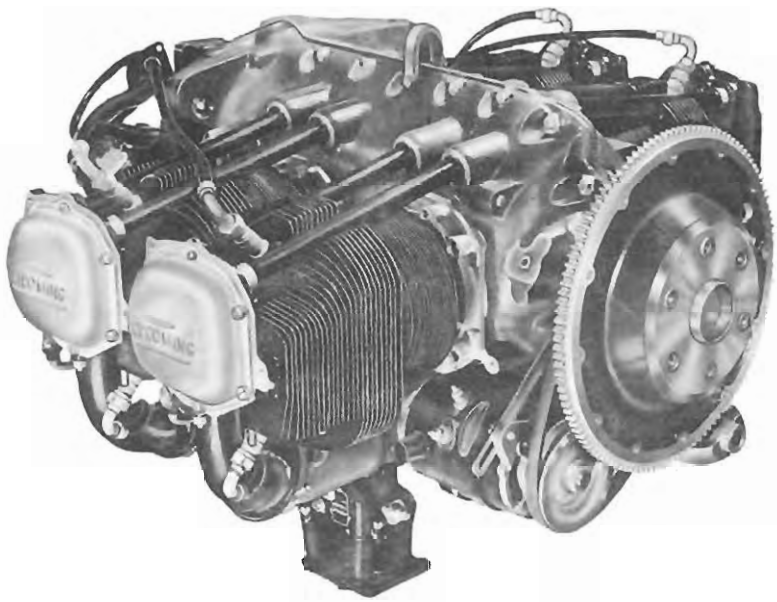
OVERHAUL MANUAL

LYCOMING

Models O-320 & O-340 Series Aircraft Engines



AVCO MANUFACTURING CORPORATION

LYCOMING

Division — AVCO MANUFACTURING CORPORATION

WILLIAMSPORT, PENNSYLVANIA, U. S. A.

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LYCOMING
Division—AVCO Manufacturing Corporation

WARRANTY

LYCOMING DIVISION — AVCO Manufacturing Corporation warrants each new engine to be free from defects in material and workmanship, when properly installed and used under normal conditions, for ninety days after the shipment of each engine from the plant or one hundred hours of operation, which ever event takes place sooner. This warranty is limited to replacing or repairing at its shops any part or parts which have been returned to LYCOMING DIVISION — AVCO Manufacturing Corporation, with transportation charges prepaid and which, in its opinion, are defective, and LYCOMING shall have no responsibility for any consequential damages. This warranty is expressly in lieu of all other warranties and representations, expressed or implied, and all other obligations or liabilities on the part of LYCOMING DIVISION — AVCO Manufacturing Corporation.

This warranty does not cover any labor charges for replacement of parts, adjustments, repairs or any other work done on LYCOMING engines.

This warranty shall not apply to any engine which shall have been repaired or altered outside of our factory in any way so as in our judgment to affect its operation, or which has been subject to misuse, negligence or accident, or which shall have been operated at a speed exceeding the manufacturer's rated speed.

This warranty shall not apply to any engine which shall have been operated with any other than fuel, oil and other lubricants conforming to specifications of LYCOMING DIVISION — AVCO Manufacturing Corporation.

LYCOMING DIVISION — AVCO Manufacturing Corporation, reserves the right at any time to revise, modify or change the construction of LYCOMING engines without incurring any obligation to incorporate such alterations to engines previously sold.

LYCOMING DIVISION — AVCO Manufacturing Corporation, makes no warranty with respect to ignition appartus, carburetors, generators, starters, voltage regulators or other trade accessories, inasmuch as they are usually warranted specially by their respective manufacturers, and all such items are sold "as is."

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Figure 1 - Left Side View

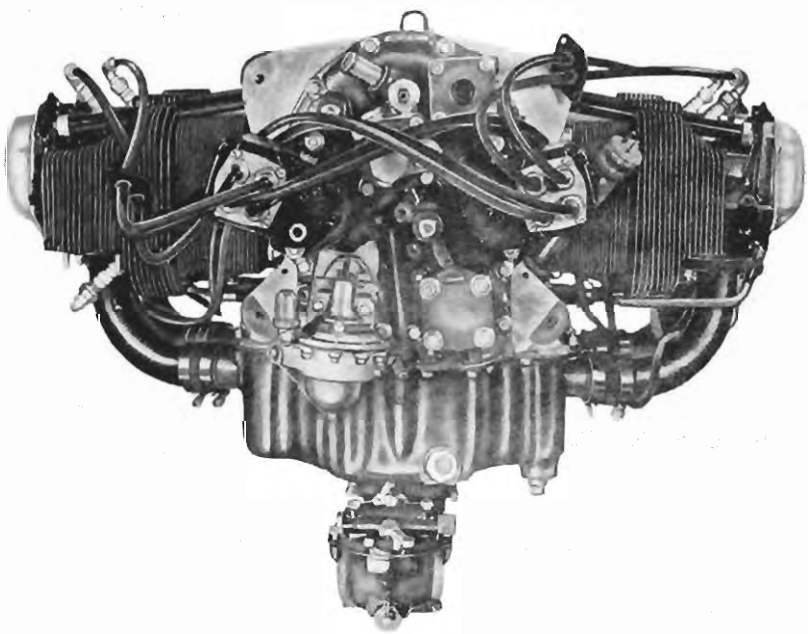


Figure 2 - Rear View

SECTION I

INTRODUCTION

This publication comprises the Overhaul Instructions for the O-320 and O-340 Series aircraft engines, manufactured by Lycoming Division — AVCO Manufacturing Corporation, Williamsport, Pennsylvania.

Frequent reference is made to the Table of Limits, Section XI. This table shall be regarded as an indispensable guide throughout the operations which involve measurement or the use of gages.

In this Overhaul Manual, the term "front" of the engine shall refer to the propeller end of the engine and the term "rear" shall refer to the accessory housing end of the engine. The terms "right" and "left" shall apply as viewed by the observer facing the rear of the engine. The oil sump area is considered the lower section of the engine. When reference is made to individual cylinders or pistons, the section nearest the crankshaft will be referred to as the lower section, and the area most remote from the crankshaft or nearest the rocker box cover will be considered as the upper section.

The right front cylinder is No. 1 and the cylinders on the right side carry odd numbers. The left front cylinder is No. 2 and the cylinders on the left side carry even numbers. (See figure 3.)

The direction of rotation of the crankshaft is clockwise as viewed from the rear of the engine.

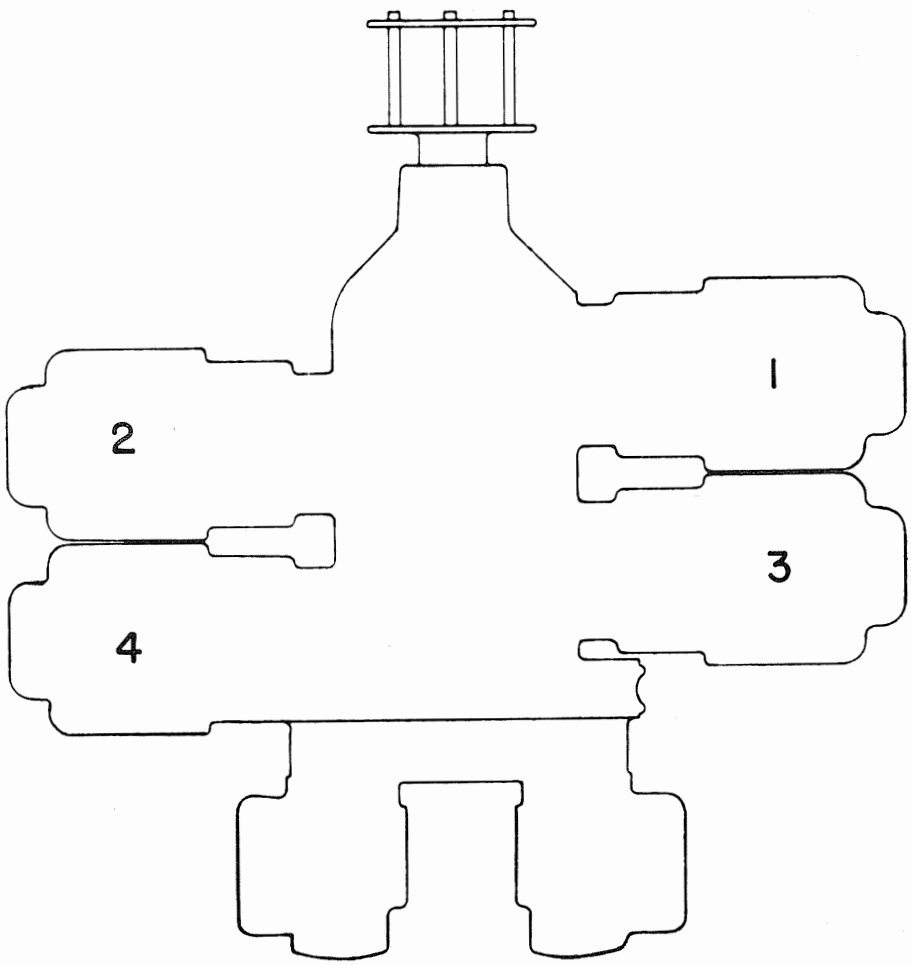


Figure 3 - Cylinder Numbering Diagram

SECTION II

DESCRIPTION

GENERAL - The Lycoming O-320 and O-340 aircraft engines are direct drive, four cylinder, horizontally opposed, air-cooled models with a piston bore of 5.125 inches. The O-320 engine has a stroke of 3.875 inches with a piston displacement of 319.8 cubic inches. The O-340 engine has a stroke of 4.125 inches with a piston displacement of 340.4 cubic inches. The cylinders are not directly opposite from each other but are staggered, thus permitting a separate throw on the crankshaft for each connecting rod.

CYLINDERS - The cylinders are of conventional air-cooled design with the two major parts, head and barrel screwed and shrunk together. The heads are made from an aluminum alloy casting with a fully machined combustion chamber. The cylinder barrel which is machined from a chrome nickel molybdenum steel forging with deep integral cooling fins, is ground and honed to a specified finish.

NOTE

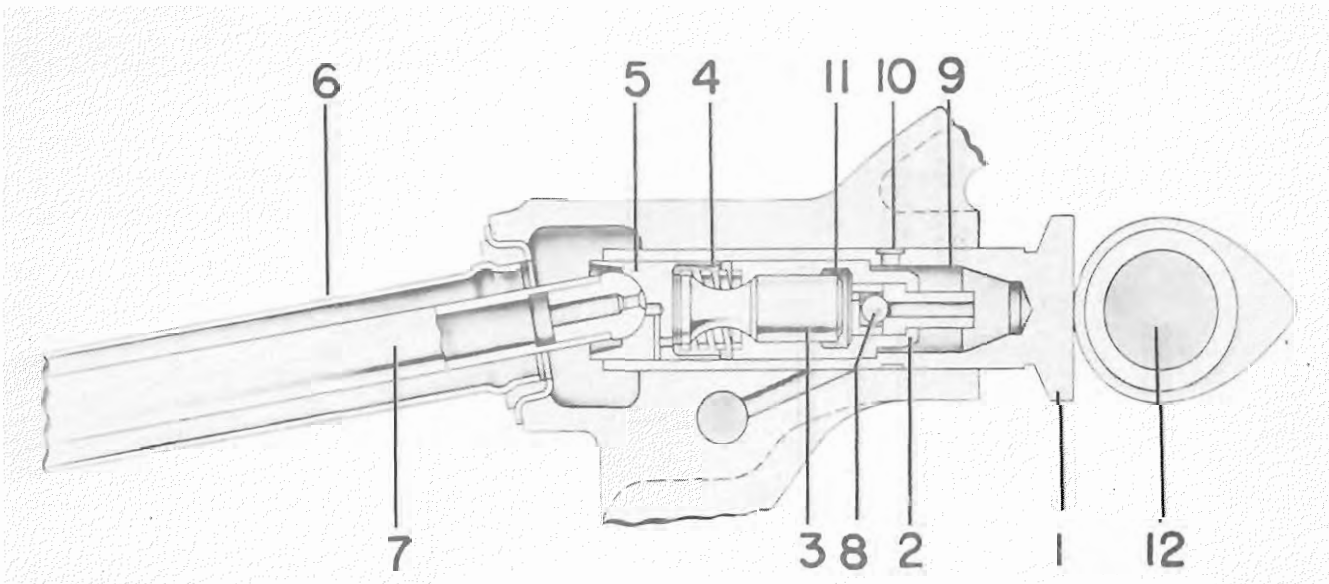
Standard O-320 and O-340 series aircraft engines are furnished with unplated cylinder barrels and chrome plated piston rings. O-320 engines manufactured with optional chrome plated barrels require unplated piston rings.

WARNING

Do not under any circumstances assemble chrome plated piston rings in a chrome plated barrel. Chrome plated cylinders are identified by an orange band around the base of the barrel.

The valve rocker shaft bearing supports and the rocker box housing are cast integrally with the cylinder head. The valves are cooled by means of fins which completely surround the area of the exhaust valve and portions of the intake valve. A sodium cooled rotator type exhaust valve is employed on O-320 engines beginning with serial no. 6012-27 and all O-340 engines. Bronze valve guides and austenitic chrome nickel steel valve seats are shrunk into machined recesses in the head.

VALVE OPERATING MECHANISM - The valve operating mechanism is located on the upper side of the engine, thereby facilitating proper lubrication and accessibility. The camshaft is positioned parallel to and above the crankshaft and operated in aluminum bearings. Hardened and ground cam lobes actuate the valves by means of mushroom type hydraulic tappets which automatically keep the valve clearance at zero, thereby eliminating the necessity of any valve clear-



1. Tappet Body
2. Cylinder
3. Plunger
4. Plunger Spring
5. Push Rod Socket
6. Push Rod Shroud Tube
7. Push Rod
8. Ball Check Valve
9. Oil Supply Chamber
10. Oil Hole
11. Oil Pressure Chamber

Figure 4 - Diagram of Hydraulic Tappet

ance adjustment mechanism. The valve springs bear against both lower and upper spring seats and are retained on the valve stems by means of split keys.

HYDRAULIC VALVE TAPPETS - When the engine valve is closed, the face of the cam follower is on the base circle or back of the cam. The light plunger spring lifts the hydraulic plunger so that its outer end contacts the push rod, exerting a light pressure against it, thus eliminating any clearance in the valve linkage. As the plunger moves outward, the ball check valve moves off its seat. (See figure 4.) Oil from the supply chamber, which is directly connected with the engine lubrication system, flows in and fills the pressure chamber. As the camshaft rotates, the cam pushes the cam follower and the hydraulic lifter cylinder outward. This action forces the ball check valve onto its seat; thus the body of oil trapped in the pressure chamber acts as a solid column. During the interval when the engine valve is off its seat, a predetermined leakage occurs between plunger and cylinder bore which compensates for any expansion or contraction occuring in the valve train. Immediately after the engine valve closes, the amount of oil required to fill the pressure chamber flows in from the supply chamber, thereby preparing for another cycle or operation.

CRANKSHAFT - The crankshaft is a chrome nickel molybdenum steel forging with nitrided bearing surfaces. Centrifugal sludge removers are provided in the form of oil tubes at each crankpin journal. During engine overhaul these tubes should be removed and cleaned.

NOTE

O-320 and O-340 crankshafts are not interchangeable. Crankshafts of either model equipped for constant speed operation are not interchangeable with same model crankshafts equipped for fixed pitch operation unless the plug installed in the rear of the hollow front section of the crankshaft is removed. In addition, two special (short) propeller flange bushings are used on constant-speed installations to accomodate a controllable pitch propeller. (See figure 121, figure 122, O-320 and O-340 Parts Catalog.)

CRANKCASE - The crankcase assembly consists of two reinforced aluminum alloy castings divided vertically at the center line of the engine and fastened together by means of through bolts and nuts. The mating surfaces of the crankcase are joined without the use of a gasket and the main bearing bores are machined for the use of precision type main bearing inserts. Machined mounting pads are incorporated into the crankcase for attaching the cylinders, accessory housing and oil sump (see figure 5.)

NOTE

Crankcase assemblies on engines fitted with Allen head cylinder base nuts are not interchangeable with crankcase assemblies on engines using splined cylinder base nuts; consult O-320 Parts Catalog.

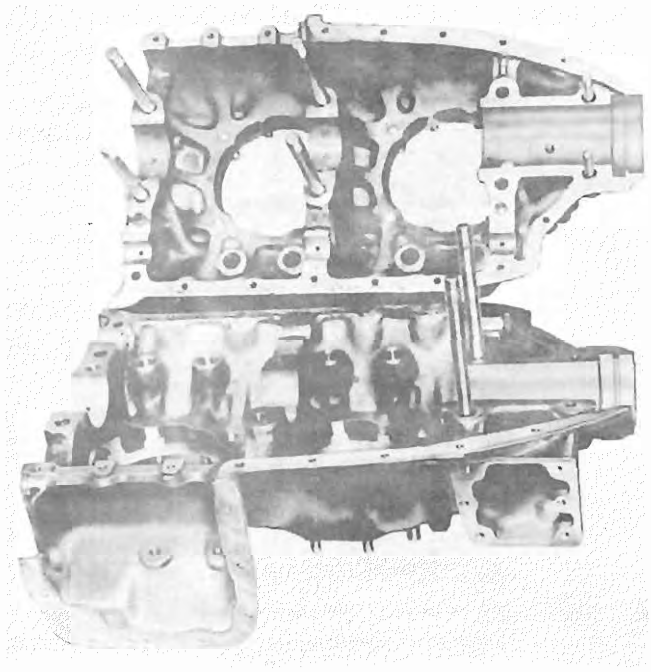


Figure 5 - Right and Left Crankcase Halves Showing Through Bolts and Studs

OIL SUMP - The oil sump, which has a maximum capacity of 8 quarts, incorporates an oil screen filter, carburetor mounting pad, the intake riser, and the intake pipe connections. The fuel air mixture, as it passes through the riser, is vaporized by the heated oil in the sump that surrounds the riser.

CONNECTING RODS - The connection rods are made in the form of "H" sections from alloy steel forgings. They have replaceable bearing inserts in the crankshaft ends and split type bronze bushing in the piston ends. The bearing caps on the crankshaft ends of the rods are retained by means of two bolts through each cap, which are secured by two slotted nuts and cotter pins.

PISTON AND PISTON PIN - The pistons are machined from aluminum alloy and their general construction is of the full skirt type. Grooves are provided for two compression rings and one expander type oil regulating ring. The piston pin is of the full floating type with an aluminum plug located at each end to prevent the pin from touching the cylinder wall.

ACCESSORY HOUSING AND ACCESSORY DRIVE GEAR - The accessory housing is an aluminum alloy casting fastened to the rear of the crankcase assembly and the top rear of the sump by hex head bolts. A gear train (see figure 6) mounted inside the housing, transmits power from the crankshaft to the camshaft, oil pump, magnetos, tachometer drive, and accessories. The gears, which are of the conventional spur type, are precision ground and hardened to insure long life and satisfactory operating qualities. Mounting pads are provided on the rear of the housing for the oil pressure screen chamber, magnetos and accessories. Optional drives available on O-320 and O-340 engines include

vacuum and hydraulic dual drives with or without vacuum pump, and (dual drives) vacuum pump drive and propeller governor drive. Optional drives available on O-340 engines include vacuum pump and drive, vacuum pump drive, and propeller governor drive. Optional drives available on both O-320 and O-340 engines are plunger-operated fuel pump drive, and fuel pump and drive with or without inlet fitting. All engines are supplied with an SAE type tachometer drive as standard equipment.

COOLING SYSTEM - The engine is designed to be cooled by pressure built up by the forward speed of the airplane. Baffles are provided to build up a pressure between the cowling and top of the cylinders, thus forcing the cool air down through the cylinder fins. The air is then exhausted through one or more gills located at the rear of the engine cowling.

LUBRICATION SYSTEM - (See figure 7.) The lubrication system is of the pressure wet sump type. The

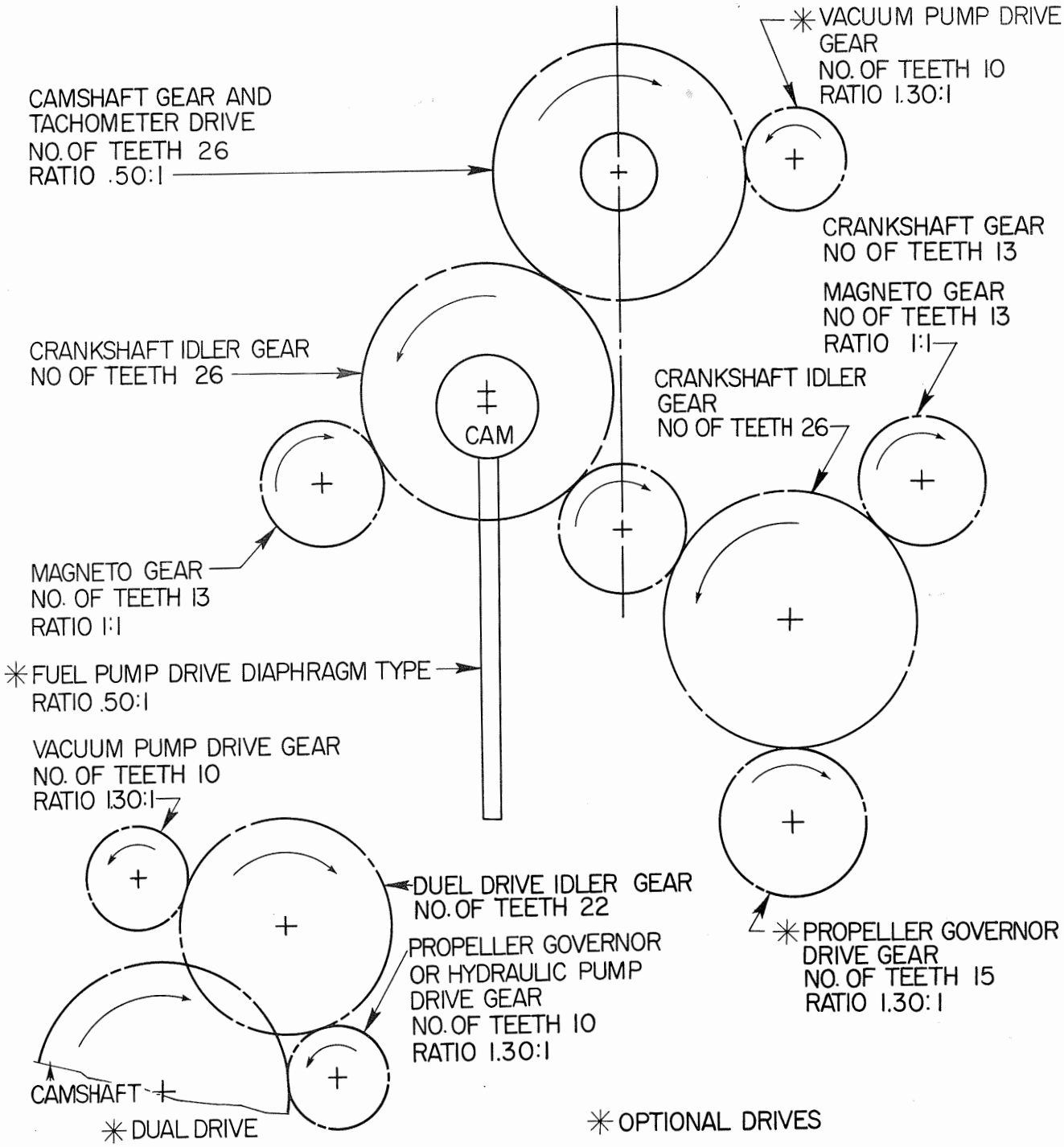


Figure 6 - Gear Train Diagram

main bearings, connecting rod bearings, camshaft bearings, valve tappets, and push rods are lubricated by positive pressure. Piston pins, gears, cylinder walls and other parts are lubricated by means of oil collectors and spray.

The oil pump, which is located in the accessory housing, draws oil through a tube from an oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external full flow oil cooler. (See figure 85.) Pressure oil from the cooler returns to a second threaded connection on the accessory housing, from which point a drilled passage conducts the oil to the oil pressure screen, which is contained in a cast chamber mounted on the accessory housing. An oil cooler by-pass valve is built in the engine to provide direct oil flow from the oil pump when congealed oil, etc., prevents oil from flowing through the oil cooler.

The oil pressure screen is provided to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure screen chamber, the oil is

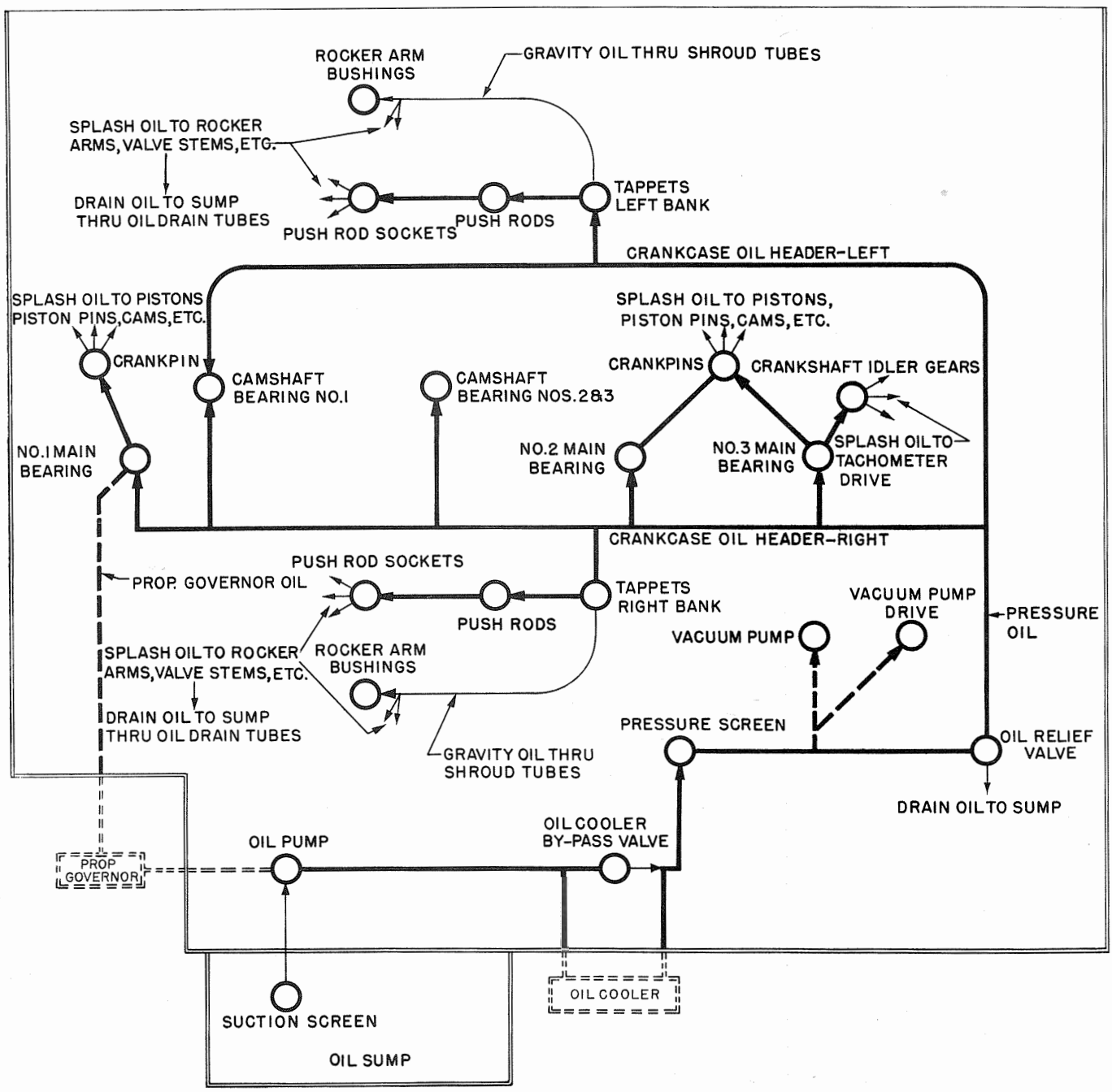


Figure 7 - Lubrication System Diagram

fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing.

This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in each half of the crankcase. During its travel through this main gallery, the oil is distributed by means of separate drilled passages to the main bearings of the crankshaft. Drilled passages are located in such a manner as to form an inertia type filter. Thus, only the cleanest oil will be fed to the bearings. Angular holes are drilled through the main bearings in the crankshaft to the rod journals where sludge removal tubes are located. Here the centrifugal force of the crankshaft removes any sludge or heavy matter that may be present in the oil. Drilled passages from the rear main bearing, supply oil to the crankshaft idler gear shafts. Oil from the main oil gallery also flows to the hydraulic tappets and camshaft bearings. Oil enters the tappets through indexing holes and travels out through the hollow push rods to the valve mechanism, lubricating the valve rocker bearings and valve stems. Residual oil from the bearings, accessory drives, and rocker boxes is returned by gravity to the sump, where after passing through a screen it is again circulated through the engine.

PROPELLER GOVERNOR - The AN20010 propeller governor drive furnished as optional equipment with the O-320 and O-340 engine permits the installation of a constant speed governor and a single acting controllable pitch propeller. High pressure oil is carried from the governor, which is mounted on the accessory housing, to the front of the crankcase by means of an external oil line. The oil then passes into the hollow front section of the crankshaft through indexing holes in the crankcase, front main bearing, and crankshaft.

Provision is also made on O-320 and O-340 engines for the installation of a metal propeller spinner.

INDUCTION SYSTEM - The O-320 engine is provided with a Marvel-Schebler Model MA-4SPA carburetor, and the O-340 with a Marvel-Schebler model MA-4-5. Both carburetors are of the single barrel float type, and are equipped with a manual altitude mixture control and an idle cut-off. Distribution of the fuel air mixture to each cylinder is obtained by the center zone induction system, which is integral with the oil sump and is submerged in oil, insuring a more uniform vaporization of fuel and aiding in cooling the oil in the sump. From the riser the fuel air mixture is distributed to each cylinder by separate steel intake pipes.

IGNITION SYSTEM - The ignition system includes two Scintilla Model S4LN-20 and S4LN-21 magnetos, which are mounted respectively on the upper right and left sides of the accessory drive housing. The left magneto incorporates an impulse coupling. The ignition wiring is so arranged that the left magneto fires the top plugs in the left hand cylinders and the bottom plugs in the right hand cylinders, while the right magneto fires the bottom plugs of the left hand cylinders and the top plugs of the right hand cylinders. This arrangement insures consistent drop-off when switching from both magnetos to either the left or right magneto.

CRANKCASE BREATHER - The centrifugal type crankcase breather (see figure 85) mounted on the upper section of the accessory housing insures trouble-free and positive venting of the crankcase.

SECTION III

OVERHAUL TOOLS

LISTING OF OVERHAUL TOOLS - The overhaul tools listed and illustrated in this section are arranged in four groups as follows: Disassembly Tool, Inspection Tools, Repair and Replacement Tools, and Test Tools. References to the use of these tools occur throughout the handbook; tool numbers mentioned in the text may be identified in this section by referring to the corresponding tool number located in either Table I, Table II, Table III, or Table IV.

TABLE I - DISASSEMBLY TOOLS

FIG. NO.	TOOL NO.		DESCRIPTION
8	218-B		Socket - Spark plug wrench .88 hex
9	1130-B		Compressor - Valve spring
10	64525-2		Block - Cylinder holding
11	64700	(a)	Wrench - Spline nut, .375 cylinder base
12	64701	(a)	Wrench - Spline nut, .500 cylinder base
13	64711	(b)	Handle - Cylinder base nut wrench
14	64717	(c)	Wrench - Hex ID, .500 cylinder base
15	64718	(c)	Wrench - Hex ID, .375 cylinder base
16	64761	(d)	Wrench - Magneto bushing
17	64842		Plate - Engine mounting
18	64843		Puller - Piston pin

(a) Use on O-320 engines. 101-27 to 667-27; 775-27 to 884-27.
(b) Use with 64700, 64701, 64717, and 64718.
(c) Use on O-320 engines; 678-27 to 774-27; 885-27 and up, and all O-340 engines.
(d) Use on Breeze harness for lightweight magnetos (O-320 and O-340 engines).

