TM 5-4320-259-34

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

PUMPING ASSEMBLY FLAMMABLE LIQUID, BULK TRANSFER, LIGHTWEIGHT, CENTRIFUGAL, 100 GPM MINIMUM, GASOLINE-ENGINE-DRIVEN (BARNES MODEL US6ACG)

FSN 4320-150-6116

HEADQUARTERS, DEPARTMENT OF THE ARMY

SEPTEMBER 1971

WARNING

Before performing maintenance, be sure the unit is not operating or subject to line pressures.

Do not operate the pump within an enclosed area without venting the exhaust gases to the outside. Exhaust fumes contain carbon monoxide, an odorless, colorless, deadly poison.

Do not allow smoking or open flames in the vicinity of this pump.

When lifting the pumping unit, be sure the lifting device has a capacity of at least 400 lbs. Do not allow the pumping unit to swing while suspended.

When using cleaning solvents, always provide adequate ventilation to prevent excessive inhalation of solvent vapors.

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DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *25 September, 1971*

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LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This technical manual covers direct support and general support maintenance for Pumping Assembly, Flammable Liquid, Bulk Transfer, Centrifugal, Gasoline-Engine-Driven, 100 gallons per minute, Federal Stock Number 4320-150-6116. This pump is manufactured by Barnes Manufacturing Company, Mansfield, Ohio, as Model US6ACG.

1-2. Forms and Records

Maintenance forms, records, and reports which are used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

1-3. Reporting of Errors

Reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028, Recommended Changes to Publications, and forwarded to Commanding General, U. S. Army Mobility Equipment Command, ATTN: AMSME-MP, 4300 Goodfellow Boulevard, St. Louis, Mo. 63120.

Section II. DESCRIPTION AND DATA

1-4. Description

a. Pumping Assembly Model US6ACG (fig. 1-1) consists of an engine-driven pump mounted on a frame, a rigid-walled suction hose, two non-rigid discharge hoses which are stored in hose containers mounted on each side of the pump, and two manually operated hose nozzles which attach to the discharge ends of the discharge hoses to control the flow of liquid.

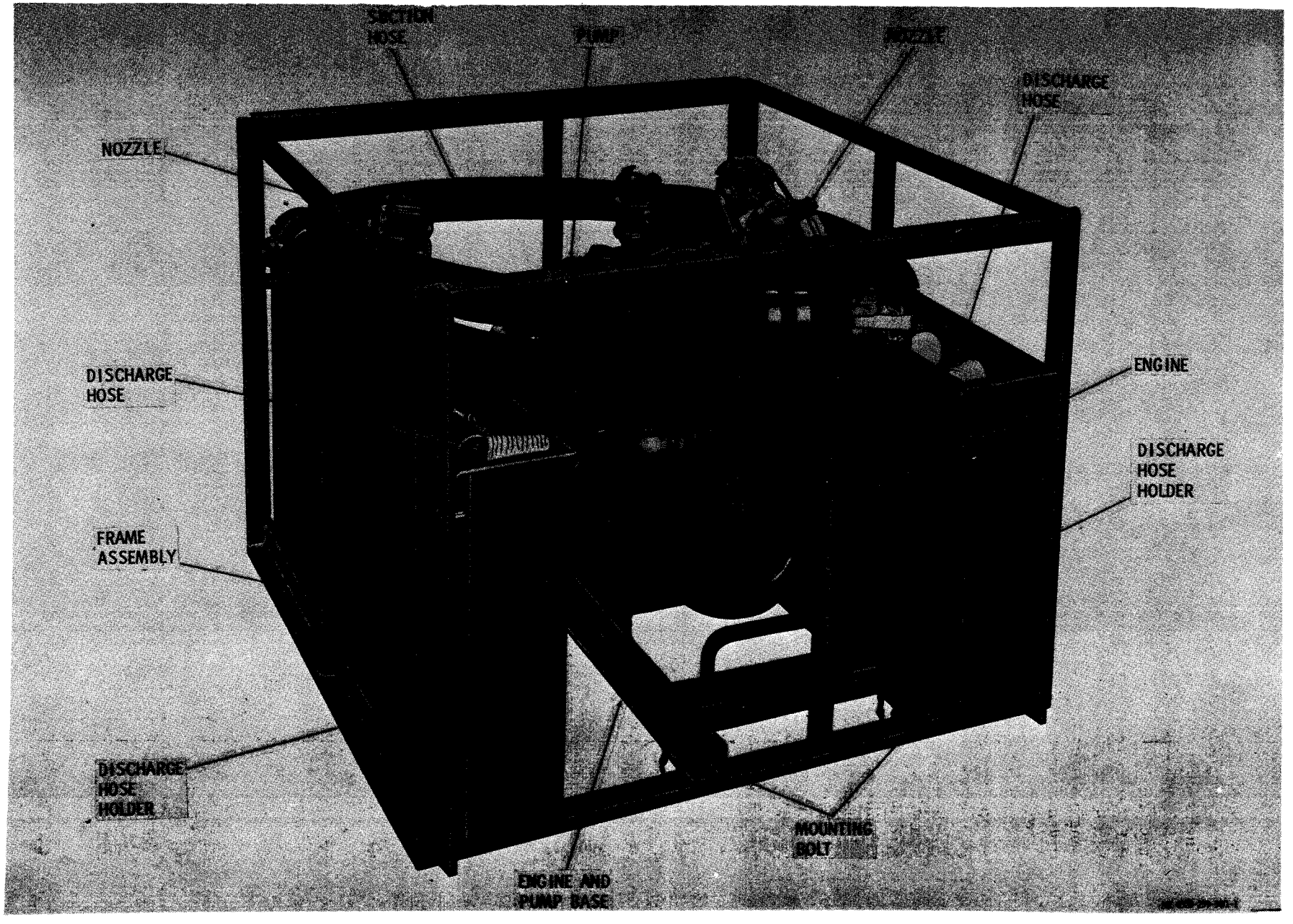


Figure 1-1. Pumping Assembly, Model US6ACG.

b. The centrifugal pump is directly coupled to the engine with the pump impeller being mounted on the threaded end of the engine crankshaft. After initial priming, the pump is self-priming, The pump has a 1½ inch suction port and discharges through a pipe cross, with the two side ports being used for hose connection. The upper port is used for priming. All ports are fitted with caps to prevent the entry of dirt when the hoses are disconnected.

c. The engine is an air-cooled, single-cylinder, gasoline-driven, four-stroke-cycle type. It develops 21½ horsepower at 3600 rpm. Speed is controlled by a mechanical-fly ball-type governor which controls the opening and closing of the carburetor throttle. The engine is splash lubricated.

d. The suction and discharge hoses are provided with quick-disconnect fittings for easy attachment to the related ports. The nozzles are also equipped with quick-disconnect-type connectors. These connectors are clamp-type, in which the connector is positioned over the mating fitting and the clam ping levers are then operated to make a leak-proof connection.

1-5. Differences Between Models

This technical manual covers only Pumping Assembly Model No. US6ACG, manufactured by Barnes Manufacturing Company, Mansfield, Ohio. No known differences exist for this model number.

1-6. Identification and Tabulated Data

a. Identification.

(1) *Army data plate.* The army data plate is located on the engine end of the pump and engine mounting plate. It specifies the nomenclature, model, serial number, federal stock number, contract number, capacity, shipping dimensions, and weight.

(2) *Engine plate.* The engine plate is mounted on the engine blower housing. It indicates the model, serial, and specification numbers, brief service and operating instructions, abbreviated maintenance instructions, and valve, point, and plug clearances. It also cites the name and address of the manufacturer.

b. Tabulated Data.

(1) *Pumping assembly.*

Manufacturer	Barnes Manufacturing Company
Model	US6ACG
Serial number range	37666-001 through 37666-700
Type	Centrifugal
Pumping medium	Flammable liquids
Capacity	.100 gallons per minute
Maximum rated driven speed	3600 rpm
Suction port size	.1½ inch male
Discharge port size	.1½ inch male
Number of discharge ports	.2

(2) *Engine.*

Manufacturer	Kohler Company
Model	K91P-31882A
Type	Four-stroke-cycle
Fuel	Gasoline
Cooling	Air
Number of cylinders	..l
Bore	2.375 inches
Stroke	2 inches
Horsepower	..2½ at 3600 rpm
Maximum speed	.3600 rpm

(3) *Hose nozzle.*

Manufacturer	OPW
Model No	.190GA
Type	Non-automatic
Nominal size	1½ inches

(4) *Suction hose.*

Nominal size	.1½ inches
Length	10 feet

Nominal size	1½ inches
Length	50 feet

(6) *Overall dimensions and weight.*

	Actual	*Shipping*
Length	32 inches	34 inches
Width	30 inches	32 inches
Height	22 inches	24 inches
Weight	216 lbs	281 lbs
Cubage	16 cubic feet	

(7) *Torque values.*

Spark plugs	27 ft-1bs
Cylinder head cap screw	l7 ft-lbs
Governor arm locking screw	35in-lbs
Flywheel retaining nut	45 ft-lbs
Connecting rod cap screw	12 ft-lbs

CHAPTER 2

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

Section I. REPAIR PARTS, SPECIAL TOOLS, AND EQUIPMENT

2-1. Special Tools and. Equipment

No special tools and equipment are required for the direct support and general support maintenance of the pumping assembly.

2-2. Maintenance Repair Parts

Repair parts and equipment are listed and illustrated in the repair parts and special tools list covering direct support and general support maintenance for this pumping assembly. Refer to TM 5-4320-259-34P

Section II. TROUBLESHOOTING

2-3. General

This section describes troubles which might occur during operation of the pumping assembly, along with the probable causes and corrective actions relating to the troubles. Only those functions which are solely within the scope of direct and general support maintenance are listed. For troubleshooting procedures which are within the scope of operator/crew and organizational maintenance, refer to TM 5-4320-259-12.

