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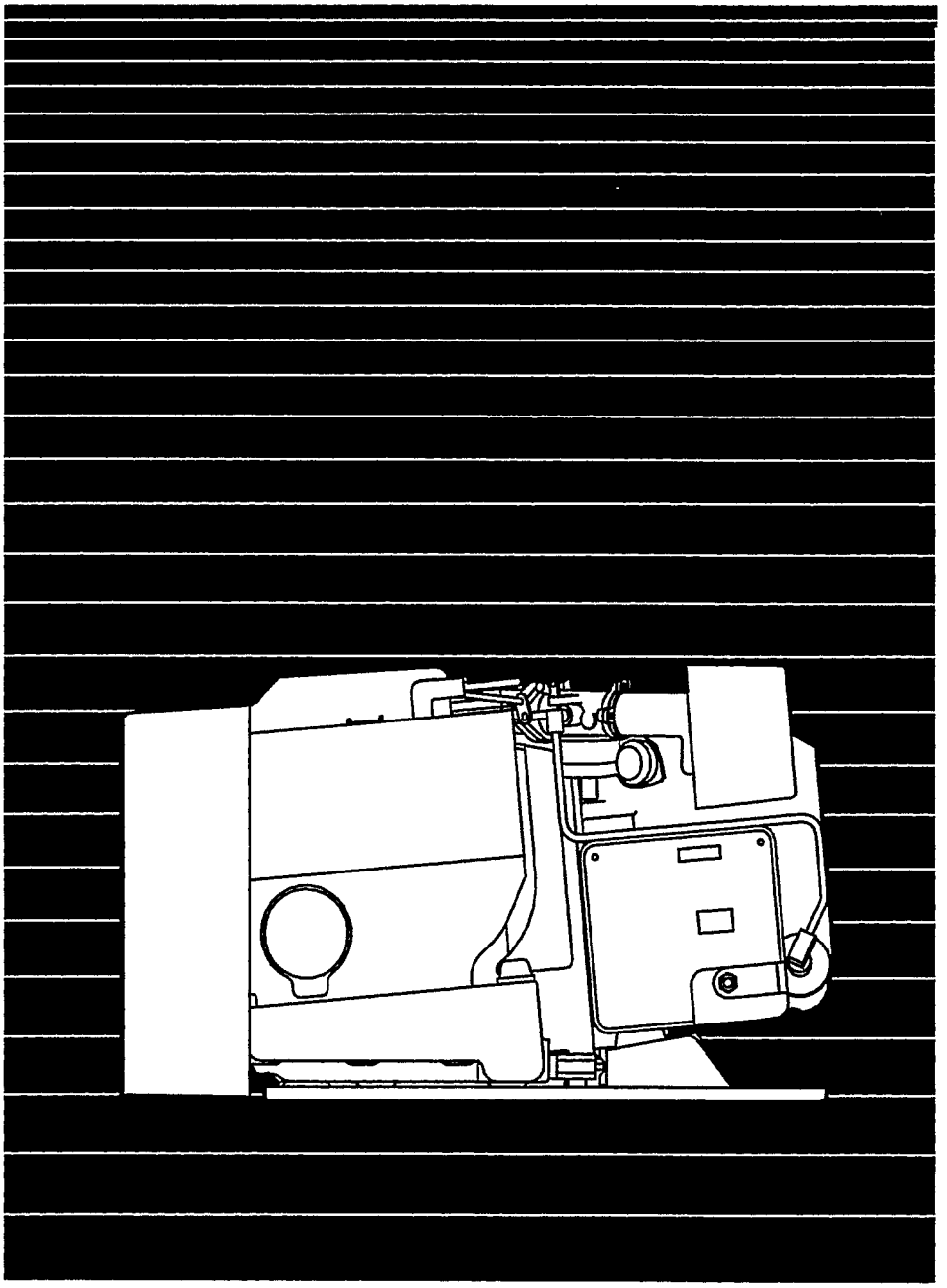
Onan GenSet

Service Manual

BGD, NHD



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965-0529
5-92 (Spec A-G)

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.

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Section 1. Introduction

ABOUT THIS MANUAL

This manual provides service information for the Onan BGD and NHD series commercial vehicle generator sets. This manual describes troubleshooting, disassembly, repair, reassembly, and adjustments to the engine, generator, and control system. The technician must understand basic principles of electrical generation and gasoline engine operation. Basic information can be found in the following Onan publications:

- Electrical/Mechanical Fundamentals (publication 932-0408)
- Onan Generator Training Manual (publication 932-0404)
- BGD and NHD Operator's Manual (publication 985-0130)
- BGD and NHD Installation Manual (publication 965-0629)

Installation must comply with the applicable codes and standards (see the Installation Manual). Improper servicing may create an unsafe installation, resulting in damage to the vehicle and equipment or severe personal injury or death to the user. Read all service procedures completely before beginning any repair work, and observe all cautions and warnings.

MODEL IDENTIFICATION

When contacting an Onan dealer or distributor, supply the complete model number and serial number from the set nameplate. This information identifies the set when ordering replacement parts.

Always use genuine Onan replacement parts, obtained from an authorized Onan dealer or distributor. Other replacement parts might not perform to Onan specifications.

⚠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.***

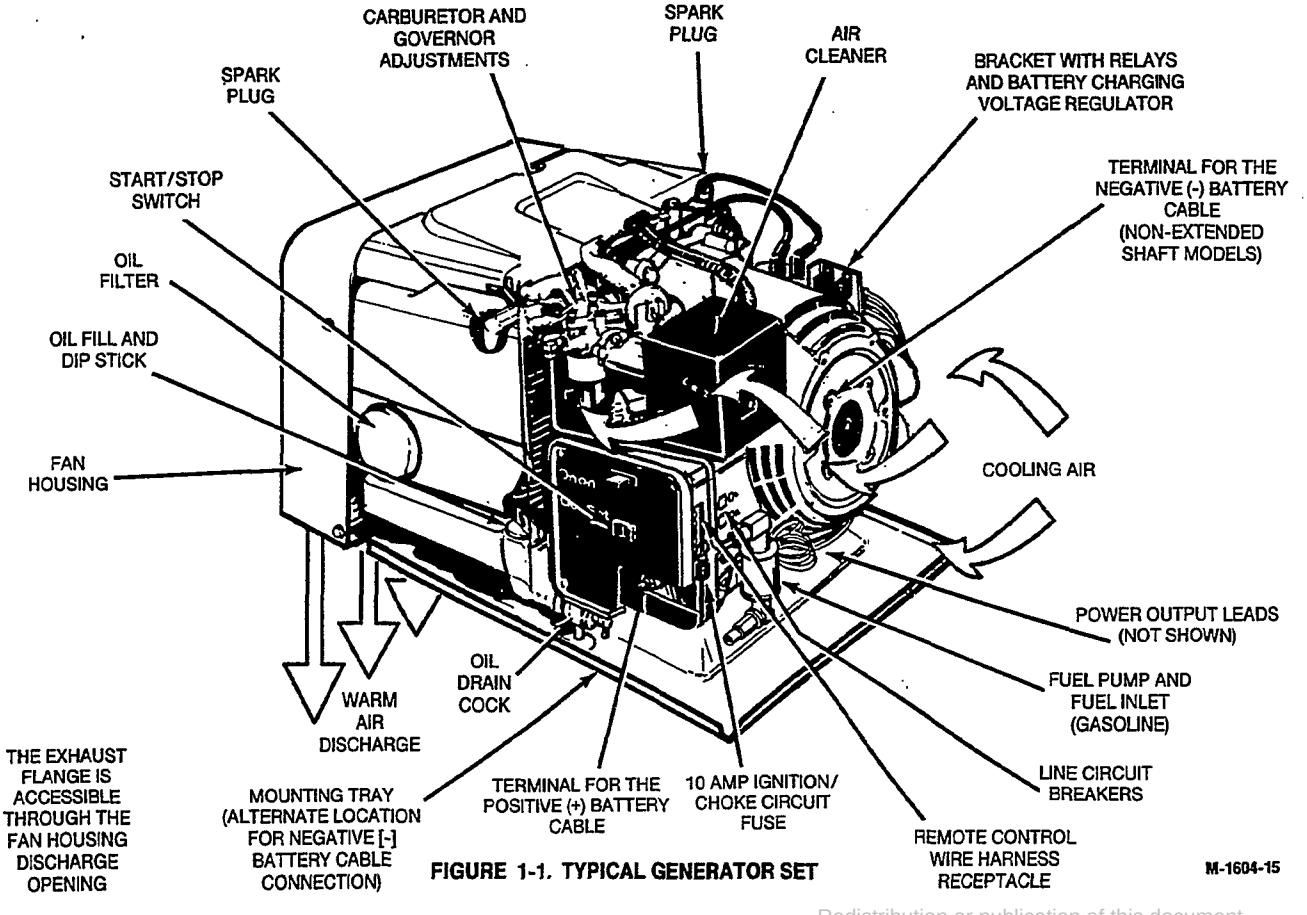

FIGURE 1-1. TYPICAL GENERATOR SET

Section 2. Specifications

	MODEL BGD	MODEL NHD
General		
Weight	204 pounds (92 kg)	230 pounds (104 kg)
Overall Dimensions (H x L x W)	14 x 25-1/4 x 19 in. (356 x 641 x 478 mm)	14-5/8 x 25-9/16 x 21-1/16 in. (371 x 649 x 535 mm)
Minimum Free Area for Ventilating Air	85 sq. in. (548 sq. cm)	85 sq. in. (548 sq. cm)
Minimum Vertical Clearance At Air Discharge Outlet	2 in. (51 mm)	2 in. (51 mm)
Exhaust Tailpipe Diameter and Material	1-3/8 in. ID, 18 Gauge Rigid Steel Tubing	1-3/8 in. ID, 18 Gauge Rigid Steel Tubing
Control Panel Fuse (F1)	5 amps Slow-Blow	5 amps Slow-Blow
Ignition / Choke Fuse (F2) (Beginning Spec F)	10 amps	10 amps
Engine		
Displacement	47.7 in^3 (782 cm^3)	60 in^3 (983 cm^3)
Compression Ratio	6.9:1	7.0:1
Bore	3.25 in. (82.6 mm)	3.56 in. (90.4 mm)
Stroke	2.87 in. (72.9 mm)	3.00 in. (76.2 mm)
Cylinder Compression (Hot)	75-115 psi (517-793 kPa)	100-120 psi (690-827 kPa)
Spark Plug Gap	0.025 in. (0.64 mm)	0.025 in. (0.64 mm)
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)
Engine Oil Capacity (Dry Filter)		
Spec F	3.5 quarts (3.3 L)	3.5 quarts (3.3 L)
Prior to Spec F	4.0 quarts (3.8 L)	4.0 quarts (3.8 L)
Ignition Timing		
Electronic (Non-adjustable)	14°-18° BTC	14°-18° BTC
Breaker-Point (Typical)*	20° BTC	20° BTC
Breaker-Point Gap*	0.016 in. (0.41 mm)	0.016 in. (0.41 mm)**
Fuel Connections		
Maximum Gasoline Supply Pressure (at Carburetor)	6 psi (41 kPa)	6 psi (41 kPa)
Maximum Gasoline Fuel Pump Lift	3 Ft. (0.9 m)	3 Ft. (0.9 m)
Gasoline Supply Fitting	1/4 in. ID Hose Barb	1/4 in. ID Hose Barb
Min. – Max. Propane Supply Pressure (Vapor Withdrawal)	7 – 14 in. (178 – 356 mm) WC	7 – 14 in. (178 – 356 mm) WC
Propane Supply Connection (Vapor Withdrawal)	3/4 in. NPTF Tapping	3/4 in. NPTF Tapping
Propane Supply Connection (Liquid Withdrawal)	1/4 in. NPTF Tapping	1/4 in. NPTF Tapping

* – Spec A for Model BGD and Specs A and B for Model NHD.

** – 0.021 in. (0.53 mm) for LPG.

Specifications (Cont.)

	MODEL BGD	MODEL NHD
Battery		
Voltage	12	12
Cold Cranking Amps (SAE J537) for Ambients Above / Below Freezing	360 / 450	360 / 450
Minimum Required Voltage At Starter Motor Terminals During Cranking	8	8
Battery Charging Voltage (at No-Load AC)	14.4	14.4
Battery Charging Voltage (at Full-Load AC)	14.6	14.6
Maximum Continuous Battery Charging Amperage	10	10
Trickle Battery Charging Amperage	0.5	0.5

	50 Hertz (1500 RPM)	60 Hertz (1800 RPM)	50 Hertz (1500 RPM)	60 Hertz (1800 RPM)
Gasoline Fueled Sets				
Rated Power Output	4.0 kW	4.5 kW	5.0 kW	6.5 kW
Full-Load Current (1-Phase Generators)				
At 110/220 Volts	36.4/18.2 amps	—	45.5/22.7 amps	—
At 120/240 Volts	—	37.5/18.8 amps	—	54.2/27.1 amps
Full-Load Current (3-Phase Generators)				
At 110/220 Volts*	21.0/10.5 amps	—	26.3/13.2 amps	—
At 120/240 Volts*	—	21.7/10.8 amps	—	31.3/15.7 amps
Gasoline Consumption				
Under Full-Load	0.73 gph (2.8 L/h)	0.8 gph (3.0 L/h)	0.8 gph (3.0 L/h)	1.3 gph (4.9 L/h)
Under Half-Load	0.53 gph (2.0 L/h)	0.6 gph (2.3 L/h)	0.57 gph (2.2 L/h)	0.7 gph (2.5 L/h)
Under No-Load	0.35 gph (1.3 L/h)	0.4 gph (1.5 L/h)	0.35 gph (1.3 L/h)	0.4 gph (1.5 L/h)
Propane Fueled Sets				
Rated Power Output	3.5 kW	4.0 kW	5.0 kW	6.3 kW
Full-Load Current (1-Phase Generators)				
At 110/220 Volts	31.8/15.9 amps	—	45.5/22.7 amps	—
At 120/240 Volts	—	33.3/16.7 amps	—	52.5/26.3 amps
Propane Consumption				
Under Full-Load	0.98 gph (3.7 L/h)	1.3 gph (4.9 L/h)	1.18 gph (4.5 L/h)	1.7 gph (6.4 L/h)
Under Half-Load	0.65 gph (2.5 L/h)	0.8 gph (3.0 L/h)	0.78 gph (3.0 L/h)	1.05 gph (4.0 L/h)
Under No-Load	0.4 gph (1.5 L/h)	0.5 gph (1.9 L/h)	0.5 gph (1.9 L/h)	0.65 gph (2.5 L/h)

* – These values are for generators having a Series-Delta connection.

Section 3. Dimensions and Clearances

MODELS	BGD	NHD
CYLINDERS AND PISTON ASSEMBLY	Values are in inches (millimeters) unless specified otherwise	
Cylinder Bore* (Std size honed)	3.2490-3.2500 (82.52-82.55 mm)	3.5625-3.5635 (90.49-90.51 mm)
Cylinder Taper (Max)	0.005 (0.13 mm)	0.003 (0.08 mm)
Cylinder Out Of Round (Max)	0.003 (0.08 mm)	0.003 (0.08 mm)
Clearance In Cylinder	0.0033-0.0053 (0.084-0.135 mm)	0.0070-0.0090 (0.178-0.229 mm)
Ring Gap	0.010-0.020 (0.25-0.50 mm)	0.010-0.020 (0.25-0.50 mm)
Piston Ring #1 (top) Groove Width	0.0602-0.0612 (1.53-1.55 mm)	0.0602-0.0612 (1.53-1.55 mm)
Piston Ring #2 Groove Width	0.0602-0.0612 (1.53-1.55 mm)	0.0602-0.0612 (1.53-1.55 mm)
Piston Ring #3 Groove Width	0.1193-0.1203 (3.03-3.06 mm)	0.1193-0.1203 (3.03-3.06 mm)
Piston Ring #1 (top) Groove Width - Prior to Spec F	0.080-0.081 (2.03-2.06 mm)	0.080-0.081 (2.03-2.06 mm)
Piston Ring #2 Groove Width - Prior to Spec F	0.080-0.081 (2.03-2.06 mm)	0.080-0.081 (2.03-2.06 mm)
Piston Ring #3 Groove Width - Prior to Spec F	0.188-0.189 (4.78-4.80 mm)	0.188-0.189 (4.78-4.80 mm)
Piston Ring #1 (Top) Side Clearance	0.003-0.008 (0.076-0.203 mm)	0.002-0.008 (0.051-0.203 mm)
Piston Pin Diameter	0.6875-0.6877 (17.46-17.47 mm)	0.7500-0.7502 (19.05-19.06 mm)
Piston Pin Fit In Rod	0.0002-0.0007 (0.005-0.018 mm)	0.0002-0.0008 (0.005-0.020 mm)
Connecting Rod Side Clearance	0.002-0.016 (0.051-0.406 mm)	0.002-0.016 (0.051-0.406 mm)
Connecting Rod Bearing Clearance	0.0020-0.0033 (0.051-0.084 mm)	0.002-0.0033 (0.051-0.084 mm)

*The bore is 0.005 inches oversize if the engine serial number has suffix "E".

MODELS	BGD	NHD
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)
Crankshaft Main Bearing Diameter	2.0024-2.0034 (50.860-50.886 mm)	2.0015-2.0040 (50.838-50.902 mm)
Crankshaft Main Bearing Clearance	0.0024-0.0042 (0.061-0.107 mm)	0.0024-0.0042 (0.061-0.107 mm)
Crankshaft End Play	0.006-0.012 (0.15-0.30 mm)	0.006-0.012 (0.15-0.30 mm)
Camshaft Journal Diameter	1.3740-1.3745 (34.90-34.91 mm)	1.3740-1.3745 (34.90-34.91 mm)
Camshaft Bearing Diameter	1.376-1.377 (34.95-34.97 mm)	1.376-1.377 (34.95-34.97 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	(0.011-0.048) (0.28-1.2 mm)	0.011-0.048 (0.28-1.2 mm)
VALVE AND LIFTERS		
Valve Spring Free Length	1.600 (40.64 mm)	1.662 (42.21 mm)
Valve Spring Compressed Length (valve closed)	1.346 (34.19 mm)	1.375 (34.92 mm)
Valve Spring Tension Open	55 lbs (25 kg)	71 lbs (32 kg)
Valve Spring Tension Closed	25 lbs (11 kg)	38 lbs (17 kg)

MODELS	BGD		NHD
Valve Face Angle	44°		44°
Valve Seat Angle	45°		45°
Valve Stem Diameter (Intake)	0.2795-0.2800 (7.099-7.112 mm)		0.3425-0.3430 (8.700-8.712 mm)
Valve Stem Diameter (Exhaust)	0.2780-0.2785 (7.061-7.074 mm)		0.3410-0.3420 (8.661-8.687 mm)
Valve Guide Diameter	Intake 0.2810-0.2820 (7.137-7.163 mm)	Exhaust 0.2805-0.2815 (7.125-7.150 mm)	Intake and Exhaust 0.344-0.346 (8.74-8.79 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 (0.051-0.089 mm)		0.0025-0.0040 (0.064-0.102 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 (0.051-0.102 mm)		0.0020-0.0040 (0.051-0.102 mm)
Intake Valve Seat Diameter (Outside)	1.470-1.471 (37.34-37.36 mm)		1.569-1.570 (39.85-39.88 mm)
Exhaust Valve Seat Diameter (Outside)	1.192-1.193 (30.28-30.30 mm)		1.255-1.256 (31.88-31.90 mm)
Valve Seat Bore Diameter (Intake)	1.4395-1.4405 (36.563-36.588 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

MODELS	BGD	
TORQUE SPECIFICATIONS	Use engine oil as a lubricant for all threads EXCEPT the spark plug and rotor through-bolt threads.	
	FOOT-POUNDS	(NEWTON-METRES)
Cylinder Head (Cold)	15-17	(20-23)
Connecting Rod	12-14	(16-19)
Rear Bearing Plate	25-27	(34-37)
Flywheel Mounting Screw	50-55	(68-75)
Oil Base	18-23	(24-31)
Gearcase Cover	8-10	(11-14)
Spark Plug	11	(15)
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 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	(11-16)
Front Vibration Isolator -Flange to Oil Base Screws	19-22	(26-30)
-Center Screw	28-32	(38-43)

MODELS	NHD	
TORQUE SPECIFICATIONS	Use engine oil as a lubricant for all threads EXCEPT the spark plug and rotor through-bolt threads	
	FOOT-POUNDS	(NEWTON-METRES)
Cylinder Head (Cold)	15-17	(20-23)
Connecting Rod	27-29	(37-39)
Rear Bearing Plate	25-28	(34-38)
Flywheel Mounting Screw	50-55	(68-75)
Oil Base	18-23	(24-31)
Gearcase Cover	8-10	(11-14)
Spark Plug	11	(15)
Exhaust Manifold	20-23	(27-31)
Intake Manifold	15	(20)
Other 3/8 Cylinder Block Nuts	18-23	(24-31)
Oil Pump	7-9	(10-12)
Rotor Through-Bolt	45-55	(61-75)
Starter Mounting Screws	30-33	(41-45)
Stator Clamp Screws	10-12	(11-16)
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	(11-16)
Front Vibration Isolator -Flange to Oil Base Screws	19-22	(26-30)
-Center Screw	28-32	(38-43)

Section 5. Preparing to Service

TROUBLESHOOTING

The generator set can be divided into four areas for servicing:

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

A separate section in this manual covers each area. Troubleshooting charts define the causes of various malfunctions.

SPECIAL TOOLS

The tools listed below are necessary to service the generator set. Some of these are available through an authorized Onan service center; consult the Onan tool catalog (publication #900-0019).

Engine Tools:

Torque wrench (0 - 75 ft-lbs or 0-100 N•m)
Feeler gauge
Pressure gauge
Spark plug gap gauge
Cylinder compression tester
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 4 in.)
Hole gauge (0.300 in. to 0.400 in.)
Plasti-Gage bearing clearance guide

Generator and Control:

Lead or dead-blow hammer
Battery hydrometer
VOM multi-tester
Insulation resistance tester (Megger)
Frequency meter
Armature growler
Load test panel and leads

SAFETY CONSIDERATIONS

Generator sets present several hazards that must be considered to service the unit safely. Study the safety precautions on the inside front cover of this manual closely, and become familiar with the hazards listed in Table 5-1. Approach the job in a safety-conscious manner, to avoid injury or death.

Safeguards to Avoid Hazards

- **Use personal protection:** Wear appropriate protective safety equipment, such as:

  - Safety shoes
  - Gloves
  - Safety glasses
  - Hard hats

  Do not wear rings or jewelry, and do not wear loose clothing that might get caught on equipment.

TABLE 5-1
HAZARDS AND THEIR SOURCE

- Fire and explosions
  - —Leaking fuel
  - —Hydrogen gas from charging battery
  - —Oily rags improperly stored
  - —Flammable liquids improperly stored
  - —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
  - —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 generator set load connections
  - —Faulty wiring
  - —Faulty electrical load wiring
  - —Faulty generator set wiring
- Rotating Machinery
  - —Flywheel fan guard not in place
- Slippery Surfaces
  - —Leaking or spilled oil
- Heavy Objects
  - —Removing generator set from vehicle
  - —Removing heavy components

- **Reduce the hazard:** A safe, orderly workshop area and well-maintained equipment reduce the hazard potential. Keep guards and shields in place on machinery, and maintain equipment in good working condition. Store flammable liquids in approved containers, away from fire, flame, spark, pilot light, arc-producing equipment or other ignition sources. Keep the workshop clean and well-lighted, and provide adequate ventilation. Keep fire extinguishers and safety equipment nearby, and be prepared to respond to an emergency.

- **Develop safe work habits:** Unsafe actions cause accidents with tools and machines. Be familiar with the equipment, and know how to use it safely. Use the correct tool for the job, and check its condition before starting. Comply with the warnings in this manual, and take special precautions when working around electrical equipment. Do not work alone if possible, and take no risks.

- **Be prepared to respond to an accident:** Agencies such as the Red Cross and public safety departments offer courses in first aid, CPR, and fire control. Take advantage of this information to be ready to respond to an accident. Learn to be safety-conscious, and make safety procedures part of the work routine.

SET REMOVAL GUIDELINES

Certain service procedures require that the generator set be removed from the vehicle. The generator set is normally mounted in a special compartment, on the vehicle bed, or below the vehicle floor.

Because generator set installations vary, it is not possible to describe a specific removal procedure. If an acceptable method cannot be determined, contact the vehicle manufacturer or the generator set installer for the preferred method.

Special fuel handling procedures are required to remove an LPG-powered set. The fuel system must be purged of LP gas before the set can be removed safely from the vehicle.

⚠WARNING ***The generator set is 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.***

LPG Purging Procedure

1. Open the set-mounted AC circuit breakers and close the shutoff valve at the fuel tank.
2. Start and run the generator set until it is out of fuel.
3. Crank the set a few times after it stops, to make certain that it is purged of fuel.

If the generator set cannot be operated, do the following:

1. Move the vehicle to a well-ventilated outdoor location, far from fire, flame, spark, pilot light, arc-producing equipment or other ignition sources.
2. Disconnect the vehicle negative (-) battery cable and the generator set negative (-) battery cable from their respective batteries.
3. Close the generator set fuel system shutoff valves, and all other shutoff valves, at the fuel tank.

⚠WARNING ***LP gas (Propane) is extremely flammable, and poisonous. Severe personal injury or death can result if it is accidentally ignited or inhaled. Eliminate all possible sources of ignition including fire, flame, spark, pilot light, arc-producing equipment or other ignition sources before purging LP gas from the fuel system. Provide adequate ventilation to dissipate LP gas as it is released.***

4. Slightly open the fuel line (flexible section) at the solenoid valve, and allow the LP gas to slowly escape. Do not open the fitting widely: a large quantity of gas may be released.
5. Disconnect the fuel supply hose from the carburetor, and hold it clear of the set.
6. Press in and hold the primer button on the regulator to release LP gas from the set fuel system.
7. When gas can no longer be heard escaping from the open end of the fuel supply hose, reconnect the hose to the carburetor.

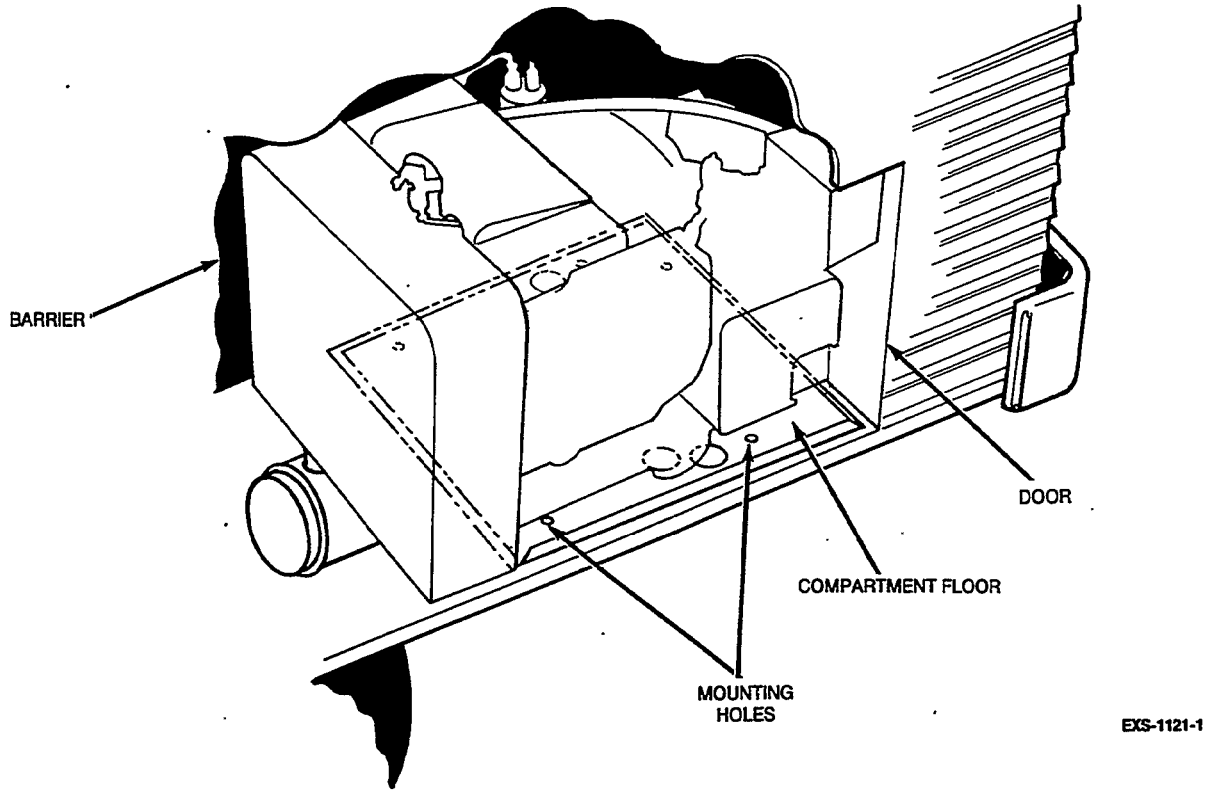

FIGURE 5-1. TYPICAL COMPARTMENT MOUNT INSTALLATION

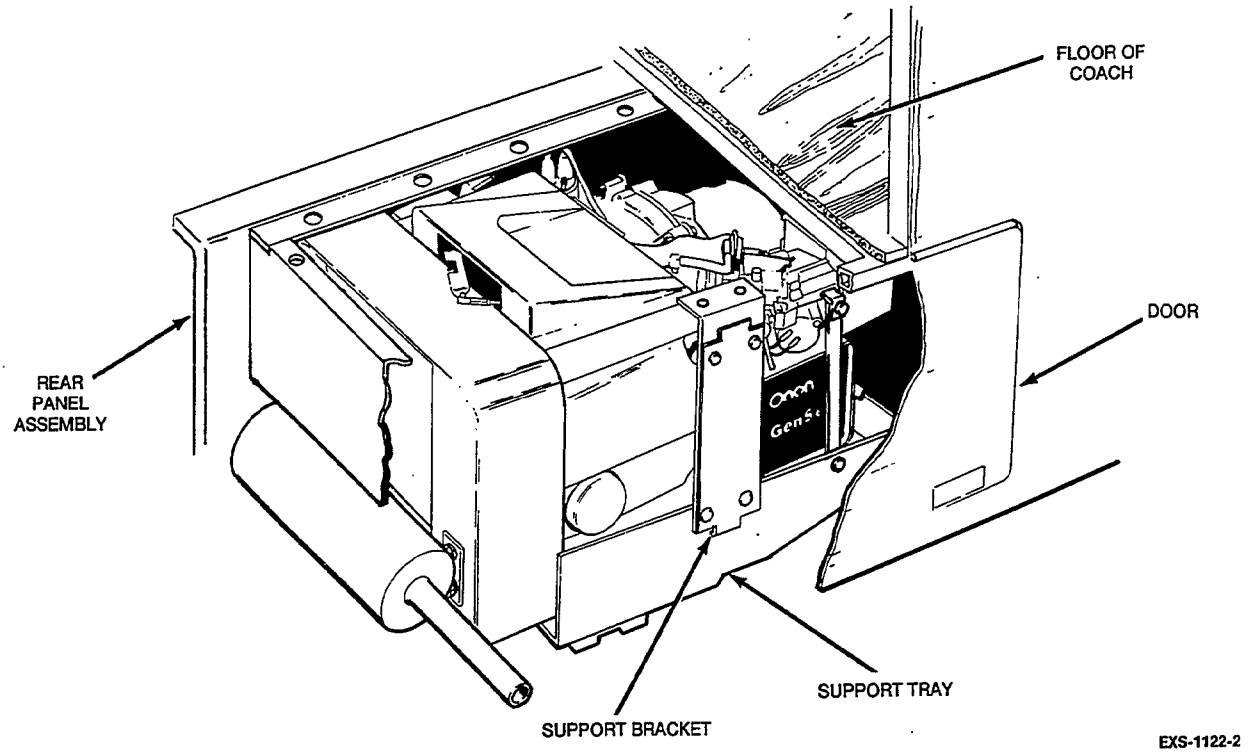

FIGURE 5-2. TYPICAL UNDER-FLOOR INSTALLATION

Disconnecting Set from Vehicle Systems

Refer to Figures 5-1 and 5-2 for component locations in typical generator set installations.

1. Disconnect the vehicle negative (-) battery cable at the battery terminal.
2. Disconnect the generator set negative (-) battery cable at the battery terminal.
3. Disconnect the generator set positive (+) battery cable from the start solenoid.
4. Disconnect the remote control wire plug from the generator set control.
5. Disconnect the generator load wires at the vehicle electrical system junction box. Tag the vehicle circuit wires for positive identification when reconnecting.
6. Loosen the conduit connector, and pull the load wires and flexible conduit free of the junction box.
7. (Extended-shaft units only) Disconnect any couplings, adapters, or power takeoff-related attachments from the extended shaft of the unit.
8. Disconnect the muffler from the exhaust manifold at the flange connection. Disconnect any support brackets or hangers that connect the muffler to the set.
9. (Gasoline sets) Turn off the fuel shutoff valve in the compartment and disconnect the fuel line at the fuel pump. Securely plug the end of the fuel line to prevent fuel leakage or an accumulation of explosive gasoline vapor.

⚠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.***

(LPG sets) After purging the system, disconnect the fuel line at the solenoid valve, and plug the end of the fuel line to prevent contamination.

Removing Above-Floor-Mounted Set From Vehicle

When the generator set has been disconnected from the electrical, exhaust, and fuel systems, examine its mounting bolts and support members. The generator set drip tray is normally bolted to the vehicle framework. Depending on the installation, the set may be removable from the side, back, or bottom.

Make certain that the set is firmly supported before loosening any mounting bolts or support members. Use a forklift, if possible, to lift or move the generator 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.***

⚠CAUTION ***Oil in the engine cylinders can cause engine damage during starting attempts. Oil can enter the cylinders if the generator set is in a tilted position. Do not leave the set in this position for more than 30 minutes if the oil has not been drained.***

Removing Under-Floor-Mounted Set From Vehicle

When the generator set has been disconnected from the electrical, exhaust, and fuel systems, the set may be partially removed for limited service, or completely removed for major service. The set is mounted on a support tray, which serves as the bottom of the underfloor housing. The inner edge of the support tray is hinged to the rear panel assembly. The outer edge of the support tray is bolted to a support bracket. (Two brackets are used on NHD units.) A front and rear panel assembly serve as sides to complete the housing.

The generator set is completely suspended underneath the vehicle by the housing assembly. To avoid dropping the set during removal, follow the recommended removal procedures.

⚠WARNING ***The generator set is heavy, and can cause severe personal injury if dropped during removal. Use the recommended removal techniques, and keep hands and feet clear while removing mounting bolts.***

If the generator set will be left in the down (tilted) position for more than 30 minutes, first drain the oil.

⚠CAUTION ***Oil in the engine cylinders can cause engine damage during starting attempts. Oil can enter the engine cylinders when the generator set is in the lowered (tilted) position. Do not leave the generator set in this position for more than 30 minutes if the oil has not been drained.***

Partial Set Removal

Fuel, exhaust, electrical and control connections must be disconnected as described previously.

1. Park the vehicle on a level surface which can support the floor jack wheels. Put the transmission in its PARK position, lock the brakes and remove the ignition key. Make sure no one moves the vehicle while performing 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. Position a floor jack under the reinforcement ribs of the drip tray, as shown in Figure 5-3.

