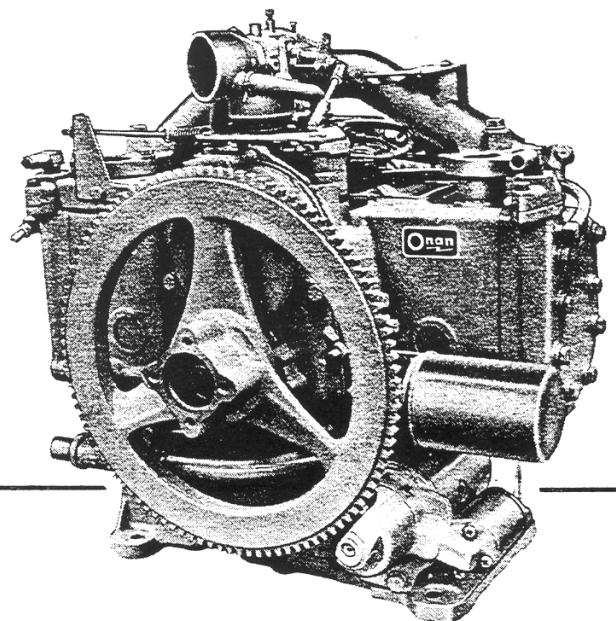


Onan

Service Manual

**MCCK
RCCK
Engine**



927-0752
RCCK SPEC A
MCCK Spec A-H
5-84
Printed in U.S.A.

Safety Precautions

It is recommended that you read your engine manual and become thoroughly acquainted with your equipment before you start the engine.

⚠ WARNING *This symbol is used throughout this manual to warn of possible serious personal injury.*

⚠ CAUTION *This symbol refers to possible equipment damage.*

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

Safety Codes

- All local, state and federal codes should be consulted and complied with.
- This engine is not designed or intended for use in aircraft. Any such use is at the owner's sole risk.

General

- Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the engine are secure and accurately torqued. Keep guards in position over fans, driving belts, etc.
- If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts

- Do not wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.
- Keep your hands away from moving parts.

Batteries

- Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.
- **DO NOT SMOKE** while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.
- Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System

- **DO NOT** fill fuel tanks while engine is running.

- **DO NOT** smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping for flexible lines as copper will work harden and become brittle enough to break.
- Be sure all fuel supplies have a positive shutoff valve.

Exhaust System

- Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine applications, especially those within a confined area, should be equipped with an exhaust system to discharge gases to the outside atmosphere.
- **DO NOT** use exhaust gases to heat a compartment.
- Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Exhaust Gas Is Deadly!

Exhaust gases contain carbon monoxide, a poisonous gas that might cause unconsciousness and death. It is an odorless and colorless gas formed during combustion of hydrocarbon fuels. Symptoms of carbon monoxide poisoning are:

- Dizziness
- Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

Cooling System

- Coolants under pressure have a higher boiling point than water. **DO NOT** open a radiator pressure cap when coolant temperature is above 212 degrees F (100 degrees C) or while engine is running.

Keep The Unit And Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and present a potential fire hazard.

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WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS MIGHT RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

General Information

INTRODUCTION

This manual deals with specific mechanical and electrical information needed by engine mechanics for troubleshooting, servicing, repairing, or overhauling the engine.

Use the table of contents for a quick reference to the separate engine system sections.

The troubleshooting guide is provided as a quick reference for locating and correcting engine trouble.

The illustrations and procedures presented in each section apply to the engines listed on the cover. The flywheel end of the engine is the front end so right and left sides are determined by viewing the engine from the front.

The disassembly section contains major overhaul procedures for step by step removal, disassembly, inspection, repair and assembly of the engine components.

If a major repair or an overhaul is necessary, a competent mechanic should either do the job or supervise and check the work of the mechanic assigned to do the job to ensure that all dimensions, clearances and torque values are within the specified tolerances.

The wiring diagram on the last page of the manual shows how the electrical components are interconnected.

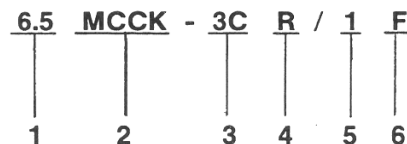
A parts catalog (available at the dealer level) contains detailed exploded views of each assembly and the individual piece part numbers and their proper names for ordering replacement parts.

Use only Genuine Onan replacement parts to ensure quality and the best possible repair and overhaul results. When ordering parts, always use the complete Model and Spec number as well as the Serial number shown on the nameplate.

ENGINE MODEL REFERENCE

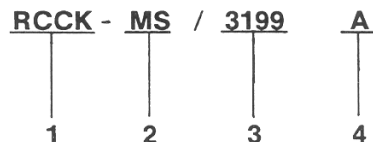
Identify your model by referring to the MODEL and SPEC (specification) NO. as shown on the unit nameplate. Always use this number and the engine serial number when making reference to your engine.

How to interpret *MODEL* and *SPEC NO.* on generator set engines.



1. Indicates kilowatt rating.
2. Series identification.
3. Voltage code of the generator.
4. Method of starting: A—automatic, R—remote electric starting, and E—electric starting.
5. Factory code for designating optional equipment, if any.
6. Specification letter which advances when the factory makes production modifications.

How to interpret *MODEL* and *SPEC NO* on industrial engines.



1. Factory code for general identification purposes.
2. Specific Type:
MS-ELECTRIC starting with stub shaft, starter and generator.
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.

Specifications

This manual contains SI metric equivalents that follow immediately in parentheses after the U.S. customary units of measure.

SPECIFICATION	UNIT OF MEASURE	SERIES	
		MCKK	RCCK
Number of Cylinders		2	2
Bore	in (mm)	3.250 (82.55)	3.250 (82.55)
Stroke	in (mm)	3.000 (76.2)	3.000 (76.2)
Displacement	cu in (cm ³)	49.8 (816)	49.8 (816)
Compression Ratio		7.0 to 1	7.0 to 1
Rated Speed (Maximum)	RPM	1800	3900
Power at Rated Speed	BHP (kW)	13.0 (9.7)	19.5 (14.5)
Oil Filter		Full Flow	Full Flow
Oil Capacity Without Filter	Qt (litre)	4 (3.8)	3.5 (3.3)
Oil Capacity With Filter Change	Qt (litre)	NA NA	4.0 (3.8)
Crankshaft Rotation (viewed from flywheel)		Clockwise	Clockwise
Governor		Mechanical	
Valve Clearance (Cold)			
Intake	in (mm)	0.012 (0.30)	0.012 (0.30)
Exhaust	in (mm)	0.012 (0.30)	0.012 (0.30)
Spark Plug Gap	in (mm)	0.025 (0.64)	0.025 (0.64)
Breaker Point Gap - Static (Full Separation and Engine Cold)	in (mm)	0.020 (0.51)	0.020 (0.51)
Ignition Timing	BTC	20°	20°

Dimensions and Clearances

All clearances given at room temperature of 70°F (21°C). All dimensions in inches (approximate millimetre dimensions in parentheses) unless otherwise specified.

DESCRIPTION	MINIMUM		MAXIMUM	
	Inches	(mm)	Inches	(mm)
CYLINDER BLOCK				
Cylinder Bore Honed Diameter	3.2490	(82.525)	3.2500	(82.550)
Maximum Allowable				
Taper			0.005	(0.127)
Out-of-Round			0.002	(0.051)
Main Bearing Inside Diameter (Without bearing)	2.187	(55.55)	2.188	(55.58)
Main Bearing Inside Diameter (Installed)	2.0020	(50.85)	2.0030	(50.88)
Camshaft Bearing Bore (Bearing installed)	1.3760	(34.95)	1.3770	(34.98)
CRANKSHAFT				
Main Bearing Journal Diameter	1.9992	(50.78)	2.0000	(50.80)
Main Bearing Clearance	0.0025	(0.064)	0.0038	(0.097)
Connecting Rod Journal Diameter	1.6252	(41.28)	1.6260	(41.30)
Crankshaft End Play	0.006	(0.152)	0.012	(0.305)
CONNECTING ROD				
Large Bore Diameter (Without bearing installed and rod bolts properly torqued)	1.7505	(44.46)	1.7510	(44.48)
Connecting Rod Side Clearance	0.0020	(0.051)	0.0160	(0.406)
Piston Pin Bushing Bore (Without bearing)	0.8115	(20.61)	0.8125	(20.64)
Piston Pin Bushing Bore with Bearing, (Finished bore)	0.7504	(19.05)	0.7508	(19.07)
Bearing to Crankshaft Clearance				
Nodular Iron Rod	0.0005	(0.013)	0.0023	(0.058)
Aluminum Rod	0.0020	(0.051)	0.0033	(0.084)
CAMSHAFT				
Bearing Journal Diameter	1.3740	(34.90)	1.3745	(34.91)
Bearing Clearance	0.0015	(0.038)	0.0030	(0.076)
End Play	0.0030	(0.076)	0.0120	(0.305)
Camshaft Lift		0.300	(7.62)	
PISTON				
Clearance in Cylinder				
Measure 90° to pin 0.10 inch below oil ring	0.0025	(0.064)	0.0045	(0.114)
Piston Pin Bore	0.7502	(19.055)	0.7506	(19.065)
Ring Groove Width				
Top 1 Compression Ring	0.0960	(2.438)	0.0970	(2.464)
No. 2 Compression Ring	0.0955	(2.426)	0.0965	(2.451)
No. 3 Oil Control Ring	0.188	(4.775)	0.189	(4.801)

DESCRIPTION	MINIMUM		MAXIMUM	
	Inches	(mm)	Inches	(mm)
PISTON PIN				
Clearance in Piston			Thumb Push Fit	
Clearance in Connecting Rod	0.0002	(0.005)	0.0007	(0.018)
Diameter	0.7500	(19.05)	0.7502	(19.06)
PISTON RINGS				
Clearance				
Top Groove	0.002	(0.051)	0.008	(0.203)
Ring End Gap in Cylinder	0.010	(0.254)	0.020	(0.508)
INTAKE VALVE				
Stem Diameter	0.3425	(8.70)	0.3430	(8.71)
Clearance (Stem to Guide)	0.0010	(0.025)	0.0025	(0.064)
Valve Face Angle		44°		
INTAKE VALVE SEAT				
Valve Seat Width	0.031	(0.787)	0.047	(1.194)
Valve Seat Angle		45°		
EXHAUST VALVE				
Stem Diameter	0.3410	(8.661)	0.3415	(8.674)
Clearance (Stem to Guide)	0.0025	(0.064)	0.004	(0.102)
Valve Face Angle		44°		
EXHAUST VALVE SEAT				
Seat Cylinder Head Bore Diameter	1.1890	(30.20)	1.1900	(30.23)
Seat Outside Diameter	1.1920	(30.28)	1.1930	(30.30)
Valve Seat Width	0.031	(0.787)	0.047	(1.194)
Valve Seat Angle		45°		
VALVE GUIDE				
Inside Diameter	0.344	(8.74)	0.346	(8.79)
TAPPET				
Body Diameter	0.7475	(18.99)	0.7480	(19.00)
Bore Diameter	0.7505	(19.06)	0.7515	(19.09)
Clearance in Bore	0.0015	(0.038)	0.003	(0.076)
VALVE SPRINGS INTAKE AND EXHAUST				
Valve Spring Free Length (Approx.)		1.662	(42.21)	
Valve Spring Length				
Valve Open		1.125	(28.58)	
Valve Closed		1.375	(34.93)	
Spring Load @ 1.375 inch (Valve Closed)	38 lb.	(17 kg)	42 lb.	(19 kg)
Spring Load @ 1.125 inch (Valve Open)	71 lb	(32 kg)	79 lb	(36 kg)
GEAR BACKLASH				
Timing Gear	0.002	(0.051)	0.003	(0.076)
Oil Pump Gear	0.002	(0.051)	0.005	(0.127)

Assembly Torques

The torque values given in Table 1 have been determined for the specific applications. Standard torque values must not be used where those listed in Table 1 apply. The engine assembly torques given here will assure proper tightness without danger of stripping threads. All threads must be clean and lubricated with new engine oil before torquing.

Check all studs, nuts, and capscrews, and tighten as required to keep them from working loose. Refer to the *PARTS MANUAL* for the location of washers and capscrews.

TABLE 1.

DESCRIPTION	TORQUE SPECIFICATION	
	Ft.-Lb.	Nm
Cylinder Head Capscrews	29-31	(39-42)
Rear Bearing Plate	20-25	(27-34)
Connecting Rod Bolt		
Iron Rod	27-29	(37-39)
Aluminum Rod	24-26	(33-35)
Flywheel Capscrew	35-40	(48-54)
Starter Mounting Bracket to		
Oil Base Screws	25-35	(34-47)
Gear Case Cover	10-13	(14-18)
Oil Pump	7-9	(10-12)
Intake Manifold	15-20	(20-27)
Exhaust Manifold	14-17	(19-23)
Oil Base	43-48	(58-65)

Special Tools

The following special tools are available from Onan. For further information see *TOOL CATALOG 900-0019*.

Valve Seat Driver
Valve Guide Driver
Oil Guide and Driver
Combination Bearing Remover (Main and Cam)
Combination Bearing Driver (Main and Cam)
Flywheel Puller

Engine Troubleshooting

TROUBLE																				GASOLINE ENGINE TROUBLESHOOTING GUIDE										
Backfire at Carburetor	Bearing Wear	Black Exhaust	Blue Exhaust	Burned Valves	Connecting Rod Wear	Crankshaft Slowly	Cylinder Wear	Engine Stops	Failure to Start	Governor Hunting	High Oil Pressure	Low Oil Pressure	Loss of Coolant (Water Cooled)	Misfiring	Overheating (Water Cooled)	Overheating (Air Cooled)	Piston Wear	Ring Wear	Poor Compression	Sticking Valves	CAUSE									
STARTING SYSTEM																														
																					Loose or Corroded Battery Connection									
																					Low or Discharged Battery									
																					Faulty Starter									
																					Faulty Start Solenoid									
IGNITION SYSTEM																														
																					Ignition Timing Wrong									
																					Wrong Spark Plug Gap									
																					Worn Points or Improper Gap Setting									
																					Bad Ignition Coil or Condenser									
																					Faulty Spark Plug Wires									
FUEL SYSTEM																														
																					Out of Fuel - Check									
																					Lean Fuel Mixture - Readjust									
																					Rich Fuel Mixture or Choke Stuck									
																					Engine Flooded									
																					Poor Quality Fuel									
																					Dirty Carburetor									
																					Dirty Air Cleaner									
																					Dirty Fuel Filter									
																					Defective Fuel Pump									
INTERNAL ENGINE																														
																					Wrong Valve Clearance									
																					Broken Valve Spring									
																					Valve or Valve Seal Leaking									
																					Piston Rings Worn or Broken									
																					Wrong Bearing Clearance									
COOLING SYSTEM (WATER COOLED)																														
																					Insufficient Coolant									
																					Faulty Thermostat									
																					Worn Water Pump or Pump Seal									
																					Water Passages Restricted									
																					Defective Gaskets									
																					Blown Head Gasket									
LUBRICATION SYSTEM																														
																					Defective Oil Gauge									
																					Relief Valve Stuck									
																					Faulty Oil Pump									
																					Dirty Oil or Filter									
																					Oil Too Light or Diluted									
																					Oil Level Low									
																					Oil Too Heavy									
																					Dirty Crankcase Breather Valve									
THROTTLE AND GOVERNOR																														
																					Linkage Out of Adjustment									
																					Linkage Worn or Disconnected									
																					Governor Spring Sensitivity Too Great									
																					Linkage Binding									

RCCK Installation

GENERAL

The type of installation can affect the life of the engine, the cost of operation and the frequency of necessary service. Plan the installation carefully to ensure the best performance.

Due to the great variety of uses, for the engine, these installation instructions are typical and general in nature. Use the installation recommendations given as a general guide, improvising or altering as necessary.

MOUNTING

There are several acceptable methods of mounting the engine. Among factors to be considered are: location, method of coupling the engine to the load, type of foundation or support, etc. The engine should be mounted level if possible. Maximum operation angle is 15° sideways, 30° front to rear tilt. If the engine will operate at an angle, be sure to re-mark the oil level indicator to compensate for the tilt.

VENTILATION

The engine must be provided with a supply of fresh air for radiator cooling and for combustion.

Open Air Installation: For installations where the engine is operated outside, ventilation usually is no problem. However, in protecting the engine from the elements, be sure nothing obstructs the flow of air around the engine.

EXHAUST

Vent exhaust gas outside enclosure. Shield the line if it passes through a combustible wall or partition. If turns are necessary, use sweeping type (long radius) elbows. Increase one pipe size (from manifold outlet size) for each additional 10 feet (3 m) in length. Locate the outlet away from the engine air intake.

WARNING

**Plan the exhaust system carefully.
Exhaust gases are poisonous!**

CARBURETOR AIR INTAKE

Proper engine efficiency depends upon a supply of fresh air to the carburetor. Under special conditions, it may be necessary to move the air cleaner off the engine, using a longer connection hose as necessary. For extreme dust or dirt conditions, install a special heavy duty air cleaner.

FUEL SYSTEM

The engine uses a mechanical type fuel pump which is mounted on top of the engine, adjacent to the carburetor. A rubber fuel line connects the fuel pump to the carburetor.

The fuel supply tank may be installed in any safe, convenient location. If the tank is installed within the engine enclosure, provide a vent line to the outside of the enclosure. The top of the tank should be about 6 inches (152 mm) below the carburetor, but not more than 4 feet (1.2 m) below the fuel pump.

The installation of a fuel filter between the fuel tank and the fuel pump is recommended. Any fuel filter should be fitted with a shutoff valve and should be easily accessible for cleaning.

WARNING

Fuel leaks create fire and explosion hazards which might result in severe personal injury or death. Always use flexible tubing between engine and the fuel supply to avoid line failure and leaks due to vibration. The fuel system must meet applicable codes.

CONNECT TO THE LOAD

The dimensions of various power take-off shafts are as follows:

SHAFT	DIMENSIONS IN INCHES		
	DIAMETER	LENGTH	KEY SIZE
Standard	1-1/2 (38.10 mm)	2-3/4 (69.85 mm)	3/8 (9.53 mm)
Rockford Clutch	1-7/16 (36.51 mm)	3-1/2 (88.90 mm)	3/8 (9.53 mm)
Gear Reduction	1-1/4 (31.75 mm)	2-3/4 (69.85 mm)	1/4 (6.35 mm)

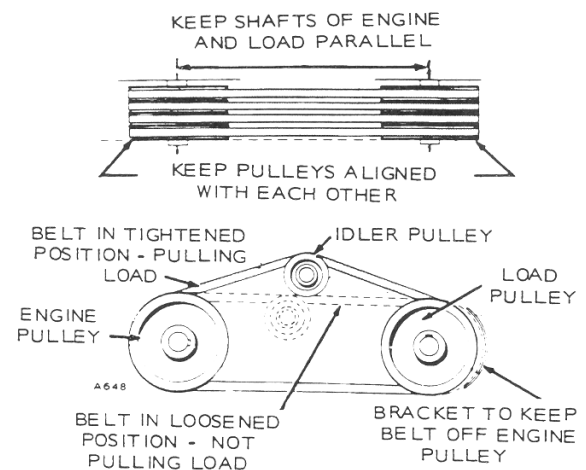


FIGURE 1. DRIVE BELT INSTALLATION

Belt Drive: V-belts are preferable to flat belts. Consult a reliable belting supplier for recommendations regarding size of pulleys, number of belts, etc., required. A typical belt drive installation is shown in Figure 1.

Comply with the following installation requirements:

1. Shafts of engine and load must be parallel with each other.
2. Pulleys of engine and load must be in alignment.
3. Mount engine pulleys as close to engine as possible.
4. If installation permits, belts should run horizontally.
5. Some method of disconnecting the load for starting is recommended. If a clutch is not used, a belt-tightener idler arrangement can be used.

Flexible Coupling: If a flexible coupling engine-to-load drive is used, the load shaft must be in line and centered with the engine shaft, Figure 2.

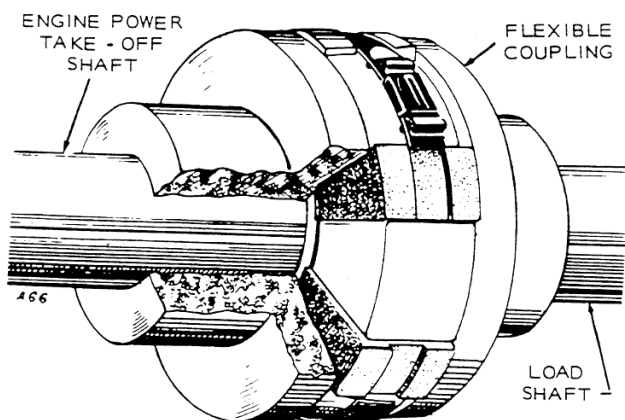


FIGURE 2. FLEXIBLE COUPLING

Reduction Gear Drive: Reduction gear drives are mounted at the factory (when ordered). The method of connecting the load is the same as when connecting directly to the engine shaft.

Clutch Installation: A Rockford clutch can be installed at the factory or in the field. Install the clutch according to the following instructions and Figure 3.

Drill a 13/64 inch (5.2 mm) hole (or filed slot) in the crankshaft for the clutch set screw. Locate center of hole 11/32 inch (9 mm) from the end and directly opposite the keyway in the crankshaft.

Install the clutch adapter, with drain slot downward using two cap screws 3/8-16 x 2 inches on the lower and one cap screw 3/8-16 x 1-3/4 inches on the upper number 2 cylinder side (cylinder nearer clutch). Install the 3/8-16 x 3-7/8-inch stud through the adapter into the engine block upper remaining hole. Use a lockwasher on each assembly screw. Use a flatwasher and a lockwasher under the stud nut.

Install the crankshaft key. Remove the clutch set screw.

Install the clutch assembly (less housing) to the crankshaft, driving it on carefully with a soft-faced hammer until set screw hole is aligned. Install set screw to bottom in crankshaft hole, then back it out one full turn. Tighten clutch retaining screws until clutch is clamped securely to crankshaft. Lock the screws and tighten the set screw.

Smear grease over splined power take-off shaft. Position the clutch throw-out collar to align the grease fitting with the hole in the housing (number 1 cylinder side, horizontal). Pull the throw-out collar outward to remove tension.

Install the clutch housing so that the clutch throw-out fork engages the throw-out collar. Be sure the serrated shaft is properly meshed with the clutch plate. Use two cap screws 7/16-14 x 2 inches on the lower and one cap screw 7/16-14 x 1-3/4 inches on the upper number 2 cylinder side. Install the stud washer and nut. Lubricate the two grease fittings just until grease appears.

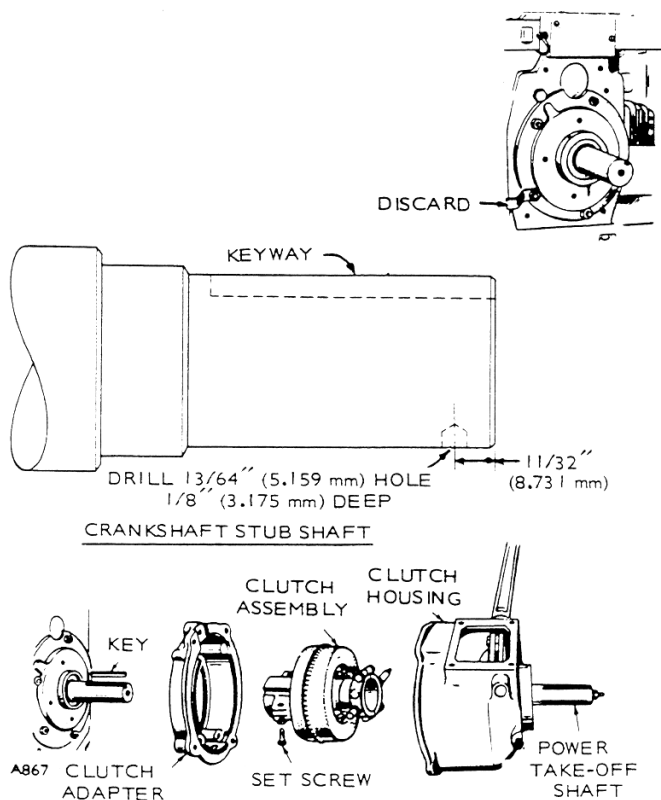


FIGURE 3. CLUTCH INSTALLATION

BATTERY CONNECTIONS (Engines with Electric Starter)

Connect the 12-volt battery positive cable to the engine start switch terminal. Connect the battery negative cable to the ground point on the engine oil base, Figure 4.

