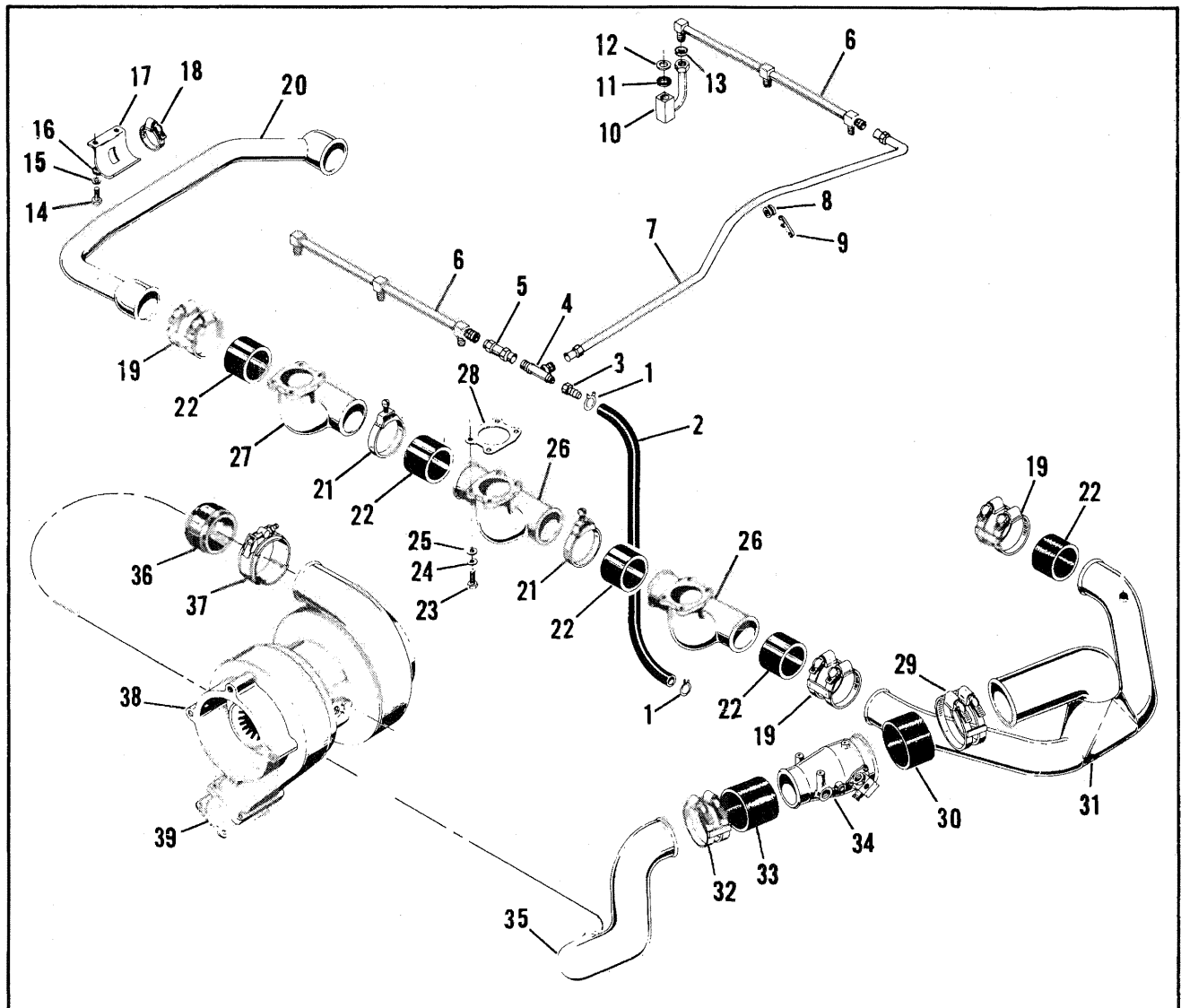


FIGURE 4-3. INDUCTION SYSTEM, TS10-520-D.

- |                       |                            |                            |
|-----------------------|----------------------------|----------------------------|
| 1. Clamp, Hose        | 14. Screw                  | 27. Elbow, Intake Manifold |
| 2. Hose               | 15. Washer, Lock           | 28. Gasket                 |
| 3. Coupling           | 16. Washer, Plain          | 29. Clamp                  |
| 4. Tee, Fitting       | 17. Bracket                | 30. Hose                   |
| 5. Tube Assembly      | 18. Clamp                  | 31. Manifold Riser         |
| 6. Tube Assembly      | 19. Clamp                  | 32. Clamp                  |
| 7. Tube Assembly      | 20. Tube, Balance          | 33. Hose                   |
| 8. Grommet            | 21. Clamp                  | 34. Air Throttle Assembly  |
| 9. Bracket            | 22. Hose                   | 35. Elbow                  |
| 10. Sleeve Assembly   | 23. Screw                  | 36. Sleeve, Coupling       |
| 11. Washer, Rubber    | 24. Washer, Lock           | 37. Clamp                  |
| 12. Washer, Plain     | 25. Washer, Plain          | 38. Turbocharger           |
| 13. Seal, Compression | 26. Elbow, Intake Manifold | 39. Gasket                 |

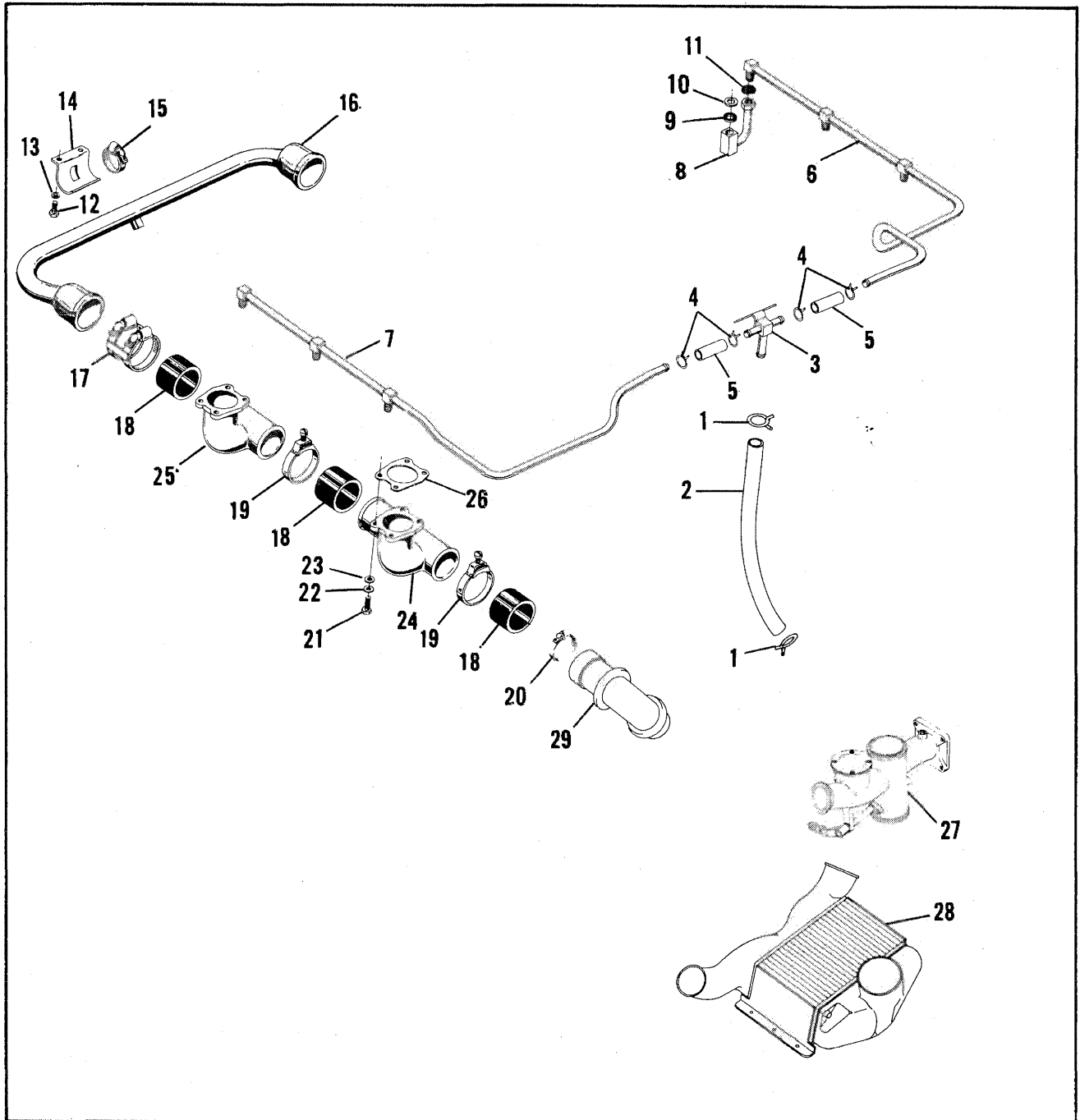


FIGURE 4-4. INDUCTION SYSTEM, TS10-520-J.

- |                    |                       |                            |
|--------------------|-----------------------|----------------------------|
| 1. Clamp           | 11. Seal, Compression | 20. Clamp                  |
| 2. Hose            | 12. Screw             | 21. Screw                  |
| 3. Junction Block  | 13. Washer, Tab       | 22. Washer, Lock           |
| 4. Clamp           | 14. Bracket           | 23. Washer, Plain          |
| 5. Hose            | 15. Clamp             | 24. Elbow, Intake Manifold |
| 6. Tube Assembly   | 16. Tube, Balance     | 25. Elbow, Intake Manifold |
| 7. Tube Assembly   | 17. Clamp Assembly    | 26. Gasket                 |
| 8. Sleeve Assembly | 18. Hose              | 27. Air Throttle Assembly  |
| 9. Washer, Rubber  | 19. Clamp             | 28. Intercooler Assembly   |
| 10. Washer, Plain  |                       | 29. Elbow, Flexible        |

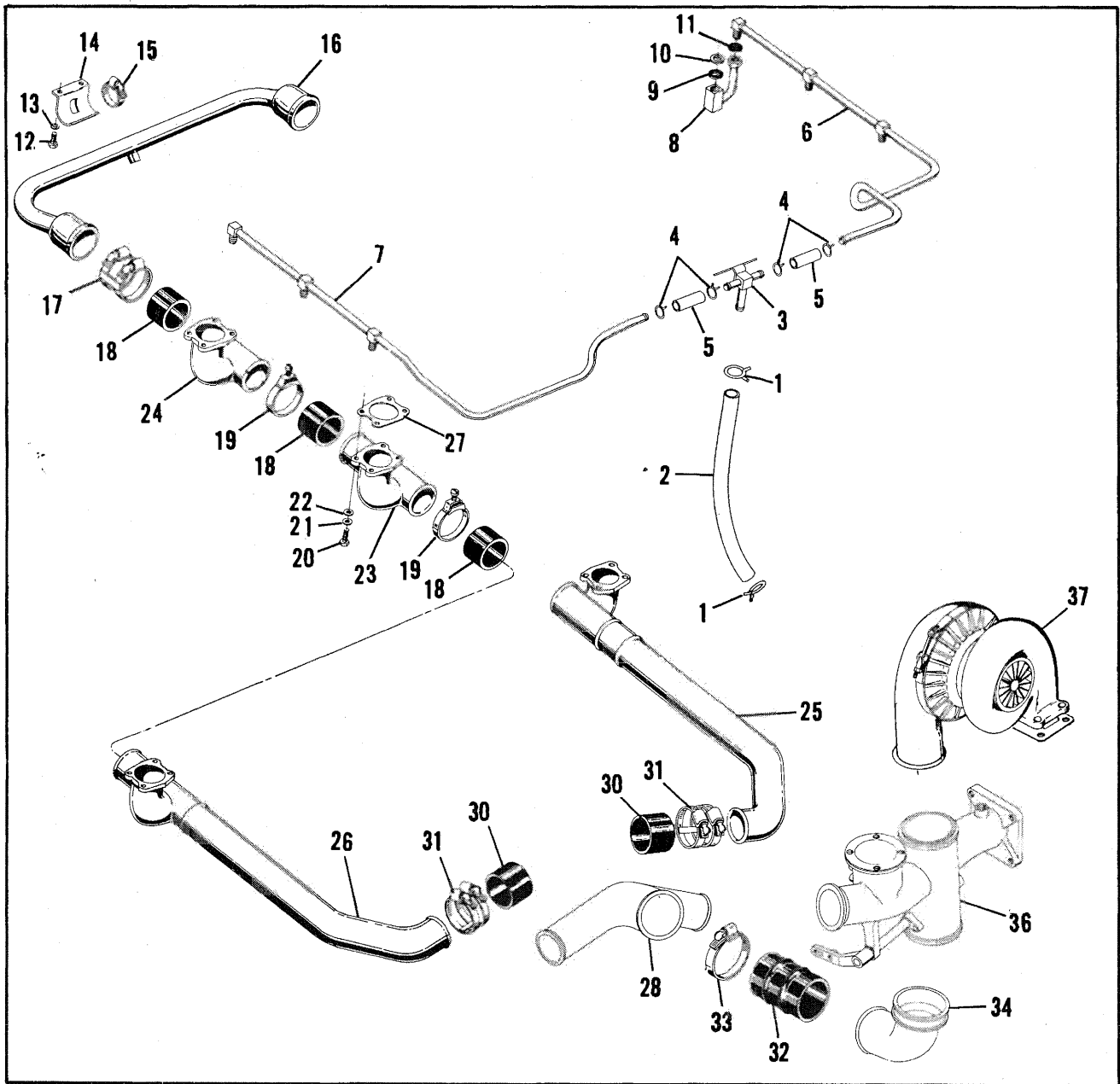


FIGURE 4-5. INDUCTION SYSTEM, TS10-520-K.

- |                                      |                                    |                            |
|--------------------------------------|------------------------------------|----------------------------|
| 1. Clamp                             | 12. Screw                          | 25. Elbow, Intake Manifold |
| 2. Hose, Junction Block-to-Fuel Pump | 13. Washer, Tab                    | 26. Elbow, Intake Manifold |
| 3. Junction Block                    | 14. Bracket                        | 27. Gasket                 |
| 4. Clamp                             | 15. Clamp                          | 28. Riser, Air Manifold    |
| 5. Hose, Tube-to-Junction Block      | 16. Tube, Balance                  | 29. Plug                   |
| 6. Tube Assembly, 1-3-5 Side         | 17. Clamp Assembly                 | 30. Hose                   |
| 7. Tube Assembly, 2-4-6 Side         | 18. Hose                           | 31. Clamp Assembly         |
| 8. Sleeve Assembly                   | 19. Clamp                          | 32. Convoluted Bellows     |
| 9. Washer, Rubber                    | 20. Screw                          | 33. Clamp                  |
| 10. Washer, Plain                    | 21. Washer, Lock                   | 34. Elbow, Air Intake      |
| 11. Seal, Compression                | 22. Washer, Plain                  | 35. Plug                   |
|                                      | 23. Tube Assembly, Intake Manifold | 36. Air Throttle Assembly  |
|                                      | 24. Tube Assembly, Intake Manifold | 37. Turbocharger           |

**4-14. FUEL INJECTION SYSTEM, TSIO-520-B & E (See Figure 4-6).**

a. Disconnect six fuel discharge tubes (2) from fuel manifold valve (4) and nozzles (3). Compress spring legs of each clamp (1) and remove tubes and clamps. Disconnect hose (5) at fuel manifold valve. Remove nozzles (3) and store in a clean container.

b. Disconnect hose assemblies (5,6) from control unit (23) and hose assemblies (6) from fuel pump (35).

c. To separate control unit (23) from air throttle body (26) remove two sets of cotter pins (8), plain washers (9) and wave washers (10). Remove link rod assembly (11 thru 14). Remove attaching parts (15,16,17 and 18,19) and remove shroud (20). Remove attaching parts (21,22) and separate control unit (23) and shroud (24) from air throttle body (26).

d. Remove two sets of attaching parts (27,28) and separate shrouds (30,31) from fuel pump (35). Disconnect tube (3, Figure 4-6) from fuel pump. Remove attaching parts (32,33,34) and lift fuel pump from crankcase studs. Remove gasket (37) and coupling (36).

**NOTE**

Further disassembly of the fuel injection system components is not advised unless proper test equipment is available.

For further information, refer to Teledyne Continental Fuel Injection Systems Overhaul Manual and Parts Catalog, Form X-30091.

**4-15. FUEL INJECTION SYSTEM, TSIO-520-C, G & H (See Figure 4-7).**

a. Disconnect six fuel discharge tubes (2) from manifold valve (4) and nozzles (3). Compress spring legs of each clamp (1), and remove tubes and clamps. Disconnect hose assembly (5) from manifold valve and control unit (23). Remove nozzles (3) and store in a clean container.

b. Disconnect hose assemblies (6 and 7) from fuel pump (32) and control unit (23), remove hose assemblies.

c. Remove shroud attaching parts (9,10,11) and remove shroud (12). Remove spring (18), two sets of cotter pins (15) and washers (16 and 17). Remove link rod assembly (19 thru 22). Remove bolts (13), tab washers (14) and separate fuel control from throttle body (24).

d. Remove attaching parts (29,30,31) and remove fuel pump (32) and shroud assembly (28) as a unit. Remove screw (25) and nut (26) and separate shroud from fuel pump. Remove gasket (33), insulator (34), gasket (33), adapter assembly (35,36) and gasket (37) from crankcase studs. Remove fuel pump drive gear (38) and plug (39) from crankcase cavity.

**NOTE**

Further disassembly of the fuel injection system components is not advised unless proper test equipment is available.

For further information, refer to Teledyne Continental Fuel Injection Systems Overhaul Manual and Parts Catalog, Form X-30091.

**4-16. FUEL INJECTION SYSTEM, TSIO-520-D (See Figure 4-8).**

a. Disconnect six fuel discharge tubes (2) from fuel manifold valve (4) and nozzles (3). Compress spring legs of each clamp (1) and remove tubes and clamps. Remove nozzles (3) and store in a clean container.

b. Disconnect hose assembly (5) from manifold valve (4) and metering unit; disconnect hose assembly (6) from metering unit and fuel pump (14).

c. Bracket (8) should have been removed at the same time as the turbocharger (38, Figure 4-8). If not, do so at this time.

d. Remove shroud assembly (9) from fuel pump (14). Remove attaching parts (11,12,13) and lift fuel pump (14) off crankcase studs. Remove gasket (15) and coupling (16).

**NOTE**

Further disassembly of the fuel injection system components should not be attempted unless proper test equipment is available.

For further information, refer to Teledyne Continental Fuel Injection Systems Overhaul Manual and Parts Catalog, Form X-30091.

**4-17. FUEL INJECTION SYSTEM, TSIO-520-J**  
(See Figure 4-9).

- a. Disconnect six fuel discharge tubes (2) from fuel manifold valve (4) and nozzles (3). Compress spring legs of each clamp (1) and remove tubes and clamps. Remove nozzles (3) and store in a clean container.
- b. The manifold valve-to-mixture control hose and mixture control-to-fuel pump hoses should have been removed. If not, do so at this time.
- c. To disassemble throttle and control assembly, proceed as follows: Remove cotter pins (17), washers (18), wave washers (19) and remove link rod assemblies (5 thru 9) and (20 thru 23).
- d. Remove attaching parts (13,14) and remove controller (15) and gasket (16) from air throttle (27).
- e. Remove attaching parts (25,26) and remove control unit (24) from air throttle (27).

- f. Remove screws (30), nuts (31) and separate shrouds (28,29) from fuel pump.

- g. Remove attaching parts (32,33,34) and pull fuel pump (35), gasket (36) and coupling (37) from crankcase.

**4-18. FUEL INJECTION SYSTEM, TSIO-520-K**  
(See Figure 4-10).

- a. Disconnect six fuel discharge tubes (2) from fuel manifold valve (4) and nozzles (3). Compress spring legs of each clamp (1) and remove tubes and clamps. Remove nozzles (3) and store in a clean container.
- b. The manifold valve-to-mixture control hose and mixture control-to-fuel pump hoses should have been removed. If not, do so at this time.
- c. Remove attaching parts (5,6,7) and remove pressure relief valve assembly (8) and "O" ring (9) from air throttle (20).
- d. To disassemble throttle and control assembly, proceed as follows: Remove cotter pins (10), washers (11), wave washers (12) and remove link rod assembly (13 thru 16).
- e. Remove attaching parts (17,18) and remove control unit (19) from air throttle (20).

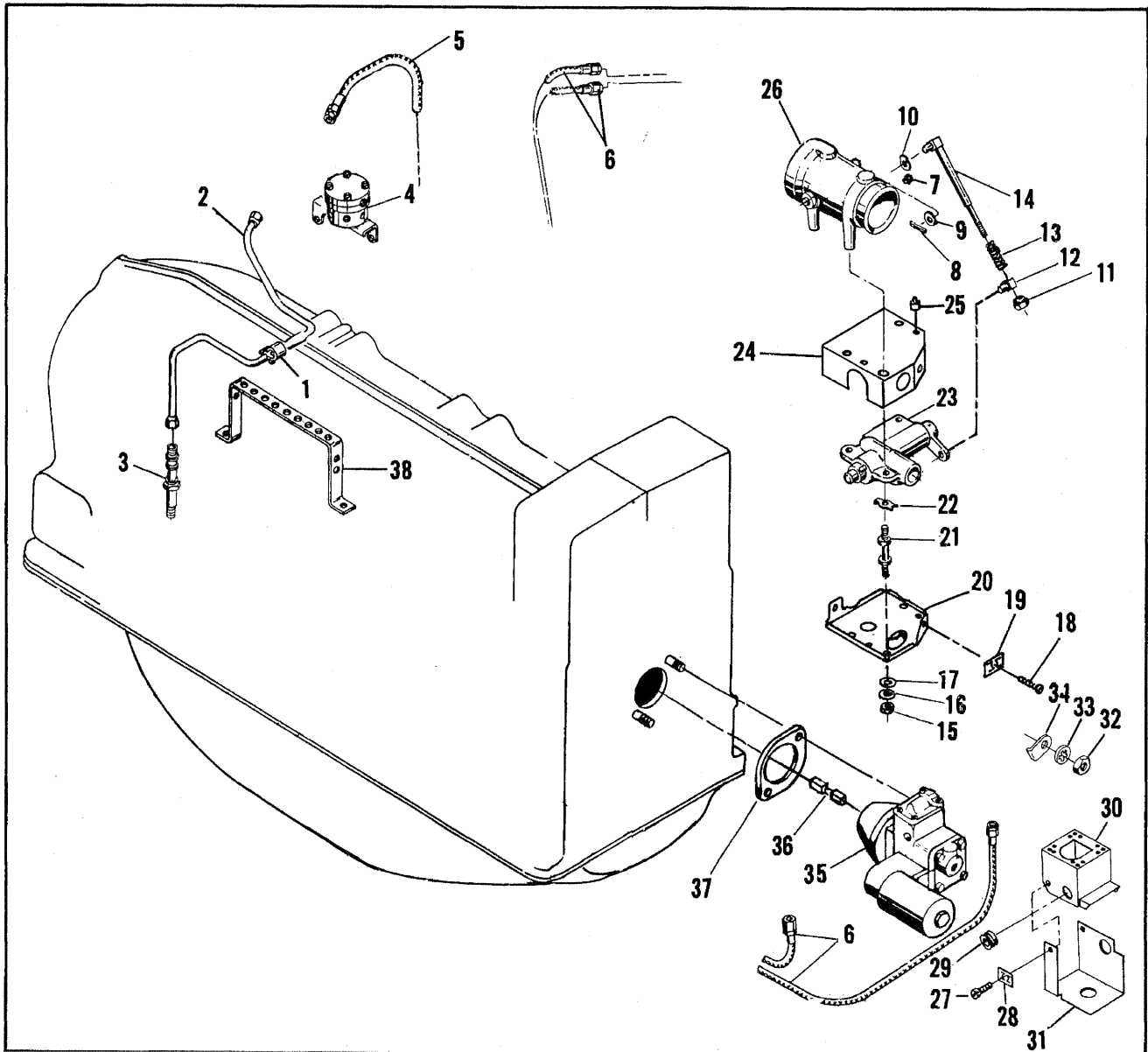


FIGURE 4-6. FUEL INJECTION SYSTEM, TSIO-520-B & E.

- |                                 |                             |                        |
|---------------------------------|-----------------------------|------------------------|
| 1. Clamp, Fuel Discharge Tube   | 14. Link Rod                | 26. Air Throttle Body  |
| 2. Tube, Fuel Discharge         | 15. Nut                     | 27. Screw              |
| 3. Nozzle Assembly              | 16. Washer, Plain           | 28. Nut                |
| 4. Fuel Manifold Valve Assembly | 17. Washer, Lock            | 29. Grommet            |
| 5. Hose Assembly                | 18. Screw, Sheet Metal      | 30. Shroud, Fuel Pump  |
| 6. Hose Assembly                | 19. Nut, Speed              | 31. Shroud, Fuel Pump  |
| 7. Plug                         | 20. Shroud, Top             | 32. Nut                |
| 8. Cotter Pin                   | 21. Bolt, Special           | 33. Washer, Plain      |
| 9. Washer, Plain                | 22. Washer, Tab             | 34. Washer, Holding    |
| 10. Washer, Wave                | 23. Control Unit            | 35. Fuel Pump Assembly |
| 11. Nut                         | 24. Shroud Assembly, Bottom | 36. Coupling           |
| 12. Rod End                     | 25. Bumper, Shroud          | 37. Gasket             |
| 13. Spring                      |                             | 38. Bracket            |



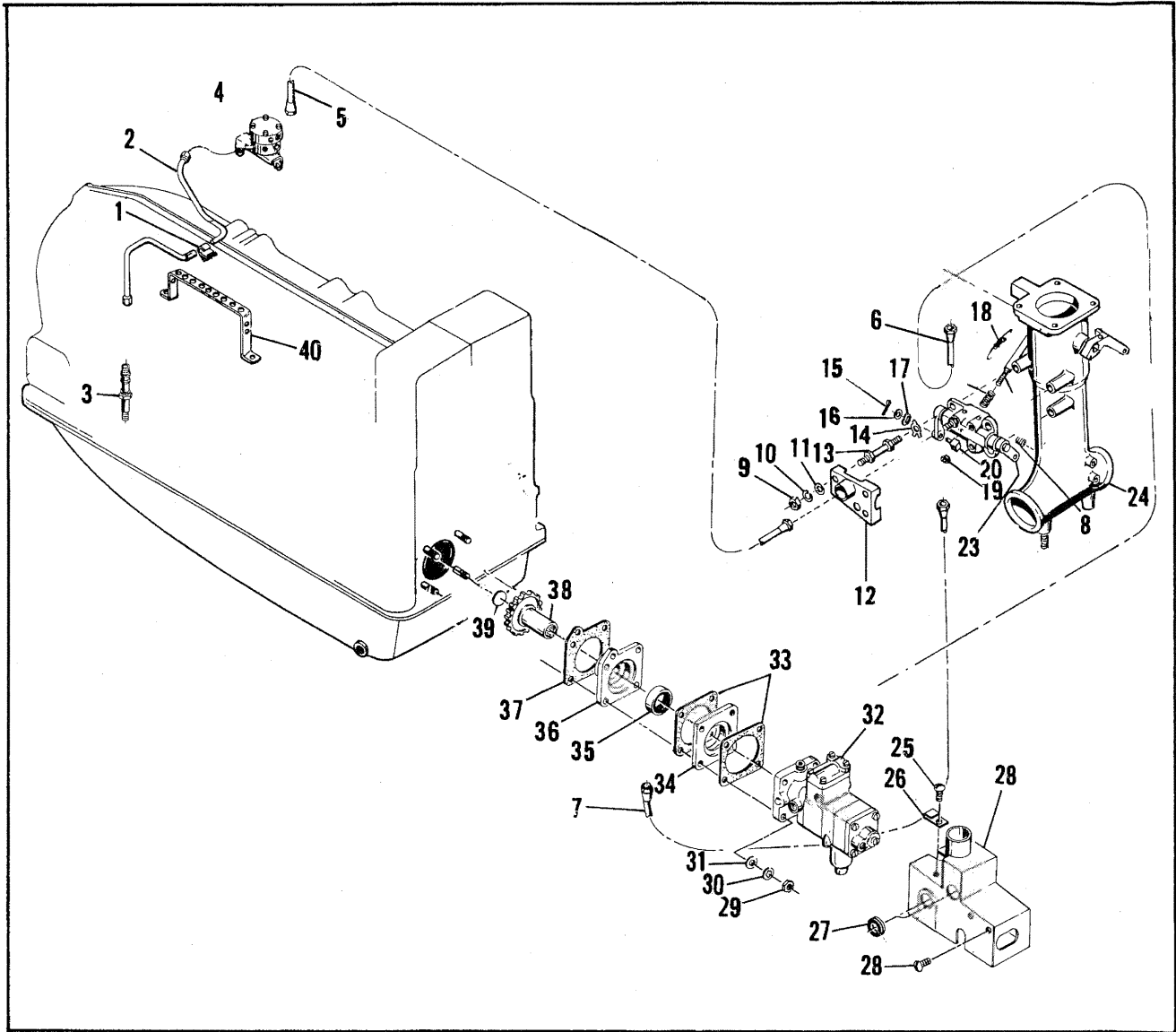


FIGURE 4-7. FUEL INJECTION SYSTEM, TS10-520-C, G & H.

- |                                 |                       |                        |
|---------------------------------|-----------------------|------------------------|
| 1. Clamp, Fuel Discharge Tube   | 14. Washer, Tab       | 28. Shroud             |
| 2. Tube, Fuel Discharge         | 15. Cotter Pin        | 29. Nut                |
| 3. Nozzle Assembly              | 16. Washer, Plain     | 30. Washer, Plain      |
| 4. Fuel Manifold Valve Assembly | 17. Washer, Wave      | 31. Washer, Lock       |
| 5. Hose Assembly                | 18. Spring            | 32. Fuel Pump Assembly |
| 6. Hose Assembly                | 19. Nut               | 33. Gasket             |
| 7. Hose Assembly                | 20. Rod End           | 34. Insulator          |
| 8. Plug                         | 21. Spring            | 35. Oil Seal           |
| 9. Nut                          | 22. Link Rod          | 36. Adapter            |
| 10. Washer, Plain               | 23. Control Unit      | 37. Gasket             |
| 11. Washer, Lock                | 24. Air Throttle Body | 38. Gear               |
| 12. Shroud                      | 25. Screw             | 39. Plug               |
| 13. Bolt, Special               | 26. Nut               | 40. Bracket            |
|                                 | 27. Grommet           |                        |

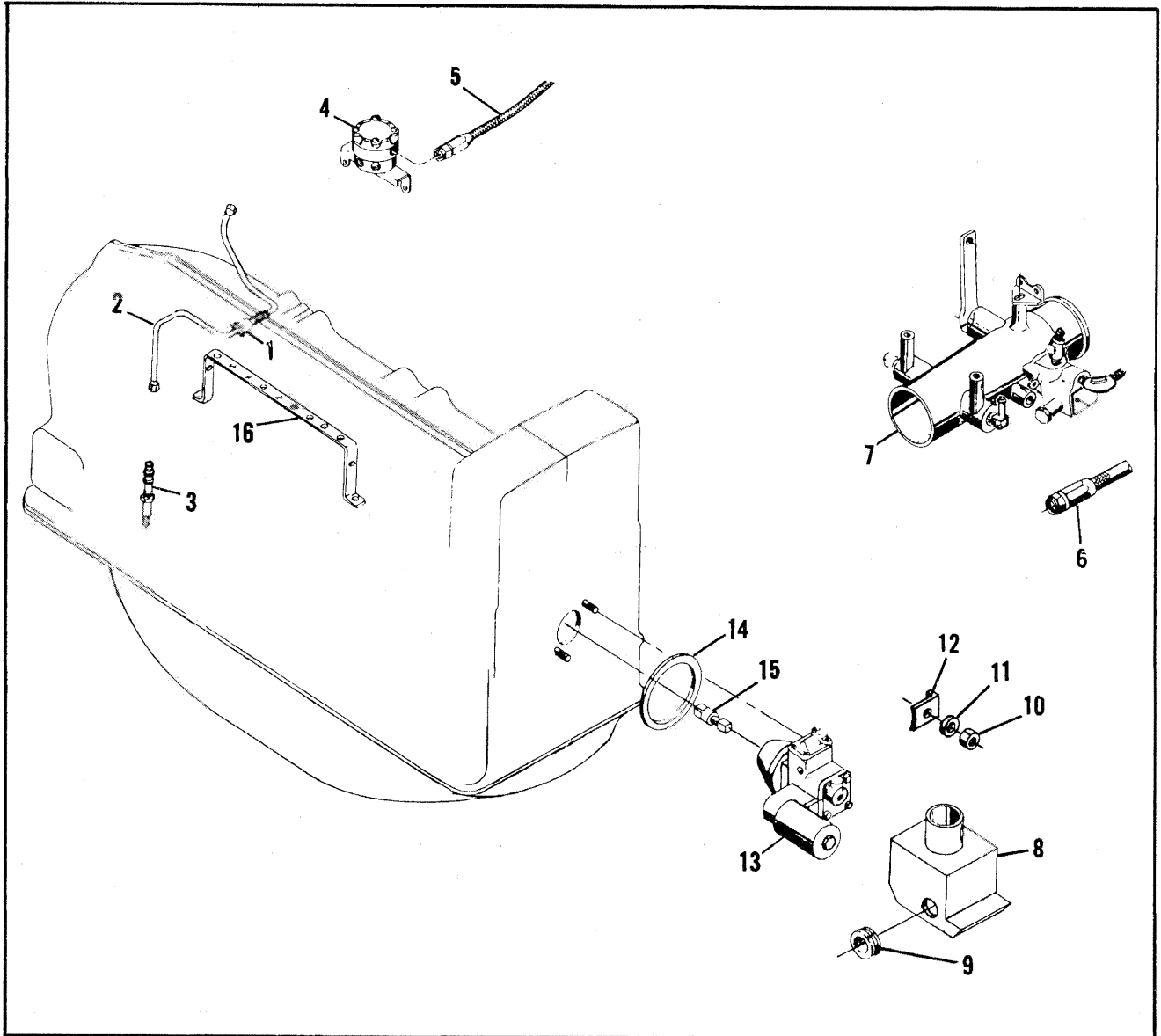


FIGURE 4-8. FUEL INJECTION SYSTEM, TS10-520-D.

- |                                 |                        |
|---------------------------------|------------------------|
| 1. Clamp, Fuel Discharge Tube   | 9. Grommet             |
| 2. Tube, Fuel Discharge         | 10. Nut                |
| 3. Nozzle Assembly              | 11. Washer, Lock       |
| 4. Fuel Manifold Valve Assembly | 12. Washer, Holding    |
| 5. Hose Assembly                | 13. Fuel Pump Assembly |
| 6. Hose Assembly                | 14. Gasket             |
| 7. Air Throttle Assembly        | 15. Coupling           |
| 8. Shroud                       | 16. Bracket            |

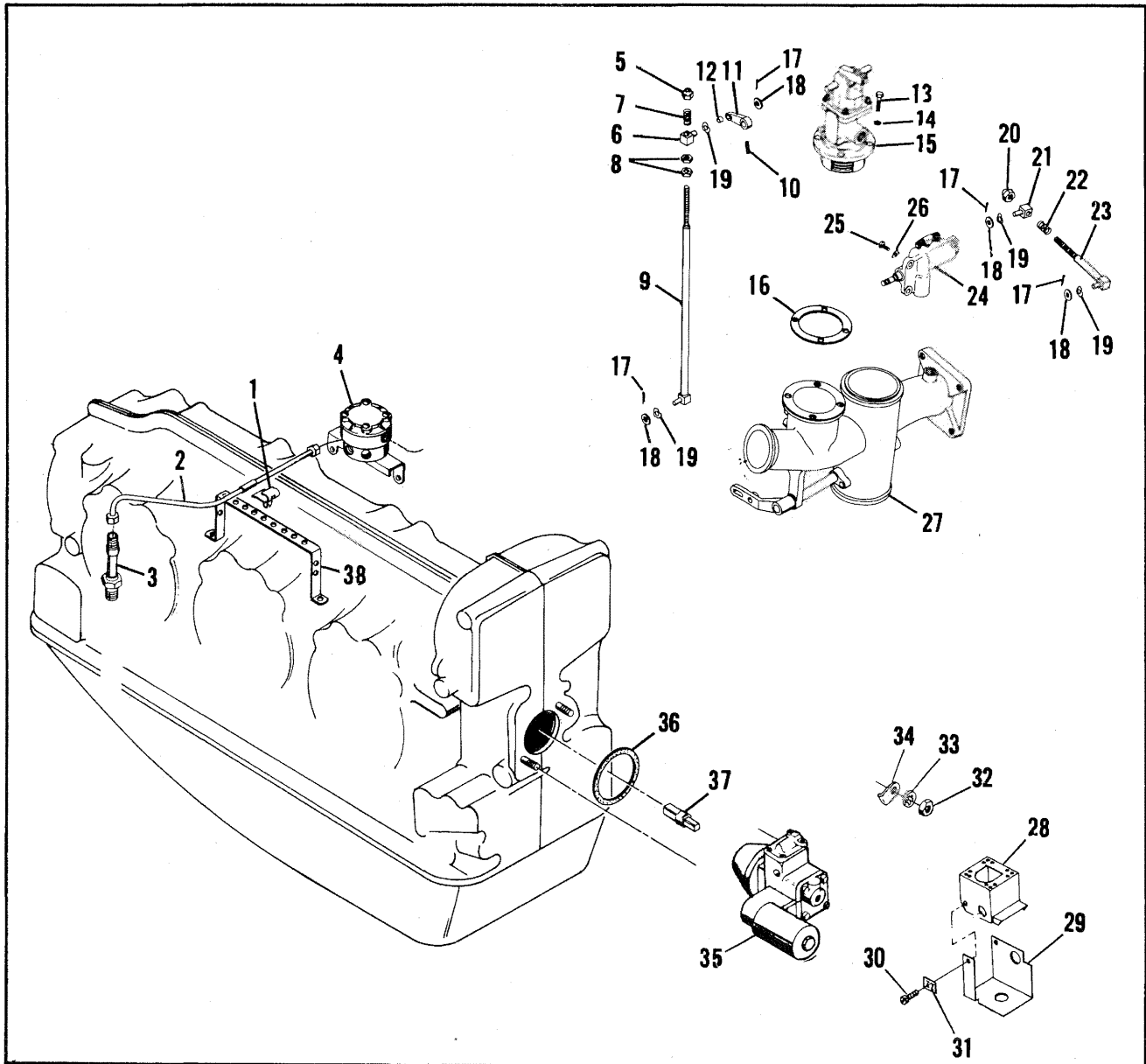


FIGURE 4-9. FUEL INJECTION SYSTEM, TS10-520-J.

- |                                 |                           |                           |
|---------------------------------|---------------------------|---------------------------|
| 1. Clamp, Fuel Discharge Tube   | 13. Screw                 | 26. Washer, Tab           |
| 2. Tube, Fuel Discharge         | 14. Washer                | 27. Air Throttle Assembly |
| 3. Nozzle Assembly              | 15. Controller            | 28. Shroud Assembly       |
| 4. Fuel Manifold Valve Assembly | 16. Gasket, Controller    | 29. Shroud                |
| 5. Nut, Elastic Stop            | 17. Pin, Cotter           | 30. Screw                 |
| 6. Rod End, Special             | 18. Washer, Plain         | 31. Nut                   |
| 7. Spring, Compression          | 19. Washer, Wave          | 32. Nut, Hex              |
| 8. Nut, Spring Adjustment       | 20. Nut, Elastic Stop     | 33. Washer, Lock          |
| 9. Rod and Link Assembly        | 21. Rod End, Special      | 34. Washer, Holding       |
| 10. Pin, Tubular                | 22. Spring, Compression   | 35. Fuel Pump Assembly    |
| 11. Lever                       | 23. Rod and Link Assembly | 36. Gasket, Fuel Pump     |
| 12. Bushing                     | 24. Control Unit          | 37. Coupling              |
|                                 | 25. Screw                 | 38. Bracket               |

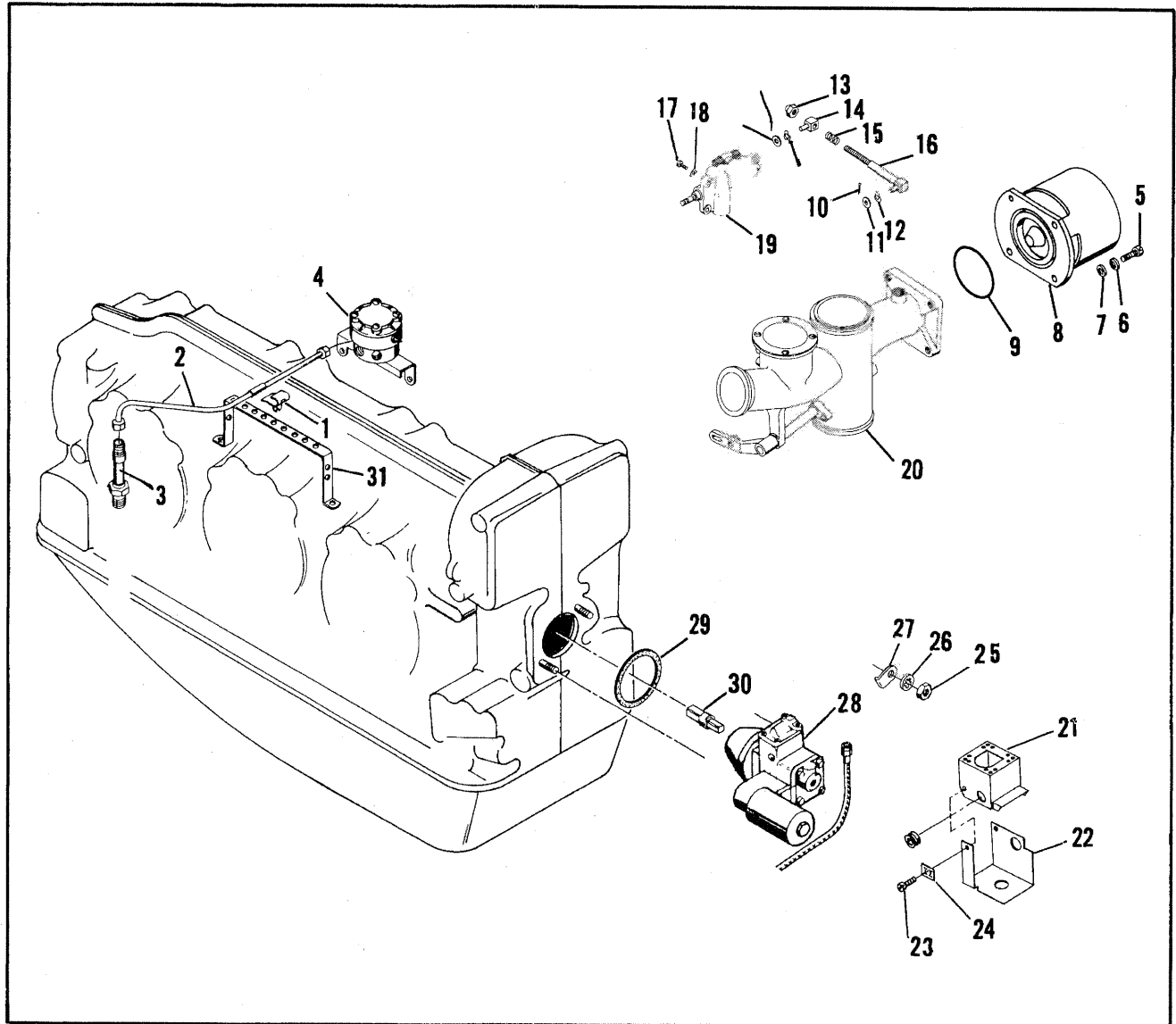


FIGURE 4-10. FUEL INJECTION SYSTEM, TS10-520-K.

- |                                   |                           |                        |
|-----------------------------------|---------------------------|------------------------|
| 1. Clamp, Fuel Discharge Tube     | 11. Washer, Plain         | 22. Shroud             |
| 2. Tube, Fuel Discharge           | 12. Washer, Wave          | 23. Screw              |
| 3. Nozzle Assembly                | 13. Nut, Elastic Stop     | 24. Nut                |
| 4. Fuel Manifold Valve Assembly   | 14. Rod End, Special      | 25. Nut, Hex           |
| 5. Screw                          | 15. Spring, Compression   | 26. Washer, Lock       |
| 6. Washer, Lock                   | 16. Rod and Link Assembly | 27. Washer, Holding    |
| 7. Washer, Flat                   | 17. Screw                 | 28. Fuel Pump Assembly |
| 8. Pressure Relief Valve Assembly | 18. Washer, Tab           | 29. Gasket, Fuel Pump  |
| 9. O-Ring                         | 19. Control Unit          | 30. Coupling           |
| 10. Pin, Cotter                   | 20. Air Throttle Assembly | 31. Bracket            |
|                                   | 21. Shroud Assembly       |                        |

**4-19. MAGNETO AND ACCESSORY DRIVES**  
(See Figure 4-11).

- a. On the 1-3-5 crankcase, remove four sets of attaching parts (1,2,3), cover (4) and gasket (5).
- b. Remove three sets of attaching parts (6,7,8), one set of attaching parts (9,10,11), bracket (33, Figure 4-7), adapter (12) and gasket (13). On the permold engine, remove the external oil filter bracket. If the AC filter is used, the Red Seal filter does not require bracketing. With the aid of an arbor press, remove bushing (14) and seal (15) from adapter.
- c. Remove magneto and accessory drive gear and sleeve assembly (16,17), magneto drive coupling bushings (19) and retainer (18).

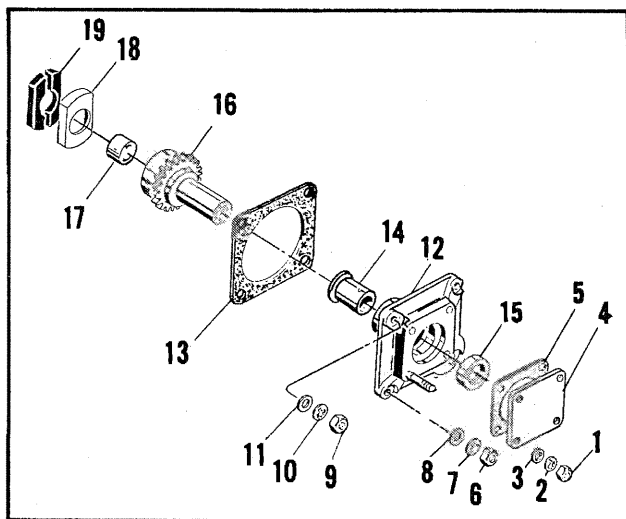


FIGURE 4-11. MAGNETO AND ACCESSORY DRIVES.

1. Nut, Hex
2. Washer, Lock
3. Washer, Plain
4. Cover
5. Gasket
6. Nut, Hex
7. Washer, Lock
8. Washer, Plain
9. Nut, Hex
10. Washer, Lock
11. Washer, Plain
12. Adapter, Accessory
13. Gasket
14. Bushing
15. Seal, Oil
16. Gear
17. Sleeve
18. Retainer
19. Bushing, Coupling

**4-20. OIL SUMP, TSIO-520-B, E, J & K** (See Figure 4-12).

- a. Drain plug (1) and gasket (2) should have been removed when engine was mounted on stand. Remove attaching parts (3,4,5) and lift sump (6) from engine. If hard to remove, tap with a soft hammer. Do not pry. Remove and discard gasket (7).
- b. Remove bolt (8), washers (9,10), nut (11), plug (12) on the outside of the crankcase at the rear 1-3-5 lower corner, and gaskets (13,14) to withdraw oil suction tube (15).

**4-21. OIL SUMP, TSIO-520-C & G** (See Figure 4-13).

- a. Drain plug (1) and gasket (2) should have been removed when engine was mounted on stand. Remove attaching parts (3,4,5) and lift sump (6) from engine. Remove and discard gasket (7).
- b. Remove screws (8,9) and washers (10) to remove oil suction tube assembly (11) and gasket (12).

**4-22. OIL SUMP, TSIO-520-D** (See Figure 4-14).

- a. Drain plug (1) and gasket (2) should have been removed when engine was mounted on stand.
- b. Remove attaching parts (3,4,5) and lift off mounting legs (6).
- c. Remove attaching parts (7,8,9) and lift off sump (10). Remove and discard gasket (1).
- d. Remove bolt (12), plug (13), on the outside of crankcase at the rear 1-3-5 lower corner, gaskets (14,15) and withdraw oil suction tube (16).

**4-23. OIL SUMP, TSIO-520-H** (See Figure 4-15).

- a. Drain plug (1) and gasket (2) should have been removed when engine was mounted on stand.
- b. Remove attaching parts (3,4,5) and lift off sump (6). Remove and discard gasket (7).
- c. Remove screws (8,9), washers (10) and remove oil suction tube assembly (11). Remove and discard gasket (12).

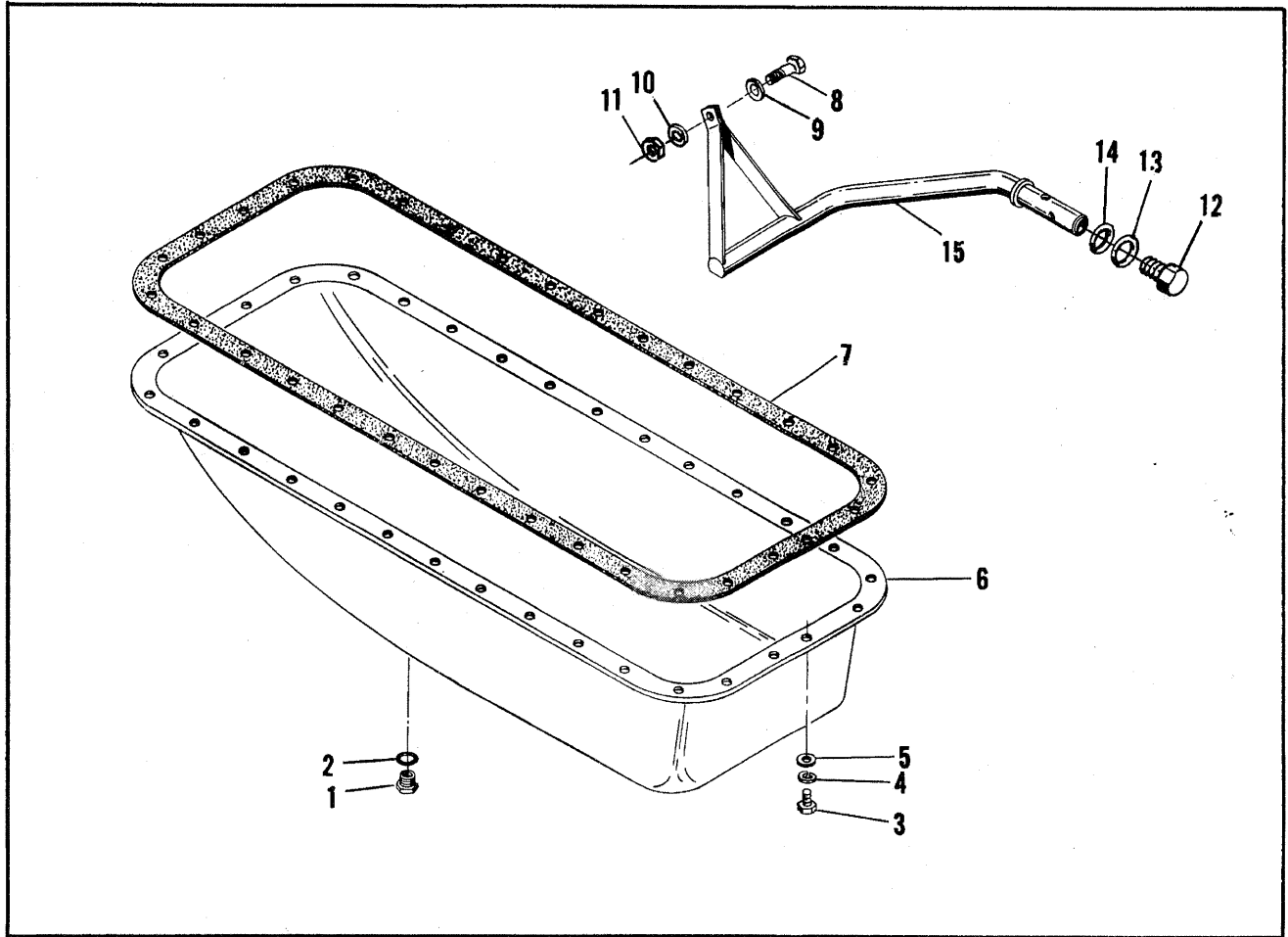


FIGURE 4-12. OIL SUMP, TSIO-520-B, E, J & K.

1. Plug, Oil Drain
2. Gasket, Annular
3. Screw, Hex Head
4. Washer, Lock
5. Washer, Plain
6. Sump Assembly, Oil
7. Gasket, Oil Sump
8. Bolt
9. Washer
10. Washer
11. Nut
12. Plug
13. Gasket, Annular
14. Gasket, Annular
15. Tube Assembly, Suction

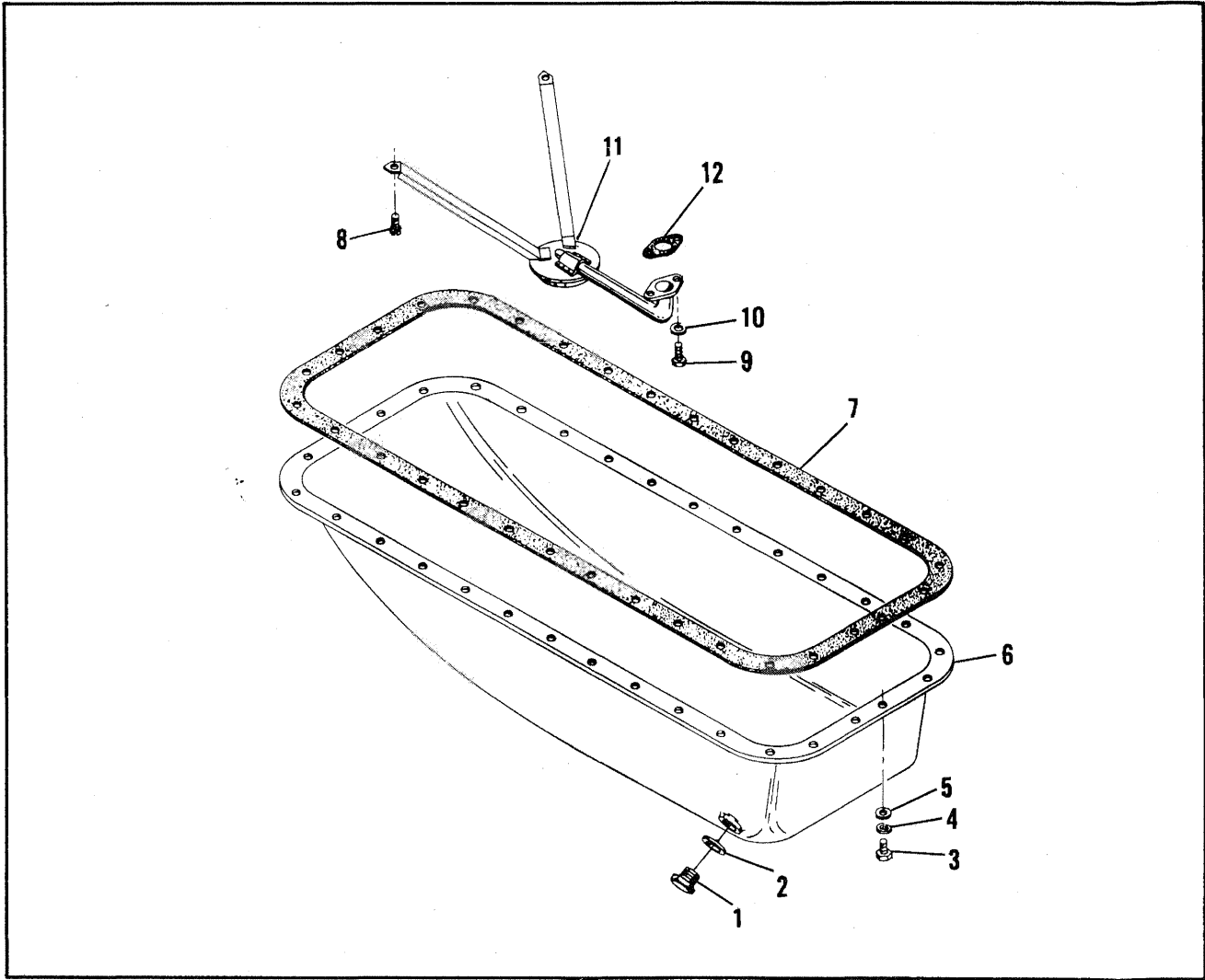


FIGURE 4-13. OIL SUMP, TS10-520-C & G.

1. Plug, Oil Drain
2. Gasket, Annular
3. Screw, Hex Head
4. Washer, Lock
5. Washer, Plain
6. Sump Assembly, Oil
7. Gasket, Oil Sump
8. Bolt, Drilled Head
9. Bolt, Drilled Head
10. Washer, Plain
11. Tube Assembly, Suction
12. Gasket, Suction Tube

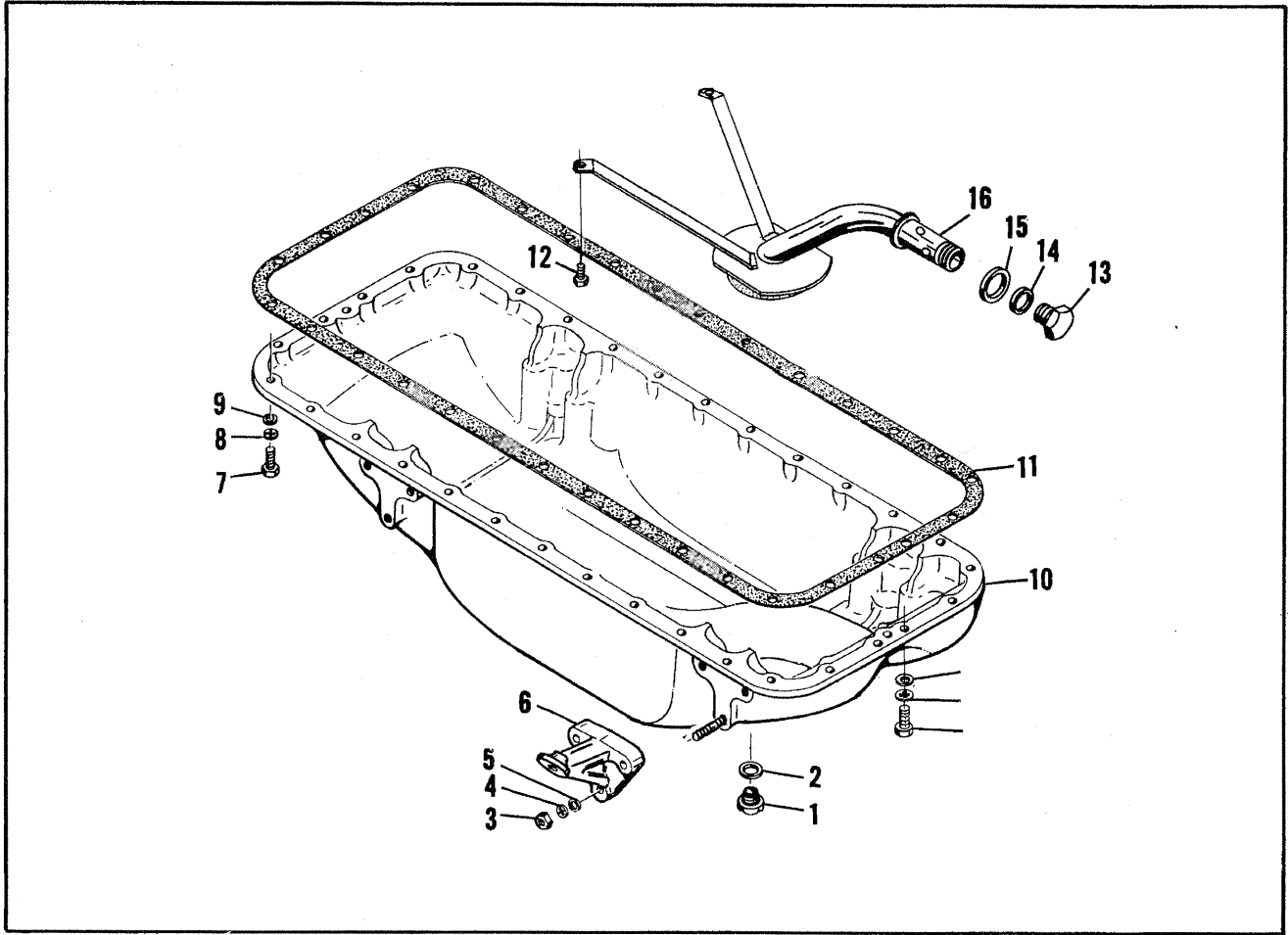


FIGURE 4-14. OIL SUMP, TSIO-520-D.

1. Plug, Oil Drain
2. Gasket, Annular
3. Nut
4. Washer, Lock
5. Washer, Plain
6. Bracket, Engine Mount
7. Bolt
8. Washer, Lock
9. Washer, Plain
10. Sump Assembly, Oil
11. Gasket, Oil Sump
12. Bolt
13. Plug
14. Gasket, Annular
15. Gasket, Annular
16. Tube Assembly, Suction



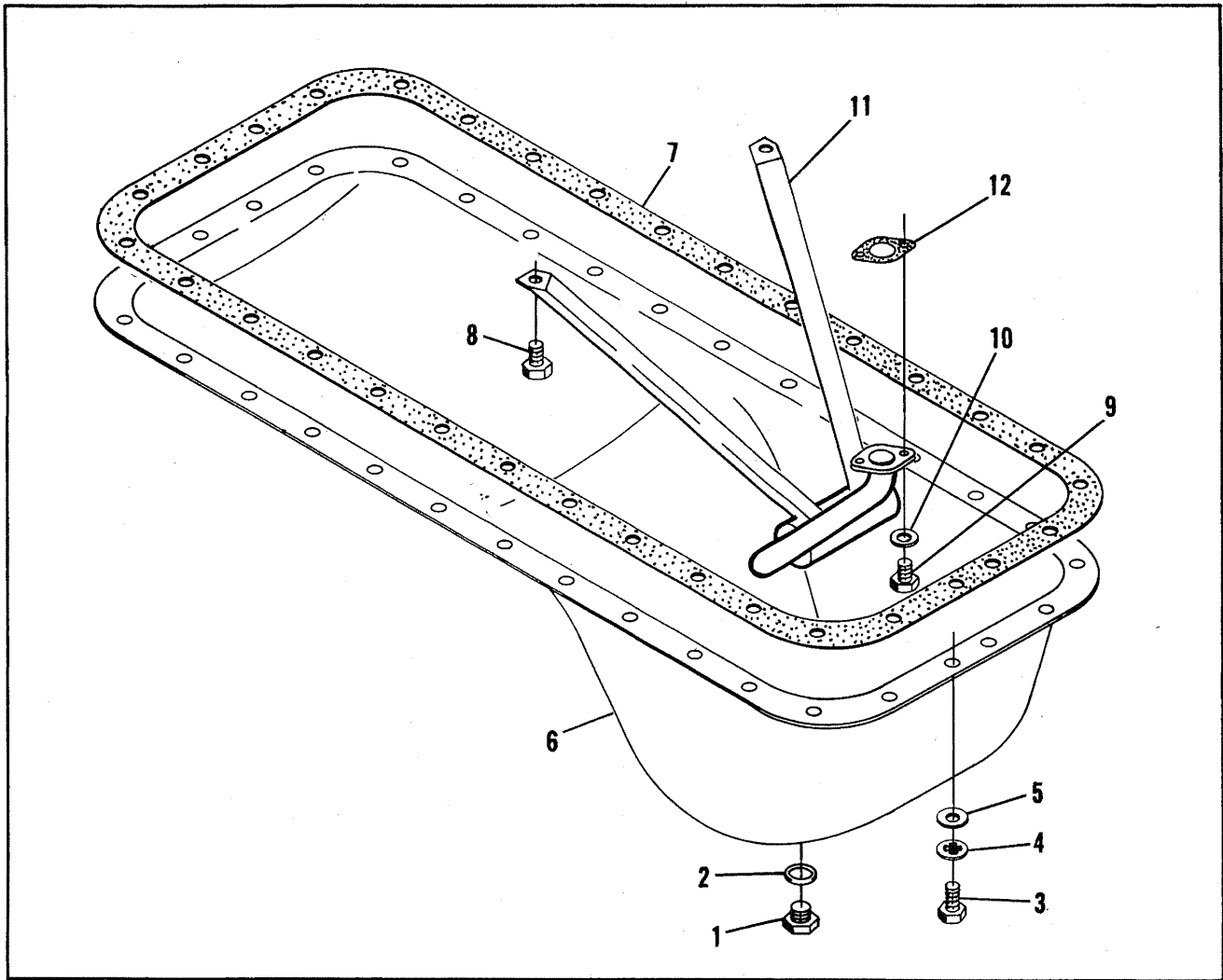


FIGURE 4-15. OIL SUMP, TS10-520-H.

1. Plug, Oil Drain
2. Gasket, Annular
3. Screw, Hex Head
4. Washer, Lock
5. Washer, Plain
6. Sump Assembly, Oil
7. Gasket, Oil Sump
8. Bolt, Drilled Head
9. Bolt, Drilled Head
10. Washer, Plain
11. Tube Assembly, Suction
12. Gasket, Suction Tube

4-24. OIL COOLER, PERMOLD ENGINE (See Figure 4-16).

a. Remove four sets of attaching parts (1,2,3) and one set of attaching parts (4,5,6); remove oil cooler (7) and gaskets (8,9).

b. Remove oil temperature control valve (16) and gasket (15).

4-25. OIL COOLER, SANDCAST ENGINE (See Figure 4-17).

a. Remove attaching parts (1,2,3) and separate oil cooler (4) and gasket (5) from adapter (9).

b. Remove attaching parts (6,7,8) and pull adapter (9) and gasket (10) from crankcase by tapping.

c. Remove oil temperature control valve (11) and gasket (12) from adapter.

4-26. ALTERNATOR ASSEMBLY, TSIO-520-B, D & E (See Figure 4-18).

a. Remove four sets of attaching parts (1,2,3) and pull baffle (5) and alternator (4) from crankcase.

b. Remove cotter pin (7) and nut (8). Pull hub assembly (10 thru 14) from alternator shaft. Remove Woodruff key (9).

c. Separate thrust washer (10), gear assembly (11,12), clutch spring (13) and hub (14).

d. Remove gasket (6).

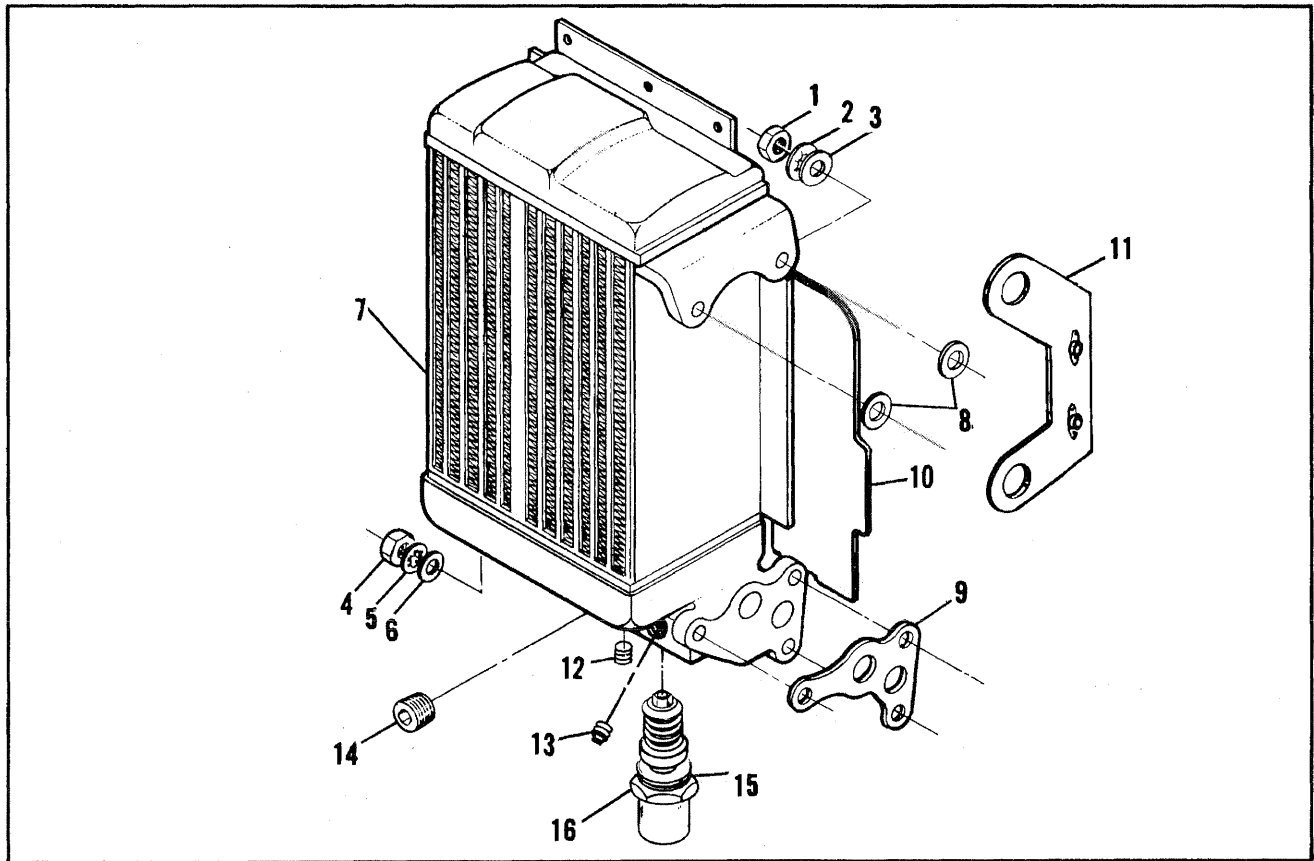


FIGURE 4-16. OIL COOLER, PERMOLD ENGINE.

- |                       |                                   |
|-----------------------|-----------------------------------|
| 1. Nut, Hex           | 9. Gasket                         |
| 2. Washer, Lock       | 10. Baffle                        |
| 3. Washer, Plain      | 11. Support Assembly, Baffle      |
| 4. Nut, Hex           | 12. Plug                          |
| 5. Washer, Lock       | 13. Plug                          |
| 6. Washer, Plain      | 14. Plug                          |
| 7. Cooler, Engine Oil | 15. Gasket, Control Valve         |
| 8. Gasket             | 16. Oil Temperature Control Valve |

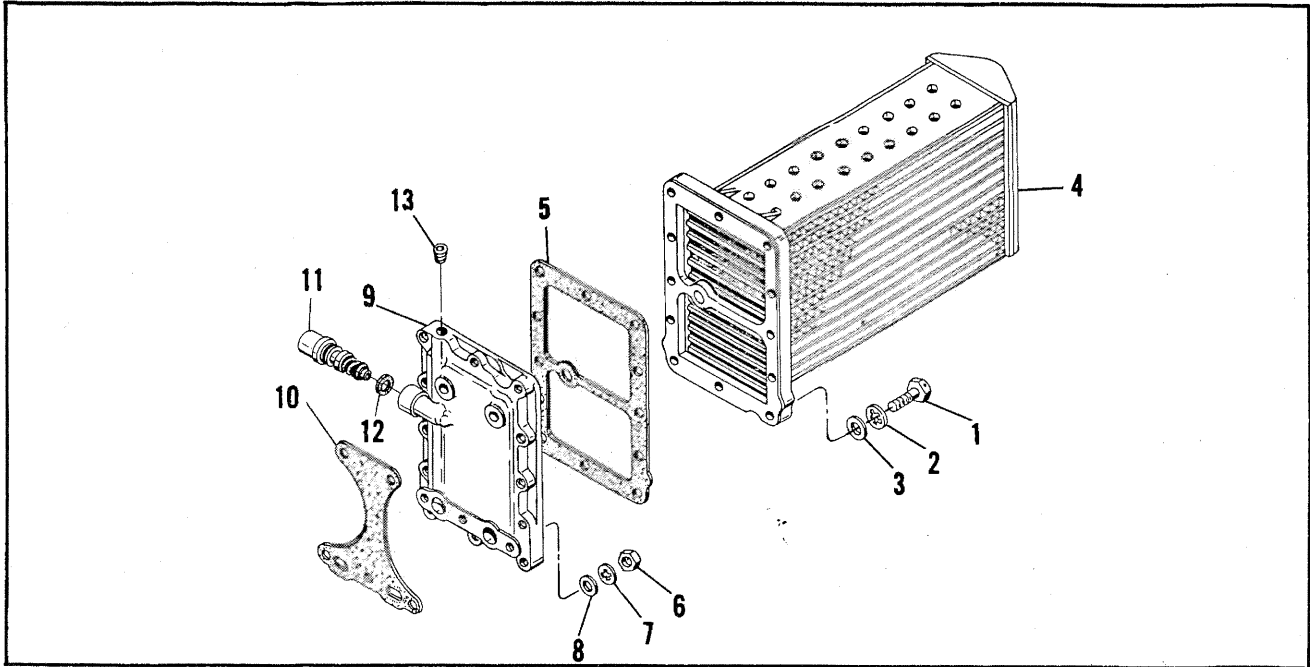


FIGURE 4-17. OIL COOLER, SANDCAST ENGINE.

- |                       |                              |                                   |
|-----------------------|------------------------------|-----------------------------------|
| 1. Bolt, Hex Head     | 6. Nut                       | 10. Gasket, Adapter Plate         |
| 2. Washer, Lock       | 7. Washer, Lock              | 11. Oil Temperature Control Valve |
| 3. Washer, Plain      | 8. Washer, Plain             | 12. Gasket, Control Valve         |
| 4. Cooler, Engine Oil | 9. Plate, Oil Cooler Adapter | 13. Plug                          |
| 5. Gasket, Oil Cooler |                              |                                   |

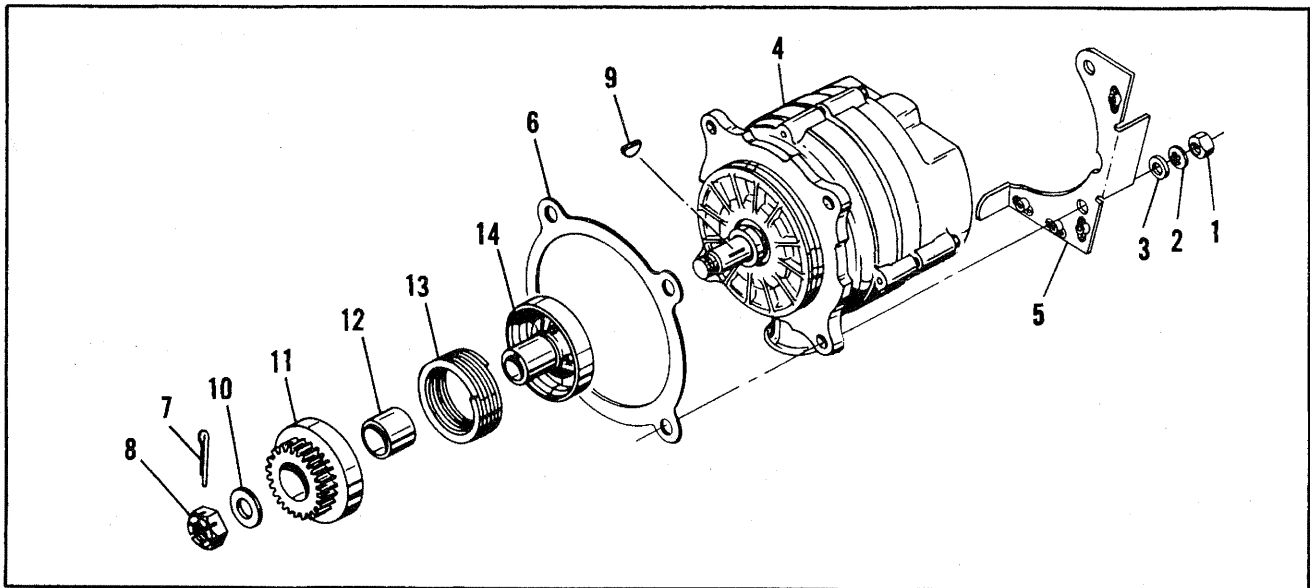


FIGURE 4-18. ALTERNATOR ASSEMBLY, TSIO-520-B, D, E, J & K.

- |                                  |                       |                                      |
|----------------------------------|-----------------------|--------------------------------------|
| 1. Nut, Hex                      | 6. Gasket, Alternator | 11. Gear Assembly, Alternator Driven |
| 2. Washer, Lock                  | 7. Pin, Cotter        | 12. Bushing                          |
| 3. Washer, Plain                 | 8. Nut, Slotted Hex   | 13. Spring, Clutch                   |
| 4. Alternator Assembly, Complete | 9. Key, Woodruff      | 14. Hub Assembly, Gear Driven        |
| 5. Support Assembly, Baffle      | 10. Washer, Thrust    |                                      |

**4-27. STARTER AND STARTER DRIVE ADAPTER, TSIO-520-B,D,E,J & K (See Figure 4-19).**

- a. Remove attaching parts (1,2) and pull starter (3) from adapter studs. Remove "O" ring (4).
- b. Remove retaining ring (33) using Truarc No. 5 or No. 25 pliers. Insert a wide blade tool into the worm gear shaft slot and rotate the shaft counterclockwise to break the ball bearing loose from the housing. If possible, remove entire shaft assembly from housing, otherwise remove after starter shaft has been removed.
- c. Remove four sets of attaching parts (5,6,7) (two on outside of crankcase between cylinder No. 1 and starter and two on cover assembly) and pull starter adapter assembly from crankcase.
- d. Remove five sets of attaching parts (9,10,11) and tap scavenge pump body (14) with a plastic hammer to remove. Remove gear and bushing assembly (15,16) and gear (17). If a Woodruff key (18) is used, the assembly must be converted to a splined drive at this time. (See Service Bulletin M72-8.)
- e. Remove two sets of attaching parts (19,20,21) and use an inertia puller or other suitable tool to detach cover assembly (22) and "O" ring (24) from starter adapter.
- f. Clamp starter shaftgear teeth in shielded vise and, with proper tool (Figure 3-8, Section III) inserted in the worm gear holes, rotate the worm

gear in driving direction to wind up the spring, at the same time pull axially to release the spring from the sleeve. Remove starter gearshaft (32) from worm wheel (30).

g. Clamp worm wheel in shielded vise and remove clutch spring retaining screw (27) and tab washer (28). With a brass drift or pin punch, tap front end of spring 180° away from spring retaining screw hole and go around spring O.D. tapping in each hole. This removes the spring tang from the drum groove. Spring can now be removed from drum.

h. If not accomplished in step b., remove bearing (34) and shaft assembly (35 thru 38). Separate worm gear (35), spring (36), Woodruff key (37) and shaft (38). It may be necessary to use arbor press to remove ball bearing (34) from shaft (38).

i. Use arbor press to remove needle bearing (39) from adapter (40).

j. Remove retaining ring (25) from shaft (32) and remove ball bearing (26).

k. An optional power take-off unit installed on some models utilizes the same basic starter adapter as described in paragraphs (a thru j). If the optional power take-off unit is used, it will not be possible to comply with the instructions in Service Bulletin M72-8. Disassemble by removing cotter pin (41), nut (42), sheave (43) and Woodruff key (44). Remove oil seal (45), retaining ring (46) and ball bearing (48) from the scavenge pump body assembly.

