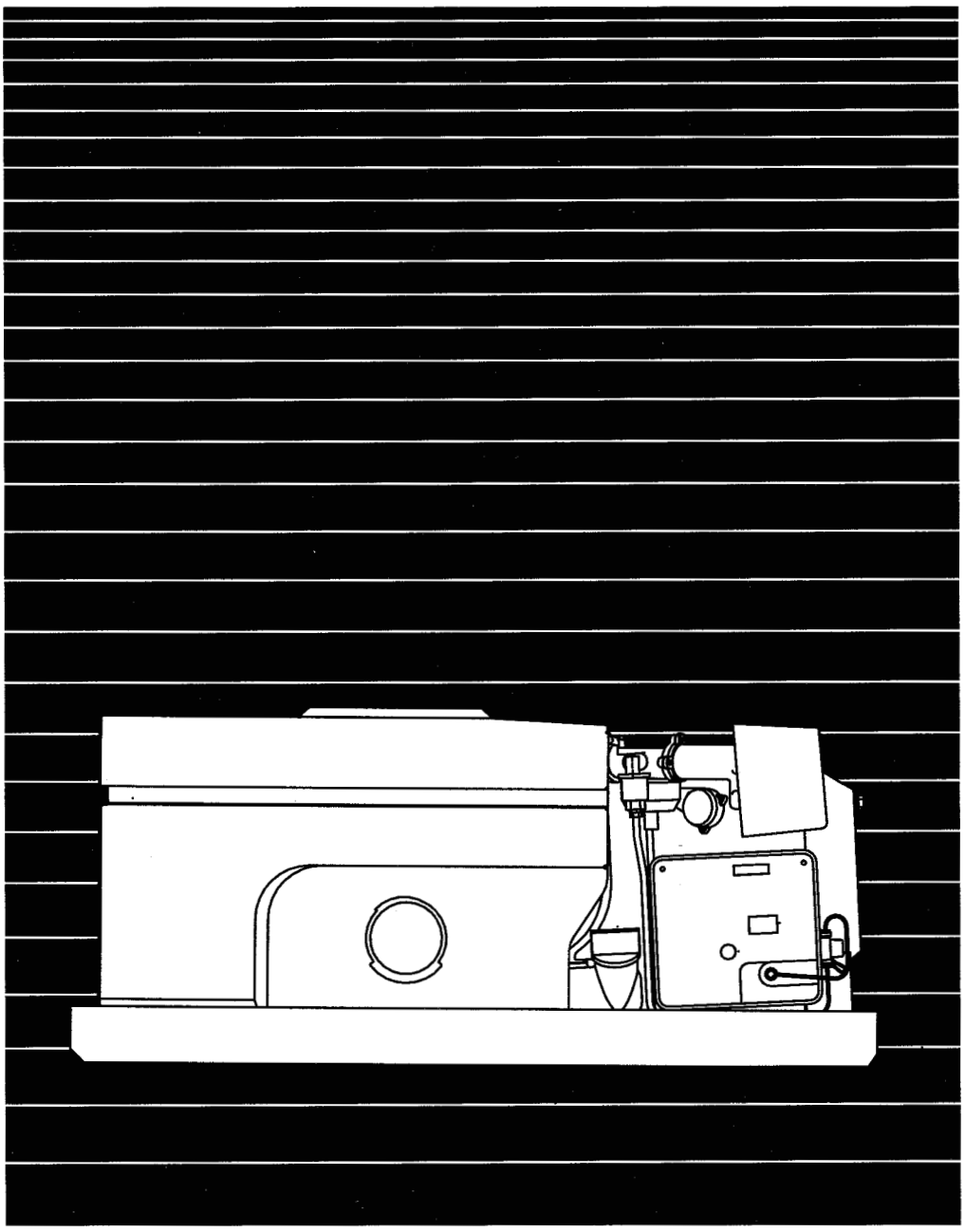
Onan

RV GenSet

Service Manual

BGM, NHM



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965-0531
Specs A, B, C, D
1-93

Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and the equipment. **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.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ 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 AND FUMES ARE FLAMMABLE. Fire, explosion, and personal injury can result from improper practices.

- DO NOT fill fuel tanks while engine is running. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT SMOKE OR USE AN OPEN FLAME near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible, non–conductive line. Do not use copper piping on flexible lines as copper will work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.

GASOLINE AND LPG FUEL MAY BE ACCIDENTALLY IGNITED BY ELECTRICAL SPARKS, presenting the hazard of fire or explosion, which can result in severe personal injury or death. When installing the generator set:

- Do not tie electrical wiring to fuel lines.
- Do not run electrical lines and fuel lines through the same compartment openings.
- Keep electrical and fuel lines as far apart as possible.
- Place a physical barrier between fuel lines and electrical lines wherever possible.
- If electrical and fuel lines must pass through the same compartment opening, make certain that they are physically separated by running them through individual channels, or by passing each line through a separate piece of tubing.
- DO NOT SMOKE while servicing batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

- Never sleep in the vehicle with the generator set running unless vehicle is equipped with an operating carbon monoxide detector.
- Provide an adequate exhaust system to properly expel discharged gases. Inspect exhaust system daily for leaks per the maintenance schedule. Be sure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Before starting work on the generator set, disconnect batteries. This will prevent accidental arcing.
- Keep your hands away from moving parts.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry while working on generator sets. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Disconnect starting battery before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved device and after building main switch is open. Consult an electrician in regard to emergency power use.

GENERAL SAFETY PRECAUTIONS

- Have a fire extinguisher nearby. Maintain extinguisher properly and become familiar with its use. Extinguishers rated ABC by the NFPA are appropriate for all applications. Consult the local fire department for the correct type of extinguisher for various applications.
- Hot coolants under pressure can cause severe personal injury. DO NOT open a radiator pressure cap while the engine is running. Stop the engine and carefully bleed the system pressure.
- 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.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage, which presents a potential fire hazard.
- DO NOT store anything in the generator compartment such as oil or gas cans, oily rags, chains, wooden blocks, portable propane cylinders, etc. A fire could result or the generator set operation (cooling, noise and vibration) may be adversely affected. Keep the compartment floor clean and dry.
- 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.

Supplement 965-1056
Date: 1-95
Insert with-
Title: BGM/NHM Service Manual
Number (Date): 965-0531 (1-93)

PURPOSE

This Supplement transmits the revisions to the Service Manual necessary for covering ***Spec F*** generator sets. Note that the nameplate on a Spec F generator set will have the statement: "This engine meets 1995-1998 California emissions regulations for ULGE engines."

To satisfy California emissions regulations Spec F generator sets have internal engine modifications and precision-manufactured carburetors with tamper-resistant fuel mixture jets. It should therefore be noted that, other than turning the altitude adjust knob shown in Figure 6-14a (which changes the main fuel mixture within a limited range), fuel mixture adjustments should not be attempted. Nor should the carburetor be overhauled. Instead, a malfunctioning carburetor (see TROUBLESHOOTING ENGINE PRIMARY SYSTEMS in Section 6) should be replaced.

California users should note that unauthorized modifications or replacement of fuel, exhaust, air intake, or speed control system components that affect engine emissions are prohibited by California regulations. Modification, removal or replacement of the generator set label is also prohibited.

SERVICE MANUAL 965-0531 REVISIONS

1. Insert this cover sheet behind the front cover of the manual.
2. On **Page 1-1** of the manual add the following note at the bottom of the page: "See the Operator's Manual for fuel and engine oil recommendations and the Periodic Maintenance Schedule."
3. On **Page 2-1** of the manual add the following note at the bottom of the page: "For Model BGM and NHM Spec F generator sets the ignition timing (non-adjustable) is 12° BTDC."
4. On **Page 6-26** of the manual add "(Does Not Apply to Spec F and Later)" to the subheading "Carburetor Fuel Mixture screw Adjustments".
5. On **Page 6-30** of the manual add "(Does Not Apply to Spec F and Later)" to the subheading "Gasoline Carburetor Overhaul".
6. On **Page 6-31** of the manual add "(Does Not Apply to Spec F and Later)" to the subheadings "Gasoline Carburetor Disassembly Procedure", "Carburetor Cleaning and Repair Procedure" and "Gasoline Carburetor Reassembly and Installation Procedure".
7. Insert the attached page (6-26-1) between **Page 6-26** and **Page 6-27** of the manual.

Attachment: Page 6-26-1

Carburetor Replacement (Beginning Spec F)

Other than turning the altitude adjust knob shown in Figure 6-14a (which changes the main fuel mixture within a limited range), fuel mixture adjustments should not be attempted. Nor should the carburetor be overhauled. Instead, a malfunctioning carburetor should be replaced. Before replacing a carburetor, however, make certain 1) that all other necessary engine and generator adjustments and repairs have been performed and 2) that the carburetor is actually malfunctioning, by carefully following the troubleshooting procedures in TROUBLESHOOTING ENGINE PRIMARY SYSTEMS in this section.

See the instructions on how to remove and replace the carburetor under the subheadings Air Intake Assembly and Carburetor And Intake Manifold Assembly in this section.

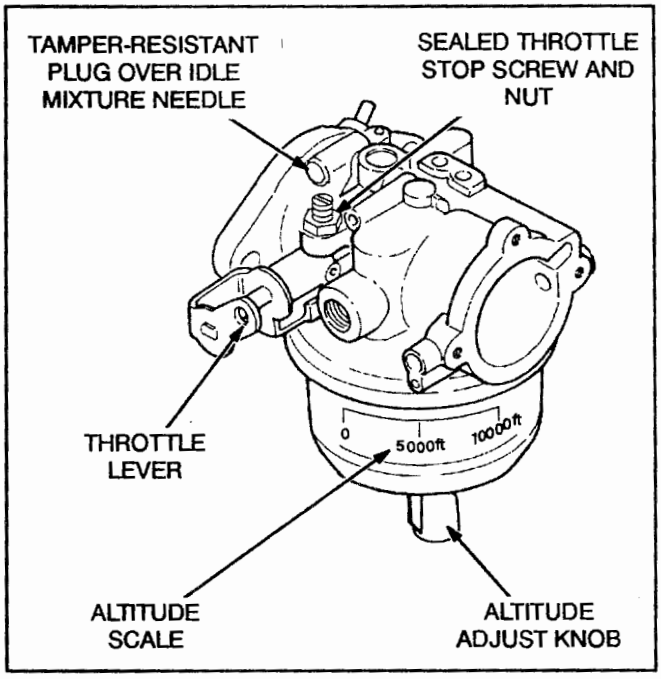

FIGURE 6-14a. CARBURETOR ADJUSTMENTS

Table of Contents

Section 1. Introduction

ABOUT THIS MANUAL

This manual contains service information for the BGM/NHM (Marquis™) generator sets. The service technician must know basic principles of electrical generation and gasoline engine operation. These are described in the following publications:

- Electrical/Mechanical Fundamentals (publication 932-0408)
- Onan® Generator Training Manual (publication 932-0404)
- BGM, NHM Operator's Manual (publication 965-0131)
- BGM, NHM Installation Manual (publication 965-0631)

Installation must comply with the codes and standards listed in the Installation Manual. Read all instructions completely before starting, and obey all cautions and warnings. Incorrect procedures may create an unsafe installation, causing vehicle and equipment damage, severe personal injury, or death.

MODEL IDENTIFICATION

When ordering replacement parts, identify the set with the complete model number and serial number listed on the set nameplate.

Use only authorized replacement parts obtained from an Onan distributor.

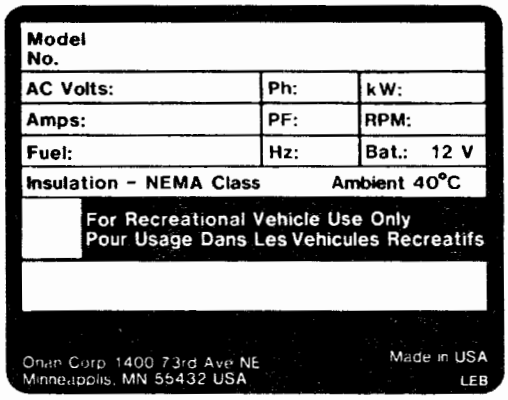

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FIGURE 1-1. ONAN NAMEPLATE

⚠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. General Specifications

MODEL	BGM	NHM
GENERAL		
Weight	255 lb (116 kg)	272 lb (123 kg)
Control Fuse	(Spec A) 5 Ampere (Spec B and later) 10 Ampere	(Spec A) 5 Ampere (Spec B and later) 10 Ampere
Fuel Pump/Autochoke Fuse	(Spec D) 10 Ampere	(Spec D) 10 Ampere
Height	15.0 in. (394 mm)	15.0 in. (394 mm)
Length	33.6 in. (854 mm)	33.6 in. (854 mm)
Width	22.3 in. (566 mm)	22.3 in. (566 mm)
Air Requirement	450 ft^3 /min 12.6 m^3/min	450 ft^3 /min 12.6 m^3/min
Ventilation (free air inlet)	85 $in.^2$ (584.4 cm^2)	85 $in.^2$ (584.4 cm^2)
ENGINE		
Displacement	47.7 in^3 (781.7 cm^3)	60.0 in^3 (983.3 cm^3)
Compression Ratio	6.9:1	7.0:1
Bore	3.25 in. (82.55 mm)	3.56 in. (90.42 mm)
Stroke	2.87 in. (72.90 mm)	3.00 in. (76.20 mm)
Oil Capacity (includes filter)		
Begin Spec C:	3.5 U.S. quarts (3.3 L)	3.5 U.S. quarts (3.3 L)
Spec B and earlier:	4.0 U.S. quarts (3.8 L)	4.0 U.S. quarts (3.8 L)
Spark Plug Gap	0.025 in. (0.64 mm)	0.025 in. (0.64 mm)
Ignition Timing	14-18° BTC	14-18° BTC
Valve Lash: Intake:	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)
Exhaust:	0.013 in. (0.330 mm)	0.013 in. (0.330 mm)
Fuel Inlet Connection:	Gasoline: 1/4 in. barb fitting LPG (liquid): 1/4 in. NPTF	Gasoline: 1/4 in. barb fitting LPG (liquid): 1/4 in. NPTF
Fuel Consumption- Gasoline:		
No Load	0.4 gph (1.5 Lph)	0.4 gph (1.5 Lph)
Half Load	0.6 gph (2.3 Lph)	0.7 gph (2.6 Lph)
Full Load	0.9 gph (3.4 Lph)	1.4 gph (5.3 Lph)
Fuel Consumption- LPG:		
No Load	–	0.5 gph (1.9 Lph)
Half Load	–	1.0 gph (3.8 Lph)
Full Load	–	1.6 gph (6.1 Lph)
Speed	1800 RPM	1800 RPM

MODEL	BGM	NHM
GENERATOR (gasoline units)	60 Hz	60 Hz
Power (watts)	5000	6800
Voltage	120 VAC	120 VAC
Current (Amperes)	41.7/20.8	58.3/29.2
GENERATOR (LPG units)	–	60 Hz
Power (watts)	–	6500
Voltage	–	120/240
Current (Amperes)	–	54.2/27.1
BATTERY RECOMMENDATIONS		
Size	12 Volts	
Capacity	360 Cold Cranking Amperes	
Cranking Current	60 Amperes	
Battery Charger	10 amp capacity	

Section 3. Dimensions and Clearances

MODELS	BGM	NHM
CYLINDERS AND PISTON ASSEMBLY	All clearances listed at 70° F (21° C) room temperature. Values are in inches (millimeters) unless specified otherwise. **Dimensions apply to Specs A, B and C gensets except as indicated.**	
Cylinder Bore (Std size honed)	3.2490-3.2500 (82.525-82.550 mm)	3.5625-3.5635 (90.488-90.513 mm)
Cylinder Taper (Max)	0.005 (0.13 mm)	0.005 (0.13 mm)
Cylinder Out Of Round (Max)	0.003 (0.076 mm)	0.003 (0.076 mm)
Clearance In Cylinder	0.0044-0.0066 (0.112-0.168 mm)	0.0070-0.0090 (0.178-0.229 mm)
Ring Gap (top and second rings)	0.008-0.018 (0.20-0.46 mm)	0.009-0.019 (0.23-0.48 mm)
Piston Ring #1 (top) Groove Width	Spec A, B sets: 0.080-0.081 (2.03-2.06 mm) Spec C sets: 0.0602-0.0612 (1.53-1.55 mm)	0.080-0.081 (2.03-2.06 mm) 0.0602-0.0612 (1.53-1.55 mm)
Piston Ring #2 Groove Width	Spec A, B sets: 0.080-0.081 (2.03-2.06 mm) Spec C sets: 0.0602-0.0612 (1.53-1.55 mm)	0.080-0.081 (2.03-2.06 mm) 0.0602-0.0612 (1.53-1.55 mm)
Piston Ring #3 Groove Width	Spec A, B sets: 0.188-0.189 (4.78-4.80 mm) Spec C sets: 0.1193-0.1203 (3.03-3.06 mm)	0.188-0.189 (4.78-4.80 mm) 0.1193-0.1203 (3.03-3.06 mm)
Piston Pin Diameter	0.6875-0.6877 (17.46-17.47 mm)	0.7500-0.7502 (19.05-19.06 mm)
Piston Pin Clearance In Rod	0.0002-0.0007 (0.005-0.018 mm)	0.00005-0.00055 (0.001-0.014 mm)
Connecting Rod Side Clearance	0.0020-0.032 (0.051-0.813 mm)	0.0020-0.0160 (0.051-0.406 mm)
Connecting Rod Bearing Clearance	0.0020-0.0033 (0.051-0.084 mm)	0.0005-0.0028 (0.013-0.071 mm)

MODELS	BGM	NHM
CRANKSHAFT AND CAMSHAFT		
Crankshaft Main Bearing Journal Diameter	1.9992-2.0000 (50.780-50.800 mm)	1.9992-2.0000 (50.780-50.800 mm)
Crankshaft Rod Journal Bearing Diameter	1.6252-1.6260 (41.280-41.300 mm)	1.6252-1.6260 (41.280-41.300 mm)
Crankshaft Main Bearing Diameter	2.0024-2.0034 (50.860-50.886 mm)	2.0024-2.0034 (50.860-50.886 mm)
Crankshaft Main Bearing Clearance	0.0024-0.0042 (0.064-0.107 mm)	0.0025-0.0038 (0.064-0.097 mm)
Crankshaft End Play	0.006-0.012 (0.15-0.30 mm)	0.005-0.009 (0.13-0.23 mm)
Camshaft Journal Diameter	1.3740-1.3745 (34.900-34.912 mm)	1.3740-1.3745 (34.900-34.912 mm)
Camshaft Bearing Diameter	1.376-1.377 (34.950-34.976 mm)	1.376-1.377 (34.950-34.976 mm)
Camshaft Bearing Clearance	0.0015-0.0030 (0.038-0.076 mm)	0.0015-0.0030 (0.038-0.076 mm)
Camshaft End Play	0.0110-0.0480 (0.280-1.22 mm)	.0.0030-0.0120 (0.076-0.305 mm)
VALVE AND LIFTERS		
Valve Spring Free Length (approx.)	1.600 (40.640 mm)	1.6620 (42.214 mm)
Valve Spring Compressed Length (Valve Closed)	1.3750 (34.925 mm)	1.3750 (34.925 mm)
Valve Spring Tension Open	71-79 lbs (9.8-10.9 N)	71-79 lbs (9.8-10.9 N)
Valve Spring Tension Closed	38-42 lbs (5.3-5.8 N)	38-42 lbs (5.3-5.8 N)

MODELS	BGM		NHM
Valve Face Angle	44°		44°
Valve Seat Angle	45°		45°
Valve Stem Diameter (Intake)	0.2795-0.2800 (7.0993-7.1120 mm)		0.3425-0.3430 (8.700-8.712 mm)
Valve Stem Diameter (Exhaust)	0.2780-0.2785 (7.0612-7.0739 mm)		0.3410-0.3415 (8.661-8.674 mm)
Valve Guide Inside Diameter	Intake 0.2810-0.2820 (7.1374-7.0739 mm)	Exhaust 0.2805-0.2815 (7.1200-7.1501 mm)	Intake and Exhaust 0.344-0.346 (8.738-8.788 mm)
Valve Stem Clearance (Intake)	0.0010-0.0025 (0.025-0.064 mm)		0.0010-0.0025 (0.025-0.064 mm)
Valve Stem Clearance (Exhaust)	0.0020-0.0035 (0.0508-0.0889 mm)		0.0025-0.0050 (0.064-0.127 mm)
Valve Lifter Diameter	0.7475-0.7480 (18.987-18.999 mm)		0.7475-0.7480 (18.987-18.999 mm)
Valve Lifter Bore Diameter	0.7500-0.7515 (19.050-19.088 mm)		0.7500-0.7515 (19.050-19.088 mm)
Valve Lifter To Block Clearance	0.0020-0.0040 (0.0508-0.1016 mm)		0.0020-0.0040 (0.0508-0.1016 mm)
Valve Seat Diameter (Intake)	1.4425-1.4435 (36.6395-36.6649 mm)		1.5690-1.5700 (39.738-39.764 mm)
Valve Seat Diameter (Exhaust)	1.192-1.193 (30.28-30.30 mm)		1.2550-1.2560 (31.877-31.902 mm)
Valve Seat Bore Diameter (Intake)	1.4395-1.4405 (36.563-36.589 mm)		1.5645-1.5655 (39.738-39.764 mm)
Valve Seat Bore Diameter (Exhaust)	1.189-1.190 30.20-30.23 mm)		1.2510-1.2520 (31.775-31.801 mm)

Section 4. Torque Specifications

MODEL	BGM	
TORQUE SPECIFICATIONS	Use engine oil as a lubricant for all threads EXCEPT the spark plug and rotor through-bolt threads	
	FOOT-POUNDS	NEWTON-METERS
Cylinder Head Bolts (cold)	14-16	19-22
Connecting Rod Bolts	12-14	16-19
Rear Bearing Plate	25-27	34-37
Flywheel Mounting Screw	50-55	68-75
Oil Base	20-24	27-33
Gearcase Cover	10-12	14-16
Spark Plug	7-9	9-12
Exhaust Manifold	9-11	12-15
Intake Manifold	6-10	8-14
Rotor Through-Bolt	45-55	61-75
Starter Mounting Screws	30-33	41-45
Stator Clamp Screws	10-12	11-16
Adapter to Engine	25-27	34-37
Mounting Screws Adapter to Generator	25	34
Mounting Screws Rear Vibration Isolator		
Center Screw	30-33	41-45
Flange to Drip Tray Screws	10-12	14-16
Front Vibration Isolator		
Flange to Oil Base Screws	19-22	26-30
Center Screw	28-32	38-43
Vibration Isolators		
Center Screw	30-33 ft-lbs	41-45
Flange to Drip Tray Screws	10-12 ft-lbs	14-16
Voltage Regulator		
Mounting Bracket Screws	7-8 ft-lbs	9-11
Regulator Attachment Screws	5-6 ft-lbs	7-8
Start Solenoid Attachment Screws	5-6 ft-lbs	7-8

MODEL	NHM	
TORQUE SPECIFICATIONS	Use engine oil as a lubricant for all threads EXCEPT the spark plug and rotor through-bolt threads.	
	FOOT-POUNDS	NEWTON-METERS
Cylinder Head Nuts (cold) (with compression washers)	14	19
Cylinder Head Nuts (cold) (without compression washers)	17	23
Connecting Rod	27-29	37-39
Rear Bearing Plate	25-28	34-38
Flywheel Mounting Screw	50-55	68-75
Starting Mounting Bracket to Oil Base Screws	20-24	27-33
Gearcase Cover	10-12	14-16
Spark Plug	7-9	9-12
Exhaust Manifold	20-23	27-31
Intake Manifold	14-16	19-22
Rotor Through-Bolt	45-55	61-75
Starter Mounting Screws	30-33	41-45
Stator Clamp Screws	10-12	14-16
Adapter to Engine Mounting Screws	25-27	34-37
Adapter to Generator Mounting Screws	25	34
Rear Vibration Isolator		
Center Screw	30-33	41-45
Flange to Drip Tray Screws	10-12	14-16
Front Vibration Isolator		
Flange to Oil Base Screws	19-22	26-30
Center Screw	28-32	38-43
Vibration Isolators		
Center Screw	30-33 ft-lbs	41-45
Flange to Drip Tray Screws	10-12 ft-lbs	14-16
Voltage Regulator		
Mounting Bracket Screws	7-8 ft-lbs	9-11
Regulator Attachment Screws	5-6 ft-lbs	7-8
Start Solenoid Attachment Screws	5-6 ft-lbs	7-8

Section 5. Preparing for Service

TROUBLESHOOTING

For most service procedures, the genset must be removed from the vehicle. If this is a problem, contact the vehicle manufacturer or set installer for help. This manual section describes how to remove the sheet metal cover, to expose the set for service.

Main service areas are covered in these manual sections:

- Section 6: Engine - Primary Systems
- Section 7: Control System
- Section 8: Generator
- Section 9: Engine Block Assembly

Troubleshooting charts in each section provide fixes for common malfunctions.

ENGINE TOOLS

- Torque wrench (0 - 175 ft-lbs or 0 - 240 N•m)
- Feeler gauge
- Pressure gauge
- Spark plug gap gauge
- Cylinder compression tester
- Carburetor adjustment wrench
- 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.)
- Telescoping gauge set (1/2 in. to 6 in.)
- Hole gauge (0.300 in. to 0.400 in.)
- Plasti-Gage bearing clearance guide
- Torx screwdriver set

GENERATOR AND CONTROL TOOLS

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

Many of these tools are available through the Onan tool catalog (publication #900-0019).

SAFETY CONSIDERATIONS

Be totally aware of genset hazards. Study the safety precautions on the inside front cover of this manual, and know the hazards listed in Table 5-1. Approach the job in a safety-conscious manner, to avoid injury and death.

Safeguards to Avoid Hazards

Use personal protection: Wear protective safety equipment, such as:

- Safety shoes
- Gloves
- Safety glasses
- Hard hats
- Ear plugs

Do not wear rings, jewelry, or loose clothing: these might get caught on equipment, or conduct electricity.

TABLE 5-1
HAZARDS AND THEIR SOURCES

- **Fire and explosions**
  - Leaking fuel
  - Hydrogen gas from charging battery
  - Oily rags improperly stored
  - Flammable liquids improperly stored
  - Any fire, flame, spark, pilot light, arc-producing equipment or other ignition sources
- **Burns**
  - Hot exhaust pipes
  - Hot engine and generator surfaces
  - Hot engine oil
  - Electrical short in DC wiring system
  - Hot engine coolant
- **Poisonous gases**
  - Carbon monoxide from faulty exhaust
  - LP gas leaking into coach interior
  - Operating generator set where exhaust gases can accumulate
- **Electrical shock (AC)**
  - Improper genset load connections
  - Faulty RV wiring
  - Faulty electrical appliance
  - Faulty genset wiring
- **Rotating Machinery**
  - Flywheel fan guard not in place
- **Slippery Surfaces**
  - Leaking or spilled oil
- **Heavy Objects**
  - Removing generator set from RV
  - Removing heavy components

Reduce the hazard: A safe, orderly work area and well-maintained equipment reduce hazard. Leave all guards and shields in place on machinery, and maintain equipment in top condition. Store flammable liquids in approved containers, away from fire, flame, spark, pilot light, arc-producing equipment and other ignition sources. Keep the work area clean, well-lighted, and well-ventilated. Keep fire extinguishers and safety equipment nearby, and be prepared for any emergency.

Develop safe work habits: Unsafe practices cause accidents. Be familiar with your tools and machines to use them safely. Use the right tool for the job, and check its condition before starting. Follow all warnings in this manual, and take extra precautions when working around electrical equipment. Avoid working alone, and take no risks.

Be prepared for a potential accident: The Red Cross and public safety departments offer courses in first aid, CPR, and fire control. Use this information to be ready for an accident. Be safety-conscious, and make safety procedures part of the work routine.

⚠WARNING ***State or federal agencies have determined that asbestos, used engine oil, and benzene cause cancer or reproductive toxicity. When adding, changing or working with fuel, oil, or asbestos gaskets take care not to breathe, ingest or come into excessive contact with these substances. Wash hands after use. Wear protective clothing and equipment. Provide adequate ventilation.***

⚠WARNING ***Generator sets are heavy and can cause 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.***

SET REMOVAL GUIDELINES

Disconnecting Set from Vehicle Systems

1. Disconnect the vehicle negative (-) battery cable and genset negative (-) battery cable at their terminals.

   ⚠WARNING ***Batteries give off explosive gas. To avoid excessive arcing, always disconnect the negative (-) cable first, and connect it last.***

2. Disconnect the set positive (+) battery cable from the start solenoid.

3. Disconnect the remote control wire connector from the set control.

4. Disconnect the generator load wires at the vehicle electrical system junction box. Tag the wires for identification when reconnecting.

5. Loosen the conduit connector, and pull the load wires and flexible conduit free of the junction box.

6. Close the fuel shutoff valve in the compartment, and disconnect the fuel line at the fuel pump. Plug the end of the fuel line to prevent fuel leakage or accumulation of explosive gasoline vapor or LPG fumes.

⚠WARNING ***Gasoline vapor is extremely flammable, and can cause severe personal injury or death if ignited. Make certain all fuel line openings are plugged to prevent gasoline vapor from accumulating. Eliminate all possible sources of ignition including fire, flame, spark, pilot light, arc-producing equipment, cigarettes, or other ignition sources before working in this area.***

Set Removal

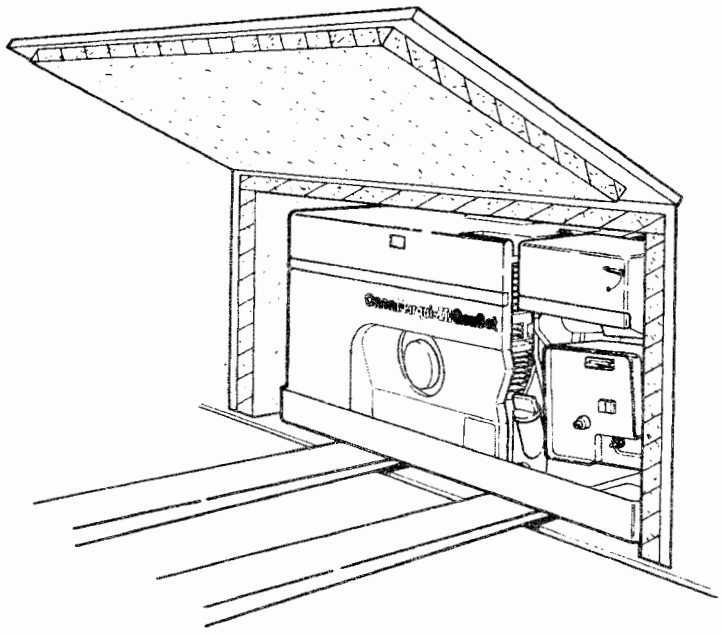
After the genset is disconnected from electrical and fuel systems, make certain that it is externally supported before loosening its mounting bolts or support members. Use a forklift to lift or move the set.

⚠WARNING ***The generator set is heavy, and can cause severe personal injury if dropped during removal. Use the recommended removal procedures, and keep hands and feet clear while removing mounting bolts. Make certain that all vehicle systems have been disconnected before performing this procedure.***

1. Park the vehicle on a level surface which can support the forklift. Move the transmission to PARK, lock the brakes and remove the ignition key. Do not move the vehicle during this procedure.

   ⚠WARNING ***Dropping the generator set can cause severe personal injury or death. Make sure no one moves the vehicle during this procedure and that the procedure is performed very carefully and only as instructed.***

2. Use a forklift to support the set tray as shown in Figure 5-1. Place a wooden block on one fork if necessary, to keep the set level.
3. Raise the lift so it contacts the drip tray, then place slight upward pressure on the tray. Make certain that the genset is fully supported by the lift before continuing.
4. Remove the bolts holding the set to its support frame.
5. Lift the genset until it is clear.
6. Pull the genset out of the compartment.
7. Slowly lower the set until it clears all obstructions and can be removed.



M-1799-1s

FIGURE 5-1. SET REMOVAL

Section 6. Engine - Primary Systems

INTRODUCTION

Primary engine systems include:

- Cooling system
- Exhaust system
- Ignition system
- Electric starter
- Crankcase ventilation system
- Governor
- Fuel system

Use the following troubleshooting guide to locate problem areas. See Section 7, *Control System,* for genset starting problems.

Poor engine performance is often caused by a dirty carburetor and/or combustion chamber. Make certain these areas are clean before continuing troubleshooting. See the Periodic Maintenance Schedule in the Operator's Manual (publication 965-0131) for a cleaning procedure using Onan 4C.

A regular maintenance routine can prevent many of the problems listed below. Poor maintenance often leads to poor engine operation. It is especially important to examine and clean the combustion chambers every 300 hours. A periodic maintenance schedule is found in the BGM/NHM Operator's Manual, Onan publication 965-0131.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuel, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

Trouble	Possible Cause	Corrective Action
Engine Misfires	1. Faulty ignition due to: a. worn or fouled spark plugs. b. faulty ignition coil. c. faulty plug wires.	1a. Replace spark plugs. 1b. Test coil and replace if necessary. 1c. 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. d. vacuum leak.	2a. Adjust carburetor main and idle adjustment screws. 2b. Adjust carburetor float level. 2c. Disassemble carburetor and clean all internal passages. Replace fuel filter. 2d. Locate leak and correct as required.
	3. *Contaminated fuel.	3. Drain fuel tank and refill with fresh fuel.
	4. *Carburetor icing	4. In cold weather, place air preheater in winter position.
Engine Backfires	1. Faulty ignition due to incorrect spark plug gap.	1. Reset spark plug gap.
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel adjustment screws. b. incorrect float level. c. dirt in carburetor.	2a. Adjust carburetor main and idle mixture 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.

*Gasoline sets only.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuel, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

Trouble	Possible Cause	Corrective Action
Engine Lacks Power	1. Faulty ignition due to incorrect spark plug gap.	1. Reset spark plug gap.
	2. Dirty air cleaner.	2. Replace air cleaner.
	3. Restricted fuel flow due to: a. Plugged fuel filter. b. Faulty fuel pump.	3a. Replace fuel filter. 3b. Test fuel pump and repair or replace if faulty.
	4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws. * b. incorrect float level. c. dirt in carburetor. d. vacuum leak.	4a. Adjust carburetor main and idle adjustment screws. 4b. Adjust carburetor float level. 4c. Disassemble carburetor and clean all internal passages. Replace fuel filter. 4d. Repair vacuum leak.
	5. Exhaust system blocked or restricted.	5. Locate and remove cause of blockage.
	6. Incorrect valve tappet clearance.	6. Adjust valve tappets (see *Engine Block Assembly* section).
	7. Excessive engine wear or damage to engine.	7. See *Engine Block Assembly* section.
	8. *Carburetor air preheater set incorrectly.	8. In hot weather, place air preheater in summer position.
	9. Combustion chamber deposits.	9. Clean combustion chamber.
	10. (Spec A sets) No-load speed set too low: excessive governor droop.	10. Adjust (mechanical) governor.
	* Gasoline sets only	

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuel, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

Trouble	Possible Cause	Corrective Action
Engine Overheats	1. Restricted airflow due to dirt or debris blocking air inlet or outlet.	1. Clear away any debris that may restrict airflow to set. Do not use compartment for storage area.
	2. Dirt or oil covering engine cooling fins.	2. Clean away all dirt and oil from engine cooling fins.
	3. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws. * b. incorrect float level. c. dirt in carburetor. d. vacuum leak.	3. a. Adjust carburetor main and idle adjustment screws. 3. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages. Replace fuel filter. d. Repair vacuum leak.
Black Exhaust Smoke	1. Rich fuel mixture due to: a. dirty air cleaner. *b. choke sticking. c. incorrectly adjusted fuel mixture screws. d. dirt in carburetor. * e. incorrect float level * f. faulty carburetor float	1a. Replace air cleaner. 1b. Clean choke and choke linkage. 1c. Adjust carburetor idle and main adjustment screws. 1d. Disassemble carburetor and clean all internal passages. 1e. Adjust carburetor float level. 1f. Replace carburetor float.
White or Blue Exhaust Smoke	1. Lean fuel mixture due to: a. incorrect float level b. incorrectly adjusted fuel mixture screws c. dirt in carburetor d. vacuum leak 2. Contaminated fuel 3. Excessive engine wear * Gasoline sets only	1a. Adjust carburetor float level 1b. Adjust carburetor idle and main adjustment screws 1c. Disassemble carburetor and clean all internal passages 1d. Repair vacuum leak. 2. Drain and replace fuel 3. See *Engine Block Assembly* section.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuel, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

Trouble	Possible Cause	Corrective Action
Engine Surges	1. Sticking or binding (mechanical) governor linkage.	1. Clean governor linkage (remove dirt or ice buildup). Check that linkage does not touch other parts.
	2. Incorrect (mechanical) governor adjustment.	2. Adjust governor speed and sensitivity.
	3. Faulty (mechanical) governor spring.	3. Replace governor spring.
	4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws *b. incorrect float level c. dirt in carburetor d. ignition misfires	4a. Adjust carburetor main and idle adjustment screws. 4b. Adjust carburetor float level. 4c. Disassemble carburetor and clean all internal passages. 4d. Check connections, see *Ignition* section.
	5. Intermittent electrical connections.	5. Check battery and ignition connections.
	6. Governor mechanism worn excessively.	6. See *Engine Block Assembly* section.
	7. Fuel supply problem caused by: a. Faulty fuel pump b. *Contaminated fuel supply c. Vapor locking d. Plugged fuel filter	7a. Check fuel pump and replace if defective. 7b. Drain and refill fuel supply 7c. Check for cause of overheating 7d. Replace fuel filter.
	8. Carburetor icing.	8. In cold weather, place air preheater in winter position.
	*Gasoline sets only.	

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuel, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

Trouble	Possible Cause	Corrective Action
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 faulty.	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. Don't 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 faulty oil pump.	5. See *Engine Block Assembly* section.

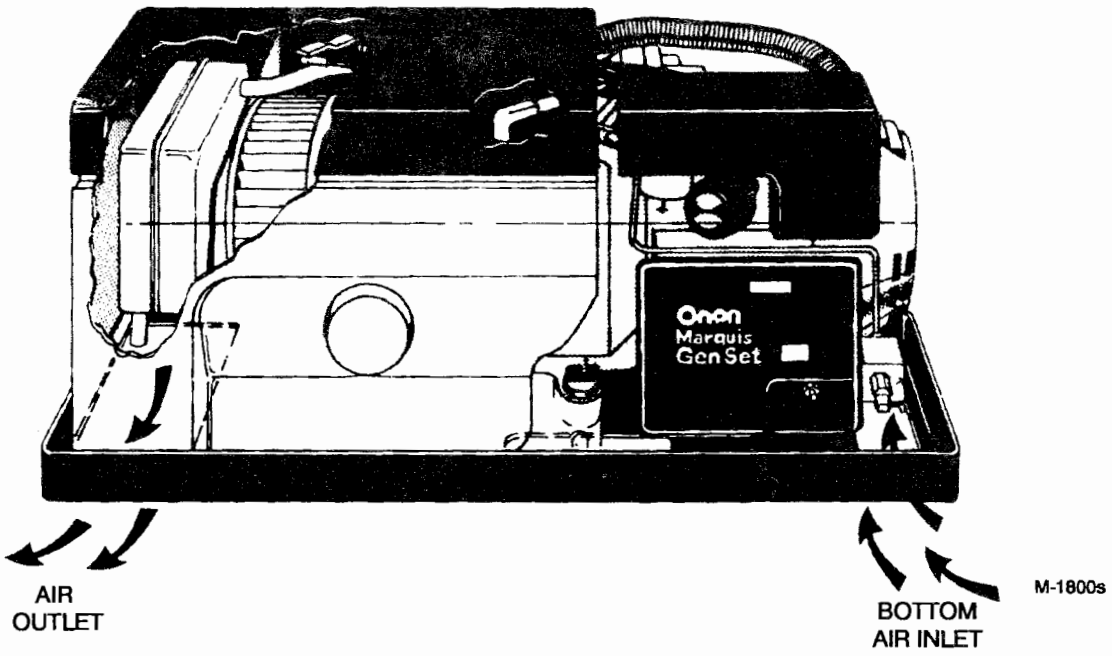


FIGURE 6-1. COOLING AIRFLOW

COOLING SYSTEM

Marquis gensets use the Vacu-Flo® cooling system (Figure 6-1) to provide a constant flow of cooling air over the engine and generator. A flywheel fan draws in cool air from under the compartment. This air passes over the cooling fins on the engine, absorbing heat. Heated air is discharged through the opening in the bottom of the set housing.

⚠WARNING ***Inhalation of carbon monoxide can result in severe personal injury or death. Never use discharged cooling air for heating the vehicle interior, because discharged cooling air can contain poisonous exhaust gases.***

⚠WARNING ***Do not run the generator set without the top cover under any circumstances. Contact with the exposed moving flywheel can result in severe personal injury or death.***

The size of the genset compartment air inlet (see *Specifications*) determines the rate of airflow. The air inlet and outlet must not obstruct airflow. Regularly remove all dirt, dust, and debris clogging the duct openings. Remove dirt lodged between the cooling fins on the engine block and cylinder heads, which can cause overheating.

Cooling System Components

The cooling system consists of:

- Right cylinder head assembly
- Left cylinder head assembly
- Backplate assembly
- Front panel assembly
- Top assembly
- Flywheel

Cooling System Disassembly Procedure

1. Disconnect the starting battery, negative (-) cable first, to prevent accidental starting.
2. If they are present, pry the trim strips off the front (engine end), left and right sides of the set to expose the Torx screws holding the top assembly of the set.
3. Using a standard Torx screwdriver, remove the screws around the genset perimeter exposed by the removal of the trim strips (if present).
4. Remove the two screws at the front of the governor cover on top of the set. Lift the top cover assembly off the set.

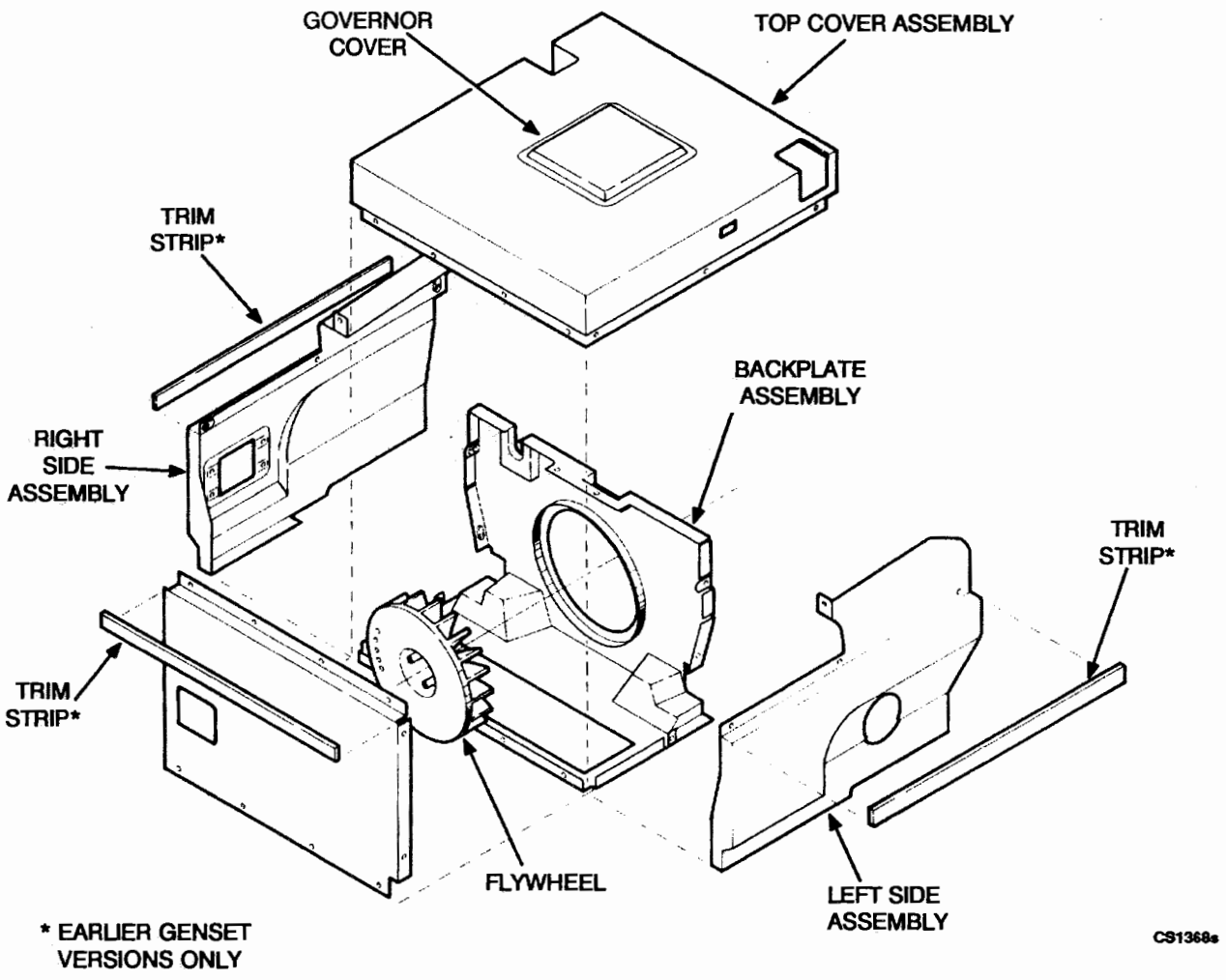


FIGURE 6-2. COOLING SYSTEM

5. Remove the five Torx screws holding the left side assembly to the genset. Reaching behind the left side assembly from the rear of the set, remove the bolt holding the side assembly to the cylinder head, and remove the last remaining screw holding the side assembly. Lift the side assembly away from the set.
6. Repeat step 4 on the right side to remove the right side assembly.
7. Remove the four screws holding the front panel to the set.

Cooling System Disassembly for Engine Block Service: To work on the engine block or cylinder heads, further disassembly is required, as follows:

⚠WARNING ***To avoid eye injury, wear safety goggles while using compressed air to remove debris from the engine cooling fins (see 8., below).***

1. Remove the muffler and tail pipe assembly (see Exhaust System, below).
2. Loosen the flywheel capscrew and back it out several turns.

3. Attach a flywheel puller to the flywheel (see Figure 6-3). The tool has two jackscrews that fit into the holes tapped in the flywheel.

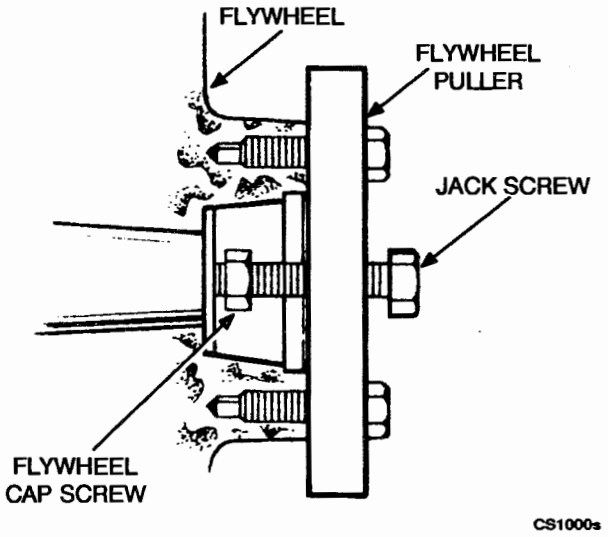


FIGURE 6-3. FLYWHEEL PULLER

4. Tighten the puller center screw until the flywheel comes loose. Remove the puller, flywheel center screw, and washer. Inspect the flywheel, and replace it if any air vanes are missing.
5. Remove the lead from the low oil pressure cutoff switch.
6. Remove the exhaust manifold (see Exhaust System, below).
7. Remove the capscrews that hold the backplate to the engine. Lift off the backplate.
8. Use a brush or low-pressure compressed air to remove dirt or debris lodged in the engine cooling fins.

Cooling System Assembly Procedure

To reassemble the cooling system, perform the assembly steps in reverse order. When installing the flywheel, align its keyway with the woodruff key on the crankshaft. Use non-hardening sealer on the flywheel capscrew threads, and tighten them to the specified torque. Refer to Exhaust System, below, to install the exhaust manifold, muffler, and tailpipe.

⚠ CAUTION ***Make certain that the low oil pressure switch is reconnected when assembling the generator set. The control board logic for this set is such that the set will start and run without the low oil pressure switch connected. This can result in engine damage if a low oil condition exists. To avoid this, make certain to reconnect the low oil pressure switch.***

⚠ CAUTION ***Generator set overheating can result in engine damage. To avoid this, never operate the generator set with any cooling system components removed.***

EXHAUST SYSTEM

Exhaust system condition is critical, because deadly exhaust gases may enter the vehicle. Repair the exhaust system immediately if there are leaking joints/connections, loose fasteners, damaged components, or if the exhaust pipe is not securely hung, with its termination beyond the vehicle perimeter. Figure 6-4 illustrates the internal Marquis exhaust system.

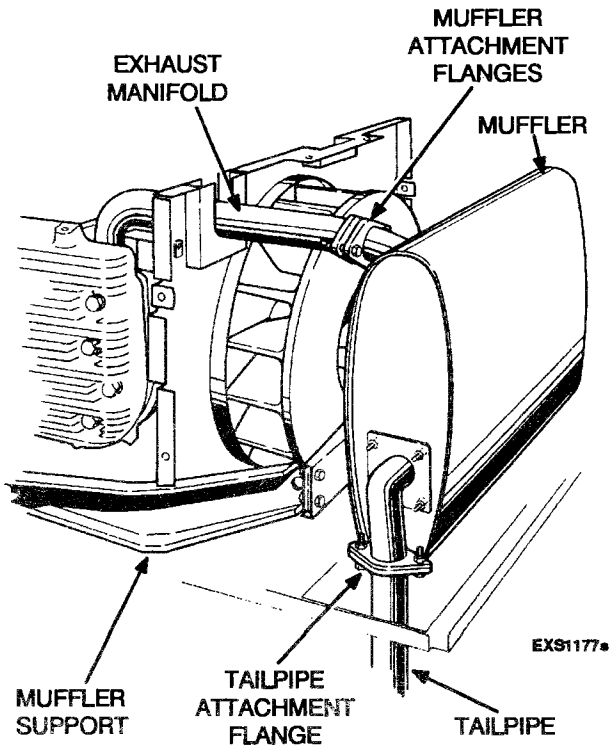


FIGURE 6-4. MARQUIS EXHAUST SYSTEM

Do not try to weld a broken exhaust pipe or manifold. Instead, replace worn components with new Onan parts. Contact an Onan distributor for exhaust kit parts and instructions. Do not use parts not supplied by Onan.

