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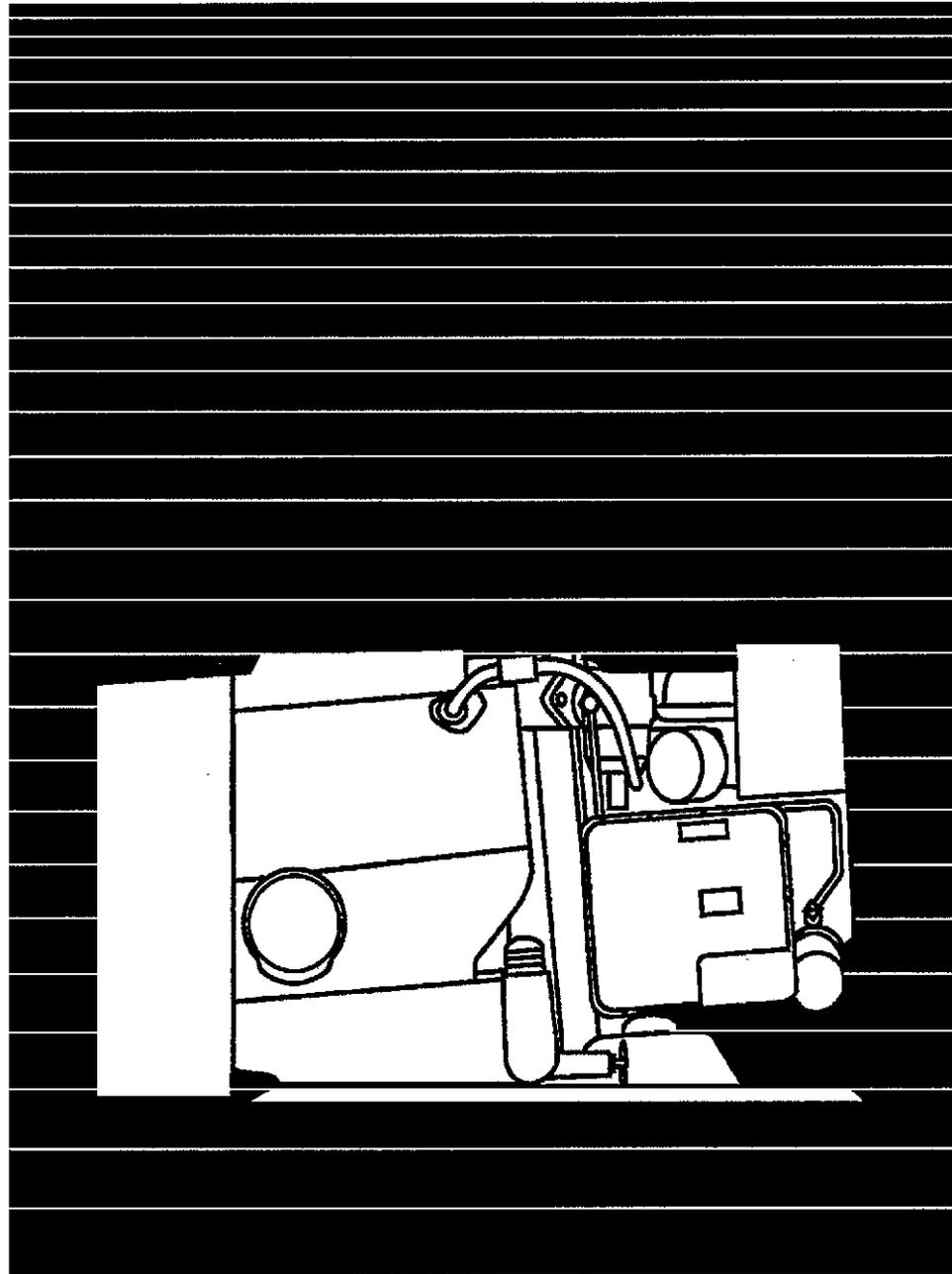
Onan

RV GenSet

Service Manual

BGE, NHE

Emerald Plus™ Series



Printed in U.S.A.

965-0528

(BGE Spec F through K, NHE Spec E through K)

9-94

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

Supplement 965-1060

Date: 11-95

Insert with-

Title: BGE/NHE Service Manual

Number (Date): 965-0528 (9-94)

PURPOSE

This Supplement supercedes Supplement 965-1055. It transmits the revisions to the Service Manual necessary for covering all **Spec M** generator sets: gasoline fueled and LPG fueled. Note that the nameplate on a Spec M generator set will have the statement: "This engine meets 1995-1998 California emissions regulations for ULGE engines."

To satisfy California emissions regulations Spec M generator sets have internal engine modifications and precision-manufactured carburetors with tamper-resistant fuel mixture jets and tamper-resistant LPG demand regulators. It should therefore be noted that fuel mixture and LPG lock-off pressure adjustments should not be attempted. Nor should the carburetor or LPG demand regulator be overhauled. Instead, a malfunctioning carburetor or LPG demand regulator should be replaced (see TROUBLESHOOTING ENGINE PRIMARY SYSTEMS in Section 6).

⚠ 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.*

Modification, removal or replacement of the generator set label is also prohibited.

SERVICE MANUAL 965-0528 REVISIONS

1. **Insert this Supplement in its entirety under the front cover of the manual.** (Discard any copy of Supplement 965-1055.)
2. On **Page 1-1** write: "See Operator's Manual for fuel and engine oil recommendations and Periodic Maintenance."
3. On **Page 2-1** write: "For Spec M and later, ignition timing (non-adjustable) is 12° BTDC."
4. On **Page 5-4** write: "See Page S-2 of Supplement 965-1060 for instructions on how to purge LPG and disconnect the genset from RV systems." Cross out the instructions under the subheadings *LP-Gas (Propane) Purging Procedure* and *Disconnecting Set from RV Systems* on Page 5-4.
5. On **Page 6-15** under the heading GOVERNOR, write: "See Supplement 965-1060 for Spec M and Later."
6. On **Page 6-17** under the heading FUEL SYSTEM-GASOLINE, write: "See Supplement 965-1060 for Spec M and Later."
7. On **Page 6-25** under the heading FUEL SYSTEM—LPG LIQUID WITHDRAWAL, write: "See Supplement 965-1060 for Spec M and Later."
8. On **Page 6-31** under the heading FUEL SYSTEM—LPG VAPOR WITHDRAWAL, write: "See Supplement 965-1060 for Spec M and Later."

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

Disconnecting Set from RV Systems (All Specs)

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 and then remove the muffler. See EXHAUST SYSTEM under *Engine Subsystems*.
5. Disconnect the fuel 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 pos-

sible, run the genset (if it starts) until it runs out of fuel with the LPG valve(s) closed.

⚠ 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.

For LPG liquid-withdrawal systems (see Figure S-6) push the regulator priming button while cranking for 10 seconds to purge some of the remaining LPG. Then loosen the threaded flexible fuel supply hose connector at the fuel filter on the genset just enough to hear gas escaping. Unthread the connector when no more gas is heard escaping. Finally, cap the end of the fuel supply hose 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.

For LPG vapor-withdrawal gensets (see Figure S-10) 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).

FUEL SYSTEM (BEGINNING SPEC M)

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 S-1 is representative of most of the fuel system parts. LPG (liquified petroleum gas) systems do not use an air preheater or choke and have different fuel connections. See Automatic Choke, Fuel Pump and LPG System Components in this section for details of the other parts of the fuel system.

⚠ 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. 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.)

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

⚠ CAUTION Take care not to cross-thread the inside adapter mounting screw.

Carburetor And Intake Manifold Assembly

Disassembly:

1. Remove the air cleaner assembly.
2. Disconnect the fuel line and governor rod from the carburetor.

⚠ WARNING Large volumes of LPG can be released in the process of disconnecting a liquid-withdrawal type of LPG supply system. See Disconnecting Set from RV Systems (Page S-2) for the proper procedures and precautions.

3. Remove the intake manifold capscrews, the carburetor air preheater (gasoline gensets only) and the carburetor and intake manifold as an assembly. On LPG gensets equipped for liquid withdrawal, it will first be necessary to disconnect the fuel vaporizer (the tube wrapped around the exhaust manifold) at both ends, remove the pressure regulator, disconnect the vaporizer line from its support bracket and rotate the vaporizer line out of the way.

⚠ 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.

4. Remove the two intake manifold gaskets and cover the intake ports to prevent loose parts from accidentally entering the ports.
5. 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 Assembly Torques.

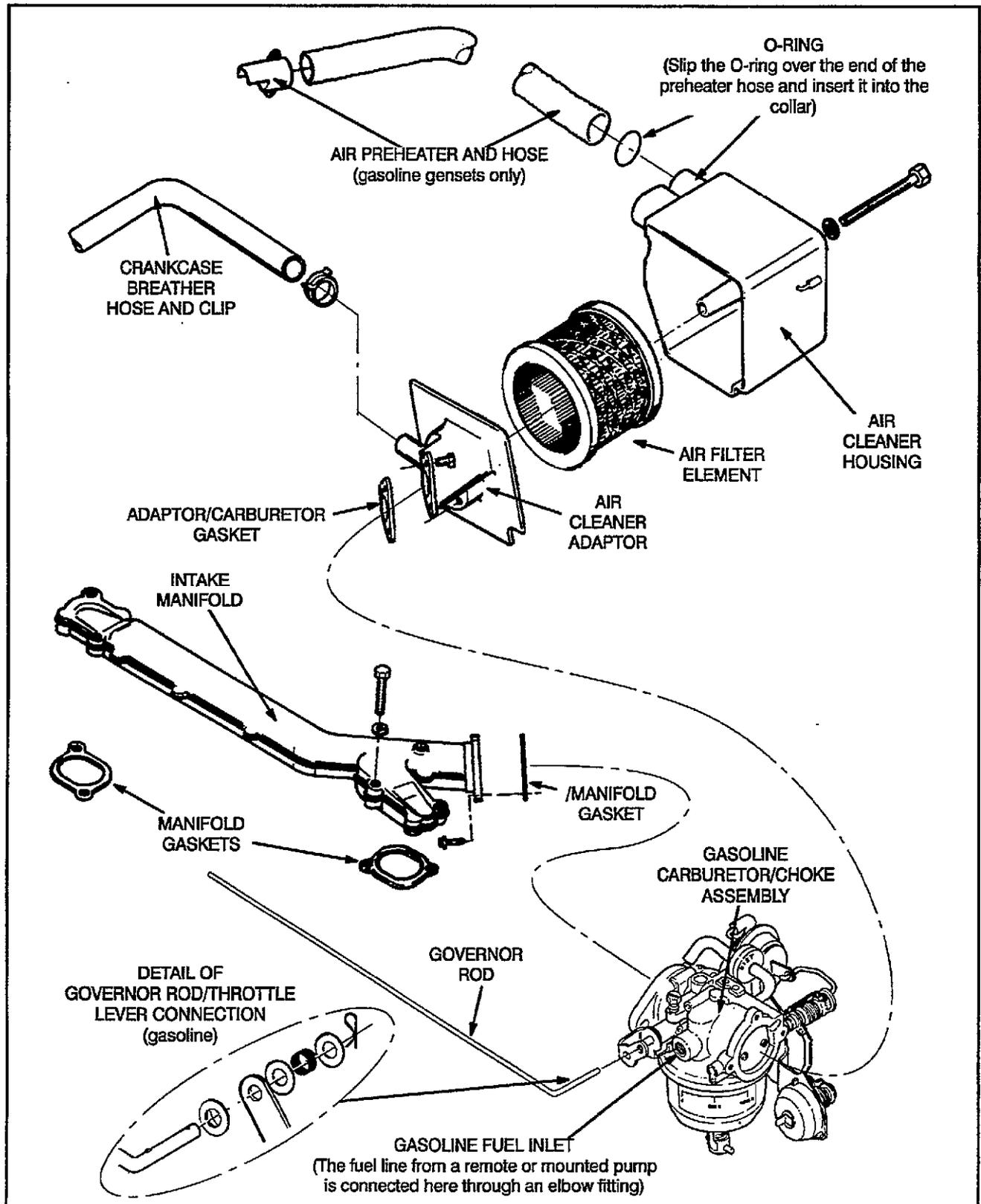


FIGURE S-1. TYPICAL FUEL SYSTEM

Governor and Carburetor Adjustments

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.

These adjustments 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.

It is recommended that the genset be disconnected from the AC service panel of the vehicle. If the genset is not disconnected, disconnect or unplug all voltage and frequency sensitive devices throughout the vehicle to protect them from the variations in frequency and voltage that occur during these adjustments.

⚠ WARNING *Disconnect or unplug all voltage and frequency sensitive devices such as TV's, VCR's, 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.*

Consequential damage to TV's, VCR's, computers and other voltage and frequency sensitive devices as a result of failing to observe this precaution is not covered under the Onan warranty policy.

Governor Rod Length Adjustment: The length of the governor rod (Figure S-2) must be checked and adjusted as follows before other adjustments are attempted:

1. Loosen the lock nut at the ball joint end of the governor rod and unsnap the socket from the ball.
2. 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.*

3. Snap the socket back over the ball.
4. 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.
5. Gently rotate the governor arm and check for binding. If necessary, loosen the locknut and repeat Step 4 until the linkage moves smoothly. Binding can cause erratic governor action.

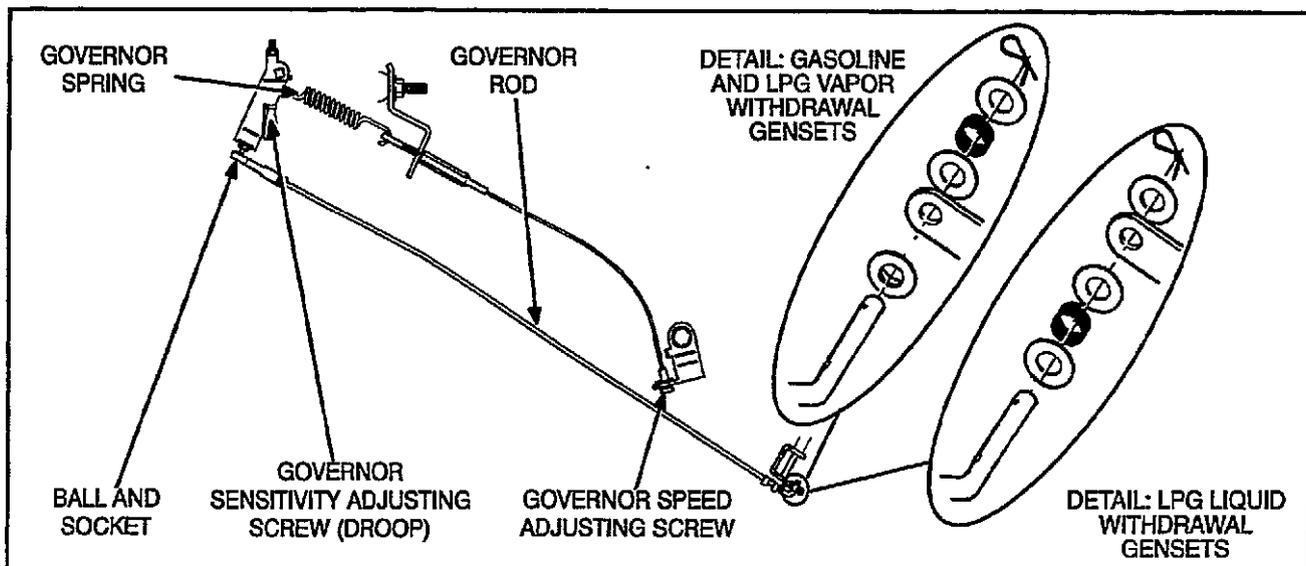


FIGURE S-2. GOVERNOR ROD

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

Idle Speed Stop Adjustment: The frequency specifications for 60 Hz gensets are followed in parentheses by the specifications for 50 Hz gensets.

1. 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 to first adjust the supply pressure as instructed under LPG System Components to get the genset to start.)
2. 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 (44-46 Hz). (On LPG carburetors the stop screw has a locknut.)

Frequency Adjustments: The frequency specifications for 60 Hz gensets are followed in parentheses by the specifications for 50 Hz gensets.

1. Set the altitude adjust knob (gasoline only) on the carburetor to your altitude.
2. Disconnect all loads (check for zero amps). Then check no-load frequency. If necessary, turn the governor speed adjusting screw to obtain a no-load frequency of 62-63 Hz (51.5-52.5 Hz).
3. Check output voltage. See *Generator* if output voltage cannot be adjusted to within 10 percent of rated voltage (Table S-1).
4. See *Troubleshooting* if the engine runs roughly.

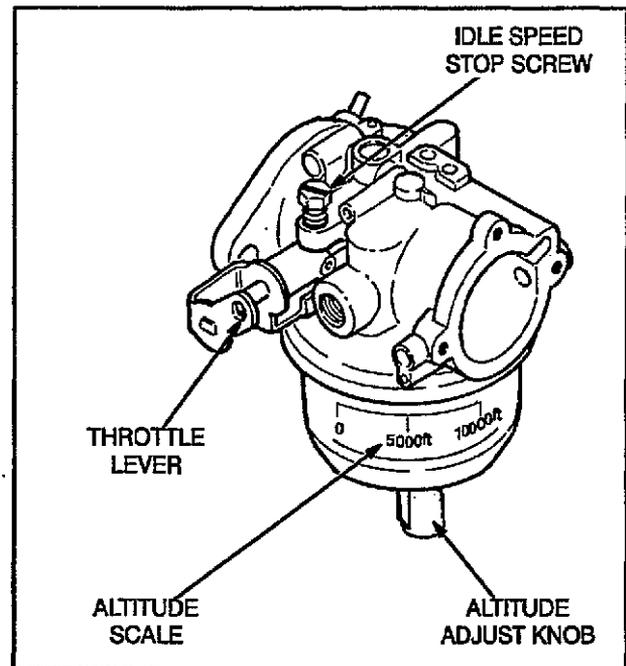


FIGURE S-3. GASOLINE CARBURETOR

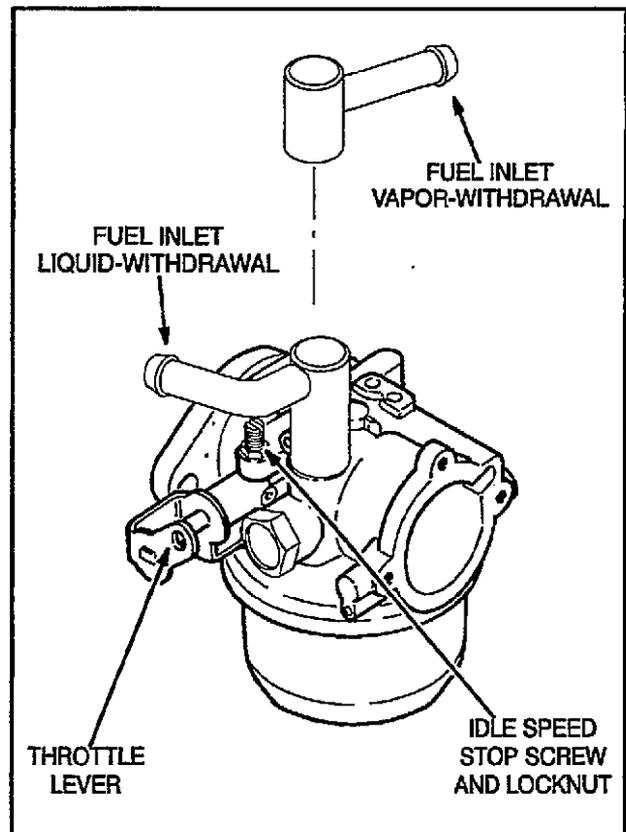


FIGURE S-4. LPG CARBURETOR

Drop Adjustments: The frequency specifications for 60 Hz gensets are followed in parentheses by the specifications for 50 Hz gensets.

1. Connect rated load.

- A. Load (watts) is the product of volts (V) and amps (A).

$$\text{Load (watts)} = V \times A$$

(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 *Generator* if output voltage cannot be adjusted to within 10 percent of rated voltage (Table S-1).

TABLE S-1. VOLTAGE SPECIFICATION

RATED OUTPUT VOLTAGE	MAXIMUM NO-LOAD VOLTAGE	MINIMUM FULL-LOAD VOLTAGE
120V, 1PH	132	112
120/240V, 1PH	264	224

2. Check and adjust droop.

- A. If droop (from no-load frequency) is more than 3 Hz (3.5 Hz) for Model BGE or 4 Hz (3.5 Hz) for Model NHE, turn the governor sensitivity adjusting screw (Figure S-2) one turn counterclockwise. Disconnect the load and, if necessary, readjust the governor speed adjusting screw to return to 62-63 Hz (51.5-52.5 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 (2 Hz) for Model BGD or 3 Hz (2 Hz) for Model NHD, turn the governor sensitivity adjusting screw (Figure S-2) one turn clockwise. Disconnect the load

and, if necessary, readjust the governor speed adjusting screw to return to 62-63 Hz (51.5-52.5 Hz) no-load frequency. Check droop again and repeat the adjustments, if necessary.

- 3. Check governor response under 1/4, 1/2 and 3/4 rated loads. See *Troubleshooting* if hunting is unacceptable.

Carburetor Replacement

Other than turning the altitude adjust knob shown in Figure S-3, which changes the main fuel mixture within a limited range (gasoline carburetors only), fuel mixture adjustments should not be attempted on gasoline or LPG carburetors. Nor should the carburetor be overhauled. Instead, a malfunctioning carburetor should be replaced. Before replacing a carburetor, however, make certain 1) that all other necessary engine and generator adjustments and repairs have been performed and 2) that the carburetor is actually malfunctioning, by carefully following the troubleshooting procedures in *Troubleshooting*.

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.*

See the instructions on how to remove and replace the carburetor under the subheadings AIR CLEANER ASSEMBLY and CARBURETOR AND INTAKE MANIFOLD ASSEMBLY in this section.

Automatic Choke (Gasoline Sets)

See Figure S-5. The automatic choke is operated by a bi-metal/heater assembly and a vacuum breaker assembly. Replace faulty choke components and reassemble as shown. Adjust the choke breaker assembly each time it is assembled to the carburetor, as follows:

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

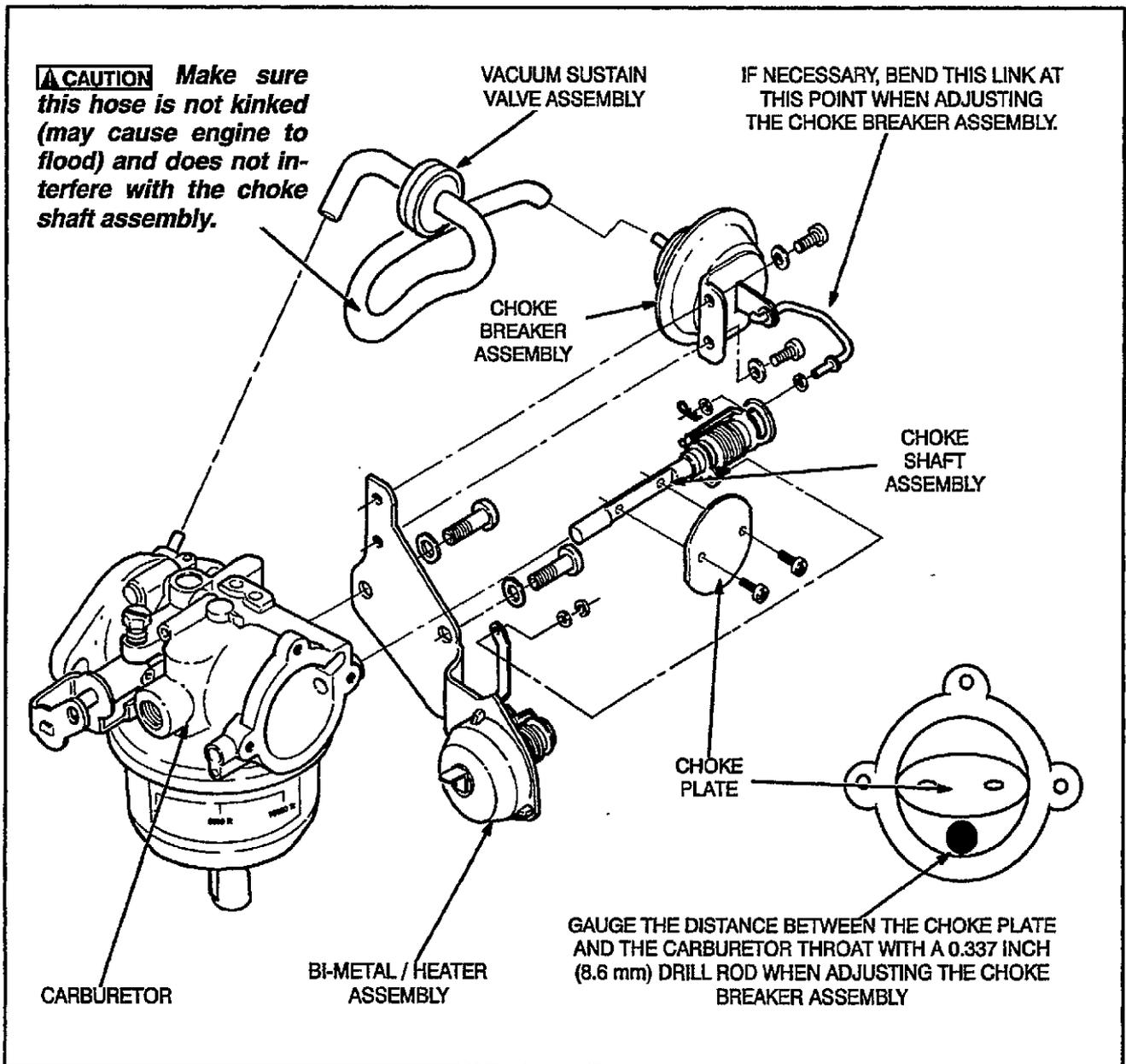


FIGURE S-5. CHOKE ASSEMBLY

Fuel Pump (Gasoline Gensets)

The fuel pump delivers fuel to the carburetor at 3.5-5 psi (24-35 kPa) and has a lift capacity (suction) of 3 feet (0.9 meters).

⚠ 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.*

Fuel Pressure Test:

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. The pump will have to be relocated closer to the fuel tank if it is located more than 3 feet (0.9 meters) above the end of the fuel pickup tube in the fuel tank. If the pump is defective, replace it with the appropriate Onan pump. The pump is not serviceable.

See the Installation Manual for important recommendations regarding the fuel supply system.

LPG System—Liquid Withdrawal

See Figure S-6. 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 Disconnecting Set from RV Systems (Page S-2) for the proper procedures and precautions.*

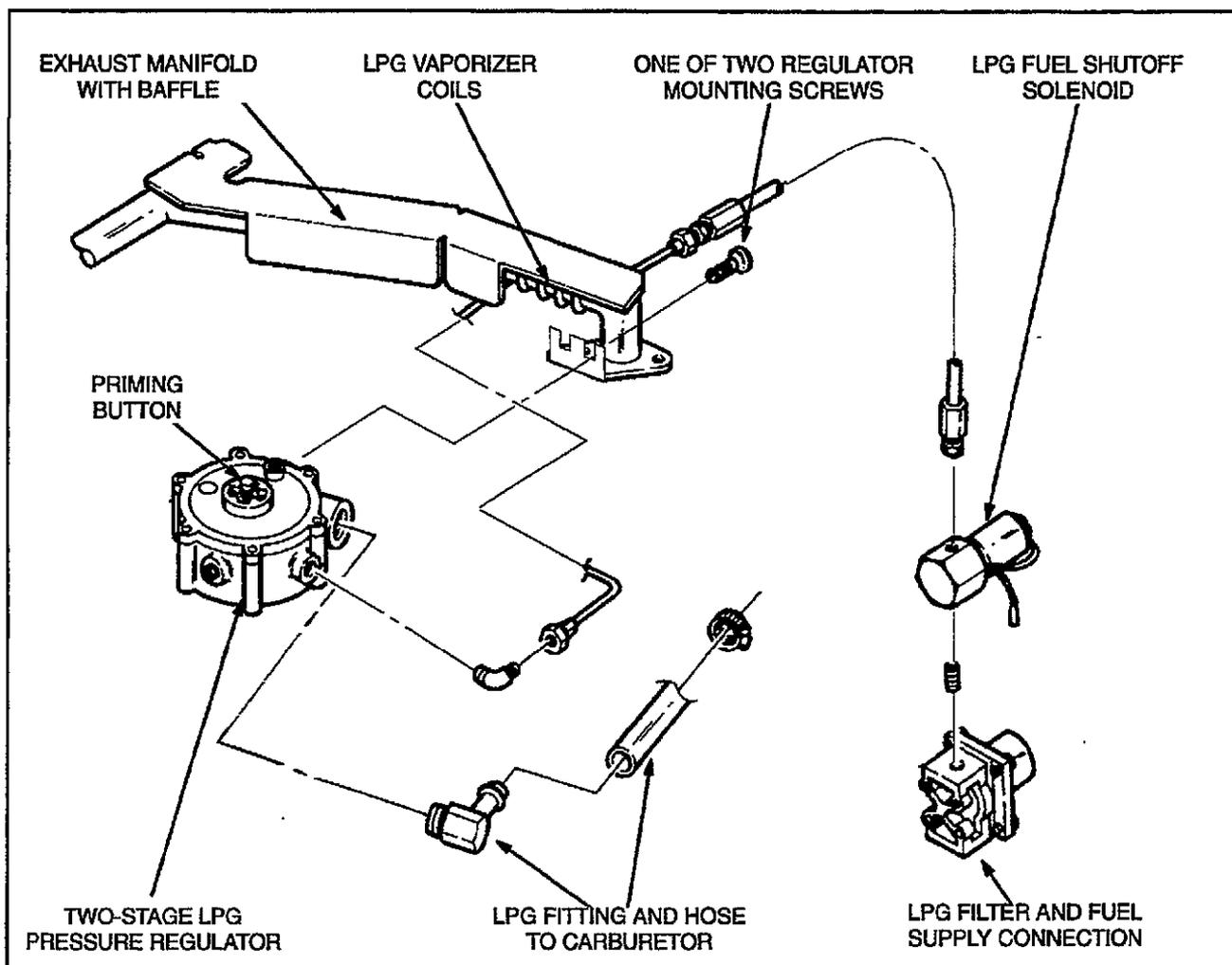


FIGURE S-6. LPG SYSTEM COMPONENTS FOR LIQUID WITHDRAWAL

Demand Regulator: See Figure S-7. 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 1-1/2 psi (10.3 kPa). The secondary stage is a demand regulator that delivers LPG vapor at the rate demanded by the carburetor.

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

- Hardened diaphragms and valve seats. The pressure regulator in a genset that has been operated and then stored for a long time might require replacement because diaphragms, gaskets and valve seats tend to shrink and harden over time.
- Fuel impurities and oils dissolved in the liquid LPG. Impurities can form granules that become embedded in the secondary valve seat causing it to leak and oils can clog passages inside the regulator. The results could be hard starting, erratic idling and poor load acceptance.

Testing the Demand Regulator: Use compressed air and a pressure gauge to test the regulator as follows:

1. Connect a pressure gauge to the test port on the back of the regulator.
2. Connect a source of compressed air (at least 80 psi [550 kPa]) to the inlet opening and open the air pressure valve.
3. If the primary valve is sound, the gauge will indicate approximately 1-1/2 psi (10.3 kPa) and the pressure will remain constant. Fluctuating pressure indicates a leaking primary valve seat.
4. Close the air pressure valve and observe the pressure gauge. The pressure should remain constant. If the pressure drops, the secondary valve seat is leaking.
5. Disassemble and clean the regulator assembly if it does not pass either test. Replace the regulator if it still does not pass either test.

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

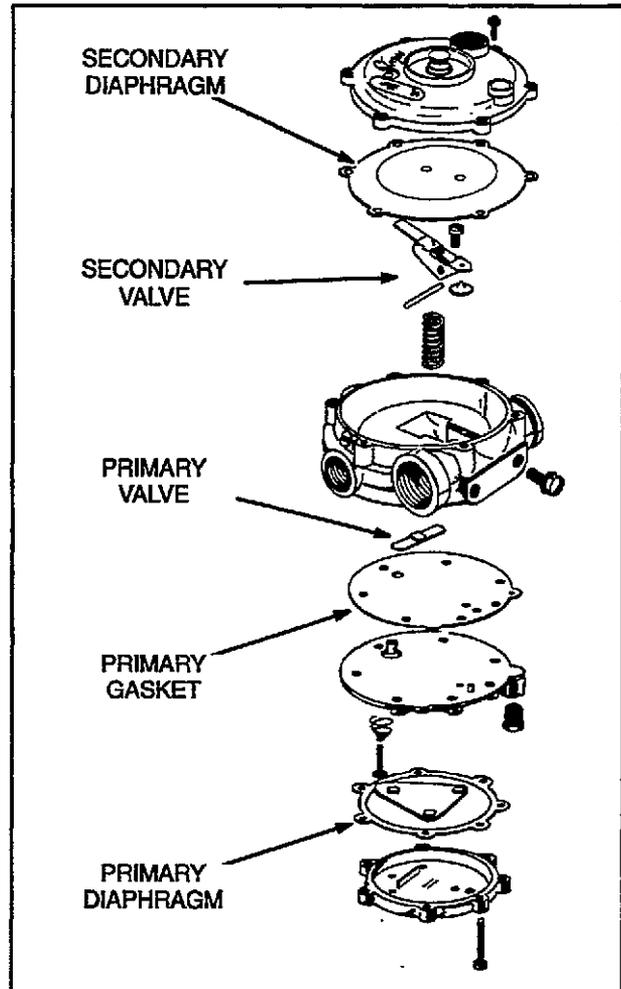


FIGURE S-7. DEMAND REGULATOR ASSEMBLY

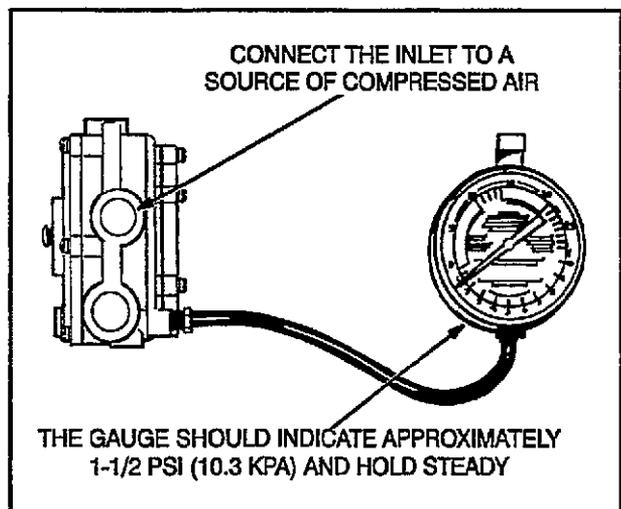


FIGURE S-8. TESTING THE DEMAND REGULATOR (LIQUID-WITHDRAWAL SYSTEM)

Fuel Filter: See Figure S-9. 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 on Page S-2 before beginning disassembly.
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 kerosene 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.
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 lb-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 several wraps of tubing around the exhaust mani-

fold. Exhaust heat vaporizes the LPG liquid. The vaporizer is not removable from the exhaust manifold.

⚠WARNING *Bending the fuel vaporizer tubing could weaken it to the point that it could crack allowing fuel under high pressure to escape, which could result in severe personal injury or death.*

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.

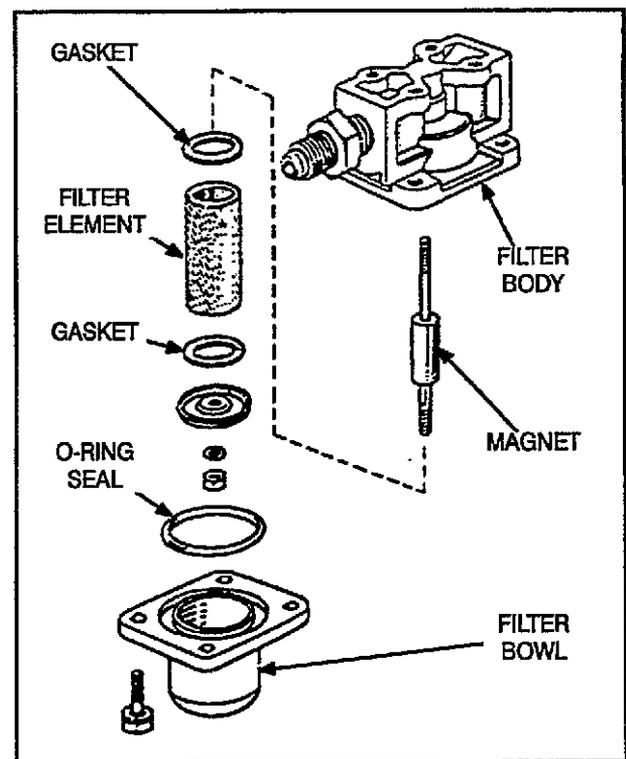


FIGURE S-9. LPG FUEL FILTER (LIQUID WITHDRAWAL SYSTEM)

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 de-

mand regulator. These are available as a kit for mounting near the genset. See Figure S-10.

⚠ 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.*

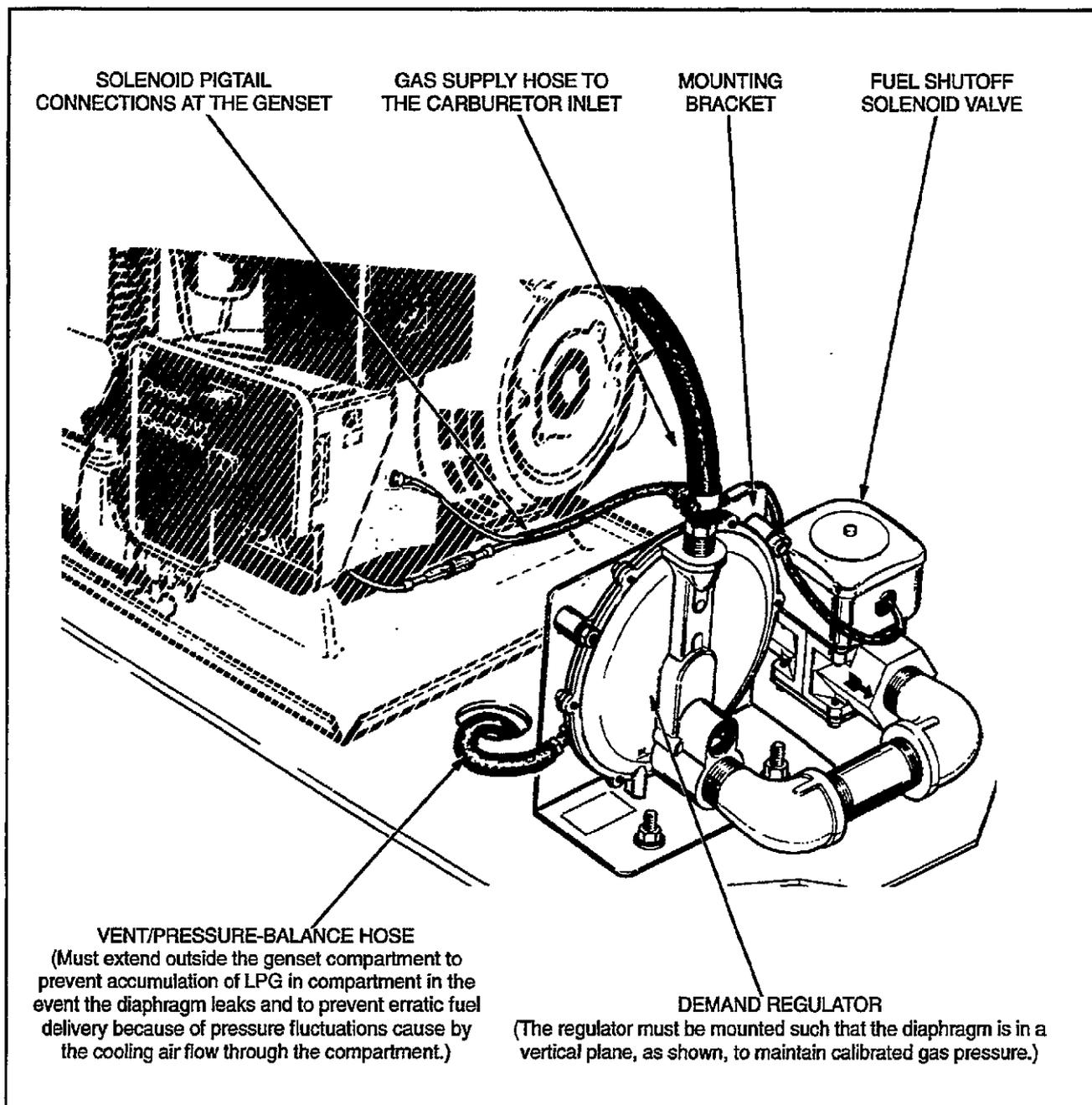


FIGURE S-10. LPG SYSTEM COMPONENTS FOR VAPOR WITHDRAWAL

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 S-11) and connect a manometer calibrated in inches or mm WC (water column) 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 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 S-11. If the regulator is being tested on the bench, connect it to a source of air pressure regulated to 11 inches WC (280 mm WC).