3. Raise the jack until it makes contact with the drip tray, then put slight upward pressure on the tray.

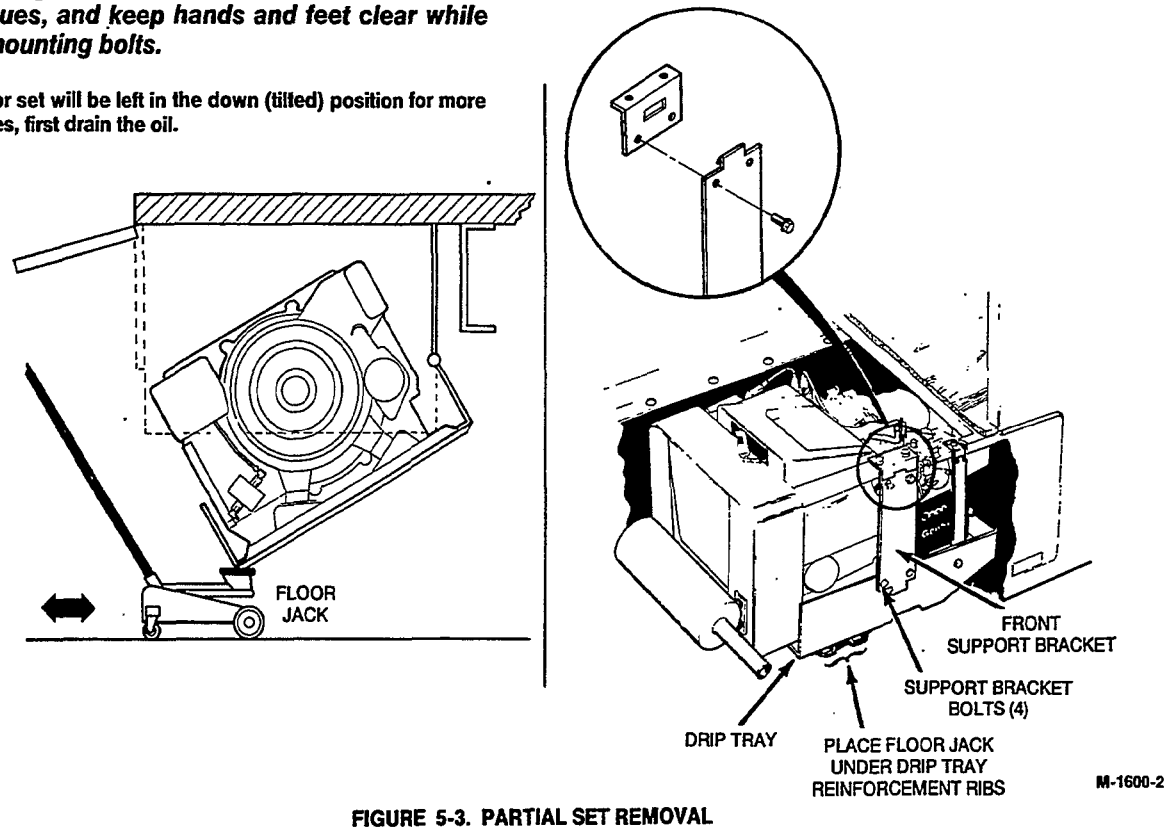

FIGURE 5-3. PARTIAL SET REMOVAL

4. Remove the bolts from the front support brackets (and the rear brackets, NHD only) and remove the brackets. This may require slight adjustment of the floor jack.

5. When the support bracket is removed, the floor jack will support all its weight on that side. Slowly lower the jack, being careful to allow the jack to roll as the generator set swings downward.

6. Support the drip tray assembly with wood blocks, so the floor jack can be removed. This will allow more access for the service procedure.

⚠WARNING ***Make sure generator is resting securely before removing floor jack. Otherwise, the generator set can swing downward causing severe personal injury.***

Complete Set Removal

Fuel, exhaust, electrical and control connections must be disconnected as described previously.

1. Park the vehicle on a level surface which is capable of supporting the floor jack wheels. Put the transmission in its PARK position, lock the brakes and remove the ignition key. Make sure no one moves the vehicle while performing 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 generator set tray at the points shown in Figure 5-4. Place a wooden block on one fork so the set will remain level.

3. Raise the forklift so it contacts the drip tray, then put slight upward pressure on the tray. Make certain that the generator set is supported by the forks before continuing.

4. Remove the bolts securing the side support to the drip tray and the underfloor bracket. (Also remove bolts from the rear support bracket, if removing a NHD unit.)

5. Lift the generator slightly until the safety catch on the side support is clear of the tray. Pull support forward and upward until disengaged from the tray and underfloor bracket.

6. Remove the side support, to provide the clearance needed for lowering the set.

7. Remove the safety catch from the center of each hinge assembly, then remove the U-shaped hinge pin.

8. Slowly lower the generator set until it is clear of all obstructions, and can be removed from under the vehicle.

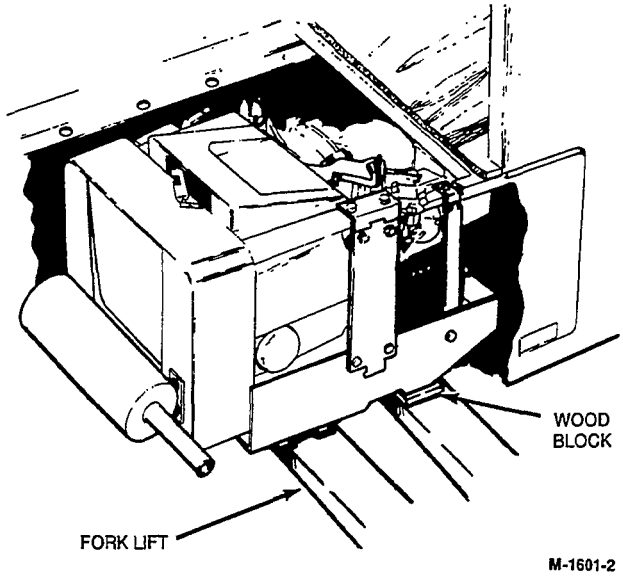

FIGURE 5-4. COMPLETE SET REMOVAL

Section 6. Engine - Primary Systems

INTRODUCTION

Primary engine systems include:

- Exhaust system
- Cooling system
- Ignition system
- Electric starter
- Crankcase ventilation system
- Governor
- Fuel system - Gasoline
- Fuel system - LPG liquid withdrawal
- Fuel system - LPG vapor withdrawal
- Electric starter

The primary engine systems can often be serviced without removing the generator set from the vehicle, and without major disassembly. Use the following troubleshooting guide to help locate problems related to the engine primary systems. Refer to the Troubleshooting Generator Set Control section for genset starting problems.

Before considering major inspection of the engine due to abnormal engine performance (engine knocks, power loss, etc.), refer to the Operator's Manual, (publication 965-0129), Periodic Maintenance Schedule, for the procedure to clean the carburetor and combustion chamber with Onan "4C".

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Untrained personnel should not attempt repair due to hazards which can result in personal injury or death. Troubleshooting information is provided for qualified repair personnel only.***

Trouble	Possible Cause	Corrective Action
Engine Misfires	1. Faulty ignition due to: a. worn or fouled spark plugs. **b. worn breaker points. **c. incorrect ignition timing. d. faulty ignition coil, or e. faulty plug wires. **f. faulty condenser. g. faulty ignition module (electronic ignition)	1a. Replace spark plugs. b. Replace breaker points. c. Set breaker point gap. d. Test coil and replace if necessary. e. Test spark plug wires and replace if faulty. f. Replace condenser. g. See *Testing Ignition Module.*
	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. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages. d. Locate leak and correct as required.
	3. *Contaminated fuel.	3. Drain fuel tank and refill with fresh fuel.
	4. *Carburetor icing. *Gasoline sets only. **Prior to Spec B for Model BGD and Spec C for Model NHD.	4. In cold weather, place air preheater in winter position.
Engine Backfires	1. Faulty ignition due to: **a. incorrect ignition timing. b. incorrect spark plug gap. **c. faulty condenser.	1a. Adjust breaker point gap. b. Reset spark plug gap. c. Replace condenser.
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws. *b. incorrect float level. c. dirt in carburetor.	2a. Adjust carburetor main and idle adjustment screws. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages.
	3. Mechanical damage to engine. *Gasoline sets only. **Prior to Spec B for Model BGD and Spec C for Model NHD.	3. See Engine Block Assembly section.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS (Continued)

⚠WARNING ***Untrained personnel should not attempt repair due to hazards which can result in personal injury or death. Troubleshooting information is provided for qualified repair personnel only.***

Trouble	Possible Cause	Corrective Action
Engine Lacks Power	1. Faulty ignition due to: **a. incorrect ignition timing. b. incorrect spark plug gap. 2. Dirty air cleaner. 3. Restricted fuel flow due to: a. plugged fuel filter or b. faulty fuel pump. 4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws. *b. incorrect float level, or c. dirt in carburetor. d. vacuum leak. 5. Exhaust system blocked or restricted. 6. Incorrect valve tappet clearance. 7. Excessive engine wear or damage to engine. 8. Carburetor air preheater set incorrectly. 9. Excessive carbon buildup. 10. No-load speed set too low. *Gasoline sets only. **Prior to Spec B for Model BGD and Spec C for Model NHD.	1a. Adjust breaker point gap. b. Reset spark plug gap. 2. Replace air cleaner. 3a. Clean fuel filter. b. Test fuel pump and repair or replace if faulty. 4a. Adjust carburetor main and and idle adjustment screws. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages. d. Repair vacuum leak. 5. Locate and remove cause of blockage. 6. Adjust valve tappets (see Engine Block Assembly section). 7. See Engine Block Assembly section. 8. In hot weather, place air preheater in summer position. 9. Dissassemble and scrape carbon. 10. Adjust governor.
Engine Overheats	1. Restricted airflow due to dirt or debris blocking air inlet or outlet. 2. Dirt or oil covering engine cooling fins. 3. Incorrect ignition timing.** 4. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws. *b. incorrect float level, or c. dirt in carburetor. *Gasoline sets only.	1. Clear away any debris that may restrict airflow to set. Do not use compartment for storage area. 2. Clean away all dirt and oil from engine cooling fins. 3. Adjust breaker point gap. 4a. Adjust carburetor main and idle adjustment screws. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages.
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. *Gasoline sets only.	1a. Replace air cleaner. b. Clean choke and choke linkage. c. Adjust carburetor idle and main adjustment screws. d. Disassemble carburetor and clean all internal passages.

⚠WARNING ***Untrained personnel should not attempt repair due to hazards which can result in personal injury or death. Troubleshooting information is provided for qualified repair personnel only.***

Trouble	Possible Cause	Corrective Action
Engine Hunts or Surges	1. Sticking or binding governor linkage.	1. Clean and lubricate governor linkage.
	2. Incorrect governor adjustment.	2. Adjust governor speed and sensitivity.
	3. Faulty governor spring.	3. Replace governor spring.
	4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws, *b. incorrect float level, or c. dirt in carburetor.	4a. Adjust carburetor main and idle adjustment screws. 4b. Adjust carburetor float level. 4c. Disassemble carburetor and clean all internal passages.
	5. Governor mechanism worn excessively.	5. See Engine Block Assembly section.
	*6. Carburetor icing.	6. In cold weather, place air preheater in winter position.
	7. Faulty ignition condenser. *Gasoline sets only.	f. Replace condenser.
High Oil Consumption (Note: New engines sometimes have high oil consumption during break-in)	1. Oil viscosity too light or oil is diluted.	1. Drain oil and refill with correct viscosity oil.
	2. Crankcase breather valve is dirty or defective.	2. Clean crankcase breather and replace if defective.
	3. Oil leaks.	3. Locate source of leak and repair as required.
	4. Excessive engine wear.	4. See Engine Block Assembly section.
	5. Light loading.	5. 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 defective oil pump.	5. See Engine Block Assembly section.

EXHAUST SYSTEM

Exhaust system condition is extremely critical, because of the possibility of exhaust gases entering the vehicle.

The exhaust system must be serviced immediately if inspection reveals leaking joints or connections, loose fasteners, or broken or damaged components.

Always replace worn components with new Onan replacement parts. Do not attempt to repair a broken exhaust pipe or manifold by welding. Do not replace worn components with parts that do not meet Onan specifications. Contact an authorized Onan service center for exhaust kit parts and installation instructions.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Modifying the exhaust system (other than shortening the downpipe) may allow poisonous exhaust gases to 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.***

Figure 6-1 shows a typical exhaust system for a compartment mount generator set. Figure 6-2 illustrates a typical exhaust system for an underfloor mount generator set. Separate service procedures cover each type of exhaust system. Also refer to the exhaust kit installation instructions.

Compartment Mount Exhaust System

The exhaust system consists of:

- Exhaust manifold
- Muffler
- Muffler strap
- Hanger
- Clamps
- Tailpipe

Disassembly Procedure:

1. Loosen the front muffler clamp, muffler strap, and tailpipe hanger. Remove the muffler and tailpipe assembly. (Figure 6-1)

2. Remove the screws that secure the exhaust tube to the exhaust manifold. Remove the exhaust tube and exhaust gasket.

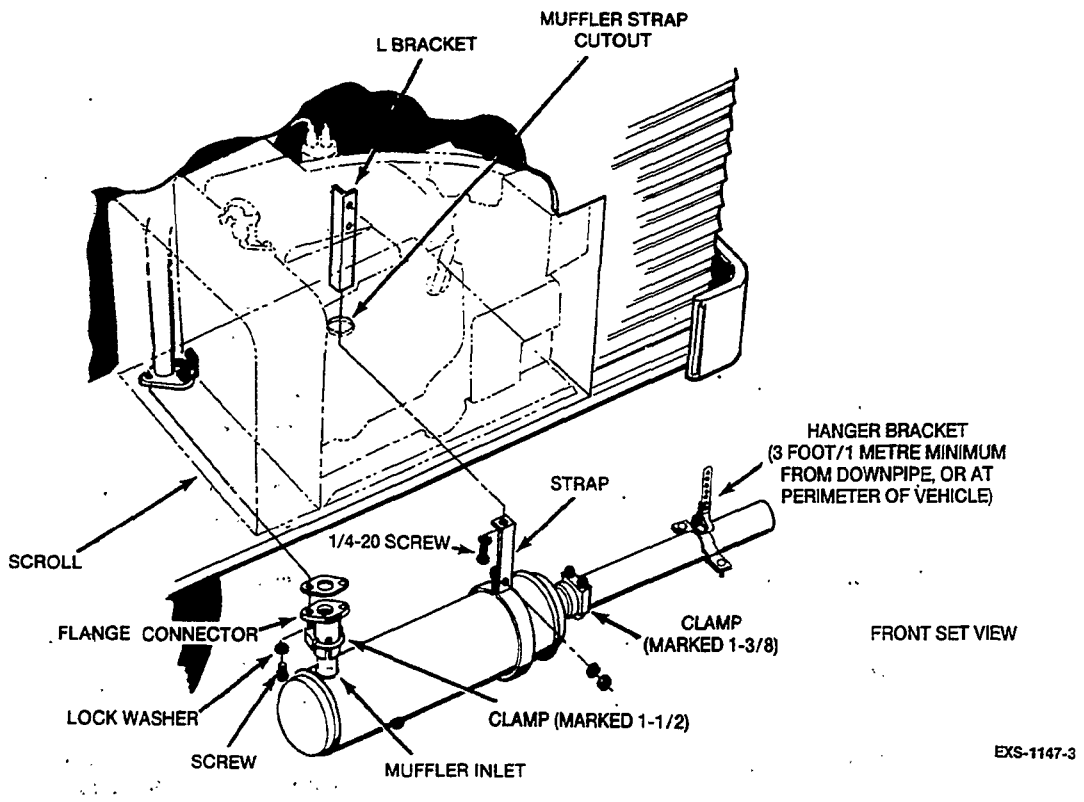

FIGURE 6-1. CONVENTIONAL COMPARTMENT MOUNT EXHAUST SYSTEM

Completion of the remaining steps requires that the generator set be removed from the vehicle. Refer to the *Preparing to Service* section for set removal procedures. For LPG sets, follow the procedure for purging LPG from the fuel line.

3. Remove the cooling system noise shield and scroll (see *Cooling* in this section) to provide access to the exhaust manifold.

4. Remove the screw that secures the exhaust manifold outlet flange to the exhaust manifold support bracket.

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

⚠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 other Onan publications.***

Assembly Procedure:

1. Install the exhaust manifold using new gaskets. Tighten the four manifold screws to the specified torque.

2. Install the 5/16-18 screw, lock washers, and nut that secure the manifold outlet flange to the manifold support bracket. Tighten securely.

3. Install the cooling system scroll and noise shield (see *Cooling System* in this section).

   If no other service is required, install the generator set in the vehicle before completing the remaining steps.

4. Install a new gasket between the exhaust manifold and exhaust tube.

   Secure the flange connector to the manifold using 5/16-18 inch capscrews and lock washers.

5. Attach the inlet of the muffler to the exhaust tube using a 1-1/2 inch U-bolt type automotive muffler clamp. Make certain that the muffler inlet pipe overlaps the exhaust tube a minimum of 1-½ inches (38 mm).

6. Place the muffler strap on the muffler, and position it below the cutout in the bottom of the generator set drip tray. Fasten the strap to the strap bracket on the set, using a 1/4-20 screw and lock washer. Tighten the strap around the muffler using a 1/4-20 screw, lock washer, and nut.

7. If replacing the original tailpipe, refer to the *Tailpipe Recommendations* section 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.

8. Support the tailpipe using a shock-mounted support hanger with clamp.

⚠CAUTION ***Incorrect muffler and tailpipe hanger bracket mounting can result in excessive vibration transfer to the vehicle. To prevent this, mount the muffler and tailpipe hanger brackets directly above the component being supported, NOT at an angle.***

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

⚠WARNING ***The muffler and exhaust pipe can ignite grass and brush. Do not operate the generator set when vehicle is parked in high grass or brush.***

10. 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 and run the set for five minutes. Then replace the pipe plug. Inspect the exhaust system for leaks at least every eight hours of running time.

Underfloor Mount Exhaust System

Underfloor mount exhaust systems consist of the exhaust manifold, muffler, clamps, hanger (if required), and tailpipe. When service is required, disassemble and reassemble as specified in the following steps.

Disassembly Procedure

1. Loosen the muffler clamp at the muffler inlet (see Figure 6-2) and remove the muffler support bracket screws.

2. Remove the two 1/4-20 screws and lock washers, and muffler and tailpipe assembly.

   Completion of the remaining steps requires that the generator set be removed from the vehicle. Refer to *Preparing to Service* section for set removal procedures. For LPG sets, follow the procedure for purging LPG from the fuel line.

3. Remove the cooling system noise shield and scroll (see *Cooling* in this section) to provide access to the exhaust manifold.

4. Remove the four exhaust manifold screws. Lift off the exhaust manifold and the two manifold gaskets.

Assembly Procedure

⚠WARNING ***Exhaust gas can cause severe personal injury or death. To prevent exhaust leaks, install all gaskets, clamps, straps, and hardware as specified.***

1. Install the exhaust manifold using new gaskets and tighten the four manifold screws to the specified torque.
2. Replace the noise shield and scroll (refer to the Cooling System section).

   If no other service is required, install the generator set in the vehicle before completing the remaining steps.

3. Place a U-bolt type automotive muffler clamp (marked 1-1/4) in position on the exhaust manifold (near elbow) prior to installing muffler.
4. Place muffler in position on set making certain that the muffler inlet pipe overlaps exhaust manifold a minimum of 1-1/2 inches (38 mm).
5. Install the two 1/4-20 screws and lock washers that secure the muffler support bracket to the set and tighten muffler clamp.

   ⚠CAUTION ***To prevent excessive vibration transfer to the vehicle, mount muffler and tailpipe hanger brackets directly above the component being supported and NOT at an angle.***

6. If replacing the original tailpipe, refer to the *Tailpipe Recommendations* section 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.
7. Support the tailpipe using a shock-mounted support hanger with clamp.

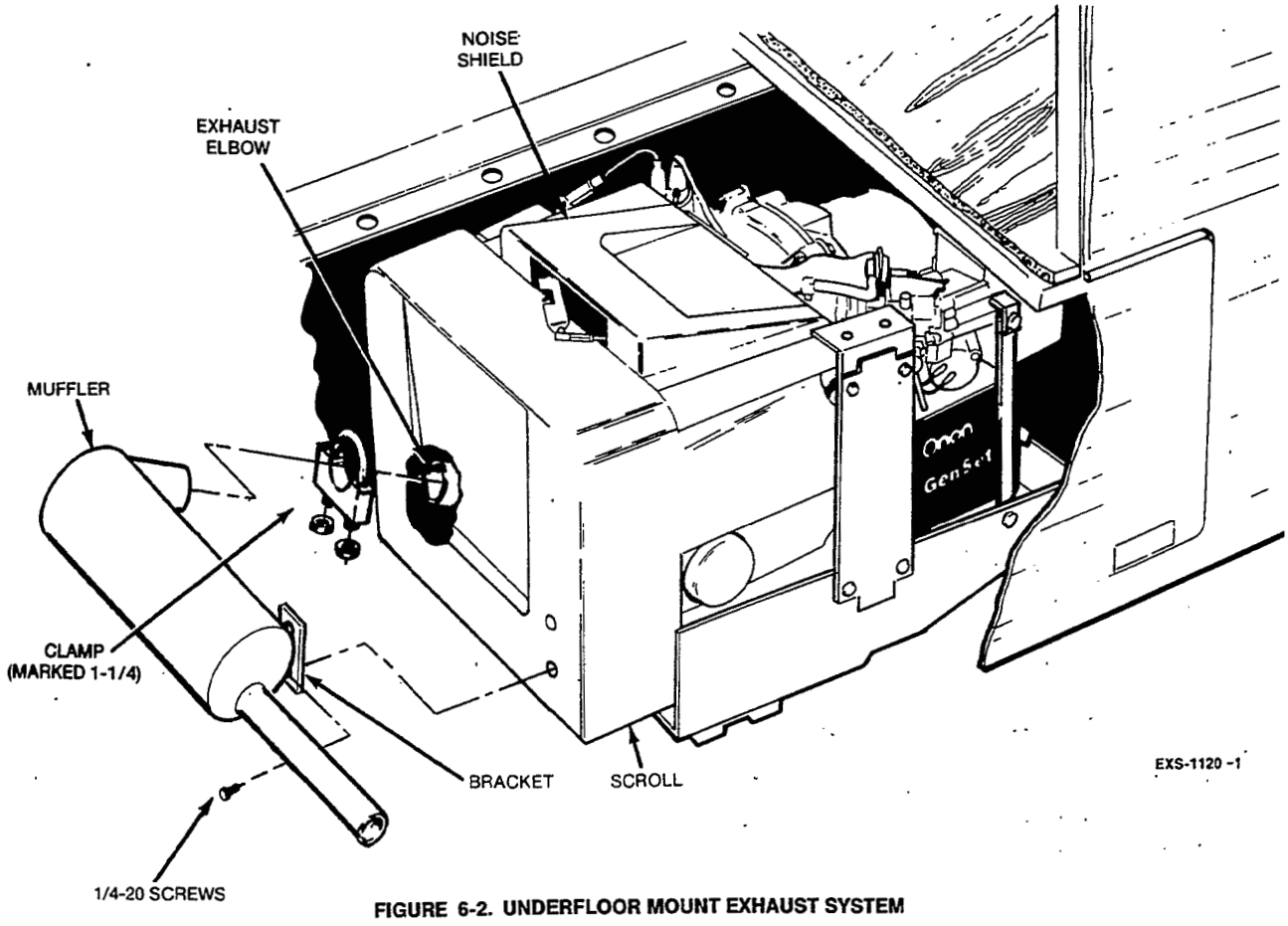

FIGURE 6-2. UNDERFLOOR MOUNT EXHAUST SYSTEM

8. Run the generator set for five minutes and check entire exhaust system (visually and audibly) for leaks or excessive noise.

⚠WARNING ***Fire can cause severe personal injury or death. Do not operate the generator set when vehicle if parked in high grass or brush.***

9. Clean spark arrester muffler every 100 hours of operation. Remove 1/8 inch pipe plug in bottom of muffler and run set for five minutes. Then replace pipe plug. Inspect exhaust system (visually and audibly) for leaks daily (at least every eight hours of running time).

Tailpipe Recommendations

Tailpipes are supplied by the vehicle manufacturer. They must meet specific design requirements for safe generator set operation. Make certain that a replacement tailpipe is the same size and configuration as the original part. Refer to the guidelines listed below and in the Installation Manual to select and locate the tailpipe.

⚠WARNING ***Inhalation of exhaust gases can result in 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 for tailpipe. Do not use flexible exhaust tailpipe, 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 cannot be maintained, install heat shielding between the tailpipe and the fuel tank or any combustible material, to prevent excessive heating.
- Do NOT terminate the exhaust tailpipe in these positions:
  - A. Under a window, door, or any opening that might allow exhaust gases to enter the vehicle interior.
  - B. Ahead of or underneath the generator compartment air intake, which might recirculate exhaust gases. Terminate the tailpipe at the rear of the compartment air intake if possible.
  - C. Under the fuel tank fill spout, so spilled fuel cannot be ignited by a hot tailpipe.
  - D. Under the vehicle, so exhaust gases cannot enter the vehicle interior through small openings in the underside of the vehicle.
- 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 generator set 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.

COOLING SYSTEM

These are air-cooled sets. A flywheel fan draws cool air in from the generator end of the compartment (see Figure 6-3). This cool air passes over the cooling fins on the engine, absorbing the heat. The heated air is then discharged through the opening in the bottom of the fan 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 gases.***

See *Specifications* regarding the minimum free area of the compartment air inlet and minimum clearance at the air discharge opening. The air inlet and discharge openings must remain free of any obstructions, to avoid restricting airflow. Regularly remove any dirt, dust, or debris clogging the duct openings. Remove any dirt lodged between the cooling fins on the engine block and cylinder heads. If the fins are dirty, heat transfer is greatly reduced, and overheating can occur.

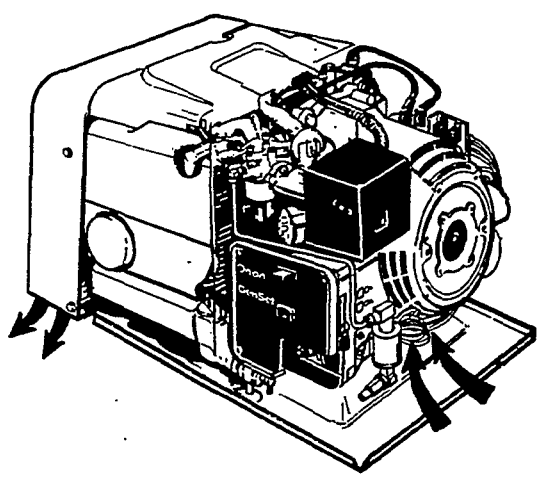

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FIGURE 6-3. COOLING AIRFLOW

The cooling system consists of:

- Noise shield
- Cylinder air housings
- Scroll
- Flywheel
- Scroll backplate

Cooling System Disassembly Procedure

1. Remove the muffler and tail pipe assembly (see Exhaust System section) to access the cooling system.

2. Remove the capscrews that secure the noise shield (see Figure 6-4) to the engine. Lift off the noise shield.

3. Remove the three nuts along the lower edge of the scroll that hold the fan guard to the scroll.

4. Remove the capscrews that fasten the scroll to the backplate and lift it away from the scroll.

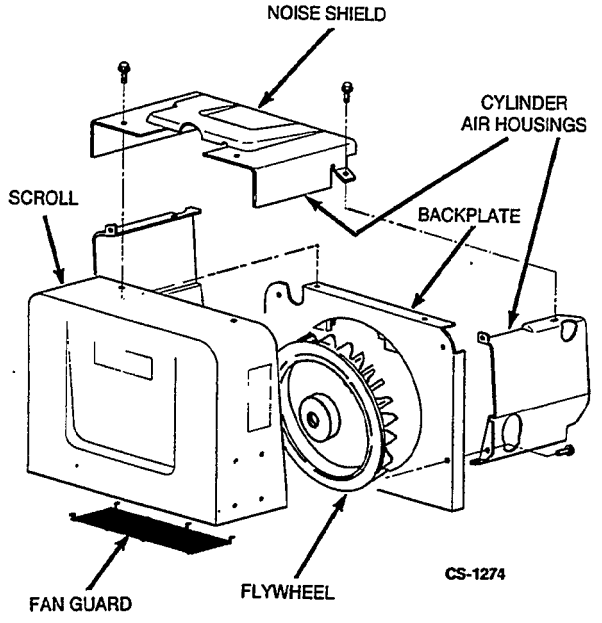


FIGURE 6-4. COOLING SYSTEM

5. Remove the screws that fasten the cylinder air housings to the backplate and cylinder heads. Lift off the air housings.

6. Loosen the flywheel capscrew and back it out several turns.

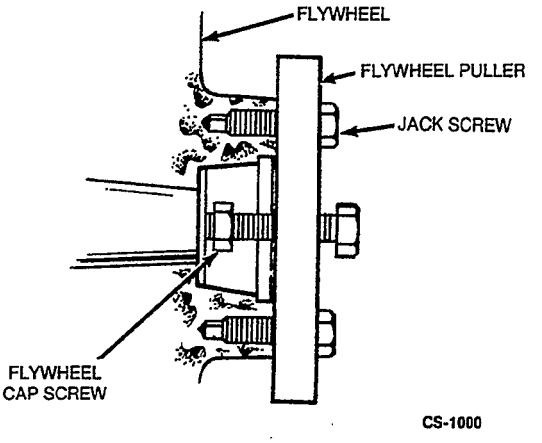


FIGURE 6-5. FLYWHEEL PULLER

7. Attach the puller tool to the flywheel (see Figure 6-5). The tool has two jack screws that fit into the holes tapped in the flywheel.

8. 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.

9. Remove the lead from the low oil pressure cutoff switch.

10. Remove the exhaust manifold (see *Exhaust System,* in this section).

11. Remove the capscrews that hold the backplate to the engine. Lift off the backplate.

12. Use a brush or low pressure compressed air to remove any dirt or debris lodged in the engine cooling fins.

Cooling System Assembly Procedure

Reassembly is the reverse of dissassembly. 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 the Exhaust System section of this manual when installing the exhaust manifold, muffler, and tailpipe.

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

ELECTRONIC IGNITION SYSTEM

(Beginning Spec B for Model BGD and Spec C for Model NHD)

The electronic ignition system consists of the following elements:

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

Ignition Rotor

The ignition rotor is keyed to the engine crankshaft (Figure 6-6). 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 normally should not require replacement during the life of the generator set.

Ignition Module

The ignition module is mounted to the generator/engine adaptor, as illustrated in Figure 6-6. 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. The ignition module contains no user-serviceable parts; problems within the module mean that it must be replaced.

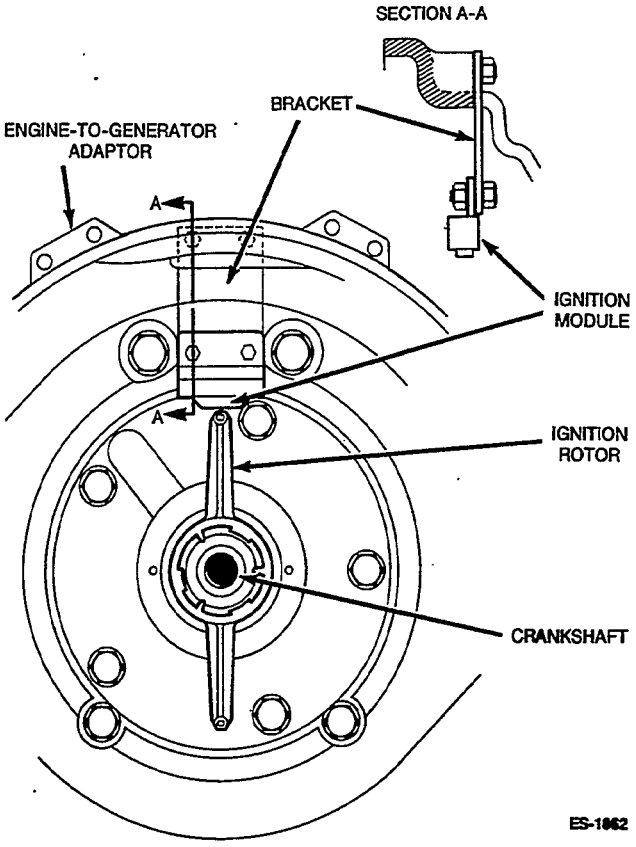


FIGURE 6-6. IGNITION MODULE AND ROTOR

Ignition Coil

The ignition coil (Figure 6-7) is a transformer that fires the spark plugs at about 20,000 volts each revolution (when the ignition module opens the primary circuit causing the coil field to collapse).

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, the ignition module (red lead), and the filter capacitor (C4).

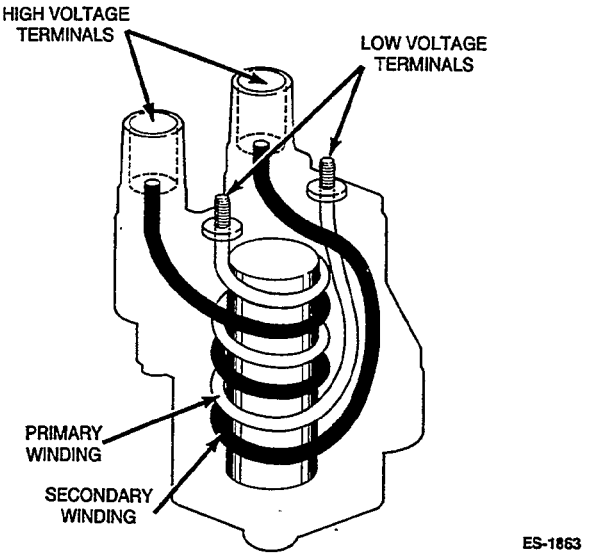


FIGURE 6-7. IGNITION COIL

Quick Ignition Test

⚠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 the 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 generator 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.

⚠WARNING ***Use extreme care when performing this test procedure. To avoid shock, do not hold the plug without adequate insulation.***

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.

Testing Ignition Coil

1. Remove all wires attached to the ignition coil.
2. Remove the coil from the engine.
3. Inspect terminals for corrosion, looseness, cracks, dents or 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 between 3 and 5 ohms. 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 6-8). This resistance should be between 10 and 40 kilohms. 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.

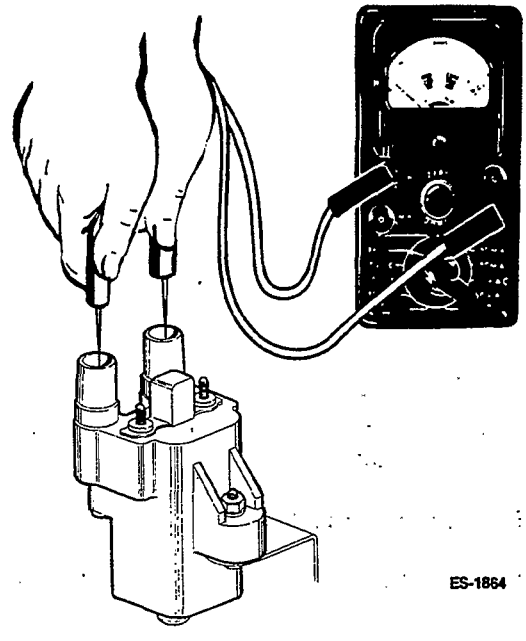


FIGURE 6-8. TESTING IGNITION COIL SECONDARY

Testing Ignition Module

- Remove the spark plugs and fan scroll (Figure 6-4) so that the engine can be turned by hand.
- 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.
- Remove all leads from the positive (+) terminal of the coil.
- Use a jumper to connect the ignition module lead (the one just removed from the coil) to the battery positive positive (+) terminal.
- 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 6-6) and lift out the bracket/module assembly. Be sure to assemble the new module to the bracket as shown by Section A-A, Figure 6-6. The studs on the bracket must point to the generator end when assembled.

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 ohmmetet) to check for breaks in the plug wire insulation.

Spark Plugs

See *Spark Plugs* under *Breaker Point Ignition System.*

BREAKER POINT IGNITION SYSTEM

(Prior to Spec B for Model BGD and Spec C for Model NHD)

The ignition system consists of the following elements:

- Breaker points
- Condenser
- Ignition coil
- Spark plugs
- Wiring

This section provides service and adjustment procedures. Refer to the *Specifications* section for the correct dimensions for adjustment.

Breaker Points and Condenser

The breaker points and condenser are mounted on the engine block. A small plunger rides on an ignition cam at the end of the camshaft. This plunger actuates the points, which open and close twice with every revolution of the camshaft. Point gap setting determines when the points will open, and consequently, ignition timing. If the timing is retarded too far, efficiency is reduced. If it is advanced too much, overheating results.