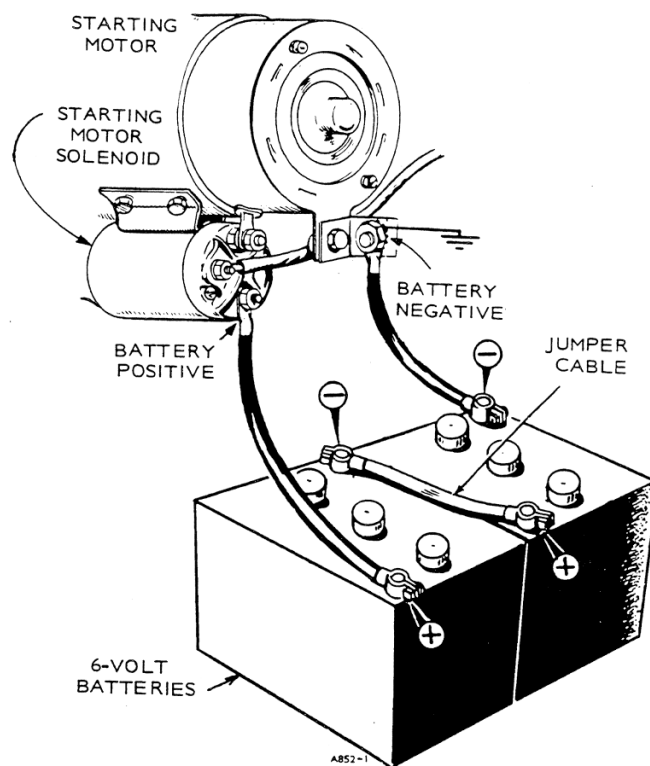


FIGURE 4. BATTERY CONNECTIONS

RCCK Fuel System

GENERAL

Satisfactory engine performance is largely dependent upon correct fuel system adjustments. However, adjustments cannot fully compensate for low engine power due to wear, etc. If trouble develops, follow an orderly procedure to determine the cause before making any adjustment.

Adjusting the carburetor is a means of obtaining the correct fuel-to-air mixture for smooth, efficient operation. Always adjust in two steps, first the load adjustment and then the idle adjustment.

GASOLINE CARBURETORS

Before adjusting the carburetor, be sure the ignition system is working properly and the governor is adjusted. Allow the engine to warm-up before starting carburetor adjustments.

If carburetor is completely out of adjustment so the engine will not run, open both valves 1 to 1-1/2 turns off their seats to permit starting. Do not force the needle valves against their seats. This can bend the needle.

Adjustments

1. With no load, turn idle fuel adjustment out until engine speed drops slightly below normal, Figure 5. Then turn needle in until speed returns to normal.
2. Apply a full load to engine.
3. Loosen packing nut and carefully turn main adjustment in until speed drops slightly below normal. Then turn needle out until speed returns to normal.
4. Tighten packing nut.

Alternate Method (No load adjustment possible)

1. Start engine and allow it to warm up.
2. Push in on governor mechanism to slow engine down to about 400 to 500 rpm.

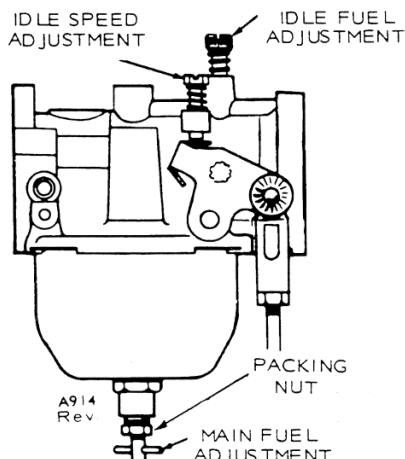


FIGURE 5. GASOLINE CARBURETOR

3. Set idle fuel adjustment screw for even operation so engine is firing on both cylinders and running smoothly.
4. Release governor mechanism to allow engine to accelerate. If engine accelerates evenly and without a lag, the main adjustment is correct. If not, adjust the needle outward about 1/2 turn and again slow down the engine and release the mechanism. Continue until the engine accelerates evenly and without a time lag after releasing the governor.

CAUTION *Loosen the packing nut before making main fuel adjustment and then tighten the nut to a snug fit after the adjustment has been made. This procedure makes it easier to use the carburetor adjusting tool and prevents fuel leaks around the packing nut. Fuel leaks cause hard starting because the float level becomes lower than normal.*

Cleaning and Repair: To clean the carburetor, soak all components thoroughly in a good carburetor cleaner following the cleaner manufacturer's instructions. Be sure all carbon is cleaned from the carburetor bore, especially in the area of the throttle valve. Blow out the passages with compressed air. If possible, avoid using wire to clean out the passages.

WARNING *Cleaning solutions typically contain strong chemicals that may cause injury if used improperly. Read all warning labels before using.*

Check the adjusting needles and nozzle for damage. If the float is loaded with fuel or damaged, replace it. The float should fit freely on its pin without binding. Invert the carburetor body and measure the float level, Figure 6. If necessary, bend the small lip that the inlet valve rides on to adjust float level.

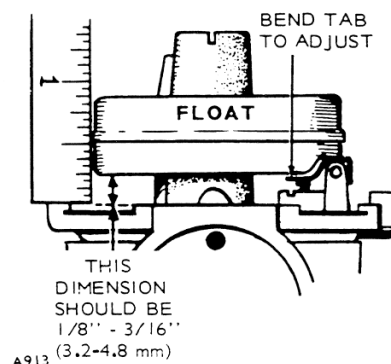


FIGURE 6. CHECKING FLOAT LEVEL

AMBIENT TEMP. (°F)	60	65	70	75	80	85	90	95	100
CHOKE OPENING (Inches)	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4

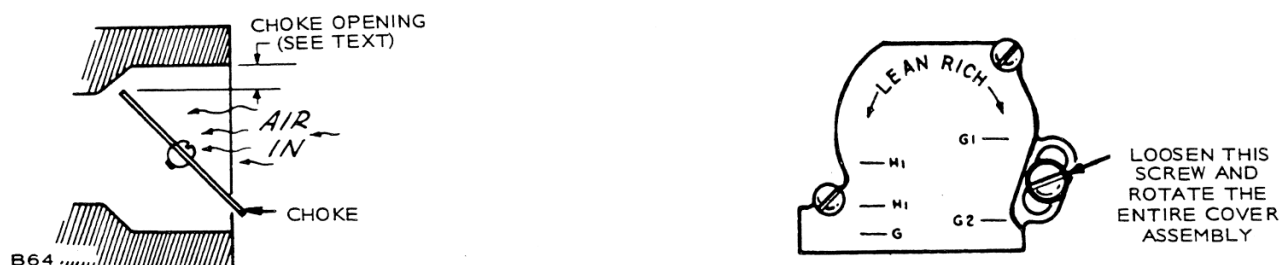


FIGURE 6a. THERMAL MAGNETIC CHOKE SETTINGS

Check the choke and throttle shafts for excessive side play and replace if necessary.

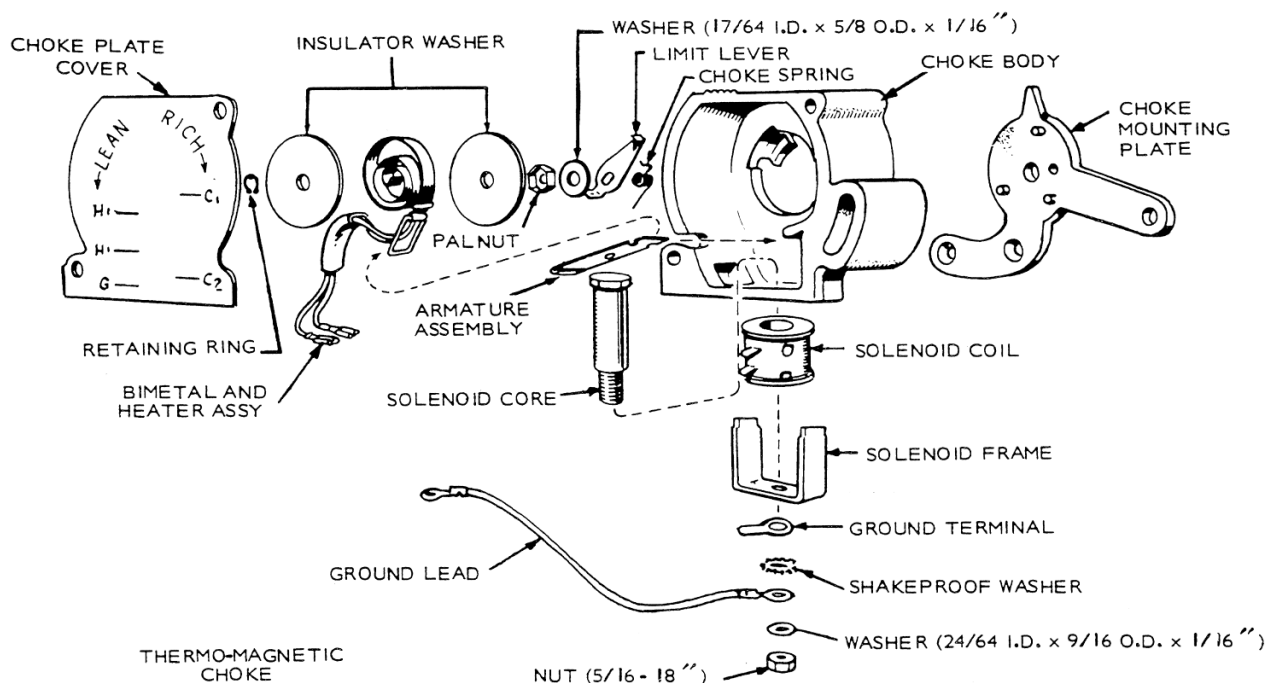
THERMAL MAGNETIC CHOKE

This choke uses a heating element and a heat sensitive bimetal spring to open the choke. The choke solenoid, actuated during engine cranking only, closes the choke according to ambient temperature, Figure 6a.

If adjustment is required, use the following instructions. Choke bimetal spring must be at ambient temperature. Allow engine to cool at least one hour before setting. Adjust choke by turning the choke body, which engages a link connected to a bimetal choke spring.

Remove air cleaner and adapter to expose the carburetor throat. Loosen the screw which secures the choke body. Rotate choke body clockwise to increase choke and counterclockwise to decrease choke action (leaner mixture). Refer to Figure 6a for correct choke setting according to ambient temperature. Use drill rod or shank of drill bit to measure choke opening.

Disassembly and Repair: If choke will not heat properly, check for broken heater wire, high-resistance connections, or broken lead wires to the bimetal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 30.6 to 37.4 ohms for a 12 volt system. If the heater is defective, replace it with a new one. When the start button is engaged, the solenoid should cause the spring-loaded armature to contact the solenoid core.



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FIGURE 6b. THERMAL MAGNETIC CHOKE ASSEMBLY

If this does not occur, check for broken lead wires or a defective solenoid coil. There must be slack in the lead wires between the choke body and the bimetal and heater assembly. The solenoid coil resistance should be 2.09 to 2.31 ohms in a 12 volt system.

When replacing the cover on the thermostat and heater assembly, be certain that the choke heater lead wires have been correctly installed in the choke housing. Improper replacement of the lead wires can cause the choke assembly to malfunction.

The wires enter the choke assembly through a small notch that is cut in the edge of the housing. A cover holds the wires in place and prevents movement when tightened. When properly installed, the lead wires will hang freely under the bimetal coil when the choke is in either the open or closed position. The end of the heater wire sleeve should be located from 1/8 inch inside the choke housing to flush with the inside wall.

When assembling the thermo-magnetic choke, the bimetal and heater assembly is connected as follows:

1. Lead tagged G goes to ground terminal on coil solenoid.
2. Lead tagged H goes to either H¹ terminal on solenoid core.

FUEL PUMP

A diaphragm type fuel pump is used. If fuel does not reach the carburetor, check the fuel pump. To do this, disconnect the fuel line at the carburetor and, while cranking the engine slowly by hand, observe whether fuel comes through the line. Be sure there is fuel in the tank. If the line is open and no fuel comes through, the pump is defective. Failure of the pump is usually due to a leaking diaphragm valve or valve gasket, a weak or broken spring, or wear in the drive linkage. Oil diluted with gasoline may indicate a faulty diaphragm. If the operator chooses to repair the pump rather than install a new one, the use of a complete repair kit is recommended.

WARNING

Fuel leakage is a fire and explosion hazard that might cause severe personal injury or death. Use care when reassembling fuel pump. All parts must align perfectly or pump will leak fuel.

Fuel Pump Reconditioning

1. Remove fuel lines and mounting screws holding pump to engine, Figure 6c.
2. Make a mark with a file across a point where upper and lower body join to assure proper reassembly. Remove four assembly screws and remove upper pump body.
3. Turn upper pump body over and remove valve retainer screws and washers. Remove valve retainer, valves, valve springs and valve gasket, noting their position. Discard valve springs, valves and valve retainer gasket.

* - PARTS INCLUDED IN REPAIR KIT.

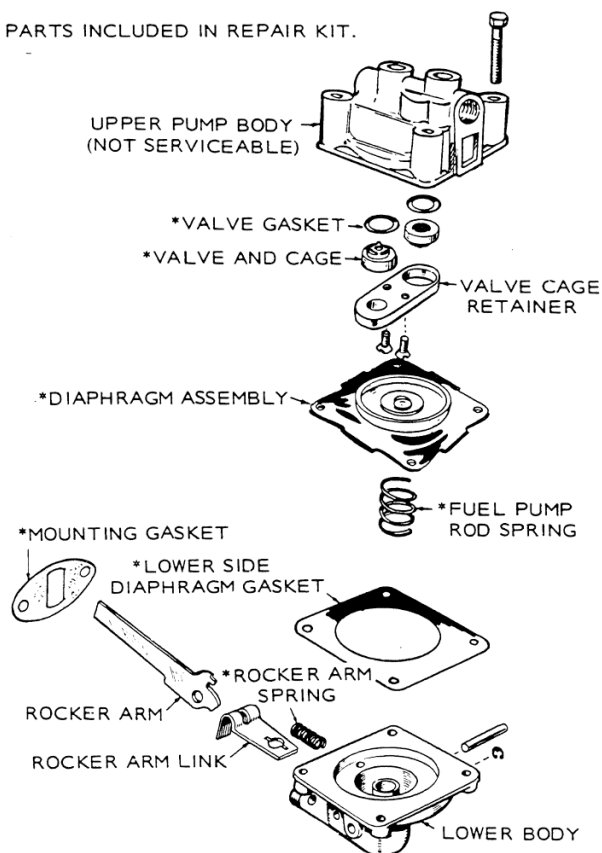


FIGURE 6c. FUEL PUMP ASSEMBLY

4. Clean pump body thoroughly with solvent and a fine wire brush.
5. Holding upper pump body with diaphragm surface up, place new valve gasket into cavity. Assemble valve spring and valves in cavity. Reassemble valve retainer. Lock in position by inserting and tightening valve retainer screws.
6. Place upper pump body assembly in a clean place and rebuild lower body.
7. Holding lower body, press down on diaphragm to compress spring under it, then turn bracket 90° to unhook diaphragm so it can be removed.
8. Clean lower body with a solvent and a fine wire brush.
9. Replace fuel pump rod spring, diaphragm gasket, stand new spring in casting, position diaphragm, compress spring and turn 90° to reconnect diaphragm.
10. Hold lower body, then place upper body on it (make sure that indicating marks are in line) and insert the four screws. DO NOT TIGHTEN. With hand on lower body only, push pump lever to limit of its travel and hold in this position while tightening the four screws. This is important to prevent stretching the diaphragm.
11. Mount fuel pump on engine, using new mounting gasket. Connect fuel lines.

ADJUSTABLE GOVERNOR

Where engine speed is governor controlled, the governor is set at the factory to allow a nominal engine speed of 2400 rpm at no-load operation (unless another speed is specified when the engine is ordered). Proper governor adjustment is one of the most important factors in maintaining the power and speed desired from the engine, Figure 6d.

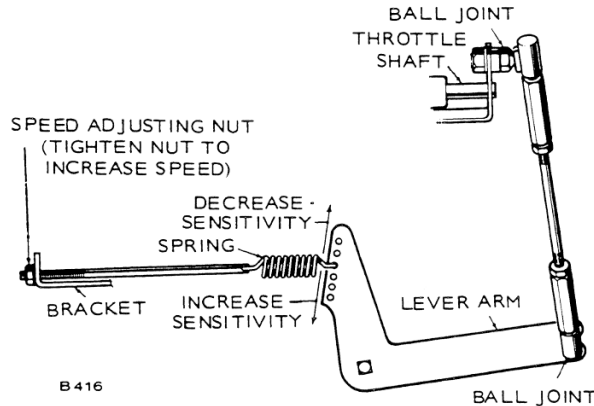


FIGURE 6d. GOVERNOR ADJUSTMENT LINKAGE

Before making governor adjustment, run the engine about 10 minutes to reach normal operating temperature. Be sure carburetor load and idle needles are properly adjusted before checking or adjusting governor system. For an accurate governor adjustment, a reliable tachometer is required.

WARNING

Contact with rotating machinery might cause serious personal injury or death. Stay clear of rotating components and ensure that protective shields and guards are in place and secured before operating machinery.

If the following checks do not remedy erratic operation, install a new governor spring. Springs become fatigued with age.

Linkage

Check the governor arm, linkage, throttle shaft and lever for a binding condition or excessive slack and wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness will cause a hunting condition and regulation will be erratic. Work the arm back and forth several times by hand while the engine idles. Replace parts as needed.

The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle arm is adjusted by rotating the ball joint. Adjust length so with the engine stopped and tension on the governor spring, the carburetor throttle lever is wide open. This setting allows immediate control by the governor after starting and synchronizes travel of the governor arm and the throttle shaft.

Speed Adjustment

The speed at which the engine operates is determined by the tension applied to the governor spring. Increasing spring tension increases engine speed. Decreasing spring tension decreases engine speed. The no-load speed of the engine should be slightly higher than the speed requirements of the connected load. For example, if the connected load is to turn at 2310 rpm, set the no-load speed of the engine at about 2400 rpm. Check speed with a tachometer. If a speed adjustment is needed, turn the speed adjusting nut in to increase the speed or out to decrease the speed, Figure 6d.

Sensitivity Adjustment

The engine speed drop from no load to full load must be within 100 rpm. Check the engine speed with no-load connected and again after connecting a full-rated load.

The sensitivity of the governor depends upon the position of the arm end of the governor spring. A series of holes in the governor arm provides for adjustment. To increase sensitivity, move the governor spring toward the governor shaft. To decrease sensitivity, move the governor spring toward the linkage end of the governor arm.

A too-sensitive setting will result in a surging speed (hunting) condition, an alternate increase and decrease in engine speed. An opposite setting will result in too much speed variation between no-load and full-load conditions.

Always recheck the speed adjustment after a sensitivity adjustment. Increasing sensitivity will cause a slight decrease in speed and will require a slight increase in the governor spring tension.

MCKK Fuel System

Satisfactory engine performance is largely dependent upon correct fuel adjustments. However, adjustments cannot fully compensate for low engine power due to wear, etc. If trouble develops, follow an orderly procedure to determine the cause before making any adjustment.

Adjusting the carburetor is a means of obtaining the correct fuel-to-air mixture for smooth, efficient operation. Always adjust in two steps, first the load adjustment and then the idle adjustment.

Before adjusting the carburetor, be sure the ignition system is working properly and the governor is adjusted. Allow the engine to warm-up before starting carburetor adjustments.

CARBURETOR ADJUSTMENTS (Spec A-G)

If carburetor is completely out of adjustment so the engine will not run, open both needles 1 to 1-1/2 turns off their seats to permit starting. Do not force needles against their seats. This can bend the needle.

WARNING *Inhalation of exhaust gases might result in serious personal injury or death. Be sure deadly exhaust gas is piped outside and away from windows, doors or other inlets to building.*

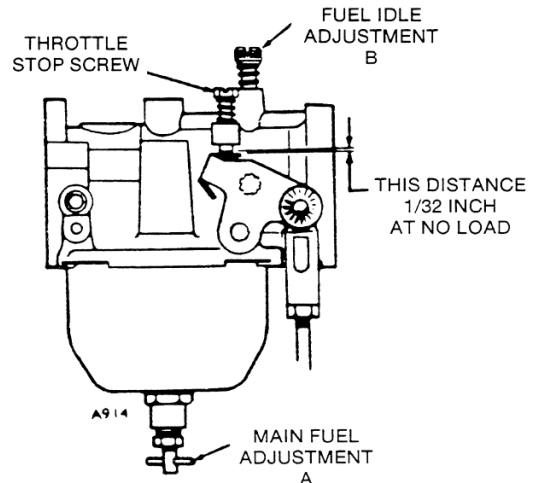
1. Apply a full load to engine.
2. Turn in load needle (Figure 7) until engine speed drops. Then turn out needle until engine speed returns to normal.
3. Remove load from engine.
4. Turn idle needle out until engine speed drops slightly. Then turn needle in until speed returns to normal.

Alternate Method (No-Load adjustment possible)

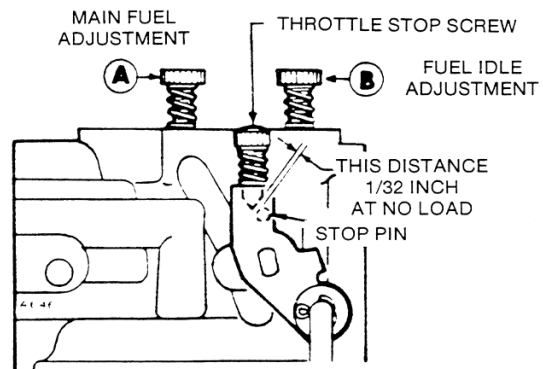
1. Start engine and allow it to warm up.
2. Push in on governor mechanism to slow the unit down to about 400 to 500 rpm.
3. Release governor mechanism to allow the engine to accelerate. If engine accelerates evenly and without a lag, the load needle setting is correct. If not, adjust needle outward about 1/2 turn and again slow down the engine and release the mechanism. Continue until engine accelerates evenly and without a time lag after releasing governor.

4. Push in on governor mechanism to slow the unit to 400 to 500 rpm. Set idle needle for even operation so engine is firing on both cylinders and running smoothly.

A Zenith carburetor is used on Spec B-G engines. Carburetor adjustments are the same as the Spec A carburetor. The only difference is the location of adjustment needles (Figure 7). The main-fuel adjustment needle (A) is on the bottom of carburetor.



SPEC B-G



SPEC A

FIGURE 7. ADJUSTING SIDEDRAFT CARBURETOR

Throttle Stop Screw Setting

Throttle stop screw is located on the throttle shaft lever (side of carburetor by ignition coil). It must be adjusted and set for 1/32 inch clearance over the manifold surface when the engine is running with no load. See Figure 7a.

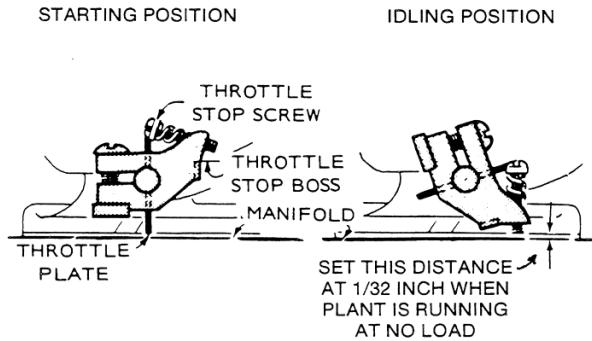


FIGURE 7a. THROTTLE STOP SCREW

Float Adjustment

To check float level, Figure 7b Spec B-G, Figure 7c Spec A, remove the entire main fuel adjustment assembly from float bowl (unscrew large nut from float bowl). The proper level from float to bowl flange gasket is 1/8 inch with fuel float weight on needle and spring. The float tab should just touch fuel inlet valve and not compress inlet valve spring. Adjust by bending tab on the float.

CAUTION

Do not apply excessive pressure to float valve.

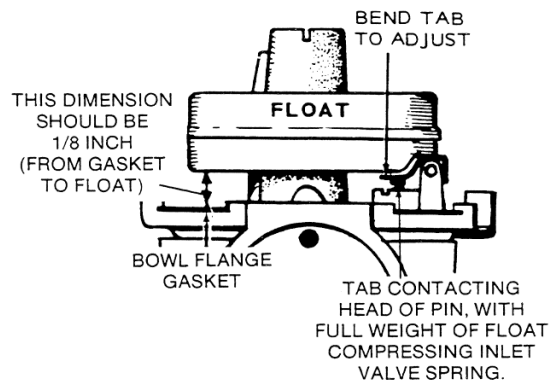


FIGURE 7b. FLOAT LEVEL ADJUSTMENT SPEC B-G

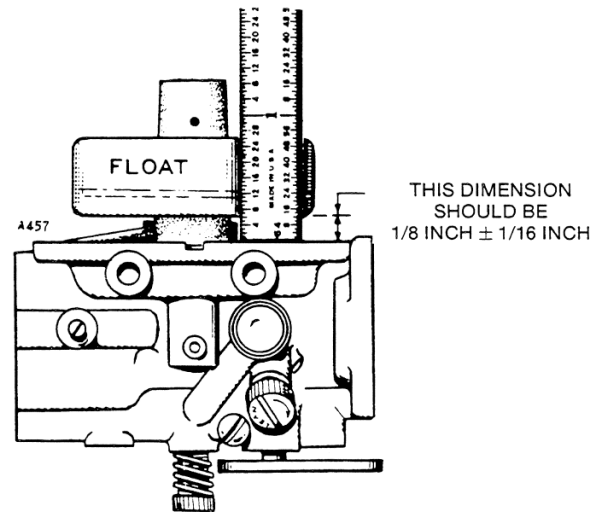


FIGURE 7c. FLOAT LEVEL ADJUSTMENT SPEC A

CARBURETOR ADJUSTMENTS (Begin Spec H)

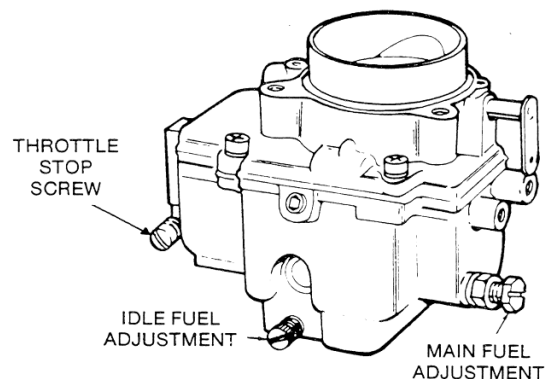
The carburetor idle and main mixture screws were set for maximum efficiency at the factory and should normally not be disturbed. If adjustments seem necessary, first be sure the ignition system is working properly and is not the source of the problem.