⚠WARNING ***Inhaling exhaust gases can cause severe personal injury or death. Modifying the exhaust system may let poisonous exhaust gases enter the vehicle. Use only Onan replacement parts to service the exhaust system. Unauthorized modifications will void the Onan warranty. Liability for injury or damages due to unauthorized modifications becomes the responsibility of the person making the change.***

Exhaust System Components

The Marquis exhaust system consists of:

- Exhaust manifold
- Muffler
- Muffler support
- Tailpipe
- Muffler attachment flanges
- Tailpipe attachment flange

Exhaust System Disassembly Procedure

1. Disconnect the starting battery, negative (-) cable first, to avoid injury from accidental starting of the genset.

   ⚠WARNING ***Batteries give off explosive gas, which may be ignited by electrical arcs or sparks, causing the risk of severe injury or death. To avoid excessive arcing, always disconnect the negative (–) cable first, and connect it last.***

2. Let the set exhaust system cool to ambient temperature, to avoid burns.

   ⚠WARNING ***The exhaust system gets very hot during normal operation and can cause severe burns if touched. Do not touch the exhaust system during and after set operation. Allow the set to cool down before working on the exhaust system.***

3. Loosen and remove the two nuts holding the tailpipe attachment flange to the muffler assembly. Remove the tailpipe from the muffler.
4. Loosen and remove the two bolts and nuts clamping the muffler attachment flange to the flange on the exhaust manifold. Loosen and

remove the four bolts and nuts holding the muffler to the lower support brackets. Pull the muffler assembly off the exhaust manifold.

5. Remove the four exhaust manifold screws. Lift off the exhaust manifold and the two manifold gaskets. Discard the used gaskets.

Exhaust System Assembly Procedure

1. Install the exhaust manifold, using new gaskets to avoid leaks of toxic exhaust gas. Tighten the four manifold screws to the specified torque.
2. Place the muffler next to its supports extending out from the genset. Using the appropriate screws and nuts, attach the flanges on the bottom of the muffler assembly to the ends of the muffler supports.
3. Press the socket on the end of the muffler inlet onto the ball at the end of the exhaust manifold. Hold the socket flange to the manifold flange, and bolt the flanges together to clamp the ball into the socket.
4. Reattach the tailpipe flange to the muffler using two nuts and lockwashers.
5. If replacing the original tailpipe, refer to the Tailpipe Recommendations section, below, to select and locate the tailpipe. Attach the tailpipe to the outlet end of the muffler. Secure it using a 1-3/8 inch U-bolt type automotive muffler clamp.
6. Support the tailpipe using a shock-mounted support hanger with clamp.

   ⚠CAUTION ***Incorrect tailpipe hanger bracket mounting can result in excessive vibration transfer to the vehicle. To prevent this, mount the tailpipe hanger brackets directly above the component being supported, NOT at an angle. Hangers must be attached to metal coach components, NOT wood components.***

7. Run the set for five minutes. Check the entire length of the exhaust system for leaks and excessive noise. Repair any leaks immediately.

   ⚠WARNING ***Fire can cause severe personal injury or death. Contact between hot genset parts and high grass or brush may cause fire. Do not operate the generator set when vehicle is parked in high grass or brush.***

8. Clean the spark arrester muffler every 100 hours of operation. To do this, remove the 1/8 inch pipe plug in the bottom of the muffler, run the set for five minutes, then replace the pipe plug. Inspect the exhaust system for leaks and for proper termination beyond the coach perimeter, before each operation, and at least once every eight hours of running time.

   ⚠WARNING ***Exhaust gas can produce severe personal injury or death, if it is inhaled. To prevent exhaust leaks, install all gaskets, clamps, straps, and hardware as specified in this manual and the installation manual.***

Tailpipe Recommendations

The tailpipe is normally supplied by the vehicle manufacturer. For safe operation, it must meet specific requirements. Make certain that a replacement tailpipe is the same size/configuration as the original.

⚠WARNING ***Inhaling exhaust gases can cause severe personal injury or death. Exhaust gases can enter the vehicle interior if the tailpipe is damaged, missing, or improperly installed. Follow the recommended exhaust system replacement procedures for safe operation.***

Use 1-3/8 inch I.D. 18 gauge rigid steel tubing as a tailpipe. Do not use flexible tubing, because it is vulnerable to road shock and vibration.

Install an exhaust tailpipe at least 3 inches (76 mm) away from the fuel tank and from any combustible material. If 3 inches clearance is not available, install heat shielding between the tailpipe and the fuel tank or any combustible material.

To reduce the chance of damaging the tailpipe and emitting exhaust gases under the vehicle, make certain that no part of the exhaust system intrudes into the departure angle or approach angle of the

vehicle, unless it is protected by a skid bar or other protection device.

⚠WARNING ***Exhaust gas presents the hazard of severe personal injury or death. Do not mount any portion of the exhaust system into the approach or departure angle unless it is adequately protected. Use only Onan-specified exhaust equipment with the generator set. Use a sufficient number of hangers to prevent dislocation of the system.***

Do not terminate the exhaust tailpipe under the vehicle. Be aware that any vent, window or opening that can be opened and that is not permanently sealed from the vehicle living space can be an avenue for carbon monoxide. The tailpipe must not terminate so that any vent, window, or opening into the living area is within a triangular area defined as an isosceles triangle with a height of 3 feet measured from the center of the tailpipe termination and with a base of 2 feet measured one foot horizontally from the center of the pipe in either direction.

Consult the Installation Manual, publication 965-0631, when installing any part of an exhaust system.

⚠WARNING ***Exhaust gas presents the hazard of severe personal injury or death. Do not terminate an exhaust pipe under the vehicle. The tailpipe must not terminate so that any vent, window, or opening into the living area is within the triangular area shown in Figure 5-1 in the Installation Manual, publication 965-0631. Keep all openings closed when the generator set is running.***

Extend the tailpipe at least one inch (25 mm) beyond the perimeter of the vehicle. Direct exhaust gases down and away from the vehicle, and away from windows, doors, or compartment openings.

Do not connect the genset exhaust tailpipe to the vehicle exhaust system. Exhaust gases will be forced into the non-running engine, and might be released through the carburetor air inlet. Water vapor from the exhaust might also damage the non-running engine.

IGNITION SYSTEM

The Marquis electronic ignition system eliminates the breaker points and condenser of the conventional ignition system. In normal use, the ignition system components should require little or no service or maintenance.

Ignition System Components

- Ignition rotor
- Ignition module
- Ignition coil
- Spark plugs
- Wiring

Ignition Rotor

The ignition rotor is attached to the engine crankshaft. It contains a magnet which rotates past the ignition module inside the generator adapter. The ends have opposite magnetic polarity (north and south). One pole switches on the ignition module, and the other pole switches it off, once each revolution of the crankshaft. The ignition rotor should not normally require replacement during the life of the genset.

Ignition Module

The ignition module is mounted to the generator/engine adapter, as illustrated in Figure 6-5. It is an electronic switch in the primary circuit of the ignition coil. It is switched on and off once each revolution by the rotor, sending a pulse of the proper amplitude and duration to the ignition coil to be stepped up to high voltage, to fire the spark plugs. The ignition module contains no user-serviceable parts.

Testing Ignition Module: This procedure determines if the ignition module needs to be replaced.

1. Remove the spark plugs to make turning the engine easier.
2. Connect the positive (+) side of a voltmeter to the negative (-) terminal of the ignition coil (larger of the two screw terminals) and the negative (-) side of the voltmeter to engine ground.
3. Remove all leads from the positive (+) terminal of the coil.
4. Use a jumper to connect the ignition module lead (the one just removed from the coil) to the battery positive (+) terminal.
5. Rotate the flywheel clockwise by hand. Replace the ignition module if voltage does not jump from about 1 volt to about 12 volts and then back again, each turn of the crank. To replace the module, remove the bracket mounting screws (Figure 6-5) and lift out the bracket/module assembly. Be sure to assemble the new module to the bracket as shown by Section A-A, Figure 6-5. The studs on the bracket must point to the generator end when assembled. Refer to Section 8 of this manual for removal and replacement instructions.

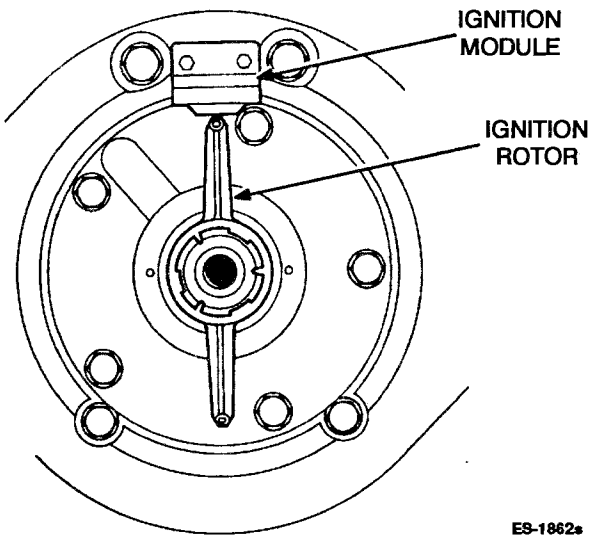


FIGURE 6-5. IGNITION MODULE

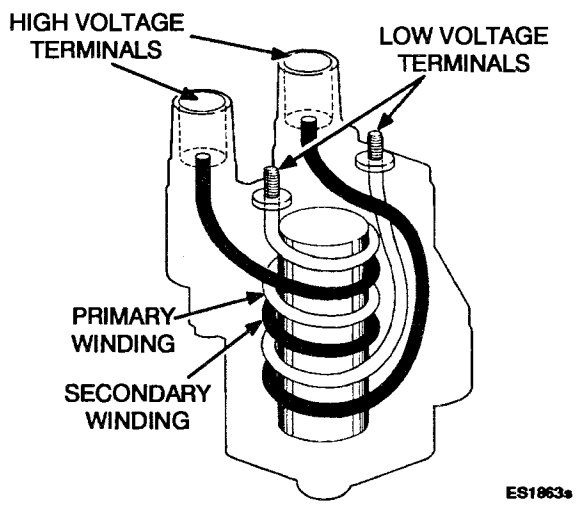


FIGURE 6-6. IGNITION COIL

Ignition Coil

The ignition coil (Figure 6-6) is a transformer that steps up the battery voltage to roughly 20,000 volts, firing the spark plug. Ignition coil and module removal and replacement are covered in Section 8 of this manual, *Generator.*

Keep all ignition coil terminals and connections clean and secure. Check for loose seams, dents, punctures, and mechanical damage. If ignition is poor and the other ignition components are not at fault, test the coil as described below. Make certain of coil polarity: the negative (-) terminal connects to the ignition module (black lead), and the positive (+) terminal connects to a battery positive (+) source within the control and the ignition module (red lead).

Ignition Coil Test Procedures

Ignition Coil Quick Test: This test checks the coil with the rest of the ignition system.

⚠WARNING ***Gasoline vapor is extremely flammable, and can result in severe personal injury or death if ignited. Make certain that no gasoline or other flammable fumes are present. Park the vehicle in a well-ventilated area, and leave the generator set compartment door open for several minutes before performing this test.***

1. Make certain that no gasoline fumes or other flammable fumes are present. Park the vehicle in a well-ventilated area, and leave the set compartment door open for several minutes before performing this test.
2. Remove a spark plug.
3. Reconnect the spark plug wire to the spark plug.
4. Ground the spark plug to bare engine metal.
5. Crank the engine.

   A strong spark should appear between the plug center electrode and the side electrode. A weak spark means that the coil or wiring may be defective.

⚠WARNING ***Electrical shock can cause severe personal injury or death. Use extreme caution when testing electrical circuitry. Attach and remove leads only when generator set is not operating. Do not touch leads during testing. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when testing electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.***

⚠WARNING ***Gasoline is extremely flammable. Severe personal injury or death can result if it is accidentally ignited. Eliminate all possible sources of ignition including fire, flame, spark, pilot light, arc-producing equipment and other ignition sources before performing this procedure.***

Ignition Coil Ohmmeter Test: The coil is removed from the circuit to perform this test.

1. Remove all wires attached to the ignition coil.
2. Remove the coil from the engine.
3. Inspect terminals for corrosion, looseness, cracks, dents and other damage. Look for carbon runners around high tension terminals: these indicate electrical leakage. Replace a damaged or leaking coil.
4. Clean the outside of the coil with a cloth dampened in parts cleaning solvent.
5. Measure resistance in the primary circuit; connect the ohmmeter leads to the positive (+) and negative (-) terminals on the coil. This resistance should be 4.15 ohms, ± 10%. Replace the coil if the resistance is higher: high resistance indicates an open circuit or a poor connection inside the coil.
6. Measure resistance in the secondary circuit; connect the ohmmeter leads to the two high voltage terminals (see Figure 6-7). This resistance should be 37.8 K ohms, ± 10%. Replace the coil if it is not within this specification; lower resistance indicates a shorted secondary winding, and higher resistance indicates the coil has excessive internal resistance or an open circuit.

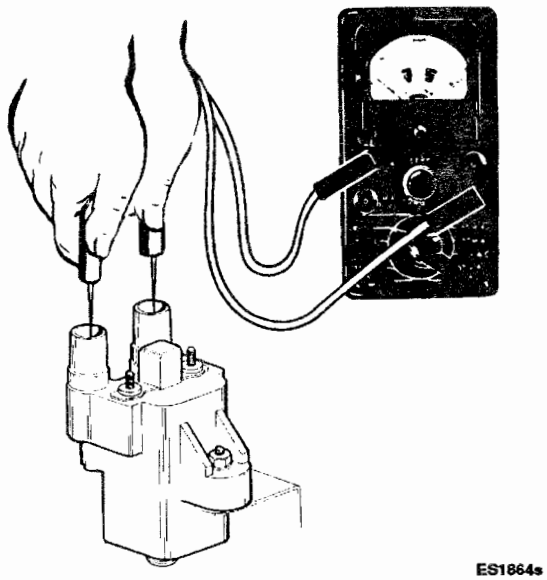


FIGURE 6-7. TESTING COIL SECONDARY

Spark Plugs

⚠WARNING ***Gasoline is extremely flammable. Severe personal injury or death can result if it is accidentally ignited. Eliminate all possible sources of ignition including fire, flame, spark, pilot light, arc-producing equipment or other ignition sources before performing this procedure.***

Remove and inspect the spark plugs at the intervals listed in the operator's manual. Carefully examining the plug can often determine the source of an engine problem.

- ***One plug carbon fouled:*** Check for an open ignition cable or low compression.
- ***Black soot deposits:*** Check for faulty choke operation, overly rich fuel mixture, or dirty air filter.
- ***Oil fouled:*** Check for faulty crankcase breather, worn rings, worn valve guides, worn valve stem seals, or missing valve stem seal retainers.
- ***Burned or overheated:*** Check for leaking intake manifold gaskets or lean fuel mixture.
- ***Chipped Insulator:*** Check for advanced timing. Bend only the side electrode when setting the gap.

- ***Splash fouled:*** Check for accumulated combustion chamber deposits. Refer to the *Cylinder Head* section of this manual.
- ***Light tan or gray deposits:*** Normal plug color.

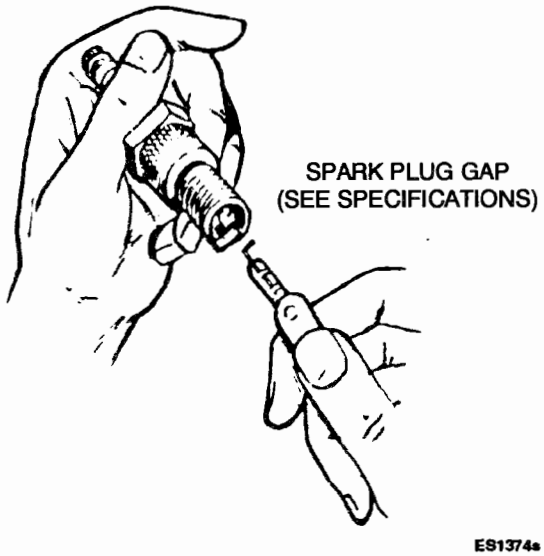


FIGURE 6-8. CHECKING PLUG GAP

Ignition Wiring

The ignition system wiring includes:

- Low voltage wiring from B+ to the ignition module
- Low voltage wiring from the ignition module to the ignition coil primary winding
- High voltage wiring from the ignition coil secondary winding to the spark plugs

The plugs and coil secondary are grounded to the engine, completing a circuit to the battery. When the ignition rotor passes the ignition module, it causes the module to ground its B+ connection, sending a low-voltage pulse through the coil primary. A high-voltage pulse is induced in the ignition coil secondary, firing the spark plug.

Check all low voltage wiring for loose connections and breaks in the insulation. Clean all terminals and connections, and use an ohmmeter to test them for continuity. Use a megger (high-range ohmmeter) to check for breaks in the plug wire insulation.

CRANKCASE VENTILATION SYSTEM

The crankcase breather prevents pressure from building up in the crankcase. It prevents oil contamination by routing moisture, gasoline vapors and other harmful blow-by materials from the crankcase to the carburetor and combustion chamber. A sticky crankcase breather can cause oil leaks, high oil consumption, rough idle, reduced engine power, and rapid formation of sludge and varnish in the engine.

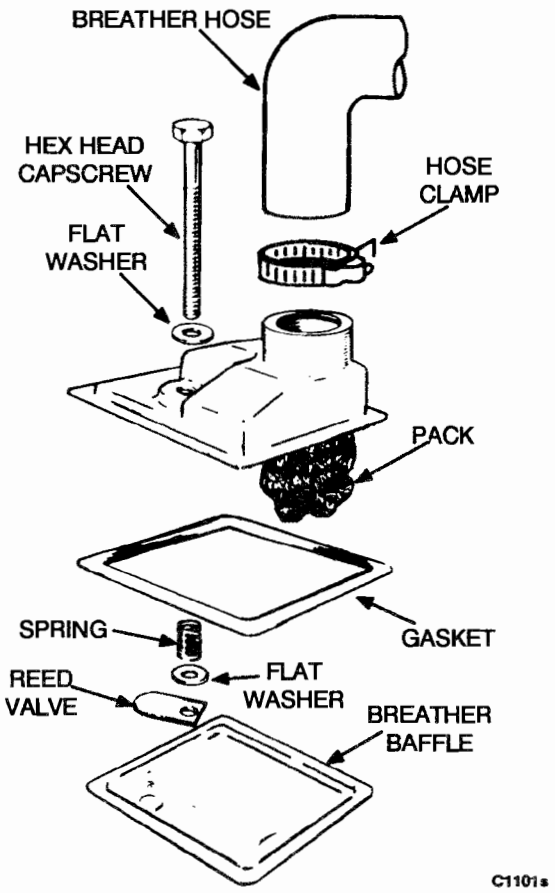


FIGURE 6-9. CRANKCASE BREATHER

Crankcase Breather Service Procedure

Oil leaks at the seals may mean that the crankcase is pressurized. Use the following procedure to eliminate this condition.

1. Remove the breather tube from the valve cover (see Figure 6-9).

2. Remove the valve cover, pack, spring, washer, reed valve, and breather baffle.
3. Clean all parts in solvent.

⚠WARNING ***Most parts cleaning solvents are flammable and can result in severe personal injury if used improperly. Follow the solvent manufacturer's recommendations when cleaning parts.***

The reed valve must be flat and uncreased. Assemble the valve using a new gasket. Do not overtighten the valve cover capscrew. The reed valve must be assembled as shown in Figure 6-9, with a washer on top and the breather baffle on the bottom.

⚠CAUTION ***Over-tightening the valve cover can cause an air leak, letting dirt enter the engine. Be careful not to distort the valve cover when tightening.***

COMBUSTION CHAMBER

Examine the spark plugs, and test cylinder compression to determine the condition of the valves, pistons, piston rings, and cylinders.

Cylinder Compression Check

1. Start the genset and let it warm up.
2. Stop the set. Remove and inspect the spark plugs (see Ignition System in this section).
3. Insert the compression gauge in one spark plug hole.
4. Place the throttle and choke in full open position.
5. Crank the engine and note the compression reading.
6. Stop cranking and perform steps 3 through 5 on the other cylinder.

Refer to the *Specifications* section for compression pressures. There may be variations due to equipment, temperature, atmospheric conditions and altitude. These pressures apply to a warm engine at cranking speed (about 300 r/min). If further inspection is necessary, refer to the *Engine - Block Assembly* section.

GOVERNOR

The governor, whether electronic or mechanical, controls engine speed, which directly affects the voltage output and frequency of the generator. An increase in engine speed causes a corresponding increase in generator voltage* and frequency. A decrease in engine speed will cause a corresponding decrease in generator voltage and frequency. The governor acts to maintain a constant engine speed under changing load conditions, so that generator voltage and frequency do not vary.

Spec A Marquis generator sets use a mechanical governor system. Spec B and later Marquis gensets use an electronic governor. Both systems are covered in this section.

* For steady state operation, voltage regulator limits maximum AC voltage to approximately 128 volts regardless of engine speed.

Electronic Governor Linkage Disassembly

This procedure disassembles the electronic governor linkage.

1. Unhook the governor spring from the bushing in the carburetor throttle lever.
2. Unhook the governor spring from the slot at the end of the actuator arm.
3. Unsnap the actuator end of the governor rod from the clip in the end of the governor actuator.
4. Unhook the carburetor end of the governor rod from the bushing in the carburetor throttle lever.

Electronic Governor Linkage Assembly

This procedure assembles the electronic governor linkage to make certain that it moves freely and that the actuator travel will fully open and fully close the throttle. **Governor set speed and sensitivity are preset in the governor controller and cannot be adjusted.** Adjusting the electronic governor system requires no adjustment of the choke, carburetor or fuel system. See Figure 6-10.

Before beginning this procedure, make sure that the actuator and carburetor are properly assembled to the engine.

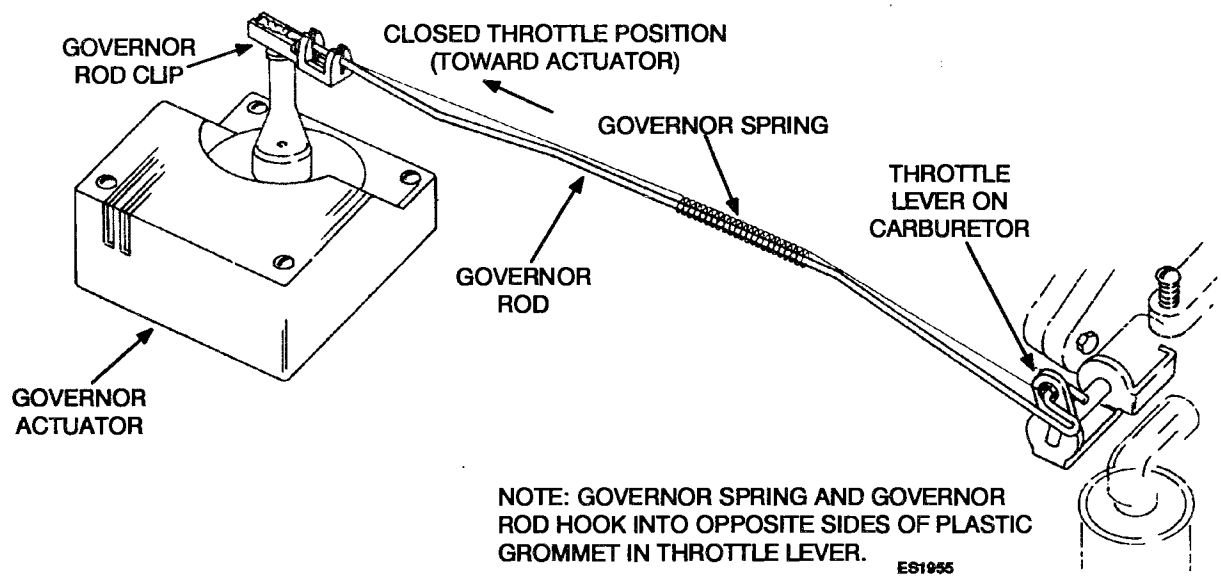


FIGURE 6-10. ELECTRONIC GOVERNOR ACTUATOR ADJUSTMENT

1. Make sure that the spring is properly oriented on the governor rod, with the coil body closest to the carburetor. Connect the rod to the carburetor throttle lever as shown in Figure 6-10.

2. Before attaching the spring, hold the governor rod in the closed throttle position (toward the actuator) and align with the clip in the actuator arm.

3. With the actuator in the closed position (relaxed state), snap the governor rod into the **nearest clip hole** by either:

   a. moving the governor rod slightly towards the carburetor

   b. rotating the actuator arm slightly toward the carburetor.

   Support the clip and rod with both hands when snapping the two parts together, and do not push down, to avoid bending the actuator arm.

4. Hook the governor spring into the plastic grommet in the carburetor throttle lever, and then into the slot at the end of the actuator arm. Check that the spring does not wrap around the rod on either side of the coil body. Make certain that the governor rod and the governor spring hook into the grommet from opposite sides (see Figure 6-10).

   If the spring is oriented correctly in the throttle lever, the actuator lever end of the spring should point straight down into the governor rod clip where it will be attached.

5. Move the governor linkage through its full range of motion, and verify that it does not stick, bind or contact any adjacent parts.

   When maintenance is done, and the top cover is replaced on the generator set, move the throttle lever back and forth a few times to make certain that the governor linkage does not stick or bind.

Mechanical Governor Adjustment

This procedure adjusts the mechanical governor to bring frequency and voltage within the specified range, and to insure governor stability. Figure 6-11 illustrates governor adjustment.

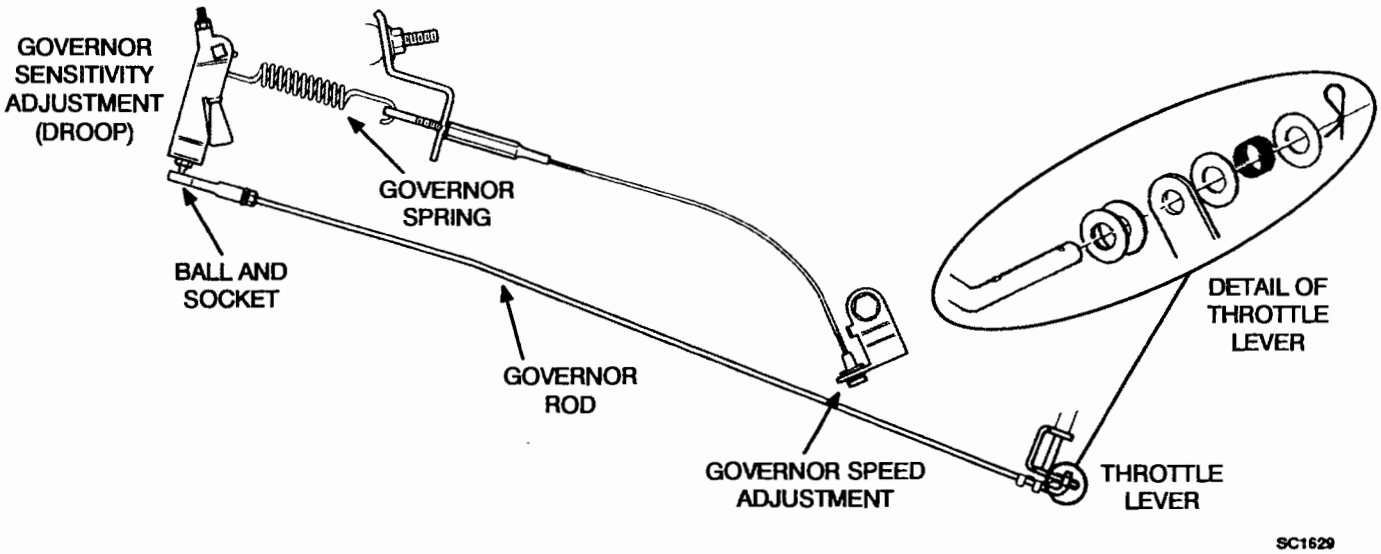


FIGURE 6-11. MECHANICAL GOVERNOR ADJUSTMENT

Equipment required for mechanical governor adjustment includes:

- Digital frequency/voltmeter with 0.3% frequency accuracy, 0.5% voltage accuracy. Recommended: Fluke 8060A or 85 series
- Digital ammeter. Recommended: Beckman 4410
- Load bank with 8 kW (minimum) capacity, variable 600 watt section

The mechanical governor operates by reacting to the speed/frequency differential between no-load and full-load conditions which is known as "droop". Good overall governor operation requires a proper amount of governor droop. Too large a droop, and genset voltage/frequency control may be adversely affected. Too small a droop, and the genset may "hunt" for the proper speed.

If a carburetion problem is suspected, make certain that the carburetor is adjusted correctly before attempting to adjust the governor system.

Preliminary adjustment: Before adjusting the governor system, make certain that the length of the governor rod is correct. Make this static adjustment with the generator set **turned off**, and completely cold. Refer to Figure 6-11 for the arrangement of these components.

1. Loosen the jam nut at the ball joint end of the governor rod.
2. Disconnect the governor rod from the throttle lever.
3. With the carburetor throttle fully open and the governor arm in its full counterclockwise position, adjust the governor rod until the end of the rod aligns with the hole in the throttle lever.
4. Turn the governor rod in (shorter) one full turn.
5. Reconnect the governor rod and retighten the jam nut while holding the ball socket in the vertical position.

⚠ CAUTION ***Voltage/frequency-sensitive equipment such as VCRs, televisions, computers, etc. may be damaged by power line frequency variations. Some solid-state devices are powered whenever connected to an AC outlet even if the device is not in actual operation. For this reason, disconnect all devices which are voltage or frequency-sensitive before attempting any carburetor/governor adjustments. If disconnecting the devices is not possible, open the circuit breaker(s) at the distribution panel or at the generator set, if so equipped.***

Adjustment procedure: Use this procedure to adjust the governor.

1. Run the genset at least 15 minutes at 50% to 75% of its rated load. Check that the choke is completely open.

   Note that adjusting a set which has not warmed up may cause low power, genset de-rating or inconsistent readings. Warmup must be done with the set output connected to a load bank.

2. Remove the load and let the set stabilize 10 to 15 seconds. Make certain that the set is running with no load.
3. Turn the governor speed adjustment counterclockwise until the no-load frequency is 50 ± 1 Hz. Access the governor speed adjustment by inserting the screwdriver between the air filter shroud and the top cover assembly.

   Make certain the throttle lever stop does not touch the throttle stop screw. If they touch, turn the screw out until there is no contact (see Figure 6-14).

4. Turn the throttle stop screw on the carburetor in (clockwise), to increase the frequency to 55 ± 1 Hz.
5. Turn the governor speed adjustment clockwise until the average no-load frequency is between 62 and 63 Hz (preferred setting is 62.5 Hz).

   Some "wandering" at no-load is normal.

6. To determine the wattage, multiply amps by volts. To apply the rated load to the genset, measure the voltage and adjust the load (amps) until the voltage times the amps equals the rated wattage. For example, with a BGM rated at 5000 watts, apply a given load, measure the voltage, and multiply the amps by the volts. If the actual wattage is less than 5000, apply more load until 5000 watts is reached.

   Voltage falls slightly as additional load is applied (i.e. as speed decreases).

7. With the rated load applied, measure frequency. Full-load readings must be 2 to 4 Hz less than the no-load reading (governor droop). If the droop is within this range, and the set is not hunting, proceed to step 8. If the frequency is outside this range or the set is hunting, adjust the governor sensitivity screw. To access this adjustment, remove the plug on the side of the top cover and insert the screwdriver into the cone-shaped guide (see Figure 6-11). Proceed as follows:
   A. If the droop is greater than 4 Hz, adjust the governor spring toward the governor shaft by turning the adjusting screw 1 to 2 turns counterclockwise. Readjust the no-load setting to 62 - 63 Hz (62.5 preferred), reapply the rated load, and check the governor droop.
   B. If the droop is less than 2 Hz or the set is hunting, adjust the governor spring away from the governor shaft by turning the adjusting screw 1 to 2 turns clockwise. Readjust the no-load setting to 62 - 63 Hz (62.5 preferred), reapply the rated load, and check the governor droop.
8. Check governor response at the following load conditions for approximately 30 seconds at each load.
   A. No load - 3/4 load - no-load - 1/2 load - no load - 1/4 load - no load
   B. No hunting is allowed under any of these load conditions. If hunting occurs, increase droop (see step 7B), but do not exceed 4 Hz maximum. If hunting is still a problem, see "Engine hunts or surges" in the *Troubleshooting* section.
9. Repeat these adjustments until droop and no-load frequency readings are within the correct ranges, and the set is stable (no hunting) at any load from no-load to rated load.

The frequency and voltage at no-load and full-load conditions should stay within the limits listed in Table 6-1. If the frequency is correct but the voltage is incorrect, the voltage regulator may need to be replaced (see "AC output voltage too low or too high" in the *Generator Troubleshooting* section).

The governor linkage, for both types of governor systems, should be inspected once a year, and cleaned if necessary (perform more often in extremely dusty conditions). For best system performance, the linkage must move freely through its entire range of travel and be dry and free of dust or dirt. Verify that it does not stick, bind, or contact any adjacent parts. Wipe the joint at each end of the

governor rod with a dry cloth to clean them. Do not use cleaning solvents. Do not attempt to remove the governor rod clip from the governor actuator lever (electronic governor). Do not apply any type of lubrication to the governor linkage. Verify that all governor linkage parts are in good condition and are securely connected.

TABLE 6-1. MARQUIS FREQUENCY/VOLTAGE (MECHANICAL-GOVERNOR SETS)

MODEL	CODE	FREQUENCY	RATED LOAD	VOLTAGE		HZ DROOP	
				MAX (NO LOAD)	MIN (FULL LOAD)	NO LOAD	(NL TO FL)
BGM	FA	60	5.0 kW	132	112	63/62	2-4
NHM	FA	60	6.8 kW	132	112	63/62	2-4

FUEL SYSTEM - GASOLINE

The fuel system must be properly adjusted and in good condition for efficient genset operation. Main components of the fuel system include:

- Air filter assembly
- Carburetor
- Choke
- Intake manifold
- Fuel filter
- Fuel pump
- Fuel solenoid
- Air preheater
- Fuel pump (solenoid)/autochoke relay K4 (begin Spec D)

⚠WARNING ***Fuel systems present the hazard of fire or explosion if accidentally ignited, which can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, and arc-producing machinery and switches from the work area when performing the following procedures.***

⚠WARNING ***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.***

Air Intake Assembly

The air intake assembly consists of:

- Air cleaner housing
- Air filter
- Air cleaner adapter
- Choke assembly
- Relay K4 (begin Spec D)

Air Intake Disassembly Procedure

⚠WARNING ***Batteries give off explosive gas, which may be ignited by electrical arcs or sparks, causing the risk of severe injury or death. To avoid excessive arcing, always disconnect the negative (-) cable first, and connect it last.***

1. Disconnect the starting battery, negative (-) cable first, to prevent accidental starting. Reconnect the cable when the procedure is complete.
2. Remove the crankcase breather hose and air preheater hose from the air cleaner housing.
3. Remove the air cleaner housing center capscrew and lift off the housing and air filter.
4. (Pre-Spec D sets): Remove the choke cover retaining nut and lift off the choke cover.
5. (Pre-Spec D sets): Disconnect the choke lead wires at the choke terminals.
6. Remove the three capscrews that hold the air cleaner adapter to the carburetor and lift off the adapter. Pre-Spec D sets: Note that the choke linkage must be disengaged from the choke assembly as the adapter is removed.
7. Remove the two capscrews that hold the choke bracket to the adapter. Lift off the choke assembly.

Air Intake Assembly Procedure

Perform the disassembly steps in reverse order. Use a new gasket between the adapter and the carburetor. The three capscrews that attach the air cleaner adapter to the carburetor include a special captive washer. Use only these capscrews in this application, to prevent loosening.

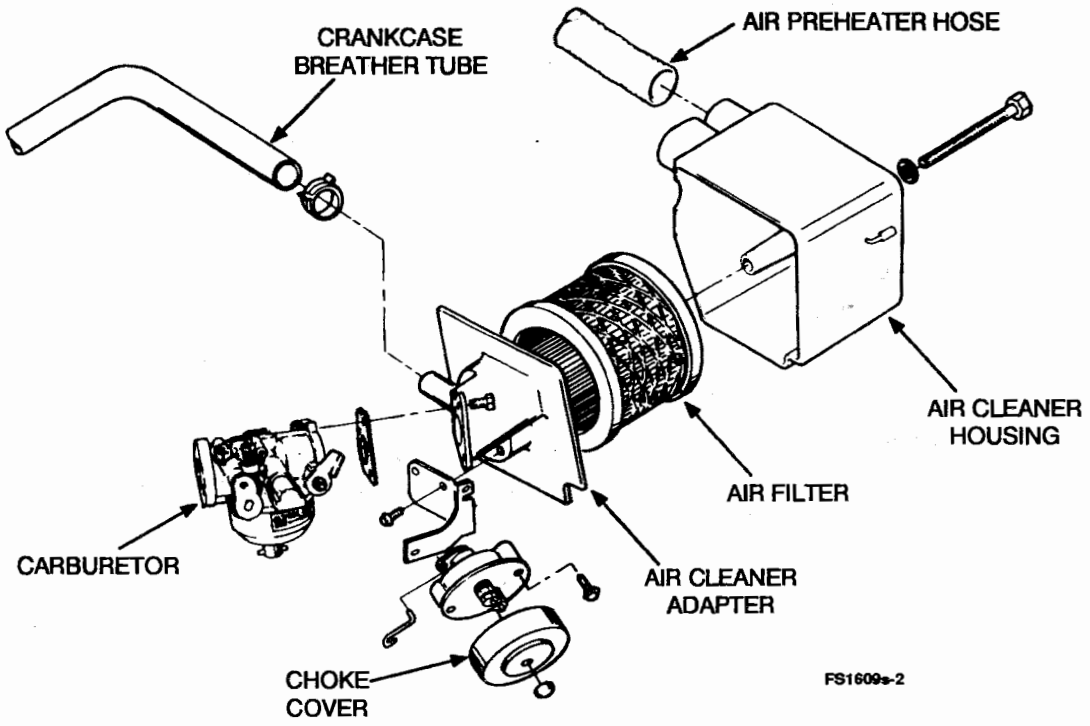


FIGURE 6-12. AIR INTAKE ASSEMBLY (PRIOR TO SPEC D)

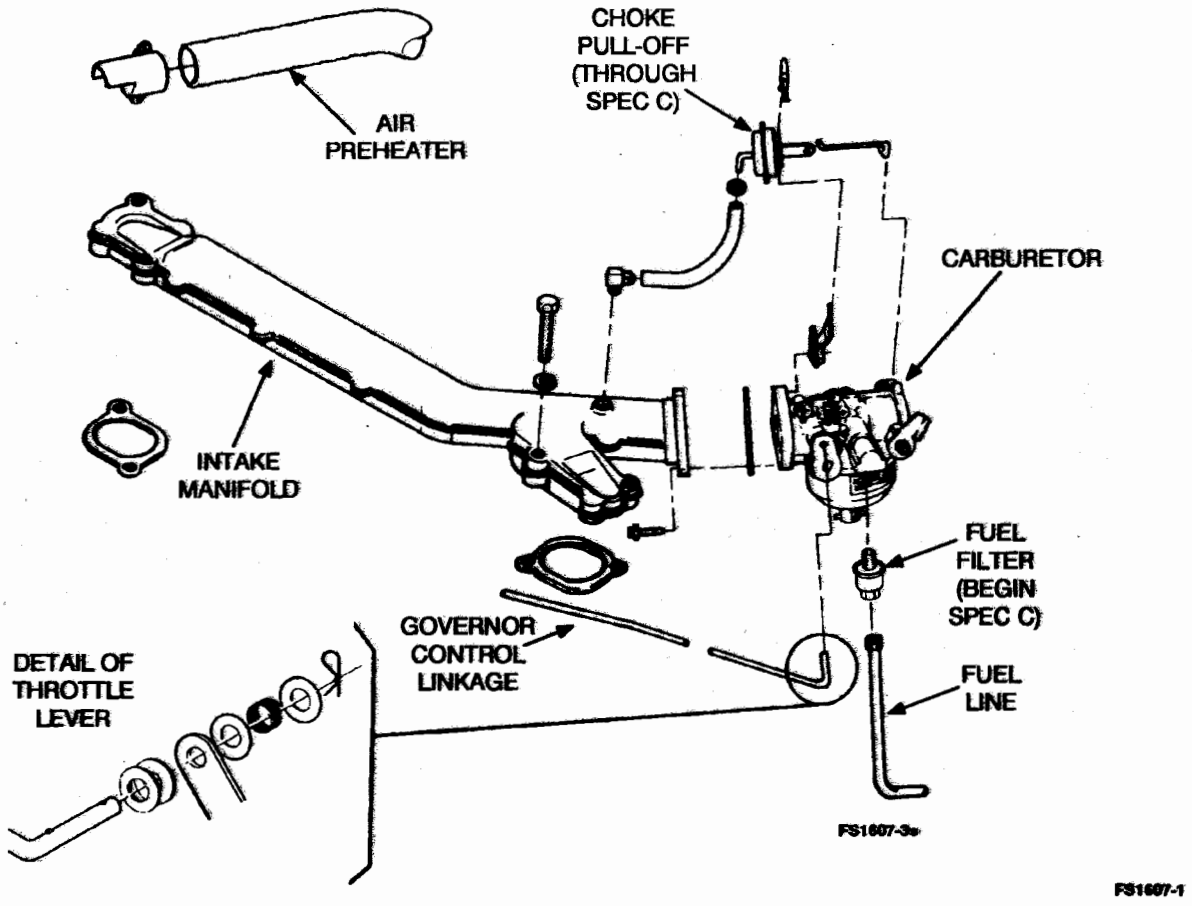


FIGURE 6-13. GASOLINE CARBURETOR AND INTAKE MANIFOLD ASSEMBLY (PRIOR TO SPEC D)

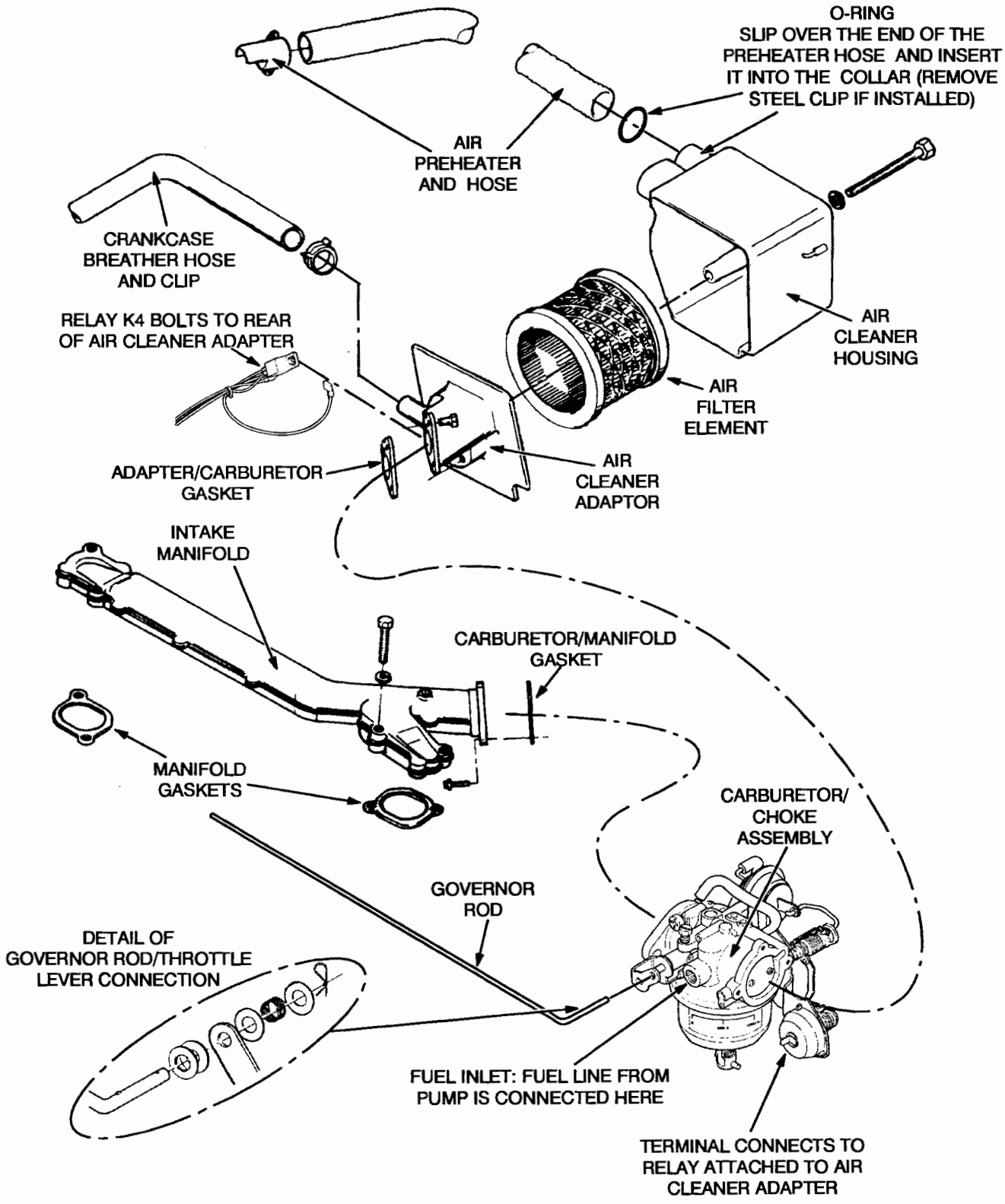


FIGURE 6-14. SPEC D GENSET GASOLINE FUEL SYSTEM

Carburetor And Intake Manifold Assembly

The carburetor and intake manifold assembly (Figures 6-12, 6-13, 6-14) consists of:

- Intake manifold
- Choke pull-off assembly (through Spec C)
- Air preheater
- Carburetor
- Fuel filter (begin Spec C)

⚠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. Eliminate all possible sources of ignition including fire, flame, spark, pilot light, arc-producing equipment or other ignition sources before working in this area.***

Carburetor/Intake Manifold Disassembly Procedure

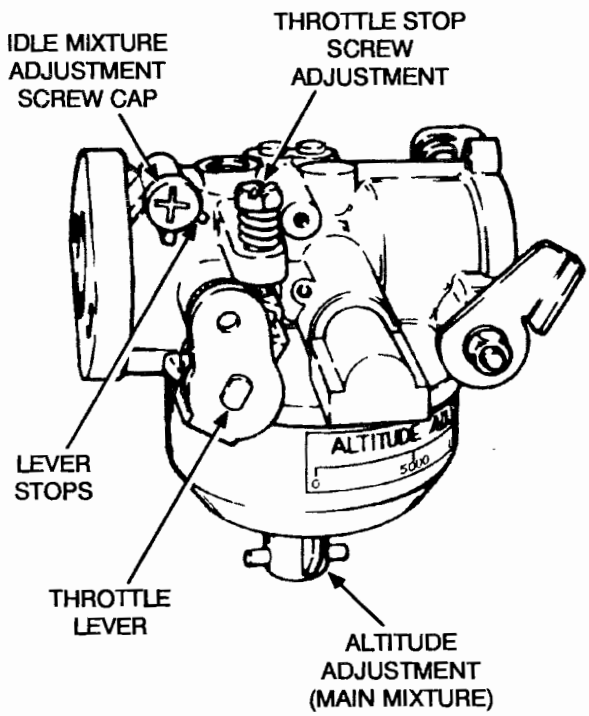
1. Remove the air intake assembly, as described in the *Air Intake Assembly* section.
2. Disassemble the governor rod from the governor rod clip, as described in *Electronic Governor Linkage Disassembly* under Governor in this section.
3. Disconnect the fuel line, fuel filter and governor control linkage from the carburetor.
4. Remove the intake manifold capscrews and lift off the carburetor air preheater. Lift off the carburetor and intake manifold as a unit.
5. Remove the two intake manifold gaskets and plug the intake ports with a rag to prevent loose parts from accidentally entering the ports.
6. Remove the two capscrews that hold the carburetor and choke pull-off assembly to the intake manifold. Pre-Spec D sets: Disengage the choke pull-off linkage from the carburetor, and carefully separate the carburetor from the intake manifold.

Carburetor/Intake Manifold Assembly Procedure

Perform the disassembly steps in reverse order. Use new gaskets between the intake manifold and the engine, and between the intake manifold and the carburetor. Do not use sealer on the gaskets. Tighten the intake manifold capscrews to the specified torque.

Carburetor Fuel Mixture Screw Adjustments

The most common causes of poor carburetion are misadjusted idle or main mixture adjustment screws, and contamination in the carburetor. Variation from the correct mixture may cause serious engine trouble. Too rich a mixture wastes fuel and increases engine wear by washing the lubricant from the cylinder walls and diluting the crankcase oil. Too lean a mixture causes power loss, flat spots in acceleration, and promotes burnt valves and spark plugs.