CAUTION *If this is a bench test of the regulator, make sure the diaphragm is in a vertical plane (see Figure S-10), 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 0.1 mm divisions and having a range of at least 1 inch (25 mm).

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.)

Replace the demand regulator if the lock-off pressure does not fall between 0.15 and 0.25

inches 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.*

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.

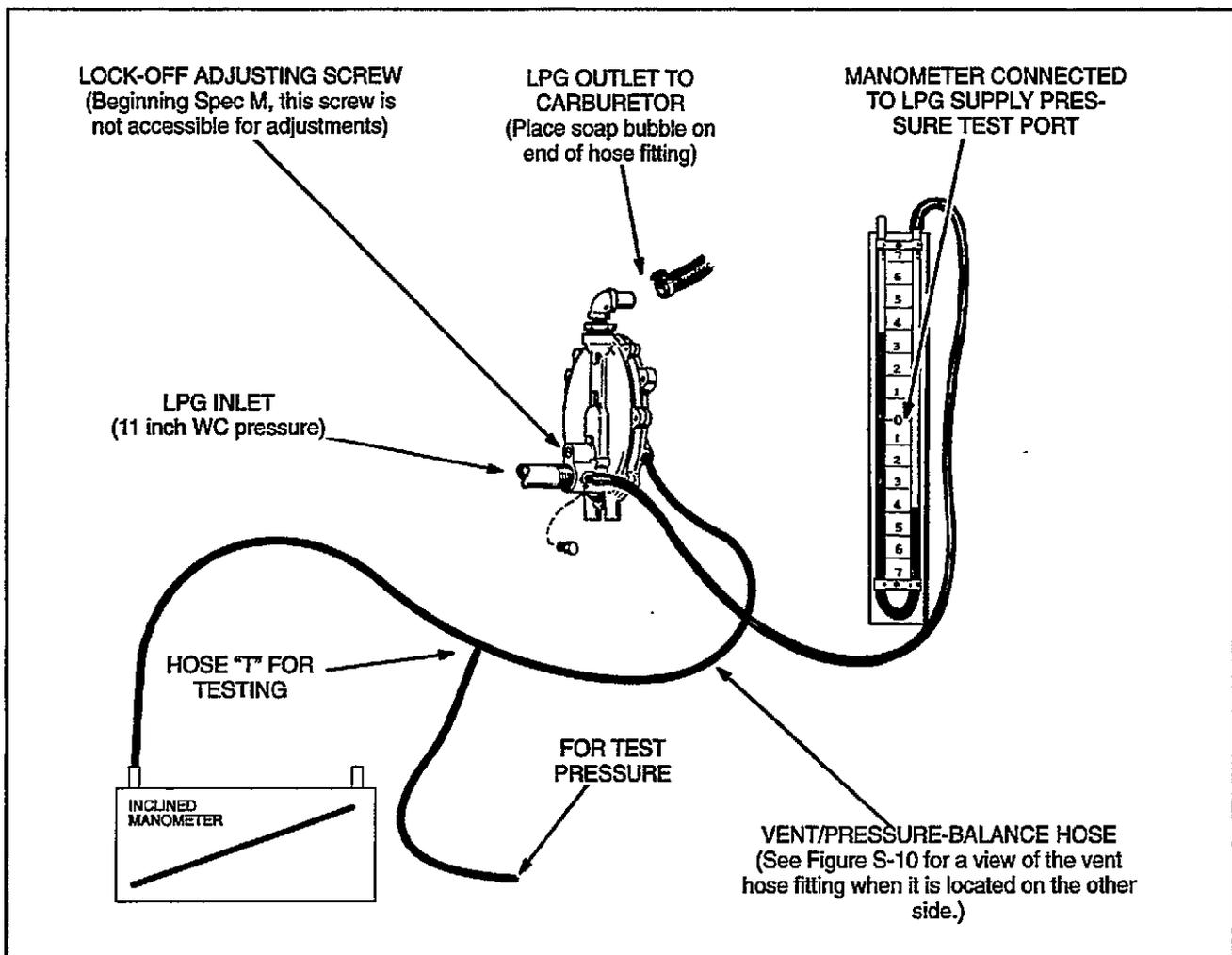


FIGURE S-11. LPG SUPPLY PRESSURE AND REGULATOR LOCK-OFF PRESSURE

Supplement 965-1065

Date: 1-97

Insert with-

Title: BGE/NHE Service Manual

Number (Date): 965-0528 (9-94)

PURPOSE

This Supplement is used in addition to Supplement 965-1060. It transmits the revisions to the Service Manual necessary for covering all changes made since Supplement 965-1060 was issued.

SERVICE MANUAL 965-0528 REVISIONS

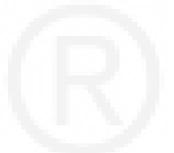
1. **Insert this Supplement in its entirety under the front cover of the manual.** (Do *not* discard Supplement 965-1060.)
2. On **Page 2-2** replace Figure 2-1 with Figure S-1 on Page S-2 of this supplement.



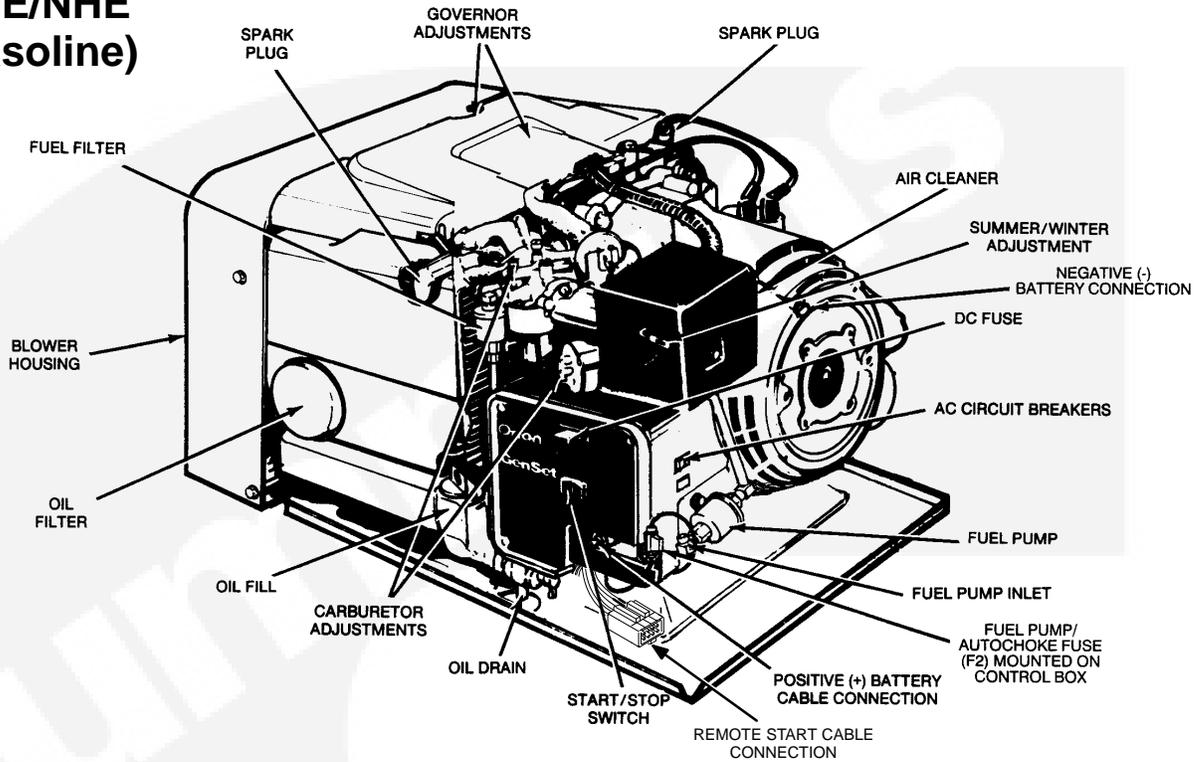
WARNING:



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



BGE/NHE (Gasoline)



BGE/NHE (LPG)

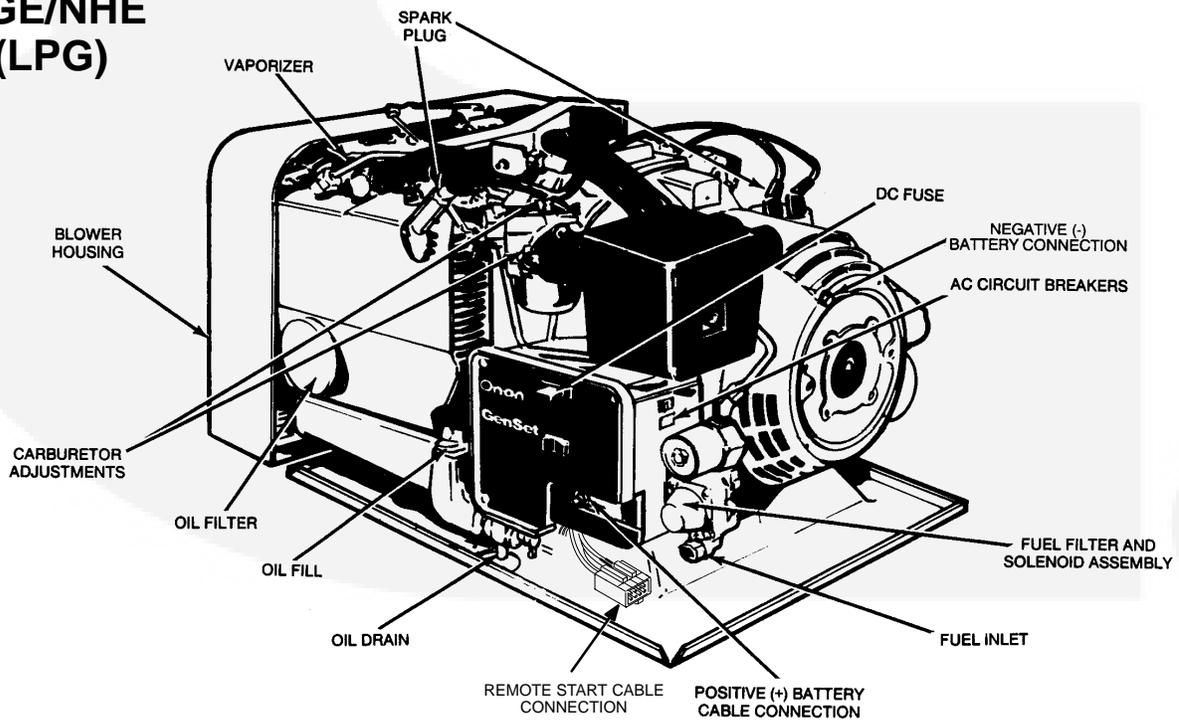


FIGURE S-1. TYPICAL EMERALD GENERATOR SETS

-
3. On **Page 7-5** replace Figure 7-3a with Figure on Page of this supplement.



Supplement 965-1069
Date: 11-98
Insert with-
Title: BGE/NHE Service Manual
Number (Date): 965-0528 (9-94)

PURPOSE

This Supplement transmits the revisions to the Service Manual necessary to cover changes beginning with **Spec N** gensets. Gensets beginning with Spec N have a sealed-type remote control connector and single, 16-pin connector on the genset control board.

SERVICE MANUAL 965-0528 REVISIONS

1. **Do not discard Supplement 965-1060, which covers changes beginning with Spec M.**
2. Look for statement "BGE Spec F through K, NHE Spec E through K" on the front cover. Strike out the "K" in both places and write in "P" in both places.
3. On **Page 6-14**, Step 6, change "12.6 and 15.4k ohms" to "12.6~~k~~ and 15.4k ohms."
4. On **Page A-1** (Appendix A) write:
"Prior to **Spec N**: In lieu of testing the connector pins with a meter, use control board tester No. 420-0572 and the appropriate adapter harness to determine whether a control board needs to be replaced. Follow Instruction Sheet G220 packaged with the tester."
"Beginning **Spec N**: See Page A-11."
5. Insert attached **Page A-11** after Appendix A Page A-10.
6. **Replace Page B-1** (Appendix B) with the attached **Page B-1** and **add** the attached **Pages B-8 through B-11**.
7. On **Page ii** (Table of Contents), change the Heading "**Appendix B SPEC J and K DIAGRAMS**", to "**Appendix B. Later Wiring Diagrams**".
8. On **Page ii** under **Appendix B. Later Wiring Diagrams** add the entries:
"Beginning Spec N:
BGE/NHE, 60 Hz (611-1244) B-8
BGE/NHE, 60 Hz, LP (611-1253) B-9
BGE/NHE, 50 Hz, LP (611-1254) B-10
BGE/NHE, 50 Hz (611-1248) B-11"

CONTROL BOARD TESTING (BEGINNING SPEC N)

If the genset does not crank, or cranks but does not start, and you think the cause might be a faulty control board, conduct the following tests to make sure.

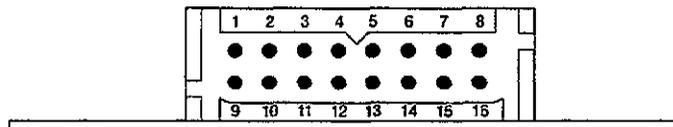
First remove the control panel and disconnect **P1/J1**. For easier test connections at **P1**, it is recommended that you make up a test harness with Onan 16-Socket Connector 323-1487-04 and Sockets 323-1486. Also, use alligator clips on the ends of the leads attached to pins **2, 4, 7** and **11** to

make for easier connections at the battery terminals.

Depending on results:

- Go back to *Troubleshooting* if a meter or light *does* indicate B+ at each pin in both tests: PC board **A1** is not faulty.
- Replace control PC board **A1** if a meter or light *does not* indicate B+ at each pin in both tests.

Tests	Results
1. Apply B+ (12 VDC) to P1-7 and B- to P1-11 and hold down the control switch in the Start position.	A meter or light should indicate B+ at: P1-1 (field flash) P1-9 (starter) P1-6 (ignition) P1-12 (fuel and choke)
2. Continuing Step1, apply B+ to P1-2 and B- to P1-4 , to simulate start disconnect, and then let go of the Start switch.	A meter or light should continue to indicate B+ at: P1-6 (ignition) P1-12 (fuel and choke)



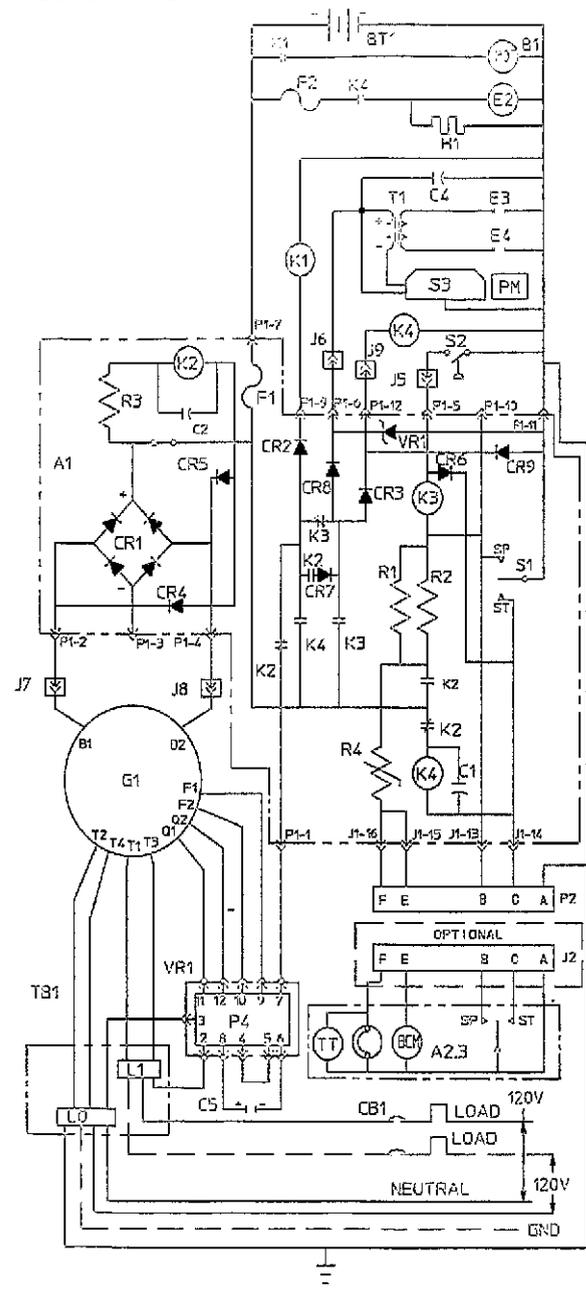
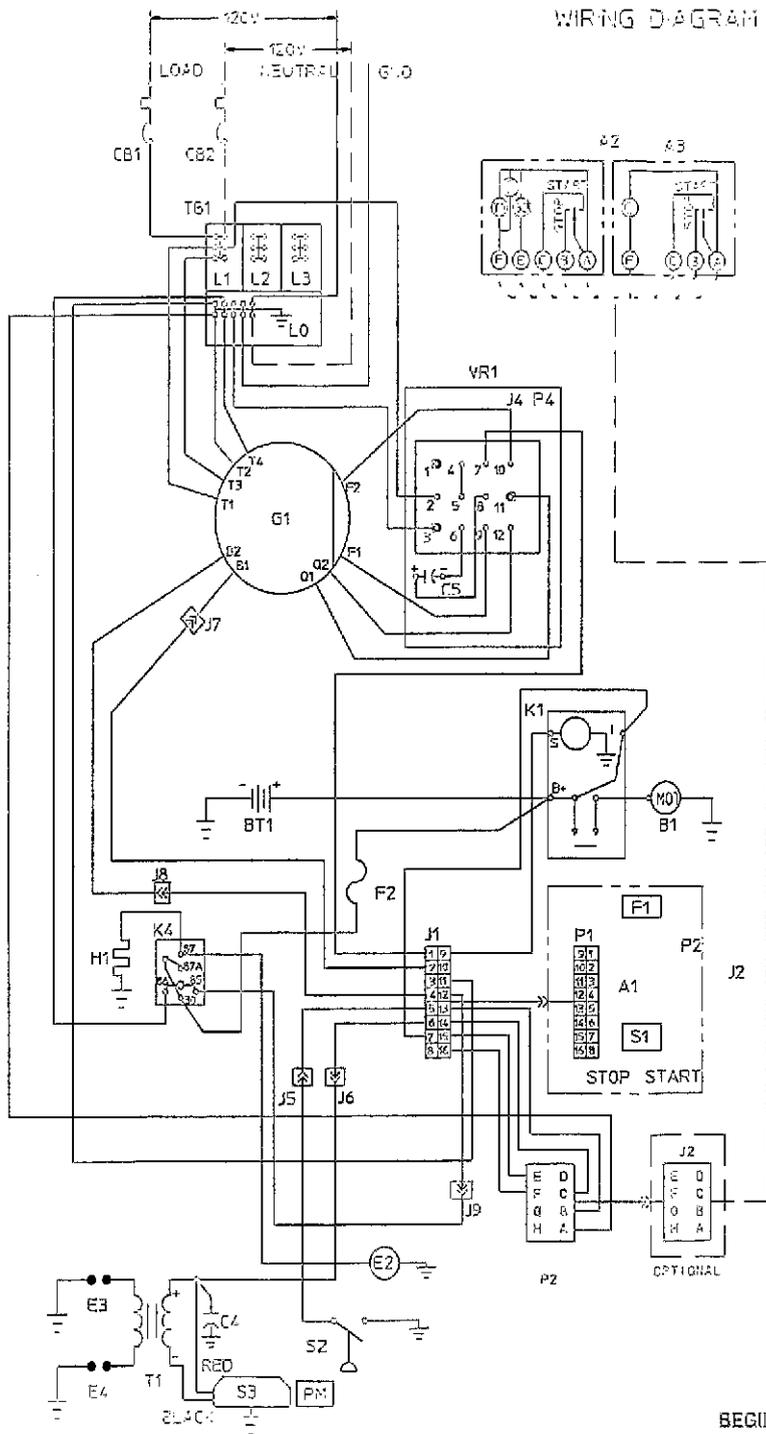
Pins in Connector P1 on Control PC Board A1

Appendix B. Later Wiring Diagrams

WIRING DIAGRAM	DRAWING No.	PAGE No.
Beginning Spec J:		
BGE/NHE 60 Hz	611-1206	B-2
BGE/NHE 50 Hz	611-1207	B-3
BGE 60 Hz, 100 V	611-1208	B-4
Beginning Spec K:		
BGE/NHE 60 Hz	611-1220	B-5
BGE/NHE 50 Hz	611-1221	B-6
BGE 60 Hz, 100 V	611-1222	B-7
Beginning Spec N: (sealed remote connector)		
BGE/NHE 60 Hz	611-1244	B-8
BGE/NHE 60 Hz, LP	611-1253	B-9
BGE/NHE 50 Hz, LP	611-1254	B-10
BGE/NHE 50 Hz	611-1248	B-11

WIRING DIAGRAM

SCHEMATIC

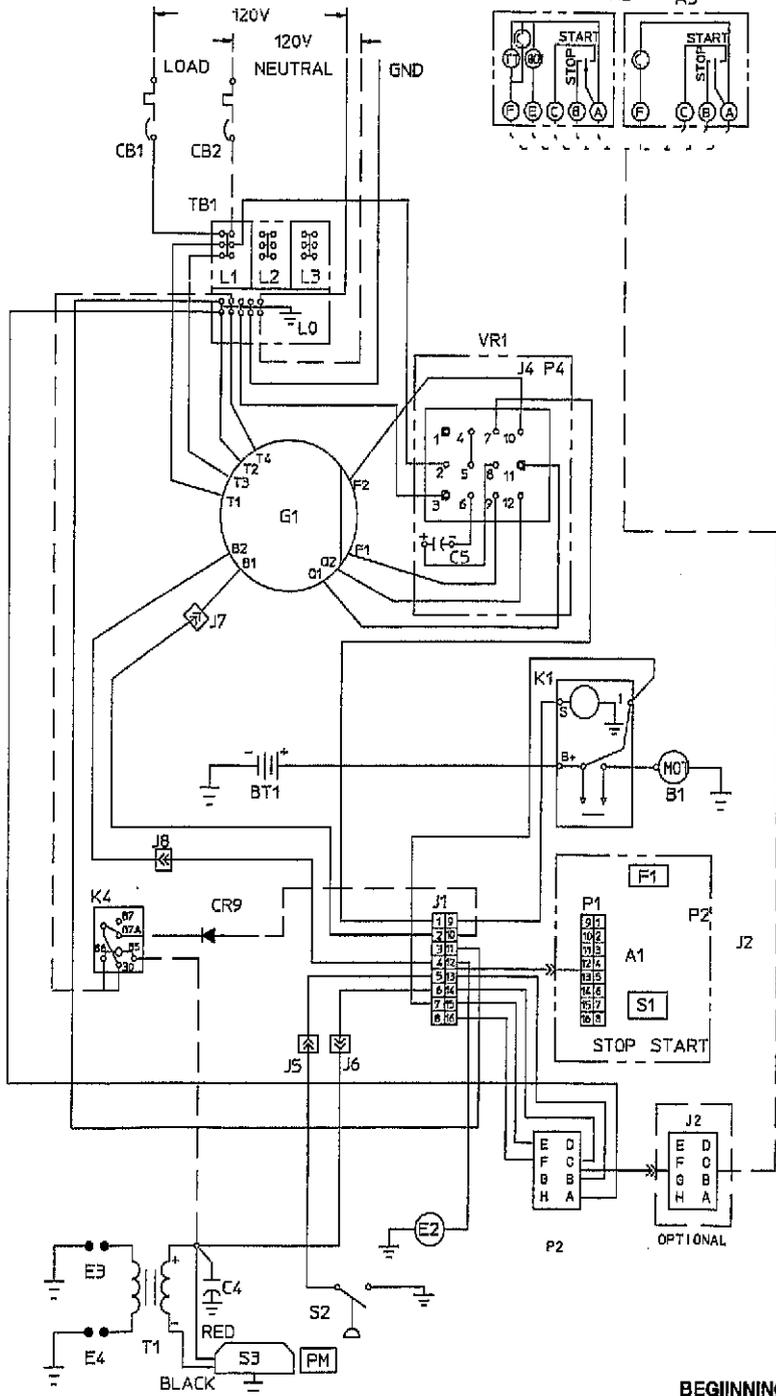


- NOTES:
- FOR P2/J2: A - GROUND
B - RMT STOP
C - RMT START
E - SW B+
F - SW B-

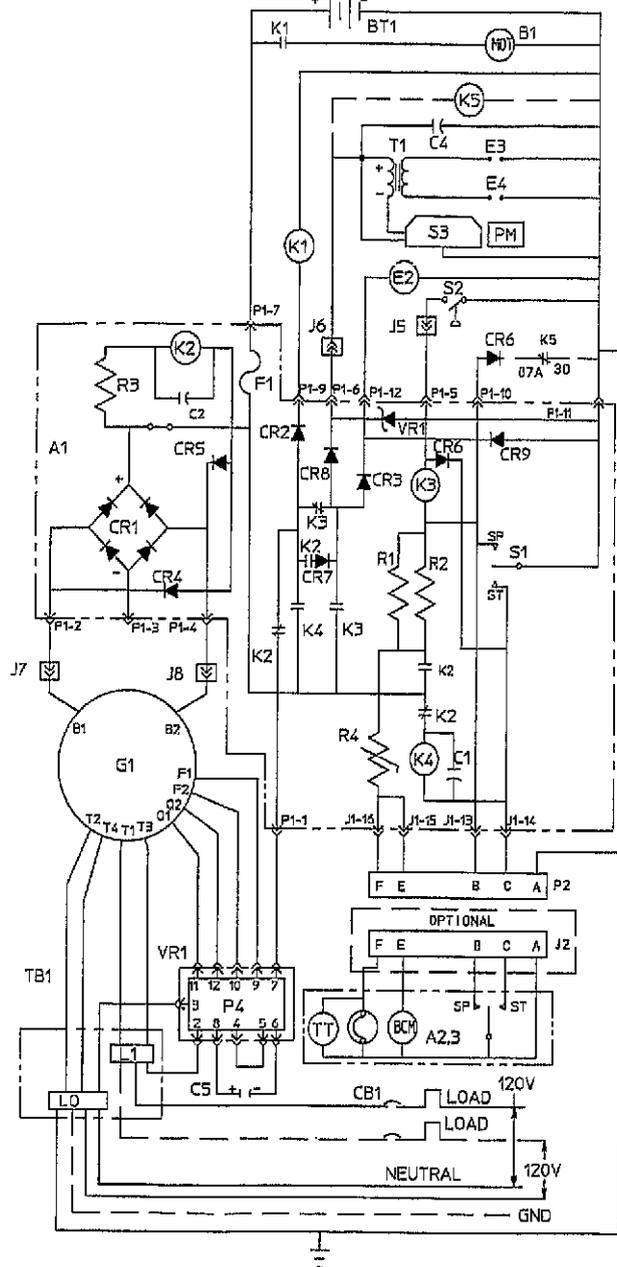
- VR1 VOLTAGE REGULATOR
- T1 IGN COIL
- S3 IGN MODULE
- S2 SWITCH-LOW OIL PRESS
- K4 RELAY-CHOKE & FUEL PUMP
- K1 RELAY-START SOLENOID
- H1 CH-4C
- G1 GENERATOR
- F2 FUSE-5A
- F1 FUSE-5A
- E4 SPARK PLUGS
- E2 FUEL PUMP
- CB1 CIRCUIT BREAKER (10 AMP)
- C4/5 CAPACITOR
- BT1 BATTERY 12V
- B1 STARTER MOTOR
- A3 REMOTE CONTROL-STANDARD
- A2 REMOTE CONTROL-CELLULE
- A1 CONTROL ASSY-1000

BEGINNING SPEC N 60E/NHE 60 HZ-611-1244

WIRING DIAGRAM



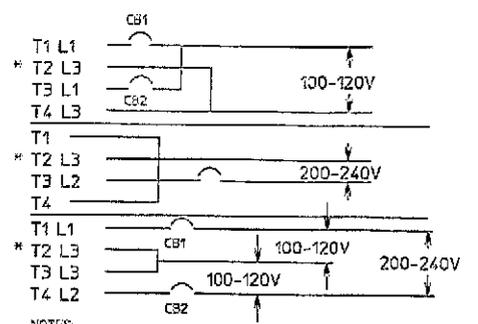
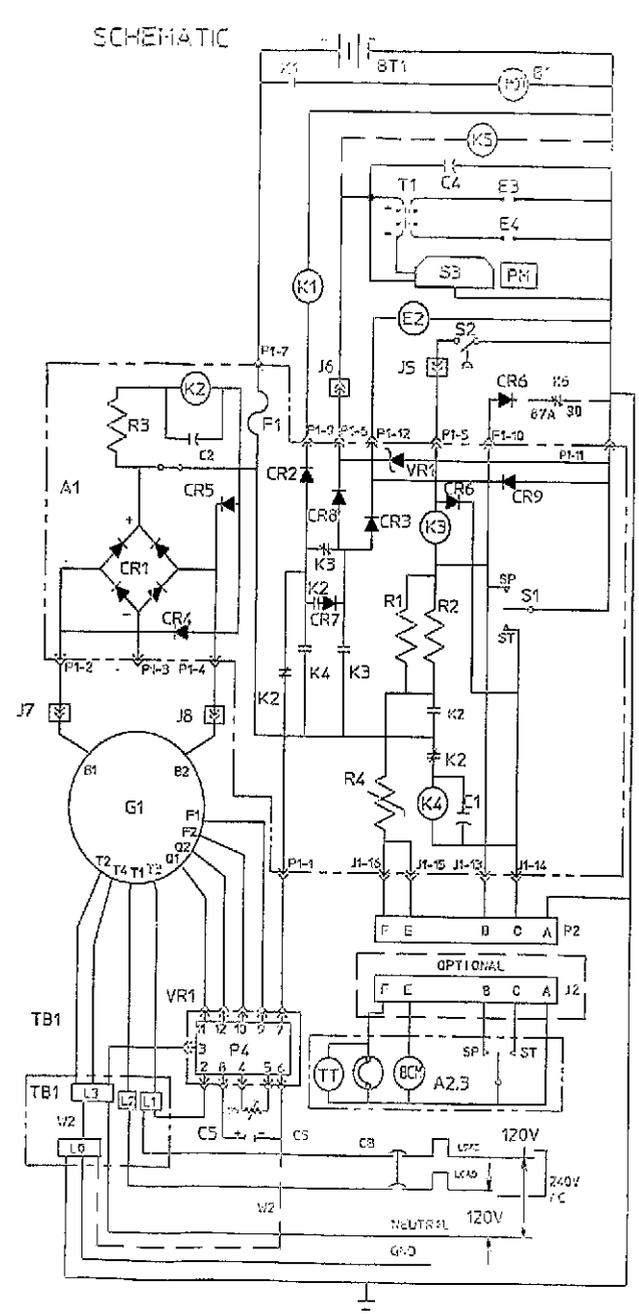
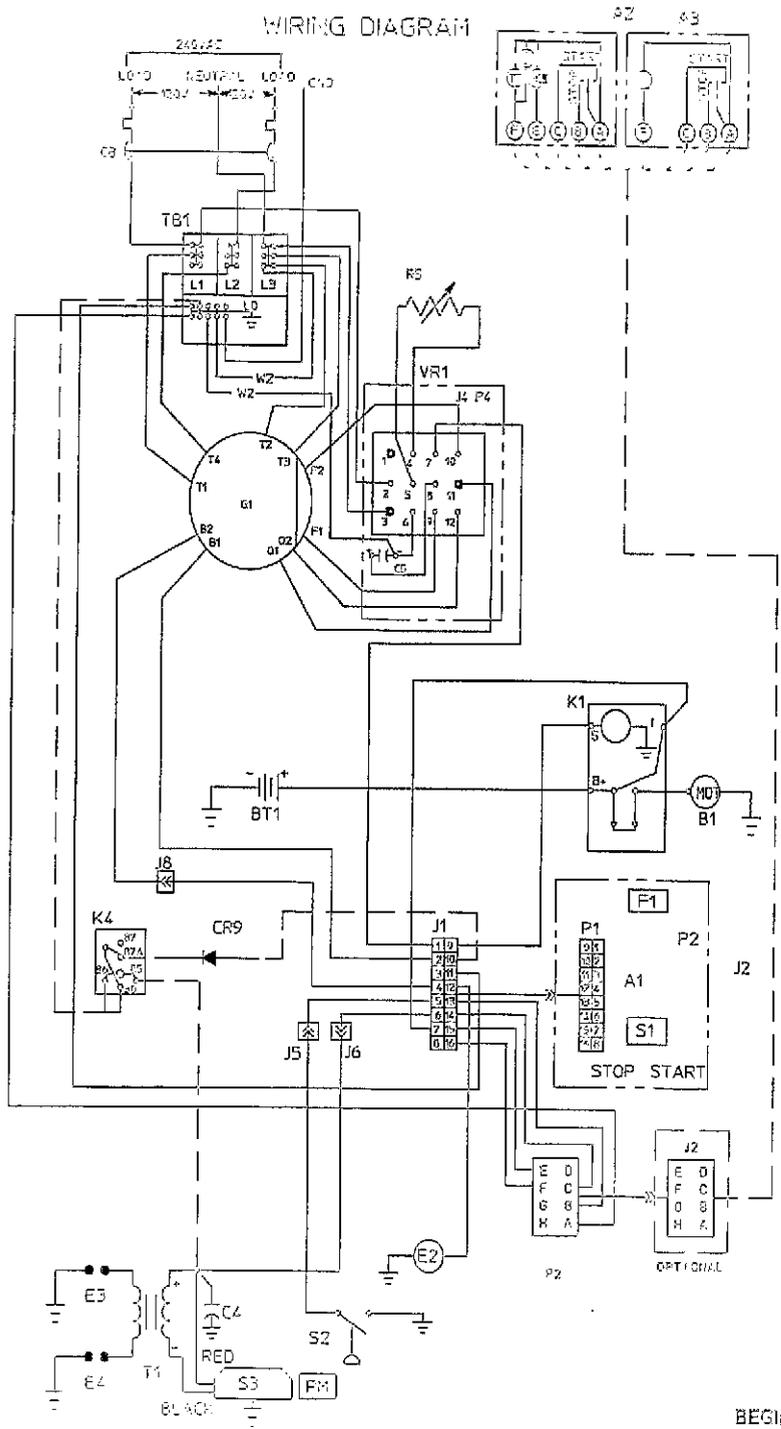
SCHEMATIC



- NOTES:
- 1. FOR P2/J2: A - GROUND
 - B - RMT STOP
 - C - RMT STAR
 - E - SW B+
 - F - SW B-

- VR1 VOLTAGE REGULATOR
- T1 IGN COIL
- S3 IGN MODULE
- S2 SWITCH-LOW GL PRESS
- R6 RESISTOR-BATTERY CHARGE
- R5 POTENTIOMETER
- KS RELAY-LPG ONLY
- K1 RELAY-START SOLENOID
- G1 GENERATOR
- F1 FUSE-SLOW BLOW SA
- E3,4 SPARK PLUGS
- E2 FUEL PUMP OR FUEL SOL
- CR6 RECTIFIER-LPG ONLY
- CB1,2 CIRCUIT BREAKER IAC OUTPUT
- C4,5 CAPACITOR
- BT1 BATTERY 12V
- B1 STARTER MOTOR
- A3 REMOTE CONTROL-STANDARD
- A2 REMOTE CONTROL-DELUXE
- A1 CONTROL ASSY-NEEL
- ITEM DESCRIPTION OR MATERIAL

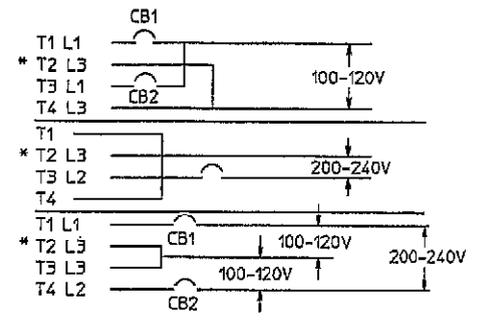
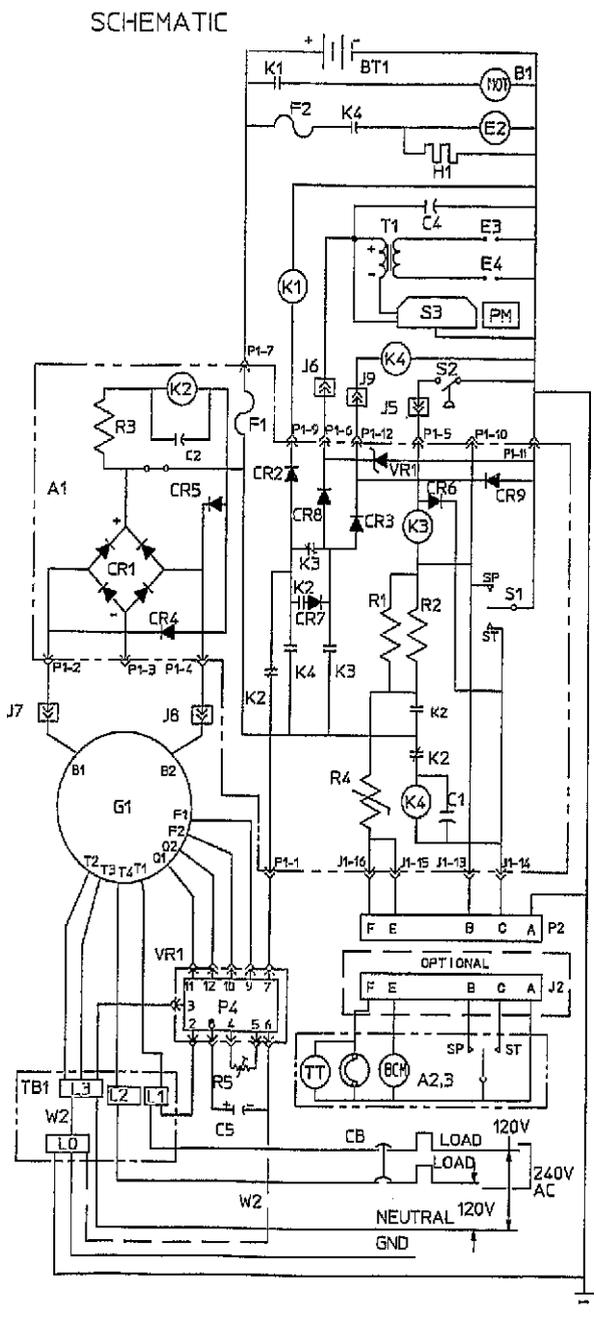
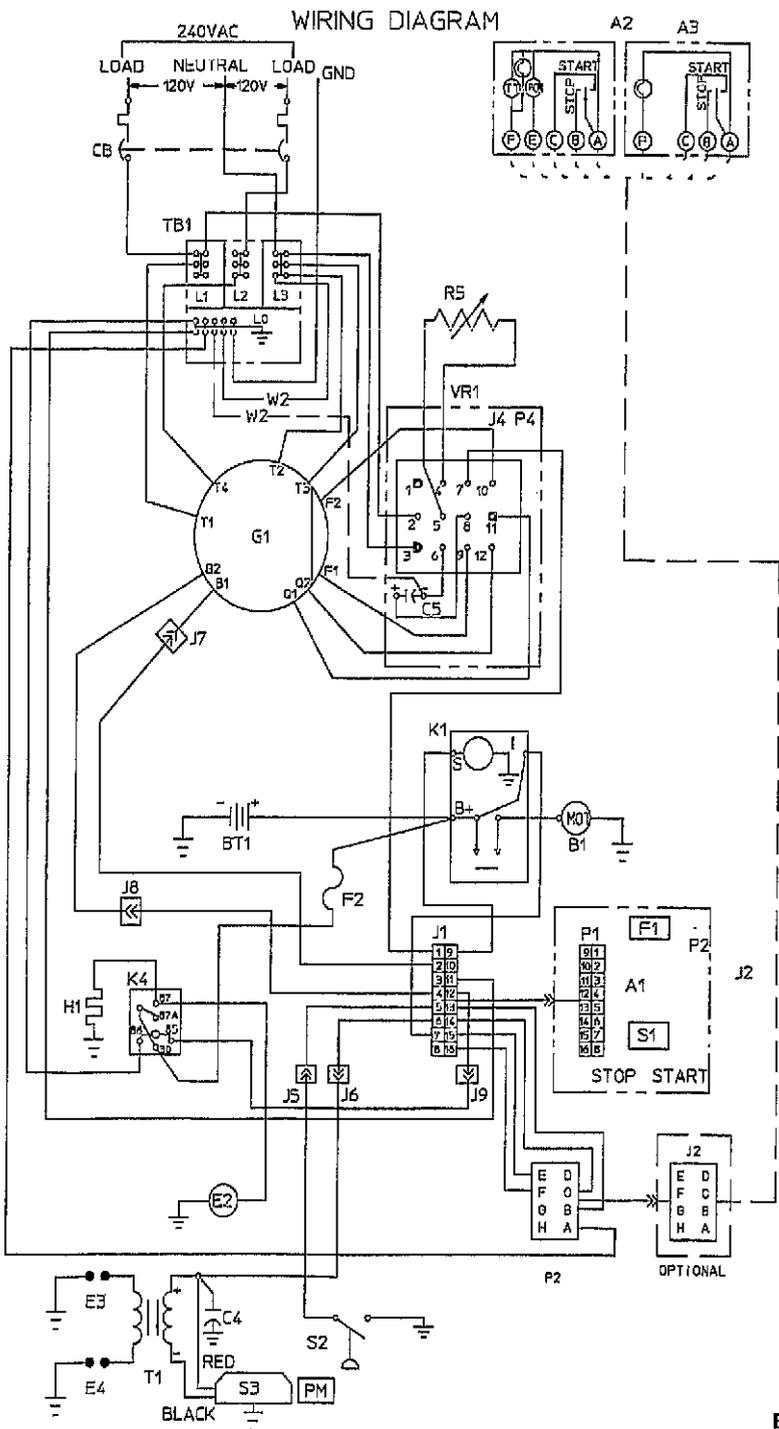
BEGINNING SPEC N BGE/NHE 60 HZ, LP-611-1253



- NOTES:
- 1 120V MAX ACROSS VR1 CONNECTIONS 2,3
 - * 2 GROUNDED AC LEAD- FOR ISOLATED NEUTRAL, REMOVE JUMPER (W2) TB1-L3, L0 AND CONNECT JUMPER TB1-L0, VR1-CS NEG-I
 - 3 FOR P2/J2: A = GROUND
B = RMT STOP
C = RMT START
E = SW B+
F = SW B-

- VR1 VOLTAGE REGULATOR
- T1 IGN COIL
- S3 IGN MODULE
- S2 SWITCH-LOW O.L. PRESSES
- R6 RESISTOR-BATTERY CHARGE
- R5 POTENTIOMETER
- K5 RELAY-LPG ONLY
- K1 RELAY-START SOLENOID
- G1 GENERATOR
- F1 FUSE-SLOW BLOW 5A
- E32 SPARK PLUGS
- E2 FUEL PUMP OR FUEL SOL
- CR6 RECTIFIER-LPG ONLY
- CB2 CIRCUIT BREAKER (AC OUTPUT)
- C45 CAPACITOR
- G11 BATTERY 12V
- B1 STARTER MOTOR
- A3 REMOTE CONTROL-STANDARD
- A2 REMOTE CONTROL-DELUXE
- A1 CONTROL ASSY-DELUXE
- CON CONTROL ASSY-STANDARD
- ITEM DESCRIBED IN MATERIAL

BEGINNING SPEC N BGE/1HE 50 HZ, LP-611-1254



- NOTES:**
- 120V MAX ACROSS VR1 CONNECTIONS 2,3
 - * GROUNDED AC LEAD- FOR ISOLATED NEUTRAL, REMOVE JUMPER (W2) TB1-L3, LO AND CONNECT JUMPER TB1-LO, VR1-CS NEG(-)

- VR1 VOLTAGE REGULATOR
- T1 IGN COIL
- S3 IGN MODULE
- S2 SWITCH-LOW OIL PRESS
- R5 POTENTIOMETER
- K4 RELAY-CHOKE & FUEL PUMP
- K1 RELAY-START SOLENOID
- H1 CHOKE
- G1 GENERATOR
- F2 FUSE-10A
- F1 FUSE-10A
- E3 SPARK PLUGS
- E2 FUEL PUMP
- CB2 CIRCUIT BREAKER AC OUTPUT
- C4,5 CAPACITOR
- BT1 BATTERY 12V
- B1 STARTER MOTOR
- A3 REMOTE CONTROL-STANDARD
- A2 REMOTE CONTROL-DELUXE
- A1 CONTROL ASSY-NRE
- ITEM F DESCRIPTION OR MATERIAL

BEGINNING SPEC N BGE/NHE 50 HZ-611-1248

Supplement 965-1075

Date: 02-01

Insert with-

Title: BGE, NHE Service Manual

Number (Date): 965-0528 (9-94)

This supplement transmits the following corrections to the service manual:

1. On **Page 6-14** under **Direct Testing Coil With Ohmmeter**: step 6, change "12.6 and 15.4 k ohms" to:

34.0 to 41.6 k ohms at 68°F (20°C)

Refer to the page 6-14 of your manual and write "Refer to Supplement" on it.

