FOR OFFICIAL USE ONLY

AN 02-15BA-2

SERVICE INSTRUCTIONS

O-435-1

AIRCRAFT ENGINES

This Handbook replaces T. O. No. 02-15BA-2 dated 1 January 1943.

This reissue replaces all pages of the above mentioned publication. Place this reissue in the existing pressed board binder.

Published under joint authority of the Commanding General, Army Air Forces, the Chief of the Bureau of Aeronautics, and the Air Council of the United Kingdom.

PROCESS LITHO. DETROIT, MICH. 11-22-44 11,600

10 NOVEMBER 1944

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General.

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LIST OF REVISED PAGES ISSUED

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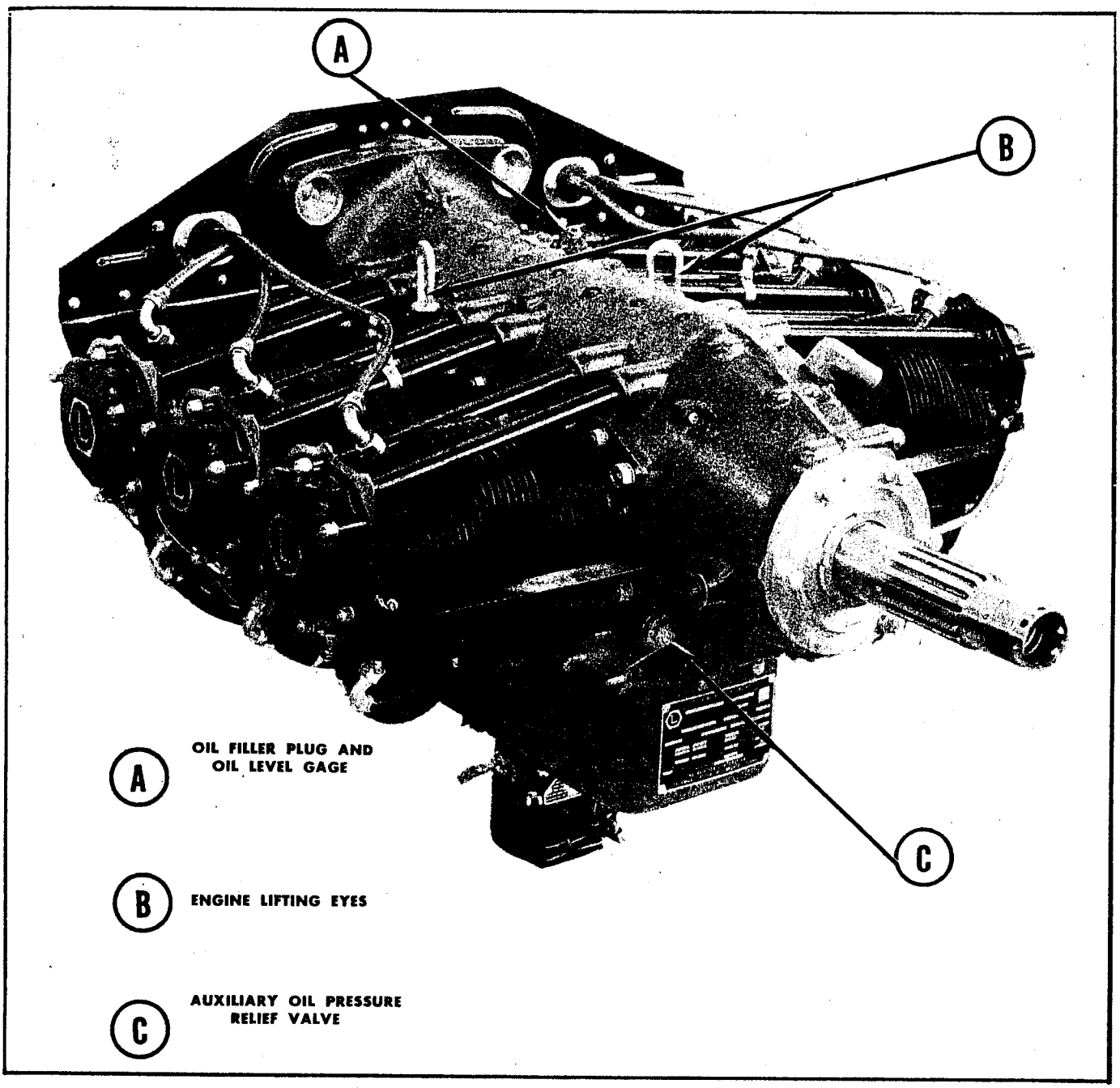


Figure 1. Three-quarter Front View, Model 0-435-1 Engine

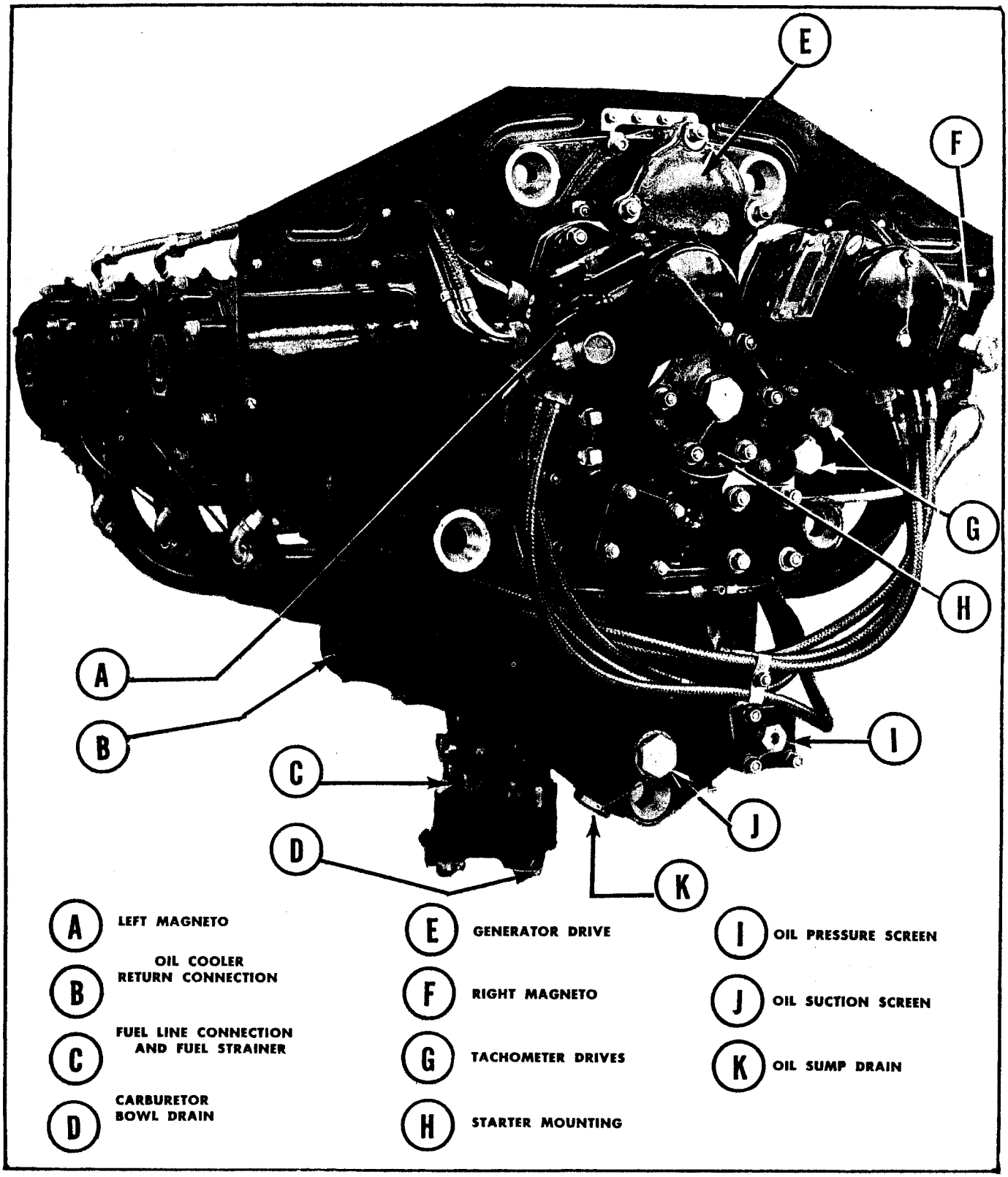


Figure 2. Three-quarter Rear View, Model 0-435-1 Engine

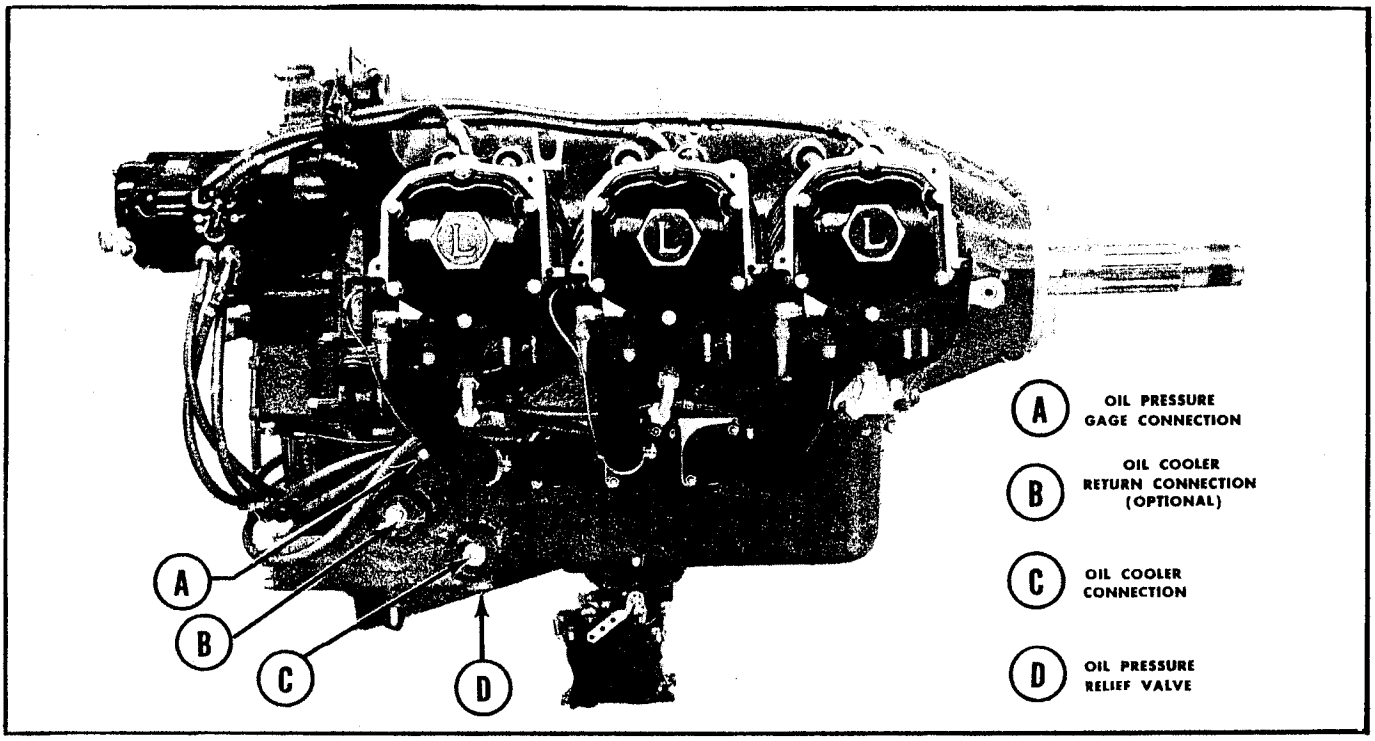


Figure 3. Right Side View, Model O-435-1 Engine

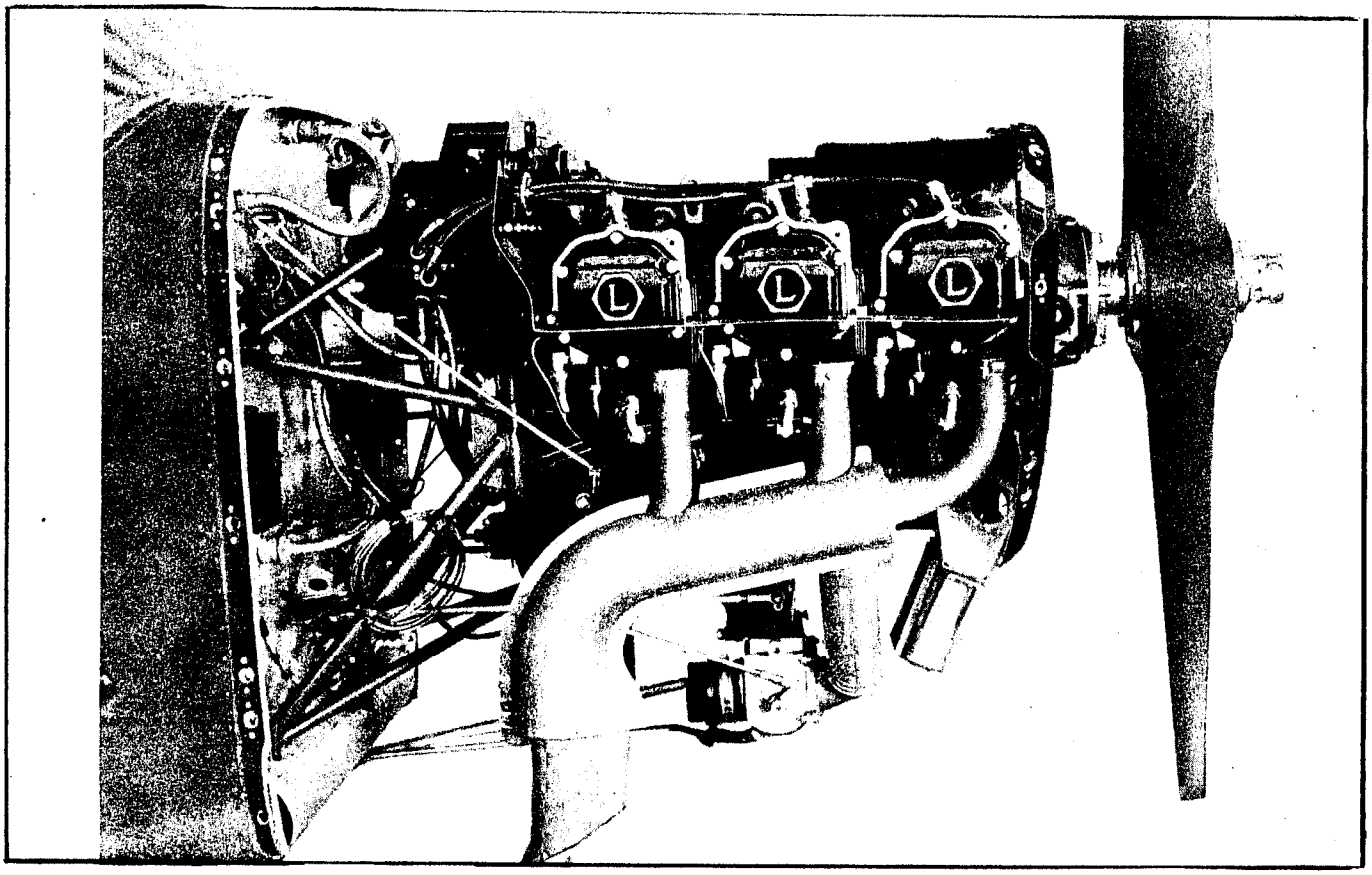


Figure 4. Typical Installation

SECTION I
INTRODUCTION

1. This Publication comprises the Service Instructions for the Model 0-435-1 Engine manufactured by Lycoming Division, The Aviation Corporation, Williamsport, Pennsylvania.

2. In this Handbook the following definitions will be used:

a. The propeller end of the engine will be considered the front of the engine, and the antipropeller end will be considered the rear of the engine.

b. The terms right and left, and the direction of crankshaft rotation are used as viewing the engine from the antipropeller end of the engine and looking toward the propeller end.

c. All directions of rotation of drives will be the direction of rotation observed when facing the drive.

d. The cylinders are numbered from front to rear. The front cylinder on the right bank is cylinder No. 1, and the remaining cylinders on the right bank have odd numbers. The front cylinder on the left bank is No. 2, and the remaining cylinders on the left bank have even numbers. *(See figure 8.)*

3. Clearances and limits to be followed in servicing 0-435-1 engines will be found in AN 02-15-1, Table of Limits.

4. The tools necessary for accomplishing the work outlined in this Handbook are listed in section VIII of this Handbook.

5. Specification numbers, as listed in this Handbook, are basic numbers and will be interpreted to include all revisions and amendments thereto.