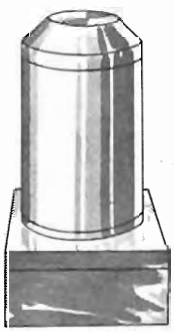
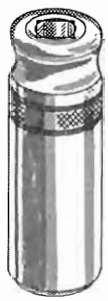


Fig. 10



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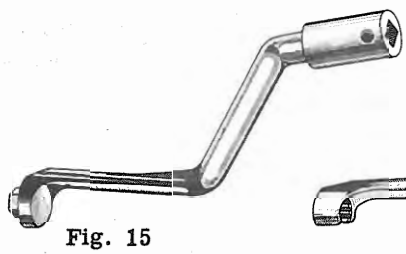


Fig. 15

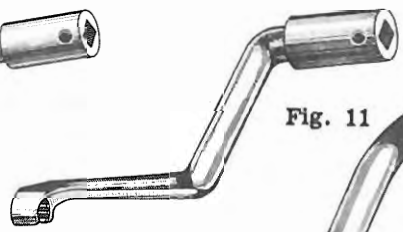


Fig. 11

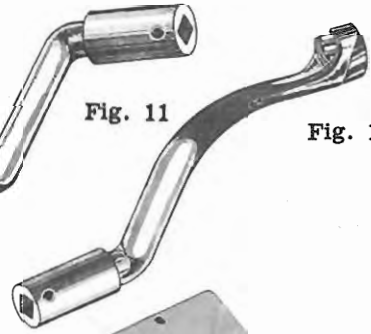
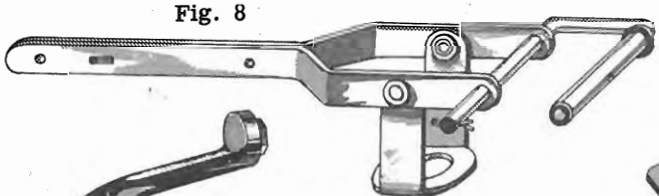


Fig. 12



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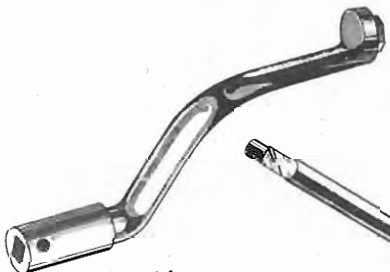

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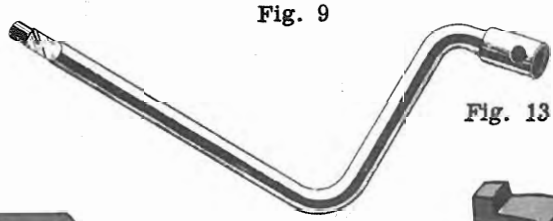


Fig. 13

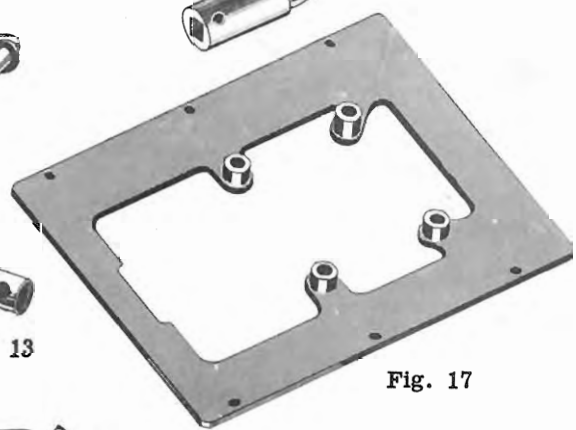


Fig. 17

Fig. 18

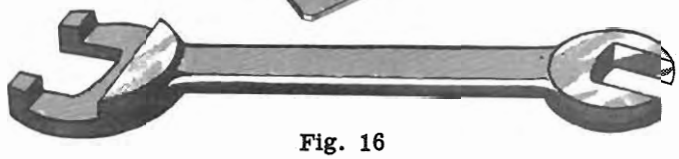


Fig. 16

TABLE II - INSPECTION TOOLS

FIG. NO.	TOOL NO.		DESCRIPTION
19	64507		Gage - Plug, .005 oversize valve guide hole in cylinder head
20	64509		Gage - Plug, .010 oversize valve guide hole in cylinder head
21	64511		Gage - Plug, .020 oversize valve guide hole in cylinder head
22	64514	(a)	Gage - Plug valve guide ID
23	64530		Gage - To check parallelism and squareness of connecting rod bores
24	64537		Gage - Flat plug rejection, connecting rod bushing
25	64545		Block - Vee crankshaft run-out
26	64553		Basket - Valve mechanism parts cleaning
27	64571		Plug gage - Standard valve guide hole in cylinder head
28	64583	(c)	Gage - Flat plug, valve guide replacement
29	64613		Gage - Service rejection, valve rocker shaft bores
30	64724	(d)	Gage - Flat plug rejection, valve guide ID
31	64725	(b)	Gage - Plug, valve guide ID
32	64810		Gage - Plug, rocker shaft bushing hole in cylinder head
33	64811		Gage - Plug, .005 oversize rocker shaft bushing hole in cylinder head
34	64823		Gage - Plug, rocker shaft bushing ID
35	65528		Gage - Valve clearance

(a) Use only on guides for solid stem valves.
(b) Use only on guides for sodium cooled valves.
(c) Use on O-320 engines with solid stem exhaust valves.
(d) Use on all O-340 and O-320 engines with sodium cooled valves.

Fig. 35

Fig. 22, 31

Fig. 24

Fig. 28, 30

Fig. 32, 33, 34

Fig. 29

Fig. 19, 20, 21, 27

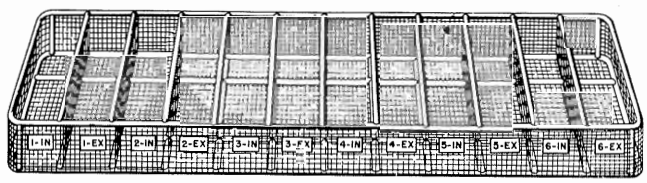


Fig. 26

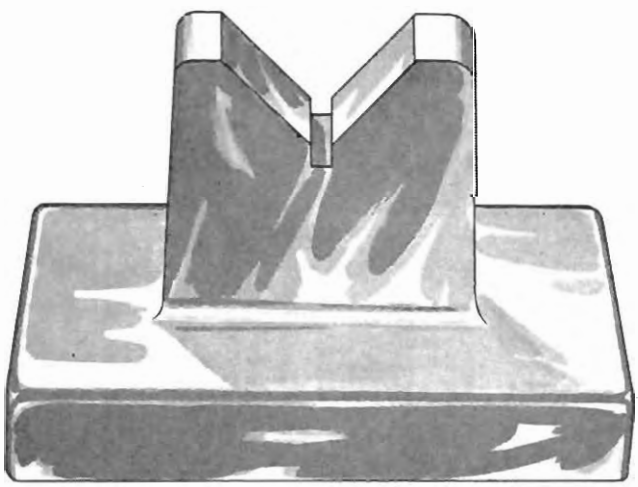


Fig. 25

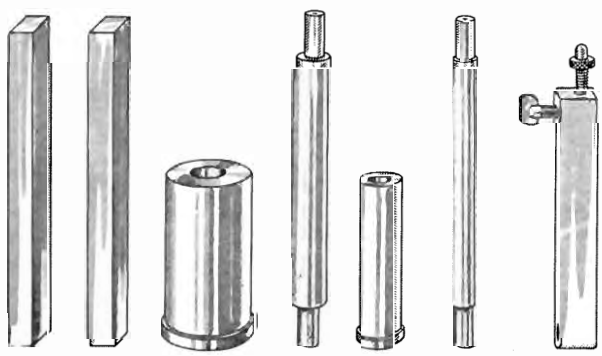


Fig. 23

TABLE III - REPAIR AND REPLACEMENT TOOLS

FIG. NO.	TOOL NO.		DESCRIPTION
36	64505	(a)	Drift - Install valve guides
37	64516-1	(a)	Pilot - Remove valve seats
38	64516-2	(b)	Pilot - Remove valve seats
39	64517		Holder - Counterbore valve seat removal
40	64520		Fixture - Remove valve seats
41	64521		Drift - To replace exhaust valve seats
42	64548		Drift - Remove and replace oil tubes
43	64593		Expanding and staking tool - For Heli-coil spark plug bushing
44	64594		Inserting tool - For Heli-coil spark plug bushing
45	64595		Extracting tool - For Heli-coil spark plug bushing
46	64596		Tap - For Heli-coil spark plug bushing
47	64645		Puller - Remove valve guide
48	64678-2		Reamer - Valve guide hole in cylinder head, .005 oversize
49	64678-3		Reamer - Valve guide hole in cylinder head, .010 oversize
50	64678-4		Reamer - Valve guide hole in cylinder head, .020 oversize
51	64684	(a)	Reamer - Valve guide ID
52	64690		Drive - Oil relief valve sleeve
53	64692		Cutter - To remove 69530 seat from head
54	64694		Cutter - To remove 67904 seat from head
55	64695		Drift - Intake valve seat replacement
56	64697		Pointer - Ignition timing
57	64712		Compressor - Piston ring
58	64713		Expander - Piston ring
59	64714		Fixture - Cylinder holding, valve guide removal
60	64726	(b)	Reamer - Valve guide ID
61	64770		Drift - For installation of 61510 oil seal plug
62	64771		Drill jig - For O-320 crankcase
63	64786		Handle - Cutter, valve seat recess
64	64788-1	(a)	Pilot - Valve seat recess cutter
65	64788-2	(b)	Pilot - Valve seat recess cutter
66	64792-1	(c)	Cutter - Valve seat recess, exhaust (0.010 oversize)
67	64792-2	(c)	Cutter - Valve seat recess, exhaust (0.020 oversize)
68	64792-5	(c)	Cutter - Valve seat recess, exhaust (0.050 oversize)
69	64794-1	(d)	Cutter - Valve seat recess, intake (0.010 oversize)
70	64794-2	(d)	Cutter - Valve seat recess, intake (0.020 oversize)
71	64794-5	(d)	Cutter - Valve seat recess, intake (0.050 oversize)
72	64795-1	(e)	Cutter - Valve seat recess, exhaust (0.010 oversize)
73	64795-2	(e)	Cutter - Valve seat recess, exhaust (0.020 oversize)
74	64795-5	(e)	Cutter - Valve seat recess, exhaust (0.050 oversize)
75	64796	(b)	Drift - Installation, valve guide
76	64814		Drift - Removal, rocker shaft bushing
77	64824		Drift - Installation, outer rocker shaft bushing
78	64825		Drift - Installation, inner rocker shaft bushing
79	64826		Reamer - Finish, inner and outer rocker shaft bushing ID
80	64838		Reamer - Rocker shaft bushing hole in cylinder head, 0.005 oversize
81	64839		Reamer - Rocker shaft bushing hole in cylinder head, 0.010 oversize

(a) Use only on guides for solid stem valves.
(b) Use only on guides for sodium cooled valves.
(c) Use on O-320 exhaust valve seats.
(d) Use on O-320 and O-340 intake valve seats.
(e) Use on O-340 exhaust valve seats.

Fig. 36, 75

Fig. 37, 38

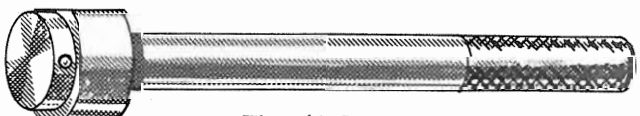


Fig. 41, 55

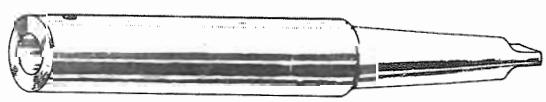


Fig. 39

TABLE III - REPAIR AND REPLACEMENT TOOLS (cont)

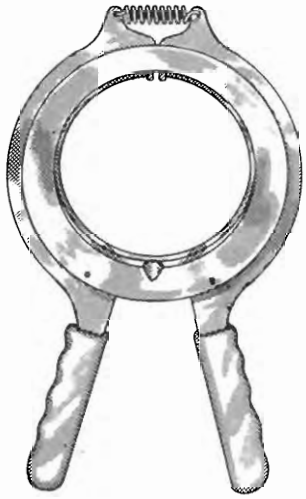


Fig. 58

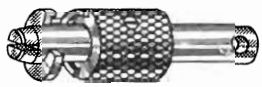


Fig. 44

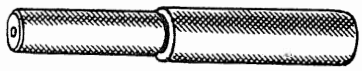


Fig. 64, 65

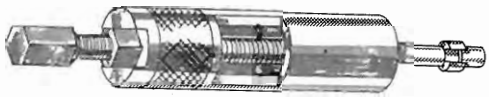


Fig. 47

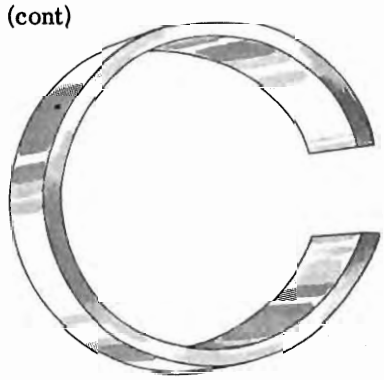


Fig. 57

Fig. 52

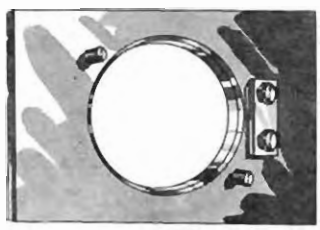


Fig. 59

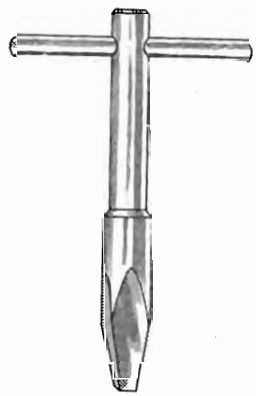


Fig. 45

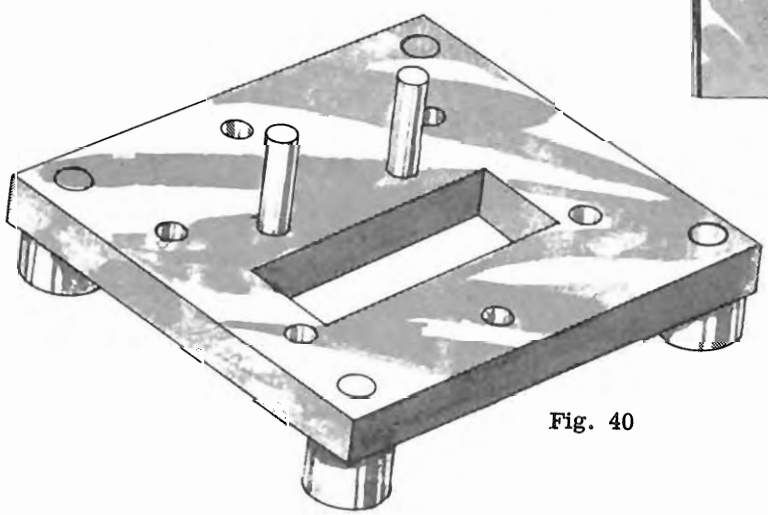


Fig. 40

Fig. 42

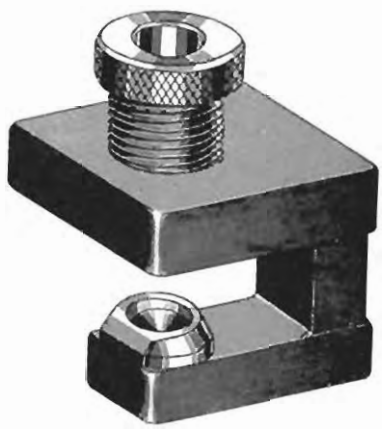


Fig. 62

Fig. 48, 49, 50

Fig. 51, 60

Fig. 43

TABLE III - REPAIR AND REPLACEMENT TOOLS (cont)

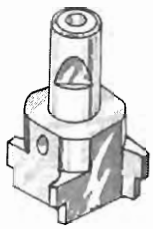


Fig. 53, 54

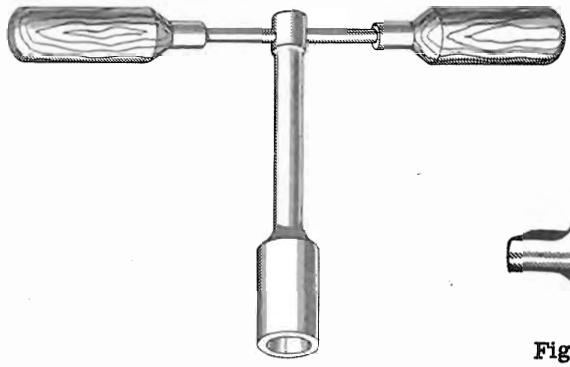


Fig. 63

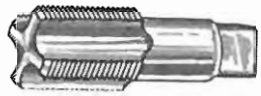


Fig. 46

Fig. 66, 67, 68, 69, 70, 71, 72, 73, 74

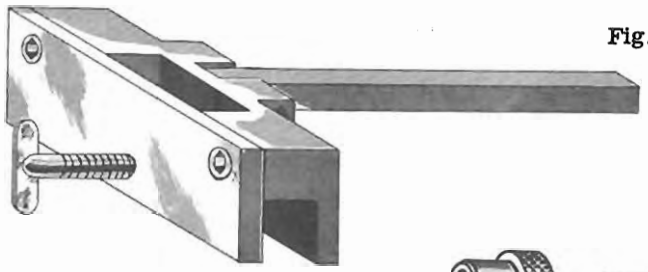


Fig. 56

Fig. 76

Fig. 78

Fig. 77

Fig. 61

Fig. 79

Fig. 80, 81

TABLE IV - TEST TOOLS

FIG. NO.	TOOL NO.	DESCRIPTION
82	64612	Shroud - Cooling, test
83	64801	Club - Test
84	64802	Club - Test

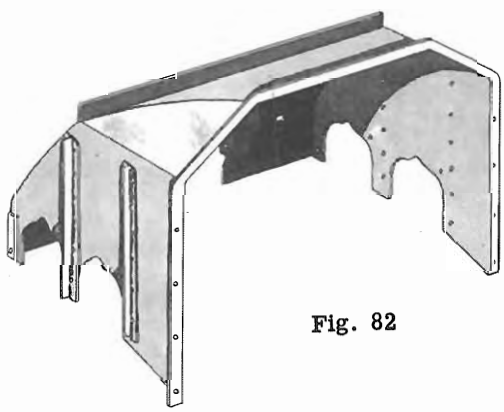


Fig. 82

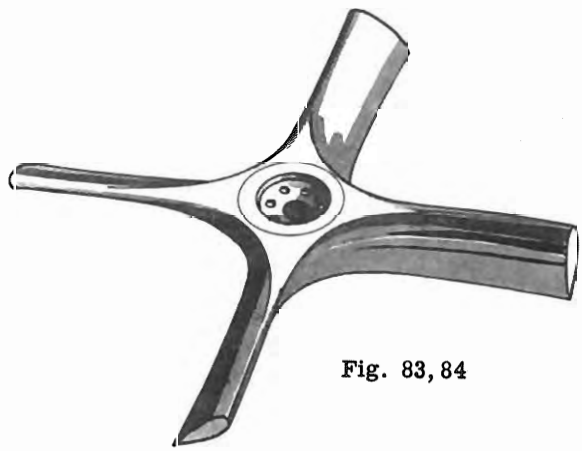


Fig. 83, 84

SECTION IV

DISASSEMBLY OF ENGINE

GENERAL - Just prior to disassembling the engine remove the 1-1/2 inch hex head plug from the bottom of the sump and drain the oil from the engine. Also remove the oil filler cap and measuring stick, which is located on the right side of the engine just behind No. 3 cylinder (see figure 2.)

Secure engine mounting plate (figure 17) to bed of rotating overhaul stand. By means of the engine lifting strap and a suitable chain hoist, remove the engine from the airplane. Attach engine to mounting plate, using four 1/2 inch bolts together with the necessary mounting rubbers and washers. Do not mount engine on the mounting without rubber bushings as the machined surfaces of the mounting lugs are likely to be damaged. The chain hoist may now be removed.

Before beginning the disassembly of the engine, keep in mind that the process should be executed with the utmost of care, and at the same time, in an efficient orderly manner. This means that the engine be disassembled in the same order as given in this Section and Section V following, because some units cannot be removed without first removing other units; also certain parts of the engine are not completely disassembled in this Section, but will be dealt with in Section V. Furthermore, as the units are removed, they should be placed in an orderly manner on a bench where they can be inspected after disassembly (do not clean any disassembled units at this time.) Also, loose studs, cracked cooling fins, etc. should be carefully marked so as not to be overlooked during inspection.

IGNITION CABLES AND SPARK PLUGS - Remove the ignition cable from all spark plugs. Remove the clamps which secure the lower ignition cables to each intake pipe and the clamps from both the right and left sides of the engine near the lower engine mounting lugs; also remove the clamp on the rear of the accessory housing. Clamps which encircle the cables should not be taken off from the cables at this time. Disengage all ignition cables from the engine. Place a suitable covering over the terminal holes in the magnetos to prevent any foreign substance from entering therein, and unscrew the spark plugs from each cylinder with spark plug wrench socket (figure 8) and a suitable handle with a 1/2 inch drive.

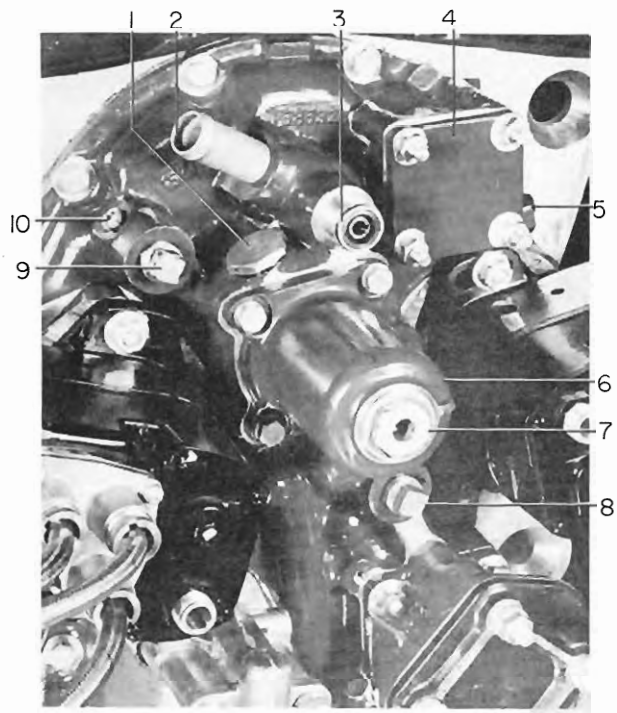
MAGNETOS - Remove the magnetos, impulse coupling adapter, and gaskets from the engine by unscrewing the two 5/16-18 plain nuts and washers from the studs which secure the magnetos to the engine. Do not disassemble the magnetos any further at this time.

OIL PRESSURE SCREEN HOUSING - (See figure 85.) Remove this unit from the engine by unscrewing the four 1/4 inch hex head bolts which secure the housing to the rear of the accessory housing.

REMOVAL OF ACCESSORIES - Detach all accessories, such as fuel pump, vacuum pump, propeller governor, etc., from the accessory housing.

PRIMER LINES - Rotate the overhaul stand so that the engine is in a horizontal inverted position. Remove the priming lines (figure 86), by detaching the clamps on the crankcase and the union nuts holding the priming line to the primer nipples in the cylinders. The primer nipples should not be removed from the cylinders unless they are damaged. The lower spark plugs can be removed now.

GENERATOR - Unfasten the two 5/16 inch hex head bolts which attach the generator to its mounting bracket, but do not remove the bracket which is attached to the crankcase. Unfasten the 5/16 inch hex head bolt which attaches the generator to its adjusting



1. Oil Cooler By-Pass Valve
2. Crankcase Breather
3. Tachometer Drive
4. Vacuum Pump Mounting Pad
5. 1/8" Pipe Plug
6. Oil Pressure Screen Housing
7. Oil Temperature Thermometer Well
8. Oil Connection to Cooler
9. Oil Connection from Cooler
10. 1/8" Pipe Plug

Figure 85 - Location of Oil Pressure Screen Housing

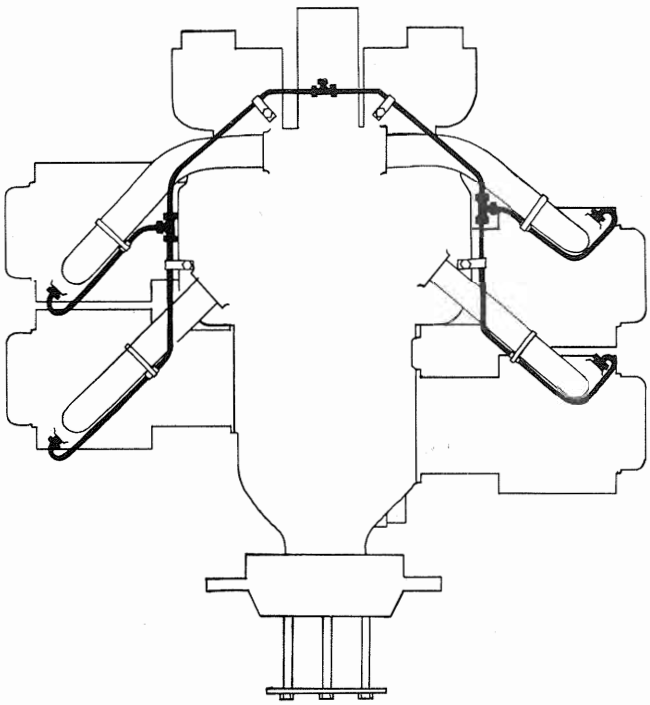


Figure 86 - Primer System

link and remove the generator. The adjust link may now be removed from the crankcase.

PROPELLER GOVERNOR OIL LINE - On engines equipped with propeller governor, remove the external oil line from the governor drive adapter to the right front of the crankcase by unscrewing the threaded fittings at both ends and pulling the line out toward the rear of the engine.

STARTER RING GEAR SUPPORT - The starter ring gear support is located on the crankshaft propeller flange by means of six tapped bushings. Remove the support from the flange by tapping lightly on the rear face of the support with a soft hammer. The generator drive belt should also be disassembled from the engine with this unit.

STARTER ASSEMBLY - The geared starter may be disassembled from the engine by removing the three 5/16 inch plain nuts and 5/16 inch hex head bolt which attach it to the lower left front of the crankcase. When taking the starter from the engine, pull it downward to avoid damage to the two dowels which locate the starter on its mounting.

OIL DRAIN TUBES - Remove all four oil drain tubes from the cylinder heads by unscrewing the gland nuts which fasten them to the elbows in the cylinder heads. They should be identified to correspond with the cylinder from which they are removed, because each tube is different. Loosen the hose clamp nearest the engine before removing the tubes from the nipples in the crankcase.

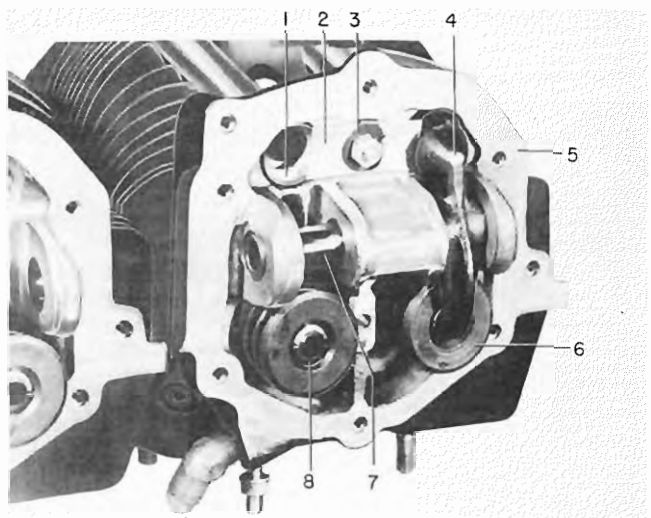
INTAKE PIPES - Remove the 1/4 inch plain nuts from the flanges which attach the intake pipes to the ports on the cylinder heads; then loosen the hose clamps nearest the sump. Following this, remove the intake pipes from the engine. Keep all of the component parts of each intake pipe with each individual pipe; also identify each pipe with its corresponding cylinder number, because only those for number one and number two cylinders are alike.

CYLINDERS - Cylinders may be removed in any sequence desired, but less movement of the crankshaft will be required if the cylinders are removed in the same sequence as the firing order (1-3-2-4). Rotate the crankshaft to place the piston of No. 1 cylinder at top center of the compression stroke. (With the piston in this position, both valves will be closed and the piston extended away from the crankcase to avoid damage when the cylinder is removed). Remove rocker box cover and remove valve rocker shaft, valve rockers, and push rods. The valve rocker shaft is full floating and may be pushed out of cylinder head with finger pressure. If it is not possible to push it out in this manner, the shaft may be driven out by tapping lightly with a fiber drift. Place each valve rocker and push rod in its proper compartment in cleaning basket.

NOTE

The cleaning basket (figure 26), provides individual compartments for keeping the valve operating parts segregated. Parts as they are removed should be placed in their proper compartments as marked on the basket. This applies to valves, valve rockers, push rods, and all parts of the hydraulic tappets.

Release and remove the push rod shroud tubes by removing the 1/4 inch plain nut and shroud tube lockplate which hold the two shroud tube springs and spacer in position. (See figure 87).



1. Shroud Tube
2. Shroud Tube Spring
3. Shroud Tube Lockplate
4. Valve Rocker
5. Rocker Box
6. Valve Spring Seat
7. Valve Rocker Shaft
8. Valve Keys

Figure 87 - Method of Securing Shroud Tubes

NOTE

Two different types of shroud tubes and oil seal rings are used on O-320 aircraft engines. In early production engines, a recess is provided in the rocker box for the oil seal ring, and the end of the shroud tube is formed straight without a recess. Later production engines have a recess provided in the shroud tube for the oil seal ring, while the hole in rocker box is straight without a groove or recess. When installing new shroud tubes or oil seal rings, it is necessary to determine which type is required as they are not interchangeable.

Using the appropriate wrench and handle, remove the four 3/8 inch and four 1/2 inch cylinder base nuts attaching the cylinder to the crankcase. On engines equipped with splined nuts, use wrenches 64700 and 64701 (figure 11 and 12); on engines equipped with Allen head nuts, use wrenches 64717 and 64718 (figure 14 and 15.) Handle 64711 (figure 13) fits both series of wrenches.

NOTE

Each cylinder of the O-340 engine is equipped with two cylinder hold down nut plates. Remove plates after removing the cylinder base nuts.

Pull the cylinder directly away from the engine, but before the piston is free from the cylinder, place a hand on the connecting rod to keep it from striking the cylinder pad of the crankcase when the piston is free from the cylinder. To prevent damage to the piston, detach it from the connecting rod immediately after the cylinder has been removed. (See "PISTONS" below.)

When the removal of No. 1 cylinder and piston has been completed, proceed to remove cylinder 3, 2, and 4 by the same method as described above for No. 1.

NOTE

The oil pressure valve, which is located between the upper right engine mounting lug and No. 3 cylinder, must be removed before the No. 3 cylinder base nuts can be removed. After unscrewing the plug, remove the gasket, spring, and ball to avoid loss.

PISTONS - Remove the piston pin plugs from their location in the piston by applying compressed air to each relief hole (one located in the bottom of each piston pin boss). If compressed air is not available, carefully tap out piston pin plugs with suitable drifts. Insert piston pin puller (figure 18) through piston pin; assemble puller nut, then proceed to remove piston pin. Do not allow the connecting rods to rest on the cylinder pads of the crankcase; the rods should be supported by heavy rubber bands (discarded cylinder base oil seal rings) or by two plates made of steel or wood as shown in figure 88.

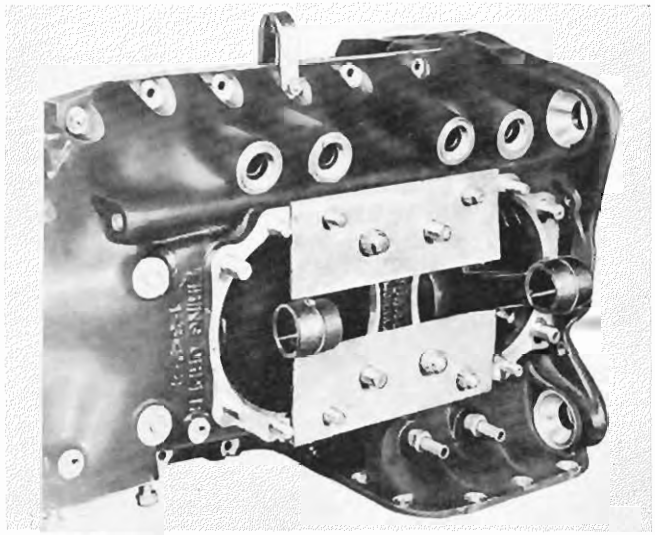


Figure 88 - Method of Supporting Connecting Rods

HYDRAULIC TAPPET PLUNGERS AND SOCKETS - Remove the hydraulic tappet sockets by placing a finger in the socket and pulling outward. (See figure 89.) If the socket tends to stick, it may be grasped lightly with a pair of "needle nose" pliers. Next remove the plunger, cylinder, and spring assembly. (See figure 90.) This is accomplished by bending a 1/8 inch right angle in one end of a piece of wire, inserting this end into the space between the plunger and the tappet body, twisting the wire 90° to engage a coil of the plunger spring, and then pulling gently on the wire, thereby withdrawing the plunger, spring and cylinder assembly from the crankcase.

NOTE

All valve operating parts should be placed in the proper compartment of the inspection and cleaning basket (figure 26) immediately upon their removal from the engine. This is of particular importance in the case of tappet plungers and cylinders, as these parts are not interchangeable.

Figure 89 - Removing Hydraulic Tappet Socket

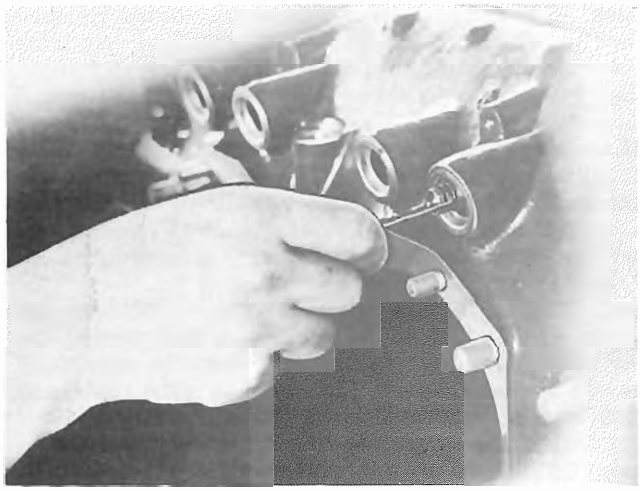


Figure 90 - Removing Hydraulic Tappet Plunger and Cylinder Assembly

OIL SUMP - Remove the twelve 1/4 inch bolts and nuts from around the oil sump as well as the two 1/4 inch capscrews which attach it to the crankcase; also remove the four capscrews which attach the rear of the sump to the accessory housing. Note that the two additional nuts at either side at the rear of the sump just above number 3 and 4 intake pipes cannot be removed without lowering the oil sump. (These two 1/4 inch nuts are attached to the accessory housing studs.)