4. Disconnect the condenser and ignition lead wires at screw A (Figure 6-10).
5. Remove the condenser, mounted outside breaker points box on engine adapter flange.
6. Remove the breaker points mounting screws (B) and lift out the point assembly.
7. Replace the condenser and point assembly and install in a reverse order of removal.
8. Use an allen head wrench to adjust set screw C to obtain the gap setting specified in the *Specifications* section. Measure the point gap with a flat thickness gauge (see Figure 6-10).

Make sure feeler gauge is clean and free of any grease, oil, or dirt.

The timing is adjusted during initial engine assembly and is fixed by the point gap adjustment. No other adjustment or alignment is necessary.

9. Replace the point box cover and hold-down wire, spark plugs, and spark plug leads.
10. Connect negative (-) battery cable to negative battery terminal.

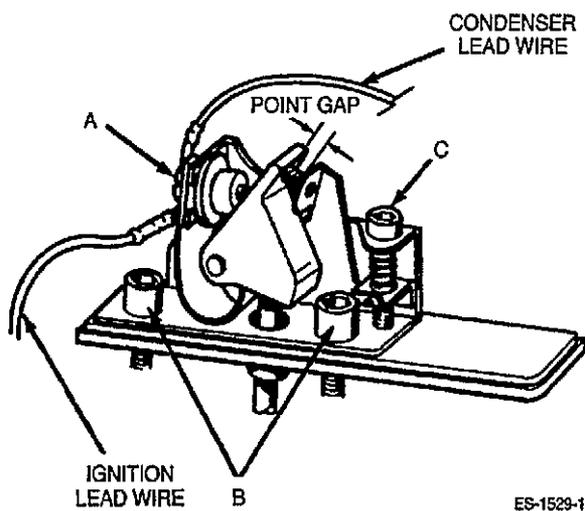


FIGURE 6-10. BREAKER POINTS

Ignition Coil

The ignition coil (Figure 6-11) is a transformer that steps up the battery voltage to approximately 20,000 volts, to fire the spark plug.

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

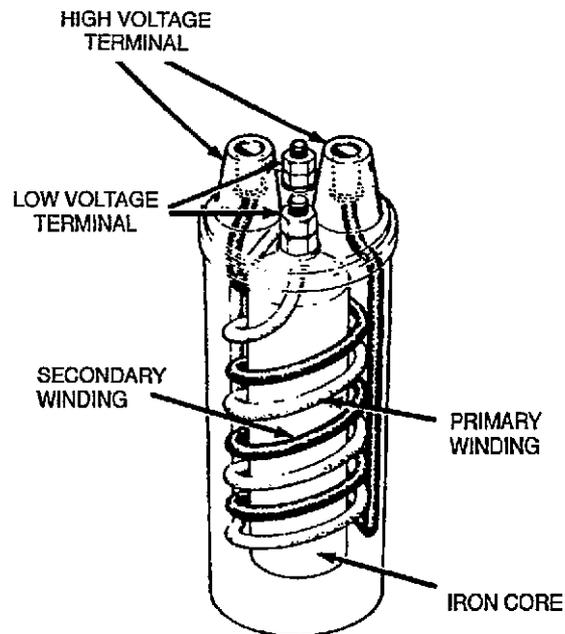


FIGURE 6-11. IGNITION COIL

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

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

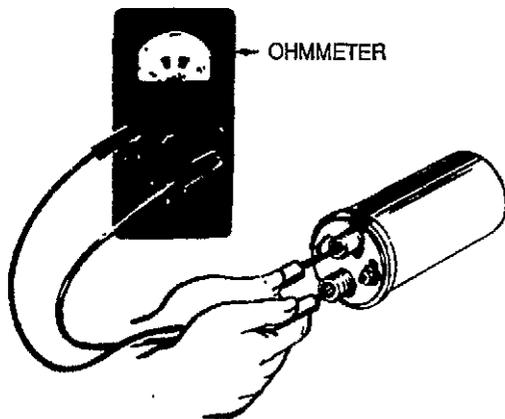
⚠ WARNING Use extreme care when performing this test procedure. To avoid shock, do not hold the plug without adequate insulation.

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

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

Direct Testing Coil With Ohmmeter: The coil is removed from the circuit to perform this test.

1. Remove all wires attached to the ignition coil.
2. Remove the coil from the engine.
3. Inspect the terminals for corrosion, looseness, cracks, dents and other damage. Look for carbon runners around the high voltage terminals. (These indicate electrical leakage.) Replace a damaged or leaking coil.
4. Clean the outside of the coil with a cloth dampened in parts-cleaning solvent.
5. Measure resistance in the primary circuit; connect the ohmmeter leads to the positive (+) and negative (-) terminals on the coil. This resistance should be between 3.87 and 4.73 ohms. Replace the coil if the resistance is higher: high resistance indicates an open circuit or a poor connection inside the coil.
6. Measure resistance in the secondary circuit; connect the ohmmeter leads to the two high voltage terminals (see Figure 6-12). This resistance should be between 34.0 and 41.6 k ohms at 68°F (20°C). Replace the coil if it is not within this specification. Lower resistance indicates a shortened secondary winding, and higher resistance indicates the coil has excessive internal resistance or an open circuit.



ES-1373

FIGURE 6-12. TESTING COIL SECONDARY

Spark Plugs

Spark plug inspection is described under *Electronic Ignition*.

Wiring

The ignition system wiring includes:

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

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

CRANKCASE VENTILATION SYSTEM

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

The crankcase breather is vented directly below the generator set. For this reason, the generator set should only be used in environments where oily vapor and dust do not create a problem.

⚠WARNING Crankcase breather vapor contains poisonous carbon monoxide which can cause personal injury or death. Do not run the generator set while parked unless the undercarriage is exposed to a steady airflow.

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Section 1. Introduction

ABOUT THIS MANUAL

This manual provides service information for Onan BGE and NHE series recreational vehicle generator sets. This is a complete service manual for the experienced serviceperson covering troubleshooting, disassembly, repair, reassembly, and adjustments for the engine, generator, and control. It is recommended that the serviceperson be thoroughly familiar with the principles of gasoline engine operation and have a basic knowledge of electrical fundamentals. Other Onan publications such as Electrical/Mechanical Fundamentals (932-0408), Onan Generator Training Manual (932-0404), BGE and NHE Operator's Manual (965-0128) and Installation Manual (965-0628) are recommended as additional sources of information.

Read all service procedures completely before beginning any repair work and observe all cautions and warnings. It is extremely important that the generator set installation maintain compliance with the applicable codes and standards for RV installations (see Installation Manual). The most critical areas of concern include the exhaust system, fuel system, electrical wiring, compartment construction, and ventilation system. Improper servicing can create an unsafe installation that can result in damage to the vehicle and equipment or can cause severe personal injury or death to the user.

MODEL IDENTIFICATION

When contacting an Onan Dealer or Distributor always supply the complete Model Number and Serial Number as shown on the set nameplate (Figure 1-1). This information is necessary to identify your set when ordering replacement parts.

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

The model number is made up of code segments that designate various features or options.

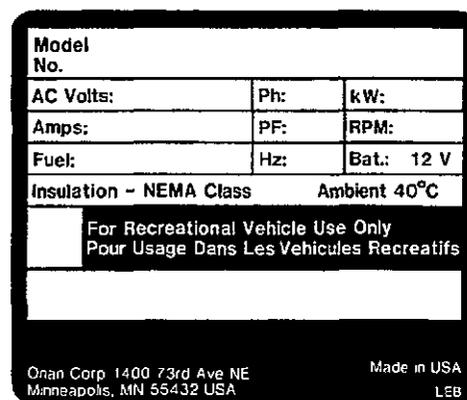


FIGURE 1-1. ONAN NAMEPLATE

▲ WARNING

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

Section 2. Specifications

ENGINE

Onan opposed 2-cylinder, 4-cycle, air-cooled, gasoline-fueled and propane-fueled models. Front-mounted control with remote start capability, negative ground, 12-volt, automotive-type starter.

ENGINE DETAILS	BGE	NHE
Displacement	47.7 in. ³ (781.8 cm ³)	60.0 in. ³ (983.0 cm ³)
Compression Ratio	6.9:1	7.0:1
Bore	3.25 in. (82.55 mm)	3.56 in. (90.42 mm)
Stroke	2.87 in. (72.90 mm)	3.00 in. (76.20 mm)
Oil Capacity (W/Filter)	(Pre-Spec J) BGE: 4.0 Qt. (3.8 L) (Spec J) BGE: 3.5 Qt. (3.3 L)	(Pre-Spec J) NHE: 4.0 Qt. (3.8 L) (Spec J) NHE: 3.5 Qt. (3.3 L)
Ventilation (Free Area)	85 in. ² (584.4 cm ²)	85 in. ² (584.4 cm ²)
Fuel: Gasoline	Lead-Free	Lead-Free
Propane	LPG (Liquid or Vapor Withdrawal)	LPG (Liquid or Vapor Withdrawal)
Cylinder Compression (Hot)	75-115 psi (517-793 kPa)	100-120 psi (690-827 kPa)

TUNE-UP SPECS

Spark Plug Gap	0.025 in. (0.64 mm)	0.025 in. (0.64 mm)
Point Gap (Prior to Spec G Only)	0.016 in. (0.41 mm)	NHE: 0.016 in. (0.41 mm)
Timing (Breaker Point Ignition)	20° BTC	20° BTC
Timing (Nonadjustable)		
Electronic Ignition	14°-18° BTC	14°-18° BTC
Valve Lash: Intake	0.005 in. (0.127 mm)	0.005 in. (0.127 mm)
Exhaust	0.013 in. (0.330 mm)	0.013 in. (0.330 mm)

GENERATOR

Onan-built, four-pole, revolving field, permanently aligned to engine.

	BGE			NHE	
	50 Hz	60 Hz	5000	50 Hz	60 Hz
Frequency	50 Hz	60 Hz	5000	50 Hz	60 Hz
Watts	3500 (1) 4000 (2)	4000	5000	5000 6300 (propane)	6500 (gasoline)
Volts	110/220 or 120/240	120	120	110/220 or 120/240	120
Amps	31.8/15.9 or 29.2/14.6 (1) 36.4/18.2 or 33.3/16.7 (2)	33.3	41.7	45.5/22.7 or 41.7/20.8 52.5 (propane)	54.2 (gasoline)
Phase	1	1	1	1	1
Wires	4	2	4	4	4

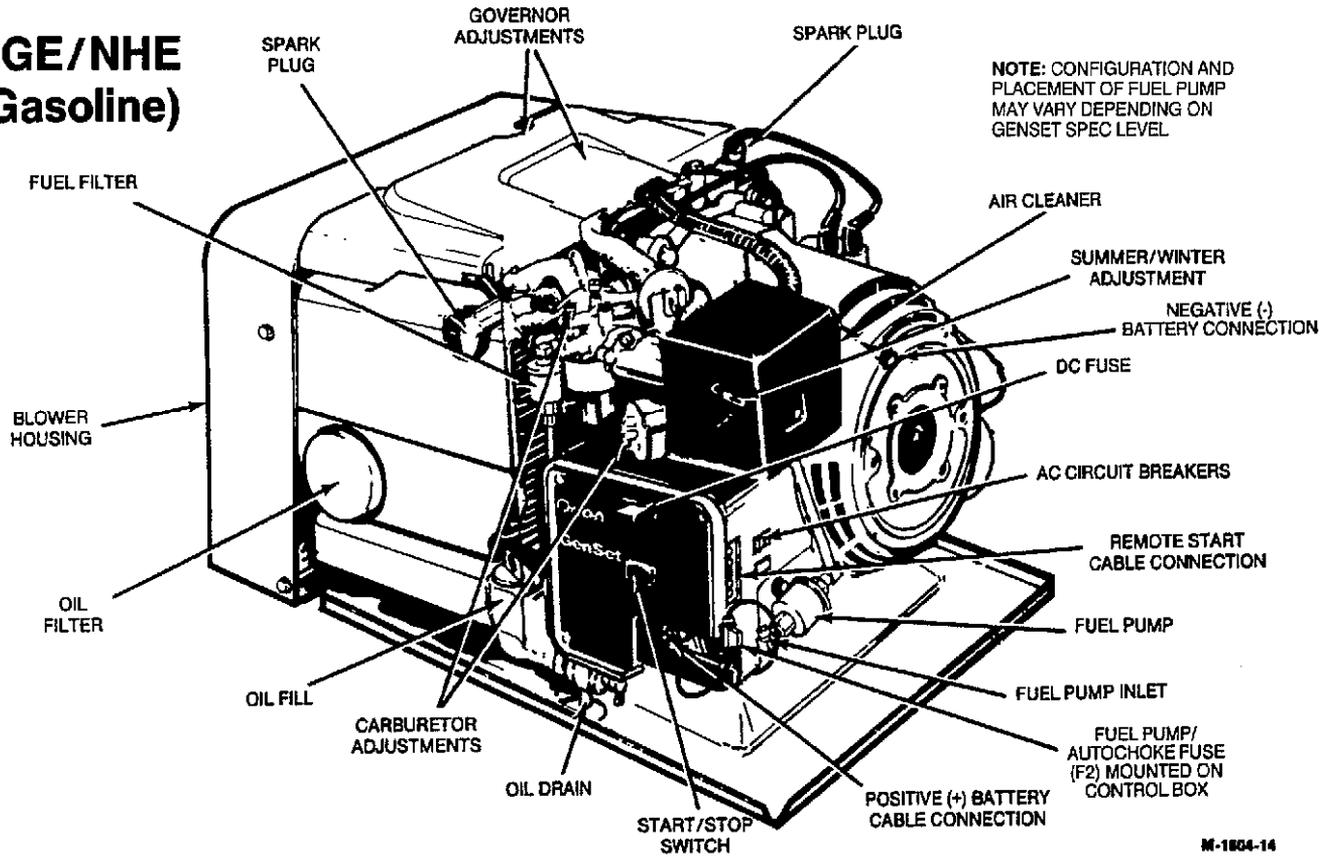
1. Prior to Spec G 2. Begin Spec G

GENERATOR SET

Dimensions*	BGE	NHE
Height	14.0 in. (356 mm)	14.6 in. (371 mm)
Length	25.0 in. (635 mm)	25.3 in. (643 mm)
Width	18.8 in. (478 mm)	21.1 in. (535 mm)
Weight: (Approximate, not including exhaust components)		
50 and 60 Hz	216 lb (97.9 kg)	230 lb (104 kg)
Fuel Inlet Connection	BGE & NHE	
Gasoline	1/4 in. barb fitting	
Propane (Liquid Withdrawal)	1/4 in. NPTF	
Propane (Vapor Withdrawal)	3/4 in. NPTF	
Battery Voltage	12 volts	
Recommended Battery Capacity (SAE No. 60 360 or equiv. minimum)	360 cold cranking amperes	
Cranking Current	100 amperes	
r/min at:		
60 Hertz	1800	
50 Hertz	1500	
Output Ratings	Unity Power Factor	

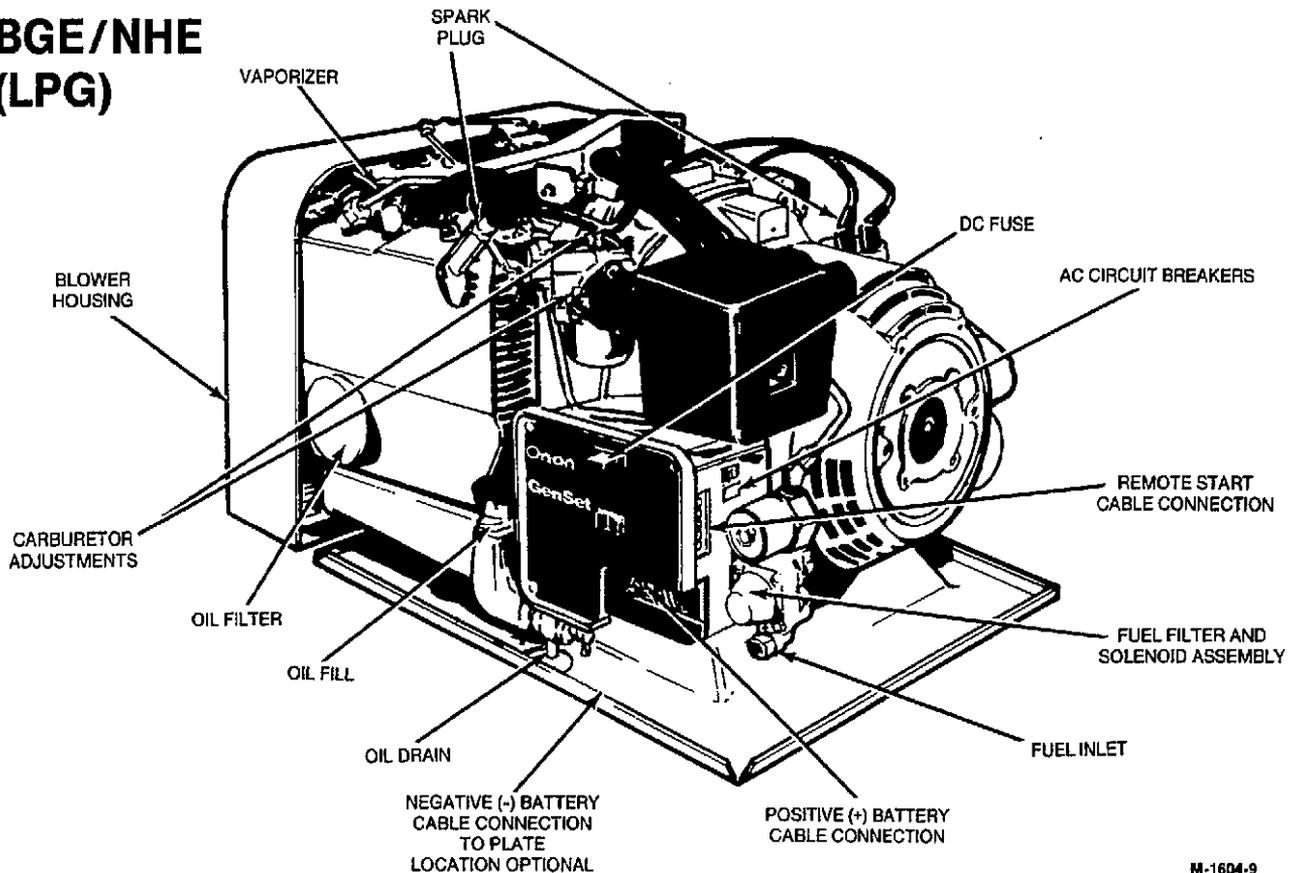
*Under-Floor mount generator set with compartment housing has slightly larger dimensions. Refer to Installation Manual.

BGE/NHE (Gasoline)



M-1604-14

BGE/NHE (LPG)



M-1604-9

FIGURE 2-1. TYPICAL EMERALD GENERATOR SETS

Section 3. Dimensions and Clearances

MODELS	BGE	NHE
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 all BGE/NHE 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	Pre-Spec J sets: 0.080-0.081 (2.03-2.06 mm) Spec J 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	Pre-Spec J sets: 0.080-0.081 (2.03-2.06 mm) Spec J 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	Pre-Spec J sets: 0.188-0.189 (4.78-4.80 mm) Spec J 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	0.0020-0.0320 (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	BGE	NHE
CRANKSHAFT AND CAMSHAFT		
Crankshaft Main Bearing Journal Diameter	1.9992-2.0000 (50.78-50.80 mm)	1.9992-2.0000 (50.78-50.80 mm)
Crankshaft Rod Journal Bearing Diameter	1.6252-1.6260 (41.28-41.30 mm)	1.6252-1.6260 (41.28-41.30)
Crankshaft Main Bearing Diameter	2.0015-2.0040 (50.84-50.90 mm)	2.0015-2.0040 (50.84-50.90 mm)
Crankshaft Main Bearing Clearance	0.0024-0.0042 (0.061-0.107 mm)	0.0024-0.0042 (0.061-0.107 mm)
Crankshaft End Play	0.006-0.012 (0.152-0.305 mm)	0.006-0.012 (0.152-0.305 mm)
Camshaft Journal Diameter	1.3740-1.3745 (34.90-34.91 mm)	1.3740-1.3745 (34.90-34.91 mm)
Camshaft Bearing Diameter	1.3757-1.3787 (34.94-35.02 mm)	1.3757-1.3787 (34.94-35.02 mm)
Camshaft Bearing Clearance	0.0015-0.0030 (0.038-0.076 mm)	0.0015-0.0030 (0.038-0.076 mm)
Camshaft End Play	0.011-0.048 (0.279-1.219 mm)	0.011-0.048 (0.279-1.219 mm)
VALVE AND LIFTERS		
Valve Spring Free Length	1.600 (40.64 mm)	1.6620 (42.21 mm)
Valve Spring Compressed Length	1.346 (34.19 mm)	1.375 (34.93 mm)
Valve Spring Tension Open	55 lbs (25 kg)	71 lbs (32 kg)
Valve Spring Tension Closed	25 lbs (11 kg)	38 lbs (17 kg)

MODELS	BGE	NHE	
Valve Face Angle	44°	44°	
Valve Seat Angle	45°	45°	
Valve Stem Diameter (Intake)	0.2795-0.2800 (7.099-7.112 mm)	0.3425-0.3430 (8.700-8.712 mm)	
Valve Stem Diameter (Exhaust)	0.2780-0.2785 (7.061-7.074 mm)	0.3410-0.3420 (8.661-8.687 mm)	
Valve Guide Diameter	Intake 0.2810-0.2820 (7.137-7.163 mm)	Exhaust 0.2805-0.2815 (7.125-7.150 mm)	Intake and Exhaust 0.3440-0.3460 (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 (0.051-0.089 mm)	0.0025-0.0040 (0.064-0.102 mm)	
Valve Lifter Diameter	0.7475-0.7480 (18.99-19.00 mm)	0.7475-0.7480 (18.99-19.00 mm)	
Valve Lifter Bore Diameter	0.7500-0.7515 (19.05-19.09 mm)	0.7500-0.7515 (19.05-19.09 mm)	
Valve Lifter To Block Clearance	0.0020-0.0040 (0.051-0.102 mm)	0.0020-0.0040 (0.051-0.102 mm)	
Valve Seat Outside Diameter (Intake)	1.4700-1.4710 (37.34-37.36 mm)	1.5690-1.5700 (39.85-39.88 mm)	
Valve Seat Outside Diameter (Exhaust)	1.192-1.193 (30.28-30.30 mm)	1.2550-1.2560 (31.88-31.90 mm)	
Valve Seat Bore Diameter (Intake)	1.4395-1.4405 (36.56-36.59 mm)	1.5645-1.5655 (39.74-39.76 mm)	
Valve Seat Bore Diameter (Exhaust)	1.189-1.190 (30.20-30.23 mm)	1.2510-1.2520 (31.78-31.80 mm)	

Section 4. Torque Specifications

MODELS	BGE	
TORQUE SPECIFICATIONS	Use engine oil as a lubricant for all threads EXCEPT the spark plug and rotor through-bolt threads. FOOT-POUNDS (NEWTON-METRES)	
Cylinder Head (Cold)	16-18	(22-24)
Connecting Rod	12-14	(16-19)
Rear Bearing Plate	25-27	(34-37)
Flywheel Mounting Screw	50-55	(68-75)
Oil Base	18-23	(24-31)
Gearcase Cover	8-10	(11-14)
Spark Plug	7-9	(9-12)
Exhaust Manifold	9-11	(12-15)
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	(11-16)
Adapter to Engine Mounting Screws	25-27	(34-37)
Adapter to Generator Mounting Screws	25	(34)
Rear Vibration Isolator -Center Screw	30-33	(41-45)
-Flange to Drip Tray Screws	10-12	(11-16)
Front Vibration Isolator -Flange to Oil Base Screws	19-22	(26-30)
-Center Screw	28-32	(38-43)

MODELS	NHE	
TORQUE SPECIFICATIONS	Use engine oil as a lubricant for all threads EXCEPT the spark plug and rotor through-bolt threads FOOT-POUNDS (NEWTON-METRES)	
Cylinder Head (Cold)	18-20 - Stud Nuts 15-17 - Capscrews	(24-27) - Stud Nuts (21-23) - Capscrews
Connecting Rod	27-29	(37-39)
Rear Bearing Plate	25-28	(34-38)
Flywheel Mounting Screw	50-55	(68-75)
Oil Base	18-23	(24-31)
Gearcase Cover	8-10	(11-14)
Spark Plug	7-9	(9-12)
Exhaust Manifold	20-23	(27-31)
Intake Manifold	20-23	(27-31)
Other 3/8 Cylinder Block Nuts	18-23	(24-31)
Oil Pump	7-9	(10-12)
Rotor Through-Bolt	45-55	(61-75)
Starter Mounting Screws	30-33	(41-45)
Stator Clamp Screws	10-12	(11-16)
Adapter to Engine Mounting Screws	25-27	(34-37)
Adapter to Generator Mounting Screws	25	(34)
Rear Vibration Isolator -Center Screw	30-33	(41-45)
-Flange to Drip Tray Screws	10-12	(11-16)
Front Vibration Isolator -Flange to Oil Base Screws	19-22	(26-30)
-Center Screw	28-32	(38-43)

Section 5. Preparing to Service

TROUBLESHOOTING

Most service procedures require that the genset be removed from the vehicle. Because genset installations vary, removal procedures vary. If removal is a problem, contact the vehicle manufacturer or genset installer for assistance. Many procedures require that the outer sheet metal cover assemblies of the generator set be removed. This section covers this procedure.

The main service areas are covered in these manual sections:

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

Troubleshooting charts in each section provide fixes for common malfunctions.

ENGINE TOOLS

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

GENERATOR AND CONTROL TOOLS

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

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

SAFETY CONSIDERATIONS

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

Safeguards to Avoid Hazards

- **Use personal protection:** Wear protective safety equipment, such as:
 - Safety shoes
 - Gloves
 - Safety glasses
 - Hard hats
 - Ear plugs

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

- **Reduce the hazard:** A safe, orderly work area and well-maintained equipment reduce hazard. Leave all guards and shields in place on machinery, and maintain equipment in top condition. Store flammable liquids in approved containers, away from fire, flame, spark, pilot light, arc-producing equipment and other ignition sources. Keep the work area clean, well-lighted, and well-ventilated. Keep fire extinguishers and safety equipment nearby, and be prepared for an emergency.
- **Develop safe work habits:** Unsafe practices cause accidents. Be familiar with your tools and machines, to use them safely. Use the right tool for the job, and check its condition before starting. Follow all warnings in this manual, and take extra precautions when working around electrical equipment. Avoid working alone, and take no risks.
- **Be prepared for a potential accident:** The Red Cross and public safety departments offer courses in first aid, CPR, and fire control. Use this information to be ready for an accident. Be safety-conscious, and make safety procedures part of the work routine.

**TABLE 5-1
HAZARDS AND THEIR SOURCE**

<ul style="list-style-type: none"> ● Fire and explosions <ul style="list-style-type: none"> -Leaking fuel -Hydrogen gas from charging battery -Oily rags improperly stored -Flammable liquids improperly stored -Any fire, flame, spark, pilot light arc-producing equipment or other ignition sources ● Burns <ul style="list-style-type: none"> -Hot exhaust pipes -Hot engine and generator surfaces -Hot engine oil -Electrical short in DC wiring system -Hot engine coolant ● Poisonous Gases <ul style="list-style-type: none"> -Carbon monoxide from faulty exhaust -LP gas leaking into coach interior -Operating generator set where exhaust gases can accumulate 	<ul style="list-style-type: none"> ● Electrical Shock (AC) <ul style="list-style-type: none"> -Improper generator set load connections -Faulty RV wiring -Faulty electrical appliance -Faulty generator set wiring ● Rotating Machinery <ul style="list-style-type: none"> -Flywheel fan guard not in place ● Slippery Surfaces <ul style="list-style-type: none"> -Leaking or spilled oil ● Heavy Objects <ul style="list-style-type: none"> -Removing generator set from RV -Removing heavy components
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▲WARNING *State and federal agencies have determined that asbestos, used engine oil, and benzene cause cancer or reproductive toxicity. When adding, changing or working with fuel, oil, or asbestos gaskets take care not to breathe, ingest or come into excessive contact with these substances. Wash hands after use. Wear protective clothing and equipment. Provide adequate ventilation.*

SET REMOVAL

Some service procedures will require that the generator set be removed from the coach. While there are many variations, generator set installations are generally classified as either conventional compartment mount or below-the-floor mount. In a compartment mount installation, a special compartment (see Figure 5-1) is built into the coach to house the generator set. The compartment is constructed with a vapor tight barrier that seals off the generator set from the coach interior. The generator set is usually fastened to the floor of the compartment, which must be able to support the weight of the set. Access to the compartment is through a door located in the exterior of the coach.

In a below-the-floor mount installation (see Figure 5-2), a special housing is used to suspend the generator set from the underside of the coach. The housing bolts to special support members that are built into the coach framework. The housing is mounted near the exterior of the coach and limited access is provided through a door panel located in the exterior of the coach.

Because of the wide variety of generator set installations, it is not possible to specify the exact removal procedures for each generator set. If, after examining the installation, a satisfactory method for removing the set cannot be determined, contact the RV coach manufacturer to obtain their recommendations before attempting to remove the set from the coach.

▲WARNING *The generator set is heavy and can result in severe personal injury if dropped during removal. Use adequate lifting devices to provide sufficient support for the set. Keep hands and feet clear while lifting.*

Special fuel handling procedures are required when removing an LP gas (propane) powered set. The fuel system must be purged of LP gas before the set can be safely removed from the coach. Follow the purging procedure before attempting to remove an LP gas powered set. If the generator set is powered by gasoline, proceed to the appropriate set removal section.

▲WARNING *LP-Gas (Propane) is extremely flammable and poisonous, and can result in severe personal injury or death if accidentally ignited or inhaled. Eliminate all possible sources of cigarettes, and arc-producing machinery or switches before purging LP-gas from the fuel system. Provide adequate ventilation to dissipate LP-gas as it is released. (Propane gas will sink to the ground and is not easily detected.)*

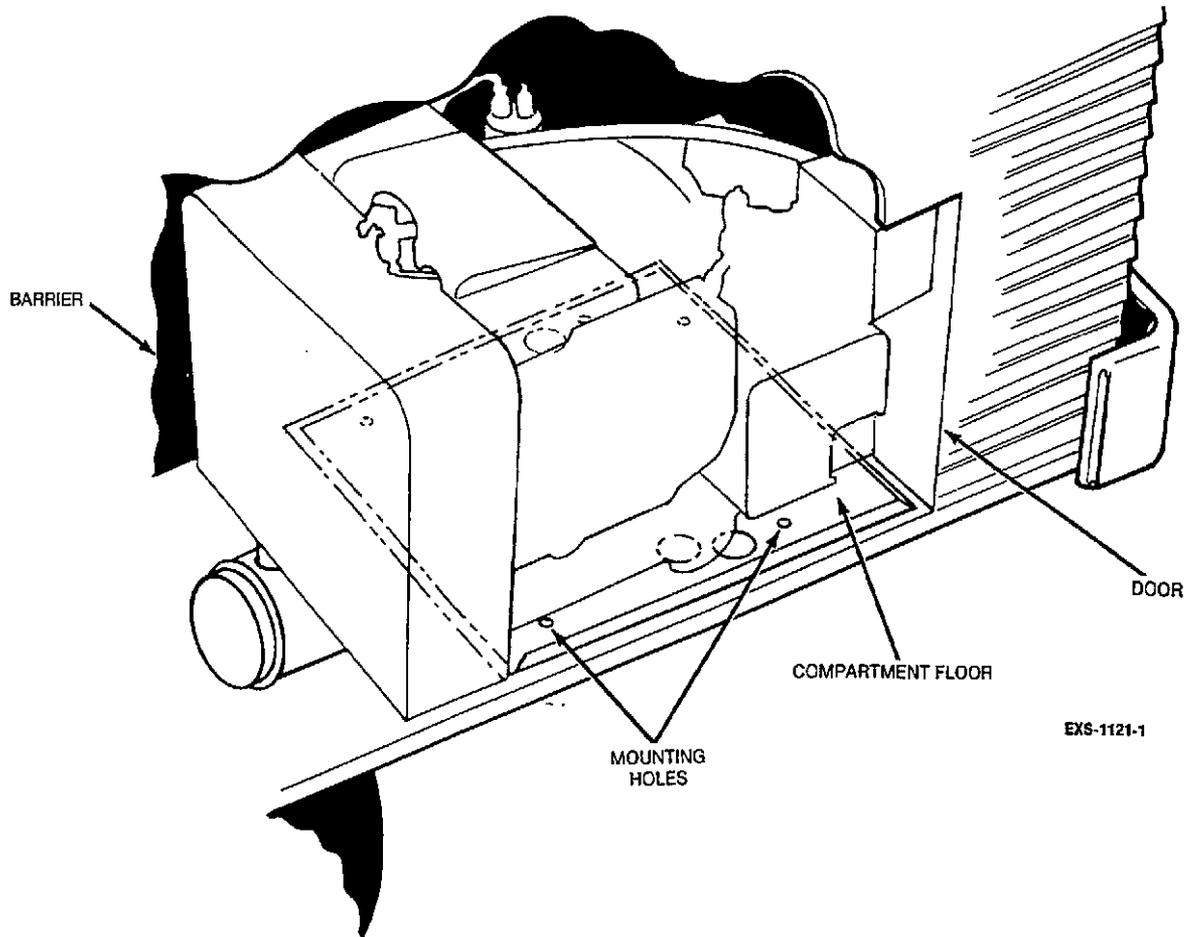


FIGURE 5-1. TYPICAL COMPARTMENT MOUNT INSTALLATION

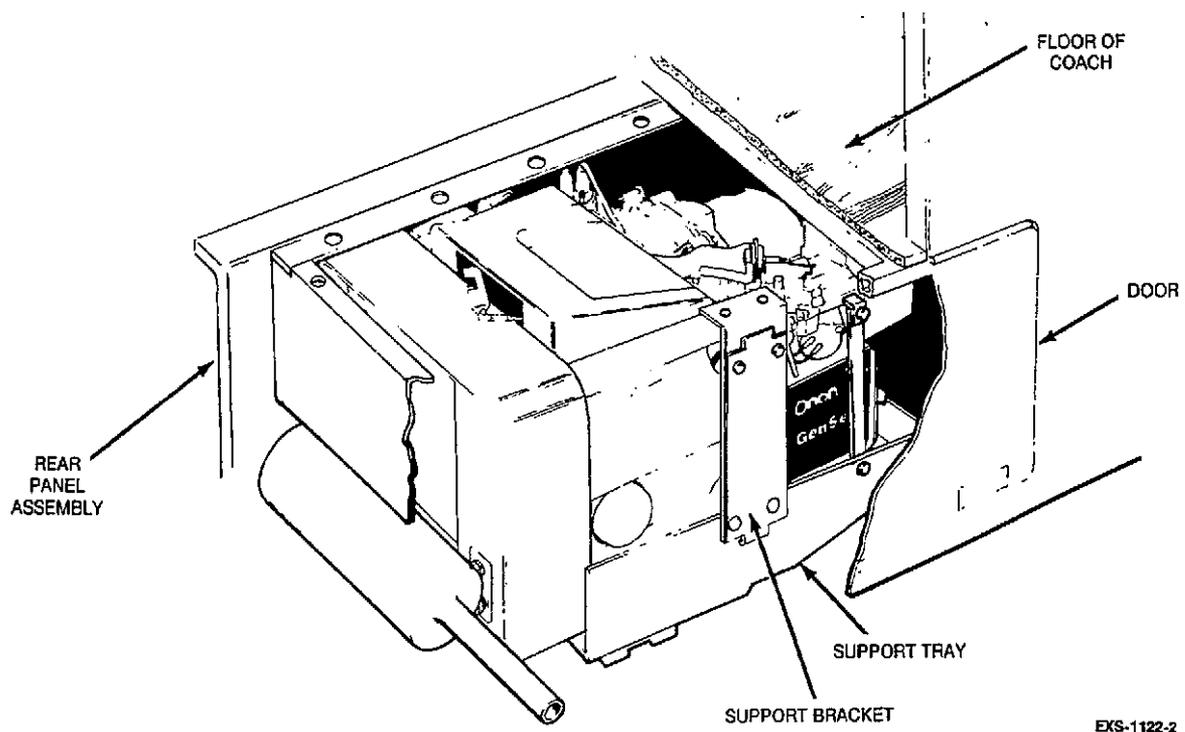


FIGURE 5-2. TYPICAL UNDER-THE-FLOOR INSTALLATION

LP-Gas (Propane) Purging Procedure

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

If the generator set cannot be operated, move the RV coach to an outdoor location that is well-ventilated and is away from open flame, sparks, pilot lights, cigarettes, and arc-producing machinery or switches. Disconnect both the vehicle negative (-) battery cable and the generator set negative (-) battery cable from their respective battery terminals. Close the fuel shutoff valves at the fuel tank for both the generator set fuel supply system and the appliance (stove, heater, etc.) fuel supply system. In addition, close the fuel shutoff valves at each appliance.