2-4. Direct Support and General Support Maintenance Troubleshooting

Refer to table 2-1 for troubleshooting which is allocated to direct support and general support maintenance levels.

Table 2-1. Troubleshooting

Malfunction	Probable Cause	Corrective Action
1. Engine will not turn over.	*a.* Impeller binding in volute.	*a.* Disassemble pump and free impeller (para 3-2).
	b. Engine seized.	*b.* Remove pump from engine (para 3-2). Repair engine as necessary (para 4-4 through 4-22).
2. Engine cranks but will not start.	Engine compression too low.	Test engine to determine fault (TM 5-4320-259-12). Repair engine as necessary (para 4-4 through 4-22).
3. Engine lacks power, smokes, or operates erratically.	*a.* One or both valves stuck open.	*a.* Free stuck valves. Replace or regrind if burned (para 4-4 through 4-6).
	b. Valve springs weak.	*b.* Replace valve springs (para 4-4 through 4-6).
	c. Defective piston.	*c.* Replace defective piston (para 4-8 through 4-10).
	d. Piston rings worn.	*d.* Replace piston rings (para 4-8 through 4-10).
	e. Crankshaft not timed to camshaft.	*e.* Correct engine timing (Para 4-14).
4. Engine makes excessive noise.	*a.* Main or connecting rod bearing defective.	a. Replace defective bearing (para 4-8 through 4-10 or 4-12 through 4-14).
	b. Flywheel rubbing on blower housing.	*b.* Aline blower housing (TM 5-4320-259-12).
	c. Loose piston pins.	c. Replace pistons (para 4-8 through 4-10).
	d. Excessive crankshaft end play.	*d.* Replace main bearings (para 4-12 through 4-14).
	e. Loose camshaft bearings.	e. Replace camshaft or pin (para 4-16 through 4-18).

Table 2-1. Troubleshooting—Continued

Malfunction	Probable Cause	Corrective Action
4. Engine makes excessive noise—Cont.	*f.* Piston slap.	*f.* Replace worn pistons (para 4-8 through 4-10).
5. Pump runs with no fluid discharger or with low discharge.	*a.* Impeller broken, worn, or damaged.	*a.* Replace impeller (para 3-2 through 3-4).
	b. Impeller-to-wear plate clearance incorrect.	*b.* Add or remove shims as required (para 3-2 through 3-4).
	c. Volute excessively worn.	*c.* Replace volute (para 3-2 through 3-4).
	d. Shaft seal defective.	*d.* Replace shaft seal (para 3-2 through 3-4).
6. Pump noisy	*a.* Impeller loose.	*a.* Tighten impeller (para 3-2 through 3-4).
	b. Foreign matter in pump.	*b.* Disassemble pump; remove foreign matter (para 3-2 through 3-4).

Section III. GENERAL MAINTENANCE

2-5. General

This section contains general maintenance procedures which are the responsibility of direct support and general support maintenance personnel. The paragraphs contained here in describe general practices applicable to several assemblies or components of the pumping assembly which would otherwise have to be repeated in each section of the manual assigned to those assemblies and components.

2-6. Cleanliness

a. Take care to assure that the work place is clean before starting to disassemble the engine or pump parts.

b. Steam-clean the exterior of the engine or pump before starting disassembly to prevent the dirt from entering the bearings. Clean the exterior of engine components with a cloth dampened with solvent.

c. If compressed air is used to clean the parts, make sure the compressed air is free from dirt and contaminants.

d. Protect disassembled parts from blowing sand and dust which could later cause rapid wear of the gears, bearings, and machined surfaces.

2-7. Care of Bearings

a. Clean all bearings by placing them in a wire basket and immersing them into a container of fresh cleaning solvent. Agitate the bearings in the solvent to remove all traces of old lubricant.

b. After the bearings are cleaned, dry them with clean, filtered compressed air. Take care to prevent spinning the bearings with the compressed air jet.

c. Dip the cleaned bearings in clean engine oil and immediately wrap them in lint-free paper to prevent the entry of dust and dirt.

2-8. Seals and Gaskets

Replace seals and gaskets of all components with each disassembly. The use of new gaskets and seals will greatly reduce the possibility of leaking and will help prevent the entry of dust and dirt after reassembly.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS AND AUXILIARIES

2-9. General

a. The pumping assembly is mounted on a frame constructed of angular and tubular steel. The pump and engine assembly are mounted on a fabricated base which has handles for easy handling of the engine and pump assembly. An engine mounting plate on the pump and engine mounting base adapts the engine for easy mounting.

b. Removal of the pump from the engine requires complete pump disassembly, since the pump impeller is screwed directly on the end of the crankshaft of the engine. The pump has no bearings since the crankshaft rides in the engine bearings. A seal is installed in the plate that adapts the pump to the engine. This seal prevents leaking around the rotating shaft.

c. Two discharge hose containers are mounted on the frame of the pumping assembly, one on each side of the pump and engine assembly. These containers are bolted to the frame.

2-10. Removal and Installation of Major Components

a. Removal.

(1) Remove the discharge hose containers as shown in figure 2-1, items 1 through 9.

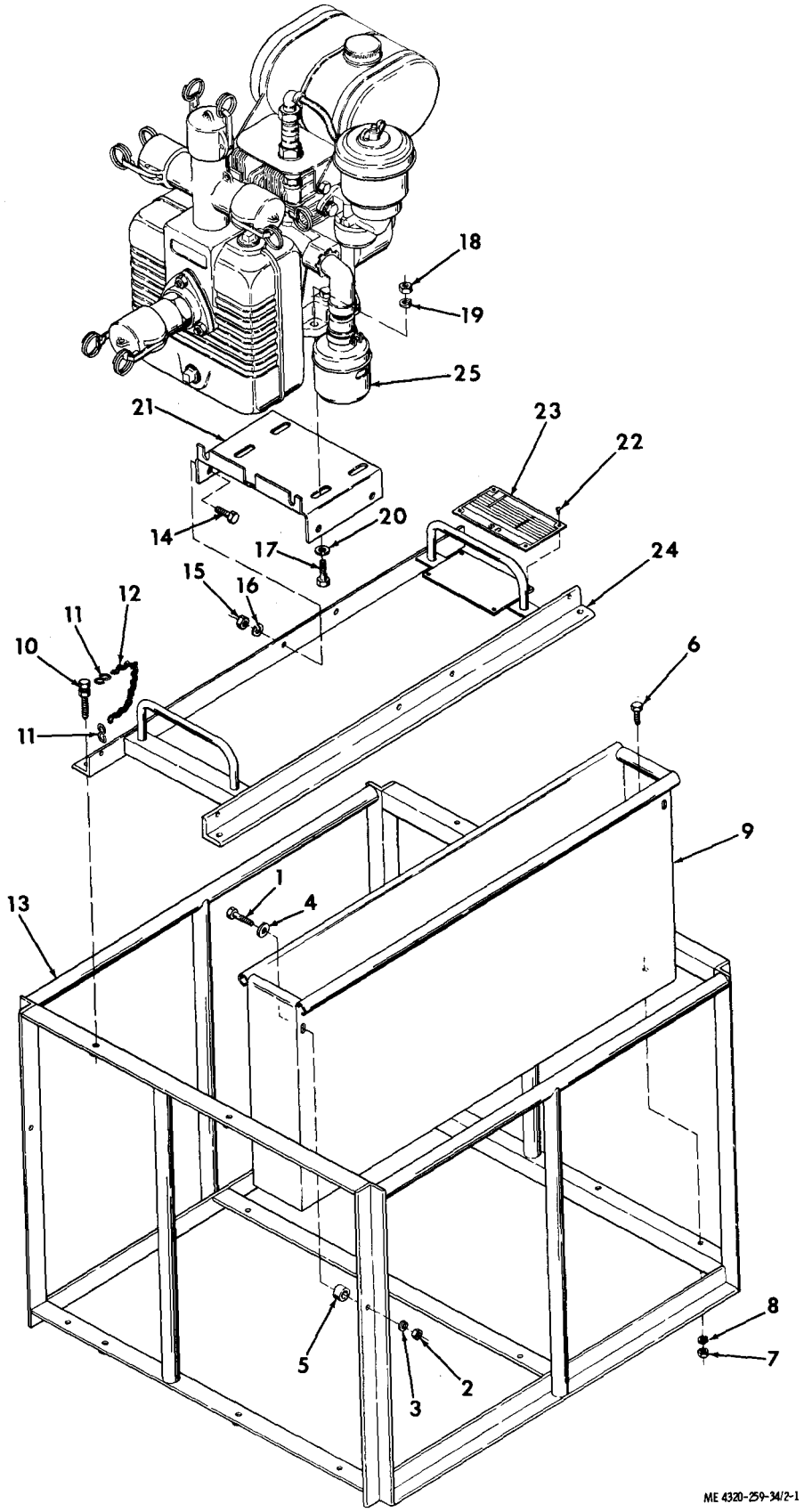


Figure 2-1. Pumping assembly, showing major components.

KEY to fig. 2-1:

1. Cap screw
2. Nut
3. Lock washer
4. Flat washer
5. Spacer
6. Cap screw
7. Nut
8. Lock washer
9. Discharge hose holder
10. Screw assembly
11. S-hook
12. Chain
13. Frame assembly
14. Cap screw
15. Nut
16. Lock washer
17. Cap screw
18. Nut
19. Lock washer
20. Flat washer
21. Engine adapter
22. Screw
23. Identification plate
24. Engine and pump base
25. Engine and pump assembly

(2) To remove the assembled engine and pump, remove the bolt assemblies that secure the pump and engine mounting base to the main frame. Use the handles to lift the assembled engine and pump from the frame.