- |                          |                            |                         |
|--------------------------|----------------------------|-------------------------|
| 1. Nut, Hex              | 17. Gear, Driven           | 33. Ring, Retaining     |
| 2. Washer, Plain         | 18. Key, Woodruff          | 34. Bearing, Ball       |
| 3. Starter               | 19. Nut                    | 35. Gear, Worm          |
| 4. O-Ring                | 20. Washer, Lock           | 36. Spring              |
| 5. Nut, Hex              | 21. Washer, Plain          | 37. Key, Woodruff       |
| 6. Washer, Lock          | 22. Cover, Starter Adapter | 38. Shaft, Worm Drive   |
| 7. Washer, Plain         | 23. Plug                   | 39. Bearing, Needle     |
| 8. Gasket, Adapter       | 24. O-Ring                 | 40. Adapter             |
| 9. Nut, Hex              | 25. Ring, Retaining        | 41. Pin, Cotter         |
| 10. Washer, Lock         | 26. Bearing, Ball          | 42. Nut                 |
| 11. Washer, Plain        | 27. Screw, Special         | 43. Sheave              |
| 12. Shaft                | 28. Washer, Tab            | 44. Key, Woodruff       |
| 13. Plug                 | 29. Spring, Clutch         | 45. Seal, Oil           |
| 14. Body, Scavenge Pump  | 30. Gear, Worm Wheel       | 46. Ring, Retaining     |
| 15. Gear, Driven         | 31. Bearing, Roller        | 47. Bearing, Ball       |
| 16. Bushing, Driven Gear | 32. Shaftgear              | 48. Body, Scavenge Pump |

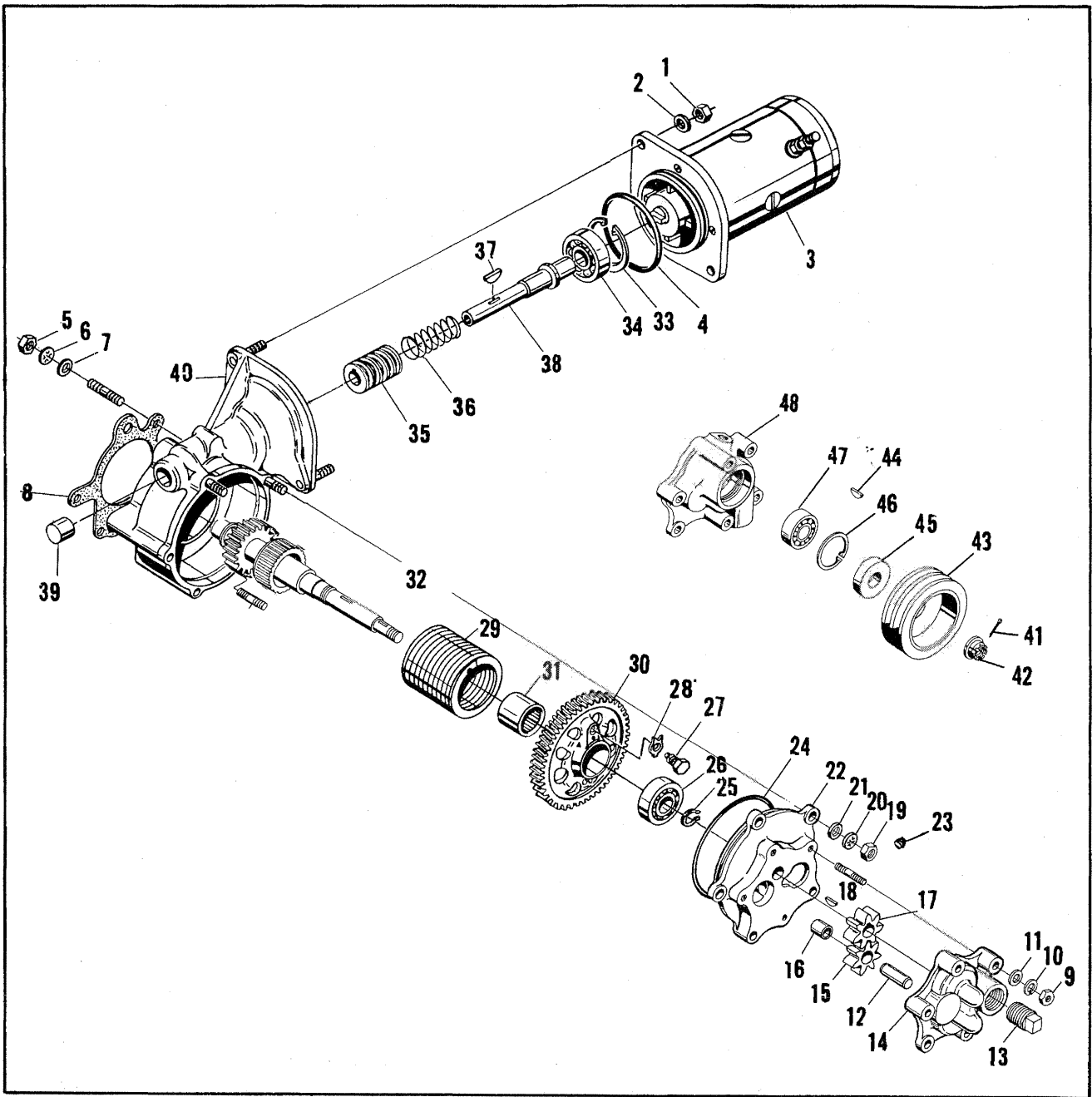


FIGURE 4-19. STARTER AND STARTER DRIVE ADAPTER, PERMOLD ENGINE.

**4-28. STARTER AND STARTER DRIVE ADAPTER, TSIO-520-C, G & H (See Figure 4-20).**

- a. Remove two sets of attaching parts (1,2,3) and pull starter (4) from adapter studs. Remove "O" ring (5).
- b. Remove retaining ring (33) using Truarc No. 5 or No. 25 pliers. Insert a wide blade tool into the worm gear slot and rotate the shaft counterclockwise to break the ball bearing (34) loose from the housing. If possible, remove the entire shaft assembly from the housing. If it does not come completely clear it will be more easily removed after the starter gearshaft has been removed.
- c. Remove four sets of attaching parts (6,7,8,9,10) and pull starter adapter assembly from crankcase studs.
- d. Clamp shaft gear (32) in shielded vise jaws and remove nut (12), lockwasher (13) and plain washer (14). Pull sheave (15) from shaft and remove Woodruff key (16).
- e. Remove attaching parts (17,18,19) and pull cover (21) together with sleeve (23), oil seal (24) and retaining ring (25) from shaft. Remove bearing (26) and "O" ring (27). It may require a few raps with a non-marring hammer to dislodge the cover (21) from the housing (40).

f. Use Truarc No. 3 or No. 23 pliers to remove retaining ring (25). Use arbor press to remove sleeve (23) and oil seal (24). Remove gasket (22) from adapter.

g. With proper tool (Figure 3-8, Section III) inserted in the worm gear holes, rotate the worm gear in driving direction to wind up the spring at the same time pull the spring axially to release the spring from the sleeve. Remove the starter shaft (32) from the worm wheel (31).

h. Clamp worm wheel (31) in shielded vise and remove spring retaining screw (29) and tab washer (30). With a brass drift or pin punch, tap front end of spring 180° from spring retaining screw, hold and go around spring O.D. tapping in each hole. This removes the spring tang from the drum groove. Spring can now be removed from drum.

i. If not accomplished in step b., remove bearing (34) and shaft assembly (35 thru 38). Separate worm gear (35), spring (36), shaft (37) and Woodruff key (38). It may be necessary to use arbor press to remove ball bearing (34) from shaft (37).

j. Use arbor press to remove needle bearing (39) from housing (40).

- |                     |                             |                       |
|---------------------|-----------------------------|-----------------------|
| 1. Nut, Hex         | 14. Washer, Plain           | 28. Spring, Clutch    |
| 2. Washer, Lock     | 15. Sheave, Generator Drive | 29. Screw, Special    |
| 3. Washer, Plain    | 16. Key, Woodruff           | 30. Washer, Tab       |
| 4. Starter          | 17. Screw                   | 31. Gear, Worm Wheel  |
| 5. O-Ring           | 18. Washer, Lock            | 32. Shaftgear         |
| 6. Nut, Hex         | 19. Washer, Plain           | 33. Ring, Retaining   |
| 7. Washer, Lock     | 20. Indicator, Timing       | 34. Bearing, Ball     |
| 8. Washer, Plain    | 21. Cover, Starter Adapter  | 35. Gear, Worm        |
| 9. Bolt             | 22. Gasket, Adapter Cover   | 36. Spring            |
| 10. Bolt            | 23. Sleeve                  | 37. Shaft, Worm Drive |
| 11. Gasket, Adapter | 24. Seal, Oil               | 38. Key, Woodruff     |
| 12. Nut, Check      | 25. Ring, Retaining         | 39. Bearing, Needle   |
| 13. Washer, Lock    | 26. Bearing, Ball           | 40. Adapter           |
|                     | 27. O-Ring                  |                       |

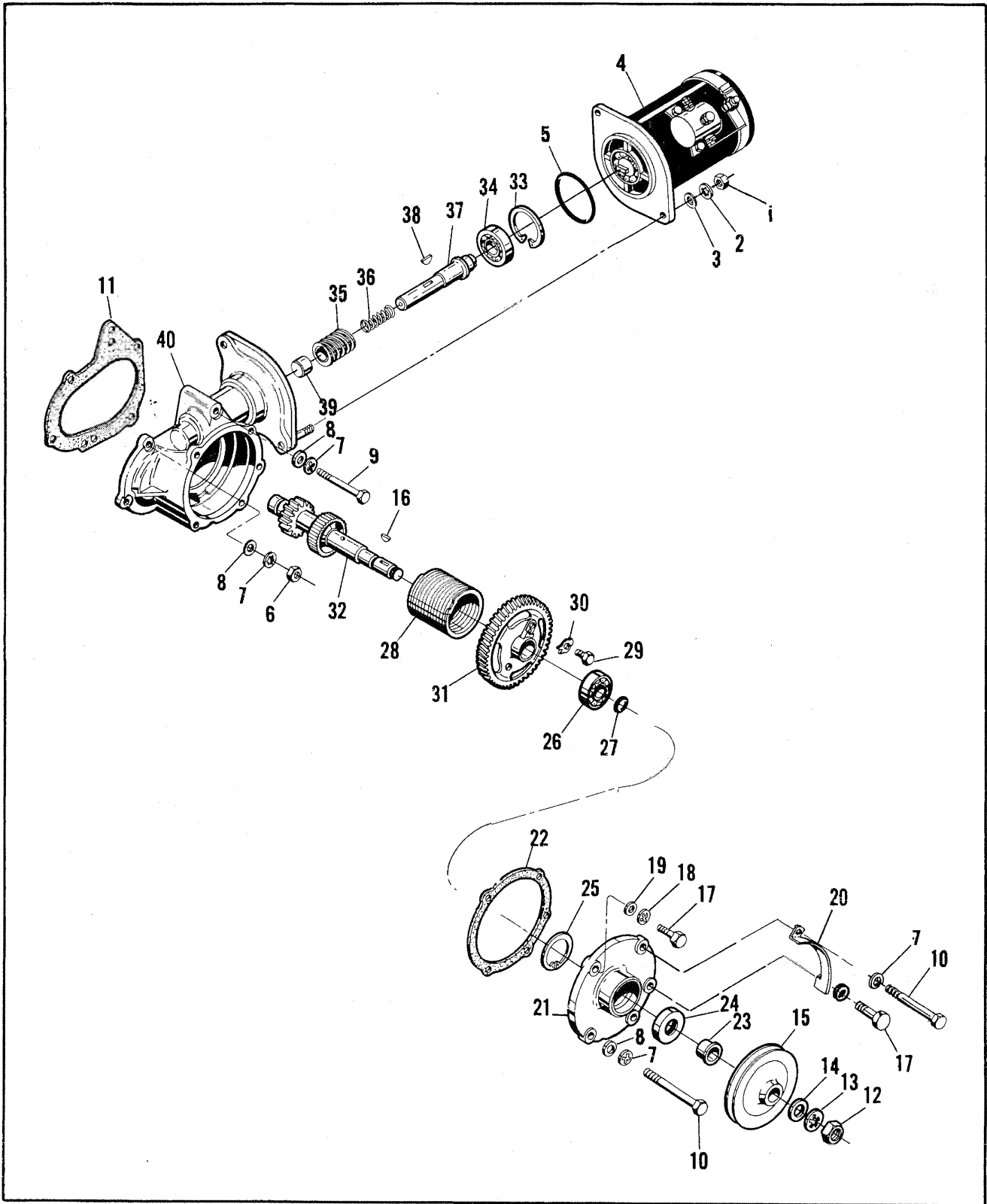


FIGURE 4-20. STARTER AND STARTER DRIVE ADAPTER, SANDCAST ENGINE.

**4-29. OIL PUMP ASSEMBLY, PERMOLD ENGINE FULL FLOW TYPE FILTER (See Figure 4-21).**

- a. If electric tachometer (23 thru 30) is used, loosen tachometer housing (27) at this time. (Housing has a left-hand thread.)
- b. If electric tachometer is used, remove attaching parts (23,24,25) and separate cover (26) from oil pump housing (47). Remove tachometer drive housing (27), gasket (28), oil seal (29) and shaft-gear (30).
- c. Cut lockwire and remove filter (1). Remove attaching parts (2,3,4) and separate adapter (5) and gasket (6) from oil pump housing (47).
- d. Remove attaching parts (7,8,9) and lift off housing (10). Remove attaching parts (11,12,13) to remove cover (14) and gasket (15). Remove attaching parts (18,19,20) to remove cover (21) and gasket (22).
- e. Remove oil seal (16) and shaftgear (17) from cover (10).
- f. Lift out shaftgear assembly (31,32,33) and driven gear assembly (34,35) from oil pump housing (47).
- g. Remove oil pressure relief valve (36 thru 43) from oil pump housing (47).
- h. Remove attaching parts (44,45,46) and pull oil pump housing (47) from crankcase studs. Remove gasket (48).
- i. Parts (49 thru 63) have been replaced by a new style spin on filter.

**4-30. OIL PUMP ASSEMBLY, SANDCAST ENGINE (See Figure 4-22).**

- a. If oil filter screen assembly (not shown) has not been removed, do so at this time.
- b. Loosen tachometer drive housing (10) to facilitate later removal. (Tachometer drive housing has a left-hand thread.) Remove ten sets of attaching parts (1,2,3) and pull pump assembly (4) to the rear. Remove gasket (5).
- c. Remove attaching parts (6,7,8); separate bracket (30, Figure 4-7) from hole marked "X" in cover (9) and remove cover from scavenge pump housing (18). Remove tachometer drive housing (10). Press oil seal (11) from housing. Remove gasket (12) and shaftgear (13).
- d. Remove attaching parts (15,16,17) and separate scavenge pump housing (18) from oil pump housing (4). Remove gear assembly (19,20) and gear (21) from scavenge pump housing. Remove Woodruff key (22).
- e. Remove oil pump drive gear assembly (23, 24,25) and separate tachometer drive gear (23), oil pump drive gear (24) and pin (25). Remove oil pump driven gear and bushing assembly (26,27).
- f. Remove oil pressure relief valve (28 through 35) and oil pressure by-pass valve assembly (36 through 39).



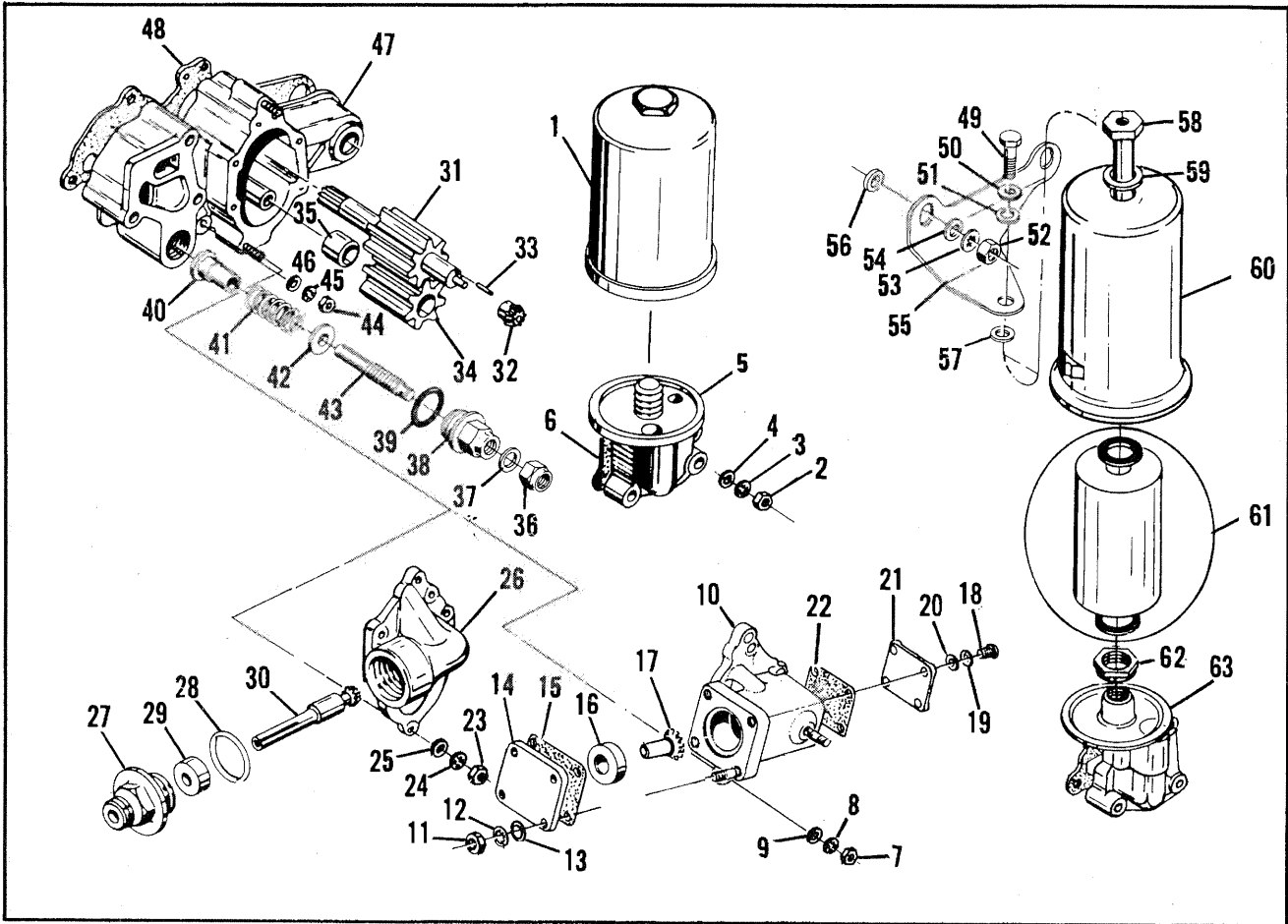


FIGURE 4-21. OIL PUMP ASSEMBLY, PERMOLD ENGINE.

- |                                 |                           |                              |
|---------------------------------|---------------------------|------------------------------|
| 1. Filter Assembly, Oil         | 21. Cover, Tach Gear Box  | 43. Screw, Adjusting         |
| 2. Nut, Hex                     | 22. Gasket, Tach Gear Box | 44. Nut, Hex                 |
| 3. Washer, Lock                 | 23. Nut, Hex              | 45. Washer, Lock             |
| 4. Washer, Plain                | 24. Washer, Lock          | 46. Washer, Plain            |
| 5. Adapter Assembly, Oil Filter | 25. Washer, Plain         | 47. Housing, Oil Pump        |
| 6. Gasket, Oil Filter Adapter   | 26. Cover, Tach Drive     | 48. Gasket, Oil Pump Housing |
| 7. Nut, Hex                     | 27. Housing, Tach Drive   | *49. Bolt                    |
| 8. Washer, Lock                 | 28. Gasket, Annular       | *50. Washer, Lock            |
| 9. Washer, Plain                | 29. Seal, Oil             | *51. Washer, Plain           |
| 10. Cover, Tach Drive           | 30. Shaftgear             | *52. Nut, Hex                |
| 11. Nut, Hex                    | 31. Shaftgear             | *53. Washer, Lock            |
| 12. Washer, Lock                | 32. Gear, Bevel           | *54. Washer, Plain           |
| 13. Washer, Plain               | 33. Dowel                 | *55. Bracket                 |
| 14. Cover, Tach Drive Pad       | 34. Gear, Driven          | *56. Spacer                  |
| 15. Gasket, Tach Drive Pad      | 35. Bushing               | *57. Spacer                  |
| 16. Seal, Oil                   | 36. Nut, Stop             | *58. Stud Assembly, Center   |
| 17. Shaftgear                   | 37. Washer, Copper        | *59. Gasket, Copper          |
| 18. Screw, Round Head           | 38. Housing, Relief Valve | *60. Housing, Oil Filter     |
| 19. Washer, Lock                | 39. Gasket, Annular       | *61. Element, Filter         |
| 20. Washer, Plain               | 40. Plunger, Relief Valve | *62. Nut, Nylon Lock         |
|                                 | 41. Spring, Relief Valve  | *63. Adapter                 |
|                                 | 42. Seat, Spring Guide    |                              |

\* Parts so indicated were used on early models and have been replaced by spin-on filter (1) and adapter (6). If adapter (63) is serviceable, a new element may be ordered.

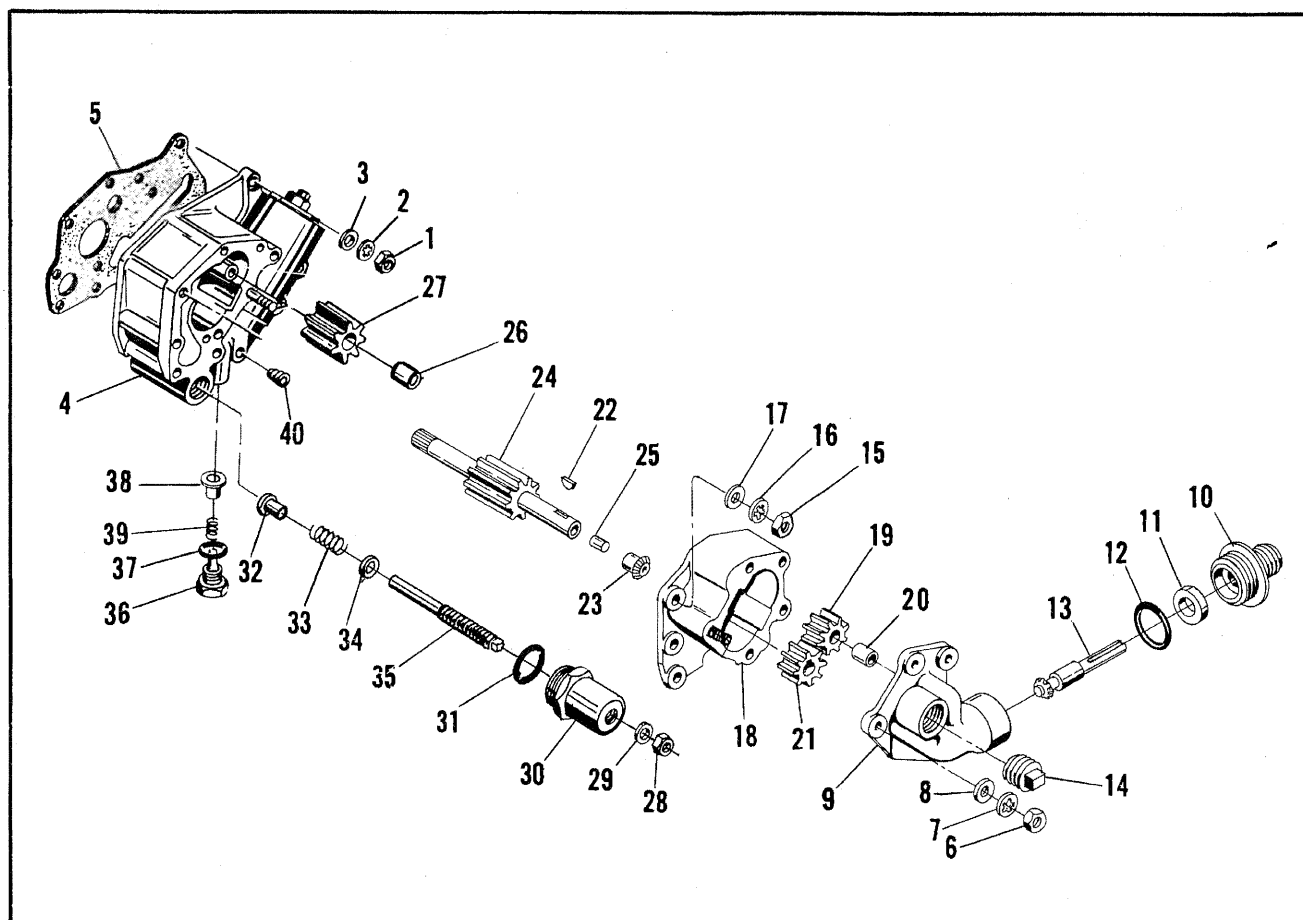


FIGURE 4-22. OIL PUMP ASSEMBLY, SANDCAST ENGINE.

- |                                |                                  |
|--------------------------------|----------------------------------|
| 1. Nut, Hex                    | 21. Gear, Driven                 |
| 2. Washer, Lock                | 22. Key, Woodruff                |
| 3. Washer, Plain               | 23. Gear, Bevel                  |
| 4. Housing, Oil Pump           | 24. Shaftgear                    |
| 5. Gasket, Oil Pump Housing    | 25. Pin, Dowel                   |
| 6. Nut, Hex                    | 26. Bushing, Driven Gear         |
| 7. Washer, Lock                | 27. Gear, Oil Pump Driven        |
| 8. Washer, Plain               | 28. Nut, Adjusting Screw         |
| 9. Cover, Scavenge Pump        | 29. Washer, Copper               |
| 10. Housing, Tach Drive        | 30. Housing, Relief Valve        |
| 11. Seal, Oil                  | 31. Gasket, Annular              |
| 12. Gasket, Tach Drive Housing | 32. Plunger, Relief Valve        |
| 13. Shaftgear                  | 33. Spring, Relief Valve         |
| 14. Plug                       | 34. Seat, Spring Guide           |
| 15. Nut, Hex                   | 35. Screw, Adjusting             |
| 16. Washer, Lock               | 36. Pin & Plug Assembly, By-Pass |
| 17. Washer, Plain              | 37. Gasket, Annular              |
| 18. Body, Scavenge Pump        | 38. Valve, By-Pass               |
| 19. Gear, Driven               | 39. Spring, By-Pass              |
| 20. Bushing, Driven Gear       | 40. Plug, Pipe                   |

#### 4-31. CYLINDER AND PISTON ASSEMBLY (See Figure 4-23).

- a. Remove attaching parts (1,2,3), cover (4) and gasket (5).
- b. Position crankshaft so valve lifters of cylinders to be removed are on base circle of cam lobes and both valves are fully closed. Remove screw (6), washer (7), shafts (8), rocker assemblies (9,10,11) and thrust washers (12). Withdraw pushrods (13). Repeat these steps on remaining cylinders.
- c. Push the pushrod housing (14) against the spring (15) until the cylinder flange end is clear. Lift cylinder end of housing and withdraw from crankcase. Remove spring (15), washers (16) and packing (17).
- d. Remove one flanged nut (18) and three flanged nuts (19) from each cylinder flange. Rotate engine stand so engine is in upright position. Make sure piston in cylinder to be removed is top dead center. Remove remainder of nuts (18,19). Cradle cylinder in arm and withdraw it straight outward. Catch piston with other hand as it clears the cylinder to prevent damage to piston or crankcase.

#### CAUTION

*Do not let the rods drop against the cylinder deck. Rod protectors can be fashioned by placing a used cylinder base "O" ring around the rod and in a figure eight manner around the cylinder deck studs (See Figure 8-4).*

- e. Remove cylinder base "O" ring (21). Use of a cylindrical wood block anchored to a workbench, with provisions for clamping the cylinder in place, is recommended to facilitate removal of valve springs and to prevent dropping of valves.
- f. Compress valve springs and remove keys (22). Be careful not to cock retainers (23,24) thus scoring valve stems. Remove roto cap (23) or upper retainer (24), outer spring (25), inner spring (26) and lower retainer (27). Hold valve stems while lifting cylinder from its support, and lay cylinder on its side. Stone down any nicks before removing valve stems (28,29). It is recommended that all exhaust valves be replaced at each major overhaul regardless of condition.

- g. Remove piston pin (38) and piston (39) with rings (40,41,42,43) as an assembly. Remove rings (40,41,42,43) from piston (39). Be careful not to score piston with ring ends.

- h. Remove hydraulic valve lifter assemblies (44). It is recommended that all hydraulic lifters be replaced at each major overhaul regardless of condition.

#### 4-32. CRANKCASE, PERMOLD ENGINE (See Figure 4-24).

- a. Remove oil gauge rod (1). Remove attaching parts (2,3,4) and detach oil filler tube (5), gasket (6) and "O" ring (7) from crankcase.
- b. Remove backbone attaching parts (8,9,10) and (11,12,13), bolts (14,16) and washer (15), lifting eye (17), spacer (18) and manifold valve (19).
- c. Remove nut (20), washers (21,22), spacer (23) and lift off governor pad cover (24) and gasket (25).
- d. Remove four sets of attaching parts (83,84, 85) and prop shaft seal retainer (82) from models B, E, J & K.
- e. Remove camshaft hole cover attaching parts (26,27,28), cover (29) and gasket (30).
- f. Rotate engine stand bed to place left crankcase downward. Place a length of pipe or wood under the left crankcase to support it during disassembly. Remove right mount brackets (58,59, 60,61 & 62).
- g. Remove two sets of attaching parts (31,32), idler gear flanged bushing (33) and gasket (34).
- h. Remove attaching parts (35 through 60). Tap crankcase through bolts (63 through 67) with a non-marring hammer and remove carefully from crankcase so as not to damage threads. Remove "O" rings (53).

#### NOTE

Do not attempt to remove bolt and washer adjacent to right magneto upper stud. These two parts are installed before the stud and cannot be removed before removal of that stud without damage to crankcase hole. Take care to avoid damage to bolt threads during subsequent operations.

i. Lift off right crankcase being careful not to let connecting rods hit cylinder deck. Lift out camshaft assembly and governor driven gear. (See Figure 4-26.) Remove idler gear, crankshaft assembly with connecting rods, thrust washers and main bearings (See Figure 4-27).

j. Remove dowel pin (68) and idler gear bushing (69).

#### 4-33. CRANKCASE, SANDCAST ENGINE (See Figure 4-25).

a. Oil gauge rod, guide and brackets (Items 1 through 12) are shipped loose with the engine, and were probably returned in the same manner. If not, remove in the order of index numbers assigned.

b. Unhook filler cap retaining ring and remove oil cap retainer assembly (13) and gasket (14). Remove three screws (15) and lift off oil filler neck (16) and gasket (17).

c. Remove backbone attaching parts (18,19,20) and (21,22,23), screws (24,26) and washer (25). Remove lifting eye (27), spacer (28) and manifold valve (29).

d. Cut locking wire and remove special plug (30), gasket (31) and "O" ring (32).

e. Remove nut (33), washers (34,35), spacer (36) and lift off governor pad cover (37). Remove gasket (38).

f. Remove idler gear support pin attaching parts (39,40) and hold idler gear while support pin (41) is withdrawn. Lower gear to rest in left crankcase. Remove gasket (42).

g. Remove parts indexed (43 through 59).

h. Rotate engine stand bed so that left crankcase will be downward. Support it with a length of pipe or wood.

i. Remove remaining crankcase-to-crankcase flange bolts (63), nuts (60) and washers (61,62).

#### NOTE

Do not attempt to remove bolt and washer adjacent to right magneto upper stud. These two parts are installed before the stud and cannot be removed prior to removal of that stud without damage to crankcase hole. Take care to avoid damage to bolt threads during subsequent overhaul operations.

j. With a non-marring hammer, tap upper ends of through bolts (64,65,66,67) and pull them downward and out of crankcase, carefully, so as not to damage threads.

k. Remove attaching parts (68,69,70) and remove mounting brackets (71).

l. Lift off right crankcase subassembly. Exercise care to prevent connecting rods from hitting cylinder deck.

m. Lift out camshaft assembly and governor driven gear (See Figure 4-26).

n. Lift out idler gear assembly, crankshaft assembly with connecting rods, thrust washers and bearings (See Figure 4-28).

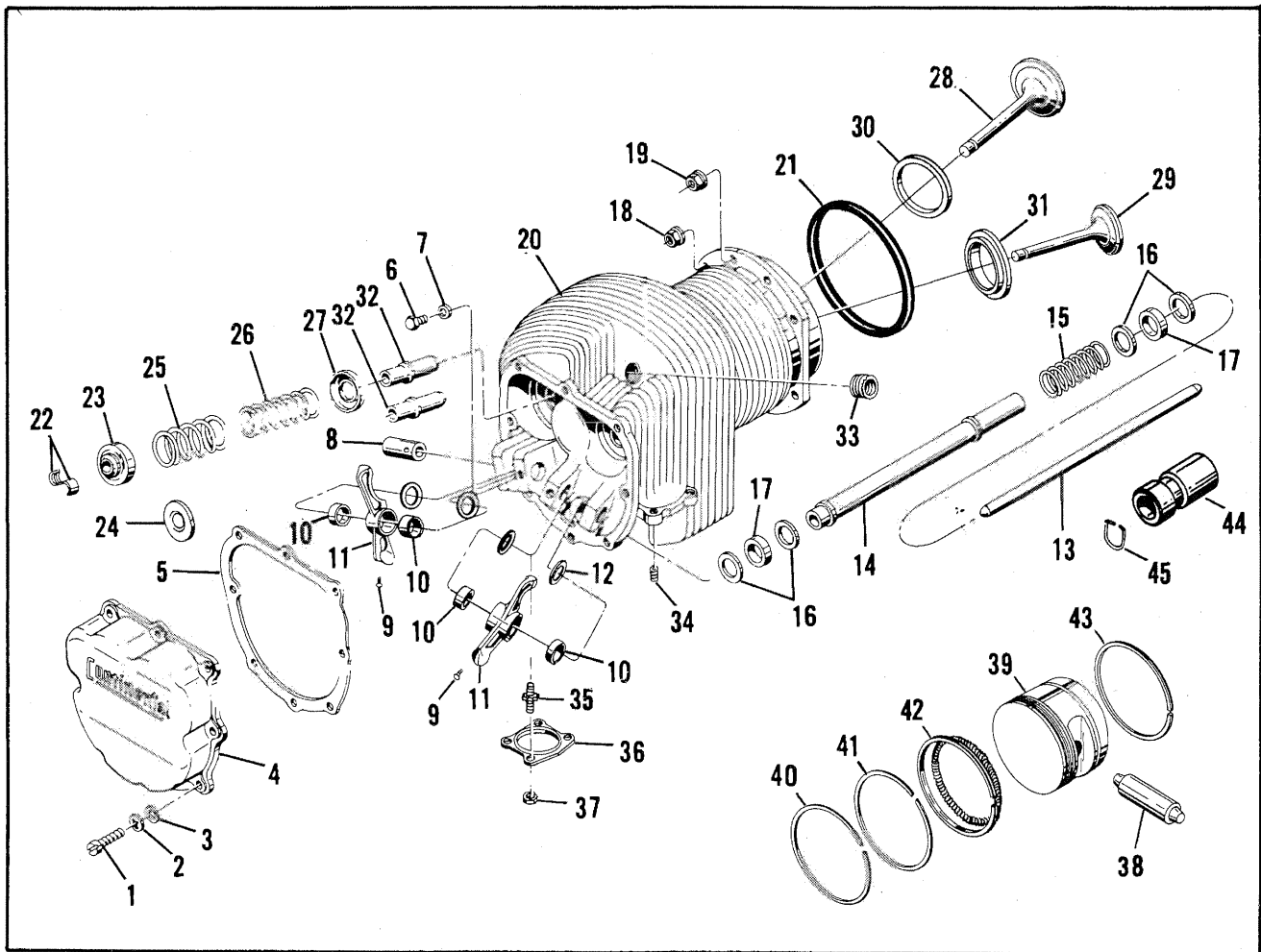


FIGURE 4-23. CYLINDER AND PISTON ASSEMBLY.

- |                               |                                       |                                      |
|-------------------------------|---------------------------------------|--------------------------------------|
| 1. Screw, Fillister Head      | 17. Packing, Push Rod Housing         | 32. Guide, Valve                     |
| 2. Washer, Lock               | 18. Nut, Flanged                      | 33. Insert, Spark Plug               |
| 3. Washer, Plain              | 19. Nut, Flanged                      | 34. Insert, Intake Flange            |
| 4. Cover, Valve Rocker        | 20. Cylinder Assembly                 | 35. Stud                             |
| 5. Gasket, Valve Rocker Cover | 21. O-Ring, Cylinder Base             | 36. Gasket Assembly, Exhaust Flange  |
| 6. Screw, Hex Head            | 22. Key, Retainer                     | 37. Nut, Hex Head                    |
| 7. Washer, Plain              | 23. Roto Coil Assembly, Exhaust Valve | 38. Pin and Plug Assembly            |
| 8. Shaft, Valve Rocker        | 24. Retainer, Intake Valve            | 39. Piston                           |
| 9. Screw, Drive               | 25. Spring, Outer                     | 40. Ring, Compression                |
| 10. Bushing, Valve Rocker     | 26. Spring, Inner                     | 41. Ring, Compression                |
| 11. Rocker,                   | 27. Retainer, Lower                   | 42. Ring Assembly, Oil Control       |
| 12. Washer, Thrust            | 28. Valve, Intake                     | 43. Ring, Scraper                    |
| 13. Push Rod                  | 29. Valve, Exhaust                    | 44. Lifter Assembly, Hydraulic Valve |
| 14. Housing, Push Rod         | 30. Insert, Intake Valve              | 45. Ring, Retaining                  |
| 15. Spring, Push Rod Housing  | 31. Insert, Exhaust Valve             |                                      |
| 16. Washer, Push Rod Housing  |                                       |                                      |

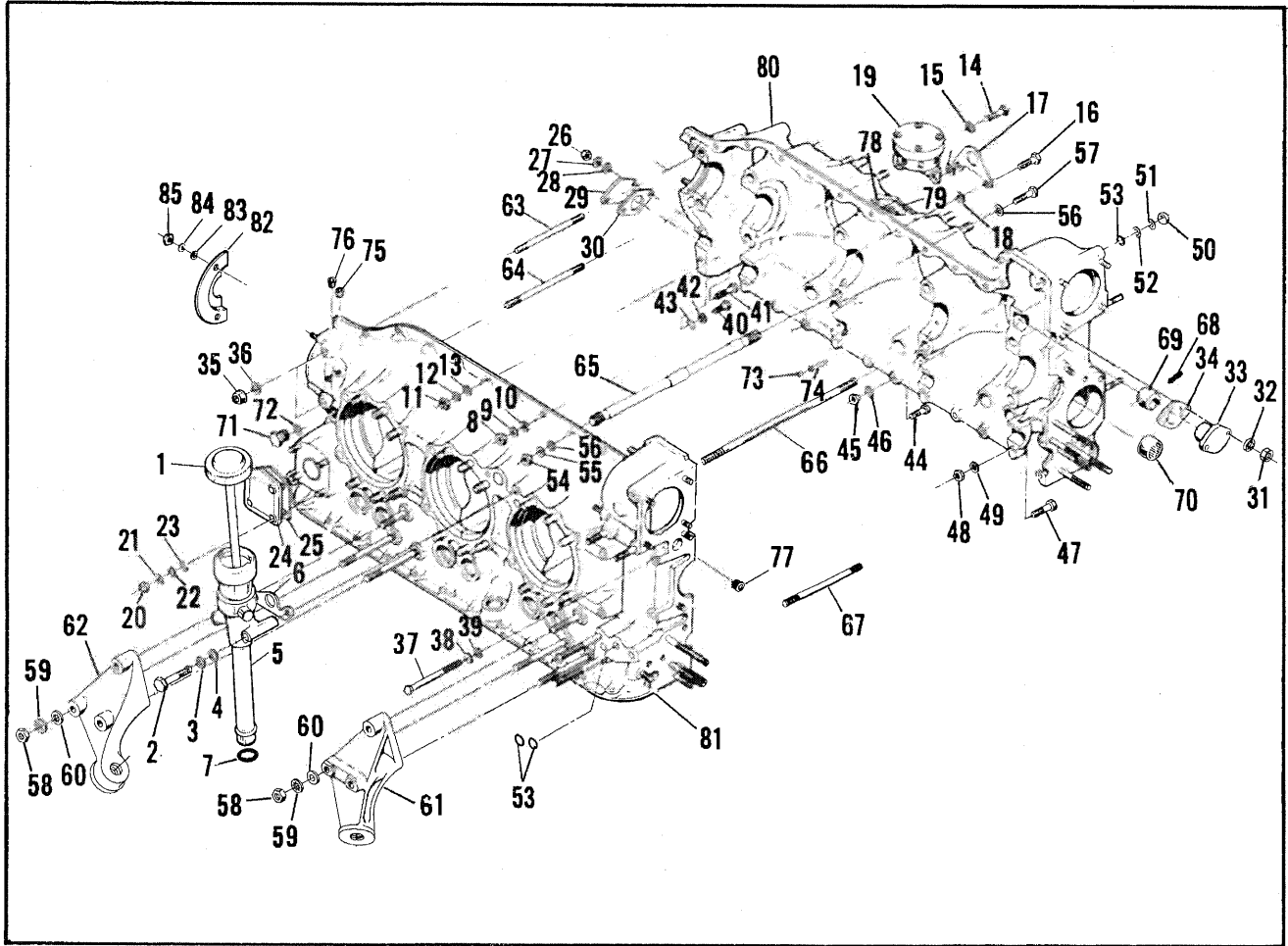


FIGURE 4-24. CRANKCASE ASSEMBLY, PERMOLD ENGINE.

- |                                       |                           |
|---------------------------------------|---------------------------|
| 1. Rod and Cap Assembly,<br>Oil Gauge | 42. Washer, Lock          |
| 2. Bolt, Hex Head                     | 43. Washer, Plain         |
| 3. Washer, Lock                       | 44. Bolt, Hex Head        |
| 4. Washer, Plain                      | 45. Nut, Lock             |
| 5. Breather Assembly,<br>Oil Filler   | 46. Washer, Plain         |
| 6. Gasket, Breather<br>Assembly       | 47. Bolt, Hex Head        |
| 7. O-Ring, Breather Assembly          | 48. Nut, Lock             |
| 8. Nut, Hex                           | 49. Washer, Plain         |
| 9. Washer, Lock                       | 50. Nut, Hex              |
| 10. Washer, Plain                     | 51. Washer, Lock          |
| 11. Nut, Hex                          | 52. Washer, Plain         |
| 12. Washer, Lock                      | 53. O-Ring                |
| 13. Washer, Plain                     | 54. Nut, Hex              |
| 14. Bolt, Hex Head                    | 55. Washer, Lock          |
| 15. Washer, Plain                     | 56. Washer, Plain         |
| 16. Bolt, Hex Head                    | 57. Bolt, Hex Head        |
| 17. Eye, Engine Lifting               | 58. Nut, Hex              |
| 18. Spacer                            | 59. Washer, Lock          |
| 19. Valve Assembly, Fuel<br>Manifold  | 60. Washer, Plain         |
| 20. Nut, Hex                          | 61. Bracket, Engine Mount |
| 21. Washer, Lock                      | 62. Bracket, Engine Mount |
| 22. Washer, Plain                     | 63. Bolt, Thru            |
| 23. Spacer                            | 64. Bolt, Thru            |
| 24. Cover, Governor Pad               | 65. Bolt, Thru            |
| 25. Gasket, Governor Pad Cover        | 66. Bolt, Thru            |
| 26. Nut, Hex                          | 67. Bolt, Thru            |
| 27. Washer, Lock                      | 68. Pin, Dowel            |
| 28. Washer, Plain                     | 69. Bushing, Idler Pin    |
| 29. Cover, Cam Hole                   | 70. Bearing, Needle       |
| 30. Gasket, Cam Hole Cover            | 71. Plug, Machine Thread  |
| 31. Nut, Hex                          | 72. Gasket, Copper        |
| 32. Washer, Lock                      | 73. Screen, Squirt Nozzle |
| 33. Bushing, Idler Gear               | 74. Nozzle, Squirt        |
| 34. Gasket, Idler Gear                | 75. Plug, Pipe            |
| 35. Nut, Flanged                      | 76. Plug, Pipe            |
| 36. Washer, Plain                     | 77. Plug, Pipe            |
| 37. Bolt, Drilled Head                | 78. Screw, Drive          |
| 38. Washer, Lock                      | 79. Plate, Identification |
| 39. Washer, Plain                     | 80. Crankcase, 1-3-5 Side |
| 40. Screw, Hex Head                   | 81. Crankcase, 2-4-6 Side |
| 41. Bolt, Hex Head                    | 82. Retainer, Oil Seal    |
|                                       | 83. Washer, Plain         |
|                                       | 84. Washer, Lock          |
|                                       | 85. Bolt                  |

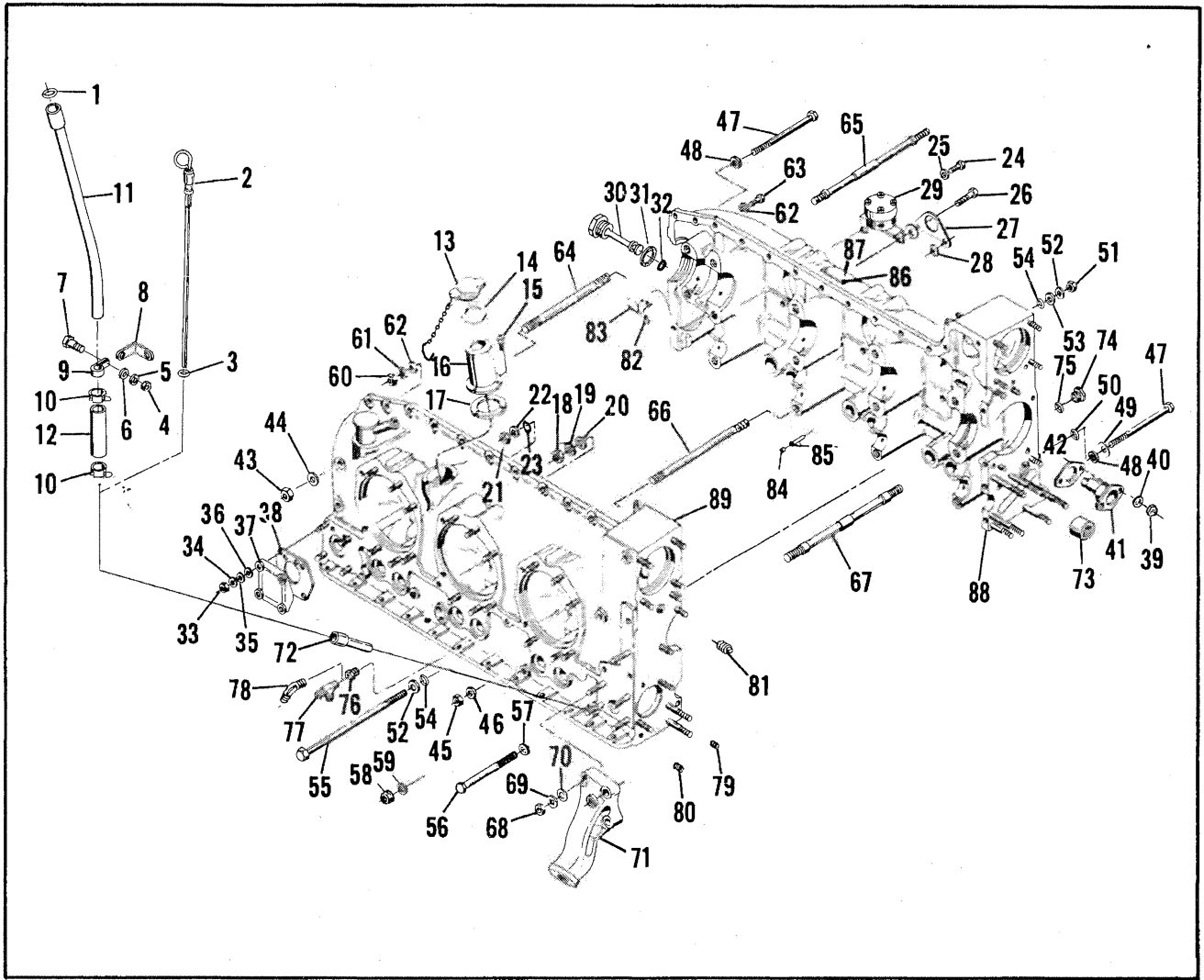


FIGURE 4-25. CRANKCASE ASSEMBLY, SANDCAST ENGINE.



- |                                   |                              |
|-----------------------------------|------------------------------|
| 1. Ring, Retaining                | 46. Washer, Plain            |
| 2. Rod Assembly, Oil Gauge        | 47. Bolt                     |
| 3. O-Ring                         | 48. Washer, Plain            |
| 4. Nut, Hex                       | 49. Washer, Plain            |
| 5. Washer, Lock                   | 50. O-Ring                   |
| 6. Washer, Lock                   | 51. Nut, Hex                 |
| 7. Screw                          | 52. Washer, Lock             |
| 8. Bracket                        | 53. Washer, Plain            |
| 9. Clamp                          | 54. O-Ring                   |
| 10. Clamp                         | 55. Bolt                     |
| 11. Housing, Extension            | 56. Bolt                     |
| 12. Hose                          | 57. Washer, Plain            |
| 13. Cap Assembly, Oil Filler      | 58. Nut, Flanged             |
| 14. Gasket, Oil Filler Cap        | 59. Washer, Plain            |
| 15. Screw, Fillister Head         | 60. Nut, Hex                 |
| 16. Neck Assembly, Oil Filler     | 61. Washer, Lock             |
| 17. Gasket, Oil Filler Neck       | 62. Washer, Plain            |
| 18. Nut, Hex                      | 63. Bolt                     |
| 19. Washer, Lock                  | 64. Bolt, Thru               |
| 20. Washer, Plain                 | 65. Bolt, Thru               |
| 21. Nut, Hex                      | 66. Bolt, Thru               |
| 22. Washer, Lock                  | 67. Bolt, Thru               |
| 23. Washer, Plain                 | 68. Nut, Hex                 |
| 24. Bolt, Hex Head                | 69. Washer, Lock             |
| 25. Washer, Plain                 | 70. Washer, Plain            |
| 26. Bolt, Hex Head                | 71. Bracket, Engine Mounting |
| 27. Eye, Engine Lifting           | 72. Housing, Oil Gauge Rod   |
| 28. Spacer                        | 73. Bearing, Needle          |
| 29. Valve Assembly, Fuel Manifold | 74. Plug, Machine Thread     |
| 30. Plug, Special                 | 75. Gasket, Copper           |
| 31. Gasket, Special Plug          | 76. Reducer (Model C)        |
| 32. O-Ring                        | 77. Tee (Model G & H)        |
| 33. Nut, Hex                      | 78. Elbow                    |
| 34. Washer, Lock                  | 79. Plug, Pipe               |
| 35. Washer, Plain                 | 80. Plug, Pipe               |
| 36. Spacer                        | 81. Plug, Pipe               |
| 37. Cover, Governor Pad           | 82. Screw                    |
| 38. Gasket, Governor Pad Cover    | 83. Clip, Oil Transfer       |
| 39. Nut, Hex                      | 84. Screen, Squirt Nozzle    |
| 40. Washer, Lock                  | 85. Nozzle, Squirt           |
| 41. Pin, Idler Gear Support       | 86. Screw, Drive             |
| 42. Gasket, Idler Pin             | 87. Plate, Identification    |
| 43. Nut, Flanged                  | 88. Crankcase, 1-3-5 Side    |
| 44. Washer, Plain                 | 89. Crankcase, 2-4-6 Side    |
| 45. Nut, Hex                      |                              |

**4-34. CAMSHAFT ASSEMBLY (See Figure 4-26).**

- a. Remove governor drive gear (2) and Woodruff key (3).
- b. Permold Engine. Remove four screws (4) and camshaft gear (5).
- c. Sandcast Engine. Remove four screws (6), cluster gear (7) and camshaft gear (8).

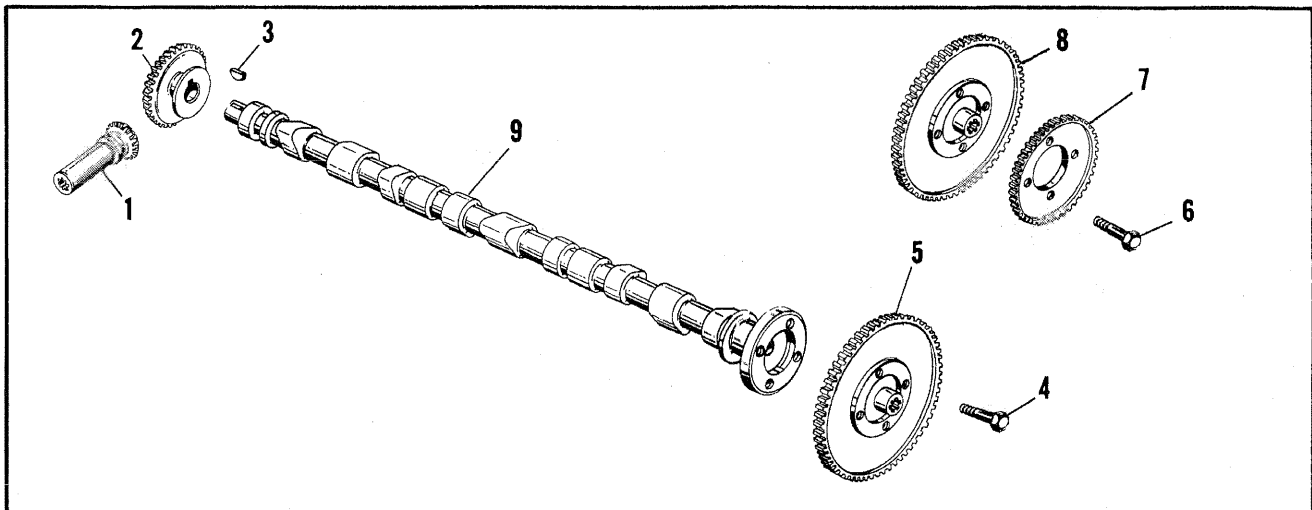
**4-35. CRANKSHAFT ASSEMBLY, PERMOLD ENGINE (See Figure 4-27).**

- a. Use wooden support blocks under front and rear main journals of crankshaft during disassembly.
- b. Remove cotter pin (4), castellated nuts (5), bolts (6) and separate connecting rod caps (7) and rods (8). Remove bearing inserts (9). Loosely reassemble rods, caps, bolts and nuts with their position numbers matched.
- c. Remove retaining ring (11), plate (12) and pins (13,14,15). Lift counterweight assemblies (16,17) from crankshaft (34).
- d. Remove nuts (18) and separate governor oil transfer (19 through 22) from crankshaft.
- e. Cut lockwire. Remove six screws (23) and cluster gears (24,25). Remove four screws (26), lockplate (27) and alternator drive gear (28).

- f. Twist and remove split reinforcing ring (30) from oil seal (31). Work oil seal spring (29) from groove and detach from seal. Twist and remove oil seal from crankshaft.

**4-36. CRANKSHAFT ASSEMBLY, SANDCAST ENGINE (See Figure 4-28).**

- a. Use wooden support blocks under front and rear main journals of crankshaft during disassembly.
- b. Remove cotter pin (5), castellated nuts (6), bolts (7) and separate connecting rod caps (8) and rods (9). Remove bearing inserts (10). Loosely reassemble rods, caps, bolts and nuts with their position numbers matched.
- c. Remove retaining rings (12), retaining plates (13) and pins (14,15,16). Remove counterweight assemblies (17,18).
- d. Remove nuts (19) and lift off governor oil transfer collar (20 through 24).
- e. Cut lockwire. Remove six screws (25) and pull gear (26) from crankshaft.
- f. Twist and remove split reinforcing ring (28) from oil seal (29). Work oil seal spring (27) from groove and detach from seal. Twist and remove oil seal from crankshaft.



**FIGURE 4-26. CAMSHAFT ASSEMBLY.**

- |                                    |  |
|------------------------------------|--|
| 1. Gear, Governor Driven           | 6. Screw, Drilled Head                 |
| 2. Gear, Governor Drive            | 7. Gear, Cam Cluster (Sandcast Engine) |
| 3. Key, Woodruff                   | 8. Gear, Camshaft (Sandcast Engine)    |
| 4. Bolt                            | 9. Camshaft                            |
| 5. Gear, Camshaft (Permold Engine) |  |

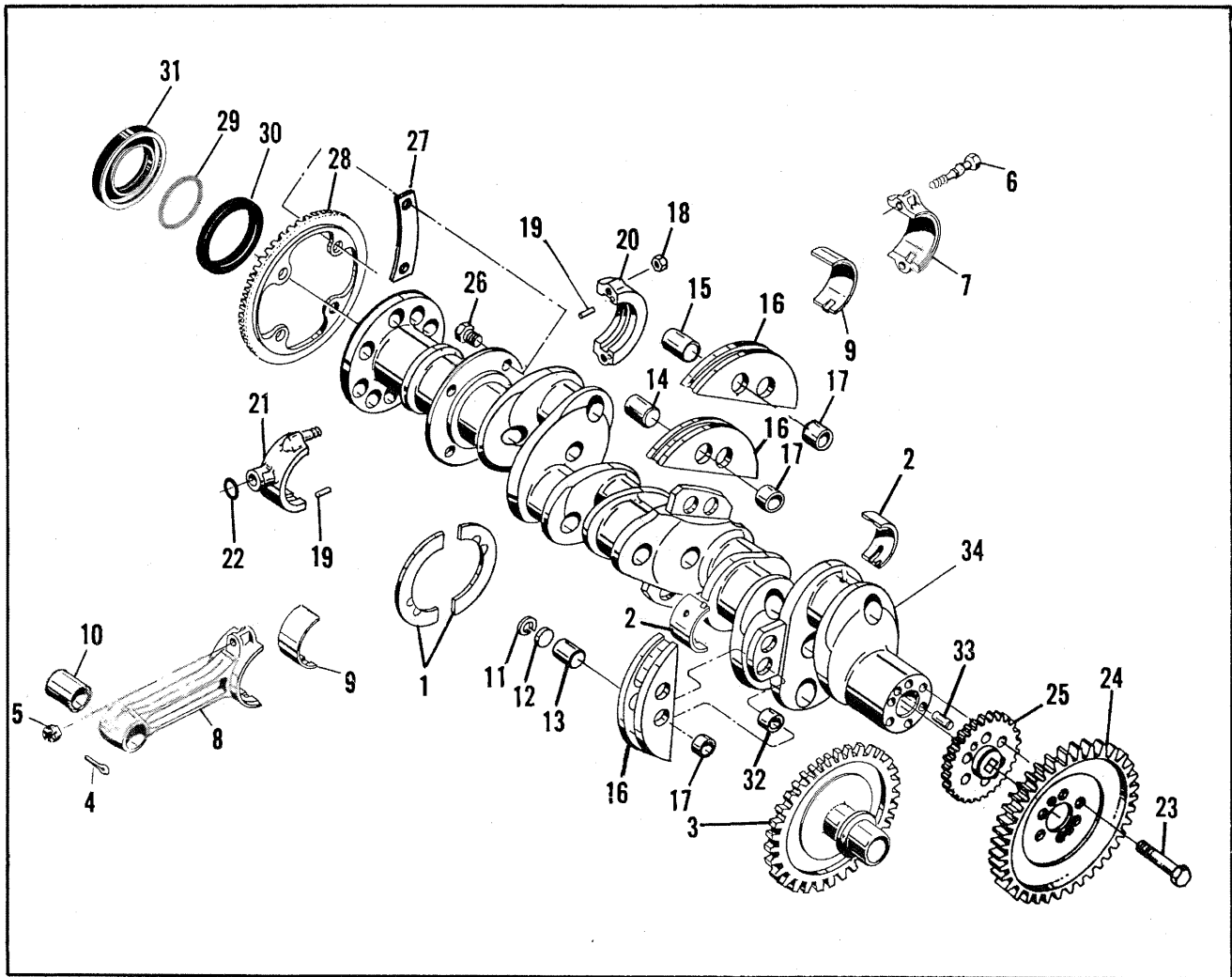


FIGURE 4-27. CRANKSHAFT ASSEMBLY, PERMOLD ENGINE.

- |                                   |                            |
|-----------------------------------|----------------------------|
| 1. Washer, Thrust                 | 18. Nut, Marsden           |
| 2. Bearing, Crankshaft, Main      | 19. Pin, Dowel             |
| 3. Gear, Idler                    | 20. Collar, 1-3-5 Side     |
| 4. Pin, Cotter                    | 21. Collar, 2-4-6 Side     |
| 5. Nut, Slotted, Special          | 22. O-Ring                 |
| 6. Bolt, Connecting Rod           | 23. Screw, Drilled Head    |
| 7. Cap, Connecting Rod            | 24. Gear, Cluster, Large   |
| 8. Rod, Connecting                | 25. Gear, Cluster, Small   |
| 9. Bearing, Connecting Rod        | 26. Screw, Hex Head        |
| 10. Bushing, Piston Pin           | 27. Plate, Tab Lock        |
| 11. Ring, Retaining               | 28. Gear, Alternator Drive |
| 12. Plate, Counterweight          | 29. Spring                 |
| 13. Pin, Counterweight, 6th Order | 30. Ring, Reinforcing      |
| 14. Pin, Counterweight, 4th Order | 31. Seal, Oil              |
| 15. Pin, Counterweight, 5th Order | 32. Bushing, Damper        |
| 16. Counterweight Assembly        | 33. Dowel, Crankshaft      |
| 17. Bushing, Counterweight        | 34. Crankshaft             |

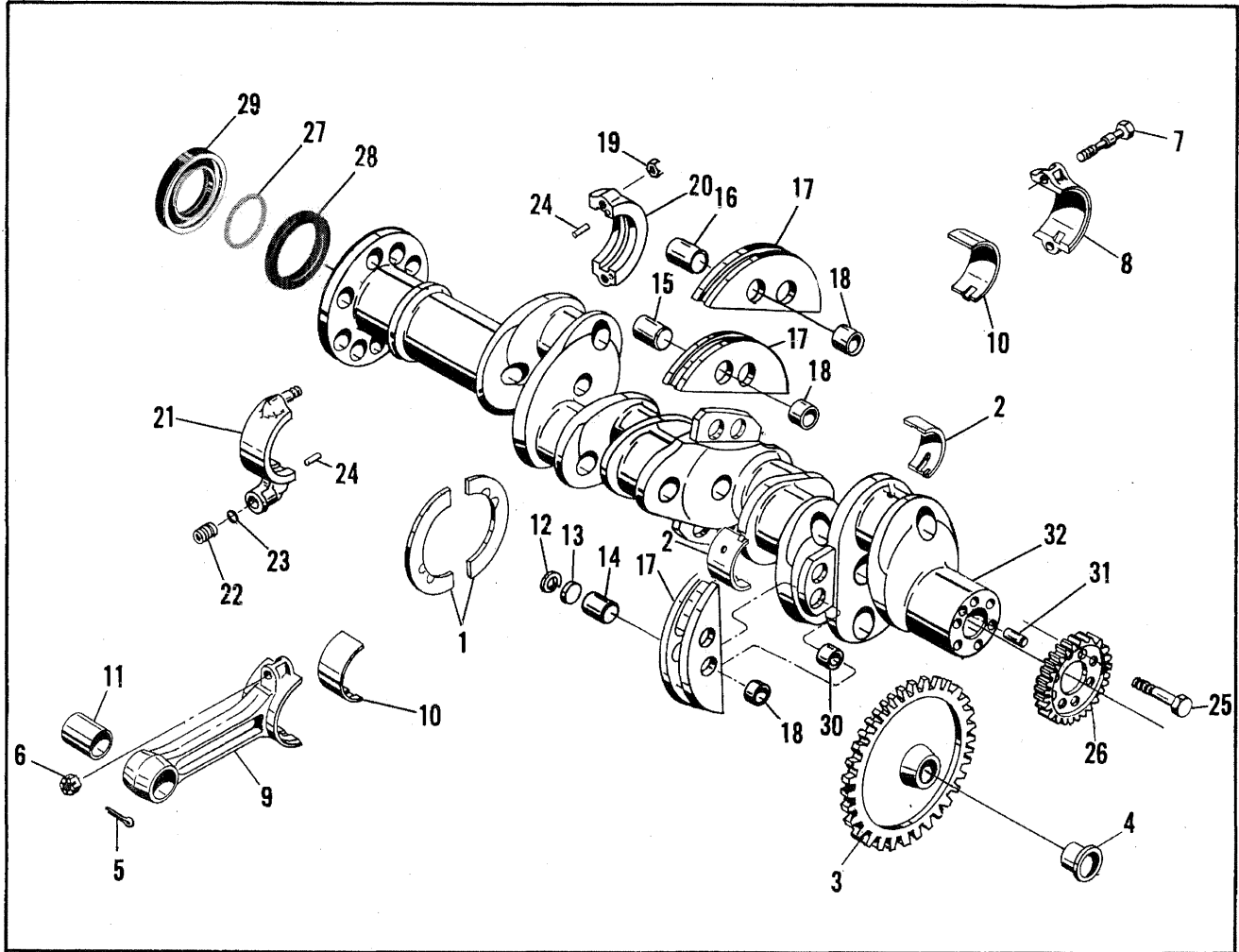


FIGURE 4-28. CRANKSHAFT ASSEMBLY, SANDCAST ENGINE.

- |                                   |                            |
|-----------------------------------|----------------------------|
| 1. Washer, Thrust                 | 17. Counterweight Assembly |
| 2. Bearing, Crankshaft, Main      | 18. Bushing, Counterweight |
| 3. Gear, Idler                    | 19. Nut, Marsden           |
| 4. Bushing, Idler Gear            | 20. Collar, 1-3-5 Side     |
| 5. Pin, Cotter                    | 21. Collar, 2-4-6 Side     |
| 6. Nut, Slotted, Special          | 22. Sleeve, Oil Transfer   |
| 7. Bolt, Connecting Rod           | 23. O-Ring                 |
| 8. Cap, Connecting Rod            | 24. Pin, Dowel             |
| 9. Rod, Connecting                | 25. Screw, Drilled Head    |
| 10. Bearing, Connecting Rod       | 26. Gear, Crankshaft       |
| 11. Bushing, Piston Pin           | 27. Spring                 |
| 12. Ring, Retaining               | 28. Ring, Reinforcing      |
| 13. Plate, Counterweight          | 29. Seal, Oil              |
| 14. Pin, Counterweight, 6th Order | 30. Bushing, Damper        |
| 15. Pin, Counterweight, 4th Order | 31. Dowel, Crankshaft      |
| 16. Pin, Counterweight, 5th Order | 32. Crankshaft             |

## SECTION V

### CLEANING, REPAIR AND REPLACEMENT

#### 5-1. MATERIALS AND PROCESSES.

5-2. Equipment, materials and processes in general use in aircraft engine overhaul shops are satisfactory for cleaning TSIO-520 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 only as long as necessary to remove the deposits. Carbon solvent should be employed only when 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 of all aluminum alloy engine parts. Do not use any strong alkaline solutions to clean aluminum alloy castings or wrought aluminum alloy parts, because strong solutions will attack and destruct a bare machined surface. 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 a foaming emulsion in the engine lubricating oil after re-assembly.*

5-4. No polishing compound or abrasive paste or powder should be needed or employed for cleaning engine parts. Scraping, abrasion with wire brushes, sandpaper or abrasive cloth and buffing wheels are dangerous methods to use on soft metals 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 desired cleaning action. Small holes and finished surfaces which do not require cleaning should be protected from the blast by seals and covers, particularly if the grit is sharp. Sand, shot and metal grit are too abrasive and too heavy for use on soft metals such as aluminum. After any blasting process, blow off all dust with dry compressed air and make sure that no grit has lodged in crevices, recesses and holes.

#### 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 remain on cylinder heads, 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 very narrow strips of crocus cloth. Do not use automotive ring groove scrapers,

since the corner radii at the bottoms of the grooves must not be altered, nor any metal removed from the sides. Discoloration and light scoring need not be removed from piston skirts. The use of abrasive cloth on the skirts is not recommended, because the diameters and cam-ground contour must not be altered. Heavily scored or burned pistons should be discarded.

**5-9. VALVES.** After degreasing valves, inspect them and discard any whose head is warped excessively, or which has insufficient stock to permit refacing within specified limits, or whose stem is burned, scored, eroded or nicked. Carbon deposits may be loosened by solvent action or they may be scraped off while the valve is rotated in a 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, then with 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 brushing or 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 high speed lathe (about 100 RPM). All gum (varnish) deposits must be removed to permit reliable magnetic indications.

**NOTE**

Internal cleaning of the hollow camshaft in TSIO-520-B, D, E, J & K engines is not necessary. Therefore, do not remove the rear pipe plug or front expansion plug unless replacement of either plug is necessary. Failure to replace either or both plugs at reassembly will result in loss of oil pressure with little or no lubrication of moving engine parts.

**5-13. CRANKCASE.** The oil passages should be pressure-flushed with mineral spirit solvent and inspected with the aid of 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 the oil passages with solvent. After the castings 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 treatment, hence 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. SHEET METAL 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 longer storage, in a corrosion-preventive oil mixture. Wrap ball bearings in waxed paper. Wrap or cover other clean parts to protect them from abrasive dust in the air.

**5-17. CASTINGS.** Remove the 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 if a true lap plate is available. Use fine grade lapping compound and move the casting in a figure 8 stroke without rocking it.

**5-18. STUD REPLACEMENT.** Remove damaged whole studs with a standard pattern stud remover or a small pipe wrench, turning slowly to avoid heating the casting. Remove broken studs which cannot be gripped by drilling on center to the correct diameter for unscrewing them with a splined stud extractor. (Splined extractors and drills are usually sold in sets.) Examine the coarse thread end of the damaged stud before discarding it to determine its size. Standard studs have no marking. For oversize stud identification refer to Table I. Clean the casting tapped hole with solvent and blow dry with compressed air; then examine the thread. If it is not torn, install the next larger oversize stud. If the old stud was of the maximum oversize, or if the thread is damaged, the hole may be tapped and a helical coil insert installed for a standard-size stud. Coat the new stud's coarse thread with Alcoa thread lube if the hole is blind

TABLE I. STANDARD AND OVERSIZE STUD IDENTIFICATION

Typical Part No.	Oversize on Pitch Dia of Coarse Thread (inches)	Optional Identification Marks 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

or with National Oil Seal compound if the hole goes through to a cavity subject to oil spray. It is advisable to drive the new stud with a tee handle stud driver. Turn it in slowly, and compare the estimated torque values listed in the Table of Limits. Drive the stud in until it projects a distance equal to the appropriate "Setting Height" listed in Table IV, Section VI.

**5-19. HELICAL COIL INSERT INSTALLATION.** Bronze helical coil inserts are installed at the factory in four tapped holes of each crankcase bottom flange, in three holes in the left crankcase parting flange and two in the right crankcase parting flange and in four bolt holes at each cylinder head intake port flange. Stainless steel helical coil inserts of special design are installed in all spark plug holes. Any of these inserts may be replaced, if damaged, with the aid of tools which are available through Authorized Distributors of the Heli-Coil Corp., Danbury, Connecticut 06810. The manufacturer's Bulletin No. 650-R lists both manual and power-driven installing tools, tang break-off tools, special taps and plug gauges. A tap drill bulletin is also available from the manufacturer. Helical coil inserts are available in both National Coarse and National Fine series in lengths equal to 1, 1-1/2 and 2 times nominal diameter and in pipe thread sizes. They are made of either carbon steel, phosphor bronze or stainless steel, as specified by part number. They are supplied with or without

a notch above the driving tang. The notch is provided to facilitate breaking off the tang in open holes.

**5-20.** Helical coil inserts are helical coils of wire with a diamond-shaped cross section forming both a male and a female thread. The diameter of the insert, when compressed into a special tapped hole at the widest part of the wire (between male and female threads), is equal to the nominal screw size. The special finishing taps size the casting hole so that the pitch diameter of the female thread of the installed insert conforms to class 3 fit with standard bolt threads or class 4 (tight) fit with standard-size studs. The difference in fit is due to a difference in pitch diameters of bolts and studs, so that only one set of helical coil special taps is required for installation of these inserts in both bolt holes and stud holes. Tap drilling depths and tapping depth for helical coil inserts to be installed in blind holes should conform to the recommendations relative to inserts of length equal to 2 times nominal diameter, as tabulated in the manufacturer's Bulletin No. 650-R. Helical coil tap drills and special taps must be run in perpendicular to the machined surface of the casting. Drilling should be done in a drill press after the casting is firmly supported and clamped and alignment checked. The tap will tend to follow the drilled hole. For drilling and tapping aluminum alloy castings use a lubricant made by mixing one part

lard oil with two parts kerosene to prevent overheating of the metal and tearing of the thread.

**5-21.** To remove a damaged helical coil insert use the proper size of extracting tool for the nominal thread size. Tap it into the insert so that the sharp edges get a good "bite"; then turn the tool to the left, and back out the helical coil until it is free. To install a new insert in a properly tapped hole (after blowing out all liquid and chips), slide it over the slotted end of the driving mandrel of the proper size of installing tool and engage the driving tang (bent end) of the helical coil in the mandrel slot; then wind the insert slowly into the tapped hole (See Figure 5-2). The outer end of the insert should lie just within the first full thread of the hole. Break off the driving tang of a notched helical coil by bending back and forth across the hole with long-nose pliers or with a special tang break-off tool.

#### **5-22. CYLINDERS.**

**5-23. FIN REPAIRS.** Straighten slightly-bent barrel fins with long-nose pliers. File to smooth the edges of broken head fins. If it becomes necessary to cut out a vee notch to stop a head fin crack, a slotted drill bushing to fit over the fin and a 3/16 inch twist drill may be used to cut the notch. Its apex must be rounded and the edges should also be rounded. If such repairs and previous breakage have removed as much as 10% of the total head fin area the cylinder assembly has reached the limit of such repair.

**5-24. SPARK PLUG HOLE HELICAL COIL INSERTS.** Before attempting to back out a damaged insert, use a sharp pointed tool to pry the teeth at outer end away from the cylinder head metal. Tap a helical coil extracting tool into the insert until it has a good bite (See Figure 5-3). Place a new helical coil in the cut-out side of the installing tool sleeve with its driving tang toward the threaded end. Engage the tang with the slotted end of the driving mandrel and wind the insert into the sleeve thread, thus compressing it. Hold the sleeve so that the helical coil can be seen through the slot in the threaded end, and turn the mandrel crank until the insert starts into the cylinder head hole. If the sleeve is then not in contact with the head surface, grip sleeve and mandrel and turn until the sleeve touches lightly (See Figure 5-4). Wind the helical coil into the cylinder head until its toothed end lies just within the first full thread. The teeth should be in position to enter the depressions made by the original insert. If driven too far, the insert will emerge in the combustion chamber and will have to be wound

on through. When the helical coil is in correct position, use long-nose pliers to bend the driving tang back and forth across the hole until it breaks off at the notch. Coat a Heli-Coil Corporation No. 520-2 expanding tool threaded end with Alcoa thread lube or a mixture of white lead and oil, and screw it into the new insert until its final thread forces the teeth firmly into the cylinder head metal (See Figure 5-5).

**5-25. VALVE GUIDES.** If the valve guides are to be replaced, the new guides must be installed so that the valve stem hole is accurately square and aligned with the valve seat. When pressing or driving out a worn guide, the cylinder assembly should be firmly supported in the inverted position with space below to allow the guide to drop out. The driving tool should pilot inside the guide and drive on its inner end. All carbon must be removed from the guide's inner end. If the cylinder head hole is not scored or enlarged, a standard size guide may be installed as a replacement. If the head hole is rough it must be broached or reamed to a diameter smaller than the next larger oversize guide by the amount of interference ("T") specified in the Table of Limits. Valve guides are supplied in oversizes of 0.005, 0.015 and 0.020 inch. The cylinder assembly must be supported firmly while the new guide is driven or pressed into place with a driver which fits over its end and bears on the filleted flange. Driving on the guide end will spread it. Before installing a new guide, dip the end to be inserted in engine lubricating oil. The flat side of the guide flange must go against the cylinder head. Watch for peeling of bronze and correct misalignment which causes it. It is not necessary to freeze the new guide before installing it. Valve guide broaches may be purchased from the Borrough's Tool and Equipment Company, Kalamazoo, Michigan. Sizes for intake and exhaust valve guides are slightly different. These tools are very expensive and may be broken during the operation if not perfectly aligned with the hole. They are intended for use in a broaching machine not normally available in overhaul shops. Valve stem holes may be reamed if solid spiral reamers of correct diameters and with 0.431 inch diameter pilots are available. (Refer to the Table of Limits for stem hole finished sizes.)

#### **NOTE**

Due to the choke specified for the cylinder barrel bore, a cam-controlled grinder is required to regrind worn barrels to the allowable 0.015 inch oversize dimension.