The condenser prevents arcing across the opening breaker points, to extend point life. An open condenser causes a weak spark and rapid point wear, and must be replaced. A shorted condenser allows no spark. A new condenser is supplied with the engine tune-up kit. Replace the condenser when replacing the points.

Breaker Point Replacement/ Adjustment Procedure

Make ignition adjustments with the engine cold and at rest. Do not file the points.

1. Disconnect the negative (-) battery cable at the battery terminal.
2. Remove the breaker box cover clip and lift off the breaker box cover.
3. Remove the spark plugs, to permit easy rotation of the engine and generator assembly. Use a socket wrench to turn the rotor through-bolt clockwise until the breaker point gap is open as far as possible.
4. Disconnect the ignition lead wire at screw A (Figure 6-9).
5. Remove the breaker points' mounting screws (B) and lift out the point assembly.
6. Replace the breaker point assembly.
7. Use an allen wrench to adjust setscrew C to the gap listed in the *Specifications* section. Measure the point gap with a flat thickness gauge.
8. Replace the point box cover, spark plugs, and spark plug leads.
9. Connect the negative (-) battery cable to the negative battery terminal.

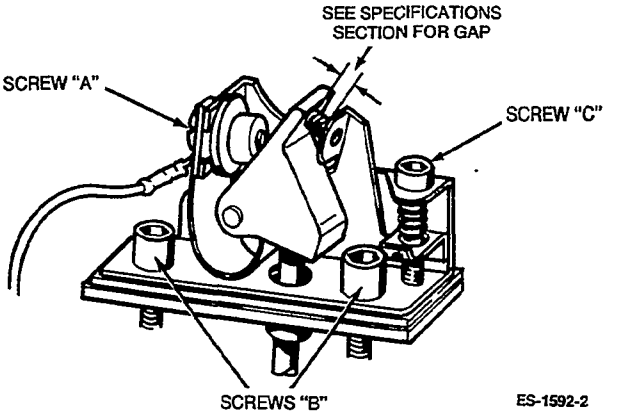


FIGURE 6-9. BREAKER POINTS

Ignition Coil

The ignition coil (Figure 6-10) is a transformer that steps up the battery voltage to approximately 20,000 volts, to fire the spark plug.

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

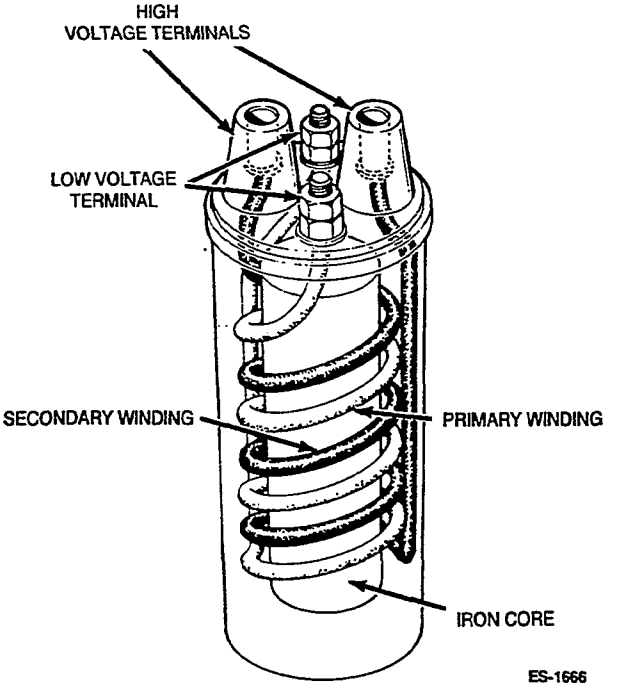


FIGURE 6-10. IGNITION COIL

Ignition Coil Testing Procedures

Quick Testing:

⚠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 the test.***

1. Remove a spark plug.
2. Reconnect the spark plug wire to the spark plug.
3. Ground the spark plug to bare engine metal.
4. Crank the engine.

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

Direct Testing With Ohmmeter:

1. Remove all wires attached to the coil.
2. Remove the coil from the engine.
3. Inspect terminals for corrosion, looseness, cracks, dents or 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 between 3 and 5 ohms. 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 6-11). This resistance should be between 10 and 40 kilohms. 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.

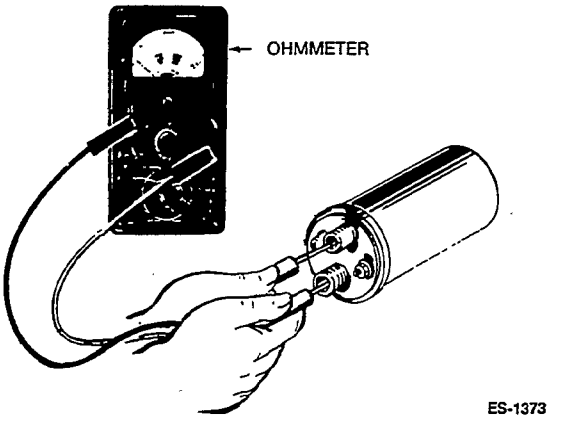


FIGURE 6-11. TESTING COIL SECONDARY

Spark Plugs

Remove and inspect the spark plugs at the intervals listed in the operator's manual. A careful examination of the plug can often determine the source of an engine problem (Figure 6-12).

Spark Plug problems include:

- One plug carbon fouled: Check 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, or worn valve guides.
- Burned or overheated: Check for leaking intake manifold gaskets, lean fuel mixture, or incorrect ignition timing. Be sure that the wrong heat range plug is not being used.
- 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 grey deposits: Normal plug color.

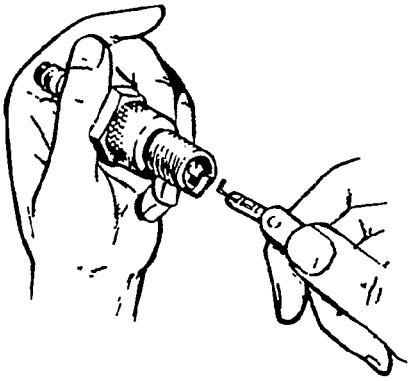


FIGURE 6-12. CHECKING PLUG GAP

Wiring

The ignition system wiring includes:

- One positive (B+) wire, which conducts low voltage from the battery to the primary winding of the coil.
- One negative (-) wire which conducts low voltage to the points and condenser.
- Two wires which carry the high voltage from the secondary coil winding to the spark plugs. The plugs and coil secondary are grounded to the engine, making a complete circuit to the battery. The ignition coil primary (low voltage side) is grounded when the breaker points close.

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 also prevents oil contamination, by removing moisture, gasoline vapors and other harmful blow-by materials from the crankcase. These vapors are routed to the outside of the generator set. A sticky crankcase breather can cause oil leaks, high oil consumption, rough idle, reduced engine power, rapid formation of sludge and varnish within the engine, and oil in the breaker point box.

⚠WARNING ***Crankcase breather vapor contains poisonous carbon monoxide. Do not run the generator set while parked unless the undercarriage is exposed to a steady airflow.***

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 6-13).
2. Remove the valve cover, pack, spring, washer, reed valve, and breather baffle.
3. Clean all parts in solvent.

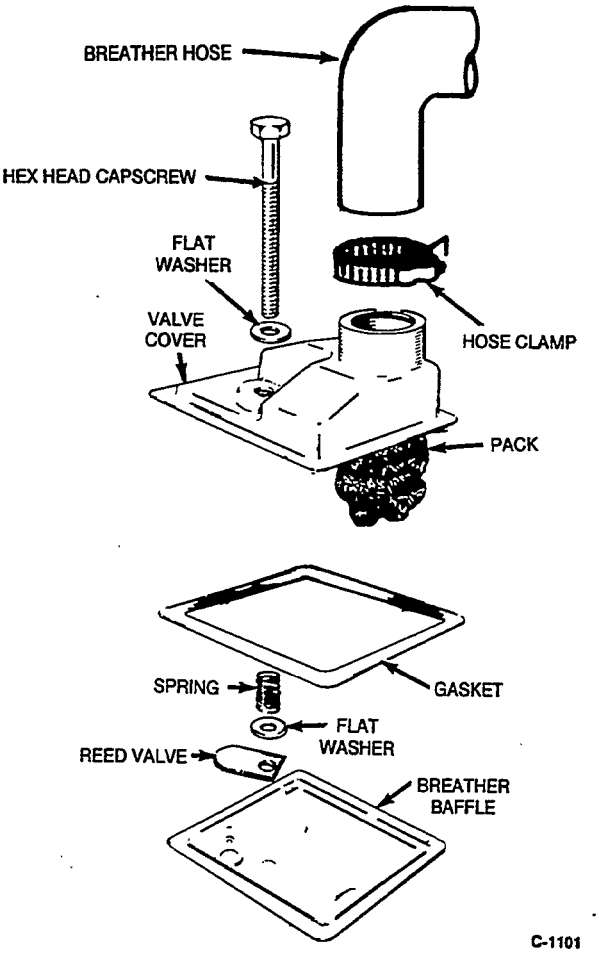


FIGURE 6-13. CRANKCASE BREATHER

⚠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.***

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 6-13, with a washer on top and the breather baffle on the bottom.

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

CYLINDER COMPRESSION TEST

Careful examination of the spark plugs and the results of compression testing will help determine the condition of the valves, pistons, piston rings, and cylinders. Use the following procedure to check cylinder compression:

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

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

GOVERNOR

The governor controls engine speed, directly affecting the voltage output and frequency of the generator. Faster engine speed increases generator voltage and frequency. Slower engine speed decreases generator voltage and frequency. The governor maintains a constant engine speed under changing load conditions, so that generator voltage and frequency do not vary.

⚠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 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.***

Governor Adjustment

Recommended equipment:

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

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 completely cold. Refer to Figure 6-14 or 6-15 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.

Adjustment:

1. Run the genset at least 15 minutes at 50% to 75% of its rated load.

   Adjusting a set which has not warmed up may cause low power or genset de-rating. Warmup must be performed on 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. Read the genset frequency. With no load, frequency must read 62 - 63 Hz (51.5 - 52.5 Hz for 50 Hz sets). If within the specification, proceed to Step 7. If outside the specification, proceed to Step 4.
4. Turn the speed nut until the no-load frequency is 48 - 50 Hz (38 - 42 Hz for 50 Hz sets).

   Make certain the throttle does not touch the idle stop screw. If they touch, turn the screw out until there is no contact.

5. Slowly turn the idle stop screw in to increase the frequency to 55 Hz (45 Hz for 50 Hz sets).
6. Turn the speed nut in until the no-load frequency is 62 - 63 Hz (51.5 - 52.5 Hz for 50 Hz sets).

   Some "wandering" through the no-load range is normal.

7. Connect rated load.

   For single phase output:
   Load (Watts) = Volts x Amperes.

   For three phase output:
   Load (Watts) = 1.73 x Volts x Amperes (average for the three phases).

   These load calculations assume a 1.0 power factor, obtainable by using a resistance load bank. True rated output may not be obtained, if appliances are used as part of the load.

8. Check output voltage. Service the generator *(Section 8. Generator)*, before proceeding, if voltage cannot be adjusted within the following limits by means of the control panel voltage adjusting rheostat:

Rated Voltage	Phases (No.)	Max. Voltage/Min. Voltage (No Load)/(Rated Load)
120	1	132/108
120/240	1	264/216
120/240	3	252/220
220/380	3	417/364
127/220	3	232/202
277/480	3	504/440

9. Check frequency with rated load connected.

   A. If droop from no load is more than 3 Hz (2.5 Hz for 50 Hz sets), turn the sensitivity adjustment screw one to two turns counterclockwise. Readjust no load frequency to 62 - 63 Hz (51.5 - 52.5 Hz for 50 Hz sets), and check droop again.

   B. If droop from no load is less than 2 Hz (1.5 Hz for 50 Hz sets), turn the sensitivity adjustment screw one to two turns clockwise. Readjust no load frequency and check droop again.

10. Check governor response under no load, 1/4 load, 1/2 load, 3/4 load and rated load. If the governor hunts, increase droop up to a maximum of 4 Hz. Go to the *Troubleshooting Guide* if the governor still hunts.

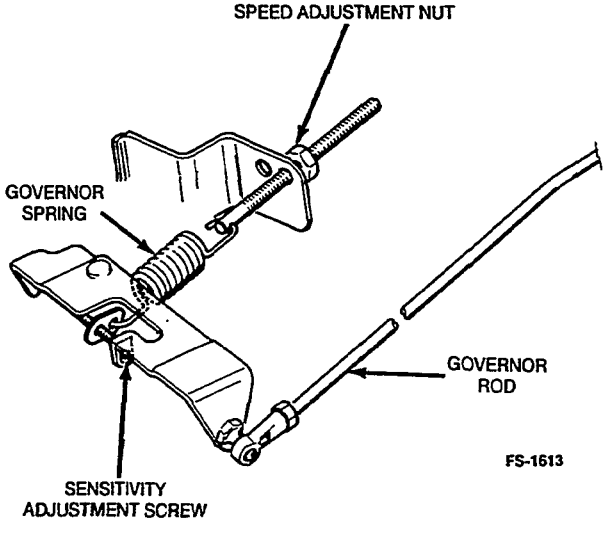


FIGURE 6-15. GOVERNOR ADJUSTMENT
(Prior to Spec B for Model BGD, Spec C for Model NHD)

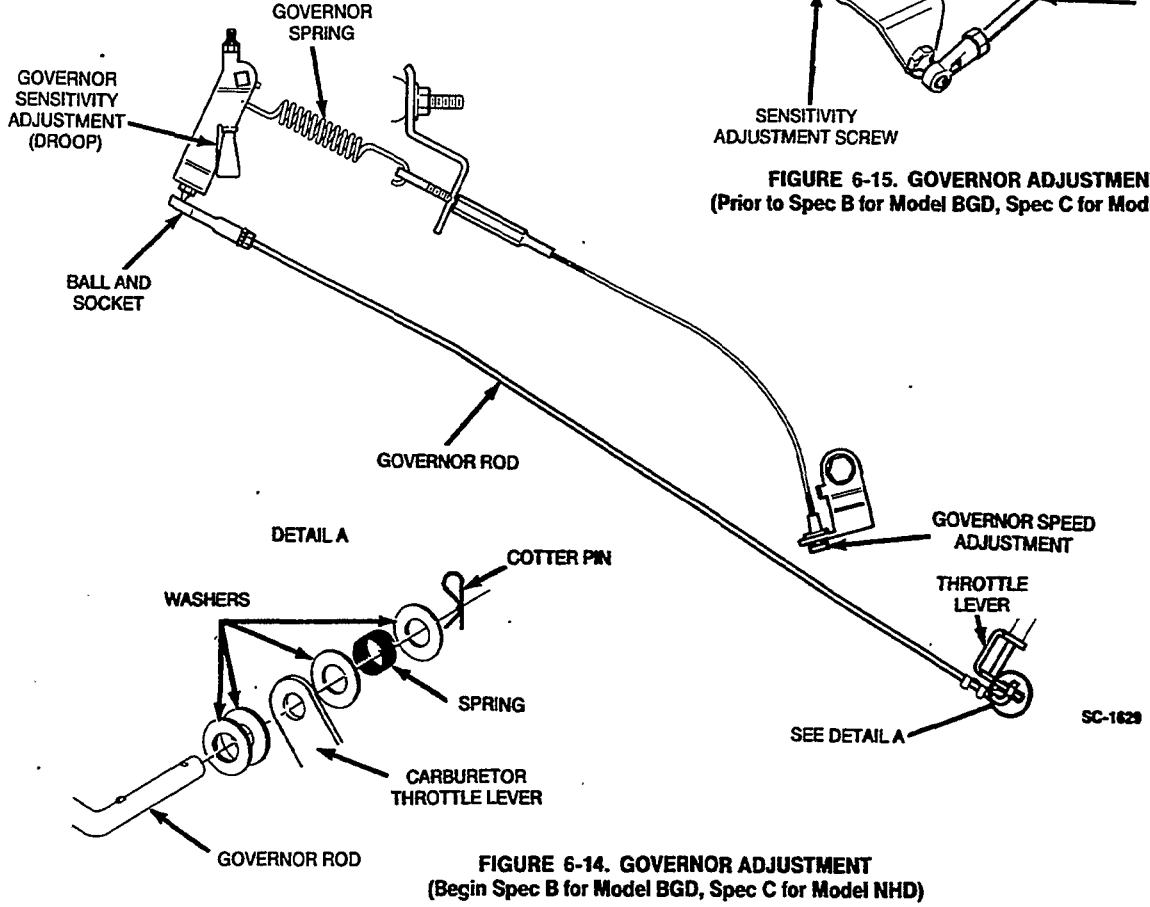


FIGURE 6-14. GOVERNOR ADJUSTMENT
(Begin Spec B for Model BGD, Spec C for Model NHD)

FUEL SYSTEM - GASOLINE

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

- Air filter assembly
- Carburetor
- Choke
- Intake manifold
- Fuel filter
- Fuel pump
- Air preheater

See Figure 6-16 or 6-17, as appropriate.

⚠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.***

Air Intake Assembly

The air intake assembly (Figure 6-16 or 6-17) consists of:

- Air cleaner housing
- Air filter
- Air cleaner adapter

Disassembly Procedure:

1. Remove the crankcase breather hose and air preheater hose from the air cleaner housing.
2. Remove the air cleaner housing center capscrew and lift off the housing and air filter.
3. For sets prior to Spec F, remove the choke cover retaining nut and lift off the choke cover.
4. For sets prior to Spec F, disconnect the choke lead wires at the choke terminals.
5. Remove the three capscrews that secure the air cleaner adapter to the carburetor and lift off the adapter. For sets prior to Spec F, note that the choke linkage must be disengaged from the choke assembly as the adapter is removed.
6. Remove the two capscrews that secure the choke bracket to the adapter. Lift off the choke assembly.

Assembly Procedure: Reverse the order of disassembly. Use a new gasket between adapter and carburetor.

Carburetor and Intake Manifold Assembly

Disassembly Procedure:

1. Remove the air intake assembly, as described in the Air Intake Assembly section.
2. Disconnect the fuel line and governor control linkage from the carburetor.
3. Remove the intake manifold capscrews and lift off the carburetor air preheater. Lift off the carburetor and intake manifold as an assembly.
4. Remove the two intake manifold gaskets and plug the intake ports with a rag to prevent loose parts from accidentally entering the ports.
5. Unbolt the carburetor from the intake manifold. For sets prior to Spec F, disengage the choke pull-off linkage from the carburetor.

Assembly Procedure: Reverse the order of the disassembly steps. 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.

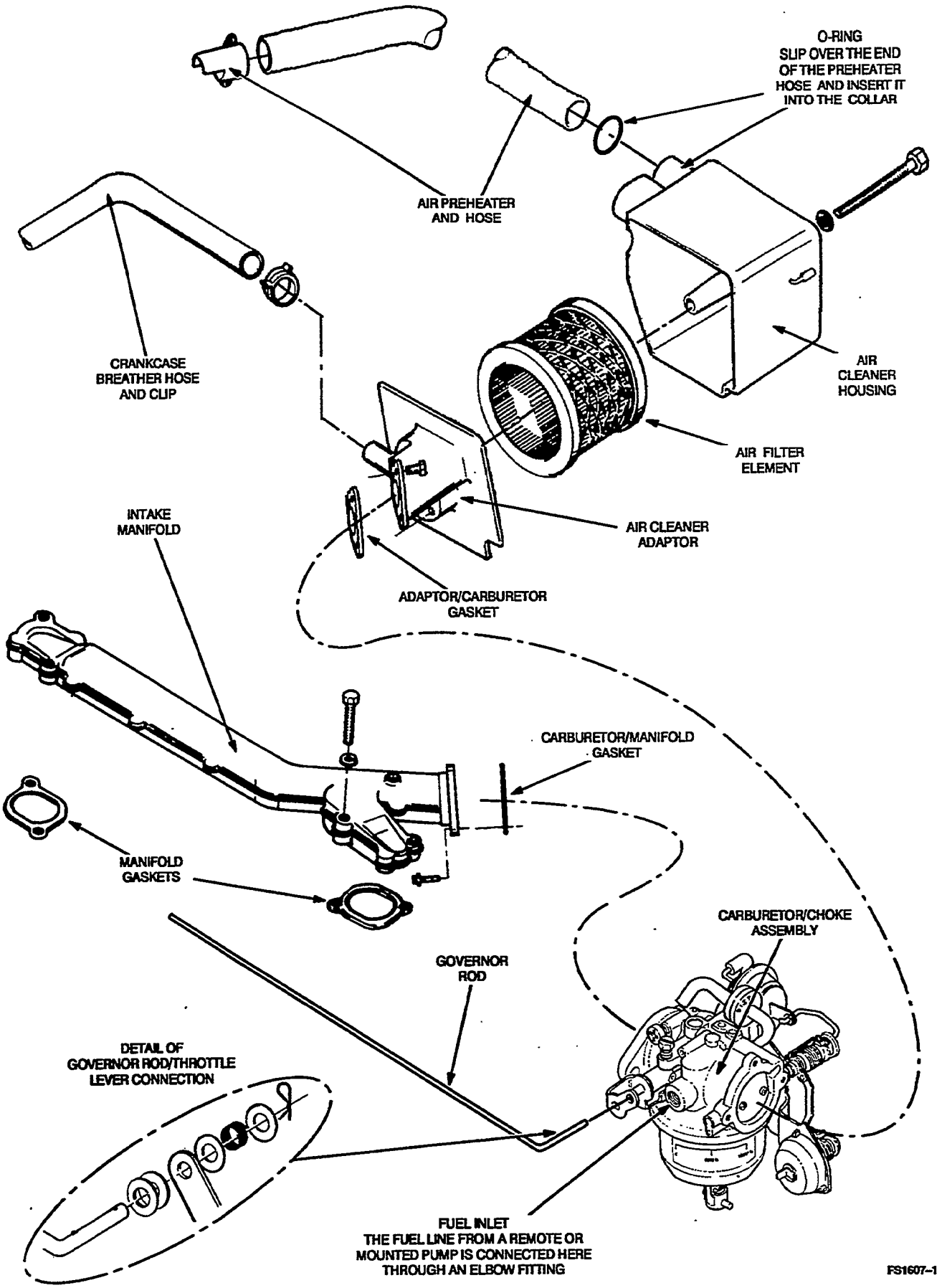


FIGURE 6-16. GASOLINE FUEL SYSTEM—SPEC F

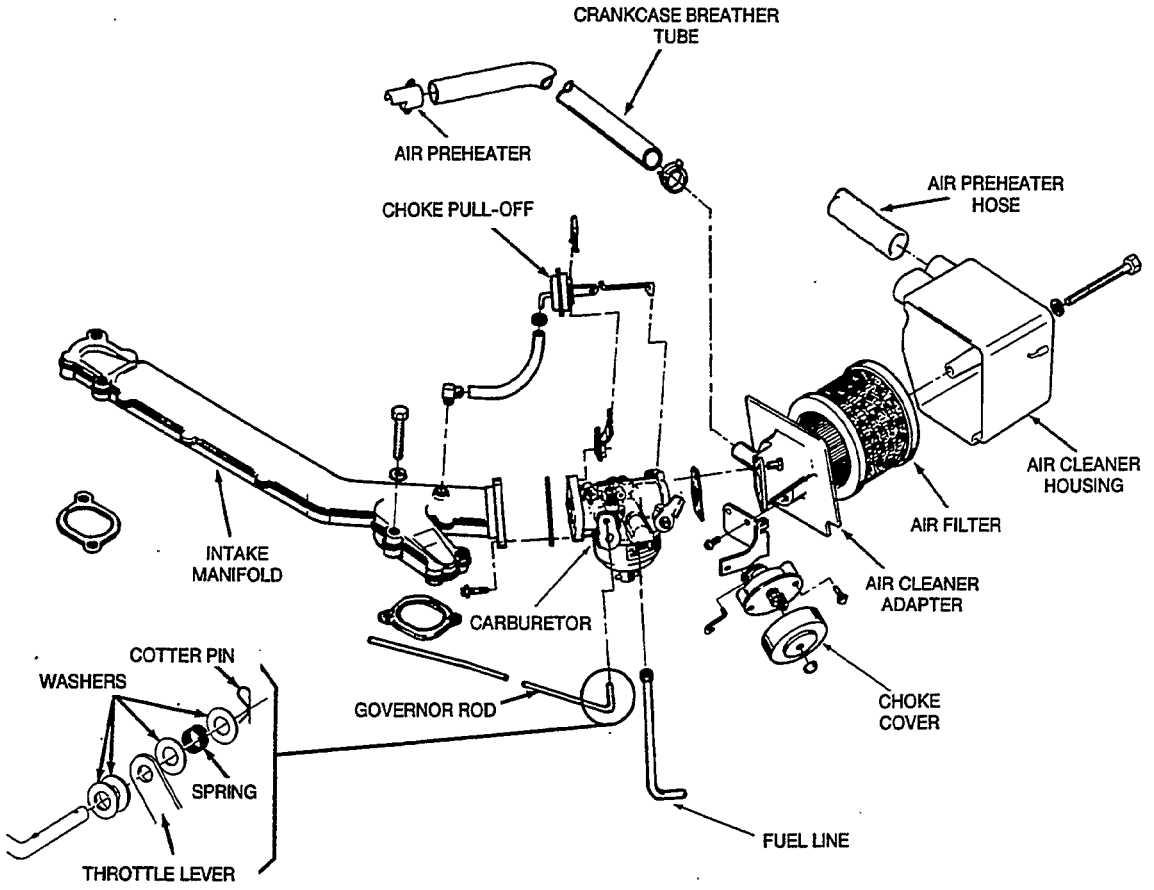


FIGURE 6-17. GASOLINE FUEL SYSTEM — PRIOR TO SPEC F

Carburetor Mixture Screw Adjustments

The most common cause of poor carburetion is incorrect adjustment of the idle or main mixture adjustment screws. Variation from the correct settings may result in 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 results in a loss of power, flat spots in acceleration, and a greater tendency to burn valves and spark plugs.

Mixture adjustments should be checked with every tuneup, and whenever a carburetion problem is suspected. Before adjusting, be sure that the ignition system is working properly, and that the governor is set correctly. If the carburetor is grossly out of adjustment, make these preliminary adjustments:

1. Turn both mixture screws in until lightly seated.
2. Turn the idle mixture screw out one full turn.
3. Turn the main mixture screw out 1-1/4 full turns.

⚠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.***

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

Start the engine and allow it to run about 10 minutes. The adjustment screw location is shown in Figure 6-18.

Mixture Adjustment Procedure:

1. Stop the set and connect a voltmeter, frequency meter, and load bank to the generator output leads.
2. Start the generator set and apply a full load. Adjust the governor speed adjustment nut to obtain 59 (49) + 2 hertz.

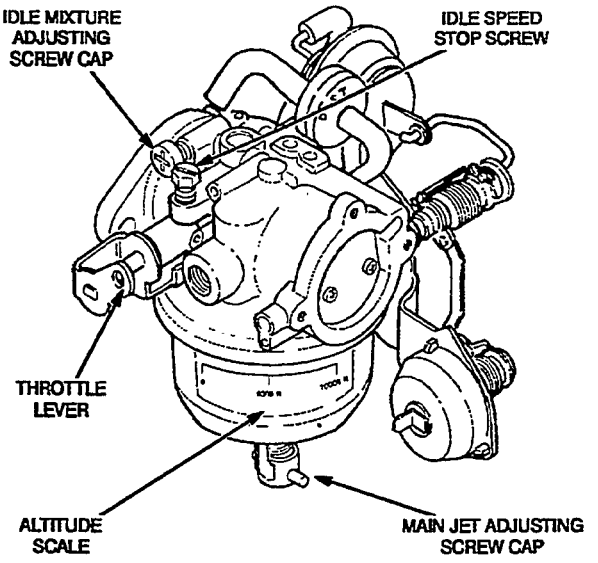


FIGURE 6-18. CARBURETOR ADJUSTMENTS

3. Remove the plastic cap over the main adjustment screw. Turn the adjustment screw inward until the voltage or frequency drops. Then turn it outward until the voltage or frequency drops again. Locate the point where voltage and frequency are highest. Replace the plastic cap. The tang on the cap should point to the altitude (scale on the float bowl) where these adjustments were made.
4. Remove the load and adjust the governor speed adjustment nut to within 62 (51.5) + 1 hertz.
5. Remove idle adjustment screw cap (limiter). Turn the idle adjustment screw inward until the voltage and frequency drop and the engine runs rough or starts hunting. Back out the idle adjustment screw as required for smooth operation without hunting. Replace the idle adjustment screw cap (limiter) with its lever located at mid-position (between stops).

   Or for a more accurate setting with CO meter (if available), after setting idle and main adjustment screws, but before installation of plastic limiter cap, set to the following (with engine running); no-load: 6 to 8% CO, rated load: 7 to 10% CO. Install limiter caps as instructed above.
6. Remove the load. Adjust the governor speed nut to 50 ± 2 Hz (50 Hz sets = 40 ± 2 hz) at no load. With the throttle lever against the idle stop screw, adjust the idle stop screw to 55 ± 1 hz (50 hz sets = 45 ± 1 hz).
7. Release the governor linkage and observe the stability of the set. Set the voltage and frequency and adjust the governor sensitivity of the governor, as specified in this section. Add and remove a full load several times, to make certain the set does not bog down or hunt.

Carburetor Overhaul

Carburetion problems not corrected by mixture or float adjustments are often caused by gummed-up fuel passages or worn internal parts. The most effective remedy is a complete carburetor overhaul.

Overhauling a carburetor consists of complete disassembly, thorough cleaning, and replacement of worn parts. Carburetor repair kits include new gaskets and replacements for the parts most subject to wear.

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 6-19.

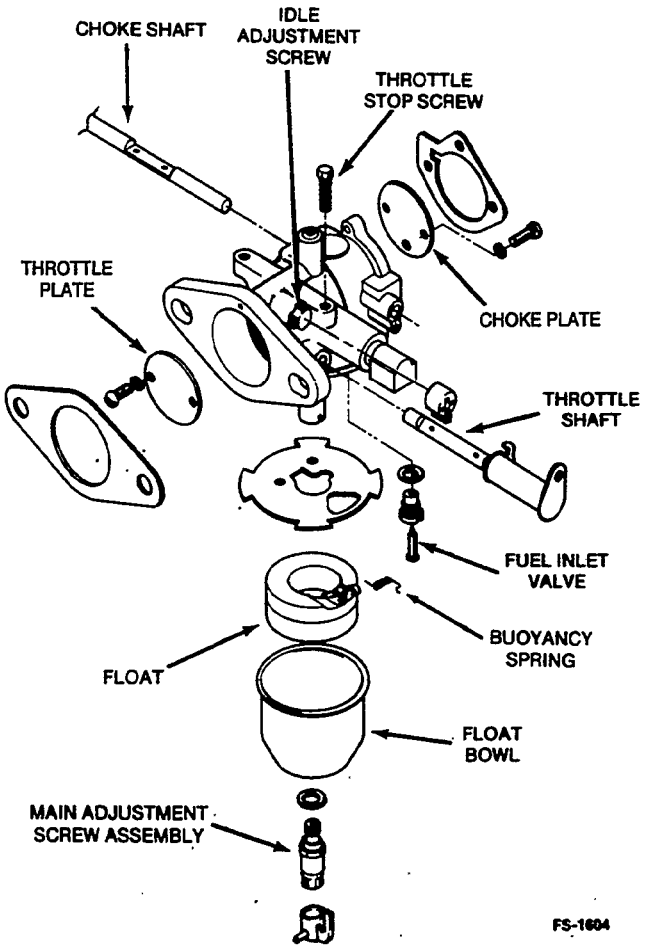


FIGURE 6-19. CARBURETOR OVERHAUL

⚠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 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:

Carburetor Disassembly Procedure

1. Remove the air cleaner adapter and the automatic choke assembly.
2. Remove the throttle 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 applied to some throttle shafts.
3. Remove the main and idle mixture screw assemblies.
4. Separate the lower section of the carburetor (fuel bowl) from the upper section (fuel bowl cover) of the carburetor.
5. Carefully note the position of the float assembly parts, then 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.

Carburetor Cleaning and Repair Procedure

1. Soak all metal components not replaced by the repair kit in carburetor cleaner. Do not soak any rubber or plastic parts. Follow the cleaner manufacturer's recommendations.

⚠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. Clean all carbon from the carburetor bore, especially where the throttle and choke plates seat. Be careful not to plug the idle or main fuel ports.
3. Blow out all passages with compressed air. Do not use wire or other objects for cleaning that might increase the size of critical passages.

4. Check the condition of any needle valve not included in the repair kit, and replace it if damaged (Figure 6-20). Replace the float if it is damaged or loaded with 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 included in the repair kit.

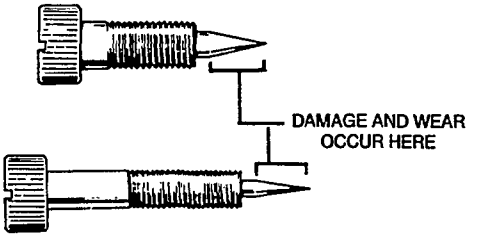


FIGURE 6-20. MIXTURE NEEDLE INSPECTION

Reassembly and Installation Procedure

1. Slide in the throttle shaft and install the throttle plate using new screws, if they are furnished in the repair kit. Before tightening the screws, the plate must be centered in the bore. To do this, back off the throttle stop screw as necessary, and completely 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 idle mixture screw assembly. Turn in the screw until lightly seated, then turn it out one turn.

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

3. Install the needle valve and seat, fuel bowl gasket, and float assembly. Make sure all clips and springs are properly placed, and that the float moves freely without binding (see Figure 6-21).

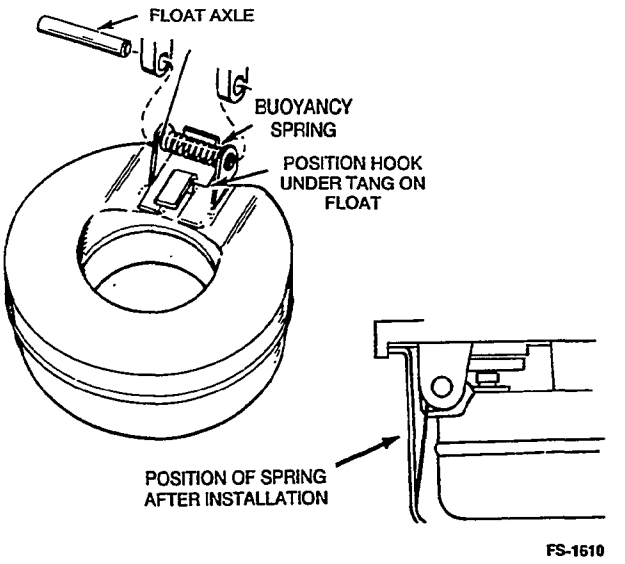


FIGURE 6-21. FLOAT INSTALLATION

4. Invert the float and needle valve assembly and check the float level by measuring from the carburetor housing to the far side (bottom) of the float; see Figure 6-22. The full weight of the float should be resting 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.

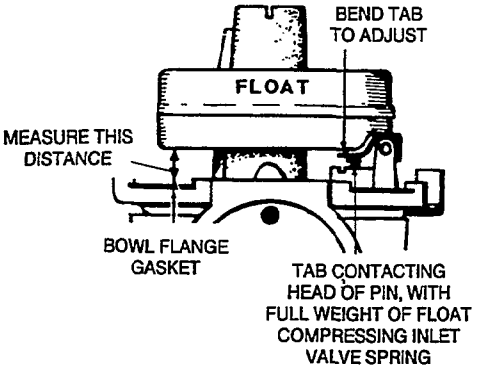


FIGURE 6-22. FLOAT LEVEL

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

5. Install the float bowl and the main mixture screw assembly. Make sure the index line on the float bowl altitude scale lines up with the arrow head cast in the mating flange of the carburetor. Turn the screw in until lightly seated, then turn it out 1-1/4 turns.

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

6. When carburetor is installed on set, make final idle and main mixture adjustments as described in the *Carburetor Fuel Mixture Adjustments* section.

Choke—Spec F

Figure 6-23 illustrates the Spec F 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.