▲WARNING *LP-Gas (Propane) is extremely flammable and poisonous, and can result in severe personal injury or death if accidentally ignited or inhaled. Eliminate all possible sources of ignition such as open flame, sparks, pilot lights, cigarettes, and arc-producing machinery or switches before purging LP-gas from the fuel system. Provide adequate ventilation to dissipate LP-gas as it is released. (Propane gas will sink to the ground and is not easily detected.)*

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

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

Disconnecting Set from RV Systems

Disconnect the following items from the generator set.

1. Disconnect the vehicle negative (-) battery cable at the battery terminal.
2. Disconnect the generator set negative (-) battery cable at the battery terminal.
3. Disconnect the generator set positive (+) battery cable from the start solenoid.
4. Disconnect the remote control wire plug from the generator set control.
5. Disconnect the generator load wires at the RV electrical system junction box. Tag the RV circuit wires if necessary for positive identification when reconnecting.

6. Loosen the conduit connector and pull the load wires and flexible conduit free of the junction box.
7. Disconnect the muffler from the exhaust manifold at the flange connection and disconnect any support brackets or hangers that connect the muffler to the set.
8. On gasoline fueled sets, turn off the fuel shutoff valve in the compartment and disconnect the fuel line at the fuel pump. Securely plug the end of the fuel line to prevent fuel leakage or an accumulation of explosive gasoline vapor.

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

On LP gas (propane) fueled sets, disconnect the fuel line (after purging) at the solenoid valve and plug the end of the fuel line to prevent entrance of dirt.

Removing Conventional Compartment Mounted Set From RV

When the generator set has been disconnected from the electrical, exhaust, and fuel systems, examine the set mounting and support system. Locate all mounting bolts and support members for the set. In most installations, the generator set drip tray will be bolted to the coach framework. Depending on the installation, the set may be removable from the side, back, or bottom.

Verify that the generator set is adequately supported before loosening any of the mounting bolts or support members. The most satisfactory way to lift or move the generator set is to use a forklift truck.

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

Removing Underfloor Mounted Set From RV

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

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

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

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

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

Partial Set Removal: Park the recreational vehicle on as level a surface as possible (surface must support floor jack wheels.) Then follow these instructions very carefully.

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

1. Park the vehicle on a level surface that can support the floor jack wheels. Put the transmission in its PARK position, lock the brakes and remove the ignition key. Make sure no one moves the vehicle while performing this procedure.

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

2. Position a floor jack under the reinforcement ribs of the drip tray, as shown in Figure 5-3.
3. Raise the floor jack until it just makes contact with the drip tray, then put a little upward pressure under the drip tray.

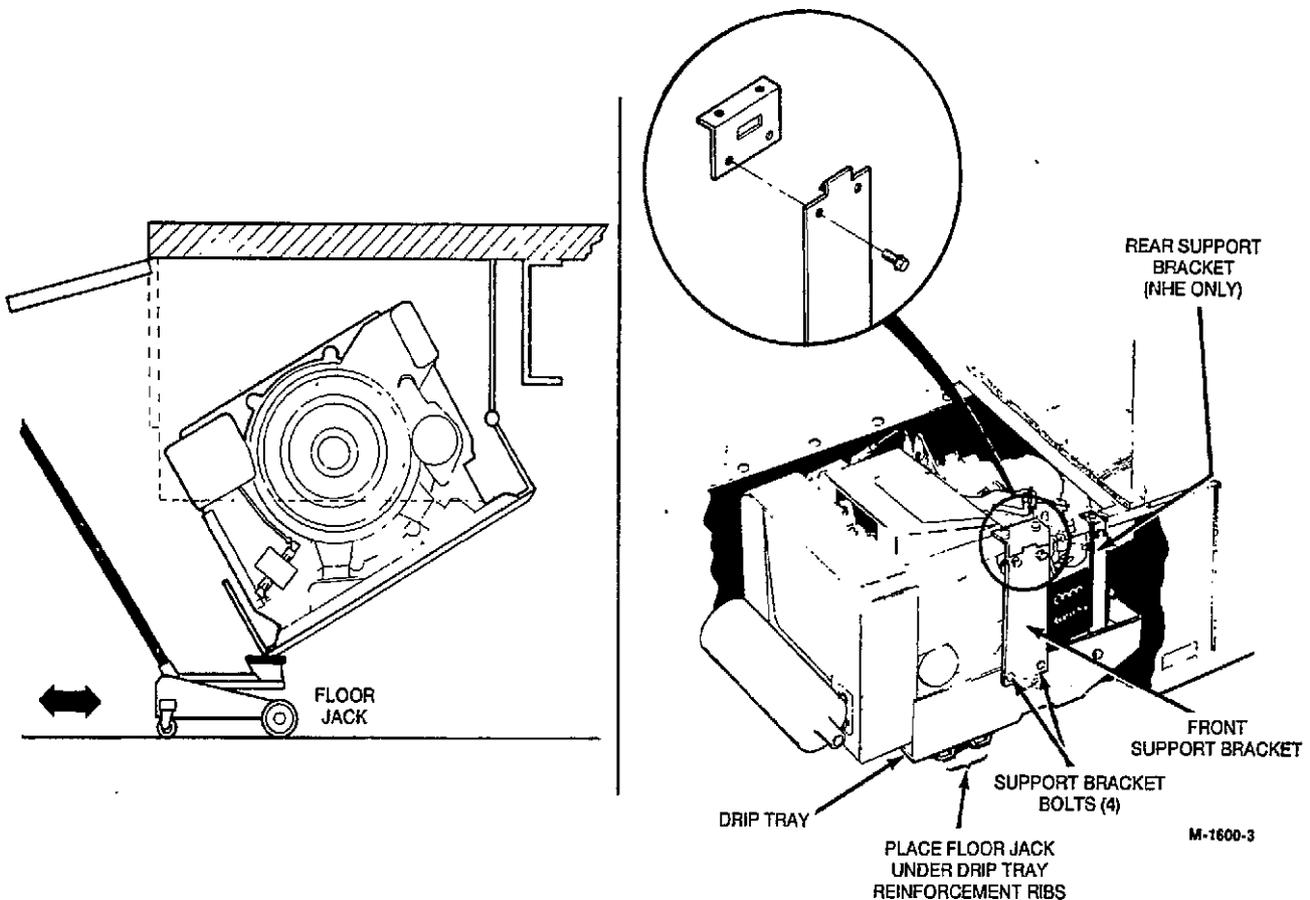


FIGURE 5-3. PARTIAL SET REMOVAL

4. Remove the four bolts from the front support brackets (and the rear brackets, NHE only) and remove the brackets. This may require slight adjustment of the floor jack.
5. When the support bracket is removed, the floor jack will support all its weight on that side. Slowly lower the jack, being careful to allow the jack to roll as the generator set swings downward.
6. Support the drip tray assembly with wood blocks, so the floor jack can be removed. This will allow more access for the service procedure.

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

Complete Set Removal

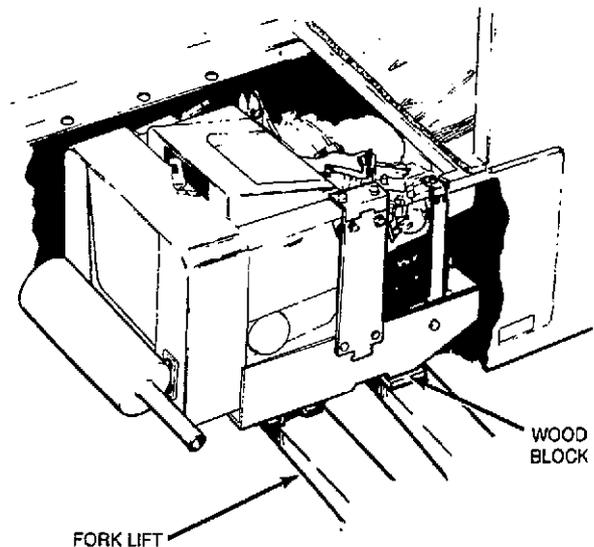
Fuel, exhaust, electrical, and control connections must be disconnected as described previously.

1. Park the vehicle on a level surface that is capable of supporting the floor jack wheels. Put the transmission in its PARK position, lock the brakes and remove the ignition key. Make sure no one moves the vehicle while performing this procedure.

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

2. Use a forklift to support the generator set tray at the points shown in Figure 5-4. Place a wooden block on one fork so the set will remain level.
3. Raise the forklift so it contacts the drip tray; then put slight upward pressure on the tray. Make certain that the generator set is supported by the forks before continuing.

4. Remove the bolts that secure the side support to the drip tray and the underfloor bracket. (Also remove bolts from the rear support bracket, if removing an NHE set).
5. Lift the generator slightly until the safety catch on the side support is clear of the tray. Pull the support forward and upward until disengaged from the tray and underfloor bracket.
6. Remove the side support, to provide the clearance needed for lowering the set.
7. Remove the safety catch from the center of each hinge assembly, then remove the U-shaped hinge pin.
8. Slowly lower the generator set until it is clear of all obstructions, and can be removed from under the vehicle.



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FIGURE 5-4. COMPLETE SET REMOVAL

Section 6. Engine - Primary Systems

INTRODUCTION

The engine primary systems include the following:

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

TROUBLESHOOTING

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

Before considering major inspection of the engine due to abnormal engine performance (engine knocks, power loss, etc.), refer to the unit Operator's Manual, Periodic Maintenance Schedule, and perform *Cleaning the Carburetor and Combustion Chamber with Onan "4C"*.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS



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 Misfires	<ol style="list-style-type: none"> 1. Faulty ignition due to: <ol style="list-style-type: none"> a. worn or fouled spark plugs. **b. worn breaker points. **c. incorrect ignition timing. d. faulty ignition coil. e. faulty plug wires. **f. faulty point condenser ***g. faulty ignition module <ol style="list-style-type: none"> 2. Lean fuel mixture due to: <ol style="list-style-type: none"> a. incorrectly adjusted fuel mixture screws. *b. incorrect float level. c. dirt in carburetor. d. vacuum leak. 3. *Contaminated fuel. 4. *Carburetor icing. <p>*Gasoline sets only. **Prior to spec G only. ***Spec G.</p>	<ol style="list-style-type: none"> 1a. Replace spark plugs. b. Replace breaker points. c. Set breaker point gap. d. Test coil and replace if necessary. e. Test spark plug wires and replace if faulty. f. Replace condenser g. Refer to <i>Testing Ignition Module</i>. <ol style="list-style-type: none"> 2a. Adjust carburetor main and idle adjustment screws. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages. d. Locate leak and correct as required. <ol style="list-style-type: none"> 3. Drain fuel tank and refill with fresh fuel. 4. In cold weather, place air preheater in winter position.
Engine Backfires	<ol style="list-style-type: none"> 1. Faulty ignition due to: <ol style="list-style-type: none"> **a. incorrect ignition timing. b. incorrect spark plug gap. **c. faulty point condenser. 2. Lean fuel mixture due to: <ol style="list-style-type: none"> a. incorrectly adjusted fuel mixture screws. *b. incorrect float level. c. dirt in carburetor. 3. Mechanical damage to engine. <p>*Gasoline sets only. **Prior to spec G only.</p>	<ol style="list-style-type: none"> 1a. Adjust breaker point gap. b. Reset spark plug gap. c. Replace condenser. 2a. Adjust carburetor main and idle adjustment screws. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages. 3. See Engine Block Assembly section.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS (Continued)

▲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 Lacks Power	<ol style="list-style-type: none"> 1. Faulty ignition due to: <ol style="list-style-type: none"> **a. incorrect ignition timing. b. incorrect spark plug gap. 2. Dirty air cleaner. 3. Restricted fuel flow due to: <ol style="list-style-type: none"> a. plugged fuel filter or b. faulty fuel pump. 4. Incorrect fuel mixture due to: <ol style="list-style-type: none"> a. incorrectly adjusted fuel mixture screws. *b. incorrect float level. c. dirt in carburetor. d. vacuum leak. 5. Exhaust system blocked or restricted. 6. Incorrect valve tappet clearance. 7. Excessive engine wear or damage to engine. 8. Carburetor air preheater set incorrectly. 9. Excessive carbon build-up. 10. No-load speed set too low. <p style="margin-left: 20px;">*Gasoline sets only. **Prior to spec G only.</p>	<ol style="list-style-type: none"> 1a. Adjust breaker point gap. b. Reset spark plug gap. 2. Replace air cleaner. 3a. Clean fuel filter. b. Test fuel pump and repair or replace if faulty. 4a. Adjust carburetor main and idle adjustment screws. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages. d. Repair vacuum leak. 5. Locate and remove cause of blockage. 6. Adjust valve tappets (see Engine Block Assembly section). 7. See Engine Block Assembly section. 8. In hot weather, place air preheater in summer position. 9. Clean combustion chamber. 10. Adjust governor.
Engine Overheats	<ol style="list-style-type: none"> 1. Restricted airflow due to dirt or debris blocking air inlet or outlet. 2. Dirt or oil covering engine cooling fins. 3. **Incorrect ignition timing 4. Lean fuel mixture due to: <ol style="list-style-type: none"> a. incorrectly adjusted fuel mixture screws. *b. incorrect float level. c. dirt in carburetor. <p style="margin-left: 20px;">*Gasoline sets only. **Prior to spec G only.</p>	<ol style="list-style-type: none"> 1. Clear away any debris that may restrict airflow to set. Do not use compartment for storage area. 2. Clean away all dirt and oil from engine cooling fins. 3. Adjust breaker point gap. 4a. Adjust carburetor main and idle adjustment screws. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS (Continued)



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
Black Exhaust Smoke	1. Rich fuel mixture due to: a. dirty air cleaner. *b. choke sticking. c. incorrectly adjusted fuel mixture screws. d. dirt in carburetor. *Gasoline Sets Only.	1a. Replace air cleaner. b. Clean choke and choke linkage. c. Adjust carburetor idle and main adjustment screws. d. Disassemble carburetor and clean all internal passages.
White or Blue Exhaust Smoke	1. Lean fuel mixture due to: *a. incorrect float level. b. incorrectly adjusted fuel mixture screws. c. dirt in carburetor. d. vacuum leak. 2. Contaminated fuel. 3. Excessive engine wear. *Gasoline Sets Only.	1a. Adjust carburetor float level. b. Adjust carburetor idle and main adjustment screws. c. Disassemble carburetor and clean all internal passages. d. Repair vacuum leak. 2. Drain and replace fuel. 3. See Engine Block Assembly section.
Engine Hunts or Surges	1. Sticking or binding governor linkage. 2. Incorrect governor adjustment. 3. Faulty governor spring. 4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws. *b. incorrect float level. c. dirt in carburetor. 5. Governor mechanism worn excessively. 6. Fuel supply problem caused by: a. faulty fuel pump. b. contaminated fuel supply. c. vapor locking. d. plugged fuel filter. 7. Carburetor icing.	1. Clean governor linkage. Check that linkage does not touch other parts. 2. Adjust governor speed and sensitivity. 3. Replace governor spring. 4a. Adjust carburetor main and idle adjustment screws. b. Adjust carburetor float level. c. Disassemble carburetor and clean all internal passages. 5. See Engine Block Assembly section. 6. Check fuel pump and replace if defective. b. Drain and refill fuel supply. c. Check for cause of overheating. d. Replace fuel filter. 7. In cold weather, place air preheater in winter position.

*Gasoline Sets Only.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS (Continued)

⚠ 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
<p>High Oil Consumption</p> <p>(Note: New engines sometimes have high oil consumption during break-in)</p>	<ol style="list-style-type: none"> 1. Oil viscosity too light or oil is diluted. 2. Crankcase breather valve is dirty or defective. 3. Oil leaks. 4. Excessive engine wear. 5. Light loading. 	<ol style="list-style-type: none"> 1. Drain oil and refill with correct viscosity oil. 2. Clean crankcase breather and replace if defective. 3. Locate source of leak and repair as required. 4. See Engine Block Assembly section. 5. Don't run set at no-load for long periods of time.
<p>Low Oil Pressure</p>	<ol style="list-style-type: none"> 1. Oil viscosity too light or oil is diluted. 2. Low oil level. 3. Low oil pressure switch defective. 4. Faulty oil bypass valve. 5. Excessive engine wear or defective oil pump. 	<ol style="list-style-type: none"> 1. Drain oil and refill with correct viscosity oil. 2. Add oil as required. 3. Replace oil pressure switch (see Engine Block Assembly section). 4. Inspect oil bypass valve and clean or replace as required (see Engine Block Assembly section.) 5. See Engine Block Assembly section.

EXHAUST SYSTEM

The condition of the exhaust system is extremely critical on RV generator sets because of the possibility of exhaust gases entering the coach.

The exhaust system must be serviced immediately if inspection reveals leaking joints or connections, loose fasteners, or broken or damaged components. The exhaust system must terminate beyond the perimeter of the vehicle.

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

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

Two basic exhaust systems are used with Emerald series generator sets. Figure 6-1 shows a typical exhaust system for a compartment mount generator set. Figure 6-2 shows a typical exhaust system for an underfloor mount generator set. Separate sections cover the service procedures for each exhaust system. Also refer to specific kit installation instructions.

Conventional Compartment Mount Exhaust System

A conventional compartment mount exhaust system consists of the exhaust manifold, flange connector, muffler, muffler strap, hanger, clamps, and tailpipe. When service is required, disassemble and reassemble as specified in the following steps.

Disassembly Procedure

1. Loosen the front muffler clamp, muffler strap, and tailpipe hanger. Remove the muffler and tailpipe assembly (see Figure 6-1).
2. Remove the screws that secure the exhaust tube to the exhaust manifold. Remove the exhaust tube and exhaust gasket.

Completion of the remaining steps requires that the generator set be removed from the vehicle. Refer to *Preparing to Service* (Section 5) for the set removal procedures. For LPG sets, also perform the procedure for purging LPG from the fuel line.

3. Remove the cooling system noise shield and scroll (see Cooling in this section) to provide access to the exhaust manifold.
4. Remove the screw that secures the exhaust manifold outlet flange to the exhaust manifold support bracket.
5. Remove the four exhaust manifold screws and lift off the exhaust manifold and the two manifold gaskets.

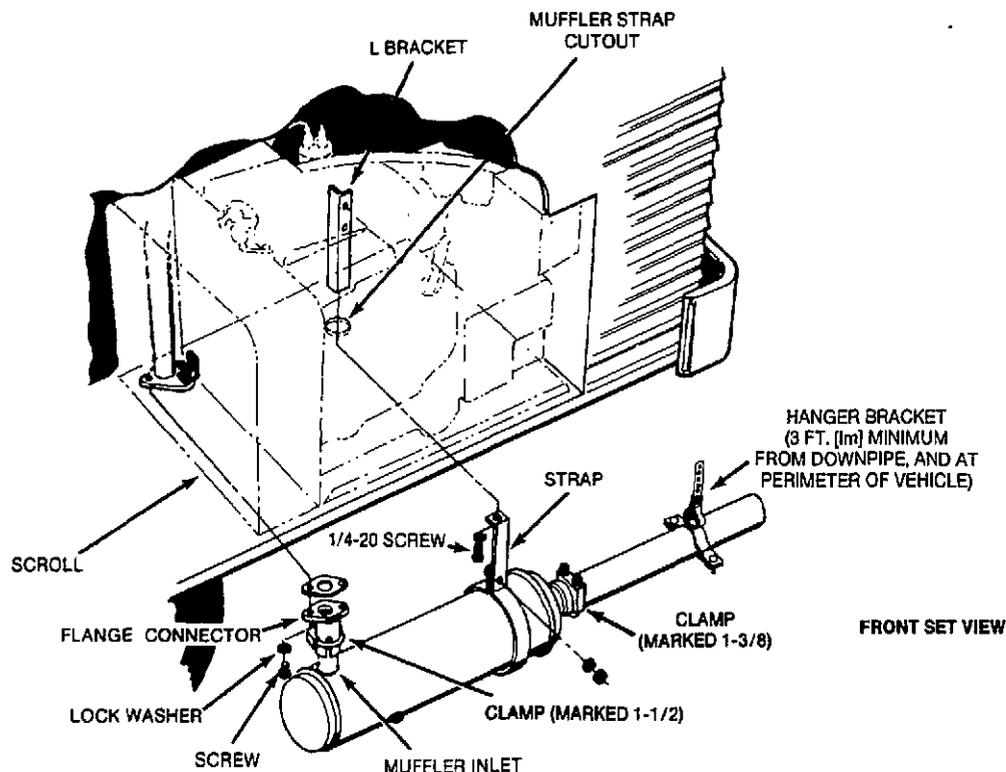


FIGURE 6-1. CONVENTIONAL COMPARTMENT MOUNT EXHAUST SYSTEM

Assembly Procedure:

▲WARNING *Inhalation of exhaust gas can result in severe personal injury or death. To prevent exhaust leaks, install all gaskets, clamps, straps, and hardware as specified. See Tailpipe Recommendations in this section.*

1. Install the exhaust manifold using new gaskets. Tighten the four manifold screws to the specified torque.
2. Install the 5/16-18 screw, lock washers, and nut that secure the manifold outlet flange to the manifold support bracket and tighten securely.
3. Install the cooling system scroll and noise shield (see Cooling System in this section).

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

4. Install a new gasket between the exhaust manifold and exhaust tube. Secure the flange connector to the manifold using 5/16-18 inch capscrews and lock washers.
5. Attach the inlet of the muffler to the exhaust tube using a 1-1/2 inch U-bolt type automotive muffler clamp. Make certain that the muffler inlet pipe overlaps the exhaust tube a minimum of 1-1/2 inches (38 mm).
6. Place the muffler strap on the muffler and position it below the cutout in the bottom of the generator set drip tray. Fasten the strap to the set strap bracket using 1/4-20 screw and lock washer. Tighten the strap around the muffler using a 1/4-20 screw, lock washers and nut.
7. If replacing the original tailpipe, refer to the Tailpipe Recommendations sections for selecting and locating the tailpipe. Attach the tailpipe to the outlet end of the muffler. Secure it using a 1-3/8 U-bolt type automotive muffler clamp.
8. Support the tailpipe using a shock mounted support hanger with clamp.

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

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

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

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

Underfloor Mount Exhaust System

An underfloor mount exhaust system consists of the exhaust manifold, muffler, clamps, hanger (if required), and tailpipe. When service is required, disassemble and reassemble as specified in the following steps.

Disassembly Procedure

▲CAUTION *Contact with hot engine parts can cause personal injury. The genset should be shut down and allowed to cool before performing this procedure.*

1. Loosen the muffler clamp at the muffler inlet (see Figure 6-2) and remove the muffler support bracket screws.
2. Remove the two 1/4-20 screws and lock washers, and muffler and tailpipe assembly.

Completion of the remaining steps requires that the generator set be partially removed from the vehicle. Refer to *Preparing to Service* (Section 5) for the set removal procedures. For LPG sets also perform the procedure for purging LP from the fuel line.

3. Remove the cooling system scroll and noise shield (see Cooling System in this section) to provide access to the exhaust manifold.
4. Remove the four exhaust manifold screws and lift off the exhaust manifold and the two manifold gaskets.

Assembly Procedure:

▲WARNING *Inhalation of exhaust gas can result in severe personal injury or death. To prevent exhaust leaks, install all gaskets, clamps, straps, and hardware as specified. See Tailpipe Recommendations in this section.*

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

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

3. Place a U-bolt type automotive muffler clamp (marked 1-1/4) in position on the exhaust manifold (near elbow) prior to installing the muffler.
4. Place the muffler in position on the set, making certain that the muffler inlet pipe overlaps the exhaust manifold a minimum of 1-1/2 inches (38 mm).

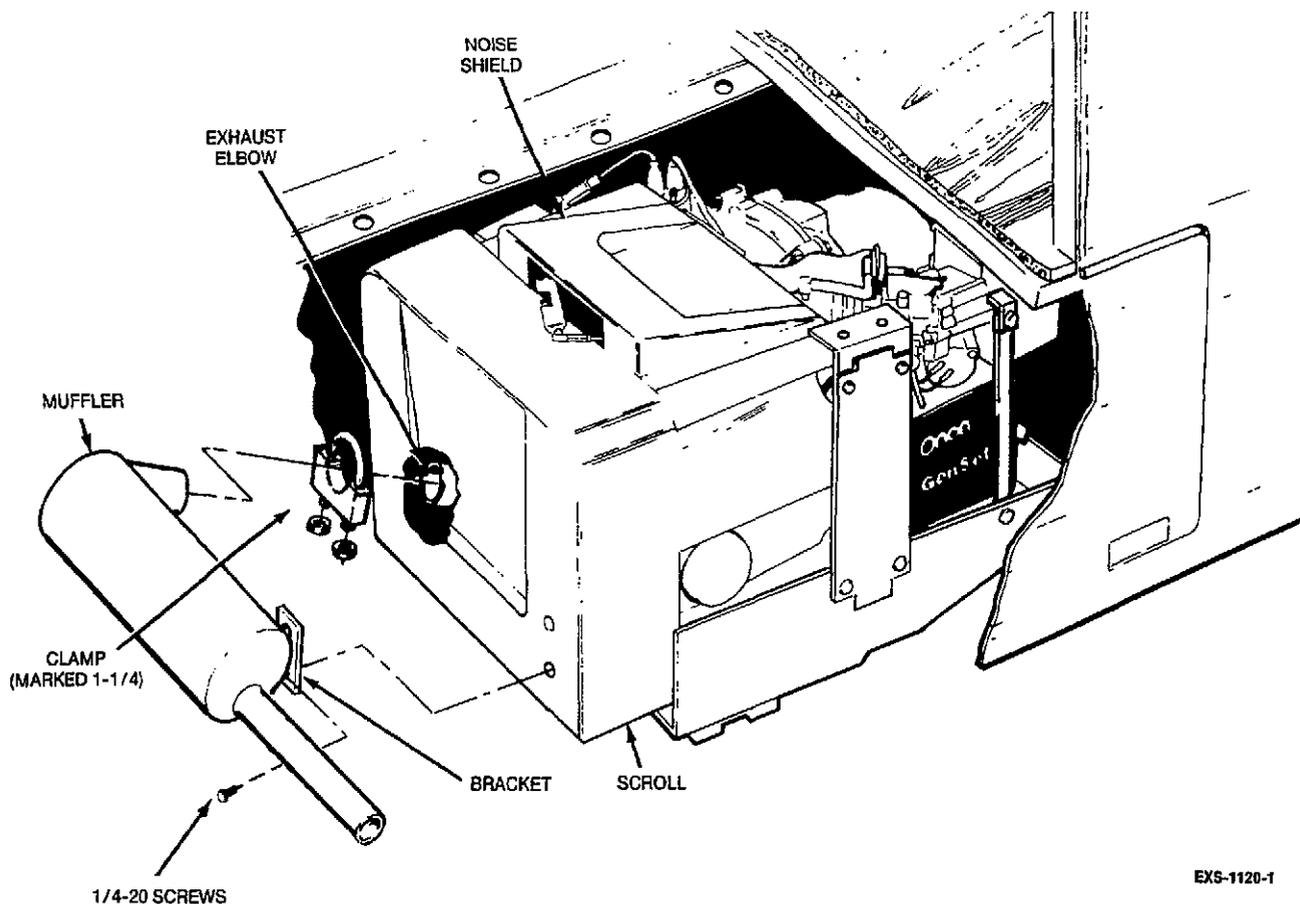


FIGURE 6-2. UNDERFLOOR MOUNT EXHAUST SYSTEM

5. Install the two 1/4-20 screws and lock washers that secure the muffler support bracket to the set and tighten the muffler clamp.

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

6. If replacing the original tailpipe, refer to the *Tailpipe Recommendations* sections to select and locate the tailpipe. Attach tailpipe to outlet end of muffler and secure using a U-bolt type and automotive muffler clamp (marked 1-3/8) ONLY.
7. Support the tailpipe using a shock mounted support hanger with clamp.
8. Run the generator set for five minutes and check the entire exhaust system for leaks or excessive noise.

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

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

Tailpipe Recommendations

Tailpipes are supplied by the RV manufacturer and must meet several design specifications to provide safe generator set operation. If replacing the tailpipe, make certain the replacement part is the same size and configuration as the original part. Refer to the following guidelines for selecting and locating the tailpipe. Also, refer to recommendations in Installation Manual.

WARNING *Inhalation of exhaust gases can result in severe personal injury or death. Exhaust gases can enter the coach interior if the tailpipe is damaged, missing, or improperly installed. Be sure to follow the recommended exhaust system replacement procedures.*

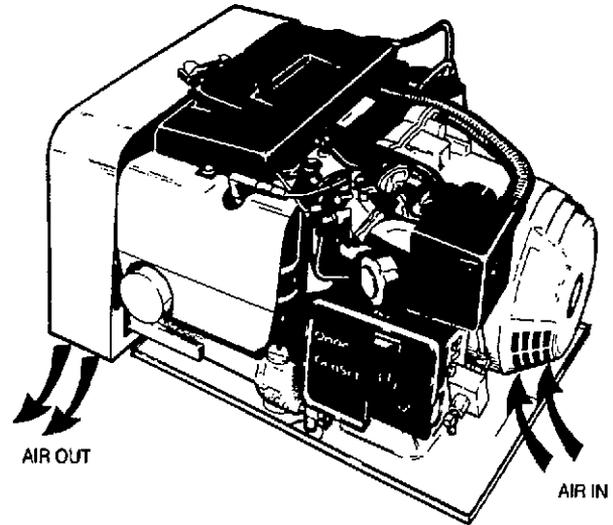
- Use 1-3/8 inch I.D., 18 gauge, rigid steel tubing for tailpipe. Do not use flexible exhaust tailpipe, because it is vulnerable to road shock and vibration.

- Install an exhaust tailpipe at least 3 inches (76 mm) away from the fuel tank and from any combustible material. If 3 inches clearance cannot be maintained, install heat shielding between the tailpipe and the fuel tank or any combustible material, to prevent excessive heating.
- Do NOT terminate the exhaust tailpipe in these positions:
 - A. Under a window, door, or any opening that might allow exhaust gases to enter the vehicle interior.
 - B. Ahead of or underneath the generator compartment air intake, which might recirculate exhaust gases. Terminate the tailpipe at the rear of the compartment air intake if possible.
 - C. Under the fuel tank fill spout, so spilled fuel cannot be ignited by a hot tailpipe.
 - D. Under the vehicle, so exhaust gases cannot enter the vehicle interior through small openings in the underside of the vehicle.
- Extend the tailpipe at least one inch (25 mm) beyond the perimeter of the vehicle. Direct exhaust gases down and away from the vehicle, and away from windows, doors, or compartment openings.
- Do not connect the generator set exhaust tailpipe to the vehicle exhaust system. Exhaust gases will be forced into the non-running engine, and might be released through the carburetor air inlet. Water vapor from the exhaust might also damage the non-running engine.

COOLING SYSTEM

Emerald generator sets use the Vacu-Flo cooling system to provide a constant air flow over the engine and generator, to minimize heat buildup. A flywheel fan draws cool air in from the generator end of the compartment (see Figure 6-3). This air passes over the cooling fins on the engine, absorbing the heat. Heated air is discharged through the opening in the bottom of the generator set housing.

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



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FIGURE 6-3 COOLING AIRFLOW

The size of the generator compartment air inlet (see *Specifications*) determines the air flow rate. The air inlet and discharge openings must remain free of any obstructions, to avoid restricting airflow. Regularly remove any dirt, dust, or debris clogging the duct openings. Remove any dirt lodged between the cooling fins on the engine block and cylinder heads. If the fins are dirty, heat transfer is greatly reduced, and overheating can occur.

The cooling system consists of:

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

Cooling System Disassembly Procedure

CAUTION Contact with hot engine parts can cause personal injury. The genset should be shut down and allowed to cool before performing this procedure.

1. Remove the muffler and tail pipe assembly (see *Exhaust System* section) to access the cooling system.
2. Remove the capscrews that secure the noise shield (see Figure 6-4) to the engine. Lift off the noise shield.
3. Remove the three nuts along the lower edge of the scroll that hold the fan to the scroll.
4. Remove the capscrews that fasten the scroll to the backplate and lift it away from the scroll.

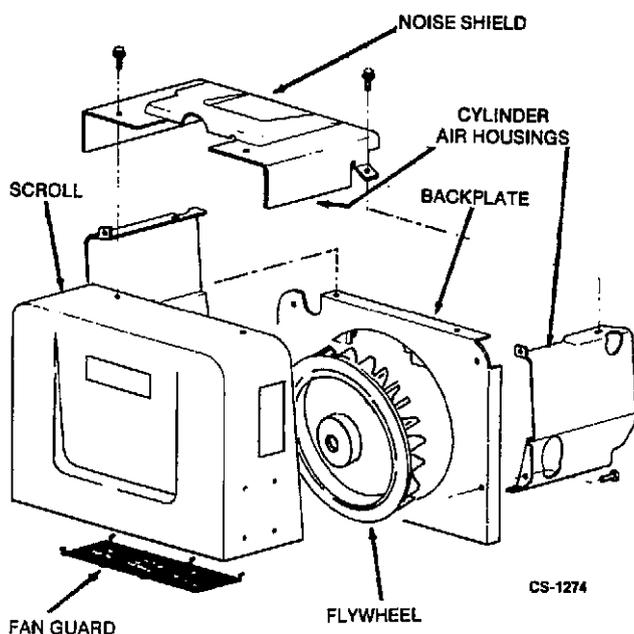


FIGURE 6-4. COOLING SYSTEM

5. Remove the screws that fasten the cylinder air housings to the backplate and cylinder heads. Lift off the air housings.
6. Loosen the flywheel capscrew and back it out several turns.
7. Attach the puller tool to the flywheel (see Figure 6-5). The tool has two jack screws that fit into the holes tapped in the flywheel.

8. Tighten the puller center screw until the flywheel comes loose. Remove the puller, flywheel center screw, and washer. Inspect the flywheel, and replace it if any air vanes are missing.
9. Remove the lead from the low oil pressure cutoff switch.
10. Remove the exhaust manifold (see *Exhaust System* in this section).
11. Remove the capscrews that secure the backplate to the engine. Lift off the backplate.
12. Use a brush or low pressure compressed air to remove any dirt or debris that may be lodged on the engine cooling fins.

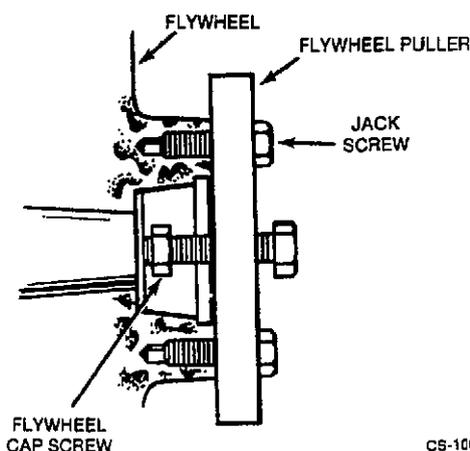


FIGURE 6-5. FLYWHEEL PULLER

Cooling System Assembly Procedure

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

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

ELECTRONIC IGNITION SYSTEM (Begin Spec G)

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

Ignition System Components

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

Ignition Rotor

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

Ignition Module

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

Testing Ignition Module:

1. Remove the spark plugs and fan scroll (Figure 6-4) so that the engine can be turned by hand.
2. Connect the positive (+) side of a voltmeter to the negative (-) terminal of the ignition coil (the larger of the two screw terminals) and the negative (-) side of the voltmeter to engine ground.
3. Remove all leads from the positive (+) terminal of the coil.
4. Use a jumper to connect the ignition module lead (the one just removed from the coil) to the battery positive (+) terminal.
5. Rotate the flywheel clockwise by hand and measure the resultant voltage.
6. If the voltage does not switch from about 1 volt to about 12 volts and back again to about 1 volt with each full revolution, the ignition module is defective.

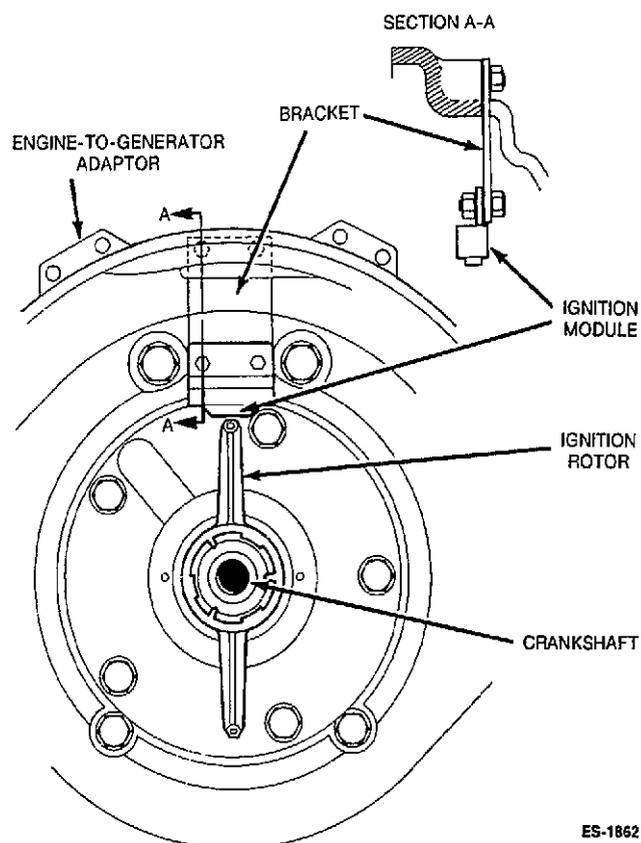


FIGURE 6-6. IGNITION MODULE AND ROTOR

Ignition Module and Rotor Replacement:

The ignition rotor and ignition module are located inside the generator housing. 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 adaptor housing as follows.

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, align the key on the rotor 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 bracket 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.
4. To replace the module, perform the steps listed above in reverse order. Be sure to assemble the new module to the bracket as shown in Figure 6-6, Section A-A. The studs on the bracket must point toward the generator end of the set, when assembled and installed.

Ignition Coil

The ignition coil (Figure 6-7) is a transformer that steps up the battery voltage to about 20,000 volts, firing the spark plug.

Keep all ignition coil terminals and connections clean and secure. Check for loose seams, dents, punctures, and mechanical damage. If ignition is poor and the other ignition components are not at fault, test the coil as described below. Make certain of coil polarity: the negative (-) terminal connects to the ignition module (black lead), and the positive (+) terminal connects to the ignition module (black lead), and the positive (+) terminal connects to a battery positive (+) source within the control, to the ignition module (red lead), and to filter capacitor C4.

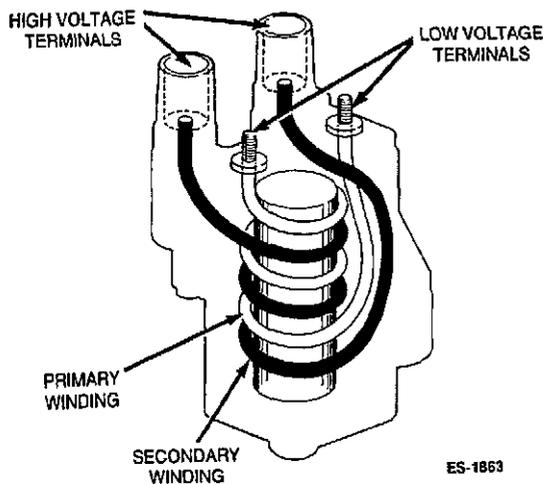


FIGURE 6-7. IGNITION COIL

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

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

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

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

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

Direct Testing Coil With Ohmmeter: The coil is removed from the circuit to perform this test.

1. Remove all wires attached to the ignition coil.
2. Remove the coil from the engine.
3. Inspect the terminals for corrosion, looseness, cracks, dents and other damage. Look for carbon runners around the high voltage terminals. (These indicate electrical leakage.) Replace a damaged or leaking coil.
4. Clean the outside of the coil with a cloth dampened in parts-cleaning solvent.
5. Measure resistance in the primary circuit: connect the ohmmeter leads to the positive (+) and negative (-) terminals on the coil. This resistance should be between 3.74 and 4.57 ohms. Replace the coil if the resistance is higher: high resistance indicates an open circuit or a poor connection inside the coil.
6. Measure resistance in the secondary circuit; connect the ohmmeter leads to the two high voltage terminals (see Figure 6-8). This resistance should be between 17.45 Kohms and 19.8 Kohms. Replace the coil if it is not within this specification. Lower resistance indicates a shorted secondary winding, and higher resistance indicates the coil has excessive internal resistance or an open circuit.

