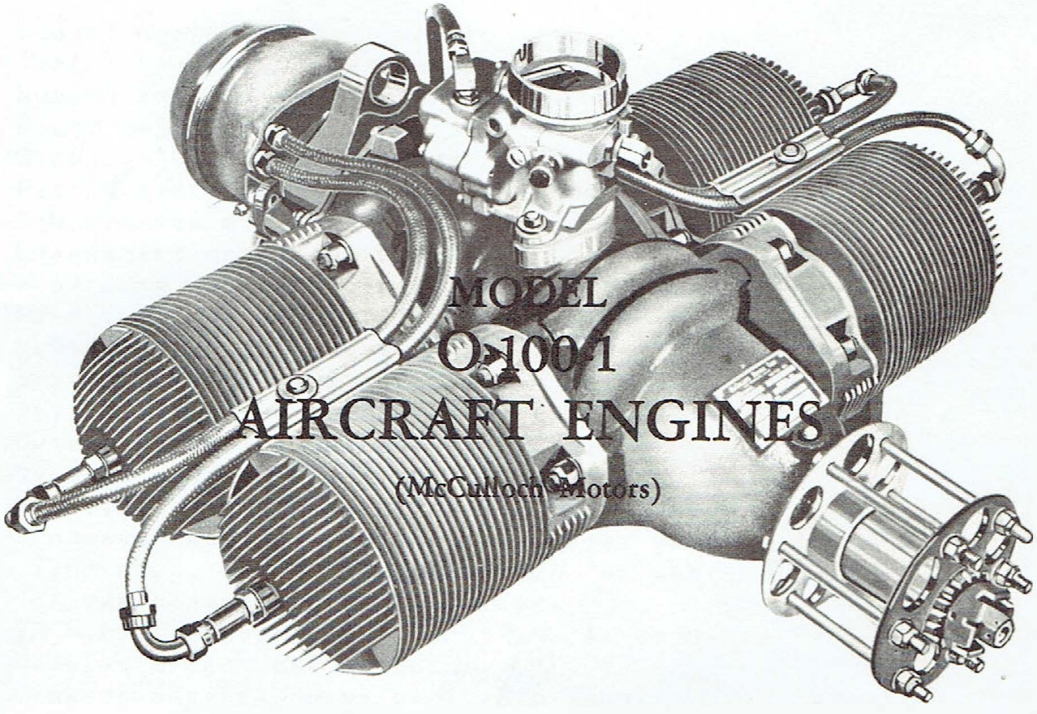
Handbook
Overhaul Instructions

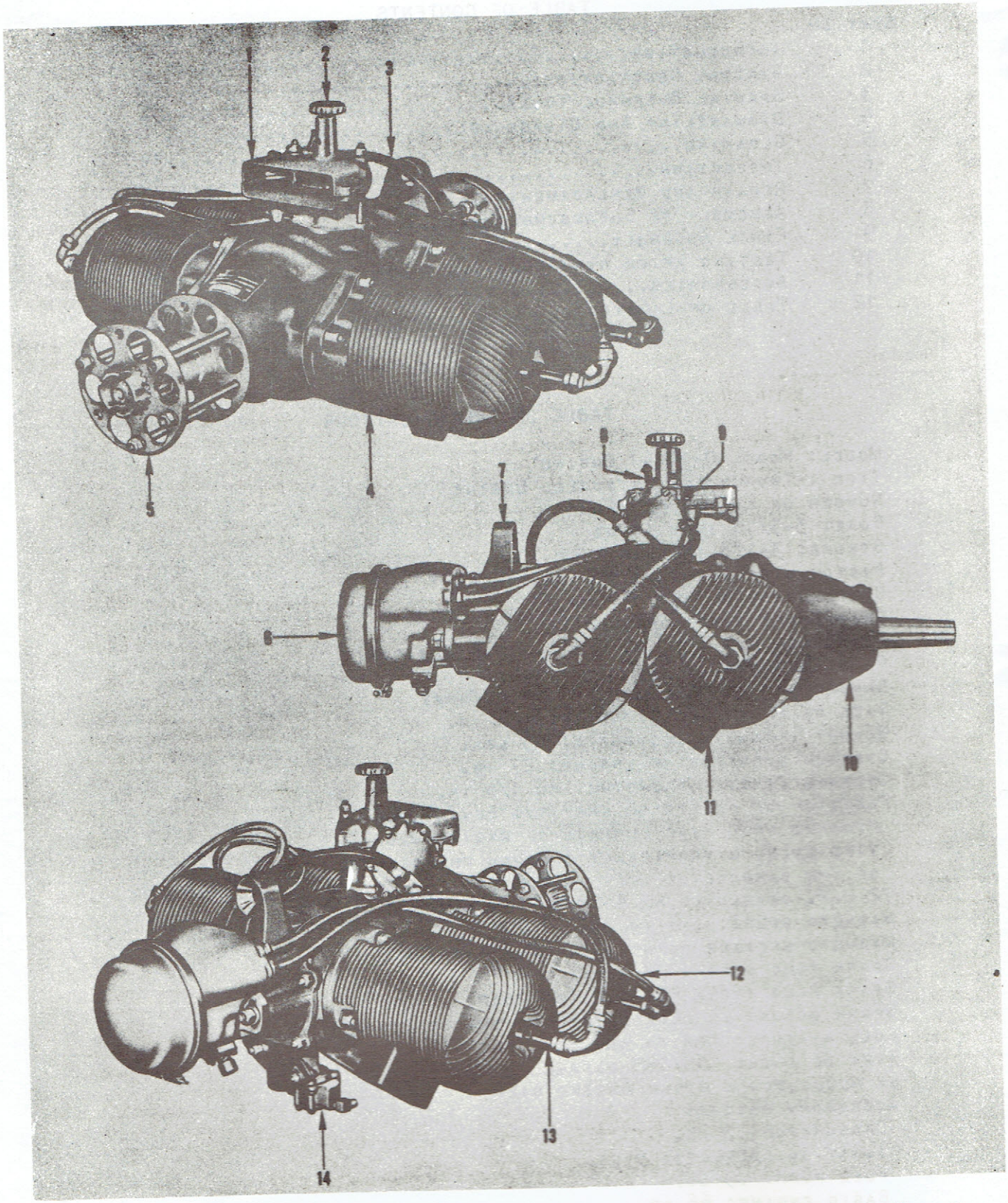


R&D Aeronautical Engineering Co., Inc.
P.O. Box 1180, Caddo Mills, TX 75135
903-527-2006
harold.smith30@verizon.net

TABLE OF CONTENTS

TABLE OF SPECIFICATIONS

Model: Model O-100-1 Engine
Type : Two-cycle air cooled Engine
Number of cylinders: Four
Bore: 3-3/16 inch. bore
Stroke: 3-1/8 inch. stroke
Piston displacement: 100 cu. inch.
Compression ratio: 8 to 1
Crankshaft rotation: Clockwise
Propeller hub bolt circle size: 4inch.dia.
Propeller hub keyway: 1/4 in.
Number of engine mounting eyes: Three
Size of engine mounting eyes: 1 in.
Weight of engine complete: 83 lbs.
Overall diameter of engine: 27 in.
Overall length of engine: 26 1/4 in.
Position of center of gravity: Seven ins. forward from rear surface of engine mounting eyes, & vertically through the center of the carburetor venturi tube.
72 H.P. developed at 4100 R.P.M. rated H.P.
Magneto speed: one to one
Magneto breaker point gap: .018 inch.
Spark plug gap: .018 inch.
Spark plug type: RB916-S (BG corp)
Spark occurs in degrees before top center-25.°
Fuel mixture: ten to one.
Type of fuel: 115/145 octane
or McCulloch 2 cycle engine oil.
Accessory Weights
Carburetor: 3 lb.
Ignition complete: 9 lb.
Fuel pump: .9 lb.
Basic engine: 66 lb.
Propeller hub: 4 lb.



1. Carburetor
2. Needle Valve
3. Fuel Line
4. Cylinder
5. Propeller Hub
6. Magneto
7. Engine Mounting Flange
8. Primer Plunger
9. Fuel Inlet Housing
10. Crankcase
11. Exhaust Port
12. Ignition Harness
13. Spark Plug
14. Fuel Pump

Figure 1-1. Model O-100-1 Target Aircraft Engine

SECTION I

INTRODUCTION

1-1. IDENTIFICATION. (See figure 1-1.)

1-2. This publication is issued as the basic Handbook of Overhaul Instructions for the Model 0-100-1 Engine Assembly (McCulloch Model 4318A), manufactured by McCulloch Motors Corporation, 6101 West Century Boulevard, Los Angeles 45, California.

1-3. SCOPE OF INFORMATION.

1-4. This handbook contains descriptive data and illustrations to facilitate understanding of the subject equipment and its individual components. Information relative to construction, maintenance and overhaul is contained herein. Section XII is a Table of Limits which contains useful information relative to overhaul measurements and tolerances.

1-5. BASIC OPERATIONAL CHARACTERISTICS.

1-6. ENGINE ORIENTATION. In this publication the following terminology will be used in location of engine components.

Front End - Propeller end

Rear End - Magneto end

Left Side, Right Side } Determined by looking towards propeller from rear end

Top Side - Carburetor side of engine

1-7. PROPELLER ROTATION. (See figure 1-2.) The propeller is directly attached to the crankshaft, and direction of rotation is clockwise when viewed from the rear of the engine.

1-8. CYLINDER DESIGNATION. (See figure 1-2.) Engine cylinders are designated by numbers as follows:

Cylinder Number	Location
1	Left front
2	Right front
3	Left rear
4	Right rear

1-9. MAGNETO ROTATION. The magneto is driven directly by and rotates in the same direction as the engine crankshaft.

1-10. MODEL DIFFERENCES.

1-11. Minor differences exist between early and late serial numbers of the 0-100-1 engine. The differences are confined primarily to the magneto and carburetor and are noted throughout the book as necessary. Otherwise, instructions in the handbook are applicable to all Model 0-100-1 engines.

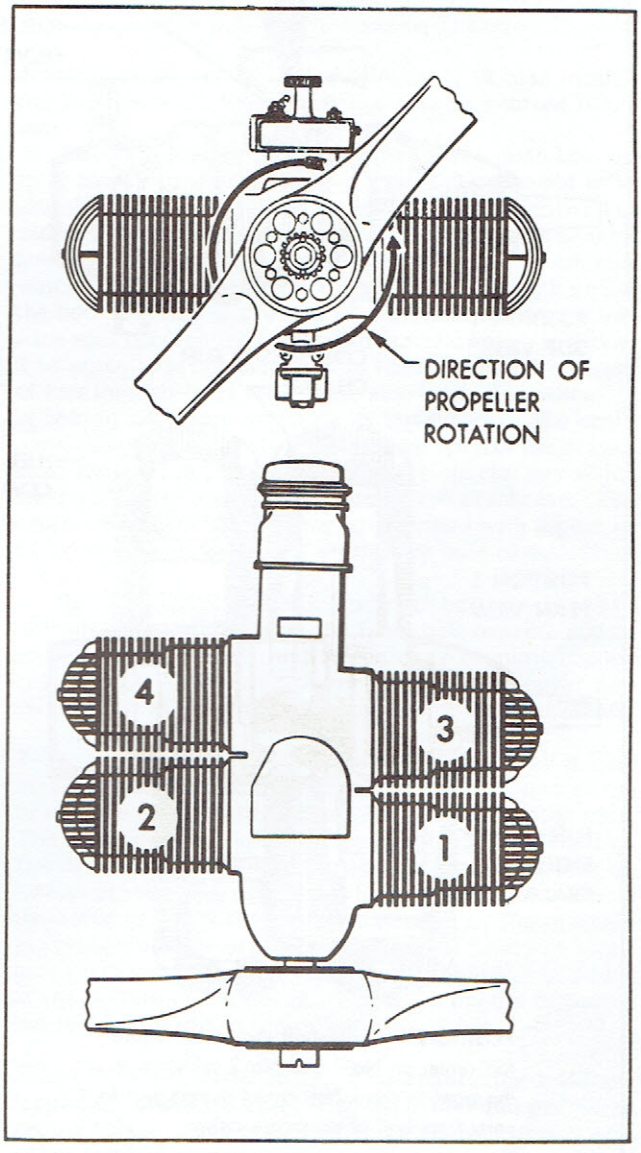


Figure 1-2. Cylinder Numbering Diagram

SECTION II

GENERAL DESCRIPTION

2-1. GENERAL DESCRIPTION.

2-2. FUNCTIONAL. The Model 0-100-1 Engine is a four-cylinder, opposed-type, air-cooled engine which operates on the conventional two-cycle principle. It is designed primarily to furnish power for propulsion of radio-controlled pilotless aircraft for target or guided missile purposes.

2-3. PHYSICAL. Figure 1-1 illustrates the 0-100-1 engine and identifies the major components. Equipment construction is covered in paragraph 2-5.

