MAINTENANCE
AND
OVERHAUL MANUAL
WITH
ILLUSTRATED PARTS LIST

FOR
A-65 AND A-75
SERIES AIRCRAFT ENGINES

NOTICE

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FAA APPROVED

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INTRODUCTION

This book is a combined Operator's Manual, Maintenance and Overhaul Manual and Illustrated Parts List for the Continental A65 and A75 Series 8 Engines.

This manual is intended for use by operators and mechanics as a guide and reference book in the operation and servicing of these engines.

The book is divided into five main groups: Operating and Maintenance Instructions, Overhaul Instructions, Table of Limits, the Illustrated Parts List, and Accessories.

It is suggested that a careful study be made of this manual. A strict adherence to the instructions outlined herein will assure a fine operating record. However, if any point is not entirely clear, do not hesitate to contact the nearest Authorized Continental Service Station or the factory Service Department.

In the event of failure of any engine part, notify the nearest Authorized Continental Service Station at once, giving the engine serial number, and full particulars. Do not attempt any repairs without factory permission if any adjustment is expected.

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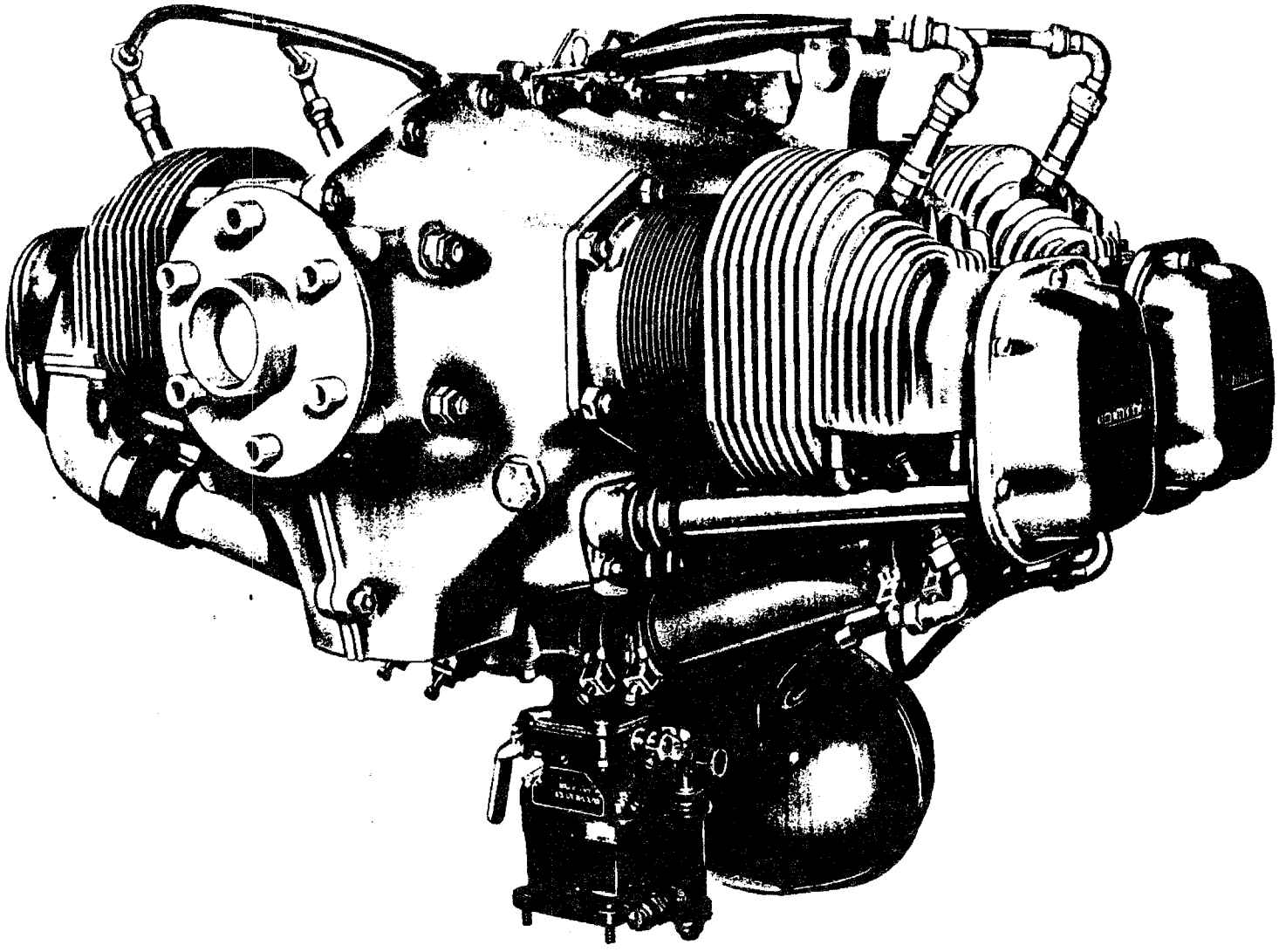


Figure 1. Three-Quarter Left Front View of A65-8F.

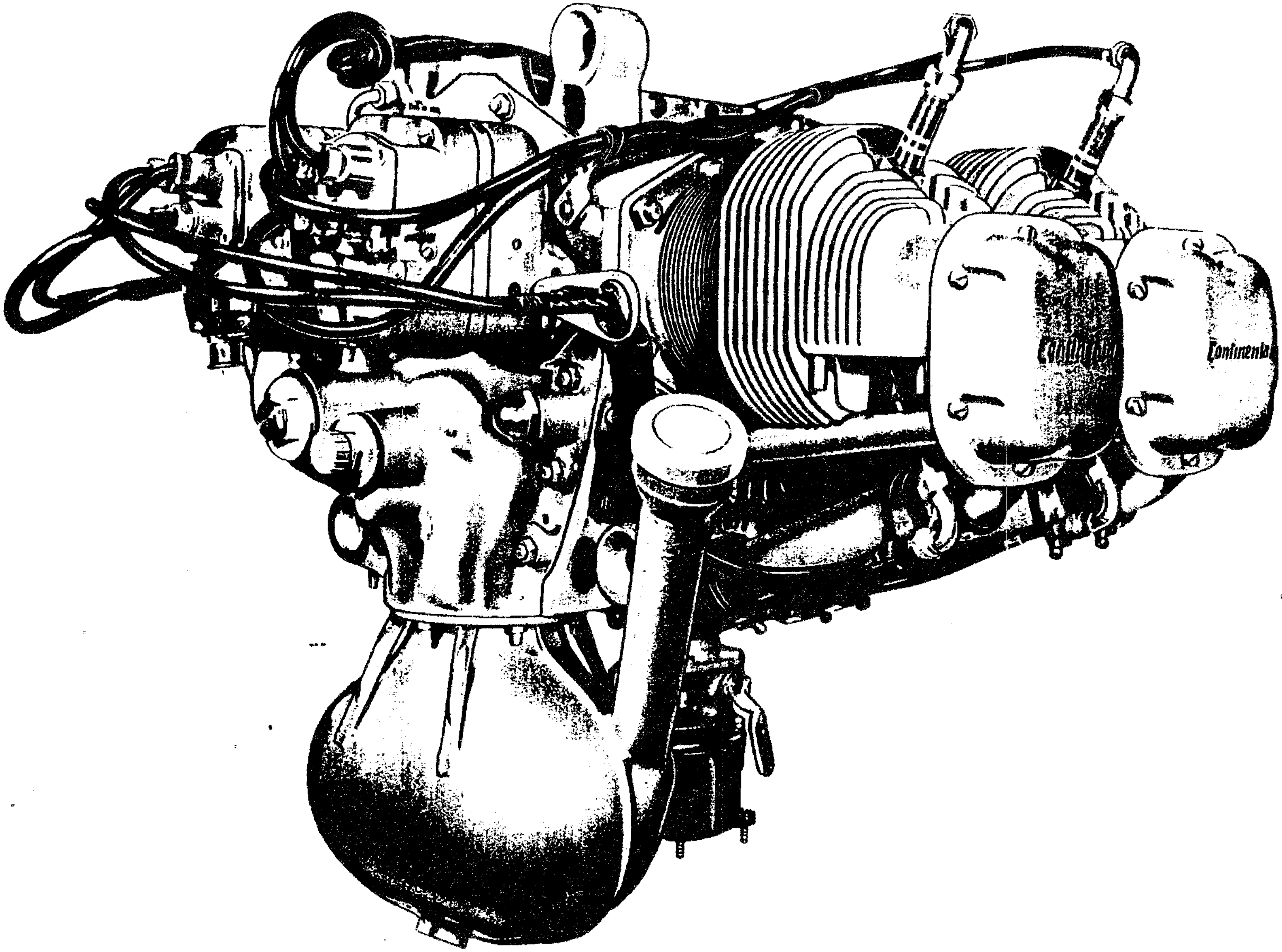


Figure 2. Three-Quarter Right Rear View of A65-8F.

SECTION 1

TABLE OF SPECIFICATIONS

GENERAL

Type	Horizontally Opposed
Operating Cycle	Otto (4 stroke)
Cooling System Type	Air
No. of Cylinders	4
Cylinder Bore	All Models 3-7/8"
Stroke	All Models 3-5/8"
Piston Displacement (cubic in.)	171
Number of Mounting Bolts	4
Diameter of Mounting Bolts	3/8" or 7/16"
Overall Width	31-1/2"
Average Dry Weight (Series 8)	170 lbs.
Average Dry Weight (Series 9)	177 lbs.
Crankshaft Rotation	*Clockwise

FEATURES PECULIAR TO EACH MODEL:

Model	A65	A75
Type Certificate No.	205	213
Compression Ratio	6.3:1	6.3:1
Rated RPM	2300	2600
Rated Horsepower at Sea Level	65	75
Maximum Allowed Manifold Pressure in In. Hg. (at rated RPM)	29.4	29.3
Recommended Cruising RPM	2150	2350
Maximum Recommended Manifold Pressure in In. Hg. (at cruising RPM)	26.8	26.0
Minimum Fuel Octane Rating (Aviation Grade)	80/87	80/87
Maximum Allowable Cylinder Head Temperature (°F.)	550	525
Maximum Oil Temperature (°F.)	220	220
Oil Temperature in °F. (Minimum at Take-Off)	90	90
Approximate Fuel Consumption in Gallons per Hr. (at cruising RPM)	4.4	4.8
Approximate Maximum desirable Oil Consumption in pints per Hr.	3/4	3/4
Oil Sump Capacity in Quarts	4	4
Oil Pressure (Cruising) in Lbs./Sq. In.	30-40	30-40
Oil Pressure (Idling) in Lbs./Sq. In. (Minimum)	10	10

IGNITION:

Type	Dual Magneto
Magneto Type	Various
Magneto Rotation (as viewed from Drive End)	Clockwise
Crankshaft: Magneto Speed Ratio	1:1
Radio Shielding (Optional)	C.M.C.
Spark Plugs (Shielded)	Champion 62S
Spark Plugs (Shielded)	EM42E
Spark Plugs (Unshielded)	Champion C27

	A65	A75
Right Magneto Fires Upper Plugs BTC	30°	29°
Left Magneto Fires Lower Plugs BTC	30°	32°
Firing Order	1-3-2-4	1-3-2-4

NOTES: * Direction of rotation as viewed from rear of engine.

TABLE OF SPECIFICATIONS - Continued

FUEL SYSTEM

Feed	††Gravity
Carburetor Type	Float (See Catalog)
†††Primer Connection	1/8" N. P. T.
Carburetor Inlet	1/4" N. P. T.

LUBRICATION SYSTEM

Pump	Gear Type
Crankshaft: Pump Speed Ratio	1:.50
Pump Drive Gear Rotation	*Counterclockwise
Sump Type	Wet

ACCESSORY DRIVES AND INSTRUMENT CONNECTIONS

Oil Pressure Gauge Line	1/8" N. P. T.
Tachometer Drive Shaft: Std.	S. A. E.
Crankshaft: Tachometer Drive Ratio	1:.50
Tachometer Drive Rotation	*Counterclockwise

ACCESSORIES AND WEIGHTS

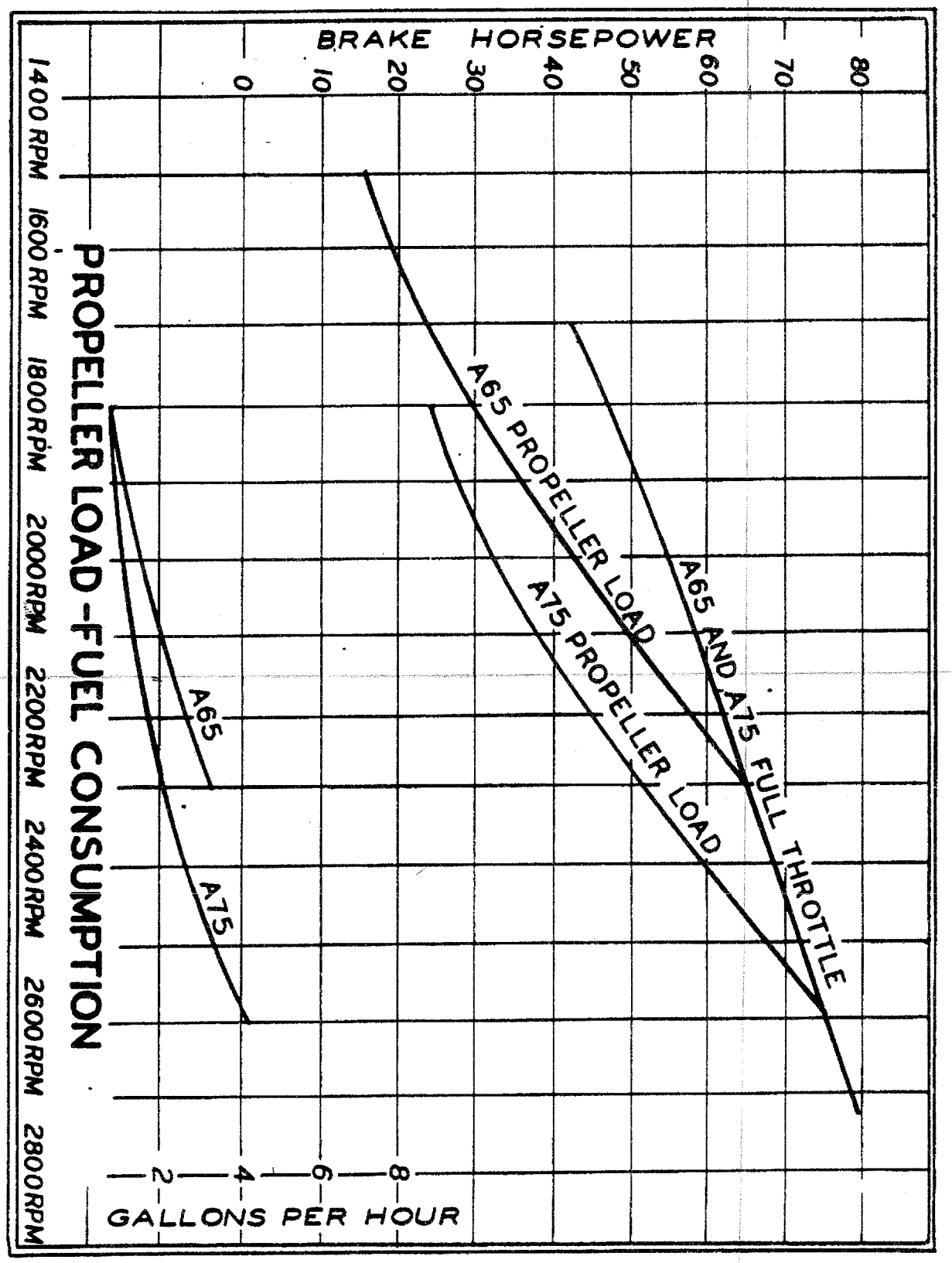
**Magnetos (2), Eisemann	AM-4: 10.69#
Magnetos (2), Eisemann	LA-4: 12.02#
Magnetos (2), Scintilla	S4RN-20: 10.35#
Radio Shielding	2.26#
Oil Cooler (Harrison)	4.00#
Air Intake and Filter Assembly	2.56#
Propeller Attaching Parts (Flanged Crankshaft)	0.90#
Carburetor (Stromberg NA-S3A1) (Optional)	2.70#
**Carburetor (Stromberg NA-S3B)	2.60#
Carburetor (Marvel MA-3PA) (Optional)	3.00#
Fuel Pump (AC Diaphragm Type)	1.75#
Exhaust Flanges and Gaskets (4)	0.55#
Rubber Mount Bushings (8) and Steel Washers (4)	0.55#

NOTES: * Direction of rotation as viewed from rear of engine.

** Accessories included in Engine Dry Weight.
Add 1.04 lbs. for Flanged Crankshaft (Series 8F).
Magneto Weights include Drive Gears.

†† A Stromberg carburetor suitable for use with a pump feed system is available. Gravity feed requires the fuel tank to be elevated and located so that the static fuel head will be at least two inches in the steepest climb and less than 90 inches in the steepest glide.

††† The primer nozzles supplied for installation in the intake manifold is effective at temperatures above -7°C. (20°F.). For starting at lower temperatures a primer manifold system with jets in cylinder intake ports is recommended.



PERFORMANCE AND FUEL CONSUMPTION CURVES

Figure 3.

SECTION 2

GENERAL DESCRIPTION

1. DIFFERENCES BETWEEN THE A65 AND A75 ENGINES

a. DIFFERENCES BETWEEN THE A65 and A75 MODELS.

(1) GENERAL DIFFERENCES.

(a) All the engine models are identical in general construction with differences in the power rating of the engine, maximum R.P.M., compression ratio, number of piston rings, exhaust valves, piston pin diameter and connecting rods.

(2) ENGINE RATINGS.

(a) The engines are rated as stated in the table of specifications, page 1.

(3) ENGINE COMPRESSION RATIO.

(a) The engines have the compression ratios and fuel Octane requirements shown in the table of specifications.

(4) NUMBER OF PISTON RINGS.

(a) The .A65 and A75 engines have a total of three rings per piston; two bevelled back, tapered face compression rings No. 530144 in the top and second grooves and one oil ring in the third groove.

(5) EXHAUST VALVES.

(a) The exhaust valves on these models are identical in construction with the exception that the valves used on the A75 engines have stellite faces to eliminate the greater wear experienced at the increased engine speeds.

(6) CONNECTING RODS.

(a) The connecting rods on these engines are identical in construction except that the rods used on the A75 engines have a 1/16 diameter drilled oil squirt hole in the cap end of the rod to provide increased lubrication to the cylinder walls and are bushed for piston pins of smaller O.D. than used in model A65.

2. CYLINDER CONSTRUCTION

Heat-treated, aluminum alloy cylinder heads are screwed and shrunk to steel barrels. Close-spaced cooling fins are provided on barrels and cylinder heads to provide ample and efficient radiation surface. Cylinder bores are ground to a smooth finish and held within extremely close limits. Stainless steel helical coil spark plug inserts are screwed in place, while aluminum bronze intake and steel exhaust valve seats are shrunk into the cylinder heads. Rocker boxes are cast integral with cylinder heads and are provided with oil sealed covers made of deep drawn sheet metal. They are scavenged by the drainage of oil back to the crankcase through the push rod housings. Cylinder heads have undersize exhaust ports to permit more positive exhaust scavenging.

3. VALVE OPERATING MECHANISM

a. General. Zero lash hydraulic tappets fit aluminum alloy guides machined in the crankcase and so sealed as positively to prevent oil leakage. Tappets are drilled in such a manner that an oil passage is provided from the tappets to the push rods, rocker arm bearings, and rocker end. Push rods are made of light steel tubing with pressed-in ball ends, hardened and ground, and drilled their entire length to provide an oil passage to the overhead mechanism. The push rod is fully enclosed, and the outer end fits into a socket in the rear of the valve rocker. The rocker acts directly on the valve through a specially designed "foot" so constructed as to prevent side-thrust on the valve stem. Splash and spray lubrication keeps valve guides oiled at all times. Oil is returned to the crankcase by the push rod housing.

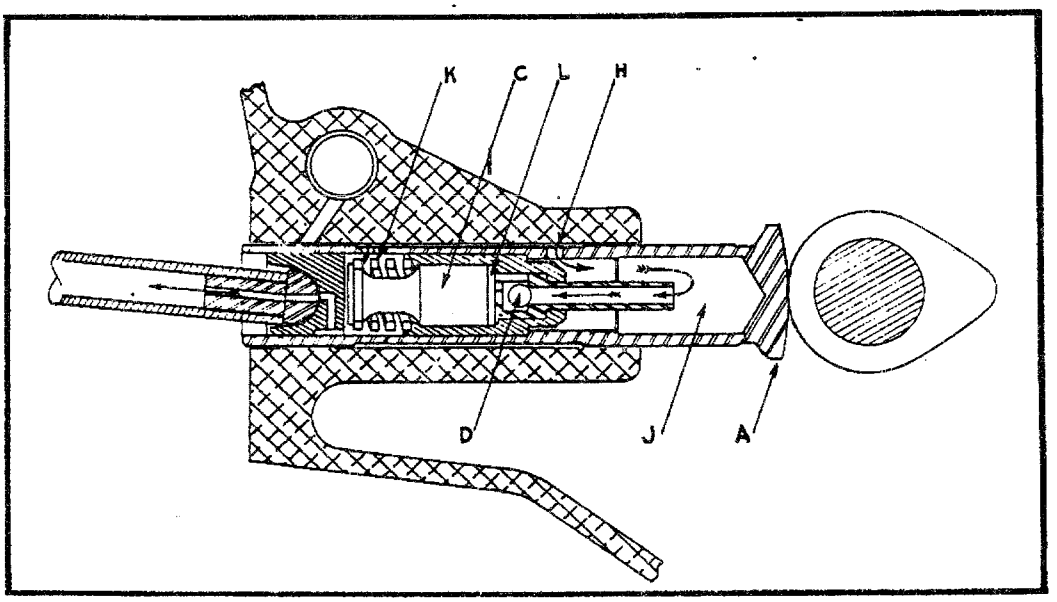


Figure 5. Section Through Hydraulic Tappet.

b. Hydraulic Tappets.

The tappets are composed of only four parts which can be disassembled: the cup, cylinder, piston, and cam follower body.

They are designed to function properly with clearances ranging from .030 inch to .110 inch.

Oil lines to tappets operate on full engine pressure and are located in such a way that they register with tappet oil passages when valves are open.

Oil under pressure from the lubricating system of the engine is supplied to the hydraulic lifter through hole (H) to supply chamber (J) (See figure 6.)

With face of the lifter on the base circle of the cam and the engine valve seated as shown in figure 5, the light plunger spring (K) lifts the hydraulic plunger (C) so that its outer end contacts the push rod, taking up the clearance at this point and all along the valve train, giving zero lash. As the plunger (C) moves outward, increasing the volume in the pressure adjusting chamber (L) the ball check valve (D) moves off its seat and oil from the supply chamber (J) flows in and fills chamber (L).

As the camshaft rotates, the cam pushes the lifter body outward, tending to decrease the volume of chamber (L) and forcing the ball check onto its seat. Further rotation of the camshaft moves the lifter body (A) outward and the confined body of oil in chamber (L) acts as a member in the valve operating mechanism, the engine valve being lifted on a column of oil. So long as the engine valve is off its seat, the load is carried by this column of oil.

During the interval when the engine valve is off its seat, a pre-determined slight leakage occurs between plunger and cylinder bore, which is necessary to compensate for any expansion or contraction occurring in the valve train. Immediately after the engine valve closes, the amount of oil required to refill the adjusting chamber (L) flows in from the supply chamber (J), thus establishing the proper length of oil column to maintain zero lash during the next cycle.

The basic principle of the hydraulic tappet is that it provides, between the cam and the push rod, a column of oil which carries the load, while the engine valve is off its seat, and the length of which is automatically adjusted so that each camshaft cycle gives zero lash.

4. CRANKSHAFT CONSTRUCTION

The alloy steel, one-piece, four-throw crankshaft is supported by six semi-circular steel-backed special alloy precision main bearings which are easily replaced. The crankshaft is drilled for lightness and to provide pressure lubrication of crankpin journals. The crankshaft end clearance is fixed by the front main bearing setting between the forward crank cheek and a flange machined on the shaft. Shafts No. 530196 and 530199 have a thin flange with no taper. This flange rides in a narrow recess in crankcase No. 53027-A1 and acts as an oil slinger.

5. CRANKCASE AND OIL SUMP CONSTRUCTION

The crankcase is a two-piece heat-treated aluminum alloy casting, bolted together at the vertical lengthwise plane through the crankshaft and camshaft. Rigid transverse webs hold the three main crankshaft bearings and the three camshaft journals. A specially designed oil seal prevents oil leakage at the front end of the crankshaft. Large tappet guides are formed in the crankcase in a plane below and parallel to the cylinders. Drilled oil galleries molded in the castings provide pressure lubrication to the tappet guides, camshaft, and main bearings. Circumferential stiffening ribs under the cylinder pads give additional strength and stiffness to the cylinder hold-down bosses. Four engine mount bosses for 7/16-inch bolt are provided at the rear of the crankcase for mounting similar to that of radial engines. To the rear and on the bottom of the crankcase there is a large flange to which the oil sump is attached.

The oil sump is a two-piece deep drawing sheet steel stamping, welded together at the flange. A heavy sheet steel mounting flange is securely welded at the top of the sump. A steel filler tube with support bracket is welded to the oil sump body. A bayonet-type oil gauge rod is combined with the oil filler cap.

6. CONNECTING RODS

Connecting rods are of conventional split-bearing design and of heat-treated alloy steel forgings. The split crank journal end bearing is of replaceable thin steel-back shell-type, lined with special alloy metal. A pressed-in bronze bushing is used at the piston pin end.

On late model A65 and all A75 Engines an oil squirt hole is provided in the connecting rods to insure more positive oiling of the cylinder walls.

7. PISTON AND PISTON PIN CONSTRUCTION

Pistons are heat-treated aluminum alloy permanent mold castings. The ring grooves are arranged to carry two compression rings and one oil control ring above the pin on A65 and A75 engines.

Piston No. 40731 is cam ground to provide better fit in the cylinder at operating temperature. It requires the large diameter piston pin No. 530856.

The full-floating type piston pin is a case-hardened, seamless steel alloy tubing, machined and ground. Each end is fitted with an aluminum plug to prevent scoring of the cylinder walls.

8. CRANKCASE COVER

The magnesium alloy crankcase cover casting at the rear end of the engine provides support for the magnetos, oil pump, and tachometer drive. It also houses the oil suction tube, the oil drain, oil screen, the pressure relief valve and oil lines to match the several crankcase oil lines. The entire assembly with accessories is removable as a unit.

9. LUBRICATING SYSTEM

To reduce the number of external oil lines, an oil sump is attached directly to the crankcase. Oil is drawn from the oil sump through a suction tube extending down into the sump and delivered under pressure to a screen from which it goes through drilled passages in the crankcase cover and crankcase

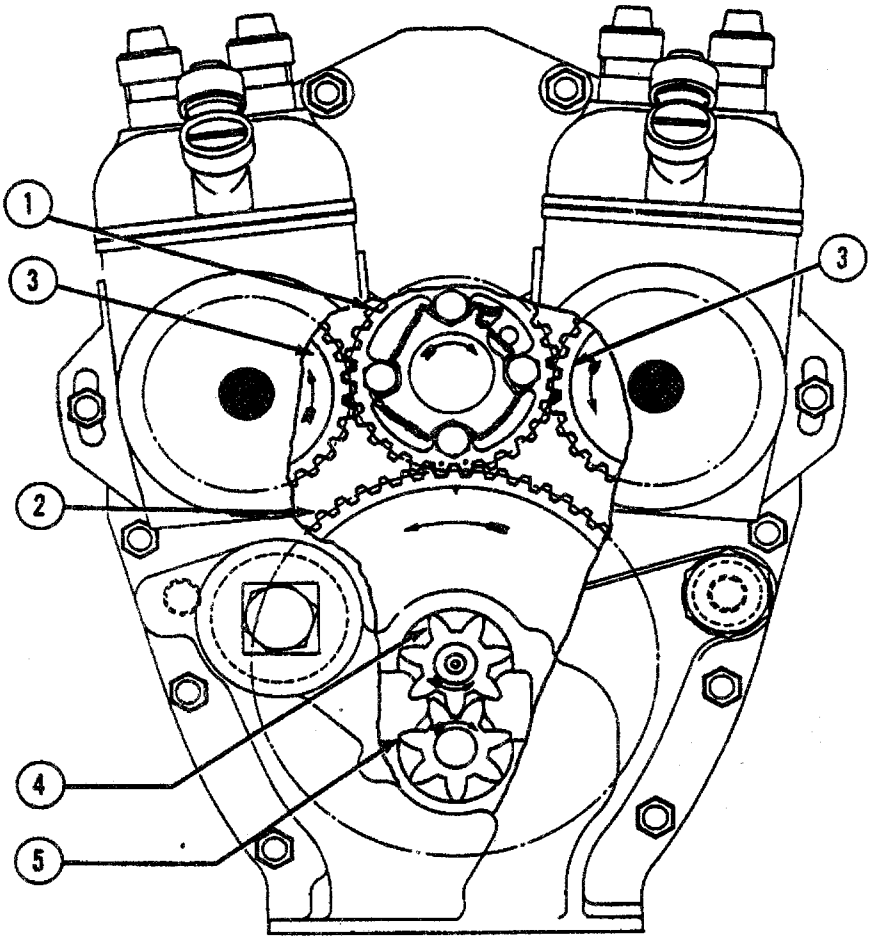


Figure 6. Cutaway View Showing Gear Train.

GEAR TRAIN ANALYSIS

Figure 6 shows the complete gearing arrangement from the crankshaft power take-off to all accessories. The arrow on each gear indicates direction of rotation as viewed from the rear of the engine, and the following analysis describes each gear function with its speed in relation to the crankshaft.

(1) The crankshaft gear is driven from the crankshaft attached to the rear end of the crankshaft by cap screws and turns in a clockwise direction at crankshaft speed.

(2) The cam gear is driven by the crankshaft gear (1) at 1/2 crankshaft speed in a counter-clockwise direction.

(3) The right and left magneto drive gears, driven by the crankshaft gear, turn in a counter-clockwise direction at crankshaft speed.

(4) The oil pressure pump driver gear is driven by cam gear (2) through a male-female square coupling, and turns in a counterclockwise direction at 1/2 crankshaft speed.

(5) The oil pressure pump driven gear is driven by gear (4), and turns in a clockwise direction at 1/2 crankshaft speed.

to all drive bearings, through the crankshaft, and to the crankpins. Engine oil from the pressure pump is carried through drilled passages in the crankcase to the hydraulic tappets. After entering the tappets, it travels out through the overhead mechanism through hollow push rods, and is spilled over the rocker arm and valve mechanism. As it drains away, it thoroughly oils the valve stems and valve guides. The oil is returned to the crankcase by way of the push rod housing, and drains back into the oil sump through the opening at the rear of the crankcase. The cylinder walls and piston pins are lubricated by spray. The excess oil in the crankcase is returned to the oil sump. The pressure relief valve is set to give approximately 35 pounds of pressure at speeds of from 1900 to 2300 R.P.M.

Refer to the Section on Table of Limits for Charts showing the lubrication system.

SECTION 3

PACKING, UNPACKING, AND PREPARATION FOR STORAGE

1. SHIPPING BOXES

Each engine is packed for domestic shipment in a light weight crate, the sides and top of which are of wood frame and corrugated cardboard construction. The crate base is constructed of wood planking with 3 skids on the lower side. The engine is supported in the inverted position on a formed plywood cradle which is bolted to the crate base. The engine crate must always be hoisted by a sling passed under the base or by a fork-lift truck so that the engine weight is never supported by the crate side panels. Overall dimensions of the crate are approximately: 34" wide x 34" long x 30" high.

2. PACKING

Four bolts and nuts attach the top engine mounts and the crankshaft propeller flange to the cradle. If the engine has a tapered crankshaft, the tapered end rests in a hole bored in the end of the cradle. The propeller hub nut thread of a tapered shaft is covered by a plastic cap. The crankcase breather and carburetor fuel inlet are plugged, and the carburetor air intake flange and cylinder exhaust flanges are covered by cardboard seals. A moisture-proof paper shroud is placed over the engine. Its edges overlap the edges of the base so that the nails which are driven through the side panel frames into the base planks pass through the shroud to hold it in place. The Air Intake assembly and propeller hub, if any, are attached to the base planks inside the shroud. This packing is not intended for long-term storage. A heavier, all-wood crate is provided for export shipping. Internal corrosion preventive compound is applied through the lubrication system and as a spray through the induction system and into spark plug holes and exhaust ports. The effective duration of this protection will depend entirely on atmospheric conditions during storage. Crated engines should be inspected at intervals of not more than thirty days during storage and re-preserved if a generous film of preservative oil is not found on all internal surfaces and unpainted surfaces.

