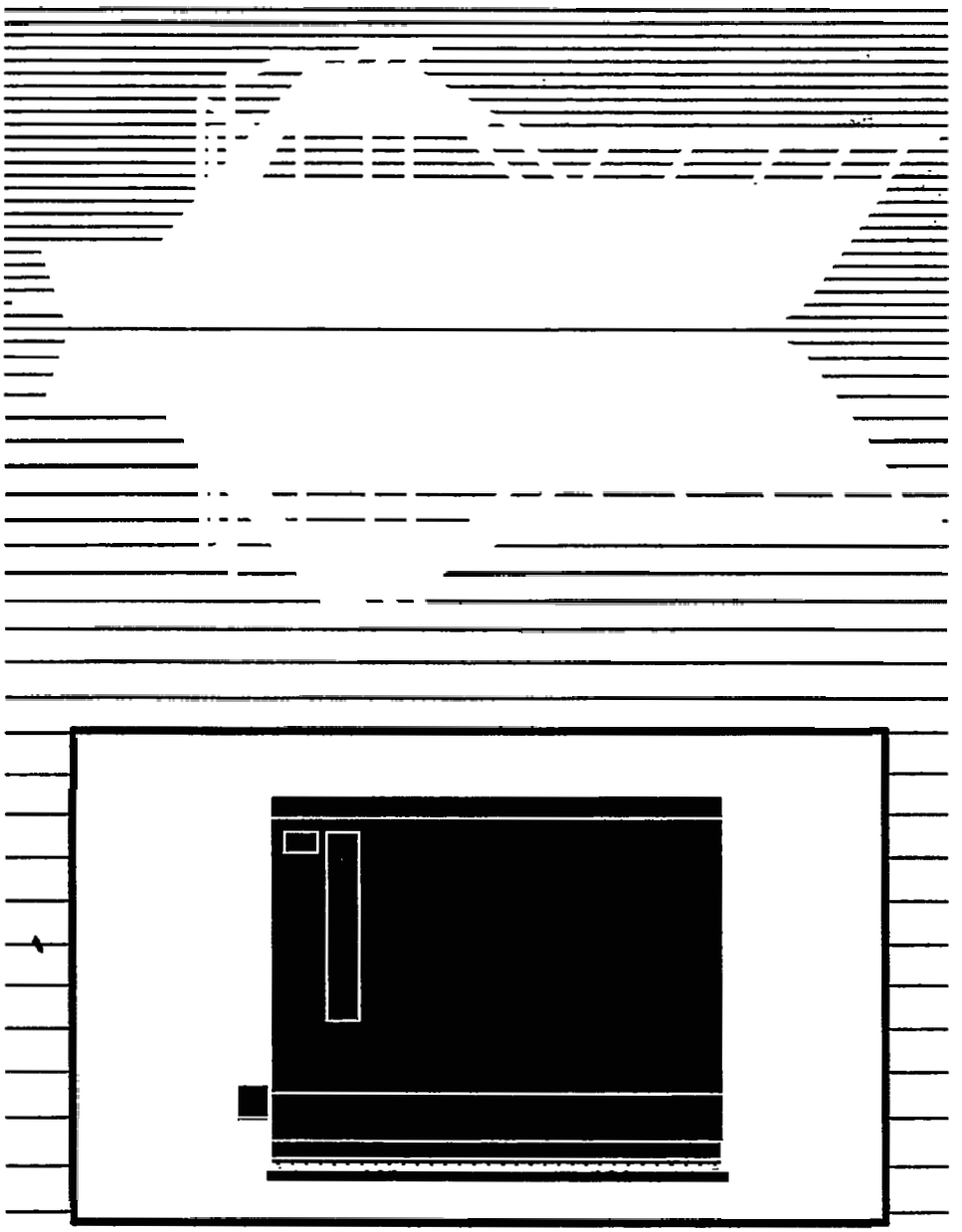
MARINE
Service Manual

MAJB



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Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and your unit. **Safe and efficient operation can be achieved only if the unit is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

Throughout this manual you will notice symbols which alert you to potentially dangerous conditions to the operator, service personnel, or the equipment itself.

⚠DANGER ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC. Fire, explosion, and personal injury can result from improper practices.

- Benzene and lead, found in some gasoline, have been identified by some state and federal agencies as causing cancer or reproductive toxicity. When checking, draining or adding gasoline, take care not to ingest, breathe the fumes, or contact gasoline.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Do not fill fuel tanks with the engine running. Do not smoke around the generator set area. Wipe up any oil or gas spills. Do not leave oily rags in engine compartment or on the generator set. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip the engine fuel supply with a positive fuel shutoff.
- Always disconnect the battery ground (-) lead first and reconnect it last. Make sure you connect the battery correctly. A direct short across the battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is very explosive.
- Keep a fire extinguisher available in or near the engine compartment and in other areas throughout the vessel. Use the correct extinguisher for the area. For most types of fires, an extinguisher rated ABC by the NFPA is available and suitable for use on all types of fires except alcohol.

EXHAUST GASES ARE DEADLY

- Provide adequate ventilation. Equip the bilge with a power exhauster.
- Be sure propulsion and generator set engine exhaust systems are free of leaks. Perform thorough, periodic inspections of the exhaust system and repair leaks immediately. Exhaust gases are deadly.
- Never sleep in the vessel with the generator set running unless the vessel is equipped with an operating carbon monoxide detector.

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

- Do not remove any belt guards or covers with the unit running.
- Keep hands and loose clothing away from moving parts. Do not wear jewelry while servicing any part of the generator set.
- Never step on the generator set (as when entering or leaving the engine compartment). It can stress and break unit components, possible resulting in dangerous operating conditions. . . from leaking fuel, leaking exhaust fumes, etc.
- Before performing any maintenance on the generator set, disconnect its batteries to prevent accidental starting. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the generator set compartment or bilge thoroughly with the power exhauster.

ELECTRICAL SHOCK WILL CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not make adjustments in the control panel or on engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel standing on dry surfaces to reduce shock hazard.
- DO NOT CONNECT THE GENERATOR SET TO THE PUBLIC UTILITY OR TO ANY OTHER ELECTRICAL POWER SYSTEM. Electrocution or damage to property can occur at a site remote from the boat where line or equipment repairs are being made if the set is connected to that power system. An approved transfer switch must be used if more than one power source is to be made available to service the boat.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

Copy and post these suggestions in potential hazard areas of the vessel.

Table of Contents

Section 1. Introduction

ABOUT THIS MANUAL

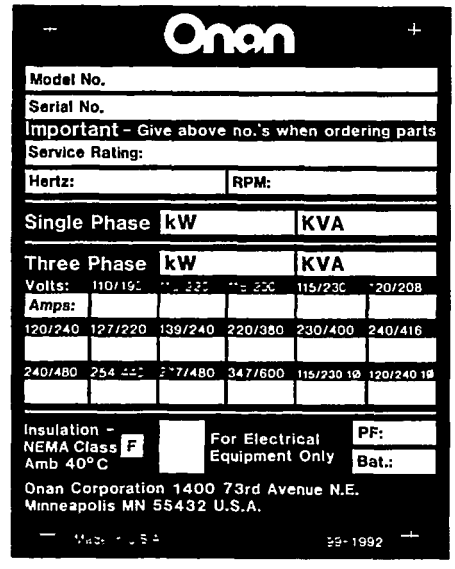
This manual provides service information for MAJB marine generator sets. This is a complete service manual for the experienced service person. It covers troubleshooting, disassembly, repair, reassembly, and adjustments for the engine, generator, and control. It is recommended that the service person be thoroughly familiar with the principles of gasoline engine operation and have a basic knowledge of electrical fundamentals. Other Onan publications such as Electrical/Mechanical Fundamentals (932-0408), Onan Generator Training Manual (932-0404), Technical Bulletin T-021 (For Onan Marine Electrical Generating Sets) and the Operator's Manual (933-0121) are recommended as additional sources of information.

Read all service procedures completely before beginning any repair work and observe all cautions and warnings. It is extremely important that the generator set installation maintain compliance with the applicable codes and standards for marine installations (see the Operator's Manual and Technical Bulletin T-021). The most critical areas of concern include the exhaust system, fuel system, electrical wiring, and ventilation system. Improper servicing can create an unsafe installation that can result in damage to the equipment or can cause severe personal injury or death to the user.

MODEL IDENTIFICATION

When contacting an Onan Dealer or Distributor, always supply the complete Model Number and Serial Number as shown on the set nameplate. This information is necessary to identify your set when ordering replacement parts.

Always use genuine Onan replacement parts obtained from an authorized Onan Dealer or Distributor. Universal replacement type parts (usually intended for automotive use) often look similar but might not perform to Onan specifications. Only genuine Onan replacement parts are designed and tested for the application to ensure reliable service and dependable operation.



ONAN NAMEPLATE

⚠WARNING

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

Section 2. Specifications

GENERAL			
Engine Design	Four-Cycle, Water-Cooled, One Cylinder		
Generator Design	Revolving Field, Two Pole		
Output Ratings	Unity Power Factor		
Starting System	Automotive Type Starter, 12 Volts		
Engine Speed	60 Hz: 3600 r/min, 50 Hz: 3000 r/min		
Weight	155 lbs (75 kg)		
ENGINE DETAILS			
Displacement	14.9 in^3 (0.244 litre)		
Compression Ratio	6.25:1		
Bore	2.75 in. (69.85 mm)		
Stroke	2.50 in. (63.5 mm)		
Oil Capacity (With Filter)	2.0 QT (0.95 Litre)		
Fuel	Regular or Unleaded Gasoline		
GENERATOR DETAILS	3.0 MAJB-1R	2.5 MAJB-53CR	2.5 MAJB-53BR
Watts	3000 @ 1.0 PF	2500 @ 1.0 PF	2500 @ 1.0 PF
Volts	120	120/240	110/220
Amps	25	20.8/10.4	22.3/11.9
Frequency (Hertz)	60	50	50
Phase	1	1	1
Wires	2	4	4
Battery Charge (Amps)	0.1-1.0	0.1-1.0	0.1-1.0
TUNE-UP SPECS			
Spark Plug Gap	0.025 in. (0.64 mm)		
Timing	25° BTC		
Valve Clearance			
Intake	0.011 in. (0.279 mm)		
Exhaust	0.011 in. (0.279 mm)		
Magneto Air Gap	0.010-0.015 in. (0.254 - 0.381 mm)		

Section 3. Dimensions and Clearances

CYLINDERS AND PISTON ASSEMBLY	MINIMUM Inches	(mm)	MAXIMUM Inches	(mm)
Cylinder Bore (Std. size honed)	2.7520	(69.900)	2.7530	(69.926)
Clearance In Cylinder	0.0040	(0.102)	0.0060	(0.152)
Ring Gap	0.0060	(0.152)	0.0180	(0.457)
Piston Ring #1 (top) Groove Width	0.0955	(2.426)	0.0965	(2.451)
Piston Ring #2 Groove Width	0.0950	(2.413)	0.0960	(2.438)
Piston Ring #3 Groove Width	0.1565	(3.975)	0.1575	(4.000)
Piston Ring #1 Top Side Clearance	0.0020	(0.051)	0.0080	(0.203)
Piston Pin Diameter	0.6250	(15.875)	0.6252	(15.88)
Piston Pin Fit In Rod	0.0004	(0.010)	0.0005	(0.013)
Connecting Rod Side Clearance	0.0120	(0.305)	0.0350	(0.889)
Connecting Rod Bearing Clearance	0.0015	(0.038)	0.0025	(0.064)
CRANKSHAFT AND CAMSHAFT				
Crankshaft Main Bearing Journal Diameter	1.6857	(42.817)	1.6865	(42.837)
Crankshaft Rod Journal Diameter	1.3742	(34.905)	1.3759	(34.925)
Crankshaft Main Bearing Diameter (installed)	1.6880	(42.875)	1.6900	(42.926)
Crankshaft Main Bearing Clearance	0.0015	(0.0381)	0.0043	(0.109)
Crankshaft End Play	0.0080	(0.203)	0.0120	(0.305)
Camshaft Journal Diameter	1.3740	(34.900)	1.3745	(34.912)
Camshaft Bearing Clearance	0.0012	(0.038)	0.0030	(0.076)
Camshaft End Play	0.0030	(0.076)	—	—

Dimensions and Clearances (Continued)

VALVES AND TAPPETS				
Valve Spring Free Length (Approx)	1.600 in. (40.64 mm)			
Valve Spring Compressed Length	1.063 in. (27 mm)			
Spring Tension Valve Closed	38 lb (17.24 kg) to 42 lb (19.05 kg)			
Spring Tension Valve Open	71 lb (32.21 kg) to 79 lb (35.83 kg)			
Valve Face Angle	44°			
Valve Seat Angle	45°			
	MINIMUM		**MAXIMUM**	
	Inches	**(mm)**	**Inches**	**(mm)**
Valve Seat Width	0.0310	(0.787)	0.0470	(1.194)
Valve Stem Diameter (Intake)	0.3095	(7.861)	0.3100	(7.874)
Valve Stem Diameter (Exhaust)	0.3080	(7.823)	0.3085	(7.836)
Valve Guide Diameter	0.3110	(7.889)	0.3120	(7.929)
Valve Stem Clearance (Intake)	0.0010	(0.025)	0.0025	(0.064)
Valve Stem Clearance (Exhaust)	0.0030	(0.076)	0.0035	(0.089)
Valve Tappet Diameter	0.7475	(18.987)	0.7480	(18.979)
Valve Tappet Bore Diameter	0.7505	(19.063)	0.7515	(19.088)
Valve Tappet to Block Clearance	0.0030	(0.076)	0.0040	(0.102)
Valve Seat Bore Diameter (Exhaust)	0.9950	(25.273)	1.0050	(25.52)
Valve Seat Outside Diameter (Exhaust)	1.1920	(30.277)	1.1930	(30.302)

Section 4. Torque Specifications

TORQUE SPECIFICATIONS	Use engine oil as a lubricant for all threads EXCEPT the spark plug and rotor through-bolt threads	
	FOOT-POUNDS	(NEWTON-METRES)
Cylinder Head (Cold)	24-26	(33-35)
Connecting Rod	10-12	(14-16)
Rear Bearing Plate	15-20	(21-27)
Flywheel Mounting Screw	35-40	(48-54)
Oil Base	25-30	(34-40)
Gearcase Cover	15-20	(21-27)
Spark Plug	25-30	(34-40)
Oil Pump	7-9	(10-12)
Fuel Pump	10-15	(14-20)
Rotor Through-Bolt	17-21	(23-28)
Stator Through-Bolts	12-15	(16-20)
Carburetor Mounting Nuts	8-12	(11-16)
Valve Cover Nut	4-8	(6-10)

Section 5. Preparing to Service

TROUBLESHOOTING

Before starting to service the generator set, follow a systematic troubleshooting procedure to locate and isolate the problem. For servicing purposes, the generator set can be divided into the following:

- Engine - Primary Systems
- Control
- Generator
- Engine - Block Assembly

Several troubleshooting guides are included in this manual to help locate the cause of various malfunctions. It should be noted that some malfunctions might have several possible causes. For this reason, you may have to investigate several likely problem areas in order to isolate the source of the malfunction. Because of the complexity of the product, a troubleshooting chart cannot list every malfunction and its cause. In some situations, you will have to rely on experience and a knowledge of the product to locate the problem and service as required.

REQUIRED TOOLS

The following special tools may be required to service the generator set.

A complete listing of the tools available from Onan is contained in the Tool Catalog (900-0019), which is available from Onan Dealer or Distributors.

Engine Tools

Torque wrench 0-175 Ft-Lbs (0-240 N•m)
Feeler gauge
Pressure gauge
Spark plug gap gauge
Carburetor adjustment wrench
Points adjustment tool
Flywheel puller
Snap ring pliers
Gear puller with puller-ring
Cylinder ridge reamer
Combination main and cam bearing remover
Combination main and cam bearing driver
Oil seal loader and driver
Piston ring compressor
Piston ring spreader
Cylinder hone
Valve seat cutter
Valve spring compressor
Valve lock replacer
Valve seat driver
Valve guide driver
Slide hammer
Piston groove cleaner
Outside micrometer set 0 to 4 in. (0 to 102 mm)
Telescoping gauge set 1/2 in. to 6 in. (13. to 152 mm)
Hole gauge 0.300 in. to 0.400 in. (7.5 to 10 mm)
Plasti-Gage bearing clearance guide

Generator and Control

Lead or dead-blow hammer
Battery hydrometer
VOM multi-tester
Frequency meter
Armature growler
Load test panel
Jumper wires

SAFETY CONSIDERATIONS

Always consider the safety aspects of any service procedure. Generator sets present several hazards that the service person must be aware of if the job is to be completed safely. Read through the safety precautions listed on the inside cover and familiarize yourself with the various hazards shown in Table 5-1. Approach the job with a safety-conscious attitude. This is the most effective way to avoid injury to yourself or others. Reduce the chance that an accident will occur by adopting the following safeguards.

Safeguards to Avoid Hazards

- **Use Personal Protection-** When the situation calls for it, protect your body by wearing the appropriate safety equipment. Protective clothing includes safety shoes, gloves, safety glasses, and hard hats. Leave rings and jewelry off and do not wear loose clothing that might get caught on equipment.

- **Work to Reduce the Hazard-** Keep machinery guards and shields in place and maintain equipment in good working condition. Store flammable liquids in approved containers, away from open flame. Keep the workshop clean and well-lighted, and provide adequate ventilation. Keep fire extinguishers and safety equipment nearby and be prepared to respond to an emergency.

TABLE 5-1
HAZARDS AND THEIR SOURCE

- Fire and explosions
  - Leaking fuel
  - Hydrogen gas from charging battery
  - Oily rags improperly stored
  - Flammable liquids improperly stored
  - Cleaning solvents
- Burns
  - Hot exhaust pipes
  - Hot engine and generator surfaces
  - Hot engine oil
  - Electrical short in DC or AC wiring system
- Poisonous Gases
  - Carbon monoxide from faulty exhaust
  - Gas leaking into boat interior
  - Operating generator set where exhaust gases can accumulate
- Electrical Shock (AC)
  - Improper generator set load connections
  - Faulty wiring
  - Faulty electrical appliance
  - Faulty generator set wiring
- Rotating Machinery
  - Flywheel guard not in place
  - Belt guard not in place
- Slippery Surfaces
  - Leaking or spilled oil
- Heavy Objects
  - Removing generator set
  - Removing heavy components

- **Develop Safe Work Habits-** Unsafe actions are identified as the cause of most accidents involving the use of tools and machines. Be familiar with the equipment and know how to use it safely. Use the correct tool for the job and check its condition before starting. Observe the warnings and cautions in this manual and take special precautions when working around electrical equipment. Do not work alone if possible and do not take risks.

Be prepared if an accident does occur. Agencies such as the Red Cross and your local police and fire departments offer basic courses in first aid, mouth-to-mouth resuscitation, and fire control. Take advantage of these offerings so you are ready to respond when an accident happens. Learn to be safety conscious and make sure safe practices are a part of your work routine.

SET REMOVAL

Some service procedures require that the generator set be removed from the boat. While there are variations, marine generator sets generally are installed in tight quarters allowing limited access. The set may also have a sound shield housing that must be removed to service many components.

The generator set is usually in the bilge area and secured to the boat stringers or other sturdy support. It may share the same compartment as the propulsion engine.

Because of the wide variety of boats and compartment sizes, it is not possible to specify the exhaust removal procedures for each installation. If, after examining the installation, a satisfactory method for removing the set cannot be determined, contact the boat manufacturer.

The battery, exhaust, sea water, and fuel lines must be shut off and disconnected from the set. The generator set has a lifting eye to facilitate removal.