ACCESSORY HOUSING - Remove the two 1/4 inch capscrews located alongside the right magneto mounting pad on the crankcase side of the crankcase - accessory housing mounting flange. Then remove the ten remaining 1/4 inch capscrews attaching the accessory housing to the crankcase and detach the housing. Should the housing have a tendency to stick, it is permissible to tap it gently with a soft hammer. Since there are various gears that are held in place by contact with the crankcase, place the housing on a suitable bench with the front side up to avoid dropping and damaging the

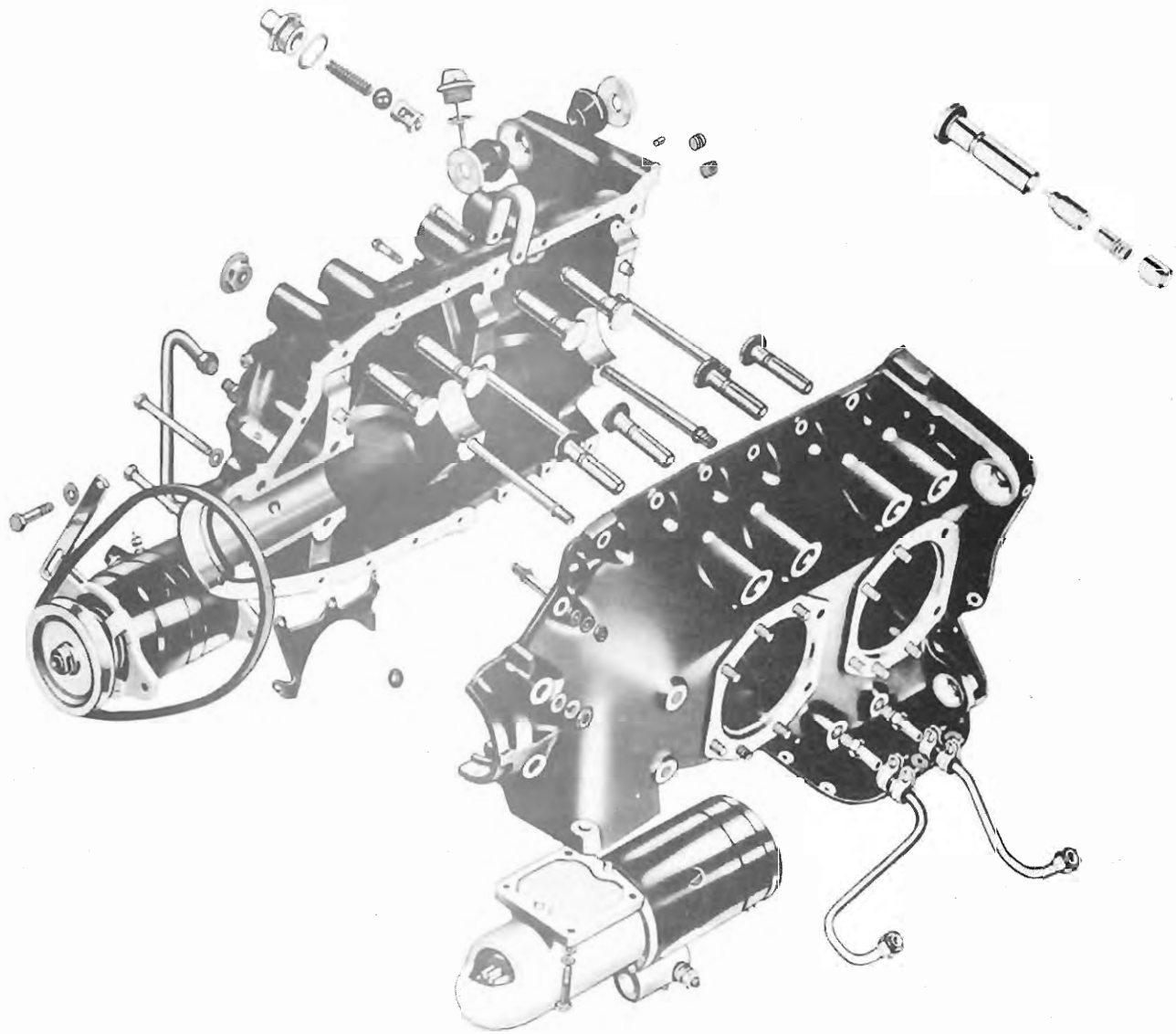


Figure 91 - Exploded View of Crankcase

gears. If the engine is equipped with a diaphragm type fuel pump, remove the plunger from the housing.

VACUUM PUMP DRIVEN GEAR - If the engine is provided with a vacuum pump driven gear, the gear should be lifted from its position in the accessory housing at this time.

CRANKSHAFT IDLER GEARS - Remove the lower crankshaft idler gear by simply pulling the gear off its shaft on the crankcase. Remove the upper crankshaft idler gear in the same manner but not until the camshaft gear and breather slinger is removed. Do not remove the crankshaft idler gear shafts at this time.

CAMSHAFT GEAR AND BREATHER SLINGER - Remove this gear and slinger by bending down the sides of the lockplates and removing the four slotted bolts together with the lockplates. Pull off the breather slinger and camshaft gear; then remove the tachometer shaft drive pin from the end of the camshaft and pull out the tachometer drive shaft.

CRANKCASE - Remove from the rear of the crankcase, the 3/8 inch hex head drilled bolt and slotted nut located above the rear end of the camshaft. At this point, remove the engine from its mounting and place it on a suitable bench with the left side of the engine downward. Remove twelve 1/4 inch hex head bolts, three of which attach the generator bracket and one the lifting strap to the crankcase. Remove the cotter pins from the three slotted shear nuts at the sump location and remove the nuts, washer and hex head bolts. Following this, remove the 5/16 inch capscrew which holds the generator adjusting link to the crankcase, if it has not been removed previously. Remove the two 3/8 inch hex head through bolts and nuts from the front end of the crankcase. At this point all fastenings holding the halves of the crankcase together will have been removed. Take a piece of soft wire about 14 inches in length and pass one end down through No. 1 cylinder pad and through the opening between the camshaft and the crankcase wall. Then pull the wire around the camshaft and upward through the cylinder pad and twist the ends of the wire around one of the cylinder base studs. Do the same at No. 3 cylinder pad. This procedure will hold the camshaft to the upper (right) half of the crankcase and prevent the tappet bodies from falling out when the crankcase halves are taken apart. The right half of the crankcase may now be separated from the left half by lifting it upward. If the crankcase has a tendency to stick, it may be tapped with a soft hammer to loosen it.

CRANKSHAFT - Lift the crankshaft assembly from the left half of the crankcase and place it on a suitable mount, supporting the crankshaft at rear and front main bearing locations.

CAMSHAFT - Remove the wires securing the camshaft to the right half of the crankcase and lift it from its bearings.

TAPPETS - Remove the hydraulic tappet bodies from each half of the crankcase and place each in its proper compartment of the cleaning basket. In the left crankcase half, the intake tappet for each cylinder is the tappet located nearest the front of the engine; in the right crankcase half, the intake tappets are toward the rear.

SECTION V

DISASSEMBLY OF SUB-ASSEMBLIES

CRANKSHAFT - After placing the crankshaft on suitable blocks, supported at the rear and front main bearing locations remove the 3/32 inch cotter pins from the 3/8 inch slotted nuts on the connecting rod bearing caps. Remove the nuts and disassemble the connecting rods from the crankshaft by tapping on the ends of the connecting rod bolts with a soft hammer. After removing each connecting rod, lay aside the bearings for examination and reassemble each cap with the corresponding rod. This is essential because the caps and rods are not interchangeable. This side of the connecting rod which is toward the bottom of the engine is stamped on both the cap and rod with its corresponding cylinder number.

Bend down the lip of the lock plate from the hex head screw which is located within the inside diameter of the gear on the rear end of the crankshaft. It will be necessary to use a 1/2 inch socket wrench to remove this 5/16 inch hex head screw. The gear can easily be removed by tapping it gently with a fiber drift. Do not remove the dowel which is located on the rear end of the crankshaft unless it is damaged.

Remove the four crankpin journal sludge tubes with the oil tube removal drift (figure 42). This is done

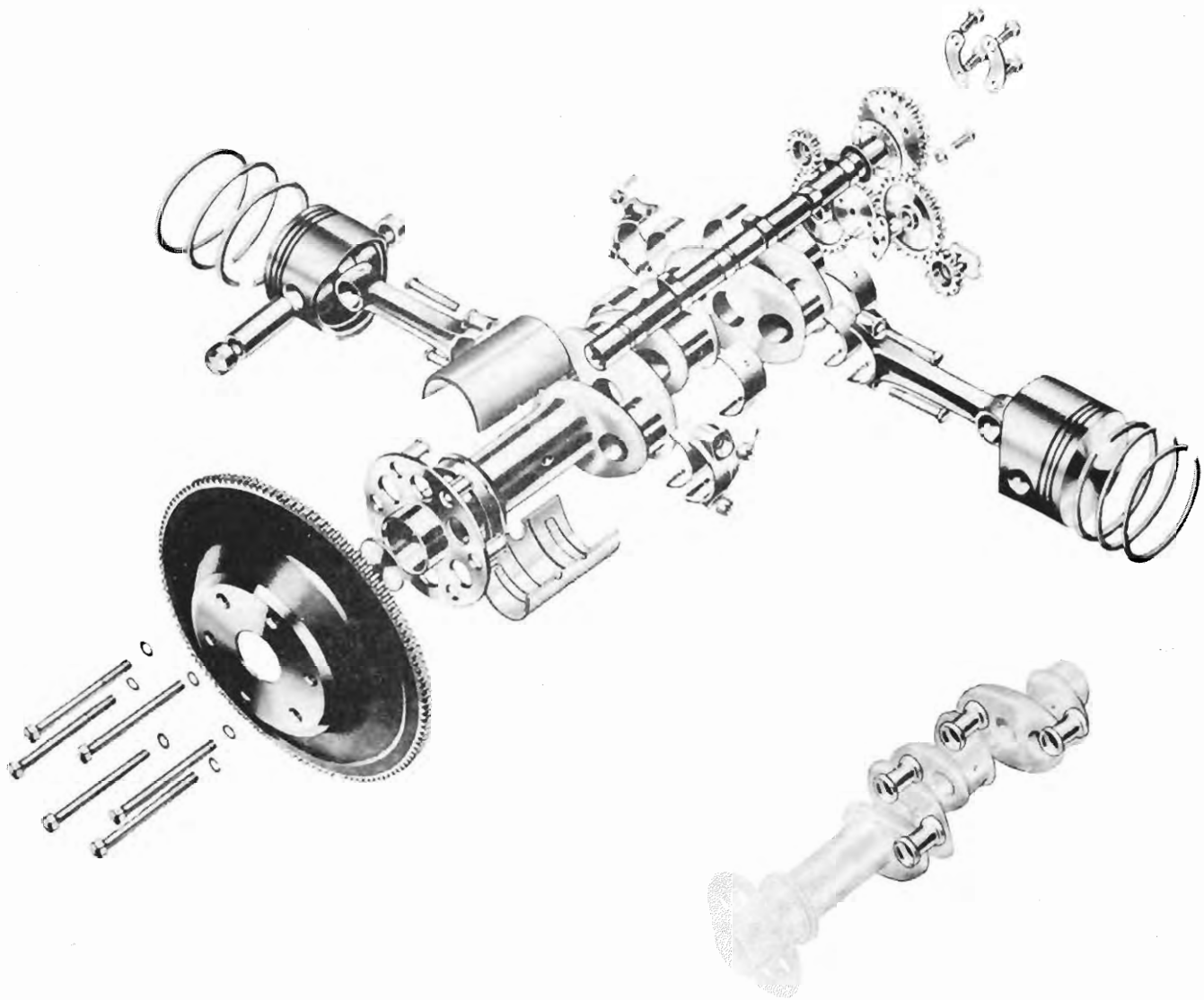


Figure 92 - Exploded View of Crankshaft and Reciprocating Parts

by placing the drift part of the tool in the oil tube and driving out the tube with the bar portion of the tool.

CAUTION

All crankpin journal sludge tubes must be removed from the crankshaft; otherwise accumulated sludge loosened during cleaning will clog the crankshaft oil passages and could cause bearing damage. The oil transfer tubes, however, which conduct oil from the main bearings to the crankpin journals must not be removed under any circumstances.

Remove the crankshaft oil seal from around the front of the crankshaft by slipping it out from its retaining spring and then off the shaft. The retaining spring can easily be removed by locating the place on its circumference where its two ends are joined; then, by twisting at this point (in the same manner as removing a nut from a bolt) the spring can be opened.

The propeller mounting bushings in the flange of the crankshaft should not be removed unless they are damaged or loose. However, if it is necessary to replace them, they may be driven out of the flange with a suitable arbor press.

Remove the expansion plug located in the front of the crankshaft by drilling a hole through the center of the plug and pulling it out with a hooked bolt. (No expansion plug is used on crankshaft equipped for constant speed operation.)

PISTONS - Using the piston ring expander, (figure 58), remove the three piston rings. The piston rings should be discarded and a new set installed during assembly.

CYLINDERS - Place the cylinder assembly over the holding block, (figure 10); then using the valve spring compressor (figure 9), compress both exhaust and intake valve springs and remove the split valve keys which secure the valve springs to the upper valve spring seat. After the springs and upper spring seats have been removed, hold the valves to keep them from dropping out of cylinder and remove cylinder from holding block. Reach up inside the cylinder and remove valves. Place each valve in its proper compartment of cleaning basket, (figure 26.) If difficulty is experienced in pulling the valve stem tip through the valve guide, push the valve back in position and clean the carbon from the stem. Do not drive the valve through the guide. Further disassembly of the cylinder is not necessary unless inspection shows that parts require replacement. Do not remove primer fittings or rocker box drain tube fittings unless they are damaged.

CRANKCASE - The center, and rear main bearing inserts of the left half of the crankcase are removed by simply lifting them from their location. The dowel pin located on the rear of the left crankcase should not be removed unless loose or damaged. The two crankshaft idler gear shafts located on the rear of the left and right crankcase halves may be disassembled by removing the 1/4 inch hex head screws and lockplates. Remove the two 1/8 inch Allen head pipe plugs which are located, one at the end of the main oil gallery near the front of the left half of the crankcase, and the other on the rear of the crankcase.

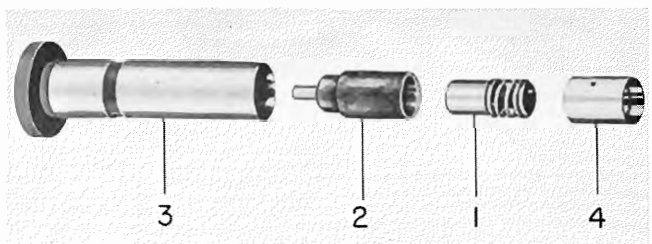
Remove the center, and rear main bearing inserts from the right half of the crankcase. Remove the eight rubber oil seals from around the studs and stud holes near each main bearing. These oil seals should be discarded and replaced with new seals during reassembly of the engine. Do not remove the two hollow dowels located in the front and rear main bearing webs unless they are loose or damaged. Remove the three 1/8 inch Allen head pipe plugs which are located, one at the end of the main oil gallery near the front of the right half of the crankcase, and two on the rear of the crankcase. The dowel which is located on the accessory housing flange of each crankcase should not be removed unless it is loose or damaged, nor should the two 1/2 inch studs located in the center main bearing web be disassembled unless they are damaged.

ACCESSORY HOUSING - Complete the removal of any accessories and drive adapters, such as vacuum pump and propeller governor, still remaining on the housing. Remove the .06 diameter cotter pins from the 1/4 inch slotted shear nuts which hold the oil suction tube flange to bottom interior of the accessory housing. Using a 7/16 inch socket wrench, remove nuts and washers, tubes, and gaskets. Remove the .051 diameter lockwire from the three 5/16 inch slotted nuts around the oil pump cover and remove the nuts with a 1/2 inch socket wrench. Remove the oil pump cover and body from the accessory housing and then detach the oil pump impellers. Pull the oil pump drive shaft out of the cover, but do not remove the idler shaft unless it is damaged. Using a 1/4 inch Allen wrench, remove the 1/4 inch pipe plug from the center bottom of the accessory housing. Then unscrew the 1/8 inch Allen plug from the upper right side of the accessory housing. Also remove a similar plug from the upper left rear side of the accessory housing. These pipe plugs are removed in order that the oil passages may be cleaned. Unscrew the oil cooler by-pass plug and remove the gasket, spring, and plunger.

NOTE

The above oil cooler by-pass parts are not used on engines equipped with a thermostatic oil by-pass valve.

Do not disassemble any other part from the acces-



1. Plunger
2. Cylinder
3. Tappet Body
4. Socket

Figure 93 - Hydraulic Tappet Assembly

sory housing unless it is damaged.

PROPELLER GOVERNOR DRIVE ADAPTER - This unit is disassembled by removing the external retaining ring from the governor drive end of the propeller governor drive shaftgear; the shaftgear may then be withdrawn from the front (accessory housing) end of the adapter.

HYDRAULIC TAPPETS - The plunger assemblies of the hydraulic tappets are disassembled by twisting and pulling outward. Place the parts in the proper compartment of the cleaning basket. Be particularly careful to keep the components of each plunger assembly together, since these parts are selectively fitted to extremely close tolerances during manufacture and are not interchangeable. (See figure 93.)

Magnetos - Remove the nut and washer that secure the magneto drive gear to the magneto shaft. Then, using a suitable gear puller, remove the magneto drive gear. The Woodruff key located in the tapered end of the magneto shaft may also be remove. Do not further disassemble the magneto. The impulse coupling on the left magneto is removed in the identical way as the drive gear; by removing the nut and washer and using a suitable puller. Do not disassemble the coupling.

OIL SUMP - No further disassembly of the sump is necessary beyond the removal of any loose or damaged studs or intake pipe connections.

SECTION VI

CLEANING

GENERAL - With certain limitations (see first paragraphs in Section VII following), it is imperative to clean all engine parts thoroughly to facilitate inspection. Two processes are involved in cleaning engine parts; degreasing and removal of dirt and sludge (soft carbon), and the removal of hard carbon deposits by decarbonizing, brushing or scraping, and grit-blasting.

DEGREASING - Degreasing is accomplished by spraying or immersing the part in a solution of carbon tetrachloride, white furnace oil (38-40 specific gravity), or a suitable commercial solvent such as Varsol or Perm-A-Chlor. Operators are warned against the use of solvents with which they are unfamiliar, since there are products on the market which are injurious to aluminum. Extreme care must be exercised if any water-mixed degreasing solution containing soap or caustic compounds are used. Such compounds, in addition to being potentially dangerous to aluminum may become impregnated in the pores of the metal and cause oil foaming when the engine is returned to service. When using water-mixed solutions, therefore, it is imperative that the parts be completely and thoroughly rinsed in clear boiling water after degreasing. Regardless of the method and type of solution used, coat or spray all parts with lubricating oil immediately after cleaning in order to prevent corrosion.

REMOVAL OF HARD CARBON - While the degreasing solution will remove dirt, grease, and soft carbon, desposits of hard carbon will almost invariably remain, particularly on the valves in the cylinder bore and combustion chamber and on the top and upper surfaces of the piston. To facilitate removal, these deposits must first be loosened by immersion in a tank containing a decarbonizing solution (usually heated). A great variety of commercial decarbonizing agents are available, including such products as Gunk, Penetrol, Carbrax, Super-Chemaco, Gerlach No. 70 and many others. Decarbonizers, like the degreasing solutions previously mentioned, fall generally into two categories, water-soluble and hydro-carbons, and the same caution concerning the use of water-soluble degreasers is applicable to water-soluble decarbonizers.

Decarbonizing will usually loosen most of the hard carbon deposits remaining after degreasing; the complete removal of all hard carbon, however, generally requires bushing, scraping or grit-blasting. All of these operations demand care on the part of the mechanic to avoid damage to machined surfaces. In particular, wire brushes and metal scrapers must never be used on any bearing or contact surface.

When grit-blasting parts, do not use sand or any metallic abrasives. It is recommended instead that mildly abrasive organic substances such as rice, baked wheat, plastic pellets, or crushed walnut shells be used. All machined surfaces must, of course, be properly and adequately masked and all openings tightly plugged before blasting. The one exception to this is the valve seats, which may be left unprotected when blasting the cylinder head combustion chamber. If is often advantageous to grit-blast the seats, since this will cut the glaze which tends to form (particularly on the exhaust valve seat) and facilitate subsequent valve seat reconditioning. Piston ring grooves may be grit-blasted if necessary; extreme caution must be used, however, to avoid the removal of metal from the sides and bottom of the grooves.

The decarbonizing solution will generally remove most of the enamel on the cylinder exterior. All remaining enamel should be removed by grit-blasting, particularly in the crevices between the cooling fins. This will aid in discovering cracks during inspection of the cylinder.

At the conclusion of cleaning operations, rinse the part in petroleum solvent, dry and remove any loose particles of carbon or other foreign matter by air-blasting, and apply a liberal coating of corrosion-preventive mixture to all surfaces.

NOTE

A recommended corrosion-preventive mixture consists of one part of the grade of lubricating oil specified for the engine and one part of any of the following compounds (all of which conform to Specification MIL-C-5545): Becker Chemicals, Inc., Compound L217; E. F. Houghton and Co., Cosmoline 949; or Shell Oil Co., Compound T864.

SPECIFIC CLEANING INSTRUCTIONS

SUMP - Using a finger brush of suitable size with stiff bristles, clean the various oil and induction passages. After cleaning, blow out all passages with petroleum solvent and air. Before washing the oil suction screen, note any excessive accumulation of metal chips that may be present.

OIL SUCTION TUBE - The oil suction tube should be cleaned, rinsed, and dried as out lined in the preceding paragraph.

CRANKCASE - All oil passages should be thoroughly cleaned by use of a solvent and compressed air.

CAUTION

Be careful in cleaning oil relief bore not to damage oil relief seat.

PISTONS - Pistons should be cleaned, rinsed, and dried as outlined in the beginning of this Section. Hard carbon which has not been removed from the piston head can be removed in accordance with the third paragraph of this Section. Slight carbon deposits in the piston bosses may be polished out with crocus cloth.

CYLINDERS - Clean cylinders in accordance with the second paragraph of this Section. Do not use any cleaning method which will damage the glaze on the cylinder walls. Hard carbon which has not been removed from the valves by the chemical cleaner can be removed in accordance with the third paragraph of this Section, taking care first to shield or mask the valve stems.

HYDRAULIC TAPPETS - Use the cleaning and inspection basket (figure 26), in order to keep the valve operating mechanism parts separate. Dip the basket, with all parts contained in their proper compartment, in petroleum solvent. Hold the ball check valve in each plunger cylinder off its seat by inserting a light copper wire or other relatively soft material through the tube on the cylinder and wash thoroughly, so that any dirt particles that may be under the ball seat will be washed out. After washing the parts of each hydraulic tappet assembly, replace the parts in the proper compartment of the cleaning basket. This is very important, because the cylinder and plunger of each tappet assembly are closely and selectively fitted during manufacture and are not interchangeable.

CRANKSHAFT - Clean inside of all crankpin and main bearing journals and all oil passages with suitable brushes, after which flush thoroughly with clean solvent and compressed air.

CAUTION

Do not attempt under any circumstances to clean the crankshaft without first removing the crankshaft oil tubes, as solvent will loosen but not remove accumulated sludge. This loose sludge is certain either to form a stoppage in the nearest oil passage, or to wash through and cause a bearing failure.

ACCESSORY HOUSING - All oil passages may be cleaned with suitable finger brush, after which they should be blown out with dry cleaning solvent and compressed air. Before washing the oil pressure screen assembly, note any excessive accumulation of metal chips that may be present.

OIL DRAIN TUBES - Using a flexible wire brush with stiff bristles, clean the inside of these tubes thoroughly with petroleum solvent.

INTAKE PIPES - Clean the intake pipes in the same manner as outlined in the preceding paragraph.

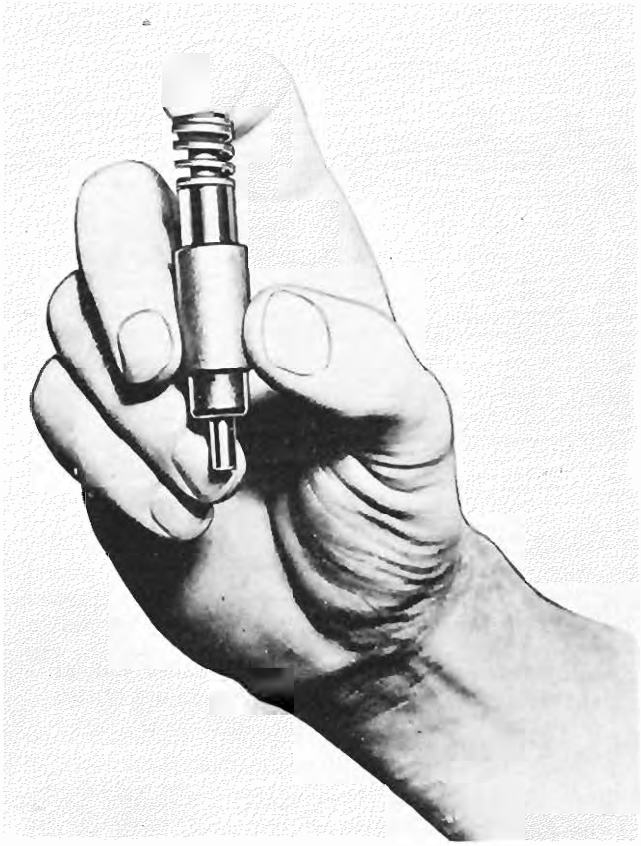


Figure 95 - Checking Hydraulic Tappet Plunger and Cylinder Assembly for Leaks

several different positions with flat plug rejection gage (figure 29). (This is a double-end gage; be sure to use the end marked "Rocker Bushing".) If the gage enters the bushing at any point, replace entire rocker assembly.

PUSH RODS - Inspect push rods for wear or looseness of ball ends. If ball ends are loose, replace the rod; manufacturing limits call for a drive fit. (See reference 535, Table of Limits.)

VALVES - Critical areas include the face and tip, both of which should be examined for pitting and excessive wear. Minor pitting on valve faces can sometimes be removed by regrinding; otherwise the valve should be rejected. Replace all exhaust valves at overhaul.

Check the clearance between the valve stem, and guide (reference 529, Table of Limits.)

SPRINGS - Check the condition of all valve springs on a suitable spring tester, using the loads and deflections as given in references 800 and 801, Table of Limits.

HYDRAULIC TAPPETS (VISUAL INSPECTION - Check each hydraulic tappet cylinder and plunger assembly to see that no burrs or binding exist and that the ball check valve is not leaking. A leaking ball check valve will make itself evident when the unit is checked as follows: Make sure cylinder and plunger assembly are dry and hold the lifter cylinder between the thumb and middle finger in a vertical position with one hand; then place the plunger in position so that plunger just enters the lifter cylinder. (See figure 95.) Depress the plunger quickly with the index finger; if plunger returns to approximately its original position, the unit may be considered to be satisfactory. If, however, the plunger does not return to its original position but remains in a collapsed position, this will indicate that the ball check valve is not seating properly. Wash the lifter cylinder again as described in Section VI, after which repeat the check as described above. If the same condition still exists, the hydraulic tappet unit is defective, and both the cylinder and plunger must be replaced. See Table of Limits for fit of cylinder assembly and socket in tappet body. It has been found that tappet bodies are subject to wear at the shoulder machined on the inside of the tappet body bore. Since this shoulder serves as a seat for the cylinder and plunger assembly, any wear occurring at the shoulder will increase the distance between the tappet cylinder and push rod socket, which in turn will result in excessive valve clearance. In addition, progressive wear of the shoulder reduces the cross sectional area of the tappet body at the adjacent oil groove (see figure 96) to the point where actual failure of the body may occur. It is recommended, therefore, that the interior of all tappet bodies be inspected at each overhaul period according to the procedure outlined below. This inspection, which is to be in addition to the inspection requirements for hydraulic tappets already described in the applicable overhaul manual, consists of three operations as follows:

a. Having thoroughly cleaned and dried the tappet body,

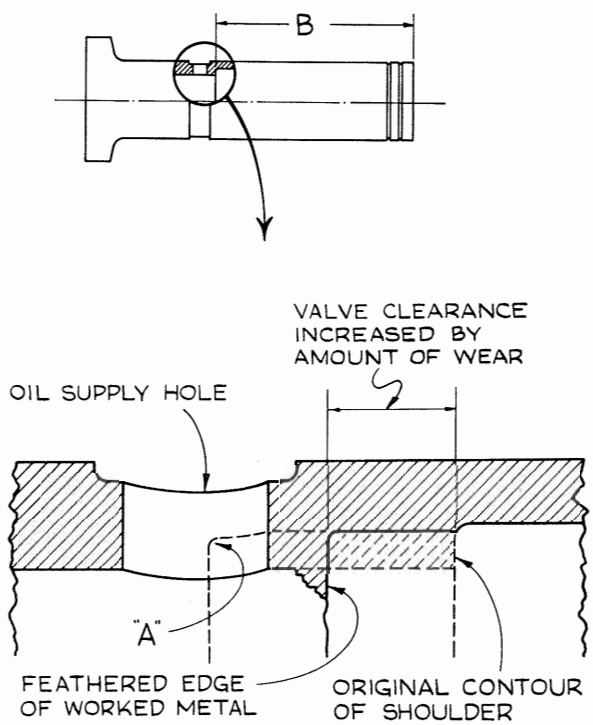


Figure 96 - Sectional View at Location of Oil Hole In Tappet Body

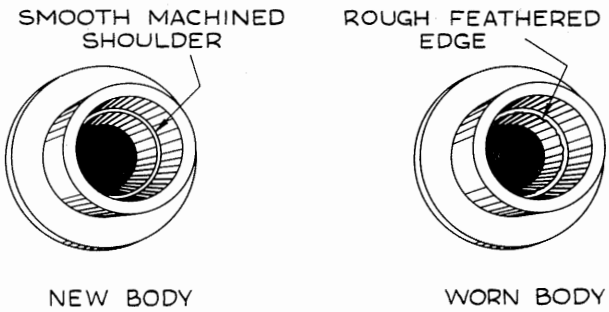


Figure 97 - View of Tappet Body Interior

examine the interior of the bore, using a small flashlight or other suitable means to illuminate the interior surfaces. If any appreciable amount of wear at the shoulder has occurred, a feathered edge of worked metal will be evident as shown in Figure 96. The existence of the feathered edge, which will appear as shown in Figure 97 is sufficient cause for rejection of the tappet.

b. In instances where extreme wear has occurred, the worn shoulder may progress into the tappet body as far as the oil supply hole as shown at "A" Figure 96. In such cases the appearance of the rough edge of the shoulder where it intersects the hole will be visibly altered as shown in Figure 98. Any tappet body showing an indication of this nature should be rejected.

c. Using a standard depth gage, measure the depth ("B" Figure 96) of the shoulder in the bore, Reject any tappet body with a shoulder depth exceeding 1-13/16 inches.

BEARING (PRECISION TYPE) - All steelbacked precision type bearing inserts used for main crankshaft bearings and connecting rod bearings should be replaced with new bearing inserts at overhaul.

CRANKSHAFT (VISUAL INSPECTION) - Carefully inspect all surfaces of the shaft for cracks, checking the bearing surfaces with particular care for scoring, galling, or other damage. Check the propeller flange bushings for tightness; mark for replacement any that

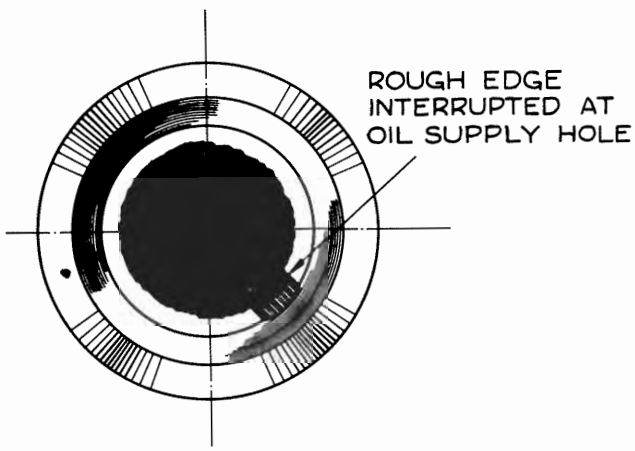


Figure 98 - Extreme Wear of Tappet Body Shoulder

are loose. Inspect all plugs and oil transfer tubes for tightness and condition.

CRANKSHAFT (DIMENSIONAL INSPECTION) - Place the crankshaft in vee blocks (figure 25,) supported at the rear and front main bearing locations. Then, with the use of a surface plate and dial indicator, measure the run-out at the center main bearing journal. (Reference No. 556, Table of Limits). If the total indicated run-out exceeds .005 inch, the shaft must not be reused. The propeller flange run-out of the crankshaft should also be checked at this time. Measure the run-out from the front face of the flange, near the outer edge. If the total flange run-out does not exceed .018 inch, straightening operations are permissible. (See Section VIII.)

CAUTION

Any attempt to straighten a bent crankshaft will result in rupture of the nitrided surfaces of the bearing journals - a condition that will eventually cause failure of the crankshaft.