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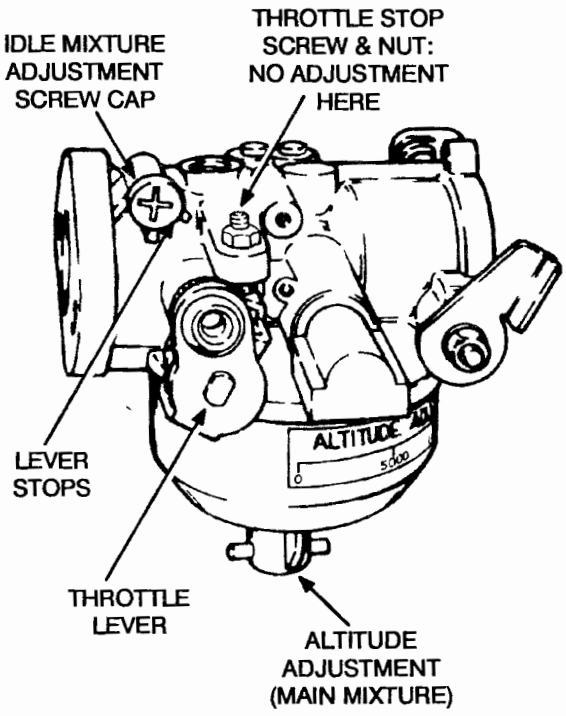
CARBURETOR ON GENSET WITH MECHANICAL GOVERNOR



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CARBURETOR ON GENSET WITH ELECTRONIC GOVERNOR

FIGURE 6-15. CARBURETOR FUEL ADJUSTMENT LOCATIONS (PRIOR TO SPEC D)

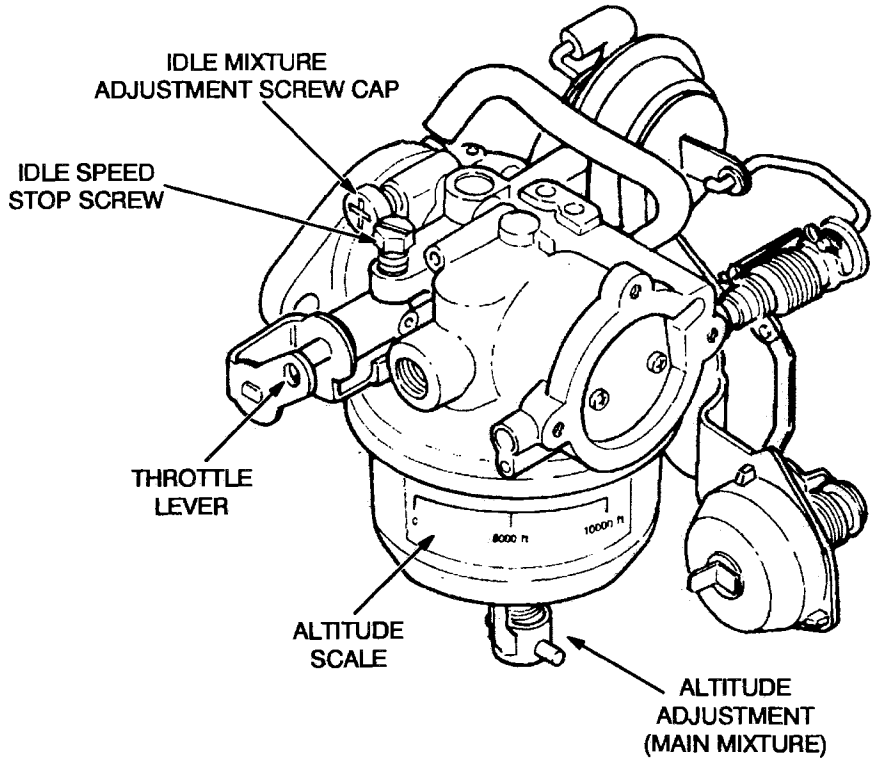

FIGURE 6-16. CARBURETOR FUEL ADJUSTMENTS (SPEC D GENSET)

The carburetor idle and main mixture screws are factory-set. See Figures 6-15, 6-16. Unless a carburetion problem is suspected, these settings should not be changed and the adjustment screw limiter caps should not be removed. This does not include problems due to high altitude, which can be corrected with small adjustments of the mixture screws within the range provided by the limiter caps.

For the mechanical governor gensets, make certain that the carburetor is adjusted first, before attempting to adjust the governor. To adjust the fuel mixture adjustment screws, the following method should be used and applies to both the mechanical and electronic governor gensets unless noted otherwise:

1. With the genset stopped, remove the idle and main mixture adjustment screw limiter caps. See Figures 6-15 and 6-16.
2. Turn both idle and main mixture adjustment screws in until **lightly** seated.

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

3. Turn the idle mixture screw out 1 full turn. Replace the limiter cap with its lever at mid-position (between stops).
4. Turn the main mixture screw out 1-3/8 and 1-5/16 full turns for the BGM and NHM, respectively. Replace the limiter cap so it aligns with the zero altitude position. Then rotate to the local altitude position, if necessary.

After adjusting the fuel mixture screws, adjust the throttle stop screw (mechanical governor gensets), as specified in this section.

For a more accurate setting of the fuel mixture, use a CO (carbon monoxide) meter. When using a CO meter, follow steps 1-4 above, except do not replace limiter caps, and continue as follows:

5. With genset stopped, connect a frequency meter and load bank to the generator output

leads. Start and run the genset for at least 15 minutes at 50% to 75% of rated load. Verify that the choke is completely open.

6. Apply rated load and adjust the governor speed (mechanical governor gensets) to 59 ± 2 hz. Adjust the main mixture screw for 8 ± 0.5 % CO.
7. Remove the load and adjust the governor speed (mechanical governor gensets) to 62.5 ± 1 hz. Adjust the idle mixture screw for 7 ± 0.5 % CO at no-load.

Before making the idle mixture adjustment for mechanical governor gensets, make certain that the throttle lever stop does not touch the throttle stop screw. If they touch, turn the screw out until there is no contact.

8. Stop the genset. Install the idle limiter cap with its lever at mid-position (between stops). Install the main limiter cap so it aligns with the local altitude position.

After adjusting the fuel mixture screws, adjust the throttle stop screw (mechanical governor gensets), as specified in this section.

⚠ CAUTION ***Voltage/frequency-sensitive equipment such as VCRs, televisions, or computers may be damaged by power line frequency variations. Some solid-state devices are powered whenever connected to an AC outlet, even if not in actual operation. For this reason, disconnect all devices which are voltage- or frequency-sensitive before attempting any carburetor/governor adjustments. If disconnecting the devices is not possible, open the circuit breaker(s) at the distribution panel or at the generator set, if so equipped.***

Carburetor Throttle Stop Screw Adjustment (Mechanical Governor Generator Sets)

1. With genset stopped, connect a frequency meter to the generator output leads. Start and run the genset at least 15 minutes at 1/2 to 3/4 load. Verify that the choke is completely open.
2. Remove the load and let the genset stabilize 10 to 15 seconds. Make certain that the genset is running with no load.
3. Adjust the governor speed to 50 ± 2 hz. Verify that the throttle lever stop does not touch the throttle stop screw. If it touches, turn the screw out until there is no contact. See Figure 6-15.
4. Adjust the throttle stop screw in (clockwise) to increase the speed to 55 ± 1 hz.
5. Adjust the governor speed to obtain a no-load frequency of 62.5 ± 0.5 hz.
6. Check governor performance and adjust governor if necessary, as specified in this section, to ensure that the set is stable (no hunting) and operates within the specified voltage and frequency ranges.

Carburetor Throttle Stop Screw Adjustment (Electronic Governor Generator Sets)

The carburetor throttle stop screw is preset and does not require any adjustment. However, if the screw has been disturbed or tampered with, i.e. the paint seal is broken, it should be adjusted as follows:

1. With the genset stopped, disassemble the governor rod spring and governor rod as specified in this section.
2. Loosen the throttle stop screw nut. Move the throttle lever toward the closed position (counter-clockwise) and turn the screw out until it no longer contacts the throttle lever stop.
3. Hold the throttle lever in the closed position, and turn the screw in until it just contacts the throttle lever stop.
4. Turn the screw in an additional 1/8 to 1/4 turn (clockwise). Hold screw in position and tighten nut.
5. Assemble and adjust the governor rod and spring as specified in this section.

⚠CAUTION ***Voltage/frequency-sensitive equipment such as VCRs, televisions, or computers may be damaged by power line frequency variations. Some solid-state devices are powered whenever connected to an AC outlet, even if not in actual operation. For this reason, disconnect all devices which are voltage- or frequency-sensitive before attempting any carburetor/governor adjustments. If disconnecting the devices is not possible, open the circuit breaker(s) at the distribution panel or at the generator set, if so equipped.***

Gasoline Carburetor Overhaul

Carburetion problems that cannot be corrected by mixture or float adjustments may be caused by blocked fuel passages or worn internal parts. The most effective remedy is a complete carburetor overhaul.

Overhauling a carburetor means complete disassembly, thorough cleaning, and replacing worn parts. Carburetor repair kits include new gaskets and replacements for the parts that wear most.

Carefully note the carburetor position while removing all parts for correct reassembly. Read and understand these procedures before beginning. Carburetor components are illustrated in Figure 6-17.

⚠WARNING ***Gasoline is extremely flammable. Severe personal injury or death can result if it is accidentally ignited. Eliminate all possible sources of ignition including fire, flame, spark, pilot light, cigarettes, arc-producing equipment or other ignition sources before performing this procedure.***

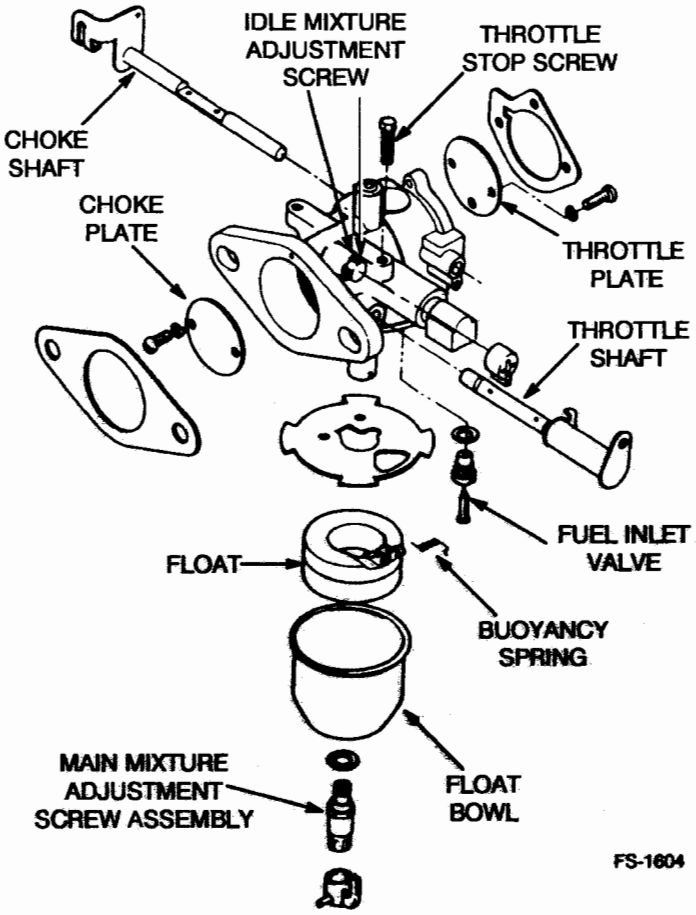

FIGURE 6-17. CARBURETOR OVERHAUL (MECHANICAL-GOVERNOR CARBURETOR SHOWN)

Remove the carburetor and intake manifold assembly, as specified in the Carburetor and Intake Manifold Assembly description in this section. Remove the carburetor from the intake manifold. Disassemble it using the following procedure:

Gasoline Carburetor Disassembly Procedure

1. Remove the air cleaner adapter and the automatic choke assembly.
2. Remove the throttle (mechanical governor only) and choke plate retaining screws, then remove the throttle and choke plates. Pull out the throttle and choke shafts, being careful not to damage the Teflon coating on certain throttle shafts and the choke shaft.
3. Remove the main and idle mixture screw assemblies. Do not discard the idle and main mixture screw limiter caps.
4. Separate the lower section of the carburetor (fuel bowl) from the upper section (fuel bowl cover) of the carburetor.
5. Note the position of the float assembly parts. Slide out the retaining pin and remove the float assembly, springs or clips, and the needle valve.
6. Unscrew and remove the needle valve seat.

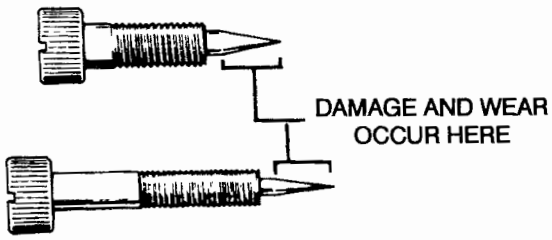

FIGURE 6-18. MIXTURE NEEDLE INSPECTION

Carburetor Cleaning and Repair Procedure

1. Soak all metal components to be reused in carburetor cleaner. Do not soak rubber or plastic parts. Follow the instructions on the cleaner container.

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

2. Remove the carbon from the carburetor bore, especially where the throttle and choke plates seat. Be certain not to plug the idle or main fuel port.
3. Blow out all passages with compressed air. Do not use wire or any cleaning utensil that might widen critical passages. Wear goggles while performing this procedure.
4. Examine any needle valves not included in the repair kit, and replace if damaged (Figure 6-18). Replace the float if it is damaged or contains fuel.
5. Check the choke and throttle shafts for excessive play in their bore. Replace them if necessary.
6. Replace old components with the new parts from the repair kit.

Gasoline Carburetor Reassembly and Installation Procedure

1. Slide in the throttle shaft and install the throttle plate using new screws (if included in the repair kit).

   Center the plate in the throttle bore before tightening the screws. To do this, back the throttle stop screw (mechanical governor only) out as necessary, and close the throttle lever. Seat the plate by gently tapping it with a small screwdriver, then tighten the screws. Install the choke shaft and plate in the same manner.

2. Install the needle valve and seat, fuel bowl gasket, and float assembly. Make sure that the float moves freely without binding (see Figure 6-19), and that all clips and springs are placed correctly.

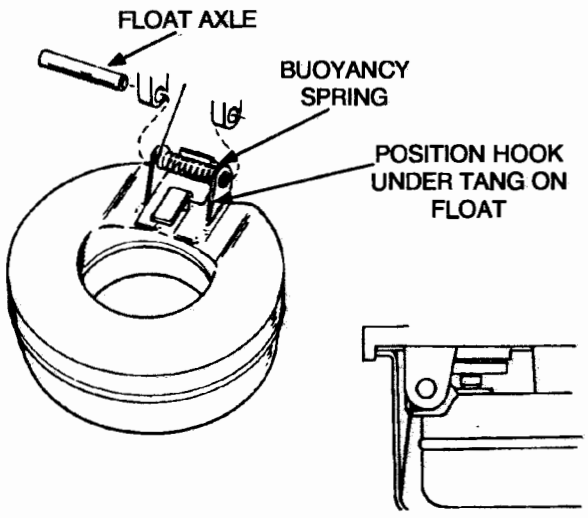

FIGURE 6-19. FLOAT INSTALLATION

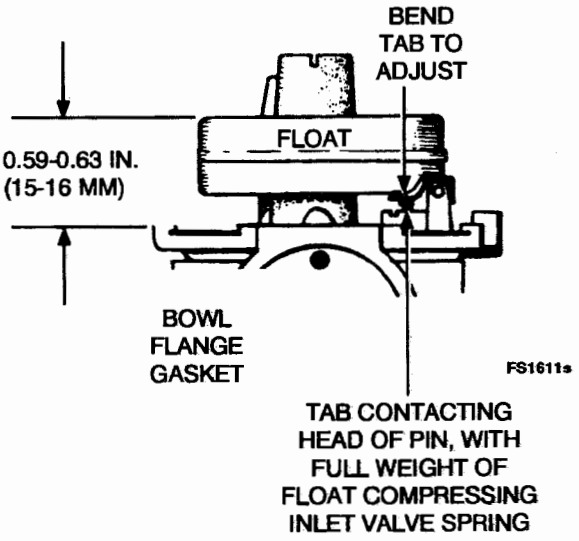

FIGURE 6-20. FLOAT LEVEL

3. Invert the float and needle valve assembly. Check the float level as follows: measure from the carburetor housing to the far side (bottom) of the float (see Figure 6-20). The full weight of the float should rest on the needle valve and spring. If the setting is incorrect, remove the float and bend the tab to adjust. Bend the float only at the point indicated.

⚠ CAUTION ***Attempting adjustments with the float assembly installed can damage the inlet needle and seat. Remove the float assembly before making adjustments.***

4. Install the float bowl and the main mixture screw assembly. Install the idle mixture screw assembly.

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

5. Adjust the idle and main mixture screws as described in this section. When the carburetor is installed, recheck the governor rod adjustment.

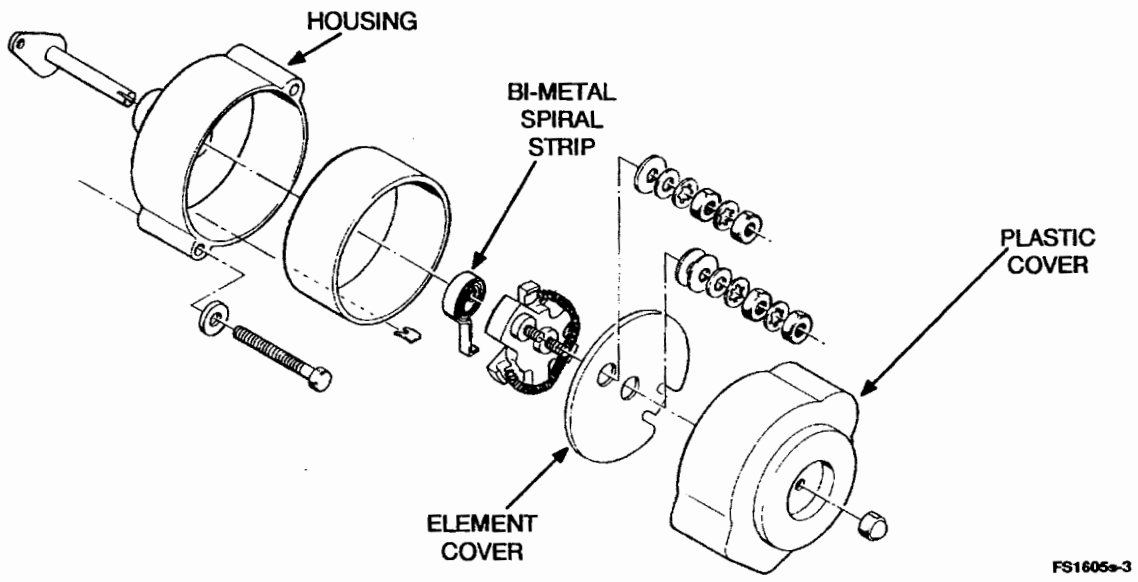

FIGURE 6-21. CHOKE ASSEMBLY (PRIOR TO SPEC D)

Choke Assembly (pre-Spec D genset)

The choke assembly (Figure 6-21) consists of a bi-metal coil, an electric heating element, and a choke pulloff diaphragm. The coil is connected to the choke shaft. It turns the shaft to hold the choke plate nearly closed when the engine is cold. When the engine starts, vacuum from the intake manifold causes the pulloff diaphragm to pull in and partially open the choke. As the engine runs, the heating element receives electric current. Heat from the element causes the bi-metal strip to coil, turning the choke shaft to gradually open the choke plate, and keeping the plate open while the engine is running.

⚠WARNING ***The choke becomes very hot during normal operation, and can cause severe burns if touched. Do not remove the choke cover while the set is operating.***

If the engine starts but runs rough and gives off black smoke after a minute or two of operation, the choke is set for too rich a mixture. If the engine starts but sputters or stops before it warms up, the choke is set for too lean a mixture.

Choke Adjustment Procedure (pre-Spec D genset)

Table 6-2 lists choke settings for various ambient temperatures. Stop the set and let it cool before adjusting the choke.

1. Remove the plastic choke cover (see Figure 6-21) and loosen the heating element cover screws.
2. Rotate the heating element until the choke plate is halfway open.
3. Slowly rotate the cover counter clockwise while tapping the carburetor choke lever to make it bounce. Continue until the lever no longer bounces. This is the fully-closed (reference) position.

TABLE 6-2 CHOKE ADJUSTMENTS

Ambient Air Temperature	Rotation From Reference Mark*
40°F(4°C)	0°
45°F(7°C)	4°CW
50°F(10°C)	8°CW
60°F(16°C)	16°CW
65°F(18°C)	20°CW
70°F(21°C)	24°CW
75°F(24°C)	27°CW
80°F(32°C)	32°CW
85°F(29°C)	35°CW
90°F(32°C)	39°CW
95°F(35°C)	43°CW
100°F(38°C)	47°CW

* Each mark on choke housing equals 5° angular rotation.

4. Refer to Table 6-2 to determine the number of degrees the element cover must be rotated clockwise from the reference position. The marks on the choke housing are spaced at 5° intervals.
5. Rotate the element cover as specified, then tighten the cover mounting screws.
6. Move the choke lever to test its operation. The lever should return to the free position when released from the open position, without sticking or binding.
7. Install the plastic choke cover and tighten the center mounting unit.

Choke Replacement Procedure

If the choke does not open, remove the protective plastic cover and check the heating element. The heating element cover should heat up after a few minutes of operation. If the element cover remains cool, start the set, then use an AC voltmeter to check the terminals on the cover. If roughly 20 VAC is not present, check for opens or shorts in the control wiring.

If voltage is present, stop the set and remove the heating element cover. Inspect the heating element and replace it if burned out or broken. Also inspect the bi-metal coil and replace it if it is damaged or binding in the housing.

When installing a new bi-metal strip, maintain the original direction of the spiral (see Figure 6-22). The outer tab must point in a clockwise direction. Make sure that the coil sets squarely in the housing, and that the inner end of the coil engages the slot in the choke shaft. The slotted tang on the element cover must engage the bi-metal strip.

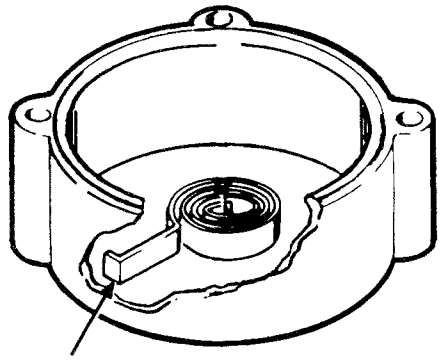

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FIGURE 6-22. BI-METAL SPIRAL STRIP

Choke Pulloff Diaphragm Adjustment Procedure

The choke pulloff diaphragm partially opens the choke plate after engine startup. This inhibits flooding, and promotes smooth engine operation as the set warms up.

1. Remove the air intake assembly as described in Air Intake Assembly in this section, to access the choke plate.
2. Disconnect the diaphragm hose from the intake manifold. Apply 4 to 18 inches (13.5 to 60.8 kPa) Hg vacuum to the diaphragm.
3. Apply light finger pressure against the choke lever to take up all free play in the pulloff linkage (see Figure 6-23).
4. Check and correct the alignment of the diaphragm stem, pulloff linkage, and slot in the choke lever, viewing them from above.
5. Measure the distance between the choke plate and the bottom of the carburetor at the point indicated in Figure 6-23. There should be 0.39 to 0.43 inches (9.9 to 10.9 mm) clearance here; if necessary, bend the diaphragm mounting bracket to reach this clearance.

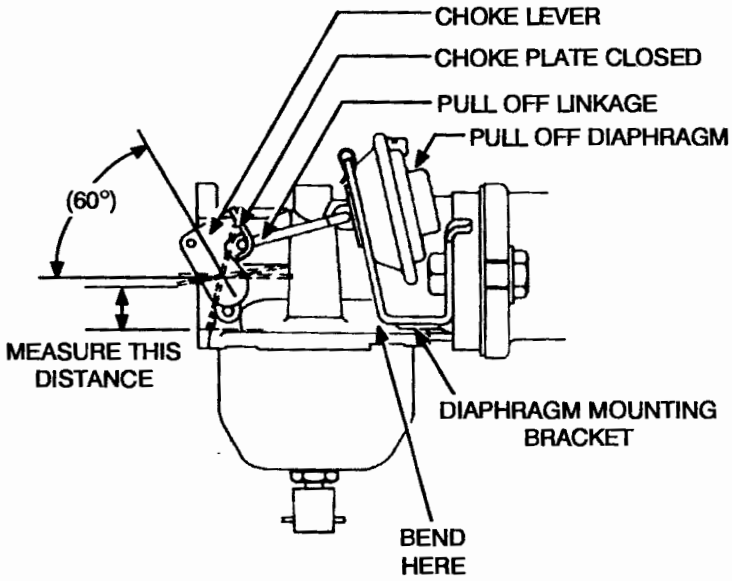


FIGURE 6-23. CHOKE PULLOFF DIAPHRAGM

6. Move the choke lever back and forth to verify that it does not bind or stick.
7. Remove the vacuum supply from the diaphragm. Install the filter assembly on the carburetor.

Fuel Pump

All gasoline-fueled generator sets use electric fuel pumps. The electric pump has an integral shutoff valve that prevents fuel flow to the carburetor when the set is idle.

⚠WARNING ***Do not substitute an automotive fuel pump for the standard Onan-supplied fuel pump. Other pumps' output pressure is much higher, and can cause carburetor flooding or fuel leakage, creating a fire hazard.***

Fuel Pump Test Procedure

If the fuel pump malfunctions or supplies insufficient fuel, test and repair/replace the pump as described below.

1. Remove the fuel line from the pump outlet. Install a pressure gauge in the line.
2. Press the Start switch and hold it for several seconds, until the pressure reading is constant. A normal pump produces 4 to 5 psi (27.5 to 34.4 kPa). Pressure should stay constant or drop off very slowly.

   If the pressure is below 3-1/2 psi (17.2 kPa), replace the fuel pump.

   If the pressure is zero, check the electrical connections, then recheck the pressure reading.

There are no serviceable components in the fuel pump. Refer to the set Parts Manuals and replace the pump with an Onan-supplied unit.

⚠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 which surrounds the electrical system. Electrical system components are not serviceable.***

Choke - Spec D

Figure 6-24 illustrates the Spec D choke components for gasoline carburetors. Replace faulty choke components and reassemble as shown. Adjust the choke breaker assembly each time it is assembled to the carburetor, as follows:

1. Apply a vacuum of at least 4 inches (100 mm) of mercury to fully pull in the choke breaker arm.
2. Insert a 0.337 inch (8.6 mm) drill rod between the choke plate and the carburetor throat.
3. If necessary, bend the link at the point shown until the lip of the choke plate just touches the drill rod. Use two pliers to bend the link.

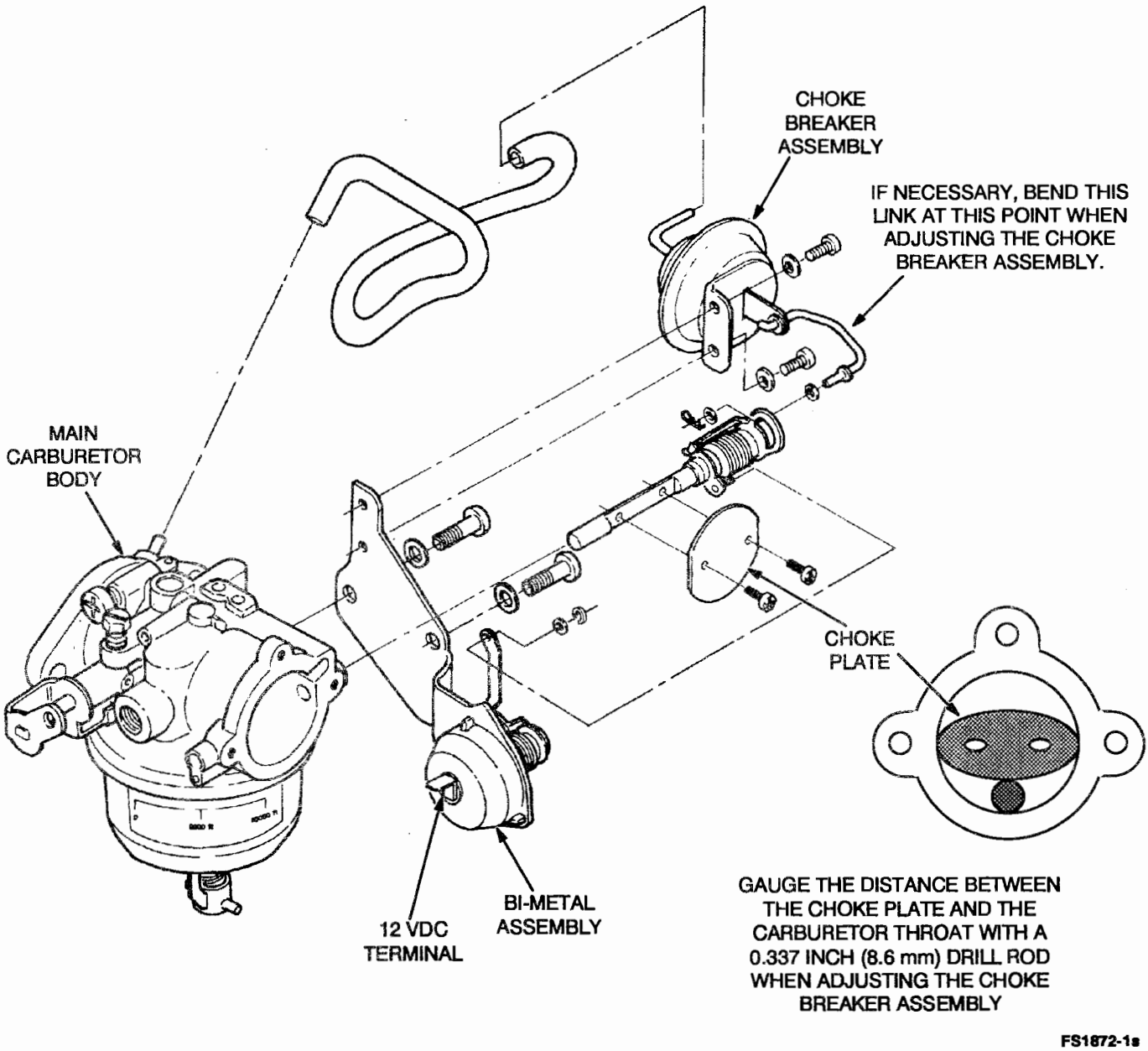


FIGURE 6-24. CHOKE ASSEMBLY - SPEC D

FUEL SYSTEM - LP GAS

The fuel system must be in good condition and properly maintained for efficient generator set operation. The main components of the fuel system are:

- Air cleaner assembly
- Carburetor
- Intake manifold
- Fuel filter
- Solenoid valve
- Vaporizer
- Two-stage regulator

The LP gas Marquis genset uses a liquid withdrawal system and is intended to share the vehicle LP gas fuel supply tank. The LP gas fuel supply tank must be designed with a dip tube to permit liquid fuel withdrawal. The following sections provide basic information about LP gas fuel systems and specific service procedures for each fuel system component.

LP Gas Fuel Systems

LP gas liquid withdrawal fuel systems typically operate at pressures as high as 240 psi (1756 kPa) when the ambient temperature is 120° F (48.7° C). Because of the high pressure, special precautions must be taken to avoid releasing large quantities of highly flammable LP gas when servicing the fuel system. Use the following procedure to purge the fuel system of LP gas before servicing any fuel system components.

LP Gas Purging Procedure: To purge the set fuel system of LP gas, close the shutoff valve at the fuel tank and then start the generator set. Allow the generator set to run until it is out of fuel. Crank the set a few times after it stops to make sure the fuel system is completely purged of all LP gas fuel.

If the generator set cannot be operated, move the RV coach to an outdoor location that is well-ventilated and far away from fire or other ignition source. Disconnect both the vehicle negative (-) battery cable and the generator set negative (-) battery cable from their respective terminals. Close the fuel shutoff valves at the fuel tank for both the generator set fuel supply system and the appliance (stove, heater, etc) fuel supply system. In addition, close the fuel shutoff valves at each appliance.

⚠WARNING ***LP gas (Propane) is extremely flammable and can cause severe personal injury or death if accidentally ignited. Eliminate all possible sources of ignition such as pilot lights or sparking electrical equipment before purging LP gas from the fuel system. Provide adequate ventilation to dissipate LP gas as it is released.***

Slightly open the fuel line (flexible section) at the fuel filter near the solenoid valve just enough to allow the LP gas to slowly escape. Do not open the fitting too much or a large quantity of gas will be released.

⚠WARNING ***Escaping LP gas is extremely cold (-46° F.) Cold temperatures can freeze or injure the hands. Wear protective gloves before beginning this operation.***

Disconnect the fuel supply hose from the carburetor and hold it clear of the set, to drain the regulator and other components of the genset. Press in and hold the primer button on the regulator to release LP gas from the set fuel system. When no more gas can be heard escaping from the open end of the fuel supply hose, reconnect the hose to the carburetor and proceed to the appropriate component service section.

Exhaust Manifold, Vaporizer and LP Gas Regulator Assembly

The exhaust manifold, vaporizer and LP gas regulator assembly consists of the following parts (see Figure 6-25):

- Exhaust manifold
- Gas regulator assembly
- Fuel line assembly
- Fuel shutoff solenoid valve*
- LPG filter*
- Carburetor line assembly (vaporizer)
- Fuel hose
- Regulator supply line

Associated parts and fittings include:

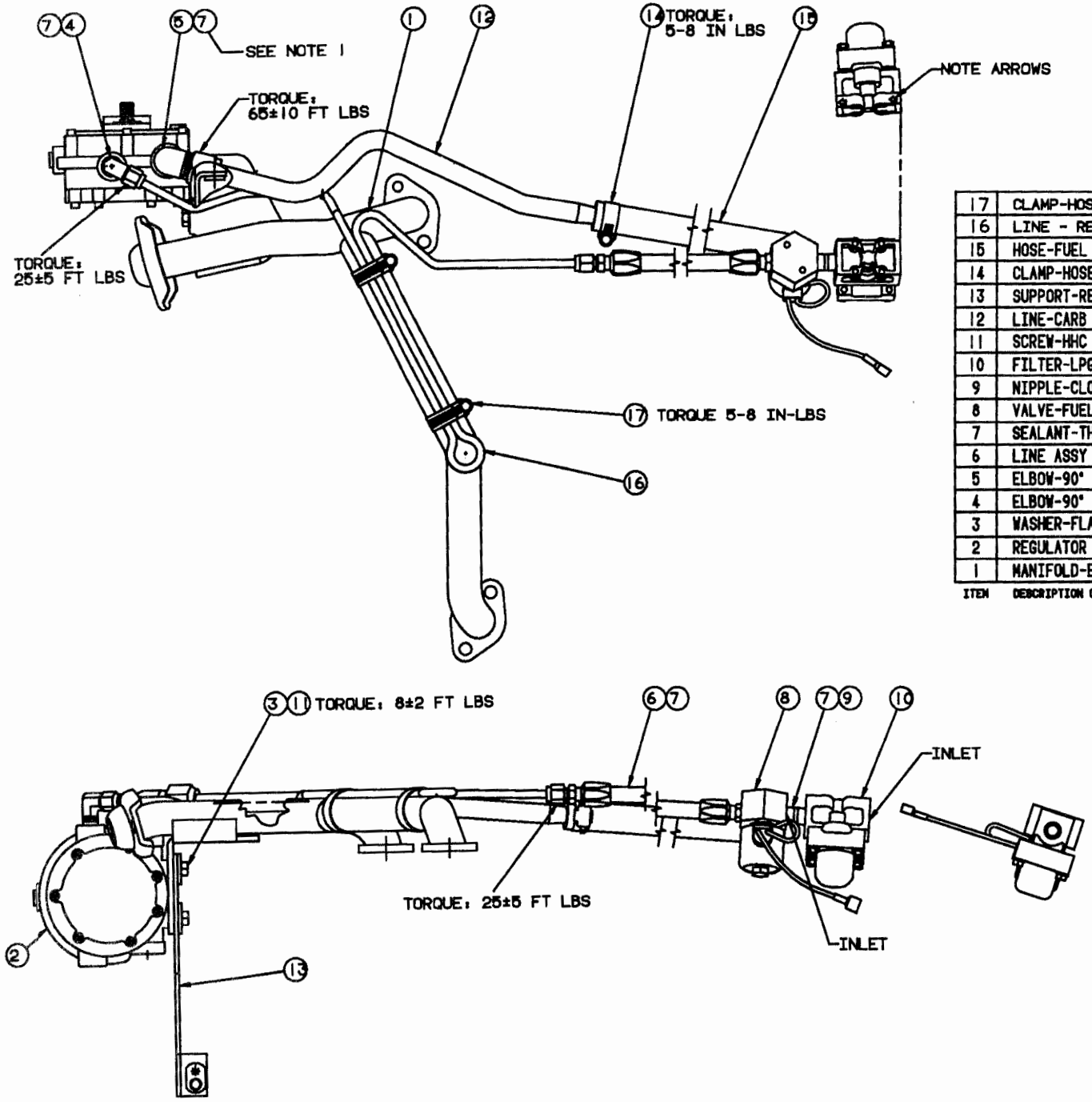
- 90° reducing elbows (2 different sizes)
- Close nipple
- Regulator support
- Hose clamp
- Flat washers

* Mounted separately, on bracket on mounting tray

Removal/disassembly procedure:

⚠WARNING LP gas (Propane) is extremely flammable and can cause severe personal injury or death if accidentally ignited. Make certain that all LP gas is purged from the system before beginning this removal/disassembly procedure.

1. Remove the flexible fuel hose, LP filter, and shutoff solenoid from the bracket on the genset mounting tray.
2. Loosen and remove the fuel connections on both ends of the vaporizer line which is clamped on top of the exhaust manifold.
3. Loosen and remove the hose clamps holding the vaporizer to the exhaust manifold. Lift the vaporizer off the manifold and set it aside.
4. Remove the hex-head capscrews holding the exhaust manifold to the engine block.
5. Remove the screws that hold the exhaust manifold to the muffler.
6. Remove the screws that hold the regulator support bracket to the genset.
7. Lift the entire manifold/vaporizer/regulator assembly off the generator set.



ITEM	DESCRIPTION OR MATERIAL
17	CLAMP-HOSE
16	LINE - REG SUPPLY
15	HOSE-FUEL
14	CLAMP-HOSE
13	SUPPORT-REGULATOR
12	LINE-CARB
11	SCREW-HHC (1/4-20 UNC-2A X 7/8)
10	FILTER-LPG
9	NIPPLE-CLOSE
8	VALVE-FUEL SHUT OFF
7	SEALANT-THREAD
6	LINE ASSY
5	ELBOW-90° REDUCING
4	ELBOW-90° REDUCING
3	WASHER-FLAT
2	REGULATOR ASSY
1	MANIFOLD-EXH

FIGURE 6-25. EXHAUST MANIFOLD/VAPORIZER/REGULATOR ASSEMBLY

Assembly/Installation procedure:

1. Place the manifold/regulator assembly on the generator set.
2. Replace the screws that hold the regulator support bracket to the genset.
3. Replace the screws that hold the exhaust manifold to the muffler.
4. Replace the hex-head capscrews holding the exhaust manifold to the engine block. (Make sure to replace the capscrews in the correct locations: one is longer than the other.)
5. Place the vaporizer on the exhaust manifold in the correct position. Replace and tighten the hose clamps to hold it in place.
6. Reconnect and tighten the fuel connections on both ends of the vaporizer line on top of the exhaust manifold.
7. Replace the flexible fuel hose, LP filter, and shutoff solenoid on the bracket on the genset mounting tray. Make certain to use lock washers when remounting the LP filter.

Carburetor, Air Filter, and Intake Manifold Assembly

The carburetor, air filter, and intake manifold assembly consists of the air cleaner housing, air filter, air cleaner adapter, carburetor, and intake manifold (see Figure 6-26).

Disassembly Procedure: Use the following procedures to remove and disassemble the carburetor, air filter, and intake manifold assembly.

1. Remove the crankcase breather hose from the air cleaner housing.
2. Remove the air cleaner housing center capscrew and lift off the housing and air filter.
3. Remove the three capscrews that secure the air cleaner adapter to the carburetor and lift off the adapter.
4. Disconnect the governor control linkage from the carburetor.
5. Disconnect the fuel hose from the carburetor.
6. Remove the two capscrews that secure the carburetor to the intake manifold and lift off the carburetor.

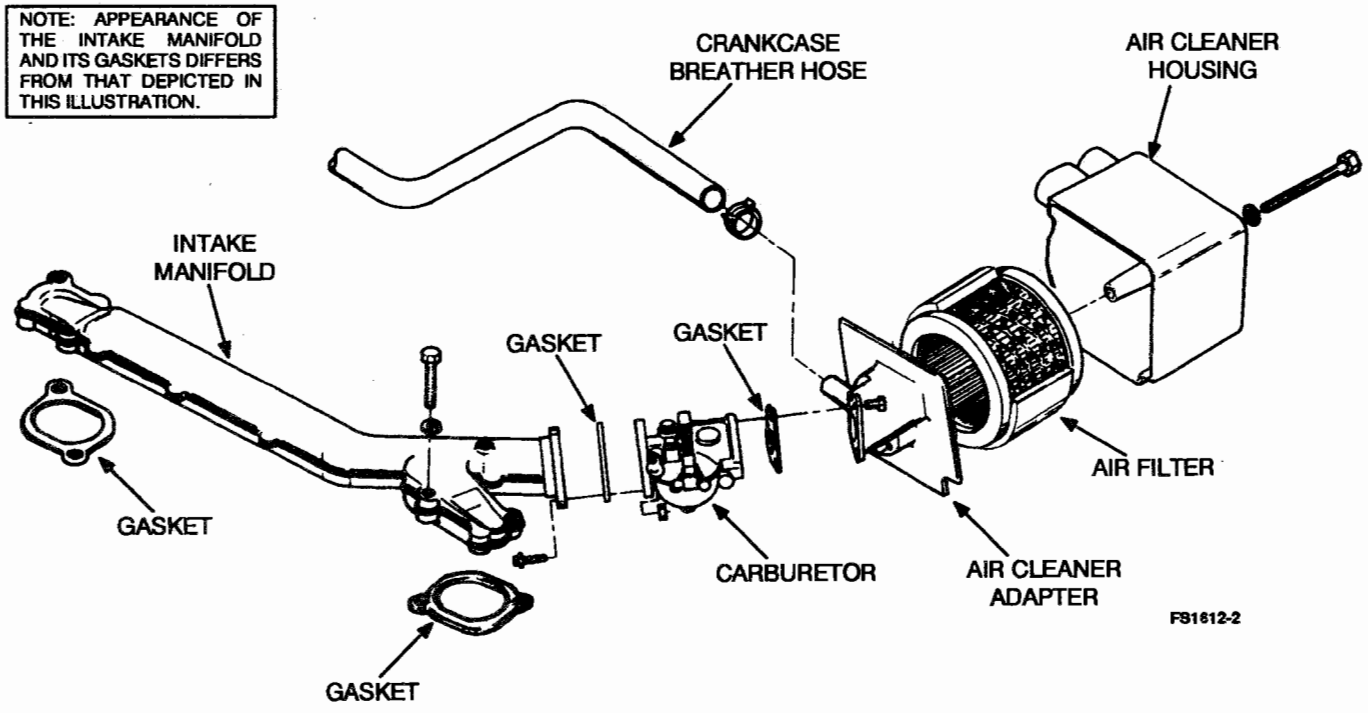


FIGURE 6-26. LPG CARBURETOR, AIR FILTER AND INTAKE MANIFOLD ASSEMBLY

7. Remove the intake manifold as follows:

   a. Disconnect the flexible fuel supply line from the fuel vaporizer.

   b. Remove the exhaust manifold as described in this section to provide clearance to lift off the intake manifold.

   ⚠CAUTION ***Bending the fuel vaporizer tubing will weaken the metal which causes cracks to form. Do not bend the vaporizer tubing to remove the intake manifold.***

   c. Remove the intake manifold capscrews and lift off the intake manifold.

   d. Remove the two intake manifold gaskets from the block and plug the intake ports with rags to prevent loose parts from accidentally entering the ports.

Assembly Procedure: Reverse order of disassembly. Use new gaskets (LP gaskets only) between the exhaust manifold and engine, the intake manifold and engine, and the carburetor and intake manifold. Tighten exhaust and intake manifold capscrews to specs listed in Section 4 of this manual. Tighten fuel vaporizer fittings and check for leaks.

⚠WARNING ***LP gas (Propane) is extremely flammable and can cause severe personal injury or death if accidentally ignited. Make certain that all LP gas is purged from the system before beginning this removal/disassembly procedure.***

Carburetor Mixture Screw Adjustments

⚠CAUTION ***Voltage/frequency-sensitive equipment such as VCRs, televisions, computers, etc. may be damaged by power line frequency variations. Some solid-state devices are powered whenever connected to an AC output even if the device is not in actual operation. For this reason, disconnect all devices that are voltage or frequency-sensitive before attempting any carburetor/governor adjustments. If disconnecting the devices is not possible, open the circuit breaker(s) at the distribution panel or at the generator set, if so equipped.***

LP gas carburetors have three adjustment screws:

- The throttle stop screw controls how much the throttle plate remains open when the throttle is pulled back to the closed position.
- The idle adjustment screw controls the fuel mixture when the set is operating at no load.
- The main adjustment screw controls the fuel mixture when the set is operating at full load.

Choke adjustment procedures are identical to those for the gasoline NHM genset. These may be found in the previous manual section, FUEL SYSTEM - GASOLINE.

This carburetor is adjusted for optimum engine performance at the Onan factory. **Under normal circumstances there should be no need to move these adjustment screws on the LPG carburetor.**

However, if adjustment is necessary, turn the mixture screws in until they are lightly seated, then turn the main adjustment screw out 2-7/8 (± 1/4) turns and the idle adjustment screw out 3-1/2 (± 1/4)

turns. This provides a rough preliminary adjustment. Then use a CO meter to adjust the carburetor to the following levels:

No-load: adjust idle adjustment screw for 4% to 6% CO concentration in exhaust
6000 W load: adjust main adjustment screw to 4% to 6% CO concentration in exhaust

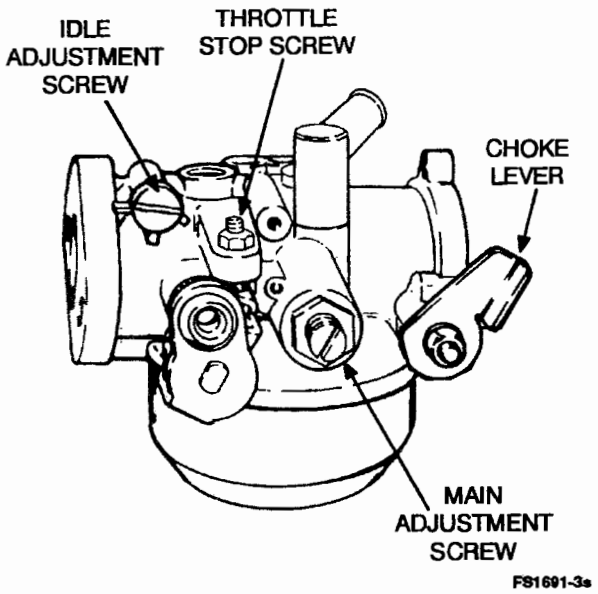


FIGURE 6-27. LP GAS CARBURETOR

Regulator

A two-stage regulator (see Figure 6-28) is used to deliver vaporized LP gas fuel to the carburetor. The primary stage of the regulator receives LP gas at container pressure and reduces it to the low pressure required for set operation. The secondary stage of the regulator restricts fuel flow through the regulator until vacuum from the engine creates a demand for fuel. Fuel flows through the regulator only when the engine is cranking or operating and stops flowing when the engine is stopped.

WARNING When removing or replacing the regulator, make certain that only the NHM regulator is used on the Marquis/NHM generator set. The Emerald/NHE regulator, though similar in appearance, is not designed to withstand the more rigorous operating conditions of the Marquis generator set, and may fail, leaking flammable LP gas.

LP gas presents the hazard of fire or explosion, and it is poisonous. These hazards can result in severe personal injury or death. Use of the incorrect LP gas regulator may allow LP gas to leak from the fuel system.

The correct (NHM/Marquis) LPG regulator may be identified by the bright red color of the edges of the primary diaphragm and gasket, visible between the two bolted-together sections of the regulator.

USE ONLY THE CORRECT LPG REGULATOR ON THIS GENERATOR SET!

The LPG regulator will normally require very little attention if the set is used on a regular basis and operated on clean high-quality fuel. Most regulator malfunctions can be traced to the following two sources:

- Hardened diaphragms and seals due to extended period of non-operation.
- Dirt or foreign matter embedded on valves and valve seats.

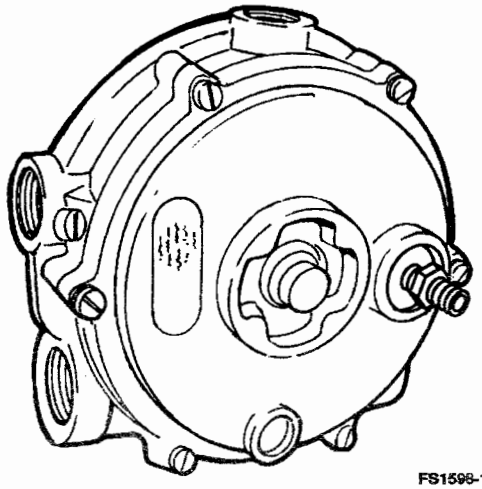


FIGURE 6-28. LP GAS REGULATOR

A regulator that has been operated and then stored for any length of time may require rebuilding or replacement. Diaphragms and gaskets tend to dry, shrink, and harden as the lighter petroleum ends evaporate. Use the test procedure specified in the Regulator Test section to check regulator operation and then rebuild or replace as required. Repair kits include detailed and illustrated installation instruc-

tions. They may be obtained from the regulator manufacturer.

A regulator that has granules of foreign matter embedded on the secondary seat may cause inconsistent starting or idling. These granules are seldom the result of insufficient filtration. The foreign matter is dissolved in the liquid propane and forms into granules as the fuel is vaporized. Remove regulator front cover and diaphragm assembly (see Figure 6-29) to check for dirt or oil deposits. If granules are embedded in the rubber of the secondary valve, wash the valve and seat clean.

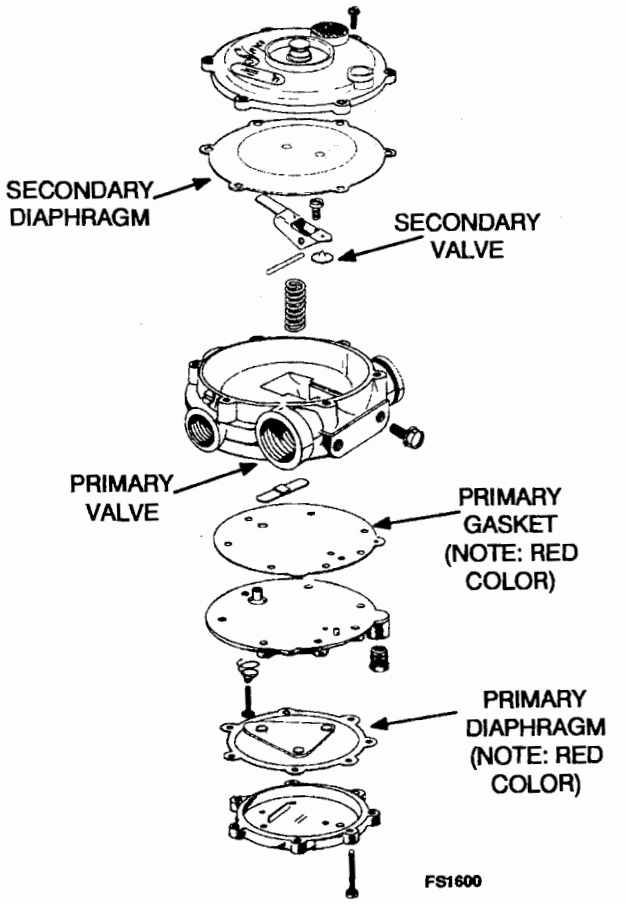


FIGURE 6-29. REGULATOR DISASSEMBLY

Regulator Test: The regulator may be bench tested using compressed air and a simple automobile fuel pressure gauge. Use the following procedure to test:

1. Attach the pressure gauge to the test port on the back of the regulator as shown in Figure 6-30.
2. Attach a pressure hose to the inlet opening and open the air pressure valve. Air pressure: 90-100 psi (620.5-689.5 kPa).
3. If the primary seal is sound, the gauge should read approximately 1-1/2 psi (10.3 kPa) and the pressure should remain constant. A fluctuating pressure reading indicates a bad primary seat.
4. Close the air pressure valve and observe the pressure gauge. The pressure should remain constant. If the pressure reading drops, the secondary seal is leaking.

