IO-520

CONTINENTAL® AIRCRAFT ENGINE

OVERHAUL MANUAL

TECHNICAL CONTENT ACCEPTED BY THE FAA

Publication X30039

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Supersedure Notice

This manual revision replaces the front cover and list of effective pages for Publication Part No. X30039, dated September 1977. Previous editions are obsolete upon release of this manual.

Effective Changes for this Manual

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SECTION I
INTRODUCTION

1-1. SCOPE. This publication comprises Overhaul Instructions for the IO-520 Series Aircraft Engines.

1-2. RELATED PUBLICATIONS. Detail part numbers and service assemblies for these engine models are contained in Parts Catalog X-30040A. Operating instructions are contained in Operator's Handbook X-30041.

a. Service instructions for Slick Magneto Model No. 662 may be obtained from Slick Electro Inc., Rockford, Illinois 61100.

b. Service instructions for Bendix Magneto Model S6RN-201, S6RN-205, S6RN-1201 and S6RN-1205 may be obtained from Bendix Corporation, Electrical Components Division, Sidney, New York 13830.

c. Service instructions for Delco-Remy Starters, Generators or Alternators may be obtained from Delco-Remy Division, General Motors Corporation, Anderson, Indiana 96011.

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 or 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. Request 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 every major airport.

1-5. CYLINDER ARRANGEMENT. Cylinders are numbered starting from the rear, with odd numbers on the right and even numbers on the left.

1-6. DEFINITIONS AND ABBREVIATIONS

Term .	Explanation
A.B.C.	After Bottom Center
Approx.	Approximately
A.T.C.	After Top Center
Bar.	Barometric
B.B.C.	Before Bottom Center
B.H.P.	Brake horsepower
B. T.C.	Before Top Center
F.A.A.	Federal Aviation Administration
C.A.R.	Civil Air Regulations
c.f.m.	Cubic feet per minute
C.G.	Center of Gravity
Dia.	Diameter
°	Degrees of Angle
°F.	Degrees Farenheit
Fig.	Figure (Illustration)
Front	Propeller End
ft.	foot or feet
G.P .M.	Gallons per minute
H2O	Water
Hg.	Mercury
I.D.	Inside Diameter
in. (")	Inches
Hex.	Hexagon
hr.	Hour
Left Side	Side on which Nos. 2, 4 and 6 cylinders are located
Lbs.	Pounds
Lockwire	Soft steel wire used to safety connections, etc.
Man.	Manifold or manometer
Max.	Maximum
Min.	Minimum
30'	thirty minutes of angle (60' equal one degree)
N.P.T.	National pipe thread (tapered)

Term .	Explanation
N.C.	National Coarse (thread)
N.F.	National Fine (thread)
O.D.	Outside Diameter
Press.	Pressure
p.s.i.	Pounds per square inch
Rear	Accessory end of engine
Right Side	Side on which Nos. 1, 3 and 5 cylinders are located
R.P.M.	Revolution per minute
Std.	Standard
T.D.C.	Top dead center
Temp.	Temperature
Torque	Force x lever arm (125 ft.-lbs. force applied one ft. from bolt center or 62-1/2 lbs. applied 2 ft. from center)

TABLE I. PURCHASED ACCESSORIES

ACCESSORY	QTY
Magneto	2
Starter	1
Alternator	1
Generator	1
Oil Cooler	1
Fuel Pump	1
Spark Plugs	12

TABLE II. IGNITION SYSTEM DETAILS

FEATURE	VALUE
Left Magneto Fires	Lower No. 1-3-5 And Upper No. 2-4-6 plugs
Right Magneto Fires	Upper No. 1-3-5 And Lower No. 2-4-6 plugs
Firing order (cylinder numbers)	1-6-3-2-5-4
Permissible RPM spread when Switched from “Both” to either “Left” or “Right” magneto	50

1-7. 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.

TABLE III.

CHARACTERISTICS AND DIMENSIONS

DIMENSION	VALUE
Piston stokes per cylinder	4
Number of cylinders	6
Cylinder bore (inches)	5.25
Piston stroke (inches)	4.00

TABLE IV. TEMPERATURE LIMITS

INDICATED CONDITION	MIN.	MAX.
Oil temperature at takeoff	75°F	--
Oil temperature in flight	--	240°F.
Cylinder head temperature (bayonet thermocouple)*	--	460°F.
Magneto temperature (at coil hold-down screw)	--	170°F.

** Installed in tapped hole in bottom of cylinder head.*

TABLE V. PRESSURE LIMITS

INDICATION	MIN.	MAX.
Oil pressure (idling)	10 psi	--
Oil pressure (in flight)	30 psi	60 psi
Oil pressure (with cold oil)	--	100 psi

TABLE VI. VISCOSITY OIL GRADES

OIL OPERATING TEMPERATURE	OIL GRADE
Below 40°F.	30 OR 10W-30
† Above 40°F.	50

† Ambient air temperature is the controlling factor on all engines having oil temperature control valves installed.

1-8. OIL SUPPLY AND MEASUREMENT.

1-9. The capacity of the oil sump is 12 U.S. quarts. The oil filler cap is attached over the oil filler neck on top of the left crankcase. The oil sump is equipped with an oil level gauge notched and stamped with numerals representing quarts.

1-10. OIL CONSUMPTION.

1-11. When operated on a rigid test stand at cruise power settings and operating within specified limits oil consumption shall not exceed 1 quart per hour and one –half.

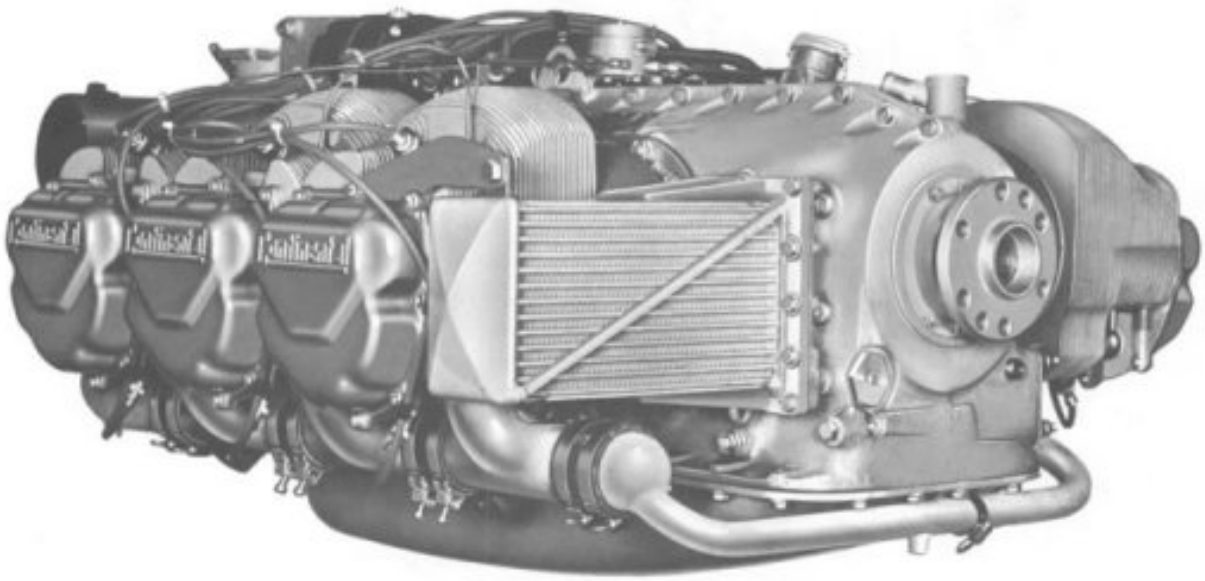


FIGURE 1-1. THREE-QUARTER RIGHT FRONT VIEW OF THE IO-520-A,E,F & K. (SANDCAST CASE)

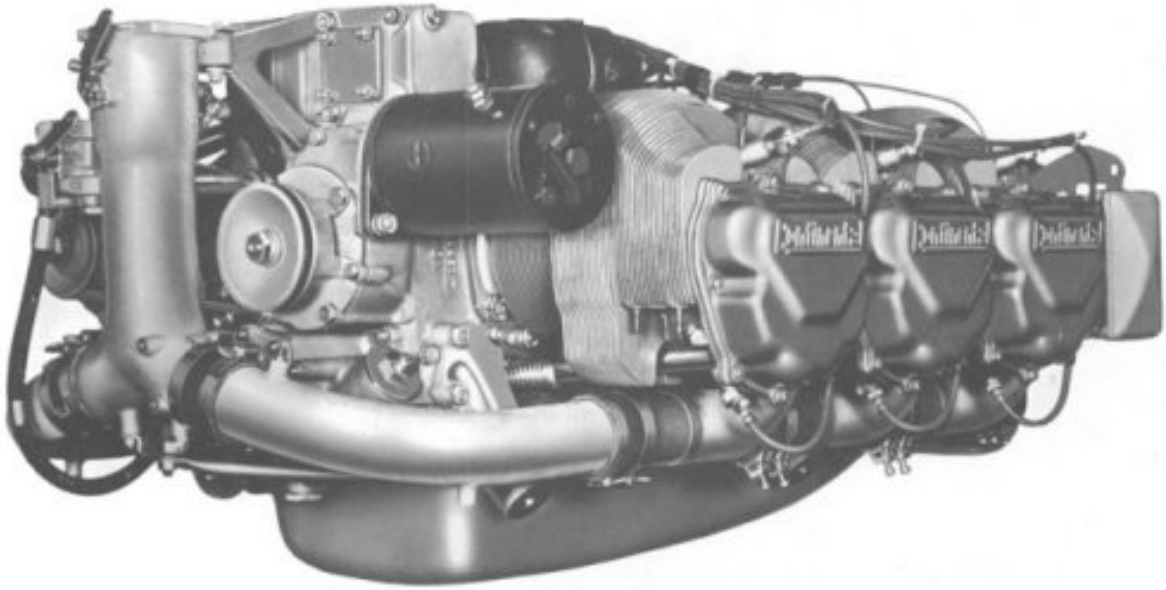


FIGURE 1-2. THREE-QUARTER REAR VIEW OF THE IO-520-A & F. (SANDCAST CASE)

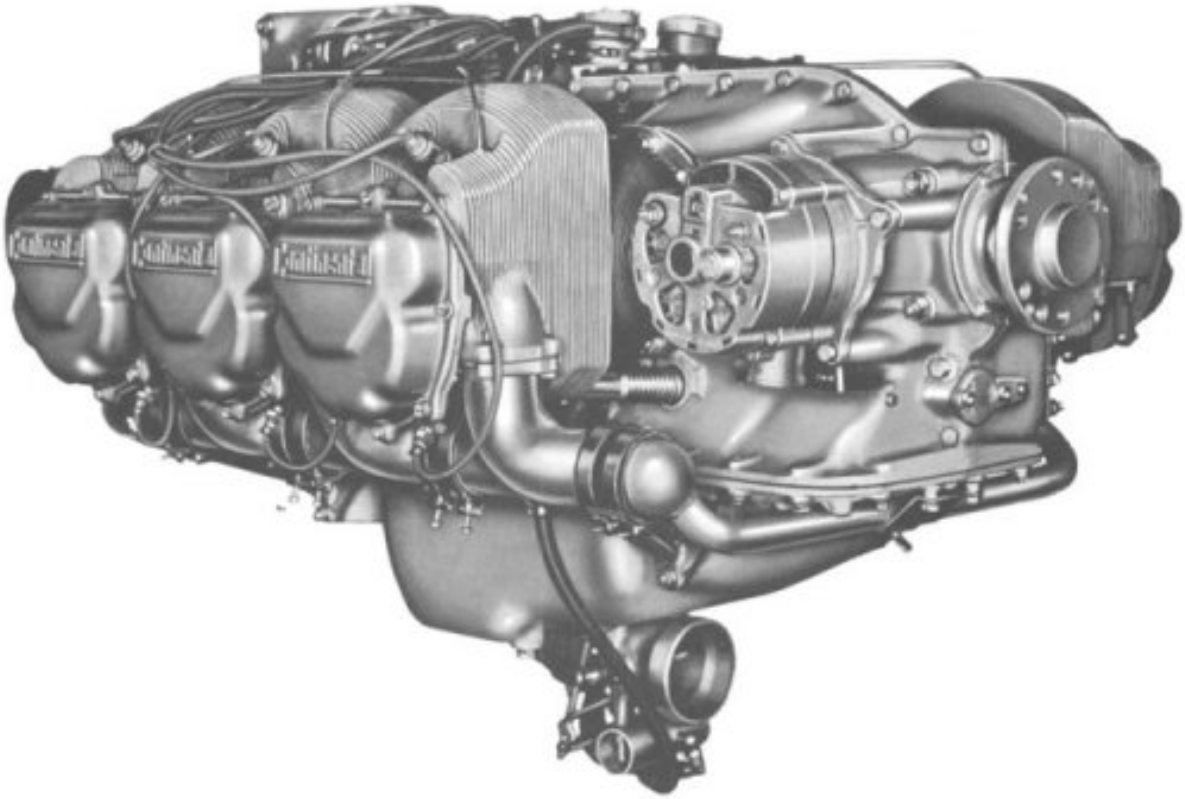


FIGURE 1-3. THREE-QUARTER RIGHT FRONT VIEW OF THE IO-520-B. (PERMOLD CRANKCASE)

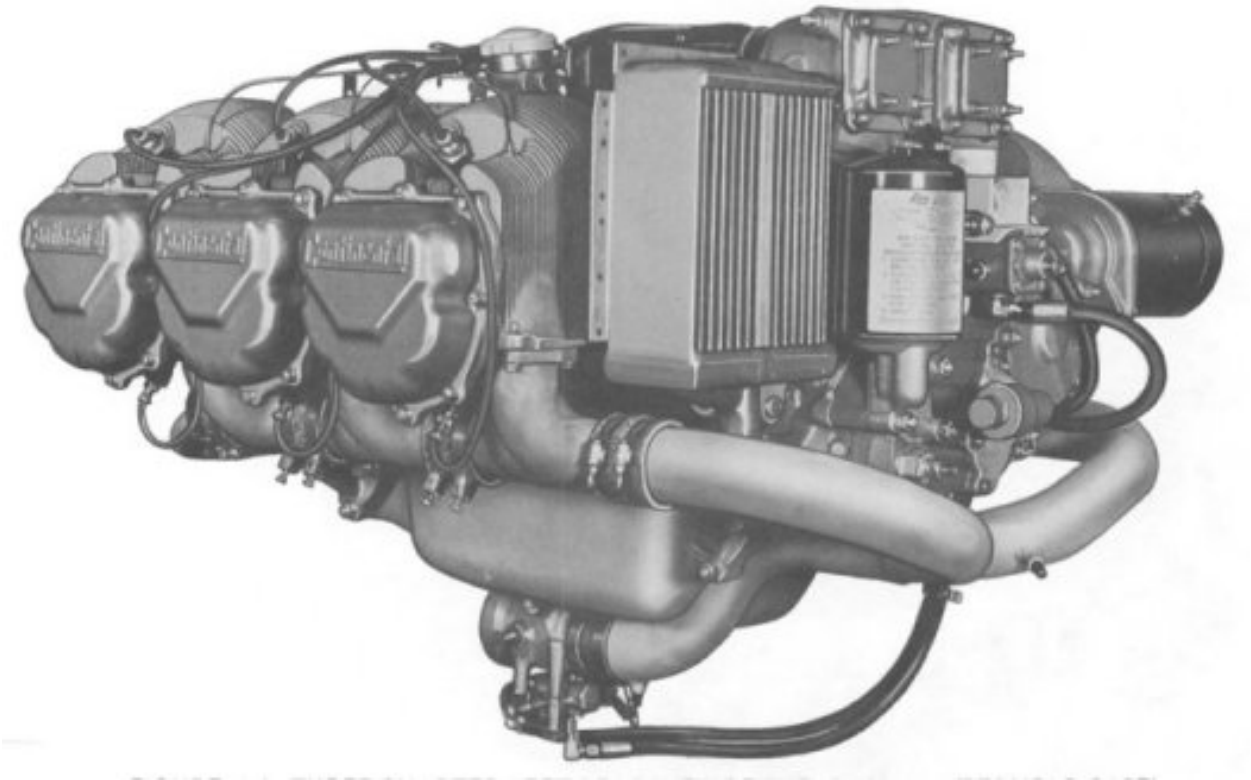
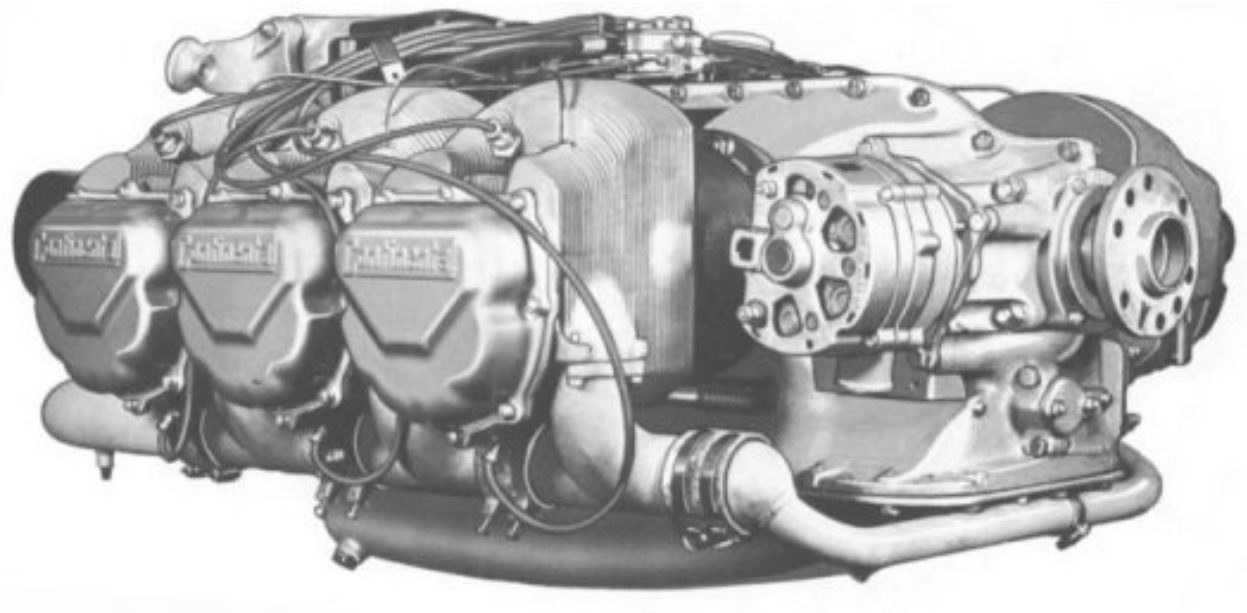


FIGURE 1-4. THREE-QUARTER LEFT REAR VIEW OF THE IO-520-B. (PERMOLD CASE)



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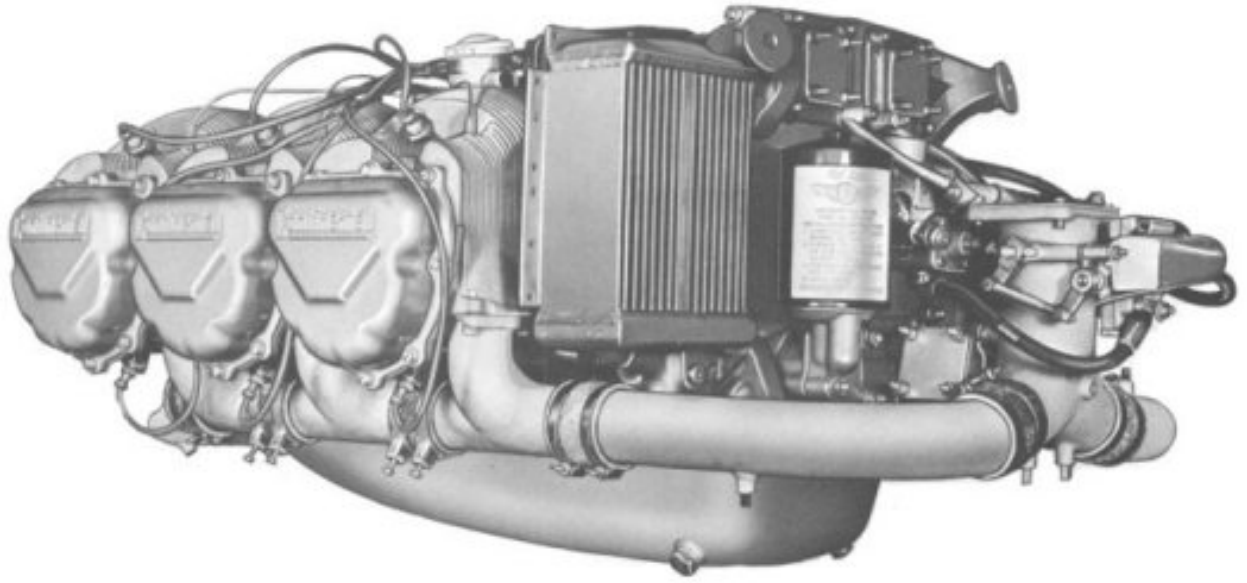

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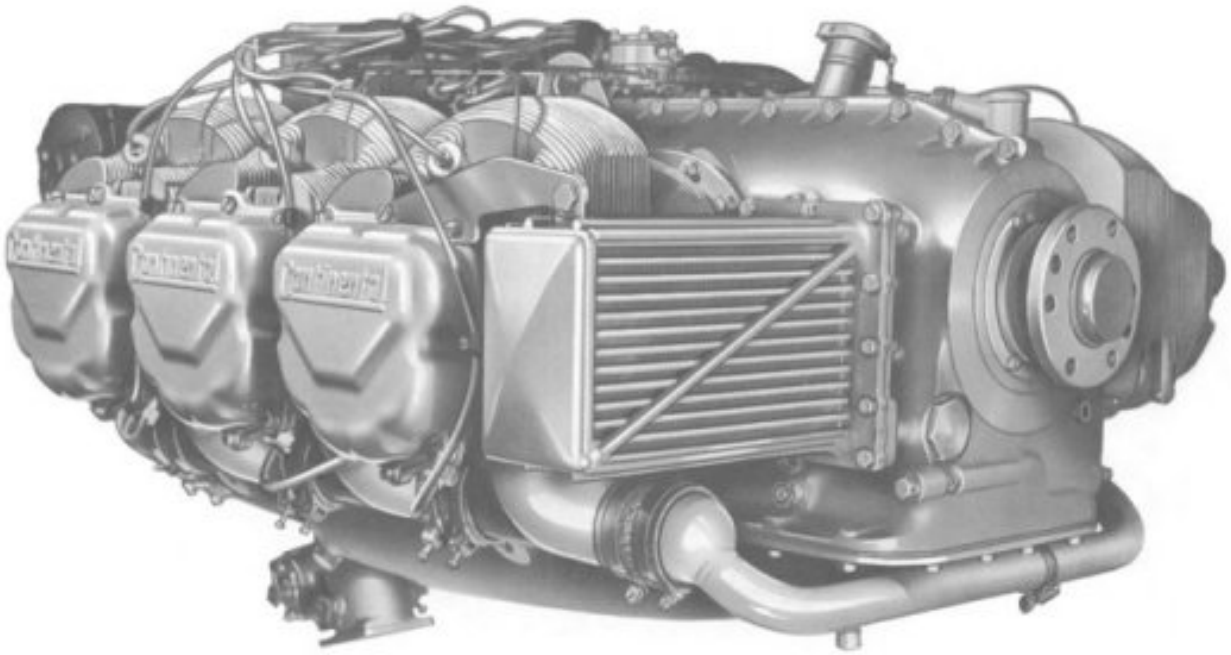


FIGURE 1-7. THREE-QUARTER RIGHT FRONT VIEW OF THE IO-520-D. (SANDCAST CRANKCASE)

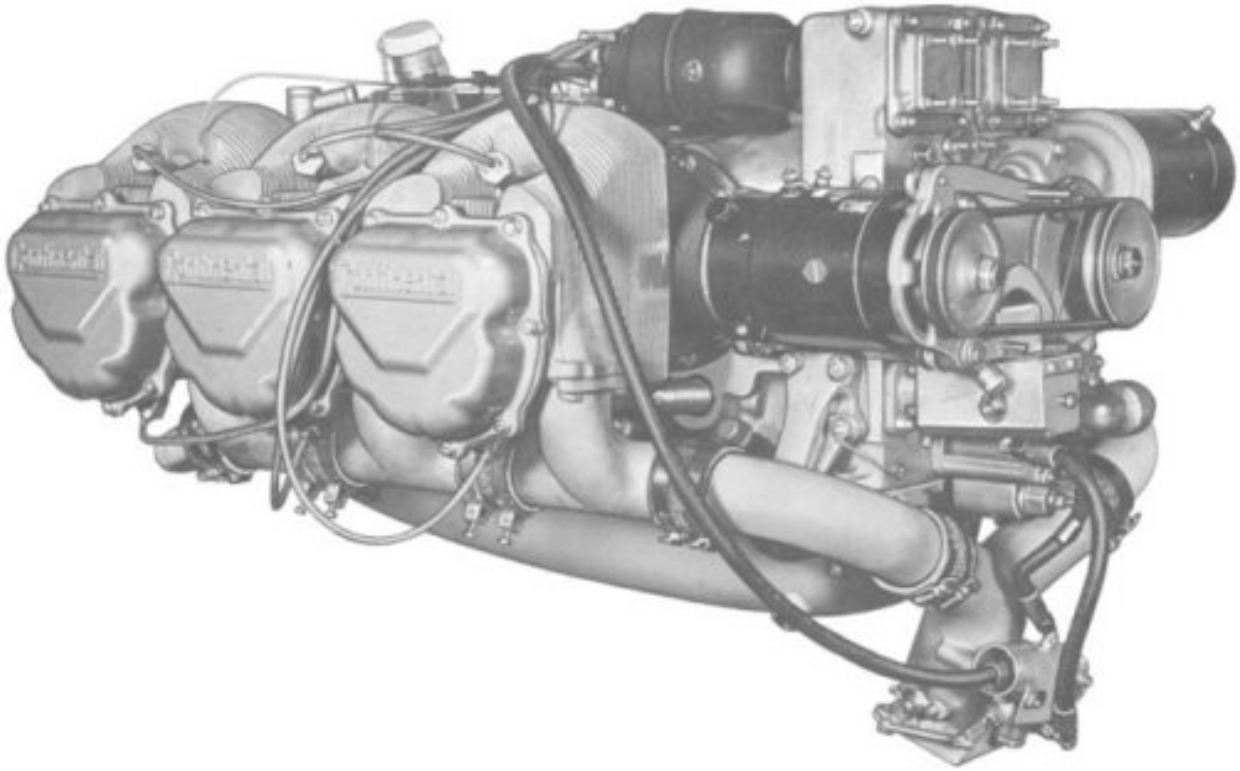
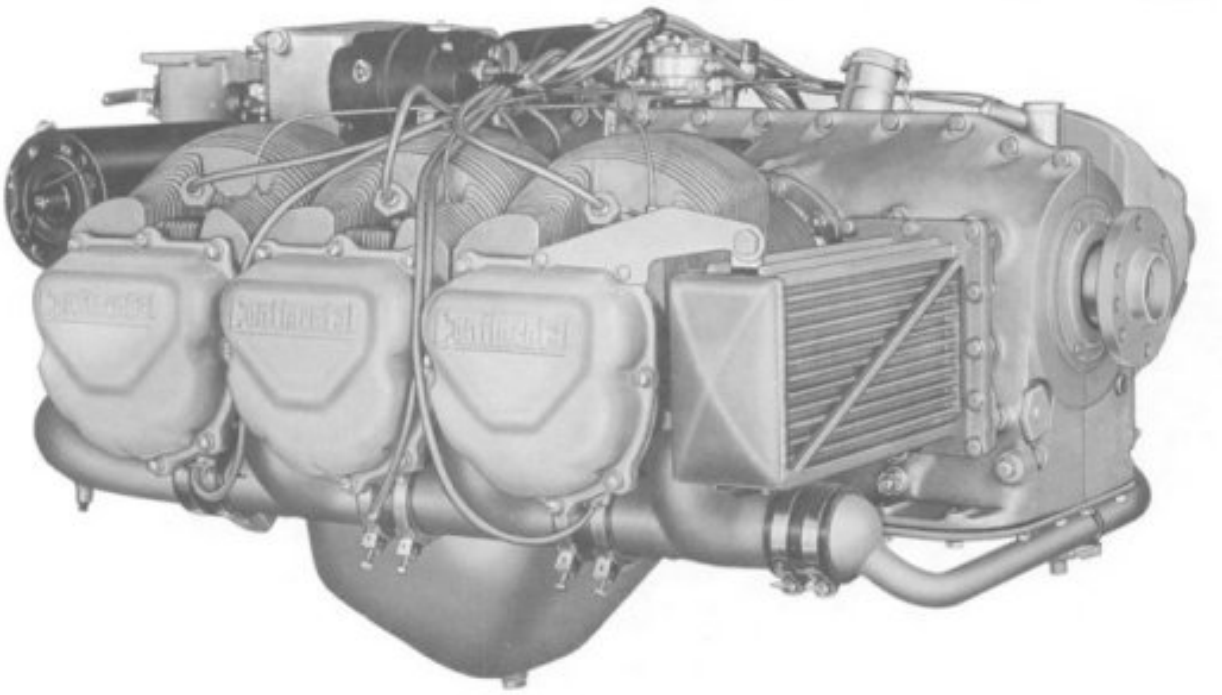


FIGURE 1-8. THREE-QUARTER LEFT REAR VIEW OF THE IO-520-D. (SANDCAST CRANKCASE)



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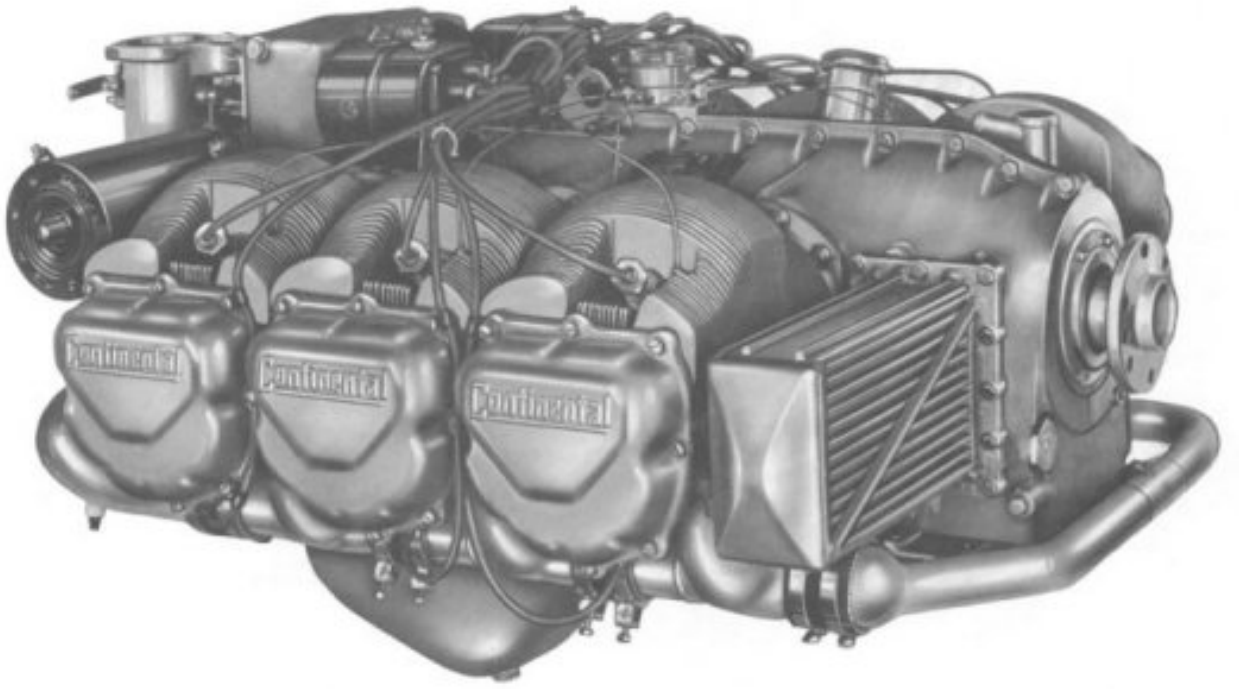

FIGURE 1-10. THREE-QUARTER RIGHT FRONT VIEW OF THE IO-520-L. (SANDCAST CRANKCASE)

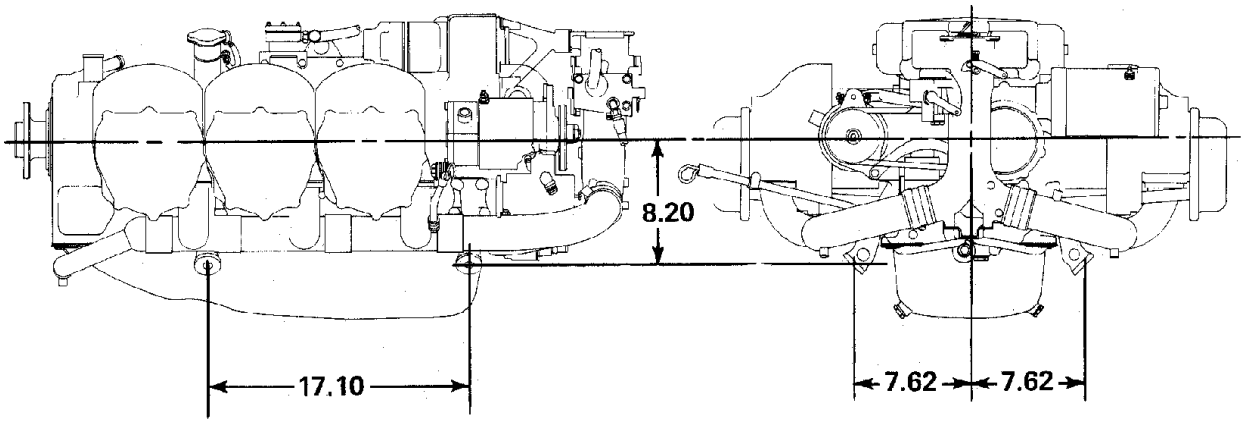

FIGURE 1-11. INSTALLATION DRAWING FOR THE IO-520-A,D,E,J,K & L.

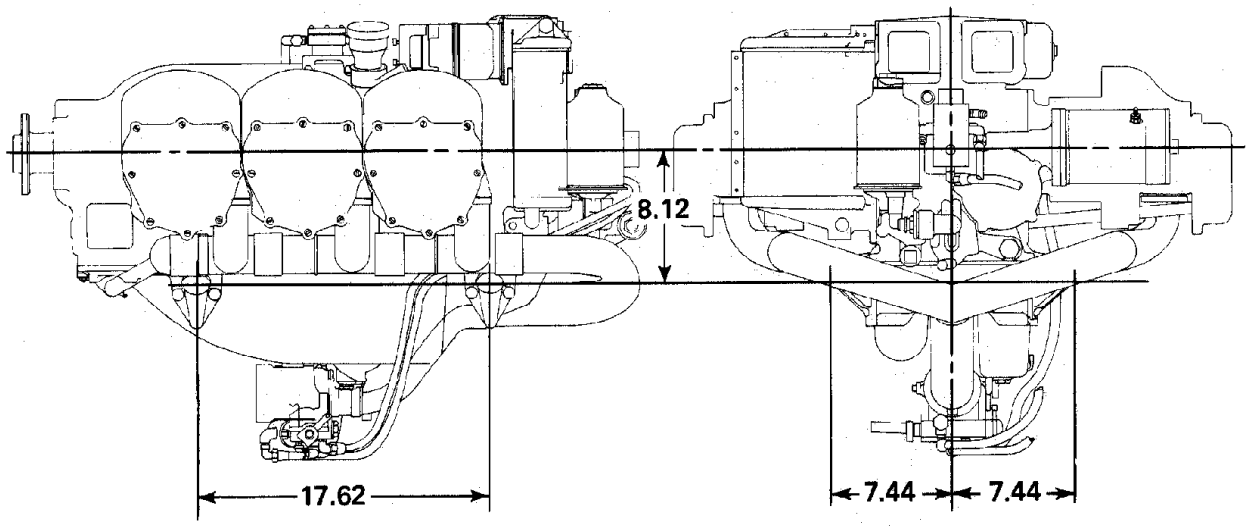

FIGURE 1-12. INSTALLATION DRAWING FOR THE IO-520-B.

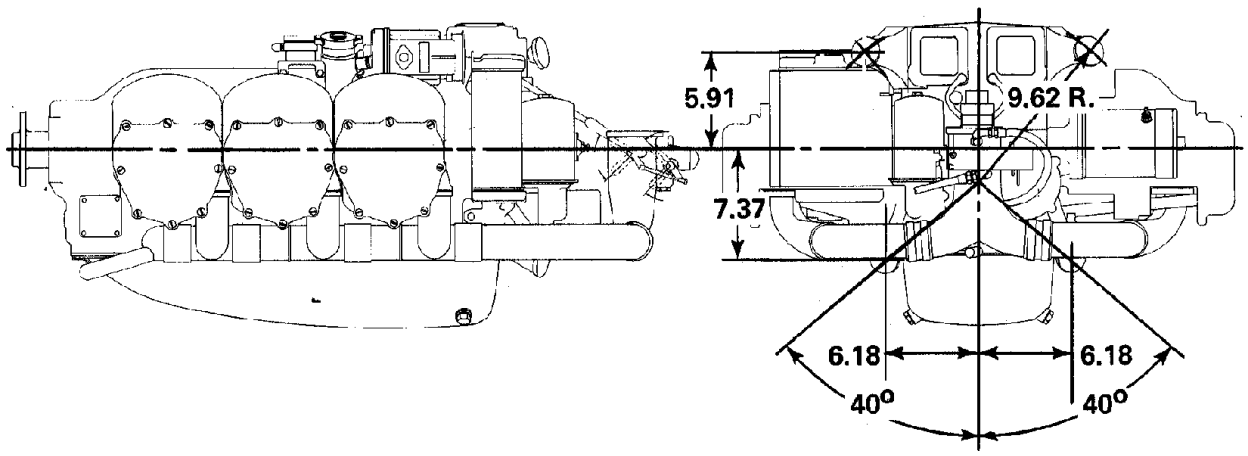

FIGURE 1-13. INSTALLATION DRAWING FOR THE IO-520-C.

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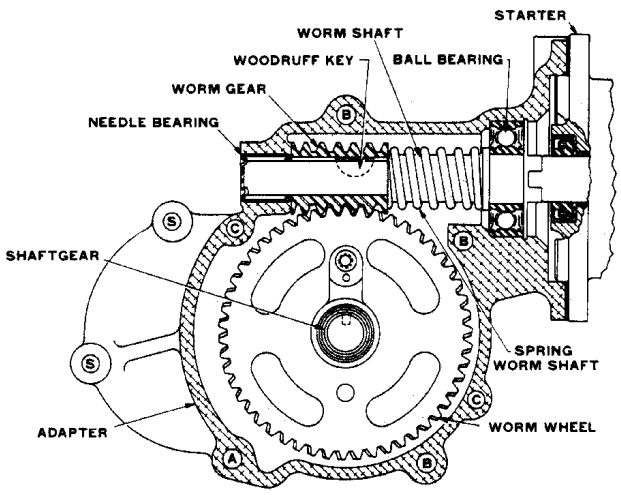
SECTION II
GENERAL DESCRIPTION

2-1. SIGNIFICANT DIFFERENCES. Specific detail parts differences in the IO-520 Series will be noted in the Parts Catalog. Significant configuration differences in the IO-520 Series are primarily related to the two different crankcases.

The SAND CAST CRANKCASE has provision for a belt driven generator (or alternator) located at the accessory end of the engine. The oil cooler is in front of the number 5 cylinder and an integral type oil screen is incorporated in the oil pump.



A. Adapter cover and adapter-to-crankcase bolt
B. Adapter-to-crankcase bolts
C. Adapter cover-to-adapter bolts
D. Crankcase-to-adapter studs

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

On the PERMOLD CRANKCASE a gear driven, alternator is located in front of the number 5 cylinder. The oil cooler is at the accessory end of the engine behind No.2 cylinder and a full flow oil filter is used in place of the integral type screen. Gear trains and lubricating systems as well as other less noticeable parts are likewise different in the two crankcases.

Other configuration differences not related to the crankcase are the oil sump, either cast aluminum or stamped aluminum sheet metal; the engine mounting legs, either attached to the sump, the crankcase bottom or the crankcase accessory end; and various induction systems, balance tubes and fuel injection assemblies.

2-2. GENERAL. The arrangement and appearance of the engine components are indicated in Figures 1-1 through 1-10. Additional information will be found in installation drawings. It will be observed that minimum length has been achieved by mounting the starter on right angle and by mounting the magnetos in the forward side of the accessory gear compartment formed by the crankcase castings at the rear. The magneto location 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 (with studs and inserts) will be referred to as the "left crankcase" and "right crankcase" through- out this publication.

a. Bosses molded in the crankcase castings are line bored in the assembled castings to form bearings for the camshaft and seats for precision, steel-backed, lead alloy lined crankshaft main bearing inserts. Guides are bored through lateral bosses for the tappets and for 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 end of the starter shaftgear.

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 at the lower front corner. On the right permold crankcase an alternator pad is located 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 allover except for some portions of the crankcheeks. The main bearing journals and crankpins are nitrided after grinding. 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 the crankcheeks 1 and 2, 3 and 4 are machined for the installation of one 4th, one 5th and two 6th order counterweights. IO-520-BA crankshafts use three sixth order counterweights and one fourth order counterweight. 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 with the permold crankcase, is heated and shrunk onto a flange just behind the oil transfer collar at the front of the crankshaft, 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. 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 rods in anyone pair is limited to 1/2 ounce in opposite bays.

2-6. CAMSHAFT. A steel alloy forging is machined on four journals, nine cam lobes and the gear mount flange at the rear end. The lobes and journals are hardened and ground. A groove around the front journal passes engine oil from the right crankcase cross passage to the left case 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 crankcase, a cluster gear is bolted with the camshaft gear and drives the fuel pump gear.

2-7. 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 grooves above the pin hole and one groove below. Compression rings arc installed in the top, second and the groove below the pin hole. A center grooved and slotted oil ring is installed in the third groove, which has six oil drain holes to the interior. Weights are limited to 1/2 ounce in opposite bays. Piston pins are full floating ground steel rubes with permanently forged-in aluminum end plugs.

2-8. TAPPETS. The barrel type hydraulic tappets 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, figure 2-6.

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. Valve guides are pressed into the cold cylinder assembly and reamed to slightly different diameters. Special 18 mm helical coil thread inserts are installed in upper and lower spark plug holes. Smaller helical coils are installed in exhaust manifold attaching stud holes. Both intake and exhaust ports are on the bottom of the head when the cylinder is installed. Exhaust valve faces are Stellite No.6 and stem tips are hardened. Valve stems are solid. Outer 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. Rotocaps are installed on exhaust valves only. The rotating action of this type retainer helps to prevent burning and eroding of the valve and valve seat. Inner 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 degree angle to the longitudinal axis. The two inside rocker shaft bosses are drilled and tapped for the 5/16 inch rocker shaft retaining screws. Valve rockers are steel forgings with hardened

sockets and 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 pushrod housings are beaded steel tubes. The bead at the cylinder end retains a packing ring between two washers. The bead at the crankcase end retains a heavy spring, washer, packing ring and second washer.

2-10. FUNCTIONAL SYSTEMS.

2-11. GEAR TRAIN- SANDCAST CRANK-CASE (See Figure 2-2). When starting the engine, torque is transmitted from the starter (16) through adapter components (17 through 22) to crankshaft gear (1). As wormwheel (20) is turned, spring mounted on its hub is tightened to grip knurled drum of shaftgear (22). 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 (22) is now used to transmit torque from the crankshaft gear to the generator drive pulley (16, Figure 4-16).

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

b. The idler gear, rotating in a counterclockwise direction, drives magneto drive gears (14 and 15). Optional accessories mounted on crankcase upper rear are driven by internal splines of magneto drive gears.

c. The fuel pump drive gear is driven by the camshaft cluster gear. The splined end of the oil pump and tachometer drive gear (8) mates with internal splines of the camshaft gear and transmits torque to the oil pump driven gear (9) and the tachometer drive gear (10). The governor drive bevel gear (6) on the front of the camshaft drives the governor driven bevel gear (7).

2-12. GEAR TRAIN -PERMOLD CRANKCASE (See Figure 2-3).

a. When starting engine, torque is transmitted from the starter (15) through adapter components (16 through 20) to crankshaft gear (1). As worm-wheel (19) is turned, spring mounted on its hub is tightened to grip knurled drum of shaftgear (20). After engine is started, spring returns to its normal position, thus disengaging starter. Torque is transmitted to the alternator by a face gear (23) mounted on the crankshaft.

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

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

d. The fuel pump coupling is driven directly from the crankshaft gear (1). 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 the tachometer drive gear (11). The governor drive bevel gear (6) is keyed to the camshaft (4) and meshes with and drives the governor driven bevel gear (7).

2-13. LUBRICATION SYSTEM FOR SANDCAST CRANKCASE.

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 to the 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 lifters, guides and valve mechanisms are lubricated by passages leading off this gallery. An oil temperature control valve is located at the front end of the right gallery to regulate oil temperature within specific limits. When oil reaches a temperature high enough to require cooling, the oil temperature control valve expands and blocks passage, directing oil to the oil cooler. From the oil temperature 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 gear and the propeller governor through pass- ages off the left main gallery. Oil is channeled through a discharge port to the crankshaft oil transfer collar, which directs it to the crankshaft interior.

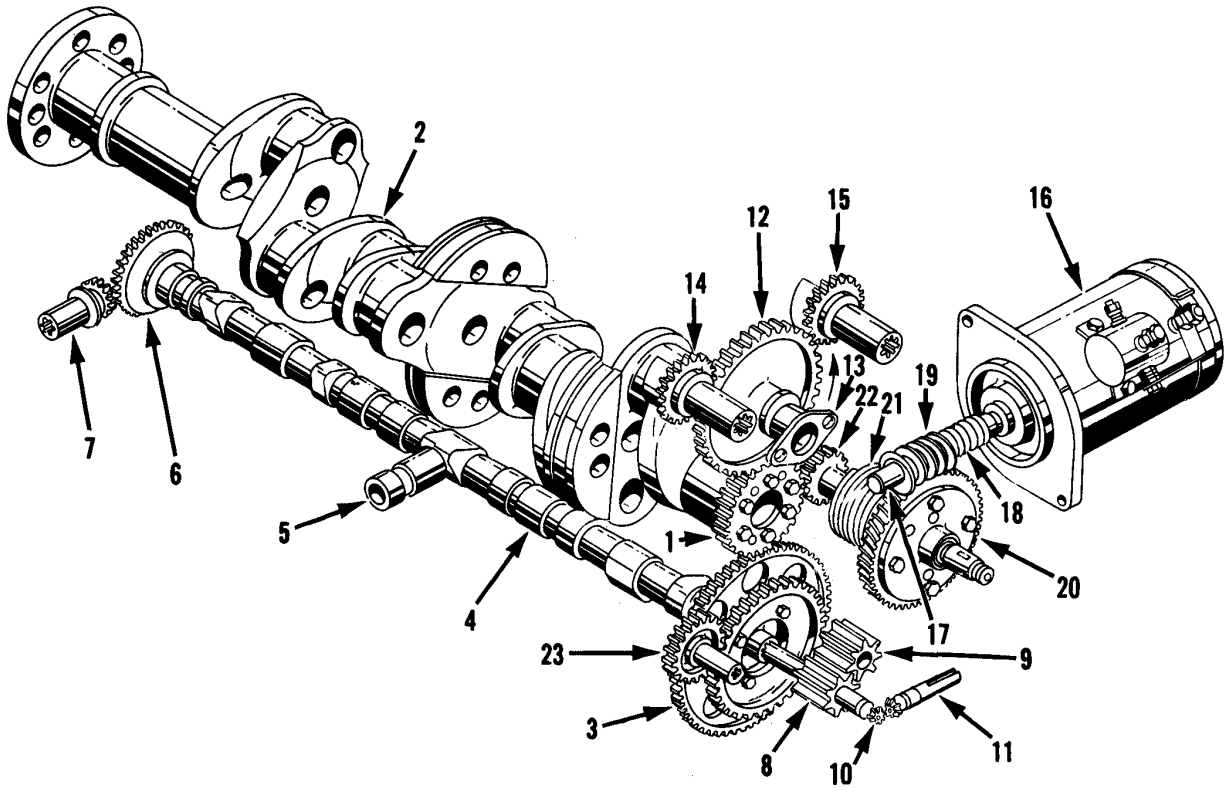


FIGURE 2-2. GEAR TRAIN DIAGRAM (TYPICAL WITH SANDCAST CRANKCASE).