Note. Pump disassembly is necessary to separate the engine from the pump. Refer to chapter 3 for pump disassembly instructions.

b. Cleaning and Inspection.

(1) Steam-clean the frame and discharge hose containers. Remove any greasy or gummy deposits with an approved cleaning solvent; dry thoroughly.

(2) Inspect the frame for cracks, distortion, broken weldments, and other damage. Straighten bent frame members. Weld broken weldments. Replace the frame assembly if damaged beyond repair.

(3) Inspect the hose containers for cracks, distortion, and other damage. Replace damaged containers.

(4) If troubleshooting indicates that repair of the pump or engine is necessary, refer to the applicable chapters of this publication and make the necessary repairs.

c. Installation.

(1) Position the assembled pump and engine on the pumping assembly frame. Secure with the bolt assemblies.

(2) Position the hose containers (9, fig. 2-1) on the pumping assembly frame; secure with cap screws (1 and 6), nuts (2 and 7), lock washers (3 and 8), and flat washers (4). Be sure to install the spacers (5) between the containers and side frame members.

CHAPTER 3

REPAIR OF CENTRIFUGAL PUMP

3-1. Description

a. The impeller of the centrifugal pump is threaded directly on the extended end of the engine crankshaft. A seal plate mounted between the impeller and the engine adapts the pump to the engine, providing the required alinement between the two components. A seal is installed in the seal plate around the rotating crankshaft to prevent the fluid being pumped from leaking, and to prevent air from being drawn into the pump at this location. Air leakage at this point can greatly reduce pump efficiency and, at higher suction lifts, prevent the pump from pumping entirely.

b. The pump impeller is encased in a close-fitting volute which is shaped to provide efficient pumping operation. As the impeller rotates, it throws the fluid outward by centrifugal force. The design of the volute converts the centrifugal force to head pressure necessary to cause fluid flow through the pump. The volute is secured to the seal plate.

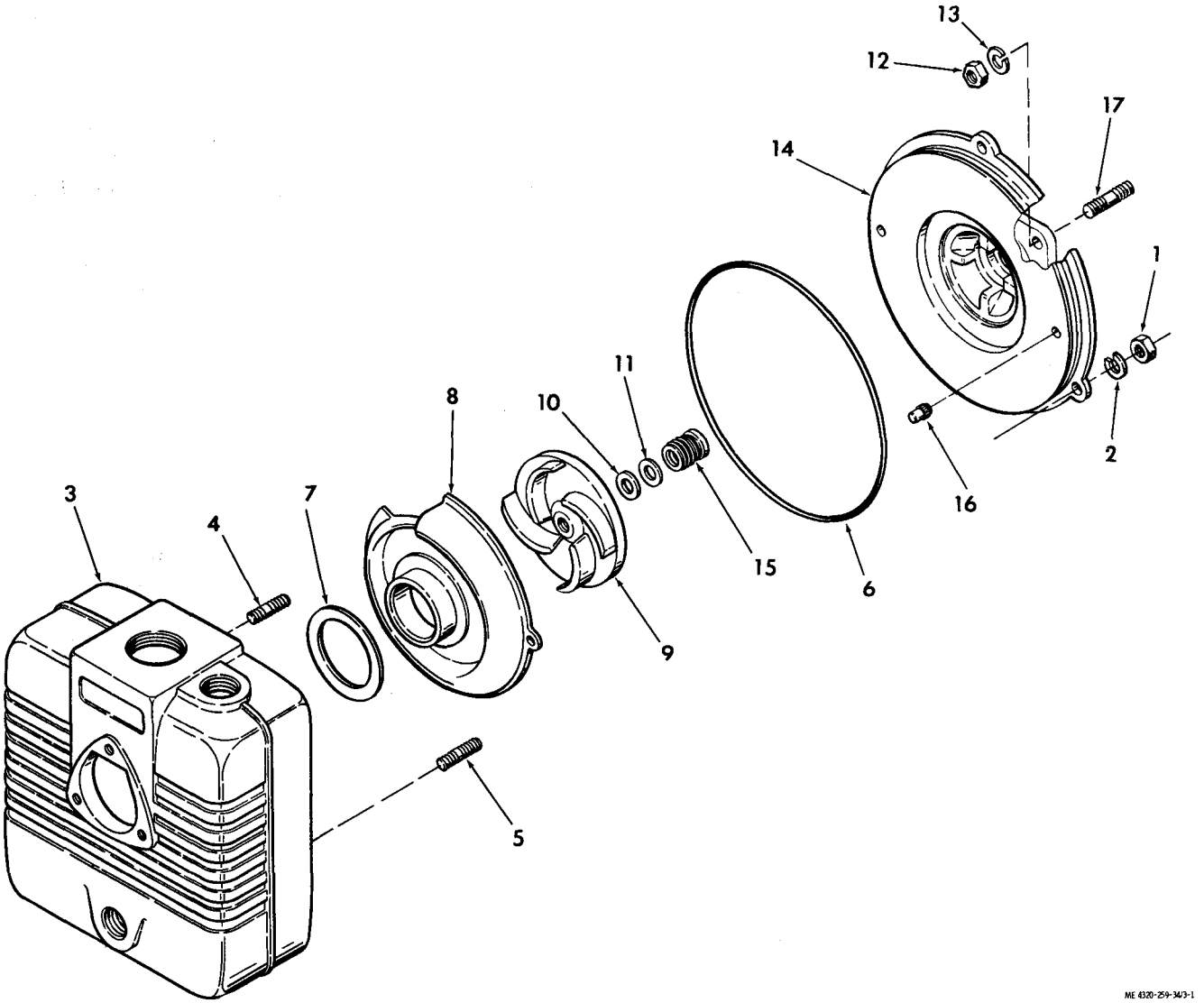
c. The volute is encased by the pump housing. The pump housing provides facilities for attaching the suction and discharge fittings. During operation, the pump housing remains filled with the fluid being pumped. Gaskets are installed between the volute and the housing, and between the housing and the seal plate to prevent leakage.

3-2. Removal and Disassembly

a. Remove the suction and discharge fittings from the centrifugal pump (TM 5-4320-259-12).

b. Disconnect the spark plug cable from the engine spark plug to prevent engine starting.

c. Remove the three nuts (1, fig. 3-1) and lock washers (2) that secure the pump body (3) to the seal plate (14); remove the pump body by pulling it straight out from the volute (8) and seal plate.



KEY to fig. 3-1:

1. Nut
2. Lock washer
3. Pump body
4. Stud
5. Stud
6. Gasket
7. Volute gasket
8. Volute
9. Impeller
10. Shim
11. Shim
12. Nut
13. Lock washer
14. Seal plate
15. Shaft seal assembly
16. Volute pin
17. Stud

Figure 3-1. *Centrifugal pump, exploded view.*

d. Do not remove the studs (4 and 5) unless they are damaged and require replacement.

e. Two volute pins (16) position the volute (8) on the seal plate (14). Pull straight out on the volute to remove it from the seal plate.

f. A right-hand thread secures the impeller (9) to the engine crankshaft. Place a block of wood on one of the impeller vanes and strike the block of wood with a hammer to rotate the impeller counterclockwise and break it loose from the shaft. Turn it from the shaft. Remove and save the shims (10 and 11).

g. Remove the four nuts (1.2) and lock washers (13) that secure the seal plate (14) to the studs (17) on the engine; remove the seal plate and shaft seal assembly (15).

h. Remove the shaft seal assembly from the seal plate.

i. Do not remove the volute pins (16) from the seal plate unless they are damaged and require replacement. Do not remove the studs (17) from the engine unless they are damaged and require replacement.

3-3. Cleaning and Inspection

a. Discard and replace the shaft seal and the gaskets.

b. Clean all remaining parts with an approved cleaning solvent; dry thoroughly.

c. Inspect the impeller for cracked, distorted, or worn vanes, damaged threads, and damaged back face. Replace a damaged impeller.

d. Inspect the volute for cracks and for wear of the inside surfaces. Check the mounting holes for enlargement or elongation. Replace the volute if damaged.

e. Inspect the seal plate for cracks, distortion, and for a damaged seal seat. Inspect the gasket seat of the seal plate for gouges, nicks, and burrs. Remove any burrs with a fine stone or file. If the volute pins are damaged, press out the damaged pins and replace with new ones.

f. Inspect the pump for cracks, damaged gasket surfaces, worn and damaged threads, and other damage. Remove burrs from gasket seats with a fine stone or file. Replace any damaged studs. Replace a damaged pump body.

3-4. Reassembly and Installation

a. Carefully press the stationary member of the shaft seal (15, fig. 3-1) into the seal plate (14) so that the seal face will be toward the impeller.

b. Position the assembled seal plate (14) and stationary member of the shaft seal (15) on the engine studs (17); secure with nuts (12) and lock washers (13).

c. Install the remaining parts of the shaft seal (15) on the engine shaft so that the seal faces are together. Lubricate the seal faces with engine oil at reassembly to prevent damage to the parts by running dry. Install the shims (10 and 11) and impeller (9) on the end of the engine crankshaft. The impeller has a right-hand thread.

d. Install the volute (8) on the volute pins (16) on the seal plate (14). Check the impeller-to-volute clearance with the volute fully seated on the seal plate. Clearance shall be 0.015 to 0.040 inch. If clearance is not within the required range, remove the volute and impeller. Add or remove impeller shims as necessary. Reinstall the impeller and volute.

e. Lightly grease the gasket (6) and install it on the seal plate (14). Install the volute gasket (7) on the volute. Position the pump body (3) on the pump so that the studs (4 and 5) engage the holes in the seal plate. Secure with nuts (1) and lock washers (2).

f. After the pump is completely assembled, make sure the spark plug cable is disconnected from the spark plug to prevent the engine from starting. Use the starter rope to turn over the engine and pump, carefully checking the pump for binding, rubbing, or other faulty operation. Correct any troubles. Reconnect the spark plug cable if no troubles are noted.