If the regulator does not pass either test, it must be rebuilt or replaced.

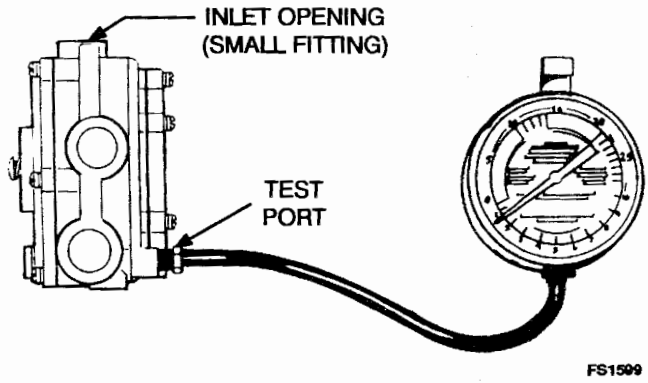


FIGURE 6-30. REGULATOR TEST

Fuel Filter

The fuel filter (see Figure 6-31) removes solid impurities such as rust or scale from the LP gas before they can clog the regulator or carburetor. The fuel filter is mounted on a bracket on the set mounting tray, next to the fuel solenoid valve. A magnet within the filter housing traps iron or rust particles while a filter element traps non-magnetic particles. The fuel filter operates at container pressure and must be carefully assembled to prevent leakage. Use the following procedures to disassemble and clean:

1. Remove the four capscrews and lock washers that secure the filter bowl to the filter body.
2. Separate filter bowl from filter body and discard the O-ring seal.

3. Remove nut and washer from center stud and pull out the filter element.
4. If filter element is clogged, wash element in kerosene and blow dry with low pressure (30 psi/207 kPa) compressed air. Replace filter element if damaged.

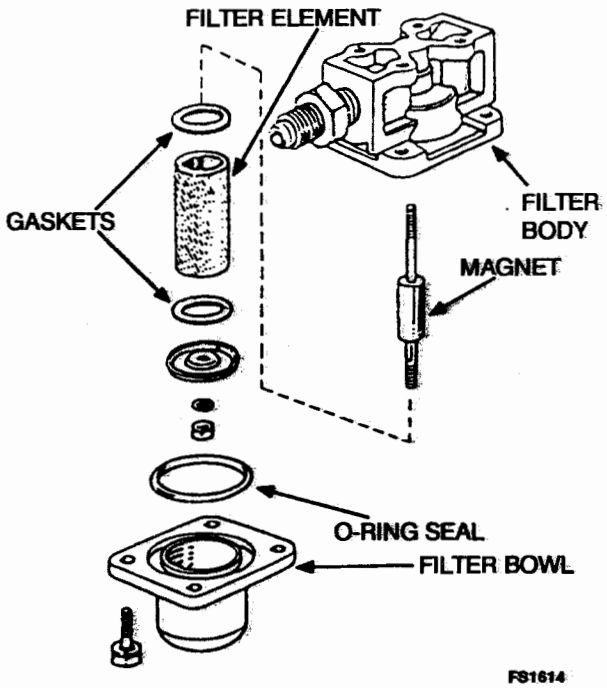


FIGURE 6-31. LIQUID LPG FUEL FILTER

5. Wipe the center stud magnet clean of any rust or scale particles that have collected.
6. Install clean filter element using new gaskets (2) and securely tighten center stud nut.
7. Place a new O-ring in the filter bowl sealing groove.
8. Align reference mark on filter bowl with reference mark on filter body and install capscrews (4) and lock washers (4). Tighten capscrews to 56 to 74 in-lbs (6.5 to 8.3 N•m) torque.

When fuel system is pressurized, check filter for leaks.

Solenoid Valve

The solenoid valve (see Figure 6-32) provides a positive fuel shutoff whenever the generator set is stopped. The solenoid must be energized before fuel will flow to the regulator. Service is limited to replacing the complete valve assembly if it does not operate properly. The valve may be bench tested by connecting battery positive (B+) to the top terminal and battery negative (B-) to the grounded terminal. The plunger assembly should withdraw and open the valve when the solenoid is energized. Replace the solenoid valve if it does not operate properly.

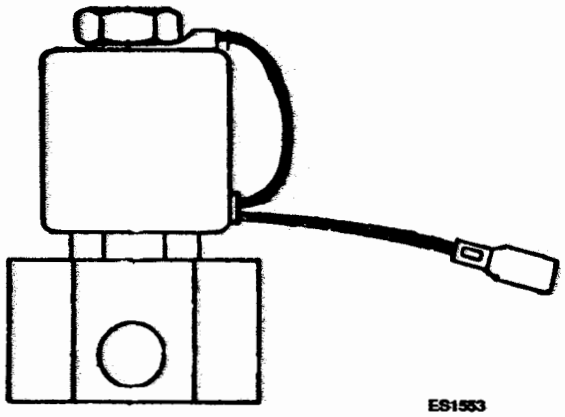


FIGURE 6-32. SOLENOID VALVE

ELECTRIC STARTER

Starter Removal and Disassembly Procedure

1. Disconnect the genset negative (-) battery cable from the set starting battery.
2. Disconnect the set positive (+) battery cable from the starter lug terminal. See Figure 6-33.

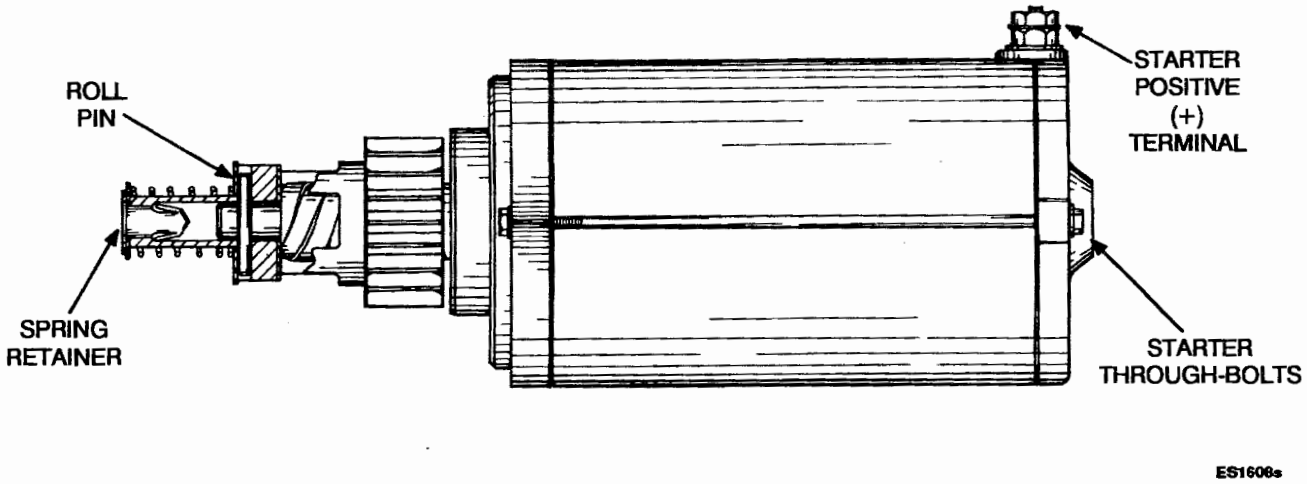


FIGURE 6-33. STARTER MOTOR

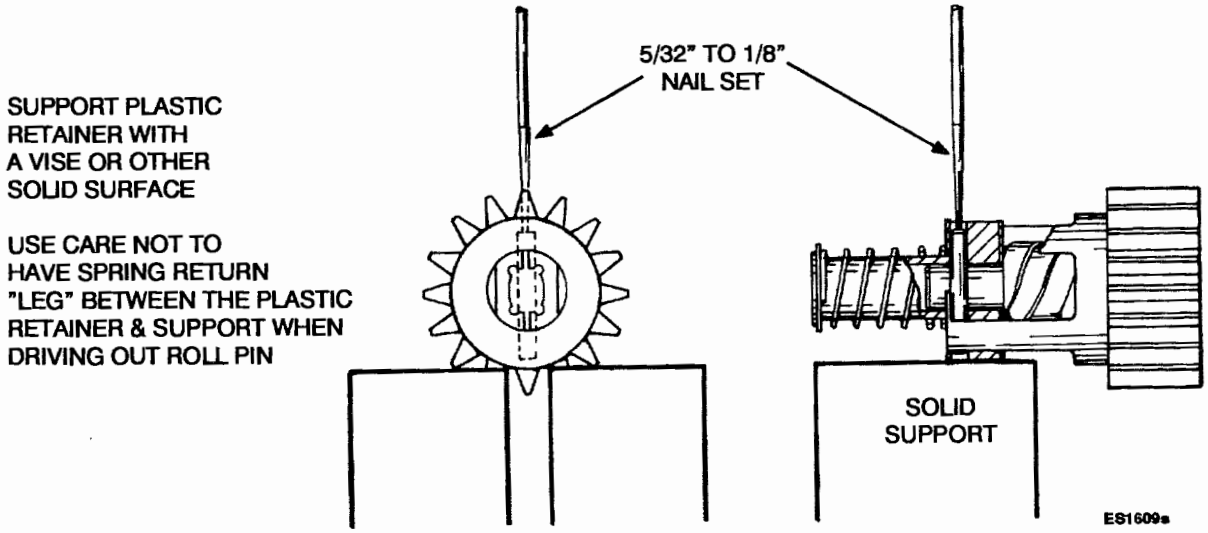


FIGURE 6-34. DRIVING ROLL PIN OUT

3. Remove the starter mounting screws. Carefully disengage the starter from the stator housing.
4. Remove the starter through-bolts. Carefully separate the brush end cap housing from the armature assembly.
5. Use a 1/8 to 5/32 inch nail set to remove the roll pin. (When reassembling, use a new roll pin.) Remove the return spring, gear and clutch assembly as required. See Figure 6-34.

Testing Armature for Grounds

Touch one ohmmeter lead to a commutator bar, then touch the other lead to the armature shaft and the core laminations. A low resistance reading indicates a grounded armature. Replace a grounded armature with a new one. See Figure 6-35.

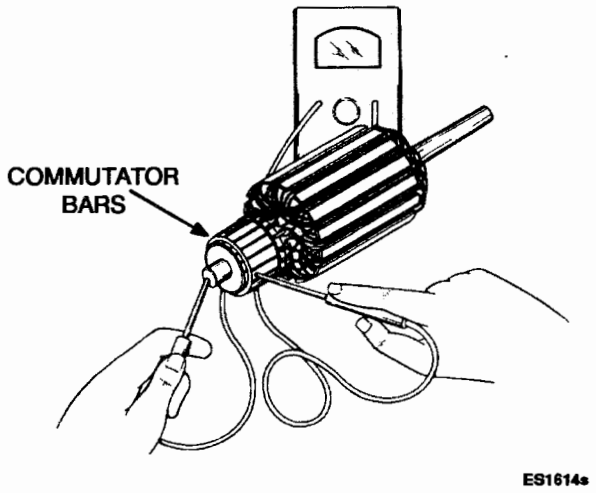


FIGURE 6-35. TESTING ARMATURE FOR GROUNDS

Testing Armature for Shorts

Use a growler (Figure 6-36) to locate shorts in the armature. Place the armature in the growler and hold a thin steel blade (hacksaw blade) parallel to the core and just above the armature, while slowly rotating the armature in the growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace a shorted armature with a new one.

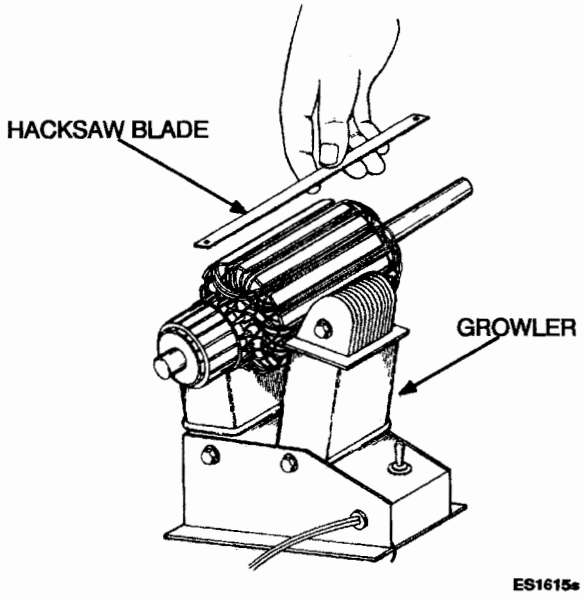


FIGURE 6-36. TESTING ARMATURE FOR SHORTS

Testing for Opens

Touch one ohmmeter lead to a commutator bar, then touch the other lead to each of the other commutator bars in turn. A high resistance indicates an open circuit between the commutator bars and armature windings. Replace an open armature with a new one.

Brush Inspection

Measure brushes (Figure 6-37) and replace them if worn less than 0.425" (11 mm).

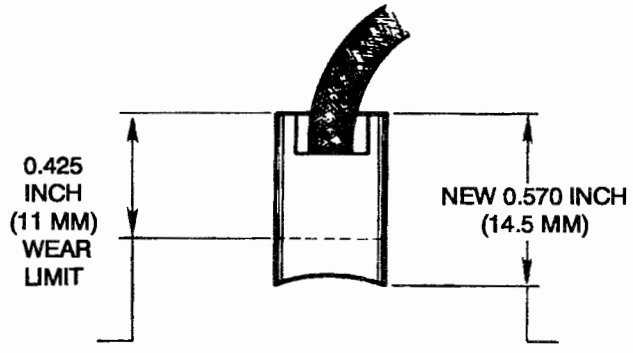


FIGURE 6-37. BRUSH INSPECTION

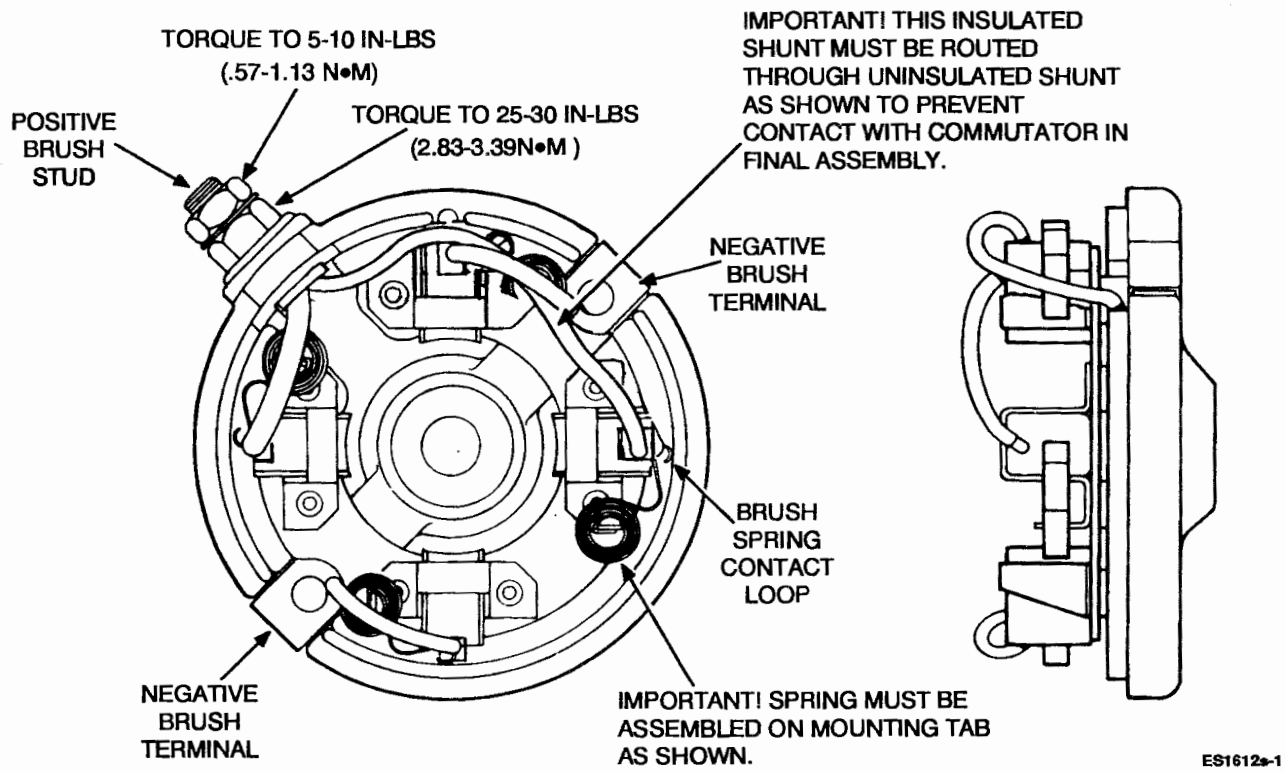


FIGURE 6-38. BRUSH ENDCAP

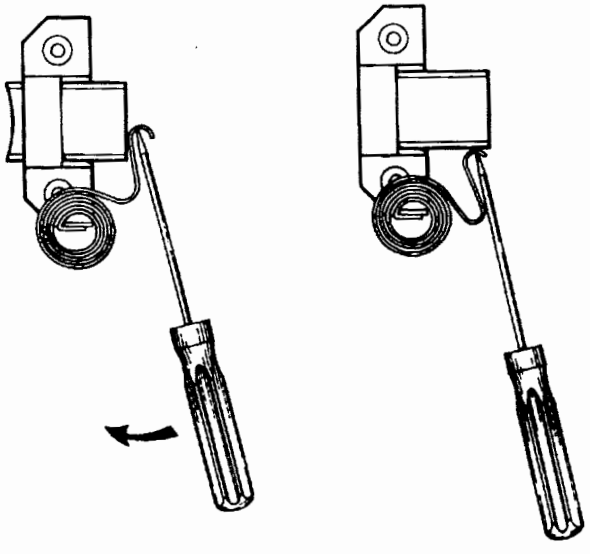


FIGURE 6-39. RESTING BRUSH SPRING ON BRUSH SIDE

Starter Assembly Procedure

Use this procedure to return the electric starter assembly to service.

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

   ⚠ CAUTION ***Oil on armature will damage starter. Do not immerse bearings in cleaning fluid. Use a brush dipped in clean engine oil to remove dirt from bearings. Avoid getting oil on brushes or commutator.***

2. Mount the brush springs on tabs as shown in Figure 6-38. Using a small screwdriver, turn the spring counterclockwise to torque it, so the contact loop is inside the brush holder. The spring should be pushed down to the mounting tab shoulder.
3. Push the negative brush terminals over the through-bolt holes on the brush endcap.
4. Insert a positive brush stud into the hole, and torque to 25-30 in-lb (2.83 - 3.39 n m).
5. Insert a small screwdriver into the brush spring contact loop to bend the spring back so that each brush can be inserted into the holder. Be sure that all brush wires are facing up.
6. If the brushes are at least 0.430 inch (10.9 mm) long, rest the brush springs against the sides of the brushes to keep them clear during armature installation. See Figure 6-39.
7. Place a washer on the commutator end of the shaft, and put the armature into the brush endcap. Push the four brushes toward the commutator, making sure that the springs are correctly positioned on the brushes. Recheck to be certain that the spring is pushed all the way down on the mounting tab.
8. Make sure that all brush wires are clear of the commutator, and that uninsulated portions of insulated wires do not touch the inside of the housing, or adjacent brush boxes.
9. Place the magnetic housing over the armature. Hold down the armature and the end cap using a nut driver pressed over the end of the shaft.
10. Place a spring washer and a flat washer on the shaft, as shown in Figure 6-40.

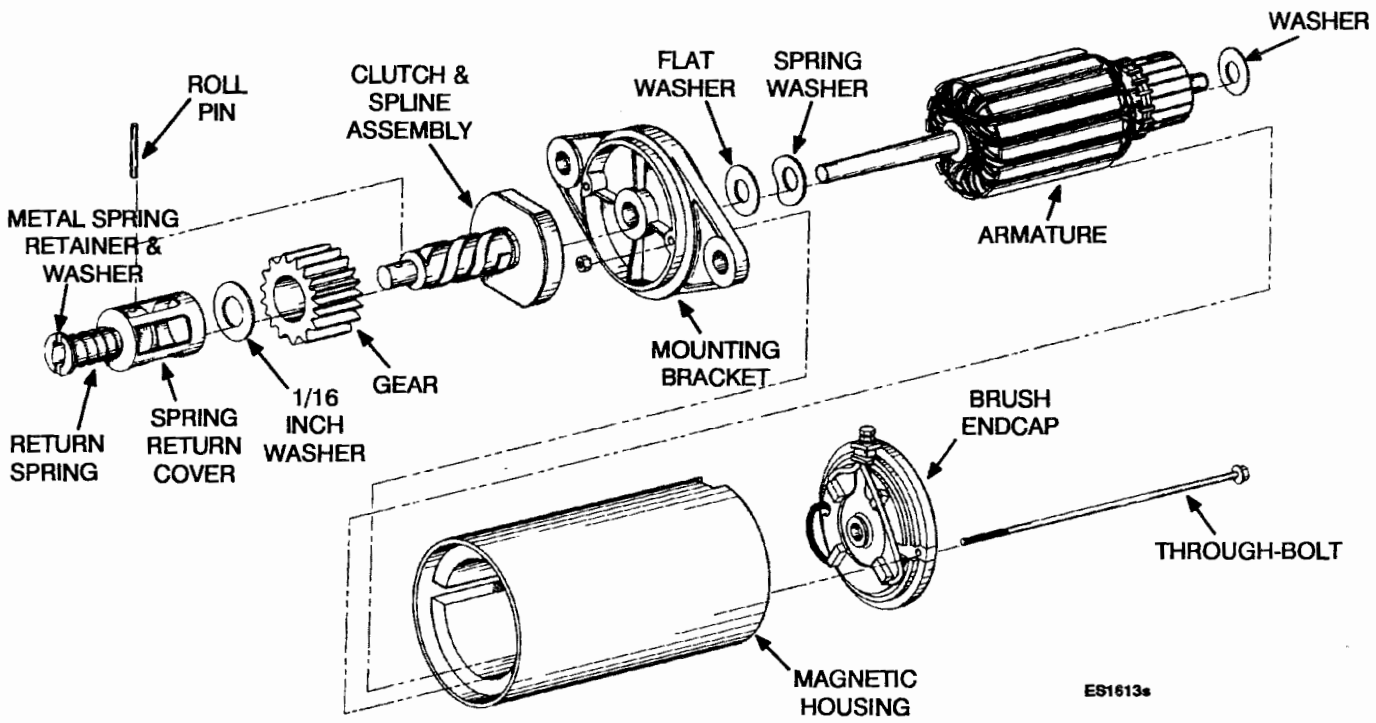


FIGURE 6-40. STARTER ASSEMBLY

11. Place the mounting bracket on the motor, facing the exposed end of the sleeve bearing and through-bolt lead-ins toward the inside of the motor. The flat near one mounting hole should line up with the positive stud on the end cap, so the through-bolts can line up.
12. Insert the through-bolts, and torque to 35-45 lb-in (3.96 - 5.09 N•m).
13. Wipe dust from the helix and gear, and apply a light coat of GE Versilube 322-L to the outside diameter of the helix, the inside diameter of the gear and the unchamfered end of the gear. Place the clutch and helix assemblies on the motor shaft, with flats engaged in the clutch hole.
14. If the return spring is unassembled, do the following:
    A. Place a 1-1/16 inch O.D. washer over the end of the shaft.
    B. With the chamfered side of the shaft hole facing up, place a plastic retainer on the shaft and line up the hole with a hole in the shaft.
    C. Support the plastic retainer with a vise or other solid surface. Using a 5/32 or 1/8 inch nail set and hammer, drive in a new roll pin. The pin should be driven about 1/10th of an inch (2.5 mm) from the edge of the plastic retainer, or in such a way that it is evenly spaced from each side.
    D. Place the spring cover over the top of the plastic retainer, then place the return spring on top of the retainer.
    E. With a washer placed over the point of the plastic retainer, push the metal retainer into the hole of the plastic retainer as far as it will go.
15. Mount the starter on the generator stator housing using capscrews, lockwashers and nuts. Tighten the mounting screws to 30-33 lb-ft (41-45 N•m).
16. Connect the set positive (+) battery cable to the starter terminal. Connect the set negative (-) terminal to the starting battery.

Section 7. Control System

INTRODUCTION

The control system governs the following functions:

- Starting
- Monitoring for fault conditions
- Instrumentation
- Stopping
- Engine speed governing (electronic governor sets only)

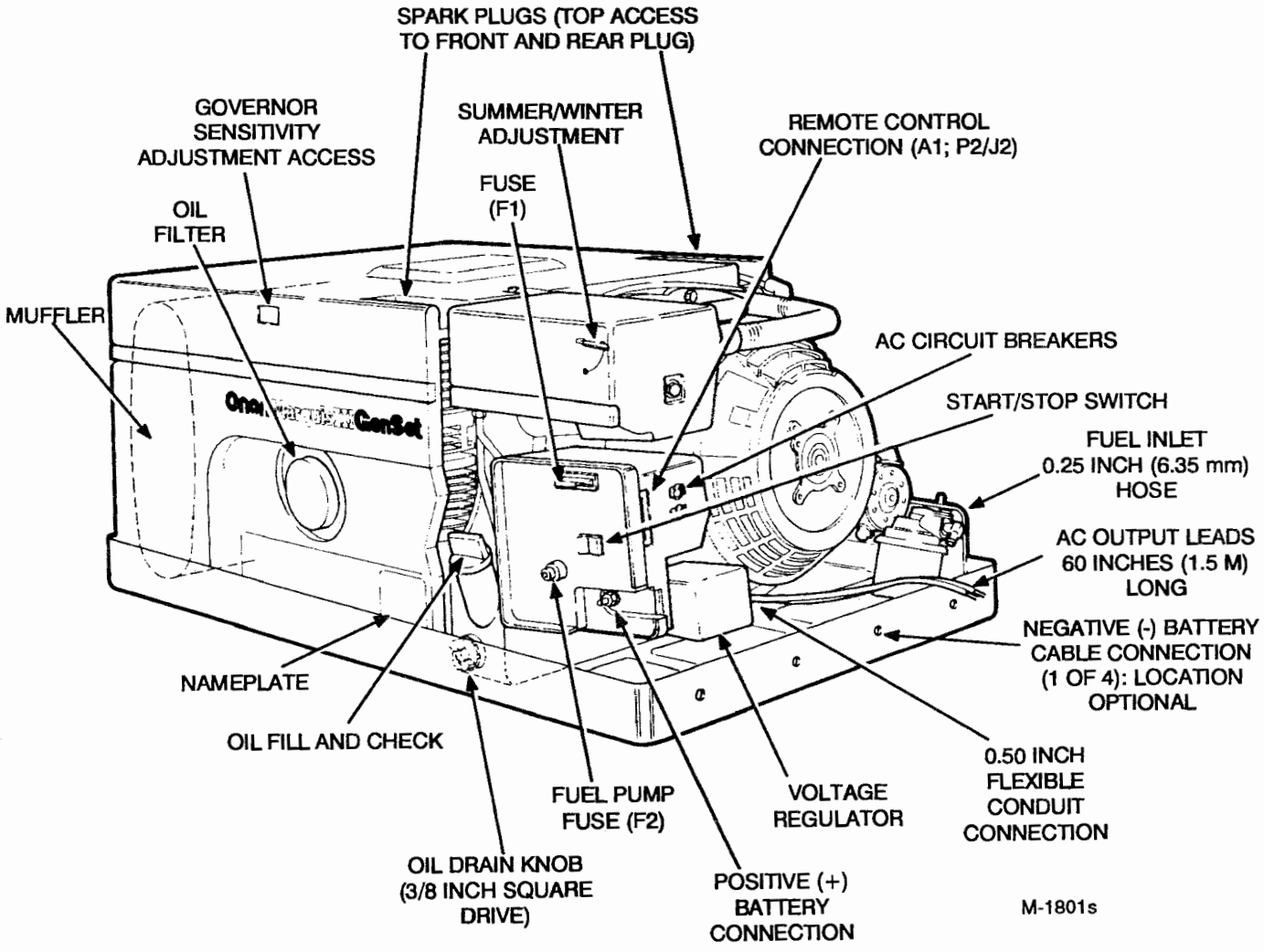


FIGURE 7-1. BGM/NHM GENERATOR SET (MECHANICAL-GOVERNOR VERSION)

CONTROL DESCRIPTION (Mechanical governor gensets)

The generator set control consists of the components listed below (see Figure 7-1):

- Control panel assembly
- Printed circuit board (A1)
- Start/Run/Stop switch (S1)
- Fuse (F1)
- Fuse (F2)
- Start solenoid (K1)
- Stop latch relay (K5)
- Fuel valve solenoid (E4)
- Fuel pump (E3)
- Remote start control
- Circuit breaker(s)
- Voltage regulator (VR1)
- Terminal board (TB1)

Control Panel Assembly

The control panel assembly consists of:

- Printed circuit board (A1)
- Start/Run/Stop switch (S1)
- Fuse (F1)
- Fuse (F2)

Printed Circuit Board (A1): The printed circuit board controls the engine start, start disconnect/run, and stop functions. It is mounted at the rear of the control panel. It contains wiring harness connections to the engine, generator, and remote start control; the start-stop switch (S1); and the control fuse (F1).

Start/Run/Stop Switch (S1): S1 is a SPDT rocker switch which starts and stops the generator set. The switch returns to the center (run) position when released. It is mounted on the circuit board, and is not field-replaceable.

Fuse (F1): This slow-blow 5-amp fuse protects printed circuit board A1 from overcurrent conditions. It is removable from the front of the control panel. Spare fuses are inside the fuse holder; use only Onan-supplied 5-amp fuses.

Fuse (F2): This slow-blow 5-amp fuse protects the fuel pump circuit from overcurrent conditions. It is removable from the front of the control panel. Spare fuses are inside the F1 fuse holder; use only Onan-supplied fuses.

Start Solenoid (K1)

The K1 start solenoid opens and closes the circuit between the starter motor and the battery. The starting current load requires that the solenoid contacts have a 300-amp contact rating. A single terminal connects to the 12-volt solenoid coil. Two studs provide connection points to the battery and starter cables; the battery B+ stud connection protrudes through the control panel to the outside of the control housing for convenient access.

Stop Latch Relay (K5)

The K5 stop latch relay latches the generator set off when switch S1 is moved to the STOP position. This prevents the set from restarting when the switch is momentarily placed in the STOP position, then released. The K5 relay is located inside the control box.

Fuel Pump (E3), Fuel Valve Solenoid (E4)

The E3 fuel pump is initially energized (through CR9) at the same time the start solenoid K1 is energized, by closure of start relay K4 contacts. After the set is started, fuel pump relay K6 is deactivated and the fuel pump then receives its current through a separate connection. Fuel pump power is rectified to DC by CR10. CR9 then serves as a blocking diode to prevent current flow to start solenoid K1 and fuel pump relay K6.

Fuel valve solenoid E4 parallels fuel pump E3; it serves as a safety measure by blocking fuel flow when the fuel pump is not activated.

Remote Start Control

The remote start control enables the generator set to be operated from a remote location. The deluxe control includes a running time meter and battery condition meter.

Circuit Breakers (CB1 and CB2)

AC output from the generator is supplied to circuit breakers CB1 and CB2, located on the right side of the control housing.

Voltage Regulator (VR1)

The voltage regulator helps provide stable output voltage under varying loads. During initial start of the set, the voltage regulator receives DC current from the starting battery, and begins excitation of the rotor through leads J4-9/F1, and J4-10/F2. After the generator set starts and runs, it provides AC power to the voltage regulator through leads J4-11/Q1, and J4-12/Q2 for the excitation system. The AC voltage is rectified to DC voltage, and the proper DC excitation voltage is conducted to the rotor in proportion to changes in demand. Reference voltage is J4-2/L1 to J4-3/L0.

The voltage regulator is protected from moisture and other contamination, reducing the risk of component failure. The capacitor and the printed circuit board are encased in the regulator housing with a potting compound. The wiring harness plug-in P4 is treated with a lubricant prior to connection.

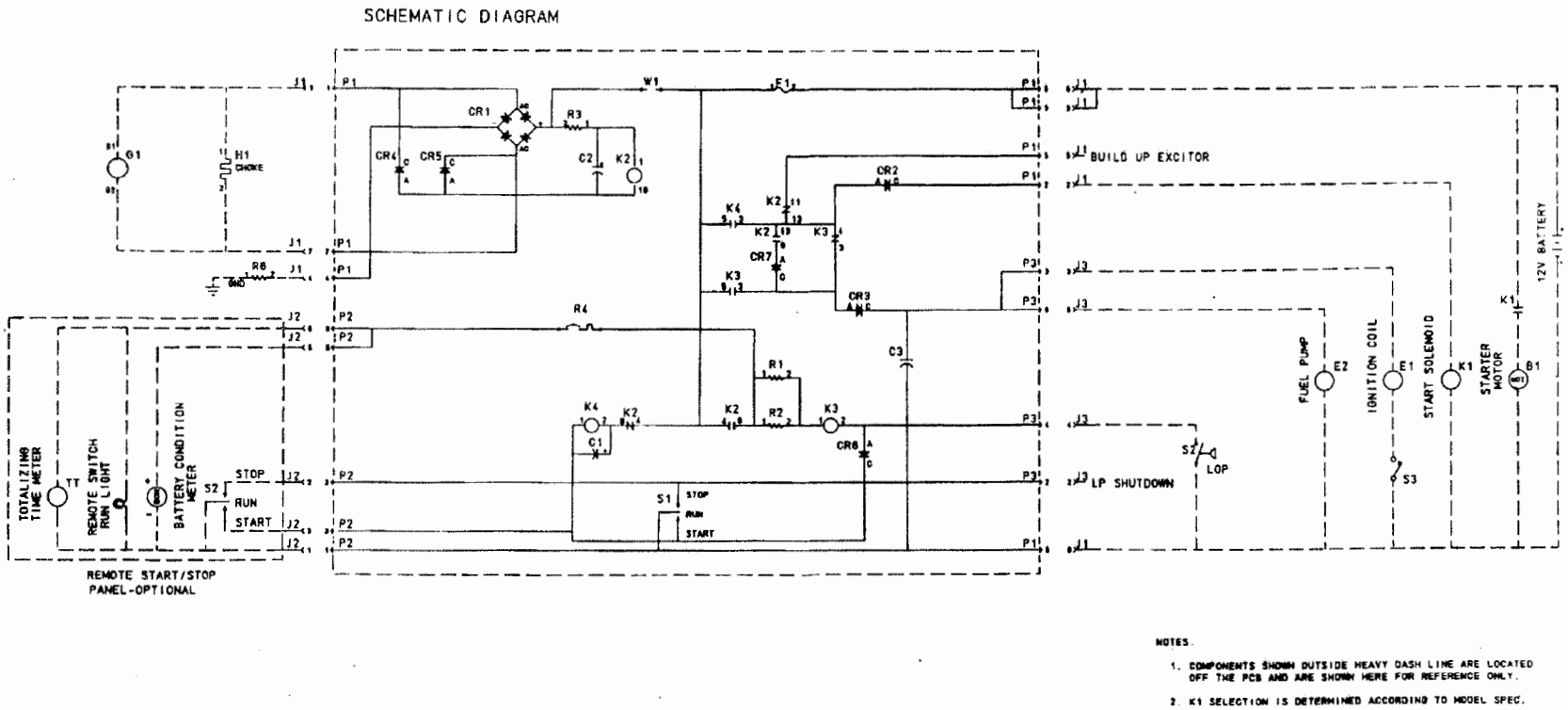
Terminal Board (TB1)

The AC output power leads from the generator (T1, T2, T3, and T4) are connected to terminal board TB1 at terminals L1 - L0.

AC power at TB1 terminals is tapped by leads of wiring harness J4 of voltage regulator VR1, and interconnect wiring to circuit breakers CB1 and CB2. These leads provide generator output to the voltage regulator for proper voltage regulation, and to the circuit breakers for power supply to load.

CONTROL OPERATION

The schematic diagram shown in Figure 7-2 is intended as an illustration of the circuit description. However, when troubleshooting, always refer to the wiring diagram that corresponds to the model and spec numbers of the generator set.



NOTES.

1. COMPONENTS SHOWN OUTSIDE HEAVY DASH LINE ARE LOCATED OFF THE PCB AND ARE SHOWN HERE FOR REFERENCE ONLY.
2. K1 SELECTION IS DETERMINED ACCORDING TO MODEL SPEC.

FIGURE 7-2. BGM/NHM CONTROL SCHEMATIC (MECHANICAL GOVERNOR SETS)

Starting

Placing the Start/Run/Stop switch in the Start position connects battery ground (B-) to the K4 start relay. This energizes K4, which closes the normally open (N. O.) contacts that connect battery positive (B+) to the following:

- N.C. contacts of K2 generator relay
- Generator voltage regulator
- Ignition coil (T1)
- Fuel pump relay (K6)
- Start solenoid (K1)

Connecting B+ produces the following control responses:

- Flashes the field, to make sure that there is adequate residual magnetism to induce voltage buildup.
- Energizes the ignition coil (T1), so it can begin producing a spark when ignition module S3 is activated.
- Energizes the fuel pump relay (K6), which connects B+ to the fuel pump and fuel solenoid.
- Energizes the start solenoid (K1), which closes its N.O. contacts in the starter motor circuit.
- Energizes the solenoid fuel valve (E4), allowing fuel to the carburetor.
- Energizes the fuel pump (E3), which begins pumping fuel to the carburetor.
- Energizes the stop latch relay (K5) to open its contacts to ground, which allows run relay K3 to be energized through closure of oil pressure switch S2 after engine startup.

Closing the K1 start solenoid contacts connects B+ to the starter motor. This energizes the starter motor, which begins to crank the engine to initiate starting.

Starter Lockout-Run

When the engine starts, the low oil pressure switch (S2) closes to connect battery ground to the run relay (K3). As the engine comes up to speed, AC output voltage from the generator energizes the generator relay (K2). This AC voltage activates the choke heater element through a separate connection, opening the choke and powering the fuel pump and fuel solenoid.

Energizing K2 opens a set of contacts to de-energize K4, and closes another set of contacts to connect B+ to the generator start disconnect/run relay (K3). Energizing K3 closes a set of contacts which provides an alternate B+ circuit to T1 ignition coil and S3 ignition module.

De-energizing K4 opens contacts which de-energize K1 start solenoid and K6 fuel pump relay. De-energizing K1 disconnects B+ from the starter motor, which stops cranking. De-energizing K6 closes contacts which connect E3 and E4 directly to generator power, rectified by CR10.

Opening these K4 contacts at this time has no effect on engine operation, because they are in parallel with the closed K3 contacts which connect B+ to the ignition coil.

When start-stop switch S1 is released and returns to center (run) position, the engine continues to run. Relays K2 (generator relay), K3 (run relay), and K5 (stop latch relay) are energized while relays K1 (start solenoid), K4 (start relay) and K6 (fuel pump relay) are de-energized.

Stopping

Moving start-stop switch S1 to the STOP position grounds resistors R1 and R2 to de-energize run relay K3. This opens its contacts to disconnect B+ from ignition coil T1, and stop latch relay K5. De-energizing K5 allows its N.C. contacts to close to ground. This prevents K3 from being energized, and prevents the set from restarting when switch S1 is released from the STOP position.

Without ignition, the engine stops. As the generator output voltage drops, generator relay K2 also deenergizes. All components return to their de-energized position following set shutdown.

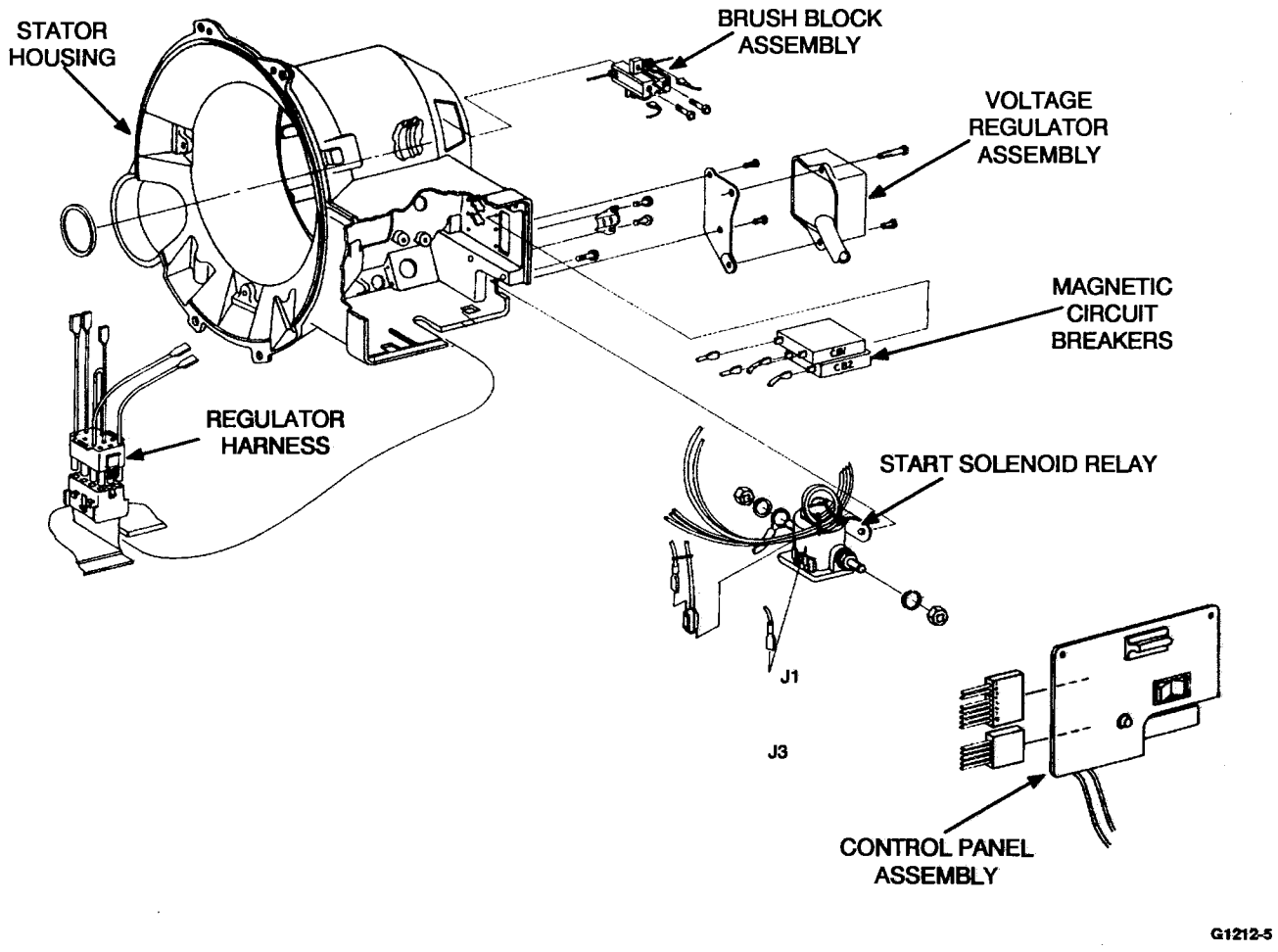


FIGURE 7-3. BGM/NHM CONTROL COMPONENTS (MECHANICAL-GOVERNOR GENSETS ONLY)

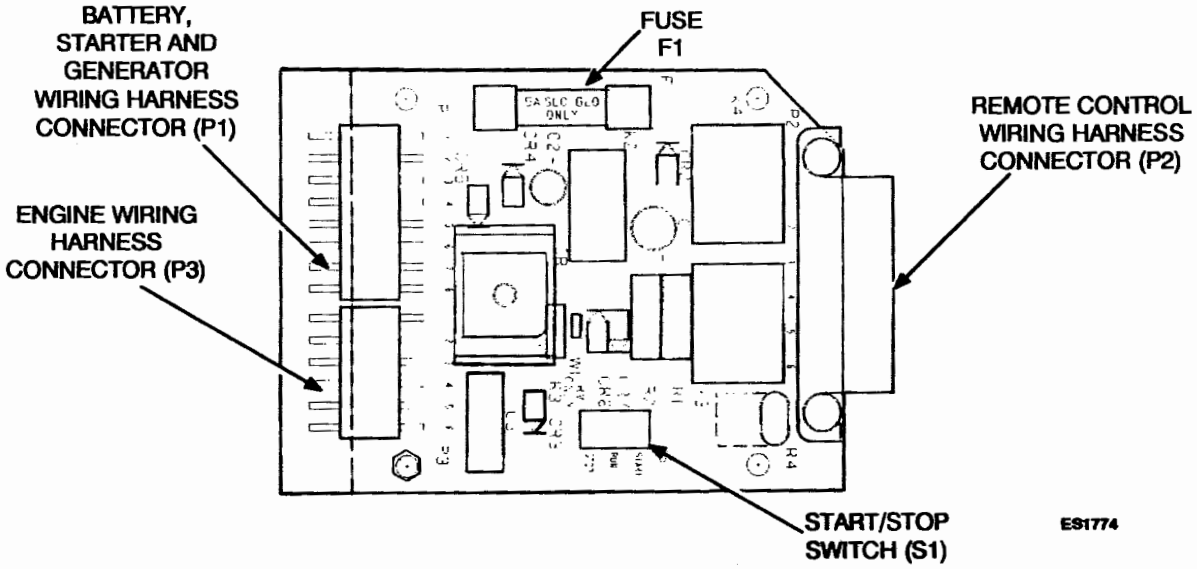


FIGURE 7-4. BGM/NHM CONTROL PCB ASSEMBLY (A1)

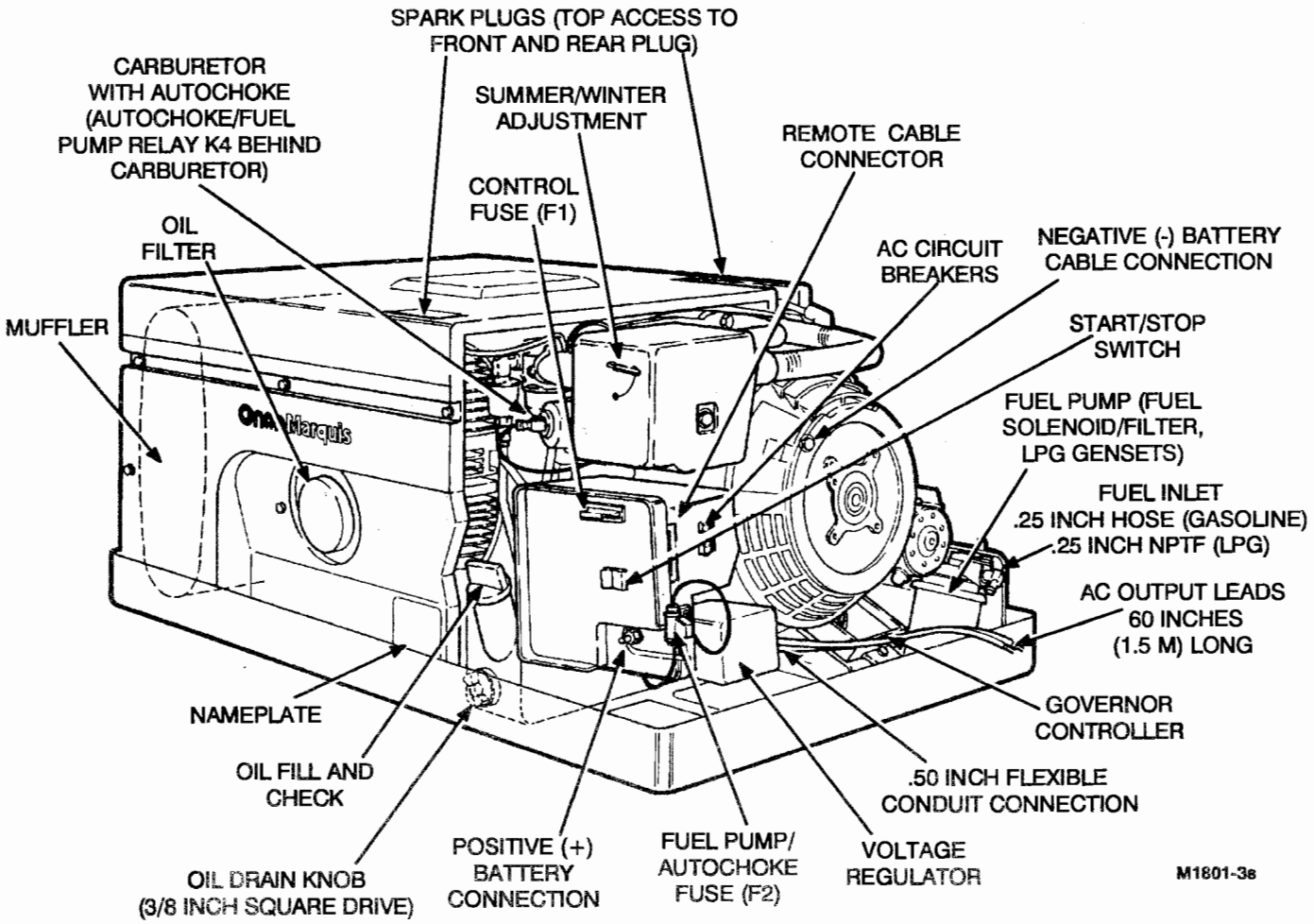


FIGURE 7-5. BGM/NHM GENERATOR SET (ELECTRONIC-GOVERNOR VERSION) (SPEC D GENSET SHOWN)

CONTROL DESCRIPTION (Electronic governor gensets)

The generator set control consists of the components listed below (see Figure 7-5):

- Control panel assembly
- Printed circuit board (A1)
- Start/Run/Stop switch (S1)
- Fuse (F1)
- Start solenoid (K1)
- Fuel pump (E3) and fuel valve solenoid
- Remote start control (optional)
- Circuit breaker(s) CB1 and CB2
- Voltage regulator (VR1)
- Terminal board (TB1)
- Governor controller board (A4)
- Fuel pump/autochoke fuse (F2) (Spec D)
- Fuel pump/autochoke relay (K4) (Spec D)

These components are described below. **The designations in these descriptions refer only to the control board schematic in Figure 7-7; they do not necessarily correlate with the designations in any other schematic or wiring diagram.**

Control Panel Assembly

The control panel assembly consists of:

- Printed circuit board (A1)
- Start/Run/Stop switch (S1)
- Fuse (F1)

Printed Circuit Board (A1): The printed circuit board controls the engine start, run, and stop functions. It is mounted behind the control panel. It includes the following parts:

- Wiring harness connections to the engine, generator, governor control board and remote start control
- Start-stop switch (S1);
- Control fuse (F1)
- Relays K1, K2 and K3 (see schematic)

The printed circuit board is not repairable in the field.