If adjustment is needed, proceed as follows:

1. Turn both mixture screws in until lightly seated (Figure 7a), then back the idle mixture screw out 1 turn and the main mixture screw out 1-1/4 turns.

CAUTION

Forcing the mixture adjustment screw tight will damage the needle and seat. Turn in only until light tension can be felt.



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FIGURE 7d. DOWNDRAFT CARBURETOR ADJUSTMENT

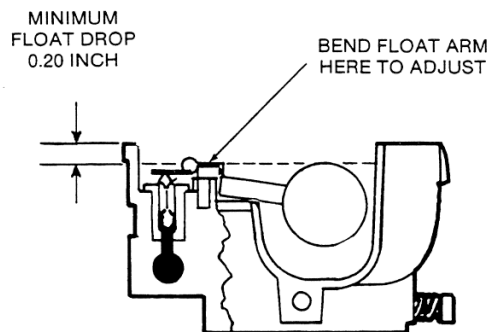
2. Start the engine and allow it to warm up thoroughly (at least 10 minutes).

3. Push in on governor arm to slow engine down to about 400 to 500 rpm.
4. Release governor arm allowing engine to accelerate. If engine accelerates evenly and without hesitation, main fuel adjustment is correct. If it does not, turn the main adjustment screw out in 1/8 turn increments until the engine accelerates smoothly, but do not turn it out more than 1/2 turn beyond the original setting.
5. Push in on governor arm to slow engine down to about 400-500 rpm. Turn the idle adjustment screw in until engine speed drops and then out until engine speed drops again. Over a narrow range between these two settings, engine speed will be at its maximum. Set the idle adjustment screw about 1/8 turn outward from the midpoint of this range.

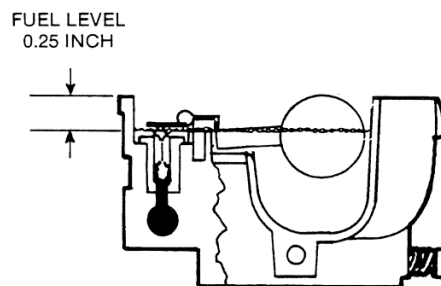
Float Adjustment

Turn carburetor and check float setting (see Figure 7e). The float should be a specific distance from the machined mating surface (without gasket). Bend the float level. Bend the float arm as required to adjust float drop.

When checking float level and float drop, measure to float body, not seam.



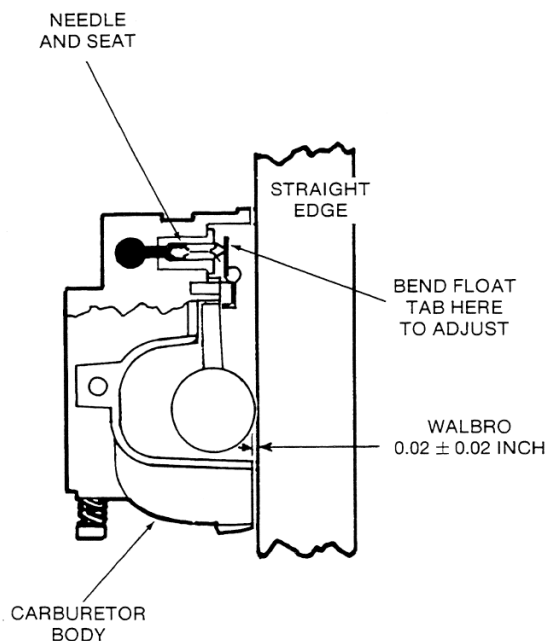
NO FUEL



FLOAT DROP ADJUSTMENTS

FS-1524

FIGURE 7e. FLOAT ADJUSTMENT BEGIN SPEC H



FLOAT LEVEL ADJUSTMENT

CARBURETOR OVERHAUL

Carburetion problems that are not corrected by mixture or float adjustments are usually a result of gummed-up fuel passages or worn internal parts. The most effective solution is a complete carburetor overhaul.

In general, overhauling a carburetor consists of complete disassembly, a thorough cleaning, and replacement of worn parts. Carburetor repair kits are available that supply new gaskets and replacements for those parts most subject to wear.

General instructions for overhauling a carburetor are given below. Carefully note the position of all parts while removing to assure correct placement when reassembling. Read through all the instructions before beginning for a better understanding of the procedures involved. Carburetor components are shown in Figures 8 and 8a.

WARNING *Ignition of fuel might cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, or other igniter near the fuel system.*

Removal and Disassembly

1. Disconnect all lines, linkages, wires, and attaching nuts or bolts; then, remove the carburetor from the engine. (Downdraft carburetors may require removal of the intake manifold to disconnect.)
2. Remove air cleaner adapter, if so equipped, and automatic choking assembly.
3. Remove throttle and choke plate retaining screws, then plates. Pull out throttle and choke shafts, being careful not to damage the teflon coating applied to some throttle shafts.
4. Remove main and idle mixture screw assemblies.
5. On downdraft carburetors, remove attaching screws and separate upper and lower carburetor sections. On sidedraft models, unscrew the retaining screw and remove fuel bowl from the upper carburetor body.

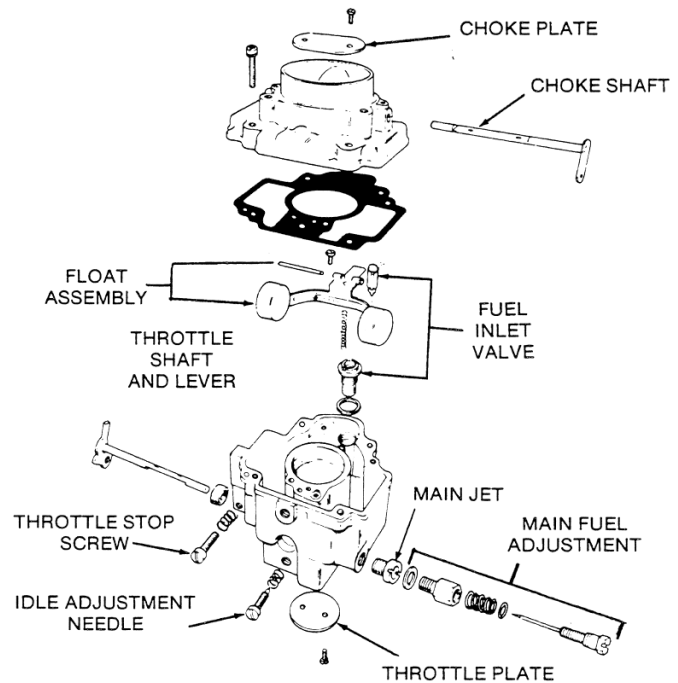


FIGURE 8. DOWNDRAFT LUA CARBURETOR ASSEMBLY

6. Carefully note position of float assembly parts, then slide out retaining pin and remove the float assembly, any springs or clips, and the needle valve.
7. Unscrew and remove needle valve seat.

Cleaning and Repair

1. Soak all metal components not replaced by repair kit in carburetor cleaner. Do not soak non-metal floats or other non-metal parts. Follow the cleaner manufacturer's recommendations.
2. Clean all carbon from the carburetor bore, especially where the throttle and choke plates seat. Be careful not to plug the idle or main fuel ports.
3. Blow out all passages with compressed air. Avoid using wire or other objects for cleaning that may increase the size of critical passages.

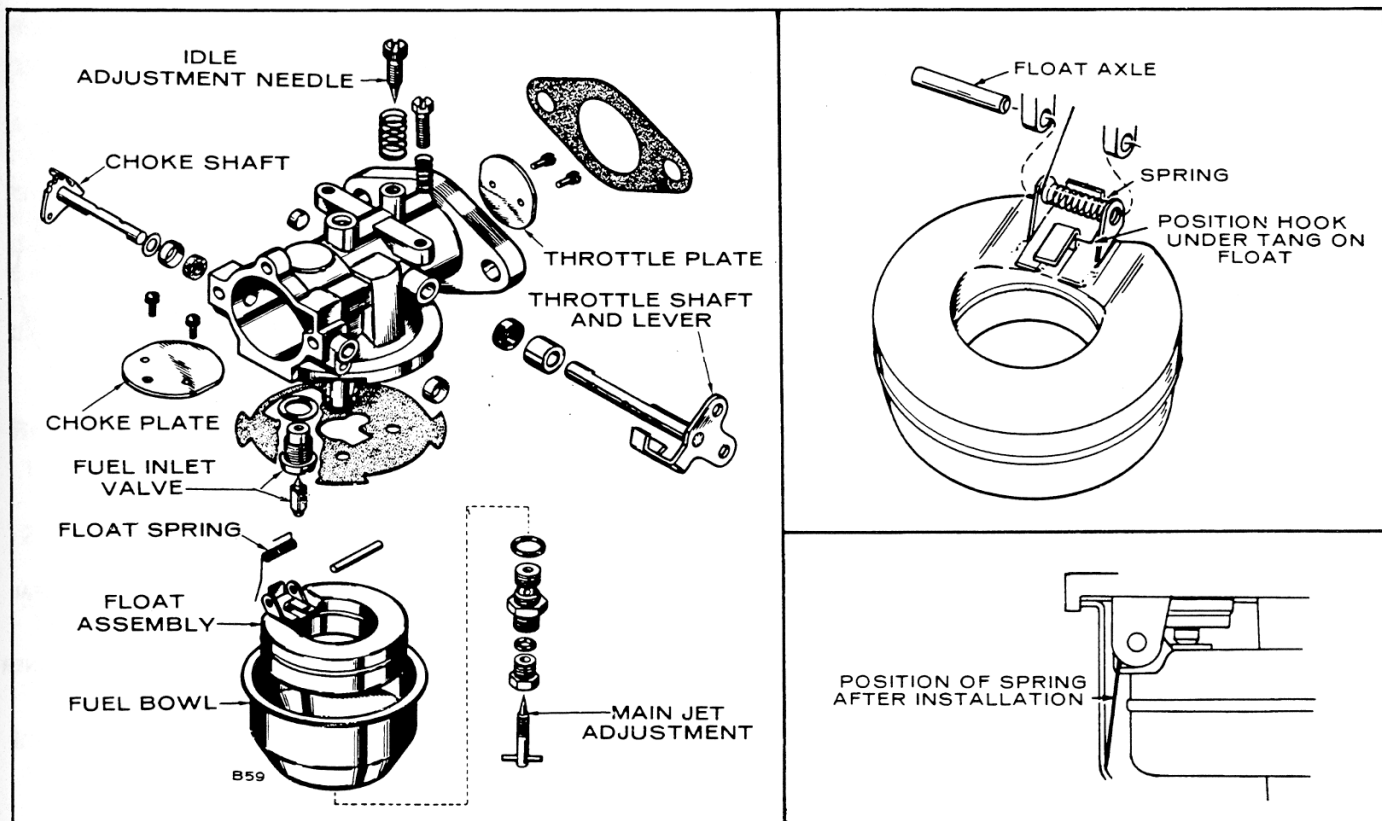


FIGURE 8a. SIDEDRAFT CARBURETOR ASSEMBLY

4. Check the condition of any needle valve not included in repair kit and replace if damaged (Figure 8b). Replace float if loaded with fuel or damaged.
5. Check the choke and throttle shafts for excessive play in their bore, and replace if necessary.
6. Replace old components with new parts included in repair kit.

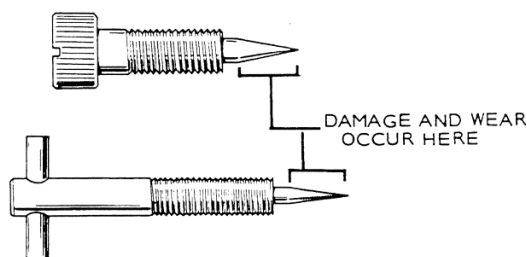


FIGURE 8b. MIXTURE NEEDLE INSPECTION

Reassembly and Installation

1. Install needle valve and seat, fuel bowl gasket, and float assembly. Make sure that all clips and springs are properly placed and that the float moves freely without binding. Check float level and adjust as necessary (see *Float Level Adjustment*).

2. Rejoin upper and lower carburetor sections on downdraft carburetors — fuel bowl and upper carburetor body on sidedraft models.

WARNING

Fuel leakage is a fire and explosion hazard that might cause severe personal injury or death. Use care when reassembling carburetor. All parts must align perfectly or carburetor will leak fuel.

The float spring on Zenith sidedraft carburetors rides on the inner face of the fuel bowl. Be sure to catch the end of the spring when reinstalling the bowl (Figure 8a).

3. Slide in throttle shaft and install throttle plate, using new screws if furnished in repair kit. Before tightening the screws, the plate must be centered in the bore. To do so, back off the throttle stop screw as necessary and completely close the throttle lever. Seat the plate by tapping with small screwdriver, then tighten screws. Install the choke shaft and plate in the same manner.
4. Install main and idle mixture screw assemblies. Turn in screws until lightly seated and then out the number of turns specified.

CAUTION

Forcing the mixture adjustment screws tight will damage the needle and seat. Turn in only until light tension is felt.

5. Reinstall carburetor on engine and connect fuel lines, linkages, and wires.
6. Reset mixture screws according to directions given earlier in this section. Install air cleaner adapter, where used, and air cleaner.

FUEL PUMP TEST

Test the fuel pump by checking the pump outlet pressure. Use the following procedure.

1. Remove the fuel line from the pump outlet and install a pressure gauge.
2. Press the START switch and hold it for several seconds until pressure reading is constant.
3. Pressure reading should be 2-1/2 to 3-1/4 psi (17.2 to 22.4 kPa). If the retention is good, the pressure should stay constant or drop off very slowly.

A low pressure reading with little or no pressure drop indicates a weak or broken diaphragm or diaphragm spring, worn linkage or leaky check valves. If pressure is above maximum, the pump diaphragm is too tight or the diaphragm (or plunger) return spring is too strong. Any of the above conditions are cause for repair or replacement of the pump.

ELECTRIC FUEL PUMP

The Facet and Bendix pumps incorporate a hollow stainless steel plunger in a brass cylinder. The plunger has no gland or seal, but is freely fitted. The fluid being pumped provides the seal by filling the small clearance between the plunger and cylinder. Energizing the pump's electric solenoid pulls the plunger downward, compressing the return spring. When the solenoid is de-energized, the return spring drives the plunger back, delivering fuel to the pump outlet.

WARNING

Do not substitute automotive type electric fuel pumps for standard Onan supplied electric pumps. The output pressure is much higher and can cause carburetor flooding or fuel leakage, creating a fire hazard.

Fuel Pump Repair

Service of the Facet pump is limited to the bottom cover, filter, plunger tube, and plunger assembly. All parts of the electric system are hermetically sealed in a gas atmosphere and are not serviceable. If electrical failure occurs, replace the pump.

CAUTION

Do not tamper with the seal at the center of the mounting bracket on the side of the pump as it retains the dry gas which surrounds the electrical system. Electrical system components are not serviceable.

Use the following procedure for servicing the pump:

1. Using a 5/8-inch wrench, loosen, the pump cover, then remove by hand.
2. Remove the filter, magnet and cover gasket (Figure 9).

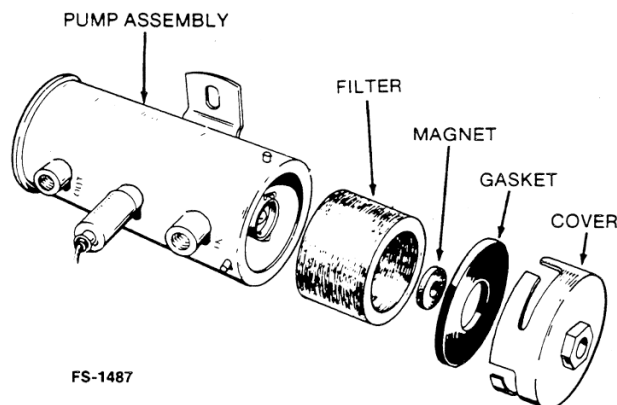


FIGURE 9. REMOVAL OF MAGNET AND FILTER

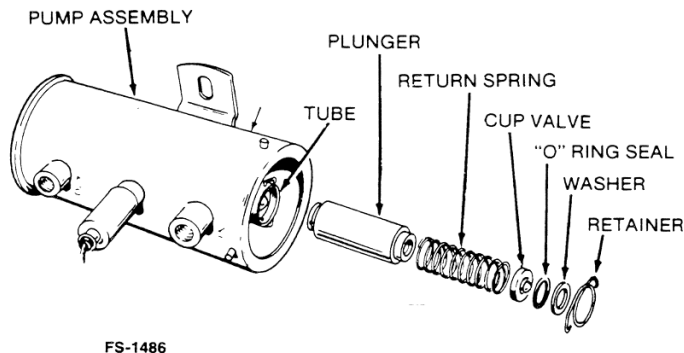


FIGURE 9a. REMOVAL OF PLUNGER ASSEMBLY

3. Using a thin nose pliers, remove the retainer spring from the plunger tube. Remove the washer, O-ring seal, cup valve, plunger spring and plunger from tube (Figure 9a).
4. Wash all parts (except gasket and seal) in parts cleaning solvent. Blow out solvent and dirt with low pressure compressed air. Slosh the pump assembly in cleaning solvent, blow dry and swab the inside of the plunger tube with a cloth wrapped around a stick. If the plunger does not wash clean or has rough spots, gently clean the surface with crocus cloth.

WARNING

Most parts cleaning solvents are flammable and could cause serious personnel injury if used improperly. Follow the manufacturer's recommendations when cleaning parts.

5. Insert plunger in tube, buffer spring end first. Check fit by slowly sliding the plunger back and forth in the tube. It should move fully without any tendency to stick. If a click cannot be heard as the plunger is slid from one end to the other, the internal pump assembly is not functioning properly and the pump should be replaced.
6. Install plunger spring, cup valve, O-ring seal and washer. Compress the spring and install the retainer with ends in the side holes of the tube.
7. Check cover gasket and replace if deteriorated. Place cover gasket and magnet in the bottom cover and install filter and cover assembly on pump. Twist cover on by hand and tighten securely with a 5/8-inch wrench.

MECHANICAL FUEL PUMP (Spec A-E)

A diaphragm type fuel pump is used. If fuel does not reach carburetor, check the fuel pump. Be sure there is fuel in the tank. If line is open and no fuel comes through, pump is defective. Failure of pump is usually due to a leaking diaphragm valve or valve gasket, a weak or broken spring, or wear in the drive linkage. Oil diluted with gasoline may indicate a faulty diaphragm.

Removal

1. Remove the fuel inlet and outlet lines from the pump.
2. Remove the two capscrews holding the pump to the engine.
3. Remove the pump, spacer (if used) and gasket from the engine and discard the gasket.

Installation

1. Remove all gasket material from mounting faces and spacer (if used). Apply oil-resistant sealer to both sides of the gasket(s) and to the threads of the attaching capscrews.
2. Place the gasket (and spacer if used) on the mounting face of the pump. Slide the mounting capscrews through the pump and gasket (and spacer) to prevent the gasket from slipping out of place.
3. Lightly place the pump in position on the engine, making sure the rocker arm is riding on the camshaft lobe. Start both capscrews and check for proper gasket placement. Alternately torque capscrews to specifications.
4. Connect the fuel inlet and outlet lines.
5. Operate the engine and check for leaks.

Repair

Repair kits are available that provide replacement parts for the pump which are most subject to wear. Use all parts included in the repair kit. Proceed as follows:

1. After the pump is removed from the engine, scribe a line on the flanges of the upper and lower pump bodies to assure correct positioning when reassembling.
2. Remove the securing screws and separate the upper and lower pump bodies.
3. Detach the valve cage retainer from the pump upper body. Noting their position, remove the valve and cage assemblies and their gaskets from the retainer (Figure 9b).

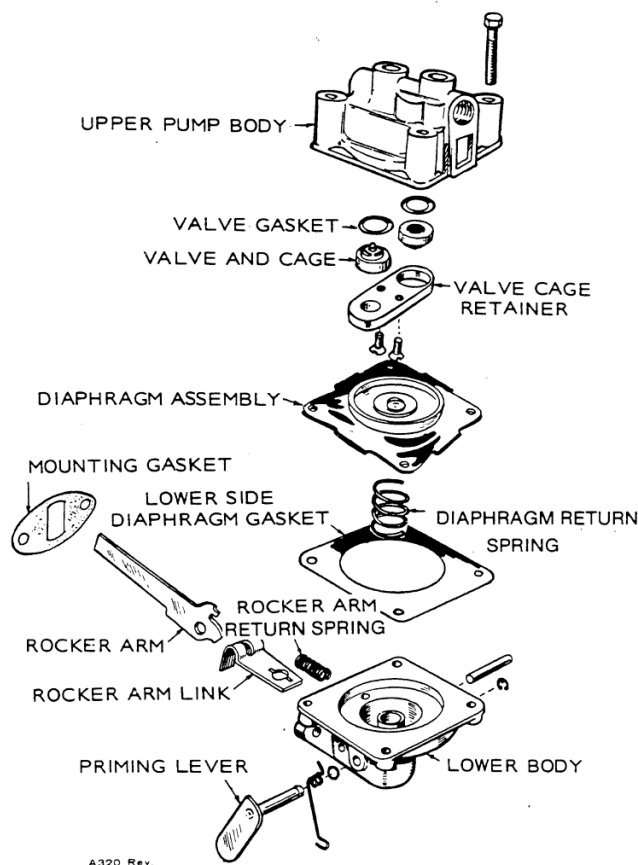


FIGURE 9b. EXPLODED VIEW OF PUMP

4. Detach the pump diaphragm by pressing its metal base into the pump body and turning it 1/4 turn. (Figure 9b).
5. The rocker arm return spring can normally be removed without removal of the rocker arm from the pump body. Use a small screwdriver or tweezers to compress the spring and tip it off the rocker arm catch. When installing the new spring, make sure it is properly placed before remounting the pump.
6. Clean in solvent all pump parts that will not be replaced and allow to dry.
7. Install the new valve and cage assemblies and their gaskets in the retainer. Be sure the assemblies are in proper position and fully seated. Reinstall the retainer and assemblies in the pump upper body.
8. To install the new pump diaphragm, turn the pump lower body upside-down and place the diaphragm and spring in the body. Press the base of the diaphragm up into the body of the pump and turn 1/4 turn.
9. Install new rocker arm return spring. Check for proper spring placement.

10. Place the upper and lower bodies of the pump together with the scribe marks aligned. Start the four securing screws, making sure they do not chew into the diaphragm fabric. Leave the screws 2 or 3 turns loose.
11. Operate the rocker arm several times to flex the new diaphragm. While holding the rocker arm fully flexed, tighten the body screws.

CAUTION *Failure to flex the rocker arm fully while tightening the pump bodies together will result in excessive pump pressure and possible engine flooding or pump diaphragm failure.*

FUEL FILTER (Spec A-E)

Periodic maintenance should consist of cleaning the fuel filter, flame arrestor, carburetor, and complete carburetor adjustment.

Remove fuel sediment bowl, empty, clean, and dry (Figure 10). Remove screen and clean any trapped particles. When replacing the sediment bowl, be sure screen and gasket are in place.

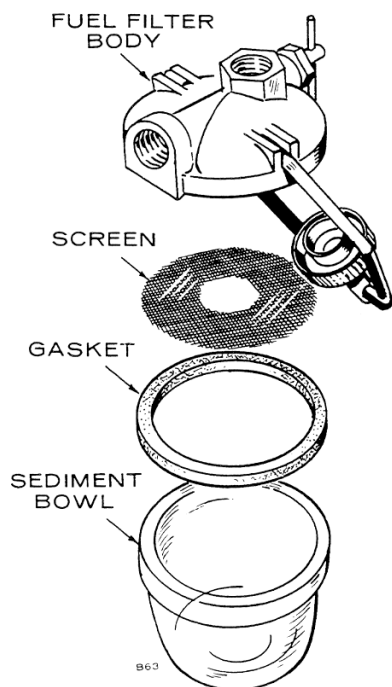
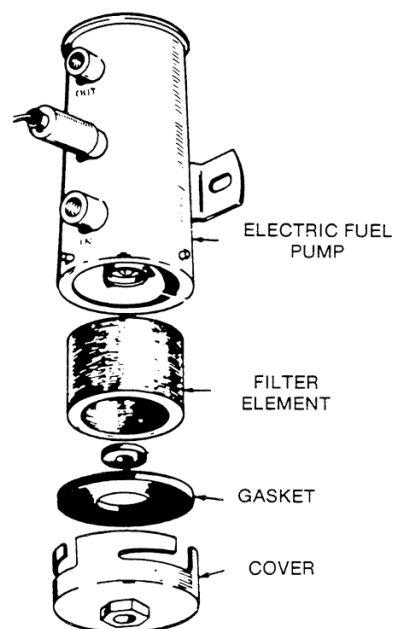


FIGURE 10. FUEL FILTER

FUEL FILTER (Begin Spec F)

Electric pumps incorporate a filter within the casing of the pump (Figure 10a). Use a 5/8 inch wrench to twist off the bottom of the pump and remove the filter element. If the filter is dirty, replace it along with the cover gasket.