CHAPTER 4

BASIC ENGINE OVERHAUL

Section I. INTRODUCTION AND FITS, TOLERANCES AND WEAR LIMITS

4-1. Introduction

This chapter provides instructions relating to engine repair and overhaul. It includes information regarding disassembly, inspection of parts to determine if their. continued serviceability is possible or if they should be replaced, instructions covering repair techniques such as valve grinding and cylinder honing, reassembly and tolerance checking to assure proper fits and clearances, and all other information relating to engine overhaul. Paragraph 4-2 provides the fits, tolerances, and allowable wear limits which are useful in determining if parts replacement is necessary.

4-2. Engine Fits, Tolerances, and Wear Limits

Table 4-1 lists the fits and tolerances applicable to the engine. Refer to the table to determine if parts replacement is required or if continued serviceability of the parts is possible.

Table 4-1. Engine Fits, Tolerances, and Wear Limits

Item	Dimension (in.)
Bore and stroke	2 3/8 x 2
Bore diameter, new	2.375
Crankshaft end play	0.0038/0.0228
Crankshaft-connecting rod journal size	0.9360/0.9355
Crankpin-connecting rod side clearance	0.0050/0.0160
Crankpin length	0.8750
Main bearing journal diameter, new	0.9840
Connecting rod to crankpin running clearance	0.0010/0.0025
Connecting rod to piston pin clearance	0.0005/0.0010
Piston pin to piston boss	0.0002 Int. to 0.0002 Loose
Piston to cylinder bore (thrust face)	0.0030/0.0040
Piston to cylinder bore (top of skirt)	0.0035/0.0060
Piston pin bore size	0.51632
Piston pin diameter	0.5620
Ring side clearance, top ring	0.0020/0.0040
Ring side clearance, middle ring	0.0020/0.0040
Ring side clearance, oil ring	0.0015/0.0035
Ring end gap	0.0070/0.0170
Ring width, inches, top ring	0.0930
Ring width, inches, middle ring	0.0930
Ring width, inches, oil ring	0.1870
Camshaft pin to camshaft clearance	0.0010/0.0025
Camshaft pin to block (bearing plate end)	0.0005/0.0012
Camshaft pin to block (P. T. O. end) (interference)	0.0055/0.0020
Camshaft pin to breaker cam	0.0010/0.0025
Camshaft end play	0.0050/0.0200
Valve stem clearance in guide, intake	0.0005/0.0020
Valve stem clearance in guide, exhaust	0.0020/0.0035
Valve seat in block, exhaust (interference)	0.0020/0.0050
Valve clearance, intake (cold)	0.0050/0.0090
Valve clearance, exhaust (cold)	0.0110/0.0150
Valve head diameter, intake	0.9790/0.9890
Valve head diameter, exhaust	0.8070/0.8170
Valve seat angle	44.5 degrees
Valve face angle	45 degrees
Valve seat width	0.0370/0.0450
Valve tappet clearance in block	0.0005/0.0020
Governor bushing to governor cross shaft clear	0.0012/0.0027
Ball bearing to cylinder block (interference)	0.0007/0.0022

Table 4-1. Engine Fits, Tolerances, and Wear Limits—Continued

Item	Dimension (in.)
Ball bearing to seal plate (interference)	0.0007 / 0.0022
Ball bearing to crankshaft (interference to loose)	0.0004 / 0.0003

Section II. CYLINDER HEAD AND VALVES

4-3. Description

a. The cylinder head is mounted on top of the cylinder / block to seal the cylinder and to provide a mounting for the spark plug. The cylinder head is deeply finned to provide efficient dissipation of heat caused by combustion in the cylinder.

b. The valves are mounted in the cylinder block and are opened at the required time by cams on the camshaft through valve tappets mounted in the cylinder block. The valves are heavily spring loaded to close when disengaged by the cams on the cam shaft. The valves use positive valve rotators to assure that the valves rotate a small amount each time they are operated. This equalizes valve wear and causes a wiping action which helps to assure a good valve seat when the valves close.

4-4. Removal and Disassembly

a. Remove the pump from the engine (para 3-2).

b. Remove the spark plug, engine housing, and the crankcase breather (TM 5-4320-259-12).

c. Make sure the engine is cooled to room temperature. Remove the six bolts (1, fig. 4-1) and flat washers (2) that secure the cylinder head (3) to the cylinder block. Remove the cylinder head and gasket (4).

KEY to fig. 4-1:

1. Cylinder head bolt
2. Flat washer
3. Cylinder head
4. Cylinder head gasket
5. Spark plug insert
6. Valve retaining pin
7. Intake valve
8. Valve rotator
9. Valve spring
10. Valve retaining pin
11. Exhaust valve
12. Valve rotator
13. Valve spring
14. Oil pan drain plug
15. Assembled washer screw
16. Oil pan
17. Oil pan gasket
18. Connecting rod cap screw
19. Flat washer
20. Lock
21. Connecting rod bearing cap
22. Compression ring
23. Compression ring
24. Oil control ring
25. Retainer ring
26. Piston pin
27. Piston
28. Connecting rod

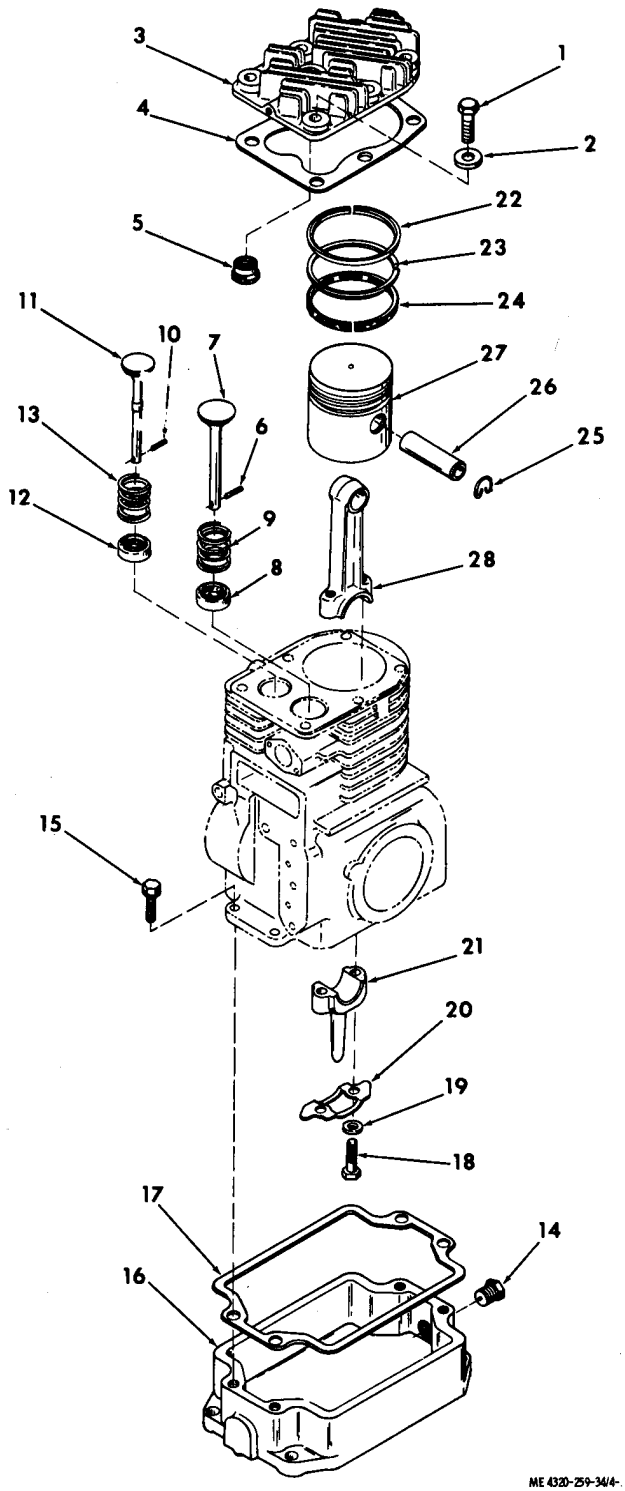


Figure 4-1. *Cylinder head, valves, and pistons, exploded view.*

d. With the crankcase breather removed, the lower ends of the valves are accessible. Use a valve spring compressor to compress the valve springs. Remove the valve retaining pins (6 and 10) and carefully release the valve springs. Pull the valves (7 and 11) out of the top of the engine. Remove the springs (9 and 13) and valve rotators (8 and 12) from the valve chamber.