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 shaftgear	1:0.5
9.	Oil pump driven gear	1:0.5
10.	Tachometer drive bevel gear	1:0.5
11.	Tachometer shaftgear	1:0.5
12.	Idler gear assembly	1:0.652
13.	Idler gear support pin	--
14.	Left magneto drive gear	1:1.5
15.	Right magneto drive gear	1:1.5
16.	Starter,	32:1
17.	Worm drive shaft	32:1
18.	Worm shaft spring	--
19.	Starter worm gear	32:1
20.	Starter worm wheel	2:1
21.	Clutch spring	2:1
22.	Starter shaftgear	1:2
23.	Fuel pump drive gear	1:1

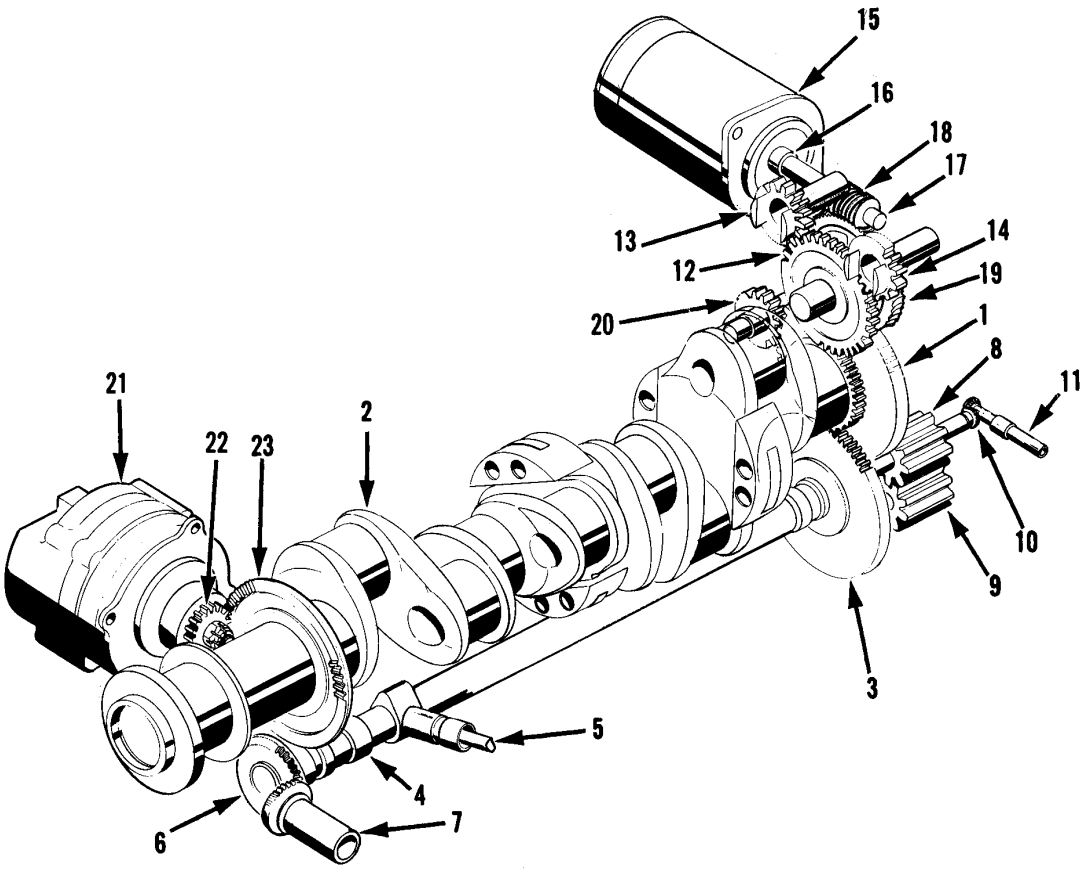


FIGURE 2-3. GEAR TRAIN DIAGRAM (TYPICAL WITH PERMOLD CRANKCASE).

1.	Crankshaft gear	1:1
2.	Crankshaft	1
3.	Camshaft 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 shaftgear	1:0.5
9.	Oil pump driven gear	1:0.5
10.	Tachometer drive bevel gear	1:0.5
11.	Tachometer drive bevel gearshaft	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.	Starter worm wheel	2:1
20.	Starter shaftgear	1:3
21.	Alternator	3:1
22.	Alternator driven gear	3:2
23.	Alternator drive gear	1:1

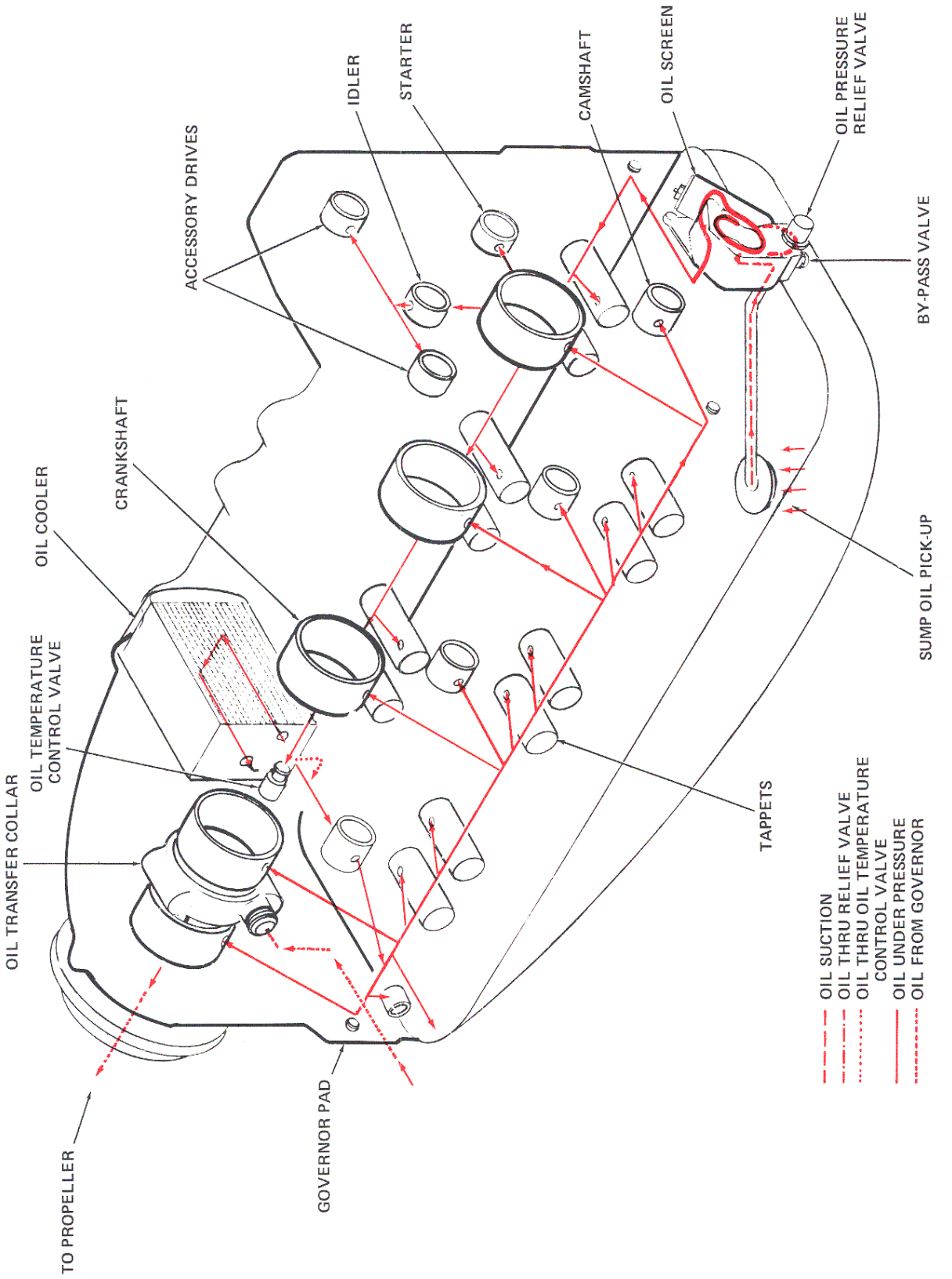


FIGURE 2-4. LUBRICATION SYSTEM (TYPICAL WITH SANDCAST CRANKCASE).

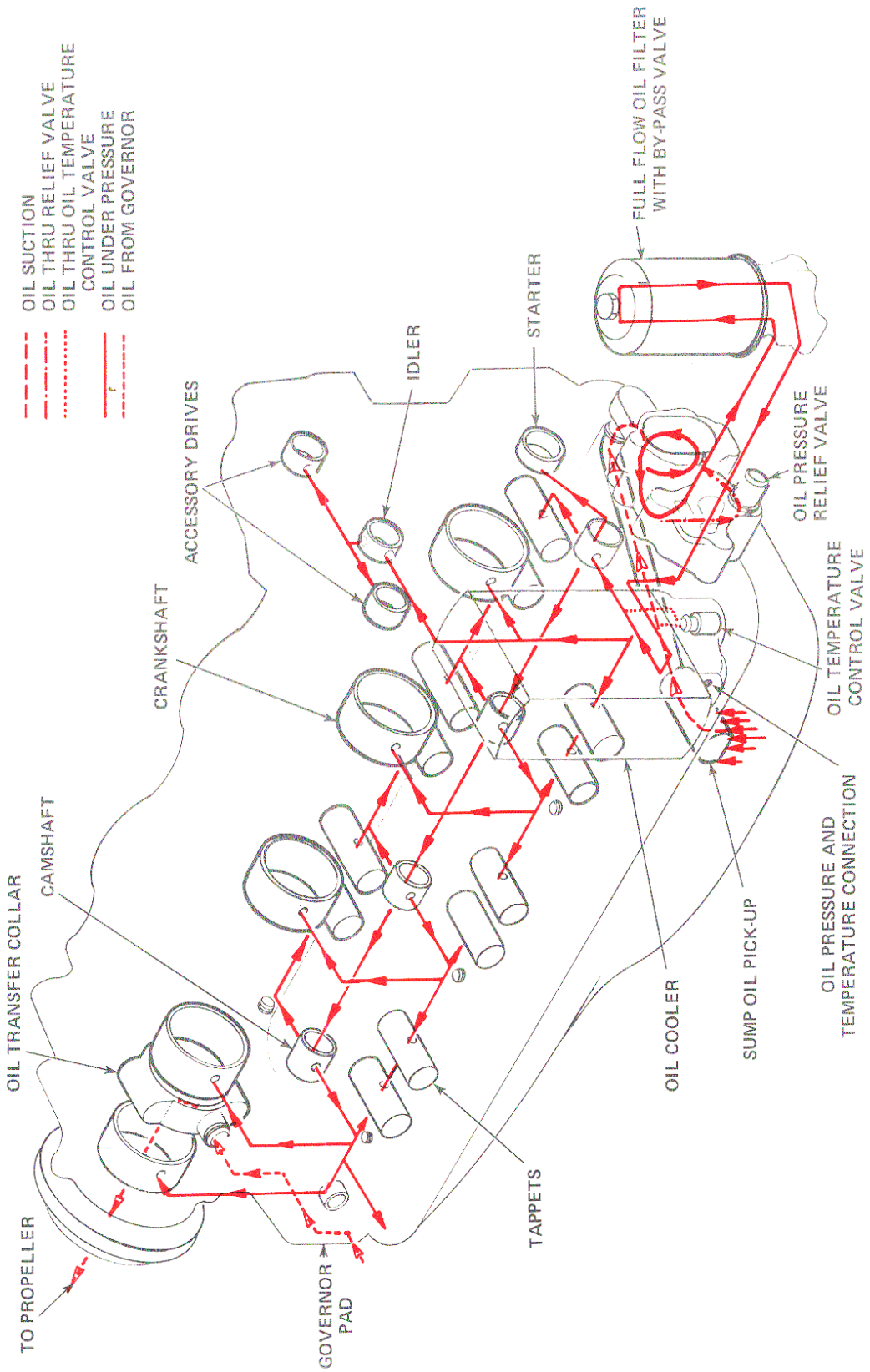


FIGURE 2-5. LUBRICATION SYSTEM (TYPICAL WITH PERMOLD CRANKCASE).

d. Passageways from the left crankcase gallery direct oil to the front, intermediate and rear main bearings.

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.

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

2-14. LUBRICATION SYSTEM FOR PERMOLD CRANKCASE.

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 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 oil 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. In addition to facilities for temperature and oil pressure connections, the oil cooler incorporates an oil temperature control valve. Oil passing through the oil temperature control valve cavity is directed either through the oil 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 170°F.

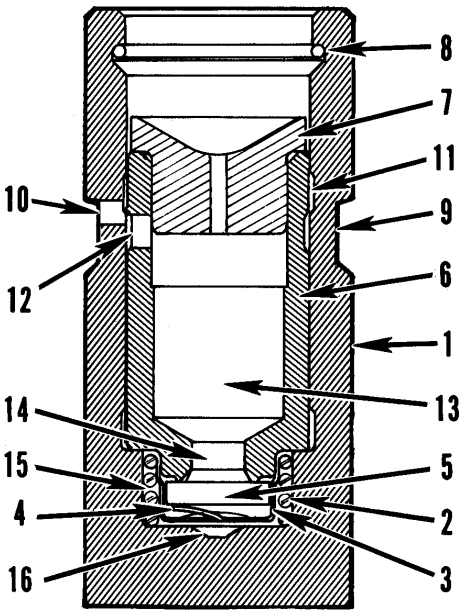
c. Oil entering the engine is directed to the hollow camshaft, which serves as the engine main oil gallery. Grooves and drilled holes in the camshaft are located so as to afford proper lubrication through a system of orifices to the main bearings, lifters, idler gear bushing, accessory drive gear bushings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

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

e. From the governor drive gear lubricating oil is directed to the crankshaft oil transfer collar, which in turn directs oil to the interior of the crankshaft.

f. Oil transfer tubes and drain holes are provided to return oil to the sump.

2-15. VALVE MECHANISM. Oil fed to hydraulic valve lifters, under pressure from the hollow cam- shaft is divided between the overhead system, the lifter guide surfaces and the reservoirs inside the lifters. The oil which reaches the pushrod ends is forced through the pushrods to the drilled rockers and the groove between their bushings. Each 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 valve lifter guides direct the returning oil to the sump.



1. Body
2. Spring, plunger
3. Housing, check valve
4. Spring, check valve
5. Plate, check valve
6. Plunger
7. Socket
8. Ring, retaining
9. Oil groove, exterior
10. Oil inlet, body
11. Oil groove, interior
12. Oil inlet, plunger
13. Oil reservoir plunger
14. Hole, oil discharge
15. Oil reservoir, body
16. Hole, oil outlet

FIGURE 2-6. CUT-AWAY VIEW OF HYDRAULIC VALVE LIFTER.

2-16. 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 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.

2-17. INDUCTION SYSTEM. The air induction system used on the IO-520 Series Engines consists of intake tubes, a balance tube, connecting hoses, clamp assemblies and a combination air throttle and fuel metering control. The air throttle assembly may be located at the rear of the engine supported by brackets or below the oil sump supported by an inverted manifold assembly or bolted to a cast oil sump. The systems are provided with a drain valve at the lowest point in the manifold assembly to remove any fuel that may collect there.

The throttle assembly is connected to the elbows at the rear cylinder intake tubes by connector hoses and clamps. This assembly is then connected to the center intake tubes and the center to the front intake tubes in the same manner. Each intake tube is attached to the cylinder by a welded flange and four bolts and is sealed by a gasket. The front cylinder intake tubes are connected by a balance tube assembly. The balance tube incorporates a boss and is supported by a bracket attached to the front of the oil sump.

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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 Engine in general and the IO-520 in particular can be purchased from the Borrough's Tool and Equipment Corporation 2429 North Burdick Street, Kalamazoo, Michigan 49007.

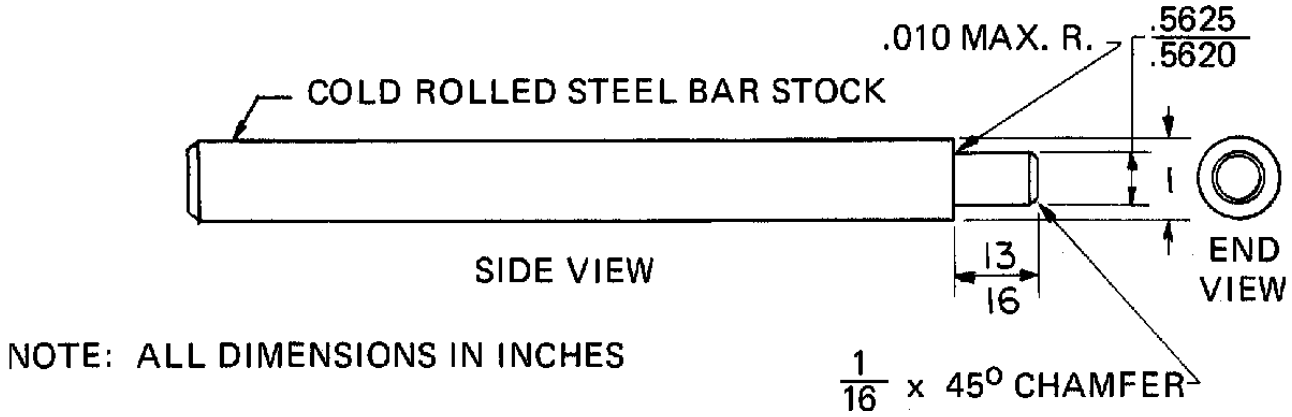


FIGURE 3-1. STARTER ADAPTER BEARING INSTALLER

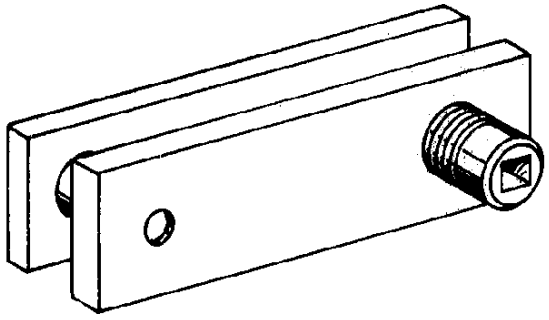


FIGURE 3-2. CRANKSHAFT BLADE AND DAMPENER BUSHING REMOVER AND REPLACER

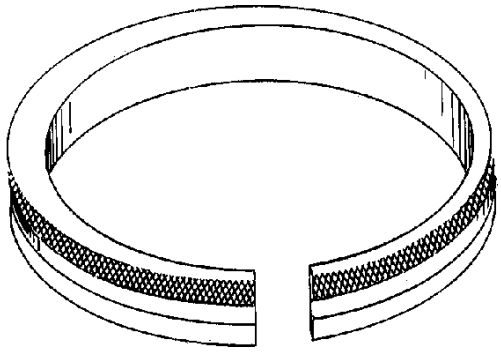


FIGURE 3-3. PISTON RING COMPRESSOR, BORROUGHS NO. 5201

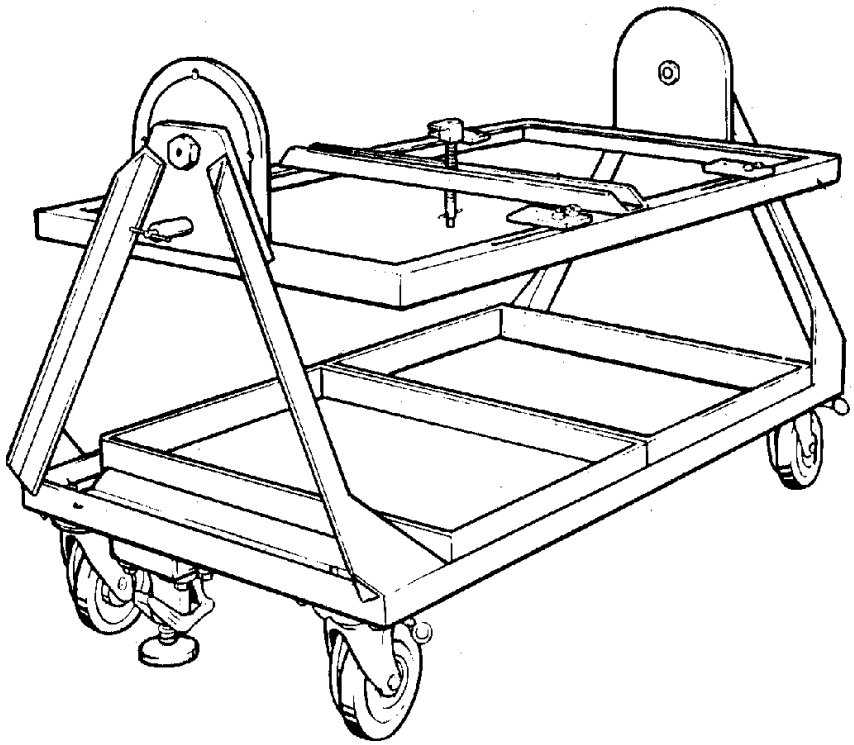


FIGURE 3-4. ENGINE TRANSPORTATION STAND

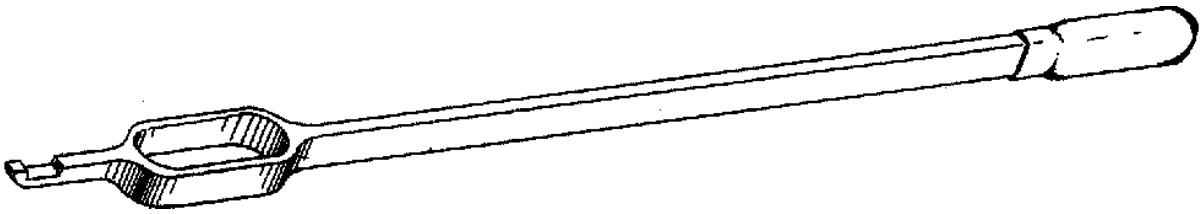
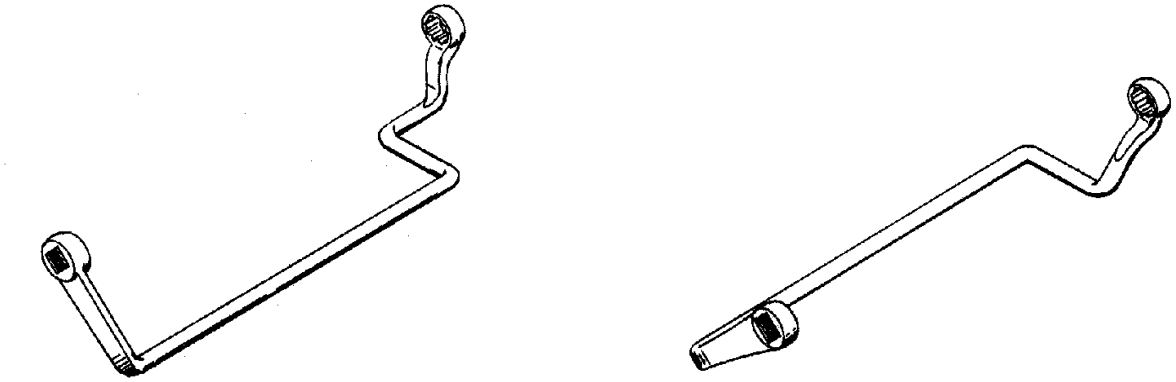


FIGURE 3-5. VALVE SPRING COMPRESSOR, BORROUGHS NO. 5202



BORROUGHS NO. 5204 RIGHT HAND *BORROUGHS NO. 5203 LEFT HAND*

FIGURE 3-6. CYLINDER BASE NUT WRENCHES

SECTION IV
DISASSEMBLY

4-1. GENERAL. .

4-2. AIRCRAFT PARTS AND ACCESSORIES.

4-3. Instructions in this section are based on the assumption that all parts attached by the aircraft manufacturer, except optional pumps, have been removed.

4-4. Accessories supplied by the engine manufacturer may be serviced according to instructions supplied by the applicable accessory manufacturer.

4-5. EXTENT OF DISASSEMBLY. Line drawings reproduced in this section are identical to those used in the parts catalog, except for order of index numbers assigned to components. Index numbers herein indicate the 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 such 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.

4-6. 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 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.

4-7. DISASSEMBLY STAND. For greatest ease of disassembly, this engine should be mounted on an engine stand with a tilting bed. See the installation drawings for necessary dimensions for mounting engine on stand.

4-8. 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 pre-cleaning, as these solutions will also remove the "alodized" finish of certain aluminum parts.

4-9. DISMANTLING.

4-10. IGNITION SYSTEM.

a. Disconnect cables from spark plugs.

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

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

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

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

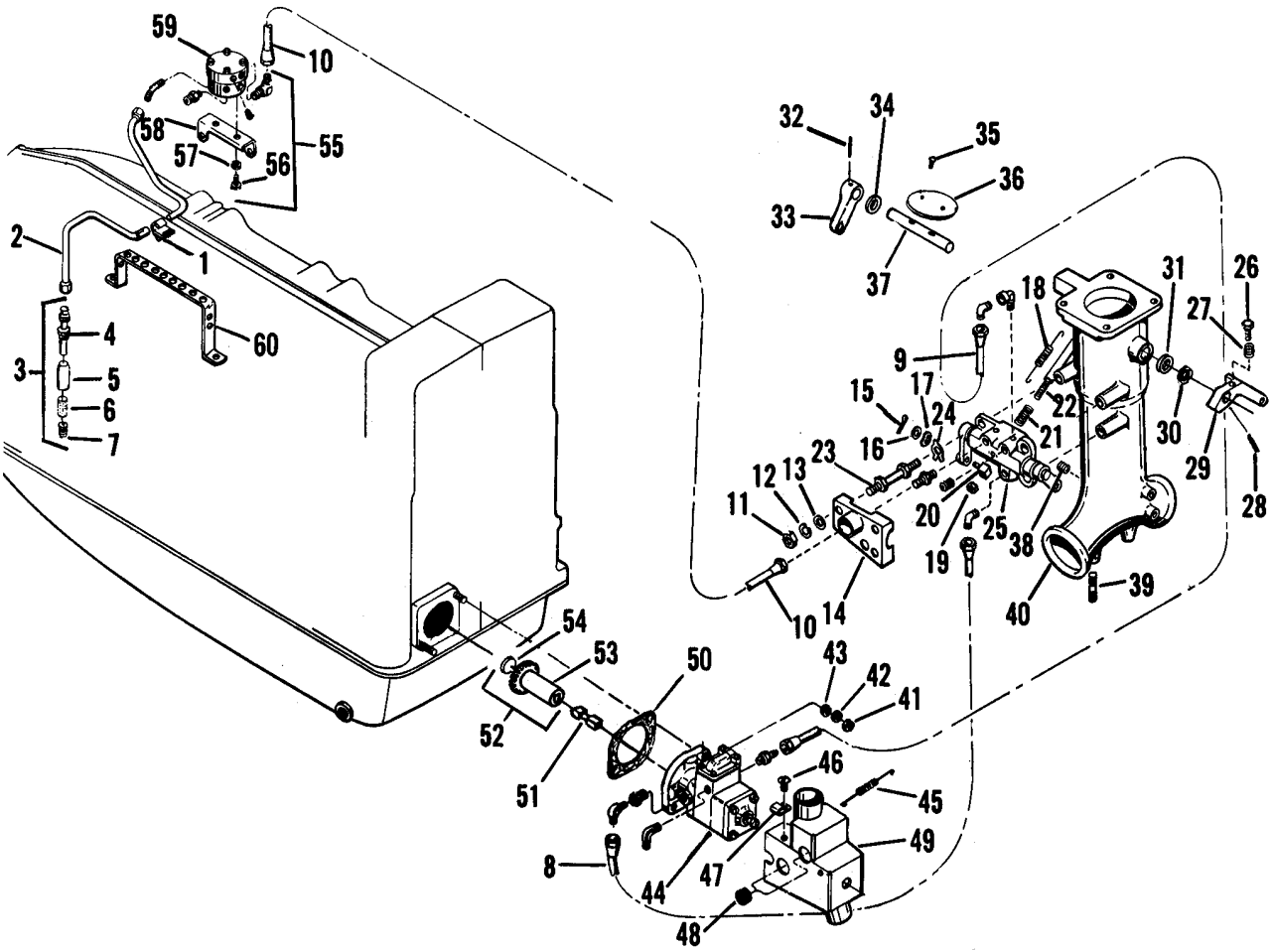


FIGURE 4-1. FUEL INJECTION SYSTEM (IO-520-A,E,F,J,K & L)

1. Clamp, Fuel Discharge Tube
2. Tube Assembly
3. Nozzle Assembly
4. Nozzle
5. Shield, Dust
6. Screen
7. Jet
8. Hose Assembly
9. Hose Assembly
10. Hose Assembly
11. Nut, Plain, Hex
12. Washer, Lock
13. Washer, Plain
14. Shroud Assembly
15. Pin, Cotter
16. Washer, Plain
17. Washer, Wave
18. Spring, Throttle
19. Nut, Elastic Stop
20. Rod End, Special
21. Spring, Compression
22. Rod and Link Assembly
23. Screw, Special
24. Washer, Tab
25. Control Assy., Complete
26. Screw, Idle Adjusting
27. Spring, Idle Adjusting
28. Pin, Tubular
29. Lever, Throttle Shaft
30. Washer, Wave
31. Washer, Plain
32. Pin, Tubular
33. Lever
34. Washer, Plain
35. Screw
36. Plate, Air Throttle
37. Shaft
38. Plug, Pipe
39. Stud
40. Body Assembly, Air
41. Nut, Plain, Hex
42. Washer, Lock
43. Washer, Plain
44. Fuel Pump Assembly
45. Spring
46. Screw
47. Nut, Tinnerman
48. Grommet
49. Shroud Assembly
50. Gasket
51. Coupling Drive
52. Gear Assy., Fuel Pump
53. Gear
54. Plug
55. Valve Assy., Fuel Manifold
56. Screw
57. Washer, Lock
58. Bracket
59. Fuel Manifold Valve
60. Bracket, Discharge Tubes

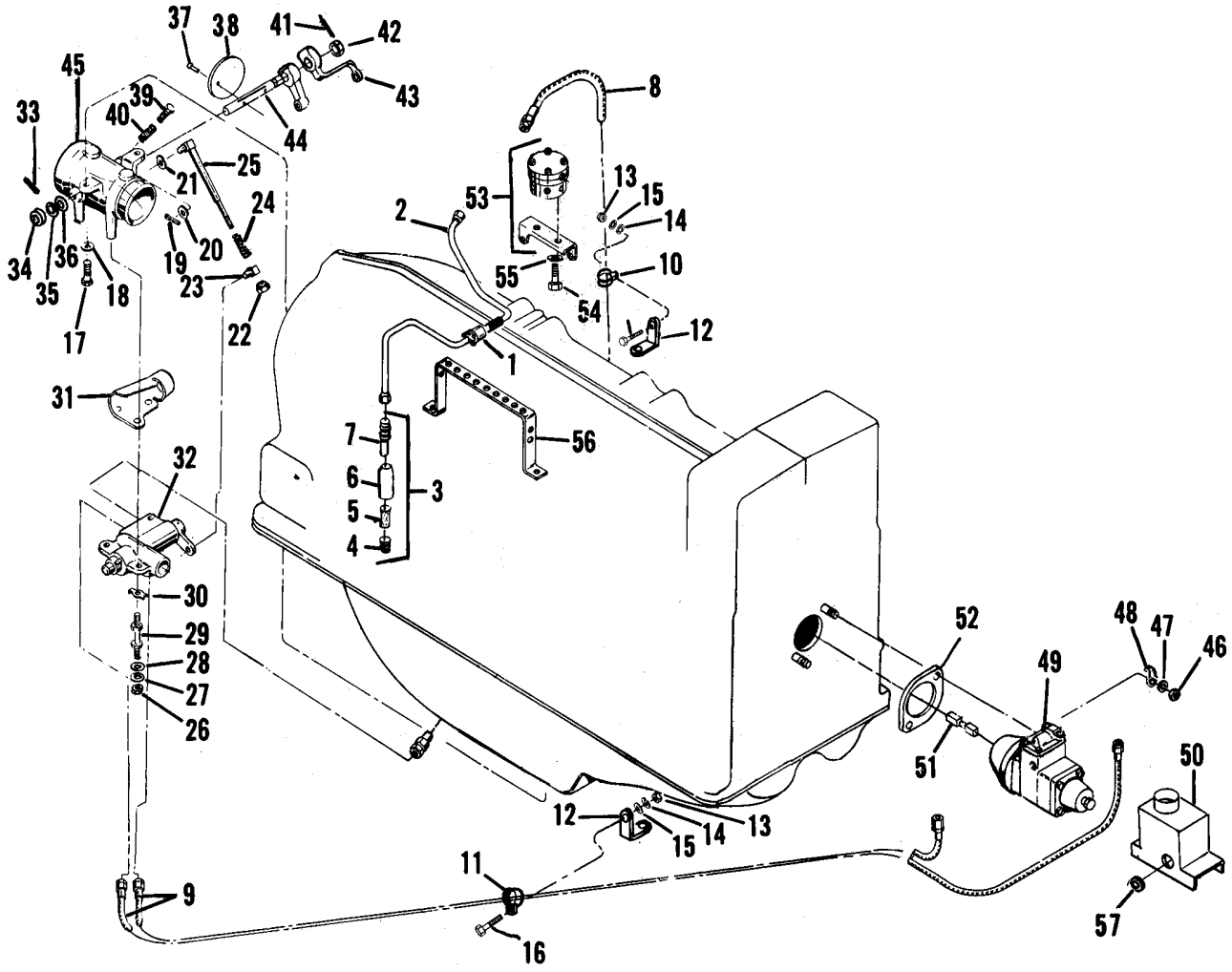


FIGURE 4-2. FUEL INJECTION SYSTEM (IO-520-B)

1. Clamp
2. Tube Assembly
3. Nozzle Assembly
4. Jet
5. Screen
6. Shield, Dust
7. Nozzle
8. Hose Assembly
9. Hose Assembly
10. Clamp
11. Clamp
12. Bracket
13. Nut, Plain, Hex
14. Washer, Lock
15. Washer, Plain
16. Bolt
17. Bolt
18. Washer, Plain
19. Pin, Cotter
20. Washer, Plain
21. Washer, Wave
22. Nut, Elastic Stop
23. Rod End, Special
24. Spring, Compression
25. Rod and Link Assembly
26. Nut, Plain, Hex
27. Washer, Lock
28. Washer, Plain
29. Screw
30. Washer, Tab
31. Shroud, Metering Shaft
32. Control Assembly
33. Pin, Tubular
34. Collar
35. Washer, Wave
36. Washer, Plain
37. Screw
38. Plate Air Throttle
39. Screw, Idle Adjusting
40. Spring
41. Pin, Cotter
42. Nut, Plain, Hex
43. Lever, Throttle Control
44. Shaft, Air Throttle
45. Body Assembly, Air
46. Nut, Plain, Hex
47. Washer, Lock
48. Washer, Hold Down
49. Fuel Pump Assembly
50. Shroud Assembly
51. Coupling
52. Gasket
53. Fuel Manifold Valve Assy.
54. Screw
55. Washer, Lock
56. Bracket, Discharge Tubes
57. Grommet

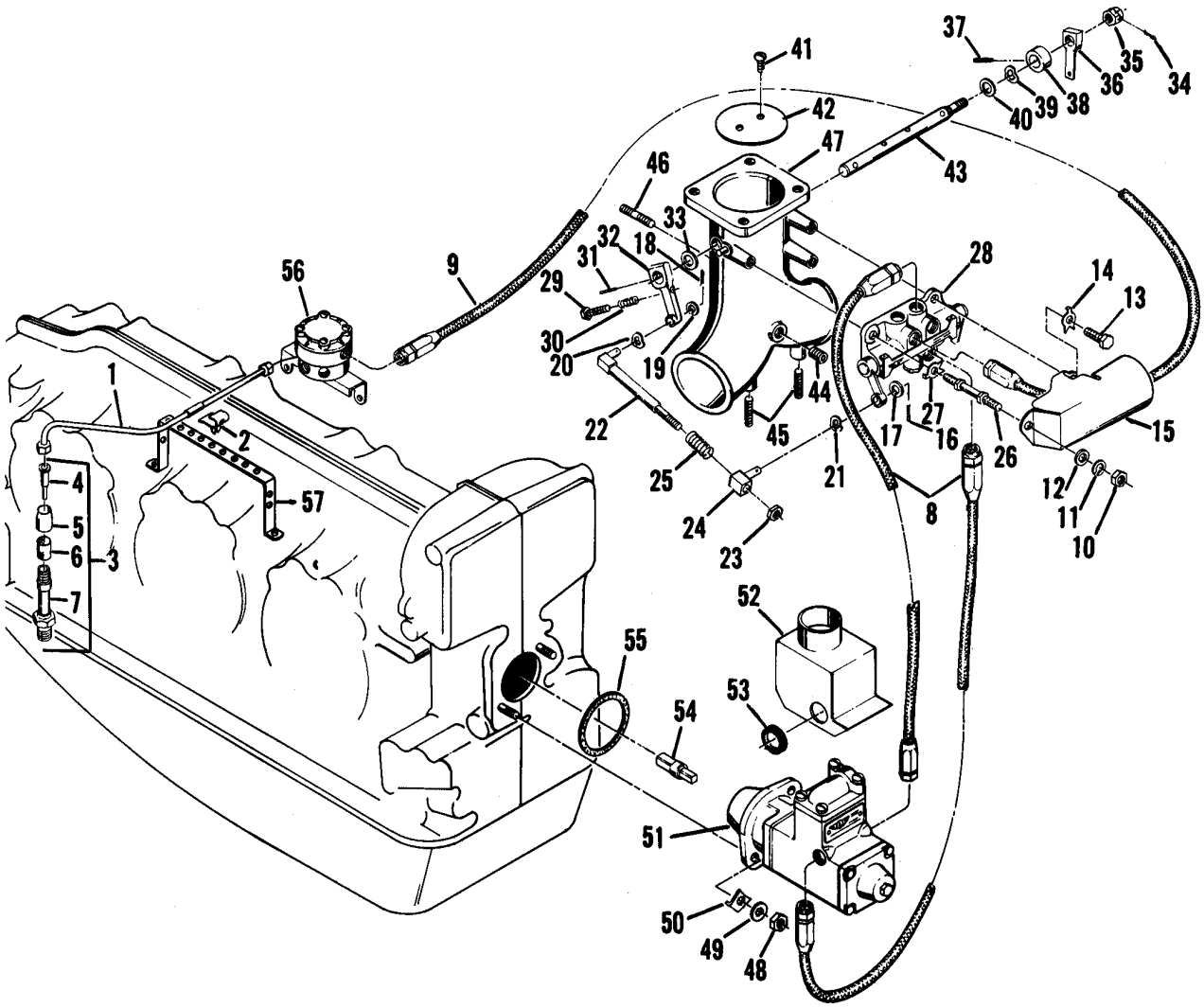


FIGURE 4-3. FUEL INJECTION SYSTEM (IO-520-C)

1. Tube Assembly
2. Clamp
3. Nozzle Assembly
4. Nozzle
5. Shield, Dust
6. Screen
7. Jet
8. Hose Assembly
9. Hose Assembly
10. Nut
11. Washer, Lock
12. Washer, Plain
13. Screw, Cap
14. Washer, Tab
15. Shroud Assembly
16. Pin, Cotter
17. Washer, Plain
18. Pin, Cotter
19. Washer, Plain
20. Washer, Wave
21. Washer, Wave
22. Rod and Link Assy.
23. Nut, Elastic Stop
24. Rod, End, Special
25. Spring, Compression
26. Screw, Special
27. Washer, Tab
28. Control Assembly
29. Screw, Idle Adjusting
30. Spring
31. Pin, Tubular
32. Lever Assembly
33. Washer, Plain
34. Pin, Cotter
35. Nut, Slotted
36. Lever
37. Pin
38. Collar
39. Washer, Wave
40. Washer, Plain
41. Screw
42. Plate
43. Shaft
44. Plug
45. Stud
46. Stud
47. Body Assembly
48. Nut
49. Washer, Lock
50. Washer, Hold Down
51. Fuel Pump Assy.
52. Shroud Assembly
53. Grommet
54. Coupling
55. Gasket
56. Valve Assembly
57. Bracket

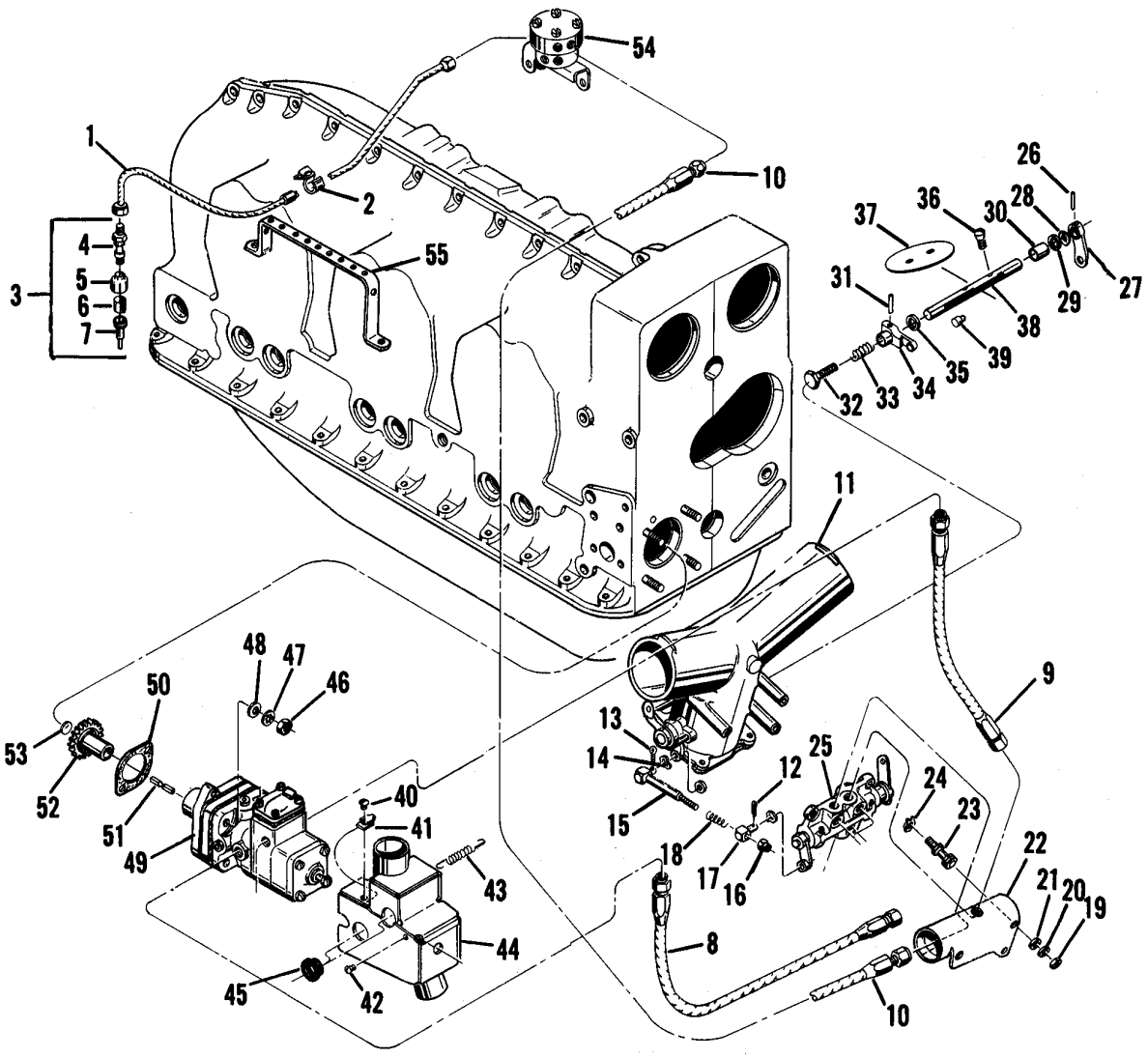


FIGURE 4-4. FUEL INJECTION SYSTEM (IO-520-D)

1. Tube Assembly
2. Clamp
3. Nozzle Assembly
4. Nozzle
5. Shield, Dust
6. Screen
7. Jet
8. Hose Assembly
9. Hose Assembly
10. Hose Assembly
11. Body Assembly
12. Pin, Cotter
13. Pin, Cotter
14. Washer, Wave
15. Rod and Link Assy.
16. Nut, Elastic Stop
17. Rod, End, Special
18. Spring, Compression
19. Nut, Plain, Hex
20. Washer, Lock
21. Washer, Plain
22. Shroud
23. Bolt, Special
24. Washer, Tab
25. Control Assembly
26. Pin
27. Lever
28. Washer, Wave
29. Washer, Plain
30. Bushing
31. Pin
32. Screw
33. Spring
34. Lever
35. Washer
36. Screw
37. Plate
38. Shaft
39. Pin
40. Screw
41. Nut
42. Screw
43. Spring
44. Shroud Assy.
45. Grommet
46. Nut
47. Washer, Lock
48. Washer, Plain
49. Fuel Pump Assy.
50. Gasket
51. Coupling
52. Gear
53. Plug
54. Valve Assembly
55. Bracket

4-11. FUEL INJECTION SYSTEM (See Figures 4-1, 4-2 and 4-3).

a. Use the following basic procedure to disassemble the fuel injection system on the IO-520 Series.

Disconnect:

1. Fuel discharge tubes and nozzles.
   (a) Tubes at fuel manifold valve.
   (b) Tube at nozzles.
   (c) Clips at tube bracket.
   (d) Nozzles at engine.

NOTE

Remove fuel injection connection fittings from fuel injection components only if necessary for replacement.

2. Fuel Hoses.
   (a) Fuel pump to metering unit.
      (1) Fuel hose to metering unit.
      (2) Fuel pump return.
   (b) Metering unit to fuel manifold valve.

3. Throttle body and metering unit from engine.
   (a) Remove clamps etc. from intake manifold.
   (b) Remove miscellaneous attaching parts.

4. Metering unit from throttle body.
   (a) Remove linkage.
   (b) Remove miscellaneous attaching parts and shroud.
   (c) Disassembly throttle body.
      (1) Levers.
      (2) Butterfly.

5. Fuel pump from engine.
   (a) Shroud.
   (b) Attaching parts.
   (c) Coupling, gear and gasket.

6. Fuel manifold valve and bracket from engine.
   (a) Attaching parts.
   (b) Valve from bracket.

NOTE

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

For further information see Teledyne Continental Fuel Injection System Manual, Form X-30091.

4-12. MAGNETO AND ACCESSORY DRIVES (See Figure 4-5).

a. Remove two sets of attaching parts (1, 2, 3) and six sets of attaching parts (4, 5,6) and remove adapter assembly (7) and related parts as a unit.

b. Remove gear assembly (18), magneto drive coupling bushings (21) and retainer (22).

c. Remove attaching parts (8, 9, 10) and lift cover (11) and gasket (12). Remove oil seal (14) from adapter (17).

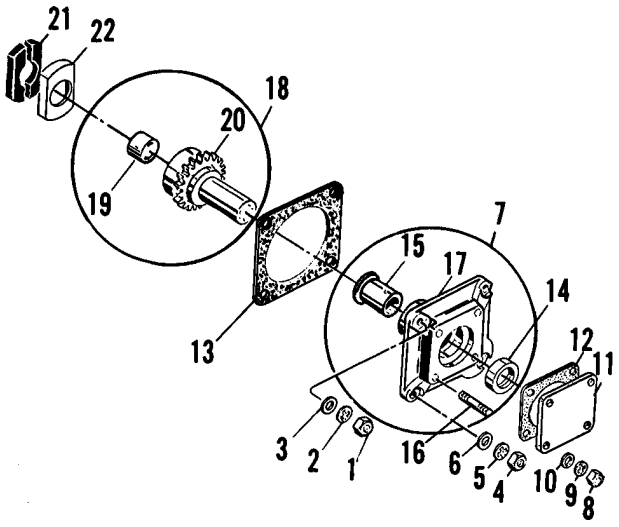


FIGURE 4-5. MAGNETO & ACCESSORY DRIVES.

1. Nut, Plain, Hex
2. Washer, Lock
3. Washer, Plain
4. Nut, Plain, Hex
5. Washer, Lock
6. Washer, Plain
7. Adapter Assembly
8. Nut, Plain, Hex
9. Washer, Lock
10. Washer, Plain
11. Cover, Accy. Drive
12. Gasket
13. Gasket
14. Seal, Oil
15. Bushing, Adapter
16. Stud
17. Adapter
18. Gear Assembly
19. Sleeve
20. Gear, Drive
21. Bushing
22. Retainer

4-13. INDUCTION SYSTEM.

a. IO-520-A, B, C, F,J, K, L (See Figure 4-6).

(1.) Loosen hose clamps (1) or clamp assemblies (2) on hoses (3) or (4) and remove elbows (5, 6) or elbow assembly (7).

(2.) Remove attaching parts (8, 9) loosen hose clamps (II, 12) and remove balance tube (13) and bracket (10).

(3.) Loosen hose clamps (14) from hoses (15) and remove attaching parts (16, 17, 18). Remove intake manifold tubes (19,20) and gasket (21).

(4.) BRACKETS. remove attaching parts (23 through 35) to separate brackets (36, 37, 38), bushing (39), sleeve (40) and housing (41).

(5.) BRACKETS. Remove attaching parts (42 through 47) to separate brackets (48, 49, 50, 51), bushing (52, 53), sleeves (54, 55) and housing (41).

b. IO-52O-D (See Figure 4-7).

(1.) Loosen hose clamps (1) on hoses (2) and re- move elbows (3, 4).