⚠WARNING ***Gasoline vapor is extremely flammable and can result in severe personal injury or death if ignited. Make certain all fuel line openings are plugged to prevent gasoline vapor from accumulating.***

⚠WARNING ***Generator sets are heavy and can result in severe personal injury if dropped during removal. Use adequate lifting devices to provide sufficient support for the set. Keep hands and feet clear while lifting.***

Section 6. Engine - Primary Systems

INTRODUCTION

The engine primary systems include the following:

- Exhaust System
- Cooling System
- Ignition System
- Crankcase Ventilation System
- Governor
- Fuel System
- Electric Starter

The engine primary systems can often be serviced without removing the generator set from the boat and without major disassembly of the set. Use the following troubleshooting guide to help locate problems related to the engine primary systems. Refer to Section 7 for problems related to starting the generator set.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Misfires	1. Faulty ignition due to: a. worn or fouled spark plugs, b. worn ignition points, c. incorrect ignition timing, d. faulty ignition coil, or e. faulty plug wires.	 1a. Replace spark plugs. 1b. Replace points. 1c. Set breaker point timing. 1d. Test coil and replace if necessary. 1e. Test spark plug wires and replace if faulty.
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, c. dirt in carburetor, or d. vacuum leak.	2a. Adjust carburetor main and idle adjustment screws. 2b. Adjust carburetor float level. 2c. Disassemble carburetor and clean all internal passages. 2d. Locate leak and correct as required.
	3. Contaminated fuel.	3. Drain fuel tank and refill with fresh fuel.
Engine Backfires	1. Faulty ignition due to: a. incorrect ignition timing or b. incorrect spark plug gap.	1a. Adjust breaker point timing. 1b. Reset spark plug gap.
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, or c. dirt in carburetor.	2a. Adjust carburetor main and idle adjustment screws. 2b. Adjust carburetor float level. 2c. Disassemble carburetor and clean all internal passages.
	3. Mechanical damage to engine.	3. See Engine Block Assembly section.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS (Continued)

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Lacks Power	1. Faulty ignition due to: a. incorrect ignition timing or b. incorrect spark plug gap.	1a. Adjust breaker point timing. 1b. Reset spark plug gap.
	2. Restricted fuel flow due to: a. plugged fuel filter or b. faulty fuel pump.	2a. Clean fuel filter. 2b. Test fuel pump and repair or replace if faulty.
	3. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, or c. dirt in carburetor.	3a. Adjust carburetor main and and idle adjustment screws. 3b. Adjust carburetor float level. 3c. Disassemble carburetor and clean all internal passages.
	4. Exhaust system blocked or restricted.	4. Locate and remove cause of of blockage.
	5. Incorrect valve tappet clearance.	5. Adjust valve tappets (see Engine Block Assembly section).
	6. Excessive engine wear or damage to engine.	6. See Engine Block Assembly section.
Engine Overheats	1. Restricted water flow due to dirt or debris blocking water inlet passages.	1. Clean away any debris from water inlet. Flush the engine cooling system.
	2. Faulty thermostat.	2. Replace thermostat.
	3. Incorrect ignition timing.	3. Adjust breaker point gap.
	4. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, or c. dirt in carburetor.	4a. Adjust carburetor main and idle adjustment screws. 4b. Adjust carburetor float level. 4c. Disassemble carburetor and clean all internal passages.
	5. Faulty water pump impeller.	5. Replace impeller.
Black Exhaust Smoke	1. Rich fuel mixture due to: a. choke sticking, b. incorrectly adjusted fuel mixture screws, or c. dirt in carburetor.	1a. Clean choke and choke linkage. 1b. Adjust carburetor idle and main adjustment screws. 1c. Disassemble carburetor and clean all internal passages.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS (Continued)

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Hunts or Surges	1. Sticking or binding governor linkage.	1a. Clean and lubricate governor linkage.
	2. Incorrect governor adjustment.	2. Adjust governor speed and sensitivity.
	3. Faulty governor spring.	3. Replace governor spring.
	4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, or c. dirt in carburetor.	4a. Adjust carburetor main and idle adjustment screws. 4b. Adjust carburetor float level. 4c. Disassemble carburetor and clean all internal passages.
	5. Governor mechanism worn excessively.	5. See Engine Block Assembly section.
High Oil Consumption (Note: New engines sometimes have high oil consumption during break-in)	1. Oil viscosity too light or oil is diluted.	1. Drain oil and refill with correct viscosity oil.
	2. Crankcase breather valve is dirty or defective.	2. Clean crankcase breather and replace if defective.
	3. Oil leaks.	3. Locate source of leak and repair as required.
	4. Excessive engine wear.	4. See Engine Block Assembly section
	5. Light loading.	5. Do not run set at no load for long periods of time.
Low Oil Pressure	1. Oil viscosity too light or oil is diluted.	1. Drain oil and refill with correct viscosity oil.
	2. Low oil level.	2. Add oil as required.
	3. Low oil pressure switch defective.	3. Replace oil pressure switch (see Engine Block Assembly section).
	4. Faulty oil bypass valve.	4. Inspect oil bypass valve and clean or replace as required (see Engine Block Assembly section).
	5. Excessive engine wear or defective oil pump.	5. See Engine Block Assembly Section

EXHAUST SYSTEM

The condition of the exhaust system is extremely critical on marine applications because of the possibility of exhaust gases entering compartments aboard the boat. The exhaust system must be serviced immediately if inspection reveals leaking joints or connections, loose fasteners, or broken or damaged components.

Always replace worn components with new original equipment replacement parts. Do not attempt to repair a broken exhaust pipe or manifold by welding and do not replace worn-out components with parts that do not meet factory specifications.

Figure 6-1 shows a typical marine exhaust system for a below-waterline installation. An incorrectly designed exhaust system can cause engine operator problems such as abnormal temperature rise, low power output, high fuel consumption and burned valves. These problems can be related to exhaust pressures exceeding 1.33 inches (34 mm) of mercury (4.5 kPa).

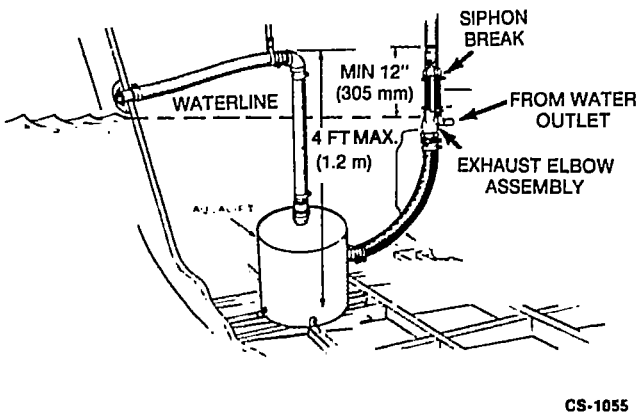


FIGURE 6-1. BELOW-WATERLINE INSTALLATION

Figure 6-1 shows a below-waterline installation using a hydrodynamic marine muffler. The exhaust line must be installed to prevent backflow of water to the engine under all conditions.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Modifying the exhaust system might allow poisonous exhaust gases to enter the boat. Use only original equipment replacement parts when servicing the exhaust system. Liability for injury or damages due to unauthorized modifications becomes the responsibility of the person making the change.***

Siphon Break

A siphon break must be installed if the exhaust injection fitting is below the waterline as shown in Figure 6-1. The siphon break must be at least 12 inches (305 mm) above the waterline and in a vertical position. When properly installed, the valve prevents flotation water (sea water) from being siphoned into the exhaust manifold and cylinders of the engine.

The siphon break valve is reliable. However, when used in contaminated waters or salt water, some corrosion may appear. The valve can be checked for free movement after unscrewing the top cover (Figure 6-2). If the valve sticks or the seat shows wear, it should be replaced (see Parts Manual).

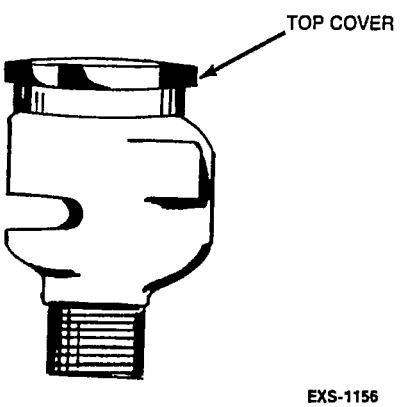


FIGURE 6-2. SIPHON BREAK VALVE

COOLING SYSTEM

Description

The MAJB is water cooled. A water pump impeller circulates cooling water through the engine and discharges it into the exhaust line, several feet ahead of the muffler.

The pump (located on the top of the engine) delivers water to the cylinder jacket and out of the cylinder head to the muffler. The water flow is controlled by the thermostat. For engine warm-up with the thermostat closed, a by-pass in the cylinder head allows water flow.

Maintenance

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

⚠WARNING ***Contact with hot coolant can result in severe burns.***

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 the thermostat (Figure 6-3) and disconnect the pump-to-engine hose at the pump. Pour flushing water into the thermostat opening until the water flowing from the disconnected hose is clean.

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

All water lines should be 1/2 inch (12.7 mm) or larger inside diameter. Long runs of pipe or hose need a larger inside diameter to reduce resistance.

Testing

The 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 the engine until the thermostat opens and then measure the length of time necessary to fill the tank. Calculate the flow rate. If it is below 1.8 GPM (6.8 litres/min), check pump operation and inspect the passages and water lines for clogging.
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 the engine is operating. If bubbles appear, inspect the cooling system thoroughly to find the source.

Thermostat

The thermostat is located on the top of the cylinder head and is connected by tubing to the water-cooled manifold. Replace the thermostat if it is damaged from corosion or other causes.

Check opening and closing by placing the thermostat and a thermometer in a water bath. The thermostat should start to open at 145°F (62.78°C) and be fully open at 165°F (73.88°C). It should close immediately when removed from hot water. Replace the thermostat if it does not operate properly.

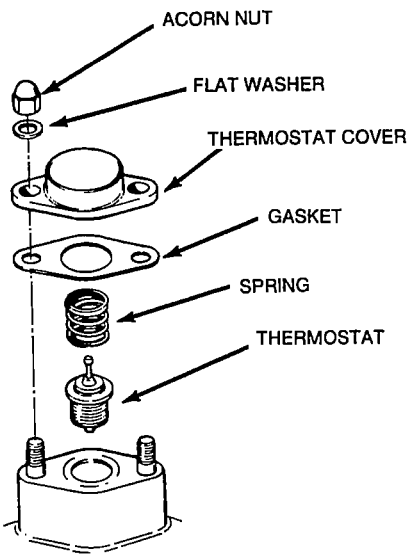


FIGURE 6-3. THERMOSTAT

High Engine Temperature Cut-off Switch

This 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 (93.33°C) and closes when the temperature drops below approximately 160°F (71.11°C).

Sea Water Pump

This pump is a positive displacement, neoprene impeller type, used to pump sea water through the cooling system. The pump impeller, because of continuous flexing, will in time need replacement. If the impeller fails after short service (under 500 hours), check for severe pitting or abrasion caused by dirt in the cooling system. All installations should have a water filter installed ahead of the pump.

⚠WARNING ***Accidental starting of the set can cause severe personal injury or death. Disconnect the starting battery cables when repairs are made to the engine, controls, or generator.***

Inspection: Check the sea water pump for wear or signs of leakage from the shaft seal. Loosen the drive belt and move the water pump pulley back and forth. The pulley should be tight on the shaft and only a slight amount of bearing play should be felt. If leakage or wear is detected, remove the pump for repair or replacement.

A pump repair kit (available from Onan) contains an impeller, seal, gasket and four cover screws. Refer to the parts catalog for the part number. Use only the first four steps of the Disassembly procedure for kit replacement.

⚠CAUTION ***Operating the water pump in a dry condition causes excessive impeller blade wear. Prime the pump before putting the genset into service and before beginning seasonal operation.***

Water Pump Priming: A neoprene impeller pump should never be operated dry. If the generator set has not operated for an extended period of time, the water pump can lose its prime. Operation with a dry pump causes excessive wear of impeller blades.

Although a total loss of prime rarely occurs, a good practice after seasonal inactivity is to prime the pump. Remove the hose from the tapered connector (input side) and pour in a small amount of clean water. (This provides lubrication for the impeller blades.) A short length of hose and a small funnel works well for this purpose.

Disassembly (refer to Figure 6-4):

1. Remove the belt guard, belt and pulley.
2. Remove the 2 capscrews securing the pump to its bracket.
3. Remove the pump end plate screws, end plate, and gasket.
4. Pull out the neoprene impeller using 2 screwdrivers, or pliers.
5. Loosen the set screw on the pump body and tap it lightly to free the cam. Lift out the cam and wear plate.
6. Remove the plastic end cap/seal from the pump body (pulley end of shaft).
7. Remove the bearing and shaft retaining rings at the pulley end of the pump body.
8. Push the shaft and bearing assembly out the pulley end of the pump body.
9. To replace the bearings, press the bearing off the pulley end of the shaft. Do not remove bearings over the sealing surface of the shaft.
10. Remove the water seal from either end of the pump body.

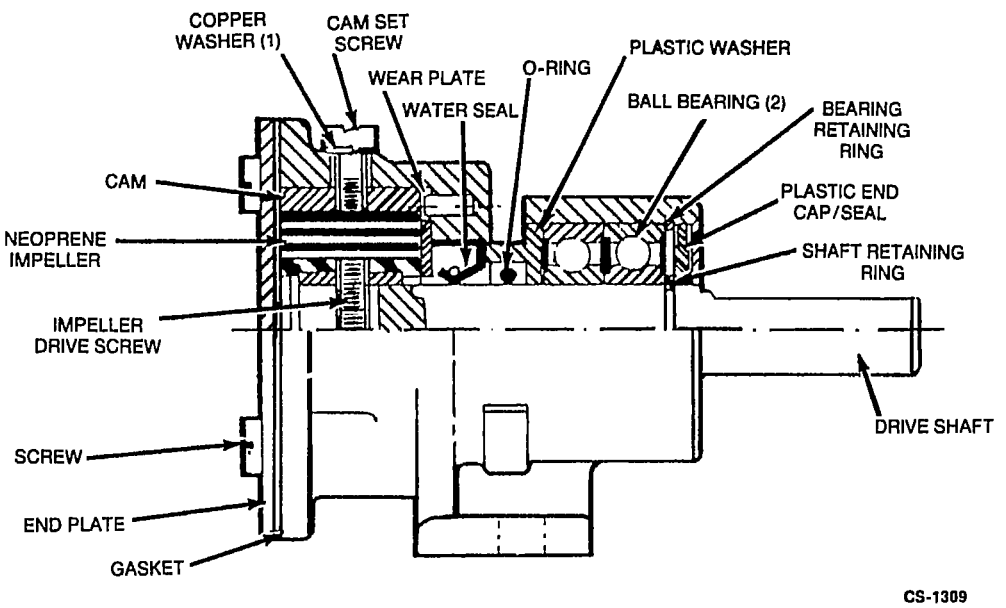


FIGURE 6-4. CUTAWAY SIDE VIEW OF SEA WATER PUMP

Assembly:

1. Press the bearing over the pulley end of the shaft far enough to clear the shaft retaining ring groove.
2. Install the new water seal oriented as shown in Figure 6-4. Lubricate the surfaces to assist assembly. The water seal surface must be just below the edge of the impeller body.
3. Install the plastic washer and O-ring over the impeller end of the shaft.
4. Press the shaft/bearing assembly into the pump until it bottoms against the pump body.
5. Install the bearing and shaft retainer rings.
6. Install the plastic end cap/seal over the end of the bearing (pulley drive end of shaft).
7. Install the wear plate in the impeller chamber. Be sure the notch in the plate fits over the locator pin.
8. Install the cam and cam set screw. Be sure only one copper washer is under the screw head.
9. Lubricate the impeller with vaseline or the like and fit it with a rotating movement in the direction of rotation.
10. Install the gasket, end plate, and end plate screws.
11. Secure the pump with its two capscrews.
12. Reinstall the pulley, belt, and belt guard.

IGNITION SYSTEM

The ignition system consists of the breaker points, condenser, magneto, spark plugs, and wiring. For reliable generator set operation, the complete ignition system must be in good working order and properly adjusted. Many generator set problems can be traced to an improperly maintained ignition system. Refer to the following paragraphs when servicing or making adjustments and to the Specifications Section for recommended dimensions.

Breaker Points and Condenser

The breaker points and condenser mount on the side of the engine block. A small plunger rides on an ignition cam at the end of the camshaft. The plunger actuates the points, which open and close with every revolution of the camshaft. The exact timing of the ignition spark is dependent on when the points open.

Correctly adjusted breaker points provide for easy starting, efficient operation, full power, and proper cooling. A retarded ignition reduces efficiency, an advanced ignition causes overheating.

The condenser extends point life by preventing arcing across the opening breaker points. A defective condenser causes a weak spark and rapid point wear. Replace the condenser if defects are suspected. A new condenser is supplied with the engine tune-up kit.

Inspect the breaker points at the interval specified in the Operator's Manual and replace if pitted or burned. Filing of the points is not recommended. Use the following procedures to adjust/replace the points.

Adjustment:

The ignition adjustments should be made with the engine in a static condition and cold.

1. Disconnect the negative (-) battery cable at the battery terminal.
2. Remove the breaker box cover.
3. Disconnect the breaker box control and magneto leads (Figure 6-5).
4. Connect the leads of an ohmmeter or continuity tester to the hot and ground sides of the breaker points.
5. Remove the spark plugs to permit easy rotation of the engine and generator assembly. Using a hex-head socket and socket wrench, turn the rotor through-bolt in a clockwise direction until the breaker points begin to open.

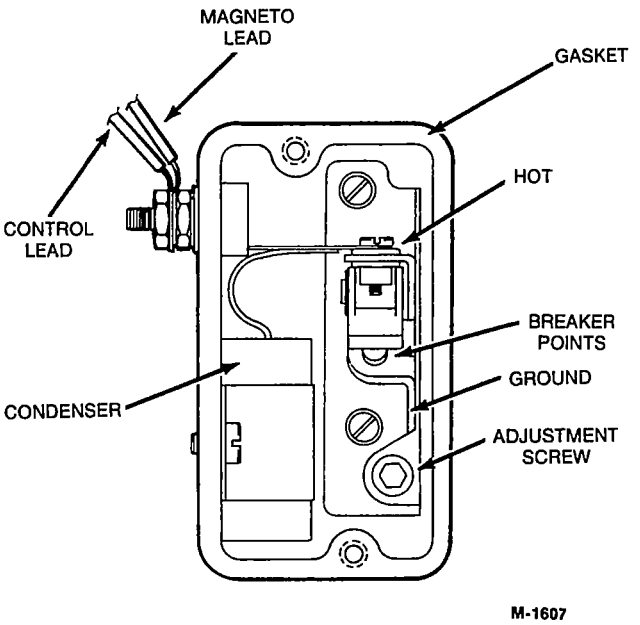


FIGURE 6-5. BREAKER POINTS

6. Adjust the breaker points so that they open when the timing mark on the flywheel is aligned with the 25 degree mark on the gear case cover.
7. Replace the point box cover, spark plugs, and spark plug leads.
8. Connect the negative (-) battery cable to the negative battery terminal.

Replacement:

The ignition adjustments should be made with the engine in a static condition and cold.

1. Disconnect the negative (-) battery cable at the battery terminal.
2. Remove the breaker box cover clip and lift off the breaker box cover.
3. Remove the condenser mounting screw and disconnect the condenser and ignition lead wires. Lift out the condenser (Figure 6-5).
4. Remove the breaker points mounting screws and lift out the breaker point assembly.
5. Replace the condenser and point assembly.
6. Adjust the points as described above.
7. Replace the breaker box cover, spark plugs, and spark plug leads.
8. Connect the negative (-) battery cable to the negative battery terminal.

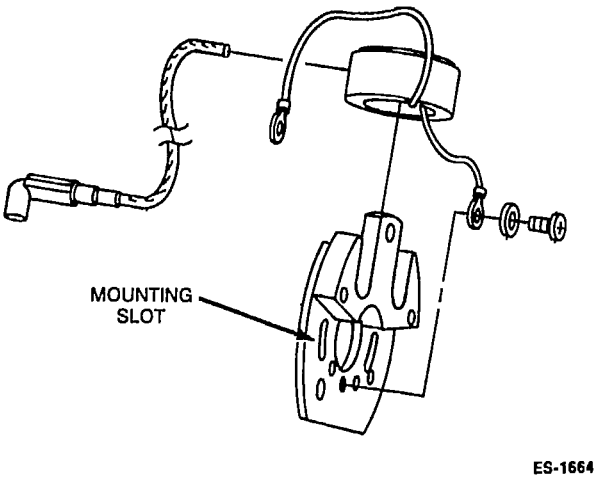


FIGURE 6-6 MAGNETO

Magneto

The magneto (Figure 6-6), is located behind the engine flywheel and reached by removing the flywheel. If ignition spark at the spark plug is defective, first inspect the breaker points. To test the coil: remove the spark plug lead, hold the spark plug about 3/16 inch (4-5 mm) away from bare metal, and crank the engine. A good spark should occur between the lead and engine. If not, the coil, flywheel magnets, or high tension lead are defective.

Magneto Coil and Wiring Tests

1. With an ohmmeter, check resistance between the breaker point lead (disconnected from the points) and a good ground on the engine. Resistance should be less than 1 ohm.
2. Remove the spark plug lead from the plug and measure the resistance to ground. Resistance should be about 10,000 ohms. If it is greater, either the lead or the magneto high tension coil contains a high resistance or is open-circuited. The magneto should be removed to test resistances of the coil and lead separately. (Inspect the high tension terminal on the coil for corrosion.) If the resistance is low, the secondary winding is probably shorted and the coil must be replaced.
3. Check for a short between the primary and secondary circuits by measuring the resistance from the breaker lead to the spark plug lead. Any continuity indicates a defective coil.

Flywheel Removal: Remove the flywheel guard and loosen the flywheel bolt a few turns. While pulling or prying outward on the flywheel, strike the flywheel bolt a short endwise blow to loosen the flywheel. Remove the flywheel bolt and carefully pull the flywheel off the crankshaft.

Flywheel Magnets: Permanent magnets mounted on the flywheel provide a magnetic field for the magneto coils. Never remove these magnets from the flywheel. It may destroy their alignment and seriously weaken the magnets.

The magnets shouldn't lose strength with age or be affected by dropping the flywheel. If the magnetism is lost, return the flywheel to the factory for recharging. Some flywheel magnet chargers can recharge the magnets in the field, but makeshift equipment will probably reduce the magnetism further. To recharge the magnet, maintain the correct polarity. The north-seeking end of a compass needle must be attracted toward the leading magnet pole.

If the magneto backplate has been loosened or removed, see that the gap between the coil pole shoes and the flywheel is 0.010 to 0.015 inch (0.254 to 0.381 mm), and that the backplate mounting screws are positioned between the center and 1/4 inch (6 mm) clockwise in the mounting slot. Improper positioning will result in a weak spark.

Spark Plug

A badly leaded plug will cause misfiring, poor operation or stopping when a load is applied.

Remove the spark plug, inspect, clean and regap it (Figure 6-7). If the plug looks discolored or has fouled, replace it.

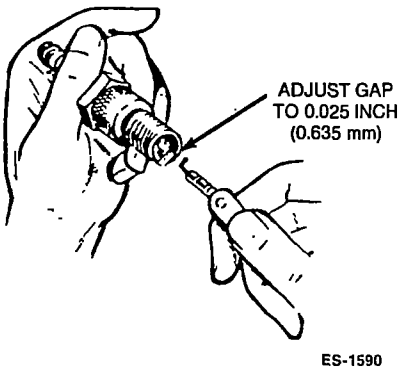


FIGURE 6-7. SPARK PLUG GAP

CRANKCASE VENTILATION SYSTEM

The crankcase breather prevents pressure from building up in the crankcase. It also prevents oil contamination by removing moisture or gasoline vapors and other harmful blow-by materials from the crankcase. These vapors are routed to the carburetor where they are mixed with incoming air and burned in the combustion chamber. A sticky breather valve can cause oil leaks, high oil consumption, rough idle, reduced engine power, a rapid formation of sludge and varnish within the engine, or oil in the breaker point box.