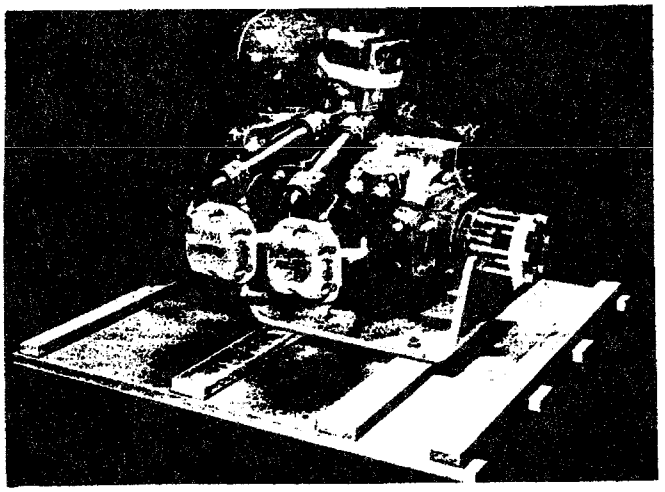


Figure 7. Engine in Shipping Cradle.

3. UNPACKING THE ENGINE

Pull out the nails which attach the side panels to the crate base. Lift off the side and top panel assembly and the engine shroud. Remove the air intake assembly from the crate. Attach a crankshaft lifting eye, such as those supplied by the Kent-Moore organization, to the crankshaft flange bushings or tapered shaft hub nut thread, as applicable. Attach a hoist to the lifting eye and take up the slack. Remove the shipping bolts which attach the crankshaft propeller flange to the cradle. While two men support the rear of the engine, remove the bolts which attach the top engine mounts to the cradle, and lift the engine clear of the cradle. Raise the front end until the engine is suspended by the crankshaft clear of obstructions. Place the engine on a suitable work stand, such as supplied by the Borroughs Tool Co., for installation of fittings, baffles, etc.

4. TREATMENT OF ENGINES FOR LONG PERIODS OF IDLENESS

When the aircraft (or a crated engine) cannot be operated daily, or weekly in very dry climates, it should be treated for storage as follows:

a. Drain the oil sump

b. Remove all spark plugs and exhause port covers or exhaust manifolds

c. With a long, thin nozzle of suitable shape, and which produces a 90°, atomized spray, connected to a source of dry, compressed air and a clean container of internal corrosion preventive compound spray each cylinder through the upper spark plug holes, moving the nozzle in and out in step with the piston through two sweeps while the crankshaft is

slowly rotated. Do not flood the cylinders.

d. Direct the spray into each exhaust port while the crankshaft is rotated several revolutions.

e. Stop the crankshaft and again spray through each upper spark plug hole so as to sweep the cylinder wall exposed. Do not turn the crankshaft thereafter.

f. Spray the crankcase interior through the oil sump drain plug and the breather elbow. Attach the drain plug to the sump with a length of safety wire, but do not install it.

g. Remove the pressure oil screen and spray the pump through the screen housing. Replace the screen.

h. If the propeller is not installed coat the exposed end of the crankshaft with a preservative grease, such as Federal Spec. 52-C-18, Grade 1, or AN-C-124, and wrap it with grease-proof paper or fabric or non-hygroscopic tape.

i. Replace all spark plugs and exhause port covers. Seal any openings to the interior of the crankcase with non-hygroscopic tape.

j. In the vicinity of salt water, the exterior surfaces may be further protected by spraying with a water-proof varnish.

k. Crated engines should be protected from dripping water by covering with a moisture-proof shroud. They should also be protected from sweating with atmospheric changes by storage in a location where the smallest possible variations in temperature occur.

l. A tag should be attached to the engine crate (or aircraft instrument panel) to warn that the oil supply has been drained and the drain plug removed. The tag should also state the date of preservation.

m. A pan of adequate size should be positioned to catch preservative oil dripping from the open sump drain.

The internal preservative mixture recommended for use with this procedure is composed of one part Army Spec. AXS-934, Grade 2, corrosion preventive oil will mixed with one part S.A.E. No. 30 aircraft engine lubricating oil. AXS-934 oil is obtainable at most refineries and bulk storage plants.

The above preservation should be repeated at intervals of thirty days during storage.

5. PREPARATION OF ENGINES FOR SERVICE AFTER STORAGE

Engines prepared for storage in accordance with the foregoing instructions may be placed in service after making the following checks:

a. Turn the propeller slowly by hand through eight or ten revolutions to permit drainage of preservative oil from cylinders and to listen for intake and exhaust flow. If the valve action is not normal, remove rocker covers and check for sticking valves. Lubricate stems of sticking valves with flushing oil or a mixture of lubricating oil and gasoline. Continue to rotate the crankshaft until the valves all operate normally. If sticking persists, the cylinder must be removed and disassembled for inspection and necessary repair.

b. Remove all spark plugs and wash out oil with Acetone, carbon tetrachloride, or clean, unleaded gasoline. Re-install spark plugs, using serviceable gaskets. See the Table of Limits for correct tightening torque.

c. Install the oil sump drain plug with a serviceable gasket. Fill the oil sump to the "Full" mark on the gauge rod with the recommended seasonal grade of aircraft engine oil.

d. Remove any seals, covers, or caps installed on carburetor air intake and connectors such as the crankcase breather. Connect the proper hoses, tubes, etc.

e. Check all engine controls for full range and free operation, proper support, and safe connection to the engine. Check fuel supply, primer, temperature, and gauge lines for tight installation.

f. Drain any water from the fuel strainer.

It is recommended that the oil supply be drained and the sump refilled with fresh oil of correct grade after approximately five hours of operation following removal from storage. While AXS-934 preservative should do no harm to the engine, this oil change will assure removal of the preservative and any foreign material. It is always advisable to avoid mixing types of oil.

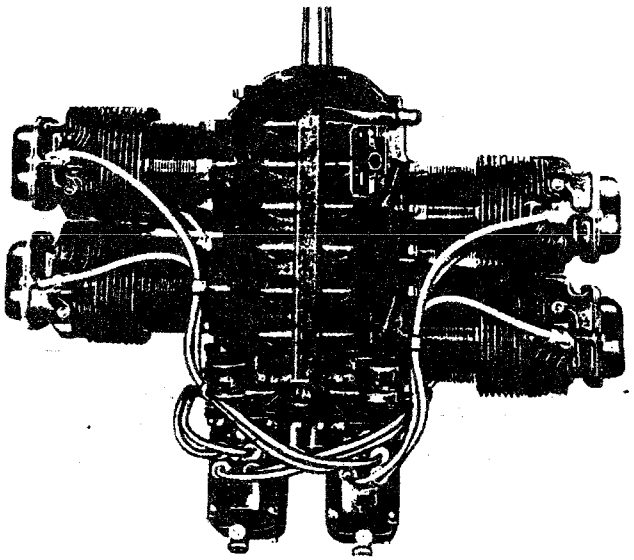


Figure 8. Hoisting Engine with Crankshaft Lifting Eye.

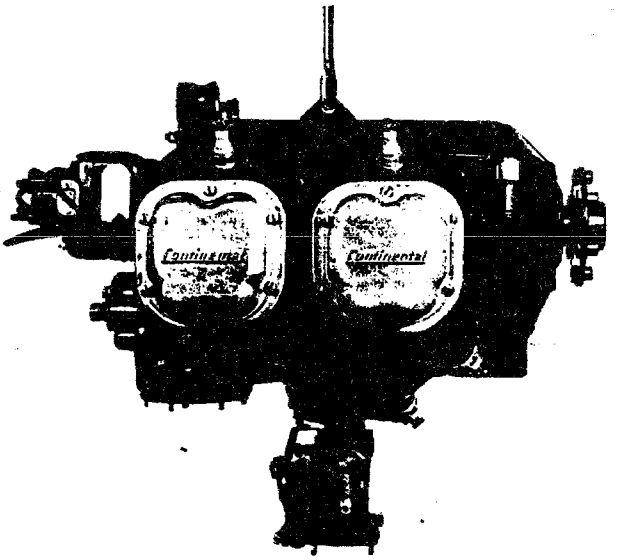


Figure 9. Hoisting Engine with Crankcase Lifting Eye.

SECTION 4

INSTALLATION AND REMOVAL

1. MOUNTING THE ENGINE

a. A lifting eye is permanently attached to the crankcase upper flange by the third and fourth screws from the rear. A hook, such as that supplied by the Borroughs Tool Company, may be engaged to the lifting eye hole and the hoist attached to it for lifting the engine in the flight attitude. See figure 9. A special hoisting older engines not equipped with the crankcase lifting eye.

b. Hoist the engine to its installed position in relation to the aircraft engine mount. Install the conical rubber mount bushings in the front and rear recesses of the four Engine mount bosses at the rear of the crankcase. Place one steel washer (of the thickness required to locate the engine C.G.) between each rear rubber bushing and its mount pad, and install the four mounting bolts. Install the front washers, nuts and cotter pins. See figure 11 for mount details. Tighten the mounting bolt nuts to the torque specified in the Table of Limits. This is very important.

c. Remove the exhaust port covers and install the exhaust manifolds. Tighten the nuts to the torque specified in the table of limits.

d. Remove the shipping plug from the carburetor fuel inlet and attach the fuel supply line.

e. Connect the priming pump inlet line to the proper fitting as required by the aircraft fuel system. Connect the priming pump discharge line to the primer jet installed in the intake manifold, or make the necessary connections if an intake port priming manifold is used. Test the system for fuel leaks when ready to start the engine.

f. Connect the throttle control, ignition switch wires, oil temperature gauge capillary, oil pressure gauge line, and the tachometer cable and conduit nut to the proper points on the engine as illustrated in figures 10 and 11.

g. Install the carburetor air intake assembly on the carburetor lower flange with the air filter forward. Connect the carburetor air heater hose from the rear inlet to the source of warm air (100°F.). Install the air heat valve control wire in the valve lever swivel, and check the valve and control operation for free movement and full range.

h. Mount the propeller on the crankshaft flange, using the bolts, flange ring, and moisture impervious plate provided. If the engine is equipped with a tapered crankshaft install the hub assembly in the propeller and check track and balance before mounting it on the crankshaft.

2. REMOVING THE ENGINE

a. Remove the propeller and engine cowling.

b. Disconnect from the engine the throttle control, carburetor air heat control, tachometer cable, fuel supply and primer lines, oil temperature gauge capillary, oil pressure gauge line, and the magneto switch wires.

c. If necessary, loosen the magneto attaching nuts and rotate the magnetos to clear the engine mount structure.

d. Attach a hoist to the crankcase lifting eye, or attach the special sling to the engine and the hoist to the sling. Take up the engine weight on the hoist.

e. Remove the lower engine mount bolts. Adjust the hoist to prevent movement of the engine as the lower mount bolts are removed. While removing the upper mount bolts it is advisable to have a second man controlling the hoist and the front end of the crankshaft to relieve vertical binding of the bolts and to prevent pitching of the engine.

f. Observe points of possible interference and avoid damage to accessories as the engine is hoisted clear of the aircraft. Place and fasten the engine on either a shipping cradle or a suitable work stand.

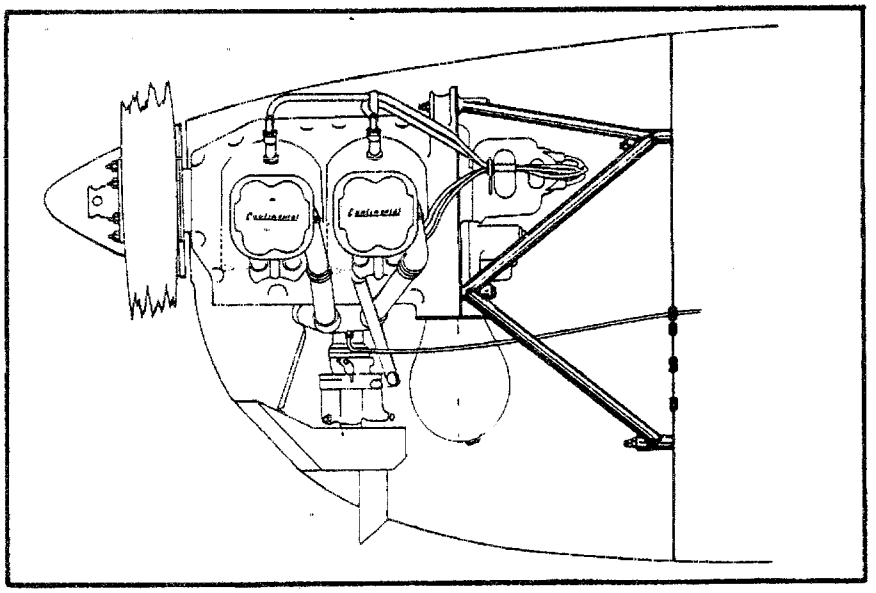


Figure 10. Typical Installation Diagram.

SECTION 5

GENERAL OPERATING INSTRUCTIONS

1. BEFORE STARTING

a. If the engine has been idle for over 2 hours, or if excessive priming has been used during starting attempts, make certain that ignition is turned to the "OFF" position, open the throttle wide and pull the engine through by hand four or five complete revolutions. If fuel or oil is present in any combustion chamber, as evidenced by excessive compression, remove the spark plugs form that cylinder, drain all liquid from the cylinder and intake pipes, and dry spark plugs thoroughly before replacing.

CAUTION: Starting the engine with excessive oil or fuel in the cylinders may result in bent or broken rods.

b. Set mixture control at "FULL RICH."

c. Open cowling flaps (if installed), except in extreme cold weather.

d. Place carburetor heat control in COLD position.

2. STARTING

a. With throttle "CLOSED," switch "OFF," and gasoline supply valve turned "ON," prime the engine three or four strokes (depending on weather conditions, warm engine, etc.) as the engine is turned over by hand five or six times. Avoid overpriming.

b. Turn ignition switch "ON" and open throttle slightly. Start engine by pulling propeller through.

c. If engine fires on one or two cylinders with weak exhaust report and resultant black smoke, it is overprimed and should be unloaded in the following manner:

(1) Turn ignition switch "OFF,"

(2) Open throttle and turn the engine backwards five or six times.

d. For cold weather starting, a half or quarter stroke on the primer when the motor fires once or twice will enable it to keep running. In extremely cold weather the oil should be preheated.

e. If the engine fails to start after a reasonable number of attempts, consult paragraph 1 of Section 6 for possible cause.

3. WARM-UP AND GROUND TEST

a. As soon as engine is started, check oil pressure gage. If the gage does not indicate pressure within 30 seconds, the engine should be shut down and investigation made.

b. All ground testing and running of engine will be accomplished with carburetor set at "FULL RICH" position and all controllable cowling flaps, grills, etc., (if installed) will be in the full "OPEN" position.

c. After engine has run approximately 3 minutes between 700 and 800 rpm, increase throttle gradually until tachometer shows from 1200 to 1500 rpm and run for an additional 5 to 7 minutes.

d. Test magnetos separately for proper firing. Speed of engine with steady throttle should not drop off more than 75 rpm on either single magneto from a "BOTH" magneto operating position.

NOTE: Prolonged running of the engine at or near "FULL THROTTLE" position should be avoided on the ground. Under average conditions, for continuous operation on the ground, speeds up to 1850 rpm are permissible. However, due to variations in the wooden propellers used, it is extremely difficult to give definite permissible and top ground rpm.

4. TAKE-OFF

a. Immediately before take-off, set brakes. Open to "FULL THROTTLE" for approximately 10 seconds and check individual magneto operation. Check oil pressure, oil temperature gages and carburetor air heater control.

b. During take-off and climb the engine should be kept at "FULL THROTTLE." When a safe altitude has been attained the engine can be throttled down.

5. FLIGHT

a. The rpm, cylinder head temperatures, oil pressure, and temperature give the most satisfactory indication of the engine's performance. If any of these appears irregular, the engine should be throttled and, if the cause cannot be eliminated, a landing should be made to investigate and remove the trouble.

b. In flight the mixture control can be leaned out only when a higher rpm can be obtained, i.e., a higher rpm must result from any leaning of the mixture, otherwise the mixture control must be returned to the "FULL RICH" position.

6. LANDING

a. The mixture control must be replaced in its "FULL RICH" position prior to landing.

b. From cruising operation, slowly close throttle to 1000 rpm.

c. The carburetor air heater should be used in long glides.

d. When throttle is closed while making long glides from high altitude, open throttle periodically to clear the cylinders and to prevent spark plug fouling.

7. STOPPING

a. Under conditions of normal usage the engine should have cooled sufficiently during the glide and taxiing period to permit turning ignition switch "OFF" without additional idling. However, if there is an excessive amount of taxiing the engine should be allowed to run two or three minutes about 800 - 1000 RPM before stopping.

b. If the engine is equipped with a Stromberg NA-S3A1 carburetor, stop from idling speed by turning the ignition switch to "OFF". As the engine stops open the throttle rapidly and leave it open to prevent after-firing. If the carburetor is a Marvel-Schebler MA-3PA model, stop by moving the mixture control

to the full "LEAN" position, where it acts as an idle cut-off. Do not open the throttle, because it actuates the accelerator pump and rapid opening will flood the engine.

8. CARBURETOR HEAT CONTROL

The engine should be operated on "COLD" air at all times, except when operating under conditions where icing is likely, in which case the carburetor air control should be placed in the "FULL HOT" position. If improved engine operation is not obtained the heat control should be returned to the "COLD" position.

9. MIXTURE CONTROL

The following expressions are applicable to manual adjustment of the mixture control:

a. "FULL RICH" is the setting of the mixture control lever in the position giving maximum fuel flow.

b. "BEST POWER" is the setting of the mixture control lever which, with a given throttle setting, results in obtaining a higher rpm., i.e., a higher rpm must result from any leaning of the mixture, otherwise the mixture control must be returned to the "FULL RICH" position.

10. GASOLINE AND OIL RECOMMENDATIONS

Engine Model	Minimum Fuel Octane Rating
A65 & A75	80/87

	Oil Viscosity Grades	
Engine Model	Ambient Air Temperature	SAE Grade
A65 & A75	Below 40°F	SAE No. 20
	Above 40°F	SAE No. 40

When average ambient air temperature is approximately at the dividing line of the above temperature ranges, use the lighter oil. It is recommended that oil be changed each 20 to 30 hours.

SECTION 6

ENGINE TROUBLE AND SERVICE REPAIRS

1. FAILURE TO START

a. Lack of Fuel.

(1) Check whether there is a sufficient level of gasoline in the airplane tank to flow to the carburetor.

(2) Check the gasoline flow at the carburetor; see that the carburetor float is not stuck, and that the jets are not clogged.

(3) Make certain that the vent holes in the gasoline tank caps are open.

b. Under-priming or Over-priming.

(1) If engine is under-primed, close throttle, with gasoline supply valve turned on, prime the engine two or three strokes.

(2) If the engine is over-primed, turn the ignition switch off, open the throttle, and turn the engine backward to unload the cylinders.

c. Defective Ignition.

(1) Examine ignition wiring for breaks in the insulation.

(2) Check all spark plugs for correct gap setting. Whenever the gap is found to exceed .025 inch, the electrodes should be adjusted to gap as shown in Continental Motors Service Bulletin M68-4.

(3) Check magneto points for clearance and possible pitted or oily condition.

(4) Examine the magnetos for correct timing to the engine. (Refer to section 11, paragraph 3, i.)

(5) Check ground terminal for possible shorting inside terminal housing.

d. Valve Action.

(1) Check valve stems to be sure they are not gummed with carbon and sticking open.

(2) Check condition of valve springs and see that they are assembled to the valve stem correctly.

(3) Check the working order of the rocker arm assemblies.

(4) Check for worn or bent push rods.

e. Cold Oil — With the ignition switch off, turn propeller over by hand to break the drag created by cold oil between the pistons, piston rings, and cylinder walls. In extremely cold weather or below zero temperatures, it is advisable to preheat engine and cylinder oil prior to any starting attempts.

f. Hot Engine — Do not prime. The engine will frequently start without an additional prime over that left in the cylinders when the engine was shut off. It may be necessary to unload the cylinders by turning the propeller opposite to the direction of rotation.

2. LOW OIL PRESSURE

a. Check for dirt in the oil screen. Remove screen and clean thoroughly.

b. Check for poor connections in the oil suction tube, causing the pump to draw air.
c. Check the quantity of oil in sump. A minimum of two quarts of oil must be used.
d. Inspect relief valve to see whether plunger is operating smoothly in its guide and seating well, and the control spring is functioning properly. Clean.
e. Inspect and clean oil screen at end of oil suction tube.

3. HIGH OIL TEMPERATURE

a. This condition may be due to the following:
(1) Insufficient amount of oil in sump.
(2) Dirty oil.
(3) Failure to remove winter baffles, or inefficiency of loose baffles.
(4) Excessively lean carburetor mixture.
(5) Worn or stuck rings, indicating piston score.
(6) Altitude control mixture not adjusted properly.
(7) Operation at full throttle, low speed.

4. LOW POWER OR SPEED

a. Check propeller for track, balance, and pitch.
b. Check spark plugs, wires, condensers, coils.
c. Check for air leaks at all connections of carburetor and intake manifold.
d. Check for full opening of throttle valve.
e. Check for unrestricted flow of fuel to carburetor inlet and for proper operation of carburetor.
f. Check cylinder compression and valve action.
g. Check carburetor air temperature. Check for proper operation of carburetor heat control.
h. Check tachometer to see that it is registering correctly.

5. ROUGH RUNNING

a. Check propeller for balance, track and correct installation on the propeller hub and shaft.
b. Clean, re-gap, and bomb test spark plugs.
c. Check magneto operation. Check whether ignition cables are breaking down at high speeds.
d. Check valve operation, especially evidence of sticking, or any lag in valve operating mechanism.
e. Check engine mounting bolts for tightness.
f. Check engine mount for cracked or broken members.
g. Check carburetor air temperature. Check for proper operation of carburetor heat control.

6. ENGINE FAILS TO ACCELERATE PROPERLY

a. Motor not sufficiently warm.
b. Heater control not on, or not functioning properly.
c. Spark plugs fouled by long idling.
d. High float level.
e. Worn intake valve guides and piston rings.

7. ENGINE FAILS TO IDLE PROPERLY

a. Check for air leaks at points of carburetor and intake manifold and intake manifold elbow to cylinder connections.
b. Leaking primer jets.
c. Idle air bleed blocked by dirt.
d. Engine idling jet set too lean or plugged.
e. Worn intake valve guides and piston rings.

SECTION 7

SERVICE INSPECTION AND ASSOCIATED MAINTENANCE

1. GENERAL

a. The work outlined in this section consists of the periodic inspection, cleaning, servicing, lubricating, adjusting, and such maintenance work as is associated with the routine Inspection System.

2. INSPECTION AND MAINTENANCE

a. Daily-Power Plant.
(1) Check oil level. Replenish oil supply if necessary.
(2) Inspect for evidence of engine throwing oil.
(3) Check security of carburetor air intake and its control valve for operation.
(4) Inspect carburetor for fuel leakage at connections, drain plugs, and passage plug. Clean fuel filter bowl and fuel tank sump if necessary. Make sure drains are properly safetied.
(5) Check throttle and mixture control connections to insure that no binding exists and they are tight and properly safetied.
(6) Check all wiring terminals for tightness and condition of wiring.
(7) Make visual inspection of entire engine for: missing or loose nuts, bolts, manifolds; proper safetying of all plugs.
(8) Inspect the front side of the carburetor intake air filter to make sure it is not restricted by dust and other foreign matter. The filter should be cleaned as often as it becomes dirty; every day under severe conditions. Whenever the intake air filter is found to be restricted by dust it must be removed and cleaned with mineral spirits solvent used for cleaning parts. Use fresh solvent for final cleaning, and drain the filter thouroughly.
b. Ignition and Electrical.
(1) 25-Hour.
(a) Remove megneto breaker cover and clean breaker housing.

(b) Inspect magneto for damaged breaker felts or cushions.
(c) Check for excessive lubrication. Clean and dry the breaker mechanism to insure that oil will not touch the breaker contacts.
(d) Make certain all necessary safety wiring or pins are installed.
(e) Replace breaker assembly, if necessary.
(f) Check security of spark plug elbow terminal and shielding nuts on radio shielded engines.

NOTE: When checking the elbow assembly, extreme care must be exercised that the barrel is not rotated with respect to the shell. Discontinue the common practice of slightly tightening the elbow nut at each 24-hour inspection. Never check the tightness of the elbow by twisting the body of the elbow.

(2) 50-Hour - Inspect all wiring for breaks in the insulation and proper securing of terminals. Replace, if necessary.
(3) 100-Hour.
(a) Remove spark plugs and clean, or replace with new or reconditioned plugs of approved type.
(b) Install serviceable spark plug gaskets.
(c) Test Ignition cables for high tension leaks.
c. Fuel System.
(1) 25-Hour.
(a) Lubricate throttle shaft bearings, using light machine oil.
(b) Remove fuel fiter bowl. Clean screen and bowl. Replace bowl and refill. Check for leaks and bubbles. Tighten bowl and safety.
(c) Remove float chamber drain plug, fuel strainer plug and strainer. Clean strainer. Flush out water and sediment by allowing fuel to flow through strainer and drain plug opening.
d. Oil System.
(1) 25-Hour.
(a) Drain engine oil after each 25-hours' operation, unless operating conditions indicate otherwise, and refill with the proper grade and quality of oil. The draining should be done while the engine is hot. See table, page 18 for proper grade.
(b) Check oil sump for security of mounting and proper safetying of all nuts.
(d) The oil screen assembly located in the crank case cover back of No. 2 cylinder should be cleaned at least once every 25 hours.
(2) 100-Hour - Clean oil screen and oil suction tube screen.
(3) At Engine Change - Clean oil screens on newly installed engines at the following periods:
(a) At completion of ground installation test.
(b) At completion of flight test.
e. Cooling System.
(1) 50-Hour.
(a) Check air deflectors for cracks, security of fastening, and to make sure they do not chafe cylinder fins.
(b) Inspect cylinders for damaged or broken fins.
f. Valve Mechanism.
(1) These engines have internal automatic lubrication of the valve machanism which should be inspected in accordance with the following periods and instructions:
(a) 25-Hour - A complete inspection of the valve mechanism should be made at the first 25-hour inspection after the engine is installed.
(b) 100-Hour - A complete inspection of the valve mechanism should be made at 100-hour intervals.
(2) In making the inspection set forth above, the following instructions should be observed:
(a) Remove rocker box covers. Inspect rocker arm for cracks, excessive side or end play, signs of interference with adjacent parts.
(b) Check for broken springs, condition of valve spring retainers and security of valve spring seat locks.
(c) Make certain all oil passages are open before replacing rocker box cover. Interior of rocker boxes should show complete coverage with engine oil.
g. Manifold and Hose Connections.
(1) 25-Hour.
(a) Check intake manifold for proper mounting and for security of the two plain nuts and palnuts.
(b) Inspect rubber hose connections and clamps on the intake pipes and elbows for proper and secure adjustment.
h. Propeller and Accessories.
(1) 100-Hour.
(a) Check propeller hub bolts for tightness and check propeller for track, making corrections if necessary. The propeller should track within 1/8 inch.
i. General.
(1) Check engine mounting bolts for proper torque.
(2) Check propeller hub and nut assembly for proper torque. Should be 200-225 ft. lbs.
(3) All unattached ignition cable ends must be covered with friction tape or other suitable protective covering and secured.

SECTION 8

ADJUSTMENT, REPLACEMENT AND MINOR REPAIRS

1. GENERAL

a. The work outlined in this section can be performed without the facilities usually available at major overhaul shops.

b. This section of the manual contains all necessary instructions for the replacement (but not repair) of accessories and removal of external or readily removable parts.

2. CARBURETOR

a. The carburetor is located at the bottom of the crankcase and is attached to the intake manifold, which in turn is assembled on the two studs provided in the crankcase.

b. The carburetor is installed to the mounting pad of the intake manifold with a gasket between the parting flanges, and is retained by four plain nuts together with suitable plain washers and lock washers.

c. The carburetor air intake and filter assembly is mounted on the base of the carburetor with a gasket, and is retained by four plain nuts with suitable lock washers.

d. Controls connecting to the carburetor are as follows:

(1) The throttle control lever is at the right side of the carburetor as viewed from the rear of the engine.

(2) The mixture control lever is located on top of the float chamber on the left side as viewed from the rear of the engine.

e. The carburetor may be removed from the engine by detaching the fuel line, throttle and mixture controls, removing the air intake assembly and the four castle nuts at the mounting pads.

3. MAGNETOS

The two magnetos are mounted on the right and left sides of the crankcase cover. The mounting flange of each magneto is attached by two studs, plain washers, lock washers and nuts.

4. MAGNETO INSTALLATION AND TIMING TO ENGINE

a. Rotate the magneto until the mark on the gear, visible through the inspection window, is in line with small pointer, which is also visible. This places the magneto in firing position for cylinder No. 1. Rotate engine in counterclockwise direction until the firing stroke of No. 1 cylinder is reached.

b. Installing the left and right magneto, set the engine as follows:

A65 Series 8,---Right and Left Magneto:	30° B.T.C.
A75 Series 8,---Right Magneto:	29° B.T.C.
A75 Series 8,---Left Magneto:	32° B.T.C.

B.T.C.

C. Tighten the mounting nuts enough to hold magneto in position against the accessory case. Before checking exact breaker opening position, rotate magneto counter-clockwise by tapping the mounting flange until it is near the end of travel permitted by the slots. Turn crankshaft backward slightly, and bring slowly up to firing position to take backlash out of the driving gear train. Insert a .0015-inch feeler between breaker points and tap magneto flange in a clockwise direction until the exact point of release is reached. Tighten mounting nuts and recheck timing by backing up crankshaft and turning it slowly forward to determine if the feeler is released the instant the disc reaches the correct mark. Turn shaft only 5° or so to check impulse coupled magnetos.

5. IGNITION WIRING

a. Refer to figure 11 where the complete ignition wire system is diagrammed and firing order given.

b. The following table shows the individual ignition cable lengths in inches and the total amount required for the Series 8 engines with S4-RN magnetos:

CYLINDER NUMBER	LEFT MAGNETO TO LOWER PLUG	RIGHT MAGNETO TO UPPER PLUG
1	26"	32"
2	21"	36"
3	37"	30"
4	32"	35"

Total length required per engine 21 feet

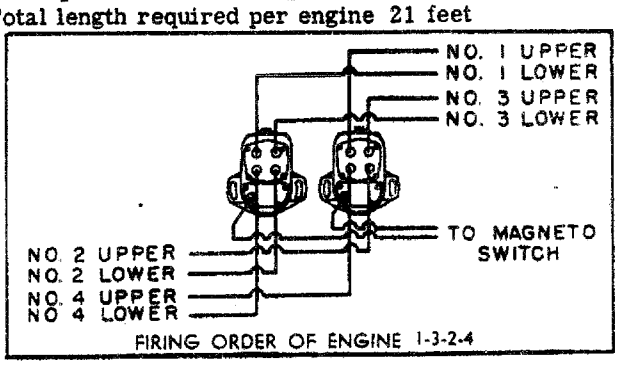


Figure 11. Ignition Wiring Diagram.

6. REMOVING PARTS

a. Cylinder and Piston.

(1) Remove wires from spark plugs, and remove spark plugs from cylinder head.

(2) Loosen the hose connections at the cylinder elbow to the intake pipe. Slide rubber hose toward carburetor.

(3) Remove screws holding the rocker box covers to the cylinders and remove covers. Push rocker arm shaft out with the finger. Make sure that the intake and exhaust valves are closed. Remove rocker arms and push rods from push rod housings.

(4) Loosen clamps holding the hose connections at foot of push rod housing. Push clamp and rubber hose up the housing toward the cylinder head.

(5) Remove the six cylinder base nuts. Remove the cylinder from the crankcase; the piston must be at the outer end of the stroke.

CAUTION: Do not allow piston to drop down as cylinder is removed from it, or damage will result.

(6) Push piston pin out and remove piston from the connecting rod.

b. Valves - Compress the valve springs in the rocker box, using a suitable valve spring compressor. Remove valve spring locks from valve stem. Remove spring seat, springs, and spring retainer. In removing valves from guides extreme caution must be exercised that they do not scratch or mar the valve guide bores.