Start/Run/Stop Switch (S1): S1 is a SPDT rocker switch, mounted on the circuit board, which starts and stops the generator set. The switch returns to the center (run) position when released.

Fuse (F1): This slow-blow 10-amp fuse protects circuit board A1 from overcurrent conditions. It is removable from the front of the control panel. Spare fuses are inside the fuse holder; use only Onan-supplied 10-amp fuses.

Start Solenoid (K1)

Start solenoid K1 opens and closes the circuit between the starter motor and the battery. Two terminals provide connection points to the battery and starter cables; the battery B+ connection protrudes through the control panel to the outside of the control housing for convenient access.

Fuel Pump (E3)

Fuel pump E3 is energized at the same time that start solenoid K1 is energized. (Spec D gensets: E3 is activated through K4 contacts.) See the set schematic diagram, in Section 11 of this manual.

Remote Start Control (A1;P2/J2) (optional)

The optional remote start control enables the user to start and stop the set from a remote location. The deluxe control includes a running time meter and battery condition meter.

Circuit Breakers (CB1 and CB2)

The set AC output is supplied for operator use through circuit breakers CB1 and CB2, located on the right side of the control housing.

Voltage Regulator (VR1)

The voltage regulator helps stabilize output voltage under varying loads by providing DC excitation voltage to the generator rotor. AC voltage is rectified to DC voltage, and the proper DC excitation voltage is conducted to the rotor in proportion to changes in demand.

Terminal Board (TB1)

AC output power leads T1, T2, T3, and T4 from the generator are connected to terminal board TB1 at terminals L1 - L0. Wiring harness J4 connects TB1 to voltage regulator VR1 and circuit breakers CB1 and CB2.

(Spec D gensets)
Fuel Pump/Autochoke Relay and Fuse (K4 and F2)

Relay K4 opens and closes the circuit that powers fuel pump E3 and autochoke K1. A connection to control assembly A1 energizes K4. K4 is located on the rear of the air cleaner adapter.

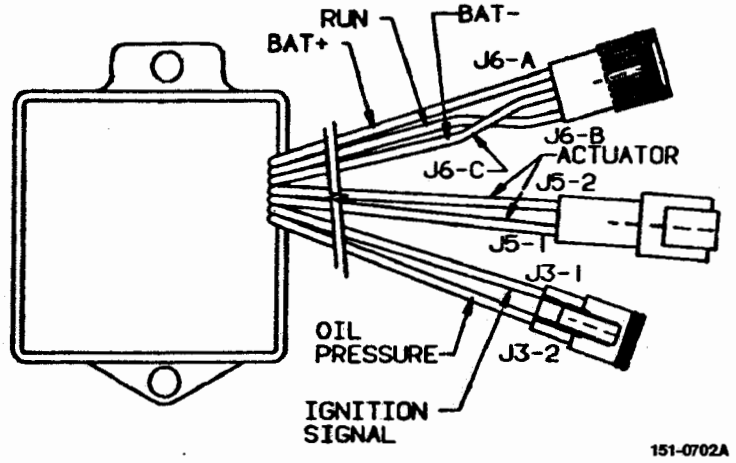


FIGURE 7-6. GOVERNOR CONTROLLER BOARD A4

Governor Controller Board (A4)

Governor controller board A4 is located on the genset mounting tray. It accepts inputs from the electronic ignition module and the oil pressure sensor. B+ and ground connections power the board. See Figure 7-6.

Governor controller board A4 outputs a DC voltage that drives the governor actuator, which in turn moves the carburetor throttle to maintain an engine speed of 1800 RPM. The inputs from the ignition module and the oil pressure sensor can signal the governor controller board to shut the engine off under the following adverse conditions:

- If power (B+) is lost to the controller
- If genset speed goes beyond 2700 RPM
- If oil pressure switch S2 closes
- If the signal from the ignition module stops
- If genset speed goes below 1760 RPM for 30 seconds

Under all these circumstances, governor controller board A4 shuts down the genset. The governor controller board is a non-serviceable component.

CONTROL OPERATION

The schematic diagram shown in Figure 7-7 is intended as an illustration of the circuit description. However, when troubleshooting, always refer to the wiring diagram that corresponds to the model and spec numbers of the generator set.

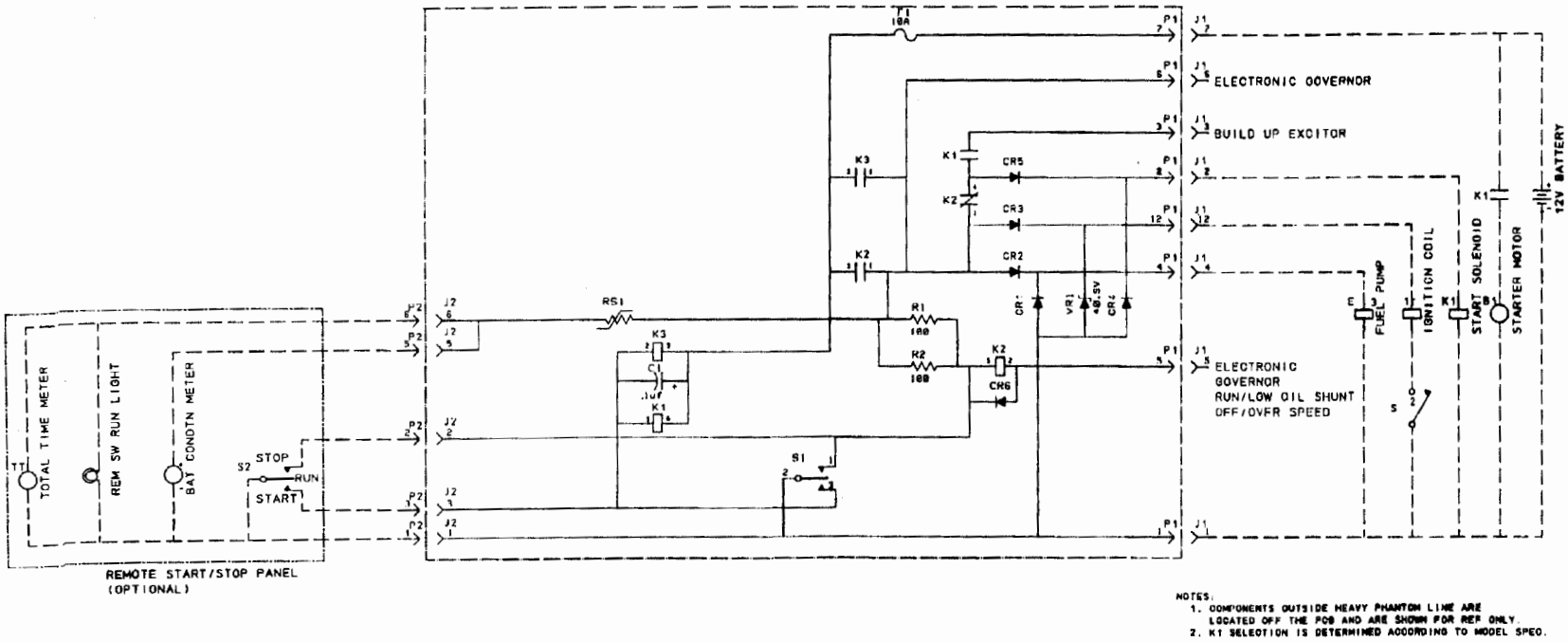


FIGURE 7-7. BGM/NHM CONTROL SCHEMATIC (ELECTRONIC GOVERNOR SETS)

Starting

Moving the Start/Run/Stop switch to the Start position connects battery ground (B-) to relays A1-K3 and A1-K1. Normally-open contacts on A1-K3 close, connecting B+ to the following:

- Governor control board A4
- Relay K4
- Ignition coil T1
- Start solenoid K1(through N.C. contacts of A1-K2 relay
- Relay K2 (through resistors R1 and R2)

Normally-open contacts on relay K1 close, connecting B+ to the following:

- Voltage regulator VR1 (to build-up exciter)

NOTE: Pre-Spec D generator sets have fuel pumps that are powered directly rather than through K4 contacts. Otherwise their control functions are identical to those described here.

The following control responses take place:

- Governor control board A4 moves the throttle to an open position after a 1-second delay.
- K4 relay contacts close to provide power to fuel pump E3 and fuel pump solenoid E4.
- The field is flashed to provide residual magnetism to induce voltage buildup. J1-3 is energized.
- Ignition coil T1 is energized, to begin producing sparks when ignition module S3 is activated.
- Start solenoid K1 is energized, connecting B+ to the starter motor, which cranks the engine for starting.
- Solenoid fuel valve E4 (see Figure 8-3) is opened, releasing fuel to the carburetor.
- Fuel pump E3 begins pumping fuel to the carburetor.

When governor control board A4 determines that the generator reaches 1150 RPM, it connects ground to relay A1-K2. A1-K2 contacts open, which opens the exciter circuit after initial start and closes another circuit to the fuel pump and ignition coil after K3 is de-energized.

Starter Lockout-Run

When the engine cranks, the low oil pressure switch is bypassed until the engine reaches operating speed. Normally, with the engine running, the switch is open. When the Start/Run/Stop switch is released and returns to center (Run) position, the engine continues to run. A1-K3 is de-energized, opening the B+ line to the field exciter, governor control board, start solenoid, fuel pump and fuel valve solenoid. At the same time, A1-K2 is energized, and A1-K2 contacts open which block the start solenoid from being activated while the set is running. Another set of K2 contacts close to continue to provide power to the fuel pump, fuel valve solenoid, ignition coil and governor controller.

(On electronic-governor generator sets, the engine can be started and run, even if the lead to the low oil pressure switch is disconnected or missing, as long as this lead is not grounded.)

Off the control board, bridge rectifier CR10 receives AC voltage through generator leads B1/B2, and provides DC voltage through battery charge resistor R1 to charge the starting battery. On pre-Spec D gensets, the B1/B2 connection is paralleled to power the choke heater element, opening the choke. On Spec D sets, the autochoke is powered directly by B+ voltage.

Stopping

Moving start-stop switch S1 to the STOP position grounds resistors A1-R1 and A1-R2. The governor actuator responds by closing the throttle, cutting off fuel to the engine. Relay A1-K2 is de-energized, disconnecting the B+ line from the fuel pump and ignition coil.

Without ignition, the engine stops. All components return to their de-energized position following set shutdown.

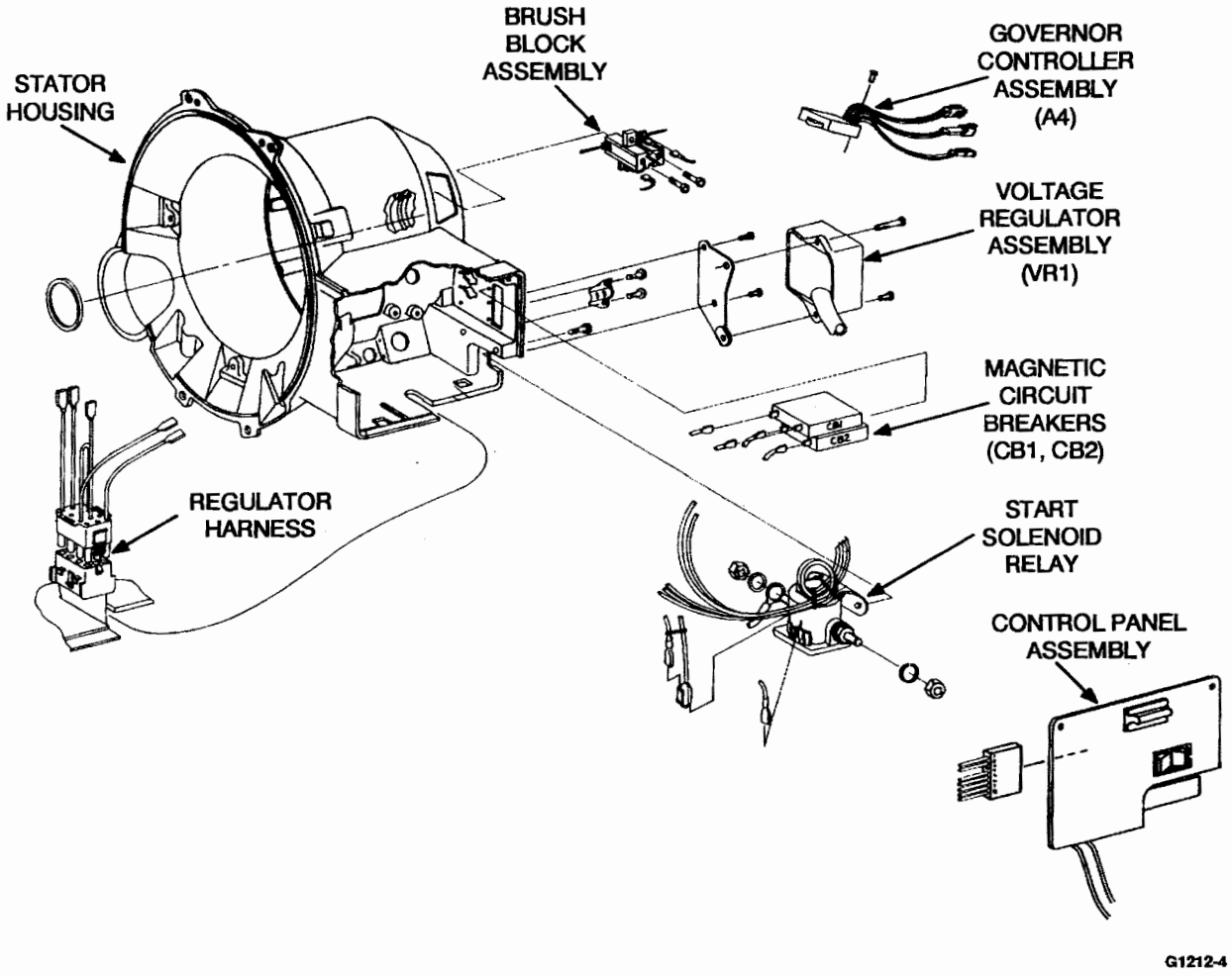


FIGURE 7-8. BGM/NHM CONTROL COMPONENTS (ELECTRONIC-GOVERNOR GENSETS ONLY)

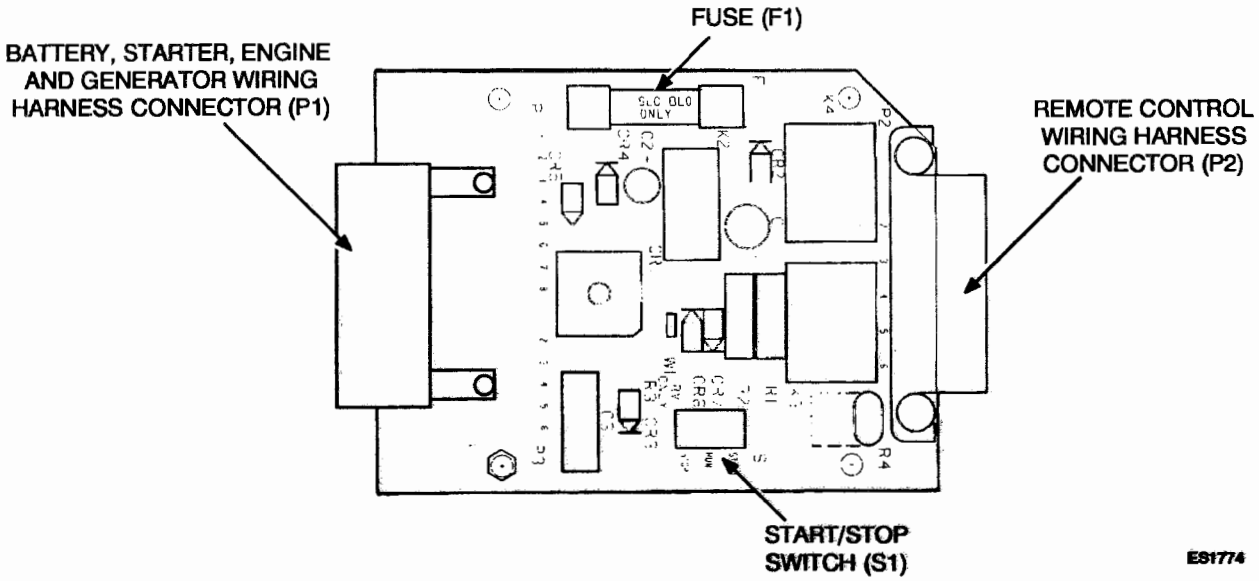


FIGURE 7-9. BGM/NHM CONTROL PCB ASSEMBLY (A1)

CONTROL TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the control circuits. Figures 7-1 and 7-5 show the location of most of the control components. Refer to the appropriate wiring diagram/schematic in Section 8 for the location of all terminal connections.

The troubleshooting guide is divided into sections. After identifying the problem, refer to the guide for the possible cause and the recommended corrective action.

Many of the components listed in the following procedures are not present on the newer, electronic governor Marquis gensets. Follow only the procedures that apply to the particular genset being serviced.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

Trouble	Possible Cause	Corrective Action
Engine Does Not Crank	1. Control fuse F1 may be open.	1. Replace fuse F1 if open with Onan-supplied fuse only.
	2. If engine cranks at set but not at remote control panel, fault is due to: a. PC board P2/J2 connection not secure. b. Open circuit in remote control. c. Remote start switch faulty.	2a. Ensure that wiring harness jack connections are fully seated to PC board. 2b. Check for continuity and correct if circuit is open. 2c. Replace remote start control switch.
	3. If engine cranks at remote control panel but not at set, fault is due to faulty S1 switch.	3. Replace PC board A1.
	4. Insufficient voltage for cranking due to: (See Low Battery Voltage also.) a. Battery not charged. b. Terminal connections loose or dirty. c. Battery cable too small.	4a. Check condition of battery and recharge or replace. 4b. Clean and tighten all connections at battery, K1 start solenoid, and starter motor. 4c. Increase cable size. ⚠WARNING ***Short circuiting the battery cables can result in severe personal injury. Disconnect the negative (-) battery cable at the battery terminal before servicing.***

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Trouble	Possible Cause	Corrective Action
Engine Does Not Crank	5. Connect a voltmeter between terminal S on the start solenoid and ground. Check for battery voltage when S1 is placed in START position. If voltage is present, fault is due to: a. K1 start solenoid not grounded. b. Defective K1 start solenoid. c. Defective starter.	5a. Tighten solenoid bracket mounting screw. 5b. Replace K1 start solenoid. 5c. Refer to *Electric Starter* (Section 6) for test and service procedures.
	6. If voltage is not present as described in step 5 test, fault is due to: a. Open circuit between K1 relay and control PC board. b. Defective control PC board.	6a. Check for continuity and correct if circuit is open. 6b. Replace control PC board.
	7. B+ fuse (F1) is open.	7. Replace fuse.
Engine Cranks But Does Not Start	1. Faulty ignition due to worn or fouled spark plugs, faulty plug wires, faulty ignition coil or control module.	1. Refer to *Ignition System* (Section 6) for test and service procedures.
	2. Faulty fuel system due to low fuel level in tank, supply valve not open, sticking choke, faulty fuel pump/fuel solenoid, or carburetor mixture screws incorrectly adjusted.	2. Refer to *Fuel System* (Section 6) for test and service procedures.
	3. Bad relay K4 and/or fuse F2	3. Replace relay and/or fuse.
	4. Connect a voltmeter between positive (+) terminal E1 ignition coil and ground. Check for battery voltage when S1 is placed in START position. If voltage not present, fault due to: a. Open E1 coil-to-control circuit. b. Defective control PC board.	4. a. Check for continuity and correct if circuit is open. 4. b. Test/replace control PC board.

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Trouble	Possible Cause	Corrective Action
Engine Cranks But Does Not Start	5. Governor controller board not operating properly (electronic governor sets)	5. Verify that throttle goes wide open after1 second of cranking. If so, problem is not governor controller. Check electrical connections to actuator, governor control, ignition. If board is defective, replace.
Engine Starts But Stops When Start Switch is Released	1. Low oil pressure switch S2 not opening due to: a. Low oil level. b. Open circuit between switch and governor controller. c. Defective low oil pressure switch. d. Low oil pressure.	1a. Check oil level and add oil if low. 1b. Check for continuity, correct if circuit is open. 1c. Replace low oil pressure switch. 1d. Refer to Section 6, *Troubleshooting*, for procedures to follow.
	2. (Spec A sets only) Ignition relay K5 contacts not opening due to: a. K5 relay circuit open. b. Defective K5 relay.	2a. Check for continuity and correct if circuit is open. 2b. Replace K5 relay.
	3. Output voltage from generator not being supplied to control due to: a. Open circuit in wiring between generator and control. b. No output voltage from generator.	3a. Check for continuity and correct if circuit is open. 3b. Refer to *Generator* section for test and service procedures.
	4. Defective control PC board A1.	4. Replace PC board A1.
Low Battery Voltage	1. Weak or discharged battery due to: a. Low electrolyte level in battery. b. Long periods of non-use. c. Improperly wired battery.	1a. Replenish electrolyte and recharge battery. 1b. Connect a separate battery charger to bring battery up to full charge. 1c. Reconnect and check battery connection.
	2. Load connected to battery while set is turned off.	2. Turn off/disconnect load and recharge battery.

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Trouble	Possible Cause	Corrective Action
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. Dirty fuel filter restricting fuel flow.	2. Clean fuel filter. Refer to Fuel System (Section 6) for test and service procedures.
	3. Faulty ignition module.	3. Replace ignition module.
	4. Contaminated fuel.	4. Refill tank with fresh fuel.
REMOTE CONTROL (if equipped) Run Lamp, Time Meter, or Battery Condition Meter Does Not Operate	1. Open circuit between control board A1 and terminal 6 or 5 of remote terminal 6 or 5 on connector plug P2/J2 and start-stop switch S2.	1. Check for continuity and correct if circuit is open.
	2. Open circuit between ground terminals on lamp or meters and terminal 1 on remote start-stop switch.	2. Check for continuity and correct if circuit is open.
	3. If battery condition meter and run lamp work but time meter does not operate, time meter is defective.	3. Replace time meter.
	4. If time meter works but battery condition meter does not operate, connect a voltmeter between the positive terminal on battery charge meter and ground. Use the following to determine fault: a. If reading equals battery voltage minus 10 volts, battery condition meter is defective. b. If reading does not equal battery voltage minus 10 volts, zener diode is defective.	4a. Replace battery condition meter. 4b. Replace zener diode.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

Trouble	Possible Cause	Corrective Action
REMOTE CONTROL (if equipped) Run Lamp, Time Meter, or Battery Condition Meter Does Not Operate	5. Meters and switch function properly but run lamp does not illuminate. Lamp (internal to switch) is burned out.	5. Replace remote start-stop switch S2.
	6. If remote switch functions OK (starting and stopping genset) but meters and run lamp do not operate, current sensing resistor R4 on control board A1 has opened, caused by a short in the remote control wiring between control board P2/J2 terminal 6/5 and remote control time meter, run lamp/battery condition meter.	6. Check for continuity of remote wiring harness and wiring on remote control in series with terminals 6 and 5. Replace wiring of control circuit.
Generator Set Does Not Stop After Switch Is Pushed to Off **Always remove load a few minutes before stopping to allow set to cool down.**	1. Faulty set control start/stop switch (S1)	1. Check start/stop switch and replace if defective.
	2. (Spec A sets only) K5 relay not energizing due to: a. Open circuit to K5 relay coil. b. Faulty K5 relay.	2. a. Check for continuity and correct if circuit is open. 2. b. Replace K5 relay.

TESTING CONTROL BOARD A1

Confirm that control board A1 is faulty before replacing it. Use a DC voltmeter and an ohmmeter to perform the following tests.

1. Disconnect the negative (-) battery cable.
2. Remove the control box cover (Figures 7-1 and 7-5) and separate it from control board A1 by removing the four screws on the back of the board.
3. With an ohmmeter, check for electrical continuity across each P1/J1 and P3/J3 connector on the control board (Figures 7-2 and 7-6). Replace the socket portion of each connector that has a measurable resistance (greater than zero ohms) or has begun to corrode.
4. Reconnect the battery and try to start and run the set.
5. If the engine does not crank, measure voltage at connector P1-2 while pressing the panel start switch (the negative (-) test probe of the voltmeter should be grounded at connector P1-8). If the voltmeter indicates zero volts, replace control board A1. If the voltmeter indicates at least 9 volts, the problem is not with the control board. Go back to the *Troubleshooting Guide*.
6. If the engine cranks, but does not start, measure voltage at connectors P3-3 and P3-6 while the engine is cranking (the negative (-) test probe of the voltmeter should be grounded at connector P1-8). Replace control board A1 if the voltmeter indicates zero volts at either connector. If the voltmeter indicates at least 9 volts at both connectors, the problem is not with the control board. Go back to the *Troubleshooting Guide*.
7. If the engine starts, but stops when the Start switch is released, the problem could be with the low oil pressure switch or generator (no voltage). Go back to the *Troubleshooting Guide*. Replace control board A1 if the oil pressure switch and generator are functioning properly.
8. Reassemble the control board and cover.

Section 8. Generator

GENERATOR/CONTROL COMPONENT DESCRIPTIONS

The generator and its control components consist of the following elements (see Figure 8-1):

- Control printed circuit board (A1)
- Brushes
- Rotor
- Stator and housing
- Terminal board (TB1)
- Voltage regulator (VR1)
- Circuit breakers (CB1/CB2)
- Wiring harness to load

The ignition module and rotor are mounted inside the generator; for this reason, their removal/replacement are described in this section.

Control Printed Circuit Board (A1) (Mechanical-governor generator sets)

The starting battery supplies initial excitation voltage to the generator rotor. While the engine cranks, battery DC voltage is supplied through the N.C. contacts of generator relay K2 (on control board A1), through voltage regulator VR1, to the brushes and slip rings of the rotor. When the engine starts and generator voltage builds up, generator relay K2 is energized, opening the N.C. contacts in the battery B+ circuit to the voltage regulator and closing a set of N. O. contacts in the start disconnect/ run relay K3 circuit of board A1. This circuit keeps relay K3 energized while the set is in operation. If relay K2 becomes de-energized, the set shuts down.

Control Printed Circuit Board (A1) (Electronic-governor generator sets)

Moving the Start/Run/Stop switch to the Start position connects battery ground (B-) to relay K3. Normally-open contacts on K3 close, connecting B+ to governor control board A4 (see Section 7), fuel pump E2, ignition coil E1, start solenoid K1, N.C. contacts of K2 relay, voltage regulator VR1 (to build-up exciter), and relay K2 (through resistors R1 and R2). The field (rotor) is flashed through the N.C. contacts of K2 . Ignition coil E1 is energized. Start solenoid K1, solenoid fuel valve E3 and fuel pump E2 are activated. After initial start, K2 on the control board is activated, opening the exciter circuit and closing another circuit to the governor control board, fuel pump and ignition coil after K3 is de-energized. Governor control board A4 is energized, which moves the throttle to an open position.

Brushes

DC excitation voltage is induced through the brushes and rotor slip rings to the rotor windings. The brush block assembly consists of a single brush block with two brushes. The brush block mounts directly over the rotor slip rings inside the generator housing, and may be accessed by removing the small plate at the rear of the housing.

Rotor

The 4-pole rotor provides the rotating magnetic field that is required to generate an AC voltage potential in the stator windings. The DC current required for field excitation is supplied through two slip rings on the rotor shaft.

The engine end of the rotor is connected directly to the engine crankshaft with 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 slip-fits inside the generator housing.

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.

Stator and Housing

During genset operation, AC current is produced in the windings of the stator. Stator winding leads are routed into the set control housing compartment, for control component connection as follows:

- Leads T1, T2, T3 and T4 to terminal board TB1.
- (Mechanical-governor sets) Leads B1 and B2 to control board A1, to rectifier CR10, to the electric choke, and for battery charging.

- (Electronic-governor sets) Leads B1 and B2 to rectifier CR10, to the electric choke, and for battery charging through R1.

- Leads Q1 and Q2 to voltage regulator VR1, wiring harness J4, for excitation of rotor. (AC voltage from stator is rectified to DC voltage in VR1).

The stator mounts inside the generator housing and is held in position with clamps and capscrews. 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 for the engine starter, rear rotor bearing, exciter brush block, control components, and fuel pump. The complete stator and housing assembly bolts to the engine-to-generator adapter.

Terminal Board (TB1)

The AC output power leads from the generator (T1, T2, T3, and T4) are connected to terminal board TB1 at terminals L1 - L0.

AC power at TB1 terminals is tapped by leads of wiring harness J4 of voltage regulator VR1, and interconnect wiring to circuit breakers CB1 and CB2. These leads provide generator output to the voltage regulator for proper voltage regulation, and to the circuit breakers for power supply to load.

Voltage Regulator (VR1)

The voltage regulator helps provide stable output voltage under varying loads. During initial start of the set, the voltage regulator receives DC current from the starting battery, and begins excitation of the rotor through leads J4-9/F1, and J4-10/F2. After the genset starts and runs, it provides AC power to the voltage regulator through leads J4-11/Q1, and J4-12/Q2 for the excitation system. The AC voltage is rectified to DC voltage, and the proper DC excitation voltage is conducted to the rotor in proportion to changes in demand. Reference voltage is J4-2/L1 to J4-3/L0.

The voltage regulator is protected from moisture and other contamination, reducing the risk of component failure. The capacitor and the printed circuit board are encased in the regulator housing with a potting compound. The wiring harness plug-in P4 is treated with a lubricant prior to connection.

Circuit Breakers (CB1,CB2)

AC output from the generator is supplied to circuit breakers CB1 and CB2, located on the right side of the control housing. Ampere rating of these breakers may differ, depending on the set model/frequency. Refer to the proper Parts Manual when ordering replacement parts.

Wiring Harness to Load

A wiring harness is provided to connect the genset to the electrical system. All leads are stranded copper wire, to withstand vibration. The leads must be protected with flexible conduit from the set control housing to the switching/disconnect device, which must be provided by the vehicle manufacturer. Load conductors are black, neutral conductors are white, and the ground conductor is green.

GENERATOR OPERATION

Refer to the wiring diagrams and schematics in Section 11 while reviewing this text. Always refer to the wiring diagram/schematic that corresponds to the specific genset when troubleshooting problems.

When the start-stop switch is moved to START, the rotating field (rotor) is momentarily connected to battery positive (B+) to provide magnetism for voltage build-up. As the engine starts and speed increases, the rotating field induces an AC voltage in the stator windings. AC voltage from the quadrature winding (Q1, Q2) is rectified for field excitation voltage. AC voltage output stabilizes at approximately 128 volts when the engine reaches governed speed.

Voltage regulator VR1 enables the generator to provide a stable AC output voltage under varying load conditions. Leads from VR1 wire harness J4-2 and -3 are connected to terminal board TB1: these leads sense voltage changes of the load on the generator.

The sensing leads provide reference voltage to the voltage regulator, depending on load. The voltage regulator increases DC excitation voltage to the rotating field proportionate to the load, continuously adjusting the field current as the load changes.

Efficient set performance depends on voltage and frequency (engine speed) regulation. On the mechanical governor generator set, output load changes can significantly decrease or increase engine speed. If the governor does not maintain proper engine speed, too large a burden may be imposed on the voltage regulator for proper current to be supplied to the load. Governor adjustment and troubleshooting is discussed in Section 6 of this manual.

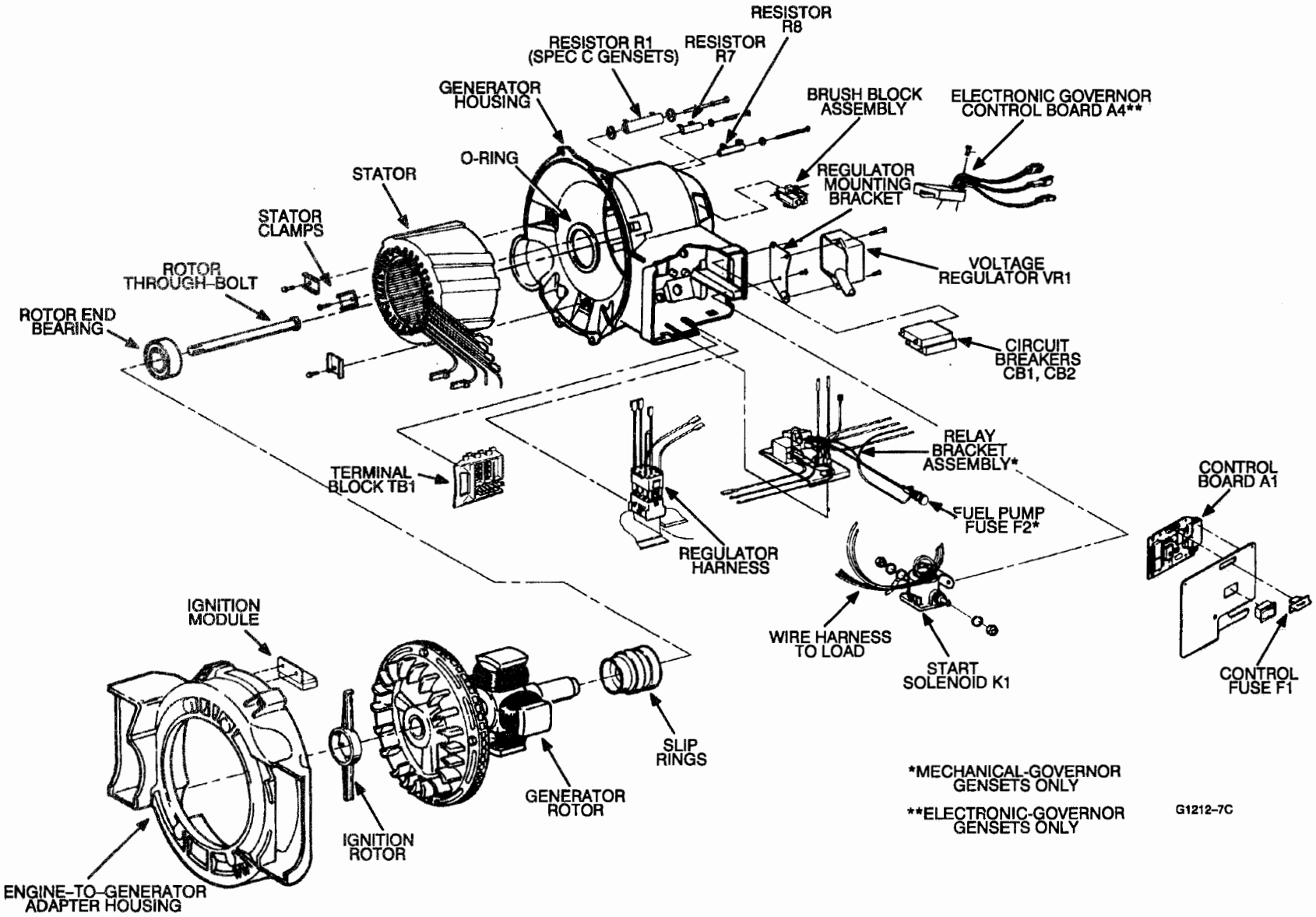

FIGURE 8-1. GENERATOR CONTROL COMPONENTS

GENERATOR TROUBLESHOOTING

This troubleshooting guide provides solutions to many common generator problems. Figure 8-1 shows the location of the generator components. Refer to the wiring diagrams/schematics in Section 11 to locate terminal connections. If these suggestions do not help, contact an authorized Onan service representative.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

Trouble	Possible Cause	Corrective Action
No AC Output Voltage Note: This condition may cause the generator set to stop when start switch S1 is released.	1. Open circuit breaker.	1. Locate cause of overload and correct as required. Reset breaker.
	2. Open circuit between voltage regulator and brush block.	2. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open.
	3. Open circuit between generator windings (Q1, Q2) and voltage regulator.	3. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open.
	4. Open circuit between terminal block TB1 and voltage regulator; wiring harness J4 leads.	4. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open.
	5. Brushes stuck in holder or not making good contact with slip rings.	5. If there are 12 or more volts on the brush block while cranking, then release brushes if jammed in holder, and clean slip rings if dirty. If not, the problem is in the control or wiring harness.
	6. Defective voltage regulator.	6. Replace voltage regulator.
	7. Open, grounded, or short circuit in rotor or stator.	7. Test each component for open, grounded, or shorted windings and replace if defective.

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Trouble	Possible Cause	Corrective Action
AC Output Voltage Too Low or Too High	1. Engine governor (mechanical) out of adjustment.	1. Refer to governor adjustments in Section 6.
	2. Brushes worn or not making good contact with slip rings. (Low or intermittent AC output voltage.)	2. Check length of brushes and replace if worn excessively. Clean or replace slip rings.
	3. Poor wiring connections to/from voltage regulator.	3. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open.
	4. If generator frequency is within specified limits but voltage is incorrect, voltage regulator is defective.	4. Replace voltage regulator.
	5. Open, grounded, or short circuit in rotor or stator.	5. Test each component for open, grounded, or shorted windings and replace if defective.
Noisy generator	1. Loose brush holder.	1. Tighten brush holder.
	2. Worn generator end bearing.	2. Replace end bearing.
	3. Rotor and stator rubbing together due to: a. Varnish lumps. b. Rotor misaligned with crankshaft.	3a. Check for varnish lumps between rotor and stator, remove as required. 3b. Follow specified assembly procedures to correct rotor to crankshaft alignment.

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Trouble	Possible Cause	Corrective Action
Generator Overheats	1. Generator overloaded due to defective circuit breaker.	1. Remove part of load and replace circuit breaker.
	2. Airflow restricted due to dirt or debris covering vent openings in stator housing.	2. Clear away all dirt or debris as required.
	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.
	5. Defective voltage regulator.	5. Replace voltage regulator.

GENERATOR SERVICE

This section describes generator disassembly/assembly procedures. Refer to Figure 8-1 to locate and identify the various generator components, and the diagrams in Section 11 for wiring interconnect information.

Generator Disassembly Procedure

1. After allowing the engine to cool, drain the engine oil while the genset is mounted in the vehicle.
2. Remove the set from the vehicle and place it on a sturdy work bench. Refer to Section 5 of this manual for set removal procedures.
3. Remove the top cover from the generator set.
4. Remove the carburetor and intake manifold to provide clearance to lift the generator stator assembly. Disconnect the following parts:
   - choke heater lead wires
   - throttle linkage
     (mechanical governor: at carburetor)
     (electronic governor: at actuator clip)
   - fuel line
   - crankcase breather hose
   - air preheater tube

   Remove the intake manifold screws, and lift off the carburetor and intake manifold as an assembly. Refer to the *Fuel System* description in Section 6 for detailed removal procedures and important safety instructions.
5. Disconnect the leads to the charge resistor, the low oil pressure cut off switch, and the B+ terminal on the ignition coil.
6. Remove the brush block cover and disconnect the F1 (+) (outboard) and F2 (-) (inboard) lead wires from the brush block terminals.
7. Pull each brush outward from the holder, and at the same time insert a piece of stiff wire into the small hole in the end of the stator housing (see Figure 8-2). Carefully guide the wire through the brush block, then release each brush. Verify that each brush is held off the slip rings by the wire.

⚠ CAUTION ***The brushes will be damaged during disassembly if not held off the slip rings. Make certain wire is in place before removing stator assembly.***

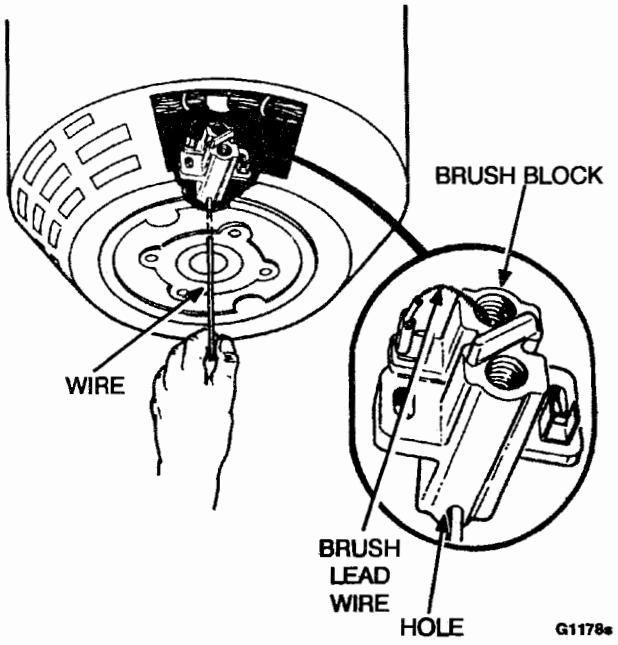


FIGURE 8-2. BRUSH BLOCK ASSEMBLY

8. Remove the two control panel screws from the housing, lift off the control panel and disconnect plug/jack connections P1/J1 and P3/J3 of the control printed circuit board.
9. Place a 3/8 inch allen wrench in the head of the rotor through-bolt. Use a rubber mallet and sharply strike the allen wrench so the through-bolt is driven in a counterclockwise (viewed from generator end) direction. Several sharp taps should break loose the generator.

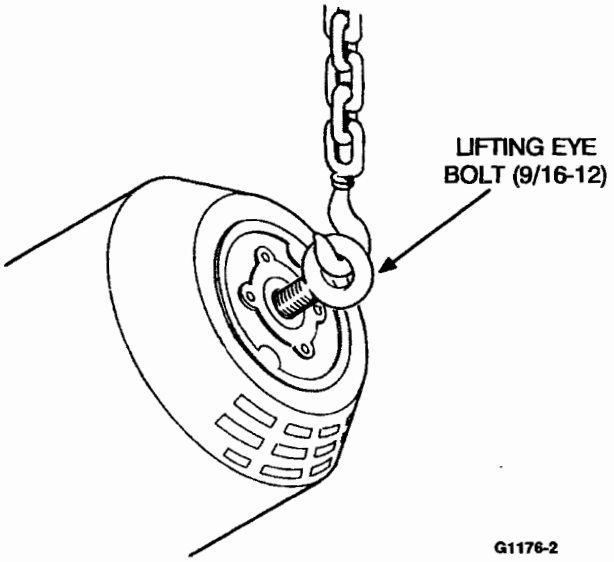


FIGURE 8-3. GENERATOR LIFT

10. Remove the rotor through-bolt and thread the special lifting eye (9/16-12) into the end of the housing. Refer to Figure 8-3.
11. Place a pad or cushion in front of the engine to protect the scroll. Attach a hoist or other lifting device to the lifting eye. Tip up the set until it is completely vertical and resting on the scroll. Remove the lifting plate when finished.

    ⚠ CAUTION ***Careless handling can damage the rotor. Do not lift the entire generator set by this method.***

12. Remove the capscrew and two EIT lock washers that hold the ground strap to the drip pan.
13. Remove the vibration-isolator center screws from the underside of the drip pan, and lift the drip pan away from the set.
14. Disconnect the lead wires attached to the starter motor. Loosen the fasteners that mount the starter to the stator housing, and remove the starter.
15. Remove the four capscrews, lock washers, and nuts that secure the stator housing to the engine-to-generator adapter.
16. Remove the lifting eye bolt (Figure 8-4).

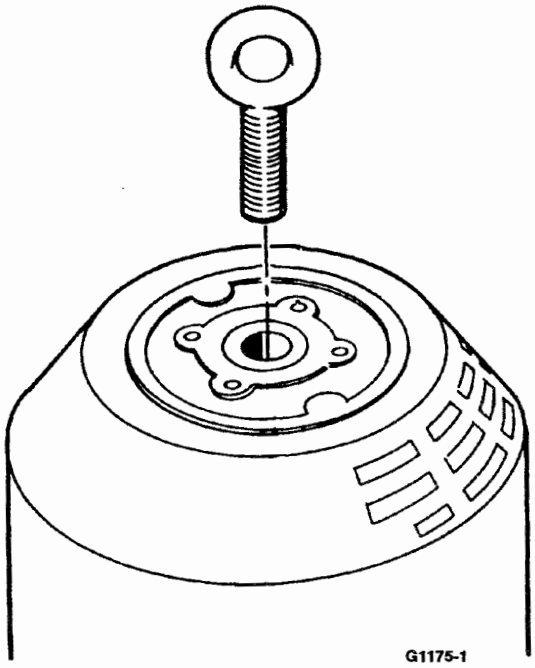


FIGURE 8-4. REMOVAL OF LIFTING EYE BOLT

17. Carefully lift the stator assembly straight up until it clears the rotor. Set stator assembly to rest on smooth, clean surface.

    ⚠ CAUTION ***Careless handling of the stator can damage the insulation on the stator windings. Do not brush the windings against the housing as it is lifted clear.***

18. Install the tool shown in Figure 8-5. Use a screwdriver to turn the rotor tool in a clockwise direction until it bottoms. Install a capscrew in the end of the rotor shaft and tighten until rotor breaks loose from crankshaft. Remove capscrew from end of rotor when complete.

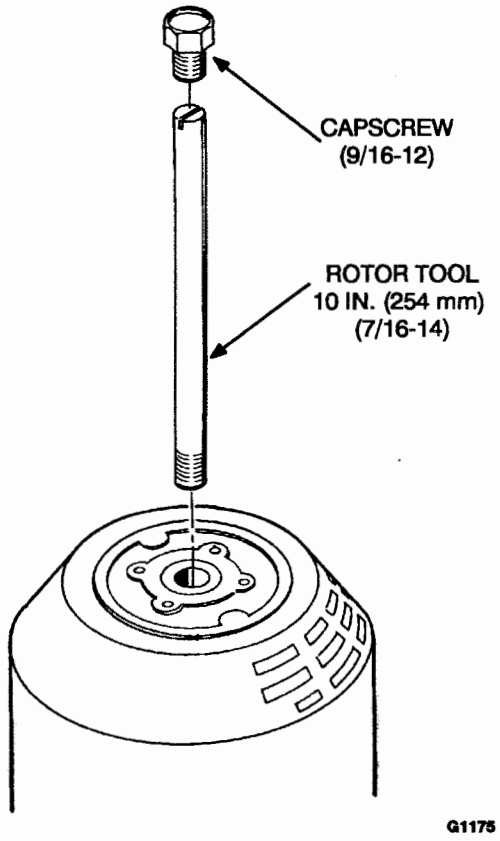


FIGURE 8-5. ROTOR TOOL

19. Carefully lift the rotor assembly off the end of the engine crankshaft and remove rotor tool.
20. Lift the brush wires and remove brush holding wire from housing. Remove the brush block mounting screw and carefully remove the brush block assembly from the stator housing.
21. Remove the stator from the stator housing as follows (see Figure 8-6):
    A. Rotate the stator/housing assembly onto a smooth, clean surface, resting on end-bearing face (bell shape of housing facing up).
    B. Disconnect stator leads:
    - T1, T2, T3, and T4 from terminal board TB1
    - Q1, Q2, F1 and F2 from voltage regulator VR1 harness J4
    - B1 and B2 from control printed circuit board harness J1

    C. Pull the stator leads from the control box.
    D. Remove the three stator clamps and capscrews.
    E. Carefully lift the stator straight up until it clears the stator housing. Set the stator down on a smooth, clean surface.

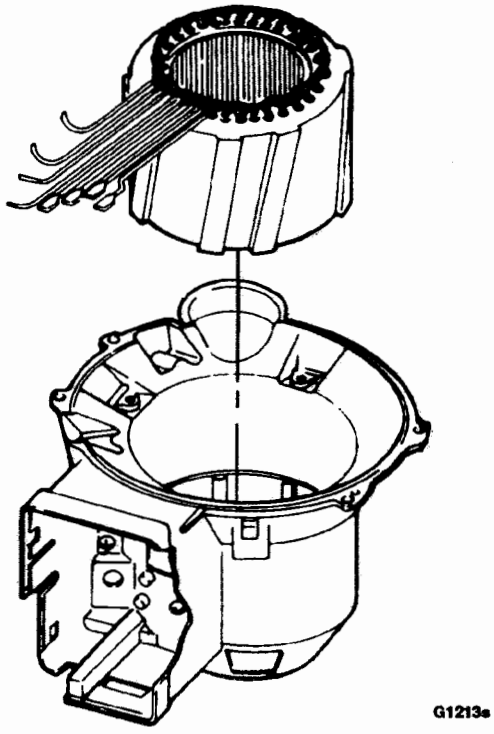


FIGURE 8-6. STATOR/HOUSING DISASSEMBLY

Rotor Bearing Removal

Use a gear puller to remove the bearing from the rotor shaft. Attach the gear puller so that the gear puller arms contact the inner race of the bearing (Figure 8-7).

⚠ CAUTION ***The bearing will be damaged if pulled by the outer race. If the bearing is to be reused, it must be pulled by the inner race.***

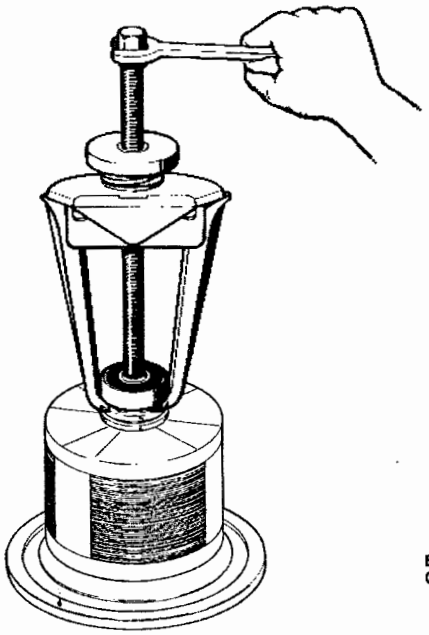


FIGURE 8-7. ROTOR BEARING REMOVAL

Rotor Bearing Replacement

1. Clean the bearing and shaft mating surfaces.
2. Apply Loctite #680 adhesive to the shaft mating surface.
3. Apply Loctite #747 activator to the bearing mating surface.
4. Install the bearing and allow ten minutes curing time before handling the assembly.