SECTION II
GENERAL DESCRIPTION

1. GENERAL.

The model 0-435-1, 6-cylinder, horizontally opposed, air-cooled engine has a piston displacement of 434 cubic inches, the bore is 4-7/8 inches, and the stroke is 3-7/8 inches. Cylinders are arranged three on each side, and each connecting rod operates on a separate throw of the crankshaft. Thus the cylinders are not exactly opposite each other, but are staggered. The cylinders are numbered from the front to the rear. *(See figure 8.)*

2. CYLINDER.

The alumninum-alloy cylinder head is screwed and shrunk onto the steel cylinder barrel. A single rocker box is employed to house both valve rockers. The valve guides and valve seats are shrunk onto the cylinder head with the valve guides parallel to the cylinder bore. Both rocker arms operate on a single full floating shaft, supported by three bosses on the cylinder head and retained at the ends by the rocker box cover.

3. VALVE OPERATING MECHANISM.

The camshaft operates in aluminum bearings parallel to and above the crankshaft main bearings. Thus the push rods are on the upper side of the cylinder. The camshaft has nine lobes and is supported by four bearings. The valves are actuated through mushroom-type hydraulic tappets which automatically keep the valve clearance at zero. Push rods are hollow and carry oil from the tappet to the valve rocker. The valve rocker operates on a plain bronze bushing; a ball socket is machined in one end of the valve rocker, and no valve clearance adjusting screw is used. The valve has two springs which bear against the upper and lower steel spring seats. The upper spring seat is retained on the valve stem by means of tapered split keys.

4. CRANKSHAFT.

The crankshaft is made from an alloy steel forging, and incorporates six throws and crankpins, and four main bearing journels. The propeller end of the crankshaft is No. 20 spline, and a shoulder is provided to retain the ball thrust bearing. The crankshaft has drilled holes to form oil passages. Centrifugal-type sludge removers are provided in the form of oil tubes at each main bearing journal and each crankpin journal. These tubes are designed to be removed at overhaul in order to clean out accumulated sludge.

5. CRANKCASE.

The crankcase assembly consists of two ribbed aluminum castings divided vertically at the center line of the engine and fastened together by means of studs and nuts. No gasket is used between the mating

surfaces of the crankcase. Bosses are provided for the four precision-type, steel-backed, copper-lead main bearings; the crankcase itself forms the bearings for the camshaft and also for several accessory drive gears. The oil sump is cast aluminum alloy and has a maximum capacity of 12 quarts. The sump casting also forms part of the induction system and incorporates the carburetor mounting pad.

6. CONNECTING RODS.

Connecting rods are "H" section steel forgings, with replaceable precision-type bearing inserts at the crankshaft end, and a split-type bronze bushing at the piston pin end. The bearing cap at the crankshaft end is retained by means of two bolts.

7. PISTON AND PISTON PIN.

The pistons are aluminum alloy; general construction is of the slipper type. Grooves are provided for two compression rings and one oil scraper compression ring above the piston pin, and one oil scraper ring below the piston pin. The piston pin is of the full-floating type and an aluminum-alloy plug is inserted in each end.

8. ACCESSORY HOUSING AND ACCESSORY DRIVE GEARS.

The accessory housing is an aluminum-alloy casting fastened to the rear end of the main crankcase assembly by means of studs and nuts. The accessory housing itself forms the bearing for most of the accessory drives. The gears are of the spur-type with conventional drives provided for two tachometers and starter. The magneto and generator drives are assembled by securing the drive gear to the accessory, and mounting the accessory on the standard pad provided in the accessory housing; the gear on the accessory meshes with the proper gear inside the accessory housing. *(See figure 5.)*

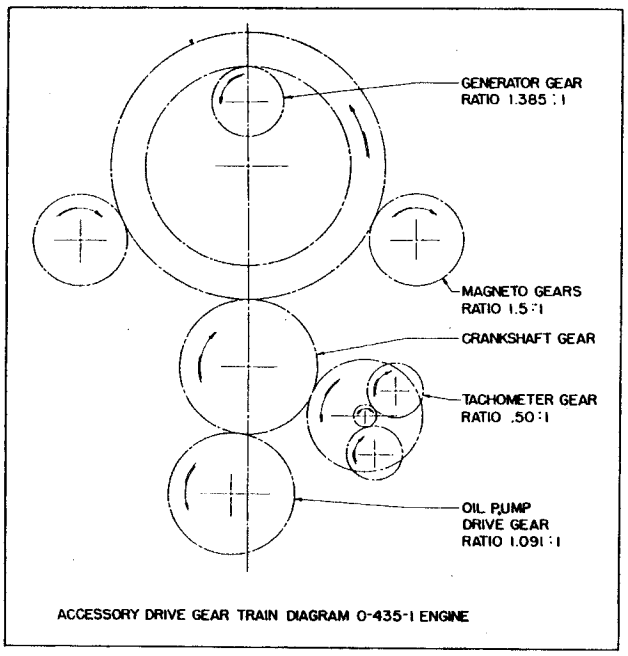


Figure 5. Gear Train Diagram

9. COOLING SYSTEM.

The engine is designed to be cooled by pressure built up by forward speed of the airplane. Baffles are provided in the front and rear of the engine and between the cylinders. The airplane in flight builds up a pressure in the area between cowling and the top of the engine, thus forcing the cool air downward through the cylinder fins. The air is then exhausted through one or more gills, located at the rear of engine cowling.

10. LUBRICATING SYSTEM.

a. The lubrication is of the pressure wet-sump type. The main bearings, connecting rod crankshaft bearings, accessory drive bearings, camshaft bearings, valve tappets, and push rods are lubricated by positive pressure. The piston pin, gear teeth, cylinder walls, and other parts not mentioned as receiving pressure lubrication are lubricated by spray.

b. The oil pump is mounted in the accessory drive housing and draws oil from the oil sump through the suction strainer and forces it through a drilled passage into the pressure oil screen, which is located in the pressure chamber at the lower right rear of the oil sump. The relief valve is located in front of the oil pressure screen chamber. The relief oil flows through the oil cooler and returns to sump. The pressure oil from the oil pressure screen chamber flows through three separate passages. The three passages are the main supply passage, the accessory passage, and the cam and valve gear feed passages.

(1) The main supply passage is a drilled passage on the right side of the main crankcase. An auxiliary oil pressure relief valve is mounted at the front end of this passage. This relief valve opens at considerably higher pressure than the main oil pressure relief valve and serves as a safety valve to prevent flooding the engine with oil if stoppage should occur in the main oil pressure relief valve. Extending from the main supply passage are drilled passages to each main bearing. These passages register with holes in the main bearing journals and deliver oil into the interior of the crankshaft. The connecting rod bearings and journals each receive pressure oil through passages drilled in the crankshaft.

(2) The accessory supply passage is a drilled passage leading directly from the pressure strainer and extending through the rear of the oil sump and through the accessory housing to each accessory drive bearing.

(3) Oil from the main supply passage flows to the two cam and valve gear passages, one running the length of each half of the crankcase. From these passages oil is conducted through branch passages to the tappets and to camshaft bearings. Oil enters the

tappets through indexing holes and travels out to the valve mechanism through the hollow push rods, lubricating the valve rocker bearings and valve stems. Oil drains from the rocker boxes through the drain tubes connecting the rocker box with the sump.

11. FUEL SYSTEM.

The engine is provided with one single-barrel, float-type Marvel MA-4SPA carburetor. The induction system consists of a riser cast integral with the oil sump; thus the oil heats this riser and improves fuel vaporization. Connections are provided at the sides of the oil sump for six intake pipes which conduct the mixture to the cylinders.

12. IGNITION SYSTEM.

Ignition is furnished by two Bendix-Scintilla SF6LN-8 shielded-type magnetos. The high-tension ignition current is conducted to the spark plugs by means of a Breeze shielded ignition harness. Ignition wiring is arranged so that each magneto fires the top plugs in three cylinders and the bottom plugs in the opposite three cylinders. This arrangement gives more consistent drop off when switching from both magnetos to either the right or left magneto. *(See figure 8.)*

SECTION III
TABLE OF SPECIFICATIONS

GENERAL

Model	0-435-1
Type	Horizontally opposed
Number of cylinders	6
Bore	4.875 in.
Stroke	3.875 in.
Piston displacement in cubic inches	434
Compression ratio	6.50:1
Rated speed	2550 rpm
Rated brake horsepower and rpm at sea level	185 hp at 2550 rpm
Direction of rotation of crankshaft, looking from the antipropeller end of engine	Clockwise
Propeller shaft spline size	No. 20
Diameter of mounting bolt circle	See Lycoming Installation Drawing No. 65207
Number of mounting bolts	5
Size of mounting bolts	0.50 in.
Average weight of engine	365.57 lb
Over-all height of engine	27.09 in.
Over-all width of engine	32.32 in.
Over-all length of engine	45.09 in.
Position of center of gravity:	
Distance from front face of thrust nut to center of gravity of engine	17.75 in.
Distance below center line of crankshaft	0.50 in.

IGNITION

Magneto type	Bendix-Scintilla type SF6LN-8
Direction of rotation of magneto drive looking at the drive	Clockwise
Magneto speed, in multiples of crankshaft speed	1.50
Spark occurs in degrees before top center:	
Right magneto	15°
Left magneto	15°

VALVES AND TIMING

Intake opens, in degrees before top center	20°
Intake closes, in degrees after bottom center	65°
Exhaust opens, in degrees before bottom center	65°
Exhaust closes, in degrees after top center	20°
Intake remains open, in crankshaft degrees	265°
Exhaust remains open, in crankshaft degrees	265°
Valve rocker clearance (hydraulic tappets collapsed)	.038 to .080 in.

FUEL SYSTEM

Carburetor	Marvel-Schebler type MA-4SPA
Grade of fuel required in flight, AN Specification	AN-F-23 (grade 73)

LUBRICATION SYSTEM

Grade of oil required in flight, AN Specification	
Summer	AN-VV-O-446 (grade 1100)
Winter	AN-VV-O-446 (grade 1080)
Minimum safe quantity of oil in whole system	6 qt
Normal oil level	10 qt
Maximum oil level	12 qt
Speed of oil pump, in multiples of crankshaft speed	1.091

ACCESSORY DRIVES AND INSTRUMENT CONNECTIONS

Oil pressure (thread)	0.125 taper pipe thread
*Fuel pump flange and drive	AN-9519
*Fuel pump speed, in multiples of crankshaft speed	1.000
*Fuel pump direction of rotation	Clockwise
Starter type	Eclipse, type 397, model 54
Starter flange and drive	6 bolt, 4.0 bolt circle, 12 tooth jaw
Starter direction of rotation	Clockwise
Generator type	Model 8, Eclipse 307
Generator direction of rotation	Counterclockwise

Generator drive speed, in multiples of crankshaft speed	1.385
Tachometer drive shaft	AN-9533, type 1
Tachometer drive speed, in multiples of crankshaft speed	.500
Tachometer drive direction of rotation	Clockwise
Propeller hub spline	No. 20
*Vacuum pump flange and drive	AN-9521, type 1
*Vacuum pump drive rotation	Clockwise
*Vacuum pump drive speed, in multiples of crankshaft speed	1.333

ACCESSORY WEIGHTS

Carburetor (MA-4SPA)	3.25 lb
Domestic shipping box	235 lb
Generator drive (weight added)	Standard equipment
Magnetos (SF6LN-8)	16.26 lb
Priming lines and connections	1.30 lb
Radio shielding, complete (Breeze)	6.75 lb
Tool kit	6.4 lb

*These drives may not be included with basic engine and are not included in the engine weight.

SECTION IV
PREPARATION FOR STORAGE OR SERVICE

1. GENERAL.

The engines are packed for shipment with the crankshaft in a horizontal position. The engine is secured to the shipping base by means of four steel supporting legs which are fastened to the engine mounting lugs at the lower front and rear of the crankcase. These four legs are in turn fastened to the base by means of bolts. The loose parts, carburetor, spark plugs, and tool kit are shipped in an extra compartment built into the engine shipping base. The shipping box for export and domestic shipment is approximately 54 x 40 x 33 inches, and has a displacement of approximately 42 cubic feet. Following are the approximate engine shipping weights:

Net weight of engine with shipping parts, covers, etc.	370 pounds
Weight of shipping box	235 pounds
Total shipping weight	605 pounds

2. PACKING.

Engines should be packed immediately following the preparation for storage. Packing the engine in the shipping box is part of the complete preparation for storage procedure.

a. Assemble lifting sling, tool No. 1240, in the two lifting eyes provided at the top of the crankcase. Attach chain hoist to the lifting sling and raise the engine clear of the floor.

b. Draw the engine bag up over the engine so that the opening in the bag is at the top, and the grommets in the bag align approximately with the mountings lugs on the engine.

c. Using two cap screws, .3125 inch—18 by 1 inch long, attach engine mounting legs to boss provided on each side at front of crankcase. The angle of the supporting legs should be turned outward.

d. Using ½-inch bolts with rubber mounting bushings and steel washers, attach supporting leg to the engine mounting lugs at the lower rear of the crankcase with the angle on the legs toward the rear.

e. Lower engine onto the shipping base and bolt mounting legs to base. The chain hoist and lifting sling may now be removed from the engine.

f. Place humidity indicator, conforming to Specification No. AN-7511, in position so that it can be seen through hole provided in the engine shipping cover.

g. Hang a 1-pound bag of silica gel, Specification No. AN-D-6, type V, at each cylinder. Tie each bag securely to engine shroud tubes.

h. Inspect engine bag for tears. If tears are found, they may be repaired by using a hot iron. Seal engine bag, using sealing iron.

Note

If sealing iron is not available, the sealing may be done with a very warm soldering iron.

i. Before completely sealing the envelope, collapse the envelope about the engine, or remove the excess air by means of a slight vacuum. The seal shall then be completed, and any excess material folded and fastened with masking tape so that no more than one thickness of envelope film covers the humidity indicator.

j. The engine box cover may now be placed in position and fastened with two bolts provided at each end of the cover. Be sure that the inspection door in the engine box cover aligns with the humidity indicator so that the condition of the humidity indicator may be inspected without removing box cover. Use extreme care to avoid rupturing the engine envelope when lowering cover.

3. UNPACKING.

a. Remove the four bolts that secure the cover to the shipping base and remove cover.

b. Open engine bag as near the point where it was originally sealed, as possible. Push engine bag aside

far enough to allow the lifting sling, tool No. 1240, to be attached to the engine lifting eyes at the top of the crankcase. Attach the chain hoist to the lifting eyes and raise the chain host enough to take up the weight of the engine. *(See figure 6.)*

c. Remove the bolts attaching steel supports to shipping base, and lift engine bag from around the engine. Remove dehydrator bags and humidity indicator.

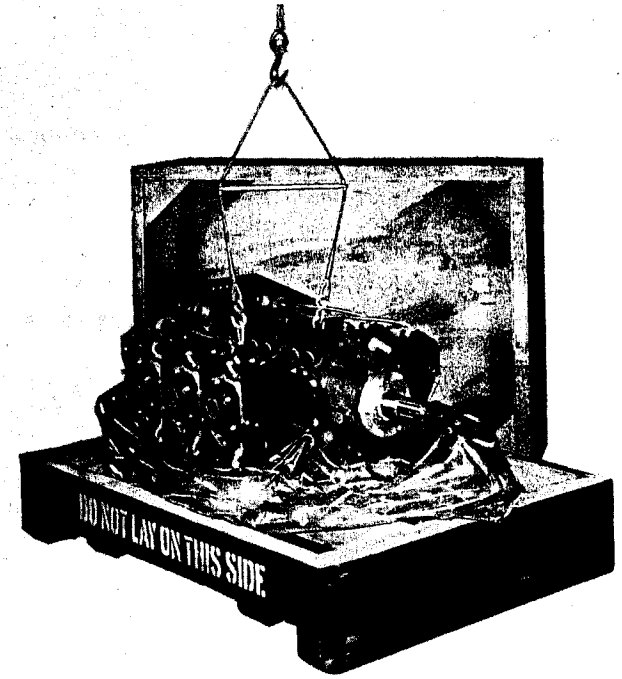


Figure 6. Removing Engine from Shipping Box with Lifting Sling and Hoist

4. PREPARATION FOR STORAGE OF ENGINES NOT INSTALLED IN AIRCRAFT.

a. ENGINES REQUIRING TREATMENT.—Aircraft engines will be initially prepared for storage as follows:

(1) ENGINES RECEIVED FOR STORAGE.—All engines received for storage without previous treatment will be treated immediately upon receipt with complete shut-down and preservation procedures as specified in the following paragraphs.