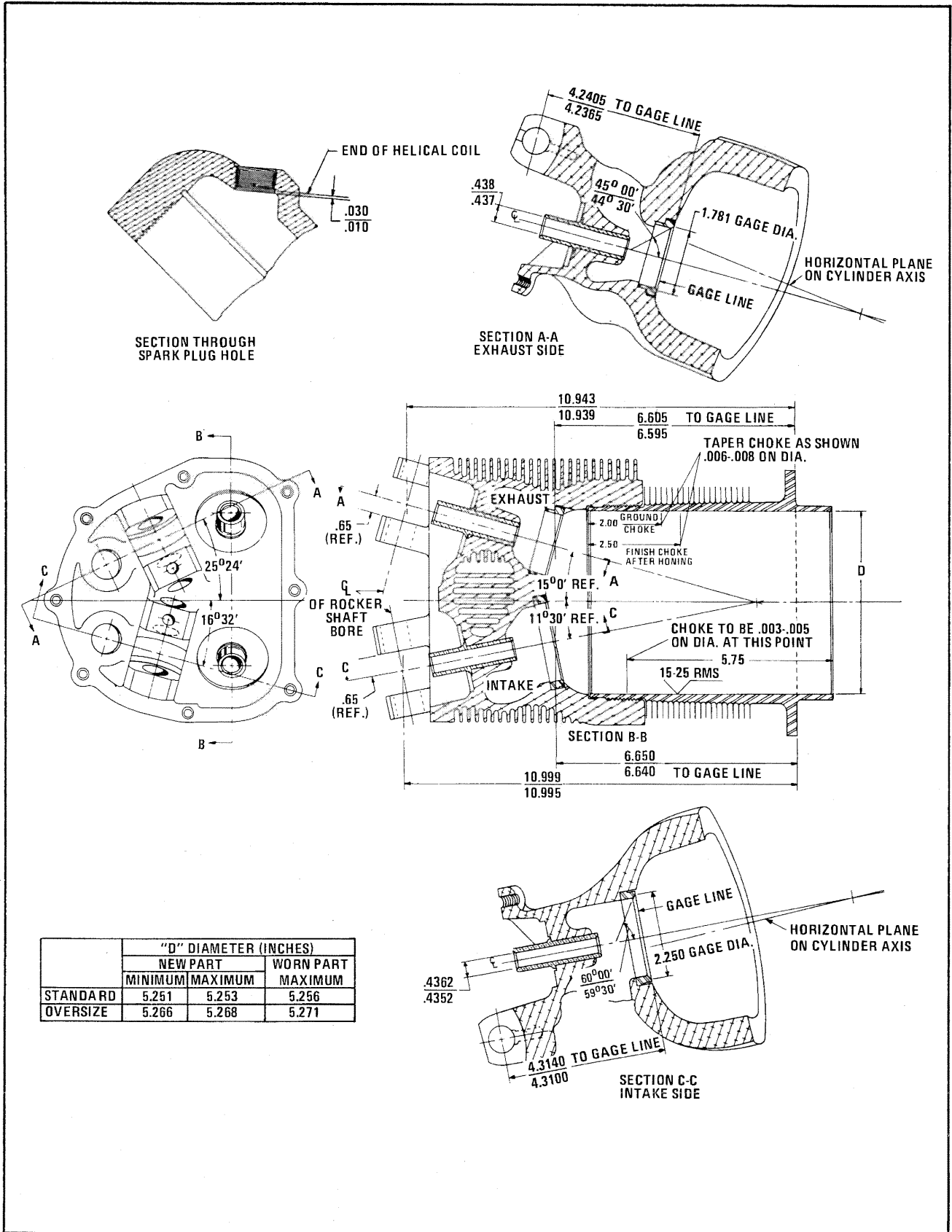


FIGURE 5-1. STANDARD CYLINDER ASSEMBLY DIMENSIONS.

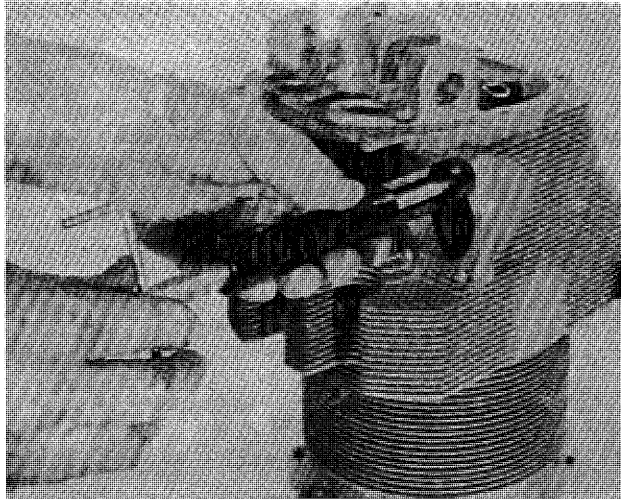


FIGURE 5-2. INSTALLING TYPICAL HELICAL INSERT

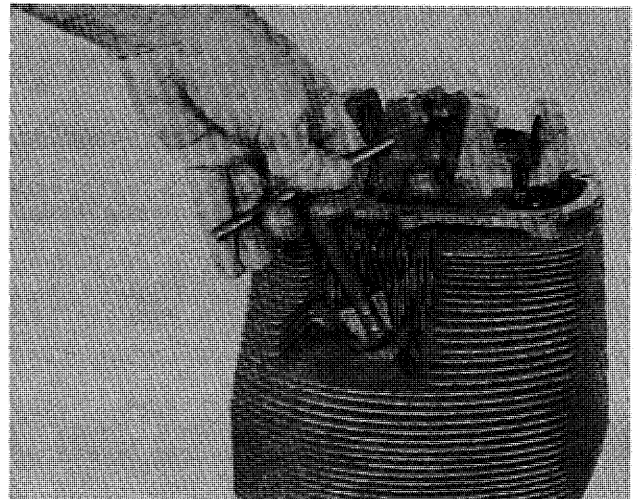


FIGURE 5-3. REMOVING SPARK PLUG HOLE HELICAL INSERT.

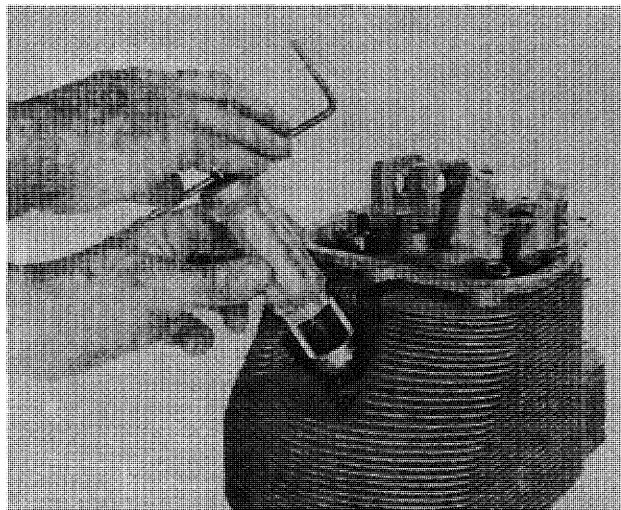


FIGURE 5-4. INSTALLING SPARK PLUG HOLE HELICAL INSERT.

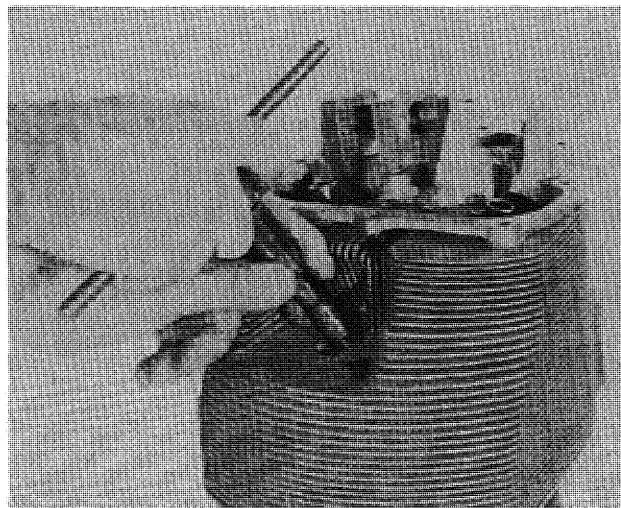


FIGURE 5-5. EXPANDING SPARK PLUG HOLE HELICAL INSERT.

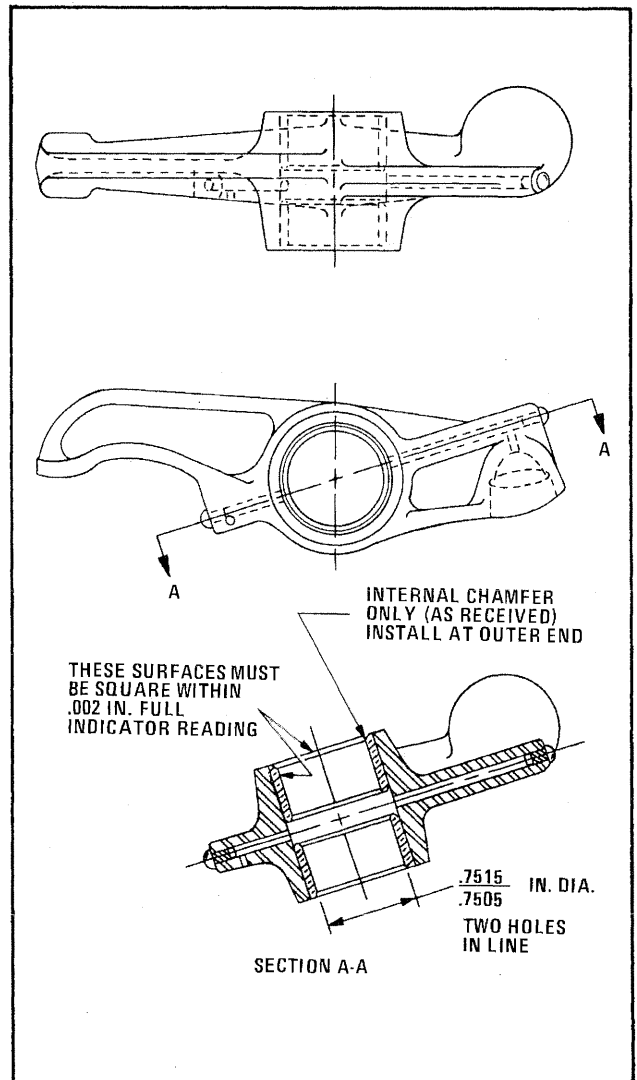


FIGURE 5-6. VALVE ROCKER BEARING DIMENSIONS.

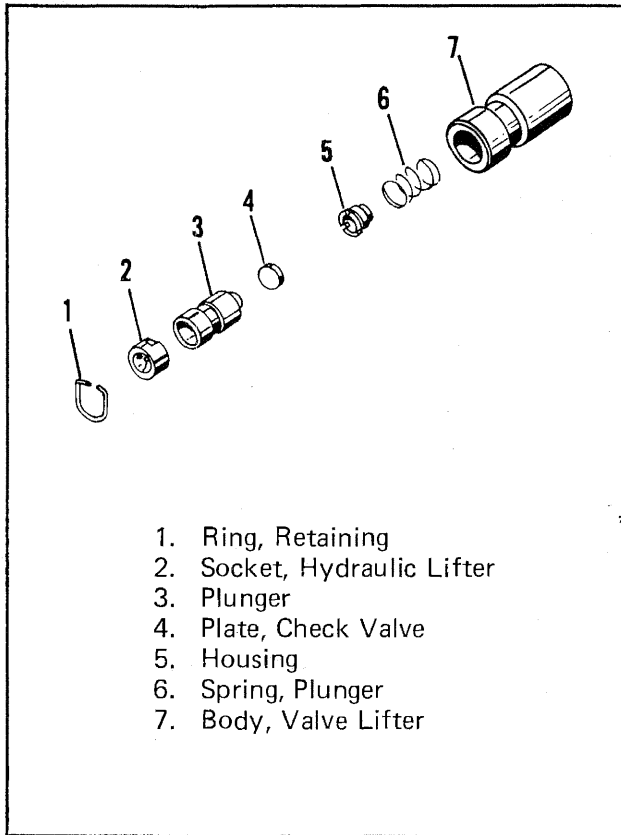


FIGURE 5-7. HYDRAULIC LIFTER.

**5-26. VALVE ROCKERS.** Worn bushings may be driven out with a suitable drift, and if properly designed the same tool may be used to drive in new bushings. The rocker must be supported on a ring which will allow the old bushing to pass through. Press the new bushing in flush with the rocker hub after dipping it in clean lubricating oil. Ream the new bushing to the specified diameter. It is advisable to plug the oil holes with beeswax before reaming. Be sure to remove the wax after reaming. Lightly break the sharp edge at each end.

**5-27. HYDRAULIC VALVE LIFTERS** (See Figure 5-7). Stand valve lifter on its flat end. Use a small screwdriver and carefully pry snap ring (1) from body groove. Hold down socket (2) with a pushrod until ring has been removed. Invert lifter and catch socket as it drops out. Insert a finger into plunger (3) and withdraw plunger (3), spring (6) and check valve assembly (4, 5). If plunger is stuck in body (7), hold plunger down fully and scrape out carbon deposit. If this obstruction cannot be removed, or if plunger is seized by score marks, the entire assembly must be replaced. Re-

move spring by turning as if to unwind it while pulling outward. Be careful not to stretch spring out of shape. Remove check valve housing from plunger with a small screwdriver by prying against plunger shoulder. Do not flip off housing. After housing is loosened lift off, and remove plate (4) and spring (6).

#### 5-28. CONNECTING RODS.

##### CAUTION

*In order to assure good dynamic balance, connecting rod assemblies for new engines are selected in pairs with a maximum weight variation of 1/2 ounce per pair. This limit cannot be maintained if material is removed from any of the original in a set. If a connecting rod must be replaced, specify the weight limits when ordering.*

**5-29. PISTON PIN BUSHING REPLACEMENT.** The connecting rod does not need to be heated for this operation. Press out the old bushing in an arbor press, using a drift only slightly smaller than the bushing O.D. Make sure that the rod bore is smooth. Dip the new bushing in engine lubricating oil before placing it in position, and locate the split as illustrated in Figure 5-9. (The position number is stamped on the rod and cap bosses on the far side.) Ream or bore the new bushing to the specified diameter and check alignment as described in paragraph 6-20. The center-to-center distance given in Figure 5-8 will be held automatically if the bore is centered in the new bushing.

**5-30. CRANKSHAFT ASSEMBLY.** Lightly scored crankpins and journals may be smoothed with a hard Arkansas stone. Do not use a coarser abrasive. Do not attempt to remove deep scoring or indications of overheating which render the crankshaft unserviceable. Remove the upstanding edges of small nicks on softer surfaces with a hard Arkansas stone. Polish crankpins and main journals with long strips of crocus cloth, preferably while the shaft is rotated about 100 RPM in a lathe. Due to the fact that gears are shrunk fit to the crankshaft, it may be necessary to dip the gear in oil heated to 300°F. before removal can be accomplished. These operations should precede magnetic particle inspection.

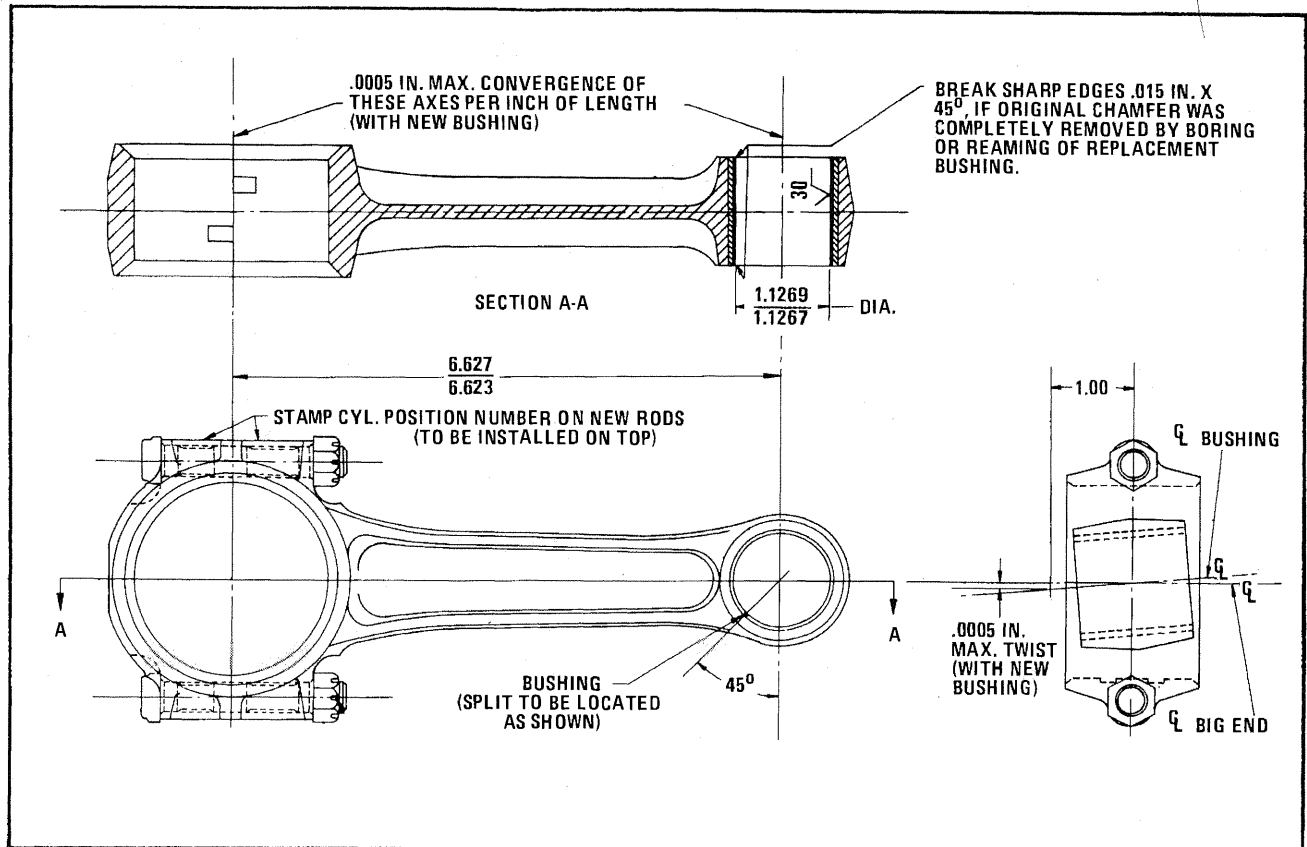


FIGURE 5-8. CONNECTING ROD AND BUSHING DIMENSIONS.

5-31. Hardened steel bushings in the crankshaft blades and in the counterweights may be removed and replaced if excessively worn. It may be necessary to chill the old bushings to free them. New bushings must be chilled before installation with a suitable drift, and the holes must be smooth. No finishing operation is required for the new bushings, since they are made to final dimensions. They must be driven in to the same positions as the original parts.

**NOTE**

Crankpins and crankshaft main journals may be reground to the allowable 0.010 inch undersize.

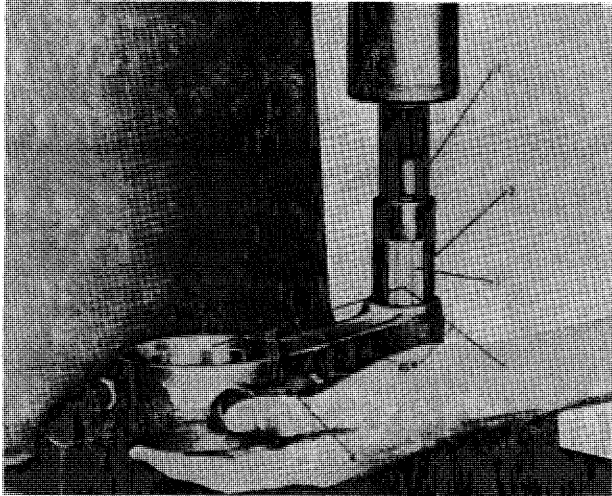
**CAUTION**

*Crankshaft counterweights are matched in pairs with a maximum weight variation of 2 grams, and the complete crankshaft and counterweights assembly is dynamically balanced. As a result, if*

*either counterweight is damaged it will be necessary to discard both on that cheek and to procure a matched pair for replacement.*

5-32. **IDLER GEAR.** Replacement of excessively worn idler gear bushings is not recommended, because a special fixture is required to hold the gear during the boring operation, in order to maintain the necessary concentricity of the bushing hole and the gear pitch circle.

5-33. **MAGNETO AND ACCESSORY DRIVE ADAPTER ASSEMBLY.** If the magneto and accessory drive adapter bushing must be replaced, it may be driven out with a 0.92 inch diameter drift while the adapter boss is supported on a 1.12 inch I.D. ring; however, this procedure involves some chance of scoring the adapter bore. A safer, though more laborious procedure is to turn down the bushing flange to the body diameter (0.942 inch) and to bore out the bushing to a thin shell which can be collapsed. If this method is used, take care not to cut into the end of the adapter boss or to mark the adapter bore. Press in a new bushing with an arbor press after dipping it in



**FIGURE 5-9. INSTALLING CONNECTING ROD BUSHING.**

1. Connecting Rod Bushing Removal and Replacing Tool
2. New Bushing
3. Bushing Split Line
4. Connecting Rod and Cap Assembly

clean engine lubricating oil. The rear pad of the adapter, rather than the studs, should be supported on a parallel block and a flat block should be used to exert pressure, unless the arbor has a perfect end. Ream or bore the bushing to the specified diameter then face the flange until it projects forward 1.454-1.458 inch from the adapter parting surface. Chamfer the bore at the flange end 1/16 inch deep on a 45° angle, and slightly break sharp edges at both ends. The bushing hole must be concentric with the adapter pilot shoulder within 0.002 inch and square with the parting surface within 0.002 inch per inch of length. Its flange

thrust face must be parallel to the parting surface within 0.002 inch (full indicator reading).

**CAUTION**

*Before boring a new bushing, plug its oil holes with beeswax to exclude chips from the adapter oil groove. Be sure to remove the wax completely after the operation.*

5-34. In most instances the old seal may be driven out with a 1/8 inch diameter pin punch inserted through the four oblique oil holes in the bushing boss alternately. If the seal is too tight for that method, drill and tap two opposite machine screw holes in the exposed flange of the seal case to match two screw clearance holes in a pressure plate which can be laid on the adapter studs. Run nuts on two long machine screws; then insert the screws through the pressure plate holes, and screw them into the holes tapped in the seal. To avoid unnecessary stoning of the seal bore, tighten the nuts against the plate to pull the seal squarely from its recess. Smooth any scores in the vacant adapter counterbore. Coat the periphery of a new oil seal with lubricating grease, and press it into the adapter with an arbor press and a flat end block of 1-3/8 inch diameter by 1-1/4 inch length.

5-35. **TACHOMETER DRIVE HOUSING.** Remove the oil seal with a suitable oil seal puller. If the housing counterbore is scored, smooth it with crocus cloth. Spread a film of Lubriplate grease on the periphery of a new seal. Then press the seal squarely into the housing with its lip pointed outward, facing the oil source.

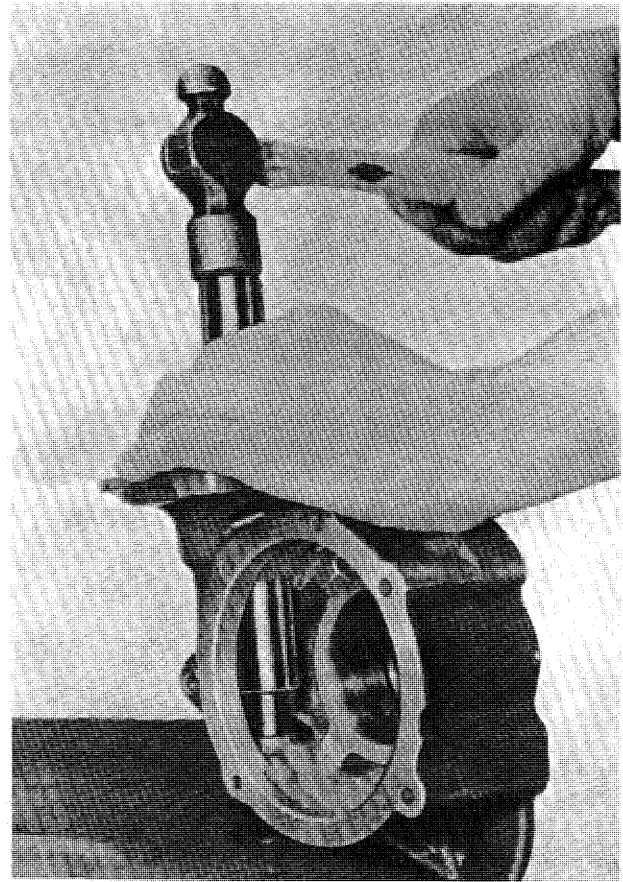
**5-36. STARTER DRIVE ADAPTER.** The clutch spring sleeve is shrunk and doweled in the housing. If it is necessary to remove the needle bearing in the adapter, a removing driver may be made similar to the driver illustrated in Figure 3-1.

Check oil feed holes to the starter adapter shaft-gear. Hole diameter should be .0918-.0968 to reduce possibility of clogging and causing lubrication loss to starter adapter clutch spring. On sandcast crankcase, hole is located off the rear main boss of the 1-3-5 crankcase half and enters the needle bearing counterbore near the top of the holes at a 10 to 11 o'clock position. This hole can be enlarged, if necessary, to the above dimension.

On permold crankcases, the oil feed hole comes off the rear cam bearing of the 1-3-5 crankcase half and intersects a very short hole in the center of the needle bearing counterbore. Hole can be enlarged as above, if necessary, after removal of the starter adapter.

**5-37. OIL PUMP ASSEMBLY.** Except for stoning down nicks on parting flanges and replacement of studs and worn parts, no repairs to the pump assembly are possible. The pump driven gear shaft is pressed into the pump housing and cannot be replaced successfully. The pump gear chamber must not be enlarged; hence, if it is scored the housing must be discarded. Heavy scoring on the gear contact area of the tachometer drive and pump cover renders this part unserviceable, unless the parting surface can be lapped smooth and perfectly flat.

**5-38. IGNITION CABLES.** Normally, all ignition cable assemblies or harness assemblies should be replaced at each overhaul. If the high tension outlet plates are in good condition, new cable assemblies and grommets may be installed on them and the cable ends secured to the grommet of each harness with a brass washer and a cable piercing screw, installed as in the original assembly. If only the cable assemblies and grommets are to be replaced, leave the cable clamping bracket on the original cables of each harness, and detach all cables from the high tension outlet plate by removing the cable piercing screws from their ends in the plate grommet. When the coupling nuts are unscrewed the cables may be withdrawn and the grommet removed from the plate. Observe the "1" mark on the exterior side of each outlet plate adjacent to the No. 1 cable outlet hole. Refer to Figure 5-12 and observe that the numerals appearing at magneto ends of the high tension cables correspond to the consecutive order of outlet plate



**FIGURE 5-11. INSTALLING NEW STARTER ADAPTER NEEDLE BEARING.**

cable holes, while the relative positions of spark plug elbows indicate the installed positions of the cables. Install cable assemblies (3 through 14, Figure 5-12) in the indicated positions in the two outlet plate and grommet assemblies (1 and 2), starting with the proper No. 1 cable assembly in the marked hole of each plate, and proceeding in consecutive order around the plates. As each cable end is inserted, screw in the cable coupling nut (33), and tighten it; then place one of the brass washers (16) and a cable piercing screw (17) at the grommet hole, and turn the screw in firmly but not enough to cut the wire strands. When all cables have been attached to the two outlet plates, locate a clamping bracket (18) on the proper cables of each harness in the same position as on the original cables, and install a rivet (19) to secure it. Parts indexed 21 through 32 will be installed at final assembly. This group should be collected and ready for installation. Parts indexed 33 through 37 are installed on the aircraft ignition switch wires. If replacement of spark plug ends is necessary, proceed with disassembly as indicated (Items 38 through 45) for Slick Harness, and (Items 46 through 52) for Bendix Harness.

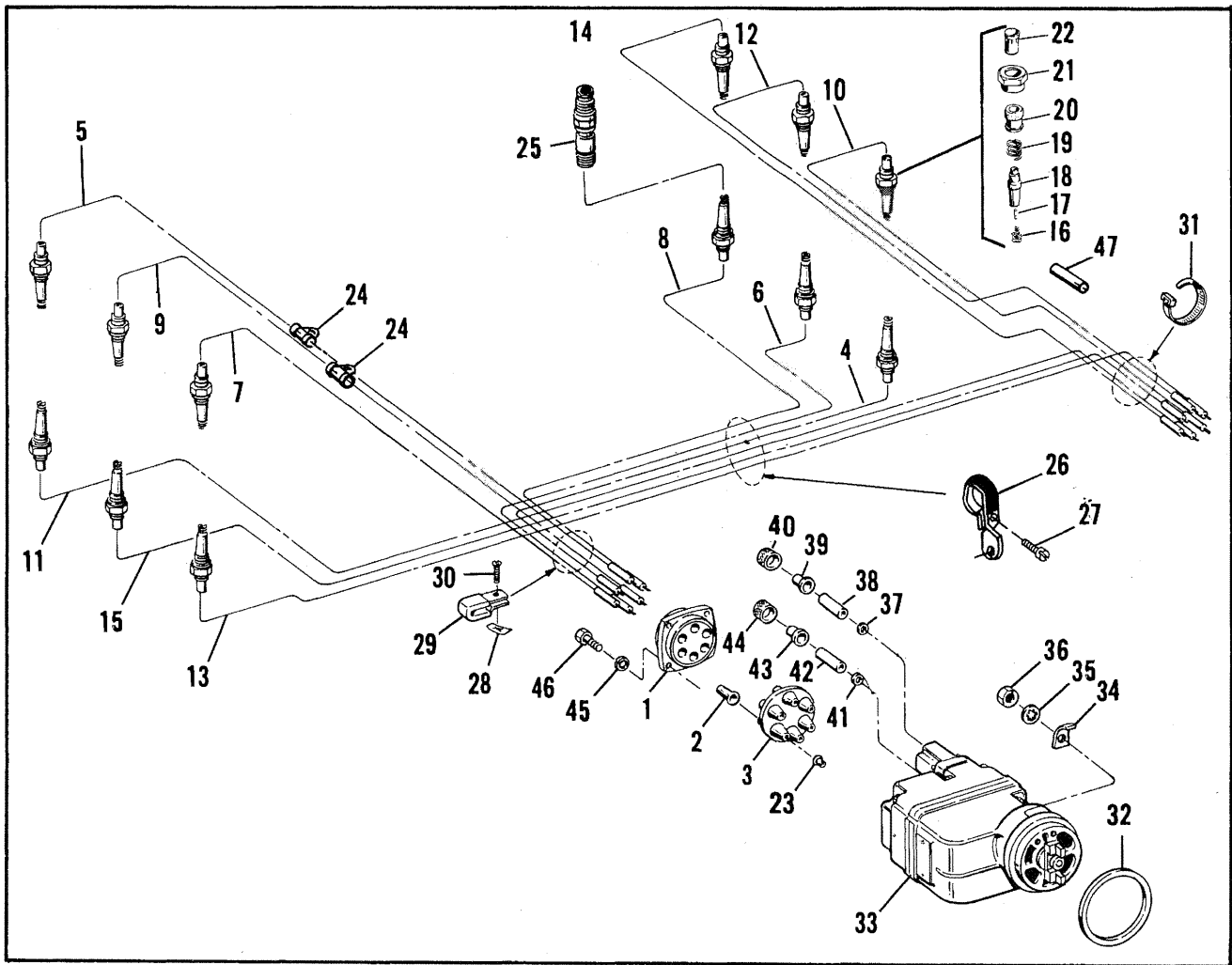


FIGURE 5-12. EXPLODED VIEW OF TYPICAL IGNITION SYSTEM.

- |   |   |                            |
|---|---|----------------------------|
| 1. High Tension Outlet Plate                    | 13. Cable Assembly-to-No. 2<br>Lower Spark Plug | 28. Nut                    |
| 2. Ferrule                                      | 14. Cable Assembly-to-No. 5<br>Upper Spark Plug | 29. Clamp                  |
| 3. Outlet Plate Grommet                         | 15. Cable Assembly-to-No. 4<br>Lower Spark Plug | 30. Screw                  |
| 4. Cable Assembly-to-No. 1<br>Lower Spark Plug  | 16. Spring                                      | 31. Strap                  |
| 5. Cable Assembly-to-No. 6<br>Upper Spark Plug  | 17. Terminal                                    | 32. Gasket                 |
| 6. Cable Assembly-to-No. 3<br>Lower Spark Plug  | 18. Sleeve                                      | 33. Magneto                |
| 7. Cable Assembly-to-No. 2<br>Upper Spark Plug  | 19. Spring                                      | 34. Magneto Holding Washer |
| 8. Cable Assembly-to-No. 5<br>Lower Spark Plug  | 20. Ferrule                                     | 35. Washer, Lock           |
| 9. Cable Assembly-to-No. 4<br>Upper Spark Plug  | 21. Nut   | 36. Nut, Hex, Plain        |
| 10. Cable Assembly-to-No. 1<br>Upper Spark Plug | 22. Ferrule                                     | 37. Washer, Plain          |
| 11. Cable Assembly-to-No. 6<br>Lower Spark Plug | 23. Eyelet                                      | 38. Bushing, Insulating    |
| 12. Cable Assembly-to-No. 3<br>Upper Spark Plug | 24. Clamp                                       | 39. Bushing, Shouldered    |
|   | 25. Approved Spark Plug                         | 40. Nut, Coupling          |
|   | 26. Clamp                                       | 41. Washer, Plain          |
|   | 27. Screw                                       | 42. Bushing, Insulating    |
|   |   | 43. Bushing, Shouldered    |
|   |   | 44. Nut, Coupling          |
|   |   | 45. Washer, Lock           |
|   |   | 46. Screw                  |
|   |   | 47. Tubing, Spiral         |





## SECTION VI

### INSPECTION

#### 6-1. DEFINITION OF TERMS.

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, boring, counter-sinking, etc., but 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 or 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. However, iron oxides 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 which 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 indicate 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.

#### 6-2. PROTECTION FROM CORROSION.

Bare steel parts should be covered 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 fingerprint 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.

### 6-3. 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 the screw threads. After visual inspection the parts should be in three groups: Apparently serviceable parts, repairable parts and parts to be discarded.

### 6-4. MAGNETIC PARTICLE 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 is doubtful after circular magnetization and inspection, demagnetize and magnetize it longitudinally for further inspection.

#### NOTE

Before magnetic particle 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 plugs and clean the part thoroughly in solvent and dry with compressed air. Check for complete demagnetization.*

### 6-5. 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 technique for this process is applicable.

### 6-6. DIMENSIONAL INSPECTION.

### 6-7. 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 micrometer calipers, 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.

### 6-8. DIMENSIONAL LIMITS.

After comparative measurements of mating parts and determination of running clearance, refer to the Table of Limits and the Limits chart 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 supplied, in some instances, to permit conformity to this requirement.

### 6-9. 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 new 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 following list of manufacturing limits on important dimensions of new parts should be consulted when the serviceability of a specific part is in doubt.

TABLE II  
CRITICAL NEW PART DIMENSIONS

PART NAME	FEATURE	NEW DIMENSION (INCHES)
Cylinder Head	Rocker Shaft Boss Bore	0.7495 – 0.7510
	Intake Valve Guide Bore	0.4352 – 0.4362
	Exhaust Valve Guide Bore	0.4370 – 0.4380
	Exhaust Valve Guide Bore (Nitralloy)	0.4375 – 0.4395
Valve Rocker Shaft	Outside Diameter	0.7490 – 0.7495
Valve Rocker Bushings	Inside Diameter	0.7505 – 0.7515
Intake Valve	Stem Diameter	0.4335 – 0.4340
Exhaust Valve	Stem Diameter	0.4333 – 0.4340
Piston (Standard)	*Diameter at Top	5.2030 – 5.2050
	*Diameter Below 1st Groove	5.2180 – 5.2200
	*Diameter at Bottom	5.2400 – 5.2410
	Pin Bore Diameter	1.1246 – 1.1250
	Third Ring Groove Width	0.1910 – 0.1920
	Fourth Ring Groove Width	0.1000 – 0.1010
Piston Pin Assembly	Length (Including Plugs)	5.2050 – 5.2200
Connecting Rod	Bushing Bore Diameter	1.1267 – 1.1269
	Bushing Center-to-Crankpin Center	6.6230 – 6.6270
Crankshaft Assembly	Damper Pin Bushing I.D. (16)	0.6240 – 0.6260
Camshaft	Journal Diameter (4) Permold Crankcase	0.9980 – 0.9990
	Journal Diameter (4) Sandcast Crankcase	1.2480 – 1.2490
Hydraulic Valve Tappets	Outside Diameter	0.9990 – 0.9995
Crankcase	Camshaft Bearings Dia. Permold Crankcase	1.0000 – 1.0010
	Camshaft Bearings Dia. Sandcast Crankcase	1.2500 – 1.2510
	Tappet Guides Dia.	1.0005 – 1.0015
	Governor Driven Gear Bearing Dia.	0.8750 – 0.8760
	Starter Shaft Needle Bearing Hole Dia.	0.9900 – 1.0000
Starter Worm Drive Shaft	Small End Diameter	0.5615 – 0.5625
	Needle Bearing Hole in Starter Adapter	0.7485 – 0.7495
Starter Shaftgear	Front Journal Diameter	0.7495 – 0.7500
	Knurled Drum Diameter	1.9310 – 1.9320
	Clutch Drum Support Dia. Sandcast Crankcase	0.7870 – 0.7880
	Clutch Drum Support Dia. Permold Crankcase	0.9995 – 1.0000
Starter Clutch Drum	Inside Diameter Sandcast Crankcase	0.7900 – 0.7910
	Inside Diameter Permold Crankcase	1.3115 – 1.3125
Starter Clutch Spring	Outside Diameter	2.3740 – 2.3760
	Inside Diameter	1.9380 – 1.9400

PART NAME	FEATURE	NEW DIMENSION (INCHES)
Starter Drive Adapter	Sleeve Front End I.D.	2.3380 – 2.3430
Oil Pump Driver Gear	Shaft Diameter	0.5600 – 0.5605
Oil Pump Driven Gear	Shaft Assembly Hole Dia. Sandcast Crankcase Shaft Assembly Hole Dia. Permold Crankcase	0.5620 – 0.5630 0.6870 – 0.6880
Oil Pump Housing and Shaft Assembly	Driven Gearshaft Dia. Sandcast Crankcase Driven Gearshaft Dia. Permold Crankcase Driver Gearshaft Hole Diameter Gear Chamber Depth Permold Crankcase Gear Chamber Depth Sandcast Crankcase	0.5015 – 0.5025 0.5640 – 0.5650 0.5620 – 0.5630 1.3275 – 1.3290 2.6235 – 2.6250
Magneto Drive Gears	Shaft Diameter	0.8120 – 0.8130
Magneto and Accessory Drive Adapter	Bushing Inside Diameter	0.7925 – 0.7975
Idler Gear Assembly	Bushing Inside Diameter Sandcast Crankcase	0.7900 – 0.7950
Idler Gear Front Bushing	Bushing Inside Diameter Permold Crankcase	0.5600 – 0.5610
Idler Gear Flanged Bushing	Bushing Inside Diameter Permold Crankcase	0.5010 – 0.5020
Idler Gear Support Pin	Gear Support Diameter Sandcast Crankcase	0.8095 – 0.8105
Idler Gear	Large Diameter Permold Crankcase Small Diameter Permold Crankcase	0.5580 – 0.5590 0.4990 – 0.5000

\* Measure piston diameters at right angles to pin bore.

#### 6-10. PROTECTIVE COATING.

The manufacturer protects all aluminum 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 19002).

#### 6-11. APPLICATION OF "ALODINE 1200".

In the event the original finish of an aluminum part has deteriorated or 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; therefore,

corrosion protection can 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.

#### 6-12. 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 a solution of one gallon 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 a 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 the 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 is too light, repeat step "c" until desired color is obtained.

**NOTE**

If "Alodine" does not adhere to 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 vigorous brushing.

**6-13. 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. Magnesium parts will be pickled and primed before painting; then baked with infra-red equipment for 15 minutes at 275-285° F. following application of each coat of enamel.

**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.*

**6-14. SPECIFIC INSPECTIONS.**

**6-15. 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 installed 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 clamped together at all attaching points before dimensional 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.

**6-16. CRANKSHAFT.**

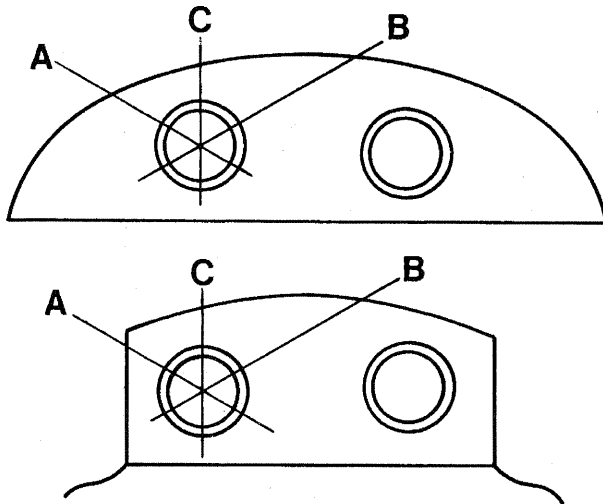
In addition to magnetic particle, visual and dimensional inspection, the crankshaft should be mounted on matched vee blocks on a surface plate (supporting the front and rear main journals), and rotated under a dial indicator placed to bear on the center main journal in order to detect excessive bending.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

**6-17. CRANKSHAFT AND COUNTERWEIGHT BUSHINGS.**

a. Excessive localized brinelling of the crankshaft

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 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.



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  $60^{\circ}$  either side of Point C.

3. After removing the bushings from 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 into the crankshaft blade holes.

c. Replacement bushings for the crankshaft are available in standard 0.0015, 0.003 and 0.005 oversize on the outside diameter. Oversize bushings for the counterweight are not allowed.

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 49007 (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.

e. This tool, Borrough's Part No. 4965, should be ordered directly from Borrough's Tool and Equipment Corporation.

#### 6-18. CAMSHAFT.

Inspect the journals for scoring, corrosion and overheating. Inspect the lobes for pitting at the toes and evidence of overheating or unusual wear. Inspect the corner radius of the oil transfer groove in the rear cam bearing. Any camshaft with less than a 0.030 corner radius must not be re-used. Shot peen with SAE #280 shot to an intensity of 0.013 to 0.015 with an A2 strip at the oil transfer groove in the rear cam bearing. Current production engines have a prefix letter "S" or "AB" before the part number and will not require this procedure.

#### 6-19. 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 its alignment with the 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 V, Ref. 44.) 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 (Table V, Ref. 44).

#### 6-20. 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 of rejection.

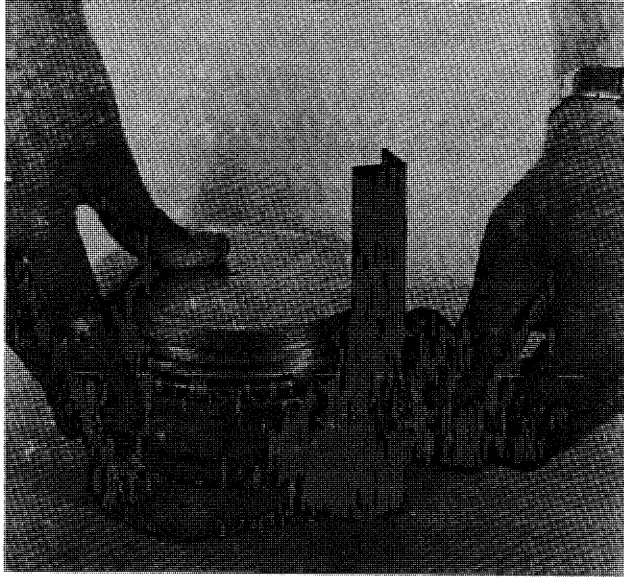


FIGURE 6-1. INSPECTION RING  
SIDE CLEARANCE.

### 6-21. PISTONS AND RINGS.

Inspect the piston 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 pin to expand rapidly so as to strike the wall hard. Inspect visually for thorough cleaning, including the oil relief holes in the oil ring groove. It is not necessary to remove light scores or discoloration from the exterior surfaces and it is not advisable to use abrasive (including crocus cloth) on the skirt, since the cam-ground contour should not be altered. If the piston is dimensionally serviceable and apparently sound, measure side clearances 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 first and second grooves and the scraper ring in the fourth groove, with part numbers toward the piston head and inserting various thickness gauges on either side of each ring (See Figure 6-1). 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 either standard or 0.005 inch oversize rings, whichever have the specified gap, as measured with the ring pushed up by the piston head to a point in line with the base flange.

### 6-22. CYLINDERS.

Measure the barrel bore near the top of the ring travel limit and at the 5-1/4 inch station from the open end in the thrust direction and at right angles to that in order to detect out-of-roundness and wear-in taper. There should be little or no wear at the open end. Look for bent barrel fins and broken head fins. Barrel fins can be straightened if not badly bent or cracked. A reduction of not over 10% in area of head fins due to breakage is allowable. Look for cracked head fins, and specify repair of any radial crack by drilling a vee notch to remove it. If a radial crack extends to the root of a fin, it may have penetrated the wall, in which case the cylinder should be rejected. If the cylinder base nuts were loose at disassembly, or if the base studs were loose or bent, test the machined side of the cylinder flange for bending, which is cause for rejection. Measure valve guides for wear, and look for scoring in their bores. Valve seats should be inspected after refacing to make sure that their outside diameters are still less than the valve head diameters. Exhaust valves should be checked for warpage before refacing, and all valves should be measured for length if the stem tips were ground. Inspect the spark plug hole and intake flange screw hole helical coil inserts for looseness, deformation and position. The outer ends should lie in the first full thread of the tapped hole in which they were installed. The spark plug hole helical coil has teeth at the outer end which are forced into the head metal and should not be visible. If there was any evidence of overheating of cylinder or piston, check as well as possible for turning of the head in relation to the barrel flange. Security between cylinder head and barrel is dependent on metal to metal contact of cylinder barrel top threads within the head shoulder. Dark stains at this area on both new and rebareled cylinders is generally due to emission of thread lubricant used upon factory assembly of head to barrel. Also, a very slight gas leakage in this area causing the same condition generally stops of its own accord when the gap fills with carbon during service. Neither condition is detrimental to engine performance or operation. Due to the TSIO-520 engine series cylinder design, however, a persistent oil leak (not sealing compound) may indicate the required pre-load at the head/barrel junction has been relieved and should be investigated for possible cylinder replacement (See Service Bulletin M69-7).

### 6-23. HYDRAULIC VALVE LIFTERS.

During examination of each part, look for sludge and carbon residues. Also check for obstructed oil

holes. Inspect face on cam follower on body for any type of damage and look for deep scoring and corrosion on exterior of tubular position. Discard any lifter body which exhibits any of these faults. 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 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 plunger and cylinder 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 check must be discarded. Discard both plunger and cylinder, since these parts are selectively-fitted and are not interchangeable.

**6-24. INTAKE TUBES.**

Inspect intake tubes for distortion, cracks and out-

of-roundness. All other types of damage will require replacement of the part.

**6-25. 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.

**6-26. FUEL INJECTION SYSTEM.**

Inspection of the components of this system is limited strictly to visual for evidence of damage or 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 paragraph 1-2, Section I).

**6-27. IGNITION SYSTEM.**

Teledyne Continental Motors recommends replacement of the complete ignition harness at every engine overhaul.

**TABLE III.  
INSPECTION CHART**

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
<b>CYLINDER ASSEMBLY</b> Head & Barrel	Head/Barrel Junction	Discoloration, Seepage.	See paragraph 5-22.
	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 over-size bore.
		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 inch diameter. Taper limit (Table of Limits) must not be exceeded by honing.



SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
	Bore Walls	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.
	Stem Holes in Valve Guides	Scoring, diameter, flare at ends.	Diameters of stem holes in new guides must be within limits for new parts and free of tool marks.
	Valve Seats	Roughness caused by honing.	If seats cannot be made serviceable by grinding within width limit, replace seat.
	Cooling Fins	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 inch out-of-flat on machined surface.
	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.

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
Valve Rockers	Contact Foot	Scoring, diameter.	Refer to Table of Limits
	Oil Passages	Obstruction.	
	Hub	Side clearance between cylinder head supports.	
Rocker Shaft	Outside Surface	Diameter, scoring, rough ends.	
<b>CONNECTING ROD ASSEMBLY</b>			
Bushing	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.)
<b>CRANKSHAFT ASSEMBLY</b>			
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, Threads	Burning, scoring, wear enough to alter profile. Damaged or dirty threads.	
<b>CAMSHAFT ASSEMBLY</b>			
Camshaft	Journals	Diameter and fit in crankcase bearings. Scoring, pitting and corrosion.	Excessive bearing wear may be compensated by enlarging bearing and installing over-size shaft. Refer to "Crankcase".

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
Gear	Lobes	Pitting along toe line, loss of slope along toe line, width across heel 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.	
	End and Rear Face of Flange	Nicks, peening, other irregularities.	Must be smooth to align gear.
	Teeth	Scoring, burning, pitting, wear enough to alter profile.	
<b>CRANKCASE ASSEMBLY</b>			
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.	See paragraph 6-15.
	Oil Passages	Inspect visually, galleries, main and camshaft bearing supply holes, using inspector's flashlight to illuminate. Probe other oil holes with brass rod.	
	Tapped Holes	Deformed or dirty threads.	
Studs	Threads	Distortion.	
	Height	Check for backing outs.	Refer to Stud Height Table.
	Squareness	Use toolmaker's square to check studs suspected of bending.	Refer to Stud Height Table.
Idler Gear Support and Bushings	Bore	Inside diameter, scoring	Refer to Table of Limits.
Needle Bearing	Rollers	Roughness or excessive play.	
Retainer	Mounting Surface Oil Seal	Warpage, cracks. Observe that old seal has been removed without damage to retainer.	
Oil Filler Neck	Tightness	Attempt to rock and pull out by hand only.	Must be tight in casting. Permold crankcase only.

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
Oil Gauge Rod	Distortion	Look for bent blade, obliterated "FULL" and "LOW" marks, loose collar, deformed cap.	
Oil Gauge Support	Tightness	Attempt to move tube by hand only.	Sandcast crankcase only.
Engine Mounting Brackets	Machined Surfaces	Warpage and scratches.	Sandcast crankcase only.
	All Areas	Cracks.	Sandcast crankcase only.
Plugs	Threads	Look for distortion.	
	Wrench Flats	Look for damaged corners.	
Oil Temperature Control Valve	Bore	Inside diameter, scoring.	Sandcast crankcase only.
	Seat	Roughness.	Sandcast crankcase only.
<b>OIL COOLER ASSEMBLY</b>			
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.	
Oil Temperature Control Valve	Seat	Roughness.	Permold crankcase only.
<b>OIL SUMP ASSEMBLY</b>			
Casting	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.	
Engine Mounting Brackets	Machined Surfaces	Scratches, cracks.	Permold crankcase only.

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
<b>OIL PUMP ASSEMBLY</b> Housing	All Areas	Cracks, scratches on machined surfaces, restrictions in oil holes.	
	Gearshaft	Look for scoring, measure diameter.	Gears must turn freely. (Refer to Table of Limits.)
	Plugs	Distorted threads, damaged wrenching surfaces.	
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.	
	Splines	Look for wear on side of splines and residual sludge.	
Gear Bushings	Bore Diameters	Use telescoping gauge and micrometer caliper.	Refer to Table of Limits.
Oil Pressure Relief Valve Plunger	Outside Surface	Measure diameter. Look for scoring, nicks, etc.	
	Conical Face	Roughness.	Must seat perfectly in housing.
Oil Pressure Relief Valve Housing	Plunger Seat	Spread Prussian blue oil base pigment on face of plunger, and turn on seat, all around, plunger face must be lapped to seat. (Plunger held centered and aligned.)	
Oil Pump Cover	Shaft Holes	Measure diameters.	Refer to Table of Limits.
Tachometer Drive Housing	Threads, Flange Seal Bore	Thread distortion, warped mounting surface, scored seal counterbore.	See that old oil seal was removed.
Oil Filter Adapter	Threads, Flange	Damaged threads, warped flange, cracks.	
Oil Filter	Threads, Screen Pilot Cup	Damaged threads, punctured screen, out-of-round pilot cup.	
<b>STARTER ADAPTER ASSEMBLY</b> Adapter	All Areas	Cracks, scratches on machined surfaces, damaged tapped holes.	

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
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.	
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.	
<b>ALTERNATOR</b>			
Hub Assembly			Permold crankcase only.
Hub	All Areas	Scored or under 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.
	Thrust Washer	Thickness, excessive wear.	
<b>INDUCTION SYSTEM</b>			
Intake Manifold	Flanges	Check for warping by placing flanges on surface plate. Look for cracks.	
	Tubes	Look for dents, out-of-round ends, cracks.	

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
Clamps	Plug Bosses  Shape	Damaged threads, cracks around bosses.  Look for distortion such as out-of-roundness and lugs converging.	
<b>FUEL INJECTION SYSTEM</b>			
Fuel Pump Adapter	All Areas	Cracks, damaged mounting holes, inspect tapped holes. Measure bore diameter.	
Fuel Pump Drive Gear	Teeth	Look for chipped, cracked and broken teeth, scoring, burning and wear enough to alter tooth profile.	
	Shaft	Measure outside diameter and compare with bore diameter.	Refer to Table of Limits.
	Gear Plug	Make sure that new plug was installed after magnetic particle inspection of gear and visual inspection for cleanliness of center bore.	
Drive Coupling	Fit	Check for looseness.	
Fuel Pump and Vapor Separator Assembly	Outside Area	Inspection is limited strictly to visual for evidence of damage or deterioration.	See paragraph 6-26.
Fuel Injection Control Assembly			
Fuel Manifold Valve Assembly			
Shroud Assembly	All Areas	Inspect visually for dents, cracks and broken joints.	
Air Throttle Assembly	Tapped Holes	Damaged threads, cracks around holes.	
	Studs	Bent or stripped stud threads.	
	All Areas	Cracks.	
	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.	

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS	
MAGNETO AND ACCESSORY DRIVE ASSEMBLY Adapter	Pipe Fittings	Threads	Distortion or stripping.	
		Wrench Flats	Look for damaged corners.	
		Gear Bushing	Measure bore diameters.	Refer to Table of Limits.
		Oil Seal	Observe that old seal has been removed without damage to casting bore.	
		Studs	Look for stripped and deformed threads.	
		Teeth	Scoring, burning or wear enough to alter tooth profile.	
		Shaft	Measure diameters and compare with bushing diameter.	
Gear			Refer to Table of Limits.	

TABLE IV.

CRANKCASE STUD SETTING HEIGHTS

	LOCATION	Chart No.	THREAD SIZE	SETTING HEIGHT	TSIO-520							
					B	C	D	E	G	H	J	K
1	Cylinder Mount Pad	1,2	7/16-14 X 7/16-20	13/16	36	24	—	36	24	24	36	36
2		2	7/16-14 X 7/16-20	13/16	—	12	—	—	12	12	—	—
3		3	7/16-14 X 7/16-20	27/32	—	—	36	—	—	—	—	—
4	Engine Mount Pads	1	3/8-16 X 3/8-24	3-5/16	8	—	—	8	—	—	8	8
5		1	3/8-16 X 3/8-24	1-33/64	4	—	—	4	—	—	4	4
6		2	3/8-16 X 3/8-24	1-7/32	—	13	—	—	13	13	—	—
7		2	3/8-16 X 3/8-24	1-1/4	—	1	—	—	1	1	—	—
8		2	3/8-16 X 3/8-24	2-7/32	—	2	—	—	2	2	—	—
9	Oil Cooler Mount Pads	2	1/4-20 X 1/4-28	7/8	—	5	—	—	5	5	—	—
10		1,3	5/16-18 X 5/16-24	*5-3/8	1	—	1	1	—	—	1	1
11		1	3/8-16 X 3/8-24	13/16	2	—	—	2	—	—	2	2
12		1	3/8-16 X 3/8-24	7/8	2	—	—	2	—	—	2	2
13		3	3/8-16 X 3/8-24	49/64	—	—	2	—	—	—	—	—
14		3	3/8-16 X 3/8-24	27/32	—	—	2	—	—	—	—	—
15	Governor Mount Pads	1,2,3	5/16-18 X 5/61-24	1-3/8	4	4	4	4	4	4	4	4
16	Magneto Mount Pads	1,2,3	5/16-18 X 5/16-24	43/64	4	4	4	4	4	4	4	4



	LOCATION	Chart No.	THREAD SIZE	SETTING HEIGHT	TS10-520							
					B	C	D	E	G	H	J	K
17	Magneto & Accessory Drive Adapter Pad	1,2,3	5/16-18 X 5/16-24	3/4	4	6	6	4	6	6	4	4
18		1	5/16-18 X 5/16-24	63/64	2	—	—	2	—	—	2	2
19		2	5/16-18 X 5/16-24	7/8	—	2	—	—	2	2	—	—
20	Idle Pin Pad	1,3	3/8-16 X 3/8-24	13/16	2	—	2	2	—	—	2	2
21		1,3	1/4-20 X 1/4-28	9/16	2	—	2	2	—	—	2	2
22	Starter Drive Pad	2	1/4-20 X 1/4-28	3/4	—	2	—	—	2	2	—	—
23		2	5/16-18 X 5/16-24	13/16	—	2	—	—	2	2	—	—
24		1,3	5/16-18 X 5/16-24	3-23/32	1	—	1	1	—	—	1	1
25		1	5/16-18 X 5/16-24	4-17/64	1	—	—	1	—	—	1	1
26	Fuel Pump Pad	3	5/16-18 X 5/16-24	4-7/32	—	—	1	—	—	—	—	—
27		1,3	5/16-18 X 5/16-24	3/4	2	—	2	2	—	—	2	2
28	Oil Pump Pad	2	5/16-18 X 5/16-24	1-5/16	—	4	—	—	4	4	—	—
29		2	1/4-20 X 1/4-28	7/8	—	1	—	—	1	1	—	—
30		1,3	1/4-20 X 1/4-28	1-49/64	1	—	1	1	—	—	1	1
31		2	1/4-20 X 1/4-28	2-9/32	—	2	—	—	2	2	—	—
32		1,3	1/4-20 X 1/4-28	3-3/8	5	—	4	5	—	—	5	5
33		2	1/4-20 X 1/4-28	3-11/16	—	2	—	—	2	2	—	—
34		2	1/4-20 X 1/4-28	3-63/64	—	2	—	—	2	2	—	—
35		2	1/4-20 X 1/4-28	5-11/16	—	3	—	—	3	3	—	—
36	Alternator Pad	1	3/8-16 X 3/8-24	2-9/16	1	—	—	1	—	—	1	1
37		1,3	3/8-16 X 3/8-24	2-15/16	2	—	3	2	—	—	2	2
38	Generator Bracket	1	5/16-18 X 5/16-24	13/16	4	—	—	4	—	—	4	4
39	Camshaft Cover Pad	2	5/16-18 X 5/16-24	19/32	—	1	—	—	1	1	—	—
40		1,3	1/4-20 X 1/4-28	11/16	2	—	2	2	—	—	2	2

**OTHER STUD SETTINGS**

Engine Mount Pads	3/8-16 X 3/8-24	31/32	—	—	12	—	—	—	—	—	—
Governor Oil Transfer Collar	1/4-20 X 1/4-28	15/16	2	2	2	2	2	2	2	2	2
Cylinder Exh. Flange	1/4-20 X 1/4-28	25/32	4	4	4	4	4	4	4	—	—
	1/4-20 X 1/4-28	7/8	—	—	—	—	—	—	—	4	4
Oil Pump Housing	1/4-20 X 1/4-28	21/32	2	1	2	2	1	1	2	2	2
	1/4-20 X 1/4-28	2-11/32	—	1	—	—	1	1	—	—	—
Oil Pump Cover	1/4-20 X 1/4-28	3/4	4	—	4	4	—	—	4	4	4
	1/4-20 X 1/4-28	7/16	1	—	1	1	—	—	1	1	1
Magneto Adapter	1/4-20 X 1/4-28	7/8	4	4	4	4	4	4	4	4	4
Adapter-to-Crankcase	5/16-18 X 5/16-24	23/32	2	—	2	2	—	—	2	2	2
Adapter-to-Scavenge Pump Top	5/16-18 X 5/16-24	11/16	2	—	2	2	—	—	2	2	2
Adapter-to-Scavenge Pump Bottom	5/16-18 X 5/16-24	1-21/64	1	—	1	1	—	—	1	1	1
Adapter-to-Starter	3/8-16 X 3/8-24	1	2	2	2	2	2	2	2	2	2
Cover, Starter Adapter	1/4-20 X 1/4-28	1-1/4	4	—	4	4	—	—	4	4	4
Scavenge Pump Body	1/4-20 X 1/4-28	5/8	—	1	—	—	1	1	—	—	—

\* Measured from crankcase parting flange.

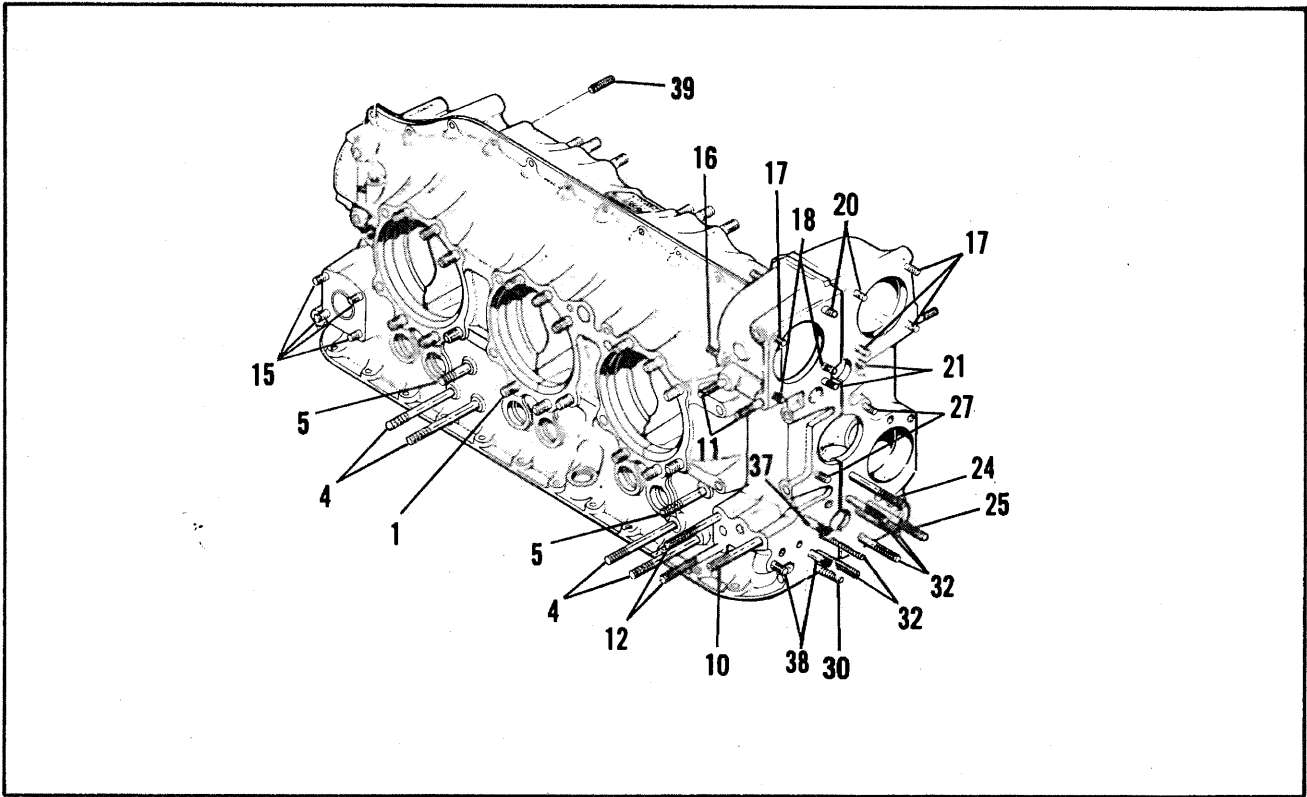


FIGURE 6-2. STUD SETTING HEIGHTS (CHART NO. 1) TSIO-520-B, E, J, K.

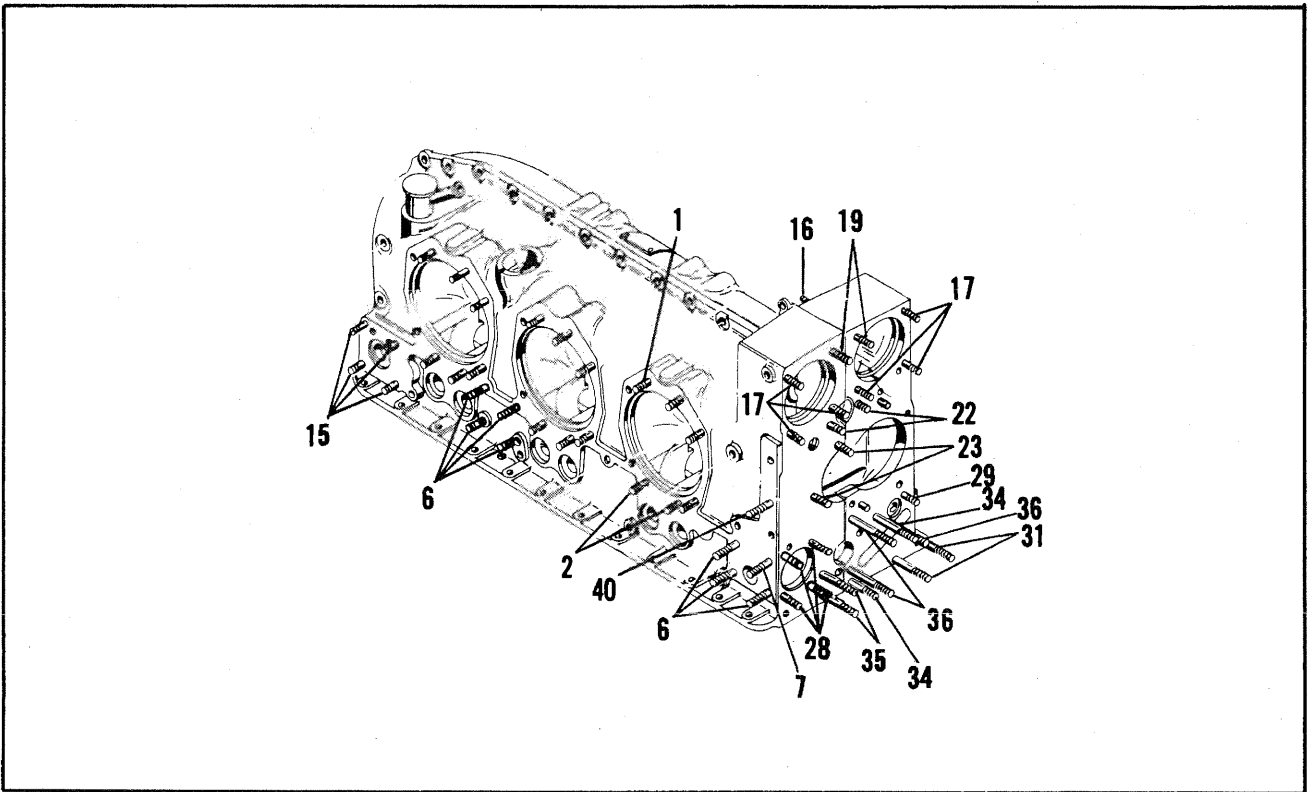


FIGURE 6-2. STUD SETTING HEIGHTS (CHART NO. 2) TSIO-520-C, G, H.

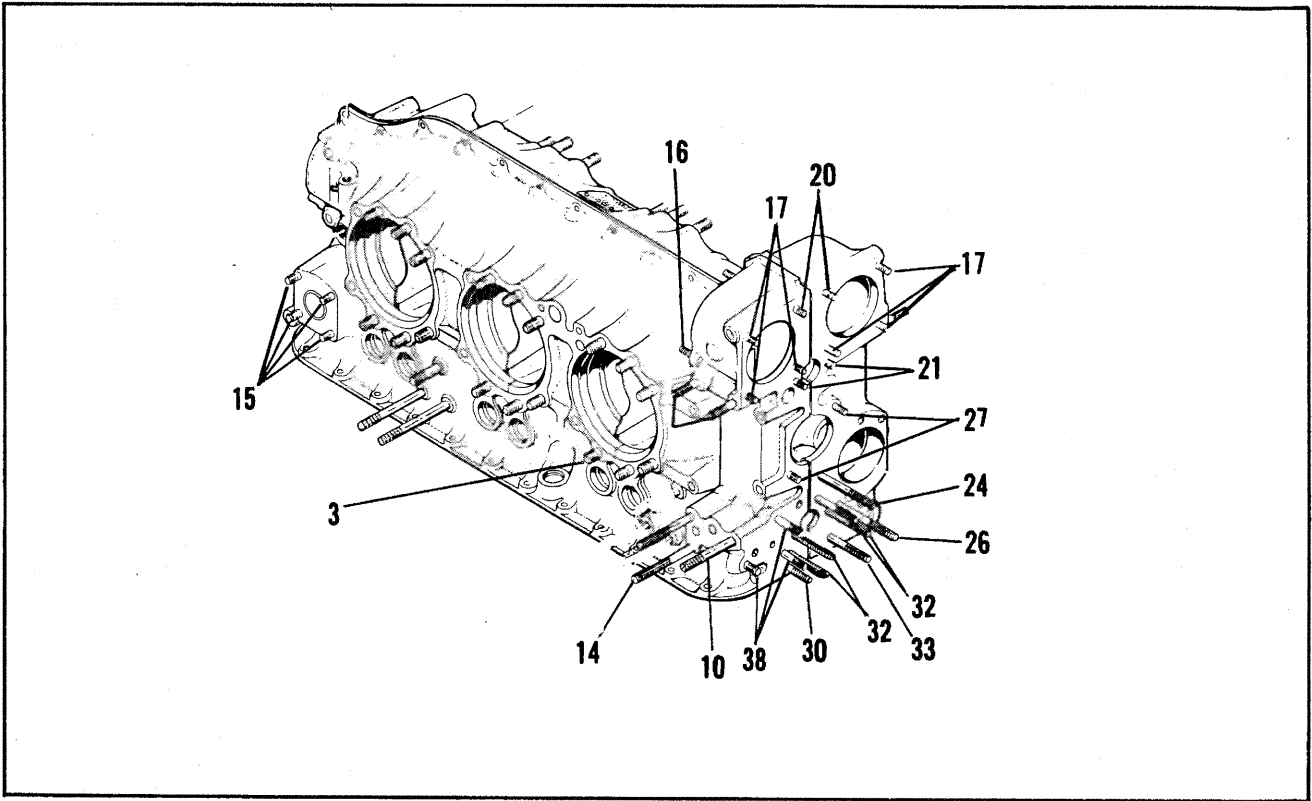


FIGURE 6-2. STUD SETTING HEIGHTS (CHART NO. 3) TS10-520-D.

**TABLE V.**  
**MAGNETIC PARTICLE INSPECTION**  
**FLUORESCENT METHOD PREFERRED,**  
**WET CONTINUOUS PROCEDURE REQUIRED**

Part	*Method of Magnetization	AC or DC Amperes	Critical Areas	Possible Defects
Crankshaft	Circular and Longitudinal	2000	Journals, fillets, oil holes, thrust flanges, prop flange.	Fatigue cracks, heat cracks, flange cracks, from prop strike
Connecting Rod	Circular and Longitudinal	1500	All areas.	Fatigue cracks.
Camshaft	Circular and Longitudinal	1500	Lobes, Journals drilled hole edges	Heat cracks. Fatigue cracks.
Piston Pin	Circular and Longitudinal	1000	Shear planes, ends, center.	Fatigue cracks.
Rocker Arms	On Conductor Bar and Single Between Heads	1000 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 Diameter	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 Rod 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**  
**TABLE OF LIMITS**

Ref. No.	Chart No.	Model	Description	Serviceable Limit	New Parts	
					Min.	Max.
<b>CYLINDER AND HEAD ASSEMBLY</b>						
1	1	All	Cylinder bore (lower 4-1/4" of barrel) . . . . . Diameter:	5.2560	5.2510	5.2530
2	1	All	Cylinder bore choke (at 5.75" from open end of barrel) . . . . . Taper:	0.0010	0.0030	0.0050
3	1	All	Cylinder bore out-of-round . . . . .	0.0030	0.0000	0.0020
4	1	All	* Cylinder bore . . . . . Allowable Oversize:	5.2700	5.2660	5.268
5	1	All	Cylinder bore surface roughness . . . . . RMS:	—	15	25
6	1	All	Cylinder barrel in crankcase . . . . . Diameter:	—	0.0040L	0.0100L
7	1	All	Intake valve seat insert in cylinder head . . . . . Diameter:	—	0.0090T	0.0120T
8	1	All	Intake valve guide in cylinder head . . . . . Diameter:	—	0.0010T	0.0025T
9	1	All	Exhaust valve guide in cylinder head . . . . . Diameter:	—	0.0010T	0.0025T
10	1	All	Exhaust valve seat insert in cylinder head . . . . . Diameter:	—	0.0070T	0.0100T
11	1	All	Intake valve seat . . . . . Width:	—	0.0630	0.1400
12	1	All	Exhaust valve Seat . . . . . Width:	—	0.0630	0.1400
	1	All	Exhaust valve seat-to-valve guide axis . . . . . Angle:	—	44° 30'	45° 00'
	1	All	Intake valve seat-to-valve guide axis . . . . . Angle:	—	59° 30'	60° 00'
<b>ROCKER ARMS AND SHAFTS</b>						
13	1	All	Rocker shaft in cylinder head bosses . . . . . Diameter:	0.0030L	0.0000	0.0020L
14	1	All	Rocker shaft in rocker arm bearing . . . . . Diameter:	0.0040L	0.0010L	0.0025L
15	1	All	Rocker arm bearing in rocker arm . . . . . Diameter:	—	0.0020T	0.0040T
16	1	All	Rocker arm . . . . . Side Clearance:	0.0350L	0.0020L	0.0015L
17	1	All	Intake valve in guide . . . . . Diameter:	0.0050L	0.0012L	0.0027L
18	1	All	Exhaust valve in guide . . . . . Diameter:	0.0070L	0.0030L	0.0050L
18	1	All	Exhaust valve in guide (niresist) . . . . . Diameter:	0.0070L	0.0030L	0.0050L
18	1	All	Exhaust valve in guide (nitralloy) . . . . . Diameter:	0.0080L	0.0030L	0.0060L
19	1	All	Intake valve face (to stem axis) . . . . . Angle:	—	59° 45'	60° 15'
20	1	All	Exhaust valve face (to stem axis) . . . . . Angle:	—	45° 00'	45° 30'
21	1	All	Intake valve (max. tip regrind .015) . . . . . Length:	4.7890	4.8040	4.8240
22	1	All	Exhaust valve (max. tip regrind .015) . . . . . Length:	4.7910	4.8060	4.8260
23	1	All	Intake and exhaust valve (full indicator reading) concentricity . . . . .	0.0040	0.0000	0.0020
	1	All	Hydraulic lifter-to-valve stem . . . . .	—	0.0600	0.2000
<b>PISTONS, RINGS AND PINS</b>						
24	1	All	Piston (2nd & 3rd lands) in cylinder . . . . . Diameter:	—	0.0310L	0.0350L
25	1	All	Piston (bottom of skirt) in cylinder . . . . . Diameter:	0.0160L	0.0100L	0.0130L
26	1	All	Top piston ring in groove . . . . . Side Clearance:	0.0080L	0.0040L	0.0060L
27	1	All	Second piston ring in groove . . . . . Side Clearance:	0.0080L	0.0040L	0.0060L
26/27	1	All	*** Top and second piston ring in groove . . Side Clearance:	0.006L	0.0015L	0.004L
28	1	All	Third piston ring in groove . . . . . Side Clearance:	0.0075L	0.0035L	0.0055L
29	1	All	Fourth piston ring in groove . . . . . Side Clearance:	0.0100L	0.0060L	0.0080L
30	1	All	Top ring gap (in cylinder barrel) . . . . . Gap:		0.0300	0.0440
31	1	All	Second ring gap (in cylinder barrel) . . . . . Gap:		0.0300	0.0460
32	1	All	Third ring gap (in cylinder barrel) . . . . . Gap:		0.0330	0.0460
33	1	All	Fourth ring gap (in cylinder barrel) . . . . . Gap:	0.0570	0.0330	0.0490
	1	All	** Top & 2nd ring (standard gap) . . . . . Tension:	12 Lbs.	13 Lbs.	17 Lbs.
	1	All	** Third ring assembly (standard gap) . . . . . Tension:	11 Lbs.	12 Lbs.	16 Lbs.
	1	All	** Fourth ring (standard gap) . . . . . Tension:	8 Lbs.	9 Lbs.	13 Lbs.

\* Use 0.005" oversize rings.

\*\* Measure piston ring tension on diameter perpendicular to gap when ring is compressed to specified inch gap.

\*\*\* For engines with cast insert pistons.