(2.) Remove attaching parts (5, 6), loosen hose hose clamps (8, 9) and remove balance tube (10) and bracket (7).

(3.) Loosen hose clamps (11) from hoses (2) and remove attaching parts (12, 13, 14). Remove in- take manifold tubes (15,16) and gasket (17).

(4.) Remove attaching parts (19, 20) and sepa- rate throttle assembly (21) from engine.

c. IO-520-E (See Figure 4-8).

(1.) Loosen hose clamps (1) on hoses (2) and re- move elbows (3,4).

(2.) Remove attaching parts (5, 6), loosen hose clamps (8, 9) and remove balance tube (10) and bracket (7).

(3.) Loosen hose clamps (11) from hoses (2) and remove attaching parts (12, 13, 14). Remove in- take manifold tubes (15,16) and gasket (17).

(4.) Remove attaching parts (18 through 27) and remove throttle assembly (28).

(5.) Remove attaching parts (29 through 32) and remove brackets (33, 34, 35).

4-14. OIL SUMP IO-520-A, D, E, F, J, K AND L (See Figure 4-9).

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 from engine.

b. Remove screws (8, 9) and washers (10) and lift off suction tube assembly (11).

c. Remove screw (13), washer (14), acorn nut (15) and gasket (16) and withdraw oil suction tube (17).

4-15. OIL SUMP IO-520-B (See Figure 4-10).

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).

d. Remove screw (13), nut (14), gasket (15) and withdraw oil suction tube (16).

4-16. OIL COOLER (See Figure 4-11).

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

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

4-17. OIL COOLER (See Figure 4-12).

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

b. Remove baffle (15) and oil temperature control valve (12).

4-18. GENERATOR (See Figure 4-13).

a. Loosen sheave retaining nut on both starter drive adapter and generator and adjusting arm screw. Tilt generator and remove bolt (1).

b. Remove generator sheave retaining nut and re- move spacer (2) and sheave (3). Tape woodruff key to shaft and replace retaining nut to protect threads.

c. Remove bracket adjusting screw (4) and washer (5). Remove bracket retaining screw (6), washers (7), bushings (8), and sleeve (9) to remove bracket (10).

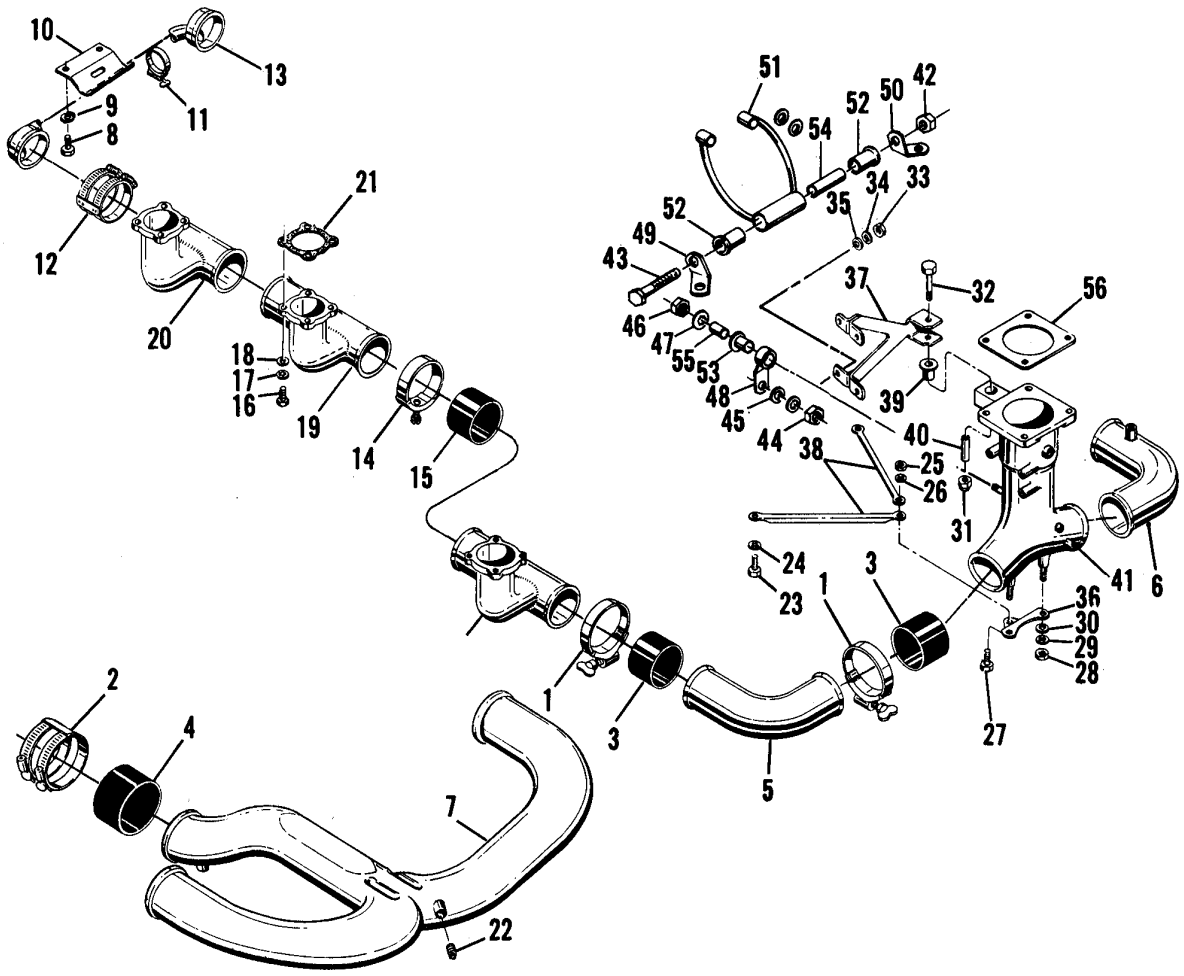


FIGURE 4-6. INDUCTION SYSTEM. (A,B,C,F,J,K & L)

1. Clamp, Hose
2. Clamp Assembly
3. Hose, Intake Manifold
4. Hose
5. Tube Assy., Elbow, 2-4-6 Side
6. Tube Assy., Elbow, 1-3-5 Side
7. Manifold Assembly
8. Bolt
9. Washer, Lock
10. Bracket
11. Clamp
12. Clamp
13. Tube Assembly, Balance
14. Clamp, Hose
15. Hose
16. Screw
17. Washer, Lock
18. Washer, Plain
19. Tube Assembly
20. Tube Assembly
21. Gasket
22. Plug, Pipe
23. Screw
24. Washer, Lock
25. Nut, Plain, Hex
26. Washer, Lock
27. Screw
28. Nut, Plain, Hex
29. Washer, Lock
30. Washer, Plain
31. Nut, Self Locking
32. Bolt
33. Nut, Plain, Hex
34. Washer, Lock
35. Washer, Plain
36. Bracket
37. Bracket
38. Bracket
39. Bushing
40. Sleeve
41. Throttle Assembly, Air
42. Nut, Self-Locking
43. Bolt
44. Nut, Plain, Hex
45. Washer, Lock
46. Nut, Plain, Hex
47. Washer, Lock
48. Bracket Assembly
49. Bracket
50. Bracket
51. Bracket Assembly
52. Bushing
53. Bushing
54. Sleeve
55. Sleeve
56. Gasket

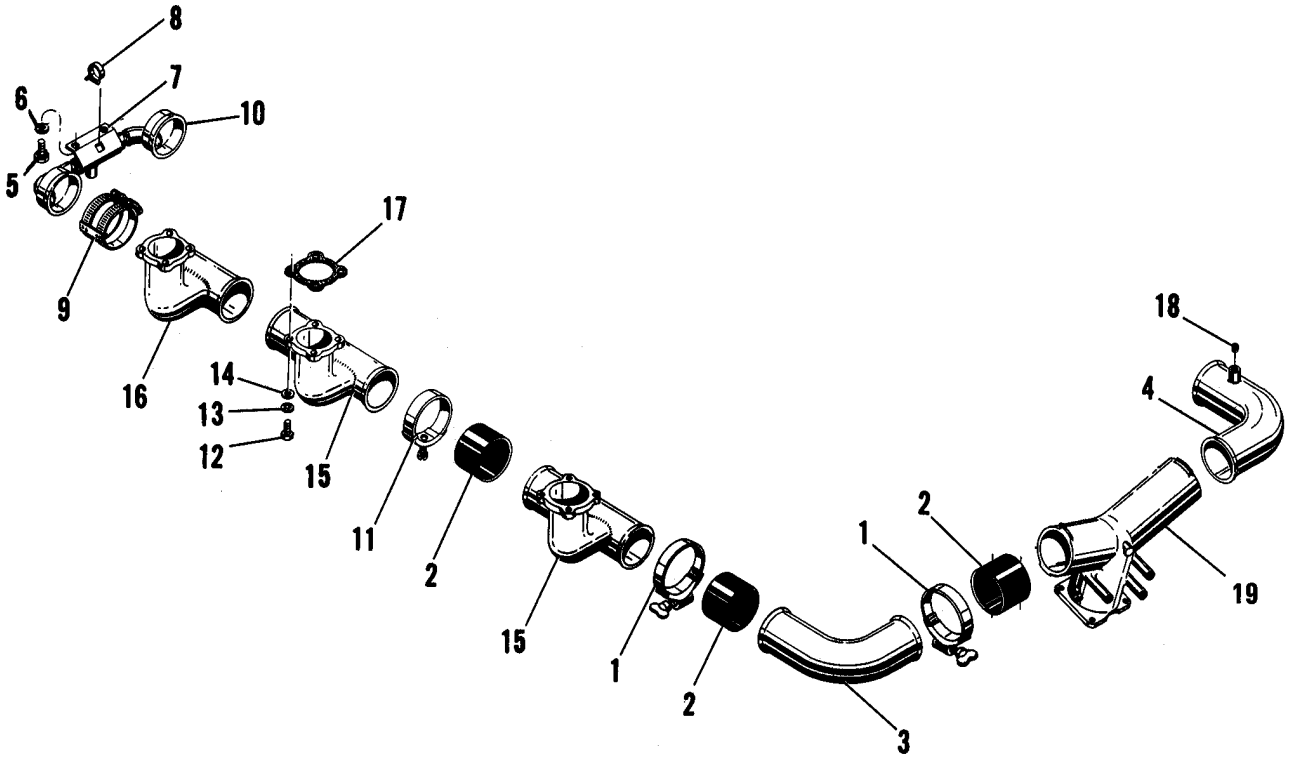


FIGURE 4-7 INDUCTION SYSTEM. (IO-520-D)

1. Clamp
2. Hose
3. Tube
4. Tube
5. Screw
6. Washer, Lock
7. Bracket
8. Clamp
9. Clamp Assembly
10. Tube Assembly
11. Clamp, Hose
12. Screw
13. Washer, Lock
14. Washer, Plain
15. Tube Assembly
16. Tube Assembly
17. Gasket
18. Plug, Pipe
19. Throttle Assy., Air

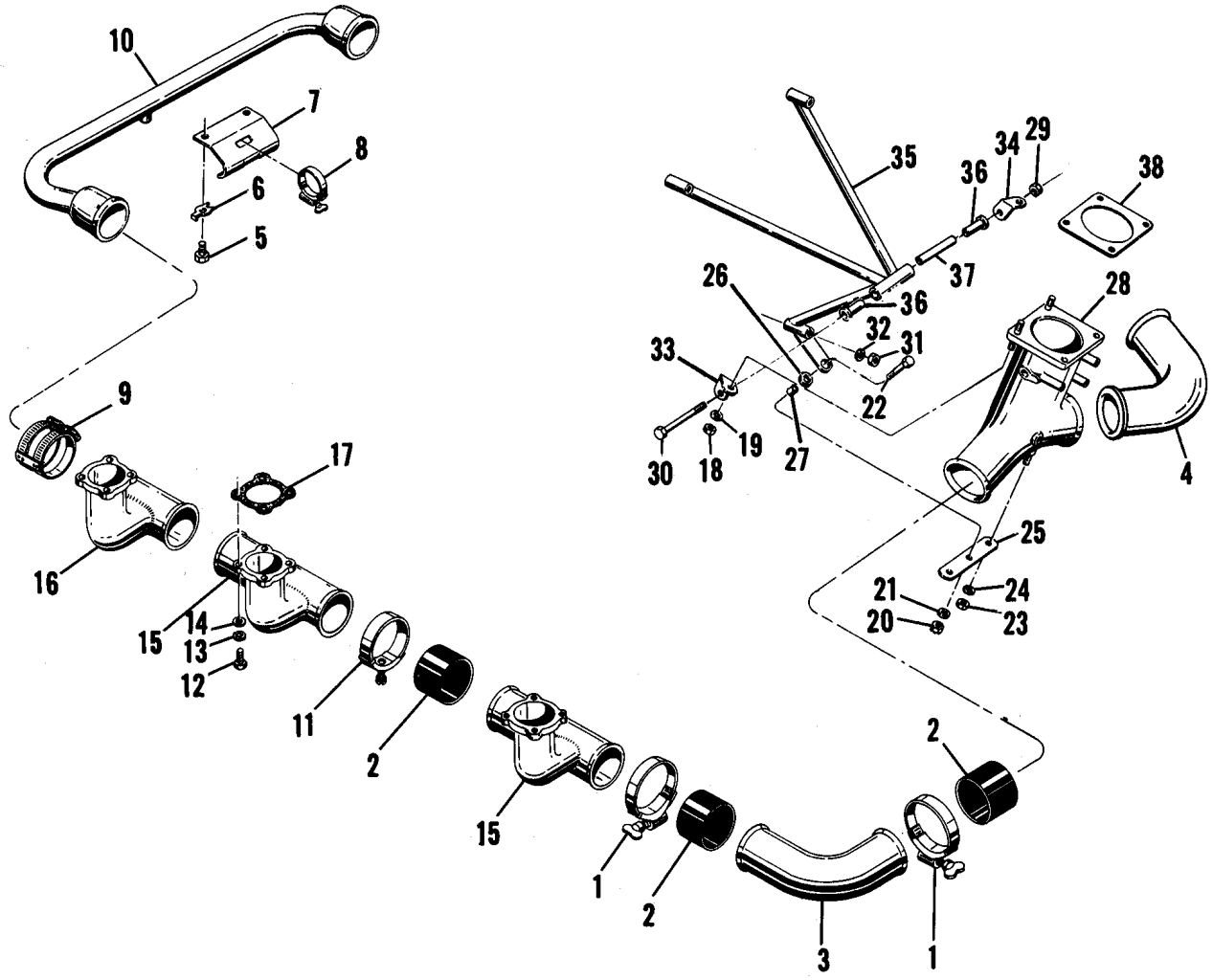


FIGURE 4-8 INDUCTION SYSTEM. (IO-520-E)

1. Clamp
2. Hose
3. Tube Assembly
4. Tube Assembly
5. Bolt
6. Washer, Tab
7. Bracket
8. Clamp
9. Clamp Assembly
10. Tube Assembly
11. Clamp
12. Screw
13. Washer, Lock
14. Washer, Plain
15. Tube Assembly
16. Tube Assembly
17. Gasket
18. Nut, Hex
19. Washer, Lock
20. Nut
21. Washer, Lock
22. Screw
23. Nut
24. Washer, Lock
25. Bracket
26. Grommet
27. Sleeve
28. Throttle Assembly
29. Nut. Self-Locking
30. Bolt
31. Nut, Plain, Hex
32. Washer, Lock
33. Bracket
34. Bracket
35. Bracket Assembly
36. Bushing
37. Sleeve
38. Gasket

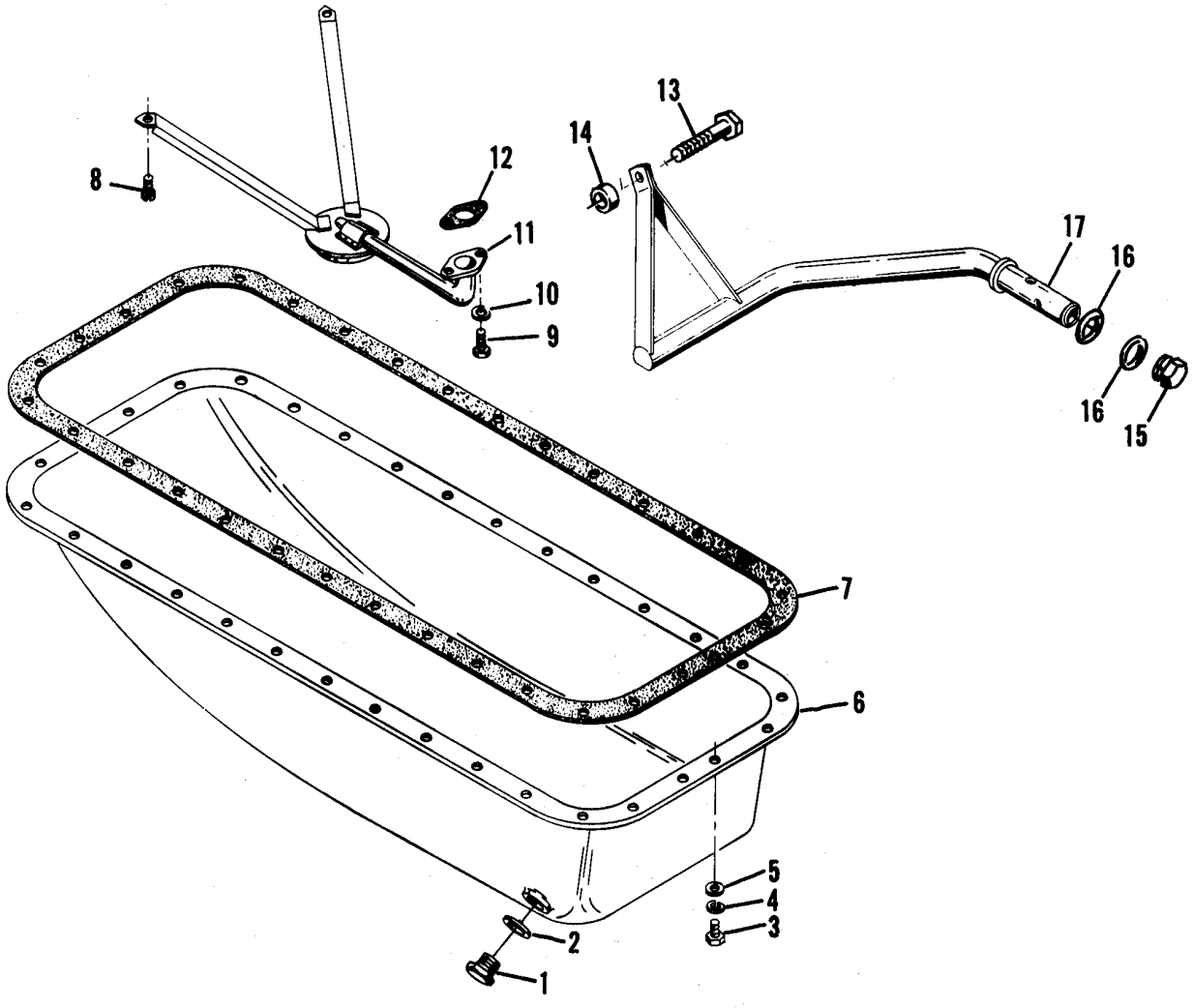


FIGURE 4-9 OIL SUMP (STAMPED ALUMINUM SHEET METAL IO-520-A,C,D,E,F & K)

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

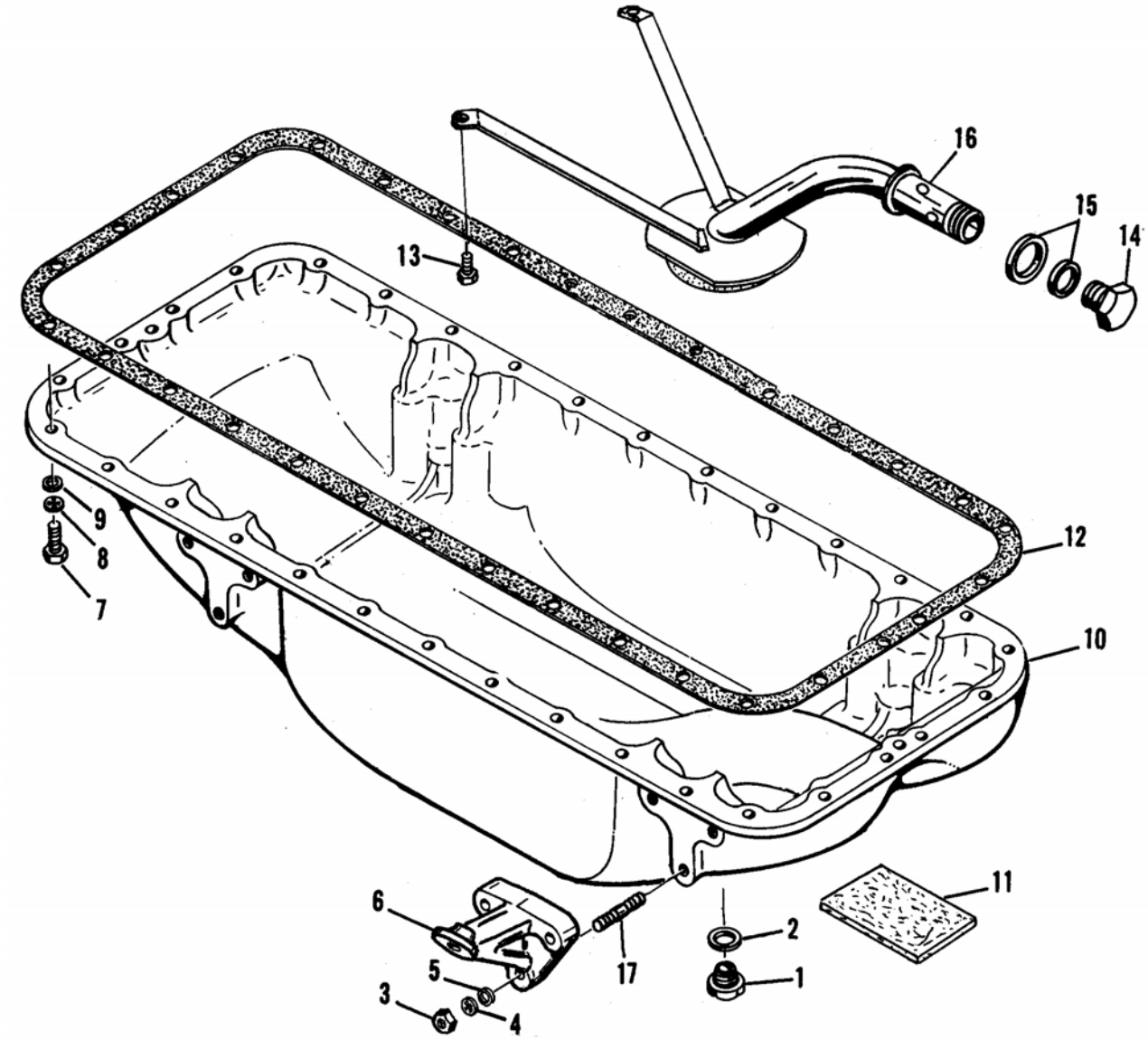
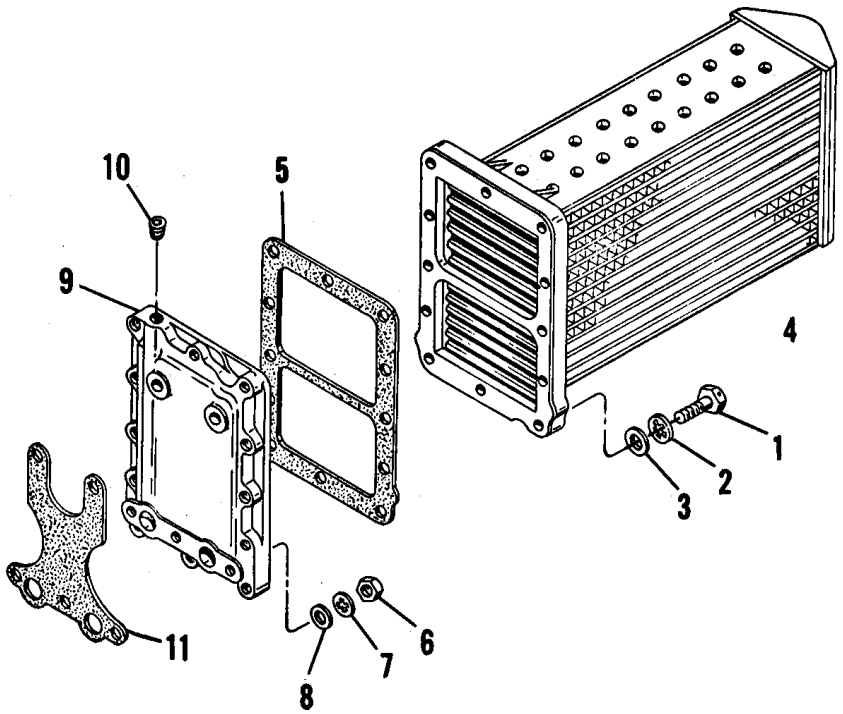


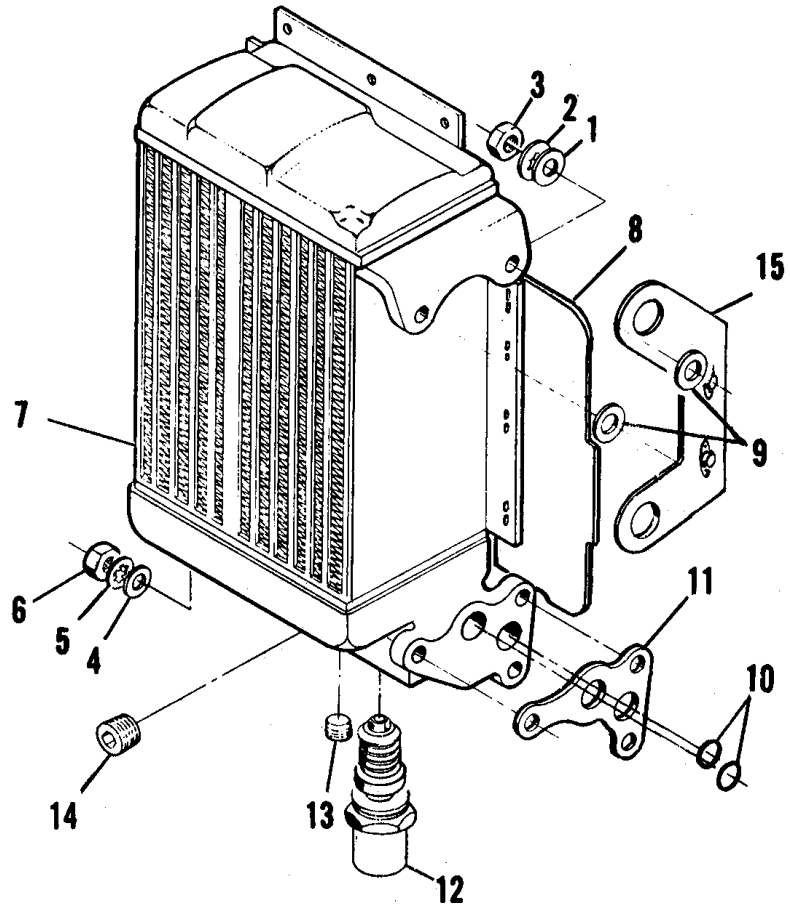
FIGURE 4-10 OIL SUMP (CAST ALUMINUM IO-520-B)

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



1. Screw
2. Washer, Lock
3. Washer, Plain
4. Cooler Assembly
5. Gasket
6. Nut, Plain, Hex
7. Washer, Lock
8. Washer, Plain
9. Plate
10. Plug, pipe
11. Gasket

FIGURE 4-11 OIL COOLER (TYPICAL ON SANDCAST CRANKCASE).



1. Washer, Plain
2. Washer, Lock
3. Nut, Plain, Hex
4. Washer, Plain
5. Washer, Lock
6. Nut, Plain, Hex
7. Oil Cooler
8. Baffle
9. Gasket
10. “O” Ring
11. Gasket
12. Valve Assembly
13. Plug
14. Plug
15. Support Assembly

FIGURE 4-12 OIL COOLER (TYPICAL ON PERMOLD CRANKCASE).

d. Remove nut (13) and washer (14), and bolts (15, 16); Idler kiss bracket (17) will come off at this time. Generator (18) should pull free. Remove special washers (19), bushings (20), and bushing spacer (21). Remove support bracket (22) and mounting bracket (23) by removing nuts and washers retaining them to the crankcase.

NOTE

Certain specifications use a belt driven alternator in place of the generator. However, the removal and assembly instructions are basically the same.

4-19. GENERATOR (See Figure 4-14).

a. Loosen sheave retaining nut on both starter drive adapter and generator. Loosen adjusting arm screw, tilt generator, and remove belt (1).

b. Remove generator sheave retaining nut and remove spacer (2) and sheave (3). Tape Woodruff key to shaft and replace retaining nut to protect threads.

c. Remove bracket adjusting screw (4) and washer (5). Remove bracket retaining screw and bracket (6). 4

d. Remove nut (9) and bolts (10, 12). Generator (14) should pull free at this time. Remove special washers (15), bushings (16) and bushing spacer (17). Remove support bracket (19) and mounting bracket (20) by removing nuts and washers retain- ing them to the crankcase.

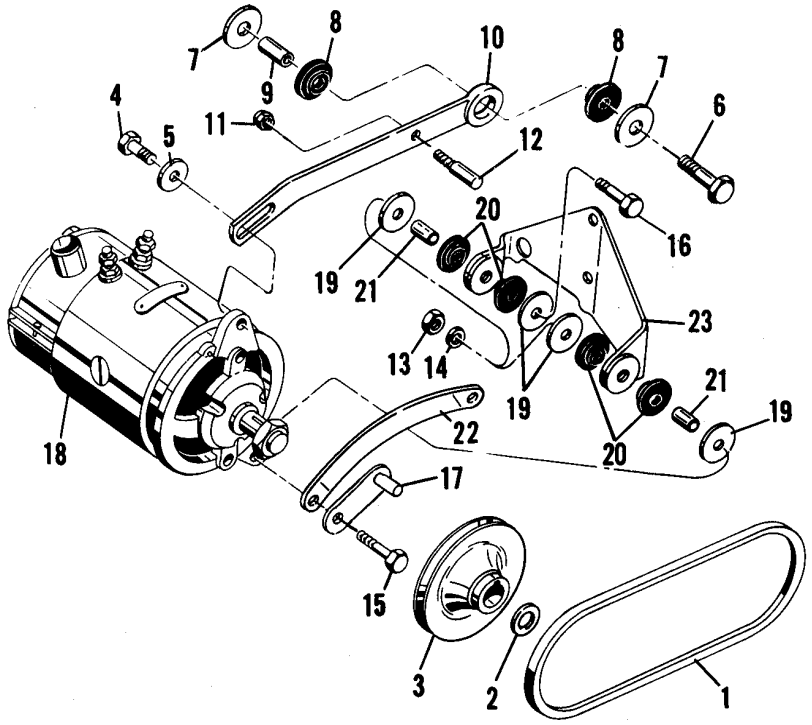
4-20. ALTERNATOR ASSEMBLY (See Figure 4-15).

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

b. Remove cotter pin (5), nut (6) and pull hub assembly from alternator shaft. Remove Woodruff key (7).

c. Separate thrust washer (8), gear assembly (9, 10), clutch spring (11) and hub (12).

d. Remove "O" ring (13).



1. Belt, Generator Driven
2. Spacer, Generator Driven
3. Sheave, Generator Driven
4. Screw
5. Washer, Plain
6. Screw
7. Washer, Special
8. Bushing, Rubber
9. Bushing, Spacer
10. Bracket
11. Nut, Self-Locking
12. Idler, Kiss
13. Nut, Plain, Hex
14. Washer, Plain
15. Bolt
16. Bolt
17. Bracket Assembly
18. Generator, 12 Volt, 50 Amp.
19. Washer, Special
20. Bushing, Rubber
21. Bushing, Spacer
22. Bracket, Support
23. Bracket, Mounting

FIGURE 4-13. GENERATOR ASSEMBLY

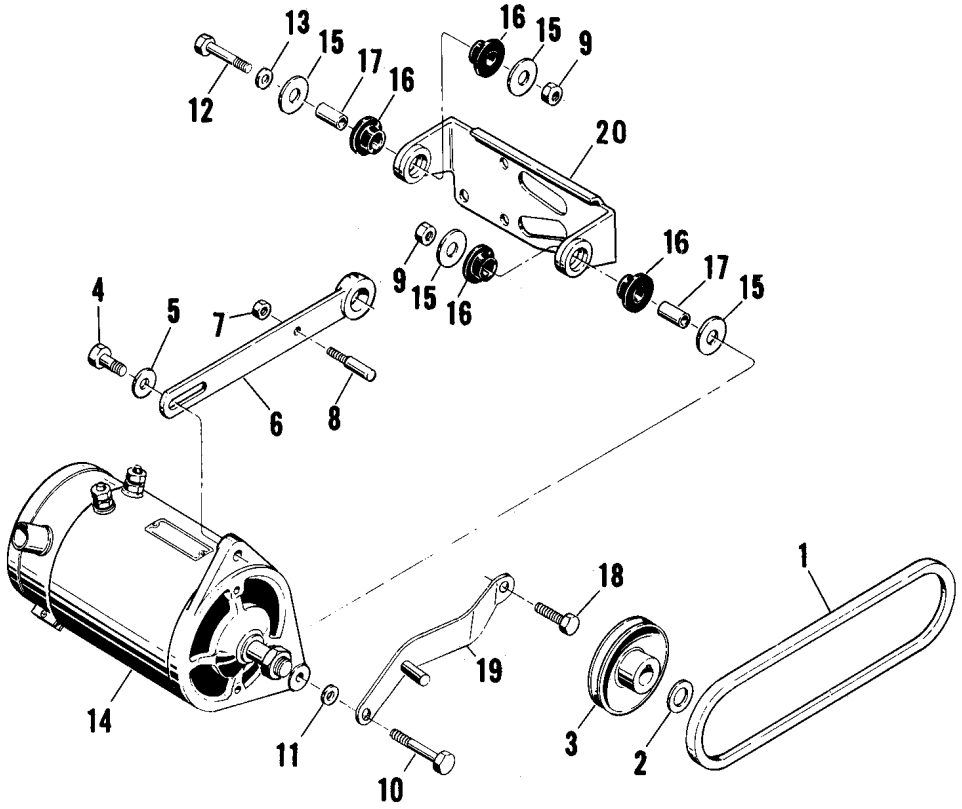


FIGURE 4-14. GENERATOR ASSEMBLY (IO-520-E)

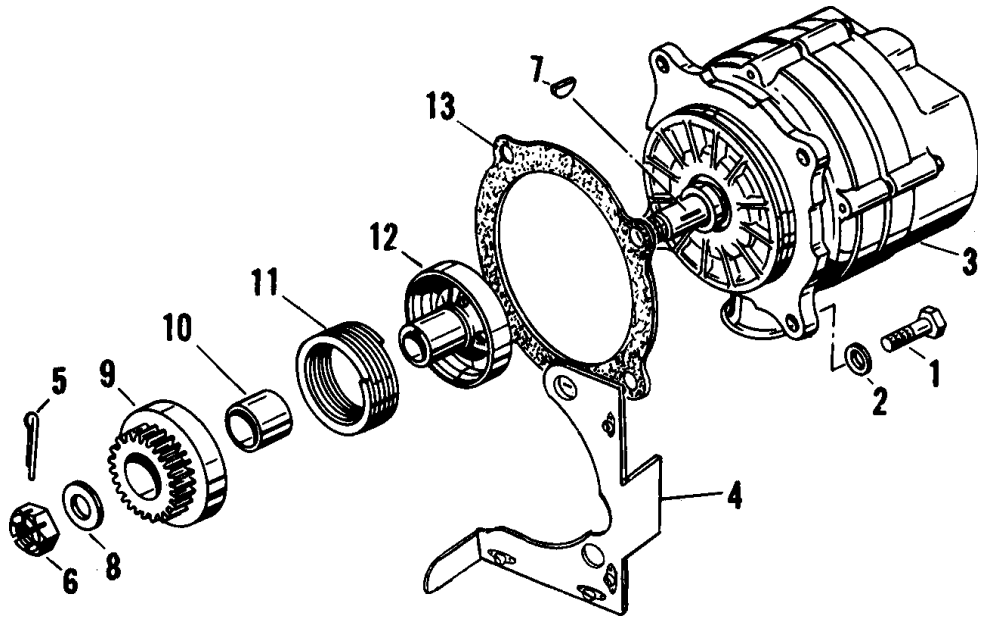


FIGURE 4-15. ALTERNATOR ASSEMBLY ON PERMOLD ENGINES (IO-520-B & C)

4-21. STARTER AND STARTER DRIVE ADAPTER (See Figure 4-16).

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

b. Remove attaching parts (6 through 11) and pull starter adapter assembly from crankcase studs. Remove gasket (12).

c. Clamp shaftgear (33) in shielded vise jaws and remove nut (13), lockwasher (14) and plain washer (15). Pull sheave (16) from shaft and remove Woodruff key (21).

d. Remove attaching parts (17, 18, 19) and pull cover (22) together with sleeve (24) and oil seal (25) from shaft.

e. Use Truarc No.3 or No. 23 pliers and remove retaining ring (26). Remove sleeve and use arbor press to remove oil seal. Remove gasket (23) from adapter.

f. Support rear side of adapter (41) on blocks and tap front end of clutch spring (29) carefully with a brass drift or pin punch all around.

g. Use a wheel puller or arbor press to press the shaftgear (33) from the wormwheel (32) and bearing (30).

h. Clamp wormwheel in shielded vise and remove retaining screw (27) and tab washer (28). Rotate the spring until its depressed rear end lies across the upper 1/4 inch hole in the flange. Insert a 3/16 inch wide screwdriver blade, and pry the spring end outward clear of the drum groove. Hold it out while pulling the spring away.

i. Clamp adapter in shielded vise and remove retaining ring (34) with Truarc No.5 or No. 25 pliers. Remove bearing (37) and worm and shaft assembly.

j. Separate worm gear (35), spring (36), Wood- ruff key (38) and shaft (39).

k. Use arbor press to remove needle bearing (40) from adapter (41).

4-22. STARTER AND STARTER DRIVE ADAPTER (See Figure 4-17).

a. Remove attaching parts (1, 2) and pull 4 starter (3) from adapter studs. Remove “O” ring (4).

b. Remove four sets of attaching parts (5, 6, 7) and pull starter adapter assembly from crankcase. Remove gasket (8).

c. Remove three sets of attaching parts (9, 10, 11) and detach cover (12) and “O” ring (13) from starter adapter.

d. Support adapter on wood blocks and tap clutch spring carefully around front end with a brass drift to remove clutch spring assembly.

e. Remove retaining ring (14). Use arbor press to remove shaftgear (21) from bearing (15) and worm gear (19).

f. Clamp worm gear in shielded vise and remove clutch spring retaining screw (16) and tab washer (17). Turn clutch spring (18) until its depressed rear end lies across the 1/4 inch worm gear hub. Use a 3/16 inch screwdriver blade to pry spring outward clear of drum groove. Hold spring end out while pulling spring from drum.

g. Clamp adapter in shielded vise jaws. Remove retaining ring (22) using Truarc No.5 or No. 25 pliers. Remove bearing (23) and worm shaft assembly.

h. Separate worm gear (24), spring (25), Woodruff key (26), and shaft (27).

i. Use arbor press to remove needle bearing (28) from adapter (32).

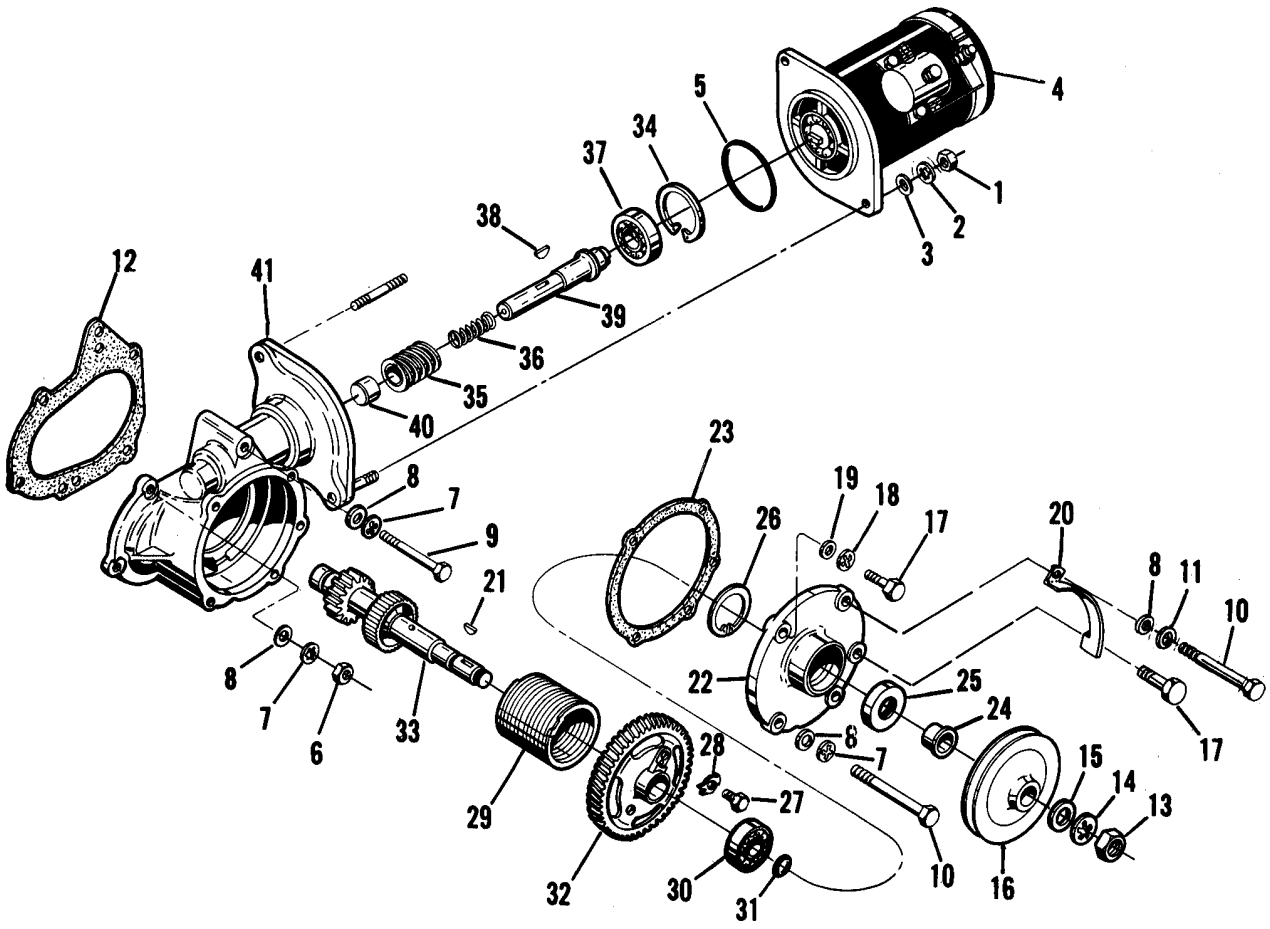


FIGURE 4-16. STARTER ADAPTER WITH GENERATOR DRIVE SHEAVE. (SANDCAST CRANKCASE)

1. Nut
2. Lockwasher
3. Washer, Plain
4. Starter
5. “O” ring
6. Nut
7. Washer, Lock
8. Washer, Plain
9. Bolt
10. Bolt
11. Washer, Lock
12. Gasket
13. Nut
14. Washer, Lock
15. Washer, Plain
16. Sheave
17. Screw
18. Washer, Lock
19. Washer, Plain
20. Indicator, Timing
21. Woodruff Key
22. Cover
23. Gasket
24. Sleeve
25. Oil Seal
26. Retaining Ring
27. Screw
28. Tab Washer
29. Clutch Spring
30. Bearing, Ball
31. "0" Ring
32. Worm Wheel
33. Shaftgear
34. Ring, Retaining
35. Gear, Starter Worm
36. Spring
37. Bearing, Ball
38. Woodruff Key
39. Shaft, Worm Drive
40. Needle Bearing
41. Adapter

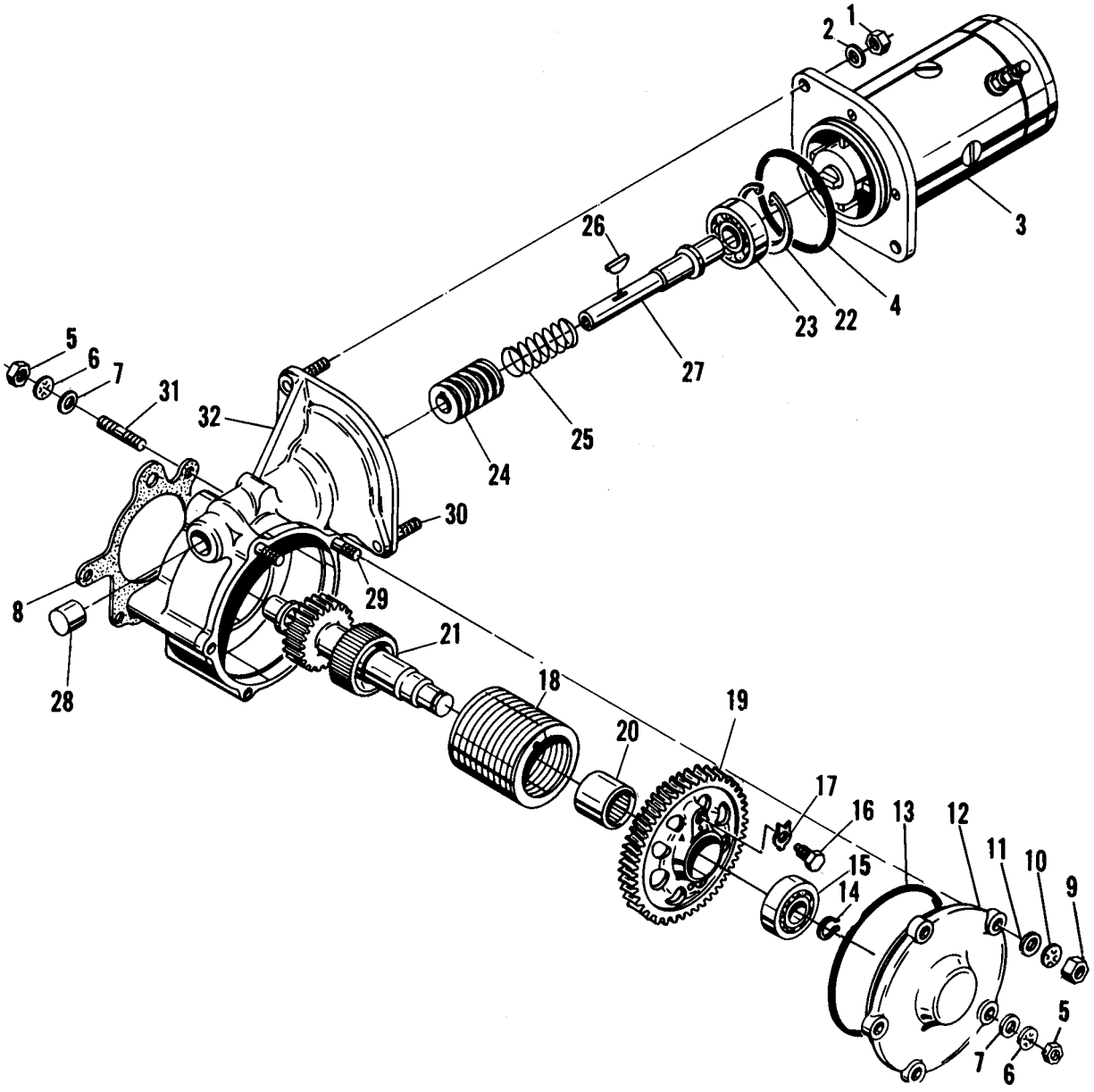


FIGURE 4-16. STARTER ADAPTER WITH GENERATOR DRIVE SHEAVE. (SANDCAST CRANKCASE)

1. Nut, Plain, Hex
2. Washer, Plain
3. Motor, 24 Volt, Starter
4. “O” ring
5. Nut, Plain, Hex
6. Washer, Lock
7. Washer, Plain
8. Gasket
9. Nut, Plain, Hex
10. Washer, Lock
11. Washer, Plain
12. Cover, Starter Adapter
13. “O” ring
14. Ring, Retaining
15. Bearing, Ball
16. Screw
17. Washer Tab
18. Spring,' Clutch
19. Gear, Starter Worm
20. Bearing, Needle
21. Shaftgear Assembly, Starter
22. Ring, Retaining
23. Bearing, Ball
24. Gear, Starter Worm
25. Spring
26. Woodruff Key
27. Shaft, Worm Drive
28. Bearing, Needle
29. Stud
30. Stud
31. Stud
32. Adapter & Sleeve Assy.