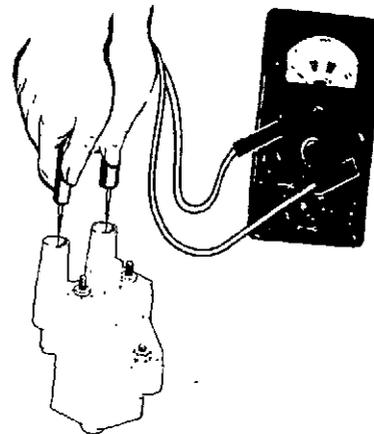


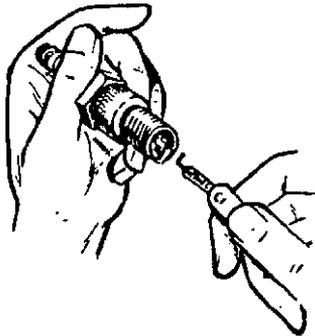
FIGURE 6-8. TESTING COIL SECONDARY

Spark Plugs

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

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

- **One plug carbon fouled:** Check for an open ignition cable or low compression.
- **Black soot deposits:** Check for faulty choke operation, overly rich fuel mixture, or dirty air filter.
- **Oil fouled:** Check for faulty crankcase breather, worn rings, or worn valve guides.
- **Burned or overheated:** Check for leaking intake manifold gaskets or lean fuel mixture.
- **Chipped insulator:** Check for advanced timing. Bend only the side electrode when setting the gap.
- **Splash fouled:** Check for accumulated combustion chamber deposits. Refer to the *Cylinder Head* section of this manual.
- **Light tan or gray deposits:** Normal plug color.



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FIGURE 6-9. CHECKING PLUG GAP

Ignition Wiring

The ignition system wiring includes:

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

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

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

BREAKER IGNITION SYSTEM

(Prior to Spec G)

The ignition system consists of the following elements:

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

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

Breaker Points and Condenser

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

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

Breaker Point Replacement/ Adjustment Procedure

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

1. Disconnect the negative (-) battery cable at the battery terminal.
2. Remove the breaker box cover clip and lift off the breaker box cover.
3. Remove the spark plugs, to permit easy rotation of the engine and generator assembly. Use a socket wrench to turn the rotor through-bolt clockwise until the breaker point gap is open as far as possible.

4. Disconnect the condenser and ignition lead wires at screw A (Figure 6-10).
5. Remove the condenser, mounted outside breaker points box on engine adapter flange.
6. Remove the breaker points mounting screws (B) and lift out the point assembly.
7. Replace the condenser and point assembly and install in a reverse order of removal.
8. Use an allen head wrench to adjust set screw C to obtain the gap setting specified in the *Specifications* section. Measure the point gap with a flat thickness gauge. (See Figure 6-10).

Make sure feeler gauge is clean and free of any grease, oil or dirt.

The timing is adjusted during initial engine assembly and is fixed by the point gap adjustment. No other adjustment or alignment is necessary.

9. Replace the point box cover and hold-down wire, spark plugs, and spark plug leads.
10. Connect negative (-) battery cable to negative battery terminal.

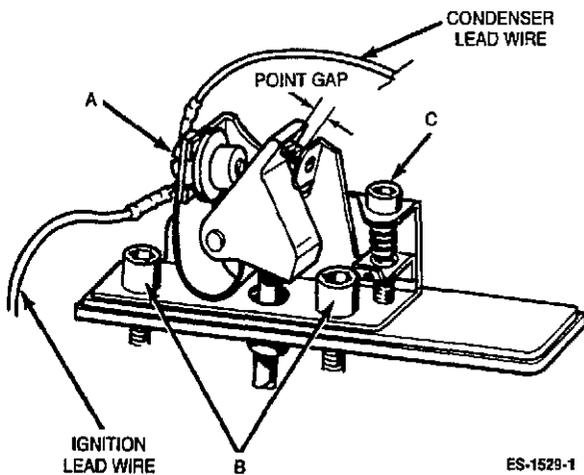
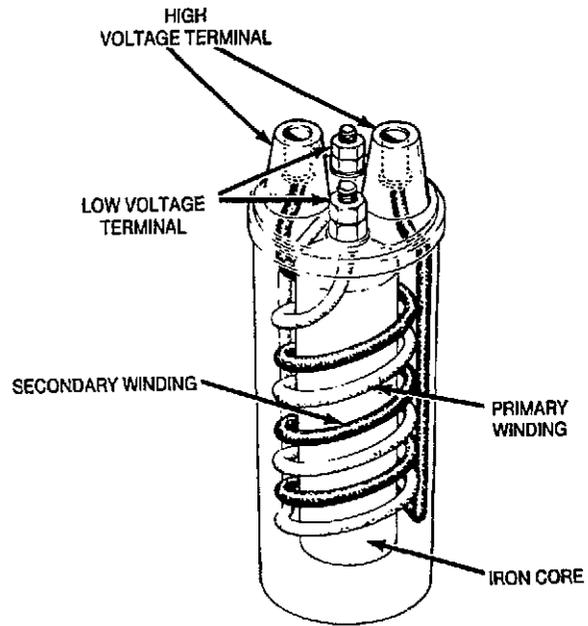


FIGURE 6-10. BREAKER POINTS

Ignition Coil

The ignition coil (Figure 6-11) is a transformer that steps up the battery voltage to approximately 20,000 volts, to fire the spark plug.

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



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FIGURE 6-11. IGNITION COIL

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

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

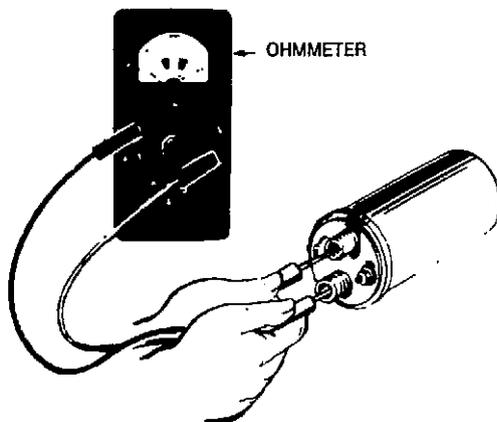
⚠ WARNING Use extreme care when performing this test procedure. To avoid shock, do not hold the plug without adequate insulation.

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

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

Direct Testing Coil With Ohmmeter: The coil is removed from the circuit to perform this test.

1. Remove all wires attached to the ignition coil.
2. Remove the coil from the engine.
3. Inspect the terminals for corrosion, looseness, cracks, dents and other damage. Look for carbon runners around the high voltage terminals. (These indicate electrical leakage.) Replace a damaged or leaking coil.
4. Clean the outside of the coil with a cloth dampened in parts-cleaning solvent.
5. Measure resistance in the primary circuit: connect the ohmmeter leads to the positive (+) and negative (-) terminals on the coil. This resistance should be between 3.87 and 4.73 ohms. Replace the coil if the resistance is higher: high resistance indicates an open circuit or a poor connection inside the coil.
6. Measure resistance in the secondary circuit; connect the ohmmeter leads to the two high voltage terminals (see Figure 6-12). This resistance should be between 12.6 and 15.4 k ohms. Replace the coil if it is not within this specification. Lower resistance indicates a shorted secondary winding, and higher resistance indicates the coil has excessive internal resistance or an open circuit.



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FIGURE 6-12. TESTING COIL SECONDARY

Spark Plugs

Spark plug inspection is described under *Electronic Ignition*.

Wiring

The ignition system wiring includes:

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

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

CRANKCASE VENTILATION SYSTEM

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

The crankcase breather is vented directly below the generator set. For this reason, the generator set should only be used in environments where oily vapor and dust do not create a problem.

▲WARNING Crankcase breather vapor contains poisonous carbon monoxide which can cause personal injury or death. Do not run the generator set while parked unless the undercarriage is exposed to a steady airflow.

Crankcase Breather Service Procedure

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

1. Remove the breather tube from the valve cover (see Figure 6-13).

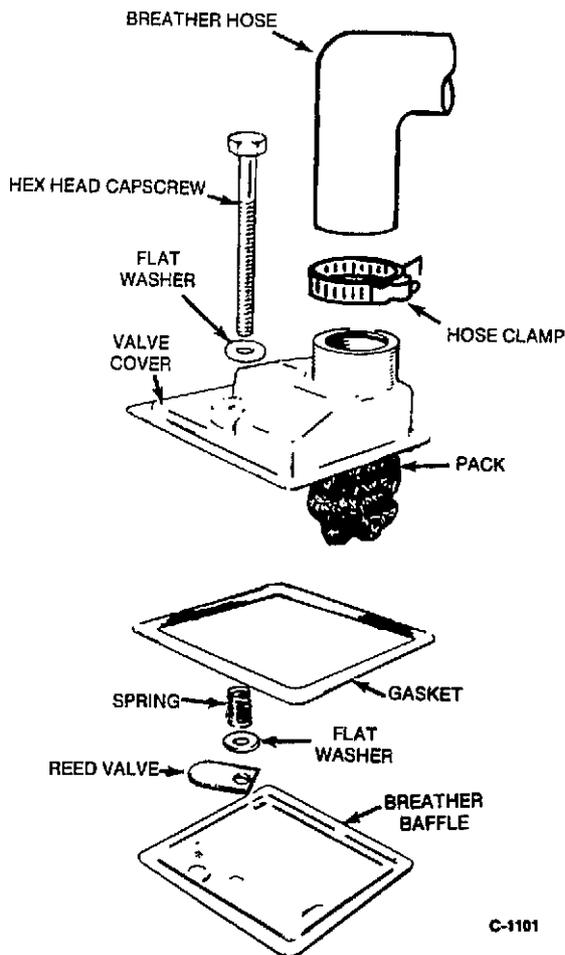


FIGURE 6-13. CRANKCASE BREATHER

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

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

The reed valve must be flat and uncreased. Assemble the valve using a new gasket. Do not overtighten the valve cover capscrew.

The reed valve must be assembled as shown in Figure 6-9, with a washer on top and the breather baffle on the bottom.

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

COMBUSTION CHAMBER

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

Cylinder Compression Check

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

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

GOVERNOR

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

Preliminary Governor Adjustment

Before adjusting the governor system, make sure that the length of the governor rod is correct. Make this static adjustment with the genset cold. Refer to Figure 6-14..

1. Loosen the jam nut at the ball joint end of the governor rod.
2. Disconnect the plastic ball joint from the ball stud.
3. With the carburetor throttle fully open and the governor rod in its full counterclockwise position, adjust the governor rod length so that the hole in the ball joint aligns with the ball stud.
4. Turn the ball joint in (shorter) one full turn.
5. While holding the ball socket in the vertical position, reconnect the ball joint to the ball stud and tighten the jam nut.

Governor Adjustment

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

CAUTION *Voltage/frequency-sensitive equipment such as VCR's, televisions, and computers, 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.*

Equipment required:

Digital frequency/voltmeter with 0.3% frequency, 0.5% voltage accuracy. Recommended: Fluke 8060A or 85 series.

Digital ammeter. Recommended: Beekman 4410

Load bank with 8 kW (minimum capacity) variable 600 watt section.

Refer to Figure 6-14 if you are adjusting a spec H set. For sets prior to spec H, refer to Figure 6-15.

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

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

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

2. Run the genset at least 15 minutes at 50% to 75% of its rated load. Then remove the load and let the set stabilize for 10 to 15 seconds. Make certain that the set is running with no load.
3. With the unit operating at no load, adjust the governor speed nut to 50 ± 2 Hz (50 Hz sets: 40 ± 2 Hz) while checking that the idle stop screw is not contacting the throttle lever. Then adjust the idle stop screw to increase the engine speed to 55 ± 1 Hz (50 Hz sets: 45 ± 1 Hz).
4. Run the generator set with no load, and adjust the speed adjustment nut to the following frequency:

Model	Adjust Speed Nut to:
60 Hz, 120 volts	62-63 Hz
50 Hz, 110/220 volts	51.5-52.5 Hz
50 Hz, 120/240 volts	51.5-52.5 Hz

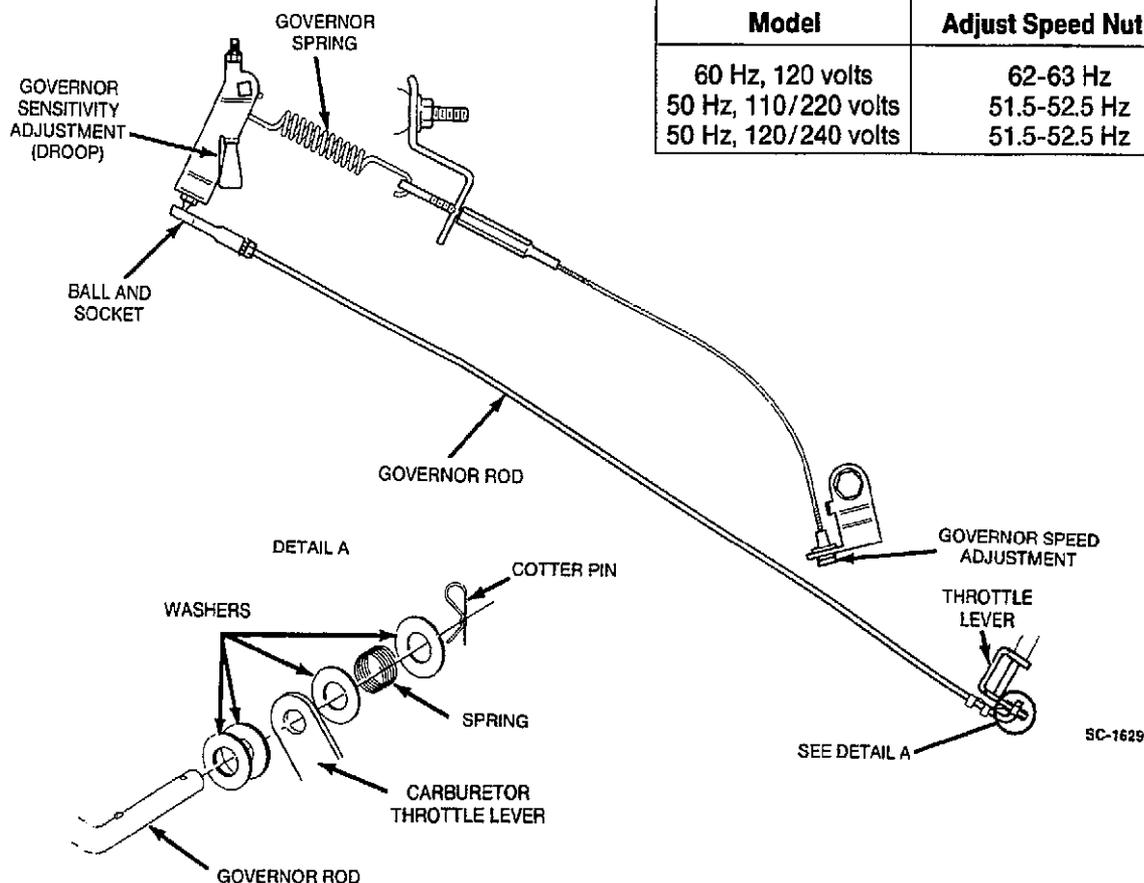


FIGURE 6-14. GOVERNOR ADJUSTMENT (SPEC H)

5. Check the frequency and voltage at no load. Frequency and voltage should stay within the limits shown in Table 6-1. Then apply rated load to the generator set, and check frequency and voltage. Calculate "droop" by subtracting the full-load frequency from the no-load frequency.
6. If the droop is greater than the specified range, adjust the governor spring towards the governor shaft by turning the adjusting screw counterclockwise 1 to 2 turns. If the droop is less than the minimum specified, or if the set is hunting, adjust the governor spring away from the governor shaft by turning the adjusting screw clockwise 1 to 2 turns.
7. Recheck the no load speed setting and readjust if needed. Reapply rated load and check the governor droop. Repeat these adjustments until droop and no load frequency readings are within the correct ranges and the set is stable (no hunting) at any load from no load to rated load.

TABLE 6-1.
CHECKING VOLTAGE AND SPEED/FREQUENCY

	60 Hz (1Ø, 2-Wire) 120 V	50 Hz (1Ø, 4-Wire)	
		110/220 V	120/240 V
Voltage			
Maximum No-Load	132	121/242	132/264
Minimum Full-Load	112	103/205	112/224
Speed/Frequency			
Maximum No-Load			
Speed (r/min)	1890	1575	
Frequency (Hz)	63	52.5	
Minimum Full-Load			
Speed (r/min)	1740	1440	
Frequency (Hz)	58	48	
Droop (Hz)	2-4	1.5 - 3.5	

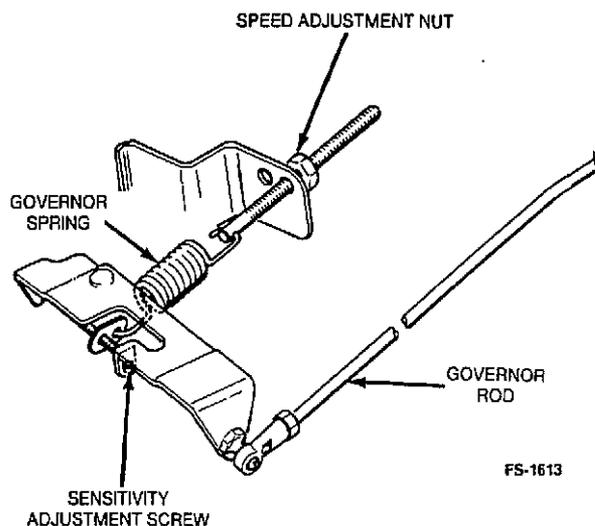


FIGURE 6-15. GOVERNOR ADJUSTMENT
(PRIOR TO SPEC H)

FUEL SYSTEM - GASOLINE

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

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

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

Air Intake Assembly

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

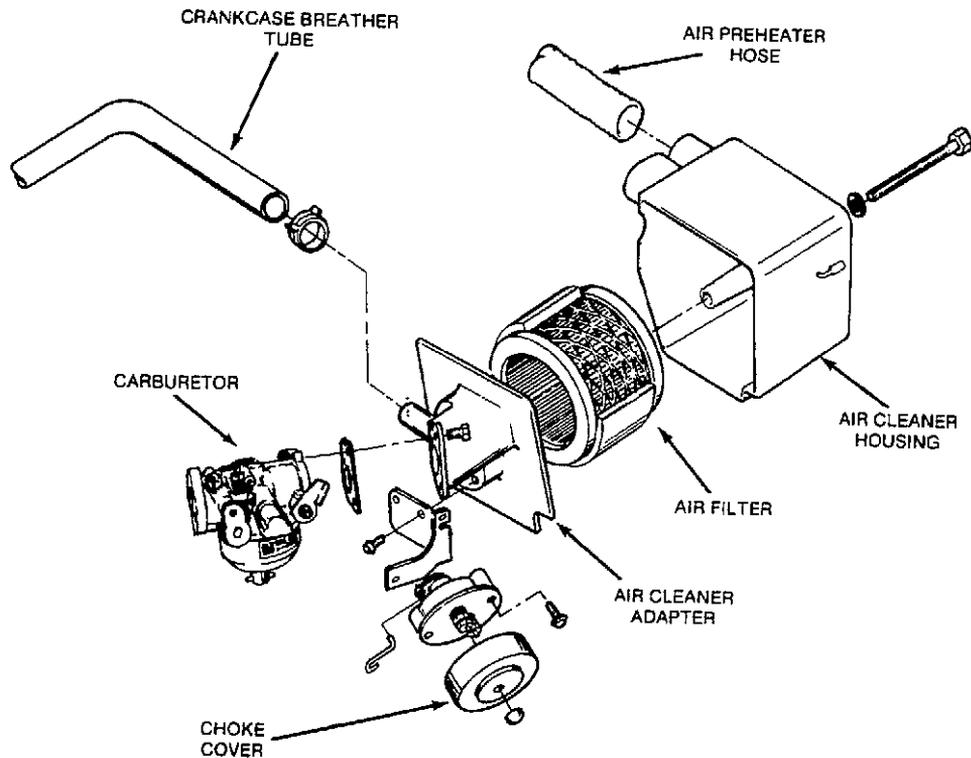
- Air cleaner housing
- Air filter
- Air cleaner adapter
- Choke assembly

Disassembly Procedure:

▲CAUTION Contact with hot engine parts can cause personal injury. The genset should be shut down and allowed to cool before performing this procedure.

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

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



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FIGURE 6-16. AIR INTAKE ASSEMBLY

Carburetor and Intake Manifold Assembly

The carburetor and intake manifold assembly (Figure 6-17) consists of:

- Intake manifold
- Choke pull-off assembly
- Air preheaters
- Carburetor
- Fuel filter

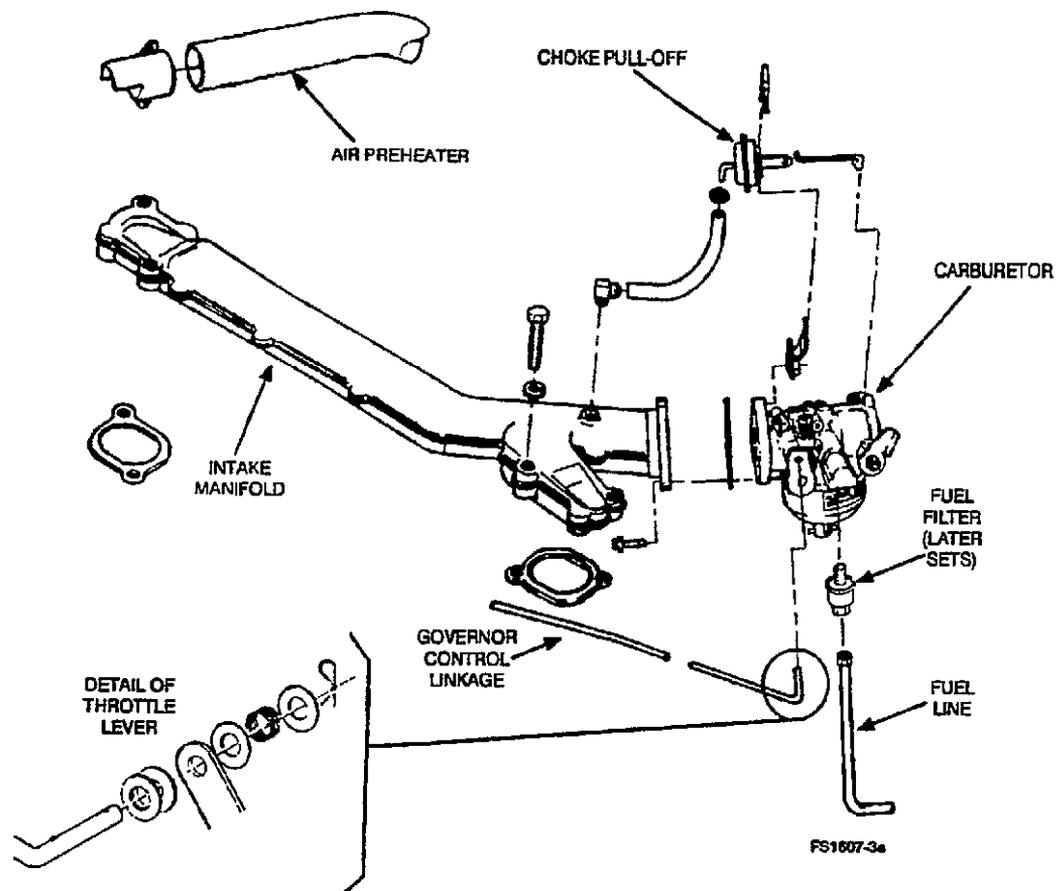
⚠ WARNING Gasoline vapor is extremely flammable, and can result in severe personal injury or death if ignited. Make certain all fuel line openings are plugged to prevent gasoline vapor from accumulating. Eliminate all possible sources of ignition including fire, flame, spark, pilot light, arc-producing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

Disassembly Procedure:

1. Remove the air intake assembly, as described in the Air Intake Assembly section.

2. Disconnect the fuel line and governor control linkage from the carburetor.
3. Remove the intake manifold capscrews and lift off the carburetor air preheater. Lift off the carburetor and intake manifold as an assembly.
4. Remove the two intake manifold gaskets and plug the intake ports with a rag to prevent loose parts from accidentally entering the ports.
5. Remove the two capscrews that secure the carburetor and choke pull-off assembly to the intake manifold. Disengage the choke pull-off linkage from the carburetor, and carefully separate the carburetor from the intake manifold.

Assembly Procedure: Reverse the order of the disassembly steps. Use new gaskets between the intake manifold and the engine, and between the intake manifold and the carburetor. Do not use sealer on the gaskets. Tighten the intake manifold capscrews to the specified torque.



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FIGURE 6-17. CARBURETOR AND INTAKE MANIFOLD ASSEMBLY

Carburetor Fuel Mixture Adjustments

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

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

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

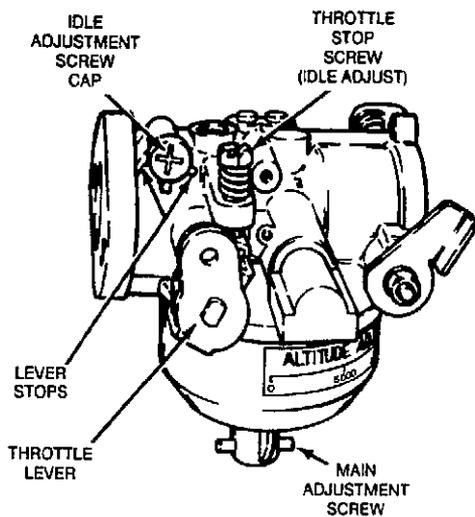
CAUTION Voltage/frequency-sensitive equipment such as VCRs, televisions, computers, etc. may be damaged by power line frequency variations. Some solid-state devices are powered whenever connected to an AC outlet even if the device is not in actual operation. For this reason, disconnect all devices which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

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

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

Mixture Adjustment Procedure:

1. Stop the set and connect a voltmeter, frequency meter, and load bank to the generator output leads.
2. Start the generator set and apply a full load. Adjust the governor speed adjustment nut to obtain $59 (49) \pm 2$ Hz.
3. Remove the plastic cap over the main adjustment limiter (cap). Turn the main adjustment screw inward until the voltage or frequency drops. Then turn it outward until the voltage or frequency drops again. Locate the point where voltage and frequency are highest. From this point, turn the main adjustment screw out another $1/4$ turn. Replace the main adjustment lever (limiter cap), so it aligns with the proper attitude position.



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FIGURE 6-18. CARBURETOR FUEL ADJUSTMENTS

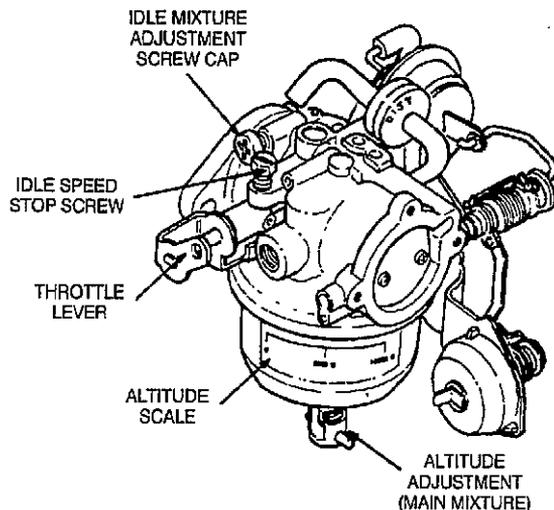


FIGURE 6-18a. CARBURETOR FUEL ADJUSTMENTS (SPEC K GENSET)

4. Remove the load and verify that frequency is within 62-63 Hz (on 50 Hz sets, 51.5 - 52.5 Hz). Adjust the governor speed adjustment nut if necessary to obtain required frequency.
5. Remove the idle adjustment screw cap (limiter). Turn the idle adjustment screw inward until voltage and frequency drop and the engine begins to run rough or starts hunting. Back out the idle adjustment screw as required for smoothest operation without hunting. Replace the idle adjustment screw cap (limiter) with the lever located at mid position between lever stops.
Or, for more accurate setting with CO meter (if available); after setting idle and main adjustment screws, but before installation of plastic limiter cap, set to the following (with engine running): no-load: 6 to 8% CO, rated load: 7 to 10% CO. Install limiter caps as instructed above.
6. With the unit at no-load, adjust the governor speed nut to 50 ± 2 Hz (50 Hz sets; 40 ± 2 Hz). With the throttle lever against the idle stop screw, adjust the idle stop screw to 55 ± 1 Hz (50 Hz sets 45 ± 1 Hz).
7. Readjust the no-load speed to 62-63 Hz (on 50 Hz sets, 51.5-52.5 Hz) and observe the stability of the set. Set the voltage and frequency and adjust the sensitivity of the governor as specified under Governor in this section. Add and remove a full load several times to make certain the set does not bog down or hunt.

Carburetor Overhaul

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

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

Carefully note the carburetor position while removing all parts, for correct reassembly. Read and understand these procedures before beginning. Carburetor components are illustrated in Figure 6-19.

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

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

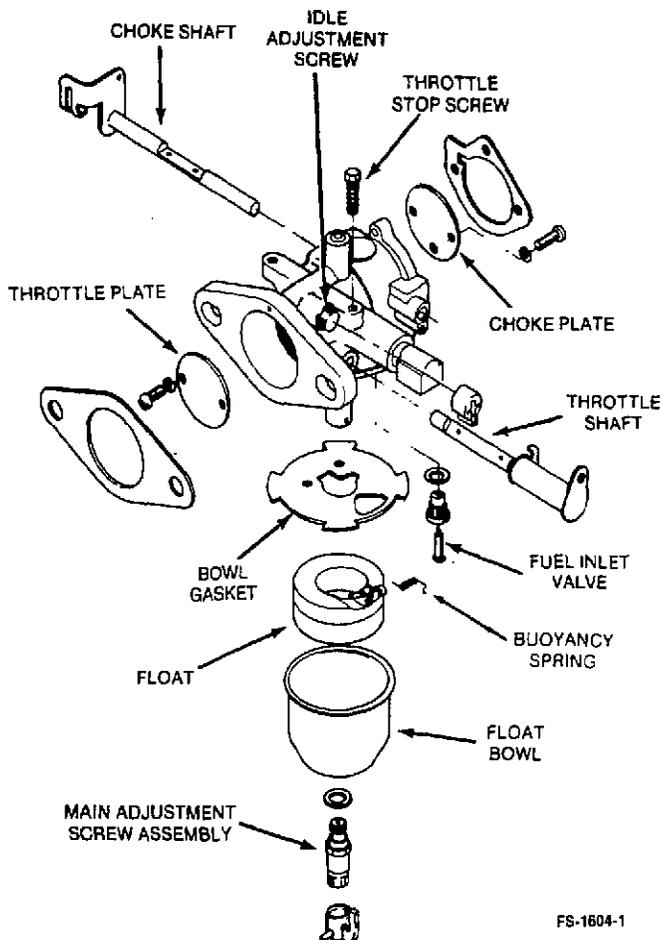


FIGURE 6-19. CARBURETOR OVERHAUL

Carburetor Disassembly Procedure

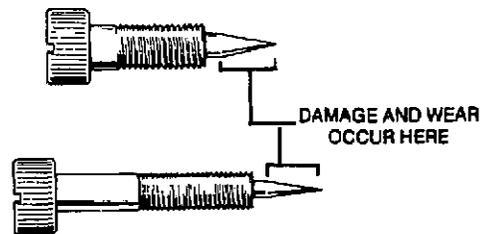
1. Remove the air cleaner adapter and the automatic choke assembly.
2. Remove the throttle and choke plate retaining screws, then remove the choke plates. Pull out the throttle and choke shafts, being careful not to damage the Teflon coating on certain throttle shafts.
3. Remove the main and idle mixture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

Carburetor Cleaning and Repair Procedure

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

⚠WARNING *Most parts cleaning solvents are flammable and can result in severe personal injury if used improperly.*

2. Remove the carbon from the carburetor bore, especially where the throttle and choke plates seat. Be certain not to plug the idle or main fuel port.
3. Blow out all passages with compressed air. Do not use wire or any cleaning utensil that might widen critical passages. Wear goggles while performing this procedure.
4. Examine any needle valves not included in the repair kit, and replace if damaged (Figure 6-20). Replace the float if it is damaged or contains fuel.
5. Check the choke and throttle shafts for excessive play in their bore. Replace them if necessary.
6. Replace old components with the new parts from the repair kit.



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FIGURE 6-20. MIXTURE NEEDLE INSPECTION

Reassembly and Installation Procedure

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

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

- Install the idle mixture screw assembly. Turn in the screws until lightly seated, then turn it out one turn.

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

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

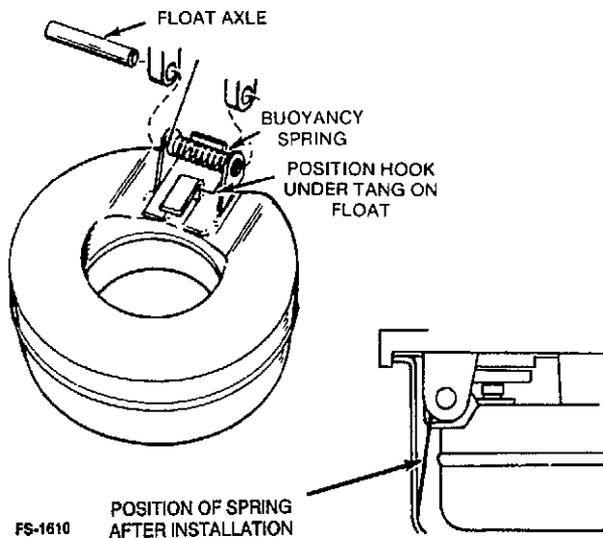


FIGURE 6-21. FLOAT INSTALLATION

- Invert the float and needle valve assembly. Check the float level as follows: measure from the carburetor housing to the far side (bottom) of the float (see Figure 6-22). The full weight of the float should rest on the needle valve and spring. If the setting is incorrect, remove the float and bend the tab to adjust. Bend the float only at the point indicated.

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

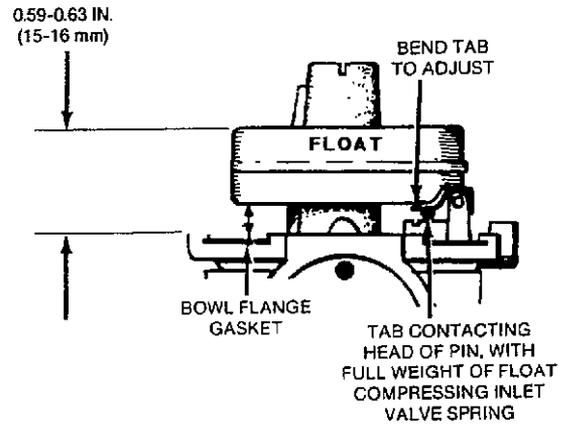


FIGURE 6-22. FLOAT LEVEL

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

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

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

Choke

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

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

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

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

1. Remove the plastic choke cover (see Figure 6-23) and loosen the heating element cover screws.
2. Rotate the heating element until the choke plate is halfway open.
3. Slowly rotate the cover counterclockwise while tapping the carburetor choke lever to make it bounce. Continue until the lever no longer bounces. This is the fully-closed (reference) position.

**TABLE 6-2.
CHOKE ADJUSTMENTS**

Ambient Air Temperature	Rotation From Reference Mark*
40°F (4°C)	0°
45°F (7°C)	4°CW
50°F (10°C)	8°CW
55°F (13°C)	12°CW
60°F (16°C)	16°CW
65°F (18°C)	20°CW
70°F (21°C)	24°CW
75°F (24°C)	27°CW
80°F (27°C)	32°CW
85°F (29°C)	35°CW
90°F (32°C)	39°CW
95°F (35°C)	43°CW
100°F (38°C)	47°CW

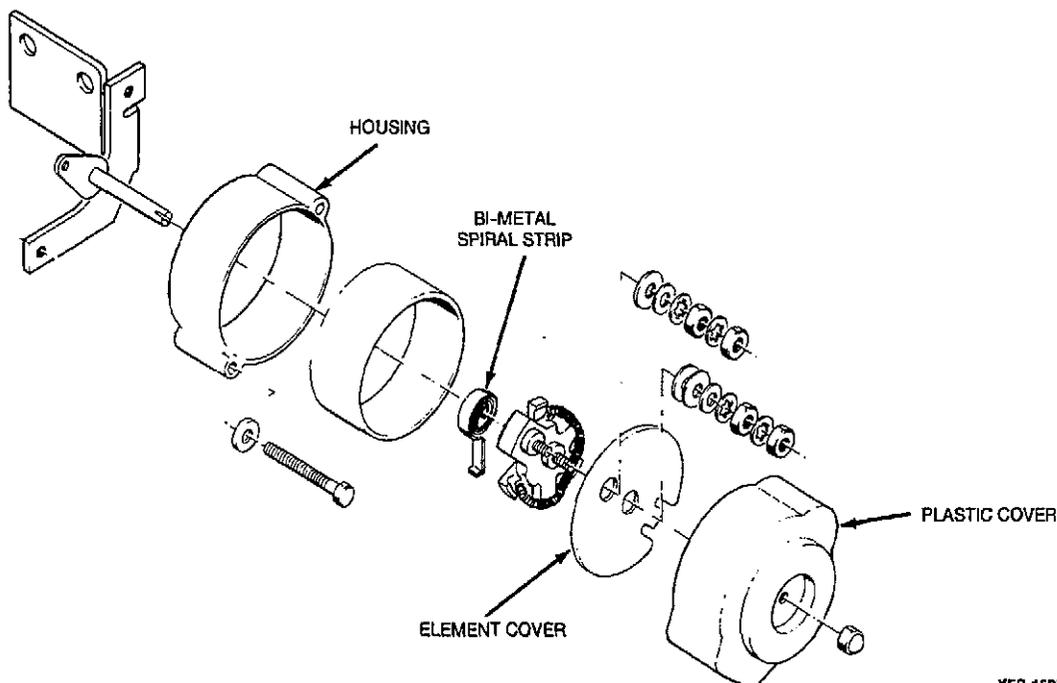
*Each mark on choke housing equals 5° angular rotation.

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

Choke Replacement

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. Check for an open or damaged element.

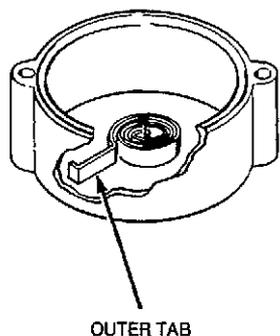
If voltage is present, stop the set and remove the heating element cover. Inspect the heating element and replace it if burned out or broken. Also inspect the bi-metal coil and replace it if it is damaged or binding in the housing.



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FIGURE 6-23. CHOKE ASSEMBLY

When installing a new bi-metal strip, maintain the original direction of the spiral (see Figure 6-24). The outer tab must point in a clockwise direction. Make sure that the coil sits squarely in the housing, and that the inner end of the coil engages the slot in the choke shaft. The slotted tang on the element cover must engage the bi-metal strip.



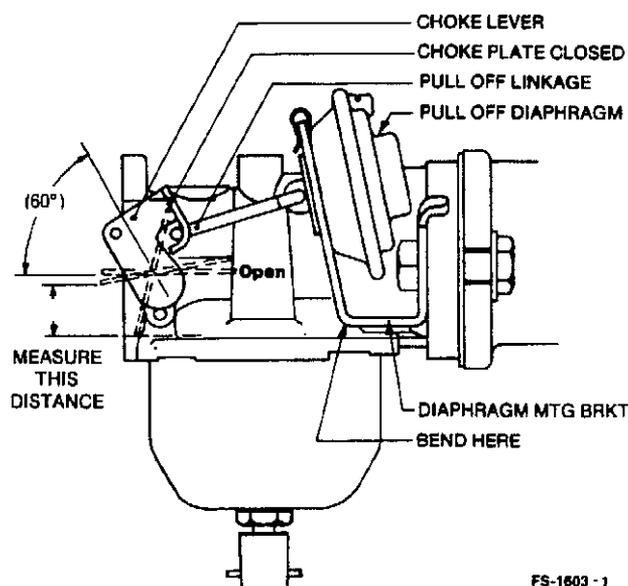
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FIGURE 6-24. BI-METAL SPIRAL STRIP

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

Choke Pulloff Diaphragm Adjustment Procedure

1. Remove the air intake assembly, as described in *Air Intake Assembly* in this section, to access the choke plate.
2. Disconnect the diaphragm hose from the intake manifold. Apply 4 to 18 inches (13.5 to 60.8 kPa) Hg vacuum to the diaphragm.



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FIGURE 6-25. CHOKE PULL-OFF DIAPHRAGM

3. Apply light finger pressure against the choke lever to take up all free play in the pulloff linkage (see Figure 6-25).
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 6-25. There should be 0.39 to 0.43 inches (9.9 to 10.9 mm) clearance here; if necessary, bend the diaphragm mounting bracket to reach this clearance.
6. Move the choke lever back and forth to verify that it does not bind or stick.
7. Remove the vacuum supply from the diaphragm. Install the filter assembly on the carburetor.

Fuel Pump

All gasoline-fueled generator sets use electric fuel pumps. The electric pump has an integral shutoff valve that prevents fuel flow to the carburetor when the set is idle. If the pump malfunctions or supplies insufficient fuel, test and repair/replace the pump as described below.