Ref. No.	Chart No.	Model	Description	Serviceable	New Parts	
				Limit	Min.	Max.
34	1	All	Piston pin in piston (standard or 0.005" oversize) . . . . . Diameter:	0.0013L	0.0001L	0.0007L
35	1	All	Piston pin . . . . . Diameter:	—	1.1243	1.1245
			Piston pin (0.005" oversize) . . . . . Diameter:	—	1.1293	1.1295
36	1	All	Piston pin in cylinder . . . . . End Clearance:	0.0300L	0.0310L	0.0480L
37	1	All	Piston pin in connecting rod bushing . . . . . Diameter:	0.0040L	0.0022L	0.0026L
38	1	All	Bushing in connecting rod . . . . . Diameter:	—	0.0025T	0.0050T
39	1	All	Bolt in connecting rod . . . . . Diameter:	—	0.0000	0.0018L
40	1	All	Connecting rod bearing on crankpin . . . . . Diameter:	0.0060L	0.0009L	0.0034L
41	1	All	Connecting rod on crankpin . . . . . End Clearance:	0.0160	0.0060	0.0100
42	1	All	Connecting bearing and bushing twist or convergence per inch of length . . . . . :	0.0010	0.0000	0.0005
<b>CRANKSHAFT</b>						
43	2/3	All	Crankshaft in main bearings . . . . . Diameter:	0.0061L	0.0018L	0.0047L
44	2/3	All	** Crankpins . . . . . Out-of-Round:	0.0015	0.0000	0.0005
45	2/3	All	** Main journals . . . . . Out-of-Round:	0.0015	0.0000	0.0005
46	2/3	All	Crankshaft main and thrust journals . . . . . Diameter:	2.3720	2.3740	2.3750
46A	2/3	All	Crankshaft rear and intermediate bearings on "B" model engines . . . . . :	2.623	2.624	2.625
47	2/3	All	Crankpins . . . . . Diameter:	2.2470	2.2490	2.2500
48	2/3	All	Crankshaft run-out at center main journals (shaft supported at thrust and rear journals) full indicator reading . . . . . :	0.0150	0.0000	0.0150
49	2/3	All	Crankshaft run-out at propeller flange (when supported at front and rear main journals) full indicator reading . . . . . :	0.0050	0.0000	0.0050
50	2/3	All	† Damper pin bushing in crankcheek ext. . . . . Diameter:	—	0.0015T	0.0030T
51	2/3	All	† Damper pin bushing in counterweight . . . . . Diameter:	—	0.0015T	0.0030T
52	2/3	All	Damper pin in counterweight . . . . . End Clearance:	0.0400	0.0010	0.0250
53	2/3	All	Crankcheek in counterweight . . . . . Side Clearance:	0.0170	0.0070	0.0120
54	3	P	Alternator gear on crankshaft . . . . . Diameter:	—	0.0005L	0.0035L
55	2/3	All	Crankshaft gear on crankshaft . . . . . Diameter:	—	0.0000	0.0020T
56	3	P	Crankshaft in thrust bearing . . . . . End Clearance:	0.0200	0.0060	0.0140
57	2	S	Crankshaft in thrust bearing . . . . . End Clearance:	0.0250	0.0080	0.0180
57-1	2/3	All	Governor oil transfer collar on crankshaft . . . . . Diameter:	—	0.0005L	0.0018L
<b>CAMSHAFT</b>						
58	2/3	All	Camshaft journals in crankcase . . . . . Diameter:	0.0050L	0.0010L	0.0030L
59	2/3	All	Camshaft in crankcase . . . . . End Clearance:	0.0140	0.0050	0.0090
60	2/3	All	Camshaft run-out at center journals (shaft supported at end journals) full indicator reading . . . . . :	0.0030	0.0000	0.0010
61	2/3	All	Camshaft gear on camshaft flange . . . . . Diameter:	—	0.0005T	0.0015L
62	3	P	Governor drive gear on camshaft . . . . . Diameter:	0.0060L	0.0010L	0.0030L
63	2	S	Governor drive gear on camshaft . . . . . Diameter:	0.0060L	0.0002L	0.0020L
<b>CRANKCASE AND ATTACHED PARTS</b>						
64	2/3	All	Through bolt in crankcase . . . . . Diameter:	—	0.0005T	0.0013L
65	1	All	Hydraulic lifter in crankcase . . . . . Diameter:	0.0035L	0.0010L	0.0025L
66	2/3	All	Governor drive shaft in crankcase . . . . . Diameter:	0.0050L	0.0014L	0.0034L

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

† Refer to Section 6-17, page 6-6 for allowable wear at damper pin bushings.

P Permold crankcase. S Sandcast crankcase.

Ref. No.	Chart No.	Model	Description	Serviceable	New Parts	
				Limit	Min.	Max.
67	3	P	Idler gear support bushing in crankcase (front) . . . . . Diameter:	—	0.0015T	0.0005L
68	2	S	Idler gear support pin in crankcase (front) . . . Diameter:	0.0010L	0.0015T	0.0005L
69	3	P	Idler gear support bushing, flanged, in crankcase (rear) . . . . . Diameter:	—	0.0015L	0.0035L
70	2	S	Idler gear support pin in crankcase (rear) . . . Diameter:	—	0.0005L	0.0025L
71	4	All	Magneto and accessory drive adapter pilot in crankcase . . . . . Diameter:	—	0.0000	0.0040L
72	2/3	All	Oil pump housing pilot in crankcase . . . . . Diameter:	—	0.0010L	0.0030L
73	4	All	Starter shaftgear needle bearing hole crankcase . . . . . Diameter:	—	0.9995	1.0005
<b>OIL PRESSURE RELIEF VALVE ASSEMBLY</b>						
74	2	All	Oil pressure relief valve adjusting screw in plunger . . . . . Diameter:		0.010	0.025
<b>ACCESSORY DRIVE IDLER ARM</b>						
75	2	S	Bushing in idler gear . . . . . Diameter:	—	0.0010T	0.0030T
76	2	S	Idler gear support in bushing . . . . . Diameter:	0.0050L	0.0015L	0.0035L
77	3	P	Idler gear in support bushing (front) . . . . . Diameter:	0.0040L	0.0010L	0.0030L
78	3	P	Idler gear in support bushing (rear) . . . . . Diameter:	0.0040L	0.0010L	0.0030L
79	2	S	Idler gear . . . . . End Clearance:	0.0430	0.0020	0.0330
80	3	P	Idler gear . . . . . End Clearance:	0.0750	0.0200	0.0670
<b>LEFT AND RIGHT MAGNETO AND ACCESSORY</b>						
81	4	All	Bushing in magneto and accessory drive adapter . . . . . Diameter:	—	0.0010T	0.0030T
82	4	All	Magneto and accessory drive gear in adapter bushing . . . . . Diameter:	0.0050L	0.0015L	0.0035L
83	4	All	Oil seal in adapter . . . . . Diameter:	—	0.0010T	0.0070T
84	4	All	Sleeve in magneto and accessory drive gear . . . . . Diameter:	—	0.0010T	0.0040T
85	4	P	Magneto and accessory drive gear . . . . . End Clearance:	—	0.0110L	0.0770L
85	4	S	Magneto and accessory drive gear . . . . . End Clearance:	—	0.0015L	0.0860L
86	4	All	Magneto coupling retainer on magneto and accessory drive gear sleeve . . . . . Diameter:	0.0550L	0.0250L	0.0400L
87	4	All	Magneto coupling retainer in magneto drive gear slot . . . . . Side Clearance:	0.0400L	0.0020T	0.0280L
88	4	P	Magneto coupling rubber bushings on magneto drive lugs . . . . . Side Clearance:	—	0.0520T	0.0140L
88	4	S	Magneto coupling rubber bushings on magneto drive lugs . . . . . Side Clearance:	—	0.0520T	0.0100L
89	4	All	Magneto pilot in crankcase . . . . . Diameter:	—	0.0010L	0.0050L
<b>OIL PRESSURE PUMP ASSEMBLY</b>						
90	3	P	Oil pump driver gear in pump housing . . . . . Diameter:	0.0070L	0.0030L	0.0050L
91	2	S	Oil pump driver gear in pump housing . . . . . Diameter:		0.0040L	0.0065L
92	2/3	All	Oil pump driver gear shaft in pump housing . . Diameter:	0.0045L	0.0015L	0.0030L
93	2/3	All	Oil pump driven gear in pump housing . . . End Clearance:	0.0050	0.0005	0.0030
94	2/3	All	Oil pump driver gear in pump housing . . . End Clearance:	0.0050	0.0005	0.0030

P Permold crankcase.  
S Sandcast crankcase.

Ref. No.	Chart No.	Model	Description	Serviceable Limit	New Parts	
					Min.	Max.
95	2	S	Scavenge pump driven gear in scavenge pump housing . . . . . Diameter:	0.0100L	0.0055L	0.0080L
96	2	S	Scavenge pump driver gear in scavenge pump housing . . . . . Diameter:	0.0100L	0.0055L	0.0080L
97	2	S	Scavenge pump drive and driven gear in scavenge pump. . . . . End Clearance:	0.0050	0.0005	0.0030
98	2/3	All	Oil pump driver gear shaft in cover oil pump . . . . . Diameter:	0.0045L	0.0015L	0.0030L
99	2/3	All	Oil pump driver gear shaft in tachometer drive bevel gear . . . . . Diameter:	0.0040L	0.0005L	0.0025L
100	2/3	All	Oil pump driven gear shaft in oil pump housing . . . . . Diameter:	—	0.0010T	0.0030T
101	2/3	All	Oil pump driven gear on shaft. . . . . Diameter:	0.0040L	0.0005L	0.0025L
102	3	P	Oil pump driven gear in housing . . . . . Diameter:	0.0080L	0.0040L	0.0060L
103	2	S	Oil pump driven gear in housing . . . . . Diameter:	0.0060L	0.0015L	0.0040L
<b>TACHOMETER DRIVE ASSEMBLY</b>						
104	2/3	All	Tachometer drive shaft in oil pump cover . . . . . Diameter:	0.0045L	0.0015L	0.0030L
105	3	P	Oil seal in tachometer drive housing . . . . . Diameter:	—	0.0015T	0.0065T
106	3	S	Oil seal in tachometer drive housing . . . . . Diameter:	—	0.0010T	0.0070T
<b>STARTER DRIVE</b>						
107	4	All	Starter shaftgear in bearing . . . . . Diameter:	0.0031L	0.0005L	0.0020L
108	4	All	Starter shaftgear front (bearing) journal . . . . . Diameter:	0.7480	0.7495	0.7500
109	4	P	Starter shaftgear in clutch drum bearing . . . . . Diameter:	—	0.0005L	0.0020L
110	4	S	Starter clutch drum on starter shaftgear . . . . . Diameter:	0.0055L	0.0020L	0.0040L
111	4	All	Clutch spring sleeve in starter adapter. . . . . Diameter:	—	0.0030T	0.0050T
112	4	All	Starter shaftgear in ball bearing. . . . . Diameter:	—	0.0005T	0.0001L
113	4	S	Starter shaftgear in oil seal sleeve. . . . . Diameter:	—	0.0000	0.0015L
114	4	All	Bearing in starter adapter cover. . . . . Diameter:	—	0.0001T	0.0010L
115	4	S	Oil seal in starter adapter cover. . . . . Diameter:	—	0.0017T	0.0063T
116	4	S	Starter adapter cover pilot in starter adapter . . . . . Diameter:	—	0.0010L	0.0030L
117	4	P	Worm wheel gear . . . . . End Clearance:	0.0250	0.0020	0.0170
118	4	S	Worm wheel gear . . . . . End Clearance:	0.0800	0.0380	0.0720
119	4	All	Clutch spring on clutch drum . . . . . Diameter:	0.0120T	0.0150T	0.0220T
120	4	All	Clutch spring on starter shaftgear (over knurl) . . . . . Diameter:	0.0130L	0.0060L	0.0090L
121	4	All	* Clutch spring in clutch spring sleeve. . . . . Diameter:	0.0270T	0.0310T	0.0380T
122	4	All	From center line of worm gearshaft to starter adapter thrust pads . . . . . :	0.2520	0.2460	0.2480
123	4	All	Needle bearing hole starter adapter . . . . . Diameter:	—	0.7485	0.7495
124	4	All	Ball bearing in starter adapter . . . . . Diameter:	—	0.0001T	0.0010L
125	4	All	Worm gearshaft in needle bearing area . . . . . Diameter:	0.5600	0.5615	0.5625
126	4	All	Worm gearshaft in ball bearing . . . . . Diameter:	—	0.0007T	0.0001L
127	4	All	Starter worm gear on shaft. . . . . Diameter:	0.0040L	0.0005L	0.0025L
128	4	All	Starter spring on worm drive shaft. . . . . Diameter:	—	0.0050L	0.0250L
129	4	All	Starter pilot to starter drive adapter. . . . . Diameter:	—	0.0010L	0.0065L
130	4	All	Starter drive tongue to worm shaft drive slot . . . . . Side Clearance:	0.0300L	0.0100L	0.0210L

\* When sand blasted finish diameter finish is worm to 75 RMS, replace sleeve.  
P Permold crankcase.  
S Sandcast crankcase.



Ref. No.	Chart No.	Model	Description	Serviceable	New Parts	
				Limit	Min.	Max.
131	4	P	Scavenge pump driver gear on starter gear shaft . . . . . Diameter:	0.0030L	0.0004L	0.0018L
132	4	P	Scavenge pump driven gear on shaft. . . . . Diameter:	0.0040L	0.0005L	0.0025L
133	4	P	Scavenge pump driver and driven gear in body . . . . . End Clearance:	0.0060	0.0015	0.0040
134	4	P	Scavenge pump driver and driven gear in body. . . . . Diameter:	0.0160L	0.0115L	0.0140L
135	4	P	Bushing in scavenge pump driven gear . . . . . Diameter:	—	0.0035T	0.0060T
136	4	P	Starter gearshaft in scavenge pump body. . . . . Diameter:	0.0040L	0.0015L	0.0028L
<b>GEAR BACKLASH</b>						
137	4	All	Crankshaft gear and camshaft gear. . . . . Backlash:	0.0160	0.0080	0.0120
138	4	All	Crankshaft gear and idler gear. . . . . Backlash:	0.0160	0.0080	0.0120
139	4	All	Idler gear and magneto drive gear (right and left). . . . . Backlash:	0.0160	0.0080	0.0120
140	2	S	Oil pump driver and driven gears. . . . . Backlash:	0.0270	0.0140	0.0128
141	3	P	Oil pump driver and driven gears. . . . . Backlash:	0.0160	0.0090	0.0130
142	2/4	All	Scavenge pump driver and driven gears. . . . . Backlash:	0.0270	0.0140	0.0218
143	2/3	All	Tachometer drive gear and tachometer driven gear . . . . . Backlash:	0.0120	0.0040	0.0080
144	4	All	Starter shaftgear and crankshaft gear . . . . . Backlash:	0.0160	0.0080	0.0120
145	4	All	Starter worm wheel gear and worm gear . . . . . Backlash:	0.0200	0.0090	0.0130
146	3	P	Governor drive gear and governor driven gear . . . . . Backlash:	0.0120	0.0040	0.0080
147	2	S	Governor drive gear and governor driven gear . . . . . Backlash:	0.0090	0.0020	0.0060
148	3	P	Alternator face gear in engine. . . . . Backlash:	0.0120	0.0020	0.0090
<b>SPRING TEST DATA</b>						
149	3	All	Oil temperature control valve 0.090 inches minimum travel at . . . . . Temperature:	—	120°	170°
	3	All	Oil temperature control valve must close between . . . . . Oil Temperature:	—	168°	172°
150	2	All	Relief valve spring (634150) compressed to 1.25 inch length. . . . . Load:	30 Lbs.	32 Lbs.	37 Lbs.
151	2		Oil filter by-pass valve spring (631478) in pump compressed to 1.09 inch length. . . . . Load:	5.0 Lbs.	5.6 Lbs.	—
152	1	All	Inner valve spring (631521) compressed to 1.230 inch length. . . . . Load:	82 Lbs.	87 Lbs.	97 Lbs.
	1	All	Inner valve spring (631521) compressed to 1.746 inch length. . . . . Load:	29 Lbs.	32 Lbs.	38 Lbs.
153	1	All	Outer valve spring (631520) compressed to 1.275 inch length. . . . . Load:	109 Lbs.	117 Lbs.	133 Lbs.
	1	All	Outer valve spring (631520) compressed to 1.791 inch length. . . . . Load:	46 Lbs.	49 Lbs.	55 Lbs.

TABLE VII.  
TABLE OF TIGHTENING TORQUES.

Ref. No.	Chart No.	Model	Special Applications	Thread Size	Qty.	Torque	
						In. Lbs.	Ft. Lbs.
T1	3	P	Crankcase through bolt	3/8-24	1	370-390	30.8-32.5
T2	2/3	All	Crankcase through bolt (nose)	7/16-20	2	490-510	40.8-42.5
T3	2/3	All	Crankcase through bolt (dowel type)	1/2-20	8	640-660	53.3-55.0
T4	3	P	Crankshaft face gear screw (alt.)	5/16-24	4	140-150	11.7-12.5
T5	2	S	Crankshaft gear screw	5/16-24	6	380-420	31.7-35.0
T5	3	P	Crankshaft gear screw	5/16-24	6	380-420	31.7-35.0
T6	2/3	All	Camshaft gear screw	5/16-24	4	240-260	20.0-21.7
T7	3	P	Oil suction tube plug	5/8-18	1	190-210	15.8-17.5
T8	1	All	Connecting rod bolt nuts	7/16-28	12	425-475	35.4-39.6
T9	1	All	Cylinder hold down nuts	7/16-20	36	490-510	40.8-42.5
T10	1	All	Cylinder hold down nuts	1/2-20	12	640-660	53.3-55.0
T11	2	S	Oil filter plug (with new gasket)*	1-3/4-16	1	500-520	41.6-43.3
T12	3	P	Oil filter center stud	5/8-18	1	180-216	15.0-18.0
T13		B,D,E	Alternator mounting bolt	5/16-18	4	150-180	12.5-15.0
T14		B,D,E	Alternator shaft nut	5/8-32	1	450-500	37.5-41.7
T15	1	All	Spark plugs	18mm	12	300-360	25.0-30.0

\* Install gasket with parting line up against plug face.

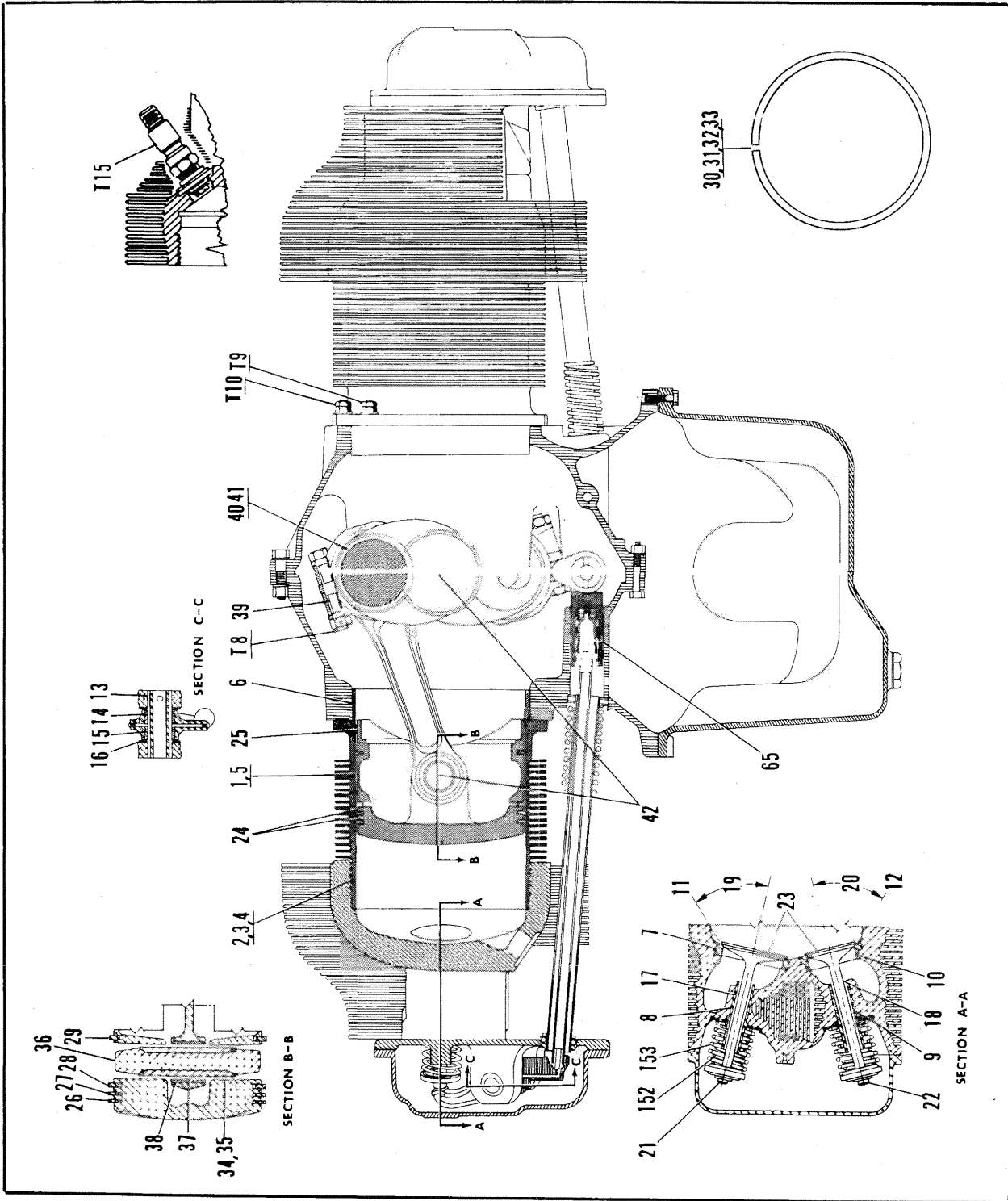


FIGURE 6-3. LIMITS AND LUBRICATION CHART (1 OF 4).

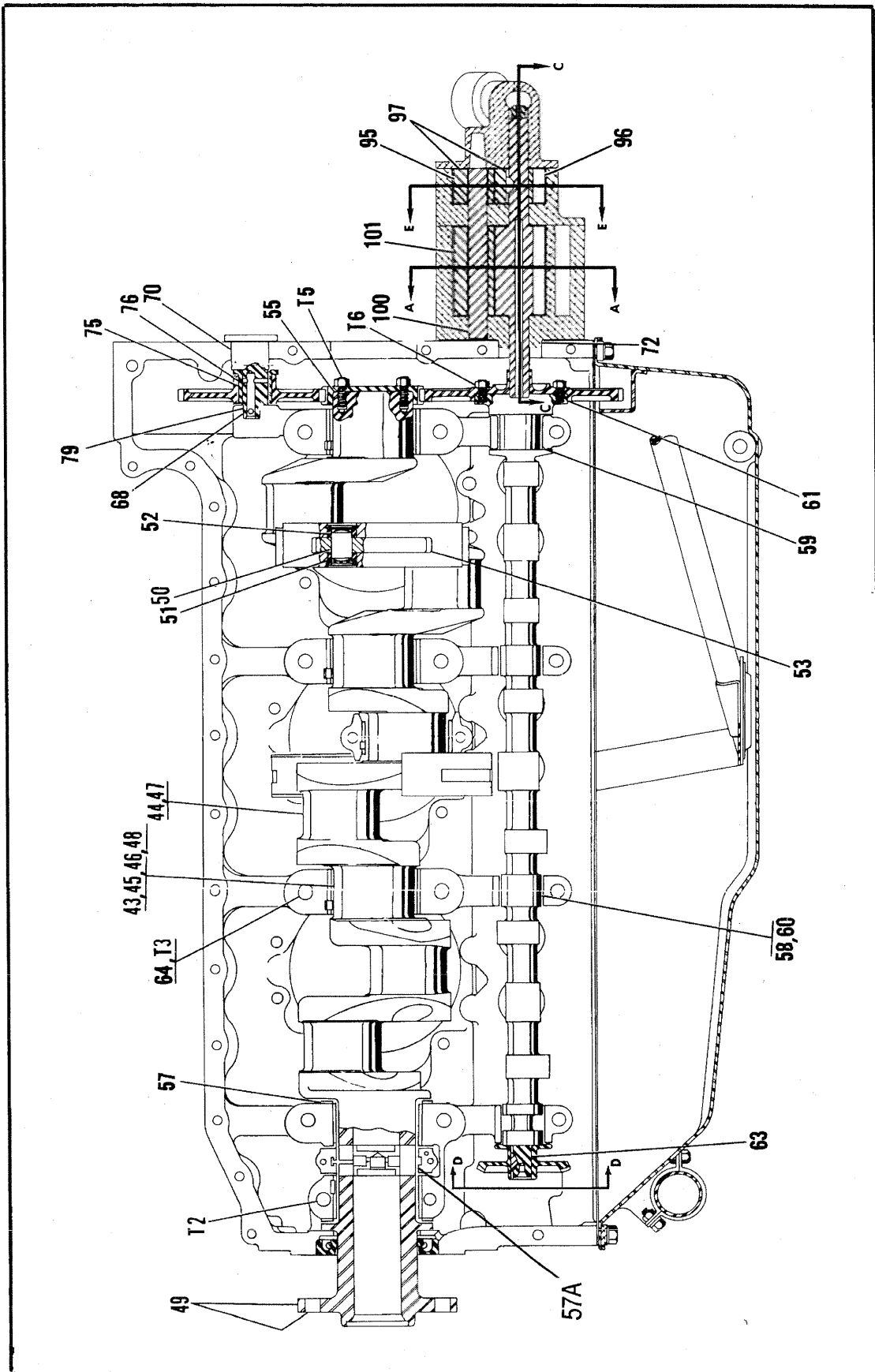


FIGURE 6-3. LIMITS AND LUBRICATION CHART (2 OF 4).

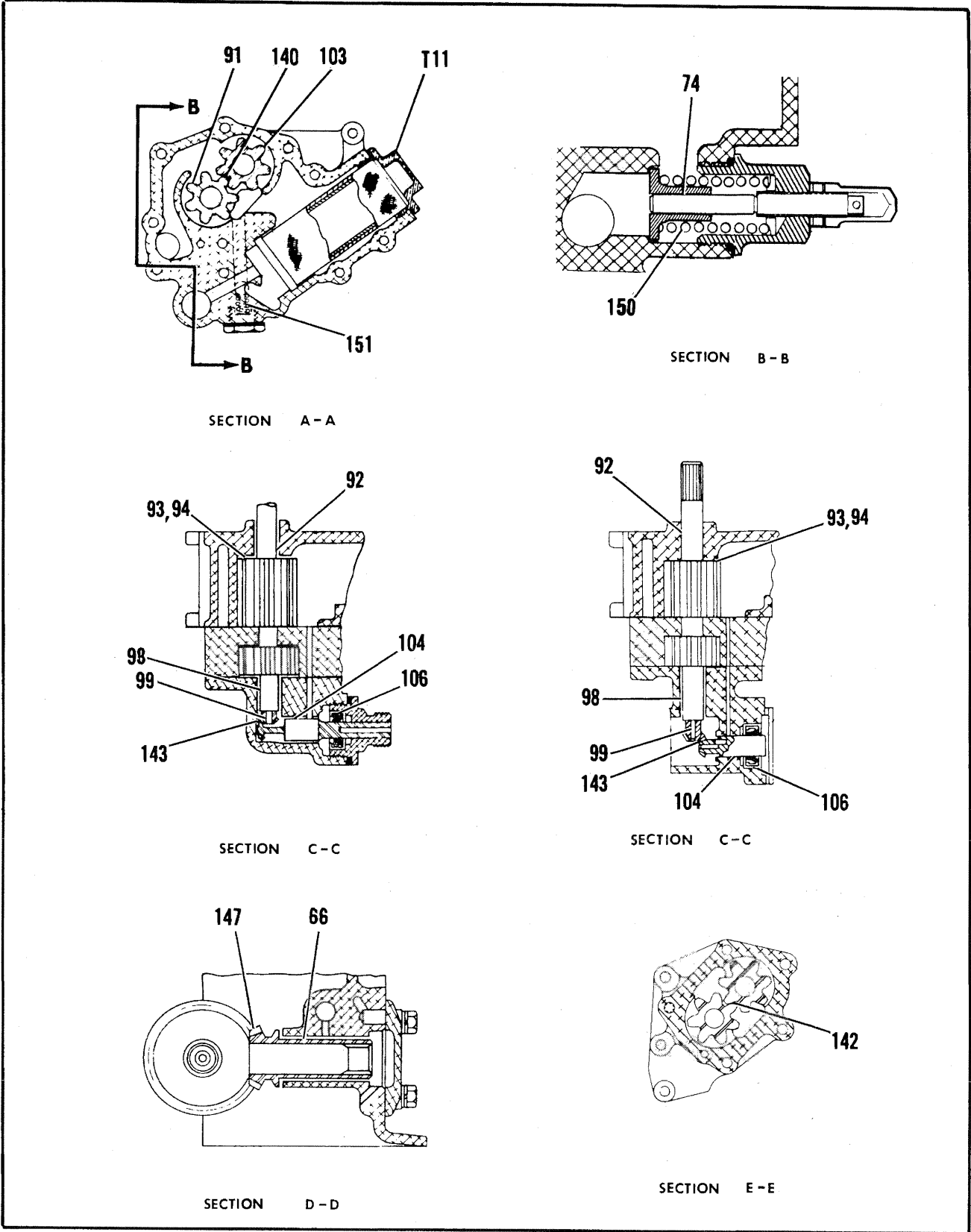


FIGURE 6-3. LIMITS AND LUBRICATION CHART (2 OF 4).

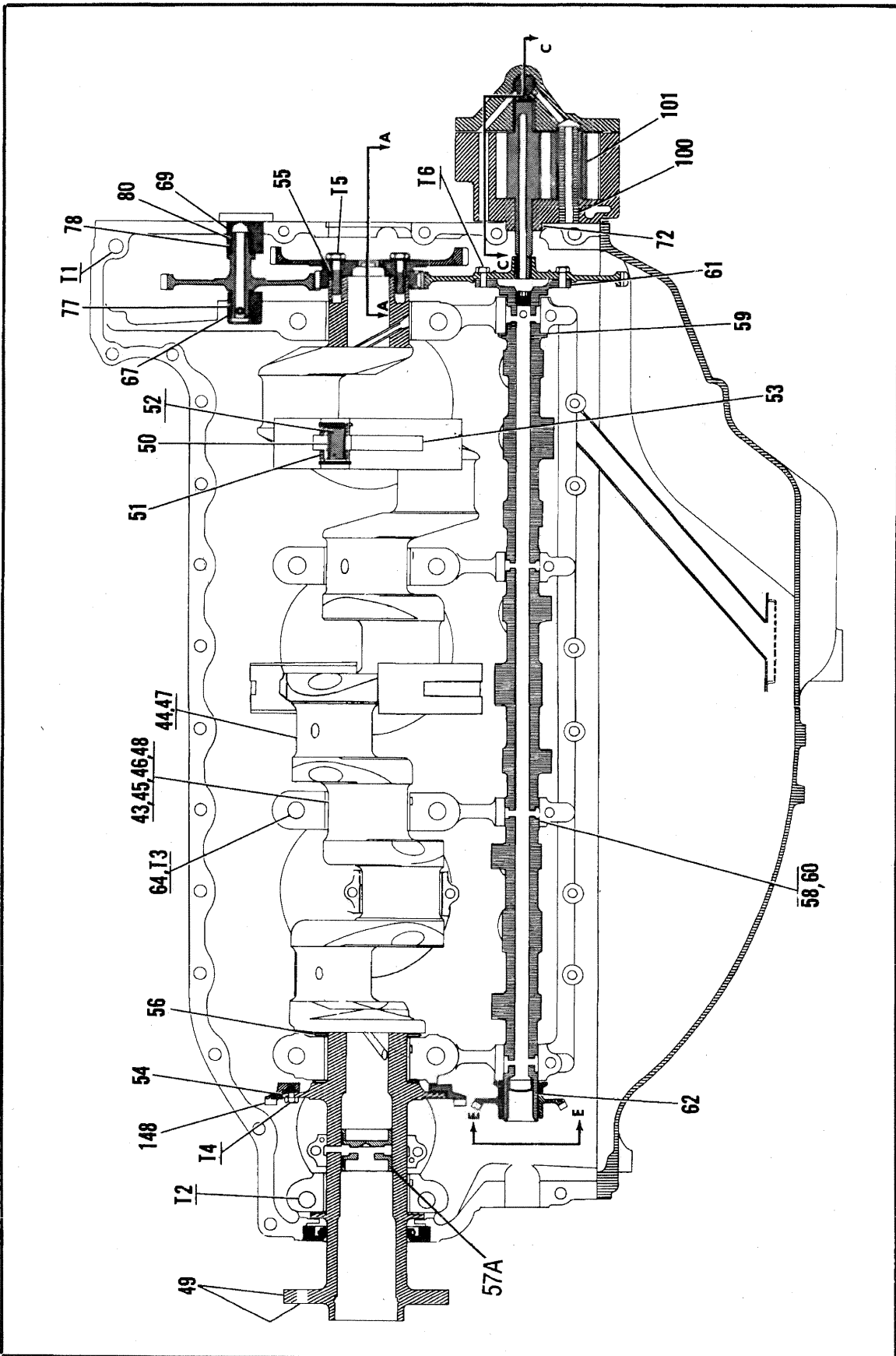
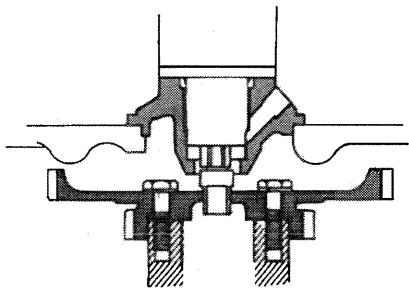
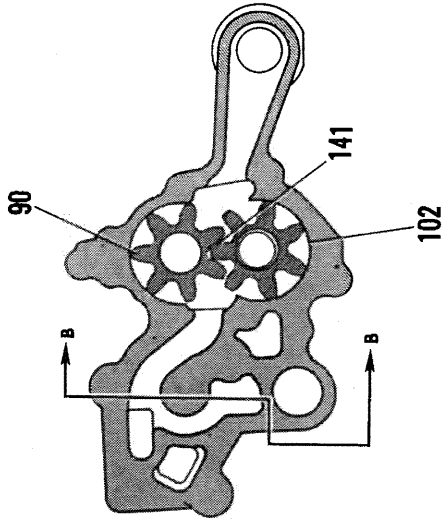


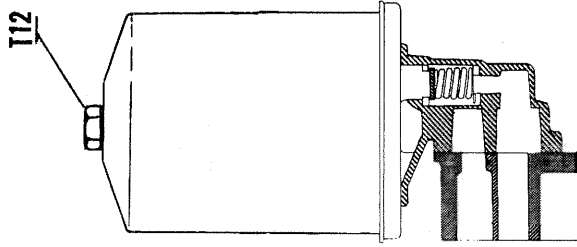
FIGURE 6-3. LIMITS AND LUBRICATION CHART (3 OF 4).



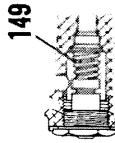
SECTION A-A



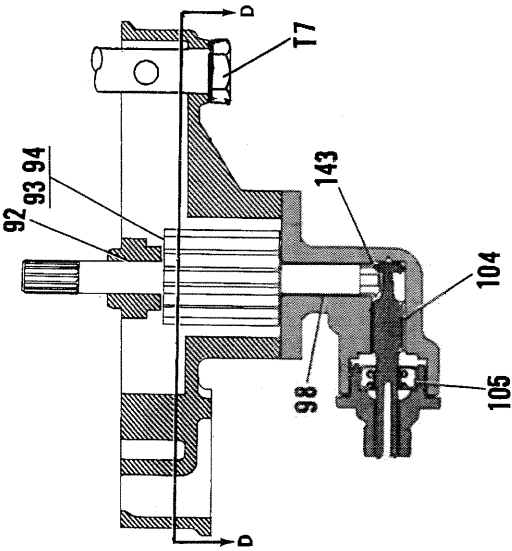
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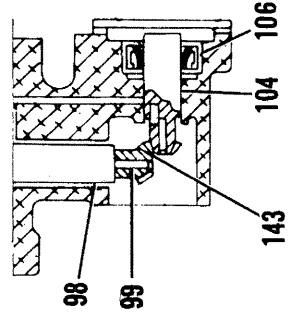
SECTION B-B



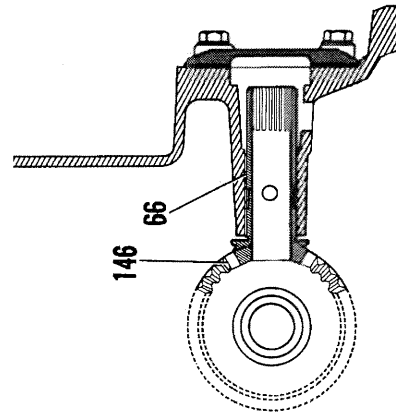
SECTION E-E



SECTION C-C



SECTION C-C



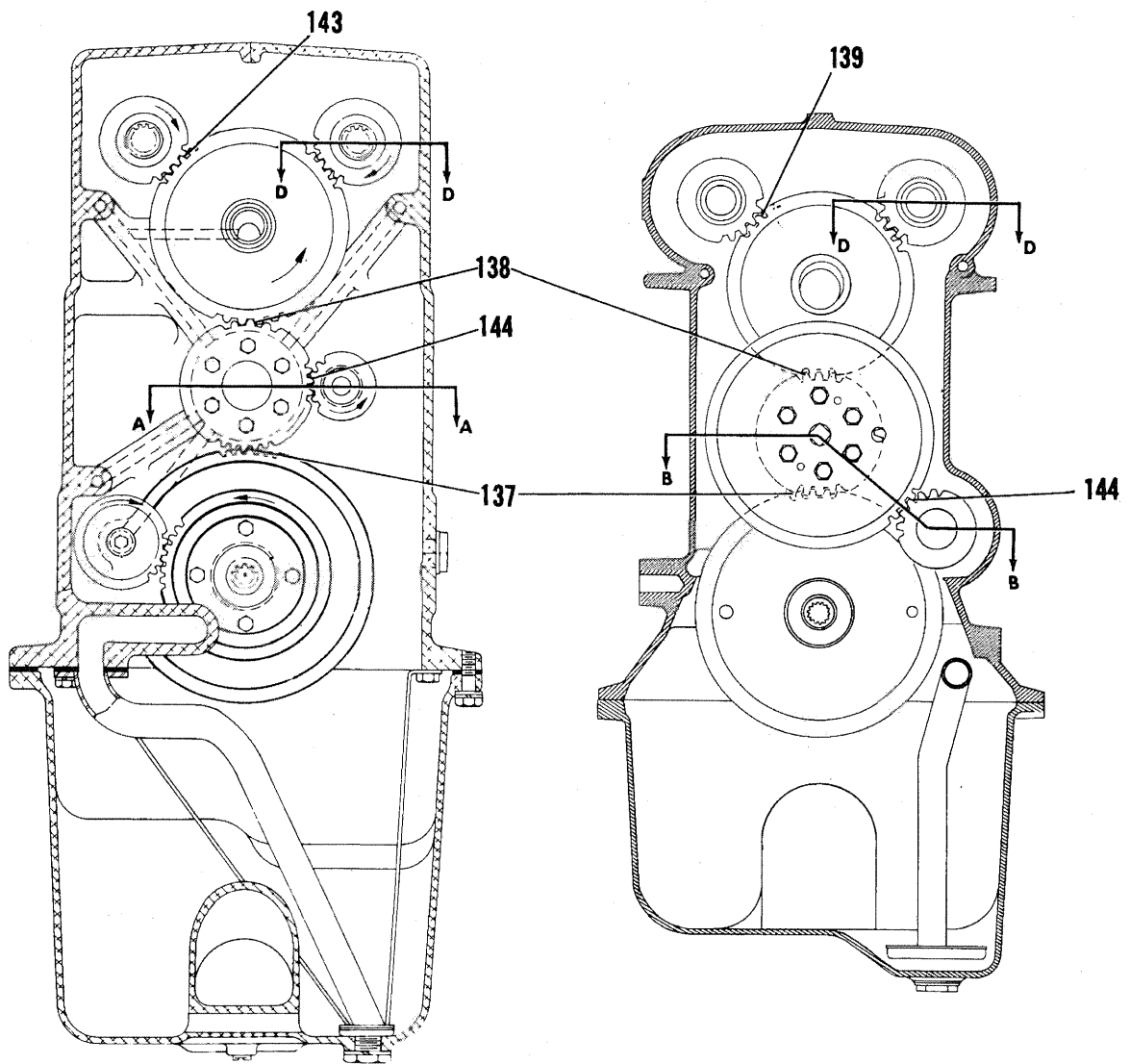
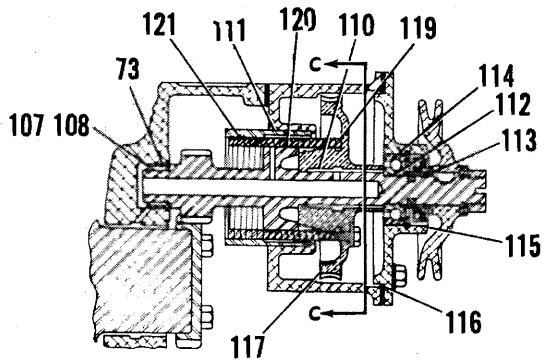
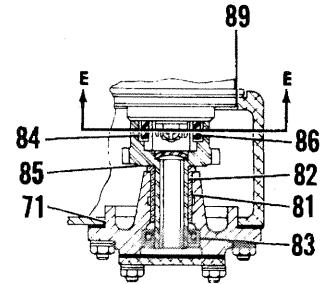


FIGURE 6-3. LIMITS AND LUBRICATION CHART (4 OF 4).

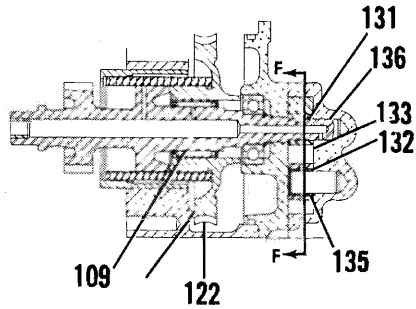




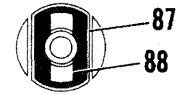
SECTION A-A



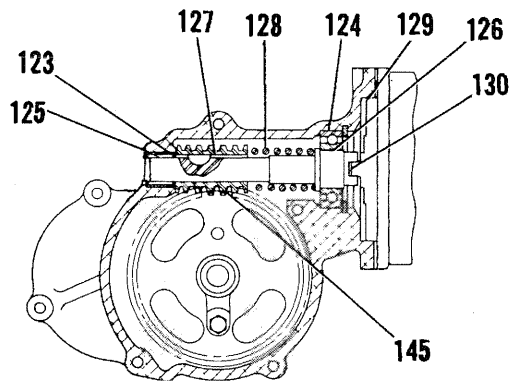
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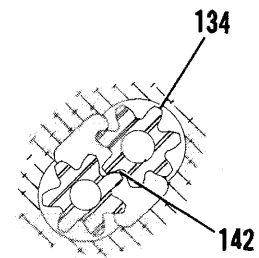
SECTION B-B



SECTION E-E



SECTION C-C



SECTION F-F

**TABLE VIII.  
GENERAL USE - TIGHTENING TORQUES.**

BOLTS, NUTS & SCREWS			DRIVING STUDS	
SIZE	IN. LBS.	FT. LBS.	IN. LBS.	FT. LBS.
8-32	22.0-30.0	1.8-2.5		
10-32	36.0-50.0	3.0-4.2		
1/4-20	75.0-85.0	6.3-7.1	50.0-70.0	4.2-5.8
1/4-28	90.0-110.0	7.5-9.2		
5/16-18	155.0-175.0	12.9-14.6	100.0-150.0	8.3-12.5
5/16-24	180.0-220.0	15.0-18.3		
3/8-16	220.0-260.0	18.3-21.7	200.0-275.0	16.7-22.9
3/8-24	275.0-325.0	22.9-27.1		
7/16-14			300.0-425.0	25.0-35.4
7/16-20	400.0-450.0	33.3-37.5		
1/2-20	550.0-600.0	45.8-50.0		

**TABLE IX.  
PIPE PLUGS.**

SIZE	IN. LBS.	FT. LBS.
1/8-27	60-80	5.0-6.7
1/4-18	130-150	10.8-12.5
3/8-18	185-215	15.4-18.0
1/2-14	255-285	21.3-23.8
3/4-14	310-350	25.8-29.2

## 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 installed at this time. This is especially true of precision bearing inserts and anti-friction bearings. Check other new parts on receipt for damage done in transit. Refer to Section IV of the parts catalog, Form X-30043A, for part numbers of the complete gasket set, the main bearing set, the piston ring set and tubes of lightweight 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 an annealed, corrosion-resistant lockwire.

#### 7-2. TIGHTENING TORQUES.

The Table of Limits in Section VI contains tightening torques for bolts, nuts, and plugs installed using oil as the 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 part is accidentally tightened too much, loosen it and tighten to a value specified within the specified limits. If a nut slot cannot be aligned with a cotter pin hole within the specified limits, substitute another serviceable nut. If the cotter pin hole in the stud lies beyond the nut slots when the nut has been tightened properly, the stud has been improperly installed or has backed out, 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.

**NOTE**

Tightening torque limits specified in Section VI are based on oiled threads, but are not applicable when special thread lubricant is used.

#### 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 dry 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 leakage of oil, coat the male threads with Snap-On Tool Corporation's anti-seizure compound. 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 INSTRUCTIONS.

#### 7-6. OIL PUMP ASSEMBLY, PERMOLD ENGINE (See Figure 4-21).

a. If oil pressure relief valve setting has been lost in disassembly, turn adjusting screw (43) into relief valve housing (38) about halfway. Secure with copper washer (37) and nut (36). Install new gasket (39), washer (42), spring (41) and plunger (40) onto adjusting screw and assemble into housing (47).

b. Install driven gear assembly (34,35) on shaft. Install driver gear assembly (31,33) in pump housing to mesh with driven gear. Install bevel gear (32) on drive gearshaft. Apply Permatex and silk thread to parting surface being careful not to place thumb on edge.

**TABLE X**  
**TABLE OF LUBRICANTS**

ITEM	APPLICATION	MATERIAL OR TRADE NAME	COMPANY
1	All moving parts and bearings except following:	Corrosion-preventive compound	Various
2	Crankshaft oil seal lip, all synthetic rubber oil seals, valve stem in guides and crankshaft thrust bearings.	Molyshield grease	American Lubricants Company Dayton, Ohio 45400
3	All tapered pipe threads, all fuel injector nozzles, connecting rods and nuts.	Thread lubricant and sealing compound	Snap-On Tools Corporation 8049 - 28th Avenue Kenosha, Wisconsin 53140
4	Valve stem ends, valve rocker arm feet, connecting rods and crankshaft bearings, all gears, valve rocker shafts, piston pin in piston, piston rings and piston.	Grade 30 Aviation lubricating oil	Various
5	Fuel injection linkage.	Dry lubricant	Dri-Slide Sales 1 Industrial Park Fremont, Michigan 49412
6	All studs, all press-type plugs.	National Oil Sealer	Standard Pressed Steel Company Highland Avenue Jenkinstown, Pennsylvania 19046
7	Magneto Adapter Assembly  All pipe thread fittings on fuel pump, manifold valve, metering unit and pressure regulator.	Loctite retaining compound Loctite Hydraulic Sealant	Loctite Corporation 115 North Mountain Road Newington, Connecticut 06111
8	Idler pin gaskets, oil drain back tubes, oil filler neck.	Tightseal	Radiator Specialty Company Charlotte, North Carolina 28200
9	All contacting surfaces between bodies and covers where gaskets are not specified.	No. 50 Silk Thread, Grade "A"  No. 3 Aviation Permatex	Various  Permatex Company, Inc. 1720 Avenue Y Brooklyn, New York 11200
10	Flushing of oil cooler.	Low viscosity lubricating oil	Various
11	Engine storage.	Preservative oil	Viscosity Oil Company Chicago, Illinois 60600

c. If electric tachometer is used, follow procedure described in paragraphs d, e, f. If mechanical tachometer is used, skip to paragraph g and proceed as described.

d. Install new oil seal (29) in tachometer drive housing (27). Install new gasket (28) on housing (27). Carefully work lip of oil seal over shaftgear (30) and push shaft through.

e. Hold gear end of tachometer drive shaftgear (30) up and insert shaftgear into cover (26). Screw housing (27), which is lefthand thread, into cover (26) keeping bevel gear upward. Hand tighten only.

f. Place cover and tachometer drive assembly on pump housing. Turn drive gear to mesh bevel gears. Attach with two sets of attaching parts (23,24,25).

**NOTE**

Check for binding. If binding occurs, loosen cover and retighten.

g. Work shaftgear (17) carefully through lips of new oil seal (16). Install oil seal and shaftgear in cover (10). Install gaskets (15,22), covers (14,21) and secure with attaching parts (11,12,13 and 18, 19,20). Install assembly on pump housing and secure with two sets of attaching parts (7,8,9).

**7-7. OIL PUMP ASSEMBLY, SANDCAST ENGINE (See Figure 4-22).**

a. Install by-pass valve assembly (36 thru 39) using new gasket (37).

b. If oil pressure relief valve setting has been lost in disassembly, turn adjusting screw (35) into relief valve housing (30) about halfway. Secure with copper washer (29) and nut (28). Install new gasket (31), washer (34), spring (33) and plunger (32) onto adjusting screw and assemble into housing (4).

c. Install driven gear assembly (26,27) on shaft. Install driver gear assembly (24,25) in pump housing to mesh with driven gear.

d. Apply Permatex and silk thread to parting surface and install scavenge pump housing.

e. Place Woodruff key (22) in oil pump drive gear slot and install scavenge pump driver gear (21). Install scavenge pump driven gear assembly (19,20)

in scavenge pump housing to mesh with driver gear. Install bevel gear (23) on oil pump drive gearshaft. Apply Permatex and silk thread to parting surface.

**7-8. STARTER DRIVE ADAPTER ASSEMBLY, PERMOLD ENGINE (See Figure 4-19).**

a. Install needle bearing (39) in adapter (40).

b. Press bearing (34) onto shaft (38). Install spring (36), Woodruff key (37) and worm gear (35). Insert assembly into adapter and install retaining ring (33).

c. Install clutch spring (29) on worm wheel (30). Turn spring so it tends to unwind until offset end drops into gear hub groove. Position spring on gear so screw notch is aligned with screw hole in gear web. Install tab washer (28) and screw (27).

d. Lubricate spring, sleeve and shaftgear liberally with clean oil. Press worm wheel bearing (31) and spring assembly onto shaftgear (32). Install bearing (26) and snap ring (25) on shaftgear. Insert shaftgear and worm wheel assembly into adapter. Make certain worm wheel and worm gear teeth are aligned.

e. Install "O" ring (24) in groove of adapter cover (22). Slide cover onto shaft and secure with two sets of attaching parts (19,20,21). Apply Permatex and silk thread to parting surface.

f. Tap Woodruff key (18) into slot of shaftgear. Install scavenge pump drive gear (17) on shaft. Install scavenge pump driven gear assembly (15,16) on shaft (12) in body (14). Install scavenge pump body with driven gear installed so that pump gears and worm gears can mesh. Secure with attaching parts (9,10,11).

g. If an optional power takeoff unit is required, use scavenge pump body (48) in place of body (14). Install ball bearing (47), retaining ring (46) and oil seal (45) over shaftgear and into pump body. Place Woodruff key (44) in shaftgear and install sheave (43). Secure with nut (42) and cotter pin (41).

**7-9. STARTER DRIVE ADAPTER ASSEMBLY, SANDCAST ENGINE (See Figure 4-20).**

a. Install needle bearing (39) in adapter (40).

b. Press bearing (34) onto worm shaft (37)

until seated against flange. Install spring (36), Woodruff key (38) and worm gear (35). Insert assembly into adapter and install retaining ring (33).

c. Install clutch spring (28) on worm wheel (31). Turn spring so it tends to unwind until offset end drops into gear hub groove. Position spring on gear so screw notch is aligned with screw hole in gear web. Install tab washer (30) and screw (29).

d. Lubricate spring, sleeve and shaftgear liberally with clean oil. Press worm wheel and spring assembly onto shaftgear (32). Install "O" ring (27) on shaft (32). Insert shaftgear and worm wheel assembly into adapter. Make sure worm wheel and worm gear teeth are aligned.

e. Compress and install retaining ring (25) in cover (21). Press in ball bearing (26) and new oil seal (24), with seal lips toward retaining ring. Insert sleeve (23) into seal.

f. Install gasket (22) and cover assembly on adapter and secure with attaching parts (17,18,19) except for one screw (17) to be used with timing indicator (20). Install timing indicator (20) and secure with attaching parts (7,10,17).

g. Install sheave (15) and secure with attaching parts (12,13,14).

#### 7-10. CYLINDER ASSEMBLY (See Figure 4-23).

a. Each cylinder should have its position number (1 through 6) stamped on edge of base flange. After assembly, cylinders should be laid on a bench in order of position number. Place piston, pin and ring assemblies in front of each cylinder in the same order. Piston position numbers are stamped on head rim. When assembled to engine, piston number will be toward propeller flange. Mark any new piston and/or cylinder accordingly.

b. Lubricate valve stems (28,29), and insert them in 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 lubricate valve stems.

c. Place valve spring retainers (27) over valve guide (32) cup side up. Install inner and outer valve springs (26,25) as shown in Figure 7-1. Install upper retainer (24) and rotator (23). Compress springs and install keys (22). Make certain keys are properly seated before releasing pressure

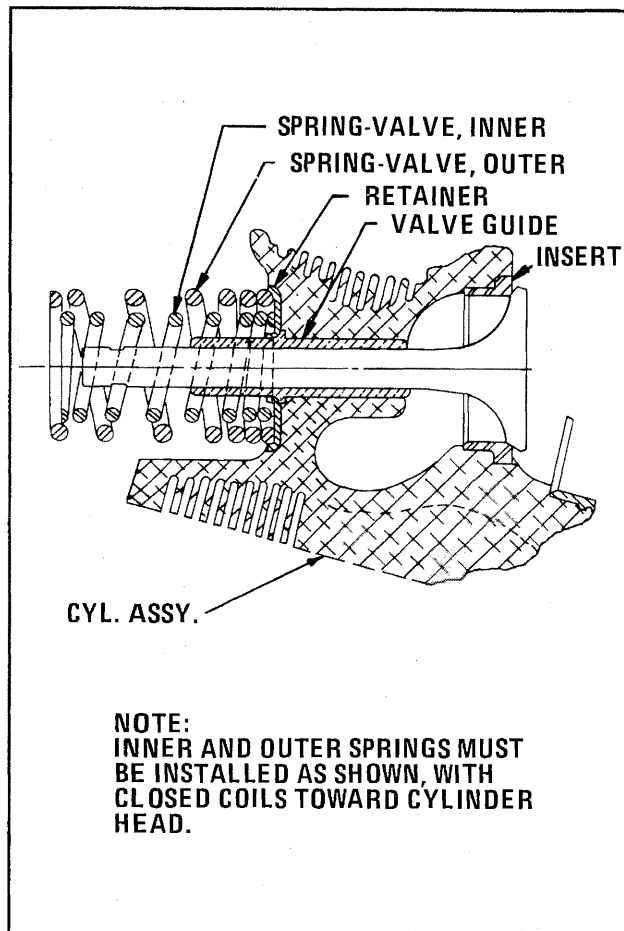


FIGURE 7-1. VALVE SPRING INSTALLATION.

on springs. Remove cylinder from fixture and set it upright on a bench. Strike end of each valve stem sharply with a rawhide mallet to seat valve stem keys.

d. Install new packing (21) on each cylinder skirt. Push against flange and make certain none are twisted. Lubricate cylinder bore walls thoroughly.

#### 7-11. PISTON AND RING ASSEMBLIES (See Figure 4-23).

a. Lubricate pistons (39) and rings (40,41,42,43) liberally with grade 30 Aviation Lubricating Oil.

b. Position first and third ring gaps on top of piston. Position second and fourth ring gaps 180° apart from the first and third ring gap.

#### 7-12. PUSHROD HOUSINGS (See Figure 4-23).

a. Install a washer (16), packing (17) and a second washer (16) on cylinder end of housing (14).

- b. Install spring (15), washer (16), packing (17) and a second washer (16) onto crankcase end of housing (14).
- c. Lay two housings with each cylinder.

**7-13. CRANKSHAFT AND CONNECTING RODS, PERMOLD ENGINE (See Figure 4-27).**

**NOTE**

Torque values are specified in Table of Limits, Section VI.

- a. Lay crankshaft on a bench with a notched wood block under front and rear journals.
- b. Lay out connecting rod assembly parts (10, 9, 8, 7, 6, 5) opposite crankpins according to position number stamped on bolt bosses. Install new bearing inserts (9) in each rod and cap so their edges project the same distance.
- c. Lubricate and install each rod and cap with their position numbers on top when odd number rods are extended to the right and even numbers to the left. Attach them with special bolts (6) and castellated nuts (5). Tighten nuts to specified torque and secure each with a cotter pin (4).
- d. Attach two sixth order counterweights (16) to crankcheek No. 2 with two pins (13) each and install plates and retaining rings (12,11). Attach one fourth order and one fifth order counterweight to crankcheek No. 5. Install pins (14,15) and secure with plates and retaining rings (12,11). Install retaining plate and retaining ring with the flat or rough side of the retaining ring to the outside.

**NOTE**

Refer to Paragraph 6-17, page 6-5 for diameter of pins.

- e. Heat crankshaft small gear (25) to 300° F., align gear dowel hole with crankshaft dowel (33) and tap gear onto crankshaft. Attach crankshaft large gear (24) to crankshaft small gear and to the crankshaft with six bolts (23). Tighten to specified torque and secure with locking wire.
- f. Remove spring (29) and reinforcing ring (30) from new oil seal (31). Unhook the spring ends using an unwinding motion. Wrap spring around shaft in seal area. Turn springs ends in unwinding direction; then join and allow one end to wind into the other.

- g. Oil propeller flange, shaft and I.D. of seal liberally with clean engine oil. Squeeze oil seal until egg-shaped and start seal over bottom of propeller flange, grooved side to the rear. Work seal carefully upward over the flange. Exercise care to prevent damage to seal lip.

**NOTE**

Placing a lightly oiled plastic bag over the prop flange will help protect the seal lip. Also, a special tool for stretching the seal over the prop flange is available from Borrough's Tool and Equipment Company, 2429 North Burdick Street, Kalamazoo, Michigan 49007.

- h. After seal is in place, wipe oil from seal and shaft. Seal must be dry before final crankcase installation.

**CAUTION**

*No sealing cement or compound is to be used.*

- i. Install reinforcing ring. Work O.D. of seal over ring to insure snug fit. Install spring in cavity in seal.
- j. Heat gear (28) in oven at 300° F. for half hour or more and install on crankshaft (See Figure 7-2). Secure with four bolts (26) and tab lock plates (27).

**NOTE**

Install gear in the proper position so that the T.C. mark is opposite No. 1 crankpin when at T.D.C.

- k. Install governor oil transfer collar (19 thru 22) and secure with nuts (18).

**7-14. CRANKSHAFT AND CONNECTING RODS, SANDCAST ENGINE (See Figure 4-28).**

- a. Instructions contained in 7-13 are also applicable to this section, with the exception of paragraphs e and j.
- b. Heat crankshaft gear (26) to 300° F., align gear dowel hole with crankshaft dowel (31) and tap gear onto crankshaft. Attach gear to crank-

shaft with six bolts (25). Tighten to specified torque and secure with locking wire.

#### 7-15. CAMSHAFT (See Figure 4-26).

- a. Tap a Woodruff key (3) on front end of camshaft (9) and install governor drive gear (2).
- b. Permold Engine. Install gear (5) and secure with four screws (4).
- c. Sandcast Engine. Install gear (8), cluster gear (7) and secure with four screws (6).

#### 7-16. CRANKCASE, PERMOLD ENGINE (See Figure 4-24).

**NOTE**

Torque values are specified in Table of Limits, Section VI.

- a. Replace any pipe plugs which were removed during previous operations. Install machine thread plugs.
- b. Install gaskets (6,7) and oil filler tube (5). Secure with attaching parts (4,3,2).
- c. Install gasket (25), governor pad cover (24) and secure with attaching parts (23,22,21,20).
- d. Install gasket (30), camshaft hole cover (29) and secure with attaching parts (28,27,26).
- e. Install "O" rings (53) and mounting legs (61). Secure with attaching parts (60,59,58).
- f. Lay crankcase halves open side up. Make sure squirt nozzle and screens (74,73) are in place. Lubricate cam bearings and main bearings. Insert main bearings (2, Figure 4-27) so that edges project equally.

#### 7-17. CRANKCASE, SANDCAST ENGINE (See Figure 4-25).

**NOTE**

Torque values are specified in Table of Limits, Section VI.

- a. Replace any pipe plugs which were removed during previous operations.

- b. Install "O" ring (32) and gasket (31) on special plug (30); install in right crankcase. Tighten and secure with lockwire.

- c. Install new gasket (38), governor pad cover (37) and secure with attaching parts (36,35,34,33).

- d. If mount brackets (71) were removed, reinstall them and attach with parts (70,69,68).

- e. Lay crankcase halves open side up. If squirt nozzles (85), and screens (84) were removed, reinstall them. Lubricate all camshaft bearings and main bearing inserts. Install main bearings (2, Figure 4-28) so that bearing ends project equally.

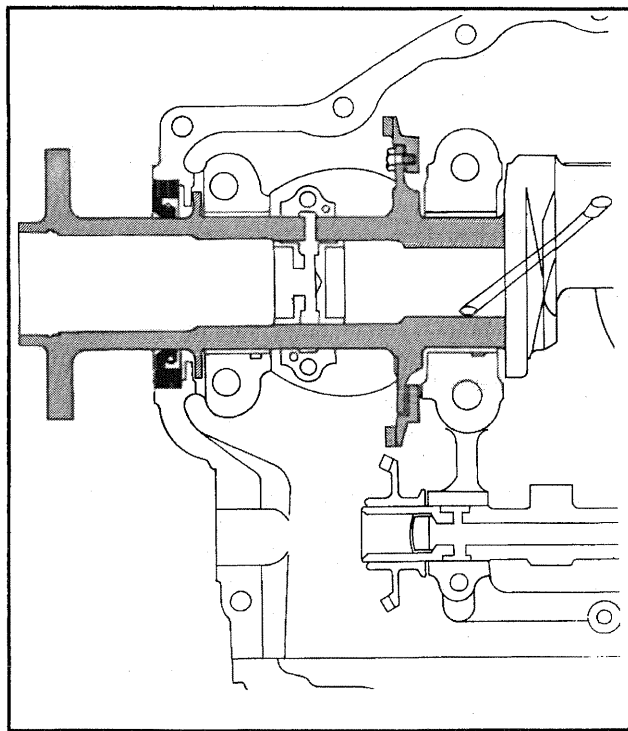


FIGURE 7-2. ALTERNATOR DRIVE GEAR INSTALLED.

#### 7-18. FUEL INJECTION CONTROL AND AIR THROTTLE BODY ASSEMBLY.

**CAUTION**

*Use only a fuel soluble thread lubricant on any injector system connection fitting.*

- a. Install plugs and any necessary replacement connection fittings in proper ports of fuel injector components (See Figure 7-3 thru 7-7).



**NOTE**

The fuel injection equipment is calibrated with plugs and fittings intact. Removal of any of these parts could allow small metal shavings to become ledged in the equipment. Prior to reassembly, any replacement fittings should first be screwed into proper size holes in a block of soft wood to reduce the likelihood of metal particles entering the system.

b. TSIO-520-B & E (See Figure 4-6).

1. Place bottom shroud (24) and control unit (23) under air throttle body (26); attach with three tab washers (22) and bolts (21). Tighten bolts to torque specified in Table of Limits, Section VI. Bend ear of tab washer to flat side of hex head on screw. Install top shroud (20) and attach with parts (15,16,17) and (18,19).

2. Place wave washer (10) on link rod (14) and insert into throttle lever; then install washer (9) and cotter pin (8).

3. Slide spring (13) and rod end (12) onto link rod (14); then attach elastic stop nut (11) to link rod. Place wave washer (10) on rod end (12) and insert rod end into control lever. Secure with washer (9) and cotter pin (8). Final adjustment of rod linkage will be established at final assembly.

c. TSIO-520-C, G & H (See Figure 4-7).

1. Place control unit (23) against throttle body (24) and attach with tab washers (14) and bolts (13). Tighten bolts and bend ear of tab washers to flat side of hex head on bolt. Install shroud (12) on bolts and attach with washers (11,10) and nuts (9).

2. Place wave washer (17) on link rod (22) and insert into throttle lever; then attach with washer (16) and cotter pin (15).

3. Slide spring (21) and rod end (20) onto link rod (22) and attach elastic stop nut (19) to link rod. Place wave washer (17) on rod end (20) and insert rod end into control unit lever. Secure with washer (16) and cotter pin (15). Final adjustment will be established at final assembly.

d. TSIO-520-D (See final assembly for instructions).

e. TSIO-520-J (See Figure 4-9).

1. Assemble control unit (24) to air throttle body (27) with tab washers (26) and screws (25). Tighten screws and bend ear of tab washers to flat side of hex head on screw. Place wave washer (19) on link rod (23) and insert into throttle lever; then secure with washer (18) and cotter pin (17).

2. Slide spring (22) and rod end (21) onto link rod (23) and attach elastic stop nut (20). Place wave washer (19) on rod end (21) and insert rod end into control unit lever. Secure with washer (18) and cotter pin (17). Final adjustment will be established at final assembly.

3. Using new gasket (16), assemble controller (15) to air throttle body with attaching parts (14, 13). Place wave washer (19) on link rod (9) and insert into throttle lever; secure with washer (18) and cotter pin (17).

4. Install two adjusting nuts (8), spring (7) and rod end (6) onto link rod; then install elastic stop nut (5). Place wave washer (19) on rod end and insert rod end into controller lever. Secure with washer (18) and cotter pin (17). Final adjustment will be established at final assembly.

f. TSIO-520-K (See Figure 4-10).

1. Position control unit (19) against throttle body (20) and attach with tab washers (18) and screws (17). Tighten screws and bend ear of tab washer to flat side of hex head on screw.

2. Place wave washer (12) on link rod (16) and insert into throttle lever; then secure with washer (11) and cotter pin (10).

3. Slide spring (15) and rod end (14) onto link rod (16); then attach elastic stop nut (13) to link rod. Place wave washer (12) on rod end and insert rod end into control unit lever. Secure with washer (11) and cotter pin (10). Final adjustment will be established at final assembly.

## 7-19. OIL COOLER.

a. See Figure 4-16. Install oil temperature control valve (16) and gasket (15).

b. See Figure 4-17. Install oil temperature control valve (11), gasket (12) and plug (13).

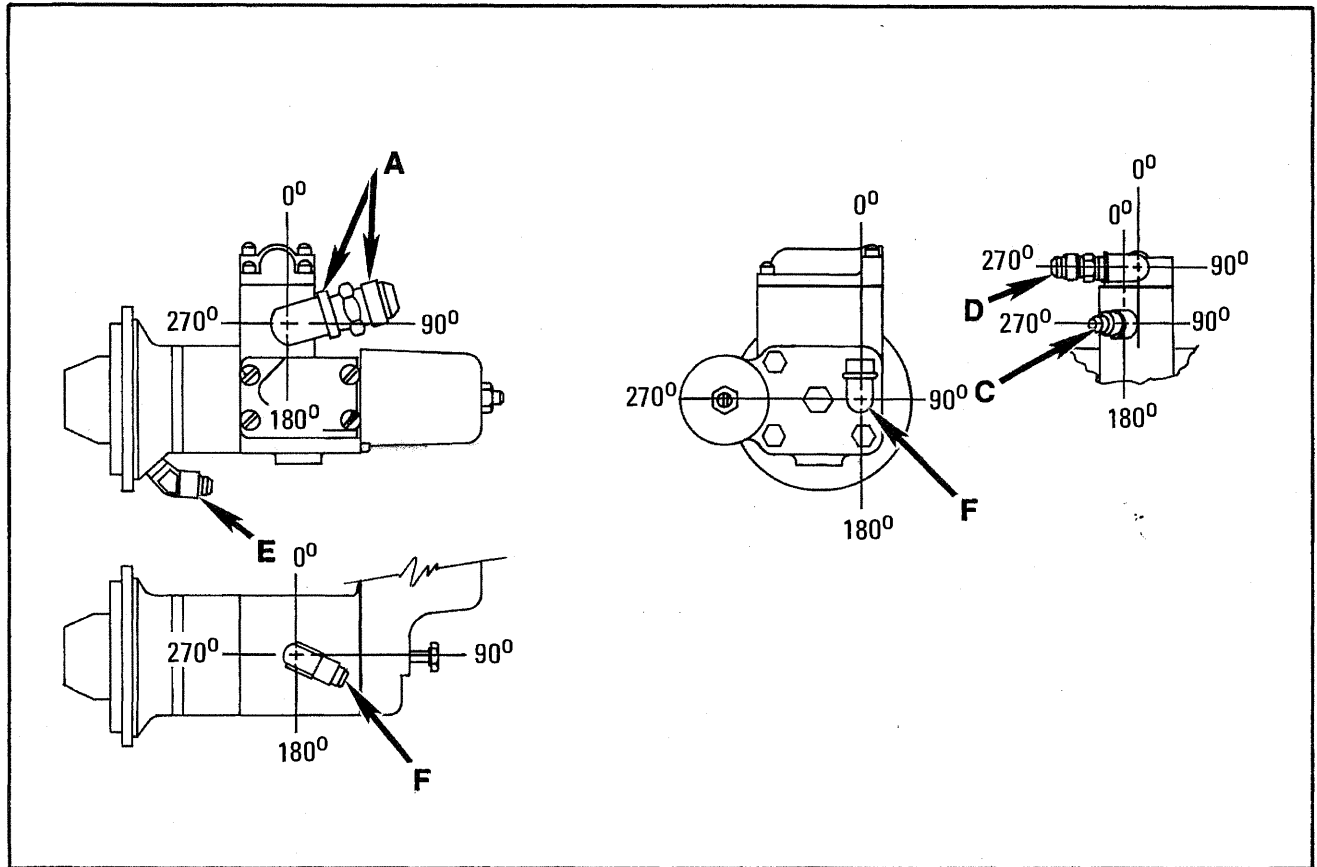


FIGURE 7-3. FUEL PUMP FITTING LOCATIONS.

	A	B	C	D	E	F
TSIO-520-B, E	90° ELBOW CONNECTOR (75°)	90° ELBOW (115°)	45° ELBOW (270°)	90° ELBOW CONNECTOR (270°)	45° ELBOW (330°)	90° ELBOW (0°)
TSIO-520-J, K	90° ELBOW CONNECTOR (75°)	45° ELBOW (0°)	90° ELBOW (225°)	90° ELBOW (280°)	45° ELBOW (330°)	TEE (0°)

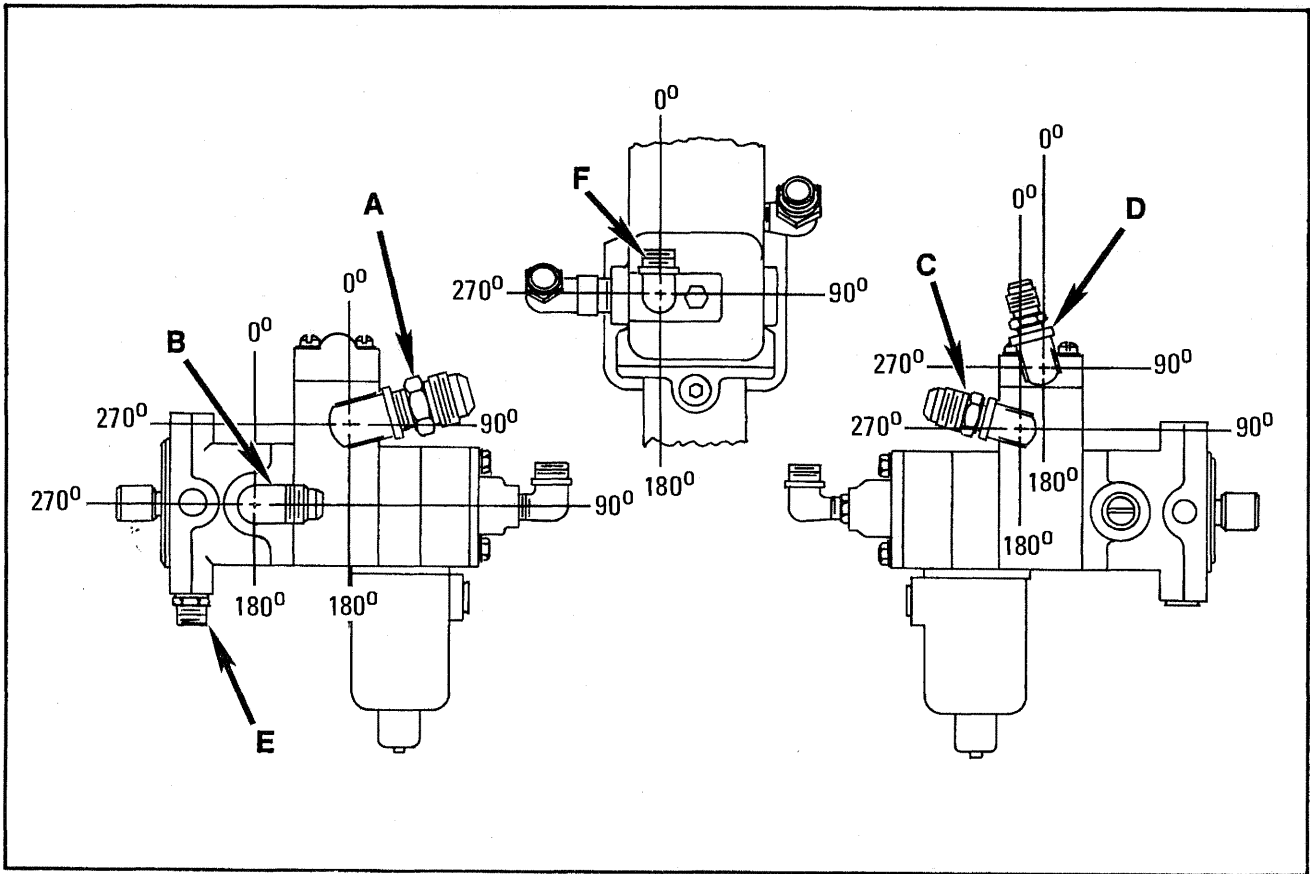


FIGURE 7-4. FUEL PUMP FITTING LOCATIONS.

	A	B	C	D	E	F
TSIO-520-C, G, H	90° ELBOW (145°)	45° ELBOW (180°)	90° ELBOW (60°) 45° ELBOW (0°)	90° ELBOW CONNECTOR (15°)	CONNECTOR	90° ELBOW (270°)

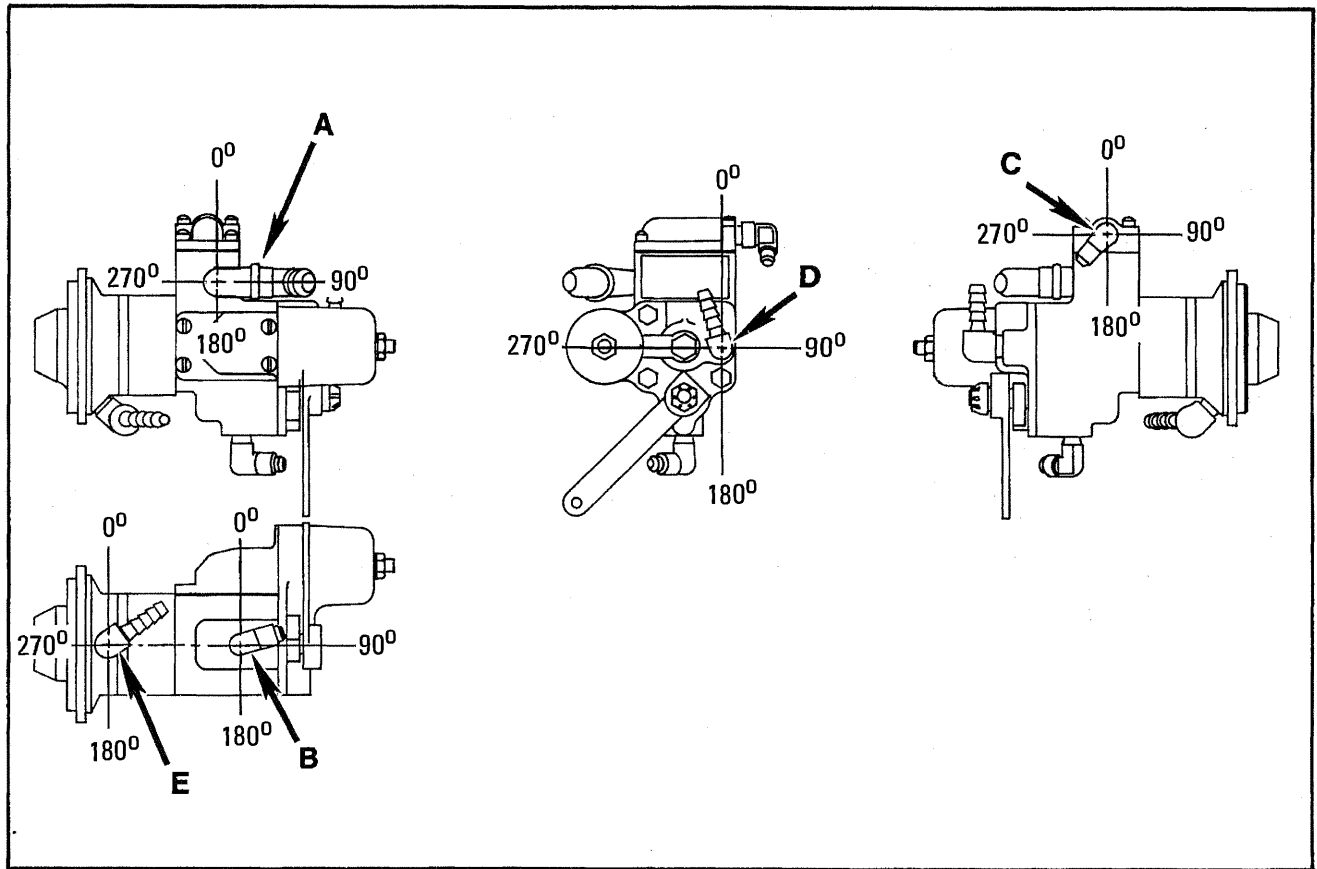


FIGURE 7-5. FUEL PUMP FITTING LOCATIONS.