4-23. OIL PUMP ASSEMBLY (See Figure 4-18).

a. Loosen oil screen (6) and tachometer drive housing (12) 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 to the rear. Remove gasket (5).

b. Remove oil screen (6) and gasket (7).

c. Remove attaching parts (8,9,10) and separate cover (11) from pump housing (4). Remove tachometer drive housing (12). Press oil seal (15) from housing. Remove gasket (13) and tachometer drive shaft (14).

d. Remove oil pump drive gear assembly and separate tachometer drive gear (33) oil pump drive gear (34) and pin (35). Remove oil pump driven gear and bushing assembly (36, 37).

e. Remove oil pressure relief valve (38 through 43). Remove by-pass assembly (46 through 48).

4-24. OIL PUMP ASSEMBLY, FULL FLOW (See Figure 4-19).

a. Cut lockwire and remove filter (1). Remove attaching parts (2,3,4) and separate adapter (5) and gasket (6) from oil pump housing (10).

b. If electric tachometer (33 through 37) is used, loosen tachometer housing (36) at this time. (Housing has a left-hand thread.)

c. Remove attaching parts (12, 13, 14) and lift off housing (15). Remove attaching parts (16,17, (18) and (21,22,23) and remove covers (19) and (24). Remove gaskets (20) and (25).

d. Remove oil seal (26) and shaftgear (27).

e. If electric tachometer is used, remove attaching parts (30,31,32) and separate cover (33) from oil pump housing (10). Remove tachometer drive housing (36), oil seal (35) and shaftgear (34).

f. Remove attaching parts (7,8,9) and pull oil pump assembly from crankcase studs. Remove gasket (11).

g. Lift out shaftgear assembly (38 through 40) and driven gear assembly (41, 42).

h. Remove oil pressure relief valve (43 through 50) from oil pump housing.

i. Parts (51 through 65) have been replaced by a new style spin on filter.

4-25. CYLINDERS AND PISTONS (See Figure 4-20).

a. Rotate engine stand so engine is in inverted position. Remove attaching parts (1, 2, 3), cover (4) and gasket (5).

b. Position crankshaft so valve lifters of cylinder to be removed are on heels 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 two sets of attaching parts (18, 19) from each cylinder flange. Rotate engine stand so engine is in upright position. Make certain piston in cylinder to be removed is top dead center. Remove nuts (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.

e. Remove piston pin (20) and piston (21) with rings (22,23,24,25) as an assembly.

f. Remove packing (26). Use of a cylindrical wood block anchored to a work bench, with provisions for clamping the cylinder in place, is recommended to facilitate removal of valve springs and to prevent dropping of valves.

g. Compress valve springs and remove keys (27). Be careful not to cock retainers (28, 29) and score valve stems. Remove rotocoil (28) or outer retainer (29), outer spring (30), inner spring (31) and inner retainer (32). Hold valve stems while lifting cylinder from its support, and lay cylinder on its side. Stone down any nicks before removing valve stems (33, 34). It is recommended that all exhaust valves be replaced at each major overhaul regardless of condition.

h. Remove rings (22,23,24 and 25) from piston (21). Be careful not to score ring lands with ring ends.

i. Remove hydraulic valve lifter assemblies (43). It is recommended that all hydraulic lifters be replaced at each major overhaul regardless of condition. If for any reason lifters are removed for inspection before the overhaul period is reached, they must be placed back in the same location from which they were removed.

4-26. SANDCAST CRANKCASE (See Figure 4-21).

a. Oil gauge rod and guide and brackets (items 1 through 11) 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 (12). Remove three screws (14) and lift off oil filler neck (15) and gasket (16).

c. Remove attaching parts (17,18,19,20) and remove lifting eye (21) and spacer (22).

d. Cut lockwire and remove oil temperature con- trol valve (23).

e. Remove bolt (24), nut (27), lockwashers (25), plain washer (26), plain washer (28), flanged nut (29) and washer (30) to remove generator mount bracket (31).

f. Remove nut (32), lockwasher (33), plain washer (30), spacer (35) and lift off governor pad cover (36) and gasket (37).

g. Remove parts indexed (38 through 49).

h. Rotate engine disassembly stand bed so that left crankcase (82) will be downward and support it as illustrated in Figure 8-1.

i. Remove remaining crankcase-to-crankcase flange bolts (50), nuts (51), lockwashers (52) and plain washers (53).

NOTE

Do not attempt to remove bolt and washer adjacent to right magneto up- per 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 overhaul operations.

j. With a non-marring hammer, tap upper ends of through bolts(54,55,56,57) and pull them downward and out of the crankcase. Discard "O" rings.

k. Remove idler gear support pin attaching parts (58, 59) and hold idler gear while support pin (60) is withdrawn. Lower gear to rest in left crankcase. Remove gasket (61).

1. Remove attaching parts (62, 63, 64) and re- move mounting brackets (65).

m. Lift off right crankcase subassembly.

n. Lift out camshaft assembly and governor driven gear (See Figure 4-23).

o. Lift out idler gear assembly, crankshaft assembly with connecting rods, thrust washers and bearings (See Figure 4-19).

4-27. PERMOLD CRANKCASE (See Figure 4-22).

a. Remove oil gauge rod (1). Remove attaching parts (2, 3, 4) and detach oil filler tube (5), gasket (6) and "O" ring (7).

b. Remove nut (8), washers (9, 10), bolt (11), lifting eye (12) and spacer (13).

c. Remove nut (14), washers (15, 16), spacer (17) and lift off governor pad cover (18) and gasket (19).

d. Remove camshaft hole cover attaching parts (20, 21, 22), cover (23) and gasket (24).

e. Rotate engine stand bed to place left crank- case downward. Place a length of pipe or wood under the left crankcase to support it during disassembly. Remove right mount brackets (IO- 520-C only).

f. Remove two sets of attaching parts (25, 26), idler gear flanged bushing (27) and gasket (28).

g. Remove attaching parts (29 through 57). Tap crankcase through bolts (58 through 61) with a non-marring hammer and remove carefully from crankcase so as not to damage threads. Remove "O" rings (47).

NOTE

Do not attempt to remove bolt and washer adjacent to right magneto upper stud. These two parts are installed be- fore 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 overhaul operations.

h. Lift off right crankcase. Lift out camshaft assembly and governor driven gear (See Figure 4- 23). Remove idler gear, crankshaft assembly with connecting rods, thrust washers and main bearings (See Figures 4-24 and 4-25).

i. Remove dowel pin (63) and idler gear bushing (64).

4-28. CAMSHAFT ASSEMBLY (See Figure 4-2)

a. Remove governor drive gear (2) and Woodruff key (3).

b. Remove four screws (4) and lift off gear (5). (IO-520-A only) and gear (6).

WARNING

Do not remove rear pipe plug (7) or front expansion plug (8) from camshaft in permold crankcase engines.

4-29. CRANKSHAFT GROUP (Typical of Sand-cast Crankcase) (See Figure 4-24).

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

b. Remove cotter pin (5), slotted nut (6), bolt (7) and separate connecting rod caps (8) and rods (9). Remove all bearing inserts (10). Loosely reassemble rods, caps, bolts and nuts with position numbers matched.

c. Remove retaining rings (12), retaining plates (13) and pins (14,15,16). Remove counterweights (17).

d. Remove nuts (19) and lift off governor oil transfer collar (20 through 25).

e. Remove six screws (26), and pull gear (27) from crankshaft.

f. Twist and remove split retainer ring, twist and detach from seal (28). Work oil seal spring (29) from its groove. Remove oil seal (30) from crank- shaft (34).

4-30. CRANKSHAFT (Typical of Permold Crank-case) (See Figure 4-25).

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

b. Remove cotter pin (4), slotted nut (5), bolt (6), and separate connecting rod cap (7) and rod (8). Remove bearing inserts (9). Loosely reassemble rod, cap, bolt and nut with their position numbers matched.

c. Remove retaining ring (11), plate (12) and pins (13, 14, 15). Lift counterweight assemblies (16, 17) from crankshaft (35).

d. Remove nuts (18) and separate governor oil transfer collar (19 through 23) from crankshaft.

e. Remove six screws (24) and gear (25). Remove four bolts (26), lockplate (27) and alternator drive gear (28).

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

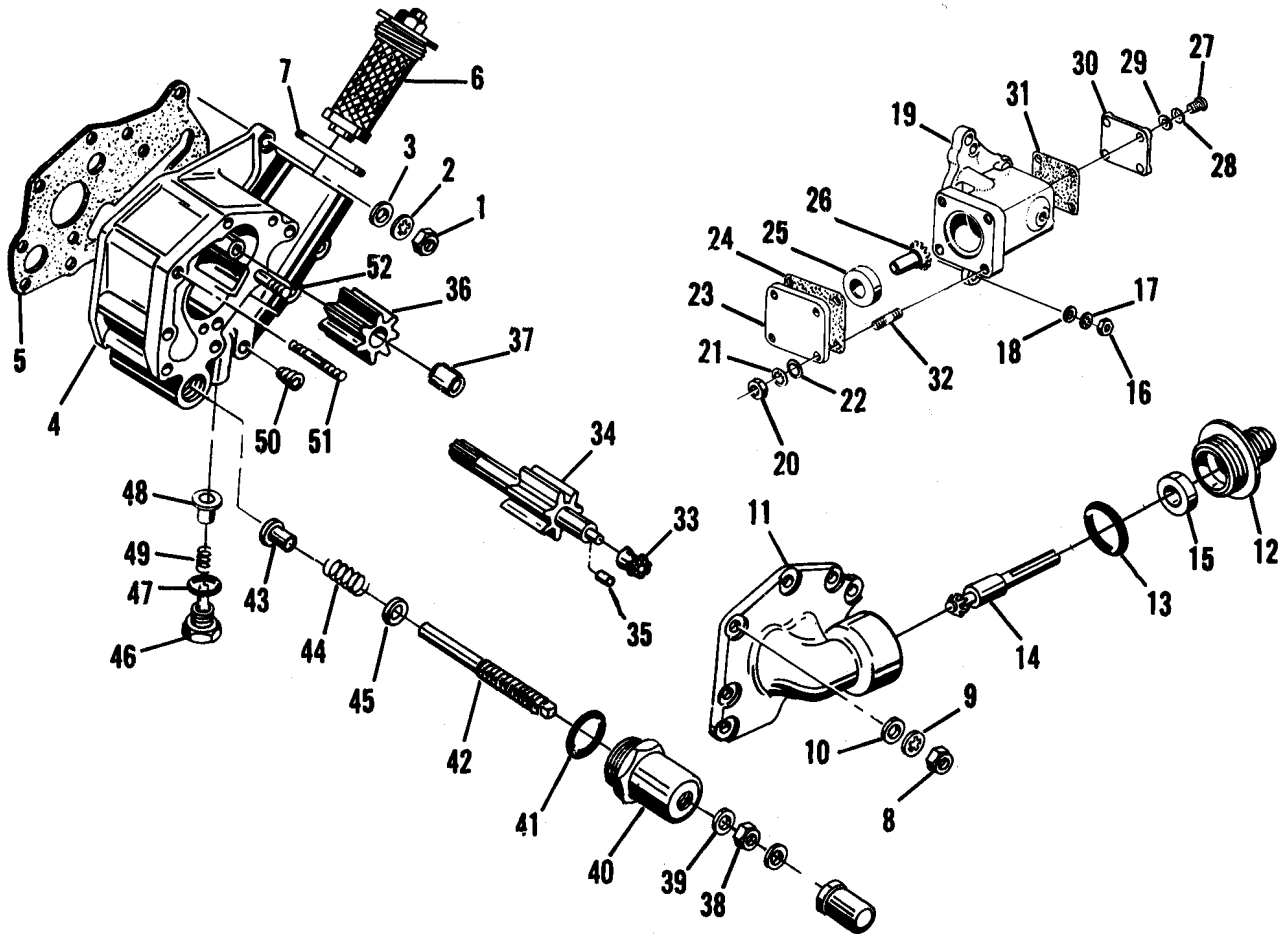


FIGURE 4-18. OIL PUMP (INTEGRAL TYPE OIL SCREEN).

1. Nut
2. Washer, Lock
3. Washer, Plain
4. Housing
5. Gasket
6. Screen Assembly
7. Gasket
8. Nut
9. Washer, Lock
10. Washer, Plain
11. Cover
12. Housing
13. Gasket
14. Shaftgear
15. Seal, Oil
16. Nut
17. Washer, Lock
18. Washer, Plain
19. Cover
20. Nut
21. Washer, Lock
22. Washer, Plain
23. Cover
24. Gasket
25. Seal, Oil
26. Gear Assembly
27. Screw
28. Washer, Lock
29. Washer, Plain
30. Cover
31. Gasket
32. Stud
33. Gear
34. Shaftgear
35. Dowel
36. Gear
37. Bushing
38. Nut, Adjusting
39. Washer
40. Housing
41. Gasket
42. Screw, Adjusting
43. Plunger
44. Spring
45. Washer
46. Pin and Plug Assy.
47. Gasket
48. Valve
49. Spring
50. Plug
51. Stud
52. Stud

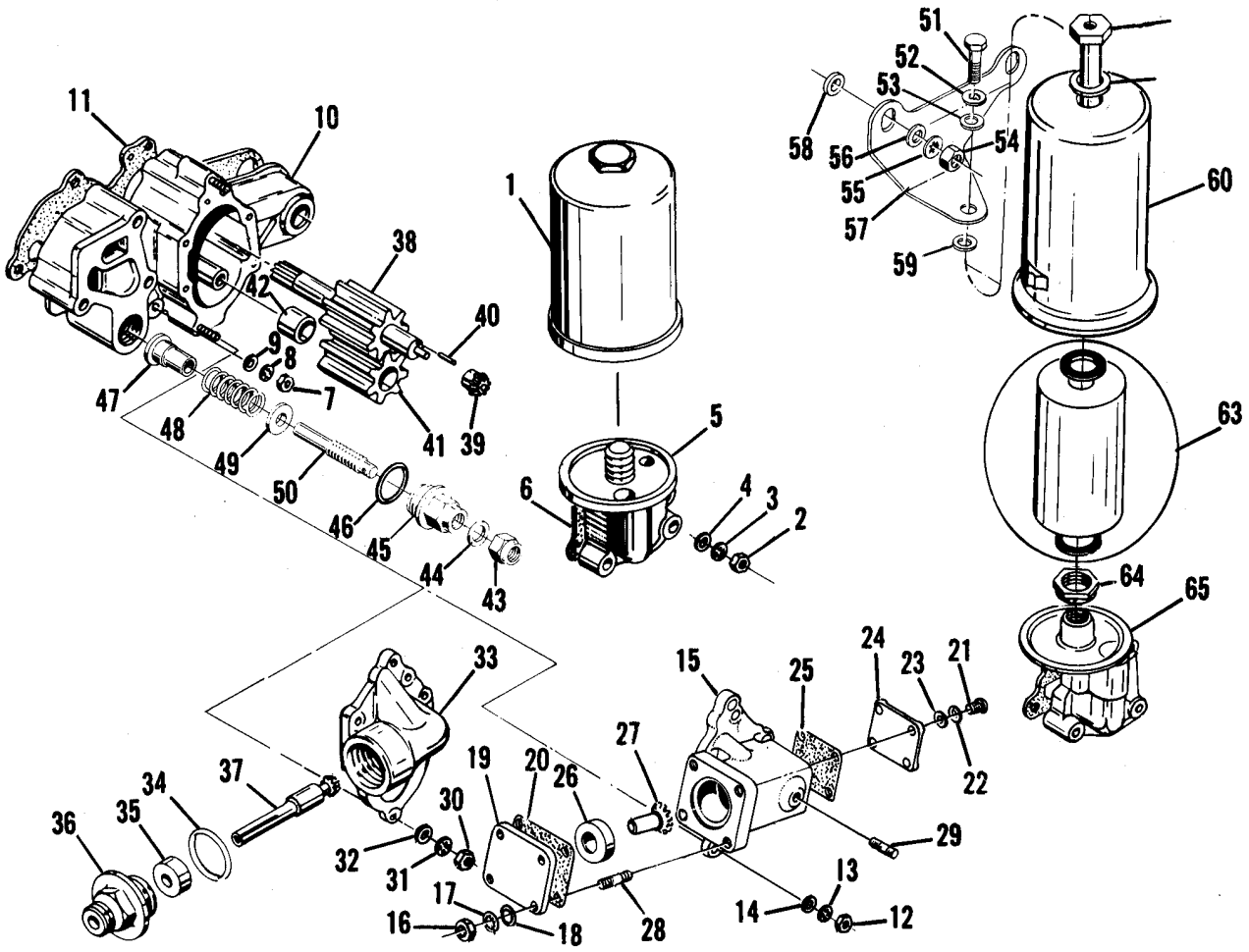


FIGURE 4-19. OIL PUMP (PERMOLD ENGINE FULL FLOW TYPE FILTER).

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

**Parts have been replaced by spin-on filter (1) and adapter (5).*

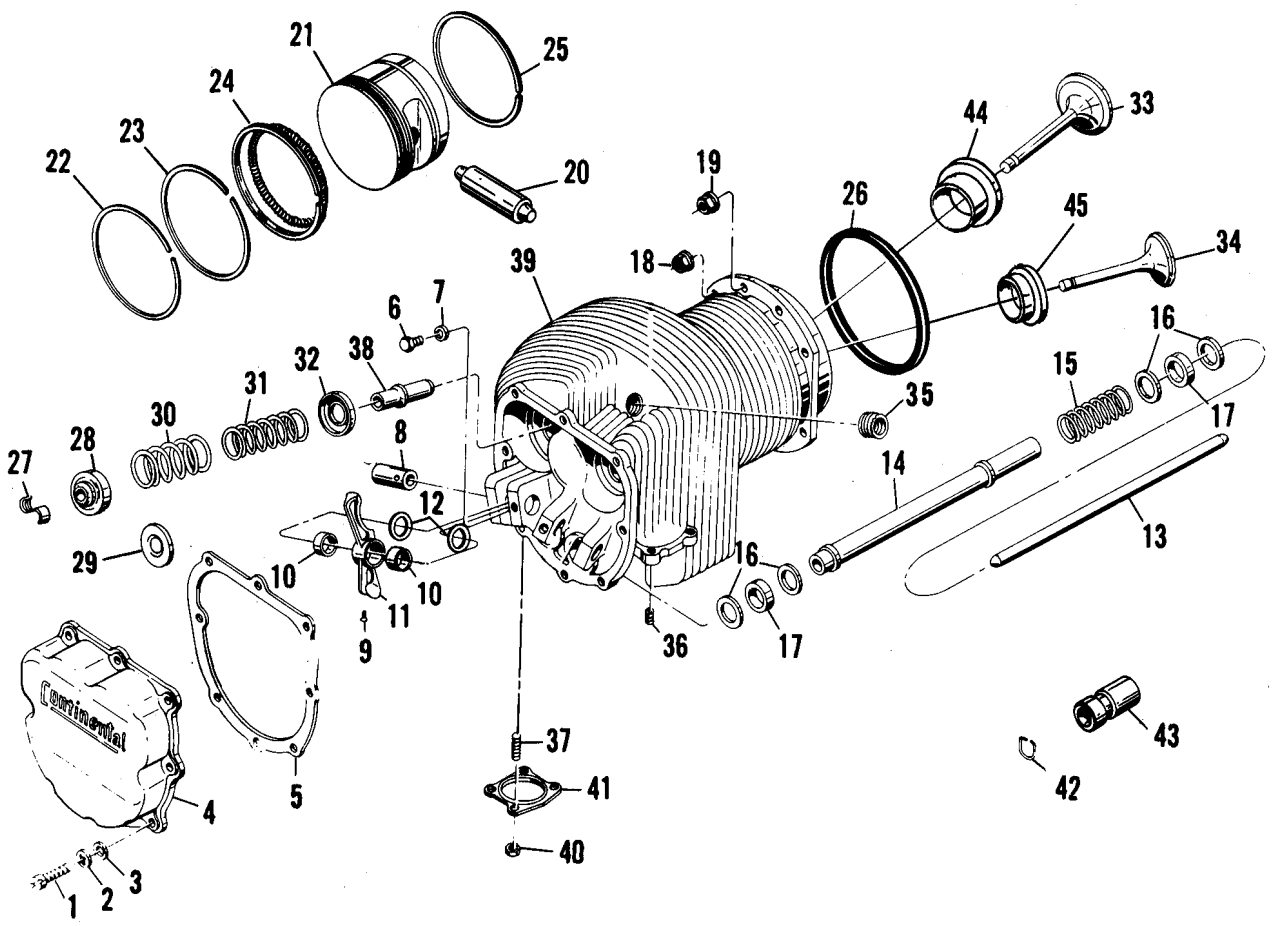


FIGURE 4-20. CYLINDER.

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

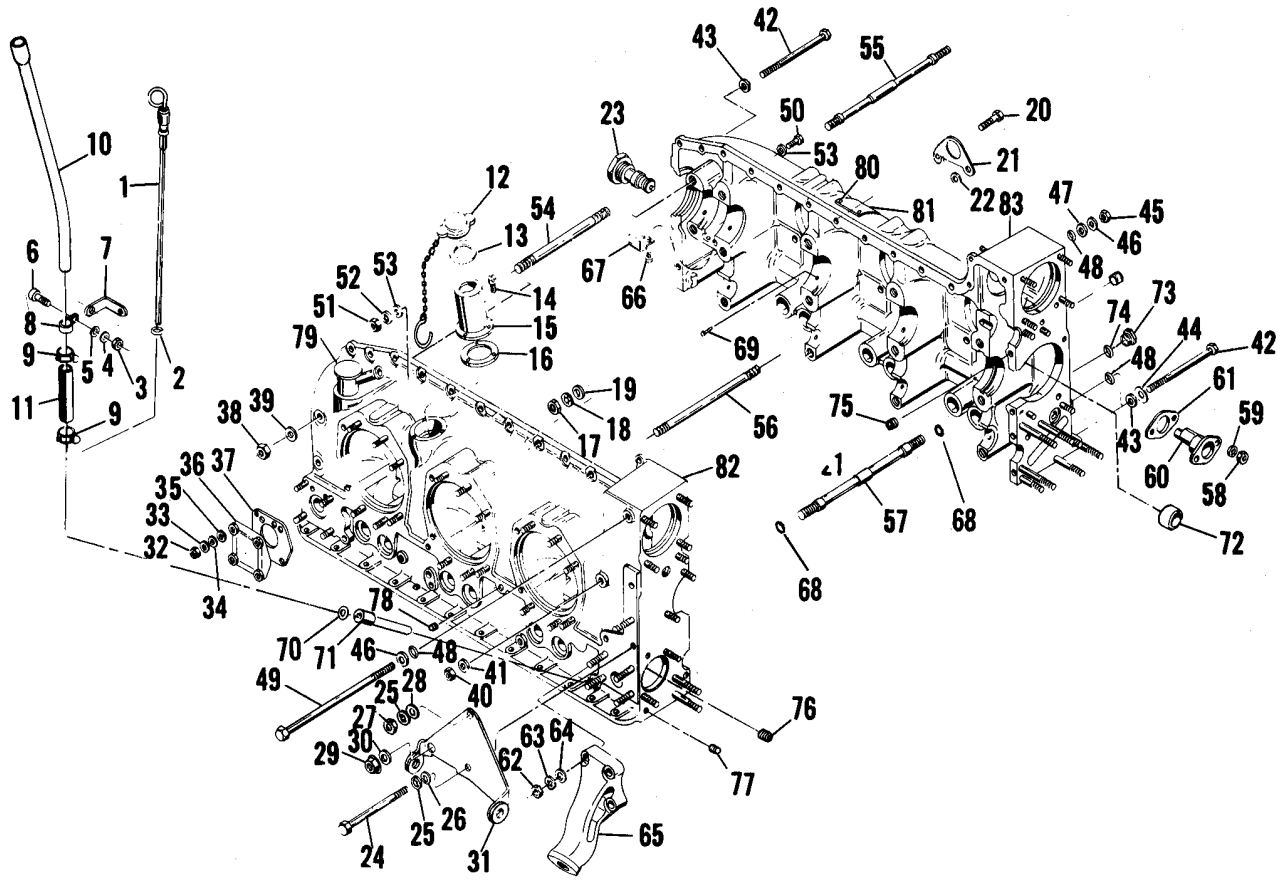


FIGURE 4-21. SANDCAST CRANKCASE ASSEMBLY COMPLETE.

1. Rod Assembly, Oil Gauge
2. “O” ring
3. Nut, No. 10-32
4. Washer, Lock
5. Washer, Plain
6. Screw
7. Bracket
8. Clamp
9. Clamp, Hose, Worm Type
10. Housing
11. Hose
12. Cap Assembly, Oil Filter
13. Gasket
14. Screw
15. Neck Assembly, Oil Filler
16. Gasket
17. Nut, Plain, Hex
18. Washer, Lock
19. Washer, Plain
20. Bolt
21. Eye, Engine Lifting
22. Spacer
23. Valve Assembly
24. Bolt
25. Washer, Lock
26. Washer, Plain
27. Nut, Plain, Hex
28. Washer, Plain
29. Nut, Flanged
30. Washer, Plain
31. Bracket, Generator
32. Nut, Plain, Hex
33. Washer, Lock
34. Washer, Plain
35. Washer
36. Cover, Gov. Pad
37. Gasket
38. Nut, Flanged
39. Spacer
40. Nut, Plain
41. Washer, Plain
42. Bolt
43. Washer, Plain
44. Washer, Plain
45. Nut, Plain, Hex
46. Washer, Lock
47. Washer, Plain
48. “O” ring
49. Bolt
50. Bolt
51. Nut, Plain, Hex
52. Washer, Lock
53. Washer, Plain
54. Bolt, Thru
55. Bolt, Thru
56. Bolt, Thru
57. Bolt, Thru
58. Nut, Plain, Hex
59. Washer, Lock
60. Pin, Idler Gear Support
61. Gasket
62. Nut, Plain, Hex
63. Washer, Lock
64. Washer, Plain
65. Bracket, Engine Mount
66. Screw
67. Clip, Oil Transfer
68. "0" Rings
69. Nozzle, Squirt
70. Ring, Retaining
71. Housing
72. Bearing, Needle
73. Plug, Machine Thread
74. Gasket, Copper
75. Insert, Thread
76. Plug
77. Plug
78. Plug
79. Breather
80. Screw, Drive
81. Plate, Identification
82. Crankcase, 2-4-6 Side
83. Crankcase, 1-3-5 Side

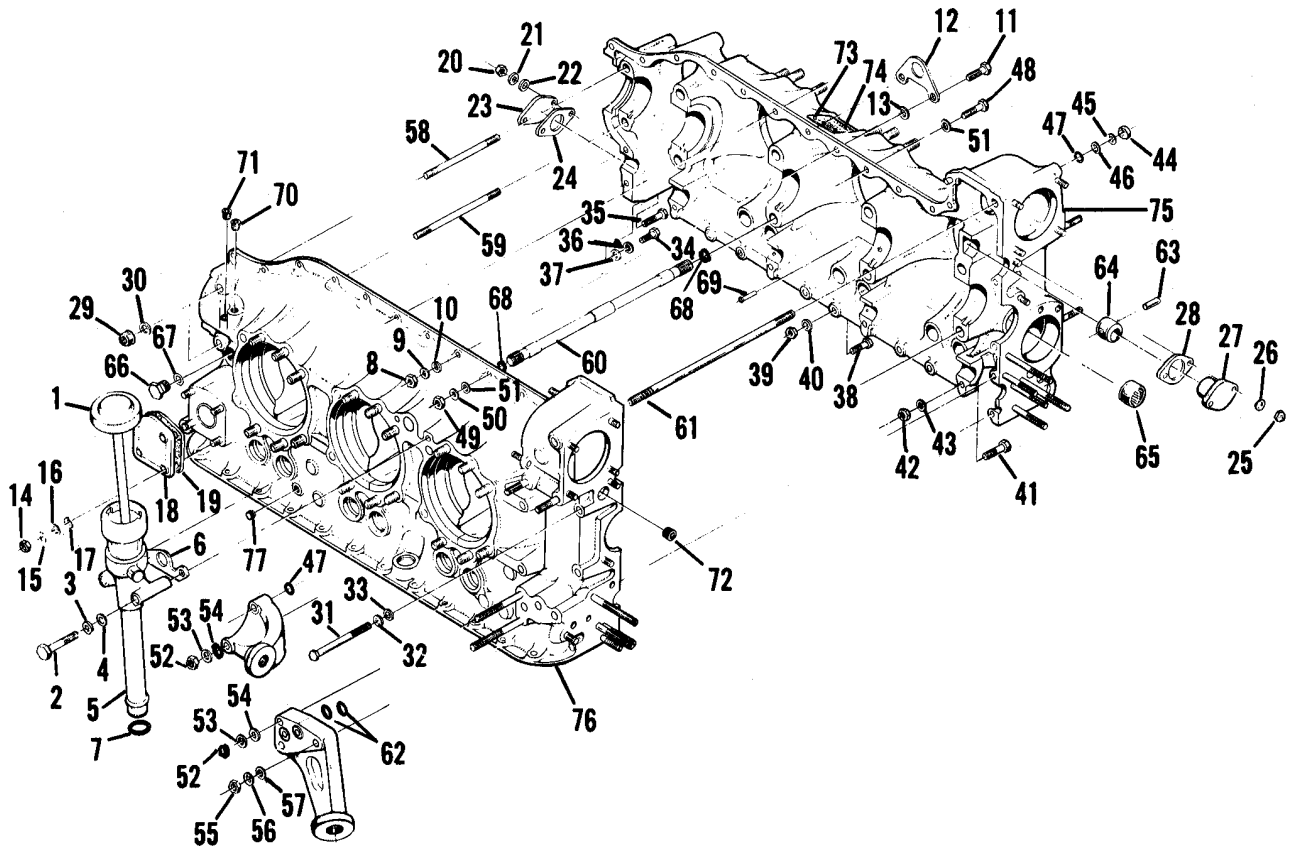


FIGURE 4-22. PERMOLD CRANKCASE ASSEMBLY COMPLETE.

1. Gauge and Cap Assy., Oil
2. Screw
3. Washer, Lock
4. Washer, Plain
5. Tube, Oil Filler Assy.
6. Gasket
7. “O” ring
8. Nut, Plain, Hex
9. Washer, Lock
10. Washer, Plain
11. Bolt
12. Eye, Engine Lifting
13. Spacer
14. Nut, Plain, Hex
15. Washer, Lock
16. Washer, Plain
17. Spacer, Gov. Pad
18. Cover, Gov. Pad
19. Gasket
20. Nut, Plain, Hex
21. Washer, Lock
22. Washer, Plain
23. Cover, Camshaft Hole
24. Gasket
25. Nut, Plain, Hex
26. Washer, Plain
27. Bushing, Flanged
28. Gasket
29. Nut, Flanged
30. Washer, Plain
31. Bolt
32. Washer, Lock
33. Washer, Plain
34. Bolt
35. Bolt
36. Washer, Lock
37. Washer, Plain
38. Bolt
39. Nut, Marsden, Lock
40. Washer, Plain
41. Bolt
42. Nut, Marsden, Lock
43. Washer, Plain
44. Nut, Plain, Hex
45. Washer, Lock
46. Washer, Plain
47. “O” ring
48. Bolt
49. Nut, Plain, Hex
50. Washer, Lock
51. Washer, Plain
52. Nut, Plain, Hex
53. Washer, Lock
54. Washer, Plain
55. Nut, Plain, Hex
56. Washer, Lock
57. Washer, Plain
58. Bolt, Thru
59. Bolt, Thru
60. Bolt, Thru
61. Bolt, Thru
62. "0" Ring
63. Dowel
64. Bushing, Idler Gear
65. Bearing, Needle
66. Plug, Machine Thrd.
67. Gasket, Copper
68. "0" Rings
69. Nozzle, Squirt
70. Plug, Pipe
71. Plug, Pipe
72. Plug, Pipe
73. Screw, Drive
74. Plate, Identification
75. Crankcase, 1-3-5 Side
76. Crankcase, 2-4-6 Side
77. Plug, Pipe

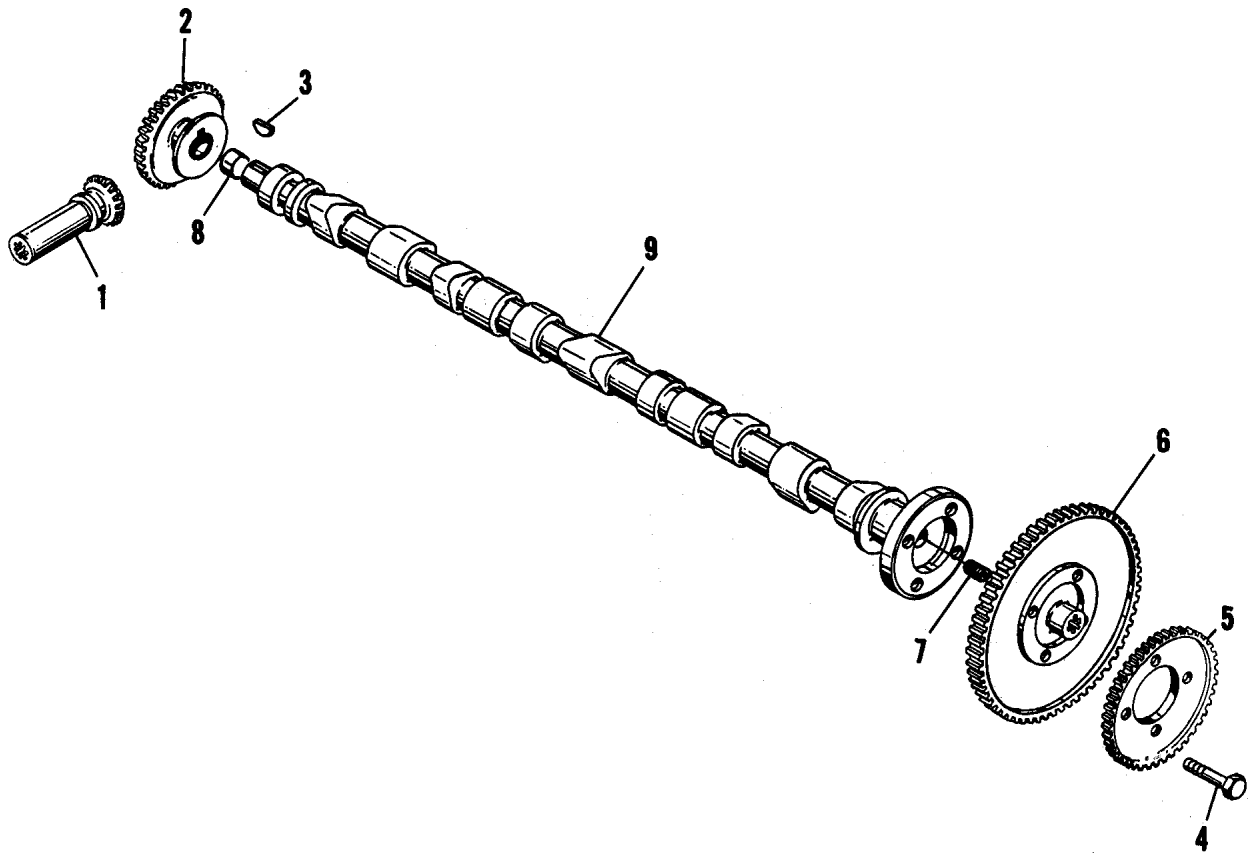


FIGURE 4-23. CAMSHAFT ASSEMBLY

1. Gear, Bevel, Driven
2. Gear, Bevel, Drive
3. Woodruff Key
4. Screw
5. Cam Gear
6. Gear, Camshaft
7. Plug, Pipe
8. Plug, Expansion
9. Camshaft

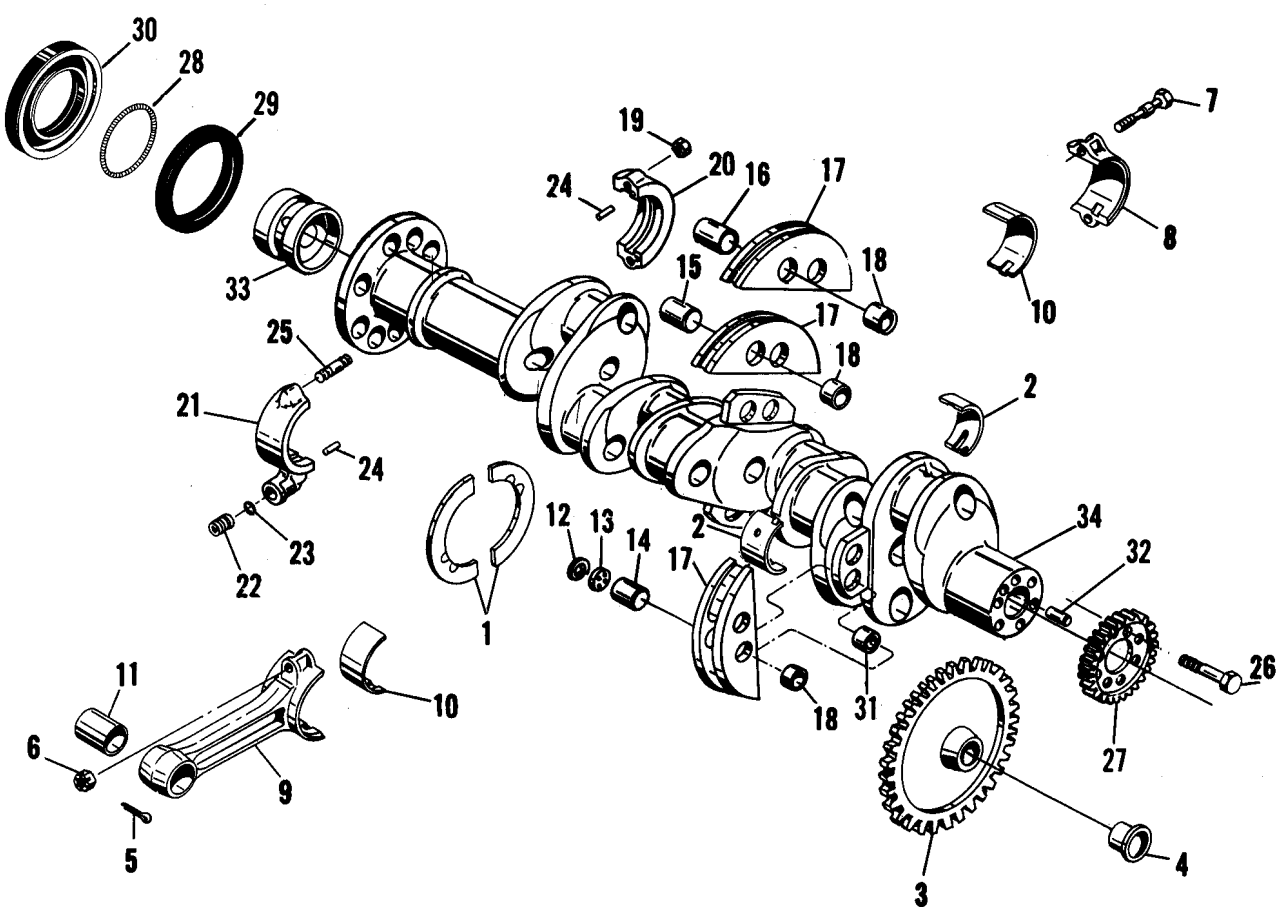


FIGURE 4-24. CRANKSHAFT GROUP (TYPICAL OF SANDCAST MODELS

1. Washer, Thrust
2. Bearing, Crankshaft, Main
3. Gear, Idler
4. Bushing, Idler Gear
5. Pin, Cotter
6. Nut, Slotted
7. Bolt, Special
8. Cap
9. Rod, Connecting
10. Bearing
11. Bushing
12. Ring, Retaining
13. Plate, Counterweight
14. Pin, Counterweight
15. Pin, Counterweight
16. Pin, Counterweight
17. Counterweight, Crankshaft
18. Bushing, Counterweight
19. Nut, Marsden
20. Collar, 1-3-5 Side
21. Collar, 2-4-6 Side
22. Sleeve, Oil Transfer
23. "0" Ring
24. Pin, Roll
25. Stud
26. Screw
27. Gear, Crankshaft
28. Spring
29. Reinforcing Ring
30. Seal
31. Bushing
32. Dowel
33. Plug, Oil Control
34. Crankshaft Group

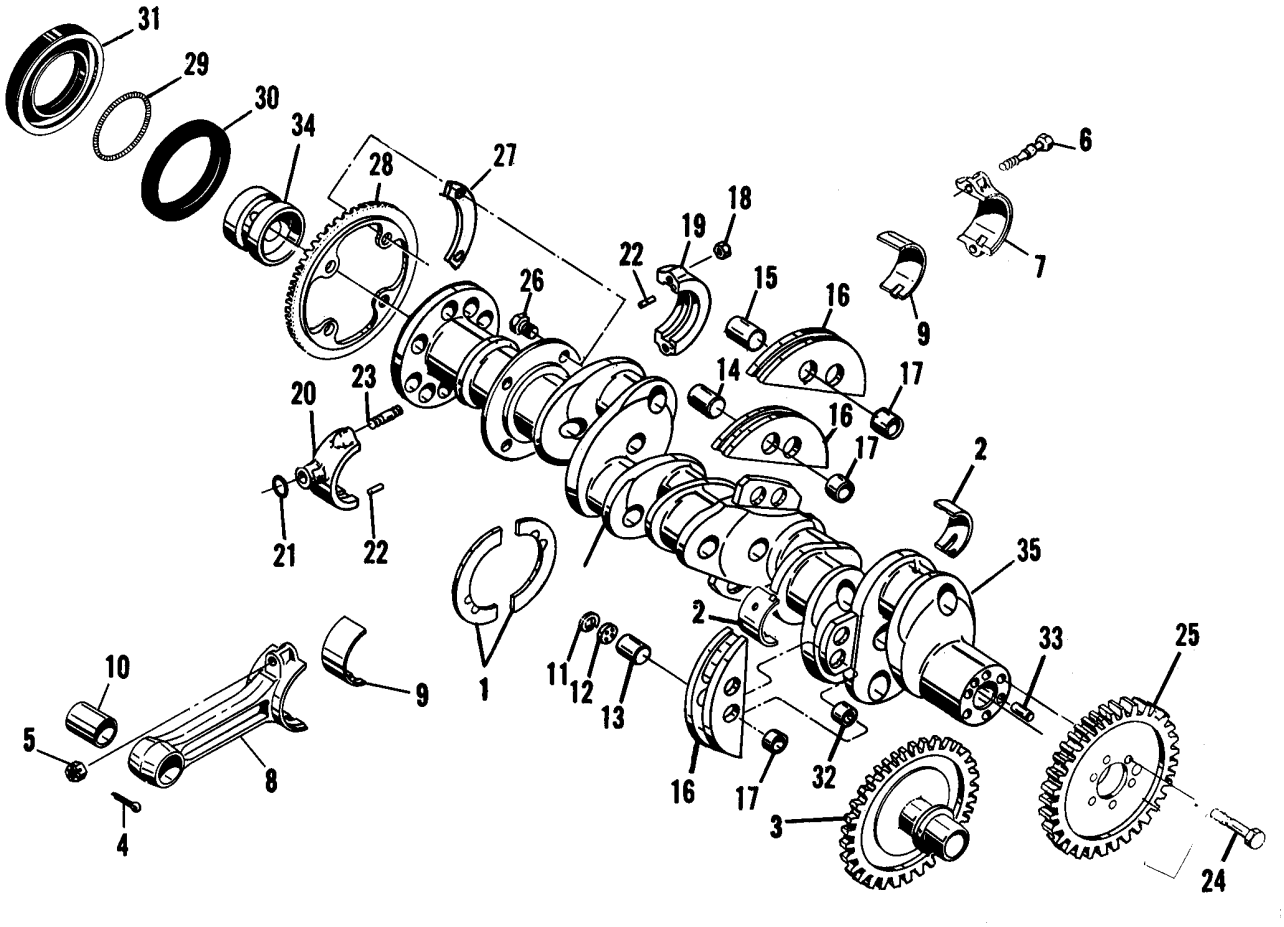


FIGURE 4-25. CRANKSHAFT GROUP (TYPICAL OF PERMOLD CRANKCASE).

1. Washer, Thrust
2. Bearing, Crankshaft, Main
3. Gear, Idler
4. Pin, Cotter
5. Nut, Slotted, Special
6. Bolt
7. Cap
8. Connecting Rod Assembly
9. Bearing
10. Bushing
11. Ring, Retaining
12. Plate, Counterweight
13. Pin, Counterweight, 6th Order
14. Pin, Counterweight, 4th Order
15. Pin, Counterweight, 5th Order
16. Counterweight Assembly
17. Bushing
18. Nut, Marsden
19. Collar, 1-3-5 Side
20. Collar, 2-4-6 Side
21. "0" Ring
22. Dowel
23. Stud
24. Screw
25. Gear, Cluster
26. Bolt
27. Plate, Tab Lock
28. Gear, Face, Alt. Drive
29. Spring
30. Retaining Ring
31. Seal, Oil
32. Bushing
33. Dowel
34. Plug, Oil Control
35. Crankshaft and Tube Assy.

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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 IO-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 boles, as well as from other surfaces, to prevent the formation of a foaming emulsion in the engine lubricating oil after reassembly.

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 car- bon remain on cylinder heads, the areas affected may be vapor blasted. All machined surfaces must be protected from abrasive action during the blasting operation.

5-6. 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 he 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 Permold engines is not necessary. Therefore, do not remove the rear pipe plug or front expansion plug unless re- placement 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.

Gasket surfaces must be thoroughly cleaned with a suitable hydrocarbon solvent such as naptha, Methyl Ethyl Ketone (MEK) or Trichloroethylene (TCE) to remove dirt, oil and grease. Wipe surfaces dry before re-use.

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 VII. Clean the casting tapped hole with solvent and blow dry with compressed air; then examine the thread. If it is not

TABLE VII. 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

torn, install the next larger oversize stud. If the old stud was of the maximum oversize, of 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 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 X.

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, phospher 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 over heating 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.

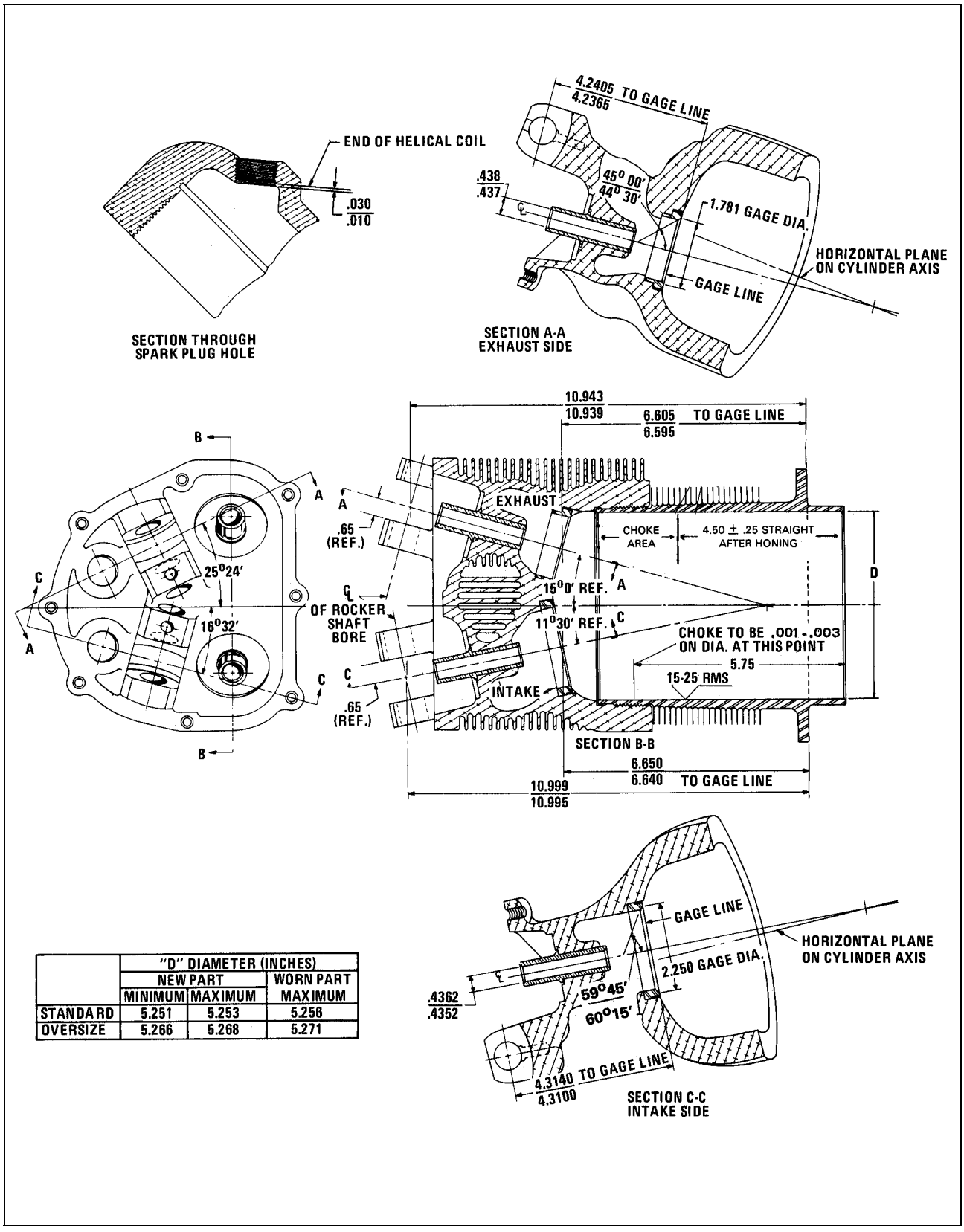
5-23. FIN REPAIRS. Straighten slightly-bent barrel fins with long-nose pliers. File to smooth the edges of broken head fins. If it becomes necessary to cut out a vee notch to stop a head fin crack, a slotted drill bushing to fit over the fin and a 3/16 inch twist drill may be used to cut the notch. Its 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.



