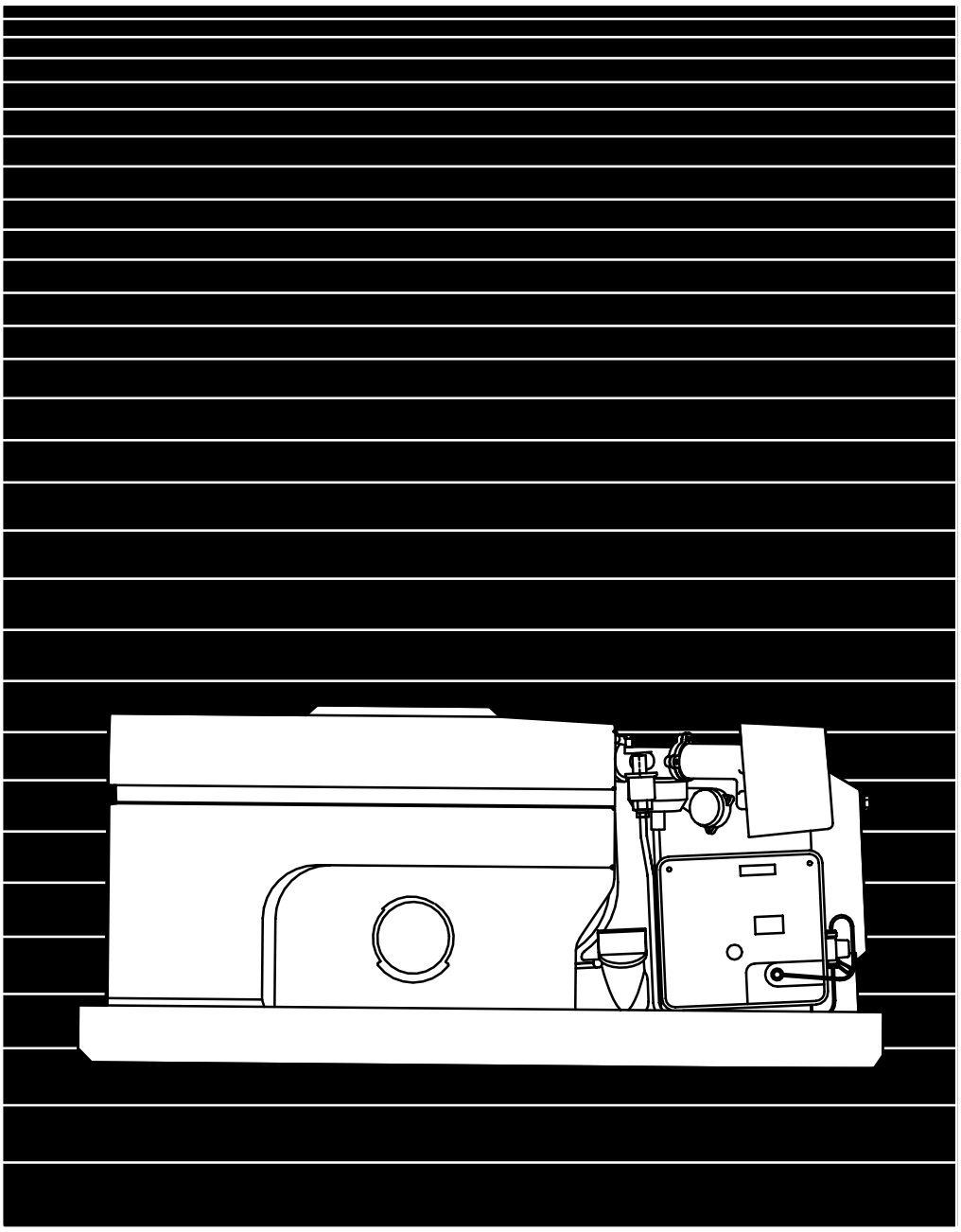
Caution: This document contains mixed page sizes (8.5 x 11 or 11 x 17), which may affect printing. Please adjust your printer settings according to the size of each page you wish to print.

Onan RV GenSet

Service Manual

BGM, NHM



Printed in U.S.A.

965-0531B

Table of Contents

⚠ WARNING: ⚠

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

Safety Precautions

Thoroughly read the INSTALLATION MANUAL before installing the genset. Safe operation and top performance can be obtained only with proper operation and maintenance.

The following symbols in this Manual alert you to potential hazards to the operator, service person and equipment.

⚠ DANGER ***Alerts you to an immediate hazard which will result in severe personal injury or death.***

⚠ WARNING ***Alerts you to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠ CAUTION ***Alerts you to a hazard or unsafe practice which can result in personal injury or equipment damage.***

Electricity, fuel, exhaust, moving parts and batteries present hazards which can result in severe personal injury or death.

GENERAL PRECAUTIONS

- Keep ABC fire extinguishers handy.
- Make sure all fasteners are secure and torqued properly.
- Keep the genset and its compartment clean. Excess oil and oily rags can catch fire. Dirt and gear stowed in the compartment can restrict cooling air.
- Before working on the genset, disconnect the negative (**-**) battery cable at the battery to prevent starting.
- Use caution when making adjustments while the genset is running—hot, moving or electrically live parts can cause severe personal injury or death.
- Used engine oil has been identified by some state and federal agencies as causing cancer or reproductive toxicity. Do not ingest, inhale, or contact used oil or its vapors.
- Benzene and lead in some gasolines have been identified by some state and federal agencies as causing cancer or reproductive toxicity. Do not ingest, inhale or contact gasoline or its vapors.
- Do not work on the genset when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.

GENERATOR VOLTAGE IS DEADLY!

- Generator output connections must be made by a qualified electrician in accordance with applicable codes.
- The genset must not be connected to the public utility or any other source of electrical power. Connection could lead to electrocution of utility workers, damage to equipment and fire. An approved switching device must be used to prevent interconnections.
- Use caution when working on live electrical equipment. Remove jewelry, make sure clothing and shoes are dry and stand on a dry wooden platform on the ground or floor.

FUEL IS FLAMMABLE AND EXPLOSIVE

- Keep flames, cigarettes, sparks, pilot lights, electrical arc-producing equipment and switches and all other sources of ignition well away from areas where fuel fumes are present and areas sharing ventilation.
- Fuel lines must be secured, free of leaks and separated or shielded from electrical wiring.
- Use approved non-conductive flexible fuel hose for fuel connections at the genset.

ENGINE EXHAUST IS DEADLY!

- Learn the symptoms of carbon monoxide poisoning in this Manual.
- Never sleep in the vehicle while the genset is running unless the vehicle has a working carbon monoxide detector.
- The exhaust system must be installed in accordance with the genset Installation Manual.
- Do not use engine cooling air to heat the vehicle interior.
- Make sure there is ample fresh air when operating the genset in a confined area.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not wear loose clothing or jewelry near moving parts such as PTO shafts, fans, belts and pulleys.
- Keep hands away from moving parts.
- Keep guards in place over fans, belts, pulleys, etc.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses and do not smoke while servicing batteries.
- When disconnecting or reconnecting battery cables, always disconnect the negative (**-**) battery cable first and reconnect it last to reduce arcing.

MBL-1

Section 1. Introduction

This is the service manual for the Series BGM and NHM generator sets (gensets). Read and carefully observe all of the instructions and precautions in this manual.

⚠WARNING ***Improper service or parts replacement can lead to severe personal injury or death and to damage to equipment and property. Service personnel must be qualified to perform electrical and mechanical service.***

⚠WARNING ***Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law in the State of California.***

⚠WARNING ***LPG (liquified petroleum gas) is flammable and explosive and can cause asphyxiation. NFPA 58, Section 1.6 requires all persons handling LPG to be trained in proper handling and operating procedures.***

See the Operator's Manual for instructions concerning operation, maintenance and storage and for recommendations concerning engine lubricating oil and fuel.

See the Installation Manual for important recommendations concerning the installation and for a list of the installation codes and standards for safety which may be applicable.

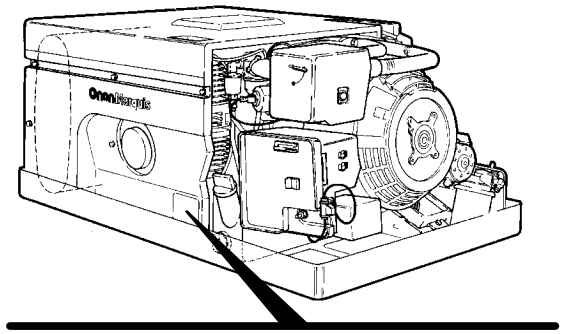
See the Parts Manual for parts identification numbers and required quantities and for exploded views of the genset subassemblies. Genuine Onan® replacement parts are recommended for best results.

When contacting Onan for parts, service or product information, be ready to provide the model number and the serial number, both of which appear on the genset nameplate. See Table 1-1 for the significance of each character of the model number and Figure 1-1 for how the model and serial numbers are displayed on the nameplate.

TABLE 1-1. MODEL NUMBER

7	NHM	F	A	26105	G
1	2	3	4	5	6

1. Rated Power in Kilowatts
2. Genset Family
3. Starting Method Code
4. Voltage and Frequency Code
5. Options and Special Features Code
6. Spec Letter designating modifications



NAMEPLATE WITH TYPICAL MODEL AND SERIAL NUMBER DATA

IMPORTANT ENGINE INFORMATION

Onan®

ONAN CORPORATION
1400 73rd Ave. NE
Minneapolis, MN 55432
Made in U.S.A.

Model No.: 7NHM-FA/26105G
S/N: A953123456

AC Volts: Ph: kW:
Amps: Pf: RPM:
Fuel: Hz: Bat: 12V

Insulation - NEMA Class Ambient: 40°C INI 3461 URC

REFER TO OPERATOR'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS.

THIS ENGINE MEETS 1995-1998 CALIFORNIA EMISSIONS REGULATIONS FOR ULGE ENGINES. EM

SN5980U1G2RA 980 cc

FIGURE 1-1. TYPICAL NAMEPLATE

Section 2. General Specifications

GASOLINE MODELS	BGM	NHM
GENERATOR: 4-Pole Revolving Field, Self-Excited, Electronically Regulated, 1-Phase		
Power (watts)	5500	6800
Frequency (Hertz)	60	60
Voltage	120	120
Current (amperes)	45.8	56.7
Speed (RPM)	1800	1800
FUEL CONSUMPTION:		
No load gph (l/h) Half load gph (l/h) Full load gph (l/h)	0.4 (1.5) 0.7 (2.6) 1.0 (3.8)	0.4 (1.5) 0.7 (2.6) 1.3 (4.9)
ENGINE: 2-Cylinder Opposed, 4-Cycle, Spark-Ignited, Side-Valve, Air Cooled		
Bore	3.250 inch (83 mm)	3.563 inch (90 mm)
Stroke	2.875 inch (73 mm)	3.000 inch (76 mm)
Displacement	48 inch^3 (782 cc)	60 inch^3 (980 cc)
Compression Ratio	7.0 : 1	7.0 : 1
Min Cylinder Compression Test Pressure	75 psi (517 kPa)	75 psi (517 kPa)
Oil Capacity (with filter)*	3.5 quart (3.3 l)	3.5 quart (3.3 l)
Intake Valve Clearance (Cold)	0.005 inch (0.13 mm)	0.005 inch (0.13 mm)
Exhaust Valve Clearance (Cold)	0.013 inch (0.33 mm)	0.013 inch (0.33 mm)
Spark Plug Gap	0.025 inch (0.64 mm)	0.025 inch (0.64 mm)
Spark Plug Tightening Torque	8 lbs-ft (10 N-m)	8 lbs-ft (10 N-m)
Ignition Timing (Begin Spec F)	12° BTDC non-adjustable	12° BTDC non-adjustable
Ignition Timing (Prior to Spec F)	14°-18° BTDC non-adjustable	14°-18° BTDC non-adjustable
Maximum Fuel Supply Pressure at Carburetor	6 psi (41 kPa)	6 psi (41 kPa)
Maximum Fuel Pump Lift	3 feet (0.9 m)	3 feet (0.9 m)
Fuel Fitting	1/4 inch OD Hose Barb	1/4 inch OD Hose Barb
Exhaust Tailpipe Requirements	1-3/8 inch ID 18 Ga Steel Tubing	1-3/8 inch ID 18 Ga Steel Tubing
CONTROL AND CRANKING SYSTEM: 12 VDC		
Nominal Battery Voltage	12 volts	
Minimum Battery Cold Cranking Capacity: Above/Below Freezing	360/450 amperes	
Fuse F1 (Control Board, Spec A only)	5 amperes slow-blow	
Fuse F2 (Fuel, Spec A only)	5 amperes slow-blow	
Fuse F1 (Control Board, Begin Spec B)	10 amperes	
Fuse F2 (Choke/Fuel, Begin Spec D)	10 amperes mini-bayonet	
* -See *Periodic Maintenance* for oil filling instructions.		

LPG MODELS	NHM
GENERATOR: 4-Pole Revolving Field, Self-Excited, Electronically Regulated, 1-Phase	
Power (watts)	6500
Frequency (Hertz)	60
Voltage	120
Current (amperes)	54.2
Speed (RPM)	1800
FUEL CONSUMPTION (HR):	
No load lbs (kg) / gp (lp) Half load lbs (kg) / gp (lp) Full load lbs (kg) / gp (lp)	2.1 (.95) / .50 (1.9) 4.1 (1.86) / 1.0 (3.7) 6.6 (3) / 1.6 (5.9)
ENGINE: 2-Cylinder Opposed, 4-Cycle, Spark-Ignited, Side-Valve, Air Cooled	
Bore	3.563 inch (90 mm)
Stroke	3.000 inch (76 mm)
Displacement	60 inch^3 (980 cc)
Compression Ratio	7.0 : 1
Min Cylinder Compression Test Pressure	75 psi (517 kPa)
Oil Capacity (with filter)*	3.5 quart (3.3 l)
Intake Valve Clearance (Cold)	0.005 inch (0.13 mm)
Exhaust Valve Clearance (Cold)	0.013 inch (0.33 mm)
Spark Plug Gap	0.025 inch (0.64 mm)
Spark Plug Tightening Torque	8 lbs-ft (10 N-m)
Ignition Timing (Begin Spec F)	12° BTDC non-adjustable
Ignition Timing (Prior to Spec F)	14°-18° BTDC non-adjustable
LPG Vapor Supply Pressure Range (Vapor-Withdrawal Only)	9 to 13 inch (229 to 330 mm) W. C. (water column)
LPG Connection for Vapor Withdrawal	3/4 inch NPT Tapping
LPG Connection for Liquid Withdrawal	1/4 inch NPTF Tapping
Exhaust Tailpipe Requirements	1-3/8 inch ID 18 Ga Steel Tubing
CONTROL AND CRANKING SYSTEM: 12 VDC	
Nominal Battery Voltage	12 volts
Minimum Battery Cold Cranking Capacity: Above/Below Freezing	360/450 amperes
Fuse F1 (Control Board)	10 amperes
* -See *Periodic Maintenance* for oil filling instructions.	

Section 3. Dimensions and Clearances

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

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

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

Section 4. Torque Specifications

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

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

Section 5. Preparing for Service

TROUBLESHOOTING

See *Troubleshooting* to determine the probable cause of the problem before removing the genset for service.

SAFETY

There are hazards in servicing gensets. Study *Safety Precautions* and become familiar with the hazards listed in Table 5-2. Note the following safeguards and ways of avoiding 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 in equipment.

- ***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, switches, arc-producing equipment and other ignition sources. Keep the workshop clean and well-lighted and provide adequate ventilation.

- ***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 for an accident:*** Keep fire extinguishers and safety equipment nearby. 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.

TABLE 5-2. HAZARDS AND THEIR SOURCES

Fire and Explosion	• Leaking or spilled fuel • Hydrogen gas from battery • Oily rags improperly stored • Flammable liquids improperly stored
Burns	• Hot exhaust pipes • Hot engine and generator surfaces • Electrical shorts
Poisonous Gas	• Operating genset where exhaust gases can accumulate
Electrical Shock (AC)	• Improper generator connections • Faulty wiring • Working in damp conditions • Jewelry touching electrical components
Rotating Machinery	• Fan guards not in place
Slippery Surfaces	• Leaking or spilled oil
Heavy Objects	• Removing genset from vehicle • Removing heavy components

SPECIAL TOOLS

The tools listed below are necessary for servicing the genset. See the Onan Tool Catalog.

Engine Tools

Torque wrench: 0-75 lbs-ft (0-100 N-m)

Hole gauge: 0.300-0.400 inch (5-10 mm)

Outside micrometer set: 0-4 inch (0-100 mm)

Telescoping gauge set: up to 4 inch (100 mm)

Feeler gauge

Plasti-Gage bearing clearance guide

Spark plug gap gauge

Oil pressure gauge: 0-30 psi (0-200 kPa)

Fuel pressure gauge (for gasoline): 0-10 psi (0-75 kPa)

Manometer (for LPG): 14 inch (350 mm) WC

Inclined Manometer (for LPG): 1 inch (25 mm) WC range with 0.01 inch (0.2 mm) WC divisions

Cylinder compression tester

Flywheel puller

Crankshaft gear puller ring, bolts and puller (or special shoulder bolts and flywheel puller)

Snap ring pliers

Combination main and cam bearing remover

Combination main and cam bearing driver

Oil seal loader and driver

Cylinder ridge reamer

Piston ring spreader

Piston groove cleaner

Piston ring compressor

Cylinder hone

Valve spring compressor

Valve lock replacer

Valve seat cutter kit

Valve guide driver

Slide hammer

Lead or dead-blow hammer

Generator and Control Tools

Rotor removal tool (headless bolt)

Battery hydrometer

Frequency meter

Digital multi-meter: AC and DC Voltage, Ohms and Diode Check

Load test panel and leads

Voltage Regulator Testor and Adaptor (1-Ph)

Rotor and Stator Testor and Adaptor

REMOVING THE GENSET

Some service procedures will require that the genset be removed from the vehicle. The genset is normally mounted in a special compartment on the vehicle floor. Because installations vary, it is not possible to describe a specific removal procedure. Contact the vehicle manufacturer or installer if the best way to remove the genset is not obvious.

Disconnections at the Genset

1. First disconnect the negative (**-**) battery cable *from the battery* and then disconnect the battery cables from the genset.

   ⚠WARNING ***Sparks and high current could cause fire and other damage to the battery, battery cables and vehicle if the loose ends of cables connected to the battery touch. Always disconnect the negative (-) battery cable from the battery before disconnecting the battery cables from the genset.***

2. Disconnect the remote control wiring harness connector at the genset.
3. Disconnect the generator output wiring and conduit from the power distribution panel or box on the vehicle. Tag all wires to make reconnections easier.

4. Disconnect the exhaust tailpipe from the outlet of the muffler. See EXHAUST SYSTEM under *Section 6. Engine-Primary Systems.*
5. Disconnect the fuel supply line from the genset. Follow the applicable instructions depending on the fuel.

   ⚠WARNING ***Gasoline and LPG (liquified petroleum gas) are flammable and explosive and can cause severe personal injury or death. Do not smoke if you smell gas or gasoline or are near fuel tanks or fuel-burning equipment or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot lights, electrical arcs and arc-producing equipment and all other sources of ignition well away.***

   Gasoline Fueled Gensets: Disconnect the fuel line from the genset and securely plug the end of the fuel line to prevent leakage or an accumulation of explosive gasoline vapor.

   LPG Fueled Gensets: Close the fuel shutoff valve(s) at the LPG container(s) and move the vehicle outside and away from below-grade spaces where LPG could accumulate. To purge the fuel line and genset as much as possible, run the genset (if it starts) until it runs out of fuel with the LPG valve(s) closed. Also see the specific additional instructions which follow for purging liquid-withdrawal and vapor-withdrawal systems and for capping off the gas supply line.

   ⚠WARNING ***LPG is flammable and explosive and can cause asphyxiation. NFPA 58, Section 1.6 requires all persons handling LPG to be trained in proper handling and operating procedures.***

   LPG "sinks" when it escapes into the air and can accumulate in explosive concentrations. Before disconnecting the LPG fuel line, close the fuel shutoff valve(s) at the LPG container(s) and move the vehicle outside and away from pits or basements or other below-grade spaces where LPG could accumulate.

   Purging LPG Liquid-Withdrawal Systems: Purge the supply line further by loosening the threaded supply connection at the LPG filter on the genset just enough to hear gas escaping. Unthread the connector when no more gas is heard escaping. To purge the LPG trapped between the solenoid and regulator, loosen the flexible hose connector at the fuel solenoid just enough to hear gas escaping, and then retighten. Finally, cap the end of the fuel supply hose or pipe with a 1/4 inch NPTF pipe cap to prevent fuel from escaping if someone inadvertently opens the shutoff valve(s) at the LPG container(s).

   ⚠WARNING ***Large volumes of LPG can be released in the process of disconnecting a liquid-withdrawal type of LPG supply system. Before disconnecting LPG fuel connections, make sure the the fuel shutoff valve(s) at the LPG container(s) are closed and that the vehicle is outside and away from pits or basements or other below-grade spaces where LPG could accumulate.***

   Purging LPG Vapor-Withdrawal Systems: Disconnect the gas supply hose at the carburetor and the fuel solenoid shutoff valve leads at the control box on the genset. If the pressure regulator/solenoid valve assembly is also to be removed, cap the end of the fuel supply line with a threaded pipe cap to prevent fuel from escaping if someone inadvertently opens the shutoff valve(s).

Removal of the Genset from the Vehicle

See Figure 5-2. When the genset has been disconnected from the electrical, exhaust and fuel systems, examine its mounting bolts and support members. The genset drip tray is normally bolted to the vehicle framework. Make sure that the genset is firmly supported before loosening any mounting bolts or support members. A fork lift is recommended to lift or move the genset.

⚠WARNING ***Gensets are heavy and can cause severe personal injury if dropped. Use a forklift or other suitable means to handle the genset while removing or installing it. Keep hands and feet clear incase the genset is dropped.***

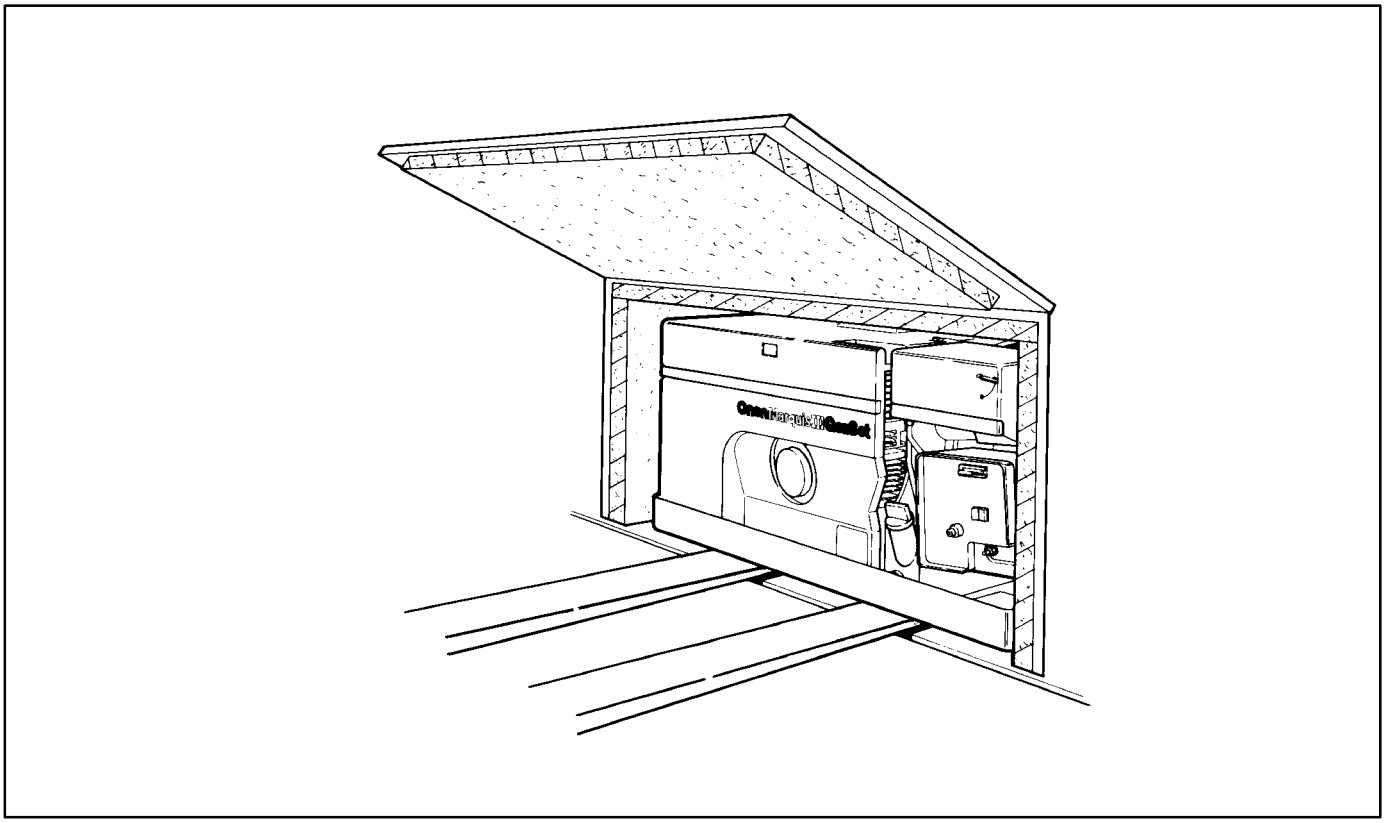


FIGURE 5-2. SET REMOVAL

Section 6. Engine - Primary Systems

The engine primary systems and service procedures covered in this section do not require removal of the cylinder heads, gearcase or rear bearing plate for access. It may be possible to perform some of these procedures without removing the genset from the vehicle.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

Regular maintenance can prevent many of the problems listed below. Removing and cleaning the cylinder heads every 500 hours is especially important for gasoline models. Before considering major engine service because of abnormal performance, refer to *Periodic Maintenance* in the Operator's Manual for instructions on how to clean the cylinder heads using Onan "4C".

The following troubleshooting tables are designed to help you think through genset problems. To save time troubleshooting, read the entire manual ahead of time to understand the genset. Try to think through problems. Go over what was done during the last service call. The problem could be as simple as an empty fuel tank, closed fuel shutoff valve, loose wire, blown fuse or tripped circuit breaker.

See *Section 7. Control System* and *Section 8. Generator* for control and generator troubleshooting tables.

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

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

1 - Prior to Spec F only
2 - Gasoline models only

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

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

Trouble	Possible Cause	Corrective Action
Engine Lacks Power	1. Faulty ignition due to incorrect spark plug gap.	1. Reset spark plug gap.
	2. Dirty air cleaner.	2. Replace air cleaner.
	3. Restricted fuel flow due to: a. Plugged fuel filter. b. Faulty fuel pump.	3a. Replace fuel filter. 3b. Test fuel pump and repair or replace if faulty.
	4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws.[1] b. incorrect float level.[1, 2] c. dirt in carburetor. d. vacuum leak. e. altitude setting.	4a. Adjust carburetor main and idle adjustment screws.[1] 4b. Adjust carburetor float level.[1] 4c. Disassemble carburetor and clean all internal passages.[1] Replace fuel filter. 4d. Repair vacuum leak. 4e. Reset altitude adjust knob on carburetor.
	5. Exhaust system blocked or restricted.	5. Locate and remove cause of blockage.
	6. Incorrect valve tappet clearance.	6. Adjust valve tappets (see *Engine Block Assembly* section).
	7. Excessive engine wear or damage to engine.	7. See *Engine Block Assembly* section.
	8. Carburetor air preheater set incorrectly.[2]	8. In hot weather, place air preheater in summer position.
	9. Combustion chamber deposits.	9. Clean combustion chamber.
	10. (Spec A sets) No-load speed set too low: excessive governor droop.	10. Adjust (mechanical) governor.
	11. Contaminants in LPG regulator. (liquid-withdrawal systems)	11. Clean LPG regulator.

1 - Prior to Spec F only
2 - Gasoline models only

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

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

Trouble	Possible Cause	Corrective Action
Engine Overheats	1. Restricted airflow due to: a. debris blocking air inlet or outlet. b. improper installation 2. Dirt or oil covering engine cooling fins. 3. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws.[1] b. incorrect float level.[1, 2] c. dirt in carburetor. d. vacuum leak.	1. a. Clear away debris. Do not use genset compartment for storage. b. See the Installation Manual. 2. Clean away all dirt and oil from engine cooling fins. 3. a. Adjust carburetor main and idle adjustment screws.[1] 3. b. Adjust carburetor float level.[1] c. Disassemble carburetor and clean all internal passages.[1] Replace fuel filter. d. Repair vacuum leak.
Black Exhaust Smoke	1. Rich fuel mixture due to: a. incorrect float level b. faulty carburetor float.[1, 2]	1a. Adjust carburetor float level.[1] 1b. Replace carburetor float.[1]
White or Blue Exhaust Smoke	1. Lean fuel mixture due to: a. incorrect float level.[1, 2] b. incorrectly adjusted fuel mixture screws.[1] c. dirt in carburetor d. vacuum leak 2. Contaminated fuel.[2] 3. Excessive engine wear	1a. Adjust carburetor float level.[1] 1b. Adjust carburetor idle and main adjustment screws.[1] 1c. Disassemble carburetor and clean all internal passages.[1] 1d. Repair vacuum leak. 2. Drain and replace fuel. 3. See *Engine Block Assembly* section.

1 - Prior to Spec F only
2 - Gasoline models only

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

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

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

1 - Prior to Spec F only
2 - Gasoline models only

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

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

Trouble	Possible Cause	Corrective Action
High Oil Consumption **(Note: New engines sometimes consume oil during break-in)**	1. Oil viscosity is too light .	1. Drain and refill with oil suitable for the ambient temperature.
	2. Crankcase breather valve is dirty or faulty.	2. Clean crankcase breather and replace if defective.
	3. Oil leaks.	3. Locate source of leak and repair as required.
	4. Excessive engine wear.	4. See *Engine Block Assembly* section.
	5. Light loading.	5. Don't run set at no-load for long periods of time.
Low Oil Pressure	1. Oil viscosity is too light.	1. Drain and refill with oil suitable for the ambient temperature.
	2. Oil dilution due to: a. faulty choke b. fouled spark plug c. rich fuel mixture	2.a. Adjust choke. b. Replace spark plugs c. Adjust fuel mixture[1, 2]
	3. Low oil level.	3. Add oil as required.
	4. Low oil pressure switch defective.	4. Replace oil pressure switch (see *Engine Block Assembly* section).
	5. Faulty oil bypass valve.	5. Inspect oil bypass valve and clean or replace as required (see *Engine Block Assembly* section).
	6. Excessive engine wear or faulty oil pump.	6. See *Engine Block Assembly* section.

1 - Prior to Spec F only
2 - Gasoline models only

EXHAUST SYSTEM

See Figure 6-3. The exhaust system consists of the exhaust manifold, muffler, tailpipe adapter and tailpipe. The muffler is mounted inside the genset housing. The tailpipe is supplied by the customer.

⚠WARNING ***Exhaust gas is deadly. The exhaust system must not leak and must discharge all engine exhaust away from the vehicle.***

Liability for injury, death, damage and warranty expense due to the use of an unapproved muffler or due to modifications becomes the responsibility of the person installing the unapproved muffler or performing the modifications. Use Onan approved exhaust system parts.

Repair the exhaust system before running the genset if there is damage or leaks. Do not try to weld a broken or leaky tailpipe, muffler or manifold.

Tailpipe

If it is necessary to replace the tailpipe, use 1-3/8 inch I. D. 18 gauge steel tubing. Because the tailpipe is connected rigidly to the engine (via the muffler) and the engine is mounted on vibration isolators, flexible shock-mount hangers must be used to support the tailpipe. Important safety warnings and instructions regarding the routing and termination of the tailpipe are included in the Installation Manual.

Muffler

It will probably be necessary to remove the genset from the vehicle. See *Section 5. Preparing to Service.*

Remove the top panel (see COOLING SYSTEM in this section). Then remove the two flange bolts of the joint between the manifold and the muffler and the four mounting bracket screws on the ends of the muffler and withdraw the muffler.

When installing the muffler make sure the self-aligning joint between the manifold and the muffler lines up properly for a leak-free joint before tightening the bracket mounting screws.

Exhaust Manifold

To remove the exhaust manifold first remove the muffler. On gensets equipped for liquid-withdrawal of LPG, disconnect both ends of the LPG vaporizer tubing clamped to the manifold. Remove the four exhaust manifold bolts and then the manifold and gaskets. Be sure to cover the openings in the block to prevent loose parts and dirt from entering the engine.

⚠WARNING ***Bending the fuel vaporizer tubing can weaken it to the point that it can crack allowing LPG under high pressure to escape, resulting in possible severe personal injury or death.***

Large volumes of LPG can be released in the process of disconnecting a liquid-withdrawal type of LPG supply system. See Section 5. Preparing to Service for proper procedures and precautions.

When installing an exhaust manifold, always use new gaskets and torque the manifold bolts according to *Section 4. Torque Specifications.* If the manifold has an LPG vaporizer tube clamped to it, connect the tubing ends before tightening the manifold bolts. Also, if necessary, loosen the tubing clamps to make the tubing connections easier and then retighten the clamps.

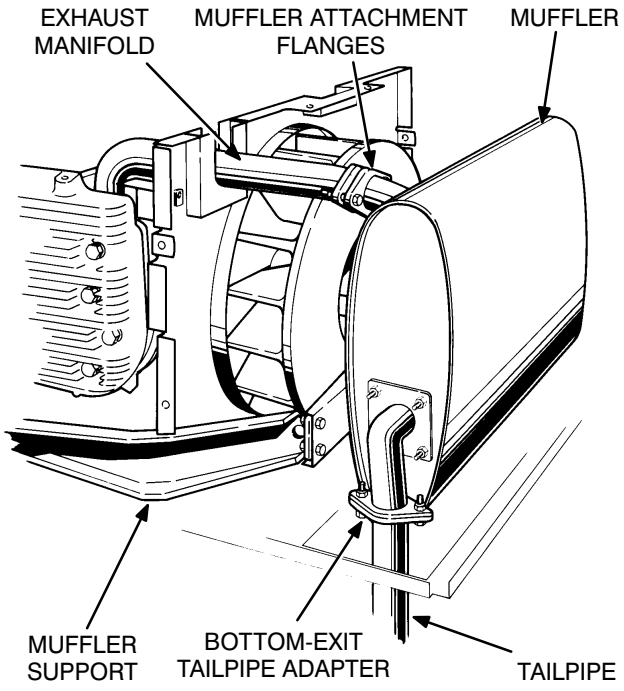


FIGURE 6-3. EXHAUST SYSTEM

COOLING SYSTEM

See Figure 6-4. These are air-cooled gensets. The engine flywheel is also a centrifugal blower that draws cooling air across the fins on the engine cylinders and heads and discharges the warm air downwards through the discharge grill.

⚠WARNING ***Do not run the generator set without all the covers in place. Contact with the rotating flywheel can result in severe personal injury or death.***

⚠WARNING ***Discharge air from the engine can include deadly exhaust gas. Therefore, do not use engine discharge air to heat the interior of the vehicle.***

See the Installation Manual regarding the minimum free area required for the air inlet to the compartment or enclosure and the minimum clearance required at the discharge opening. The engine will overheat if the inlet and outlet openings are too small or are obstructed or if dust has accumulated on the cooling fins.

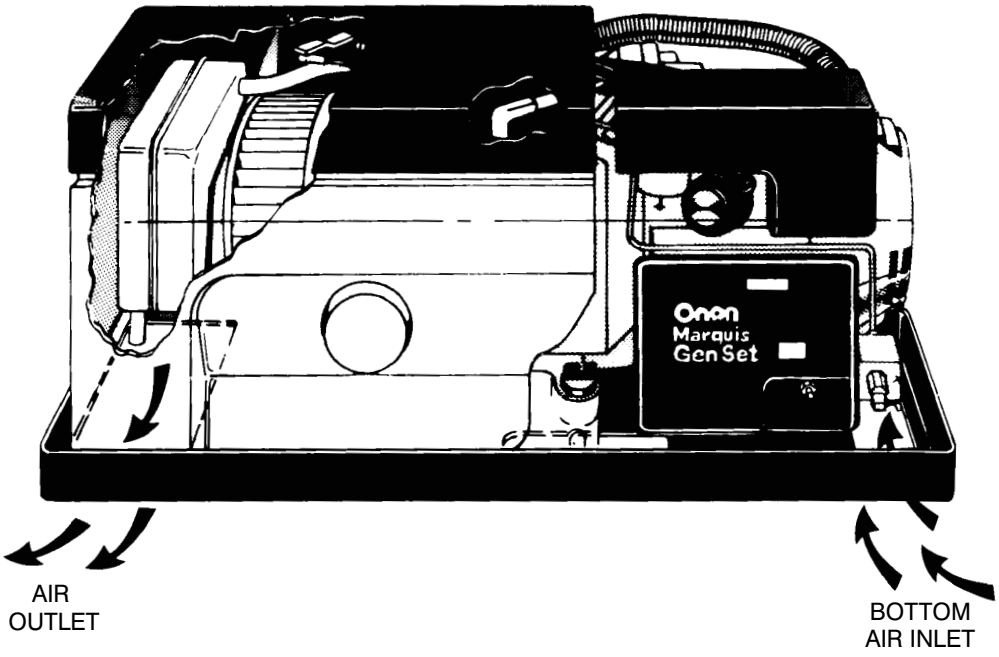


FIGURE 6-4. COOLING AIR FLOW

Cooling System Panel Removal

1. Disconnect the starting battery, negative (-) cable first, to prevent accidental starting.
2. Pry off the trim strips (if any) around the three sides of the top panel and remove the exposed Torx screws and the two screws on top. See Figure 6-5. Through the spark plug access opening, unhook the left-side (oil filter side) spark plug lead from the top panel and remove the panel.
3. Remove the left and right side panels. Five remaining Torx screws and two capscrews at the top of the cylinder heads secure each.
4. Remove the end panel which is secured by four remaining screws along its bottom edge.

Cooling System Disassembly for Engine Block Service:

1. Remove the cooling system panels, muffler and exhaust manifold (see EXHAUST SYSTEM in this section).
2. Remove the flywheel. See Flywheel Removal.
3. Disconnect the lead connected at the low oil pressure cutoff switch (next to the oil filter).
4. Remove the four capscrews that secure the inner bulkhead to the engine and remove it.
5. Thoroughly clean the engine cooling fins.

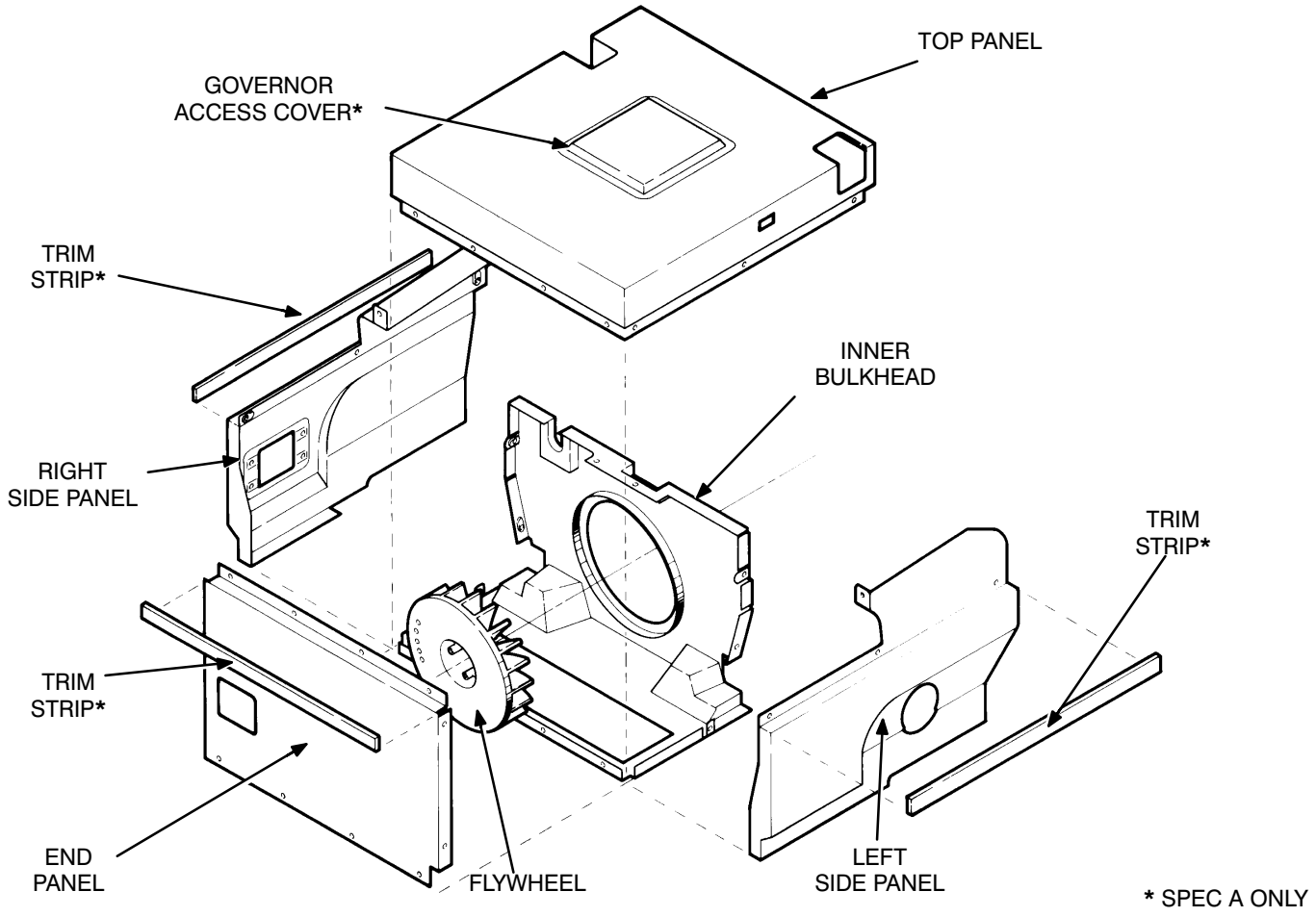


FIGURE 6-5. COOLING SYSTEM

Flywheel Removal

1. Loosen the flywheel capscrew and back it out several turns. See Figure 6-6.
2. Attach the puller tool to the flywheel. The tool has two jack screws that fit into the holes tapped in the flywheel. 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.