Crankcase Breather Service: At 100-hour intervals or if the crankcase becomes pressurized as evidenced by oil leaks at the seals, remove the breather tube (Figure 6-8) from the valve cover and wash the ball valve in a cleaning solvent.

⚠WARNING ***Most part-cleaning solvents are flammable and can result in severe personal injury if used improperly. Follow the manufacturers recommendations when cleaning parts.***

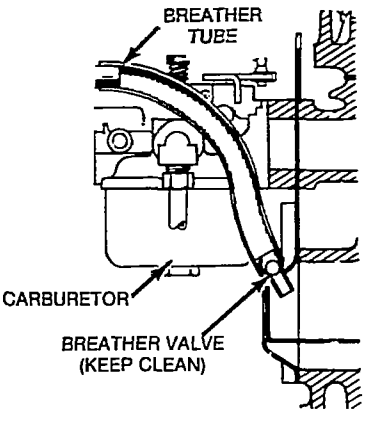


FIGURE 6-8. CRANKCASE BREATHER

GOVERNOR

The governor controls engine speed. An increase in engine speed causes a corresponding increase in generator voltage and frequency. A decrease in engine speed causes a corresponding decrease in generator voltage and frequency. The governor maintains a constant engine speed under changing load conditions so that generator voltage and frequency do not vary.

Governor Adjustments: Before making governor adjustments, run the unit about 10 minutes under light load to reach normal operating temperature. If the governor is completely out of adjustment, make a preliminary adjustment at no load to first attain a safe voltage and speed operating range.

An accurate voltmeter and frequency meter should be connected to the generator in order to correctly adjust the governor. A small speed drop that is not noticeable without instruments will result in an objectionable volt-drop.

A binding in the bearings of the governor shaft, in the ball joint, or in the carburetor throttle assembly will cause erratic governor action or alternate increase and decrease in speed (hunting). A lean carburetor adjustment can also cause hunting. Springs tend to lose their calibrated tension through fatigue after long usage.

If the governor action is erratic after all adjustments are made, replace the spring. If this does not improve operation, the problem is probably within the governor mechanism. Refer to the Governor Cup in section 9 for service procedures.

Adjustments to the governor should be made in the following sequence:

1. The carburetor fuel mixture screws must be correctly adjusted before governor adjustments are made. If the carburetor needs adjusting, refer to the Carburetor Adjustments in this section before making any adjustments to the governor.

⚠WARNING ***Contact with rotating machinery can cause severe personal injury or death. Stay clear of rotating components and ensure that protective shields and guards are in place and secured before operating machinery.***

⚠WARNING ***Touching hot exhaust pipes or moving parts can result in severe personal injury. Use extreme caution when making adjustments while the engine is running.***

2. Adjust the length of the governor linkage and check for binding or excessive looseness. The length of the linkage connecting the governor arm to the throttle shaft assembly is adjusted by loosening the lock nut and rotating the ball joint (Figure 6-9). Adjust this length so that, with the engine stopped and tension on the governor spring, the stop on the throttle shaft assembly almost touches the stop on the side of the carburetor. (One more turn of the governor ball joint would allow the throttle shaft stop to touch the carburetor.) Tighten the lock nut.

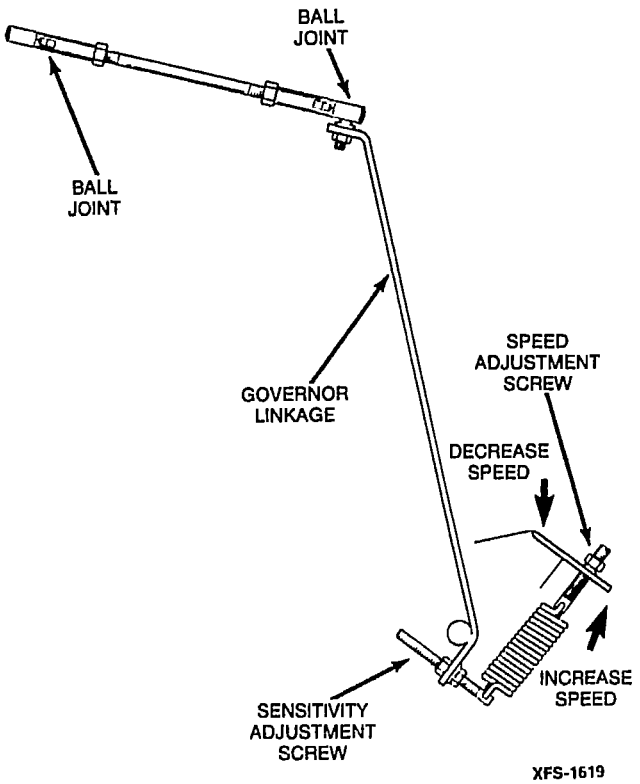


FIGURE 6-9. GOVERNOR ADJUSTMENT LINKAGE

3. With the warmed-up unit operating at no load, adjust the speed adjustment nut to obtain 62 hertz (on a 60 hertz unit) or 52 hertz (on a 50 hertz unit).
4. Check the frequency and voltage, first with a load applied and then with no load applied. The frequency should not vary by more than 5 percent of nominal (57 hertz to 63 hertz on a 60-hertz unit, 47.5 hertz to 52.5 hertz on a 50-hertz unit). Within this frequency range, voltage regulation must be 8 percent.
5. Adjust the governor sensitivity to give the closest regulation (least speed and voltage difference between no load and full load) without causing a hunting condition. To increase sensitivity (closer regulation), turn the sensitivity adjustment screw counterclockwise. To decrease sensitivity, turn the sensitivity adjustment screw clockwise.
6. Recheck the speed setting made in step #3 and readjust if necessary.
7. Set the carburetor throttle stop screw as specified under Carburetor Adjustments.

Governor Linkage Lubrication: Clean the ball joints and lubricate the linkage with powdered graphite as shown in Figure 6-10.

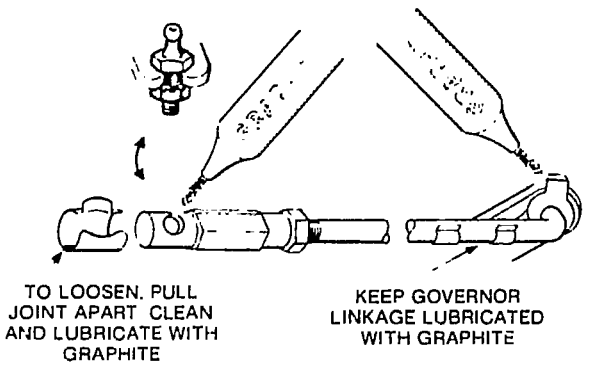


FIGURE 6-10. GOVERNOR LINKAGE

FUEL SYSTEM

The fuel system must be in good condition and properly adjusted for efficient generator set operation. The main components of the fuel system are the carburetor, choke, intake manifold, fuel filter and fuel pump.

Carburetor Adjustments

The most common cause of poor carburetion is misadjustment of the idle or main mixture adjustment screws. Significant variation from the correct settings may result in serious engine trouble. An overly rich mixture not only wastes fuel, but can increase engine wear by washing the lubricant from the cylinder walls and diluting the crankcase oil. An overly lean mixture results in a loss of power, flat spots in acceleration, and a greater tendency to burn valves and spark plugs.

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

Mixture Adjustments: Before adjusting the carburetor, be sure the ignition system is working properly.

Allow the engine to warm-up before starting carburetor adjustments.

If the carburetor (Figure 6-11) is completely out of adjustment and the engine will not run, open both needles 1 to 1-1/2 turns off their seats to permit starting.

1. Apply a full load to the engine.
2. Turn in the main fuel adjustment until the engine speed drops. Then turn out the needle until the engine speed returns to normal.
3. Remove the load from the engine.
4. Turn the idle fuel adjustment out until the engine speed drops slightly. Then turn the needle in until the speed returns to normal.

Throttle Stop Screw Setting: The throttle stop screw (Figure 6-11) is located on the throttle shaft lever. It must be adjusted to permit an additional 1/32 inch (.79 mm) of throttle shaft travel (toward the closed position) when the genset is running with no load.

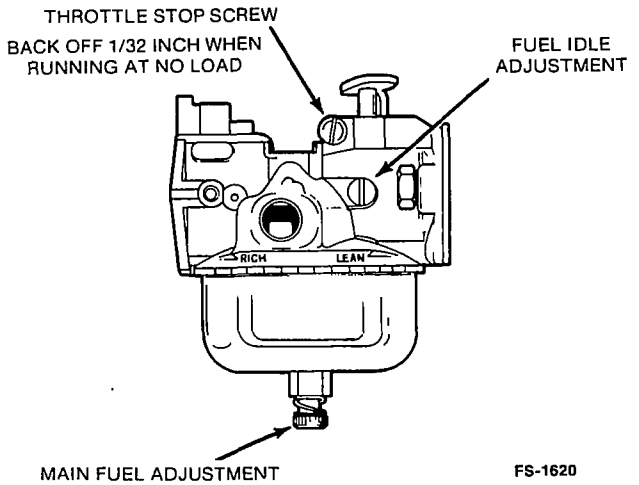


FIGURE 6-11. ADJUSTING CARBURETOR

Float Adjustment: To check the float level, remove the entire fuel adjustment assembly from the float bowl, invert the float and needle valve assembly, and measure between the float and gasket at the point shown in Figure 6-12. The full weight of the float should be resting on the needle valve and spring. The correct distance is 1/8 inch (3.175 mm). If the setting is incorrect, remove the float and bend the tab to adjust.

⚠CAUTION ***Excessive pressure will damage the needle valve. Allow only the weight of the float to rest on the valve assembly.***

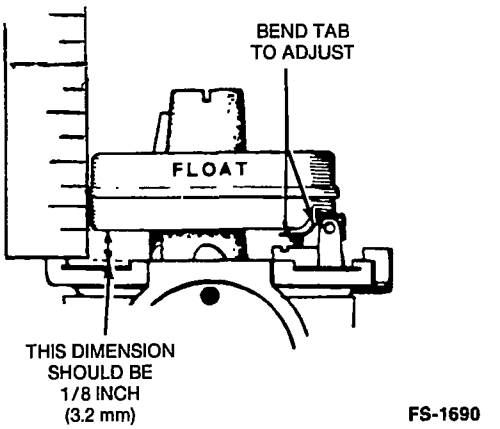


FIGURE 6-12. CHECKING FLOAT LEVEL

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 to ensure correct placement when reassembling. Read through all the instructions before beginning. Carburetor components are shown in Figure 6-13.

⚠WARNING ***Ignition of fuel can cause severe 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.
2. Remove the resonator and flame arrester.

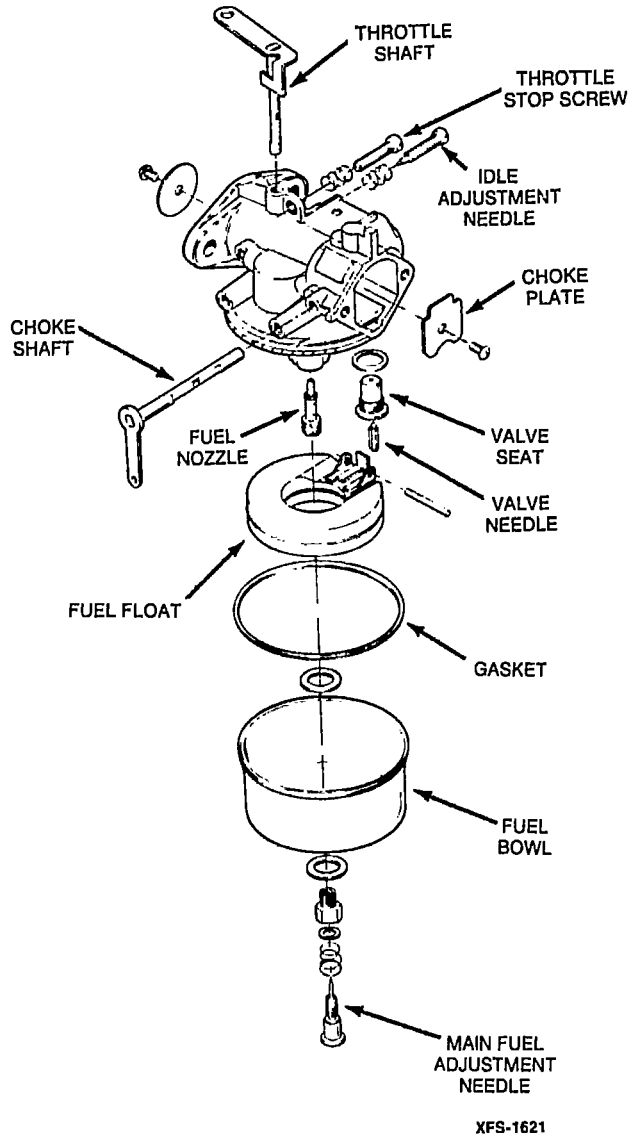


FIGURE 6-13. CARBURETOR COMPONENTS

3. Remove the throttle and choke plate retaining screws. Remove the plates. Pull out the throttle and choke shafts, being careful not to damage the teflon coating applied to some throttle shafts.
4. Remove the main fuel and adjustment screw assemblies.
5. Unscrew the main fuel adjustment retaining nut and remove the fuel bowl from the upper carburetor body.
6. Carefully note the position of the float assembly parts, then slide out the retaining pin and remove the float assembly and the needle valve.
7. Unscrew and remove the needle valve seat.

Cleaning and Repair:

1. Soak all metal components that are to be reused. 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. Do not use wire or other objects for cleaning critical passages.
4. Clean the flame arrester in solvent.

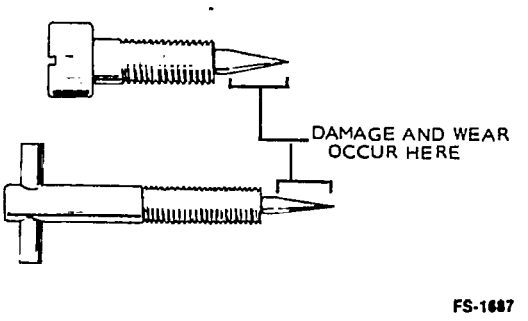


FIGURE 6-14. MIXTURE NEEDLE INSPECTION

5. Check the condition of any needle valve not included in the repair kit and replace if damaged (Figure 6-14). Replace the float if it is filled with fuel or damaged.
6. Check the choke and throttle shafts for excessive play in their bore, and replace if necessary.
7. Replace old components with new parts included in the repair kit.

Reassembly and Installation:

1. Install the 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 the float level and adjust as necessary (see *Float Level Adjustment).*
2. Rejoin the carburetor body.

⚠WARNING ***Gasoline presents a hazard of fire and explosion that can cause severe personal injury or death. Use care when reassembling the carburetor. All parts must align perfectly or the carburetor will leak fuel.***

3. Slide in the throttle and install the throttle plate. 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 a small screwdriver, then tighten the screws. Install the choke shaft and plate in the same manner.
4. Install the main fuel and idle adjustment screw assemblies. Turn in the screws until lightly seated and then turn out 1 to 1-1/2 turns.

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

5. Reinstall the carburetor on the engine and connect the fuel lines, linkages, and wires.
6. Reset the adjustment screws according to the mixture adjustment instructions.

Fuel Pump

The MAJB generator set is equipped with an electric fuel pump. The fuel pump has an integral shutoff valve that prevents fuel flow to the carburetor when the set is not in operation. If the pump malfunctions or insufficient fuel delivery is suspected, use the following procedures to test or repair the pump.

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

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. The pressure reading should be 4-1/2 to 5 psi (31 to 34.5 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 the 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.

Fuel Pump Repair: Service of the fuel 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 because it retains the dry gas that 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 the cover by hand.
2. Remove the filter, magnet and cover gasket (Figure 6-15).

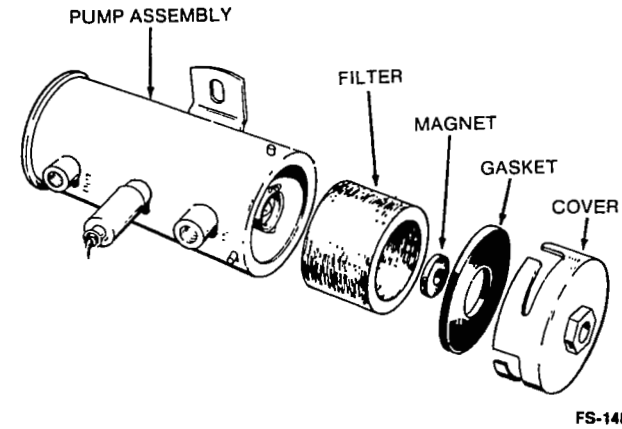


FIGURE 6-15. REMOVAL OF MAGNET AND FILTER

3. Using a thin nose pliers, remove the retainer spring from the plunger tube. Remove the washer, O-ring seal, cup valve, return spring, and plunger from the tube (Figure 6-16).

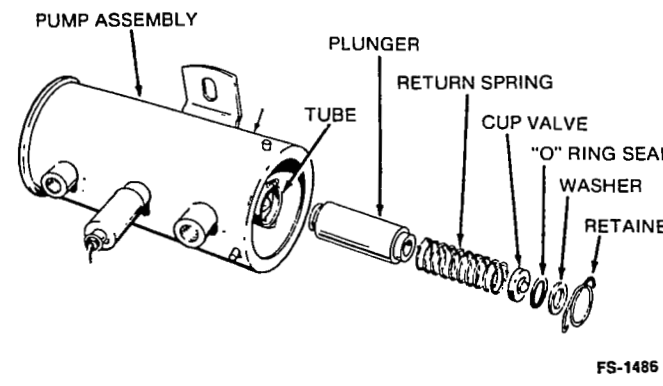


FIGURE 6-16. REMOVAL OF PLUNGER ASSEMBLY

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. 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 can cause severe personal injury if improperly used. Follow the manufacturer's recommendations when cleaning parts.***

5. Insert the plunger in the tube, 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 the plunger spring, cup valve, O-ring seal and washer. Compress the spring and install the retainer with the ends in the side holes of the tube.
7. Check the cover gasket and replace if deteriorated. Place the cover gasket and magnet in the bottom cover and install the filter and cover assembly on the pump. If the filter element is dirty, replace it along with the cover gasket. Twist the cover by hand and tighten securely with a wrench.

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.

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. Figure 6-14 illustrates adjustment of the electric choke.

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.

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

Adjustment: Table 6-1 lists average choke settings. Loosen the two mounting screws (Figure 6-17) 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 screw after adjustment.

TABLE 6-1. CHOKE SPECIFICATIONS

ENGINE COLD	CHOKE PLATE SETTING					
	AMBIENT TEMP ° F					
	40°	60°	70°	80°	90°	100°
Fraction Drill Size Inch	7/64	5/32	11/64	7/32	1/4	1/2

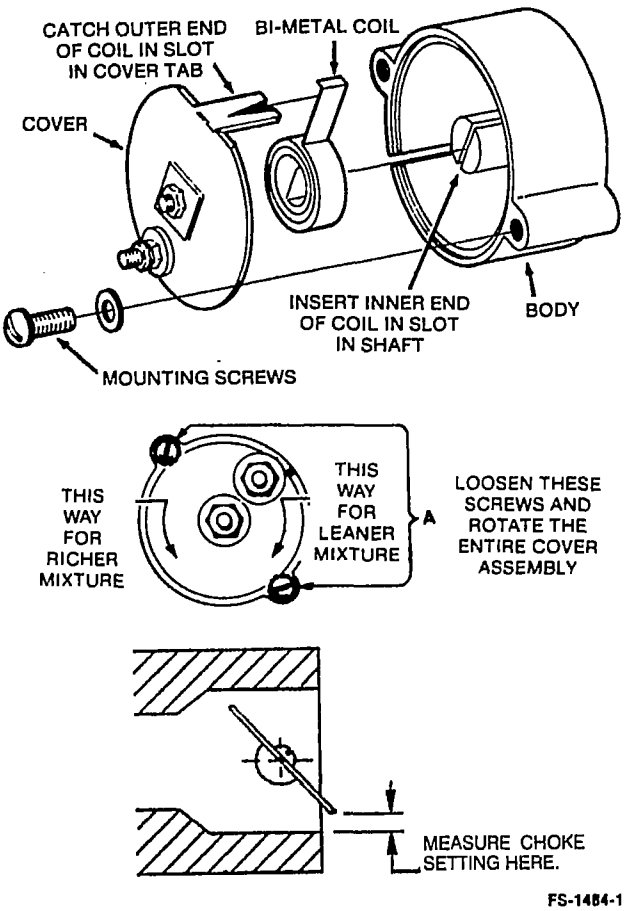


FIGURE 6-17. CHOKE ADJUSTMENTS

Repair: If the choke fails to operate, check to see that 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. 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, binding in the housing, or have an improperly directed spiral.

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. The cover holds the wires in place and prevents movement when tightened. When properly installed, the lead wires 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 (3.18 mm) inside the choke housing to flush with the inside wall.

ELECTRIC START SYSTEM

A 12-volt electric starter with negative ground is used for cranking the generator set. When the starter is energized, an inertial engagement system causes the starter pinion gear to engage the fan and ring gear assembly. As the starter spins, the starter pinion gear drives the ring gear causing the generator set to crank.

Electric Starter

Because the starter is an integral part of the set control system, check the control before servicing the starter. Use the following procedures to disassemble, inspect and assemble the starter.

Disassembly: Use the following procedures to remove and disassemble the starter.

1. Disconnect the generator set negative (-) battery cable from the starting battery.
2. Disconnect the generator set positive (+) battery cable from the starter lug terminal.
3. Remove the starter mounting screws and then carefully disengage the starter from the stator housing.
4. Remove starter through-bolts and carefully separate the brush end cap, housing, and armature assembly (Figure 6-18).
5. Use an impact wrench to remove the pinion gear stop nut from the armature assembly. Carefully separate the pinion gear assembly and drive the end cap from the armature.