	"D" DIAMETER (INCHES)		
	NEW PART		WORN PART
	MINIMUM	MAXIMUM	MAXIMUM
STANDARD	5.251	5.253	5.256
OVERSIZE	5.266	5.268	5.271

FIGURE 5-1. STANDARD CYLINDER ASSEMBLY DIMENSIONS

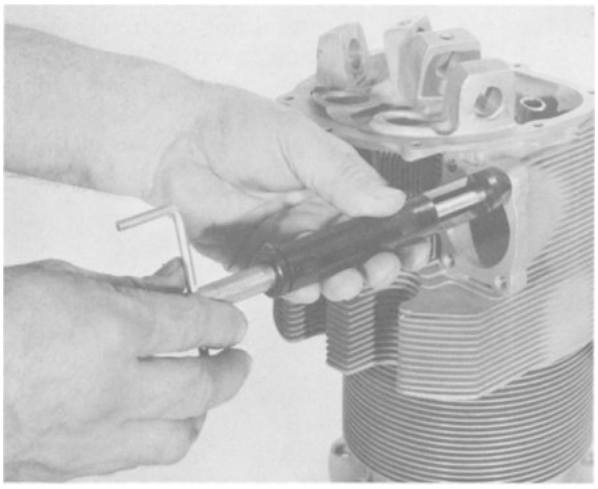


FIGURE 5-2. INSTALLING TYPICAL HELICAL INSERT

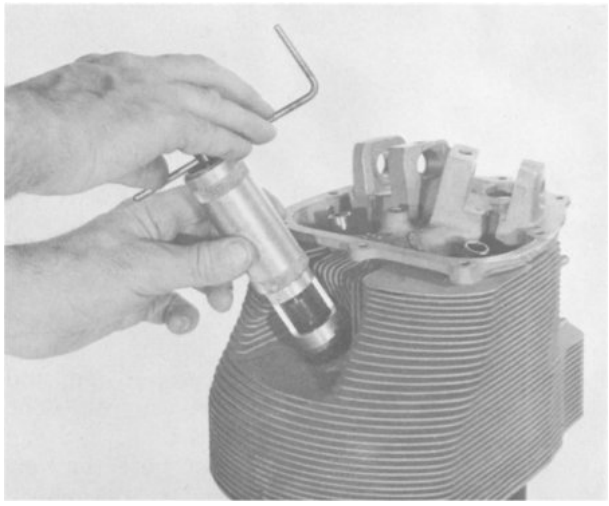


FIGURE 5-4. INSTALLING SPARK PLUG HOLE HELICAL INSERT.

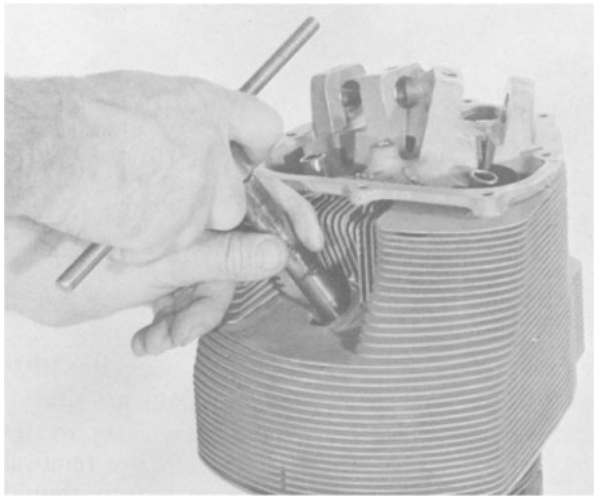


FIGURE 5-5. EXPANDING SPARK PLUG HOLE HELICAL INSERT.

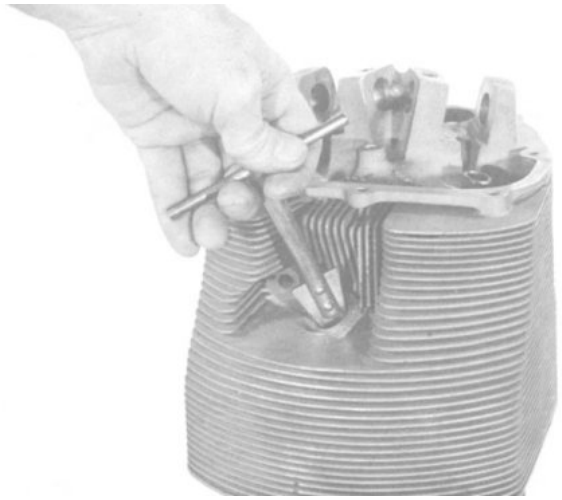


FIGURE 5-3. REMOVING SPARK PLUG HOLE HELICAL INSERT.

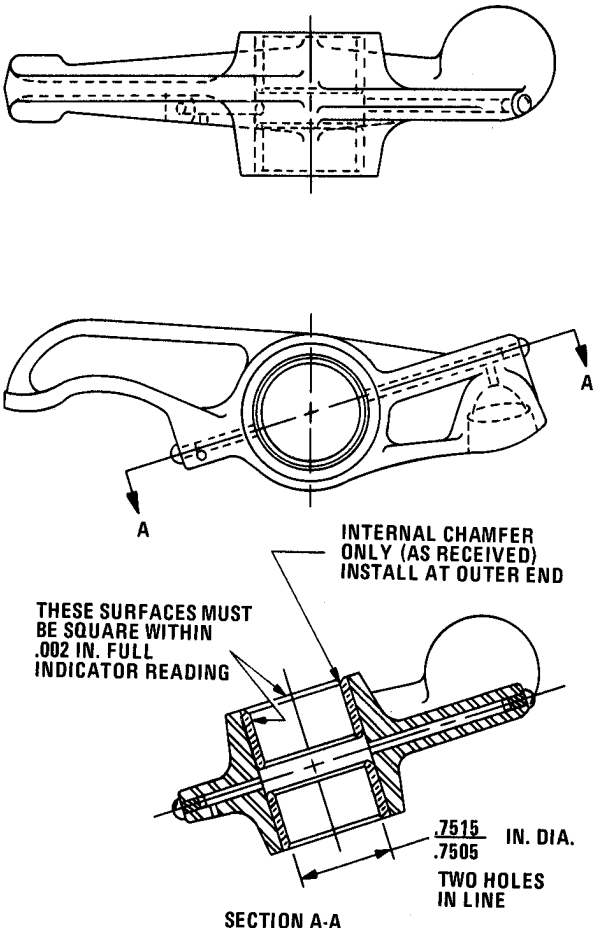
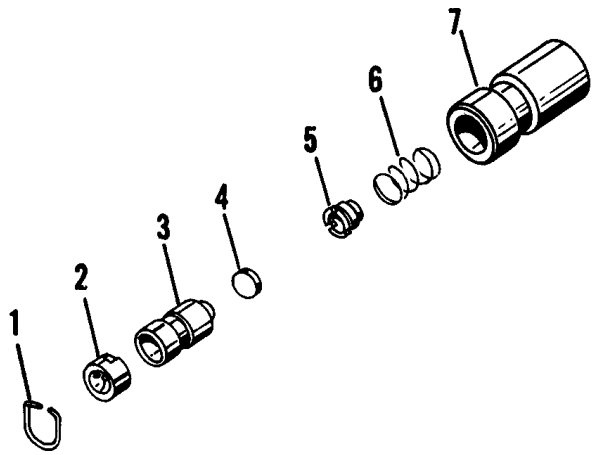


FIGURE 5-6. VALVE ROCKER BEARING DIMENSIONS



1. Ring, Retaining
2. Socket, Hydraulic lifter
3. Plunger
4. Plate, Check Valve
5. Housing
6. Spring, Plunger
7. Body, Valve Lifter

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. Remove 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 in opposite bays. This limit cannot be main- tained 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.

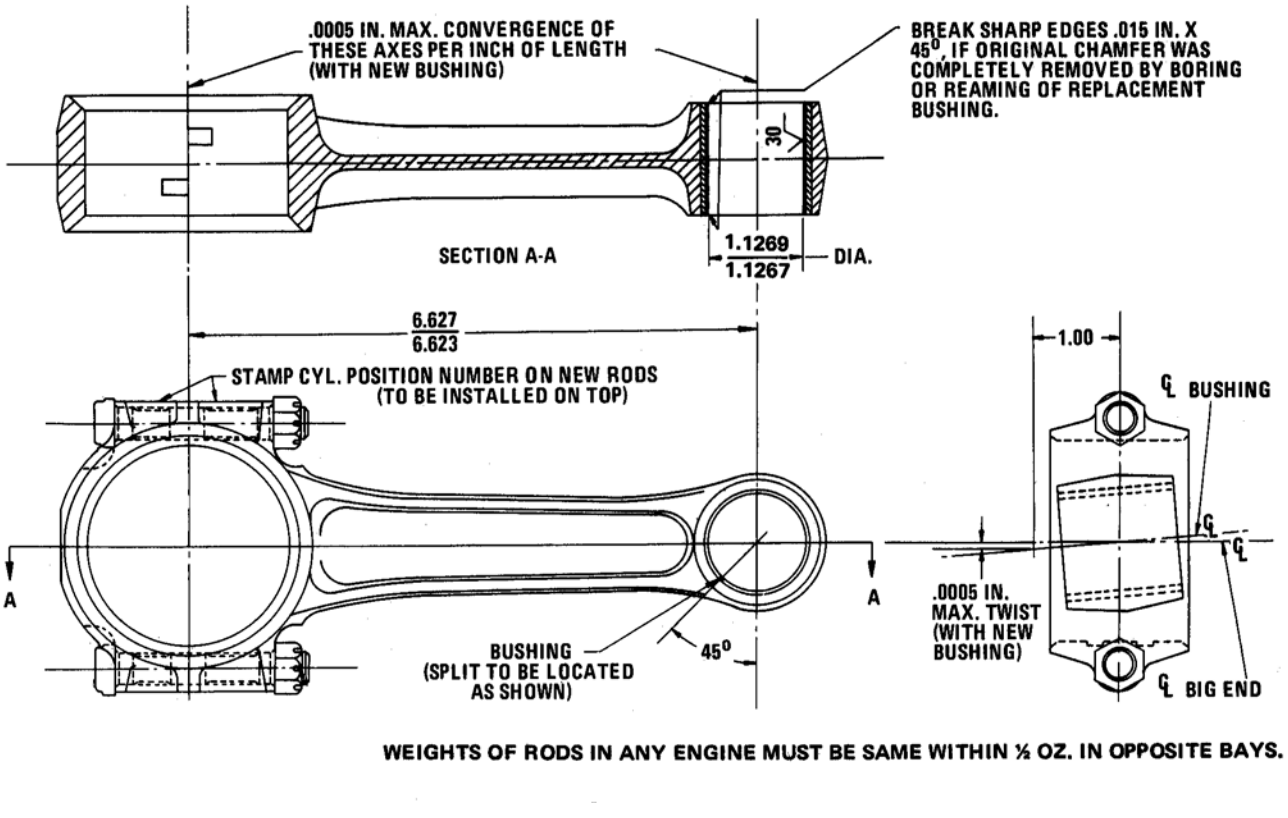


FIGURE 5-8. CONNECTING ROD AND BUSHING DIMENSIONS.

5-31. Hardened steel bushings in the crankshaft blades 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, ifeither 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 1.0. 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

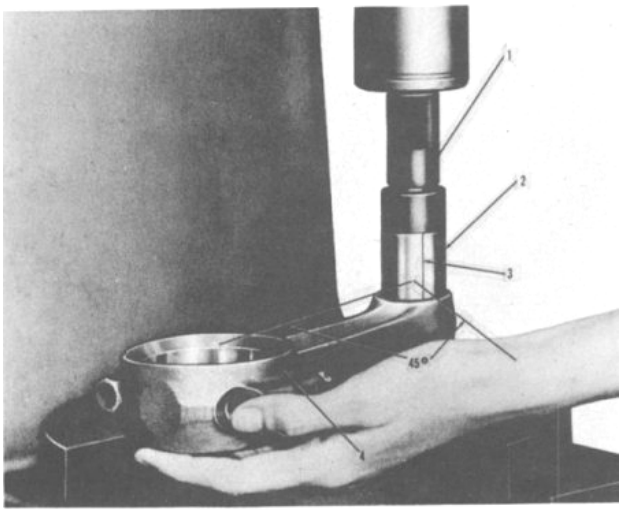


FIGURE 5-9. INSTALLING CONNECTING ROD BUSHING.

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 450 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 boles with beeswax to exclude cbips from tbe 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 counter bore. 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 5-11 and observe that the numerals appearing at magneto ends of the high tension cables correspond to the consecutive order of outlet plate cable holes, while the

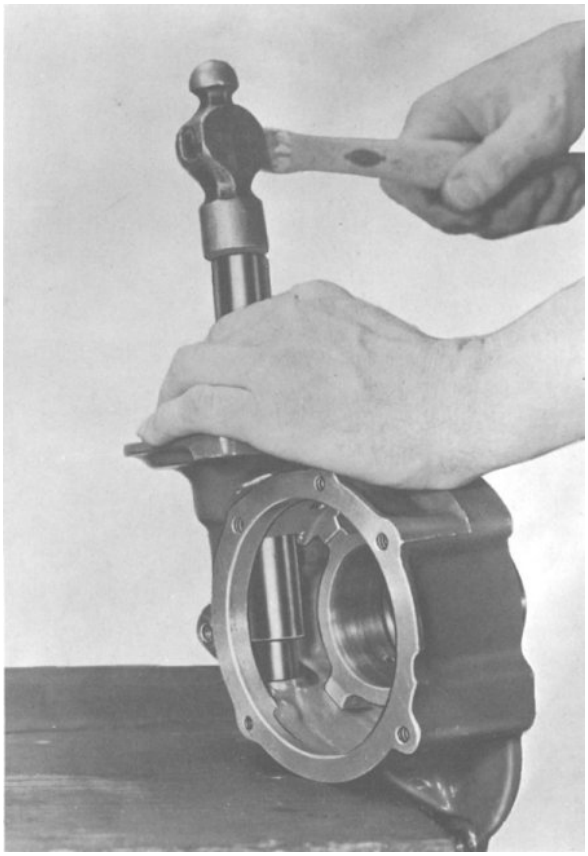


FIGURE 5-10. INSTALLING NEW STARTER ADAPTER NEEDLE BEARING.

relative positions of spark plug elbows indicate the installed positions of the cables. Install cable assemblies (3 through 14, Figure 5-11) 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 I (Items 38 through 45) for Slick Harness, and (Items 46 through 52) for Bendix Harness.

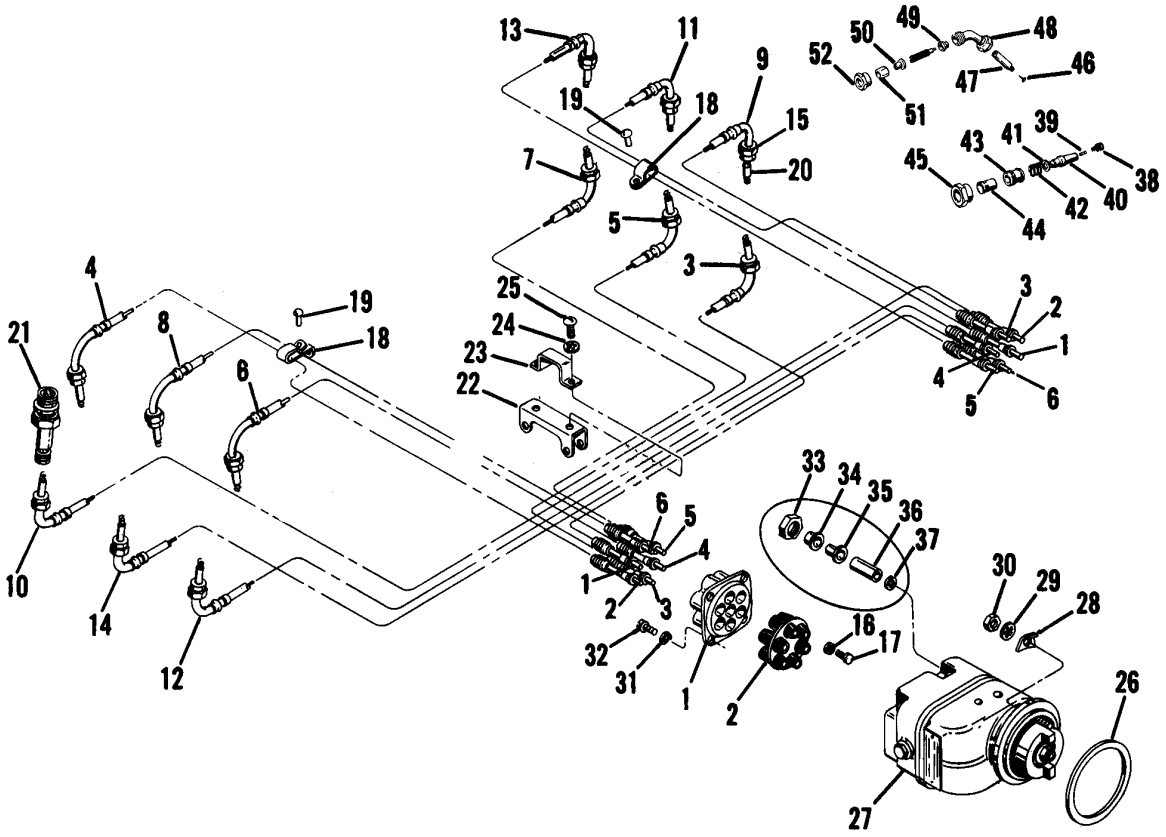


FIGURE 5-11. EXPLODED VIEW OF IGNITION SYSTEM.

1. High Tension Cable Outlet Plate
2. Outlet Plate Grommet
3. Cable Assy. to No.1 Lower Spark Plug
4. Cable Assy. to No.6 Upper Spark Plug
5. Cable Assy. to No.3 Lower Spark Plug
6. Cable Assy. to No.2 Upper Spark Plug
7. Cable Assy. to No.5 Lower Spark Plug
8. Cable Assy. to No.4 Upper Spark Plug
9. Cable Assy. to No.1 Upper Spark Plug
10. Cable Assy. to No.6 Lower Spark Plug
11. Cable Assy. to No.3 Upper Spark Plug
12. Cable Assy. to No.2 Lower Spark Plug
13. Cable Assy. to No.5 Upper Spark Plug
14. Cable Assy. to No.4 Lower Spark Plug
15. Coupling Nut
16. Brass Washer
17. Cable Piercing Screw
18. Two-Wire Cable Bracket
19. Round-Head Rivet
20. Spark Plug Terminal Sleeve
21. Approved Spark Plug
22. Brace (Assembled on Crankcase)
23. Clip
24. Internal Tooth Lockwasher
25. Round-Head Screw
26. Magneto Gasket
27. Magneto
28. Magneto Holding Washer
29. Internal Tooth Lockwasher
30. Plain Hex Nut
31. Spring Lockwasher
32. Fillister-Head Screw
33. Hex Coupling Nut
34. Outer Ferrule
35. Inner Ferrule
36. Insulating Sleeve
37. Brass Washer
38. Spring
39. Screw, Electrode
40. Sleeve, Ignition Cable
41. Washer
42. Spring
43. Drive Ferrule
44. Drive Ferrule, Plug End
45. Nut, Spark Plug End
46. Nail
47. Sleeve
48. Elbow Assembly
49. Grommet
50. Ferrule, Cable, Inner
51. Ferrule, Cable, Outer
52. Nut, Spark Plug End

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SECTION VI
INSPECTION

6-1. DEFINITIONS OF TERMS.

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

A. ABRASION: Scratching of a surface, either by motion while in contact with another part 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 of the temper of steel parts 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, countersinking, 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 in 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 subject 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. 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 lubricant.

6-3. PROTECTION FROM CORROSION. Bare steel 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 often have a high acid content. Application of lubricating oil or corrosion-preventive mixture will not necessarily stop corrosion from this cause.

6-4. VISUAL INSPECTION: Parts without critical dimensions and small parts, as well as running parts and others of major importance, should be inspected visually under good light for surface damage such as nicks, dents, deep scratches, visible cracks, distortion, burned areas, pitting, pick-up of foreign metal and removal of enamel coating. Visual inspection should also determine the need for further cleaning of obscure

areas. Inspect all studs for possible bending, looseness or partial removal. Inspect all threaded parts for nicks and other damage to the screw threads. After visual inspection the engine parts should be in three groups: Apparently serviceable parts, repairable parts and parts to be discarded.

6-5. MAGNETIC PARTICLE INSPECTION. Inspection by the Magnaflux method must be conducted on all ferrous parts listed in Table XI, and in accordance with the methods and data in the table before dimensional inspection. The Magna-glow 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 a "black light", as in the Zyglo process, to amplify weak indications. If a crankshaft is doubtful after a circular magnetization and inspection, demagnetize and remagnetize 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-fitting 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; then dry with compressed air. Check for complete demagnetization.

TABLE VIII

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
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	0.4335 - 0.4340
Piston (Standard)	*Diameter at Top	5.2030 - 5.2050
	*Diameter Below 1St Groove	5.2180 - 5.2200
	*Diameter at Bottom	5.2405 - 5.2420
	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
	Diameter	1.1243 - 1.1245
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

PART NAME	FEATURE	NEW DIMENSION (INCHES)
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
	Crankshaft Bearing Bore in Crankcase Std.	2.5625 - 2.5635
	Crankshaft Bearing Bore in Crankcase "B" Configuration. Rear and Intermediate Bearings Only.	2.8160 - 2.8170
	Tappet Guides Dia.	1.0005 - 1.0015
	Governor Driven Gear Bearing Dia.	0.8750 - 0.8760
	Starter Shaft Needle Bearing Hole Dia.	0.9990 - 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
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	0.5620 - 0.5630
	Shaft Assembly Hole Dia. Permold Crankcase	0.6870 - 0.6880
Oil Pump Housing and Shaft Assembly	Driven Gearshaft Dia. Sandcast Crankcase	0.5015 - 0.5025
	Driven Gearshaft Dia. Permold Crankcase	0.5640 - 0.5650
	Driver Gearshaft Hole Diameter	0.5620 - 0.5630
	Gear Chamber Depth Permold Crankcase	1.3275 - 1.3290
	Gear Chamber Depth Sandcast Crankcase	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	0.5580 -0.5590
	Small Diameter Permold Crankcase	0.4990 -0.5000

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

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

6-7. DIMENSIONAL INSPECTION.

6-8. INSTRUMENTS. Areas of running parts and bushings subject 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.

6-9. DIMENSIONAL LIMITS. After comparative measurements of mating parts and determination of running clearance, refer to the Table of Limits, Section VI, and to the Limits and Lubrication 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, and the low limit applies in all instances; however, such clearances are allowed to increase with wear to, but not beyond, the values in the column headed "Serviceable Limit". All press and shrink fits must be maintained as specified in the "New Parts" columns when the inserted member is replaced. Oversize parts are supplied, in some instances, to permit conformity to this requirement.

6-10. ORIGINAL DIMENSIONS. Although comparative measurements of mating parts will determine the serviceability of the fit, it is not always easy to determine which part has worn the most, and in some instances (e.g., main journals in 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. Hence, the manufacturing limits in Table VIII on important dimensions of new parts should be consulted when the serviceability of a specific part is in doubt.

6-11. 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).

6-12. APPLICATION OF "ALODINE 1200". In the event the original finish of an aluminum part has deteriorated or been removed, the part may be "Alodized" or 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 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 an 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.

6-13. 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 the part from one to five minutes or until color of the new film is approximately same as 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 with plenty of hot water and vigorous brushing.

6-14. ENAMEL COATINGS. Ferrous parts when painted with gold enamel will be baked with infrared 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 infrared 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 accept to the surface areas 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.

6-15. SPECIFIC INSPECTIONS.

6-16. 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, then it is possible that 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 and the shaftgear bushing. The castings must be clamped together at all attaching points before dimensional inspection of camshaft bearings.

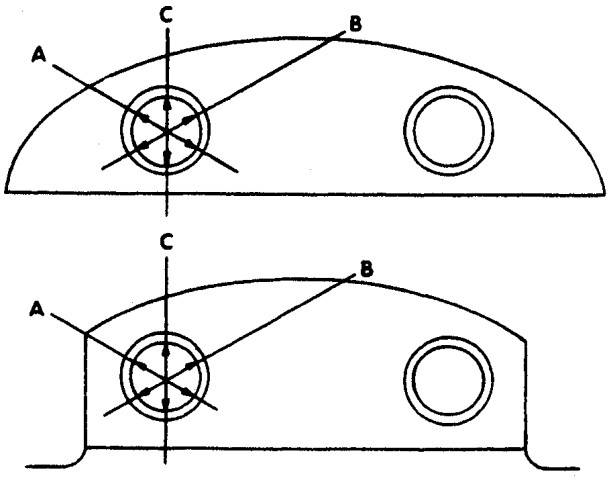
NOTE...If camshaft bearings are excessively worn, the crankcase may be line bored for a 0.020 inch oversize camshaft.

6-17. CRANKSHAFT. In addition to magnetic particle, visual and dimensional inspection, the shaft 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 the Table of Limits for limits of "runout" at the center journal).

6-18. CRANKSHAFI' AND COUNTERWEIGHT PINS AND 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. Worn or out of round counterweight bushing holes will require counterweight replacements.

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 .001" then 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° either side of Point C.

3. After removing the bushings from the dampeners or the crankshaft blades, measure the inside diameter of the holes. Select a replacement

bushing which will give an interference fit of 001"-003" into each the dampener or the dampener or the crankshaft blade holes.

c. Replacement bushings are available in standard, .0015", .003" and .005" oversize on the outside diameter.

d. A special tool for removing and replacing these bushings has been developed by Borroughs Tool and Equipment Corporation, 2429 North Burdick Street, Kalamazoo, Michigan. We recommend that this tool only be used for these operations.

e. Counterweight pins are identified by dash numbers stamped on one end. Because the damper order is controlled by this pin diameter, it is imperative that only the correct pin, properly identified, be used.

6-19. CAMSHAFT. Inspect the journal for scoring, corrosion and overheating. Inspect lobes for pitting at the toes and for evidence of overheating or unusual wear.

NOTE...The following rework procedure is for camshaft P/N 629726. See service bulletin M86-14 or current revision as applicable. Camshafts manufactured to Change letter A thrn Z and AA are not qualified for the repair procedure outline below and should not be reworked or reused. Only camshafts with Change Letter AB and after are qualified for the repair procedure outlined below.

1. Dress the outer edges of the cross holes, approximately .010-.020, with the use of a Dremel tool and emery wheel point No. 953 (or equivalent) paying particular attention to the edge of the cross hole where it intersects the fillet of the groove

2. Shot peen the entire groove including its radii using SAE 330 shot to an intensity of .013 to .015 inches with an A2 strip.

3. Comply with all other procedures and inspection requirements set forth in this overhaul manual including, but not limited to, the procedures and inspection requirements relating to magnetic particle inspection and dimensional and visual inspection.

4. Identify reworked cams: vibro etch M86-14 after the part number to show compliance with service bulletin M86-14 or current revision as applicable.

WARNING ...The benefits of this repair procedure may be negated if the camshaft bearing surface or its supports in the crankcase are worn so as to exceed running clearance of .001 to .005 specified in the table of limits section of this manual.

6-20. CONNECTING RODS. Use a telescoping gauge and an outside micrometer caliper 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; then lay the big end arbor in the vee blocks on the surface plate, and place the ground steel blocks under the ends of 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. (Refer to limit in Section VI.) To measure bushing and bearing convergence, mount a 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 Section VI.

6-21. GEARS. Inspect gear teeth for signs of overheating and excessive wear. Normal wear produces a fine polish on the tooth thrust faces. Alteration of the tooth profiles, score marks and pitting are sufficient cause for rejection.

6-22. PISTONS AND RINGS. Inspect the skirt for long, deep scores which indicate overheating and are sufficient cause for rejection. If a telescoping gauge is used to measure the pin bore, do not allow the spring pin to expand rapidly so as to strike the wall hard. Inspect visually for thorough cleaning, including the oil relief holes in the third 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

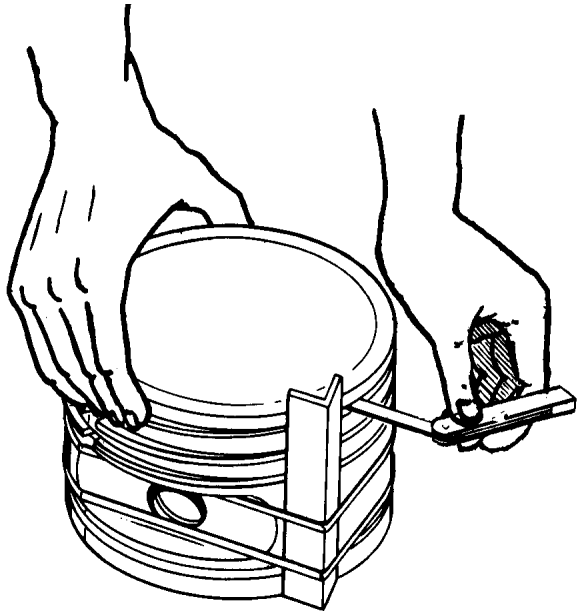


FIGURE 6-1. INSPECTING RING SIDE CLEARANCE.

cam-ground contour should not be altered. If the piston is dimensionally serviceable in other respects 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 top 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 in the barrel should be measured first so that 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 their 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.

6-23. 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; hence, 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 in 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 holes in which they are 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 rebarreled 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 IO-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).

6-24. HYDRAULIC VALVE LIFTERS. During examination of each part, look for sludge and carbon residues. Also check for obstructed oil holes. Inspect face of cam follower on body for any type of damage and look for deep scoring and corrosion on exterior of tubular portion. 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 it and the cylinder are excessively worn. If it does kick back on the second test, either 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.

6-25. INTAKE TUBES. Inspect intake tubes for distortion, cracks and out-of-roundness. All other types of damage will require replacement of the part.

6-26. 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.

6-27. FUEL INJECTION SYSTEM. Further disassembly of the fuel injection system is not recommended unless proper flow equipment is available. For complete overhaul instructions see Fuel Injection Overhaul Manual and Parts Catalog, Form X-30091.

6-28. IGNITION SYSTEM. Teledyne Continental Motors recommends replacement of the complete ignition harness at every engine overhaul.

TABLE IX.
INSPECTION CHART

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
CYLINDER ASSEMBLY			
HEAD & BARREL	Head/Barrel Junction	Discoloration, Seepage.	See Section 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 re- move ring step of more than 0.002 inch diameter. Taper limit (Table of limits) must not be exceeded by honing.
	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.

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
	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 re- paired, 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 deter- mine 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 reduc- tion due to tip grinding.	Stretched valves may fail. Shortened valve may exceed ability of hydraulic lifters to take up lash.
	Contact Foot	Scoring, diameter.	
	Oil Passages	Obstruction.	
	Hub	Side clearance between cylinder head supports.	Refer to Table of limits
	Outside Surface	Diameter, scoring, rough ends.	

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
CONNECTING ROD ASSEMBLY			
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).
CRANKSHAFT ASSEMBLY			
Crankshaft	Main Journals	Diameters, scoring, burning	Must be polished before magnetic inspection.
	Crankpins	Diameters, scoring, burning	Must be polished before magnetic inspection.
	Oil Seal Race	Scoring	Must be polished
	Screw Holes	Damaged or dirty threads	
	Oil Holes	Obstructions	
	Bending	Measure run-out at center journal and wobble on face of flange.	Required only if shaft has been subject to shock.
Gear Dowel	Tight Fit	Attempt to pull out by hand only.	
Oil Control Plug	Presence	Obstruction of oil hole, tight fit.	
Gear	Teeth, Screw, Threads	Burning, scoring, wear enough to alter profile. Damaged or dirty threads.	
CAMSHAFT ASSEMBLY			
Camshaft	Journals	Diameter and fit in crankcase bearings. Scoring, pitting and corrosion.	Excessive bearing wear may be compensated by enlarging bearing and installing oversize shaft. Refer to “Crankcase”.
	Lobes	Pitting along toe line, loss of slope along toe line, width across 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.

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
Gear	Teeth	Scoring, burning, pitting, wear enough to alter profile.	
CRANKCASE ASSEMBLY			
Crankcase Castings	Valve Lifter Guides	Diameter, scoring.	
	Bearing Seats	Roughness, wear in tang notches.	Refer to Table of Limits.
	Camshaft Bearings	Diameter, scoring, fit of rear bearing between camshaft flanges.	See paragraph 6-16.
	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.
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.

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
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.
OIL COOLER ASSEMBLY			
Oil Cooler	Headers, Fins Core	Inspect visually for dents, deformed fins, punctures, stripped plug hole threads, cracks and scratches.	
	Machined Surfaces	Warpage and scratches.	
	All areas	Cracks	
Oil Temperature Control Valve	Seat	Roughness	Permold Crankcase only.
OIL SUMP ASSEMBLY			
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.	
OIL PUMP ASSEMBLY			
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.	

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
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.	
STARTER ADAPTER ASSEMBLY			
Adapter	All Areas	Cracks, scratches on machined surfaces, damaged tapped holes.	
Needle Bearing	Rollers	Roughness or excessive play.	
Studs	Threads	Distortion or stripping.	
	Height	Check for backout.	Refer to Stud Height Table.
	Alignment	Check studs suspected of bending with toolmaker's square.	

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
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.	
ALTERNATOR			
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.	
INDUCTION SYSTEM			
Intake Manifold	Flanges	Check for warping by placing flanges on surface plate. Look for cracks.	
	Tubes	Look for dents, out-of-round ends, cracks.	
	Plug Bosses	Damaged threads, cracks around bosses.	
Clamps	Shape	Look for distortion such as out-of-roundness and lugs converging.	
FUEL INJECTION SYSTEM			
Fuel Pump Adapter	All Areas	Cracks, damaged mounting holes, inspect tapped holes. Measure bore diameter.	

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
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 6-27.
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 limit established.
	Plate	Check for warpage.	
Fuel Discharge Tubes	All Areas	Look for cracks, flat spots, out-of-round ends.	
Pipe Fittings	Threads	Distortion or stripping.	
	Wrench Flats	Look for damaged corners.	

SUBASSEMBLY AND PART	INSPECT	NATURE OF INSPECTION	SPECIAL CONSIDERATIONS
MAGNETO AND ACCESSORY DRIVE ASSEMBLY			
Adapter	Gear Bushing	Measure bore diameter.	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.	
Gear	Teeth	Scoring, burning or wear enough to alter tooth profile.	
	Shaft	Measure diameters and compare with bushing diameter.	Refer to Table of Limits.

TABLE X

CRANKCASE STUD SETTING HEIGHTS

LOCATION	THREAD SIZE	SETTING HEIGHT	MODEL IO-520								
			A	B	C	D	E	F	J	K	L
Cylinder Mount Pads	7/16-14 X 7/16-20	13/16	36	36	36	36	36	36	36	36	36
Engine Mount Pads	3/8-16 X 3/8-24	1-7/32	15	--	--	15	15	15	15	15	15
	3/8-16 X 3/8-24	1-1/4	1	--	--	1	1	1	1	1	1
	3/8-16 X 3/8-24	1-49/64	--	--	2	--	--	--	--	--	--
	3/8-16 X 3/8-24	1-1/2	--	--	4	--	--	--	--	--	--
	3/8-16 X 3/8-24	1-13/16	--	--	2	--	--	--	--	--	--
	3/8-16 X 3/8-24	1-7/8	--	--	2	--	--	--	--	--	--
Oil Cooler Mount Pads	1/4-20 X 1/4-28	7/8	5	--	--	5	5	5	5	5	5
	3/8-16 X 3/8-24	49/64	--	2	--	--	--	--	--	--	--
	3/8-16 X 3/8-24	27/32	--	2	--	--	--	--	--	--	--
	5/16-18 X 5/16-24	5-7/8	--	1	--	--	--	--	--	--	--
Governor Mount Pad	5/16-18 X 5/16-24	1-3/8	4	4	4	4	4	4	4	4	4
Magneto Mount Pad	5/16-18 X 5/16-24	43/64	4	4	4	4	4	4	4	4	4
Magneto & Accessory Drive Adapter Pad	5/16-18 X 5/16-24	3/4	6	6	3	6	6	6	6	6	6
	5/16-18 X 5/16-24	7/8	--	--	1	--	--	--	--	--	--
	5/16-18 X 5/16-24	1-45/64	--	--	2	--	--	--	--	--	--
	3/8-16 X 3/8-24	13/16	2	2	2	2	--	2	2	2	2
	3/8-16 X 3/8-24	7/8	2	--	--	2	2	2	2	2	2
Idler Pin Pad	1/4-20 X 1/4-28	9/16	--	2	2	--	--	--	--	--	--
	1/4-20 X 1/4-28	3/4	2	--	2	2	2	2	2	2	2
Starter Drive Pad	5/16-18 X 5/16-24	13/16	2	--	2	2	2	2	2	2	2
	5/16-18 X 5/16-24	3-21/32	--	2	2	--	--	--	--	--	--
Fuel Pump Pad	5/16-18 X 5/16-24	3/4	2	--	2	2	2	2	2	2	2
Oil Pump Pad	1/4-20 X 1/4-28	7/8	1	--	--	1	1	1	1	1	1
	1/4-20 X 1/4-28	1-49/64	--	1	1	--	--	--	--	--	--
	1/4-20 X 1/4-28	2-9/32	2	--	--	2	2	2	2	2	2
	1/4-20 X 1/4-28	3-3/8	--	5	5	--	--	--	--	--	--
	1/4-20 X 1/4-28	3-11/16	2	--	--	2	2	2	2	2	2
	1/4-20 X 1/4-28	3-63/64	5	--	--	5	5	5	5	5	5
	3/8-16 X 3/8-24	2-15/16	--	3	3	--	--	--	--	--	--
Generator Bracket	5/16-18 X 5/16-24	19/32	1	--	--	1	1	1	1	1	1
Camshaft Cover Pad	1/4-20 X 1/4-28	11/16	--	2	--	--	--	--	--	--	--
Crankcase Thru 1-3-5 Side Accessory End	5/16-18 X 5/16-24	5-13/32	--	1	--	--	--	--	--	--	--
	5/16-18 X 5/16-24	6-13/32	--	--	1	--	--	--	--	--	--
Governor Oil Transfer Collar	1/4-20 X 1/4-28	15/16	2	2	2	2	2	2	2	2	2
Cylinder Exhaust Flange	1/4-20 X 1/4-28	25/32	4	4	4	4	4	4	4	4	4
Oil Pump Housing	1/4-20 X 1/4-28	19/32	1	--	--	1	1	1	1	1	1
	1/4-20 X 1/4-28	21/32	1	2	2	1	1	1	1	1	1
Oil Pump Cover	1/4-20 X 1/4-28	3/4	--	--	4	4	4	--	--	--	--
	1/4-20 X 1/4-28	7/16	--	--	1	--	--	--	--	--	--
Magneto Adapter	1/4-20 X 1/4-28	7/8	4	4	4	4	4	4	4	4	4
	5/16-18 X 5/16-24	23/32	--	3	3	--	--	--	--	--	--
	5/16-18 X 5/16-24	1	--	2	2	--	--	--	--	--	--
	3/8-16 X 3/8-24	7/8	2	2	2	2	2	2	2	2	2
Oil Sump	3/8-16 X 3/8-24	31/32	--	12	--	--	--	--	--	--	--
Starter Adapter	5/16-18 X 5/16-24	13/16	2	--	--	2	2	2	2	2	2

TABLE XI

MAGNETIC PARTICLE INSPECTION

FLUORESCENT METHOD PREFFERED,
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 XII

TABLE OF LIMITS

Ref. No.	Chart No.	Model	Description	Serviceable Limit	New Parts	
					Min.	Max.
			CYLINDERS			
1	1	All	Cylinder bore (lower end of barrel) ..... Diameter:	5.256	5.251	5.253
2	1	All	Cylinder bore choke (at 5.75" from open end of barrel). ..... Taper:	--	0.001	0.003
3	1	All	Cylinder bore out-of-round .....:	0.003	0.000	0.002
4	1	All	Cylinder bore. ..... Allowable Oversize:	5.266	5.261	5.263
4	1	All	Cylinder bore. ..... Allowable Oversize:	5.271	5.266	5.268
5	1	All	Cylinder bore surface roughness. .....RMS:	--	15	25
6	1	All	Cylinder barrel in crankcase. ..... Diameter:	--	0.004 L	0.010 L
7	1	All	Intake valve seat insert in cylinder head. ..... Diameter:	--	0.009 T	0.012 T
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:	--	0.017	0.156
12	1	All	Exhaust valve seat ..... Width:	--	0.120	0.171
			Exhaust valve seat to valve guide axis. ..... Angle:	--	45° 00'	45° 30'
			Intake valve seat to valve guide axis ..... Angle:	--	59° 30'	60° 00'
			ROCKER ARMS AND SHAFT			
13	1	All	Rocker shaft in cylinder head bosses. ..... Diameter:	0.003 L	0.0000	0.0020L
14	1	All	Rocker shaft in rocker arm bearing. ..... Diameter:	0.004 L	0.0010L	0.0025 L
15	1	All	Rocker arm bearing in rocker arm..... Diameter:	--	0.0020T	0.0040T
16	1	All	Rocker arm ..... Side Clearance:	0.035 L	0.002 L	0.015 L
17	1	All	Intake valve in guide. ..... Diameter:	0.005 L	0.0012L	0.0027 L
18	1	All	Exhaust valve in guide ..... Diameter:	0.006 L	0.0030 L	0.0045L
19	1	All	Intake valve face (to stem axis) ..... Angle:	--	59° 45'	60° 15'
20	1	All	Exhaust valve face (to stem ax is). ..... Angle:	--	45° 00'	45° 30'
21	1	All	Intake valve (max. tip regrind .015) .....Length:	4.789	4.804	4.824
22	1	All	Exhaust valve (max. tip regrind .015). .....Length:	4.791	4.806	4.826
23	1	All	Intake and exhaust valve (full indicator reading) ..... Concentricity:	0.004	0.000	0.002
			Valve rocker toe to valve stem (dry lifter) .....:		0.060	0.200
24	1	All	Deleted			
25	1	All	Piston (below 3rd ring groove) in cylinder. ..... Diameter:	0.027 L	0.010 L	0.013 L
26	1	All	Deleted			
27	1	All	Top piston ring in groove. ..... Side Clearance:	0.008 L	0.004 L	0.006 L
28	1	All	Second piston ring in groove. ..... Side Clearance:	0.008 L	0.004 L	0.006 L
29	1	All	Third piston ring in groove. ..... Side Clearance:	0.0075L	0.0035 L	0.0055 L
30	1	All	Fourth piston ring in groove. ..... Side Clearance:	0.012 L	0.0060L	0.0080L
31	1	All	Top ring gap (in cylinder barrel) .....Gap:		0.033	0.044
32	1	All	Second ring gap (in cylinder barrel) .....Gap:		0.030	0.046
33	1	All	Third ring gap (in cylinder barrel) .....Gap:		0.021	0.032
34	1	All	Fourth ring gap (in cylinder barrel) .....Gap:	0.059	0.033	0.049
			Top and Second ring (standard gap). ..... Tension*:	12 lbs.	13 lbs.	17 lbs.
			Fourth ring (standard gap). ..... Tension*:	8 lbs.	9 lbs.	13 lbs.
35	1	All	Piston pin in piston (standard or 0.005 oversize) ... Diameter:	0.0015L	0.0001 L	0.0007 L
36	1	All	Deleted			
37	1	All	Piston pin in cylinder. ..... End Clearance:	0.090 L	0.036 L	0.048 L
38	1	All	Piston pin in connecting rod bushing. ..... Diameter:	0.0040 L	0.0022 L	0.0026L

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

Ref. No.	Chart No.	Model	Description	Serviceable Limit	New Parts	
					Min.	Max.
39	1	All	Bushing in connecting rod. ..... Diameter:	--	0.0050T	0.0025T
40	1	All	Bolt in connecting rod ..... Diameter:	--	0.0000	0.0018L
41	1	All	Connecting rod bearing on crankpin (tri-metal bearing) ..... Diameter:	0.006 L	0.0009 L	0.0034L
42	1	All	Connecting rod on crankpin ..... End Clearance:	0.016	0.006	0.010
43	1	All	Connecting bearing and bushing..... ..... Twist or Convergence Per 1 inch of Length:	0.001	0.0000	0.0005
			CRANKSHAFT			
44	2/3	All	Crankshaft in main bearings (tri-metal). ..... Diameter:	0.0050	0.0005L	0.0035L
45	**2/3	All	Crankpins ..... Out-of-Round:	0.0015	0.0000	0.0005
46	**2/3	All	Main journals. ..... Out-of-Round:	0.0015	0.0000	0.0005
47	2/3	All	Crankshaft main and thrust journals (STD) ..... Diameter:	2.372	2.374	2.375
			Crankshaft rear and intermediate bearing for "B" model engines ..... Diameter:	2.623	2.624	2.625
48	2/3	All	Crankpins ..... Diameter:	2.247	2.249	2.250
49	2/3	All	Crankshaft run-out at center main journals (shaft supported at thrust and rear journals) ..... Full Indicator Reading:	0.015	0.000	0.015
50	2/3	All	Crankshaft run-out at propeller flange (when supported at front and rear main journals) ..... Full Indicator Reading:	0.005	0.000	0.005
51	2/3	All	Damper pin bushing in crankcheek extension ..... Diameter:	--	0.0015T	0.0015T
52	2/3	All	Damper pin bushing in counterweight. ..... Diameter:	--	0.0015T	0.0030T
53	† 2/3	All	Damper pin bushing bore in counterweight and crankshaft hanger. ..... Diameter:	0.6265	0.622	0.626
			Damper pin (4thOrder) ..... Diameter:	0.4735	0.474	0.475
			Damper pin (5th Order) ..... Diameter:	0.5265	0.527	0.528
			Damper pin (6th Order) ..... Diameter:	0.5549	0.5554	0.5574
54	2/3	All	Damper pin in counterweight. ..... End Clearance:	0.040	0.001	0.025
55	2/3	All	Crankcheek in counterweight. ..... Side Clearance:	0.017	0.005	0.011
56	2/3	P	Alternator gear on crankshaft. ..... Diameter:	--	0.0005 L	0.0035L
57	2/3	All	Crankshaft gear on crankshaft. ..... Diameter:	--	0.000	0.002
58	2	S	Crankshaft in thrust bearing. ..... End Clearance:	0.022	0.008	0.018
59	3	P	Crankshaft in thrust bearing. ..... End Clearance:	0.020	0.008	0.016
		All	Oil transfer collar on crankshaft. ..... Diameter:		0.0005	0.0018
			CAMSHAFT			
60	2/3	All	Camshaft journals in crankcase. ..... Diameter:	0.005 L	0.001 L	0.003 L
61	2/3	All	Camshaft in crankcase. ..... End Clearance:	0.014	0.005	0.009
62	2/3	All	Camshaft run-out at center journals (shaft supported at end journals) ..... Full Indicator Reading:	0.001	0.000	0.001
63	2/3	All	Camshaft gear on camshaft flange. ..... Diameter:	--	0.0005T	0.0015L
64	2	S	Governor drive gear on camshaft. ..... Diameter:	0.006 L	0.0002 L	0.0020L
65	3	P	Governor drive gear on camshaft. ..... Diameter:	0.006 L	0.001 L	0.003 L
			CRANKCASE AND RELATED PARTS			
66	2/3	All	Crankcase oil seal in crankcase (split seal) ..... Diameter:	--	0.000 T	0.004 T
67	2/3	All	Through bolt (10.75") in crankcase. ..... Diameter:	--	0.0005T	0.0013L
68	1	All	Hydraulic tappet in crankcase. ..... Diameter:	0.0035L	0.0015L	0.0020L

** *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.*

† *If these limits are exceeded, new bushings, pins and retaining plates must be installed to maintain proper crankshaft dampening (paragraph 6-17).*

P Permold Crankcase

S Sandcast Crankcase.