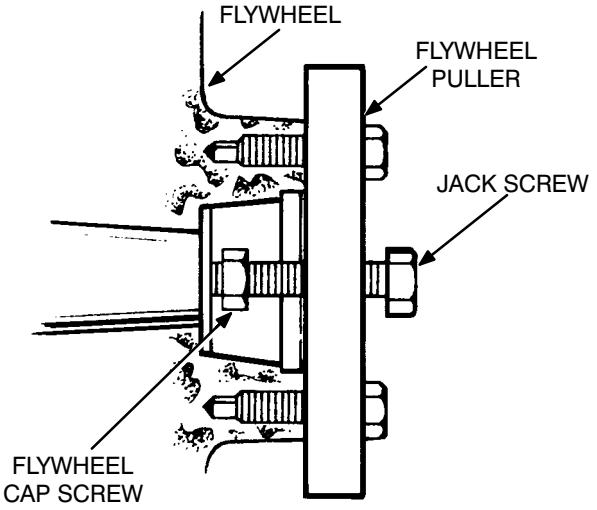


FIGURE 6-6. FLYWHEEL PULLER

Cooling System Reassembly

Reassembly is the reverse of disassembly.

1. Make sure the woodruff key is in place when installing the flywheel. Use non-hardening sealer on the flywheel capscrew threads and tighten according to *Section 4. Torque Specifications.*
2. Make sure the pieces of insulation used to seal the openings in the inner bulkhead where the two muffler support brackets and the exhaust manifold pass through are in place.
3. Make sure the lead to the low oil pressure switch has been reconnected.

   ⚠ CAUTION ***Running the set without the low oil pressure cutoff switch connected can lead to serious engine damage in the event of low oil pressure.***

4. Make sure the spark plug cable (oil filter side) has been rehooked by the clip inside the top panel to prevent it from interfering with the governor rod and causing erratic operation.

⚠ CAUTION ***The engine will overheat and can be damaged if it is operated without all the cooling system components in place.***

IGNITION SYSTEM

These gensets are equipped with an electronic ignition system consisting of a rotor, module, coil, capacitor, spark plugs and associated wiring. Energy for ignition is supplied by the 12 volt cranking battery.

Rotor

See Figure 6-7. The ignition rotor is keyed to the engine crankshaft. 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 rotor should not normally require replacement.

Module

The ignition module is secured and grounded to the generator-engine adaptor by two cap screws. It is an electronic switch in the primary circuit of the ignition coil. See *Appendix B. Wiring Diagrams* for the appropriate wiring diagram. It is switched on and off once each revolution by the rotor. The module contains no serviceable parts and should not normally require replacement.

Coil

See Figure 6-8. The ignition coil is a transformer that fires the spark plugs at roughly 20,000 volts each revolution when the ignition module opens the primary circuit causing the coil field to collapse.

⚠ CAUTION ***The leads connected at the low voltage terminals of the ignition coil (Figure 6-8) should not be routed so as to pass between the high voltage terminal posts. Otherwise, false signals can be induced in the low voltage wires, leading to erratic operation.***

Capacitor

The ignition capacitor is secured and grounded to the top of the generator-engine adaptor by one cap screw. The pig tail is connected to the positive (**+**) low voltage terminal of the ignition coil.

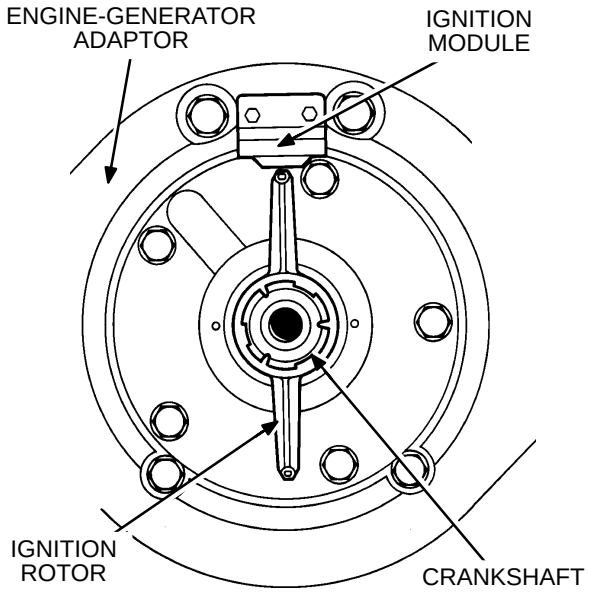


FIGURE 6-7. IGNITION ROTOR AND MODULE

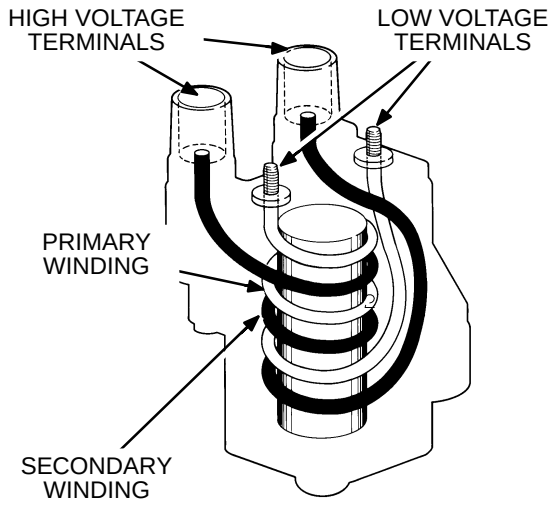


FIGURE 6-8. IGNITION COIL

Spark Plugs

The genset has two spark plugs. The spark plugs must be in good condition and have the proper gap for top engine performance. See Figure 6-9 and *Section 2. General Specifications.*

To prevent crossthreading a spark plug, always thread it in by hand until it seats. Then tighten the spark plug according to *Section 4. Torque Specifications.* Alternatively, turn it with a wrench an additional 1/4 turn.

If the engine misses or performance otherwise deteriorates, remove and examine the spark plugs for signs of the following problems:

Light tan, gray or reddish deposits - Normal

One spark plug fouled - Broken spark plug cable, low cylinder compression

Soot fouled - Wrong spark plug heat range (too cold), duty cycle too short for engine to reach normal operating temperature

Fuel fouled - Wrong spark plug heat range (too cold), faulty choke operation, overly rich fuel mixture, dirty air filter

Oil fouled - Malfunctioning crankcase breather, worn rings, worn valve guides or seals

Burned Or Overheated - Leaking intake manifold gaskets, lean fuel mixture

Worn - Spark plug service life used up.

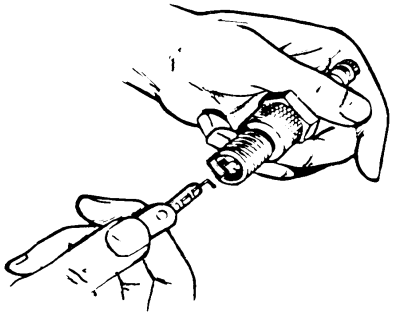


FIGURE 6-9. CHECKING SPARK PLUG GAP

Quick Ignition Test

If the engine misfires, test the ignition system as follows to quickly determine if the problem is in the ignition system. First recheck, clean and tighten the connections at the ignition coil terminals. See *Appendix B. Wiring Diagrams* for the proper connections at the "**-** " and "**+**" terminals.

⚠WARNING ***Gasoline and LPG are flammable and explosive and can cause severe personal injury or death. Park the vehicle in a well-ventilated area, leave the generator compartment door open for several minutes and make sure you cannot smell gas or gasoline vapors before conducting this test. Have an ABC rated fire extinguisher handy.***

1. Park the vehicle in a well-ventilated area, leave the generator compartment door open for several minutes and make sure you cannot smell gas or gasoline vapors before conducting this test.
2. Remove one of the spark plugs.
3. Reconnect the spark plug cable and lay the spark plug on bare engine metal to ground it.

   ⚠WARNING ***HIGH VOLTAGE. To prevent electric shock do not touch the spark plug or wire during this test.***
4. Crank the engine and observe the spark. A strong, consistent spark indicates that the ignition system is probably functioning properly and that the problem is elsewhere. See *Troubleshooting*. Service the ignition system as required if the spark is weak or inconsistent.

Spark Plug Cable Resistance Test

Remove both spark plug cables and check resistance across the ends with an ohmmeter. Replace a cable if resistance is not between 3,000 and 15,000 ohms.

Ignition Module Test

1. Remove both spark plug cables from the ignition coil so that the engine cannot start when the crankshaft is manually rotated.

   ⚠WARNING ***Severe personal injury or death can result if the engine starts while manually rotating the crankshaft. To prevent starting during this test, remove both spark plug cables from the ignition coil.***

2. Connect the positive (**+**) side of a voltmeter to the negative (**-**) terminal of the ignition coil (larger of the two screw terminals) and the negative (**-**) side of the voltmeter to engine ground.
3. Remove all leads from the positive (**+**) terminal of the coil.
4. Use a jumper to connect the red lead of the ignition module (the one just removed from the coil) to the battery positive (**+**) terminal.
5. Rotate the engine clockwise using a socket head wrench (either a 3/8 inch Allen or Torx) on the generator through bolt. Replace the ignition module if voltage does not jump from approximately 1 volt to approximately 12 volts, and then back again, each revolution.

Ignition Coil Test

1. Remove all wires attached to the ignition coil.
2. Remove the coil from the engine.
3. Inspect the terminals for corrosion, looseness, cracks or other damage. Look for carbon runners around the 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 primary coil resistance (across the positive [**+**] and negative [**-**] terminals). Replace the ignition coil if primary resistance is not between 3 and 5 ohms.
6. Measure secondary coil resistance (across the spark plug cable terminals). Replace the ignition coil if secondary resistance is not between 14,000 and 30,000 ohms. See Figure 6-10.

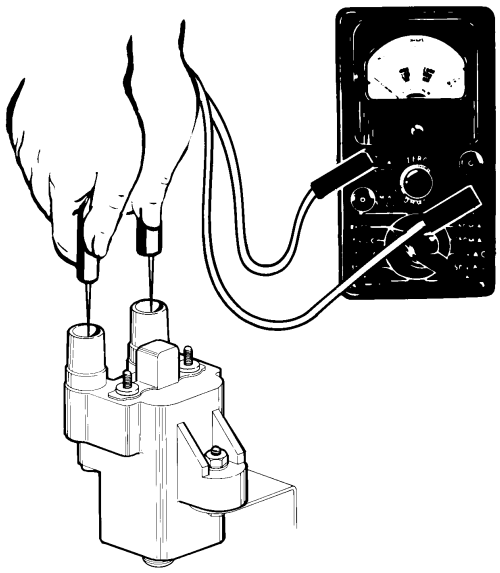


FIGURE 6-10. TESTING THE IGNITION COIL

CYLINDER COMPRESSION TEST

Examining the spark plugs and testing cylinder compression can tell much about the condition of the valves, piston rings and cylinders. Test cylinder compression as follows:

1. Start the genset and let it warm up.
2. Stop the genset and remove and inspect the spark plugs. See IGNITION SYSTEM in this section.
3. Insert the compression gauge nozzle into one of the spark plug holes, hold the throttle open and crank the engine. Note the pressure indicated by the gauge.
4. Repeat the test on the other cylinder.
5. Refer to *Section 9. Engine Block Assembly* if cylinder compression test pressures do not meet *Specifications.*

CRANKCASE BREATHER ASSEMBLY

See Figure 6-11. The crankcase breather is a reed valve assembly that opens to discharge crankcase vapors on the piston down-stroke and closes on the up-stroke, resulting in a negative pressure in the crankcase when the engine is running. The crankcase vapors (blowby gases, gasoline vapors, moisture, air) are routed to the carburetor for burning in the cylinders. A dirty or sticking valve can cause oil leaks, high oil consumption, rough idle, reduced engine power and sludge formation within the engine.

Disassembly: The breather assembly is serviced by disassembling it and cleaning all the parts in parts cleaning solvent. The assembly comes apart when the capscrew is unscrewed.

⚠WARNING ***Most parts cleaning solvents are flammable and corrosive and can cause severe burns and inflammation. Use only as recommended by the manufacturer.***

Reassembly: Reassemble using a new gasket. Replace the reed valve if it does not lie flat across the discharge orifice. Torque the cover capscrew to 12-24 lbs-in (1.3-2.6 N-m).

⚠ CAUTION ***Over-tightening the capscrew can distort the cover allowing dirt to enter the engine.***

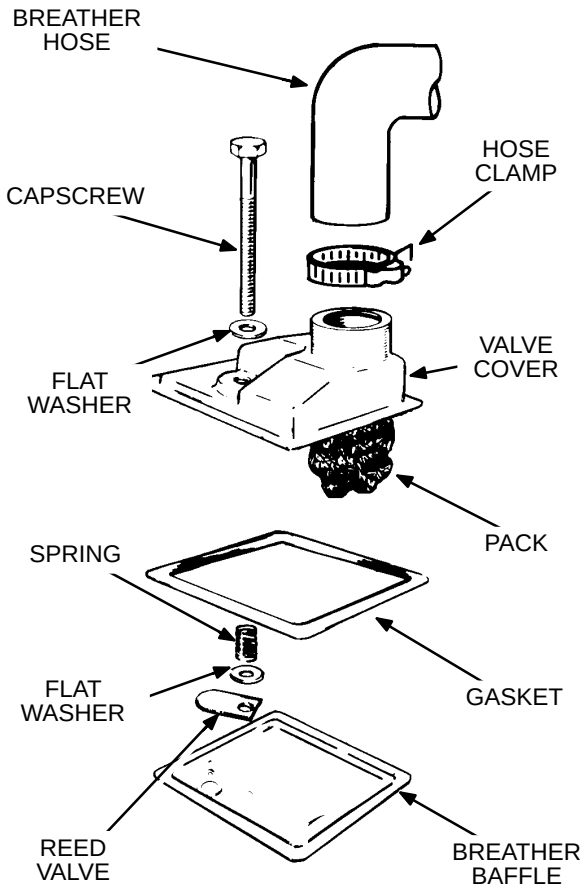


FIGURE 6-11. CRANKCASE BREATHER ASSEMBLY

GOVERNOR AND CARBURETOR ADJUSTMENTS

The governor operates the throttle to maintain a nearly constant engine speed (frequency) as the electrical load on the genset varies. Careful adjustments of the carburetor and governor are essential for top performance. Perform all necessary engine and generator maintenance and repairs before making these adjustments.

Governor and carburetor adjustments should be done together. They require the use of meters to measure voltage, frequency and amperage and a stepped load bank of at least 8 kW, where a portion of at least 600 watts is variable. Digital meters are recommended. Accuracy should be at least 0.3 percent for frequency measurement and 0.5 percent for voltage measurement.

Beginning Spec F, carburetor fuel mixture adjusting screws are not accessible. Other than turning the altitude adjust knob to compensate for altitude on gasoline carburetors, fuel mixture adjustments should not be attempted.

⚠WARNING ***Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law in the State of California.***

⚠WARNING ***Disconnect or unplug all voltage and frequency sensitive devices such as TVs, VCRs, computers and other solid-state electronic devices before making governor and carburetor adjustments. Typically, some internal circuits are powered when these types of devices are plugged in, even if the device has been switched "OFF". These circuits can be damaged by variations in voltage and frequency that occur during these tests.***

Electronic Governor

Electronic governor speed and sensitivity set points are not adjustable. The governor actuator and linkage (Figure 6-12) are accessible by removing the top panel. The governor controller is mounted on the base pan (Figure 7-5).

Disconnecting the Governor Rod: Remove the top panel (see COOLING SYSTEM in this section) for access to the governor rod. Unhook the governor rod and spring from the governor actuator arm first. Use both hands so as not to bend the actuator arm. Then unhook the rod and spring from the throttle.

Reconnecting the Governor Rod: Before reconnecting the governor rod, check to see if the paint seal on the throttle stop screw on the carburetor has not been broken. If it has been broken, readjust the throttle stop screw as follows:

1. Disconnect the governor rod from the actuator arm if it has not already been removed.

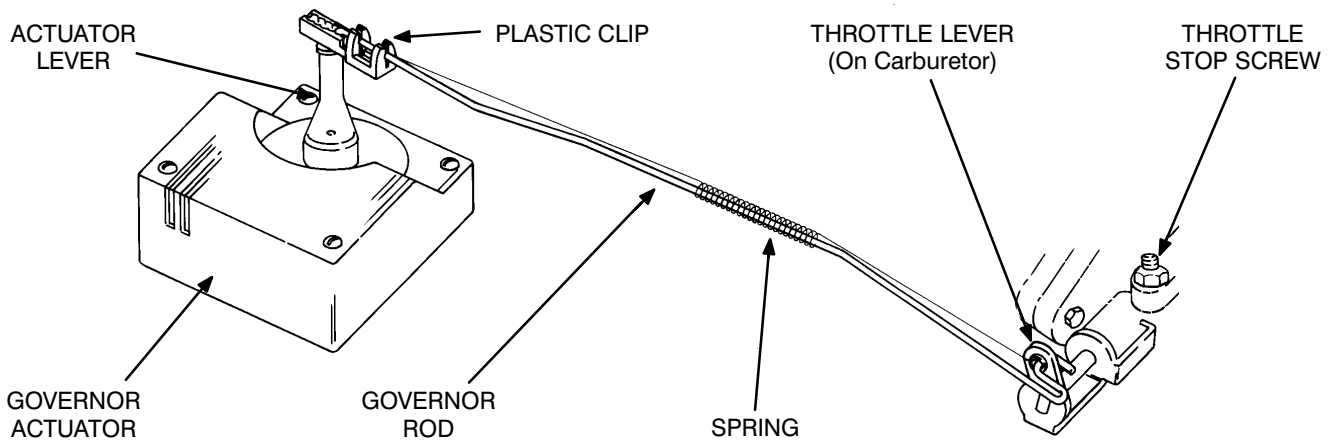


FIGURE 6-12. ELECTRONIC GOVERNOR LINKAGE

2. Loosen the throttle stop screw locknut and back the screw out away from the tang on the throttle lever, while gently rotating the throttle lever counterclockwise as far as if will go.
3. While gently holding the throttle lever counterclockwise as far as it will go, turn the stop screw in until it just touches the tang. Then turn the screw an additional 1/8-1/4 turn (clockwise) and set and seal the locknut.

If the throttle stop screw adjustment is okay, reconnect the governor rod as follows:

1. Insert the rod in the spring such that the shorter hook wire is on the throttle side.
2. Hook the rod and spring into the grommet in the throttle lever. (The spring should pull on one side and the rod push on the other side of the grommet when fully assembled.)
3. Pull the governor rod towards the plastic clip on the end of the actuator lever as far as the throttle stop screw permits. Leave the actuator lever in its fully counterclockwise (rest) position. Snap the dogleg on the end of the rod into the slot in the clip that most closely lines up with it. Use both hands so as not to bend the actuator lever.
4. Hook the spring into the slot in the end of the actuator lever. When assembled, the spring hook wires should not wrap around the governor rod.
5. Move the actuator back and forth through its full movement to make certain there is no sticking or binding.
6. After installing the top panel, hook the spark plug cable with the clip inside the panel to keep it from interfering with the governor rod.

Idle Fuel Mixture Adjustment: *These instructions do not apply to Spec F and later gensets.*

1. If the carburetor has been overhauled, gently turn the idle and main fuel mixture screws in by hand until they seat.

   For Gasoline Gensets: Turn the idle mixture screw out **1** turn and the main fuel mixture screw out **1-3/8** turns so that the engine will start and run.

   For LPG Gensets: Turn the idle mixture screw out **1-1/4** turns and the main fuel mixture screw out **2-1/2** turns so that the engine will start and run.

   CAUTION ***Forcing a mixture adjusting screw in tight will score the needle and seat. Turn it lightly by hand only.***

2. Start the genset and let it warm up for ten minutes under 1/2 to 3/4 rated load. (On vapor withdrawal type LPG gensets it might be necessary first to adjust the demand regulator and supply pressure to get the genset to start. See LPG System—Vapor Withdrawal.)

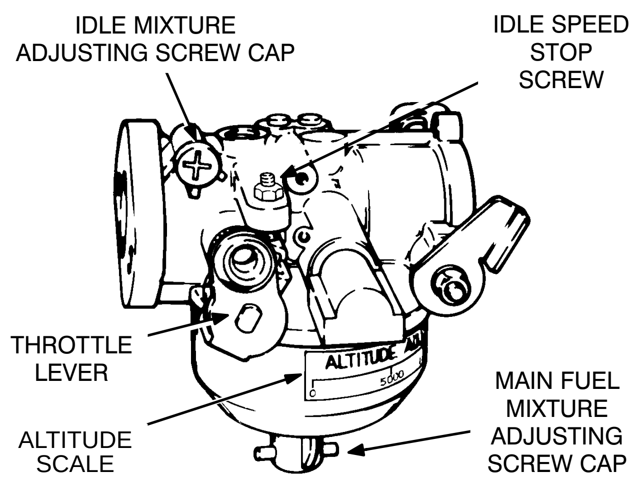


FIGURE 6-13. GASOLINE CARBURETOR

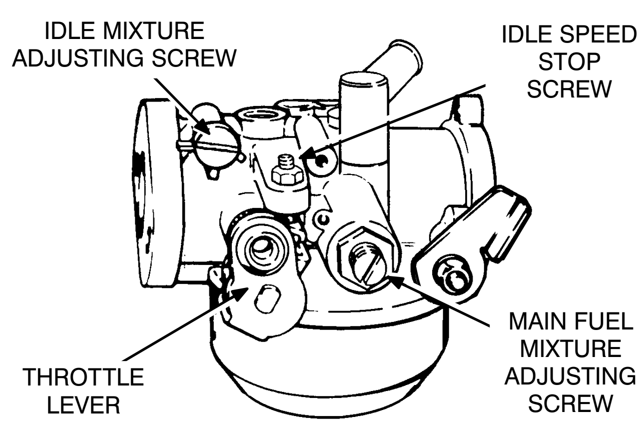


FIGURE 6-14. LPG CARBURETOR

3. Disconnect the load (check for zero amps). Turn the idle mixture adjusting screw clockwise until the engine begins to stumble. Then, counting the number of turns, turn the screw counterclockwise until it begins to stumble again. Set the screw halfway in between. For closer adjustments, use a CO meter to adjust to 6-8% CO (gasoline) or 4-6% CO (LPG). See *Troubleshooting* if the engine runs roughly.
4. Push the adjustment limiter cap on over the mixture screw head such that it will allow equal adjustment in either direction (gasoline carburetors).

Main Fuel Mixture Adjustment: *These instructions do not apply to Spec F and later gensets.*

1. Connect rated load.
   A. Load (watts) is the product of volts (V) and amps (A).

      Load (watts) = V x A

      (A 1.0 power factor, obtainable with a resistance load bank, is assumed. True rated output might not be obtained if appliances are used as part of the load.)

   B. See *Section 8. Generator* if output voltage cannot be adjusted to within 10 percent of rated voltage (Table 6-3).
2. Turn the main fuel mixture adjusting screw clockwise until the engine begins to stumble. Then, counting the number of turns, turn the screw counterclockwise until it begins to stumble again. Set the screw halfway in between. For closer adjustments, use a CO meter to adjust to 6-8% CO (gasoline) or 2-4% CO (LPG). See *Troubleshooting* if the engine runs roughly.
3. Push the adjustment limiter cap on over the mixture screw head such that the cap pointer indicates the current altitude (gasoline carburetors).

TABLE 6-3. VOLTAGE SPECIFICATION

RATED OUTPUT VOLTAGE	MAXIMUM NO-LOAD VOLTAGE	MINIMUM FULL-LOAD VOLTAGE
120V, 1PH	126	114

Mechanical Governor (Spec A Only)

Mechanical governor speed and sensitivity set points are adjustable. The following adjustments must be made in the sequence that they appear.

Governor Rod Length Adjustment: The length of the governor rod (Figure 6-15) must be checked and adjusted as follows before other adjustments are attempted:

1. To access the governor linkage remove access cover or the top panel (Figure 6-5).
2. Loosen the lock nut at the ball joint end of the governor rod and unsnap the socket from the ball.
3. Push the governor rod gently towards the carburetor (full-throttle position). While keeping it there, turn the socket, as necessary, to lengthen or shorten the rod so that the ball and socket line up.

   ⚠ CAUTION ***Too much pressure on the rod can result in a faulty adjustment of the rod length.***
4. Snap the socket back over the ball.
5. Tighten the lock nut while holding the socket square with the axis of the ball. Also, the leg at the throttle end of the rod must be kept level.
6. Gently rotate the governor arm and check for binding. If necessary, loosen the locknut and repeat Step 5 until the linkage moves smoothly. Binding can cause erratic governor action.

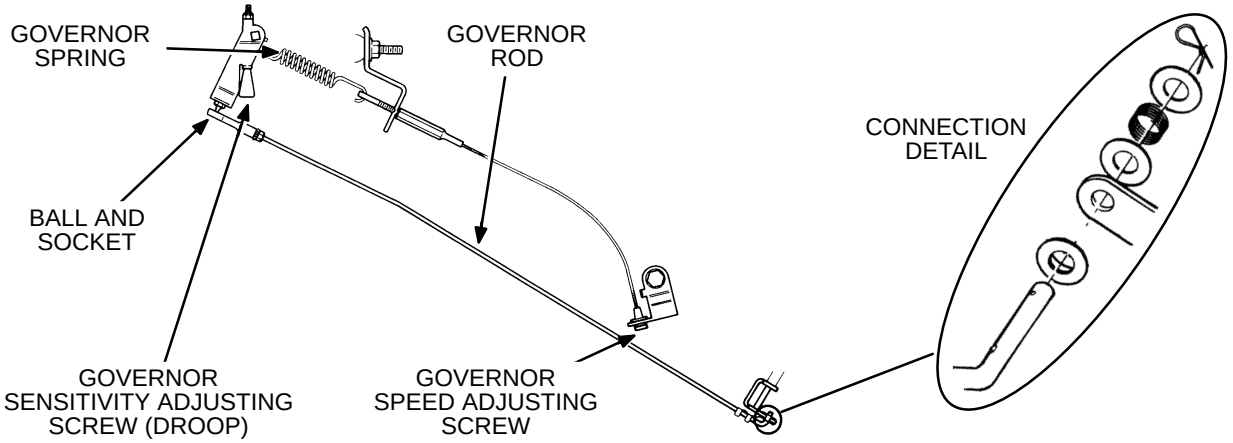


FIGURE 6-15. MECHANICAL GOVERNOR (SPEC A ONLY)

Note: The following groups of adjustments must be performed in sequence.

Idle Speed Stop Adjustment (Spec A only):

1. If the carburetor has been overhauled, gently turn the idle and main fuel mixture screws in by hand until they seat (Figure 6-16).

   Turn the idle mixture screw out **1** turn and the main fuel mixture screw out **1-3/8** turns so that the engine will start and run.

   ⚠ CAUTION ***Forcing a mixture adjusting screw in tight will score the needle and seat. Turn it lightly by hand only.***

2. Start the genset and let it warm up for ten minutes under 1/2 to 3/4 rated load.
3. Disconnect the load (check for zero amps). Pull the governor rod so that the tang on the throttle lever bears against the idle speed stop screw. Adjust the screw to obtain 54-56 Hz.

Idle Mixture and Frequency Adjustments (Spec A only):

1. Disconnect all loads (check for zero amps). Then check no-load frequency. If necessary, turn the governor speed adjusting screw (Figure 6-15) to obtain a no-load frequency of 62-63 Hz.
2. Turn the idle mixture adjusting screw clockwise until the engine begins to stumble. Then, counting the number of turns, turn the screw counterclockwise until it begins to stumble again. Set the screw halfway in between. For closer adjustments, use a CO meter to adjust to 6-8% CO. See *Troubleshooting* if the engine runs roughly.
3. Push the adjustment limiter cap on over the mixture screw head such that it will allow equal adjustment in either direction (gasoline carburetors).
4. If no-load frequency has changed because of idle mixture adjustment, repeat Step 1.
5. Check output voltage. See *Section 8. Generator* if output voltage cannot be adjusted to within 10 percent of rated voltage (Table 6-3 on Page 6-16).

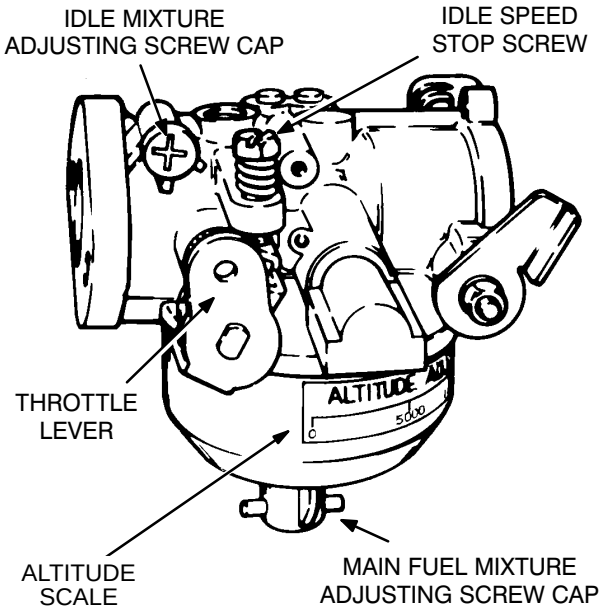


FIGURE 6-16. CARBURETOR (SPEC A ONLY)

Main Fuel Mixture and Droop Adjustments (Spec A only):

1. Connect rated load.
   A. Load (watts) is the product of volts (V) and amps (A).
      Load (watts) = V x A
   B. (A 1.0 power factor, obtainable with a resistance load bank, is assumed. True rated output might not be obtained if appliances are used as part of the load.)
   C. See *Section 8. Generator* if output voltage cannot be adjusted to within 10 percent of rated voltage (Table 6-3 on Page 6-16).
2. Turn the main fuel mixture adjusting screw clockwise until the engine begins to stumble. Then, counting the number of turns, turn the screw counterclockwise until it begins to stumble again. Set the screw halfway in between. For closer adjustments, use a CO meter to adjust to 6-8% CO. See *Troubleshooting* if the engine runs roughly.
3. Push the adjustment limiter cap on over the mixture screw head such that the cap pointer indicates the current altitude (gasoline carburetors).
4. Disconnect the load and readjust the governor speed adjusting screw to return no-load frequency to 62-63 Hz.
5. Check and adjust droop.
   A. If droop (from no-load frequency) is more than 3 Hz for Model BGM or 4 Hz for Model NHM, turn the governor sensitivity adjusting screw (Figure 6-15) one turn counterclockwise. Disconnect the load and, if necessary, readjust the governor speed adjusting screw to return to 62-63 Hz no-load frequency. Check droop again and repeat the adjustments, if necessary.
   B. If droop (from no-load frequency) is less than 2 Hz for Model BGM or 3 Hz for Model NHM, turn the governor sensitivity adjusting screw (Figure 6-15) one turn clockwise. Disconnect the load and, if necessary, readjust the governor speed adjusting screw to return to 62-63 Hz no-load frequency. Check droop again and repeat the adjustments, if necessary.
6. Check governor response under 1/4, 1/2 and 3/4 rated loads. See *Troubleshooting* if hunting is unacceptable.

FUEL SYSTEM

The carburetor mixes air and fuel in the correct proportion for good performance. The governor operates the throttle to maintain a nearly constant engine speed (frequency) as the load varies. Figure 6-17 is representative of most of the fuel system parts beginning Spec B. LPG (liquified petroleum gas) systems do not use an air preheater or choke and have different fuel connections. See Choke Assembly, Fuel Pump and LPG System (Liquid Withdrawal and Vapor Withdrawal) in this section for other details which may be applicable.

See GOVERNOR AND CARBURETOR ADJUSTMENTS in this section for carburetor adjustments.

⚠WARNING ***Gasoline and LPG are flammable and explosive and can cause severe personal injury or death. Do not smoke if you smell gas or gasoline vapors or are near fuel tanks or fuel-burning equipment or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and other sources of ignition well away.***

⚠WARNING ***LPG is flammable and explosive and can cause asphyxiation. NFPA 58, Section 1.6 requires all persons handling LPG to be trained in proper handling and operating procedures.***

Air Cleaner Assembly

Disassembly:

1. Remove the crankcase breather hose and air preheater hose (gasoline gensets only) from the air cleaner housing.
2. Remove the air cleaner housing center capscrew and lift off the housing and air filter.
3. Prior to Spec D gasoline and Spec F LPG, remove the choke cover retaining nut and cover and disconnect the leads connected at the terminals.
4. Remove the three capscrews that secure the air cleaner adapter to the carburetor and lift off the adapter. (One of the screws is inside the throat of the adapter.)

   Prior to Spec D gasoline and Spec F LPG, the choke linkage must be disengaged from the choke as the air cleaner adapter is being removed. See Figure 6-18.

5. Beginning Spec D gasoline, disconnect the leads at Relay K4 or remove the relay and bracket from the air cleaner adapter.

Reassembly: Reassembly is the reverse of disassembly. Use a new gasket between the adapter and the carburetor.

⚠ CAUTION ***Make sure you use the right screws to mount the adapter on the carburetor. The screw inside the throat will interfere with the choke shaft if it is too long or tightened too tight. Take care also not to cross thread it.***

Carburetor And Intake Manifold Assembly

Disassembly:

1. Remove the top panel (see COOLING SYSTEM in this section).
2. Remove the air cleaner assembly.
3. Disconnect the fuel line and governor rod from the carburetor (see GOVERNOR AND CARBURETOR ADJUSTMENTS in this section).
4. Remove the intake manifold capscrews, the carburetor air preheater (gasoline gensets only) and the carburetor and intake manifold as an assembly.

   Prior to Spec D gasoline and Spec F LPG, disengage the choke pulloff linkage from the carburetor. See Figure 6-19.

5. Remove the two intake manifold gaskets and cover the intake ports to prevent loose parts and dirt from entering the engine.
6. Unbolt the carburetor from the intake manifold.

Reassembly: Reassembly is the reverse of disassembly. 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 all fasteners according to *Section 4. Torque Specifications.*

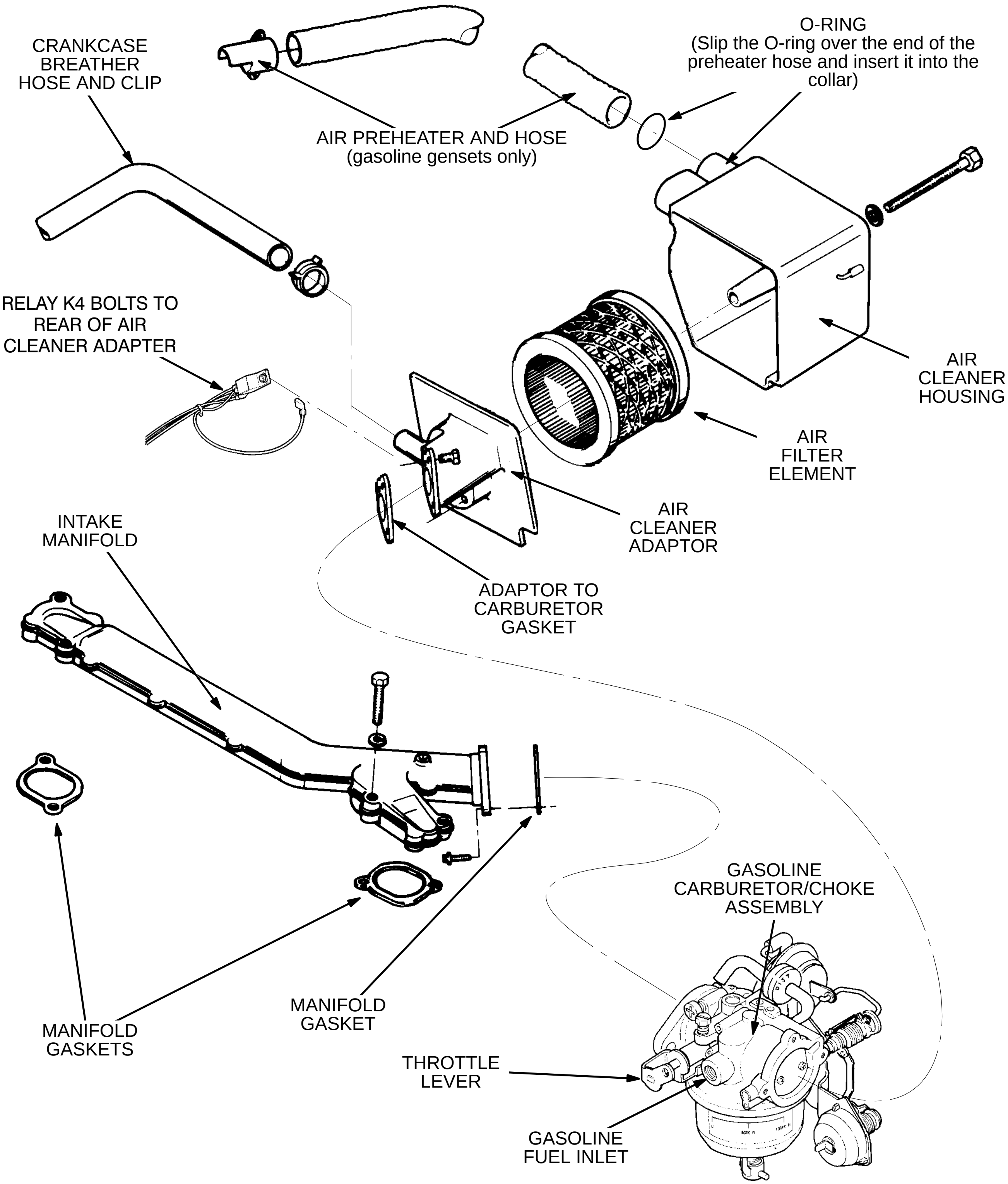


FIGURE 6-17. TYPICAL FUEL SYSTEM (BEGINNING SPEC D GASOLINE)

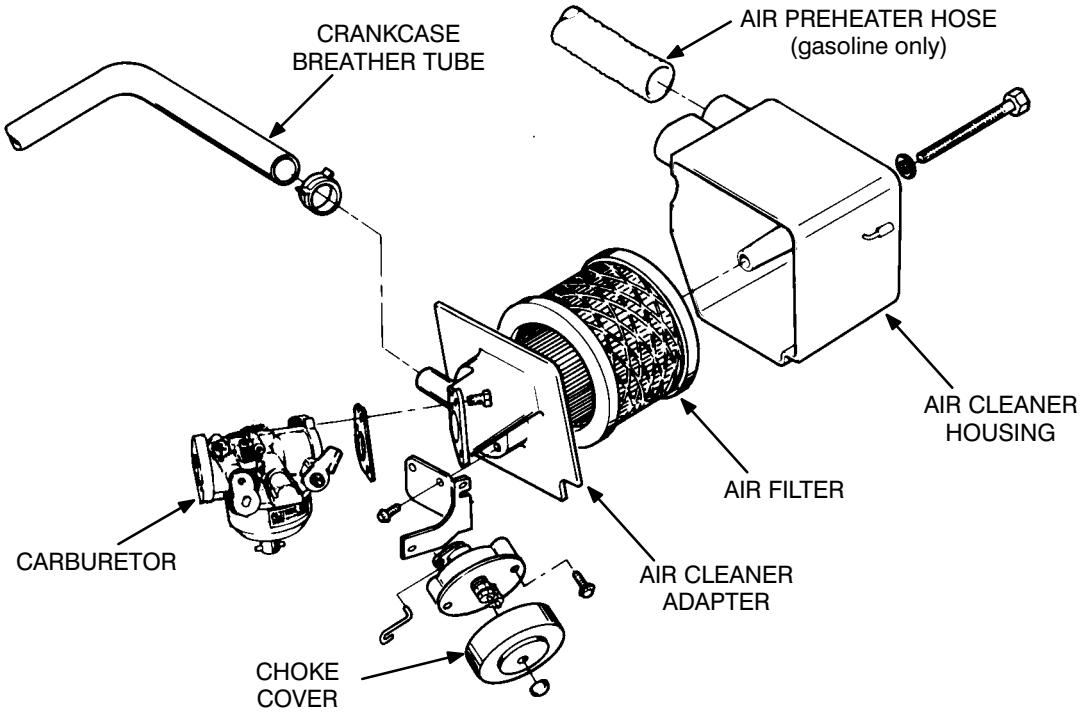


FIGURE 6-18. AIR INTAKE ASSEMBLY (PRIOR TO SPEC D GASOLINE AND SPEC F LPG)

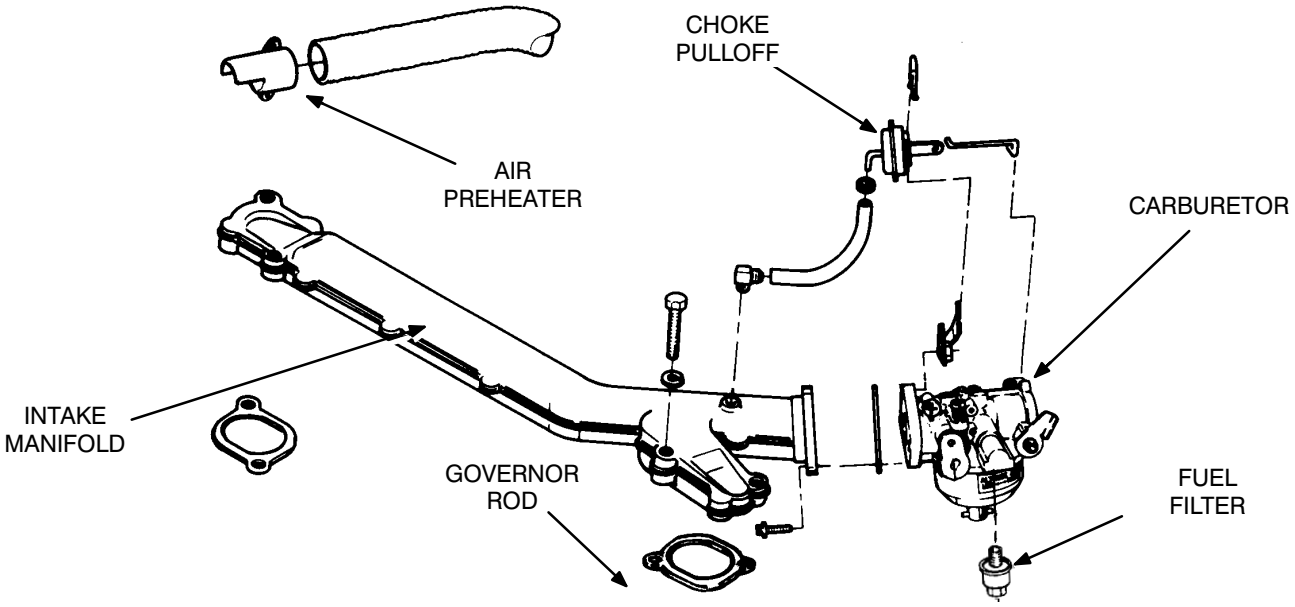


FIGURE 6-19. CARBURETOR AND INTAKE MANIFOLD (PRIOR TO SPEC D GASOLINE AND SPEC F LPG)

Carburetor Replacement (Beginning Spec F)

Beginning Spec F, the gasoline or LPG carburetor should not be overhauled. Instead, a malfunctioning carburetor should be replaced. Before replacing a carburetor, however, make certain 1) that all other necessary engine and generator adjustments and repairs have been performed and 2) that the carburetor is actually malfunctioning, by carefully following the troubleshooting procedures in *Troubleshooting*.