4-5. Cleaning and Inspection

a. Clean all parts with an approved cleaning solvent; dry thoroughly.

b. Scrape all carbon deposits from the cylinder head with a putty knife or other bladed instrument. Take care not to score or gouge the gasket surface of the cylinder head.

c. Inspect the cylinder head for cracks, burning, broken cooling fins, and other damage. Check the cylinder head for flatness by laying it on a true flat surface. Attempt to insert feeler gages under the edges of the cylinder head to determine if it is warped. Slight warping can be corrected by resurfacing. To resurface, lay a piece of fine sandpaper on a true flat surface and rub the cylinder head against the sandpaper. Do not remove more material than is necessary to correct the warping.

d. If the spark plug insert in the cylinder head has defective threads, press out the insert and replace with a new one.

e. Inspect the valves for worn or bent stems, rough, checked, burned, or distorted valve heads, and enlarged mounting pin holes. Check the fit of the valve stems in the bores of the cylinder block. Intake valve side clearance shall be 0.0005 to 0.0020 inch. Exhaust valve side clearance shall be 0.0020 to 0.0035 inch.

f. Check valve head diameter. Intake valve head diameter shall be 0.979 to 0.989 inch. Exhaust valve head diameter shall be 0.807 to 0.817 inch.

g. Check the valve seat in the cylinder block. Valve seat width shall be 0.037 to 0.045 inch for both intake and exhaust valves. Use a 15-degree cutter if necessary to narrow the valve seat.

h. Check the fit of the valves in the valve seats in the block. A tight seal must be made. If necessary, regrind the valves and valve seats. The valve head angle is 45 degrees for both valves. The valve seat angle is 89 degrees for both valves. Lap the valve to the seat, using fine grade of grinding compound and a hand valve grinder with a suction cup.

i. If the valve seat in the cylinder block cannot be properly reground, replace the valve seat as directed in paragraph 4-21 *d.*

4-6. Reassembly and Installation

Reassemble and install the valves and cylinder head as shown in figure 4-1. Note the following:

a. Make sure the valve seats, ports, and valves are thoroughly cleaned after regrinding or lapping. Insert the valves in the valve seats as shown in figure 4-2 and check the clearance between the valve stems and valve tappet with a feeler gage. With the valve held firmly on the valve seat, the valve clearance with the engine cold shall be 0.005 to 0.009 inch for intake valves and 0.011 to 0.015 inch for exhaust valves. If clearance is insufficient, grind off the bottom of the valve to meet the requirement. Make sure the valve ends are ground square and are free of burrs.

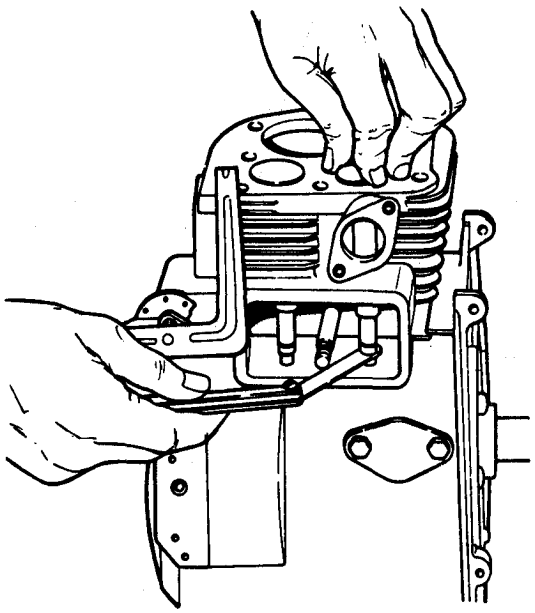


Figure 4-2. Checking valve clearance.

b. When installing the valve springs (9 and 13, fig. 4-1), use a valve spring compressor and insert the valve retaining pins (6 and 10).

c. Check that the valve rotators (8 and 12) provide proper rotation of the valves as the valves are lifted by the valve tappets.

d. When installing the cylinder head (3), be sure to use a new gasket (4). Tighten the cylinder head bolts (1) to 16 to 17 foot-pounds. Tighten the bolts in the sequence shown in figure 4-3.

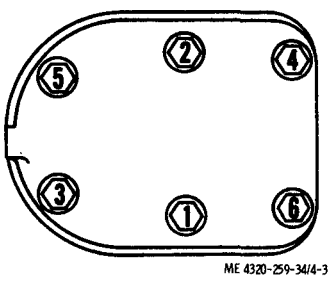


Figure 4-3. Cylinder head bolt tightening sequence.

e. Install the spark plug, crankcase breather, and engine housing (TM 5-4320-59-12).

f. Install the centrifugal pump on the engine (para 3-4).

Section III. PISTONS, RINGS, AND CONNECTING RODS

4-7. Description

a. The engine uses an aluminum alloy piston with two compression rings and one oil control ring. Pistons and rings are available in standard sizes and in 0.010-, 0.020-, and 0.030-inch oversizes. The oversized pistons and rings accommodate rebored cylinder bores. Piston pins are available in standard sizes and in 0.005- and 0.010-inch oversizes.

b. The connecting rod and connecting rod cap make up a matched set and should not be replaced individually or intermixed with the parts of another engine. The connecting rod bearing cap is fitted with a dipper that dips into the engine oil in the oil pan, thereby causing splashing which lubricates the working parts of the engine.

4-8. Removal and Disassembly

a. Disassembly the pump from the engine (para 3-2).

b. Remove the cylinder head from the engine (para 4-4).

c. Remove the oil pan drain plug (14, fig. 4-1) and drain the oil into a suitable container. Remove the four assembled washer screws (15) that secure the oil pan (16) to the engine crankcase; remove the oil pan and gasket (17).

d. Bend up the tangs on the lock (20) and remove the cap screws (18) and flat washers (19) that secure the connecting rod bearing cap (21) to the connecting rod.

e. Use a hammer handle or similar device to push the piston (27) and assembled connecting rod (28) out through the top of the cylinder block.

f. Remove and discard the piston rings (22, 23, and 24).

g. Remove and discard the piston pin retainer ring (25). Press the piston pin (26) from the piston (27) to disengage the piston from the connecting rod (28).

4-9. Cleaning and Inspection

a. Piston rings and piston pin retainer rings should not be reused. Discard and replace.

b. Clean all remaining parts with an approved cleaning solvent; dry thoroughly. Take care to remove all carbon deposits from the top of the piston and from the piston ring grooves.

c. Inspect the piston for cracks, wear, and other damage. Refer to table 4-1 for pertinent piston dimensions. Use new rings when checking piston ring side clearance.

d. Check the piston pin for scoring, signs of overheating, wear, and other damage. Check the fit of the piston pin in the piston and in the connecting rod. Piston pin fit must be within the limits indicated in table 4-1.

e. Inspect the connecting rod for cracks, twisting, damaged threads, worn crankpin bearing surf aces, and worn or scored piston pin bore. Check that connecting rod and cap dimensions are within limits indicated in table 4-1.

Note. Before checking piston ring end gap by inserting the new piston rings in the cylinder bore, check that the cylinder bore is within the required tolerances as directed in paragraph 4-21. Rebore the cylinder if it is scored or damaged and use oversized piston and rings.

4-10. Reassembly and Installation

Reassemble and install the piston and connecting rod as shown in figure 4-1, items 18 through 28. Note the following:

a. When installing the piston rings on the pistons, use a standard piston ring expander and install the bottom ring first. Several types of production and service rings are available. If the cylinder bore has not been rebored, use standard size "service" rings which incorporate an expander. If the cylinder has been newly rebored, use "production"-type oversized replacement rings. If the engine has been in--service for a considerable length of time since the last reboring, use oversized "service" -type rings, Refer to figure 4-4 for proper ring installation information. Stagger the gaps of the three rings so that they are not in line.

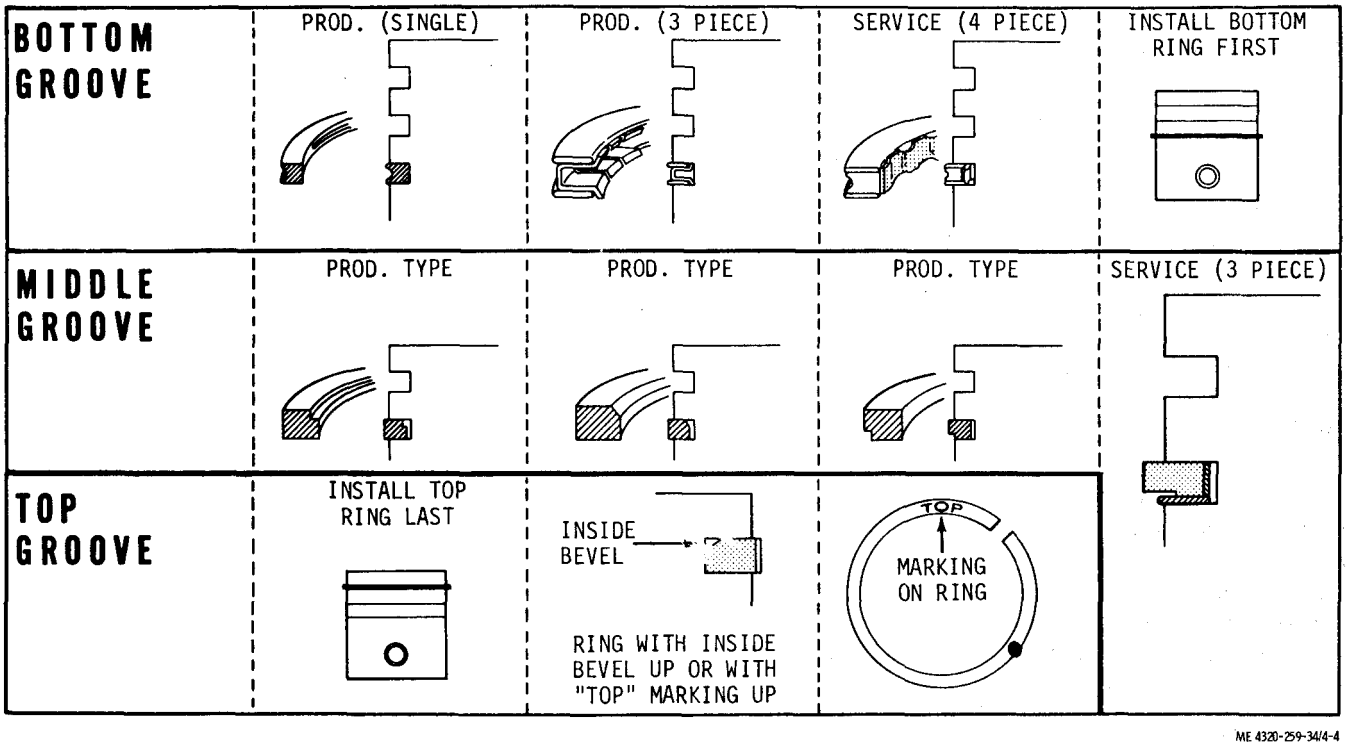


Figure 4-4. Piston rings installed on piston.