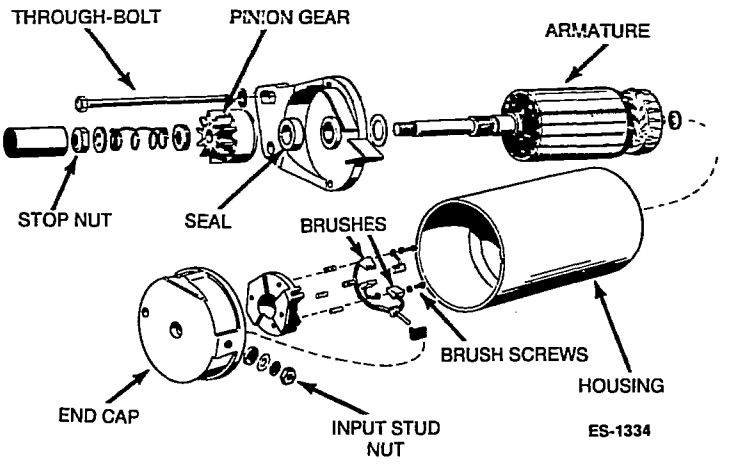


FIGURE 6-18. STARTER MOTOR

Testing Armature For Grounds: Touch an ohmmeter lead to a commutator bar and then touch the other lead to the armature shaft and core laminations. A low resistance reading indicates a grounded armature. Replace a grounded armature with a new part.

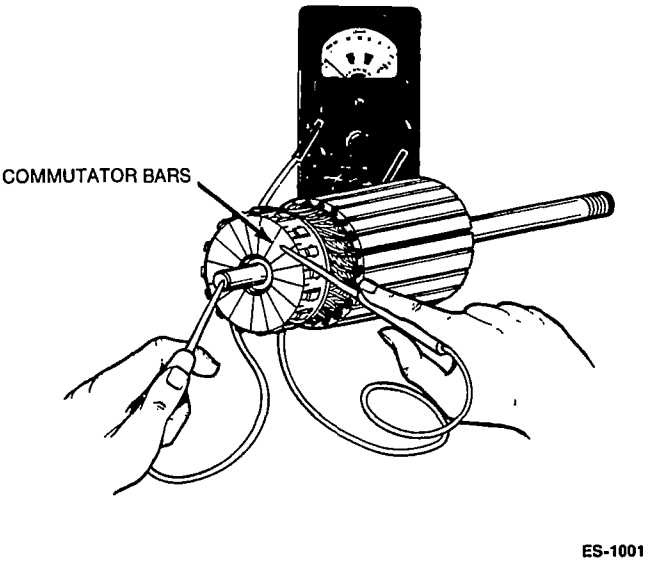


FIGURE 6-19. TESTING ARMATURE FOR GROUNDS

Testing for Shorts: Use a growler (Figure 6-20) for locating shorts in the armature. Place the armature in the growler and pass a thin steel blade just above the armature. Rotate the armature 180° and repeat. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace a shorted armature.

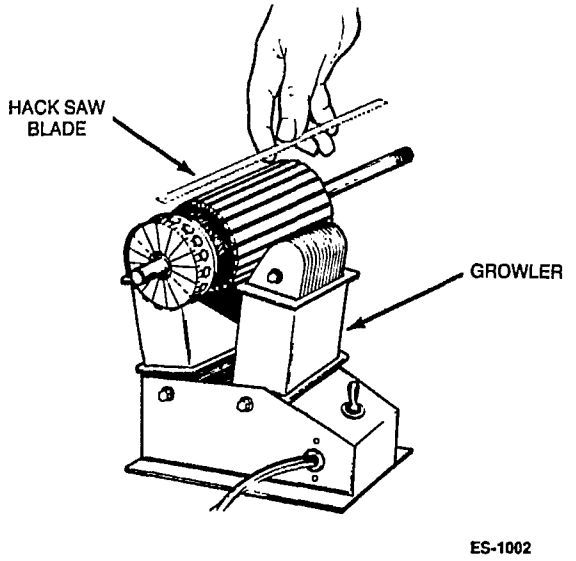


FIGURE 6-20. TESTING ARMATURE FOR SHORTS

Testing for Opens: Touch an ohmmeter lead to a commutator bar and then systematically touch the other lead to each of the remaining commutator bars. A high resistance reading indicates an open circuit between the commutator bars and armature windings. Replace armature if open.

Brush Inspection: Measure the brushes (Figure 6-21) and replace if worn to less than 1/4 inch (6.4 mm). Check to see that the brushes move smoothly in the brush holders. Replace brushes that are burned.

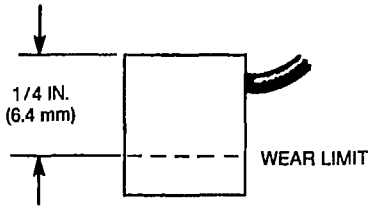


FIGURE 6-21. BRUSH INSPECTION

Housing Inspection: Inspect the inside of the starter housing. Magnets are glued to the housing and must be secure and free of cracks.

Assembly:

1. Wipe off all dirt and oil from starter components using a clean cloth or blow off dirt with filtered low-pressure compressed air.

⚠CAUTION ***Do not immerse bearings in cleaning fluid. Use a brush dipped in clean engine oil for dirt removal.***

2. Assemble the brushes in the brush holder so the chamfered edge is away from the brush springs. Make certain brush wires do not rub against commutator or end cap.
3. Tighten the brush screws to 3 to 3-1/2 ft-lbs (4 to 5 N•m) torque.
4. Tighten the lug terminal nut to 4 to 5 ft-lbs (5 to 7 N•m) torque.
5. Apply a thin film of silicone-based grease (GE Versilube 322-L or equivalent) to the portions of the armature shaft that contact the bearings. Apply a heavy coat of silicone-based grease to the starter drive section of the shaft.
6. Install the pinion gear stop nut and tighten to 20 to 25 ft-lbs (27 to 34 N•m) torque.
7. Place the armature end cap in position on the starter housing and then carefully insert the armature into the housing. Install the starter through-bolts and tighten securely.
8. Mount the starter on the generator stator housing and secure using hex head capscrews, lockwashers, and nuts. Tighten the mounting screws to 30 to 33 ft-lbs (41 to 45 N•m) torque.
9. Connect the generator set positive (+) battery cable to the starter lug terminal.
10. Connect the generator set negative (-) battery cable to the generator set starting battery.

Section 7. Control

INTRODUCTION

The control system includes all functions that relate to starting, monitoring for fault conditions, instrumentation, battery charging, and stopping. This section covers how the control operates, where the components are located, and basic troubleshooting procedures.

CONTROL DESCRIPTION

The generator set control (Figure 7-1) includes:

- Panel-mounted Start/Stop switch (S1)
- Three fuses
- AC circuit breaker
- Total Hours indicator
- Four control relays
- Battery charge and generator field diodes

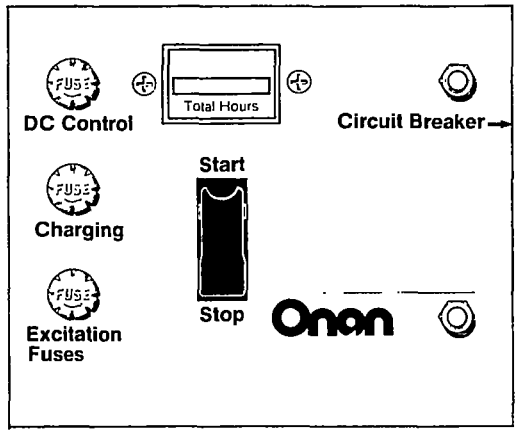


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FIGURE 7-1. CONTROL PANEL

The generator set control system includes:

Starter solenoid
High engine temperature switch
High exhaust temperature switch
Low oil pressure switch
Optional remote Start/Stop switch

NOTE: A PC Board-Mounted Start/Disconnect relay replaces Relay K2 on Spec B MAJB generator sets. Circuit functions and wiring diagram remain unchanged.

CONTROL OPERATION

The schematic diagrams shown in Figure 7-2 and 7-3 are not identical. Always refer to the specific wiring diagram that corresponds to the model and spec number of the generator set when troubleshooting.

Starting: Placing the Start/Stop switch (S1) in the Start position connects B+ (through F1) to the starter solenoid (K1), the control relay (K4), the fuel pump (E3), the electric choke (E4), and the Total Hours indicator (M1). The closing of the normally open K1 contacts supplies battery power to the starter motor (B1) and (through excitation fuse F3 and diode CR2) to the generator field windings. The opening of normally closed K4 contacts removes the ground from the positive voltage side of the breaker contacts.

As a result of these actions:

- The starter cranks the engine.
- The ignition system provides spark.
- The fuel pump provides fuel.
- The electric choke begins to heat.
- The Total Hours indicator records running time.

Starter Lockout - Run: As the engine starts, the low oil pressure switch (S3) closes and the generator begins to produce an output. The closing of switch S3 provides battery ground (B-) to relay coil K5, closing the normally open K5 contacts. The generator output energizes relay K2, closing its normally open contacts (8/6) and opening its normally closed contacts (4/1).

As a result of these actions:

- Closing the normally open K2 and K5 contacts provides another path for B+ to the fuel pump, the electric choke, the Total Hours indicator, and the coils of relays K4 and K5.
- Opening the normally closed K2 contacts de-energizes starter solenoid K1, which disconnects B+ from the starter motor and the field excitation circuit.

Under normal operation:

- The current through the choke heater causes the choke to open to its run position.
- The generator field windings are excited through the bridge rectifier and the field brushes.
- The generator charge winding provides charge current to the battery through charging fuse F2 and charging diode CR1.
- The generator AC output is supplied to terminal block TB1 through circuit breaker CB1.

Stopping: Placing the Start/Stop switch (S1) in the Stop position connects B+ to the coil of relay K3, opening its normally closed contacts.

As a result of this action:

K4 is de-energized, closing its normally closed contacts and grounding out the ignition system

- The fuel pump (E3) is shut off
- Relay K5 is de-energized
- The Total Hours indicator is shut off

Without ignition or fuel, the engine stops. As the generator output voltage drops, K2 de-energizes. All components return to their de-energized state following shutdown. Charging diode CR1 prevents the battery from discharging through the generator windings when the unit is not running.

Automatic (Sensor) Shutdowns: When engine oil pressure drops below 9 psi (62 kPa), the low oil pressure switch (S3) opens and de-energizes K5. When the normally open contacts of K5 open, the ignition circuit is grounded (via K4) and the fuel pump is shut off.

When engine temperature exceeds 200°F (93°C), the normally open high engine temperature switch (S4) closes and grounds-out the ignition circuit.

When engine exhaust temperature exceeds 190°F (88°C), the normally open high exhaust temperature switch (S5) closes and grounds-out the ignition circuit.

Optional Remote Start Control

The remote start control is an optional accessory that allows the generator set to be started, monitored, and stopped from a remote location. The deluxe control includes a running time meter and a battery condition meter.

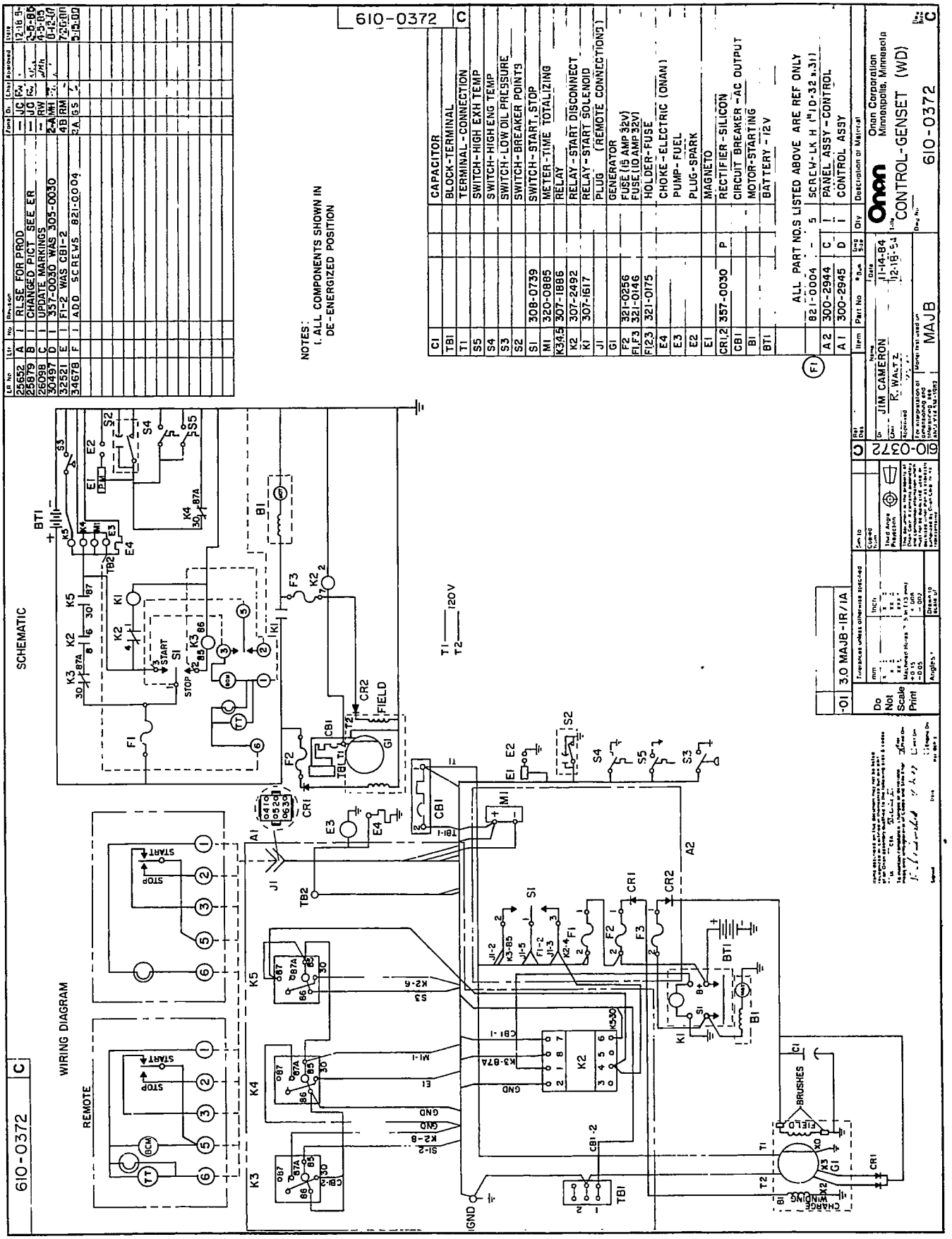

FIGURE 7-2. 3.0 MAJB WIRING DIAGRAM AND SCHEMATIC

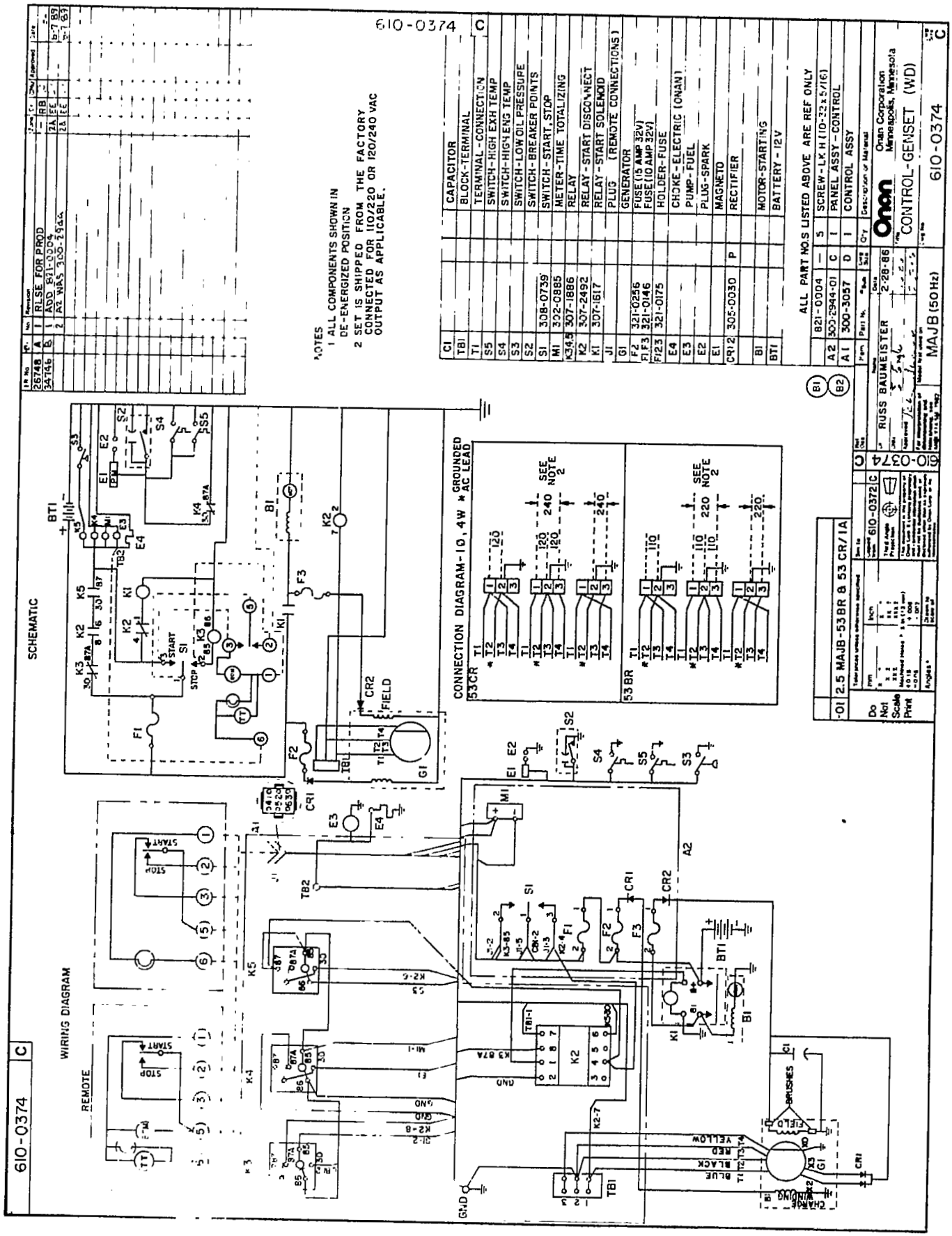

FIGURE 7-3. 2.5 MAJB WIRING DIAGRAM AND SCHEMATIC

CONTROL TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the control.

Refer to the wiring diagram in Figures 7-2 and 7-3 for the location of all terminals.

The troubleshooting guide is divided into six sections. After identifying the problem, refer to the guide for the possible cause and the recommended corrective action. Figure 7-4 illustrates the location of the control components.

TROUBLESHOOTING THE CONTROL

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Does Not Crank	1. If engine cranks at set but not at remote control panel, fault is due to: a. open circuit in remote control or b. remote start switch faulty.	1a. Check for continuity and correct if circuit is open. 1b. Replace remote start control switch.
	2. If engine cranks at remote control panel but not at set, fault is due to faulty S1 switch.	2. Replace S1 switch.
	3. Insufficient voltage for cranking due to: a. battery not charged or b. terminal connections loose or dirty.	3a. Check condition of battery and recharge or replace. b. Clean and tighten all connections at battery, K1 start solenoid, and starter motor. ⚠WARNING ***Short circuiting the battery cables can result in severe personal injury. Disconnect the negative battery (-) cable at the battery terminal before servicing.***
	4. Control fuse (F1) is open.	4. Replace fuse (10 ampere).
	5. Connect a voltmeter across the coil of the start solenoid. Check for voltage when S1 is placed in Start position. If voltage is present, fault is due to: a. defective K1 relay or b. defective starter.	5a. Replace K1. 5b. Refer to Electric Starter section for test and service procedures.
	6. If voltage is not present as described in step 5 test, fault is probably due to: a. open circuit between K1 relay and start switch or b. defective start switch.	6.a. Check for continuity and correct if circuit is open. 6b. Replace start switch.

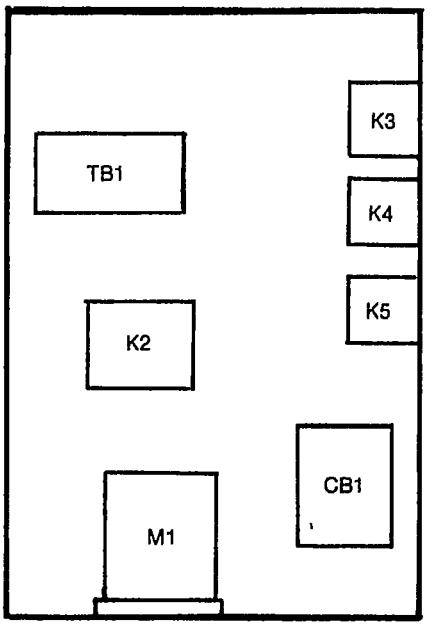

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FIGURE 7-4. CONTROL INTERIOR

TROUBLESHOOTING THE CONTROL

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Cranks But Does Not Start	1. Faulty ignition due to worn or fouled spark plugs, magneto malfunction, worn ignition points, incorrect ignition timing, or faulty plug wires.	1. Refer to Ignition System section for test and service procedures.
	2. Faulty fuel system due to sticking choke, faulty fuel pump, or carburetor mixture screws incorrectly adjusted.	2. Refer to Fuel System section for test and service procedures.