2-4. OPERATIONAL. As illustrated in figure 2-1, the engine crankshaft is designed to function as a rotary valve to meter fuel into the front and rear crankcase chambers. From the crankcase the fuel is forced into

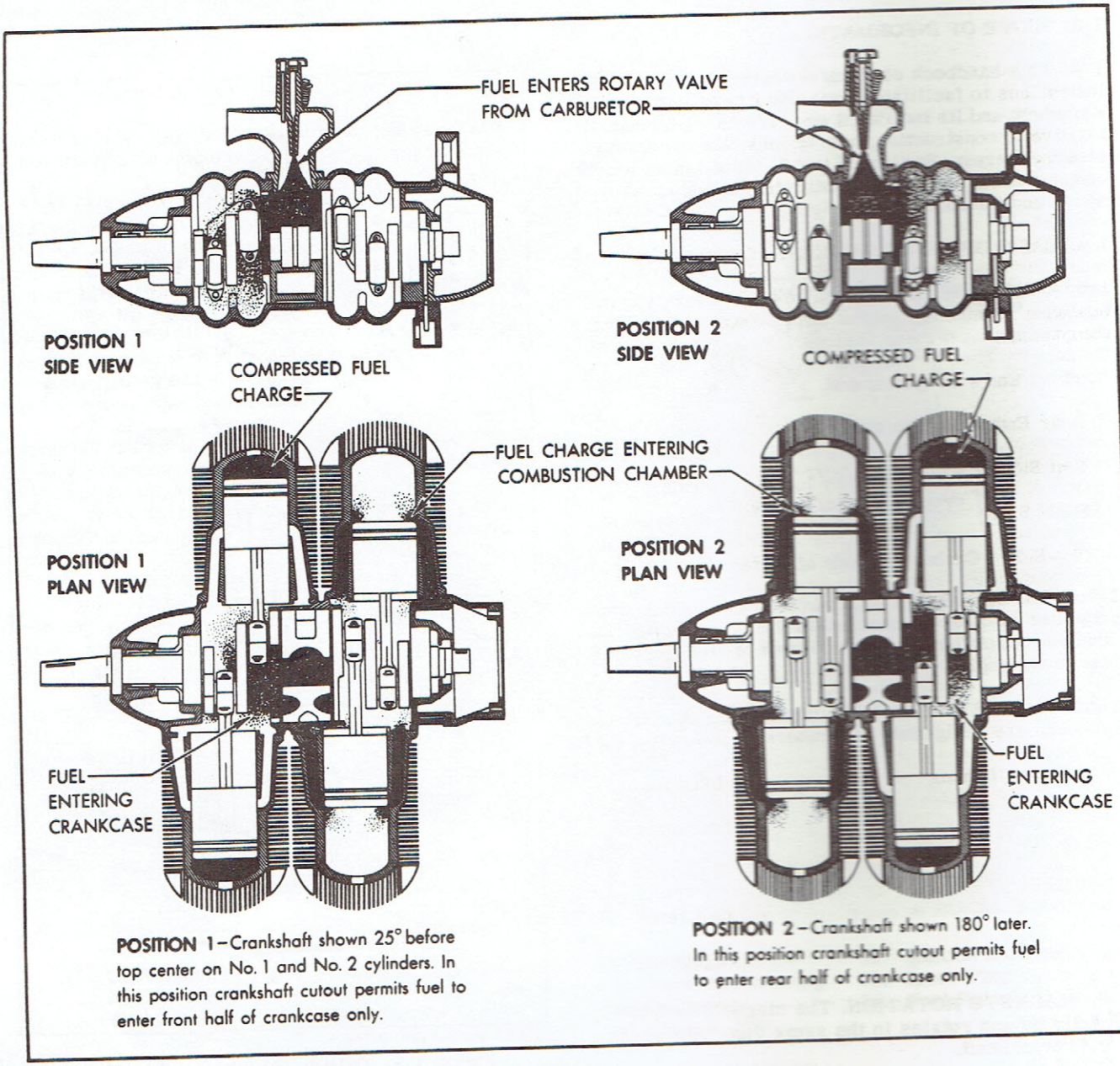


Figure 2-1. Crankshaft Function as Rotary Valve

the combustion chambers, then detonated on the compression stroke. Exhaust action occurs near the end of the power stroke, then a new fuel charge enters the combustion chambers from the crankcase and the cycle is repeated. The engine is so constructed that the opposite cylinders fire together, and the front and rear cylinder pairs fire alternately, 180° apart, to provide smoother engine operation.

2-5. DETAILED DESCRIPTION.

2-6. CYLINDER CONSTRUCTION. The four identical engine cylinders are constructed of die cast aluminum with integral cooling fins and a chrome plated bore. Cylinders mount on the crankcase by means of studs and nuts which mate with four holes in the cylinder mounting pads. Cylinders are interchangeable for all four positions on the engine.

2-7. CRANKSHAFT CONSTRUCTION. The crankshaft is forged of SAE 4615 steel, with main bearing journals drilled through to reduce weight. Transfer of crankcase pressure is prevented by means of four cup plugs pressed in the crankshaft centerline hole. The bearing journals are hardened and precision ground. A cam, which actuates the fuel pump plunger, is provided at the rear end of the crankshaft. A Woodruff keyway is also provided at the rear end to drive the magneto coupling. The front end of the crankshaft is provided with an SAE No. 00 taper and square keyway for mounting the propeller hub. It is threaded in the end to accommodate a 5/8-18 NF propeller hub retaining thrust bolt. The two integral scalloped cheeks at the center of the crankshaft form the rotating part of the intake rotary valve which governs the admittance of the fuel charge of the crankcase sections.

2-8. CRANKCASE. The crankcase is an aluminum casting in which suitable bores are provided for the crankshaft main bearings. The extreme front end is bored to accommodate an oil seal. The right and left sides of the crankcase are bored for cylinder openings and machined to form the cylinder mounting pads. The cylinder mounting studs are screwed into the crankcase. The rear end of the crankcase is bored and machined to mount the rear cover assembly. The rear cover mounting studs are screwed into the crankcase. The carburetor assembly mounts on the top of the crankcase on the pad machined for it. The carburetor mounting studs are also screwed into the crankcase. A fuel pump mounting pad is provided at the bottom of the crankcase near the rear end. This pad is machined to accommodate the fuel pump, fuel pump lower plunger and plunger oil seal. A small pad is machined on the lower right side of the engine for the center main bearing retaining key. Two of the three engine mounting lugs are located at the bottom rear of the crankcase.

2-9. MAIN BEARINGS. (See figure 2-2.) The crankshaft runs on four main bearings, all of which are of the anti-friction type.

a. FRONT NEEDLE BEARING. The front needle bearing is pressed into the crankcase near the extreme front end. It is separated from the front ball bearing by means of a spacer.

b. FRONT BALL BEARING. The front ball bearing is pressed into the crankshaft just forward of number one crankthrow and seats in the crankcase. It also locates the position of the crankshaft and acts as a thrust bearing.

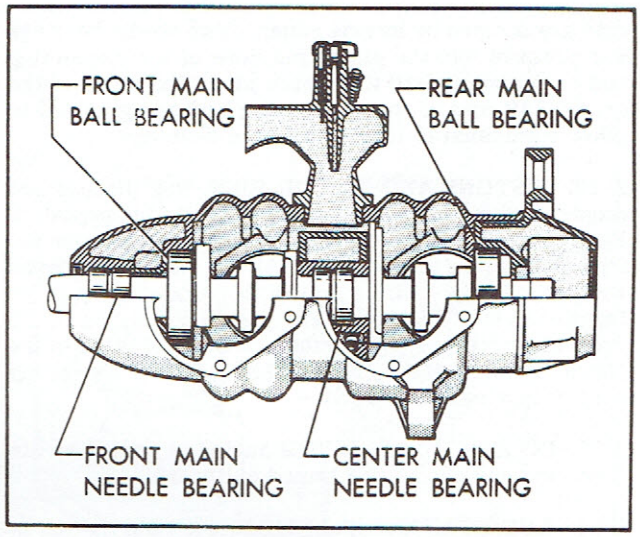


Figure 2-2. Main Bearing Location

c. CENTER MAIN BEARING. The center main bearing is of the split needle bearing type and is housed in an aluminum housing. It is located between number two and number three crankthrows. The center main bearing housing is also split to accommodate the needle bearing which locates in the center of the bore. At each end of the bore a series of grooves is provided to form a pressure seal between the front and rear crankcase sections. The whole bearing assembly is held together by means of four through-bolts and elastic stop nuts. The assembly is held in alignment by means of two dowels. The complete assembly is located in the large bore of the crankcase and held in place by means of a special key which enters from the right bottom side of the crankcase. The center main bearing housing is provided with a port on each end, which forms the stationary part of the intake rotary valve.

d. REAR MAIN BEARING. The rear ball bearing is of the same type and size as the front ball bearing and is pressed on the shaft just to the rear of number four crankthrow. It seats in the crankcase rear cover assembly and also locates the position of the crankshaft.

2-10. REAR COVER. The crankcase rear cover is cast of aluminum and machined to fit the rear end of the crankcase. It is held in place by six elastic stop nuts. The rear cover houses the magneto drive coupling. Bores are provided for the crankshaft rear ball bearing and an oil seal. A pad is machined on the rear side of the cover to mount the magneto assembly. The magneto mounting studs are screwed into the rear cover. A small hole which guides the fuel pump upper plunger is provided at the bottom of the cover. The third engine mounting lug is located at the top of the rear cover.

2-11. CONNECTING RODS. The connecting rods are forged of SAE 4615 steel with hardened and precision ground bores. They are fitted at the crankshaft end with 18 loose bearing rollers which run in specially designed beryllium copper cages. The cap is secured to the connecting rod by means of two special bolts and nuts. The

nuts are secured by locking plates. Two needle bearings are pressed into the piston pin bore of the connecting rod to accommodate the piston pin. The sides of the crankshaft end of the connecting rod are grooved to allow admission of lubricant to the bearings.

2-12. PISTONS AND PISTON PINS. The pistons are constructed of aluminum and are graphite impregnated. Each piston has two compression ring grooves near the top. Piston pins are made of SAE 3115 steel, hardened and ground. Each pin is hollow throughout most of its length to reduce weight. The piston pin floats in the connecting rod needle bearing and is a press fit in the piston. It is retained in the piston by means of one spring wire snap ring at each end.

2-13. COOLING SYSTEM. The engine is cooled by air flow over and around the finned cylinders.

2-14. LUBRICATION (Fuel Mixture). Lubrication is provided for the engine by the oil mixed with fuel as in conventional two-cycle engines. No other lubrication is required. This fuel-oil mixture consists of one part of oil, by volume, Specification MIL-O-6082A, Grade 1065, thoroughly mixed with ten parts of fuel, by volume, Specification MIL-F-5572, Grade 115/145.

2-15. FUEL SYSTEM. (See figure 2-3.) The fuel system on the 0-100-1 engine consists of a fuel pump mounted on the bottom of the engine, an interconnecting fuel line with fittings and a carburetor assembly mounted atop the engine. In operation, fuel-oil mixture flows from the target fuel tank through a fuel filter and into the engine fuel pump. From here it is delivered to the carburetor at a pressure of approximately 3-1/2 psi. In the carburetor, fuel first passes through a mesh screen, then enters the diaphragm chamber through the ball check valve. The amount of fuel admitted is controlled by movement of the diaphragm which is mechanically coupled to the check valve. From the diaphragm chamber fuel flows through the single jet located in the carburetor venturi. The fuel-air ratio is controlled by means of an adjustable needle valve located in the jet passage.

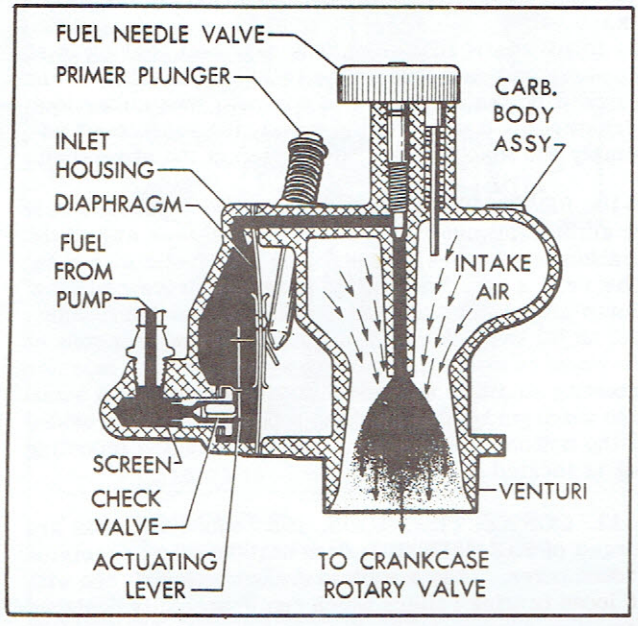


Figure 2-3. Carburetor Operation

2-16. CARBURETOR CONSTRUCTION. Basically, the carburetor consists of a machined aluminum alloy die cast body to which are attached the die cast cover and fuel inlet housing. The fuel diaphragm of Thycol or Hycar coated fabric, together with the filter screen and check valve assembly, are contained in the fuel inlet housing. A spring-loaded primer plunger protruding from the carburetor cover serves to actuate the fuel diaphragm during the priming operation, forcing raw fuel into the engine for initial starting. The steel needle valve fits into a threaded boss on the carburetor cover. Engines with serial numbers 43110879 and below are equipped with carburetors having a separate screw-in detent mechanism for preventing undesired rotation of the needle valve; engine serials 43110880 and up are equipped with a new carburetor cover having an integral detent mechanism.

2-17. FUEL PUMP. The fuel pump is an A.C. reciprocating diaphragm type pump actuated by a plunger driven from a cam on the crankshaft. The plunger consists of two parts, upper and lower, in line. The upper plunger moves in the hole provided in the rear cover casting and the bottom plunger moves in the crankcase. The fuel inlet connection is 1/8 in. U.S. standard pipe thread.

2-18. IGNITION SYSTEM. (See figure 2-4.) Ignition is provided by means of a single high-tension magneto driven from the crankshaft through a coupling. This coupling is of the impulse type, which, in starting, snaps the magneto shaft over at a speed equivalent to 800 rpm.

a. MAGNETO. The magneto shaft runs in ball bearings and has the magneto rotor, which contains the magnets, securely pinned to it. Magnetos used on engine serials 43110327 and above are equipped with a radio noise suppressor which is an integral part of the electrical connector on the magneto.

b. COILS. Two coils are provided. The right hand coil fires the two right cylinders and the left hand coil the two left cylinders. The two front cylinders fire simultaneously as do the two rear ones 180° later.

c. CONDENSER. The magneto is provided with a condenser which has a capacity of 0.18 to 0.23 microfarad.

d. DISTRIBUTOR. The high tension spark is distributed to the various cylinders by means of a distributor cover and rotor which form a part of the magneto assembly and are located under the shield cover. The wires from numbers one and two cylinders lead to the bottom grooves of the distributor cover. Numbers three and four spark wires lead to the top inside grooves and the leads from the right and left coils go to the right and left outside grooves, respectively. The center groove of the cover is not used. Examination of the inside of the distributor cover will show six contact points. The two top points communicate with numbers three and four cylinders; the two middle points, with the coils; and the two bottom points, with numbers one and two cylinders.

e. DISTRIBUTOR ROTOR. The distributor rotor is so designed that when the two brass segments are in the top position they connect the coils with numbers three and four cylinders. At this point, the breaker points open and spark is transmitted from the two coils via the segments to numbers three and four spark plugs.