LPG carburetors are usually not the cause of problems. Make certain all other possible causes of the problem have been eliminated before replacing an LPG carburetor.

⚠WARNING ***Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law in the State of California.***

Gasoline Carburetor Overhaul (Prior to Spec F)

See Figure 6-20. Carburetor 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 to replace or overhaul the carburetor. Overhauling a carburetor consists of complete disassembly, thorough cleaning and replacement of worn parts. Repair kits are available for gasoline carburetors that include new gaskets and float assembly parts.

Disassembly: Carefully note how the carburetor parts fit together as the carburetor is being disassembled so that it will be easier to reassemble. Read and understand these instructions before starting.

1. Remove the air cleaner adapter and the automatic choke assembly (gasoline carburetors).
2. Remove the main and idle mixture screw assemblies.
3. Separate the lower section of the carburetor (float bowl) from the body of the carburetor.
4. Carefully note the position of the float assembly parts, then remove the hinge pin, float and needle valve.

Cleaning and Inspection:

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 corrosive and can cause severe burns and inflammation. Use only as recommended by the manufacturer.***

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. Replace the fuel mixture screws if they are scored (Figure 6-21).
5. Replace the carburetor if either the choke or the throttle sticks after cleaning. It is usually not necessary to disassemble the throttle or choke.

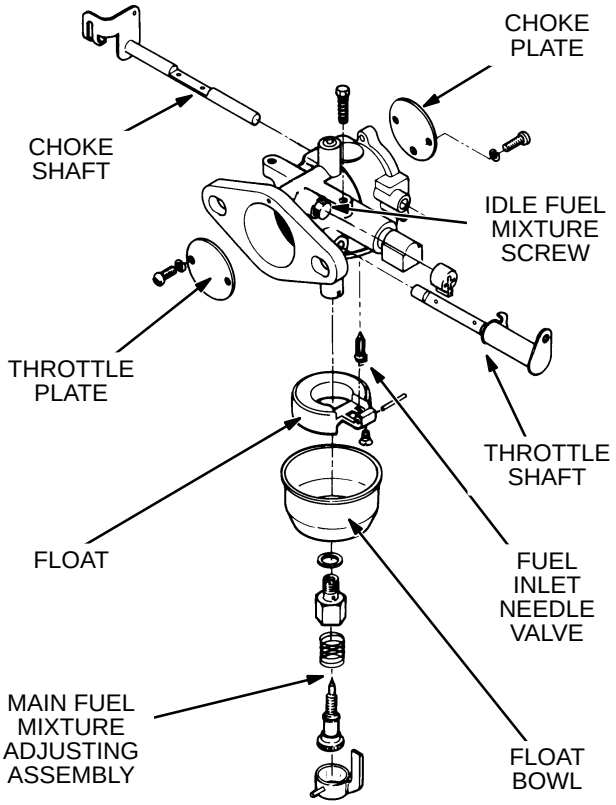


FIGURE 6-20. GASOLINE CARBURETOR

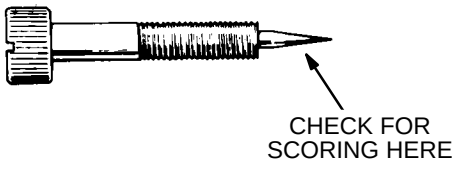


FIGURE 6-21. TYPICAL FUEL MIXTURE SCREW

Reassembly:

1. See Figure 6-22. Turn the carburetor upside down and install the new needle valve, float, float hinge pin and fuel bowl gasket in the repair kit. Make sure the wire clip properly engages the groove around the end of the needle valve and loops around the metal tang of the float. (The clip pulls down on the needle valve when the float level drops, breaking the needle loose if it is stuck.) Check to see that the float moves freely without binding.
2. See Figure 6-23. Check the float level as shown while the carburetor is still upside down. Measure the height above the bowl gasket flange on the side opposite the hinge. Make sure the full weight of the float is resting on the needle valve. Remove the float and bend the metal tang to adjust the height.

   ⚠ CAUTION ***Remove the float before bending the tang so as not to damage the soft nose of the needle valve.***
3. Install the float bowl and the main mixture screw assembly.
4. Install the idle and main fuel mixture screws. Turn them lightly by hand until they seat. Then turn the idle mixture screw out **1** turn and the main fuel mixture screw out **1-3/8** turns so that the engine will start and run.
5. If it is necessary to reassemble the throttle or choke, secure the plate screws such that they will not loosen.

   ⚠ CAUTION ***Loose throttle or choke plate screws can get drawn into the engine and cause serious engine damage.***

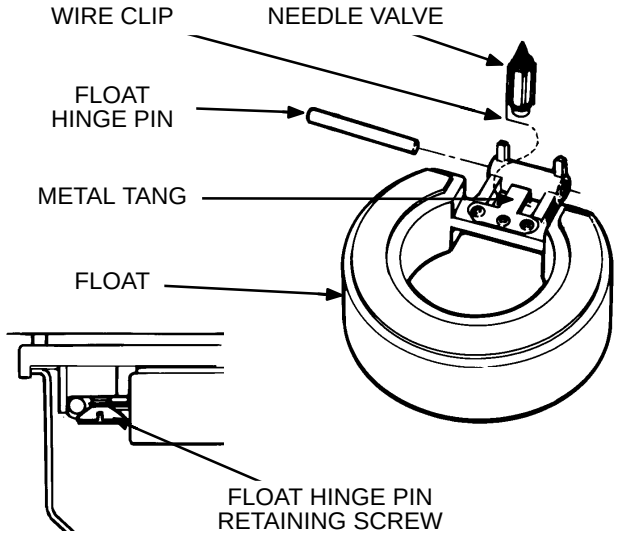


FIGURE 6-22. FLOAT INSTALLATION (GASOLINE)

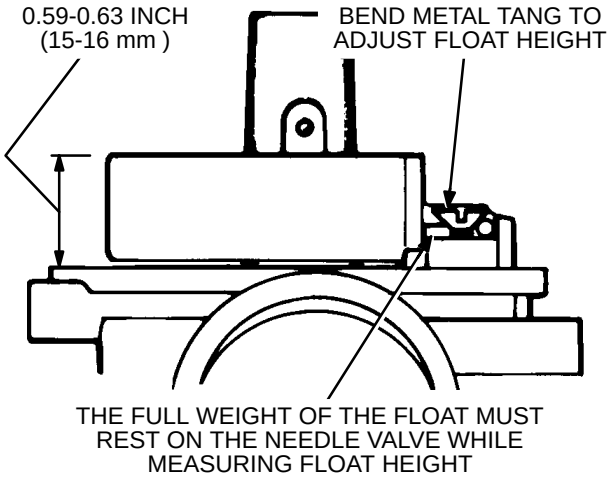


FIGURE 6-23. FLOAT LEVEL (GASOLINE)

Choke Assembly
(Prior to Spec D Gasoline and Spec F LPG*)

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

1. Remove the plastic choke cover (see Figure 6-24) and loosen the heating element cover screws.
2. Rotate the heating element until the choke plate is halfway open.
3. Slowly rotate the cover counter clockwise while tapping the carburetor choke lever to make it bounce. Continue until the lever no longer bounces. This is the fully-closed (reference) position.
4. Refer to Table 6-4 to determine the number of degrees the element cover must be rotated clockwise from the reference position. The marks on the choke housing are spaced at 5° intervals.
5. Rotate the element cover as specified, then tighten the cover mounting screws.
6. Move the choke lever to test its operation. The lever should return to the free position when released from the open position, without sticking or binding.
7. Install the plastic choke cover and tighten the center mounting unit.

TABLE 6-4. CHOKE SETTINGS

Ambient Air Temperature	Rotation from Reference Mark*
40°F(4°C)	0°
45°F(7°C)	4°CW
50°F(10°C)	8°CW
60°F(16°C)	16°CW
65°F(18°C)	20°CW
70°F(21°C)	24°CW
75°F(24°C)	27°CW
80°F(32°C)	32°CW
85°F(29°C)	35°CW
90°F(32°C)	39°CW
95°F(35°C)	43°CW
100°F(38°C)	47°CW
* Each mark on choke housing equals 5°	

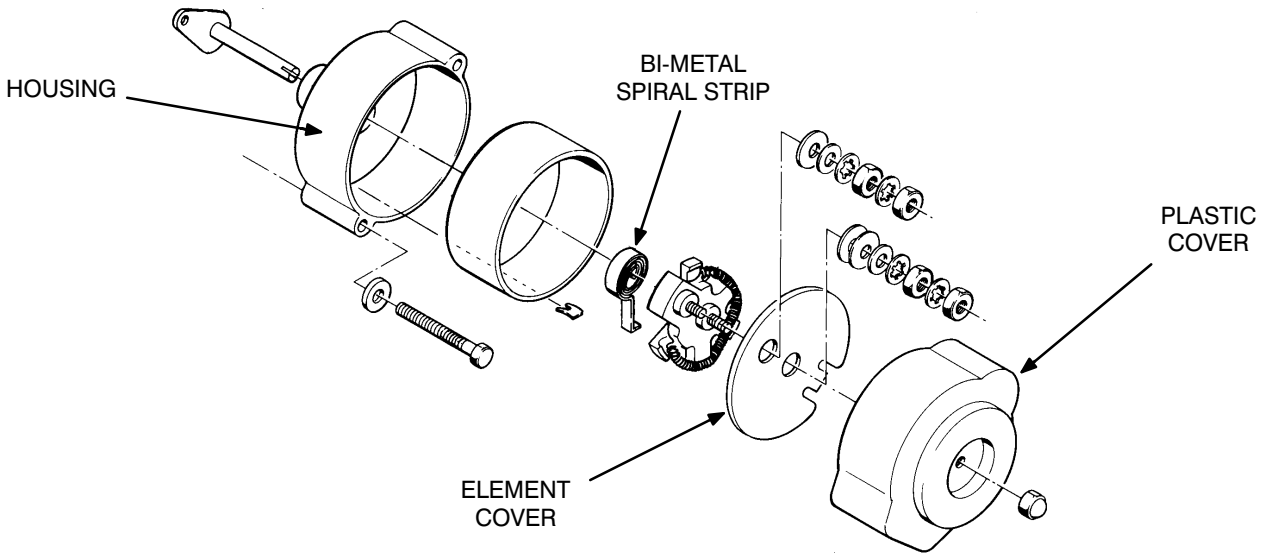


FIGURE 6-24. CHOKE ASSEMBLY (SPEC A GASOLINE AND UP TO SPEC E LPG)

* Beginning Spec F, LPG models do not incorporate a choke.

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

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

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

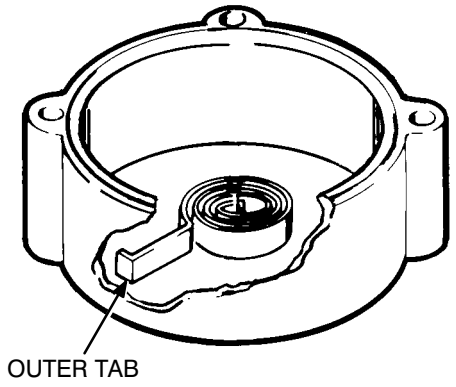


FIGURE 6-25. BI-METAL COIL

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

1. Remove the air cleaner assembly as described in Air Cleaner Assembly in this section, to access the choke plate.
2. Disconnect the diaphragm hose from the intake manifold. Apply 4-18 inch (13.5-60.8 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).
4. Check and correct the alignment of the diaphragm stem, pulloff linkage, and slot in the choke lever, viewing them from above.
5. Measure the distance between the choke plate and the bottom of the carburetor at the point indicated in Figure 6-26. There should be 0.39-0.43 inch (9.9-10.9 mm) clearance here; if necessary, bend the diaphragm mounting bracket to reach this clearance.
6. Move the choke lever back and forth to verify that it does not bind or stick.
7. Remove the vacuum supply from the diaphragm. Install the filter assembly on the carburetor.

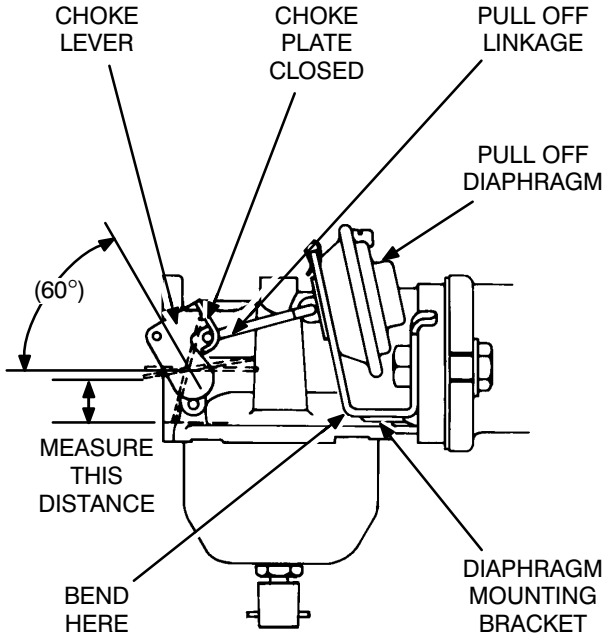


FIGURE 6-26. CHOKE PULLOFF DIAPHRAGM

Choke Assembly
(Beginning Spec D Gasoline)

See Figure 6-27. The choke is operated automatically by a 12 VDC heater/bi-metal assembly and a vacuum break, both of which are mounted on the side of the carburetor by a bracket. Reassemble the choke components as shown.

The choke bi-metal/heater assembly is adjusted at the factory. If the factory settings have been disturbed, loosen the three bezel ring screws at the base of the assembly and rotate the body counterclockwise for a richer setting and clockwise for a leaner setting and retighten the screws.

The choke plate opening should be checked with a gauge each time the vacuum break is remounted. Check and readjust the opening as follows:

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

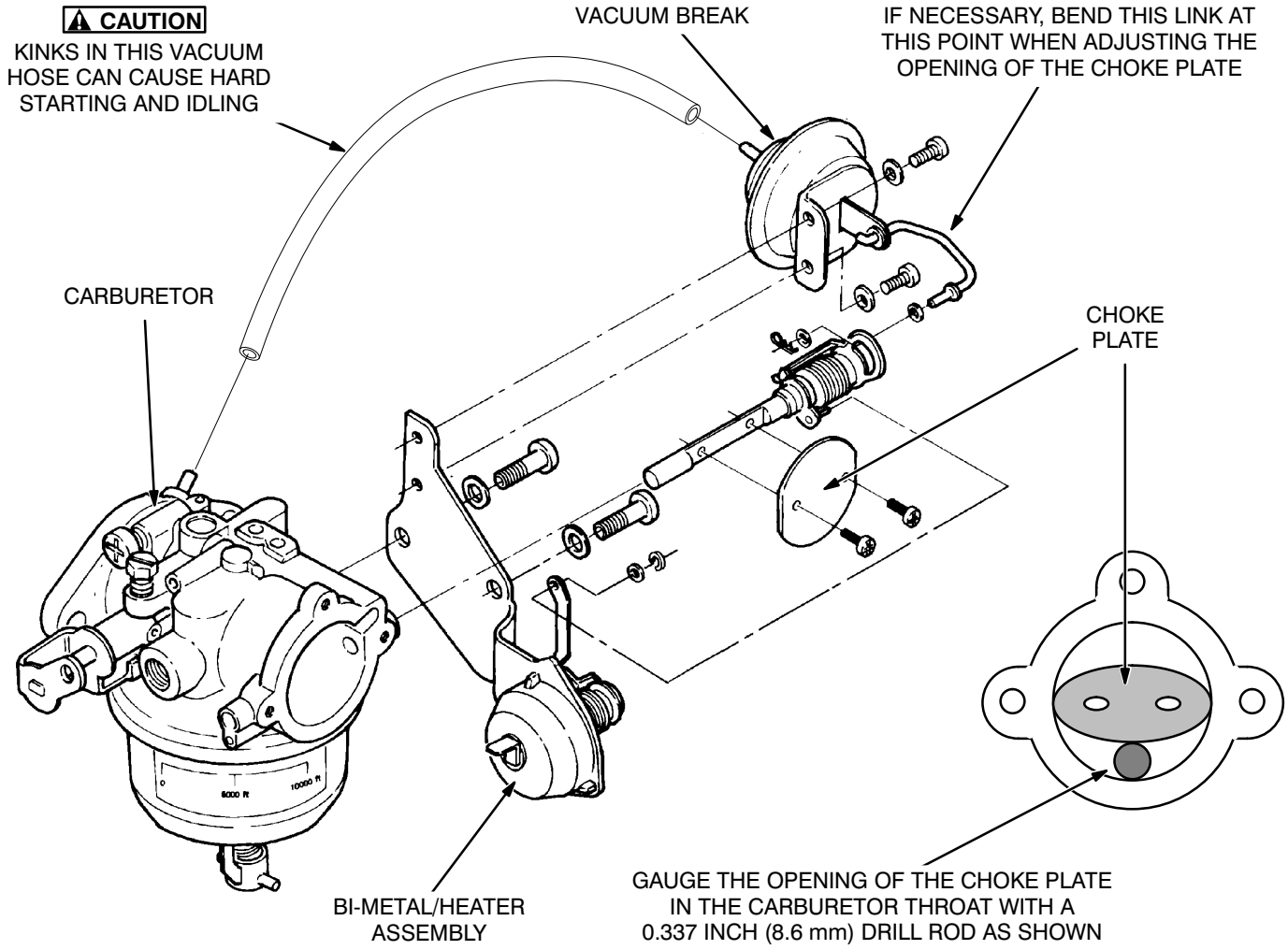


FIGURE 6-27. CHOKE ASSEMBLY (BEGINNING SPEC D GASOLINE)

Fuel Pump (Gasoline Gensets)

If a problem in fuel delivery is indicated (see TROUBLESHOOTING in this section), test fuel pump pressure as follows:

1. Disconnect the fuel line at the outlet of the fuel pump and connect a pressure gauge at the pump outlet. A gauge calibrated for 0-15 psi (0-100 kPa) is recommended. Do not tee into the fuel line. This is a static pressure test.
2. Push the Start/Stop switch to **START** and hold it there for several seconds until the fuel pressure stabilizes. Fuel pressure should stabilize between 3.5 and 6 psi (24 and 41 kPa).
3. Repeat the test with the vehicle engine running.

A fuel pressure greater than 6 psi (41 kPa) is not acceptable. Find out why the pressure is high. If it is high when the vehicle engine is not running, check to see that the proper Onan supplied pump is being used. If it is high when the vehicle engine is running, a separate fuel pickup tube in the fuel tank, or equivalent means, will be required.

If the fuel pressure is less than 3.5 psi (24 kPa), check for fuel restrictions in the system. If the pump is defective, replace it with the appropriate Onan pump. The pump is not serviceable.

⚠ **CAUTION** ***Tampering with the seal at the center of the mounting bracket on the side of the pump can cause the dry gas which surrounds the electrical components to leak, leading to pump failure. The pump is not serviceable.***

⚠**WARNING** ***Do not substitute an automotive fuel pump for the standard pump removed from the genset. Other pumps can cause carburetor flooding because of the high pressures they develop. Carburetor flooding can cause poor performance and engine damage and lead to possible fire and severe personal injury or death. Fuel pressure at the carburetor fitting must not exceed 6 psi (41 kPa) under any operating condition.***

LPG System—Liquid Withdrawal

See Figure 6-28. For liquid withdrawal systems the LPG container(s) must be equipped to withdraw LPG as a liquid. See the Installation Manual for important recommendations regarding the installation of a LPG liquid withdrawal type of fuel supply system.

⚠WARNING ***LPG is flammable and explosive and can cause asphyxiation. NFPA 58, Section 1.6 requires all persons handling LPG to be trained in proper handling and operating procedures.***

It is important to understand that the fuel filter, solenoid shutoff valve, vaporizer and demand regulator handle LPG liquid at the same pressure as in the LPG container. Depending on ambient temperature, LPG container pressure can exceed 200 psi (1379 kPa). Therefore, discharge or leakage from LPG liquid-containing components can result in the escape of large volumes of flammable and explosive gas.

Purging the LPG System: It is imperative that the LPG system be purged before disconnecting fuel system components.

⚠WARNING ***Large volumes of LPG can be released in the process of disconnecting a liquid-withdrawal type of LPG supply system. See the instructions in* Section 5. Preparing to Service *for proper procedures and precautions when disconnecting LPG fuel lines.***

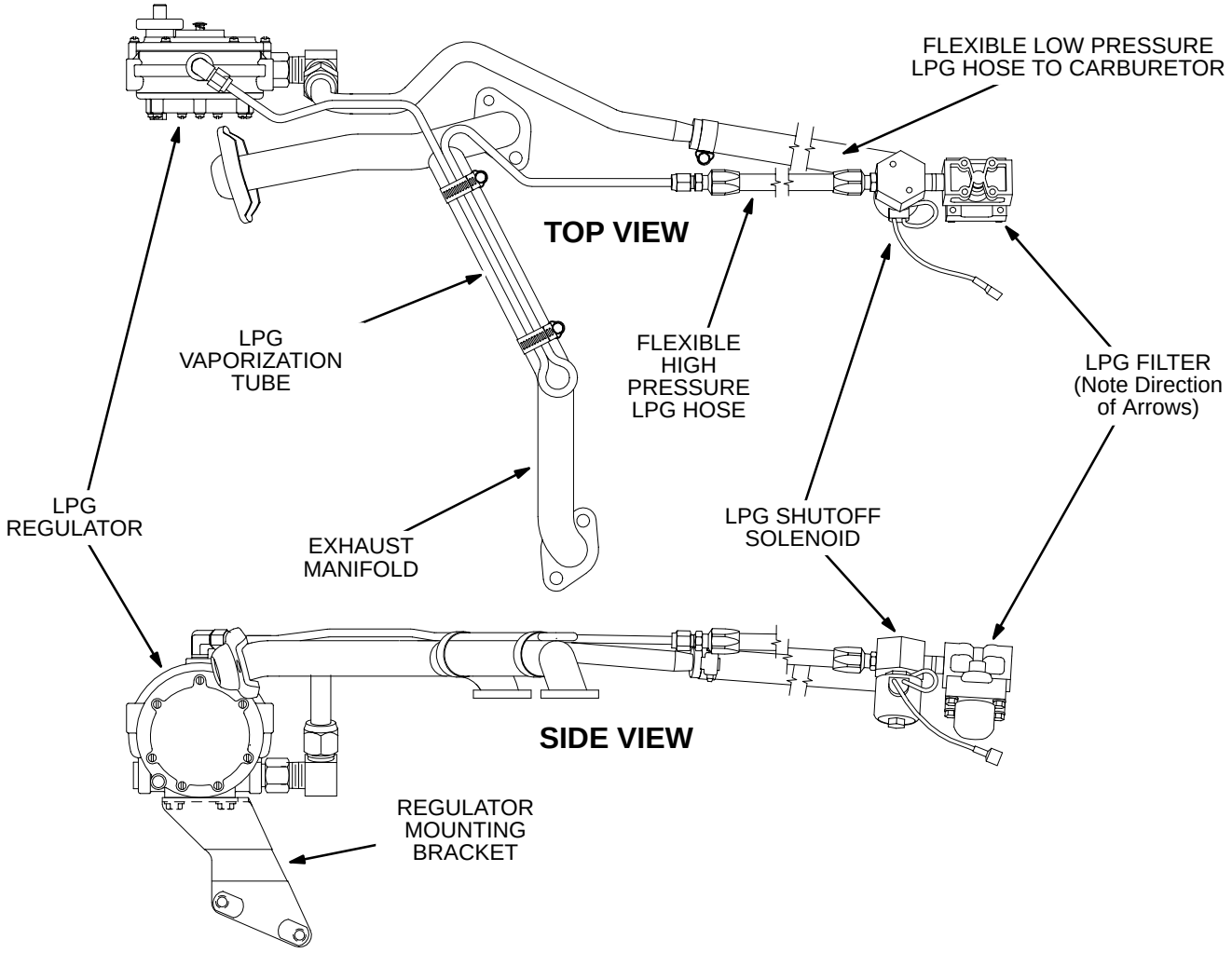


FIGURE 6-28. LPG SYSTEM COMPONENTS FOR LIQUID WITHDRAWAL

Demand Regulator: See Figure 6-29. The two-stage demand regulator delivers vaporized LPG to the carburetor. The primary stage receives LPG vapor (and liquid) at LPG container pressure and reduces it to approximately 1.5 psi (10.3 kPa). The secondary stage delivers LPG vapor at the rate demanded by the carburetor.

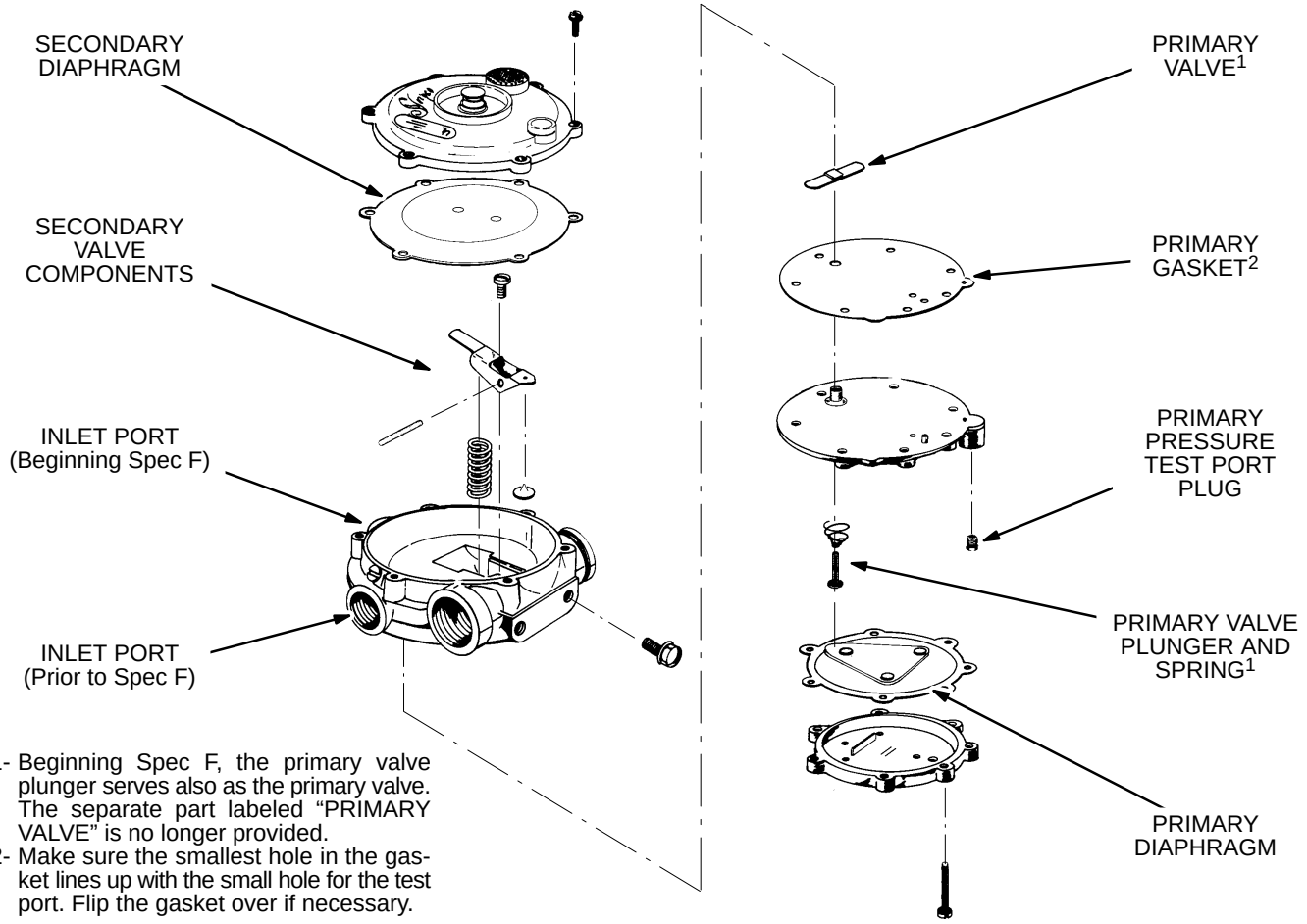
The regulator should require little attention if the genset is operated regularly. Most problems are due to:

- *Hardened Diaphragms, Gaskets and Valve Seats:* Diaphragms, gaskets and valve seats tend to shrink and harden when a genset is stored for long periods of time and may need to be replaced.
- *Impurities and Dissolved Oils in Liquid LPG:* Impurities can embed on valve seats causing them to leak and oils can clog regulator passages, resulting in hard starting, erratic idling and poor load acceptance.

Primary Pressure Test:

1. Connect a pressure gauge to the primary pressure test port and a source of compressed air (at least 80 psi [550 kPa]) to the inlet port.
2. The gauge should indicate approximately 1.5 psi (10.3 kPa) and hold steady when the test pressure valve is opened. The pressure should not drop off when the test pressure valve is closed.
3. Disassemble and clean and retest the regulator if it cannot hold the proper pressure. Replace it if it still does not function properly.

⚠WARNING ***Parts cleaning solvents are flammable and corrosive and can cause burns and inflammation. Follow the manufacturer's instructions.***



1- Beginning Spec F, the primary valve plunger serves also as the primary valve. The separate part labeled "PRIMARY VALVE" is no longer provided.
2- Make sure the smallest hole in the gasket lines up with the small hole for the test port. Flip the gasket over if necessary.

FIGURE 6-29. DEMAND REGULATOR ASSEMBLY

Fuel Filter: See Figure 6-30. The fuel filter removes rust and scale and other solid particles from the LPG liquid to keep them from embedding in the valve seats of the shutoff valve and pressure regulator and causing them to leak. A magnet traps iron and rust particles and a filter element traps non-magnetic particles.

Disassembling and Cleaning the Fuel Filter:

1. Purge the LPG system as instructed in *Section 5. Preparing to Service.*
2. Remove the four capscrews and lock washers that hold the filter bowl to the filter body.
3. Separate the filter bowl from the filter body and discard the O-ring seal.
4. Remove the nut and washer from the center stud and pull out the filter element.
5. Wash the filter element in solvent to remove the particles it has collected. Blow it dry with low pressure (30 psi / 207 kPa) compressed air. Replace the filter element if damaged.

   ⚠WARNING ***Parts cleaning solvents are flammable and corrosive and can cause burns and inflammation. Follow the manufacturer's instructions.***
6. Wipe the magnet clean of the particles it has collected.
7. Install a clean filter element using two new gaskets and securely tighten the center stud nut.
8. Place a new O-ring in the filter bowl sealing groove.
9. Align the reference mark on the filter bowl with the reference mark on the filter body and torque the capscrews to 65 lbs-in (7.2 N-m). Check for and fix leaks at the filter when connections have been made to the fuel supply system. **The fuel filter operates at fuel supply tank pressure.**

Fuel Vaporizer: The fuel vaporizer consists of tubing clamped to the exhaust manifold. See EXHAUST SYSTEM in this section for removal.

Fuel Shutoff Solenoid Valve: Test the fuel solenoid by disconnecting its long lead and jumpering it directly to the battery positive (**+**) terminal on the genset. Replace the solenoid if it does not "click" open when it is powered.

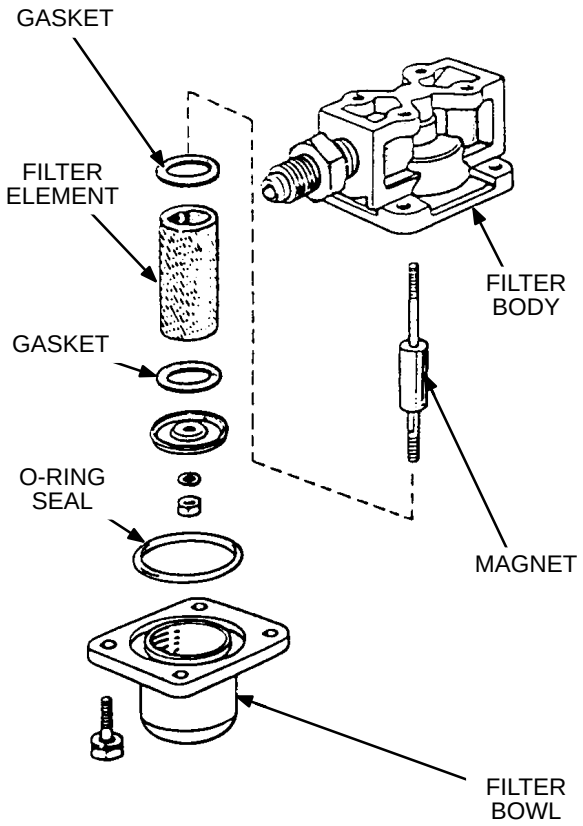


FIGURE 6-30. LPG FUEL FILTER (LIQUID WITHDRAWAL SYSTEM)

LPG System—Vapor Withdrawal

See the Installation Manual for important recommendations regarding the installation of an LPG vapor withdrawal type of fuel supply system. Gensets equipped for vapor withdrawal of LPG must be equipped with a fuel shutoff solenoid valve and demand regulator. These are available as a kit for mounting near the genset. See Figure 6-31.

⚠WARNING ***LPG is flammable and explosive and can cause asphyxiation. NFPA 58, Section 1.6 requires all persons handling LPG to be trained in proper handling and operating procedures.***

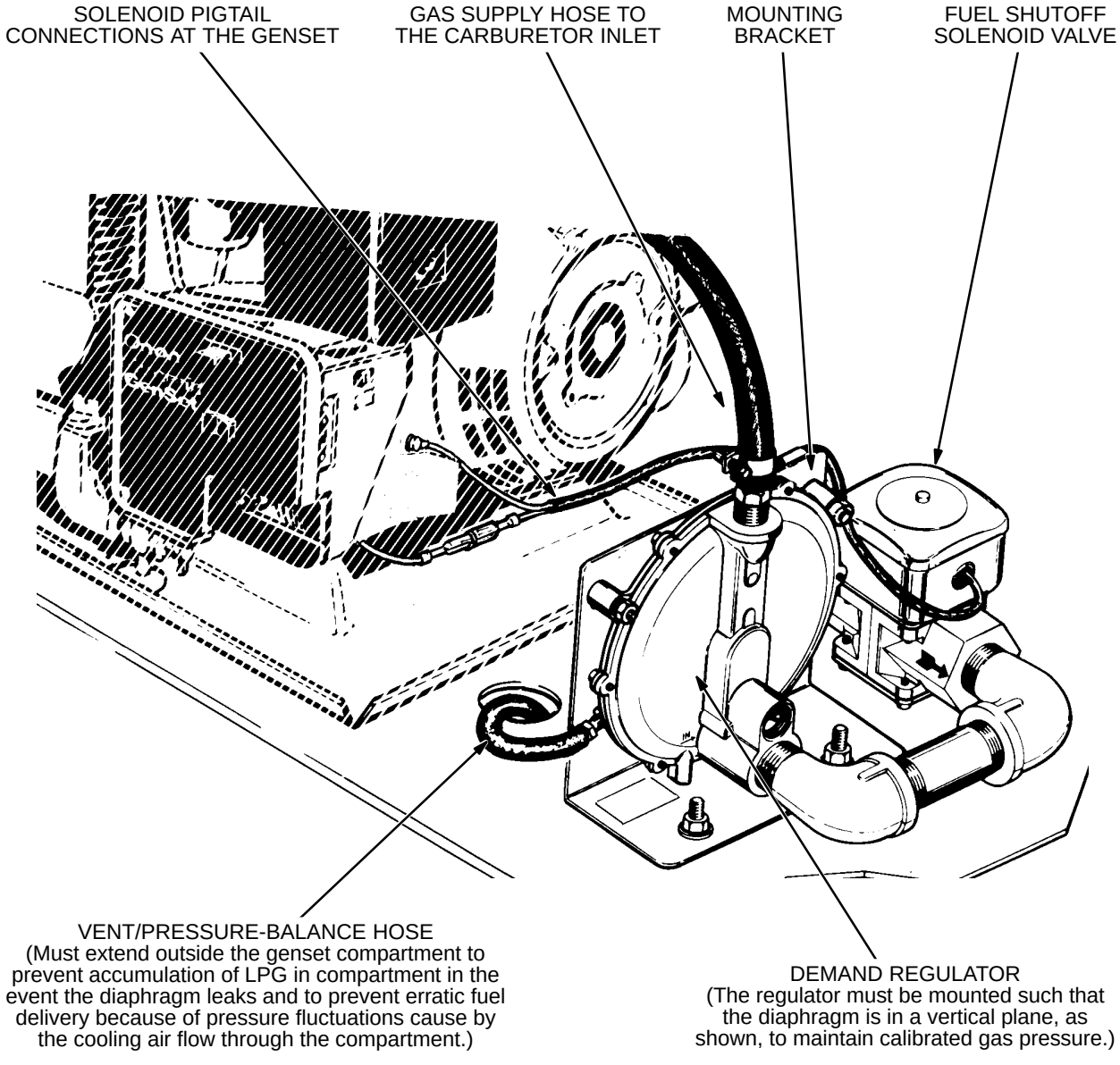


FIGURE 6-31. LPG SYSTEM COMPONENTS FOR VAPOR WITHDRAWAL

LPG Supply Pressure: LPG supply pressure must be maintained at 9-13 inches (229-330 mm) water column (WC) under all conditions. Adjust the supply pressure as follows:

1. Close the gas shutoff valve(s) at the LPG container(s).

2. Remove the 1/8 inch pipe plug from the regulator test port (Figure 6-32) and connect a manometer calibrated in inches or mm WC having a scale range of at least 14 inches (350 mm).

3. Open the LPG container shutoff valve and try starting the genset.

4. While the genset is running, check the manometer and adjust the LPG supply pressure regulator to obtain 11 inches (279 mm) WC. (If there is a secondary pressure regulator in the supply line, adjust the secondary regulator instead of the primary regulator at the LPG container.)

5. If the genset will not start, jumper the fuel solenoid to the battery cable connections on the genset so that it stays open (the regulator will keep gas from flowing)and then check and adjust the LPG supply pressure.

6. If the genset is operable, check LPG supply pressure under full load. If it drops below the minimum required pressure, either the LPG container is too small to provide the rate of vaporization necessary or it is less than half full or the supply line is too restrictive.