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

Pump Test Procedure

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

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

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

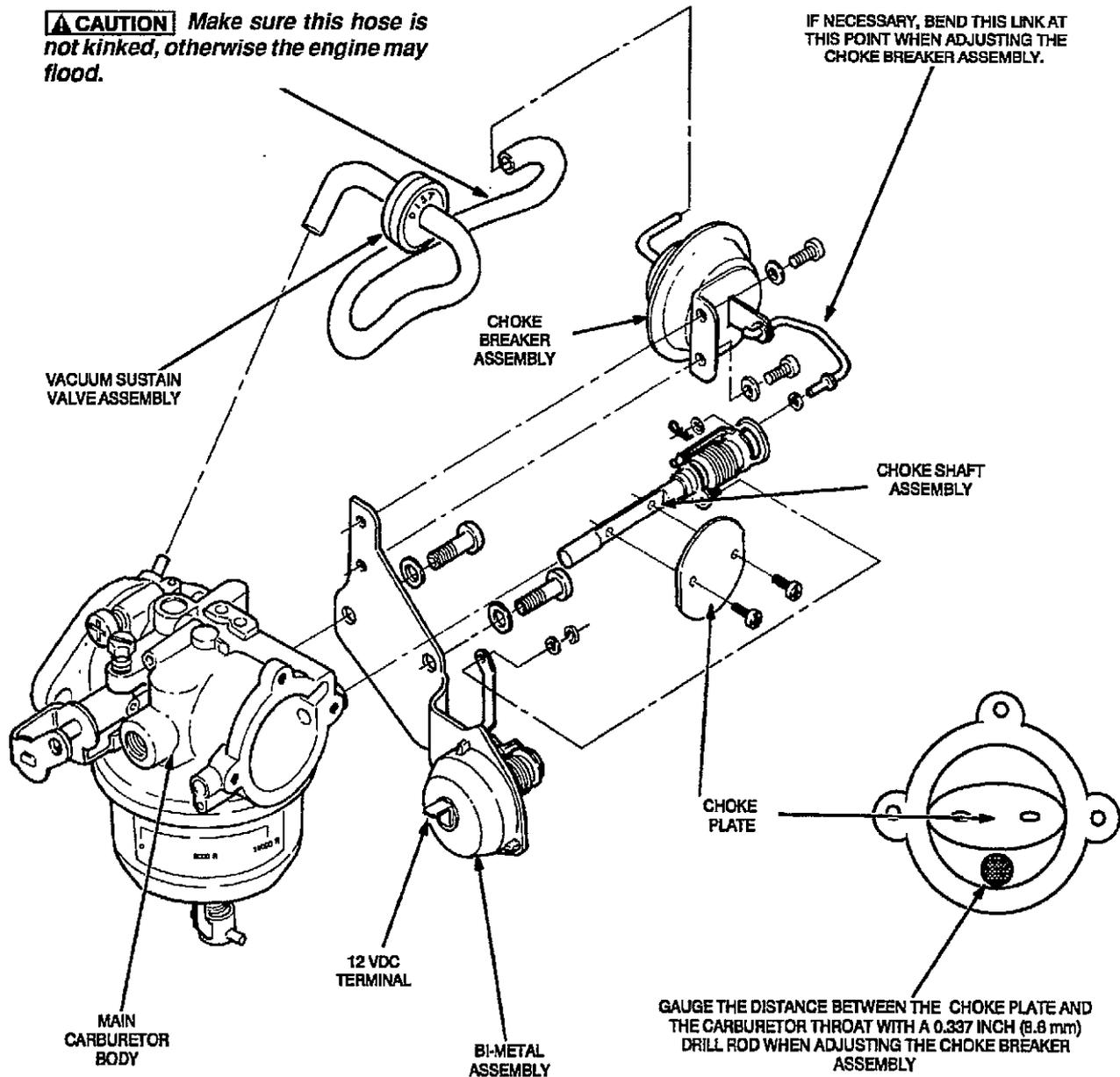
There are no serviceable components in the fuel pump. Refer to the generator set Parts Manuals and replace the pump with an Onan-supplied unit.

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

Choke - Spec K

Figure 6-25a illustrates the Spec K choke components for gasoline carburetors. Replace faulty choke components and reassemble as shown. Adjust the choke breaker assembly each time it is assembled to the carburetor, as follows:

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



FS-1872-1s

FIGURE 6-25a. CHOKE ASSEMBLY - SPEC K

FUEL SYSTEM - LPG LIQUID WITHDRAWAL

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

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

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

LPG Liquid Withdrawal Fuel Systems

LPG liquid withdrawal fuel systems typically operate at pressures as high as 200 psi (1379 kPa) when the ambient temperature is 110°F (43.3°C). Because of the high pressure, special precautions must be taken to avoid releasing large quantities of highly flammable LP gas when servicing the fuel system. Use the procedure described below to purge the fuel system of LP gas before servicing any fuel system components.

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

LPG Purging Pressure

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

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

1. Move the vehicle to a well-ventilated outdoor location, far from fire or flame.
2. Disconnect the vehicle negative (-) battery cable and the generator set negative (-) battery cable from their battery terminals.
3. Close fuel shutoff valves at the fuel tank for the generator set fuel supply system and any other fuel supply system. Close the fuel shutoff valves for any auxiliary equipment.
4. Slightly open the fuel line (flexible section) at the solenoid valve, and allow the LP gas to slowly escape. Do not open the fitting widely; a large quantity of gas may be released.
5. Disconnect the fuel supply hose from the carburetor, and hold it clear of the set.
6. Press in and hold the primer button on the regulator to release LP gas from the set fuel system.
7. When gas can no longer be heard escaping from the open end of the fuel supply hose, reconnect the hose to the carburetor.

Carburetor, Air Filter, and Intake Manifold Assembly

The carburetor, air filter, and intake manifold assembly (Figure 6-26) consists of:

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

Disassembly Procedure:

1. Remove the crankcase breather hose from the air cleaner housing.
2. Remove the air cleaner housing center capscrew and lift off the housing and air filter.
3. Disconnect the lead wires from the K5 relay terminals.
4. Remove the three capscrews that secure the air cleaner adapter and lift off the relay assembly.
5. Remove the two capscrews that secure the K5 relay bracket to the adapter and lift off the relay assembly.
6. Disconnect the fuel hose and governor control linkage from the carburetor.
7. Remove the two capscrews that secure the carburetor to the intake manifold. Lift off the carburetor.

8. Remove the intake manifold, as follows:
 - A. Disconnect the flexible fuel supply line from the fuel vaporizer.
 - B. Remove the exhaust manifold (as described in this section) to provide clearance to lift off the intake manifold.

CAUTION *Bending the fuel vaporizer tubing weakens the metal, enabling cracks to form. Do not bend the vaporizer tubing to remove the intake manifold.*

- C. Remove the intake manifold capscrews and lift off the intake manifold.
- D. Remove the two intake manifold gaskets from the block and plug the intake ports with clean rags to prevent loose parts from accidentally entering the ports.

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

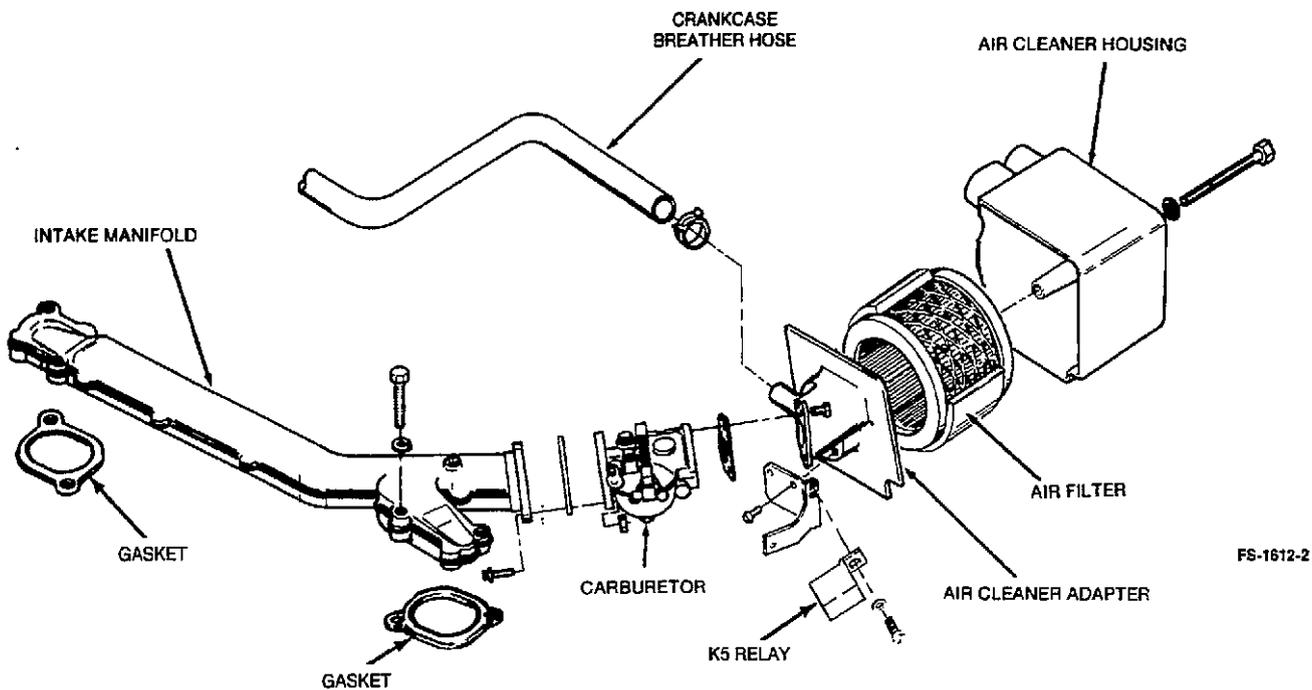


FIGURE 6-26. CARBURETOR, AIR FILTER AND INTAKE MANIFOLD ASSEMBLY

Carburetor Mixture Screw Adjustments

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

LPG carburetors have three adjustment screws:

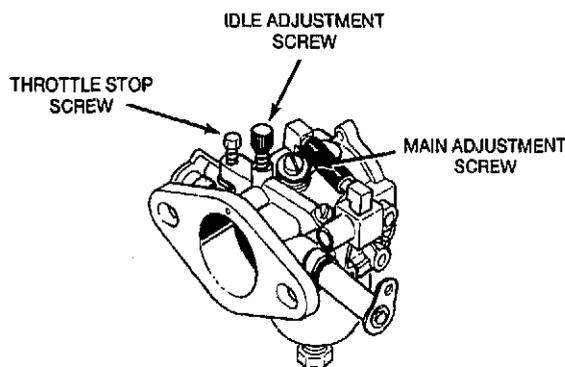
- The throttle stop screw sets the width of the throttle plate opening when the throttle is pulled back to the closed position.
- The idle adjustment screw controls the fuel mixture when the set is operating at no load.
- The main adjustment screw controls the fuel mixture when the set is operating at full load.

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

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

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

Start the engine and allow it to run for 10 minutes at light load. Figure 6-27 illustrates the location of the adjustment screws.



FS-1601

FIGURE 6-27. MIXTURE SCREW ADJUSTMENTS

Adjustment Procedure:

1. Stop the set and connect a voltmeter, frequency meter, and load bank to the generator output leads.
2. Start the generator set and apply a full load. Adjust the governor speed adjustment nut, if necessary, to obtain $59 (49) \pm 2$ Hz.
3. Turn the main adjustment screw inward until the voltage or frequency drops, then outward until the voltage or frequency drops again. Set the main adjustment screw at the point where the voltage and frequency are highest.
4. Remove the load. Adjust the governor speed adjustment nut if necessary, to obtain $62 (51.5) \pm 1$ Hz.
5. Turn the idle adjustment screw inward until the voltage and frequency drop and the engine begins to run rough or starts hunting. Back out the idle adjustment screw until the engine runs smoothly without hunting.

Or for a more accurate setting with CO meter (if available), after setting idle and main adjustment screws, but before installation of plastic limiter cap, set to the following (with engine running); no-load: 6 to 8% CO, rated load: 7 to 10% CO. Install limiter caps as instructed above.

6. With unit at no-load, adjust governor speed nut to 50 ± 2 Hz (50 Hz sets: 40 ± 2 Hz). With the throttle lever against the idle stop screw, adjust the stop screw to 55 ± 1 Hz (50 Hz sets: 45 ± 1 Hz).
7. Readjust no-load speed to $62 (51.5) \pm 1$ Hz and observe the stability of the set. Set the voltage and frequency and adjust the sensitivity of the governor as specified in the *Governor* section. Add and remove a half-load several times, to make certain the set does not bog down or hunt.

Carburetor Overhaul

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

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

Note the position of all components while removing them, for correct reassembly. See Figure 6-28 for component designations.

Removal and Disassembly Procedures:

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

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

2. Remove the throttle stop collar and throttle stop lever from the end of the throttle shaft.
3. Remove the throttle plate retaining screws and throttle plate. Remove the dust seals from the throttle shaft, and carefully pull out the throttle shaft.
4. Remove main and idle mixture screw assemblies.
5. Separate the lower section (bowl) of carburetor from the upper section (bowl cover).

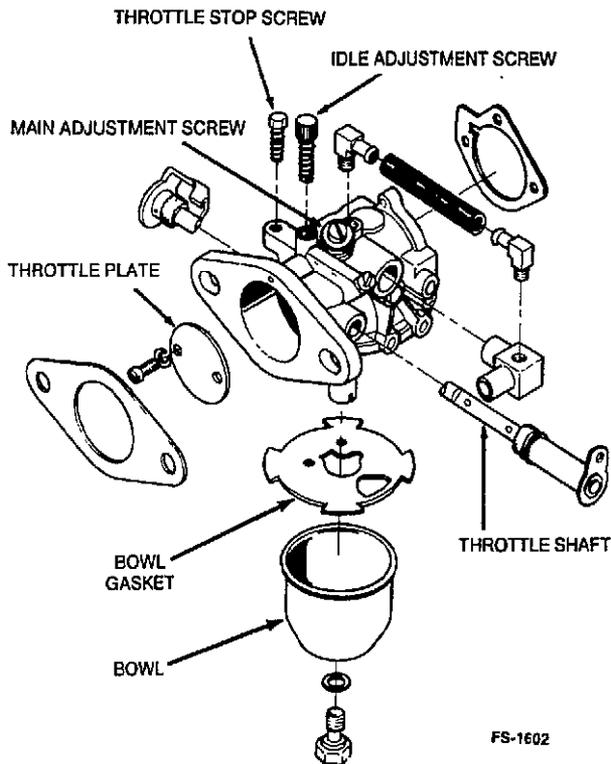
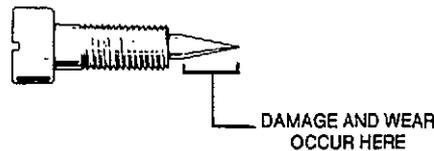


FIGURE 6-28. CARBURETOR OVERHAUL

Cleaning and Repair Procedures:

1. Soak all metal components that have not been replaced in carburetor cleaner. Do not soak any non-metal parts: they may be damaged by the cleaning solution. Follow the cleaner manufacturer's recommendations.
2. Clean all carbon from the throttle bore, especially where the throttle plate seats. Be careful not to plug the idle or main fuel ports.
3. Blow out all passages with low pressure (30 kPa) compressed air. Do not use wire or other objects for cleaning that might increase the size of critical passages.
4. Check the condition of the mixture screws (see Figure 6-29) and replace them if worn or damaged.
5. Replace all old components, seals, and gaskets with new parts included in the kit.



FS-1483

FIGURE 6-29. MIXTURE NEEDLE INSPECTION

Reassembly and Installation Procedure:

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

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

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

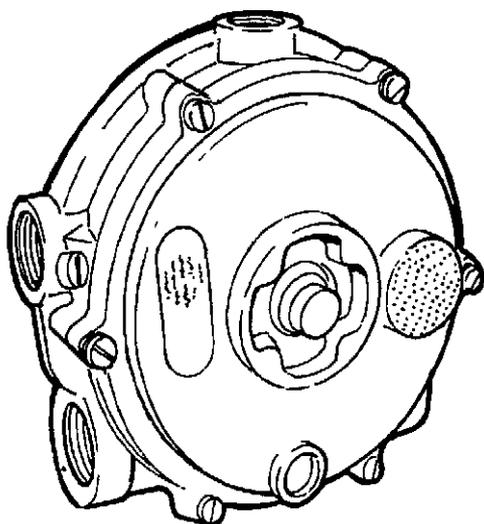
3. Join the upper and lower sections of the carburetor, and install the bowl plug and washer.
4. When the carburetor is installed on the set, make final adjustments to mixture screws as specified in the *Carburetor Mixture Screw Adjustments* section.

Regulator

A two-stage regulator (see Figure 6-30) delivers vaporized LPG fuel to the carburetor. The primary stage of the regulator receives LP gas at container pressure and reduces it to the low pressure required for set operation. The secondary stage of the regulator restricts fuel flow through the regulator until the vacuum from the engine creates a demand for fuel. Fuel flows through the regulator only when the engine is cranking or operation; it stops flowing when the engine is stopped.

The regulator should require little attention if the set is used on a regular basis, and operated on clean, high quality fuel. Most regulator malfunctions can be traced to two sources:

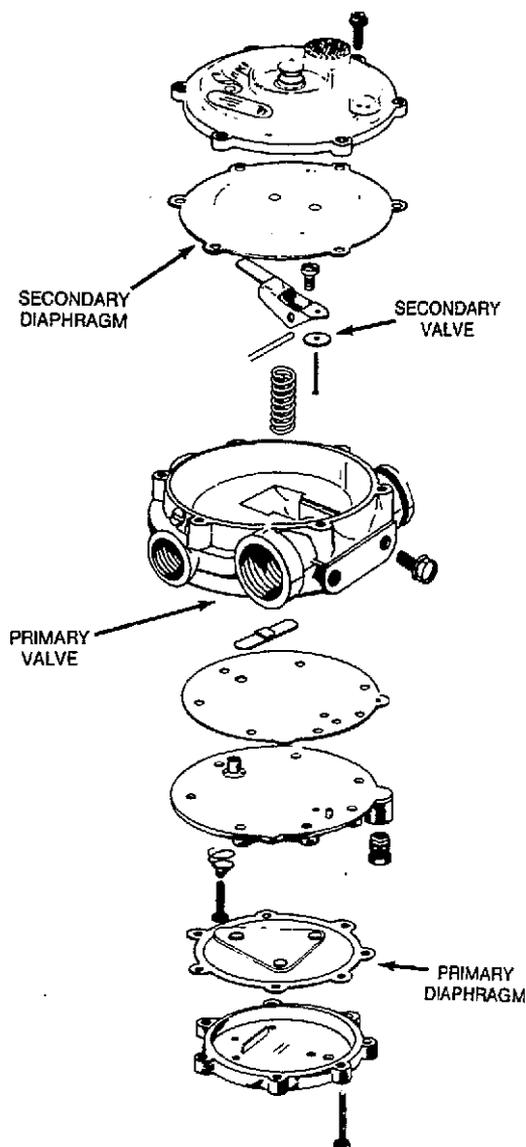
- Hardened diaphragms and seats due to extended periods of non-use.
- Dirt or foreign matter embedded in valves and valve seats.



FS-1598

FIGURE 6-30. LP GAS REGULATOR

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



XFS-1600

FIGURE 6-31. REGULATOR DISASSEMBLY

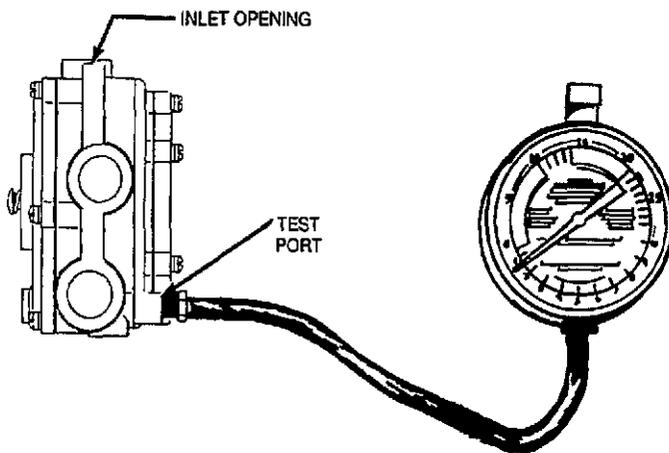
A regulator with granules of foreign matter embedded in the secondary seat may cause inconsistent starting or idling. Foreign matter dissolved in the LPG can form granules as the fuel is vaporized. Remove the regulator front cover and diaphragm assembly (see Figure 6-31) to check for dirt or oil deposits. If granules are embedded in the rubber of the secondary valve, wash the valve and seat clean.

Regulator Test Procedure:

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

1. Attach the pressure gauge to the test port on the back of the regulator as shown in Figure 6-32.
2. Attach a pressure hose to the inlet opening, and open the air pressure valve.
3. If the primary seal is sound, the gauge should read approximately 1-1/2 psi (10.3 kPa), and the pressure should remain constant. A fluctuating pressure reading indicates a bad primary seat.
4. Close the air pressure valve and observe the pressure gauge. The pressure should remain constant. If the pressure reading drops, the secondary seat is leaking.

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

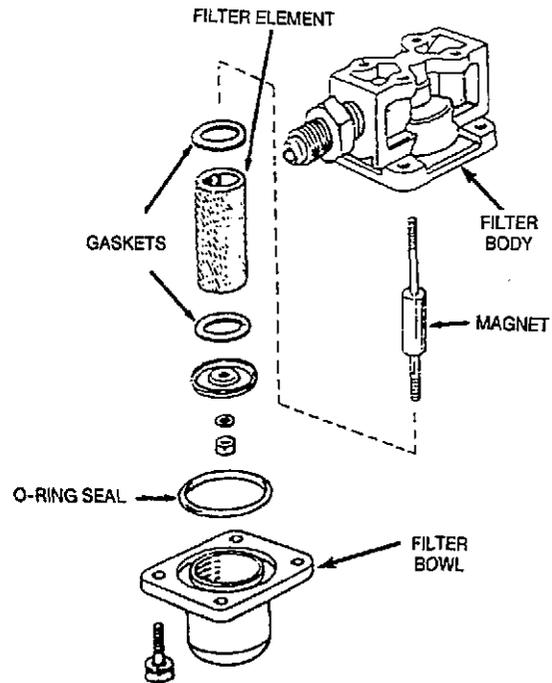


FS-1599

FIGURE 6-32. REGULATOR TEST

Fuel Filter

The fuel filter (see Figure 6-33) removes solid impurities such as rust and scale from the LP gas before they can clog the regulator and carburetor. A magnet within the filter housing traps iron and rust particles, and a filter element traps non-magnetic particles. The fuel filter operates at container pressure; it must be carefully assembled to prevent leakage.



FS-1614

FIGURE 6-33. FUEL FILTER

Disassembly and Cleaning Procedure:

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

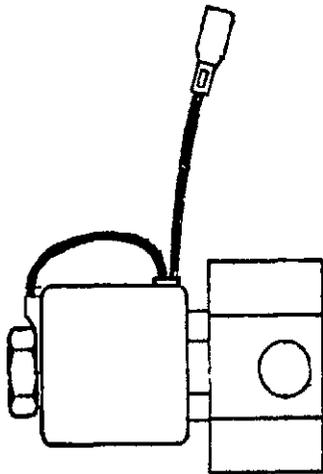
1. Remove the four capscrews and lock washers that hold the filter bowl to the filter body.
2. Separate the filter bowl from the filter body, and discard the O-ring seal.
3. Remove the nut and washer from the center stud and pull out the filter element.
4. If the filter element is clogged, wash the element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

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

Solenoid Valve

The solenoid valve (see Figure 6-34) provides a positive fuel shutoff when the generator set is stopped. The solenoid must be energized for fuel to flow to the regulator. A faulty valve must be replaced.

To bench-test the valve, connect battery positive (B+) to the top terminal, and battery negative (B-) to the grounded terminal. The plunger assembly should withdraw and open the valve when the solenoid is energized. Replace the solenoid valve if it does not operate properly.



ES-1553

FIGURE 6-34. SOLENOID VALVE

FUEL SYSTEM - LPG VAPOR WITHDRAWAL

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

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

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

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

The fuel supply line pressure to the demand regulator of the generator set fuel system components must be in the range of 6 to 8 ounces per square inch (equivalent to 10 to 14 inches water column).

The fuel supply from the primary regulator to the generator set fuel system components must be dedicated to the generator set only, not shared with any appliances.

CAUTION *LP gas presents the hazard of fire or explosion and it is poisonous. These hazards can result in severe personal injury or death. If flameout occurs with an unvented appliance, LP gas can accumulate inside the vehicle and create a safety hazard. If the generator set fuel supply line is shared by any vehicle appliances, do not continue with any further service procedures. Obtain a copy of the Instruction Sheet - G65 - Assembly Instructions for the Installation of LP Vapor Kit for Use with BGE and NHE Generator Sets. Compare the instruction sheet procedures and applicable codes to the generator set and fuel supply system installation. Correct as necessary before continuing service work.*

LP Fuel Supply at Carburetor Adjustment

Open the fuel supply shutoff valve at the supply tank and proceed as follows:

1. Loosen the lock nut on the gas adjustment screw (located near the LP gas inlet (see Figure 6-35).
2. Turn the LP gas adjustment screw inward until seated.
3. Push the generator set start button, while the set is cranking, slowly turn the adjusting screw out counterclockwise (1/4 to 1/2 turn) until set starts. This adjustment is critical for proper operation of the set. If the set does not start, reseal the gas adjustment screw and repeat the adjustment procedure.
4. If the set still does not start, refer to the Regulator Adjustment information that follows, and check that main fuel supply system is supplying fuel to the generator set solenoid valve.

For satisfactory operation, it may be necessary to reset the gas adjustment screw due to variations in the BTU content of local LP gas supplies and for changes in the ambient temperature. The idle and main adjustment screws on the gasoline carburetor will have no effect during LP gas operation.

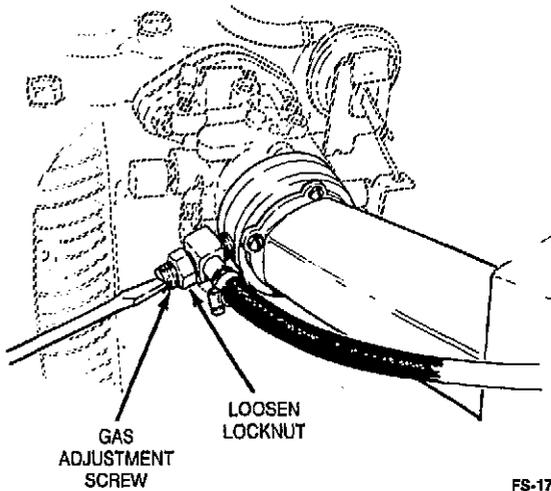


FIGURE 6-35. ADJUSTING FUEL FLOW AT CARBURETOR

Demand Regulator Adjustment Procedure

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

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

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

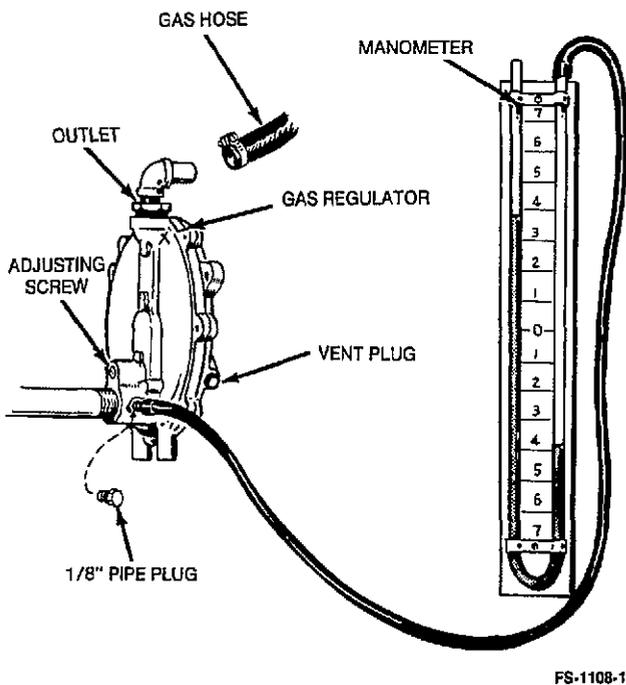


FIGURE 6-36. MANOMETER TESTING (IF REQUIRED)

2. Connect a manometer that reads up to 14 inches (356 mm) of water column to the test hole. One inch of water equals 0.58 ounce/square inch (250 Pa).
3. Energize the solenoid shutoff valve by connecting its insulated lead to a battery positive (B+) source.

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

4. Remove the gas supply hose from the regulator outlet, then open the fuel tank shutoff valve. Gas should not come from the regulator outlet during testing, because of the closing action of the regulator valve.
5. Alternately cover and uncover the regulator outlet with the palm of your hand while at the same time observing the manometer. If the regulator closes completely, the manometer will hold a steady reading. If the manometer reading drops slightly each time you remove your hand, it indicates the regulator is not locking off properly. To adjust, turn the adjusting screw inward until the manometer reading holds constant when you repeatedly cover and uncover the regulator outlet. Failure to lock off indicates too high an incoming pressure or a dirty regulator valve and seat.

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

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

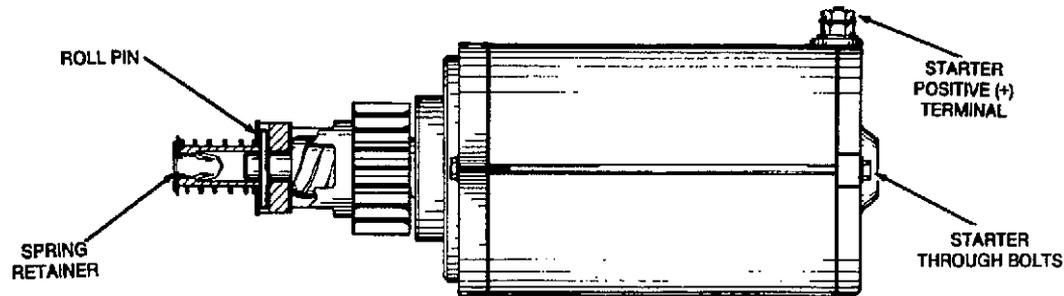
▲WARNING *LP gas presents the hazard of fire or explosion, and it is poisonous. These hazards can result in severe personal injury or death. Cranking the engine or disconnecting the solenoid valve will create sparks that can ignite accumulated gas vapors. Make sure that any gas vapors, accidentally released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

7. De-energize the solenoid valve, and reconnect the solenoid lead to its control lead.
8. Connect the gas supply hose to the regulator outlet fitting and secure it with a clamp.
9. Remove the manometer, and install a 1/8 inch plug in the test hole.
10. Verify that the vent hose is properly routed through the opening in the compartment floor, then open the gas supply shutoff valve.
11. Adjust the gas adjustment screw, as described in the previous section. Operate the generator set to test that it starts correctly.

ELECTRIC STARTER

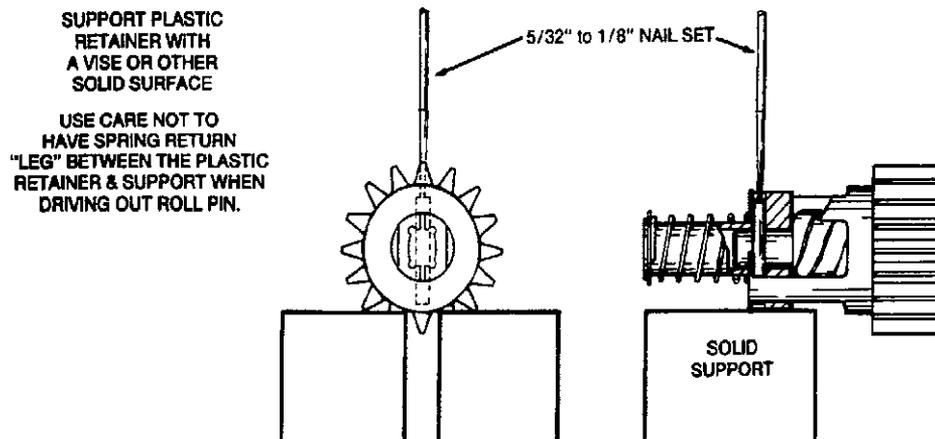
Removal and Disassembly Procedure:

1. Disconnect the generator set negative (-) battery cable from the set starting battery.
2. Disconnect the generator set positive (+) battery cable from the starter lug terminal. See Figure 6-37.
3. Remove the starter mounting screws. Carefully disengage the starter from the stator housing.
4. Remove the starter through-bolts. Carefully separate the brush end cap housing from the armature assembly.
5. Use a 1/8 to 5/32 inch nail set to remove the roll pin. (When reassembling, use a new roll pin.) Remove the return spring, gear and clutch assembly as required. See Figure 6-38.



ES-1608

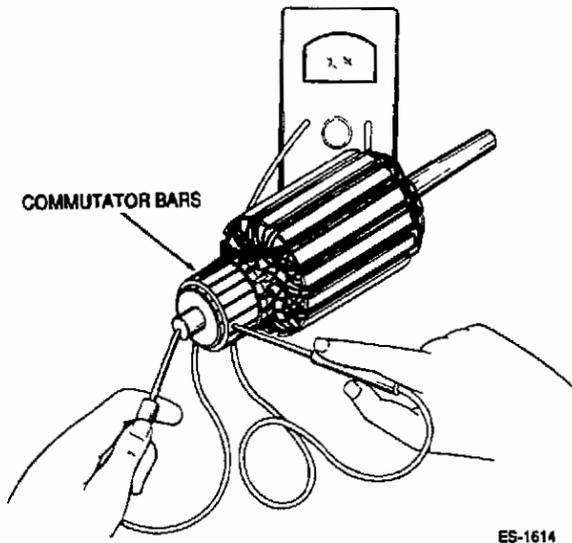
FIGURE 6-37. STARTER



ES-1609

FIGURE 6-38. DRIVING ROLL PIN OUT

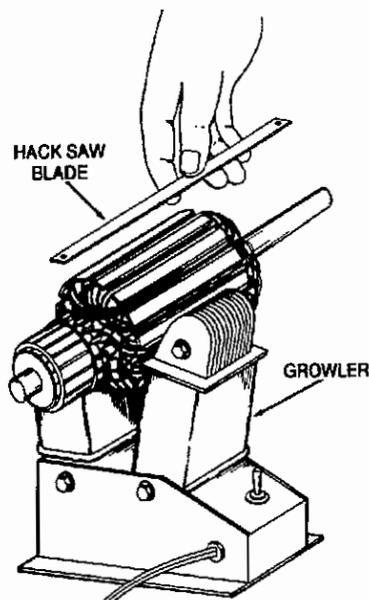
Testing Armature for Grounds: Touch one ohmmeter lead to a commutator bar, then touch the other lead to the armature shaft and the core laminations. A low resistance reading indicates a grounded armature. Replace a grounded armature with a new one. See Figure 6-39.



ES-1614

FIGURE 6-39. TESTING ARMATURE FOR GROUNDS

Testing for Shorts: Use a growler (Figure 6-40) 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.

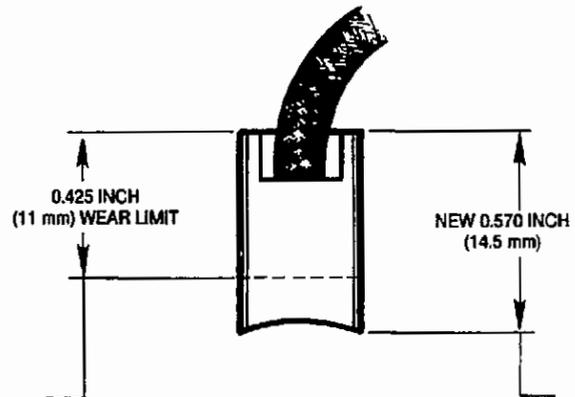


ES-1615

FIGURE 6-40. TESTING ARMATURE FOR SHORTS

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

Brush Inspection: Measure brushes (Figure 6-41) and replace them if worn less than 0.425" (11 mm).



ES-1610

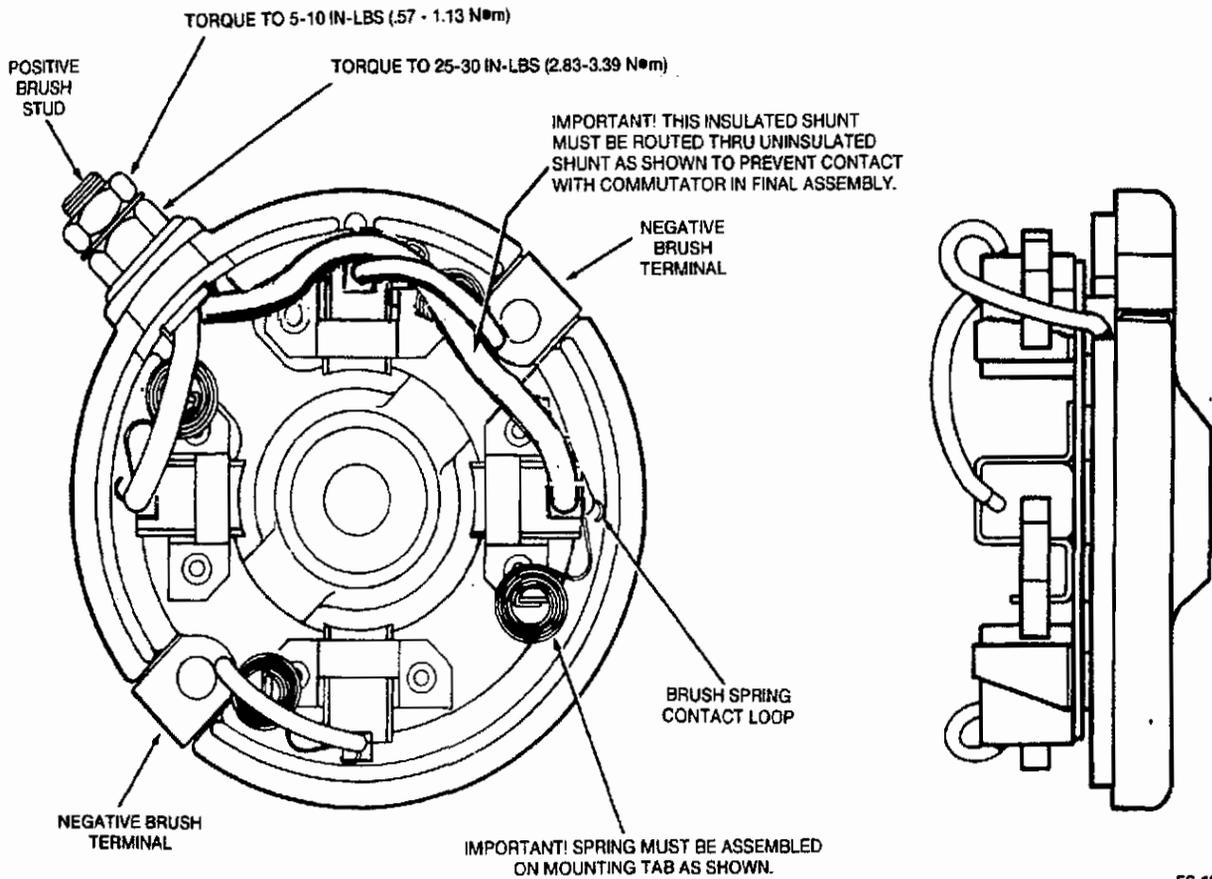
FIGURE 6-41. BRUSH INSPECTION

Assembly

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.

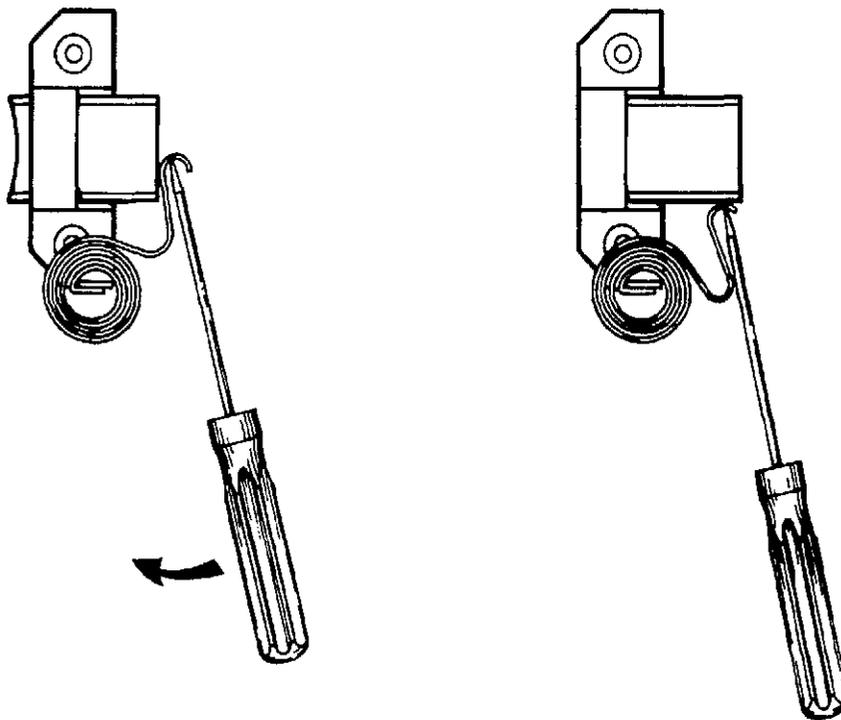
2. Mount the brush springs on tabs as shown in Figure 6-42. Using a small screwdriver, turn the spring counterclockwise to torque it, so the contact loop is inside the brush holder. The spring should be pushed down to the mounting tab shoulder.
3. Push the negative brush terminals over the through-bolt 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.