Ref. No.	Chart No.	Model	Description	Serviceable Limit	New Parts	
					Min.	Max.
70	3	All	Governor drive shaft in crankcase. ..... Diameter:	0.005 L	0.0014L	0.0034L
70	2	S	Idler gear support pin in crankcase (front). ..... Diameter:	0.0010L	0.0005 L	0.0015 L
71	3	P	Idler gear support bushing in crankcase (front) ..... Diameter:	--	0.0005 L	0.0015 L
72	2	S	Idler gear support pin in crankcase (rear) ..... Diameter:	--	0.0005 L	0.0025 L
73	3	P	Idler gear support bushing, flanged, in crankcase (rear) ..... Diameter:	--	0.0015L	0.0035L
74	4	All	Magneto and accessory drive adapter pilot in crankcase ..... Diameter:	--	0.000	0.003 l
75	2	All	Oil pump housing pilot in crankcase. ..... Diameter:	--	0.001 L	0.003 L
			OIL PRESSURE RELIEF VALVE ASSEMBLY			
76	2	All	Oil pressure relief valve adjusting screw in plunger ..... Diameter:	0.0030 L	0.0005 L	0.0020 L
			ACCESSORY DRIVE IDLER ASSEMBLY			
77	2	S	Bushing in idler gear ..... Diameter:	--	0.001 T	0.003 T
78	2	S	Idler gear support in bushing. ..... Diameter:	0.0050 L	0.0015 L	0.0035 L
79	3	P	Idler gear in support bushing (front). ..... Diameter:	0.0040L	0.001 L	0.003 L
80	3	P	Idler gear in support bushing (rear) ..... Diameter:	0.0040L	0.001 L	0.003 L
81	2	S	Idler gear ..... End Clearance:	0.043	0.002	0.033
82	3	P	Idler gear ..... End Clearance:	0.075	0.020	0.067
			LEFT AND RIGHT MAGNETO AND ACCESSORY			
83	4	All	Bushing in magneto and accessory drive adapter ..... Diameter:	--	0.001 T	0.004 T
84	4	All	Magneto and accessory drive gear in adapter bushing ..... Diameter:	0.0050L	0.0015 L	0.0035 L
85	4	All	Oil seal in adapter ..... Diameter:	--	0.007 T	0.001 T
86	4	All	Sleeve in magneto and accessory drive gear. ..... Diameter:	--	0.004 T	0.001 T
87	4	S	Magneto and accessory drive gear. ..... End Clearance:	--	0.0015 L	0.0086 L
87	4	P	Magneto and accessory drive gear. ..... End Clearance:	--	0.011 L	0.077 L
88	4	All	Magneto coupling retainer on magneto and accessory drive gear sleeve. ..... Diameter:	0.055 L	0.025 L	0.040 L
89	4	All	Magneto coupling retainer in magneto drive gear slot Side ..... Clearance:	0.040 L	0.0082 L	0.0182 L
90	4	S	Magneto coupling rubber bushings on magneto drive lugs. ..... Side Clearance:	--	0.010 L	0.052 L
90	4	P	Magneto coupling rubber bushings on magneto drive lugs. ..... Side Clearance:	--	0.014 L	0.052 L
91	4	All	Magneto pilot in crankcase. ..... Diameter:	--	0.001 L	0.005 L
			OIL PRESSURE PUMP ASSEMBLY			
92	2	S	Oil pump driver gear in pump housing. ..... Diameter:	0.0060L	0.0015L	0.0040L
93	3	P	Oil pump driver gear in pump housing. ..... Diameter:	0.0070L	0.003 L	0.005 L
94	2/3	All	Oil pump driver gear shaft in pump housing. ..... Diameter:	0.0045 L	0.0015 L	0.0030 L
95	2/3	All	Oil pump driven gear in pump housing. ..... End Clearance:	0.0050	0.0011	0.0030
96	2/3	All	Oil pump driver gear in pump housing. ..... End Clearance:	0.0050	0.0011	0.0030
97	2/3	All	Oil pump driver gear shaft in cover oil pump ..... Diameter:	0.0045 L	0.0015 L	0.0030 L
98	2/3	All	Oil pump driver gear shaft in tachometer drive bevel gear ..... Diameter:	0.0040 L	0.0005 L	0.0025 L

P Permold crankcase.

S Sandcast crankcase.

Ref. No.	Chart No.	Model	Description	Serviceable Limit	New Parts	
					Min.	Max.
99	2/3	All	Oil pump driven gear shaft in oil pump housing ..... Diameter:	--	0.001 T	0.003 T
100	2/3	All	Oil pump driven gear on shaft. ..... Diameter:	0.0040L	0.0005L	0.0025L
101	2	S	Oil pump driven gear in housing. ..... Diameter:	0.0045 L	0.0015L	0.0040L
102	3	P	Oil pump driven gear in housing..... Diameter:	0.0070L	0.0030L	0.0050L
			TACHOMETER DRIVE ASSEMBLY			
103	2/3	All	Tachometer drive shaft in oil pump cover. ..... Diameter:	0.0045 L	0.0015L	0.0030L
104	2/3	ABDF JKL	Oil seal in tachometer drive housing. ..... Diameter:	--	0.001 T	0.007 T
105	2	CE	Oil seal in tachometer drive housing. ..... Diameter:	--	0.0015T	0.0065T
			STARTER DRIVE			
106	4	All	Starter shaftgear in needle bearing. ..... Diameter:	0.0031L	0.0005 L	0.0015 L
107	4	All	Starter shaftgear front (bearing) journal. ..... Diameter:	0.748	0.7495	0.7500
108	4	S	Starter clutch drum on starter shaftgear ..... Diameter:	0.0055L	0.001 L	0.004 L
109	4	P	Starter shaftgear in clutch drum bearing. ..... Diameter:	--	0.0005 L	0.0020 L
110	4	All	Clutch spring sleeve in starter adapter. ..... Diameter:	--	0.003 T	0.005 T
111	4	All	Starter shaftgear in ball bearing. ..... Diameter:	--	0.0001 L	0.0005 L
112	4	S	Starter shaftgear in oil seal sleeve. ..... Diameter:	--	0.0000	0.0015
113	4	All	Bearing in starter adapter cover. ..... Diameter:	--	0.0010L	0.0001L
114	4	S	Oil seal in starter adapter cover. ..... Diameter:	--	0.0017T	0.0063T
115	4	All	Starter adapter cover pilot in starter adapter. ..... Diameter:	--	0.001 L	0.003 L
116	4	S	Worm wheel gear ..... End Clearance:	0.080	0.0426	0.0736
117	4	P	Worm wheel gear ..... End Clearance:	0.025	0.0016	0.0166
118	4	All	Clutch spring on clutch drum. ..... Diameter:	0.012T	0.015 T	0.022 T
119	4	All	Clutch spring on starter shaftgear (over knurl) ..... Diameter:	0.013L	0.006 L	0.009 L
120	4	All	Clutch spring in clutch spring sleeve. ..... Diameter:	0.027T	0.031 T	0.038 T
121	4	All	From center line of worm gearshaft to starter adapter thrust pads. ..... :	0.252	0.246	0.248
122	4	All	Ball bearing in starter adapter. ..... Diameter:	--	0.0010L	0.0001T
123	4	All	Worm gearshaft in needle bearing. ..... Diameter:	0.5600	0.5615	0.5625
124	4	All	Worm gearshaft in ball bearing. ..... Diameter:	--	0.0001L	0.0007T
125	4	All	Starter worm gear on shaft. ..... Diameter:	0.0040L	0.0005L	0.0025L
126	4	All	Starter spring on worm driveshaft ..... Diameter:	--	0.005 L	0.025 L
127	4	All	Starter pilot to starter drive adapter. ..... Diameter:	--	0.001 L	0.0065 L
128	4	All	Starter drive tongue to worm shaft drive slot. .. Side Clearance:	0.030L	0.010 L	0.021 L
			FUEL PUMP			
129	3	S	Fuel pump drive coupling to fuel pump drive ..... Clearance:		0.0035	0.0095
130	3	S	Fuel pump drive coupling to fuel pump drive gear .. Clearance:		0.0035	0.0095
131	3	P	Fuel pump drive coupling to fuel pump. ..... Clearance:		0.0030	0.0090
132	3	P	Fuel pump drive coupling to crankshaft gear ..... Clearance:		0.0095	0.0155
			GEAR BACKLASH			
133	4	All	Crankshaft gear and camshaft gear. ..... Backlash:	0.016	0.008	0.012
134	4	All	Crankshaft gear and idler gear. ..... Backlash:	0.016	0.008	0.012
135	4	All	Idler gear and magneto drive gear (right and left) ..... Backlash:	0.016	0.008	0.012
136	2/3	All	Oil pump driver and driven gears. ..... Backlash:	0.016	0.009	0.013

P Permold crankcase.

S Sandcast crankcase.

Ref. No.	Chart No.	Model	Description	Serviceable Limit	New Parts	
					Min.	Max.
137	3	C	Tachometer drive gear and tachometer driven gear ..... Backlash:	0.012	0.004	0.008
138	4	All	Starter shaftgear and crankshaft gear. ..... Backlash:	0.016	0.008	0.012
139	4	All	Starter worm wheel gear and worm gear. ..... Backlash:	0.025	0.009	0.013
140	2	S	Governor drive gear and governor driven gear. ..... Backlash:	0.009	0.002	0.006
141	3	P	Governor drive gear and governor driven gear. ..... Backlash:	0.012	0.004	0.008
142	3	P	Alternator face gear in engine. ..... Backlash:	0.012	0.002	0.009
			SPRING TEST DATA			
143	2	S	Oil temperature control valve 0.16 inches minimum travel at ..... Temperature:	--	135°	173°
144	3	P	Oil temperature control valve 0.090 inches minimum travel at ..... Temperature:	--	120°	170°
	2	S	Oil temperature control valve to flow 4 gpm of oil between. ..... Oil Pressure:	--	18 psi	23 psi
	2	S	Oil temperature control valve must close between ..... Oil Temperature:	--	171°	175°
	3	P	Oil temperature control valve must close between ..... Oil Temperature:	--	168°	172°
	2	S	Oil temperature control valve at oil temperature 180° must not open below ..... Pressure:	18 psi	--	--
	3	P	Oil temperature control valve at oil temperature 180° must not open below. ..... Pressure:	18 psi	--	--
145	2	All	Relief valve spring compressed to 1.25 in. length ..... Load:	20 lbs.	32 lbs.	37.5 lbs.
146	2	S	Oil filter by-pass valve spring in pump compressed to 1.09 inch length. ..... Load:	5.0 lbs.	5.6 lbs.	--
147	1	All	Inner valve spring No. 631521 (compressed to 1.230 inch length) ..... Load:	82 lbs.	87 lbs.	97 lbs.
	1	All	Inner valve spring No. 631521 (compressed to 1.746 inch length) ..... Load:	29 lbs.	32 lbs.	38 lbs.
148	1	All	Outer valve spring No. 631520 (compressed to 1.275 inch length) ..... Load:	110 lbs.	117 lbs.	133 lbs.
	1	All	Outer valve spring No. 631520 (compressed to 1.791 inch length) ..... Load:	46 lbs.	49 lbs.	55 lbs.

P Permold crankcase.

S Sandcast crankcase.

TABLE XIII

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)	1/20	8		
T4	3	P	Crankshaft face gear screw (alt.)	5/16-24	4	140-150	11.7-12.5
T5	2/3	All	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 acorn nut	3/4-16	1	175-200	14.6-16.7
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	240-260	20.0-21.7
T11	2	S	Oil filter plug (with old gasket)	1-3/4-16	1	290-310	24.2-25.8
T12	3	P	a il filter center stud	5/8-18	1	180-220	15.0-18.0
T13		P	Alternator mounting bolt	5/16-18	4	150-180	12.5-15.0
T14		P	Alternator shaft nut	5/8-32	1	450-500	37.5-41.7
T15		All	Spark plugs	18 mm	12	300-360	25.0-30.0

NOTE:

P / PERMOLD

S / SANDCAST

TABLE XIV

GENERAL USE – TIGHTENING TORQUES

BOLTS, NUTS & SCREWS			DRIVING STUDS	
SIZE	IN. LBS.	FT. LBS.	IN. LBS.	FT. LBS.
8-32	17.5-22.5	1.5-1.9		
10-32	36.0-50.0	3.0-4.2		
¼-20	75.0-85.0	6.3-7.1	50.0-70.0	4.2-5.8
¼-28	90.0-110.0	7.5-9.1		
5/16-18	155-175	13.0-14.6	100-150	8.3-12.5
5/16-24	180-220	15.0-18.4		
3/8-16	220-260	18.3-21.7	200-174	16.6-22.8
3/8-24	275-325	22.9-27.1		
7/16-14			300-424	25.0-35.4
7/16-20	400-450	33.3-37.5		
½-20	550-600	45.8-50.0		

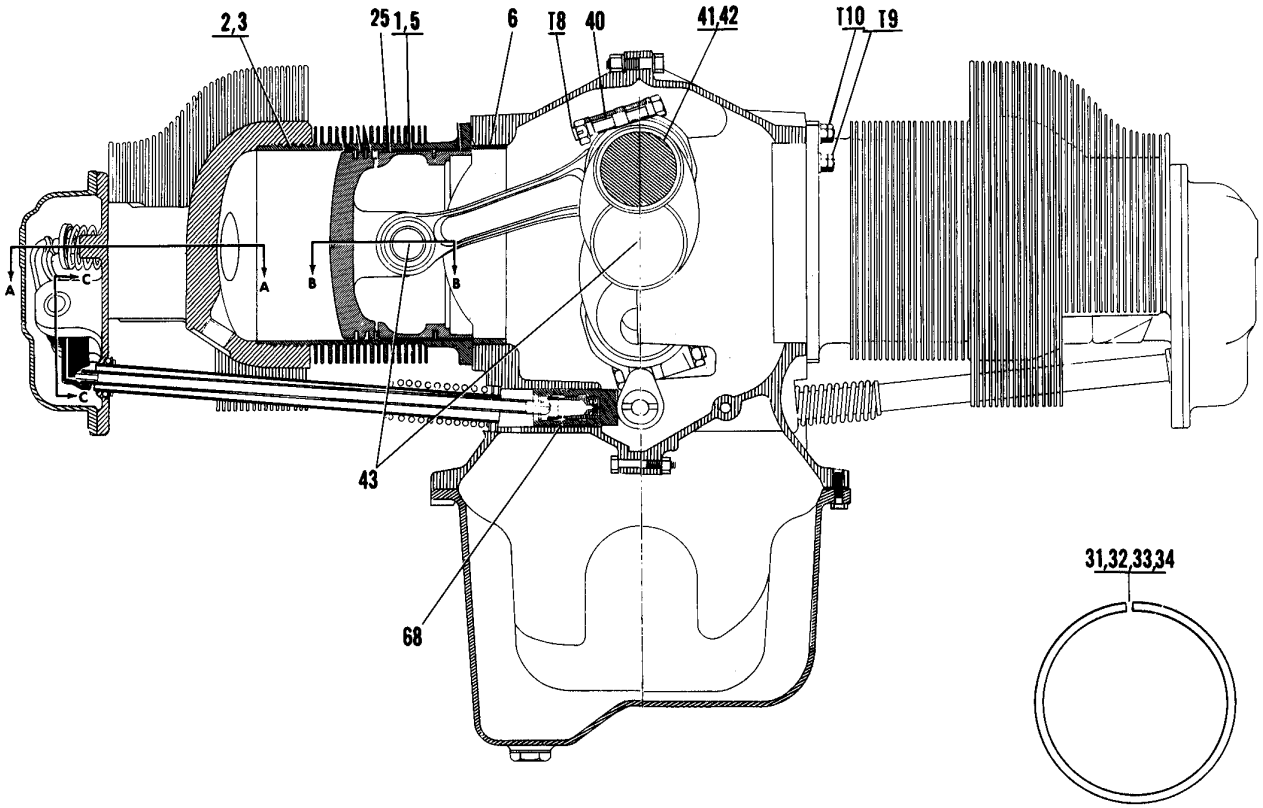
TABLE XV

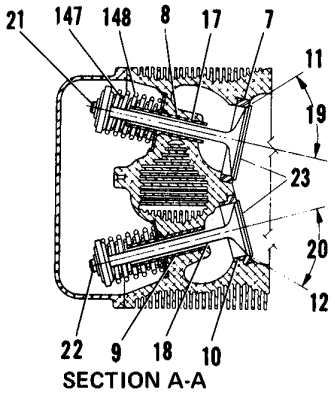
PIPE PLUGS

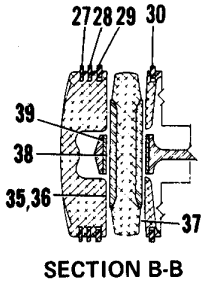
SIZE	IN. LBS.	FT. LBS.
1/8-27	60-80	5.0-6.6
¼-18	130-150	10.9-12.5
3/8-18	185-215	15.4-18.0
½-14	255-285	21.2-23.8
¾-14	310-350	25.8-29.2

NOTE

Torque loads listed are for use with oil on threads. If cotter pin holes must be aligned, set torque wrench at low limit and tighten nut to first hole beyond this torque, except for connecting rods. Stud driving torques apply when studs are coated with lubricant or sealer.







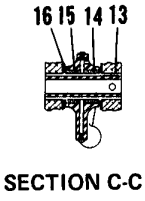


FIGURE 6-2. TABLE OF LIMITS CHART (1 OF4).

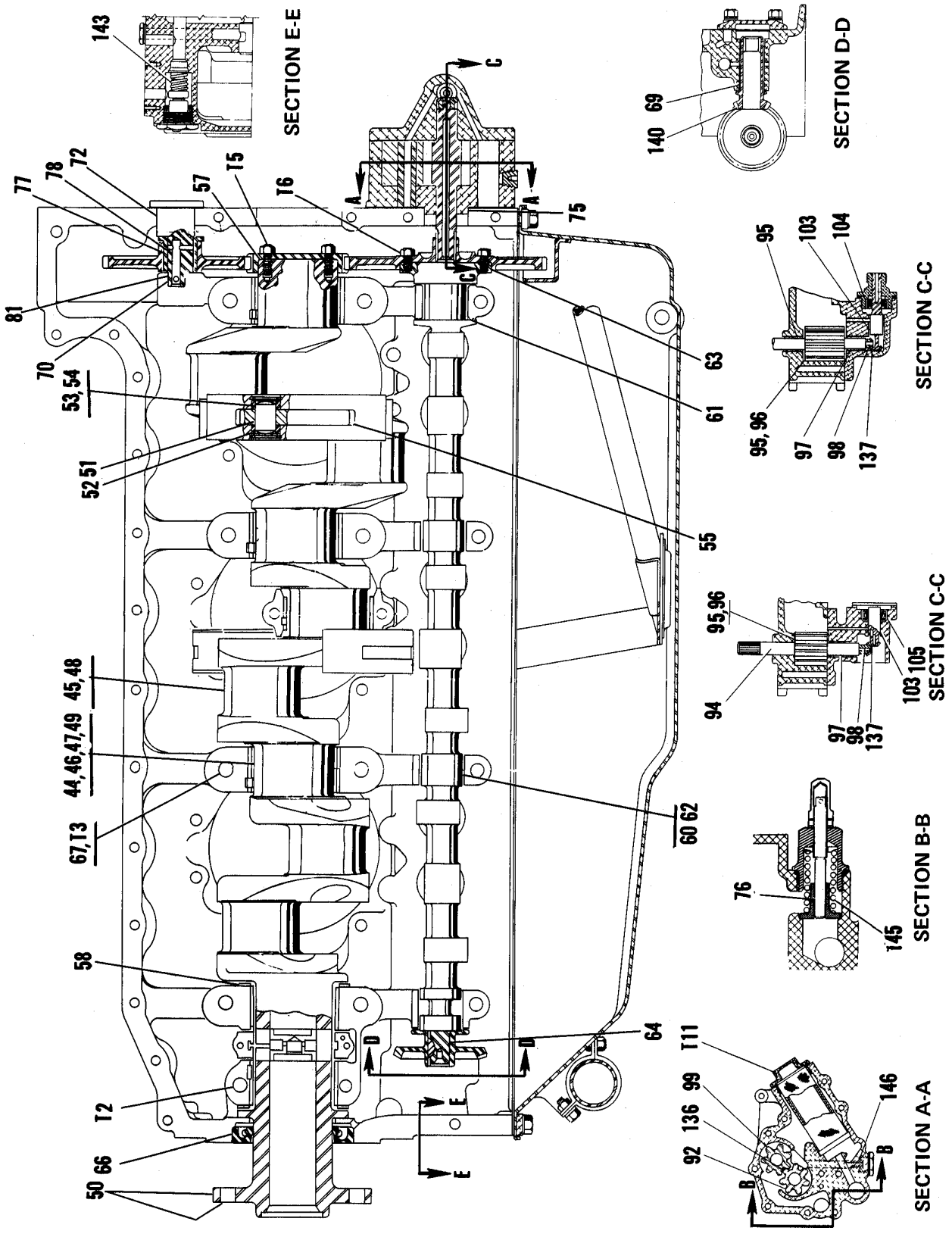


FIGURE 6-2. TABLE OF LIMITS CHART (2 OF4).

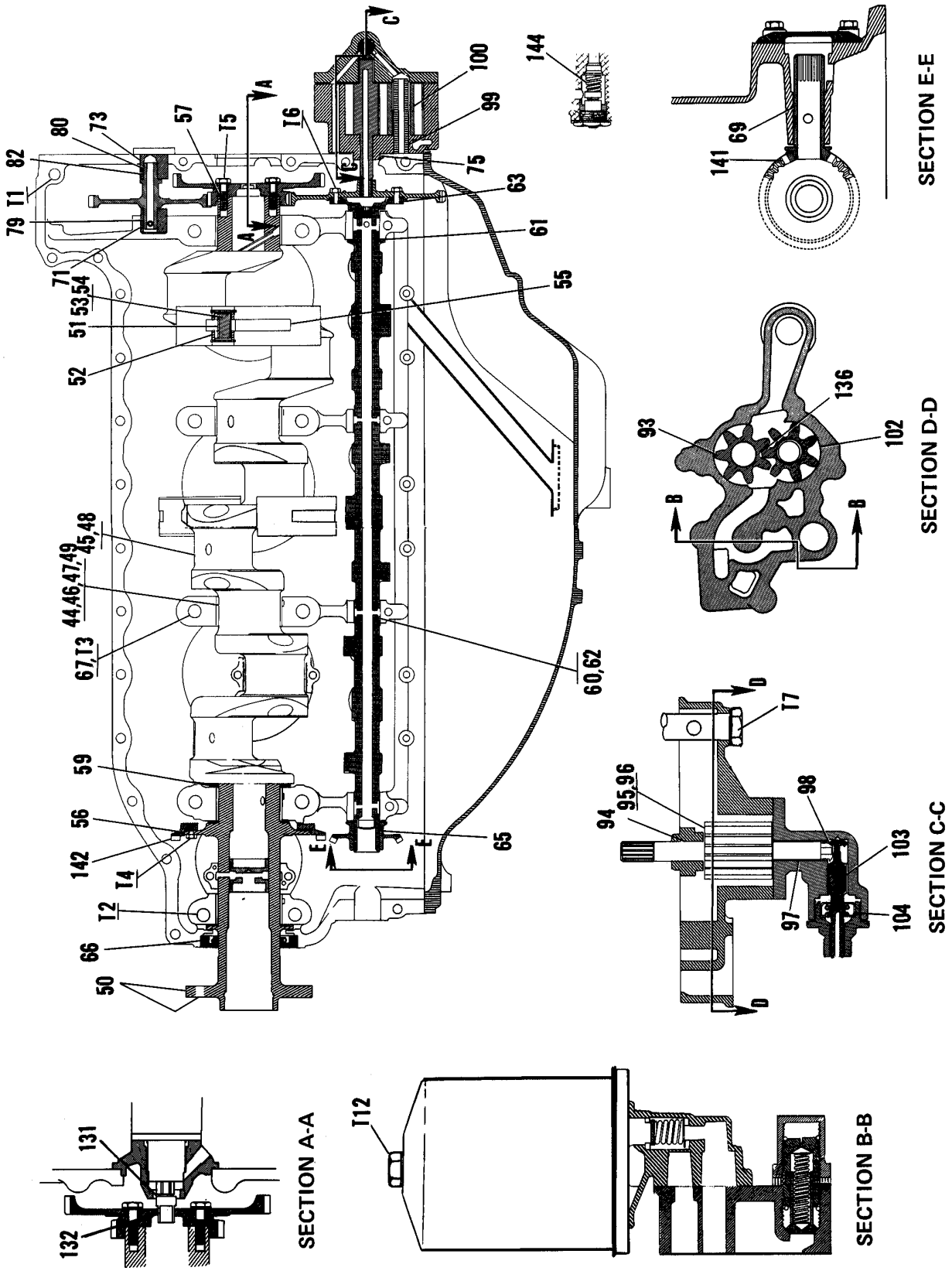


FIGURE 6-2. TABLE OF LIMITS CHART (3 OF4).

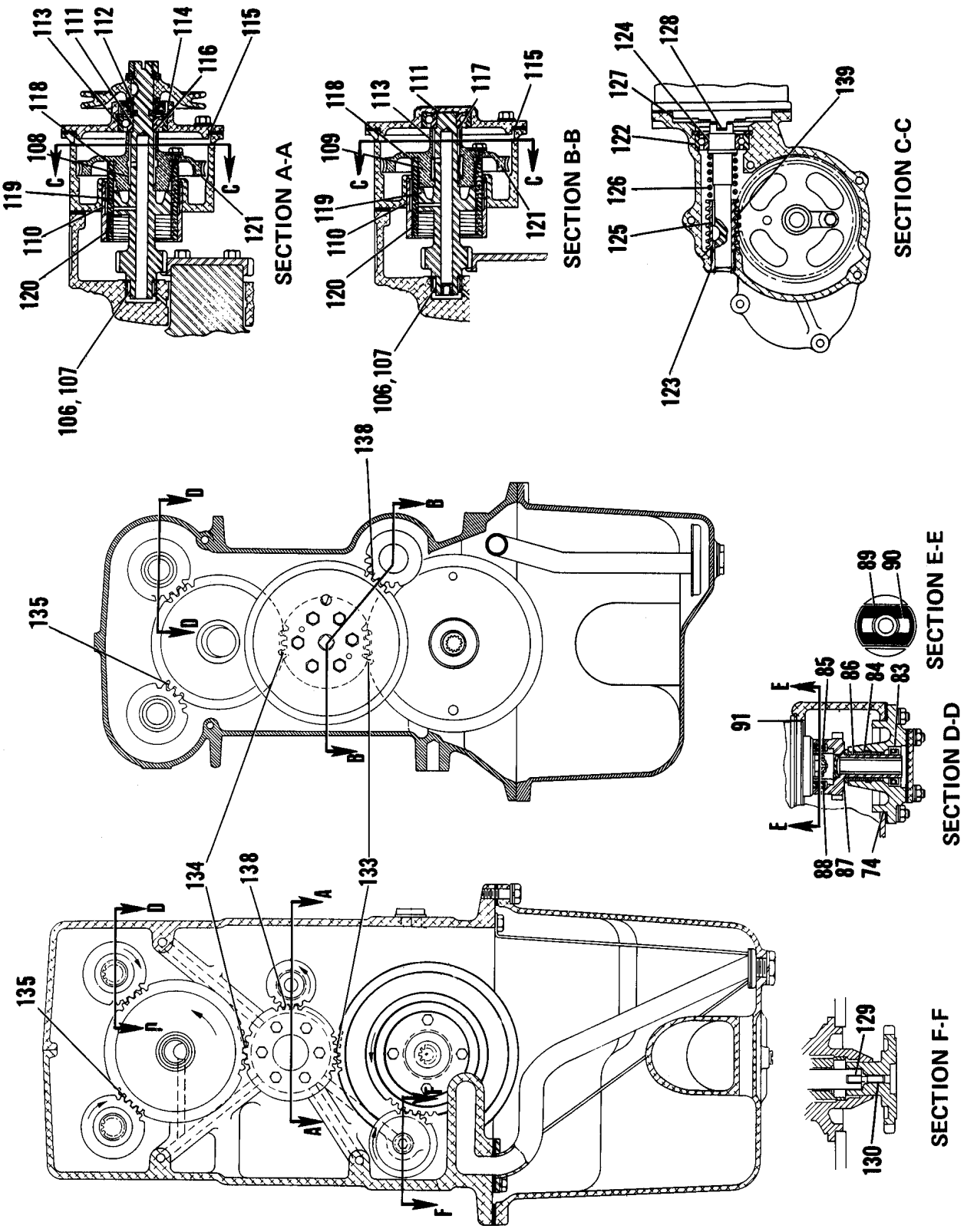


FIGURE 6-2. TABLE OF LIMITS CHART (1 OF4).

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SECTION VII
ASSEMBLY OF SUBASSEMBLIES

7-1. NEW PARTS. Parts which require protection from atmospheric dust and moisture are wrapped or boxed individually or in sets. These should not be unpacked until they are ready to be installed. This is especially true of precision bearing inserts and anti-friction bearings. Check other new parts on receipt for damage done in transit. Refer to Section IV of the parts catalog, Form X-30040A, for part numbers of the complete gasket set, the main bearing set, the piston ring set and tubes of light weight Tite-Seal gasket paste, all of which should be on hand when work is started. Use only new shakeproof or split lockwashers, tab washers, elastic stop nuts, cotter pins and annealed, corrosion-resistant lockwire.

7-2. TIGHTENING TORQUES. The Table of Limits in Section VI contains tightening torques for bolts, nuts and plugs lubricated with castor oil. 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 condition. If part is accidentally tightened too much, loosen it and retighten it to a value 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 stud lies beyond the nut slots when the nut has been tightened properly, the stud has been improperly installed or has backed out, or the attached part has been reduced in thickness, or either nut or washer is incorrect part for that location. The situation must be corrected by whatever replacement is indicated by inspection.

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

7-4. LUBRICATION. Immediately after final cleaning and before installation, coat all bare steel surfaces and journals with clean engine lubricating oil, except where special lubricants are mentioned in the text. In some instances where gears and other running parts are 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 anti-seize compound "Never-Seez". Coat both sides of gaskets with light weight tight seal compound to assure a perfect seal and to counteract the permanent "set" caused by compression.

7-5. SPECIFIC ASSEMBLY OPERATIONS.

7-6. OIL PUMP ASSEMBLY -INTEGRAL TYPE SCREEN (See Figure 4-18).

a. Install by-pass valve assembly (46 through 49) using new gasket (47). Install adjusting screw (42) in housing (40) until 13/16 inch of screw shows above housing. Secure with copper washer (39) and nut (38). Install gasket (41), washer spring seat (45), spring (44) and plunger (43) and screw assembly into housing (4).

b. Slide a new gasket (7) over oil screen (6) and insert filter into its chamber in pump housing. Tighten it by hand only.

c. Install pump drive and driven gears (34,36) in housing chambers, and place bevel gear (33) on end of drive shaft (34). Apply permatex and silk thread to parting surface.

d. Install new oil seal (15) in tachometer drive housing (12). Install new gasket (13). Carefully work lip of oil seal over shaftgear (14) and push shaft through.

e. Hold gear end of tachometer drive shaftgear (14) up and insert shaftgear into cover (11). Screw housing (12) into cover hand tight only, keeping bevel gear upward.

f. Place cover and tachometer drive assembly on pump housing, turning drive gear to mesh bevel gears, and attach it temporarily with two sets of attaching parts (8,9, 10).

NOTE

The oil screen and left-hand threaded tachometer drive housing can best be tightened after being installed on the engine.

7-7. OIL PUMP ASSEMBLY -PERMOLD ENGINE FULL FLOW TYPE FILTER (See Figure 4-19).

a. If oil pressure relief valve setting has been lost in disassembly, screw adjusting nut (45) onto adjusting screw (50) about halfway. Slide gasket (46) against nut and install washer (49) and spring (48) on adjusting screw (50) and plunger (47). Install assembly in pump housing.

b. Install driven gear assembly (41, 42) on shaft. Install driver gear assembly (38, 40) in pump housing to mesh with driven gear. Install bevel gear (39) on drive gearshaft. Apply permatex and silk thread to parting surface.

c. RIGHT ANGLE TACH DRIVE. Install parts indexed (30 through 37) as in paragraphs d, e, f in 7-6.

d. RIGHT ANGLE TACH DRIVE. Install new oil seal (26) in cover (15). Work shaftgear assembly (27) carefully through lips of oil seal. Install gaskets (20, 25), covers (19, 29), and secure with attaching parts (16, 17, 18 and 21, 22, 23). Install assembly on pump housing and loosely secure with two sets of attaching parts (12, 13, 14).

e. On engines with the spin on type filter, install a new gasket (6), adapter (5) and secure with attaching parts (2, 3, 4).

For engines using the full flow filter as illustrated by parts indexed (51 through 65) install new gasket (6) and adapter (65) and secure with attaching parts (2, 3,4). Install gasket (62) on stud (61) and insert stud in housing (60). Install element (63) in housing and secure with nut (64). Install assembly on adapter (65). Install spacer (59) and bracket (57) on stud and attach with washers (52, 53) and screw (51).

7-8. STARTER AND DRIVE ASSEMBLY - WITH GENERATOR DRIVE SHEAVE (See Figure 4-16).

a. Place depressed end of spring (29) over knurled end of gear (33). Push spring away from depressed end sidewise, work end coil over drum and push spring inward until depressed end snaps into groove. Install tab washer (28) and retaining screw (27).

b. Hold adapter (41), sleeve downward, and insert shaftgear and clutch assembly. Bear down on worm wheel (32) while turning counterclockwise, thus winding up spring to start into adapter sleeve. Push spring fully into sleeve. Install "0" ring (31) in shaftgear groove.

c. Support inner race of bearing (37) on a steel ring and press worm shaft (39) through until bearing is seated against flange. Tap serviceable woodruff key (38) into worm shaft key slot. Install spring (36) and worm gear (35) on shaft.

d. Holding worm and shaft assembly vertical, slide it into adapter and needle bearing. Invert adapter. With Truarc pliers, compress and install retaining ring (34). Test by hand for end clearance.

e. With Truarc pliers, compress and install retaining ring (26) in cover (22). Press in ball bearing (30) and new oil seal (25) with seal lip towards retaining ring. Insert sleeve (24) into seal.

f. Install gasket (23) and cover assembly on adapter and secure with attaching parts (17, 18, 19). Install timing indicator (20) and secure with attaching parts (17,18,19).

g. Install sheave (16) and attaching parts (13, 14, 15).

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

7-9. STARTER AND DRIVE ASSEMBLY - TYPICAL OF PERMOLD CRANKCASE (See Figure 4-17).

a. Press bearing (23) onto shaft (27). Install spring (25), Woodruff key (26) and worm gear (24). Insert assembly into adapter and install retaining ring (22).

b. Install clutch spring (18) on worm wheel (19). 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 (17) and screw (16).

c. Lubricate spring, sleeve and shaftgear liberally with clean oil. Press worm wheel, bearing (20) and spring assembly onto shaftgear (21). Install bearing (15) and retaining ring (14) on shaftgear. Insert shaftgear and worm wheel assembly into adapter. Make certain worm wheel and worm gear teeth are aligned. Install a new "O" ring (13) in groove of cover (12). Slide cover over shaft. Install three sets of attaching parts (9,10,11).

d. Install "O" ring (4) on starter adapter. Turn starter shaft until tongue is aligned with worm gear shaft slot. Mount starter (3) on adapter studs and secure with attaching parts (1,2).

7-10. CYLINDER (See Figure 4-20). 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 towards propeller flange. Mark any new cylinder and/or piston accordingly.

a. Spread a film of Gredag No. 44 grease on valve stems (33, 34) and insert them in cylinders to which they have been lapped. Grasp valve stems and lift cylinder onto a post which will support valve heads. Clamp cylinder base flange to prevent it from rising. Again apply Gredag No. 44 to valve stems.

b. Place valve spring retainers (32) over valve guide (38) cupped side up. Install inner and outer valve springs (30, 31), per instructions in Figure 7-1, outer retainer (29) and rotator (28). Compress springs and install keys (27). Make certain keys are properly seated before releasing pressure 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 stem keys.

c. Install new packing (26) on each cylinder skirt. Push against flange and make certain none are twisted. Coat cylinder bore walls thoroughly with Cities Service No Scuff Oil No. 9028 or castor oil.

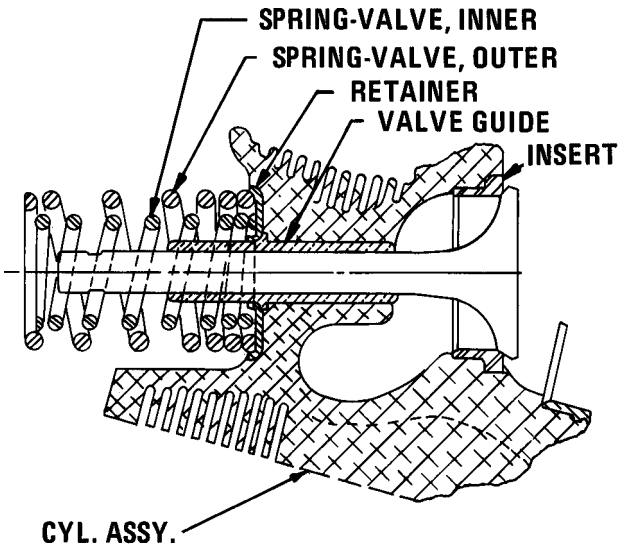


FIGURE 7-1. VALVE SPRING INSTALLATION.

7-11. PISTON AND RING ASSEMBLIES (See Figure 4-20).

a. Lubricate pistons (21) and rings (22, 23, 24, 25) liberally with Cities Service CMS No. 50 or No. 9028 No Scuff Oil.

b. Position first and third ring gaps on top of piston. Position second and fourth ring gaps so they will be 1800 apart from first and third ring gaps.

7-12. PUSHROD HOUSINGS (See Figure 4-20).

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

b. Install spring (15), washer (16), packing (17) and second washer (16) onto crankcase end of housing (14).

c. Lay two housings with each cylinder.

7-13. CRANKSHAFT AND CONNECTING RODS -TYPICAL OF SANDCAST CRANKCASE (See Figure 4-24).

a. Lay crankshaft on a bench with a notched wood block under front and rear journals.

b. Layout connecting rods, caps, bolts and nuts (9, 8, 7, 6) opposite crankpins according to position number stamped on bolt bosses. Install new bearing insert in each rod and cap so their ends project the same distance.

c. Lubricate and install each rod and cap with position numbers on top when odd number rods are extended to the right and even numbers to the left. Attach them with special bolts (7) and slotted nuts (6). Tighten nuts to specified torque and secure each with a cotter pin (5).

d. Attach two sixth order counterweights (17) to crankcheek No.2 with two pins (14) each and install retaining plates and rings (13, 12). Attach one fourth order and one fifth order counterweight to crankcheek No.5. Install pins (15, 16) and se- cure with plates (13) and retaining rings (12). Install retaining rings with the flat or rough side to the outside.

e. Heat crankshaft gear (27) to 300° F., align gear dowel hole with crankshaft dowel (32) and tap gear onto crankshaft. Attach gear to shaft with six screws to specified torque and secure head with lockwire.

f. Remove spring and reinforcing ring from oil seal. Unhook the spring ends using an unwinding motion. Wrap spring around shaft in seal area, turn spring ends in an unwinding direction, then join and allow one end to wind into the other end. Oil propeller flange, shaft and I.D. of seal liberally with clean engine oil. Squeeze oil seal until egg-shaped and start seal over propeller flange, groove side toward the rear. Work seal carefully, to prevent damage to the lip, upward over the flange. Placing a lightly oiled plastic bag over the prop flange will help protect the seal. Also, a special tool, Borrough's Tool and Equipment Company P/N 5209, is available (See Section III). After the seal is on the shaft, wipe any oil from the O.D. of the seal. The O.D. of the seal is to be dry when installed in the crankcase. No sealing cement or compound is to be used. Install the reinforcing ring, working O.D. of seal over ring to insure a snug fit. Install spring in cavity in seal.

g. Install governor oil transfer collar (20 through 25) and secure with nuts (19).

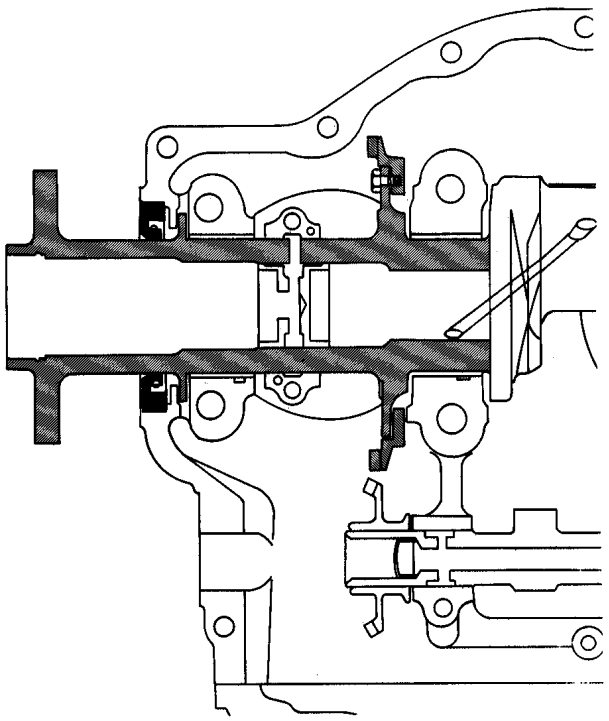


FIGURE 7-2. ALTERNATOR DRIVE GEAR INSTALLED.

7-14. CRANKSHAFT AND CONNECTING RODS -TYPICAL OF PERMOLD CRANKCASE (See Figure 4-25).

a. Paragraphs a, b, c, d, e and f of 7-13 also apply to the IO-520-C crankshaft and all of the foregoing paragraphs except "d" shall also apply to the IO-520-B.

The IO-520-B has been modified by the use of three (3) sixth order counterweights and one (1) fourth order counterweight.

This modification requires a change to the name plate which consists of an "A" stamped after the model designation.

b. Heat alternator 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).

NOTE

Install gear in proper position so that timing marks are in line with the No.2 throw when at TDC.

7-15. CAMSHAFT (See Figure 4-23).

a. Tap a Woodruff key (3) on front end of camshaft (9) and install bevel gear (2).

b. Install gears (5 and 6) on the IO-520-A camshaft and gear (6) only on the IO-520-B and C camshafts, and secure with four screws (4).

WARNING

Camshaft (permold engines) must have rear pipe plug (7) and front expansion plug (8) installed in camshaft before camshaft is assembled in engine.

7-16. CRANKCASE, SANDCAST (See Figure 4-21).

a. Replace any pipe plugs removed during previous operations.

b. Install oil temperature control valve (23) in right crankcase. Tighten and secure with lockwire.

c. Install new gasket (37), governor pad cover (36) and attaching parts (32,33,34,35).

d. If mount brackets (65) were removed, reinstall them and attaching parts (62,63,64).

e. Turn both crankcase halves open side up. If squirt nozzles (72) were removed, reinstall them. Lubricate all camshaft bearings and main bearing inserts. Install main bearings so bearing ends project equally.

7-17. CRANKCASE, PERMOLD (See Figure 4-22).

a. Replace any pipe plugs removed during previous operations. Install machine thread plugs.

b. Install gaskets (7, 6) and oil filler tube (5). Secure with attaching parts (2, 3,4).

c. Install gasket (19), governor pad cover (18) and secure with attaching parts (14, 15, 16, 17).

d. Install gasket (24), camshaft hole cover (23) and attaching parts (20,21,22).

e. Install "O" rings (47 and 62) and install mounting legs. Secure with attaching parts (52, 53,54). (Applicable to IO-520-C only.)

f. Lay crankcase halves open side up. Make sure squirt nozzles(69) are in place. Lubricate cam bearings and main bearings. Insert main bearings so that edges project equally.

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

CAUTION

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

NOTE

General instructions for reassembly of fuel injection components will apply to all engine models.

NOTE

Prior to reassembly of fuel injection components, any replacement fittings should first be screwed into proper size holes in a block of soft wood to reduce likelihood of metal particles entering the system.

a. Install plugs and any necessary replacement connection fittings in proper ports of fuel injection components. (See Figures 7-3 thru 7-5)

b. Install shaft and throttle plate in air throttle body, if removed, and fuel control and mixture control levers on end sections of shaft. Secure with nut and cotter pins.

c. Install fuel injection control unit assembly on air throttle body along with shroud assembly, but do not secure shroud until fuel injection hoses are installed on control unit.

d. Install all throttle control rod assembly linkage with spring, washers and cotter pins.