7. GENERAL INSPECTION

a. Replace all spark plugs with new or reconditioned plugs. Carefully inspect the entire ignition harness for serviceable condition.

b. Remove all cylinder hold-down studs that are loose, broken, or have damaged threads, and install proper replacements. Available oversize replacements are listed in the Illustrated Parts List.

c. Check entire engine and make sure all nuts are tight in accordance with torque values set forth in the Table of Limits, and see that all safetying is complete and tight. Palnuts must be tightened as follows: After the regular nuts are tightened to the desired torque, install palnuts with the smooth face against the plain nuts. Tighten the palnuts with the fingers, then turn with a wrench until the nut is locked, or approximately one-sixth of a turn. Never tighten palnuts more than one-quarter of a turn. Excessive tightening will render them unserviceable.

CAUTION: Do not attempt to tighten or loosen the palnut and plain nut at the same time.

d. Inspect, tighten, and safety all engine mounting bolts.

8. REASSEMBLY

a. General - In this operation it will be assumed that all parts and assemblies are in a serviceable condition, thoroughly clean, and have been lubricated with engine oil on their bearing surfaces. When assembling the engine, use new gaskets and packing throughout.

b. Valves - Clean and oil valve guides and stems. Insert valve stems in guides.

c. Valve Springs.

(1) Insert valve spring retainer, valve outer and inner springs in rocker box housing.

(2) Fit spring seat over springs.

(3) Observe the following instructions before compressing valve springs for installation:

(a) Place a block (having the same contour as the inside of the head) against the dome of the combustion chamber to prevent the valve stems from descending in the guides when the springs are compressed for installation.

(b) Compress valve springs and install locks.

d. Piston Pins, Pistons, and Cylinders.

(1) Install new rings on piston. Fit assembly to its respective connecting rod with numbered side facing the propeller end of the crankshaft. Push piston pin carefully into position. Be sure piston pin plugs remain in place.

CAUTION: Piston must be carefully supported to avoid coming into contact with other metallic surfaces.

(2) Turn crankshaft until its position is brought to the outer end of the stroke. Carefully wipe off cylinder with clean cloth. Oil both cylinder and piston. Use new cylinder base packing between the cylinder base flange and crankcase.

(3) Install push rod housing rubber hoses on the housing and push back toward the cylinder head for clearance.

(4) Before placing cylinder on the crankcase section, all of the cylinder studs and hold-down nuts should be examined for cracks, damaged threads, or other visible defects. Any stud or nut that is defective must be disposed of. The threads of the studs and hold-down nuts must be thoroughly cleaned. Both faces of the stud washers and the recesses in the cylinder flange for the washers will also be cleaned, and any roughness or burrs removed.

(5) Assemble cylinder over piston. Rotate rings until gaps are evenly spaced about the piston, compress rings and slide the cylinder over them.

(6) Tighten cylinder hold-down nuts in the following manner: First put on all nuts and screw down in contact with flange using light pressure on hand wrench. Then torque each as specified in the Table of Limits in order shown on figure. Then retorque clockwise starting with #1. It is very important that the position of the wrench be maintained so that the turning axis of the wrench always coincides with the vertical center line of the hold-down nut which is being tightened. All nuts will be tightened slowly and smoothly until the proper torque has been applied.

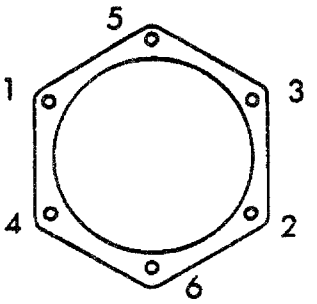


Figure 12. Cylinder Flange Torque Sequence.

CAUTION: Jerking of the torque wrench must always be avoided. Care must be exercised at all times to insure that the socket of the wrench does not contact the cylinder wall during the tightening procedure as such contact will cause an incorrect torque reading.

(7) Cylinder hold-down nuts should be checked by installing the torque wrench on the particular nut and gradually turning to the desired torque limit. If any movement is noted during this check, the nut will be loosened and retightened in accordance with instructions in paragraph (6) above.

(8) Upon completion of the check specified in paragraph (7) above, install palnuts. No further inspection of cylinder stud hold-down nuts will be necessary between engine overhauls.

(9) Slip rubber hose connections down in place on the push rod housing and tighten with metal hose clamp.

(10) Attach intake manifold and install intake pipes and hose connections.

(11) Attach the carburetor.

e. Rocker Arms and Push Rods.

(1) Rotate crankshaft so that intake and exhaust valve tappets are at their inward position.

(2) Insert push rods in the housings, hold rocker arms in place, and push in rocker arm shaft. If the tappets fill with oil, it will be necessary to compress valve springs while inserting the shaft.

f. Rocker Box Cover.

(1) Fit gasket on mounting face of rocker box cover.

(2) Fasten cover on rocker box housing with 1/4-inch screws.

g. Spark Plugs.

(1) Apply a small quantity of mica thread lubricant on the threads of the spark plugs.

CAUTION: Do not allow any of the compound to collect on the electrodes, as subsequent fouling of the spark plug may result.

(2) Screw spark plugs in cylinder head and tighten.

NOTE: Spark plugs will be tightened to a maximum torque of 360-inch pounds.

h. Adjustment of Valve Tappet Clearances.

As these engines are equipped with hydraulic tappets, no method of adjusting clearances is provided. Tappets will function properly with clearances ranging from .030 inch to .110 inch. (with tappets deflated).

OVERHAUL INSTRUCTIONS

SECTION 9

DISASSEMBLY, CLEANING AND INSPECTION

1. GENERAL

a. Before proceeding with the operations of engine overhaul as outlined in this section, remove the engine from its packing box or the airplane in which it is installed, as outlined in Section 4 and 5. Mount engine on an engine overhaul stand.

b. Spray the exterior of the engine with an approved cleaner to remove all traces of dirt and grease.

c. Remove all safety wiring, palnuts and cotter pins where necessary before each part is disassembled from the engine.

2. PRELIMINARY OPERATIONS

a. Ignition Wiring Assembly - Unfasten at spark plugs, magnetos, remove nuts securing brackets and remove ignition wires from engine.

b. Spark Plugs - Remove upper and lower plugs.

c. Magnetos - Remove nuts that fasten magnetos to crankcase cover and remove magnetos.

d. Caruburetor Air Intake - Remove the four nuts that hold the carburetor air intake to the carburetor and remove air intake.

e. Carburetor - Remove four nuts which fasten the carburetor to the intake manifold and remove carburetor.

3. DISASSEMBLY

a. Oil Sump and Suction Tube - Remove the six nuts that hold the oil sump to the crankcase, and the nut that fastens the oil filler bracket to the crankcase and remove oil sump. The oil suction tube inside the oil sump and attached to the crankcase cover can be removed by unscrewing the hex portion at the top, using a 7/8-inch openend wrench.

b. Intake Pipes and Manifold - Unfasten clamps which secure hose connections to intake elbow at cylinder. Slide the rubber hose down toward carburetor. Remove the two 3/8-inch nuts holding intake manifold to crankcase. Remove intake manifold and pipes by dropping straight down.

c. Rocker Box Covers - Remove the 1/4-inch screws that fasten the rocker box covers to the cylinder head and remove covers.

d. Push Rods and Rocker Arms - After covers are removed, push out rocker arm shaft with the finger, or, if necessary, use aluminum drift and lightly tap out. Remove rocker arms from cylinder head and push rods from their housings.

CAUTION: make certain that the cam is in such a position that the intake and exhaust valves are completely closed before removing rocker shafts.

e. Cylinder and Pistons.

(1) Loosen clamps holding hose connections at foot of the push rod housing. Push clamp and rubber hose back up on the housing toward cylinder head.

(2) Turn crankshaft until piston within cylinder to be removed is at top of the stroke.

(3) Remove the six cylinder hold-down nuts and pull off cylinder from the crankcase.

CAUTION: Do not allow piston and connecting rod to drop down when cylinder is removed, as damage will result.

(4) After removal, place cylinders on wood or appropriate carrier to prevent damage at bottom end of barrels. Cover crankcase openings to prevent dust or grit from entering the crankcase.

(5) Push piston pin out and remove piston from connecting rod. If necessary, use aluminum drift to drive out piston pin, being careful to support the piston in the hand during this operation to prevent damage to the connecting rod.

(6) Remove the piston rings from the ring grooves of all pistons. Tie the set of rings for each piston together and tag. Number each tag with the number of the piston from which the rings were removed.

(7) Placing the cylinder over a wooden stand, shaped to fit the inside of the cylinder head, compress valve springs in rocker box, using a suitable valve spring compressor, (figure 13), such as supplied by the Borroughs Tool Company, remove the seat locks with thin-nosed pliers, release the compressor, and remove the spring seat, inner and outer springs, spring retainers and valves.

CAUTION: In removing valves, care must be taken that they do not scratch or mar cylinder walls or valve guide bores.

Figure 13. Compressing Valve Springs for Installation and Removal of Locks.

f. Crankcase.

(1) Remove the four push rod housing flanges by unscrewing the nuts which secure them to the crankcase.

(2) Remove the valve tappet cups on the push rod end of the hydraulic valve tappets. Remove the hydraulic units of each tappet with the aid of a small wire hook. (Figure 14.) Keep tappets numbered according to the order removed - keeping assemblies grouped together.

NOTE: If the cylinder and piston of the hydraulic units do not come out together, it may be necessary to wedge a wooden plug into the cylinder of the hydraulic unit and remove cylinder in this manner. Care must be taken that the wooden plug does not damage cylinder.

NOTE: The valve tappet cam follower body cannot be removed until the crankcase is disassembled. Place push rod housing connections over ends of cam follower to prevent their falling into crankcase when crankcase is lifted off. See Fig. 21, page 25.

(3) Remove the ten 5/16 inch nuts holding the crankcase cover to the crankcase. Lift the cover off as a complete unit - the oil pump, relief valve and tachometer drive units remain intact in the crankcase cover.

(4) Remove the four 1/4 inch cap screws holding the cam gear to the camshaft and remove gear.

(5) Remove the four 1/4 inch cap screws holding the crankshaft gear to crankshaft and remove gear.

(6) Remove all 1/4 inch nuts from the bolts holding halves of crankcase together, located on centerline of crankcase on both top and bottom of the engine.

(7) Remove two 7/16 inch nuts attached to long studs at front of crankcase on the No. 2-4 cylinder side, two 7/16 inch nuts on the No. 1-3 cylinder side above the intake pipes between the cylinders.

(8) Rotate the engine stand until No. 2-4 crankcase is lying on its side, check all crankcase-to-crankcase studs to see that all nuts have been removed, and carefully lift the No. 1-3 crankcase off and lay aside with contact surface up. Do not pry the parting faces of the crankcase apart with a screw driver as the contact surfaces may be damaged.

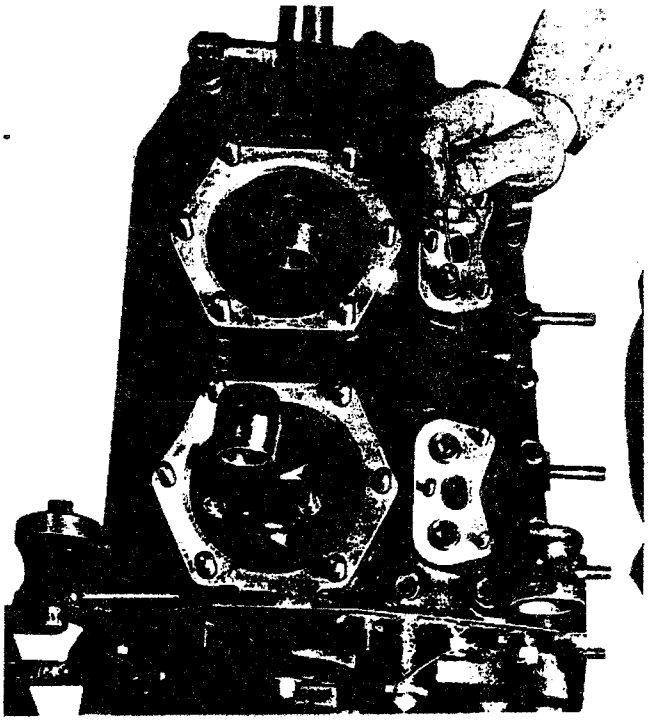


Figure 14. Removal of Hydraulic Unit from Cam Follower Body.

(9) Lift crankshaft, with connecting rods attached, out of the crankcase.

(10) Remove crankcase oil seal from front of shaft.

(11) Remove camshaft and bearing shells from both halves of the crankcase.

(12) Remove all connecting rods from the crankshaft, carefully noting their position on the shaft Point up rod numbers before disassembling.

(13) Remove push rod housing connections from ends of cam followers and remove cam followers from both halves of the crankcase.

g. Crankcase Cover Assembly (Series 8)

(1) Remove oil pump cover nuts holding the oil pump gear plate to the inside of the cover and lift out the two oil pump gears.
(2) Unscrew the tachometer drive housing from the outside of the cover.
NOTE: The housing is attached to the crankcase cover with a left-hand thread.
(3) Remove the oil pressure relief valve cap, gasket, spring and plunger from the outside of the cover.
(4) Remove oil screen and gasket from outside of cover.

4. CLEANING

a. MATERIALS AND PROCESSES.

(1) Equipment, materials and processes in general use in aircraft engine overhaul shops are satisfactory for cleaning "A" Series engine parts.

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

CAUTION

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

(3) No polishing compound or abrasive paste or powder should be needed or employed for cleaning engine parts. Scraping, abrasion with wire brushes, sand paper or abrasive cloth and buffing wheels are dangerous methods to use on soft metals such as aluminum. Scratches resulting from such methods allow a concentration of stress at the scratch and may cause fatigue failure.

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

b. SPECIFIC PARTS.

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

(2) PISTONS. Do not use wire brushes or scrapers of any kind. Soft and moderately hard carbon deposits may yield to solvent action. If deposits remain, blast the heads with soft grit or by the vapor grit method, first having installed tight fitting skirt protectors. Ring grooves may be cleaned by pulling through them lengths of binder twine or very narrow strips of crocus cloth. Do not use automotive ring groove scrapers, since the corner radii at the bottoms of the grooves must not be latered, nor any metal removed from the sides. Discoloration and light scoring need not be removed from piston skirts. The use of abrasive cloth on the skirts is not recommended, because the diameters and cam-ground contour must not be altered. Heavily scored or burned pistons should be discarded.

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

(4) ROCKER SHAFTS. Degrease these parts by brushing on any mineral spirit solvent. Prior to magnetic inspection, polish the steel bearing surfaces with crocus cloth moistened with kerosene, then with dry crocus cloth.

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

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

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

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

(9) SHEET METAL PARTS. Clean these parts with a mineral spirit spray or by brushing with the same liquid, or use a cold emulsion type cleaner and flush with water to rinse.

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

5. INSPECTION

a. General.

(1) After the sub-assemblies and parts of the engine have been cleaned and dried, place on a table for visual inspection. This inspection will be a basis for determining which parts have been defective or damaged in the course of operation. Parts that are damaged beyond repair, or worn in excess of the permissible tolerances, must be replaced.

b. Magnaflux Inspection.

Parts listed in Table 1 should be inspected at each overhaul by the Magnaflux process or an equivalent method of crack detection. The Magnaflux method is recommended whenever the necessary equipment is available. Table I provides data for proper inspection by the Magnaflux method. This method employs magnetic particles coated with a flourescent organic material which may be illuminated with "blacklight", as in the Zyglo process, to amplify weak indications. If a crankshaft is doubtful after circular magnetization and inspection, demagnetize and remagnetize it longitudinally for further inspection.

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

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

c. Flourescent Particle Inspection.

This process, commonly known under the grade name of "Zyglo", is recommended for inspecting aluminum and magnesium alloy parts for invisible cracks. The standard operating technique for the process is applicable.

b. Inspection of Engine Parts.

(1) Crankcase.

a. Check thoroughly for fatigue cracks.

b. Examine bearing seats for cracks and scratches and excessive wear.

c. Check studs for damaged threads and straightness.

(2) Cylinders.

a. Cylinder Heads - Examine cylinder head for cracks. Small cracks found at head fins are not cause for rejection. However, if cracks are of appreciable size and indicate ultimate failure, replace the cylinder.

b. Cylinder Barrels - Inspect cylinder barrel flange for nicks, evenness and for condition of cylinder hold-down nut recesses. Inspect inside of cylinder barrel for dents and scoring, for corrosion as indicated by rust and pitting, and for ring wear as evidenced by a ridge near the top and bottom of the barrel. Also check inside of barrel for out-of-round and taper, using dial indicator.

c. Spark Plug Inserts and Pins - Examine for crossed or otherwise damaged threads and looseness of insert in head.

d. Rocker Shaft Bosses - Examine rocker shaft bosses for oversize and galling of bearing surfaces.

e. Valve Seat Inserts - Examine for signs of erosion, burning, pitting or warping.

f. Valve Guides - Examine for wear and looseness. If loose in cylinder head, or if excessive clearance is found between valve stem and guide, replace.

g. Rocker Boxes - Examine for smoothness of finished surfaces.

h. Intake and Exhaust Flanges - Examine for nicks and burrs and smoothness of surfaces.

(3) Valve Mechanism.

a. Inspect exhaust and intake rockers for cracks, particularly around lubrication holes. Also inspect rockers for straightness, nicks and condition of bushing. Check rocker shaft for wear.

b. Examine push rods for straightness by rolling them on a flat plate. See that lubrication holes on ball ends are not obstructed.

c. Check valve springs for fractures, corrosion and for proper pressure and length as specified in Table of Limits. Inspect ends of each spring for splitting and cracks.

d. Inspect valve spring retainers and seats for cracks and wear.

TABLE 1 MAGNAFLUX INSPECTION DATA

Part	Method of Magnetization	Amperes	Method of Inspection	Critical Areas	Possible Defects
Crankshaft	Circular	2500	Wet Continuous	Journals, fillets, oil holes, crankpins thrust flanges	Fatigue cracks, heat cracks
Connecting rod	Circular	1800	Wet Continuous	All areas	Fatigue cracks
Piston pin	Circular	1500	Wet Residual	Shear planes, ends	Fatigue cracks, stringers
Rocker arms	Circular	1800	Wet Continuous	Rocker face, socket	Fatigue cracks
Camshaft gear	Circular	1800	Wet Continuous	Teeth, holes	Fatigue cracks
Crankshaft gear	Circular	1800	Wet Continuous	Teeth, around screw holes	Fatigue, heat cracks
Oil pump gear	Circular	1800	Wet Continuous	Teeth	Fatigue cracks

e. Inspect valve spring retainer locks for wear and galling on outside diameter, and for wear and fit on valve stem.

f. Inspect exhaust valves carefully, using a magnifying glass and magnaflux equipment, for cracks on end of valve stem, valve head and in grooves for retainer locks. Inspect valve stem and tip for scoring, pitting and wear. Check valve face for warpage, pitting and burning.

g. Inspect intake valves as discribed in preceding paragraph.

h. Check hydraulic tappets in accordance with instructions given in accessory section.

(4) Oil Sump - Examine body of sump for excessive dents and possible fractures or cracks. Inspect oil filler body. Check drain hole for damaged threads.

(5) Crankshaft and Connecting Rods.

a. Carefully inspect crankshaft, using magnaflux equipment. A fractured shaft must be replaced.

b. Check keyway on front of shaft for nicks or burrs if shaft is of taper end type.

c. Inspect connecting rod bearing surfaces for galling, scoring and for proper clearance with connecting rods in accordance with the Table of Limits.

d. Inspect oil tubes for tightness in shaft and for freedom from obstructions.

e. Inspect oil plug and propeller hub nut threads at front of crankshaft.

f. Inspect all connecting rods and caps for cracks. Check alignment of crankshaft bushing with piston pin bushing. The crankshaft hole and the piston pin hole must be parallel with each other within .001 per inch of bearing length.

(6) Pistons and Piston Pins.

a. Check piston pin plugs for smoothness, wear and proper fit in the piston pins. Discard piston pin plugs which are cracked or show excessive wear.

b. Check piston pins carefully for cracks, using magnaflux equipment. Also check piston pins for scoring, flat spots, out-of-round, straightness and for proper fit in piston. Piston pins which are cracked, out-of-round, bent, scored, or excessively worn must be replaced.

c. Carefully inspect pistons for cracks, scores, corrosion and for proper size of skirt. Check ring lands for cracks by applying a light side pressure. Also check ring grooves and lands for proper width. Inspect bearing surfaces in piston pin bosses for wear and scoring.

d. Replace cracked or badly-corroded pistons. Piston rings must be replaced at each overhaul. If cylinder barrels have been reground, or if piston ring grooves have been remachined, exercise care that proper oversize piston rings are installed.

(7) Crankcase Cover.

a. Inspect cover for cracks, particularly around stud holes and using a magnifying glass and, if necessary, by etching any doubtful portions for possible cracks. Inspect magneto mounting flanges for corrosion, burrs, scratches and flatness.

b. Check all studs on cover for cracks and tightness. Stretched or loose studs must be replaced.

c. Inspect threads of oil pressure relief cap, oil suction tube, oil screen and tachometer housing.

(8) Camshaft.

a. Inspect cam lobes for scoring, wear and pitting. Crankcase bearing surfaces for camshaft should be checked for out-of-round condition, for cracks and scoring.

(9) Gears.

a. Check magneto drive, cam and crankshaft gears for cracks, nicks, burrs, wear and proper fit.

SECTION 10

REPAIR AND REPLACEMENT

1. GENERAL

a. Special Tools required for repair and assembly work may be purchased from the Borroughs Tool and Equipment Company, Kalamazoo, Michigan.

b. Repair such damage to finished surfaces as scores, nicks, burrs and roughness by careful hand stoning, using a fine stone and gasoline. Polish with crocus cloth and gasoline.

c. Lap flanged surfaces which are bent or uneven to a flat surface.

d. Repair slightly-damaged threads with proper thread chasers.

e. All loose, bent or otherwise damaged studs will be replaced by the next oversize stud. Replacement of steel studs driven in aluminum alloy parts requires good judgment as well as a great deal of care on the part of the mechanic. Unless the replacement is properly made, more difficulties may be encountered than would have been evident had no attempt been made to correct the original difficulty.

(1) The first problem is not just to get the broken or damaged stud out, but to get it out without injury to the part in which it has been set. If the outside threads have been stripped, it is usually a simple matter to remove the stud. A stud driver or a small pipe wrench, if necessary, may be used. Apply pressure on the handle of whatever tool is used in such a manner that there will be no tendency to bend the stud. Back the stud out slowly to avoid overheating of the threads. It should be remembered that any thread lubricant or sealing material used when the part was originally installed has probably congealed, and rapid withdrawal of the parts may cause damage to the housing threads. Either of two methods has been used successfully to remove studs broken off at or near the base. The center section of the stud may be drilled out and a square shanked stud remover installed. Use a wrench of the proper size and back the stud out carefully. If this method does not work satisfactorily, it may be possible to electric weld a short piece of steel bar stock or a steel nut to the broken stud. The bar stock or the nut may then be used to withdraw the broken piece. The welding must be done carefully to avoid melting or damaging the metal around the base of the stud.

(2) The threads in whatever part the stud is to be replaced should be cleaned up before attempting to drive a new stud. Be sure that the tap to be used is the correct size. New taps usually cut oversize, and the mechanic should handle them carefully. If the tap appears to be cutting material away instead of just cleaning out the threads, withdraw it and use an older tool. Rough edges or burrs on a tap may also cause it to cut oversize. Carefully inspect all taps for evidence of this difficutly before they are used.

(3) If a stud was removed because it was loose, the next oversize stud should be installed. Oversizes of .003 inch., .006 inch, and .009 inch for five digit studs and .003 inch, .007 inch and .012 inch for 6 didgit studs are supplied to replace standard studs. These studs may be identified by the machining on the end that is driven into the housing. Refer to figure 16 for section drawings showing the identifying shapes on the ends of the studs. Examine the stud removed to determine what size it is, and install the next oversize stud available. If the stud being removed was broken and is not being replaced merely because it fit loosely, install the same size stud that was taken out.

(4) An approved lubricant should be applied to the threads on all studs before they are installed. The lubricant should be stirred before using and applied in conservative quantities.

(5) Before installing a stud, make certain that it is the correct part and that the right end will be inserted in the housing. Examine the new stud carefully, since these parts easily become mixed in stock.

(6) There is a definite height that each stud in the engine must protrude when it has been installed. Check this height with the blueprint when such information is available.

(7) When driving the stud, feed it in carefully until reasonably sure the threads are meshing properly. Then turn in slowly and steadily until the stud is approximately in position. A T-handle stud driver should always be used.

(8) Do not turn the studs in rapidly, or it is possible that the threads may overheat and either seize or be damaged.

f. Dress washers, nuts, lock nuts and screw heads to remove burrs, nicks, or scratches from outside surfaces. Nuts, washers and screws used externally should be zinc or cadmium plated to prevent corrosion.

g. Replace any part found to be cracked unless it is an unstressed part that can be repaired by welding without further damage of distortion to it.

h. Replace all gaskets and packings at the time of a major overhaul.

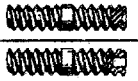
Typical Part No.	Oversize on Pitch Dia of Coarse Thread (inches)	Optional Identification Marks on Coarse Thread End		Identification Color Code
		Stamped	Machined	
XXXXXX	Standard	None		None
XXXXXXP003	.003			RED
XXXXXXP006	.006			BLUE
XXXXXXP009	.009			GREEN
XXXXXXP007	.007			BLUE
XXXXXXP012	.012			GREEN

Figure 16 Stud Identification.

REPAIR AND REPLACEMENT OF ENGINE PARTS

a. Crankcase.

(1) Make repairs to the crankcase in accordance with instructions given in paragraph 1 of this section. Particular attention should be given to removing nicks and burrs from all finished surfaces, using a fine stone and polishing with crocus cloth.

b. Cylinders.

(1) Replace cylinder and head assemblies which are found to have loose heads or cracks, except for small cracks near the surface of the cylinder fins. Small cracks on the end of cylinder fins should be carefully removed by filing. Round off sharp corners.

(2) Remove nicks on flanged surface of cylinder barrel flanges by hand stoning. Polish flanges with crocus cloth.

(3) Repair cylinder bores which are slightly corroded, scored or pitted by honing. If the maximum permissible out-of-round condition, the maximum permissible taper, or the average maximum barrel diameter is exceeded, the cylinder bore should be reground and honed to the first standard oversize that will remove all out-of-round and taper. If cylinders are ground oversize, it will be necessary to fit oversize pistons and piston rings. Pistons are available to fit cylinders .015 inch oversize.

(4) Reface valve seats which are pitted, burned or worn by removing the least amount of metal possible. Following the repair of valves, the valve seats may then be lapped in with suitable valve-grinding compound.

CAUTION: After the valves have been ground and checked for proper seating, remove all traces of grinding compound with an approved cleaner.

(5) Replace valve guides if loose in cylinder head or if excessive clearance is found between valve stem and guide. If guides are scored, they should be replaced. Remove guides with the use of the proper tools and an arbor press.

(6) Remove and replace spark plug inserts which are loose or leaking. Remove hard carbon from threads in inserts with a tap, being careful not to remove any metal.

(7) Remove burrs, nicks and roughness from exhaust flanges with a fine file or scraper.

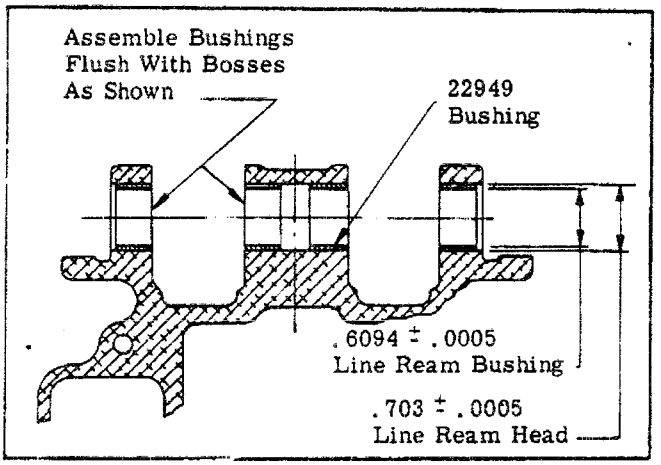


Figure 17. Assembling Rocker Shaft Bushings.

(8) Repair intake flanges by removing nicks with a stone. Polish flange with crocus cloth. Tighten studs on intake flange, if necessary, and dress threads, using thread chaser.

(9) Stone finished surfaces of rocker boxes for nicks and scores. Polish surface with crocus cloth. Check rocker box covers for true flatness by rubbing on a sheet of sandpaper placed on a surface plate.

NOTE: If rocker shaft bosses are excessively worn, bushings (No. 22949) may be installed as shown in Fig. 17.

c. Valve Mechanism.

(1) Remove nicks and scores from exhaust and intake rockers and polish finished surfaces with crocus cloth.

(2) Polish valve rocker bushings for slight scores and roughness.

(3) Straighten push rods which are slightly bent by tapping into proper shape, using a light mallet. Polish ball ends with crocus cloth. Loose or badly worn ball ends must be replaced by complete push rod assembly.

(4) Valve springs which are broken at flat ends cannot be repaired satisfactorily and therefore should be replaced.

(5) Remove scores or burrs from valve spring seats by stoning and polishing.

(6) Polish valve spring seat locks with crocus cloth inside and outside diameter.

(7) Stone valves to remove burrs and scores in the lock grooves and on stem tips. If tips are worn, they should be dressed with a fine emery wheel to secure a flat surface, square with valve stem. Replace warped or badly pitted valves. Use a standard valve refacing machine for conditioning valve contact faces and lap into valve seats as described in paragraph 2. (b). (4) above.

d. Crankshaft and Connecting Rods.

(1) Dress with proper dies damaged threads on front end of crankshaft. Remove all nicks and scores on bearing surfaces by careful stoning and polishing with crocus cloth. Stone keyway on front of shaft if taper end type to remove scores, nicks, and burrs.

(2) If main and connecting-rod bearings are worn, or if checks or cracks are visible, make replacement.

(3) Remove all nicks and scores from connecting rods by stoning and polishing with crocus cloth. Remove slight scores in piston pin bushing by polishing with crocus cloth. If bushing appears burned or rough, replace. Repair slightly damaged threads on connecting rod bolts, using proper dies.

e. Pistons and Piston Pins.

(1) Repair pistons, pins and plugs which are slightly scored or burred by careful use of a fine stone and by polishing with crocus cloth.

CAUTION: Stone only enough to remove the metal which has piled up—deep scratches cannot be removed. If scoring is heavy, piston and piston pin must be replaced. Do not at any time use a wire brush or buffer wheel on the pistons.

(2) Replace piston rings at the time of a major overhaul. If cylinder barrels have been reground or if piston ring groves have been remachined, care should be exercised in securing the proper oversize piston rings.

(3) Replace cracked or badly eroded pistons with pistons which are within 1/4 ounce of the same weight.

f. Crankcase Cover Assembly.

(1) Make repairs to crankcase cover in accordance with instructions given in paragraph 1. (d) and (g) of this section. Particular attention should be given to removing nicks and burs from all finished surfaces, using a fine stone and polishing with crocus cloth.

(2) Carefully dress and chase with proper dies damaged threads in cover for the oil screen assembly, oil pressure relief valve cap and tachometer drive

housing.

(3) Repair with proper thread chasers damaged threads on oil screen assembly, oil pressure relief valve cap and tachometer drive housing.

(4) If oil pump gears are nicked or scratched, stone lightly. Remove all burrs. If the gears are badly dented or worn, replace.

(5) Replace tachometer drive oil seal at the time of a major overhaul.

g. Camshaft and Hydraulic Tappets.

(1) If lobes on the cam are scuffed, stone lightly.

(2) If cam followers are scuffed, stone light. Examine the tappets for wear and damage. If either the piston or cylinder is damaged, replace both parts. For complete information on Hydraulic Tappets refer to section 19.

CAUTION: Do not drop hydraulic tappets or allow them to come in contact with other metallic objects, as damage will result.

h. Gears—Stone lightly crankshaft, magneto drive and cam gears if nicked or scratched. Remove all burrs. If the gears are badly dented or worn, they should be replaced. Cap screws should be replaced if heads or threads are damaged.

i. Intake Pipes, Connections and Clamps.

(1) Remove small dents from intake pipes by careful hammering on a suitable mandrel and without reducing the wall thickness of the pipe, to obtain a smooth and even surface. Replace cracked or leaking intake pipes.

(2) Replace rubber hose connections for intake pipes at the time of a major overhaul.