TROUBLESHOOTING THE CONTROL

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Starts But Stops When Start Switch is Released	1. Low oil pressure switch not closing due to: a. low oil level, b. open circuit between switch and control, c. defective low oil pressure switch, or d. low oil pressure.	1a. Check oil level and add oil if low. 1b. Check for continuity and correct if circuit is open. 1c. Replace low oil pressure switch. 1d. Refer to Lubrication system section for test and service procedures.
	2. Output voltage from generator not being supplied to control due to: a. open circuit in wiring between generator and control, b. defective bridge rectifier, or c. no output voltage from generator.	2a. Check for continuity and correct if circuit is open. 2b,c. Refer to Generator section for test and service procedures.
Engine Starts And Runs; Then Stops. Set Restarts Immediately or Set Restarts After Cooling Down	1. Fuel level is below generator set fuel pickup tube or oil level is low.	1. Check fuel and oil levels and refill as necessary.
	2. Faulty choke operation due to sticking choke linkage, incorrect choke adjustment, open circuit in wiring between choke heater and generator, or defective choke heater.	2. Refer to Fuel System section for testing and service procedures.
	3. Vapor lock due to: a. high ambient air temperatures or b. faulty fuel pump.	3a. Refer to Cooling System section. 3b. Refer to Fuel System section for test and service procedures.
	4. Breaker points sticking.	4. Replace breaker points.
	5. Contaminated fuel.	5. Refill tank with fresh fuel.
Low Battery	1. Weak or discharged battery. Generator set charger will not recharge a battery that is in a very low state of charge.	1. Connect a separate battery charger to bring battery up to full charge.
	2. Load connected to battery while set is turned off.	2. Turn off load.
	3. Open in charge circuit due to: a. blown charging fuse or b. open charging diode (CR1).	3a. Replace fuse. 3b. Replace CR1.

TROUBLESHOOTING THE CONTROL

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Run Lamp, Time Meter, or Battery Condition Meter Does Not Operate	1. Open circuit between the control and the remote Start/Stop switch.	1. Check for continuity and correct if circuit is open.
	2. If the battery condition meter works but the time meter does not, the time meter is defective.	2. Replace time meter.

Section 8. Generator

INTRODUCTION

The MAJB generator set has a two-pole, revolving-field generator. AC load connections are made at a terminal block (TB1). A circuit breaker provides overcurrent protection for the generator and also functions as an on/off switch in the load circuit.

GENERATOR DESCRIPTION

The generator consists of the following major components:

- Stator
- Rotor
- Field Current Rectifier
- Brushes

Stator

During generator set operation AC current is produced in the windings of the stator. On 60-hertz units, there is one winding (T1-T2) for providing the 120-volt AC output. On 50-hertz units, there are two windings (T1-T2 and T3-T4) that can be connected for 110/220-volt AC (53BR) or 120/240-volt AC (53 CR).

All stators have two exciter windings (X2-X0 and X3-X0) for battery charging. (Refer to the appropriate schematic and wiring diagram in Figures 8-1 and 8-2).

The stator mounts inside the generator housing and is held in position with four generator through studs. A series of air-intake openings in the end of the housing allow cool air to be drawn inside the housing for generator cooling. The housing also provides a mounting point for the starter, rear bearing, brushes and controls. The complete stator and housing assembly bolts to the engine-to-generator adapter.

Rotor

The 2-pole rotor provides the rotating magnetic field that is required for generating an AC voltage potential in the stator windings. The DC current required for field excitation is supplied through two slip rings that mount on the rotor shaft.

The inner end of the rotor is connected directly to the engine crankshaft using a tapered seat/shaft coupling and through-bolt. The outer end of the rotor is supported by a single bearing that is pressed onto the rotor shaft. The bearing fits inside the generator housing bearing.

Cooling airflow for the generator is provided by a centrifugal fan that mounts on the inner end of the rotor shaft. The fan also serves as a mount for the starter ring gear.

Field Current Rectifier (CR1)

The CR1 rectifier is a full wave bridge rectifier used to rectify a portion of the generator AC output voltage to DC for field excitation. The positive and negative terminals of the rectifier are connected to the generator brushes. The rectifier mounts inside the generator set and can be accessed by removing the endbell cover.

Brushes

The brush block assembly consists of a brush guide with two brushes. The brush guide mounts inside the endbell and can be accessed by removing the endbell cover.

GENERATOR OPERATION

Generator operation involves the control, stator, rotor, brushes, and full wave bridge rectifier. (Refer to the appropriate schematic and wiring diagram in figures 8-1 and 8-2).

When the Start/Stop button is placed in the Start position, the rotating field (rotor) is momentarily connected to battery positive (B+) to ensure adequate residual magnetism for voltage build-up. As the engine starts and speed increases, the rotating field induces a voltage build-up in the stator windings. A portion of the AC current generated in the stator windings is rectified to DC by the CR1 bridge rectifier. The DC current is supplied to the rotating field windings to create the strong magnetic field required for generating the rated current. The AC voltage build-up stabilizes at approximately 128 volts when the engine reaches governed speed.

GENERATOR TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the generator. Figure 8-3 shows the location of most of the generator components. Refer to the wiring diagrams in Figures 8-1 and 8-2 for the location of all terminal connections. The troubleshooting guide is divided into four sections. After identifying the problem, refer to the guide for the possible cause and the recommended corrective action.

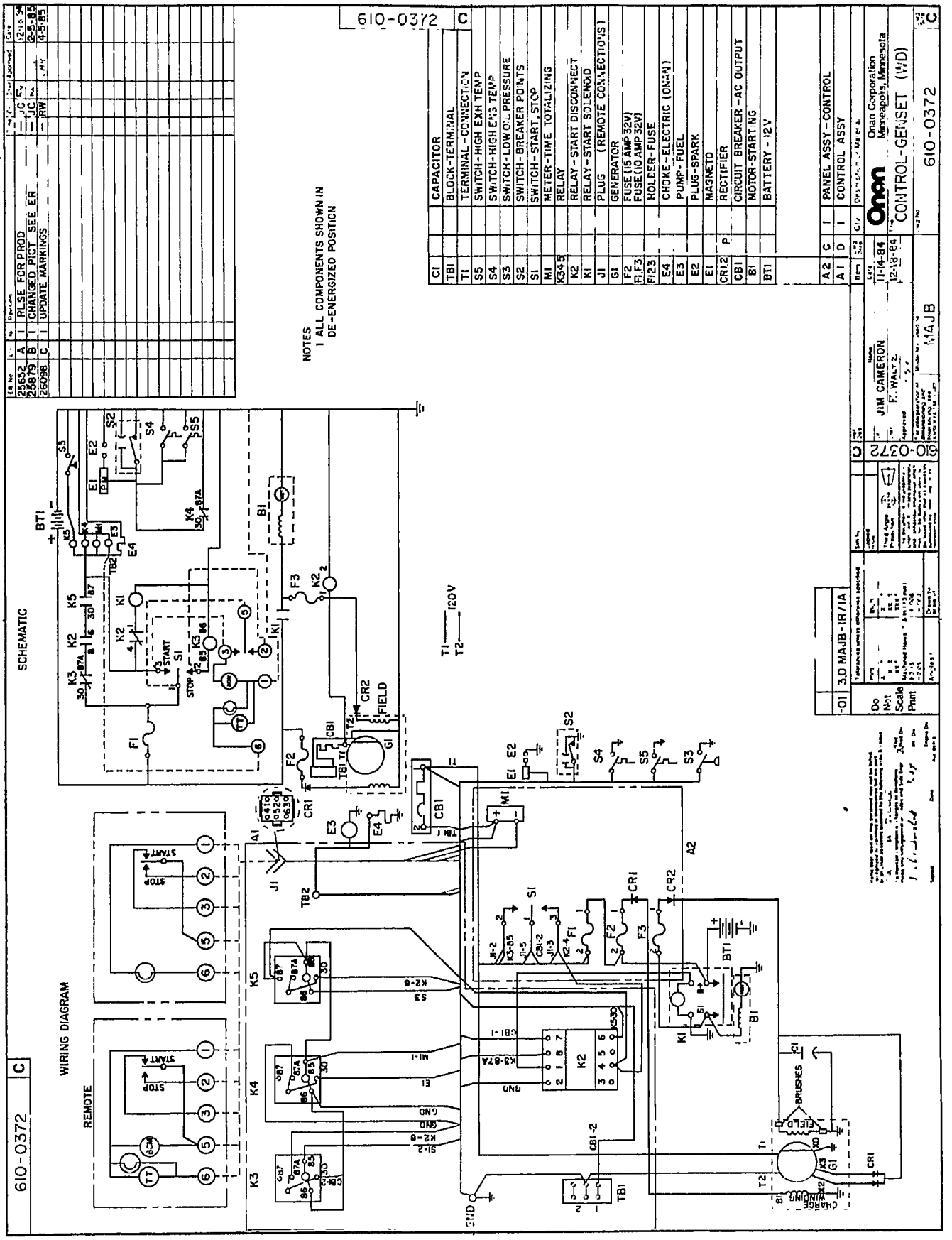


FIGURE 8-1. 3.0 MAJB WIRING DIAGRAM AND SCHEMATIC

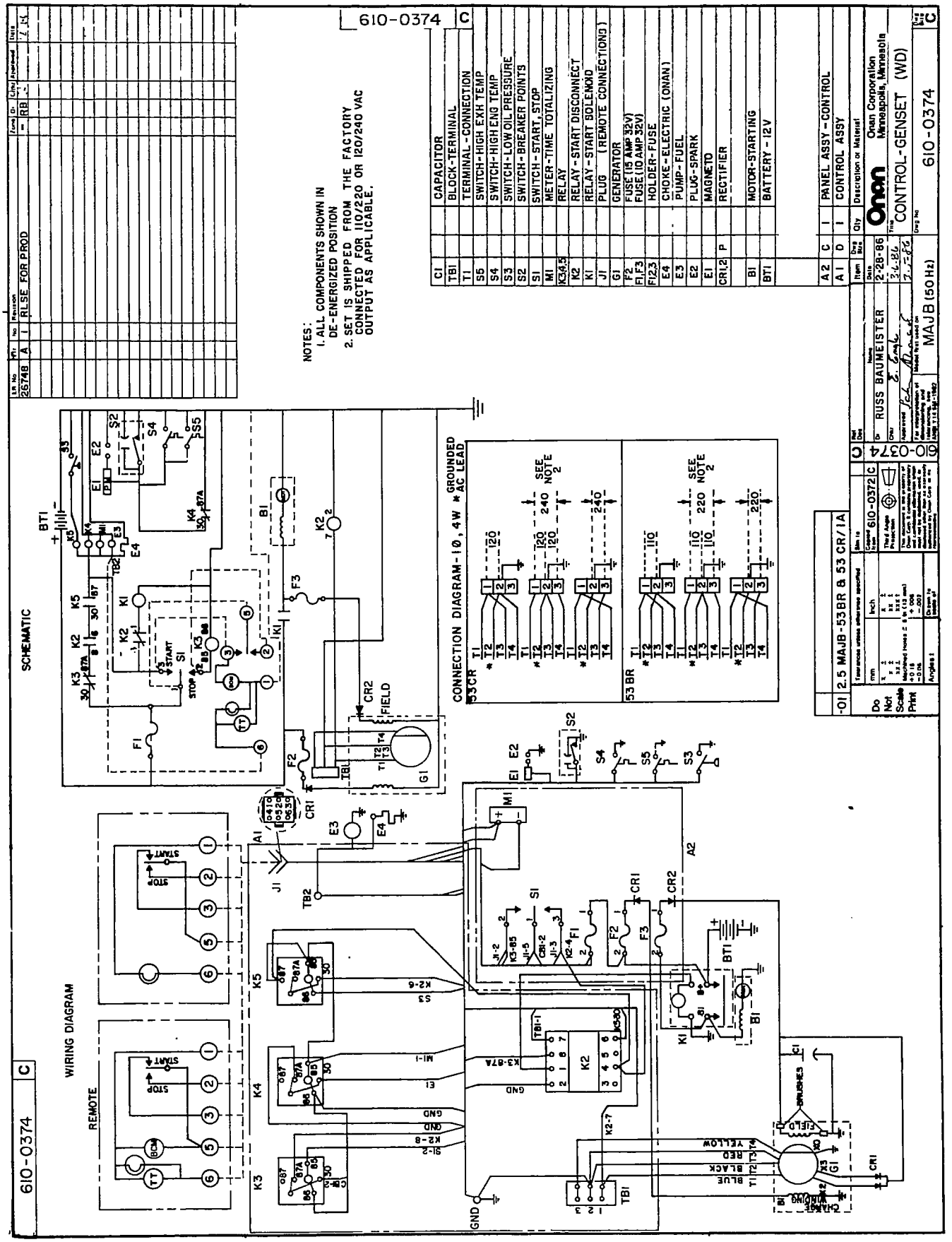


FIGURE 8.2. 2.5 MAJB WIRING DIAGRAM AND SCHEMATIC

TROUBLESHOOTING THE GENERATOR

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
No AC Voltage Note: This condition may cause the generator set to stop when the Start switch is released.	1. Open circuit breaker.	1. Locate cause of overload and correct as required. Reset breaker.
	2. Open circuit between the brushes and the CR1 bridge rectifier.	2. Check for continuity and correct if circuit is open.
	3. Brushes stuck in holder or not making good contact with slip rings.	3. Release brushes if jammed in holder. Clean slip ring if dirty.
	4. Excitation fuse open.	4. Check and replace if it is defective.
	5. Defective CR1 bridge rectifier.	5. Check and replace if it is defective.
	6. Defective capacitor C1.	6. Check and replace if it is defective.
	7. Open, grounded, or short circuit in rotor or stator.	7. Test each component for open, grounded, or shorted windings and replace if it is defective.
AC Output Voltage Too Low Or Too High	1. Engine governor incorrectly adjusted.	1. Refer to Governor section.
	*2. Defective CR1 bridge rectifier.	2. Test rectifier and replace if it is defective.
	*3. Brushes worn or not making good contact with slip rings.	3. Check length of brushes and replace if worn excessively - clean slip rings if dirty.
	4. Excitation fuse open.	4. Check and replace if it is defective.
	5. Defective capacitor C1.	5. Check and replace if it is defective.
	6. Defective rectifier CR2.	6. Check and replace if it is defective.
	*7. Open, grounded, or short circuit in rotor or stator.	7. Test each component for open, grounded, or shorted windings and replace if defective.
Noisy Generator	1. Loose brush guide.	1. Tighten brush guide.
	2. Worn generator end bearing.	2. Replace end bearing.
	3. Rotor and stator rubbing together due to: a. varnish lumps or b. rotor misaligned with crankshaft.	3a. Check for varnish lumps between rotor and stator and remove as required. b. Follow specified assembly procedures to correct rotor-to crankshaft to-crankshaft alignment.
Generator Overheats	1. Generator overloaded due to defective circuit breaker.	1. Remove part of load and replace circuit breaker.
	2. Airflow restricted due to obstructed vent openings in stator housing.	2. Clear away all obstructions.
	3. Stator windings covered with oil or dirt.	3. Clean stator windings.
	4. Open, grounded, or short circuit in rotor or stator.	4. Test each component for open, grounded, or shorted windings and replace if defective.

*causes low AC output voltage.

GENERATOR SERVICE

This section covers generator disassembly and assembly procedures. Refer to Figure 8-3 to locate and identify the various generator components described in each sub-section.

Generator Disassembly

Use the following procedures to disassemble the generator:

1. Remove the control cover. Remove the screws in the control that secure the end bell cover. Remove additional wiring as needed.
2. Remove the end bell cover.
3. Disconnect the stator leads.
4. Remove the four long capscrews, lockwashers and nuts that fasten the end bell, stator and generator adapter together. Pull the end bell straight out from the stator and set it aside. Pull the stator straight out. The starter is also connected to the generator adapter and the start solenoid is connected to the control mounting bracket by the top two long capscrews. The generator set mounting brackets are attached to the generator adapter.

   ALL PARTS INSIDE OF THE END BELL; INCLUDING DIODES, CAPACITOR, BEARINGS, WIRES, AND CONNECTIONS CAN BE TESTED AT THIS TIME. THE ROTOR, STATOR, AND COLLECTOR RINGS CAN ALSO BE CHECKED OR TESTED AT THIS TIME WITHOUT FURTHER DISASSEMBLY. THE BRUSHES MUST BE REMOVED FOR INSPECTION.
5. Remove the internal allen screw, sleeve and rotor through-stud. Tap the rotor gently with a soft-faced hammer (brass or lead) to loosen the rotor from the tapered engine crankshaft.

   The internal allen screw and rotor through-stud may come out as one piece or separately.
6. Remove the three capscrews, nuts, and lockwashers that secure the generator adapter to the engine and remove the adapter.
7. Generator assembly is the reverse of disassembly. Follow the torque values listed in section 4. Be sure the internal allen nut is fully threaded onto the rotor through-stud (coarse thread end) prior to installing the rotor through-stud into the engine crankshaft.

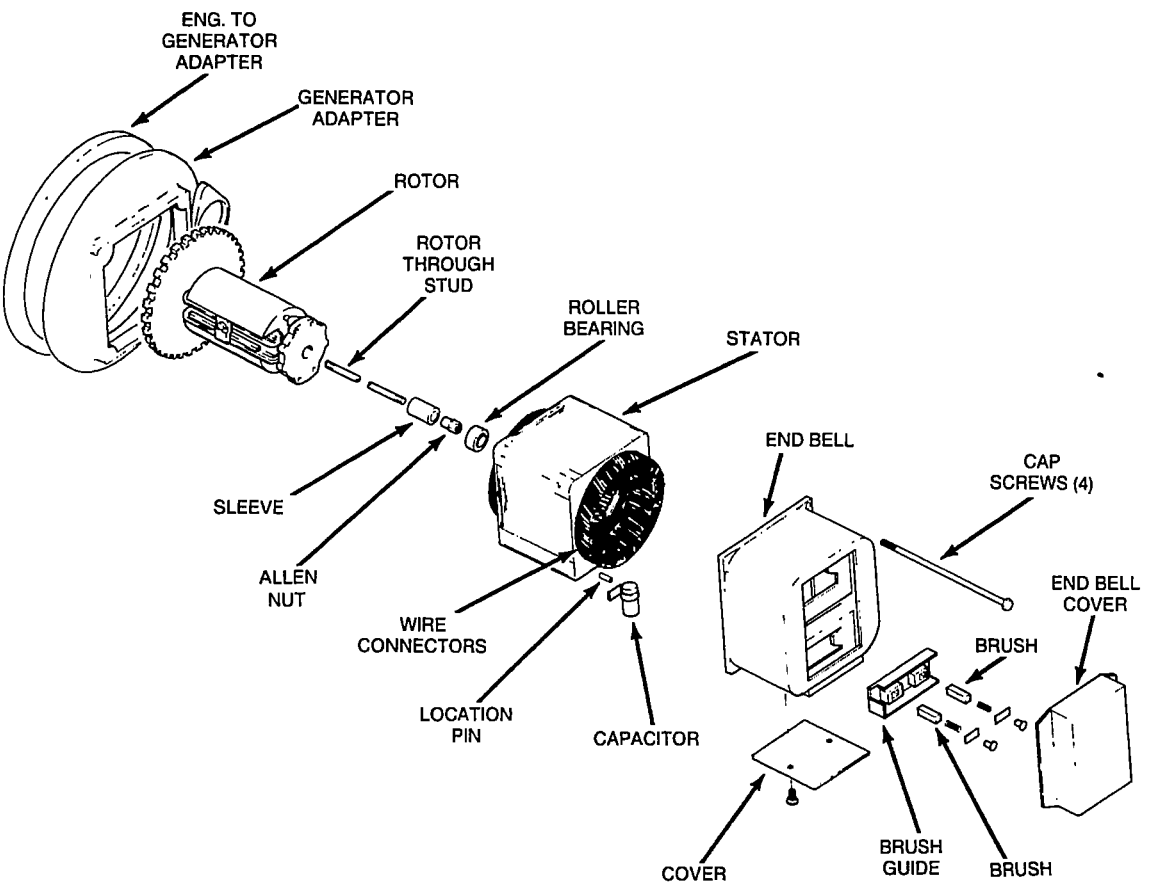


FIGURE 8-3. GENERATOR DISASSEMBLY

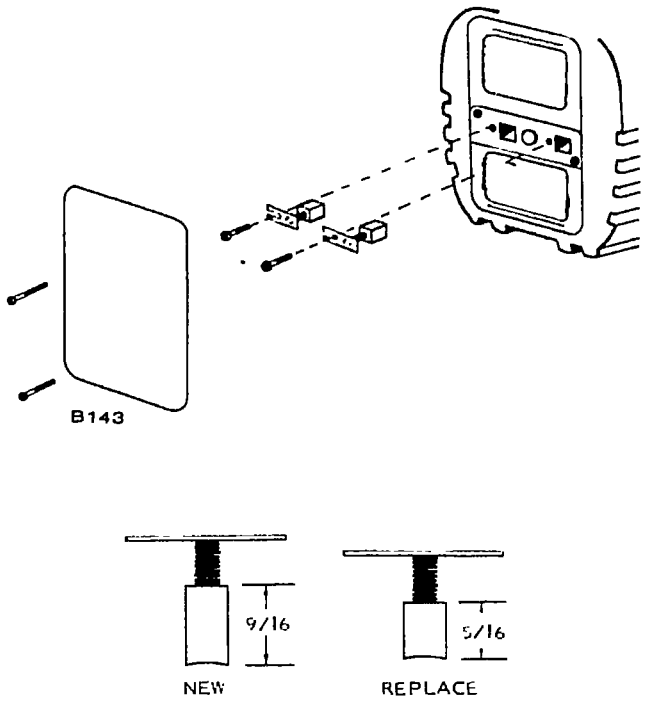
Brushes and Slip Rings

To inspect the brushes:

1. Remove the cover plate from the end bell (Figure 8-4).
2. Unfasten the brush mounting (Hex Head) screws.
3. Slide the brushes out of their holders.
4. Replace if worn to 5/16 inch or less.