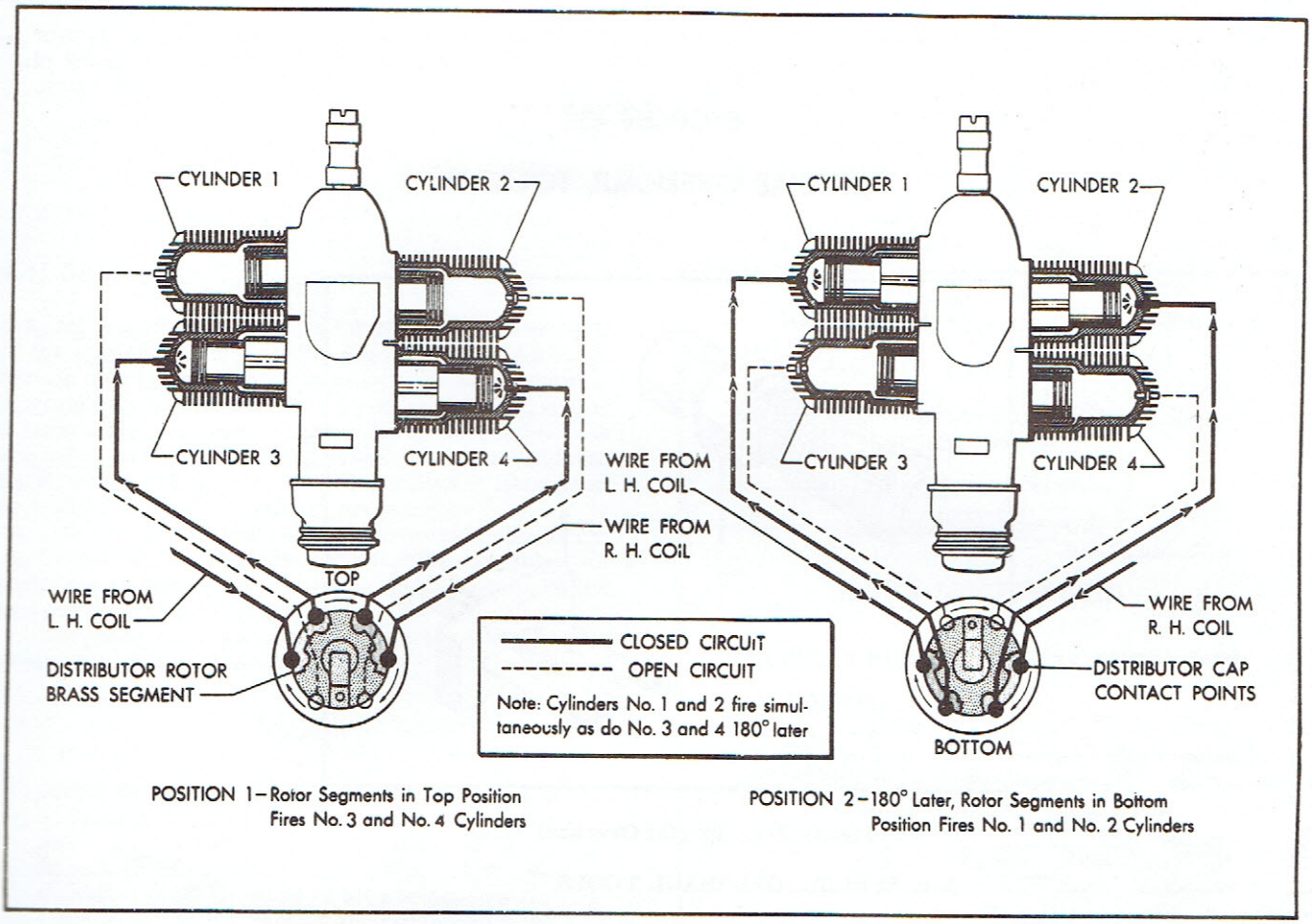


Figure 2-4. Electrical System Wiring and Cylinder Firing Diagram

At 180° later in the rotation cycle, the segments are in the bottom position and connect the coils to numbers one and two spark plugs. The distributor rotor is molded of a special plastic which is very resistant to "spark tracking".

f. SPARK PLUGS. A relatively cold spark plug is used on this engine because of the somewhat high compression ratio (7.8 to 1). The recommended spark plug is a B G Corp. Type RB916-S.

2-19. PROPELLER HUB CONSTRUCTION. The propeller hub and flange are machined from steel forgings. The flange fits onto the hub over splines and is held in place by the six 5/16-inch mounting bolts running through the propeller. Provision is made on the propeller hub for the use of a suitable puller. The entire assembly fits on the taper of the crankshaft and is provided with a square key. It is secured to the crankshaft by a 5/8-18 NF thrust bolt. The bolt is drilled for the use of safety wire.

SECTION III

SPECIAL OVERHAUL TOOLS

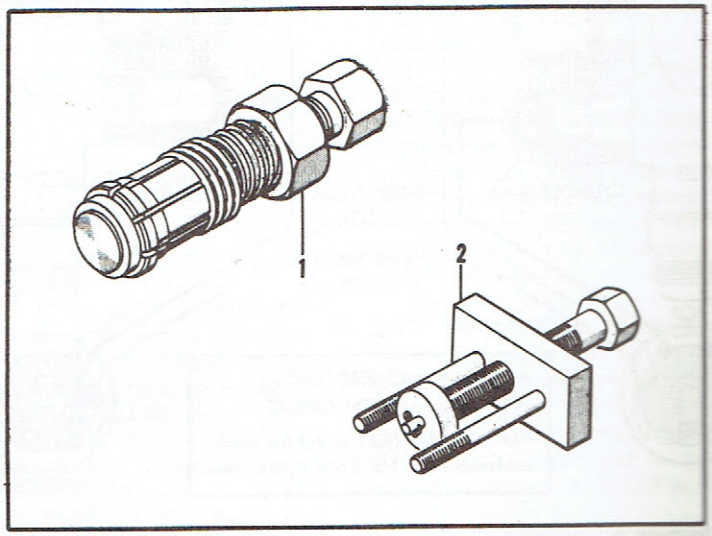


Figure 3-1. Special Overhaul Tools

3-1. SPECIAL OVERHAUL TOOLS.

3-2. The tools shown in figure 3-1 are the only special tools required for disassembly and reassembly.

KEY TO FIGURE 3-1

Figure and Index No.	Tool No.	Nomenclature	Application
3-1-1	10121A	Puller - Propeller hubs	Propeller hub removal
3-1-2	10148A	Puller - Magneto drive assy	Magneto drive assy removal

SECTION IV

DISMANTLING AND DISASSEMBLY

4-1. GENERAL.

4-2. All procedures necessary for complete disassembly of the engine are included in this section. Although certain operations such as propeller hub or carburetor removal may be performed with engine installed, major disassembly and overhaul procedures covered herein are based on the engine being completely removed from the airframe. Where applicable, the following steps must be applied to all disassembly procedures.

a. Use the proper tools for each overhaul operation.

b. Choose a clean working area for disassembly. As parts are removed, place them in clean containers for protection against dust and dirt.

c. Carefully note manner of lockwiring so it may be duplicated on reassembly.

NOTE

During the various stages of disassembly, close attention must be given to the parts as they are removed from the engine and any abnormal wear, defects or damage should be noted. Close observation must be made of all components for signs of scoring or burning through undue friction. Many indications of defects are obscured by the presence of dirt, carbon deposits, etc., and can only be discovered after the various parts have been cleaned. Any indication of work incorrectly performed on a previous overhaul should be reported immediately in the proper manner.

4-3. DETAILED.

WARNING

During engine disassembly, once the ground wire has been removed from the magneto electrical receptacle, the engine will be "hot" and may be started inadvertantly unless the magneto lead is positively grounded in some manner or ignition harness leads disconnected from spark plugs.

4-4. PROPELLER HUB REMOVAL. (See figure 4-1.) The propeller hub is sometimes difficult to remove, particularly when it has been attached to the engine for a long time. For this reason, special tool No. 10121A, Propeller Hub Puller, is required. The propeller hub puller grips the hub at an annular groove inside the nose of the hub and may be used without removing the propeller from the hub. If the starter jaws are badly battered,

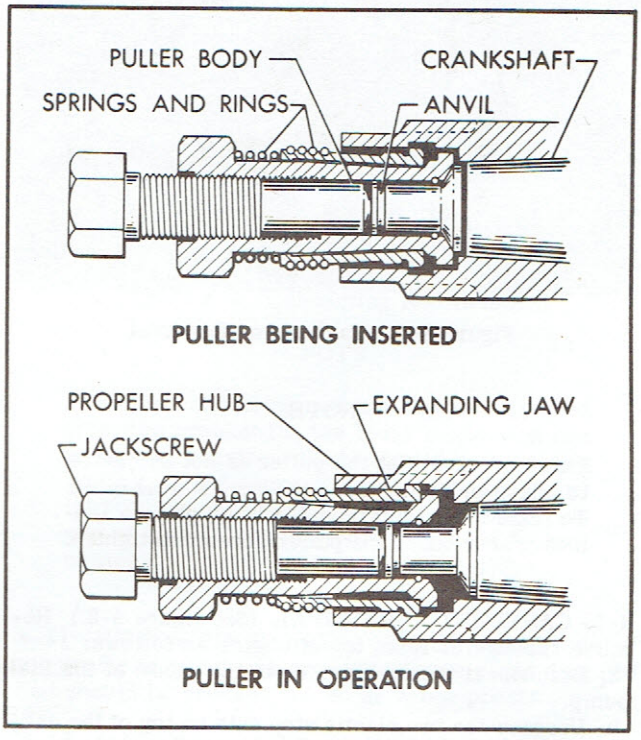


Figure 4-1. Propeller Hub Removal

it may be necessary to clean out the center hole although the puller is designed to clear moderate burrs. The puller consists of six expanding jaws to grip the hub; a threaded body which forces the jaws into engagement with the hub and locks them in place; an anvil to press against the crankshaft; and a jackscrew to pull the hub from the crankshaft. Springs and rings hold all parts together during normal handling. To remove the propeller hub, proceed as follows:

a. Remove propeller thrust bolt retainer ring and thrust washer.

b. Unscrew and remove propeller hub thrust bolt.

c. Back out the puller jackscrew far enough to let the anvil rest against the end of the puller body.

d. Insert the puller as far as it will go (about 1-1/4 inches).

e. Withdraw the puller body about 3/16-inch, holding the jaws in place. This will expand the jaws where they will be locked by a buttress on the puller body.

f. The hub can now be removed by tightening the jackscrew. This action may be augmented by the judicious use of a hammer.

g. Remove key from crankshaft.

h. To remove the puller, push the body inward about 3/16-inch and grasp the body and the rings or the jaw extensions and remove from hub.

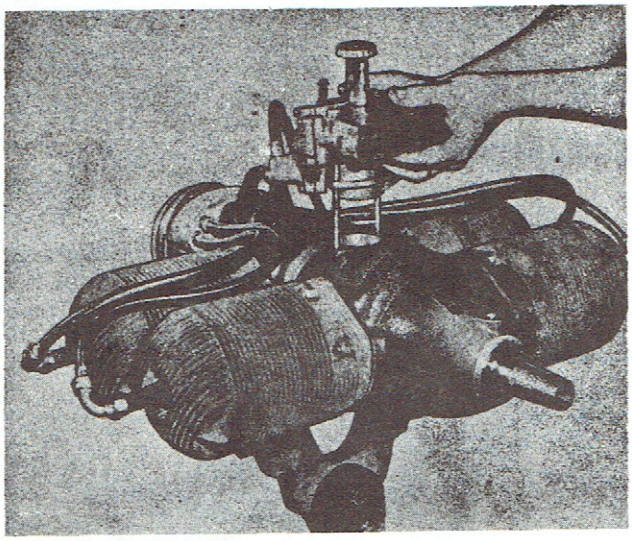


Figure 4-2. Carburetor Removal

NOTE

Exercise care that the puller is not subjected to abuse or rust. Keep the screw well oiled. To remove the anvil from the body, place a 1/4-inch spacer under the puller screw and tighten.

4-5. CARBURETOR REMOVAL. (See figure 4-2.) Remove carburetor from top of engine as follows:
a. Disconnect the fuel line from the elbow at the fuel pump.
b. Unscrew the two elastic stop nuts on top of the carburetor. Remove the two flat washers.
c. Carefully lift carburetor assembly straight up until clear of mounting studs.

NOTE

Provision should be made to prevent dirt entering the engine while carburetor is removed.

4-6. MAGNETO REMOVAL. (See figure 4-3.) The magneto assembly is mounted on two 3/8-inch elastic stop nuts and washers, one pair on each side. To remove the magneto assembly:

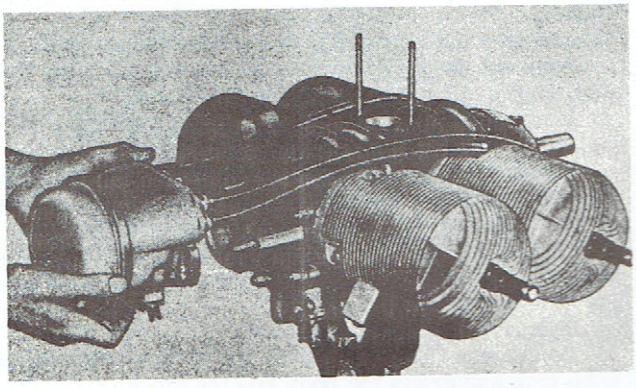


Figure 4-3. Magneto Removal

a. Disconnect all four spark plug leads at the spark plugs.
b. Remove shielding harness attachment to the engine.
c. Disconnect the ignition switch wire and the ground wire at the magneto, if necessary.
d. Unscrew the two 3/8-inch magneto mounting nuts.
e. Pull magneto assembly straight out to remove.
f. Remove rubber magneto drive coupling insert.

4-7. FUEL PUMP REMOVAL. To remove the fuel pump:
a. Disconnect fuel feed line from the inlet side of the fuel pump.
b. Disconnect fuel line to the carburetor at the fuel pump.
c. Unscrew the two elastic stop nuts and remove the mounting bolt and washer from each side of the fuel pump.
d. Carefully slide pump forward to disengage pump arm from push rod and housing. Remove gasket.

4-8. CYLINDER REMOVAL. (See figure 4-4.) Mark the cylinders in such a way that they may be identified later and returned to their original positions. To remove each cylinder:

Figure 4-4. Cylinder Removal

a. Remove the spark plug.
b. Unscrew the four 3/8-inch elastic stop nuts holding the cylinder to the crankcase. Take off the four flat washers.
c. Pull the cylinder straight out until it is free of the piston.
d. Handle cylinder carefully and set it in a place where the cooling fins will not be damaged.
e. Remove the cylinder gasket.

NOTE

If the pistons are not to be removed immediately, cover the top and bottom studs with a protective device such as a short length of rubber tubing to prevent these studs from scratching the piston while moving it in or out of the crankcase.

4-9. PISTON REMOVAL. (See figure 4-5.) Before removing pistons, mark each piston to its related cylinder to insure correct replacement. Proceed with piston removal as follows:

NOTE

The pistons are more readily removed if all the cylinders are dismounted.