(2) FOLLOWING THE BLOCK TEST.—Each engine will be treated with complete shut-down and preservation procedures upon completion of block testing, except those which are to be installed in operating aircraft within 48 hours.

(3) UPON REMOVAL FROM AIRCRAFT FOR OVERHAUL.

(a) OPERABLE ENGINES.—Operable engines will be given the preliminary shut-down treatment before removal from the aircraft. Upon removal the standard preservation procedure will be followed.

(b) INOPERABLE ENGINES.—Inoperable engines removed from aircraft will be treated as far as practicable with the regulation preservation procedure within 48 hours after removal, unless it is definitely known that they will be disassembled within the 48-hour period.

(4) NEW ENGINES.—New engines will be initially treated by the manufacturer before delivery.

b. RE-TREATMENT.

The engine humidity indicator card, conforming to Specification No. AN-7511, will be inspected at least semimonthly for the first 6 weeks following preparation, and monthly thereafter to determine the color of the silica gel contained therein. Under unfavorable climatic conditions, the humidity indicator card will be inspected each week for the first 6 weeks; thereafter once each 2 weeks. Experience will dictate the frequency of this inspection. If the color of the silica gel corresponds to those shown as safe on this card, no further treatment is necessary. *(See figure 7.)* If the color of the silica gel corresponds to those shown as unsafe, the following procedure will be employed:

(1) Remove the engine box top.

(2) Carefully cut the seal at the top of the engine envelope in such a manner as to remove the least possible amount of material.

(3) Carefully roll the engine bag down from the engine.

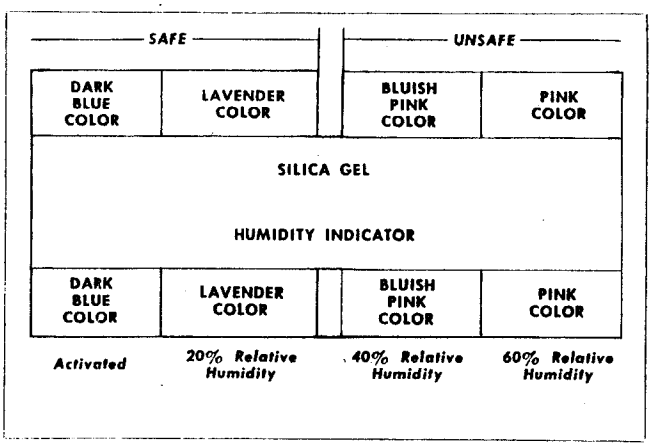


Figure 7. Humidity Indicator

(4) Replace the bags of silica gel with fresh bags, and replace humidity indicator chart. Engine cylinder and crankcase dehydrator plugs will be replaced with new dehydrator plugs.

(5) Bring the engine envelope back over the engine and reseal. The engines should require no other treatment than the periodic replacement of the

silica gel bags and plugs to insure adequate protection from atmospheric corrosion.

c. PRELIMINARY TREATMENT.

(1) CORROSION-PREVENTIVE MIXTURE.—Corrosion-preventive compound, Specification No. AN-VV-C-576, has been developed to aid in the prevention of atmospheric or other common types of engine corrosion. It is used in combination with lubricating oil, Specification No. AN-VV-O-446, in the proportion of one part of the compound to three parts of the lubricating oil. Spray gun, AC Specification No. 50127, may be used for applying this mixture.

(2) SHUT-DOWN PROCEDURE.—Before removing engine from airplane or test stand, the oil should be drained and replaced with 6 quarts of corrosion-preventive mixture. (This mixture may be used for 10 engines.) The engine will then be operated at not more than 50 percent power for a minimum of 15 minutes. The fuel used for this run shall conform to grade 62, Specification No. AN-F-22. At the end of the run the engine will be stopped by closing the valve on the fuel line. The throttle will be opened a sufficient amount and in time to permit the engine to reach a speed of 1500 to 1600 rpm at the time the engine stops firing.

(3) PRELIMINARY TREATMENT OF CYLINDER BORES.

(a) Aspiration with the corrosion-preventive mixture will be started while the engine is still firing and operating at 800 to 1000 rpm. The mixture will be injected under air pressure by one of the following methods:

1. Aspiration of the corrosion-preventive mixture through the carburetor by spraying the mixture into the carburetor air intake. Should this procedure be followed, very careful cleaning of the carburetor and its parts is necessary upon removal from the engine.

2. Injection of the corrosion-preventive mixture from an auxiliary oil tank into an appropriate opening such as a mixture thermometer opening or the impeller section drain. This tank will be supplied with air pressure to insure rapid and positive injection of the mixture to the intake manifold.

(b) The ignition will be cut at the instant a white smoke is emitted from the exhaust outlet(s), and aspiration will be continued. The quantity of corrosion-preventive mixture will be sufficient to continue aspiration until the engine ceases to rotate.

d. PRESERVATION PROCEDURE.—The complete preparation procedure shall be accomplished as soon as possible after engine shutdown, but in every case drain the oil and the rocker boxes immediately. The camshaft, exhaust ports, and rocker boxes will be sprayed within 6 hours maximum. The complete preservation procedure will be accomplished within 12 hours.

(1) OIL DRAINAGE.—While the engine is still warm, the lubricating oil will be drained from the crankcase, screen chambers, and sump. Screens or filters will be removed, cleaned, and replaced. All drain plugs will be replaced and safetied. Drained oil anti-corrosion compound mixture may be re-used for approximately 9 additional engines.

(2) CYLINDERS.—After the engine has cooled to air temperature, corrosion-preventive mixture should be sprayed into each cylinder through the spark plug holes with the piston at the bottom of its stroke, and in sufficient quantity to insure adequate coverage of all internal surfaces.

(3) ENGINE INTERIOR.—Using 3 gallons of fresh corrosion-preventive mixture, slush the interior of the engine. This can conveniently be done by placing the mixture in the oil sump and mounting the engine on a rotating overhaul stand. The engine will then be turned on one side for 5 minutes, inverted for 5 minutes, and on the other side for 5 minutes. The engine should also be placed in nose-down position to make sure that the thrust bearing is covered with the mixture. This process will completely cover all internal parts with the corrosion-preventive mixture. After this slushing operation is complete, the mixture should be drained and stored for re-use.

(4) ROCKER BOXES.—Rocker box covers will be removed and each rocker box cleaned and so sprayed with corrosion-preventive mixture as to thoroughly coat the valve rocker arms, valve stems, springs, push rods, and interior of boxes. Replace covers and gaskets and screw down to an airtight seal.

(5) EXHAUST PORTS AND MANIFOLDS.—Each exhaust port will be sprayed with a sufficient quantity of corrosion-preventive mixture to thoroughly coat the exhaust valve. The exhaust manifold, if shipped with the engine, will be attached. A ½-pound bag containing silica gel, conforming to Specification No. AN-D-6, type V, will be placed in the exhaust opening of exhaust manifold, anchored in place, and the opening sealed by covering with an oil and moisture-resistant diaphragm. The silica gel bag will not be removed from its moistureproof shipping container until immediately before being inserted in the opening. If the exhaust manifold is not to be shipped with the engine, the individual exhaust ports will be sealed by closing with gasketed oil and moisture-resistant plates.

(6) THRUST BEARINGS.—The thrust bearing cover plate will not be removed, as the thrust bearing will be thoroughly coated with corrosion-preventive mixture as a result of slushing the engine interior with the mixture.

(7) ACCESSORY HOUSING.—Remove generator or generator cover plate and thoroughly spray inside of accessory housing with corrosion-preventive mixture. Remove caps and spray each tachometer drive.

(8) CARBURETOR.—The carburetor will be

emptied of all gasoline, and filled with oil conforming to grade 1065A, Specification No. AN-VV-O-446, and all interior surfaces will be thoroughly slushed. Drain excess oil and replace plugs. Lock throttle to closed position. Place carburetor in moistureproof envelope with a ½-pound bag of silica gel. The carburetor will not be attached to the engine for shipment.

(9) PROPELLOR SHAFT.—The exposed surface of the propellor shaft should be thoroughly coated with corrosion-preventive mixture. A propellor shaft thread cap should be installed.

(10) BREATHERS.—Seal the breather opening at the front end of the engine with a moistureproof plug.

(11) CYLINDER BORES.—Engine cylinder dehydrator plugs conforming to Specification No. AN-4062 will be installed in all spark plug openings and firmly seated. The seals of the dehydrator plugs shall not be removed until immediately before screwing into the individual spark plug holes. The spark plug lead shall be supported in shipment by using a protector and cable support.

(12) CRANKCASE.—The plug in the center of the starter drive cover will be removed and replaced by a crankcase dehydrator plug conforming to Specification No. AN-4061, which will be screwed to a tight seal. The replaced plug will be attached to the sump.

(13) INTAKE MANIFOLD.—A 2-ounce bag of silica gel dehydrating agent will be securely anchored in the intake manifold. The intake manifold will then be sealed by assembling a gasketed oil and moisture-resisting plate on the carburetor attaching studs.

(14) SPARK PLUGS.—After serviceable spark plugs have been removed, they will be cleaned and their gaps will be adjusted. Threads of plugs only shall then be coated with corrosion-preventive mixture and all plugs placed in a suitable moisture-resistant enclosure. New plugs need no treatment.

(15) MARKING.—Army engines should be marked with a tag indicating that the engine has been prepared for storage in accordance with T. O. No. 02-1-1. Navy engines should be marked to indicate that they have been prepared for storage in accordance with Specification No. AN-FE-568. Any variations or omissions in the preparation procedure, regardless of the reason for such variation or omission, should be clearly indicated on the tag.

(16) MAGNETOS.—Magnetos as received on new engines or magnetos which have been overhauled need no further preparation for storage. An inspection will be made, however, to see that cam, springs, and all other steel parts of the breaker mechanism are lightly coated with oil.

e. EXCEPTIONS.—The above procedure will be followed for the preservation of new engines and of engines overhauled in service, except that omissions are permitted under the following conditions:

(1) When it is definitely known that the engine will be placed in service within 30 days, engine envelopes and the bags of silica gel may be omitted. In such cases the engine cylinder and sump dehydrator plug will be inspected biweekly and changed as soon as their color indicates that they are no longer functioning. However, under extremely adverse atmospheric or storage conditions where deterioration of the engine interior might occur before the engine could normally be expected to be operated, the complete procedure will be used. Replacement of the dehydrator plugs should not be made on highly humid or rainy days.

(2) On service overhauled engines to be mounted on quick-change stands, the entire preservation procedure will be accomplished except that all engine parts such as the carburetor, carburetor line, and fuel lines shall be left on the engine. The carburetor openings shall be sealed with oil-resistant, gasketed plates. The engine envelope used shall be of a type which will completely enclose the engine and mount.

5. PREPARATION OF ENGINES FOR SERVICE AFTER TREATMENT.

Serviceable engines that have been treated for storage will be prepared for service as follows:

a. Remove engine envelope, silica gel, dehydrating plugs, and all seals and enclosures. The engine envelope will be carefully cleaned and folded for subsequent re-use. Every care should be exercised to assure a maximum service life for these envelopes. Previous to re-use, the envelopes should be carefully inspected for tears and holes and repaired if necessary.

CAUTION

Care must be exercised in the removal of the dehydrating plugs. If they should be broken and the silica gel should fall into the engine, that part of the engine must be disassembled and thoroughly cleaned.

b. Drain excess corrosion-preventive mixture from the cylinders and sump.

c. Remove the oil strainers and immerse several times in gasoline. Blow out with compressed air and repeat this operation until strainers are thoroughly clean.

d. Fuel drain screens, if installed, should be checked by using a short hose and mouth pressure.

e. Inspect the magneto breaker mechanism for proper lubrication.

f. Before installing the spark plugs the following procedure should be observed:

(1) Remove the dehydrating plugs from the spark plug holes while the engine is on the shipping stand, and before installing the spark plugs, slowly rotate

the crankshaft four or five revolutions and observe for proper operation of the valve mechanism; also make sure that excessive corrosion-preventive mixture is not present in the cylinders. Remove any excess corrosion-preventive mixture with a hand pump or by draining. Any valves that are found to be sticking will have the stems generously lubricated with a mixture of gasoline and lubricating oil. Continue to turn the engine over by hand until all evidence of sticking valves has been eliminated. If the mixture of gasoline and lubricating oil does not free all the valves, the necessary repairs will be made before the engine is placed in service.

(2) Before starting the engine after installation, one spark plug from each cylinder will be removed, and the crankshaft turned by hand at least four complete revolutions for final check to determine that there is no excess corrosion-preventive mixture in any cylinder.

Note

Corrosion-preventive mixture has a detrimental effect on paint. If any is spilled on a painted surface of the airplane or engine, it should be wiped off immediately with a clean rag.

(3) Prior to ground testing the engine, sufficient oil will be placed in the sump to insure completion of the ground test. In general, one-half the sump capacity will be adequate for this purpose. After the engine has been ground tested, the lubricating oil will be drained from the oil system. The oil system will then be filled with new oil. This drained oil is not suitable for further use in aircraft engines, since the corrosion-preventive compound in the oil promotes rapid sludging with consequent sticking of piston rings. The drained lubricating oil will be placed in containers for reclaiming.

6. PREPARATION FOR STORAGE OF INSTALLED ENGINES.

a. SHORT STORAGE.—Engines which are installed in airplanes which will be inoperative for more than 1 day but will be operated within 7 days will be treated as follows:

(1) On alternate days the propellers will be rotated at least four complete revolutions by hand.

(2) Short storage periods will not be extended or repeated. If the time the engine is to be inoperative is not definitely known to be less than 7 days, it is best to prepare the engine for temporary or extended storage.

b. TEMPORARY STORAGE.—Engines installed in aircraft that are not to be operated for a period of more than 1 week, but will be operated within 30 days, will be treated as follows:

(1) The sump drain plug will be removed, the oil drained from the sump, and the plug wired to the engine without being reinstalled. In its place install a crankcase dehydrator plug conforming to Specification No. AN-4061. Thoroughly spray the exhaust valves with corrosion-preventive mixture. This spraying will be accomplished through the exhaust port with the exhaust valves fully opened, except in engines having exhaust collectors that are difficult to remove, in which case the spraying may be done through the spark plug holes with the exhaust valves fully open. Upon completion of these operations, the crankshaft will be rotated at least four revolutions to thoroughly work the corrosion-preventive mixture into the valve guide. Corrosion-preventive mixture will then be sprayed into the cylinder bores with the piston at the bottom of the stroke in such a manner as to cover all the interior surfaces. Install cylinder bore dehydrator plugs conforming to Specification No. AN-4062 into the spark plug holes.

(2) A minimum of one each ½-pound bags of silica gel will be placed in the exhaust outlet or outlets and in the carburetor air intake scoop. The ends will be covered with a double thickness of moisture-impervious plastic material conforming to Specification No. AN-O-P-406. Special tape, Specification No. AN-T-12, will be used in anchoring the plastic material to the outlets.

c. EXTENDED STORAGE.—Engines installed in aircraft that are not to be operated for a period of more than 30 days will be treated as follows:

(1) Engines will be run on fuel conforming to service requirements while using the corrosion-preventive mixture as a lubricant at idling speed for at least 15 minutes. Following this treatment, they will be prepared for storage as specified in paragraph 4.*d.* with exceptions and additions given below. Prior to this 15-minute run, the oil in the engines will be drained, and the sump will be refilled with corrosion-preventive mixture. Only a sufficient quantity of this mixture will be used to insure lubrication during this running period. The oil coolers will be blanked off or bypassed in order to increase the oil temperature.

(2) Carburetors installed in engines being prepared for storage in aircraft need not be removed. However all fuel lines will be disconnected, a suitable nipple installed in the carburetor fuel inlet connection, and lubricating oil, grade 1065A, Specification No. AN-VV-O-446, introduced by means of a funnel and a hose. Drain plugs in the bottom of the carburetor will be removed and the carburetor flushed several times with lubricating oil, and the throttle and mixture controls moved several times. After this procedure, the carburetor will again be drained of lubricating oil, connections and all plugs reinstalled. The fuel lines of the airplane fuel system will be left disconnected, and the openings in the carburetor and fuel lines closed with suitable plugs.

CAUTION

Do not move throttle control rapidly when any oil is in carburetor, as bending of throttle shaft may result.