(3) Replace intake hose clamps if broken or cracked.

j. Push Rod Housing Flanges, Connections and Clamps.

(1) Stone lightly all finished surfaces of the flanges to remove all nicks and scratches. If flange is cracked, it must be replaced.

(2) Replace the rubber push rod housing connections at the time of a major overhaul.

(3) Replace push rod housing clamps if broken or cracked.

k. Ignition System—Replace all ignition cables at overhaul. For instructions on repair and replacement of ignition cables refer to Section 8, page 14.

SECTION 11

ASSEMBLY, TIMING AND TESTING

1. GENERAL

This section covers the procedure of the reassembly of the major sub-assemblies, the final assembly of the complete engine, the timing of magnetos to the engine and the final testing of the engine following the overhaul of each major sub-assembly and separate parts as described in the previous section.

2. REASSEMBLY OF MAJOR SUBASSEMBLIES

a. Cylinder and Valve Assembly Procedure.

(1) Apply a light coat of oil on valve stems. From inside of cylinder and head assembly, assemble intake valve through intake valve guide. In same manner, assemble exhaust valve through exhaust valve guide.

(2) Holding both valve stems so that head of each valve is against valve seat, mount cylinder and head assembly over suitable holding block on bench. Assemble intake and exhaust valve spring retainers over valve guides.

(3) Assemble inner and outer valve springs over exhaust valve and guide and onto the valve spring retainer. Assemble valve spring seat over valve stem with spring lands toward springs.

(4) Using a suitable valve spring compressor, (Fig. 13), assemble valve-spring seatlocks in groove on valve stem so that large diameter of locks is toward end of valve stem.

(5) Assemble valve spring over intake valve and guide in same manner as described above.

(6) Assemble new rubber push rod housing connections and clamps on the push rod housings, pushing them toward the cylinder head for clearance when cylinder is assembled to crankcase.

(7) Install new cylinder base packing on cylinder barrel base, using a very thin film of sealing compound on the cylinder flange on the flat surface that will contact the crankcase.

CAUTION: Do not pick up cylinders by push rod housings as they are only pressed into the rocker box and are easily bent. Any bending or misalignment will result in an oil leak.

b. Connecting Rods to Crankshaft.

(1) Snap both halves of the connecting rod bushings into the connecting rod and cap.

(2) Assemble connecting rods in their proper positions on the crankshaft with the connecting rod numbers pointing up.

NOTE: The connecting rod bolts must be assembled on the connecting rods with the threaded end pointed toward the piston pin bushing. Torque nuts to low limit - if cotter pin will not enter increase torque gradually up to high limit only. If cotter pin will not enter in this range replace nut and repeat. In no case shall nuts be torqued below low limit or over high limit. (Refer to Section 12 for torque limits).

c. Pistons and Piston Pins.

(1) With top of piston upward on bench, assemble the oil control ring in the third ring groove from top of piston. Assemble the compression rings in the second and first grooves from top of piston. Assemble each ring on piston with the part number or word "TOP" towards the top of the piston. The oil control ring is symmetrical and is functional with either side up. The compression rings are of the inside bevel design and it is imperative the inside bevel be assembled towards the top of the piston.

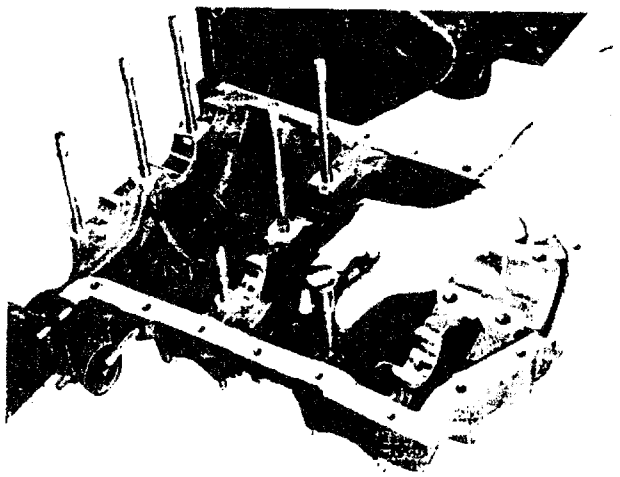


Figure 18. Installing Cam Follower Body into Crankcase.

(2) Assemble the piston pin and plugs temporarily into pistons.

d. Crankcase Cover Assembly

(1) Install oil screen assembly into crankcase cover.

(2) Install oil pressure relief valve plunger, spring, gasket and cap into crankcase cover. See that the plunger works freely in its cage without sticking.

(3) Press tachometer drive oil seal into tachometer housing. Assemble oil pump drive gear into cover with square coupling on the inside of the cover. Insert driven gear into mesh with drive gear. Assemble oil pump cover over studs, if utilized, and gear shaft on inside of cover. Holding cover in place with one hand, assemble tachometer drive housing (with oil seal pressed in place) and gasket over end of drive gear shaft on outside of cover, pushing the shaft through the oil seal. It is advisable to use a 3/8 inch rod to lead the shaft through the packing in order that it will not be pushed out of position. Screw tachometer drive housing securely to cover.

NOTE: The tachometer drive housing has a lefthand thread which secures it to the crankcase cover.

(4) Test the oil pump gears for free running in the case. If they are free from binding, assemble washers and nuts to the pump cover and safety wire. If cap screws are utilized, assemble screws and washers and safety wire.

e. Intake Pipes and Hose Connection.

(1) Push one 1 1/2 inch hose and one 1 3/4 inch hose (one inserted into the other) over one end of intake pipe.

(2) Run four hose clamps over end of intake pipe.

(3) Push another set of hose connections over other end of intake pipe. (See (1) above.)

3. FINAL ASSEMBLY PROCEDURE

a. Preliminary.

(1) Mount No. 2-4 crankcase (referring to cylinder numbers) with contact face, or inside of crankcase up, on a suitable engine stand which will permit tilting the crankcase to horizontal and upright position. Lay crankcase No. 1-3 with contact face up on bench. Put a very thin film of sealing compound on the contact face of crankcase No. 2-4 and on the front of the No. 1-3 crankcase where the oil seal is pressed in.

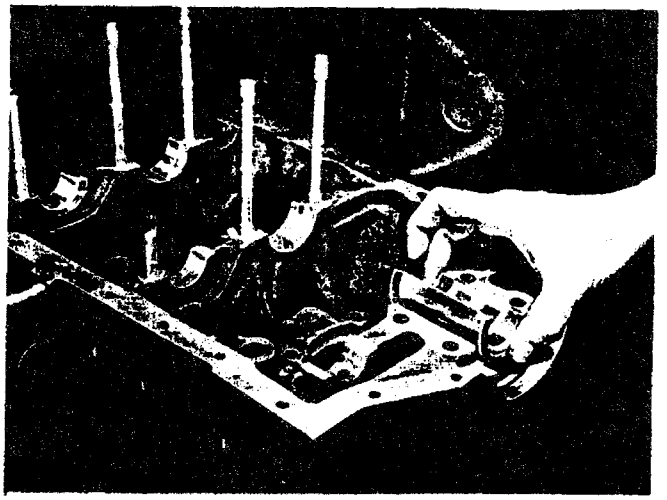


Figure 19. Installing Crankshaft Bearings into Crankcase.

(2) Dip cam followers in light oil and insert into the push rod housing pads from the inside of the crankcase (Fig. 18). Install in both halves of the crankcase.

NOTE: Insert push rod hose connections over the ends of the cam followers installed in the No. 1-3 crankcase to prevent them from slipping out when crankcases are assembled together.

(3) Insert bearings in both cases and gently tap into place, (Fig. 19). The shell-type bearings have "tangs" and can only be replaced in their proper positions. On Series 9 engines lay starter gear bushing in position on the No. 2-4 crankcase with flange on outside of the crankcase and with the oil hole in the bushing in line with the oil passage in the crankcase.

(4) Oil camshaft and lay in No. 2-4 crankcase. Check camshaft for end clearance in accordance with limits as set forth in the Table of Limits.

b. Installing Crankshaft and Connecting Rods.

(1) Oil bearings thoroughly. Lay crankshaft, with connecting rods assembled, into place in the No. 2-4 crankcase. (Fig. 20). The No. 2 and No. 4 connecting rods must be carefully guided through the No. 2 and No. 4 cylinder ports of the crankcase, taking care that they do not strike and damage the openings.

(2) Check end clearance of crankshaft in the crankcase as specified in the Table of Limits.

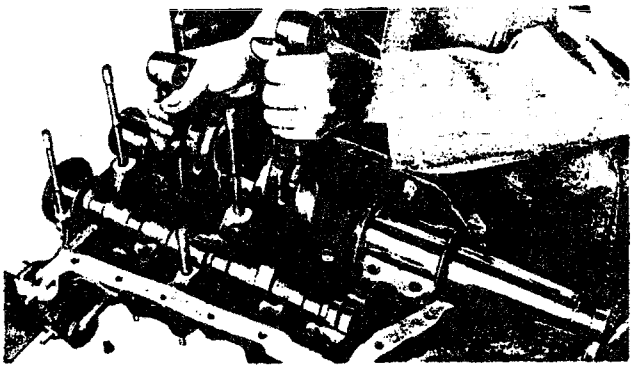


Figure 20. Installing and Removing Crankshaft and Connecting Rods.

c. Assembly of Crankcases and Component Parts.

(1) Install oil seal on front of crankshaft, pushing securely into place on the No. 2-4 crankcase.

(2) Lay No. 1-3 crankcase in place on No. 2-4 crankcase, carefully guiding connecting rods No. 1 and No. 3 through cylinder ports. (Fig. 21.) Be sure dowel bolts are in their proper locations. Check camshaft and crankshaft for free running to see that crankcases are installed in their proper positions. Remove push rod hose connections from cam followers on No. 1-3 crankcase.

(3) Assemble the six (6) 1/4 inch cap screws, washers and nuts at top of the crankcase. Assemble the five 1/4 inch cap screws, washers, and nuts at bottom of crankcase. Three dowel cap screws are used for properly lining up the crankcases. Assemble remaining cap screws, washers, and nuts on front end of crankcase. Assemble remaining washers and nuts to crankcase studs. Install breather connection in tap provided in side of No. 1-3 crankcase opening pointed toward the bottom of the crankcase.

(4) Rotate engine stand so that front of engine is pointing straight up. Tighten all nuts holding the two halves of the crankcase firmly and evenly. Install propeller hub key in keyway if taper end type crankshaft--tapping carefully in place with mallet. Install palnuts on all nuts holding crankcase together.

d. Installing Gears and Crankcase Cover.

(1) Rotate engine stand until rear end of crankcase is pointing straight up.

(2) Assemble crankshaft gear to crankshaft with four 1/4 inch cap screws, turning them down as far as possible by hand.

NOTE: The holes in the crankshaft gear and camshaft gear are so spaced that it is impossible to assemble the gears to the shafts incorrectly.

(3) Install cam gear to camshaft with four 1/4 inch cap screws. The timing mark on the cam gear must mesh between the two timing marks on the crankshaft gear (Fig. 6). Place a screw driver in one of the lightening holes in the cam gear and rotate gear until screw driver is blocked against the crankcase, preventing gears from turning when cap screws are tightened. If cam gear does not have lightening holes utilize other suitable means, such as a proper wedge between the teeth of crankshaft and cam gears to prevent the gears from rotating when the cap screws are tightened. Be sure the wedge does not damage teeth of the gears. Tighten cap screws on cam gear and crankshaft gear with standard 1/4 inch wrench (Fig. 22).

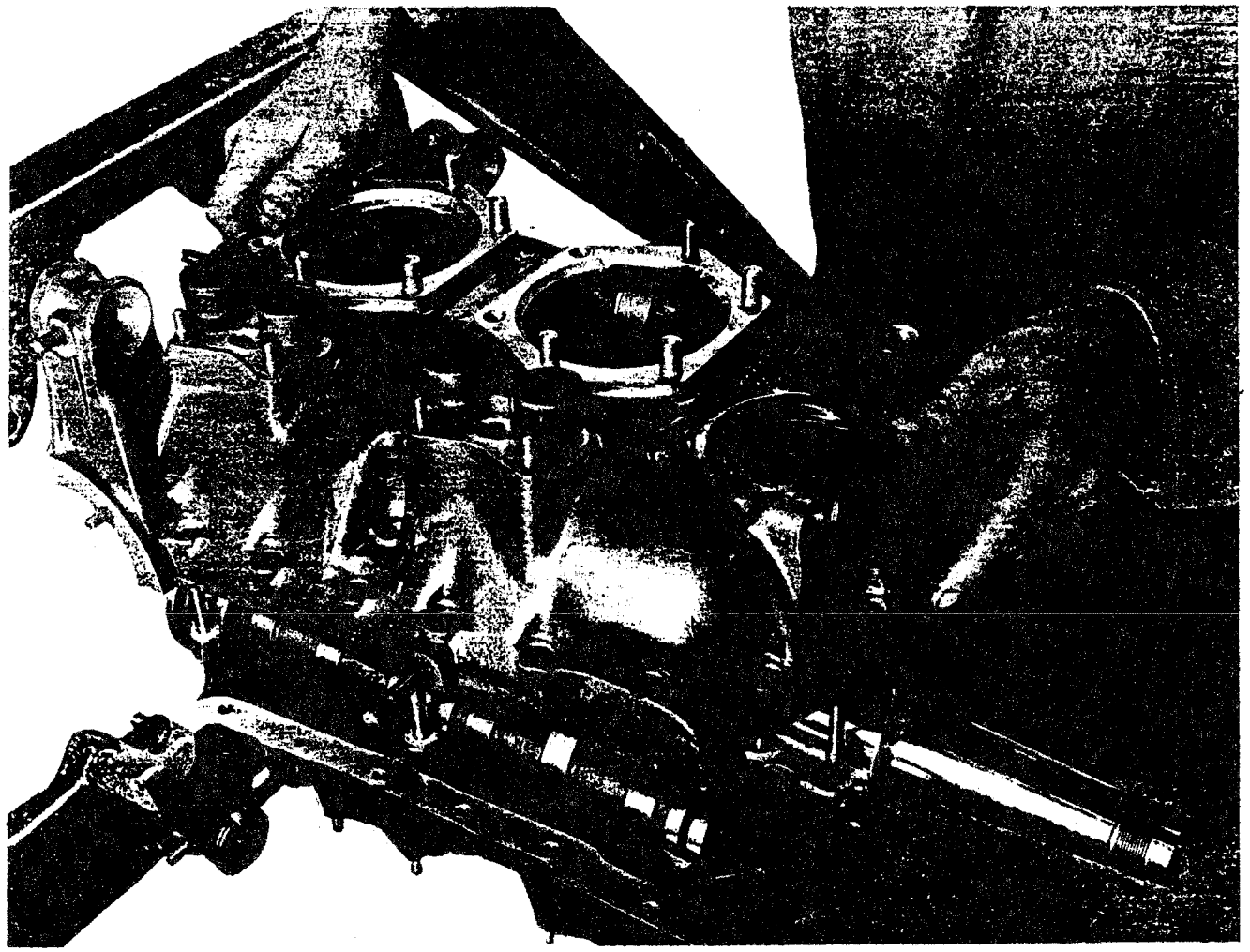


Figure 21. Installing Crankcase 1-3 over Crankcase 2-4.

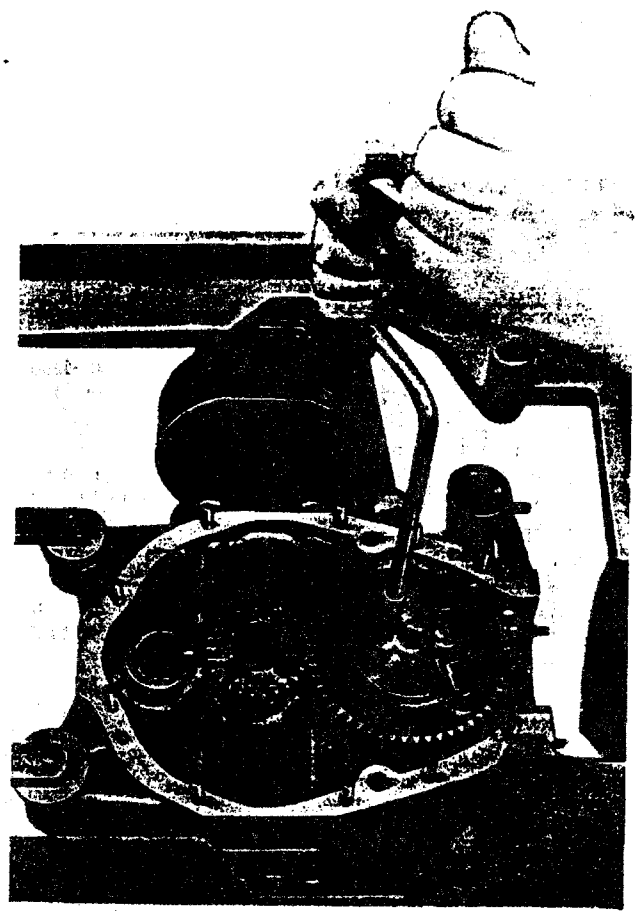


Figure 22. Installing Gears in Crankcase.

(4) Remove screw driver or wedge from cam gear and check backlash of gears.

(5) Safety wire cap screws on both gears. Care must be taken to press wire tightly against the gear body to avoid a possibility of interference with the studs, if utilized, of the oil pump cover.

(6) Place crankcase cover gasket over end of crankcase and mounting studs. Assemble crankcase cover assembly over gasket and studs (Fig. 23).

(7) Rotate engine stand so that crankshaft is horizontal. Install washers and nuts to studs. Tighten nuts securely and install palnuts.

NOTE: Safety wire oil pressure relief valve cap to nearest stud holding crankcase cover to crankcase, and secure with palnut.

e. Installing Oil Sump and Oil Suction Tube.

(1) Rotate engine stand so that the crankcase cover is facing up.

(2) Cut off the portion of the crankcase cover gasket which crosses the oil sump opening.

(3) Install oil suction tube in the tapped hole in the bottom of the crankcase cover, tightening with a 7/8 inch wrench. Safety wire suction tube to crankcase cover in holes provided.

(4) Install oil sump gasket to mounting studs on bottom of crankcase and cover. Mount oil sump on the six mounting studs on the case and cover and fit oil filler bracket over stud in crankcase mounting arm. Secure sump with washers and castle nuts on the case and cover and install nut and palnut on stud holding oil filler bracket.

f. Installing Hydraulic Units and Push Rod Housing Flanges.

(1) Rotate engine stand so that crankshaft is horizontal. Oil hydraulic units with thin coat of light oil.

NOTE: Be sure that the hydraulic unit is working properly and smoothly by depressing the piston with the thumb several times. Units should be partially deflated of trapped air and oil by releasing the ball check. Insert a 3/32 inch diameter rod in tube of unit (rod should have a dull end) so as to lift ball check from seat while piston is being depressed. Refer to page 67 for complete information.

(2) Insert hydraulic units, tube end first, into the cam follower body. Insert tappet cups on top of hydraulic units in the cam follower body.

(3) Place push rod housing flange gaskets over studs on housing pads in crankcase. Install push rod housing flanges over studs and gaskets.

(4) Secure flanges to crankcase with suitable washers and nuts.

NOTE: Tighten middle nut of flange first. Do not tighten nuts excessively, as the flange may be cracked.

g. Installing Cylinders

(1) Rotate engine stand so that the front of the

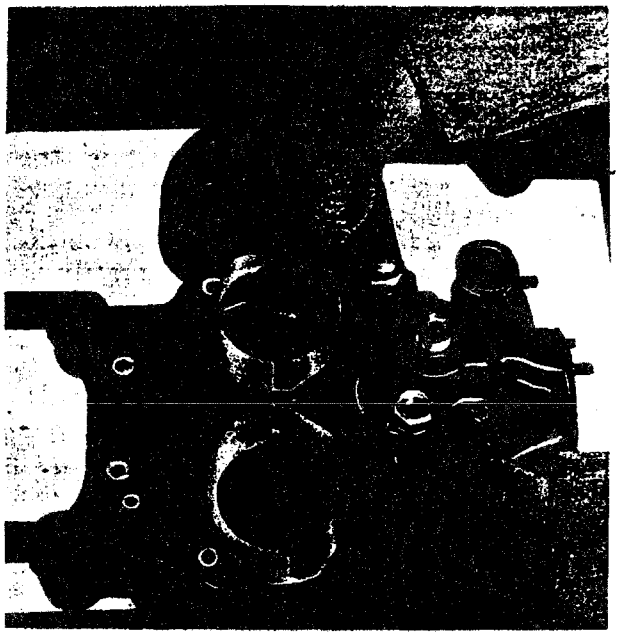


Figure 23. Installing Crankcase Cover to Crankcase.

engine is facing up.

(2) Oil piston pin bushing on connecting rods. Install piston pin plugs into piston pin. Oil piston thoroughly and work oil into piston ring grooves. Oil piston pin and install piston (with rings assembled) to the connecting rod. Install piston with the numbers toward the front of the engine. The connecting rod must be fully extended through the port.

(3) Stagger gaps in piston rings on the piston so that they are evenly distributed around the piston to prevent blow-by. Assemble steel clamping band around the piston, compressing the piston rings and also retaining the piston pin and plugs in the piston.

(4) Coat inside cylinder barrel with a thin coat of engine oil.

(5) With one hand compressing the steel clamping band around the rings, insert the cylinder barrel over the top of the piston. (Fig. 24.)

CAUTION: Do not pick up cylinders by push rod housings as they are only pressed into the rocker boxes and are easily bent. Any bending or misalignment will result in an oil leak.

(6) Steady the cylinder with the body, push the cylinder carefully back to the mounting studs, moving the steel band back on the piston. Remove steel band when cylinder is pushed on the full length of the piston.

(7) Assemble cylinder flange over studs on crankcase. Be sure that cylinder base packing is properly in place and not twisted. Assemble nuts on studs and tighten slowly and evenly. Install palnuts.

CAUTION: Do not tighten nuts excessively as the studs may be stretched or broken. See Table of Limits for the proper amount of torque to be applied on nuts.

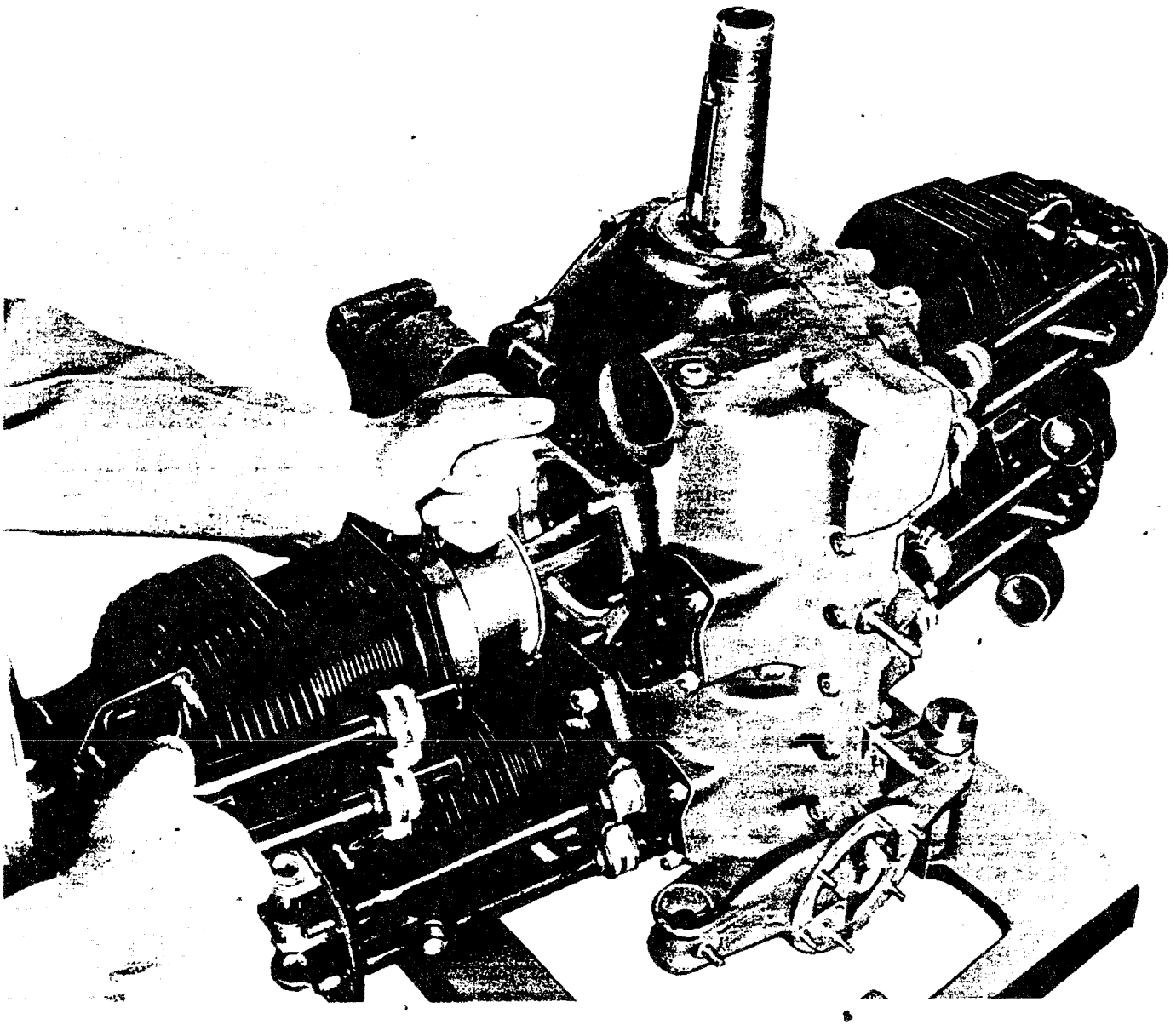


Figure 24. Installing Cylinder on Crankcase.

(8) Rotate crankshaft so that intake and exhaust valves are closed. Insert push rods into the housings, hold rocker arms in place, and push in the rocker arm shaft.

(9) Assemble gaskets on rocker box flanges and install valve rocker box covers and secure with fillister screws.

(10) Slip push rod connections and clamps down over push rod housing flange, and tighten clamp moderately.

(11) Assemble remaining cylinders in the same manner as described above.

h. Installing Air Intake System.

(1) Assemble carburetor to intake manifold securing with four nuts. The nut nearest the altitude control of the carburetor should be installed first to facilitate assembly.

(2) Assemble intake manifold (with carburetor attached) to the crankcase on the two studs provided at the bottom. Secure with suitable washers and nuts. Tighten nuts.

(3) Place gaskets on intake flanges. Attach intake elbows on the two studs on the flange, and secure with suitable washers and nuts.

(4) Assemble intake pipes (with hose connections and clamps installed) to intake manifold and elbow, pushing outer hose connections over ends of manifold and intake elbows. Install clamps on both ends of each connection and tighten securely.

i. Installing Ignition System.

(1) Assemble lower spark plugs with gasket in each cylinder.

(2) Determine the firing position of cylinder No. 1 in the following manner:

(a) Place timing disc on the tapered crankshaft so that the slot in the hub fits over the key on the shaft. The top center (T.C.) mark stamped on the timing disc must line up with the split of the two crankcases on the top dead center of the compression stroke.

(b) To determine that the piston is on the compression stroke, place thumb over upper spark plug hole and turn crankshaft in direction of rotation. The intensity of the pressure will indicate that the piston is on the compression stroke.

(c) When the piston is on top dead center with the top center (T.C.) mark in line with the split of the crankcases, turn crankshaft in a clockwise direction until the timing disc is set as specified in the Table of Specification, Section 1, for the particular engine being timed. The piston is then set at its firing position. (See figure 25.)

(3) Installing and Timing Magneto to the Engine.

(a) Before installing magnetos, insure that they have been correctly timed and checked in accordance with the section covering the accessories.

(b) Rotate the magneto drive gear, attached to the magneto, until the timing marks on the chamfered tooth of gear and timing pointer are opposite each other as seen through the timing window in the magneto cover. At this position the breaker contacts should begin to open.

(c) All adjustments for exact timing to the engine are made at the drive end and not by altering the position of the contact points. See that the mounting faces are clean and smooth. With the timing marks (as described in (b) above) opposite each other,

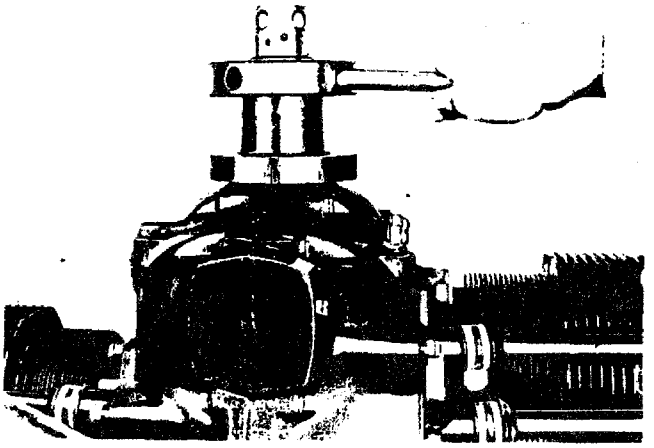


Figure 25. Determining Firing Position.

install the magneto on the engine and secure with its mounting nuts. Exact timing is obtained by turning the magneto through the angle provided by the slots in the magneto flange. (Figure 42, page 65.)

(d) Before checking the exact breaker opening position, rotate magneto counter-clockwise by tapping the mounting flange until it is near the end of the travel permitted by the slots.

(e) Turn crankshaft backward a quarter turn, then bring up slowly to firing position to take the backlash out of driving gear train.

(f) Insert a .0015 inch feeler between breaker points (cellephane may be used as a substitute), and tap mounting flange in a clockwise direction until the exact point of release is obtained. (Figure 26.)

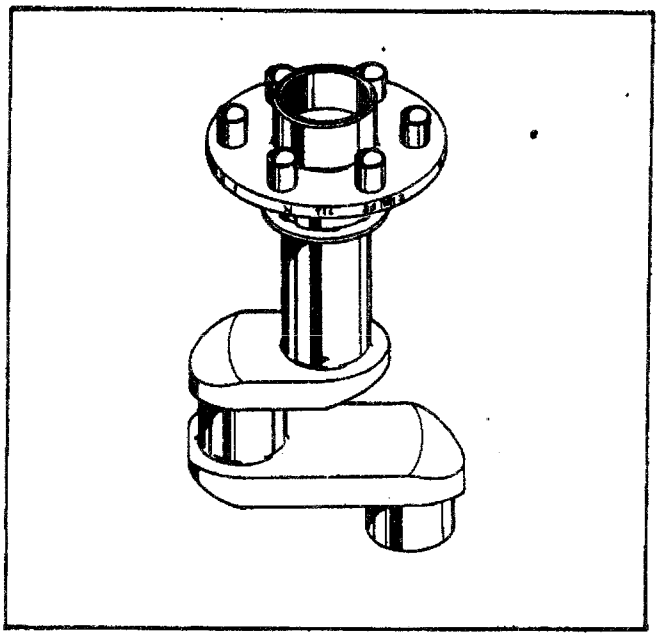


Figure 26. Timing Marks on Flanged Crankshaft.

NOTE

If a Bendix Scintilla No. 11-851 timing light or equivalent is available, it should be used to determine the opening of the contacts rather than using a feeler gage or cellophane strip. The use of shim stock or cellophane feeler strips invariably introduces a possibility of fouling the points, since oil and dirt is nearly always present on such feeler strips. If the strip is of soft material such as cellophane, brass, or foil, particles of the strip itself are likely to remain between the contacts, causing unsatisfactory magneto operation.

(g) Tighten the mounting nuts. Check timing by backing up the crankshaft and turning it slowly forward to determine if the feeler is released the instant the timing disc reaches the mark specified on the particular engine being timed.

NOTE: If cellophane is used instead of a feeler or a timing light all traces of the cellophane must be removed before replacing the breaker cover.

(h) Install other magneto on the engine following the procedure outlined above.

(i) Remove timing disc from the crankshaft.

(4) Assemble upper spark plugs with gasket in each cylinder.

(a) On engines using a tapered crankshaft, place a timing disc on the shaft so that the slot in the hub fits over the key on the shaft. The top center (T. C.) mark stamped on the timing disc or the propeller flanged edge of a flanged crankshaft must line up with the split of the two crankcases on the top dead center of the compression stroke. Use a flat metal indicator or square to align the marks with the split.