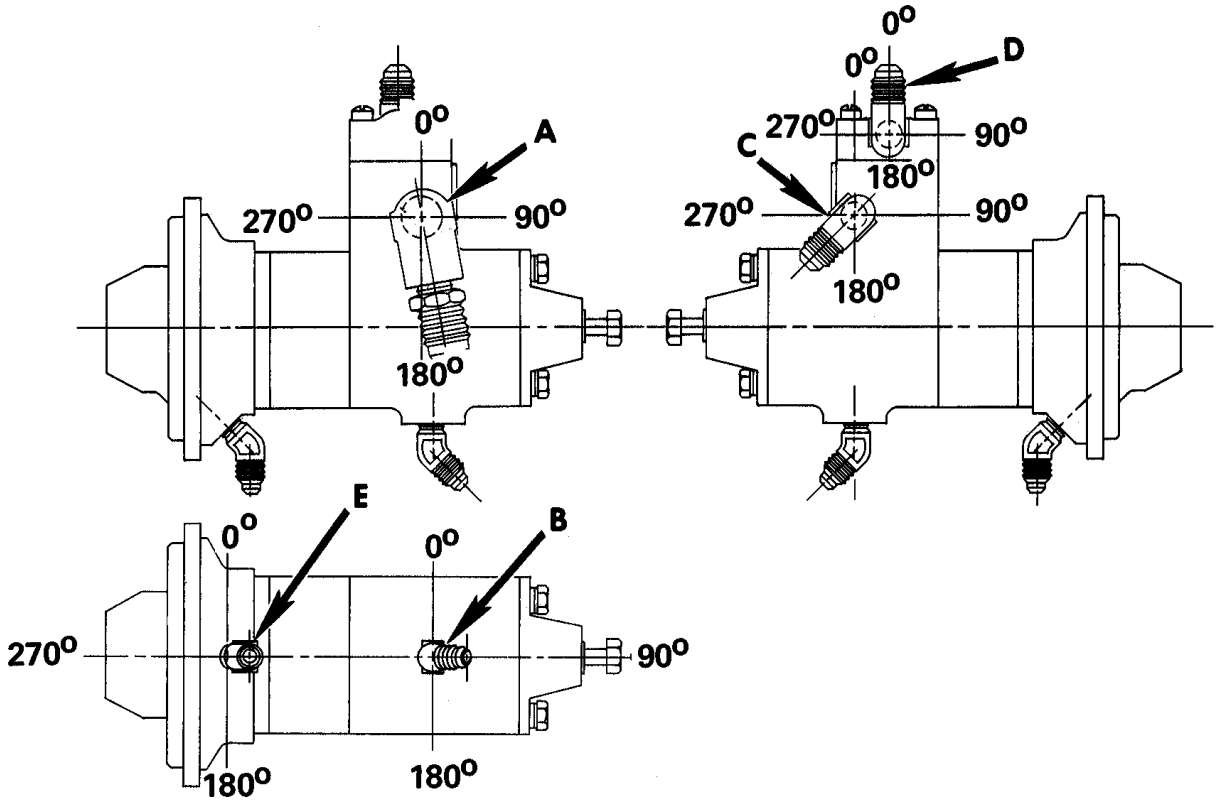


FIGURE 7-3. FUEL PUMP AND VAPOR SEPARATOR FITTING LOCATIONS

	A	B	C	D	E
	INLET AND ANGLE°	OUTLET AND ANGLE°	MIXTURE RETURN AND ANGLE°	VAPOR RETURN AND ANGLE°	DRAIN AND ANGLE°
IO-520-A	90° ELBOW - (200°)	45° ELBOW - (270°)	90° ELBOW - (60°) 45° ELBOW - (60°)	90° ELBOW - (15°) CONNECTOR	CONNECTOR
IO-520-B	90° ELBOW - (90°)	90° ELBOW - (285°)	90° ELBOW - (225°)	45° ELBOW - (225°)	45° ELBOW - (255°)
IO-520-C	90° ST. ELB. - (135°) 45° ST. Elb. - CONNECTOR	90° ELBOW - (285°)	45° ELBOW - (225°)	CONNECTOR	45° ELBOW - (255°)
IO-520-D	90° ELBOW - (135°)	CONNECTOR	90° ELBOW - (270°) 90° ELBOW - (180°)	45° ELBOW - (225°)	CONNECTOR
IO-520-E	90° ELBOW - (170°)	45° ELBOW - (270°)	90° ELBOW - (235°) CONNECTOR	90° ELBOW - (15°) CONNECTOR	CONNECTOR
IO-520-F	90° ELBOW - (200°)	45° ELBOW - (270°)	90° ELBOW - (60°) 45° ELBOW - (60°)	90° ELBOW - (15°) CONNECTOR	CONNECTOR
IO-520-J	90° ELBOW - (200°)	45° ELBOW - (270°)	90° ELBOW - (60°) 45° ELBOW - (60°)	90° ELBOW - (15°) CONNECTOR	CONNECTOR
IO-520-K	90° ELBOW - (200°)	45° ELBOW - (270°)	90° ELBOW - (60°) 45° ELBOW - (60°)	90° ELBOW - (15°) CONNECTOR	CONNECTOR
IO-520-L	90° ELBOW - (200°)	45° ELBOW - (270°)	90° ELBOW - (60°) 45° ELBOW - (60°)	90° ELBOW - (15°) CONNECTOR	CONNECTOR

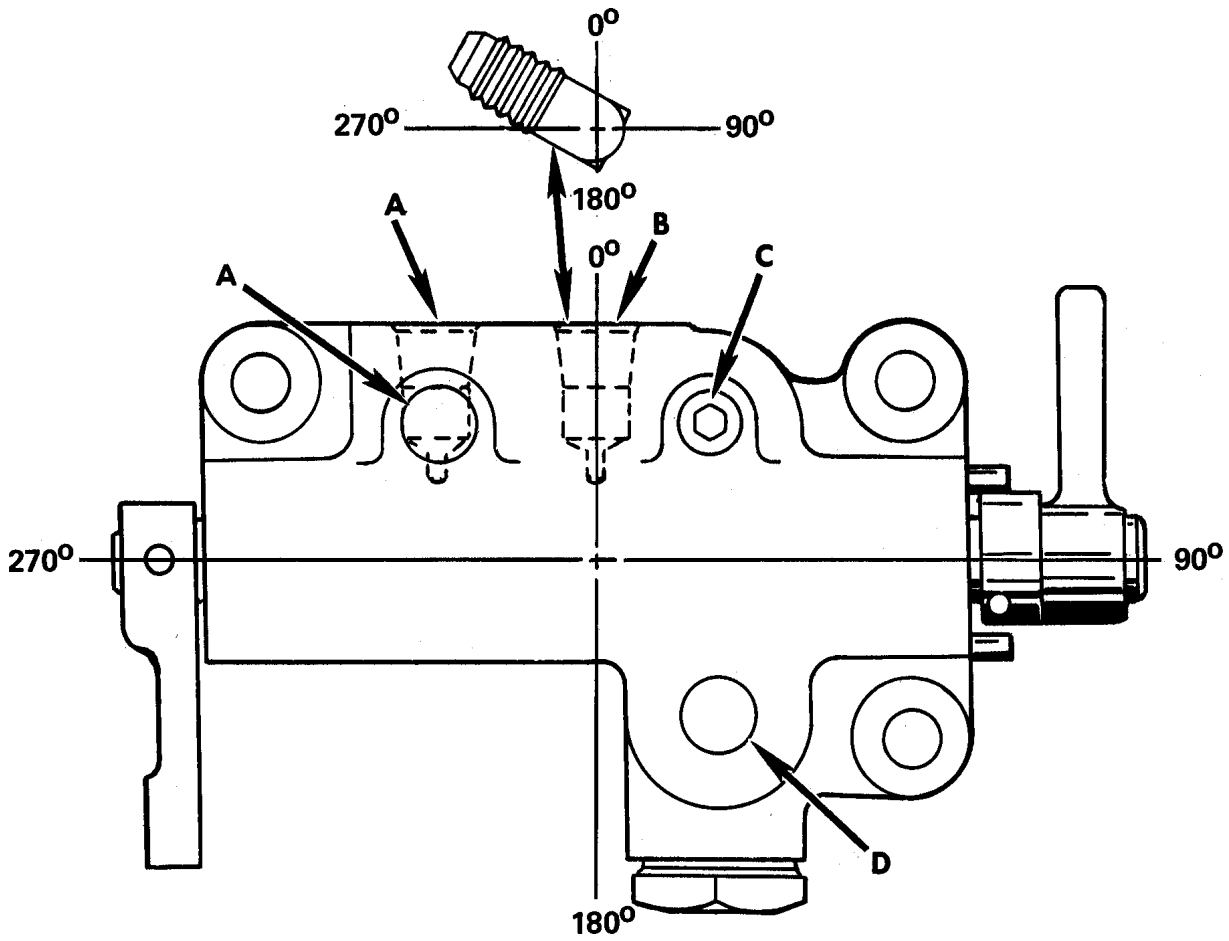


FIGURE 7-4. FUEL CONTROL VALVE FITTING LOCATIONS

	A	B	C	D	E
ENGINE MODEL	TO MANIFOLD VALVE	FUEL RETURN TO TANK	–	FUEL INLET	TO MANIFOLD VALVE
IO-520-A, F, J, K, L	PLUG	90° ELBOW 30°	PLUG	ADAPTER 165° 90° ELBOW	NIPPLE
IO-520-B	PLUG	EXTENSION 165° 90° ELBOW 90° ELBOW 195°	PLUG	ADAPTER 225° 90° ELBOW	EXTENSION 315° 90° ELBOW
IO-520-C	PLUG	90° ELBOW 205°	PLUG	90° ELBOW 270°	90° ELBOW 90°
IO-520-D	90° ELBOW 180°	EXTENSION 20° 45° ELBOW		EXTENSION 195° 90° ELBOW	PLUG
IO-520-E	90° ELBOW 180°	EXTENSION 90° ST. ELBOW 170° 90° ELBOW		TEE NIPPLE 205° PLUG	PLUG

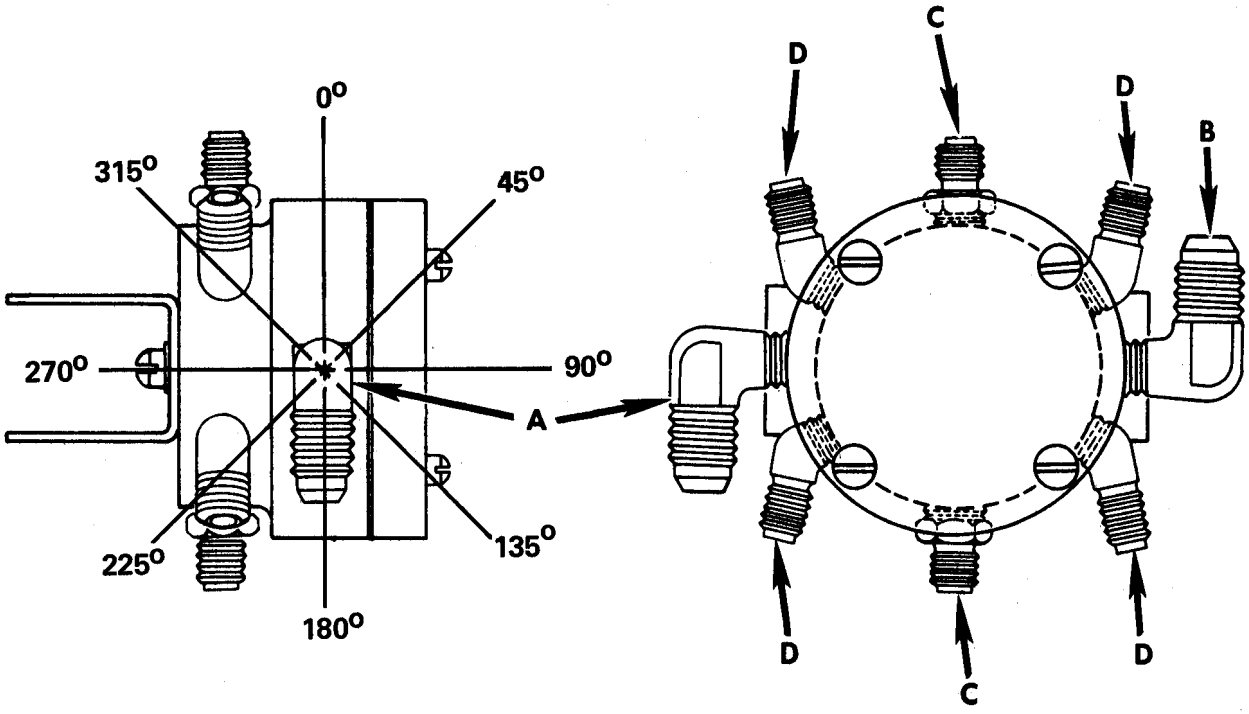


FIGURE 7-5. FUEL MANIFOLD VALVE FITTING LOCATIONS

ENGINE MODEL	FITTING "A" NUMBER	FITTING "B" NUMBER	FITTING "C" NUMBER	FITTING "D" NUMBER
IO-520-A	90° ELBOW - (0°)	90° ELBOW - (180°)	NIPPLE, UNION	45° ELBOW
IO-520-B	90° ELBOW - (180°)	90° ELBOW - (180°)	NIPPLE, UNION	45° ELBOW
IO-520-C	90° ELBOW - (0°)	90° ELBOW - (180°)	NIPPLE, UNION	45° ELBOW
IO-520-D	90° ELBOW - (0°)	90° ELBOW - (180°)	NIPPLE, UNION	45° ELBOW
IO-520-E	90° ELBOW - (0°)	90° ELBOW - (180°)	NIPPLE, UNION	45° ELBOW
IO-520-J	90° ELBOW - (0°)	90° ELBOW - (180°)	NIPPLE, UNION	45° ELBOW
IO-520-K	90° ELBOW - (0°)	90° ELBOW - (180°)	NIPPLE, UNION	45° ELBOW
IO-520-L	90° ELBOW - (0°)	90° ELBOW - (180°)	NIPPLE, UNION	45° ELBOW

SECTION VIII

FINAL ASSEMBLY AND TEST

8-1. GENERAL INSTRUCTIONS.

8-2. LUBRICATION. Apply clean engine lubricating oil liberally 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 and backlashes cannot be measured with normal thickness gauges due to the inaccessible position of the parts, test for binding and excessive looseness as well as possible by moving the running part.

8-5. COVERS. Unless the atmosphere is unusually free of dust and airborne grit, it is advisable to cover openings as soon as possible and to cover assemblies and the 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, SANDCAST (See Figure 4-21).

a. Install mount brackets on left crankcase and attach assembly to engine stand with support under casting.

b. Lubricate all main bearing inserts and crankshaft journals and install thrust washers. Lift shaft assembly by No.1 connecting rod and propeller flange. With the aid of an assistant holding up Nos. 3 and 5 rods, 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 upper case flange. Carefully lay odd numbered rods on upper case flange.

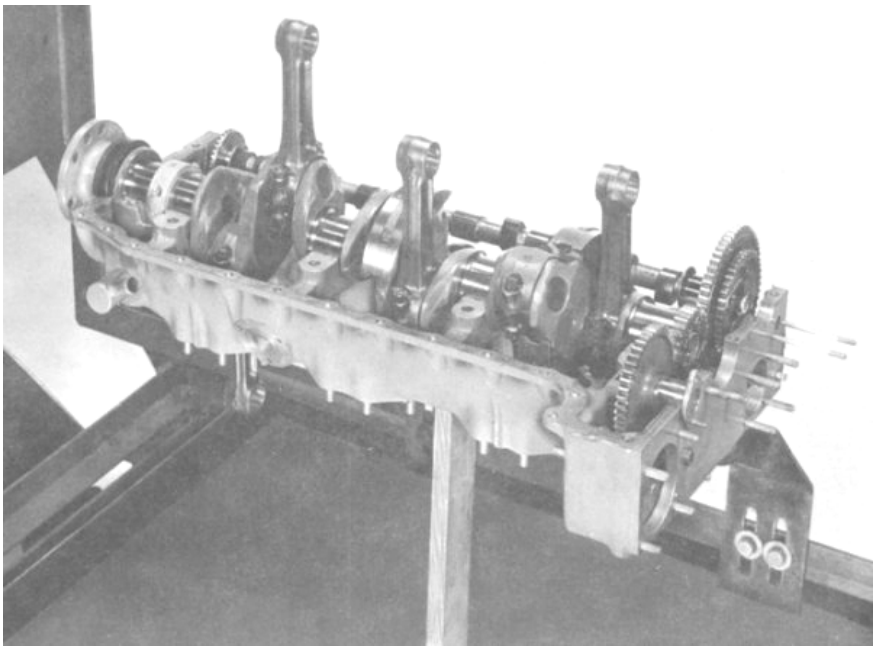
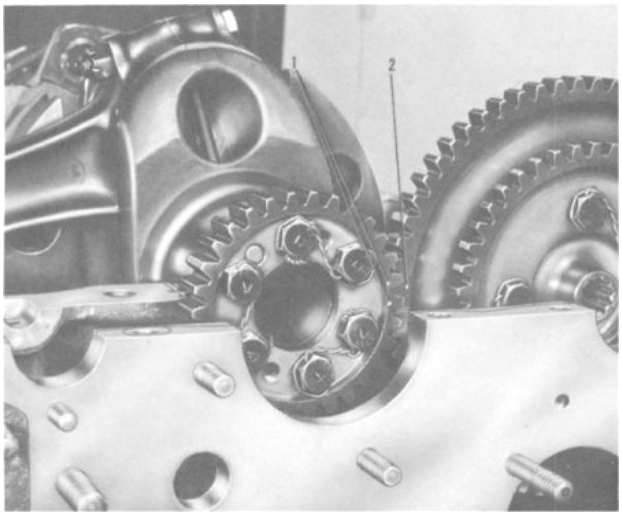


FIGURE 8-1. LEFT CRANKCASE AND SHAFTS ASSEMBLED ON STAND

c. Insert governor driven gear (1, Figure 4-23) into its bearing.

d. Lay camshaft assembly in its bearings in left crankcase, meshing spur gear teeth with those of crankshaft gear so that timing marks are aligned in the manner illustrated in Figure 8-2, and turning governor driven gear to mesh it with driver gear.



1. Crankshaft gear timing marks
2. Camshaft gear timing mark

FIGURE 8-2. ALIGNMENT OF TIMING MARKS.

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. Install idler gear assembly and support pin in left crankcase as illustrated (Figure 8-1) 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.

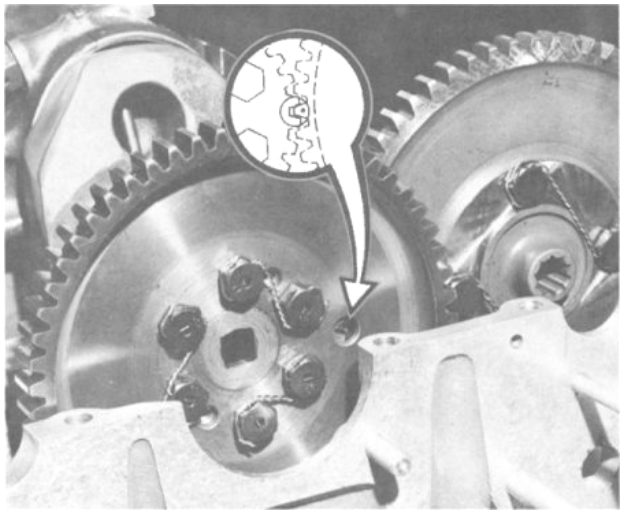


FIGURE 8-3. ALIGNMENT OF TIMING MARKS.

j. Insert (from above) two 8-7/8 inch through bolts (54, Figure 4-21) at front of crankcase, one 9-13/16 inch through bolt (55) in front of No.5 cylinder mount pad, seven 10-3/4 inch through bolts (57) through cylinder mount pads and four 10-1/2 inch through bolts (56) below camshaft level. Tap all of these through to centered positions with a non-marring hammer. These bolts align crankcase castings and bearings.

k. Install a spacer and flanged nut on each end of the two front through bolts, a spacer and flanged nut on top end of two through bolts ahead of No. 5 cylinder pad and, on bottom end of upper rear through bolt nearest magneto mount pad.

l. Install fuel manifold valve over crankcase flanges. Install spacer (22), lifting eye (21) and secure with attaching parts (20, 19, 18, 17). Install attaching parts (50 through 53).

m. Install one bolt and washers (42, 43, 44) at left rear, one "O" ring (48) and two bolts and washers (42, 43, 44) at right rear and one bolt and washer (42, 43) at right front. Do not tighten any parts in this group yet.

n. Seat idler gear support pin. The eccentric shoulder must be away from crankshaft. Do not install attaching parts yet.

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

p. Install two "O" rings (48), one bolt (49) and attaching parts (45, 46, 47, 49) in the upper rear case hole and tighten nut.

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

r. Install generator mount bracket (31) and secure with attaching parts (24 through 30).

s. Install, but do not tighten support pin attaching parts (58, 59).

8-7. CRANKCASE, PERMOLD (See Figure 4-22).

a. Install mounting legs on the left crankcase of the IO-520-C and attach to assembly stand, supported as shown in Figure 8-1. Install engine stand bracket to crankcase with 3/8-16 bolts attached in tapped holes provided on the IO-520B, BA,M.

b. Lubricate all main bearing inserts and crankshaft journals. Lubricate both thrust washer halves with Gredag No. 44 and install. 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 4-23) into its bearing.

d. After cranJ5shaft has been properly placed in crankcase, and governor driven gear has been installed, lay camshaft assembly in. place meshing spur gear teeth of the cam gear with those of the crankshaft small gear so that the timing marked tooth of the cam gear is at the center of the 3/8 inch observation hole in the web of the crank- shaft large gear. See Figure 8-3.

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

f. Install idler gear bushing (64, Figure 4-22) in left crankcase and secure with dowel pin (63). Install idler gear and idler gear flanged bushing (27).

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.

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.

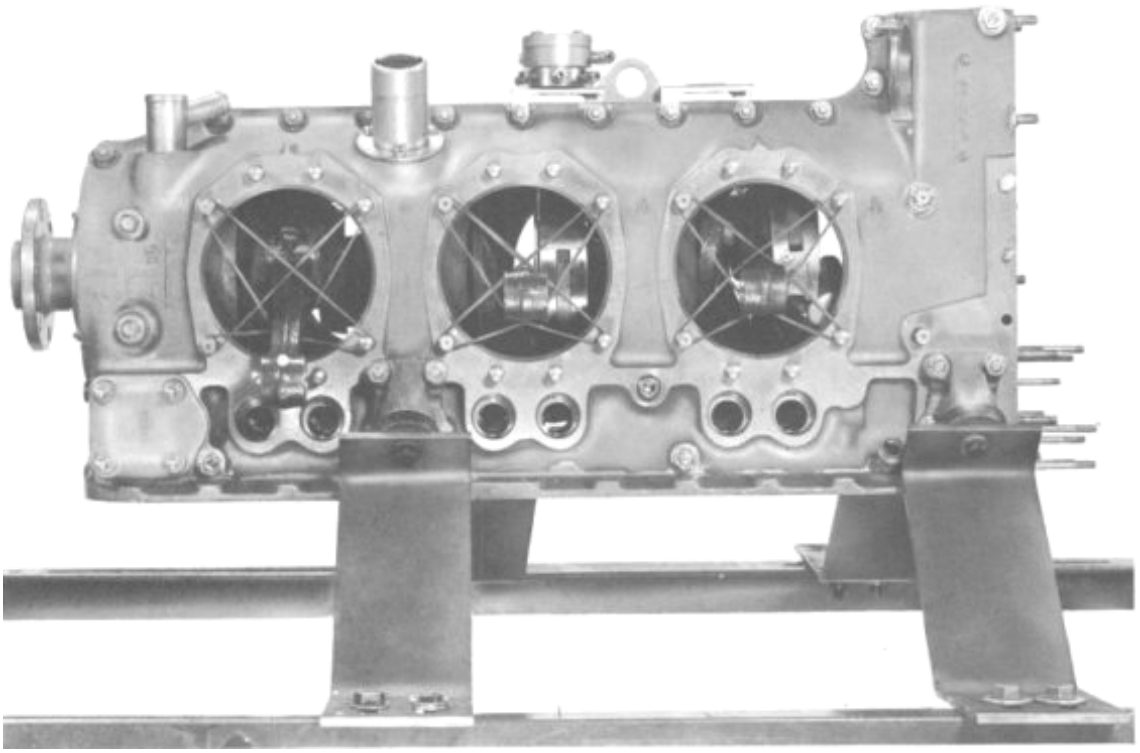


FIGURE 8-4. LEFT SIDE OF COMPLETED CRANKCASE ON STAND.

j. Insert, from above, through bolts (58, 59,60, 61). Tap all of these through to centered positions with non-marring hammer. These bolts align crank- case castings and bearings.

k. Install a washer (30) and flanged nut (29) on each of the two front through bolts. Install an "0" ring (47), plain washer (46), lockwasher (45) and nut (44) on extreme upper rear through bolt on right crankcase.

l. Install fuel manifold valve and bracket, lifting eye (12), spacer (13) and secure with attaching parts (11, 10, 9, 8). Install bolts (48), washers (50, 51) and nuts (49). Install attaching parts (31 through 43).

m. Install "O" rings (47, 48) and mounting legs not previously installed (IO-520-C).

n. Seat idler gear flanged bushing (27). Do not install attaching parts yet.

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

p. Attach right mount bracket or crankcase to assembly stand and rotate stand until engine is upright.

q. Install, but do not tighten, idler gear flanged bushing attaching parts (25, 26).

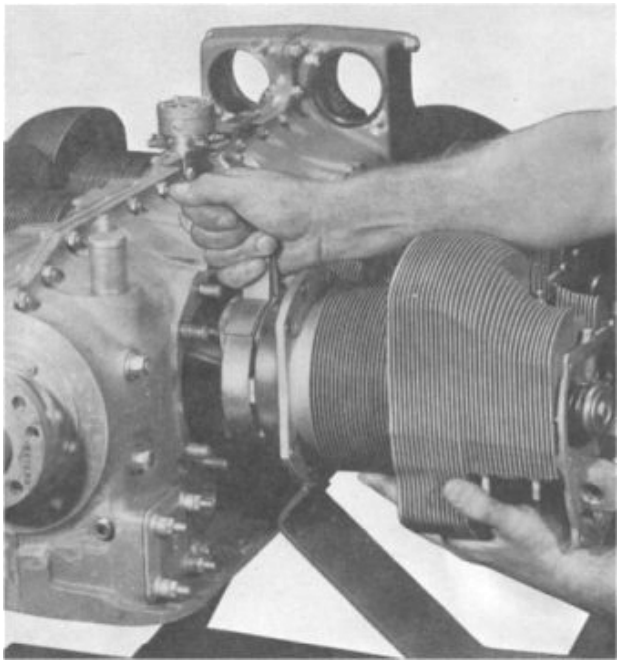


FIGURE 8-5. INSTALLING NO. 6 CYLINDER.

8-8. CYLINDERS AND PISTONS.

a. Before installing each cylinder and piston, rotate crankshaft to place rod in top center position.

b. Place piston over the rod with the position number toward the propeller flange.

c. Lubricate pistons and rings liberally with Cities Service No Scuff Oil, No. 9028.

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

e. Remove ring compressor and place cylinder base flange onto hold down studs. Make sure packing is in place and not twisted and seat cylinder flange on the crankcase cylinder pad.

f. Pistons and cylinders may be installed in any order, but to minimize turning of crankshaft and any undue loss of balance it is suggested that No.1 and 2 be installed first, followed by 3,4 and 5,6.

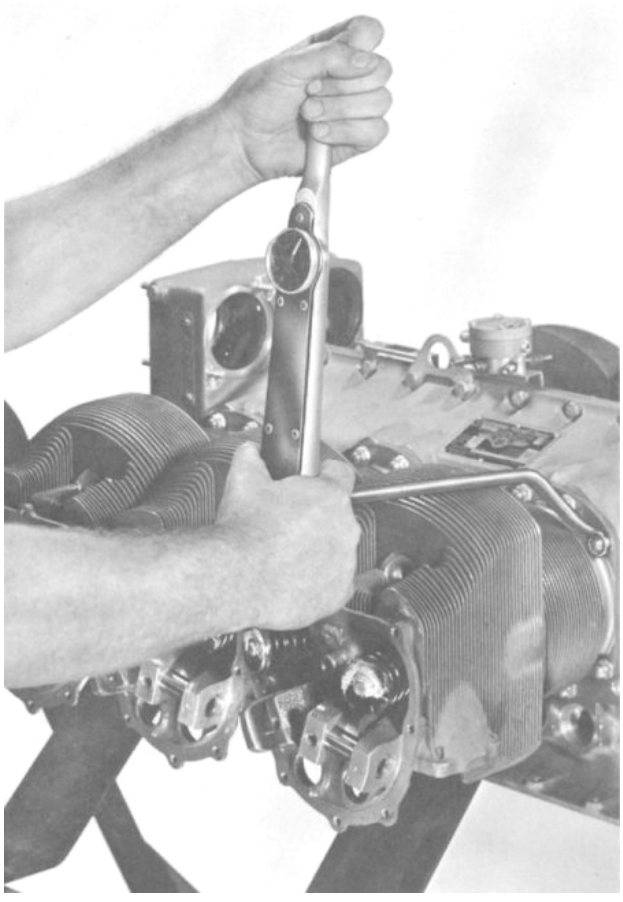


FIGURE 8-6. TIGHTENING CYLINDER BASE NUT.

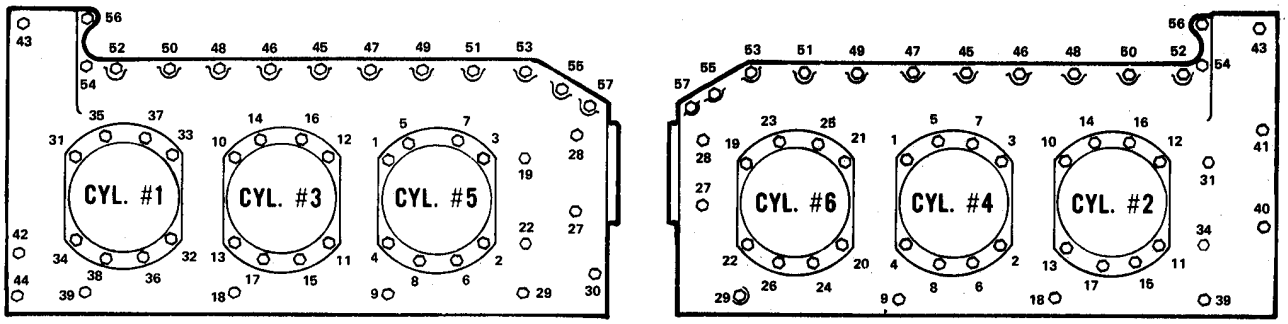


FIGURE 8-7 TORQUING SEQUENCE

a. Nuts on both ends of thru bolts must torqued.

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

ASSEMBLY PROCEDURE.

1. Insert thru bolts.
2. Snug bolts No. 27,28,43,44.
3. Install cylinders 4 & 5. Tighten stud nuts to 300-450 in. lbs.
4. Tighten thru bolts No. 1,4 & 9 to 300-400 in. lbs. in sequence shown.
5. Tighten thru bolts and stud nuts to 500 in. lbs.
6. Tighten thru bolts No. 1 & 4 in accordance with note below. Tighten No. 9 to 500 in. lbs.
7. Repeat above on cylinders No. 2 & 3.
8. Repeat above on cylinder No. 6, including bolts No. 27 & 28 in sequence shown.
9. Repeat above on cylinder No. 1
10. Tighten bolts No. 40 thru 57 to specified torque in sequence shown.

NOTE- Reference .50 thru bolts, item 6 above.

1. If Part Number 634504 and 634505 bolts and nuts are used, use 700 in. lbs. of torque.
2. If Part Number 539050 and 539969 bolts and nuts are used, use 650 in. lbs. of torque.

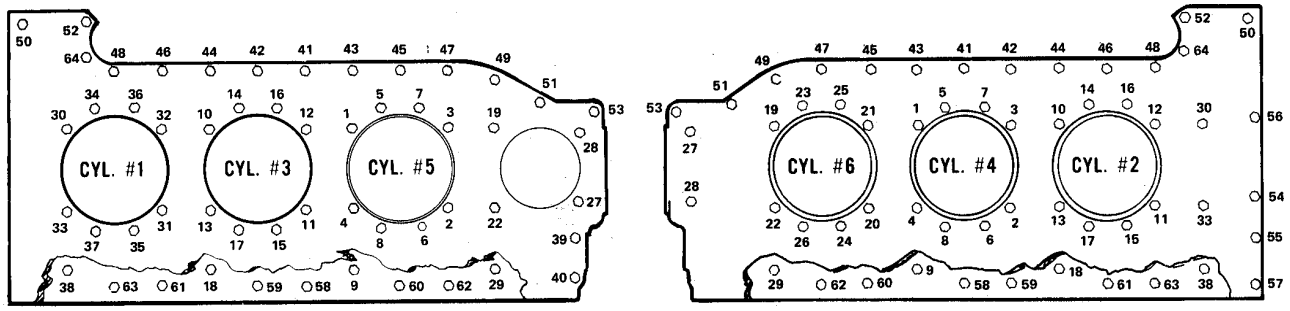


FIGURE 8-8 TORQUING SEQUENCE

a. Nuts on both ends of thru bolts must torqued.

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

ASSEMBLY PROCEDURE.

1. Insert thru bolts.
2. Snug bolts No. 27,28,54& 56.
3. Install cylinders 4 & 5 and Tighten stud nuts to 350 in. lbs.
4. Tighten thru bolts No. 1 & 4 to 350 in. lbs. in sequence shown.
5. Tighten thru bolts and stud nuts to 500 in. lbs.
6. Tighten thru bolts No. 1 & 2 in accordance with note below. Tighten bolt No. 9 to 200 in. lbs.
7. Repeat above on cylinders No. 2 & 3.
8. Repeat above on cylinder No. 6, including bolts No. 18 & 27 in sequence shown.
9. Repeat above on cylinder No. 1
10. Tighten bolts No. 38 thru 64 to specified torque in sequence shown.
11. NOTE: Both sides of crankcase to be cross torqued simultaneously.

NOTE- Reference .50 thru bolts, item 6 above.

1. If Part Number 634504 and 634505 bolts and nuts are used, use 700 in. lbs. of torque.
2. If Part Number 539050 and 539969 bolts and nuts are used, use 650 in. lbs. of torque.

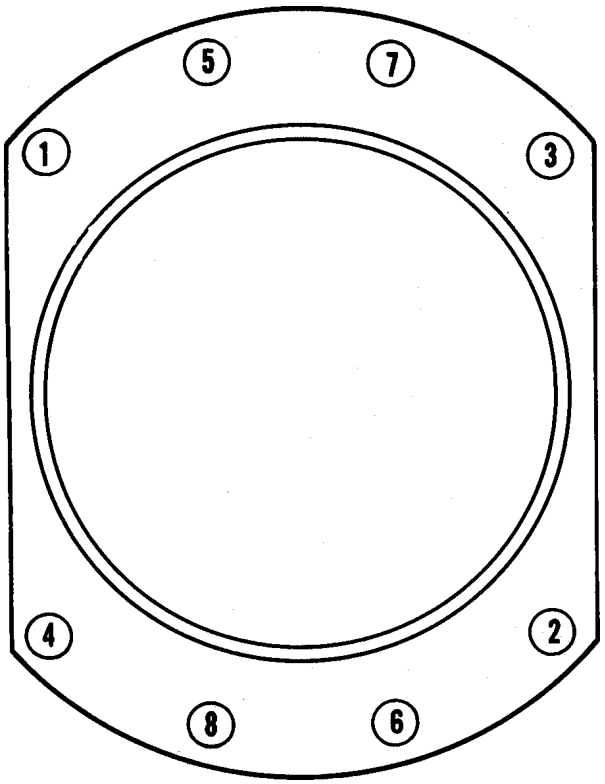


FIGURE 8-9. CYLINDER FLANGE TORQUE SEQUENCE

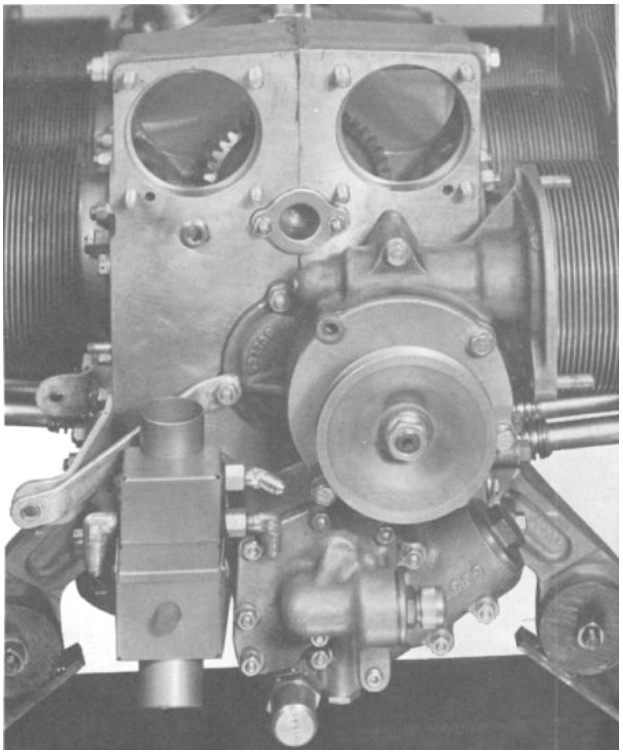


FIGURE 8-10. FUEL PUMP, OIL PUMP AND STARTER ADAPTER INSTALLED. SANDCAST CRANKCASE.

g. As soon as each cylinder has been installed, secure it moderately with flange nuts (18, 19, Figure 4-20).

h. Tighten flanged nuts according to sequence in Figure 8-7 or 8-8 or 8-9.

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

8-9. OIL PUMP-INTEGRAL TYPE OIL SCREEN (See Figure 4-18).

a. Remove two sets of attaching parts and remove tachometer drive and pump cover.

b. Spread a thin film of No.3 Aviation Permatex on the rear parting surface of the oil pump housing. 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 oil filter cap and left-hand threaded tachometer drive housing.

8-10. OIL PUMP -FULL FLOW TYPE FILTER, PERMOLD ENGINE (See Figure 4-19).

a. Remove attaching parts (23, 24, 25, IO-520-B) or (31, 32, 33, IO-520-C) 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 (22) on crankcase.

e. Mount oil pump assembly on crankcase studs and secure with attaching parts (19, 20, 21). Torque to value given in Table of Limits, Section VI.

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

If filter indexed (60 through 64) is being used, install spacers (58) and secure bracket (57) to crankcase with attaching parts (54,55, 56).

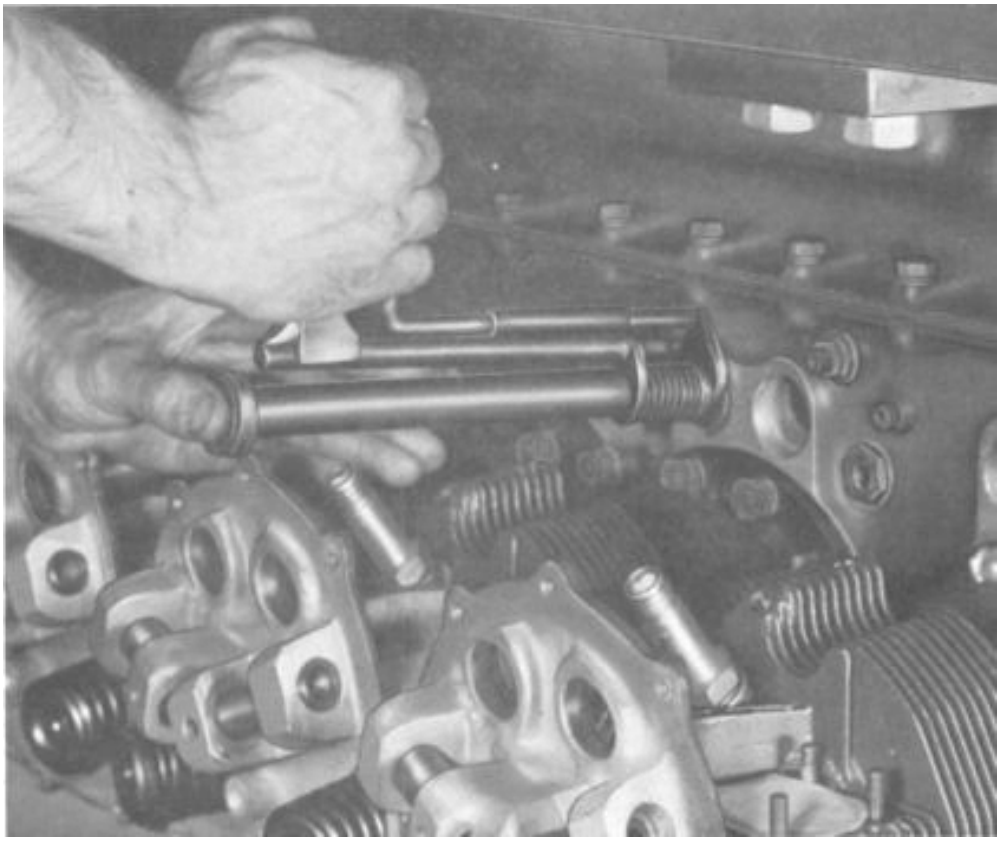
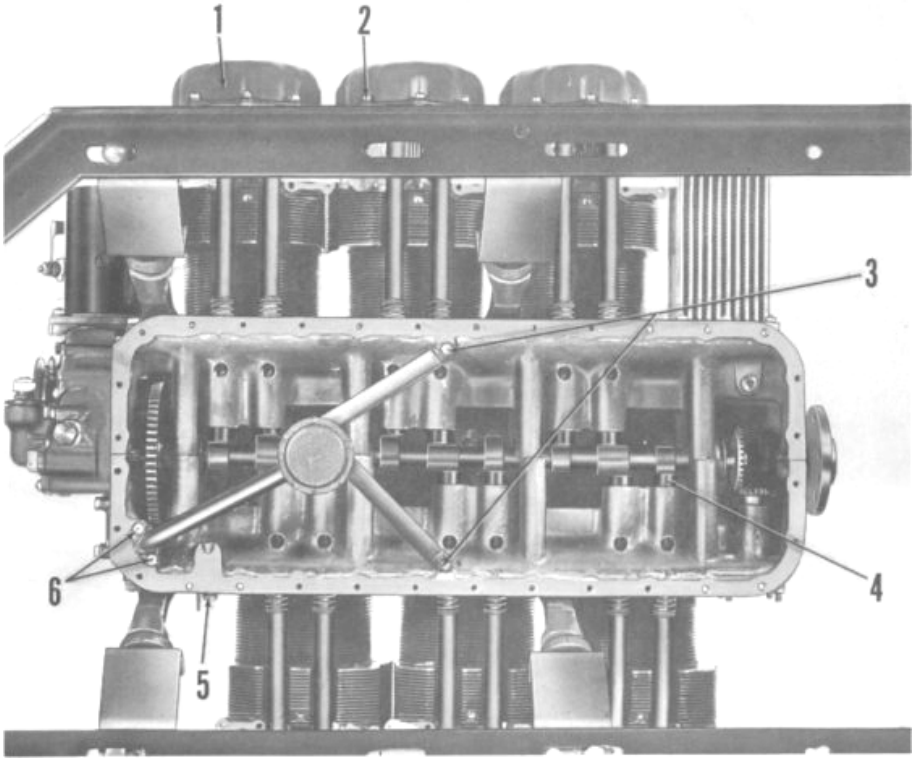


FIGURE 8-11. INSTALLING PUSHROD HOUSING.



1. Valve rocker cover
2. Washer, lockwasher
3. Screws
4. Hydraulic valve lifter
5. Oil gauge rod support
6. Screws

FIGURE 8-12. BOTTOM VIEW WITH VALVE MECHANISM AND OIL SUCTION TUBE INSTALLED. SANDCAST CRANKCASE.

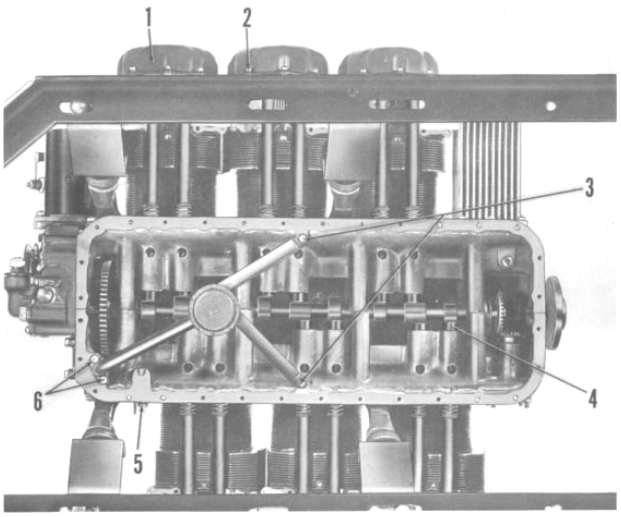


FIGURE 8-13. BOTTOM VIEW WITH VALVE MECHANISM AND OIL SUCTION TUBE INSTALLED PERMOLD CRANKCASE.

1. Oil suction tube
2. Screws
3. Pushrod housing.

8-11. FUEL PUMP -TYPICAL OF SANDCAST CRANKCASE (See Figure 4-1).

a. Lubricate fuel pump drive gear and coupling with Gredag No. 44.

b. Install a new gasket on two lower left rear crankcase studs. Install coupling in gear and install fuel pump and vapor separator. Secure with two sets of attaching parts.

8-12. FUEL PUMP -TYPICAL OF PERMOLD CRANKCASE (See Figure 4-2).

a. Lubricate fuel pump drive coupling with Gredag No. 44.

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.

8-13. STARTER DRIVE ADAPTER (See Figure 4-16).

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

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

b. Lubricate spur gear and mesh it with crankshaft gear as adapter is placed in position. Seat adapter against gasket. Secure adapter to sandcast crankcase with two sets of nuts and washers and two bolts and lockwashers. Attach lower generator support bracket as shown in Figure 8-10. Secure adapter to permold crankcase with five sets of nuts, plain washers and lockwashers.

8-14. GENERATOR (See Figure 4-13).

a. Install upper support bracket components (7 through 12) and secure it with bolt (6).

b. Position crankcase mounting bracket bushings (20) on each side mounting hole and press sleeve (21) through bushings. Position generator (18) so that it straddles mount bracket with the rear flange between washer and support bracket. Align holes in flanges and secure bracket assembly (17), lower support bracket (22) and generator (18) to bracket (23) with washers (19) and bolts (16).

8-15. ALTERNATOR ASSEMBLY (See Figure 4-15).

a. Install the baffle support assembly (4). Secure with crankcase through bolt attaching parts.

b. Install Woodruff key (7), gear hub (12), spring (11), driven gear assembly (9, 10), washer (8) and nut (6). 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 (5).

c. Install new gasket (13) on flange of alternator.

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

8-16. MAGNETO AND ACCESSORY DRIVE ADAPTERS (See Figure 4-5).

a. Place two new gaskets on two upper four stud mount pads at the rear of the crankcase so that oil holes in gaskets are aligned with crankcase oil outlet holes.

b. Install two adapter assemblies with oil holes aligned with crankcase oil outlet holes. Attach both with plain washers, lockwashers and nuts.

8-17. OIL COOLER -TYPICAL OF SANDCAST CRANKCASE (See Figure 4-11).

a. Install new gasket (11) on crankcase studs. Install oil cooler end plate (9) on crankcase. Secure with five sets of attaching parts (6, 7, 8).

b. Install new gasket (5) and oil cooler (4) on oil cooler end plate. Secure with twelve sets of attaching parts (1,2, 3).

8-18. OIL COOLER -TYPICAL ON PERMOLD CRANKCASE (See Figure 4-12).

a. Install baffle support assembly (15) on crankcase through bolts.

b. Install gaskets (10, IO-520-C) or (9 and 11, IO-520-B). Mount oil cooler on mounting legs (IO-520-C) or crankcase (IO-520-B). Secure with attaching parts (1 through 6).

c. Install oil temperature control valve (12).

8-19. VALVE MECHANISM (See Figure 4-20 and Figure 2-6).

a. Turn engine upside down.

b. Lubricate exterior surface of each tappet just prior to installation. Apply oil to socket, but not into body oil holes. Install all tappets.

c. 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) has entered cylinder hole. Release spring slowly until it is free and remove compressor.

d. Install six pushrod housings nearest to engine mount brackets first, since compressor must lie close to horizontal in order to clear crankcase flange.

e. Before installing valve-actuating parts on each cylinder, turn crankshaft until cam lobes for that pair of tappets are pointed to the opposite side of the engine.

f. Install lubricated pushrods (13) and seat them in tappet sockets. Install proper rocker assembly (9, 10, 11), thrust washers (12) and insert rocker shaft (8). Install rocker shaft retaining screw (6) and washer (7) and secure with safety wire.

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).

8-20. OIL SUMP -STAMPED ALUMINUM SHEET METAL (See Figure 4-9).

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. '

c. Install gasket (16) on suction tube (17). Insert threaded end of tube through crankcase and oil pump. Install new gasket (16) and nut (15) on protruding, threaded end of suction tube. Install washer (14) and screw (13). Secure screw to brace with lockwire. Tighten nut to torque specified in Table of Limits, Section VI (IO-520-C).

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

e. Lay sump on crankcase and install attaching parts (3, 4, 5).

8-21. OIL SUMP -CAST ALUMINUM (See Figure 4-10).

a. Install gasket (15) on suction tube assembly (16). Insert threaded end of tube through crankcase and oil pump. Install new gasket (15) and acorn nut (14) on protruding, threaded end of suction tube. Secure suction tube to crankcase with screw (13) 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 (12) and position it on crankcase.

c. Lay sump (10) on crankcase, and install attaching parts (7, 8, 9).

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

8-22. INDUCTION SYSTEM, IO-520-A, B, C, F, J, K, L (See Figure 4-6).

a. Push a new hose (15) on either end of center intake tubes. Slide one hose clamp (14) 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 of 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 (16,17,18). Position clamp on two center hoses on each side inside tube beads and tighten.

f. For IO-520-B engines push rear hose on No.1 and No.2 intake tubes back onto tube until clear of ends. Position hose (4) on rear manifold assembly. Slide clamp assembly (2) over hose. Install air throttle body assembly and control assembly on bottom of sump and secure with bolt and washer (17, 18, Figure 4-2).

Slide other end of hose (4) onto air throttle body, and other end of No.1 and No.2 intake tube hoses onto rear manifold assembly. Position clamps and tighten.

g. For IO-520-A, C, F, J, K and L push hose clamp on both elbows (5, 6) and push elbows into connecting hoses of rear intake tubes. Position clamps and tighten only enough to hold tubes.

h. Install clamp (11) and bracket (10) on balance tube (13). Push tube ends into connecting hoses installed on front intake tubes. Position clamp and secure to sump with attaching parts (8, 9). Position clamp assemblies (12) over tube beads and tighten.

i. While engine is inverted, secure brackets (38) to sump with corner sump bolts and washers (23, 24). Place bracket (63) between free ends of brackets (38) and align holes. Attach all three with screw (27), washer (26) and nut (25). Turn engine upright.

j. Secure IO-52O-A, F, J, K and L support bracket (37) to upper magneto drive adapter studs and idler gear support studs with attaching parts (33, 34, 35). Assemble IO-520-C support brackets (48 through 55). Secure bracket (51) to lower magneto drive adapter studs and bracket (48) to right and tachometer drive housing.

k. Position air throttle assembly on bracket (36) and secure with attaching parts (28,29, 30). Place hose clamp over each hose (3) on elbows (5, 6) and work hoses onto throttle body position and tighten clamp. Secure IO-520-A, F, J, K and L support bracket to air throttle body with attaching parts (31, 32). Secure IO-520-C support bracket (48) and (51) as illustrated.

8-23. INDUCTION SYSTEM, IO-520-D (See Figure 4-7).

a. Push a new hose (2) on either end of center intake tubes. Slide one hose clamp (11) to a position midway on overlapping portion. Turn each clamp so that a screwdriver can be aligned with its screw and yet clear of the stand when tube is installed. Tighten screw only enough to hold clamp in position.

b. Place a hose clamp (11) on each end of cylinder intake tubes so it faces center tube. Push end tubes into hoses 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 (1) on overlapping portion behind tube bead. Tighten these clamps.

d. Lay a new gasket (17) 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 (12, 13, 14). Position clamp on two center hoses on each side inside tube beads and tighten.

f. Push hose clamp on elbows (3, 4) and push elbows into connecting hoses of rear intake tubes. Position clamps and tighten only enough to hold tubes.

g. Install clamp (8) and bracket (7) on balance tube (10). Push tube ends into connecting hoses installed on front intake tubes. Position clamp, and secure to sump with attaching parts (5, 6). Position clamp assemblies (9) over tube beads and tighten.

h. While engine is inverted, position air throttle body (19) with hoses (2) and brackets (1) in relative position.

Position hoses (2) over beads and secure with clamps(1).

8-24. INDUCTION SYSTEM, IO-520-E (See Figure 4-8).

a. Push a new hose (2) on either end of center intake tubes. Slide one hose clamp (11) to a point midway on overlapping portion. Turn each clamp so that a screwdriver can be aligned with its screw and yet clear of the stand when tube is installed. Tighten only enough to hold clamp in position.

b. Place a hose clamp (11) on each end of cylinder intake tubes so it faces center tube. Push end tubes into hoses 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 (2) on each front intake tube, and hose (2A) on each rear intake tube and install a clamp (1) on the overlapping portion behind the tube bead of the rear intake tube. Tighten these clamps.

d. Lay a new gasket (17) 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 (12, 13, 14). Position clamp on two center hoses on each side tube beads and tighten.

f. Push hose clamp on elbows (3, 4) and push elbows into connecting hoses of rear intake tubes. Position clamps and tighten only enough to hold tubes.

g. Install clamp (8) and bracket (7) on balance tube (10). Push tube ends into connecting hoses installed on front intake tubes. Position bracket and secure to sump with attaching parts (5,6). Position clamp assembly (9) over tube beads and tighten. Turn engine upright.

h. Secure support bracket (35) to upper magneto drive adapter studs and oil pump cover and secure with attaching parts (31, 32).

i. Position air throttle assembly on bracket (25) and secure with attaching parts (23, 24). Place hose clamp (1) over each hose (2A) and work hoses onto throttle body. Position and tighten clamps. Secure support bracket (35) to throttle body with attaching parts (28, 20, 11) and sleeve (27) and grommet (26). Attach bracket (33, 34) to throttle body with attaching parts (18, 19). Insert sleeve (37) and bushings (36) in support bracket (35). Secure support bracket to throttle body with bolt (30), and nut (29).