(3) Sump plugs will be removed and corrosion-preventive mixture drained from the engine.

(4) Cylinder bore dehydrator plugs conforming to Specification No. AN-4062 will be installed in all spark plug holes. The crankcase dehydrator plug will be installed in the sump plug opening. A minimum of one ½-pound bag of silica gel will be placed in the exhaust pipe outlet or outlets and in the carburetor air intake scoop. The ends will be covered with a double thickness of moisture-impervious plastic material, Specification No. AN-O-P-406. Special tape, Specification No. AN-T-12, will be used in anchoring the plastic material to the outlets. All other openings in the engine will be sealed with suitable locally manufactured plugs to insure an airtight and moisture proof engine interior.

(5) Protect magnetos by enclosing them in a suitable envelope fabricated of moisture-impervious plastic material, Specification No. AN-O-P-406.

(6) If metal propellers are to remain installed, all exposed parts of the propeller shaft and the propeller will be sprayed with corrosion-preventive mixture. In adverse climatic conditions a propeller cover may be fabricated from the moisture-impervious transparent plastic film covered by Specification No. AN-O-P-406.

(7) Wood propellers should be removed and properly stored. Coat crankshaft end with corrosion-preventive mixture and wrap with moisture-impervious plastic material, Specification No. AN-O-P-406.

(8) All engines installed in airplanes will be covered with engine covers furnished with the airplane and securely fastened. The condition of the cylinder bore and crankcase dehydrator plugs will be inspected weekly and will be replaced at any time when they indicate a relative humidity above 200 per cent. The seals on these plugs will not be removed until immediately before the plugs are screwed into their respective positions.

7. RETREATMENT OF INSTALLED ENGINES.

a. Engines in short storage require treatment on alternate days.

b. Engines in temporary or extended storage status will be inspected biweekly. The dehydrator plugs mounted in the spark plug holes and oil sump will be replaced at any time when they indicate a relative humidity above 20 per cent. The bags of dehydrating agent anchored in the intake and exhaust manifolds will be replaced bimonthly, and the ends of manifolds resealed.

8. PREPARATION FOR SERVICE AFTER TREATMENT OF INSTALLED ENGINES.

a. Engines installed in aircraft which have been prepared for short storage need no preparation for service.

b. Engines installed in aircraft which have been prepared for temporary storage will be prepared for service as follows:

(1) All plugs, cover plates, nipples, etc which have been installed to close lines or other engine openings will be removed, and fuel lines, controls, etc replaced.

(2) Prior to the installation of spark plugs, inspection will be made of the cylinder bores. If excessive corrosion-preventive mixture is found therein, it should be drained.

(3) The propeller will then be rotated slowly by hand to determine if the cylinders are free and the valves operate freely. In the case of sticking valves, treat as described in paragraph 5.*f.* before operating the engine.

c. Engines installed in aircraft that have been prepared for extended storage will be prepared for service as follows:

(1) All plugs, cover plates, nipples, wrappings, etc. which were installed will be removed.

(2) Excess corrosion-preventive mixture will be drained from the cylinder bores and the oil sump.

(3) The propeller will then be rotated slowly by hand at least four or five revolutions to determine if the cylinders are free and if the valves operate freely. In the case of sticking valves, treat as directed in paragraph 5.*f.* before operating the engine.

(4) Install spark plugs and all disconnected fuel lines, controls, etc.

(5) Clean the propeller hub and propellers, if treated with the engine.

(6) Oil screens shall be removed, cleaned in gasoline, dried, recoiled, and reinstalled.

(7) Prior to ground testing the engine, sufficient oil will be placed in the oil sump to insure completion of the ground test. In general, one-half the sump capacity will be adequate for this purpose. After the engine has been ground tested, the lubricating oil will be drained from the oil system. The oil system will then be filled with new oil. This drained oil is not suitable for further use in aircraft engines, since the corrosion-preventive compound in the oil promotes rapid sludging with consequent sticking of the piston rings. The drained lubricating oil will be placed in containers for reclaiming.

9. ENGINES IN MOUNTS NOT INSTALLED IN AIRCRAFT.

a. ENGINES NOT PREPARED FOR STORAGE.—Engines which have not been prepared for storage prior

to installation in the engine mount will be so prepared in accordance with procedures for engines installed in aircraft. (Refer to paragraph 6.) The time limits for short storage, temporary storage, and extended storage will apply.

b. ENGINES PREVIOUSLY PREPARED FOR STORAGE.—In the event the engine has been rotated during installation in the engine mount, the cylinders will be resprayed, and the crankshaft will not be rotated further.

c. RETREATMENT.—Retreatment of engines in engine mounts will be the same as for engines installed in aircraft. (Refer to paragraph 7.)

d. PREPARATION FOR SERVICE AFTER TREATMENT.—Engines will be prepared for service in accordance with procedures for engines installed in aircraft. (Refer to paragraph 8.) Engines will not be prepared for service until 48 hours or less prior to airplane installation.

SECTION V
ENGINE TROUBLES AND THEIR REMEDIES

1. GENERAL.

a. A symptom of engine trouble may usually be attributed to a number of possible sources, thus complicating the determination of the actual source of trouble. However, experience has proved that the best method of "trouble shooting" is first, to decide on the various possible causes of a given trouble, and second, to eliminate the possible causes, one by one, beginning with the most probable.

b. The use of the following outline of common engine troubles and their possible causes is recommended to assist personnel in maintaining the engines in a serviceable condition.

2. FAILURE OF ENGINE TO START.

a. LACK OF FUEL.—Examine fuel tanks, fuel lines and connections, shut off cocks and strainers. As a final check remove the drain plug from the bowl of the carburetor. With fuel supply turned "ON" a steady stream of fuel from the drain plug opening indicates that fuel is reaching the carburetor. On airplanes using fuel pump it will be necessary to operate hand pump in making this check.

b. OVERPRIMING OR UNDERPRIMING.—Insufficient priming is usually indicated by a tendency of the engine to kick back when starting. Overpriming is usually indicated by a muffled, hollow explosion from the exhaust, or by excess fuel dripping from the carburetor drain or coming out of the exhaust in vapor form.

c. SPARK PLUGS.—Remove spark plugs and examine to see whether or not they have been fouled by oil or condensed moisture. Wash plugs with clear gasoline and dry with compressed air.

d. MAGNEO.—Check magneto to see that breaker points are clean and operating properly. Also remove distributor cover from the magneto and remove any oil that has accumulated on the distributor electrodes or insulation with a clean, dry, lintless cloth.

e. WIRING.—Check ignition wiring for burned, chafed or cracked insulation and for secure and correct connections. *(See Wiring Diagram, figure 8.)*

f. WATER IN GASOLINE.—If the fuel is reaching carburetor, and engine fails to run after fuel supplied by priming system is exhausted, remove the carburetor and either replace with another carburetor, or disassemble carburetor and clean all fuel and air passages with compressed air.

3. LOW POWER AND UNEVEN RUNNING.

a. SPARK PLUGS.—Remove spark plugs and check for cleanliness and correct gap setting.

b. WIRING.

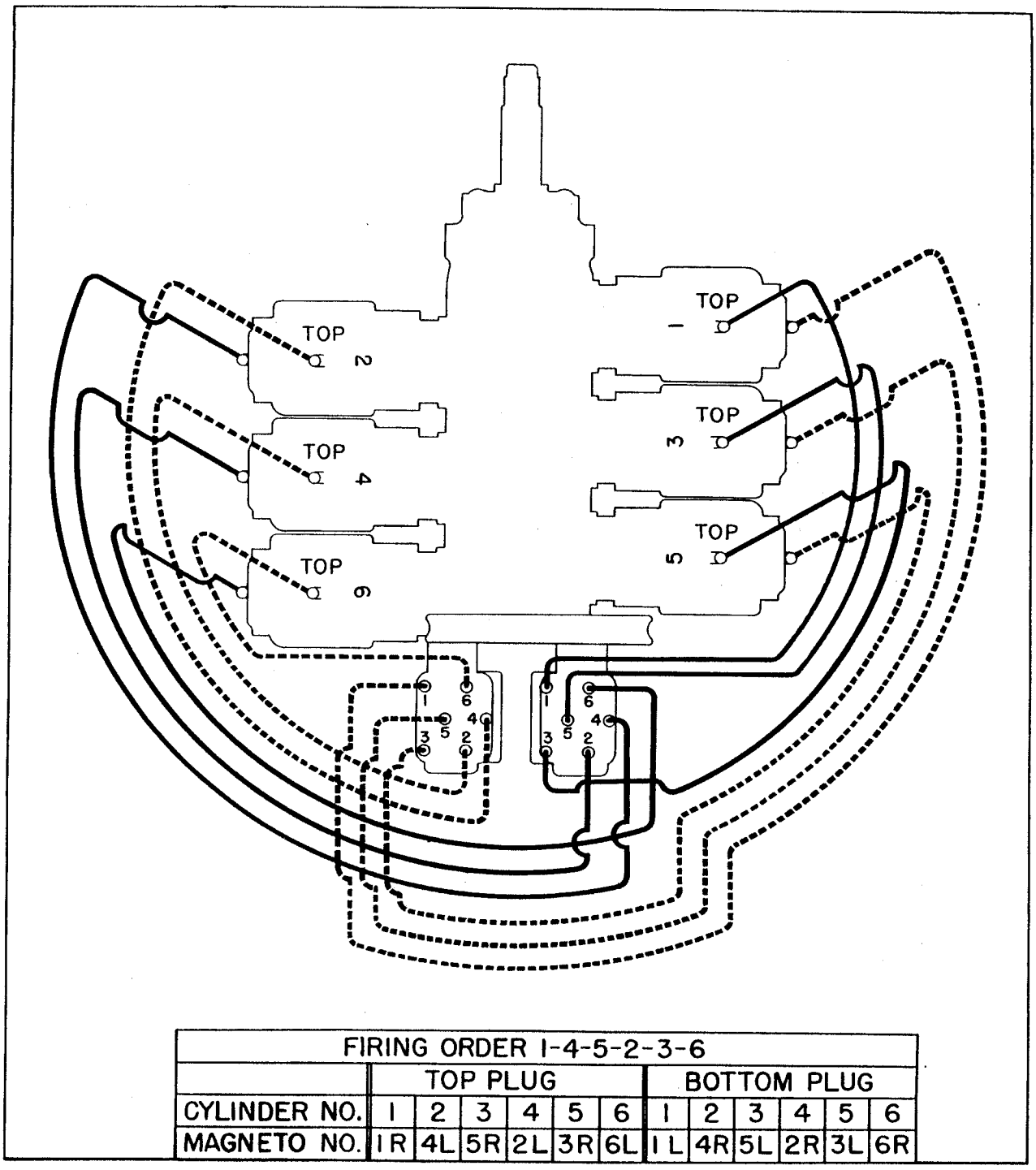
(1) Check ignition wiring for damaged insulation and if possible check entire harness for open circuits and insulation leaks with a high tension ignition harness test set.

(2) Check insulating terminal at both spark plug and magneto end of each wire for cracked or burned insulating material. Clean electrode at magneto end of cable.

c. MIXTURE.

(1) A rich mixture is indicated by sluggish operation of engine, red exhaust flame at night, and in extreme cases by black smoke from exhaust. Rich mixture can be caused by leaky primer shut-off valve, or by improper functioning of internal parts of carburetor.

(2) Lean mixture is indicated by uneven running, overheating, and in extreme cases, by a tendency to backfire through the carburetor. A lean mixture will give a pale blue white flame at night. Too lean a mixture can be caused by a leaky intake system (which will often make itself evident by a high pitched whistle at idle), by improper adjustment of mixture control linkage, or by improper internal functioning of the carburetor.



FIRING ORDER 1-4-5-2-3-6												
	TOP PLUG						BOTTOM PLUG					
CYLINDER NO.	1	2	3	4	5	6	1	2	3	4	5	6
MAGNETO NO.	1R	4L	5R	2L	3R	6L	1L	4R	5L	2R	3L	6R

Figure 8. Wiring Diagram

(3) In checking for mixture troubles it should be remembered that incorrect or misaligned assembly of parts of the air intake system to the carburetor will disturb the air flow to the carburetor and cause malfunctioning of the engine. Therefore before removing the carburetor, check the operation of the engine with all air intake ports removed from the carburetor. If engine still indicates poor carburetion, remove carburetor and replace with a serviceable unit.

Note

Failure to properly clean and oil the carburetor air filter is cause for a large number of carburetor troubles. This is particularly true under dusty or sandy conditions. Therefore after locating trouble in carburetor system be sure to clean and oil air filter.

d. MAGNETO.—Check magneto for proper timing. (Refer to section VII.) Inspect distributor and breaker points for cleanliness.

e. VALVE GEAR.—Check engine compression. If compression is found weak on one or more cylinders, check valves and valve operating mechanism. See that valves are not burned or sticking open. Very noisy valve operation is probably caused by dirt or other foreign matter in the hydraulic valve lifter. This may be determined by removing rocker box cover and checking each rocker arm for looseness with the valve in the closed position. If it is possible to remove the end of the rocker arm up and down with hand pressure, the hydraulic tappet plunger assembly should be removed, disassembled and cleaned, or replaced with another plunger assembly. Refer to section VII for instructions on assembly and disassembly of cylinder and valve mechanism.

f. FUEL.—See that fuel of proper specification is in the tank. Roughness caused by sticking and burning valves, and by lead deposits on the spark plugs may be experienced if fuel containing more than 1 cc of lead per U. S. gallon is used.

4. ROUGH RUNNING.

a. PROPELLER.—Rough operation as well as poor performance can often be traced to a damaged propeller, to a propeller of the wrong design, or a propeller that is out of balance or that has been warped because of weather conditions or improper storage. If the propeller is suspected to be the cause of roughness, another propeller known to give normal performance and smooth operation on another 0-435-1 engine should be tried.

b. ENGINE MOUNT.—Check engine mount for looseness, and cracked or broken members. Pay particular attention to the engine mount bushings. The engine mount bushing nuts should be tightened snug, but not so tight as to deform the bushing. A bushing which shows signs of deterioration or distortion should be replaced immediately.

c. CRANKSHAFT.—Inspect crankshaft for run-out at front and rear cone locations. (Refer to paragraph 7.)

d. Check all items enumerated in 3, even though the engine seems to be firing evenly.

5. HIGH OIL TEMPERATURE

a. COOLING SYSTEM AND OIL COOLER.—Check cooling system to see that air inlets and outlet gills have not been deformed, and that air flow around the crankcase or through the oil cooler has not been restricted. Remove oil cooler and check cooler for sludge deposits or other foreign matter tending to clog the cooler. Check any thermostatic valves used in oil cooler.

b. INSUFFICIENT OIL.—Under no circumstances should the engine be operated with less than six quarts of oil in the crankcase.

c. INFERIOR GRADE OF OIL.

d. EXCESSIVE "BLOW BY".—"Blow By" caused by worn or stuck piston rings will raise the oil temperature and in most cases cause oil to be discharged from the crankcase breather.

e. DEFECTIVE TEMPERATURE GAGE.—Maintenance personnel should ascertain that the temperature gage calibration is accurate before disassembling major parts of the engine in locating the cause of high oil temperatures.

6. LOW OIL PRESSURE.

a. INSUFFICIENT OIL IN SUMP.—If the engine has had an oil change since the last flight, the oil level should be checked immediately before starting the engine.

b. LEAK IN PRESSURE OR OIL PUMP INTAKE PASSAGE.—Check gasket between oil sump and crankcase, and between accessory housing and crankcase.

c. OIL PRESSURE RELIEF VALVE.—Check pressure relief valve for improper operation.

d. WORN BEARINGS.—Excessive bearing clearance will cause low oil pressure and also high oil temperature. However, this is generally a gradual loss of pressure over a long period of operating time unless some abnormal condition has caused sudden bearing failure.

e. DEFECTIVE PRESSURE GAGE.—Ascertain that pressure gage is accurately calibrated before replacing or removing major parts of the engine to locate cause of low oil pressure.

f. WORN OR DAMAGED OIL PUMP.—A worn oil pump will cause a gradual drop in oil pressure over a number of hours of operation. A sudden drop in oil pressure or complete loss of oil pressure may be caused by a foreign object being drawn through the pump. However, this should not occur if the suction strainer is properly serviced.

g. STOPPAGE IN OIL PUMP INTAKE PASSAGE.—In rare cases, lack of oil pressure may be caused by stoppage of the oil pump intake passage, or clogging of the oil suction strainer. In very cold weather any water that is allowed to remain in the oil sump may freeze and possibly clog the suction line.