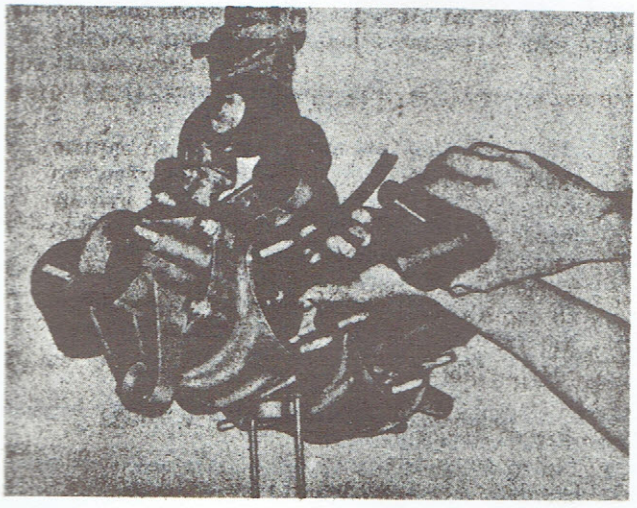


Figure 4-5. Piston Removal

a. Remove the snap ring in one end of the piston pin bore by inserting a narrow screwdriver under the snap ring in the groove provided and prying out the ring.
b. With piston properly supported, carefully drive out the piston pin, using a wooden dowel and a small hammer.
c. Slide piston away from connecting rod.
d. If removal is necessary, pry out snap ring and the two piston rings, using extreme care to avoid damage to piston ring lands.

4-10. CONNECTING ROD REMOVAL. (See figure 4-6.) A connecting rod can be removed only after the opposing cylinder has been removed. To remove number one connecting rod, for example, both number one and number two cylinders must be removed. In most cases, the work is facilitated by removing the piston also. Mark rod for cylinder identification, then proceed as follows:

a. Rotate crankshaft by hand until the connecting rod nuts on number one rod are accessible through the number two cylinder crankcase bore.
b. Using a small punch and hammer, straighten the flanges on the lock plates securing the connecting rod nuts.
c. Unscrew and remove both connecting rod nuts, using a 7/16-inch socket wrench. Take off lock plates.
d. Using a small punch and hammer, drive the two connecting rod bolts out far enough to loosen the connecting rod cap.
e. Remove number one connecting rod through number one cylinder bore in crankcase, at the same time holding the connecting rod cap and removing it through the number two cylinder bore. Remove other connecting rods in the same manner.

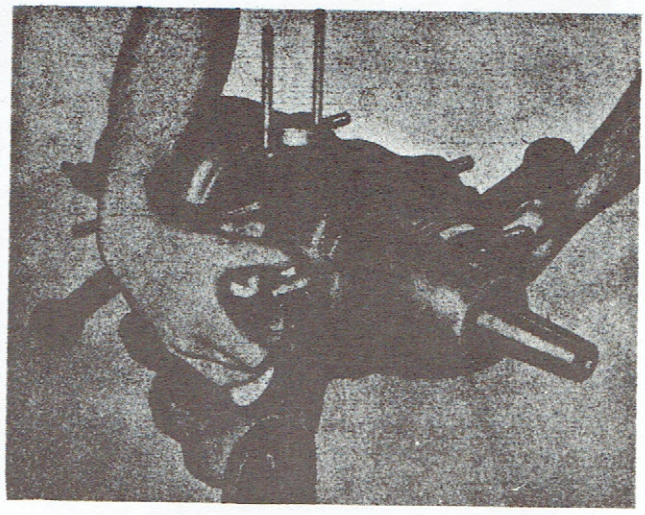


Figure 4-6. Connecting Rod Removal

NOTE

When the connecting rod and cap are detached from the crankshaft, the loose connecting rod cages and bearing rollers should be caught in a suitable container. Those rollers which fall into the crankcase can be retrieved easily by use of a small magnet or a magnetized piece of steel.

4-11. PISTON PIN BEARING REMOVAL. The piston pin needle bearings are pressed into the connecting rod and should be pressed out on an arbor press.

4-12. MAGNETO DRIVE ASSEMBLY REMOVAL. To remove the magneto drive assembly:
a. Remove the magneto as described in paragraph 4-6.
b. Pull the magneto drive assembly with the Magneto Drive Assembly Puller, special tool No. 10148A, by screwing the two small screws of the puller into the holes provided in the drive assembly and screw up the center screw to pull the drive assembly until it is clear of the crankshaft.
c. Remove the Woodruff key from the keyway in the crankshaft with a pair of pliers.

4-13. REAR COVER REMOVAL. Fuel pump must be removed prior to removal of the engine rear cover. To remove the rear cover casting:
a. Using a pair of long-nosed pliers, remove the fuel pump lower plunger through the round hole in the fuel pump mounting boss on the engine crankcase. (See figure 4-7.)
b. Unscrew and remove the six 5/16-inch elastic stop nuts holding the cover in place. Remove washers.
c. Hold fuel pump upper plunger in place while starting to pull cover.
d. The rear cover is a comparatively close fit in the crankcase. To loosen cover, tap gently and evenly around the mating circumference with a rubber mallet.
e. Slide cover away from crankcase when it becomes sufficiently loose. After cover is free the enclosed fuel pump upper plunger can be extracted.
f. Remove rear cover gasket.

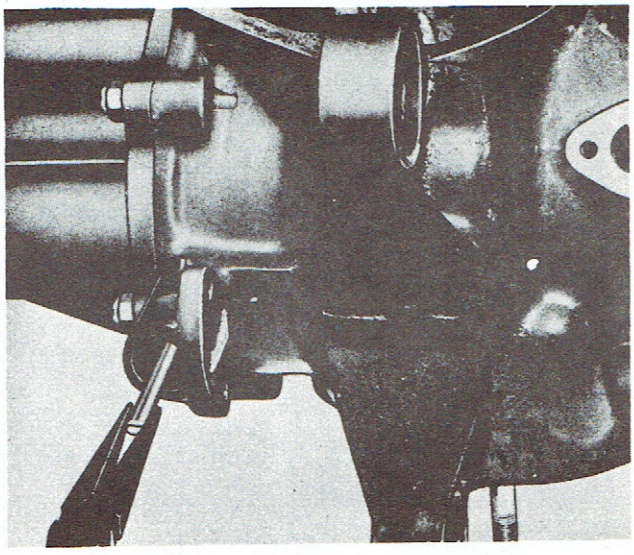


Figure 4-7. Fuel Pump Lower Plunger Removal

4-14. CRANKSHAFT REMOVAL. Remove the crankshaft as follows:

a. Unscrew the two 1/4-inch hex head cap screws and remove the cover over the key in the lower right hand side of the crankcase. (See figure 4-8.)

b. Remove the key by screwing a 1/2-20 screw into key and pulling it from crankcase.

c. While supporting the rear end of the crankshaft, drive it backwards by striking the taper end of the crankshaft with a rubber mallet. If the crankshaft is still not free of the engine after the taper end is driven into the crankcase, continue the driving procedure using a brass or copper rod until the crankshaft is free and can be pulled out. (See figure 4-9.)

NOTE

If it is desired to remove the crankshaft but not entirely disassemble it, the magne o drive coupling, rear cover, magneto and tne crankshaft

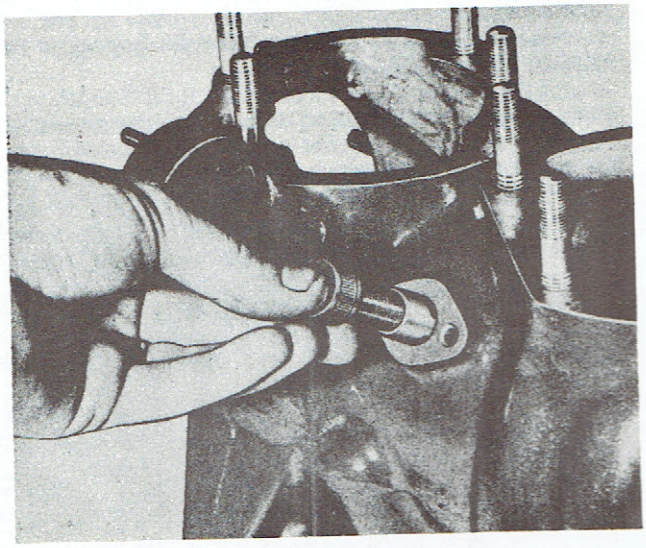


Figure 4-8. Bearing Cage Key Removal

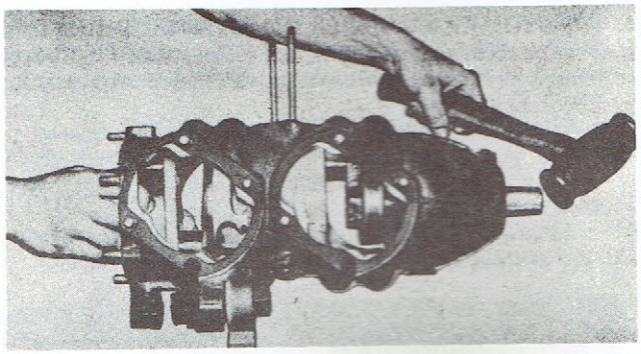


Figure 4-9. Driving Out Crankshaft

can all be driven out as one assembly. To remove the crankshaft in this manner, remove the fuel pump lower plunger, unscrew the six elastic stop nuts holding the rear cover in place, remove the center main bearing key and proceed to drive the crankshaft out as described above. By this method it is not necessary to remove the magneto, magneto drive coupling or disassemble the rear cover in any manner.

4-15. CENTER MAIN BEARING REMOVAL. To remove the center main bearing:

a. Unscrew the four 1/4-inch elastic stop nuts using an extension socket wrench and drive out the four bolts through the main bearing cage.

b. Separate the two halves of the aluminum cage by tapping them first with a rubber mallet and then prying them apart at the parting line.

c. Separate the inner needle bearing cage and remove both the cage and the needle bearings.

4-16. MAIN BALL BEARINGS REMOVAL. To remove the main ball bearings, press them off the crankshaft using an arbor press.

KEY TO FIGURE 4-10

1. Screw
2. Washer
3. Inlet Housing
4. Check Valve
5. Washer
6. Hinge
7. Strainer Screen
8. Diaphragm
9. Lever
10. Retainer Ring
11. Washer
12. Spring
13. Plunger
14. Needle Valve
15. Packing
16. Detent Body
17. Gasket (or lockwasher)
18. Needle Valve
19. Packing
20. Detent Plunger
21. Spring
22. Screw
23. Screw
24. Carburetor Body
25. Carburetor Cover (old)
26. Carburetor Cover (new)
27. Screw
28. Washer
29. Pulsator Cover
30. Screw
31. Washer
32. Pulsator Diaphragm
33. Upper Body
34. Diaphragm Assy
35. Spring
36. Pin
37. Rocker Arm
38. Spring
39. Link
40. Lower Body