FS-1488

FIGURE 10a. BENDIX AND FACET ELECTRIC PUMP FILTER

AUTOMATIC CHOKES

Automatic chokes may occasionally require adjustment to provide the best fuel-to-air mixture for the existing temperature conditions. Several adjustments may be necessary to arrive at the correct setting. Let the engine cool to ambient air temperature between each adjustment.

If the engine starts, runs for a few minutes, then stops, the choke mixture may be too lean. If the engine starts, but runs rough and is sluggish once it has warmed up, the choke mixture may be too rich.

AMBIENT TEMP. (°F)	60	65	70	75	80	85	90	95	100
CHOKE OPENING (Inches)	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4



FIGURE 11. THERMO-MAGNETIC CHOKE SETTINGS AND ADJUSTMENTS

Thermo-Magnetic Chokes (Spec A-G)

Thermo-magnetic chokes have a strip-type heating element attached directly to a bi-metal coil (Figure 11a). As the element heats, the coil twists and gradually opens the choke valve. An electromagnetic solenoid pulls the coil in tighter during engine starting to increase the choking effect. The coil is calibrated to provide the correct choke setting under various temperature conditions.

Adjustment: Adjustment of the choke setting must be made with the engine cold. Do not attempt adjustment until the engine has been shut down for at least an hour. Refer to Figures 11 and 11a and proceed as follows:

1. Loosen the screw which secures the choke body assembly.
2. Rotate the choke body until the correct choke setting is attained. Figure 11, lists the correct settings for various temperature conditions.
3. Start the engine and observe its operation. Slight readjustment of the choke setting may be necessary for best engine operation.
4. Retighten the securing screw when adjustment has been completed.

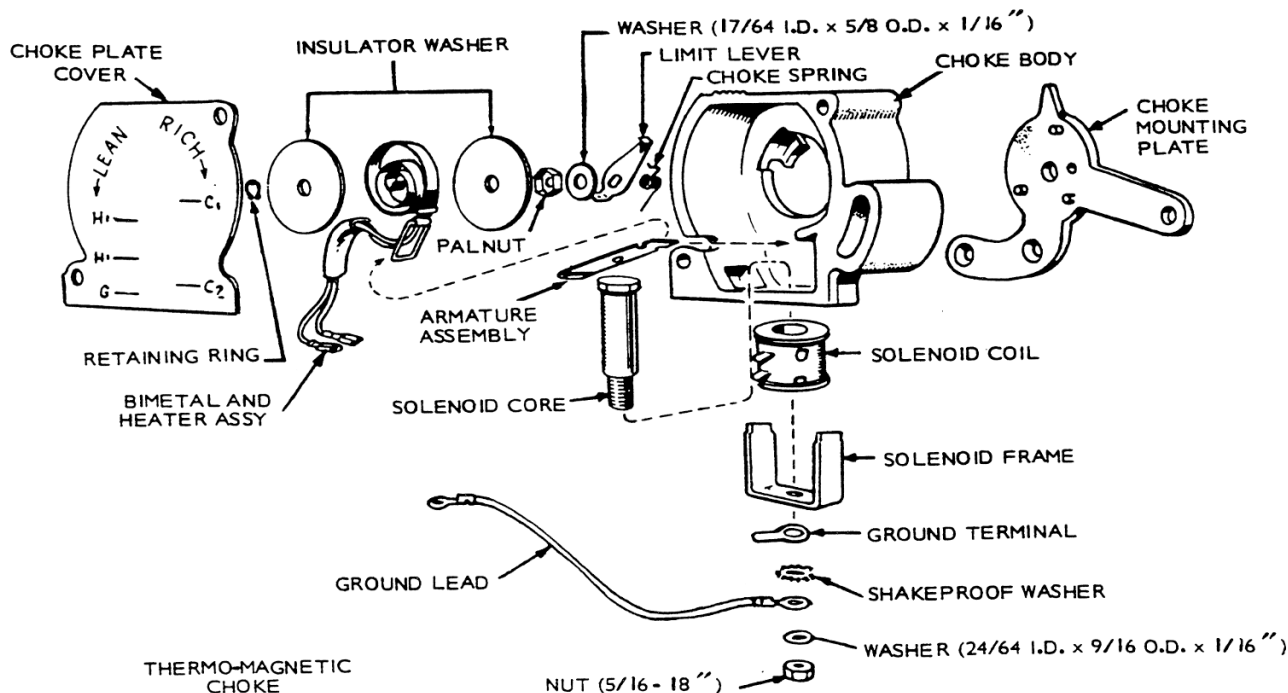


FIGURE 11a. THERMO-MAGNETIC CHOKE ASSEMBLY

Repair: If choke will not heat properly, check for broken heater wire, high-resistance connections, or broken lead wires to the bi-metal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 30.6 to 37.4 ohms for a 12 volt system. If the heater is defective, replace it with a new one. When the start button is engaged, the solenoid should cause the spring-loaded armature to contact the solenoid core.

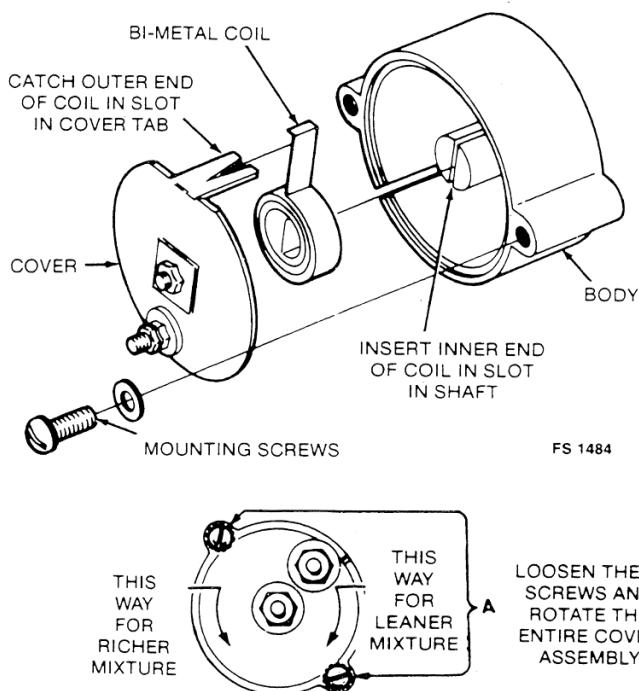
If this does not occur, check for broken lead wires or a defective solenoid coil. There must be slack in the lead wires between the choke body and the bi-metal and heater assembly. The solenoid coil resistance should be 2.09 to 2.31 ohms in a 12 volt system.

When replacing the cover on the thermostat and heater assembly, be certain that the choke heater lead wires have been correctly installed in the choke housing. Improper replacement of the lead wires can cause the choke assembly to malfunction.

The wires enter the choke assembly through a small notch that is cut in the edge of the housing. A cover holds the wires in place and prevents movement when tightened. When properly installed, the lead wires will hang freely under the bi-metal coil when the choke is in either the open or closed position. The end of the heater wire sleeve should be located from 1/8 inch inside the choke housing to flush with the inside wall.

When assembling the thermo-magnetic choke, the bi-metal and heater assembly is connected as follows:

1. Lead tagged G goes to ground terminal on coil solenoid.
2. Lead tagged H goes to either H¹ terminal on solenoid core.



ELECTRIC CHOKE

The choke consists of a bi-metal coil and an electric heating element. The bi-metal coil connects to the choke shaft and holds the choke plate nearly closed when the engine is cold.

As the engine starts, current is supplied to the electric heating element in the choke cover. Heat from the element causes the bi-metal coil to twist. The twisting action of the coil turns the choke valve shaft and gradually opens the valve. Heat from the element keeps the choke open while the engine is running.

WARNING

The choke cover gets very hot during normal operation and can cause serious burns if touched. Do not touch the choke cover while the engine is operating.

If the engine starts but runs roughly and blows out black smoke after a minute or two of operation, the choke is set too rich. If the engine starts but sputters or stops before it warms up, the choke is set too lean.

Adjustment: Table 2 lists average choke settings. Loosen the two mounting screws and rotate the choke cover until the correct setting is attained. Check the setting by starting the engine and observing its operation. Be sure to retighten the mounting screws after adjustment (See Figure 12).

TABLE 2. CHOKE SPECIFICATIONS

AVERAGE CHOKE SETTING	
AMBIENT TEMP	CHOKE OPENING
40°F 4.4°C	7/32 to 9/32 inch 5.6 to 7.1 mm
70°F 21°C	11/32 to 13/32 inch 8.9 to 10.4 mm

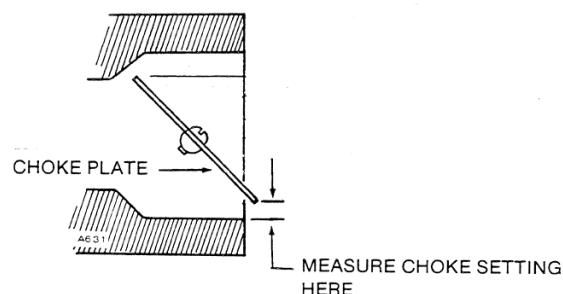


FIGURE 12. ELECTRIC CHOKE ADJUSTMENT

Repair: If the choke fails to operate, check to see if the heating element is working. If it is, the choke cover should become hot after a few minutes of engine operation. If the cover does not get hot, check for current at the cover terminal. The engine must be running. Trace down any opens or shorts.

Remove the choke cover to inspect the heating element and coil. See that the element is not burned out or broken. The bi-metal coil must not be damaged, dragging in the housing, or have an improperly directed spiral.

When installing a new coil, maintain the original direction of spiral inward from the fastening screw. Be sure the coil sets squarely in the housing so it will not bind. Coil should not touch inside of choke body.

FIXED SPEED GOVERNOR

Before making governor adjustment, run the engine about 10 minutes to reach normal operating temperature. Be sure carburetor load and idle needles are properly adjusted before checking or adjusting governor system. For an accurate governor adjustment, a reliable tachometer is required.

WARNING

Contact with rotating machinery might cause serious personal injury or death. Stay clear of rotating components and ensure that protective shields and guards are in place and secured before operating machinery.

Be sure to clean, check, and lubricate governor linkage (steel ball joints) before making any adjustments. Binding in the linkage joints can cause erratic operation. Some early models used plastic ball joints which require no lubrication.

If the following checks do not remedy erratic operation, install a new governor spring. Springs become fatigued with age.

Governor and vacuum booster control engine speed (Figure 13). Rated speed and voltage appear on nameplate. On a 4 pole generator engine speed divided by 30 equals frequency.

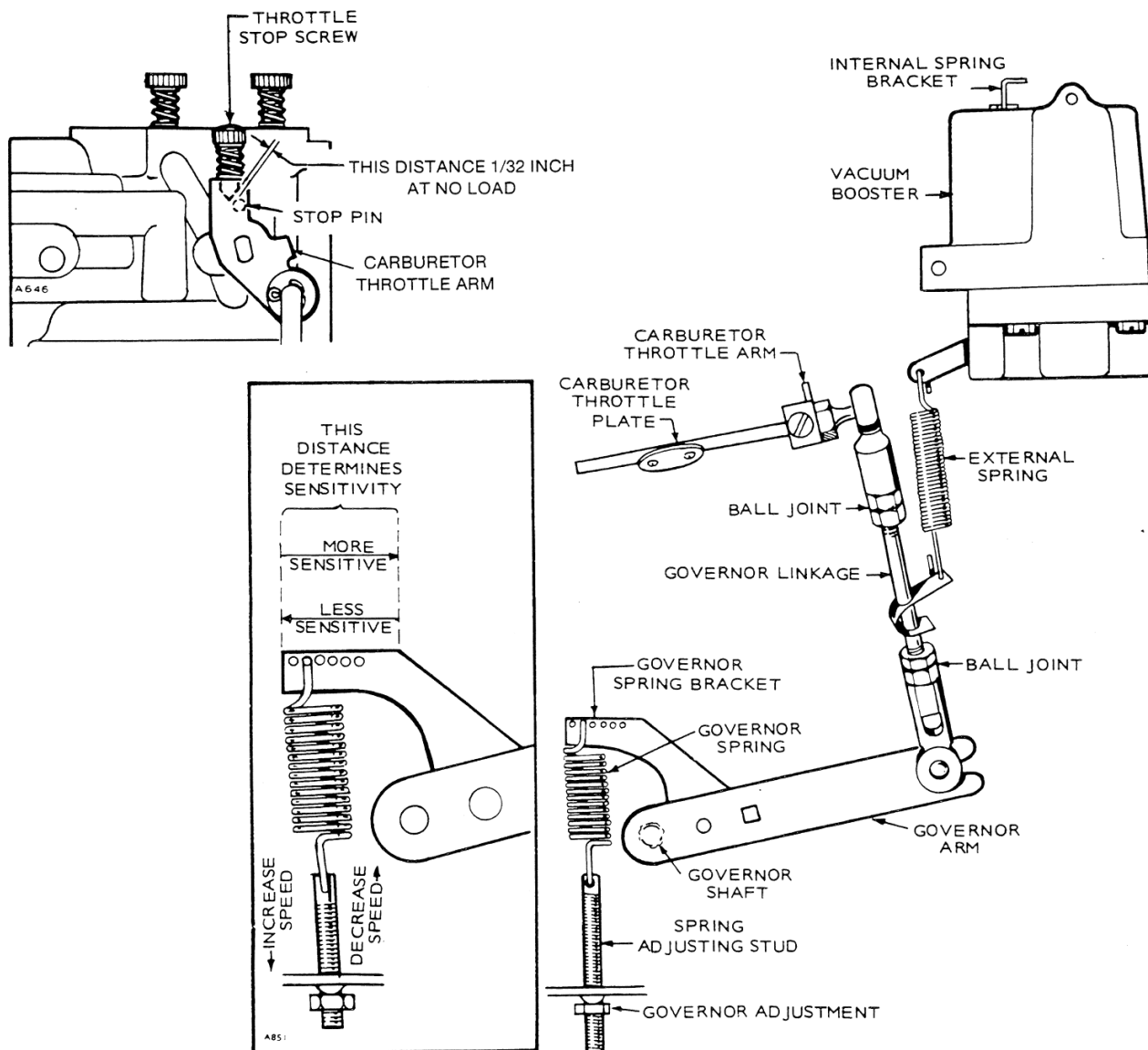


FIGURE 13. GOVERNOR AND GOVERNOR ADJUSTMENTS

Thus, 1800 rpm gives a 60 hertz frequency, and 1500 rpm gives 50 hertz frequency.

Preferred speed varies approximately 3 hertz from no-load to full-load operation. Be sure throttle, linkage, and governor mechanism operate smoothly.

Linkage

The engine starts at wide open throttle. Length of linkage connecting governor arm to throttle arm is adjusted by rotating the ball joint. Adjust length so that with engine stopped and with tension on governor spring, the stop screw on carburetor throttle lever is 1/32 inch from the stop pin. This setting allows immediate control by the governor after starting, and synchronizes travel of governor arm and throttle shaft. See Figure 13.

Speed Adjustment

1. Start engine and allow to warm up without load.

WARNING *Inhalation of exhaust gases might result in serious personal injury or death. Be sure deadly exhaust gas is piped outside and away from windows, doors or other inlets to building.*

2. Remove vacuum booster external spring from bracket slide on the governor link (Figure 13).
3. Refer to voltage and speed charts. If needed, increase speed by increasing tension on the governor spring. Decrease tension on the governor spring to reduce speed.
4. Add a full-rated load to the engine and compare lower speed and voltage with those shown in the charts. If operation does not remain within these limits, check governor linkage and governor spring, and, if necessary, follow preceding procedure again.
5. Check and, if necessary, adjust governor sensitivity (see *Sensitivity Adjustment*).

Sensitivity Adjustment

1. Start engine and allow to warm up.
2. Check voltage and speed, first without load and then with a full load. See voltage and speed charts.
3. Increase sensitivity (closer regulation) by shifting adjusting clip toward governor shaft (Figure 13). Move clip away from governor shaft to decrease sensitivity.

Too much sensitivity causes engine to hunt. Too little sensitivity results in too much speed difference between no-load and full-load conditions.

4. A change in sensitivity adjustment usually requires a compensating speed adjustment (spring tension). Then proceed to vacuum booster adjustment.

Vacuum-Booster Adjustment

1. After sensitivity adjustment, connect booster external spring to slide on governor link (Figure 13a).
2. With engine running at no-load, move adjustable slide to point where there is no tension on spring.
3. Apply full-rated load to engine.
4. If speed increases more than at no-load, lessen internal spring tension of the booster. To change tension, pull out spring bracket and move the pin to a different hole (Figure 13a). If speed decreases when load is applied, increase internal spring tension of the booster.

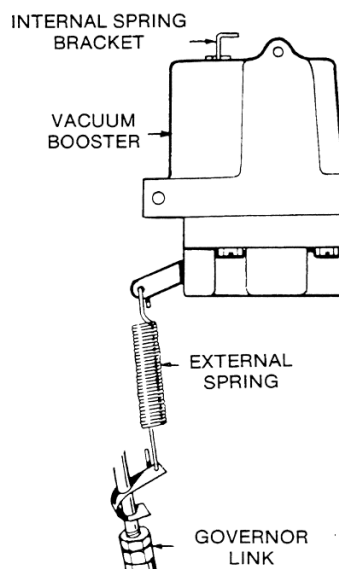


FIGURE 13a. VACUUM BOOSTER

SPEED CHART FOR CHECKING GOVERNOR REGULATION

AC GENERATING SETS	60 HERTZ	50 HERTZ
Maximum No-Load Speed RPM	1890	1560
Frequency (Hz)	63	52
Minimum Full-Load Speed (Without Booster) RPM	1770	1490
Frequency (Hz)	59	49

VOLTAGE CHART FOR CHECKING GOVERNOR REGULATION

AC GENERATING SETS	120 VOLT (1 PH. 2 W) OR 120/240 V (1 PH. 3 W)	240 VOLT (1 PH. 2W) OR 240 VOLT (3 PH. 3W)
Maximum No-Load Volts	126	252
Minimum Full-Load Volts (Without Booster)	110	220

NOTE: Output rating is at UNITY power factor load.

Ignition System

The engine is equipped with an automotive type battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. The major components of the ignition system are: the spark plugs, coil, breaker points and condenser. The MCCK ignition system is shielded to prevent radio interference.

IGNITION COIL

To test primary and secondary windings within the ignition coil proceed as follows:

1. Use a Simpson 260 VOM or equivalent.
2. Place black lead on ground (-) terminal of coil and red lead to positive (+) terminal. Primary resistance should read:
RCCK 3.87—4.73 ohms
MCCK 1.00—1.10 ohms.
3. Change resistance setting on ohmmeter. Place ohmmeter leads inside of spark plug cable holes (Figure 14). Secondary resistance should read:
RCCK 12,600—15,400 ohms
MCCK 10,800—13,200 ohms.

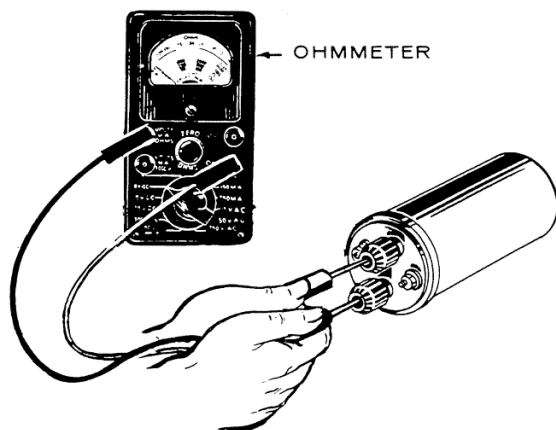


FIGURE 14. TESTING IGNITION COIL

4. If any of the above conditions are not met, replace coil. Refer to *PARTS CATALOG* for correct part number.

BREAKER POINTS

The timing is adjusted during initial engine assembly and is fixed by the point gap adjustment. To maintain maximum engine efficiency, change the breaker points every 200 hours of operation.

1. Remove two screws and cover on breaker box.
2. Remove both spark plugs so engine can be easily rotated by hand. If plugs have not been changed within last 100 hours, replace them with new ones after setting breaker points.

3. Remove two mounting screws (A) and pull points out of box just far enough so screw B can be removed. See Figure 15. Replace points with a new set but do not completely tighten mounting screws (A).
4. Rotate crankshaft clockwise (facing flywheel) by hand until points are fully open. Turn screw (C) until point gap measures 0.020 inch (0.51 mm) with a flat thickness gauge.
5. Tighten mounting screws and recheck gap.
6. Proceed to *Ignition Timing*.

Each time new breaker points are installed, place a drop of oil on the breaker arm pivot.

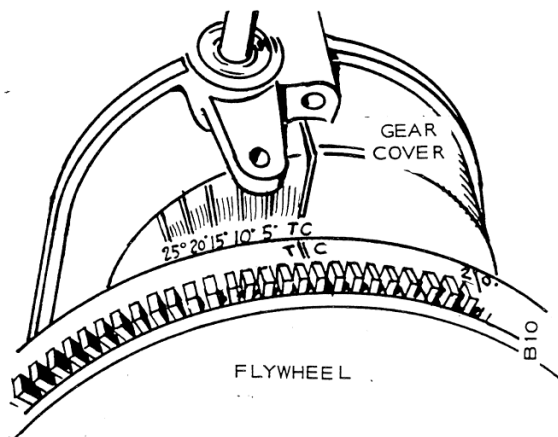
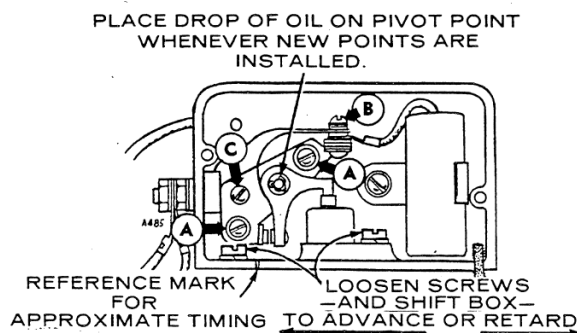


FIGURE 15. IGNITION TIMING

IGNITION TIMING

Ignition Timing — Engine Running

Always check timing after replacing ignition points or if noticing poor engine performance. Proceed as follows:

1. To check ignition timing accurately, use a timing light when engine is running. Connect timing light according to manufacturer's instructions. Either spark plug can be used as they fire simultaneously.

2. Place a white chalk or paint mark on flywheel TC mark.
3. Start engine and check timing. The TC on flywheel should line up with correct timing mark (20° BTC).
4. If timing needs adjustment, loosen breaker box mountings screws and move left to advance or right to retard timing (when facing rear of engine).
5. Be sure mark on flywheel lines up with correct timing mark.
6. Replace breaker box cover and any other hardware removed.

3. Lamp should go out just as points open (20° BTC) and ignition occurs. Timing marks should align.
4. If timing needs adjustment, loosen mounting screws on breaker box and move left to advance or right to retard timing (when facing rear of engine).

SPARK PLUGS

Check, and regap spark plugs every 100 hours of operation (Figure 16). Replace spark plugs that show signs of fouling or electrode erosion.

Ignition Timing — Engine Not Running

1. Connect a continuity test lamp set across ignition breaker points. Touch one test prod to breaker box terminal to which the coil lead is connected and touch other test prod to a good ground on engine.
2. Turn crankshaft against rotation (counterclockwise) until points close. Then slowly turn crankshaft with rotation (clockwise).

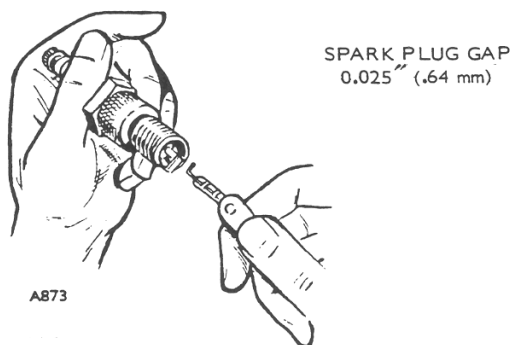


FIGURE 16. SPARK PLUG GAP

Battery Charging System

BATTERY CARE

Check battery cells with a hydrometer. The specific gravity reading should be approximately 1.260 at 77°F (25°C).

If one or more cells are low on water, add distilled water and recharge. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

Keep the battery terminals clean and tight. Push the cable terminal down flush with or slightly below the top of the battery post. After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

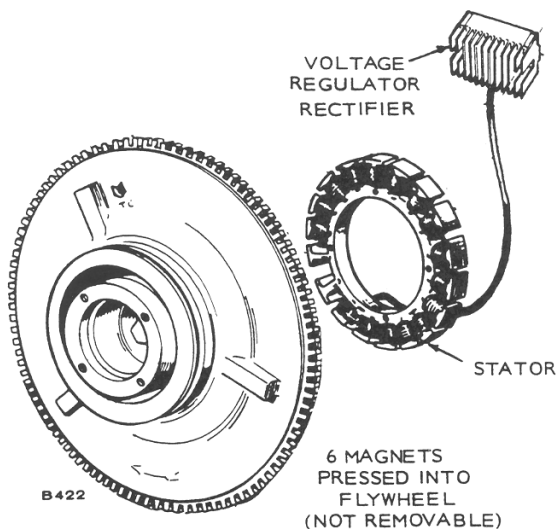
Poor contact at the battery cable connections is often a source of trouble. Make sure battery cables are in good condition and that contacting surfaces are clean and tightly connected. Do not reverse battery leads. Use recommended battery tools when disconnecting leads to avoid mechanical battery damage.