7. LACK OF COMPRESSION.

Lack of compression may be the cause of several of the troubles previously mentioned. It is caused either by leaking or sticking valves, or by sticking or worn piston rings. For causes of leaking or sticking valves, refer to paragraph 3. Sticking rings are caused in most

cases by overheating, particularly during ground operation. Worn rings, and, in some cases, sticking rings may be caused by dirt getting into the engine through the carburetor air intake. Where lack of compression and high oil consumption become a problem, special attention should be given to servicing the carburetor air cleaner.

8. ENGINES THAT HAVE BEEN IN ACCIDENTS INVOLVING SUDDEN STOPPAGE OF THE PROPELLER.

When engines have been in accidents that involve sudden stoppage of the propeller, the crankshaft run-out should be checked as follows:

a. Mount dial indicator on long stud installed in place of one of the thrust bearing cap retaining cap-screws. *(See figure 9.)* Adjust indicator so that plunger rests on crankshaft at front cone location. Rotate crankshaft and record total indicator movement. Maximum allowable run-out at front cone location is .007 inch.

b. Move dial indicator to rear cone location and check run-out in the same manner. Maximum allowable run-out at rear cone location is .003 inch.

c. If run-out at either location exceeds the given limits, the engines must be removed and overhauled. Under no circumstances should any attempt be made to straighten the shaft.

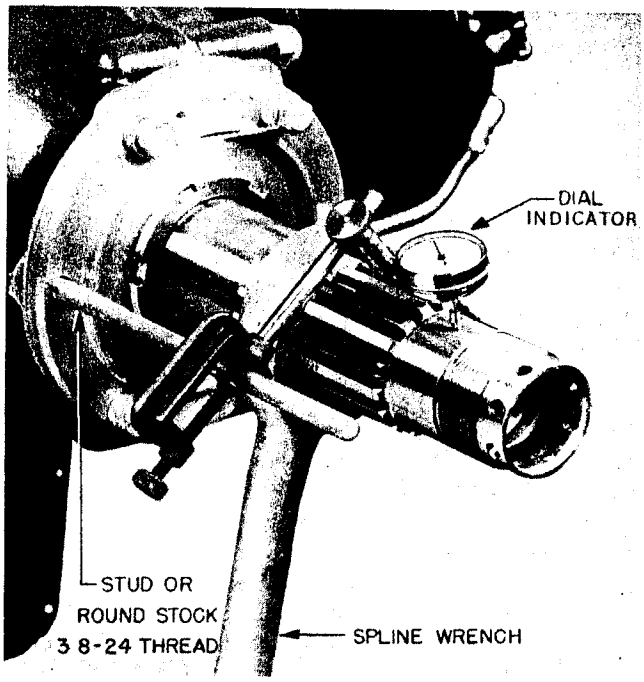


Figure 9. Checking Chankshaft Run-out with Engine Installed

SECTION VI
SERVICE INSPECTION AND ASSOCIATED MAINTENANCE

1. GENERAL.

a. The work outlined in this section is a normal function of the operating organizations. It consists of the periodic inspection, cleaning, servicing, lubricating, adjusting, and such maintenance work as is associated with the routine inspection system. For preflight inspection, refer to the Handbook for the airplane in which the engine is installed.

b. The special tools necessary for accomplishing the work outlined herein will be found listed in section VIII of this Handbook.

c. AAF inspections at 25-, 50-, and 100-hour periods are equivalent to Navy inspections at 30, 60, and 120 hours respectively.

2. INSPECTION AND MAINTENANCE.

Note

The entire valve operating mechanism of the 0-435-1 engine is automatically lubricated and valve clearance is automatically maintained by hydraulic tappets. No adjustment or inspection is required between overhauls, and the rocker box covers should not be removed between overhauls unless the operation of the engine indicates that some trouble exists in the valve operating mechanism.

a. DAILY.

(1) Inspect engine for evidence of oil leakage.

(2) Inspect for proper safetying of all drain plugs and covers.

(3) Inspect carburetor and fuel line connections for leakage.

(4) Check all engine controls for general condition of connections and safety locking devices, and for full range and free operation.

(5) Check fuel and oil level.

(6) Check cowling (and propeller spinner if used). Make sure that all fastenings are secure.

(7) Clean and reoil air filter.

b. 25-HOUR (NAVY 30-HOUR).

(1) IGNITION AND ELECTRICAL.

(a) Check spark plug elbow terminal and shielding nuts for security.

(b) Remove magneto breaker covers and inspect cam and interior of breaker housing for excessive oil. Felt on breaker arm should contain just enough lubricant so that oil appears when felt is squeezed with the fingers. Excess oil should be removed with a clean, dry, lintless cloth.

(c) Inspect all electrical wiring for secure connections and breaks, or chafing of insulation.

(2) FUEL SYSTEM.

(a) Lubricate all exposed moving parts of carburetor, using oil, Specification No. AN-O-6.

(b) Turn fuel supply valve to "OFF" position, remove and clean carburetor fuel strainer. In order to remove fuel strainer, the carburetor fuel line must first be disconnected at the carburetor. Replace strainer and fuel line. Remove float chamber drain plug from bottom of carburetor, turn fuel supply valve to the "ON" position long enough to flush out the carburetor with fuel. Replace and safety drain plugs.

Note

The carburetor should be drained and fuel strainer cleaned at any time between 25-hour inspections that excessive water or foreign matter is found in the airplane fuel strainer or sediment bulb.

(c) Check priming system for leaks (particularly at priming pump shut-off) and for secure anchorage of all priming lines.

(3) OIL SYSTEM.

(a) Inspect oil lines for: leaks, particularly at connections; security of anchorage; wear due to rubbing or vibration; dents and cracks.

(b) Check oil radiator for foreign matter in air passages.

(c) Drain oil by removing drain plug. *(See figure 10.)*

(d) Remove and clean suction and pressure strainers. *(See figure 10.)* Clean strainer chambers and replace strainers and drain plug. When replacing pressure strainer, a new gasket should be used.

CAUTION

When assembling oil pressure screen, be sure that screen seats in recess in inner end of chamber. Otherwise the screen will be damaged when cover nuts are tightened.

(e) Refill oil sump to normal capacity of 10 quarts. Maximum capacity of 12 quarts should be used only for cross-country flights. Oil should conform to Specification No. AN-VV-O-446, grade 1100 for summer temperatures, grade 1080 for winter temperatures.

(f) Check all plugs for proper safetying.

(4) COOLING SYSTEM.

(a) Check baffles for secure anchorage, and for holes, cracks, or bending, and close fit around cylinder.

(b) Check cylinders for cracked or broken fins and for excessive foreign matter between fins.

(c) Check air entrances and exits for deformation; any bent or dented metal around the air entrances or exits should be repaired immediately.

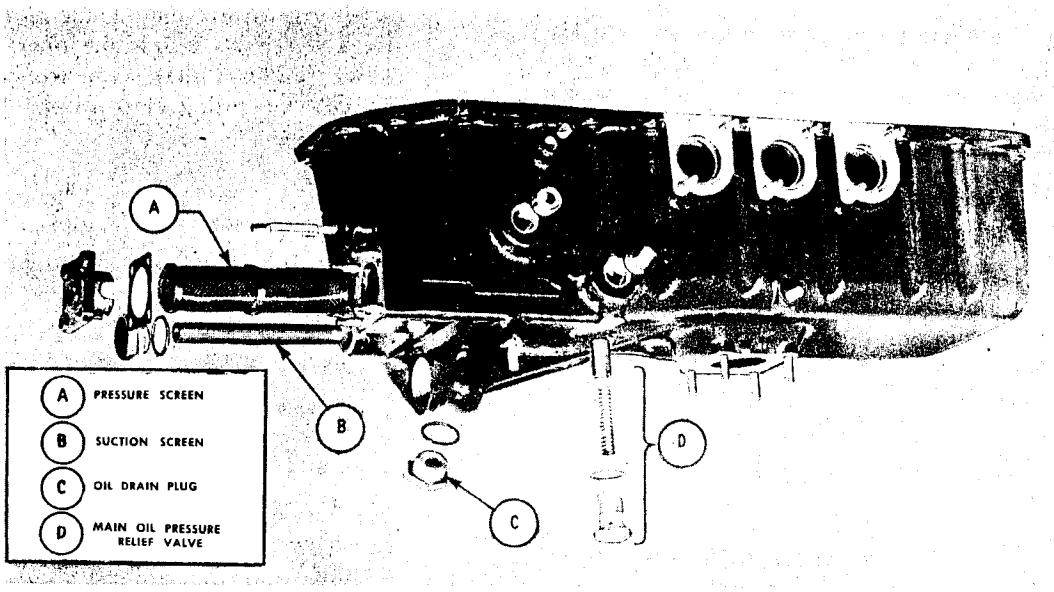


Figure 10. Oil Strainers and Main Oil Pressure Relief Valve

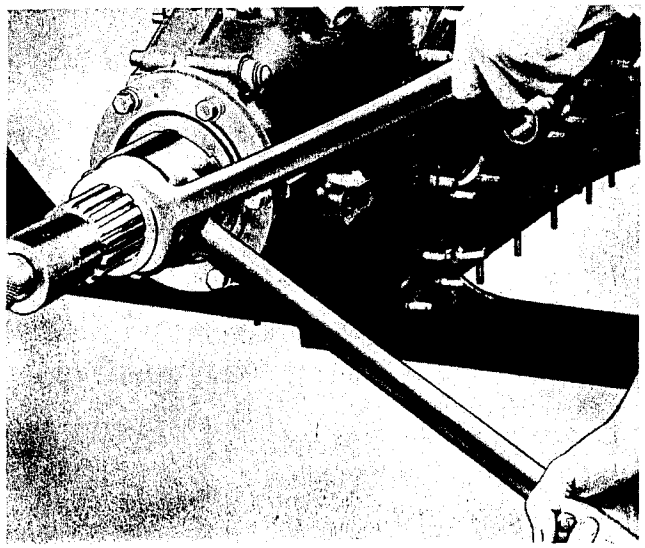


Figure 11. Tightening Thrust Nut

(5) MANIFOLDS AND SUPERCHARGERS.

(a) Check intake system for leaks. Leaks are usually indicated by erratic idling and often by a high pitched whistle when the engine is idling.

(b) Check exhaust system for cracks, leaks, and looseness. Leaks in the exhaust system are usually indicated by exhaust deposits or soot on the outside of the exhaust pipe.

(c) To repair leaks at intake or exhaust connection, remove the necessary parts and renew gaskets. DO NOT attempt to stop leaks by tightening nuts.

c. 50-HOUR (NAVY 60-HOUR).

(1) IGNITION AND ELECTRICAL.—Inspect ignition shielding for proper anchorage and condition of shielding braid.

(2) MANIFOLDS AND SUPERCHARGERS.—Check for tightness of all nuts securing intake pipes and exhaust manifolds.

(3) PROPELLERS AND ACCESSORIES.—Check thrust bearing nut and tighten if necessary. *(See figure 11.)* Thrust bearing nut should be tightened to 4500 inch-pounds. If a torque indicator is not available, correct torque may be obtained by proper choice of wrench handle. The length of the wrench handle in inches (actually the distance from center of crankshaft to point of application of weight) multiplied by the force exerted on the wrench in pounds must equal 4500 inch-pounds. (If a man uses his own weight to tighten the thrust nut, his weight is considered the force exerted.) The following table shows the length which should be selected for men of different weights:

For 100-pound man	45 in.
For 125-pound man	36 in.
For 150-pound man	30 in.
For 175-pound man	26 in.
For 200-pound man	22½ in.
For 225-pound man	20 in.
For 250-pound man	18 in.

(4) POWER PLANT.—Inspect cylinders for general condition.

d. 100-HOUR (NAVY 120-HOUR).

(1) IGNITION AND ELECTRICAL.—Replace all spark plugs with new or reconditioned plugs of approved type. Use a torque wrench to tighten plugs to 300 to 360 inch-pounds torque.

CAUTION

Do not install spark plugs unless engine is cool.

(2) POWER PLANT.—Check all engine nuts for proper tightening, using torque wrench. (Refer to Table of Limits, AN 02-15-1, for tightening torque values for various nuts.)

SECTION VII

ADJUSTMENT, REPLACEMENT, AND MINOR REPAIR

1. GENERAL.

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

b. Before complying with the following instructions, the airplane will be brought indoors to protect it against dust and rain. The engine need not be removed from the airplane for the accomplishment of this work.

2. REMOVAL OF CYLINDER AND RELATED PARTS.

(See figure 12.)

a. Remove exhaust manifold.

b. Remove rocker box drain tube, intake pipe, baffles, priming lines, and any clips that interfere with the removal of cylinders.

c. Disconnect ignition cable and remove spark plugs. Remove rocker box cover and rotate crankshaft until piston is approximately at top center of the compres-

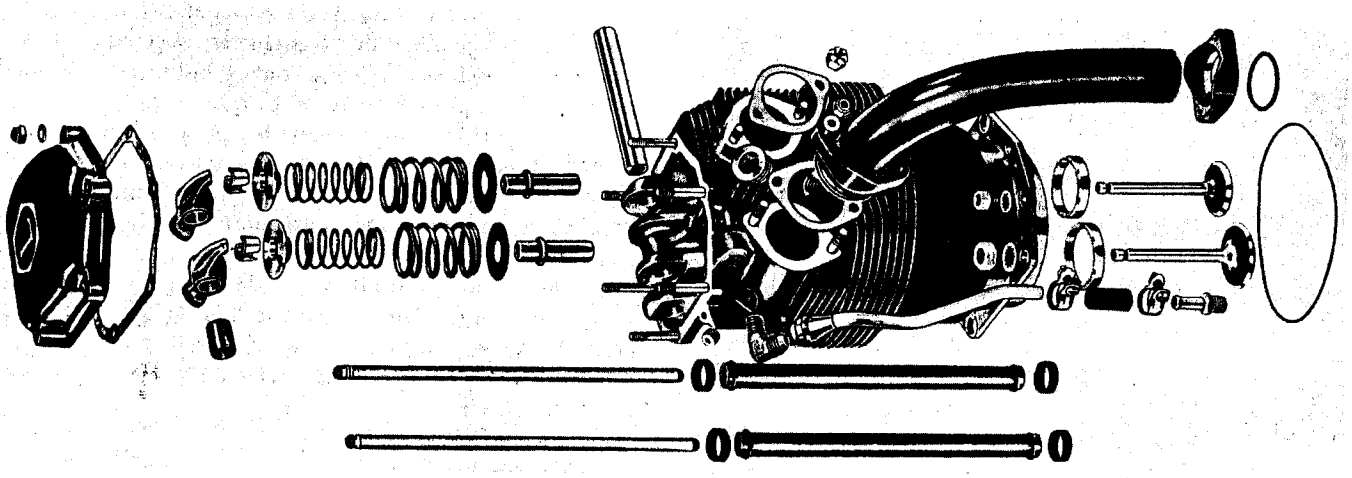


Figure 12. Exploded View of Cylinder Assembly

sion stroke. This approximate position may be located by observing top of the piston through the spark plug hole and also watching the valve action. At top center of the compression stroke the piston will be at the top of its stroke, and both valves will be closed. This method of locating top center is approximate and must not be used for any timing operation.

d. Remove valve rockers by sliding valve rocker shaft out of the cylinder head.

Note

Valve rocker shaft on Nos. 3 and 4 cylinders must be left in cylinder head until cylinder is removed.

e. Remove push rods by grasping ball end and pulling rod out of shroud tube.

CAUTION

The hydraulic tappets, push rods, rocker arms, and valves must be marked so that they can be assembled in the same location from which they were removed.

f. Remove cylinder base, nuts and washers, and remove cylinder by pulling cylinder directly away from crankcase. Be careful not to allow the piston to drop against the crankcase as the piston leaves the cylinder. Shroud tubes must also be held to prevent their being dropped.

3. REMOVAL OF VALVES AND VALVE SPRINGS FROM CYLINDER.

Place the cylinder over a block of wood so as to hold the valves in a closed position. Compress the valve springs using the valve spring compressor, tool No. 1130-B. Remove the tapered split keys from the end of the valve stem. The valve spring and valve spring seats may now be removed from the cylinder head. Hold the valve stems so that the valves will not fall out, and remove the cylinder from the holding block. The valves may now be removed from the inside of the cylinder.

4. REMOVAL OF PISTON FROM CONNECTING ROD.

a. Remove piston pin plugs. This may be done by inserting a piece of bent lock wire through the hole in the piston pin plug and pulling the plug out of the piston pin.

b. Drive the piston pin out of the piston, using a fiber drift on the end of the piston pin. *(See figure 13.)* The piston should be held firmly during this operation in order to avoid bending the connecting rod. If the piston pin tends to stick in the piston, it may be loosened by heating the piston with hot oil.