7. Disconnect any jumpers which may have been used to energize the fuel solenoid and thread in and tighten the pressure test port plug unless tests are going to be continued.

Fuel Shutoff Solenoid Valve: Replace the fuel solenoid if it fails to open (as indicated by the absence of gas pressure on the manometer scale in the previous test) when it is jumpered across the the battery cable connections at the genset.

Demand Regulator Lock-Off Pressure Test: Lock-off pressure is determined as follows by pressurizing the back (vent) side of the regulator diaphragm to simulate carburetor venturi vacuum:

1. Continue with the test setup for adjusting LPG supply pressure shown in Figure 6-32. If the regulator is being tested on the bench, connect it to a source of air pressure regulated to 11 inches (280 mm) WC.

   ⚠ CAUTION ***If this is a bench test of the regulator, make sure the diaphragm is in a vertical plane (see Figure 6-31), otherwise the weight of the diaphragm will cause erroneous readings of lock-off pressure.***

2. “T” in two hoses to the end of the hose connected to the regulator vent fitting (3/8 inch I. D.). Use one hose to provide the test pressure and the other to measure pressure by connecting it to an inclined manometer calibrated with 0.01 inch or 0.2 mm WC divisions and having a range of at least 1 inch (25 mm) WC.

3. Disconnect the hose to the carburetor and attach a soap bubble to the regulator outlet hose fitting. While reading the pressure indicated by the inclined manometer and watching the soap bubble, blow lightly into the hose being used to pressurize the regulator. Regulator lock-off pressure is the minimum pressure that will cause gas to flow through the regulator, as indicated by the expanding soap bubble. (At first the soap bubble may expand due to diaphragm movement but will stop expanding if gas or air is not flowing through the regulator.)

   For Gensets Beginning Spec F: Replace the demand regulator if the lock-off pressure does not fall between 0.15 and 0.25 inch WC (3.8 and 6.4 mm WC).

   ⚠WARNING ***Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law in the State of California.***

For Gensets Prior to Spec F: Adjust lock-off pressure as follows:

- If the lock-off pressure is greater than 0.25 inches (6.4 mm) WC, remove the locking screw and back out the adjusting screw (counterclockwise) until the lock-off pressure falls between 0.15 and 0.25 inch WC (3.8 and 6.4 mm WC). Set the locking screw and test lock-off pressure again. Repeat the procedure if necessary.
- If the lock-off pressure is less than 0.15 inch (3.8 mm) WC, remove the locking screw and turn in the adjusting screw (clockwise) until the lock-off pressure falls between 0.15 and 0.25 inch WC (3.8 and 6.4 mm WC). Set the locking screw and test lock-off pressure again. Repeat the procedure if necessary.
- Replace the demand regulator if it continues to leak after lock-off pressure adjustments have been attempted.

4. If the genset is mounted in a compartment, make sure the vent/pressure-balance hose is routed properly to the outside.
5. Reconnect the hose to the carburetor, disconnect any jumpers which may have been used to energize the fuel solenoid and thread in and tighten the pressure test port plug.
6. For gensets prior to Spec F, adjust fuel mixture as instructed under GOVERNOR AND CARBURETOR ADJUSTMENTS in this section.

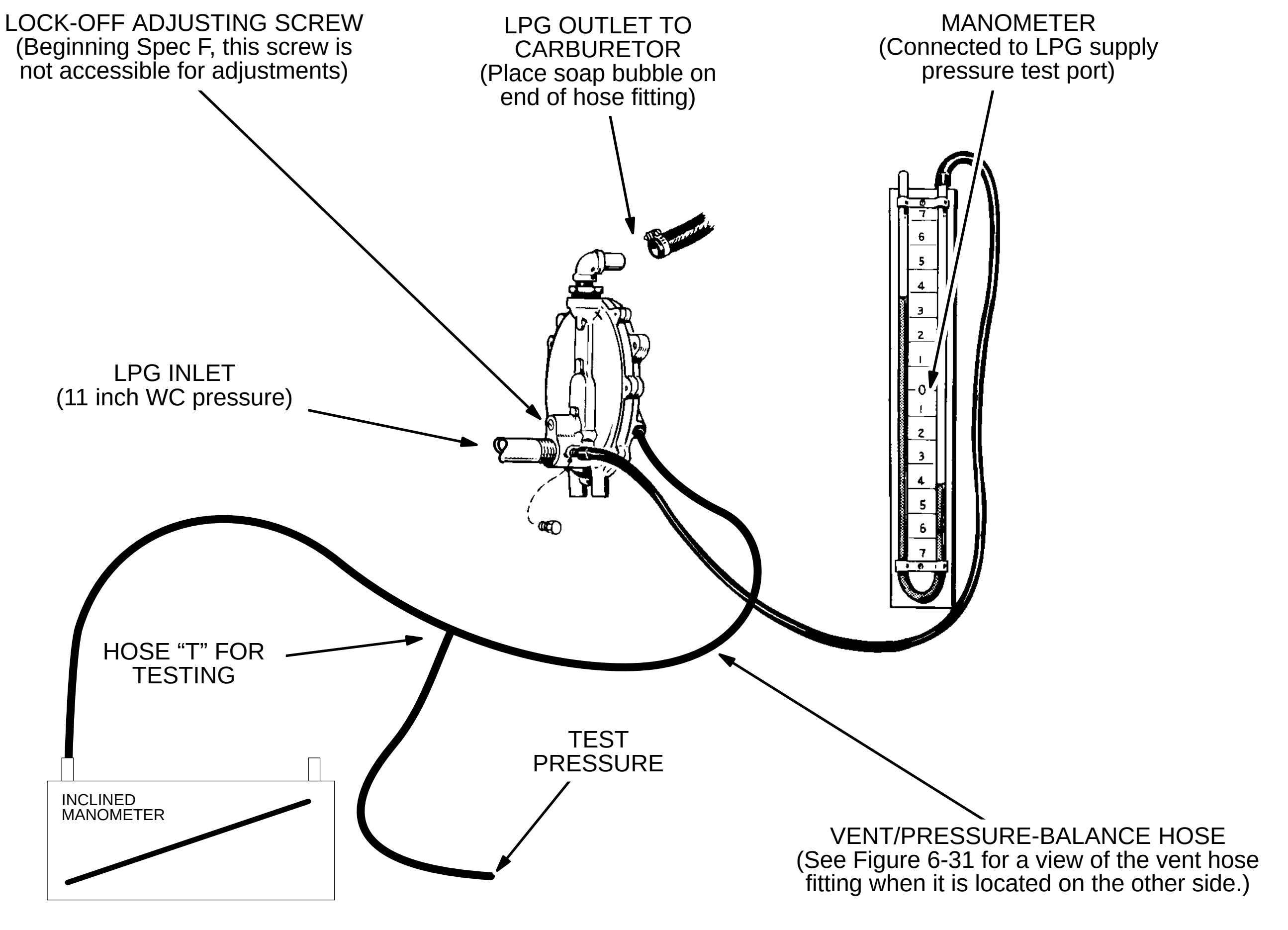


FIGURE 6-32. LPG SUPPLY PRESSURE AND REGULATOR LOCK-OFF PRESSURE

ELECTRIC STARTER

Starter Removal and Replacement

To remove the starter for service or replacement:

1. Disconnect the negative (-) cable from the starting battery.
2. Disconnect the cable at the motor terminal.
3. Remove the two starter mounting bolts and remove the starter.

Replacement is the reverse of removal. Torque the mounting bolts to specifications.

Starter Disassembly

Motor Disassembly: See Figure 6-33. Remove the starter from the genset. The drive housing, motor frame and end bell are separable after the motor through bolts have been removed. Before loosening the through bolts, however, scratch register lines on the drive housing, motor frame and end bell so that these parts can be easily reassembled the same way relative to each other. While removing the end bell, be prepared to catch the brush springs, which tend to spring loose.

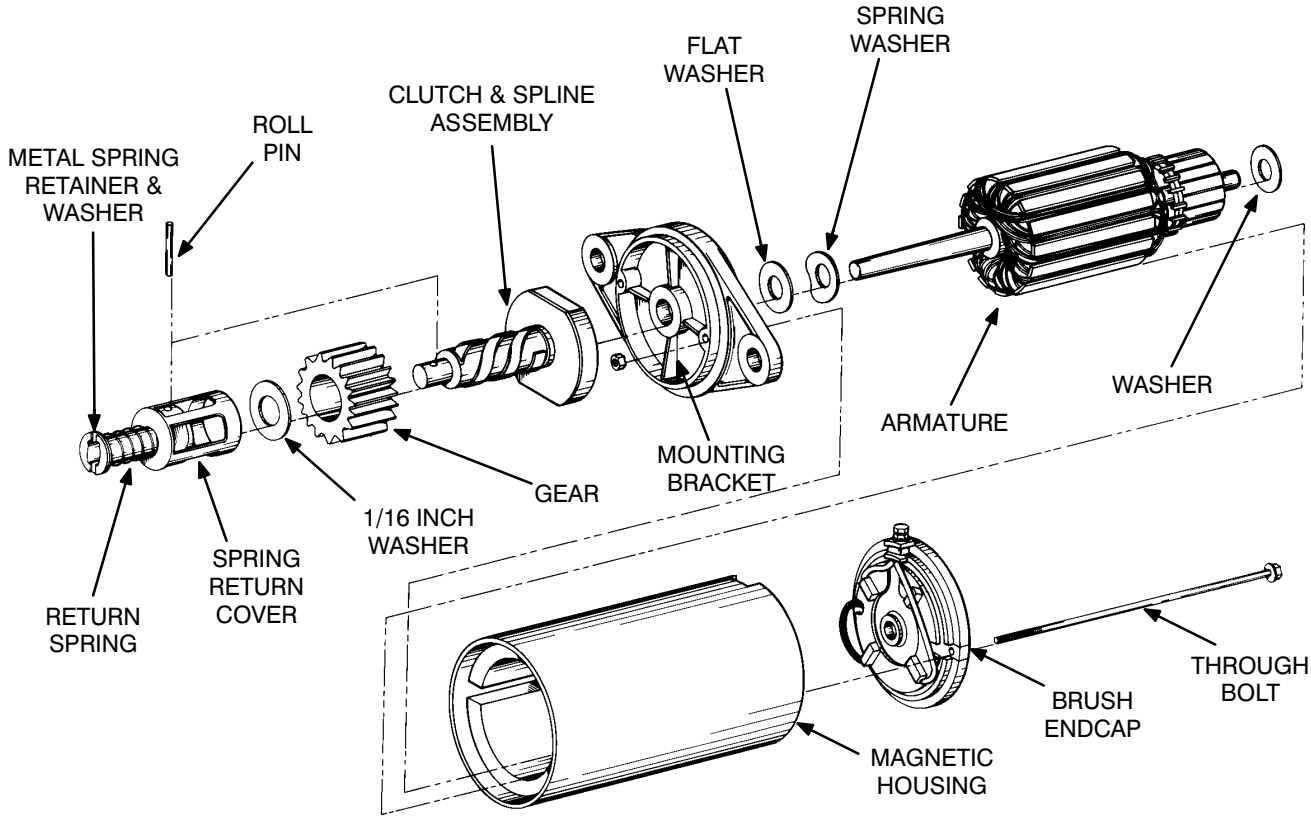


FIGURE 6-33. STARTER ASSEMBLY

Removing the Roll Pin: Remove the return spring, gear and clutch assembly if necessary by driving out the roll pin. Use a 1/8 to 5/32 inch nail set (Figure 6-34). Always use a new roll pin when reassembling the drive assembly.

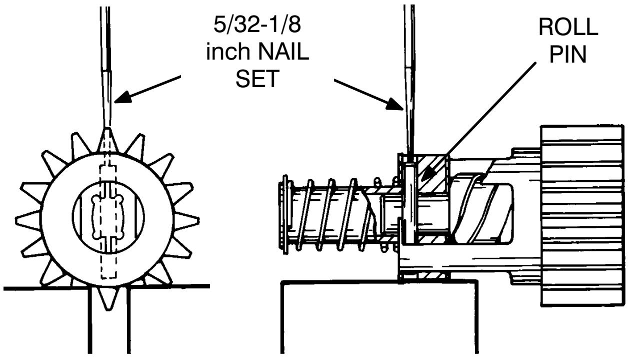


FIGURE 6-34. REMOVING ROLL PIN

Testing and Inspecting the Starter

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 (Figure 6-35). A low resistance reading indicates a grounded armature. Replace a grounded armature with a new one.

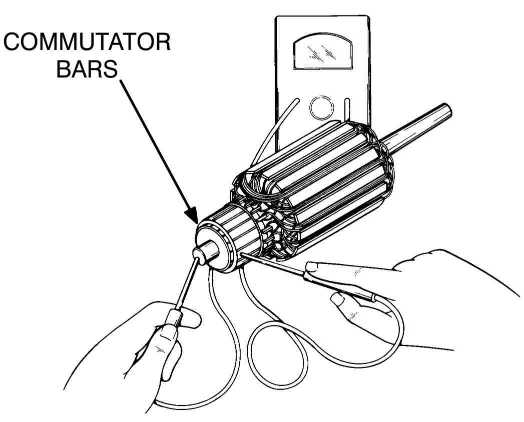


FIGURE 6-35. TESTING ARMATURE FOR GROUNDS

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

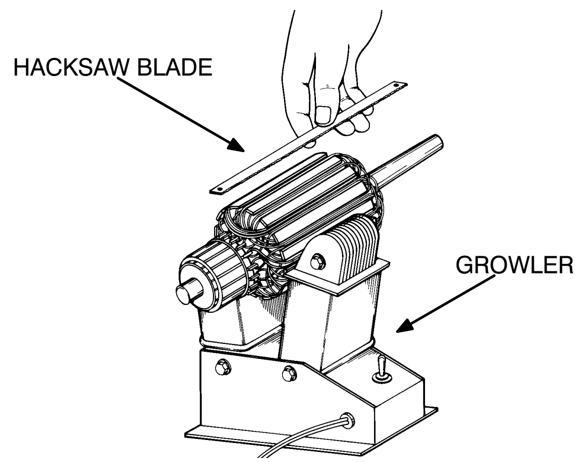


FIGURE 6-36. TESTING ARMATURE FOR SHORTS

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

Brush Inspection: Measure brushes (Figure 6-37) and replace them if worn to less than 0.425 inch (11 mm).

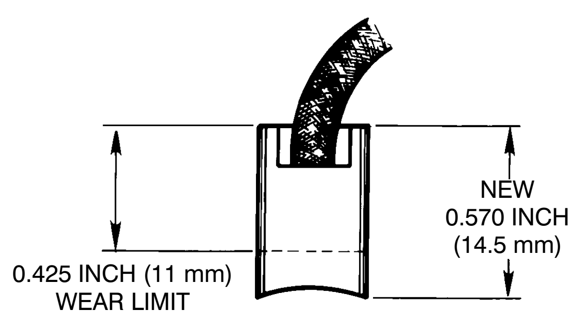


FIGURE 6-37. BRUSH INSPECTION

Starter Assembly

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

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

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

2. Mount the brush springs on tabs as shown in Figure 6-39. Using a small screwdriver, turn the spring counterclockwise to torque it, so the contact loop is inside the brush holder. The spring should be pushed down to the mounting tab shoulder.
3. Push the negative brush terminals over the through-bolt holes on the brush endcap.
4. Insert a positive brush stud into the hole, and torque to 25-30 in-lb (2.83-3.39 N-m).
5. Insert a small screwdriver into the brush spring contact loop to bend the spring back so that each brush can be inserted into the holder. Be sure that all brush wires are facing up.
6. If the brushes are at least 0.430 inch (10.9 mm) long, rest the brush springs against the sides of the brushes to keep them clear during armature installation. See Figure 6-38.
7. Place a washer on the commutator end of the shaft, and put the armature into the brush endcap. Push the four brushes toward the commutator, making sure that the springs are correctly positioned on the brushes. Recheck to be certain that the spring is pushed all the way down on the mounting tab.
8. Make sure that all brush wires are clear of the commutator, and that uninsulated portions of insulated wires do not touch the inside of the housing, or adjacent brush boxes.
9. Place the magnetic housing over the armature. Hold down the armature and the end cap using a nut driver pressed over the end of the shaft.
10. Place a spring washer and a flat washer on the shaft, as shown in Figure 6-33.

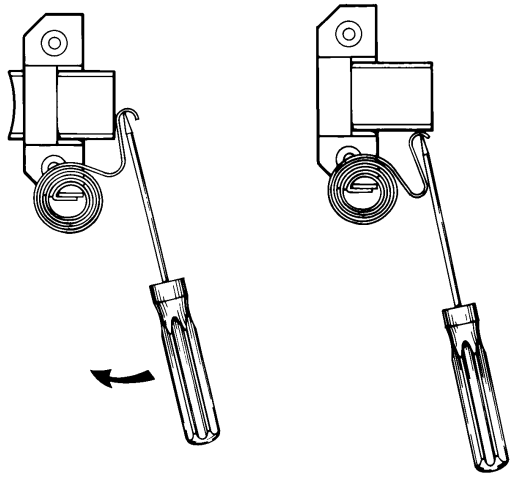


FIGURE 6-38. RESTING BRUSH SPRING ON SIDE OF BRUSH

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

12. Insert the through-bolts, and torque to 35-45 lbs-in (3.96-5.09 N-m).

13. Wipe dust from the helix and gear, and apply a light coat of GE Versilube 322-L to the outside diameter of the helix, the inside diameter of the gear and the unchamfered end of the gear. Place the clutch and helix assemblies on the motor shaft, with flats engaged in the clutch hole.

14. If the return spring is unassembled, do the following:

    A. Place a 1-1/16 inch O.D. washer over the end of the shaft.

    B. With the chamfered side of the shaft hole facing up, place a plastic retainer on the shaft and line up the hole with a hole in the shaft.

    C. Support the plastic retainer with a vise or other solid surface. Using a 5/32 or 1/8 inch nail set and hammer, drive in a new roll pin. The pin should be driven about 1/10th of an inch (2.5 mm) from the edge of the plastic retainer, or in such a way that it is evenly spaced from each side.

    D. Place the spring cover over the top of the plastic retainer, then place the return spring on top of the retainer.

    E. With a washer placed over the point of the plastic retainer, push the metal retainer into the hole of the plastic retainer as far as it will go.

15. Mount the starter on the generator stator housing using capscrews, lockwashers and nuts. Tighten the mounting screws to 30-33 lbs-ft (41-45 N-m).

16. Reconnect the starter cable and battery.

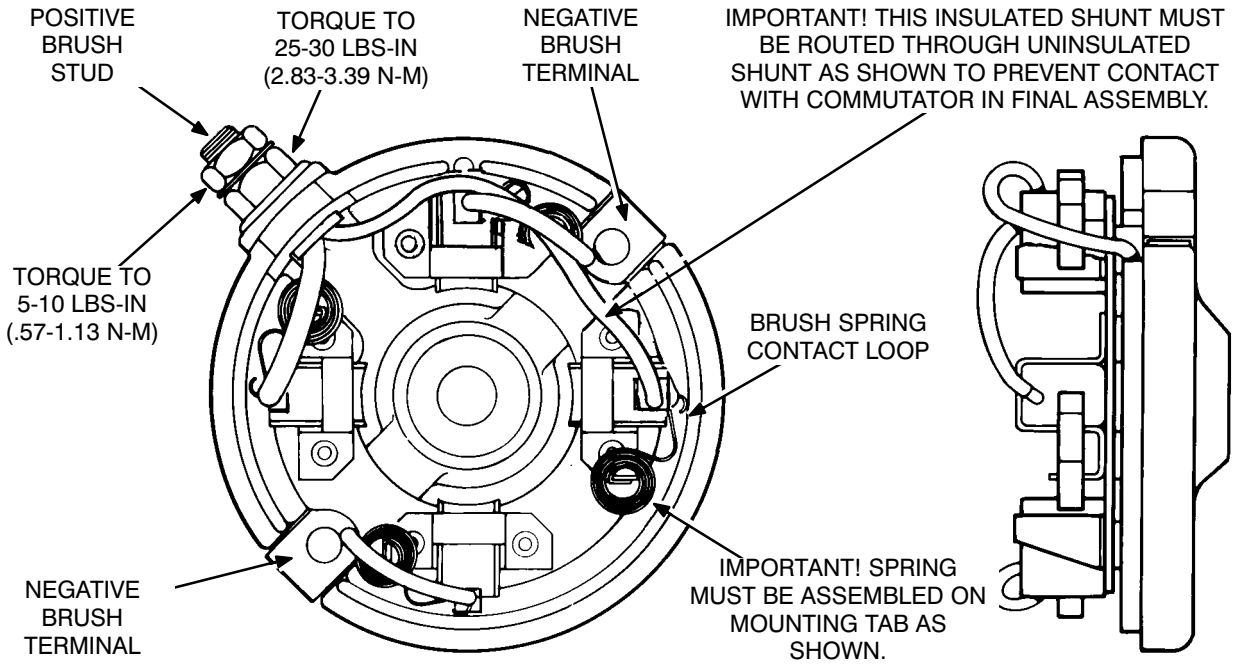


FIGURE 6-39. BRUSH END CAP

Section 7. Control System

INTRODUCTION

The control system governs the following functions:

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

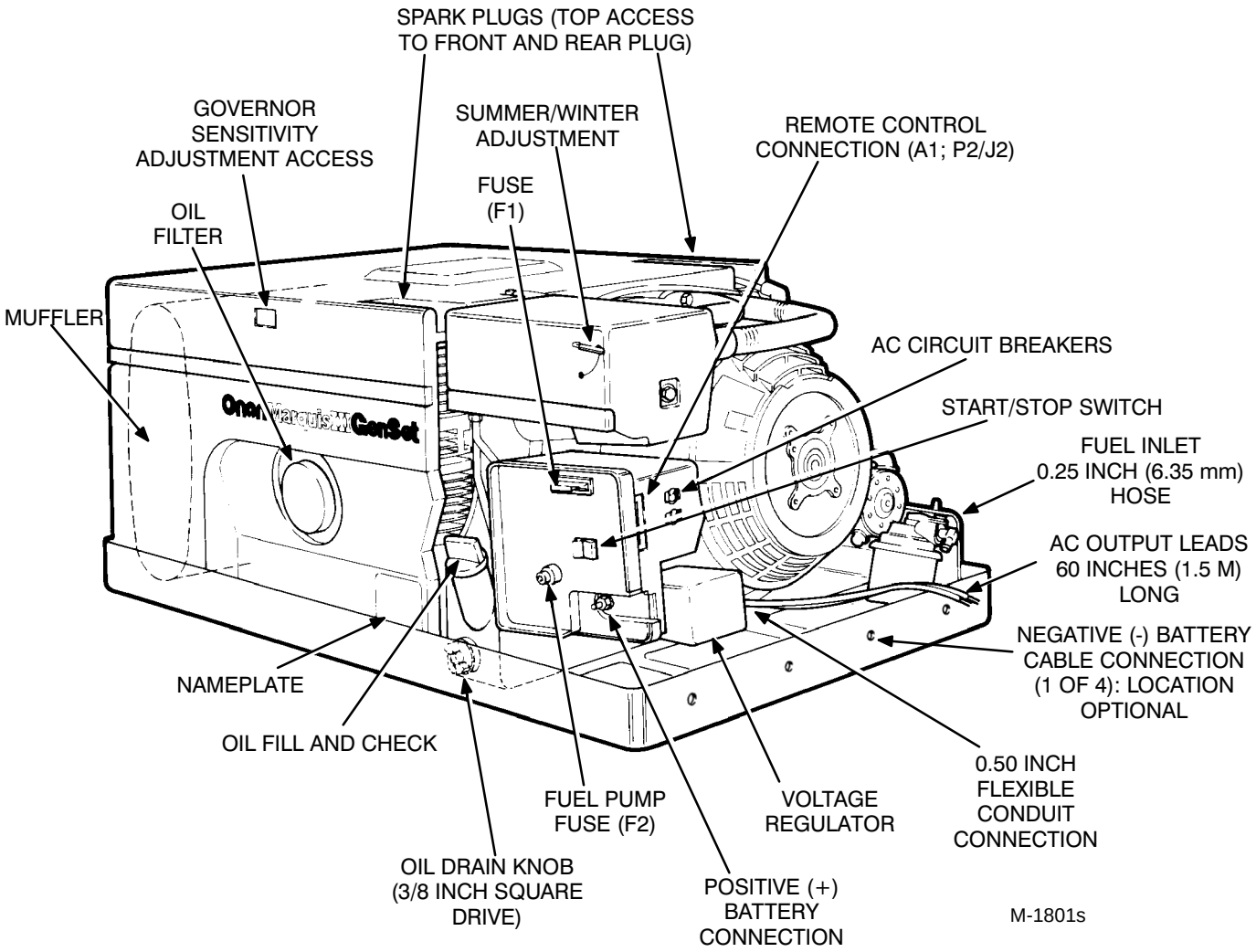


FIGURE 7-1. BGM/NHM GENERATOR SET (MECHANICAL-GOVERNOR VERSION)

CONTROL DESCRIPTION (Mechanical governor gensets)

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

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

Control Panel Assembly

The control panel assembly consists of:

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

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

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

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

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

Start Solenoid (K1)

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

Stop Latch Relay (K5)

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

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

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

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

Remote Start Control

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

Circuit Breakers (CB1 and CB2)

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

Voltage Regulator (VR1)

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

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

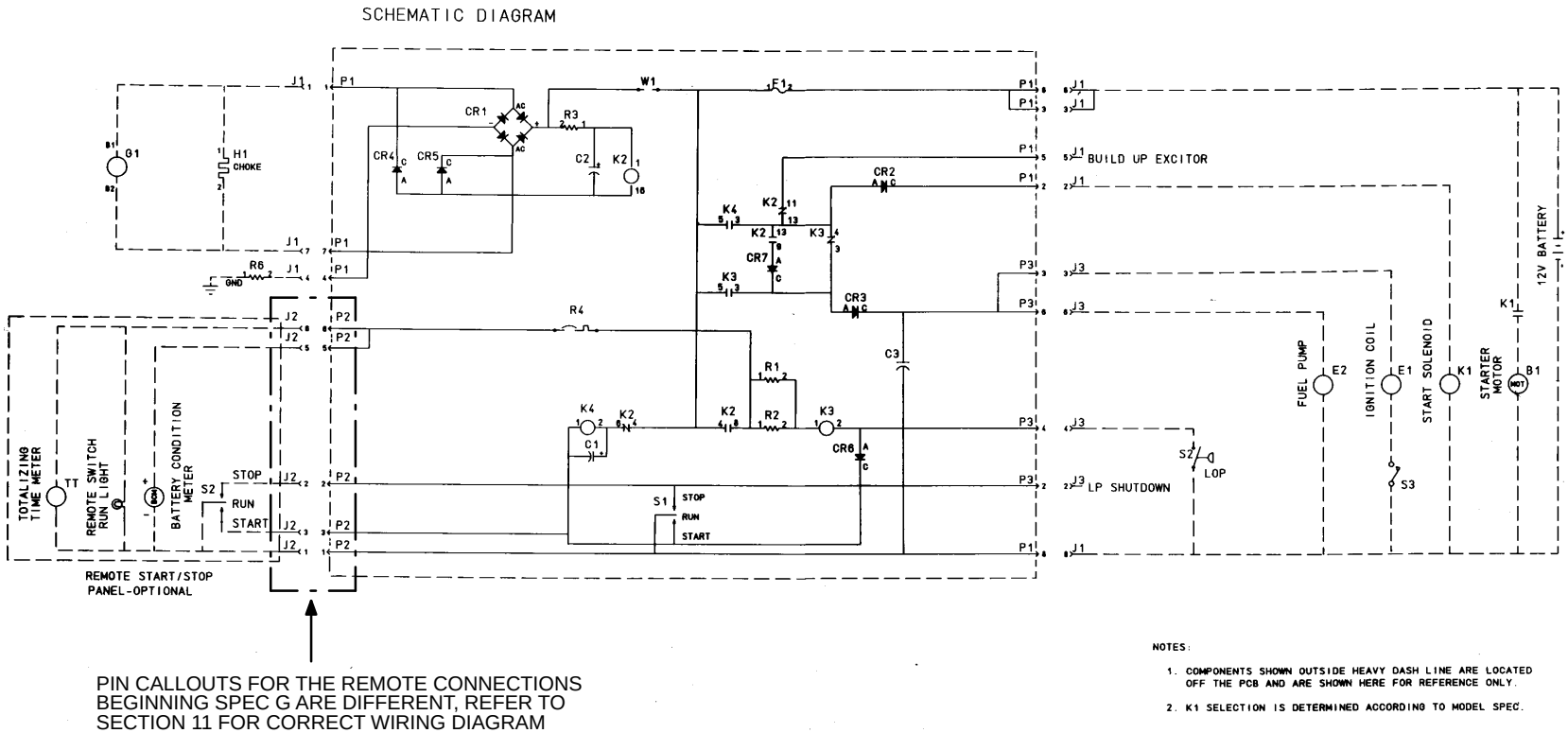
Terminal Board (TB1)

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

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

CONTROL OPERATION

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



PIN CALLOUTS FOR THE REMOTE CONNECTIONS BEGINNING SPEC G ARE DIFFERENT, REFER TO SECTION 11 FOR CORRECT WIRING DIAGRAM

NOTES:

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

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

Starting

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

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

Connecting B+ produces the following control responses:

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

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

Starter Lockout-Run

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

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

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

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

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

Stopping

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

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

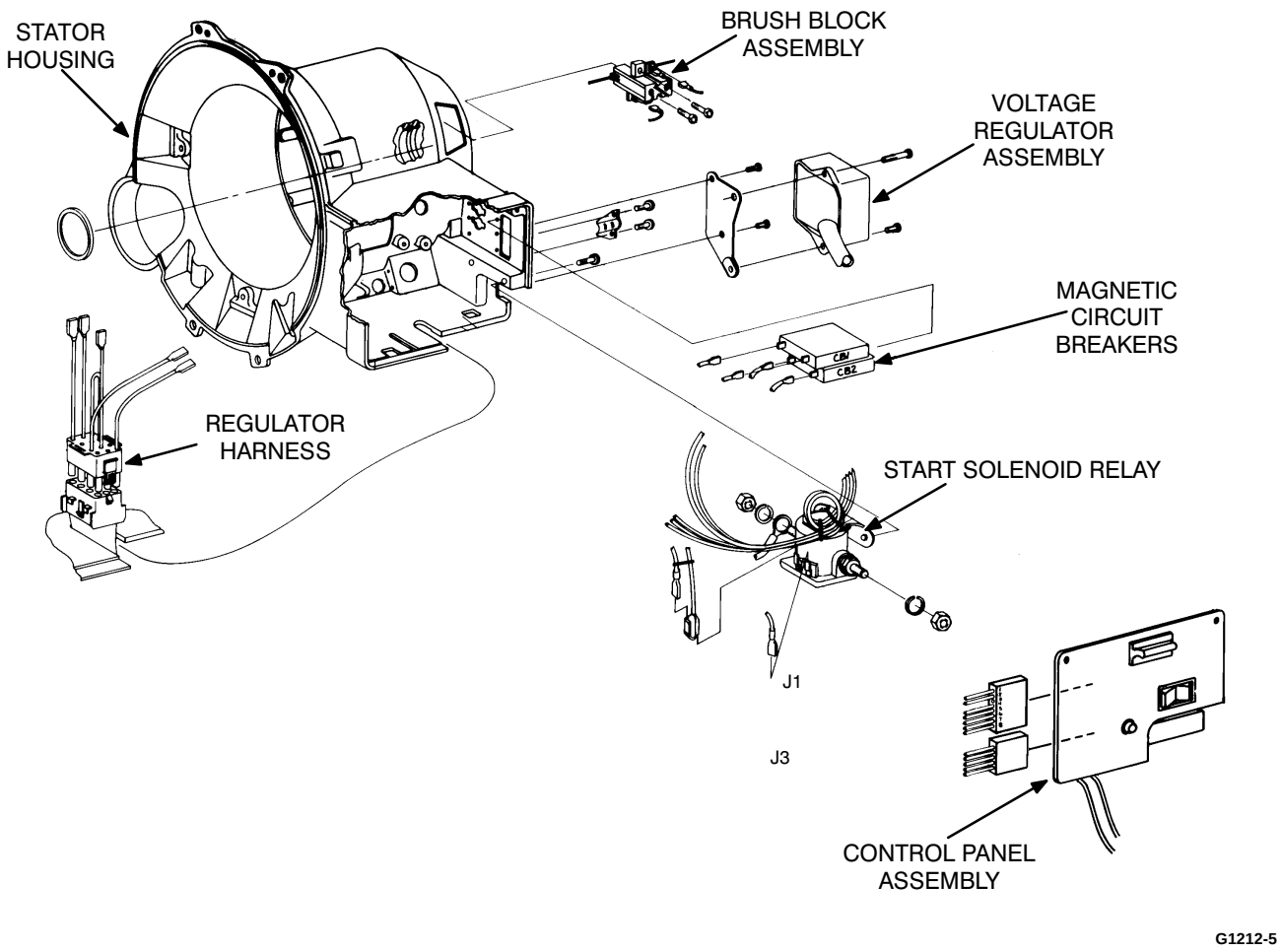


FIGURE 7-3. BGM/NHM CONTROL COMPONENTS (MECHANICAL-GOVERNOR GENSETS ONLY)

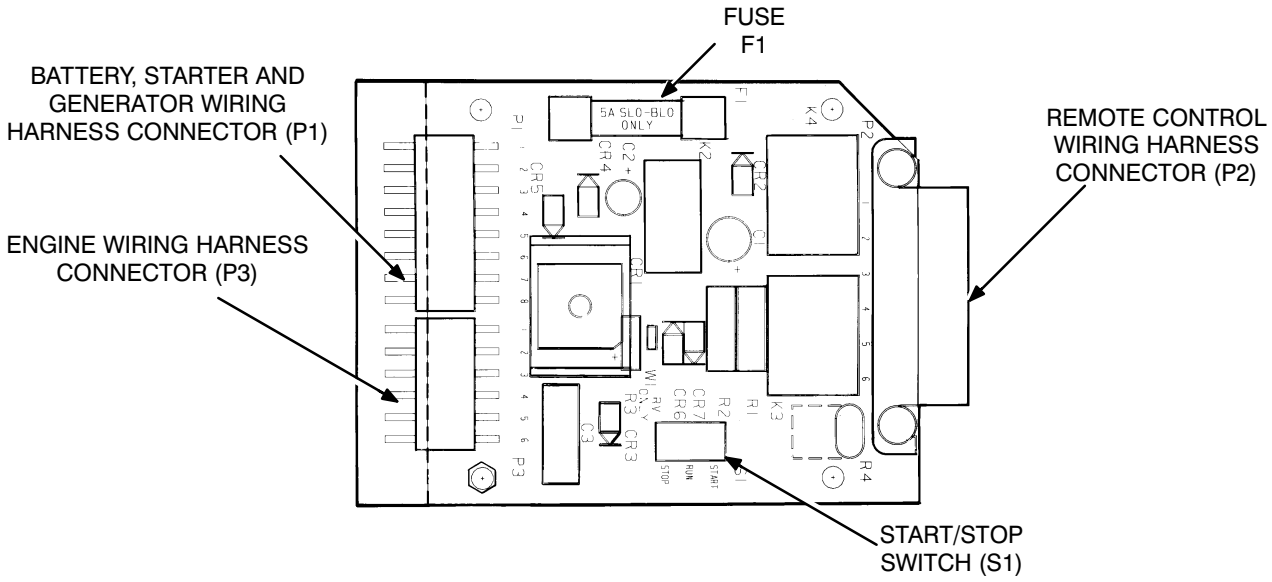


FIGURE 7-4. BGM/NHM CONTROL PCB ASSEMBLY (A1)
(MECHANICAL-GOVERNOR GENSET ONLY)

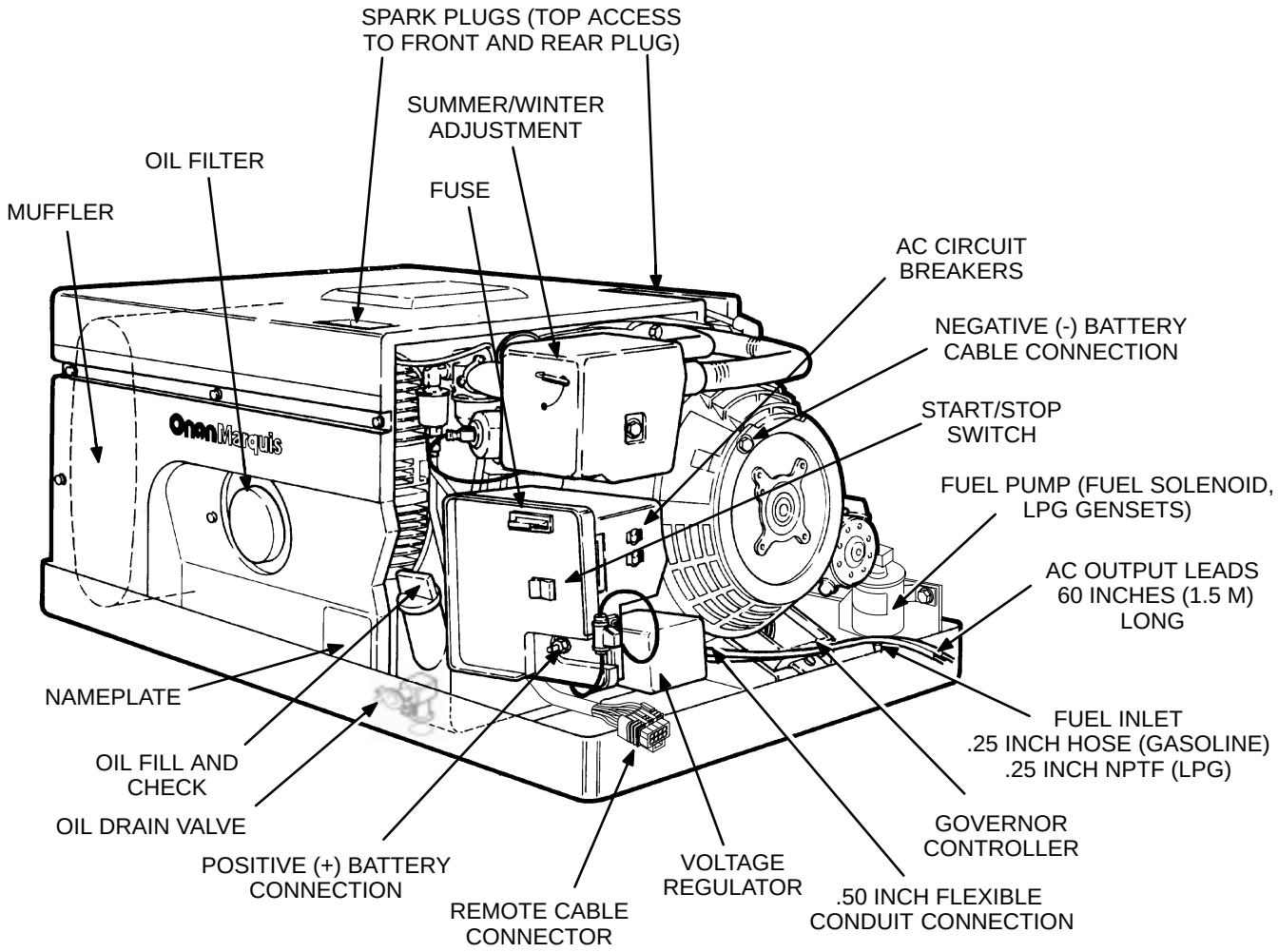


FIGURE 7-5. BGM/NHM GENERATOR SET (ELECTRONIC-GOVERNOR VERSION) (SPEC G GENSET SHOWN)

CONTROL DESCRIPTION (Electronic governor gensets)

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

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

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

Control Panel Assembly

The control panel assembly consists of:

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

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

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

The printed circuit board is not repairable.