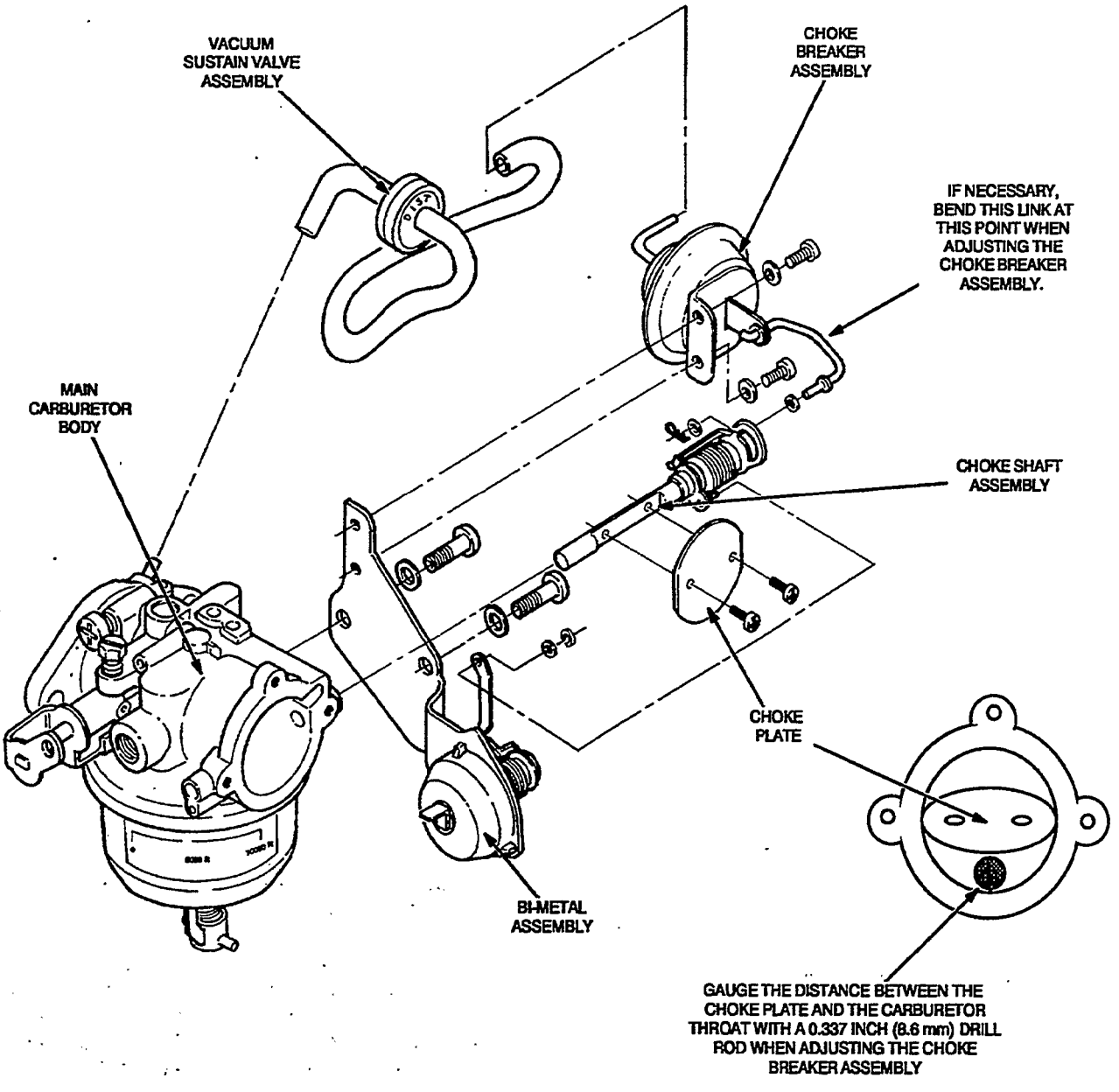


FIGURE 6-23. CHOKE ASSEMBLY—SPEC F

Choke — Prior to Spec F

The choke consists of a bi-metal coil, an electric heating element, and a choke pulloff diaphragm. The coil is connected to the choke shaft, and holds 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, electric current is supplied to the heating element. Heat from the element causes the bi-metal strip to coil. The coiling action of the bi-metal strip turns the choke shaft and gradually opens the choke plate. Heat from the element keeps the choke 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 blows out 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: Table 6-1 lists choke settings for various ambient temperatures. Stop the set and allow it to cool before adjusting.

1. Remove the plastic choke cover (see Figure 6-24) and loosen the heating element cover screws.
2. Rotate the heating element until the choke plate is halfway open.
3. Slowly rotate the cover counterclockwise while tapping the carburetor choke lever and making it bounce. Continue rotation until tapping the choke lever no longer makes it bounce. This is the fully-closed position, and becomes the reference position.
4. Refer to Table 6-1 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 back and forth to check for smooth operation. The lever should return automatically to the free position when released from the open position without sticking or binding.
7. Install plastic choke cover and tighten center mounting unit.

TABLE 6-1.
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 (27°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.

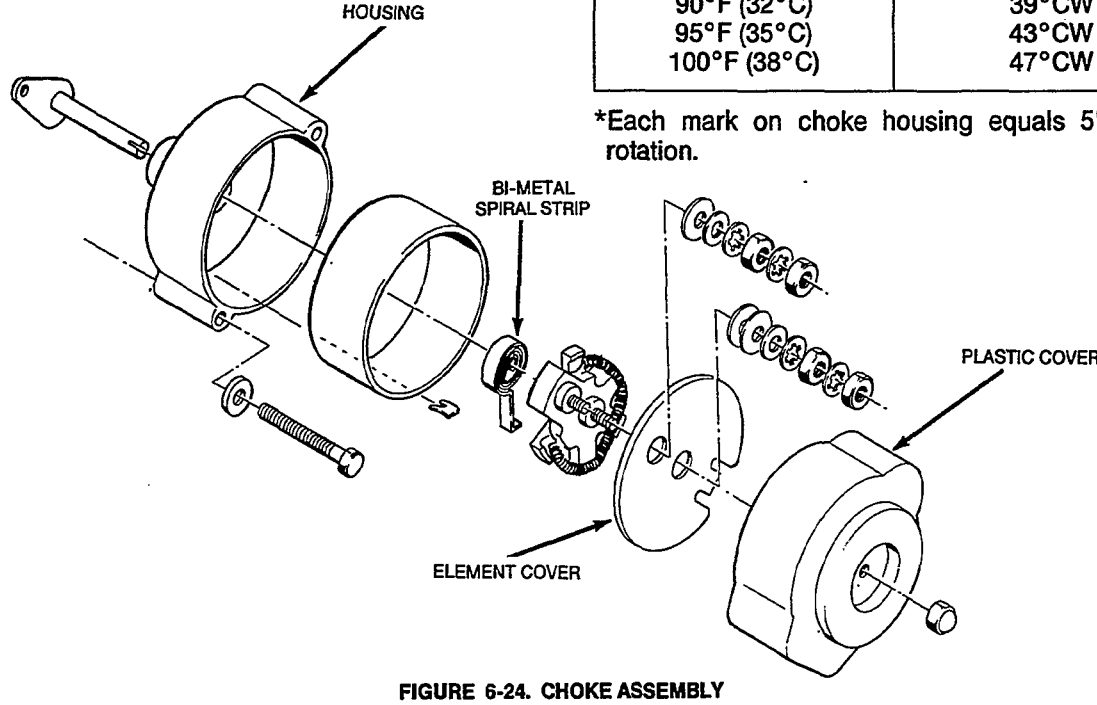


FIGURE 6-24. CHOKE ASSEMBLY FS-1605-3

Choke Replacement (Prior to Spec F):

If the choke fails to open, remove the protective plastic cover and check to see if the heating element is operating. The heating element cover should become hot after a few minutes of operation. If the element cover does not get hot, start the set, then use an AC voltmeter to check for voltage (approximately 20 VAC) at the element cover terminals. If voltage is not present, check for opens or shorts in the control wiring.

If this voltage is present at the heating element cover terminals, 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, deteriorated, or dragging in the housing.

When installing a new bi-metal strip, maintain the original direction of the spiral (see Figure 6-25). The outer tab must point in a clockwise direction. Make sure the coil sets squarely in the housing, and that the inner end of the coil engages the slot in the choke shaft. When installing the element cover, make sure that the slotted tang on the cover engages the bi-metal strip.

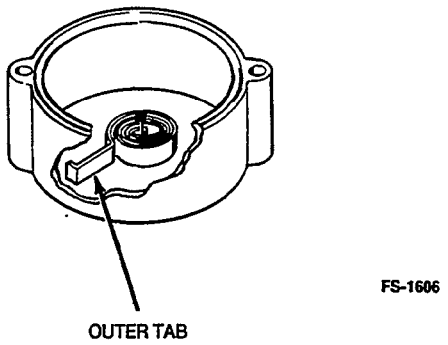


FIGURE 6-25. BI-METAL SPIRAL STRIP

Choke Pulloff Diaphragm Adjustment: The choke pulloff diaphragm partially opens the choke plate after engine startup. This helps prevent flooding, and promotes smooth engine operation as the set warms up.

Choke Pulloff Diaphragm Adjustment Procedure (Prior to Spec F):

1. Remove the complete air intake assembly as specified in Air Intake Assembly in this section to access the choke plate.

2. Disconnect the diaphragm hose from the intake manifold and 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 6-26).

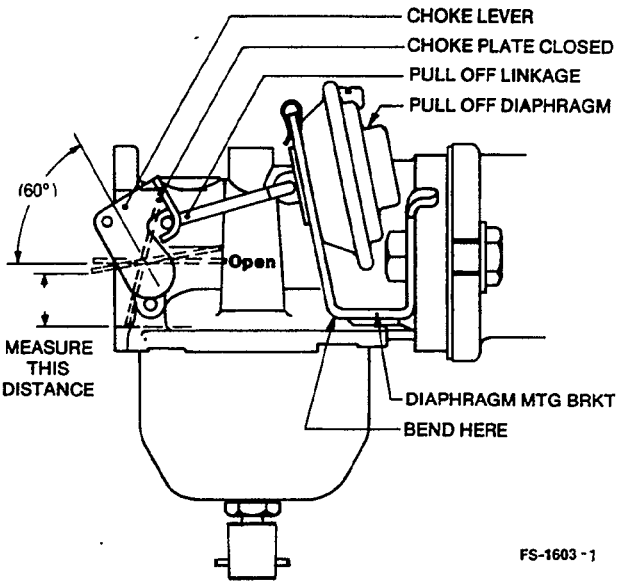


FIGURE 6-26. CHOKE PULLOFF DIAPHRAGM

4. Check the alignment of the diaphragm stem, pulloff linkage, and slot in the choke lever, as viewed from the top. Correct the alignment as required.

5. Measure the distance between the choke plate and the bottom of the carburetor at the point indicated in Figure 6-26. If necessary, bend the diaphragm mounting bracket to obtain 0.39 to 0.43 inches (9.9 to 10.9 mm) clearance.

6. Move choke lever back and forth to check for free movement. Verify that the choke does not bind or stick.

7. Remove the vacuum supply from the diaphragm, and install the filter assembly on the carburetor.

Fuel Pump

All gasoline-fueled generator sets are equipped with an electric fuel pump. All fuel pumps have an integral shutoff valve that prevents fuel flow to the carburetor when the set is not in operation. If the pump malfunctions or insufficient fuel delivery is suspected, use the appropriate procedure, listed below, to test and repair/replace the pump.

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

Pump Test Procedure

1. Remove the fuel line from the pump outlet and install a pressure gauge.

2. Press the Start switch and hold it for several seconds until the pressure reading is constant.

3. The pressure reading for a good pump will fall between 4 and 5 psi (27.5 to 34.4 kPa). Pressure should stay constant or drop off very slowly.

- If pressure reading is below 3-1/2 psi (17.2 kPa), replace fuel pump.
- If pressure reading is at zero, stop engine cranking and check electrical connections. Press the START switch and recheck pressure reading.
- There are no serviceable components in the fuel pump. Refer to the generator set Parts Manuals (Onan publications 965-0228 [BGD] and 940-0229 [NHD]), and replace pump with Onan-supplied pump only.

⚠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.***

FUEL SYSTEM - LPG LIQUID WITHDRAWAL

The fuel system must be properly adjusted and in good condition. Components of the fuel system are:

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

LPG generator sets which use a liquid withdrawal system are intended to share the vehicle LPG fuel tank. The LPG fuel tank must be designed with a dip tube to permit liquid fuel withdrawal. This manual section provides basic information about LPG fuel systems and service procedures for each fuel system component.

LPG Liquid Withdrawal Fuel Systems

LPG liquid withdrawal fuel systems typically operate at pressures as high as 200 psi (1379 kPa) when the ambient temperature is 110° F (43.3° 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 procedure described below to purge the fuel system of LP gas before servicing any fuel system components.

LPG Purging Procedure

1. Open the AC load circuit breaker and close the shutoff valve at the fuel tank.
2. Start the generator set and run it until it stops for lack of fuel.
3. Crank the set a few times after it stops, to make sure the fuel system is purged of fuel.

If the generator set cannot be operated, do the following:

1. Move the vehicle to a well-ventilated outdoor location, far from fire or flame.
2. Disconnect the vehicle negative (-) battery cable and the generator set negative (-) battery cable from their battery terminals.
3. Close fuel shutoff valves at the fuel tank for the generator set fuel supply system and any other fuel supply system. Close the fuel shutoff valves for any auxiliary equipment.

⚠WARNING ***LP gas (Propane) is extremely flammable. Severe personal injury or death can result if it is accidentally ignited. Eliminate all fire, flame, spark, pilot light, arc-producing equipment or other ignition sources before purging LP gas from the fuel system. Provide adequate ventilation to dissipate LP gas as it is released.***

4. Slightly open the fuel line (flexible section) at the solenoid valve, and allow the LP gas to slowly escape. Do not open the fitting widely: a large quantity of gas may be released.
5. Disconnect the fuel supply hose from the carburetor, and hold it clear of the set.
6. Press in and hold the primer button on the regulator to release LP gas from the set fuel system.
7. When gas can no longer be heard escaping from the open end of the fuel supply hose, reconnect the hose to the carburetor.

Carburetor, Air Filter, and Intake Manifold Assembly

The carburetor, air filter, and intake manifold assembly (Figure 6-27) consists of:

- Air cleaner housing
- Air filter
- Air cleaner adapter
- K5 relay assembly*
- Carburetor
- Intake Manifold

* - Prior to Spec B for Model BGD and Spec C for Model NHD.

Disassembly Procedure:

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. Disconnect the lead wires from the K5 relay terminals.
4. Remove the three capscrews that secure the air cleaner adapter to the carburetor and lift off the adapter.
5. Remove the two capscrews that secure the K5 relay bracket to the adapter and lift off the relay assembly.
6. Disconnect the fuel hose and governor control linkage from the carburetor.
7. Remove the two capscrews that secure the carburetor to the intake manifold. Lift off the carburetor.
8. 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 weakens the metal, enabling 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 clean rags to prevent loose parts from accidentally entering the ports.

Assembly: Reverse order of disassembly steps. Use new gaskets between the exhaust manifold and engine, the intake manifold and engine, and the carburetor and intake manifold. Tighten the exhaust and intake manifold capscrews to the specified torque. Tighten the fuel vaporizer fittings and check for leaks.

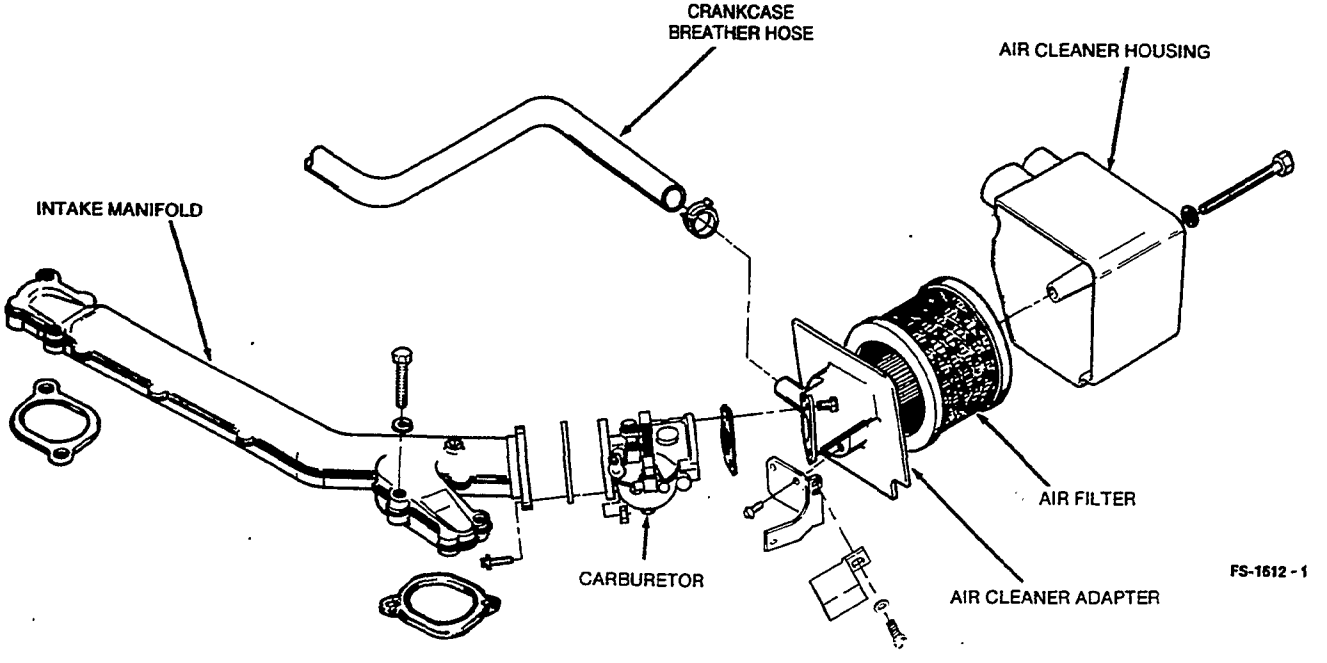


FIGURE 6-27. CARBURETOR, AIR FILTER AND INTAKE MANIFOLD ASSEMBLY

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, 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.***

LPG carburetors have three adjustment screws:

- The throttle stop screw sets the width of the throttle plate opening 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.

No other adjustments are necessary with an LPG carburetor, because there are no float or choke adjustments.

Do not make these adjustments until the ignition system, governor, and other fuel system components have been checked for correct operation. If the carburetor is grossly out of adjustment, turn the mixture screws in until they are lightly seated, then turn the main adjustment screw out 2-1/2 (+ 1/4) turns and the idle adjustment screw out 1 (+ 1/4) turn. This provides a rough preliminary adjustment.

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

Start the engine and allow it to run for 10 minutes at light load. Figure 6-28 illustrates the location of the adjustment screws.

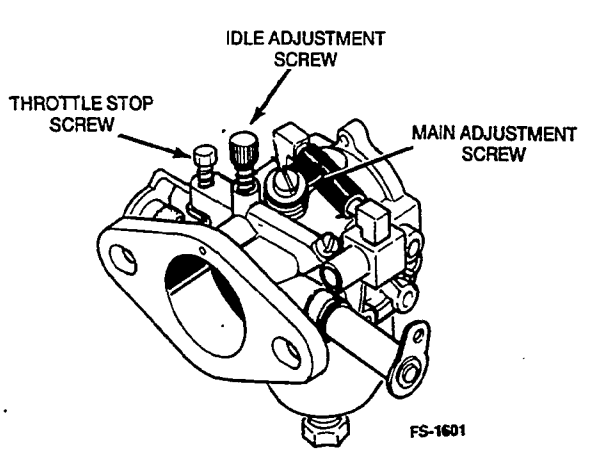


FIGURE 6-28. MIXTURE SCREW ADJUSTMENTS

Adjustment Procedure:

1. Stop the set and connect a voltmeter, frequency meter, and load bank to the generator output leads.
2. Start the generator set and apply a full load. Adjust the governor speed adjustment nut, if necessary, to obtain 59 ± 2 hertz.
3. Turn the main adjustment screw inward until the voltage or frequency drops, then outward until the voltage or frequency drops again. Set the main adjustment screw at the point where the voltage and frequency are highest.
4. Remove the load. Adjust the governor speed adjustment nut if necessary, to obtain 62 ± 1 hz.
5. Turn the idle adjustment screw inward until the voltage and frequency drop and the engine begins to run rough or starts hunting. Back out the idle adjustment screw until the engine runs smoothly without hunting.

   Or for a more accurate setting with CO meter (if available), after setting idle and main adjustment screws, but before installation of plastic limiter cap, set to the following (with engine running); no-load: 6 to 8% CO, rated load: 7 to 10% CO. Install limiter caps as instructed above.
6. With unit at no-load, adjust governor speed nut to 50 ± 2 hz (50 hz sets: 40 ± 2 hz). With the throttle lever against the idle stop screw, adjust idle stop screw to 55 ± 1 hz (50 hz sets: 45 ± 1 hz).
7. Readjust no-load speed to 62 (51.5) ± 1 hz and observe the stability of the set. Set the voltage and frequency and adjust the sensitivity of the governor as specified in the *Governor Description* in this section. Add and remove a half-load several times, to make certain the set does not bog down or hunt.

Carburetor Overhaul

Carburetor problems which cannot be corrected by mixture adjustments may be caused by dirt in fuel passages, or by worn internal parts. Normally, the carburetor should seldom require cleaning, because LP gas vaporizes completely before reaching the carburetor, leaving no residue. However, a bad fuel supply or fuel filter may let dirt or oil through to the carburetor. This may mean that the carburetor should be cleaned to restore satisfactory operation.

Overhauling the carburetor involves its complete disassembly, thorough cleaning, and replacement of worn parts. Carburetor repair kits are available that supply new gaskets and replacement parts for the components subject to wear.

Note the position of all components while removing them, for correct reassembly. See Figure 6-29 for component designations.

Removal and Disassembly Procedures:

1. Remove the carburetor from the intake manifold, as described in the *Carburetor, Air Filter, and Intake Manifold Assembly* section.

   ⚠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 throttle stop collar and throttle stop lever from the end of the throttle shaft.

3. Remove the throttle plate retaining screws and throttle plate. Remove the dust seals from the throttle shaft, and carefully pull out the throttle shaft.

4. Remove main and idle mixture screw assemblies.

5. Separate the lower section (bowl) of carburetor from the upper section (bowl cover).

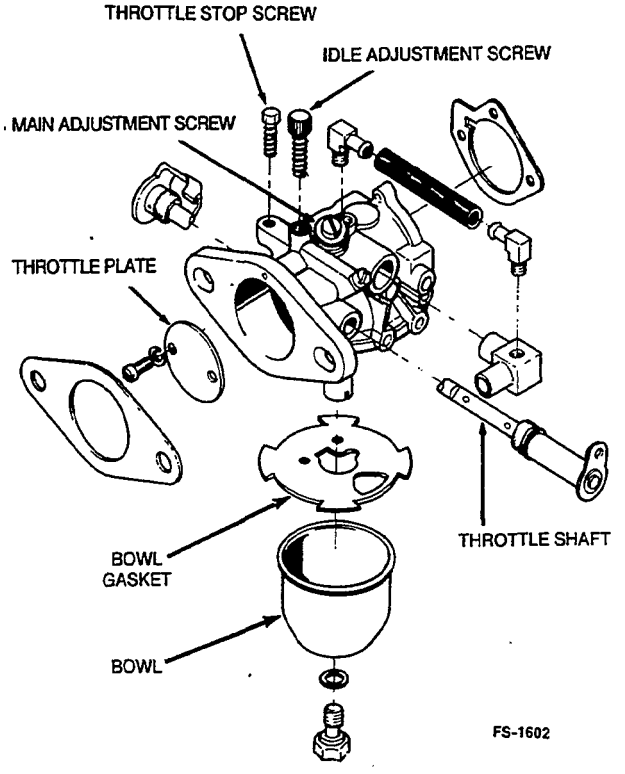


FIGURE 6-29. CARBURETOR OVERHAUL

Cleaning and Repair Procedures:

1. Soak all metal components that have not been replaced in carburetor cleaner. Do not soak any non-metal parts: they may be damaged by the cleaning solution. Follow the cleaner manufacturer's recommendations.

2. Clean all carbon from the throttle bore, especially where the throttle plate seats. Be careful not to plug the idle or main fuel ports.

3. Blow out all passages with low pressure (30 kPa) compressed air. Do not use wire or other objects for cleaning that might increase the size of critical passages.

4. Check the condition of the mixture screws (see Figure 6-30) and replace them if worn or damaged.

5. Replace all old components, seals, and gaskets with new parts included in the kit.

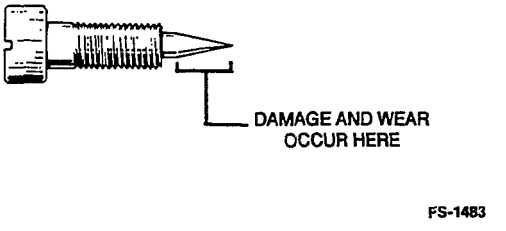


FIGURE 6-30. MIXTURE NEEDLE INSPECTION

Reassembly and Installation Procedure:

1. Slide in the throttle shaft and install the throttle plate using new screws (if furnished in the repair kit). Center the plate in the throttle bore before tightening the screws. To do this, move the throttle lever to the completely closed position. Seat the plate by gently tapping on it with a small screwdriver, then tighten the screws. Install the seal, the throttle stop lever, and the collar on the throttle shaft.

2. Install the idle and main adjustment screws and turn them in until lightly seated. For preliminary settings, turn the idle screw out 1 (±1/4) turn and the main screw out 2-1/2 (±1/4) turns.

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

3. Join the upper and lower sections of the carburetor, and install the bowl plug and washer.

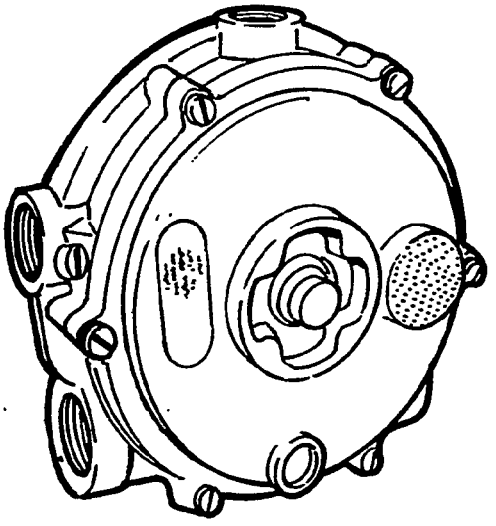
4. When the carburetor is installed on the set, make final adjustments to mixture screws as specified in the *Carburetor Mixture Screw Adjustments* section.

Regulator

A two-stage regulator (see Figure 6-31) delivers vaporized LPG 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 the vacuum from the engine creates a demand for fuel. Fuel flows through the regulator only when the engine is cranking or operating: it stops flowing when the engine is stopped.

The regulator should require 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 two sources:

- Hardened diaphragms and seats due to extended periods of non-use.
- Dirt or foreign matter embedded in valves and valve seats.



FS-1586-1

FIGURE 6-31. LP GAS REGULATOR

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

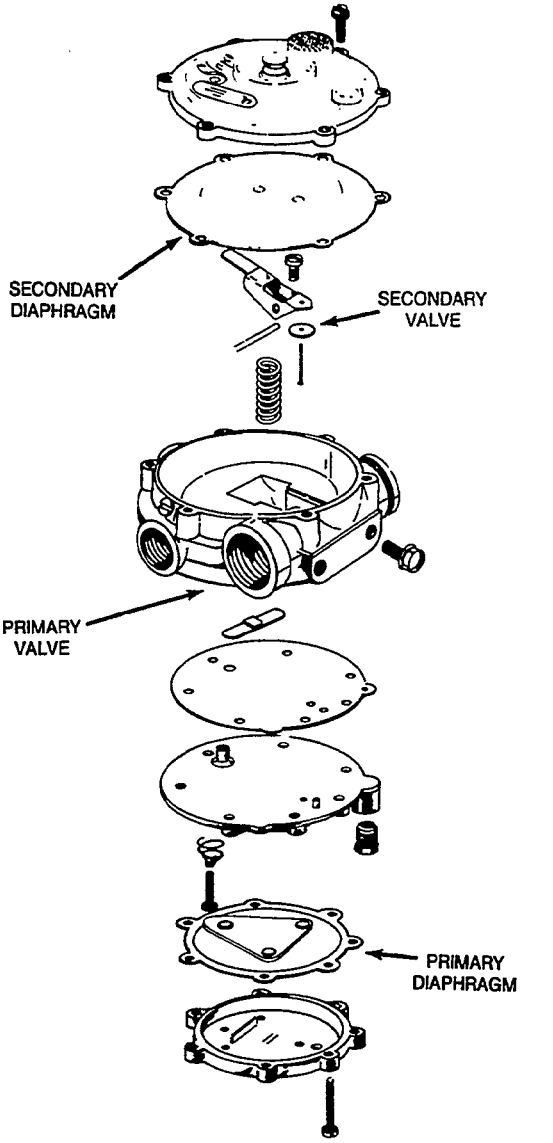


FIGURE 6-32. REGULATOR DISASSEMBLY

A regulator with granules of foreign matter embedded in the secondary seat may cause inconsistent starting or idling. Foreign matter dissolved in the LPG can form granules as the fuel is vaporized. Remove the regulator front cover and diaphragm assembly (see Figure 6-32) to check for dirt or oil deposits. If granules are imbedded in the rubber of the secondary valve, wash the valve and seat clean.

Regulator Test Procedure:

Use compressed air and an automobile fuel pressure gauge to test the regulator.

1. Attach the pressure gauge to the test port on the back of the regulator as shown in Figure 6-33.
2. Attach a pressure hose to the inlet opening, and open the air pressure valve.
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 seat is leaking.

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

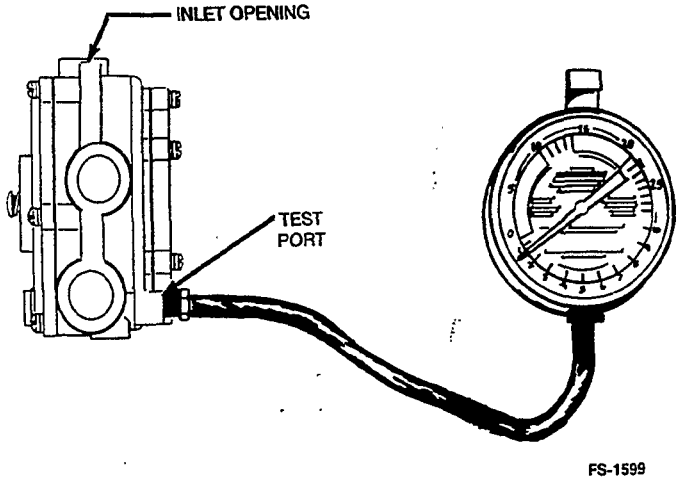


FIGURE 6-33. REGULATOR TEST

Fuel Filter

The fuel filter (see Figure 6-34) removes solid impurities such as rust and scale from the LP gas before they can clog the regulator and carburetor. A magnet within the filter housing traps iron and rust particles, and a filter element traps non-magnetic particles. The fuel filter operates at container pressure; it must be carefully assembled to prevent leakage.

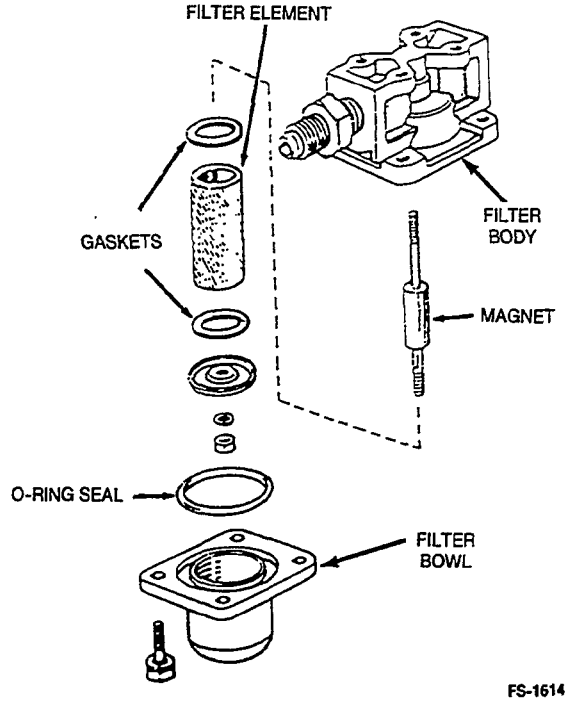


FIGURE 6-34. FUEL FILTER

Disassembly and Cleaning Procedure:

⚠WARNING ***LPG 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.***

1. Remove the four capscrews and lock washers that hold the filter bowl to the filter body.
2. Separate the filter bowl from the filter body, and discard the O-ring seal.
3. Remove the nut and washer from the center stud and pull out the filter element.
4. If the filter element is clogged, wash the element in kerosene. Blow it dry with low pressure (30 psi/207 kPa) compressed air. Replace the filter element if damaged.

5. Wipe the center stud magnet clean of any rust or scale particles that have collected.

6. Install a clean filter element using two new gaskets, and securely tighten the center stud nut.

7. Place a new O-ring in the filter bowl sealing groove.

8. Align the reference mark on the filter bowl with the reference mark on the filter body. Install capscrews (4) and lock washers (4). Tighten the capscrews to 56 to 74 in-lbs (6.5 to 8.3 N-m) torque. When the fuel system is pressurized, check the filter for leaks.

Solenoid Valve

The solenoid valve (see Figure 6-35) provides a positive fuel shutoff when the generator set is stopped. The solenoid must be energized for fuel to flow to the regulator. A faulty valve must be replaced.

To bench-test the valve, connect 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.

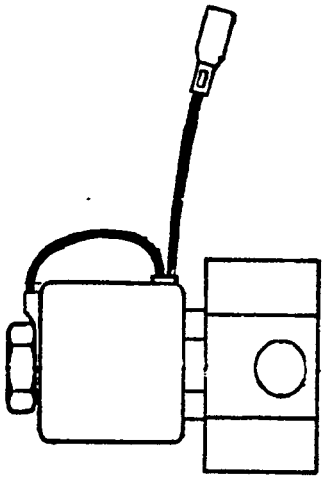


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FIGURE 6-35. SOLENOID VALVE

FUEL SYSTEM - LPG VAPOR WITHDRAWAL

The LPG vapor withdrawal fuel system is very similar to the liquid withdrawal system. Main components of the LPG vapor withdrawal fuel system are:

- Air cleaner assembly
- Carburetor
- Intake manifold
- Solenoid valve
- Demand regulator (externally mounted)

Special precautions must be taken to avoid releasing large quantities of highly flammable LP gas when servicing the fuel system. Use the *LPG Purging Procedure* described in the *LPG Liquid Withdrawal Fuel System* section to purge the fuel system of LP gas before servicing any fuel system components.

Service procedures for the air cleaner assembly, carburetor, intake manifold and solenoid valve are described in the previous sections. The following service procedure applies to the LPG vapor withdrawal demand regulator, which is unique to the vapor withdrawal system.

Demand Regulator Adjustment Procedure

Difficult starting may be caused by slow cranking due to a weak battery. Temperatures below 32° F/0°C increase the load on the battery at cranking speed. Low cranking speed in turn inhibits proper intake vacuum for starting.

If the generator set fails to start or operate properly, and the starting or ignition systems are not at fault, check and adjust the demand regulator inlet pressure and the regulator lockoff as follows:

1. Close the gas supply valve at the fuel tank(s) and remove the 1/8 inch pipe plug from the regulator test hole. See Figure 6-36.