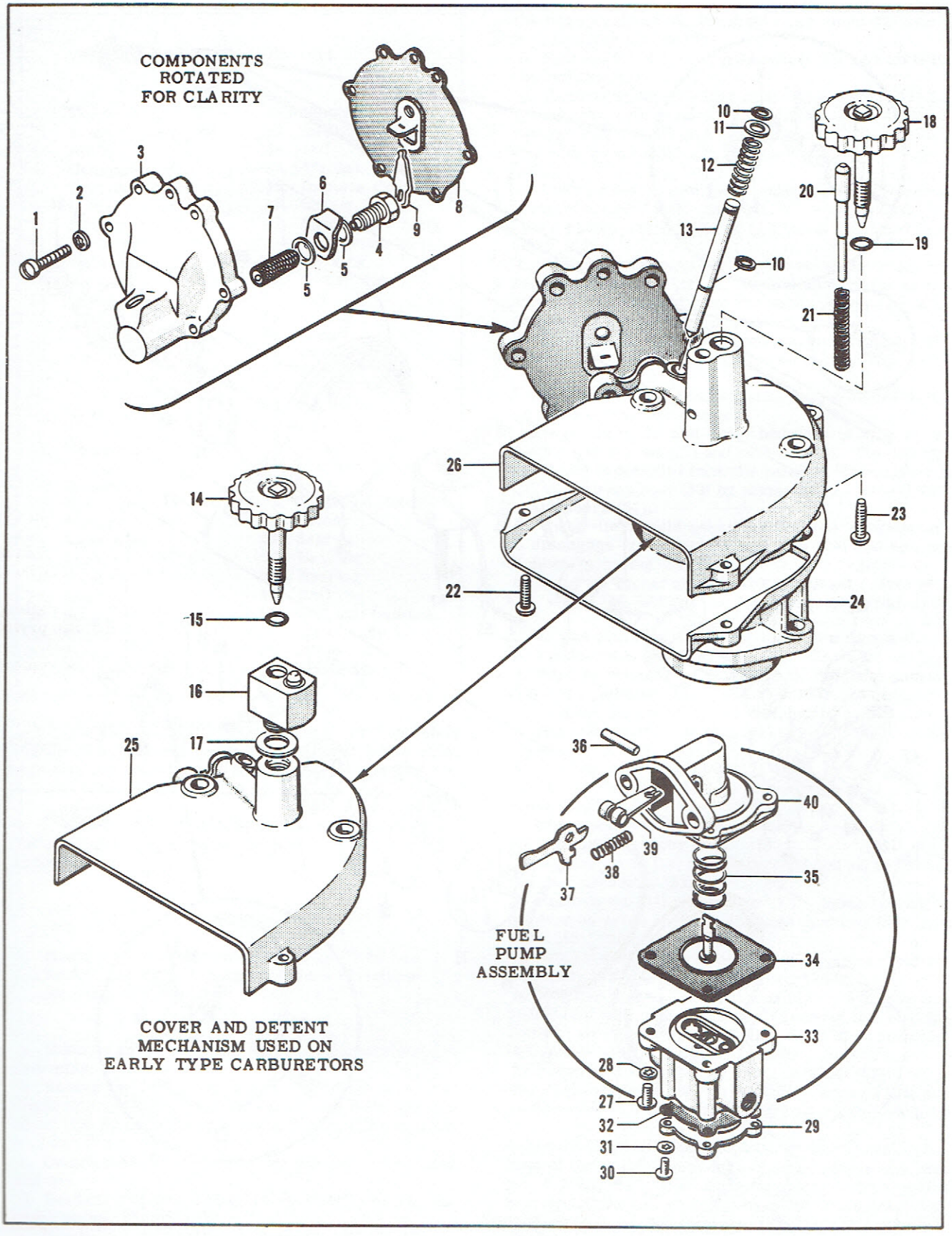


Figure 4-10. Carburetor and Fuel Pump Assemblies, Exploded View

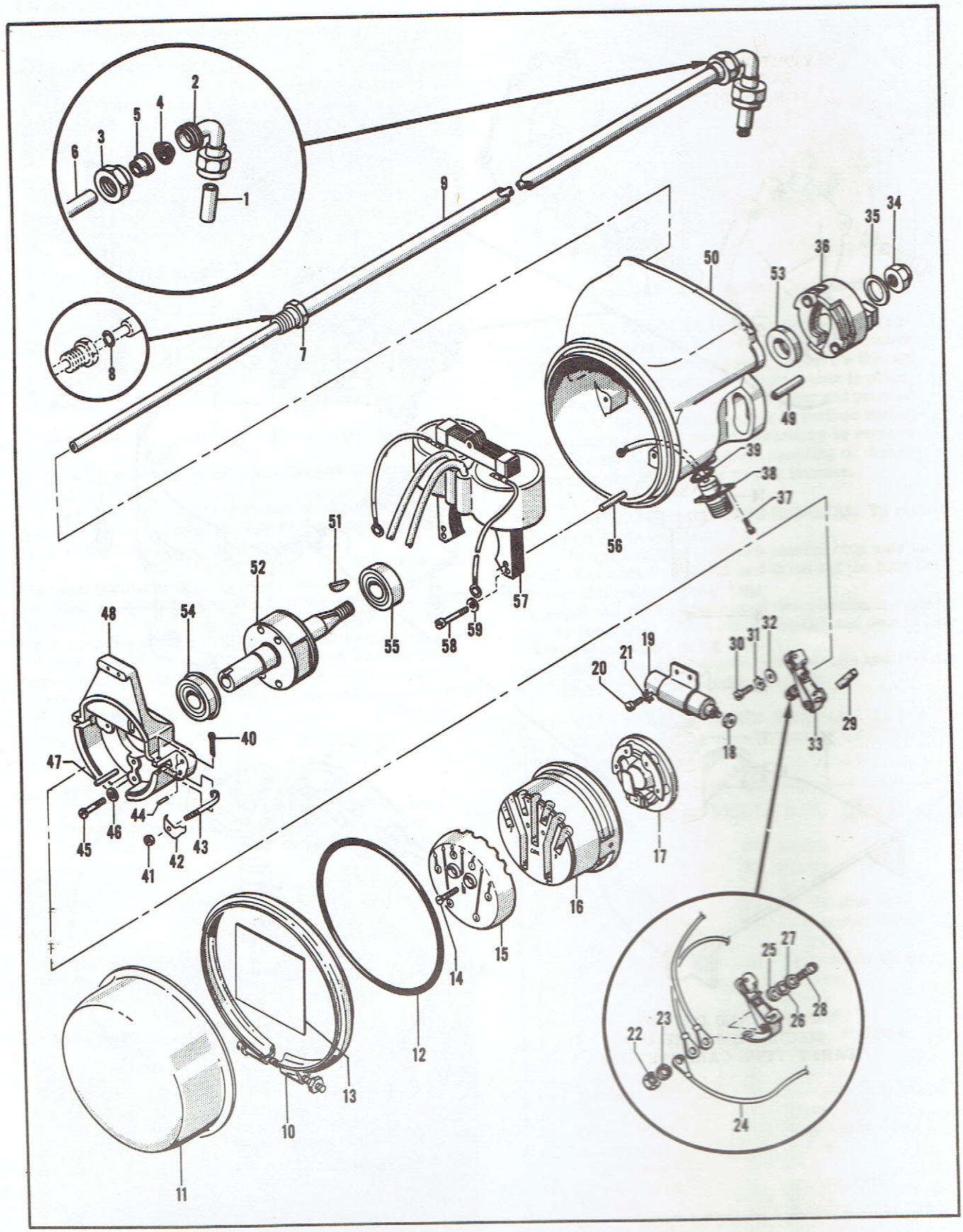


Figure 4-11. Magneto Assembly, Exploded View

KEY TO FIGURE 4-11

1. Sleeve
2. Elbow
3. Nut
4. Grommet
5. Ferrule
6. Cable
7. Fitting
8. Packing
9. Metal Hose
10. Retainer
11. Cover
12. Gasket
13. Insulation
14. Screw
15. Distributor Cap
16. Distributor Cover
17. Rotor Assy
18. Nut
19. Condenser
20. Screw
21. Washer
22. Nut
23. Washer
24. Wire Assy
25. Spacer
26. Washer
27. Washer
28. Screw
29. Wiper
30. Screw
31. Washer
32. Washer
33. Breaker Assy
34. Nut
35. Washer
36. Impulse Coupling
37. Screw
38. Suppressor Assy (Receptacle)
39. Packing
40. Cotter Pin
41. Nut
42. Clamp
43. Screw
44. Dowel Pin
45. Screw
46. Washer
47. Pivot Pin
48. Bearing Retainer
49. Dowel Pin
50. Magneto Body
51. Key
52. Shaft and Rotor Assy
53. Seal
54. Bearing
55. Bearing
56. Roll Pin
57. Coil and Lamination Assy
58. Screw
59. Washer

4-17. PROPELLER HUB DISASSEMBLY. To completely disassemble hub components, remove the attaching nuts, washers, and bolts through the propeller and detach the hub and front flange from the propeller.

4-18. CARBURETOR DISASSEMBLY. (See figure 4-10.) To completely disassemble the carburetor, proceed as follows:

NOTE

Basic procedures given herein apply to late model carburetors, with procedure variations for early models noted as required.

a. Unscrew and remove fuel line from carburetor inlet assembly.
b. Detach the fuel inlet assembly and the lever and diaphragm assembly from the carburetor body (24) and cover (26) by removing the six attaching fillister head screws (1) and washers (2).
c. Detach the inlet housing (3) by moving it downward slightly.
d. Bend the diaphragm hinge (6) up slightly to free the check valve assembly (4).
e. Unscrewing the check valve assembly (4) will release the fiber washers (5), the diaphragm hinge (6) and the fuel strainer screen (7).
f. Remove the diaphragm assembly (8) and slide out the diaphragm lever (9).
g. Remove upper retainer ring (10), washer (11) and spring (12) from primer plunger (13). Remove lower retainer ring (10) through opening in side of carburetor, and slide primer plunger (13) out of carburetor cover (26).
h. Unscrew and remove needle valve assembly (18) from carburetor cover (26). Take off "O" ring packing (19). Detent plunger (20) and spring (21) can be extracted from cover (26).
i. On early type carburetors, the separate detent assembly (16) and gasket (17) (or lockwasher) can be unscrewed and removed from carburetor cover (25) after removal of the needle valve assembly.
j. To separate cover (26) from carburetor body (24), remove the three attaching screws (22 and 23).

4-19. FUEL PUMP DISASSEMBLY. (See figure 4-10.) To disassemble fuel pump:
a. Separate upper and lower body assemblies by removing four screws (27) and washers (28). The pulsator cover (29) is detached from the pulsator diaphragm (32) and upper pump body (33) by removing four screws (30) and washers (31).
b. Twist diaphragm assembly (34) one-quarter turn to disengage from rocker arm link (39) and release diaphragm spring (35).
c. Drive out rocker arm pin (36) to release rocker arm (37), spring (38) and link (39) from lower pump body (40).

4-20. MAGNETO DISASSEMBLY. (See figure 4-11.) To disassemble the magneto:
a. Remove retainer (10), cover (11), "O" ring packing (12) and insulation (13).
b. Remove screws (14) and distributor cap (15).
c. Remove elastic stop nuts (42) to release distributor cover clamps (43).
d. Remove magneto rotor (17).
e. Detach condenser (19) by removing screws (20) and washers (21).
f. Disconnect wiring as required.
g. Lift out felt wiper (29).
h. Remove screw (30) and washers (31 and 32) to release breaker assembly (33).
i. Remove nut (34) and washer (35). Using two screw drivers as pries, remove impulse coupling (36) from shaft (53). Remove key (52).
j. Remove screws (37) to detach radio noise suppressor assembly (38) and "O" ring packing (39).
k. Remove screws (45), washers (46) and bearing retainer (48) with shaft and rotor assembly (52) still installed. By using a wooden mallet, drive shaft and rotor (52) out of bearing retainer (48).
l. Press bearings (54 and 55) from shaft (52).
m. Remove roll pins (56). Remove screws (58) and washers (59) to detach coil and lamination assembly (57).

4-21. CRANKCASE DISASSEMBLY. The oil seal in the nose of the crankcase is driven out by means of a long punch from the inside of the crankcase. The needle bearing and the spacer in the front end of the crankcase can then be driven out from the outside of the crankcase. Small items such as plugs can be removed as necessary,

SECTION V

CLEANING

5-1. GENERAL. All parts of these engines, internal and external, can be cleaned with kerosene, Federal Specification VV-K-211. This cleaning can be in the form of a spray or immersion and washing with a soft brush. Dry by blowing with compressed air or wiping with a clean cloth.

5-2. CLEANING AFTER LANDING. Due to the open exhaust ports, dirt and sand frequently enter the cylinders after a landing. This also applies to the carburetor. To clean the engine after landing, disassemble the dirty parts as described in Section IV and clean with kerosene as specified in paragraph 5-1.

5-3. CLEANING AFTER IMMERSION.

5-4. ENGINE. No damage or impaired operation of the engine will result from salt water immersion if the following operations are performed without delay after removal of target from the water.

a. Remove engine from target and drain out salt water.
b. Remove magneto, carburetor and spark plugs, then completely disassemble remainder of engine assembly as instructed in Section IV.
c. Take out crankcase drain plugs located at top and bottom of nose bearing and ascertain that bearing cavity is drained thoroughly.
d. Immerse or wash out crankcase and engine components with clean, fresh water. Drain out all water, then clean all parts and areas completely with kerosene or gasoline and oil mixture. Dry thoroughly; if necessary use compressed air on areas such as nose bearing cavity in crankcase.
e. Clean out carburetor as instructed in paragraph 5-5.
f. Check magneto for water as instructed in paragraph 5-6.
g. Overhaul spark plugs as instructed in paragraph 5-7.
h. Reassemble engine and components as instructed in Sections VIII and IX.
i. After reassembly, run engine at least five minutes, with propeller installed, using an oil and fuel mixture having a minimum ratio of 1 to 10.

5-5. CARBURETOR. After removal, clean carburetor as follows:

a. Immerse entire carburetor assembly in kerosene, Federal Specification VV-K-211, to wash out all dirt and salt water.
b. Open the fuel mixture adjusting valve and blow out channels and orifices with compressed air.

CAUTION

Do not apply pressures higher than 5 - 10 psi or damage to carburetor diaphragm will result.

c. Dry carburetor external surfaces with a clean cloth or compressed air.

5-6. MAGNETO. Remove band and cap and inspect magneto internally for signs of leakage. If water is found, proceed as follows:

a. Remove the two distributor cover elastic stop nuts and clamps and move distributor cover back. Remove two screws holding distributor cap in place and remove cap. It is not necessary to detach wires from distributor cover.
b. Remove distributor rotor.
c. Blow out complete assembly with compressed air to remove any trace of water.
d. Blow out distributor cover.
e. Using a small, soft brush or clean, lint-free cloth, thoroughly wash all magneto internal parts (except condenser) with clean kerosene. Dry with compressed air.
f. Inspect points for burning or pitting and set point gap to 0.022 inch.
g. Check all wires for deterioration of insulation.
h. Check inside and outside of distributor cover for cracks and check cover contacts for evidence of tracking.
i. Check rotor for cracks and loose segments.
j. Replace rotor, making sure alignment lug is in line with slot in end of shaft and that rotor is pushed firmly in place.
k. Replace distributor cover, seating it firmly in groove with locating lug in correct position. Secure cover with the two elastic stop nuts and clamps. Replace distributor cap and secure with two screws.
l. Lubricate "O" ring packing liberally and replace cap and band, making sure that cap and band are correctly seated.

5-7. DRYING SPARK PLUGS. If the target is equipped with non-waterproofed BG RB916-S spark plugs, it is recommended that the following procedure be carried out after salt water immersion.
a. Disassemble plug, using proper wrenches.
b. Place the three separate parts in a tray, keeping the plug together as one component, and bake for one

hour at 121°C (250°F).

c. Reassemble and tighten by hand, making sure core is concentric with the barrel ceramic insulator.

d. Torque to 400 inch pounds.

e. Regap plug to 0.020 inch.

f. Test at 100 psi in normal spark plug test chamber.

g. Store in a heated cabinet.

5-8. CLEANING PISTONS AND CYLINDERS. Due to the open exhaust ports, the cylinders and pistons frequently become dirty, particularly when landings are made in dirt or sand. In these cases, remove the cylinders and pistons as described in paragraphs 4-8 and 4-9. Wash thoroughly as specified in paragraph 5-1 above.

5-9. CARBON REMOVAL. Carefully scrape away carbon deposits, taking care not to scrape the metal and scratch machined surfaces. Then wash thoroughly with kerosene as specified in paragraph 5-1 above.

5-10. PISTON RING GROOVES. Piston ring grooves can be cleaned by scraping away the carbon with a small narrow scraper made of soft metal or wood. A broken piston ring can be used for this purpose by grinding one end down to a sharp edge and sliding it along the groove.

5-11. PROTECTIVE MEASURES. If the parts are not to be used immediately, apply a thin coating of oil, conforming to Specification MIL-O-6082A (Grade 1065) to each part after the kerosene washing and drying. Store in a clean place and cover securely.

SECTION VI

INSPECTION

6-1. GENERAL. When overhauling the engine, the various parts should be given close attention in order to determine if any evidence of wear, scoring or defects is present. Often these indications are obscured due to the presence of dirt, carbon deposits, etc., and can only be discovered after the various parts have been cleaned. In most cases the presence of serious defects is sufficient cause to reject the part. Rejection of parts showing minor defects is left to the discretion of the person in charge. Some of the minor defects can be readily corrected or repaired as described in Section VII.

6-2. PROPELLER HUB ASSEMBLY. Carefully inspect the taper bore of the hub for evidence of "fretting" corrosion. This will be indicated usually by reddish brown discoloration of the inside of the taper bore. This discoloration will also be found on the taper portion of the crankshaft. It is caused by a poorly fitted taper seat between the two parts or by the propeller not being tightened sufficiently. Inspect the condition of the threads on the propeller thrust bolt and also on the six propeller mounting bolts.

6-3. CARBURETOR ASSEMBLY. Remove the needle valve from the carburetor entirely and inspect the taper end for evidence of burrs or grooving. Check detent spring, plunger and underside of needle valve knob for defects or signs of excessive wear which might result in failure of needle valve to retain a given setting. Check the diaphragm for breaks or cracks. This can most readily be done by removing the diaphragm, as described in paragraph 4-18, and holding it up before a strong light, at the same time slightly stretching it. Remove the fuel inlet screen to determine if the fuel flow can be obstructed by the presence of foreign matter around the screen.