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

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

Start Solenoid (K1)

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

Fuel Pump (E3)

Fuel pump E3 is energized at the same time that start solenoid K1 is energized. (Spec D gensets: E3 is activated through K4 contacts.) See *Appendix B. Wiring Diagrams.*

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

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

Circuit Breakers (CB1 and CB2)

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

Voltage Regulator (VR1)

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

Terminal Board (TB1)

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

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

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

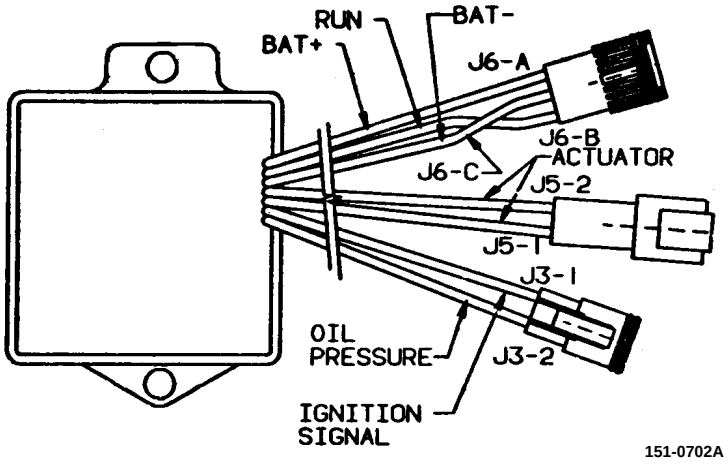


FIGURE 7-6. GOVERNOR CONTROLLER BOARD A4

Governor Controller Board (A4)

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

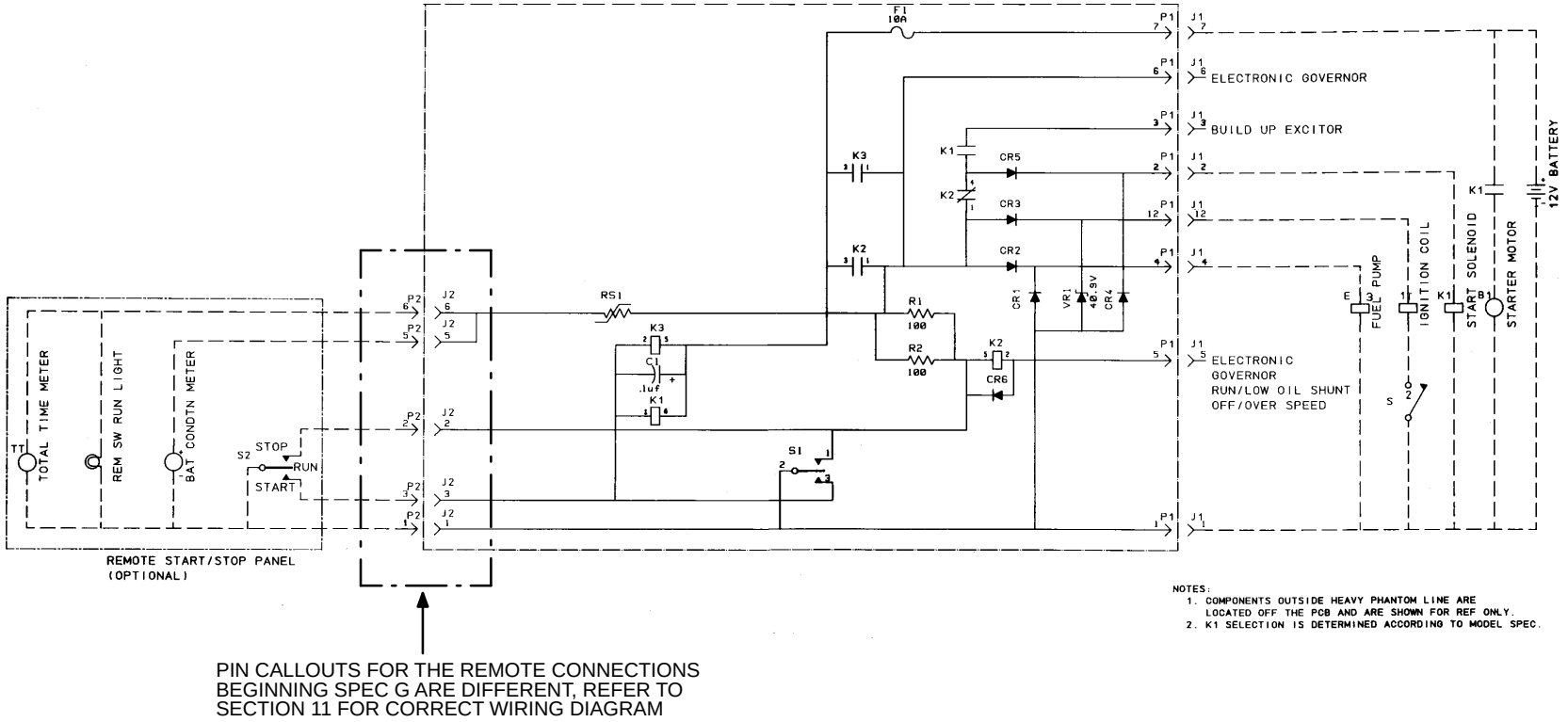
Governor controller board A4 outputs a DC voltage that drives the governor actuator, which in turn moves the carburetor throttle to maintain an engine speed of 1800 RPM. The inputs from the ignition module and the oil pressure sensor can signal the governor controller board to shut the engine off under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

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

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

CONTROL OPERATION

The schematic diagram shown in Figure 7-7 is intended as an illustration of the circuit description. Also see *Appendix B. Wiring Diagrams.*



PIN CALLOUTS FOR THE REMOTE CONNECTIONS BEGINNING SPEC G ARE DIFFERENT, REFER TO SECTION 11 FOR CORRECT WIRING DIAGRAM

FIGURE 7-7. BGM/NHM CONTROL SCHEMATIC (ELECTRONIC GOVERNOR SETS) (PRIOR TO SPEC G)

Starting

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

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

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

- Voltage regulator VR1 (to build-up exciter)

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

The following control responses take place:

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

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

Starter Lockout-Run

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

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

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

Stopping

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

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

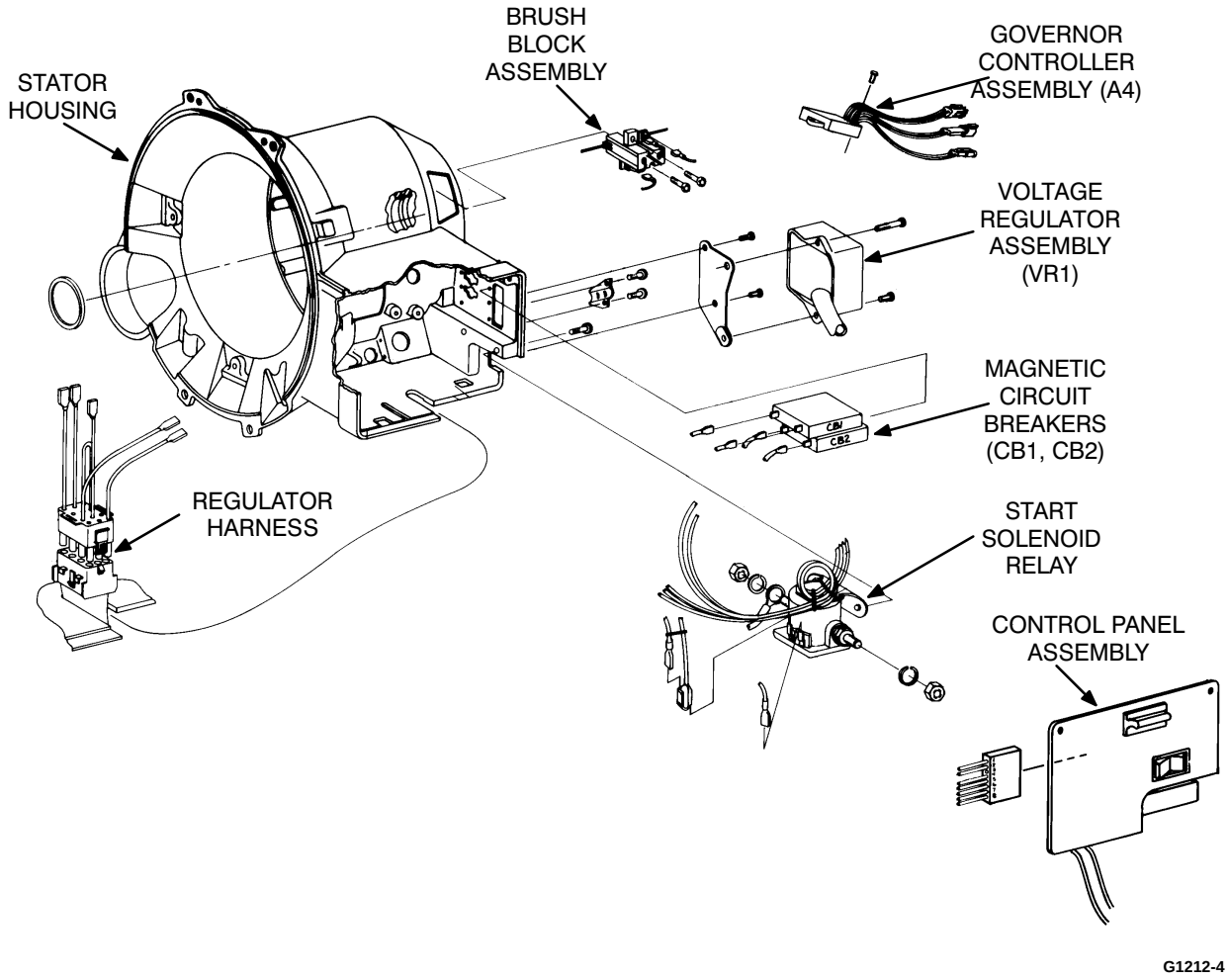
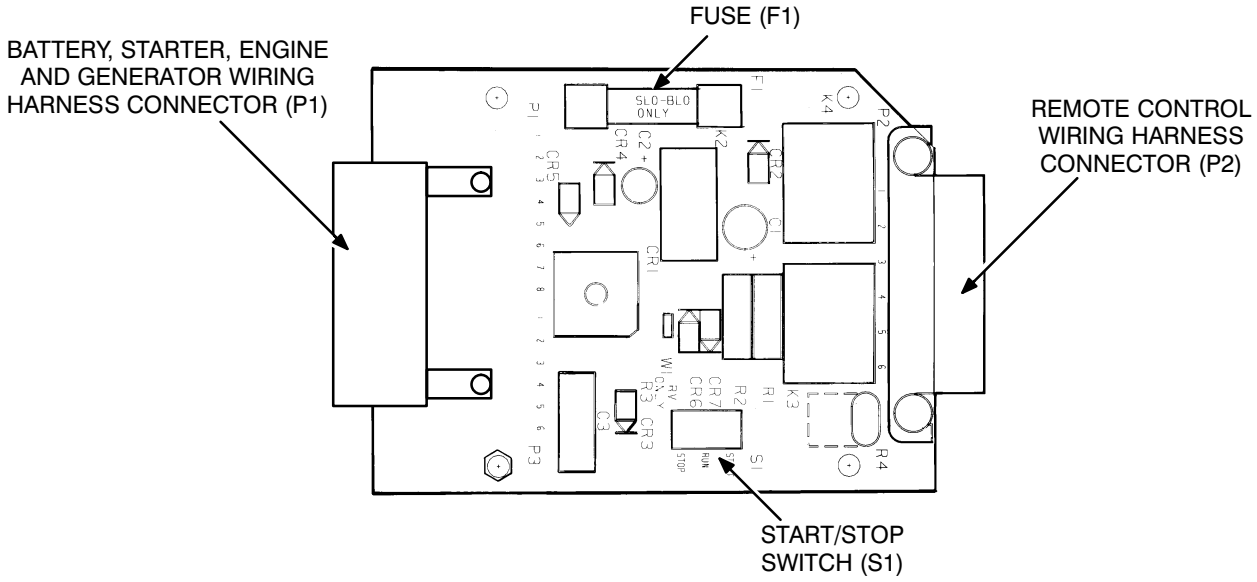
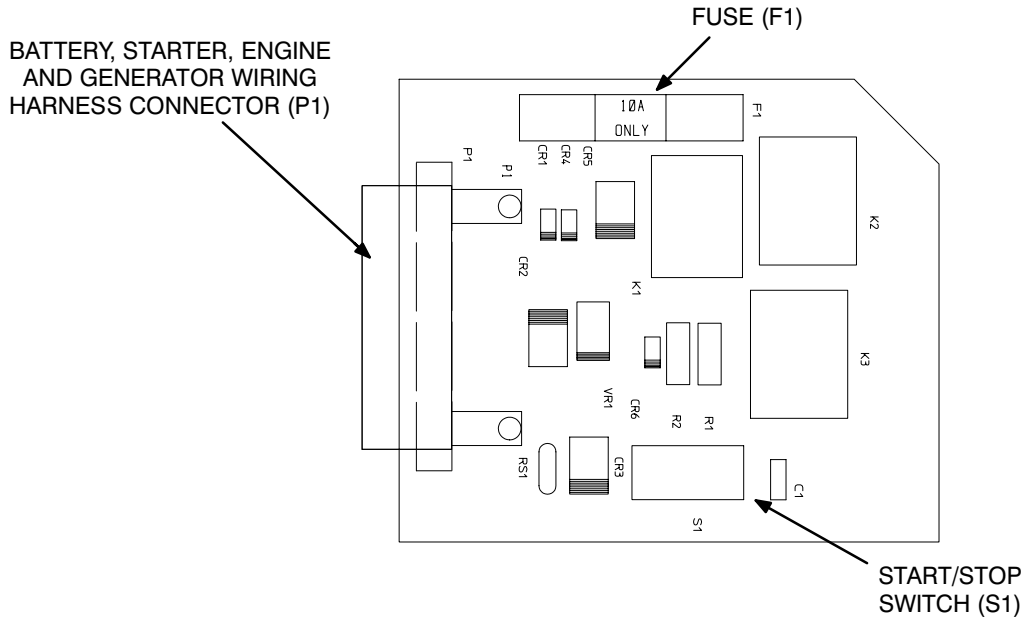


FIGURE 7-8. BGM/NHM CONTROL COMPONENTS (ELECTRONIC-GOVERNOR GENSETS ONLY)



(PRIOR TO SPEC G)



(BEGINNING SPEC G)

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

CONTROL TROUBLESHOOTING

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

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

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

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

Trouble	Possible Cause	Corrective Action
Engine Does Not Crank	1. Control fuse F1 is blown.	1. Replace fuse F1 (see *Section 2. General Specifications*). If it blows again, look for a loose or pinched wire inside and outside control box. If wiring is good, see *Appendix B. Wiring Diagrams* and disconnect all DC loads from the control board. Reconnect one at a time. Press the Start Switch after each connection. Replace the component that causes the fuse to blow. Recommended order: fuel solenoid or pump (E3, E4), ignition coil (T1) ignition capacitor (C4), start solenoid coil (K1) relay (K4, K5 and K6, depending on Spec) Replace control board A1 if fuse still blows.
	2. If engine cranks at set but not at remote control panel, fault is due to: a. PC board P2/J2 connection not secure. b. Open circuit in remote control. c. Remote start switch faulty.	2a. Ensure that wiring harness jack connections are fully seated to PC board. 2b. Check for continuity and correct if circuit is open. 2c. Replace remote start control switch.
	3. If engine cranks at remote control panel but not at set, fault is due to faulty S1 switch.	3. Replace PC board A1.
	4. Insufficient voltage for cranking due to: (See Low Battery Voltage also.) a. Battery not charged. b. Terminal connections loose or dirty.	4a. Check condition of battery and recharge or replace. 4b. Clean and tighten all connections at battery, K1 start solenoid, and starter motor.

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

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

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

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

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

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

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

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

TESTING CONTROL BOARD A1

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

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

Section 8. Generator

GENERATOR/CONTROL COMPONENT DESCRIPTIONS

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

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

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

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

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

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

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

Brushes

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

Rotor

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

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

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

Stator and Housing

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

- Leads T1, T2, T3 and T4 to terminal board TB1.
- (Mechanical-governor sets) Leads B1 and B2 to control board A1, to rectifier CR10, to the electric choke, and for battery charging, where applicable.
- (Electronic-governor sets) Leads B1 and B2 to rectifier CR10, to the electric choke, and for battery charging through R1.
- Leads Q1 and Q2 to voltage regulator VR1, wiring harness J4, for excitation of rotor. (AC voltage from stator is rectified to DC voltage in VR1).

The stator mounts inside the generator housing and is held in position with clamps and capscrews. A series of air intake openings in the end of the housing allow cool air to be drawn inside the housing for generator cooling. The housing also provides a mounting for the engine starter, rear rotor bearing, exciter brush block, control components, and fuel pump. The complete stator and housing assembly bolts to the engine-to-generator adapter.

Terminal Board (TB1)

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

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

Voltage Regulator (VR1)

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

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

Circuit Breakers (CB1,CB2)

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

Wiring Harness to Load

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

GENERATOR OPERATION

Refer to *Appendix B. Wiring Diagrams* while reviewing this text. Always refer to the wiring diagram/ schematic that corresponds to the specific genset when troubleshooting problems.

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

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

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

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

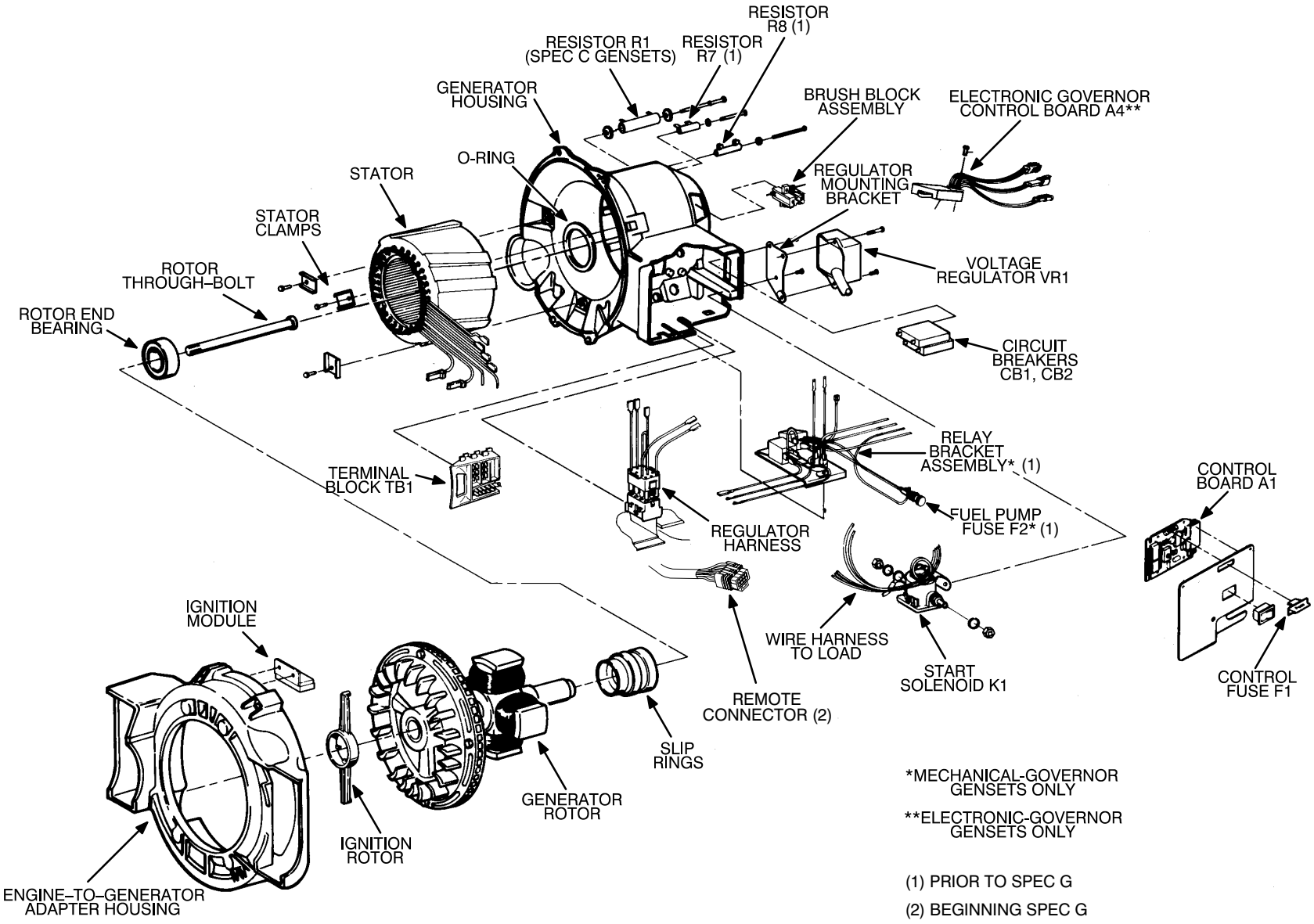


FIGURE 8-1. GENERATOR CONTROL COMPONENTS

GENERATOR TROUBLESHOOTING

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

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

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

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

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

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

Trouble	Possible Cause	Corrective Action
Generator Overheats	1. Generator overloaded due to defective circuit breaker.	1. Remove part of load and replace circuit breaker.
	2. Airflow restricted due to dirt or debris covering vent openings in stator housing.	2. Clear away all dirt or debris as required.
	3. Stator windings covered with oil or dirt.	3. Clean stator windings.
	4. Open, grounded, or short circuit in rotor or stator.	4. Test each component for open, grounded, or shorted windings and replace if defective.
	5. Defective voltage regulator.	5. Replace voltage regulator.

GENERATOR SERVICE

This section describes generator disassembly/assembly procedures. Refer to Figure 8-1 to locate and identify the various generator components and *Appendix B. Wiring Diagrams.*

Generator Disassembly Procedure

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

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

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

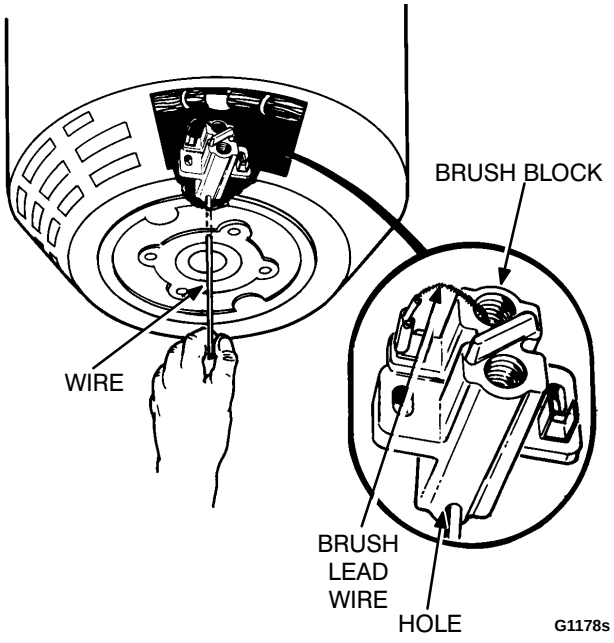


FIGURE 8-2. BRUSH BLOCK ASSEMBLY

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

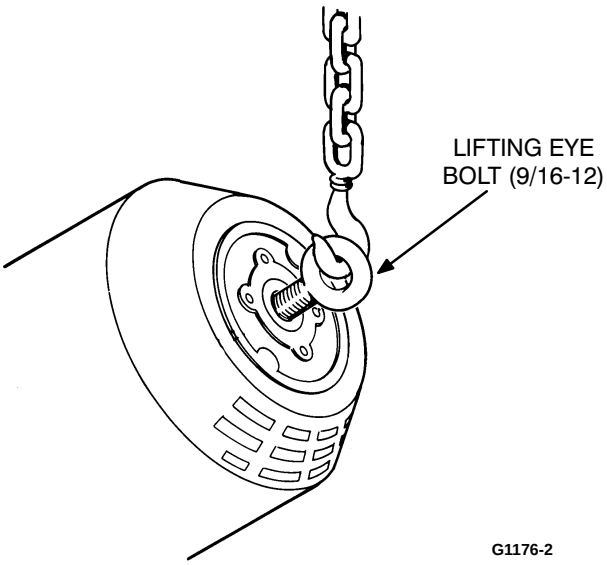


FIGURE 8-3. GENERATOR LIFT

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

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

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

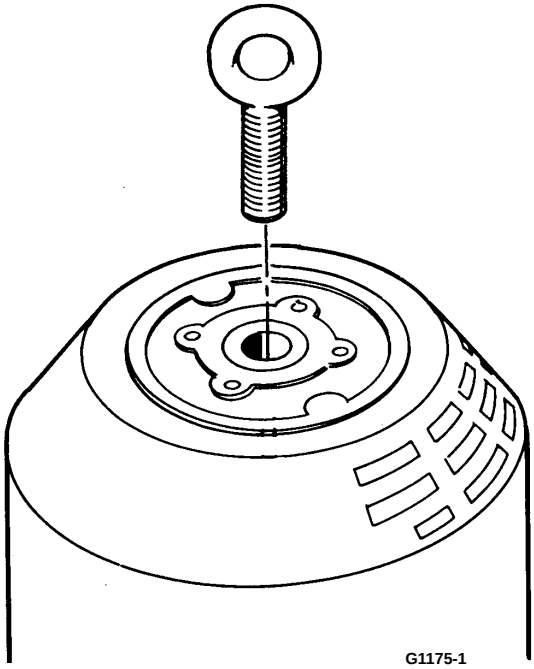


FIGURE 8-4. REMOVAL OF LIFTING EYE BOLT

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

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

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

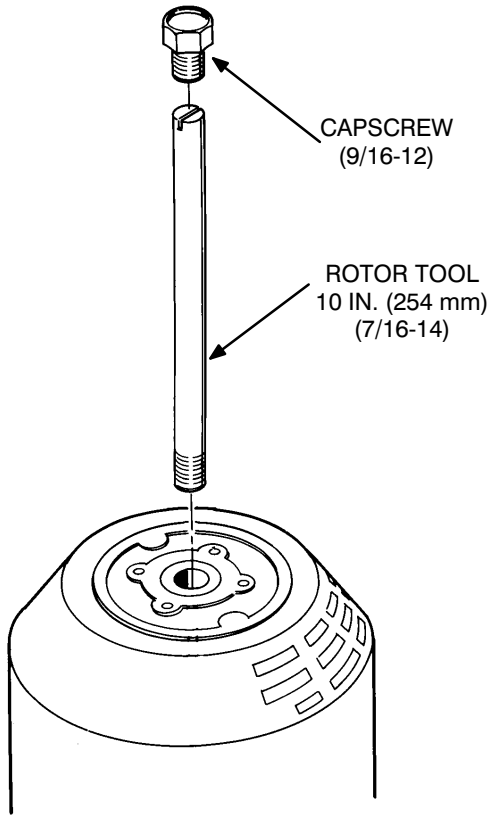


FIGURE 8-5. ROTOR TOOL

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

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

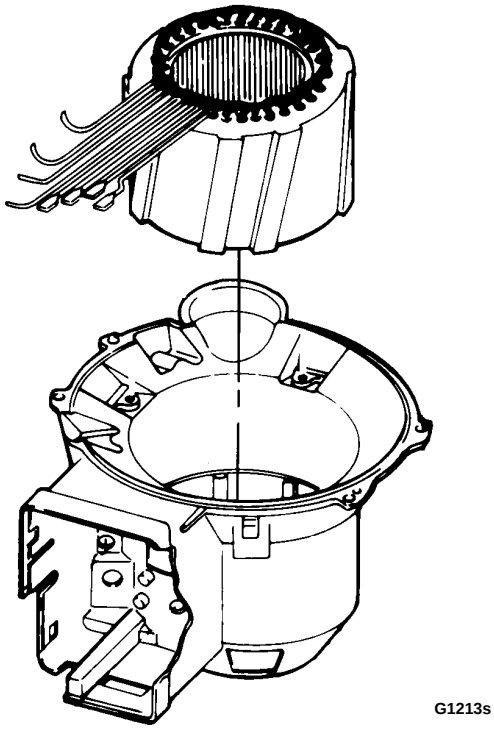
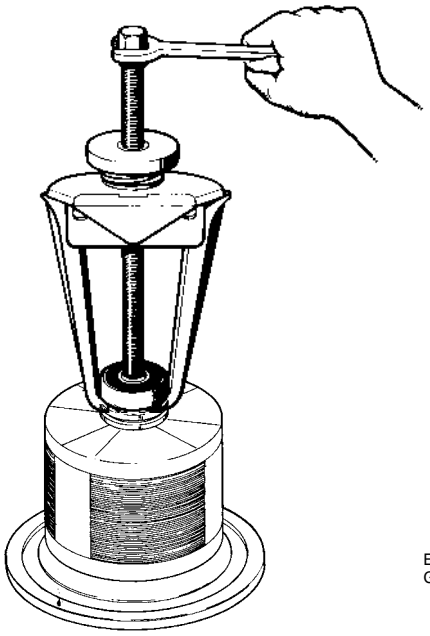


FIGURE 8-6. STATOR/HOUSING DISASSEMBLY

Rotor Bearing Removal

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

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



ES-1495/
G-1175

FIGURE 8-7. ROTOR BEARING REMOVAL

Rotor Bearing Replacement

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

Ignition Components

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

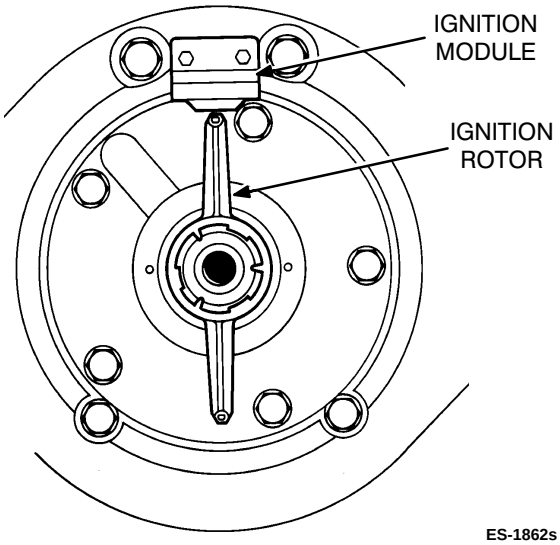
Ignition Rotor Removal/Replacement

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

Ignition Module Removal/Replacement

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

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



ES-1862s

FIGURE 8-8. IGNITION COMPONENTS

Generator Assembly Procedure

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

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

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

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

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

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

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

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

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

BRUSHES AND SLIP RINGS

Brush Inspection

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

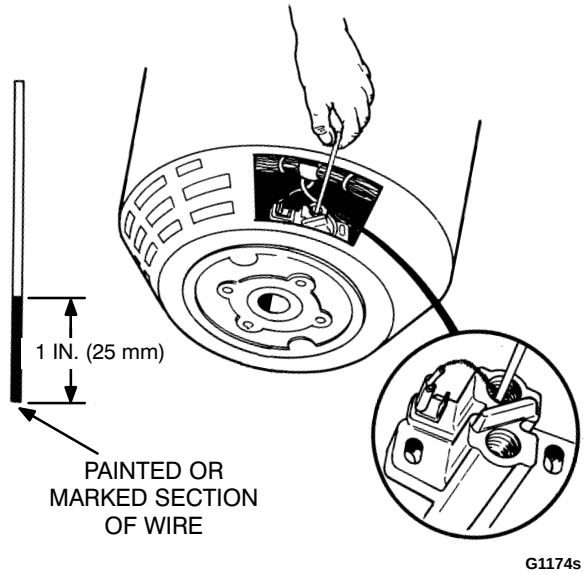


FIGURE 8-9. CHECKING BRUSH WEAR

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

Brush Replacement Procedure

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

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

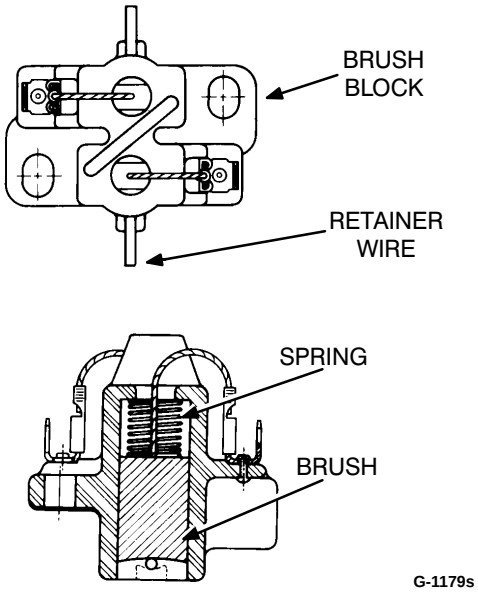


FIGURE 8-10. BRUSH REPLACEMENT

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

Slip Ring Inspection and Maintenance

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

Slip Ring Service Procedure

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

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

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

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

GENERATOR TESTING

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

Field Voltage Test

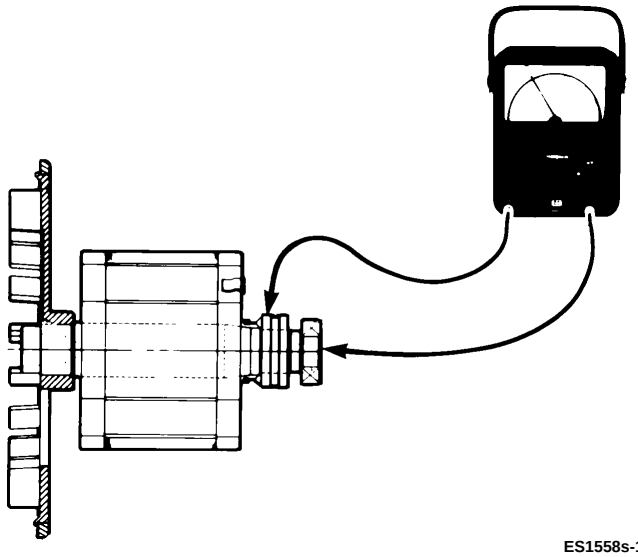
To check the field voltage, remove the brush block cover and connect a DC voltmeter to the brush block terminals. Connect the positive lead to the B+ (outboard) terminal and the negative lead to the B- (inboard) terminal.

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

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

Rotor Test

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



ES1558s-1

FIGURE 8-11. TESTING ROTOR FOR GROUNDS

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

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

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

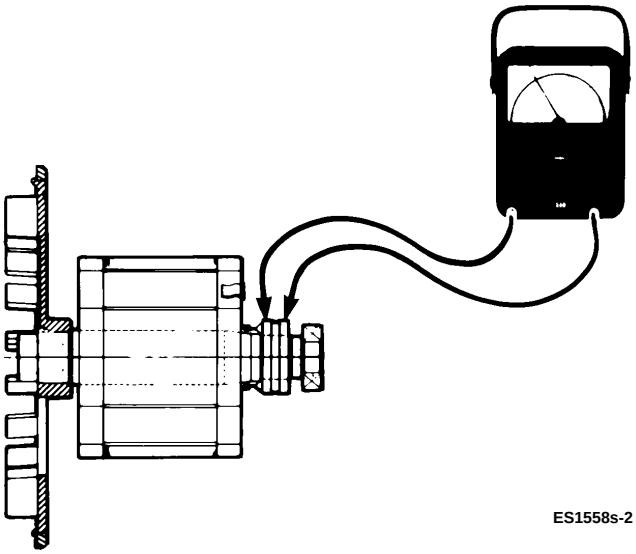


FIGURE 8-12. TESTING ROTOR FOR OPENS OR SHORTS

Stator Test

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

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

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

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

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

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

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

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

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

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

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

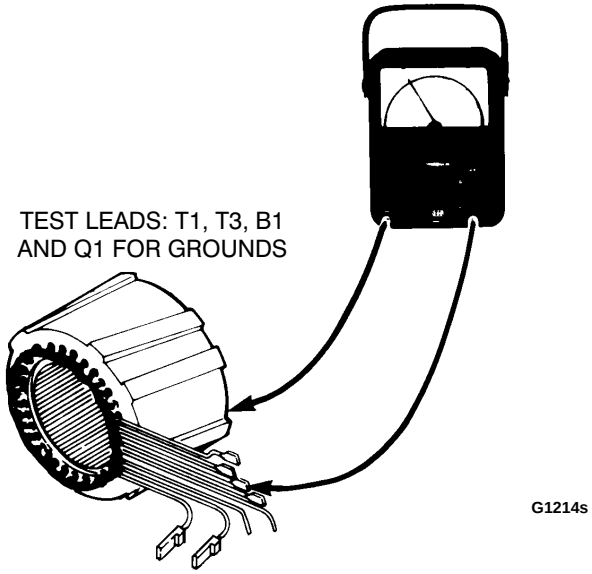


FIGURE 8-13. TESTING STATOR FOR GROUNDS

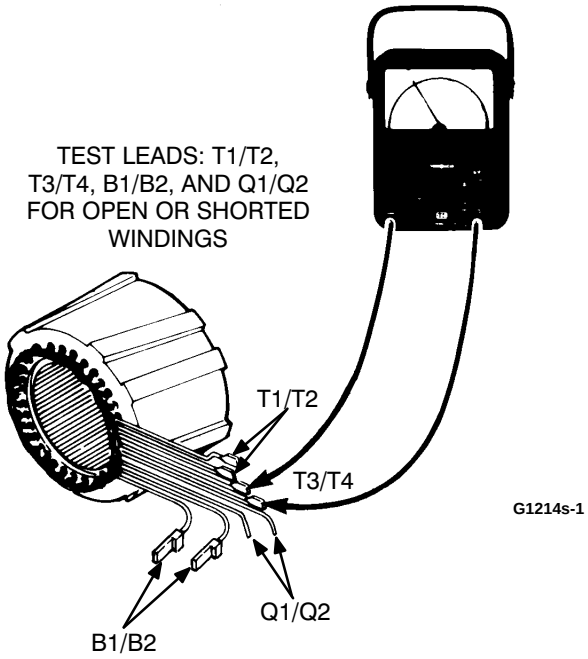


FIGURE 8-14. TESTING STATOR FOR OPENS OR SHORTS

Section 9. Engine Block Assembly

GENERAL

The engine block assembly includes:

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

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

OIL FILTER AND ADAPTER

Disassembly Procedure

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

Assembly Procedure

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

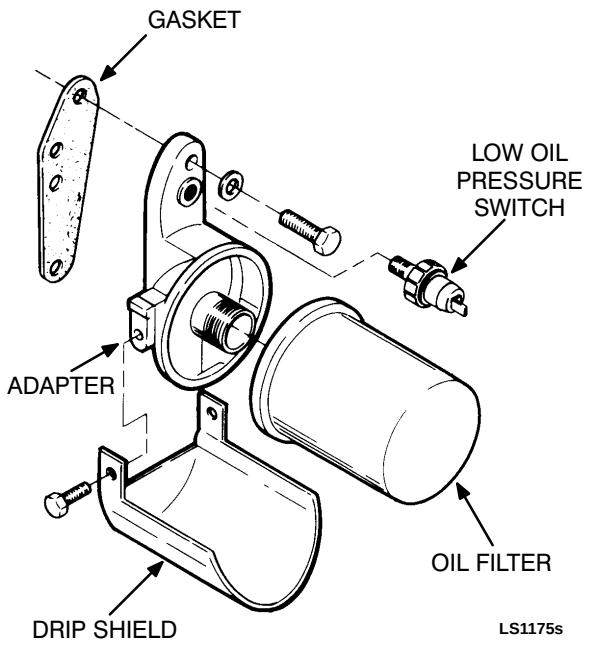


FIGURE 9-1. OIL FILTER AND ADAPTER (BGM SHOWN)

CYLINDER HEADS

Removal/Cleaning Procedure

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

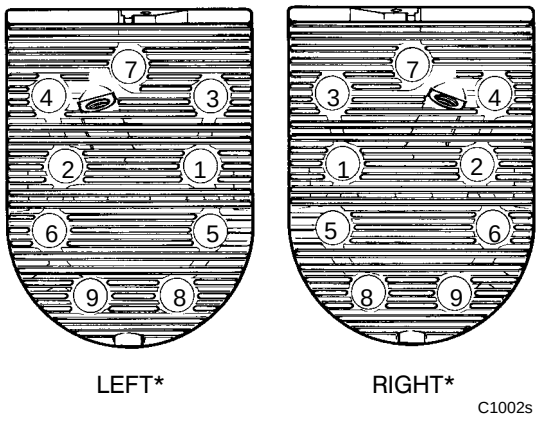
   ⚠ CAUTION ***The heads may warp if they are removed while hot. Also, contact with hot parts may cause burns to skin. Wait until the engine has cooled before removing the heads.***

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

Assembly Procedure (BGM)

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

bolts or stud nuts are tightened to the specified torque (see *Torque Specification* section).



***** AS VIEWED FROM FRONT OF ENGINE

FIGURE 9-2. BGM CYLINDER HEAD TIGHTENING SEQUENCE

Assembly Procedure (NHM)

1. Use new head gaskets, and clean both the heads and the cylinder block thoroughly where the gaskets rest.
2. Place a head gasket on the cylinder head and align the stud holes in the gasket with the stud holes in the cylinder head. While holding the gasket against the cylinder head, carefully install the cylinder head on the engine. Do not attempt to slide the gasket over the studs without the cylinder head behind it or the gasket may tear.
3. install a flat washer, two compression washers, and nut on each of the top six studs (see Figure 9-3 for correct sequence). When properly installed, only the outside edges of the compression washers will be in contact with each other. Install a flat washer and nut on each of the four bottom studs.

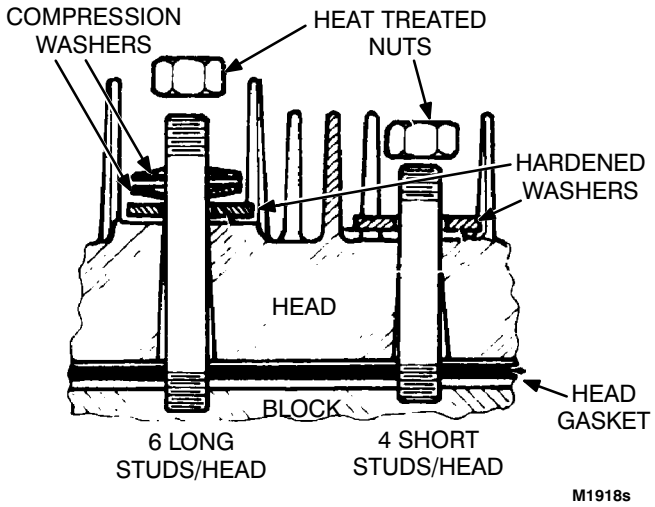


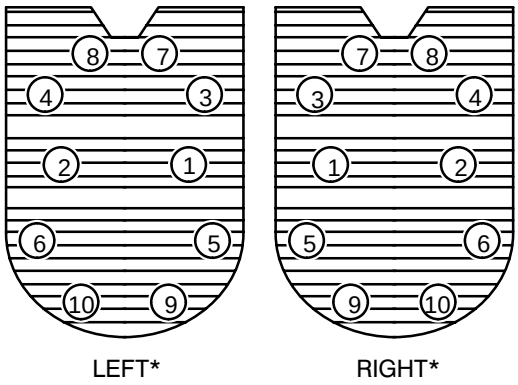
FIGURE 9-3. NHM CYLINDER HEAD WITH COMPRESSION WASHERS

4. Follow the head torque tightening sequence shown in Figure 9-4 for the NHM. Start by tightening all bolts to 5 ft-lbs (7 N•m), then 10 ft-lbs (14 N•m), etc., until all bolts or stud nuts are tightened to the specified torque (see *Torque Specification* section). Recheck all nuts for correct torque.