Caution: Before installing "service" piston rings in an engine which has not had the cylinder rebored recently, use a hone to break the glaze of the cylinder walls to assure proper seating of the rings when the engine is restored to service.

b. After pressing the piston pin (26, fig. 4-1) into the piston (27) and rod (28), install a new retainer ring (25) to secure the piston pin into place. Never reuse the old retainer ring.

c. Oil the piston and ring assembly with engine oil before inserting it into the cylinder bore. Make sure the cylinder bore is also lubricated.

d. Use a standard piston ring compressor to compress the piston rings on the piston when installing it on the engine. Push the piston into the cylinder bore, using the handle of a hammer as shown in figure 4-5. Do not pound it into place.

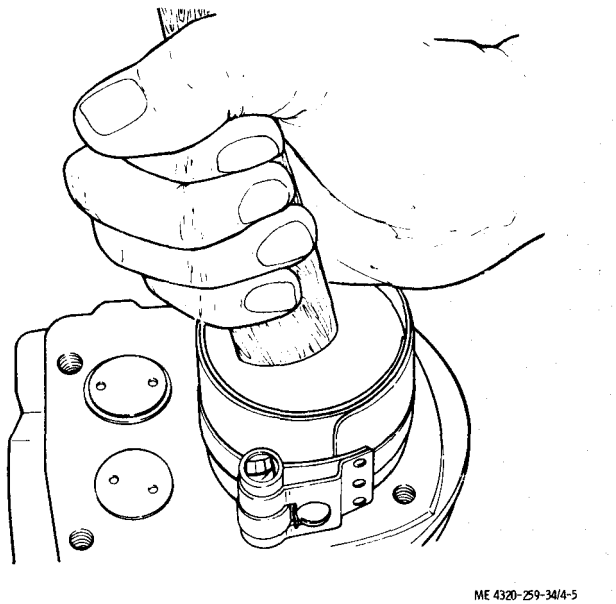


Figure 4-5. Pressing piston assembly into cylinder bore.

e. When securing the connecting rod (28) and cap (21) in the crankshaft journal, check that the match marks on the parts are alined and that they are toward the bearing plate end of the engine. Refer to figure 4-6. Make sure the bearing journal is thoroughly lubricated.

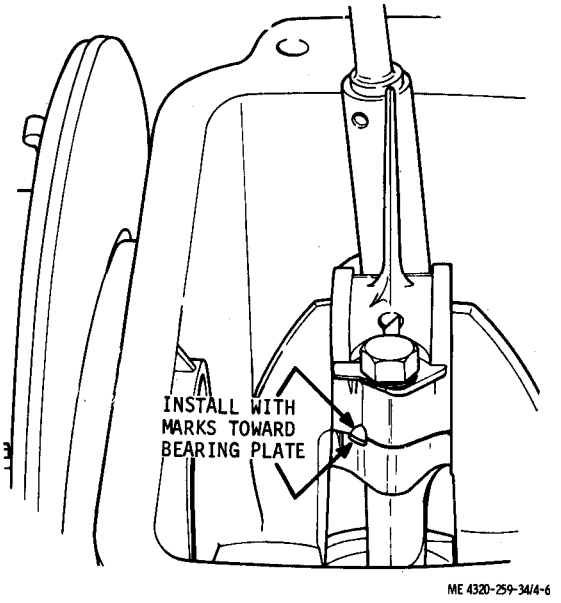


Figure 4-6. Connecting rod and cap matching and positioning marks.

f. Temporarily install the connecting rod cap (21, fig. 4-1) on the connecting rod and torque the cap screws (18) to 12 foot-pounds. Use plastigage or other means of determining the running clearance between the crankpin and the connecting rod. Running clearance shall be 0.001 to 0.0025 inch. If running clearance is excessive, check the dimensions given in table 4-1 to determine if the crankshaft or the connecting rod must be replaced.

g. Secure the connecting rod cap (21) to the connecting rod (28) with cap screws (18), flat washers (19), and the lock (20). Torque the cap screws to 12 foot-pounds. After tightening, bend tangs of the lock against a flat of the screws to lock them in place.

h. When installing the oil pan (16), be sure to use a new gasket (17). Tighten the cap screws (15) evenly and alternately to prevent gaps in the gasket which could result in oil leaks.

i. Install the cylinder head on the engine (para 4-6).

j. Install the centrifugal pump on the engine (para 3-4).

Section IV. MAIN BEARINGS AND CRANKSHAFT

4-11. Description

a. The crankshaft rides in two ball bearings, one at each end of the crankshaft. The bearing at the power takeoff end of the shaft is seated in the bearing bore of the cylinder block. The bearing at the flywheel end of the shaft is seated in a bearing plate which is bolted to the cylinder block. Both bearings are lubricated by splash as the dipper on the connecting rod cap dips into the engine oil in the oil pan with each revolution of the crankshaft, dispersing oil throughout the interior of the engine.

b. Since both ends of the crankshaft extend from the crankcase, it is necessary to provide shaft seals to prevent oil leakage around the shaft. These are lip-type seals, one of which is pressed into the cylinder block bore and the other into the bearing plate bore.

c. The crankshaft is counterbalanced to counteract the weight of the connecting rod and piston assembled, minimizing vibration as the crankshaft rotates. The toothed segment of the crankshaft engages the camshaft gear to drive the crankshaft and governor.

4-12. Removal and Disassembly

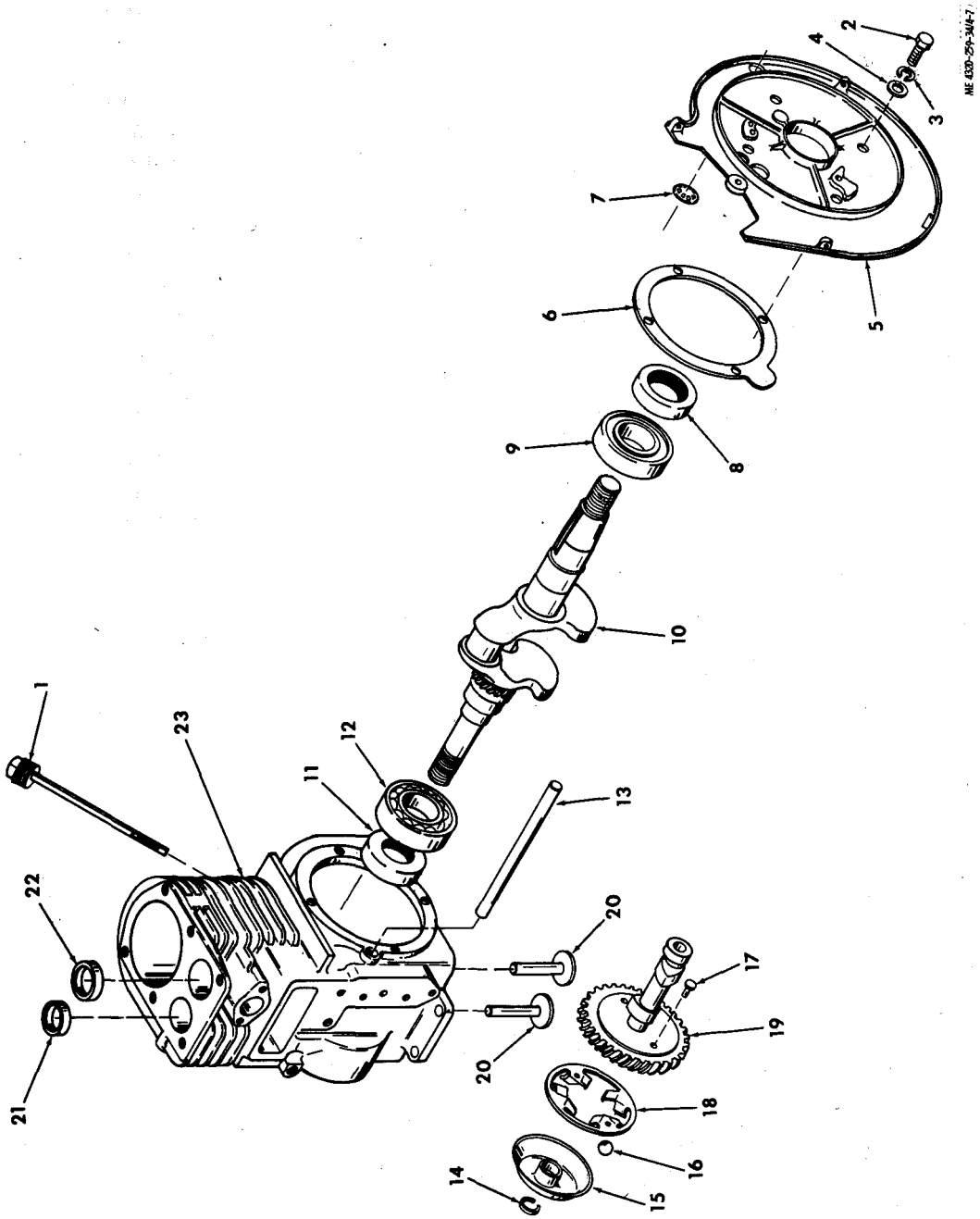
a. Remove the air cleaner, muffler, fuel tank and lines, and carburetor. (TM 5-4320-259-12).

b. Remove the centrifugal pump from the engine (para 3-2).

c. Remove the piston and connecting rod (para 4-8).

d. Remove the flywheel and magneto (TM 5-4320-259-12).

e. Remove the four cap screws (2, fig. 4-7), lock washers (3), and flat washers (4) that secure the bearing plate (5) to the cylinder block (23). Remove the bearing plate. If necessary, use a puller as shown in figure 4-8 to remove the bearing plate. Remove the gasket (6, fig. 4-7).