6-4. MAGNETO INSPECTION. After the magneto is disassembled as described in paragraph 4-20, inspect the distributor cap and cover for cracks and evidence of "spark tracking". Check the distributor rotor for loose segments. Observe the condition of the breaker points and determine if any evidence of pitting or burning is present. Burning will be indicated by dark discoloration of the points. Examine all wires carefully for evidence of insulation abrasion and loose connections at the terminals. Check the condition of the impulse coupling and inspect for evidence of binding in its moving parts. Examine the condition of the magneto shaft, particularly at the bearing points, for indications of insufficient lubrication or scoring. Test the condenser on a Condenser Tester, particularly for dielectric leakage.

6-5. MAGNETO IMPULSE RUBBER COUPLING. Inspect for incipient deterioration caused by the corrosive action of petroleum compounds on rubber.

6-6. FUEL PUMP. Test the fuel pump by immersing the intake side of the pump in kerosene and manually actuating the pump lever. If operating properly, the pump should discharge a substantial amount of kerosene with each stroke.

6-7. CYLINDER ASSEMBLY. Discard the cylinder if large pieces of cooling fins are broken off. Pay particular attention to the condition of the cylinder mounting pad for evidence of cracks around the cylinder mounting holes. Examine the cylinder bore for score marks, grooving or abrasion.

6-8. PISTON ASSEMBLY. Inspect the pistons for scoring and evidence of erosion due to excessive blowby. Check the piston rings for indications of sticking. Examine the piston for nicks or cracks, particularly around the skirt. Remove the piston pin and inspect for abrasion and any evidence of lack of lubrication. This will be indicated by heat discoloration. (See Table of Limits, Section XII).

6-9. CONNECTING ROD ASSEMBLY. Check the connecting rod bearing bores, particularly on the crankshaft end, for evidence of excessive heating. Also, observe if any abrasion evidence is present. Inspect the connecting rod forging itself for indications of physical failure such as cracks. The bearing rollers should not be discolored and should be free of flat spots. (See Table of Limits, Section XII.) Assemble cap to rod and tighten nuts to normal torque, then check to see that there is no ledge where cap and rod meet.

6-10. CRANKCASE ASSEMBLY. Carefully inspect the areas around the cylinder mounting studs for cracks due to fatigue. Carefully examine the engine mounting lugs for breaks or cracks, which are often caused by abnormal landings. Observe the condition of the oil seal in the front of the crankcase and replace if the leather appears to be worn. Pay particular attention to the needle bearing in the front of the crankcase and examine it carefully for heat discoloration or corrosion. (See Table of Limits, Section XII.)

6-11. REAR COVER ASSEMBLY. Inspect carefully for cracks or fractures, especially around the upper cylinder mounting lug.

6-12. CRANKSHAFT ASSEMBLY. Carefully examine all bearing journals on the crankshaft for evidence of heat or abrasion. Inspect for cracks or other evidence of fatigue failure, especially in and around the corners of the journals. Disassemble the center main bearing and check the condition of the inner needle bearing. Inspect the aluminum bore, particularly around the sealing grooves and also the faces of the rotary valve for abrasion or evidence of metal pick-up. If the engine has been subjected to hard landings, particularly on the

front of the engine, examine the two front throws. After a hard nose landing, the two front throws may be pinched opposite the connecting rod journals. If possible, support the crankshaft at the main bearing locations and check for excessive run-out at the propeller end of the crankshaft. The maximum allowable TIR run-out measured at the extreme end of the crankshaft is 0.020 inch. (See Table of Limits, Section XII.)

SECTION VII

REPAIR AND REPLACEMENT

7-1. GENERAL. It is possible to make some repairs on these engines with the overhaul facilities generally found at overhaul stations.

CAUTION

It is not recommended that welding be used to repair any portion of the engine because of the distortion induced by this method. Seriously damaged cylinders, crankcases, crankshafts, etc., should be replaced.

7-2. PROPELLER HUB REPAIR. Fretting corrosion, if not too serious, can be corrected by dressing down the propeller shaft taper and the taper bore of the propeller hub with fine emery cloth. Then lap the hub on the shaft, using a fine lapping compound until a good fit is obtained.

NOTE

This method is not applicable to cases where severe fretting is present, or where serious galling has caused deep scores in the crankshaft taper. The hub and flange constitutes a matched assembly and should be installed and/or stored as a matched set.

7-3. CARBURETOR REPAIR. Burrs or grooves on the taper end of the needle valve can be removed by dressing them down with fine emery cloth, being careful to maintain the same original taper and angle. Clean the fuel inlet screen by the use of compressed air and thorough washing. Replace the diaphragm if cracks or defects are present. Smooth the taper end of the check valve with fine emery cloth if necessary.

7-4. MATNETO REPAIR. If the magneto breaker points are pitted or burned seriously, it is better to replace them. Minor pitting or burning can be corrected by filing the points with a breaker point file. Be sure the points are filed so they come together squarely. Then adjust the points as described in paragraph 8-4h. Resolder any loose wire terminals and tape any bare spots on the wire to prevent grounding. If the magneto shaft shows indications of excessive heat at the bearing points, it may be advisable to dress these places down with fine emery cloth providing the clearance limits in Table of Limits, Section XII, are not exceeded. Replace the distributor rotor and/or the distributor cap if cracks in them are observed. Replace the condenser if the capacitance is not between 0.18 and 0.23 microfarad or if it shows dielectric leakage.

7-5. MAGNETO IMPULSE RUBBER COUPLING. Replace the rubber insert of the magneto impulse coupling if any cracks or breaks are observed or if serious deterioration has started.

7-6. FUEL PUMP. After disassembly to extent outlined in paragraph 4-19, all components should be examined for excessive wear. Inspect springs for signs of fatigue or cracks. Inspect diaphragm assembly for cracks or excess hardening of diaphragm material. Replace any parts showing indications of possible defects.

7-7. CYLINDER REPAIR. No attempt should be made to repair damage to the cylinder cooling fins. Cylinders with large areas of cooling fins damaged or broken, particularly at or near the top of the cylinder, should be immediately discarded. Small pieces of cylinder fin broken off should not affect the cooling of the cylinder. Carefully remove any carbon deposits in the top of the cylinder and especially around the exhaust ports. Cylinders having visible cracks on the mounting holes should be replaced.

7-8. PISTON ASSEMBLY. Reject the piston if nicks or cracks are discovered. Remove the carbon from the top of the piston and also from the ring grooves as described in paragraphs 5-8 and 5-9. Minor scratches and grooves can be removed by polishing the piston with very fine emery cloth, being careful to maintain the concentricity of the piston, providing the clearance listed in Table of Limits, Section XII, is not exceeded.

7-9. CONNECTING ROD ASSEMBLY. Any defects or misalignment found in the connecting rod is sufficient cause for rejection of this part.

SECTION VIII

ASSEMBLY OF SUB-ASSEMBLIES

8-1. GENERAL. This section describes in detail the proper methods and sequence of assembling the various parts which make up the sub-assemblies of the engine.

NOTE

It is important that the component parts be thoroughly cleaned before assembling them. It is also important that the various parts be assembled in the order given.

8-2. CRANKCASE ASSEMBLY. To assemble the nose bearing into the crankcase, first stand the crankcase, nose down, on the work table. Working through the crankcase interior, install the needle bearing in the crankcase nose and carefully tap into place until fully seated, using a long brass or copper rod and hammer. Install the bearing spacer in the same manner. Reposition the crankcase and press the oil seal into place in the front end recess. If necessary, the oil seal may be driven into place, using a soft mallet so as not to injure the seal.

8-3. FUEL PUMP ASSEMBLY. (See figure 4-10.) To reassemble the fuel pump:

a. Insert pin (36) into lower body (40) and drive in to partly engage link (39).

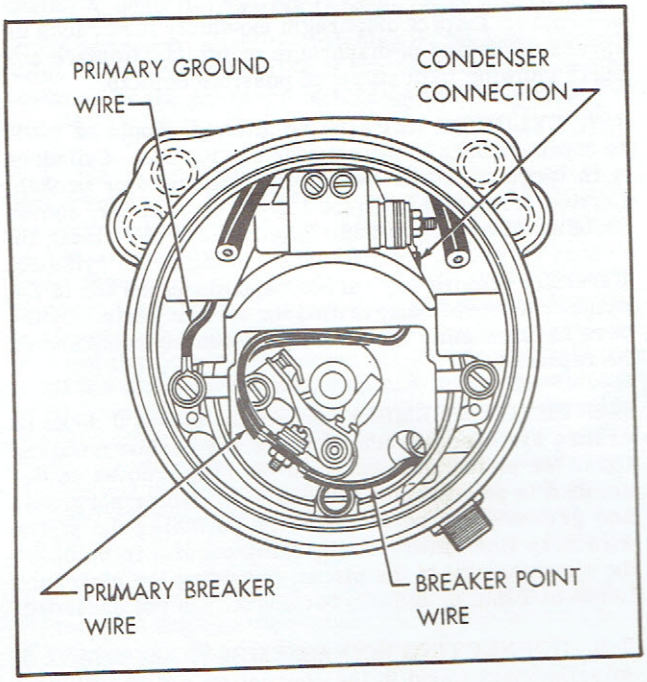


Figure 8-1. Magneto Wiring

b. Hold rocker arm (37) and spring (38) in position. Drive in pin (36) until flush with outer surface of lower body (40).

c. Insert diaphragm assembly (34) and spring (35) with flat sides of diaphragm stem perpendicular to pin (36). Diaphragm stem will slip into slot of link (39) and will engage link when diaphragm assembly is given one quarter turn.

8-4. MAGNETO ASSEMBLY. (See figure 4-11.) To reassemble the magneto:

a. Install coil and lamination assembly (57) in body (50) loosely with screws (58) and washers (59). Temporarily insert rotor (52) and, using wooden wedges, pry laminations outward and install roll pins (56). Tighten screws.

b. Press bearings (54 and 55) to shoulders on shaft (52) and press the assembly into retainer (48).

c. Attach bearing retainer (48) to magneto body (50) with screws (45) and washers (46).

d. Install oil seal (53). Secure impulse coupling (36) on rotor shaft (52) with key (51), washer (35) and nut (34).

e. Slip breaker (33) over pivot pin (47) and secure with screw (30) and washers (31 and 32).

f. Turn rotor shaft (52) until the breaker point follower block rests on the highest part of one of the cams.

g. Loosen screw (30) until breaker (33) moves freely.

h. Place an 0.022 feeler gage between the breaker points and move breaker up or down until a slight drag is felt on the gage when sliding it between the points. Tighten screw (30) and recheck points for 0.022 gap.

i. Connect wiring as shown in figure 8-1.

j. Turn rotor shaft (52) several times to make certain it does not bind at any point. Binding is usually due to uneven tightening of bearing retainer (48) to magneto body (50).

k. Install the distributor rotor (17) by aligning the rotor bore with the keyway on rotor shaft (52). Gently press rotor on shaft, or tap lightly into place with a soft mallet.

l. Clamp the entire assembly in a vise by one of the mounting lugs. Turn the impulse coupling (36) in its normal direction of rotation to determine that it snaps freely without binding.

m. Install the distributor cover (16) and secure with retainer clamps (42). Insert the spark wires and shielding harness assembly into the two holes in each side of the magneto and secure by screwing in the mounting connector.

n. Return the spark plug leads and coil wires to their grooves in the distributor cover and press into place. Check wiring with figure 2-4 before replacing distributor cap (15).

o. Replace distributor cap (15) and secure with two screws (14).

p. Replace cover insulation (13), "O" ring packing (12) and cover (11). Lock in place with retainer (10).

8-5. CARBURETOR ASSEMBLY. (See figure 4-10.)

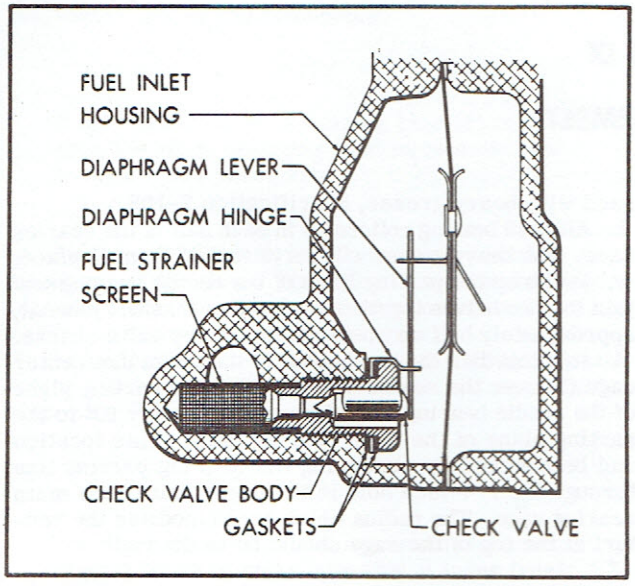


Figure 8-2. Fuel Check Valve Installation

To assemble carburetor:

a. Attach carburetor cover (26) to body (24) with two screws (22) and one screw (23).

b. Install retainer ring (10) in upper groove of plunger (13), then install washer (11) and spring (12) over plunger. Insert this assembly through hole in carburetor cover (26) and install lower retainer ring (10) on plunger.

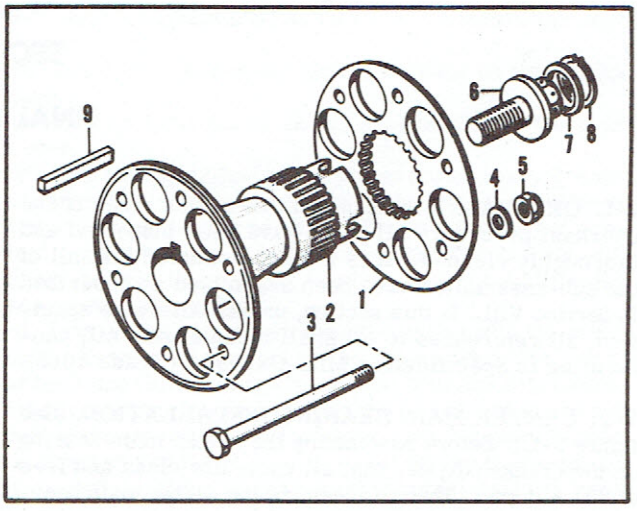
c. Install screen (7), washers (5), diaphragm hinge (6) and check valve body (4) in threaded hole in fuel inlet housing (3). (See figure 8-2 for installation arrangement.) Tighten housing (3) securely, with diaphragm hinge parallel to the horizontal reference line of the carburetor, then bend the hinge over to engage the diaphragm lever.

d. Insert check valve in place in the check valve body.

e. Place diaphragm lever (9) in the hinge (6), making certain that it is properly positioned over the check valve assembly (4).

f. Position diaphragm (8) with the center piece engaging the diaphragm lever (9), then attach diaphragm and entire inlet housing assembly to the flat machined side of the carburetor with six screws (1) and washers (2).

g. For late type carburetors, insert spring (21) and detent plunger (20) into hole in boss of cover (26). Install "O" ring packing (19) on needle valve shaft groove, then screw needle valve assembly into threaded hole in carburetor cover.