	A	B	C	D	E
TSIO-520-D	45° ELBOW (270°) 90° ELBOW (90°)	90° ELBOW (75°)	90° ELBOW (220°)	90° HOSE COUPLING (345°)	45° ELBOW (55°)

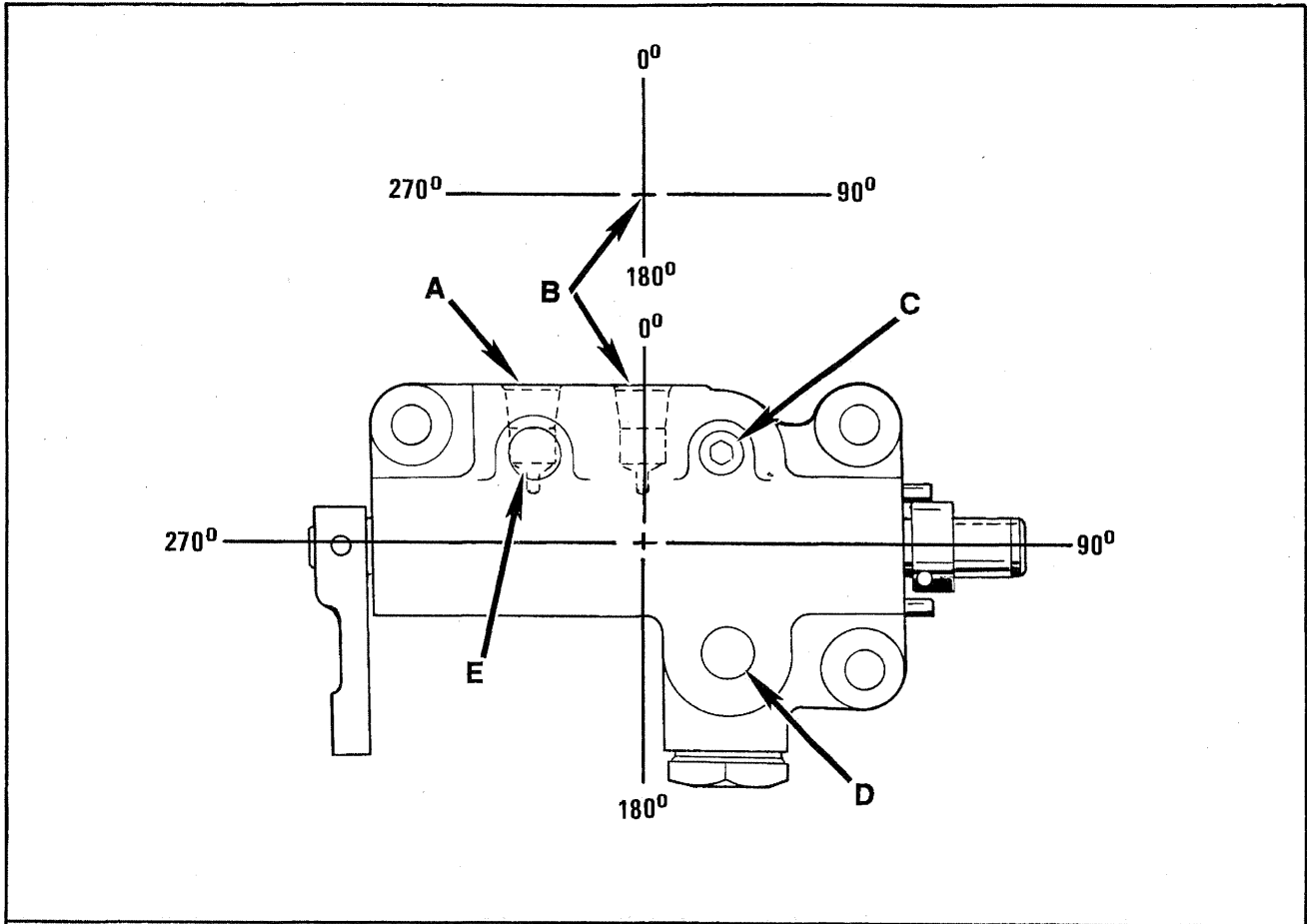


FIGURE 7-6. CONTROL VALVE FITTING LOCATIONS.

	A	B	C	D	E
	FUEL OUTLET	MIXTURE RETURN		FUEL INLET	FUEL OUTLET
TSIO-520-B, E TSIO-520-C, G, H TSIO-520-J, K	90° ELBOW (270°) PLUG PLUG	CONNECTOR 90° ELBOW (300°) TEE (95°)	CONNECTOR PLUG PLUG	45° ELBOW (291°) 45° ELBOW (165°) TEE (15°)	PLUG CONNECTOR 45° ELBOW (180°)

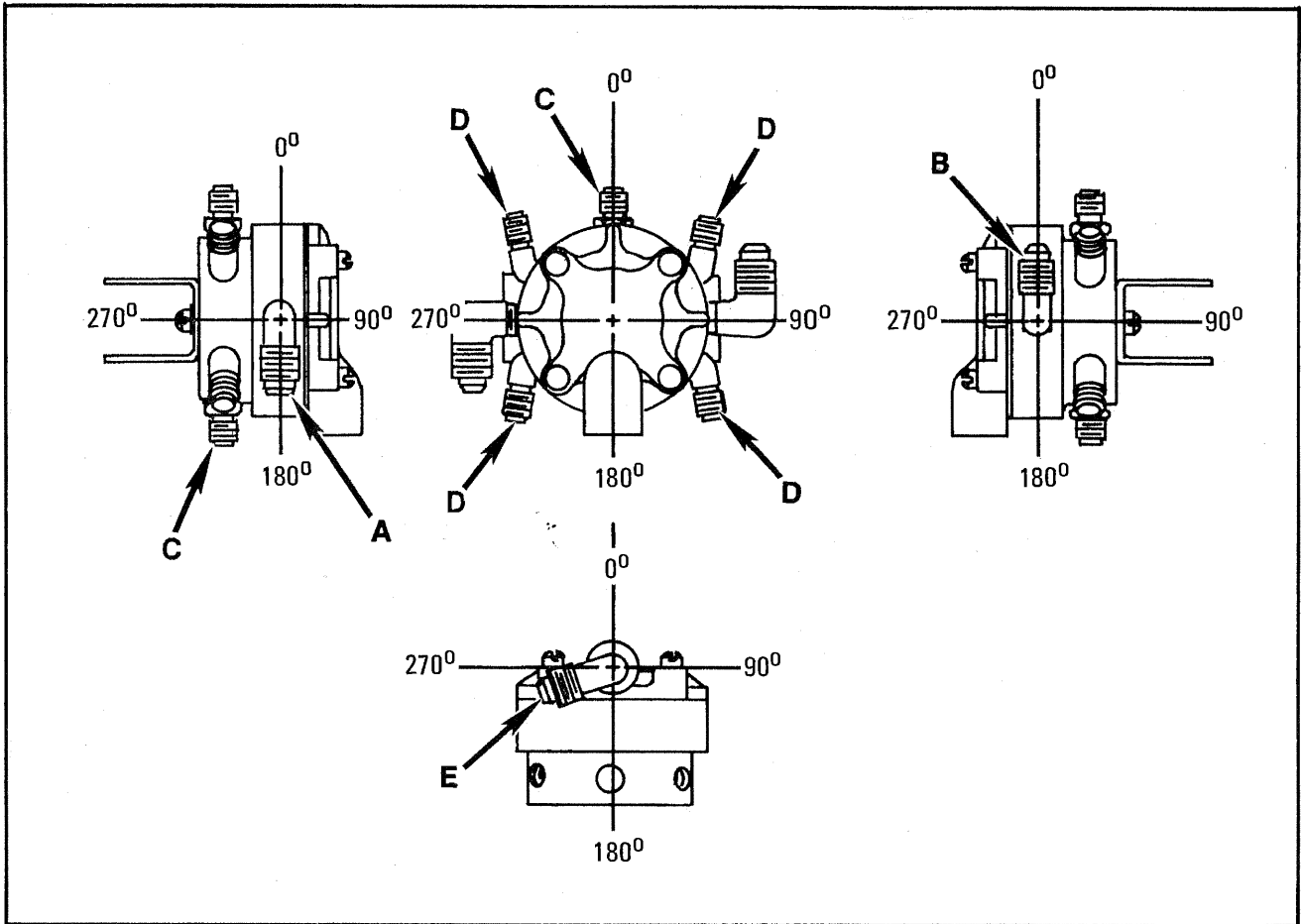


FIGURE 7-7. FUEL MANIFOLD VALVE FITTING LOCATIONS.

	A	B	C	D	E
TSIO-520-B, E	90° ELBOW (0°)	90° ELBOW (0°)	NIPPLE, UNION	45° ELBOW	—
TSIO-520-C,D,G,H	90° ELBOW (0°)	90° ELBOW (180°)	NIPPLE, UNION	45° ELBOW	—
TSIO-520-J,K	90° ELBOW (0°)	90° ELBOW (180°)	NIPPLE, UNION	45° ELBOW	45° ELBOW (250°)

## SECTION VIII

# FINAL ASSEMBLY AND TEST

### 8-1. GENERAL INSTRUCTIONS.

### 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 Tightening Torques, 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 use of a dial indicator.

### 8-5. COVERS.

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

### 8-6. CRANKCASE, PERMOLD (See Figure 4-24).

a. Install left crankcase on assembly stand, supported as shown in Figure 8-1.

b. Lubricate all main bearing inserts, crankshaft journals and install thrust washers. Lift crankshaft assembly by No. 1 connecting rod and propeller flange. With the aid of an assistant holding Nos. 3

and 5 rods, carefully lower the assembly into the left crankcase bearings, making certain the oil seal enters the oil seal cavity. The connecting rod position numbers will be toward the upper flange, if properly installed. Lay odd numbered rods on upper case.

c. Insert governor driven gear (1, Figure 4-26) into its bearing.

d. Lay camshaft assembly in the bearings in the left crankcase. Mesh spur gear teeth of the cam gear with those of the crankshaft small gear. The timing marked tooth of the cam gear should be at the center of the 3/8" observation hole in the web of the crankshaft large gear when No. 1 connecting rod is at T.D.C. Turn governor driven gear so that it meshes with governor drive gear. (Refer to Figure 8-2.)

e. Measure crankshaft and camshaft end clearance. See Table of Limits, Section VI for allowable tolerances.

f. Install idler pin bushing (69) in left crankcase and secure with dowel pin (68). Install idler gear (3, Figure 4-27), gasket (34) and idler gear flanged bushing (33). Do not install attaching parts at this time.

g. Spread a thin film of No. 3 Aviation Permatex on the left crankcase parting flange. Lay lengths of No. 50 silk thread on the parting flange inside the bolt holes but not on the edge. Do not install attaching parts at this time.

h. Stand up odd numbered connecting rods. Make sure thrust washers are in place.

i. Lay right crankcase subassembly on the left case. Take care not to displace or damage the crankshaft oil seal or the governor oil transfer collar "O" rings.

j. Insert, from above, through bolts (63,64,65, 66). Tap through to centered positions with non-marring hammer. These bolts align crankcase castings and bearings.

**NOTE**

Support connecting rods with the old cylinder head "O" rings as shown in Figure 8-4.

k. Install a washer (36) and flanged nut (35) on each of the two front through bolts. Install an "O" ring (53), plain washer (52), lockwasher (51) and nut (50) on extreme upper rear through bolt on right crankcase.

l. Install fuel manifold valve (19) and bracket, lifting eye (17), spacer (18) and secure with attaching parts (16,10,9,8). Install bolts (57), washers (56,55) and nuts (54). Install attaching parts (37 through 49).

m. Install "O" rings (53) and mounting brackets not previously installed.

n. Seat idler gear flanged bushing (33). Do not install attaching parts at this time.

o. Tighten attaching parts installed in steps "l" and "m".

p. Attach right mount bracket to stand and rotate bed until engine is upright.

q. Install, but do not tighten, idler gear flanged bushing attaching parts (31,32).

r. Install prop shaft oil seal retainer (82) and attaching parts (83,84,85). Used on models B, E, J & K only.

### 8-7. CRANKCASE, SANDCAST (See Figure 4-25).

a. Install left crankcase to engine stand with support under casting.

b. Lubricate all main bearing inserts, crankshaft journals and install thrust washers. Lift crankshaft assembly by No. 1 connecting rod and propeller flange. With the aid of an assistant holding up Nos. 3 and 5 connecting rods, carefully lower assembly into position in left crankcase bearings with oil seal positioned so it enters the seal cavity in the crankcase. The connecting rod position numbers, if properly installed, will be toward the

upper case flange. Carefully lay odd numbered rods on the upper case flange.

c. Insert governor driven gear (See Figure 4-26) into its bearing.

d. Lay camshaft assembly in its bearings in left crankcase. Mesh spur gear teeth with those of crankshaft gear so that timing marks are aligned in the manner illustrated in Figure 8-2 at No. 1 T.D.C. position. Turn governor driven gear to mesh it with driver gear.

e. Measure crankshaft end clearance either with a feeler gauge or a dial indicator set at zero against the propeller flange. Measure camshaft end clearance at either end of its rear main bearing. See Table of Limits, Section VI, for allowable tolerances.

f. (See Figure 4-28.) Install idler gear assembly and support pin in left crankcase as illustrated (Figure 8-1) with bushing thrust to rear.

g. Spread a thin film of No. 3 Aviation Permatex on the left crankcase parting flange. Lay lengths of No. 50 silk thread on parting flange. Thread should be inside the bolt holes but never on the edge.

h. Stand up odd numbered connecting rods.

i. Lay right crankcase subassembly on the left case. Take care not to displace or damage the crankshaft oil seal or governor oil transfer sleeve "O" rings. Make sure thrust washers are in place.

**NOTE**

Support connecting rods with the old cylinder head "O" rings as shown in Figure 8-4.

j. Insert (from above) two through bolts (64) at front of crankcase, one through bolt (65) in front of No. 5 cylinder mount pad, seven through bolts (67) through cylinder mount pads and four through bolts (66) below camshaft level. Tap all of these through to a centered position with a non-marring hammer. These bolts align crankcase castings and bearings.

k. Install a spacer and flanged nut on the following: Two front thru bolts, two thru bolts ahead of No. 5 cylinder pad and upper rear thru bolt nearest magneto mount pad.



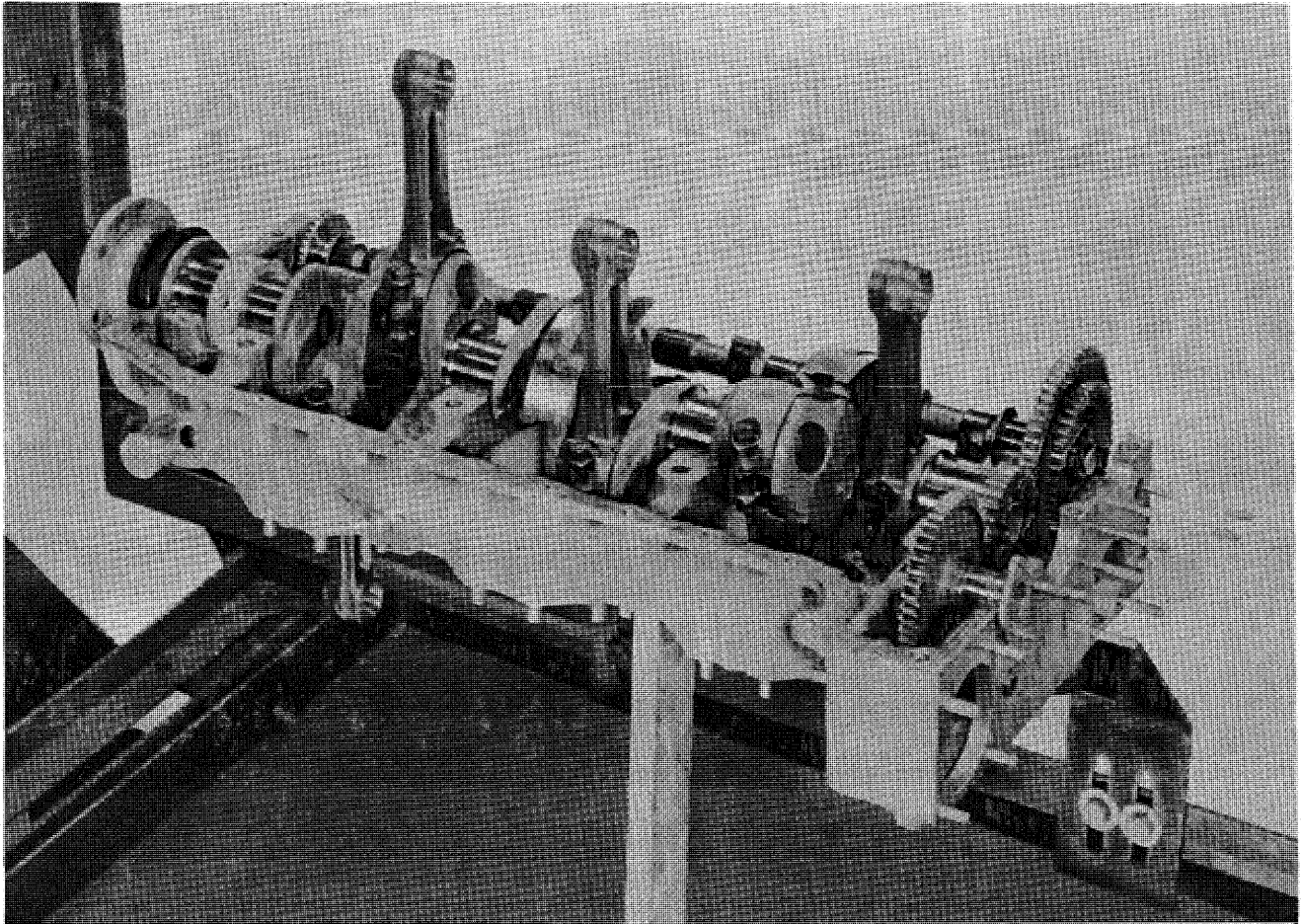


FIGURE 8-1. LEFT CRANKCASE AND SHAFTS ASSEMBLED ON STAND.

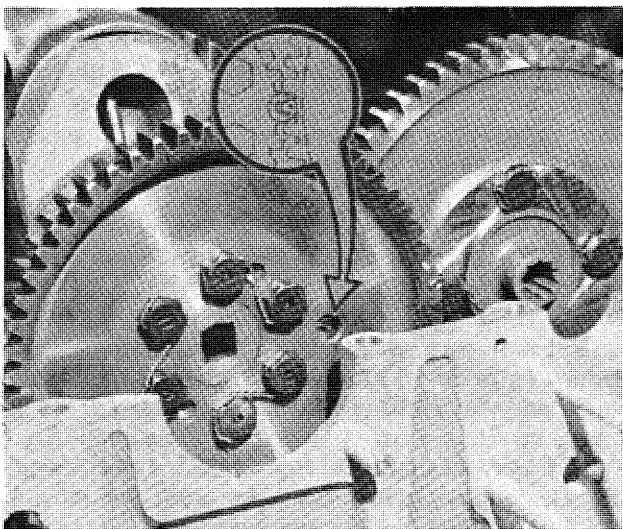
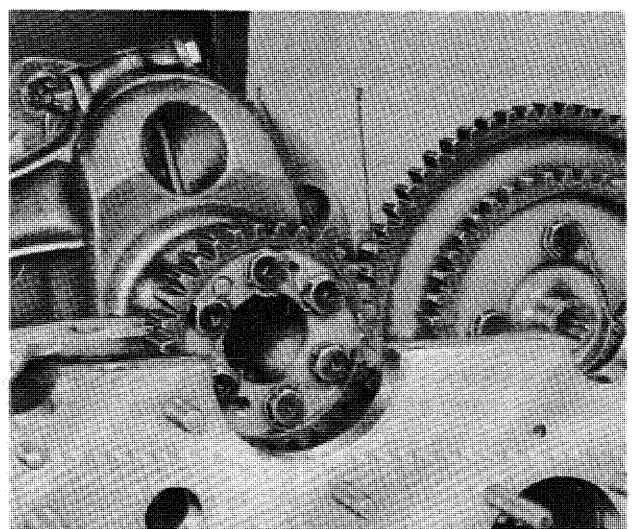


FIGURE 8-2. ALIGNMENT OF TIMING MARKS.



1. Crankshaft Gear Timing Marks
2. Camshaft Gear Timing Mark

FIGURE 8-3. ALIGNMENT OF TIMING MARKS.

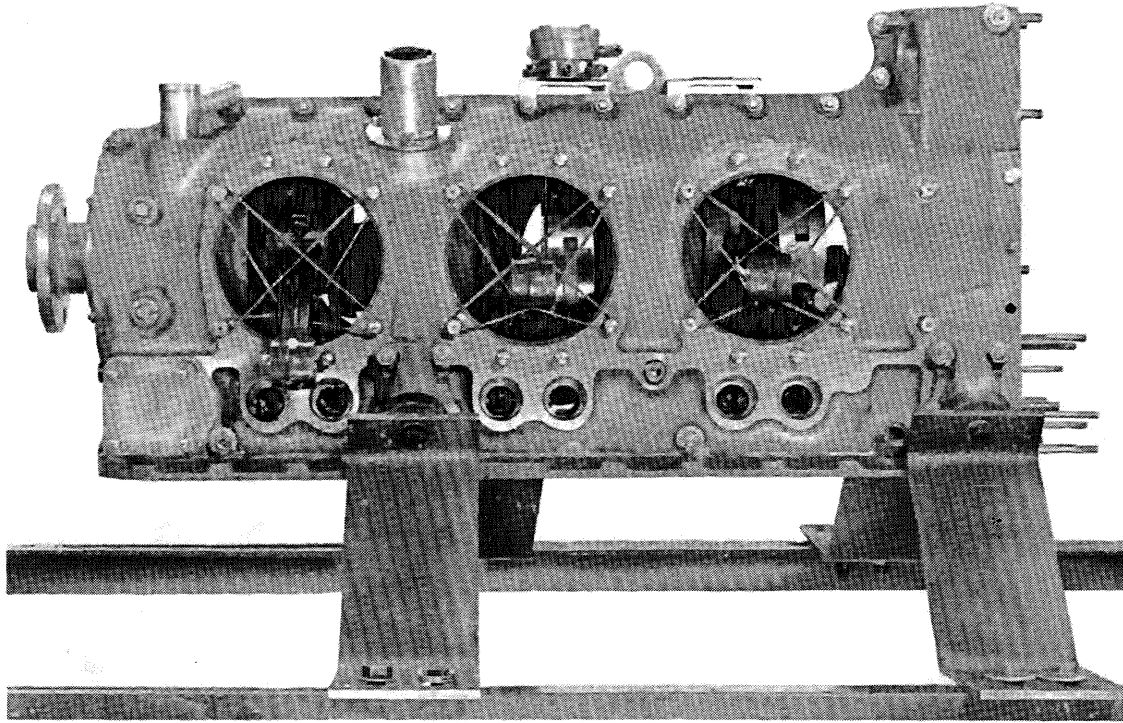


FIGURE 8-4. LEFT SIDE OF COMPLETED CRANKCASE ON STAND.

l. Install fuel manifold valve over crankcase flanges. Install spacer (28), lifting eye (27) and secure with attaching parts (26,25,24,23,22,21). Install attaching parts (60 through 63).

m. Install one bolt and washers (47,48,49) at left rear, one "O" ring (50) and two bolts and washers (47,48,49) at right rear and one bolt and washer (47,48) at right front. Do not tighten any parts in this group at this time.

n. Seat gasket (42) and idler gear support pin (41). The eccentric shoulder must be away from crankshaft. Do not install attaching parts.

o. Tighten all attaching parts installed in steps "l" and "m".

p. Install two "O" rings (54), one bolt (55) and attaching parts (53,52,51) in the upper rear case hole and tighten nut.

q. Attach right crankcase mount brackets to case and secure to assembly stand. Rotate stand until engine is upright as shown in Figure 8-4.

r. Install, but do not tighten idler gear support pin attaching parts (39,40).

#### 8-8. CYLINDERS AND PISTONS (See Figure 4-23).

a. Before installing each cylinder and piston, rotate crankshaft to place connecting rod in its outermost position.

b. Dip piston pin in lubricating oil before installing in piston and connecting rod. Lubricate all cylinder head studs before installation of cylinder assemblies to crankcase. Lubricate piston and rings liberally with engine lubricating oil.

c. Piston ring gaps should be positioned 180° apart with the first or top ring gap toward top of piston.

d. Install pistons and cylinders in any desired order. In order to minimize turning of the crankshaft and to prevent excessive unbalance, it is suggested that Nos. 4 and 5 be installed first. Turn the crankshaft for Nos. 2 and 3 and install the assemblies. Then turn the shaft for Nos. 1 and 6 and install the last two assemblies.

e. Place the piston over the connecting rod with the position number on its head forward. Push the pin through until it is centered.

1 - Nuts on both ends of thru bolts must be torqued.

2 - All stud and thru bolt threads to be lubricated with castor oil.

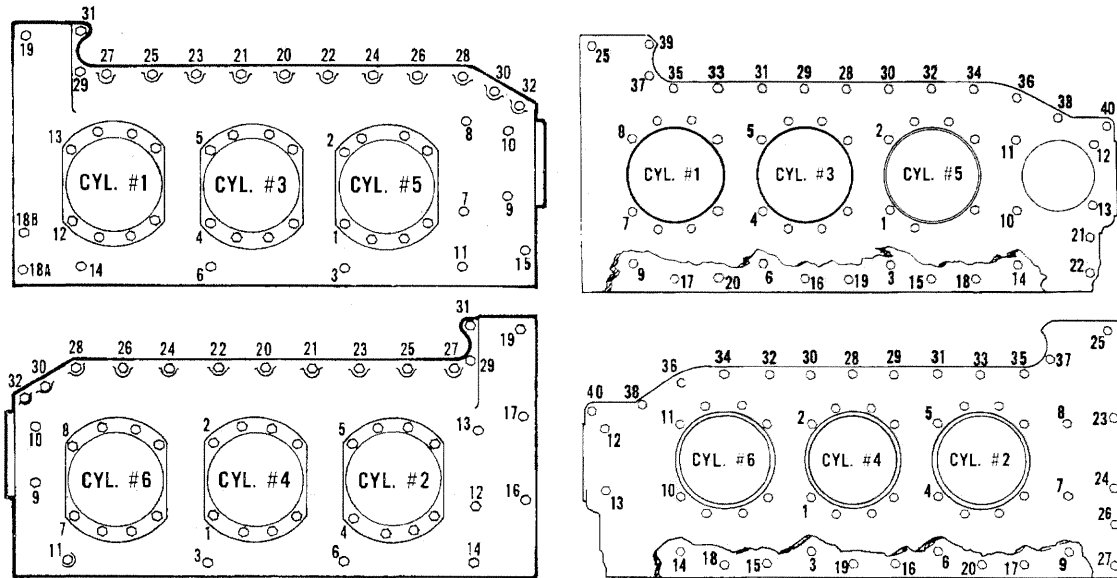


FIGURE 8-5. TORQUING SEQUENCE.

#### ASSEMBLY PROCEDURE TSIO-520 SANDCAST CRANKCASE

- 1 - Insert thru bolts.
- 2 - Thru bolts Nos. 1 thru 14 shall be torqued in sequence shown in two passes (300-400 in./lbs. and final)
- 3 - Snug bolts Nos. 9, 10, 18A and 19.
- 4 - Install cylinders 4 and 5 - tighten stud nuts to 300-400 in./lbs.
- 5 - Tighten thru bolts Nos. 1, 2 and 3 to 300-400 in./lbs. in sequence shown (see step 2).
- 6 - Tighten thru bolts and stud nuts to 500 in./lbs.
- 7 - Tighten thru bolts Nos. 1 and 2 to 700 in./lbs., No. 3 to 500 in./lbs.
- 8 - Repeat above on cylinders 2 and 3.
- 9 - Repeat above on cylinder No. 6, including bolts Nos. 9 and 10 in sequence shown.
- 10 - Repeat above on cylinder No. 1.
- 11 - Tighten bolts Nos. 15 thru 32 to specified torque in sequence shown.

#### ASSEMBLY PROCEDURE TSIO-520 PERMOLD CRANKCASE

- 1 - Insert thru bolts.
- 2 - Thru bolts Nos. 1 thru 14 excepting 3,6,9 & 14 shall be torqued in sequence shown in two passes (350 in./lbs. and final).
- 3 - Snug bolts 12, 13, 23 and 24.
- 4 - Install cylinders 4 and 5 - tighten nuts to 350 in./lbs.
- 5 - Tighten thru bolts Nos. 1, 2 and 3 to 200 in./lbs. in sequence shown (see step 2).
- 6 - Tighten thru bolts and stud nuts to 500 in./lbs.
- 7 - Tighten thru bolts Nos. 1 and 2 to 700 in./lbs.
- 8 - Repeat above on cylinders Nos. 2 and 3.
- 9 - Repeat above on cylinder No. 6, including bolts Nos. 12 and 13 in sequence shown.
- 10 - Repeat above on cylinder No. 1.
- 11 - Tighten bolts Nos. 15 thru 40 to specified torque in sequence shown.

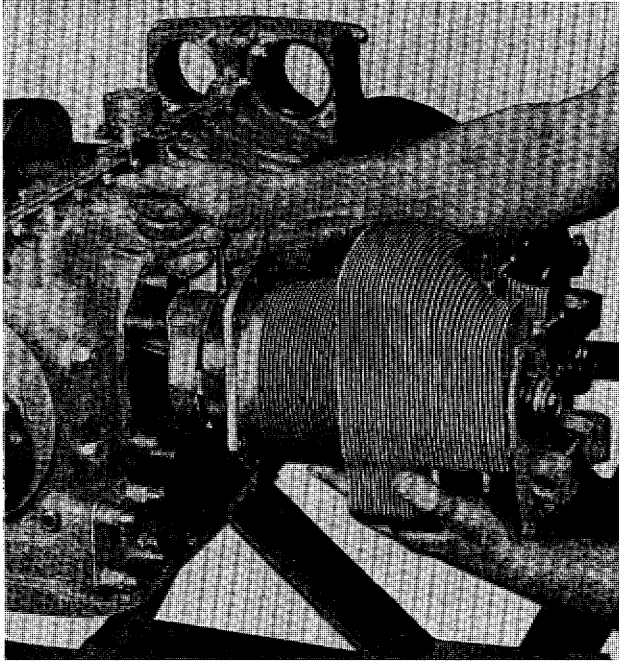


FIGURE 8-6. INSTALLING NO. 6 CYLINDER.

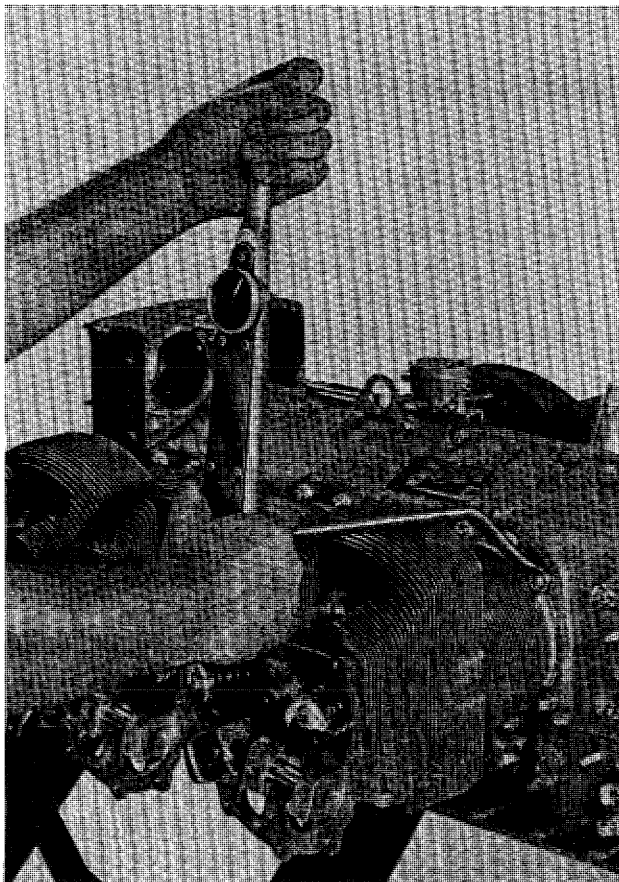


FIGURE 8-7. TIGHTENING CYLINDER BASE NUT.

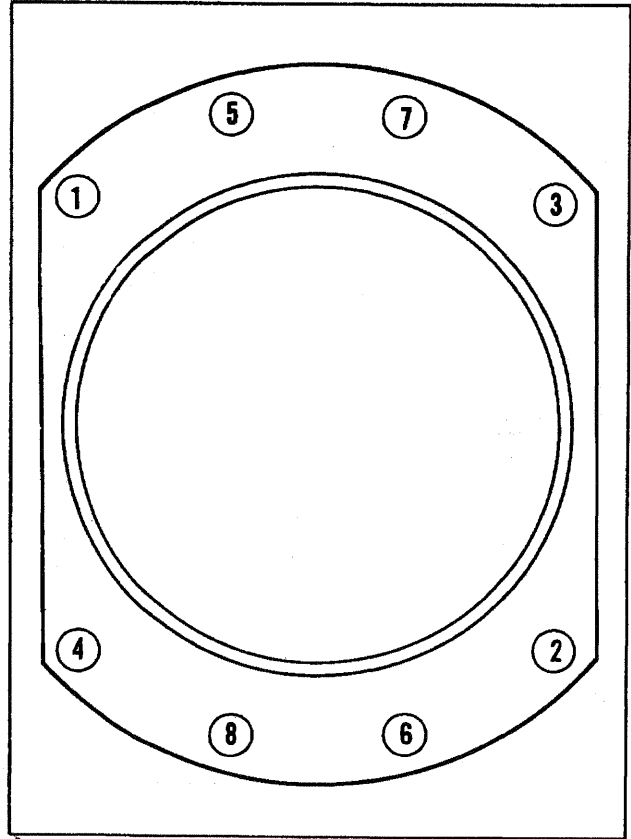


FIGURE 8-8. CYLINDER FLANGE TORQUE SEQUENCE.

f. Hang a piston ring compressor on the piston skirt. Holding the cylinder in left arm, center the compressor over the piston rings and compress them fully. Push the cylinder onto the piston, forcing the compressor off the piston.

g. Remove the ring compressor and start the cylinder base flange onto the hold down studs. Make sure the base flange packing ring is in place and not twisted. Seat cylinder barrel flange on crankcase cylinder pad. Install, but do not tighten, attaching parts (18,19). Top four nuts should be installed first.

h. After installing all pistons and cylinders, tighten and torque nuts according to sequence shown in Figure 8-7.

i. Install spark plugs and gaskets in upper cylinder holes.

#### 8-9. OIL PUMP, PERMOLD ENGINE (See Figure 4-21).

a. Remove attaching parts (7,8,9) and detach cover from pump.

b. Spread a film of No. 3 Aviation Permatex on the rear cover flange of the oil pump. Lay No. 50 silk thread inside the bolt holes and studs but clear of the edge.

c. Replace cover assembly and secure with same attaching parts.

d. Install gasket (48) on crankcase.

e. Mount oil pump assembly gasket (6) and oil filter adapter (5) on crankcase studs and secure with attaching parts (2,3,4 and 44,45,46). Torque to value given in Table of Limits, Section VI.

f. Install spin on filter and torque to value given in Table of Limits.

g. **OPTIONAL.** Install new gasket (6), adapter (63) and secure with attaching parts (2,3,4). Install gasket (59) on stud (58) and insert stud in housing (61). Install element (61) in housing and secure with nut (62). Install assembly on adapter (63). Install spacer (57) and bracket (55) on stud; attach with plain washer (51), lockwasher (50) and bolt (49). Install spacers (56) and secure bracket (55) to crankcase with attaching parts (52,53,54).

h. Tighten lefthand threaded tachometer drive housing.

#### 8-10. OIL PUMP, SANDCAST ENGINE (See Figure 4-22).

a. Remove two sets of attaching parts (6,7,8) and separate tachometer drive and scavenge pump cover from scavenge pump.

b. Spread a thin film of No. 3 Aviation Permatex on the rear parting surface of the scavenge pump housing (18). Lay No. 50 silk thread inside bolt holes and studs, but clear of edge.

c. Install cover and secure it as before, with two sets of attaching parts.

d. Without delay, lubricate pump shaft splines and install gasket and pump assembly on crankcase studs. Install attaching parts and torque to values specified in Table of Limits, Section VI.

e. Tighten lefthand threaded tachometer drive housing.

#### 8-11. FUEL PUMP, PERMOLD ENGINE (See Figures 4-6, 4-8, 4-9 and 4-10).

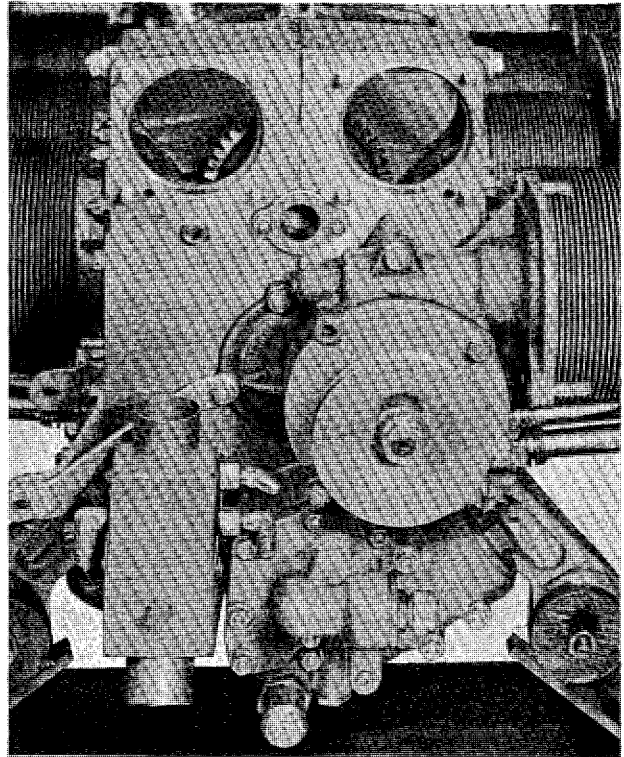


FIGURE 8-9. FUEL PUMP, OIL PUMP AND STARTER ADAPTER INSTALLED.

a. Lubricate fuel pump drive coupling with Molyshield grease.

b. Install coupling in pump. Install new gasket and mount fuel pump and vapor separator on crankcase studs. Secure with two sets of attaching parts.

#### 8-12. FUEL PUMP, SANDCAST ENGINE (See Figure 4-7).

a. Lubricate fuel pump drive gear with Molyshield grease.

b. Install gear in pump. Install new gasket and mount fuel pump and vapor separator on crankcase studs. Secure with four sets of attaching parts.

#### 8-13. STARTER DRIVE ADAPTER (See Figures 4-19 and 4-20).

a. Apply a thin coat of "Loctite Gasket Eliminator #515 to the crankcase surface only.

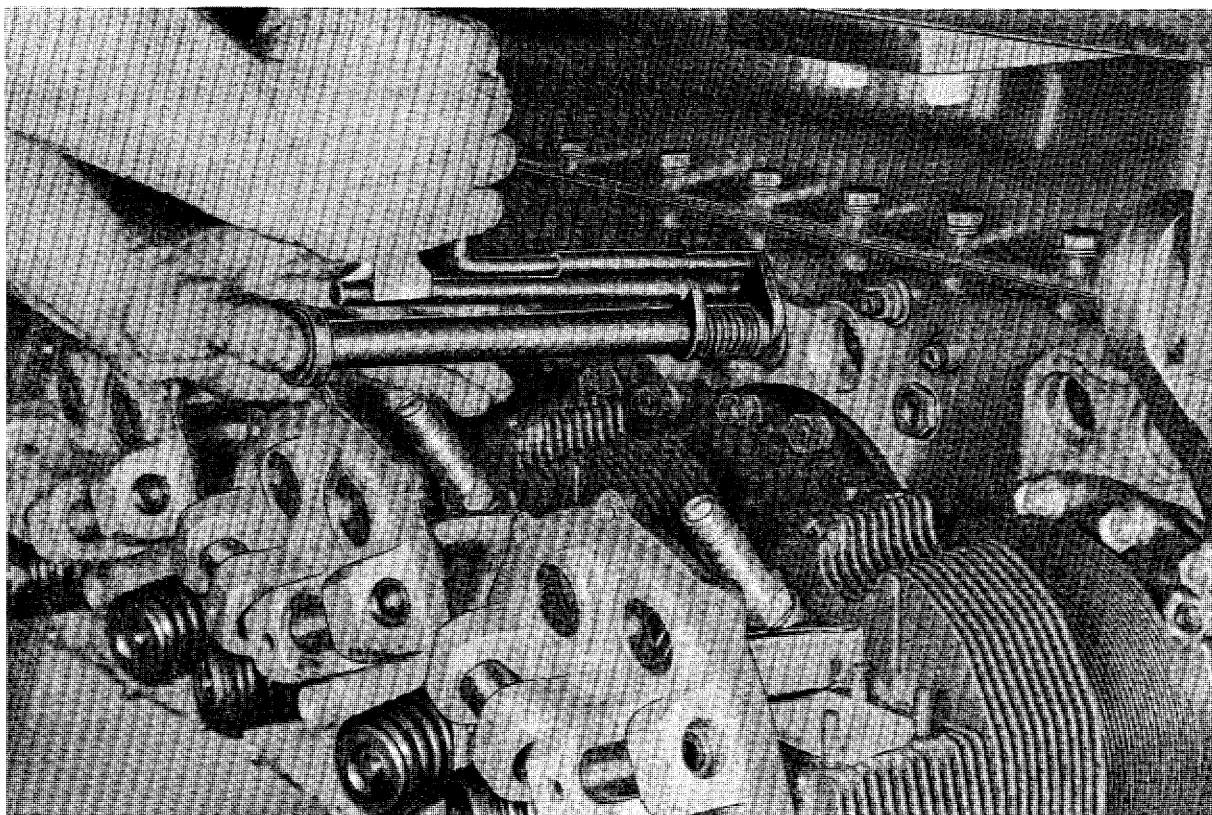


FIGURE 8-10. INSTALLING PUSHROD HOUSING.

**CAUTION**...Sealant must be applied sparingly to prevent contamination of the engine oil system.

**NOTE**

Turn gears by hand to be certain they mesh freely before installing subassembly on crankcase mount pad.

b. Lubricate spur gear and mesh it with crankshaft gear as adapter is placed in position. Seat adapter against gasket. Secure adapter assembly to crankcase with attaching parts (5,6,7 and 19,20, 21, Figure 4-19) or (6 through 10, Figure 4-20).

c. Install "O" ring (4 or 5) on starter pilot. Turn starter shaft until tongue aligns with worm drive shaft slot. Mount starter (3 or 4) and secure with attaching parts (2, 1 or 3, 2, 1).

**8-14. ALTERNATOR ASSEMBLY, TSIO-520-B, D, E, J & K (See Figure 4-18).**

a. Install the baffle support assembly (5). Secure with crankcase through bolt attaching parts.

b. Install Woodruff key (9), gear hub (14), spring (13), driven gear assembly (11,12), washer (10) and nut (8). Tighten nut to 450 inch pounds torque. If slots of nut do not align with cotter pin hole in alternator shaft, nut may be tightened further, not to exceed 500 inch pounds torque. Install cotter pin (7).

**NOTE**

Washer (10) to be installed with bearing surface toward gear.

c. Spread a film of Loc-Tite on new gasket (6) and install on flange of alternator.

d. Install the alternator (4) on the crankcase mounting flange. Install four sets of attaching parts (1,2,3). Torque bolts to value specified in Table of Limits, Section VI. Secure bolt heads in pairs with lockwire.

### 8-15. MAGNETO AND ACCESSORY DRIVE ADAPTERS (See Figure 4-11).

- a. Place two new gaskets (13) on two upper rear mount pads so that oil holes in gaskets are aligned with crankcase oil outlet holes.
- b. Install oil seal (15) in adapter (12).
- c. Install two adapter assemblies with oil holes aligned to crankcase oil outlet holes. Secure both with attaching parts (11,10,9 and 8,7,6).

### 8-16. OIL COOLER, PERMOLD ENGINE (See Figure 4-16).

- a. Install baffle support (11) on crankcase thru bolts.
- b. Install gaskets (8,9). Mount oil cooler on crankcase and secure with attaching parts (1 thru 6).

### 8-17. OIL COOLER, SANDCAST ENGINE (See Figure 4-17).

- a. Install new gasket (10) on crankcase studs. Install oil cooler end plate (9) on crankcase. Secure with attaching parts (8,7,6).
- b. Install new gasket (5) and oil cooler (4) on oil cooler end plate. Secure with attaching parts (3,2,1).

### 8-18. VALVE MECHANISM (See Figure 4-23 and 2-6).

- a. Turn engine upside down.
- b. Lubricate exterior surface of each hydraulic valve lifter just prior to installation. Apply oil to socket, but not into body oil holes. Install all valve lifters.
- c. Install six pushrod housings nearest to engine mount brackets first, since compressor must lie close to horizontal in order to clear crankcase flange.
- d. To install each pushrod housing (14) compress spring (15) and place packing (17) between two steel washers (16) on that end of housing. Insert this end of housing into crankcase guide until other end and its seal ring can be aligned with cylinder

head opening. Move assembly outward until packing (17), sandwiched between two steel washers (16), has entered cylinder hole. Release spring slowly until it is free and remove compressor (See Figure 8-11).

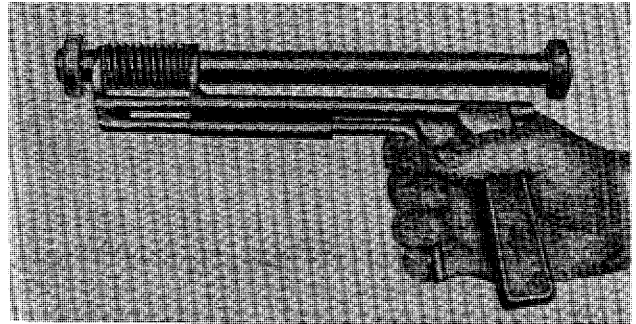


FIGURE 8-11. PUSHROD HOUSING AND SPRING COMPRESSOR.

- e. Before installing valve-actuating parts on each cylinder, turn crankshaft until cam lobes for that pair of valve lifters are on the base circle and not on the ramp.
- f. Install lubricated pushrods (13) and seat them in valve lifter sockets. Install proper rocker assembly (9,10,11), thrust washers (12) and insert rocker shaft (8). Line up hole in shaft with hole in rocker shaft boss. Install rocker shaft retaining screw (6) and washer (7), and secure with safety wire.

#### NOTE

Be sure to lubricate all moving parts liberally with engine oil.

- g. Install all pushrods and rockers in other cylinders in same manner. Install valve rocker covers (4), gaskets (5) and secure with attaching parts (1,2,3).

### 8-19. OIL SUMP, TSIO-520-B,E,J & K (See Figure 4-12).

- a. Install gasket (14) on suction tube (15). Insert threaded end of tube through crankcase into oil pump. Install gasket (13) and nut (12) on protruding, threaded end of suction tube. Attach suction tube brackets to crankcase with washer (9), bolt (8), washer (10) and nut (11). Secure bolt to brace with lockwire. Tighten nut to torque specified in Table of Limits, Section VI.

b. Spread a film of Tite-Seal compound on both sides of the sump gasket (7) and position it on the crankcase.

c. Lay sump on crankcase and install attaching parts (5,4,3). Make sure plug and gasket (1,2) are installed and tight.

#### 8-20. OIL SUMP, TSIO-520-C & G (See Figure 4-13).

a. Place a new gasket (12) on crankcase suction tube pad and position suction tube assembly on crankcase.

b. Attach suction tube assembly (11) to crankcase with two slotted screws (8) and two sets of screws and washers (9,10). Torque screws (9) to value specified in Table of Limits, Section VI. Lockwire screws.

c. Spread a film of Tite-Seal compound on both sides of the sump gasket (7) and position it on the crankcase.

d. Install sump on crankcase with attaching parts (5,4,3). Make sure plug and gasket (1,2) are installed and tight.

#### 8-21. OIL SUMP, TSIO-520-D (See Figure 4-14).

a. Install gasket (15) on suction tube assembly (16). Insert threaded end of tube through crankcase into oil pump. Install new gasket (14) and nut (13) on protruding, threaded end of suction tube. Secure suction tube to crankcase with screw (12) and secure with lockwire. Torque acorn nut to value specified in Table of Limits, Section VI.

b. Spread a film of Tite-Seal compound on both sides of gasket (11) and position it on crankcase.

c. Lay sump (10) on crankcase, and install attaching parts (7,8,9). Make sure plug and gasket (1,2) are installed and tight.

d. Install mounting legs (6) and secure with attaching parts (3,4,5).

#### 8-22. OIL SUMP, TSIO-520-H (See Figure 4-15).

a. Place new gasket (12) on crankcase suction tube pad and position suction tube assembly on crankcase.

b. Attach suction tube assembly (11) to crankcase with two slotted screws (8) and two sets of screws and washers (9,10). Torque screws (9) to value given in Table of Limits, Section VI. Lockwire screws.

c. Spread a film of Tite-Seal compound on both sides of the sump gasket (7) and position it on the crankcase.

d. Lay sump on crankcase and install attaching parts (3,4,5). Make sure plug and gasket (1,2) are installed and tight.

#### 8-23. INDUCTION SYSTEM (See Figures 4-1 thru 4-5).

a. Push a new applicable hose on either end of intake manifold elbows. Slide one hose clamp to a position midway on overlapping portion. Turn each clamp so that a screwdriver can be aligned with its screw and yet clear of stand when tube is installed. Tighten screw only enough to hold hose in position.

b. Place a hose clamp on each end cylinder intake tube so it faces center tube. Push end tubes into hose previously installed on center intake tubes. Work hose clamps over ends of hoses, but not past bead. Do not tighten at this time.

c. Push a hose on each front and rear intake tube and install a clamp on overlapping portion behind tube bead. Tighten these clamps.

d. Lay a new gasket on intake flange of each cylinder. Position each assembly of tubes and hoses on proper bank of cylinders and adjust each tube so it seats squarely on cylinder port.

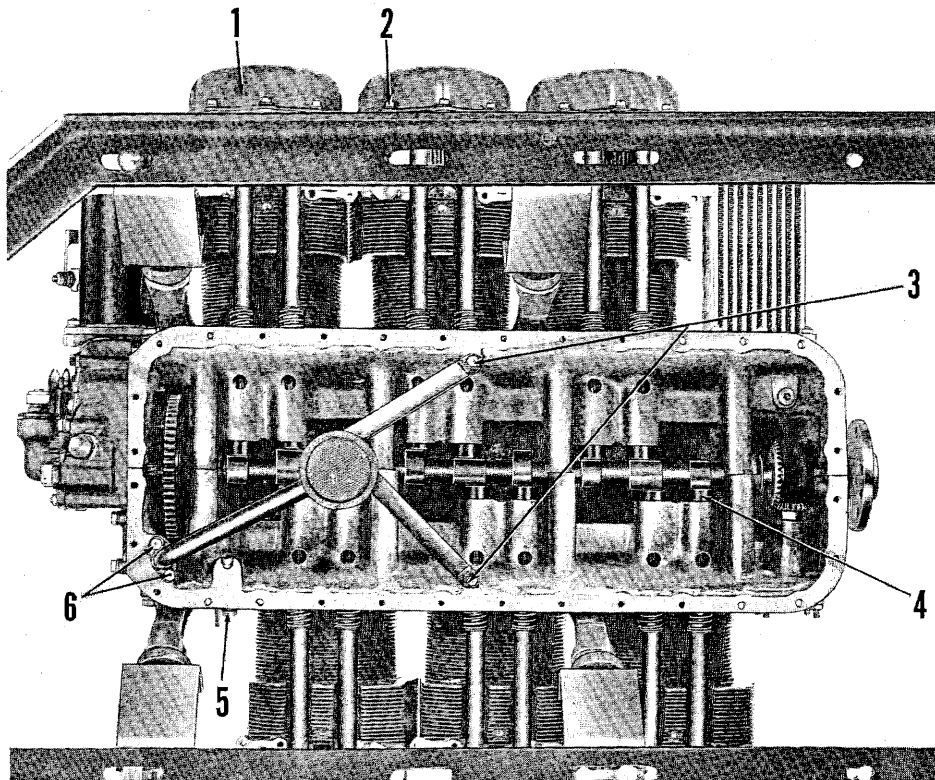
e. Attach each intake flange to its cylinder with four sets of attaching parts. Torque to value specified in Table of Limits, Section VI. Position clamp on two center hoses on each side inside tube beads and tighten.

f. Install clamps and bracket on balance tube. Push tube ends into connecting hoses installed on front intake tubes. Position clamp and secure bracket to sump with two sets of attaching parts. Position clamp assemblies, between tube and elbow, over beads and tighten. Turn engine upright.

g. TSIO-520-B, D, E & K.

(1) Push hoses and clamps on No. 1 and No. 2 intake tubes until clear of ends. Position manifold riser between tubes and install hoses and clamps.





1. Valve Rocker Cover
2. Washer, Lockwasher Screw
3. Oil Suction Tube
4. Hydraulic Valve Lifter
5. AN74A3 Bolt
6. AN74A4 Bolt
7. Oil Gauge Rod Support

FIGURE 8-12. BOTTOM VIEW WITH VALVE MECHANISM AND OIL SUCTION TUBE INSTALLED TSIO-520-C.

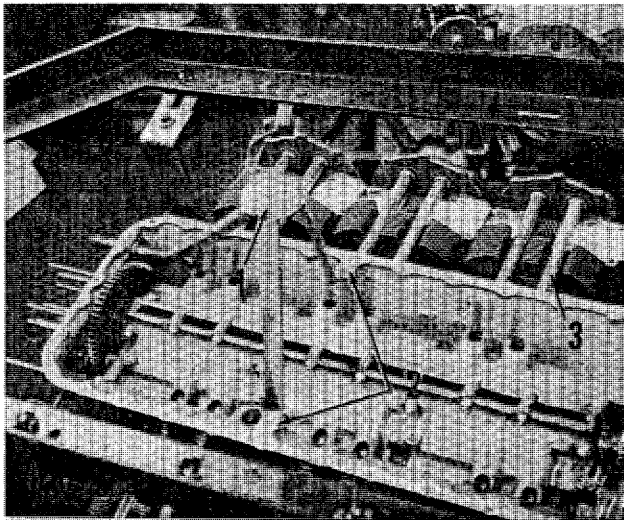


FIGURE 8-13. BOTTOM VIEW WITH VALVE MECHANISM AND OIL SUCTION TUBE INSTALLED TSIO-520-B, D, E, J & K.

1. Oil Suction Tube
2. 630966-.56 Bolt
3. Pushrod and Pushrod Housing

(2) Secure air throttle assembly to riser with convoluted bellows, clamp sleeves and clamps. On Model D, attach with hose and clamp.

h. TSIO-520-C, G & H.

(1) Push hose clamp on both elbows (25,26) and push elbows into connecting hoses of rear intake tubes. Position clamps and tighten only enough to hold tubes.

(2) Secure support bracket (33) to upper magneto drive adapter studs and idler gear support studs with attaching parts (9,10,11, Figure 4-11).

(3) Position air throttle assembly on lower bracket and secure with attaching parts (28,29). Place hose clamp over each hose (24) on elbows (25, 26) and work hoses onto throttle body. Position and tighten clamp. Secure support bracket to air throttle body with attaching parts (31,32).

i. TSIO-520-J.

(1) Make sure flexible elbows are attached to intake manifold elbows from cylinders 1 and 2.

**NOTE**

Check arrow for air flow direction on elbows.

(2) Intercooler and air throttle assembly should be installed after engine is placed in airframe.

**8-24. FUEL INJECTION, PERMOLD ENGINE**  
(See Figures 4-6, 4-8, 4-9 and 4-10).

a. Place square drive coupling in crankcase cavity after it has been thoroughly lubricated.

b. Coat both sides of gasket with a film of Tite-Seal compound. Install gasket on crankcase studs. Slide fuel pump onto studs and secure with two sets of attaching parts. Install shroud on fuel pump.

**8-25. FUEL INJECTION, SANDCAST ENGINE**  
(See Figure 4-7).

a. Lubricate fuel pump drive gear (28) and install into crankcase with plug (39).

b. Coat both sides of gaskets (33,37) with a film of Tite-Seal compound. Install gasket (37, on mounting studs and slide fuel pump adapter (36, with seal (35) over studs. Install gasket (33), insulator (34) and gasket (33); then install fuel pump (32) and secure with four sets of attaching parts (29,30,31). Install shroud (28) and secure with attaching parts (25,26).

c. Install one hose assembly (5) from metering unit to manifold valve and two hose assemblies (6,7) from fuel pump to metering unit. Also connect tube assembly (1, Figure 4-2) from junction block to fuel pump.

**8-26. PLACING CRANKSHAFT IN TIMING POSITION, PERMOLD ENGINE.**

a. Cover the lower spark plug hole of No. 1 cylinder with thumb and turn crankshaft clockwise until pressure is felt on thumb.

b. Remove plug (71, Figure 4-24) in front of No. 6 cylinder and observe timing mark on the

alternator drive gear as the crankshaft is rotated slowly. When the 20° mark on the gear is centered in the viewing hole, No. 1 piston is at the 20° BTC position.

**8-27. PLACING CRANKSHAFT IN TIMING POSITION, SANDCAST ENGINE.**

a. Cover the lower spark plug hole of No. 1 cylinder with thumb and rotate crankshaft clockwise until pressure is felt on thumb. The timing marks on the crankshaft are now turning towards the bottom parting lines of the crankcase halves.

b. Using an adjustable square or depth gauge on the front of the crankshaft flange, align the 20° timing mark on the crankshaft flange with the crankcase bottom parting line flange.

**8-28. MAGNETO DRIVE GEARS** (See Figure 4-11).

a. With engine in upright position, insert one pressed steel retainer (18) into each gear hub slot.

b. Cover each of four new rubber coupling bushings with a film of Molyshield grease and insert two bushings (19) into each retainer, rounded long edges first.

c. Turn the crankshaft to the No. 1 cylinder advance firing angle as described in the paragraphs 8-26 and 8-27. Install sleeve (17) into magneto drive gear (16). Lubricate each gear (16) and insert into bushings (14). Observe the shaft ends from the rear as they are carefully pushed through the adapter oil seals to make sure the oil seal lips are not reversed or damaged. Mesh the magneto drive gears to the idler gear to the approximate position shown in 8-12. These positions will vary slightly due to the difference in magnetos and gears.

**8-29. MAGNETOS.**

a. Remove inspection hole plugs from magnetos.

b. Turn impulse coupling backward, so latches will not engage, until timing pointer inside inspection hole is aligned with marked distributor gear tooth.

c. Without turning the magneto coupling, hold the magneto in the horizontal position it will occupy when installed, and check alignment of gear coupling slot and impulse coupling lugs. If not aligned, pull gear out of mesh (but not out of oil

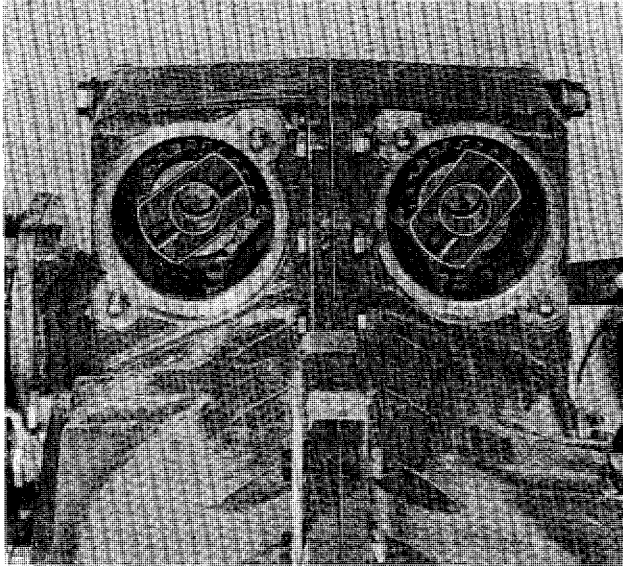


FIGURE 8-14. POSITION OF MAGNETO COUPLINGS.

seal) and turn to correct alignment. Push gear back into mesh.

d. Place new gasket on magneto flange and install magneto carefully so drive coupling lugs mate with slots of drive bushings. Install holding washers, lockwashers and nuts, but tighten only enough to permit turning the magneto for final timing, without looseness. Install right magneto with outer end slightly below horizontal and left magneto with outer end slightly above horizontal.

e. Connect timing light lead to ground terminal of each magneto. Both timing lights should be on. Tap the right magneto up with a non-marring hammer until the light goes out. Tap the left magneto down until the light goes out. Secure magnetos.

f. Turn the crankshaft a few degrees counter-clockwise and bring it back again until the timing marks are aligned. Both timing lights should go out at the same instant that the timing mark on the crankshaft flange aligns with the crankcase parting flange, or the timing mark on the alternator drive gear appears in the center of the crankcase inspection hole.

g. If timing lights do not go out at the same time, loosen the magneto that is late or early and repeat the process.

#### 8-30. IGNITION HARNESS.

a. The high tension cable outlet plates, can be attached to either magneto in only one position.

The shortest ignition cable is for No. 1 upper spark plug, and identifies proper assembly for the right magneto. Notice the "1" on the outlet plates next to the No. 1 cylinder cable outlet holes.

b. Attach cable outlet plate to magneto.

c. Install spark plugs and gaskets in cylinders. Tighten to torque specified in Table of Limits, Section VI.

d. Install ignition harness assemblies. Insert terminals into plugs and connect elbows to spark plugs. Make certain conduits are not kinked or interfering with some other part.

e. Attach brackets and tighten all coupling nuts.

#### 8-31. FUEL LINES.

a. Make sure that all nozzles have been installed and properly tightened. Install air manifold tubes to nozzle sleeves. Make sure attaching parts are assembled as shown in Figures 4-1 thru 4-5.

b. Snap the discharge tube retaining clamps into brackets and secure tubes in clamps.

c. Connect tubes to respective nozzles and manifold valve fittings.

#### 8-32. FINAL PARTS.

a. Install gaskets and covers on mount pads behind magneto drive gears and attach with four sets of plain washers, lockwashers and nuts.

#### 8-33. TESTING AFTER OVERHAUL.

##### NOTE

When necessary, the airframe can be considered a suitable test stand for running in overhauled engines contingent on use of a test propeller and equipped with a suitable shroud or scoop to gather and direct cooling air over the cylinders. Engine must be equipped with cylinder head pickups on all cylinders and other instrumentation as needed.

#### 8-34. TEST EQUIPMENT.

#### 8-35. 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 Fan Company, 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 XI for the model on test, when used in the cell, stand and engine combination for which it was calibrated.

#### 8-36. 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 dimensions shown in the installation drawings. The crankshaft should be at least five feet above the cell floor so that the club will not cause excessive air disturbance at floor level. If the cell does not have a paved floor, the ground under the stand and for a considerable distance around it should be treated to hold the soil.

#### 8-37. COOLING AIR SCOOP.

In warm climates it may 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. It may be found necessary to construct vanes to direct cooling air downward to the center cylinder and/or the oil cooler. The temperatures of all cylinder heads should be measured until uniformity within  $50^{\circ}$  has been obtained. It is also advisable to provide a duct from the cylinder scoop to the generator or alternator vent tube, or to provide a separate scoop.

#### 8-38. INDUCTION AIR INTAKE.

An air filter and housing should be attached to the turbocharger air inlet flange. 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 approximately 389 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 the accumulation of dirt.

#### 8-39. EXHAUST STACKS.

If the engine is being tested after overhaul on a test stand, it will be necessary to install a complete exhaust system and turbocharger installation.

#### 8-40. CONTROLS.

The only necessary controls 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.

#### 8-41. ELECTRICAL WIRING.

A 24-volt storage battery 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 solenoid coil terminal to a 5 amp. pushbutton switch. The other switch terminal must be connected to the engine, or both to a common ground.

#### 8-42. INSTRUMENTS.

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 as required.
- b. An oil pressure gauge and tube assembly.
- c. An oil temperature gauge and capillary assembly.
- d. A cylinder head temperature gauge, wiring and spark plug bayonet thermocouple. (Install under a lower spark plug.)
- e. A water manometer with rubber hose connection to the vacuum pump oil return hole at the rear of the crankcase.
- f. An ammeter connected in the generator or alternator circuit.

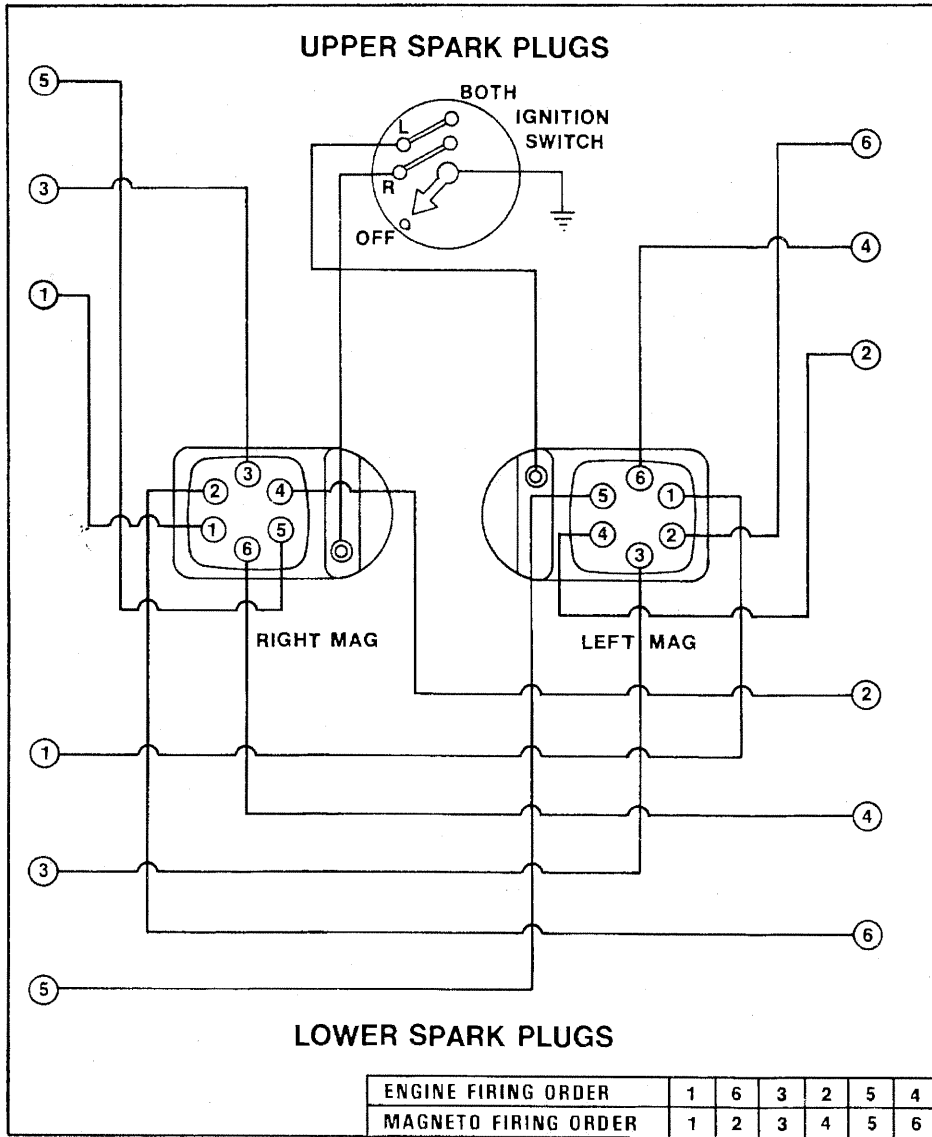


FIGURE 8-15. WIRING DIAGRAM.

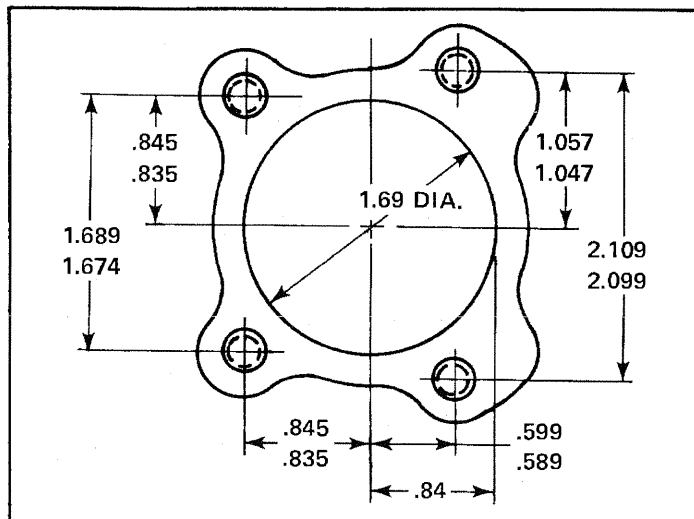


FIGURE 8-16. EXHAUST FLANGE DIMENISONS.

#### 8-43. 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 the engine.

#### 8-44. FUEL SYSTEM.

The test stand fuel system is to incorporate an auxiliary pump capable of delivering fuel to and through the engine system at a pressure of 2 to 2-1/2 psi indication on fuel pressure gauge. Means of determining by weight, fuel consumption for given periods of time and at specified percentage of power should also be included. Connect stand fuel supply line to upper elbow projecting from left side of fuel pump shroud. Connect fuel pump-to-supply tank 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 manifold valve.

#### 8-44A GOVERNOR PAD COVER.

A removable oil transfer tube conducts oil under pressure from the front main bearing through the crankshaft to the propeller hub. Crankshafts are equipped with an oil transfer collar to supply the governor controlled oil to the crankshaft for use with an oil controlled propeller.

When a test club or fixed pitch propeller is used for testing purposes, the governor pad cover must have an internal grooved surface to allow the circulating oil to lubricate the oil transfer collar. The governor pad cover is not needed if a governor is installed.

#### 8-45. ENGINE TEST AFTER OVERHAUL.

- a. After a partial or complete disassembly and repair of an engine in which no major part (cylinders, pistons, bushings, gears, etc.) was replaced, the engine will be tested in accordance with Table X.
- b. Run the engine according to Table XI after a major overhaul which included the replacement of cylinders, pistons, bushings and any gear or any assembly containing gears.
- c. 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.

d. 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.

e. Make one check on performance of each magneto alone at 2100 RPM (Refer to Tables IX, X or XI). 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 IX) must not be exceeded at any time during the test.

#### 8-45A ENGINE PRE-OILING BEFORE INITIAL START-UP

- a. Lubricating oil used for the initial servicing and pressure pre-oiling shall be a straight mineral oil conforming to Mil-L-6082, containing such additive required to provide corrosion preventive equivalent to that required by Mil-C-6529, Type II.
- b. The oil viscosity grades used shall be determined by the minimum ambient temperature of the area in which the run-in will be made. Above +40°F — SAE grade 50. Below +40°F — SAE grade 30.
- c. The engine shall be pressure pre-oiled no more than 24 hours prior to the initial start. Pre-oil the engine by using suitable equipment which supplies pressure oil at not more than 60 psi. Apply pressure oil to the engine lubrication system such that all oil lines, oil galleries, oil pump and oil filter are filled with oil.
- d. Fill sump to maximum level with oil of appropriate viscosity per paragraph C.
- e. It is intended that the lubricating oil specified in paragraph C be used only for the initial 24 hours of engine operation. At the conclusion of the initial period the oil shall be drained and replaced with an approved ashless dispersant lubricant, as described in Teledyne Continental Motors Aircraft Engine Service Bulletin "Recommended Fuel and Oil Grades" latest revision.

f. Make-up oil during the initial period shall be straight mineral oil, with or without the corrosion preventive additive.

#### 8-46. STARTING PROCEDURE.

- a. Open throttle to approximately 900 to 1200 RPM position.
- b. Turn magneto switch to "BOTH" position.
- c. Press boost pump button and hold it until 2.5 to 3.0 psi nozzle pressure is obtained. After obtaining adequate pressure, 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 nozzle pressure. DO NOT use boost pump after engine is running smoothly.

#### 8-47. PRESERVATION.

If the engine is not to be installed in an aircraft and placed in service immediately, an additional period of 15 minutes test time will be required to preserve the engine internally. The engine must be stopped so the oil may be drained and replaced with a corrosion-preventive oil mixture (suitable for flight operation). During the same period, unleaded gasoline should be supplied to the fuel system.





TABLE XI. OPERATING TEST LIMITS (ONLY)

FEATURE	TSIO-520-B	TSIO-520-C & H	TSIO-520-D	VALUE TSIO-520-E	TSIO-520-G	TSIO-520-J	TSIO-520-K
Rated max. BHP/RPM	285 @ 2700	285 @ 2700	285 @ 2700	300 @ 2700	300 @ 2700	310 @ 2700	285 @ 2700
Full throttle speed RPM	2675-2725	2675-2725	2675-2725	2675-2725	2675-2725	2675-2725	2675-2725
Idling speed RPM	575-625	575-625	575-625	575-625	575-625	575-625	575-625
Fuel grade (octane)	100/130	100/130	100/130	100/130	100/130	100/130	100/130
Fuel consumption at full throttle, 2700 RPM (lbs./hr.)	165-170	165-170	165-170	175-180	175-180	170-178	165-175
Fuel pump pressure at full throttle, 2700 RPM (psi)	30.8-32.2	30.8-32.2	30.8-32.2	31.0-33.0	32.4-34.4	31.0-33.0	30.0-32.0
Fuel pump pressure at idle (psi)	5.50-6.50	5.50-6.50	6.0-7.0	5.50-6.50	5.50-6.50	5.50-6.50	5.50-6.50
Metered fuel press. at full throttle, 2700 RPM (psi)	16.0-18.0	17.0-18.0	17.0-18.0	16.0-18.0	15.6-16.6	16.0-17.5	
Metered fuel press. at idle (psi)	3.5-4.0	3.5-4.0	3.5-4.0	3.5-4.0	3.5-4.0	3.5-4.0	3.0-3.5
Engine intake air temp. (S/C inlet)	70° - 100° F.	70° - 100° F.	70° - 100° F.	70° - 100° F.	70° - 100° F.	70° - 100° F.	60° - 100° F.
Engine intake air pressure (max.) H <sub>2</sub> O	1.0"	1.0"	1.0"	1.0"	1.0"	1.0"	1.0"
Manifold press. at max. rated power (Hg)	31.8-32.2"	32.3-32.7"	32.3-32.7"	34.3-34.7"	34.8-35.2"	35.8-36.2"	32.8-33.2"
Manifold press. at idle (Hg)	15.5-18.0"	16.5-18.5"	15.5-18.0"	15.5-18.0"	15.5-18.0"	15.5-18.0"	15.5-18.0"
Oil grade	SAE 50	SAE 50	SAE 50	SAE 50	SAE 50	SAE 50	SAE 50
Oil consumption at max. rated power (lbs./45 min.)	2.1	2.1	2.1	2.2	2.1	2.2	2.1
Oil temperature (desired range)	150° - 200° F.	150° - 200° F.	150° - 200° F.	150° - 200° F.	150° - 200° F.	150° - 200° F.	150° - 200° F.
Oil temperature (max.)	240° F.	240° F.	240° F.	240° F.	240° F.	240° F.	240° F.
Oil press. at full throttle (psi) (oil temp. 175° - 185° F.)	30-60	30-60	30-60	30-60	30-60	30-60	30-60
Oil press. at idle (psi min.) (oil temp. 140° - 150° F.)	10	10	10	10	10	10	10

TABLE XI. OPERATING TEST LIMITS  
(CONTINUED)

FEATURE	TSIO-520-B	TSIO-520-C & H	TSIO-520-D	VALUE TSIO-520-E	TSIO-520-G	TSIO-520-J	TSIO-520-K
Ignition timing	19° - 21°	19° - 21°	19° - 21°	19° - 21°	21° - 22°	19° - 21°	19° - 21°
Left magneto BTC	19° - 21°	19° - 21°	19° - 21°	19° - 21°	21° - 22°	19° - 21°	19° - 21°
Right magneto BTC	19° - 21°	19° - 21°	19° - 21°	19° - 21°	21° - 22°	19° - 21°	19° - 21°
Magneto spread (at 2100 RPM) maximum	50	50	50	50	50	50	50
Cylinder head temp. (max.) (with bayonet thermocouple)	460° F.	460° F.	460° F.	460° F.	460° F.	460° F.	460° F.
Crankcase press. (max.) H <sub>2</sub> O *	4.0"	4.0"	4.0"	4.0"	4.0"	4.0"	4.0"
Turbocharger air inlet pressure (max.)							7.0" H <sub>2</sub> O
Turbocharger air outlet pressure (max.)							35.0" Hg
Turbocharger exhaust outlet pressure (max.)						1.0" Hg	7.0" Hg
Temperature of exhaust (max.) gas into turbocharger							1650° F.
Cooling air press. drop - intercooler (60% power)						2.0" Hg	
Cooling air pressure drop - intercooler (full throttle)						4.0" Hg	
Cooling air entrance temp. - intercooler						70° - 100° F.	

\* 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 the manometer.

**NOTE**

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

TABLE XII.

TOP OR MINOR AND  
MAJOR OVERHAUL TEST RUN  
(ALL MODELS EXCEPT K)

Period	Time-Minutes	RPM	
1	10	2400	Warm-up
2	10	2600	
3	5	2675-2725	100% Power
4	5	2275	60% Power
5	5	*2100	Check Magnetos
		575-625	Idle Cooling

NOTE

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

Period	Time-Minutes	RPM	
6	5	2400	Warm-up
7	5	2500	
8	5	2600	
9	10	**2675-2725	100% Power
10	10	2675-2725	100% Power
11	5	2275	
12	5	575-625	Idle Cooling

NOTE

Stop engine, drain oil, weigh and record engine oil consumption. Oil consumption at a rate of 2.1 Lbs./45 Min. run maximum is acceptable. If value in excess of 2.1 Lbs./45 Min. run is determined, rerun 45 minutes. If oil consumption is still excessive, return engine to overhaul.

\* Magneto drop and spread to be taken prior to oil consumption run. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.

\*\* Readings must be recorded after completion of each 10-minute interval during oil consumption run.

**TABLE XIII.  
TOP OR MINOR AND  
MAJOR OVERHAUL TEST RUN  
(TSIO-520-K)**

Period	Time-Minutes	RPM	
1	10	2400	Warm-up
2	10	2600	
3	5	2675-2725	100% Power
4	5	2610	90% Power
5	5	2275	60% Power
		*2100	Check Magnetos

**METERED FUEL PRESSURE CHECK**

Period	Time-Minutes	Metered Fuel Pressure Setting (PSIG)	Flowmeter Limits (Lbs./Hr.)
6	5	16.4	166.5 - 173.5
7	5	12.4	136.0 - 143.0
8	5	9.8	111.0 - 118.0
9	5	7.6	87.0 - 93.0
10	5	5.6	62.0 - 68.0
11	5	575-625 RPM	Idle Cooling

**NOTE**

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

**START OIL CONSUMPTION DETERMINATION**

Period	Time-Minutes	RPM	
12	5	2400	Warm-up
13	5	2500	
14	5	2600	
15	10	**2675-2725	100% Power
16	10	2675-2725	100% Power
17	5	2275	
18	5	575-625	Idle Cooling

**NOTE**

Stop engine, drain oil, weigh and record engine oil consumption. Oil consumption at a rate of 2.1 Lbs./45 Min. run maximum is acceptable. If value in excess of 2.1 Lbs./45 Min. run is determined, rerun 45 minutes. If oil consumption is still excessive, return engine to overhaul.

\* *Magneto drop and spread to be taken prior to oil consumption run. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.*

\*\* *Readings must be recorded after completion of each 10-minute interval during oil consumption run.*

## **SECTION IX**

### **INTRODUCTION**

In general, instructions relevant to the basic permold crankcase TSIO-520 series engine, as described in Sections I thru VIII, are also applicable to the TSIO-520-L, LB and WB. Wherever there are differences, instructions for the TSIO-520-L, LB and WB are covered in Section IX.