(b) When the piston is on top dead center with the top center (T. C.) mark in line with split of the crankcases, turn crankshaft in a clockwise direction until timing disc, or degree marks on flange are set as specified in the Table of Specifications, Section 1, for the particular engine being timed. The piston is then set at its firing position. (See figure 25 or 26.)

j. Installing Radio Shielded Ignition Wires.

Refer to figure 11 where the complete ignition wire system is diagrammed and firing order given.

(1) When it is necessary to install new ignition wiring (i.e., at an overhaul period), refer to section 8, paragraph 5, for length of cables.

(2) Slip the knurled nut, brown bakelite ferrule, and the rubber gland over cable in the order named.

(3) Strip insulation from cable end about 1/4 inch and attach terminal clip by inserting bare cable strands through the hole of the clip and secure with solder.

(4) Fit spark plug elbows over the end of the cable and secure it by means of the union nut and cone.

(5) Check wiring by a recognized standard electrical test.

(6) Reassemble brackets to ignition cables.

4. TESTING ENGINE AFTER OVERHAUL

It is very important that an engine be carefully run-in after a complete or top overhaul. The length of time necessary for this depends upon the new parts installed during the overhaul and the facilities available for the running-in process. A flying propeller does not cool the engine properly if the airplane is not in flight. If it becomes necessary to run-in an overhauled engine in the aircraft a 4-bladed Test Club type propeller should be used. The cowling should not be installed and the aircraft should be headed into the wind to provide the best possible cooling. It is also advisable to have a thermocouple attached at the base of the spark plugs and not allow the cylinder head temperature to exceed 500°F.

When new pistons or bearings are installed, at least 70 minutes of run-in time should be put on the engine. New rings may be broken in sufficiently for flight in possibly 3 to 4 hours.

The engine should be filled with a light grade of oil and run at approximately 800 r.p.m. until the oil is thoroughly warm. Then at intervals of 15 to 20 minutes, the speed should be increased by 100 r.p.m. If a special propeller is not being used, a speed of approximately 1400 r.p.m. should not be exceeded for more than a few minutes at a time with the airplane on the ground. If a thermocouple is used, speeds may be increased until the cylinder head temperature reaches 500°F. The remainder of the run-in, after installing the cowling, may be put on in cruising flight, with a final run of about 30 minutes at a speed approximately 100 r.p.m. less than full-throttle. Any flight run-in should be made over the airport in order that a quick landing may be made if any trouble develops.

Preservation. If the engine is not to be installed in an aircraft and placed into service immediately, the last 15 minutes of operation should be used to circulate a corrosion preventive oil mixture (suitable for flight operation). This will be an additional period, since the engine must be stopped to change oil. During the same period, unleaded gasoline should be supplied to the carburetor.

Inspection. After completion of the test run, inspect the following features:

(a) Remove oil screen, and inspect for metal particles.

(b) Remove oil gauge, and check oil quantity and quality.

(c) Remove all spark plugs, and measure electrode gaps. Readjust if necessary, and clean any fouled plugs before reinstalling.

(d) Using a flashlight for illumination, inspect all cylinder bores for scoring while the propeller is turned slowly.

(e) Replace spark plugs, and test for uniform cylinder compression by turning the propeller, or use a cylinder pressure gauge before installing the upper set of spark plugs. Actual pressure values will depend on several variables, but they should be uniform among cylinders.

SECTION 12

TABLE OF LIMITS

Ref. No.	Fig. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
		PISTON (40731) in Cylinder (A65)			
1	27	Top 3 lands . . . . . dia:	.037 L	.028 L	.032 L
2	27	Top of skirt . . . . . dia:	.016 L	.009 L	.013 L
3	27	Bottom of skirt . . . . . dia:	.012 L	.005 L	.009 L
		PISTON (40577) in Cylinder (A75)			
		Top land . . . . . dia:	.037 L	.028 L	.032 L
		2nd and 3rd lands . . . . . dia:	.037 L	.028 L	.032 L
		Skirt . . . . . dia:	.020 L	.014 L	.017 L
		PISTON RING (side clearance)			
4	27	Piston ring in top groove (comp.) (A65) side clearance:	.009	.0045	.0065
5	27	Piston ring in 2nd groove (comp.) (A65) side clearance:	.007	.003	.005
6	27	Piston ring in 3rd groove (oil) (A65) . side clearance:	.006	.0017	.004
		Piston ring in top groove (comp.) (A75) side clearance:	.009	.0045	.0065
		Piston ring in 2nd groove (comp.) (A75) side clearance:	.007	.003	.005
		Piston ring in 3rd groove (oil) (A75) . side clearance:	.006	.0017	.004
		PISTON RING (gap)			
		Compression rings in cylinder barrel . . . . . gap: %	.033	.008	.028
		Oil rings in cylinder barrel . . . . . gap: %	.033	.013	.028
		Compression rings . . . . . tension: *	10 lbs.	11 lbs.	14 lbs.
		Oil ring . . . . . tension: *	9 lbs.	10 lbs.	14 lbs.
		PISTON PIN			
7	27	Plug in piston pin . . . . . dia:	.003 L	.0005T	.0025T
8	27	Piston pin and plug in cylinder . . . . end clearance:	.060 L	.010 L	.040 L
9	27	Piston pin in piston . . . . . dia:	.0015L	.0001L	.0007L
10	27	Piston pin in connecting rod bushing . . . . . dia:	.004 L	.0014L	.0021L
		CONNECTING RODS			
11	27	Piston pin bushing in connecting rod . . . . . dia:	------	.002 T	.0045T
		VALVE ROCKERS, SHAFTS, PUSHRODS			
12	27	Rocker shaft in rocker bearing . . . . . dia:	.004 L	.0010L	.0025L
13	27	Rocker shaft in cylinder head bosses . . . . . dia:	† .007 L	.0002L	.0017L
14	27	Valve rocker bushing in valve rocker . . . . . dia:	------	.002 T	.004 T
15	27	Valve rocker . . . . . side clearance:	.016	.004	.011
16	27	Push rod (overall length) . . . . . :	10.785	10.797	10.827
17	27	Valve stem to rocker clearance (lifter deflated) . . . :	------	.030	.110
		CYLINDER			
18	27	Exhaust valve in guide . . . . . dia:	.007 L	.0027L	.0047L
19	27	Intake valve in guide . . . . . dia:	.005 L	.001 L	.003 L
20	27	Exhaust valve insert in cylinder head . . . . . dia:	------	.0045T	.0075T
21	27	Intake valve insert in cylinder head . . . . . dia:	------	.005 T	.008 T
22	27	Valve guide in cylinder head . . . . . dia:	------	.001 T	.0025T
23	27	Cylinder barrel bore maximum allowable taper . . . :	** .002	.000	.001
23	27	Cylinder bore . . . . . out-of-round:	** .002	.000	.001
23	27	Cylinder bore (standard) . . . . . diameter at any point . . . . . :	** 3.882	3.875	3.877
		Cylinder bore (reground to .015" O.S.) . . . . . dia:	3.897	3.890	3.892
23	27	Cylinder bore surface roughness (Micro Inches, RMS) . . . . . :	25	30	40
24	27	Cylinder barrel in crankcase . . . . . dia:	------	.003 L	.010 L
25	27	Connecting rod bearing on crankshaft . . . . . dia:	.006 L	.0005L	.003 L
26	28	Connecting rod to crankshaft . . . . . end clearance:	.015	.006	.010

NOTES:

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

(%) If necessary use .005" oversize rings to maintain specified limits in cylinder bore to Service Limits.

TABLE OF LIMITS (Continued)

Ref. No.	Fig. No.	Description	Serviceable Limit	New Parts Min.	New Parts Max.
		CRANKSHAFT & MAIN BEARINGS			
27	28	Crankshaft main journals (std.) . . . . . dia:	†† 1.870	1.872	1.873
28	28	Crankshaft in front bearing . . . . . end clearance:	.025	.004	.0152
29	28	Crankshaft in main bearing . . . . . dia:	.0055L	.0005L	.0035L
30	28	Crankshaft in main bearings (center & rear) . . . dia:	.0055L	.0005L	.0035L
31	28	Crank pins . . . . . dia:	†† 1.934	1.936	1.937
31	28	Crank pins . . . . . .out-of-round:	.0015	.000	.001
32	28	Crankshaft run out (center main) (supported at front & rear mains) . . . . . :	.010	.000	.010
33	28	Crankshaft run out (at front of taper) (supported at front & rear mains) . . . . . :	.008	.000	.006
34	28	Crankshaft flange run out (near perimeter on face of flange) (shaft supported at front & rear mains) . :	.005	.000	.005
		CAMSHAFT JOURNAL			
35	28	Journals in crankcase . . . . . dia:	*** .005 L	.001 L	.003 L
36	28	Rear journal in crankcase. . . . . end clearance:	.012	.004	.008
37	27	VALVE TAPPET IN CRANKCASE. . . . . dia:	.0035L	.0005L	.002 L
		OIL PUMP			
38	28	Oil pump shafts in crankcase cover . . . . . dia:	.0045L	.0015L	.003 L
39	28	Oil pump shaft in plate . . . . . dia:	.0045L	.0015L	.003 L
40	28	Gears in oil pump housing . . . . . end clearance:	.006	.002	.005
41	28	Gears in oil pump housing . . . . . dia:	.008 L	.003 L	.006 L
42	28	Front crankshaft oil seal in crankcase . . . . . dia:	------	.001 T	.007 T
43	28	Crankshaft gear on crankshaft pilot . . . . . dia:	------	.0005T	.0015L
44	28	Camshaft gear on camshaft pilot. . . . . dia:		.0005T	.0015L
45	28	Oil seal in tachometer housing. . . . . dia:	------	.001 T	.007 T
46	28	Magneto pilot in accessory case . . . . . dia:	------	.001 L	.005 L
47		Deleted			
48	28	Oil pump drive shaft in camshaft gear . . across flats:	.020 L	.007 L	.0135L
		GEAR TEETH BACKLASH			
49	29	Crankshaft gear to cam gear . . . . . :	.013	.006	.009
50	29	Magneto drive gears to crankshaft gear. . . . . :	.016	.008	.012
51	29	Oil pump gears . . . . . :	.025	.014	.022

NOTES:

(**) If Cylinder Barrel exceeds these limits, replace, re-barrel or regrind .015" O.S.
(***) If Camshaft Bearings exceed these limits they must be reamed and .020" O.S. shafts fitted.
(†) If Rocker Shaft Bearings exceed loose fit, install bushings, Part No. 22949.
(††) Crankshafts worn below limit must be reground to .010" U.S.

Ref. No.	Fig. No.	Description	Torque Limits in In. Lbs.
		TORQUE LIMITS	
T1	27	Spark plugs	300-360 in. lbs.
T2	28	Plug, oil sump drain	Oil Tight
T3	27	Nuts, 7/16-20, cylinder to crankcase thru studs	400-450 in. lbs.
T4	27	Nuts, 3/8-24, cylinder to crankcase thru bolts	410-430 in. lbs.
		Nuts, 7/16-20, cylinder to crankcase thru bolts & deck studs.	490-510 in. lbs.
		Nuts, 3/8-24, crankcase to crankcase	370-390 in. lbs.
T5	27	Nuts and cap screws (1/4-28)	90-110 in. lbs.
		Nuts and cap screws (5/16-24)	180-220 in. lbs.
T6	27	Nuts, 3/8-24, connecting rod bolts #.	400-475 in. lbs.

NOTE: Torque limits apply to oiled studs (not Alcoa Thread Lube).

Torque to low limit - if cotter pin will not enter increase torque gradually up to high limit only. If cotter pin will not enter in this range replace nut and repeat. In no case shall nuts be torqued below low limit or over high limit.

TABLE OF LIMITS (Continued)

T9	28	Bolts, 1/4-28, gear to crankshaft	140-160 in. lbs.
T10	28	Bolts, 1/4-28, gear to camshaft	140-160 in. lbs.

Ref. No.	Fig. No.	Description	Part No.	Wire Dia.	Compress To	New Parts lbs. min.	New Parts lbs. max.	Used Parts lbs. min.
52	27	Spring, valve inner	21365	.105 in.	.86 in.	34.5	37.5	31.5
53	27	Spring, valve outer	21366	.135 in.	.95 in.	52	56	49
54	29	Spring, oil pressure relief valve	631706	.041 in.	1.56 in.	6.06	6.31	5.75
54	29	Spring, oil pressure relief valve	21352	.041 in.	1.56 in.	5.12	5.37	4.87

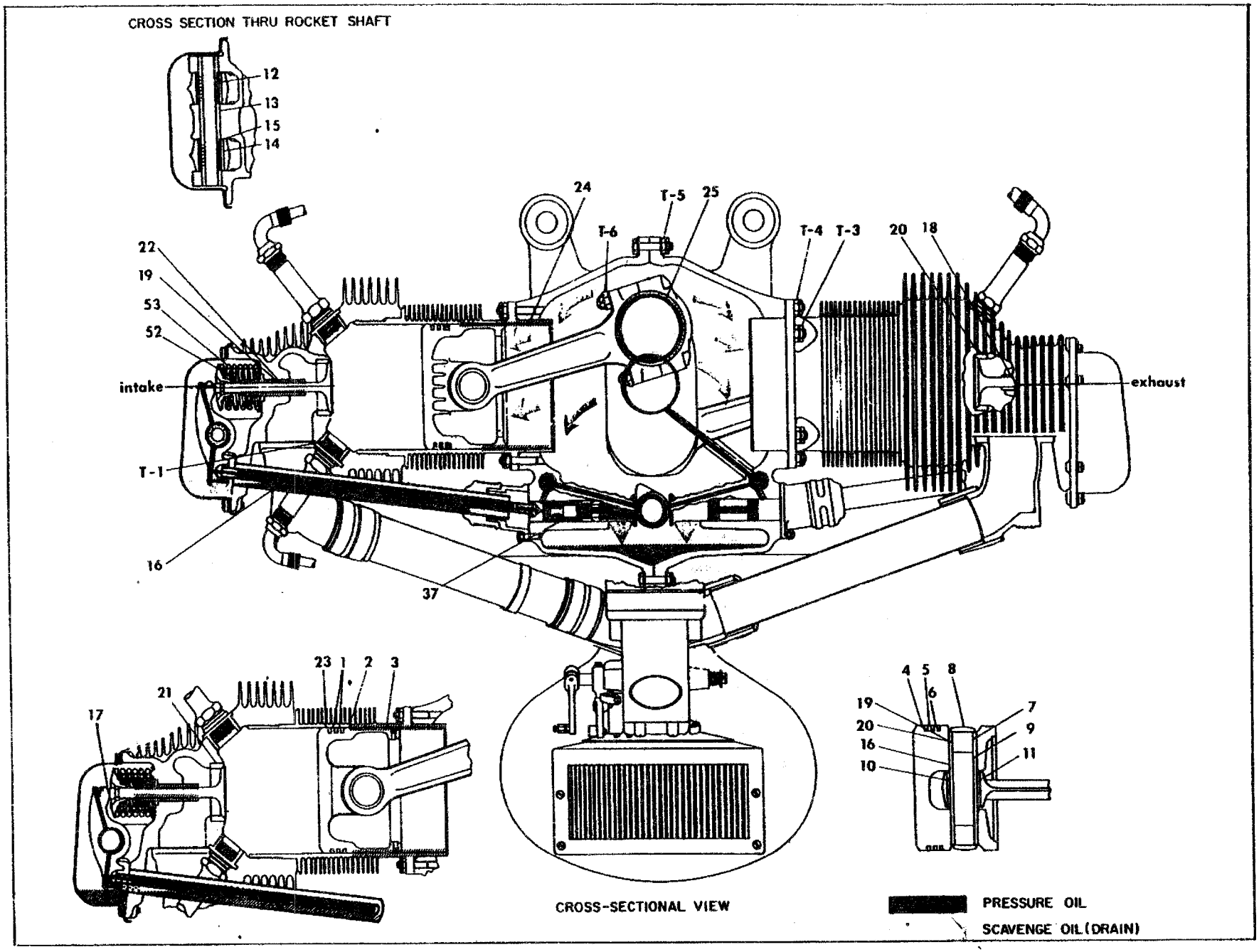


Figure 27. Lubrication Chart - Cross Section View.

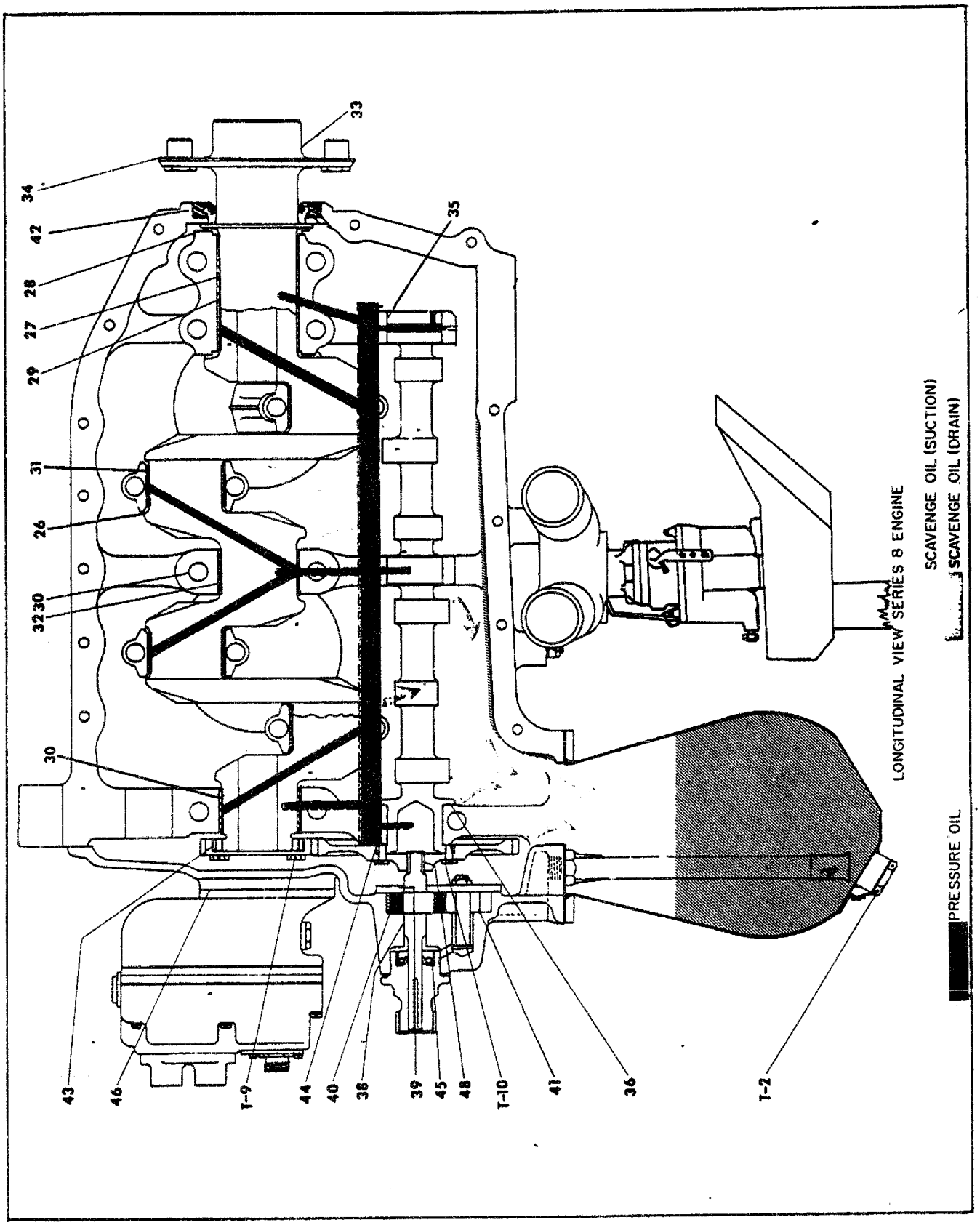
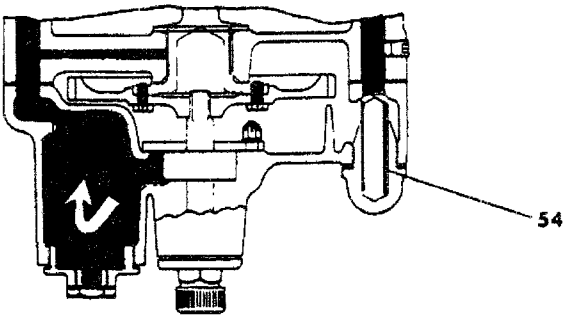
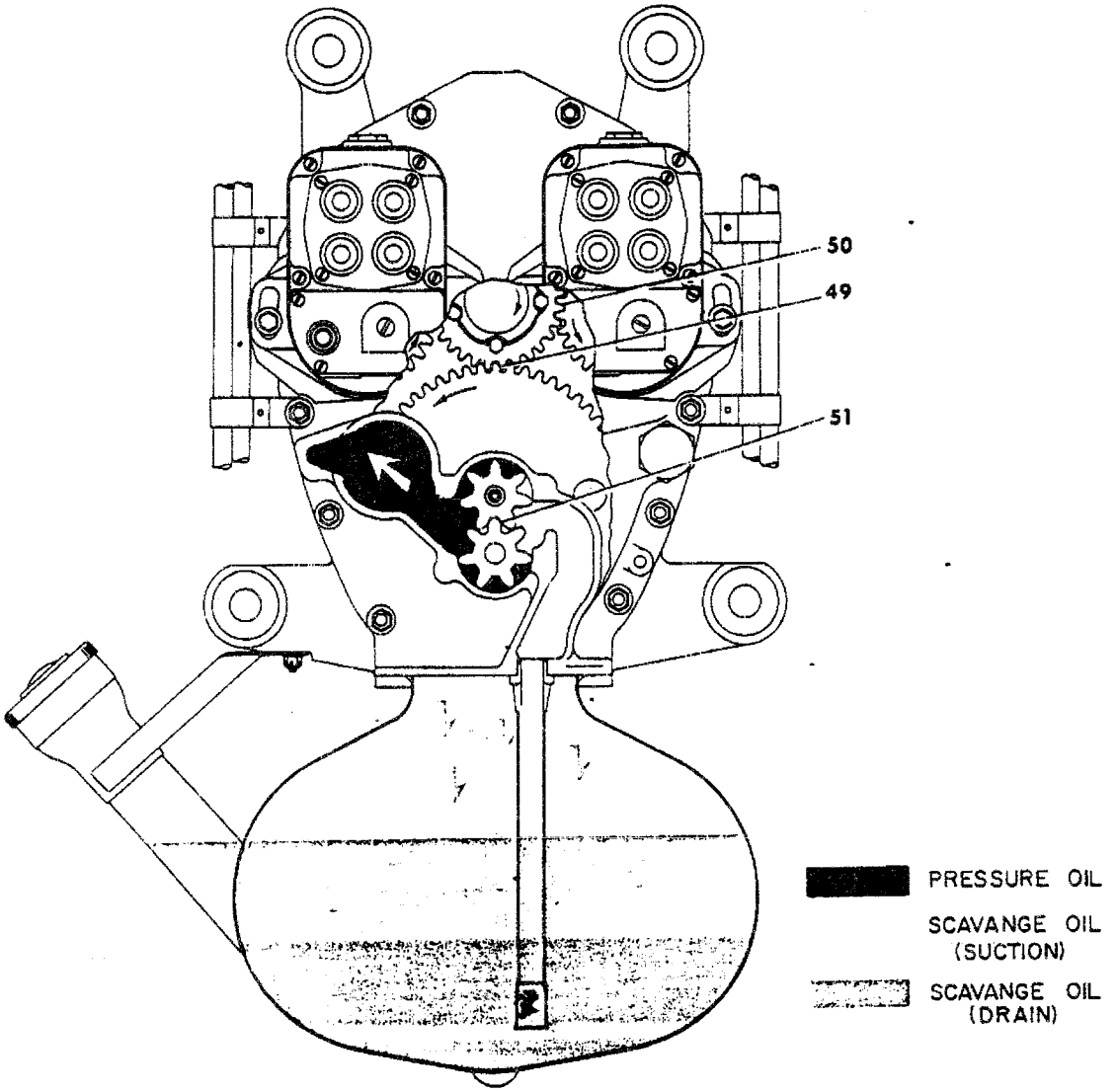


Figure 28. Lubrication Chart - Side View.



VIEW SHOWING PRESSURE OIL
THRU OIL SCREEN INTO OIL GALLERY
& PRESSURE RELIEF VALVE



REAR VIEW SERIES 8 ENGINE

Figure 29. Lubrication Chart - Rear View.

SECTION 13

ILLUSTRATED PARTS LIST

INTRODUCTION

GENERAL

This catalog lists and describes the parts for the models A65 and A75 series 8 engines manufactured by the Continental Motors Corporation, Muskegon, Michigan.

The Group Assembly Parts List consists of the complete engine divided into ten (10) main groups. Each assembly listed is followed immediately by its component parts, properly idented thereunder, to show their relationship to the assembly. Component parts of the complete engine which are not included in any assembly but which are used in conjunction with, attach, or attach to a certain assembly, are listed immediately following the last detail of that assembly and in line with the major assembly.

The quantities specified in the Assembly Parts List are those used at the location shown, and not necessarily the total number used per engine. Refer to the Numerical Parts List for the total quantities used per engine.

Parts which may be obtained in oversize or undersize are indicated throughout the catalog by an asterisk (*) preceding the part number Refer to the "Oversize and Undersize Parts List' for the sizes available.

The reference numbers appearing on the illustrations are numerically arranged in the Assembly Parts List and are used mainly to assist in locating a part in the Group Assembly Parts List after it has been found on an illustration.

Spare parts are sold only through Continental Authorized and Approved Service Stations and Dealers. When ordering be sure to give name and address of person or organization to whom parts are to be shipped, the part number, the exact description as listed, the quantity required, and the engine model and serial number.

INSTRUCTIONS TO C.M.C. DEALERS: C.O.D. orders cannot be accepted unless arrangements have been made in advance with C.M.C. Service Department.

We will make any shipment by any means of transportation specified, subject to the transportation company's regulations. All shipments will be carefully packed before leaving the Factory. Continental Motors Corporation shall not be held liable for damages to engines or parts incurred while in transit — our liability ceasing when shipment is delivered to the transportation agency. If damage is evident on receipt of shipment, see that a notation is made on the shipping bill and file a claim with the transportation agency. If the contents do not show damage until after the container is opened, have the carrier's claim agent make an inspection before unpacking, then file a claim for damages.

Telegraphic orders will be accepted and immediate shipment will be made. However, all telegraphic orders should be confirmed by mail. Care should be exercised in composing telegraphic orders that sufficient words are used to clearly indicate the intended meaning.

USABLE ON CODE	
A-65	A
A-75	B

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
30-	627386-A1	Crankcase Assembly, Complete	1	A
	50327-A1	Crankcase Assembly, Complete	1	B
	627386-A2	. Studding Assembly, Crankcase	1	A
	No Number	. Studding Assembly, Crankcase	NS	B
-1	No Number	. . Crankcase, 1-3 Side	NS	AB
-2	No Number	. . Crankcase, 2-4 Side	NS	AB
-3	2265	. . Plug, Crankcase Oil Lines	2	A
-3	2025	. . Plug, Crankcase Oil Lines	2	B
-4	AN900-10	. . Gasket, Annular	2	A
-5	2024	. . Plug, Oil Pressure Gauge Connection	1	AB
-6	21080	. . Dowel, Crankcase Cover to Crankcase	2	AB
-7	*2465	. . Stud, 5/16 X 1-3/8 in. lg.	10	AB
-8	*21075	. . Stud, 3/8 X 5 in. lg.	1	AB
-9	*22423	. . Stud, 1/4 X 1-1/16 in. lg.	15	AB
-10	*23030	. . Stud, 5/16 X 1-1/16 in. lg.	2	AB
-11	*25329	. . Stud, 7/16 X 6-3/32 in. lg.	4	AB
-12	*25330	. . Stud, 7/16 X 3-5/8 in. lg.	2	AB
-13	*25331	. . Stud, 7/16 X 1-1/2 in. lg.	8	AB
-14	*25361	. . Stud, 3/8 X 2-3/8 in. lg.	2	AB
-15	*402127	. . Stud, 3/8 X 1-17/32 in. lg.	8	A
-15	*22006	. . Stud, 3/8 X 1-3/8 in. lg.	8	B
-16	*633398	. Bearing, Crankshaft, center & rear, 1-3 Side	2	AB
-17	*633399	. Bearing, Crankshaft, center & rear, 2-4 Side	2	AB
-18	†*530058	. Bearing, Crankshaft, front.	2	AB
-18	†*40237	. Bearing, Crankshaft, front.	2	AB
-19	†*633141	. Washer, Thrust	4	AB
-20	627275	. Bolt, Crankcase Thru, 7/16-20 X 10.60 in. lg.	2	A
-20	*25329	. Stud, 7/16 X 6-3/32 in. lg.	2	B
-21	24251	. Screw, 1/4-28 X 1-1/4 in. lg.	10	AB
-22	24252	. Screw, Dowel	3	AB
-23	20522	. Washer, Plain	23	AB
-24	AN960-516	. Washer, Plain	3	AB
-25	AN936A416	. Washer, Lock	13	AB
-26	2437	. Nut, Plain, Hex.	13	AB
-27	24879	. Eye, Engine Lifting	1	AB
		ATTACHING PARTS		
-28	24878	. Screw	2	AB
-29	25164	. Washer, Special	2	AB
-30	20522	. Washer, Plain	2	AB
-31	AN936A416	. Washer, Lock	2	AB
-32	2437	. Nut, Plain, Hex.	2	AB
		- - * - -		
-33	2474	. Washer, Plain, 3/8	1	AB
-34	2441	. Nut, Plain, Hex, 3/8-24	1	AB
-35	2561	. Palnut, 3/8	1	AB
-36	2475	. Washer, Plain, 7/16	2	AB
-37	2443	. Nut, Plain, Hex, 7/16-20	2	AB
-38	2958	. Palnut, 7/16-20	2	AB
-39	22387	Bushing, Engine Mount	8	AB
-40	21530	Washer, Engine Mount	4	AB
-41	22653	Plate, Identification.	1	A
-41	21445	Plate, Identification.	1	B
		ATTACHING PARTS		
-42	21007	Screw, Drive	6	AB
		- - * - -		
-43	24321	Seal, Oil, Crankshaft	1	AB
-44	530019	Seal, Oil, Crankshaft (For Flanged Shaft)	1	AB
-45	AN842-10	Elbow, 5/8 ID Hose, Breather Connection	1	AB

(†) New style crankcases have had a groove added to accomodate thrust washers P/N 633141. Use 530058 bearings with thrust washers. Cases not having this groove must use old style bearing P/N 40237.

* Oversize or Undersize parts available.