Use only the replacement brushes specified in the parts manual. Other brushes may have entirely different electrical characteristics. Be sure the brushes slide freely in their holders, without any binding.

If the slip rings are rough, smooth the ring surfaces with #240 sandpaper. Do not use emery cloth.



ALTERNATOR BRUSHES

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FIGURE 8-4. BRUSH REMOVAL AND REPLACEMENT

Capacitor C1

To replace the capacitor:

1. Remove the screw that secures the capacitor mounting bracket to the end bell (Figure 8-5). Remove the bracket.
2. Free the capacitor from its position.
3. Slide the two terminal wires off the terminal posts at the top of the capacitor.
4. Connect the terminal wires to the terminal posts of the replacement capacitor. Be sure to attach the white grounding wire to the unpainted terminal post. The black wire (+) attaches to the terminal post with the red marking.
5. Install the capacitor into position with the mounting bracket.
6. Fasten the screw through the mounting bracket to the end bell. Be sure the grounding wire is in position.

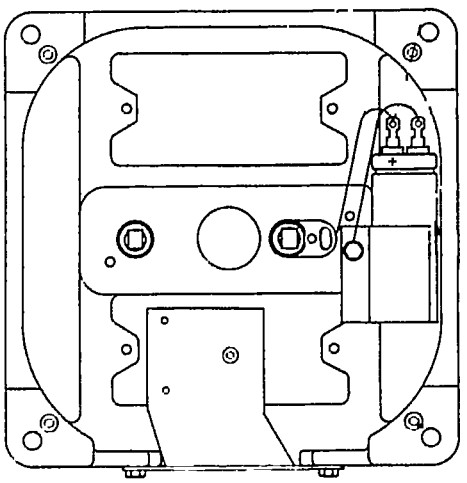


FIGURE 8-5. CAPACITOR LOCATION

Bridge Rectifier

To check the bridge rectifier: Remove two small AC leads (X2 and X3) and the positive (+) DC lead from the bridge rectifier (Figure 8-6). Connect one lead of the ohmmeter to one of the AC terminals and the other ohmmeter lead to the positive (+) DC terminal of the bridge rectifier. Observe the reading. Now reverse ohmmeter leads and again observe the meter. (Check both AC terminals to positive (+) in this manner.) A good rectifier will have a much higher resistance in one direction than the other. If both readings (on one AC terminal) are high or low, the rectifier is defective and must be replaced.

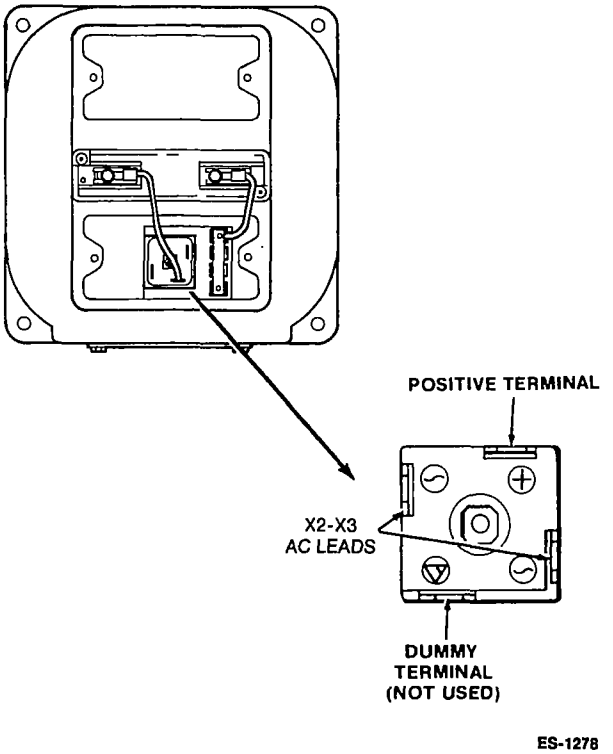


FIGURE 8-6. BRIDGE RECTIFIER

Rotor

To measure the Rotor Winding Resistance: Use an accurate ohmmeter for this test. Connect meter leads to each slip ring (Figure 8-7). Resistance should be 25.6 to 28.4 ohms at room temperature. Replace the rotor if it does not meet this specification.

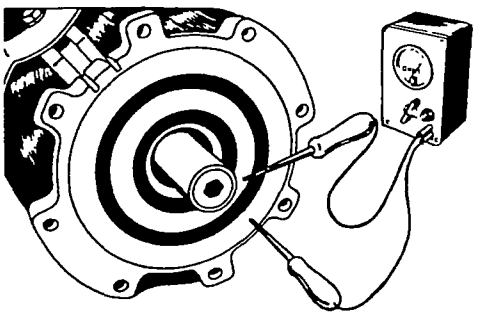
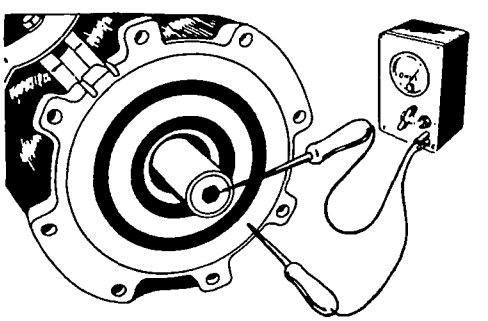


FIGURE 8-7. MEASURING ROTOR RESISTANCE

To Test the Rotor for Grounds: Connect an ohmmeter from each slip ring to the rotor shaft Figure 8-8). There should be a high resistance (open) from each ring to the shaft (ground). Replace the rotor if there is low resistance to ground.



ES-1282

FIGURE 8-8. CHECKING ROTOR WINDINGS FOR GROUND

Testing Stator Windings

Stator winding resistances are listed in table 8-1. A Wheatstone or Kelvin bridge is necessary to accurately measure resistances below one ohm.

To measure the AC stator windings:

- 3.0 MAJB (60 Hertz) - measure the resistance from T1 to T2 (Figure 8-9).
- 2.5 MAJB (50 Hertz, both 110/220- and 120/240-volt units) - measure the resistance from T1 to T4 with T2 and T3 shorted together (Figure 8-10).

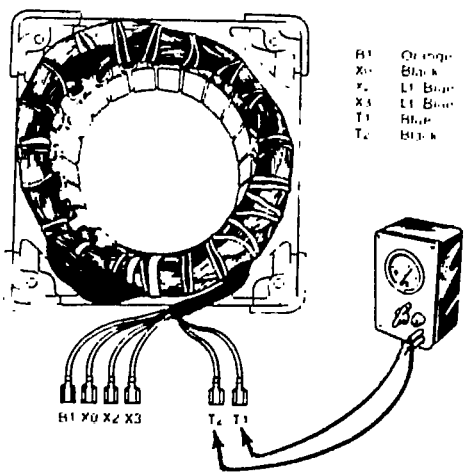


FIGURE 8-9. TESTING STATOR WINDINGS (3.0 MAJB)

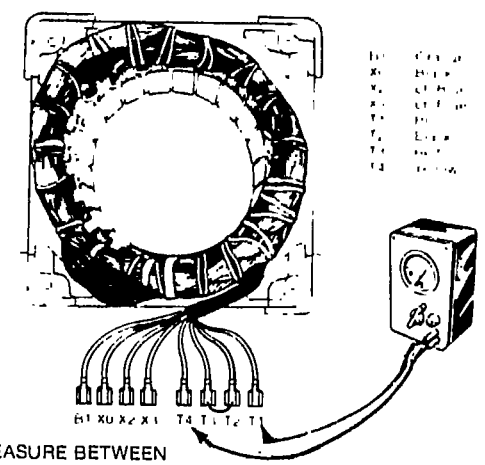


FIGURE 8-10. TESTING STATOR WINDINGS (2.5 MAJB)

To measure the exciter windings:
Measure the resistance from X2 to X3 (Figure 8-11).

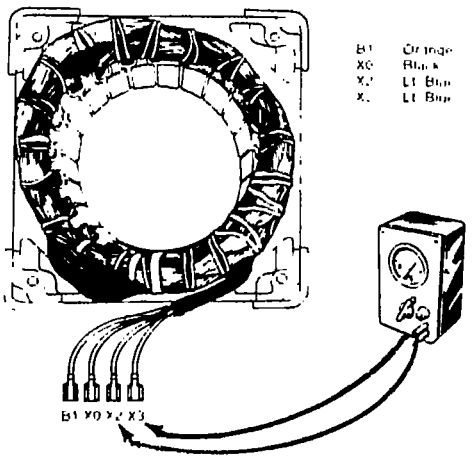


FIGURE 8-11. TESTING EXCITER WINDINGS

To measure the battery charge windings: Measure the resistance from B1 to X0 (Figure 8-12).

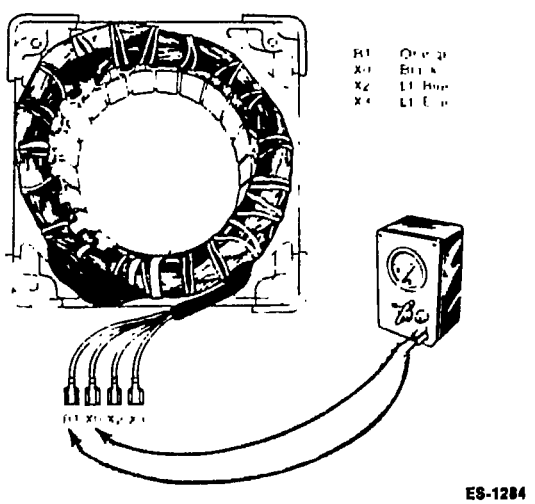


FIGURE 8-12. TESTING BATTERY CHARGE WINDINGS

TABLE 8-1. STATOR WINDING RESISTANCE

MAJB MODEL	WINDING RESISTANCE (OHMS)		
	AC	Exciter	Battery Chg.
3.0 120V	0.20	1.65	0.14
2.5 110/220V	0.82	2.22	0.18
2.5 120/240V	0.90	1.88	1.18

Section 9. Engine - Block Assembly

INTRODUCTION

The engine block assembly includes the pistons and connecting rods, crankshaft, camshaft, valves and lifters, cylinder heads, lubrication system, timing gears, governor mechanism, bearings, and cylinder block.

To gain access to the block assembly, the control, generator, and all primary engine systems must also be removed. Refer to the previous sections for the disassembly and removal procedures.

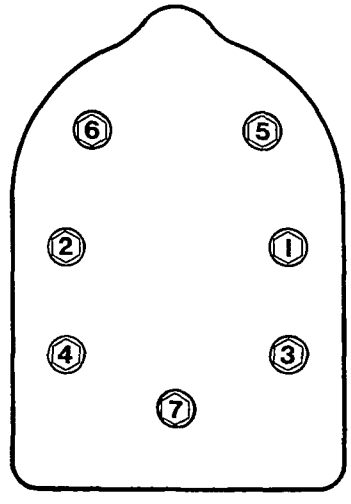
CYLINDER HEAD

Remove the cylinder head for cleaning when poor engine performance is noticed. Use the following procedures to service.

1. Use a socket wrench to remove the cylinder head nuts and lift off the head.

⚠CAUTION ***Warpage can occur if the head is removed while hot. Wait until the engine has cooled before removing the head.***

2. After removing the head, clean out all carbon deposits. Be careful not to damage the outer sealing edge where the gasket fits.
3. Use a new head gasket and clean the head and the cylinder block thoroughly where the head gasket rests.
4. Place the head in position and follow the tightening sequence shown in Figure 9-1. Tighten all nuts to 5 ft-lbs (7 N•m), then 10 ft-lbs (14 N•m), etc., until they are tightened to 24 to 26 ft-lbs (33 to 35 N•m).
5. Retorque before the engine has run a total of 25 hours.



M-1606

FIGURE 9-1. CYLINDER HEAD TORQUE SEQUENCE

VALVE SYSTEM

A properly functioning valve system is essential for good engine performance.

Access to the valve system (Figure 9-2) can be obtained by removing the cylinder head and the valve cover. A valve spring compressor must be used to remove valves from the cylinder block. Use the following procedures to inspect and service the valve system.

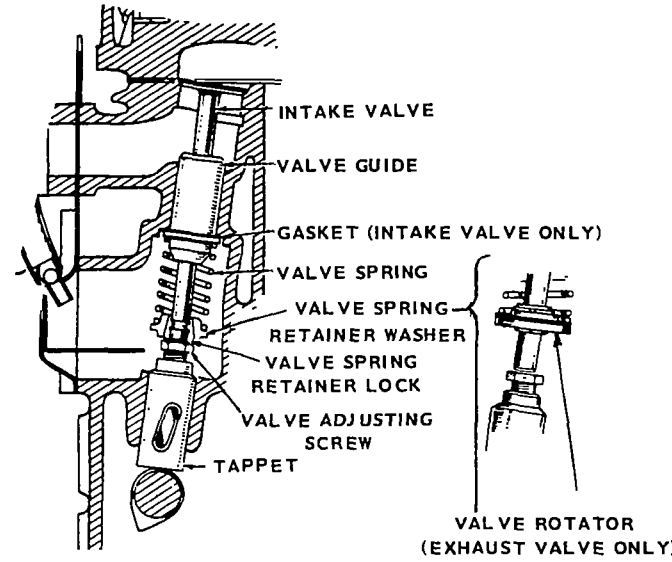


FIGURE 9-2. VALVE SYSTEM

Inspection

Valve Face: Check the valve face for evidence of burning, warpage, out-of-round, and carbon deposits.

Burning and pitting are caused by the valve failing to seat tightly. This condition is often caused by hard carbon particles on the seat. It may also be due to weak valve springs, insufficient tappet (lifter) clearance, warpage, and misalignment.

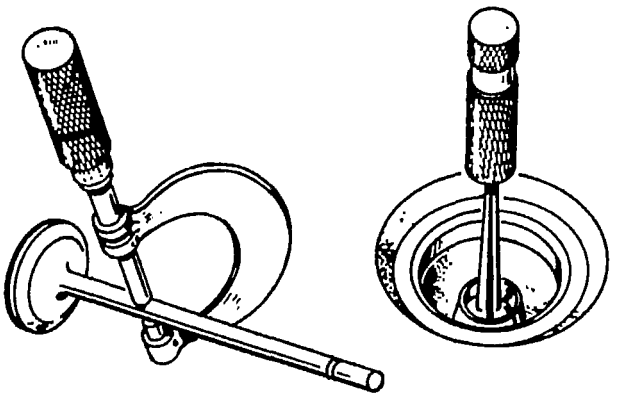
Warpage occurs chiefly in the upper stem due to its exposure to intense heat. Out-of-round wear occurs when the seat is pounded by a valve whose head is not in line with the stem and guide. If a valve face is burned or warped, or the stem worn, install a new one.

Too much clearance in the intake guide admits air and oil into the combustion chamber, upsetting carburetion, increasing oil consumption, and causing heavy carbon deposits. Carbon prevents heat dissipation. Clean metal is a good heat conductor, but carbon insulates and retains heat. This increases combustion chamber temperatures, which causes warping and burning.

Unburned carbon residue gums valve stems and causes them to stick in the guide. Deposits of hard carbon with sharp points become white hot and cause pre-ignition and "pinging".

Valve Stem Seal: A valve stem seal is used on the intake valve guide. This seal must be replaced each time the valve is removed.

Stems and Guides: Check valve stems and guides for wear as shown in Figure 9-3. Use a hole gauge to measure the valve guide. When clearance exceeds the specified limits, replace either the valve, the guide, or both, as necessary. Always regrind the seat to make it concentric with the newly installed guide.



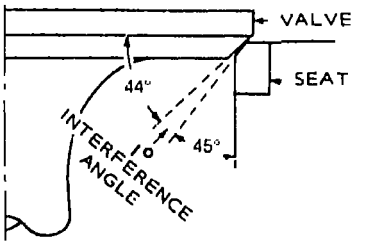
VT-1020

FIGURE 9-3. VALVE STEM & VALVE GUIDE INSPECTION

Springs: Check the valve springs for cracks, worn ends, distortion and tension. If spring ends are worn, check the valve spring retainer for wear. Check for spring distortion by placing the spring on a flat surface next to a square. Measure the height of the spring and rotate it against square edge to measure distortion. Check tension spring at the installed height for both the valve open and closed positions using an accurate valve spring tester. Replace any valve spring that is weak, cracked, worn, or distorted.

Reconditioning Valves and Valve Seats

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 (Figure 9-4).



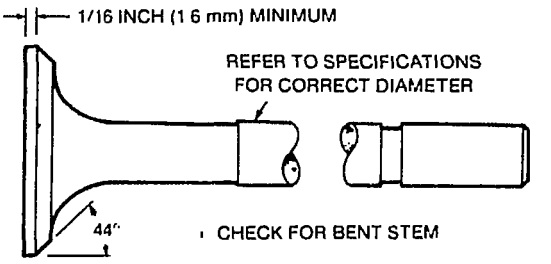
VT-1021

FIGURE 9-4. VALVE INTERFERENCE ANGLE

The valves should not be hand lapped because the sharp contact will be destroyed.

Valve faces must be finished in a machine to 44 degrees.

Every valve must have a minimum of 1/16-inch (1.6 mm) margin (Figure 9-5). If the valve has less margin than this, it will heat up excessively. It would retain that heat during the compression stroke and pre-ignite the mixture, causing loss of power and economy. This valve would also be susceptible to warping and breakage.



VT-1022

FIGURE 9-5. VALVE MARGIN

Not all valves can be reconditioned. A badly warped valve must be replaced because the excessive grinding required to make it seat correctly removes the margin. To make a valve gas-tight, every trace of pitting must be removed from the valve face and seat. Deeply pitted or cut valves must be replaced because the grinding removes the margin.

Valve seats should be ground with a 45-degree stone and the width of the seat band should be 1/32-inch to 3/64-inch (0.79 to 1.2 mm) wide. Grind only enough to ensure proper seating.

Place each valve in its proper location. Check each valve for a tight seat. Make several marks at regular intervals across the valve face using machinist's bluing. Observe that the marks rub off uniformly when the valve is rotated part of a turn against the seat. The valve seat should contact the valve face evenly at all points. The line of contact should be at the center of the valve face.

Valve Guide Replacement

Worn valve stem guides can be replaced from inside the valve chamber (a seal is provided behind the intake valve guide 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.

Removal: Before removing the valve guides, use an electric drill with a wire brush to remove carbon and other foreign material from top surface of guides. Failure to perform this operation may result in damage to the guide bores. Drive the guides out with a hammer and valve guide driver.

⚠CAUTION ***Driving out old guides can damage the tappet bores. Be careful not to strike the bores with the driver.***

Installation: Run a small polishing rod with crocus cloth through the valve guide holes to clean out carbon and other foreign materials. Place a new gasket on the intake valve guide and coat the outer edge of each new guide with oil. Place the guide, notch up, in the cylinder block and press it in until the shoulder of the guide rests against the cylinder block.

Exhaust Valve Seat Insert

Inspect the valve seat insert. If the seat is loose, cracked, or severely pitted, a new insert must be installed. Remove the valve seat insert using a valve seat removal tool.

Removal: Remove the carbon and combustion deposits from the valve seat. Select the proper puller. (Size is determined by the inside diameter of the valve seat). The puller jaws must expand into the cylinder block at the point where the bottom of the valve seat insert rests on the cylinder block (Figure 9-6). Using the new seat insert as a guide, adjust the puller depth. Position the puller on the valve seat and tighten the hex nut. Clamp the cylinder block to a solid bench. Attach the slide hammer to the puller. Between blows with the slide hammer, tighten the hex nut.

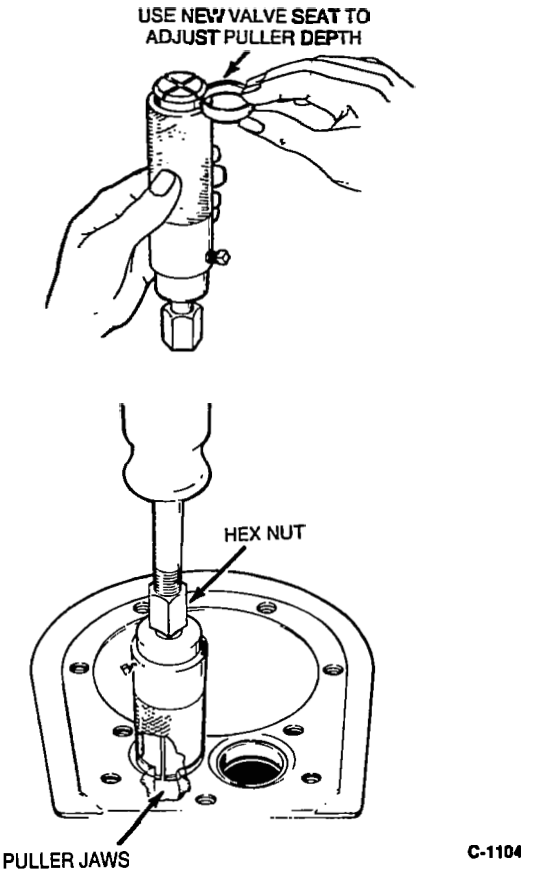


FIGURE 9-6. VALVE SEAT REMOVAL

Replacement: After the old seat has been removed, clean out any carbon or metal burrs from the seat insert recess. Use a valve seat insert driver and a hammer to install the insert.

Insert the pilot of the tool into the valve guide hole in the cylinder block. Drive the valve seat insert evenly to the bottom of the recess in the cylinder block. Make certain that the valve seat insert rests solidly on the bottom of the recess all the way around its circumference (Figure 9-7).

The valve seat must be staked to ensure a tight fit and to eliminate the danger of its loosening in the bore.

Insert the valve seat staker in the cylinder block valve guide hole. Rotate the staking tool until it drops to the original stake marks. Rotate the stacking tool another 60 degrees (1/6 turn). Using a lead hammer, strike the staking tool a sharp blow to wedge the new valve seat securely in place. Before installing the valve, refinish the valve seat insert.