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

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

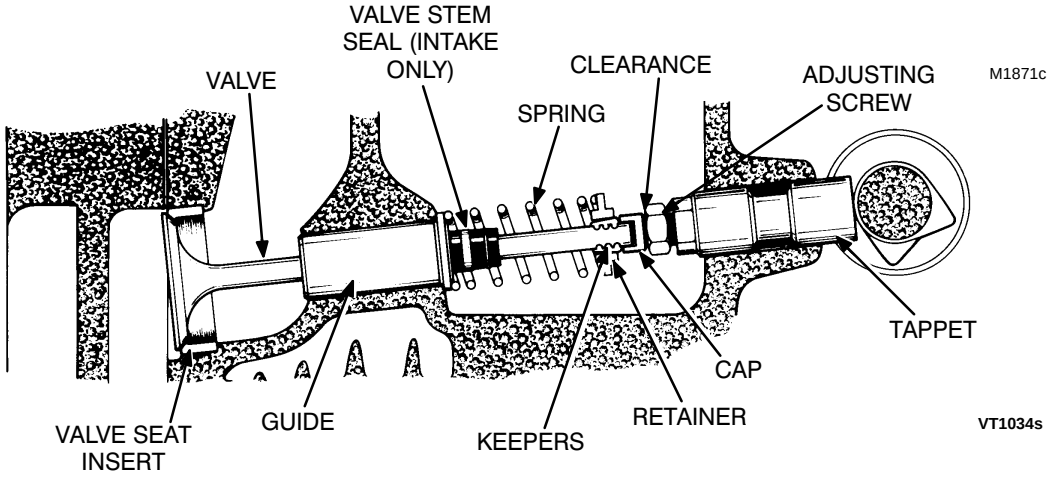
   ⚠ CAUTION ***Do not torque or remove heads when they are hot. Warpage may occur. The gasket surface must be below 100° F before removal. At temperatures above 100° F, the gasket will become gummy and difficult to remove from the surface of the block and cylinder head.***



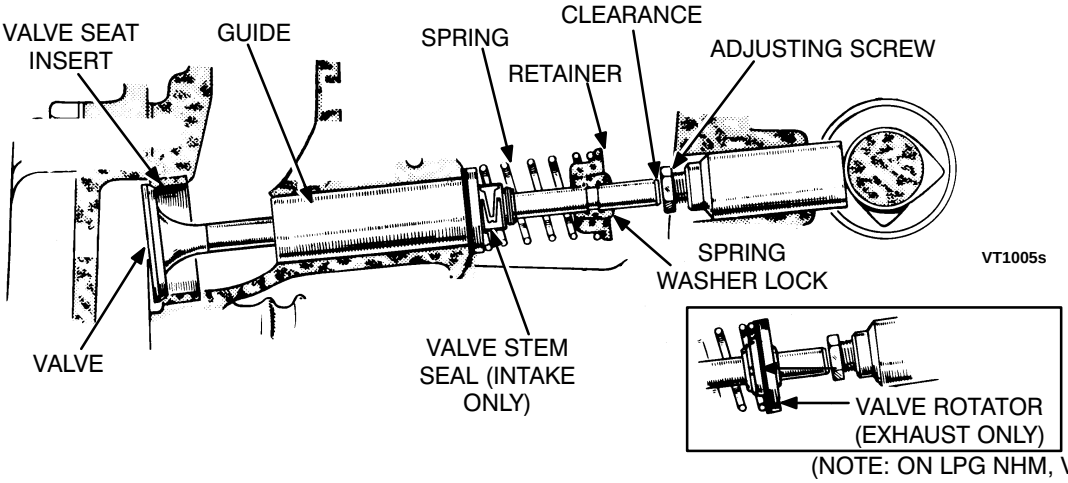
* AS VIEWED FROM FRONT OF ENGINE

FIGURE 9-4. NHM CYLINDER HEAD TIGHTENING SEQUENCE

BGM



NHM

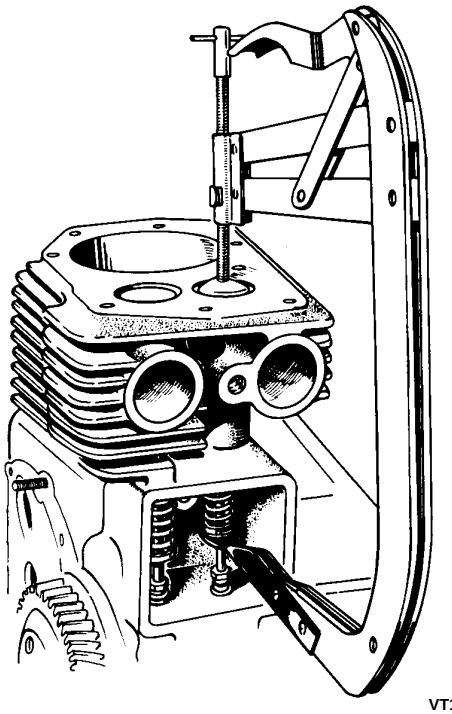


(NOTE: ON LPG NHM, VALVE ROTATORS ARE PRESENT ON BOTH INTAKE AND EXHAUST)

FIGURE 9-5. VALVE SYSTEM

VALVE SYSTEM

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

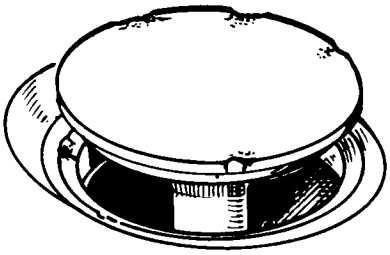


VT1018s

FIGURE 9-6. VALVE SPRING COMPRESSOR

Valve Inspection Procedure

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



VT1017s

FIGURE 9-7. VALVE FACE

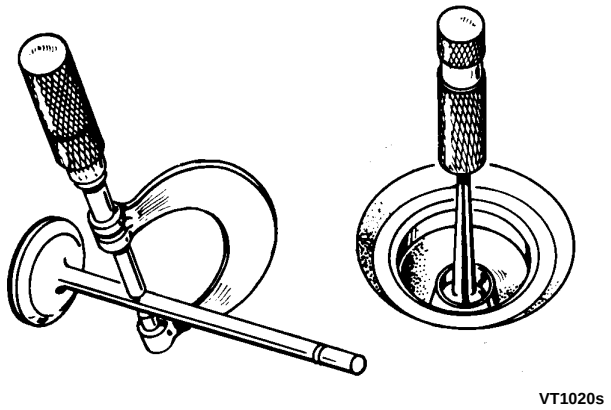
Burning and pitting are caused by the valve failing to seat tightly. This condition is often caused by hard carbon particles on the seat. It may also be caused by weak valve springs, insufficient tappet clearance, valve warpage, and misalignment.

Warping occurs chiefly in the upper stem, because it is exposed to intense heat. Out-of-round wear results from warping, when the seat is pounded by a valve whose head is not in line with the stem and guide. If a valve face is burned or warped, or the stem is worn, install a new valve.

Excess clearance in the intake guide admits air and oil into the combustion chamber, upsetting carburetion, increasing oil consumption, and making heavy carbon deposits. Carbon prevents heat dissipation. Clean metal is a good heat conductor, but carbon insulates and retains heat. This increases combustion chamber temperatures, causing warping and burning. Unburned carbon residue gums valve stems, causing them to stick in the guide.

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

Stems and Guides: Check valve stems and guides for wear, as shown in Figure 9-8. Use a hole gauge to measure the valve guide. When valve clearance with the stem exceeds the original clearance by 0.002 inch (0.05 mm), replace either the valve or guide or both, as necessary. Regrind the seat if necessary, to make it concentric with the newly installed guide.



VT1020s

FIGURE 9-8. VALVE STEM AND VALVE GUIDE INSPECTION

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

Reconditioning Valves and Valve Seats

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

The valve face angle is 44 degrees. The valve seat angle is 45 degrees. This 1-degree interference angle results in a sharp seating surface between the valve and the top of the valve seat (see Figure 9-9).

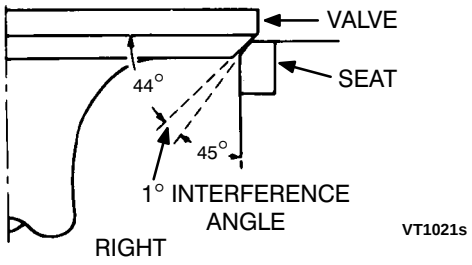


FIGURE 9-9. VALVE INTERFERENCE ANGLE

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

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

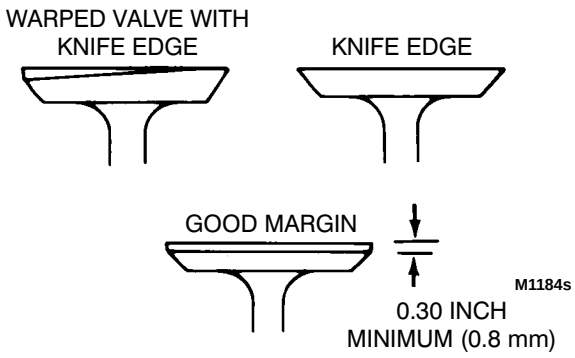


FIGURE 9-10. VALVE MARGIN

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

cut valves must be replaced, because grinding removes the margin.

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

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

Valve Guides

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

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

Valve Guide Removal Procedure

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

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

Valve Guide Installation Procedure

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

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

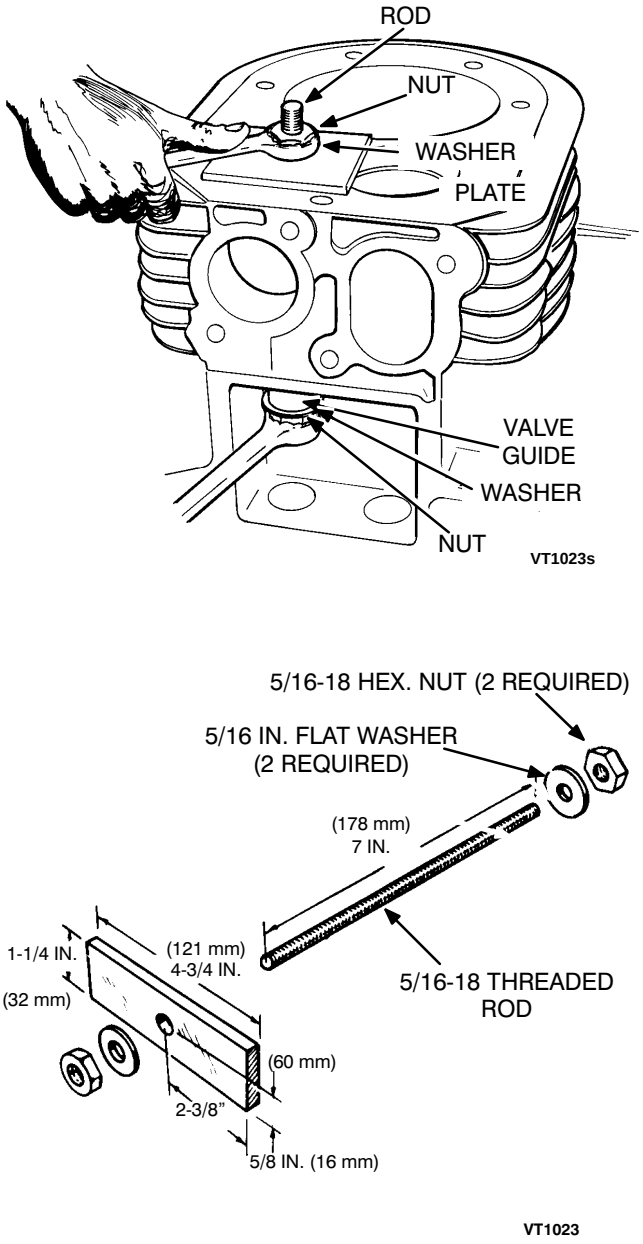


FIGURE 9-11. VALVE GUIDE INSTALLATION

Valve Seats

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

Valve Seat Removal Procedure

1. Remove carbon and combustion deposits from the valve seat.
2. Select the proper size puller (determined by the inside diameter of the valve seat). The puller jaws must expand into the cylinder block at the point where the bottom of the valve seat insert rests on the cylinder block (Figure 9-12).
3. Using the new seat insert as a guide, adjust the puller depth. Position the puller on the valve seat and tighten its hex nut. Clamp the cylinder block to a solid bench. Attach a slide hammer to the puller. Between blows with the slide hammer, tighten the hex nut.

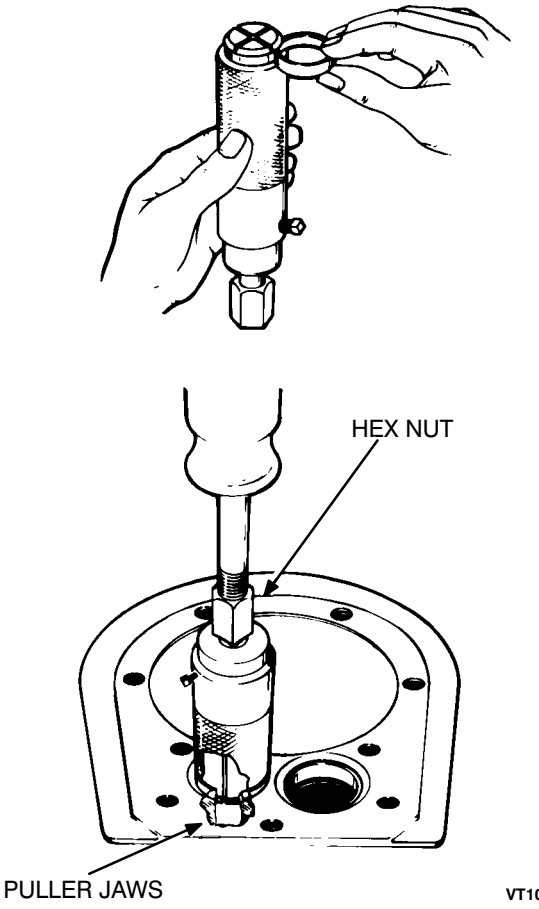


FIGURE 9-12. VALVE SEAT REMOVAL

Valve Seat Installation Procedure

1. After the old seat has been removed, clean out carbon and metal burrs from the seat insert recess. Use a valve seat insert driver and a hammer to install the insert.
2. Insert the pilot of the driver into the valve guide hole in the cylinder block. Quickly drive the valve seat insert in, so that the insert goes evenly to the bottom of the recess in the cylinder block. Make certain that the valve seat insert rests solidly on the bottom of the recess all the way around its circumference (Figure 9-13).

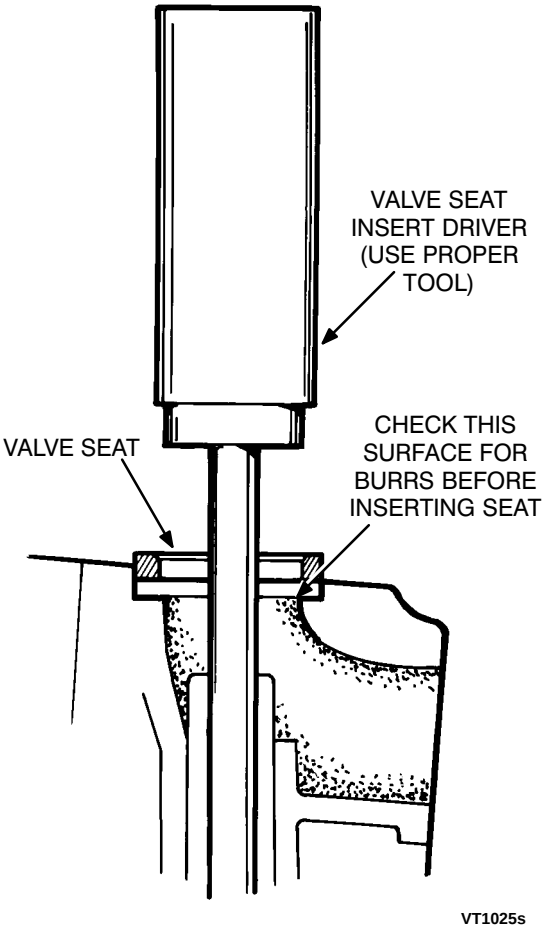


FIGURE 9-13. INSERTING NEW VALVE SEAT

3. Insert a valve seat staker into the cylinder block valve guide hole. Rotate the staking tool until it drops to the original stake marks. Rotate the staking tool another 60° (1/6 turn). Using a lead hammer, strike the staking tool a sharp blow to wedge the new valve seat securely in place. The valve seat must be staked to ensure a tight fit and eliminate the danger of its loosening in

the bore. Before installing the valves, refinish the valve seat inserts.

Valve Tappets

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

Tappet Adjustment Procedure

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

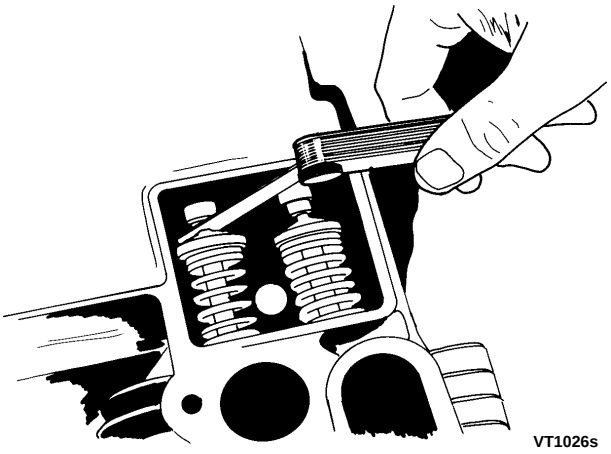


FIGURE 9-14. VALVE CLEARANCE ADJUSTMENT

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

GEAR COVER

Gear Cover Removal Procedure

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

Gear Cover Installation Procedure (Mechanical governor gensets)

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

1. Use new gaskets and apply thread sealant to the bolts when installing the gear cover. Make sure that the pin in the gear cover engages the nylon-lined (smooth) hole in the governor cup. See Figure 9-15.
2. Turn the governor cup so the nylon-lined hole is at the three o'clock position. Use a small amount of grease to help hold the cup in position. The rounded side of the governor yoke must ride against the governor cup.
3. Turn the governor arm and shaft clockwise as far as possible, and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal.

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

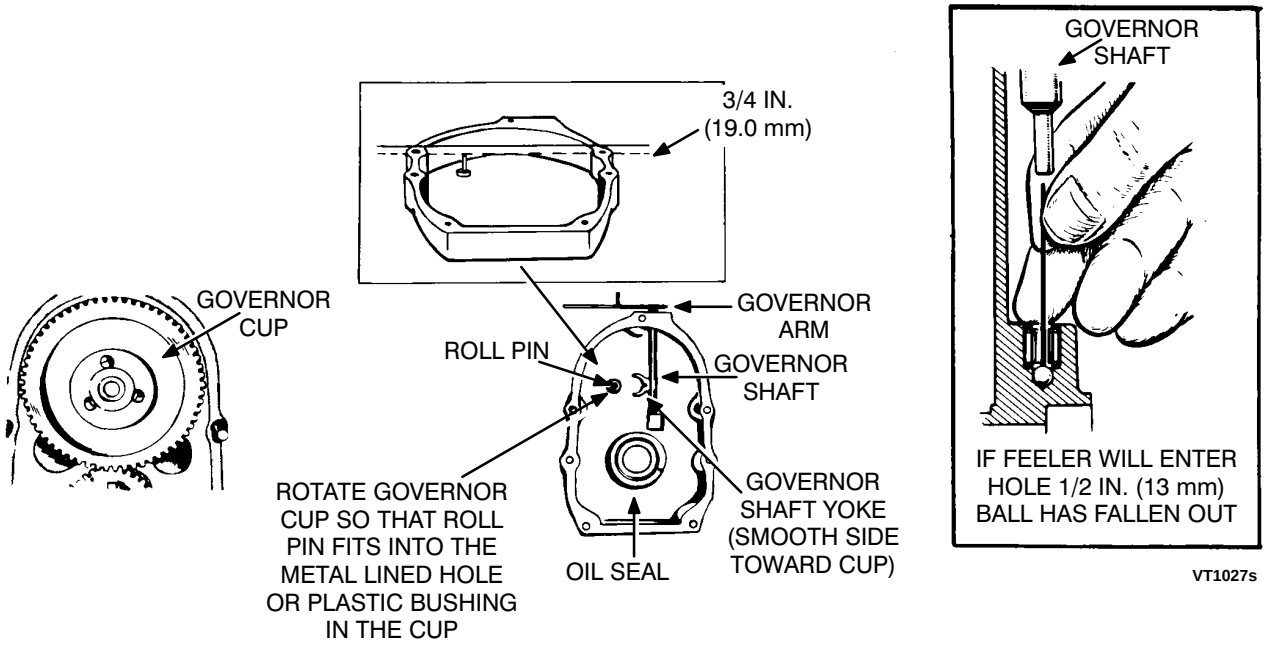
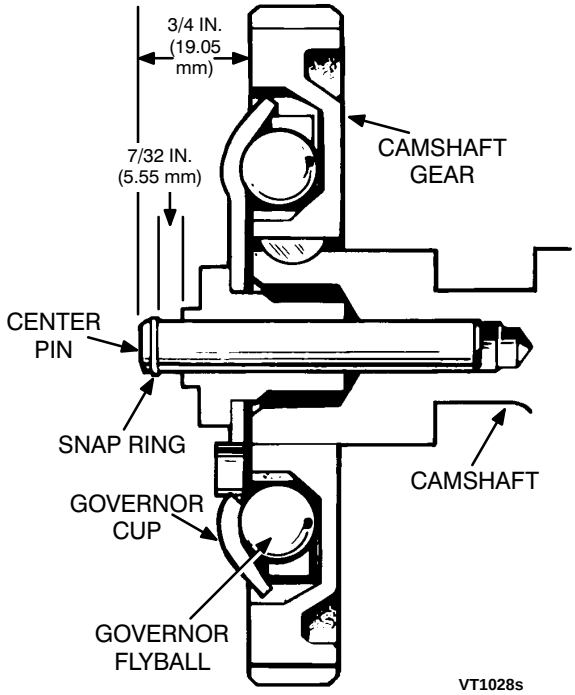


FIGURE 9-15. GEAR COVER ASSEMBLY

GOVERNOR CUP (MECHANICAL)

Governor Cup Removal Procedure

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



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

FIGURE 9-16. GOVERNOR CUP

3. Slide the governor cup off, making certain to catch the flyballs. Replace any flyball that is grooved or has a flat spot.
4. Examine the ball spacer. If the arms of the ball spacer are worn or otherwise damaged, remove the spacer by splitting it with a chisel. Use a press to install a new spacer on the camshaft gear.
5. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

Governor Cup Installation Procedure

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

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

Camshaft Center Pin Installation Procedure

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

TIMING GEARS AND CAMSHAFT

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

Timing Gear Removal Procedure

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

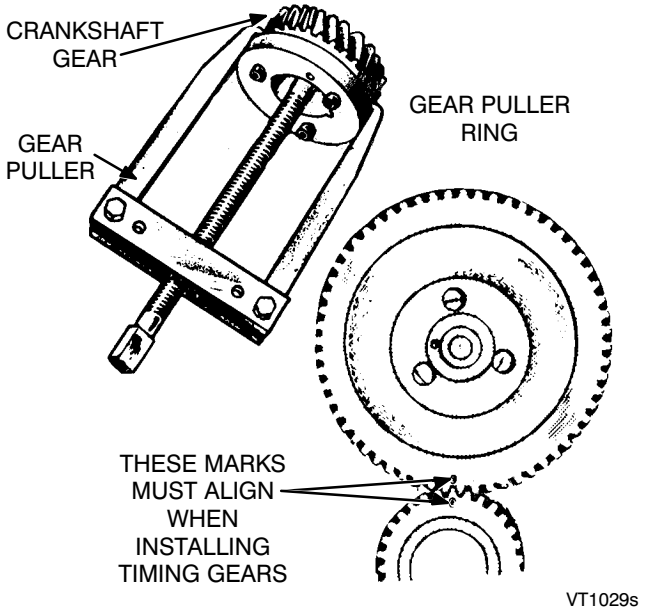


FIGURE 9-17. TIMING GEAR REMOVAL AND INSTALLATION

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

The camshaft and gear are removed as an assembly.

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

Timing Gear Installation

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

LUBRICATION SYSTEM

All genset engines use an oil pump to provide a constant flow of oil to the engine parts. The oil supply collects in the oil base, where it is picked up by the oil pump pickup cup. A bypass valve controls oil pressure. Drain the oil before removing the oil base, and always use a new gasket when replacing the oil base.

Oil Pump

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

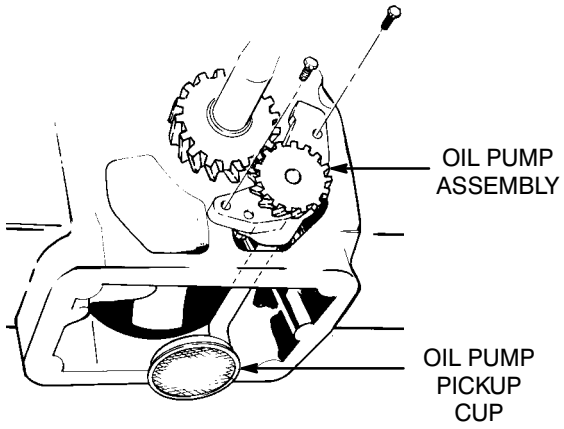


FIGURE 9-18. OIL PUMP ASSEMBLY

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

Normal oil pressure should be no less than 13.5 psi (93 kPa) for the BGM, or 21 psi (144.8 kPa) for the NHM, when the engine is at normal operating temperature. If pressure drops below this value at governed speed, inspect the oil system for faulty components.

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

Oil Bypass Valve

The bypass valve (located to the right and behind the gear cover, Figure 9-19), controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open at roughly 13-14 psi on BGM gensets, or 19-21 psi on NHM gensets.

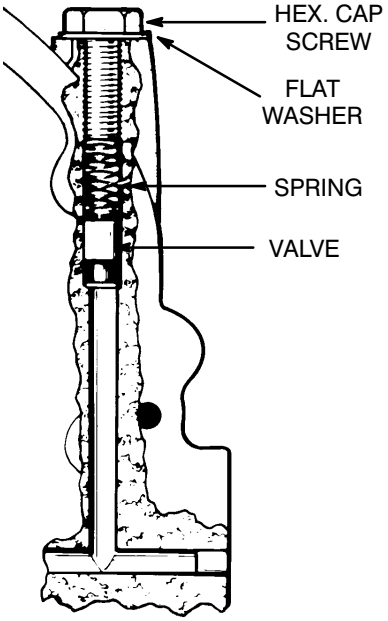


FIGURE 9-19. OIL BYPASS VALVE

Oil Bypass Valve Test

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

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

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

   Spring

   Free Length.....1.00 in. (25.4 mm)

   Load.....2.6+0.2 lbs (11.6+0.9N) when compressed to 0.500 in. (12.7 mm)

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

PISTON ASSEMBLY

The piston assembly consists of:

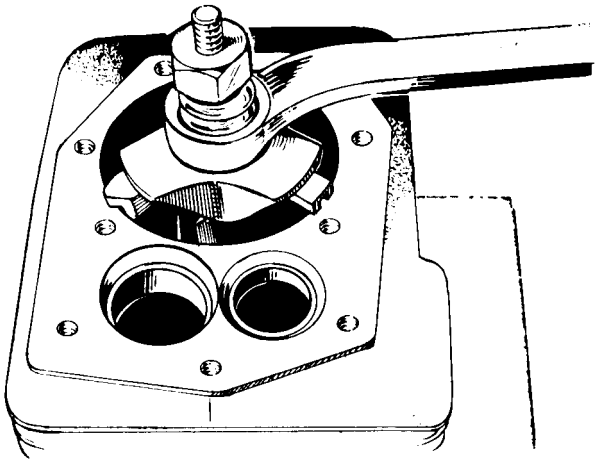
- Piston
- Piston rings
- Piston pin
- Connecting rod assembly and bearing

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

Piston Removal and Disassembly Procedure

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

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

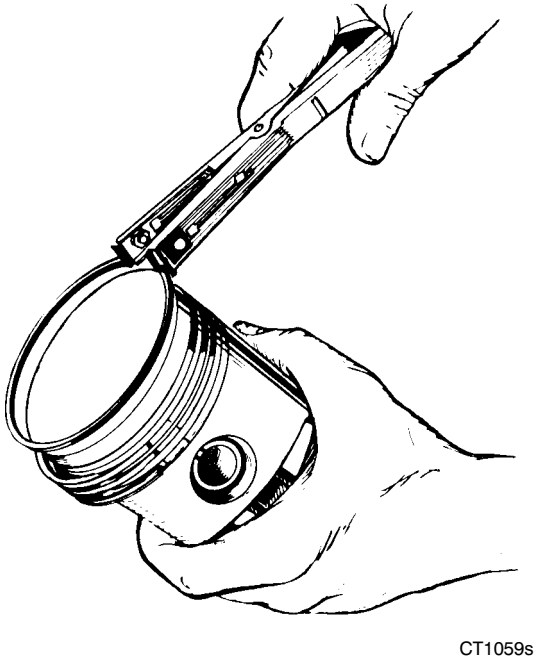


CT1058s

FIGURE 9-20. REMOVING WEAR RIDGE

2. Turn the crankshaft until a piston is at the bottom of its stroke. Remove the nuts from the connecting rod bolts.
3. Lift the rod bearing cap from the rod, and push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.
4. Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep the connecting rod bearing caps with their respective rods.
5. The pistons are fitted with two compression rings and one oil control ring. Remove these rings from the piston using a piston ring spreader, as shown in Figure 9-21.

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



CT1059s

FIGURE 9-21. REMOVING PISTON RINGS

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

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

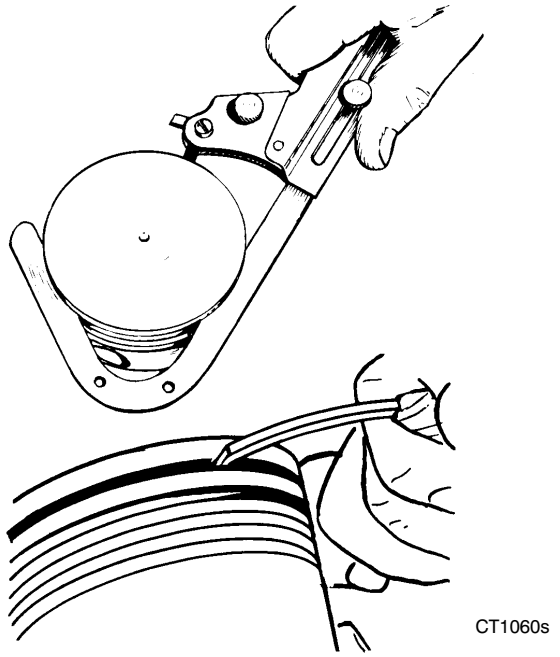


FIGURE 9-22. CLEANING RING GROOVES

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

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

Piston and Connecting Rod Inspection Procedure

Piston Inspection: Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands, using a new ring and feeler gauge, as shown in Figure 9-23. Replace the piston if the side clearance of the top compression ring is as much as 0.008 inch (0.20 mm).

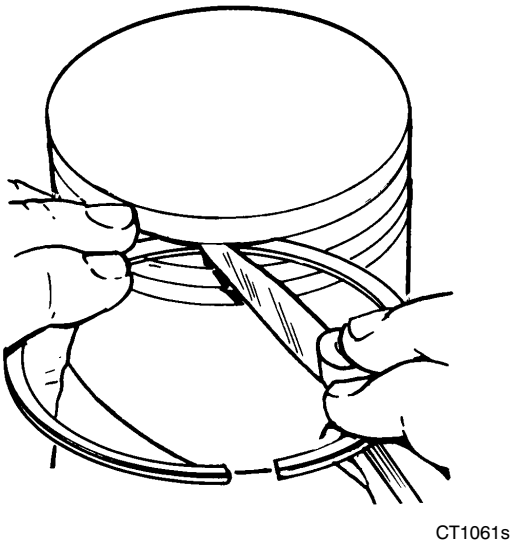


FIGURE 9-23. CHECKING RING LAND

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

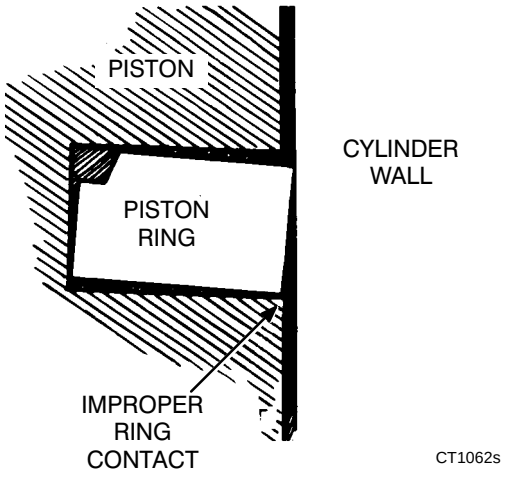


FIGURE 9-24. NEW RING IN WORN RING GROOVE

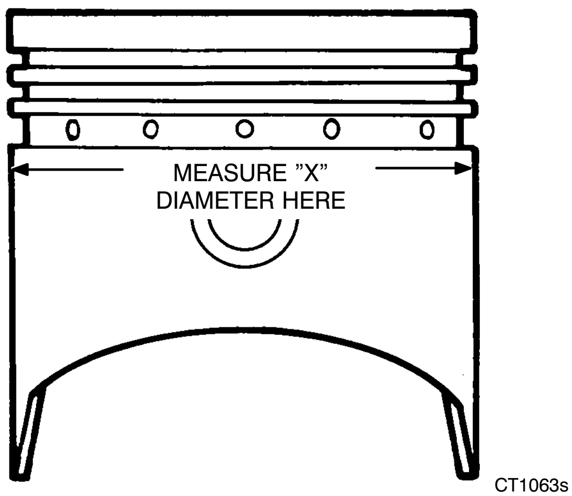


FIGURE 9-25. PISTON CLEARANCE MEASUREMENT

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

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

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

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

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

Piston Clearance

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

Fitting Piston Rings

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

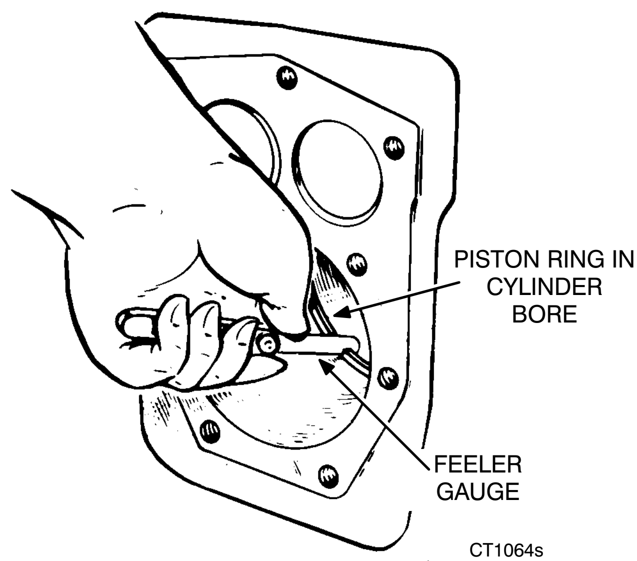


FIGURE 9-26. CHECKING RING GAP

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

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

Piston Assembly Procedure

1. Lubricate all parts with clean engine oil.

2. Position the piston on the connecting rod. Install the piston pin. The piston pin is a full-floating type, and must be kept in place (in the piston) with two lock rings, one at each side. Install the lock rings and ensure they are properly in place before installing the piston and connecting rod in the engine.
3. Install the rings on the piston beginning with the oil control ring (Figure 9-27). Use a piston ring spreader to prevent twisting or excessive expansion of the ring. Compression rings are marked with a dot or the word "top" on one side of the ring to indicate which side faces the top of the piston. Unmarked piston rings can be installed either way. The oil control ring has an expander. Install the expander first, then close until the expander ends butt together. Locate the expander gap 180 degrees from the ring gap. Make certain that the piston ring gaps are **not** aligned with one another.

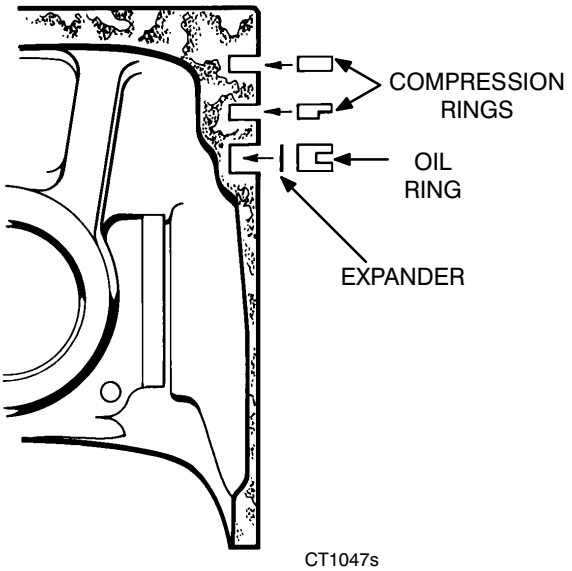


FIGURE 9-27. PISTON RINGS

Piston Installation Procedure

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

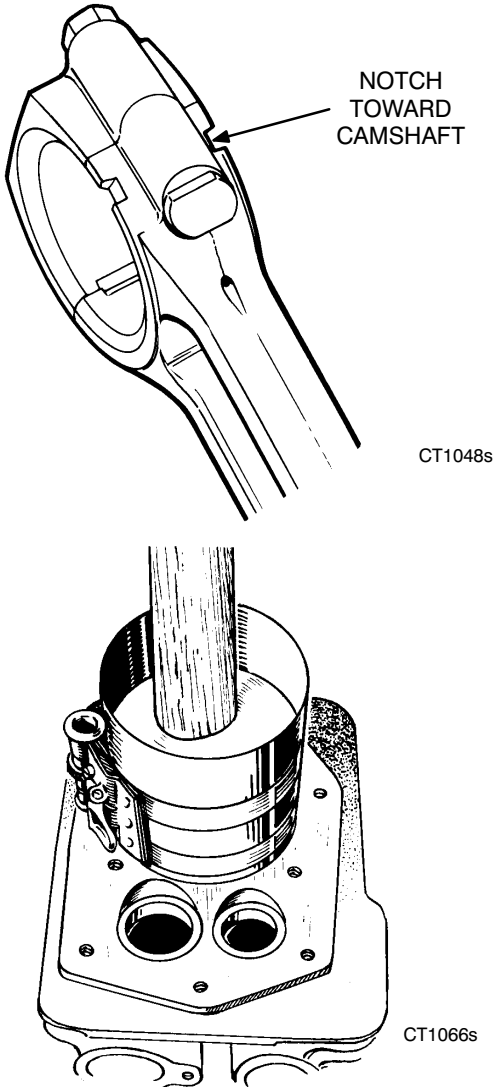


FIGURE 9-28. INSTALLING PISTON AND CONNECTING ROD

3. Position the piston and rod assembly in the cylinder block with the connecting rod oil hole toward the camshaft.
4. Tap the piston down into the bore with the handle end of the hammer until the connecting rod is seated on the journal. Check the bearing clearance before proceeding to step 5 (see Rod Bearing Clearance section).

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

Rod Bearing Clearance Procedure

1. Mark all parts so they can be installed in their original positions, and wipe all parts clean of oil and grease.
2. Place a piece of the correct size Plasti-gage across the full width of the bearing cap, about 1/4 inch (6 mm) off-center.
3. Install the bearing cap, and tighten to the specified torque. Do not rotate the crankshaft after the cap is in place.
4. Remove the bearing cap and leave the flattened Plasti-gage on the part to which it adheres. Compare the widest point of the flattened Plasti-gage with the graduations on the envelope (see Figure 9-29) to determine the bearing clearance.