WARNING

Ignition of explosive battery gases might cause severe personal injury. Do not smoke while servicing batteries.

BATTERY CHARGING, ALTERNATORS

The flywheel alternator is a permanent magnet alternator and uses a solid-state voltage regulator-rectifier for controlling output. Figures 17 and 18.



Weak ignition spark or a discharged battery indicate trouble in the charging system. But before testing the charging system, always check the battery for serviceability.

Keep these points in mind when testing or servicing the flywheel alternator:

1. Be sure output control plug (connector) is inserted properly. The plug must bottom in receptacle—eliminates any resistance due to a poor connection. Keep clean and tight.
2. Make sure alternator stator leads are not shorted together.
3. Be sure regulator-rectifier output control has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.
4. Never reverse the battery leads.

Charging system tests require a fully charged battery.

15 AMP FLYWHEEL ALTERNATOR SYSTEM

The 15 amp system has two white wires coming from stator and is used on 3600 rpm engines. See Figure 17.

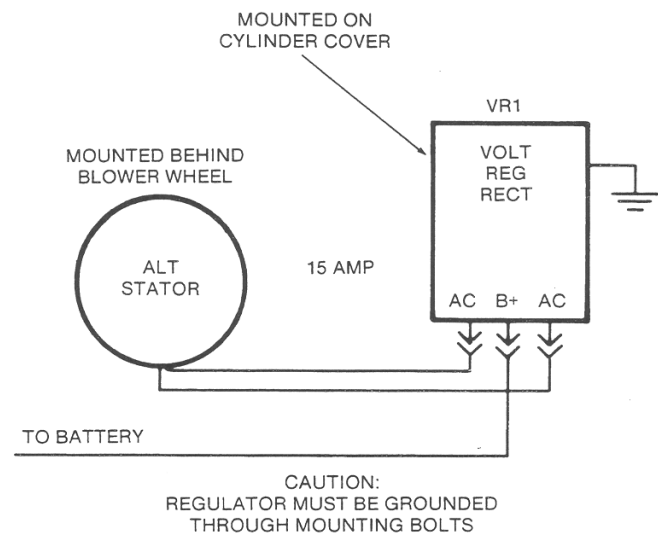


FIGURE 17. 15 AMP SYSTEM

TESTING PHELON 15 AMP SYSTEM

BASIC TEST	PROCEDURE	TEST VALUES
1. Battery	Battery Voltage - unit not running.	12 VDC
2. Regulator	Battery Voltage after unit is running 3 to 5 minutes.	13.6 to 14.7 VDC
3. Alternator Stator and Wiring	Ohmmeter reading from stator output, unit not running. Check at plug.	0.11 to 0.19-Ohms
4. Alternator and Wiring	Measure AC open circuit stator voltage with unit running. Measure between two stator leads with plug disconnected and unit running at approximately 3600 rpm.	28 VAC minimum 65 VAC maximum

20 AMP FLYWHEEL ALTERNATOR SYSTEM

The 20 amp flywheel alternator systems use a separate regulator and a separate rectifier. Figure 18. Two black wires and one red wire come from the stator assembly.

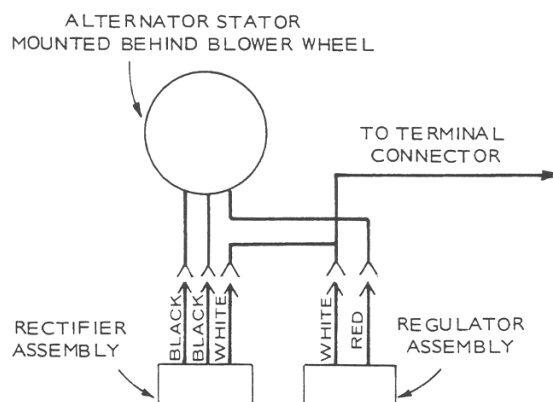
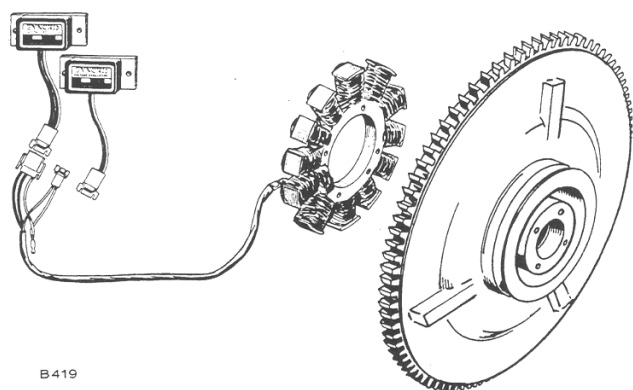


FIGURE 18. 20 AMP SYSTEM

TESTING ALTERNATOR

For testing this system, use a voltmeter-ohmmeter such as a Simpson 270. Listed below are various alternator problems with individual test procedures following.

No Output - Stator Assembly

Examine leadwires for loose or broken connections at the regulator and rectifier. Use the Rx1 scale on the ohmmeter for detecting opens in the stator. Disconnect the three wires that come from alternator stator (two black, one red). Connect ohmmeter test leads to red leadwire and ground to check continuity. The ohmmeter reading should be about 2.0-ohms. See Figure 18.

Next connect meter to black leadwires and ground. Approximately 0.1-ohm should be read from either black lead to ground. If no connection exists between ground and black leads, stator assembly should be replaced.

Checking Rectifier Assembly

Examine each of the two diodes for breakdown by connecting ohmmeter (Rx1 scale) to one black lead and to the white lead. Meter should read 10-ohms in proper polarity. A shorted diode would read zero resistance and would cause a short circuit through the lead winding when in operation. An open diode would read infinite in both directions, indicating that replacement is necessary.

TESTING REGULATOR ASSEMBLY

To check for proper voltage regulation, attach a DC voltmeter to battery and operate engine at approximately 1800 rpm. Battery voltage will climb to the present factory setting (14.2 to 14.8 volts).

Some installations may vary due to voltage drop in the length of ammeter harnesses. Other variations may stem from a loose connector in the harness or loose or corroded battery leads. Low voltage readings at the battery mean poor battery connections.

To test regulator, remove connector. Using the Rx10,000 scale of the ohmmeter, connect one meter lead to red leadwire and other meter lead to regulator base. See Figure 18. No deflection should be noted on the ohmmeter in either polarity. Next connect meter to black leadwire and base of regulator. Meter will deflect fully in one polarity, with no deflection in the other.

Full Charge - Will Not Regulate

Check for broken leads at connection to regulator plates. To be sure regulator winding operates properly, connect red lead to ground and start engine. A maximum of 4 amperes should be noted. This would indicate stator winding is satisfactory. If so, replace regulator.

No Charge

If alternator does not charge when load is applied to battery, shut off engine and disconnect one red leadwire from regulator terminal. Be sure lead is taped or isolated from conducting engine parts. Once again, start engine. Alternator should charge to full output; if it doesn't, replace stator assembly.

TESTING 20 AMP SYSTEM

TEST	VALUE
Battery voltage - unit not running.	12 Volts DC
Battery voltage with unit running at 1800 rpm or more.	14.2 - 14.8 Volts DC
AC voltage from stator with plug disconnected and unit running at approximately 1800 rpm.	23 VAC minimum* Black to Black
Ohmmeter reading at plug when checking two AC stator leads - unit not running.	0.5 to 0.7-Ohms** Black to Black

* - 48 VAC maximum at 3600 rpm. Red to Ground.

** - Resistance values (Ohms) are as follows between wire pairs.

Oil System

The engine has pressure lubrication to all working parts. The oil system includes:

- Oil intake cup
- Gear type oil pump
- Oil pressure gauge
- Oil passages to deliver oil throughout engine
- Oil filter (if used)

WARNING

Crankcase pressure could blow out hot oil and cause serious burns. Do NOT check oil while the engine is operating.

The oil pump is located on the front surface of the crankcase and is driven by the crank gear. The inlet pipe and screen assembly attach directly to the pump body. Figure 19. A discharge passage in the cover of the pump registers with a drilled passage in the crankcase. Parallel passages distribute oil to the front main bearing, rear main bearing, and pressure control bypass valve.

Circumferential grooves in the main bearings supply oil to the connecting rod bearings through drilled passages from each main journal.

A drilled passage connects the front main bearing oil supply to the front camshaft bearing. The flyball governor is lubricated by a drilled passage in the front camshaft journal.

The oil overflow from the bypass valve furnishes lubrication to the camshaft drive gears.

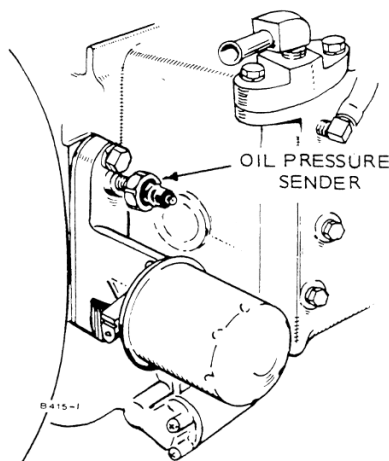


FIGURE 20. OIL PRESSURE

Normal oil pressure should be 30 psi (207 kPa) or higher when the engine is at operating temperature. If pressure drops below 30 psi (207 kPa) at governed speed, inspect the oil system for faulty components.

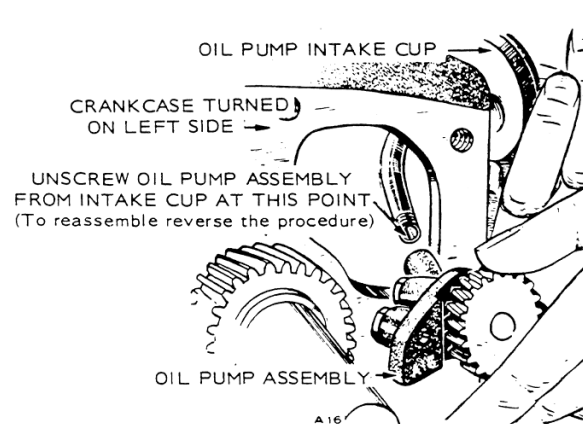


FIGURE 19. OIL PRESSURE PUMP ASSEMBLY

OIL BYPASS VALVE

The by-pass valve (located to the right and behind gear cover), controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open about 30 psi (207 kPa).

The valve is non-adjustable and normally needs no maintenance. To determine if abnormal (high or low) oil pressure is caused by a sticky plunger inspect as follows:

1. Remove 3/8 x 24 x 3/4 cap screw located behind gear cover and under governor arm.
2. Remove spring end plunger with a magnet tool. Clean plunger and spring with a suitable solvent and install.

CRANKCASE BREATHER RCCK AND MCCK (Begin Spec B)

These engines are equipped with a crankcase breather for maintaining crankcase vacuum. Clean the crankcase breather cap and valve assembly and the breather tube baffle in a suitable solvent every 300 operational hours. To remove breather cap and valve assembly, remove breather hose clamp and breather tube clamp. See Figure 21.

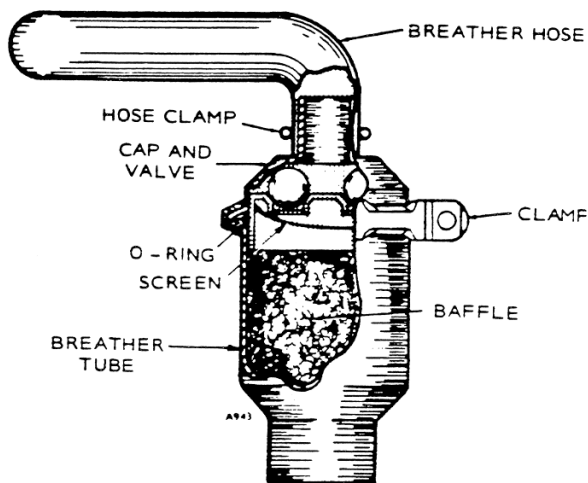


FIGURE 21. CRANKCASE BREATHER

CRANKCASE BREATHER MCCK (Spec A Only)

Lift off rubber breather cap. Carefully pry valve from cap. Otherwise, press hard with both of your thumbs on top of cap and keep fingers below to release valve from rubber cap. Wash this fabric, flapper-type check valve in a suitable solvent. Dry and install. Position perforated disc toward engine. See Figure 22.

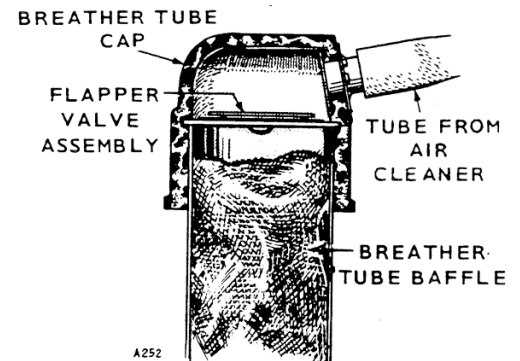


FIGURE 22. CRANKCASE BREATHER MCCK SPEC A ONLY

RCCK Cooling System

DESCRIPTION

The RCCK cooling system is a closed system which uses an engine mounted pump to draw and circulate coolant through the engine and radiator.

Water from the radiator enters the pump located on the front of the engine. The pump delivers water to the cylinder jacket and it flows through the jacket and out of the cylinder heads to the radiator. The water flow is controlled by thermostats. For engine warm-up, with thermostats closed, a by-pass between the cylinder heads allows water flow.

MAINTENANCE

Cooling system maintenance includes periodic inspection for leaks, and flushing and cleaning.

FLUSHING

The cooling system must be kept clean to function properly. Scale reduces heat transfer and restricts water flow. Flush the system at least once a year and more often if operation indicates clogged passages, pump wear, or overheating.

To flush the engine, remove both thermostats, Figure 23. Attach a flushing gun nozzle to the thermostat opening and fill the block with water; then apply air pressure. Repeat the process until water coming from the block is clean.

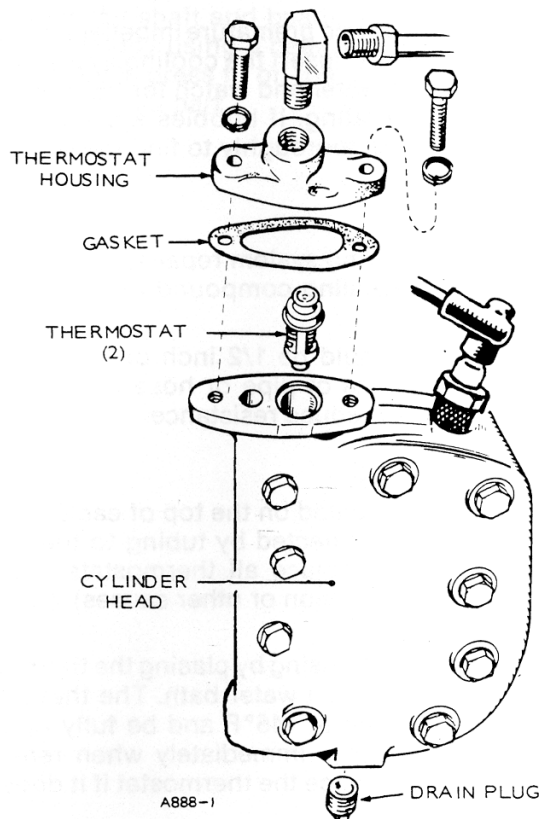


FIGURE 23. THERMOSTAT REMOVAL

CLEANING

To clean the cooling system, drain and fill with radiator cleaner. When chemical cleaning is done, always flush the cooling system to wash out deposits loosened by the chemical cleaning. Flush the engine water jacket as previously discussed. When flushing is completed, check the system thoroughly for leaks.

REPAIR

When making cooling system repairs, use Permatex or other thread-sealing compound on all threaded connections.

All water lines should be 1/2 inch (13 mm) inside diameter or larger. Long runs of pipe or hose need a larger inside diameter to reduce resistance.

Water Pump: Refer to centrifugal pump repair in *MCKK COOLING SYSTEM* for repair procedures.

Thermostats: A thermostat is located on the top of each cylinder head. Replace thermostats that are damaged from corrosion or other causes.

Check opening and closing by placing the thermostat and a thermometer in heated water. The thermostat should start to open at 175° F (70° C) and be fully open at 202° F (94° C). It should close immediately when removed from hot water. Replace the thermostat if it does not operate properly.

High Water Temperature Cut-off Switch: This normally closed switch (Figure 24) senses water temperature in the engine cooling jacket. The switch opens, breaking the circuit to the coil primary when the water temperature reaches about 230° F (110° C) and closes when the temperature drops below 190° F (88° C).

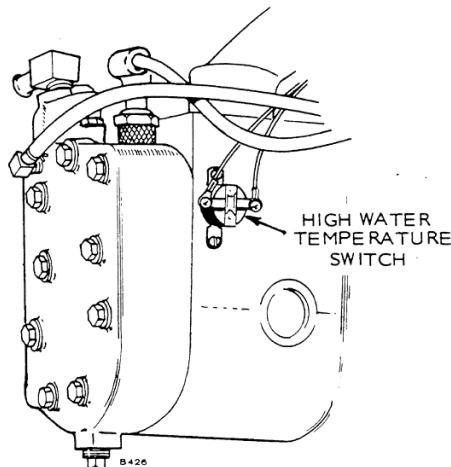


FIGURE 24. HIGH WATER TEMPERATURE SWITCH

MCKK Cooling System

DESCRIPTION

The MCKK cooling system is a pressure type system which uses an engine mounted rubber impeller pump to draw and circulate raw water throughout the system.

In open type cooling systems, water enters the pump located on the front right side of engine. The pump delivers water to the cylinder jacket. Water flows through the jacket and out openings in cylinder heads controlled by thermostats. For engine warm-up, with thermostats closed, a by-pass from the cylinder block to the thermostat allows water flow. From thermostat, water passes through the water-cooled exhaust manifold and out engine cooling system.

MAINTENANCE

Cooling system maintenance includes periodic inspection for leaks, inspection of the rubber pump impeller, and flushing and cleaning.

WARNING

Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.

The rubber impeller, because of continuous flexing, will, in time, need replacement. If impeller fails after short service (usually under 500 hours), check for possible defects, such as severe pitting or abrasion caused by dirt in the cooling system.

Cooling system **MUST** be kept clean to function properly. Scale reduces heat transfer and restricts water flow. Flush system at least once a year and more often if operation indicates clogged passages, pump wear, or overheating.

To flush engine, remove the thermostats, Figure 25 and the water pump cover. Partially restrict pump opening so the cylinder block fills with water. Attach a flushing gun nozzle to thermostat opening and fill block with water; then apply air pressure. Repeat the process until water coming from the block is clean.

TESTING

Cooling system can be tested for two abnormal conditions: (1) insufficient water flow and (2) air leaks.

1. To measure water flow, install a tank of known capacity at the water outlet. Run engine until the thermostat opens and then measure the length of time necessary to fill the tank. From this, obtain the flow in gallons per minute (GPM). If water flow is below 3.5 GPM, check pump operation and inspect passages and water lines for clogging.

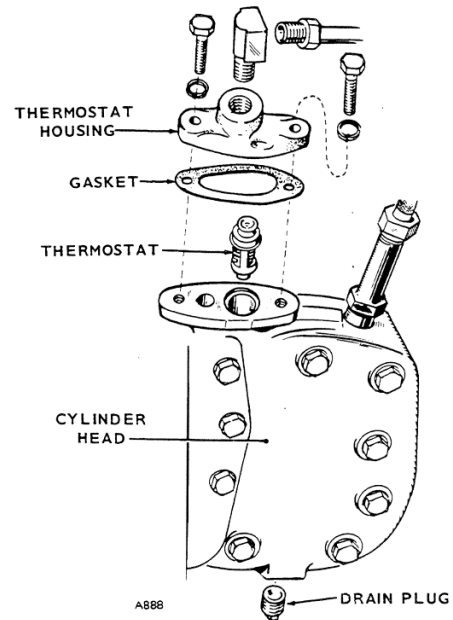


FIGURE 25. THERMOSTAT REMOVAL

2. Air leaks will cause premature impeller failure. To test for air leaks, insert the cooling system outlet into a tank of water and watch for bubbles while engine is operating. If bubbles appear, inspect cooling system thoroughly to find the source.

REPAIR

When making cooling system repairs, use Permatex or other thread-sealing compound on all threaded connections.

All water lines should be 1/2 inch or larger inside diameter. Long runs of pipe or hose need a larger inside diameter to reduce resistance.

THERMOSTATS

Thermostats are located on the top of each cylinder head. These are connected by tubing to the water-cooled manifold. Replace all thermostats that are damaged (from corrosion or other causes). See Figure 25.

Check opening and closing by placing the thermostat and a thermometer in a water bath. The thermostat should start to open at 145°F and be fully open at 165°F. It should close immediately when removed from hot water. Replace the thermostat if it does not operate properly.

HIGH WATER TEMPERATURE CUT-OFF SWITCH

This normally closed switch senses water temperature in the engine cooling jacket. The switch opens, breaking the circuit to the coil primary when the water temperature reaches approximately 200°F and closes when the temperature drops below approximately 160°F.

WATER PUMP

This pump is a positive displacement, neoprene impeller type, used to pump raw water through the cooling system.

Disassembly (Pump 131-0165)

1. Remove the pump end plate screws, end plate, and gasket as shown in Figure 26 (Step a).
2. Pull out neoprene impeller with a pair of pliers (Step b).
3. If further disassembly is required, disconnect the hoses and remove the two capscrews holding the pump to the engine (Step c). Lift pump from engine.
4. Loosen the set screw on the side of the pump and tap it lightly to free the cam from the pump body. Lift out cam and wear plate (Step d).
5. Remove the retaining ring (using a screwdriver) as shown in Step e and slide the seat assembly (O-ring and ceramic seal) off the pump shaft.
6. Pry the bellows assembly out of the pump body by inserting a screwdriver through the drain slots (Step f).
7. Drive the shaft and bearing assembly out of the pump body using a bearing driver or press. The bearing is press fit on the shaft and comes off in one integral part.

Assembly (Pump 131-0165)

Inspect the pump housing for wear, rough surfaces, or pitting and replace if any of these conditions exist. Replace any other worn components such as bearings, seals, or impeller and use a new end plate gasket.

1. Apply sealing compound to the sealing lip around the edge of the bellows seal. Place the bellows seal in the pump body and drive it into place (Step g).
2. Apply a small amount of Loctite or equivalent on the outside surface of the bearing (Step h).
3. Place the bearing and shaft assembly in the pump bore and drive into place (Step i). Strike outer race only to avoid damage to pump shaft and bearing.
4. Lubricate both sides of the seat assembly (ceramic seal and O-ring) with lubricating oil and slide assembly over pump shaft. The ceramic portion of the seat assembly should contact the bellows. Compress the seat assembly against the bellows and at the same time push the retaining ring into its groove on the pump shaft.
5. Place wear plate and cam so notch in wear plate lines up with tank on cam (Step j). Fasten cam to housing with screw.
6. Align the flat spot in the center of the impeller with the flat spot on the pump shaft. Bend back the impeller blades nearest the cam and push the impeller onto the shaft. Do not remove the factory coating of oil from the new impeller before installing.
7. Install the pump end plate using a new gasket and tighten end plate screws to 15-17 in-lb (1.7-1.9 Nm).
8. Install pump on engine (Step k) and attach hoses.