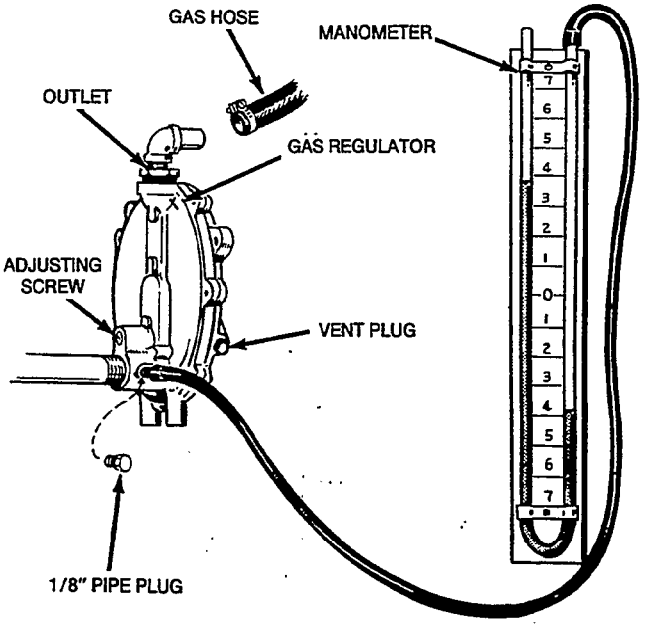

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FIGURE 6-36. MANOMETER TESTING (IF REQUIRED)

2. Connect a manometer that reads up to 14 inches (356 mm) of water column to the test hole. One inch of water equals 0.58 ounce/square inch (250 Pa).

3. Energize the solenoid shutoff valve by connecting its insulated lead to a battery positive (B+) source.

⚠WARNING ***LP gas presents the hazard of fire or explosion and it is poisonous. These hazards can result in severe personal injury or death. Provide adequate ventilation while adjusting regulator to prevent any possible accumulation of LP gas.***

4. Remove the gas supply hose from the regulator outlet, then open the fuel tank shutoff valve. Gas should not come from the regulator outlet during testing, because of the closing action of the regulator valve.

5. Alternately block and uncover the regulator outlet while checking the manometer. If the regulator closes completely, the manometer will hold a steady reading. If the manometer reading drops slightly each time when the outlet is uncovered, the regulator is not locking off properly.

To adjust the regulator, turn the adjusting screw inward until the manometer fluctuates when the outlet is alternately covered and uncovered and then back off until the manometer remains steady when the outlet is alternately covered and uncovered. Failure to lock off indicates either too high an incoming pressure, or a dirty regulator valve and seat.

⚠CAUTION ***A soap bubble placed over the regulator outlet will not accurately test regulator closing and will cause the very sensitive demand regulator to shut off.***

6. Close the gas supply shutoff valve at the fuel tank.

⚠WARNING ***LP gas presents the hazard of fire or explosion, and it is poisonous. These hazards can result in severe personal injury or death. Cranking the engine or disconnecting the solenoid valve will create sparks that can ignite accumulated gas vapors. Make sure that any gas vapors, accidentally released during testing, have been safely and completely dissipated before proceeding.***

7. De-energize the solenoid valve, and reconnect the solenoid lead to its control lead.

8. Connect the gas supply hose to the regulator outlet fitting and secure it with a clamp.

9. Remove the manometer, and install a ⅛ inch plug in the test hole.

10. Verify that the vent hose is properly routed through the opening in the compartment floor, then open the gas supply shutoff valve.

11. Adjust the gas adjustment screw, as described in the previous section. Operate the generator set to assure that it starts correctly.

ELECTRIC STARTER

Removal and Disassembly Procedure:

1. Disconnect the generator set negative (-) battery cable from the set starting battery.

2. Disconnect the generator set positive (+) battery cable from the starter lug terminal. See Figure 6-37.

3. Remove the starter mounting screws, then carefully disengage the starter from the stator housing.

4. Remove starter through-bolts and carefully separate the brush end cap housing and armature assembly.

5. Use a 1/8 to 5/32 inch nail set to remove the roll pin. Remove the return spring, gear and clutch assembly as required. When reassembling, always use a new roll pin. See Figure 6-38.

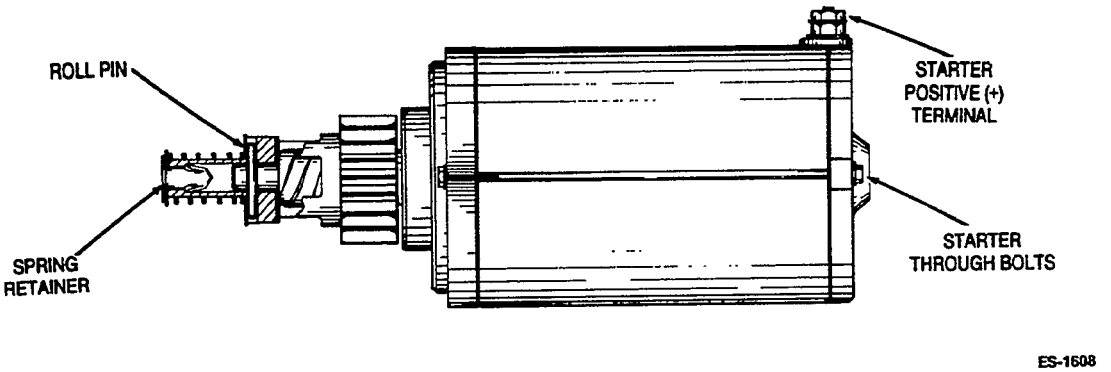

FIGURE 6-37. STARTER MOTOR

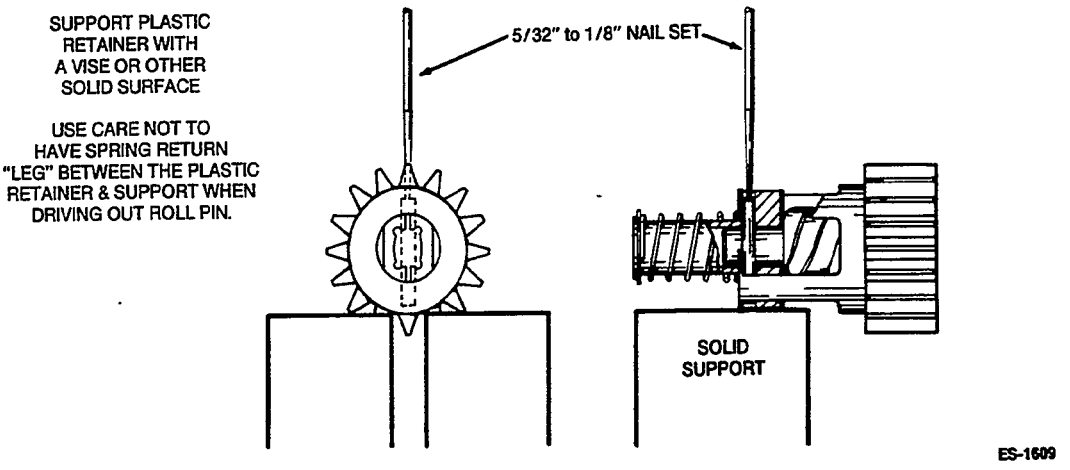

FIGURE 6-38. DRIVING ROLL PIN OUT

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 6-39.

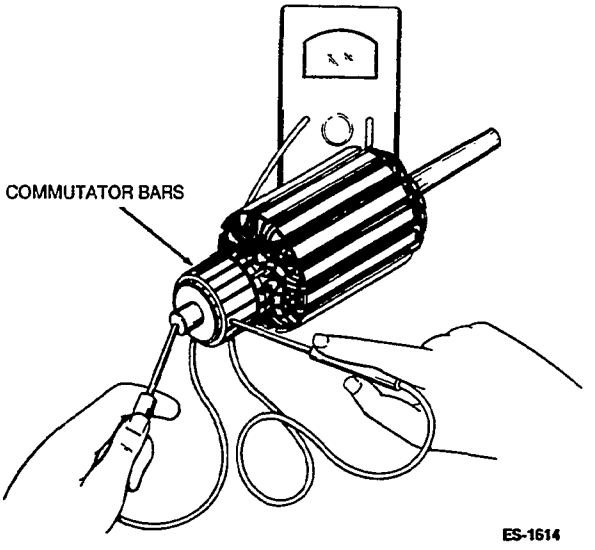

FIGURE 6-39. TESTING ARMATURE FOR GROUNDS

Testing for Shorts: Use a growler (Figure 6-40) to locate shorts in the armature. Place armature in 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. (Turn off the growler before rotating the armature.) A shorted armature will cause the blade to vibrate and be attracted to the core. Replace a shorted armature with a new one.

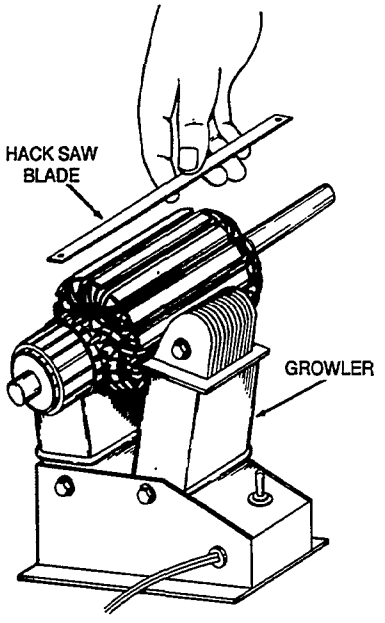

FIGURE 6-40. TESTING ARMATURE FOR SHORTS

Testing for Opens: Touch one ohmmeter lead to a commutator bar, then systematically touch the other lead to each of the remaining commutator bars. 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 6-41) and replace them if worn less than 0.425 (11 mm).

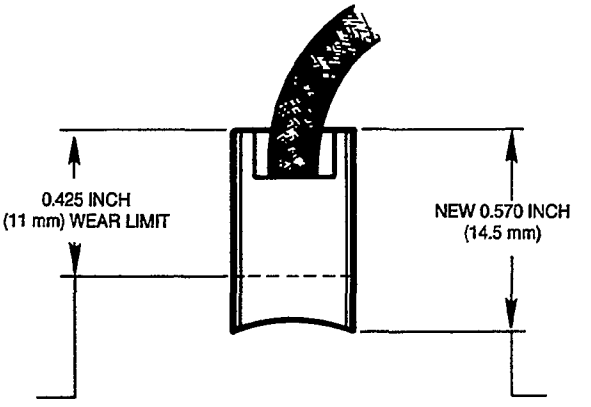

FIGURE 6-41. BRUSH INSPECTION

1. Wipe off 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 6-42. Using a small screwdriver, turn the spring counterclockwise to torque, 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.

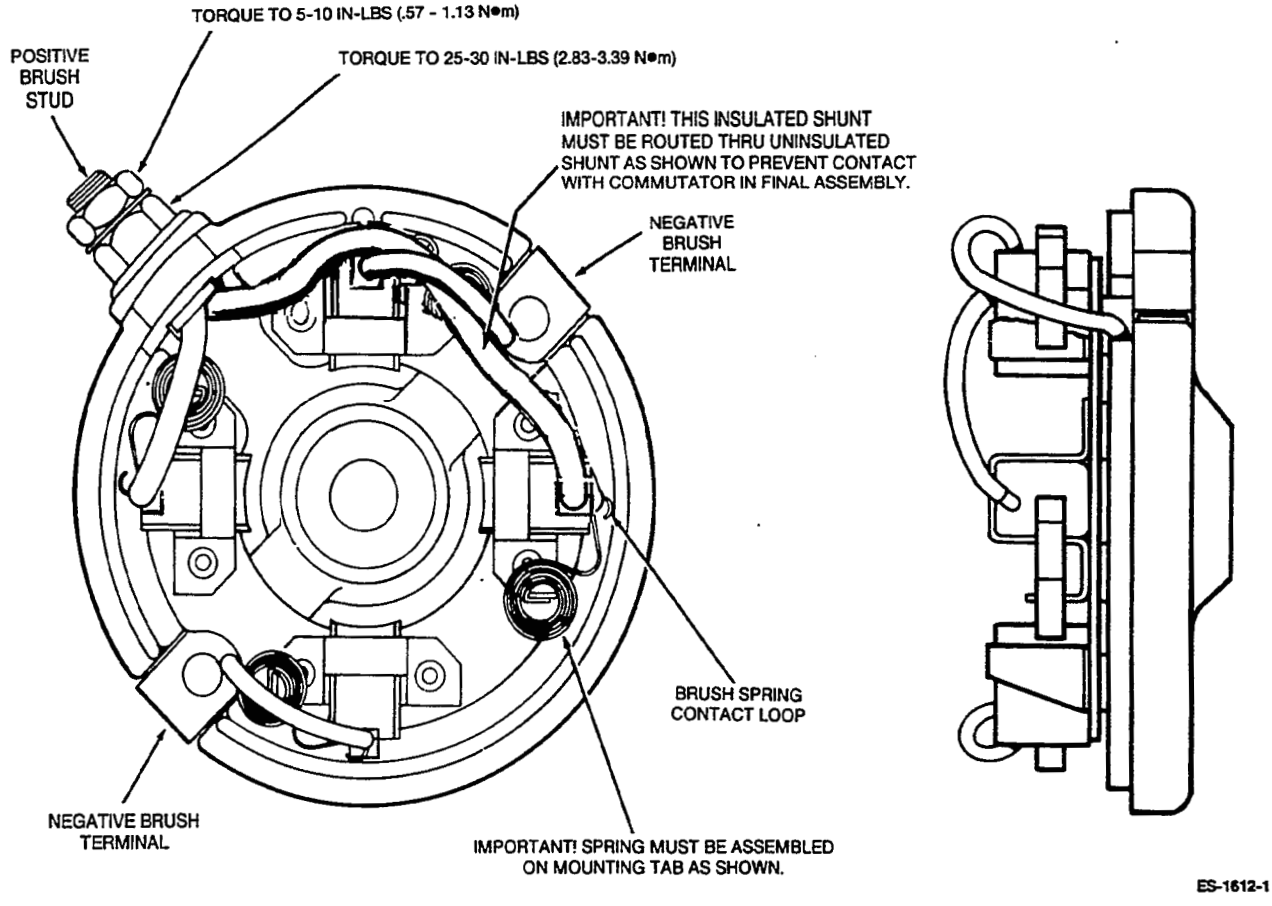

FIGURE 6-42. BRUSH ENDCAP

4. Insert a positive brush stud into the hole, and torque to 25-30 lb-in (2.83 - 3.39 N-m).

5. Using a small screwdriver inserted into the brush spring contact loop, 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 6-43.

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 properly 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 diameter of the housing. Uninsulated portions of wires must also not touch adjacent brush boxes.

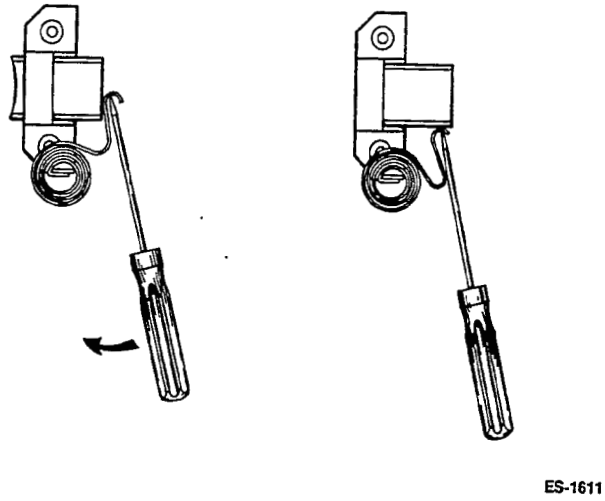

FIGURE 6-43. RESTING BRUSH SPRING ON BRUSH SIDE

9. Place the magnetic housing over the armature. Use a nut driver over the end of the shaft to hold down the armature and the endcap.

10. Place a spring washer and a flat washer on the shaft, as shown in Figure 6-44.

11. Place the mounting bracket on the motor with the exposed end of the sleeve bearing and through-bolt lead-ins facing the inside of the motor. The flat near one mounting hole should line up with the positive stud on end cap, so the through-bolts will 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 on 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 clutch hole.

14. If the return spring is unassembled:

    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 generator set positive (+) battery cable to starter terminal. Connect generator set negative (-) terminal to generator set starting battery.

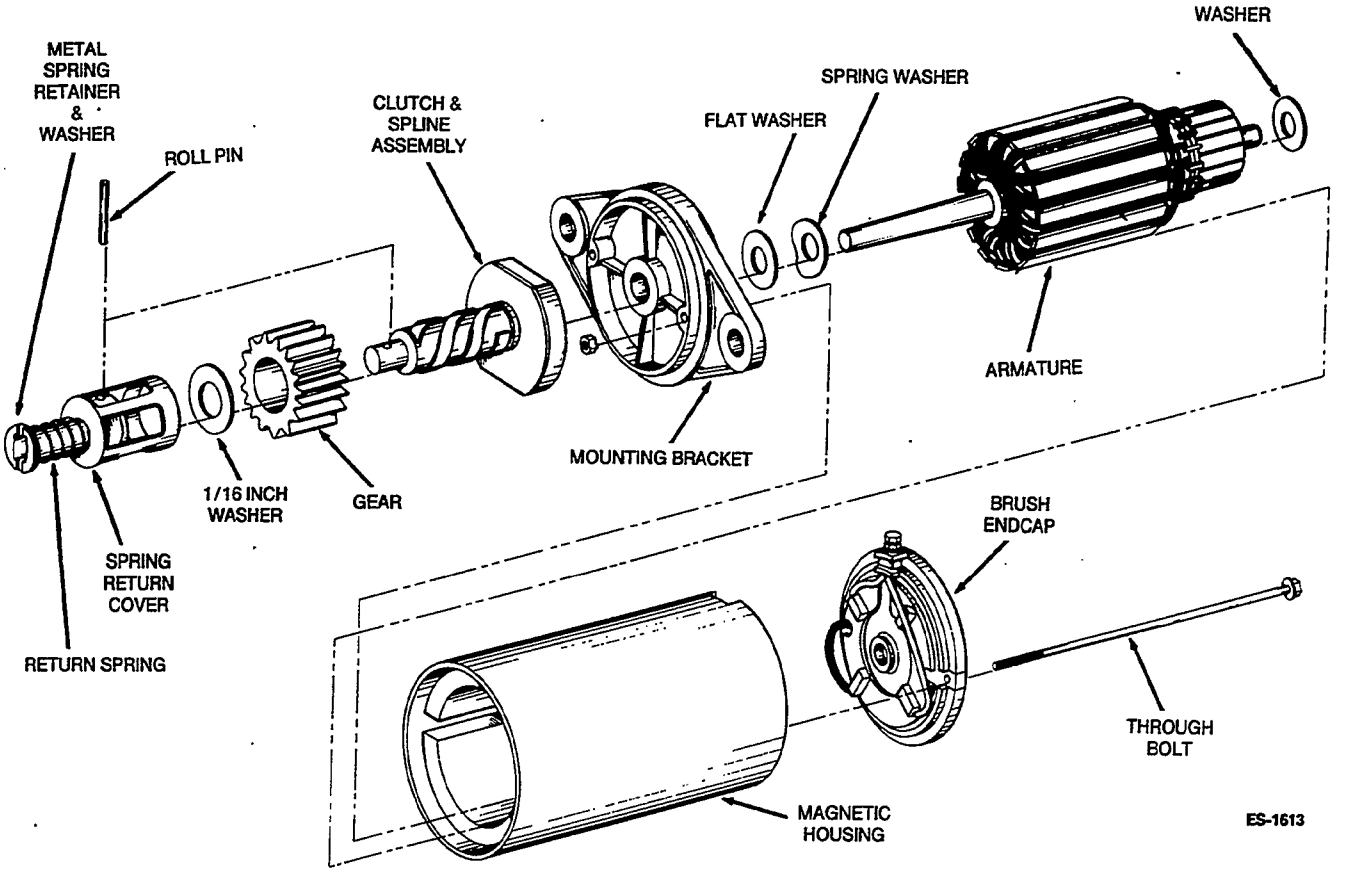

FIGURE 6-44. STARTER ASSEMBLY

Section 7. Control

INTRODUCTION

The control system governs the following functions:

- Starting
- Monitoring for fault conditions
- Instrumentation
- Battery charging
- Stopping

This section covers how the control operates, where the components are located, and basic troubleshooting procedures.

CONTROL DESCRIPTION

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)
- Start solenoid (K1)
- Stop relay (K5)
- Ignition coil (T1)
- Fuel pump (E2) (gasoline units)
- Fuel solenoid (E2) (LPG units)
- Remote start control (optional)
- Circuit breaker(s) (CB1, CB2, CB3)
- Voltage regulator (VR1)
- Voltage regulator (VR2)
- Terminal board (TB1)
- Ignition relay (K6)

The following sections describe each component and how it functions.

This description is generalized: features and components may differ between models of the generator set.

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, start disconnect/run, and stop functions. It is mounted to the rear of the control panel. It contains wiring harness connections to the engine, generator, and optional 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 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 fuses.

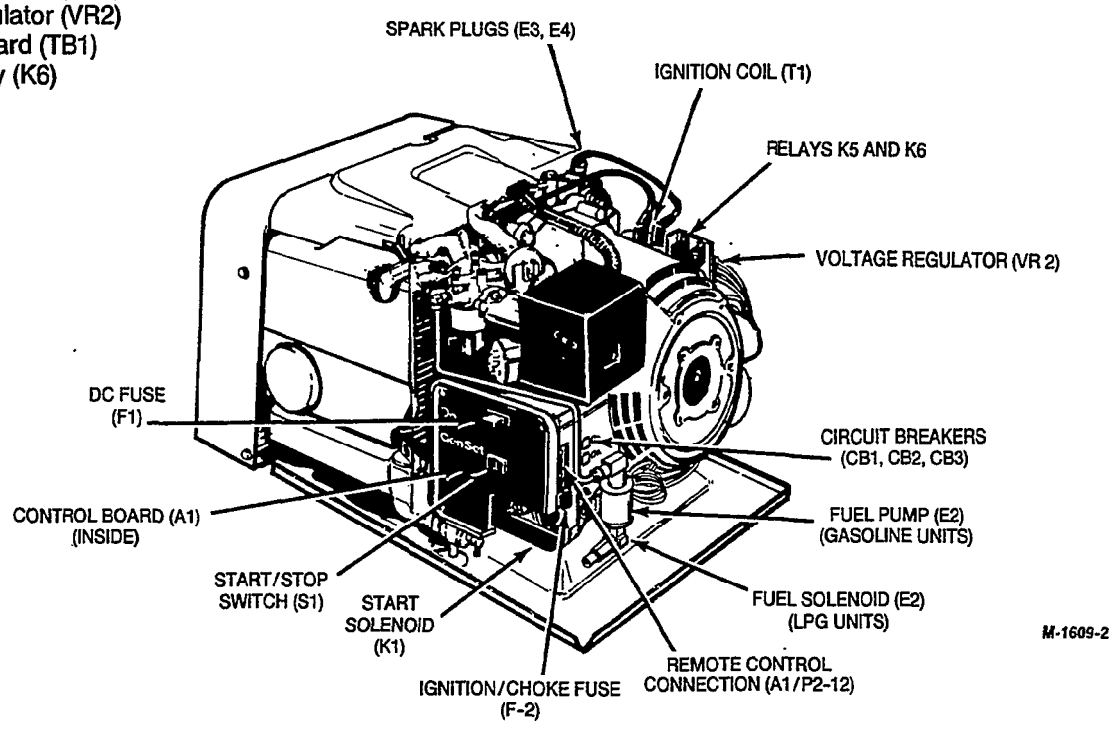

FIGURE 7-1. TYPICAL GENERATOR SET

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 Relay (K5)

The K5 stop relay (Figure 7-1) 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.

Ignition Coil (T1)

The ignition coil is energized at the same time as start solenoid K1 when start relay K4 (on A1) contacts close. Run relay K3 (on A1) continues to keep the ignition coil energized when K4 drops out.

Fuel Pump (E2) (gasoline units)

The fuel pump is energized in the same manner as the ignition coil.

Fuel Solenoid (E2) (LPG units)

The solenoid valve provides a positive fuel shutoff whenever the generator set is stopped. The solenoid must be energized before fuel will flow to the regulator. It is energized in the same manner as the fuel pump is energized in gasoline units.

Remote Start Control (optional)

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

Line Circuit Breaker(s) (CB1, CB2, CB3)

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

Separate circuit breakers are included when output is 3 phase or greater than 240 VAC.

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 induced to the rotor in response to changes in demand. Leads from J4-2 and J4-3 are connected to monitor output voltage.

The voltage regulator is protected from moisture, reducing the risk of component failure. The printed circuit board control is encased in the regulator housing with a potting compound, the ends of the J4 wiring harness are booted, covering the terminals of capacitor C5 (mounted to the outside of the regulator housing), and the wiring harness plug-in P4 is treated with a lubricant prior to connection. More protection is provided by mounting the voltage regulator assembly inside the generator control housing.

Voltage Regulator (VR2)

Voltage regulator VR2 maintains a full charge on the generator set starting battery. It accepts 16-21 VAC from generator terminals B1 and B2, and provides a steady 14.2 VDC output. VR2 regulates battery charging current to 10 - 13 amps. Circuit breaker CB2 (40 amps) protects the battery and VR2 from overcurrent conditions.

Terminal Board (TB1)

The generator leads (T1, T2, T3, etc.) and the line circuit breaker leads (CB1, CB2, etc.) are interconnected at terminal board TB1. See the appropriate wiring diagram for specific connections.

Ignition Relay K6 (Beginning Spec F)

Relay K6 energizes the ignition coil (T1) and the choke heater (H1) when it is powered by engine control board A1 (through the start and run relay contacts). It is mounted next to Relay K5.

Fuse F2 (Beginning Spec F)

Fuse F2 protects the ignition and the choke heater circuits. It is mounted on the side of the control box.

CONTROL OPERATION

When troubleshooting, refer to the appropriate wiring schematic in *Section 11. Wiring Diagrams.*

Starting

Holding the Start/Run/Stop switch in the Start position energizes start relay K4 by completing the circuit to battery ground (B-). The relay K4 contacts close, connecting battery voltage (B+) to the following components:

- Generator Field (through VR1) — Battery voltage flashes the field to initiate generator voltage buildup.
- Starter Solenoid K1 — The solenoid connects the starter motor to (B+) to crank the engine.
- Gasoline Fuel Pump E2 or Gas Solenoid Valve E2 —The pump or valve delivers fuel to the carburetor.
- Ignition Coil T1 — The ignition system begins firing the spark plugs.
- Stop Relay K5 — The relay K5 contacts open to allow run relay K3 to be energized (through oil pressure switch S2 and the relay K2 contacts).
- Ignition Relay K6 (Beginning Spec F) — The ignition coil and choke heater are energized through relay K6 contacts.

Starter Disconnect-Run

As oil pressure builds, 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).

Energizing K2 opens a set of contacts to de-energize K4, and closes another set of contacts to connect B+ to the run relay K3. Relay K3 continues to keep the fuel and ignition circuits energized.

De-energizing K4 disconnects the battery from the generator field and drops out relay K1, which disconnects the starter motor.

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

Stopping

Moving the 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, stop relay K5, and fuel pump/fuel solenoid E2. The relay K5 contacts close, grounding resistors R1 and R2. This prevents K3 from being energized, and the set from restarting when switch S1 is released from the STOP position.

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

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 (Figure 7-3) 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 (Figure 7-4). 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, check control board fuse F1. If the fuse is good, 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.

CONTROL TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the control circuits. Figures 7-2 and 7-3 show the location of most of the control components. Refer to the appropriate wiring diagram/schematic in Section 11 for 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.

⚠WARNING ***Untrained personnel should not attempt repair due to hazards which can result in personal injury or death. Troubleshooting information is provided for qualified repair personnel only.***

Trouble	Possible Cause	Corrective Action
Engine Does Not Crank	1. Control fuse F1 may be open.	1. Check fuse F1. Replace 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. b. Check for continuity and correct if circuit is open. c. 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.	4a. Check condition of battery and recharge or replace. b. Clean and tighten all connections at battery, K1 start solenoid, and starter motor, VR2 battery charge regulator. **⚠WARNING** ***Short circuiting the battery cables can result in severe personal injury. Disconnect the negative (-) battery cable at the battery terminal before servicing.***
	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 relay not grounded. b. Defective K1 relay. c. Defective starter.	5a. Tighten solenoid bracket mounting screw. b. Replace K1 start solenoid. c. 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 board or connector.	6a. Check for continuity and correct if circuit is open. b. See *Testing of Control Board A1.*
	7. B+ is circuit breaker tripped (R4).	7. Wait for circuit breaker to return to local ambient temperature to reset.

⚠WARNING ***Untrained personnel should not attempt repair due to hazards which can result in personal injury or death. Troubleshooting information is provided for qualified repair personnel only.***

Trouble	Possible Cause	Corrective Action
Engine Cranks But Does Not Start	1. Faulty ignition due to worn or fouled spark plugs, worn ignition points, incorrect ignition timing, faulty plug wires, faulty condenser, or faulty electronic 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, or carburetor mixture screws incorrectly adjusted.	2. Refer to *Fuel System* (Section 6) for test and service procedures.
	3. Connect a voltmeter between positive (+) terminal T1 ignition coil and ground. Check for battery voltage when S1 is placed in the START position. If the voltage is not present, fault is due to: a. Open circuit between T1 coil and control. b. Defective control board or connector. c. Fuse F2 has blown. (Beginning Spec F.) d. Relay K6 is faulty. (Beginning Spec F.)	3a. Check for continuity and correct if circuit is open. 3b. See *Testing of Control Board A1.* 3c. Replace the fuse. 3d. Replace Relay K6 if there is cranking voltage at terminals 87 and 85, but not at terminal 30 when cranking.
Engine Starts But Stops When Start Switch is Released	1. Low oil pressure switch S2 not closing due to: a. Low oil level. b. Open circuit between switch and control. c. Defective low oil pressure switch. d. Low oil pressure.	1a. Check oil level and add oil if low. 1b. Check for continuity and correct if circuit is open. 1c. Replace low oil pressure switch. 1d. Refer to Section 6 *Troubleshooting* for procedures to follow.
	2. Stop 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 board A1 or connector.	4. See *Testing of Control Board A1.*
Low Battery Voltage	1. Weak or discharged battery due to: a. Low electrolyte level in battery. b. Long periods of non-use.	1a. Replenish electrolyte and recharge battery. 1b. Connect a separate battery charger to bring battery up to full charge.
	2. Load connected to battery while set is turned off.	2. Turn off/disconnect load and recharge battery.
	3. Weak or discharged battery due to: a. Faulty VR2 (battery charge regulator) b. Open VR2 circuit breaker	3a. Check VR2 input voltage: should be 16-21 VAC. Measure battery voltage. If less than 13 volts, VR2 must be replaced. b. Check breaker continuity; replace if open.

⚠WARNING ***Untrained personnel should not attempt repair due to hazards which can result in personal injury or death. Troubleshooting information is provided for qualified repair personnel only.***

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. Breaker points sticking.	3. Replace breaker points.
	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 terminal 6 or 5 of remote connector plug P2/J2 and terminal 6 or 5 on 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 works 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.
	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 properly (starting and stopping generator set) 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 shorted circuit.

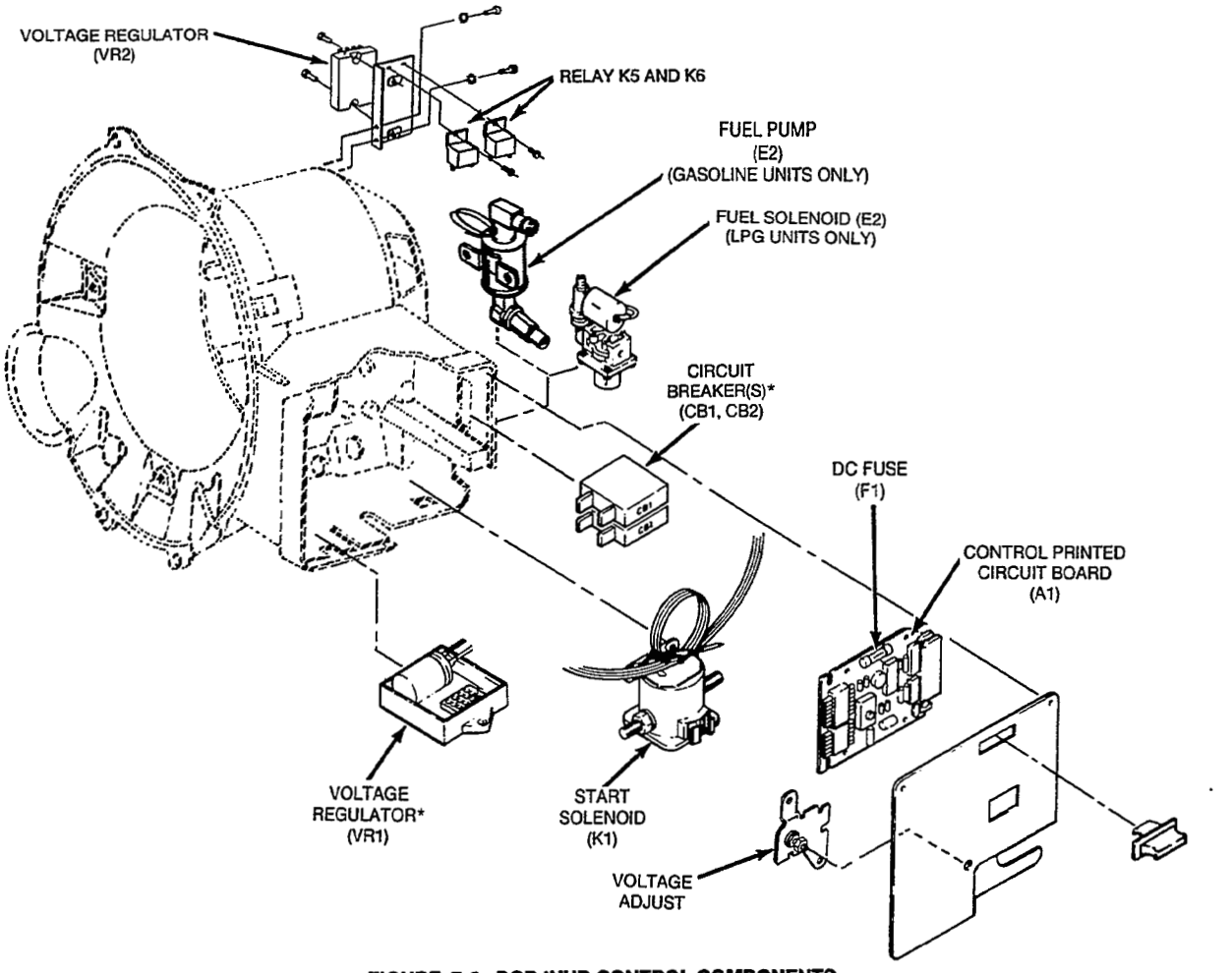

FIGURE 7-2. BGD/NHD CONTROL COMPONENTS

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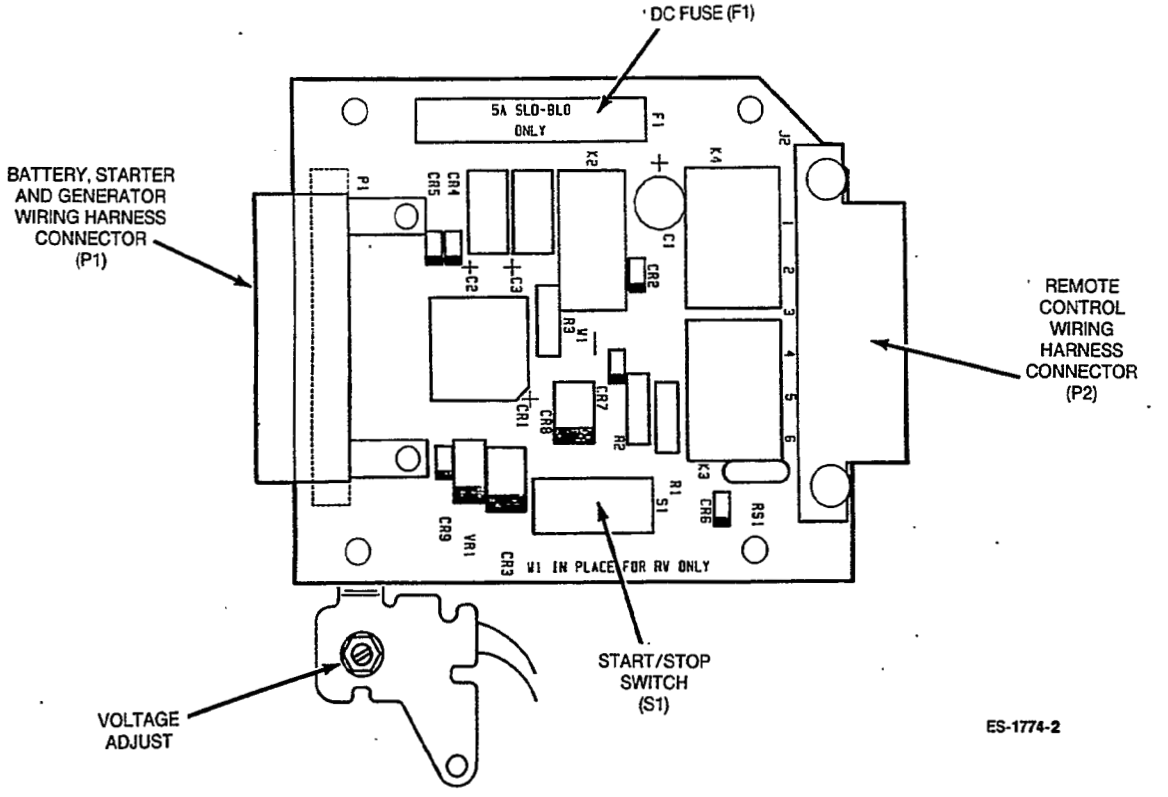

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FIGURE 7-3. BGD, NHD CONTROL P.C.B. ASSEMBLY (A1)

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)
- AC voltage regulator (VR1)
- DC voltage regulator (VR2)
- Circuit breaker(s) (CB1/CB2/CB3)
- Wiring harness to load

Some of these parts are used on selected models; the following discussion is general.