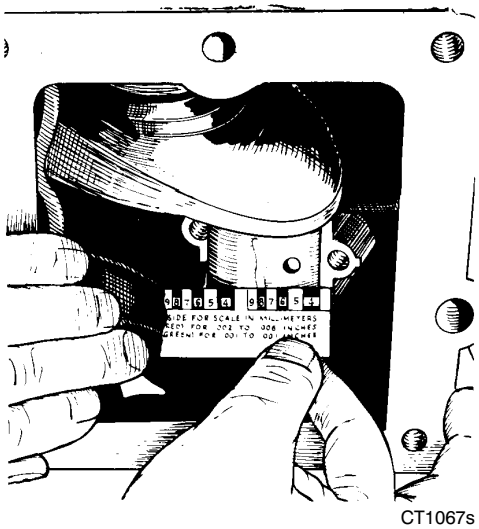


FIGURE 9-29. MEASURING BEARING CLEARANCE

CRANKSHAFT

Crankshaft Removal Procedure

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

Crankshaft Inspection

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

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

Crankshaft Installation Procedure

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

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

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

Endplay Checking Procedure

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

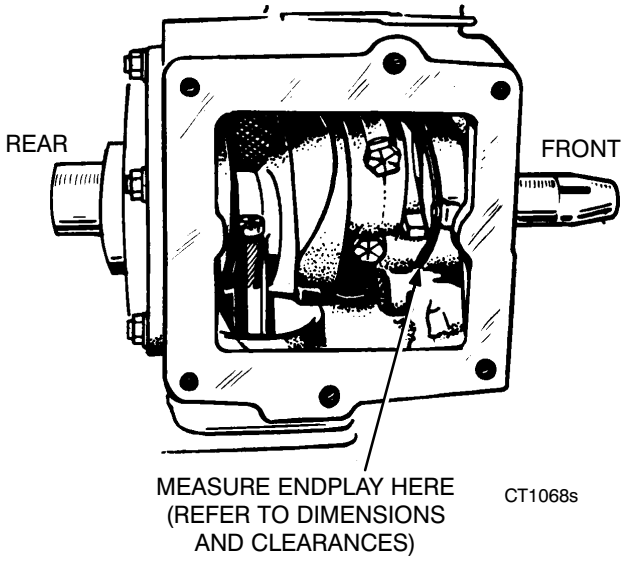


FIGURE 9-30. CHECKING ENDPLAY

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

CYLINDER BLOCK

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

Cylinder Block Cleaning

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

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

Cylinder Block Inspection

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

1. Make a thorough check for cracks. Minute cracks may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at the defective area. (Remove this coating after the test, and before reassembly.) Always replace a cracked cylinder block.
2. Inspect all machined surfaces and threaded holes. Carefully remove any nicks or burrs from machined surfaces. Clean out tapped holes and clean up any damaged threads.
3. Check the top of the block for flatness with a straight-edge and a feeler gauge.

Cylinder Bore Inspection: Inspect the cylinder bores for scuffing, scratches, wear, and scoring. If these conditions exist, they must be rebored and honed for the next oversize piston.

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

1. Check cylinder bore for taper, out-of-round, and wear with a cylinder bore gauge, telescope gauge, or inside micrometer. These measurements should be taken at four places: the top and bottom of piston ring travel, and parallel and perpendicular to the axis of the crankshaft.
2. Record the measurements taken at the top and bottom of the piston travel as follows (see Figure 9-31).
   A. Measure and record as “A” the cylinder bore diameter (parallel to crankshaft) near the top of cylinder bore where the greatest amount of wear occurs.
   B. Measure and record as “B” the cylinder bore diameter (parallel to crankshaft) at the bottom of piston travel.
   C. Measure and record as “C” the cylinder bore diameter (perpendicular to crankshaft) near the top of cylinder bore where the greatest amount of wear occurs.
   D. Measure and record as “D” the cylinder bore diameter (perpendicular to crankshaft) at the bottom of piston travel.
   E. Reading “A” subtracted from reading “B” and reading “C” subtracted from reading “D” indicates the cylinder taper.
   F. Reading “A” compared to reading “C” and reading “B” compared to reading “D” indicates whether or not the cylinder is out-of-round. If the out-of-round exceeds 0.003 inches (0.08 mm), the cylinders must be rebored and honed to the next oversize. A reboring machine is used when changing to oversize pistons. The following repair data describes the boring and honing procedure.

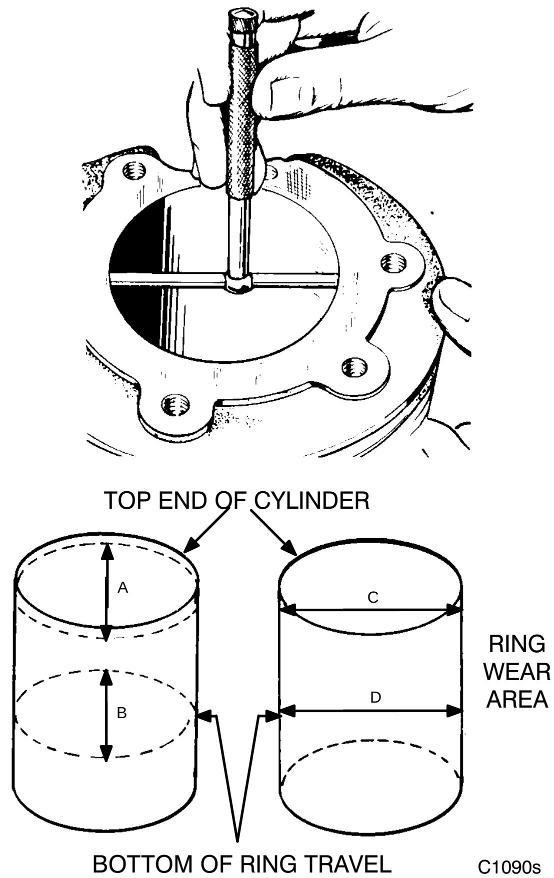


FIGURE 9-31. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

Reboring the Cylinder

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

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

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

bore dimension and piston and ring clearance should be correct.

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

When reboring cylinders, take these precautions:

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

Honing Cylinders Using Precision Hones

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

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

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

Deglazing Cylinder Bores

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

1. Wipe cylinder bores with a clean cloth which has been soaked in light engine oil.
2. Use a brush-type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.
3. The deglazing tool should be driven by a slow-speed drill. Move the deglazing tool up and down in the cylinder (10 to 12 complete strokes) rapidly enough to obtain a crosshatch pattern, as shown in Figure 9-32.

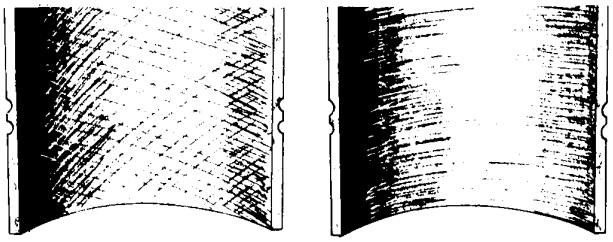


FIGURE 9-32. CROSSHATCHING

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

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

BEARINGS

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

Camshaft Bearing Replacement Procedure

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

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

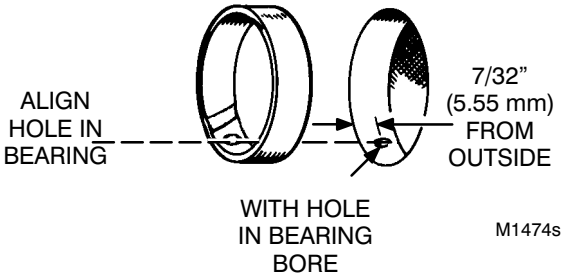


FIGURE 9-33. CAMSHAFT BEARING

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

Crankshaft Bearings

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

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

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

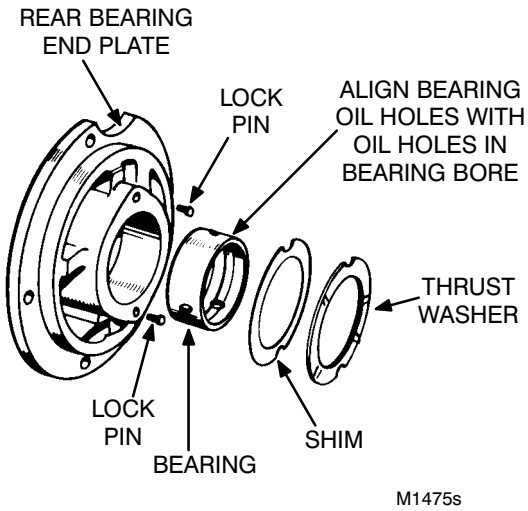


FIGURE 9-34. REAR BEARING

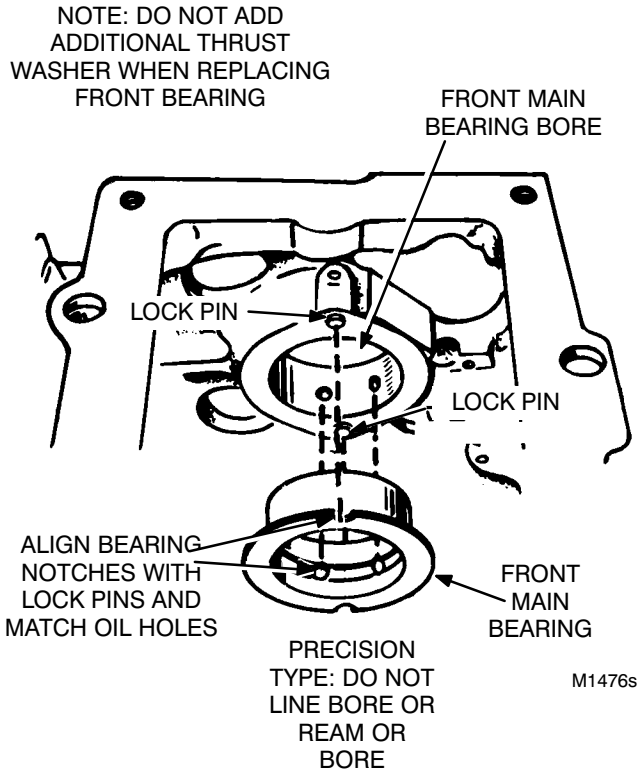


FIGURE 9-35. FRONT BEARING

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

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

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

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

OIL SEALS

Oil Seal Replacement Procedure

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

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

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

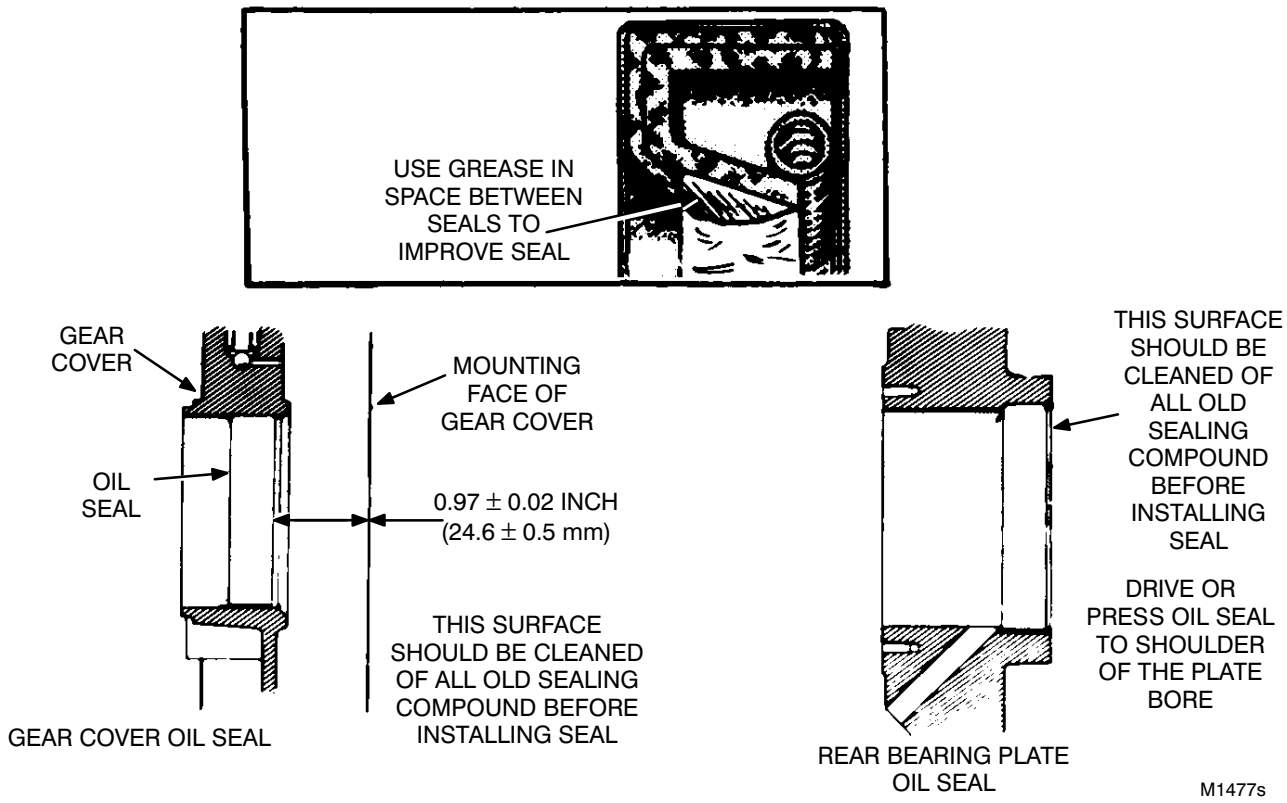


FIGURE 9-36. OIL SEALS

Section 10. Service Checklist

After servicing, inspect and test the installation to confirm that the generator set will operate to its rated capacity. Check each of the areas described below before putting the set into service.

MOUNTING

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

LUBRICATION

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

WIRING

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

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

INITIAL START ADJUSTMENTS

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

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

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

OUTPUT CHECK

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

EXHAUST SYSTEM

With the generator set operating, inspect the entire exhaust system, including the exhaust manifold, muffler, and exhaust pipe. Make certain that the exhaust pipe terminates beyond the perimeter of the coach. Visually and audibly check for leaks at all connections, welds, gaskets, and joints. Also make sure that exhaust pipes do not heat surrounding areas excessively. If leaks are detected, correct immediately.

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

FUEL SYSTEM

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

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

CONTROL

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

MECHANICAL

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

Appendix A. Troubleshooting Guides

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

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

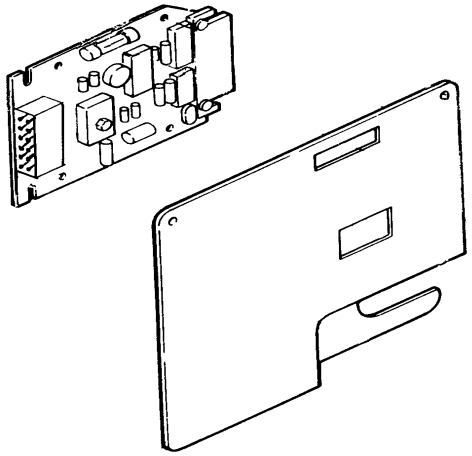
Two Onan product support bulletins are also reprinted in this supplement, as follows:

⚠ WARNING

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

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

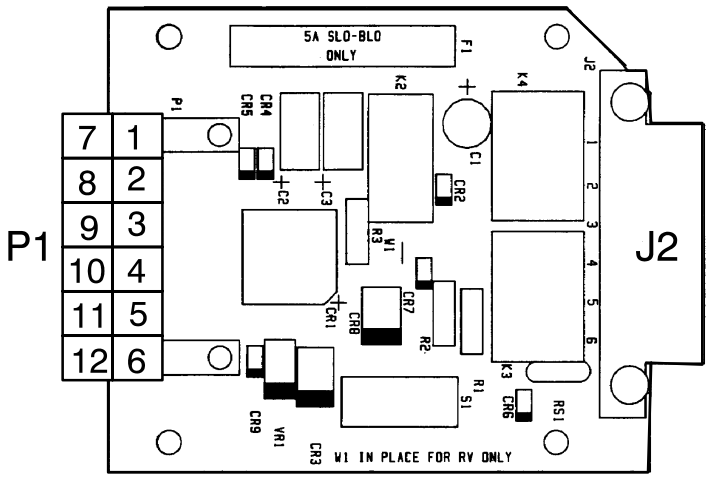
EMERALD/MARQUIS CONTROL BOARD CHECK-OUT (300-3763-01, 02)



MODELS:

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

P1 plug turned for better viewing.



ES2051s

⚠WARNING

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

Emerald/Marquis is a trademark of Onan Corporation

REMOVE CIRCUIT BOARD

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

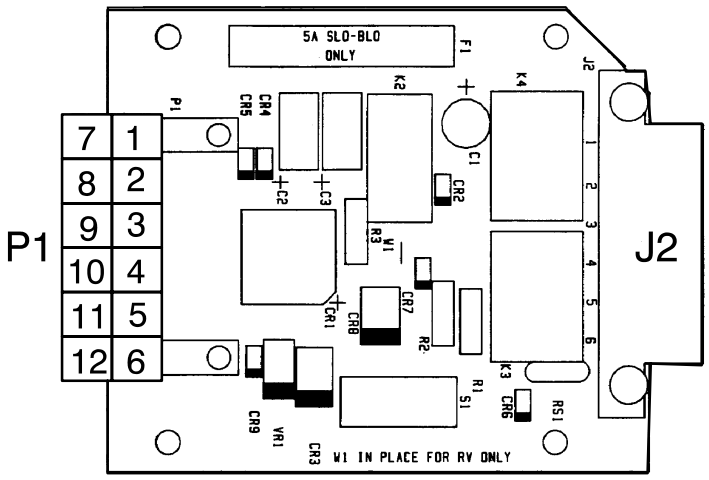
Place the circuit board on a non-conductive surface with the component side of the board up.

For the following tests, the battery must be connected.

STATIC MODE

(With the switch in the Center position)

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

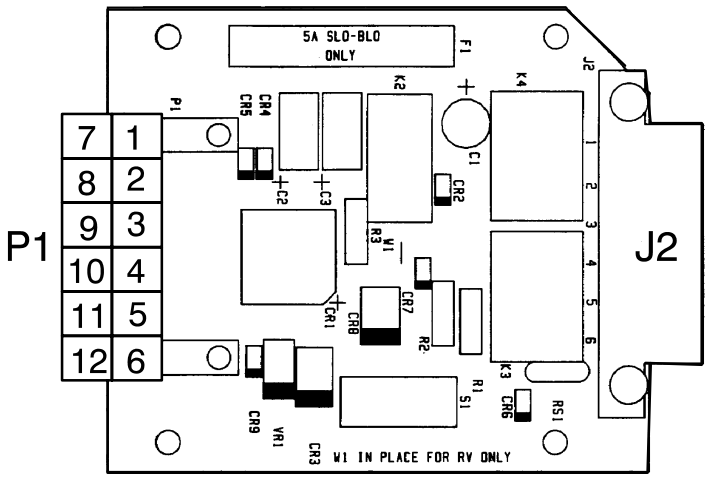


ES2051s

CRANK & START MODE

(With the switch pressed to the Start position)

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

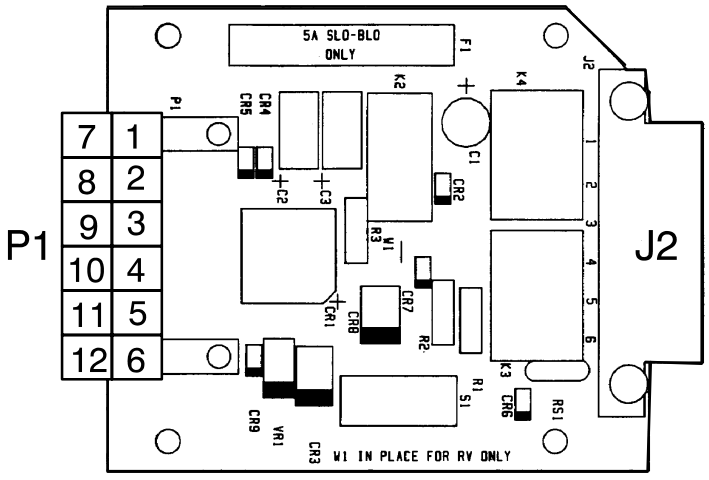


ES2051s

RUN & GENERATE MODE

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

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



ES2051s

STOP MODE

(With the switch pressed to the Stop position)

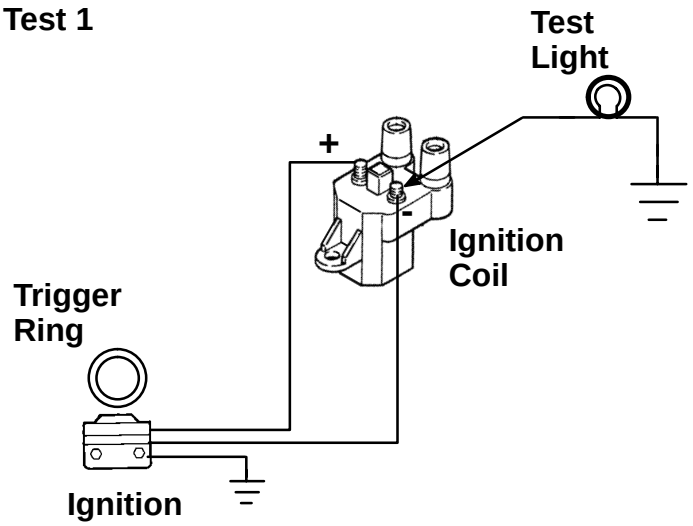
	Meter Test Lead +	Meter Test Lead -	Meter Reading
	P1-6	J2-1	0 VDC
	P1-12	J2-1	0 VDC
*	P1-7	P1-10	12 VDC

*** Gensets with K5 relay**

Troubleshooting Electronic Ignition Module

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

Test 1

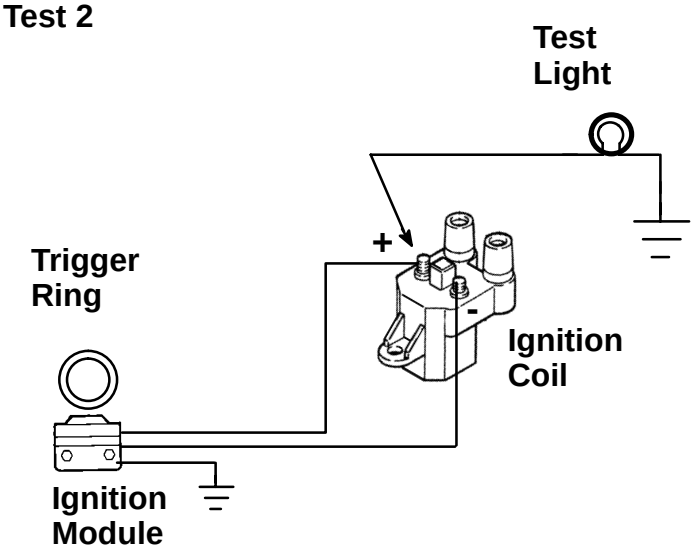


1. **Check wiring: red lead to positive (+); black lead to negative (-).**
2. **Connect a DC powered test light from the negative (-) coil terminal to ground.**
3. **Turn the ignition switch on and crank the engine over. Does the test light flash, bright then dim?**

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

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

Test 2



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

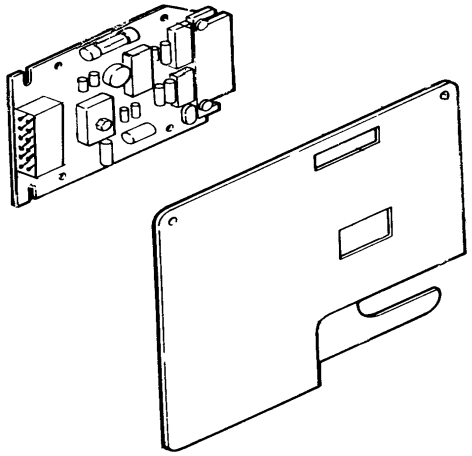
   Yes - Crank the engine over. Does the light stay on while cranking?
   Yes - Replace the module and the trigger ring as a set if the coil tests good.
   No - It is not a module problem. Check the wiring and connections to the coil and the ignition switch, then retest the module.

⚠WARNING

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

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

MODEL:
BGM/NHM
(Beginning Spec. B)



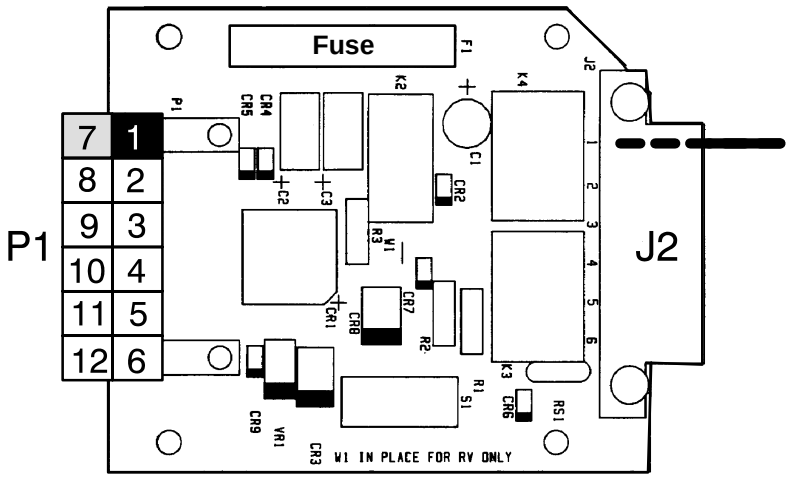
REMOVE CIRCUIT BOARD

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

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

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

P1 plug turned for better viewing.



ES2051s

⚠WARNING

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

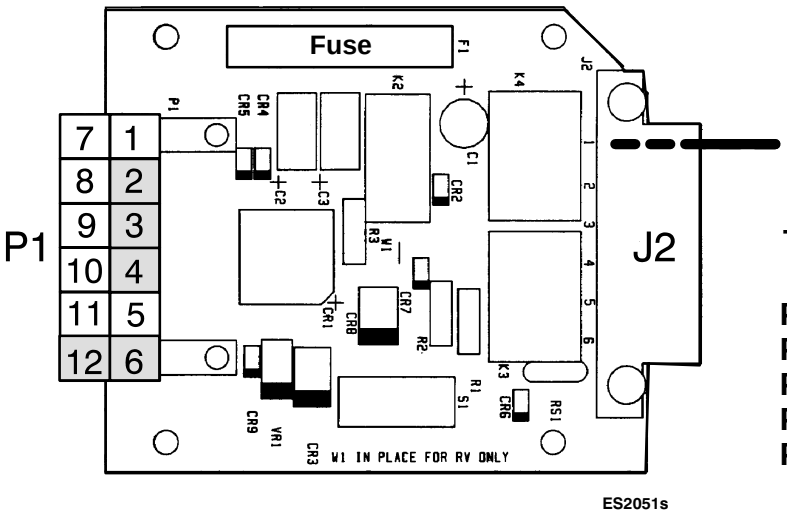
STATIC MODE

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

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

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

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

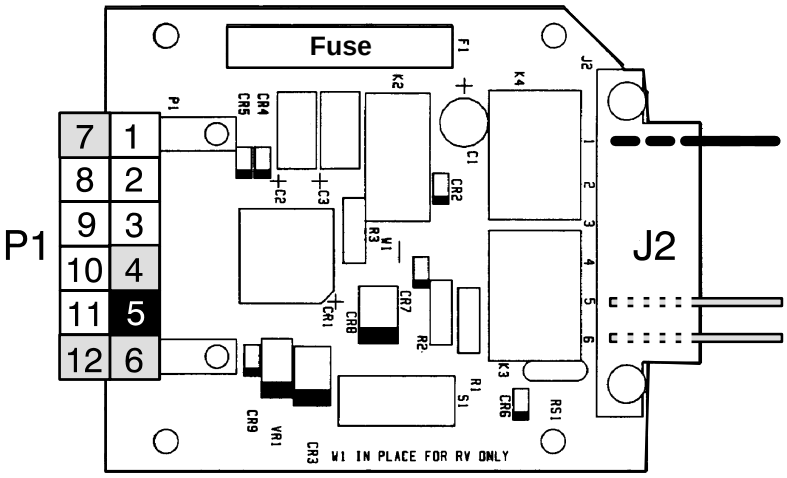


ES2051s

CRANK & START MODE

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

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

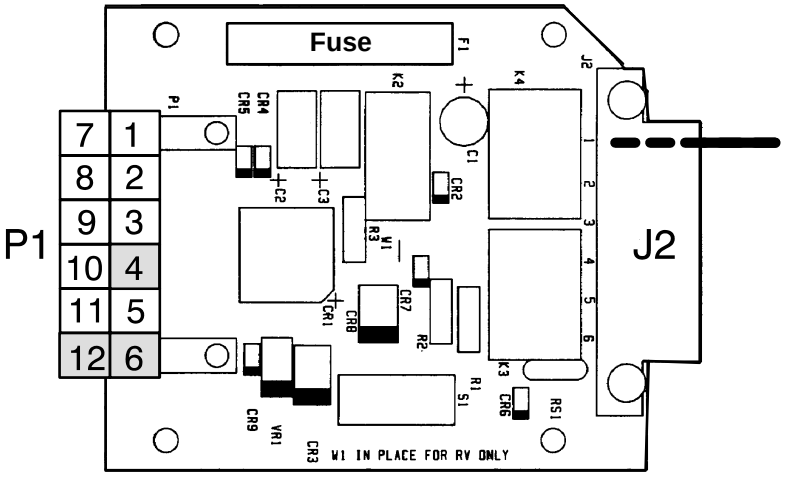


ES2051s

RUN & GENERATE MODE

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

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



ES2051s

STOP MODE

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

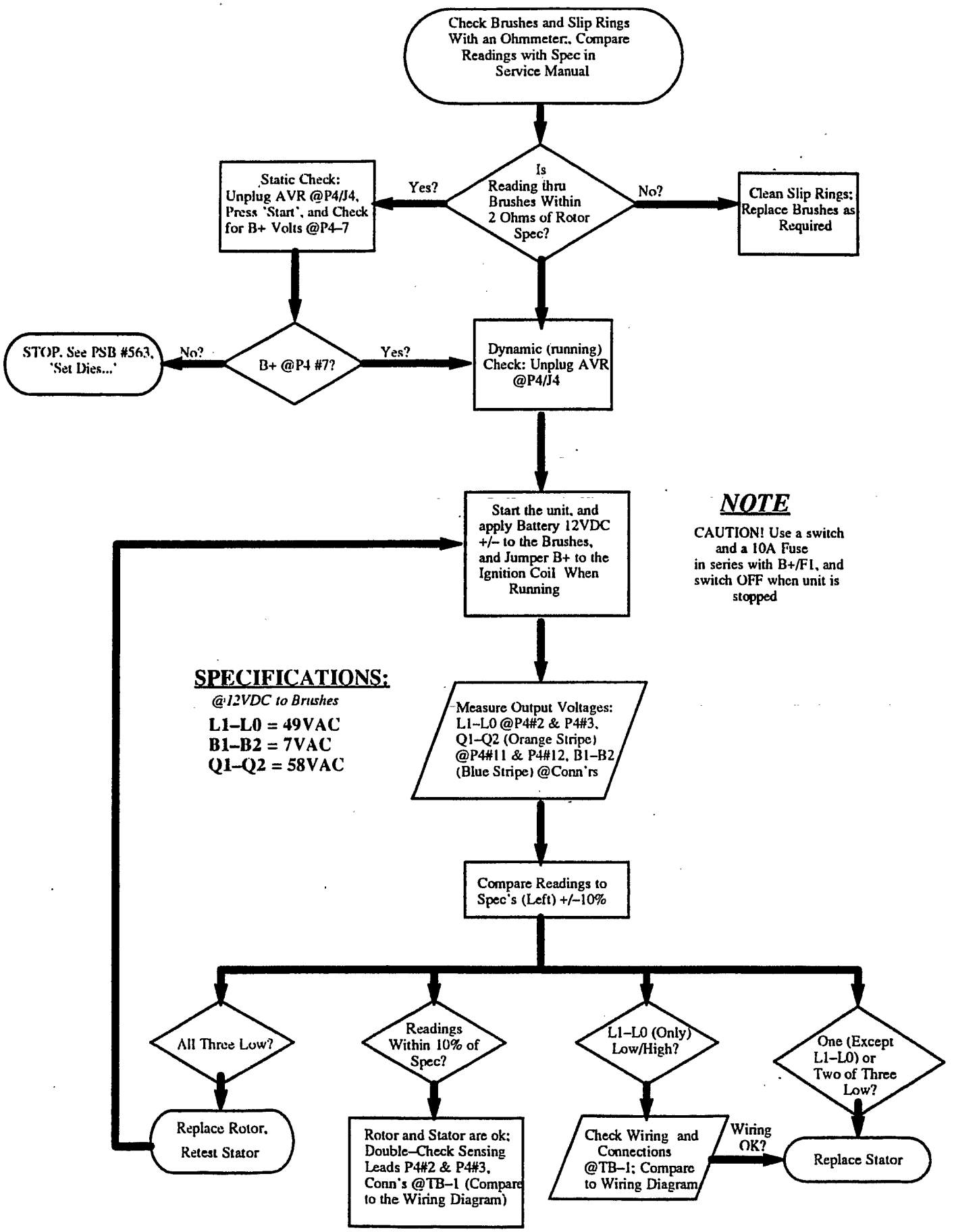
Meter Test Lead +	Meter Test Lead -	* Meter Reading
P1-4	J2-1	10-12 then 0 VDC
P1-6	J2-1	11-13 then 0 VDC
P1-12	J2-1	10-12 then 0 VDC

Onan

Product Support Bulletin #564

ROTOR/STATOR CHECK

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



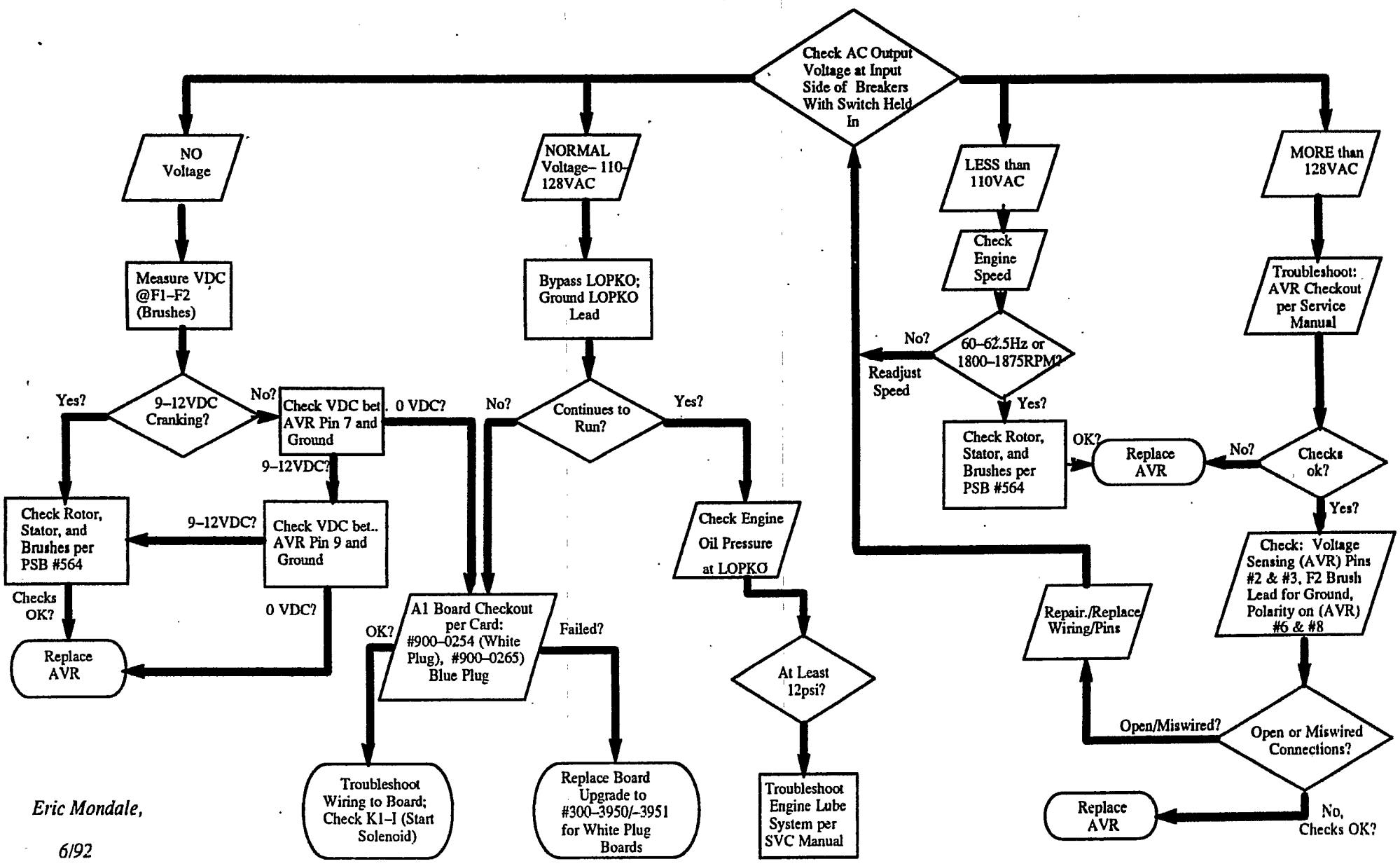
Eric Mondale,
6192

Onan

Product Support Bulletin #563

SET DIES WHEN SWITCH RELEASED

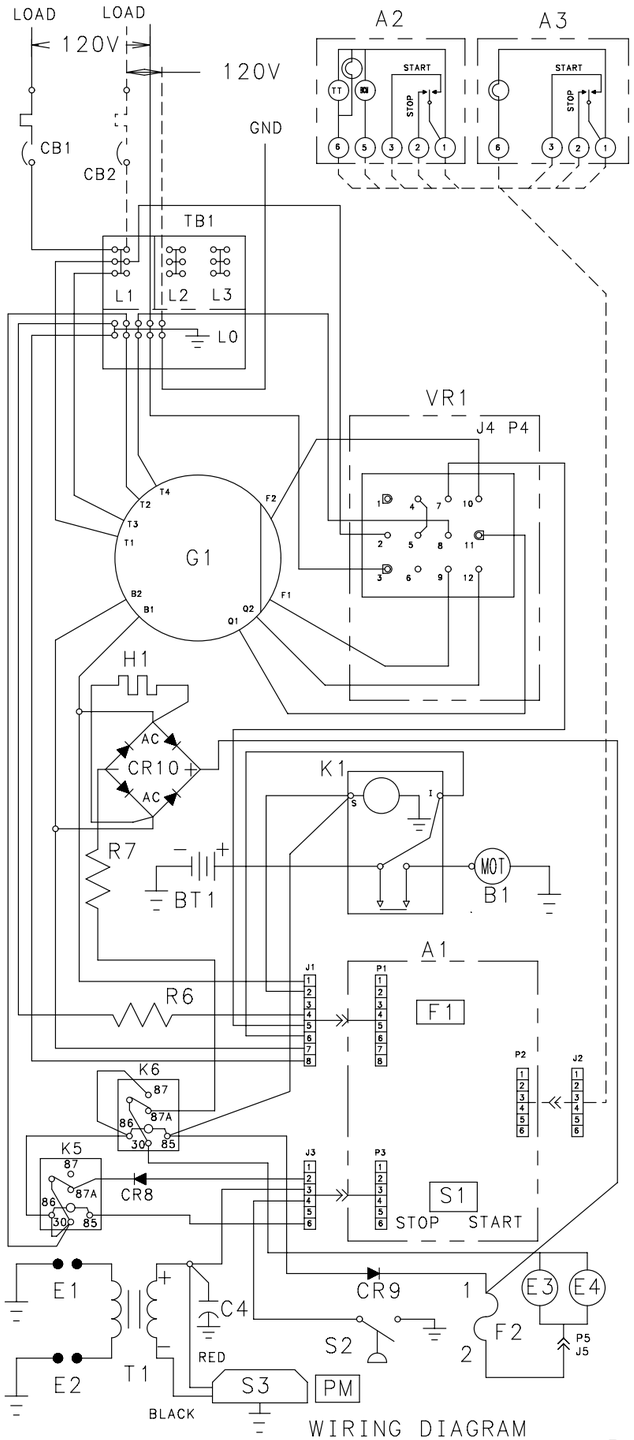
–EMERALD AND MARQUIS WITH ELECTRONIC VOLTAGE REGULATOR (AVR)–