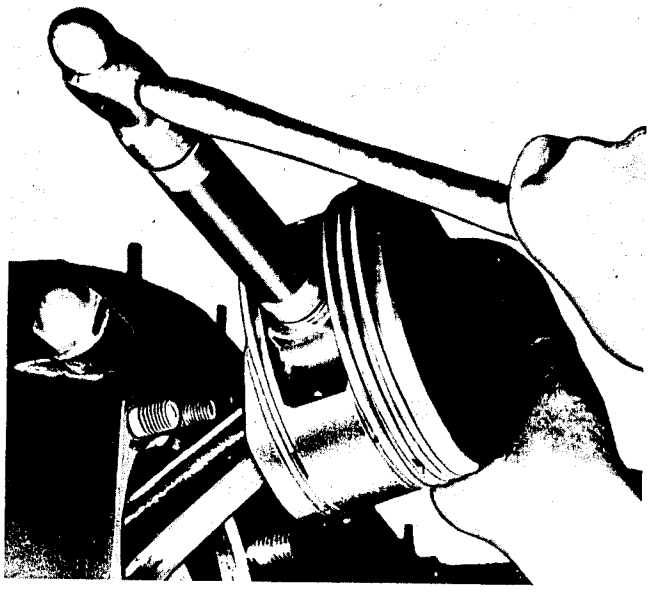
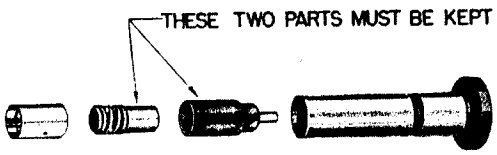
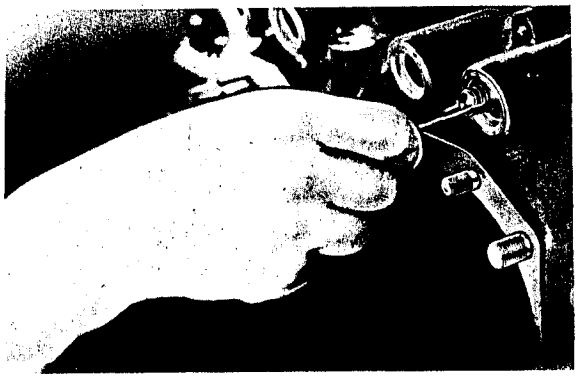


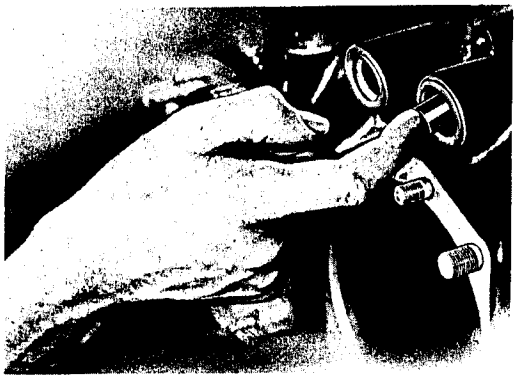
Figure 13. Removing Piston Pin



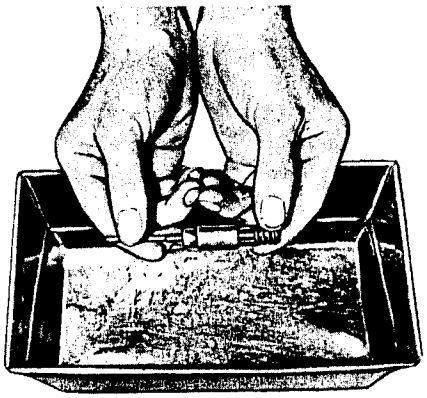
Hydraulic Tappet Assembly



Removing Plunger Assembly

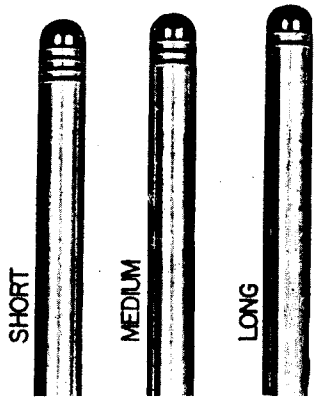


Removing Tappet Socket

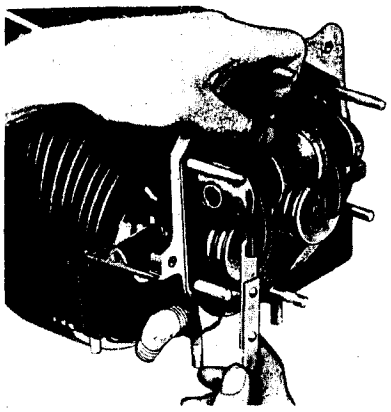


Washing Plunger Assembly

Testing Plunger Assembly



Three Lengths of Push Rods



Checking Valve Clearance

Figure 14. Hydraulic Tappet—Disassembly, Cleaning, and Inspection

5. REMOVAL OF HYDRAULIC TAPPET SOCKETS AND PLUNGER ASSEMBLIES.

The hydraulic tappet socket may usually be removed by inserting the forefinger into the concave end of the socket. The socket will usually stick to the finger firmly enough to be pulled out of the tappet body. If the socket can not be removed in this manner, it may be removed by grasping the edge of the socket with a pair of needle nose pliers. However, care should be exercised to avoid scratching the socket. To remove the hydraulic tappet plunger assembly, bend a hook in the end of a short piece of lock wire, insert the lock wire around the edge of the plunger assembly and turn the wire so that the hook engages the spring of the plunger assembly. Draw the plunger assembly out to the tappet body by pulling gently on the wire. *(See figure 14.)*

6. CLEANING AND INSPECTION OF HYDRAULIC TAPPET PLUNGER ASSEMBLY.

a. Disassemble hydraulic tappet plunger assembly by grasping the tube end of the plunger assembly in one hand and the spring end in the other. Remove the plunger by twisting the spring end of the plunger assembly in a clockwise direction and pulling the plunger out of the tube.

CAUTION

Do not allow parts of two or more plunger assemblies to become mixed as the parts of the plunger assembly are lapped together and are not interchangeable.

b. Clean the plunger assembly by flushing with petroleum solvent. Work the plunger up and down while the unit is immersed in the solvent, holding the check valve off its seat by means of a copper wire or other relatively soft article inserted through the tube. *(See figure 14.)* Do not use a blast of air or pressure spray to clean the plunger assembly as damage to the check valve and check valve seat may result.

c. Thoroughly dry the plunger assembly and start the plunger into the cylinder. Check the operation of the plunger assembly by depressing and releasing the plunger with one finger, as shown in figure 14. On a serviceable plunger assembly, the plunger will spring back if pressure is released immediately after the plunger is depressed. This is caused by the air trapped inside the plunger assembly. If the plunger assembly, when pushed down by the finger, does not have a "springy" feel and stays at the bottom when released, the check valve is leaking, or the plunger assembly is worn and will not hold air under the plunger. If the plunger assembly fails to pass inspection as outlined above, clean the plunger assembly as directed in paragraph *b.* and repeat the check. If the plunger assembly still fails to pass inspection, it should be rejected and replaced with a new plunger assembly.

Note

The above inspection procedure must be made with the plunger assembly absolutely dry and free from oil or cleaning solvent.

d. The plunger assembly should be reassembled *without oil.* This may be accomplished by placing the plunger in position, compressing the spring slightly, and at the same time twisting the spring end of the plunger in a clockwise direction until the spring is felt to click into place.

7. ASSEMBLY OF VALVES IN CYLINDER.

a. Insert each valve stem in its respective guide, being certain that the exhaust and intake valves are not reversed.

Note

The exhaust valve head is slightly smaller than the intake valve head.

b. Place cylinder over a wood block so that the valves are held against the seats and assemble the lower spring seat, auxiliary valve spring and outer valve spring over the valve stem and guide. Place the upper spring seat on top of the springs.

c. Using valve spring compressor, tool No. 1130-B, compress the valve spring and assemble the two valve keys into the groove around the upper end of the valve stem. *(See figure 15.)* Slowly release the pressure on the valve spring compressor, and allow the upper spring seat to lock itself in place around the valve keys.

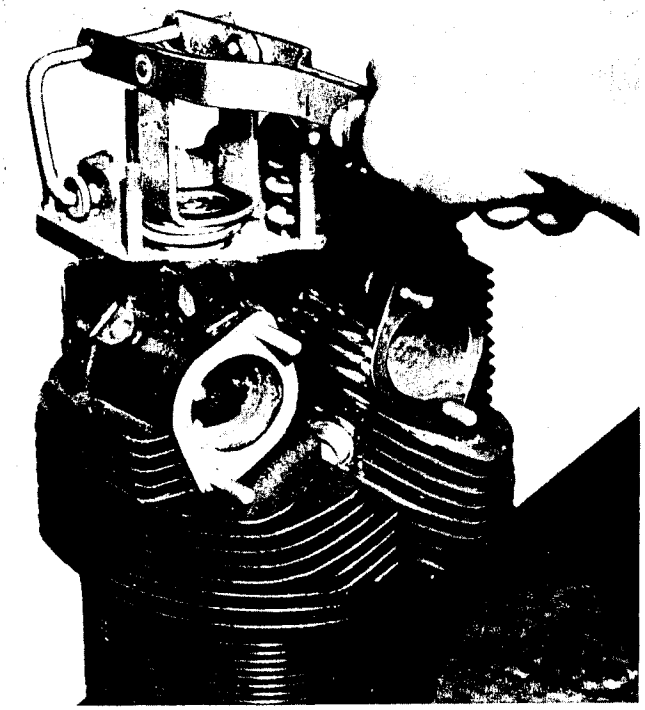


Figure 15. Use of Valve Spring Compressor

8. ASSEMBLY OF CYLINDER AND RELATED PARTS.

a. Rotate crankshaft so that the connecting rod of the cylinder being assembled is at the top center position, with both tappets on the low side of the cam in closed-valve position.

b. If plunger assembly has not been previously removed and cleaned, tappet socket and plunger assembly must be removed as directed in paragraph 5 and plunger assembly must be washed and reassembled without oil as directed in paragraph 6.

c. Assemble each plunger assembly in its respective tappet body. Assemble socket on top of plunger assembly.

d. Assemble piston with rings so that the cylinder number stamped on the piston pin boss is toward the front end of the engine. The piston pin should be a hand push fit. If difficulty is experienced in inserting the piston pin, it is probably caused by carbon or burrs in the piston pin hole. During assembly always use a generous quantity of oil, both in the piston pin hole and on the piston pin.

e. Assemble one piston pin plug at each end of the piston pin, and place a new rubber oil-seal ring around the cylinder skirt. Coat piston and rings and the inside of the cylinder generously with oil.

f. Using piston ring compressor, tool No. 64529, assemble the cylinder over the piston so that intake and exhaust ports are toward the bottom of the engine. *(See figure 16.)*

g. Push the cylinder down onto the cylinder mounting studs.

h. Insert a new shroud tube oil seal over each end of shroud tube.

i. Pull the cylinder back far enough to insert one end of each shroud tube into position in the cylinder head, and hold shroud tube so that rubber seals will enter the seal seats in the crankcase.

j. Push the cylinder all the way down and assemble lock washers and nuts. Be sure that shroud tube seals are seated properly, then tighten cylinder base nuts using wrenches Nos. 65522 and 65523. Use 300 inch-pounds torque on 3/8-inch nuts and 550 inch-pounds torque on 1/2-inch nuts. If wrenches Nos. 65472 and 1121-B are available they should be used together with a torque indicating wrench to tighten the cylinder base nuts.

k. Install baffles, intake pipe, rocker box drain tubes and exhaust manifold.

l. Assemble each push rod in its respective shroud tube, and assemble each rocker in its respective position by placing rocker between bosses, and sliding valve rocker pin in place to retain rocker. *(See figure 17.)*

m. Be sure that the piston is at top center compression stroke and that both valves are closed. Check clearance between the valve stem tip and the valve rocker. In order to check this clearance, place the thumb of one hand on the valve rocker directly over the end of the push rod and push down so as to compress the hydraulic tappet spring. *(See figure 15.)* While holding the spring compressed, check valve clearance using valve clearance gage, tool No. 65528. This clearance should be between .038 and .080 inch. If the clearance does not come within these limits, remove the push rod and insert a longer or shorter push rod as required to correct clearance. Push rods are made in three lengths: the longest rod is marked by a single groove, cut near the one end; the medium length rod is marked by two grooves; and the shortest rod is marked by three grooves. *(See figure 14.)*

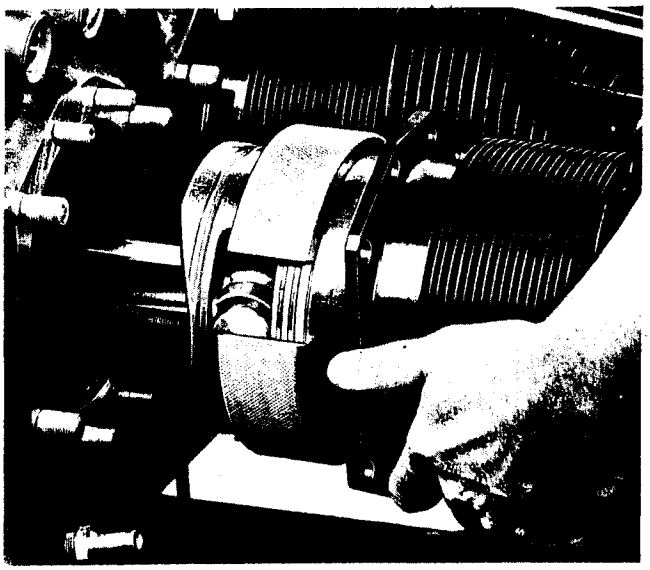


Figure 16. Use of Piston Ring Compressor

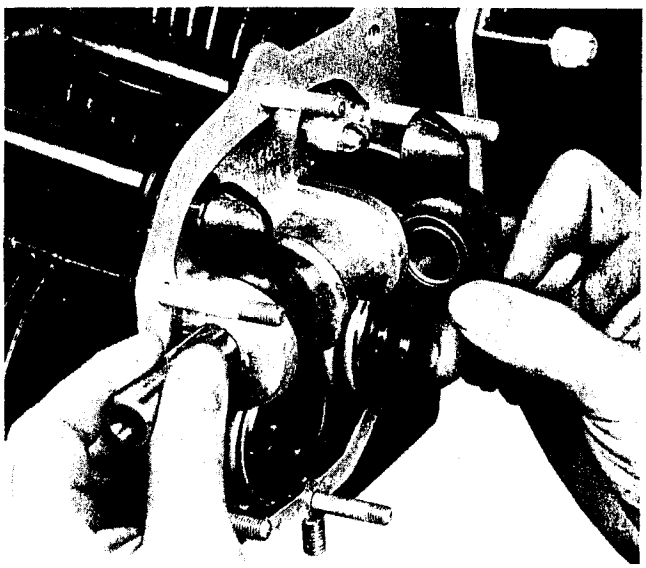


Figure 17. Installing Valve Rocker

Note

Inserting a longer rod will cause a decrease in the valve clearance.

9. VALVES.

The valves are actuated by hydraulic tappets which automatically keep the valve clearance at zero. No valve clearance adjustment is provided, and no attempt should be made to adjust valve clearance except during assembly or replacement of valve gear parts. Refer to preceding paragraph for instructions on adjusting valve clearance during replacement of cylinder.

10. OIL PRESSURE RELIEF VALVE.

The main oil pressure relief valve is located at the bottom of the oil sump and the auxiliary pressure relief valve is located at the lower front of the crankcase. The settings of both valves are fixed at the factory and oil pressure relief is controlled by calibrated springs.

CAUTION

Do not attempt to change relief valve setting by stretching the spring. If it is suspected that incorrect oil pressure is caused by faulty functioning of the relief valve, first be sure that relief valve plunger and seat are clean and operate freely.

11. CARBURETOR.

For complete information on Marvel-Schebler Model MA-4SPA Carburetor, see AN 03-10BD-2.

a. REMOVAL.

(1) Remove carburetor air intake housing and attached controls.

(2) Turn airplane fuel valve to the "OFF" position and disconnect fuel line at carburetor.

(3) Remove throttle linkage and mixture control linkage, in each case leaving the arm that operates the control shaft in the carburetor attached to the shaft.