Ignition Components

The ignition rotor and ignition module are located inside the generator. When the stator in its housing has been removed, the ignition rotor can be removed/replaced on the crankshaft, and the ignition module can be removed/replaced on the generator adapter housing as follows (see Figure 8-8).

Ignition Rotor Removal/Replacement

To remove the ignition rotor, simply pry it off using a dull-edged pry bar or other implement. To install the ignition rotor, place it over the end of the crankshaft, line the key on the rotor up with the corresponding slot in the end of the crankshaft, and tap the rotor gently into place.

Ignition Module Removal/Replacement

1. Unscrew the red and black wires extending from the ignition module to the ignition coil. Make certain to note which wire attaches to which terminal on the coil.
2. Unscrew the two screws holding the ignition module in place on the generator adapter.
3. When the ignition module is loose, pull the red and black wires through the gap in the generator adapter.

To replace the module, perform the steps listed above in reverse order.

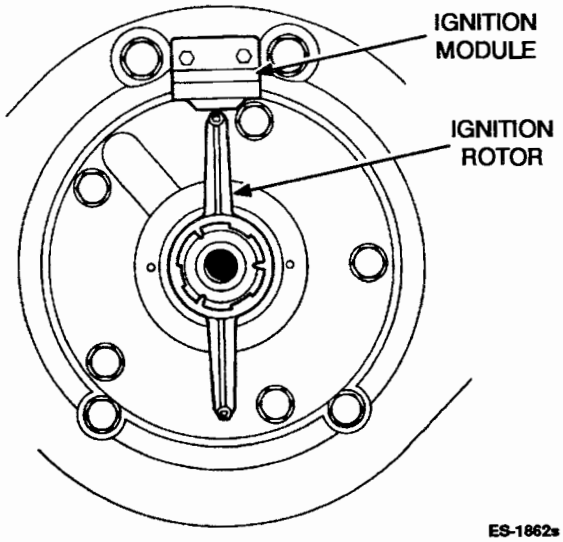


FIGURE 8-8. IGNITION COMPONENTS

Generator Assembly Procedure

1. Install the stator in its housing as follows (see Figure 8-6):
   A. Position the stator so the output leads align with the access hole to control housing. Carefully lower the stator straight down into the stator housing.

   ⚠ CAUTION ***Careless handling of the stator can damage the insulation on the stator windings. Do not brush the windings against the housing as it is lowered into housing, and take care not to drop or drag the stator on work area outside of stator housing.***

   B. Install the three stator clamps and capscrews.
   C. Pull the stator leads into control box.
   D. Connect stator leads;
   - T1, T2, T3 and T4 to terminal board TB1
   - Q1, Q2, F1 and F2 to voltage regulator VR1 harness J4
   - B1 and B2 to control printed circuit board harness J1

   E. Rotate the stator/housing assembly onto a smooth, clean surface, resting on the bell shape of the housing (end bearing face up).
2. Install the brush block assembly in the stator housing. Lift the brush wires and install the brush holding wire in the housing. The wire holds the brushes off the slip rings during assembly (see Figure 8-10).
3. Carefully place the rotor assembly on the end of the engine crankshaft, and replace the rotor through-bolt. Tighten the rotor through-bolt only enough to hold the rotor in place.

   ⚠ CAUTION ***Tightening the rotor through-bolt to the specified torque before the stator assembly is installed can result in rotor shaft misalignment. Follow the recommended installation procedures to avoid any possibility of shaft misalignment.***

4. Carefully place the stator assembly straight down over the rotor and into position for assembly to the engine-to-generator adapter. The rotor end-bearing should fit snugly into the bearing bore hole.

   ⚠ CAUTION ***Careless handling of the stator can result in damage to the stator windings. Do not brush the stator windings against the rotor as it is lowered into position.***

5. Install the four nuts, locking washers, and capscrews that secure the stator housing to the engine-to-generator adapter. Tighten the cap screws to the specified torque. Note that each locking washer is installed under the capscrew head.
6. Tighten the rotor through-bolt to the specified torque.
7. Mount the starter on the generator stator housing using capscrews, lock washers and nuts. Tighten to the specified torque.
8. Connect the leads to the starter terminal stud.
9. Hold the drip pan in position to mount to the underside of the set, and install the vibration-isolator center screws. Note that proper flat washers are used (large flat washers at each isolator position). Tighten the center screws to the specified torque.
10. Secure the ground strap to the drip tray using a capscrew and two EIT locking washers. Note that the ground strap is installed between the locking washers to ensure a good electrical connection.
11. Attach the lifting bolt (Figure 8-3) to the end of the stator housing.
12. Attach a hoist or other lifting device to the lifting bolt. Carefully tilt the set back until it rests on the drip tray. Remove the lifting bolt when complete.
13. Connect plug/jack connections P1/J1 and P3/J3 of the control printed circuit board. Install the control panel assembly on generator housing. Tighten the mounting screws.
14. Pull the brush leads outward and remove the wire holding the brushes off the slip rings. Make certain that the brushes are centered on the slip rings. If the brushes are not centered, loosen the brush block mounting screws and adjust. Retighten the mounting screws when complete.

15. Connect the B+ lead to the outboard brush terminal and the B- lead to the inboard brush terminal. Install the brush block cover and tighten the cover mounting screws.
16. Connect the leads to the charge resistor, low oil pressure cut-off switch, and ignition coil B+ terminal.
17. Place new intake manifold gaskets on the engine block, and install the carburetor and intake manifold assembly. Tighten the intake manifold screws to the specified torque. Connect the preheater tube, crankcase breather hose, fuel lines, throttle linkage, and choke heater wires (gasoline units). Refer to Fuel System (Section 6) for detailed assembly procedures.
18. Install the top cover on the generator set.
19. Install the set in the vehicle and securely fasten all mounting screws and hardware. Connect the fuel, exhaust, and electrical systems in reverse order of disassembly. Refer to the Set Removal section for more information.
20. Fill crankcase with oil of the recommended classification and viscosity.

BRUSHES AND SLIP RINGS

Brush Inspection

Remove the brush block cover and inspect the brushes and brush holder for burns or other damage. If the brushes appear to be in good condition, use a piece of wire (marked as shown in Figure 8-9) to check for excessive brush wear. Insert the wire through the hole above each brush. Make sure the wire is resting on the brush and not on part of the spring. If the painted part of the wire is not visible, the brush is excessively worn and must be replaced.

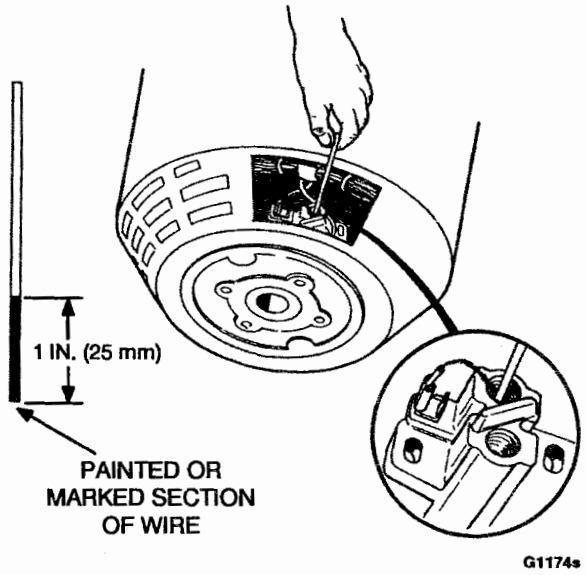


FIGURE 8-9. CHECKING BRUSH WEAR

Always replace the brush springs when installing new brushes to ensure that proper tension is maintained.

Brush Replacement Procedure

1. Disconnect the negative (-) battery cable at the battery terminal.
2. Remove the air cleaner cover and air cleaner filter element.
3. Remove the brush block cover from the stator housing.
4. Disconnect the F1 (+) (outboard) and F2 (-) (inboard) lead wires from the brush block terminals.
5. Remove the brush block mounting screws and lift out the brush block.
6. Remove brushes and brush springs from holder and replace with new parts.
7. Pull and hold both brush lead wires outward from brush holder. Place brush block assembly into mounting position inside stator housing.

8. While continuing to hold the brushes away from slip rings, insert the brush retainer wire from outside stator housing hole, through brush block assembly. Release both brush lead wires. See Figure 8-10.

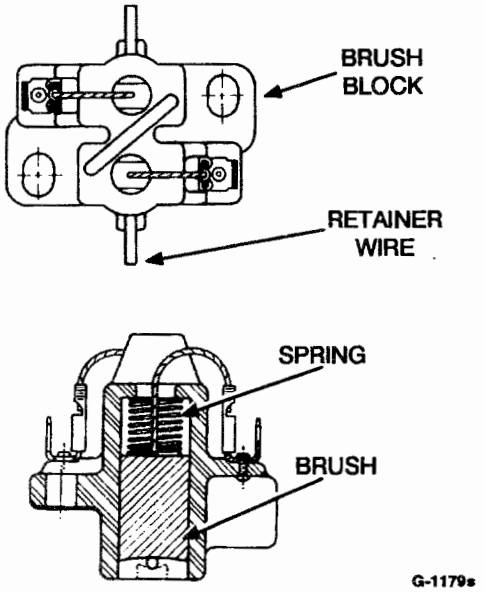


FIGURE 8-10. BRUSH REPLACEMENT

9. Install brush block mounting screws and tighten only enough to hold brush block assembly in position.
10. Lift both brush lead wires and remove brush retaining wire completely from stator housing.
11. Adjust brush block assembly so that brushes are aligned on slip rings, and tighten brush block mounting screws. Do not overtighten, or the plastic will crack.
12. Connect the voltage regulator and brush lead wires to brush block terminals; F1 with (+) outboard brush lead, and F2 with (-) inboard brush lead.
13. Install brush block cover onto stator housing.
14. Install air filter element and air cleaner cover.
15. Connect negative (-) battery cable to battery terminal.

Slip Ring Inspection and Maintenance

Remove the brush block cover and inspect the slip rings for grooves, pits, or other damage. If the slip rings are not in good condition, they may be refinished using a commutator stone. A shiny brown/black surface is normal, with one or two areas with exposed brass.

Slip Ring Service Procedure

1. Remove the air cleaner cover and air cleaner filter.
2. Disconnect the lead wires from the brush block terminals and then insulate the lead wire ends. Tie the lead wires to one side to allow clear access to the slip rings.
3. Remove the brush block mounting screws and lift out the brush block assembly.
4. Insert a 3/8 inch allen wrench into the rotor through-bolt and rotate the engine and generator one full turn. While rotating, inspect condition of slip rings. If the slip rings need refinishing, continue to next step. If slip rings do not need refinishing, follow steps 9 through 14 in the Brush Replacement section.
5. Move the Start-Stop switch to START position to crank the engine. During this step, crank the engine for 3 to 6 second cranking periods with a rest period between, so the starter will not overheat.

   During engine cranking, hold a commutator stone (Onan tool 420-0259) against rotating slip rings. Remove the commutator stone after each cranking period and check that carbon is being removed and all roughness and grooves are smoothed out.

   ⚠WARNING ***Contact with rotating machinery can cause severe personal injury. Keep hands, fingers, clothing and jewelry clear while servicing slip rings.***

6. Remove insulating material from ends of voltage regulator lead wires F1 and F2, and then install brush block assembly. Follow steps 6 through 14 in the Brush Replacement section.

GENERATOR TESTING

This section describes test procedures for checking field voltage, rotor, and stator.

Field Voltage Test

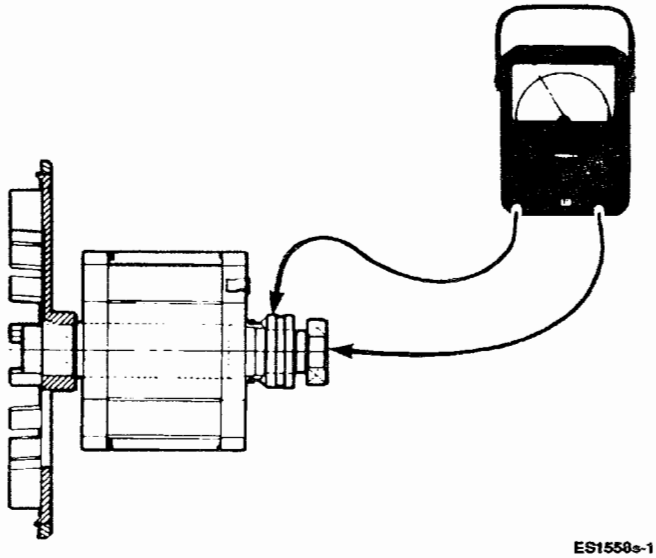
To check the field voltage, remove the brush block cover and connect a DC voltmeter to the brush block terminals. Connect the positive lead to the B+ (outboard) terminal and the negative lead to the B- (inboard) terminal.

Start the genset and allow it to stabilize. Measure the field voltage with no load applied and then with full load applied. Both readings should fall between 18 and 60 volts DC, and be stable at constant load. If field voltage fluctuates at constant load, refer to Troubleshooting in this section; a possible governor or voltage regulator problem exists.

Stop the genset, remove the test leads and replace the brush block cover when the test is complete.

Rotor Test

The rotor may be tested for grounded, open, or shorted windings using an ohmmeter. Figures 8-11 and 8-12 show the rotor removed from the generator for testing. However, it is possible to test the rotor without removing it from the generator. To obtain access to the slip rings, remove the brush block cover. Lift the brush lead wires and insert a brush retaining wire from outside stator housing, through brush block assembly to hold the brushes off the slip rings during testing.



ES1558s-1

FIGURE 8-11. TESTING ROTOR FOR GROUNDS

Ground Test: To test for grounds, set the ohmmeter to the highest resistance scale. Touch one test prod to the rotor shaft and hold it there. Touch the other test prod to one of the slip rings (Figure 8-11). A reading less than one megohm indicates that the rotor is grounded. Replace a grounded rotor with a new rotor.

Open Or Shorted Windings Test: To test for open windings, set the ohmmeter for the highest resistance scale. Place test prods on the slip rings as shown in Figure 8-12. The ohmmeter should indicate continuity between slip rings. A high resistance reading indicates a poor connection or an open winding. Check the connection between the slip rings and rotor lead wires. Replace the rotor if the rotor winding is open.

To test for shorted windings, set the ohmmeter for the lowest scale. Place the test prods on the slip rings as shown in Figure 8-12. Resistance reading should be 20.25 to 24.75 ohms at 77° F (25° C). Replace a rotor with shorted windings with a new rotor.

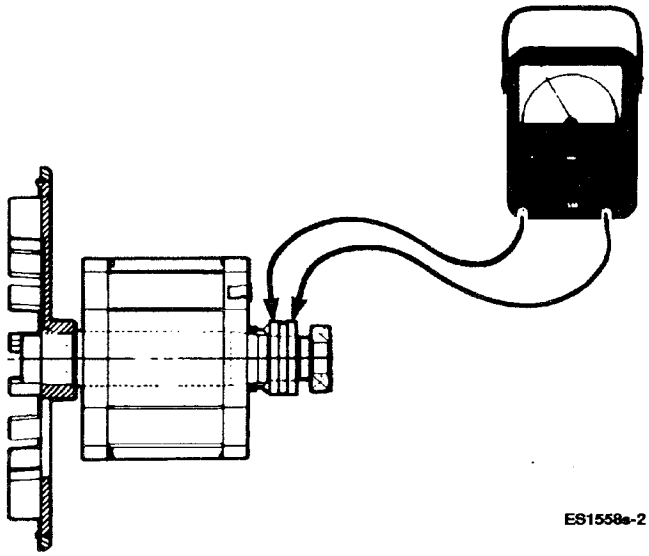


FIGURE 8-12. TESTING ROTOR FOR OPENS OR SHORTS

Stator Test

The stator may be tested for grounded or open windings by using an ohmmeter. Testing for shorted windings requires a digital ohmmeter that can read to within 0.01 ohms.

Figures 8-13 and 8-14 show the stator removed from the generator for testing. However, it may be tested without removing it from the generator. Remove the control panel to obtain access to the specified lead wires during testing.

Ground Test: To test for grounds, disconnect the transformer and stator leads listed below:

- Stator leads T1 and T3 from TB1
- Stator lead B1 from A1/P1-1
- Stator lead Q1 from VR1/J4-11

Insulate or position the lead wire ends so they do not touch the set housing or other components within the control. Set the ohmmeter to its highest resistance scale, then connect one test prod to the generator housing. Touch the other test prod (see Figure 8-13) to the listed leads individually. A reading less than one megohm indicates a ground. Replace a grounded stator with a new stator.

Open or Shorted Windings Test: To test for opens, disconnect the following leads:

- Stator leads T1, T2, T3 and T4 from TB1
- Stator leads B1 and B2 from A1
- Stator leads Q1 and Q2 from VR1

Set the ohmmeter to the highest resistance scale. Connect the test prods (see Figure 8-14) to the generator lead ends in pairs: T1/T2, T3/T4, B1/B2, and Q1/Q2. The ohmmeter should indicate continuity between lead ends. A high resistance reading indicates an open winding. Replace an open stator with a new stator.

To test for shorted windings, use a digital ohmmeter that reads to within 0.01 ohms. Disconnect the stator leads as specified in the Open Test section. Connect the test prods (see Figure 8-14) to the leads in pairs as specified in the Open Test section. The readings for lead pairs should be as follows (plus or minus 10%):

Leads T1/T2: 0.327 ohms
Leads T3/T4: 0.327 ohms
Leads B1/B2: 0.058 ohms
Leads Q1/Q2: 2.089 ohms

A reading less than these values indicates shorted windings. Replace a shorted stator with a new stator.

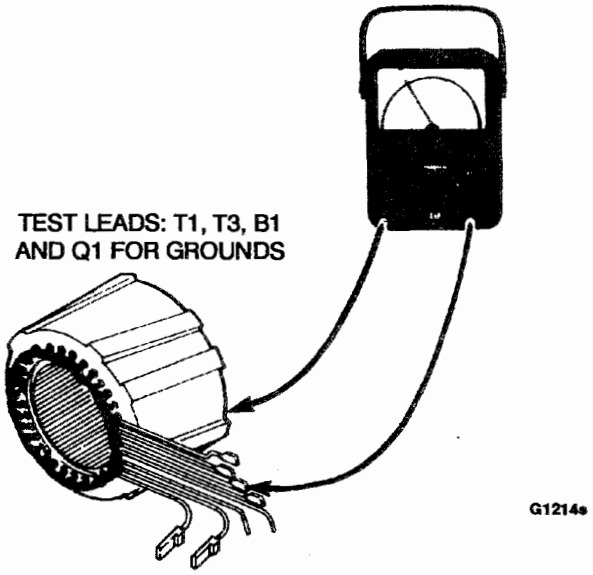


FIGURE 8-13. TESTING STATOR FOR GROUNDS

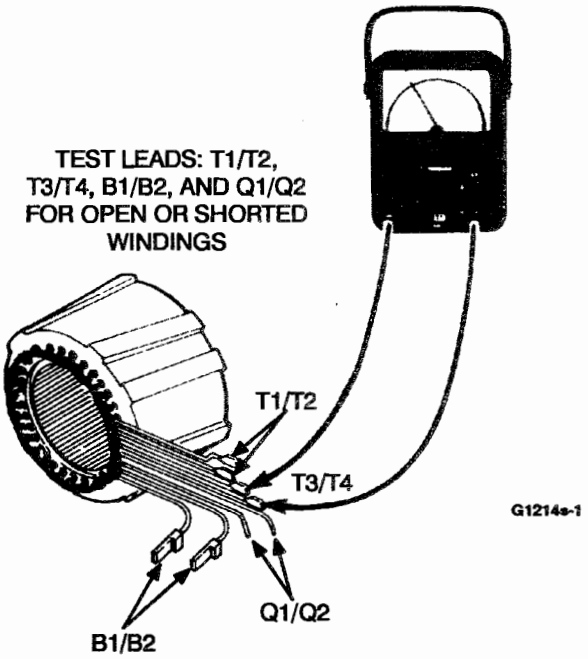


FIGURE 8-14. TESTING STATOR FOR OPENS OR SHORTS

Section 9. Engine Block Assembly

GENERAL

The engine block assembly includes:

- Pistons and connecting rods
- Crankshaft
- Camshaft
- Valves and lifters
- Cylinder heads
- Lubrication system
- Timing gears
- Governor mechanism (mechanical)
- Bearings
- Cylinder block

Performing major service on the block assembly requires that the genset be removed from the vehicle (see *Set Removal* section). The control, generator, electronic governor actuator, and all primary engine systems must also be removed for complete access to the block assembly. Refer to the previous sections for disassembly and removal procedures.

OIL FILTER AND ADAPTER

Disassembly Procedure

1. After allowing the engine to cool, open the oil drain valve and drain the crankcase oil.
2. Remove the filter (see Figure 9-1) by turning it counterclockwise with Onan filter wrench 420-0550.
3. Loosen the two capscrews that secure the adapter to the engine block and remove the adapter and gasket. The low oil pressure cut-off switch is installed in a threaded hole in the filter adapter.

Assembly Procedure

To assemble the oil filter and adapter, perform these steps in reverse order. Install a new adapter gasket so that the two small oil holes are aligned with the oil holes in the block. This gasket should be installed dry. Coat the threads of each capscrew with non-hardening sealer, and tighten to the recommended torque.

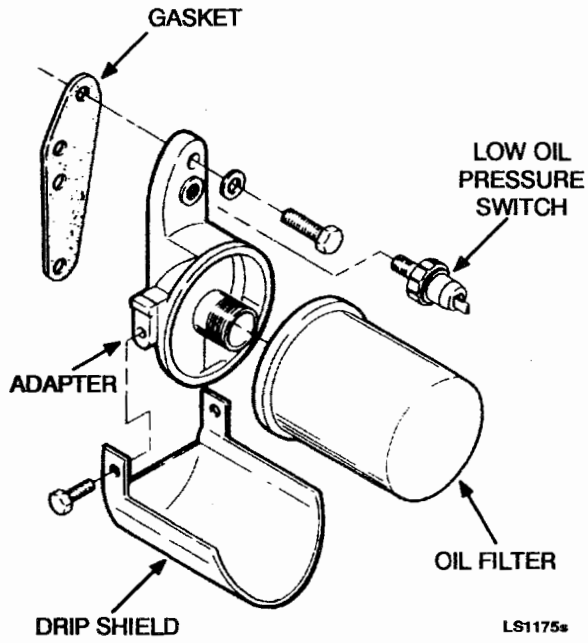


FIGURE 9-1. OIL FILTER AND ADAPTER (BGM SHOWN)

CYLINDER HEADS

Removal/Cleaning Procedure

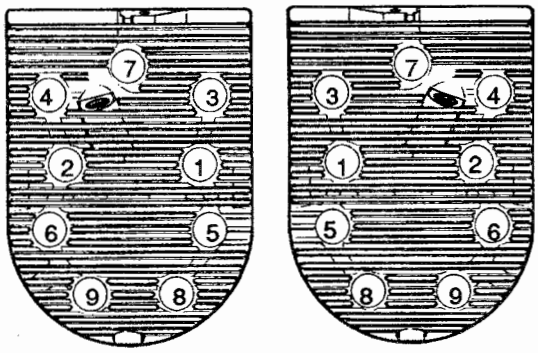
1. Remove the cylinder head capscrews or nuts by using a 1/2 inch socket wrench. Lift off the cylinder head.

   ⚠ CAUTION ***The heads may warp if they are removed while hot. Also, contact with hot parts may cause burns to skin. Wait until the engine has cooled before removing the heads.***

2. After removing the heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where the gaskets fit. The heads are made of aluminum, and may be damaged by careless handling.

Assembly Procedure (BGM)

1. Use new head gaskets, and clean both the heads and the cylinder block thoroughly where the gaskets rest.
2. Place the heads in position, and follow the head torque tightening sequence shown in Figure 9-2. Start by tightening all bolts to 5 ft-lbs (7 N•m), then 10 ft-lbs (14 N•m), etc., until all bolts or stud nuts are tightened to the specified torque (see *Torque Specification* section).



* AS VIEWED FROM FRONT OF ENGINE

FIGURE 9-2. BGM CYLINDER HEAD TIGHTENING SEQUENCE

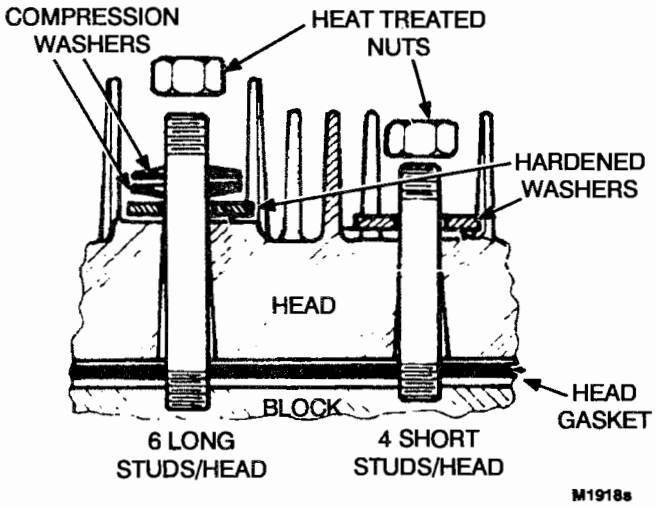


FIGURE 9-3. NHM CYLINDER HEAD WITH COMPRESSION WASHERS

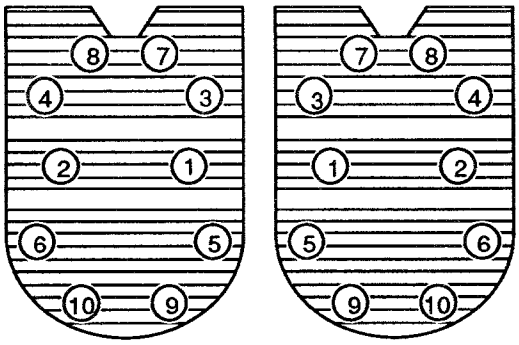
Assembly Procedure (NHM)

1. Use new head gaskets, and clean both the heads and the cylinder block thoroughly where the gaskets rest.
2. Place a head gasket on the cylinder head and align the stud holes in the gasket with the stud holes in the cylinder head. While holding the gasket against the cylinder head, carefully install the cylinder head on the engine. Do not attempt to slide the gasket over the studs without the cylinder head behind it or the gasket may tear.
3. Install a flat washer, two compression washers, and nut on each of the top six studs (see Figure 9-3 for correct sequence). When properly installed, only the outside edges of the compression washers will be in contact with each other. Install a flat washer and nut on each of the four bottom studs.
4. Follow the head torque tightening sequence shown in Figure 9-4 for the NHM. Start by tightening all bolts to 5 ft-lbs (7 N•m), then 10 ft-lbs (14 N•m), etc., until all bolts or stud nuts are tightened to the specified torque (see *Torque Specification* section). Recheck all nuts for correct torque.

   ⚠ CAUTION ***Too much torque will flatten the compression washers and could result in engine damage.***

5. Recheck torque before engine has run a total of 50 hours.

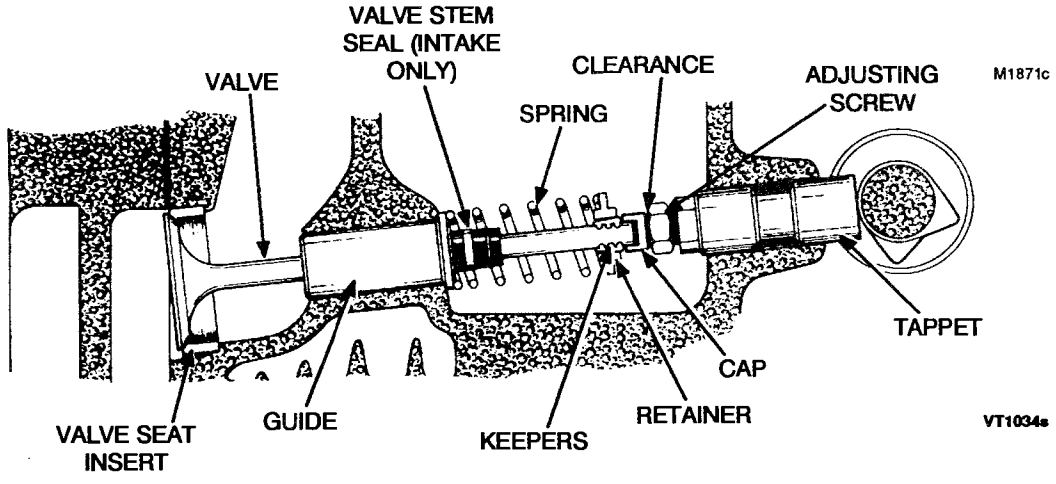
   ⚠ CAUTION ***Do not torque or remove heads when they are hot. Warpage may occur. The gasket surface must be below 100° F before removal. At temperatures above 100° F, the gasket will become gummy and difficult to remove from the surface of the block and cylinder head.***



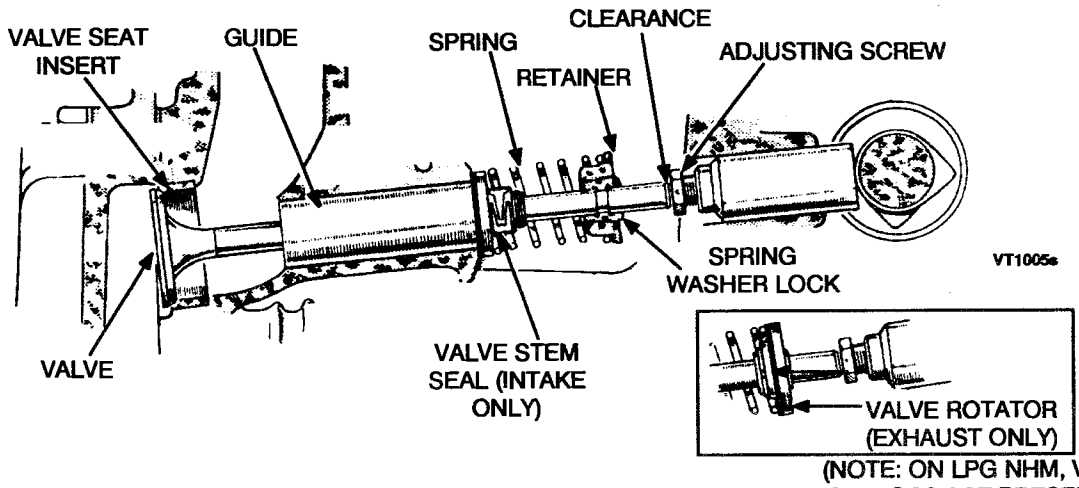
* AS VIEWED FROM FRONT OF ENGINE

FIGURE 9-4. NHM CYLINDER HEAD TIGHTENING SEQUENCE

BGM



NHM

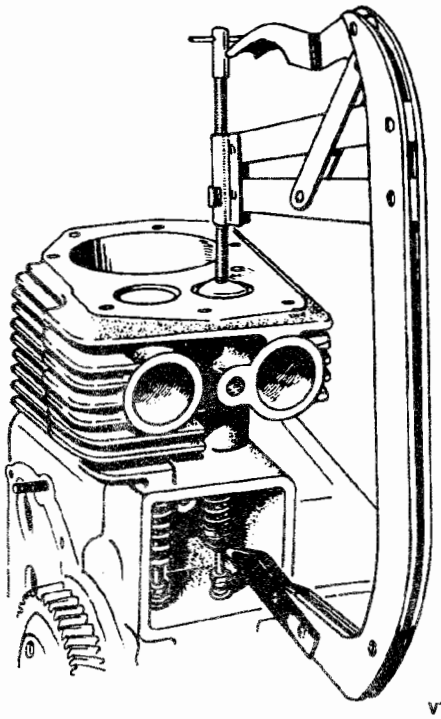


(NOTE: ON LPG NHM, VALVE ROTATORS ARE PRESENT ON BOTH INTAKE AND EXHAUST)

FIGURE 9-5. VALVE SYSTEM

VALVE SYSTEM

A properly functioning valve system is essential for the engine to perform well. Onan gensets use an L-head valve design, as shown in Figure 9-5. The valve system may be accessed by removing the cylinder heads and valve covers on top of the engine. A valve spring compressor must be used to remove the valves (see Figure 9-6) from the cylinder block. Use the procedures described below to inspect and service the valve system.

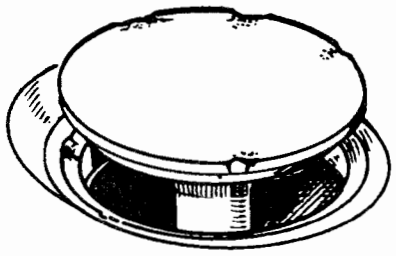


VT1018a

FIGURE 9-6. VALVE SPRING COMPRESSOR

Valve Inspection Procedure

Valve Face: Check the valve face for evidence of burning, warping, out-of-round, and carbon deposits (see Figure 9-7).



VT1017a

FIGURE 9-7. VALVE FACE

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 caused by weak valve springs, insufficient tappet clearance, valve warpage, and misalignment.

Warping occurs chiefly in the upper stem, because it is exposed to intense heat. Out-of-round wear results from warping, 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 is worn, install a new valve.

Excess clearance in the intake guide admits air and oil into the combustion chamber, upsetting carburetion, increasing oil consumption, and making 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, causing warping and burning. Unburned carbon residue gums valve stems, causing them to stick in the guide.

Valve Stem Seal: A valve stem seal is used on the intake valve guides. 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 9-8. Use a hole gauge to measure the valve guide. When valve clearance with the stem exceeds the original clearance by 0.002 inch (0.05 mm), replace either the valve or guide or both, as necessary. Regrind the seat if necessary, to make it concentric with the newly installed guide.

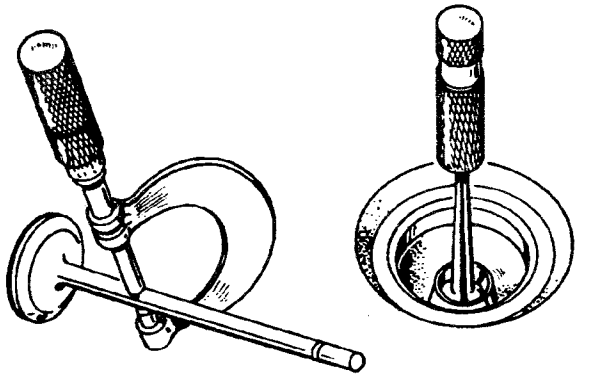


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FIGURE 9-8. VALVE STEM AND VALVE GUIDE INSPECTION

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

Reconditioning Valves and Valve Seats

The interference angle method of valve seating is used on all B and N series genset engines. This method uses different seat and face angles, and line contact is made between the valve face and seat.

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 (see Figure 9-9).

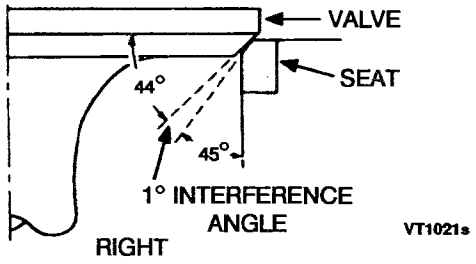


FIGURE 9-9. VALVE INTERFERENCE ANGLE

The valves must not be hand lapped, because the sharp contact between the valve and the seat will be destroyed. This is especially important where chrome cobalt faced valves and seats are used. Valve faces must be finished to 44 degrees, in a machine.

Each valve must have a minimum of 1/32 inch (0.8 mm) margin (see Figure 9-10). If the valve has less margin than this, it will heat up excessively. It will retain this heat during the compression stroke, and pre-ignite the mixture, causing loss of power and economy. This valve is also susceptible to warping and breakage.

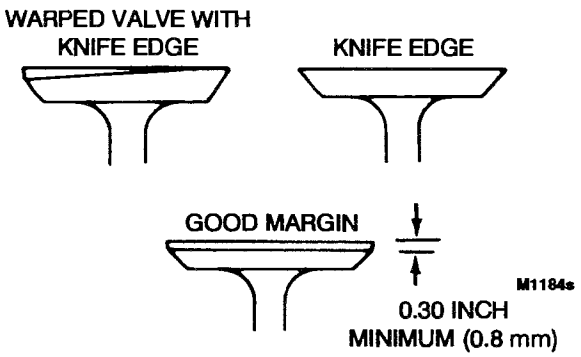


FIGURE 9-10. VALVE MARGIN

Not all valves can be reconditioned. A badly warped valve must be replaced, because the amount of grinding required to make it seat correctly removes its margin. To make a valve gas-tight, remove all pitting from the valve face and

seat. Deeply pitted or cut valves must be replaced, because grinding removes the margin.

Grind valve seats with a 45-degree stone. 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 be sure of proper valve 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 if 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 Guides

Worn valve stem guides can be replaced from inside the valve chamber. The smaller diameter of the tapered valve guides must face toward the valve head.

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

Valve Guide Removal Procedure

1. Before removing the valve guides, use an electric drill with a wire brush to remove carbon and other foreign material from the top surface of the guides. Failure to do this may result in damage to the guide bores.
2. Drive the guides out with a hammer and a valve guide driver. Wear goggles while performing this procedure.

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

Valve Guide Installation Procedure

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

A suggested method of installation is shown in Figure 9-11.

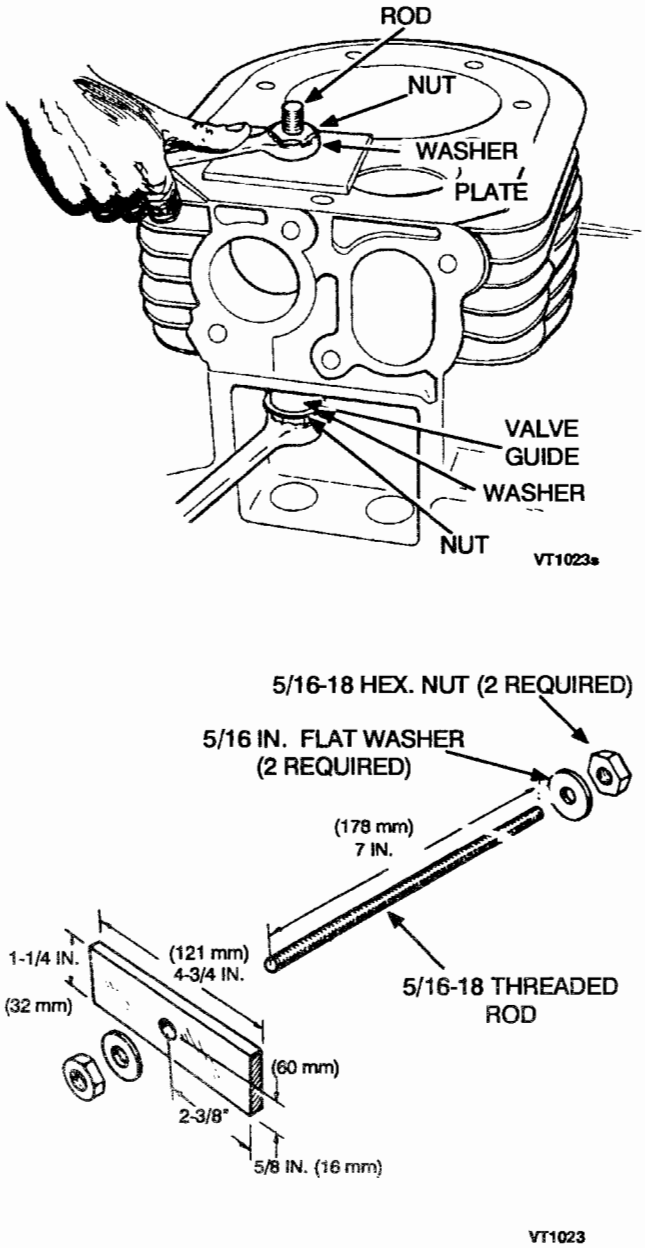


FIGURE 9-11. VALVE GUIDE INSTALLATION

Valve Seats

Inspect the valve seat inserts. If the seats are loose, cracked, or severely pitted, new (oversize) inserts must be installed. Remove valve seat inserts using a valve seat removal tool.

Valve Seat Removal Procedure

1. Remove carbon and combustion deposits from the valve seat.
2. Select the proper size puller (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 9-12).
3. Using the new seat insert as a guide, adjust the puller depth. Position the puller on the valve seat and tighten its hex nut. Clamp the cylinder block to a solid bench. Attach a slide hammer to the puller. Between blows with the slide hammer, tighten the hex nut.

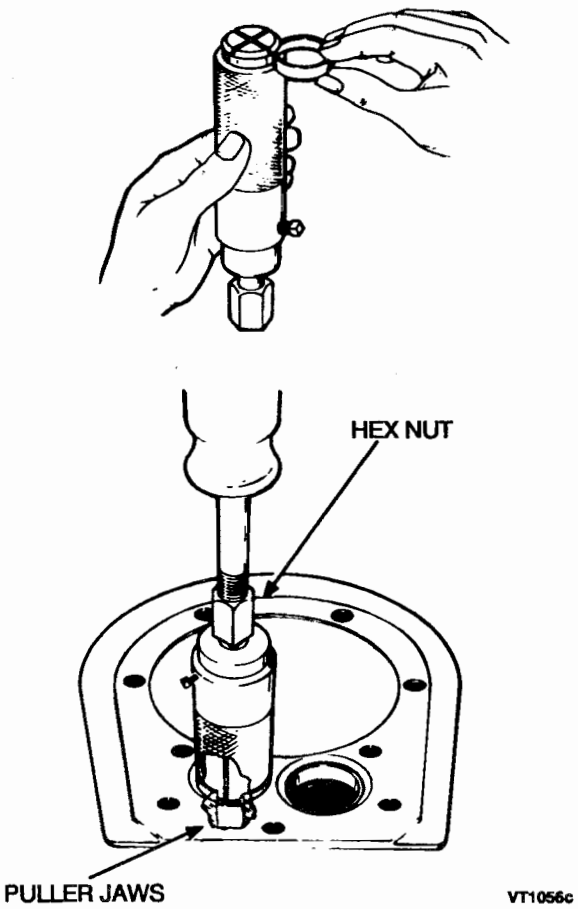


FIGURE 9-12. VALVE SEAT REMOVAL

Valve Seat Installation Procedure

1. After the old seat has been removed, clean out carbon and metal burrs from the seat insert recess. Use a valve seat insert driver and a hammer to install the insert.
2. Insert the pilot of the driver into the valve guide hole in the cylinder block. Quickly drive the valve seat insert in, so that the insert goes 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 9-13).

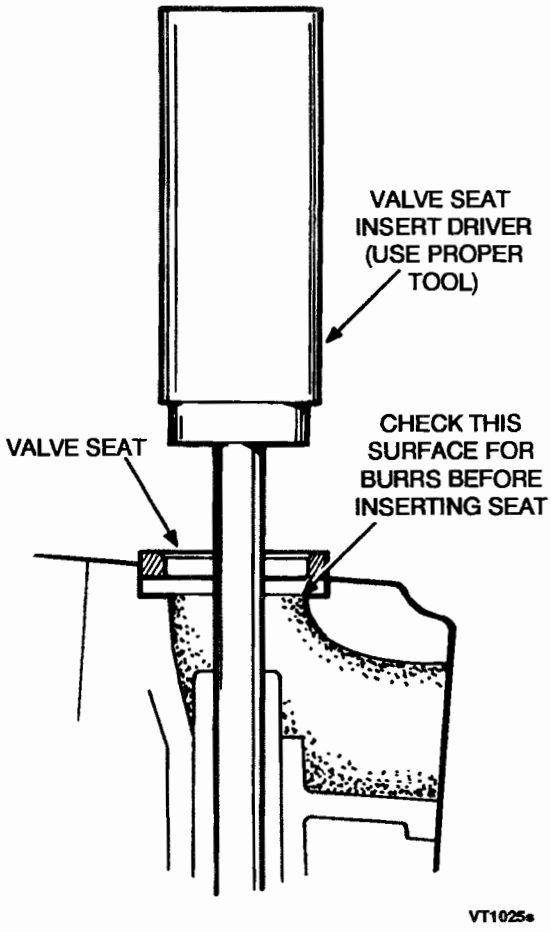


FIGURE 9-13. INSERTING NEW VALVE SEAT

3. Insert a valve seat staker into the cylinder block valve guide hole. Rotate the staking tool until it drops to the original stake marks. Rotate the staking tool another 60° (1/6 turn). Using a lead hammer, strike the staking tool a sharp

blow to wedge the new valve seat securely in place. The valve seat must be staked to ensure a tight fit and eliminate the danger of its loosening in the bore. Before installing the valves, refinish the valve seat inserts.

Valve Tappets

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

Tappet Adjustment Procedure

1. Remove all parts that block 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 left intake valve (viewed from flywheel end) opens and closes. Continue turning the crankshaft until the TDC mark on the flywheel is lined up with the TDC mark on the gear cover. This should place the left piston (#1) at the top of its compression stroke. Verify that the left intake and exhaust valves are closed and that there is no pressure on the valve lifters.
4. Clearances are listed in the Dimensions and Clearances section. For each valve, the gauge should just pass between the valve stem and valve tappet (see Figure 9-14).

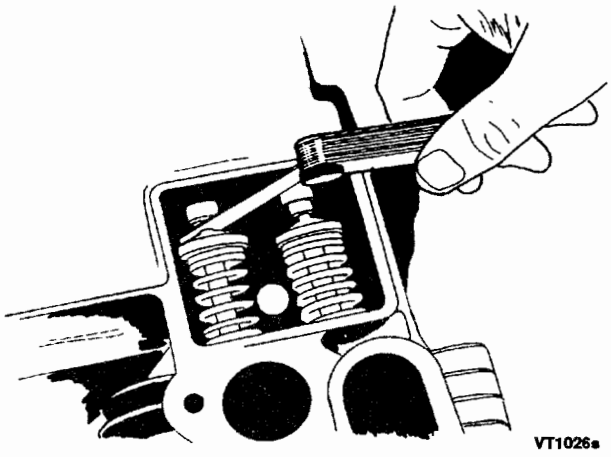


FIGURE 9-14. VALVE CLEARANCE ADJUSTMENT

5. To correct the valve clearance, turn the adjusting screw as needed. The screw is self-locking.
6. To adjust the valves on the right cylinder, turn the engine one complete revolution, and line up the mark on the flywheel and the TDC mark on the gear cover again. Then follow the adjustment procedure given for the left cylinder.
7. Replace all parts removed. Use new gaskets on valve covers. Tighten all screws securely. Torque manifold bolts.

GEAR COVER

Gear Cover Removal Procedure

1. Remove the flywheel key and gear cover mounting screws.
2. Gently tap the gear cover with a plastic-faced hammer to loosen it (see Figure 9-15).

Gear Cover Installation Procedure (Mechanical governor gensets)

NOTE: Electronic governor gensets have no governor arm, shaft, etc. to consider when performing this step.

1. Use new gaskets and apply thread sealant to the bolts when installing the gear cover. Make sure that the pin in the gear cover engages the nylon-lined (smooth) hole in the governor cup. See Figure 9-15.
2. Turn the governor cup so the nylon-lined hole is at the three o'clock position. Use a small amount of grease to help hold the cup in position. The rounded side of the governor yoke must ride against the governor cup.
3. 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.

Refer to the Oil Seals section if replacing the gear cover oil seal.

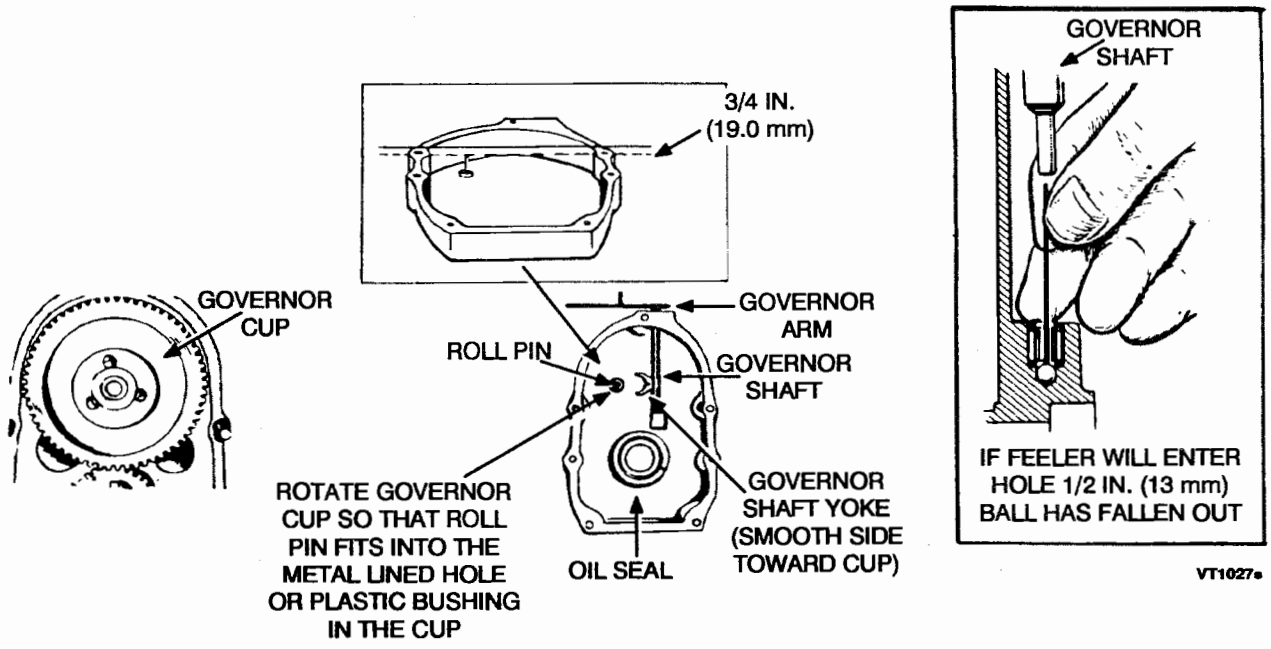
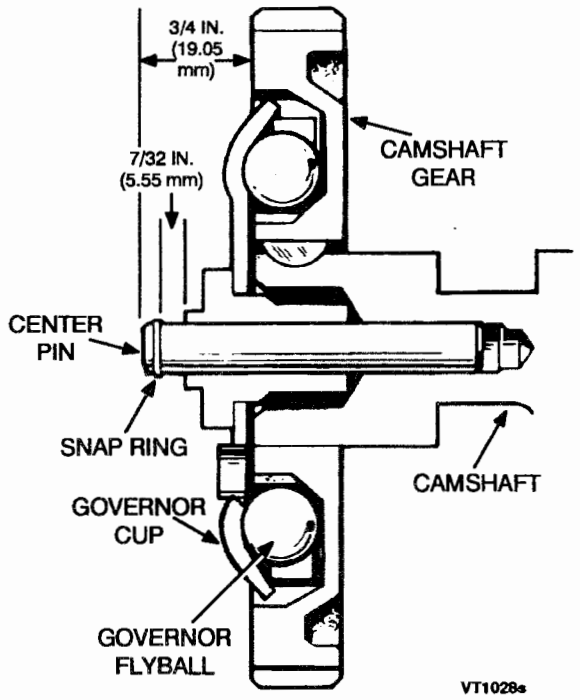


FIGURE 9-15. GEAR COVER ASSEMBLY

GOVERNOR CUP (MECHANICAL)

Governor Cup Removal Procedure

1. Remove the gear cover, as described above.
2. Remove the snap ring from the camshaft center pin (see Figure 9-16).



WHEN GOVERNOR IS PROPERLY ASSEMBLED, DIMENSIONS SHOWN ON THIS DRAWING WILL BE AS INDICATED

FIGURE 9-16. GOVERNOR CUP

3. Slide the governor cup off, making certain to catch the flyballs. Replace any flyball that is grooved or has a flat spot.
4. Examine the ball spacer. If the arms of the ball spacer are worn or otherwise damaged, remove the spacer by splitting it with a chisel. Use a press to install a new spacer on the camshaft gear.
5. 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.