1. Dipstick oil gage
2. Cap screw
3. Lock washer
4. Flat washer
5. Bearing plate
6. Gasket
7. Plug button
8. Oil seal
9. Ball bearing
10. Crankshaft
11. Oil seal
12. Ball bearing
13. Camshaft pin
14. Retaining ring
15. Governor ball race
16. Flyball
17. Rivet
18. Flyball retainer
19. Camshaft
20. Tappet
21. Exhaust valve insert
22. Intake valve insert
23. Cylinder block

Figure 4-7. *Crankshaft, camshaft, governor, and cylinder block, exploded view.*

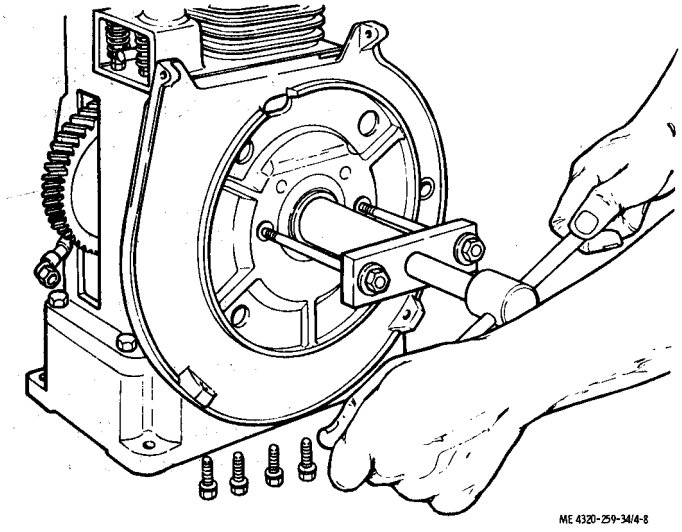


Figure 4-8. Using puller to remove bearing plate.

f. Remove the cylinder block. It may be necessary to use a press to dislodge the crankshaft. Take care to prevent damage to the threaded crankshaft ends.

g. The ball bearings (9 and 12, fig. 4-7) may remain with the shaft or may remain in the bearing seats of the cylinder block or bearing plate. Press out the seals (8 and 11) and bearings (9 and 12).

4-13. Cleaning and Inspection

a. Discard the seals and gaskets.

b. Clean bearings as directed in paragraph 2-7.

c. Clean all other parts with an approved cleaning solvent; dry thoroughly.

d. Inspect the ball bearings for scored races or balls, excessive looseness between races and balls, rough, binding, or catching operation, and other damage; replace damaged ball bearings.

e. Inspect the crankshaft for damaged threads, worn or broken gear teeth, scored or worn crankpin, misalinement, and other damage. The minimum allowable diameter of the crankpin journal is 0.9355 inch. The journal width shall be at least 0.875 so that connecting rod side play does not exceed 0.016 inch. Check the bearing seat surface for scoring or damage. Remove any burrs from the crankshaft with a fine stone. Replace the crankshaft if damaged.

f. Inspect the bearing plate for cracks, distortion, damaged bearing bore, and damaged threads; replace a damaged bearing plate.

4-14. Reassembly and Installation

Reassemble the crankshaft as shown in figure 4-7, items 2 through 11. Note the following:

a. Press the rear main bearing (12) into the bearing seat of the cylinder block so that the bearing shield faces out of the block.

b. Place the cylinder block on an arbor press and insert the untapered end of the crankshaft into the bore of the bearing in the cylinder block. Aline the timing mark on the tooth of the gear section of the crankshaft with the timing mark (dot) on the cam shaft gear as shown in figure 4-9. With the marks alined, press in the crankshaft until it is fully seated on the ball bearing. Recheck timing marks to assure that they are alined.

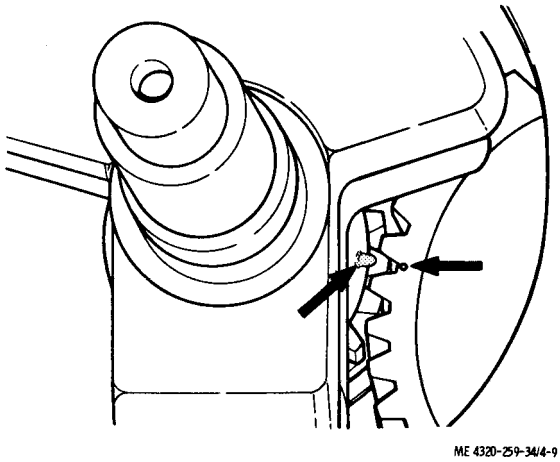


Figure 4-9. Crankshaft gear to camshaft gear timing marks.

c. Press the ball bearing (9, fig. 4-7) into the bearing plate (5) so that the shielded side will face out when the bearing plate is installed on the engine. Make sure the bearing is pressed squarely into the bearing plate or correct crankshaft end play will not be registered.

d. Position the bearing plate (5) on the cylinder block, using one 0.020-inch and one 0.010-inch gasket. Install the thicker gasket next to the cylinder block. Carefully press the bearing plate into position on the cylinder block. Secure the bearing plate with four cap screws (2), lock washers (3), and flat washers (4). Tighten the cap screws evenly and alternately to prevent distorting the bearing plate.

e. Check the crankshaft end play by measuring with a feeler gage. Measure between the inner race of the ball bearing pressed into the cylinder block and the shoulder on the crankshaft as shown in figure *4-10.* End play shall be 0.0038 to 0.0228 inch. If end play is not within the required limits, remove the bearing plate (5, fig. 4-7) and add or remove gaskets (6). The addition of gasket thickness will increase end play. Subtraction of gaskets will decrease end play.

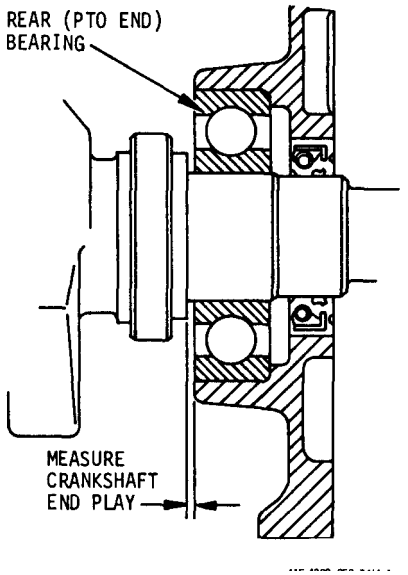


Figure 4-10. Crankshaft end play measuring point.

f. Check that the crankshaft rotates freely without any binding or catching. Correct any difficulties.

g. Lubricate the lips of the oil seals (8 and 11) with grease. Slide the seals on the ends of the crankshaft, taking care to prevent damage to the sealing lips. Position the seals on the shaft so that the lips face inward. Turn the engine on its side and drive the seals squarely into the seats on the engine cylinder block and on the bearing plate.

h. Install the magneto and flywheel (TM 5-4320-259-12).

i. Install the piston and connecting rod (para 4-10).

j. Install the centrifugal pump on the engine (para 3-4).

k. Install the carburetor, fuel tank and lines, muffler, and air cleaner on the engine and service the engine (TM 5-4320-259-12).

Section V. CAMSHAFT AND GOVERNOR

4-15. Description

a. The camshaft is gear driven by the geared portion of the crankshaft. It rotates in a 1:2 ratio with the crankshaft. The camshaft rides on a pin which extends through the cylinder block, parallel with the crankshaft. The camshaft has one exhaust valve cam, one intake valve cam, and one breaker point cam. The valve cams operate the valve tappets to open and close the valves at the required time of the engine cycle. The breaker point cam engages the breaker point pin which operates the ignition breaker point.

b. The governor is driven by the camshaft to maintain control of the engine speed. The governor is a flyball type in which a driver forces four captive steel balls to rotate. As the balls rotate, centrifugal force throws them outward against a dished race. This causes the dished race to move axially. The axial movement of the race is transferred to an externally mounted lever through a cross shaft. The cross shaft extends through the wall of the crankcase and is perpendicular to the camshaft. The externally mounted lever is linked to the throttle lever on the carburetor. As engine speed increases, the movement of the governor parts causes the throttle lever to close to decrease engine speed. As the engine speed decreases, the governor parts cause the throttle lever to open. In this manner, a state of equilibrium is reached and the engine speed remains constant. An increased engine load will cause the engine to slow down momentarily. This change will be sensed by the governor and a resulting adjustment of the carburetor throttle lever will restore the engine to the governed speed almost immediately.

4-16. Removal and Disassembly

a. Remove the air cleaner, muffler, fuel tank and lines, carburetor, and breaker points (TM 5-4320-159-12).

b. Remove the centrifugal pump from the engine (para 3-2).

c. Remove the cylinder head and valves (para 4-4).

d. Remove the piston and connecting rod (para 4-8).

e. Remove the flywheel and magneto (TM 5-4320-259-12).

f. Remove the main bearings and crankshaft (para 4-12).