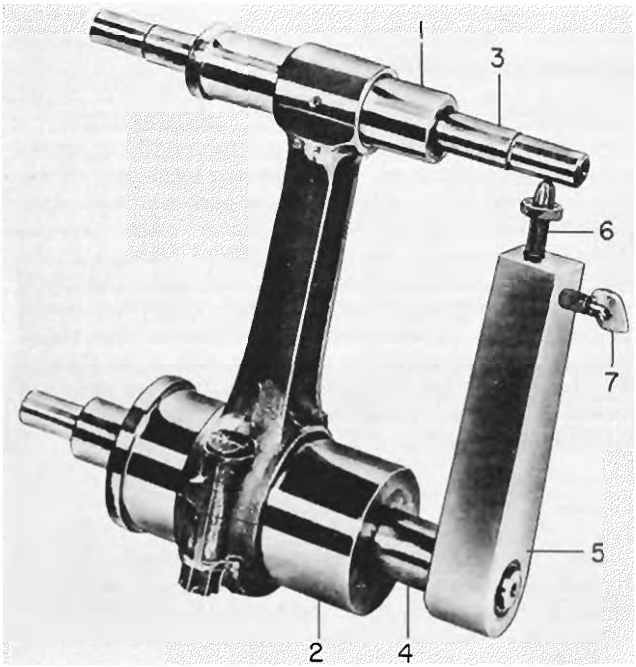
Using new inserts at all three main bearing locations, assemble crankcase halves together temporarily and measure the ID of the bearings. Measure the OD of the crankshaft main bearing journals and compare the resulting clearances with the Table of Limits (reference 501). Assemble the connecting rods temporarily (using new bearing inserts) and check the crankpin journal clearance in the same manner (see reference 502, Table of Limits). If clearances do not fall within prescribed limits, the shaft must be reground for .003 or .010 undersize bearings.

CAMSHAFT (DIMENSIONAL INSPECTION) - Support the camshaft in vee blocks (figure 25) at its front and rear bearing journals and check its run-out at the center bearing location. (See reference 539, Table of Limits.) Slight bending operations are permissible on the camshaft, provided careful magnetic inspection follows such bending operations. At the same time, measure the diameter of the camshaft bearing journals and check them against the bearings formed by the crankcase. (See reference 537, Table of Limits.)

CRANKCASE (DIMENSIONAL INSPECTION) - See preceding paragraphs ("Crankshaft " and " Camshaft").

CONNECTING RODS - The parallelism and squareness of the connecting rods may be checked in the following manner:

To check parallelism (figure 99), insert tapered sleeves (1) and (2) in bearing holes in connecting rod. Place arbors (3) and (4) through sleeves (1) and (2) and place gage arm (5) on arbor (4). Set adjusting screw (6) on gage arm to exact distance between arbors and lock with wing nut (7). Remove gage arm and place on other end of arbor (4) and check distance to small end arbor (3). See reference No. 566, Table of Limits.

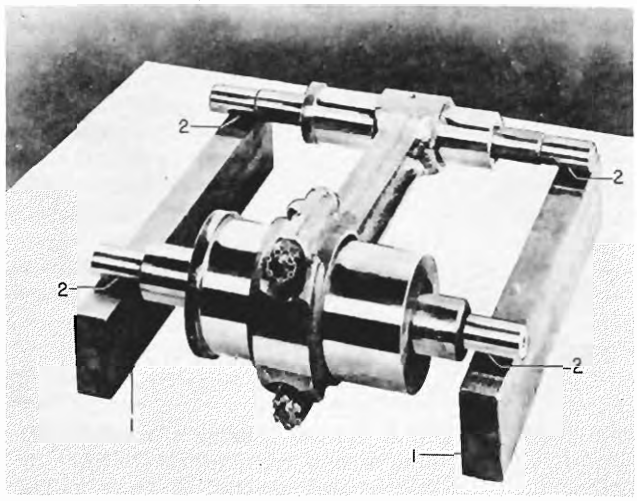


1. Tapered Sleeve (small end)
2. Tapered Sleeve (large end)
3. Arbor (small end sleeve)
4. Arbor (large end sleeve)
5. Gage Arm
6. Adjusting Screw
7. Wing Nut

Figure 99 - Checking Parallelism of Connecting Rods

To check the squareness, (figure 100), place parallel blocks on surface plate and with sleeves and arbors in link rod as described in preceding paragraph, place ends of arbors on parallel blocks (1) and check the four points (2) with a feeler gage. (See reference number 567, Table of Limits.)

All connecting rod bolts and nuts should be replaced at each overhaul. Check connecting rod small end bushing for wear, scoring, and looseness. Check ID of bushing with flat plug rejection gage (figure 24); if bushing ID exceeds limits, replace entire rod assembly. Check bore and tang slot in large end of connecting rod for any roughness or distortion that may cause improper seating of the bearing insert. (see preceding



1. Parallel Blocks 2. Points to be checked

Figure 100 - Checking Squareness of Connecting Rods

paragraph "Crankshaft" for dimensional check of large end bearing.)

MAGNETIC INSPECTION - All ferro-magnetic steel parts should be inspected by the magnetic particle method. The successful detection of structural failure by magnetic inspection demands skill and experience on the part of the operating personnel. It must be remembered that almost any fabricated steel part will show indications of some kind, and it is important that the operator exercise proper judgment in evaluating the indications. Too rigid an interpretation may result in the rejection of a sound part, while on the other hand, a part showing a dangerous indication may be returned to service as a result of a too casual diagnosis. In general, areas of stress concentration must be watched closely for fatigue cracks. These areas include such location as keyways, gear teeth, splines, roots of threads, small holes and fillets.

Proper judgment must also be used in determining the amount of current (amperage) applied; too little current (or too short an application) will not sufficiently magnetize the part, while too heavy an application will permanently damage the part by overheating and burning thin areas adjacent to the electrodes. Again, skill and experience on the part of the operator are of the utmost importance.

SECTION VIII

REPAIR AND REPLACEMENT

DAMAGED PARTS - Abnormal damage such as burrs, nicks, scratches, scoring, or galling should be removed with a fine oil stone, crocus cloth, or any similar abrasive substance. Following any repairs of this type, the part should be carefully cleaned in order to be certain that all abrasive has been removed; then checked with its mating part to assure that the clearances are not excessive. Flange surfaces that are bent, warped, or nicked may be repaired by lapping to a true surface on a surface plate. Again the part should be cleaned to be certain that all abrasive has been removed. Defective threads can sometimes be repaired with a suitable die or tap. Small nicks can be removed satisfactorily with Swiss pattern files or small edged stones. Pipe tapped threads should not be tapped deeper in order to clean them up, because this practice will invariably result in an oversize tapped hole. If scratches or galling are removed from a bearing surface of a journal, it should be buffed to a high finish. Generally it is impossible to repair cracks; however, welding operations may be performed in some parts of housings, providing the area is not a stressed section of the parts. For example, almost any area of a rocker box may be welded, but no part of the cylinder head except the fins may be welded.

PAINTED PARTS - Following repair of parts requiring use of paint for protection of appearance, parts should be repainted according to the following recommendations:

Aluminum-alloy parts should have original exterior painted surfaces rubbed smooth to provide a proper paint base. See that surfaces to be painted are thoroughly cleaned. Care must be taken to avoid painting mating surfaces. Exterior aluminum parts should first be primed with a thin coat of zinc chromate primer. Each coat should be either air dried for two hours or baked at 177°C (350° F), for one-half hour. After the primer is dry, parts should be painted with gray engine enamel, which should be air dried until hard or baked for one-half hour at 82°C (180° F). Aluminum parts from which the paint has not been removed may be repainted without the use of a priming coat providing no bare aluminum is exposed.

Parts requiring a black gloss finish should first be primed with zinc chromate primer and then painted with glossy black cylinder enamel, and each coat baked for 1-1/2 hours 177° C(350° F). If baking facilities are not available, cylinder enamel may be air dried; however, an inferior finish will result. All paint applied in the above operations should preferably be sprayed; however, if it is necessary to use a brush, care should be exercised to avoid an accumulation of pockets of paint.

Shroud tubes should be refinished inside and out by dipping in zinc chromate primer thinned to spraying consistency. After the zinc chromate primer is dried the outside of the shroud tubes should be refinished with glossy black enamel.

STUD REPLACEMENT - Any studs which are bent, broken, damaged, or loose must be replaced with new ones. After a stud has been removed, the tapped stud hole should be examined for size and condition of threads. If it is necessary to retap the stud hole, it will also be necessary to use a suitable oversize stud. Oversize studs are furnished .003, .007 and .012 inch oversize. Studs that have been broken off flush with the case must be drilled and removed with an "Easy-Out" or other suitable stud remover. Be careful not to damage threads. When replacing studs, coat the coarse threads of the stud with anti-seize compound.

VALVE SEAT RECONDITIONING - The use of suitable valve seat equipment is recommended for reconditioning valve seats. For the proper grinding wheel and pilot, consult the valve seat manufacturer's recommendations (Among these are: Black and Decker Mfg. Co., Towson 4, Maryland, and Albertson & Company, Inc., Sioux City 3, Iowa.) When grinding valve seats, there are several items the operator should keep in mind, such as (1) Using the proper wheel (A stone for steel seats will not make a satisfactory seat on an aluminum bronze insert). (2) Dressing the stone to the proper angle. (3) Seeing that the pilot is not loose in the valve guide. (4) Keeping the grinding face of the wheel well lubricated, smooth, and free from chips.

In the event that the valve seat manufacturer's catalog does not list the O-320 and O-340 engines, the data necessary to enable personnel to secure the proper grinding wheels is listed in Table V.

After the seat face has been ground just enough to restore the surface and concentricity, narrow the face to the width specified in Table V and figure 101, dimension "C" and "D". The following procedure is recommended:

Using a 15° wheel, grind the top surface of the seat to produce an outer face diameter which will make a fit with the valve as shown in figure 102. When this has been done, bring the face to specified width by narrowing the throat with a 75° wheel. Throat narrowing is desirable on intake seats to preserve the desired venturi shape of the seat.

Upon completion of grinding operations, break all edges of intersecting surfaces with a hand stone.

When seat wear has progressed to the extent that the entire face of the 15° narrowing wheel must be brought in contact with the seat in order to achieve the

TABLE V

SEAT DIMENSIONS FOR RECONDITIONING

Models	Outer Diameter of Face		Face Width		Degree on Seat	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
O-320, O-340	2.155/2.145	1.750/1.740	.117/.076	.077/.058	30°0'/30°30'	45°0'/44°30'

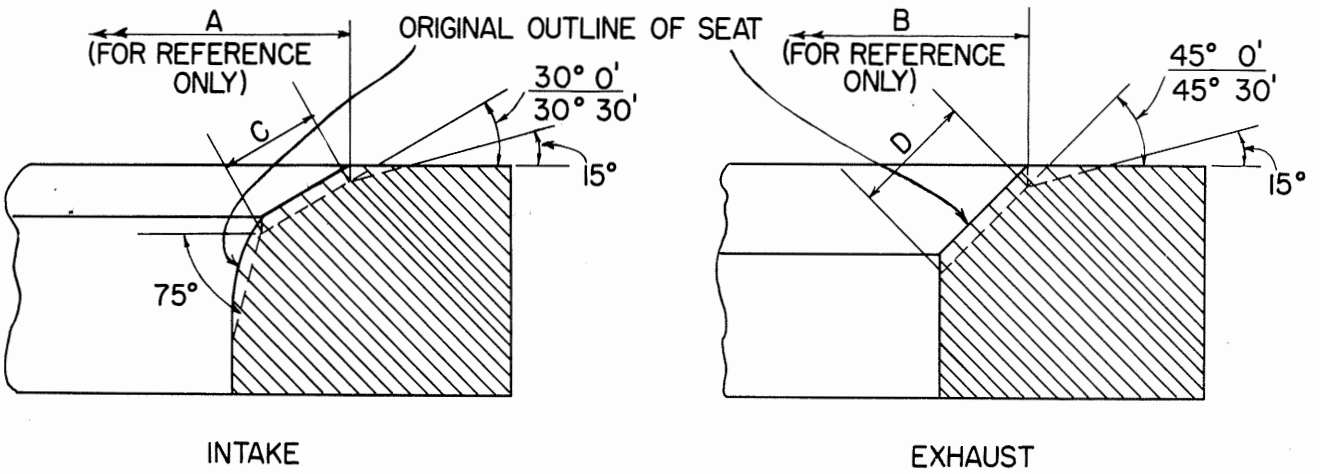


Figure 101 - Correct Method of Narrowing Valve Seats

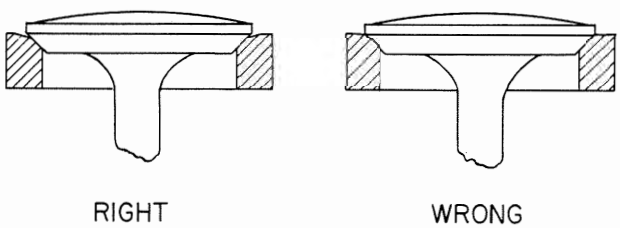


Figure 102 - Method of Fitting Valve to Seat

specified face diameter (thus producing a grinding step as shown in figure 103), the seat must be replaced.

NOTE

The ID of the valve guide is used as a piloting surface during all valve seat reconditioning operations. Note that the finished ID of all valve guides on Lycoming opposed-type engines is .4050/.4040, with the exception of valve guides used with sodium cooled exhaust valves. These guides are machined to .4370/.4360 inside diameter.

SPARK PLUG THREAD INSERTS - Spark plug thread inserts which were rejected during inspection are removed and replaced in the following manner:

Insert the extracting tool (figure 45 in the spark plug hole so that the edges of the tool cut into the top thread of the insert. Then rotate the tool in a counterclockwise direction, unscrewing the insert from the hole.

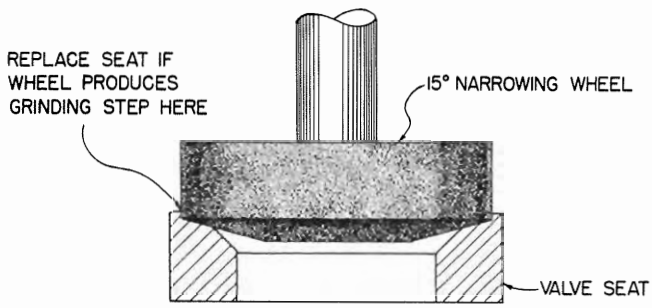


Figure 103 - Valve Seat Rejection During Narrowing Operation

A new insert may be installed by use of the inserting tool (figure 44). Withdraw the mandrel part of the tool beyond the recess section of its sleeve. The insert may then be assembled into the recess and the mandrel advanced to engage its slotted end with the tang of the insert. Rotate the mandrel clockwise and press forward slightly; this will engage the insert in the threaded end of the sleeve. Continue to rotate the mandrel while holding the sleeve, thus securing the insert firmly on the inserting tool. The insert may then be wound through the threaded portion of the sleeve within one-half turn from the end of the coil.

The adjustable brass screw on the sleeve tends to act as a brake, preventing the insert from unwinding. It is important that the insert be kept tight on the mandrel to facilitate its assembly in the threads of the cylinder head. The insert should be wound so that the adjacent turns of the insert are in contact with each other. This will eliminate the possibility of crossed threads.

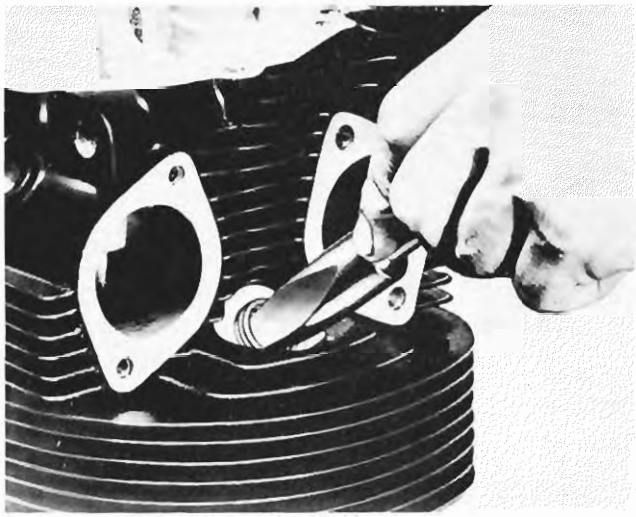


Figure 104 - Removing Heli-Coil Insert

When screwing the insert into the hole in the cylinder head, be sure that the first coil picks up the first thread. As the tool is turned, the insert will advance into the hole. When the face of the sleeve is approximately 1/16 inch from the face of the boss, the inserting tool should be held tightly by the handle and the sleeve rotated clockwise with the other hand, freeing the last half-turn of the insert. By sliding the sleeve toward the top of the mandrel, the end of the insert can be seen projecting above the boss. The mandrel may then be rotated in a counter-clockwise direction until the insert disappears from sight. When this state is reached, the turning action may be stopped and the tool withdrawn. The top of the insert will be approximately one-half turn from the face of the boss. However, if it is not, the tool should be reassembled and the insert turned until it is about one-half turn from the face of the boss.

The tang of the insert can be broken off with needle nosed pliers at the location of the notch. Then using the expanding tool (figure 43), secure the insert firmly

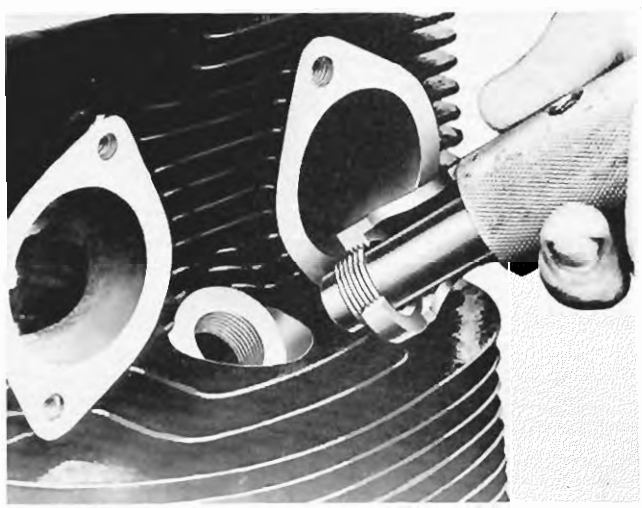


Figure 105 - Heli-Coil Insert Assembled on Inserting Tool

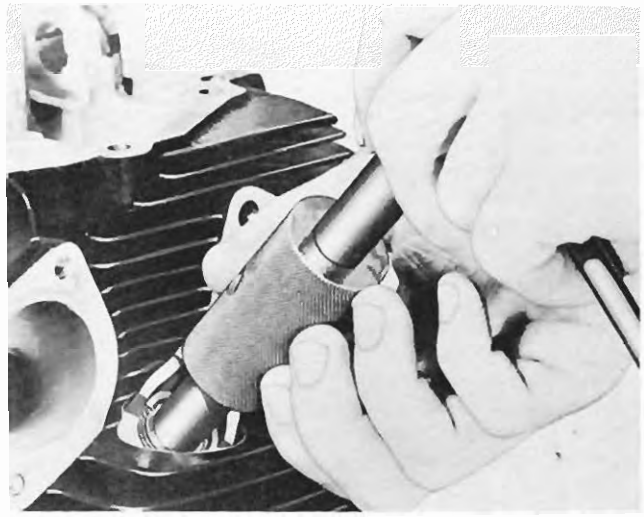


Figure 106 - Installing Heli-Coil Insert

in the spark plug holes. The limit of expansion can be kept within thread gage limits by fixing the stop nut on the expanding tool at the correct position. After expanding the insert, it may be staked by assembling the staking sleeve over the mandrel until the sleeve meets the boss. A slight blow on the top of the sleeve will impress a slight chamfered edge around the periphery of the tapped hole. The staking sleeve may then be removed, the adjusting screw released, and the expanding mandrel removed from the insert.

VALVE GUIDE REPLACEMENT - Damaged valve guides are removed and new guides installed in the cylinder head according to the following procedure:

Place valve guide puller (figure 47) over guide inside of rocker box and, with nut at extreme outer end, insert puller bolt down through guide. Place horseshoe puller retainer on end of puller bolt with small pilot of retainer toward open end of guide. Lock puller bolt nut by inserting nut between sides of large slot across top of puller body. Tighten screw gently until pilot of

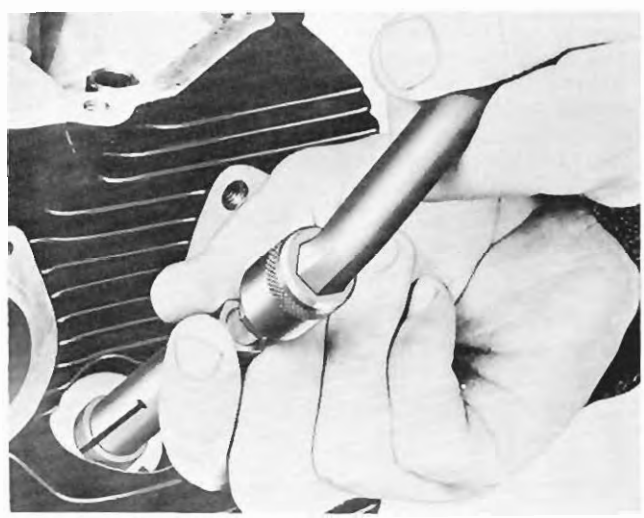


Figure 107 - Expanding Heli-Coil Insert

Figure 108 - Staking Heli-Coil Insert

horseshoe retainer is felt by fingers to enter the lower or port end of the guide then pull guide out of cylinder head by turning puller screw clockwise. (See figure 109.)

Remove the valve guide using puller No. 64645 (figure 47) and check the ID of the hole in the cylinder head with the valve guide hole plug gage (figure 27). If the gage enters the hole more than 1/8-inch, it will be necessary to ream the hole and install an oversize guide. If the gage enters the hole easily or seems loose in the hole, it is evident that an oversize guide has already been installed and the next larger size guide must be used. Refer to Table VI for the selection of the proper size guide and reamer.

Having determined the proper size reamer, mount the reamer in a drill press spindle and proceed to ream the valve guide hole in the cylinder head. (See figure 110). Check the reamed hole with the corresponding gage (See Table VI).

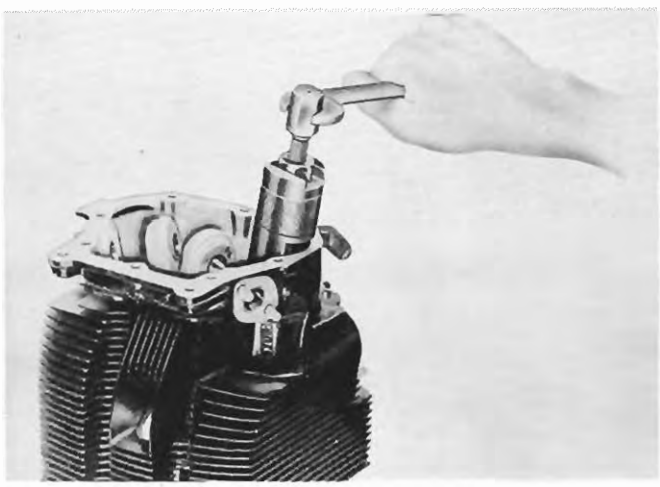


Figure 109 - Removing Valve Guide

Heat the cylinder to 600° - 650° F, place the new guide on the valve guide replacement drift (figure 36 or 75), and insert the guide in the hole in the cylinder head. Drive the guide to a firm seat with a sharp hammer blow on the end of the drift. After the cylinder has cooled, ream the hole in the guide with the valve guide ID reamer (figure 51 or 60). Check the finished ID of the guide with the valve guide ID plug gage (figure 22 or 31).

TABLE VI

VALVE GUIDE REPLACEMENT

Nominal Oversize	Reamer	Gage
Standard	------	Figure 27
.005	Figure 48	Figure 19
.010	Figure 49	Figure 20
.020	Figure 50	Figure 21

REFACING INTAKE VALVES - Reface intake valves in valve refacing machine. Remove no more metal

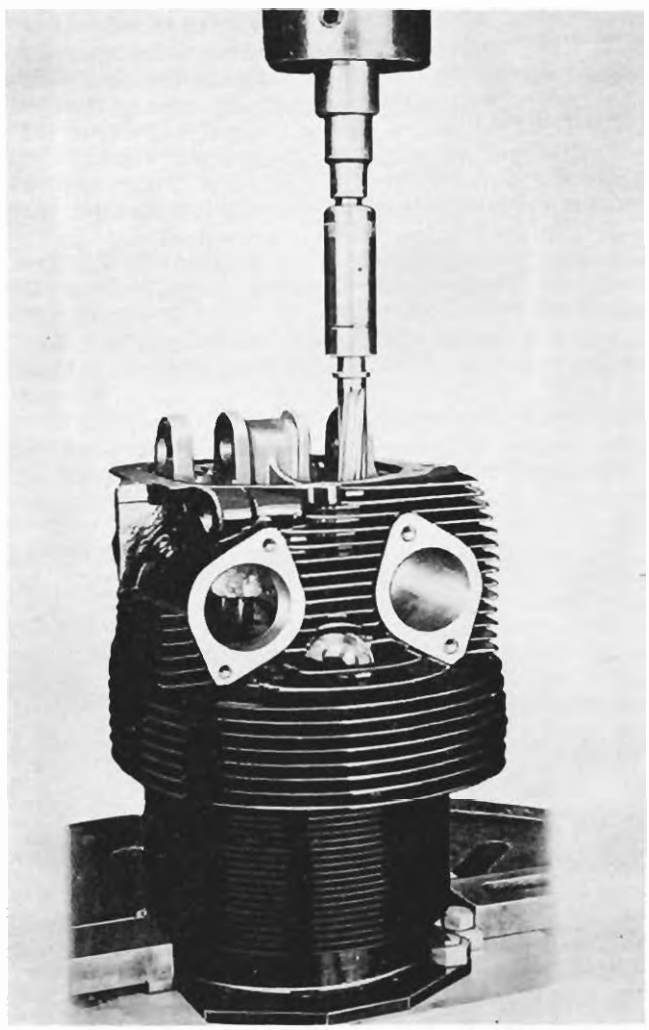


Figure 110 - Reaming Valve Guide Hole in Cylinder Head

than is necessary to clean up pits in valve face or to correct any apparent warping condition. Set refacer to 30° for intake valve. Round off with a hand stone any burred or sharp edges left around the valve face after refacing; this is best done while valve is turning in the refacing machine. After the intake valves have been ground, place an intake valve and new exhaust valve in position in cylinder. Place the cylinder in a horizontal position with both exhaust and intake ports facing upward. Fill ports with petroleum solvent or gasoline and observe through cylinder barrel for leakage. If no leakage is evident the valves may be considered gas tight. If any leakage occurs, repeat refacing operation check as directed.

NOTE

At normal overhaul periods, replace all exhaust valves with new ones.

REPLACEMENT OF STANDARD EXHAUST VALVES WITH SODIUM COOLED EXHAUST VALVES - To replace the solid stem exhaust valves of the O-320 engine with sodium cooled exhaust valves it will be necessary to replace the valve guide to accomodate the larger sized valve stems of the sodium cooled valves. This modification may be accomplished in the following manner:

a. Remove exhaust valve guide from the cylinder as previously described.

b. Check each valve guide hole in the cylinder head with the appropriate plug gage (figure 19, 20, or 21).

c. If necessary, ream the valve guide hole in the cylinder head to fit the appropriate oversize valve guide. See "Table VII" for the various valve guides and tools.

d. Install new valve guides as previously described.

e. After valve guide has been installed, ream the hole in the guide with the valve guide ID reamer (figure 51 or 60); check size of reamed hole in guide with valve guide ID plug gage (figure 22 or 31).

NOTE

Sodium cooled exhaust valves as well as solid exhaust valves, should be replaced at each overhaul.

TABLE VII

Valve Guide	Reamer	Gage	Normal Oversize
69533		64571	Standard
69533-PO5	64678-2	64507	.005
69533-P10	64678-3	64509	.010
69533-P20	64678-4	64511	.020

REMOVAL OF ROCKER SHAFT BUSHINGS - Remove rocker shaft bushings from the cylinder head in the following manner:

a. Secure the cylinder to a suitable fixture on a workbench.

b. Remove the outer rocker shaft bushings with the rocker shaft bushing removal drift (76).

c. Remove the inner rocker shaft bushings with the same tool as mentioned in step "b".

GAGING ROCKER SHAFT BUSHING HOLES - After the rocker shaft bushings have been removed, check each rocker shaft bushing hole in cylinder head with rocker shaft bushing hole in cylinder head plug gage (32). If plug gage enters hole more than 1/8 inch, an oversize rocker shaft bushing will be required. If the fit of the plug gage in the hole is quite loose, it is evident that the rocker shaft bushing that was removed is an oversize bushing. Use the 0.005 oversize rocker shaft bushing hole in cylinder head plug gage (33) to determine what oversize bushings should be used for replacement.

HAND REAMING ROCKER SHAFT BUSHING HOLES - When the proper size of replacement rocker shaft bushing has been determined, proceed to ream the bushing hole in the cylinder head in the following manner:

a. Secure the cylinder to a suitable fixture on a workbench.

b. Place the pilot of the 0.005 or 0.010 oversize rocker shaft bushing hole in cylinder head reamer (80 or 81) through the outer bushing hole and ream the four bushing holes.

c. Clean cylinder and reamed holes thoroughly.

INSTALLING ROCKER SHAFT BUSHINGS - Install new rocker shaft bushings in the following manner:

a. Place a new bushing on the driver of the inner rocker shaft bushing installation drift (78).

b. Locate bushing and driver in front of inner rocker shaft bushing hole in cylinder head.

c. Insert the pilot of the inner rocker shaft bushing installation drift (78) through the outer bushing hole into the driver and tap inner bushing into place.

d. Install the other inner bushing in the same above manner.

e. Install the stop of the outer rocker shaft bushing installation drift (77) between the inner and outer shaft bushing bosses.

f. Place a new bushing on the outer rocker shaft bushing installation drift (77) and tap the outer bushing in place.

g. Repeat steps "e" and "f" for the other rocker shaft bushing.

HAND REAMING ROCKER SHAFT BUSHING - After installing new rocker shaft bushings in cylinder head,

ream the bushing inside diameters in the following manner:

a. Secure the cylinder to a suitable fixture on a workbench.

b. Place the pilot of the inner and outer rocker shaft bushing ID finish reamer (79) through the outer bushing hole and ream the four bushings.

c. Check the finished ID holes of the rocker shaft bushings with the rocker shaft bushing ID plug gage (34).

d. Clean cylinder and reamed holes thoroughly.

NOTE

After the new rocker shaft bushings are machined, they must be impregnated by immersing the cylinder for at least 15 minutes in engine oil that has been heated to 140° F.

REGRINDING UNPLATED CYLINDER BARRELS - All unplated cylinder barrels which exceed allowable service limits in diameter, taper, or out-of-roundness must be reground to .010 or .020 oversize. (See following paragraph for information relative to chrome plated barrels.) This work must be done by a competent operator on a suitable internal grinding machine; do not attempt to regrind a barrel on a lightweight grinder such as a block-mounted automotive type or other similar machine.

The oversize to which the cylinder is to be ground is determined by adding .004 inch cleaning-up allowance (.002 inch per wall) to the barrel diameter measured at the point of greatest wear; the barrel is then ground to the next oversize above this figure. Barrels with wear at any point exceeding .020 inch over the basic manufactured diameter must be replaced. (See reference 522, Table of Limits.)

The following data is included as a guide in selecting an efficient wheel and set-up:

a. Wheel
Grain Size - 60 or 70 (medium to fine)
Grade I or J (medium)
Structure - 8 (porous)
Diameter - 3 1/2 to 4 inches

b. Wheel speed
5600 to 6000 surface feet per minute (5350 to 5730 r.p.m. for 4 inch diameter wheel).

c. Work Speed - 120 r.p.m.

It is recommended that barrels be ground to a surface finish of 30-45 micro-inches minimum. Providing that suitable equipment is used, such a finish can be obtained by grinding if the barrel diameter is brought to within .0005 to .001 inch of the desired ID by roughing cuts, after which the wheel is redressed and the finish pass made. The wheel should then be allowed to run out over the work four or five times. When setting up the job, make sure that the stops are arranged to prevent the edge of the wheel from running past the top of the barrel more than 1/8-inch. This will protect the interior of the combustion chamber from damage.

Cylinders with barrels ground .010 or .020 oversize must be fitted with corresponding oversize rings and pistons.

It is feasible under certain circumstances to rebarrel a cylinder; this operation is strictly a factory job, however, and the cylinder must be returned to Lycoming.

RECONDITIONING BARRELS BY CHROME PLATING - The restoration of worn cylinder barrels by chrome plating can be done provided the barrels can be ground to not more than .015 inch diameter over the maximum standard cylinder bore diameter, prior to chrome plating. The barrel diameter after plating will be within the limits established for standard cylinders. Barrels that have been chrome plated develop wear steps only under extreme operating conditions; although it is not practical to remove wear steps by regrinding, such barrels can be restored at subsequent overhaul periods by a stripping and replating process.

BROKEN FINS - If any of the fins are found to be cracked, the area surrounding the crack should be ground out so that the crack is entirely removed. If several fins are cracked and considerable material has been removed so that the cooling properties of the fins are impaired, the cylinder should be discarded. Any nicks that are found on the fins should be carefully stoned or removed with a small file, because even a small nick can develop into a crack. If a crack has progressed beyond the base of the fin into the head, the cylinder must be rejected.

CYLINDER BASE NUT REPLACEMENT - O-320 engines having spline nuts can be modernized if so desired, by replacing all spline nuts with Allen head nuts. This can be done by removing the one lower fin on the cylinder barrels, and by replacing all cylinder base attaching studs with shorter studs.