ES-1612-1

FIGURE 6-42. BRUSH ENDCAP

6. If the brushes are at least 0.430 inch (10.9 mm) long, rest the brush springs against the sides of the brushes to keep them clear during armature installation. See Figure 6-43.
7. Place a washer on the commutator end of the shaft, and put the armature into the brush endcap. Push the four brushes toward the commutator, making sure that the springs are 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 6-44.
11. Place the mounting bracket on the motor, facing the exposed end of the sleeve bearing and throughbolt lead-ins toward the inside of the motor. The flat near one mounting hole should line up with the positive stud on the end cap, so the through-bolts can line up.
12. Insert the through bolts, and torque to 35-45 lb-in (3.96-5.09 N•m).
13. Wipe dust from the helix and gear, and apply a light coat of GE Versilube 322-L to the outside diameter of the helix, the inside diameter of the gear and the unchamfered end of the gear. Place the clutch and helix assemblies on the motor shaft, with flats engaged in the clutch hole.



ES-1611

FIGURE 6-43. RESTING BRUSH SPRING ON BRUSH SIDE

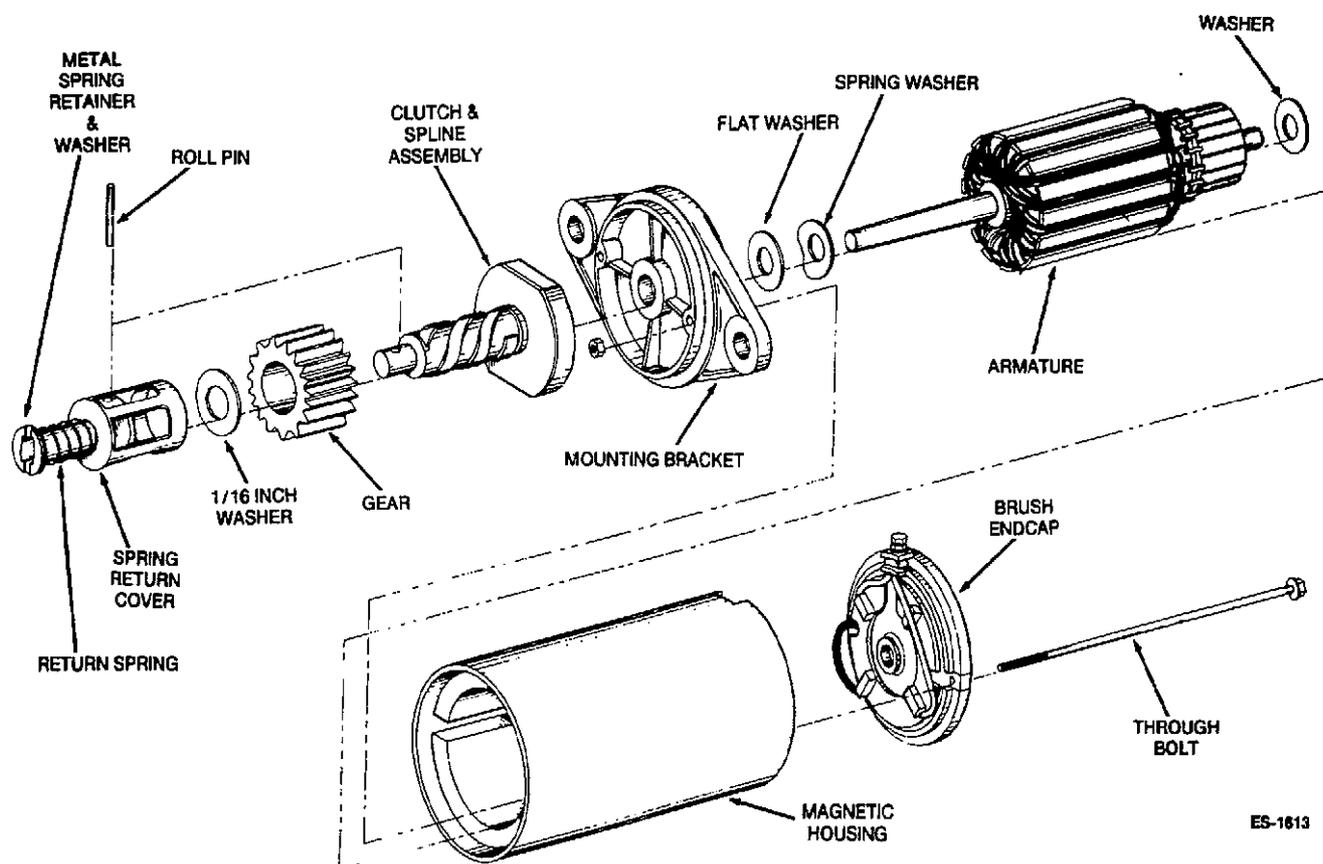


FIGURE 6-44. STARTER ASSEMBLY

14. If the return spring is unassembled, do the following:
 - A. Place a 1-1/16 inch O.D. washer over the end of the shaft.
 - B. With the chamfered side of the shaft hole facing up, place a plastic retainer on the shaft and line up the hole with a hole in the shaft.
 - C. Support the plastic retainer with a vise or other solid surface. Using a 5/32 or 1/8 inch nail set and hammer, drive in a new roll pin. The pin should be driven about 1/10th of an inch (2.5 mm) from the edge of the plastic retainer, or in such a way that it is evenly spaced from each side.
 - D. Place the spring cover over the top of the plastic retainer, then place the return spring on top of the retainer.
 - E. With a washer placed over the point of the plastic retainer, push the metal retainer into the hole of the plastic retainer as far as it will go.
15. Mount the starter on the generator stator housing using capscrews, lockwashers and nuts. Tighten the mounting screws to 30-33 lb-ft (41-45 N•m).
16. Connect generator set positive (+) battery cable to starter terminal. Connect generator set negative (-) terminal to generator set starting battery.

Section 7. Control

INTRODUCTION

The control system governs the following functions:

- Starting
- Monitoring for fault conditions
- Instrumentation
- Stopping

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

CONTROL DESCRIPTION

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

- Control panel assembly
- Printed circuit board (A1)
- Start/Run/Stop switch (S1)
- Fuse (F1)
- Start solenoid (K1)
- Ignition relay (K5) (LPG units)
- Fuel pump (E2) (gasoline units)
- Fuel solenoid (E2) (LPG units)
- Remote start control (optional)
- Circuit breaker(s)
- Voltage regulator (VR1)
- Terminal board (TB1)

The following sections describe each component and how it functions.

The control panel assembly consists of:

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

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

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

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

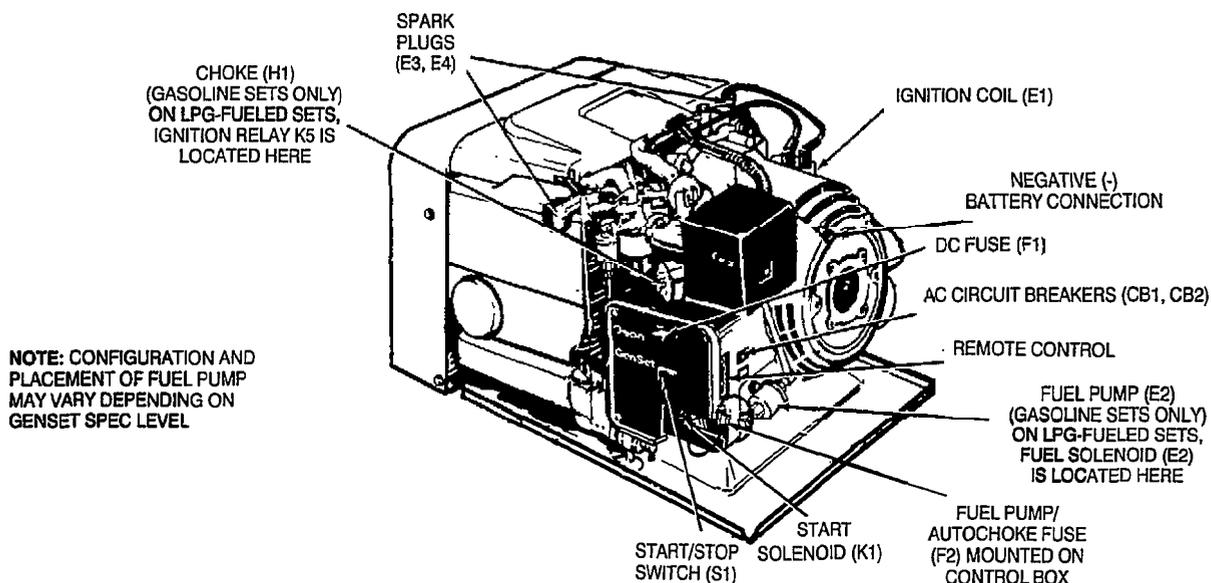


FIGURE 7-1. BGE/NHE GENERATOR SET

M-1604-14
(modified)

Fuse (F2) (Spec K gensets): This 5-amp fuse protects the fuel pump and choke heater circuit. It is mounted on the front of the control box (see Figure 7-1a).

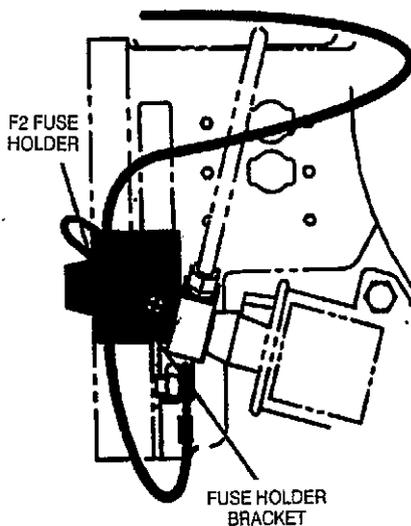


FIGURE 7-1a. AUTOCHOKE/FUEL PUMP FUSE F2 LOCATION

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.

Ignition Relay (K5) (LPG units)

The K5 ignition 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 on the choke bracket.

Fuel Pump (E2) (gasoline units)

The E2 fuel pump is initially energized at the same time the start solenoid K1 is energized by closure of start relay K4 contacts. After a successful startup, the fuel pump then receives its current through the contacts of run relay K3.

Fuel Solenoid (E2) (LPG units)

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

Remote Start Control (optional)

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

Control Circuit Breaker(s) (CB1 and CB2 [if equipped])

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 generator set model/frequency. Refer to the proper Parts Manual when ordering replacement parts.

Voltage Regulator (VR1)

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

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

Terminal Board (TB1)

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

These connections may differ between models. Refer to the proper Wiring Diagram/Schematic for specific information.

AC power at TB1 terminals is tapped by leads of wiring harness J4 of voltage regulator VR1, and interconnect wiring to the circuit breaker(s) CB1 (and CB2, if equipped). These leads provide generator output to the voltage regulator for proper voltage regulation, and to the circuit breaker(s) 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.

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 or solenoid valve (E2)
- Start solenoid (K1)

Connecting B+ produces the following control responses:

- Flashes the field, to ensure 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 (prior to Spec G, breaker point ignition is used.)
- Energizes the start solenoid (K1), which closes its N.O. contacts in the starter motor circuit.
- (Gasoline units) Energizes the fuel pump (E2), which begins pumping fuel to the carburetor.
- (LPG units) Energizes the fuel solenoid (E2), which allows LPG to flow to the vaporizer and the regulator.
- Energizes the stop latch (ignition) 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 start-stop switch S1 is released and returns to the center (run) position, the engine continues to run. Relays K2 (generator relay), K3 (run relay), and K5 (ignition relay [LPG sets only]) are energized while relays K1 (start solenoid) and K4 (start relay) are de-energized.

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 E1 fuel pump/fuel solenoid.

De-energizing K4 opens contacts which de-energize the K1 start solenoid. De-energizing K1 disconnects B+ from the starter motor, which stops cranking.

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 and the fuel pump/fuel solenoid.

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

Stopping

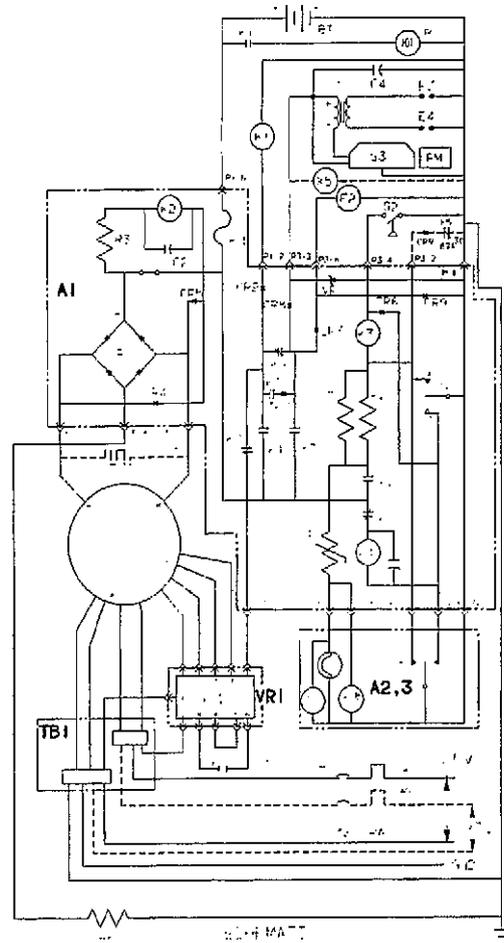
Moving start-stop switch S1 to the STOP position grounds resistors R1 and R2 to de-energize run relay K3. This opens its contacts to disconnect B+ from ignition coil T1, fuel pump/fuel solenoid E2, and (on LPG sets) ignition relay K5. De-energizing K5 allows its N.C. contacts to close to ground. This prevents K3 from being energized, and prevents the set from restarting when switch S1 is released from the STOP position.

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

TESTING CONTROL BOARD A1

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

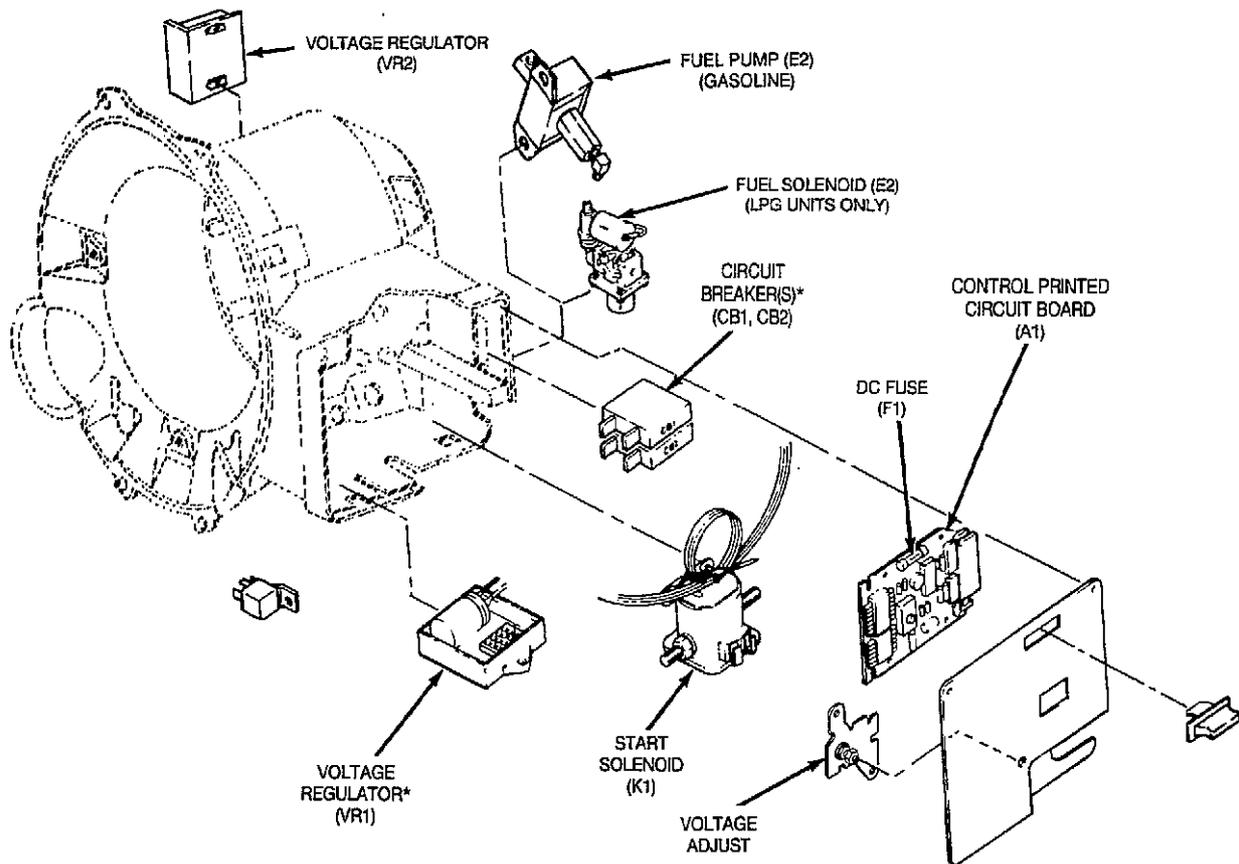
1. Disconnect the negative (-) battery cable.
2. Remove the control box cover (Figure 7-3) and separate it from control board A1 by removing the four screws on the back of the board.
3. With an ohmmeter, check for electrical continuity across each P1/J1 and P3/J3 connector on the control board (Figures 7-2 and 7-4). Replace the socket portion of each connector that has a measurable resistance (greater than zero ohms) or has begun to corrode.
4. Reconnect the battery and try to start and run the set.
5. If the engine does not crank, measure voltage at connector P1-2 while pressing the panel start switch (the negative (-) test probe of the voltmeter should be grounded at connector P1-8). If the voltmeter indicates zero volts, and if fuse F1 is good, replace control board A1. If the voltmeter indicates at least 9 volts, the problem is not with the control board. Go back to the *Troubleshooting Guide*.
6. If the engine cranks, but does not start, measure voltage at connectors P3-3 and P3-6 while the engine is cranking (the negative (-) test probe of the voltmeter should be grounded at connector P1-8). Replace control board A1 if the voltmeter indicates zero volts at either connector. If the voltmeter indicates at least 9 volts at both connectors, the problem is not with the control board. Go back to the *Troubleshooting Guide*.
7. If the engine starts, but stops when the Start switch is released, the problem could be with the low oil pressure switch or generator (no voltage). Go back to the *Troubleshooting Guide*. Replace control board A1 if the oil pressure switch and generator are functioning properly.
8. Reassemble the control board and cover.



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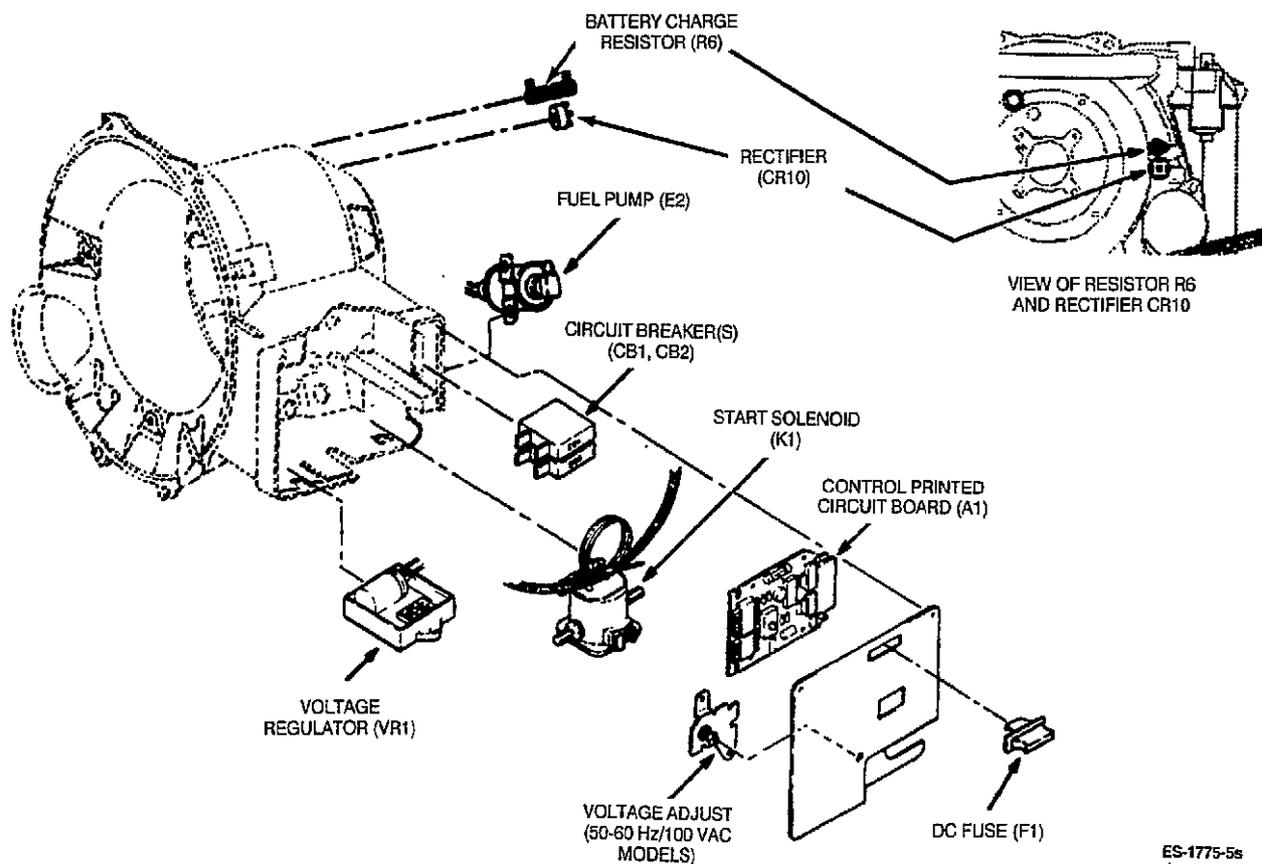
Item	Description of Material
VR1	Voltage Regulator
T1	Ignition Coil
S3	Ignition Module
S2	Switch-Low Oil Pressure
R6	Resistor-Battery Charge
R5	Potentiometer
K5	Relay-LPG Only
K1	Relay-Start Solenoid
H1	Choke-Gasoline Only
G1	Generator
F1	Fuse-Slow Blow 5A
E3,4	Spark Plugs
E2	Fuel Pump or Fuel Solenoid
CR9	Rectifier-LPG Only
CB1,2	Circuit Breaker (AC Output)
C4,5	Capacitor
BT1	Battery - 12V
B1	Starter Motor
A3	Remote Control-Standard
A2	Remote Control - Deluxe
A1	Control Assy - NHE/NHEL
A1	Control Assy - BGE/BGEL

FIGURE 7-2. SCHEMATIC BGE/NHE CONTROL



ES-1775-3

FIGURE 7-3. BGE/NHE CONTROL COMPONENTS



ES-1775-5s
(modified)

FIGURE 7-3a. BGE/NHE CONTROL COMPONENTS (SPEC K)

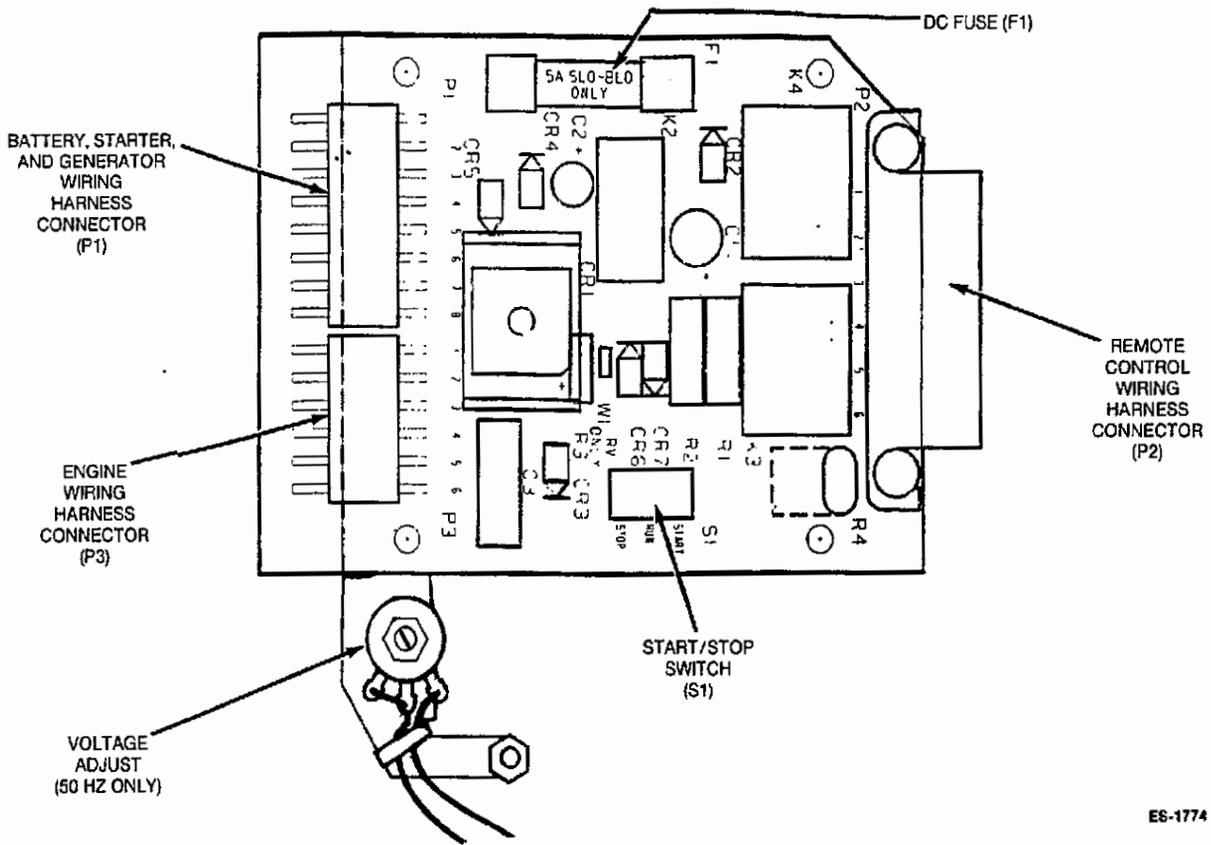


FIGURE 7-4. BGE/NHE CONTROL P.C.B. ASSEMBLY (A1)

ES-1774

CONTROL TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the control circuits. Figures 7-3 and 7-4 show the location of most of the control components.

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.

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

⚠ WARNING *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	<ol style="list-style-type: none"> 1. Control fuse F1 may be open. 2. If engine cranks at set but not at remote control panel, fault is due to: <ol style="list-style-type: none"> a. PC board P2/J2 connection not secure. b. Open circuit in remote control. c. Remote start switch faulty. 3. If engine cranks at remote control panel but not at set, fault is due to faulty S1 switch. 4. Insufficient voltage for cranking due to: (See Low Battery Voltage also.) <ol style="list-style-type: none"> a. Battery not charged. b. Terminal connections loose or dirty. c. Battery cable too small. 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: <ol style="list-style-type: none"> a. K1 relay not grounded. b. Defective K1 relay. c. Defective starter. 6. If voltage is not present as described in step 5 test, fault is due to: <ol style="list-style-type: none"> a. Open circuit between K1 relay and control PC board. b. Defective control PC board. 	<ol style="list-style-type: none"> 1. Replace fuse F1 if open with Onan supplied fuse only. 2a. Ensure that wiring harness jack connections are fully seated to PC board. <ol style="list-style-type: none"> b. Check for continuity and correct if circuit is open. c. Replace remote start control switch. 3. Replace PC board A1. 4a. Check condition of battery and recharge or replace. <ol style="list-style-type: none"> b. Clean and tighten all connections at battery, K1 start solenoid, and motor. c. Increase cable size. ⚠ WARNING <i>Short circuiting the battery cables can result in severe personal injury. Disconnect the negative (-) battery cable at the battery terminal before servicing.</i> 5a. Tighten solenoid bracket mounting screw. <ol style="list-style-type: none"> b. Replace K1 start solenoid. c. Refer to <i>Electric Starter</i> (Section 6) for test and service procedures. 6a. Check for continuity and correct if circuit is open. <ol style="list-style-type: none"> b. Refer to <i>Testing Control Board A1</i>.

⚠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	<ol style="list-style-type: none"> 1. Faulty ignition due to worn or fouled spark plugs, faulty plug wires, faulty ignition coil, breaker worn points*** or faulty ignition module****. 2. Faulty fuel system due to low fuel level in tank, supply valve not open, sticking choke*, faulty fuel pump*, faulty fuel solenoid**, or carburetor mixture screws incorrectly adjusted. 3. Connect a voltmeter between positive (+) terminal T1 ignition coil and ground. Check for battery voltage when S1 is placed in the START position. If the voltage is not present, fault is due to: <ol style="list-style-type: none"> a. Open circuit between T1 coil and control. b. Defective control PC board. <p style="margin-left: 40px;">*Gasoline Sets Only. **LPG Sets Only. ***Prior to Spec G. ****Spec G and Later.</p> 	<ol style="list-style-type: none"> 1. Refer to <i>Ignition System</i> (Section 6) for test and service procedures. 2. Refer to <i>Fuel System</i> (Section 6) for test and service procedures. 3a. Check for continuity and correct if circuit is open. b. Refer to <i>Testing Control Board A1</i>.
Engine Starts But Stops When Start Switch is Released	<ol style="list-style-type: none"> 1. Low oil pressure switch S2 not closing due to: <ol style="list-style-type: none"> a. Low oil level. b. Open circuit between switch and control. c. Defective low oil pressure switch. d. Low oil pressure. 2**. Ignition relay K5 contacts not opening due to: <ol style="list-style-type: none"> a. K5 relay circuit open. b. Defective K5 relay. 3. Output voltage from generator not being supplied to control due to: <ol style="list-style-type: none"> a. Open circuit in wiring between generator and control. b. No output voltage from generator. 4. Defective control PC board A1. **LPG Sets Only. 	<ol style="list-style-type: none"> 1a. Check oil level and add oil if low. b. Check for continuity and correct if circuit is open. c. Replace low oil pressure switch. d. Refer to Section 6 <i>Troubleshooting</i> for procedures to follow. 2a. Check for continuity and correct if circuit is open. b. Replace K5 relay. 3a. Check for continuity and correct if circuit is open. b. Refer to <i>Generator</i> section for test and service procedures. 4. Refer to <i>Testing Control Board A1</i>.
Low Battery Voltage	<ol style="list-style-type: none"> 1. Weak or discharged battery due to: <ol style="list-style-type: none"> a. Low electrolyte level in battery. b. Long periods of non-use. 2. Load connected to battery while set is turned off. 	<ol style="list-style-type: none"> 1a. Replenish electrolyte and recharge battery. b. Connect a separate battery charger to bring battery up to full charge. 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
<p>Engine Starts And Runs; Then Stops. Set Restarts Immediately or Set Restarts After Cooling Down</p>	<ol style="list-style-type: none"> 1. Fuel level is below generator set fuel pickup tube or oil level is low. 2. Dirty fuel filter restricting fuel flow. 3. *Faulty choke operation due to sticking choke linkage, incorrect choke adjustment, open circuit in wiring between choke heater and generator, defective choke heater. 4. *Vapor lock due to: <ol style="list-style-type: none"> a. High ambient air temperatures. b. Faulty fuel pump. 5. ***Breaker points sticking. 6. ****Faulty ignition module. 7. ***Faulty ignition condenser. 8. Contaminated fuel. <p>*Gasoline Sets Only. ***Prior to Spec G. ****Spec G and Later.</p>	<ol style="list-style-type: none"> 1. Check fuel and oil levels and refill as necessary. 2. Refer to <i>Fuel System</i> (Section 6) for test and service procedures. 3. Refer to <i>Fuel System</i> (Section 6) for test and service procedures. 4a. Remove any objects or debris that may restrict airflow to and from the set. b. Refer to <i>Fuel System</i> (Section 6) for test and service procedures. 5. Replace breaker points. 6. Replace ignition module. 7. Replace condenser. 8. Refill tank with fresh fuel.
<p>REMOTE CONTROL (if equipped) Run Lamp, Time Meter, or Battery Condition Meter Does Not Operate</p>	<ol style="list-style-type: none"> 1. Open circuit between control board A1 terminal 6 or 5 of remote connector plug P2/J2 and terminal 6 or 5 on start-stop switch S2. 2. Open circuit between ground terminals on lamp or meters and terminal 1 on remote start-stop switch. 3. If battery condition meter and run lamp works but time meter does not operate, time meter is defective. 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: <ol style="list-style-type: none"> 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. 	<ol style="list-style-type: none"> 1. Check for continuity and correct if open. 2. Check for continuity and correct if circuit is open. 3. Replace time meter. 4a. Replace battery condition meter. b. Replace zener diode.



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 (Continued)	<ol style="list-style-type: none"> 5. Meters and switch function properly but run lamp does not illuminate. Lamp (internal to switch) is burned out. 6. Remote switch functions properly (starting and stopping generator set) but meters and run lamp do not operate. Current sensing resistor R4 on control board A1 has opened, caused by a short in the remote control wiring between control board P2/J2 terminal 6/5 and remote control time meter, run lamp/battery condition meter. 	<ol style="list-style-type: none"> 5. Replace remote start-stop switch S2. 6. Check for continuity of remote wiring harness and wiring on remote control in series with terminals 6 and 5. Replace wiring of shorted circuit.
Generator Set Does Not Stop After Switch is Pushed to Off Position Note: Always remove load a few minutes before stopping to allow set to cool down.	<ol style="list-style-type: none"> 1. Faulty set control start/stop switch (S1) 2. **K5 relay not energizing (its N.O. contacts should be open) due to: <ol style="list-style-type: none"> a. Open circuit to K5 relay coil b. Faulty K5 relay. 3. Defective K3 relay. <p>**LPG Sets Only.</p>	<ol style="list-style-type: none"> 1. Check start/stop switch and replace if defective. 2a. Check for continuity and correct if circuit is open <ol style="list-style-type: none"> b. Replace K5 relay. 3. Replace control circuit board.

Section 8. Generator

GENERATOR/CONTROL COMPONENT DESCRIPTIONS

The generator and its control components consist of the following: (Refer to Figure 8-1.)

- Control Printed Circuit Board (A1)*
- Brushes
- Rotor
- Stator and Housing
- Terminal Board (TB1)
- Voltage Regulator (VR1)
- Circuit Breaker(s) (CB1, and CB2 if equipped)
- Wiring Harness to Load(s)

*Refer to Section 7, Control, for further information.

Control Printed Circuit Board (A1)

Initial excitation voltage to the generator rotor is supplied by the generator set starting battery BT1. During cranking of the engine, DC voltage of the battery is supplied through N.C. contacts of generator relay K2 (on control board A1), through the voltage regulator VR1, to the brushes and slip rings of the rotor. Upon successful engine start and generator voltage build-up, generator relay K2 becomes energized, which opens the N.C. contacts in the battery B+ circuit to the voltage regulator and closes 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 will shut down.

Brushes

DC excitation voltage is induced through the brushes and rotor slip rings to the rotor windings. The brush block assembly consists of a single brush block with two brushes. The brush block mounts inside the generator housing, directly over the rotor slip rings, and can 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 for generating an AC voltage potential in the stator windings. The DC current required for field excitation is supplied through two slip rings that mount on the rotor shaft.

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

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

Stator and Housing

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

- Leads T1, T2, T3, and T4 to Terminal Board TB1, for supplying power to load.
- Leads B1 and B2 to Control Board A1, wiring harness J1, for supplying power to generator relay K2.
- Leads Q1 and Q2 to Voltage Regulator VR1, wiring harness J4, for excitation voltage of rotor. (AC voltage from stator is rectified to DC voltage in VR1.)

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

Terminal Board (TB1)

The AC output power leads from the generator (T1, T2, T3, and T4) are connected to terminal board TB1 at terminals L1-L0 (connection configuration is model dependent, refer to proper Wiring Diagram/Schematic for further information). AC power at TB1 terminals is tapped by leads of wiring harness J4 of voltage regulator VR1, and interconnect wiring to the circuit breaker(s) CB1 (and CB2, if equipped). These leads provide generator output to the voltage regulator for proper voltage regulation, and to the circuit breaker(s) for power supply to load.

Voltage Regulator (VR1)

The voltage regulator helps to provide stable generator output voltage under varying load conditions. During initial start of the generator set, the voltage regulator receives DC current from the set starting battery, and begins excitation of the rotor (through leads J4-9/F1, and J4-10/F2). After the generator set starts and runs, it provides AC power to the voltage regulator (through leads J4-11/Q1, and J4-12/Q2). The AC voltage is rectified to DC voltage, and the proper DC excitation voltage is induced to the rotor in response to changes in load demand.

The voltage regulator design reduces the risk of component failure by not allowing moisture to contact/interfere with its operation, by; the printed circuit board control being encased in the regulator housing with a potting compound, the booted ends of the J4 wiring harness covering the terminals of capacitor C5 (mounted to the outside of the regulator housing), and the wiring harness plug-in P4 being treated with a lubricant prior to connection. Further protection is provided by mounting the voltage regulator assembly inside the generator control housing.

Control Circuit Breaker(s) (CB1, and CB2 if equipped)

The output power from the generator set is supplied to the control circuit breaker(s), located on side of the control right housing. The ampere rating of the circuit breaker(s) may differ, depending on generator set model/frequency. Be sure to refer to proper Parts Manual when ordering any replacement parts.

Wiring Harness to Load(s)

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

GENERATOR OPERATION

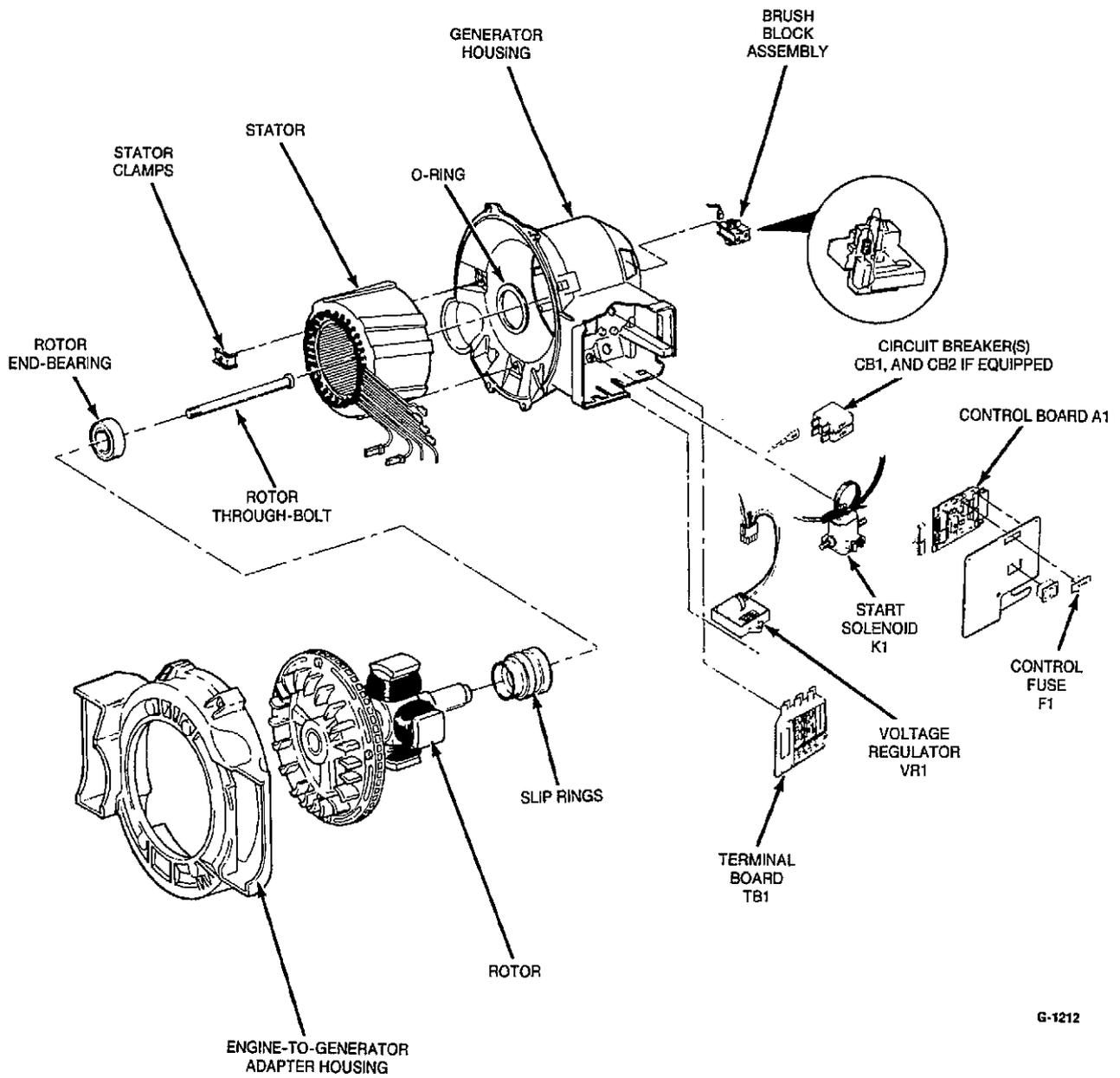
Generator operation involves all control components previously described. The wiring diagrams/schematics examples shown in Figures 8-2, 8-3, 8-4, and 8-5 reflect representative generator set models, and are intended for reference only. Always refer to the specific wiring diagram/schematic that corresponds to the specific generator set when troubleshooting problems.