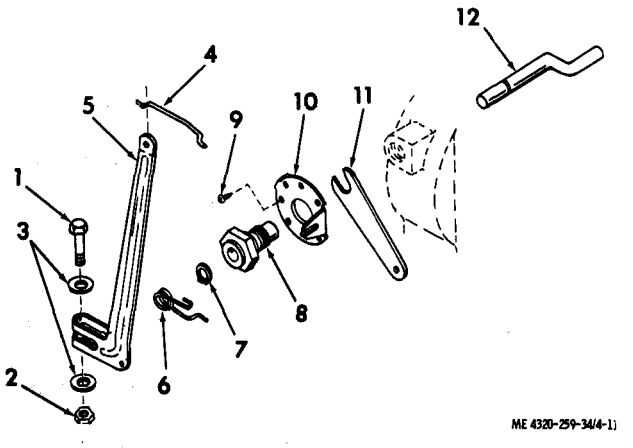
g. Invert the cylinder block. Using a small punch, drive out the camshaft pin (13, fig. 4-7), applying pressure from the power takeoff side of the engine. After the pin clears the rear end of the crankcase, it will slide out easily.

h. Lift the assembled camshaft and governor from the cylinder block.

i. Remove the valve tappets (20) from the cylinder block.

j. Remove the retaining ring (14) and slide the governor ball race (15), catching the fly balls (16) as they are released.

k. Loosen the clamping screw (1, fig. 4-11). Slide the governor lever (5) and spring (6) from the outside end of the governor cross shaft (12).



1. Clamping screw
2. Nut
3. Flat washer
4. Throttle link
5. Governor lever
6. Torsion spring
7. Retaining ring
8. Bushing
9. Drive screw
10. Regulating disk
11. Speed control bracket
12. Cross shaft

Figure 4-11. Governor control linkage, exploded view.

l. Remove the retaining ring (7). Unscrew the governor bushing (8) and remove the bushing, regulating disk (10), and speed control bracket (11). Remove the governor cross shaft (12) from the inside of the cylinder block.

4-17. Cleaning and Inspection

a. Clean all parts with an approved cleaning solvent; dry thoroughly.

b. Inspect the camshaft for chipped or broken gear teeth, scored or worn cams, and worn or scored bore. Insert the camshaft pin into the camshaft and check the clearance. Camshaft pin-to-camshaft clearance shall be 0.0010 to 0.0025 inch. If clearance is excessive, replace the camshaft. If the camshaft pin is ridged, grooved, or worn, also replace the camshaft pin.

c. Inspect the governor ball race for scoring or distortion; replace a damaged race.

d. Check the governor flyballs for wear, scoring, out-of-round condition, pits, and other damage; replace damaged fly balls.

e. Inspect the flyball retainer for cracks, distortion, and wear; replace if damaged.

f. Inspect the valve tappets for wear and scoring. Check the fit of the valve tappets in the bores of the cylinder block. Valve tappet clearance in the cylinder block shall be 0.0005 to 0.0020. If clearance is excessive, check the fit of new valve tappets in the cylinder block. If clearance is still excessive, the cylinder block is worn and must be replaced.

g. Inspect the governor cross shaft for wear, scoring, and distortion. Check the fit of the cross shaft in the bushing. The shaft-to-bushing clearance shall be 0.0012 to 0.0027 inch. If clearance is excessive, replace the cross shaft, the bushing, or both.

h. Inspect all other parts for cracks, distortion, wear, damaged threads, and other damage; replace damaged parts.

4-18. Reassembly and Installation

Reassemble the camshaft and governor as shown in items 13 through 20 of figure 4-7 and in figure 4-11. Note the following:

a. Insert the governor cross shaft (12, fig. 4-11) from the inside of the crankcase. Install the speed control bracket (11), regulating disk (10), and bushing (8) on the outside of the crankcase. Secure the cross shaft with the retaining ring (7).

b. Position the fly balls (16, fig. 4-7) in the flyball retainer (18) on the camshaft (19) and position the governor ball race (15) on the cam shaft. Secure the parts with the retaining ring (14).

c. Insert the tappets (20) in the cylinder block. Position the assembled camshaft and governor assembly in the cylinder block and insert the cam shaft pin (13) from the bearing plate side of the cylinder block. Tap it into place so that the ends are flush with the sides of the cylinder block.

Caution: **Do not attempt to insert the camshaft pin from the power takeoff side of the cylinder block. The camshaft pin hole on this side is smaller in diameter and driving the pin through it may damage the cylinder block.**

d. Check the camshaft end play with a feeler gage inserted between the camshaft and block. End play shall be 0.005 to 0.020 inch. If end play is excessive, add shim washers at the breaker cam end of the camshaft.

e. Install the crankshaft and main bearings (para 4-14). Make sure timing marks on the crankshaft and camshaft are properly alined. After installing the crankshaft, check that the crankshaft and camshaft rotate freely without binding.

f. Install the magneto and flywheel (TM 5-4320-259-12).

g. Install the piston and connecting rod (para 4-10).

h. Install the valves and cylinder head (para 4-6).

i. Install the centrifugal pump on the engine (para 3-4).

j. Install the breaker points, carburetor, fuel tank and lines. muffler, and air cleaner (TM 5-4320-259-12).

k. Install the governor lever and related parts (items 1 through 6, fig. 4-11). Adjust the engine breaker points and governor (TM 5-4320-259-12).

Section VI. CYLINDER BLOCK

4-19. Description

a. The cast iron cylinder block includes the cylinder and crankcase. The valves seat in valve seat inserts which are pressed into the top of the cylinder block. Valve tappets and valve stems ride in bores in the cylinder block. The exterior of the cylinder is deeply finned to provide efficient air cooling of the cylinder, dispelling the heat of combustion of the burning gases in the cylinder.

b. One side of the cylinder block is bored to provide seats for the shaft seal and the ball bearing in which the crankshaft rides. The opposite side of the cylinder block is open and provides mounting facilities for the bearing plate. The bottom of the cylinder block is open and provides mounting facilities for the oil pan.

4-20. Removal

a. Remove the air cleaner, muffler, fuel tank and lines, carburetor, breaker points, flywheel, and magneto (TM 5-4320-259-12).

b. Remove the centrifugal pump from the engine (para 3-2).

c. Remove the cylinder head and valves (para 4-4).

d. Remove the piston and connecting rod (para 4-8).

e. Remove the main bearings and crankshaft (para 4-12).

f. Remove the camshaft and governor (para 4-16).

4-21. Cleaning and Inspection

a. Clean the cylinder block thoroughly with an approved cleaning solvent; dry thoroughly.

b. Inspect the cylinder block for cracks, damaged threads, cracked cooling fins, scored cylinder bore, and damaged bearing and seal seats.

c. Check the cylinder bore for an out-of-round condition. Use an inside micrometer and check at points 90. degrees apart for the full length of the working surface of the cylinder bore. If the cylinder bore is out of round, tapered, or worn beyond the limits cited in table 4-1, rebore the cylinder as follows:

(1) Lower the hone into the bore after it is properly centered. Adjust the stones so that they are in full contact with the walls. Use diesel fuel or kerosene as a cutting and cooling agent.

(2) With the lower end of the hone alined with the lower end of the cylinder, start the rotation of the hone. Move the hone up and down continuously during reboring to prevent the formation of ridges. Check the size frequently.

(3) When the bore is within 0.0025 inch of desired size, remove the coarse stones and replace with the burnishing stones. Continue to rebore with the burnishing stones until the bore is within 0.0005 inch of the desired size. Change stones and use finish stones to polish the bore to the desired size.

(4) After reboring, clean the cylinder walls with soap and water. Dry thoroughly. Apply a light coat of SAE 10 engine oil to prevent rust.

d. Make sure the valve seats meet the requirements given in paragraph 4-5 g and *h.* If the valve seat inserts are cracked or damaged beyond repair, new inserts (21 and 22, fig. 4-7) can be installed. When installing new inserts, heat the engine cylinder block in an oven to about 200° F. Chill the valve seat inserts with dry ice. The chilled inserts should press easily into the valve seat insert counterbores in the heated cylinder block. Make sure the counterbores are thoroughly cleaned before installing the inserts, otherwise the valves will not seat properly. The valves must be lapped into the replaced inserts. Refer to paragraph 4-5 *h.*

4-22. Reassembly

a. Install the camshaft and governor parts (para 4-18).

b. Install the main bearings and crankshaft (para 4-14).

c. Install the piston and connecting rod (para 4-10).

d. Install the valves and cylinder head (para 4-6).

e. Install the centrifugal pump on the engine (para 3-4).

f. Install the magneto, flywheel, breaker points, carburetor, fuel tank and lines, muffler, and air cleaner (TM 5-4320-259-12).

g. Service the engine completely and adjust the breaker points and governor (TM 5-4320-59-12).

APPENDIX A

REFERENCES

A-1. Fire Protection

TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved for Army Users

A-2. Lubrication

C9100-IL	Identification List for Fuels, Lubricants, Oils and Waxes
LO 5-4320-249-12	Lubrication Order Pumping Assembly Flammable Liquid, Bulk Transfer, Centrifugal, GED, 100 GPM, Barnes Model US6ACG

A-3. Radio Suppression

TM 11-483	Radio Interference Suppression

A-4. **Maintenance**

TM 38-750	The Army Maintenance Management System
TM 5-4320-259-12	Operator and Organizational Maintenance Manual
TM 5-4320-259-20P	Organizational Repair Parts and Special Tools List Manuals
TM 5-4320-259-34P	DS and GS Repair Parts and Special Tools List Manual

4-5. Shipment and Storage

TB 740-97-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage
TB 740-93-3	Administrative Storage of USAMEC Mechanical Equipment

A-6. Destruction to Prevent Enemy Use

TM 750-244-3	Procedure for Destruction of Equipment to Prevent Enemy Use

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General, United States Army,
Chief of Staff.

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☆ U.S. GOVERNMENT PRINTING OFFICE: 1971-769-159/116

TM 5-4320-259-34 PUMPING ASSEMBLY- 1971