The 1/2 inch diameter studs are to be driven to .63 inch height and the 3/8 inch diameter studs are to be

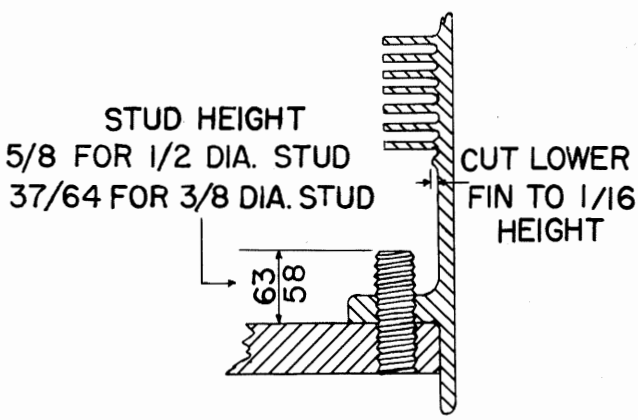
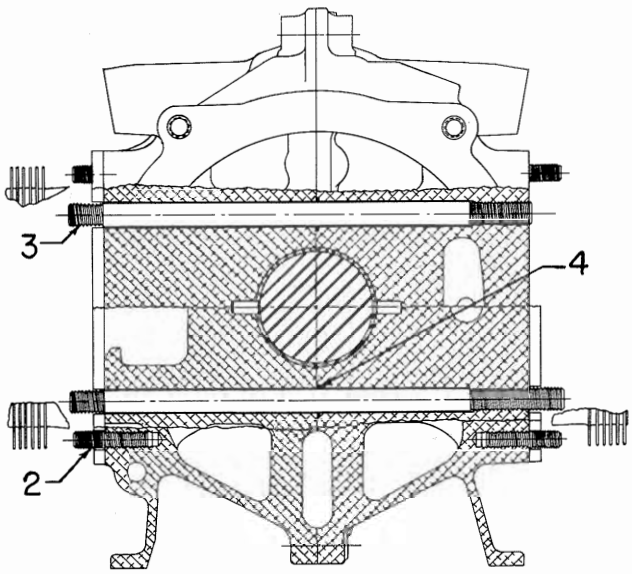


Figure 111 - Stud Height and Machining for Allen Head Nuts



1. Short Stud Anchored in Cylinder Pad
2. Thru-Stud Anchored in Cylinder Pad
3. Thru-Stud Anchored in Crankcase
4. O-Ring

Figure 112 - Types of Cylinder Hold - down Studs

driven to .58 inch height. The procedure for removing the lower cylinder fin is as follows:

a. Chuck flange end of cylinder on lathe being careful not to overtighten chuck jaws.

b. Support head end of cylinder assembly on tail stock center, using center hole located on rib between valve spring pockets.

c. Cut off lower fin to approximately 1/16 inch (see figure 111).

d. Smooth the sharp edges of the fins.

e. Check maximum out-of-roundness of cylinder barrel. (See reference 521, Table of Limits.)

f. Paint the exposed surface with black cylinder enamel according to instructions in the beginning of this section.

REMOVAL AND REPLACEMENT OF CYLINDER BASE STUDS - If a stud fails, the adjacent studs are immediately placed under a greater operating pressure and likely to be stressed beyond their elastic limit. Overstressing in a stud is a condition equivalent to actual failure of the stud. Therefore, in the event of a stud failure, all of the hold-down studs adjacent to the broken stud must be replaced.

As shown in figure 112, there are three types of cylinder hold-down studs employed on O-320 and O-340 engines. The simpler of the three is a short stud anchored in the cylinder base pad. The other two types are thru-studs, different in that one is anchored in the crankcase and the other is longer and is anchored in the crankcase cylinder pad. The method of removing the studs is dependent on the type and the manner in which it is broken. The following procedure describes the method to be employed for removal of studs and their replacement.

PREPARATION FOR STUD REMOVAL - Remove cylinder having broken stud. If a thru-stud anchored in the cylinder pad is broken, a cylinder on the opposite side of the engine must be removed. (See Table VIII.)

TABLE VIII

Broken Stud Cylinder No.	Cylinder to be Removed on Opposite Side
2	3
3	2

METHOD OF STUD REMOVAL - There are two separate sets of tools required for removing studs. The one set (any stud removal tools equivalent to Snap-On Tool Corporations No. CG-500 Threaded Collet Type Stud Puller, and No. 1020 Extractor Set may be used) consists of a tapered collet that threads on to the stud and a housing slips over the collet; tightening a bolt on the top of the housing draws the collet into the housing, locking the puller onto the stud with a tight grip. This type of stud removal tool is to be used when sufficient thread area is available on the stud to permit its use. The other type of stud removal tool consists of a set of drills, pilots and extractors and is to be used when the stud cannot be removed with the collet type tool. A small hole is first drilled in the stud. If the stud is broken beneath the surface of the cylinder mounting pad a pilot bushing is employed to guide the drill to the center of the stud. The hole is then redrilled to enlarge the hole to accommodate the proper size extractor. The flared edges of the extractor grip the sides of the drilled hole permitting extraction of the stud. The following conditions determine how the various types of studs shall be removed:

1. Short studs should be removed with the collet grip tool, providing there is enough thread remaining on stud to provide a gripping surface for the collet. If the stud is broken near or below the surface of the cylinder pad the stud must be drilled and the extractor used.

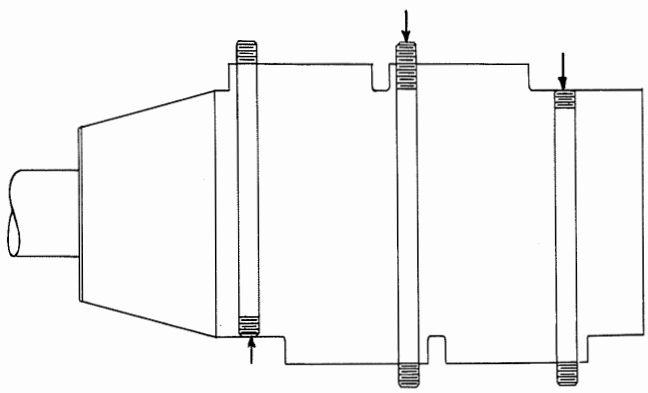


Figure 113 - Top View of Engine Showing Location of Thru Studs

2. Thru-studs anchored at the cylinder pads can be removed by use of the collet by turning the stud from its unbroken end. The direction in which the stud is turned is dependent on the end from which it is being turned. If the stud is being turned from its anchored end it must be turned in a clockwise direction. If it is being turned from its free, or unanchored end it must be turned in a counter-clockwise direction.

NOTE

Figure 113 shows the location of thru-studs in the O-320 and O-340 engines. The place of anchorage of each stud is indicated by arrows.

3. Thru-studs anchored at the crankcase can be removed with the collet tool providing sufficient thread area remains on the stud to allow a gripping surface for the collet, otherwise the stud must be removed from the crankcase by means of the drill and extractor. The direction for turning the stud is the same as described in the preceding paragraph (2) above.

4. After the broken stud, as well as the adjacent studs from the same cylinder pad have been removed, check for size and condition of thread in the stud holes to determine whether oversize studs must be used for replacement. Generally, on 3/8 inch and 1/2 inch short studs and 1/2 inch thru-studs that anchor in crankcase, it is recommended that the next oversize stud be installed. On the 1/2 inch thru-studs anchored in the cylinder pad it is not necessary to use the next oversize stud.

5. Using a suitable stud driver assemble the required studs. Use a white lead base thread lubricant and drive the studs to the correct depth.

NOTE

It is recommended that all straight cylinder base thru-studs (figure 114) be replaced with necked thru-studs (figure 115) at overhaul. See above paragraph for removing and replacing cylinder base studs. Part numbers have not been changed so that all studs shipped on present orders will be necked studs, Part No. 68751 should be driven to a height of .82 inch and Part No. 69376 should be driven to .63 inch. (See figures 116 and 117.)

PIPE FITTINGS - If any pipe threaded fitting shows indication of being loose or damaged, it should be replaced. However, if it is apparently in good condition, it should not be removed. If it is necessary to replace

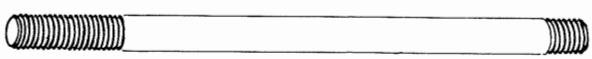


Figure 114 - Straight Thru-Stud

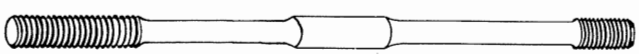


Figure 115 - Necked Thru-Stud

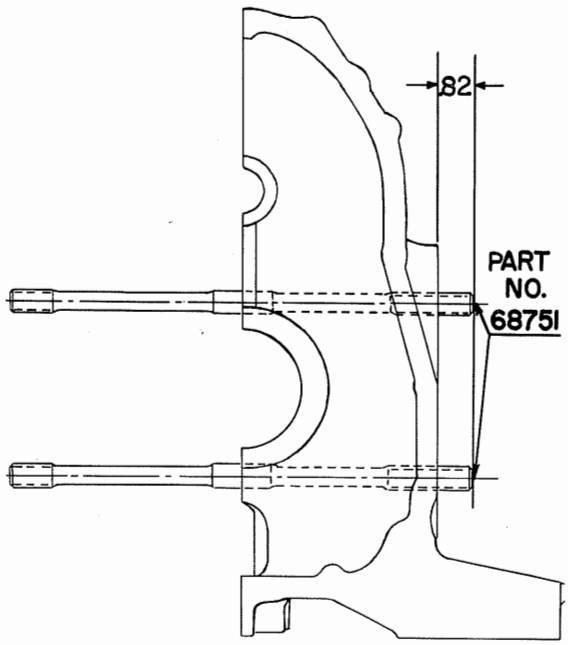


Figure 116 - Dimension for Driving Necked Thru-Studs in O-340 Crankcase Half

such fittings as those connecting the rocker box drain tubes, the new fitting should have its threads coated with white lead or other suitable thread lubricant before screwing the fitting into the hole. Extreme care must be exercised not to over-tighten such a fitting, because it can result in the hole becoming oversize or cracking the part.

CRANKSHAFT REPAIRS - If, during inspecton, it is found that the crankshaft run-out exceeds the maxi-

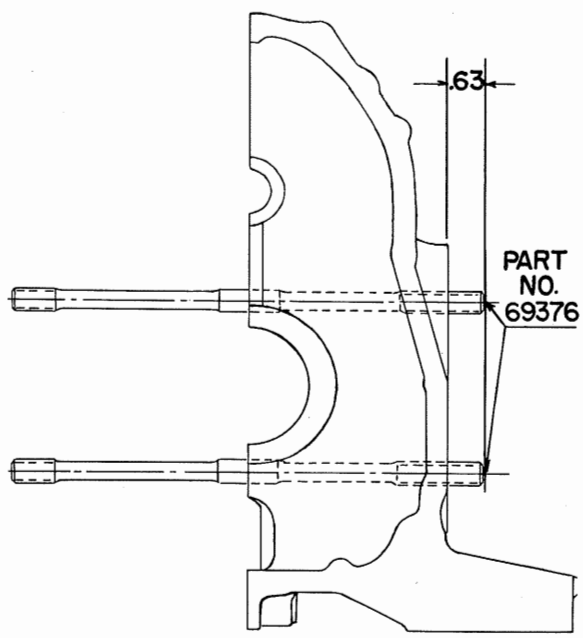


Figure 117 - Dimension for Driving Necked Thru-Studs in O-320 Crankcase Half

mum allowable service limit, the crankshaft must not be used again. No bending operation whatsoever is permissible, because the bearing surfaces are nitrided during manufacture of the crankshaft and have a glass hard surface that will crack if the shaft is bent. In handling a crankshaft during repair and assembly operations, the bearing surfaces must not be damaged. A crankshaft that has been scratched or scored may be polished with crocus cloth or some other fine abrasive to remove the scratches or scores, providing the maximum service limits have not been exceeded. If, however, after polishing the shaft the maximum service allowance has been exceeded, the shaft must be lapped to .003 inch undersize and then fitted with .003 inch undersize bearing inserts.

If it is necessary to make the journals more than .003 undersize, the crankshaft must be ground .010 undersize. The grinding operation is a very delicate one, requiring adequate grinding facilities and a high degree of skill and care on the part of the operator. A properly dressed wheel, Carborundum GA54-J5-V10 or one of corresponding grade, must be used in conjunction with generous quantities of coolant. The wheel must be fed to the journal or pin very slowly and the final ground finish maintained during the complete operation. This procedure must be followed to eliminate possibility of grinding cracks. After grinding, the crankshaft must be carefully inspected by the magnetic particle method and examined for cracks or checks. If any cracks or checks are found, the shaft must be rejected.

NOTE

It is mandatory that all reground crankshafts be re-nitrided. This is necessary because of the non-uniformity of grinding tools. The possibility exists wherein the grinding wheel will cut through the nitrided surfaces on one or more of the journal radii causing areas of stress concentration that can develop into fatigue cracks and ultimately result in a broken crankshaft. Crankshafts may be returned to Lycoming for regrinding and nitriding if desired.

STRAIGHTENING BENT CRANKSHAFT FLANGE - In the event that the front flange of the crankshaft should become bent through sudden stoppage of the engine or other cause, straightening operations are permissible, provided that the total flange run-out does not exceed .018 inch. If so desired, the crankshaft may be returned to Lycoming for this work.

NOTE

Remove the six flange bushings before attempting any straightening operations.

When the surface distortion of the flange has been reduced as much as possible the front face of the flange should then be trued by grinding. This operation is permissible, however, only if the minimum width of the flange after grinding is not less than .260.

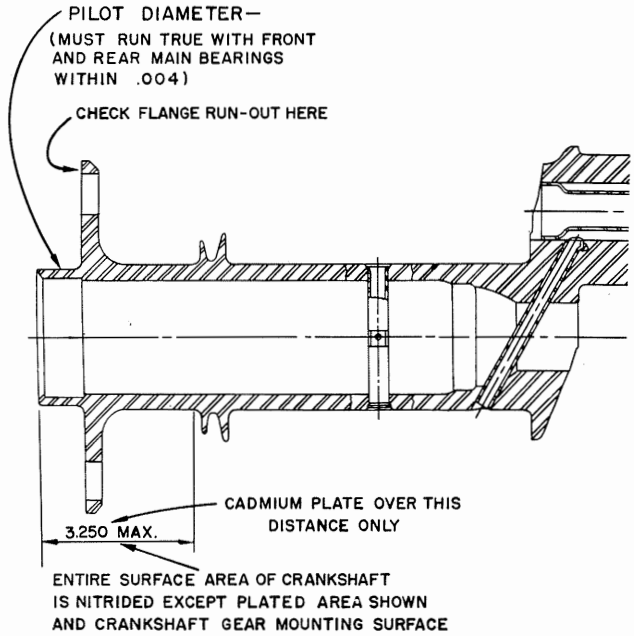


Figure 118 - View Showing Un-nitrided Surface of Crankshaft

CAUTION

Extreme care must be exercised during straightening operations to avoid damage to the nitrided surfaces of the crankshaft. These surfaces, which extend without interruption from the front oil seal seat to the crankshaft gear seat, are glass-hard and will crack if the shaft is bent, dropped, or carelessly handled in any way.

At the conclusion of all straightening operations, the entire crankshaft must be inspected by the magnetic particle method, paying particular attention to bearing surfaces and the fillet areas at the base of the flange.

After inspection, install the six flange bushings and then cadmium plate the ground surfaces of the crankshaft flange. The plating, which should be .0005 maximum thickness, should be permitted to extend along the crankshaft proper only to the dimension shown in figure 118.

OIL PASSAGE TUBES - No attempt should be made to remove the oil transfer tubes or propeller oil tube from the crankshaft. If for any reason these tubes must be replaced, the crankshaft should be returned to Lycoming Division for their removal and replacement.

CRANKSHAFT OIL PLUG - The crankshaft oil plug installed in the rear of the hollow front section of crankshafts fitted for constant speed operation will not require replacement under ordinary circumstances. In the event that replacement of this plug is necessary, the crankshaft should be returned to Lycoming.

OIL RELIEF VALVE SLEEVE - The oil relief valve

sleeve has a .001 press fit with the relief valve bore in the crankcase. If the sleeve seat is badly scored or otherwise damaged, remove and replace the seat as follows:

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

CAUTION

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

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

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

Place a new relief valve sleeve into the crankcase bore with the seat end of the sleeve toward the crankcase. Making sure that the sleeve is centered in the bore, insert the driver (figure 47) in the sleeve and drive the sleeve into place with light hammer blows.

CONVERSION FROM 60883 ENGINE MOUNTING BUSHINGS TO LORD BUSHINGS - O-320 engines being converted from fixed pitch to constant speed operation must be equipped with Lord mounting bushings in order to satisfy CAA approval requirements. The installation of Lord bushings involves drilling out the four crankcase mounting flange holes from .88 diameter to 1.00 diameter. The drilling operation can be performed with standard shop equipment, provided that the equipment is capable of drilling out the holes exactly parallel to the longitudinal centerline of the engine.

Owners desiring to convert to Lord mounting bushings can obtain bushings from the airframe manufacturer.

SECTION IX

ASSEMBLY

CORROSION PREVENTIVE - Prior to assembly of subassemblies, all parts should be cleaned to remove all traces of corrosion-preventive mixture and accumulated foreign matter. During assembly, cover all steel parts with a heavy coat of corrosion-preventive mixture. (Recommended products and correct proportion of mix will be found in the note on page 24). This mixture should be used on all internal parts on which corrosion may occur, and especially on all bearing surfaces, cylinder bores, and piston rings. The practice of using plain lubricating oil during assembly is not satisfactory.

NOTE

During assembly, new oil seals and gaskets are to be used in all instances. Do not reuse oil seals and gaskets.

IGNITION HARNESS - Unless the ignition harness is in obvious new condition, it is suggested that the entire harness be replaced at overhaul.

CRANKSHAFT

CRANKPIN JOURNAL SLUDGE TUBES - New tubes must be used when reassembling the crankshaft. The new tubes may be installed in any order that is most convenient. However, it is important that the proper tools be used for their installation and also that they be driven to their exact and proper location in each journal. See figure 119 for correct location of each tube in its respective journal. The oil tube drift (figure 42) which was used for removing the old tubes is used again for installing the new ones. By hand pressure, insert the drift in the tube, the bar in the drift, and drive the tube to its correct depth with a hammer. (See figure 120.)

EXPANSION PLUG (FIXED PITCH ONLY) - Place a new expansion plug in the front of the crankshaft with the convex side toward the front. Be sure that the plug fits firmly against the shoulder provided for it on the inside diameter of the crankshaft. Then place the end of a suitable drift exactly on the center of the expansion plug and drive it to a tight fit with a sharp blow of a hammer.

NOTE

On engines equipped with hydraulically controlled pitch propeller, no expansion plug is used.

PROPELLER FLANGE BUSHINGS - If the propeller flange bushings have been removed from the crankshaft, new bushings must be installed. To install the new bushings, support the crankshaft on suitable blocks on the bed of an arbor press and drive each bushing separately with an even pressure of the press until the bushing seats squarely with the rear of the propeller flange. If this operation is performed, the run-out of the propeller flange must be rechecked.

NOTE

The propeller flange bushing arrangement used on controllable propeller installations differs from that used on fixed pitch installations; see figure 121 and 122 for details.

CRANKSHAFT OIL SEAL - The crankshaft oil seal assembly, consisting of a split oil seal and spring,

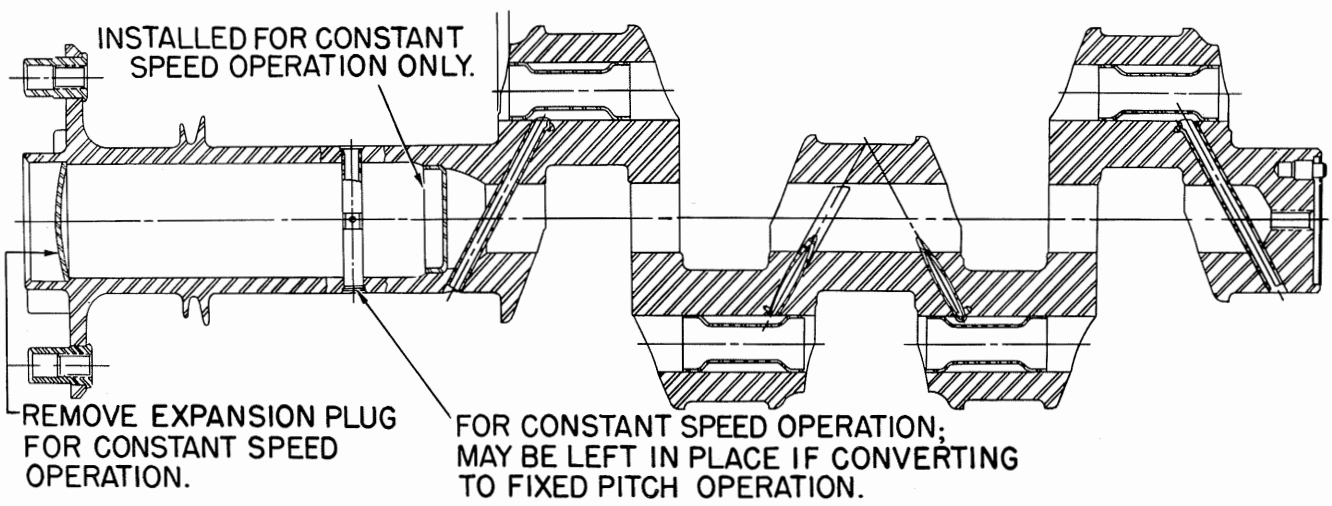


Figure 119 - O-320 and O-340 Crankshaft

Figure 120 - Installing Crankpin Oil Tubes

should be replaced at overhaul. To assemble oil seal, loop the garter spring around the crankshaft and lock by twisting each end in opposite directions, placing the ends together and allowing the torsion of the spring to lock the ends. (See figure 123.) Slip the seal around the crankshaft ahead of spring, bevel side to the front. Assemble spring in the groove in seal.

CRANKSHAFT GEAR - (See figure 124) - The crankshaft gear (1) may now be assembled on the rear of the crankshaft (2). Make sure that it fits over the dowel (3) and is located securely in the counterbored recess provided for it in the rear of the crankshaft. Fit a new lock plate (4) into the recess of the crankshaft gear in such a manner that the lip of the lock plate extends through the slot in the gear hub. Secure the crankshaft gear and lock plate assembly to the crankshaft with the crankshaft gear screw (5); see Table of Limits for proper torque limit.

CRANKSHAFT AND CONNECTING RODS - Place crankshaft in suitable fixture on bench so that all crankpins are free for the installation of the connecting rods. Each connecting rod and its corresponding cap is stamped with a number which designates to what crankshaft journal it is to be assembled. These numbers are located on the connecting rod bolt boss of both the cap and the rod. The cap must be assembled to the rod so that the numbers are adjacent to each other. In other words, the cap must not be assembled with its number on the opposite side from the number on the rod. When assembling the connecting rods to the crankshaft, use new crankpin bearing inserts, bolts, and nuts. Be certain that the correct size of inserts is used.

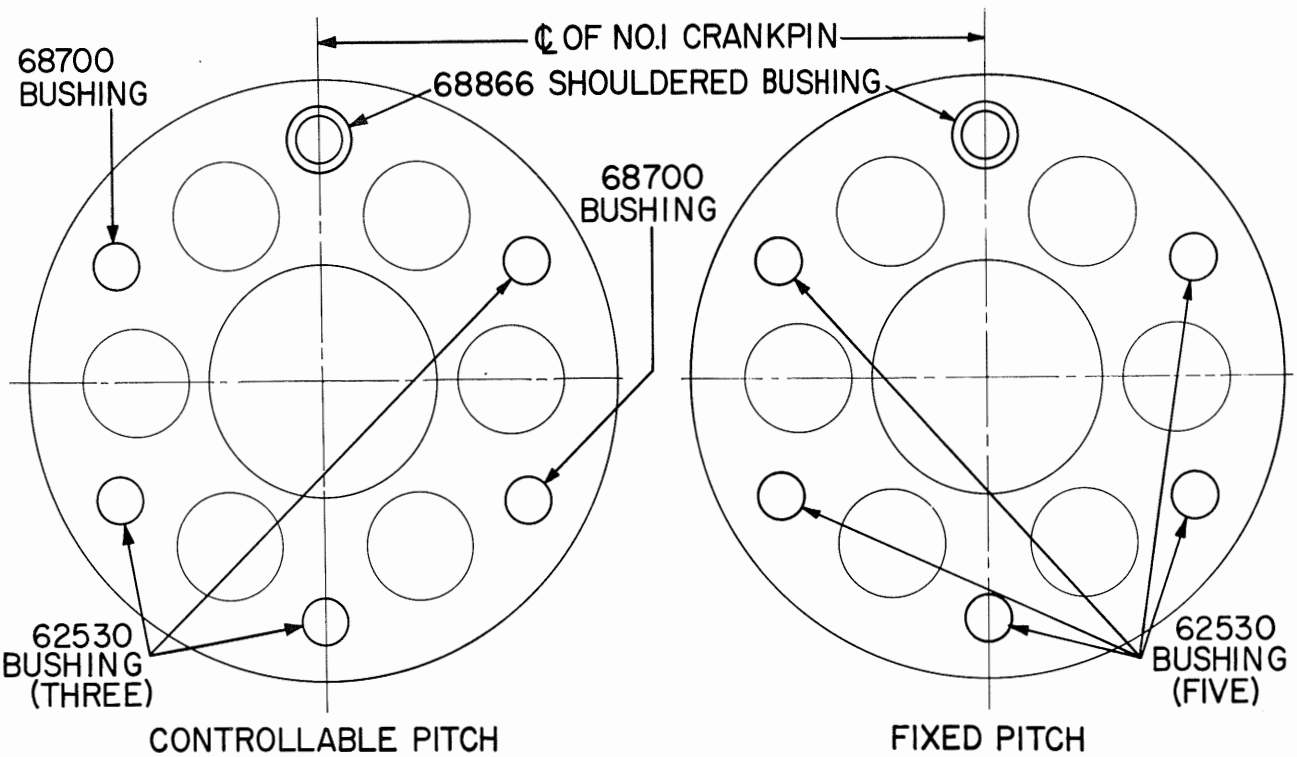


Figure 121 - Arrangement of Propeller Flange Bushing, O-320 Engine

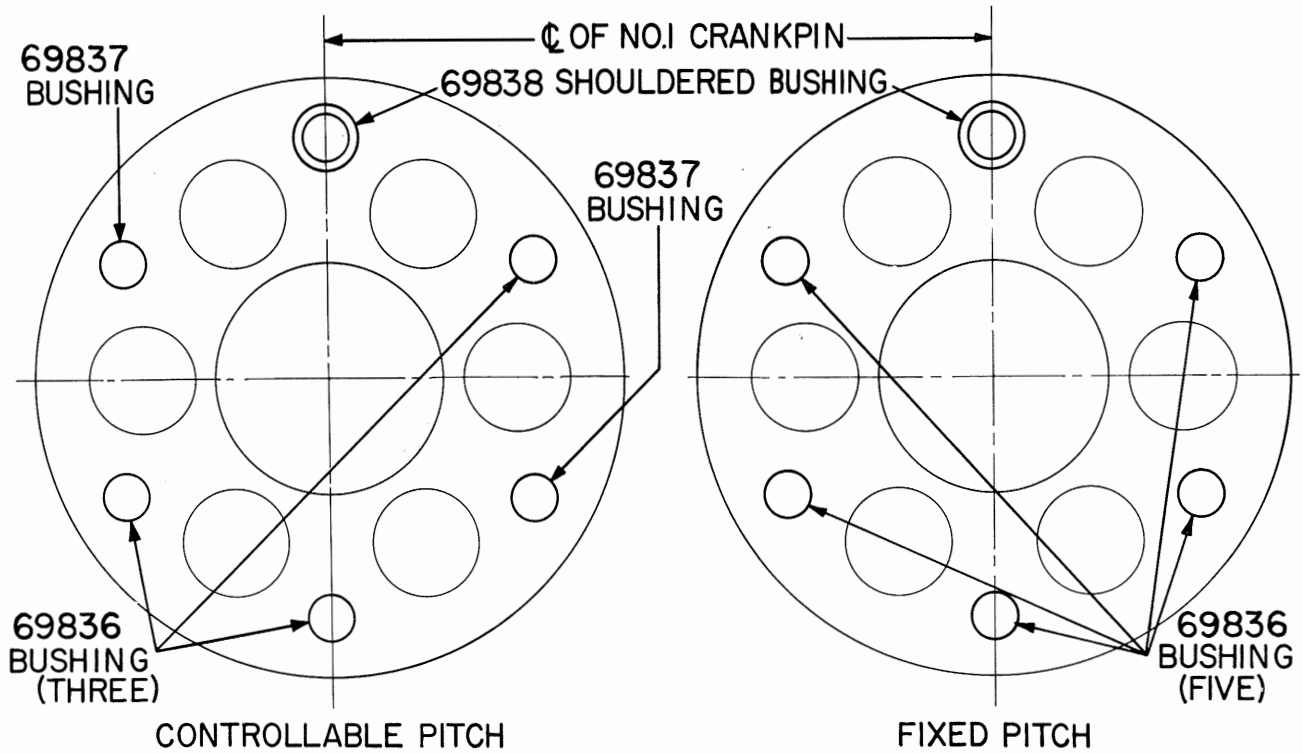


Figure 122 - Arrangement of Propeller Flange Bushing, O-340 Engine

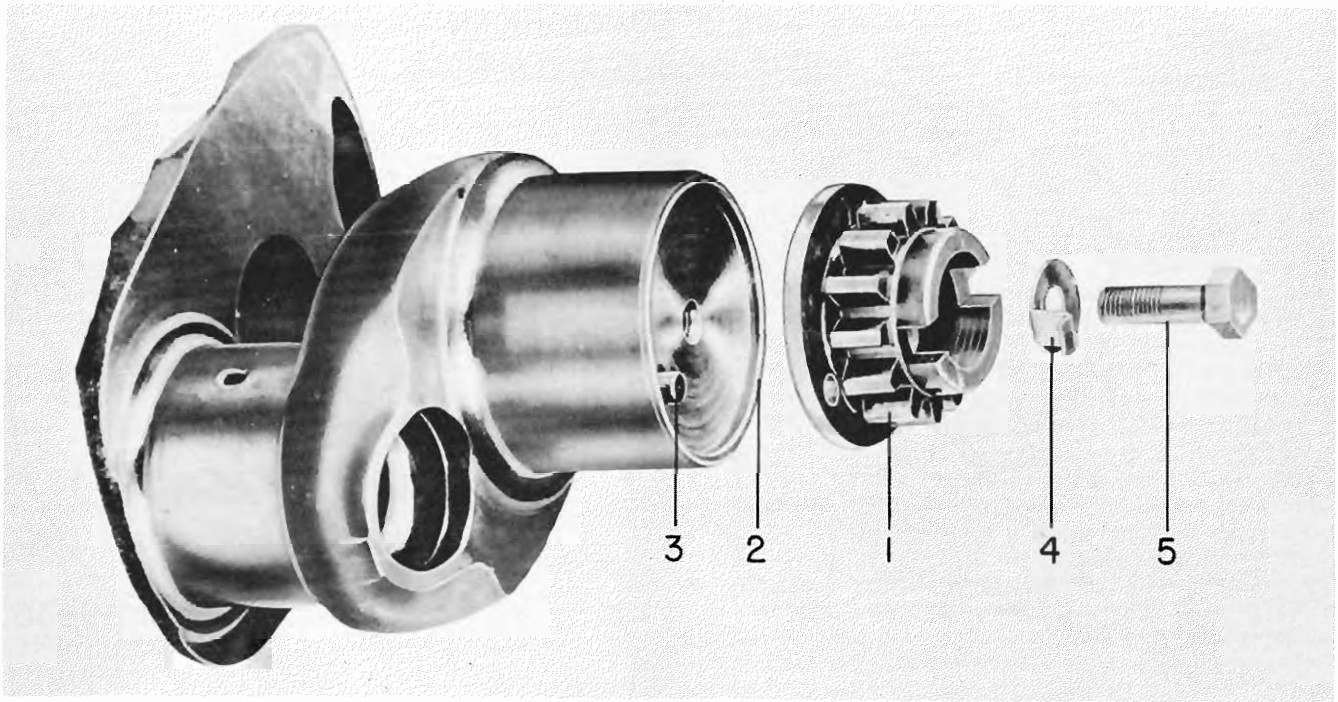
It is important also to assemble the connecting rods to the crankshaft in such a manner that numbers stamped on the rods will be in a downward position when the engine is finally assembled. This will not be difficult to accomplish if the mechanic will remember that numbers one and three cylinders are on the right side of the engine, and numbers two and four cylinders are on the left. Before assembling a connecting rod and cap to a crankpin journal, coat both the bearing inserts and the crankpin journal with a liberal amount of lubricating oil. Use a torque wrench when tightening the connecting rod nuts. (See the Table of Limits for proper torque limits on all fastenings.) See Table of Limits for clearance between the connecting rod bearing and the crankpin journal. After the connecting rods have been assembled, nuts properly tightened, and cotters inserted, the crankshaft assembly is ready for installation in the crankcase.

CRANKCASE

ALLEN HEAD PIPE PLUGS - During the inspection and repair of the crankcase, all loose or damaged studs, plugs, and nipples shall have been replaced and the crankcase prepared for assembly. However, before beginning its assembly, examine the right half of the crankcase and make sure that the three .125 Allen head pipe plugs have been assembled, one in the front end of the main oil gallery, one in the rear of the main oil gallery, and one at the angular passage near the rear end of the main passage. If these three plugs have not been installed, the oil passages should be rechecked to ascertain if any foreign matter has lodged in them. However, before screwing them in, the threads of the plug should be coated with a suitable thread lubricant.