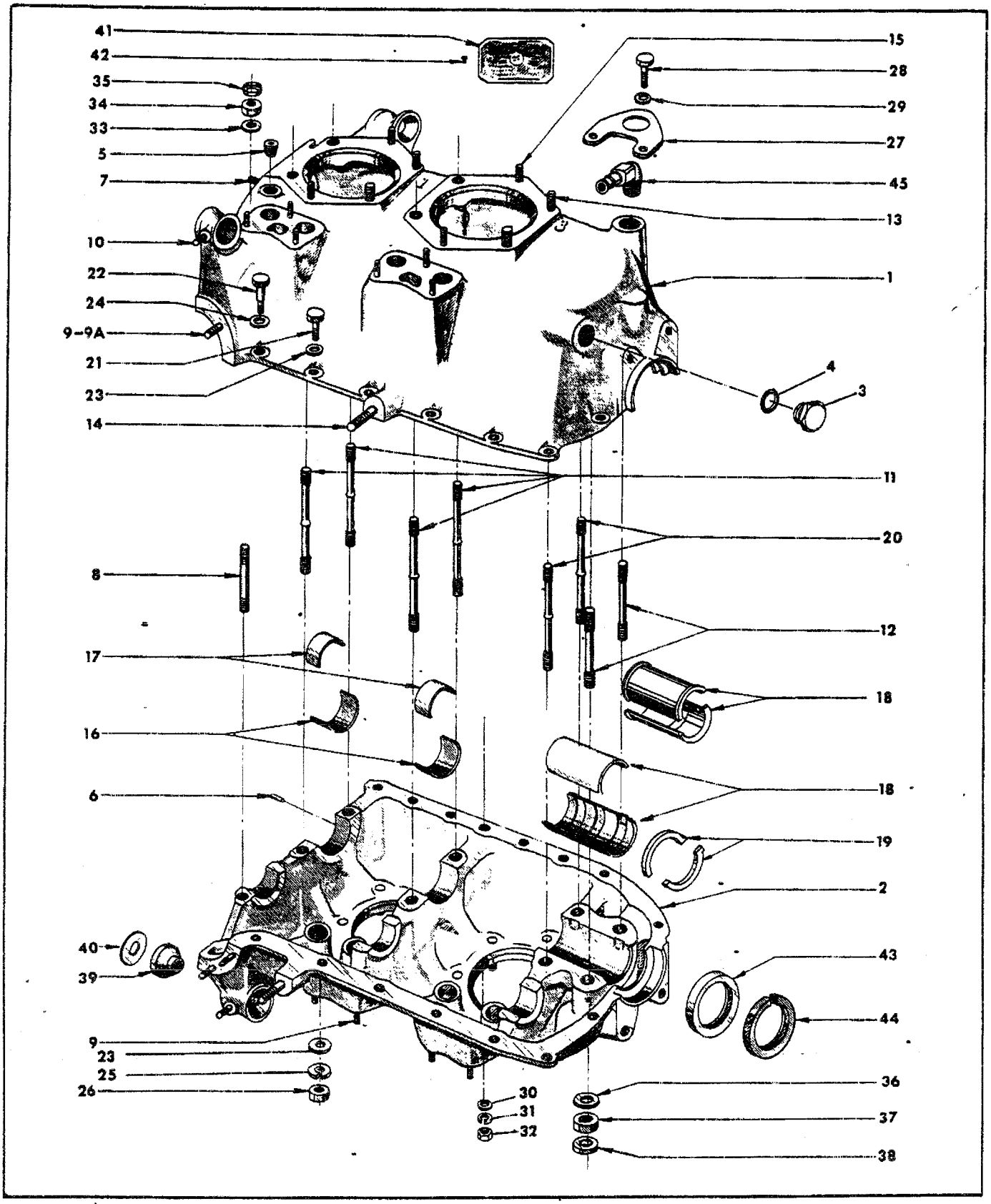


Figure 30. Crankcase.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
31-	530196	Crankshaft Assembly	1	A
-1	No Number	. Crankshaft and Tube Assembly	NS	A
-1	A50446	. Crankshaft and Tube Assembly	1	B
-2	*630651	. Dowel, Stepped	1	AB
-3	500398	Plug, 1-3/16-18 X 11/32	1	AB
-4	500400	Key, Propeller Hub	1	AB
	530199	Crankshaft Assembly, Complete (Optional) (Flanged Type I)	1	AB
-5	No Number	. Crankshaft and Tube Assembly	NS	AB
-6	*22386	. Dowel, Stepped	1	AB
-7	24769	. Bushing, Propeller Hub Flange	6	AB
-8	24770	. Plug, Hubbard	1	AB
-9	35956	Plate, Moisture Impervious	1	AB
-10	3991	Flange, Propeller Hub	1	AB
-11	24767	Washer, Propeller Hub Flange Bolt	6	AB
-12	24768	Bolt, Propeller Hub Flange	6	AB
-13	35897	Bearing, Connecting Rod	8	AB
	A35160-A2	Connecting Rod Assembly	4	A
	A35159-A2	Connecting Rod Assembly	4	B
-14	No Number	. Rod and Cap, Connecting	NS	AB
-15	25369	. Bushing, Piston Pin	1	A
-15	21003	. Bushing, Piston Pin	1	B
-16	530213	. Bolt, Connecting Rod	2	AB
-17	24804	. Nut, Slotted, 3/8-24	2	AB
-18	2501	. Pin, Cotter	2	AB
	40731-A1	Piston & Pin Assembly, Complete	4	A
	A40577	Piston & Pin Assembly, Complete	4	B
-19	* 40731	. Piston, 6.3:1 Compression Ratio	1	A
-19	* 40577	. Piston, 6.3:1 Compression Ratio	1	B
-20	* 530144	. Ring, Piston, Compression, top & 2nd groove	2	AB
-21	* 530145	. Ring, Oil Control, third groove	1	AB
	* 530856	. Pin and Plug Assembly, piston	1	A
	* 25127-A1	. Pin and Plug Assembly, piston	1	B
-22	* 25127	. . Pin, Piston	1	B
-23	25117	. . Plug, Piston Pin	2	B

* Oversize or Undersize parts available

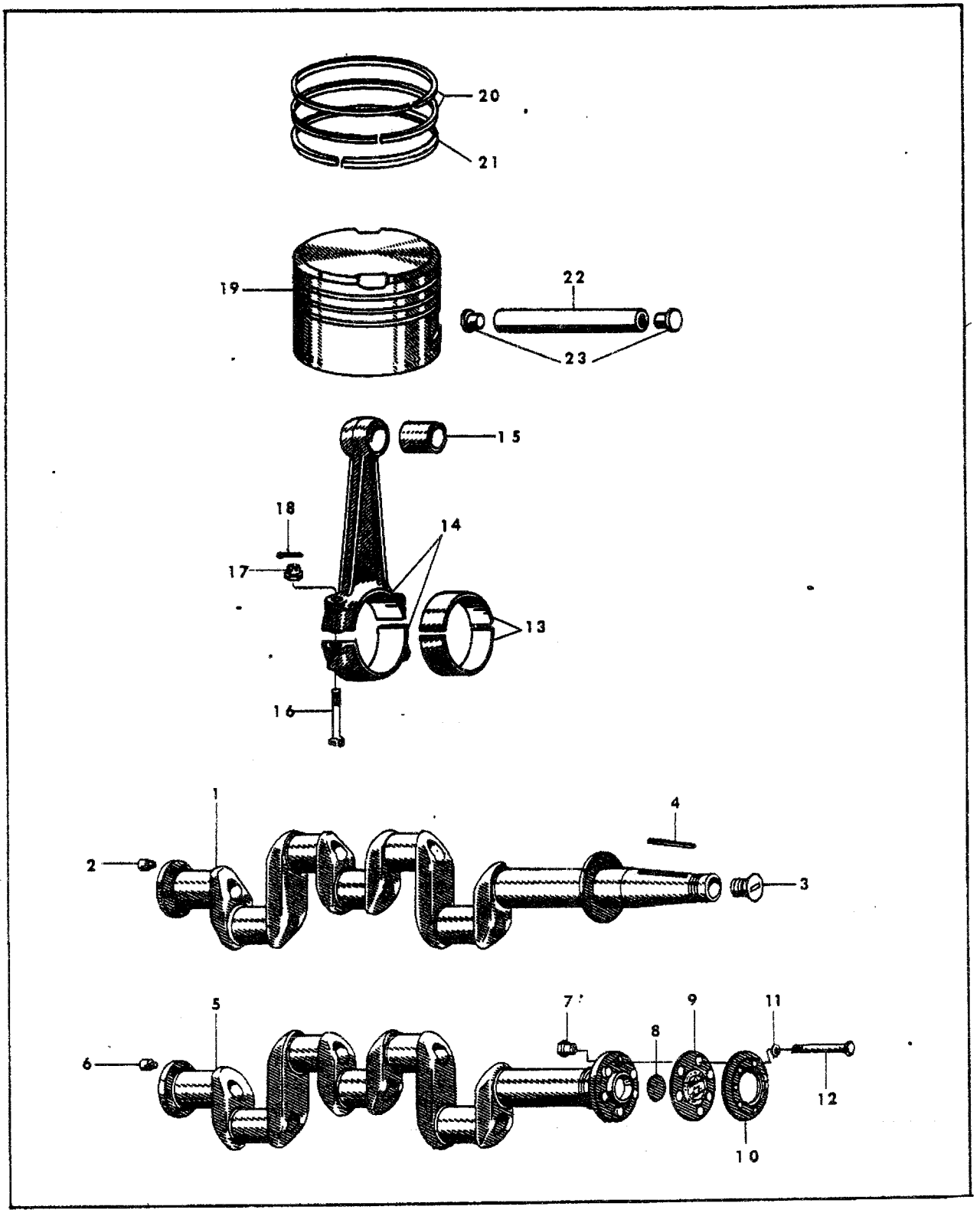


Figure 31. Crankshafts, Connecting Rods and Pistons.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
32-	B-3762-A2	Cylinder Assembly, Complete	4	A
	B-3762-B	Cylinder Assembly, Complete	4	B
		ATTACHING PARTS		
-1	2443	Nut, Plain, Hex, 7/16-20	16	AB
-2	2958	Palnut, 7/16-20	16	AB
-3	2457	Nut, Plain, Hex, 3/8-24	16	AB
-4	2561	Palnut, 3/8-24	16	AB
		- - * - -		
	B-3762-A1	. Cylinder and Valve Assembly	1	A
	B-3762-B1	. Cylinder and Valve Assembly	1	B
	B-3762	. . Cylinder Assembly	1	AB
-5	520112	. . . Insert, Spark Plug	2	AB
-6	2024	. . . Plug, Primer Jet Hole	1	AB
-7	*401885	. . . Stud, 5/16 X 1-5/16 in. lg.	2	AB
-8	*401963	. . . Stud, 1/4 X 1 in. lg.	2	AB
-9	*24805	. . . Insert, Valve Seat, Exhaust	1	AB
-10	*24806	. . . Insert, Valve Seat, Intake	1	AB
-11	*25276	. . . Guide, Exhaust Valve	1	AB
-12	*21419	. . . Guide, Intake Valve	1	AB
-13	21284	. . . Housing, Pushrod	2	AB
-14	No Number	. . . Head and Barrel Assembly	NS	AB
-15	22211	. . Valve, Exhaust	1	A
-15	21479	. . Valve, Exhaust	1	B
-16	21359	. . Valve, Intake	1	AB
-17	21365	. . Spring, Valve, Inner	2	AB
-18	21366	. . Spring, Valve, Outer	2	AB
-19	21119	. . Seat, Valve Spring	2	AB
-20	21025	. . Retainer, Valve Spring	2	AB
-21	21361	. . Lock, Valve Spring Seat	4	AB
	A24122	. Rocker Assembly, Valve	2	AB
-22	No Number	. . Rocker, Valve	NS	AB
-23	24122	. . Bushing, Valve Rocker	1	AB
-24	21007	. . Plug, Oil Passage	2	AB
-25	*21153	. Shaft, Valve Rocker	1	AB
-26	530162	. Gasket, Rocker Cover	1	AB
-27	40762	. Cover, Valve Rocker	1	AB
		ATTACHING PARTS		
-28	AN936A416	. Washer, Lock	6	AB
-29	535091	. Screw, 1/4-20 X 1/2 in. lg.	6	AB
		- - * - -		
-30	21477	. Packing, Cylinder Base	1	AB
-31	21493	Gasket, Exhaust Flange	4	AB
-32	22022	Nut, Plain (Brass) 5/16-24	8	AB

* Oversize or Undersize parts available.

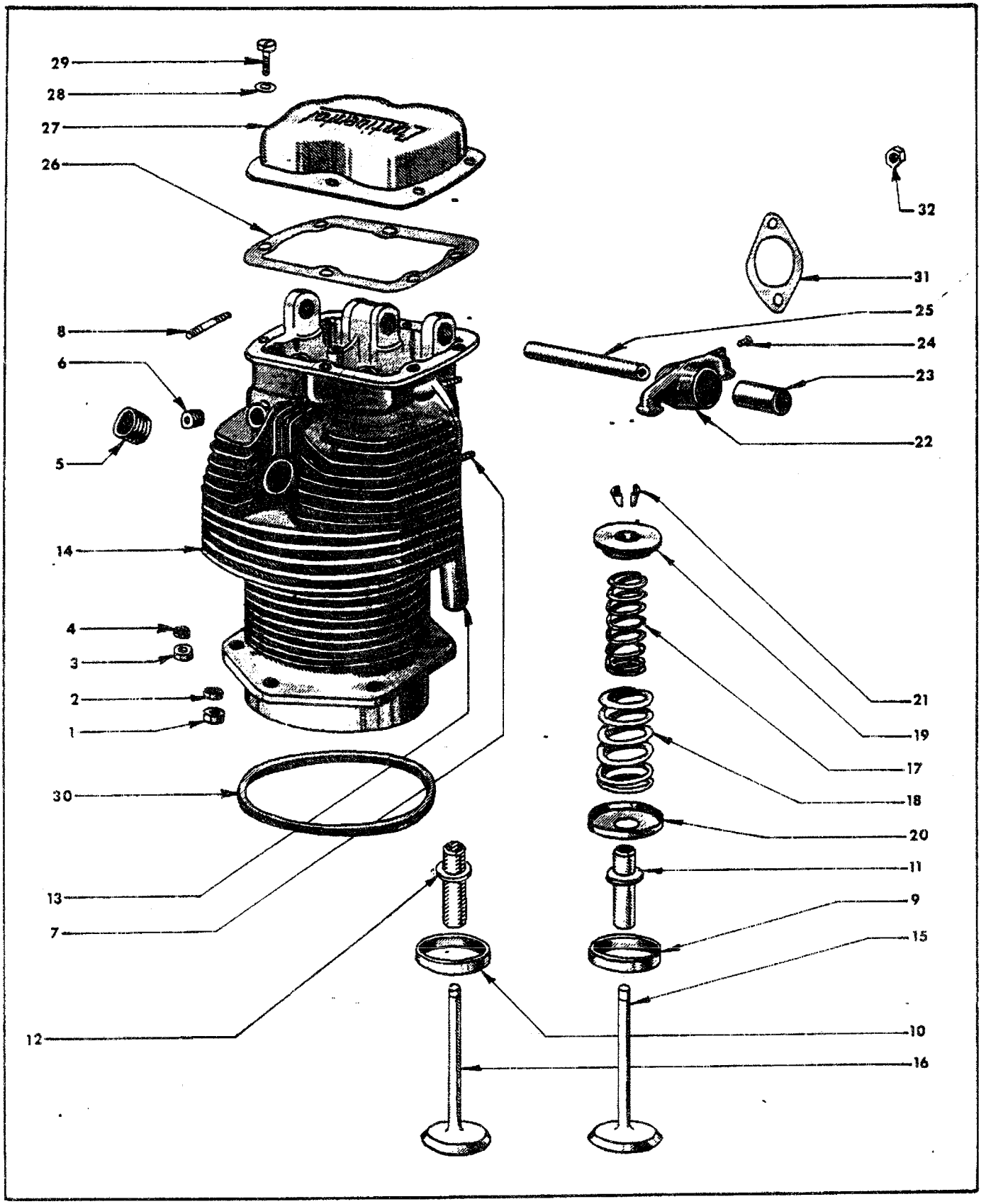


Figure 32. Cylinder and Valves.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
33-1	4577	Gasket, Crankcase Cover To Crankcase	1	AB
	A4587-A1	Crankcase Cover Assembly, Complete.	1	A
	A4587-A	Crankcase Cover Assembly, Complete.	1	B
		ATTACHING PARTS		
-2	2473	Washer, Plain, 5/16.	10	AB
-3	AN936A516	Washer, Lock	10	AB
-4	2439	Nut, Plain, Hex, 5/16-24	10	AB
		- - * - -		
	A4587	. Crankcase Cover Assembly.	1	AB
-5	No Number	. . Cover, Crankcase.	NS	AB
-6	*22423	. . Stud, 1/4 X 1-1/16 in. lg.	3	AB
-7	*23297	. . Stud, 5/16 X 1-1/2 in. lg.	4	AB
-8	21114	. Plunger, Oil Pressure Relief Valve	1	AB
-9	631706	. Spring, Oil Pressure Relief Valve.	1	A
-9	21352	. Spring, Oil Pressure Relief Valve.	1	B
-10	AN900-14	. Gasket, Annular.	1	AB
-11	21113	. Cap, Oil Pressure Relief Valve.	1	AB
-12	AN900-28	. Gasket, Oil Screen	1	AB
-13	A3568	. Oil Screen Assembly.	1	AB
-14	AN900-10	. Gasket, Annular.	1	AB
-15	24142	. Plug, 5/8-18	1	AB
-16	632085	. Gasket, Tachometer Drive Housing	1	A
-16	AN900-22	. Gasket, Tachometer Drive Housing	1	B
-17	21163	. Seal, Oil	1	AB
-18	21208	. Housing, Tachometer Drive	1	AB
-19	626972-4	. Caplug (Shipping Only)	1	AB
-20	3562	. Gear and Drive Shaft	1	AB
-21	21343	. Gear and Shaft	1	AB
-22	21160	. Cover, Oil Pressure Pump.	1	AB
		ATTACHING PARTS		
-23	20522	. Washer, Plain	4	AB
-24	22537	. Screw, Drilled, 1/4-20 X 5/8 in. lg.	4	AB
		- - * - -		
-25	530641	Gear, Crankshaft	1	AB
		ATTACHING PARTS		
-26	21346	Screw, 1/4-20 X 7/16 in. lg.	4	AB
		- - * - -		
-27	3506	Gear, Camshaft.	1	AB
		ATTACHING PARTS		
-28	21346	Screw, 1/4-20 X 7/16 in. lg.	4	AB
		- - * - -		

* Oversize or Undersize parts available.

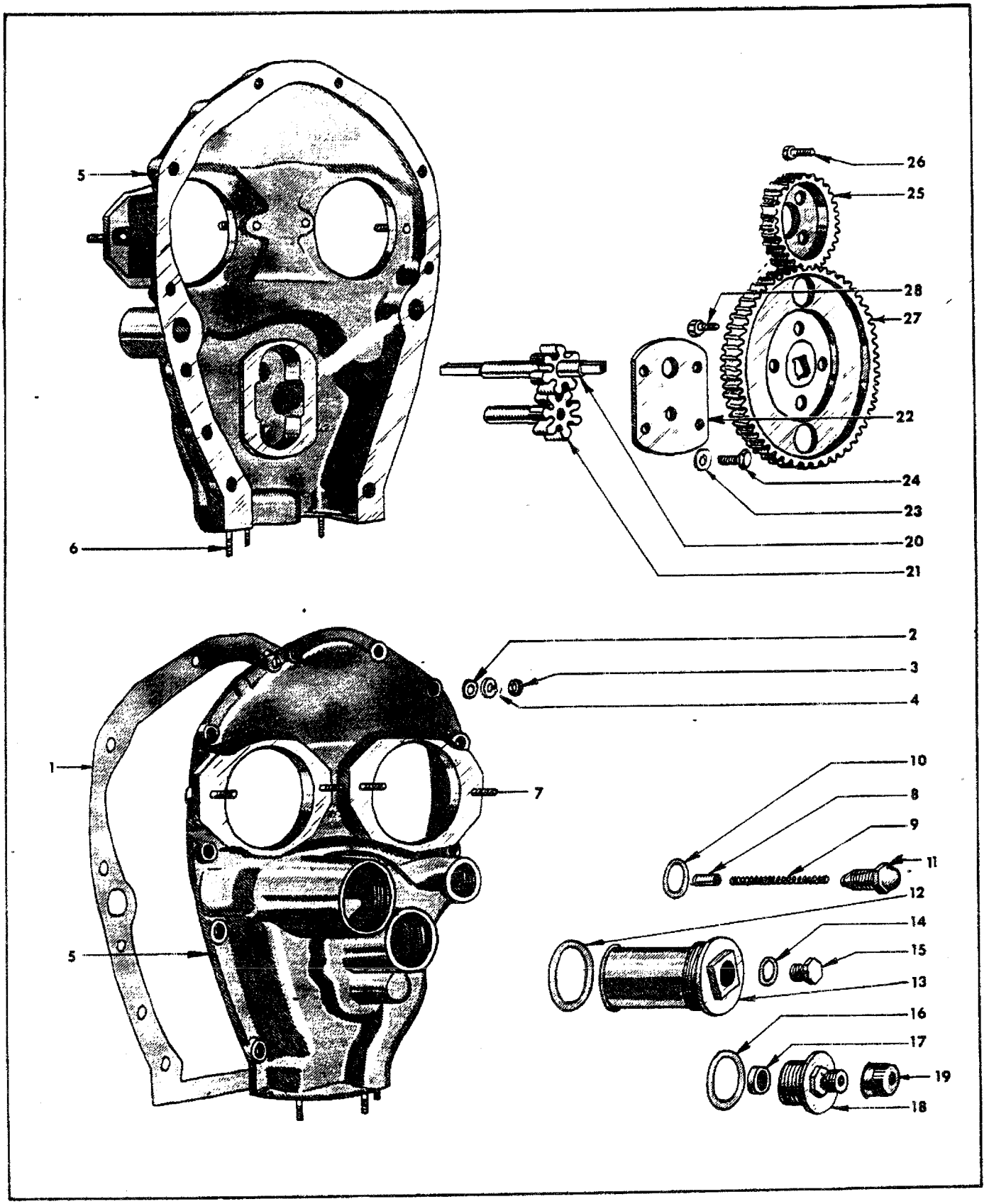


Figure 33. Rear Crankcase Cover and Gear Train.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
34-1	3577	Gasket, Oil Sump	1	AB
	No Number	Oil Sump Assembly, Complete	1	AB
		ATTACHING PARTS		
-2	20522	Washer, Plain, 1/4	6	AB
-3	22661	Nut, Elastic Stop, 1/4-28	6	AB
-4	2473	Washer, Plain, 5/16	1	AB
-5	21213	Nut, Elastic Stop, 5/16-24	1	AB
		- - * - -		
-6	*No Number	. Oil Sump Assembly	1	AB
-7	*No Number	. Oil Gauge and Rod Assembly	1	AB
-8	AN900-10	Gasket, Annular	1	AB
-9	2265	Plug, Oil Sump Drain	1	AB
-10	AN900-10	Gasket, Oil Suction Tube	1	AB
-11	A22301	Oil Suction Tube Assembly	1	AB

NOTE: (*) When ordering oil sumps, specify the number stamped on the flange or advise airplane make and model or engine serial number.

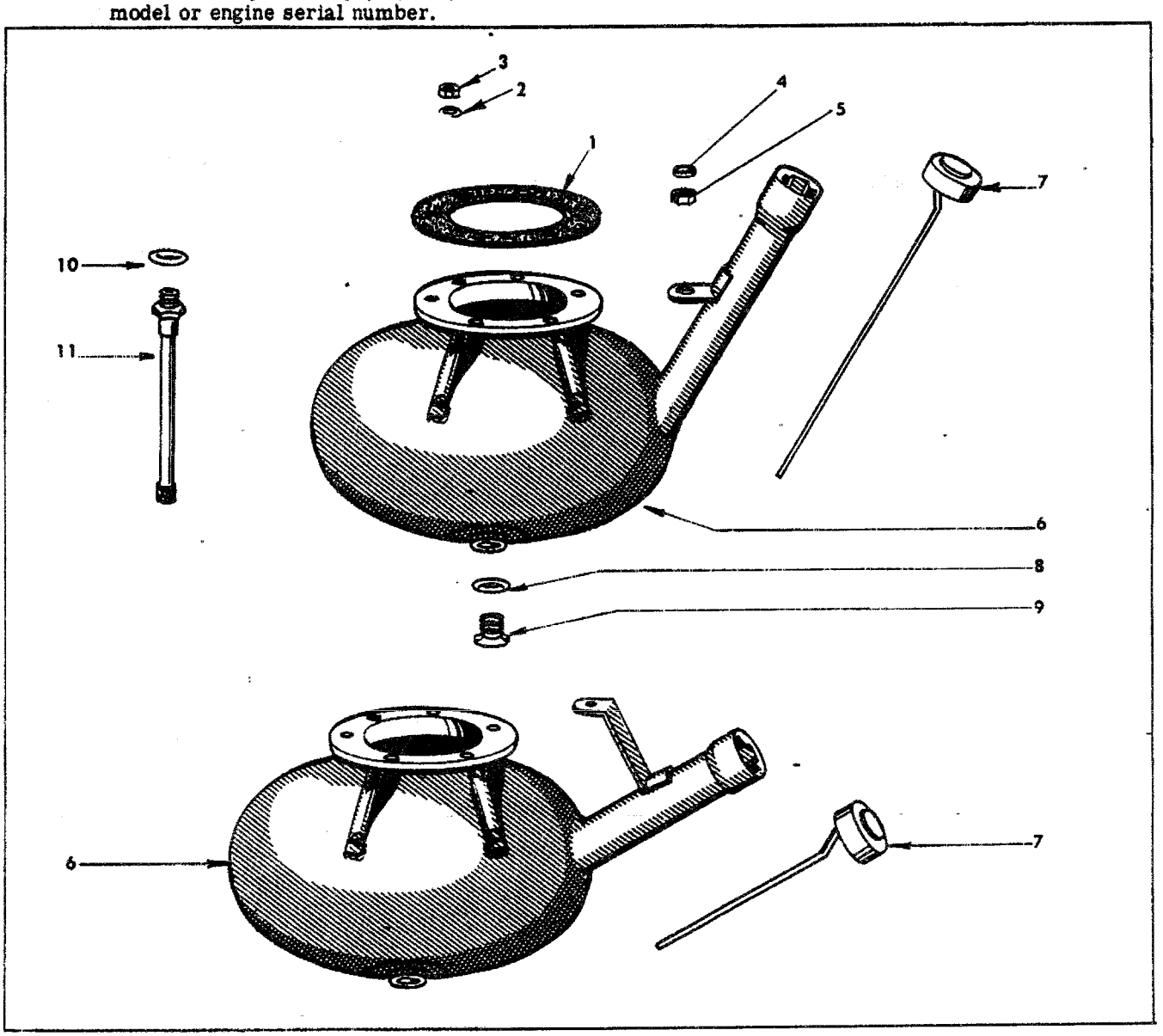


Figure 34. Oil Sump and Oil Suction Tube.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
35-1	500278	Gasket, Magneto Flange	2	B
	24739-A1	Magneto and Gear Assembly	1	B
-2	24739	. Magneto, Eiseman R. H. AM-4 (without impulse)	1	B
-3	3513	. Gear, Magneto Drive	1	B
	50406-A1	Magneto and Gear Assembly	1	B
-4	50406	. Magneto, Eiseman, L. H. AM-4 (with impulse)	1	B
-5	36067	. Gear, Magneto Drive	1	B
		ATTACHING PARTS		
-6	2555	Washer, Special, 5/16	4	B
-7	2439	Nut, Plain, Hex, 5/16-24	4	B
-8	2560	Palnut, 5/16	4	B
		- - * - -		
	A-21082-A2	Ignition Cable Assembly	1	B
-9	21082	. Cable, Ignition	UAR	B
-10	2306	. Terminal, Spark Plug Cable Safety Lock	1	B
-11	25142	. Clip, Magneto Terminal	1	B
-12	22460	Spark Plug, Champion C26	8	B
-13	22493	Bracket, Ignition Cable (On Magneto Stud)	2	B
	24841	Bracket, Ignition Cable (On Cylinder Stud)	4	B
-14	22495	Grommet, Ignition Cable	6	B

IGNITION CABLE LENGTHS

CYLINDER NO.	1	2	3	4
RIGHT MAGNETO	24"	30"	23"	30"
LEFT MAGNETO	27"	21"	35"	33"

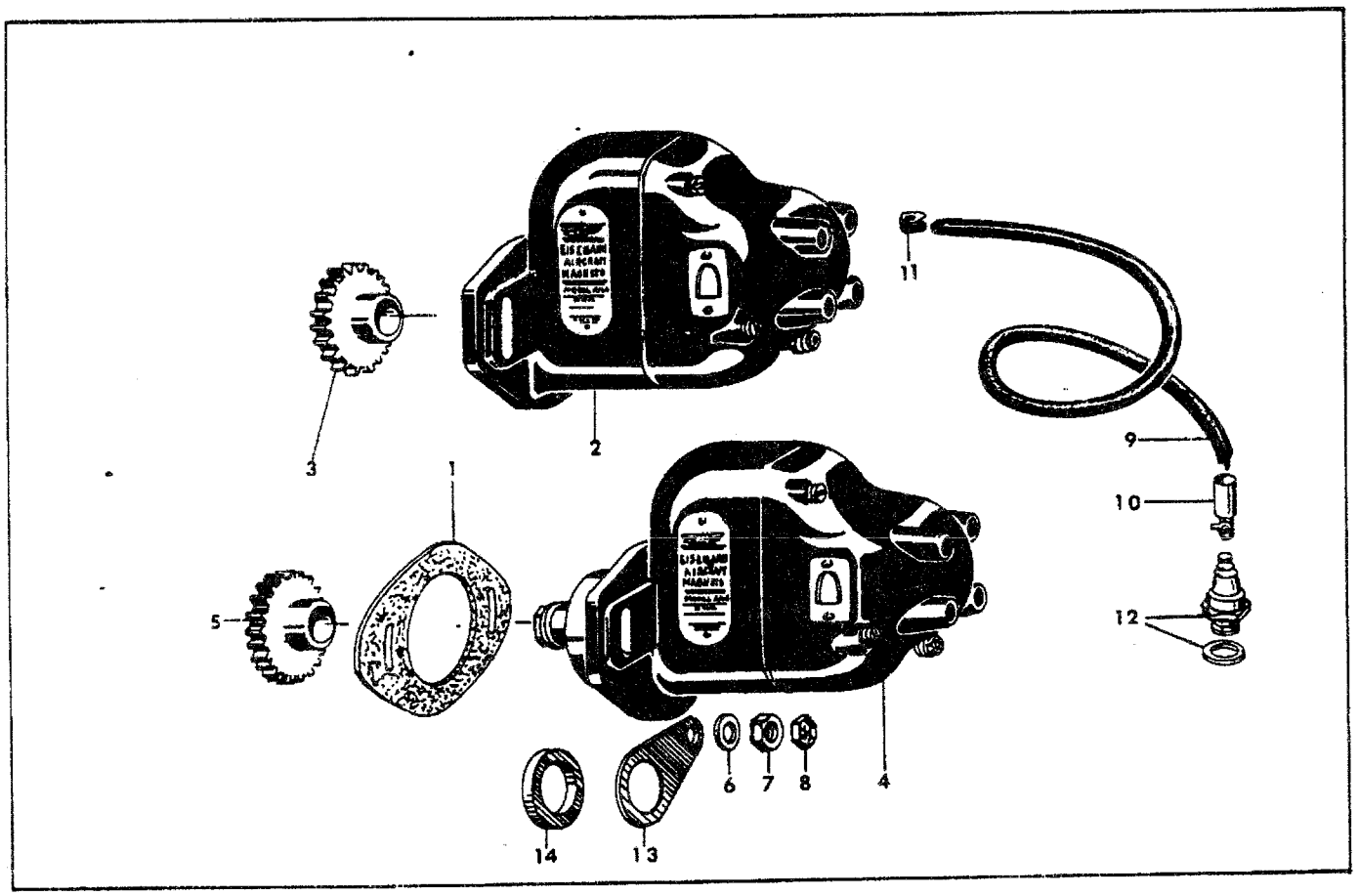


Figure 35. Ignition System.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
36-1	535324	Gasket, Magneto Flange	2	A
-2	36067	Gear, Magneto Drive (Left Magneto)	1	A
	3513	Gear, Magneto Drive (Right Magneto)	1	A
-3	530209	Magneto, Left Side	1	A
	530225	Magneto, Right Side	1	A
		ATTACHING PARTS		
-4	401506	Washer, Plain	4	A
-5	AN936A516	Washer, Lock	4	A
-6	2439	Nut, Plain, Hex, 5/16-24	4	A
		- - * - -		
-7	A25277	Kit, Ground Terminal	2	A
-8	25314	. Washer, Plain	1	A
-9	25315	. Sleeve, Insulating	1	A
-10	25316	. Ferrule, Inner	1	A
-11	25317	. Ferrule, Outer	1	A
-12	25318	. Nut, Hex, Coupling	1	A
	627667-A1	Harness Assembly, Ignition Complete	1	A
		ATTACHING PARTS		
-13	AN936-10	Washer, Lock	8	A
-14	AN501-10-10	Screw	8	A
		- - * - -		
	627667	. Cable and Plate Assembly, Right Magneto	1	A
-15	21082-31.50	. . Cable, Ignition, Right Magneto to Cylinder #1	1	A
-16	21082-36.50	. . Cable, Ignition, Right Magneto to Cylinder #3	1	A
-17	21082-36.00	. . Cable, Ignition, Right Magneto to Cylinder #2	1	A
-18	21082-35.00	. . Cable, Ignition, Right Magneto to Cylinder #4	1	A
-19	*25305	. . Plate, Cable Outlet	1	A
-20	*40794	. . Grommet, Cable	1	A
-21	*627002	. . Washer, Terminal	4	A
-22	*25387	. . Screw, Terminal	4	A
	627668	. Cable and Plate Assembly, Left Magneto	1	A
-23	21082-25.50	. . Cable, Ignition, Left Magneto to Cylinder #1	1	A
-24	21082-36.60	. . Cable, Ignition, Left Magneto to Cylinder #3	1	A
-25	21082-21.00	. . Cable, Ignition, Left Magneto to Cylinder #2	1	A
-26	21082-32.00	. . Cable, Ignition, Left Magneto to Cylinder #4	1	A
-27	2306	. Terminal, Spark Plug End	8	A
-28	531116	. Bracket, Ignition Cable	2	A
-29	22493	. Bracket, Ignition Cable	2	A
-30	22495	. Grommet, Ignition Cable	4	A
-31	25145	. Bracket, Ignition Cable	2	A

NOTE: (*) Parts 19 through 22 also part of assembly 627668.