Control Printed Circuit Board (A1)

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.

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

- Leads T1, T2, T3 and T4 to Terminal Board TB1, for supplying power to load.
- Leads B1 and B2 to Control Board A1, wiring harness J1, for supplying power to generator relay K2, and for battery charging.
- Leads Q1 and Q2 to Voltage Regulator VR1, wiring harness J4, for excitation voltage 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, B+ voltage regulator (VR2), rear rotor bearing, exciter brush block, control components, and fuel pump or solenoid (LPG). 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, L2, L3 and L0. Refer to the proper Wiring Diagram/Schematic for specific information.

AC power at TB1 terminals is tapped by leads of wiring harness J4 of voltage regulator VR1, and interconnect wiring to the circuit breaker CB1 (and CB2, if equipped). (3-phase units: winding X1/X2 and isolation transformer T2 provide reference voltage to the voltage regulator: see the schematic.) 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 generator set starts and runs, it provides AC power to the voltage regulator through leads J4-11/Q1, and J4-12/Q2. The AC voltage is rectified to DC voltage, and the proper DC excitation voltage is induced to the rotor in response to changes in demand. The potentiometer on the Emerald faceplate acts directly on VR1, and allows a limited range of output voltage adjustment.

The voltage regulator is protected from moisture, reducing the risk of component failure. The printed circuit board control is encased in the regulator housing with a potting compound, the ends of the J4 wiring harness are booted, covering the terminals of capacitor C5 (mounted to the outside of the regulator housing), and the wiring harness plug-in P4 is treated with a lubricant prior to connection. More protection is provided by mounting the voltage regulator assembly inside the generator control housing.

Voltage Regulator (VR2)

Voltage regulator VR2 maintains a full charge on the generator set starting battery. It accepts 16-21 VAC from generator terminals B1 and B2, and provides a steady 14.2 VDC output. VR2 regulates battery charging current to 10 - 13 amps. A 40-amp thermal circuit breaker protects the battery and VR2 from overcurrent conditions.

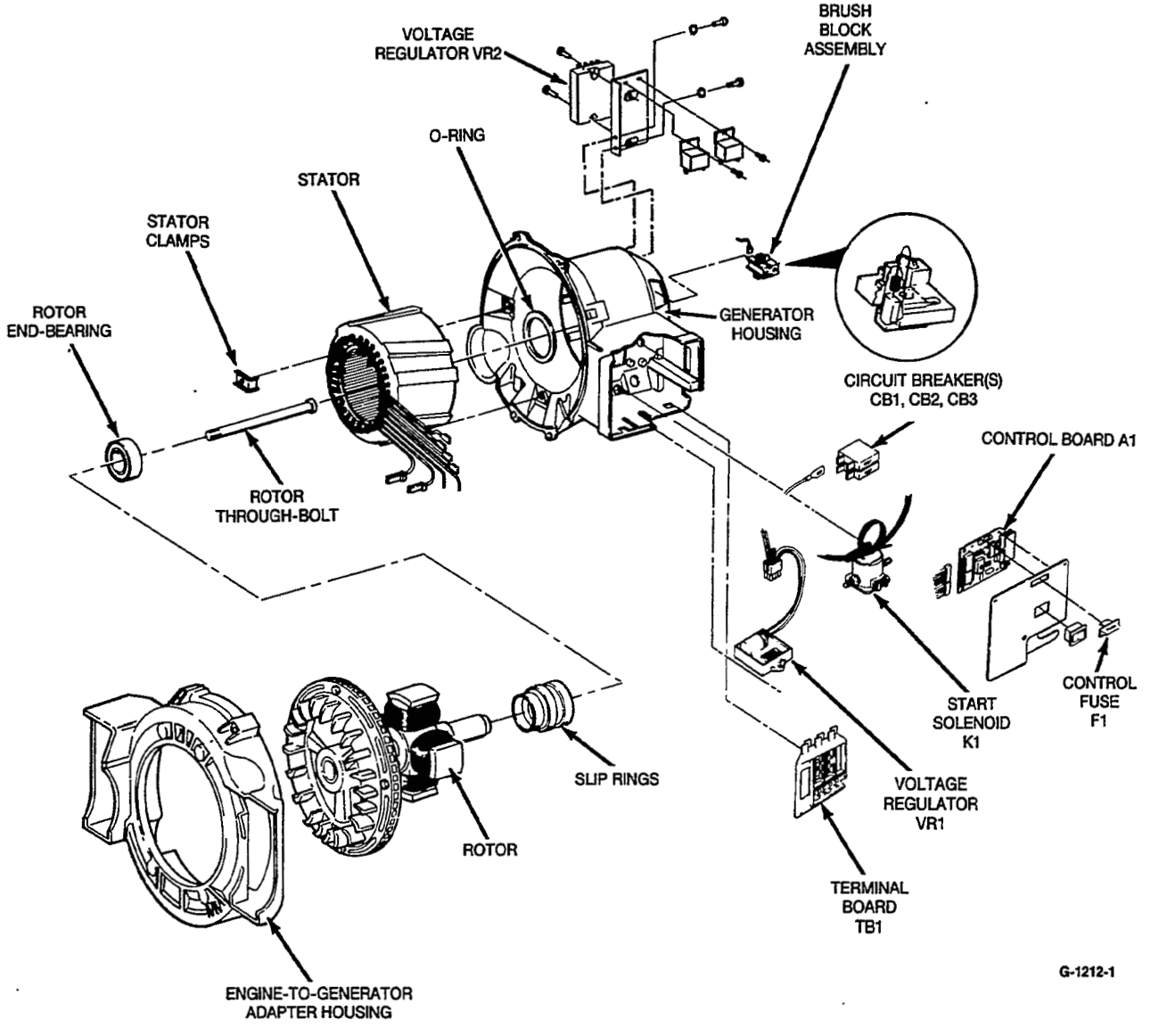

FIGURE 8.1 GENERATOR CONTROL COMPONENTS

Line Circuit Breaker(s)

AC output from the generator is supplied to circuit breakers, CB1 and CB2, and CB3 located on the right side of the control housing. Ampere rating of these breakers may differ, depending on generator set model/frequency. Refer to the proper Parts Manual when ordering replacement parts.

Separate circuit breakers are included with generator sets whose output exceeds 240 VAC. Consult the Installation manual for more information.

Wiring Harness to Load(s)

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

GENERATOR OPERATION

See the appropriate wiring diagram in *Section 11. Wiring Diagrams* 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. (3-phase/reconnectible units: voltage is sensed through isolation transformer T2).

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 generator set performance depends on voltage and frequency (engine speed) regulation. 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.

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 appropriate wiring diagram to locate terminal connections. If these suggestions do not help, contact an authorized Onan service representative.

⚠WARNING ***Untrained personnel should not attempt repair due to hazards which can result in personal injury or death. Troubleshooting information is provided for qualified repair personnel only.***

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. Brushes stuck in holder or not making good contact with slip rings.	4. Release brushes if jammed in holder. Clean slip rings if dirty.
	5. Defective voltage regulator.	5. Replace voltage regulator.
	6. Open, grounded, or short circuit in rotor or stator.	6. Test each component for open, grounded, or shorted windings and replace if defective.
AC Output Voltage Too Low or Too High	1. Engine governor incorrectly adjusted.	1. Refer to governor adjustments in section 6.
	2. Brushes worn or not making good contact with slip rings. (Low 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. Test voltage regulator and replace if faulty.
	5. Open, grounded, or short circuit in rotor or stator.	5. Test each component for open, grounded, or shorted windings and replace if defective.
	6. Output voltage pot misadjusted.	6. Readjust output voltage pot.
	7. Open circuit between terminal block TB1 and voltage regulator; wiring harness J4 leads.	7. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open.

⚠WARNING ***Untrained personnel should not attempt repair due to hazards which can result in personal injury or death. Troubleshooting information is provided for qualified repair personnel only.***

Trouble	Possible Cause	Corrective Action
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.
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. Test voltage regulator and replace if faulty.

GENERATOR SERVICE

This section describes generator disassembly/assembly procedures. Refer to Figure 8-1 to locate and identify the various generator components, and to the appropriate wiring diagram.

Generator Disassembly Procedure

1. Drain the engine oil while the generator set is mounted in the vehicle.

2. Remove the generator 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 flywheel guard from the scroll opening. Remove the noise shield.

4. Remove the carburetor and intake manifold to provide clearance to lift the generator stator assembly. Disconnect the following parts:

   - choke heater lead wires (gasoline units)
   - throttle linkage
   - 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.

5. Disconnect the leads to the charge resistor, the low oil pressure cutoff 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.***

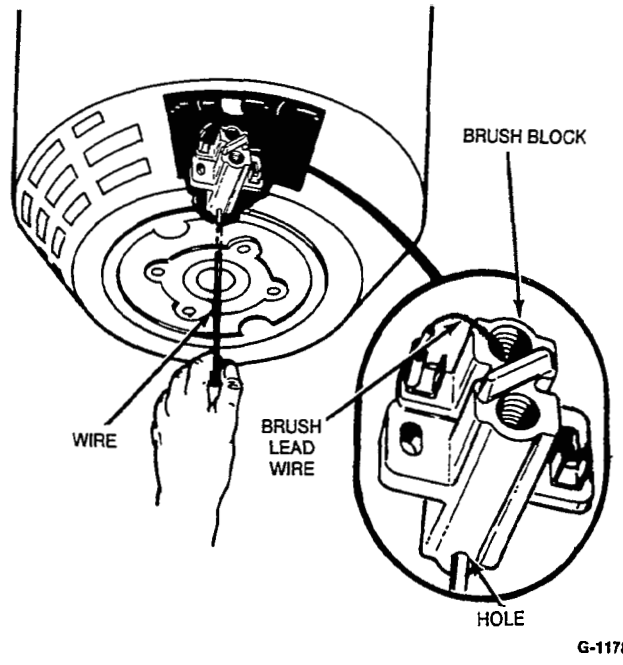

FIGURE 8-2. BRUSH BLOCK ASSEMBLY

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. (LPG units) Disconnect the fuel line at the vaporizer coupling.

10. 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 through-bolt.

11. 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.

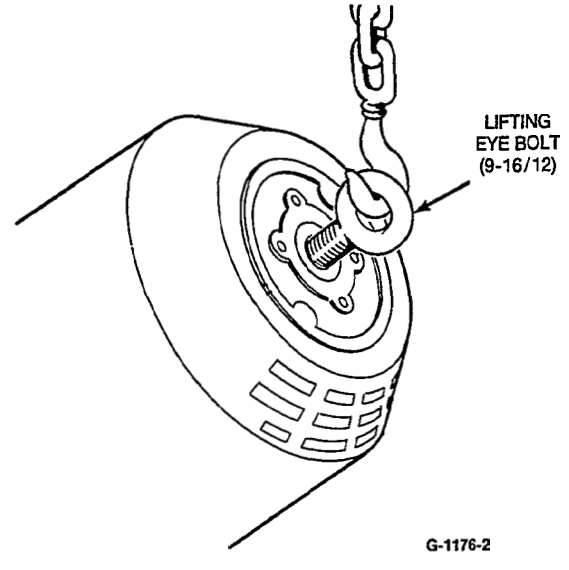

FIGURE 8-3. GENERATOR LIFT

12. Place a pad in front of the engine to cushion and protect the scroll. Attach a hoist or other suitable lifting device to the lifting eye. Tip up the set as shown in Figure 8-3 until it is completely vertical and resting on the scroll housing end.

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

13. Remove the capscrew and two EIT lock washers that secure the ground strap to the drip pan.
14. Remove the three vibration isolator center screws from the underside of the drip pan and lift drip pan away from engine-generator.
15. Disconnect lead wires attached to the starter motor. Loosen the fasteners that mount the starter to the stator housing, and remove starter.
16. Remove the four capscrews, lock washers, and nuts that secure the stator housing to the engine-to-generator adapter.
17. Remove the lifting eye bolt (Figure 8-4).
18. Carefully lift the stator assembly straight up until it clears the rotor. Set stator assembly to rest on smooth, clean surface.

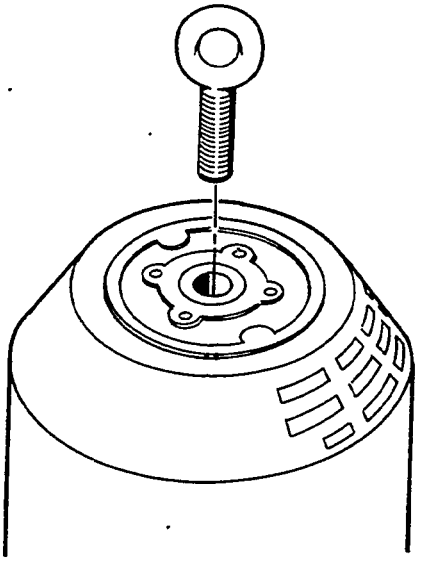

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FIGURE 8-4. REMOVE LIFTING EYE BOLT

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

19. 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 9/16-12 x 2 capscrew in the end of the rotor shaft and tighten until rotor breaks loose from crankshaft. Remove capscrew from end of rotor when complete.

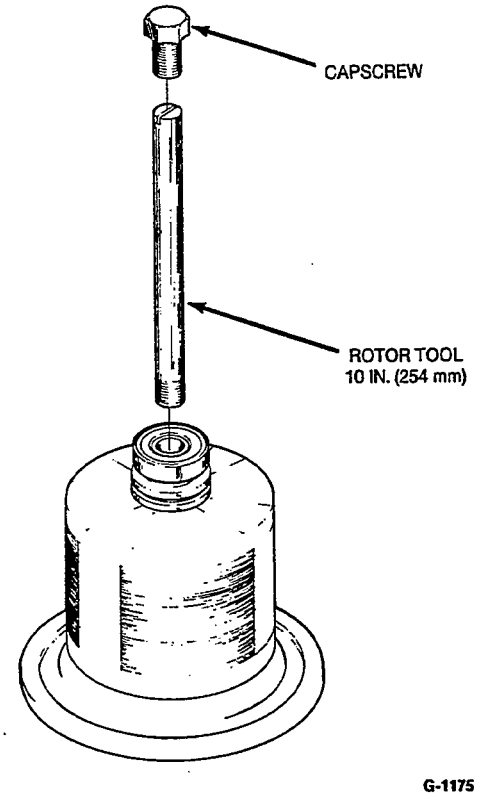

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FIGURE 8-5. ROTOR TOOL

20. Carefully lift the rotor assembly off the end of the engine crankshaft. Remove the rotor tool.
21. Lift the brush wires and remove the brush holding wire from housing. Remove the brush block mounting screw, and carefully remove the brush block assembly from the stator housing.

22. 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.

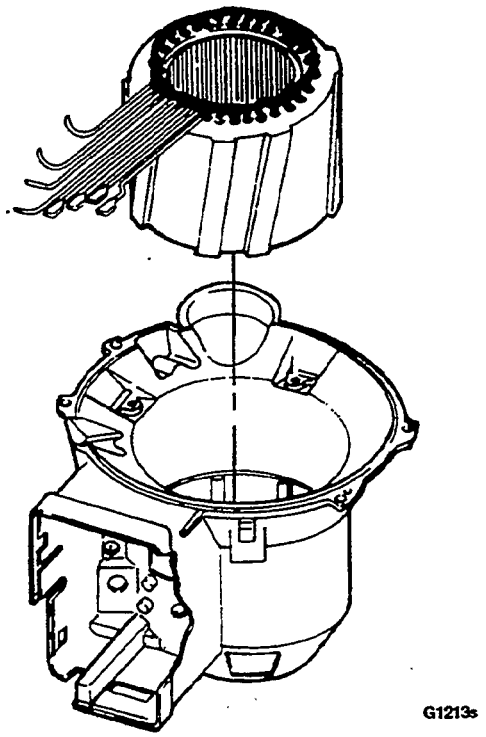


FIGURE 8-6. STATOR/HOUSING DISASSEMBLY

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.***

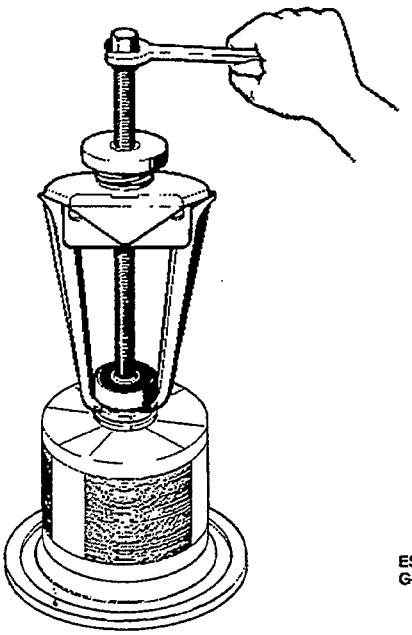


FIGURE 8-7. BEARING REMOVAL

Rotor Bearing Replacement

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

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 from 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 8-2).

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 capscrews 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 two generator 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 plate (Figure 8-3) to the end of the stator housing, using four 5/16-18 x 1 capscrews.

12. Attach a hoist or other lifting device to the lifting plate. Carefully tilt the set back until it rests on the drip tray. Remove the lifting plate when complete.

13. (LPG units) Connect the fuel line at the vaporizer housing.

14. 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.

15. 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.

16. 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.

17. Connect the leads to the charge resistor, low oil pressure cut-off switch, and ignition coil B+ terminal.

18. 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.

19. Install the flywheel guard (scroll opening) and the noise shield.

20. 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.

21. 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 (modified as shown in Figure 8-8) 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.

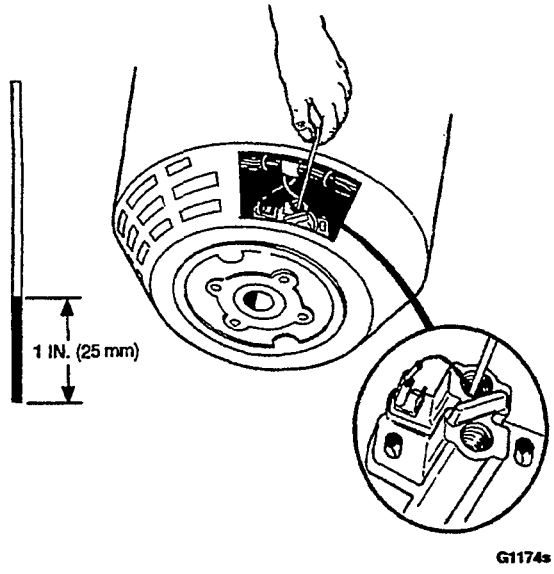


FIGURE 8-8. CHECKING BRUSH WEAR

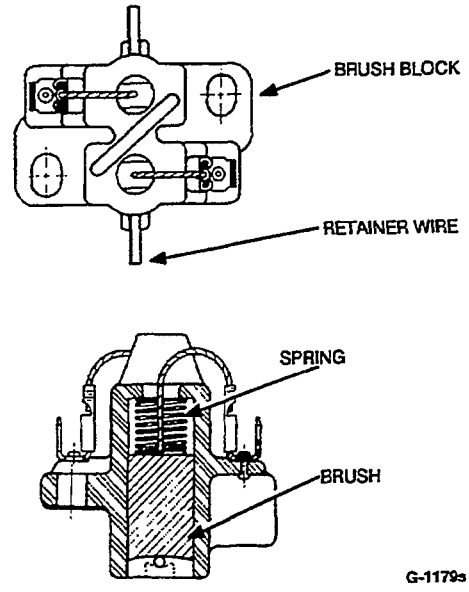


FIGURE 8-9. BRUSH REPLACEMENT

Always replace the brush springs when installing new brushes to insure 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 8-9.
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.
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.

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 6 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 9 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 8-10 and 8-11 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.

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 8-12). A reading less than one megohm indicates that the rotor is grounded. Replace a grounded rotor with a new rotor.

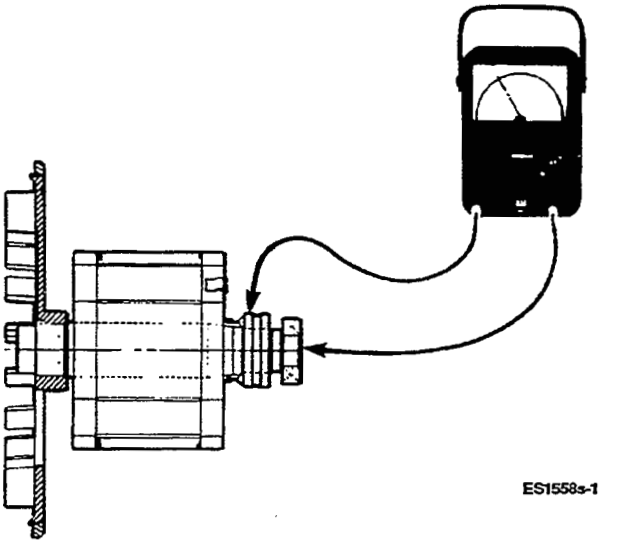


FIGURE 8-10. TESTING ROTOR FOR GROUNDS

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 8-11. 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 8-11. 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.

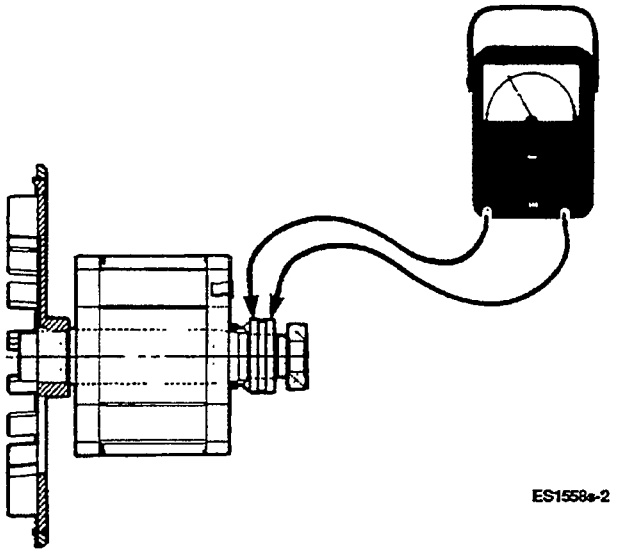


FIGURE 8-11. TESTING ROTOR FOR OPENS OR SHORTS

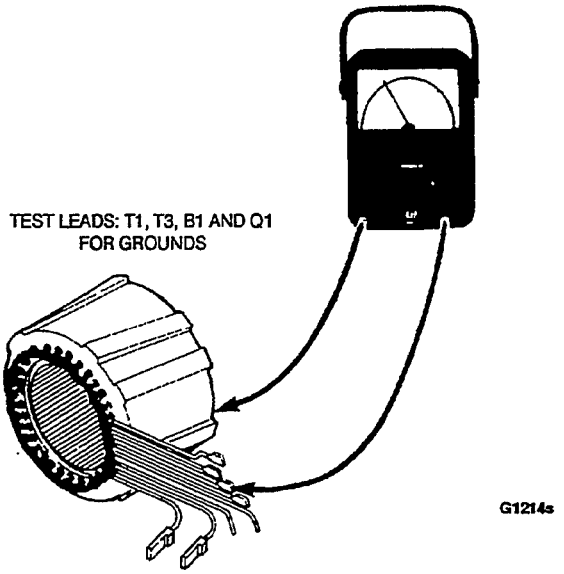


FIGURE 8-12. TESTING STATOR FOR GROUNDS

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 8-12 and 8-13 show the stator and transformer removed from the generator for testing. However, both components may be tested without removing them 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 8-12) 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 leads listed below:

- Stator leads T1, T2, T3, and T4 from TB1 (3-phase units: leads T1-T12)

- Stator leads B1 and B2 from A1

- Stator leads Q1 and Q2 from VR1 (single-phase units)

Set the ohmmeter to the highest resistance scale. Connect the test prods (see Figure 8-13) to the generator lead ends in pairs, as shown in the tables below. The ohmmeter should indicate continuity between lead ends. A high resistance reading indicates an open winding. Replace an open stator with a new stator. Test the rotor in the same manner.

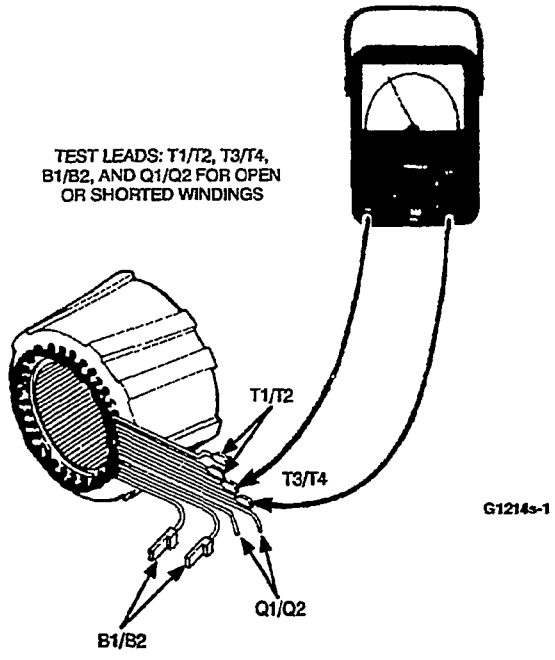


FIGURE 8-13. TESTING STATOR FOR OPENS OR SHORTS

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 8-13) 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%):

	T1/T2 T3/T4	B1/B2	Q1/Q2	Rotor Resistance
60 Hz, 1-phase 120/240 VAC	0.327	0.058	2.089	22.50
50 Hz, 1-phase 120/240 VAC	0.502	0.112	2.873	22.50
60 Hz, 1-phase 100/200 VAC	0.246	0.044	2.089	22.50

Use the following table to test the stator resistance of the models listed below:

	T1/T4, T5/T2, T3/T6, T10/T7, T8/T11, T12/T9	B1/B2	Rotor Resistance
60 Hz, 3-phase Reconnectible	1.089	0.101	24.78
50 Hz, 3-phase Reconnectible	1.625	0.114	24.78
120/240 VAC delta	0.716	0.101	24.78

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

TESTING VOLTAGE REGULATOR VR1

Confirm that voltage regulator VR1 is faulty before replacing it. Use a meter with a diode checking function (Fluke Model 73 Multimeter, for example) to perform the following tests.

1. Disconnect the negative (-) battery cable.
2. Remove the generator control box cover (Figure 8-1).
3. Disengage the wiring connector and remove the voltage regulator.
4. With the meter on "Diode Check," test between connector terminal pairs 5-9, 7-9, 10-9, 11-9, 12-9, 10-5, 5-11, 5-12, and 5-3 (Figure 8-16). **It is important that the positive lead of the meter be connected to the first terminal of each pair.** Replace the voltage regulator if any reading indicates "short" or "open," except for pair 10-5, which should indicate "open."

"Short" is indicated by zero or a number very nearly zero. Meters of a different type may indicate "open" differently. Read the meter instructions. If in doubt, compare with readings of a regulator of the same part number known to be good.

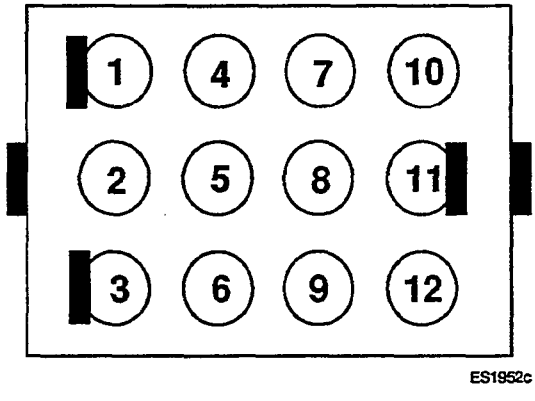


FIGURE 8-14. VOLTAGE REGULATOR CONNECTOR TERMINALS

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
- Bearings
- Cylinder block

Performing major service on the block assembly requires that the generator set be removed from the vehicle (see Set Removal section). The control, generator, 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 SERVICE

1. Open the oil drain valve and drain the crankcase oil.
2. Remove the filter (see Figure 9-1) by turning it counterclockwise with a filter wrench.
3. Loosen the two capscrews that secure the adapter to the engine block and remove the adapter and gasket. The low oil pressure cutoff switch is installed in a threaded hole in the filter adapter.

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.

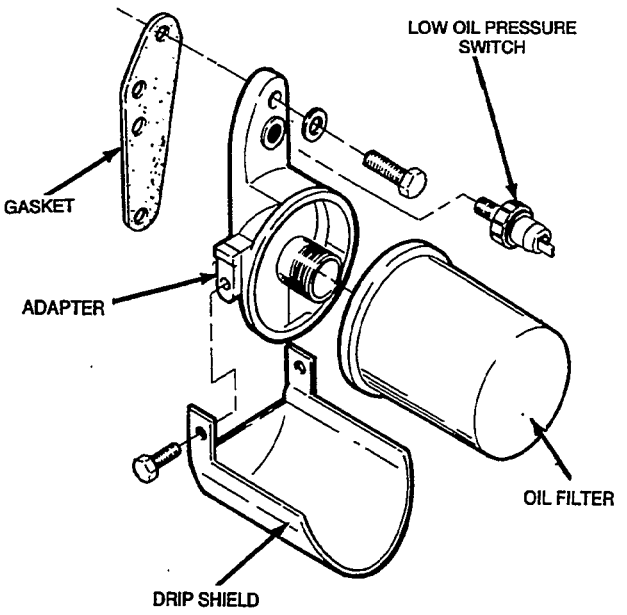


FIGURE 9-1. OIL FILTER AND ADAPTER

CYLINDER HEADS

Remove the cylinder heads for cleaning when poor engine performance is noticed.

Cylinder Head Service Procedures:

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

   ⚠CAUTION ***The heads may warp if they are removed while hot. 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.
3. Use new head gaskets, and clean both the heads and the cylinder block thoroughly where the gaskets rest.

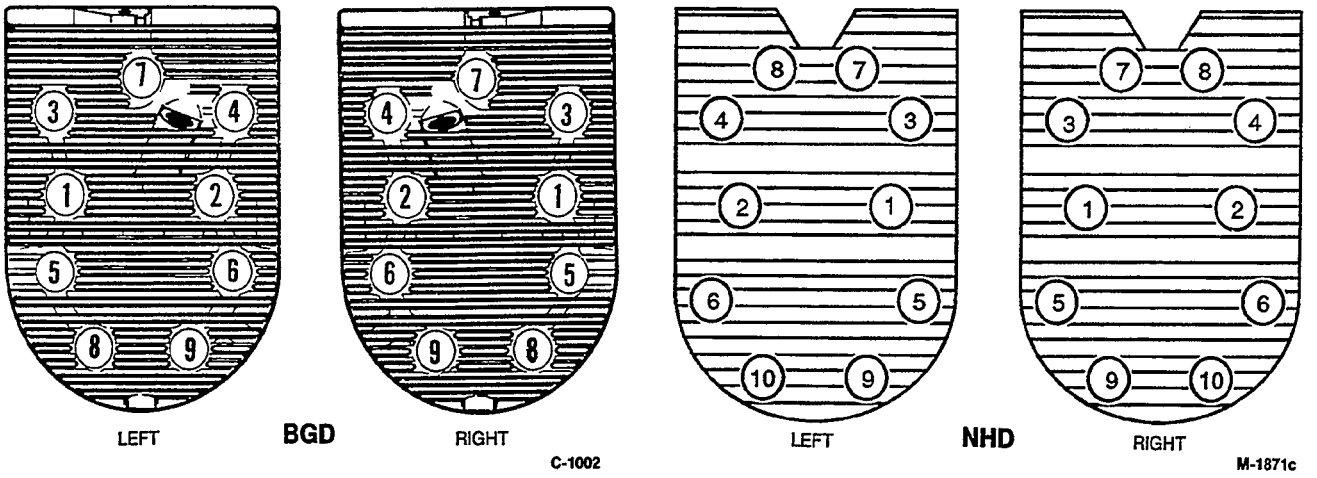


FIGURE 9-2. CYLINDER HEAD TIGHTENING SEQUENCE

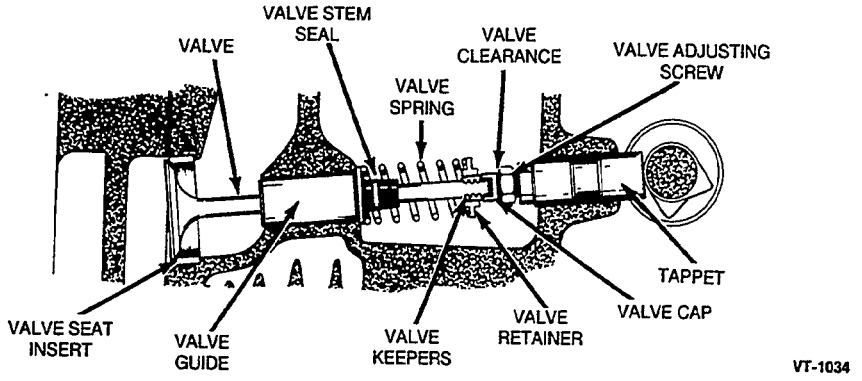
4. Place the heads in position, and follow the head torque tightening sequence shown in Figure 9-2. Start by tightening all bolts to 5 ft-lbs (7 N-m), then 10 ft-lbs (14 N-m), etc., until all bolts or stud nuts are tightened to the specified torque (see *Torque Specification* section).

5. Retorque before engine has run a total of 25 hours.

VALVE SYSTEM

A properly functioning valve system is essential for the engine to perform well. Onan generator sets use an L-head valve design, as shown in Figure 9-3. 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 9-4) from the cylinder block. Use the procedures described below to inspect and service the valve system.