1. Propeller Hub Flange
2. Propeller Hub
3. Bolt
4. Washer
5. Nut
6. Lock Screw
7. Thrust Washer
8. Retainer Ring
9. Key

Figure 8-3. Propeller Hub Assembly

CAUTION

When tightening the needle valve, be careful not to force or jam it tight, as this may cause damage to the needle or valve seat, with resultant leakage.

h. On early type carburetors, install gasket (17) (or lockwasher) and detent assembly (16) on boss on carburetor cover, and tighten securely. Replace "O" ring packing (15) and needle valve assembly (14).

i. Rotate needle valve and check for proper locking action of detent mechanism.

8-6. PROPELLER HUB ASSEMBLY. (See figure 8-3.) Place flange (1) on hub (2) with marked ("O") spline on hub between the two similar marks on flange. Secure with bolts (3), washers (4) and nuts (5), taking up evenly to keep parallel.

SECTION IX

FINAL ASSEMBLY

9-1. GENERAL. It is assumed that at this stage of the overhaul procedure all parts have been inspected and thoroughly cleaned. It is further assumed that all of the sub-assemblies have been assembled as described in Section VIII. In this section, unless otherwise specified, all references to oil shall mean engine oil, conforming to Specification MIL-O-6082A (Grade 1065).

9-2. CENTER MAIN BEARING INSTALLATION. (See figure 9-1.) Before assembling the center main bearing on the crankshaft, see that all parts are clean and free of dirt and grit. Then to assemble the center main bearing, proceed as follows:

a. Coat the inside of each half (1) of the needle bearing race with heavy grease, Specification 2-108.

b. Align 19 bearing rollers (2) in each half of the bearing race. The heavy grease will serve to hold them in place.

c. Match up the parting lines of the needle bearing and join the two halves together over the crankshaft journal, approximately half way between the rotary valve checks.

d. Join together the two halves of the aluminum center cage (3) over the needle bearing (1). The parting plane of the needle bearing should be approximately 60° to the parting plane of the main bearing cage. This location can be checked by observing the bearing parting line through the 1/4-inch hole in the upper half of the main bearing cage. The radius which accommodates the venturi at the top of the cage should be to the right side of

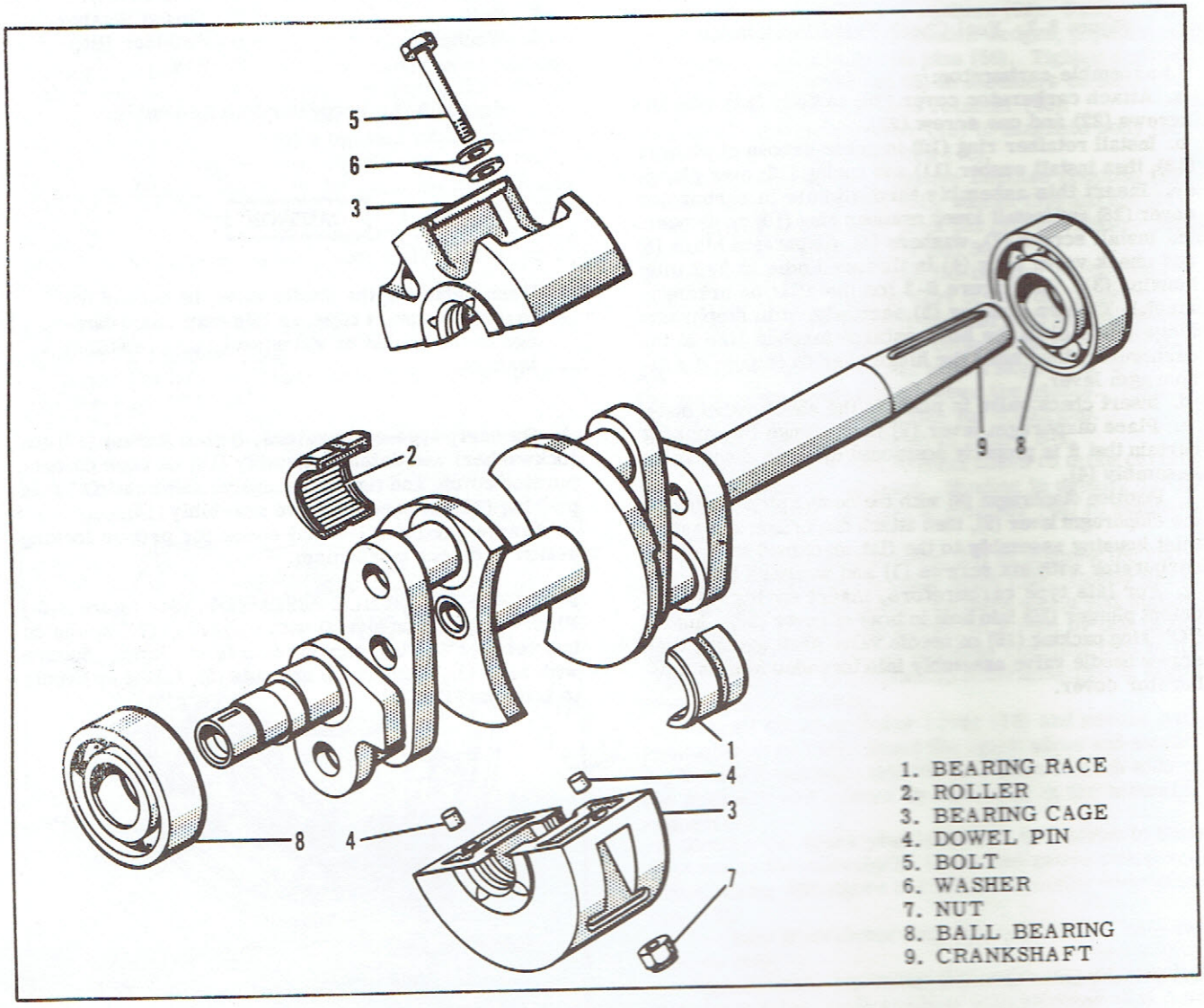


Figure 9-1. Center Main Bearing Installation

the center line of the crankshaft.

NOTE

If one section of main bearing cage (3) is damaged, the entire assembly must be replaced since these are matched parts.

e. Fit the two halves (3) tightly together and align them by means of the dowel pins (4). Drive the dowel pins (4) into place if necessary and peen over the metal around them to secure them in place.
f. Insert the four bolts (5) and washers (6) through the entire assembly from the top. Secure with four elastic stop nuts (7). Tighten securely.

NOTE

Spin the center main bearing assembly around several times to make sure that it turns freely without binding.

9-3. MAIN BALL BEARING INSTALLATION. The ball bearings at each end of the crankshaft are installed by pressing or driving them into place, using a piece of tubing against the inner race of the bearing.

9-4. CRANKSHAFT INSTALLATION.
a. Apply a little oil or light grease to the needle bearing and the oil seal leather in the front of the crankcase.
b. Apply a little oil to the ball bearings on the crankshaft and also to the rotary valve faces.
c. Turn the center main bearing cage until the intake ports are at the top. Insert the crankshaft assembly into the crankcase as shown in figure 9-2.

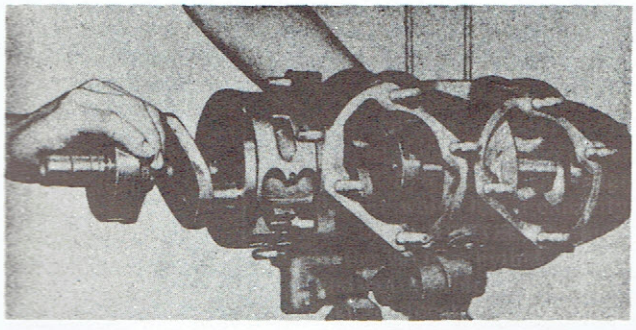


Figure 9-2. Crankshaft Installation

d. Drive crankshaft assembly in with a soft mallet until the front ball bearing is properly seated against the crankcase bore.
e. Turn the center main bearing cage around until the keyway lines up with the keyhole in the lower right side of the crankcase. This can be done by inserting a small punch of soft metal down from the top of the crankcase through the venturi bore and tapping the center main bearing cage around as required.
f. Install the center main bearing key in place by screwing a 1/2-20 screw into it and removing when the key is in place. Cover with the retaining plate and gasket and secure by screwing in the two cap screws.

9-5. REAR COVER INSTALLATION. To install the rear cover:
a. Install the rear cover gasket in place on the crankcase.
b. Apply a little oil to the oil seal leather in the rear cover.
c. Coat the upper fuel pump plunger with heavy grease and insert it in the reamed hole in the bottom of the rear cover casting, taper end down. Be sure it does not project from the bottom of the casting. The grease will serve to hold the plunger in place while installing the rear cover assembly.
d. Line up the rear cover mounting holes with the studs on the crankcase and press the rear cover into place, at the same time guiding the oil seal over the crankshaft. Be certain that the fuel pump plunger has not fallen out during this operation. If the rear cover becomes cocked or jammed, tap it lightly with a soft mallet to straighten it up and continue pressing or tapping until the rear cover is seated against the crankcase. Secure the rear cover to the crankcase by means of the six washers and six elastic stop nuts. Torque the nuts to 9-12 ft. lbs.
e. After the rear cover is tightened in place, check the end play of the crankshaft by first driving it as far as possible toward the front with a soft mallet and check the clearance between number one throw on the crankshaft with the inner front face of the crankcase by inserting a thickness gage between them. Make a note of this clearance and then drive the crankshaft as far as possible toward the rear of the engine and check the clearance again in the same place. The difference between the two clearances will be the total crankshaft end play, which should be between 0.015 and 0.025 total end play.

9-6. FUEL PUMP INSTALLATION. To install the fuel pump, insert the lower fuel pump plunger (the short one) into the plunger hole in the bottom of the crankcase with the slotted end down, using heavy grease to hold it in place. Turn the crankshaft over several times while exerting a steady pressure upward on the plunger with a finger to determine if the fuel pump plungers work freely. Then proceed to install the fuel pump as follows:
a. Turn the crankshaft over while exerting steady upward pressure on the fuel pump plunger with the finger until the plunger is in its maximum inward position.
b. Mount the fuel pump on its mounting pad by means of the two mounting bolts and nuts. Tighten only enough to hold the fuel pump in place.

NOTE

Be sure lower slot in plunger properly engages fuel pump arm.

c. Turn crankshaft until the fuel pump plunger is in its maximum outward position.
d. The fuel pump should be so installed that a free movement of the pump arm of 1/32-inch over the required maximum stroke position is obtained when the fuel pump arm is in its maximum position. This can be determined by hooking the fuel pump arm with a wire hook and observing if any additional movement is present at full outward stroke position. (See figure 9-3.) Do not mistake springing of the fuel pump arm for free movement.

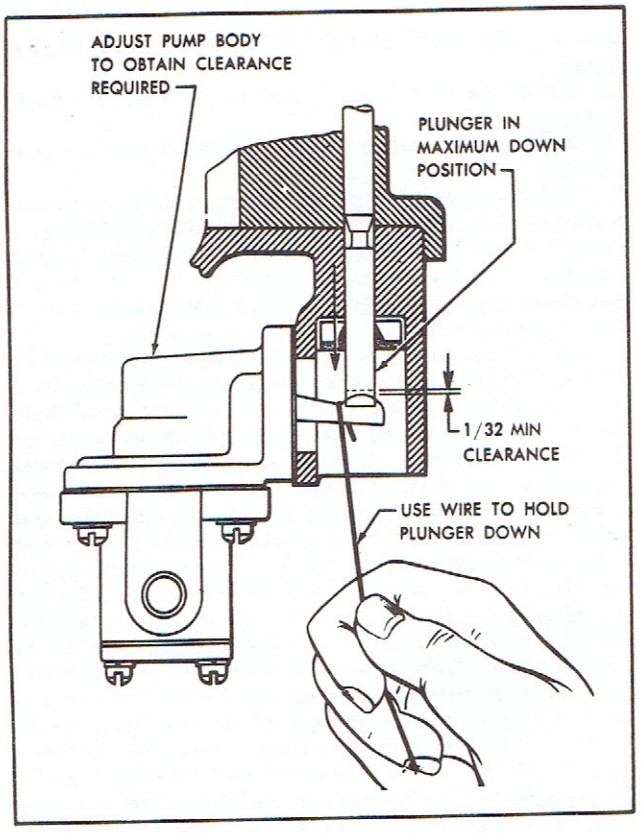


Figure 9-3. Adjusting Fuel Pump

9-7. CONNECTING ROD INSTALLATION. Press needle bearings into the piston bore, one from each side, until the outer ends of the needle bearings are flush with the ends of the piston pin bore. Before installing the connecting rod, lay all the component parts, connecting rod, bearing cages, and bearing rollers, out on a clean surface, preferably a clean cloth. The connecting rods are marked "one, two, three and four" to identify their position. The numeral on the connecting rod cap must be on the same side as the numeral on the connecting rod. The entire connecting rod is assembled with these numerals toward the top of the engine. Proceed with the connecting rod installation as follows:

a. Coat crankshaft journal with heavy grease and place one roller cage on upper surface of journal with six rollers in place.

b. Press down connecting rod bolts until heads are seated. Place one cage and six rollers in connecting rod cap in relative position to cage on crankshaft journal. Place remaining cage and six rollers in relative position in connecting rod. Use heavy grease to hold cages and rollers in position.

c. Place connecting rod cap in position on crankshaft journal on one side of engine and insert connecting rod assembly through from opposite side. Line up rod and cap and press together.

d. Install the lock-plates in place over the connecting rod screws and screw on the connecting rod nuts. The connecting rod plates are installed with the square face toward the center of the connecting rod.

e. Tighten connecting rod nuts evenly to 100-115 in. lb torque and bend over lock-plates around side of nut.

f. Turn the crankshaft around several times while holding the connecting rod, and see that the connecting rod turns freely without binding. If any binding is present, it indicates that the bearing rollers are not properly aligned and it will be necessary to disassemble the rod and repeat the procedure.