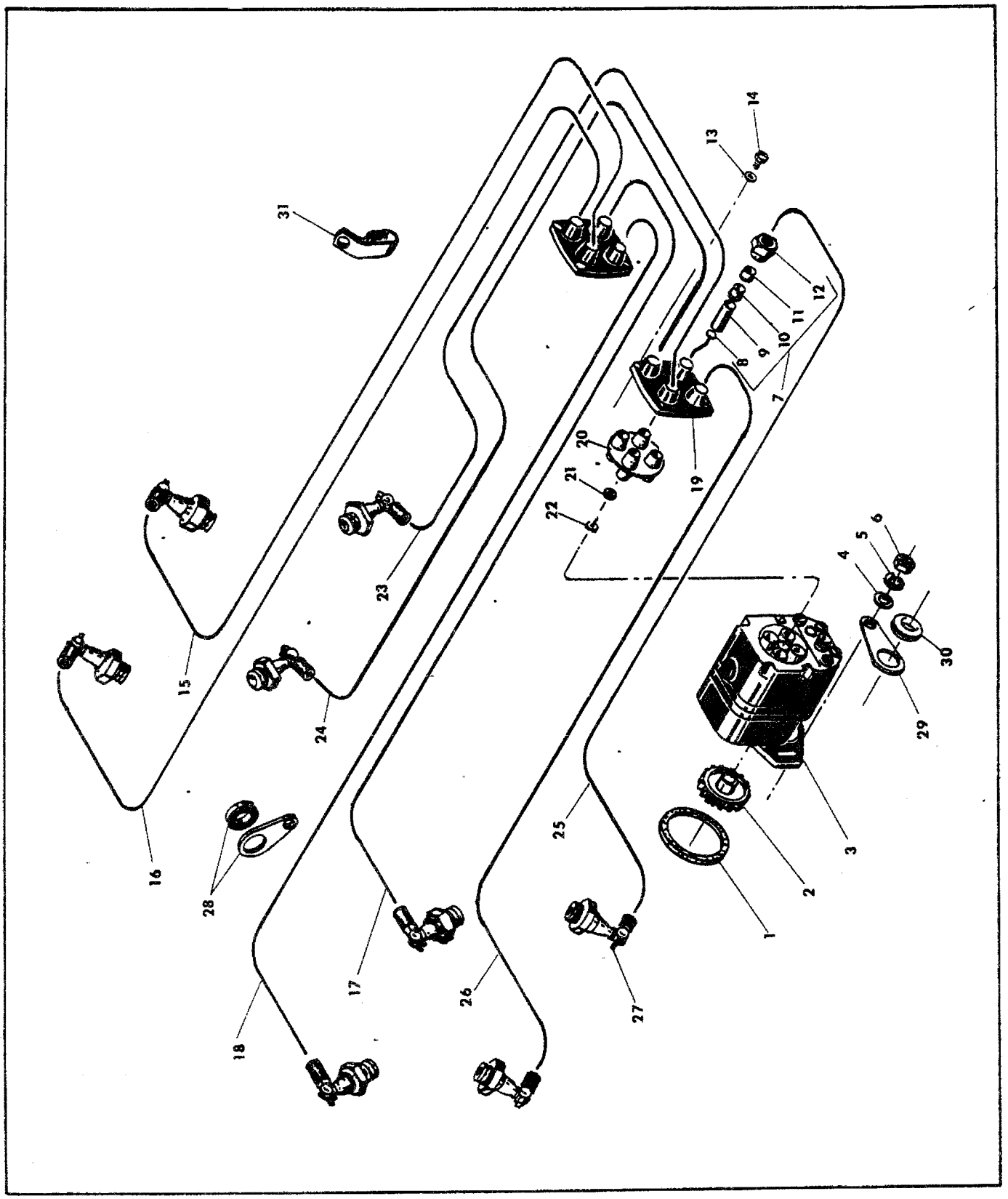


Figure 36. Ignition System.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
37-	4780-A1	Intake Manifold Assembly	1	AB
		ATTACHING PARTS		
-1	2474	Washer, Plain, 3/8	2	AB
-2	AN936A616	Washer, Lock	2	AB
-3	2557	Nut, Plain, Hex, 3/8-24	2	AB
		- - * - -		
-4	No Number	. Manifold, Intake	NS	AB
-5	*401806	. Stud, 1/4 X 1-1/4 in. lg.	4	AB
-6	21182	Pipe, Intake	4	AB
-7	22800	Hose, 1-3/4 O.D. Intake Pipe To Manifold & Elbow	8	AB
-8	21185	Hose, 1-1/2 O.D. Intake Pipe To Manifold & Elbow	8	AB
-9	36151-N	Clamp.	16	AB
-10	21327	Gasket, Intake Elbow	4	AB
-11	3585	Elbow, Intake Cylinder No. 2 & 3	2	AB
-12	4602	Elbow, Intake Cylinder No. 1 & 4	2	AB
		ATTACHING PARTS		
-13	20522	Washer, Plain, 1/4.	8	AB
-14	AN936A416	Washer, Lock	8	AB
-15	2437	Nut, Plain, Hex, 1/4-28	8	AB
		- - * - -		
-16	AN4022-1	Primer Jet, Intake Manifold.	1	AB
-17	AN800C2	Cone, Union	1	A
-17	20720	Cone, Union, 1/8	1	B
-18	AN805-2	Nut, Union	1	AB
-19	21051	Gasket, Carburetor To Air Intake Assembly.	1	AB
-20	627365	Carburetor, Marvel-Schebler No. 10-4233	1	A
-20	3628	Carburetor, Stromberg NA-53A1.	1	B
		ATTACHING PARTS		
-21	AN960-416L	Washer, Plain	4	AB
-22	AN936A416	Washer, Lock	4	AB
-23	2437	Nut, Plain, Hex, 1/4-28	4	AB
		- - * - -		
-24	*402711	Stud, 1/4 X 7/8 in. lg.	4	AB
-25	21323	Gasket	1	AB
	A40793	Carburetor Air Throttle Assembly	1	A
	A40522	Carburetor Air Throttle Assembly	1	B
		ATTACHING PARTS		
-26	AN936A416	Washer, Lock	4	AB
-27	2437	Nut, Plain, Hex, 1/4-28	4	AB
		- - * - -		
-28	A50495	. Housing Assembly	1	A
-28	A50256	. Housing Assembly	1	B
	627361	. Filter Assembly	1	AB
-29	35923	. . Gasket	1	AB
-30	40599	. . Filter.	1	AB
-31	24306	. . Stud, Fastener.	4	AB
-32	24308	. . Pin, Cross	4	AB
-33	A35917	Support Assembly, Carburetor Air Intake.	1	AB
		ATTACHING PARTS		
-34	2471	Washer	2	AB
-35	AN501A10-5	Screw.	2	AB
		- - * - -		

* Oversize or Undersize parts available.

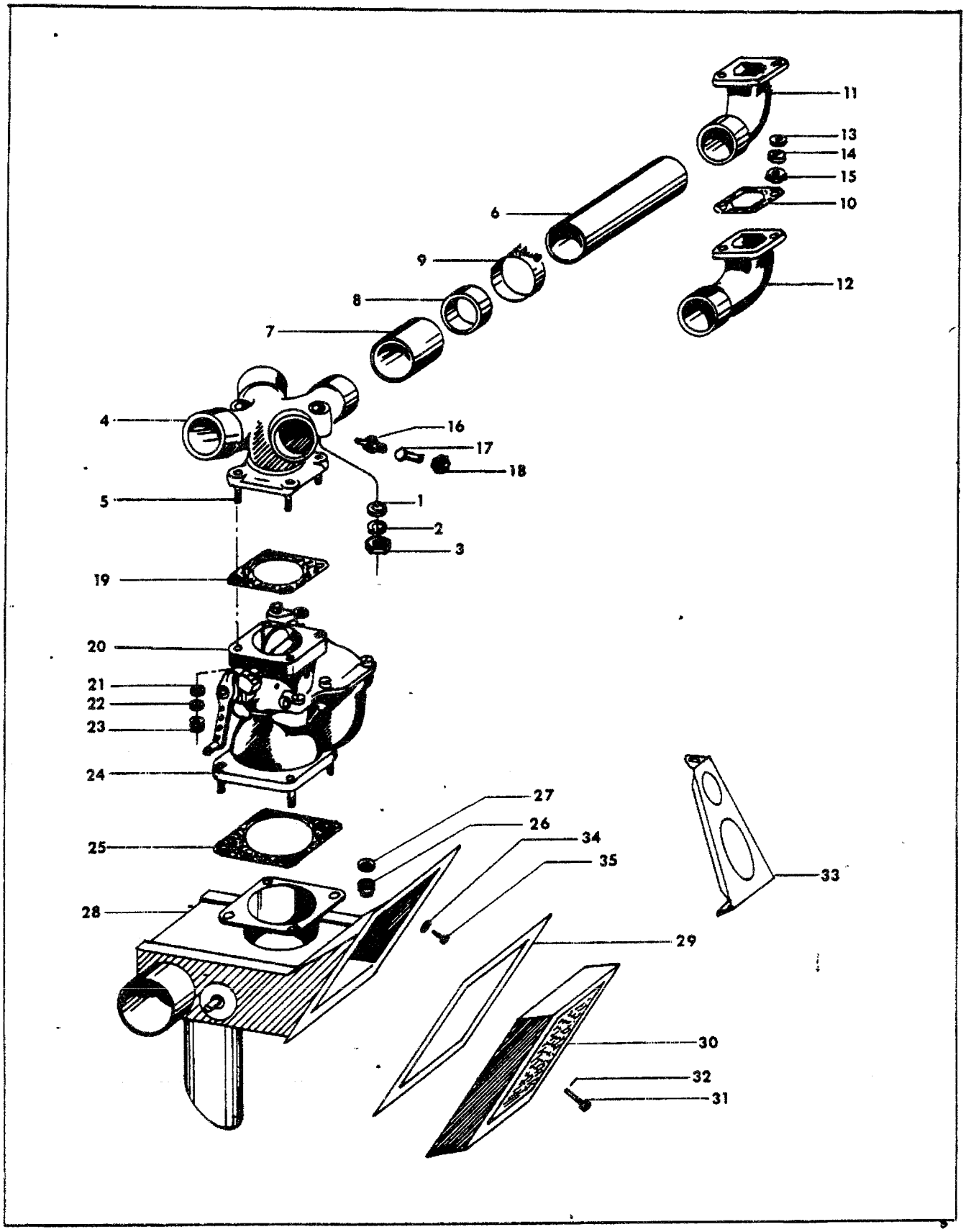


Figure 37. Carburetor, Air Intake and Filter System.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
38-1	† *40584	Camshaft	1	A
-1	† *4546	Camshaft	1	B
-2	537870	Pushrod Assembly	8	AB
	A21599	Valve Tappet Assembly	8	AB
-3	21608	. Body	1	AB
-4	533399	. Hydraulic Unit	1	AB
-5	25042	. Socket	1	AB
-6	530940	. Snap Ring	1	AB
-7	530928	Gasket, Pushrod Housing Flange	4	A
-7	21170	Gasket, Pushrod Housing Flange	4	B
-8	530163	Flange, Pushrod Housing	4	AB
		ATTACHING PARTS		
-9	20522	Washer, Plain, 1/4	12	AB
-10	AN936A416	Washer, Lock	12	AB
-11	2437	Nut, Plain, Hex, 1/4-28	12	AB
		- - * - -		
-12	539840	Connector, Push Rod Housing	8	AB
-13	536388-1.25	Clamp, Hose	16	AB
	A-3746	Propeller Hub Assembly	1	AB
-14	3745	. Hub, SAE #0 Taper Shaft	1	AB
-15	3991	. Flange, Propeller Hub	1	AB
		ATTACHING PARTS		
-16	21468	. Bolt, 3/8-24 X 4-1/4 in. lg.	6	AB
-17	2474	. Washer, Plain, 3/8	6	AB
-18	2458	. Nut, Castle, 3/8-24	6	AB
-19	2506	. Pin, Cotter, 3/32 X 3/4 in. lg.	6	AB
		- - * - -		
-20	21202	. Nut, Propeller Hub	1	AB
-21	21203	. Ring, Snap	1	AB
-22	AN392-11	. Pin, 1/8 X 11/32 in. lg.	1	AB
-23	2500	. Pin, Cotter, 1/16 X 3/8 in. lg.	1	AB

† P/N 40584 can only be used in A65 Engines if crankcase halves are P/N 6794 & 6795. Otherwise you must use 4546 cam in both A65 & A75.

* Oversize or Undersize parts available.

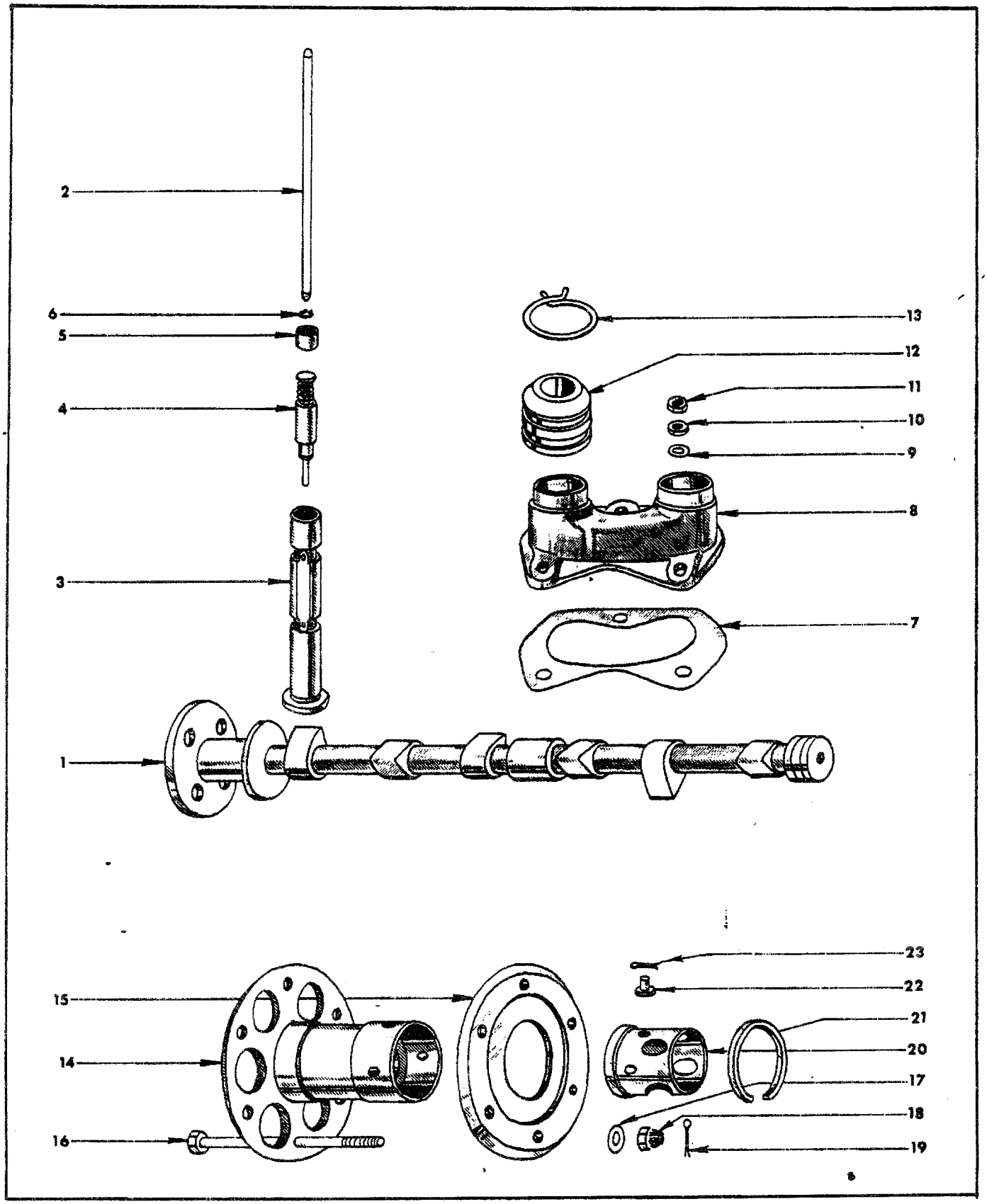


Figure 38. Camshaft, Push Rods & Valve Tappets Propeller Hub.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
39-	EQ5198	Oil Cooler Equipment (Under Engine)	1	
-1	22131	. Bracket, Crankcase 2-4 Side	1	
-2	22132	. Bracket, Crankcase 1-3 Side	1	
		ATTACHING PARTS		
-3	22134	. Screw, 1/4-28 X 2-3/4 in. lg.	2	
-4	22139	. Washer, Bracket To Crankcase Spacer	2	
		- - * - -		
-5	3875	. Adapter, Oil Cooler.	1	
-6	22133	. Gasket, Oil Cooler To Adapter	1	
-7	3883	. Oil Cooler	1	
		ATTACHING PARTS		
-8	2474	. Washer, Plain, 3/8.	3	
-9	2441	. Nut, Plain, Hex, 3/8-24	3	
-10	2561	. Palnut, 3/8	3	
		- - * - -		
-11	2849	. Ball, By-Pass Valve, 7/16.	1	
-12	2848	. Spring, By-Pass Valve	1	
-13	AN900-10	. Gasket.	1	
-14	2265	. Plug, 5/8, Hex Head	1	
-15	20882	. Plug, 1/8 NPT	1	
-16	22295	. Elbow, 45 Degree, 3/8 NPT Street	2	
-17	22296	. Elbow, 45 Degree, 3/8 NPT X 3/8 Tube.	2	
-18	22130	. Sleeve, Crankcase Oil Line	1	
-19	22271	. Elbow, 90 Degree, 3/8 Pipe to 3/8 Tube	2	
-20	22293	. Tube, Oil Cooler To Crankcase	2	
	EQ5199	Oil Cooler Equipment (Side Mounted)	1	
-21	*20990	. Stud, 5/16 X 1-1/4 in. lg.	2	
-22	21064	. Gasket, Adapter To Crankcase.	1	
-23	4732	. Adapter, Oil Cooler.	1	
		ATTACHING PARTS		
-24	2473	. Washer, Plain, 5/16	2	
-25	2457	. Nut, Castle, 5/16-24	2	
		- - * - -		
-26	22133	. Gasket, Oil Cooler	1	
-27	3883	. Oil Cooler	1	
		ATTACHING PARTS		
-28	2474	. Washer, Plain, 3/8.	3	
-29	2441	. Nut, Plain, Hex, 3/8-24.	3	
-30	2561	. Palnut, 3/8	3	
		- - * - -		
-31	2849	. Ball, 7/16, By-Pass Valve	1	
-32	2840	. Spring, By-Pass Valve	1	
-33	AN900-10	. Gasket, By-Pass Valve Plug.	1	
-34	2265	. Plug, By-Pass Valve	1	
-35	20288	. Plug, 1/4 NPT	1	
-36	22271	. Elbow, 90 Degree, 3/8 NPT Street	2	
-37	22198	. Tube, Oil Cooler To Crankcase	1	
-38	22130	. Sleeve, Oil Line	1	
-39	530208	. Elbow, 90 Degree, 3/8 NPT X 3/8 Tube	2	
-40	22199	. Tube, Oil Cooler To Crankcase	1	
-41	20976	. Plug, 3/8 NPT	1	

* Oversize or Undersize parts available.

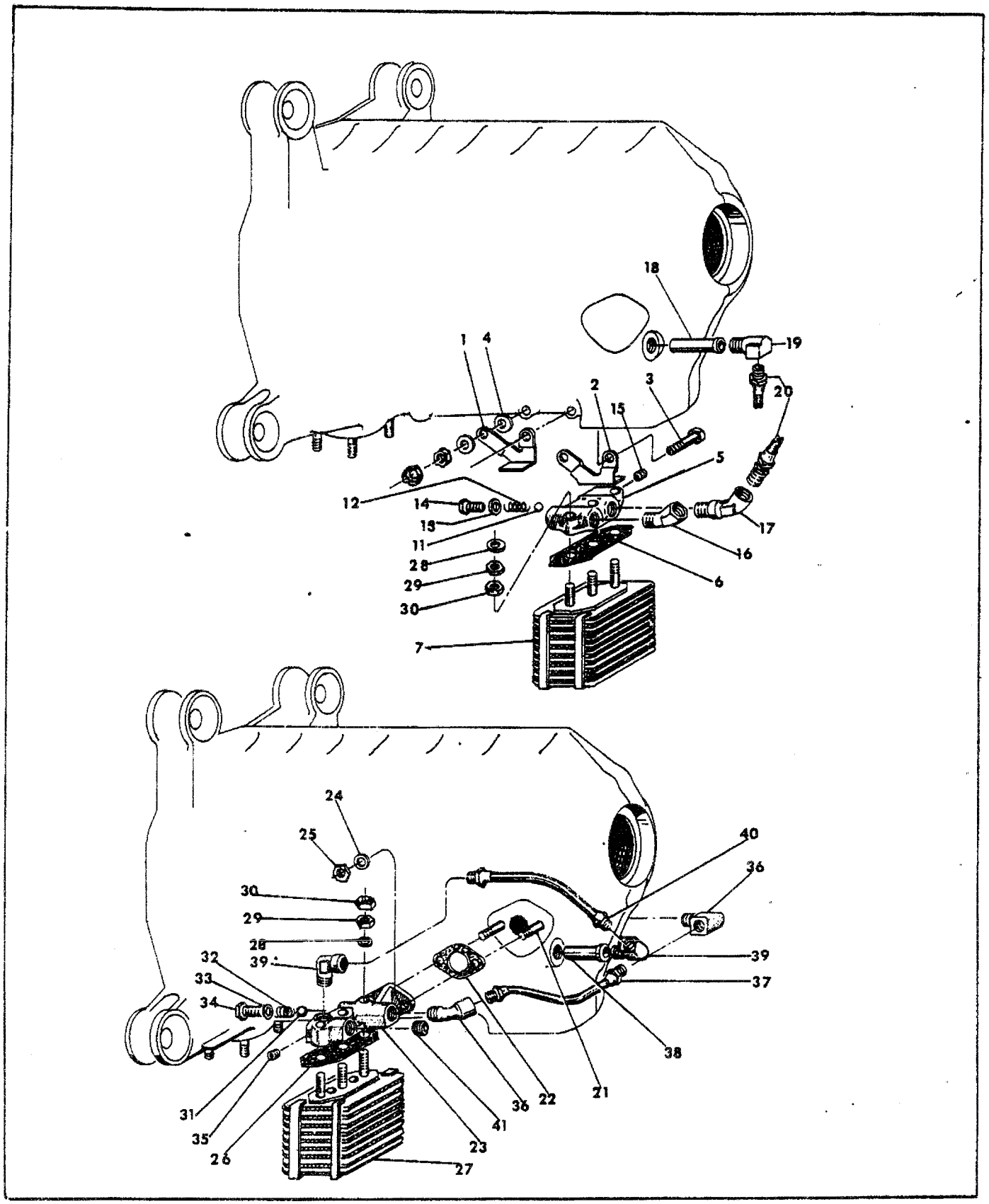


Figure 39. Oil Cooler Equipment.

Fig. & Index No.	Part Number	Description 1 2 3 4 5	Qty.	Usable On Code
40	EQ5148	Fuel Pump Equipment	1	
-01	20001	. Stud, 5/16 X 1-1/4 in. lg.	2	
-02	21064	. Gasket, Fuel Pump	1	
-03	40585	. Fuel Pump (AC#1539051)	1	
		ATTACHING PARTS		
-04	2473	. Washer, Plain, 5/16	2	
-05	2439	. Nut, Plain, Hex, 5/16-24	2	
-06	2560	. Palnut, 5/16	2	
		- - * - -		
-07	40584	. Camshaft	1	
	A25233A	. Fuel Line Assembly	1	
	AN790-4	. Elbow, 1/8 Pipe X 7/16-20	1	
	25306	. Elbow, 1/4 Pipe X 7/16-20	1	
	21619	. Elbow, Flared Tube	1	

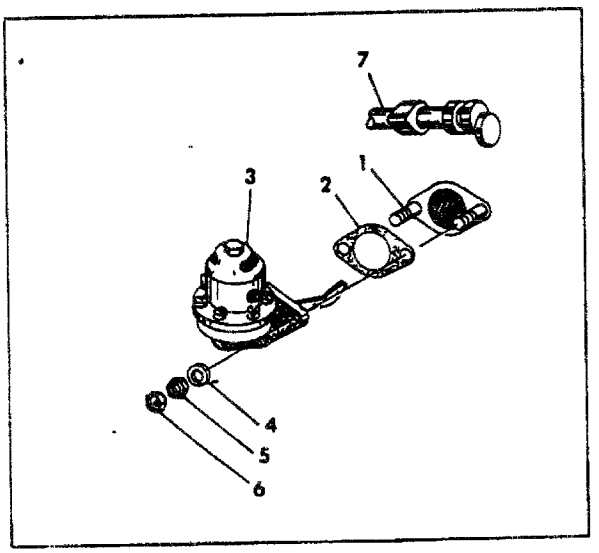


Figure 40. Fuel Pump.

SECTION 14

NUMERICAL PARTS LIST

PART NUMBER	FIG. & INDEX	QTY PER ASSY
AN4022-1	37-16	1
AN501-10-10	36-14	8
AN790-4	40-	1
AN800C2	37-17	1
AN805-2	37-18	1
AN842-10	30-45	1
AN900-10	30-04	2
	33-14	1
	34-08	1
	34-10	1
	39-13	1
	39-33	1
		7*
AN900-14	33-10	1
AN900-22	33-16	1
AN900-28	33-12	1
AN932-11	38-22	1
AN936-10	36-13	8
AN936A416	30-25	13
	30-31	2
	32-28	6
	37-14	8
	37-22	4
	37-26	4
	38-10	12
		49*
AN936A516	33-03	10
	36-05	4
		14*
AN936A616	37-02	2
AN960-416L	37-21	4
AN960-516	30-24	3
A21082-A2	35-	1
A21599	38-	8
A22301	34-11	1
A24122	32-	2
A25233A	40-	1
A25277	36-07	2
A35159-A2	31-	4
A35160-A2	31-	4
A3568	33-13	1
A35917	37-33	1
A3746	38-	1
A40522	37-	1
A40522	37-	1
A40577	31-	4
A40793	37-	1
A4587	33-	1
A4587-A	33-	1
A4587-A1	33-	1
A501A10-5	37-35	2
A50256	37-28	1
A50446	31-01	1
A50495	37-28	1
B-3762	32-	1
B-3762-A1	32-	1
B-3762-A2	32-	4
B-3762-B	32-	4
B-3762-B1	32-	1
EQ5148	40-	1
EQ5198	39-	1
EQ5199	39-	1
20001	40-01	2
2024	30-05	1
	32-06	1
		2*
2025	30-03	2
20288	39-35	1
20522	30-23	23
	30-30	2
	33-23	4
	34-02	6
	37-13	8
	38-09	12
		55*
20720	37-17	1
20882	39-15	1
20976	39-41	1
20990	39-21	2
21003	31-15	1
21007	30-42	6
	32-24	2
		8*
21025	32-20	2
21051	37-19	1
21064	39-22	1
	40-02	1
		2*
21075	30-08	1
21080	30-06	2
21082	35-09	AR
21082-21.00	36-25	1
21082-25.50	36-23	1
21082-31.50	36-15	1
21082-32.00	36-26	1
21082-35.00	36-18	1
21082-36.00	36-17	1
21082-36.50	36-16	1
21082-36.60	36-24	1
21113	33-11	1
21114	33-08	1
21119	32-19	2
21153	32-25	1
21160	33-22	1
21163	33-17	1
21170	38-07	4

PART NUMBER	FIG. & INDEX	QTY PER ASSY
21182	37-06	4
21185	37-08	8
21202	38-20	1
21203	38-21	1
21208	33-18	1
21213	34-05	1
21274	38-12	8
21282	38-13	8
21284	32-13	2
21323	37-25	1
21327	37-10	4
21343	33-21	1
21346	33-26	4
	33-28	4
		8*
21352	33-09	1
21359	32-16	1
21361	32-21	4
21365	32-17	2
21366	32-18	2
21419	32-12	1
21445	30-41	1
21468	38-16	6
21477	32-30	1
21479	32-15	1
21493	32-31	4
21530	30-40	4
21608	38-03	1
21619	40-	1
22006	30-15	8
22022	32-32	8
22130	39-18	1
	39-38	1
		2*
22131	39-01	1
22132	39-02	1
22133	39-06	1
	39-26	1
		2*
22134	39-03	2
22139	39-04	2
22198	39-37	1
22199	39-40	1
22211	32-15	1
22271	39-19	2
	39-36	2
		4*
22293	39-20	2
22295	39-16	2
22296	39-17	2
22386	31-06	1
22387	30-39	8
22423	30-09	15
	33-06	3
		18*
22460	35-12	8
22493	35-13	2
	36-29	2
		4*

PART NUMBER	FIG. & INDEX	QTY PER ASSY
22495	35-14	6
	36-30	4
		10*
22537	33-24	4
2265	30-03	2
	34-09	1
	39-14	1
	39-34	1
		5*
22653	30-41	1
22661	34-03	6
22800	37-07	8
23030	30-10	2
2306	35-10	1
	36-27	8
		9*
23297	33-07	4
24122	32-23	1
24142	33-15	1
24251	30-21	10
24252	30-22	3
24306	37-31	4
24308	37-32	4
24321	30-43	1
2437	30-26	13
	30-32	2
	37-15	8
	37-23	4
	37-27	4
	38-11	12
		43*
2439	33-04	10
	35-07	4
	36-06	4
	40-05	2
		20*
2441	30-34	1
	39-09	3
	39-29	3
		7*
2443	30-37	2
	32-01	16
		18*
2457	39-25	2
	32-03	16
		18*
2458	38-18	6
2465	30-07	10
2471	37-34	2
2473	33-02	10
	34-04	1
	39-24	2
	40-04	2
		15*
24739	35-02	1
24739-A1	35-	1
2474	30-33	1
	37-01	2
	38-17	6

PART NUMBER	FIG. & INDEX	QTY PER ASSY
2474	39-08	3
	39-28	3
		15*
2475	30-36	2
24767	31-11	6
24768	31-12	6
24769	31-07	6
24770	31-08	1
24804	31-17	2
24805	32-09	1
24806	32-10	1
24841	35-	4
24878	30-28	2
24879	30-27	1
2500	38-23	1
2501	31-18	2
25042	38-05	1
2506	38-19	6
25117	31-23	2
25127	31-22	1
25127-A1	31-	1
25142	35-11	1
25145	36-31	2
25164	30-29	2
25276	32-11	1
25305	36-19	1
25306	40-	1
25314	36-08	1
25315	36-09	1
25316	36-10	1
25317	36-11	1
25318	36-12	1
25329	30-11	4
	30-20	2
		6*
25330	30-12	2
25331	30-13	8
25361	30-14	2
25369	31-15	1
25376	32-31	4
25387	36-22	4
2555	35-06	4
2557	37-03	2
2560	35-08	4
	40-06	2
		6*
2561	30-35	1
	32-04	16
	39-10	3
	39-30	3
		23*
2840	39-32	1
2848	39-12	1
2849	39-11	1
	39-31	1
		2*
2958	32-02	16
	30-38	2
		18*
3506	33-27	1

PART NUMBER	FIG. & INDEX	QTY PER ASSY
3513	35-03	1
	36-	1
		2*
3562	33-20	1
3577	34-01	1
3585	37-11	2
35897	31-13	8
35923	37-29	1
35956	31-09	1
36067	35-05	1
	36-02	1
		2*
36151-N	37-09	16
3628	37-20	1
3745	38-14	1
3875	39-05	1
3883	39-07	1
	39-27	1
		2*
3991	31-10	1
	38-15	1
		2*
401506	36-04	4
401806	37-05	4
401885	32-07	2
401963	32-08	2
402127	30-15	8
40237	30-18	2
402711	37-24	4
40577	31-19	1
40584	38-01	1
	40-07	1
		2*
40585	40-03	1
40599	37-30	1
40731	31-19	1
40731-A1	31-	4
40762	32-27	1
40794	36-20	1
4546	38-01	1
4577	33-01	1
4602	37-12	2
4732	39-23	1
4780-A1	37-	1
500278	35-01	2
500398	31-03	1
500400	31-04	1
50327-A1	30-	1
50406	35-04	1
50406-A1	35-	1
520112	32-05	2
530019	30-44	1
530058	30-18	2
530144	31-20	2
530145	31-21	1
530162	32-26	1
530163	38-08	4
530196	31-	1