## SECTION IX

### TSIO-520-L, LB & WB

#### 9-1 GENERAL

a. Physical Differences. The TSIO-520, L, LB & WB are a complete engine package, including an engine bracketed turbocharger, an exhaust system furnished with the engine, and provisions for cabin pressurization. An intercooler is provided between the turbo and intake system. A Freon compressor kit is available which is operated by a belt driven power take off unit located at the rear of the starter adapter.

b. Operating Differences. The TSIO-520-L, LB is rated at 310 horsepower at 2700 RPM and 38.0" Hg. manifold pressure. The TSIO-520-WB is rated at 325 horsepower at 39.5" Hg. manifold pressure.

#### 9-2 EXHAUST ASSEMBLY (Figure 9-1)

#### 9-3 REMOVAL AND DISASSEMBLY.

a. Loosen couplings (7) and slide onto connector tube (8) and flange (9). Remove elbows (6, 10), connector tube (8), and flange (9).

b. Remove cylinder to exhaust attaching parts (37, Fig. 4-23) and drop exhaust elbows from cylinders. Separate elbows (1 thru 5). Remove gaskets (36, Fig. 4-23).

c. Remove attaching parts (11, 12, 13), gasket (14), and adapter (15).

#### 9-4 ASSEMBLY AND INSTALLATION

a. Install new gasket (14) to turbocharger, and attach adapter (15) with attaching parts (11, 12, 13). Use new self locking nut (13).

b. Install exhaust elbows (1 thru 5) using gasket (36, Figure 4-23) and nut (37, Figure 4-23).

c. Install flange (9), elbows (6, 10), and connector tube (8). Position connector tube (8) and flange (9) in place at adapter.

NOTE . . . Flange (9) must not be jammed against adapter (15) flange.

Secure connector tube (8) and flange (9) loosely with couplings (7).

d. Tighten couplings (7) to approximately 42 in. lbs. Tap outer periphery of band to distribute band tension and tighten to torque value of 50-60 in. lbs.

#### 9-5. FUEL INJECTION SYSTEM (FIGURE 9-2, 9-3)

#### 9-6 REMOVAL AND DISASSEMBLY

a. (Figure 9-2) Remove hose clamps (1), hose assembly (2) fuel pump to control, and hose assembly (3) control to manifold valve.

b. Disconnect six fuel discharge tubes (4) from manifold valve (8) and nozzle (6). Compress spring legs of clamps (5) and remove. Remove nozzles (6) and washers (7). Store in clean container.

c. Remove manifold valve (8). Remove fittings (9 thru 13). Remove attaching parts (14, 15) and separate bracket (16) from manifold valve body (22). Cut lockwire and remove screws (17) and lift off cover (18). Remove spring (19) screen (20) and seal (21).

d. Remove attaching parts (24, 25, 26) and pull fuel pump (23) from crankcase. Remove drive

coupling (27) and gasket (28). Remove fittings (29) thru (31).

e. (Figure 9-3) Remove attaching parts and lift control unit (3) from bracket (4).

#### NOTE

For overhaul of control unit, refer to Bendix Corporation RSA-7DA1 Overhaul Manual, which may be obtained from Bendix Corporation, Energy Controls Division, 717 N. Bendix Drive, South Bend, Indiana 46620.

f. Remove cotter pins (5) and washers (6) and link rod assembly (7 thru 12).

g. Remove attaching parts (13,14) and separate controller (15) from throttle body (3). Remove gasket (18), pin (16) and lever (17).

h. Remove washer (19), screw (20) and pull pressure relief valve (21) from throttle body (3). Remove O Ring (22). Fitting (23), check valve (24) and elbow (25) may be removed at this time.

#### 9-7 ASSEMBLY AND INSTALLATION

a. Assemble in reverse order of disassembly.

#### 9-8 INDUCTION SYSTEM(FIGURE 9-4,9-5)

#### 9-9 REMOVAL AND DISASSEMBLY

a. Figure 9-4. Remove controller to engine hose (1), controller to wastegate valve hose (5), oil cooler to wastegate valve hose (9) and turbo to oil cooler hoses (13,15) and check valve (14). Remove associated fittings only as required.

b. Figure 9-4. Remove sonic venturi attaching parts (28,29,30) and remove sonic venturi (27) and gasket (26). Loosen coupling (32) and separate induction tube (31) from turbo charger (39) and throttle and control assembly (34).

c. Figure 9-5. Remove air manifold to throttle body hose clamps (2) and remove hose (1). Remove air manifold tube (3) and separate tee (4) barbed hose fitting (5) and tube assembly (6). Unscrew sleeve nuts and remove air manifold tubes (7). Remove sleeves (8), washers (9) and gaskets (10,11). Remove grommet (28). Bracket (27) will come off when the crankcase halves are separated.

d. Figure 9-5. Invert engine and loosen hose clamps (12,21) and slide them onto adjoining elbows and tubes. Work hoses (13) over beads and remove elbows (14,15,16) tubes (17,18,19) and riser (20).

e. Figure 9-5 Remove balance tube clamp (25) and attaching parts (23,24) and remove clamp (26) and balance tube (22).

#### 9-10 ASSEMBLY AND INSTALLATION.

a. Use new hoses and gaskets and install in reverse order of disassembly.

#### 9-11 OIL SUMP (FIGURE 9-6)

a. Drain plugs (1) and gaskets (2) should have been removed when engine was installed on disassembly stand.

b. Remove attaching parts (3, 4, 5) and lift off oil sump (6) and gasket (7).

c. Remove plug (12) and gasket (13). Remove attaching parts (8,9,10,11) and pull suction tube assembly (15) from crankcase. Remove gasket (14).

#### 9-12 REASSEMBLY

a. Assemble in reverse order of disassembly.

#### 9-13 OIL COOLER (FIGURE 9-7)

#### 9-14 REMOVAL AND DISASSEMBLY

a. Remove attaching parts (2,3,4) and pull oil cooler (1) from crankcase studs. Remove gaskets (5) and spacer (6).

b. Remove nut (10), lock washer (9), plain washers (8), bolt (7) and spacer (11). Remove gaskets (13), turbocharger bracket (14) and "O"-rings (12).

c. Remove fittings (15, 16, 17) and temperature control valve (19) and gasket (18).

#### 9-15 REASSEMBLY AND INSTALLATION

a. Use new gaskets and install in reverse order of disassembly.

## 9-16 STARTER ADAPTER ASSEMBLY (SEE FIGURE 9-8)

### 9-17 REMOVAL AND DISASSEMBLY

- a. Remove attaching parts (1,2) and pull starter (3) from adapter studs. Remove "O"-ring (4).
- b. Remove retaining ring (36) using Truarc No.5 or 25 pliers. Insert a wide blade tool (see Figure 3-7) into the worm blade slot and rotate the shaft counterclockwise to break the bearing loose from the housing. If possible, remove the entire shaft assembly from the housing, otherwise remove parts after the shaft has been removed.
- c. Remove four sets of attaching parts (8,9, 10) and pull starter adapter from crankcase.
- d. Remove cotter pin (5), nut (6) and sheave (7) or sleeve (44) as applicable. Remove five sets of attaching parts (11,12, 13) and tap scavenge pump body (15) with a plastic hammer to remove. Remove gear and bushing assembly (19, 20), gear (21), sleeve (44), oil seal (16), retaining ring (17) and ball bearing (18).
- e. Remove two sets of attaching parts (22, 23, 24) and use an inertia puller or other suitable tool to detach cover assembly (25) and "O"-ring (27) from starter adapter.
- f. Clamp starter shaft gear teeth in shielded vise jaws and with proper tool (Figure 3-8) inserted in the worm gear holes, rotate the worm gear in driving direction to wind up the spring, at the same time pull axially to release the spring from the sleeve. Remove starter gearshaft (35) from the worm wheel (33).
- g. Clamp worm wheel in shielded vise and remove clutch spring retaining screw (30) and tab washer (31). With a brass drift or pin punch, tap front end of spring 180° away from retaining screw hole and go around spring. Tapping in each hole in wormwheel web. Spring can now be removed from drum.
- h. If not accomplished in step b., remove bearing (37) and shaft assembly (38 thru 41). Separate worm gear (38), spring (39), woodruff key (40) and shaft (41). It may be necessary to use arbor press to remove ball bearing (37) from shaft (41).

- i. Use arbor press to remove needle bearing (42) from adapter (43).
- j. Remove retaining ring (28) from shaft (35) and remove ball bearing (29).

### 9-18 REASSEMBLY AND INSTALLATION

- a. Install needle bearing (42) in adapter (43).
- b. Press bearing (37) onto shaft (41). Install spring (39), woodruff key (40) and worm gear (38) onto shaft and insert assembly into adapter. Secure assembly in adapter with retaining ring (36).
- c. Install clutch spring (32) on worm wheel (33). Turn spring in unwinding direction until offset end drops into gear hub groove. Position spring on gear so screw notch is aligned with screw hole in gear web. Install tab washer (31) and screw (30).
- d. Install bearing (34) in worm wheel (33). Lubricate spring, sleeve and shaft gear liberally with clean oil and press spring assembly onto shaft gear (35). Install bearing (29) and snap ring (28) on shaft gear.
- e. Install "O"-ring (27) in groove of adapter cover (25). Install cover and secure with attaching parts (22,23,24). Apply permatex and silk thread to the surface.
- f. Install scavenge pump drive gear (21) on shaft gear. Install scavenge pump driven gear assembly (19,20) on shaft in body (15). Install bearing (18), retaining ring (17) and oil seal (16) and install assembly on cover. Secure with attaching parts (11, 12, 13).
- g. Install sleeves (44) or sleeve (44) and sheave (7) as applicable. Screw on nut (6) and torque to 700-850 pounds for sheave installation, Torque to 450-500 in. lbs. when sheave (7) is replaced with sleeve (44). Install cotter pin (5).

### 9-19 FREON COMPRESSOR (OPTIONAL) FIGURE 9-9

### 9-20 REMOVAL AND DISASSEMBLY

- a. Relieve belt tension and remove belt.



b. Remove four nuts (2) eight washers (3) and four bolts (4) and separate compressor (not shown) from bracket.

c. Remove attaching parts (8,9 figure 9-7) and bolt (5) and washer (6) and separate bracket (7) from crankcase.

d. Remove special bolt (11), rectangular nut (8) lock nut (10) and washer (9). Remove bolt (12), washers (13,14) and nut (15) and pull block assembly from bracket. Remove bolt (16), retaining ring (17) and ball bearing (18) from sheave 19. Remove spacer (20).

e. Sheave (22) is retained to starter shaft with pin (23) and may already have been removed.

## 19-21 ASSEMBLY AND INSTALLATION

a. Assemble bracket components in reverse order of disassembly.

b. Install bracket on crankcase and secure with two bolts and washers (5,6) and one nut, washer, and lockwasher (10,8,9 figure 9-7) Torque bolts to 220-260 inch lbs. and torque nut to 275 to 325 inch lbs. (Nuts must be torqued on both ends of thru bolt).

c. Install compressor on bracket and secure with four sets of attaching parts (2, 3, 4). Torque nut to 275-325 inch lbs.

d. Install belt (1). Adjust belt tension by turning adjusting bolt so belt tension equals 65-75 lbs.

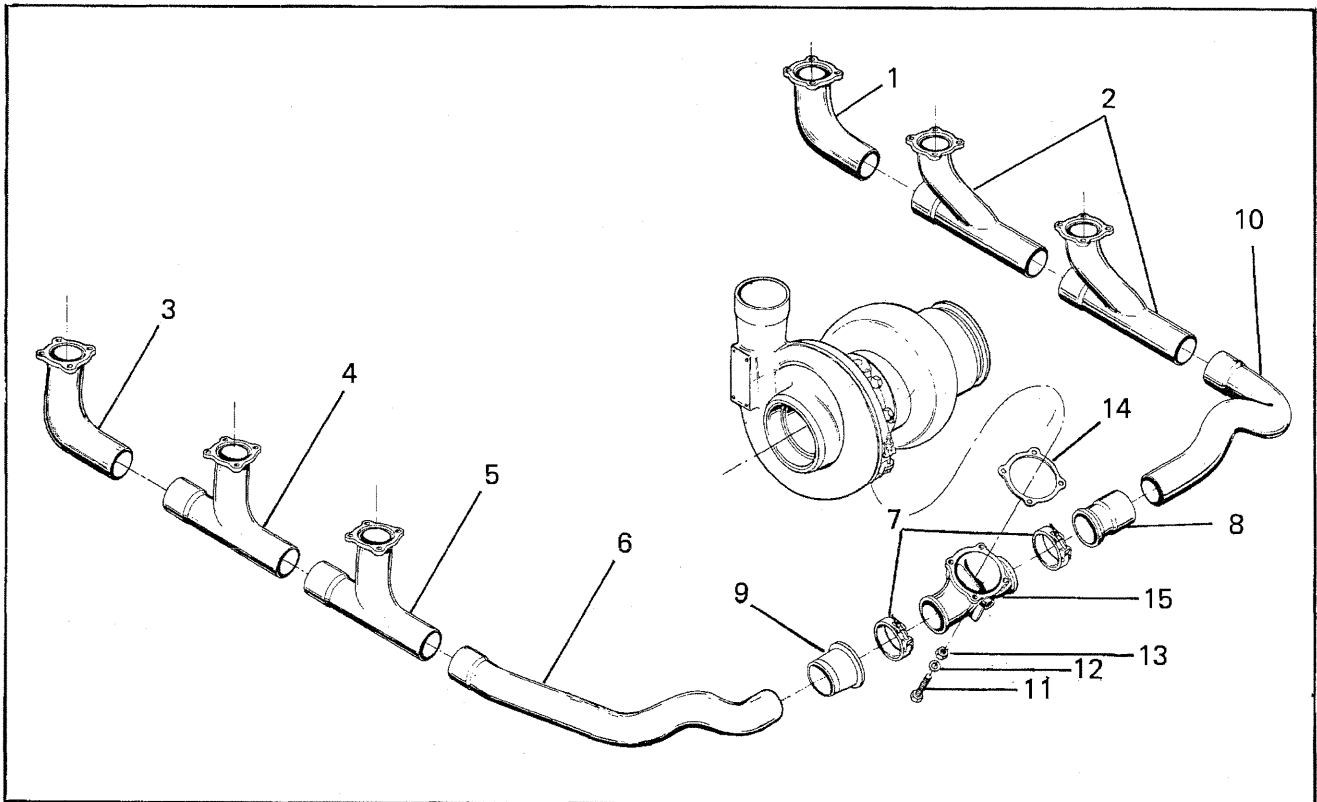


FIGURE 9-1 EXHAUST ASSEMBLY

- |                            |                   |
|----------------------------|-------------------|
| 1. Elbow Assembly          | 9. Flange         |
| 2. Elbow Assembly          | 10. Elbow         |
| 3. Elbow Assembly          | 11. Bolt          |
| 4. Elbow Assembly          | 12. Washer        |
| 5. Elbow Assembly          | 13. Nut           |
| 6. Elbow                   | 14. Gasket        |
| 7. Coupling                | 15. Turbo Adapter |
| 8. Connector Tube Assembly |                   |

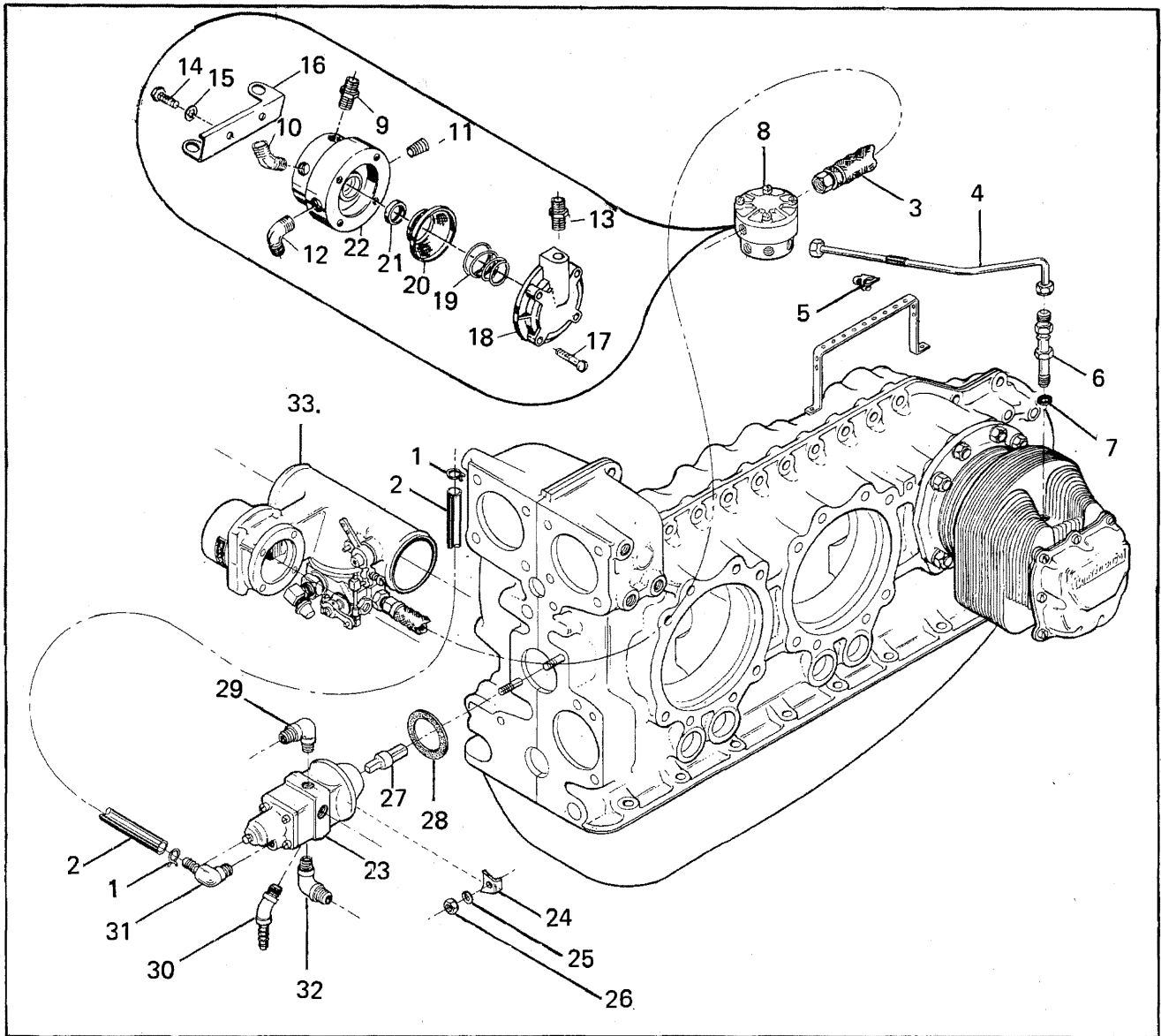


FIGURE 9-2 FUEL INJECTION SYSTEM

- |                        |                                   |
|------------------------|-----------------------------------|
| 1. Hose Clamp          | 18. Cover                         |
| 2. Hose                | 19. Spring                        |
| 3. Hose                | 20. Screen                        |
| 4. Fuel Discharge Tube | 21. Seal                          |
| 5. Clamp               | 22. Body                          |
| 6. Nozzle              | 23. Fuel Pump                     |
| 7. Gasket              | 24. Washer, Holding               |
| 8. Fuel Manifold Valve | 25. Washer, Lock                  |
| 9. Nipple              | 26. Nut                           |
| 10. Elbow              | 27. Coupling, Drive               |
| 11. Pipe Plug          | 28. Gasket                        |
| 12. Elbow              | 29. Elbow                         |
| 13. Fitting            | 30. Hose Fitting                  |
| 14. Bolt               | 31. Elbow                         |
| 15. Lockwasher         | 32. Elbow                         |
| 16. Bracket            | 33. Throttle and Control Assembly |
| 17. Bolt               |                                   |

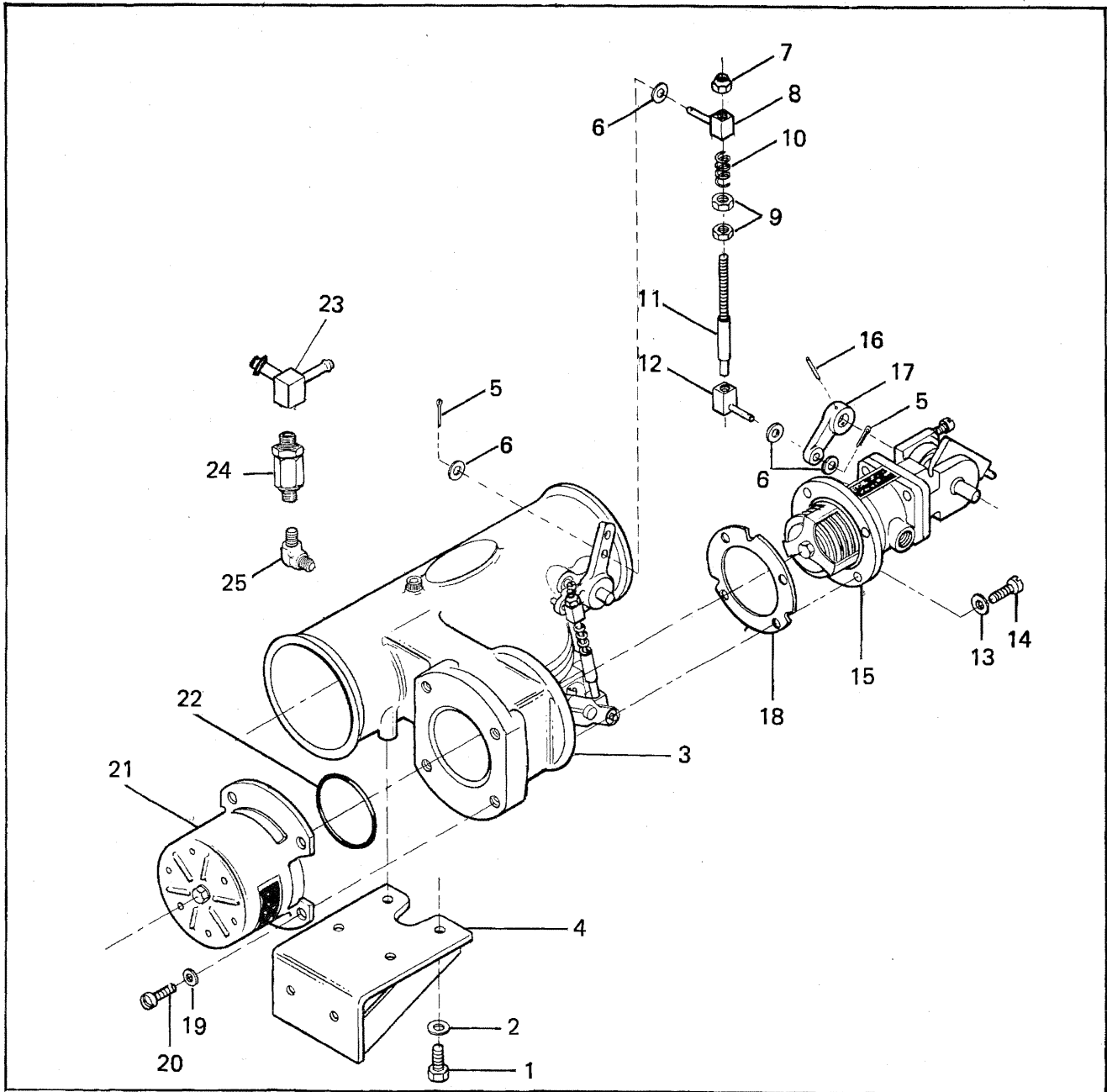


FIGURE 9-3 THROTTLE AND CONTROL ASSEMBLY

- |                                  |                           |
|----------------------------------|---------------------------|
| 1. Bolt                          | 13. Washer                |
| 2. Washer                        | 14. Bolt                  |
| 3. Throttle and Control Assembly | 15. Controller            |
| 4. Bracket                       | 16. Pin                   |
| 5. Cotter Pin                    | 17. Lever                 |
| 6. Washer                        | 18. Gasket                |
| 7. Nut                           | 19. Washer                |
| 8. Rod End                       | 20. Bolt                  |
| 9. Nut                           | 21. Pressure Relief Valve |
| 10. Spring                       | 22. Gasket                |
| 11. Rod                          | 23. Fitting               |
| 12. Rod End                      | 24. Check Valve           |
|                                  | 25. Elbow                 |

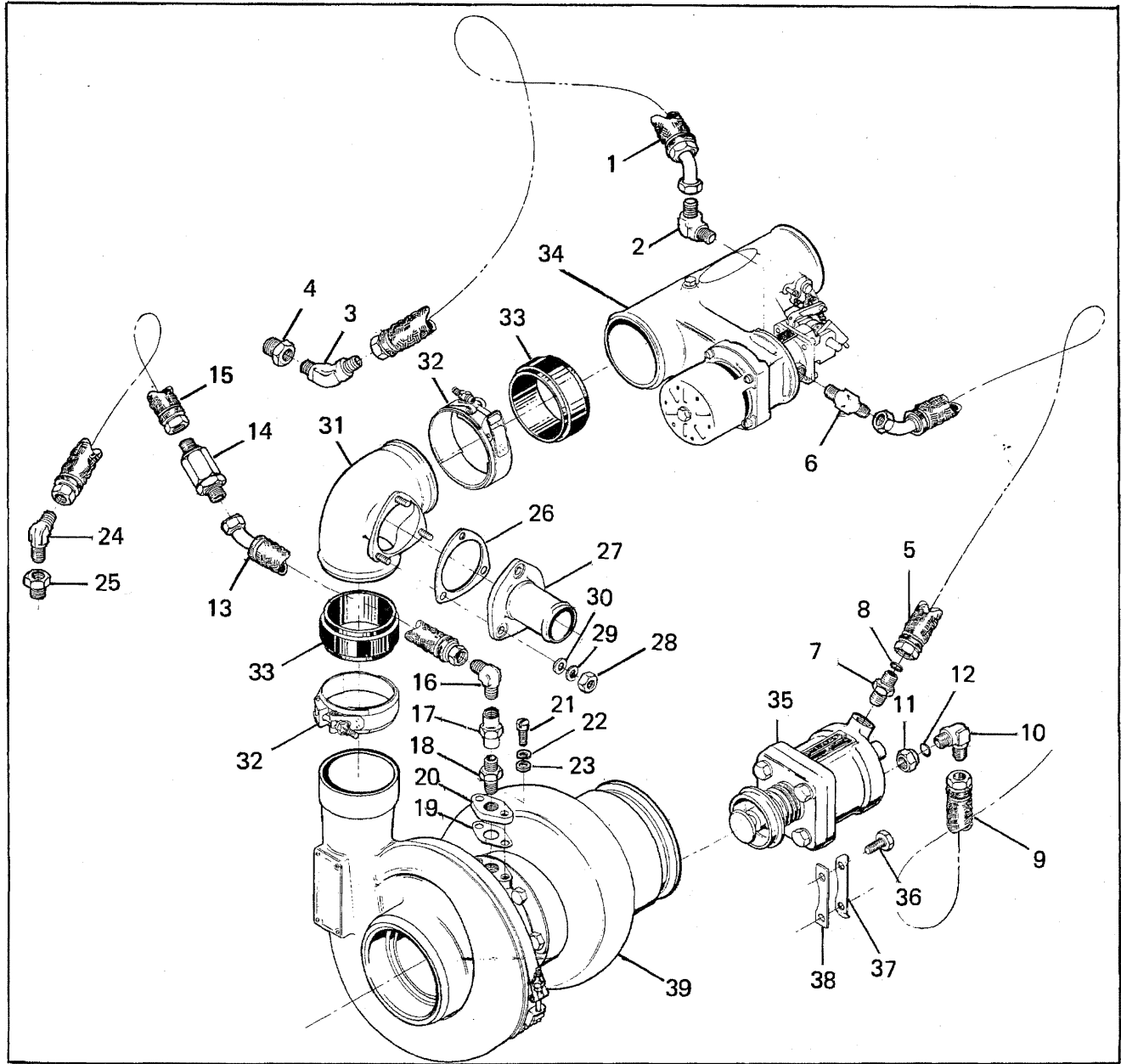


FIGURE 9-4 INDUCTION/EXHAUST RELATED PARTS

- |                                  |                                    |                               |
|----------------------------------|------------------------------------|-------------------------------|
| 1. Hose, Controller to Engine    | 14. Check Valve                    | 27. Sonic Venturi             |
| 2. Elbow 90°                     | 15. Hose Check Valve to Oil Cooler | 28. Nut                       |
| 3. Elbow 45°                     | 16. Elbow 90°                      | 29. Lockwasher                |
| 4. Reducer                       | 17. Coupling                       | 30. Washer                    |
| 5. Hose, Controller to Wastegate | 18. Nipple                         | 31. Induction Tube            |
| 6. Elbow                         | 19. Gasket                         | 32. Coupling                  |
| 7. Nipple                        | 20. Adapter, Turbo Oil Inlet       | 33. Sleeve                    |
| 8. O-Ring                        | 21. Bolt                           | 34. Throttle and Control Assy |
| 9. Hose, Wastegate to Oil Cooler | 22. Lockwasher                     | 35. Wastegate Valve           |
| 10. Elbow 90°                    | 23. Washer                         | 36. Bolt                      |
| 11. Nut                          | 24. Elbow                          | 37. Clamp Plate               |
| 12. O-Ring                       | 25. Reducer                        | 38. Lock Plate                |
| 13. Hose, Turbo to Check Valve   | 26. Gasket                         | 39. Turbocharger              |

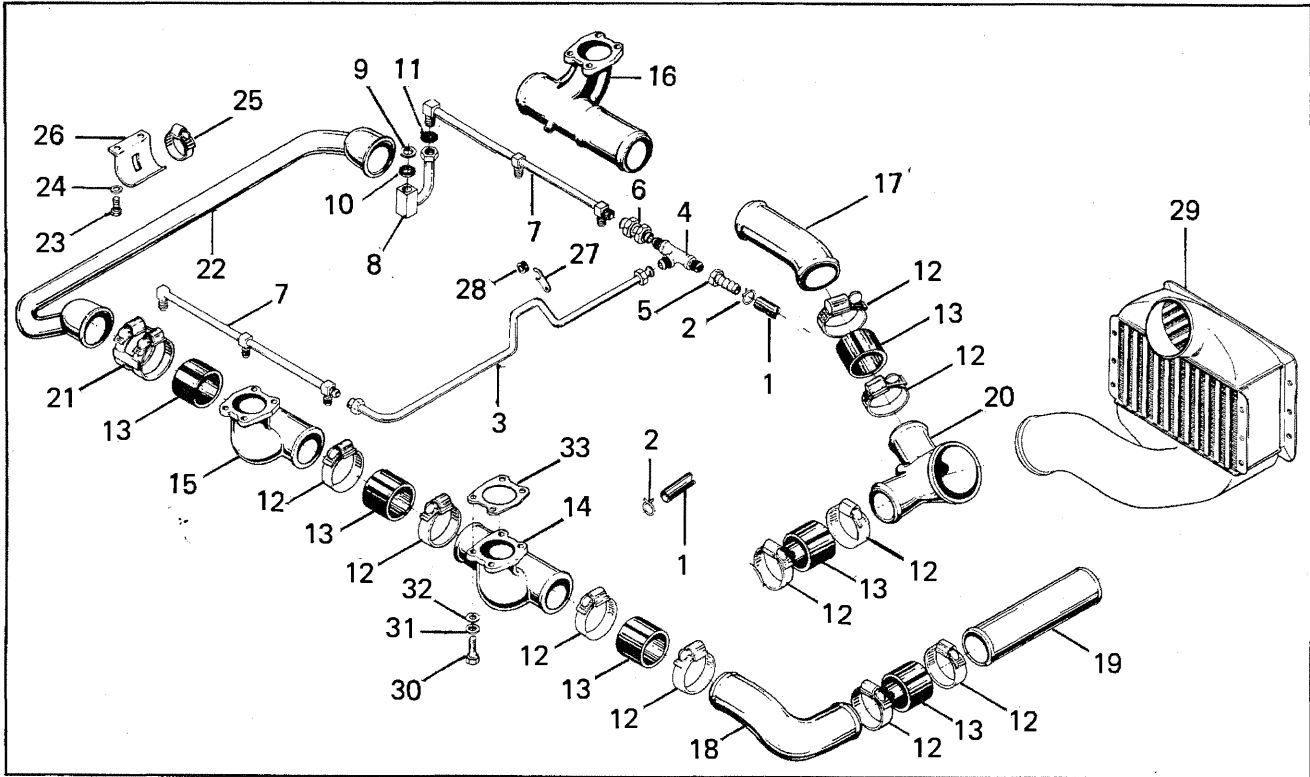


FIGURE 9-5 INDUCTION SYSTEM

- |                         |                       |
|-------------------------|-----------------------|
| 1. Hose                 | 18. Elbow, 2-4-6 side |
| 2. Hose Clamp           | 19. Tube              |
| 3. Air Manifold Tube    | 20. Riser             |
| 4. Tee                  | 21. Clamp Assembly    |
| 5. Coupling, Barbed     | 22. Balance Tube      |
| 6. Tube Assembly        | 23. Bolt              |
| 7. Tube Assembly        | 24. Tab Washer        |
| 8. Sleeve               | 25. Clamp             |
| 9. Washer               | 26. Bracket           |
| 10. Gasket              | 27. Bracket           |
| 11. Gasket              | 28. Grommet           |
| 12. Clamp               | 29. Intercooler       |
| 13. Hose                | 30. Bolt              |
| 14. Elbow, Cyl. 2, 4, 5 | 31. Lockwasher        |
| 15. Elbow, Cyl. 1, 6    | 32. Washer            |
| 16. Elbow, Cyl. 3       | 33. Gasket            |
| 17. Elbow, 1-3-5 side   |                       |

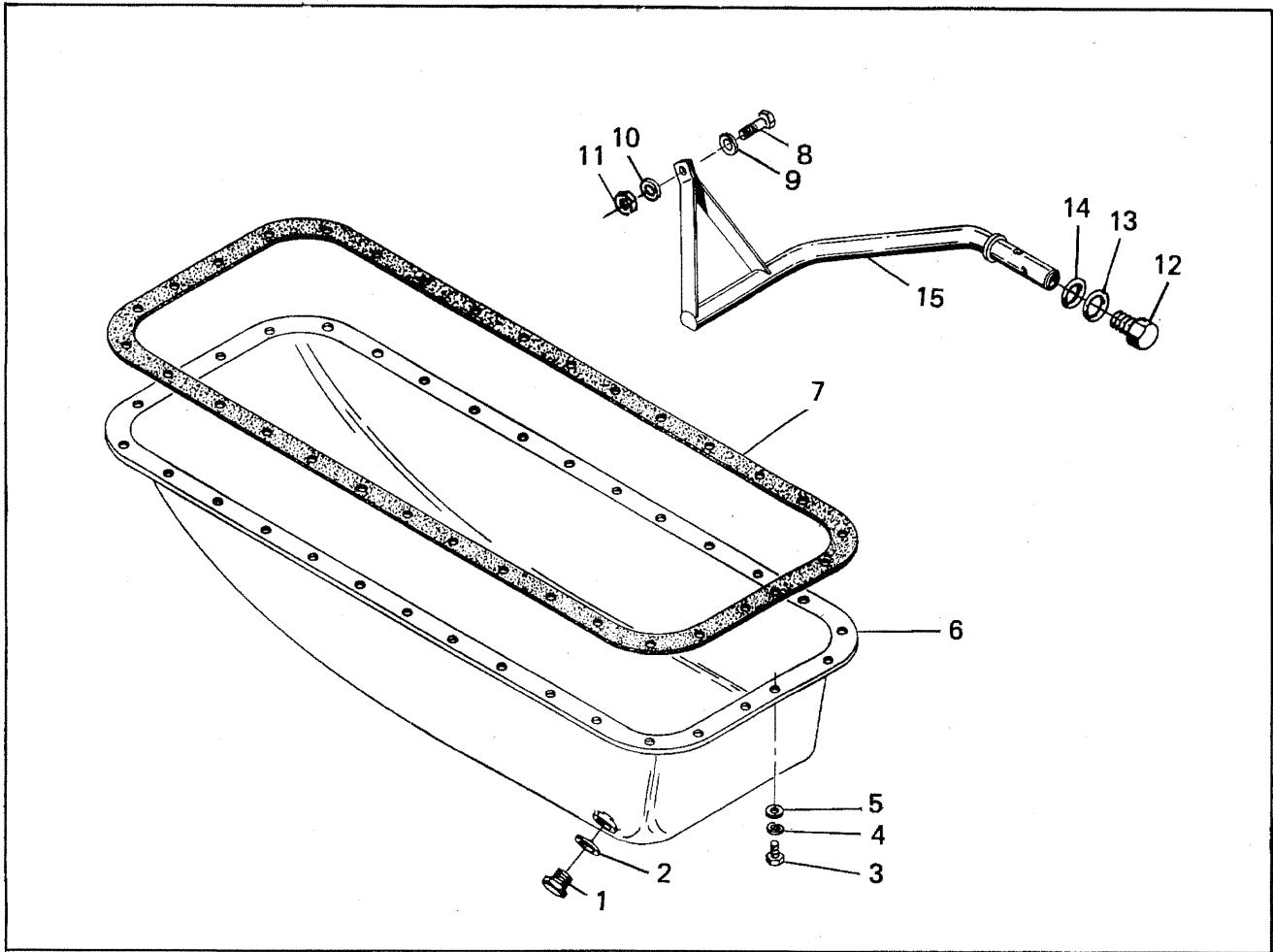


FIGURE 9-6 OIL SUMP

1. Plug, Oil Drain
2. Gasket, Annular
3. Screw, Hex Head
4. Washer, Lock
5. Washer, Plain
6. Sump Assembly, Oil
7. Gasket, Oil Sump
8. Bolt
9. Washer
10. Washer
11. Nut
12. Plug
13. Gasket, Annular
14. Gasket, Annular
15. Tube Assembly, Suction

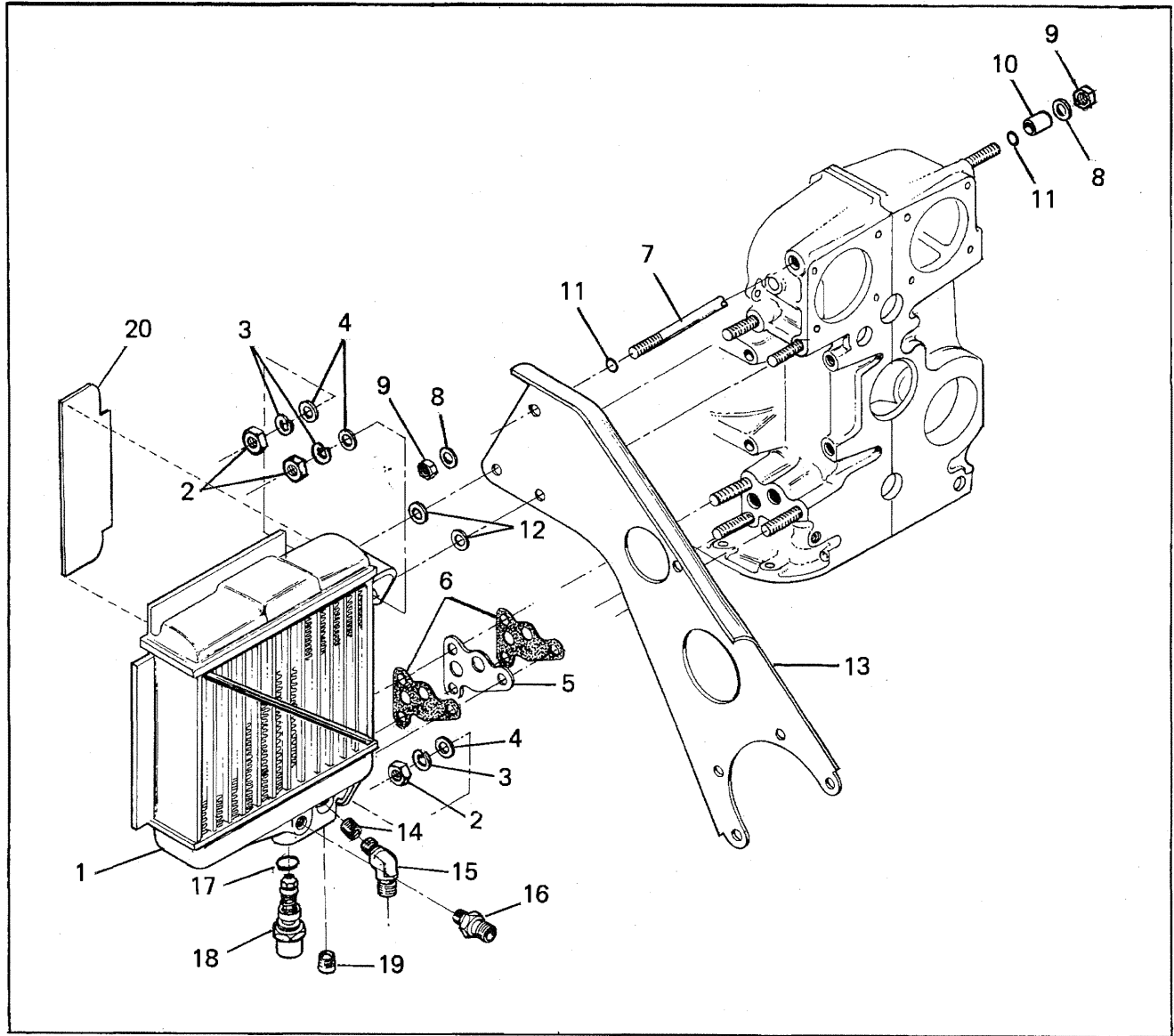


FIGURE 9-7 OIL COOLER ASSEMBLY

- |                  |                                   |
|------------------|-----------------------------------|
| 1. Oil Cooler    | 11. O-Ring                        |
| 2. Nut           | 12. Gasket                        |
| 3. Washer, Lock  | 13. Turbocharger Bracket          |
| 4. Washer, Plain | 14. Reducer                       |
| 5. Gasket        | 15. Elbow                         |
| 6. Spacer        | 16. Fitting                       |
| 7. Bolt, Thru    | 17. Oil Temp Control Valve Gasket |
| 8. Washer, Plain | 18. Oil Temp Control Valve        |
| 9. Nut           | 19. Plug                          |
| 10. Spacer       | 20. Baffle                        |

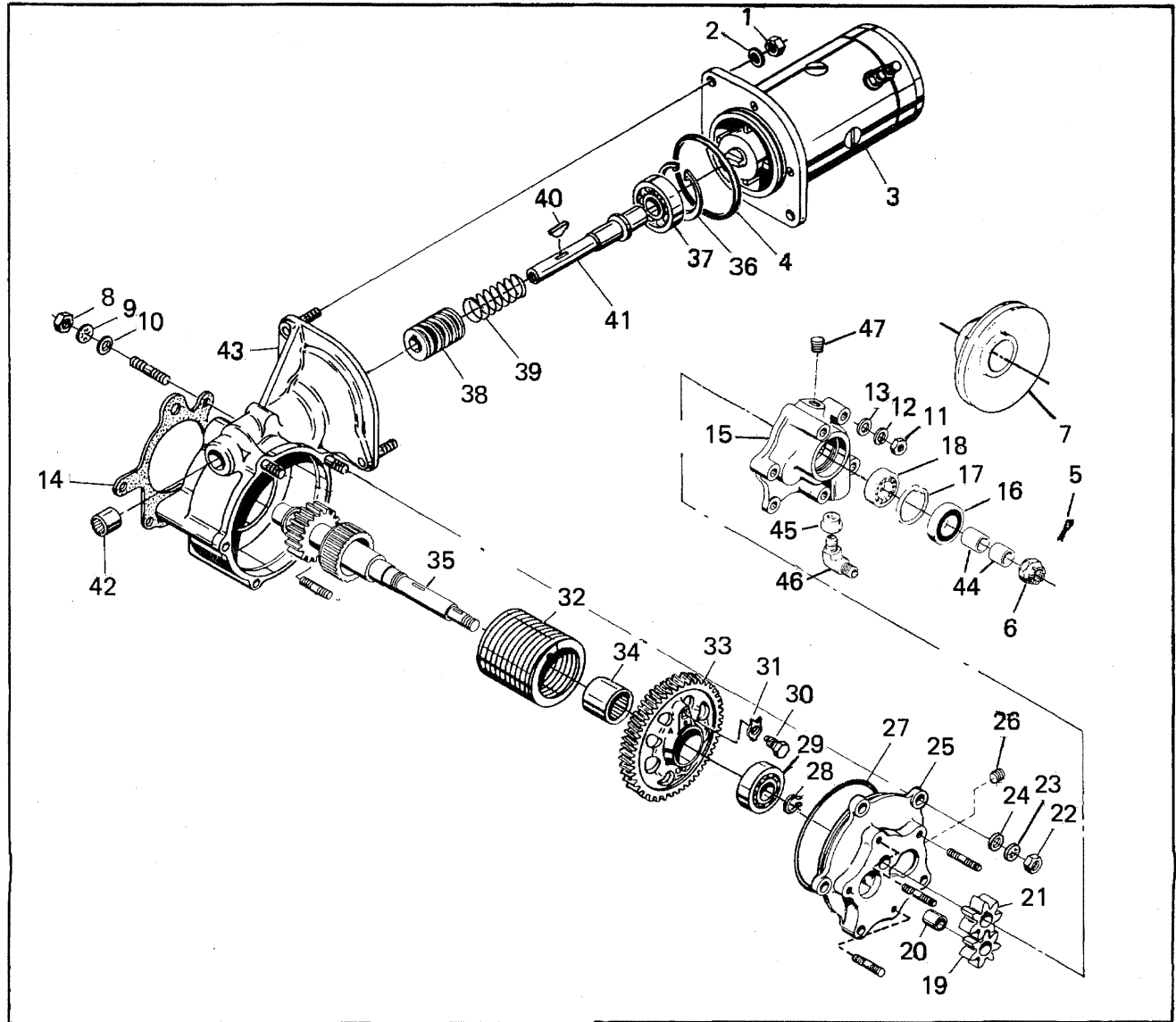


FIGURE 9-8 STARTER & STARTER ADAPTER ASSEMBLY

- |                         |                             |                       |
|-------------------------|-----------------------------|-----------------------|
| 1. Nut, Hex             | 17. Ring, Retaining         | 33. Gear, Worm Wheel  |
| 2. Washer, Plain        | 18. Bearing, Ball           | 34. Bearing, Roller   |
| 3. Starter              | 19. Gear, Driven            | 35. Shaftgear         |
| 4. "O"- Ring            | 20. Bushing, Driven Gear    | 36. Ring, Retaining   |
| 5. Cotter Pin           | 21. Gear, Driver            | 37. Bearing, Ball     |
| 6. Nut                  | 22. Nut                     | 38. Gear, Worm        |
| 7. Sheave               | 23. Washer, Lock            | 39. Spring            |
| 8. Nut, Hex             | 24. Washer, Plain           | 40. Key, Woodruff     |
| 9. Washer, Lock         | 25. Cover, Starter Adapter  | 41. Shaft, Worm Drive |
| 10. Washer, Plain       | 26. Plug                    | 42. Bearing Needle    |
| 11. Nut, Hex            | 27. "O"-Ring, Starter Cover | 43. Adapter           |
| 12. Washer, Lock        | 28. Ring, Retaining         | 44. Sleeve            |
| 13. Washer, Plain       | 29. Bearing, Ball           | 45. Bushing, Reducer  |
| 14. Gasket, Adapter     | 30. Screw, Special          | 46. Elbow             |
| 15. Body, Scavenge Pump | 31. Washer, Tab             | 47. Plug              |
| 16. Seal, Oil           | 32. Spring, Clutch          |                       |



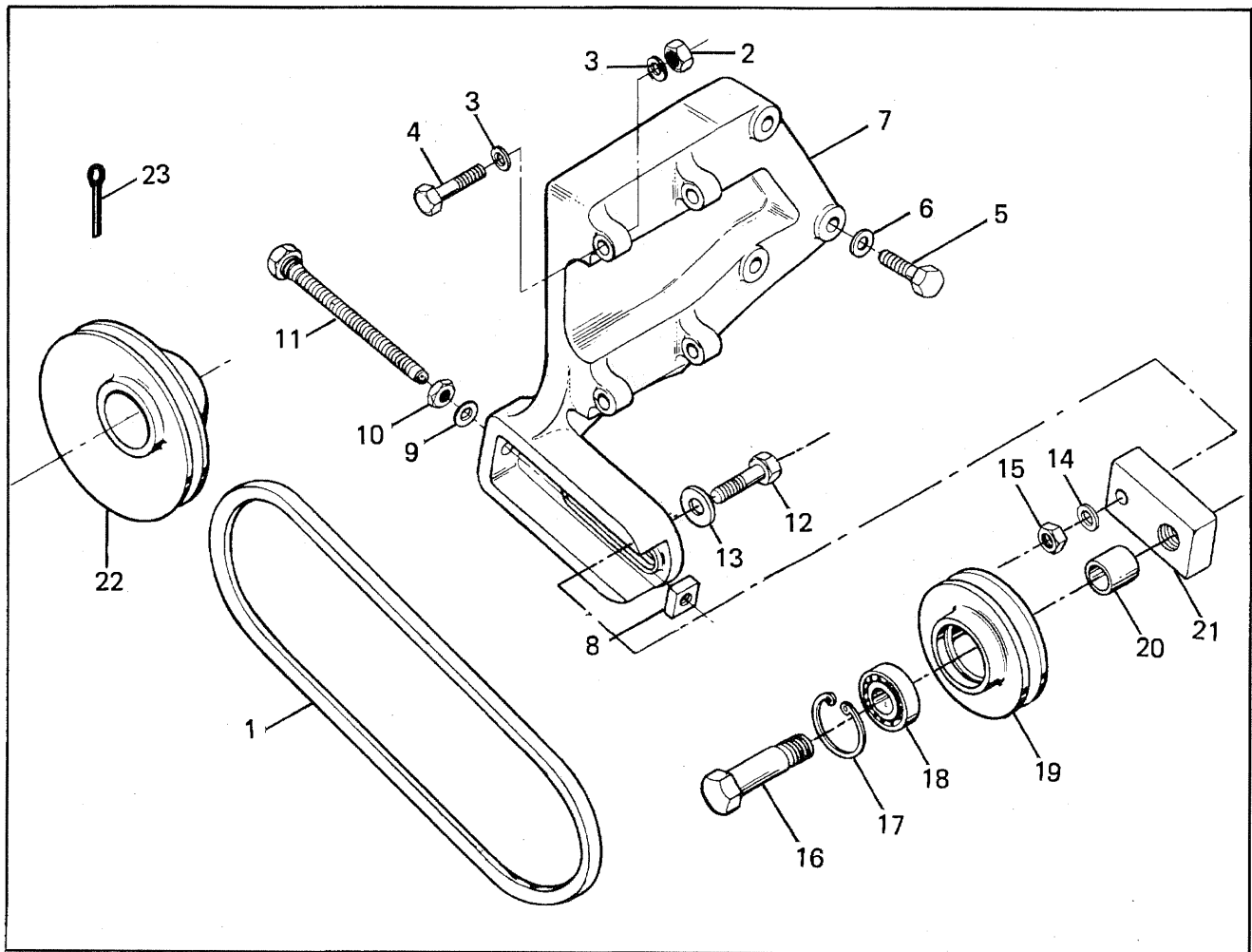


FIGURE 9-9 FREON COMPRESSOR MOUNTING

- |                     |                    |
|---------------------|--------------------|
| 1. Belt             | 13. Washer         |
| 2. Nut              | 14. Washer         |
| 3. Washer           | 15. Nut            |
| 4. Bolt             | 16. Bolt           |
| 5. Bolt             | 17. Retaining Ring |
| 6. Washer           | 18. Ballbearing    |
| 7. Bracket          | 19. Sheave         |
| 8. Nut, Rectangular | 20. Spacer         |
| 9. Washer           | 21. Idler Arm      |
| 10. Nut, Lock       | 22. Sheave         |
| 11. Bolt Special    | 23. Cotter Pin     |
| 12. Bolt            |                    |

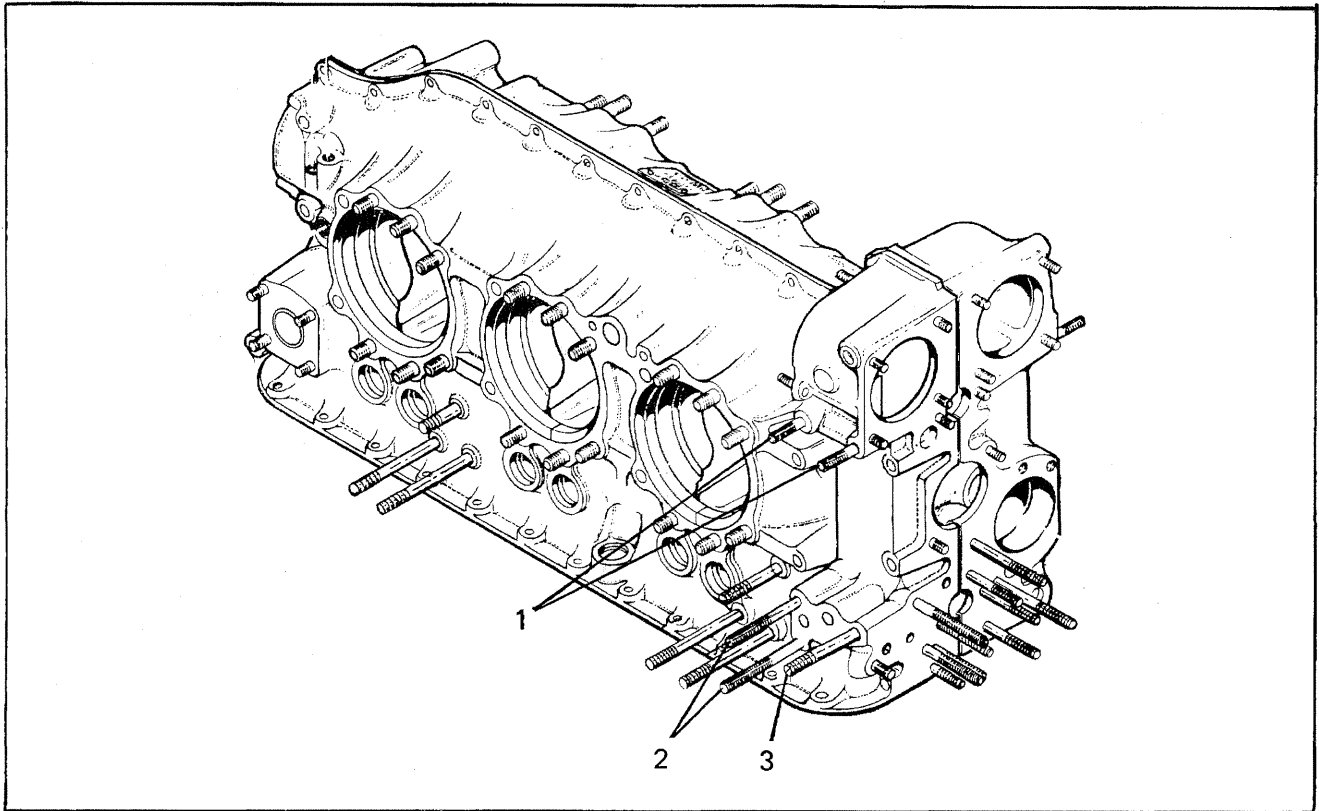


FIGURE 9-10. CRANKCASE STUD SETTING HEIGHTS

LOCATION	THREAD SIZES	SETTING HEIGHTS	NO. REQUIRED
1. Oil Cooler & Turbo Bkt Mount Pad	3/8-16 x 3/8-24	.92	2
2. Oil Cooler Mount	3/8-16 x 3/8-24	1.08	2
3. Oil Cooler Mount	5/16-18 x 5/16-24	1.13	1

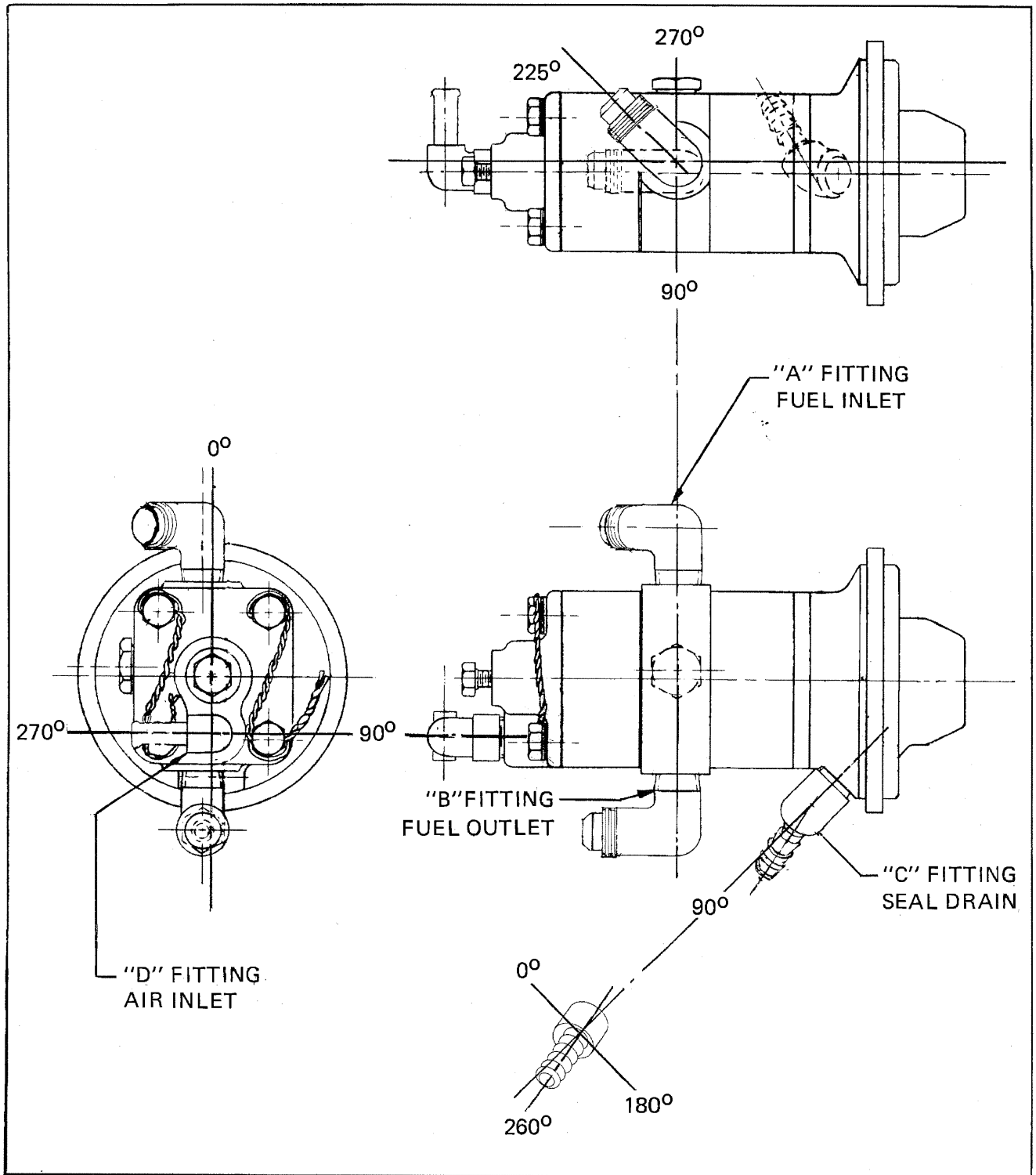


FIGURE 9-11 FUEL PUMP FITTING LOCATIONS

A	B	C	D
90° Elbow (225°)	90° Elbow (180°)	45° Elbow (260°)	90° Elbow (270°)

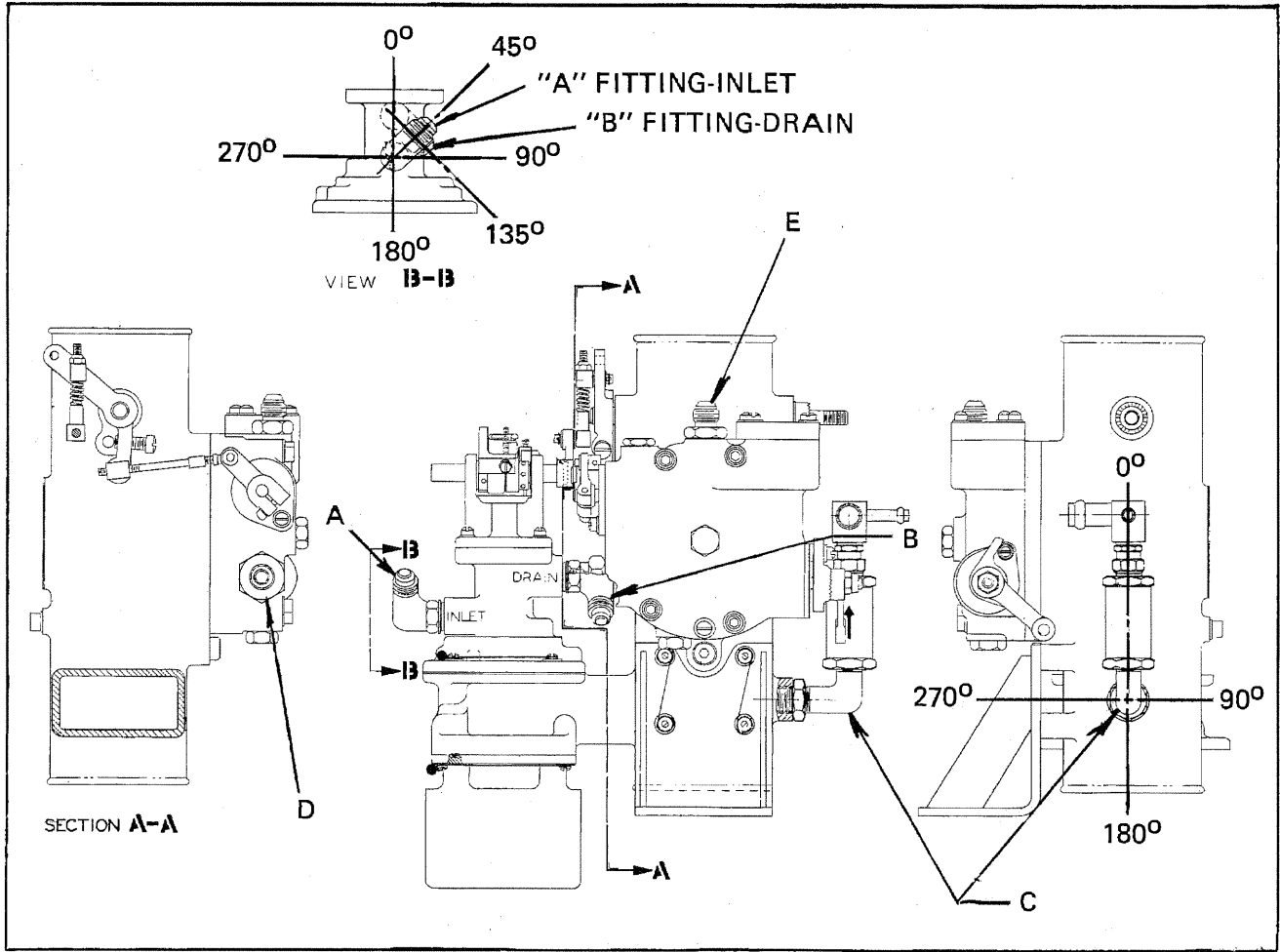


FIGURE 9-12 AIR THROTTLE/FUEL INJECTOR FITTING LOCATIONS

A	B	C	D	E
Elbow 45°	Elbow 135°	Elbow	Union	Union

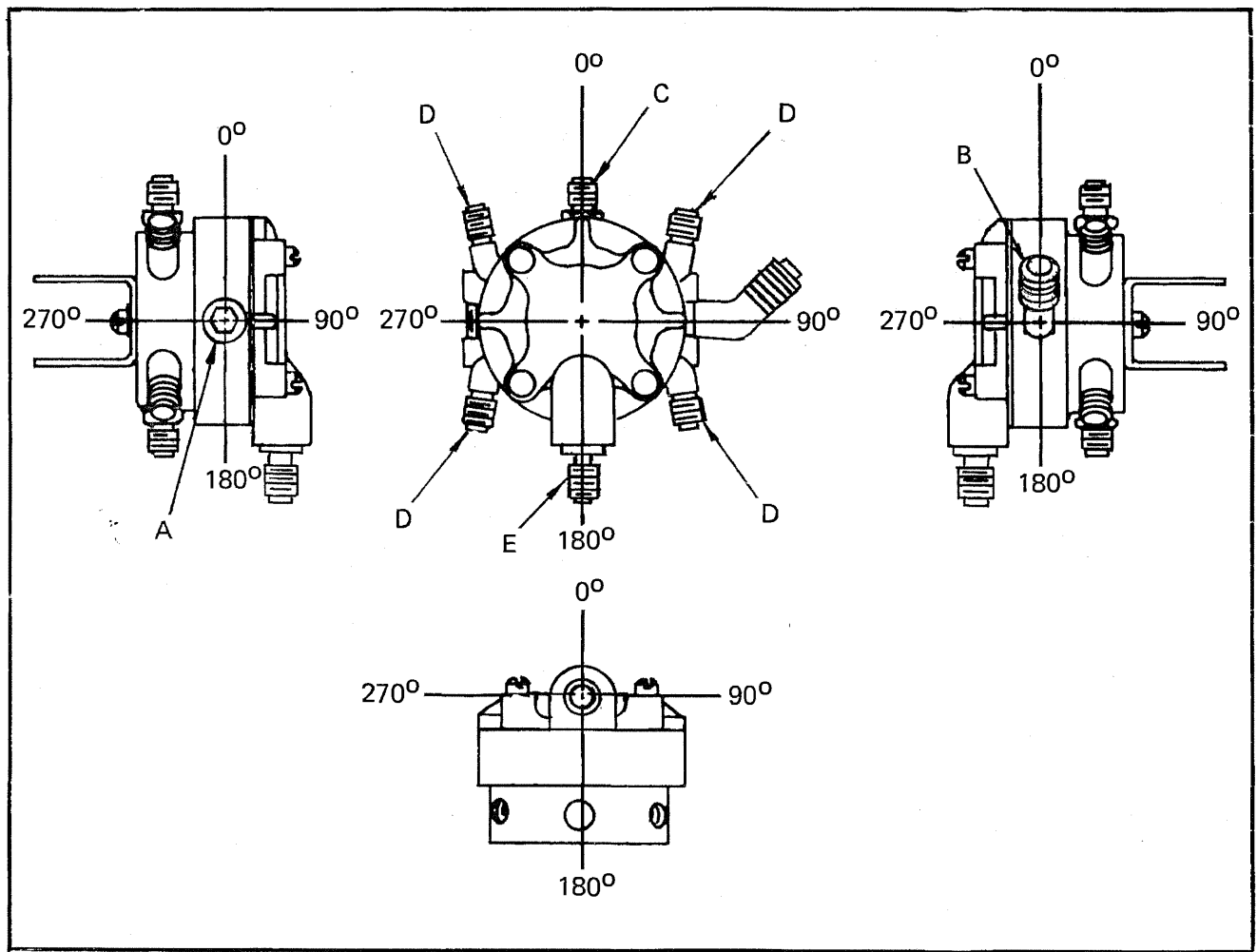


FIGURE 9-13 FUEL MANIFOLD FITTING LOCATIONS

A	B	C	D	E
Plug	45° Elbow (0°)	Nipple, Union	45° Elbow	Fitting (180°)

**TABLE XIV (a)**  
**OPERATING TEST LIMITS**  
**TSIO-520-L, LB**

Run-in schedule	1 hr. 20 min.
Maximum rated RPM and tolerance	2675-2725 RPM
Oil consumption at maximum rated power	2.0 lbs/40 MIN
Oil grade to be used	SAE No. 50
Fuel grade to be used	100, 100LL
Idling RPM and tolerance	600± 25 RPM
Manifold pressure at maximum rated power	38.0" Hg Abs.
Manifold pressure at idle	15.5" - 18.0" Hg Abs.
Magneto spread at 2100 RPM	50 RPM maximum
Crankcase pressure *	4.0" H <sub>2</sub> O max.
Oil temperature	240° F. max.
Oil temperature - desired range	150° - 200° max.
Oil pressure at max. rated power (engine oil temperature 175° - 185° F.)	30-60 psi
Oil pressure at idle (engine oil temperature 140° - 150° F.)	10 psi minimum
Timing of engine and tolerance	Left - 20° BTC ± 1° Right - 20° BTC ± 1°
Intercooler cool air press drop	4.0" H <sub>2</sub> O
Turbocharger exhaust outlet pressure	± 7.0" H <sub>2</sub> O
Cylinder head temperature	460° F. max. (at bayonet thermocouple)
Normal rated power	310 BHP @ 2700 RPM
Power correction for intake air temperature * *	1% per 6° F.

\* 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.

\* \* Correct horsepower for turbocharger inlet air temperature is as follows:  
(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° F. colder than 60° F.

TABLE XV (a)  
 TOP OR MINOR AND  
 MAJOR OVERHAUL TEST RUN  
 TSIO-520-L, LB

Period	Time-Minutes	RPM	
1	10	2400	Warm-up
2	10	2600	
3	5	2675-2725	100% Power
4	5	2275	60% Power
		* 2100	Check Magnetos
5	5	575-625	Idle Cooling

NOTE . . . . Stop engine, drain oil, weigh in oil for oil consumption determination.

Period	Time-Minutes	RPM	
6	5	2400	Warm-up
7	5	2500	
8	5	2600	
9	10	** 2675-2725	100% Power
10	10	2675-2725	100% Power
11	5	2275	
12	5	575-625	Idle Cooling

NOTE . . . Stop engine, drain oil, weigh and record engine oil consumption. Oil consumption at a rate of 2.0 lbs./40 Min. run maximum is acceptable. If value in excess of 2.0 lbs./40 Min. run is determined, rerun 40 minutes. If oil consumption is still excessive, return engine to overhaul.

\* Magneto drop and spread to be taken prior to oil consumption run. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.

\*\* Readings must be recorded after completion of each 10-minute interval during oil consumption run.

**TABLE XIV (b)**  
**OPERATING TEST LIMITS**  
**TSIO-520-WB**

Run-in schedule	1 hr. 20 min.
Maximum rated RPM and tolerance	2700-2750 RPM
Oil consumption at maximum rated power	2.0 lbs/40 MIN
Oil grade to be used	SAE No. 50
Fuel grade to be used	100, 100LL
Idling RPM and tolerance	600 ± 25 RPM
Manifold pressure at maximum rated power	39.5 in. Hg. Abs.
Manifold pressure at idle	15.5 - 18 in. Hg. Abs.
Fuel consumption, sea level, std. day at full throttle, 2700 RPM (lbs/hr)	190-200
Fuel pump pressure at full throttle, 2700 RPM (PSIG)	45-55
Fuel pump pressure at idle (PSIG) minimum	20
Magneto spread at 2100 RPM	50 RPM max.
Magneto drop at 2100 RPM	150 RPM
Crankcase pressure *	4.0" H <sub>2</sub> O max.
Oil temperature	240° F. max.
Oil temperature - desired range	140° - 200° F. max.
Oil pressure at max. rated power (engine oil temperature 175° - 185° F.)	30 - 60 psi
Oil pressure at idle (engine oil temperature 140° - 150° F.)	10 psi minimum
Timing of engine and tolerance	Left - 20° BTC ± 1° Right - 20° BTC ± 1°
Intercooler cooling air pressure drop	6.0" H <sub>2</sub> O
Turbocharger exhaust outlet pressure and inlet pressure	± 7.0" H <sub>2</sub> O
Cylinder head temperature	460° F. max. (at bayonet thermocouple)
Normal rated power	325 BHP at 2700 RPM
Power correction for intake air temperature * *	1% per 6° F.

\* 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.

\* \* Correct horsepower for turbocharger inlet air temperature as follows:  
(1) Add 1% for each 6° F hotter than 60° F. (2) Subtract 1% for each 6° F colder than 60° F;



TABLE XV (b)

TOP OR MINOR AND  
MAJOR OVERHAUL TEST RUN  
TSIO-520-WB

Period	Time-Minutes	RPM	
1	5	1200	Warm-up
2	5	1600	
3	5	2450	
4	10	(1) 2700-2750	100% Power
5	10	(2) 2100	Check Magnetos
6	10	575-625	Idle Cooling

NOTE . . . Stop engine, drain oil, weigh in oil for oil consumption determination.

Period	Time-Minutes	RPM	
7	5		Warm up to rated RPM (1200)
8	30	(3) 2450	
9	5	600	

NOTE . . . Stop engine, drain oil, weigh and record engine oil consumption. Oil consumption at a rate of 2.0 lbs./40 Min. run maximum is acceptable. If value in excess of 2.0 lbs./40 Min. run is determined, rerun 40 minutes. If oil consumption is still excessive return engine to overhaul.

- (1) Adjust engine fuel flow, fuel pressure, etc. (Reduce RPM for adjustments.)
- (2) Engine parameter checks - see applicable data. Perform mag check at 2100 RPM. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.
- (3) Readings must be recorded after completion of each 10 minute interval during oil consumption run.

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## SECTION X INTRODUCTION

The TSIO-520-M is rated at 285 BHP at 2600 RPM Max Continuous with a five minute take-off rating of 310 BHP at 2700 RPM. Overhaul procedures for the TSIO-520-M will be the same as those for the TSIO-520-C or G in Sections I thru VIII except for the operating limits and run-in schedule. Applicable operating limits and run-in schedules are contained in Section X.

TABLE XVIII  
OPERATING TEST LIMITS

Run-in schedule	1 hr. 20 min.
Maximum rated RPM	2600 RPM
Take off RPM	2750 RPM
Oil Consumption at max. rated power	2.0 lbs/40 MIN
Oil grade to be used	SAE No. 50 (see SIB M81-11 Rev 1 or latest Fuels and Lubricants Bulletin.
Fuel grade to be used	100,100LL
Idling RPM and tolerance	600 $\pm$ 25 RPM
Manifold pressure at max. rated power	36.5 Hg Abs.
Manifold pressure at idle	18.5" Hg Abs. Max.
Magneto spread at 2100 RPM	50 RPM max.
Crankcase pressure*	4.0" H <sup>2</sup> O max.
Oil temperature	240° F. Max.
Oil temperature - desired range	150° - 200° max.
Oil pressure at max. rated power (engine oil temperature 175° - 185° F.)	30-60 psi
Oil pressure at idle (engine oil temperature 140° - 150° F.)	10 psi minimum
Timing of engine and tolerance	Left - 22° BTC $\pm$ 1° Right - 22° BTC $\pm$ 1°
Intercooler Cool Air Press Drop at Max Power	4.0" H <sup>2</sup> O
Turbocharger inlet air pressure and outlet exhaust pressure	$\pm$ 7.0" H <sup>2</sup> O
Cylinder head temperature	460° F. max. (at bayonet thermocouple)
Normal rated power	285 @ 2600 RPM
Take Off Power (Five Minutes)	310 BHP @ 2700
Power Correction for intake air temperature **	1% per 6° F.

\* 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.

\*\* Correct horsepower for turbocharger inlet air temperature is as follows:  
(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° F. Colder than 60° F.

TABLE XVII  
 TOP OR MINOR AND  
 MAJOR OVERHAUL TEST RUN  
 TSIO-520-M

Period	Time-Minutes	RPM	
1	5	1200	Warm-up
2	5	1600	
3	5	2450	
4	10	(1) 2700-2750	100% Power
5	10	(2) 2100	Check Magnetos
6	10	575-625	Idle Cooling

NOTE

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

Period	Time-Minutes	RPM	
7	5	Warm up to rated RPM(1200)	
8	30	(3) 2450	
9	5	600	

NOTE

Stop engine, drain oil, weigh and record  
 engine oil consumption. Oil consumption  
 at a rate of 2.0 lbs./40 Min. run maximum  
 is acceptable. If value in excess of 2.0 lbs./  
 40 Min. run is determined, rerun 40 minutes.  
 If oil consumption is still excessive return  
 engine to overhaul.

- (1) Adjust engine fuel flow, fuel pressure, etc. (Reduce RPM for adjustments.)
- (2) Engine parameter checks - see applicable data. Perform mag check at 2100 RPM. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.
- (3) Readings must be recorded after completion of each 10 minute interval during oil consumption run.



## SECTION XI INTRODUCTION

The TSIO-520-N is similar to the TSIO-520-J except for certain operating limits. Overhaul procedures for the TSIO-520-N will be the same as for the TSIO-520-J in Sections I thru VIII. Applicable operating limits and run-in schedule are contained in Section XI.

TABLE XVIII  
OPERATING TEST LIMITS

Run-in schedule	1 hr. 20 min.
Maximum rated RPM and tolerance	2700-2750 RPM
Oil Consumption at max. rated power	2.0 lbs/40 MIN
Oil grade to be used	SAE No.50
Fuel grade to be used	100,100LL
Idling RPM and tolerance	600 $\pm$ 25 RPM
Manifold pressure at max. rated power	38.0" Hg Abs.
Manifold pressure at idle	18.5" Hg Abs. Max.
Magneto spread at 2100 RPM	50 RPM max.
Crankcase pressure *	4.0" H <sup>2</sup> O max.
Oil temperature	240° F. Max.
Oil temperature - desired range	150° - 200° max.
Oil pressure at max. rated power (engine oil temperature 175° - 185° F.)	30-60 psi
Oil pressure at idle (engine oil temperature 140° - 150° F.)	10 psi minimum
Timing of engine and tolerance	Left - 20° BTC $\pm$ 1° Right - 20° BTC $\pm$ 1°
Intercooler Cool Air Press Drop at Max Power	4.0" H <sup>2</sup> O
Turbocharger inlet air pressure and outlet exhaust pressure	$\pm$ 7.0" H <sup>2</sup> O
Cylinder head temperature	460° F. max. (at bayonet thermocouple)
Normal rated power	310 BHP @ 2700 RPM
Power Correction for intake air temperature **	1% per 6° F.

\* 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.

\*\* Correct horsepower for turbocharger inlet air temperature is as follows:  
(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° F. Colder than 60° F.