8-25. FUEL INJECTION SYSTEM, IO-520-A (See Figure 4-1).

a. Attach shroud assembly (49) to fuel pump and vapor separator (44) with speed nuts (47), screws (46) and spring (45).

b. Connect fuel hoses from fuel supply to fuel pump, from fuel pump to fuel control metering unit and fuel return line from fuel control metering unit to fuel pump; also, fuel supply line from fuel control metering unit to fuel manifold valve.

8-26. MAGNETO DRIVE GEARS (See Figure 4-5).

a. With engine in upright position, insert one pressed steel retainer (22) into each gear hub slot.

b. Cover each of four new rubber bushings with a film of Gredag No. 44 and insert two bushings (21) into each retainer, rounded long edges first.

c. Turn the crankshaft to the No.1 cylinder advance firing angle as described in the following paragraph. Lubricate each magneto drive gear shaft and teeth (20) and insert into bushings (15). Observe the shaft ends from the rear as they are carefully pushed through the adapter oil seals to make sure the seal lips are not reversed or damaged. Mesh the magneto drive gears to the idler gear to the approximate position shown in Figure 8-14. These positions will vary slightly due to differences in magnetos and gears.

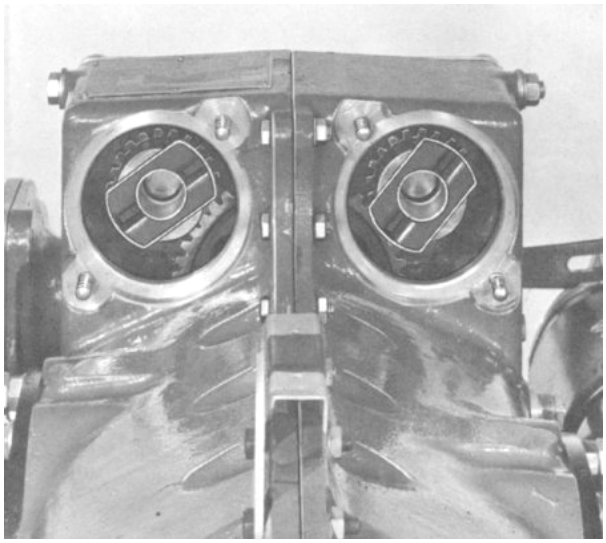


FIGURE 8-14. POSITION OF MAGNETO COUPLINGS.

8-27. PLACING CRANKSHAFT IN TIMING POSITION TYPICAL OF SANDCAST CRANKCASE.

a. Cover the lower spark plug hole with the thumb and turn crankshaft clockwise until pressure is felt on thumb. The timing marks on the crankshaft flange are now turning towards the bottom parting line of the crankcase halves.

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

8-28. PLACING CRANKSHAFT IN TIMING POSITION TYPICAL OF PERMOLD CRANK CASE.

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

b. Remove plug (66, Figure 4-22) in front of No.6 cylinder and observe the timing mark on the alternator drive gear as the crankshaft is rotated slowly. When the mark on the gear is centered in the viewing hole, No.1 piston is at the 22° BTC position.

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

d. Place a new gasket on magneto flange and in- stall magneto carefully so drive coupling lugs mate with slots of drive bushings. Install holding washers, lock washers 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 the ground terminal of each magneto. Both timing lights should be on. Tap the right magneto up with a non-marring hammer until that light goes out. Tap the left magneto down until the light goes out. Secure magnetos.

f. Turn the crankshaft a few degrees counterclockwise and bring it back again until the timing marks are aligned. At this point 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 outlined in step "f" above.

8-30. IGNITION HARNESS.

a. The high tension cable outlet plates can be attached to either magneto in only one position. The very 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. Lay lower spark plug cables from each magneto across the brace on crankcase top flange in two layers of three cables each. Install clamp and its attaching parts.

d. Install a clamp on each ignition cable and position fuel discharge tube bracket over cables on right cylinder bank.

e. Snap retaining clamp of cable 1R into top hole in rear leg of bracket. Following this, starting from the rear, snap 1L into first hole, 3R into 3rd hole, 3L into fourth hole, 5R into sixth hole and 5L into front leg of bracket. Position bracket so that its centerline is 6-3/4 inches from edge of No. 1R ferrule and 20-3/4 inches from edge of No. 5L ferrule. Position second bracket over cables on left cylinder bank. Snap retaining clamp of No. 2L cable into bottom and 2R into top hole in rear leg of bracket. Starting from the rear, snap cable 4R into second hole, 4L into fourth hole, 6R into sixth hole and 6L into hole in front leg of bracket.

Position bracket so that its centerline is 21-1/4 inches from edge of No. 2R ferrule and 7-1/2 inches from edge of No.6 ferrule.

f. Install all spark plugs not already in place with smooth copper gaskets. Tighten all plugs to torque specified in Table of Limits, Section VI.

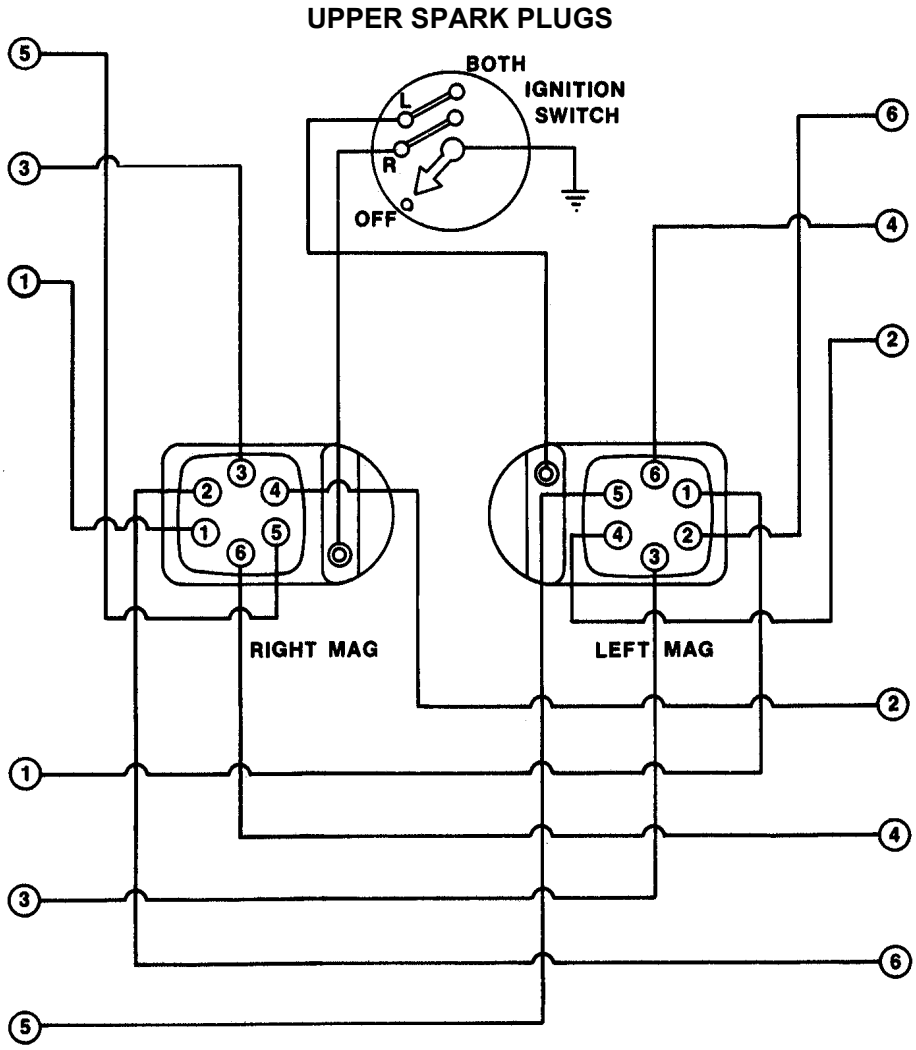
g. Insert cable terminal sleeves into the proper plugs and screw on the elbow coupling nuts only enough to keep the elbows from turning. Keep the lower spark plug cables above the intake manifold and inside the intake elbows.

h. Check service bulletins occasionally issued by ignition harness manufacturers regarding tips for increased service life.

8-31. FUEL LINES.

a. Make sure that all nozzles have been installed and properly tightened. 1

b. Snap fuel discharge tube retaining clamp of No.1 cylinder into second hole from rear, No.3 cylinder tube clamp fifth hole and No.5 cylinder tube clamp into seventh hole. On opposite side of engine snap No.2 cylinder tube clamp into first hole, No.4 tube clamp into third hole and No.6 tube clamp into fifth hole. After tubes have been clamped to brackets, connect them to their respective fittings in manifold valve.



ENGINE FIRING ORDER	1	6	3	2	5	4
MAGNETO FIRING ORDER	1	2	3	4	5	6

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.

8-34. TEST STAND. After each major overhaul, engine performance should be tested and new parts run-in while the engine is mounted on a rigid test stand, preferably enclosed in cell of such design that recirculating air is held to a minimum. The engine stand should be constructed in such a way as to permit accessibility to all engine line and instrument connections and to permit frequent inspection of all points of possible leakage. All tubes, wires, rods and cables used to connect instruments and controls should be well supported, yet of sufficient flexibility to permit them to be moved out of the way during installation and removal of the engine.

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.

8-35. TEST EQUIPMENT.

8-36. 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 Co., 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 XVI for model on test, when used in the cell, stand and engine combination for which it was calibrated.

8-37. COOLING AIR SCOOP. In warm climates it will probably 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 cylinder and to all valve rocker covers, in order to direct an adequate flow of air downward through the cylinder fins. Vanes may be found necessary to direct a portion of the cooling air to the center cylinder and/or the oil cooler, therefore, the temperatures of all cylinder heads should be measured until uniformity within 50° F. has been obtained between coolest and hottest cylinder. It is advisable to provide a duct from the cylinder scoop to the generator or alternator vent tube or to provide a separate scoop for it.

8-38. INDUCTION AIR INTAKE. An air filter and housing should be attached to the air throttle body inlet flange. The filter area must be sufficient to avoid restriction of air flow. Always clean filter 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 dirt accumulation.

8-39. EXHAUST STACKS. For testing purposes the exhaust back pressure should be zero. Short stacks may be made locally to match the cylinder port diameter and the flange stud dimensions shown in applicable installation drawings. (See Figure 8-16.)

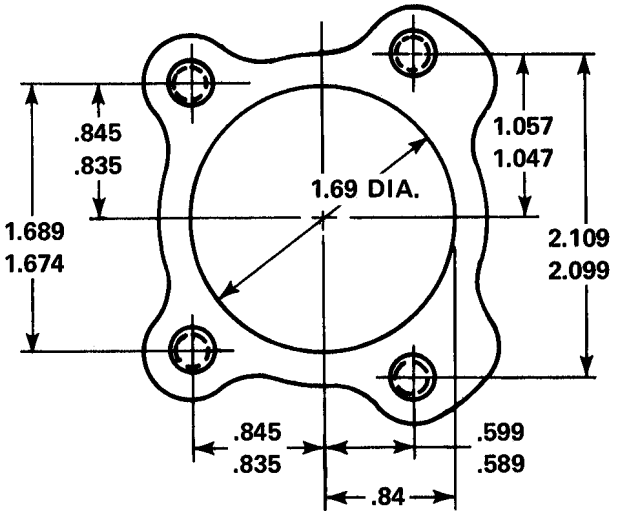


FIGURE 8-16. EXHAUST FLANGE DIMENSIONS.

8-40. CONTROLS. The only controls required are a mixture control and throttle control capable of operating the fuel control and metering shafts through their complete ranges, and a standard twin magneto switch connected to the magneto ground 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 starter solenoid coil terminal to a 5 ampere pushbutton switch. The other switch terminal must be connected to the engine or both to 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 is required.

b. An oil pressure gauge and tube connection.

c. An oil temperature gauge and capillary assembly.

d. A cylinder head temperature gauge and wiring. (See test operating limitations for different maximum temperatures.)

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.

8-43. BREATHER. A substantial hose of 3/4 inch ID should be securely clamped over crankcase breather elbow and support so as to lead to a point above and to the rear of engine.

8-44. FUEL SYSTEM. The test stand fuel system is to incorporate an auxiliary pump capable of delivering fuel to and through engine system at a pressure of 2 to 2-1/2 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.

8-45. 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 propeller governor is installed.

8-46. ENGINE TEST AFTER OVERHAUL.

a. After a partial or complete disassembly and repair of a 285 HP engine, the engine will be tested in accordance with Table XVII.

b. Run the 300 HP engine according to the schedule in Table XVIII after a major overhaul.

c. Extend the second period of each test schedule, if necessary, to raise the oil temperature to 100^{o} F.

NOTE

It tests must be conducted in extremely t 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 XVII or XVIII. 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 allow- able oil temperature (Table XVI) must not be exceeded at any time during the test.

8-47. 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 2.5-3.0 psi nozzle pressure is obtained; then release boost pump button and press starter button.

NOTE

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

8-48. 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). Refer to Service Bulletin M84-10.

TABLE XVI. TEST OPERATING LIMITS

FEATURE	IO-520-A	IO-520-B, BA & C	IO-520-D, F, K & L	IO-520-J	IO-520-E
Maximum takeoff power	285 @ 2700	285 @ 2700	300 @ 2700	285 @ 2700	300 @ 2700
Maximum continuous power	285 @ 2700	285 @ 2700	285 @ 2700	285 @ 2700	285 @ 2700
Full throttle speed (RPM)	2700-2750	2700-2750	2850-2900	2700-2750	2850-2900
Idling speed (RPM)	575-625	575-625	575-625	575-625	575-625
Fuel grade (Octane)	100LL/100	100LL/100	100LL/100	100LL/100	100LL/100
Fuel consumption at full throttle (Lbs./Hr.	139/147	139/147	143/153	139/147	143/153
Fuel pump pressure at full throttle (psi)	29.2-30.8	28.0-31.0	29.0-32.5	29.2-30.8	29.0-32.5
Fuel pump pressure at idle (psi)	9.0-11.0	9.0-11.0	9.0-11.0	9.0-11.0	9.0-11.0
Metered fuel pressure at full throttle (psi)	16.5-17.5	15.6-16.5	17.5-18.7	16.5-17.5	17.5-18.7
Metered fuel pressure at idle (psi)	3.5-4.0	2.0-2.5	3.5-4.0	3.5-4.0	3.5-4.0
Engine intake air temperature	Ambient	Ambient	Ambient	Ambient	Ambient
Engine intake air pressure (Max.) (In. H2O)	1.0	1.0	1.0	1.0	1.0
Manifold pressure at full throttle (In. Hg)	28.75	28.75	28.75	28.75	28.75
Manifold pressure at idle (I n. Hg)	18.5 Max.	18.5 Max.	18.5 Max.	18.5 Max.	18.5 Max.
Oil Grade Above 40° F.	SAE 50	SAE 50	SAE 50	SAE 50	SAE 50
Below 40° F.	SAE 30 or 10W30	SAE 30 or 10W30	SAE 30 or 10W30	SAE 30 or 10W30	SAE 30 or 10W30
Oil consumption at max. continuous power (Lbs./Hr.)	3	3	3	3	3
Oil temperature (desired range)	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.
Oil pressure at full throttle (psi max.) (oil temperature 175-185°F.)	30-60	30-60	30-60	30-60	30-60
Oil pressure at idle (psi min.) (oil temperature 140-150°F.)	10	10	10	10	10
Ignition timing Left Magneto (BTC)	22°	22°	22°	22°	22°
(±1°) Right Magneto (BTC)	22°	22°	22°	22°	22°
Magneto drop at 2100 RPM (Max.) (RPM)	150	150	150	150	150
Magneto Spread	50	50	50	50	50
Cylinder head temperature (Max.) with bayonet thermocouple	460°F.	460°F.	460°F.	460°F.	460°F.
*Crankcase pressure (Max.) (In. H2O)	4.0	4.0	4.0	4.0	4.0

TABLE XVII. STANDARD ACCEPTANCE TEST FOR IO-520, 285 H.P. ENGINE

PROPELLER STAND

Note: Engine oil pressure must be supplied to propeller transfer collar during all testing.

Period	Time – Minutes	RPM
1	5	1200
2	5	1600
3	10	2450
4	15	Rated RPM (adjust engine – fuel flow, pr., ect.,) (Reduce RPM for adjustments).
5	10	Engine Parameter checks (fuel inj., Oil pr., temp. etc., - see applicable data) 2100 mag check (3.(b)).
6	10	2450
7	5	Idle RPM (cooling period - 300° max.

60 Total Minutes

Inspect engine and apply corrosion prevention treatment in accordance with TCM Service Bulletin M74-9.

START OIL CONSUMPTION DETERMINATION

Period	Time – Minutes	RPM
1	5	1200
2	5	1600
3	10	2450
4	15	Rated RPM (adjust engine – fuel flow, pr., ect.,) (Reduce RPM for adjustments).
5	10	Engine Parameter checks (fuel inj., Oil pr., temp. etc., - see applicable data). 2100 mag check (3.(b)).
6	5	Idle RPM (cooling period - 300° Max. C.H.T. before shut-down).
Stop engine, drain oil, weigh oil in for oil consumption determination.		
7	5	Warm up to rated RPM (minimum 1200 RPM).
8	30	2450 (3.(c)).
9	5	600 Idle (cooling period - 300° Max. C.H.T. before shut-down).

80 Total Minutes

Stop engine, drain and weigh oil and record. (3. (d)). Inspect engine and apply corrosion prevention treatment in accordance with TCM Service Bulletin M74-9.

TABLE XVII. STANDARD ACCEPTANCE TEST FOR IO-520, 300 H.P. ENGINE

PROPELLER STAND

Note: Engine oil pressure must be supplied to propeller transfer collar during all testing.

Period	Time – Minutes	RPM
1	5	1200
2	5	1600
3	10	2450
4	15	Rated RPM (adjust engine – fuel flow, pr., ect.,) (Reduce RPM for adjustments).
5	10	Engine Parameter checks (fuel inj., Oil pr., temp. etc., - see applicable data) 2100 mag check (3.(b)).
6	10	2450
7	5	Idle RPM (cooling period - 300° max.

60 Total Minutes

Inspect engine and apply corrosion prevention treatment in accordance with TCM Service Bulletin M74-9.

START OIL CONSUMPTION DETERMINATION

Period	Time – Minutes	RPM
1	5	1200
2	5	1600
3	10	2450
4	15	Rated RPM (adjust engine – fuel flow, pr., ect.,) (Reduce RPM for adjustments).
5	10	Engine Parameter checks (fuel inj., Oil pr., temp. etc., - see applicable data). 2100 mag check (3.(b)).
6	5	Idle RPM (cooling period - 300° Max. C.H.T. before shut-down).
Stop engine, drain oil, weigh oil in for oil consumption determination.		
7	5	Warm up to rated RPM (minimum 1200 RPM).
8	30	2450 (3.(c)).
9	5	600 Idle (cooling period - 300° Max. C.H.T. before shut-down).

80 Total Minutes

Stop engine, drain and weigh oil and record. (3. (d)). Inspect engine and apply corrosion prevention treatment in accordance with TCM Service Bulletin M74-9.

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SECTION IX

IO-520-M

The IO-520-M is similar to the other Permold engines covered in Sections I thru VIII except that the air throttle body is air frame mounted.

The instructions contained in Sections I thru VIII pertaining to the Permold engine design, together with the parts catalog, will provide adequate instructions for the overhaul of the IO-520-M engine.

Those systems which are unique to the IO-52D-M, the Induction System and the Fuel Injection System are covered on the following pages.

9-1. INDUCTION SYSTEM.(See Figure 9-1).

a. Loosen hose clamps (7) or clamp assemblies (8) on hoses (9). Remove attaching parts (4,5,6) and remove elbows (2,3 and 10).

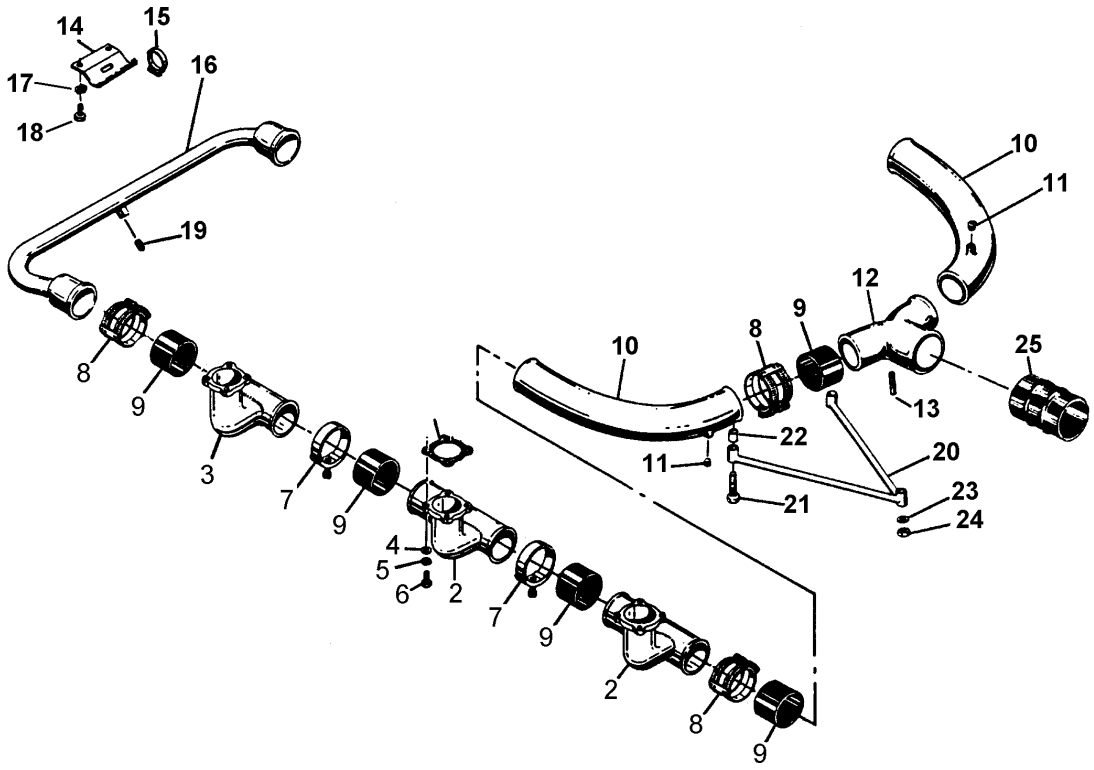

FIGURE 9-1. INDUCTION SYSTEM

1. Gasket, Intake Manifold Flange
2. Tube Assembly, Intake Manifold, Cyl.1 ,2,3,4,5
3. Tube Assembly, Intake Manifold, Cyl.6
4. Washer Plain
5. Washer, Lock
6. Screw, 1/4-20 x 7/8 Inch Long
7. Clamp, Hose
8. Clamp Assembly, Hose
9. Hose, Intake Manifold
10. Tube Elbow
11. Plug, Pipe
12. Riser
13. Stud, 1/4 X 1-1 13/32 Inch Long
14. Bracket, Balance Tube
15. Clamp, Balance Tube to Bracket
16. Tube Assembly, Balance
17. Washer
18. Bolt, 15/16-18 X 1-1/8 Inch Long
19. Plug, Pipe
20. Bracket, Crankcase-to-Riser
21. Screw, 5/1&18 X 2.00 Inch Long
22. Spacer
23. Washer
24. Nut
25. Flexible Duct

b. Remove attaching parts (17,18) Clamp (16) and remove balance tube (16) and bracket (14).

c. Remove attaching parts (21 thru 24) and re move bracket (20). Remove clamp (26) and separate riser (12) and flexible coupling (25).

9-2. INSPECTION.

a. Inspect intake tubes for distortion, cracks and out-of-roundness.

b. Inspect stud in riser for straightness and thread damage. Stud height should be 1.04 inches.

9-3. REASSEMBLY.

a. Push a new hose (9) on either side of center intake tube (2). Slide one hose clamp (7) to a position midway on overlapping portion. Turn each clamp so that a screwdriver can be aligned with its screw 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 of cylinder intake tube (2,3) 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 (9) on each front intake tube (3) and hose (9) on each rear intake tube (10). Locate clamp assemblies (8) so tube beads are inside of clamps and tighten clamps.

d. Lay a new gasket (1) 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. Attach each intake flange to its cylinder with attaching parts 5,6). Position clamp on two center hoses on each side of tube beads and tighten.

e. Push hose clamp assembly (8) on each rear elbow (10) and work hose (9) over bead. Install riser (12) in hoses and position hose clamp assembly so beads are inside of clamps. Tighten clamps.

f. Install bracket (20) on riser stud (13) and secure with attaching parts (23, 24). Secure bracket to sump with spacer (22) and bolt (21).

g. Install clamp (15) and bracket (14) on balance tube (16). Push tube ends into connecting hoses installed on front intake tubes. Position bracket and secure to sump with attaching parts (17, 18). Position clamp assembly (8) over tube beads and tighten.

h. Secure flexible coupling (25) to riser with clamp (26).

9-4 FUEL INJECTION SYSTEM (See Figure 9-2).

a. Instructions relative to the removal, inspection, repair, replacement and reassembly of the fuel injection system is the same as those in Sections 1 thru 8 with the exception that the air throttle body and control assembly and connecting hoses are to be installed after the engine is installed in the airframe.

b. If it is necessary to replace fittings, they are to be oriented according to figures 9-3, 9-4 and 9-5.

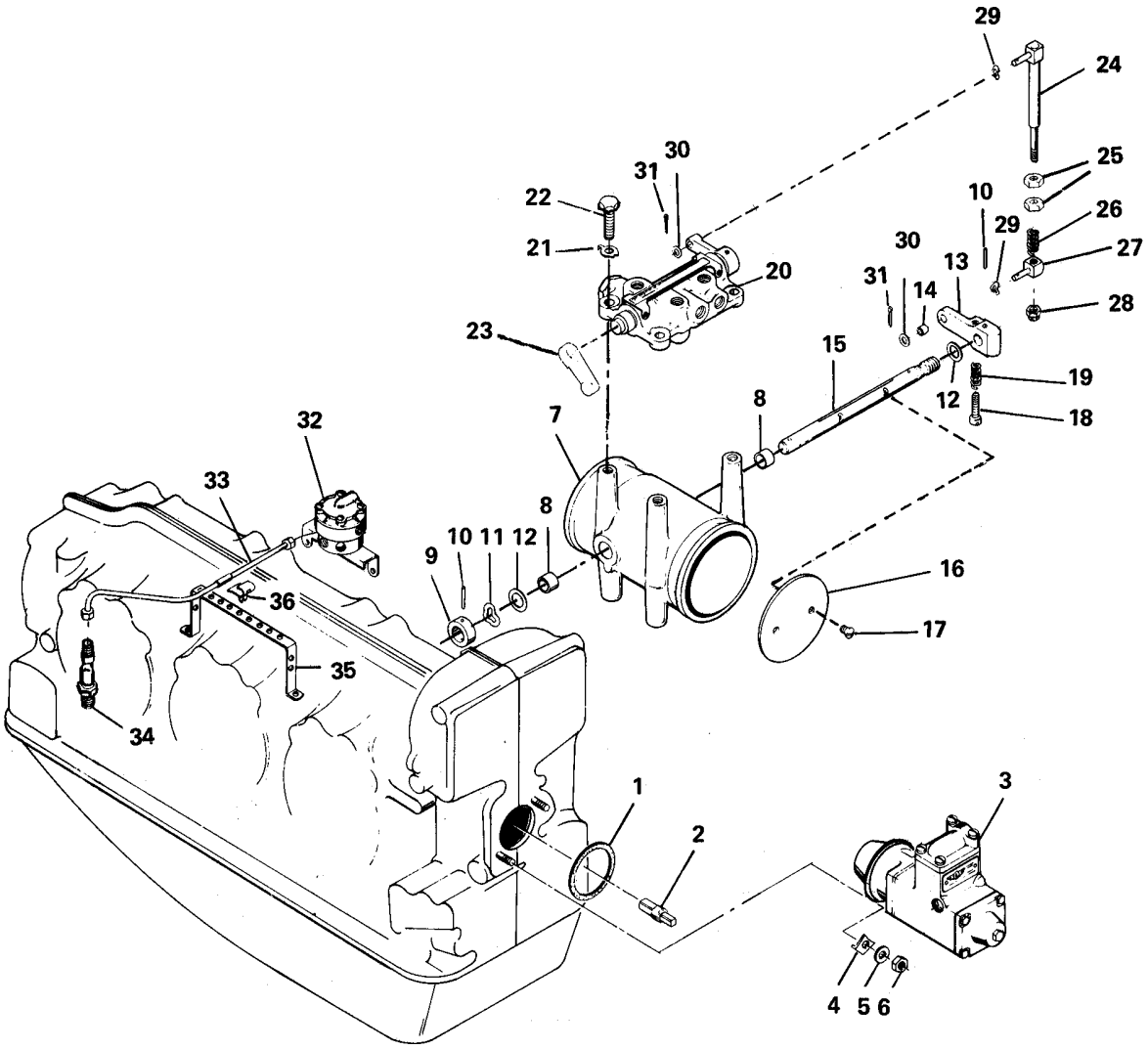

FIGURE 9-2. FUEL INJECTION SYSTEM.

1. Gasket, Fuel Pump to Crankcase
2. Coupling
3. Fuel Pump
4. Washer, Holding
5. Washer, Lock
6. Nut
7. Throttle Assembly
8. Bushing
9. Collar
10. Pin
11. Washer, Wave
12. Washer, Plain
13. Lever Assembly
14. Bushing
15. Shaft, Throttle Plate
16. Plate, Throttle
17. Screw
18. Screw, Adjusting
19. Spring
20. Control Assembly
21. Washer Tab
22. Bolt
23. Lever
24. Rod Assembly
25. Nut
26. Spring
27. Rod End
28. Nut, Self Locking
29. Washer, Wave
30. Washer, Plain
31. Pin, Cotter
32. Fuel Manifold Valve Assembly
33. Tube Assembly
34. Nozzle Assembly
35. Bracket, Fuel Discharge Tube
36. Clamp, Tube-to-Bracket

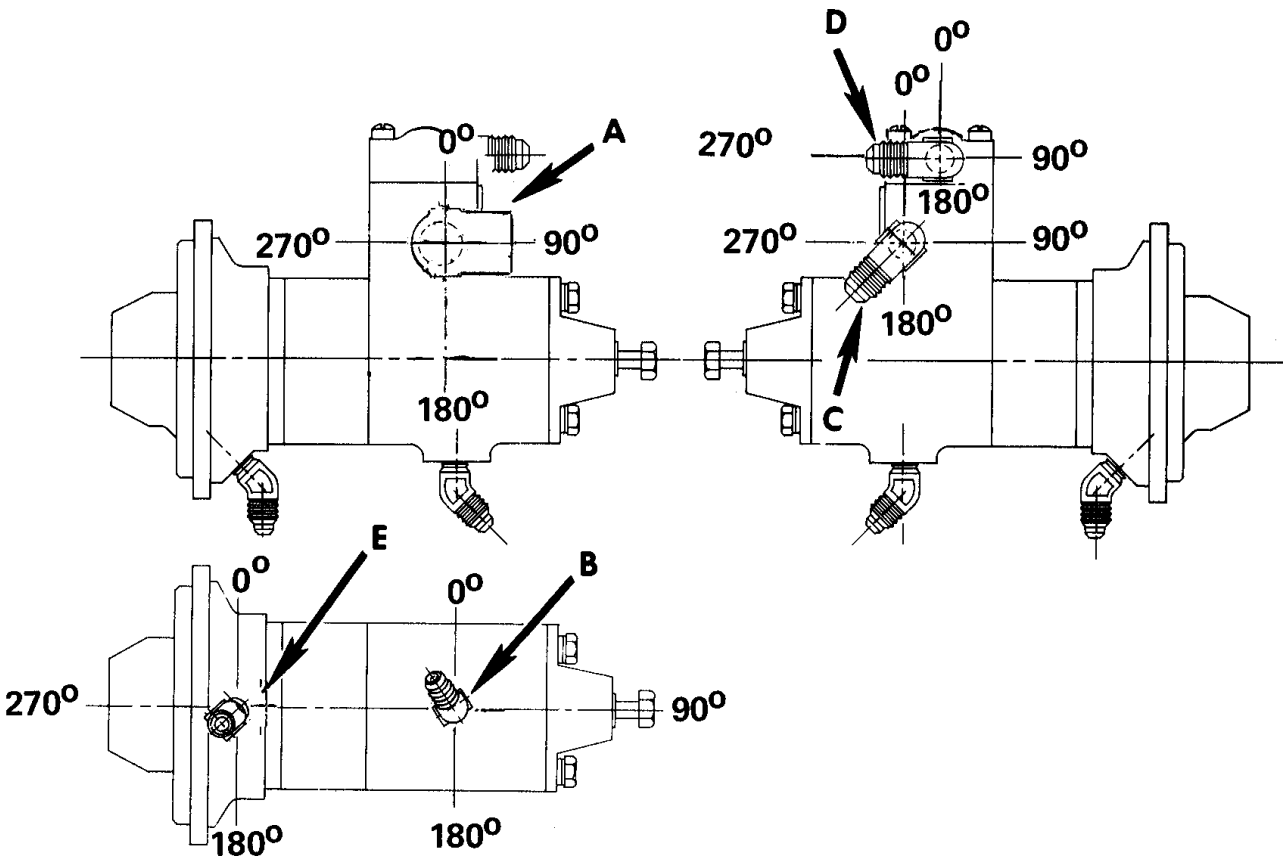

FIGURE 9-3. FUEL PUMP AND VAPOR SEPARATOR FITTING LOCATIONS

	A	B	C	D	E
	INLET AND ANGLE°	OUTLET AND ANGLE°	MIXTURE RETURN AND ANGLE°	VAPOR RETURN AND ANGLE°	DRAIN AND ANGLE°
IO-520-M	90° ELBOW 90° 45° ELBOW 270°	90° ELBOW 310°	45° ELBOW 250°	90° ELBOW 270°	45° ELBOW 240°

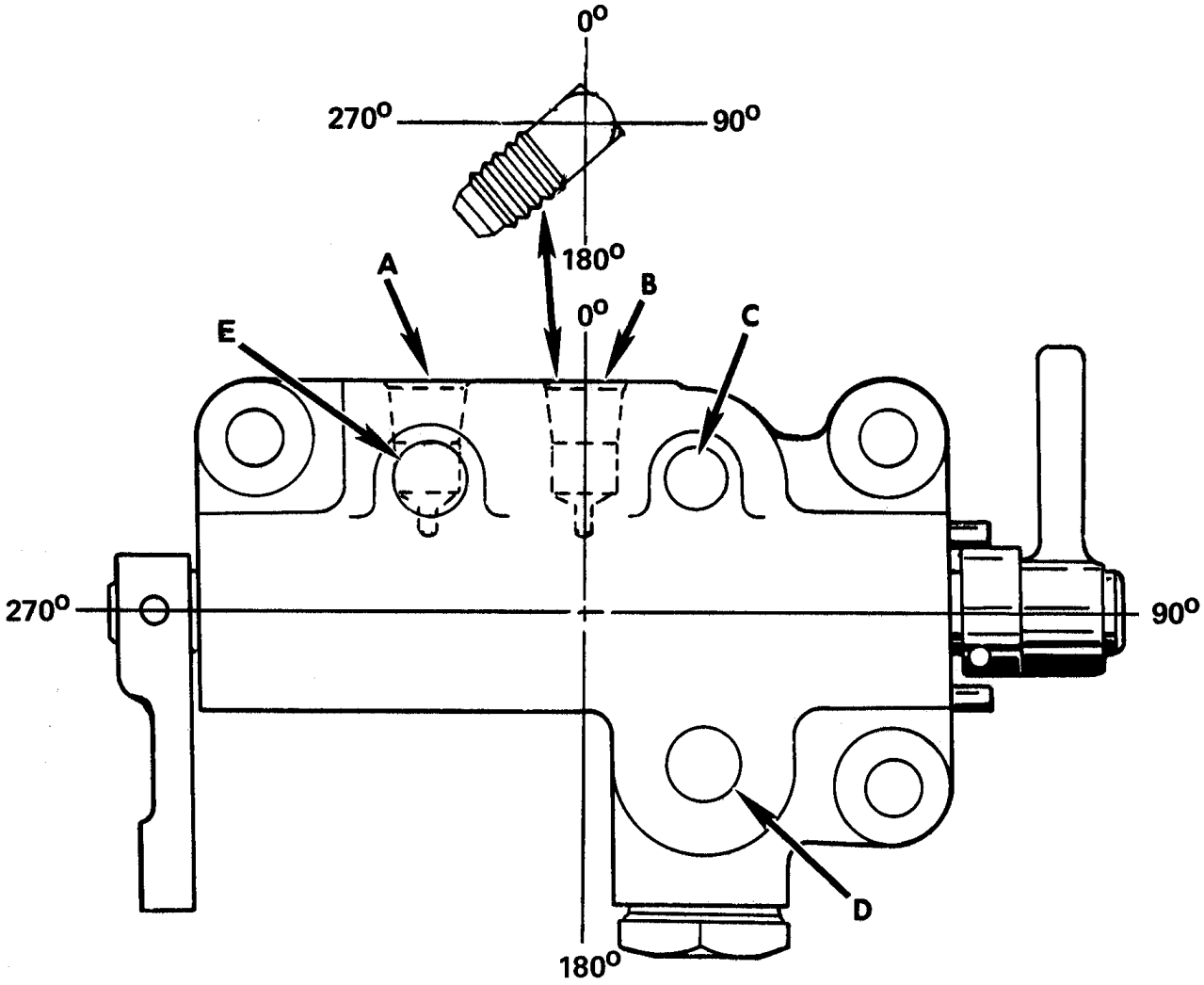

FIGURE 9-4. FUEL CONTROL VALVE FITTING LOCATIONS

	A	B	C	D	E
	TO MANIFOLD VALVE	FUEL RETURN TO TANK	PRESSURE TAP	FUEL INLET	TO MANIFOLD VALVE
IO-520-M	PLUG	90° ELBOW 240°	90° ELBOW 235°	90° ELBOW 150°	90° ELBOW 260°

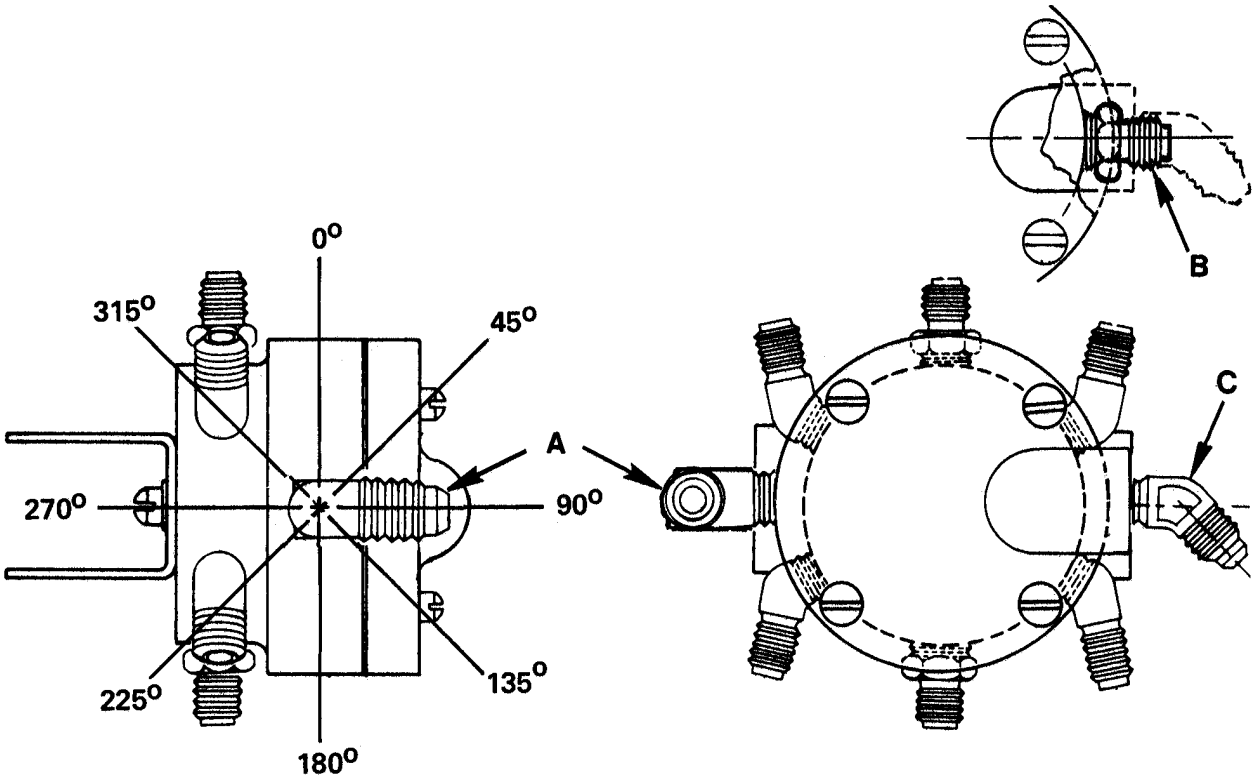

FIGURE 9-5. FUEL MANIFOLD VALVE FITTING LOCATIONS

ENGINE MODEL	FITTING "A" NUMBER	FITTING "B" NUMBER	FITTING "C" NUMBER
IO-520-M	90° ELBOW 90°	NIPPLE 0°	45° ELBOW 270°

TABLE XIX. TEST OPERATING LIMITS

FEATURE	IO-520-M
Maximum takeoff power	285
Maximum continuous power	285
Full throttle speed (RPM)	2700-2750
Idling speed (RPM)	575-625
Fuel grade (Octane)	100LL/100
Fuel consumption at full throttle (Lbs./Hr.	139-147
Fuel pump pressure at full throttle (psi)	29.5-33.5
Fuel pump pressure at idle (psi)	6.0-7.0
Metered fuel pressure at full throttle (psi)	17.6-19.2
Metered fuel pressure at idle (psi)	3.5-4.0
Engine intake air temperature	Ambient
Engine intake air pressure (Max.) (In. H2O)	1.0
Manifold pressure at full throttle (In. Hg)	28.75
Manifold pressure at idle (I n. Hg)	18.5 Max.
Oil Grade Above 40° F.	SAE 50
Below 40° F.	SAE 30 or 10W30
Oil consumption at max. continuous power (Lbs./Hr.)	3
Oil temperature (desired range)	150-200° F.
Oil temperature (Max.)	240°F.
Oil pressure at full throttle (psi max.) (oil temperature 175-185°F.)	30-60
Oil pressure at idle (psi min.) (oil temperature 140-150°F.)	10
Ignition timing Left Magneto (BTC)	22°
(±1°) Right Magneto (BTC)	22°
Magneto drop at 2100 RPM (Max.) (RPM)	150
Magneto Spread	50
Cylinder head temperature (Max.) with bayonet thermocouple	460°F.
*Crankcase pressure (Max.) (In. H2O)	4.0

TABLE XX. STANDARD ACCEPTANCE TEST

PROPELLER STAND

Note: Engine oil pressure must be supplied to propeller transfer collar during all testing.

Period	Time – Minutes	RPM
1	5	1200
2	5	1600
3	10	2450
4	15	Rated RPM (adjust engine – fuel flow, pr., ect.,) (Reduce RPM for adjustments).
5	10	Engine Parameter checks (fuel inj., Oil pr., temp. etc., - see applicable data) 2100 mag check (3.(b)).
6	10	2450
7	5	Idle RPM (cooling period - 300° max.

60 Total Minutes

Inspect engine and apply corrosion prevention treatment in accordance with TCM Service Bulletin M74-9.

START OIL CONSUMPTION DETERMINATION

Period	Time – Minutes	RPM
1	5	1200
2	5	1600
3	10	2450
4	15	Rated RPM (adjust engine – fuel flow, pr., ect.,) (Reduce RPM for adjustments).
5	10	Engine Parameter checks (fuel inj., Oil pr., temp. etc., - see applicable data). 2100 mag check (3.(b)).
6	5	Idle RPM (cooling period - 300° Max. C.H.T. before shut-down).
Stop engine, drain oil, weigh oil in for oil consumption determination.		
7	5	Warm up to rated RPM (minimum 1200 RPM).
8	30	2450 (3.(c)).
9	5	600 Idle (cooling period - 300° Max. C.H.T. before shut-down).

80 Total Minutes

Stop engine, drain and weigh oil and record. (3. (d)). Inspect engine and apply corrosion prevention treatment in accordance with TCM Service Bulletin M74-9.

SECTION X

IO-520-BB,CB,MB

10-1 INTRODUCTION

A. Information contained herein applies to the modified crankshaft version of the Permold IO-520 engines (IO-520 BB, CB, MB). Only those instructions which are different from the standard models (IO-520 B, BA, C, M) will be covered.

B. For overhaul instructions not contained in these pages, use the instructions contained in sections 1 thru 9 for the standard versions.

10-2 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.

10-3 TABLE OF LIMITS

A. Except for the differences in the crankshaft section of the Table of Limits, all procedures listed in sections 1 thru 9 for the standard Perm old engines apply to the modified crankshaft version.

B. Use the values in Table 21 instead of Table 12, reference items 44 thru 59, for the modified crankshaft engines -

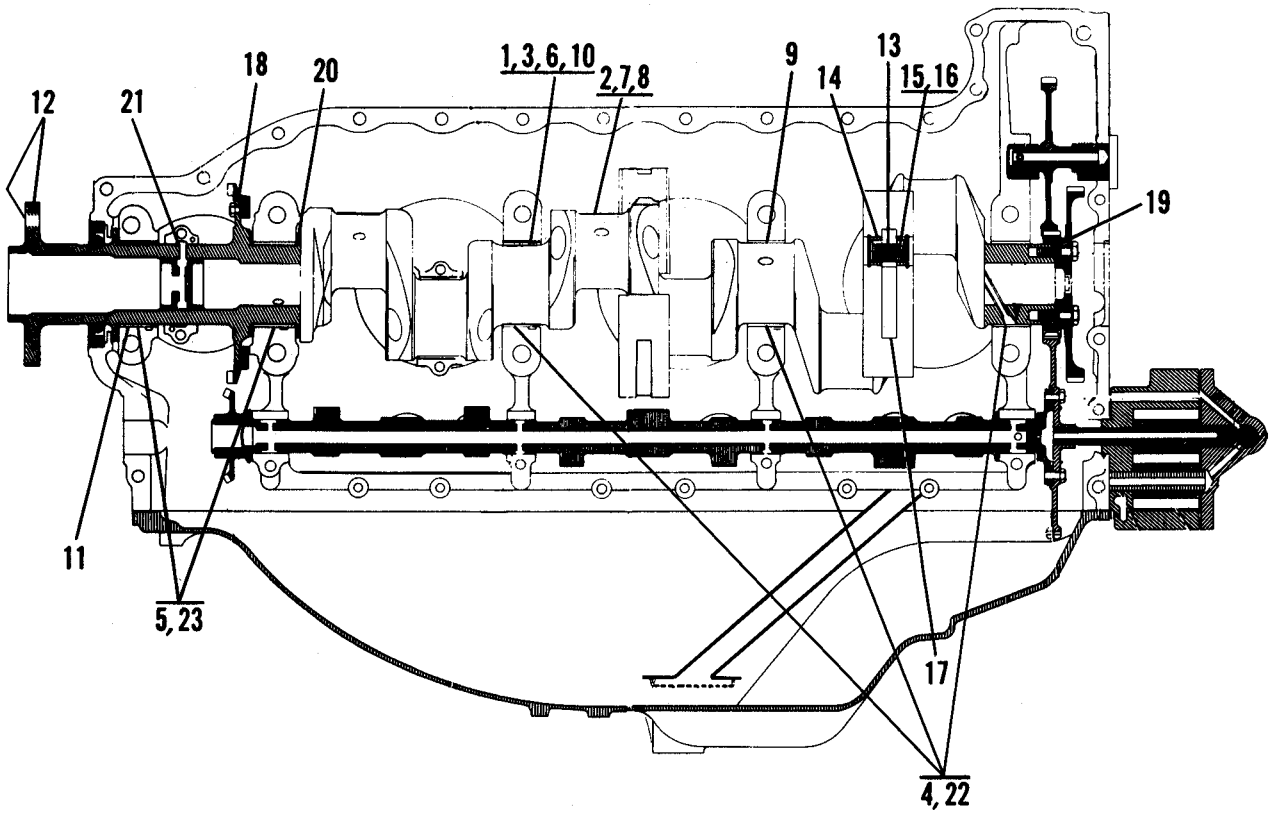

FIGURE 10-1 TABLE OF LIMITS CHART

TABLE XXI

(SEE FIGURE 10-1)

		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 Collar 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

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