MAIN BEARING INSERTS - Place both crankcase halves on a suitable support with the interior of each case facing upward. Place new bearing inserts in the center and rear main bearings of both crankcase halves, making certain that the tang of each insert is fitted into the recess provided in the crankcase. Place the front main bearing temporarily in position in the left crankcase half, making sure that the bearing is properly seated on the two dowels. (Note that this bearing, unlike the center and rear main bearings, splits on the horizontal center line of the engine.) Using a sharp pencil, trace on the assembled bearing

Figure 123 - Method of Assembling Oil Seal Spring



1. Crankshaft Gear
2. Crankshaft
3. Dowel
4. Lockplate
5. Crankshaft Gear Screw

Figure 124 - Crankshaft Gear Assembly

both lines of intersection between the crankcase parting flanges and the bearing. Also make a vertical reference mark on both the bearing and crankcase at any convenient point along the line of intersection, thus locating the bearing both radially and axially. These marks are necessary to insure proper seating of the bearing halves on the two locating dowels when the crankshaft is placed in position in the crankcase.

IDLER GEAR SHAFTS - These parts must be assembled before the halves of the crankcase are joined. One is assembled to the rear of each half of the crankcase in the following manner: Insert the pilot of the shaft into the hole provided for it in the crankcase and turn the shaft until the holes of the pilot flange align with the drilled holes in mounting pad of the crankcase. Place a lock plate over the flange, insert two 1/4-inch hex head screws into the mounting holes, and tighten to specified torque. Lock the screws by bending the ears of the lock plate over the hex heads.

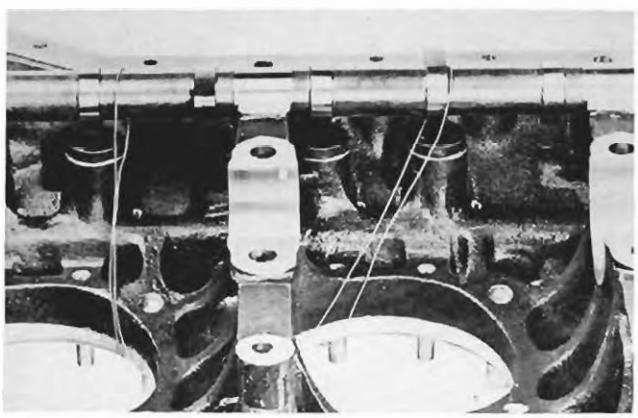


Figure 125 - Camshaft Wired to Crankcase

CAUTION

Although the idler gear shafts used on the O-320 and O-340 Series are similar in general appearance and overall dimensions to those used on the O-290-D and other four cylinder models, the shafts are not interchangeable. O-320 and O-340 idler gear shafts are partially hollow, being drilled from the front end. They are lubricated by pressure oil from drilled passages leading from the rear main bearing. Other engines, however, employ completely hollow shafts lubricated by pressure oil from the accessory housing, and any attempt to interchange idler gear shafts will result in serious malfunctioning of the lubrication system.

OIL SEAL RINGS - The right half of the crankcase has two through bolts and four long studs; the left has two long studs. (See figure 5.) A counterbored recess is provided for an oil seal ring at each through bolt and stud location. One of these rings should be assembled at the base of each stud and through bolt hole. Do not reuse oil seal rings; new ones should be installed at each overhaul.

TAPPET BODIES - Coat each tappet body liberally with 600-W oil and insert the bodies in the crankcase halves.

CAMSHAFT - Coat the camshaft with 600-W oil and and lay the shaft in position in the right crankcase half. Loop a wire or rubber band around the camshaft and then around an adjacent cylinder stud in such a manner that the shaft will be held securely in place when the crankcase is turned over (See figure 125.)

INSTALLING CRANKSHAFT - Remove the front main bearing halves from the left crankcase half, coat each bearing half liberally with corrosion-preventive mixture and assemble the bearing on the crankshaft. Rotate the bearing on the journal so that the three oil transfer holes will be uppermost when the crankshaft is placed in position in the left crankcase half. Pick up the assembled crankshaft by numbers one and three connecting rods and lower the crankshaft into the left crankcase half permitting numbers two and four rods to protrude through their respective cylinder mounting pads. Using the reference marks made previously (see "Main Bearing Inserts" above), adjust the main bearing so that the halves are seated squarely on the locating dowels. Protect the crankshaft oil seal from damage during assembly of the crankcase halves by pulling the seal out to the propeller flange end of the crankshaft.

CRANKCASE ASSEMBLY - Coat the main bearing journals of the crankshaft and the main bearing inserts of the right half of the crankcase with a generous amount of corrosion-preventive mixture. Following this, apply a film of non-hardening gasket compound to the outside mating flanges of each half of the crankcase. The film of gasket compound must be confined to the outside mating flanges only, and must not be applied to any other mating surface of the crankcase halves such as the bearing support webs. Next place a length of silk thread along the upper mating flange of the left crankcase, seating the thread securely in the gasket compound. The thread should extend all the way along the flange from front to rear of the crankcase half. Before assembling the right half of the crankcase over the left, place the numbers one and three connecting rods in a vertical position so that they will enter the cylinder holes of the right half of the crankcase. Lower the right half carefully so that the studs align properly with the opposite half. If the right half has a tendency to stick, tap it gently with a soft hammer to facilitate its assembly. However, no difficulty will be encountered if the halves of the cases are kept parallel while the right half is being lowered onto the left. After the cases are together, the right may be tapped with a soft hammer to seat it securely all around. Push the crankshaft oil seal into its recess in the foremost end of the crankcase and remove the wire or rubber band that was used to hold the camshaft in position.

CRANKCASE FASTENINGS - It will be noted that the halves of the crankcases are secured together by means of several sizes and types of bolts, capscrews, and nuts. It is important that the correct fastening be used in its proper position.

SUPPORTING CONNECTING RODS - Immediately after initial assembly of the crankcase, secure all four connecting rods, either with heavy rubber bands (discarded cylinder base oil seal rings) or metal plates fitted over the cylinder studs as shown in figure 88.

LIFTING STRAP - Assemble this part at the third crankcase fastening from the rear at the top of the engine with a 1/4-inch through bolt and nut.

GENERATOR MOUNTING BRACKET - Fit this part in place on the lower right front of the crankcase and fasten with two 1/4-inch capscrews and washers and 1/4-inch through bolt, nut, and washer. On engines with propeller governor, assemble a governor oil line clip on the rear or through bolt, hole on the generator bracket.

CRANKCASE THROUGH BOLTS - Assemble two 3/8-24 hex head bolts 3 1/2-inches long through the right side of the crankcase near the propeller flange. These bolts will protrude through the left side of the crankcase and are fastened with 3/8-inch lockwashers, plain washers and nuts.

STARTER RING GEAR ASSEMBLY - Place the generator drive belt in the pulley groove of the starter ring gear support; then fit the starter ring gear assembly over the propeller flange bushings of the crankshaft. The bushing in line with No. 1 crankpin is shouldered, thereby assuring proper alignment of the timing marks on the ring gear. (See indexing marks on the shaft and gear assembly.)

MOUNTING ENGINE TO OVERHAUL STAND - At this stage of assembly, a chain hoist may be attached to the lifting strap and the partially assembled engine raised from its support. After the engine has been raised to a convenient height, it may be mounted to an overhaul stand in the following manner: Attach the engine mounting plate (figure 17) to the overhaul stand. Insert eight engine mounting bushings in the mounting lugs at the rear of the crankcase. Assemble 1/2-inch plate washers over the bushings and fasten the engine to the mounting plate with four 3/8-inch bolts and nuts.

TIGHTENING CRANKCASE FASTENINGS - Before further assembly of the engine is accomplished all crankcase fastenings may be firmly, but not tightly, secured. Final tightening should not be accomplished until all cylinders have been assembled. The final tightening should then be done in accordance with the sequence shown in figure 130.

PISTONS AND CYLINDERS

PISTON RINGS - Assemble new rings on each piston in the following manner: First assemble the oil regulating ring equalizer in the first groove above the piston pin hole. Then install the regulating ring over the equalizer with its gap 180° opposite the equalizer gap. Compress the assembly several times with the fingers to make sure the ring lies free and loose in the groove.

NOTE

Both the equalizer and the regulator ring are symmetrical and may be installed with either side upward.

Assemble the second compression ring in the groove above the oil regulating ring, and than install the first compression ring in the top groove of the piston.

CAUTION

Do not under any circumstances assemble chrome plated piston rings in a chrome plated barrel. Chrome plated cylinders are identified by an orange band around the base of the barrel.

All rings should be assembled with a piston ring expander (figure 58), being careful that rings marked with the word "TOP" on them are assembled with the marked side of the ring toward the top of the piston. Check the side clearance of all rings with the piston; they should be within the dimensions shown in the Table of Limits, Reference 514, 515, and 516. Also, if inspection of cylinder barrels and piston grooves has indicated that oversize rings are required, it will be necessary to select the proper oversize rings.

VALVES - Coat stems of both intake and exhaust valves of each cylinder with corrosion-preventive mixture and insert in their respective guides. Be sure that each valve is inserted in its proper guide; although the stems of both intake and exhaust valves are alike in length and diameter, exhaust valves may be identified by the fact that the valve head is smaller in diameter than the intake valve head. Further identification is provided by the valve ports in the cylinder head; the exhaust and intake ports can be determined by the fact that the exhaust is smaller than the intake.

NOTE

Replace all exhaust valves with new valves.

After the valves have been inserted in the cylinder, place the cylinder over the cylinder holding block (figure 10).

VALVE SPRINGS - Slide a lower spring seat over each valve guide and fit each seat into the recess provided in the cylinder head. Assemble an inner and outer valve spring over each valve stem and fit an upper spring seat in place on top of each pair of springs. Compress the springs with the valve spring compressor (figure 9) and assemble the valve retaining keys in place, making certain that the larger diameter of the key is uppermost and the internal ring is recessed into the groove on the valve stem.

NOTE

When installing valve springs, place the close wound dampener coils (marked with red dye or lacquer) toward the cylinder.

ASSEMBLING CYLINDERS TO ENGINE - Beginning with No. 1 cylinder, assemble pistons and cylinders to the engine in the following manner:

Rotate the crankshaft until it is at top dead center of the firing stroke for No. 1 cylinder. At this point, the connecting rod will be at the limit of its extension out from the crankcase and both valves will be closed (i.e. both tappet bodies resting on the base circle of the cam).

After applying a liberal coating of corrosion-preventive mixture to all surfaces to be joined, assemble the piston and the connecting rod. Be sure that the piston number, which is stamped on the bottom of the piston head, is positioned toward the front of the engine. The piston pin should be a hand or palm push fit. If a new piston or piston pin is being installed, select a pin which will give a palm push fit at room temperature (60° to 70° F). After the piston pin is in place and centered in the piston, insert a piston pin plug in each end of the piston pin hole.

NOTE

It is permissible to heat the piston in order to assemble a pin which does not make a free fit, provided that both piston pin and piston pin bore in piston have been given thorough dimensional and visual inspection (see Reference 512, Table of Limits).

Selecting the parts from the proper compartment of the cleaning basket (figure 27), slide a hydraulic tappet spring onto the plunger and insert the plunger into the tappet cylinder. Then insert the cylinder, plunger and spring assembly into the tappet body (which was mounted in place during assembly of the crankcase). Complete the assembly of the tappet by sliding the socket (ball end outward) into the tappet body so that the socket bears against the plunger. During assembly of the tappets, be sure that there is no corrosion-preventive mixture inside the tappet body and that the plunger and cylinder assemblies are thoroughly clean and dry. This is absolutely necessary to insure the accuracy of the subsequent valve clearance check.

Assemble a new cylinder base oil seal ring around the base of the cylinder and coat the piston, rings, and interior of cylinder with a generous quantity of corrosion-preventive mixture. Fit a piston ring compressor (figure 58) over the piston rings and carefully slide the cylinder assembly over the piston. Adjust the cylinder over the studs and begin tightening all cylinder base nuts in the following sequence, using the proper base nut wrenches (figure 11, 12, or 14, 15) and handle (figure 13) in conjunction with a suitable torque indicator.

NOTE

Torque wrenches employing the flexible beam design are recommended in preference to those using the hydraulic principle or a dial indicator with rack and pinion.

a. Tighten all 3/8 inch cylinder base nuts to 200 inch

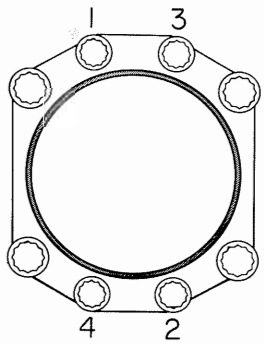


Figure 126 - Sequence of tightening 3/8" Cylinder Base Nuts

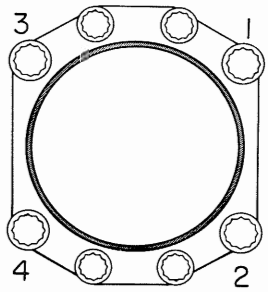


Figure 127 - Sequence of tightening 1/2" Cylinder Base Nuts

pounds torque. The order of cylinders is immaterial, but the nuts on each individual cylinder should be tightened in the sequence as shown in figure 126.

b. Tighten all 1/2 inch cylinder base nuts on the No. 2 cylinder to 300 inch pounds torque in the sequence shown in figure 127. Then using the same sequence, proceed to tighten the 1/2 inch nuts on cylinders 3, 4, and 1 in that order. For the correct designation of cylinders, use figure 3.

c. Repeat step "a" above, this time tightening the 3/8 inch nuts to 300 inch pounds torque.

d. Repeat step "b" above, this time tightening the 1/2 inch nuts to 550 inch pounds torgue.

e. During the final tightening procedure, bearing crush or crankcase shift may have occurred, relieving the load on certain of the 1/2 inch stud nuts. Therefore, as a final check, repeat step "d". This may be done by holding the wrench on each nut for about five seconds at 550 inch pounds. If the nut does not turn it may be presumed to be tightened to the proper torque.

Secure Allen head nuts by lock wiring as shown in figure 128, using .0403 diameter wire.

Install a suitable vented plug in both spark plug holes, thereby preventing the entrance of moisture or foreign matter while at the same time permitting easy turning of the engine by hand.

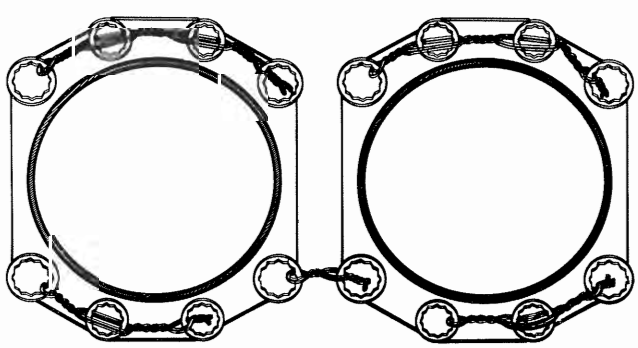


Figure 128 - Method of Lockwiring Allen Head Cylinder Base Nuts

Place a new shroud tube oil seal on the crankcase end of each shroud tube and fit a new oil seal ring in the groove provided in the rocker box end of the tube.

NOTE

On earlier models (Engine Serial Numbers 101-27 to 216-27 inclusive, 257-27 to 268-27 inclusive, and 357-27 to 368-27 inclusive), an annular oil seal ring was provided which fitted into a machined recess in the shroud tube hole in the rocker box, and the rocker box end of the shroud tube was formed with straight side walls. On current O-320 and all O-340 models the shroud tube hole in the rocker box is machined smooth, and the oil seal ring lies in a groove formed near the end of the shroud tube. Complete cylinder assemblies with either type of machining are interchangeable, but shroud tubes and oil seal rings (furnished with individual cylinders of one design are not interchangeable with tubes and rings designed for the other; consult the parts catalog when ordering replacements.

Install each shroud tube through its hole in the rocker box and seat the end firmly in the crankcase. Place a spacer, two springs, a lock plate, and a plain 1/4-20 nut over the stud provided in the rocker box. Tighten the nut to proper torque and secure by bending the lock plate over nut and springs (see figure 87).

After applying a liberal coating of corrosion-preventive mixture to all parts to be assembled, insert a push rod in each shroud tube, placing the grooved end of the rod outward (i.e. away from the crankcase).

NOTE

A sodium cooled rotator type exhaust valve is employed on O-320 engines beginning with serial no. 6012-27 and O-340 engines. These valves require valve stem caps on their stem end.

Next, start a valve rocker shaft into one of the rocker shaft mounting bosses in the cylinder head. While holding a valve rocker in place, push the rocker shaft through the valve rocker and into the hole in the middle boss. Repeat with the other rocker, pushing the shaft through until it protrudes equally from both outside mounting bosses. After the rockers are installed, check the clearance between the valve stem tip and the valve rocker. This is done by inserting the valve clearance gage (figure 35) into the gap between rocker and valve stem while pushing down on the push rod end of the valve-rocker. If the valve clearance exceeds the minimum and maximum limits (see Table of Limits) it must be adjusted by inserting a push rod of different length. These lengths may be identified by the number of grooves turned into the tappet end of the rod (see figure 129); the shortest rods have three grooves, the medium length rods have two grooves, and the longest rods have one groove. Inserting a longer rod will decrease the clearance. After the proper clearance has been obtained, attach the rocker box cover and gasket with the necessary capscrews and washers.

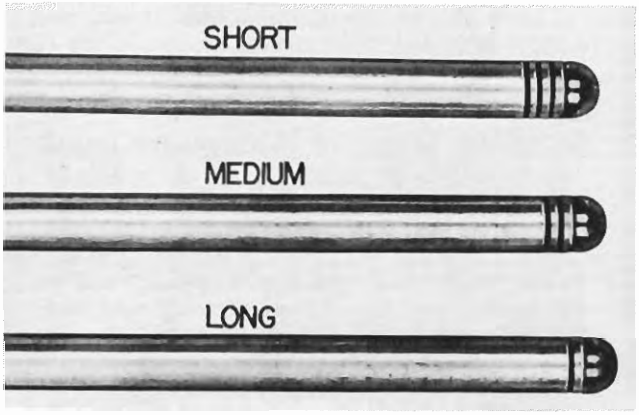


Figure 129 - Identification of Push Rod Length

After completing the assembly of No. 1 cylinder to the crankcase, proceed in the same manner with the assembly of the remaining cylinders, assembling the cylinders in the same sequence as the firing order (1-3-2-4).

TIGHTENING CRANKCASE FASTENINGS - Following the assembly of the cylinders, all crankcase fastenings should be tightened in their proper sequence (see figure 130) to the correct torque linit. For proper torque limits see Table of Limits.

The three 1/4-inch bolts located along the bottom of the crankcase near the rear and fastened with slotted shear nuts are secured with 1/16-inch diameter cotter pins. Also, the 3/8-inch bolt located at the rear of the crankcase above the camshaft flange is secured with a 3/32-inch diameter cotter pin.

TACHOMETER DRIVE SHAFT, CAMSHAFT GEAR AND CRANKSHAFT IDLER GEARS - (See figure 131.) Secure the tachometer shaft assembly (1) in the end of the camshaft (2) with a .187 diameter by 1-1/8 inch long pin (3). Fit the camshaft gear (4) into place on the rear of the camshaft and insert the tachometer shaft centering spacer (5) into the center recess of the camshaft gear.

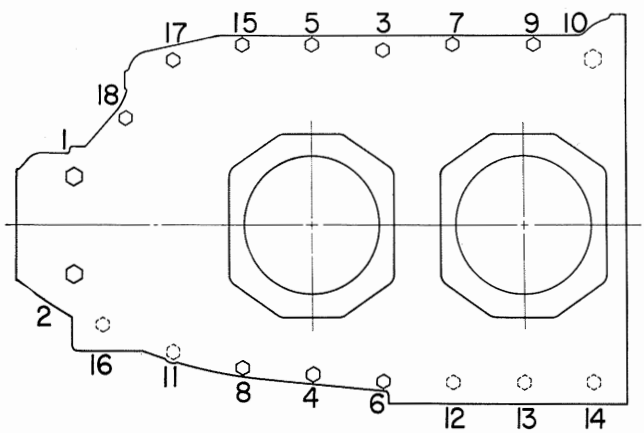


Figure 130 - Proper Sequence for Tightening Crankcase Fastenings

NOTE

Improper assembly of the tachometer shaft centering spacer during overhaul in the field has occassionally been responsible for the nose seal blowouts on the Lycoming O-320 engine. This spacer when reassembled on the wrong side of the breather slinger shuts off the breather passage and the consequent pressure build-up finds relief at the point of least resistance, usually the nose seal. The reason for this blow-out has been elusive because ground operation seemed normal, but when full power was applied, the spacer was free to move into a restricting position. When increased pressure demanded free breathing, the spacer was creating an effective block in the passage way. The centering spacer must be placed on the tachometer shaft between the camshaft gear and the breather slinger.

Place the crankshaft idler gear on the shaft located between the camshaft gear and the crankshaft gear. It will be noted that this gear is marked at two places with a small, etched circle. One of these marks is located at the space between two gear teeth, while the other mark is located on a gear tooth. The camshaft gear is marked with a small, etched dot at the space between two teeth, while the crankshaft gear is marked with a small, etched dot on one of the gear teeth. The marked tooth on the idler gear must mesh with the marked space on the camshaft gear, while the marked space on the idler gear must mesh with the marked tooth of the crankshaft gear. (See figure 132.)

This idler gear must be assembled in it proper relationship with the crankshaft gear and the camshaft gear, because no other combination of these three gears will permit the valve timing to be correct.

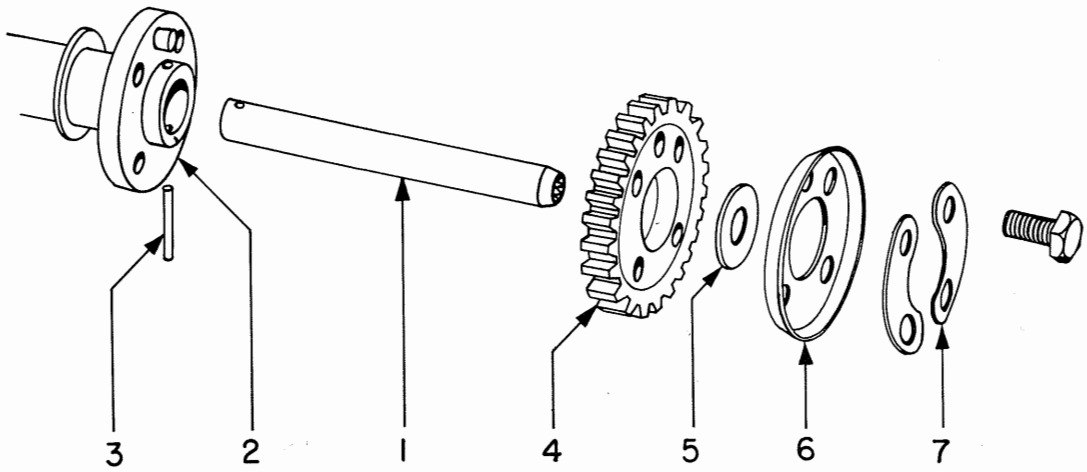
Locate the breather slinger (6) over the camshaft gear bolt holes, place two new lock plates (7) in position, and secure the assembly to the camshaft with four new 5/16-24 hex head bolts. Torque the bolts (see Table of Limits) and secure by bending up the ears of the lock plates.

The backlash between the camshaft gear and the crankshaft idler gear should not be less than .004 inch nor more than .020 inch. The same is true for the backlash between the crankshaft idler gear and the crankshaft gear; and also the backlash between the crankshaft idler gear and the magneto gear.

OIL RELIEF VALVE - Insert the ball in the sleeve of the oil relief valve chamber. Fit a copper asbestos gasket over the threads of the oil relief valve plug and insert the oil relief valve spring into the plug chamber. The assembled plug may now be screwed into the oil relief valve chamber.

ACCESSORY HOUSING

INSTALLATION OF VACUUM PUMP AND PROPELLER GOVERNOR DUAL DRIVE KIT - A dual drive kit providing a vacuum pump and propeller governor drive



1. Tachometer Shaft Assembly
2. Camshaft
3. Pin
4. Camshaft Gear
5. Tachometer Shaft Centering Spacer
6. Breather Slinger
7. Lockplate

Figure 131 - Camshaft Gear and Related Parts

is now available for installation on O-320 and O-340 engines. The kit (Lycoming Part No. 70385) is intended primarily for use on those installations where engine cowling or other restrictions prevent the use of the governor drive provided on the lower right hand corner of the accessory housing. The kit, which consists of a cast aluminum housing assembly, together with the required gears, attaching parts, and gaskets, is packed assembled and ready to install on the vacuum pump mounting pad. Instructions for installing the kit are as follows:

1. Remove vacuum pump from accessory housing.

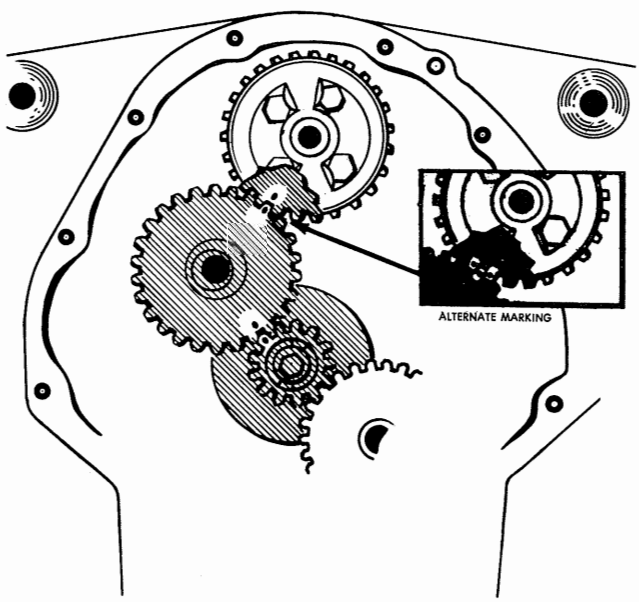


Figure 132 - Proper Relationship of Timing Marks on Idler, Camshaft, and Crankshaft Gears

2. Remove vacuum pump adapter; then remove vacuum pump gear assembly.

3. Remove all four studs from the vacuum pump mounting pad and install one 69943 (PO3) stud to a driven height of .83 inches in the upper left hand hole; the other three holes are left as is. (See figure 133.)

4. Mount the drive assembly on the vacuum pump mounting pad as shown in figure 134, securing the assembly in place as follows: Install a 1/4-20 nut, plain washer, and lock washer on the stud installed in the accessory housing in step 3 above. Install three 1/4-20 socket head capscrews, plain washers, and lock washers in the three holes ("B," figure 134) in the governor drive mounting pad.

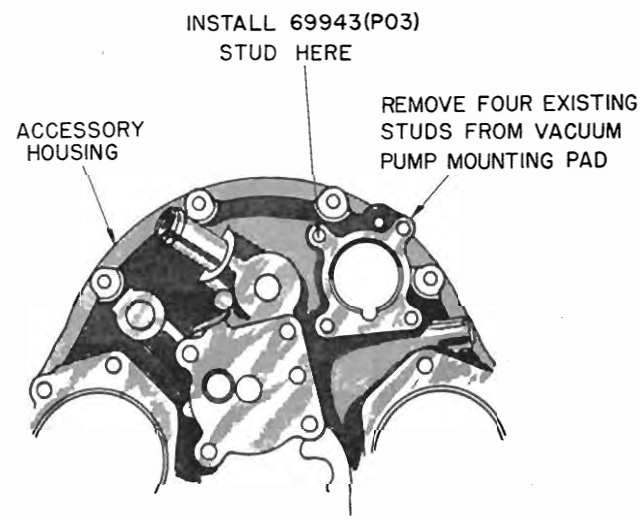


Figure 133 - Vacuum Pump Pad Stud Modification

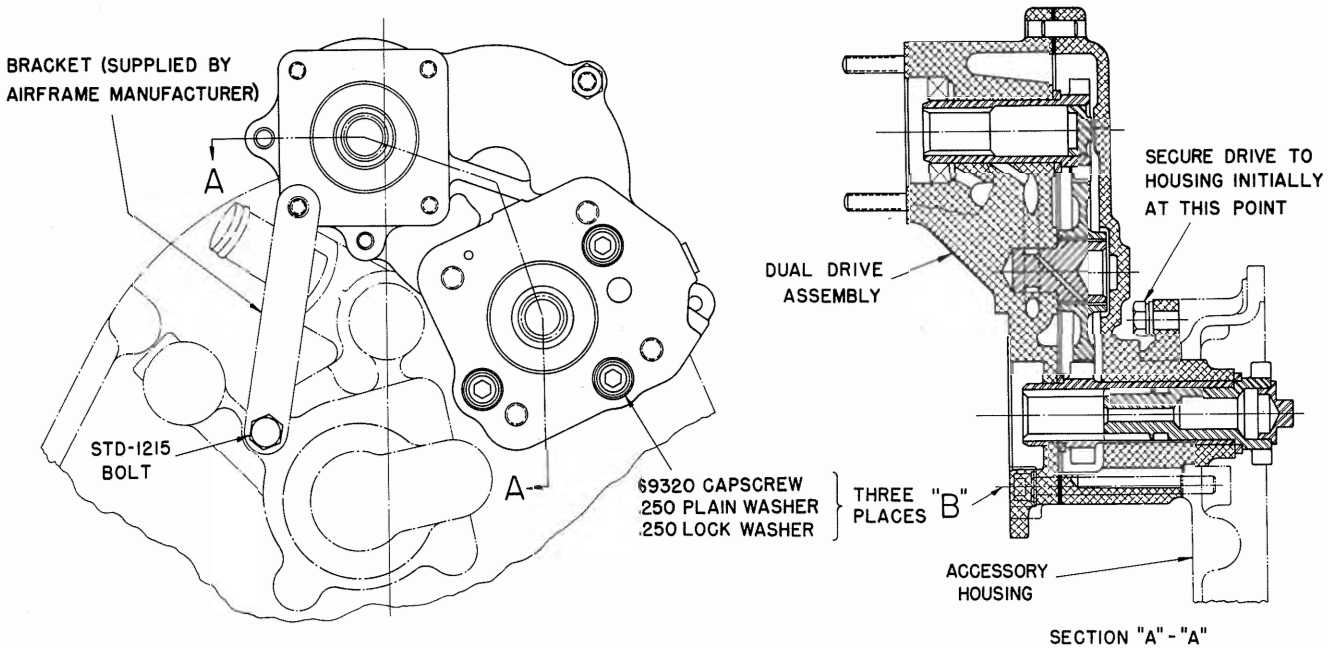


Figure 134 - Dual Drive Assembly

5. Install the vacuum pump and propeller governor on the dual drive housing. Use the gasket provided in the kit and the nuts and washers removed from the original vacuum pump drive on the accessory housing to attach the vacuum pump to the mounting pad. Secure one end of the P-7068-Y bracket (supplied by the airframe manufacturer) to the lower left hand stud on the vacuum pump pad and attach the other end to the upper left hand corner of the pressure screen housing mounting flange as shown in figure 134, using the STD-1512 bolt provided. Check bracket for fit after vacuum pump is installed. Before mounting the governor, install a 69827 gasket, 69737 spacer, and 69723 gasket on the mounting pad in the order named. Attach the governor with the 5/16-18 bolts, plain washers, and lock washers provided.

6. The conversion of a Lycoming O-320 engine from fixed pitch to constant speed operation requires the installation of an external high pressure line from the governor to an elbow fitting at the front of the right crankcase. Two clips (68604) are provided in the kit for supporting the high pressure line; one clip is attached to the bottom of the crankcase by the same crankcase flange bolt that secures the rear of the generator mounting bracket, and the other is fastened to the sump-crankcase parting flange along the right side of the engine. A 1/4-20 bolt (STD-1415) is furnished to replace the shorter STD-1414 bolt furnished at the generator bracket location on earlier O-320 engines; with later engines the STD-1415 bolt in the kit need not be used.

INSTALLATION OF VACUUM PUMP AND HYDRAULIC PUMP DUAL DRIVE KIT - A dual drive kit (Lycoming Part No. 69912) providing a vacuum pump and hydraulic pump drive is now available for installation on Lycoming O-320 and O-340 aircraft engines equipped for constant speed operation. The kit, which consists of a cast aluminum housing assembly, together with the required gears, attaching parts, and gaskets, is packed assembled and ready to install on the vacuum pump mounting pad on the accessory housing. The drive is installed as follows:

1. Remove vacuum pump from accessory housing.

2. Remove vacuum pump adapter; then remove vacuum pump gear assembly.

3. Remove all four studs from the vacuum pump mounting pad and install three 69740 (PO3) studs, to a height of 3.34 inches, and one 69943 (PO3) stud, to a height of .83 inches in the pad at the locations shown in figure 135.