PART NUMBER	FIG. & INDEX	QTY PER ASSY
530199	31-	1
530208	39-39	2
530209	36-03	1
530213	31-16	2
530225	36-	1
530641	33-25	1
530828	31-23	2
530856	31-	1
530857	31-22	1
530928	38-07	4
530940	38-06	1
531116	36-28	2
533399	38-04	1
533546	40-	1
535091	32-29	6
535324	36-01	2
536388-1.25	38-13	16

PART NUMBER	FIG. & INDEX	QTY PER ASSY
537870	38-02	8
539840	38-12	8
626972-4	33-19	1
627002	36-21	4
627275	30-20	2
627361	37-	1
627365	37-20	1
627386-A1	30-	1
627386-A2	30-	1
627667	36-	1
627667-A1	36-	1
627668	36-	1
630651	31-02	1
631706	33-09	1
632085	33-16	1
633141	30-19	4
633398	30-18	2
633399	30-18	2

SECTION 15

OVERSIZE AND UNDERSIZE PARTS

PART NO.	NAME	DESCRIPTION
20001P003	Stud	.003" OS on PD
20001P006	Stud	.006" OS on PD
20001P009	Stud	.009" OS on PD
20990P003	Stud	.003" OS on PD
20990P006	Stud	.006" OS on PD
20990P009	Stud	.009" OS on PD
21075P003	Stud	.003" OS on PD
21075P006	Stud	.006" OS on PD
21075P009	Stud	.009" OS on PD
21153P005	Shaft	.005" OS on OD
21419P005	Guide	.005" OS on OD
21419P010	Guide	.010" OS on OD
21419P020	Guide	.020" OS on OD
22006P003	Stud	.003" OS on PD
22006P006	Stud	.006" OS on PD
22006P009	Stud	.009" OS on PD
22386P005	Dowel	.005" OS on OD
22423P003	Stud	.003" OS on PD
22423P006	Stud	.006" OS on PD
22423P009	Stud	.009" OS on PD
23030P003	Stud	.003" OS on PD
23030P006	Stud	.006" OS on PD
23030P009	Stud	.009" OS on PD
23297P003	Stud	.003" OS on PD
23297P006	Stud	.006" OS on PD
23297P009	Stud	.009" OS on PD
2465P003	Stud	.003" OS on PD
2465P006	Stud	.006" OS on PD
2465P009	Stud	.009" OS on PD
24805P002	Insert	.002" OS on OD
24805P010	Insert	.010" OS on OD
24805P020	Insert	.020" OS on OD
24805P030	Insert	.030" OS on OD
24806P002	Insert	.002" OS on OD
24806P010	Insert	.010" OS on OD
24806P020	Insert	.020" OS on OD
24806P030	Insert	.030" OS on OD
25127P005	Piston Pin	.005" OS on OD
25276P005	Guide	.005" OS on OD
25276P010	Guide	.010" OS on OD
25276P020	Guide	.020" OS on OD
25329P003	Stud	.003" OS on PD
25329P006	Stud	.006" OS on PD
25329P009	Stud	.009" OS on PD
25330P003	Stud	.003" OS on PD
25330P006	Stud	.006" OS on PD
25330P009	Stud	.009" OS on PD
25331P003	Stud	.003" OS on PD
25331P006	Stud	.006" OS on PD
25331P009	Stud	.009" OS on PD
25361P003	Stud	.003" OS on PD
25361P006	Stud	.006" OS on PD
25361P009	Stud	.009" OS on PD
35897M010	Bearing C/Rod	.010" US on ID
633398M010	Bearing C/Shaft	.010" US on ID
633399M010	Bearing C/Shaft	.010" US on ID
401806P003	Stud	.003" OS on PD
401806P007	Stud	.007" OS on PD
401806P012	Stud	.012" OS on PD
401885P003	Stud	.003" OS on PD
401885P007	Stud	.007" OS on PD
401885P012	Stud	.012" OS on PD
401963P003	Stud	.003" OS on PD
401963P007	Stud	.007" OS on PD
401963P012	Stud	.012" OS on PD
402127P003	Stud	.003" OS on PD
402127P007	Stud	.007" OS on PD
402127P012	Stud	.012" OS on PD
40237M010	Bearing C/Shaft	.010" US on ID
402711P003	Stud	.003" OS on PD
402711P007	Stud	.007" OS on PD
402711P012	Stud	.012" OS on PD
40577P015	Piston	.015" OS on OD
40584P020	Camshaft	.020" OS on OD
40731P015	Piston	.015" OS on OD
4546P020	Camshaft	.020" OS on OD
530058M010	Bearing C/Shaft	.010" US on ID

OVERSIZE & UNDERSIZE PARTS (Continued)

PART NO.	NAME	DESCRIPTION	PART NO.	NAME	DESCRIPTION
530144P005	Ring	.005" OS on OD	530856P005	Piston Pin Assy	.005" OS on OD
530144P015	Ring	.015" OS on OD	530857P005	Piston Pin	.005" OS on OD
530145P005	Ring	.005" OS on OD			
530145P015	Ring	.015" OS on OD	630651P005	Dowel	.005" OS on OD

GASKET SETS

PART NO.	DESCRIPTION	SIZE	CODE
20705-1	Gasket Paste - Tite Seal, Lightweight	1 oz. tube	AB
B3973	Gasket - Complete Overhaul	Standard	A
530144-A1	Ring Set - Complete Engine	Standard	AB
530144-A1P005	Ring Set - Complete Engine	.005" OS on OD	AB
530144-A1P015	Ring Set - Complete Engine	.015" OS on OD	AB
40237-A1	Bearing Set - Crankshaft	Standard	AB
40237-A1M010	Bearing Set - Crankshaft	.010" US on ID	AB
530058-A1	Bearing Set - Crankshaft	Standard	AB
530058-A1M010	Bearing Set - Crankshaft	.010" US on ID	AB
626531-1	Enamel - Gold, Engine	1 Quart	AB
626531-2	Enamel - Gold, Engine	1 Gallon	AB
535011	Lockwire - .040 in dia. steel	Order by the foot	AB

SECTION 16

STROMBERG CARBURETOR TYPE NAS3A1

SERVICE INSTRUCTIONS

a. Installation.

(1) The carburetor should be so mounted on the engine that the float chamber is at the side of the throttle barrel, preferably with the fuel inlet to the rear. With the carburetor in this position, the throttle lever, which is adjustable to any radial position, is at the right side of the carburetor as viewed from the rear of the engine. The mixture control lever is located on top of the float chamber on the right hand side. The fuel inlet is a 1/4" pipe tap connection located at the back near the bottom of the main body if the carburetor is installed as above. When the fuel level is set at the factory, a pressure of one-half pound per square inch at the carburetor is used. As these carburetors will undoubtedly be used on engines having a gravity feed system, it is recommended that the tanks be located so that the minimum head of fuel at the carburetor inlet is nineteen (19) inches under all normal conditions of flight.

b. Starting.

(1) As these carburetors are not equipped with a priming device, the following procedure is recommended for starting. With the mixture control in the full rich postion and the throttle closed the engine should be turned over two or three times before the ignition is turned on. This will draw fuel up through the idle system and then if the ignition is turned on the engine will usually start on the next turn over. As soon as the engine starts to fire it is usually necessary to open the throttle slightly to keep the engine running and to warm it up sufficiently for normal operation.

c. Adjustment.

(1) The main metering jet used in the carburetor is of the fixed orifice type, and its size as well as the remainder of the carburetor specifications has been determined by test work as previously mentioned, so that no adjustment for cruising and full throttle speeds is required except at altitude when the mixture control may be used to obtain best power. An idle adjustment is provided to take care of slight production variations in the carburetors and engines. The small knurled screw on the throttle valve body, may be adjusted to control the richness of the mixture at idling speeds. Turning this screw in a clockwise direction closes off the passage leading to the upper idle discharge hole and leans out the idle mixture Turning in the opposite direction of course gives a richer mixture. A throttle stop is provided on the throttle shaft next to the throttle control lever which should be adjusted to obtain the desired idling speed. Both the throttle stop and the idle adjustment should be set with the engine hot to obtain the proper idling speed and smooth operation.

d. Servicing.

(1) Once the carburetor is properly installed and the idle adjustment made, very little attention is required in service. A fuel strainer is provided near the fuel inlet of the carburetor, and may be removed by the removal of the large hexagon head plug on the side of the float chamber. A small square head plug is provided as a drain in the bottom of the carburetor. The strainer and drain plug should be removed frequently to get rid of any dirt or water which may have accumulated in the strainer chamber or the float chamber. The entire carburetor should also be inspected to see that all parts are tight and properly safety wired.

e. Description and Functioning of Carburetors.

(1) FLOAT MECHANISM: A conventional hinge type of float mechanism located in a float chamber having ample fuel capacity to operate in all ordinary maneuvers is used. This float mechanism is adjusted at the factory to obtain the proper fuel level, and requires no adjustment in service unless it is necessary after a long period of service to install new parts. For information concerning the proper level see the section of these instruction pertaining to "Overhaul."

(2) MAIN METERING SYSTEM: The metering system used in the carburetor is of the plain tube type with an air bleed to the main discharge nozzle. The main discharge nozzle is located at the center of the venturi and is screwed into a boss projecting into the air intake. The main air bleeder is screwed into the air bleed arm which is held in place by the main discharge nozzle. The actual metering of the fuel is accomplished by the main metering jet which is assembled in the bottom of the float chamber in a channel through which the gas flows to the main discharge nozzle. The size of the main metering jet affects the fuel consumption at all speeds from approximately 1000 RPM to full throttle speed.

(3) MIXTURE CONTROL: The altitude or mixture control is of the back suction type which may be used to lean out the mixture by placing a portion of the venturi suction on the fuel in the float chamber so that it opposes the suction in the venturi on the main discharge nozzle. This control consists of a venturi suction channel from above the mixture control plates to the throttle bore at the upper edge of the venturi, a manually operated valve, and the necessary passages to the float chamber and venting system. The valve consists of a lower and upper valve plate, the former fastened in place and the latter free to move. When the control is in the full rich position, holes in both the upper and lower plates mate and air is allowed to

flow through the plates from the space behind the venturi. As the mixture control is moved from the full rich position to the full lean position, a series of progressively smaller holes open up over the hole in the lower plate, thereby restricting the flow of air from the the vent space behind the venturi and increasing the suction on top of the fuel in the float chamber and a leaner mixture is the result.

(4) IDLING SYSTEM: Inasmuch as the main metering system will not function at very low air flows (low engine speed), an idling system is provided. This consists of an idle tube with an idle metering orifice in the bottom and several air bleed holes in the wall, an idle air bleed, and two holes in the throttle barrel, which act as idle discharge nozzles. A needle valve type of adjustment is provided on the upper discharge nozzle, which regulates the quality of the idle mixture. Fuel for the idle system is taken from the annular space around the main discharge nozzle, passes through the idle metering jet and mixes with the air from the idle air bleed located in the main body behind the venturi. The air enters the tube through the bleed holes and the mixture then passes out of the upper or lower idle discharge hole. The relative quanities passing through the upper and lower idle hole depends upon the position of the throttle. At extreme idle, all the fuel passes through the upper hole and as the throttle opening is increased, more and more of it passes through the lower hole. The idle system operates up to an engine speed of approximately 900 to 1000 RPM.

f. Overhaul

(1) DISASSEMBLY: The carburetor should be disassembled for cleaning and inspection each time the engine is given an overhaul. After the carburetor has been removed from the engine and the hot spot and air intake or heater taken off, the halves of the carburetors may be separated by the removal of the fillister head screws at the parting surface. The venturi is held in the lower half by a hexagon head screw.

Remove the set screw which holds the float fulcrum pin in place and the plug at the side of the carburetor which will permit the removal of the float fulcrum pin. The float and the float needle valve will then come out and it will be possible to remove the main metering jet, which is located below the float. Remove the idle tube which is screwed into the main body. If there is any indication of dirt or foreign matter in the float chamber, it is advisable to remove the main discharge nozzle. The mixture control may be disassembled by removing the two fillister head screws holding the cover to the throttle body. The removal of the above parts will permit a thorough inspection and cleaning of the carburetor, and unless replacements are necessary, further disassembly is not recommended.

(2) INSPECTION AND CLEANING: The bodies and all parts should be thorougly cleaned in gasoline, and all passages blown out with an air hose.

The float needle valve and seat should be inspected and if either part is worn both parts should be replaced as it is very difficult to fit a new needle to an old seat or a new seat to an old needle. The needle valve is made of stainless steel and the seat of naval brass so that under ordinary service these parts should last for many hundreds of hours. Check the main metering jet and float needle seat to make sure they are tight. It is important that the throttle valve fits in the barrel tightly when in the closed position and that the lower edge be flush with the top of the lower idle hole. If it was found necessary to replace either of the mixture control plates, they should be lapped in with a very fine lapping compound to eliminate any possibility of air leakage.

(3) REPLACEMENTS: If due to accident or wear after long service it is necessary to make replacements, the parts should be obtained for the Bendix Products Division, Stromberg Carburetor Section, South Bend, Indiana, or an authorized Stromberg aircraft carburetor service organization.

In ordering parts, be sure to state on what make and model engine the carburetor is being used as the sizes of some parts are different for different engines. Ordering by part numbers as shown in the service parts list and also giving the serial number of the carburetor will greatly facilitate service.

(4) REASSEMBLY: All headless screw plugs below the fuel level should be assembled with shellac, being careful not to get it on the end of the plug where it will come off and be carried by the fuel into one of the metering orifices. Headless screw plugs above the fuel level and all other threaded parts screwed into the bodies should have a compound of graphite and castor oil put on the threads.

The float level on these carburetors should be 13/32"below the parting surface and is dependent upon the thickness of the gasket under the needle valve seat. The level should be checked under the same conditions encountered in service as regards the fuel used and the fuel pressure or head at the carburetor. The levels are set at the factory with a pressure at the carburetor of one-half pound per sq. inch (19" gasoline at .710 Sp. Gr.), and this is recommended for setting the levels in the field. If, after fitting new parts, the level is not correct, remove the needle valve seat and put in thicker gaskets to lower the level and thinner gaskets to raise it. One-sixty-fourth inch change in gasket thickness will change the level approximately 5/64".

The mixture control lever should be correctly pinned to the stem so that when the stop is in the full rich position, the large hole in the upper plate lines up with the hole in the lower plate. The parts of the carburetor should be safety wired before installing on an engine.

SECTION 17

SCINTILLA MAGNETO
TYPES SF4RN-8 AND SF4LN-8
SERVICE INSTRUCTIONS

A. GENERAL

These new magnetos are characteristic of all Scintilla magnetos in principle and construction. The outstanding features incorporated are the new and powerful rotor and a coil of new design which increase their efficiency and ability to give dependable service for longer periods of time. Their general appearance is somewhat changed which is due mostly to the new feature incorporated for the distribution of the spark. In place of distributor blocks, separate terminals, which protrude from the main cover, are provided for the installation of the spark plug cables.

These magnetos are radio shielded and provision is made for attaching radio shielded cables. A screened ventilator on each side of the housing and one in the base insure adequate ventilation for the magneto.

B. INSTALLING AND TIMING TO THE ENGINE

Before installing the magneto, insure that is has been correctly timed and checked in accordance with the section entitled "Adjustment of the Breaker Contact Points." It is installed to the engine in the following manner:

(1) Set the piston of cylinder No. 1 at its firing position.

(2) Place the breaker in its full advance position (if variable spark magneto).

(3) Rotate the magneto drive shaft until the timing mark R on the chamfered tooth of gear, Fig. 41, and timing pointer P are opposite each other as seen through the timing window in the magneto cover. At this position the breaker contacts should begin to open.

(4) All adjustments for exact timing to the engine are made at the drive end and not by altering the position of the contact points. Insure that the mounting faces are clean and smooth. With the timing marks P and R (Fig. 41) opposite each other, install the magneto on the engine and secure with its mounting bolts. Exact timing is obtained by turning the magneto through the angle provided by the slots in the magneto flange. A convenient way of checking this adjustment is to place a strip of .0015" shim stock between the contact points and pull on it slightly. When the shim stock slips, the contact points are just opening. (Fig. 42.)

When the exact timing to the engine has been made, tighten and lock the mounting bolts and recheck the adjustment.

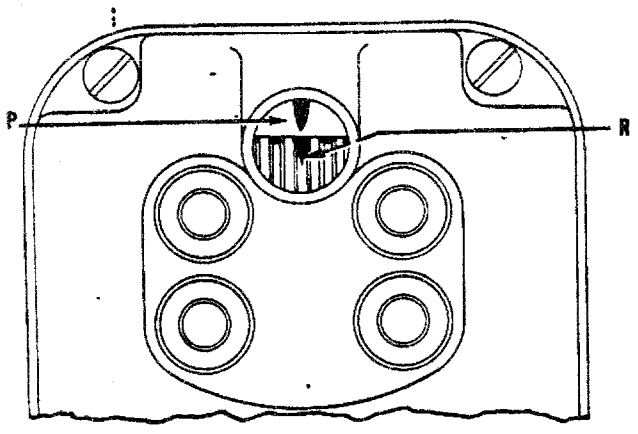


Figure 41. Showing Magneto Timing Marks.

C. INSTALLING THE CABLES

(1) The new type of individual high tension terminals for each cylinder used in these series magnetos eliminates the use of cable-piercing screws. It permits the use of a snap terminal clip on the cable end which can be quickly attached to or disconnected from the distributor terminals which protrude from the main cover. The cable outlets are water-tight and are separat-

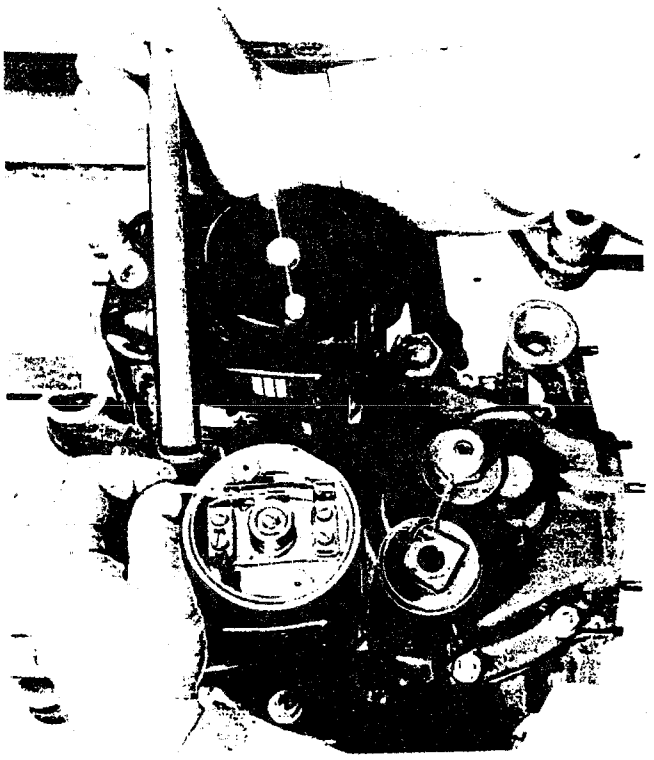


Figure 42. Timing Magneto.

ed sufficiently to prevent flashing between the cables.

The number discs adjacent to the high tension terminal bushing on the main cover indicate the serial firing order of the magneto and are not engine cylinder numbers.

Attach the high tension cables to the magneto as follows:

1. Slip the knurled nut, brown bakelite collar, and the rubber gland over the cable in the order named.
2. Strip the insulation from the cable end for about 1/4" and attach the terminal clip which is provided with the magneto. Insert the bare cable strands through the hole of the terminal clip and secure with a drop of solder.
3. Push the cable into the terminal with a steady and firm pressure until the crimped portion on the terminal clip snaps into the groove inside of the terminal. ALWAYS MAKE SURE that the cable is pushed all the way in. The terminal clip must snap into the groove.

After the cable is properly installed, tighten the knurled nut.

D. CARE IN OPERATION

The ball bearings of the magneto are packed in grease and require no lubrication except when the magneto is disassembled for overhaul. At such times the grease should be washed out and replaced with Keystone No. 44 grease or its equivalent.

At routine inspection intervals, take off the breaker cover by loosening the two securing screws and remove any excess oil. Thoroughly clean and dry the breaker mechanism to insure that oil will never touch the breaker contacts.

E. ADJUSTING THE BREAKER CONTACT POINTS

During major overhaul periods, at intervals which should not exceed 400 hours operating time, the contact points are adjusted in the following manner:

(1) Place the breaker in its full advance position (if variable spark magneto).

(2) Turn the drive shaft until the mark R (Fig. 41) on the chamfered tooth of the large distributor gear is opposite the timing pointer P inside the magneto cover as seen through the timing window. When these two marks are opposite each other, the breaker contacts should be just opening. A convenient way of checking this adjustment is to place a strip of .0015" shim stock between the contacts and pull against it slightly. When the shim slips, the contacts are separating.

(3) If the contacts do not open at the proper time, loosen the two screws, A and B (Fig. 43), which hold the adjustable contact assembly in place and move the adjustable contact assembly to right or left until the two contacts separate when the timing marks are opposite each other. It should be noted that the contact points are not adjusted for any fixed clearance between them.

(4) If the contacts do not line up properly, the location of the contact and cam follower assembly can be adjusted by loosening the two screws, C and D (Fig. 43) which secure the contact and cam follower assembl to the housing. The hole for screw D is slightly oversize to permit this adjustment. After retightening the screws, recheck this adjustment to insure that it is correct.

(5) Insure that the lubrication felt attached to the cam follower is soft and moist with oil. This felt supplies a very minute quantity of lubricant to the breaker cam. If oil appears on the surface when the felt is squeezed between the fingers, do not add any more oil. If the felt is dry, however, moisten with a few drops of medium bodied mineral lubricating oil, SAE 60 or equivalent. Do NOT give it all it will hold.

Before replacing the breaker, wip out any dirt or excess oil which may have entered into the breaker adjustment.

NOTE: On production magnetos now supplied, the breaker cam is staked in position on its shaft thereby eliminating the use of a cam key. The same cam is used for both clockwise and anti-clockwise magnetos, and therefore the directional arrow on the cam has been discontinued.

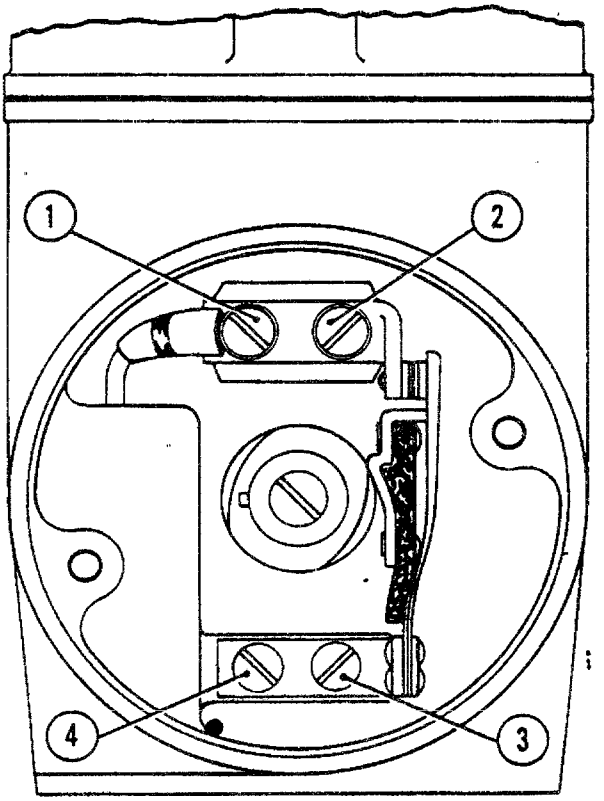


Figure 43. Breaker Mechanism.

SECTION 18

HYDRAULIC LIFTERS

SERVICE INSTRUCTIONS

THINGS TO BE REMEMBERED IN HANDLING

1. Plungers not interchangeable:
The plunger in the hydraulic unit is not interchangeable in the cylinder as tests are made after assembly for the rate of leak-down, which determines the quality of the unit rather than diametric clearances.

2. Plunger spring must be snapped in counterbore:
Anytime the plunger is removed from the bore and replaced, the plunger spring should be snapped into the counterbore of the hydraulic cylinder. This can readily be done by a slight twisting motion in the direction to wind up the coil of the spring.

3. No grinding or machining to be done on unit;
It is not advisable to do any kind of grinding or machining on the hydraulic untis. In cases where valves have been re-seated to a depth which would require increasing their mechanical clearance, the valve stems should be ground off to provide this clearance.

4. Shellac or gasket cement not to be used:
No shellac or gasket cement of any kind should be used at any point where it will be possible for it to get into the hydraulic lifters, as this will cause the check-ball to be glued to the seat and prevent operation.

ESSENTIALS OF OPERATION

1. Body free in guide:
The tappet body, itself, must be a free fit in the guide. A proper test for this is to insure that the tappet will drop of its own weight in the guide.

2. Check-ball must not leak:
The check-ball must not leak more than about one drop per second when filled with kerosene, and the plunger loaded with 50 lbs. pressure.

3. Check-ball travel must not be too great:
The check-ball should not have more than .014" travel. This is provided for in manufacturing and it would be very seldom the travel would exceed this amount.

4. Plunger must be free in bore:
The plunger must be a free fit in the hydraulic cylinder and, at the same time, the leakdown rate must be right. The production limit is 1/4" travel with 50 lbs. load in not less than four seconds when unit is filled with kerosene.
Fixtures are available for service inspection which compare a unit to be tested with a master unit. As there are a number of these fixtures, the method of testing is not given here, therefore reference should be made to the instructions provided with each fixture.

5. Lifters must have proper mechanical clearance:
The mechanical clearance should be checked each time installation is made. This check should be made without oil in the unit.

6. Proper oil supply must be maintained:
Oil must be supplied to the hydraulic lifters with at least three or four pounds of pressure at idle and twenty pounds of pressure at high speeds; and the maximum oil pressure should not exceed fifty-five pounds for any great period of time, as excessive oil pressure can cause the entire hydraulic unit to pump up and down in the body, preventing compensation, resulting in noise.

HANDLING

The usual handling will be: Removal for valve grind or some other repair or replacement, in which case it is only necessary to wash-up the hydraulic lifters, removing the plunger from the hydraulic cylinders one at a time to prevent interchanging, washing them thoroughly in clean gasoline, kerosene, or any cleaning solution used for other parts and replacing them in the engine without any attempt being made to fill them with oil before assembly. After assembly, check clearance using a screwdriver to pry the plunger down. With valve in closed position, measure the clearance between the end of the plunger and the valve stem. Running the engine, the units should quiet themselves usually within forty-five minutes in a horizontal engine. The time required for any given unit to quiet is not indicative of the quality but means only that the particular unit has a larger amount of air to dispose of.
The engine should be run at the lowest speed which produces maximum oil pressure, until all lifters have become quiet.
It often happens that when a hydraulic unit is operated in an engine for a considerable length of time, carbon may form on the inside of the cylinder above travel of the plunger during normal operation. If this this takes place, the plunger will appear to be stuck in the cylinder. The following is the condition which actually occurs in this case:
Removal of the valve stem from the top of the plunger allows the plunger to move upwards and the hydraulic unit completely fills with oil. The carbon which has formed on the inside of cylinder above the shoulder on the plunger makes removal of the plunger very difficult and, since the unit has filled with oil, the plunger cannot be forced down because the oil is trapped by the check ball. This gives the impression of a stuck unit and, in order to free the plunger, the following can be applied:
Press the plunger all the way down while holding the check valve off its seat with a matchstick or other blunt instrument. This will allow the oil to escape and permit the unit to be checked with the leakdown tester.

In most cases the carbon which has formed above the plunger can usually be broken by twisting the plunger and pulling outward at the same time. In case the carbon buildup is quite great and cannot be removed easily, it is advisable to place the unit in a solution which will dissolve the carbon ring. Once the plunger has been removed any carbon remaining on the cylinder should be cleaned off with a rough rag. The cylinder and the plunger should then be washed thoroughly before reassembling.

In replacing the plunger into the cylinder, give it a twist, while it is fully depressed; this will cause the end of the spring to snap into its seat.

TYPES OF FAILURE

With respect to failure of hydraulic lifters, there are four general classifications:

1. Where very slight single or multiple noise is heard.
2. Where a single noise will be heard.
3. Where there is a general noise in the entire set.
4. Intermittent or general noise in any particular section of the engine.

1. Slight Noise:

In the case of item 1, there is a variety of things other than the hydraulic lifter which can cause the trouble; such as, excessive clearance between the valve stem and the guide, eccentricity of the valve seat or anything which can cause the valve to contact the seat in closing at a point materially above the point where the valve sets on the seat.

In cases where this type of noise is made by the unit itself, it is due either to a leaky check valve or a plunger having too much clearance in the bore.

2. Loud Noise:

With reference to item 2 where single loud noise is heard in the valve gear: It is generally found that for reason a hydraulic plunger has become sticky or tight in the bore to such an extent that the plunger spring will not move the plunger in the bore. This results in the plunger being forced all the way down so that the bottom of the plunger contacts the ball cage and the tappet clearance is approximately 1/16".

The particular tappet causing the trouble can be located in the following manner: By using some kind of a listening rod and comparing the noise in each cylinder, it can readily be determined which cylinder the noisy tappet is in. Very often by listening directly over the exhaust or the intake, the individual tappet can be determined before disassembly. In any case, removal of these two tappets and examination will disclose which one has been sticking.

It will be found that the seating of the valve where a hydraulic unit is stuck produces a very perceptible shock to the valve spring at the instant of seating. This can readily be determined by either touch or sound. One readily accessible method is to push the end of a hammer handle against the valve spring keeper. If the tappet is noisy, a decided shock will be felt at the instant of closing. Whereas when the lifter is working properly there will be almost no shock felt. Once this comparison is made, there will be no question about its finality thereafter.

If it is found that one unit has a tendency to stick due to oil varnish, it is very likely that all units may need immediate attention to prevent a recurrence of sticking.

3. General Noise:

In cases of general noise in the entire set (item 3), it is a definite indication that insufficient oil is being delivered to the hydraulic units. As a general rule, in cases where engines run out of oil the hydraulic units will provide a warning before serious damage is done as air will periodically be taken into the intake side of the pump as soon as the level is very low. This, however, is not recommended as a means for determining when oil is needed in the engine. In any case where general noise is observed, it is advisable to determine oil pressures at the hydraulic lifters.

4. Intermittent or General Noise:

In the case of item 4, the general or intermittent noise in any particular section of the engine is usually an indication that air separation is inadequate at this point. This type of noise will usually occur when the engine is brought down to idle from high speed, or possibly in some cases on starting. This is usaully a question of design and is not often encountered in the field.

However, there have been some examples of individual engines where some air-leak occurred on the intake side of the oil pump, providing excessive aeration, so that the air separation provided in the job may not be adequate—either for all or part of the engine. In anycase, if this trouble should be found, the inlet side of the pump should first be examined for air leaks—particularly as excessive aeration is apt to cause trouble in bearings or other parts of the engine. If no air leak is found, any arrangement which will increase the capacity for air separation may remedy the trouble.

In some cases it has been found that the valves were definitely being held open, causing defective performance; but this has been found to be something other than the hydraulic lifters themselves—generally a camshaft with sufficient runout on the base circle of the cams to crack the valves off the seat when they should be closed. The maximum allowable runout on the base circle of a cam used with hydraulic lifters is .002" total indicator reading. It is not likely that many cases of this condition would be found.

5. To Summarize:

Noisy operation of hydraulic lifters is likely to result from inadequate oil supply, dirt, or air in the oil, etc., as outlined above and usually is not caused by any structural failure of the hydraulic unit itself.

Remember that no adjustment is necessary or possible on hydraulic lifters and that they are designed as a sturdy part of the engine to give long and trouble-free service---provided they are correctly handled and provided they are supplied with clean oil at the correct pressure. Therefore, it is advisable to leave them alone unless noisy operation is due to one of the causes mentioned above.