Governor Cup Installation Procedure

The governor cup and flyballs are easily installed when the camshaft assembly is removed from the engine. If necessary, the engine may be tilted up to install the cup and flyballs.

1. Put the flyballs between the spacer arms and install the cup on the center pin.
2. Lock the cup in place with the snap ring.

Camshaft Center Pin Installation Procedure

1. The camshaft center pin extends 3/4 inch (19 mm) from the end of the camshaft. This distance provides 7/32 inch (5.6 mm) travel for the governor cup, as illustrated in Figure 9-16. Measure this distance while holding the cup against the flyballs. If the distance is less, the engine may race, especially at no load.
2. Remove the center pin and press in a new pin the specified amount. Do not hammer the new pin into place, or it will be damaged. The camshaft center pin cannot be pulled outward or removed without damage. If the center pin extends too far, the cup will not hold the flyballs properly.

TIMING GEARS AND CAMSHAFT

If either the crankshaft gear or the camshaft gear needs replacement, both gears should be replaced.

Timing Gear Removal Procedure

1. Remove the snap ring and retainer washer.
2. Attach the gear pulling ring using two 10-32 screws (Figure 9-17). Tighten the screws alternately, until both are tight.

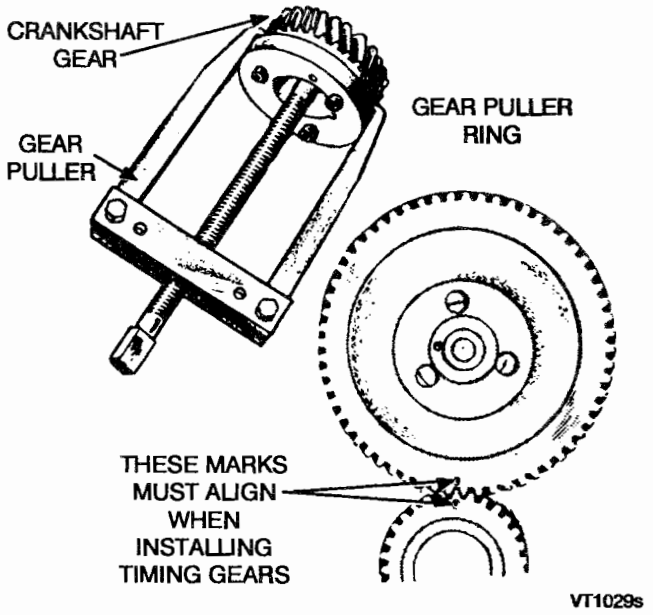


FIGURE 9-17. TIMING GEAR REMOVAL AND INSTALLATION

3. Attach a gear puller to the puller ring and remove the crankshaft gear.

The camshaft and gear are removed as an assembly.

4. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies, then remove the actuating plunger for the breaker points and tappets.

Timing Gear Installation

Each timing gear is stamped with "O" near its 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.

LUBRICATION SYSTEM

All genset engines use an oil pump to provide 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 pickup cup. A bypass valve controls 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 (Figure 9-18) is mounted on the front of the crankcase behind the gear cover. It is driven by the crankshaft gear. The inlet pipe and screen assembly is attached to the pump body. A discharge passage in the pump cover is aligned with a passage drilled in the crankcase. Other passages distribute oil to the front main bearing, rear main bearing and pressure control bypass valve.

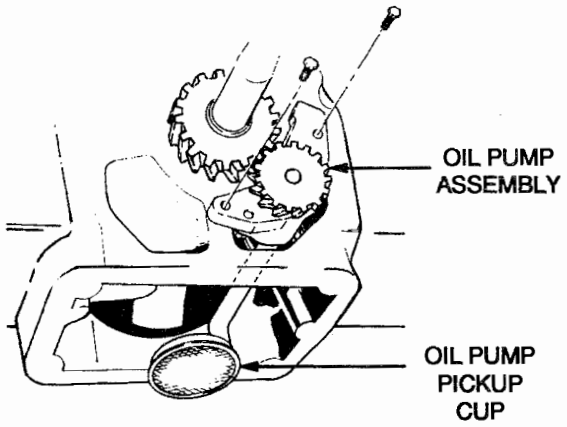


FIGURE 9-18. OIL PUMP ASSEMBLY

Circumferential grooves in the main bearings supply oil to the connecting rod bearings through passages from each main journal. A passage connects the front main bearing oil supply to the front camshaft bearing. The oil overflow from the bypass valve lubricates the camshaft drive gears.

Normal oil pressure should be no less than 13.5 psi (93 kPa) for the BGM, or 21 psi (144.8 kPa) for the NHM, 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 it. Except for the gaskets and pick-up cup, the component parts of the pump are not individually available. 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, Figure 9-19), controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open at roughly 13-14 psi on BGM gensets, or 19-21 psi on NHM gensets.

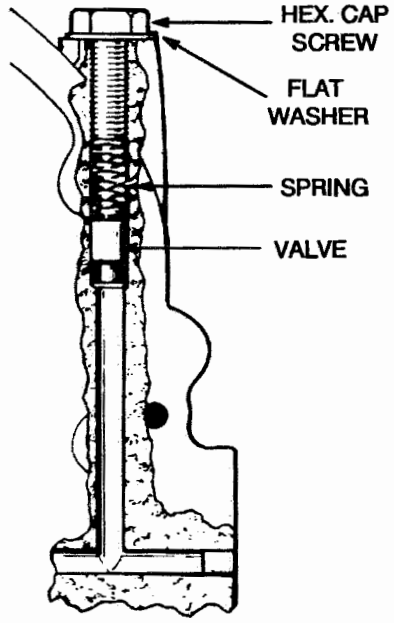


FIGURE 9-19. OIL BYPASS VALVE

Oil Bypass Valve Test

The bypass valve 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 3/8-24 x 7/8 in. (BGM) or 3/8-24 x 1 in. (NHM) capscrew behind the gear cover and under the governor arm.
2. Remove the spring and plunger with a magnetic tool.
3. Determine the proper valve operation by checking the spring and plunger against the measurements listed below:

   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+0.9N) 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.

PISTON ASSEMBLY

The piston assembly consists of:

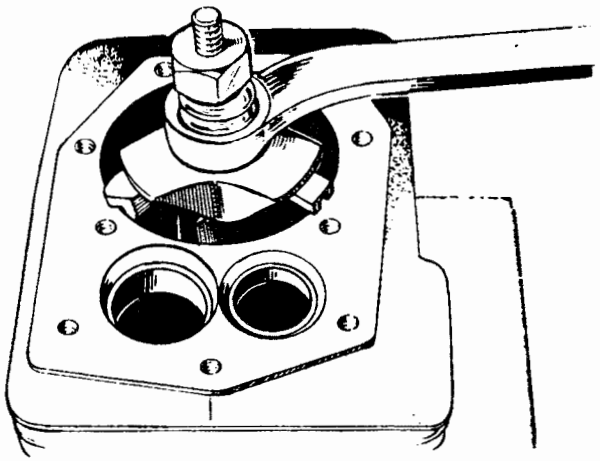
- Piston
- Piston rings
- Piston pin
- Connecting rod assembly and bearing

After removal from the engine, all parts must be carefully inspected for damage and wear before they are replaced.

Piston Removal and Disassembly Procedure

1. Remove carbon from the top of cylinder bore, and check for a ridge. Remove this ridge (see Figure 9-20) with a ridge reamer before attempting piston removal.

   ⚠ CAUTION ***Improper use of a ridge reamer can damage the cylinder bore. Use this tool with extreme care.***



CT1058s

FIGURE 9-20. REMOVING WEAR RIDGE

2. Turn the crankshaft until a piston is at the bottom of its stroke. Remove the nuts from the connecting rod bolts.
3. Lift the rod bearing cap from the rod, 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.
4. Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep the connecting rod bearing caps with their respective rods.
5. The pistons are fitted with two compression rings and one oil control ring. Remove these rings from the piston using a piston ring spreader, as shown in Figure 9-21.

   ⚠WARNING ***Piston rings can fly off the spreader, causing severe eye injury. Wear eye protection while performing piston ring removal procedure.***

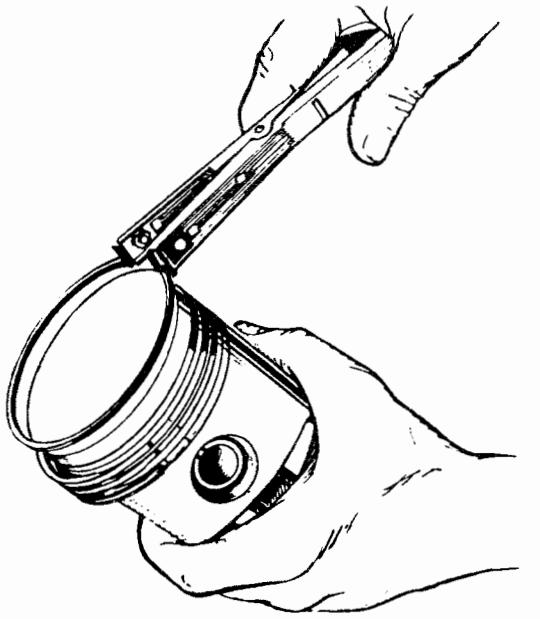


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FIGURE 9-21. REMOVING PISTON RINGS

6. Mark each piston's orientation to make sure the rod is assembled on the piston from which it was removed. Remove the piston pin retainer from each side, and push the pin out.
7. Remove dirt and deposits from the piston surfaces with an approved cleaning solvent. Clean the piston ring grooves with a groove cleaner, or with the end of a piston ring filed to a

sharp point (Figure 9-22). Take care not to remove metal from the groove sides.

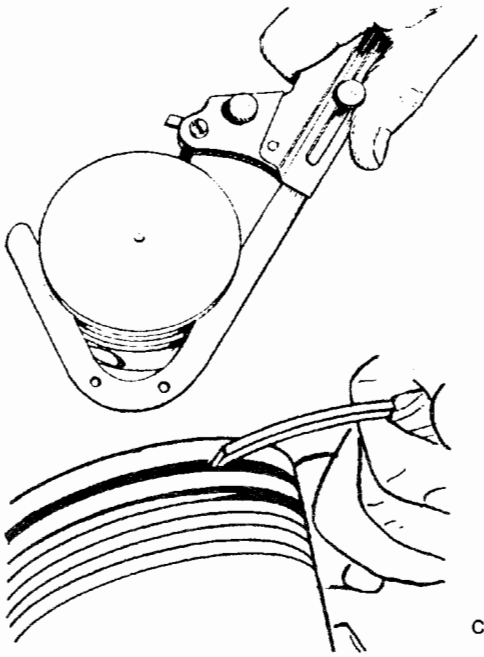


FIGURE 9-22. CLEANING RING GROOVES

⚠ CAUTION ***Using a caustic cleaning solvent or wire brush for cleaning pistons will cause piston damage. Use only parts cleaning solvent for this job. Make certain to follow the solvent manufacturer's instructions.***

When cleaning the connecting rods in solvent, make certain to include the rod bore.

Piston and Connecting Rod Inspection Procedure

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 9-23. Replace the piston if the side clearance of the top compression ring is as much as 0.008 inch (0.20 mm).

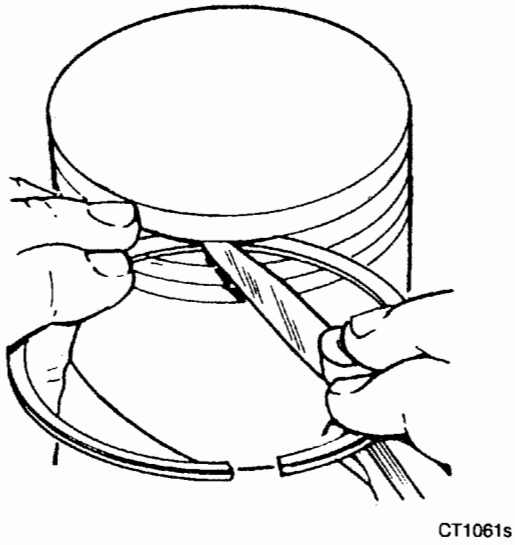


FIGURE 9-23. CHECKING RING LAND

Improper ring width or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves do not make adequate contact with the cylinder wall (Figure 9-24).

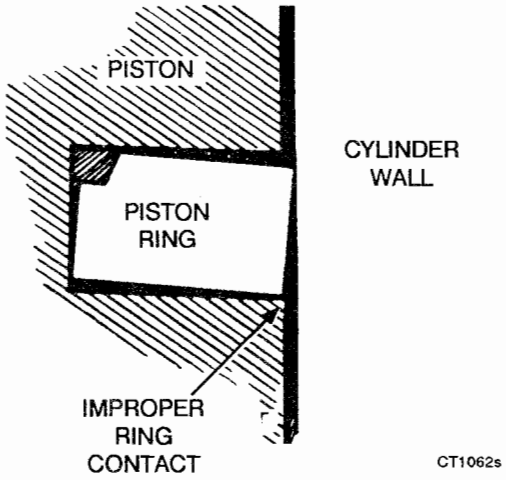


FIGURE 9-24. NEW RING IN WORN RING GROOVE

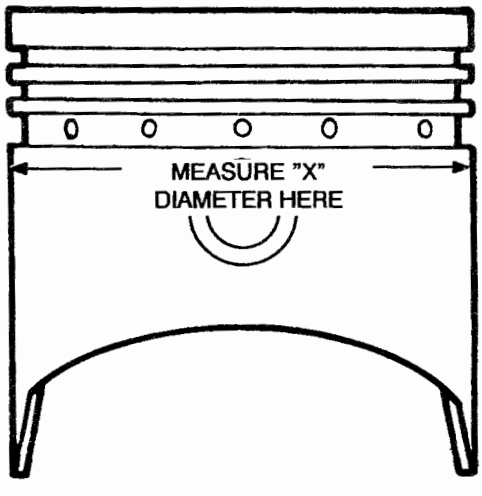


FIGURE 9-25. PISTON CLEARANCE MEASUREMENT

Replace pistons showing signs of scuffing, scoring, worn ring lands, fractures or damage from pre-ignition.

Connecting Rod Inspection: Replace connecting rod bolts and nuts with damaged threads. Replace connecting rods with deep nicks, signs of fractures, scored bores or bores out of round more than 0.002 inch (0.05 mm).

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

Piston Pin Inspection: Replace piston pins that are cracked, scored, or out of round more than 0.002 inch (0.05 mm).

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

Piston Clearance

Correct piston tolerances must be maintained. Use a micrometer to measure the piston diameter at the point shown in Figure 9-25. When the cylinder bore is measured (see Cylinder Block section), subtract the piston diameter from the cylinder bore diameter to obtain the piston-to-cylinder wall clearance. Refer to the Dimensions and Clearances section for the recommended piston clearance.

Fitting Piston Rings

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder, at a position corresponding to the bottom of its travel (Figure 9-26). The gap between the ends of the ring is given in the *Dimensions and Clearances* section of this manual.

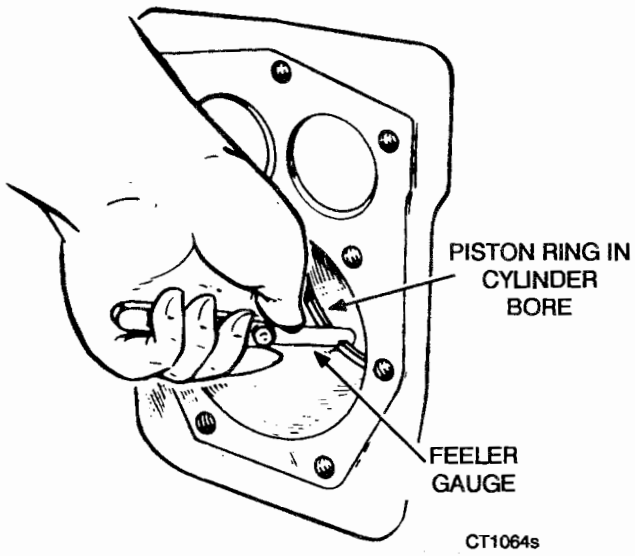


FIGURE 9-26. CHECKING RING GAP

Do not file the ring ends to increase the end gap. If the ring end gap does not meet the specifications, check 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).

Rings that are 0.010, 0.020, 0.030 and 0.040 inch (0.25, 0.51, 0.76 and 1.02 mm) oversize should be used on corresponding oversize pistons. Tapered piston rings are usually marked TOP on one side, or identified in some other manner. Install these rings with the identification mark toward the closed end of the piston.

Piston Assembly Procedure

1. Lubricate all parts with clean engine oil.

2. 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 they are properly in place before installing the piston and connecting rod in the engine.
3. Install the rings on the piston beginning with the oil control ring (Figure 9-27). 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, then close until the expander ends butt together. Locate the expander gap 180 degrees from the ring gap. Make certain that the piston ring gaps are **not** aligned with one another.

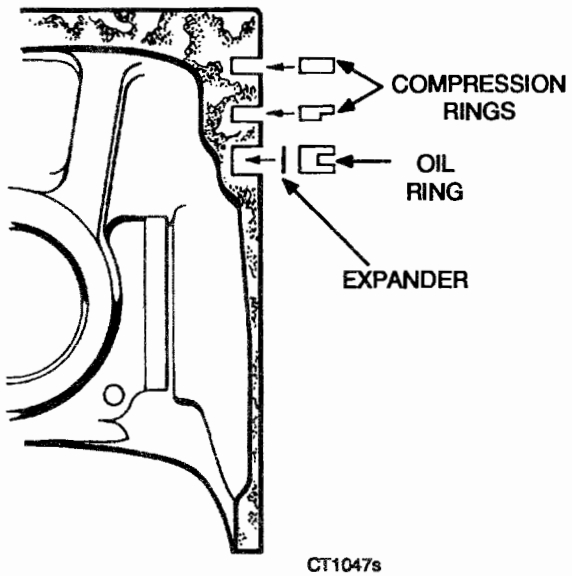


FIGURE 9-27. PISTON RINGS

Piston Installation Procedure

1. Turn the crankshaft to position the #1 rod bearing journal at the bottom of its stroke.
2. Lubricate the #1 piston assembly and the inside of the cylinder. Compress the rings with a ring compressor as shown in Figure 9-28. Install the bearing insert in rod.

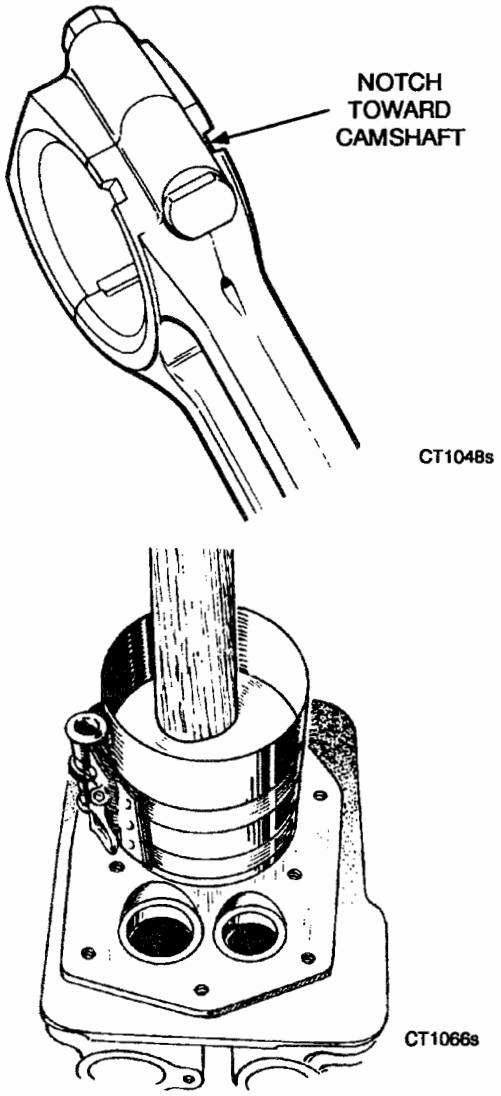


FIGURE 9-28. INSTALLING PISTON AND CONNECTING ROD

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 the hammer until the connecting rod is seated on the journal. Check the bearing clearance before proceeding to step 5 (see Rod Bearing Clearance section).

5. Install the bearing cap on the rod. Install one fastener and tighten to 5 ft-lbs (7 N•m). Repeat this for the other fastener. Tighten both fasteners to 14 ft-lbs (19 N•m).
6. Install the remaining piston and rod in the same way. Crank the engine by hand, to see that all bearings are free.

Rod Bearing Clearance Procedure

1. Mark all parts so they can be installed in their original positions, and wipe all parts clean of oil and grease.
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.
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 adheres. Compare the widest point of the flattened Plasti-gage with the graduations on the envelope (see Figure 9-29) to determine the bearing clearance.

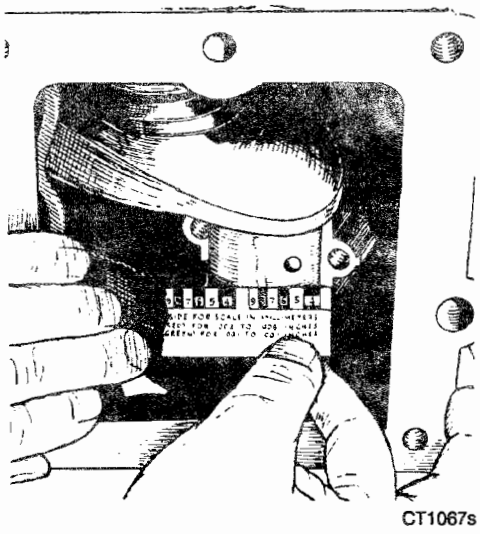


FIGURE 9-29. MEASURING BEARING CLEARANCE

CRANKSHAFT

Crankshaft Removal Procedure

1. Loosen the rear bearing plate screws and remove the bearing plate, gasket, thrust washer, and shims.
2. Turn the crankshaft so the crankthrow is aligned with the notch in the rear opening of the crankcase.
3. Carefully slide the crankshaft out of the crankcase.

Crankshaft Inspection

Inspect the rod and main bearing journals. If they are worn or scored, and cannot be smoothed by polishing, either the journals should be reground to fit one of the standard undersize bearings, or the crankshaft should be replaced. Remove only enough metal to restore the journal surface while maintaining the correct bearing clearance.

When making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to ensure lubrication of the connecting rods.

Crankshaft Installation Procedure

1. Lubricate the front and rear main bearings with engine oil.
2. Use oil or gear lubricant to hold the front thrust washer in place against the engine block. The flat side of the thrust washer goes against the block.
3. Position the crankshaft so that the crank throw is aligned with the notch at the rear of the crankcase, and install the crankshaft. Make sure the front thrust washer did not slip out of place during installation.
4. Place the oil seal loader on the oil seal guide and driver, and insert into the rear bearing plate. Remove the seal guide and driver leaving the loader in the bearing plate. The loader prevents the seal from being cut on the crankshaft keyway during installation of the rear bearing plate.
5. Use oil or gear lubricant to hold the shim(s) and rear thrust washer in position on the rear bearing plate (see Figure 9-34). The shim goes

against the bearing plate, and the flat surface of the thrust washer goes against the shim.

6. Place the new bearing plate gasket in position on the block, making sure the oil hole on the back of the block is exposed.
7. Install the rear bearing plate and fasten with two nuts (or capscrews) tightened to the specified torque. Make sure the rear thrust washer and shim(s) did not slip out of place during installation. The crankshaft should turn freely by hand.

Endplay Checking Procedure

After tightening two rear bearing plate nuts (or capscrews) to the specified torque, check the crankshaft endplay at the point shown in Figure 9-30, using a feeler gauge.

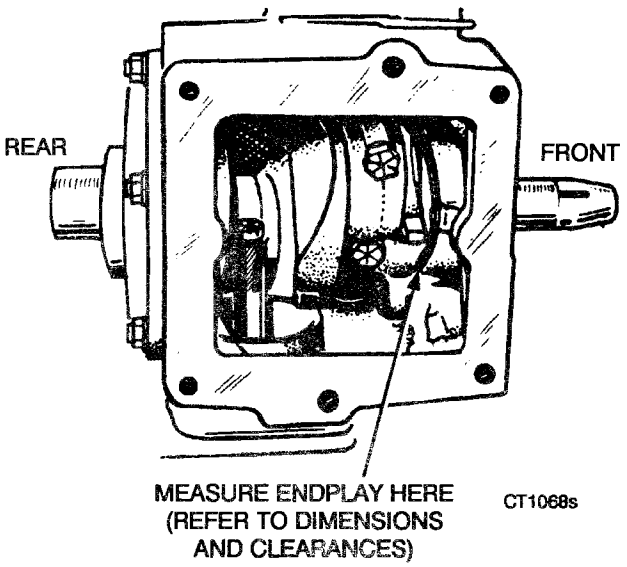


FIGURE 9-30. CHECKING ENDPLAY

1. Lightly tap the front of the crankshaft with a plastic-faced hammer to take up the freeplay. Refer to the Dimensions and Clearances section for the recommended crankshaft endplay.
2. If necessary, remove the rear bearing end plate and add or remove shims as required.
3. Install the end plate, and tighten all nuts (or capscrews) to the specified torque.
4. Make sure the shim and thrust washer are in place, and recheck crankshaft endplay. Verify that the crankshaft turns freely without binding.

CYLINDER BLOCK

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

Cylinder Block Cleaning

After removing the pistons, crankshaft, cylinder heads, etc., inspect the block for cracks and extreme wear. If it is still serviceable, prepare it for cleaning as follows:

1. Carefully scrape all old gasket material from the block. Remove oil bypass to allow cleaning solution to contact 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 cleaning solution.

Cylinder Block 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 may 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. (Remove this coating after the test, and before reassembly.) 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 bores for scuffing, scratches, wear, and scoring. If these conditions exist, they must be rebored and honed for the next oversize piston.

When the appearance of cylinder bores is acceptable and there are no scuff marks, check the bores 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: the top and bottom of piston ring travel, and parallel and perpendicular to the axis of the crankshaft.
2. Record the measurements taken at the top and bottom of the piston travel as follows (see Figure 9-31).
   A. Measure and record as "A" the cylinder bore diameter (parallel to crankshaft) near the top of cylinder bore where the greatest amount of wear occurs.
   B. Measure and record as "B" the cylinder bore diameter (parallel to crankshaft) at the bottom of piston travel.
   C. Measure and record as "C" the cylinder bore diameter (perpendicular to crankshaft) near the top of cylinder bore where the greatest amount of wear occurs.
   D. Measure and record as "D" the cylinder bore diameter (perpendicular to crankshaft) at the bottom of piston travel.
   E. Reading "A" subtracted from reading "B" and reading "C" subtracted from reading "D" indicates the cylinder taper.
   F. Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicates whether or not the cylinder is out-of-round. If the out-of-round exceeds 0.003 inches (0.08 mm), the cylinders must be rebored and honed to the next oversize. A reboring machine is used when changing to oversize pistons. The following repair data describes the boring and honing procedure.

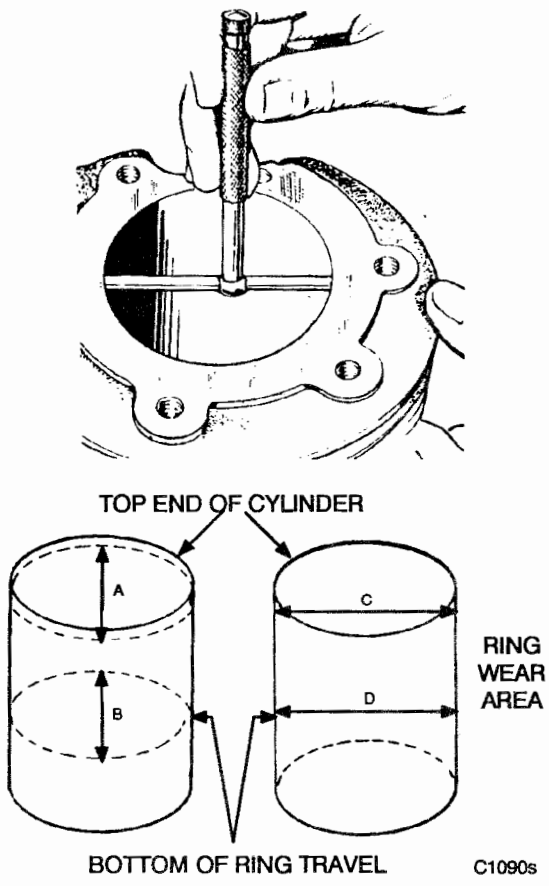


FIGURE 9-31. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

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 can be cleaned up. The final finish and bore diameters should then be obtained by honing.

⚠ CAUTION ***Operating the boring bar incorrectly can produce a rough cylinder surface that may not be repairable, even by honing. Make certain that only an experienced technician performs this job.***

After boring to the correct oversize, there should be no need to adjust or "fit" pistons and rings; cylinder

bore dimension and piston and ring clearance should be correct.

⚠WARNING ***Metalworking techniques can endanger eyes and hands. Make certain to wear goggles when performing these procedures.***

When reboring cylinders, take these precautions:

1. Make sure the cutting tool is properly ground.
2. Be sure that 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, causing the cylinder to 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 Cylinders Using Precision Hones

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

1. Position the block solidly for either vertical or horizontal honing. Use either a drill press or a heavy-duty drill which operates at approximately 250 to 450 rpm.
2. Follow the hone manufacturer's instructions for the use of oil or lubricant on the stones. Do not use lubricants with a dry hone.
3. Insert the hone in the bore, and adjust the stone to fit snugly to the narrowest section. When adjusted correctly, the hone should not shake or chatter in the cylinder bore, but will drag freely up and down when hone is not running.
4. Connect the drill to the hone and start the drill. Note that high spots in the bore cause an increased drag on the stones. Move the hone up and down in bore with short overlapping strokes, about 40 times per minute. Usually the bottom of the cylinder must be honed first, because it is smaller. As the cylinder takes a uniform diameter, move the hone up and down through the length of the cylinder bore.
5. Check the diameter of the cylinder regularly during honing, at six places in the bore; measure twice at top, middle, and bottom at 90-degree angles. A dial bore gauge is the easiest method, but a telescoping gauge can be used.
6. The crosshatch formed by the stones should form an included angle of 23 degrees. This can be achieved by moving the rotating hone (250 to 450 rpm) up and down in the cylinder bore roughly 40 times per minute.
7. Clean the cylinder bores thoroughly with soap, water and clean rags. A clean white rag should not become soiled on the cylinder wall after cleaning is complete.

   Do not use gasoline or other solvents to clean the cylinder walls. Solvents wash oil from the walls, but leave metal particles.
8. Dry the crankcase and coat it with oil.

Deglazing Cylinder Bores

Deglazing the cylinder bore provides cavities to hold oil during piston ring break-in. Deglazing produces a good finish, but does not enlarge the cylinder diameter, so the original pistons with new rings may still be used. Deglaze the cylinder bores if there are no scuff marks and no wear or out-of-round beyond specifications before installing new rings.

1. Wipe cylinder bores with a clean cloth which has been soaked in 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 the cylinder (10 to 12 complete strokes) rapidly enough to obtain a crosshatch pattern, as shown in Figure 9-32.

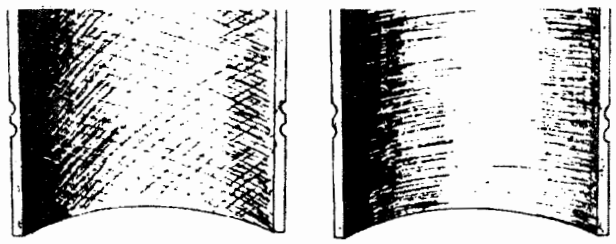


FIGURE 9-32. CROSSHATCHING

⚠ CAUTION ***Abrasives not removed from the engine will rapidly wear the rings, cylinder walls, and bearing surfaces of all lubricated parts. For this reason, do not use gasoline or commercial solvents to clean the cylinder bores after deglazing or honing. These solvents cannot remove abrasives from the cylinder walls.***

4. Clean the cylinder bore thoroughly with soap, water, and clean rags, until a clean white rag shows no discoloring when wiped through the cylinder bore.

BEARINGS

To remove the camshaft or crankshaft bearings, the engine must be completely disassembled. Drive out the bearings by using a combination main and cam bearing removal tool, and a press. Support the casting to avoid distorting or damaging the bearing bores.

Camshaft Bearing Replacement Procedure

Precision replacement camshaft bearings do not require line reaming or line boring after installation.

1. Coat the bearing with lubricating oil.
2. Position the front bearing so that the oil hole in the bearing is aligned with the oil hole (see Figure 9-33) in the block.

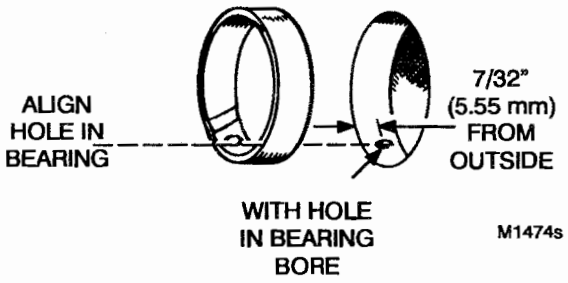


FIGURE 9-33. CAMSHAFT BEARING

3. Position the rear bearing so that the elongated slot is aligned with the breaker point plunger hole in the top of the block.
4. Use the combination main and cam bearing driver with a press to install the front and rear cam bearings. Push in the bearings to the depth allowed by the flange on the driver.

Crankshaft Bearings

Precision replacement crankshaft main bearings do not require line reaming or line boring after installation. They are available in standard size, 0.002, 0.010, 0.020 or 0.030 inch undersize.

When installing either the front or rear main bearing, always align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore. The oil passage must be at least half open.

Rear Bearing: Use the combination main and cam bearing driver and a press to install the rear main bearing. Push the bearing into the bearing plate from the inner side (see Figure 9-34) to the depth allowed by the flange on the driver.

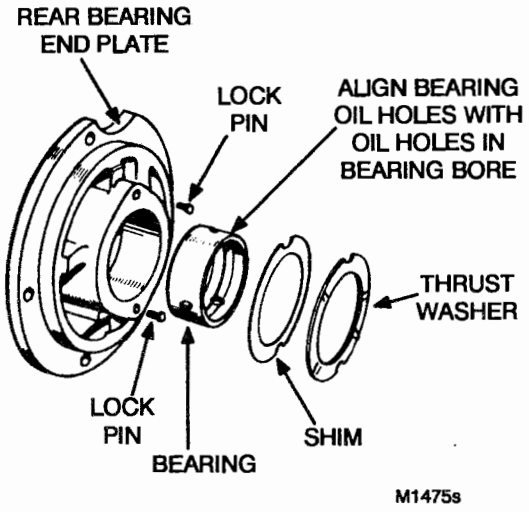


FIGURE 9-34. REAR BEARING

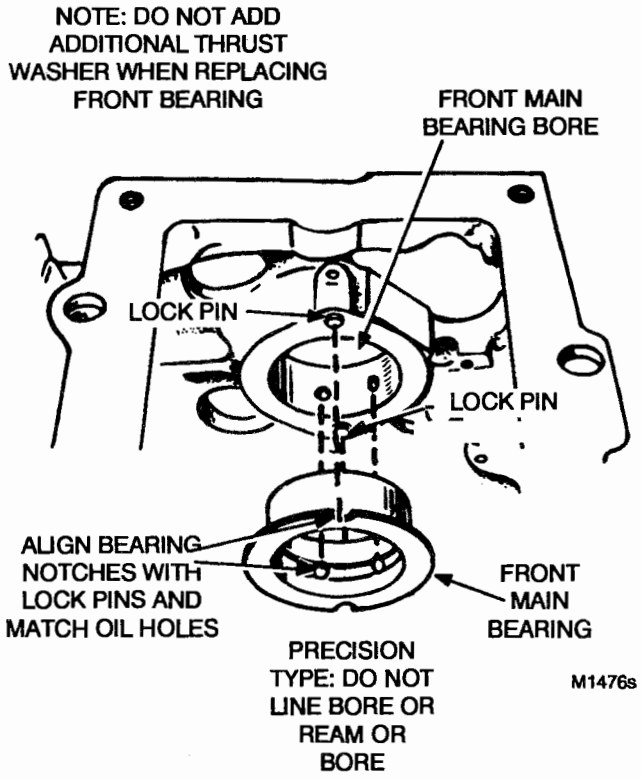


FIGURE 9-35. FRONT BEARING

Front Bearing: Loctite brand Bearing Mount is used when installing the front bearing. Use the towelette furnished with the bearing kit to clean the outside of the bearing and the bearing bore in the block. Apply the Loctite to the mating surfaces of the bearing and bearing bore. Allow three to four minutes for drying.

⚠WARNING ***Breathing the vapor from the towelette provided with the Loctite, or prolonged contact with skin, can be harmful. Be sure the area is well-ventilated.***

Use the combination main and cam bearing driver and a press to install the front bearing. Push the bearing in to the depth allowed by the flange on the driver. Wipe off any excess Loctite, and allow one hour for hardening at room temperature.

Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. The front bearing replacement part is a one-piece bearing (with attached thrust washer), as shown in Figure 9-35. Do not add an additional thrust washer to this front bearing.

OIL SEALS

Oil Seal Replacement Procedure

Remove the rear bearing plate to replace the rear oil seal. Remove the gear cover to replace the front oil seal. Use an oil seal remover to pry out the front or rear oil seal.

Use an oil seal guide and driver to press or drive the rear seal into the rear bearing plate until it bottoms against the shoulder of the plate (see Figure 9-36). Press or drive the front oil seal into the gear cover until it is 0.97 ± 0.02 inch (24.6 ± 0.5 mm) from the mounting face of the cover.

Place a light coating of grease on the lips of the replacement seal before installing the rear bearing plate or gear cover. This provides initial lubrication until engine oil reaches the seal. Refer to the Crankshaft section for the rear bearing plate installation procedures. Refer to the Gear Cover section for the gear cover installation procedures.

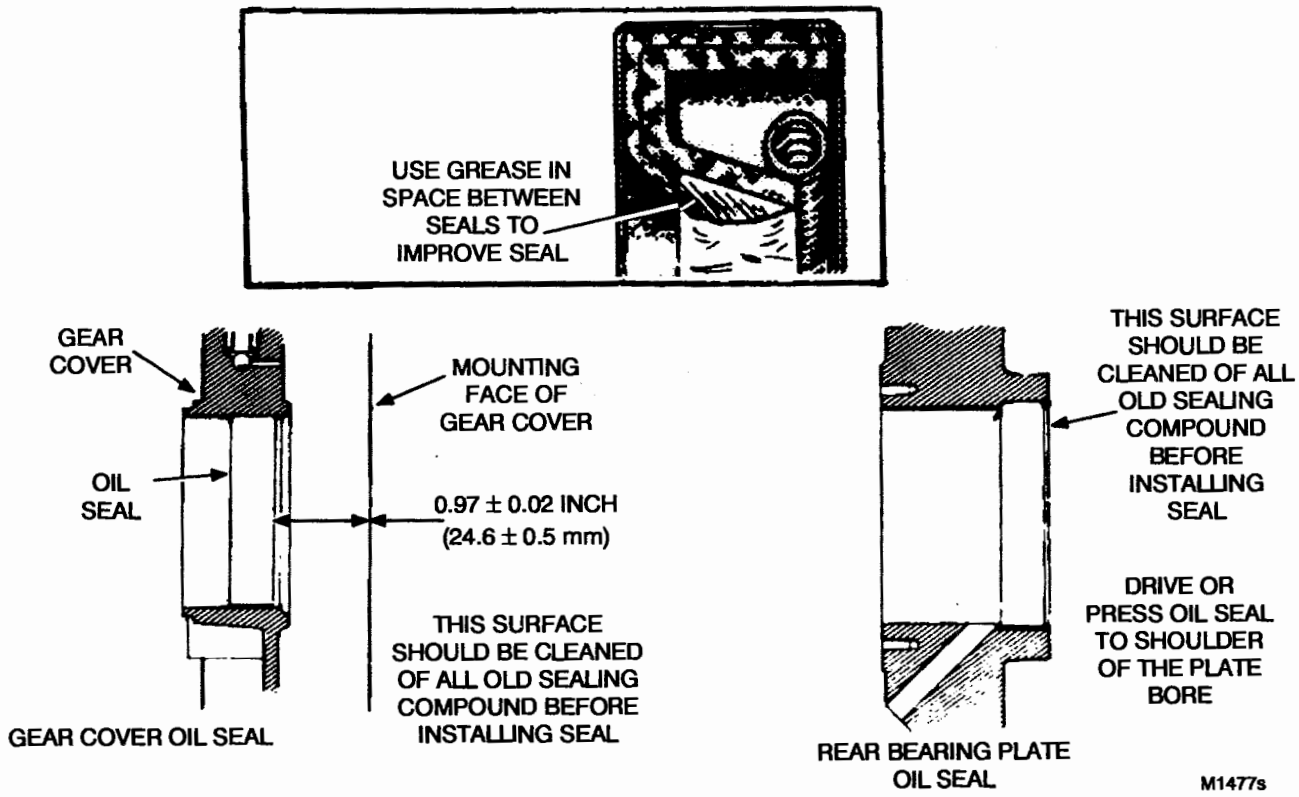


FIGURE 9-36. OIL SEALS

Section 10. Service Checklist

After servicing, inspect and test the installation to confirm that the generator set will operate to its rated capacity. Check each of the areas described below 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 appropriate operators' manual for the specific recommendations and procedures.

WIRING

Verify that all wiring connections are tight and installed properly. Make certain that wires do not run over hot, sharp or rough surfaces and are not kinked or worn. Check each of these connections:

- Load wires
- Control wires
- Ground strap
- Battery cables

INITIAL START ADJUSTMENTS

Gasoline sets: Before starting the genset, check that the idle and main mixture adjustment screw limiter caps are in the correct position. If the limiter caps are missing, adjust the idle and main mixture screws, and reinstall the limiter caps. For instructions, see the Fuel System section of this manual.

Mechanical-governor sets: Start the set, then immediately adjust the governor speed for a safe no-load operating speed (mechanical governor gensets). With no load applied, listen for unusual sounds or vibrations. Warm up the genset for at least 15 minutes at 50% to 75% of rated load and check that the choke is completely open. Adjust governor (mechanical governor gensets) as specified in the Governor section of this manual.

⚠CAUTION ***Voltage/frequency-sensitive equipment such as VCRs, televisions, computers, etc. may be damaged by power line frequency variations. Some solid-state devices are powered whenever connected to an AC outlet even if the device is not in actual operation. For this reason, disconnect all devices which are voltage- or frequency-sensitive before attempting any carburetor/governor adjustments. If disconnecting the devices is not possible, open the circuit breaker(s) at the distribution panel or at the generator set, if so equipped.***

OUTPUT CHECK

Apply a full load to make sure the set can 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. Make certain that the exhaust pipe terminates beyond the perimeter of the coach. Visually and audibly check for leaks at all connections, welds, gaskets, and joints. Also make sure that exhaust pipes do not heat 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. Shut off the engine and repair leaks immediately.***

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.

⚠WARNING ***Leaking fuel creates a fire hazard which might result in severe personal injury or death if fire, flame, spark, pilot light, cigarettes, arc-producing equipment or other ignition sources are present. If fuel leaks are detected, shut off the generator set and correct immediately.***

CONTROL

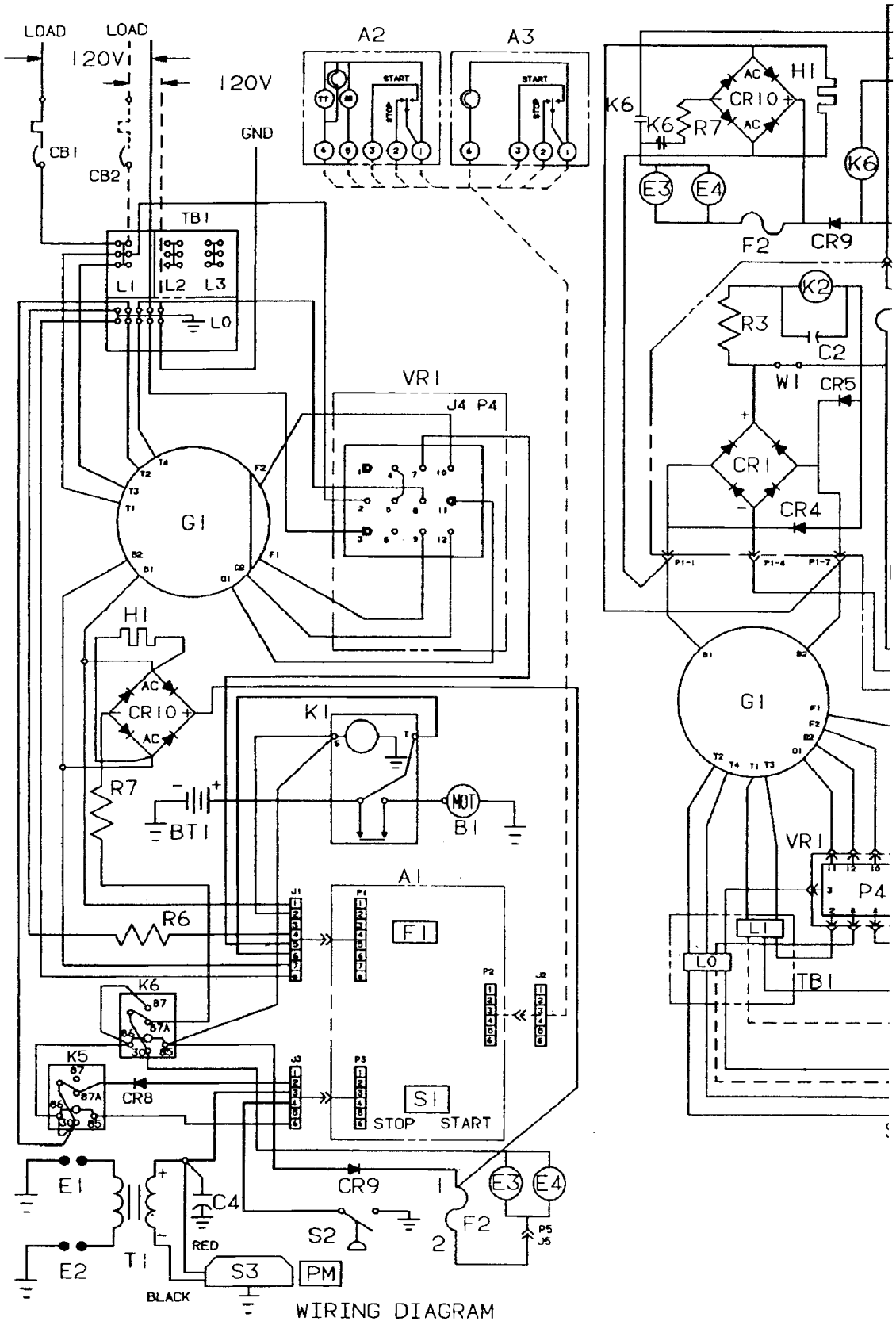
Stop and start the generator set several times at the set control and remote control to verify that it functions properly.

MECHANICAL

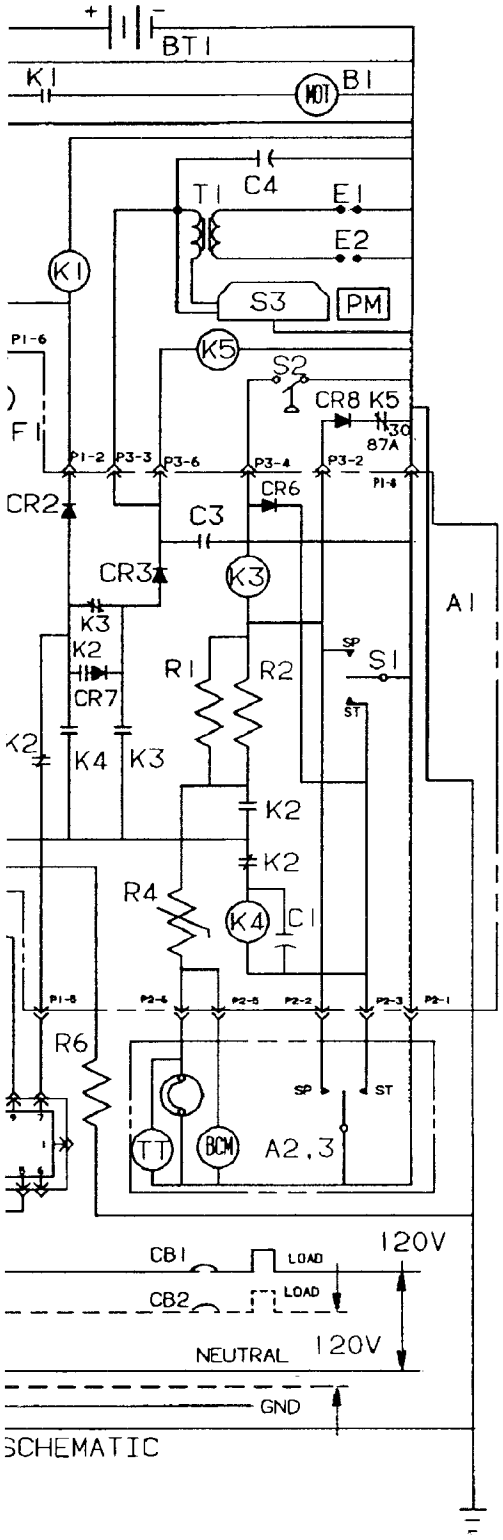
Stop the generator set and inspect it for leaking gaskets, loose fasteners, damaged components, or interference problems. Repair as required. Inspect the generator set compartment and verify that there are no breaks or openings in the vaporproof wall that separates the compartment from the vehicle interior.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

Section 11. Wiring Diagrams

The electrical schematics and wiring diagrams that apply to the generator sets covered in this manual are listed below.