BGD



NHD

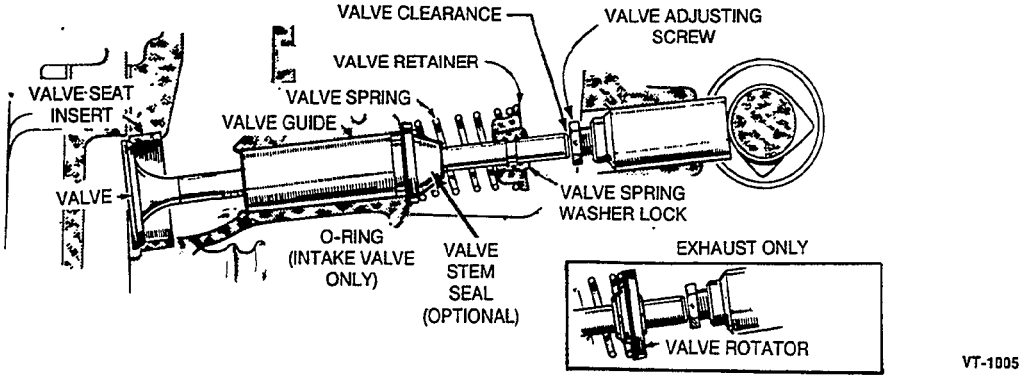


FIGURE 9-3. VALVE SYSTEM

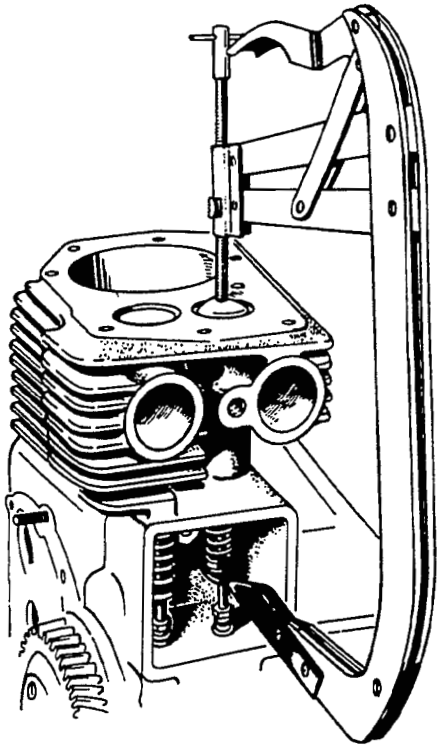


FIGURE 9-4. VALVE SPRING COMPRESSOR

Valve Inspection Procedure

Valve Face: Check the valve face for evidence of burning, warping, out-of-round, and carbon deposits (see Figure 9-5).

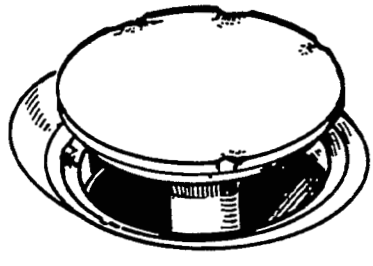


FIGURE 9-5. VALVE FACE

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. Deposits of hard carbon with sharp points projecting become white-hot, causing preignition and "pinging".

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 9-6. 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. Always regrind the seat, to make it concentric with the newly installed guide.

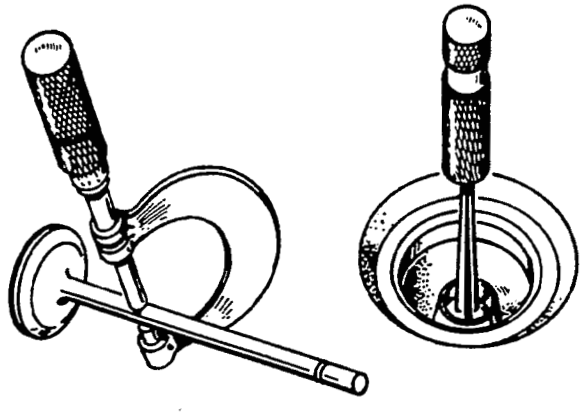


FIGURE 9-6. VALVE STEM AND VALVE GUIDE INSPECTION

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 generator set 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 9-7).

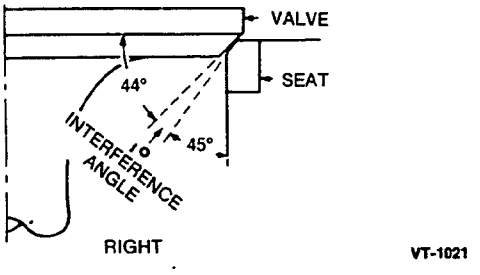


FIGURE 9-7. VALVE INTERFERENCE ANGLE

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 9-8). 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.

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.

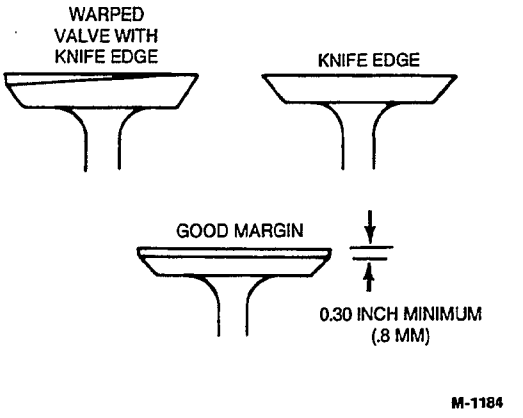


FIGURE 9-8. VALVE MARGIN

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 ensure 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 Guide Replacement

Worn valve stem guides may be replaced from inside the valve chamber (a seal is provided behind the intake valve guides only). The smaller diameter of the tapered valve guides must face toward the valve head.

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

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.

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

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. Place a new gasket on the intake valve guide, and 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 9-9.

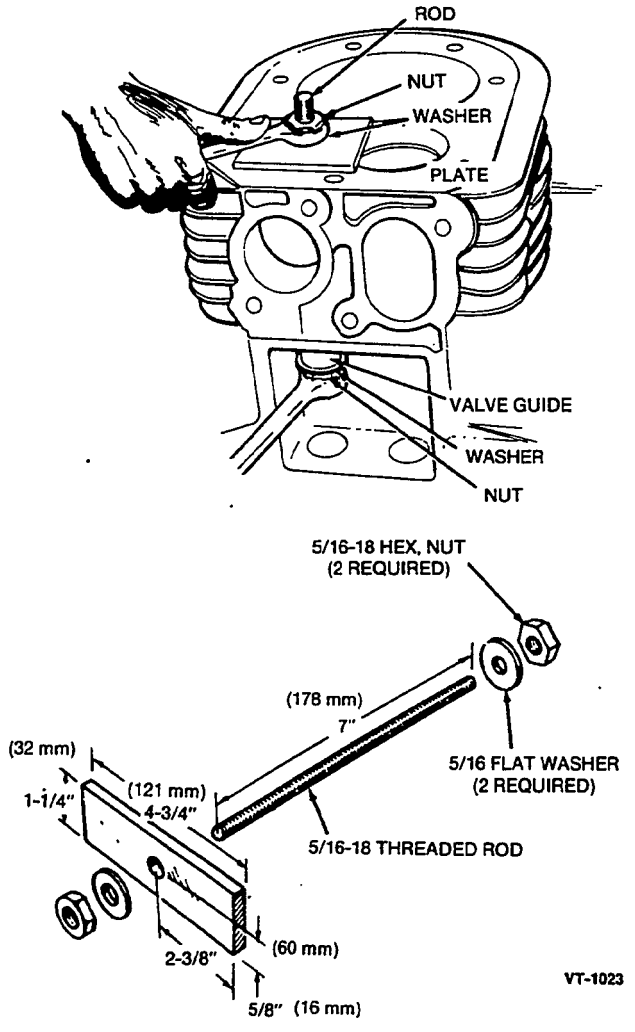


FIGURE 9-9. VALVE GUIDE INSTALLATION

Valve Seat

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

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 9-10).
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.

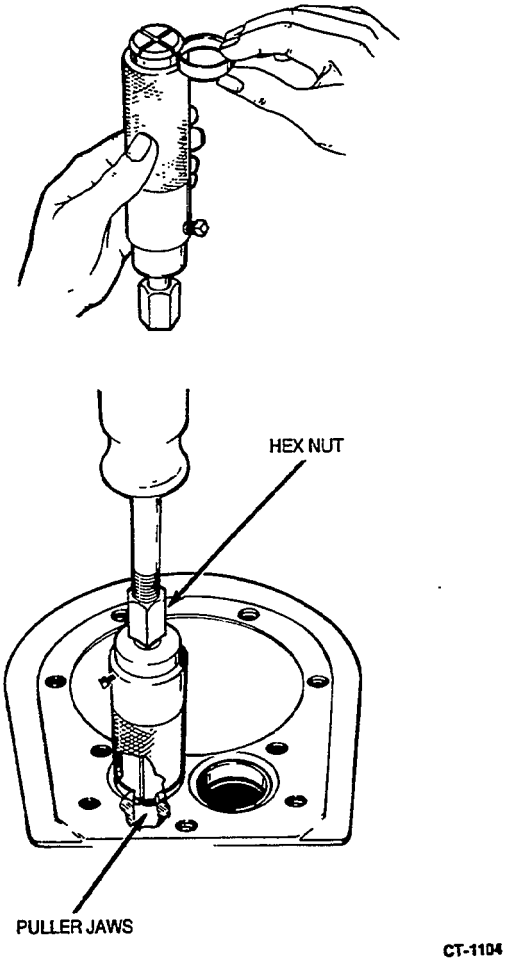


FIGURE 9-10. VALVE SEAT REMOVAL

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 9-11).

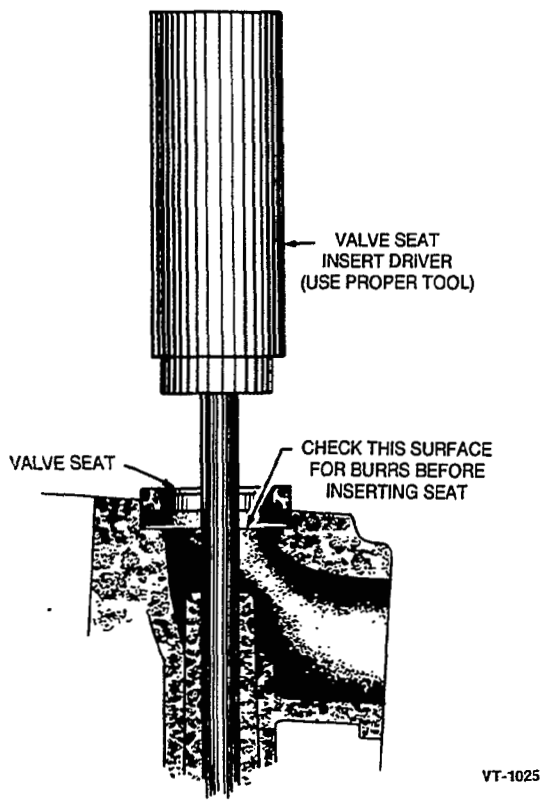


FIGURE 9-11. INSERTING NEW VALVE SEAT

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.

Tappet Adjustment Procedure

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

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 TC mark on the flywheel is lined up with the TC 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 Specifications section. For each valve, the gauge should just pass between the valve stem and valve tappet (see Figure 9-12).

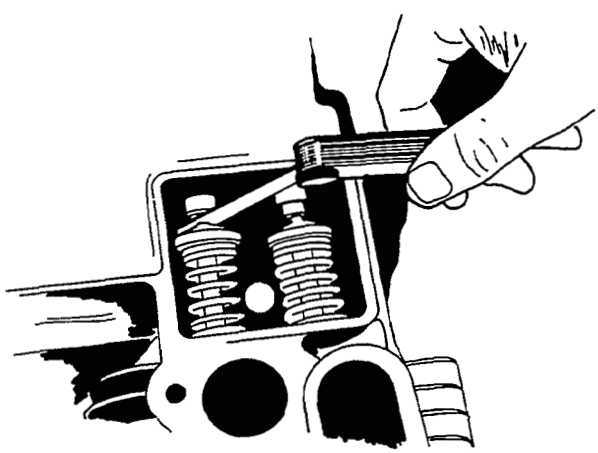


FIGURE 9-12. VALVE CLEARANCE ADJUSTMENT

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 TC mark on the gear cover again. Then follow the adjustment procedure given for the left cylinder.

7. Replace all parts removed. Tighten all screws securely. Torque manifold bolts.

GEAR COVER

Removal Procedure

Remove the flywheel key and gear cover mounting screws.

Gently tap the gear cover with a plastic-faced hammer to loosen it (see Figure 9-13).

Installation Procedure

1. When installing the gear cover, make sure that the pin in the gear cover engages the nylon-lined (smooth) hole in the governor cup.
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.

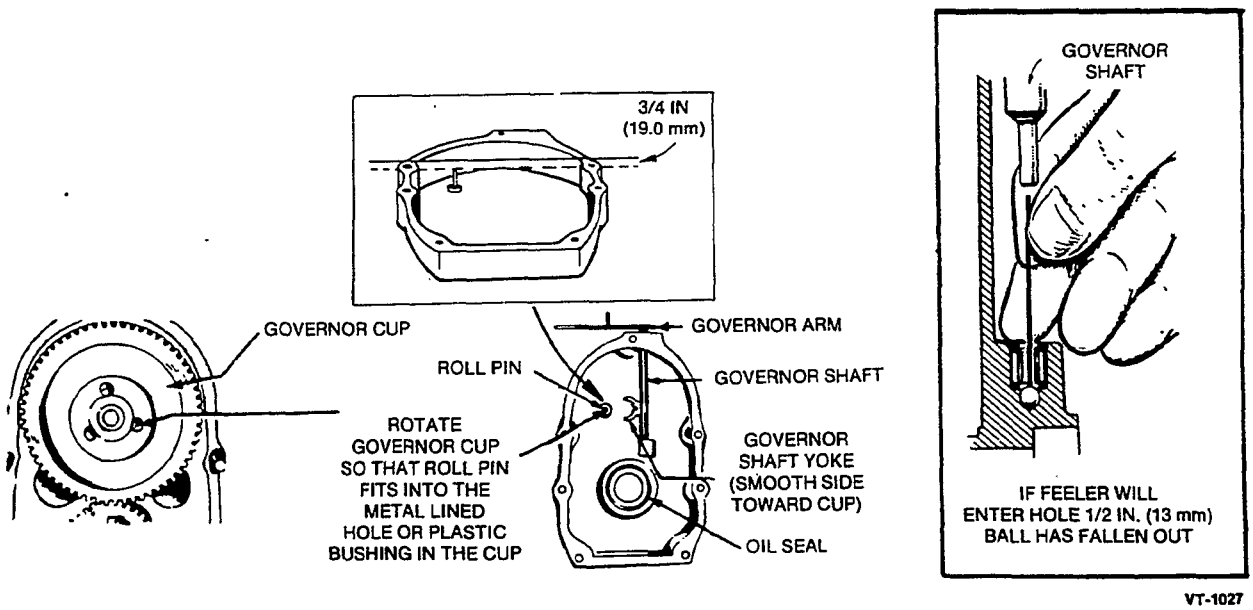


FIGURE 9-13. GEAR COVER ASSEMBLY

GOVERNOR CUP

Removal Procedure

1. Remove the gear cover, as described above.

2. Remove the snap ring from the camshaft center pin (see Figure 9-14).

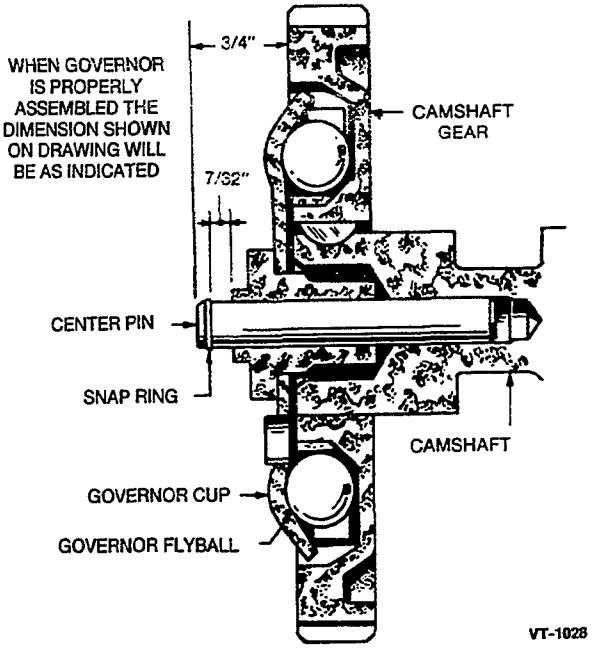


FIGURE 9-14. GOVERNOR CUP

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.

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

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 9-14. 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.

Removal Procedure

1. Remove the snap ring and retainer washer.

2. Attach the gear pulling ring using two 10-32 screws (Figure 9-15). Tighten the screws alternately, until both are tight.

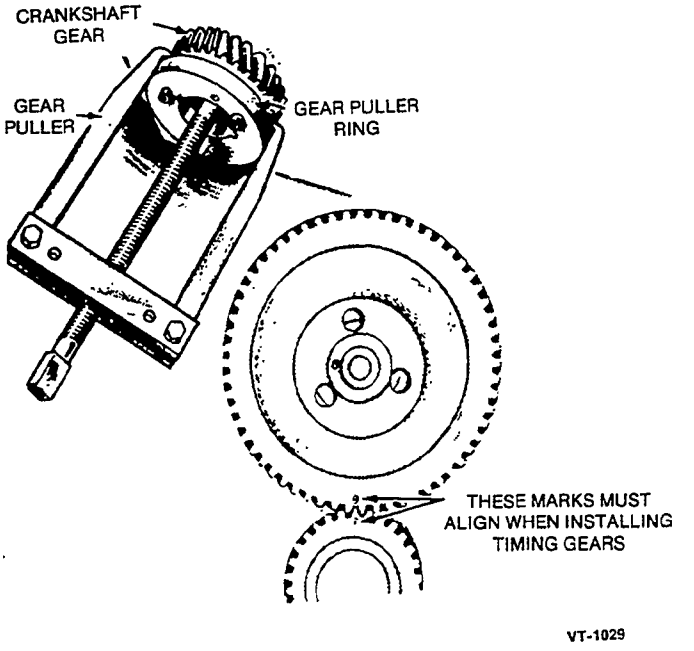


FIGURE 9-15. TIMING GEAR REMOVAL AND INSTALLATION

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.

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 generator set 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 9-16) 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.

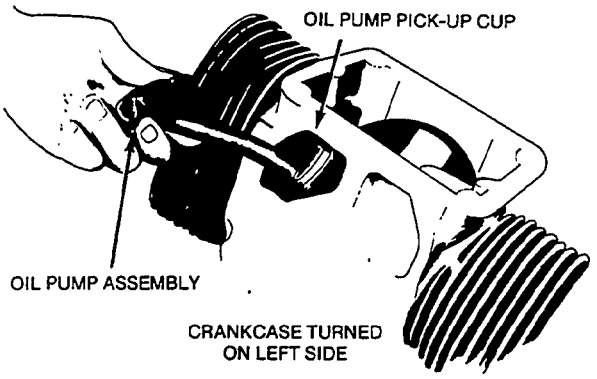


FIGURE 9-16. OIL PUMP ASSEMBLY

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 is at least 13 psi (90 kPa) for Model BGD and at least 20 psi (138 kPa) for Model NHD generator sets 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 9-17), controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open at 13-14 psi (89.6-96.5 kPa).

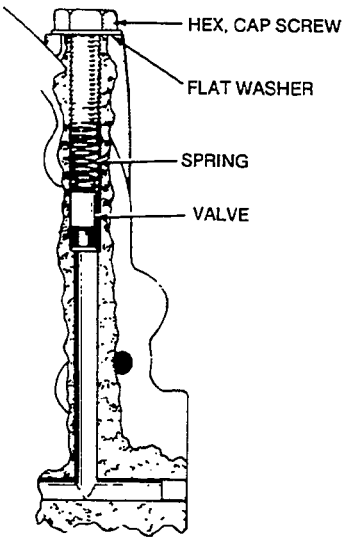


FIGURE 9-17. OIL BYPASS VALVE

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 in. 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±0.9 N) when compressed to 0.5 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.

Removal and Disassembly Procedure

1. Remove carbon from the top of cylinder bore, and check for a ridge. Remove this ridge (see Figure 9-18) 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.***

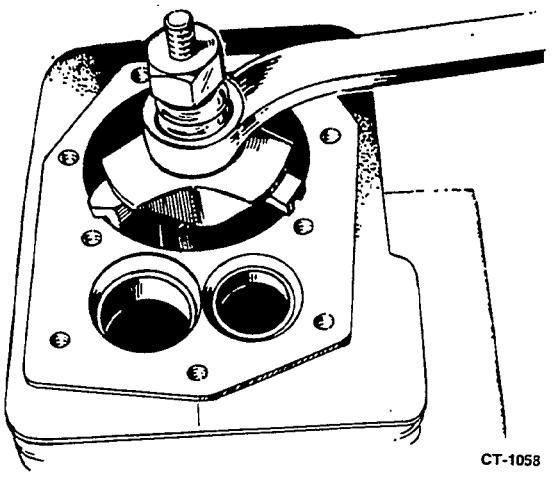


FIGURE 9-18. REMOVING WEAR RIDGE

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 9-19.

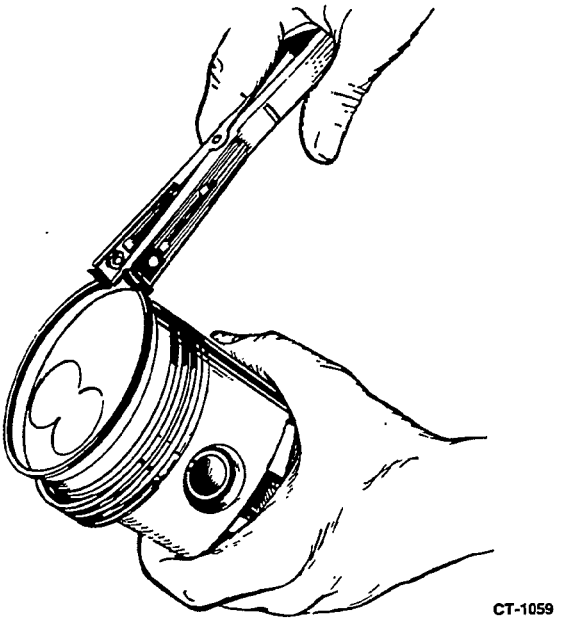


FIGURE 9-19. REMOVING PISTON RINGS

6. Mark each piston 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.

   Newer replacement pistons and Spec F pistons have round-wire piston pin lock rings. Pry out the lock ring with a small screwdriver inserted into the slot behind the ring. If necessary, push the ring around in its groove until the slot is behind it.

⚠CAUTION ***Wear safety glasses and hold your thumb over the ring to keep the ring from flying out and getting lost or causing personal injury.***

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 9-20). Take care not to remove metal from the groove sides.

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

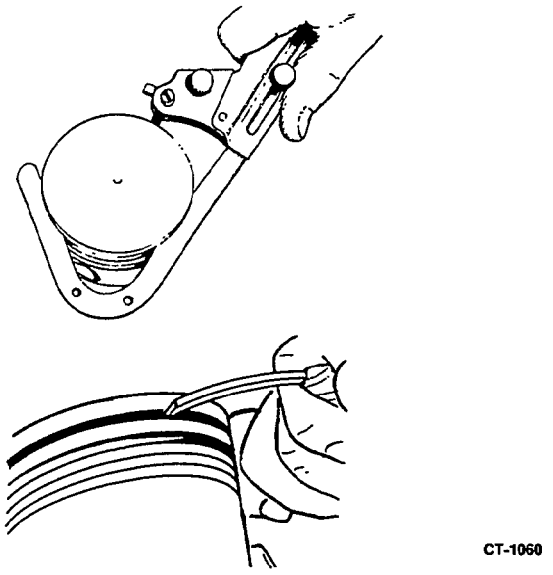


FIGURE 9.20. CLEANING RING GROOVES

When cleaning the connecting rods in solvent, make certain to include the rod bore. Blow out all passages with low-pressure compressed air.

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 9-21. Replace the piston if the side clearance of the top compression ring is as much as 0.008 inch (0.20 mm).

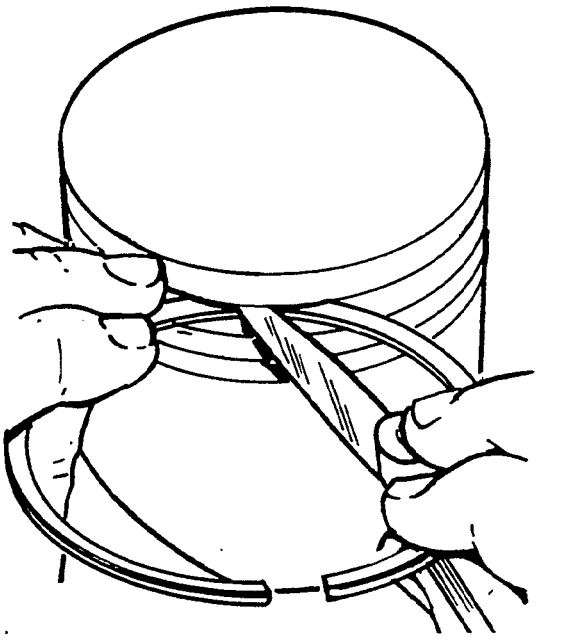


FIGURE 9-21. CHECKING RING LAND

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 9-22).

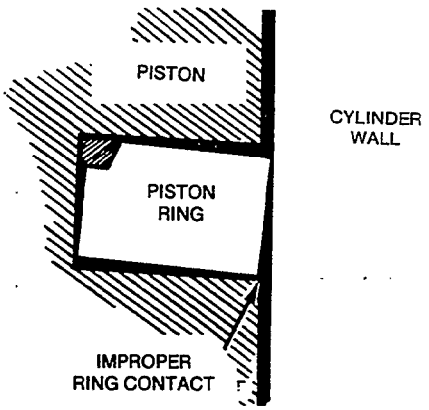


FIGURE 9-22. NEW RING IN WORN RING GROOVE

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.

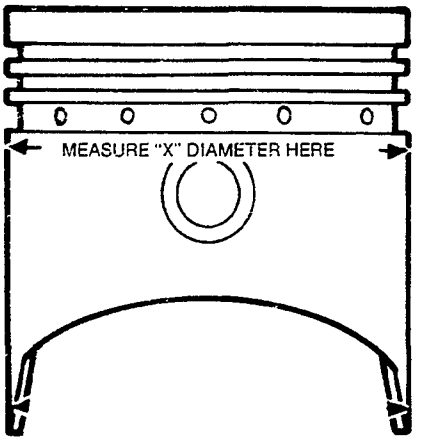


FIGURE 9-23. PISTON CLEARANCE MEASUREMENT

Piston Clearance

Correct piston tolerances must be maintained. Use a micrometer to measure the piston diameter at the point shown in Figure 9-23. 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 9-24). The gap between the ends of the ring is given in *Dimensions and Clearances* section.

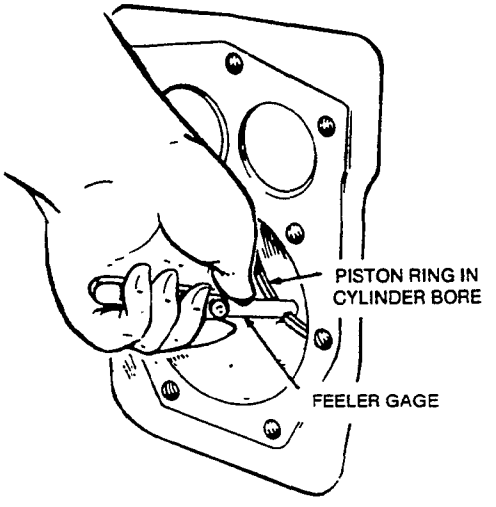


FIGURE 9-24. CHECKING RING GAP

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.

   Newer replacement pistons and Spec F pistons have round-wire piston pin lock rings. These can be pushed in by thumb pressure or pried in with a small screwdriver.

   ⚠CAUTION ***Wear safety glasses and hold your thumb over the ring to keep the ring from flying out and getting lost or causing personal injury.***

3. Install the rings on the piston beginning with the oil control ring (Figure 9-25). 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.

   The rings for newer replacement pistons and Spec F pistons are packaged with instructions. Follow the instructions exactly. Note especially which ring goes in which groove and which side of the ring is "up". Also note that the oil control ring is an assembly of three pieces.

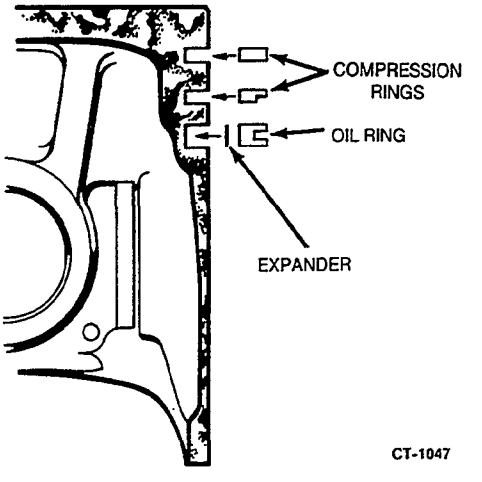
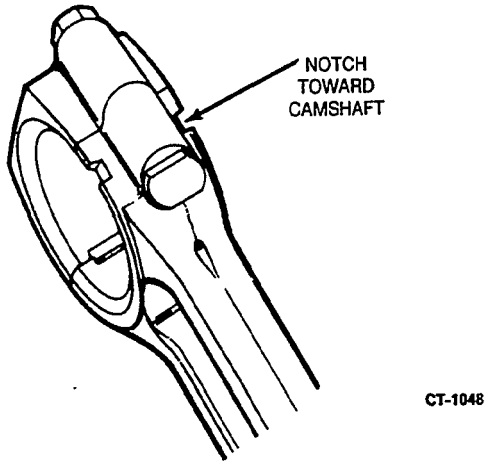


FIGURE 9-25. PISTON RINGS

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 9-26. Install the bearing insert in rod.



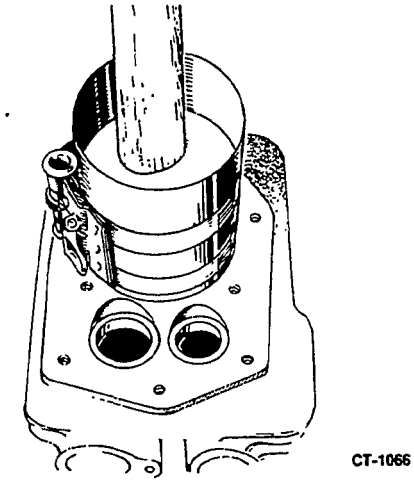


FIGURE 9-26. INSTALLING PISTON AND CONNECTING ROD

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 ¼ 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 9-27) to determine the bearing clearance.

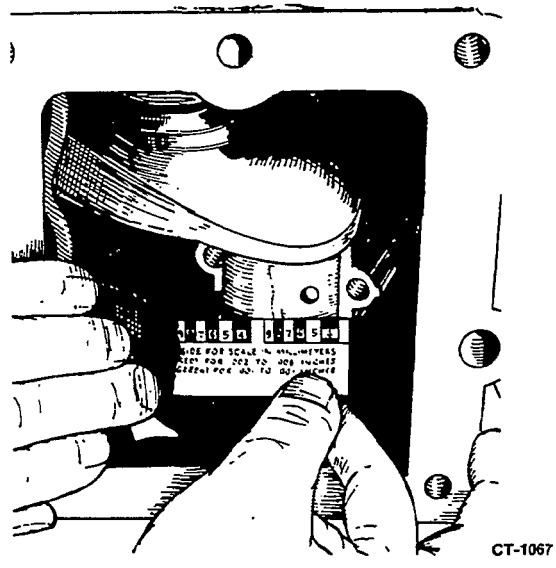


FIGURE 9-27. MEASURING BEARING CLEARANCE

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.

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.

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 (see Figure 9-32). 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 9-32). The shim goes against the bearing plate, and the flat surface of the thrust washer goes against the shim.

6. Place the 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 9-28, using a feeler gauge.

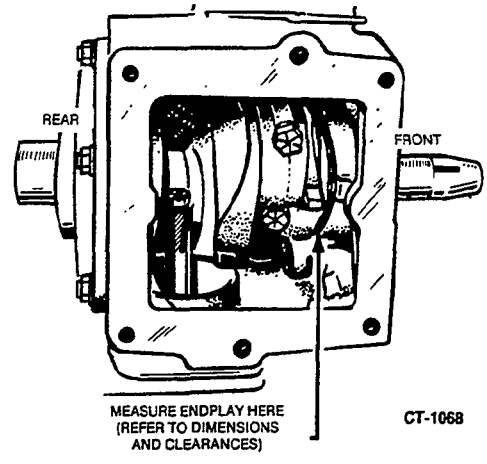


FIGURE 9-28. CHECKING ENDPLAY

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.

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. 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.

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 9-29).

   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 honing procedure.

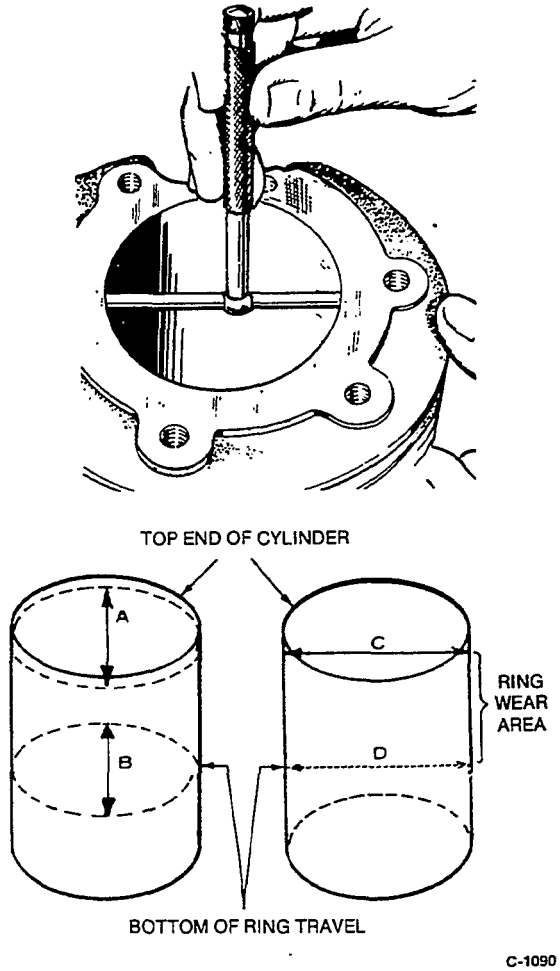


FIGURE 9-29. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

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 may 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 appropriate.

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 9-30.

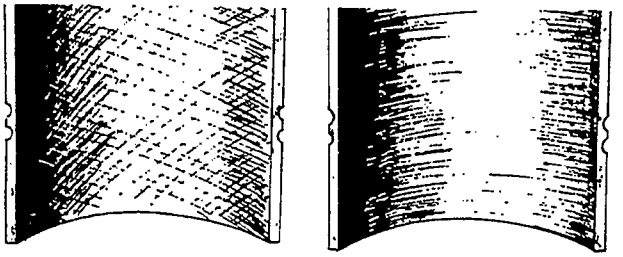


FIGURE 9-30. CROSSHATCHING

⚠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 9-31) in the block.

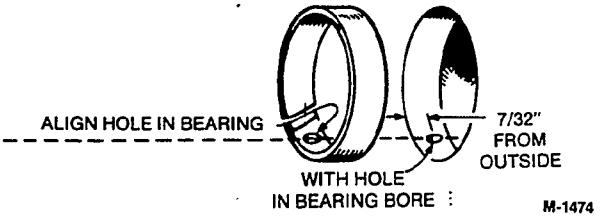


FIGURE 9-31. CAMSHAFT BEARING

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 1/2 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 9-32) to the depth allowed by the flange on the driver.

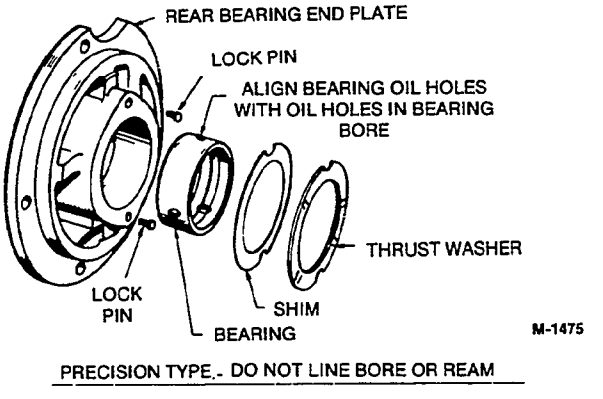


FIGURE 9-32. REAR BEARING

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 9-33. Do not add an additional thrust washer to this front bearing.