TABLE XIX  
 TOP OR MINOR AND  
 MAJOR OVERHAUL TEST RUN  
 TSIO-520-N

Period	Time-Minutes	RPM	
1	5	1200	Warm-up
2	5	1600	
3	5	2450	
4	10	(1) 2700-2750	100% Power
5	10	(2) 2100	Check Magnetos
6	10	575-625	Idle Cooling

NOTE

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

Period	Time-Minutes	RPM	
7	5		Warm up to rated RPM(1200)
8	30	(3) 2450	
9	5	600	

NOTE

Stop engine, drain oil, weigh and record  
 engine oil consumption. Oil consumption  
 at a rate of 2.0 lbs./40 Min. run maximum  
 is acceptable. If value in excess of 2.0 lbs./  
 40 Min. run is determined, rerun 40 minutes.  
 If oil consumption is still excessive return  
 engine to overhaul.

- (1) Adjust engine fuel flow, fuel pressure, etc. (Reduce RPM for adjustments.)
- (2) Engine parameter checks - see applicable data. Perform mag check at 2100 RPM. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.
- (3) Readings must be recorded after completion of each 10 minute interval during oil consumption run.



## SECTION XII

### INTRODUCTION

The TSIO-520-P is rated at 285 BHP at 2600 RPM Max Continuous with a five minute take-off rating of 310 BHP at 2700 RPM. Overhaul procedures for the TSIO-520-P will be the same as those for the TSIO-520-C or G in Sections I thru VIII except for the operating limits and run-in schedule. Applicable operating limits and run-in schedules are contained in SECTION XII.

TABLE XX  
OPERATING TEST LIMITS

Run-in schedule	1 hr. 20 min.
Maximum rated RPM	2600 RPM
Take Off RPM (5 Minutes)	2700 RPM
Oil Consumption at max. rated power	2.0 lbs/40 MIN
Oil grade to be used	SAE No.50
Fuel grade to be used	100,100LL
Idling RPM and tolerance	600 ± 25 RPM
Manifold pressure at max. rated power	38.0 Hg. Abs.
Manifold pressure at idle	18.5" Hg. abs. Max.
Magneto spread at 2100 RPM	50 RPM max.
Magneto drop at 2100 RPM	150 RPM
Crankcase pressure	4.0" H <sub>2</sub> O max.
Oil temperature	240° F. Max.
Oil temperature - desired range	150° - 200° max.
Oil pressure at max. rated power (engine oil temperature 175° - 185° F.)	30-60 psi
Oil pressure at idle (engine oil temperature 140° - 150° F.)	10 psi minimum
Timing of engine and tolerance	Left - 22° BTC ± 1° Right - 22° BTC ± 1°
Turbocharger exhaust outlet pressure and inlet pressure	± 7.0" H <sub>2</sub> O
Cylinder head temperature	460° F. max. (at bayonet thermocouple)
Normal rated power	285 BHP
Take-Off Power (5 Minutes)	310 BHP
Power Correction for intake air temperature **	1% per 6° F.

\* 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.

\*\* Correct horsepower for turbocharger inlet air temperature is as follows:  
(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° F. colder than 60° F.

TABLE XXI

TOP OR MINOR AND MAJOR OVERHAUL TEST RUN  
TSIO-520-P

Period	Time-Minutes	RPM
1	5	1200
2	5	1600
3	5	2450
4	10	2700-(Adjust Engine-(Fuel flow, Pr.,etc.) (Reduce RPM for adjustment)
5	12	Engine Parameter checks (Fuel inj.,oil Pr.Temp.etc. - See Table 2100 RPM Mag Check.
6	5	(600 Idle, (Cooling Period - 300o Max. C.H.T. before Shutdown)
Stop engine, drain oil, weigh oil in for oil consumption determination.		
7	5	Warm up to rated RPM (1200 RPM Min.).
8	30	2450 (Reading to be recorded after each 10 min.interval
9	5	600 idle (Cooling period - 300 <sup>o</sup> Max C.H.T. before shutdown.

If engine is not to be placed in service apply corrosion preventive treatment in accordance with service bulletin M74-9.



## SECTION XIII

### INTRODUCTION

The TSIO-520-R is rated at 285 BHP at 2600 RPM Max Continuous with a five minute take-off rating of 310 BHP at 2700 RPM. Overhaul procedures for the TSIO-520-R will be the same as those for the TSIO-520-H described in Sections I thru VIII except for the operating limits and run-in schedule. Applicable operating limits and run-in schedules are contained in Section XIII.

TABLE XXII

## OPERATING TEST LIMITS

Run-in schedule	1 hr. 20 min.
Maximum rated RPM	2600
Take-Off RPM (5 Minutes)	2700
Oil Consumption at max. rated power	2.0 lbs/40 MIN
Oil grade to be used	SAE No.50
Fuel grade to be used	100,100LL
Idling RPM and tolerance	600 $\pm$ 25 RPM
Manifold pressure at max. rated power	36.5" Hg Abs.
Manifold pressure at idle	18.5" Hg Abs. Max.
Magneto spread at 2100 RPM	50 RPM max.
Crankcase pressure*	4.0" H <sub>2</sub> O max.
Oil temperature	240 <sup>o</sup> F. Max.
Oil temperature - desired range	150 <sup>o</sup> - 200 <sup>o</sup> max.
Oil pressure at max. rated power (engine oil temperature 175 <sup>o</sup> - 185 <sup>o</sup> F.)	30-60 psi
Oil pressure at idle (engine oil temperature 140 <sup>o</sup> - 150 <sup>o</sup> F.)	10 psi minimum
Timing of engine and tolerance	Left - 22 <sup>o</sup> BTC $\pm$ 1 <sup>o</sup> Right - 22 <sup>o</sup> BTC $\pm$ 1 <sup>o</sup>
Turbocharger Inlet Air Pressure and outlet exhaust pressure	$\pm$ 7.0" H <sub>2</sub> O
Cylinder head temperature	460 <sup>o</sup> F. max. (at bayonet thermocouple)
Normal rated power	285 BHP
Take-Off Power (5 Minutes)	310 BHP
Power Correction for intake air temperature **	1% per 6 <sup>o</sup> F.

\* 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.

\*\* Correct horsepower for turbocharger inlet air temperature is as follows:  
(1) Add 1% for each 6<sup>o</sup> F. hotter than 60<sup>o</sup> F. (2) Subtract 1% for each 6<sup>o</sup> F. Colder than 60<sup>o</sup> F.



**TABLE XXIII**  
**TOP OR MINOR AND**  
**MAJOR OVERHAUL TEST RUN**  
**TSIO-520-R**

Period	Time-Minutes	RPM	
1	5	1200	Warm-up
2	5	1600	
3	5	2450	
4	10	(1) 2700-2750	100% Power
5	10	(2) 2100	Check Magnetos
6	10	575-625	Idle Cooling

NOTE

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

Period	Time-Minutes	RPM	
7	5		Warm up to rated RPM(1200)
8	30	(3) 2450	
9	5	600	

NOTE

Stop engine, drain oil, weigh and record  
engine oil consumption. Oil consumption  
at a rate of 2.0 lbs./40 Min. run maximum  
is acceptable. If value in excess of 2.0 lbs./  
40 Min. run is determined, rerun 40 minutes.  
If oil consumption is still excessive return  
engine to overhaul.

- (1) Adjust engine fuel flow, fuel pressure, etc. (Reduce RPM for adjustments.)
- (2) Engine parameter checks - see applicable data. Perform mag check at 2100 RPM. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.
- (3) Readings must be recorded after completion of each 10 minute interval during oil consumption run.

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## SECTION XIV

### TSIO-520 BB, DB, EB, JB, KB, LB, NB, UB, VB, WB

#### 14-1 INTRODUCTION

A. Information contained herein applies to the modified crankshaft version of the Permold TSIO-520 engines (TSIO-520-BB, DB, EB, JB, KB, LB, NB, UB, VB, WB). Only those instructions which are different from the standard models (TSIO-520-B, D, E, J, K, L, N, U, V) will be covered.

B. For overhaul instructions not contained in these pages, use the instructions contained in sections 1 thru 12 for the standard versions.

#### 14-2 GENERAL

A. The modified crankshaft version of the Permold engines has a different crankcase, crankshaft, connecting rod and fuel pump.

B. Specifically the three rear bearing bores of the crankcase have been enlarged, the three rear main bearings of the crankshaft have been increased in diameter and the rods have been made narrower. Because of the increased bore size of the crankcase, the fuel pump requires a larger adapter pilot. The different bearing diameters also require different bearings, and the narrow rods require different rod bearings.

#### 14-3 TABLE OF LIMITS

A. Except for the differences in the crankshaft section of the Table of Limits, all procedures listed in sections 1 thru 12 for the standard Permold engines apply to the modified crankshaft version.

B. Use the values in Table 22 instead of Table 6, reference items 43 thru 57, for the modified crankshaft engines —

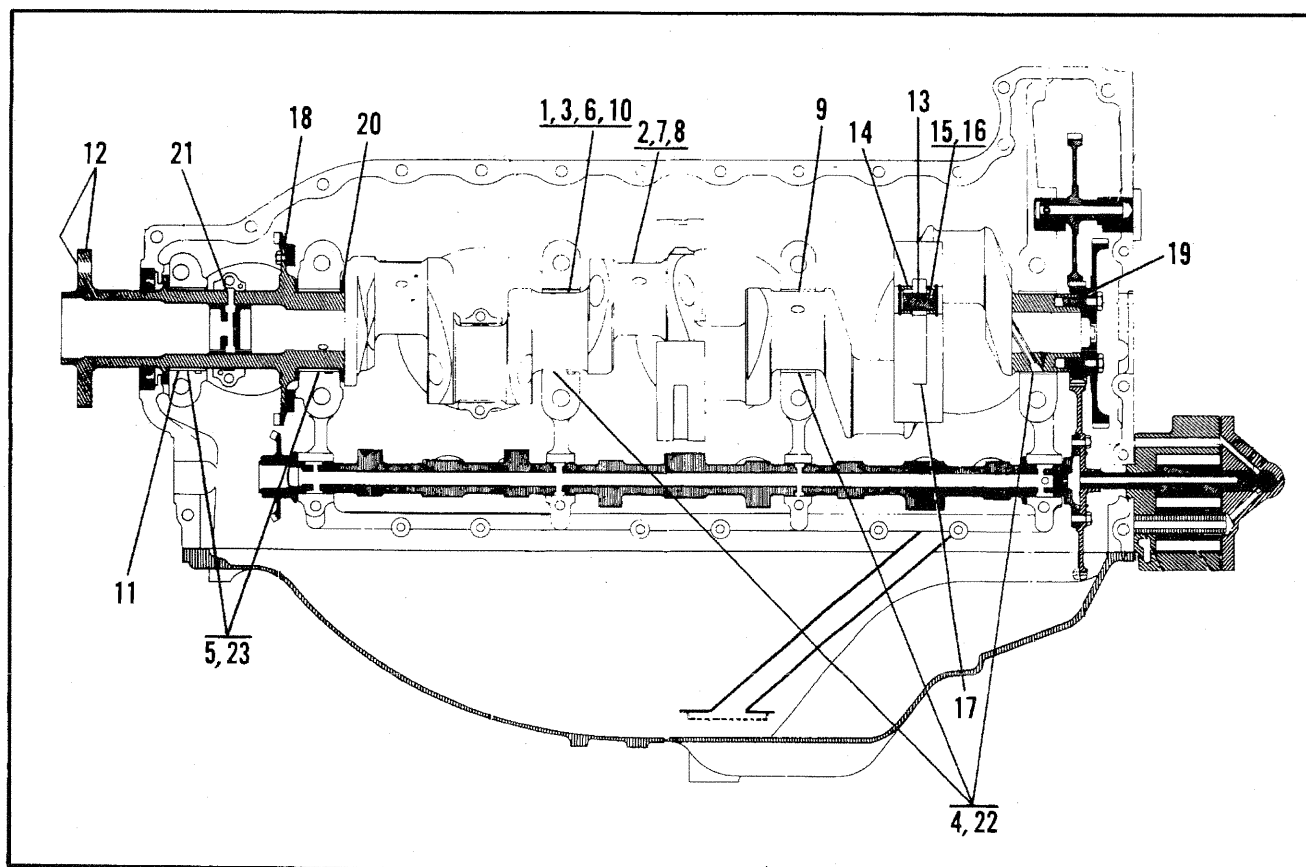


FIGURE 14-1. TABLE OF LIMITS CHART

TABLE XXIV  
(SEE FIGURE 14-1)

	SERVICE	NEW MIN.	MAX.
1. Crankshaft in Main Bearings . . . . . Dia:	0.006 L	0.001 L	0.004 L
2. Crankpins . . . . . Out of Round:	0.0010	0.0000	0.0004
3. Main Journals . . . . . Out of Round:	0.0010	0.0000	0.0004
4. Crankshaft Main Bearings 1,2,3 . . . . . Dia:	2.622	2.624	2.625
5. Crankshaft Main Bearings 4,5 . . . . . Dia:	2.372	2.374	2.375
6. Crankshaft Main Bearing . . . . . Taper:	0.0010	0.0000	0.0004
7. Crankshaft Crankpin . . . . . Taper:	0.0010	0.0000	0.0004
8. Crankpins . . . . . Dia:	2.2470	2.2490	2.2500
9. Crankshaft Runout At Main Bearing 2 When Mounted On Bearings 1 & 4 . . . . . *F.I.R.:	0.008	0.000	0.008
10. Crankshaft Runout At Main Bearing 3 When Mounted On Bearings 1 & 4 . . . . . *F.I.R.:	0.008	0.000	0.008
11. Crankshaft Runout At Main Bearing 5 When Mounted On Bearings 1 & 4 . . . . . *F.I.R.:	0.002	0.000	0.002
12. Crankshaft Runout At Propeller Flange When Mounted On Bearings 1 & 4 . . . . . *F.I.R.:	0.005	0.000	0.005
13. Damper Pin Bushing In Crankcheek Extension . . . . . Dia:	—	0.0015 T	0.0030 T
14. Damper Pin Bushing In Counterweight . . . . . Dia:	—	0.0015 T	0.0030 T
15. Damper Pin Bushing Bore In Counterweight & Crankshaft Hangar . . . . . Dia:	0.6265	0.622	0.626
Damper Pin (4th Order) (-38) . . . . . Dia:	0.4735	0.4740	0.4750
Damper Pin (5th Order) (-37) . . . . . Dia:	0.5265	0.5270	0.5280
Damper Pin (6th Order) (-40) . . . . . Dia:	0.5647	0.5652	0.5662
16. Damper Pin In Counterweight . . . . . End Cl:	0.0400	0.0010	0.0250
17. Crankcheek In Counterweight . . . . . Side Cl:	0.0170	0.0070	0.0120
18. Alternator Gear On Crankshaft . . . . . Dia:	—	0.0005 L	0.0035 L
19. Crankshaft Gear On Crankshaft . . . . . Dia:	—	0.0000	0.0020 T
20. Crankshaft In Thrust Bearing . . . . . End Cl:	0.020	0.008	0.016
21. Oil Transfer Collor On Crankshaft . . . . . Dia:	—	0.0005 L	0.0018 L
22. Crankcase Bearing Bore (Bearings 1, 2, 3) . . . . . Dia:	—	2.816	2.817
23. Crankcase Bearing Bore (Bearings 4, 5) . . . . . Dia:	—	2.5625	2.5635

\* Full Indicator Reading

## **SECTION XV INTRODUCTION**

The TSIO-520-T is rated at 310 BHP at 2700 RPM. Overhaul procedures for the TSIO-520-T will be the same as those for the TSIO-520-C or G except for the differences noted in Section XV.

## SECTION XV

### TSIO-520-T

#### 15-1 GENERAL.

- a. Physical Differences. The TSIO-520-T includes an engine bracketed turbocharger, an exhaust system and intercylinder baffles and supports.
- b. Operating Differences. The TSIO-520-T is rated at 310 BHP at 2700 RPM and 39.5 in Hg. manifold pressure at sea level. At critical altitude of 7500 feet the BHP is 310 and 2700 RPM with 37.5 in. Hg. manifold pressure.

#### 15-2 EXHAUST SYSTEM (See Figure 15-1)

#### 15-3 REMOVAL AND DISASSEMBLY

- a. Remove clamp (1) tail pipe to turbo and four sets of attaching parts (3, 4, 5) tail pipe assembly to bypass valve assembly and separate tail pipe assembly from exhaust system.
- b. Remove hose and check valve, turbo to scavenge pump. Remove hose and check valve, turbo to crankcase.
- c. Loosen hose clamps, turbo to throttle body intake tube. Remove four sets of bolts, nuts and washers exhaust to turbo and turbo bracket and remove turbocharger.
- d. Remove four sets of attaching parts per cylinder and remove remaining exhaust assembly components. Separate components as required. Remove exhaust to cylinder gaskets.

#### 15-4 INSPECTION

- a. Remove heater shroud and install rubber

expansion plug in either end. Pressurize to 5 psi for two (2) minutes and check for leaks with the heater tube assembly submerged in water.

- b. Visually examine the exhaust system components for leaks and condition.

#### 15-5 INSTALLATION

- a. Install new gaskets on exhaust pads of cylinders. Secure exhaust elbows to cylinder pads with special nuts (31). Do not tighten at this time.
- b. Assemble exhaust tube (35) and cross pipe and turbine flange assembly (36) to exhaust tee and elbow assemblies.
- c. Position turbocharger (30) on flange assembly (36) and secure both to bracket (38) with attaching parts (27, 28, 29).
- d. Use new gaskets (8) and secure bypass valve assembly to cross pipe (6). Attach tail pipe assembly to bypass valve with four bolts, nuts and washers (3, 4, 5), and to turbocharger with clamps (1).

NOTE... For preliminary setting of ground adjustable bypass valve, see that 8 threads are visible above the hex nut.

- e. Secure exhaust flange to cylinder. Torque to value specified in Table of Limits.
- f. Attach check valve to turbo oil outlet elbow and install hose, turbo to scavenge pump. Install check valve to turbo oil inlet elbow and install crankcase to turbo hose assembly.

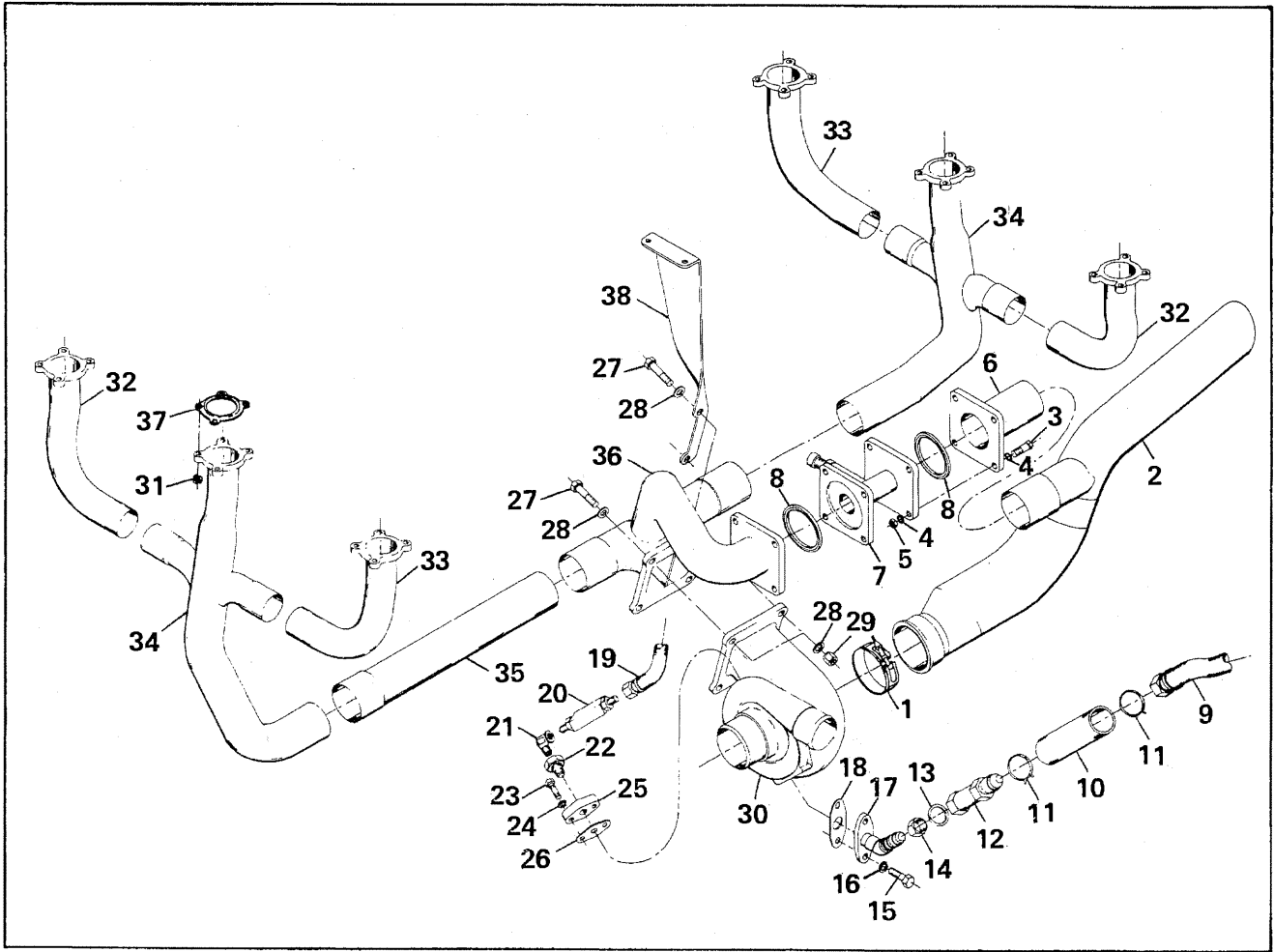


FIGURE 15-1. EXHAUST SYSTEM

- |                                 |                              |
|---------------------------------|------------------------------|
| 1. Clamp                        | 20. Check Valve              |
| 2. Tail Pipe Assembly           | 21. Elbow                    |
| 3. Bolt                         | 22. Bushing, Reducer         |
| 4. Washer                       | 23. Screw                    |
| 5. Nut                          | 24. Washer, Lock             |
| 6. Adapter Assembly             | 25. Adapter, Turbo Inlet     |
| 7. By-Pass Valve                | 26. Gasket, Turbo Inlet      |
| 8. Gasket                       | 27. Bolt                     |
| 9. Hose, Turbo-to-Scavenge Pump | 28. Washer                   |
| 10. Fire Sleeve                 | 29. Nut                      |
| 11. Clamp                       | 30. Turbocharger             |
| 12. Check Valve                 | 31. Nut                      |
| 13. "O" Ring                    | 32. Elbow, Exhaust           |
| 14. Nut                         | 33. Elbow, Exhaust           |
| 15. Screw                       | 34. Tee, Exhaust             |
| 16. Washer, Lock                | 35. Exhaust Tube             |
| 17. Adapter, Turbo Outlet       | 36. Cross Pipe & Flange Assy |
| 18. Gasket, Turbo Outlet        | 37. Gasket                   |
| 19. Hose, Turbo-to-Crankcase    | 38. Bracket                  |

## 15-6 STARTER ADAPTER (See Figure 15-2)

NOTE . . . The starter adapter for the TSIO-520-T is the same as the TSIO-520-C or G except that the "T" incorporates a scavenge pump. Removal and installation of starter and adapter are the same as the "C" and "G". Disassembly and reassembly procedures other than those listed herein are the same as those for the "C" or "G".

## 15-7 REMOVAL AND DISASSEMBLY

- a. Remove the nut on the end of the starter shaft.
- b. Lift the sheave from the shaft.
- c. Remove bolts (6, 7) from the oil scavenge pump housing.
- d. Lift the oil scavenge pump housing from the starter adapter. The starter shaft will have to be turned while removing the scavenge pump in order to line the woodruff key in the shaft with the slot in the scavenge pump cover (13).
- e. Remove the countersunk screws (12) from the oil scavenge pump cover and remove the scavenge pump cover from the scavenge pump housing (10).
- f. Remove the scavenge pump (14), oil seal (16) and bearing (17) as required. Remove and discard "O" ring (11).

## 15-8 INSPECTION

- a. Cleaning, Inspection, Repair and Replacement procedures will be the same as for like components in the "C" or "G" models.
- b. Inspect gerotor scavenge pump for nicks or deformation of profile.

## 15-9 REASSEMBLY

- a. Press bearing in place, if removed, and install new oil seal.
- b. Install scavenge pump in housing and install cover with keyways aligned. Cover is to be secured

with Loctite No. 271 on the four countersunk screws. Use extreme care to avoid loctite spillover.

- c. Use a new gasket (15) and install assembly on the starter adapter. Torque attaching parts to value specified in Table of Limits.
- d. Install spacer (5) on shaft and slide on sheave (4). Install washer (3), lockwasher (2) and nut (1). Tighten nut to a torque value of 400 - 450 in. lbs.

NOTE . . . The sheave is not keyed to the shaft, therefore, there are no timing marks for the engine on the sheave. The engine timing marks are located on the outside diameter of the propeller flange. When the TC mark is lined up with the lower crankcase split line, No. 1 cylinder is at TDC.

## 15-10 INDUCTION SYSTEM (See Figure 15-3)

### 15-11 REMOVAL AND DISASSEMBLY

- a. Remove three hoses, air throttle body adapter to air manifold line, fuel metering assembly to fuel manifold valve and fuel metering assembly to fuel pump.
- b. Remove adapter (11) from air throttle body. Separate overboost valve (10) from adapter.
- c. Loosen clamps (19), intake elbows to throttle body and intake elbow to cylinders 2 and 5 intake elbow. Remove elbows and throttle body. Separate as required.
- d. Remove intake elbows to cylinder attaching parts (26, 27, 28) and balance tube bracket attaching parts (13, 14) and remove intake runners as an assembly. Separate components.

- e. Remove air manifold tubes (1, 2) and hose. Sleeve assemblies (3) will be removed with nozzles.

### 15-12 INSPECTION, REPAIR AND REPLACEMENT

- a. Procedures for inspection, repair and replacement of the induction system components will be the same as those for like components in the basic engine section.



### 15-13 REASSEMBLY

- a. Install sleeve (3) over nozzle using new gaskets (6) and washers (5). Compression seal (4) on sleeve can be replaced if necessary. Install air manifold tubes (1, 2) on each bank. Install hose between 2 - 4 - 6 side and 1 - 3 - 5 side air manifold tubes.
- b. Loosely assemble intake elbows and install on the respective cylinders using new gaskets (29). Tighten finger tight. Install balance tube (16) and secure bracket (17) to sump rail. Position hoses

and secure clamps. Tighten intake tube attaching parts to specified torque.

- c. Loosely assemble intake elbows (25) to air throttle body (20). Position assembly and secure with hose clamps (19).

- d. Secure adapter (11) to air throttle body and control assembly using new gasket (12) with four sets of attaching parts. Use new gasket (30) and mount overboost valve on adapter. Secure with attaching parts (7, 8, 9).

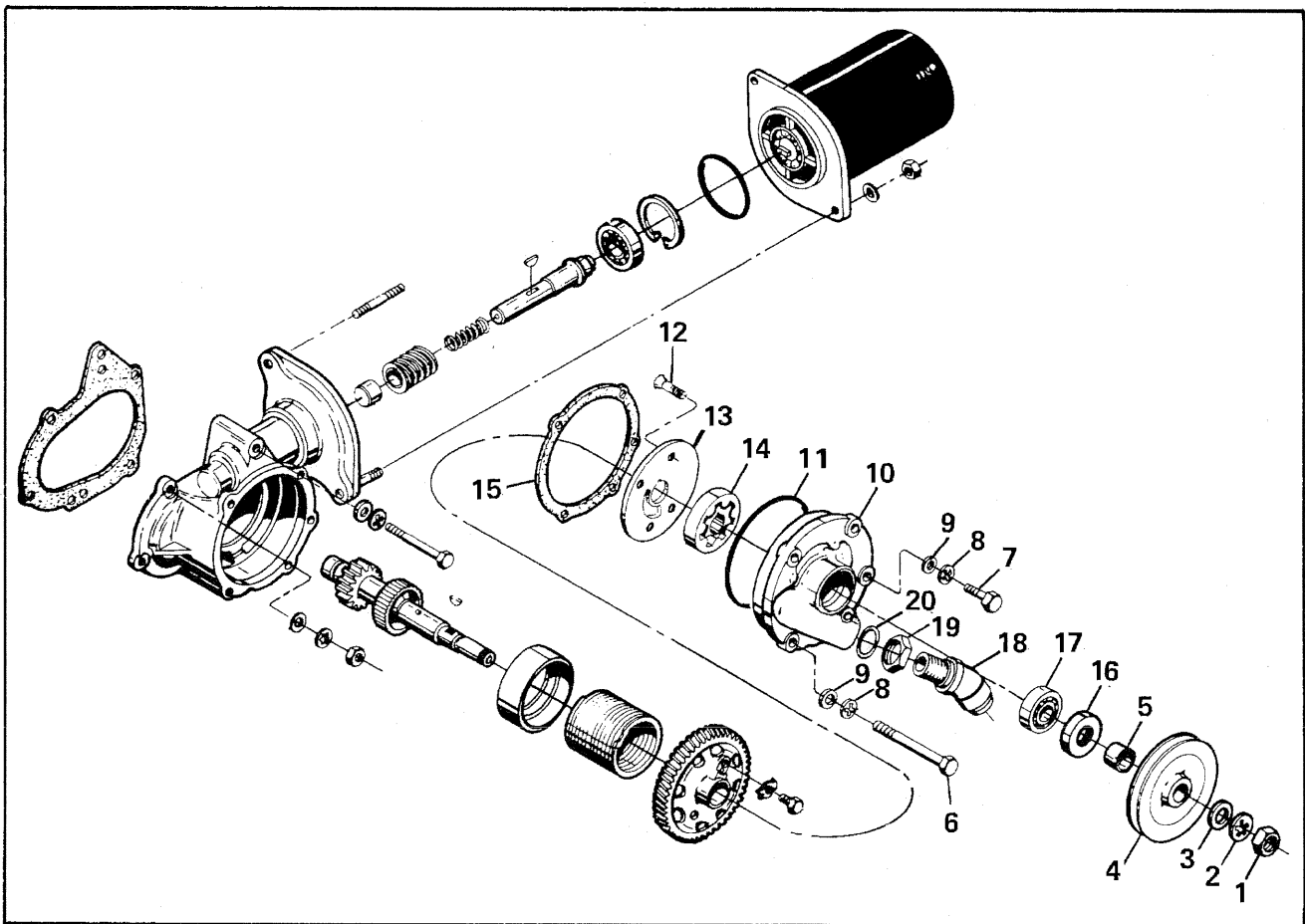


FIGURE 15-2. STARTER ADAPTER

- |                            |                            |
|----------------------------|----------------------------|
| 1. Nut                     | 11. "O" Ring               |
| 2. Washer, Lock            | 12. Screw                  |
| 3. Washer, Plain           | 13. Cover, Scavenge Pump   |
| 4. Sheave                  | 14. Gerotor, Scavenge Pump |
| 5. Spacer                  | 15. Gasket                 |
| 6. Bolt                    | 16. Seal                   |
| 7. Bolt                    | 17. Bearing, Ball          |
| 8. Washer, Lock            | 18. Elbow                  |
| 9. Washer, Plain           | 19. Nut                    |
| 10. Cover, Starter Adapter | 20. "O" Ring               |

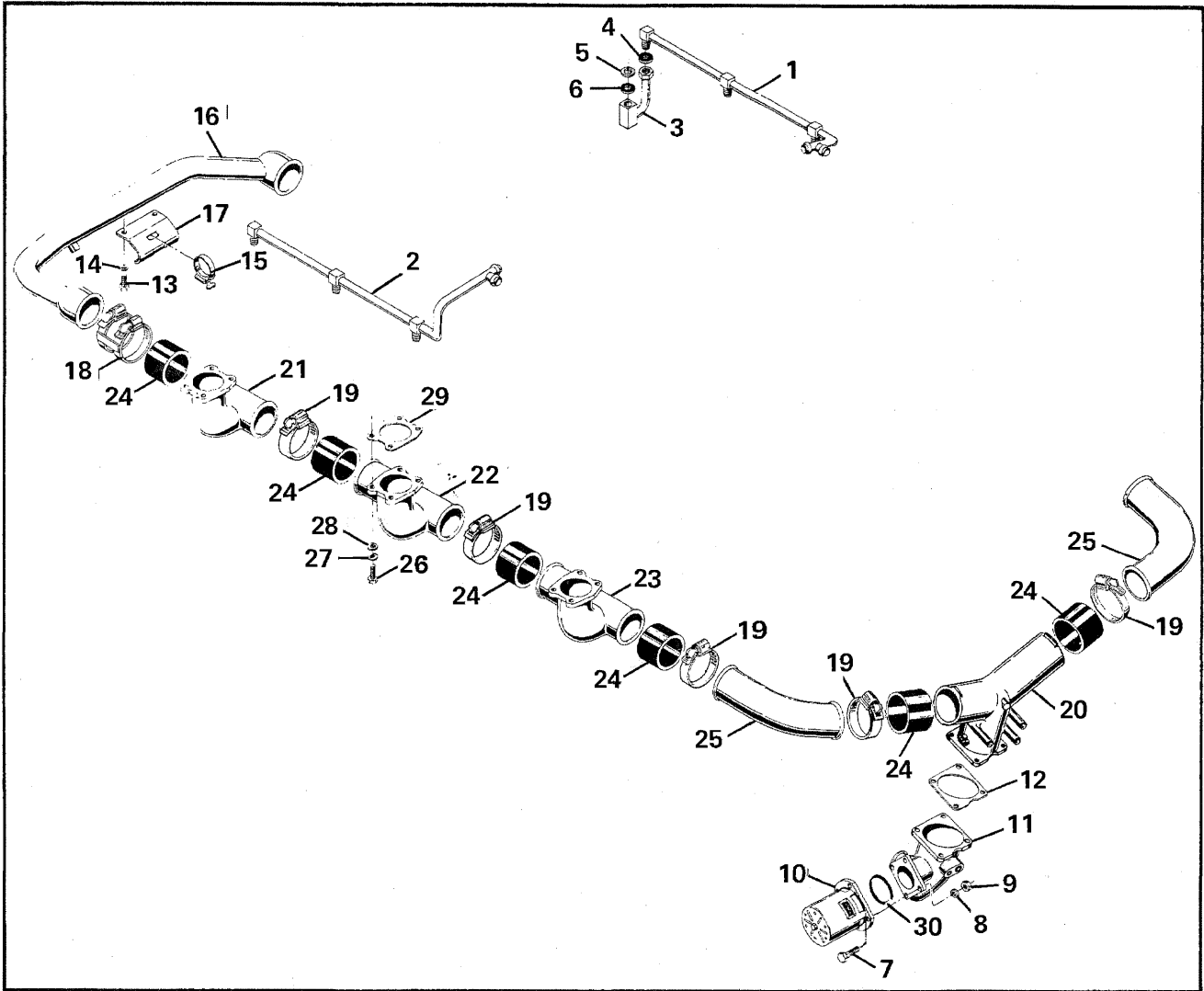


FIGURE 15-3. INDUCTION SYSTEM

- |                      |                        |
|----------------------|------------------------|
| 1. Tube Assembly     | 16. Tube, Balance      |
| 2. Tube Assembly     | 17. Bracket            |
| 3. Sleeve Assembly   | 18. Clamp Assembly     |
| 4. Seal, Compression | 19. Clamp              |
| 5. Washer, Plain     | 20. Body, Air Throttle |
| 6. Gasket            | 21. Elbow              |
| 7. Screw             | 22. Elbow              |
| 8. Washer            | 23. Elbow              |
| 9. Nut               | 24. Hose               |
| 10. Overboost Valve  | 25. Elbow              |
| 11. Adapter          | 26. Screw              |
| 12. Gasket           | 27. Washer, Lock       |
| 13. Screw            | 28. Washer, Plain      |
| 14. Washer           | 29. Gasket             |
| 15. Clamp            | 30. Gasket             |

**TABLE XXV  
OPERATING TEST LIMITS**

Run-in schedule	1 hr. 20 min.
Maximum rated RPM and tolerance	2700-2750 RPM
Oil Consumption at maximum rated power	2.0 lbs/40 MIN
Oil grade to be used	SAE No. 50
Fuel grade to be used	100, 100LL
Idling RPM and tolerance	600 ± 25 RPM
Manifold pressure at maximum rated power	39.5 Hg Abs.
Manifold pressure at idle	18.5" Hg Abs. Max.
Magneto spread at 2100 RPM	50 RPM max.
Magneto drop at 2100 RPM	150 RPM max.
Crankcase pressure *	4.0" H <sup>2</sup> O max.
Oil temperature	240° F. max.
Oil temperature - desired range	150° - 200° max.
Oil pressure at maximum rated power (engine oil temperature 175° - 185° F.)	40-60 psi
Oil pressure at idle (engine oil temperature 140° - 150° F.)	10 psi minimum
Timing of engine and tolerance	Left - 22° BTC ± 1° Right - 22° BTC ± 1°
Turbocharger inlet air pressure and outlet exhaust pressure	± 7.0" H <sup>2</sup> O
Cylinder head temperature	460° F. max. (at bayonet thermocouple)
Normal rated power	310 BHP @ 2700 RPM
Power Correction for intake air temperature * *	1% per 6° F.

\* 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.

\* \* Correct horsepower for turbocharger inlet air temperature is as follows:  
(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° F. colder than 60° F.

**TABLE XXVI**  
**TOP OR MINOR AND**  
**MAJOR OVERHAUL TEST RUN**  
**TSIO-520-T**

Period	Time-Minutes	RPM	
1	5	1200	Warm-up
2	5	1600	
3	5	2450	
4	10	(1) 2700-2750	100% Power
5	10	(2) 2100	Check Magnetos
6	5	575-625	Idle Cooling

NOTE . . . Stop engine, drain oil, weigh in oil for oil consumption determination.

Period	Time-Minutes	RPM	
7	5	Warm up to rated RPM (1200)	
8	30	(3) 2450	
9	5	600	

NOTE . . . Stop engine, drain oil, weigh and record engine oil consumption. Oil consumption at a rate of 2.0 lbs./40 Min. run maximum is acceptable. If value in excess of 2.0 lbs./40 Min. run is determined, rerun 40 minutes. If oil consumption is still excessive return engine to overhaul.

- (1) Adjust engine fuel flow, fuel pressure, etc. (Reduce RPM for adjustments.)
- (2) Engine parameter checks - see applicable data. Perform mag check at 2100 RPM. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.
- (3) Readings must be recorded after completion of each 10 minute interval during oil consumption run.

## **SECTION XVI**

### **INTRODUCTION**

The TSIO-520-U, UB is rated at 300 BHP at 2700 RPM. Overhaul procedures for the TSIO-520-U, UB will be the same as those for the TSIO-520-D except for the differences noted in Section XVI.

## SECTION XVI

### TSIO-520-U, UB

#### 16-1 SIGNIFICANT DIFFERENCES

A. Physical Characteristics. The TSIO-520-U, UB includes an engine mounted turbocharger, complete turbo control system with pressure controller, wastegate and overboost valve and a complete exhaust system including tail pipe and integral cabin air heater.

B. Operating Characteristics. The TSIO-520-U, UB has a maximum continuous rating of 300 BHP at 2700 RPM and 36.0 in. Hg manifold pressure.

#### 16-2 EXHAUST SYSTEM (See Figure 16-1)

#### 16-3 DISASSEMBLY

- A. Remove hoses as required.
- B. Remove clamp (15) tail pipe to turbo and four sets of attaching parts, tail pipe to wastegate. Separate tail pipe and gasket (13).
- C. Remove wastegate to turbo adapter attaching parts and lift off wastegate (12). Remove gasket (13).
- D. Remove four nuts and bolts (19, 20) turbo to turbo adapter (6) and clamp assembly, turbo to intake and lift turbocharger from bracket.
- E. Take off four nuts and bolts (10, 11) from each end of the heater assembly and separate heater from turbo adapter and exhaust elbow. Discard gaskets (9).
- F. Remove four nuts (21) from each cylinder

exhaust port and lift off remainder of exhaust system. Separate elbows (1 thru 5) and adapter (6).

#### 16-4 INSPECTION

A. Inspection of the exhaust system and cabin air heater is to be accomplished every 100 hours of operation. The entire exhaust system should be visually inspected for condition and leaks at this time.

B. Remove the heater assembly at the 100 hour interval and inspect both core and shroud thoroughly. Install a rubber expansion plug in either end of heater. Pressurize to 5 psi for two (2) minutes and check for leaks with heater submerged in water.

#### 16-5 REASSEMBLY

- A. Use new gaskets (22) and position exhaust elbows (1 thru 5) on cylinder exhaust ports. Secure finger tight with special nuts (21).
- B. Position turbo adapter (6) and heater assembly (7). Use new gaskets (9) and secure heater assembly with nuts and bolts (10, 11). Secure adapter to turbo with nuts and bolts (19, 20).
- C. Use new gasket (13) and secure wastegate valve (12) to adapter (6) and tail pipe (14) with attaching parts (10, 11). Secure tail pipe to turbocharger with clamp assembly.
- D. Tighten all attaching parts, including exhaust to cylinder nuts, to specified torque.

1. Elbow	9. Gasket	17. Bracket, Turbo
2. Elbow	10. Bolt	18. Turbo
3. Elbow	11. Nut	19. Nut
4. Elbow	12. Wastegate	20. Bolt
5. Elbow	13. Gasket	21. Washer, Plain
6. Turbo Adapter	14. Tailpipe Assy.	22. Nut
7. Heater Assy.	15. Coupling	23. Gasket
8. Elbow	16. Gasket	

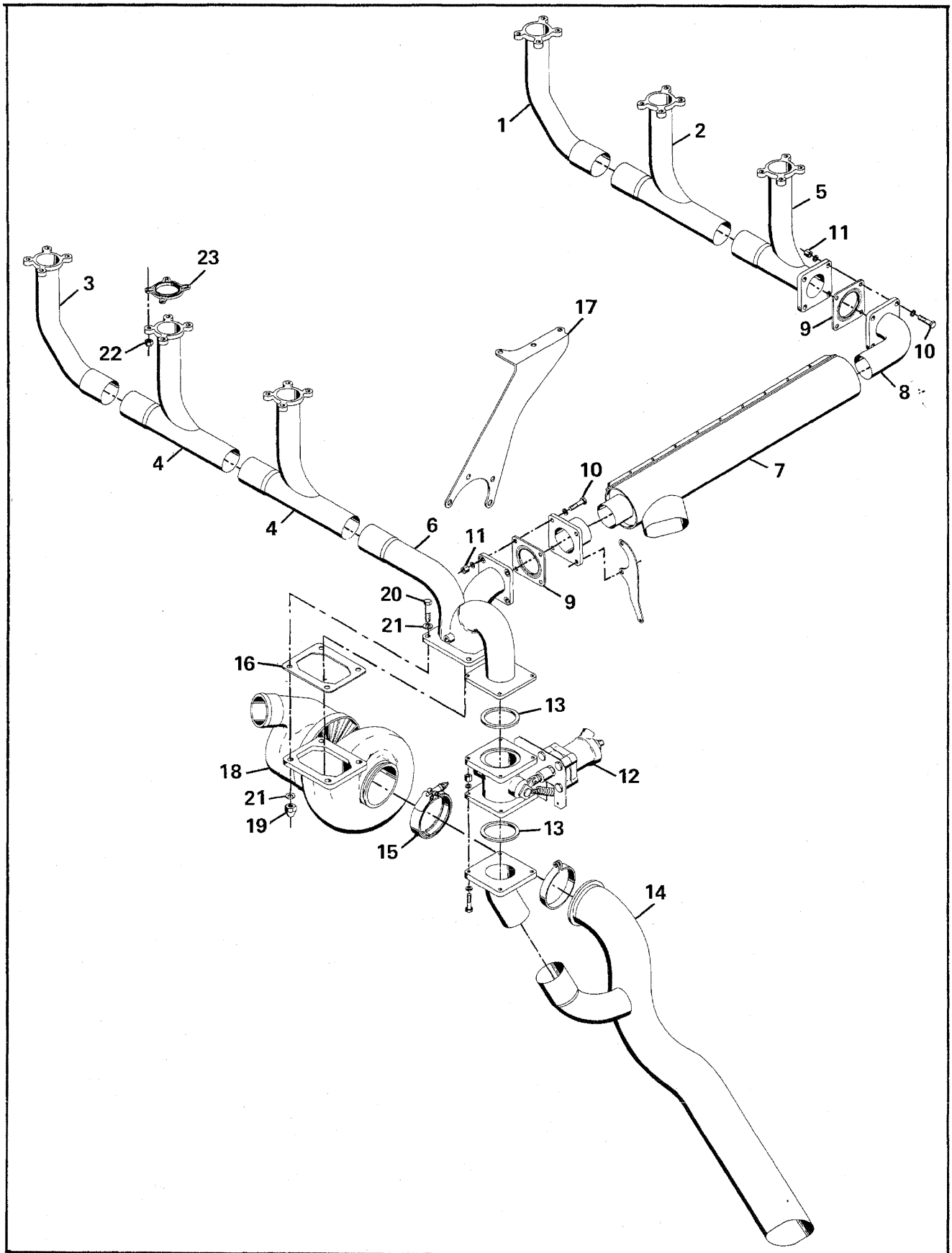


FIGURE 16-1. EXHAUST SYSTEM

## 16-6 INDUCTION SYSTEM (See Figure 16-2)

### 16-7 DISASSEMBLY

- A. Remove hoses as required.
- B. Remove hose clamps (1) and pull hose (2) from fuel pump and coupling (3). Remove and separate tube assemblies (5, 6, 7), tee fitting (4) and coupling (3). Nozzles (10) can be removed after fuel discharge lines are loosened.
- C. Loosen clamps (18, 19) and remove attaching parts (14, 15) and pull bracket (17) from sump and balance tube (20) from elbows (21).
- D. Loosen clamps (32) and (37) and separate elbows (35) from throttle body (34) and turbocharger (38). Loosen hose (39) and pull throttle body and controller assembly (34) from manifold riser (31).
- E. Loosen clamps (19) and remove riser (31) and elbows (39, 40).
- F. Remove attaching parts (23, 24, 25) and lift off intake elbows (24, 26) from each side. Separate components as required.

### 16-8 INSPECTION, REPAIR AND REPLACEMENT

- A. Procedures for inspection, repair and re-

- 1. Clamp, Hose
- 2. Hose
- 3. Coupling
- 4. Tee, Fitting
- 5. Tube Assembly
- 6. Tube Assembly
- 7. Tube Assembly
- 8. Grommet
- 9. Bracket
- 10. Sleeve Assembly
- 11. Washer, Rubber
- 12. Washer, Plain
- 13. Seal, Compression
- 14. Screw

- 15. Washer, Lock
- 16. Washer, Plain
- 17. Bracket
- 18. Clamp
- 19. Clamp
- 20. Tube, Balance
- 21. Clamp
- 22. Hose
- 23. Screw
- 24. Washer, Lock
- 25. Washer, Plain
- 26. Elbow, Intake Manifold
- 27. Elbow, Intake Manifold
- 28. Gasket

placement will be the same as for like parts in sections five and six.

### 16-9 REASSEMBLY

- A. Loosely assemble intake elbows (26, 27) with hoses (22) and clamps (21). Use new gaskets (28) and secure to cylinder intake parts with plain washers (25), lockwashers (24) and screws (23).
- B. Position balance tube (20) in hoses (22) and secure with clamp assemblies (19). Secure at front of engine with bracket (17) and clamp (18). Secure bracket (17) to sump rail with attaching parts (14, 15, 16).
- C. Attach elbows (39, 40) to elbows (26) and riser (31). Secure throttle assembly (34) to riser with hose (30) and clamp (39). Secure elbow assembly (35) to throttle assembly with hose (33) and clamp assembly (32) and to turbocharger with clamp assembly (37) and sleeve (36). Tighten all nuts and screws to specified torque values.
- D. Install elbows (10) using new rubber washers (11) and plain washers (12). Compression seals (13) should be replaced if necessary. Install air manifold tubes (6), tube assembly (5), crossover tube (7), fitting (4) and coupling (3). Secure hose (2) to coupling and fuel pump with clamps (1).
- E. Replace hoses.

- 29. Clamp
- 30. Hose
- 31. Manifold Riser
- 32. Clamp
- 33. Hose
- 34. Air Throttle Assembly
- 35. Elbow
- 36. Sleeve, Coupling
- 37. Clamp
- 38. Turbocharger
- 39. Elbow
- 40. Elbow
- 41. Relief Valve



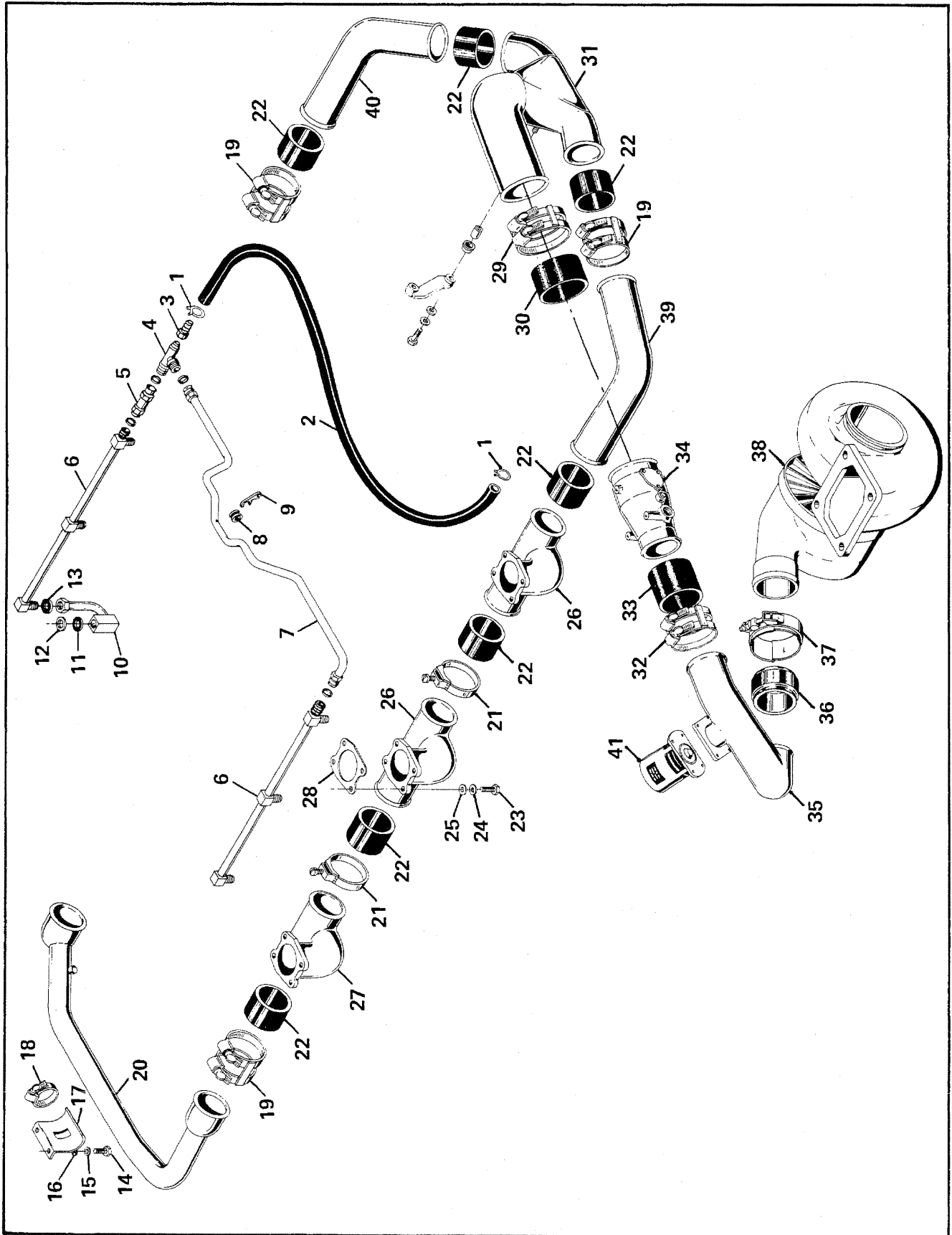


FIGURE 16-2. INDUCTION SYSTEM

## 16-10 FUEL INJECTION SYSTEM (See Figure 16-3)

### 16-11 DISASSEMBLY

A. Remove hose assembly (6), fuel pump to fuel metering and hose, fuel pump to air throttle body.

B. Remove attaching parts (10, 11, 12) and pull fuel pump (13) from crankcase. Separate shroud (8) from pump. Remove coupling (15) and gasket (14).

C. The air throttle assembly (7) was removed with the induction system.

D. Remove clamp (1) from bracket (16) and separate fuel discharge tube (2) from fuel manifold valve (4) and nozzle (3). Remove nozzles and fuel manifold valve.

E. (See Fig. 16-8) Remove tube assembly (14) and linkage assembly (3).

F. See Fuel Injection Manual, X30091 for overhaul procedures to be used on the throttle and metering assembly and the controller assembly.

### 16-12 INSPECTION, REPAIR AND REPLACEMENT

A. Inspection of the components of the fuel system is limited to visual inspection for evidence of damage or deterioration. Unless proper test facilities are available, Teledyne Continental Motors

does not recommend any disassembly of the fuel pump, fuel manifold valve, controller or metering assembly.

### 16-13 REASSEMBLY

A. (See Fig. 16-8) Install fittings, if removed, in the attitude shown in figures 16-4, 16-5 and 16-8, being careful that no loose metal shavings get into the fuel stream.

B. Install bracket (5) on controller (1) and install controller on throttle body. Secure with attaching parts (6 thru 10).

C. Install adapter fittings (12, 13) and install tube assembly (14).

D. (See Fig. 16-3) Install nozzles (3). Install sleeves over nozzles and attach fuel discharge tubes (2). Secure tube to bracket (16) with clamp (1). Attach discharge tubes to fuel manifold valve (4).

E. Position shroud (8) on fuel pump (13). Lubricate coupling (15) and install in pump. Attach fuel pump to crankcase using new gasket (14) and secure with attaching parts (10, 11, 12).

### 16-14 OIL SUMP (See Figure 16-6)

A. Instructions relevant to removal, inspection and installing the sump are the same as the TSIO-520-D except that Loctite No. 515 sealant is used in place of a mounting gasket. Install a 1/8 inch bead of sealant on sump rail per manufacturer's instructions.

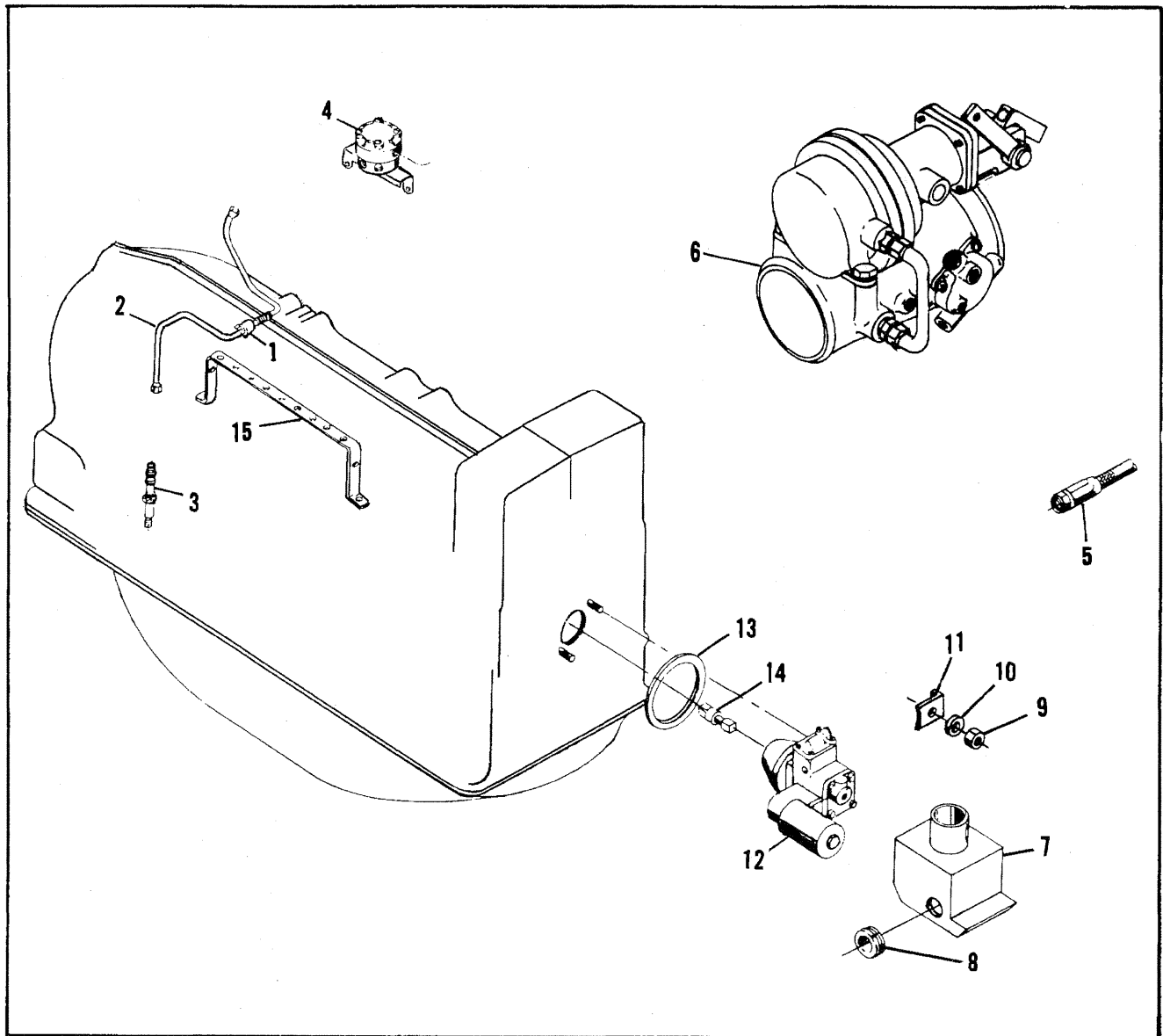


FIGURE 16-3 FUEL INJECTION SYSTEM

- |    |                                      |     |                    |
|----|--------------------------------------|-----|--------------------|
| 1. | Clamp, Fuel Discharge Tube           | 9.  | Nut                |
| 2. | Tube, Fuel Discharge                 | 10. | Washer, Lock       |
| 3. | Nozzle Assembly                      | 11. | Washer, Holding    |
| 4. | Fuel Manifold Valve Assembly         | 12. | Fuel Pump Assembly |
| 5. | Hose Assembly, Fuel Pump to MTR Unit | 13. | Gasket             |
| 6. | Air Throttle Assembly                | 14. | Coupling           |
| 7. | Shroud                               | 15. | Bracket            |
| 8. | Grommet                              |     |                    |

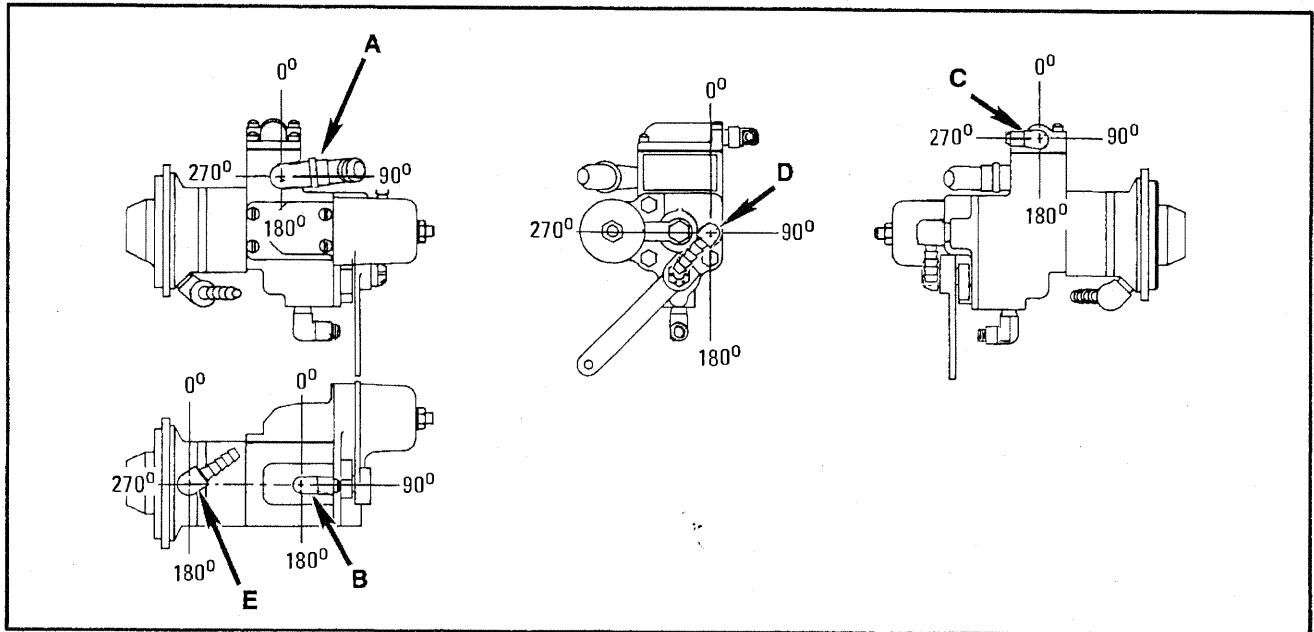


FIGURE 16-4. FUEL PUMP FITTING LOCATIONS

	A	B	C	D	E
TSIO-520-U, UB	90° ELBOW (85°)	90° ELBOW (90°)	90° ELBOW (270°)	90° HOSE COUPLING (225°)	45° ELBOW (55°)

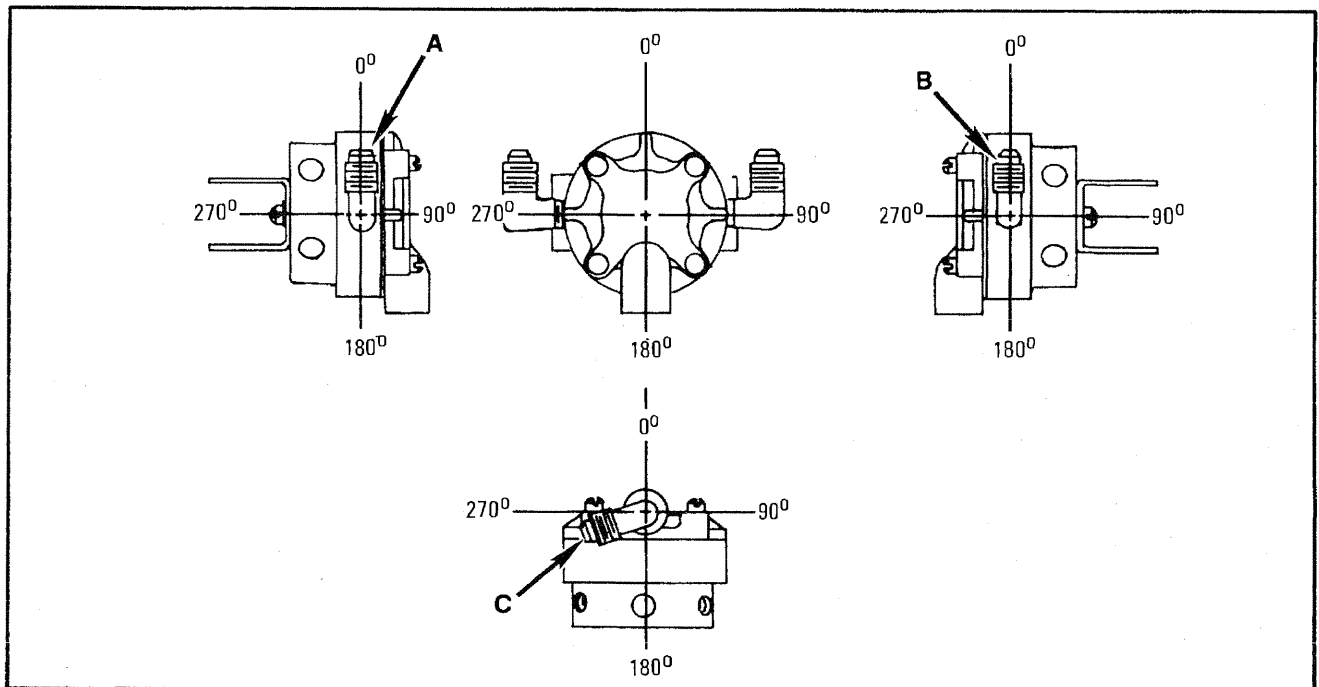


FIGURE 16-5. FUEL MANIFOLD VALVE FITTING LOCATIONS

	A	B	C
TSIO-520-U, UB	90° ELBOW (0°)	90° ELBOW (0°)	45° ELBOW (240°)

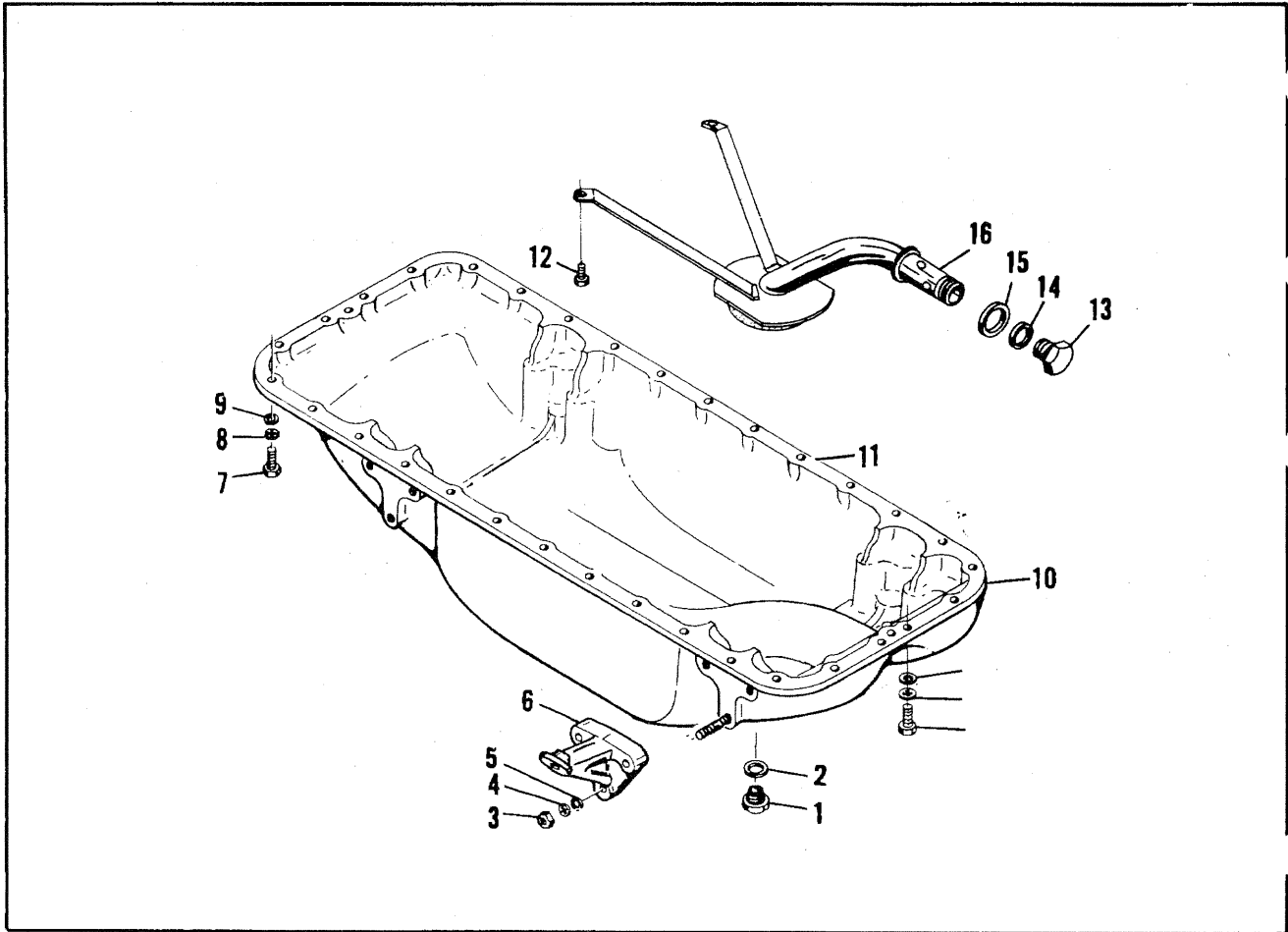


FIGURE 16-6.OIL SUMP

1. Plug, Oil Drain
2. Gasket, Annular
3. Nut
4. Washer, Lock
5. Washer, Plain
6. Bracket, Engine Mount
7. Bolt
8. Washer, Lock
9. Washer, Plain
10. Sump Assembly, Oil
11. Sealant
12. Bolt
13. Plug
14. Gasket, Annular
15. Gasket, Annular
16. Tube Assembly, Suction

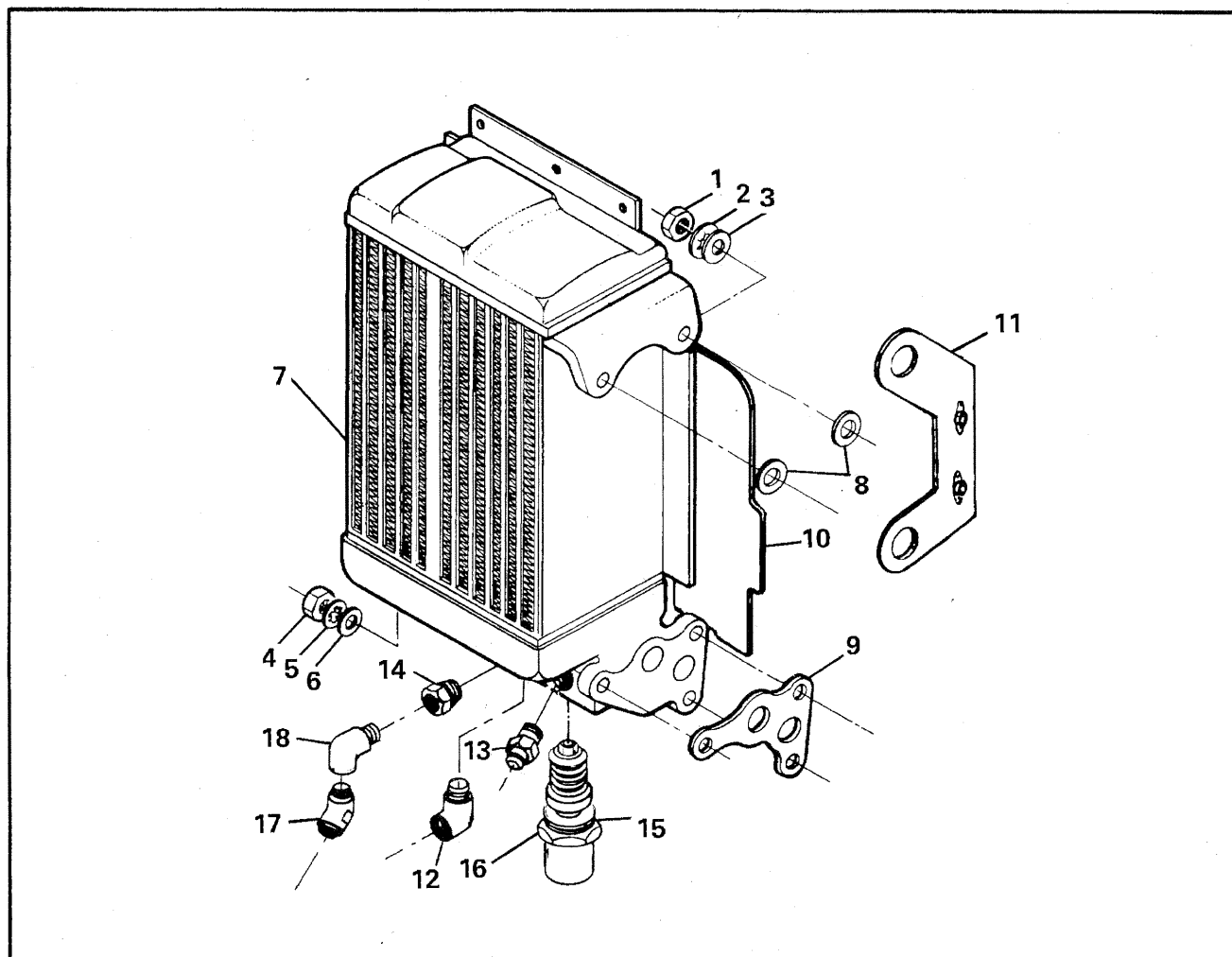


FIGURE 16-7. OIL COOLER

- |                       |                                   |
|-----------------------|-----------------------------------|
| 1. Nut, Hex           | 10. Baffle                        |
| 2. Washer, Lock       | 11. Support Assembly, Baffle      |
| 3. Washer, Plain      | 12. Elbow (90°)                   |
| 4. Nut, Hex           | 13. Nipple                        |
| 5. Washer, Lock       | 14. Bushing                       |
| 6. Washer, Plain      | 15. Gasket, Control Valve         |
| 7. Cooler, Engine Oil | 16. Oil Temperature Control Valve |
| 8. Gasket             | 17. Elbow                         |
| 9. Gasket             | 18. Elbow                         |

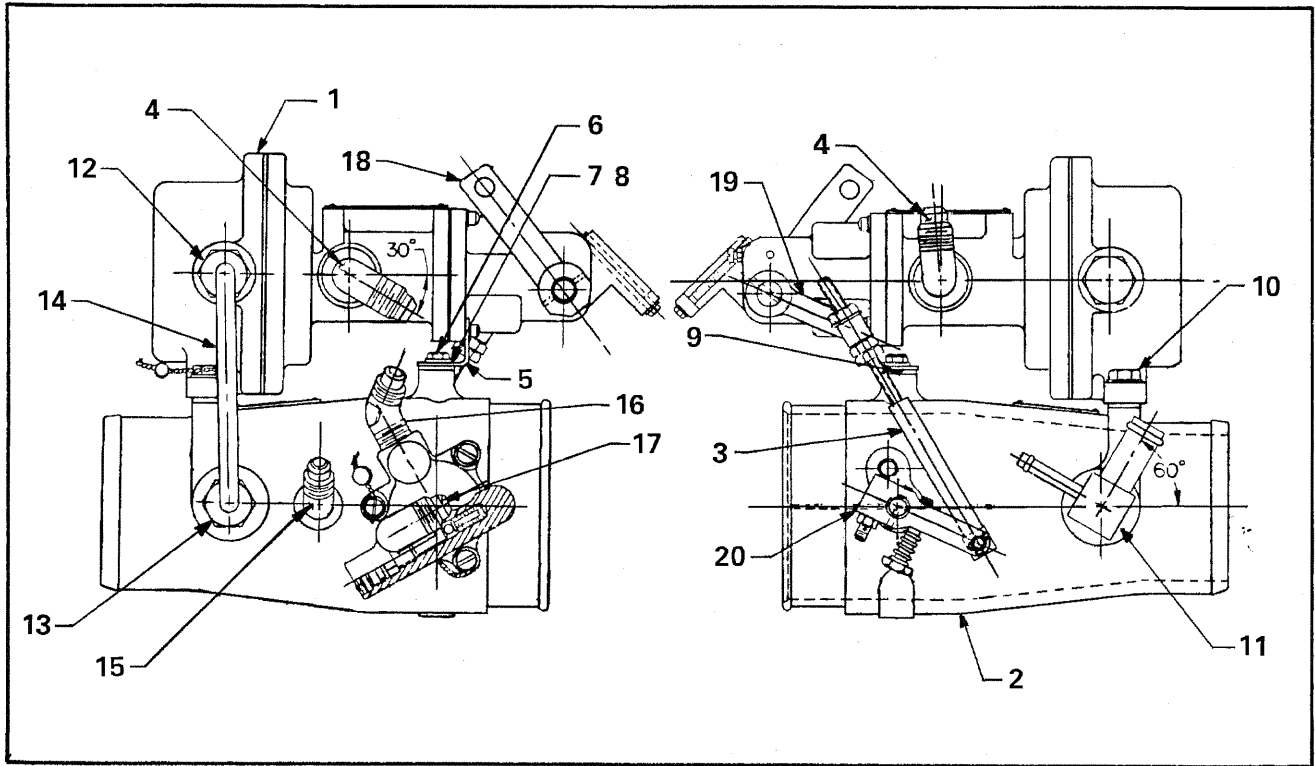


FIGURE 16-8. THROTTLE, CONTROLLER ASSEMBLY

- |                        |                           |
|------------------------|---------------------------|
| 1. Controller Assembly | 11. Junction Box Assembly |
| 2. Throttle Assembly   | 12. Adapter Fitting       |
| 3. Linkage Assembly    | 13. Adapter Fitting       |
| 4. Elbow               | 14. Tube Assembly         |
| 5. Bracket             | 15. Elbow, 45°            |
| 6. Bolt                | 16. Elbow, 45°            |
| 7. Washer, Lock        | 17. Elbow, 90°            |
| 8. Washer              | 18. Lever                 |
| 9. Washer              | 19. Lever                 |
| 10. Bolt               | 20. Lever                 |

**TABLE XXVII  
OPERATING TEST LIMITS  
TSIO-520-U, UB**

Run-in schedule	1 hr. 20 min.
Maximum rated RPM and tolerance	2700-2750 RPM
Oil Consumption at max. rated power	2.0 lbs./40 MIN
Oil grade to be used	SAE No. 50
Fuel grade to be used	100,100LL
Idling RPM and tolerance	600 ± 25 RPM
Manifold pressure at max. rated power	36.0 Hg. Abs.
Manifold pressure at idle	18.5" Hg.abs.Max
Magneto spread at 2100 RPM	50 RPM max.
Magneto drop at 2100 RPM	150 RPM
Crankcase pressure*	4.0" H <sub>2</sub> O max.
Oil temperature	240° F. Max.
Oil temperature - desired range	150° - 200° max.
Oil pressure at max. rated power (engine oil temperature 175° - 185° F.)	30-60 psi
Oil pressure at idle (engine oil temperature 140° - 150° F.)	10 psi minimum
Timing of engine and tolerance	Left - 22° BTC ± 1° Right-22° BTC ± 1°
Turbocharger exhaust outlet pressure and inlet pressure	± 7.0" H <sub>2</sub> O
Cylinder head temperature	460° F. max. (at bayonet thermocouple)
Normal rated power	300 BHP @ 2700 RPM
Power Correction for intake air temperature **	1% per 6° F.

\* 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.

\*\* Correct horsepower for turbocharger inlet air temperature is as follows:  
(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° F. colder than 60° F.