WIRING DIAGRAM

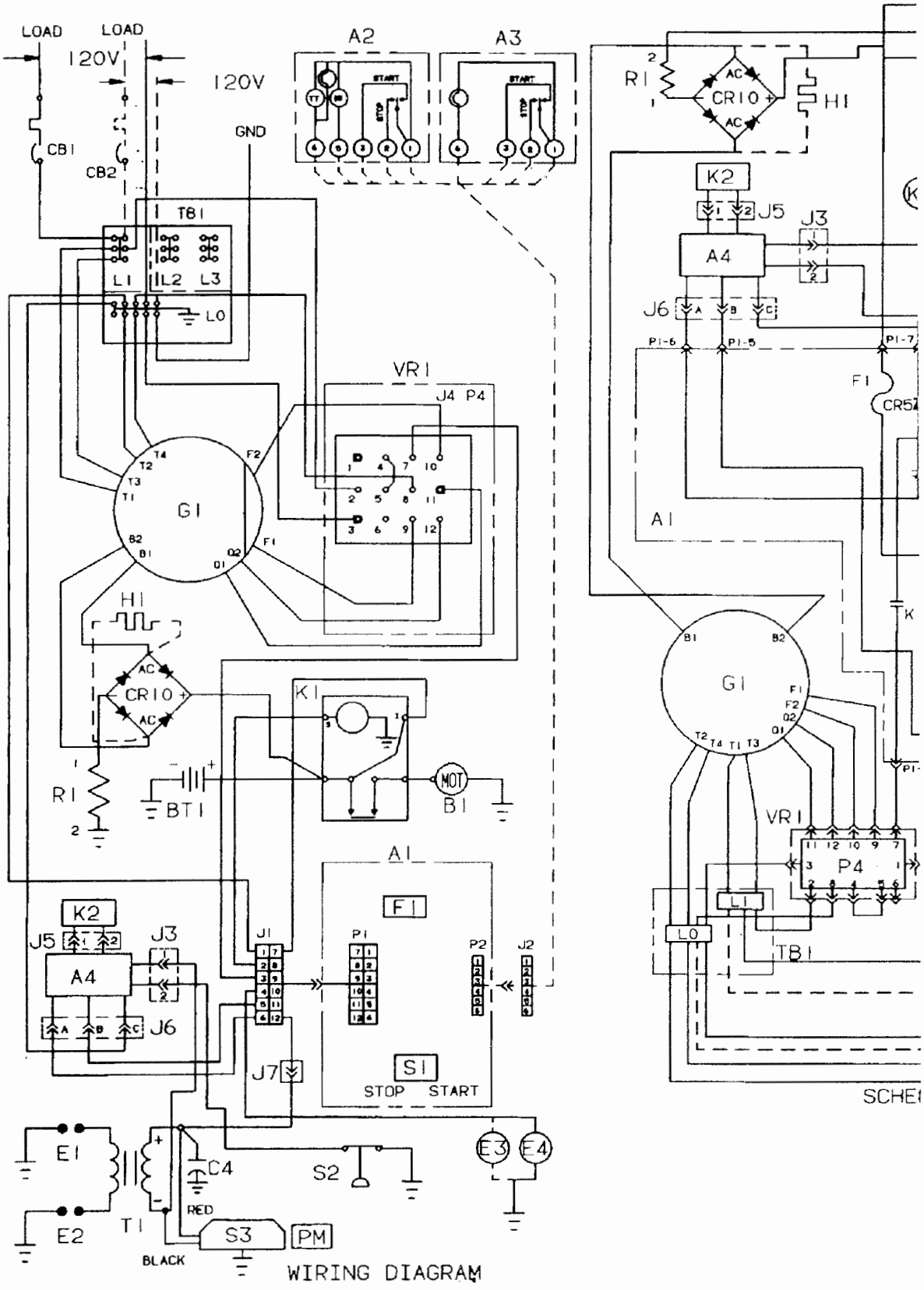


NOTES:

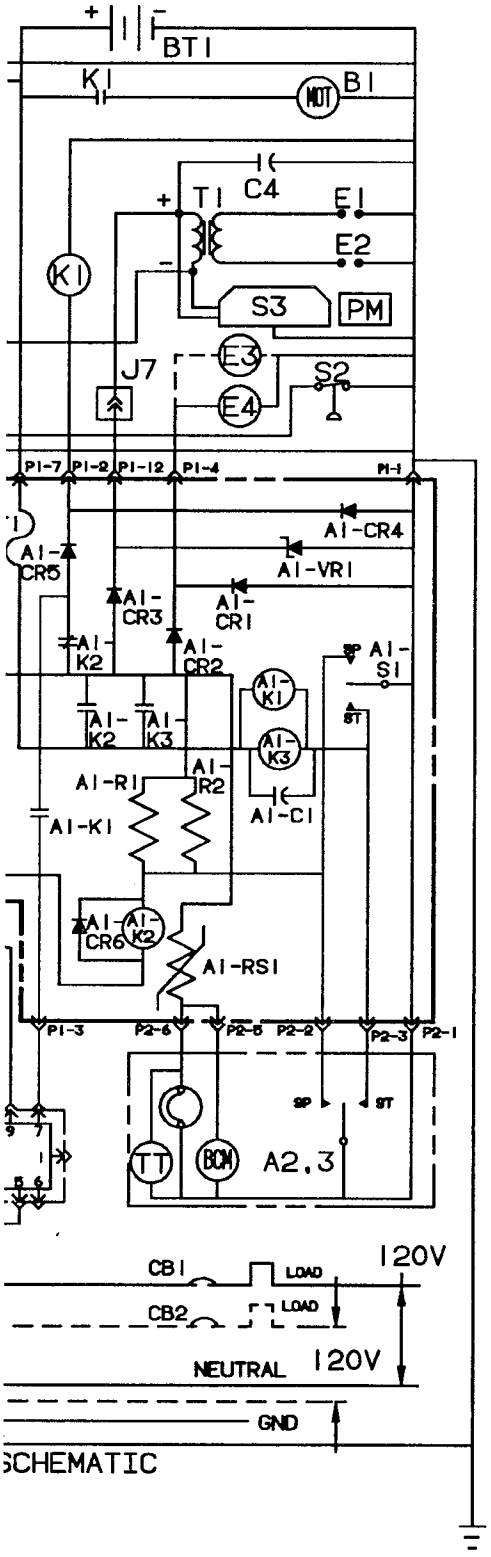
1. ALL ELECTRICAL COMPONENTS ARE DRAWN IN THE DE-ENERGIZED POSITION.

ITEM	PART NO	*BULK	DWG SIZE	QTY	DESCRIPTION OR MATERIAL
VR1					VOLTAGE REGULATOR
T1					IGN COIL
S3					IGN MODULE
S2					SWITCH-LOW OIL PRESSURE
R7					RESISTOR-FUEL PUMP
R6					RESISTOR-BATTERY CHARGE
K6					RELAY-FUEL PUMP
K5					RELAY-STOP LATCH
K1					RELAY-START SOLENOID
H1					CHOKE-GASOLINE ONLY
G1					GENERATOR
F2					FUSE-SLOW BLOW 5A
F1					FUSE-SLOW BLOW 5A
E4					SOLENOID FUEL VALVE
E3					FUEL PUMP
E1,2					SPARK PLUG
CR10					RECTIFIER-FUEL PUMP POWER
CR9					RECTIFIER-FUEL PUMP
CR8					RECTIFIER-STOP LATCH
CB1,2					CIRCUIT BREAKER (AC OUTPUT)
C4					CAPACITOR
BT1					BATTERY 12V
B1					STARTER MOTOR
A3					REMOTE CONTROL-STANDARD
A2					REMOTE CONTROL-DELUXE
A1	300-3590-02		C	REF	CONTROL ASSY-NHM
A1	300-3590-01		C	REF	CONTROL ASSY-BGM

NO. 611-1186
REV. A
MODIFIED



WIRING DIAGRAM

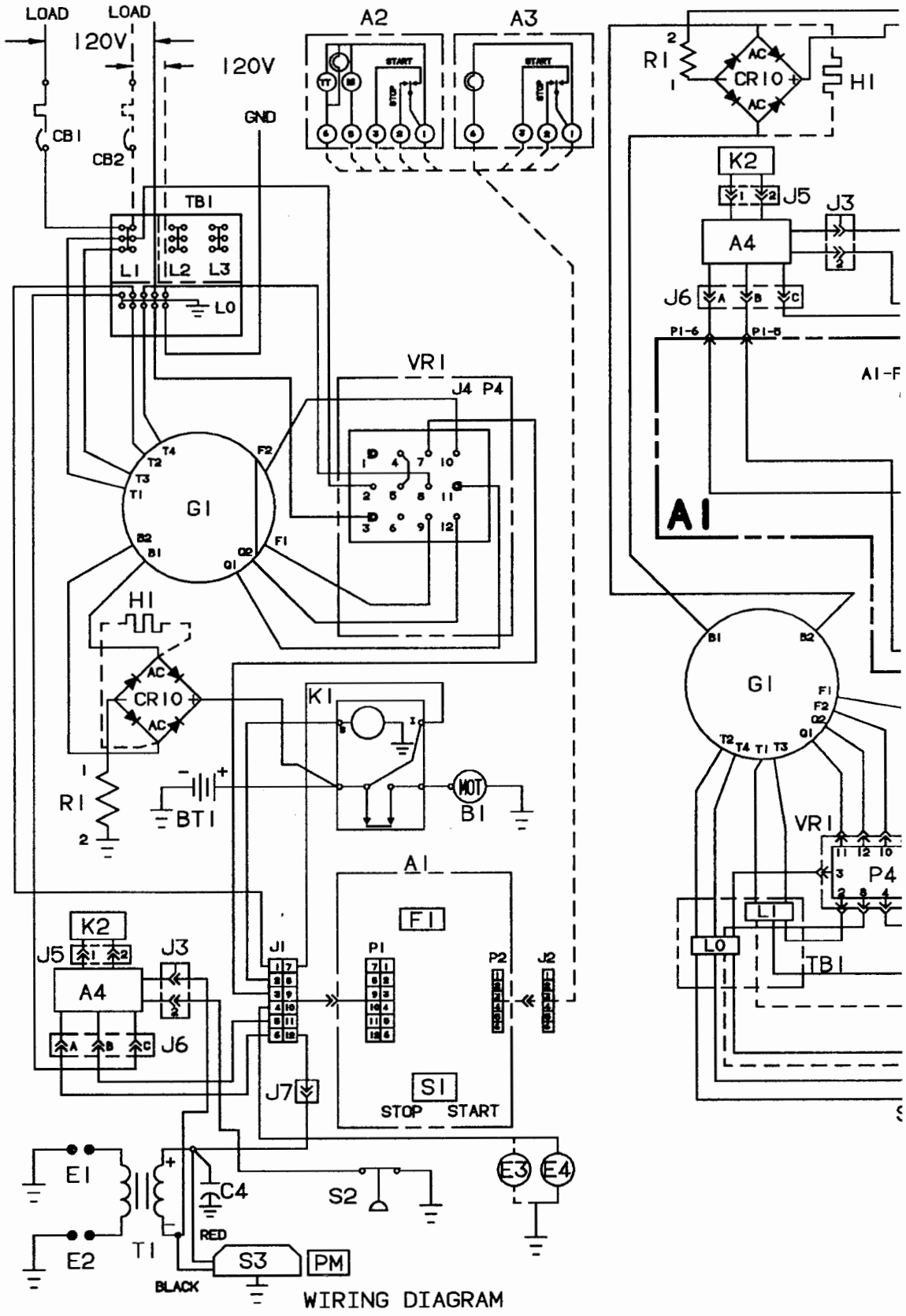


NOTES:

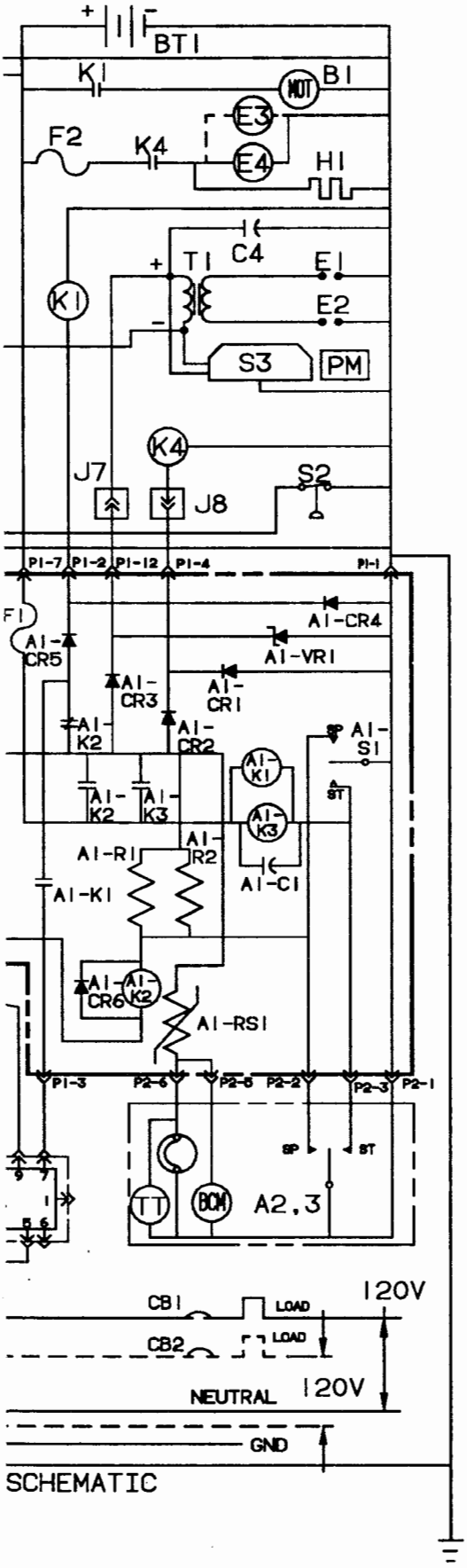
1. ALL ELECTRICAL COMPONENTS ARE DRAWN IN THE DE-ENERGIZED POSITION.

ITEM	PART NO	*MAX	DWG REF	QTY	DESCRIPTION OR MATERIAL
VR1					VOLTAGE REGULATOR
T1					IGN COIL
S3					IGN MODULE
S2					SWITCH-LOW OIL PRESSURE
R1					RESISTOR-BATTERY CHARGE
K2					GOVERNOR ACTUATOR
K1					RELAY-START SOLENOID
H1					CHOKE-GASOLINE ONLY
G1					GENERATOR
F1					FUSE-10A
E4					SOLENOID FUEL VALVE
E3					FUEL PUMP (OR FUEL FILTER-LP)
E1,2					SPARK PLUG
CB1,2					CIRCUIT BREAKER (AC OUTPUT)
C4					CAPACITOR
BT1					BATTERY 12V
B1					STARTER MOTOR
A4					ELECTRONIC GOVERNOR
A3					REMOTE CONTROL-STANDARD
A2					REMOTE CONTROL-DELUXE
A1			C	REF	CONTROL ASSY-NHM
A1			C	REF	CONTROL ASSY-BGM

NO. 611-1196
REV. F
MODIFIED



WIRING DIAGRAM



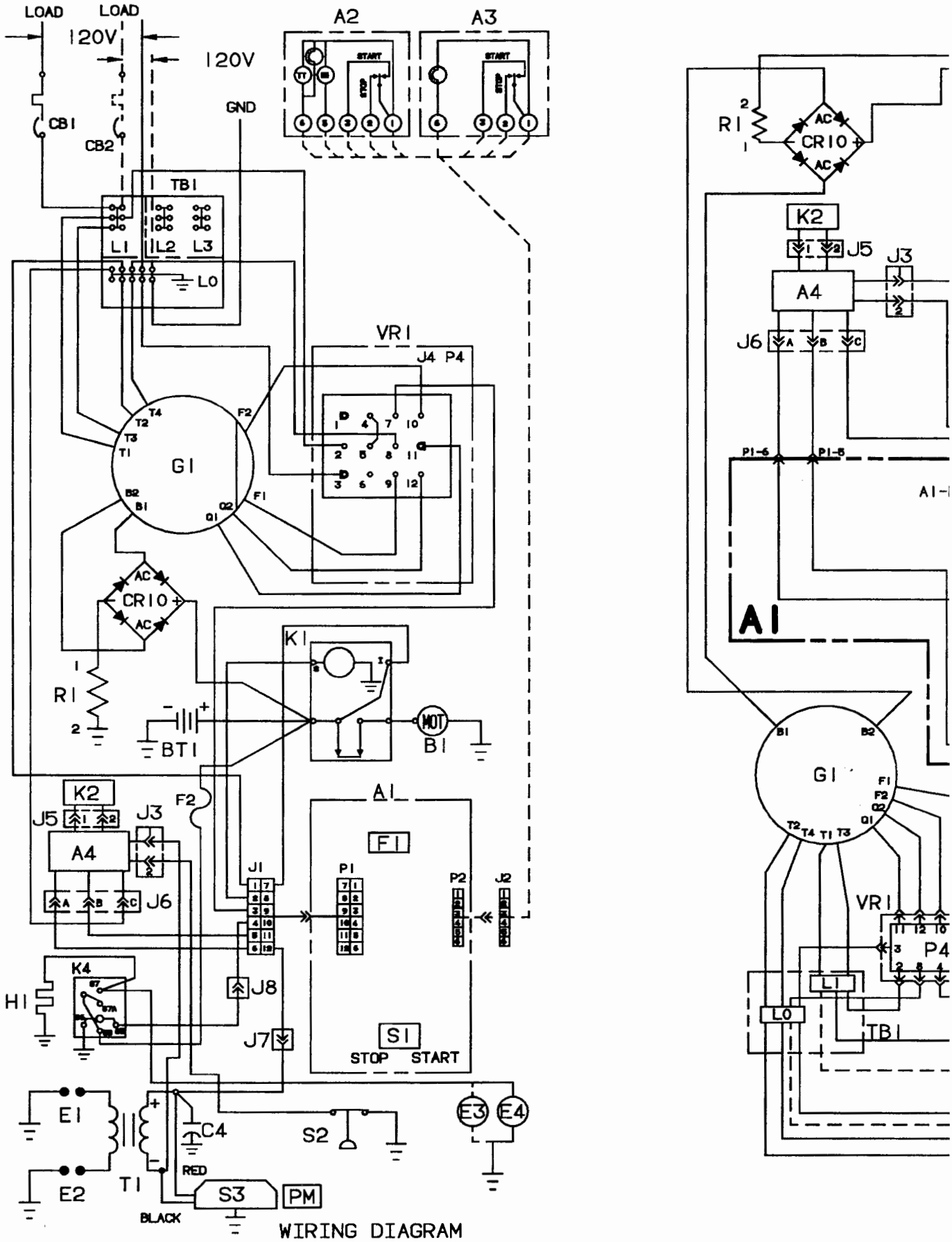
SCHEMATIC

NOTES:

1. ALL ELECTRICAL COMPONENTS ARE DRAWN IN THE DE-ENERGIZED POSITION.

	VR1			VOLTAGE REGULATOR
	T1			IGN COIL
	S3			IGN MODULE
	S2			SWITCH-LOW OIL PRESSURE
	R1			RESISTOR-BATTERY CHARGE
	K4			RELAY
	K2			GOVERNOR ACTUATOR
	K1			RELAY-START SOLENOID
	H1			CHOKE
	G1			GENERATOR
	F2			FUSE-10A
	F1			FUSE-10A
	E4			SOLENOID FUEL VALVE
	E3			FUEL PUMP
	E1,2			SPARK PLUG
	CB1,2			CIRCUIT BREAKER (AC OUTPUT)
	C4			CAPACITOR
	BT1			BATTERY 12V
	B1			STARTER MOTOR
	A4			ELECTRONIC GOVERNOR
	A3			REMOTE CONTROL-STANDARD
	A2			REMOTE CONTROL-DELUXE
REF	A1		C	CONTROL ASSY-NHM
REF	A1		C	CONTROL ASSY-BGM
QTY	ITEM	PART NO.	SPEC CODE	DESCRIPTION OR MATERIAL

NO. 611-1219
REV. A
MODIFIED


LOAD
LOAD
120V
120V
GND
CB1
CB2
A2
A3
START
STOP
TB1
L1
L2
L3
L0
VR1
J4 P4
G1
T4
T2
T3
T1
F2
F1
B2
B1
Q2
Q1
AC
CR10
AC
R1
K1
BT1
MOT
B1
K2
J5
J3
A4
J6
A
B
C
F2
A1
J1
P1
P2
J2
F1
K4
H1
J8
J7
S1
STOP
START
E1
E2
T1
C4
RED
BLACK
S2
S3
PM
E3
E4
WIRING DIAGRAM
R1
CR10
K2
J5
J3
A4
J6
P1-6
P1-5
A1
G1
VR1
P4
L1
L0
TB1

Appendix A. Troubleshooting Guides

The following pages contain simplified troubleshooting procedures for these Marquis electronic components:

Use a volt-ohmmeter and a test light with these procedures to test Marquis control circuit boards for proper functioning.

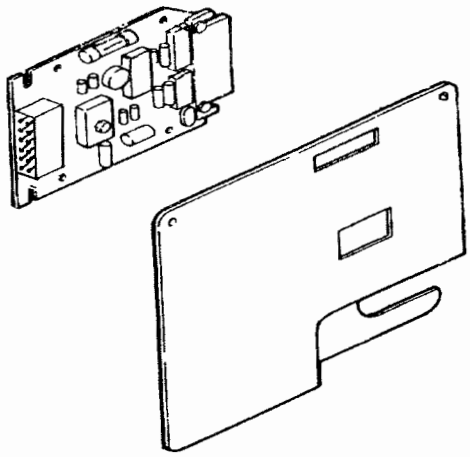
Two Onan product support bulletins are also reprinted in this supplement, as follows:

⚠WARNING

The steps described in this appendix are intended as quick reference guides, rather than complete procedures. Consult the appropriate sections of this manual before using the procedures found in this Appendix.

Incorrect service or parts replacement can result in severe personal injury, death, and/or equipment damage. Service personnel must be qualified to perform electrical and/or mechanical service.

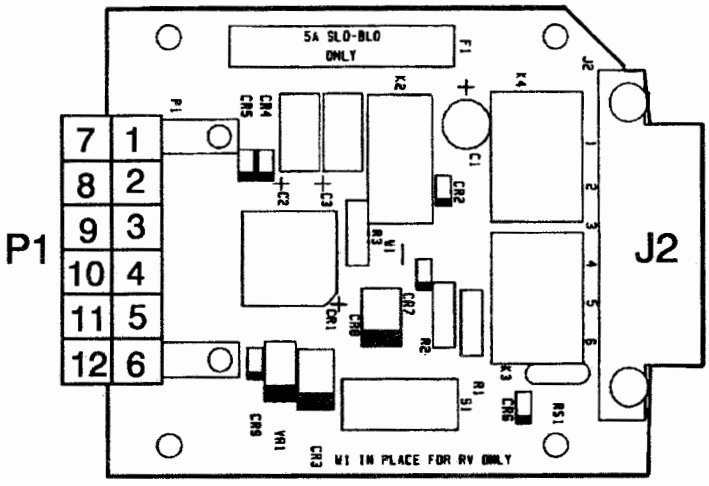
EMERALD/MARQUIS CONTROL BOARD CHECK-OUT (300-3763-01, 02)



MODELS:

- BGE Spec. F & G
- BGEL Spec. E & G
- NHE, NHEL Spec. D, E & G
- BGM, NHM Spec. A
- BGD Spec. A & B
- NHD Spec. A, B & C

P1 plug turned for better viewing.



ES2051a

⚠WARNING

Use extreme caution when working on operating generator sets. Operating generator sets presents hazards of electrocution, burns, fire and explosion, asphyxiation, and entanglement with rotating parts. Review Important Safety Instructions in Operator's Manual.

Emerald/Marquis is a trademark of Onan Corporation

REMOVE CIRCUIT BOARD

To perform the following tests the circuit board must be removed from the control cover.

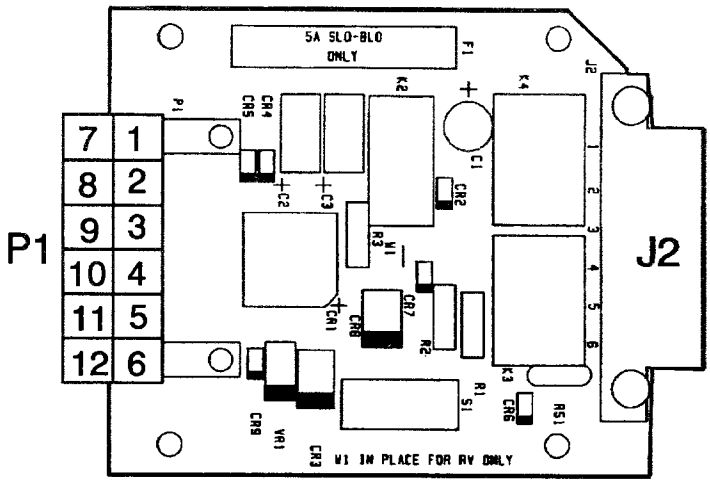
Place the circuit board on a non-conductive surface with the component side of the board up.

For the following tests, the battery must be connected.

STATIC MODE

(With the switch in the Center position)

Meter Test Lead +	Meter Test Lead −	Meter Reading
P1-7	P1-11	12 VDC
P1-7	J2-1	12 VDC

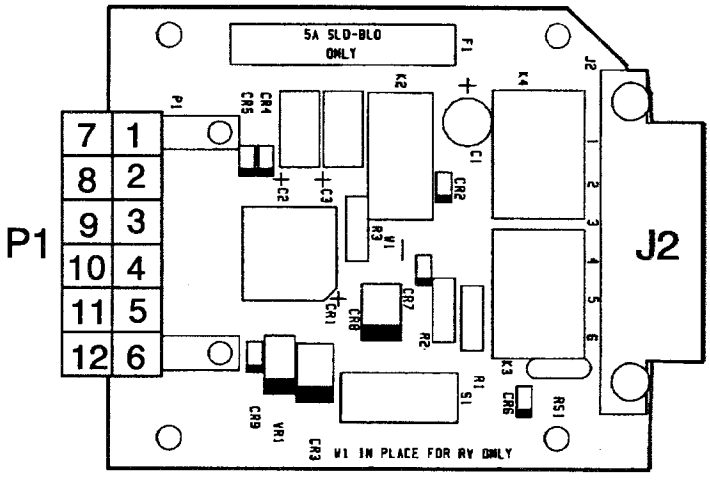


ES2051s

CRANK & START MODE

(With the switch pressed to the Start position)

	Meter Test Lead +	Meter Test Lead −	Meter Reading
	P1-1	J2-1	10-12 VDC
	P1-6	J2-1	10-12 VDC
	P1-9	J2-1	10-12 VDC
	P1-12	J2-1	10-12 VDC
*	P1-7	P1-10	10-12 VDC

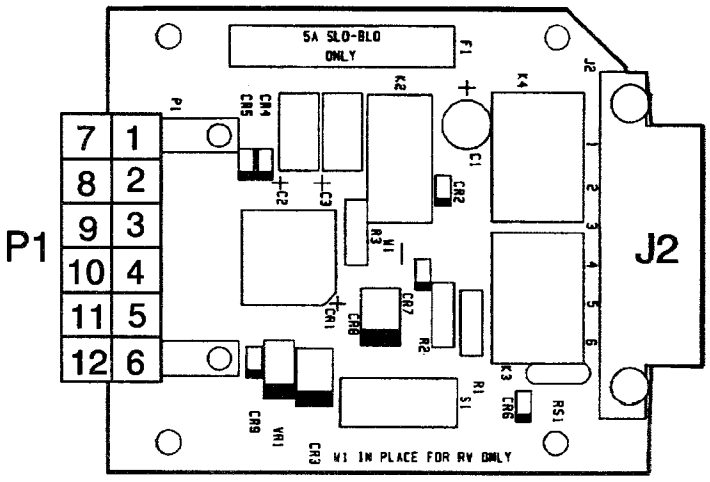


ES2051s

RUN & GENERATE MODE

(With the generator set running and the switch in the Center position)

	Meter Test Lead +	Meter Test Lead −		Meter Reading
	P1-6	J2-1		18-20 VDC
	P1-7	P1-3	N/A BGD/NHD	18-20 VDC
	P1-7	P1-5		10-13 VDC
*	P1-7	P1-10		0 VDC
	P1-12	J2-1		10-13 VDC
	J2-5	J2-1		10-13 VDC
	J2-6	J2-1		10-13 VDC
	P1-2	P1-4		18-22 VAC



ES2051s

STOP MODE

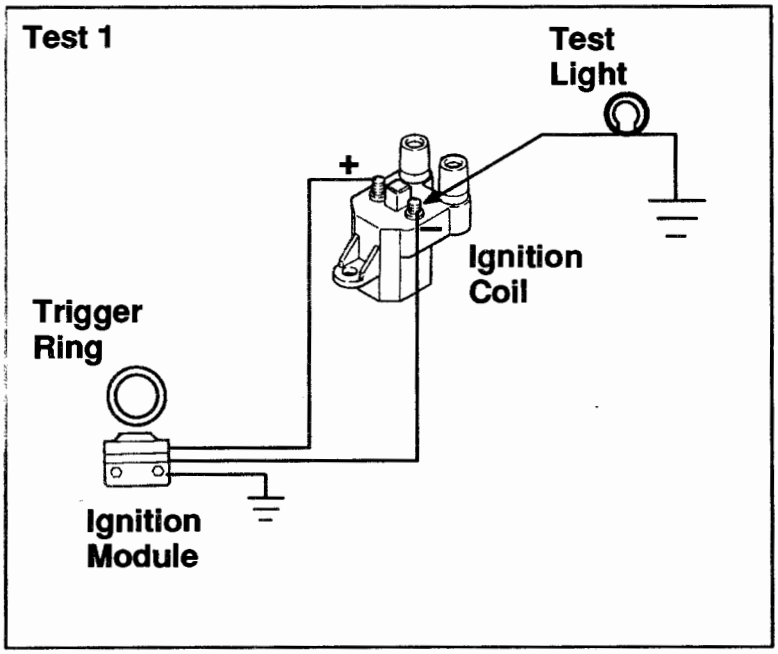
(With the switch pressed to the Stop position)

	Meter Test Lead +	Meter Test Lead −	Meter Reading
	P1-6	J2-1	0 VDC
	P1-12	J2-1	0 VDC
*	P1-7	P1-10	12 VDC

*** Gensets with K5 relay**

Troubleshooting Electronic Ignition Module

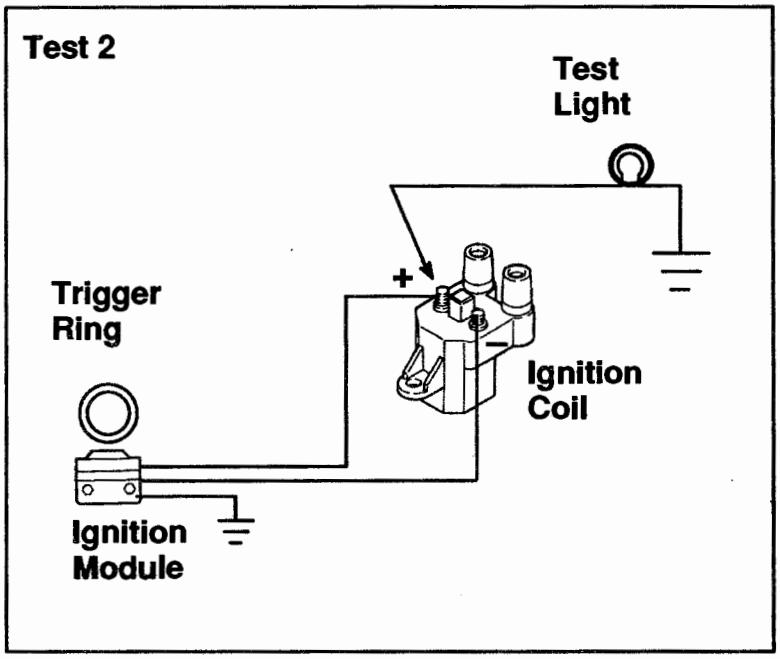
Models: Performer™, Emerald Plus™, Marquis™, Ensign™



1. Check wiring: red lead to positive (+); black lead to negative (–).
2. Connect a DC powered test light from the negative (–) coil terminal to ground.
3. Turn the ignition switch on and crank the engine over. Does the test light flash, bright then dim?

   Yes - The module is ok; do not replace the module.
   No - Go to Test 2.

   Note: If the primary winding of the ignition coil is open, the light will not come on.



4. Connect the test light from the positive (+) coil terminal to ground.
5. Turn the ignition switch to the on position. Does the light come on?

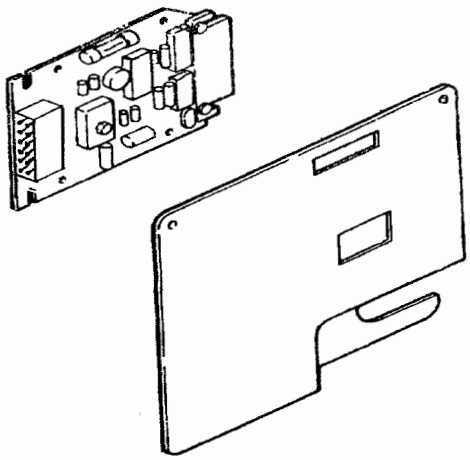
   Yes - Crank the engine over. Does the light stay on while cranking?
   Yes - Replace the module and the trigger ring as a set if the coil tests good.
   No - It is not a module problem. Check the wiring and connections to the coil and the ignition switch, then retest the module.

⚠WARNING

Use extreme caution when working on operating equipment. Operating equipment presents hazards of electrocution, burns, fire and explosion, asphyxiation, and entanglement with rotating parts. Review Important Safety Instructions in Operator's Manual.

MARQUIS® CONTROL BOARD CHECK-OUT (300-3764)

MODEL:
BGM/NHM (Beginning Spec. B)



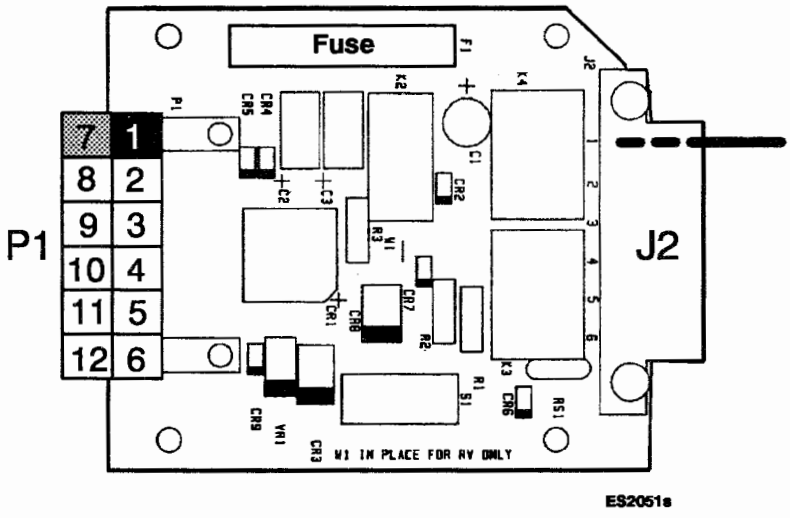
REMOVE CIRCUIT BOARD

To perform the following tests the circuit board must be removed from the control cover.

Place the circuit board on a non-conductive surface with the component side of the board up.

For the following tests, the battery must be connected and in a fully charged state.

P1 plug turned for better viewing.



STATIC MODE

(With the switch in the Center position and the unit not running)

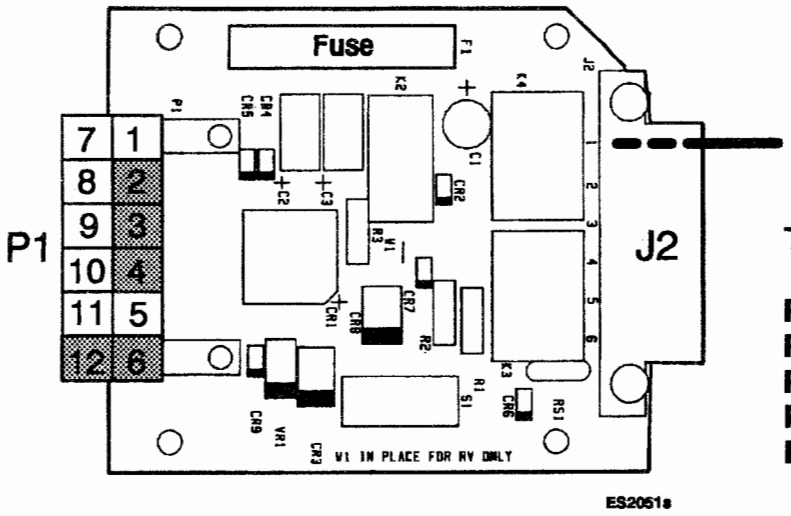
Meter Test Lead +	Meter Test Lead -	* Meter Reading
P1-7	P1-1	12-13 VDC
P1-7	J2-1	12-13 VDC

Note: Care must be taken not to touch more than one P1 pin at a time with a meter lead.

*** All readings +/- 5%. Note that the coating on the P1 pins may have to be scraped off to get a good meter reading.**

⚠WARNING

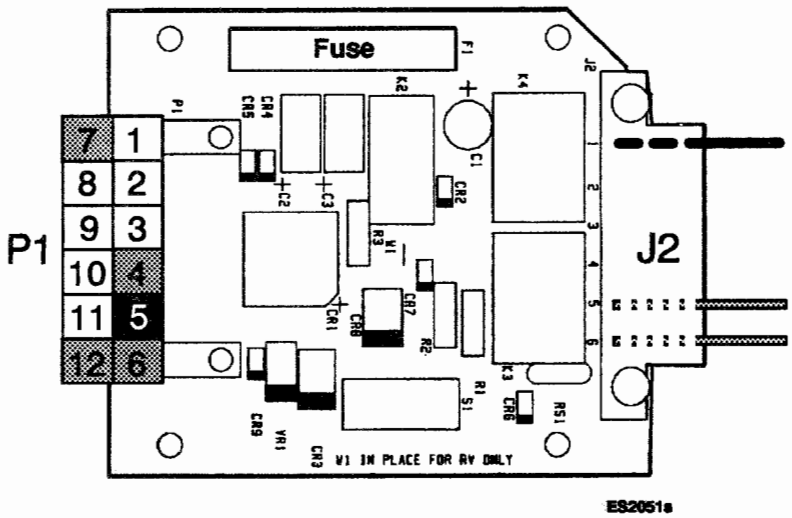
Use extreme caution when working on operating generator sets. Operating generator sets presents hazards of electrocution, burns, fire and explosion, asphyxiation, and entanglement with rotating parts. Review Important Safety Instructions in Operator's Manual.



CRANK & START MODE

(With the switch pressed and held to the Start position)

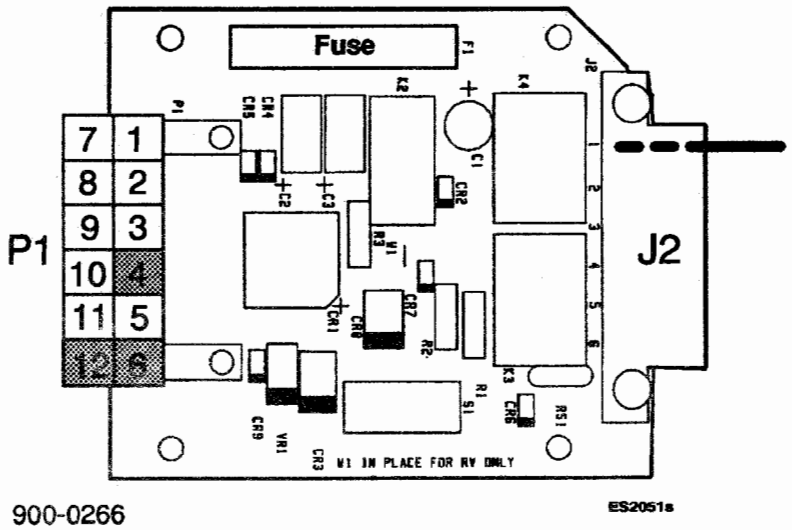
Meter Test Lead +	Meter Test Lead -	* Meter Reading
P1-2	J2-1	..... 8-9 then 0 VDC
P1-3	J2-1	..... 9-10 then 0 VDC
P1-4	J2-1	..... 8-9 then 10-12 VDC
P1-6	J2-1	..... 9-10 then 11-13 VDC
P1-12	J2-1	..... 8-9 then 10-12 VDC



RUN & GENERATE MODE

(With the generator set running and the switch in the Center position)

Meter Test Lead +	Meter Test Lead -	* Meter Reading
P1-4	J2-1	..... 10-12 VDC
P1-6	J2-1	..... 11-13 VDC
P1-12	J2-1	..... 10-12 VDC
P1-7	P1-5	..... 11-13 VDC
J2-5	J2-1	..... 11-13 VDC
J2-6	J2-1	..... 11-13 VDC



STOP MODE

(With the set running, then the switch pressed to the Stop position)

Meter Test Lead +	Meter Test Lead -	* Meter Reading
P1-4	J2-1	..... 10-12 then 0 VDC
P1-6	J2-1	..... 11-13 then 0 VDC
P1-12	J2-1	..... 10-12 then 0 VDC

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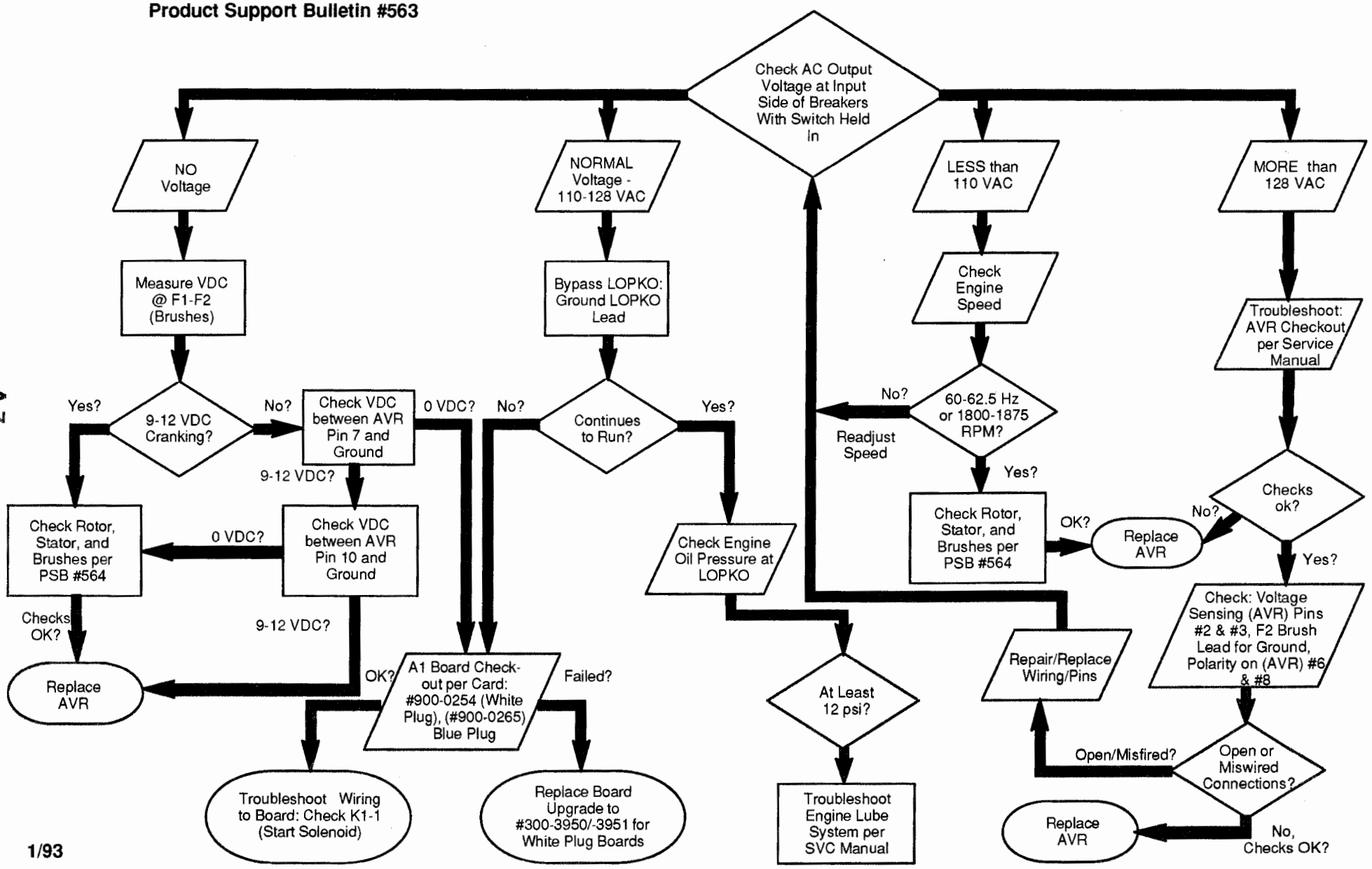
Product Support Bulletin #563

SET DIES WHEN SWITCH RELEASED

–EMERALD AND MARQUIS WITH ELECTRONIC VOLTAGE REGULATOR (AVR)–



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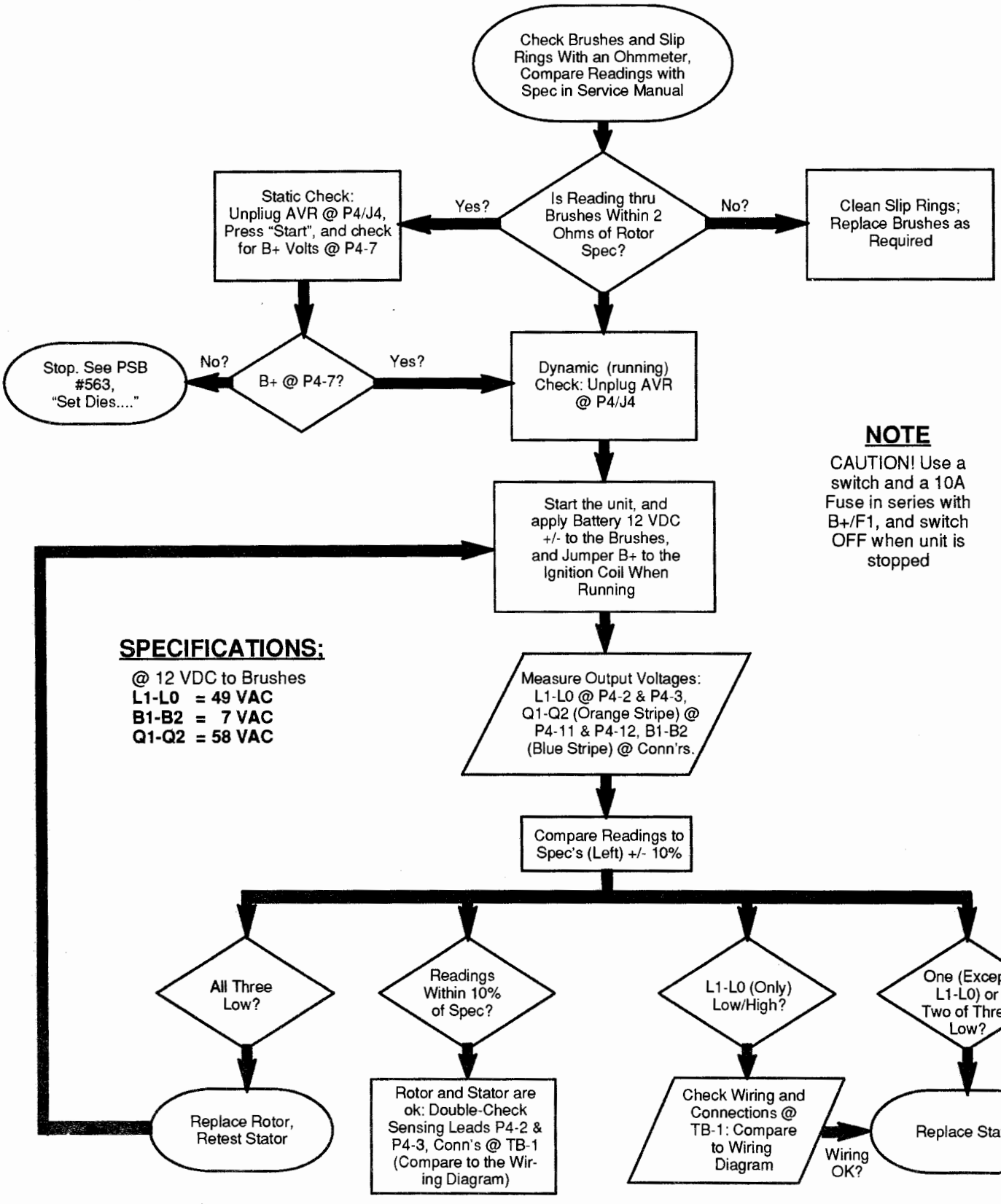
Product Support Bulletin #564

ROTOR/STATOR CHECK

–EMERALD AND MARQUIS WITH ELECTRONIC VOLTAGE REGULATOR (AVR)–



NOTE

CAUTION! Use a switch and a 10A Fuse in series with B+/F1, and switch OFF when unit is stopped

SPECIFICATIONS:

@ 12 VDC to Brushes
L1-L0 = 49 VAC
B1-B2 = 7 VAC
Q1-Q2 = 58 VAC

1/93

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