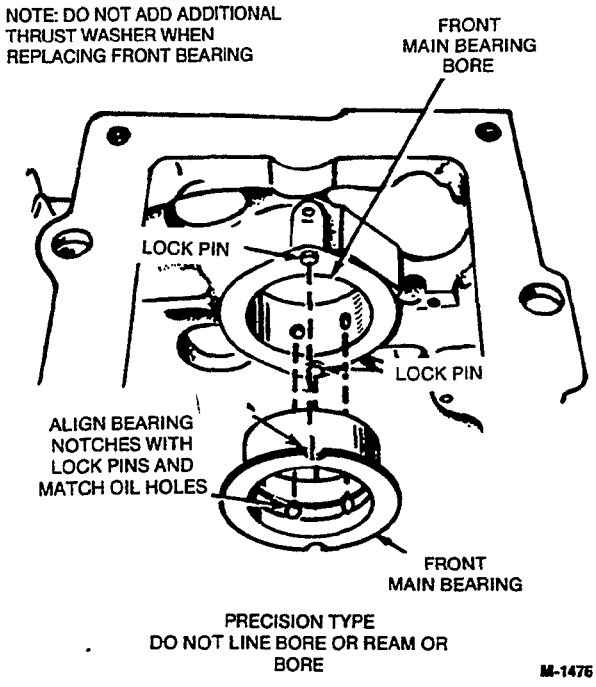


FIGURE 9-33. FRONT BEARING

OIL SEALS

Replacement Procedures

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 9-34). Press or drive the front oil seal into the gear cover until it is 0.97 ± 0.002 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.

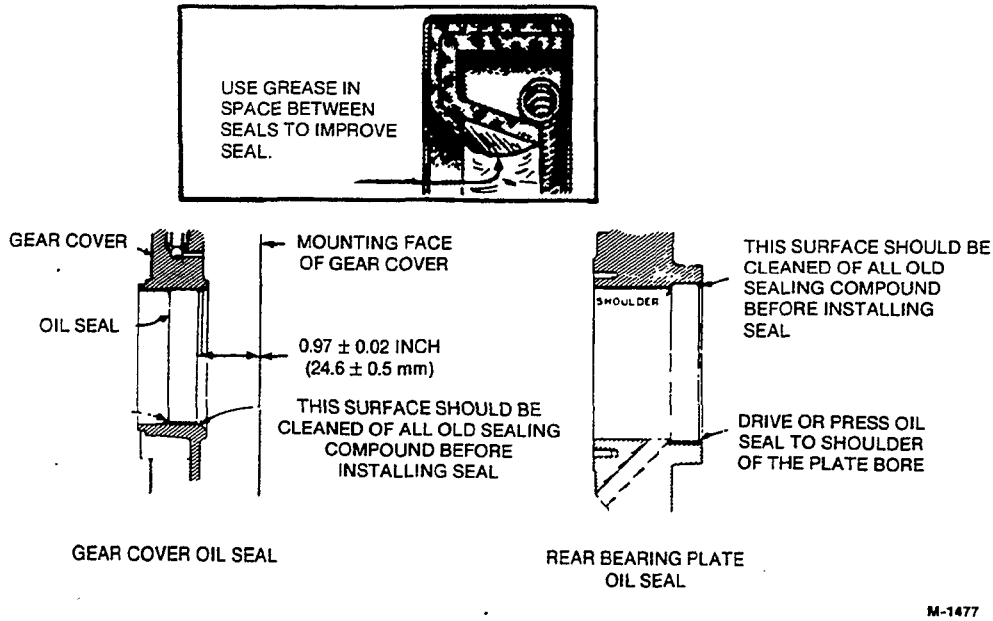


FIGURE 9-34. OIL SEALS

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. Check each of these connections:

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

INITIAL START ADJUSTMENTS

Adjust the carburetor idle and main adjustment screws, as specified in the *Fuel System* section.

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

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. 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. 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 can result in severe personal injury or death if fire, flame, spark, pilot light, 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 vapor-proof wall that separates the compartment from the vehicle interior. Seal openings as required. Make sure that all soundproofing material is in place.

⚠WARNING

EXHAUST GAS IS DEADLY!

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

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

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

Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspections of the complete exhaust system.

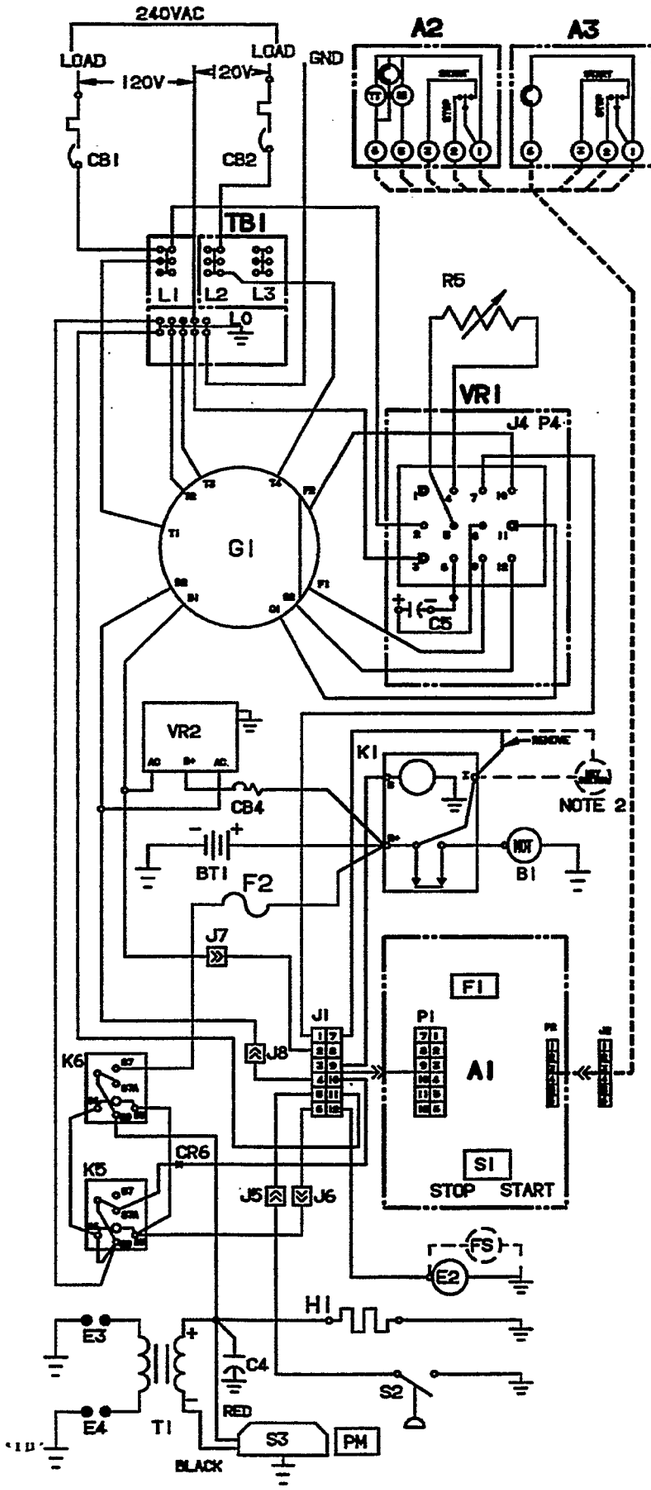
1-P/EM

Section 11. Wiring Diagrams

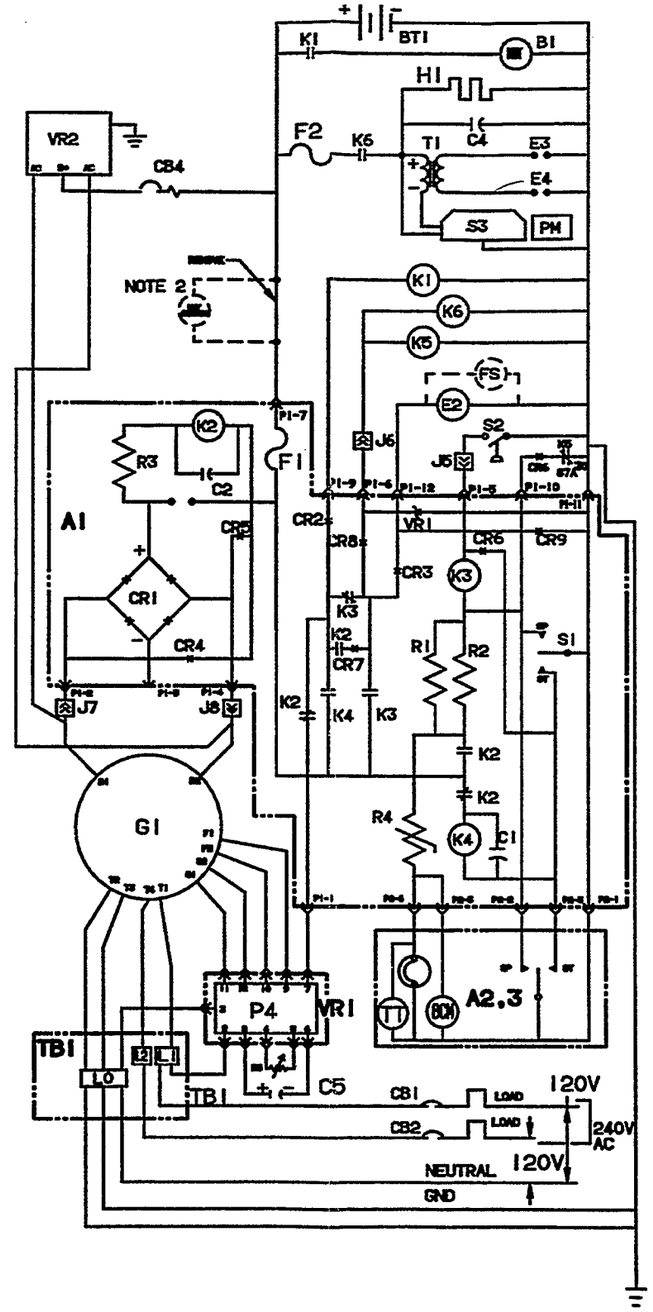
This section consists of the set wiring diagrams referenced in the text. The following drawings are included:

- Page 11-3—Wiring, Schematic and Connection Diagrams for Single-Phase, Gasoline-Fueled Spec F Generator Sets
- Page 11-4—Wiring, Schematic and Connection Diagrams for Three-Phase, Gasoline-Fueled Spec F Generator Sets
- Page 11-5—Wiring, Schematic and Connection Diagrams for Single-Phase, Propane-Fueled Spec F Generator Sets
- Page 11-6—Typical Wiring, Schematic and Connection Diagrams for Sets Prior to Spec F and Having Breaker-Point Ignition.

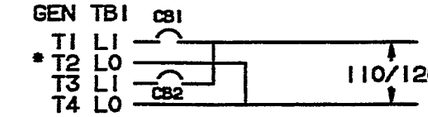
WIRING DIAGRAM



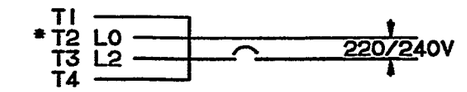
SCHEMATIC



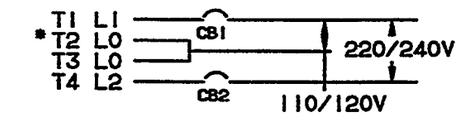
110-120 VOLTS 2 WIRE:
T3 TO TB1-L1; T4 TO TB1-L0; MOVE:
TB1-L2 TO CB2 TO; TB1-L1 TO CB2;
CONNECT OUTPUT LEADS (BLACK CB1 TO LOAD
AND CB2 TO LOAD) TOGETHER TO LOAD.



220 TO 240 VOLTS, 2 WIRE:
T4 TO TB1-L1; REMOVE TB1-L1 TO CB1
TO OUTPUT LOAD LEAD (BLACK).



STANDARD CONNECTION DIAGRAM
(120/240 V, 3 WIRE):

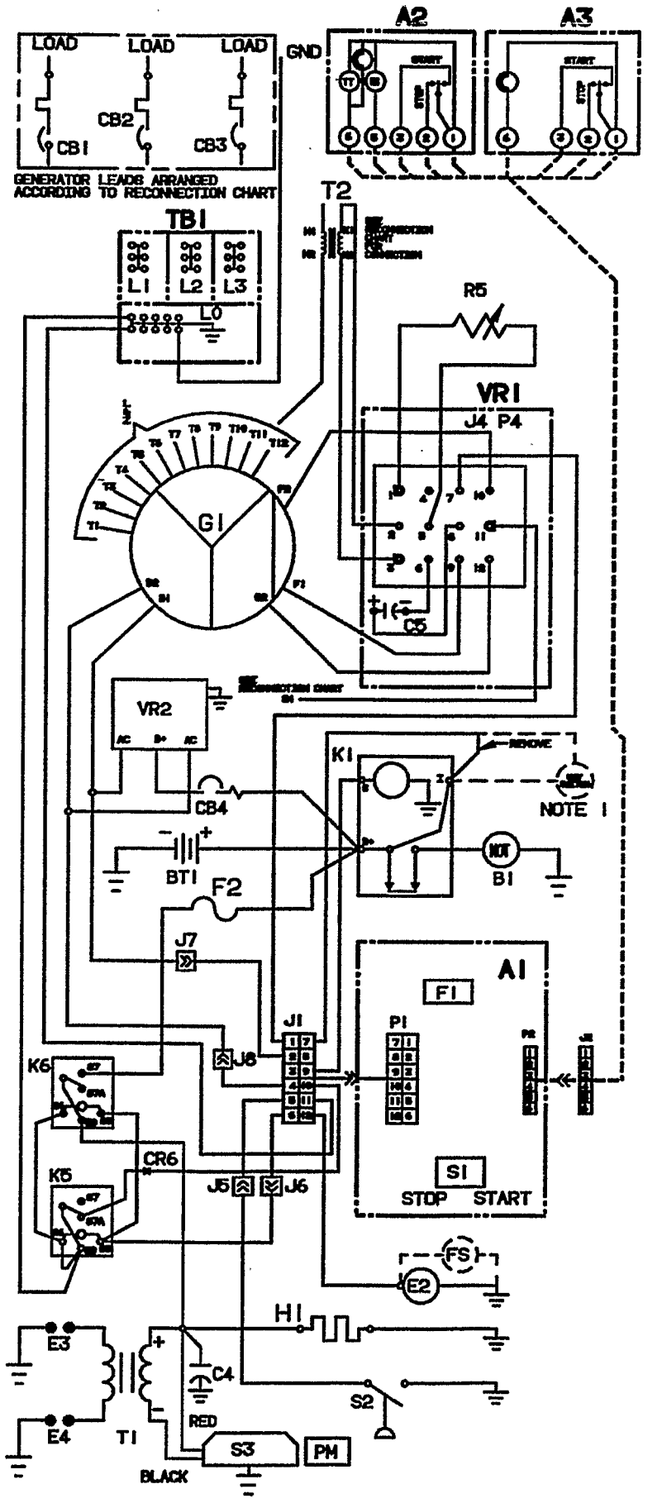


VR2	VOLTAGE REGULATOR (DC)
VR1	VOLTAGE REGULATOR(AC)
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R5	POTENTIOMETER
K5,6	RELAY
K1	RELAY-START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 6A
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOL
CR6	RECTIFIER
CB4	CIRCUIT BREAKER(THERMAL)
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL
ITEM	DESCRIPTION OR MATERIAL

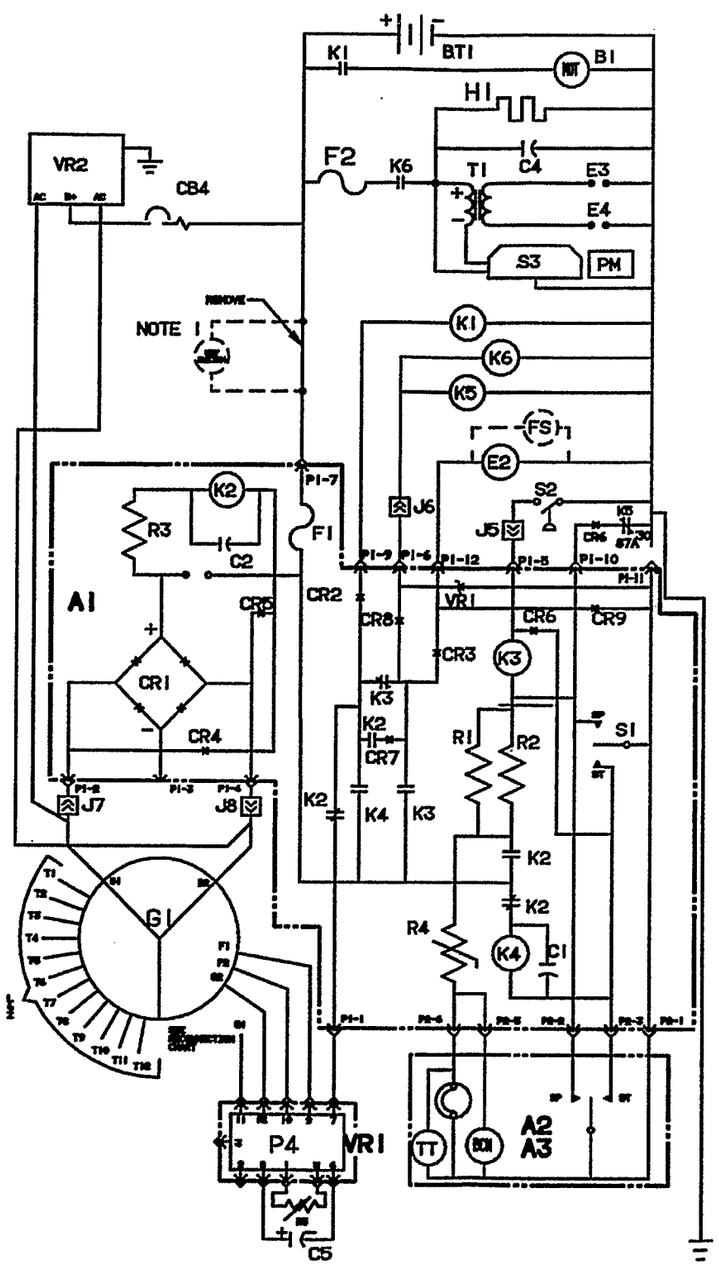
NOTES:
1. *GROUNDED AC LEAD
2. DISARM SWITCH BY CUSTOMER/INSTALLER NOT SUPPLIED BY ONAN. REQUIRES CONNECTING WITH NECESSARY EXTENSION LEADS FROM J1-6 TO KEY SWITCH AND CONNECTING FROM KEY SWITCH TO K1-I AND DISCONNECTING LEAD AT K1-I. USE 16 GA Cu WIRE.

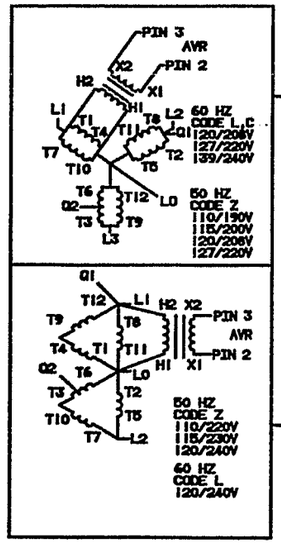
NO. 611-1215
REV. B
MODIFIED

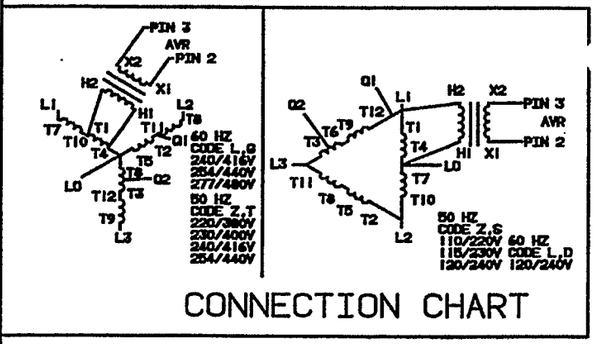
WIRING DIAGRAM



SCHEMATIC







CONNECTION CHART

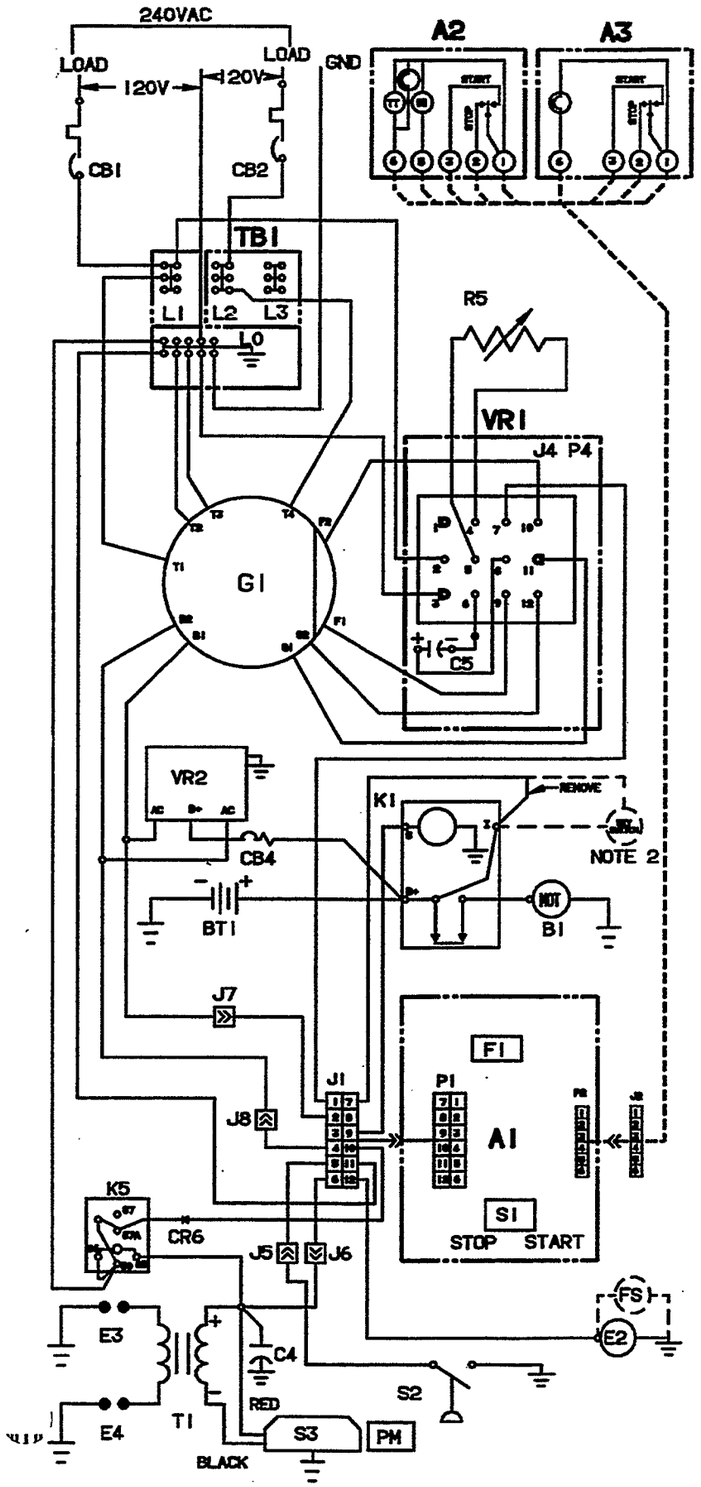
VR2	VOLTAGE REGULATOR (DC)
VR1	VOLTAGE REGULATOR (AC)
T2	TRANSFORMER VOLTAGE REC
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESSURE
R5	POTENTIOMETER
K5	RELAY
K1	RELAY-START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 5A
C3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOLENOID
CR6	RECTIFIER
CB4	CIRCUIT BREAKER (THERMAL)
CB1,2,3	CIRCUIT BREAKER (AC OUTPUT)
C1,2,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTER
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL
ITEM	DESCRIPTION OR MATERIAL

NOTES:

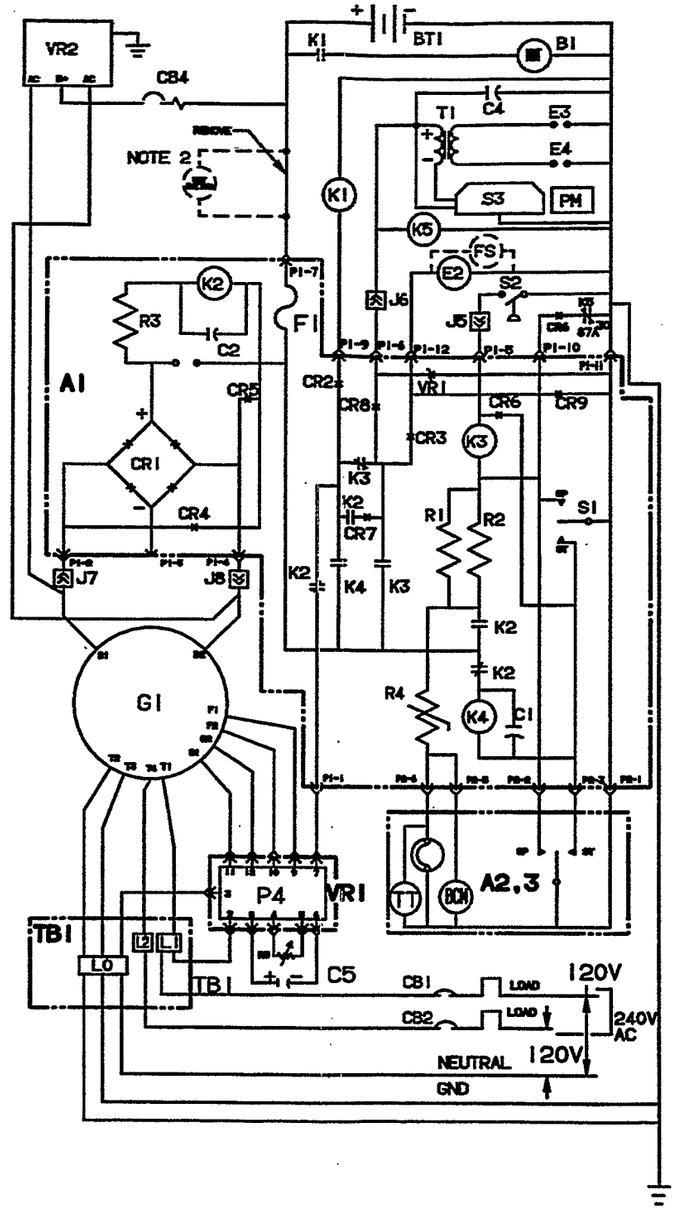
1. DISARM SWITCH BY CUSTOMER/INSTALLER NOT SUPPLIED BY ONAN. REQUIRES CONNECTING WITH NECESSARY EXTENSION LEADS FROM J1-6 TO KEY SWITCH AND CONNECTING FROM KEY SWITCH TO K1-I AND DISCONNECTING LEAD AT K1-I. USE 16 GA Cu WIRE.

NO. 611-1216
REV. B
MODIFIED

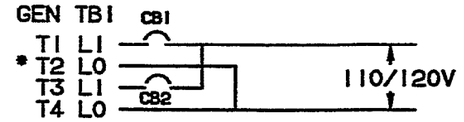
WIRING DIAGRAM



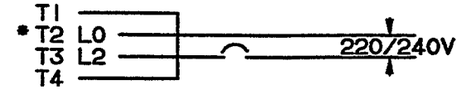
SCHEMATIC



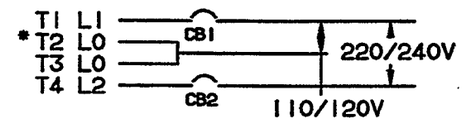
110-120 VOLTS 2 WIRE:
T3 TO TBI-LI; T4 TO TBI-LO; MOVE:
TBI-L2 TO CB2 TO: TBI-LI TO CB2;
CONNECT OUTPUT LEADS (BLACK CBI TO LOAD
AND CB2 TO LOAD) TOGETHER TO LOAD.



220 TO 240 VOLTS, 2 WIRE:
T4 TO TBI-LI; REMOVE TBI-LI TO CBI
TO OUTPUT LOAD LEAD (BLACK).



STANDARD CONNECTION DIAGRAM
(120/240 V, 3 WIRE):



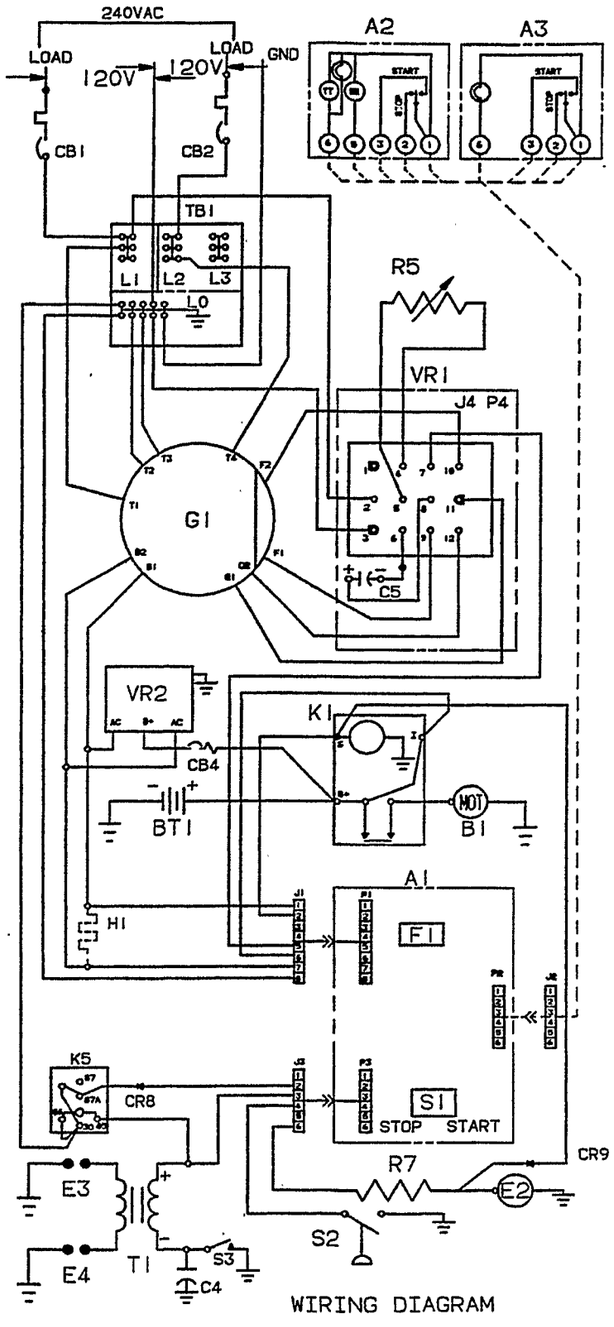
VR2	VOLTAGE REGULATOR (DC)
VR1	VOLTAGE REGULATOR(AC)
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R5	POTENTIOMETER
K5	RELAY
K1	RELAY-START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 5A
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOL
CR6	RECTIFIER
CB4	CIRCUIT BREAKER(THERMAL)
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL

ITEM | DESCRIPTION OR MATERIAL

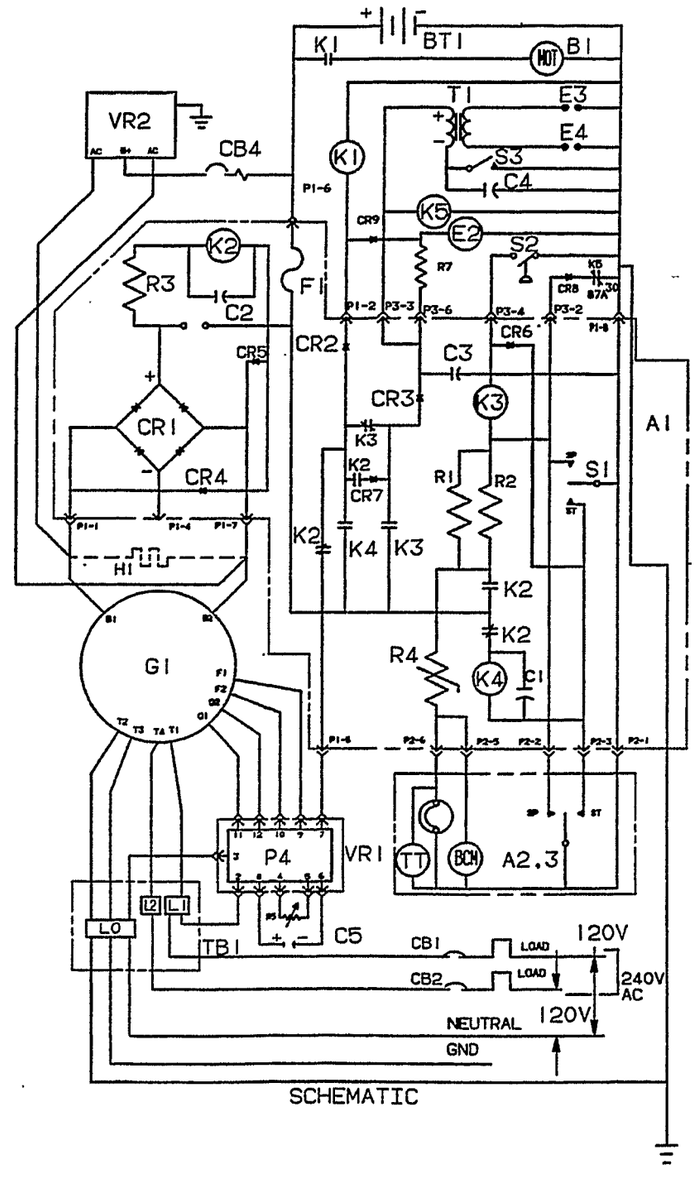
NOTES:
1. *GROUNDED AC LEAD
2. DISARM SWITCH BY CUSTOMER/INSTALLER NOT SUPPLIED BY ONAN. REQUIRES CONNECTING WITH NECESSARY EXTENSION LEADS FROM J1-6 TO KEY SWITCH AND CONNECTING FROM KEY SWITCH TO K1-I AND DISCONNECTING LEAD AT K1-I. USE 16 GA Cu WIRE.

NO. 611-1210
REV. C
MODIFIED

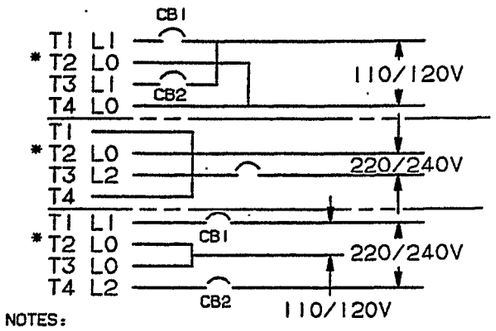
WIRING, SCHEMATIC AND CONNECTION DIAGRAMS FOR SINGLE-PHASE, PROPANE-FUELED SPEC F GENERATOR SETS



WIRING DIAGRAM



SCHEMATIC



NOTES:

1. *GROUNDED AC LEAD

R5				POTENTIOMETER
R7				RESISTOR FUEL PUMP
CB4				CIRCUIT BREAKER(THERMAL)
VR2				VOLTAGE REGULATOR (DC)
CR8				RECTIFIER
VR1				VOLTAGE REGULATOR(AC)
S3				IGN POINTS
S2				SWITCH-LOW OIL PRESS
K5				RELAY
K1				RELAY-START SOLENOID
H1				CHOKE-GASOLINE ONLY
G1				GENERATOR
F1				FUSE-SLOW BLOW 5A
E3,4				SPARK PLUGS
E2				FUEL PUMP OR FUEL SOL
T1				IGN COIL
CB1,2				CIRCUIT BREAKER (AC OUTPUT)
C4,5				CAPACITOR
BT1				BATTERY 12V
B1				STARTER MOTOR
A3				REMOTE CONTROL-STANDARD
A2				REMOTE CONTROL-DELUXE
A1	300-3339-4,5,6,7	C	REF	CONTROL ASSY-NHD/NHDL
A1	300-3339-1,2,3	C	REF	CONTROL ASSY-BGD/BGDL

NO. 611-1182

TYPICAL WIRING, SCHEMATIC AND CONNECTION DIAGRAMS FOR SETS PRIOR TO SPEC F AND HAVING BREAKER POINT IGNITION

Onan

Onan Corporation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
1-800-888-ONAN
612-574-5000 International Use
Telex: 275477
Fax: 612-574-8087