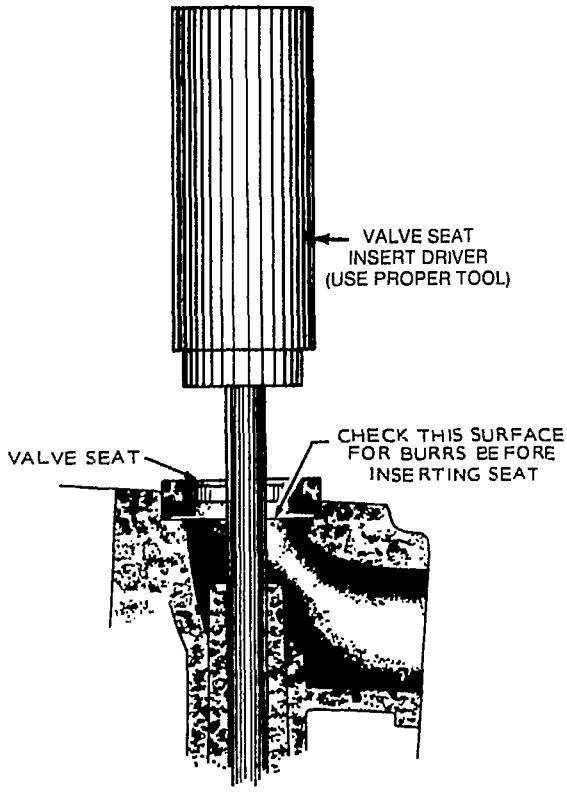


FIGURE 9-7. INSERTING NEW VALVE SEAT

Tappet Adjustment

The engine is equipped with adjustable valve tappets. Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows.

1. Remove all parts necessary to gain access to the valve tappets.
2. Remove the spark plugs to make turning the engine easier.
3. Place a socket wrench on the flywheel capscrew and rotate the crankshaft in a clockwise direction until the intake valve (the one nearest the carburetor) opens and closes. Continue turning the crankshaft until the mark on the flywheel is lined up with the TC mark on the gear cover. This places the piston at the top of its compression stroke. Verify that the intake and exhaust valves are closed and there is no pressure on the valve lifters.
4. Measure the valve clearance as shown in Figure 9-8. Clearance specifications are listed in Section 3.
5. To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking.
6. Reinstall all parts. Tighten all screws securely. Torque the manifold bolts.

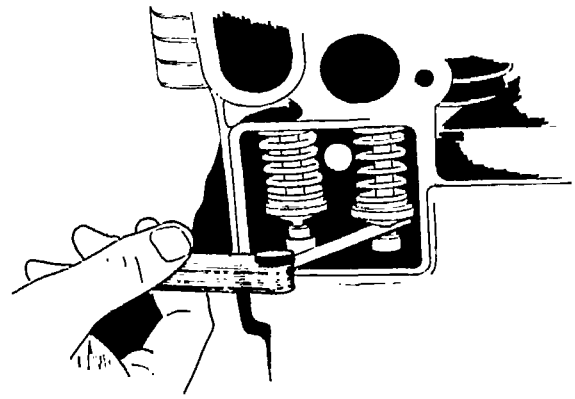


FIGURE 9-8. MEASURING VALVE CLEARANCE

GEAR COVER

Remove the flywheel key and mounting screws. Tap the gear cover gently, using a soft-faced hammer to loosen it.

When removing the gear cover, it is not necessary to remove the magneto assembly from the cover. Just disconnect the spark plug lead (at the spark plug) and the stop wire. When installing the gear cover, make sure the pin in the gear cover engages in the metal-lined hole of the governor cup (Figure 9-9). Turn the governor cup so that the hole is in an upward (12 o'clock) position. 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.

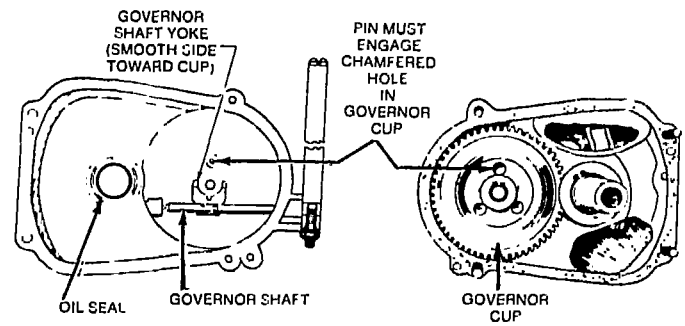


FIGURE 9-9. GEAR COVER ASSEMBLY

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.

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 9-10).

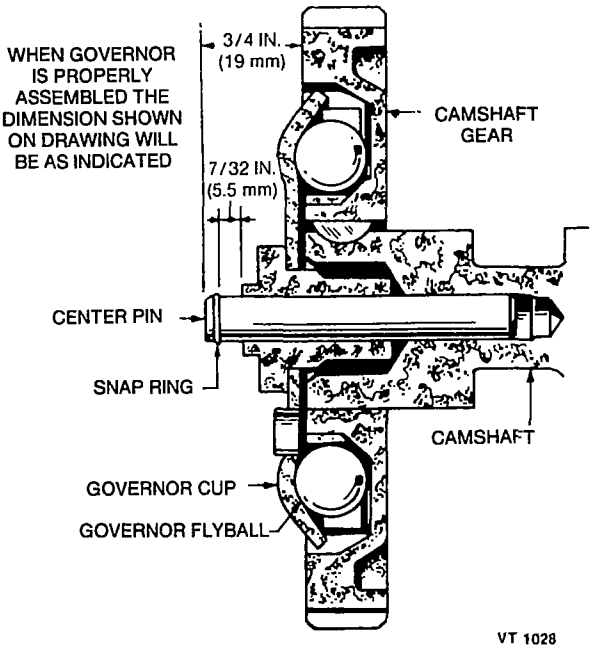


FIGURE 9-10. GOVERNOR CUP

If a new governor cup is being installed, the distance from the small lock ring on the center pin to the face of the governor cup must be exactly 7/32 inch (5.5 mm) when the cup is pressed back against the flyballs as far as possible. If the distance is too small, carefully dress the face of the cup as required, being sure to remove any burr from the inside of the cup bore. If the distance is more than 7/32 inch (5.5 mm) carefully press the pin in the required amount. Do not damage the pin, as it is difficult to replace it in the field. Replacement of governor flyballs is easier if the set is tipped backward with the timing gears upward. Be sure that all flyballs are replaced and evenly spaced.

TIMING GEARS AND CAMSHAFT

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, both gears should be replaced.

To remove the crankshaft gear, first remove the snap ring and retainer washer; then attach the gear pulling ring (Figure 9-11). Tighten the screws alternately until both are tight. Attach a gear puller to the puller ring and remove the gear.

The camshaft and gear are removed as an assembly. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies. Then remove the operating plunger for the breaker points and tappets.

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

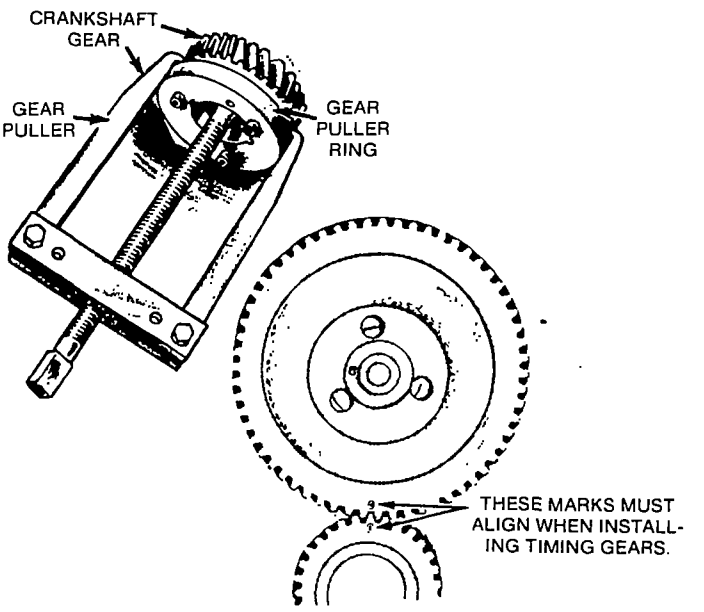


FIGURE 9-11. TIMING GEAR REMOVAL AND INSTALLATION

LUBRICATION SYSTEM

An oil pump provides a constant flow of oil to the engine parts. The oil supply collects in the oil base where it is picked up by the oil pump pick-up cup. A bypass valve is used to control oil pressure. Drain the oil before removing the oil base and always use a new gasket when replacing the oil base.

Oil Pump

The oil pump is mounted on the front of the crankcase behind the gear cover and is driven by the crankshaft gear. The inlet pipe and screen assembly is attached directly to the pump body. 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 (Figure 9-12).

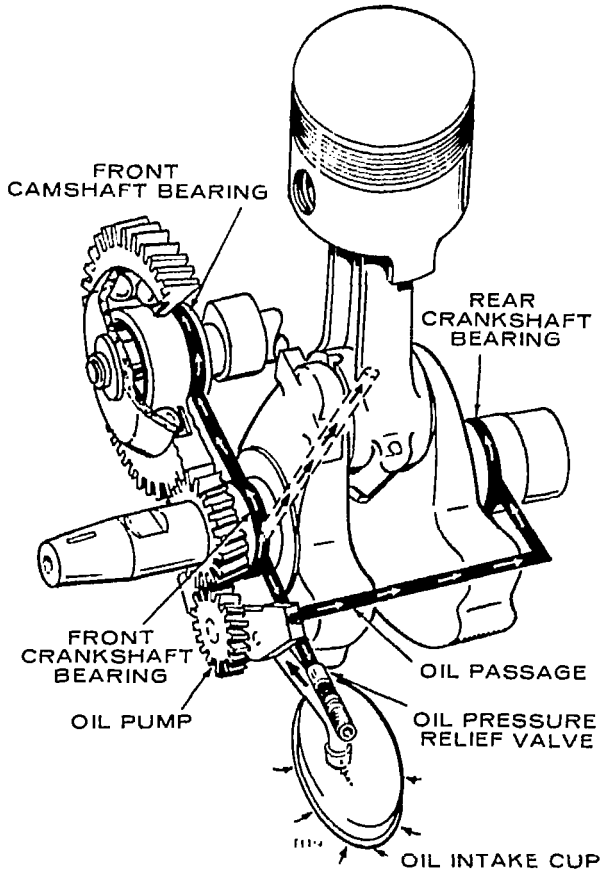


FIGURE 9-12. OIL SYSTEM

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

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

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for the gaskets and pick-up cup, the component parts of the pump are not available individually. Install a new pump assembly if any parts are worn.

Oil Bypass Valve

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

The valve (Figure 9-13) is non-adjustable and normally needs no maintenance. To determine if abnormal (high or low oil pressure is caused by improper valve operation, inspect as follows:

1. Remove the capscrew located behind the gear cover.
2. Remove the spring and plunger with a magnetic tool.

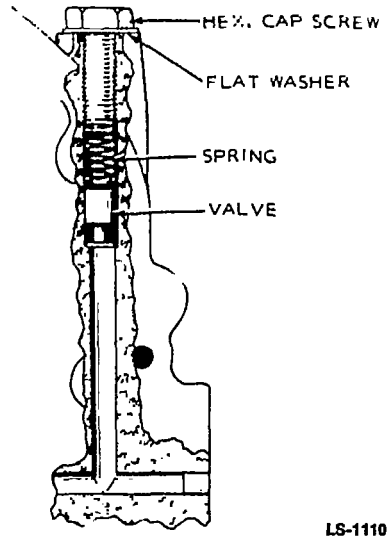


FIGURE 9-13. OIL BYPASS VALVE

3. Determine proper valve operation by checking the spring and plunger according to the following measurements.

   Plunger Diameter .....0.3105 to 0.3125 in. (7.89 to 7.94 mm)

   Spring
   Free Length.....1.00 in. (25.4 mm)
   Load.....2.6 ± 0.2 lbs (11.6 ± 0.9 N) when compressed to 0.500 in. (12.7 mm)

4. Check the valve seat and clean away any accumulation of metal particles, which could cause erratic valve action. Verify that the valve seat is concentric with the larger diameter valve bore.
5. Clean the plunger and spring in parts-cleaning solvent and reinstall.

Valve Compartment Oil Drain

A drain hole from the valve compartment allows oil to enter the crankcase. This hole must be unobstructed to provide for proper drainage of oil from the valve compartment.

Oil Level

Check the oil level at least every 8 hours of operation. Check more frequently on a new or reconditioned engine because oil consumption is higher until the piston rings seat properly. Keep the oil level approximately half way up the threads on the inside of the oil-plug hole. When adding oil between changes, use the same brand. Mixing brands may reduce oil lubricating properties.

Crankcase Oil: Use a good quality heavy-duty detergent oil that meets the API (American Petroleum Institute) service designation SF. If SF oil is not available, (API), SE or SE/CC oil can be used. Oil should be labeled as having passed the MS Sequence Tests and the MIL-L-2104B Tests.

⚠WARNING ***Crankcase pressure can blow out hot oil and cause severe burns. Do NOT check the oil while the engine is operating.***

⚠CAUTION ***Do not overfill the crankcase. Excess oil can cause higher operating temperatures and foaming, and can result in engine damage.***

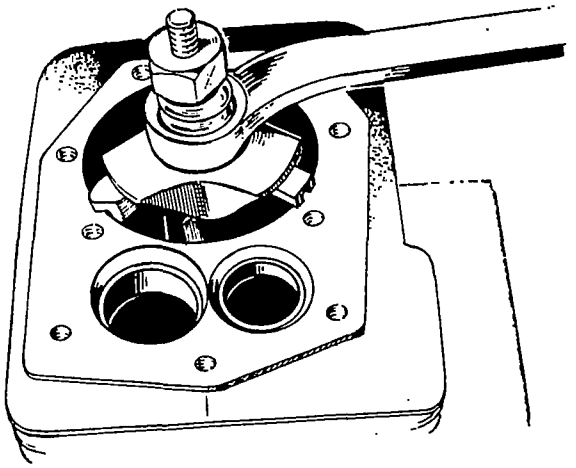
PISTON ASSEMBLY

The piston assembly consists of the piston, piston rings, piston pin, connecting rod assembly, and bearing. After removal from engine, all parts must be carefully inspected for damage and wear.

Removal and Disassembly

Remove carbon from the top of the cylinder bore and check for a ridge. Remove the ridge (Figure 9-14) with a ridge reamer before removing the piston.

⚠CAUTION ***Improper use of a ridge reamer can damage the cylinder bore.***



CT-1058

FIGURE 9-14. REMOVING WEAR RIDGE

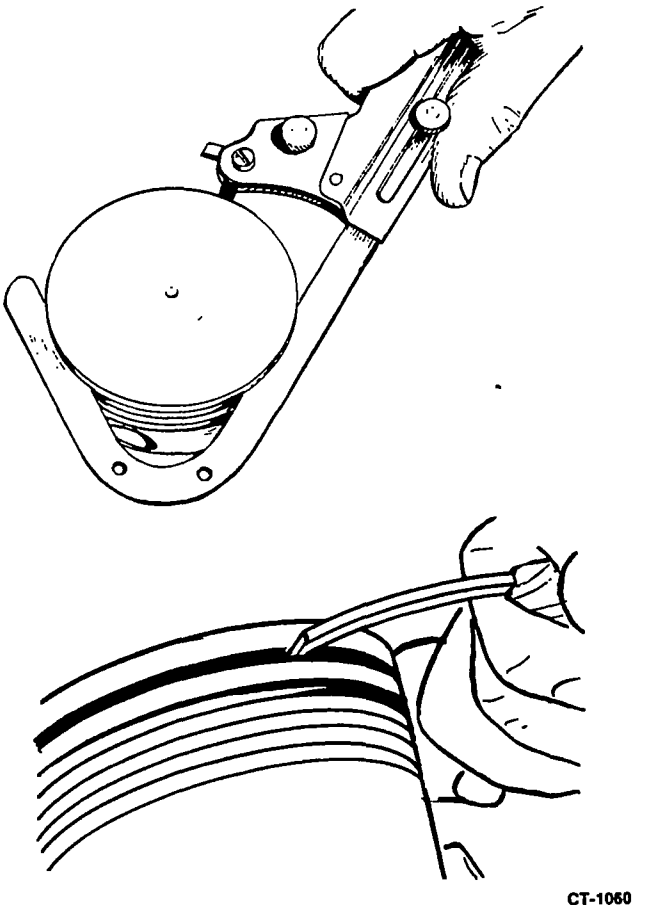
To remove the piston and connecting rod assembly: Turn the crankshaft until the piston is at the bottom of the stroke. Remove the connecting rod screw. Lift the rod cap from the crank journal and push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

⚠CAUTION ***Forcing the piston from the cylinder before reaming can cause damage to the piston lands and break rings.***

Remove the piston pin retainer from each side and push the pin out.

The piston is 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 9-15). All passages should be cleaned with a non-caustic solvent. Clean the rod bore and the back of the connecting rod bearing thoroughly.



CT-1060

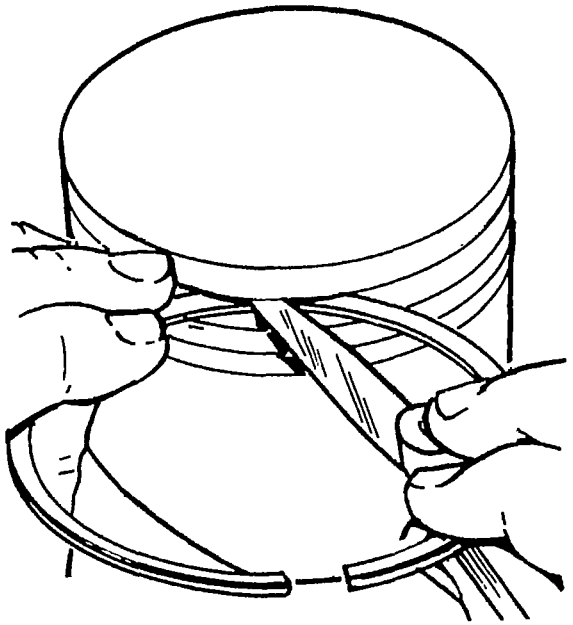
FIGURE 9-15. CLEANING RING GROOVES

⚠CAUTION ***Using a caustic cleaning solvent or wire brush for cleaning pistons will cause piston damage. Use only parts-cleaning solvent.***

Inspection

The following covers inspection procedures for pistons and connecting rods.

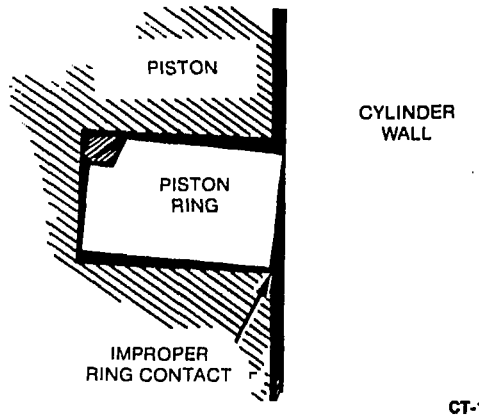
Piston Inspection: Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge as shown in Figure 9-16. Replace the piston when the side clearance of the top compression ring reaches 0.008 inch (0.20 mm).



CT-1061

FIGURE 9-16. CHECKING RING LAND

Improper ring width or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves do not have good cylinder wall contact (Figure 9-17).



CT-1062

FIGURE 9-17. NEW RING IN WORN RING GROOVE

Replace the piston if it shows signs of scuffing, scoring, worn ring lands, fractures or damage from pre-ignition.

Connecting Rod Inspection: Replace connecting rod bolts and nuts that have damaged threads. Replace the connecting rod if it has deep nicks, signs of fractures, a scored bore or a bore out of round more than 0.002 inch (0.05 mm). Connecting rods are available in standard size or 0.010 inch (0.254 mm), 0.020 inch (0.508 mm) and 0.030 inch (0.762 mm) undersize.

Use a new piston pin to check the connecting rod for wear. A push-fit clearance is required. If a new piston pin falls through a dry rod pin bore as a result of its own weight, replace the rod.

Piston Pin Inspection: Replace the piston pin if it is cracked, scored, or out of round more than 0.002 inch (0.05 mm).

Bearing Inspection: Inspect the bearings for burrs, breaks, pitting and wear. Replace bearing inserts that are scored, have the overlay wiped out, show fatigue failure, or are badly scratched. If bearings appear to be serviceable, check them for proper clearance.

Piston Clearance

Proper piston tolerances must be maintained for satisfactory operation. Use a micrometer to measure the piston diameter at the point shown in Figure 9-18. When the cylinder bore is measured (see *Cylinder Block*), subtract the piston diameter from the cylinder bore diameter to obtain the piston to cylinder wall clearance. Refer to Dimensions and Clearances section for the recommended piston clearance.

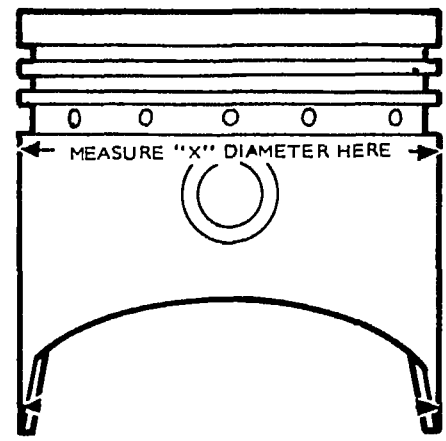


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FIGURE 9-18. PISTON CLEARANCE MEASUREMENT

Fitting Piston Rings

Before installing new rings on the piston, check the ring gap by placing each ring squarely in the cylinder at a position corresponding to the bottom of its travel (Figure 9-19). The gap between the ends of the ring is given in the Dimensions and Clearances section.