(4) Remove nuts from carburetor attaching studs and remove carburetor.

b. INSTALLATION.

(1) Place gasket and carburetor over carburetor mounting studs at the bottom of the oil sump. Assemble washers and nuts over carburetor mounting studs and lock nuts with lock wire. Check fuel line for obstructions and check carburetor strainer to be sure that it is clean. Connect fuel line.

(2) Connect throttle and mixture control linkages. Check operation to be certain that they operate freely and that cockpit controls will move the carburetor controls through their full range without binding or lost motion. Be sure to safety all pins and bolts in throttle and mixture control linkages.

(3) Attach carburetor air intake housing and associated connections and controls. Check operation of heater valve to see that hot and cold air can be properly controlled from the cockpit.

c. ADJUSTMENT.—With exception of idling adjustment and in rare cases the acceleration pump adjustment, no adjustment of the carburetor is necessary. The mixture is controlled by means of jets and air passages that are not adjustable, and are calibrated at the factory.

(1) To adjust the idle mixture and speed: With engine thoroughly warmed up, set throttle stop screw so that engine idles at approximately 550 rpm. Turn idle adjusting needle out slowly by means of a long thin bit screw driver until engine "rolls" from richness. Then turn needle in slowly until engine "lags" or runs irregularly from leanness. This step will give an idea of the idle adjustment range and of how the engine operates under these extreme idle mixtures. From the lean setting, turn needle out slowly to the richest mixture that will not cause the engine to "roll" or run unevenly. This adjustment will in most cases give a slower idle speed than a slightly leaner adjustment, with the same throttle stop screw setting, but will give smoothest idle operation. A change in idle mixture will change the idle speed and it may be necessary to readjust the idle speed with throttle stop screw to the desired idle speed of 550 rpm.

(2) The acceleration pump link should be in the outer or long stroke hole for all normal operation.

12. MAGNETO.

For complete information on Scintilla Model SF6LN-8 Magneto see AN 03-5DA-6. *(See figure 18.)*

a. REMOVAL.

(1) Remove spark plug cable by unscrewing the knurled nut at the magneto end of each cable and pulling the electrode out of the magneto.

(2) Check marking of each cable as it is removed.

(3) Disconnect magneto ground wires to ignition switch.

CAUTION

Always remove spark plug cables before disconnecting ground wire, as the magneto may fire if it is turned with the ground wire disconnected.

(4) Dismount magneto by removing the magneto mounting nuts and washers. Leave mounting in place in engine.

(5) If the magneto is to be replaced, remove coupling from magneto shaft using a standard gear puller. Be careful not to damage thread on end of magneto shaft.

b. TIMING.—The following procedure should be followed in timing the magneto to the engine. *(See figure 19.)*

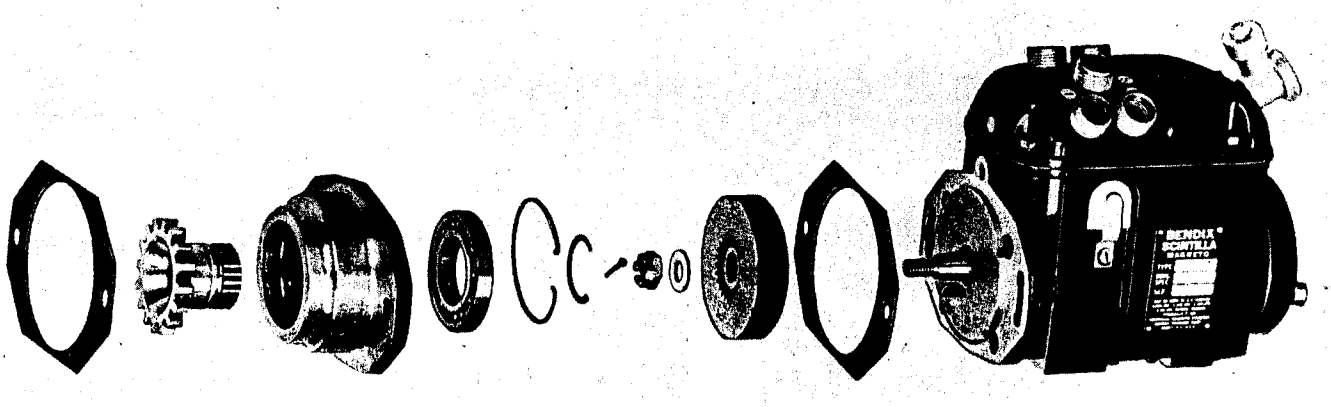


Figure 18. Exploded View of Magneto Drive

(1) Slide spline wrench on crankshaft spline. Assemble timing pointer on crankshaft so that mark on the face of the timing disc aligns with mark on head of dowel in crankshaft spline. If no mark is visible, use center of dowel head. Clamp disc in place by tightening clamp nut.

(2) Align mark on the pointer of the timing disc with the upper division line between crankcase sections when the engine is on the compression stroke of No. 1 cylinder. The engine is now set for firing No. 1 cylinder (15 degrees before top center). The compression stroke may be located in the following manner:

(a) Remove one spark plug from No. 1 cylinder.

(b) Place thumb firmly over spark plug hole.

(c) Turn crankshaft rapidly in direction of normal rotation (counterclockwise when viewed from the front). A definite positive pressure tending to lift the thumb off the spark plug hole indicates the compression stroke.

(3) Check breaker point adjustment on each magneto as directed in paragraph 12. *d.* following. Assemble magneto coupling with key, washer, nut, and cotter pin on each magneto. Assemble adapter, with gear and bearing installed, on each magneto so that spline on magneto gear engages spline of magneto coupling.

(4) Rotate magneto until white tooth of distributor gear is exactly opposite pointer as viewed through window at top front of magneto cover. Hold the magneto in this position. Assemble magneto to the engine so that magneto drive gear meshes with the cam gear inside the accessory housing. Assemble flat washers and nuts. Tighten nuts with fingers. Turn the magneto body clockwise as viewed from the breaker point end as far as it will go. Attach positive clip of timing light, part No. 8042-273875, or equivalent, to ground connection on magneto, exercising care that clip does not touch the housing at any point. Attach timing light ground clip to a suitable convenient point on magneto or engine. Rotate the magneto body slowly in a counterclockwise direction until exact point of breaker opening is indicated by timing light going out. Lock the magneto exactly in this position.

Note

If a timing light is not available, a .0015-inch steel feeler gage may be used. The feeler gage is the only method which should be used. Do not use cellophane, as it leaves a greasy or waxy residue on the points which causes them to arc and burn. The use of cigarette paper is not recommended in the absence of the timing light, as the pits on the points will tear small particles at the time of removal.

(5) If it is found that the breaker points will not close when the magneto body is rotated clockwise as far as it will go, magneto should be loosened far enough for the magneto drive gear to be disengaged and drive gear rotated one tooth counterclockwise. If the breaker points will not open when the magneto body is rotated counterclockwise as far as it will go, rotate the drive gear one tooth in a clockwise direction.

(6) Repeat preceding procedure for the other magneto.

(7) After both magnetos have been timed, turn the crankshaft about 45 degrees in the direction opposite normal rotation and connect timing light to both magnetos. Rotate or "bump" the crankshaft slowly in the direction of normal rotation. If the engine is properly timed, both lights should flash on simultaneously as the mark on the timing pointer aligns with the division line of the crankcase sections. If the breaker points open too early, loosen the mounting nuts and rotate magneto clockwise. If the breaker points open too late, rotate magneto counterclockwise.

c. MAGNETO CHECK.—To check magneto timing after engine is in service in the airplane, repeat paragraphs (1), (2), and (7). If timing is not correct, check and correct (if necessary) breaker point adjust-

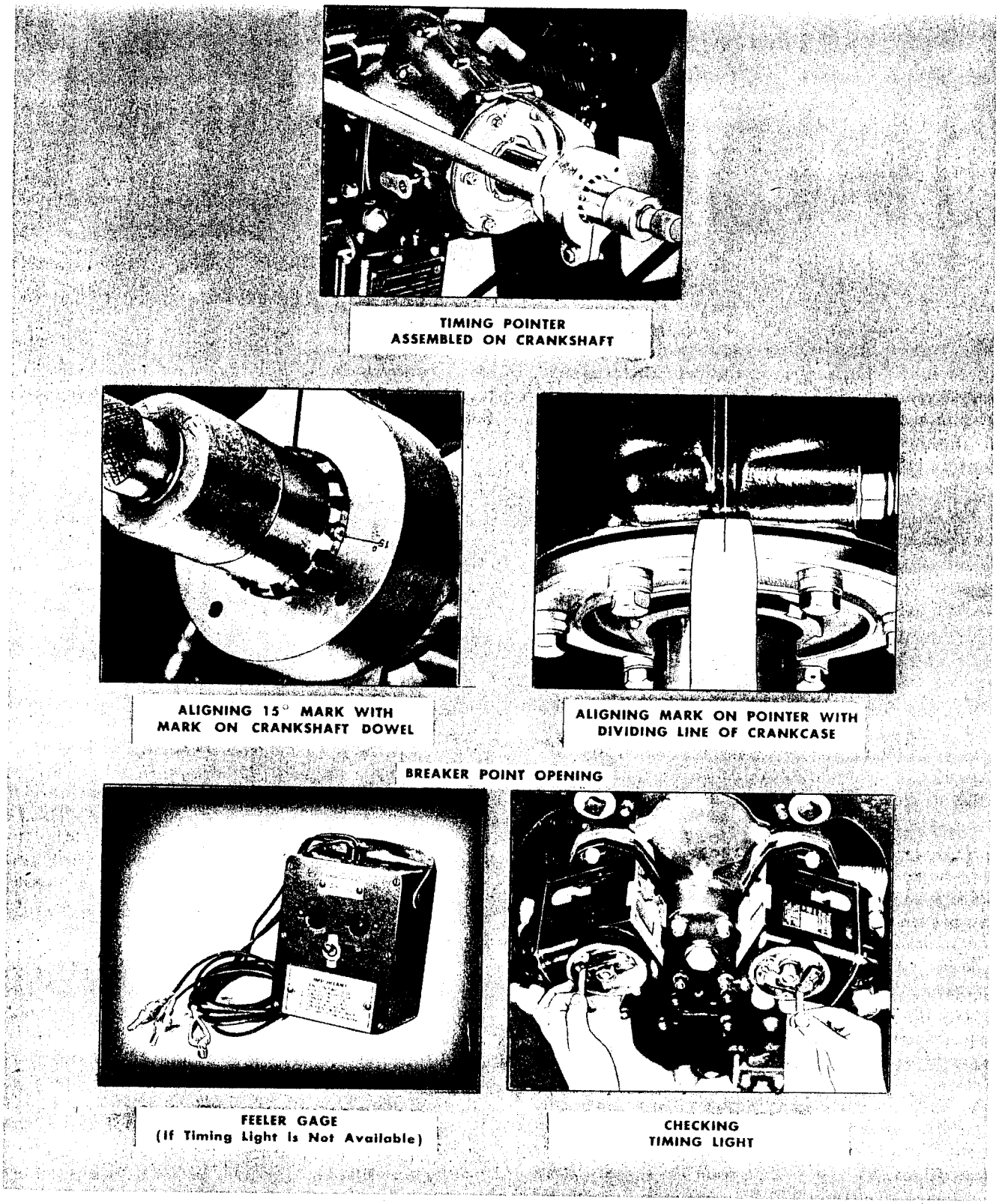


Figure 19. Magneto Timing

ment as directed in paragraph 12.*d.* following. If the breaker point opening of both magnetos still does not come at exactly 15 degrees before top center, the magneto timing may be adjusted as directed in paragraph 12.*b.* (7) preceding.

d. BREAKER POINT ADJUSTMENT.

(1) Attach positive clip of timing light, part No. 8042-273875, or equivalent, to ground connection on magneto, exercising care that clip does not touch the housing at any point. Attach timing light ground clip to a suitable convenient point on magneto. Rotate the magneto drive shaft in the direction indicated by the arrow at the breaker point end of the magneto cover until chamfered tooth on the distributor gear is exactly opposite the pointer as seen through the timing window at the front end of the magneto cover. As these two marks line up, the breaker points should just begin to open as indicated by timing light going out.

(2) If the breaker points do not open at the proper time, loosen the two screws that hold the stationary breaker points and move the breaker point assembly to right or left as required. Separating the breaker points will cause the breaker to open earlier; moving the breaker points closer together will cause it to open later.

Note

It should be remembered that the breaker points are not adjusted to any fixed clearance between them.

(3) If the breaker point contacts do not line up properly, the movable breaker point may be adjusted by loosening the two screws that secure the movable breaker points. The hole for the right-hand screw is slightly oversize to permit adjustment of the movable breaker point assembly. After tightening the screws, check both the timing and alignment to be sure that they are correct.

13. STARTER.

a. REMOVAL.

(1) Before removing starter, disconnect airplane battery.

(2) Disconnect cables from rear end of starter, marking each cable as it is removed.

(3) Remove starter mounting nuts and remove starter from engine.

b. INSTALLATION.

(1) Remove nuts from starter mounting and place starter in position over studs. Be sure that starter is assembled in such a position that cables may be properly assembled, and that starter will not interfere with other parts of airplane or engine.

(2) Connect starter cables. Be sure that the grounded cable is fastened to the grounded terminal on the starter.

(3) Connect airplane battery.

14. GENERATOR.

a. REMOVAL.

(1) Disconnect airplane battery or turn airplane master switch to "OFF" position. Disconnect generator wiring at generator, marking each wire as it is removed.

(2) Remove nuts from generator mounting studs and lift generator clear of mounting.

(3) Remove cap screw from end of generator drive shaft and remove generator drive gear.

b. INSTALLATION.

(1) Assemble generator drive gear on generator drive shaft.

(2) Secure with flat washer, lock plate, and cap screw.

(3) Lock cap screw in place by bending up edge of lock plate.

CAUTION

Generator gear retaining cap screw must be tightened to 150 inch-pounds with a torque wrench, and lock plate bent up on two sides of cap screw. Tongue on lock plate must fit into recess in gear. Be sure to check to see that gear has end play on shaft after tightening cap screw.

(4) Install generator in place on engine so that generator drive gear engages internal teeth on cam gear.

(5) Secure generator with nuts and washers on generator mounting studs.

(6) Connect generator wiring. If wiring has not been marked when generator was removed, refer to wiring diagram in the airplane Handbook for proper connections.

SECTION VIII
SERVICE TOOLS

1. SERVICE TOOL KIT.

The following list of tools is included in the service tool kit assembly, No. 65335. *(See figure 20.)*

Tool No.	*Description*
1130-B	Compressor—Valve spring
1155	Wrench—1.25 hex
1163	Container—Tool
65522	Wrench—Cylinder stud nut—.75 hex
65523	Wrench—Cylinder stud nut—.56 hex
65524	Handle—Sliding—stud nut wrench
65525	Socket—Universal joint—.44 hex
65526	Socket—Universal joint—.50 hex
65528	Gage—Valve clearance

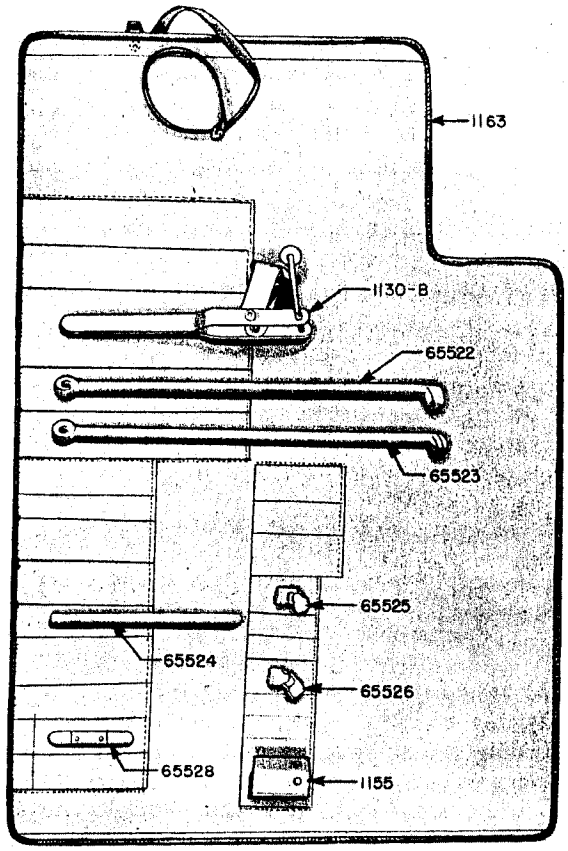


Figure 20. Tool Kit Assembly No. 65335

2. OVERHAUL TOOLS RECOMMENDED FOR OPERATING ACTIVITIES.

Only the tools most frequently used can be included in the service tool kit. Additional special tools which are necessary or desirable at stations servicing 0-435-1 engines are listed below:

Tool No.	*Description*	*Application*
64607	Block—Thrust cap	Install thrust nut in thrust cap
64529	Compressor—Piston ring	Assemble cylinder to engine
64527	Drift—Piston pin	Remove piston pin
64528	Expander—Piston ring	Assemble rings on piston
*64582	Pointer—Ignition timing	Time engine
1240	Sling—Engine lifting	Lift engine
*1225-B	Wrench—Crankshaft spline	Turn crankshaft
*1121-B	Wrench—Cylinder stud nut 3/8 in. For use with torque indicator	Tighten cylinder base nuts
*64572	Wrench—Cylinder stud nut 1/2 in. For use with torque indicator	Tighten cylinder base nuts
*1228-B	Wrench—Thrust nut	Turn thrust nut

*These tools are necessary to perform work covered by this Handbook.