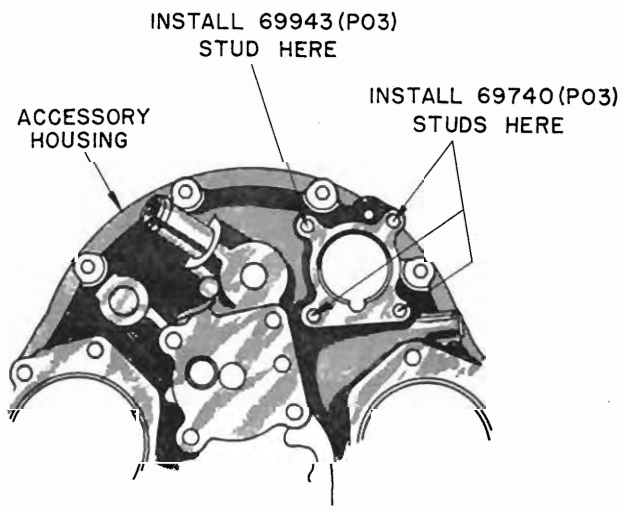


Figure 135 - Vacuum Pump Pad Stud Modification

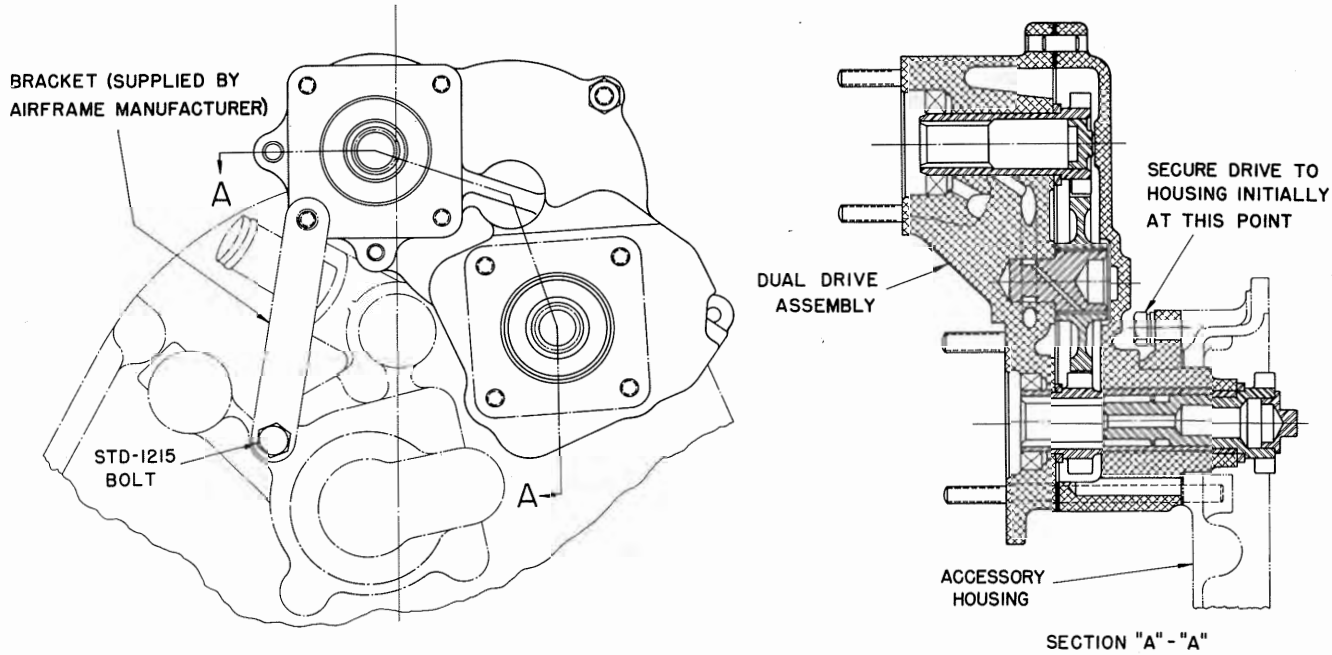


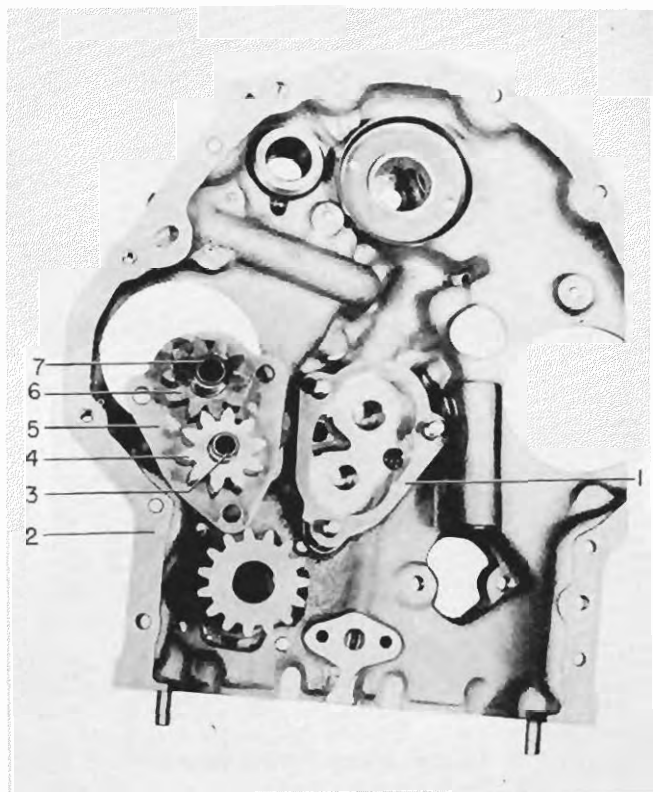
Figure 136 - Dual Drive Assembly

4. Install the drive assembly on the vacuum pump mounting pad on the accessory housing as shown in figure 136, securing the assembly in place with a 1/4-20 nut, plain washer, and lock washer on the short stud installed in the accessory housing in step 3 above.

5. Install the vacuum pump and hydraulic pump on the dual drive housing, using the remaining four sets of nuts and washers in the kit plus the four sets removed from the accessory housing in step 1 above. Secure one end of the P-7068-Y bracket (supplied by the airframe manufacturer) to the lower left hand stud on the vacuum pump pad and attach the other end to the upper left hand corner of the pressure screen housing mounting flange as shown in figure 136, using the STD-1215 bolt provided. Check bracket for fit after vacuum pump is installed.

STUDS, PLUGS, AND BUSHINGS - All semi-permanent fittings on the accessory housing should have been replaced during inspection and repair. However, before beginning assembly of the accessory housing, check the three oil passage openings to determine if they have been properly sealed. One opening is located on the upper side of the oil screen chamber mounting pad and should be closed with a .125 inch Allen head pipe plug (10, figure 85). An identical pipe plug (5, figure 85) should also be located in the oil passage on the right side of the accessory housing near the magneto mounting pad. In addition, a .250 inch Allen head pipe plug should be located in the oil passage on the bottom (sump) flange of the accessory housing.

If these three plugs have not been inserted during inspection and repair of the housing, the oil passages should be carefully checked to ascertain if any foreign substances have accumulated in them. Immediately following this inspection, coat the threads of the plugs with a suitable thread lubricant and screw them tightly



1. Oil Pump Body
2. Accessory Housing
3. Oil Pump Idler Shaft
4. Driven Impeller
5. Oil Pump Cover
6. Driving Impeller
7. Oil Pump Drive Shaft

Figure 137 - Interior View of Accessory Housing with Oil Pump Cover Removed

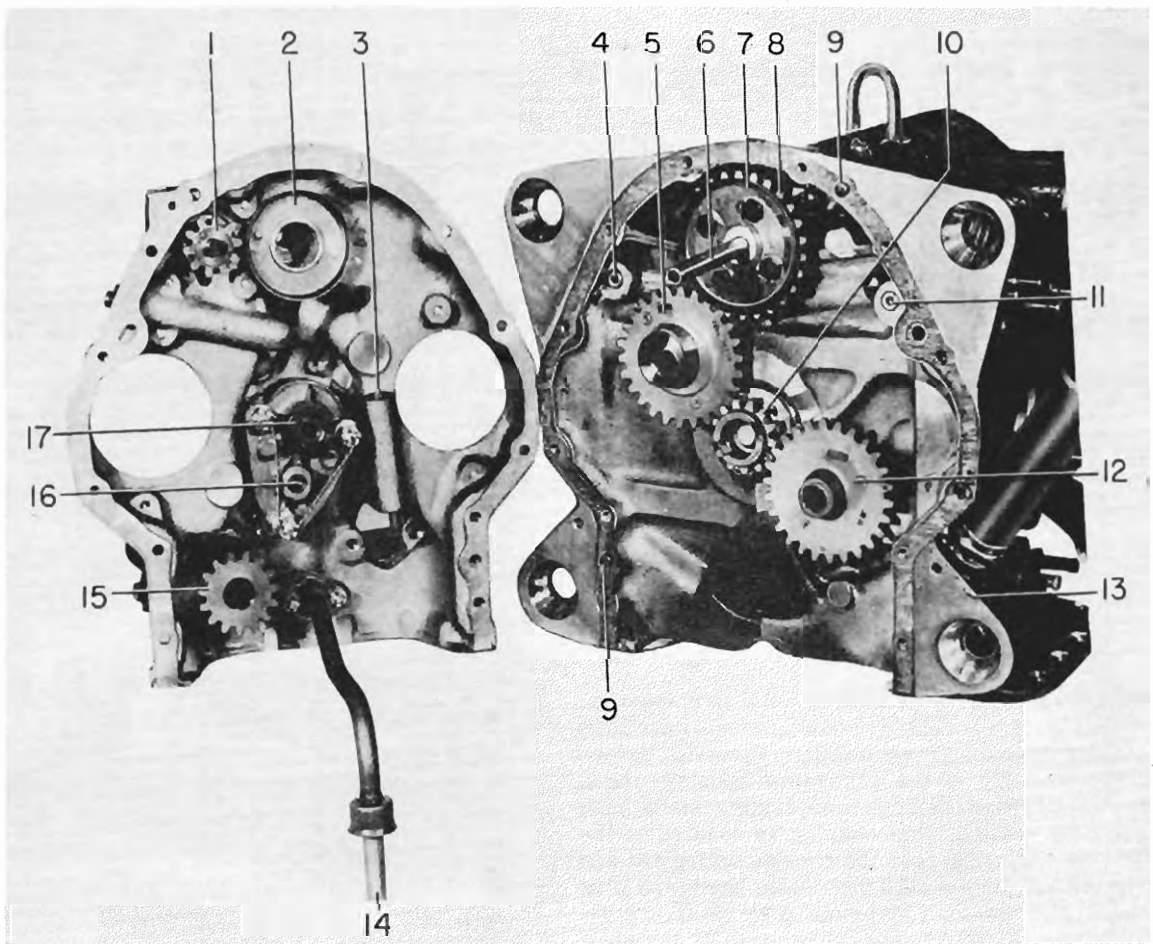
in their proper locations.

OIL PUMP - (See figure 137) - Assemble the oil pump body (1) over the studs on the interior of the accessory housing (2). No gasket or shim is used with any part of the oil pump. Then insert the oil pump impellers into the body. The driving impeller (6) is made of steel and must be assembled in the upper compartment of the oil pump body. The driven impeller (4) is made from aluminum and must be assembled in the lower compartment of the oil pump body.

Check the side clearance between the oil pump cover and the impellers; also the diameter clearance between the oil pump body and the impellers. (See Table of Limits.)

After the impellers have been inserted in the oil pump body, the oil pump cover (5) may be placed over the studs and fitted against the oil pump body. (This cover should have the oil pump idler shaft (3) assembled with it and secured with a .13 inch diameter cotter pin.)

Insert the oil pump drive shaft (7) into the oil pump drive impeller. Place a 5/16 inch plain washer over each of the oil pump studs; assemble 5/16 inch slotted nuts onto the studs, and tighten evenly and gradually, turning the oil pump drive shaft at the same time to make sure that the shaft turns freely. Should the shaft stick, or not turn freely, tap the side of the cover lightly with a soft hammer to get proper alignment. When it is determined that the shaft will turn freely, the nuts may be tightened to 150 inch pounds torque and secured with .051 inch diameter lockwire as shown in figure 138.



1. Vacuum Pump Driven Gear
2. Breather Oil Shield
3. Fuel Pump Plunger
4. Rear of Left Main Oil Passage
5. Crankshaft Idler Gear (with cam)
6. Tachometer Drive Shaft
7. Breather Slinger
8. Camshaft Gear
9. Locating Dowels
10. Crankshaft Gear
11. Rear of Right Main Oil Passages
12. Crankshaft Idler Gear (plain)
13. Lockwire Hole (for oil level gage tube)
14. Oil Suction Tube
15. Propeller Governor Drive Shaftgear
16. Oil Pump Idler Shaft
17. Oil Pump Drive Shaft

Figure 138 - Accessory Housing and Rear of Assembled Crankcase

OIL PRESSURE SCREEN CHAMBER - Insert the oil pressure into the oil pressure screen chamber, being very careful not to use the oil suction screen, which is intended for the oil sump. Using a new gasket, secure the chamber to its mounting pad with four 1/4-inch hex head bolts and shakeproof lock washers. (See figure 85.)

OIL COOLER BY-PASS VALVE - Insert the valve plunger and spring in the oil cooler by-pass valve recess in top of oil pressure screen chamber mounting boss. Place a copper asbestos gasket on the valve plug, screw the plug in place and secure with .040 inch diameter lockwire.

THERMOSTATIC OIL COOLER BY-PASS VALVE - On engines equipped with this device, all parts of the standard oil cooler by-pass valve are eliminated except the plug and plug gasket, both of which should be assembled in place at this time. Then insert the oil pressure screen into the valve and screen chamber and attach the chamber to the accessory housing in the same manner as the standard chamber described above. Using new gaskets on both parts, screw the thermostatic by-pass valve and the electric thermometer bulb into their respective holes in the chamber.

OIL SUCTION TUBE - Assemble copper washers over two drilled end 1/4-20 bolts and insert the bolts through the accessory housing from the rear. (It is important to use these particular copper washers, because they serve as oil seals.) A gasket may now be placed over the bolt ends and the flange of the oil suction tube assembled against the gasket with its end extending downward. The tube is then secured to the housing on the interior with two 1/4-inch plain washers and two slotted shear nuts. After tightening the nuts to proper torque, secure each with a .06 inch diameter cotter pin. (See figure 138.)

INSTALLING ACCESSORY HOUSING ON ENGINE - (See figure 138.) As soon as all the preceding steps have been accomplished, the assembled accessory housing is ready to be installed on the crankcase. Place a new accessory housing gasket over the locating dowels on the rear of the crankcase. Check the assembly of the two crankshaft idler gears; if the engine is equipped with a diaphragm type fuel pump, the hub of the left-hand gear should incorporate a cam, and the fuel pump plunger (3) should be inserted in the accessory housing as shown. Make sure that a new oil seal has been inserted in the tachometer drive shaft bore. Rotate the oil pump drive shaft (17) so that the lobes on the shaft align with the slots in the crankshaft gear (10) as shown. Apply a liberal coating of corrosion-preventive mixture to the tachometer drive shaft (6) and all other contact surfaces, such as gear teeth and hub of left idler gear. Carefully fit the accessory housing in place on the rear of the crankcase, guiding the housing first over the tachometer drive shaft and then on to the locating dowels (9). Secure the housing in place with ten 1/4-20 hex head bolts 15/16-inches long and two 1/4-20 bolts 1 3/4-inches long. The latter two fastenings are inserted from the crankcase side through the holes adjacent to the right magneto. Assemble all fastenings with plain washers and lock washers.

VACUUM PUMP DRIVE - If the engine is equipped with a vacuum pump drive, assemble the unit as follows:

Insert a new oil seal into the recess in the pump side of the vacuum pump adapter assembly; make sure that the seal is inserted with the grooved side toward the adapter. Place a new accessory drive gear washer over the shaft of the vacuum pump driven gear and insert the gear into the adapter, being careful not to push the oil seal out of its seat. Using a new gasket, attach the adapter to the accessory housing with four 1/4-20 plain nuts, washers and lock washers. Place a cover over the exposed end of the drive to prevent the entrance of dirt and foreign matter.

PROPELLER GOVERNOR DRIVE - On engines equipped with a propeller governor drive, insert the propeller governor drive shaft gear into the adapter; place a new accessory driven gear washer over the drive end of the shaft and secure the shaft in place with a 13/16 diameter external retaining ring. Using a new gasket, attach the adapter to the housing with four 5/16-18 plain nuts, washers and lock washers. Attach a cover on the exposed end of the drive as protection against dirt and foreign matter.

OIL LEVEL GAGE TUBE - Assemble this part into its proper place on the right side of the crankcase, near the rear lower mounting lug. Secure the tube by lockwiring one of the ears on the base to the small adjacent hole (13, figure 138) in the engine mounting flange.

NOTE

The engine may now be revolved on its overhaul stand so that the bottom (sump) side is uppermost.

EXHAUST AND INTAKE PORT COVERS - To prevent the possibility of foreign matter dropping into the exhaust or intake ports, covers should temporarily be placed over the openings.

OIL SUMP GASKET - Place the oil sump gasket on the oil sump flange of the crankcase, making certain that the gasket is right side up. If it is upside down, the holes will not match with the holes in the flange.

OIL SUMP - Assemble the oil sump over the gasket and studs. Using 1/4-inch nuts, plate washers, and lock washers, fasten the sump to the two studs that are located near the rear intake sleeves.

NOTE

It will be necessary to raise the sump slightly to provide clearance between the intake sleeves and the studs for the nuts.

After the nuts have been assembled on the studs, six 1/4-inch capscrews, plate washers, and lock washers may be assembled at the rear of the sump; and twelve 1/4-inch bolts, washers, lock washers, and nuts around the front and sides. Tighten all fastenings evenly to specified torque.

OIL SUMP DRAIN PLUGS - Place a gasket over the threads of the oil drain plug and assemble it into the oil drain hole of the sump. The auxiliary drain plug is made with 1/2-inch pipe threads and is assembled without a gasket.

SUCTION TUBE OIL SCREEN - Insert the suction tube oil screen through the oil sump drain plug hole. Make sure that it is clean and not damaged.

GENERATOR - Assemble the generator to its mounting bracket with two 5/16-inch bolts, nuts and lock washers. Do not tighten until other assembly operations have been completed on the generator.

Fasten the generator adjusting lever to the crankcase with a 5/16-18 bolt and lock washer. Then fasten the slotted end of the adjusting lever to the generator with a 5/16-18 bolt and plate washer. Now fit the generator drive belt into the groove of the generator drive pulley and swing the generator to tighten the belt. When the belt is sufficiently tight, tighten all generator fastenings to specified torque.

CARBURETOR - Place a gasket over the studs on the carburetor mounting pad. Then place the carburetor over the gasket with the mixture control lever toward the rear of the engine and secure in place with four 5/16-inch plain washers, 5/16-18 plain nuts and locknuts.

STARTER - The starter, including the Bendix drive, is secured to its mounting pad by one 5/16-18 hex head bolt, plain washers, shakeproof washers and nuts. No gasket is required. Tighten nuts to specified torque.

INTAKE PIPES - In the event that the intake pipes were not marked during disassembly to indicate the cylinder from which each pipe was removed, determine now the proper location for each intake pipe. Then assemble on each pipe an intake pipe flange, a hose connection, and a hose clamp on each end of the hose. Insert the intake pipe sleeve of the oil sump into the hose of the intake pipe; then adjust the flange end of the intake pipe to the intake port of the cylinder. Make certain that an intake gasket is placed between the intake pipe flange and the mounting pad of the intake port; then tighten the screws of the hose clamps. Use 1/4-20 nuts, plain washers, and lock waskers to fasten the flange to the intake port; tighten to specified torque.

ROCKER BOX DRAIN TUBES - The drain tubes, like the intake pipes, are different for each cylinder. Determine the proper location for each tube. Assemble a screw fitting, hose connection, and two hose clamps on each tube. Then insert the nipple of the crankcase fitting into the hose of each tube and adjust the other end of the tube to the fitting in the cylinder head. Screw the coupling onto the fitting and tighten the hose clamps.

MAGNETO TIMING - Remove the top spark plug from the No. 1 cylinder. Place the thumb of one hand over the spark plug hole and rotate the crankshaft in direction of normal rotation until the compression stroke is reached. The compression stroke is indicated by a positive pressure inside the cylinder tending to lift the thumb off the spark plug hole. In this position both valves of No. 1 cylinder are closed.

Rotate the crankshaft opposite to its normal direction of rotation until it is approximately 35° before top center of the compression stroke of No. 1 cylinder.

Align the timing mark on the front face of the ring gear support with the drilled hole in the starter, making sure the final motion of the ring gear is in the direction of normal rotation. The ring gear must always be in this position when either magneto is locked in position.

NOTE

An alternate method is provided to perform the above method if so desired. Locate and fasten ignition timing pointer on the 25° mark located on the rear face of the starter ring gear. Align the pointer with the parting flange of the crankcase.

With the magneto gear assembled on the right magneto, turn the magneto gear until the chamfered tooth on the distributor gear inside the magneto aligns with the white pointer as seen through the window in the front of the magneto cover. (See figure 139.)

Without allowing the gear to turn from this position, assemble the magneto with gasket on the engine. Secure magneto in place with washers and nuts; tighten nuts only finger tight.

Fasten ground wire of electric timing light to any unpainted metallic portion of the engine, and one of the positive wires of the timing light to a suitable terminal connected to the ground terminal connection of the right magneto. Then turn the engine crankshaft several

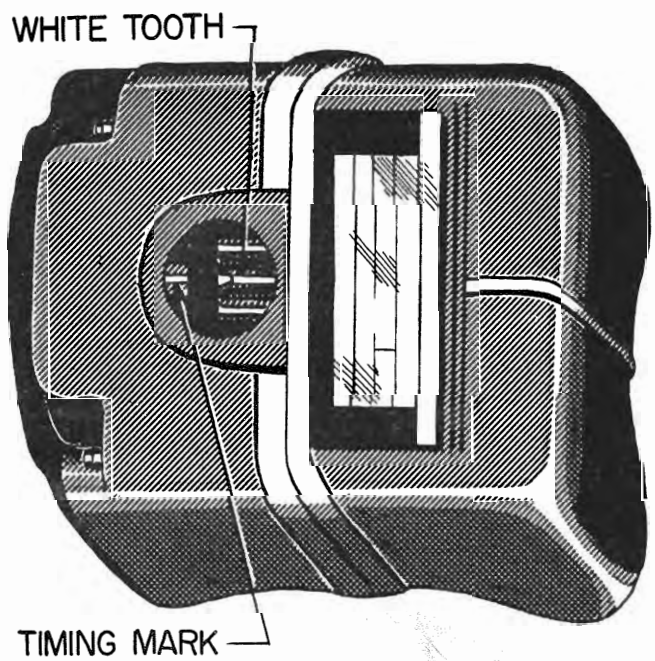


Figure 139 - Lining Up Timing Marks

degrees from the 25° BTC in direction opposite to that of normal rotation.

Turn on the switch of the timing light. The light should be lit. Turn the crankshaft very slowly in direction of normal rotation until the timing mark on the front face of the ring gear support aligns with the drilled hole in the starter, at which point the light should dim (or go out on battery operated models.) If not, turn the magneto in its mounting flange slots and repeat the procedure until the light dims (or goes out on battery operated models) at 25° before top dead center. Tighten the two mounting nuts and replace magneto inspection plug.

Install magneto impulse coupling adapter with gasket on left magneto mounting pad of the accessory housing.

CAUTION

The impulse coupling magneto can be used only on the left side of the engine, when viewed from the rear, or accessory housing, end.

Remove inspection plug and turn magneto drive coupling until the white beveled tooth on the magneto gear aligns with the pointer.

NOTE

In order to turn the shaft on the impulse coupling magneto, depress the pawl on the impulse coupling with the finger.

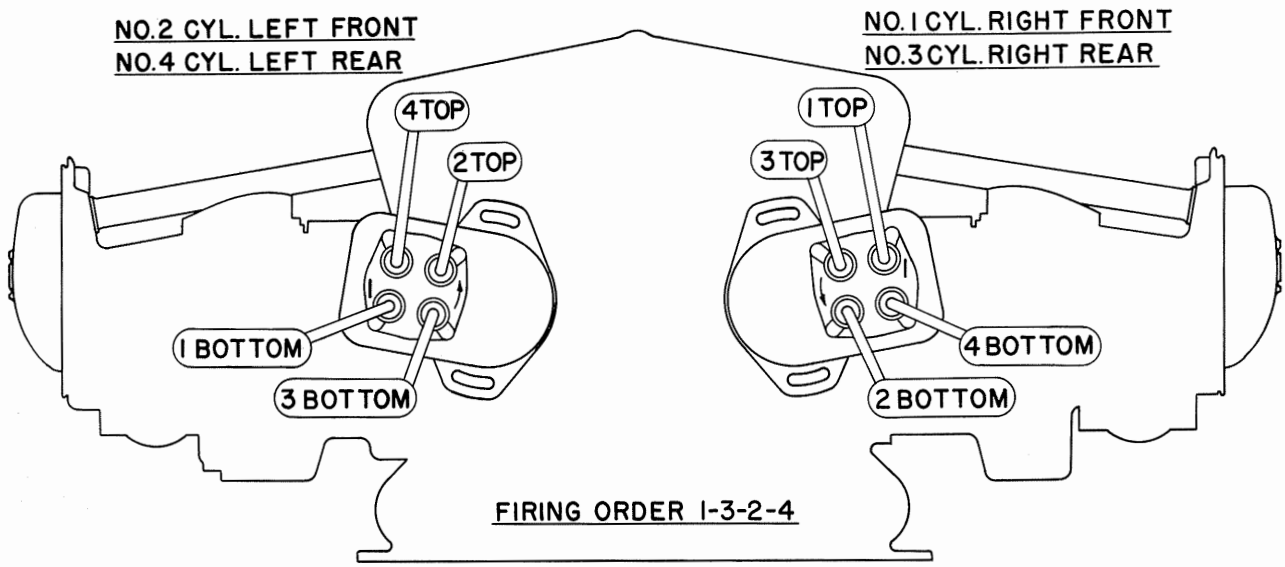
Place magneto gasket over mounting studs and secure left magneto in place with washers and nuts; tighten nuts only finger tight.

Connect the other positive wire of the timing light to a suitable terminal connected to the ground terminal connection of the left magneto and time the magneto in the same manner as described for the right magneto.

NOTE

The crankshaft should not be rotated more than 35° in direction opposite normal rotation as the pawl on the impulse coupling will engage with the stop pin and late timing will be indicated through the impulse coupling mechanism. If this should happen, rotate engine in normal direction until sharp click is heard, which will indicate that impulse coupling has passed through firing position; then turn crankshaft in direction opposite normal rotation to approximately 35° before top center and proceed with timing check.

After both magnetos have been timed, leave the timing light wires connected and re-check magneto timing as previously described to make sure that both magnetos are set to fire together. If timing is correct, both timing lights will dim (or go out on battery operated models) simultaneously when the mark on the front face of the ring gear support aligns with the drilled hole in the starter. If the breaker points open too early, loosen the mounting nuts and rotate the magneto counterclockwise. Remove timing



REAR VIEW OF CABLE OUTLET
SHOWING POSITION OF NO.1 CABLE
AND ARROW INDICATING DIRECTION
OF DISTRIBUTOR ROTATION

Figure 140 - Ignition Wiring Diagram

light and ignition timing pointer.

After magnetos have been properly timed, clean the breaker points to remove any trace of oil or dirt. Replace breaker cover and lock the retaining screws together with lockwire.

NOTE

Breaker points on Bendix Scintilla S4LN type magnetos are not to be adjusted to a given clearance. For proper S4LN magneto adjustment refer to Scintilla's instructions.

SECTION X

ENGINE TEST

Following the completion of assembly after overhaul it is recommended that the engine be mounted upon a test stand for its initial operation or run-in. The run-in serves a dual purpose; it burnishes or polishes the new parts that may have been installed, and it gives the operator control over the critical first few hours of operation during which time he can observe the functioning of the engine by means of the instruments in the test stand.

A test stand is much more suitable than an airframe for the run-in of an aircraft engine due to the number of additional instruments that can be installed for checking the operation of various integral parts of the engine. Such instruments as fuel flow meters, oil measuring devices, cylinder head temperature gauges, oil temperature gauges, oil pressure gauges, counter tachometer, and manifold pressure gauges are essential and should be supplemented by any additional instruments as may be necessary or available for checking the operation of the engine and its component parts.

When the engine has been mounted on the test stand, it should be equipped with suitable baffles in order to provide proper cooling throughout all phases of the run-in. In order that the engine receives the maximum of cooling air blast from the propeller, a test club propeller should be used. The propeller must be of correct size to allow the engine to turn its rated RPM.

TABLE OF SPECIFICATION

	O-320	O-340
C.A.A. Type Certificate	274	277
Rated Horsepower	150	170
Rated Speed, RPM	2700	2700
Cruise Speed (Economy), RPM	2350	2350
Cruise Speed (Performance), RPM	2450	2450
Fuel Consumption (Economy Cruise), Gal./Hr.	8.6	8.5
Propeller Drive Ratio	1:1	1:1
Propeller Shaft Rotation	Clockwise	Clockwise
Bore, Inches	5.125	5.125
Stroke, Inches	3.875	4.125
Displacement, Cubic Inches	319.8	340.4
Compression Ratio	7.00:1	8.50:1
Oil, SAE Number, above 40° F.	50	50
Oil, SAE Number, below 40° F.	30	30
Oil Sump Capacity, Quarts	8	8
Oil Pressure, psi, normal	60-85	60-85
Oil Pressure, psi, minimum idling	25	25
Oil Inlet Temperature, °F.	180-245	180-245
Fuel, Aviation Grade, Octane	80/87	91/96
Fuel Pressure, psi	3-5	3-5
Cyl. Head Temp., Max., °F.	500	500
Spark Advance, Degrees BTC	25°	25°
Tappet Setting, Cold Engine, Inches	.028-.080	.028-.080
Magneto Dropoff Max. @ 1800 rpm (each Mag. alone)	125	125
(diff. between Mags.)	25	25
Carburetor, Marvel-Schebler	MA4SPA	MA-4-5
Magneto (2), Scintilla	S4LN-20 (Right) S4LN-21 (Left)	S4LN-20 (Right) S4LN-21 (Left)

CAUTION

Do not use a flight propeller, as it will not supply sufficient air to cool the engine properly.

After all instrument attachments and engine controls have been connected, fill the engine with the required amount of proper grade oil. With the switch in "OFF" position, turn the engine by hand through several revolutions to make sure that the cylinders are clear of fuel or oil. It is desirable to have some method to preheat the lubrication oil. If this method is not available, hold engine speed at approximately 1000 RPM for five minutes or until a minimum oil temperature of 140°F. is reached before increasing speed.

NOTE

If the engine is to be installed in an airframe at the completion of the test run, the engine should be operated during the test run using oil of the specified grade. If, however, the engine is to be stored upon completion of the run, the sump should be filled during the run with a mixture consisting of one part of specified grade oil and one part of corrosion-preventive compound conforming to Specification MIL-C-5545.*

When starting the engine, the following procedure is recommended:

1. Place mixture control in full rich position.

2. Move throttle to approximately 1/10 open position.

3. Open fuel supply valve.

4. With ignition switch in "Off" position, engage starter. Allow the engine to turn through approximately one revolution and then turn the ignition to the "LEFT MAG." position. The engine should start within the next one or two revolutions. As soon as the engine starts, check oil pressure gauge; if oil pressure does not build up within 30 seconds after engine is started, shut down to investigate.

After engine has started, turn ignition switch to "BOTH" and maintain an engine speed of 700 to 1000 RPM for approximately five minutes. The engine should then be run-in according to the following schedule:

1000 RPM	9.0" M.P.	15 Min.
1200	11.0	15
1400	12.0	15
1580	13.2	30
1815	16.1	30
1990	18.3	30
2150	20.3	30
2280	21.2	30
2410	23.6	30
2455	24.1	30
2505	25.5	15
2620	27.3	15
2700	F.T.	15

Mixture control should be kept in the "Full Rich" position throughout the entire run-in. A log should be kept and the instrument readings recorded at frequent intervals, preferably every fifteen minutes.

During the run-in, the generator must be connected to a 12-volt storage battery and its operation checked by means of a suitable ammeter. The generator should begin to show a charge at approximately 1400 to 1500 RPM.

Make any and all adjustments necessary to secure maximum performance from the engine, particularly during the last 30 minutes. Any oil leaks that cannot be corrected during the test should be noted and corrected after removal of the engine from the test stand. Oil pressure at rated speed should be between 65 and 85 pounds.

If desired, oil consumption checks may be made at the completion of the run-in in the following manner: Record oil temperature. Stop engine in usual manner. Place a previously weighed receptacle under engine and remove oil drain plug. Turn engine until it is on approximately TDC of No. 1 cylinder and allow engine to drain for 15 minutes. Replace drain plug. Weigh oil and container. Record weight of oil (total weight less weight of container). Replace oil in engine. Start engine and warm up to cruising speed (2350 rpm) and operate at this speed for one hour.

At conclusion of one hour's operation and with the oil temperature the same as recorded at the time of previous draining, again drain the oil in the same manner as before. The difference in oil weights at start of run and at end of run will give the amount of oil used during one hours's operation. The oil consumption for one hour should not exceed .66 quarts.

At completion of run-in reduce engine speed slowly to idling. Adjust idling speed and mixture, if necessary, to give a smooth idling at 550 RPM. The minimum oil pressure for idling should be 25 lbs. After completion of all running, remove all oil screens. Any abnormal conditions indicated by the presence of foreign matter on the oil screen should be investigated and corrected.

NOTE

If the engine is to be preserved for storage upon completion of the test run, perform the operations described below under "PRESERVATION RUN" before shutting down the engine.

PREPARATION OF ENGINE FOR STORAGE

GENERAL - The following procedure is intended for application to installed engines which are being removed from aircraft, and will provide protection from corrosion for a period of 30 to 60 days.

*The following compounds conform to Specification MIL-C-5545; Becker Chemical, Inc., compound L-217; E.P. Houghton and Co., Cosmoline 949; or Shell Oil Co., compound T864.