The practice of filing ring ends to increase the end gap is not recommended. If the ring end gap does not meet specifications, check for the correctness of ring and bore sizes. A cylinder bore that is 0.001 inch (0.03 mm) undersize will reduce the end gap 0.003 (0.08 m).

Standard size rings can be used on 0.005 inch (0.13 mm) oversize pistons. Rings that are 0.010, 0.020, 0.030 and 0.040 inch (0.25, 0.51, 0.76 and 1.02 mm) oversize are to be used on corresponding oversize pistons.

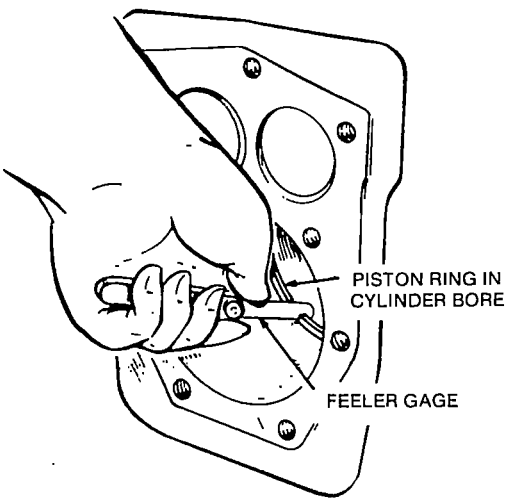

FIGURE 9-19. CHECKING RING GAP

Piston Assembly Installation

Lubricate all parts with clean engine oil. Position the piston on the connecting rod. Install the piston pin. The piston pin is a full-floating type and must be kept in place (in the piston) with two lock rings, one at each side. Install the lock rings and ensure that they are properly in place before installing the piston and connecting rod in the engine.

Install the rings on the piston beginning with the oil control ring. Use a piston ring spreader to prevent twisting or excessive expansion of the ring. Compression rings are marked with a dot or the word "top" on one side of the ring to indicate which side faces the top of the piston. Unmarked piston rings can be installed either way. The oil control ring has an expander. Install the expander first and then close until the expander ends butt together. Place the expander gap 180 degrees from the ring gap.

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. If a chrome-faced ring is used, it should be placed in the top groove.

Installing Piston in Cylinder: When installing the piston assembly, the raised lines (witness marks) on the rods and caps must be aligned. Also, note that the connecting rod bolt is offset to one side of the cap. When assembled on the crankshaft, the thin side of the cap should be next to the cylinder block.

1. Turn the crankshaft to position the rod bearing journal at the bottom of its stroke.
2. Lubricate the piston assembly and inside of the cylinder. Compress rings with a ring compressor as shown in Figure 9-20. Install the bearing insert in the rod.

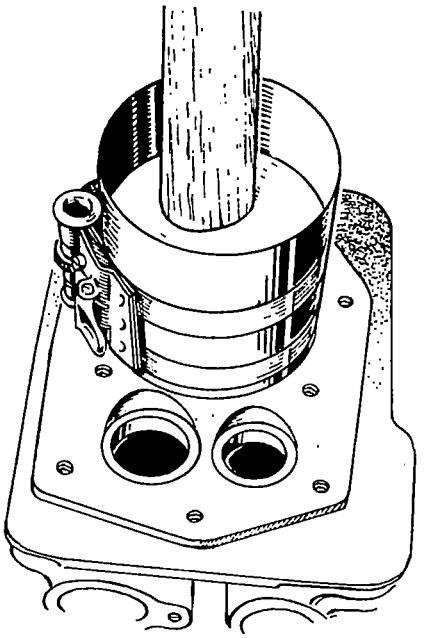

FIGURE 9-20. INSTALLING PISTON

3. Position the piston and rod assembly in the cylinder block with the connecting rod oil hole toward the camshaft.
4. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the journal. Check the bearing clearance before proceeding to the next step (see Rod Bearing Clearance).
5. Lubricate the rod bearing journal and install the connecting rod cap. Tighten the connecting rod bolts to the specified torque.
6. The bearing cap must be tapped several times to properly align it with the connecting rod. Clearance varies on the journal if this is not done.
7. Crank the engine by hand to see that all bearings are free.

Rod Bearing Clearance

1. Mark all parts so they can be installed in their original positions, and wipe all parts clean of any oil or grease.

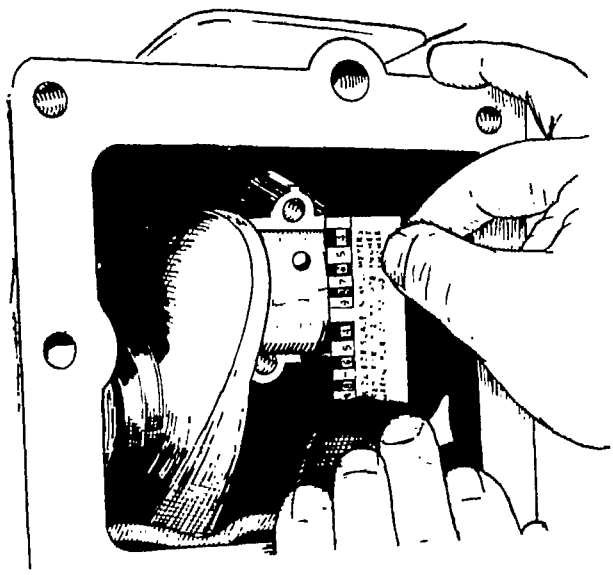

FIGURE 9-21 MEASURING BEARING CLEARANCE WITH PLASTI-GAGE

2. Place a piece of the correct size Plasti-gage across the full width of the bearing cap about 1/4 inch (6 mm) off center (Figure 9-21).
3. Install the bearing cap and tighten to the specified torque. Do not rotate the crankshaft after the cap is in place.
4. Remove the bearing cap and leave the flattened Plasti-gage on the part to which it has adhered. Compare the widest point of the flattened Plasti-gage with the graduations on the envelope to determine the bearing clearance.

CYLINDER BLOCK

The cylinder block is the main support for all other basic engine parts. All crankshaft and camshaft are supported by the block, ensuring alignment of the crankshaft and cylinder bores.

Cleaning

After removing the piston, crankshaft, cylinder head, etc., inspect the block for cracks and extreme wear.

To clean the block:

1. Scrape all old gasket material from the block. Remove the oil bypass to allow cleaning solution to contact the inside of oil passages.
2. Remove grease and scale from the cylinder block by agitating in a bath of commercial cleaning solution or hot soapy washing solution.
3. Rinse the block in clean hot water to remove the cleaning solution.

Inspection

When rebuilding the engine, thoroughly inspect the block for any condition that would make it unfit for further use. This inspection must be made after all parts have been removed and the block has been thoroughly cleaned and dried.

1. Make a thorough check for cracks. Minute cracks can be detected by coating the 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 the defective area. Always replace a cracked cylinder block.
2. Inspect all machined surfaces and threaded holes. Carefully remove any nicks or burrs from machined surfaces. Clean out tapped holes and clean up any damaged threads.
3. Check the top of the block for flatness with a straight edge and a feeler gauge.

Cylinder Bore Inspection: Inspect the cylinder bore for scuffing, scratches, wear, and scoring. If the cylinder bore is scuffed, scratched, scored, or worn, it must be rebored and honed for the next oversize piston.

When the appearance of the cylinder bore is good and there are no scuff marks, check the cylinder bore for wear or out of roundness as follows:

1. Check cylinder bore for taper, out-of-round, and wear with a cylinder bore gauge, telescope gauge, or inside micrometer. These measurements should be taken at four places, top and bottom of piston ring travel and parallel and perpendicular to axis of crankshaft.
2. Record measurements taken at the top and bottom of piston travel as follows (Figure 9-22).

   A. Measure and record as "A" the cylinder bore diameter (parallel to the crankshaft) near the top of the cylinder bore where the greatest amount of wear occurs.
   B. Measure and record as "B" the cylinder bore diameter (parallel to the crankshaft) at the bottom of piston travel.
   C. Measure and record as "C" the cylinder bore diameter (perpendicular to the crankshaft) near the top of the cylinder bore where the greatest amount of wear occurs.
   D. Measure and record as "D" the cylinder bore diameter (perpendicular to the crankshaft) at the bottom of piston travel.

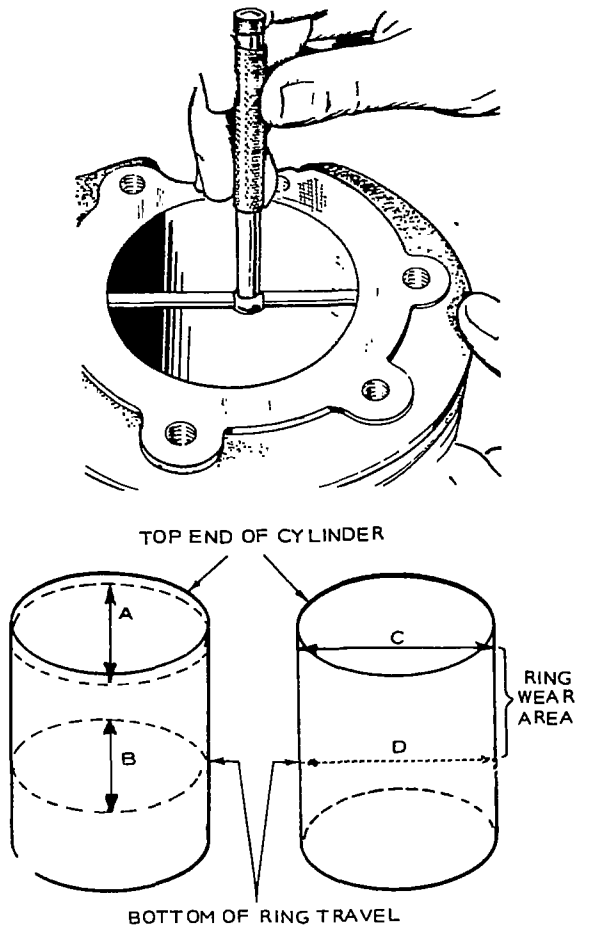

FIGURE 9-22. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

E. Reading "A" subtracted from reading "B" and reading "C" subtracted from reading "D" indicate cylinder taper.

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

F. Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicate whether or not cylinder is out-of-round.

   If out-of-round exceeds 0.003 inch (0.08 mm), the cylinders must be rebored and honed to the next oversize.

Reboring the Cylinder

Rebore and hone the engine whenever the cylinder bore is worn, damaged, out-of-round, or if the cylinder taper exceeds specifications. A worn cylinder bore should be resized to the smallest standard oversize diameter at which it will clean up. The final finish and bore diameters should then be obtained by honing.

⚠CAUTION ***If the boring bar is operated incorrectly, it will produce a rough cylinder surface that may not clean up even when honed. Boring should be done only by qualified service personnel.***

After boring to the correct oversize, cylinder bore dimension as well as piston and ring clearance should be correct. There is no need to adjust or "fit" pistons and rings.

When reboring the cylinder, take the following precautions:

1. Make sure the cutting tool is properly ground before using it.
2. Be sure the top of the engine block is smooth and free of deposits.
3. Clean the base of the boring bar before the bar is set up. Deposits under the boring bar will cause it to tilt, and the cylinder will be distorted after boring.
4. Make an initial rough cut, followed by a finish cut. Then hone the cylinder bore to the specified oversize.

Honing Cylinder (Using Precision Hones)

Refer to the hone manufacturer's recommended grit size to produce a specified surface finish of 20 to 40 RMS. Too rough of a finish will wear out the rings and too smooth of a finish can retard piston ring seating.

1. Position the block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill that operates at approximately 250 to 450 rpm.
2. Follow the hone manufacturer's instructions for the use of oil or lubricant on stones. Do not use lubricants with a dry hone.
3. Lower the hone into the cylinder until it protrudes 1/2 to 3/4 inch (13 to 19 mm) past the end of the cylinder. Rotate the adjusting nut until the stones come in contact with the cylinder wall at the narrowest point.
4. Loosen the adjusting nut until the hone can be turned by hand.
5. Connect the drill to the hone and start the drill. Move the 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 the cylinder takes a uniform diameter, move the 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 the diameter of the 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 (0.51 mm) within the desired bore, change to fine stones and finish the bore. The finish should not be smooth but should be as shown in Figure 9-23. The crosshatch formed by the scratching of the stones should have an angle of 23 degrees. This can be achieved by moving the hone up and down in the cylinder about 40 cycles per minute.

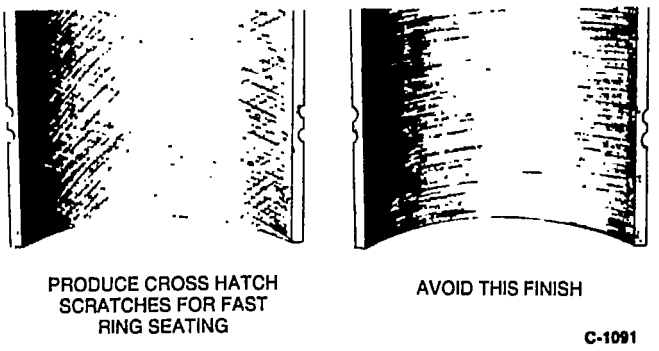

FIGURE 9-23. CROSSHATCHING

8. Clean the 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 the cylinder bore 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 the crankcase and coat it with oil.

Deglazing Cylinder Bores

Deglaze the cylinder bores (if there are no scuff marks and no wear or out of round beyond specifications) before installing new rings. Deglazing gives a fine finish but does not enlarge cylinder diameter, so the original pistons with new rings can still be used.

The reason for deglazing a cylinder is to provide cavities to hold oil during piston ring break-in.

1. Wipe cylinder bores with a clean cloth that has been dipped in clean, light engine oil.
2. Use a brush type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.
3. The deglazing tool should be driven by a slow-speed drill. Move the deglazing tool up and down in cylinder (10 to 12 complete strokes) rapidly enough to obtain a crosshatch pattern as shown in Figure 9-23.
4. Clean the cylinder bore thoroughly with soap, water, and clean rags. Continue cleaning until a clean white rag shows no discoloring when wiped through the cylinder bore.

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 distorting or damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing, and lubricate again with oil after installing. Use a combination bearing driver to install the camshaft bearings.

Camshaft Bearings

Replacement camshaft bearings are precision type, which do not require line reaming or line boring after installation. Coat the bearing with lubricating oil. Position the front bearing with the lubricating groove at the top (Figure 9-24). 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 so that the outside edge is flush with the counterbored area (Figure 9-24).

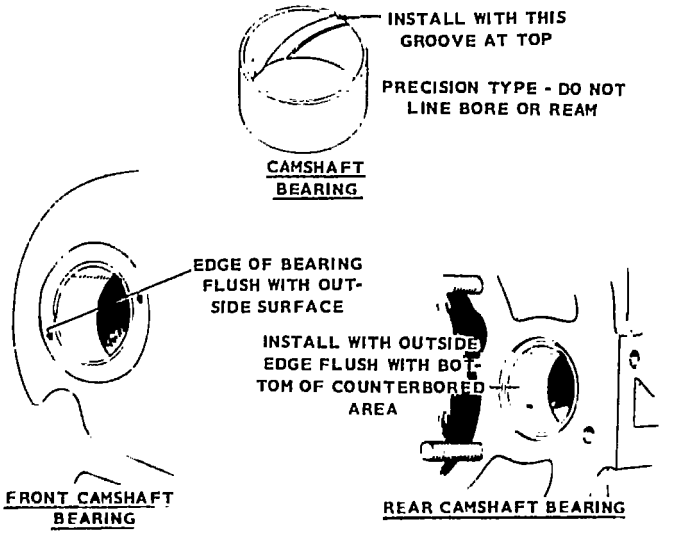

FIGURE 9-24. CAMSHAFT BEARINGS

Crankshaft Bearings

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 and coat it with oil.

When putting in either the front or rear main bearing, align the oil hole(s) in the bearing bore (Figure 9-25). 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 an "Easy-Out" tool to remove the pin and install a new lock pin. Apply oil to the thrust washers to hold them in place when the crankshaft is installed. The oil grooves in the thrust washer bearing must face the crankshaft. Be sure the notches fit over the lock pins.

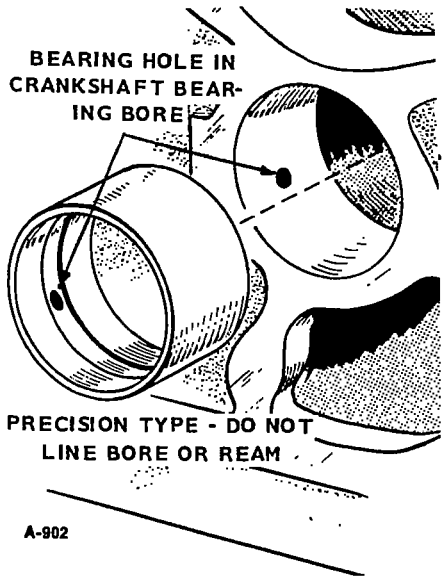

FIGURE 9-25. CRANKSHAFT BEARINGS

OIL SEALS

The bearing plate must be removed to replace the rear oil seal. Drive the oil seal out from the inside using an oil seal driver. There is a separate driver required for rear bearing plate and gear cover seals.

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

When installing the gear cover oil seal (Figure 9-26), 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 (Figure 9-26), 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.

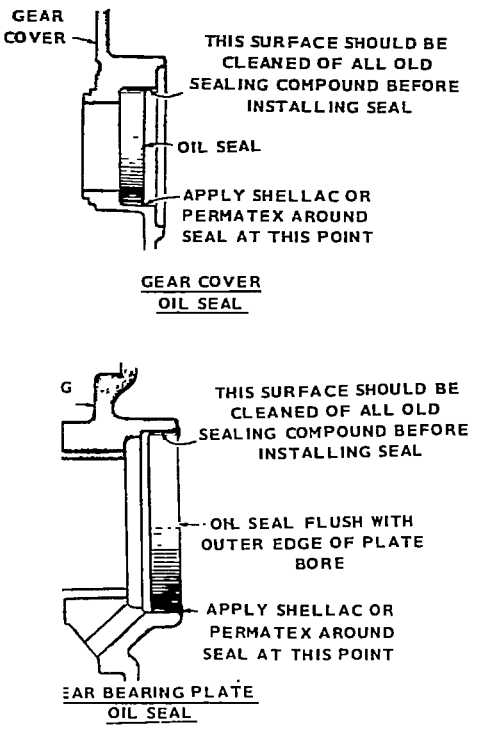

FIGURE 9-26. OIL SEALS

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 9-27. 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 the endplay of the crankshaft.

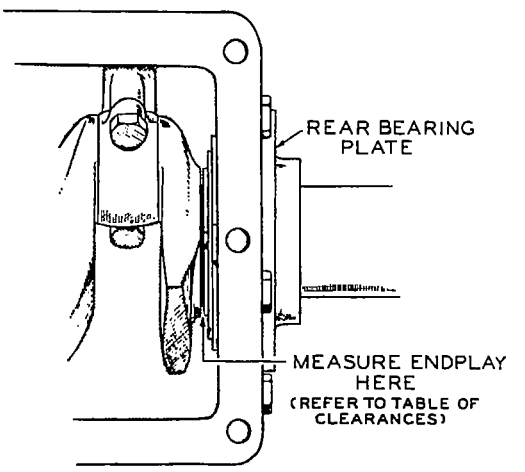

FIGURE 9-27. MEASURING CRANKSHAFT ENDPLAY

Section 10. Service Checklist

After servicing, inspect and test the complete installation to confirm that the generator set will operate properly and will pull full rated load. Check each of the following areas before putting the set into service.

MOUNTING

Examine all mounting bolts and supporting members to verify that the generator set is properly mounted. All fasteners should be tightened securely to prevent them from working loose when subjected to vibration.

LUBRICATION

If the engine oil was drained, fill the crankcase with oil of the recommended classification and viscosity. Refer to the operator's manual for the specific recommendations and procedures.

WIRING

Verify that all wiring connections are tight and hooked up properly. Check each of the following:

- Load Wires
- Control Wires
- Ground Strap
- Battery Cables

INITIAL START ADJUSTMENTS

Adjust the carburetor idle adjustment screw and main adjustment screw to their pre-startup settings as specified in the Fuel System section.

Start the set and immediately adjust the governor speed adjustment nut to obtain a safe no-load operating speed. With no load applied, listen for any unusual sounds or vibrations. When the choke is completely open, adjust the carburetor and governor as specified in the Fuel System section.

OUTPUT CHECK

Apply a full load to make sure the set will produce its full rated output. Use a load test panel to apply a progressively greater load until full load is reached.

EXHAUST SYSTEM

With the generator set operating, inspect the entire exhaust system including the exhaust manifold, muffler, and exhaust pipe. Visually and audibly check for leaks at all connections, welds, gaskets, and joints and also make sure exhaust pipes are not heating surrounding areas excessively. If leaks are detected, correct immediately.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Inspect exhaust system audibly and visually for leaks daily. Repair leaks immediately.***

⚠WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Throbbing in Temples***
- ***Muscular Twitching***
- ***Vomiting***
- ***Inability to Think Coherently***

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Never sleep in the vessel with the generator set running unless the vessel interior is equipped with an operating carbon monoxide detector. Protection against carbon monoxide inhalation also includes proper exhaust system installation and visual and audible inspection of the complete exhaust system at the start of each generator set operation.

1-M

FUEL SYSTEM

With the generator set operating, inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage.

⚠CAUTION ***Leaking fuel will create a fire hazard that can result in severe personal injury or death if ignited. If leaks are detected, correct immediately.***

CONTROL

Stop and start the generator set several times at the set control and remote control to verify that the control functions properly.

MECHANICAL

Stop the generator set and inspect for leaking gaskets, loose fasteners, damaged components, or interference problems. Repair as required. Inspect the generator set compartment and verify there are no breaks or openings in the vapor-proof wall that separates the compartment from the cabin interior. Seal openings as required. Make sure all soundproofing material is in place.

Onan

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