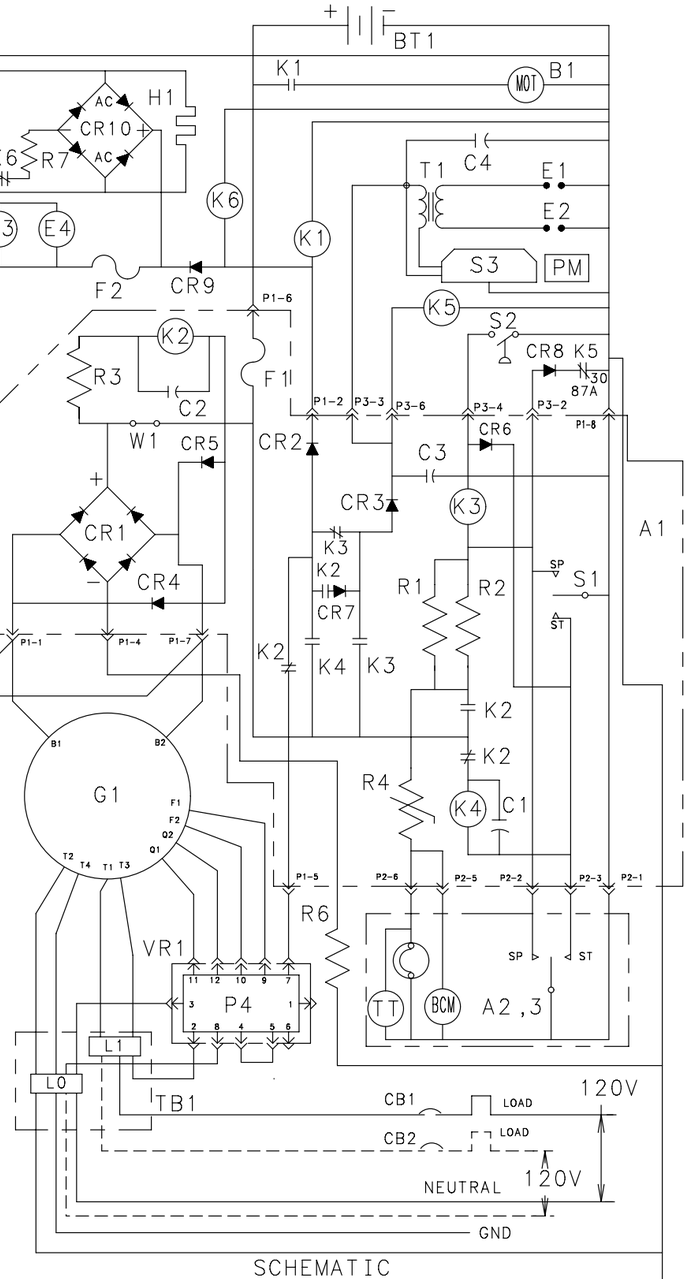
Eric Mondale,

6/92

Appendix B. Wiring Diagrams



WIRING DIAGRAM



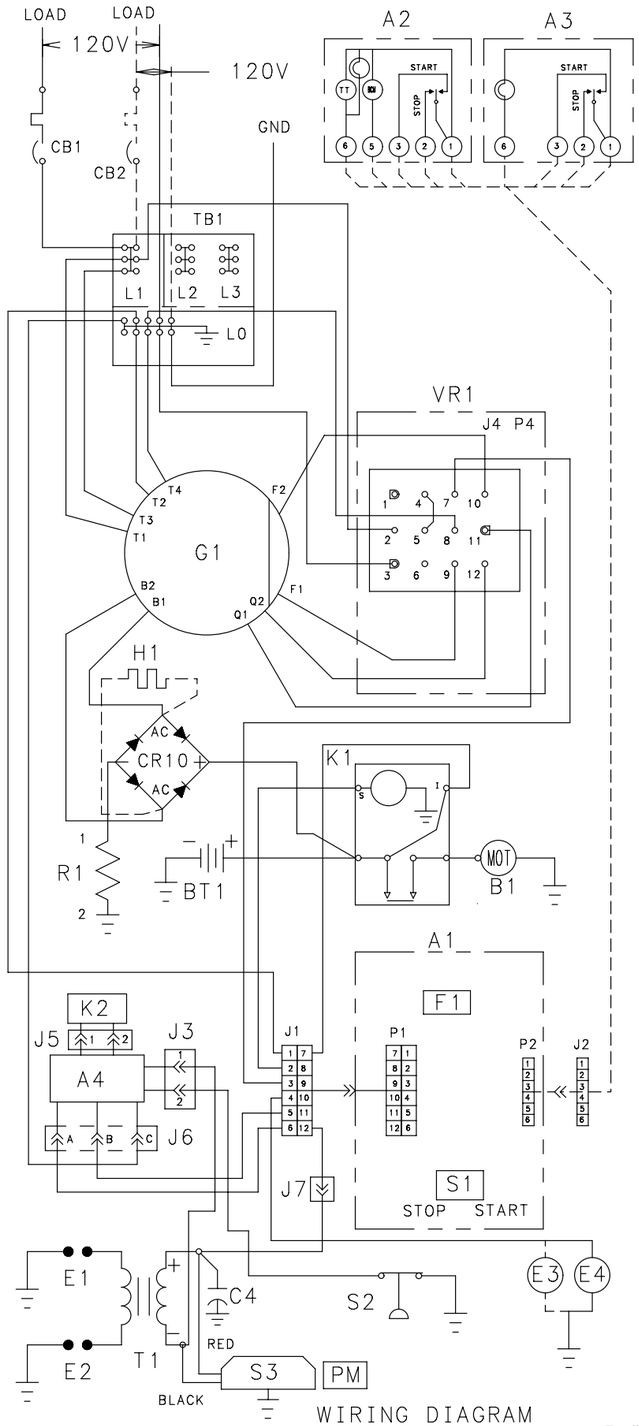
SCHEMATIC

NOTES:

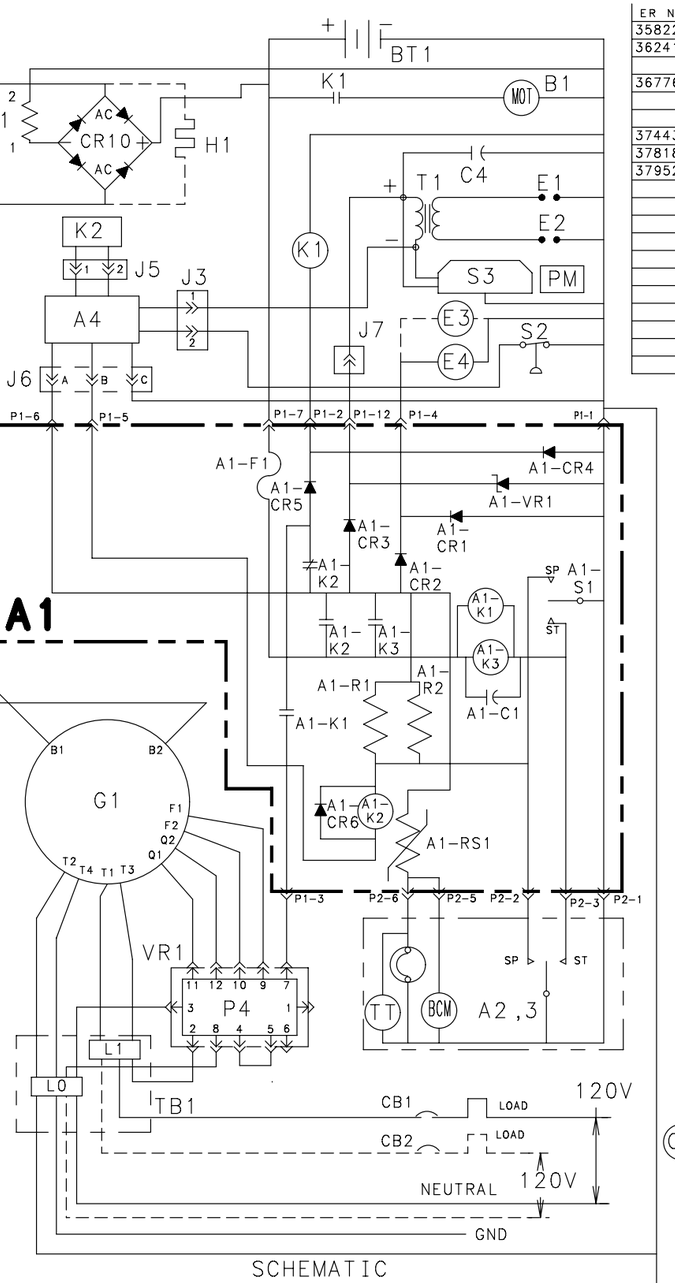
1. ALL ELECTRICAL COMPONENTS ARE DRAWN IN THE DE-ENERGIZED POSITION.

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

611-1186



WIRING DIAGRAM



SCHEMATIC

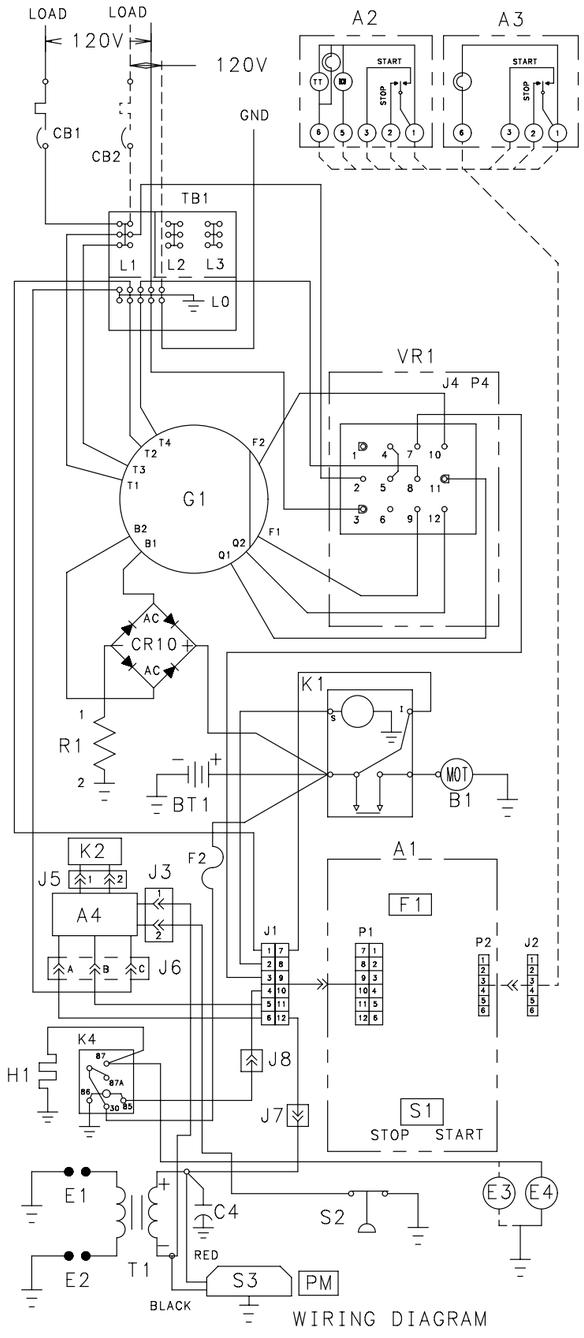
ER NO	LTR	NO	REVISION	ZONE	DR	CKHR	APPROVED	DATE
35822	A	1	PROD RELEASE	–	JP	KD	WMH	11-28-89
36241	B	1	REMOVE COLORED LEADS FROM A4	3-D	KD	JP	WMH	2-7-90
		2	J5-1&2 & J3-1&2 WERE J5-A&B & J3-A&B	3-D	KD	JP	WMH	2-7-90
36776	C	1	ADDED HIDDEN LINES TO HI & E3	–	KD	JP	WMH	5-3-90
		2	REMOVED CR8	2-A	KD	JP	WMH	5-3-90
		3	UPDATE CIRCUIT BOARD	2-C	KD	JP	WMH	5-3-90
37443	D	1	ADDED A1-K1	–	JP	KD	WMH	7-27-90
37818	E	1	UPDATE CIRCUIT BOARD	–	JP	GS	RB	4-8-91
37952	F	1	ADD A1 DESIGNATIONS TO CONTROL BOARD COMPONENTS	2-C	KE			

NOTES:

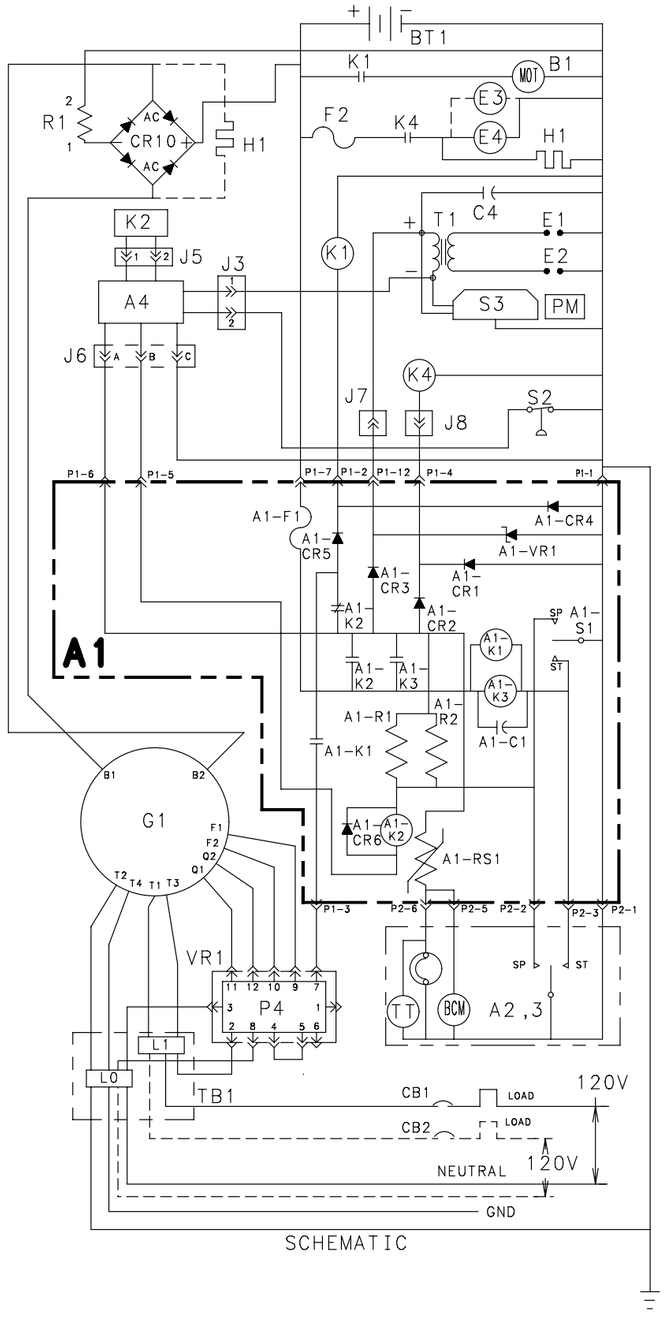
1. ALL ELECTRICAL COMPONENTS ARE DRAWN IN THE DE-ENERGIZED POSITION.

ITEM	PART NO	*BULK	DWG SIZE	QTY	DESCRIPTION OR MATERIAL
VR1					VOLTAGE REGULATOR
T1					IGN COIL
S3					IGN MODULE
S2					SWITCH-LOW OIL PRESSURE
R1					RESISTOR-BATTERY CHARGE
K2					GOVERNOR ACTUATOR
K1					RELAY-START SOLENOID
H1					CHOKE-GASOLINE ONLY
G1					GENERATOR
F1					FUSE-10A
E4					SOLENOID FUEL VALVE
E3					FUEL PUMP (OR FUEL FILTER-LP)
E1,2					SPARK PLUG
C2					
CB1,2					CIRCUIT BREAKER (AC OUTPUT)
C4					CAPACITOR
BT1					BATTERY 12V
B1					STARTER MOTOR
A4					ELECTRONIC GOVERNOR
A3					REMOTE CONTROL-STANDARD
A2					REMOTE CONTROL-DELUXE
A1			C	REF	CONTROL ASSY-NHM
A1			C	REF	CONTROL ASSY-BGM

611-1196



WIRING DIAGRAM



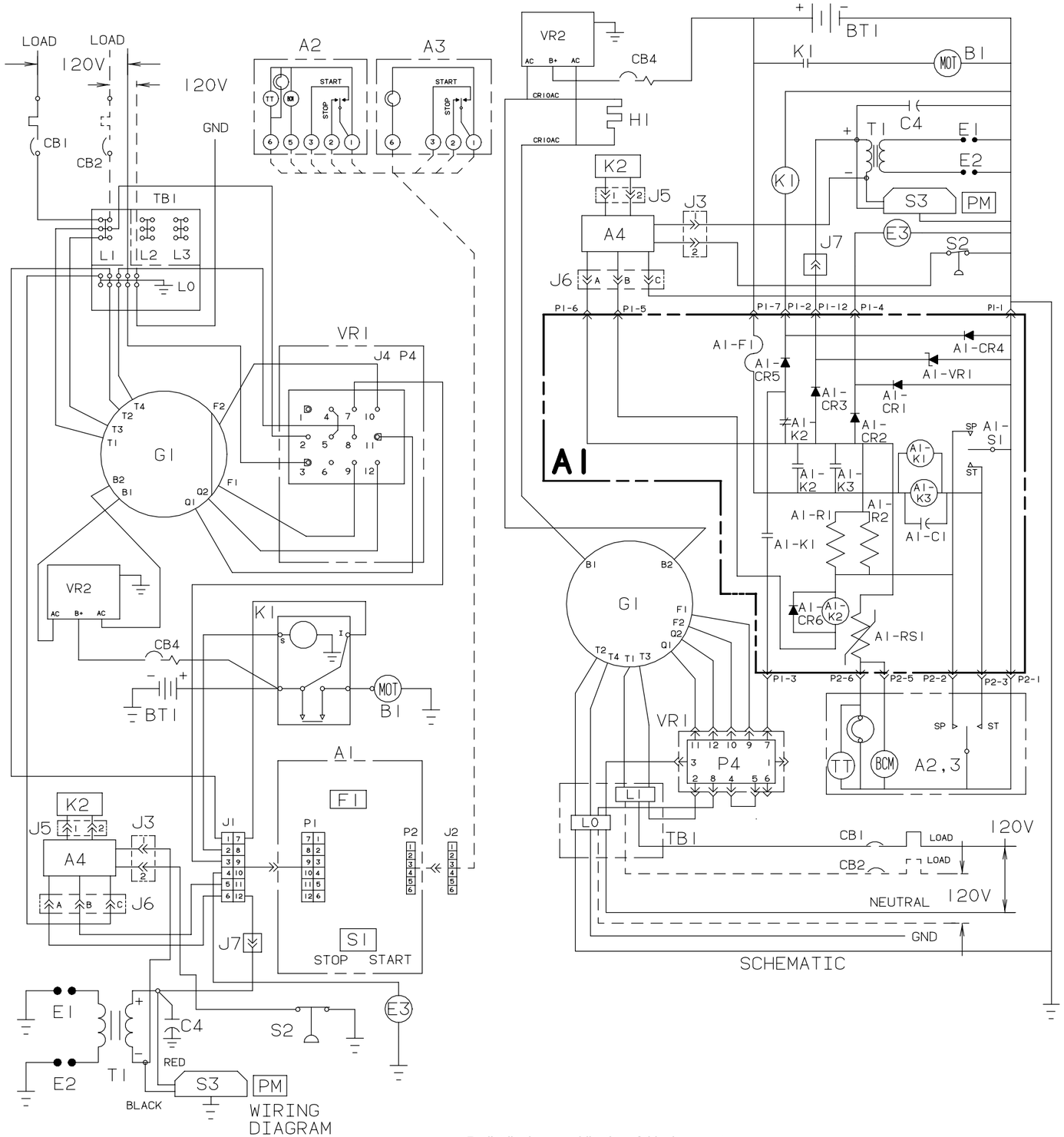
SCHEMATIC

NOTES:

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

QTY	ITEM	PART NO.	DEC S17F	DESCRIPTION OR MATERIAL
	VR1			VOLTAGE REGULATOR
	T1			IGN COIL
	S3			IGN MODULE
	S2			SWITCH-LOW OIL PRESSURE
	R1			RESISTOR-BATTERY CHARGE
	K4			RELAY
	K2			GOVERNOR ACTUATOR
	K1			RELAY-START SOLENOID
	H1			CHOKE
	G1			GENERATOR
	F2			FUSE-10A
	F1			FUSE-10A
	E4			SOLENOID FUEL VALVE
	E3			FUEL PUMP
	E1,2			SPARK PLUG
	CB1,2			CIRCUIT BREAKER (AC OUTPUT)
	C4			CAPACITOR
	BT1			BATTERY 12V
	B1			STARTER MOTOR
	A4			ELECTRONIC GOVERNOR
	A3			REMOTE CONTROL-STANDARD
	A2			REMOTE CONTROL-DELUXE
REF	A1		C	CONTROL ASSY-NHM
REF	A1		C	CONTROL ASSY-BGM

611-1219



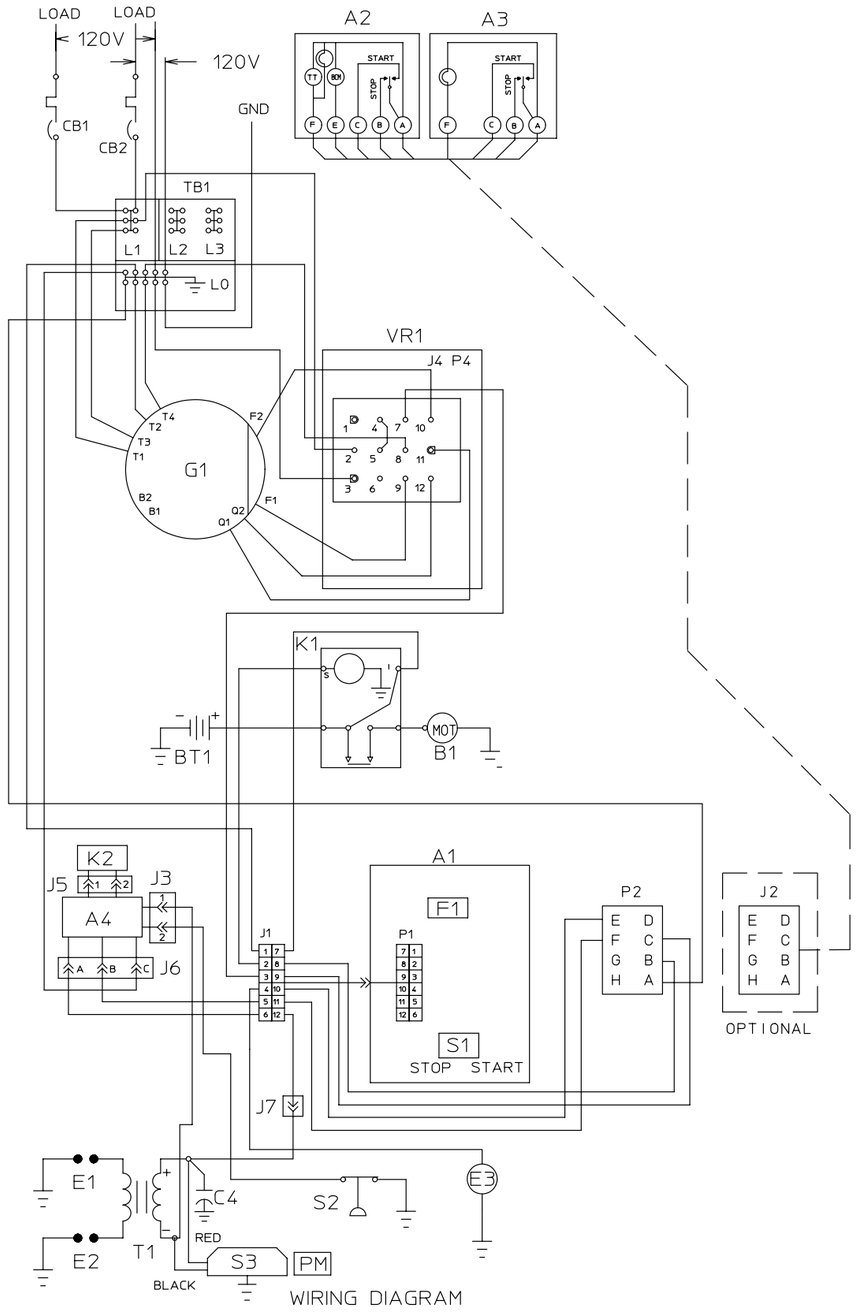
NOTES:

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

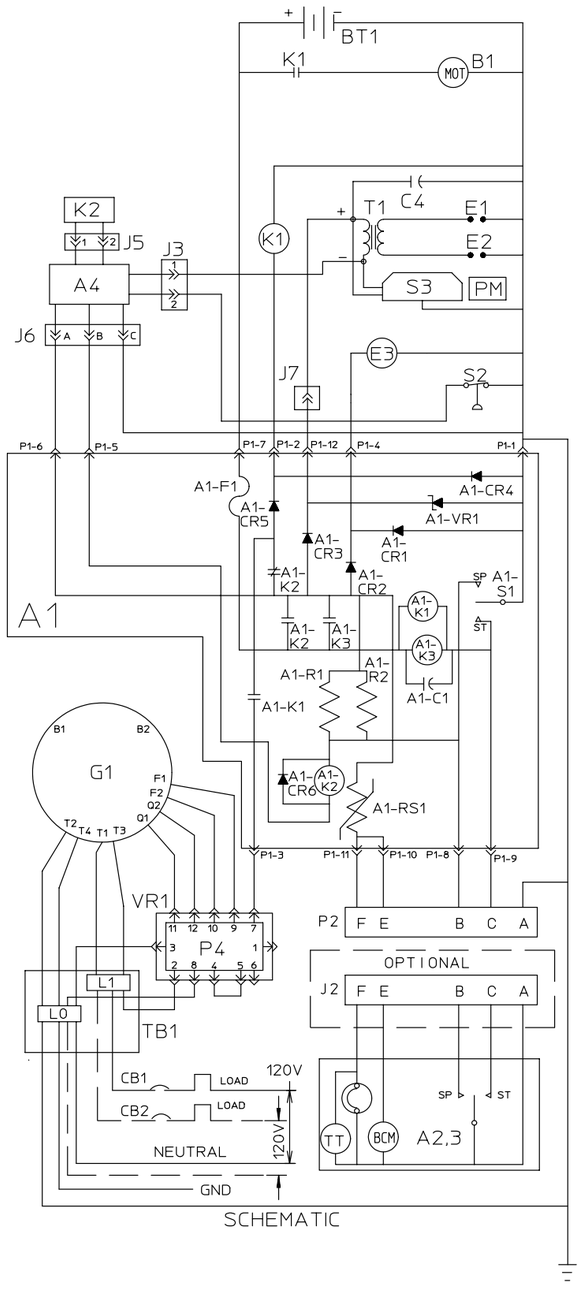
CLASSIFICATION OF CHARACTERISTICS
CRITICAL ●
MAJOR ◐ APPROVED B BERG
MINOR (NONE) DATE 01-25-95
LINE BELOW SYMBOL ● APPLIES TO UPPER LIMIT
LINE ABOVE SYMBOL ● APPLIES TO LOWER LIMIT
NO LINE WITH SYMBOL APPLIES TO BOTH LIMITS

ITEM	PART NO	*BULK	DWG SIZE	QTY	DESCRIPTION OR MATERIAL
H1					CHOKE-LP ONLY
VR2					VOLTAGE REGULATOR DC
VR1					VOLTAGE REGULATOR AC
T1					IGN COIL
S3					IGN MODULE
S2					SWITCH-LOW OIL PRESSURE
K2					GOVERNOR ACTUATOR
K1					RELAY-START SOLENOID
G1					GENERATOR
F1					FUSE-5A
E3					SOLENOID FUEL VALVE
E1,2					SPARK PLUG
CB4					CIRCUIT BREAKER-THERMAL
CB1,2					CIRCUIT BREAKER (AC OUTPUT)
C4					CAPACITOR
BT1					BATTERY 12V
B1					STARTER MOTOR
A4					ELECTRONIC GOVERNOR
A3					REMOTE CONTROL-STANDARD
A2					REMOTE CONTROL-DELUXE
A1			C	REF	CONTROL ASSY-NHM
A1			C	REF	CONTROL ASSY-BGM

611-1233



WIRING DIAGRAM



SCHEMATIC

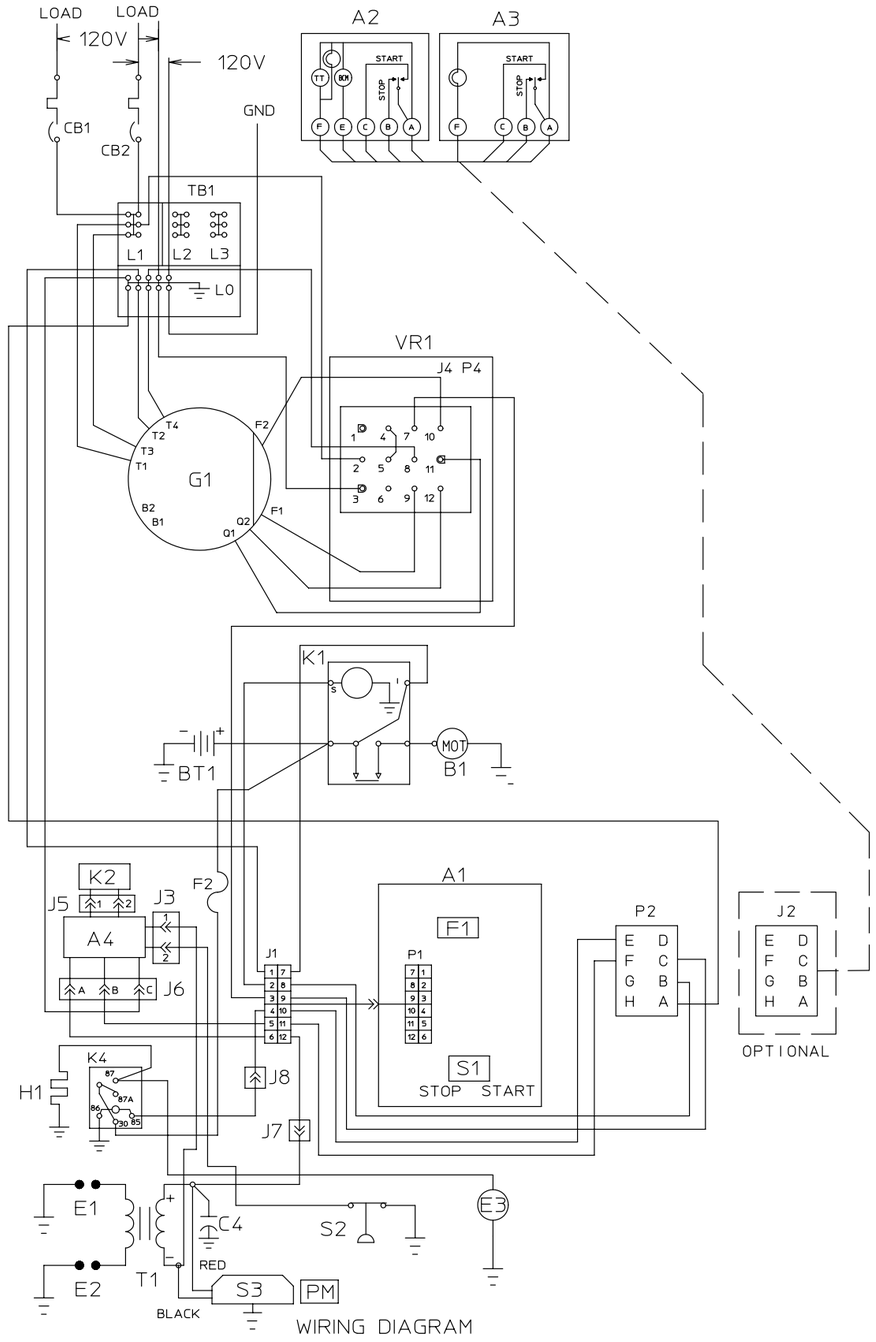
NOTES:

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

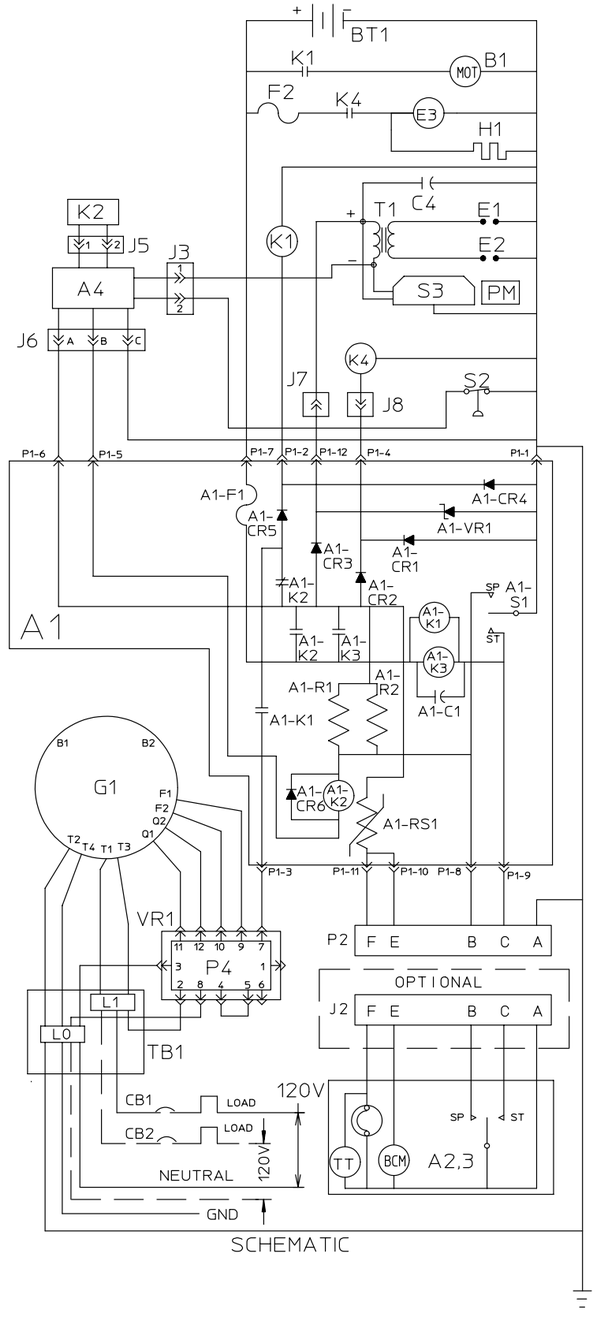
2. FOR P2 / J2:
   A = GROUND
   B = RMT STOP
   C = RMT START
   E = SW B+
   F = SW B+

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

611-1250



WIRING DIAGRAM



SCHEMATIC

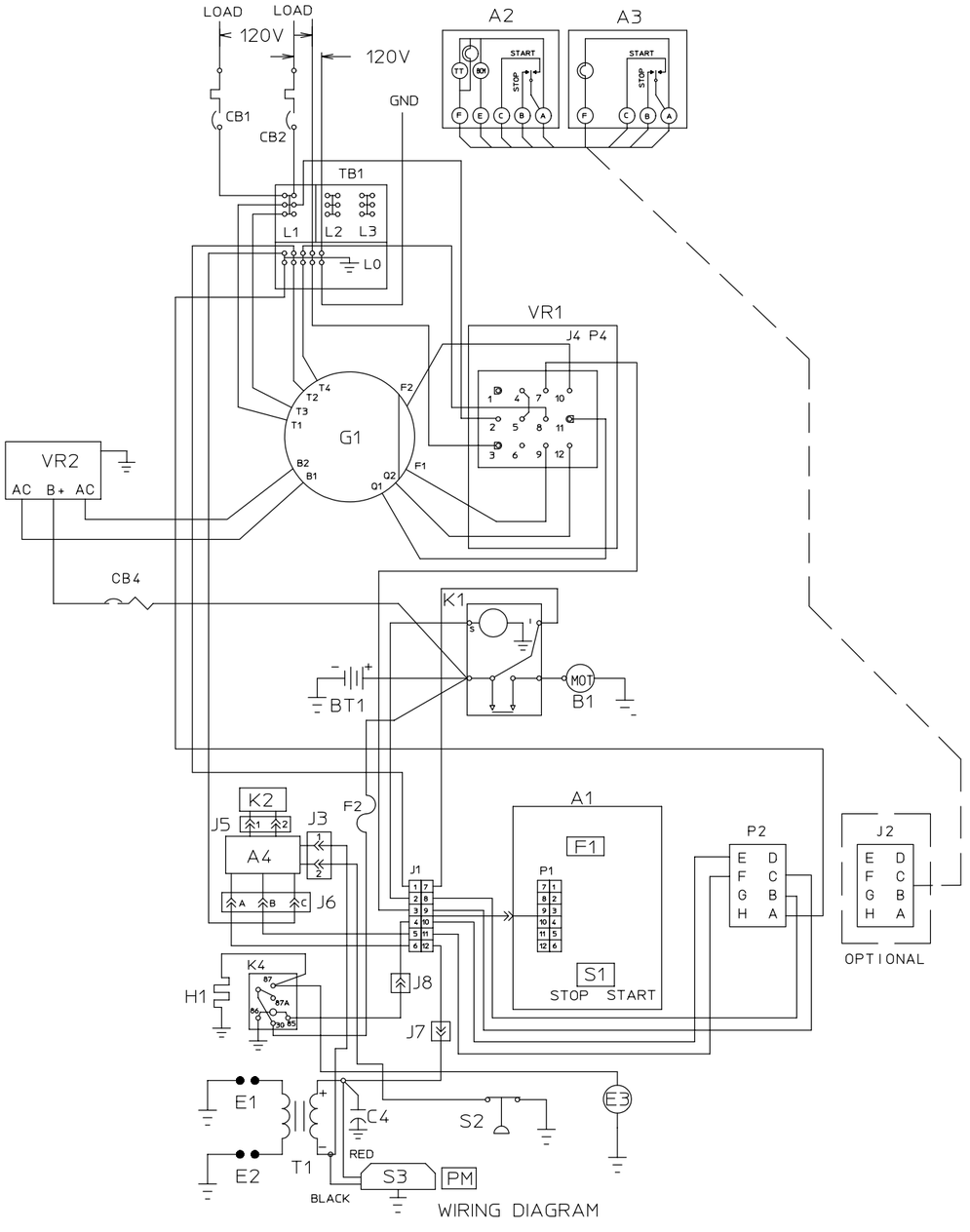
NOTES:

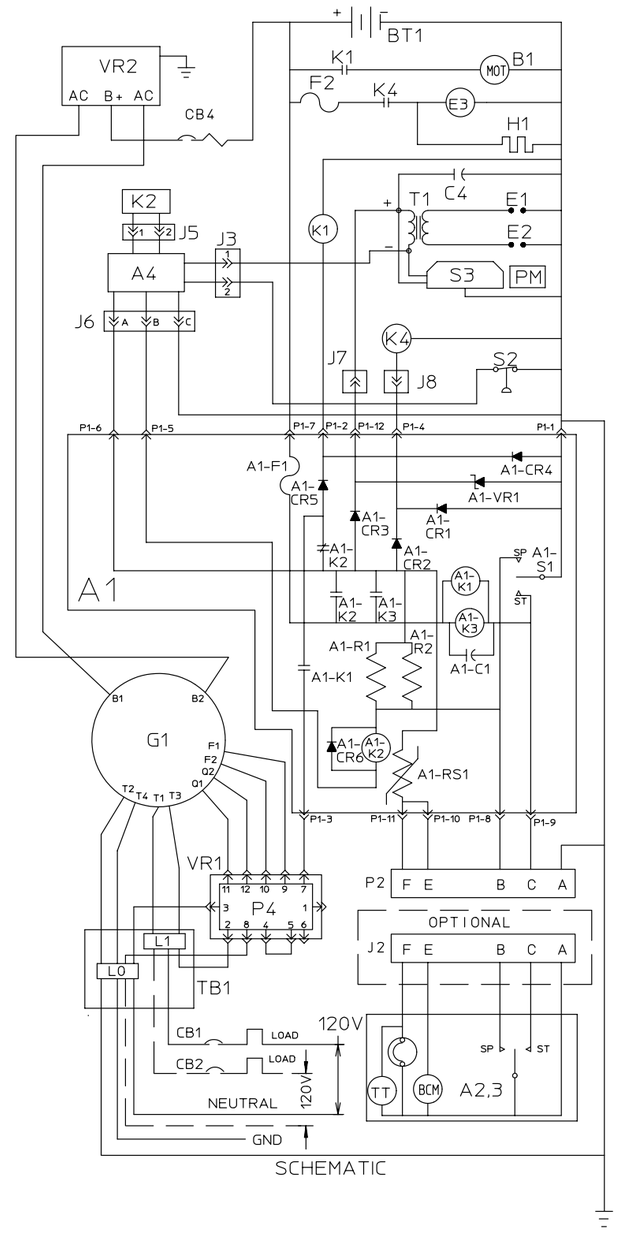
1. ALL ELECTRICAL COMPONENTS ARE DRAWN IN THE DE-ENERGIZED POSITION.

2. FOR P2 / J2:
   A = GROUND
   B = RMT STOP
   C = RMT START
   E = SW B+
   F = SW B+

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

611-1240





NOTES:

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

2. FOR P2 / J2:
   A = GROUND
   B = RMT STOP
   C = RMT START
   E = SW B+
   F = SW B+

QTY	ITEM	PART NO.	DWG SIZE	DESCRIPTION OR MATERIAL
	VR2			VOLTAGE REGULATOR (DC)
	VR1			VOLTAGE REGULATOR (AC)
	T1			IGN COIL
	S3			IGN MODULE
	S2			SWITCH-LOW OIL PRESSURE
	K4			RELAY
	K2			GOVERNOR ACTUATOR
	K1			RELAY-START SOLENOID
	H1			CHOKE
	G1			GENERATOR
	F2			FUSE-10A
	F1			FUSE-10A
	E3			FUEL PUMP
	E1,2			SPARK PLUG
	CB4			CIRCUIT BREAKER, THERMAL
	CB1,2			CIRCUIT BREAKER (AC OUTPUT)
	C4			CAPACITOR
	BT1			BATTERY 12V
	B1			STARTER MOTOR
	A4			ELECTRONIC GOVERNOR
	A3			REMOTE CONTROL-STANDARD
	A2			REMOTE CONTROL-DELUXE
REF	A1			CONTROL ASSY-NHM
REF	A1			CONTROL ASSY-BGM

611-1251

Onan

Cummins Power Generation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
763-574-5000
Fax: 763-528-7229