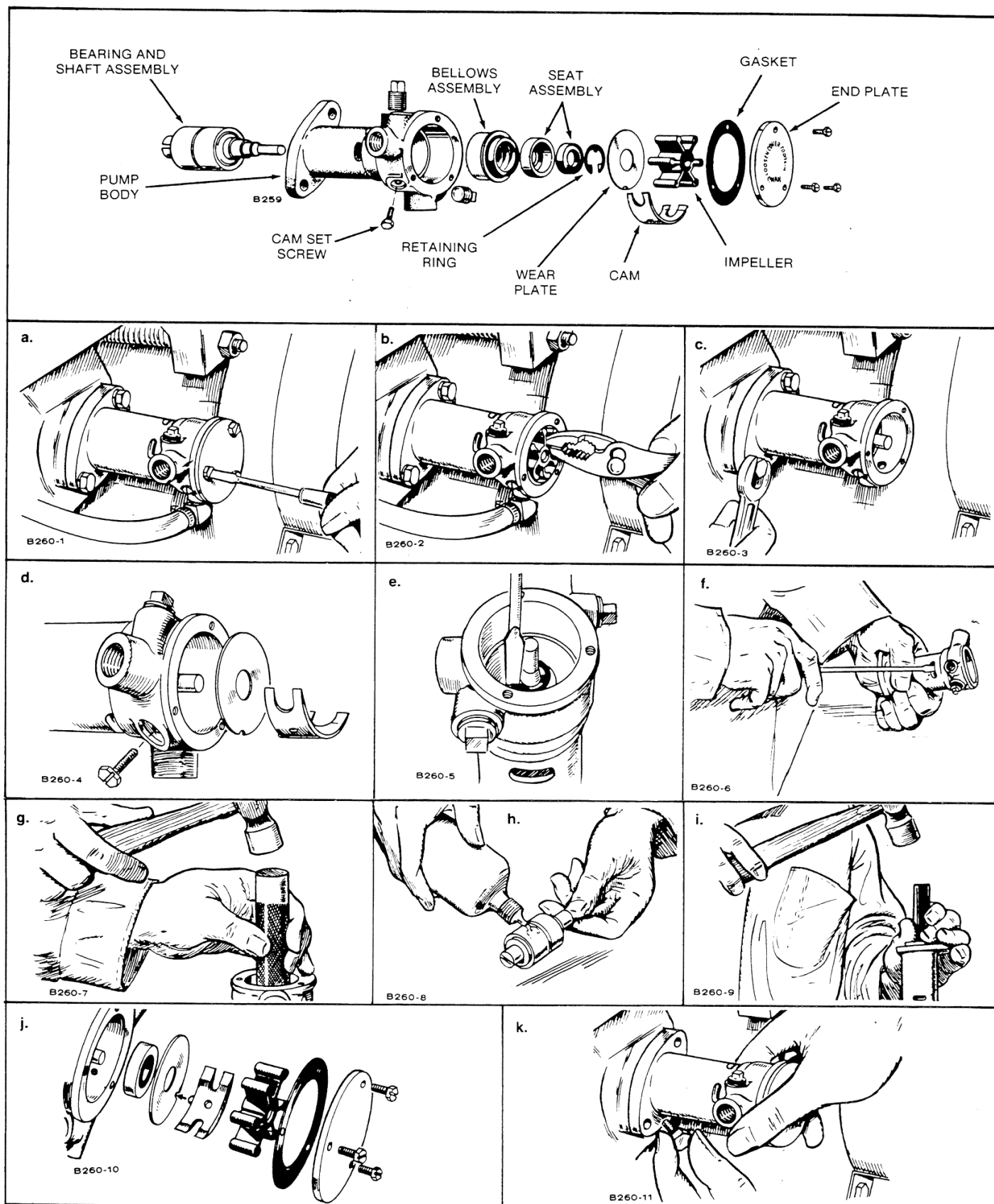


FIGURE 26. PUMP 131-0165

Disassembly (Pump 131-0257)

1. Disconnect all hoses and remove the pump from the engine.
2. Loosen the pulley set screw and remove the pulley from the pump shaft.
3. Remove the impeller housing screws, impeller housing, and gasket.
4. Pull the impeller out of the impeller housing.
5. Remove the wear plate from the pump housing, using a screwdriver to pry loose the plate if necessary.
6. Remove the external retaining ring from the impeller end of the water pump shaft.
7. Remove the two piece seal assembly. The spring portion of the seal is removed first. The second portion of the seal can be loosened and removed with a screwdriver or needle-nose pliers.
8. Remove the internal retaining ring from the drive pulley end of the pump housing.
9. Carefully drive out the shaft and bearing assembly from the impeller end of the housing.
10. Remove the slinger from the water pump shaft.

Assembly (Pump 131-0257)

Inspect the impeller housing for wear, rough surfaces, or pitting and replace if any of these conditions exist. Replace any other worn components such as bearings, seals, or impeller and use a new impeller housing gasket.

1. Install the new slinger on the water pump shaft.
2. Install the ceramic part of the two piece seal assembly in the pump housing. The rubber side of the seal should be toward the bearings.
3. Coat the inside of the water pump housing and the outside of the ball bearing races with grease.
4. Insert the water pump shaft into the pump housing, and install the internal retaining ring in the drive pulley end of the housing.
5. Install the spring portion of the two piece seal on the pump shaft and secure in place with the external retaining ring.
6. Install the wear plate so that the notch in the plate fits into the machining in the pump housing.
7. Coat the inside of the impeller housing with grease.
8. Install the impeller in the impeller housing by twisting it clockwise while pushing it into place.
9. While holding the gasket in place against the pump housing, install the impeller housing securing it with four screws removed during disassembly.
10. Mount the pump on the engine and attach the hoses.
11. Align the pump drive pulley with the crankshaft drive pulley and tighten the set screw.

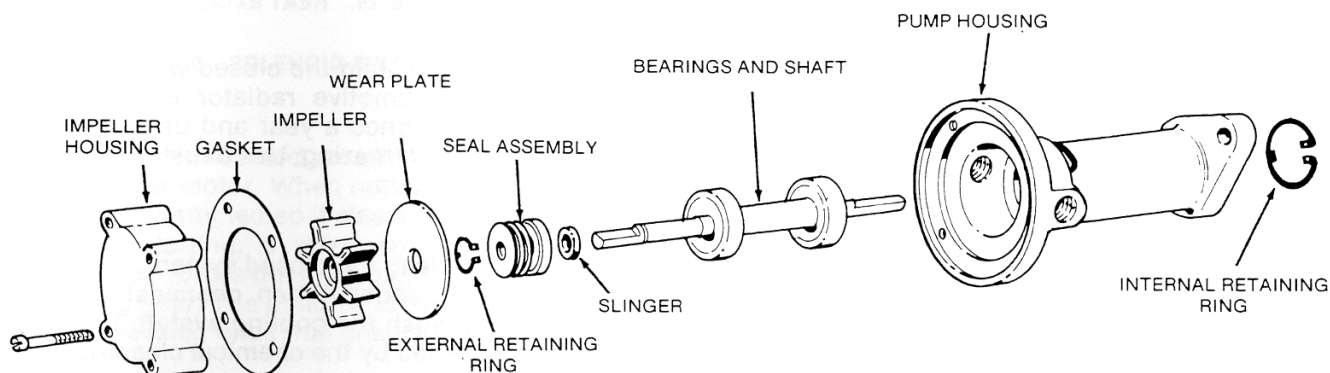


FIGURE 27. PUMP 131-0257

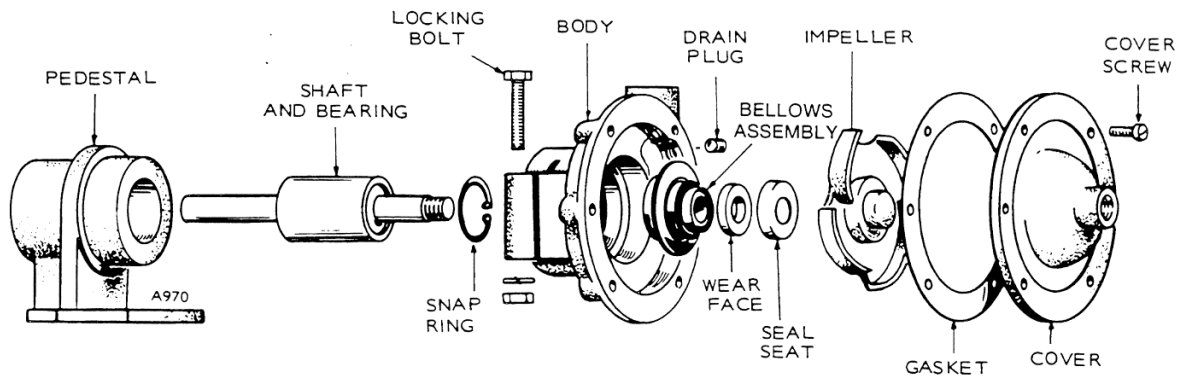


FIGURE 28. CENTRIFUGAL PUMP 132-0110

Disassembly (Centrifugal Pump 132-0110)

1. Remove the water inlet fitting, drive belt pulley, cover screws, and pump cover gasket.
2. Unscrew the threaded impeller from the pump shaft by turning the impeller in a counterclockwise direction when facing impeller.
3. Slide the seal seat, wear face, and bellows assembly off the shaft. Loosen the clamp screw and slide the pump body off the pedestal.
4. Remove the bearing lock ring and drive the shaft and bearing assembly out of the pedestal. The bearing is press fit on the shaft and comes off in one integral part. The bearing is packed with a lifelong lubricant and is sealed at each end.

Assembly (Pump 132-0110)

Replace all worn components such as bearings, seals, wear face, and impeller and use a new cover gasket. Assembly sequence is the reverse of the disassembly procedure.

HEAT EXCHANGER

Closed-type cooling systems are commonly referred to as fresh water cooling or heat exchanger cooling. Water circulated through the engine is called fresh water, hot water, etc. Water circulated through the heat exchanger only is called raw water, sea water, cold water, discharged water, etc. This system with an anti-freeze coolant is recommended where freezing conditions exist, or where the owner wants to prevent the possibility of salt water or rust problems.

The closed water system continually recirculates captive water through the water jacket, exhaust manifold, centrifugal pump, and one side of the heat exchanger. Figure 29 shows a typical heat exchanger.

CAUTION Do not use the existing neoprene impeller water pump in the hot water side of the cooling system. Heat or soluble oil (in many rust inhibitors and anti-freezes) will damage the impeller. Instead, connect the neoprene impeller pump on the cold water side. Use a metal impeller, centrifugal-type water pump (Onan 132-0110 or equal) in the fresh water side. See Figure 28.

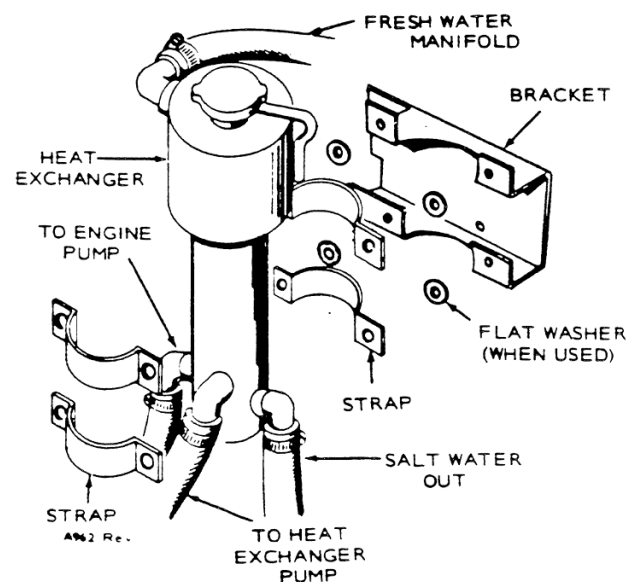


FIGURE 29. HEAT EXCHANGER

Maintenance: Maintain the closed water system the same as an automotive radiator cooling system. Clean and flush once a year and use anti-freeze if there is danger of freezing. Use a rust inhibitor in the closed water system.

Cleaning: To clean the closed system, drain and fill with radiator cleaner. When chemical cleaning is done, always flush the cooling system to wash out deposits loosened by the chemical cleaning.

Flush the engine water jacket as previously discussed. First remove the water outlet hose from the engine water jacket to the heat exchanger. Flush both the open and closed water system sides of the heat exchanger. Remove the rubber impeller pump cover to flush the open system. Also flush the water-cooled exhaust manifold. When flushing is completed, check the system thoroughly for leaks.

Starting System

STARTER

A solenoid-shift starter is shown in Figure 30. After the starter button is pushed, battery current energizes the start solenoid. The solenoid causes an arm to push the starter pinion into the flywheel ring gear. Simultaneously, the start solenoid contacts close and allow the starter motor to start turning. The starter remains engaged until the start button is released. An overrunning clutch protects the starter from damage before it can be disengaged from the flywheel.

Beginning with Spec H, the starter motor on MCCK engines is the gear drive starter shown in Figure 30a.

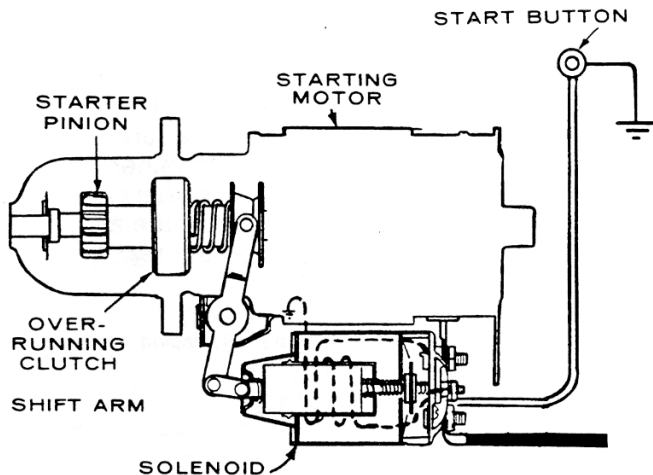


FIGURE 30. SOLENOID-SHIFT STARTER

The gear drive is mounted on a shaft which extends from the starter motor. When not running, the drive pinion gear is retracted so it clears the flywheel ring gear. When starting, a spiral spring through increasing speed forces the drive pinion to engage the flywheel ring gear. The pinion and flywheel ring gear teeth have beveled ends that ensure their engaging properly.

CAUTION Starter motors are not designed for continuous operation. Do not operate more than 30 seconds per ON cycle. Do not operate starter more than 10 seconds in a stall condition if engine will not rotate. Serious damage could result if these time limits are exceeded.

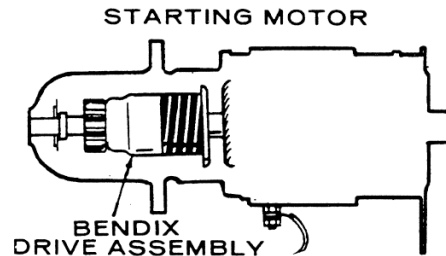


FIGURE 30a. GEAR-DRIVE STARTER

Maintenance

For proper cranking-motor operation with a minimum of trouble, a periodic maintenance procedure should be followed. Periodic lubrication, inspection of the brushes, and commutator as described in this section will insure long cranking motor life. Periodic disassembly (see *Disassembly*) of the cranking motor for a thorough overhaul is recommended as a safeguard against accumulations of dust, grease, and parts wear.

Lubricate all oil-type bearings with 8 to 10 drops of light engine oil (SAE 20). All oil-less type bearings and bushings should be given a few drops of light oil. Lubricate the cranking motor drives with a few drops of light engine oil.

Never oil the commutator. Oil on the commutator reduces the cranking ability of the motor.

The commutator can be cleaned by using number 00 sandpaper. Never use emery cloth. If the commutator is out of round or has high mica, remove it from the cranking motor. Turn the commutator down on a lathe being careful to remove only enough material to true up the commutator and remove high mica.

It is not necessary to undercut mica on starter motor commutators.

Replace worn brushes. If brushes wear rapidly, check for excessive brush spring tension and roughness or high mica on the commutator.

Solenoid Shift

Periodically inspect solenoid and shift lever to make sure they are operating properly. Keep the solenoid shift lever free of dirt and excess grease.

The overrunning clutch is packed in a special high melting point grease and after its initial assembly, needs no further lubrication. This clutch prevents the engine from turning the starter motor at too high a speed once it is started. Do not subject the overrunning clutch to grease dissolving or high temperature cleaning methods. This may cause the clutch to lose some or all of its grease.

If the pinion does not turn freely in the clutch in the overrunning direction, or the clutch tends to slip in the opposite direction, replace the assembly. A worn clutch indicated by excessive looseness of the pinion requires replacement.

Never attempt to repair or relubricate a defective clutch.

Pinion Clearance

The pinion clearance is adjusted by increasing or decreasing the fiber washer thickness at the mounting surface of the shift solenoid.

More washers decrease the clearance while less washers increase the pinion clearance.

The clearance between the pinion and the housing should be 0.02 to 0.08 inch (0.5 to 2 mm) when the pinion is in the cranking position, Figure 30b.

Drive Pinion

The teeth of the drive pinion are chamfered on only one side and specially rounded and polished to make the automatic meshing with the flywheel ring gear more efficient. The drive is designed so that if the ends of the pinion teeth meet end to end with the ring gear teeth (keep in mind that the drive is freely mounted on the drive shaft), the drive assembly can

move back a slight amount against the pressure of the driving spring. The longitudinal movement permits the pinion to turn farther and enter the flywheel ring gear.

It is important the correct length of drive spring be used when making replacements. The length of the drive spring controls the longitudinal movement of the bendix pinion (meshing and unmeshing of the pinion and flywheel ring gear).

Keep the drive shaft free of rust, burrs or bends so the drive can move freely along it. A damaged pinion necessitates the replacement of the assembly.

Onan recommends replacement of faulty gear drive assemblies and provides no further service information concerning their repair. For further repair information, contact the manufacturer of your starter motor.

Disassembly

1. Remove all wires to the starting unit. Tag each wire so it can be reconnected as originally.
2. Remove the solenoid (where applicable).
3. Remove the starter motor thru-bolts and divide the starter into three main assemblies — the front bracket, the housing, and the rear bracket. On some model starters, short screws are used to hold the three starter sections together (Figure 31). The spacers on the solenoid starters are used for adjustment of the thrust gap of the armature shaft and are located between the rear bracket and the commutator shaft.

On the solenoid shift models, the steel spacing washer is on the commutator side.

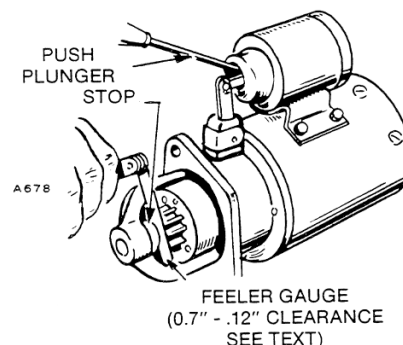
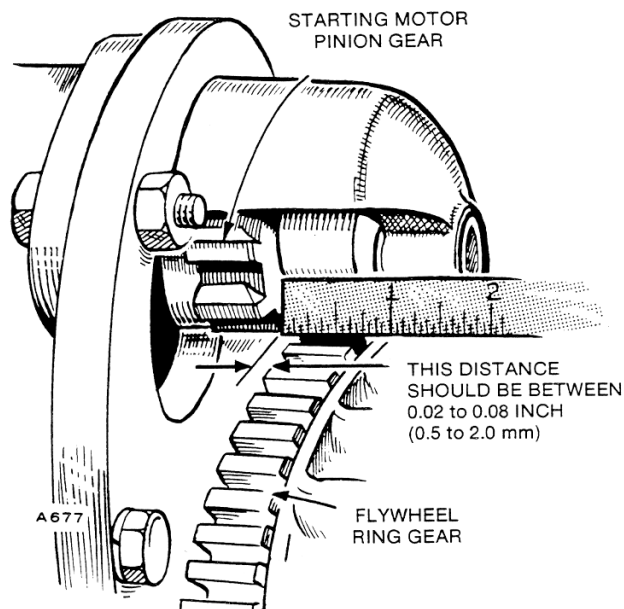


FIGURE 30b. PINION CLEARANCES (GEAR DRIVE)

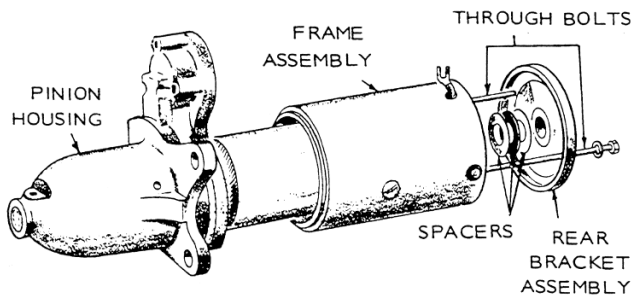


FIGURE 31. SOLENOID SHIFT STARTER

4. **Solenoid Starter Only:** The armature can now be removed from the front bracket. Be careful not to miss the small steel washer used in the end of the armature shaft. Remove the shift lever at the same time the armature is removed. The spring holder, lever springs, and retainer can be removed prior to removing the lever (Figure 31a).

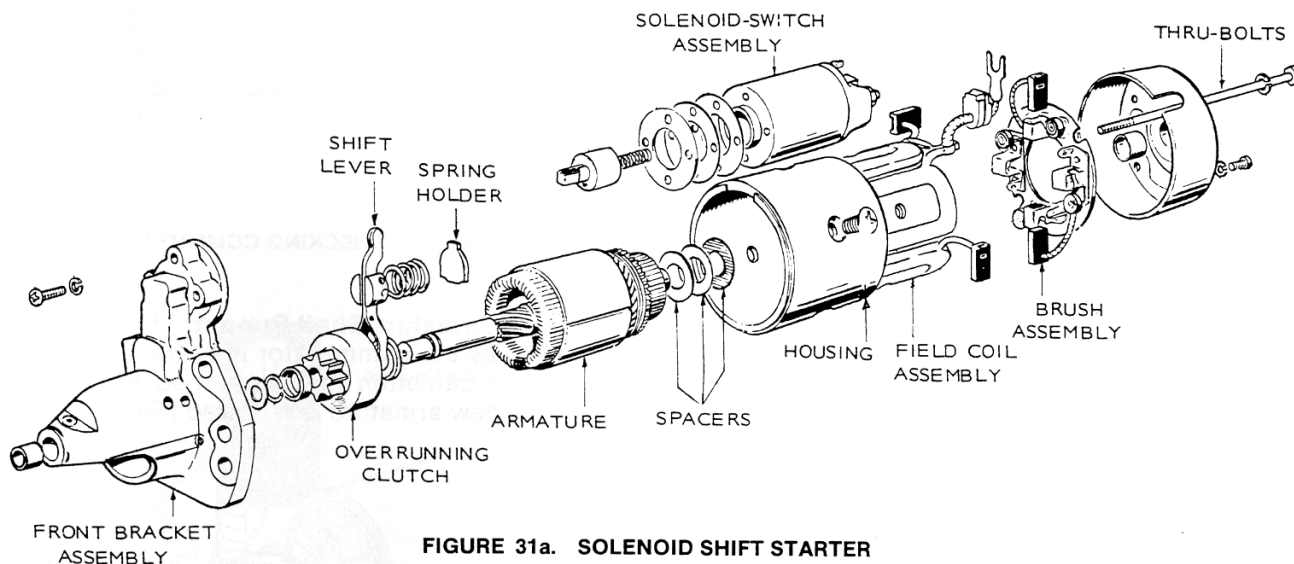


FIGURE 31a. SOLENOID SHIFT STARTER

5. **Solenoid Starter Only:** Remove the ring after driving the pinion stopper toward the pinion gear, using a cylindrical tool (Figure 32). Remove the overrunning clutch and the pinion stopper at the same time.

6. **Gear Drive Starter Only:** The entire assembly is mounted on the armature shaft. When disassembling the starter, pay particular attention to the various parts and their positioning in the starter assembly (Figure 33). If the gears of the pinion are damaged, replace the entire pinion. Inspect the screw shaft for rust and burrs.

7. Remove the brushes from the brushholder and inspect them (inspection of brushes and brush springs discussed later).

8. Remove the pole shoes, if necessary, by removing the flathead machine screws which anchor them to the frame.

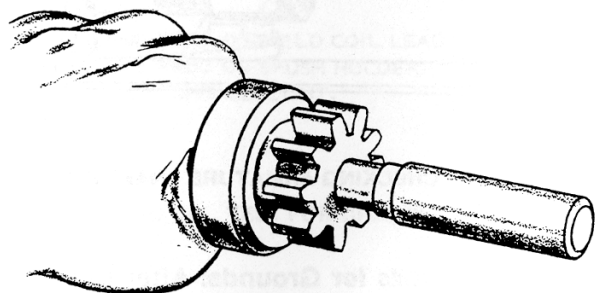


FIGURE 32. TOOL FOR DRIVING PINION STOPPER

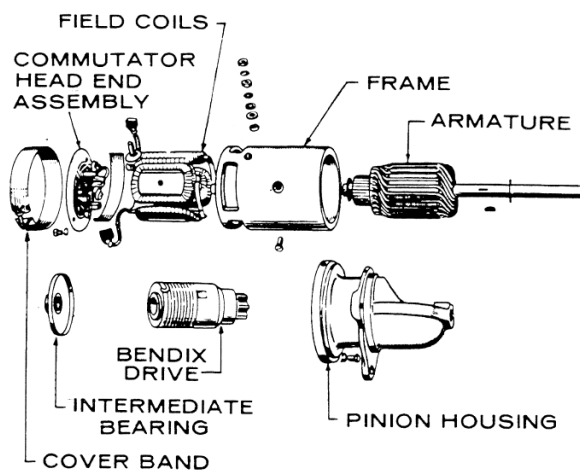


FIGURE 33. GEAR DRIVE STARTER

ELECTRIC STARTER INSPECTION AND TROUBLESHOOTING

Testing the Armature for Shorts: Place the armature in the growler and hold a thin steel blade parallel to the core and just above it, while slowly rotating the armature in the growler (Figure 34). A shorted armature causes the blade to vibrate and move toward the core. A shorted armature must be replaced.

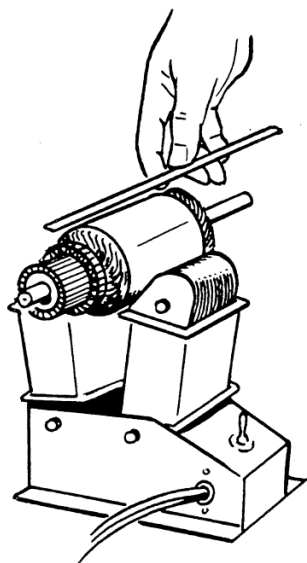


FIGURE 34. TEST FOR SHORTED ARMATURE

Testing Armature for Grounds: Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads (Figure 35). If the ohmmeter reading is low, it indicates a grounded armature. Replace a grounded armature.