HEADQUARTERS, ARMY AIR FORCES
WASHINGTON 25, D. C.

TECHNICAL ORDER
NO. 02-15BA-12

28 May 1945

LYCOMING—MODIFICATION OF EXHAUST VALVE GUIDE—0-435-1

NOTE As prescribed in T. O. No. 00-20A, appropriate reference to this Technical Order will be entered on AAF Forms 60-B, by depots only, at the time of compliance, for the engines affected. The work directed herein will be accomplished by depots at the time of next engine overhaul. Spare exhaust valve guides, part No. 60028, and those installed in spare cylinder assemblies, part No. 65394 and 65756, in stock, will be reworked prior to issue.

1. To prevent loss of compression and burning of the exhaust valves in 0-435-1 engines caused by the valves sticking, the exhaust valve guides will be modified in accordance with instructions contained in paragraph 2.

2. Exhaust valve guides will be modified by counterboring a recess .500 ± .002-inch diameter to a depth of .500 inch in the port end, as shown in figure 1.

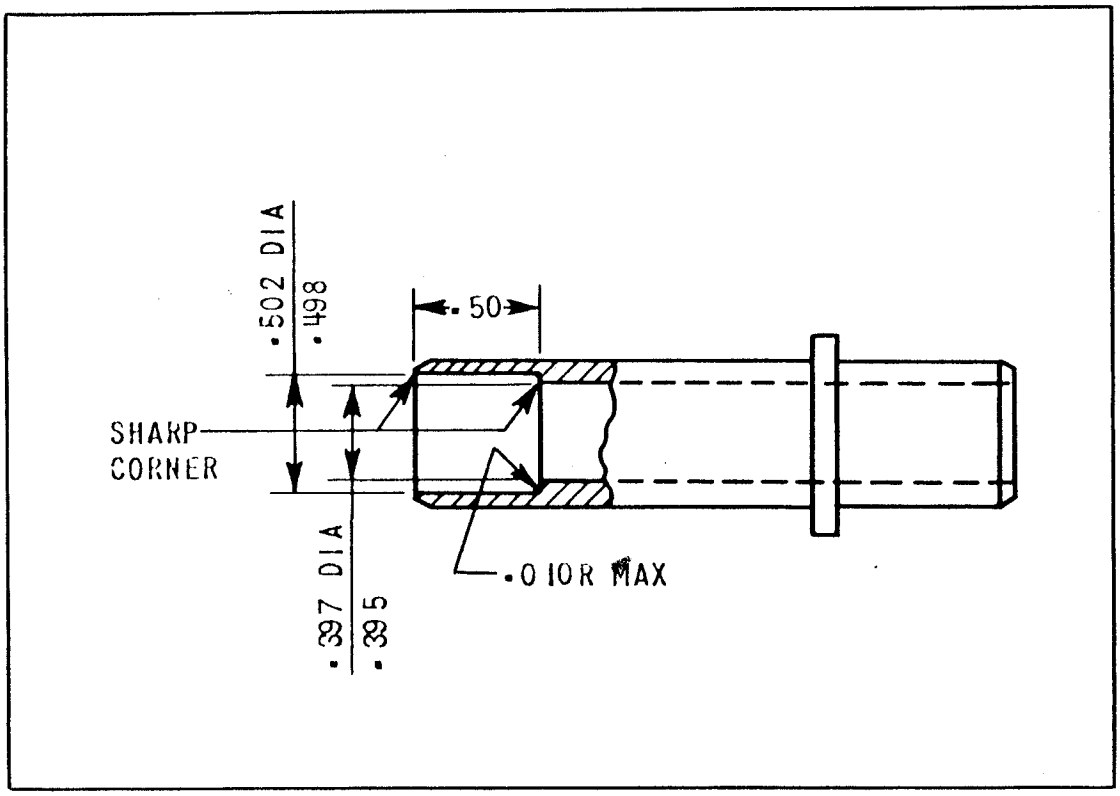


Figure 1

BY COMMAND OF GENERAL ARNOLD:

Prepared by
Engine Section,
Maintenance Div,
Hq, ATSC.

B. E. MEYERS
Major General, U. S. A.
Acting Director
Air Technical Service Command

HEADQUARTERS, ARMY AIR FORCES
WASHINGTON 25, D. C.

TECHNICAL ORDER
NO. 02-15BA-13

ENGINES AND MAINTENANCE PARTS

12 September 1945

LYCOMING—INSTALLATION AND DOWELING OF SPARK PLUG BUSHINGS—0-435-1

NOTE As prescribed in T. O. No. 00-20A, appropriate reference to this Technical Order will be entered on AAF Forms 60-B, by depots only, at the time of compliance, for the engines affected. The work directed herein will be accomplished by depots at the time of overhaul, if not previously accomplished.

1. To prevent spark plug bushings, part No. 65530, from backing out when removing spark plugs from 0-435-1 cylinders, spark plug bushings which are tight in the cylinder head will be secured with two dowels set 180 degrees apart in accordance with the instructions contained in paragraph 2.b. Spark plug bushings which are damaged or loose will be replaced and cylinders equipped with Heli-coil inserts which are damaged to the extent that an oversize Heli-coil insert cannot be installed, will be repaired by installing a spark plug bushing in accordance with instructions contained in paragraph 2.

2. a. Instructions for replacing spark plug bushings or installing a spark plug bushing in a cylinder originally equipped with a Heli-coil insert are as follows:

(1) To remove spark plug bushing place cylinder holding fixture, tool No. 64500, on drill press table and assemble cylinder on the fixture with spark plug bushing to be removed in the up position. Assemble holder, tool No. 1307, and counterbore, tool No. 64502, on drill press spindle. Align center line of spark plug bushing to center line of counterbore tool and clamp cylinder holding fixture, tool No. 64500, to drill press table. Bore completely through the spark plug bushing. Remove the remaining shell, being careful not to damage the threads in the cylinder head. Remove dowel pin and mark the location to make certain the new dowel pin will not be put into the same location.

(2) Clean up the threads in the cylinder head with a spark plug bushing hole tap, stock No. 8037-AAF487810. If an oversize spark plug bushing is required, the spark plug bushing hole in cylinder head will be tapped oversize with a .005-inch oversize tap, stock No. 8037-AAF487800, or a .010-inch oversize tap, stock No. 8037-AAF487805, and the corresponding oversize bushing installed.

(3) To install a spark plug bushing in a cylinder assembly originally equipped with a Heli-coil insert, mount the cylinder assembly on the drill press and counterbore, as described in paragraph 2.a.(1).

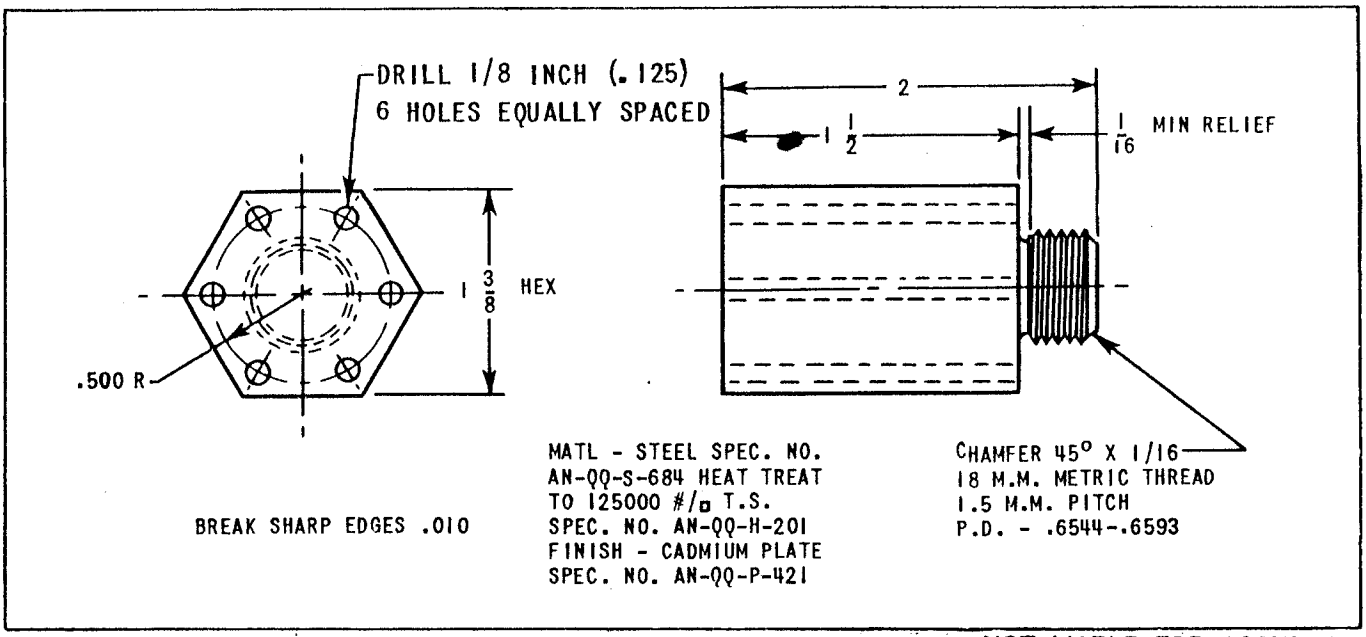


Figure 1 - Drill Jig, Part No. ASC45A979

(4) Tap the hole bored in the cylinder head with a standard spark plug bushing hole tap, stock No. 8037-AAF487810.

(5) To install the spark plug bushing in the cylinder, screw the spark plug bushing on the spark plug bushing driver, tool No. 1304, and tighten the lock nut against the bushing flange. Heat the cylinder head to 204°C (400°F). Coat the outside threads of the spark plug bushing with shellac, Specification No. TT-V-91, and immediately screw spark plug bushing to a full seat in the cylinder head. Loosen the lock nut and remove the bushing driver.

NOTE Spark plug bushings may be made from Ranger insert spark plug bushings, part No. 5030, by machining the outside diameter of the flange to 1.200 to 1.220 inches and chamfering the corners .005 to .015 inch at approximately 45 degrees.

(6) Dowel spark plug bushing as directed in paragraph 2.b.

b. Instructions for doweling spark plug bushings are as follows:

(1) Manufacture a drill jig as shown in figure 1.

(2) Grind a 1/8-inch twist drill to .123-inch diameter for a distance of 1/2 inch from the point.

(3) Screw drill jig into the spark plug bushing flush against the face of the bushing so that the hole used to guide the drill is located at the position the new dowels are to be placed. When possible place dowels at 12 and 6 o'clock position.

(4) Place the modified 1/8-inch twist drill in the chuck of the drill so that 1-29/32 inches of the 1/8-inch drill extends from the chuck.

(5) Drill the dowel pin holes using the guide holes in the drill jig nearest the 12 and 6 o'clock position. If previously doweled at this position, drill the holes approximately at 3 and 9 o'clock position.

NOTE The desired location of new dowel hole is 90 degrees from previous dowel location.

(6) Using the chuck for a stop to determine that the proper depth of .410 inch is obtained for the dowel pinhole.

NOTE It is important that the 1/8-inch twist drill be adjusted in the chuck so that the chuck can be used as a stop.

(7) Press in dowel pin, part No. STD-132, flush with or .020 inch below the spark plug bushing surface.

(8) Spotface spark plug bushing only deep enough to clean up the surface and furnish a square seat for the spark plug gasket.

(9) Tap spark plug bushing with tap, stock No. 8003-44A6955.

3. a. The following parts are required per airplane to accomplish this change:

QTY	STOCK NO.	NOMENCLATURE	CLASS	SOURCE
As req	0233-65530	Bushing - Spark plug	02-E	Local Mfr
		Mfr from:		
As req		Insert - Spark plug bushing, part No. 5030	02-L	AF Stock
		OR		
As req		Insert - Spark plug bushing, .003 OS, part No. 5030-003	02-L	AF Stock
		OR		
As req		Insert - Spark plug bushing, .005 OS, part No. 5030-005	02-L	AF Stock
As req	0233-65530-005	Bushing - Spark plug, .005 OS	02-E	Local Mfr
		Mfr from:		
As req		Insert - Spark plug bushing, .005 OS, part No. 5030-005	02-L	AF Stock
As req	0233-65530-010	Bushing - Spark plug, .010 OS	02-E	Local Mfr
		Mfr from:		
As req		Bronze Alum. - Rod round grade B, 1-1/4 inches, Specification No. QQ-B-666, stock No. 6800-243500	23-A	AF Stock
As req	0233-STD-132	Dowel - .125-inch diameter x .340-inch long	02-E	AF Stock
		OR		
		Mfr from:		
As req		Steel - Carbon drill rod, 1/8-inch, Specification No. 57-108, stock No. 6800-402350	23-A	AF Stock

b. The following tools are required to accomplish this change:

QTY	STOCK NO.	PART NO.	NOMENCLATURE	CLASS	SOURCE
1		ASC45A979	Drill Jig - Spark plug bushing dowel pin	18	Local Mfr
			Mfr from:		(See figure 1.)
2-1/8 in.			Steel - Medium carbon chrome molyb X4130 hex. bar 1-3/8 inches, Specification No. AN-QQ-S-684, stock No. 6800-527200	23-A	AF Stock
1	8003-44A6955		Tap - Spark plug bushing	18	AF Stock
1	8037-AAF487810		Tap - Spark plug bushing overhaul line 1 14 inches, 3 PD, .9557- to .9562-inch	18	AF Stock
1	8037-AAF487800		Tap - Spark plug bushing overhaul line 1 14 inches, 3 PD, .005-inch OS, .9607- to .9612-inch	18	AF Stock
1	8037-AAF487805		Tap - Spark plug bushing overhaul line 1 14 inches, 3 PD, .010-inch OS, .9657- to .9662-inch	18	AF Stock

4. The weight change effected by this modification is negligible.

BY COMMAND OF GENERAL ARNOLD:

Prepared by Engine Section,
Maintenance Div, Hq, ATSC.

H. J. KNERR
Major General, U.S.A.
Commanding General
Air Technical Service Command

HEADQUARTERS, ARMY AIR FORCES
WASHINGTON 25, D. C.

TECHNICAL ORDER
NO. 02-15BA-14

11 September 1945

ENGINES AND MAINTENANCE PARTS

LYCOMING—INSTALLATION OF STELLITE FACED VALVES—0-435-1

NOTE As prescribed in T. O. No. 00-20A, appropriate reference to this Technical Order will be entered on AAF Forms 60-B, by depots only, at the time of compliance, for the engines affected. The work directed herein will be accomplished by depots at the time of overhaul, if not previously accomplished.

1. To prevent the loss of compression and power of 0-435-1 engines caused by the exhaust valve burning, exhaust valve, part No. 66081, will be replaced at overhaul with a Stellite faced exhaust valve, part No. S-66081.

2. a. The following parts are required per engine to accomplish this change:

QTY	STOCK NO.	PART NO.	NOMENCLATURE	CLASS	SOURCE
6	0233-S-66081	S-66081	Valve - Exhaust	02-E	AF Stock

b. The following part removed in accordance with the preceding instructions will be condemned at once, and so tagged for disposition as administratively condemned property.

PART NO.	NOMENCLATURE
66081	Valve - Exhaust

3. The weight change effected by this modification is negligible.

BY COMMAND OF GENERAL ARNOLD:

Prepared by
Engine Section,
Maintenance Div,
Hq, ATSC.

H. J. KNERR
Major General, U. S. A.
Commanding General
Air Technical Service Command