**TABLE XXVIII**  
**TOP OR MINOR AND**  
**MAJOR OVERHAUL TEST RUN**  
**TSIO-520-U, UB**

Period	Time-Minutes	RPM	
1	5	1200	Warm-up
2	5	1600	
3	5	2450	
4	10	(1) 2700-2750	100% Power
5	10	(2) 2100	Check Magnetos
6	10	575-625	Idle Cooling

NOTE

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

Period	Time-Minutes	RPM	
7	5		Warm up to rated RPM(1200)
8	30	(3) 2450	
9	5	600	

NOTE

Stop engine, drain oil, weigh and record engine oil consumption. Oil consumption at a rate of 2.0 lbs./40 Min. run maximum is acceptable. If value in excess of 2.0 lbs./40 Min. run is determined, rerun 40 minutes. If oil consumption is still excessive return engine to overhaul.

- (1) Adjust engine fuel flow, fuel pressure, etc. (Reduce RPM for adjustments.)
- (2) Engine parameter checks - see applicable data. Perform mag check at 2100 RPM. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.
- (3) Readings must be recorded after completion of each 10 minute interval during oil consumption run.



## **SECTION XVII**

### **INTRODUCTION**

The TSIO-520-VB is rated at 325 BHP at 2700 RPM. Overhaul procedures for the TSIO-520-VB will be the same as those for the TSIO-520-E except for the differences noted in Section XVII.

## SECTION XVII

### TSIO-520-VB

#### 17-1 SIGNIFICANT DIFFERENCES

A. Physical Differences. The TSIO-520-VB differs from the TSIO-520-E in that the induction system includes a convoluted bellows, a throttle body adapter and a control cable adapter. The fuel injection system employs a different throttle body arrangement.

B. Operating Characteristics. The TSIO-520-VB develops 325 BHP at 2700 RPM. Operating test limits are contained in Table XXIX.

#### 17-2 INDUCTION SYSTEM (SEE FIG. 17-1)

#### 17-3 DISASSEMBLY

A. Loosen hose clamps (1) and remove hose (2) and clamps. Loosen hose clamps (4) and remove air manifold lines (6,7), hoses (5) and junction block (3).

B. Invert engine and remove screw (12), washer (13) and loosen clamp assembly (17) and remove balance tube (16).

C. Remove adapter (32), bracket (31) and throttle body assembly (30). Loosen clamps and remove riser (29), elbows (28) and convoluted bellows (20).

D. Loosen clamps (19) and remove attaching parts (21, 22, 23) and pull intake elbows (24, 25,) from each side. Discard gaskets (27).

#### 17-4 INSPECTION, REPAIR & REPLACEMENT.

A. Check for cracks and dents in intake elbows. Replace hoses and gaskets.

B. Check bellows for abnormal wear and leaks.

#### 17-5 REASSEMBLY

A. Loosely assembly intake elbows and install using new gaskets (27) and secure with attaching parts (21, 22, 23). Do not tighten until hoses are evenly distributed and hose clamps are secure.

B. Install balance tube and secure to sump rail with bracket (14) and attaching parts (12, 13, 15). Tighten clamps (17).

C. Install sleeves (8) using plain washers (10) and new rubber washers (9). Compression seal (11) can be replaced if required. Install air manifold tubes (6, 7) on sleeves. Install hoses (5) on air manifold tubes (6, 7) and junction block (3). Secure with hose clamps (4). Hose (2) junction block to fuel pump can be installed at this time. Secure with hose clamps (1).

D. Clamps for attaching the convoluted bellows are furnished by the air frame manufacturer. If new clamps are required, consult the Cessna parts catalog.

#### 17-6 FUEL INJECTION SYSTEM (SEE FIG. 17-2)

The fuel pump, manifold valve, nozzles and tubes are removed and replaced the same as the TSIO-520-E. The throttle body and control assembly are air frame mounted.

17-7 Prepare the engine for test after overhaul according to instructions in Section 8. The Operating Test Limits and run-in schedule are contained in Tables XXIX and XXX.

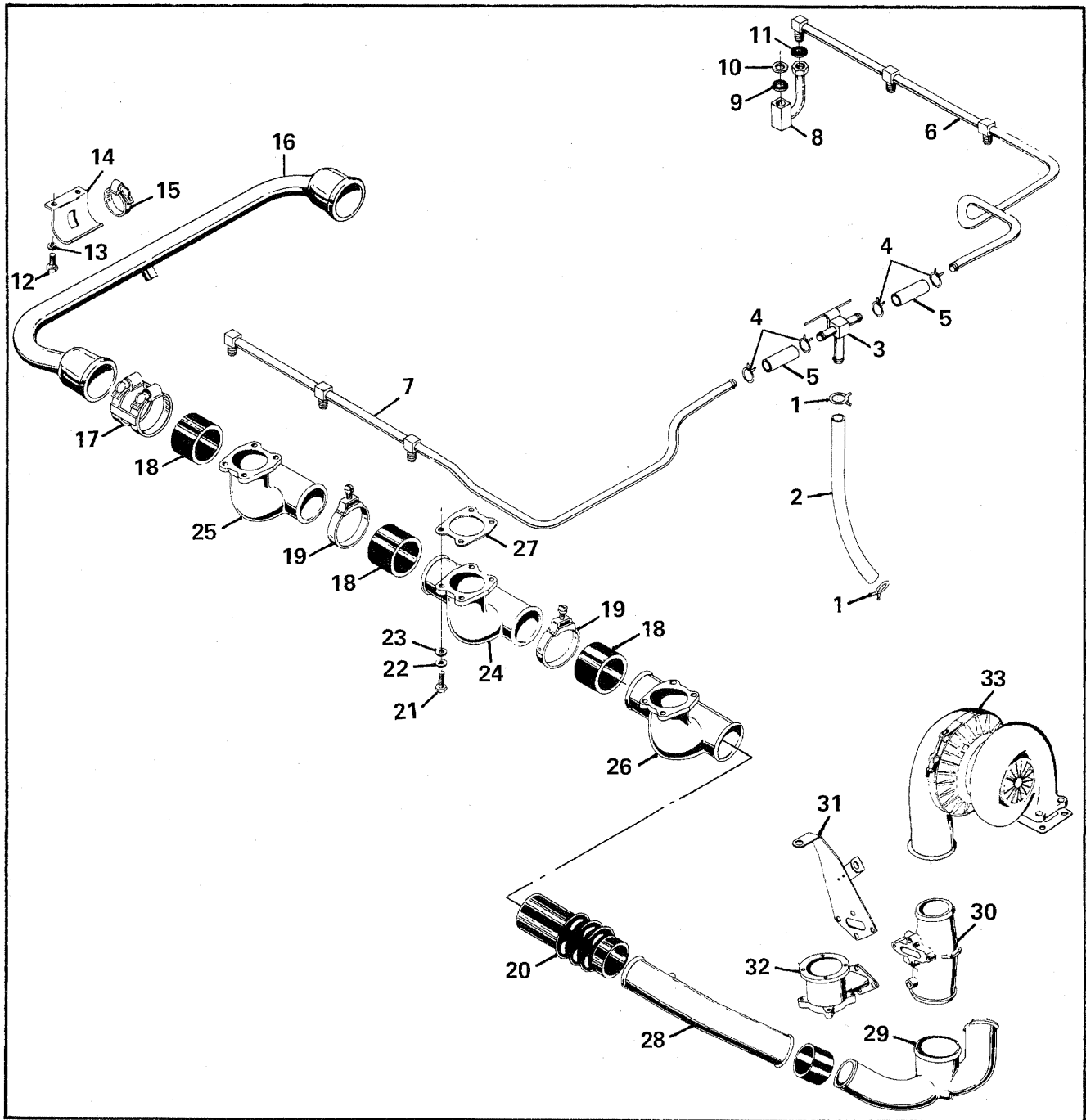


FIGURE 17-1. INDUCTION SYSTEM.

- |                       |                         |                            |
|-----------------------|-------------------------|----------------------------|
| 1. Clamp              | 12. Screw               | 23. Washer, Plain          |
| 2. Hose               | 13. Washer, Tab         | 24. Elbow                  |
| 3. Junction Block     | 14. Bracket             | 25. Elbow                  |
| 4. Clamp              | 15. Clamp               | 26. Elbow                  |
| 5. Hose               | 16. Tube, Balance       | 27. Gasket                 |
| 6. Tube Assembly      | 17. Clamp Assembly      | 28. Tube, Induction        |
| 7. Tube Assembly      | 18. Hose                | 29. Riser, Air Manifold    |
| 8. Sleeve Assembly    | 19. Clamp               | 30. Throttle Body Assembly |
| 9. Washer, Rubber     | 20. Bellows, Convoluted | 31. Bracket, Control Cable |
| 10. Washer, Plain     | 21. Bolt                | 32. Adapter, Throttle Body |
| 11. Seal, Compression | 22. Washer, Lock        | 33. Turbocharger           |

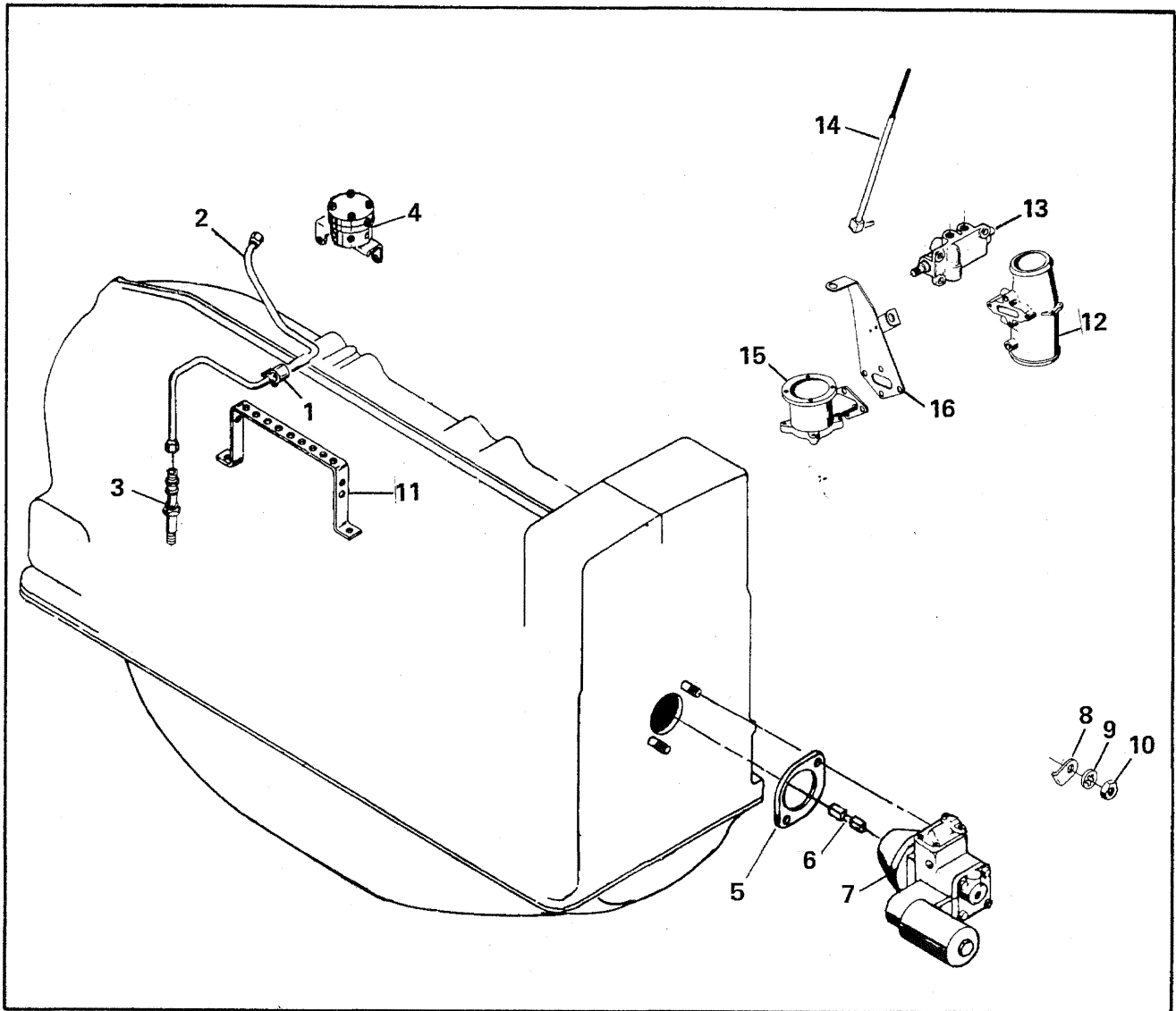


FIGURE 17-2. FUEL INJECTION SYSTEM.

- |    |                              |     |                        |
|----|------------------------------|-----|------------------------|
| 1. | Clamp, Fuel Discharge Tube   | 9.  | Washer, Plain          |
| 2. | Tube, Fuel Discharge         | 10. | Nut                    |
| 3. | Nozzle Assembly              | 11. | Bracket                |
| 4. | Fuel Manifold Valve Assembly | 12. | Throttle Body          |
| 5. | Gasket                       | 13. | Metering Unit          |
| 6. | Coupling                     | 14. | Link Rod               |
| 7. | Fuel Pump Assembly           | 15. | Adapter, Throttle Body |
| 8. | Washer, Holding              | 16. | Bracket, Control Cable |

**TABLE XXIX  
OPERATING TEST LIMITS  
TSIO-520-VB**

Run in schedule	1 Hr. 20 Min.
Maximum rated RPM and tolerance	2700 - 2750 RPM
Oil Consumption at max. rated power	2.1 lbs./40 Min.
Oil Grade to be used	SAE No. 50
Fuel Grade to be used	100, 100LL
Idling RPM and tolerance	600 ± 25 RPM
Manifold pressure at max. rated power*	40.5 In. Hg. Abs.
Manifold pressure at idle	17 In. Hg. Abs.
Magneto Spread at 2100 RPM	50 RPM Max.
Crankcase Pressure**	4.0 In. H <sub>2</sub> O Max.
Oil Temperature	240° F. Max.
Oil Temperature - Desired range	150° F. - 200° F. Max.
Oil pressure at max. rated power (Engine oil temperature 175° - 185° F.)	30 - 60 PSI
Oil pressure at idle (Engine oil temperature 140° - 150° F.)	10 PSI Min.
Ignition timing and tolerance	Left - 20° BTC ± 1° Right-20° BTC ± 1°
Turbocharger inlet air pressure and outlet pressure	±7.0 In. H <sub>2</sub> O
Cylinder head temperature	460° F. Max. (At bayonet thermocouple)
Normal Rated Power	325 BHP @ 2700 RPM
Power Correction for intake air temperature ***	1% per 6° F.

\* Max. Manifold Pressure at 39.1 in. Hg. exhaust gas back pressure.

\*\* 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.

\*\*\* Correct horsepower for turbocharger inlet air temperature as follows:

(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° colder than 60° F.

**TABLE XXX**  
**TOP OR MINOR AND**  
**MAJOR OVERHAUL TEST RUN**  
**TSIO-520-VB**

Period	Time-Minutes	RPM	
1	5	1200	Warm-up
2	5	1600	
3	5	2450	
4	10	(1) 2700-2750	100% Power
5	10	(2) 2100	Check Magnetos
6	10	575-625	Idle Cooling

NOTE

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

Period	Time-Minutes	RPM	
7	5	Warm up to rated RPM(1200)	
8	30	(3) 2450	
9	5	600	

NOTE

Stop engine, drain oil, weigh and record  
engine oil consumption. Oil consumption  
at a rate of 2.0 lbs./40 Min. run maximum  
is acceptable. If value in excess of 2.0 lbs./  
40 Min. run is determined, rerun 40 minutes.  
If oil consumption is still excessive return  
engine to overhaul.

- (1) Adjust engine fuel flow, fuel pressure, etc. (Reduce RPM for adjustments.)
- (2) Engine parameter checks - see applicable data. Perform mag check at 2100 RPM. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.
- (3) Readings must be recorded after completion of each 10 minute interval during oil consumption run.



## SECTION XVIII INTRODUCTION

The TSIO-520AE and LTSIO-520AE are counter-rotating engines rated at 250 BHP at 2700 RPM. Overhaul procedures for the "AE" will be the same as other sandcast versions of the TSIO-520 series in Sections I thru VIII of this manual except for the differences noted herein.

The major differences between the "AE" series and the other sandcast TSIO-520 engines are:

1. Mounting legs designed for rear mounting rather than bed mounting.
2. Straight valve cylinders

3. A three ring piston
4. A gerotor (scavenge pump) in the starter adapter
5. An oil pump with an integral full flow oil filter

*CAUTION . . . The LTSIO-520AE is a counter-rotating engine. Certain parts are therefore opposite turning to the TSIO-520AE. Be sure the correct parts are used in all installation procedures. See Parts Catalog X30043A.*

## 18-1 GENERAL

a. Physical differences. The TSIO-520AE and LTSIO-520AE have mounting legs extending from the rear of the engine rather than bed mounts. The cylinders are straight valve rather than inclined valves and the "AE" has a full flow oil filter externally mounted on the oil pump.

b. Operating differences. The L/TSIO-520AE is rated at 250 BHP at 2400 RPM and 32.5 in. Hg.

## 18.2 FUEL INJECTION SYSTEM

(See Figure 18-1)

### 18-3 DISASSEMBLY

a. Remove hoses (21) fuel pump to air throttle body and (22) air throttle body to fuel manifold valve.

b. Remove attaching parts (3,4,5) and pull pump (2) from crankcase. Separate shroud (6) from pump. Remove coupling (41), gasket (1) and fuel pump drive gear (39).

c. Remove air throttle body (16) from intake elbows.

d. Remove clamp (43) from bracket (42) and separate fuel discharge tube (39) from nozzles (37) and fuel manifold valve (25).

e. Remove fuel manifold valve (26 thru 35) from crankcase. Remove cover (31) and separate components (28, 29, 30).

f. Remove fittings only as required.

g. Further disassembly of the fuel injection system is to be accomplished in accordance with instructions in the Fuel Injection Manual, Form X30091.

### 18-4 INSPECTION, REPAIR AND REPLACEMENT

a. Inspect threads of fittings and components for deformation. Inspect screen (29) for deterioration. Inspect teeth of gear (39) for abnormal wear. Inspect drive coupling (41) for nicks and wear of drive surfaces.

b. Clean and/or replace parts in accordance with procedures detailed in Section V.

### 18-5 REASSEMBLY

a. Before installing any new fittings, be sure there are no burrs which could flake off and enter the fuel stream.

b. Coat one side of fuel pump gasket (1) and install on crankcase studs.

c. Liberally coat gear (39) and coupling (41) with clean engine oil and install. Install pump (2) with shroud (6) in place. Secure with attaching parts (3,4,5).

d. Reassemble manifold valve and bracket (25 thru 35) and install on crankcase at 8th and 9th bolts from the nose.

e. Install throttle body (16) on intake elbows. Install hose (22) and hose (21).

f. Install nozzles (37) in sleeves. Attach fuel discharge tubes (36) to nozzles and fuel manifold valve (25). Secure tube to bracket (42) with clamp (43).

### 18-6 STARTER ADAPTER.

(See Figure 18-2)

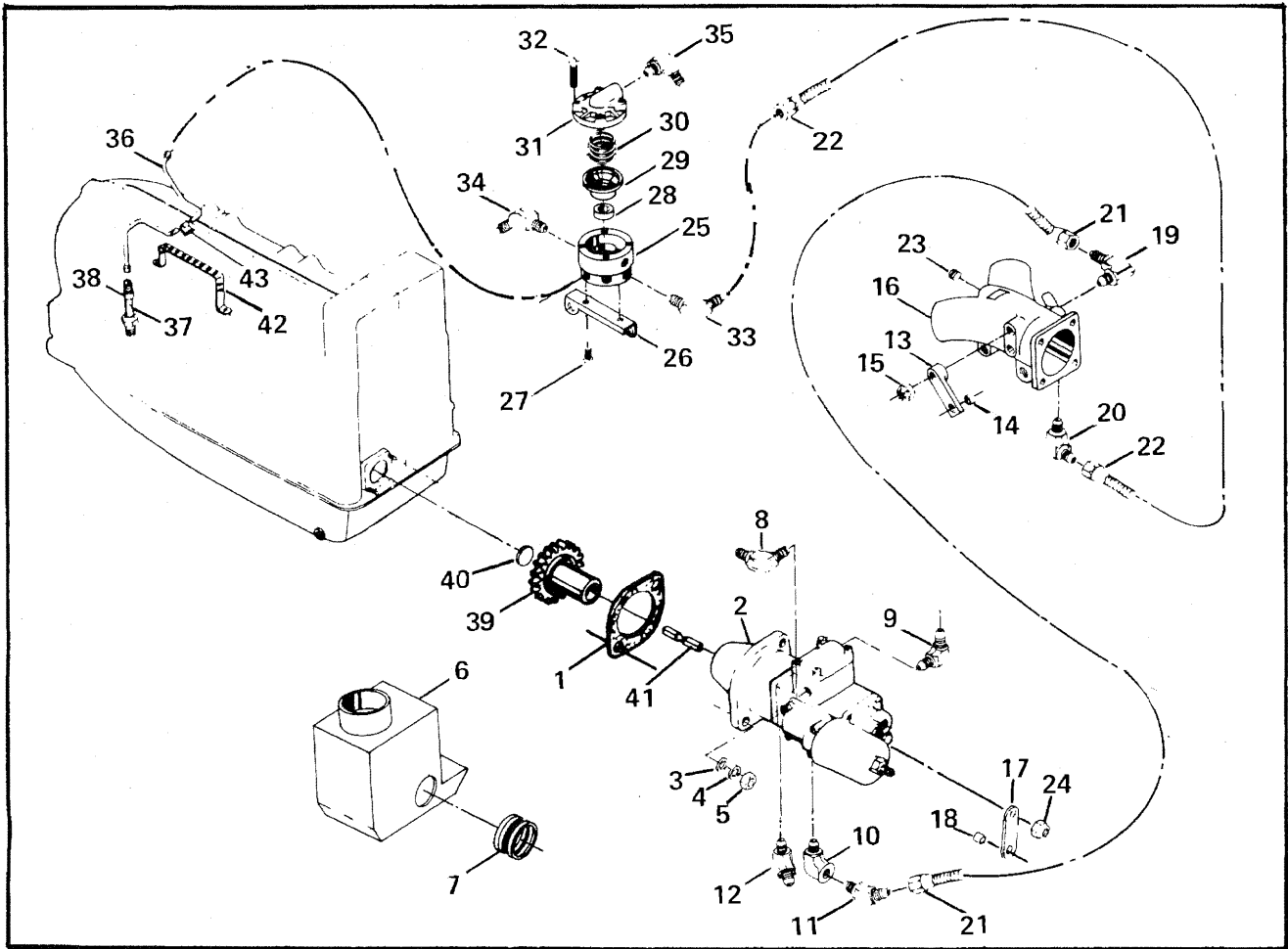
NOTE . . . The LTSIO-520AE and TSIO-520AE starter adapters rotate in opposite directions. See Parts Catalog for correct applications. The starter adapter for the "AE" is the same as the basic sandcast engine except that the scavenge pump is incorporated therein rather than on the oil pump. Disassembly, inspection and re-assembly procedures are the same as the basic sandcast engine except for those procedures listed herein.

### 18-7 DISASSEMBLY

a. Remove nut (31) lockwasher (30) and plain washer (29) from the starter drive shaft. Lift sheave (28) and sleeve (21) from the shaft.

b. Loosen check nut (33). Remove attaching parts (24,25,26) and (35,36,39,40) and separate timing indicator (27) and cover (23) from adapter. The starter shaft will have to be turned to line up the woodruff key (22) with the slot in the cover. The mark on the end of the starter shaft (9) is marked in the location of the woodruff key.

c. Remove the countersunk screws (15) from



**FIGURE 18-1  
FUEL INJECTION SYSTEM**

- |  |                               |
|--|-------------------------------|
| 1. Gasket, Fuel Pump                         | 23. Plug, Pipe                |
| 2. Fuel Pump Assembly                        | 24. Nut                       |
| 3. Washer, Flat                              | 25. Fuel Manifold Valve       |
| 4. Washer, Lock                              | 26. Bracket                   |
| 5. Nut, Plain                                | 27. Screw                     |
| 6. Shroud                                    | 28. Seal                      |
| 7. Grommet                                   | 29. Screen                    |
| 8. Elbow, 90 Degree, Fuel Pump Inlet         | 30. Spring                    |
| 9. Elbow, 90 Degree, Vapor Return            | 31. Cover                     |
| 10. Elbow, 90 Degree, Fuel Pump Outlet       | 32. Screw                     |
| 11. Elbow, 45 Degree, F.P. Outlet to Control | 33. Elbow, Inlet              |
| 12. Elbow, 45 Degree, Seal Drain             | 34. Elbow, Pressure           |
| 13. Lever Assembly                           | 35. Elbow                     |
| 14. Bushing                                  | 36. Tube Assembly, Cyl. No. 6 |
| 15. Nut                                      | 37. Nozzle Assembly, Fuel     |
| 16. Throttle & Control Assembly              | 37. Nozzle Assembly, Fuel     |
| 17. Lever Assembly                           | 38. "O" Ring                  |
| 18. Bushing                                  | 39. Gear Assembly, Fuel Pump  |
| 19. Elbow, 90 Degree, Fuel Inlet             | 40. Plug                      |
| 20. Elbow, 90 Degree, Fuel Outlet            | 41. Coupling, Drive           |
| 21. Hose Assembly, Control to Fuel Pump      | 42. Bracket                   |
| 22. Hose Assembly, Control to Manifold Valve | 43. Clamp                     |

the scavenge pump cover (14) and remove the cover. Remove and discard O-Ring (20).

d. Lift out gerotor (19). Remove oil seal (19) snap ring (18) and ball bearing (17).

e. Remove snap ring (7) and pull shaft gear (5) with bearing (6) as an assembly.

f. Remove attaching parts (12,13). Use narrow blade screw driver and lift tang of clutch spring (10) from slot in drum of gear (11) and withdraw gear (11). Separate starter shaft gear (9), clutch spring (10) and woodruff key (22).

### 18-8 INSPECTION

a. Cleaning, inspection and repair will be the same as for the sandcast models.

b. Inspect gerotor scavenge pump for nicks or deformation of profile.

### 18-9 REASSEMBLY

a. Except that the "AE" models do not have a steel sleeve and the shaft and worm gear are one piece, items 2 thru 13 are reassembled the same as the sandcast engine starter adapters.

b. Install ball bearing (17) and secure with snap ring (18). Install new oil seal (19).

c. Install woodruff key (22) and gerotor (19) in scavenge pump cavity and secure cover (14) to housing (23) with screws (15). Screws (15) are to be installed using Loctite 222 and torqued to 75-85 in. lbs.

d. Install sleeve (21) and sheave (28). Secure sheave with attaching parts (29,20,31): Torque nut (31) to 500-550 in. lbs. The timing marks on the end of the shaft (ref. page 4 Figure 18-2 item 9) and the mark on the sheave (28) must be matched when installing the sheave.

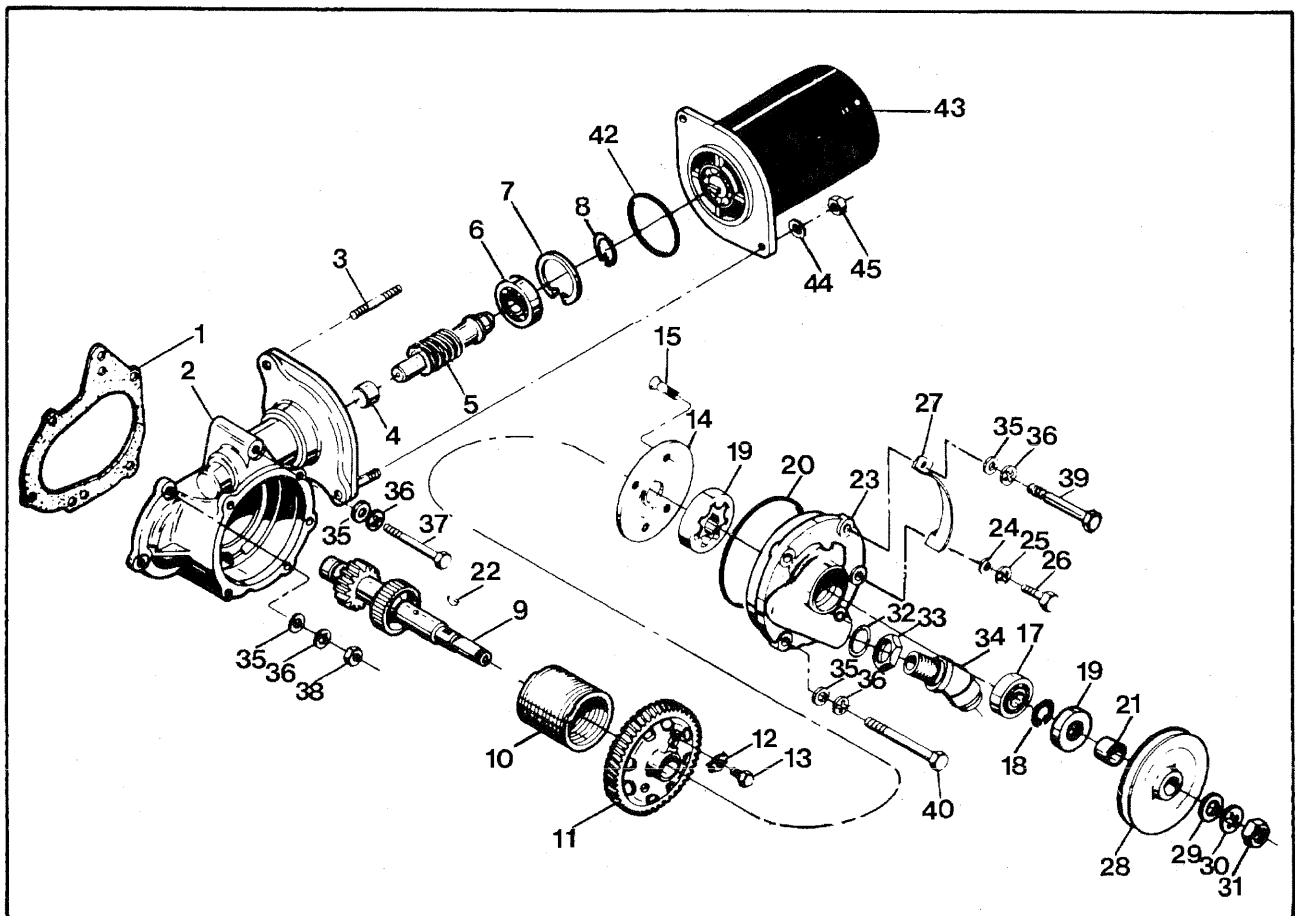


FIGURE 18-2  
STARTER AND ADAPTER ASSEMBLY

- |                             |                              |                                    |
|-----------------------------|------------------------------|------------------------------------|
| 1. Gasket                   | 16. Gerotor, Oil Pump        | 31. Nut                            |
| 2. Adapter                  | 17. Bearing, Ball            | 32. "O" Ring                       |
| 3. Stud 3/8 x 1 17/32 In Lg | 18. Ring, Retaining          | 33. Nut                            |
| 4. Bearing, Needle          | 19. Oil Seal                 | 34. Elbow                          |
| 5. Shaft Assembly, Worm     | 20. "O" Ring                 | 35. Washer, Plain                  |
| 6. Bearing, Ball            | 21. Sleeve                   | 36. Washer, Lock                   |
| 7. Ring, Retaining          | 22. Key, Woodruff            | 37. Screw, 5/16-18 x 2 13/16 In Lg |
| 8. Ring, Retaining          | 23. Cover, Starter Adapter   | 38. Nut, Plain                     |
| 9. Shaft Gear, Starter      | 24. Washer, Plain            | 39. Bolt, 5/16-18 x 3 5/8 In Lg    |
| 10. Spring, Clutch          | 25. Washer, Lock             | 40. Bolt                           |
| 11. Gear, Starter           | 26. Screw                    | 41. "O" Ring                       |
| 12. Washer, Tab             | 27. Indicator, Engine Timing | 42. Starter                        |
| 13. Screw                   | 28. Sheave                   | 43. Washer                         |
| 14. Cover, Scavenge Pump    | 29. Washer, Plain            | 44. Nut                            |
| 15. Screw                   | 30. Washer, Lock             |                                    |

#### 18-10 OIL PUMP

(See Figure 18-3)

#### 18-11 REMOVAL AND DISASSEMBLY

NOTE . . . The LTSIO-520AE and TSIO-520AE oil pump rotate in the opposite direction. See Parts Catalog for correct application.

- a. Remove oil filter (27). Stud (3) need not be removed unless damaged.
- b. Remove attaching parts (24,25,26) and pull oil pump from crankcase studs. Remove and discard gasket (1).
- c. Remove relief valve components (7 thru 15).
- d. Remove attaching parts (19,20,21) and lift off tach drive cover (18). Remove oil seal (22).
- e. Pull gear and bushing assembly (5,6) and driver gear assembly (16,17) from oil pump cavity.
- f. Loosen nut (24) and remove elbow (23) nut (24) and "O" ring (25). Remove adapter (26) from LTSIO-520AE.

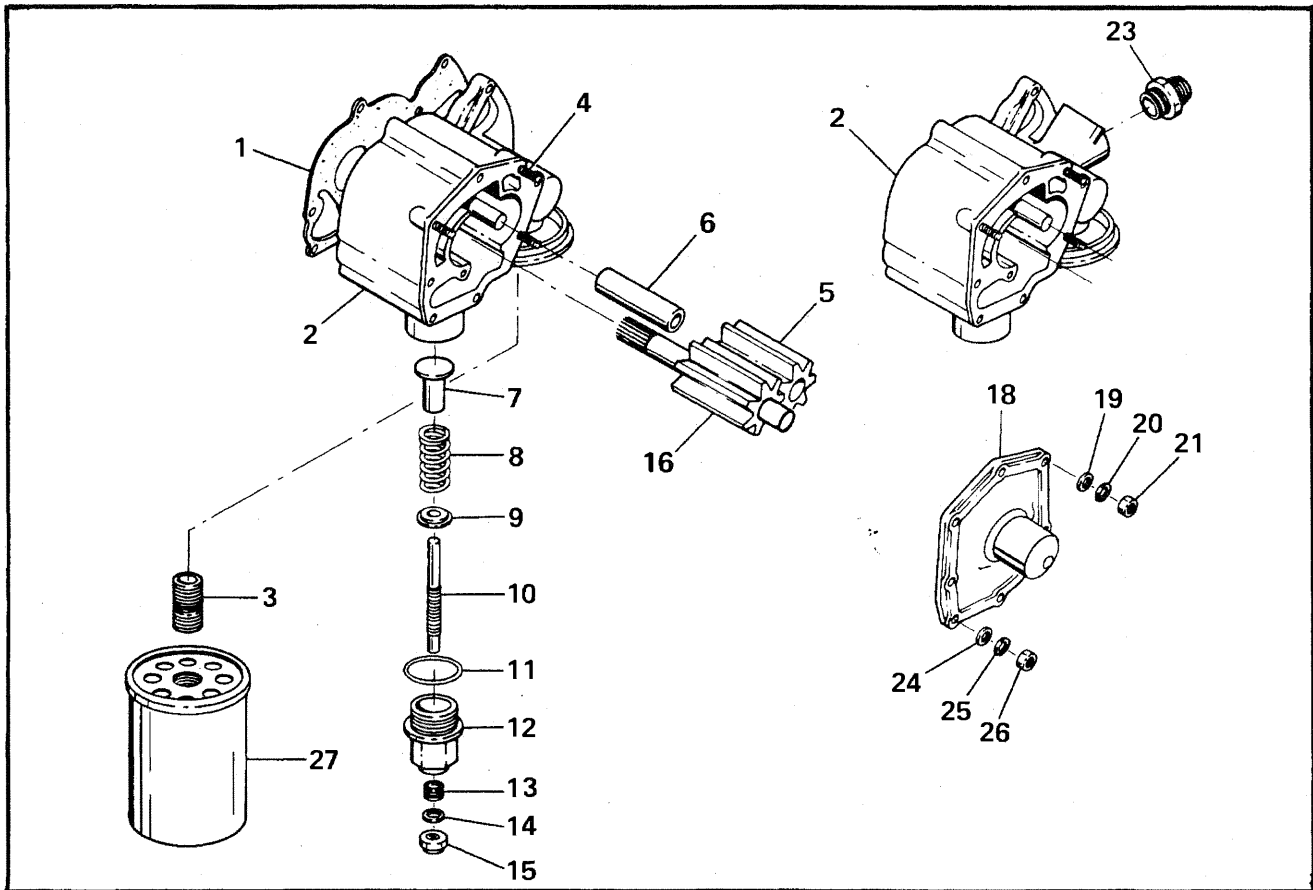
#### 18-12 INSPECTION, CLEANING, REPAIR

- a. Cleaning and repair are the same as procedures for other oil pumps.

b. The O.D. of the gear chamber in the pump cavity is 1.4975 - 1.4990. The chamber depth is 2.6235 - 2.6250. Any scoring or nicks which cannot be cleaned up without altering these dimensions means the pump must be replaced. Be sure there are no nicks or steps in the relief valve cavity which will prevent the plunger from operating smoothly.

#### 18-13 REASSEMBLY

- a. If oil pressure relief valve setting has been lost in disassembly, turn adjusting screw (10) into relief valve housing (12) about half way. Secure with copper washer (14) and nut (15). Install new gasket (11), washer (9) spring (8) and plunger (7) onto adjusting screw and assemble into housing (2).
- b. Install driven gear (5,6) on shaft in housing (2). Install driver gear (16) in pump housing to mesh with driven gear. Apply permatix and silk thread to parting surface.
- c. Secure with attaching parts (19,20,21).
- d. Install "O" ring (25) check nut (24) and elbow (25). Install adapter (26) on LTSIO-520AE.
- e. Install gasket paste on one side of gasket (1) and place on crankcase studs. Install pump and secure with attaching parts (27,28,29). Install filter (30).



**FIGURE 18-3  
OIL PUMP ASSEMBLY**

- |                               |                                    |                               |
|-------------------------------|------------------------------------|-------------------------------|
| 1. Gasket, Oil Pump to C'case | 10. Screw, Adjusting               | 19. Washer, Plain             |
| 2. Housing Assembly           | 11. Gasket                         | 20. Washer, Lock              |
| 3. Stud, Adapter              | 12. Housing Assembly, Relief Valve | 21. Nut                       |
| 4. Stud 1/4 x 1 1/16 In Lg    | 13. Helical Coil Insert            | 22. Adapter, Outlet to Cooler |
| 5. Gear Assembly              | 14. Washer                         | 23. Washer, Plain             |
| 6. Bushing                    | 15. Nut, Elastic Stop              | 24. Washer, Lock              |
| 7. Plunger                    | 16. Gear Assembly, Drive           | 25. Nut, Plain                |
| 8. Spring                     | 17. Adapter, Drive                 | 26. Filter Assembly           |
| 9. Washer                     | 18. Cover Assembly                 |                               |

**18-14 CYLINDER AND PISTON AND RING ASSEMBLIES** (See Figure 18-4)

a. General. The cylinders for the "AE" engines are straight valve cylinders. Except for the pushrod housing attachment, all instructions relative to the inclined valve cylinders used in the basic 520 series will also apply to the straight valve cylinder. The piston is a three ring piston.

**18-15 DISASSEMBLY**

a. Remove screw (40) and washers (39) to separate clip (38) from crankcase. All other disassembly procedures applicable to the inclined valve cylinders will also apply to the straight valve cylinders.

b. When the cylinders are removed from the engine, remove the pushrod housing (33) and one "O" ring (36) from the cylinder end. Remove the washer (34) and packing (35) from the crankcase end.

**18-16 CLEANING, INSPECTION AND REPAIR**

a. Cleaning and repair instructions for the "AE" cylinder and pistons are the same as the inclined valve cylinders. The valve guides for the "AE" are prefinished so they do not require reaming to size after replacement.

b. Inspect the cylinder in accordance with Figure 18-5.

### 18-17 REASSEMBLY

a. Reassemble the straight valve cylinder components in the same manner as the inclined valve cylinder. Note that there is one common rocker shaft for both valve rockers which is secured by the tab washer (26) and screw (25).

b. Install the "O" ring (36) on the cylinder end of the pushrod housing and the washer (34) and packing (35) on the crankcase end. When the cylinder and pushrod housings are installed on the crankcase, secure the pushrod with clip (38) and washers and screws (39,40).

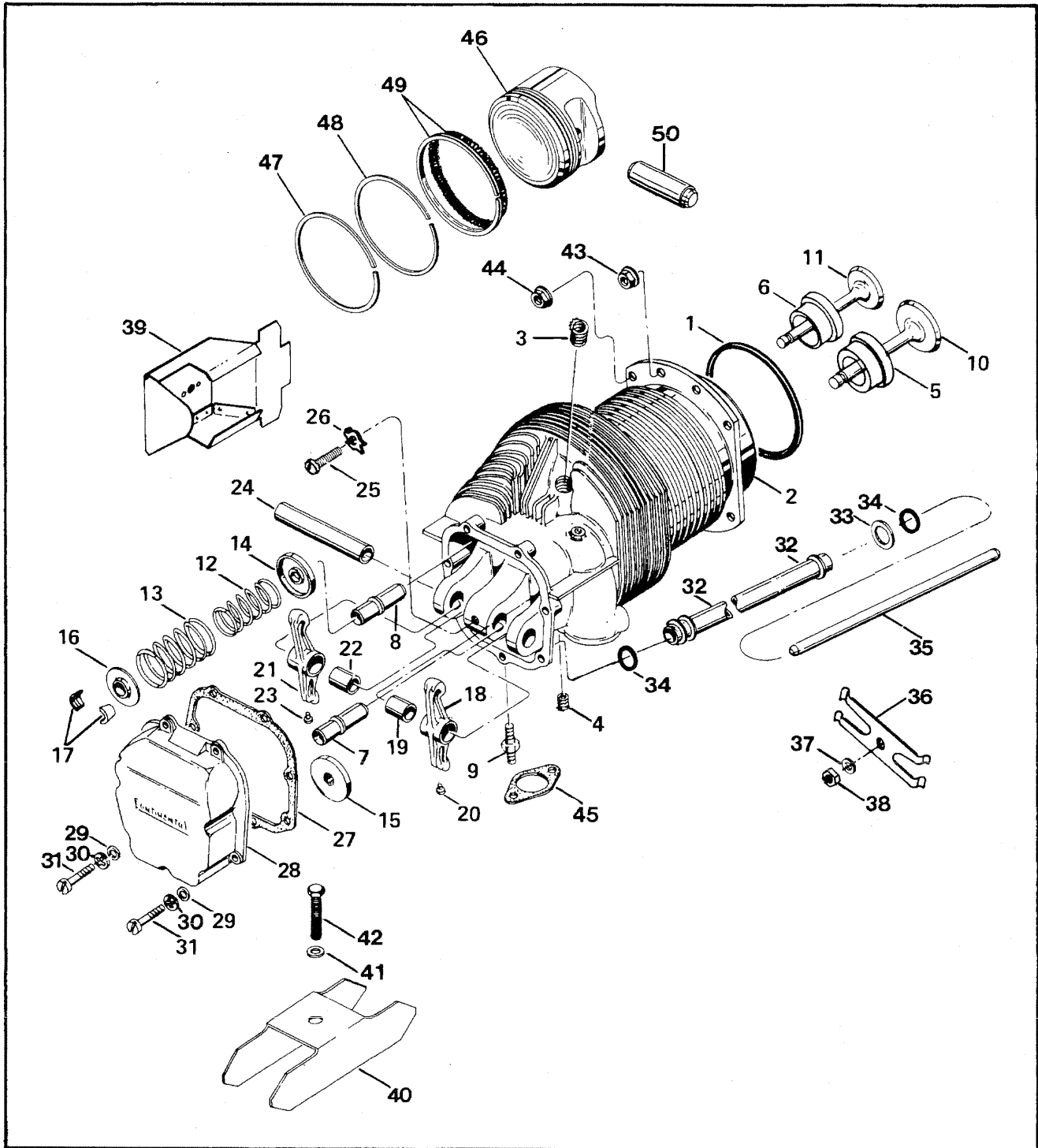
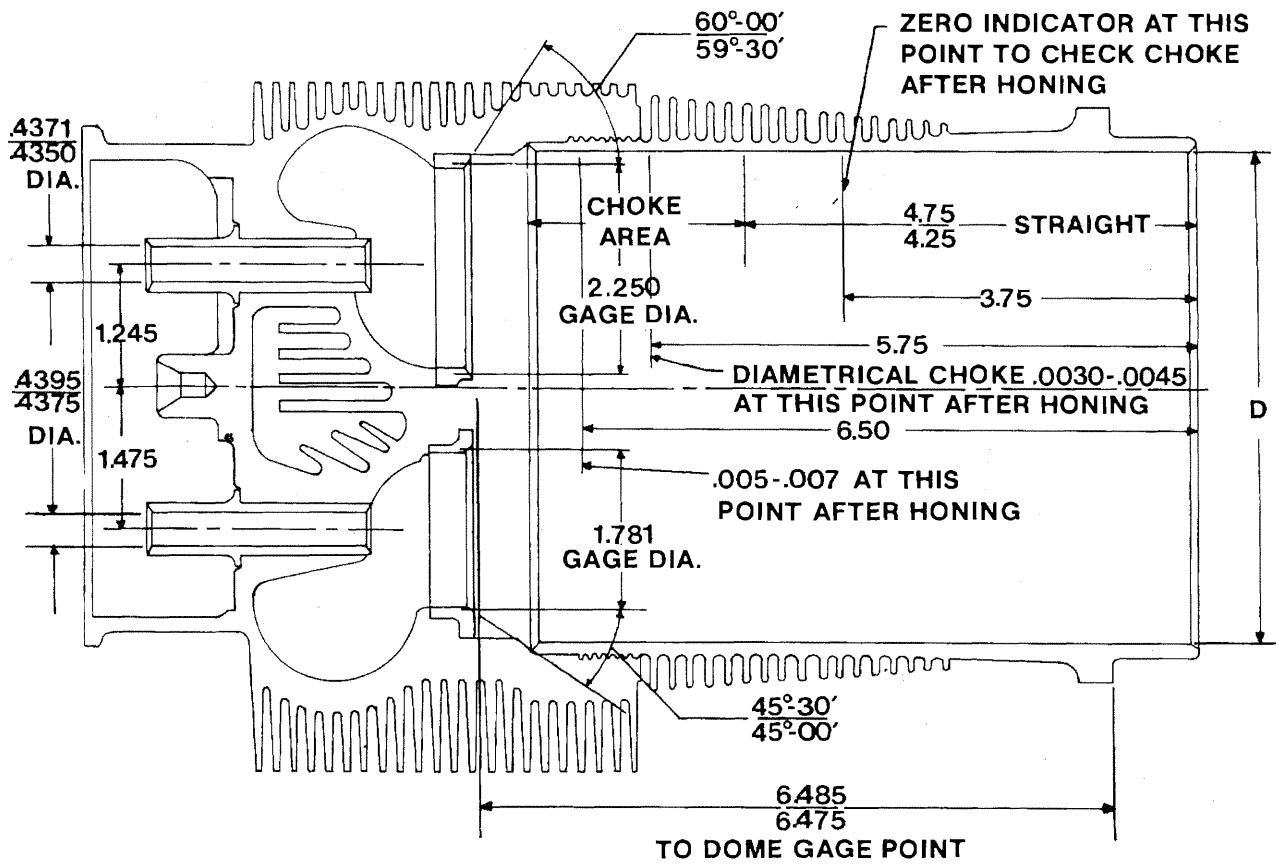


FIGURE 18-4  
CYLINDER ASSEMBLY

1. "O" Ring
2. Cylinder Assembly
3. Insert, Spark Plug
4. Insert, Intake Flange
5. Insert, Intake Valve Seat
6. Insert, Exhaust Valve Seat
7. Guide, Intake Valve
8. Guide, Exhaust Valve
9. Stud, Ring Locked
10. Valve, Intake
11. Valve, Exhaust
12. Spring, Valve, Inner
13. Spring, Valve, Outer
14. Retainer, Valve Spring, Inner
15. Retainer, Valve Spring, Outer, Intake
16. Roto Coil, Valve Spring, Outer, Exhaust
17. Key, Valve Spring Retainer
18. Rocker Assembly, Intake
19. Bushing
20. Screw, Drive No. 2
21. Rocker Assembly, Exhaust
22. Bushing
23. Screw, Drive No. 2
24. Shaft, Valve Rocker
25. Screw
26. Washer, Tab
27. Gasket, Valve Rocker Cover
28. Cover, Valve Rocker
29. Washer, Plain
30. Washer, Lock
31. Screw
32. Housing, Pushrod
33. Washer, Pushrod Housing
34. Gasket, "O" Ring
35. Rod Assembly, Push
36. Clip, Pushrod Housing
37. Washer, Plain
38. Nut, Plain
39. Baffle Assembly
40. Baffle, Engine Support
41. Washer, Plain
42. Bolt
43. Nut, Flanged, 7/16
44. Nut, Flanged, 1/2
45. Gasket, Exhaust
46. Piston
47. Ring, Top Groove
48. Ring, 2nd Groove
49. Ring Assembly, 3rd Groove
50. Pin and Plug Assembly





SIZE	"D" DIAMETER (INCHES)		
	NEW PARTS		SERVICE LIMIT
	MIN.	MAX.	
STANDARD	5.251	5.253	5.256

FIGURE 18-5. CYLINDER DIMENSIONS.

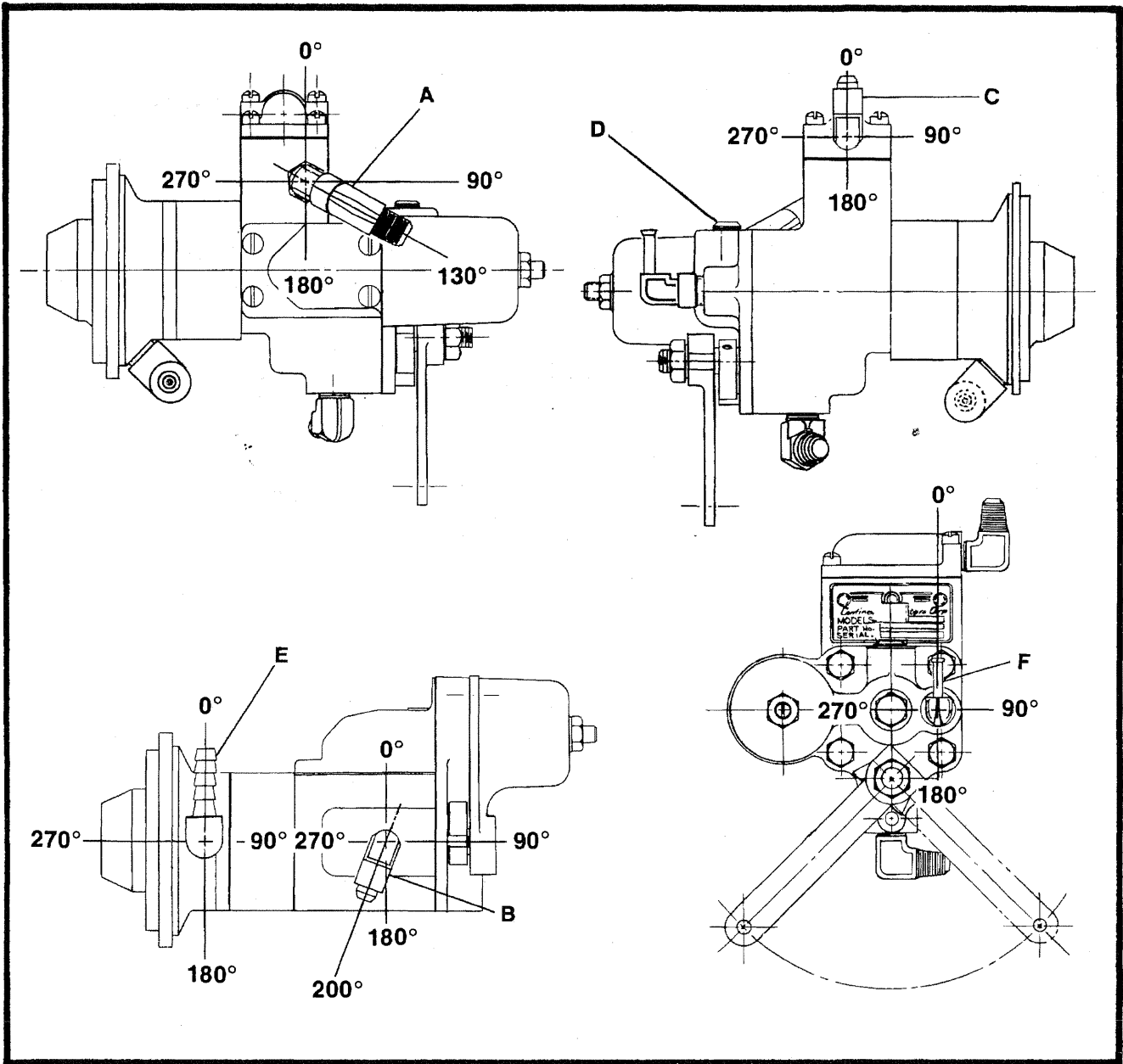


FIGURE 18-6. FUEL PUMP FITTING LOCATIONS.

Inlet Fitting	Outlet Fitting	Vapor Return Fitting	S/C Press. Fitting	Seal Drain Fitting	S/C Press. Fitting
"A"	"B"	"C"	"D"	"E"	"F"
130°	200°	0°		0°	0°

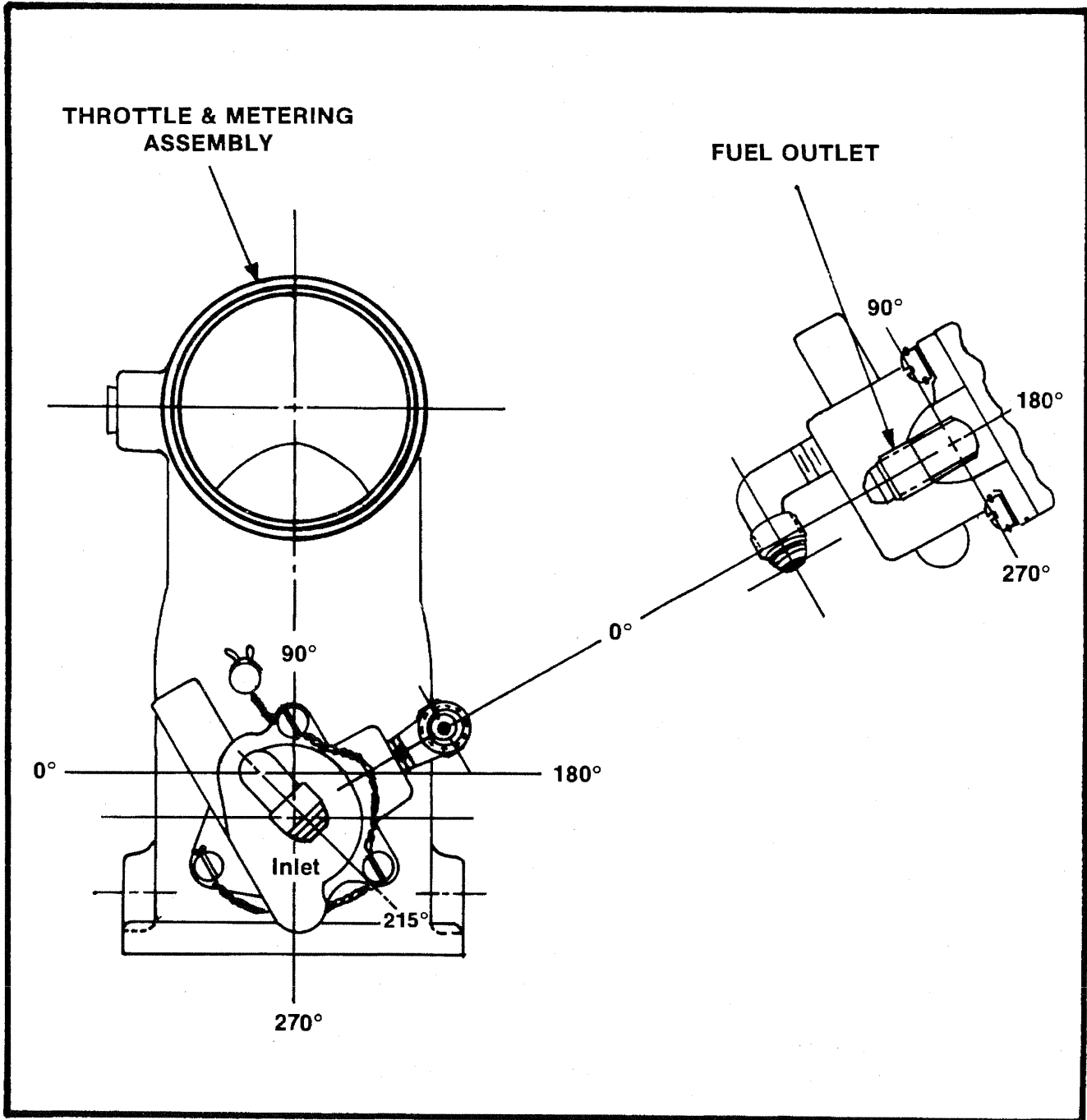


FIGURE 18-7. AIR THROTTLE & METERING ASSEMBLY FITTING LOCATIONS.

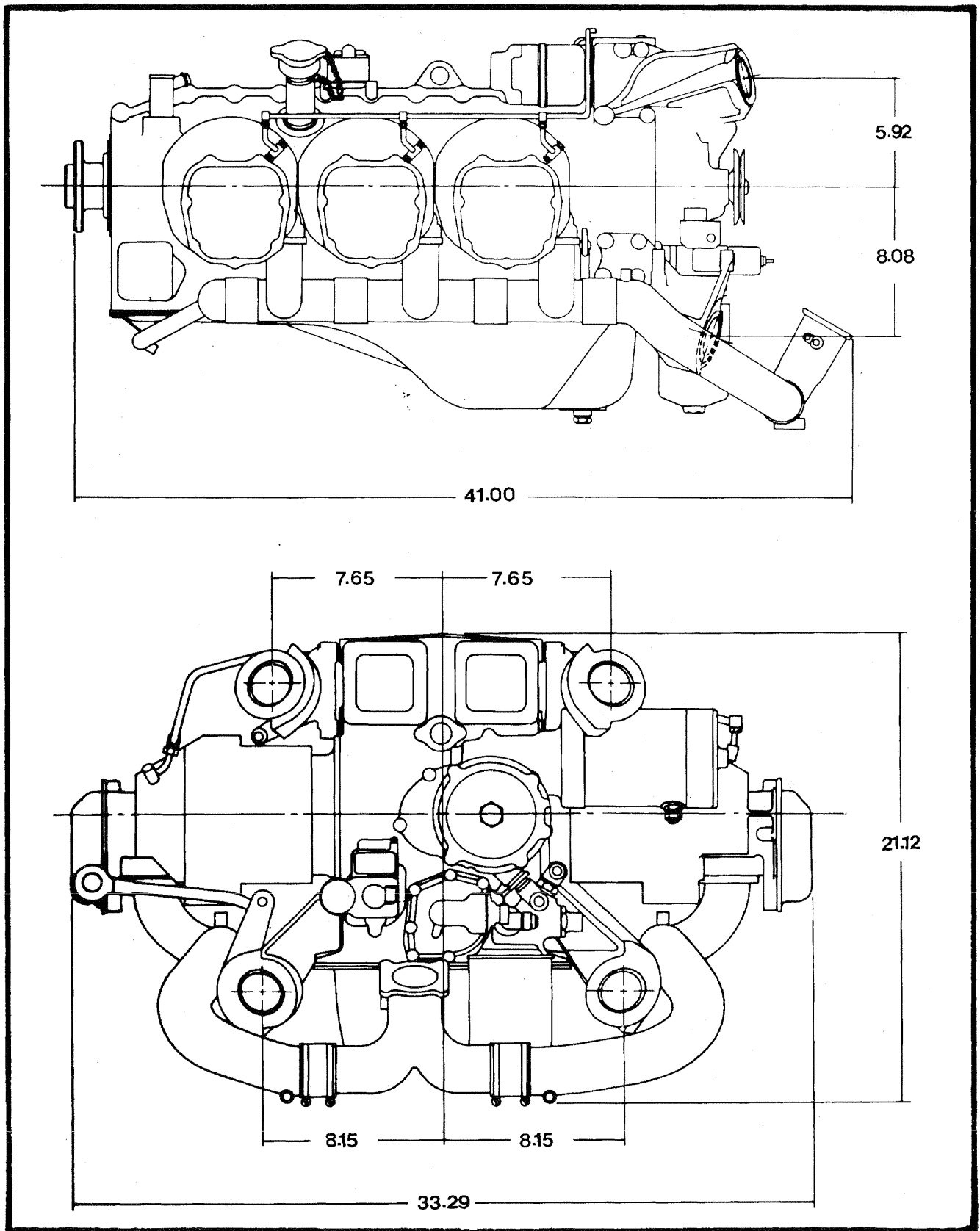


FIGURE 18-8. ENGINE DIMENSIONS.

**TABLE XXXI  
OPERATING TEST LIMITS  
TSIO-520-AE**

Run in schedule	1 Hr. 20 Min.
Maximum rated RPM and tolerance	2700 - 2750 RPM
Oil Consumption at max. rated power	2.0 lbs./40 Min.
Oil Grade to be used	SAE No. 50
Fuel Grade to be used	100, 100LL
Idling RPM and tolerance	600 ± 25 RPM
Manifold pressure at max. rated power*	32.5 In. Hg. Abs.
Manifold pressure at idle	18.5 In. Hg. Abs.
Magneto Spread at 1700 RPM	50 RPM Max.
Crankcase Pressure**	4.0 In. H <sub>2</sub> O Max.
Oil Temperature	240° F. Max.
Oil Temperature - Desired range	150° F. - 200° F. Max.
Oil pressure at max. rated power (Engine oil temperature 175° - 185° F.)	30 psi
Oil pressure at idle (Engine oil temperature 140° - 150° F.)	10 psi Min.
Ignition timing and tolerance	Left - 20° BTC ± 1° Right - 20° BTC ± 1°
Turbocharger inlet air pressure and outlet pressure	± 7.0 In. H <sub>2</sub> O
Cylinder head temperature	460° F. Max. (At bayonet thermocouple)
Normal Rated Power	250 BHP @ 2400 RPM
Power Correction for intake air temperature***	1% per 6° F.

\*Max. Manifold Pressure at 32.5 In. Hg. exhaust gas back pressure.

\*\*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.

\*\*\*Correct horsepower for turbocharger inlet air temperature as follows:

(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° F. colder than 60° F.

**TABLE XXXII**  
**TOP OR MINOR AND**  
**MAJOR OVERHAUL TEST RUN**  
**TSIO-520-AE**

Period	Time-Minutes	RPM	
1	5	1200	Warm-up
2	5	1600	
3	5	2100	
4	10	(1) 2400-2450	100% Power
5	10	(2) 1700	Check Magnetos
6	10	575-625	Idle Cooling

**NOTE**

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

Period	Time-Minutes	RPM	
7	5		Warm up to rated RPM (1200)
8	30	(3) 2100	
9	5	600	

**NOTE**

Stop engine, drain oil, weight and record engine oil consumption. Oil consumption at a rate of 2.0 lbs./40 Min. run maximum is acceptable. If value in excess of 2.0 lbs./40 Min. run is determined, rerun 40 minutes. If oil consumption is still excessive return engine to overhaul.

- (1) Adjust engine fuel flow, fuel pressure, etc. (Reduce RPM for adjustments.)
- (2) Engine parameter checks - see applicable data. Perform mag check at 1700 RPM. Engine must be throttled to specified RPM and temperature allowed to settle out before taking magneto drop and spread.
- (3) Readings must be recorded after completion of each 10 minute interval during oil consumption run.

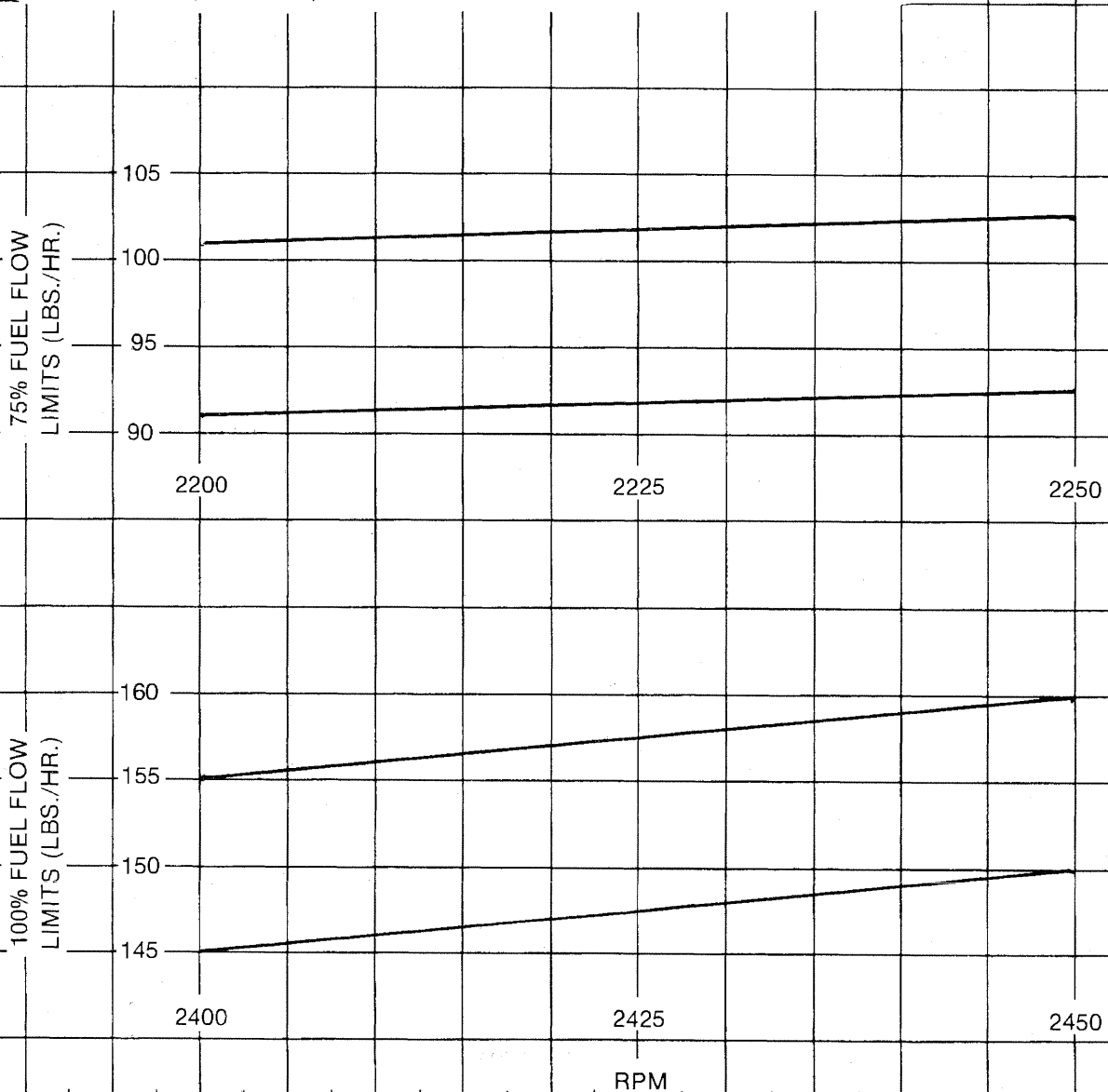
## FUEL FLOW LIMITS FOR L/TSIO-520A

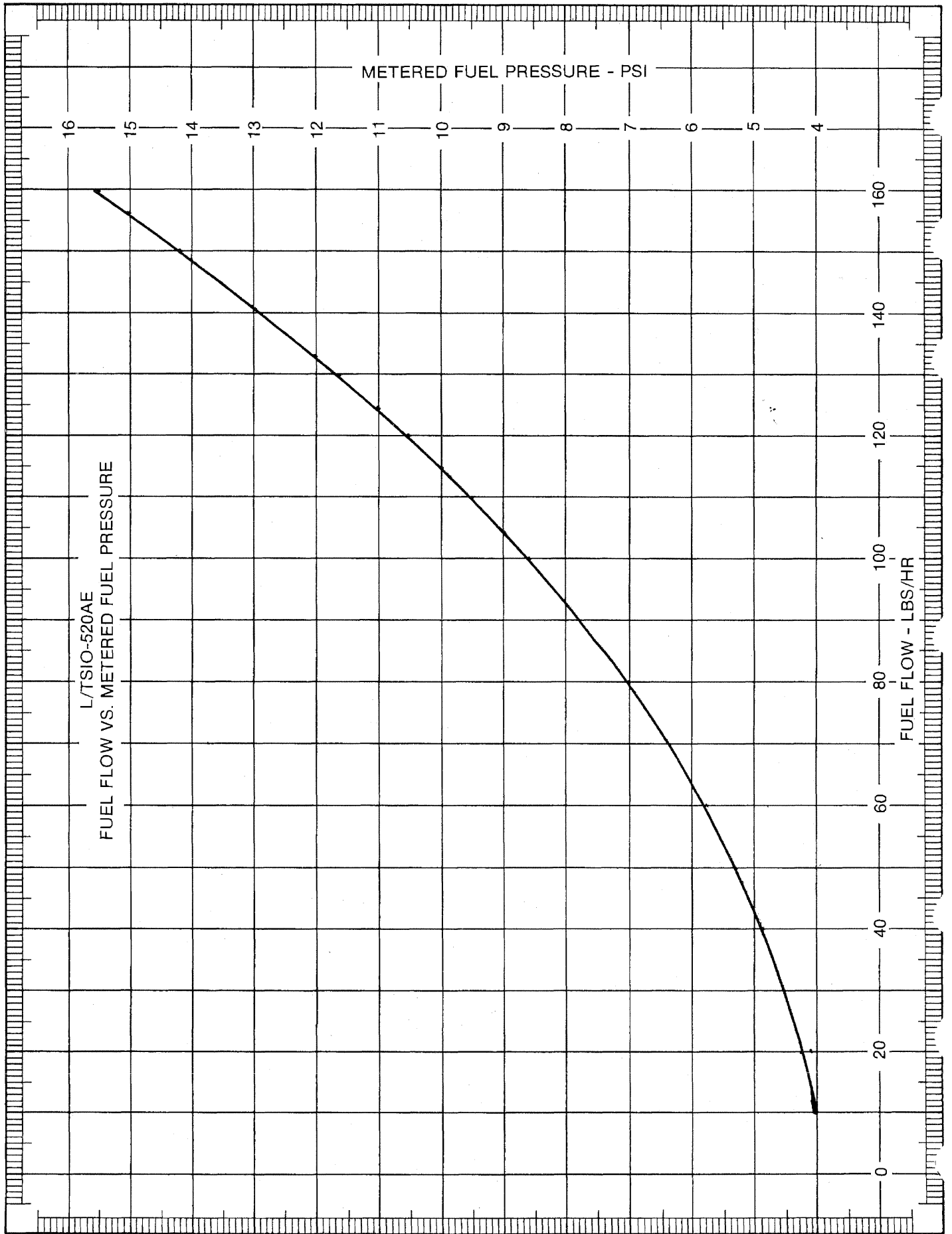
NOTE: THIS CHART IS FOR 70° F INJECTOR FUEL TEMPERATURE. FOR EVERY 10° F INCREASE IN INJECTOR INLET FUEL TEMPERATURE, SUBTRACT 1 LB. OF FUEL FROM THE CURVE. FOR EVERY 10° F DECREASE IN INJECTOR INLET FUEL TEMPERATURE, ADD 1 LB. OF FUEL TO THE CURVE.

### CHART INSTRUCTIONS:

1. OBTAIN ACTUAL MAXIMUM RATED RPM.
2. DETERMINE REQUIRED RPM FOR 100% AND 75% POWER BY READING DIRECTLY ABOVE THE ACTUAL MAXIMUM RATED RPM POINT.
3. DETERMINE FUEL FLOW LIMITS FOR 100% AND 75% POWER BY READING DIRECTLY ABOVE THE ACTUAL MAXIMUM RATED RPM POINTS.

NOTE: IDLE (600 + 25) FUEL FLOW 10.0 - 12.0 LBS./HR.





L/TSIO-520AE  
 FUEL FLOW VS. METERED FUEL PRESSURE

METERED FUEL PRESSURE - PSI

FUEL FLOW - LBS/HR



## **SECTION XIX**

The TSIO-520-AF is rated at 285 BHP at 2600 RPM with a five minute take-off rating of 310 BHP at 2700 RPM. Overhaul procedures for the TSIO-520-AF will be the same as those for the TSIO-520-C or -G except for the differences noted in Section XIX.

## SECTION XIX

### 19-1 GENERAL

a. Physical Differences. The TSIO-520-AF engine incorporates a new cylinder design. The new cylinder is assembled with a venturi type intake seat, nitralloy pre-sized valve guides, a roto coil in both the intake and exhaust position and an intake valve guide seal.

The piston installed on the TSIO-520-AF has a steel insert cast into the aluminum into which the top piston ring groove is machined.

b. Operating Differences. The TSIO-520-AF is rated at 285 BHP at 2600 RPM and 34.5 in Hg manifold pressure at Sea Level. A five minute take-off rating is allowed at 310 BHP at 2700 RPM and 35.5 in Hg at Sea Level.

### 19-2 CYLINDER ASSEMBLY

General. Except for the roto coil in both exhaust and intake positions and the use of valve guide seals, the procedures are the same as those in sections one through eight.

The roto coil needs no further elaboration in this

section.

a. Valve guide seal installation.

1. Install valve spring inner retainer.
2. Place plastic installation cap on the end of the valve stem and lightly lubricate the outer surface. If the cap extends more than 1/16 inch below the valve stem key groove, remove cap and cut off excess length. (Cap prevents the sharp edges of the valve spring key groove from cutting the valve seal insert.)
3. Start valve seal carefully over the valve stem. Hold thumbs against the white insert to prevent dislodging it and push seal down until the seal jacket touches the top of the valve guide.
4. Place two small blade screwdrivers about 90 degrees from the cap in the retaining ring and pull the ring down over the valve guide until the seal is flush with the top of the guide.

NOTE... Compress springs only enough to install keepers. Excess compression can cause spring retainers to damage valve seal.

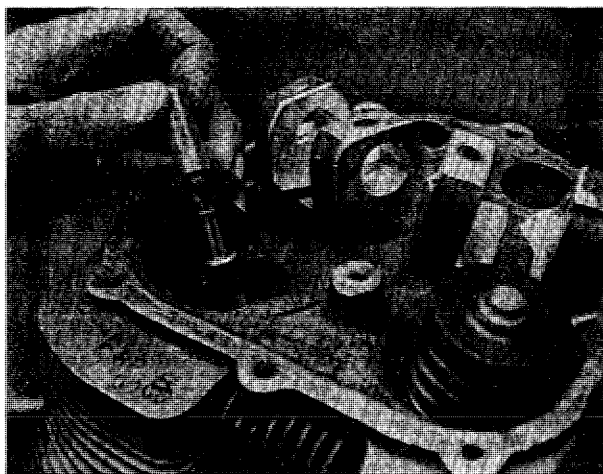


FIGURE 19-1

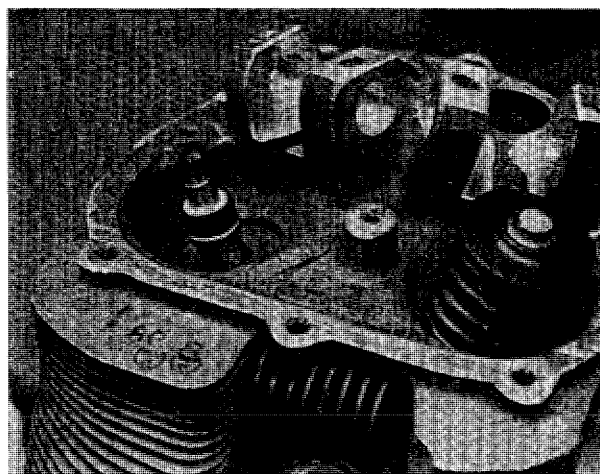


FIGURE 19-2

**TABLE XXXIII**  
**OPERATING TEST LIMITS**

Run-in schedule	1 hr. 20 min
Maximum rated RPM	2600 RPM
Take Off RPM	2700 RPM
Oil Consumption	$.006 \times \frac{\% \text{ Power}}{100}$
Oil grade to be used	SAE No. 50
Fuel grade to be used	100, 100 LL
Idling RPM and tolerance	600 $\pm$ 25 RPM
Manifold pressure at max. rated power (sea level)	34.5
Manifold pressure at take off power (sea level)	35.5
Manifold pressure at idle	18.5" Hg.abs.Max.
Magneto spread at 2100 RPM	50 RPM max.
Magneto drop at 2100 RPM	150 RPM
Crankcase Pressure*	4.0" H <sub>2</sub> O max.
Oil temperature	240° F. Max.
Oil temperature - desired range	150° - 200° max.
Oil pressure at max. rated power (engine oil temperature 175° - 185° F.)	30-60 psi
Oil pressure at idle (engine oil temperature 140° - 150° F.)	10 psi minimum
Timing of engine and tolerance	Left - 22° BTC $\pm$ 1° Right - 22° BTC $\pm$ 1°
Turbocharger exhaust outlet pressure and inlet pressure	$\pm$ 7.0" H <sub>2</sub> O
Cylinder head temperature	460° F. max. (at bayonet thermocouple)
Normal rated power	285 BHP
Take Off Power (5 Minutes)	310 BHP
Power Correction for intake air temperature**	1% per 6° F.

\* 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.

\*\* Correct horsepower for turbocharger inlet air temperature is as follows:  
(1) Add 1% for each 6° F. hotter than 60° F. (2) Subtract 1% for each 6° F. colder than 60° F.

**TABLE XXXIV**

**TOP OR MINOR AND MAJOR OVERHAUL TEST RUN  
TSIO-520-AF**

Period	Time-Minutes	RPM
1	5	1200
2	5	1600
3	5	2450
4	10	2600 (Adjust Engine-Fuel flow, Pr., etc.) (Reduce RPM for adjustment)
5	12	Engine Parameter checks (Fuel inj., oil Pr. Temp. etc. - See Table XXXIII 2100 RPM Mag. Check.)
6	5	600 Idle, (Cooling Period - 300° Max. C.H.T. before Shutdown)

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

7	5	Warm up to rated RPM (1200 RPM Min.).
8	30	2450 (Reading to be recorded after each 10 min. interval)
9	5	600 idle (Cooling period - 300° Max C.H.T. before shutdown.)

If engine is not to be placed in service apply corrosion preventive treatment in accordance with service bulletin M81-3 Rev 1.