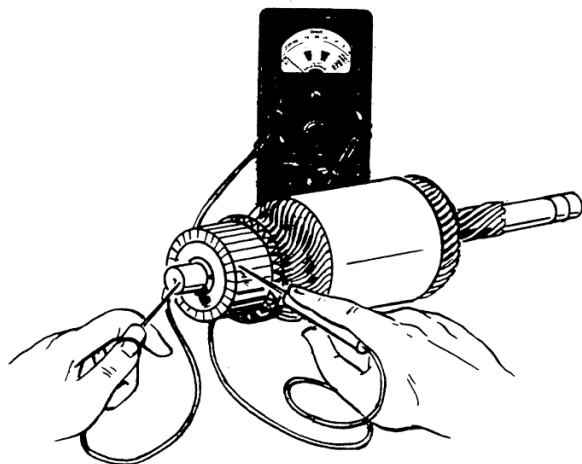


FIGURE 35. TEST FOR GROUNDED ARMATURE

Testing the Armature for Open Circuit: The most common place for an open circuit is at the commutator riser bars. Inspect conductors for loose connections at points where they are joined to the commutator bars.

Testing Commutator Runout: Place the commutator on a test bench and check runout with a dial indicator (Figure 36). When commutator runout exceeds 0.004 inch, reface the commutator.

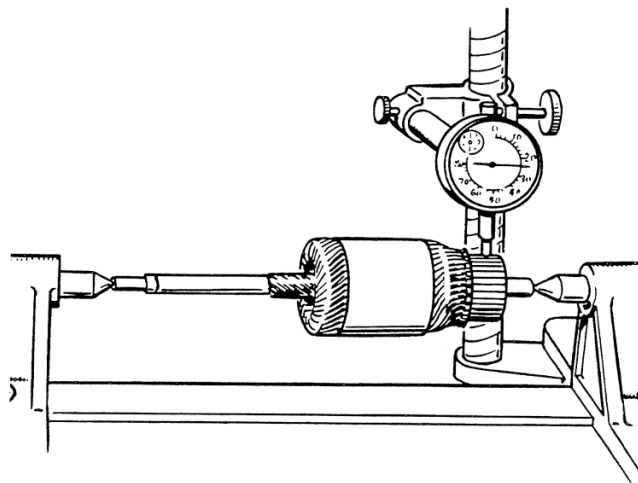


FIGURE 36. CHECKING COMMUTATOR RUNOUT

Testing Armature Shaft Runout: The armature shaft as well as the commutator may be checked. A bent armature can often be straightened, but if the shaft is worn a new armature is required (Figure 37).

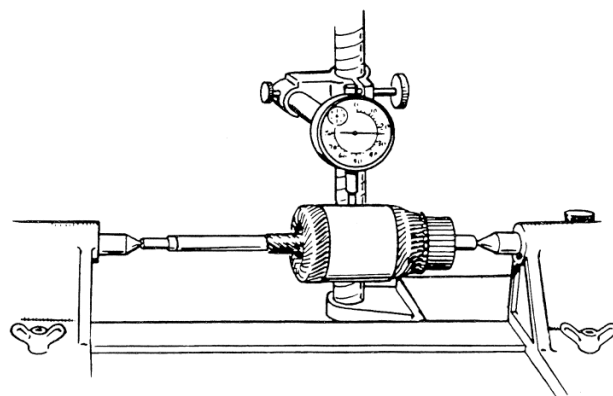


FIGURE 37. CHECKING ARMATURE SHAFT RUNOUT

Testing Field Coils for Grounds: After unsoldering the shunt field coil wire, place one test prod on the connector and the other on a clean spot on the frame. If the ohmmeter indicates continuity, the fields are grounded either at the connector or in the windings (Figure 37a).

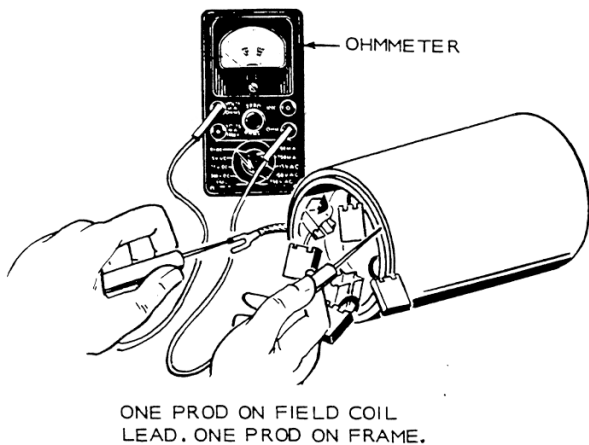


FIGURE 37a. FIELD COIL GROUND TEST

Testing Field Coils for Open Circuits: Place one prod on the connector and the other on a clean spot on the brushholder (Figure 38). If continuity is good, the field coil is good. Check all brushholders in the same manner.

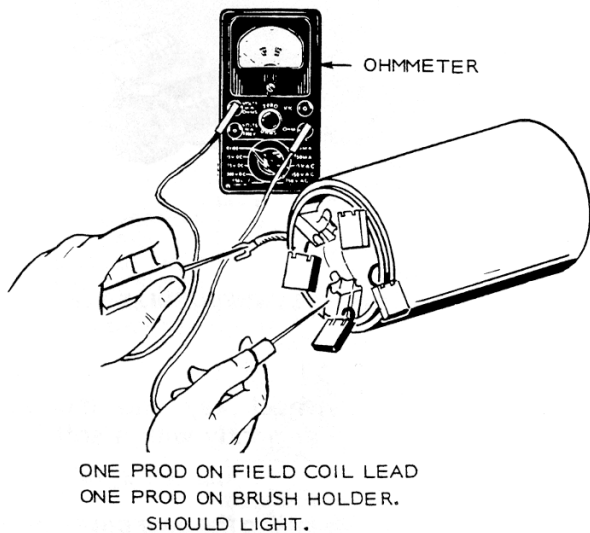


FIGURE 38. TEST FOR OPEN FIELD COIL

Inspection of Brushes: When brushes are worn more than 0.3 inch, replace them. Figure 39 shows the wear limit. See that the brushes move smoothly in the brushholders.

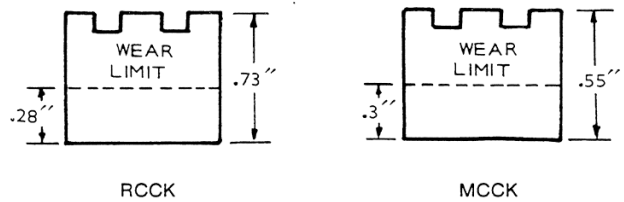


FIGURE 39. BRUSH WEAR LIMITS

Inspection for Brush Spring Tension: Measure brush spring tension with a tension meter (Figure 39a). Push the brush into its holder and take the reading just as the brush slightly projects from the brushholder. On a new brush the spring tension should be 49 to 59 ounces (1.37—1.65 kPa) for RCCK engines and 29 to 38 ounces (0.81 to 1.06 kPa) for MCCK engines.

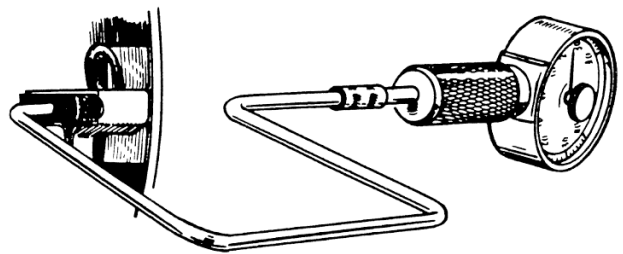


FIGURE 39a. MEASURING BRUSH SPRING TENSION

Assembly: Reassembly is much the reverse of disassembly procedure. Follow these precautions and procedures:

1. Clean all parts carefully with a dry cloth and compressed air if available.

CAUTION Do not immerse bearing equipped parts in cleaning fluid. Clean with a brush dipped in mineral spirits.

CAUTION Do not clean overrunning clutch in solvent or liquid cleaning solution. Washing the clutch will cause the grease to leak out.

2. Apply 20 weight oil to armature shaft and splines. Use grease sparingly on solenoid starter shift lever pin, joint of shift lever and plunger, plunger and spacing washers at end of the shaft.
3. Use spacing washers to adjust armature end play of 0.004 to 0.020 inch (0.102 to 0.508 mm).
4. When assembling starter to engine oil base, do not draw the mounting bolts up tight. The gears should have 0.004 to 0.007 inch backlash. Tap the starter in or out from the oil base to adjust. Then tighten starter mounting bolts to 30 ft.-lb. (41 Nm).

Engine Disassembly

If engine disassembly is necessary, first remove all the complete assemblies (e.g. manifold with carburetor and vacuum speed booster). Individual assemblies, as the carburetor, can be removed and serviced later, if necessary. Follow the general disassembly steps given below and refer to the appropriate detailed instructions in this section. When reassembling, check the text for special assembly instructions.

Keep all parts in their respective order . . . valve assemblies, rod caps for respective rod and piston assemblies, etc. Analyze reasons for parts failures. Use new gaskets for assembly.

GENERAL DISASSEMBLY

1. Drain crankcase oil.
2. Disconnect exhaust pipe, fuel line, battery cables, and electrical connections.
3. Remove flywheel using Onan flywheel puller.
4. Remove gear cover using care to protect oil seals from keyway damage.
5. Remove snap ring and remove crankshaft gear using a gear pulling ring and gear puller.
6. Remove air cleaner, manifold assembly (with carburetor and vacuum speed booster), fuel pump, fuel lines, spark plugs, ignition breaker box, etc.
7. Remove cylinder heads, oil base and oil pump.
8. Remove valves, springs, tappets, etc.
9. Remove camshaft and gear assembly.
10. Remove connecting rods, pistons and bearings.
11. Remove rear bearing plate.
12. Remove crankshaft.
13. Remove bearings as needed using correct bearing remover.

GENERAL ASSEMBLY

Engine assembly usually is the reverse of the disassembly procedure. Use a torque wrench whenever possible and observe proper clearances throughout assembly. Coat all internal parts with oil. During assembly, turn engine over by hand — should turn over freely.

1. Install new main bearings, if required, using proper bearing driver.
2. Install crankcase and rear bearing plate (check end play).
3. Install pistons, rods, bearings and rod caps.
4. Install crankshaft and timing gear assembly.
5. Install oil pump and oil base.

6. Install crank gear aligning timing mark with mark on camshaft gear.
7. Install valve assemblies and cylinder heads.
8. Install gear cover and oil seal.
9. Install flywheel.
10. Install fuel pump, manifold assembly, air cleaner, fuel lines, spark plug, breaker box, etc.
11. Connect electrical wires, exhaust line and battery.
12. Fill crankcase with proper oil.

FLYWHEEL

To remove the flywheel, turn the flywheel mounting screw outward about two turns and use Onan puller 420-0100 to pull the flywheel, Figure 40.

Do not drop the flywheel. Always use a steel key for mounting the flywheel.

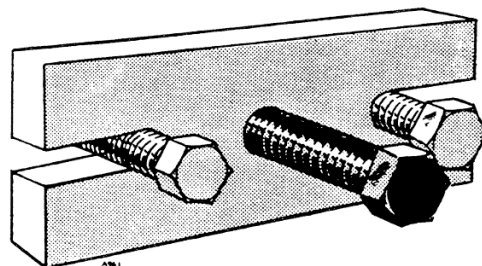


FIGURE 40. ONAN FLYWHEEL PULLER

GEAR COVER

After removing the flywheel key and mounting screws, tap the gear cover gently with a soft-faced hammer to loosen it.



When installing the gear cover, make sure that roll pin in the gear cover engages the governor cup correctly. Figure 41.

Turn the governor cup so that the plastic bushed hole is at the three o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. be careful not to damage the gear cover oil seal. Adjust the roll (stop) pin to protrude to a joint 3/4 inch from the cover mounting surface. See Figure 41.

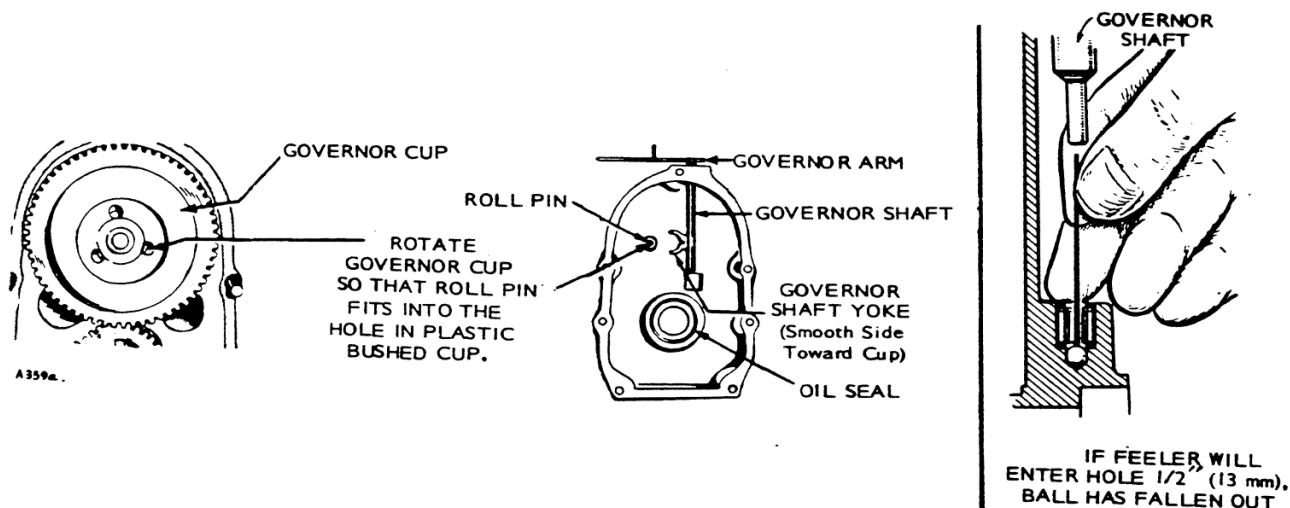


FIGURE 41. GEAR COVER ASSEMBLY

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off. See Figure 41.

Replace any flyball that is grooved or has a flat spot. If the arms of the ball spacer are worn or otherwise damaged, replace the entire timing gear set. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place and install the

cup and snap ring on the center pin, Figure 42.

The camshaft center pin extends out $\frac{3}{4}$ inch from the end of the camshaft. This distance provides and in and out travel distance of $\frac{7}{32}$ inch for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine may race, especially at no load), remove the center pin and press a new pin in only the required amount. otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, install both gears new, never one only. Use a gear pulling ring to remove the crankshaft gear. Be sure to remove the snap ring first.

The camshaft gear is pressed on and keyed to the camshaft. The camshaft and gear must be removed as an assembly after first removing the crankshaft gear lock ring and washer. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies. Remove the operating plunger for the breaker points. Remove the fuel pump and tappets.

The camshaft may be pressed out of the gear by use of a hollow tool or pipe which will fit over the camshaft center pin. Do not press on the center pin or damage it in any way. The governor ball spacer is a press fit to the camshaft gear.

When pressing a camshaft gear onto the camshaft, be sure the gear is started straight and that the key is properly in place. Install the governor cup assembly before installing the camshaft and gear in the engine.

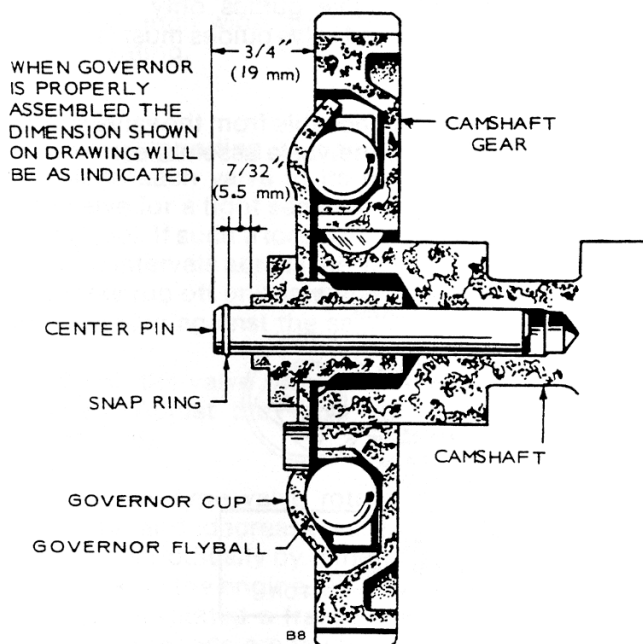


FIGURE 42. GOVERNOR CUP

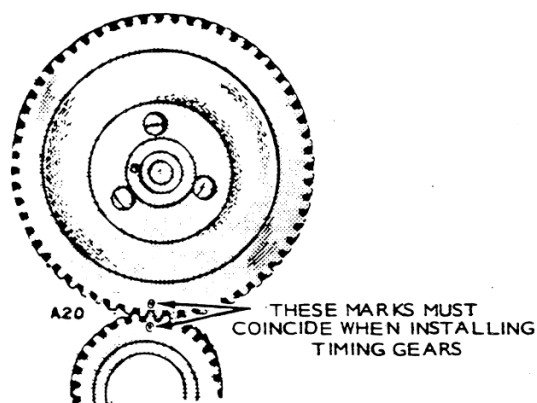
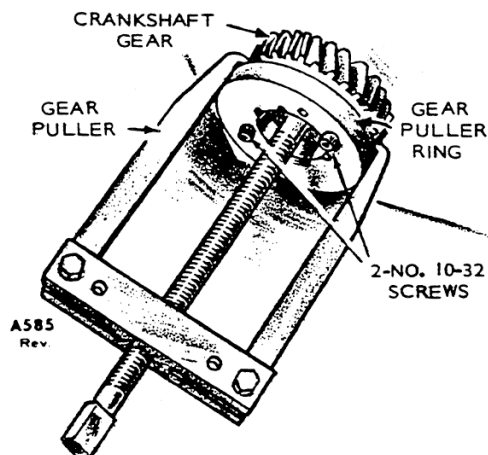


FIGURE 43. TIMING GEAR REMOVAL AND INSTALLATION

Each timing gear is stamped with an "O" mark near the edge. The gear teeth must mesh so that these marks coincide exactly when the gears are installed in the engine, Figure 43. Be sure, when installing the camshaft gear and shaft assembly, that the thrust washer is properly in place behind the camshaft gear. Replace the camshaft retaining washer and lock ring to the crankshaft.

CYLINDER HEADS

The cylinder head should be tightened in the order designated per Figure 44 to a torque of 5 foot-pounds (6.8 N•m), then 10 foot-pounds (13.5 N•m), etc. until all are torqued to 29 to 31 foot-pounds (39-42 N•m).

VALVES

Properly seated valves are essential to good engine performance. The cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head. Rap sharply on the edge with a soft-faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

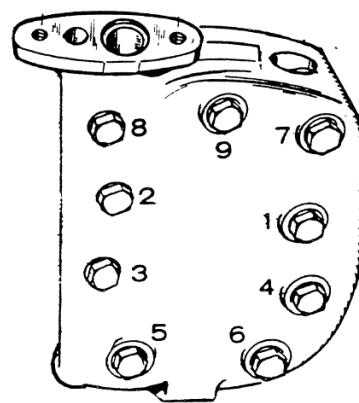


FIGURE 44. CYLINDER HEAD BOLT TORQUE SEQUENCE

Worn valve stem guides may be replaced from inside the valve chamber. See Figure 45. A seal is provided behind the intake valve guides only. The smaller diameter of the tapered valve guides must face toward the valve head.

Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

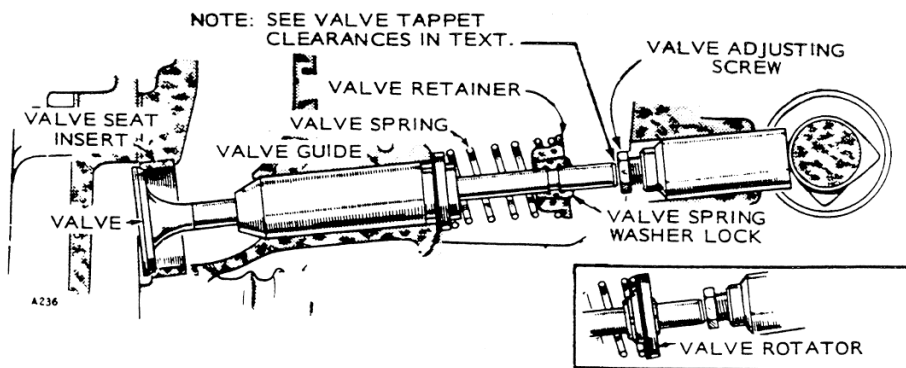


FIGURE 45. VALVE SYSTEM

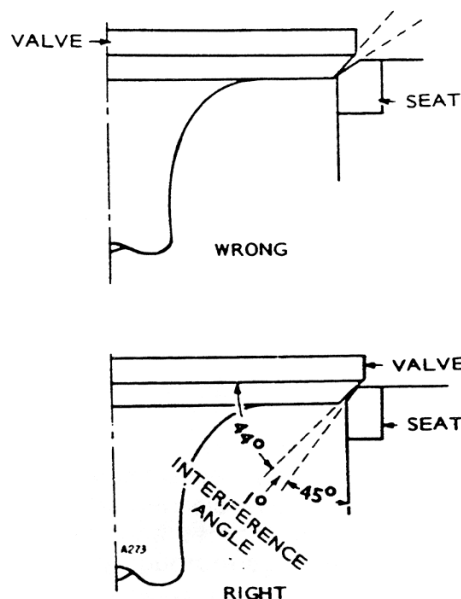


FIGURE 46. VALVE FACE AND SEAT ANGLES

The valve face angle is 44 degrees. The valve seat angle is 45 degrees. This 1 degree interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life, Figure 46.

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where chrome-cobalt faced valves and seats are used. Valve faces should be finished in a machine to 44 degrees. Valve seats should be ground with a 45 degree stone and the width of the seat band should be 1/32 to 3/64 (0.79-1.2 mm) of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance (see *Tappet Adjustment*).

The positive type valve rotocoils serve to prolong valve life and decrease valve repairs. Check the rotocoils periodically by removing the cylinder heads and cranking the engine. When functioning properly, the valve is rotated a fraction of a turn each time it opens. If rotocoils are faulty, install new ones.

TAPPET ADJUSTMENT

The engine is equipped with adjustable tappets. To make a valve adjustment, remove the valve covers. Crank the engine over slowly by hand until the left hand intake valve, when facing the flywheel, opens and closes. Continue about 1/4 turn until the correct timing marks align. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left hand cylinder. Clearances are shown in *DIMENSIONS AND CLEARANCES* section. For each valve, the gauge should just pass between the valve stem and valve tappets (Figure 47).

**INTAKE AND EXHAUST VALVES
(SEE TABLE OF CLEARANCES)**

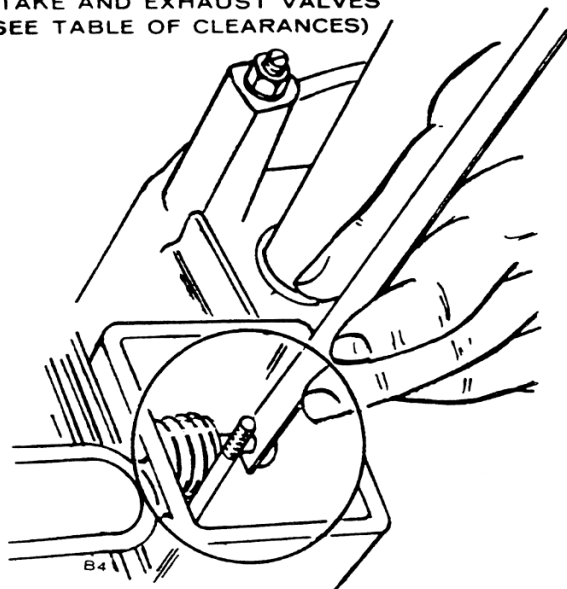


FIGURE 47. TAPPET ADJUSTMENT

To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking.

To adjust the valves on the right hand cylinder, crank the engine over one complete revolution and again line up the correct timing marks. Then follow the adjustment given for the valves of the left hand cylinder.

PISTON AND RINGS

Whenever there is a noticeable wear ridge at the top of each cylinder, remove the ridge with a ridge reamer before removing the pistons. If not, the rings can catch the ridge when pushing out the pistons and cause a ring land fracture, Figure 48.