CURVE NO. 9540-B

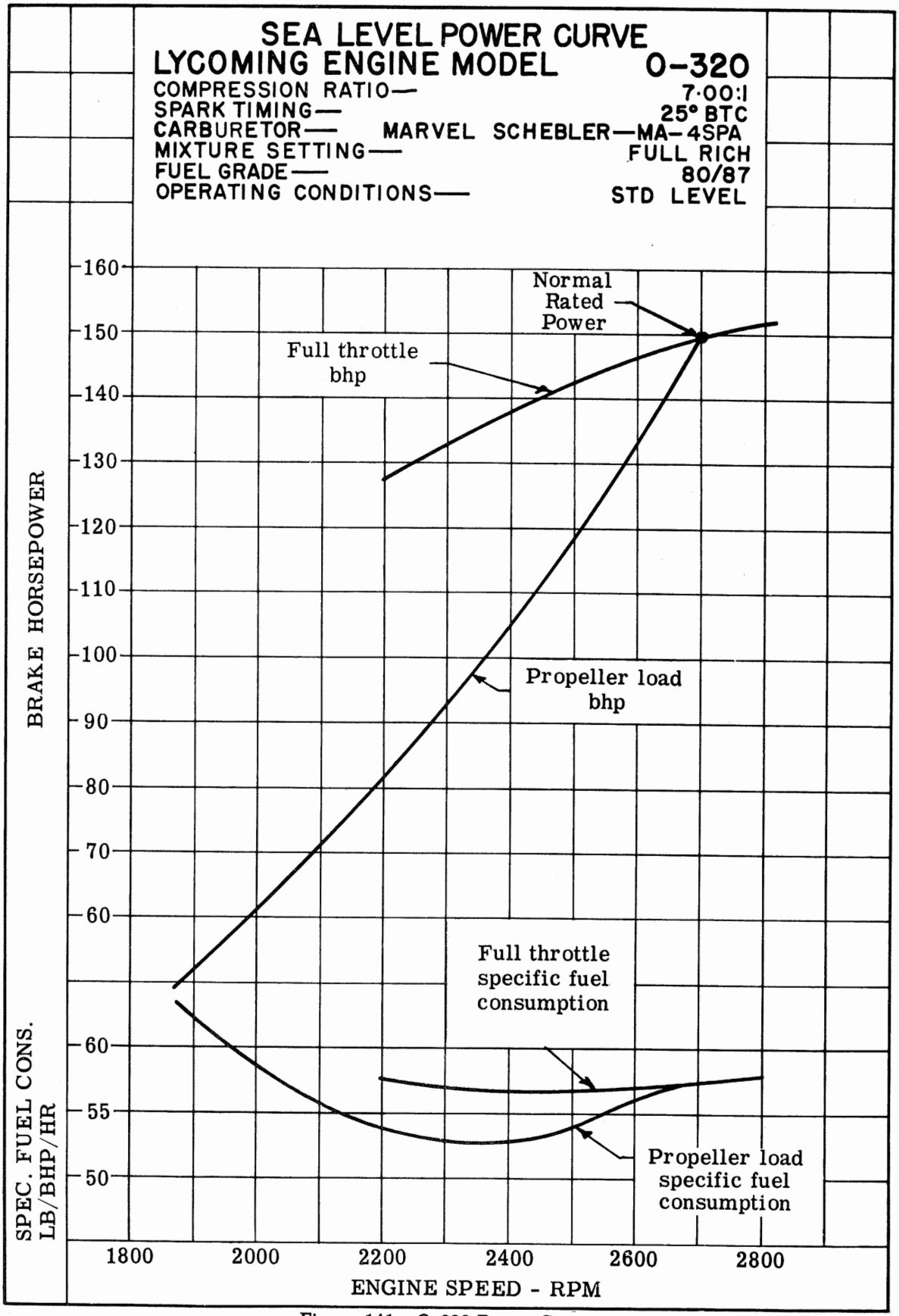


Figure 141 - O-320 Power Curve

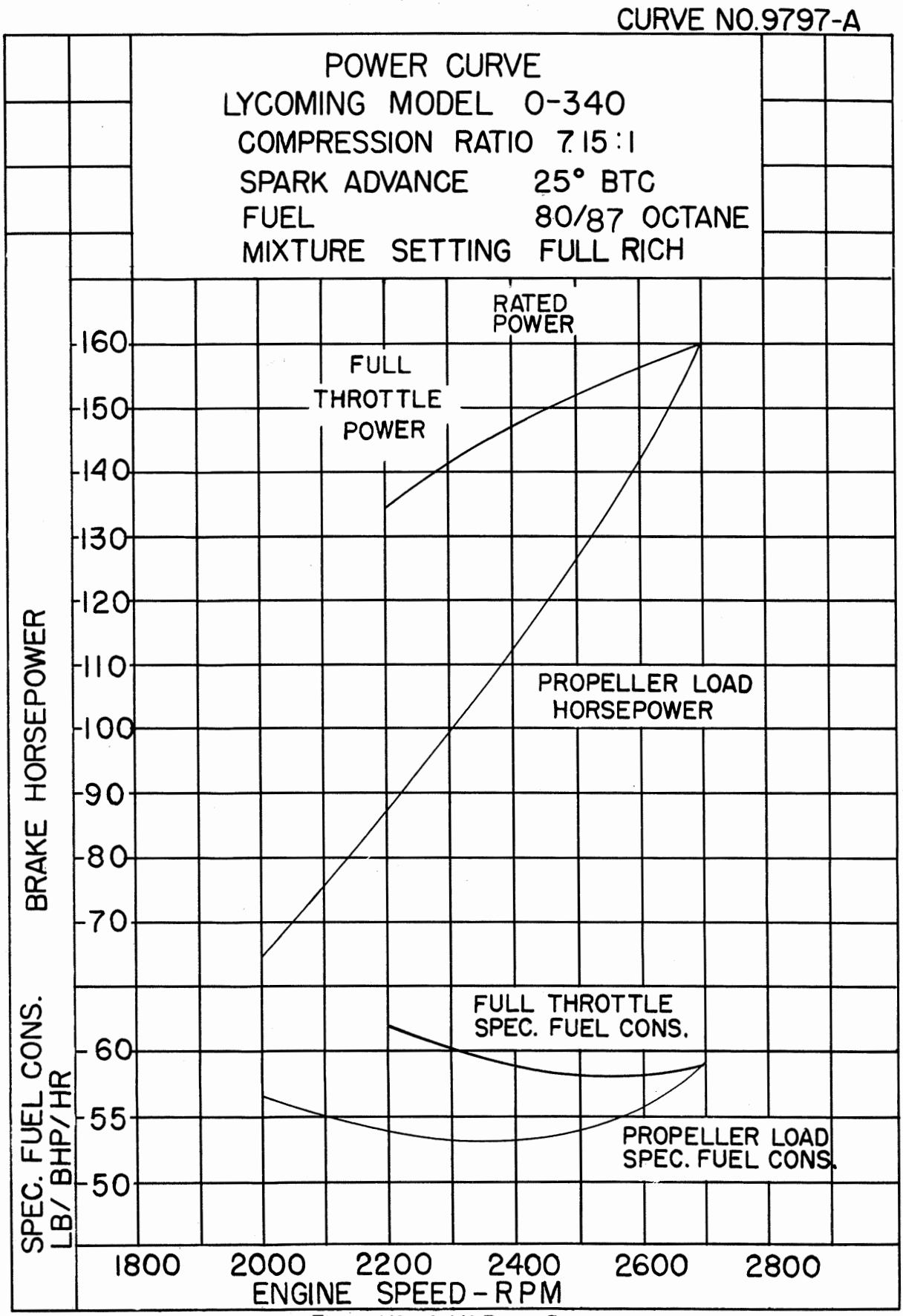


Figure 142 - 0-340 Power Curve

PRESERVATION RUN - Immediately prior to removal of the engine from the aircraft, the engine should be given a preservation run under the following operating conditions:

Fuel - Normal service fuel.
Oil - 8 quarts (normal sump capacity) of preservative type lubricating oil (Sinclair RUS-O-LENE 50 or equivalent.)

DURATION OF RUN - Operate the engine for a period of four minutes, holding the engine speed to a maximum of 1800 RPM. Cylinder head, ignition harness, and magneto temperatures should not be allowed to exceed the prescribed limits.

COMPOUND INJECTION - Upon completion of the preservation run, drain the preservative oil from the engine and remove, clean, and replace the oil pressure and oil suction screens. Perform any engine checks, such as valve clearance or ignition timing, which require rotation of the crankshaft. Disconnect the ignition harness and remove the spark plugs. While rotating the crankshaft five full turns for each cylinder (the engine starter may be used), spray each cylinder through the spark plug holes with approximately two ounces of preservative oil. Use the same oil as specified for the preservation run, maintaining the spray nozzle temperature between 200° F. and 220° F. (93° C. and 104° C.) for all spraying operations described herein. When all four cylinders have been sprayed, remove the carburetor and spray approximately two ounces of preservative oil into the intake riser while rotating the crankshaft five full turns. Then spray the exhaust port and valve of each cylinder with the piston 1/4 turn before top center on the exhaust stroke. When absolutely certain that no further need exists for turning the crankshaft, again spray each cylinder through the spark plug holes, this time without moving the crankshaft.

NOTE

Preservative oil drained from a single engine may be saved and returned to the stock tank, provided the mixture is replenished to the original quantity after the preservation of each engine. Where the stock tank capacity is less than ten gallons, the re-use of the mixture although replenished, shall be limited to one engine for each two gallons' capacity. Where the tank capacity is more than ten gallons, the tank mixture shall be completely replaced at least once every 30 hours operation time.

INSTALLATION OF SEALS AND PLUGS - Install a crankcase dehydrator plug (Lycoming Part No. 40234 or equivalent) in the oil sump drain hole, and cylinder dehydrator plugs (Lycoming Part No. 40238 or equivalent) in the spark plug holes. Install ignition cable and secure by attaching to the end of the dehydrator plug. Flush all accessory drives for which oil seals are provided with preservative oil before assembling the drive covers.

Make sure that all other openings in the engine are properly sealed. Suitable metal covers (Lycoming Part No. 66693 or equivalent) should be used in sealing the exhaust ports; moisture resistent tape (Minnesota Mining and Manufacturing Co. 711 Acetate Fibre Tape or equivalent) will be sufficient for the magneto ground connections and similar openings. Seal the intake riser opening with an oil and moisture resistant cover (Lycoming Part No. 65329 or equivalent) and install sealing caps (Lycoming Part No. 61596 or equivalent) over the breather opening and the generator blast tube. Seal the tachometer drive with a cap (Lycoming Part No. 61545 or equivalent) and install a plug (Lycoming Part No. 62744 or equivalent in the thermometer well at the rear of the oil pressure screen housing.

EXTERIOR SURFACES - All exposed cadmium plated and machined surfaces should be coated with soft film corrosion-preventive compound (E. F. Houghton and Co. Cosmoline 1059 or equivalent). The starter ring gear and propeller mounting surfaces in particular should receive a liberal coating of compound.

CARBURETOR - Drain all residual gasoline from the carburetor, fill with flushing oil (Esso Rust-Ban 392 or equivalent), and flush the interior surfaces by rocking the carburetor. After flushing, drain the carburetor, replace all plugs, lock the throttle in the closed position, and pack the carburetor in a cardboard carton.

SHIPPING CASE - Upon completion of the above procedures, the engine should be secured in a suitable engine shipping container. The date of preservation and the following legend should be legibly marked on the side of the container:

"On.....(Date).....this engine was preserved for 60 day short term storage with preservative oil and cylinder and crankcase dehydrator plugs. The dehydrator plugs shall be inspected on arrival at destination or 30 days after the above date (whichever occurs sooner) to determine if renewal of the dehydrating agent is necessary."

RECOMMENDED PROCEDURE FOR RE-PRESERVATION - The engine shall be examined every 30 days (or less, depending on weather and locality). If any evidence of corrosion is present, the affected area shall be cleaned free of corrosion and the engine re-preserved.

Engines prepared by the above procedure are not adequately protected for extended periods of storage. If at the end of 60 days it is found that the engine must remain in storage for an additional period, the engine must be re-preserved according to the foregoing procedure.

NOTE

Inspection and re-preservation will not be the responsibility of the engine manufacturer after engines have been shipped from the engine manufacturer's plant. It shall be the responsibility of the consignee to put engines into service in the order of storage preparation date to reduce the storage period to a minimum.

SECTION XI

TABLE OF LIMITS

DESCRIPTION AND USE - The following Table of Limits lists all tolerances and dimensions that must be maintained on the various parts of the engine. The figures in the first column, entitled "Reference Number," correspond to the figures shown on the Limits Chart and list the various parts or fits. The second column, entitled "Nomenclature," gives a brief description of the part or fit, while the third and fourth columns, entitled "Manufacturing," list the minimum and maximum tolerances allowed during manufacture of the engine. The fifth column, "Maximum Service Allowable," indicates the limits that must not be exceeded in rebuilding the engine. With respect to engine overhaul, the dimensions in the "Manufacturing" column should be considered as ideal limits, while those in the final column indicate measurements which, if not exceeded, permit the part to be continued in service.

SYMBOLS - The letter "L" following a limit indicates a loose fit, while the letter "T" indicates a tight fit. The letter "A" indicates either shrink fits controlled by machining, fits that may be readily adjusted, or fits where wear does not normally occur; in each case, however, the fit must be held to manufacturing tolerances.

Reference No.	Nomenclature	Manufacturing Minimum	Manufacturing Maximum	Maximum Service Allowable
501	Main Bearings and Crankshaft	.0015L	.0036L	.0055L
	Main Bearing - Front and Crankshaft	.0025L	.0055L	.007L
	Diameter of Main Bearing Journal	2.375	2.376	
502	Connecting Rod Bearings and Crankshaft	.0008L	.0033L	.0050L
	Diameter of Connecting Rod Journal on Crankshaft	2.124	2.125	
504	Crankshaft Timing Gear and Crankshaft	.001L	.001T	(A)
510	Connecting Rod and Connecting Rod Bushing	Bushing must be burnished in place		
	Finished ID of connecting Rod Bushing	1.1254	1.1259	
511	Connecting Rod Bushing and Piston Pin	.0008L	.0016L	.003L
512	Piston Pin and Piston	.0000	.0006L	.003L
	Diameter of Piston Pin Hole in Piston	1.1246	1.1249	
	Diameter of Piston Pin	1.1243	1.1246	
513	Piston and Piston Pin Plug	.0011L	.0024L	.005L
	OD of Piston Pin Plug	1.1225	1.1235	
514	Piston Ring and Piston - Side Clearance Top Ring	.0024L(B)	.0064L(B)	.008L(B)
515	Piston Ring and Piston - Side Clearance Second Ring	.0024L(B)	.0064L(B)	.008L(B)
516	Piston Ring and Piston - Side Clearance Third Ring	.0035L	.0055L	.0075L
519	Piston Skirt and Cylinder-Cast Type Piston (O-320)	.005L(C)	.0065L(C)	.017L(C)
	Piston Skirt and Cylinder-Cast Type Piston (O-340)	.006L(C)	.0075L(C)	.0172L(C)
	Piston-Diameter at Bottom Cast Type Piston (O-320)	5.119(C)	5.120(C)	
	Piston-Diameter at Bottom Cast Type Piston (O-340)	5.118(C)	5.119(C)	
	Piston-Diameter at Top Cast Type Piston (O-320)	5.0846	5.0876	
	Piston-Diameter at Top Cast Type Piston (O-340)	5.0826	5.0856	
520	Cylinder-Maximum Taper	.0000	.0005	.004
	Cylinder-Maximum Taper Chrome Plated (O-320)	.000	.0015	.004
521	Cylinder-Maximum Out-of-Round	.0000	.0005	.004
	Cylinder-Maximum Out-of-Round Chrome Plated (O-320)	.000	.0015	.004

Reference No.	Nomenclature	Manufacturing Minimum	Manufacturing Maximum	Maximum Service Allowable
	Cylinder-Maximum Out-of-Round Chrome Plated (O-320)	.000	.0015	.004
522	Cylinder Bore Diameter	5.1245	5.1255	5.1295
	Cylinder Bore Diameter Chrome Plated (O-320)	5.1245	5.1265	5.1295
523	Exhaust Valve Seat and Cylinder Head	.005T	.008T	(A)
	OD Exhaust Seat	1.740	1.741	
	ID Exhaust Seat Hole in Cylinder Head	1.733	1.735	
524	Intake Valve Seat and Cylinder Head	.005T	.008T	(A)
	OD Intake Seat	2.082	2.083	
	ID Intake Seat Hole in Cylinder Head	2.075	2.077	
526	Exhaust Valve Guide and Cylinder Head	.001T	.0025T	(A)
527	Intake Valve Guide and Cylinder Head	.001T	.0025T	(A)
	Finished ID of Valve Guides (Intake Only)	.4040	.4050	
	Finished ID of Exhaust Valve Guide-Rotator Type	.4360	.4370	
	OD Valve Guides	.5933	.5938	
	ID Valve Guide Holes in Cylinder Head	.5913	.5923	
528	Exhaust Valve Stem and Valve Guide	.0020L	.0035L	.008L
	OD of Valve Stem-Exhaust Rotator Type	.4335	.4340	
529	Intake Valve Stem and Valve Guide	.0010L	.0025L	.006L
	OD of Valve Stem - Intake	.4025	.4030	
531	Valve Rocker Shaft and Valve Rocker Bushings	.0005L	.0012L	.004L
	OD of Valve Rocker Shaft	.6243	.6245	
532	Valve Rocker Bushing and Valve Rocker	Bushing must be burnished in place		
533	Valve Rocker and Cylinder Head - Side Clearance	.003L	.009L	.012L
535	Push Rod and Push Rod Ball End	.0005T	.0025T	(A)
536	Tappet Body and Crankcase	.0010L	.0025L	.004L
	OD of Tappet Body	.7172	.7177	
	ID of Tappet Bore in Crankcase	.7187	.7197	
537	Camshaft and Crankcase	.002L	.004L	.006L
538	Camshaft - End Clearance	.002L	.009L	.015L
539	Camshaft - Run-Out at Center Bearing Journals	.000	.001	.006
540	Tachometer Drive Shaft and Accessory Housing	.0015L	.0035L	.006L
542	Oil Pump Impellers - Diameter Clearance	.002L	.005L	.008L
543	Oil Pump Impellers - Side Clearance	.001L	.003L	.004L
	Width of Oil Pump Impellers	.749	.750	
544	Oil Pump Driven Impeller and Idler Shaft	.0010L	.0025L	.004L
545	Oil Pump Drive Shaft and Oil Pump Cover	.0015L	.0030L	.004L
553	Oil Pump Impellers - Backlash	.008	.015	.020
556	Crankshaft Run-Out at Center Main Bearings			.005
558	Oil Pump Idler Shaft and Oil Pump Cover Or Body	.0000	.0015T	(A)
559	Hydraulic Tappet Plunger Assembly and Tappet Body	.0010L	.0047L	(A)
560	Hydraulic Tappet Socket and Tappet Body	.0020L	.005L	(A)
563	Crankcase Main Bearing Bore Alignment with Front and Rear Bearings			.003
564	Connecting Rod - Side Clearance	.004L	.010L	.016L
566	Connecting Rod Alignment			.010 in 10 Inches
567	Connecting Rod Twist			.012 in 10 Inches
568	Crankshaft and Crankcase Front End Clearance	.009L	.016L	.026L
590	Vacuum Pump Gear - End Clearance	.000	.067L	.075L
601	Oil Pump Drive Shaft and Accessory Housing	.0015L	.0030L	.006L
602	Oil Pump Idler Shaft and Accessory Housing	.0005L	.0020L	.003L
607	Crankshaft Propeller Flange Run-Out			.005

Reference No.	Nomenclature	Manufacturing Minimum	Manufacturing Maximum	Maximum Service Allowable
611	Valve Rocker Shaft and Rocker Shaft Bushing	.0001L	.0010L	.0025L
	Finished ID of Valve Rocker Shaft Bushings in Cylinder Head	.6246	.6253	
612	Rocker Shaft Bushing and Cylinder Head	.0022T	.0035T	(A)
615	Piston Ring Gap	.020	.030	.045
616	Crankshaft Idler Gear and Camshaft Gear-Backlash	.004	.015	.020
617	Crankshaft Idler Gear and Crankshaft Gear-Backlash	.004	.015	.020
618	Crankshaft Idler Gear and Magneto Gear-Backlash	.004	.015	.020
619	Crankshaft Idler Gear and Crankshaft Idler Gear Shaft	.001L	.003L	.005L
620	Crankshaft Idler Gear-End Clearance	.010L	.045L	.055L
622	Vacuum Pump Driven Gear and Vacuum Pump Adapter	.0013L	.0033L	.005L
623	Vacuum Pump Driven Gear and Camshaft Gear - Backlash	.004	.015	.020
629	Fuel Pump Plunger and Accessory Housing	.0015L	.003L	.005L
658	Oil Cooler By-Pass Plunger and Accessory Housing	.0015L	.0035L	.005L
674	Propeller Governor Drive Shaft Gear-End Clearance	.002L	.024L	.034L
675	Propeller Governor Drive Shaftgear and Adapter	.0010L	.0025L	.005L
676	Crankshaft Idler Gear and Propeller Governor Drive Shaftgear-Backlash	.004L	.015L	.020L
800	Outer Valve Spring - Compression Load at 1.30 inch (Wire Diameter .162)	82Lbs.	89Lbs.	79 Lbs. Min.
801	Auxiliary Valve Spring-Compression Load at 1.17 inch (Wire Diameter .135)	61 Lbs.	67 Lbs.	58 Lbs. Min.
807	Oil Relief Valve Spring-Compression Load at 1.30 inch (Wire Diameter .054)	7 Lbs.4 Oz.	7 Lbs. 12 Oz.	
811	Oil Cooler By-Pass Spring-Compression Load at 1.94 inch (Wire Diameter .0465)	6.54 Lbs.	6.92 Lbs.	6.41 Lbs. Min.

TORQUE LIMITS

829	Connecting Rod Bolt Nuts 3/8 inch	275 to 325 In. Lbs.
830	Spark Plug 18 MM	300 to 360 In. Lbs.
831	1/2-inch Nuts and Capscrews	550 In. Lbs.
832	3/8-inch Nuts and Capscrews The desired torque for tightening the propeller attaching bolts is 125 in. lbs. and the maximum torque for tracking the propeller is 175 in. lbs. These limits apply to wooden propellers only.	300 In. Lbs.
833	1/4-inch Nuts and Capscrews	75 In. Lbs.
834	5/16-inch Nuts and Capscrews	150 In. Lbs.
839	#10-32 Screw (To attach ignition cable outlet plate to magneto)	12 to 15 in. Lbs.
840	3/8 Nut (To attach gear to magneto)	180 to 300 In. Lbs.

(B) Side clearance on wedge type rings must be measured with face of ring flush with piston.

(C) The dimension shown is measured at bottom of piston skirt at right angles to piston pin. The dimension in line with piston pin is .010 smaller.

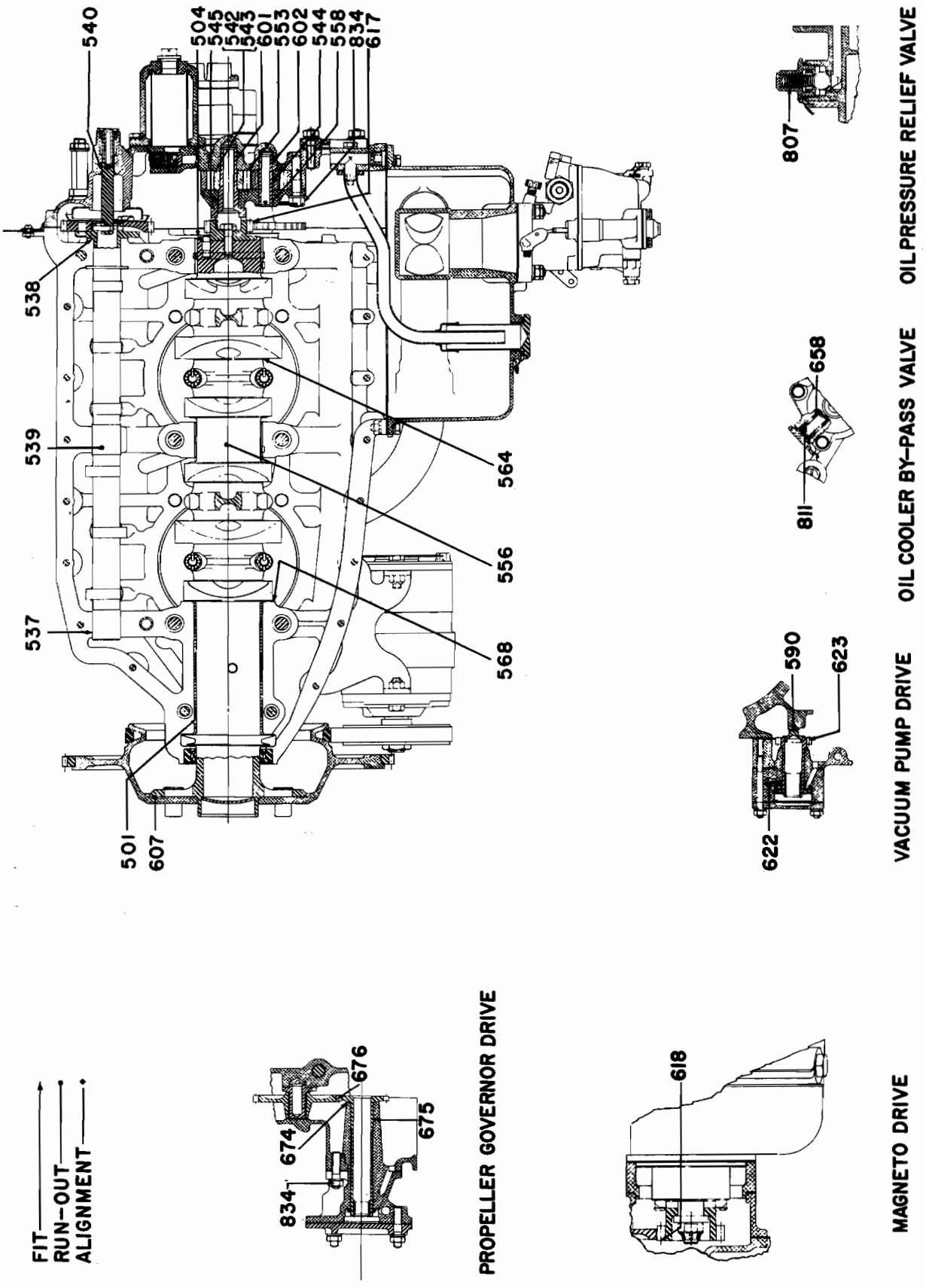


Figure 143 - Limits Chart

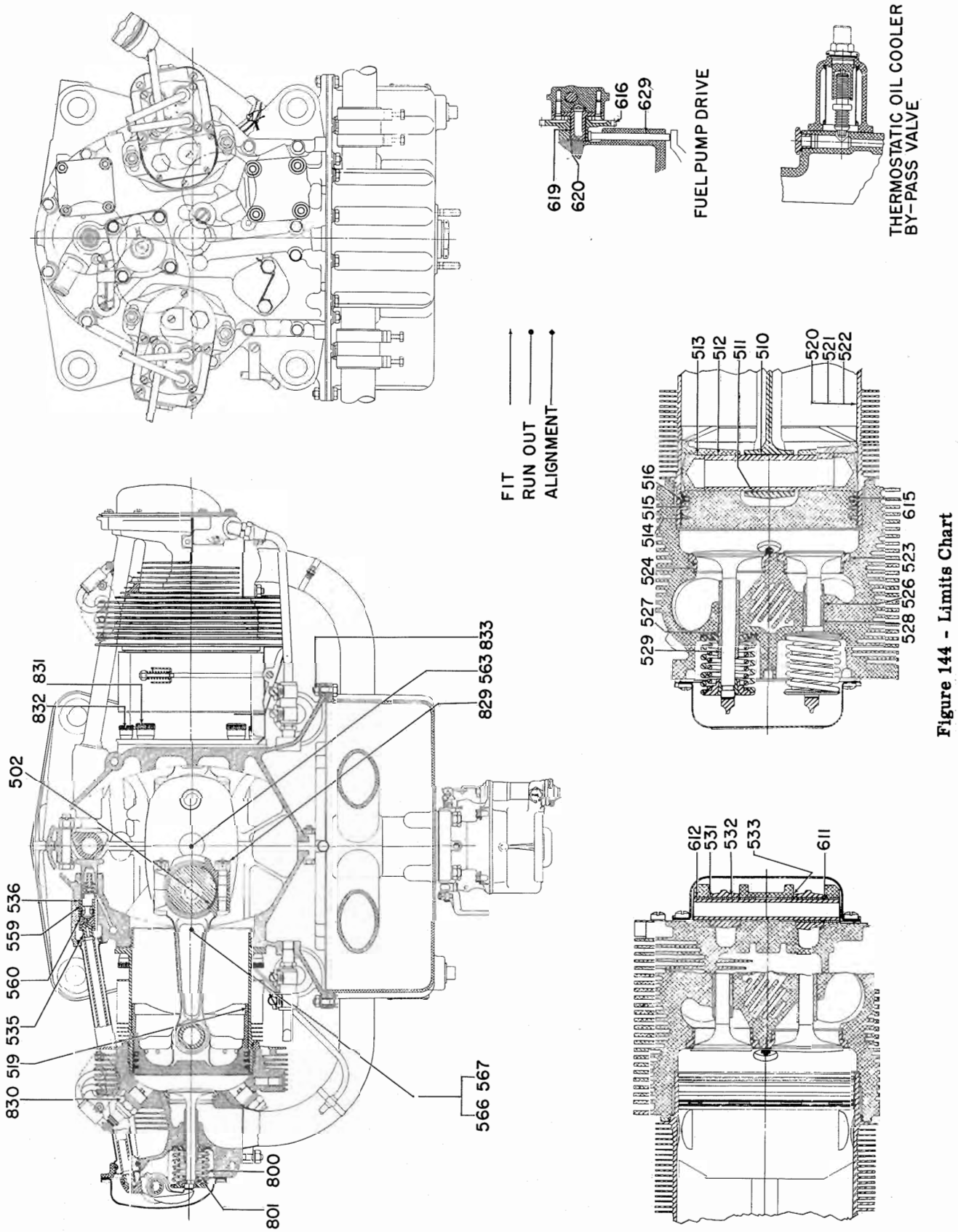


Figure 144 - Limits Chart

LYCOMING

OVERHAUL Supplement

Applicable Handbook 0-290-D2 - - - Second Edition
0-320 & 0-340 Series &
0-360 Series - - First Edition

Supplement No 1 Page 1 Of 1 Pages Date 3/31/58

THIS SUPPLEMENT IS PROVIDED TO INFORM USERS OF LYCOMING OVERHAUL MANUALS OF CHANGES, DELETIONS, ADDITIONS, AND SUPERCEDURES THAT HAVE OCCURRED SINCE PUBLICATION OF THE EDITION NOTED ABOVE. KEEP THIS SUPPLEMENT WITH YOUR COPY OF THE APPLICABLE HANDBOOK.

This supplement provides users of the above noted overhaul manuals with latest information on overhaul procedures applicable to the subject engines. The procedure listed below is concerned with replacing a damaged oil relief valve sleeve and is to be accomplished during repair and replacement of the crankcase and its related parts.

OIL RELIEF VALVE SLEEVE - The oil relief valve sleeve has a 0.001 inch press fit with the relief valve bore in the crankcase. If the sleeve is badly scored or otherwise damaged, remove and replace it as follows:

1. Apply a liberal coating of heavy grease to the threads of a standard 1/2 in. - 20 bottoming hand tap. (This will aid in subsequent cleaning of the relief valve bore, since loose metal particles resulting from the action of the tap will tend to adhere to the tap when it is withdrawn from the bore.)

2. Insert the tap into the relief valve bore, making sure that the tap is centered in the ball seat of the sleeve. Screw the tap into the sleeve a maximum of four full turns.

CAUTION

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

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

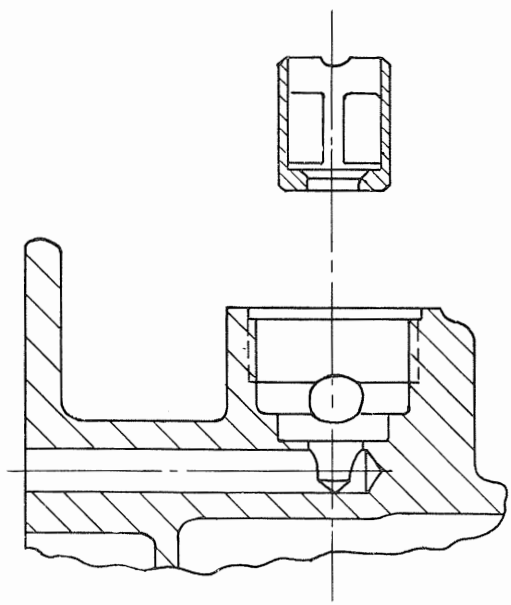
4. Clean relief valve bore thoroughly with petroleum solvent and a suitable bristle brush, taking care to see that all metal particles are removed. The sleeve seat in particular must be entirely free from foreign matter, or the new sleeve will not seat properly.

5. Place a new relief valve sleeve into the crankcase bore with the seat end of the sleeve toward the crankcase. Making sure that the sleeve is centered in the bore, insert the oil relief valve sleeve driver (Lycoming Part No. 64690) into the sleeve and drive the sleeve into place with light hammer blows.

If the sleeve does not make a 0.001 press fit with the crankcase, but is loose, remove the standard size sleeve and install a 0.003 oversize oil relief valve sleeve in the same manner described above.

CAUTION

In the event the hole in the crankcase is too small for installation of the 0.003 oversize sleeve, no attempt should be made to ream the hole to the correct size. Instead, place the oversize sleeve in a lathe and lap it sufficiently to fit the hole in the crankcase.



Cross-section of Oil Relief Valve and Oil Relief Valve Bore in Crankcase