9-8. PISTON INSTALLATION. Install the piston on the connecting rod with the solid end of the piston pin to rear of engine after first applying a little oil (Specification 2-104B) to the piston pin needle bearings. Be sure the snap rings at both ends of the piston pin are securely seated in grooves provided.

9-9. CYLINDER INSTALLATION. To install the cylinders, first place the cylinder gasket into position over the cylinder mounting studs on the crankcase. Apply a light coating of oil (Specification 2-104B) around the piston, particularly on the piston rings. Compress the piston rings with a 3-3/16 inch diameter piston ring compressor and slide the cylinder into place over the piston. Install the washers and elastic stop nuts and tighten progressively in sequence. Torque to 15-18 ft-lbs.

NOTE

When all the cylinders and pistons are installed, turn the crankshaft over several times to be sure no binding is present. It should turn evenly and smoothly.

9-10. MAGNETO DRIVE ASSEMBLY INSTALLATION. Place a Woodruff key into the keyway in the end of the crankshaft and, after lining up the keyway on the drive assembly, drive the assembly in place using a tube of soft metal or a punch. Drive only against the steel insert to prevent damage to the aluminum portion. Continue driving the assembly on the shaft until it seats against the shoulder on the crankshaft. (See figure 9-4.)

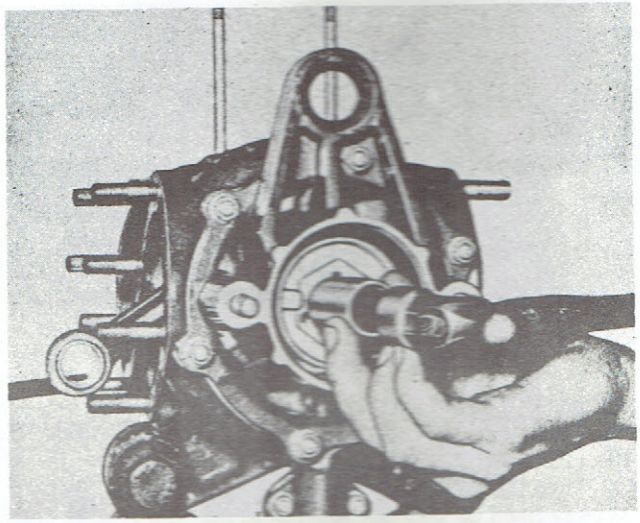


Figure 9-4. Installing Magneto Drive Assembly

9-11. MAGNETO INSTALLATION. To install the magneto assembly on the engine:

a. Turn the crankshaft until the mark "X" on the face of the magneto drive assembly is on the top. (See figure 9-5.)

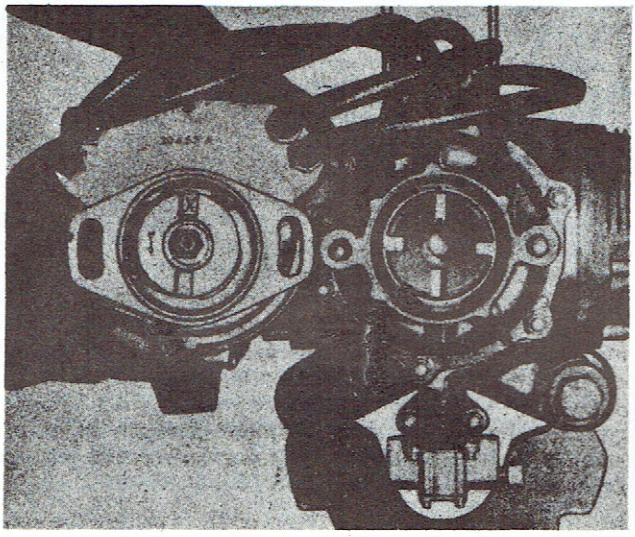


Figure 9-5. Installing Magneto

b. Locate the rubber coupling insert in place in the magneto drive assembly.
c. Turn the magneto shaft until the "X" on the impulse coupling lines up with the mark on the magneto drive assembly.
d. Locate the magneto assembly in place on the mounting studs and push into position, being careful that the rubber coupling insert is properly positioned. If it is not, the magneto will go into place only with great difficulty.
e. Place one washer over each stud and then screw on the two 3/8-inch elastic nuts only enough to hold the magneto in place. Do not tighten until the magneto is timed as described in paragraph below.
f. Turn the crankshaft over in its normal rotating direction several times to determine if the impulse coupling functions freely. If the impulse coupling does not snap readily while turning the engine over, it means the rubber coupling insert is not positioned properly. In this case it will be necessary to remove the magneto again and repeat the procedure.

9-12. MAGNETO TIMING. A line scribed on the front face of the rear rotary valve cheek of the crankshaft and a line scribed in the crankcase on the rear side of the venturi bore are the timing marks. (See figure 9-6.) The crankshaft is turned (viewing along center line of engine) until the timing marks match and beyond until magneto impulse coupling snaps, then back to line up marks. This alignment represents 25° before top center on numbers one and two cylinders. This is the correct firing position. To time the magneto:
a. Remove the shielding cover at the rear of the magneto.
b. Remove the two elastic stop nuts and clamps holding the distributor cover in place and raise the distributor cover up to expose the distributor rotor. Secure the distributor cover up out of the way with a wire hook or other means.
c. Remove the distributor rotor by prying it off with two screwdrivers.
d. Check breaker points at 0.022 and if necessary, adjust as described in paragraph 8-4 through 8-4j.
e. Align the timing marks as described in paragraph

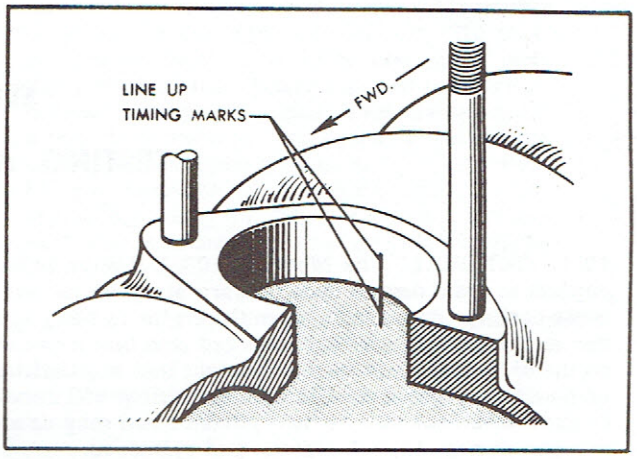


Figure 9-6. Timing the Magneto

above. Do not move the crankshaft after timing marks are aligned.
f. Move the magneto in its mounting slots to the right or left until the breaker points just start to open. This can be determined by using a continuity meter or by inserting a very thin piece of cellophane or paper between the points when they are closed. Exert a slight, but steady, pull on the paper while moving the magneto. When the breaker points open, the paper will pull free. This would be the correct timing position.
g. Torque the two magneto mounting nuts evenly to 13-16 ft-lbs. when the magneto is in the correct timing position. Recheck timing and readjust if necessary.
h. Replace the distributor rotor and cover and clamp securely into position. Replace the ground wire. Replace the cover and retainer clamps, making sure that both are correctly seated. Secure with two screws.

CAUTION

Incorrect timing of more than ±1° from 25° before top dead center may cause engine failure.

9-13. CARBURETOR INSTALLATION. To install the carburetor on the engine:
a. Install gasket over studs on crankcase.
b. Place carburetor in position over studs.
c. Secure with washers and nuts.
d. Install fuel line from carburetor to fuel pump.

9-14. PROPELLER HUB INSTALLATION. (See figure 8-3.) To install the propeller hub:
a. Lap propeller hub on shaft, using a fine lapping compound. Clean compound from shaft and hub.
b. Coat tapered section of crankshaft with light coat of graphite base grease.
c. Press square key securely in the keyway provided.
d. Line up keyway in the hub with the key on the crankshaft and slip hub into place on the taper as far as it will go.
e. Screw in the propeller thrust bolt and torque to 150-200 ft-lbs. Install washer and snap ring.
f. Thread safety wire through the propeller hub body and through propeller thrust bolt head and fasten securely.

SECTION X

TESTING AFTER OVERHAUL

10-1. GENERAL. The Model O-100-1 Engine is dependent to great degree upon forward airspeed for adequate cooling. As a result, when the engine is being test run on the ground, whether mounted on a test stand or on the airframe, it is very important that any baffling or cowling be removed. Use of such baffling will result in excessive heat rise in the cylinders and may cause serious damage to both pistons and cylinders.

NOTE

It is suggested that during ground test running, the fuel mixture be kept as rich as possible (without the engine missing or "four-cycling"), thus allowing the engine to run much cooler than with a lean mixture.

10-2. STARTING ENGINE. After installing propeller on engine hub, clear all personnel except those operating the starter and engine controls away from propeller area.

NOTE

Three men are necessary as a starting crew; two handling the starter and one operating the ON-OFF switch and carburetor controls.

a. Open carburetor needle valve about 1/2 turn from fully closed position.

NOTE

There is no spark adjustment. The engine is timed with the spark in the optimum operating position.

b. Prime cold engine twice (depressing primer plunger). Do not prime hot engine. Be careful not to overprime engine as this will cause flooding.
c. Make certain target ignition switch is "OFF", then crank engine with the starter several times to build up fuel pressure to carburetor.
d. Turn ignition switch "ON".
e. Engage starter with propeller hub and energize starter. When engine fires, withdraw starter. As soon as the engine starts, quickly open the needle valve.
f. If the engine fails to start in about 100 revolutions, turn ignition switch "OFF" and close needle valve completely. Pull propeller through backwards several times to clear the engine of excess fuel. Turn ignition "ON" again, then repeat starting procedure outlined in step 10-2e above.

10-3. ENGINE WARM-UP.
a. Adjust mixture by turning carburetor needle valve "IN" (clockwise) until engine begins to slow down, then back valve "OUT" (counterclockwise) until engine just starts to fire on every second cycle (approximately 1/2 to 3/4 turn) instead of every cycle. Then turn needle valve "IN" very slightly so that engine is not "four-cycling", except for an occasional misfire, which is permissible. This will be the proper carburetor setting for ground operation.

NOTE

When running the engine on the ground a slightly rich fuel mixture setting is required to prevent engine overheating. Before take off needle valve must be readjusted to provide slightly leaner fuel mixture for flight conditions.

b. Excessive misfires are primarily due to over-priming the engine. However, this should be eliminated after the crew becomes more familiar with both the amount of priming necessary for engine starting and also the proper carburetor setting for engine operation.

CAUTION

If at any time sparks are observed coming from the exhausts, it indicates an excessively hot cylinder and a burning piston. Stop the engine immediately and determine the cause of trouble.

10-4. CORRECTION FOR MISFIRING. If the engine continues to misfire, adjust the fuel mixture leaner by turning the needle valve toward the right or clockwise. Leave in this position until the excess fuel is cleared out of the engine and it runs smoothly on all four cylinders. Then increase the fuel mixture by turning the needle valve toward the left or counterclockwise until the engine begins to miss or four-cycle because of an excessively rich mixture. When this occurs, adjust the needle valve leaner or back toward the right just enough to make the engine run smoothly again. This should be the ideal mixture for static running on the ground for testing or run-in purposes at wide open throttle. If the engine fails to clear out after starting and continues to misfire even with a leaner mixture, it is often possible to bring in a missing cylinder by grounding out the spark plug of the opposing cylinder for short intervals. As an example, if number four cylinder is missing, ground out the plug in number three cylinder for a period of two or three seconds. Repeat this procedure five or

six times. To ground out a spark plug, simply unscrew the shielding connection to the plug and pull out the spark wire terminal far enough to cause the plug to misfire. This can be done while the engine is running without danger of an ignition shock. Care should be taken not to keep the plug grounded out too long at one time, otherwise it will foul also. Should the engine continue to misfire, then adjust needle valve richer again. If this fails it will be necessary to stop the engine and clean or replace the missing spark plug. However, it must be remembered that the engine may misfire due to other causes.

NOTE

It is sometimes very difficult to determine which cylinder is missing when the engine is firing on only three cylinders. This can most readily be done by feeling of the cylinder fins. The coolest cylinder is most likely the one that is misfiring or not firing. Another method is to ground out the spark plugs as described above, one at a time in sequence. The cylinder which fails to produce a decided drop in engine speed while being grounded is the missing cylinder. After engine is running smoothly, a run of 5 minutes is all that is necessary to assure that the engine is in good order.

10-5. STOPPING THE ENGINE. To stop the engine while running on the ground, turn off the ignition switch. If the engine is not to be used again immediately, the carburetor air intake and the exhaust ports should be covered.

SECTION XI

ACCESSORIES

11-1. All accessories used on the Models 0-100-1 engine are either manufactured by McCulloch Motors Corporation or are reworked to meet the requirements of these engines. No reference is made to other service publications since all possible phases of overhaul of the entire engine and its accessories are covered in this handbook.

SECTION XII

TABLE OF LIMITS

12-1. INTRODUCTION. The following Table of Limits gives all vital clearance and end-play data necessary for checking and replacing parts as described therein.

12-2. TABLE OF LIMITS.

Description	Manufacturing Minimum	Manufacturing Maximum	Replacement Maximum
1. Front and center main needle bearing journals	1.3734	1.3740	1.3730
2. Total crankshaft end play, engine assembled	0.015	0.025	
3. Connecting rod journals	1.2487	1.2492	1.2477
4. Connecting rod bearing bore, large end	1.6252	1.6257	1.6262
5. Total chordal clearance per section between bearing rollers and connecting rod bearing cage	0.003L	0.006L	0.009L
6. Piston pin needle bearing to connecting rod bore	0.001T	0.0025T	
7. Total end clearance, center main bearing thrust face to crankshaft rotary valve face	0.0055L	0.0075L	0.009L
8. Piston skirt in cylinder	0.004L	0.006L	0.009L
9. Piston pin bore in piston	0.8127	0.8129	0.8131
10. Piston ring side clearance	0.0035L	0.005L	0.010L
11. Piston ring side clearance, lower	0.001L	0.0025L	0.005L
12. Piston pin outside diameter	0.8123	0.8126	0.8117
13. Magneto shaft to bushings	0.0005L	0.0020L	0.003L
14. Maximum crankshaft run-out at propeller end			0.020

12-3. Ordinarily the wear on the ball bearings and needle bearing is negligible, providing adequate lubrication has been supplied. It may be assumed that the tolerances are within limits and the bearings are fit for use, provided inspection discloses no scoring, galling or evidence of excessive heat on the bearing journal.