To remove the piston and connecting rod assemblies, turn the crankshaft until a piston is at the bottom of the stroke. Remove the nuts from the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out the top of the

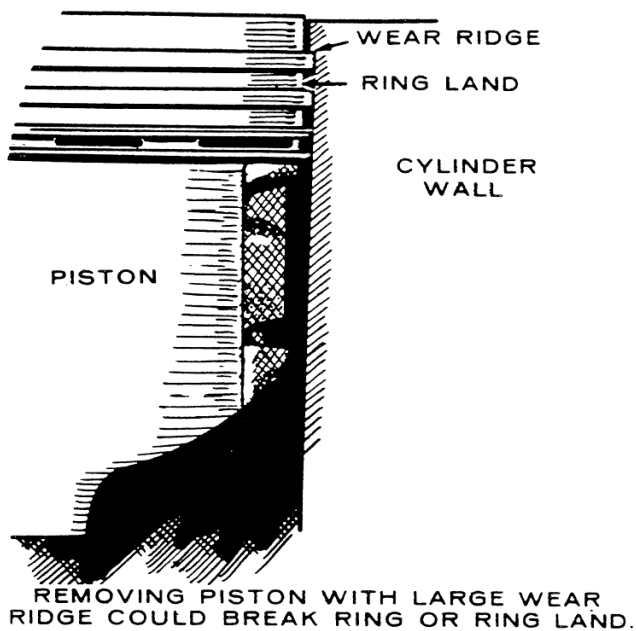


FIGURE 48. WEAR RIDGE ON CYLINDER WALL

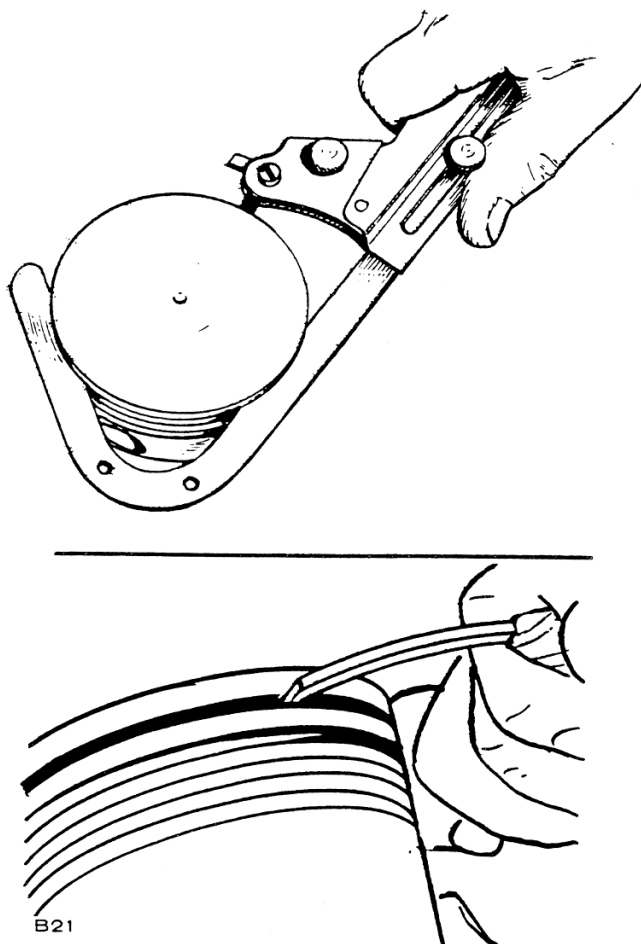


FIGURE 49. CLEANING PISTON RING GROOVES

cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

Keep the connecting rod bearing caps and bearings with their respective rods.

The pistons are fitted with two compression rings and one oil control ring with an expander. Remove these rings from the piston using a piston ring spreader.

Clean the piston ring grooves with a groove cleaner or the end of a broken ring filed to a sharp point, Figure 49. All passages should be cleaned with a non-caustic solvent. Clean the rod bores and the back of the connecting rod bearings thoroughly.

Mark each piston to make sure the rod will be assembled on the piston from which it was removed. Remove the piston pin retainer from each side and push the pin out.

Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring land using new rings and a feeler gauge as shown in Figure 50. See *DIMENSIONS AND CLEARANCES* section for proper side clearance measurement and ring groove widths.

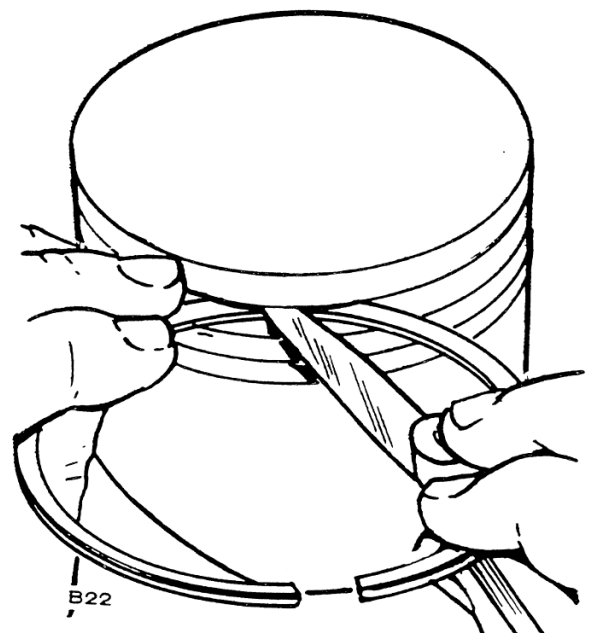


FIGURE 50. INSPECTING RING LANDS

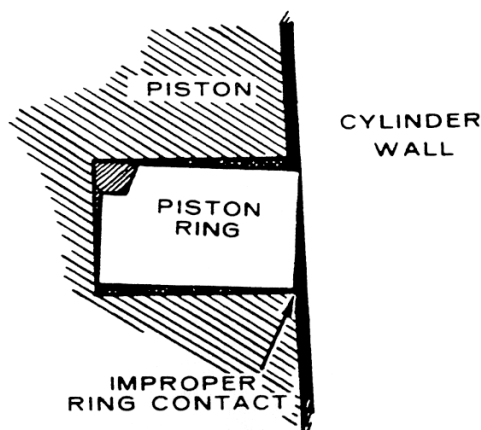


FIGURE 51. NEW RING IN WORN PISTON RING GROOVE

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves do not have good cylinder wall contact, Figure 51.

Replace pistons showing signs of bad scoring or burring, excessive skirt clearance, wavy or worn ring lands, fractures or damage from detonation. Replace piston pins showing fractures, scored bores or bores out of round more than 0.002 inch (0.051 mm).

Use a new piston pin to check the pin bushing in the connecting rod for wear. The clearance should be as shown in *DIMENSIONS AND CLEARANCES* section.

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder at a position corresponding to the bottom of its travel (Figure 52). The gap between the ends of the ring is given in *DIMENSIONS AND CLEARANCES* section.

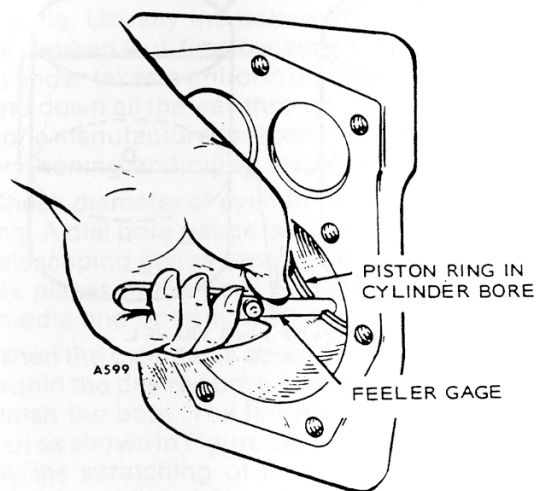


FIGURE 52. FITTING PISTON RINGS TO CYLINDER

Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on 0.005 inch oversize pistons. Other oversize rings must be used with corresponding oversize pistons. Rings of the tapered type are usually marked top on one side, or identified in some other manner and the ring must be installed with this mark toward the closed end of the piston.

Space each gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

The piston is fitted with a full-floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine. Refer to *DIMENSIONS AND CLEARANCES* section for the correct piston-to-cylinder clearance.

CONNECTING RODS

The connecting rods should be serviced at the same time the pistons or rods are serviced. Rods must be removed with the piston. Replaceable bushings and bearings are used.

Proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

Install the connecting rods and caps with raised lines (witness marks) aligned and with the caps facing toward the oil base. The rod and cap numbered 2 fits on the crankshaft journal nearest the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft-faced hammer to set the rod square on the journal.

Checking Bearing Clearance With Plastigage: Make certain that all parts are marked or identified so that they are reinstalled in their original positions.

Place a piece of correct size Plastigage in the bearing cap the full width of the bearing insert about 1/4 inch (6.35 mm) off center, Figure 53.

Rotate the crank about 30 degrees from bottom dead center and reinstall the bearing cap. Tighten the bolts to the torque specified in the *ASSEMBLY TORQUES* section. Do not turn the crankshaft.

Remove the bearing cap. Leave the flattened

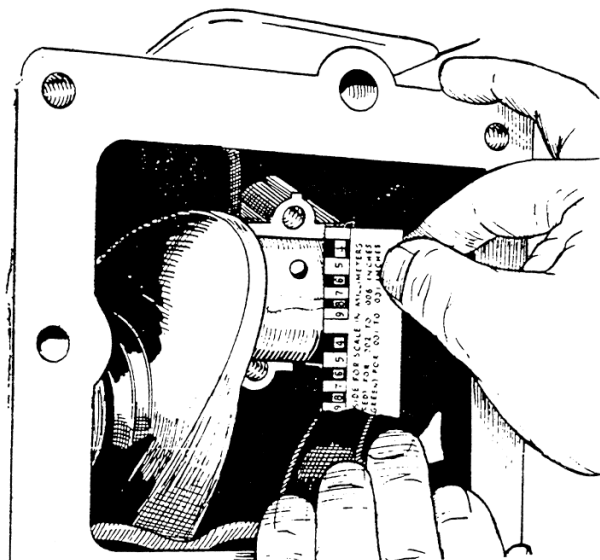


FIGURE 53. MEASURING BEARING CLEARANCE WITH PLASTIGAGE

Plastigage on the part to which it has adhered and compare the widest point with the graduations on the Plastigage envelope to determine bearing clearance.

CYLINDER BLOCK

Inspection:

1. Make a thorough check for cracks. Minute cracks may be detected by coating suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at defective area.
2. Inspect cylinder bore for scoring. Check Welsh plugs for a tight, even fit and the fins for breakage.
3. Check cylinder bore for taper, out of round and wear with a cylinder bore gauge, telescope gauge or inside micrometer, Figure 54. These measurements should be taken at four places — near top and bottom of piston ring travel.
4. Referring to Figure 54, measure cylinder diameter and record the readings as follows:
 - a. Measure reading A across top of cylinder where greatest piston ring wear occurs.
 - b. Measure reading B across cylinder at bottom of piston ring travel.
 - c. Measure reading C across top of cylinder where greatest ring wear occurs.
 - d. Measure reading D across cylinder at bottom of piston ring travel.
5. Compare reading A with reading B, then compare reading C with reading D to determine cylinder taper due to wear.

If taper exceeds 0.005 inch (0.127 mm), rebore and hone cylinder to accommodate the next oversize piston.

6. Reading A compared to C and reading B compared to D indicates whether or not the cylinder is out of round.

If cylinder is out of round 0.002 inch (0.051 mm), rebore and hone cylinders for next oversize piston.

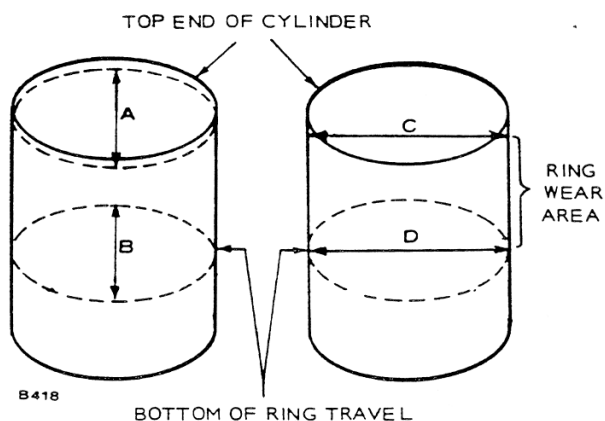
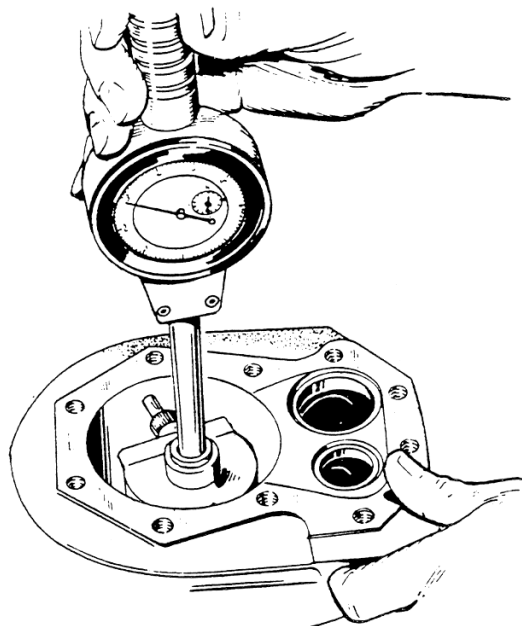


FIGURE 54. CYLINDER BORE MEASUREMENT

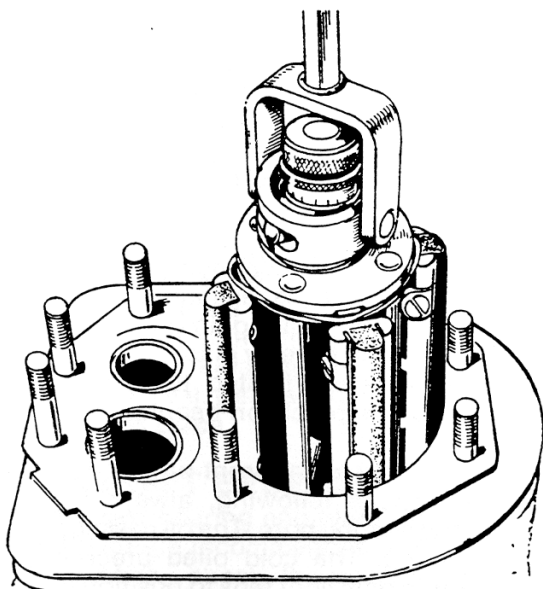


FIGURE 55. HONING CYLINDER

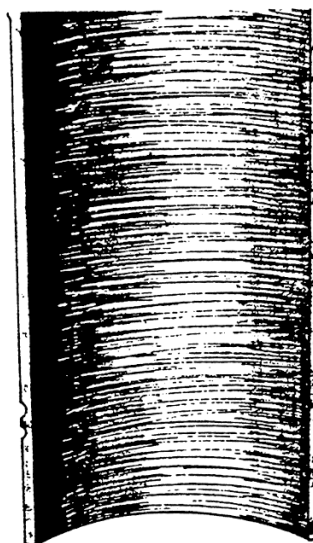
HONING PROCEDURE

1. A hone can be used to rebores a cylinder, Figure 55. Remove stock to 0.002 inch (0.051 mm) less than finished bore with coarse hone (100 grit), then complete honing with finish hones (300 grit).
2. Anchor block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at about 250 to 450 rpm.
3. Lower hone into cylinder until it protrudes 1/2 to 3/4 inch (13 to 19 mm) past end of cylinder. Rotate adjusting nut until stones come in contact with cylinder wall at narrowest point.
4. Loosen adjusting nut until hone can be turned by hand.
5. Connect drill to hone and start drill. Move hone up and down in the cylinder about 40 cycles per minute. Usually the bottom of the cylinder must be worked out first because it is smaller. When cylinder takes a uniform diameter, move hone up and down all the way through the bore. Follow the hone manufacturer's recommendations for wet or dry honing and oiling the hone.
6. Check diameter of cylinder regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check the size at six places in the bore; measure twice at the top, middle and bottom at 90 degree angles.
7. When the cylinder is about 0.002 inch (0.051 mm) within the desired bore, change to fine stones and finish the bore. The finish should not be smooth but as shown in Figure 56. The crosshatch formed by the scratching of the stones should form an angle of 23 degrees. This can be achieved by moving the hone up and down in the cylinder about 40 cycles per minute.

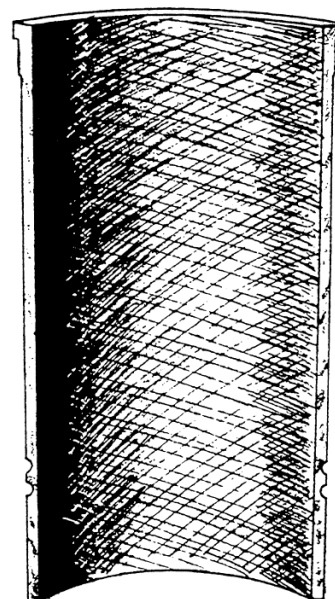
8. Clean cylinder block thoroughly with soap, water and clean rags. A clean white rag should not be soiled on the wall after cleaning is complete.

CAUTION *Never use gasoline or commercial cleaners to clean cylinder bores after deglazing or honing. These solvents will not remove abrasives from the walls. Abrasives not removed from engine will rapidly wear rings, cylinder walls, and bearing surfaces of all lubricated parts.*

9. Dry crankcase and coat it with oil.



AVOID THIS FINISH



PRODUCE CROSS HATCH SCRATCHES FOR FAST RING SEATING

FIGURE 56. CORRECT HONE FINISH

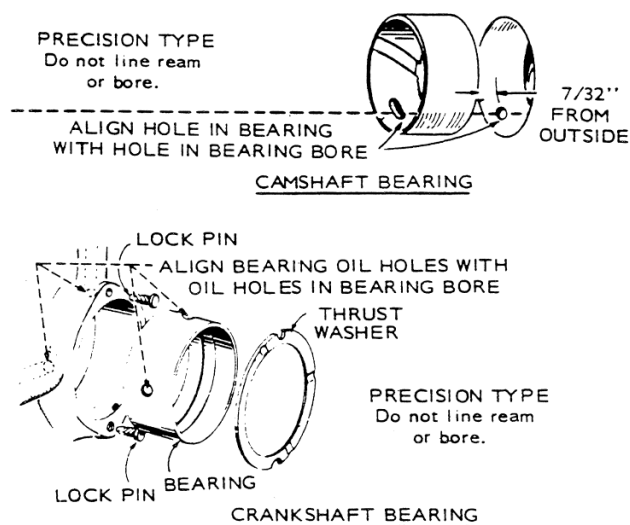


FIGURE 57. INSTALLATION OF CAM AND CRANKSHAFT BEARINGS

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing and again lubricate with oil after installing. See Figure 57. Use combination bearing driver to install the camshaft bearings.

Camshaft

Replacement camshaft bearings are precision type which do not require line reaming or line boring after

installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in proper position. Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in until past the ignition plunger hole.

Crankshaft

New crankshaft main bearings are precision type which do not require line reaming or line boring after installation. Before putting in the main bearings, expand the bearing bore by placing the casting in hot water or in an oven heated to 200°F (93°C). If practical, cool the precision bearing to shrink it.

For putting in either the front or rear main bearing, using instructions following, always align the oil hole(s) in the bearing bore. The oil passage must be at least half open. The cold oiled precision bearing should require only light taps to position it. Install the bearing flush with the inside end of the bore. If the head of a lock pin is damaged, use side cutters or "Easy-Out" tool to remove pin. Then install a new lock pin. Apply oil to the thrust washers to hold in place when the crankshaft is installed. The oil grooves in the thrust washer bearing must face the crankshaft. Be sure two notches fit over lock pins.

OIL SEALS

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside using a bearing plate driver and gear cover driver. See *Special Tools* section.

Before installing the seals, fill the space between seals with a fibrous grease or stiff cup grease. This will improve sealing. See Figure 58.

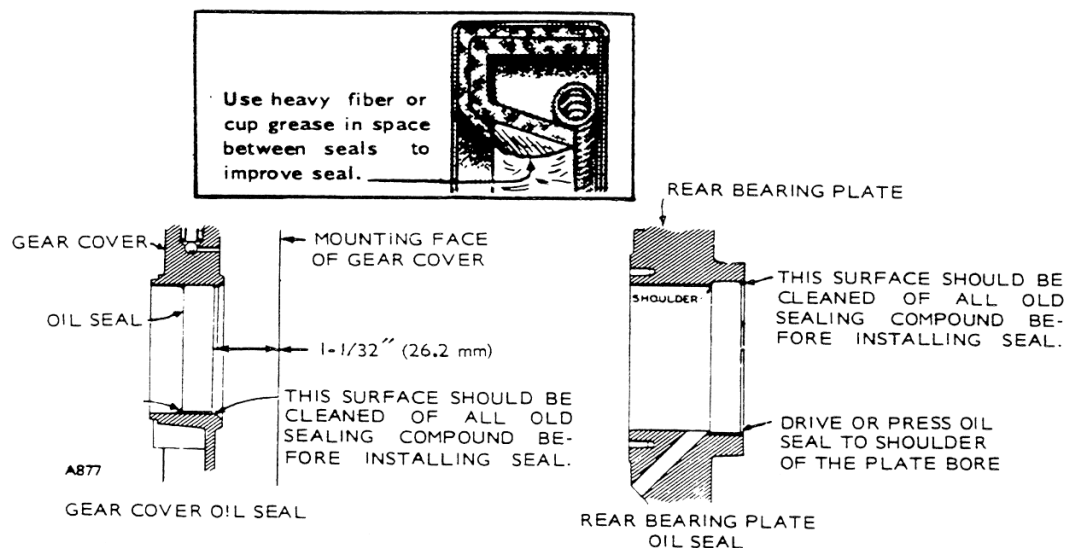


FIGURE 58. GEAR COVER AND REAR BEARING PLATE OIL SEALS

When installing the gear cover oil seal, tap the seal inward until it is 1-1/32 (26.2 mm) of an inch from the mounting face of the cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in *ASSEMBLY TORQUES* section, check the crankshaft endplay as shown in Figure 59. If there is too much endplay (see *DIMENSIONS AND CLEARANCES* section for minimum and maximum endplay), remove the rear bearing end plate and replace the gasket with a thinner gasket from the gasket kit. For too little endplay, remove the rear bearing end plate and replace the gasket with a thicker one. Reinstall the end plate making sure the thrust washer notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

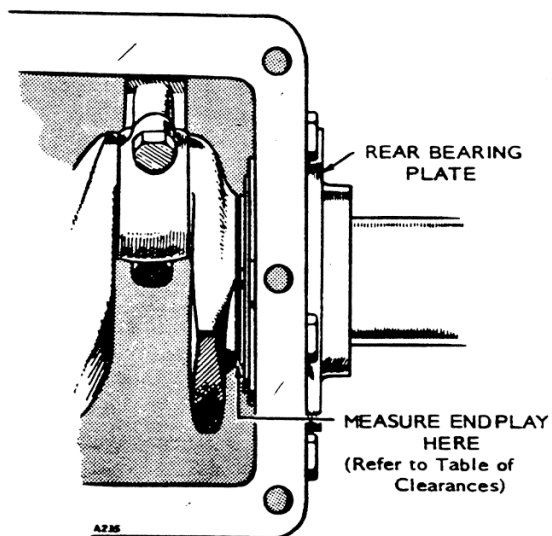


FIGURE 59. MEASURING CRANKSHAFT ENDPLAY

OIL PUMP

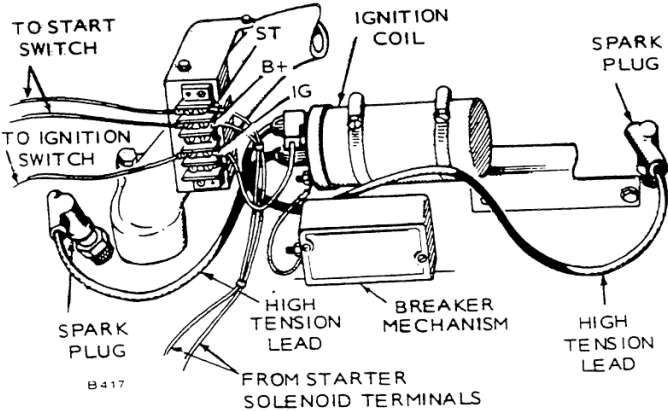
Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly, if required.

Wiring Diagram

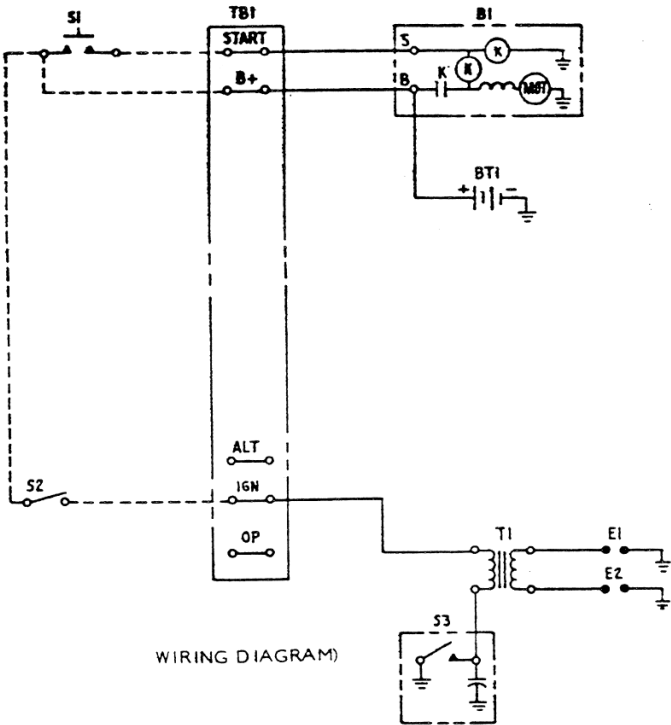
LEGEND

E1, E2	SPARK PLUGS
B1	STARTER
BT1	BATTERY
S1*	START SWITCH
S2*	IGNITION SWITCH
S3	BREAKER POINTS
T1	IGNITION COIL
TB1	TERMINAL BOARD

* - CUSTOMER SUPPLIED.



BATTERY IGNITION SYSTEM





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