When the start-stop switch is placed in the START position, the rotating field (rotor) is momentarily connected to battery positive (B+) to provide adequate residual magnetism for voltage build-up. As the engine starts and speed increases, the rotating field induces a voltage build-up in the stator windings. A portion of the AC current generated in the stator windings is provided to the voltage regulator (VR1) by the quadrature windings (Q1, Q2). The AC voltage is rectified to DC by the voltage regulator. The DC current is supplied to the rotating field windings to create the strong magnetic field required for generating the rated current. The AC voltage build-up stabilizes at approximately 128 volts when the engine reaches governed speed.

To prevent an excessive voltage drop when a load is applied to the generator, a method for regulating the AC output voltage is required. The voltage regulator allows the generator to provide a stable AC output voltage under varying load conditions through wire taps from voltage regulator VR1 wire harness J4-2 and -3 that are connected to terminal board TB1. These leads sense voltage changes of the load on the generator.

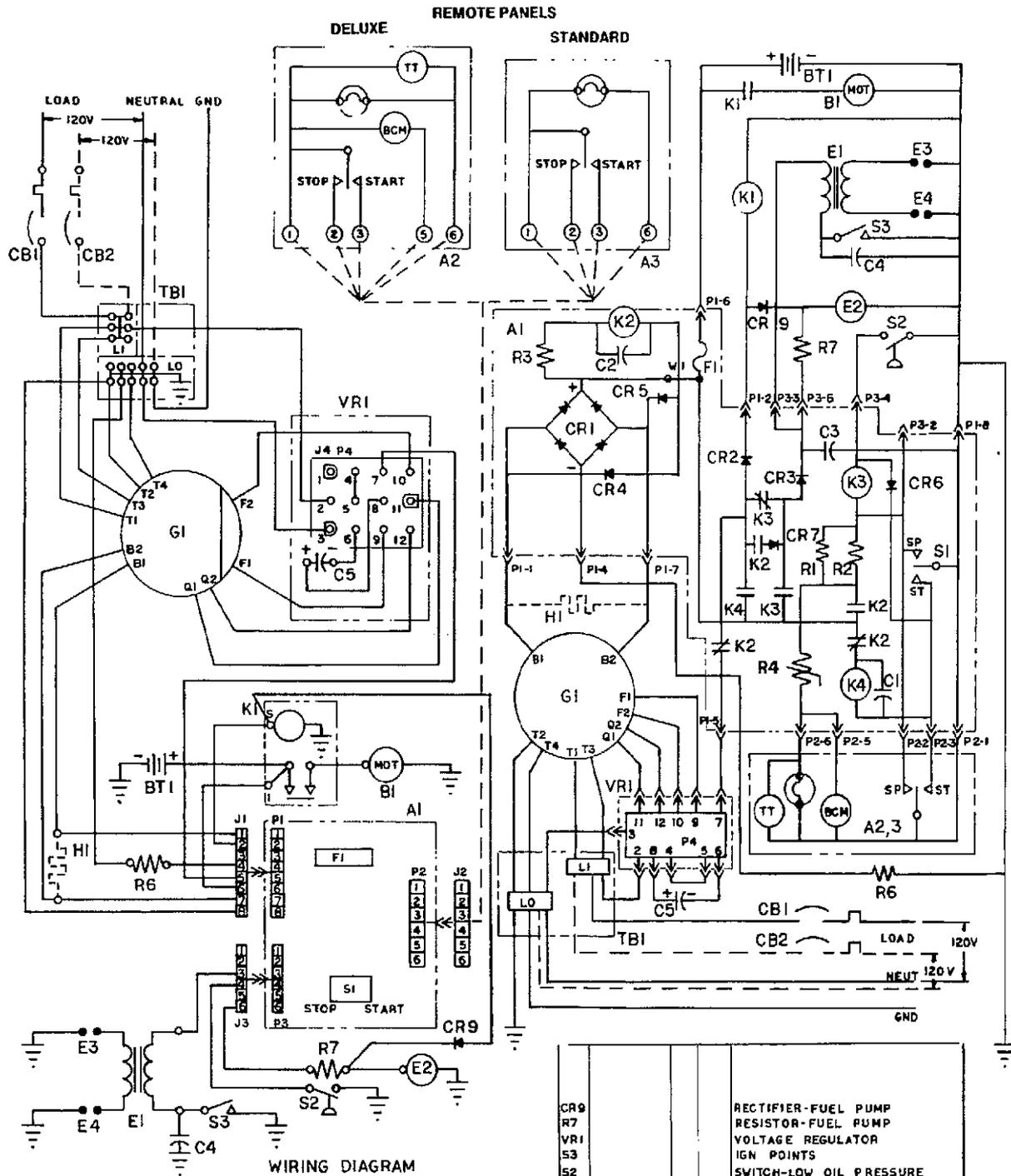
During operation, adding load increases the current flow through terminal board TB1 and the sensing leads to the regulator. The circuitry of the voltage regulator will then adjust the DC excitation voltage to the rotating field to a higher level, offsetting the voltage drop that would normally occur when a load is applied. In the same manner, decreasing the load reduces the DC field current to offset the voltage rise that would normally occur when a load is removed. Continuously adjusting the field current as the load changes is how voltage regulation is achieved.

Efficient generator set performance relies on effective voltage regulation and maintaining proper frequency (engine speed). Load changes on the generator output can cause engine speed to decrease or increase significantly. If the governor does not maintain proper engine speed, too much of a burden can be imposed on the voltage regulator to provide proper current to load. Review the information in *Section 6, Engine Primary Systems* for governor troubleshooting and adjustments.



G-1212

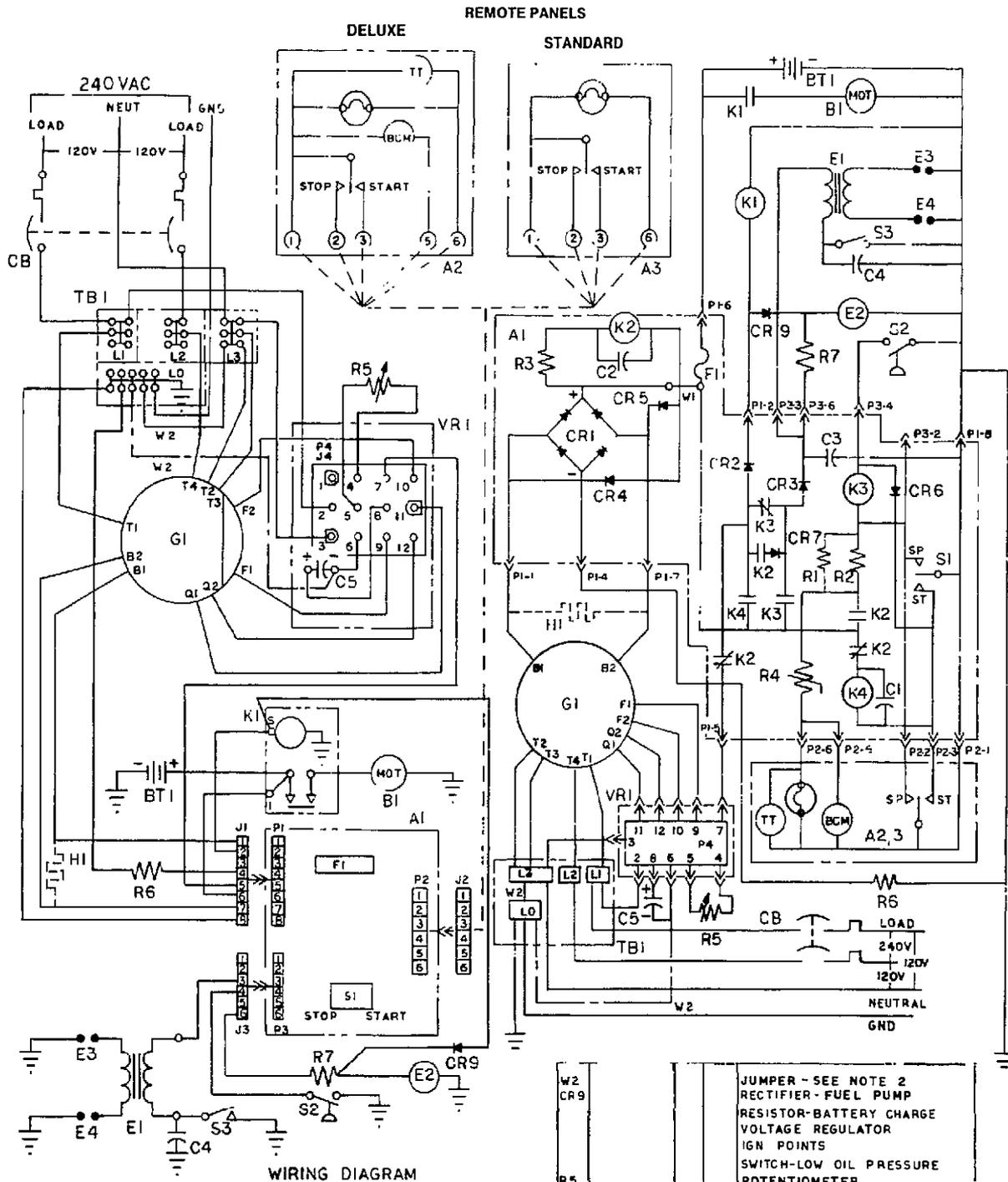
FIGURE 8-1. GENERATOR CONTROL COMPONENTS



CR9					RECTIFIER-FUEL PUMP
R7					RESISTOR-FUEL PUMP
VR1					VOLTAGE REGULATOR
S3					IGN POINTS
S2					SWITCH-LOW OIL PRESSURE
R6					RESISTOR-BATTERY CHARGE
K1					RELAY-START SOLENOID
HI					CHOKE
G1					GENERATOR
F1					FUSE
E3,4					SPARK PLUG
E2					FUEL PUMP
E1					IGN COIL
CB1,2					CIRCUIT BREAKER (AC OUTPUT)
C4,5					CAPACITOR
BT1					BATTERY 12V
B1					STARTER MOTOR
A3					REMOTE CONTROL-STANDARD
A2					REMOTE CONTROL-DELUXE
A1	300-3091-02	C	REF		CONTROL ASSY- NHE/NHEL
A1	300-3091-01	C	REF		CONTROL ASSY- BGE/BGEL
Item	Part No	QTY	Desc	Qty	Description or Material

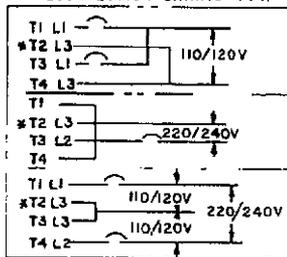
611-1180

FIGURE 8-2. 60 HZ BGE/NHE GASOLINE-FUELED GENERATOR SET WIRING DIAGRAM/SCHEMATIC
(Prior to Spec G; Breaker Points and Condenser)



WIRING DIAGRAM

RECONNECTION CHARTS 1 PH 4 WIRE

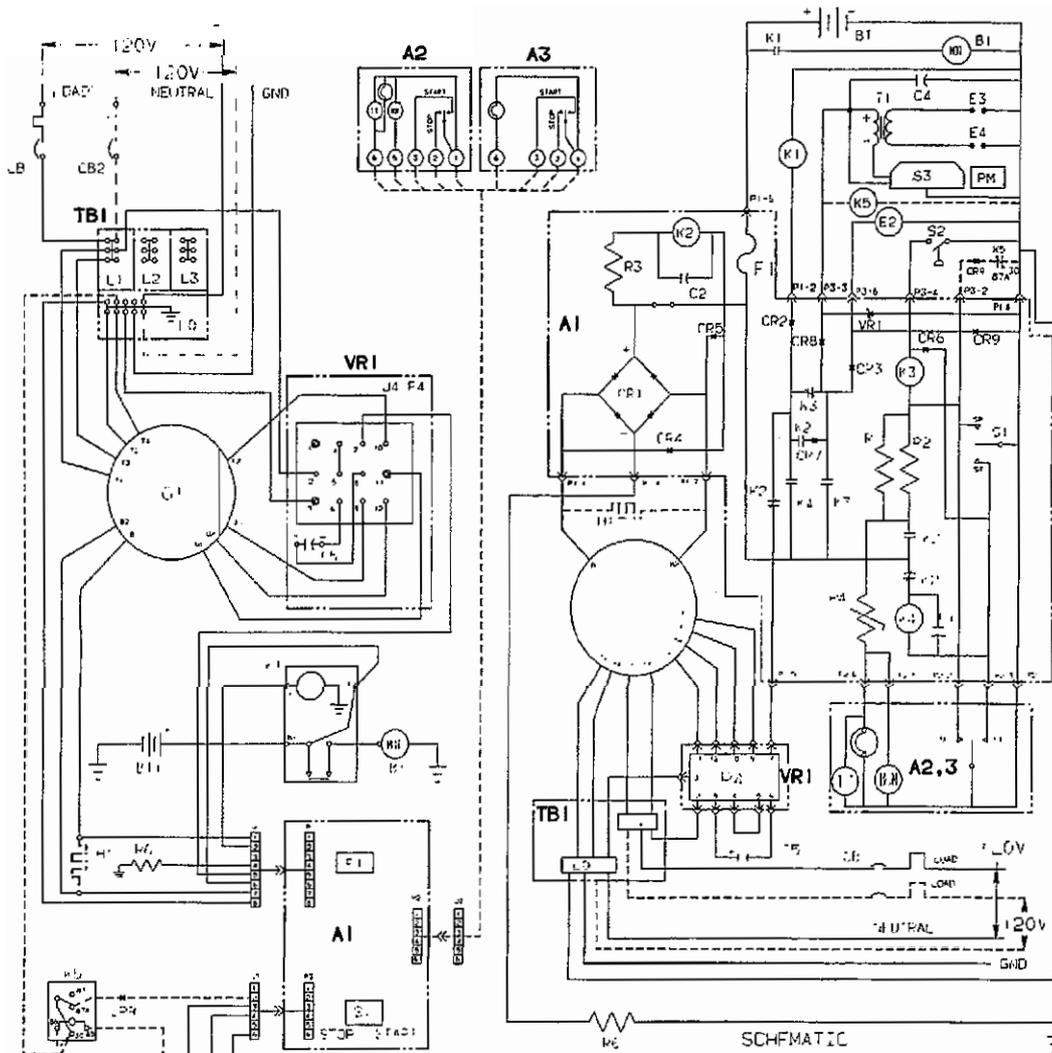


* GROUND AC LEAD - FOR ISOLATED NEUTRAL, REMOVE JUMPER (W2) TB1-L3, L0 AND CONNECT JUMPER TB1-L0, VR1-CB NEG(-)

611-1183

W2	JUMPER - SEE NOTE 2
CR9	RECTIFIER - FUEL PUMP
	RESISTOR-BATTERY CHARGE
	VOLTAGE REGULATOR
	IGN POINTS
R5	SWITCH-LOW OIL PRESSURE
R7	POTENTIOMETER
K1	RELAY - START SOLENOID
H1	CHOKE
G1	GENERATOR
F1	FUSE-SLOW BLOW 5A
E3,4	SPARK PLUG
E2	FUEL PUMP
E1	IGN COIL
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1 300 3128-02	C EF CONTROL ASSY- NHE/NHEL
A1 307 3128-01	C REF CONTROL ASSY- BGE/BGEL

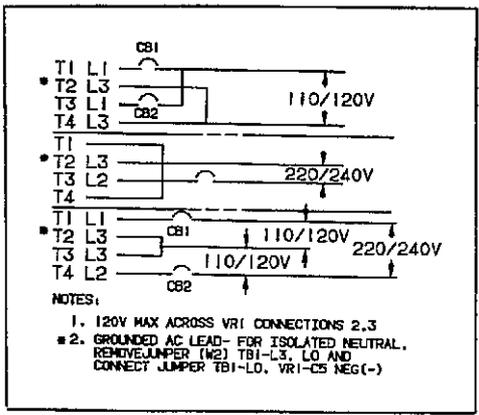
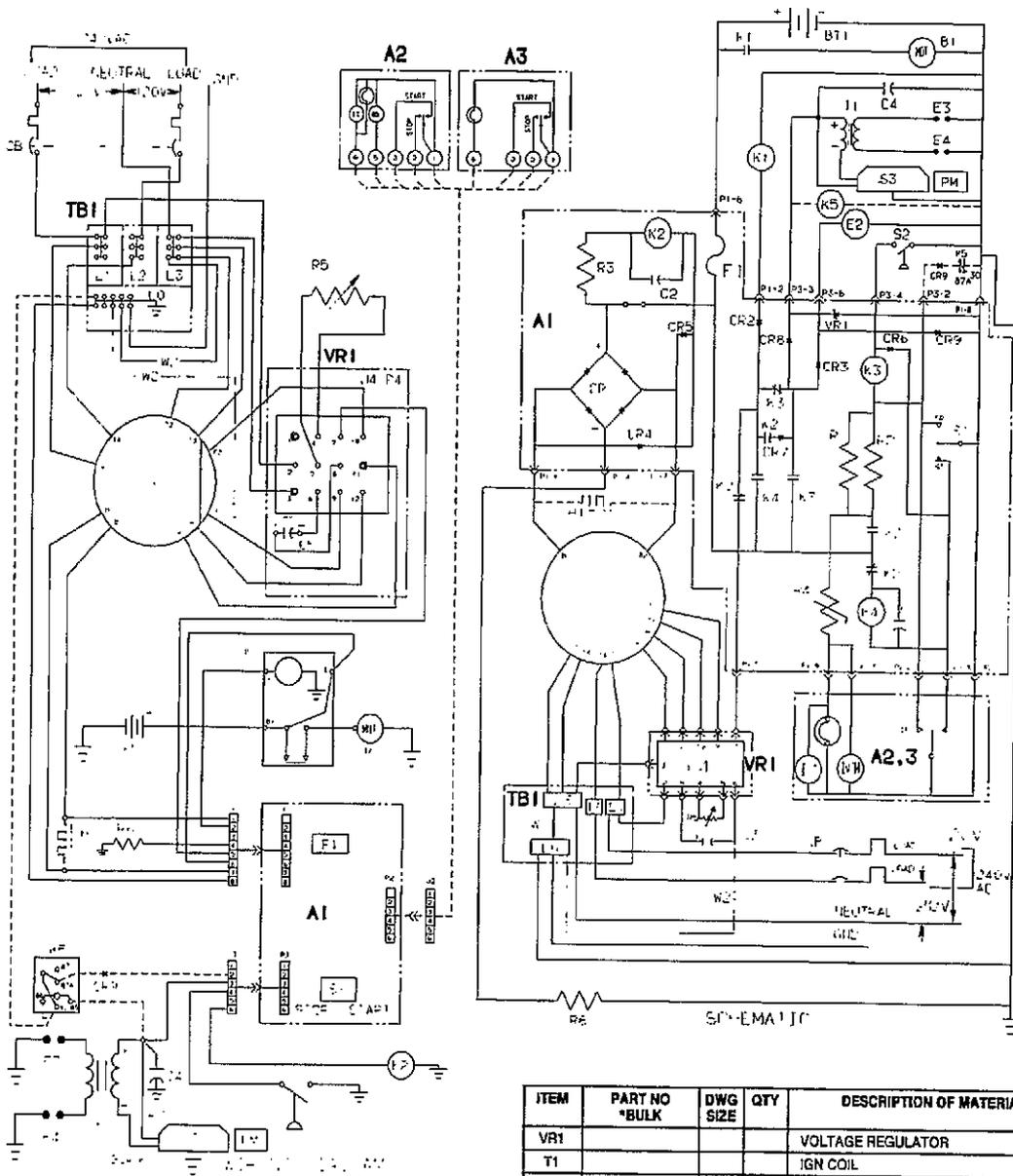
FIGURE 8-3. 50 HZ BGE/NHE (GASOLINE-FUELED) GENERATOR SET WIRING DIAGRAM/SCHEMATIC (Prior to Spec G: Breaker Points and Condenser)



ITEM	PART NO *BULK	DWG SIZE	QTY	DESCRIPTION OF MATERIAL
VR1				VOLTAGE REGULATOR
T1				IGN COIL
S3				IGN MODULE
S2				SWTCH-LOW OIL PRESS
R6				RESISTOR-BATTERY CHARGE
R5				POTENTIOMETER
K5				RELAY-LPG ONLY
K1				RELAY-START SOLENOID
H1				CHOKE-GASOLINE ONLY
G1				GENERATOR
F1				FUSE-SLOW BLOW 5A
E3,4				SPARK PLUGS
E2				FUEL PUMP OR FUEL SOL
CR9				RECTIFIER-LPG ONLY
CB1,2				CIRCUIT BREAKER (AC OUTPUT)
C4,5				CAPACITOR
BT1				BATTERY 12V
B1				STARTER MOTOR
A3				REMOTE CONTROL-STANDARD
A2				REMOTE CONTROL-DELUXE
A1	300-3091-02	C	REF	CONTROL ASSY-NHE/NHEL
A1	300-3091-01	C	REF	CONTROL ASSY-BGE/BGEL

611-1190

FIGURE 8-4. 60 HZ BGE/NHE GENERATOR SET WIRING DIAGRAM/SCHEMATIC
(Spec G: Electronic Ignition)



ITEM	PART NO *BULK	DWG SIZE	QTY	DESCRIPTION OF MATERIAL
VR1				VOLTAGE REGULATOR
T1				IGN COIL
S3				IGN MODULE
S2				SWITCH-LOW OIL PRESS
R6				RESISTOR-BATTERY CHARGE
R5				POTENTIOMETER
K5				RELAY-LPG ONLY
K1				RELAY-START SOLENOID
H1				CHOKE-GASOLINE ONLY
G1				GENERATOR
F1				FUSE-SLOW BLOW 5A
E3,4				SPARK PLUGS
E2				FUEL PUMP OR FUEL SOL
CR9				RECTIFIER-LPG ONLY
CB1,2				CIRCUIT BREAKER (AC OUTPUT)
C4,5				CAPACITOR
BT1				BATTERY 12V
B1				STARTER MOTOR
A3				REMOTE CONTROL-STANDARD
A2				REMOTE CONTROL-DELUXE
A1	300-3128-02	C	REF	CONTROL ASSY-NHE/NHEL
A1	300-3128-01	C	REF	CONTROL ASSY-BGE/BGEL

FIGURE 8-5. 50 HZ BGE/NHE GENERATOR SET WIRING DIAGRAM/SCHEMATIC (Spec G: Electronic Ignition)

611-1191

GENERATOR TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the generator. Figure 8-1 shows the location of the generator components. Refer to the wiring diagrams/schematics in Figures 8-2, 8-3, 8-4, or

8-5 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.

TROUBLESHOOTING THE GENERATOR

⚠ 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
<p>No AC Output Voltage</p> <p>Note: This condition may cause the generator set to stop when start switch S1 is released.</p>	<ol style="list-style-type: none"> 1. Open circuit breaker. 2. Open circuit between voltage regulator and brush block. 3. Open circuit between generator windings (Q1, Q2) and voltage regulator. 4. Open circuit between terminal block TB1 and voltage regulator; wiring harness J4 leads. 5. Brushes stuck in holder or not making good contact with slip rings. 6. Defective voltage regulator. 7. Open, grounded, or short circuit in rotor or stator. 	<ol style="list-style-type: none"> 1. Locate cause of overload and correct as required. Reset breaker. 2. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open. 3. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open. 4. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open. 5. Release brushes if jammed in holder. Clean slip rings if dirty. 6. Replace voltage regulator. 7. Test each component for open, grounded, or shorted windings and replace if defective.
<p>AC Output Voltage Too Low or Too High</p>	<ol style="list-style-type: none"> 1. Engine governor incorrectly adjusted. 2. Brushes worn or not making good contact with slip rings. (Low AC output voltage.) 3. Poor wiring connections to/from voltage regulator. 4. If generator frequency is within specified limits but voltage is incorrect, voltage regulator is defective. 5. Open, grounded, or short circuit in rotor or stator. 6. Voltage Regulator sensing leads 2 and 3 wired incorrectly. 	<ol style="list-style-type: none"> 1. Refer to governor adjustments in section 6. 2. Check length of brushes and replace if worn excessively. Clean or replace slip rings. 3. Check for good wiring connections and correct as required. Check for continuity and correct if circuit is open. 4. Refer to <i>Testing Voltage Regulator VR1</i>. 5. Test each component for open, grounded, or shorted windings and replace if defective. 6. Correct wiring.

TROUBLESHOOTING THE GENERATOR (Continued)

⚠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
Noisy Generator	<ol style="list-style-type: none"> 1. Loose brush holder. 2. Worn generator end bearing. 3. Rotor and stator rubbing together due to: <ol style="list-style-type: none"> a. Varnish lumps. b. Rotor misaligned with crankshaft. 	<ol style="list-style-type: none"> 1. Tighten brush holder 2. Replace end bearing. 3a. Check for varnish lumps between rotor and stator, remove as required. b. Follow specified assembly procedures to correct rotor to crankshaft alignment.
Generator Overheats	<ol style="list-style-type: none"> 1. Generator overloaded due to defective circuit breaker. 2. Airflow restricted due to dirt or debris covering vent openings in stator housing. 3. Stator windings covered with oil or dirt. 4. Open, grounded, or short circuit in rotor or stator. 5. Defective voltage regulator. 	<ol style="list-style-type: none"> 1. Remove part of load and replace circuit breaker. 2. Clear away all dirt or debris as required. 3. Clean stator windings. 4. Test each component for open, grounded, or shorted windings and replace if defective. 5. Refer to <i>Testing Voltage Regulator VR1</i>.

GENERATOR SERVICE

This section covers generator disassembly and assembly procedures. Refer to Figure 8-1 to locate and identify the various generator components described, and Figure 8-2, 8-3, 8-4, or 8-5 for wiring interconnect information.

Generator Disassembly

Use the following procedure to disassemble the generator:

1. Drain the engine oil while the generator set is still mounted in the vehicle.
2. Remove the generator set from the vehicle and place it on a sturdy work bench. Refer to *Set Removal* in section 5 for the recommended set removal procedure.
3. Remove the flywheel guard (from scroll opening) and the sound shield.
4. The carburetor and intake manifold must be removed to provide clearance for lifting the generator stator assembly. Disconnect the choke heater lead wires, throttle linkage, fuel line crankcase breather hose, and preheater tube. Remove the intake manifold screws and lift off the carburetor and intake manifold as an assembly. Refer to *Fuel System* in section 6 for detailed removal procedure.
5. Disconnect the lead wires from the charge resistor, low oil pressure cutoff switch, and 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 lead wire 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 8-6. Carefully guide the wire through the brush block and then release each brush. Verify that each brush is held off the slip rings by the holding wire.

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

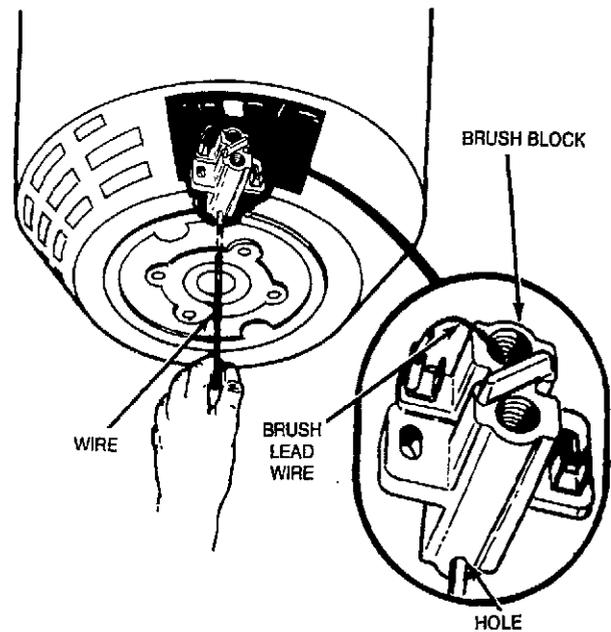


FIGURE 8-6. BRUSH BLOCK ASSEMBLY

G-1178

8. Remove the two control panel screws from housing, lift off control panel and disconnect plug/jack connections P1/J1 and P3/J3 of control printed circuit board.
9. If the set is LP-gas fueled, disconnect the fuel line at the vaporizer coupling.
10. Place a 3/8 inch allen wrench in the head of the rotor through-bolt. Use a rubber mallet and sharply strike the allen wrench so the through-bolt is driven in a counterclockwise (viewed from generator end) direction. Several sharp taps should break loose the through-bolt.
11. Remove the rotor through-bolt and thread the special lifting eye (9/16-12) into the end of the housing. Refer to Figure 8-7.

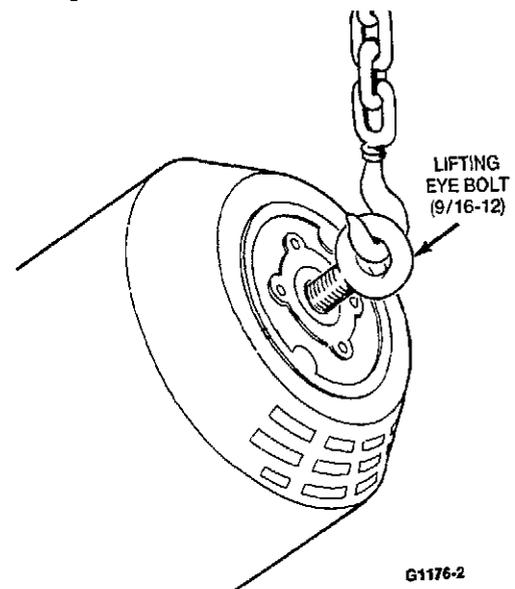


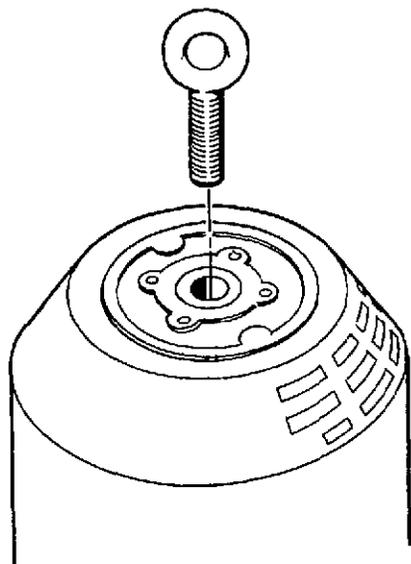
FIGURE 8-7. GENERATOR LIFT

G1176-2

- Place a pad in front of the engine to cushion and protect the scroll. Attach a hoist or other suitable lifting device to the lifting eye. Tip up the set as shown in Figure 8-7 until it is completely vertical and resting on the scroll housing end.

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

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

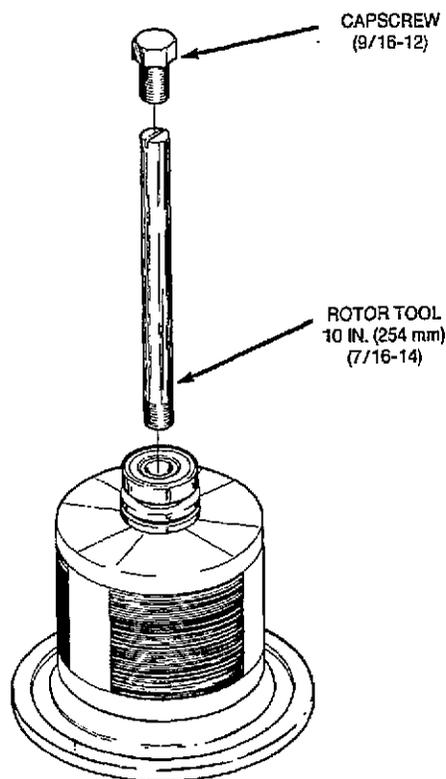


G1175-1

FIGURE 8-8. REMOVE LIFTING EYE BOLT

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

- Install the tool shown in Figure 8-9. Use a screwdriver to turn the rotor tool in a clockwise direction until it bottoms. Install a 9/16-12 x 2 capscrew in the end of the rotor shaft and tighten until rotor breaks loose from crankshaft. Remove capscrew from end of rotor when complete.



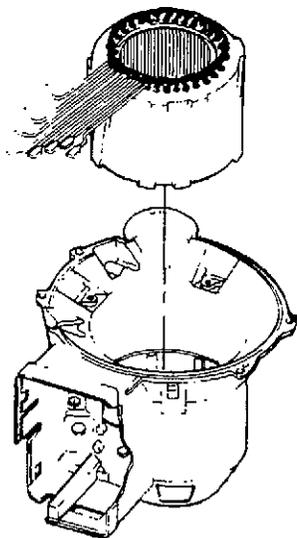
G-1175

FIGURE 8-9. ROTOR TOOL

- Carefully lift the rotor assembly off the end of the engine crankshaft and remove rotor tool.
- 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.

22. Refer to Figure 8-10 and use the following procedure to remove the stator from the stator housing:
- Rotate the stator/housing assembly onto a smooth, clean surface, resting on end-bearing face (bell shape of housing facing up).
 - Disconnect stator leads;
 - T1, T2, T3, and T4 from terminal board TB1,
 - Q1 and Q2 from voltage regulator VR1 harness J4,
 - B1 and B2 from control printed circuit board harness J1.
 - Draw stator leads from control box.
 - Remove the three stator clamps and capscrews.
 - Carefully lift the stator straight up until it clears the stator housing. Set stator to rest on a 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, and take care not to drop or drag the stator on work area outside of stator housing.



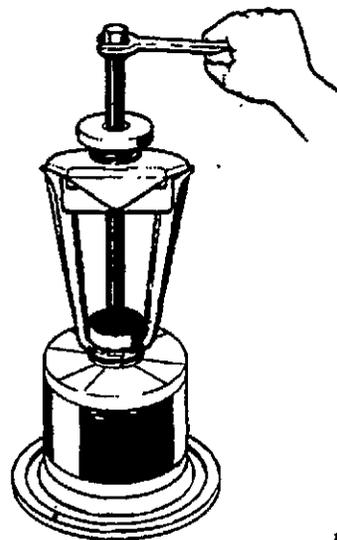
G-1213

FIGURE 8-10. 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 1).

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 8-10a. BEARING REMOVAL

Bearing Replacement

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

Component Inspection

While the generator components are disassembled, perform rotor and stator tests as indicated in Generator Testing, this section. Also check mechanical condition of generator parts (rotor end-bearing, generator housing and o-ring, etc.) for signs of wear. Refer to proper unit Parts Manual and replace any components found to be defective.

Generator Assembly

Use the following procedure to assemble the generator:

- Refer to Figure 8-10 and use the following procedure to install the stator into the stator housing:
 - Position the stator so the output leads align with access hole to control housing, then 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. Draw stator leads into control box.
 - d. Connect stator leads;
 - T1, T2, T3, and T4 to terminal board TB1,
 - Q1 and Q2 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 bell shape of housing (end-bearing face up).
2. Install the brush block assembly into the stator housing. Lift the brush wires and install brush holding wire into housing. The wire holds the brushes off the slip rings during assembly. See Figure 8-6.
 3. Carefully place the rotor assembly onto the end of the engine crankshaft and replace the rotor through-bolt. Tighten rotor through-bolt only enough to hold rotor in place.

CAUTION *Tightening the rotor through-bolt to specified torque before the stator assembly is installed can result in rotor shaft misalignment. Follow 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 hole.

CAUTION *Careless handling of the stator assembly can damage the insulation on the stator windings. Do not brush the stator windings against the rotor as it is lowered into position.*

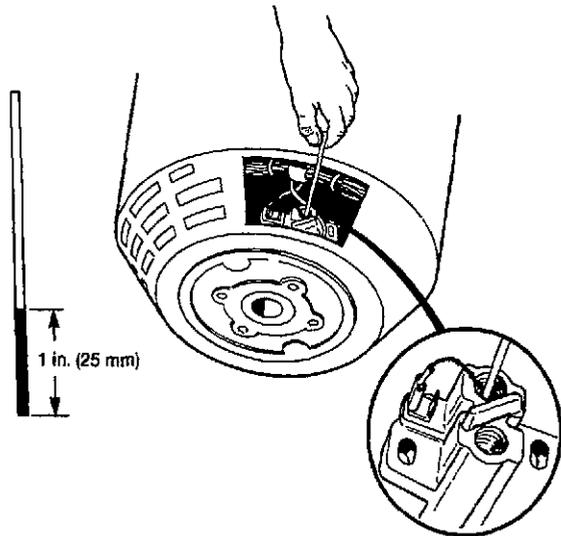
5. Install the four capscrews, lock washers, and nuts that secure the stator housing to the engine-to-generator adapter. Tighten capscrews to specified torque. Note that each locking washer is installed under capscrew head.
6. Tighten the rotor through-bolt to specified torque.
7. Mount starter on generator stator housing using capscrews, lock washers and nuts. Tighten to specified torque.
8. Connect lead wires to starter terminal stud.
9. Hold the drip pan in position for mounting to the underside of the set and install the three vibration isolator center screws. Note that proper flat washers are used (large flat washers at two generator isolator positions). Tighten the center screws to specified torque.

10. Secure ground strap to drip tray using a capscrew and two EIT locking washers. Note that ground strap is installed between locking washers to provide a good electrical connection.
11. Attach the special lifting plate to the end of the stator housing using four 5/16-18 x 1 capscrews. See Figure 8-7.
12. Attach a hoist or other suitable lifting device to the lifting plate. Carefully tilt the set back until it is resting on the drip tray. Remove lifting plate when complete.
13. If the set is LP-gas fueled, connect the fuel line at the vaporizer coupling.
14. Connect plug/jack connections P1/J1 and P3/J3 of control printed circuit board. Install control panel assembly onto generator housing. Tighten mounting screws.
15. Pull the brush lead wires outward and remove the piece of wire that is holding the brushes off the slip rings. Check the brushes to verify that they are centered on the slip rings. If brushes are not centered, loosen the brush block mounting screws and adjust. Retighten mounting screws when complete.
16. Connect the F1 (+) (outboard) and F2 (-) (inboard) lead wires to the brush block terminals. Install the brush block cover.
17. Connect the lead wires to the charge resistor, low oil pressure cutoff switch, and B+ terminal on the ignition coil.
18. Place new intake manifold gaskets on the engine block and install the carburetor and intake manifold assembly. Tighten the intake manifold screws to the specified torque. Connect the preheater tube, crankcase breather hose, fuel lines, throttle linkage, and choke heater wires. Refer to *Fuel System* in section 6 for detailed assembly procedures.
19. Install the flywheel guard (scroll opening) and the noise shield.
20. Install the generator set in the vehicle and securely fasten all mounting screws and hardware. Connect the fuel, exhaust, and electrical system in reverse order of disassembly. Refer to *Set Removal* in section 5 for the recommended procedures.
21. Fill crankcase with oil of the recommended classification and viscosity.

BRUSHES AND SLIP RINGS

Brush Replacement

Remove the brush block cover and inspect the brushes and brush holder for burn marks or other damage. If the brushes appear to be in good condition, use a piece of wire (modified as shown in Figure 8-11) 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.



G-1174

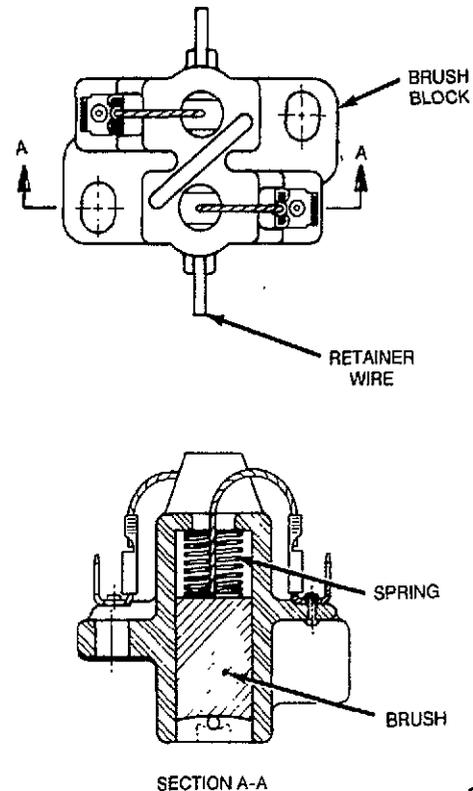
FIGURE 8-11. CHECKING BRUSH WEAR

Always replace the brush springs when installing new brushes so that proper pressure is maintained when brushes contact slip rings.

Use the following procedure to replace the brushes.

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 stator housing.
4. Disconnect the F1 (+) (outboard) and F2 (-) (inboard) voltage regulator 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 brushes away from slip rings, insert brush retainer wire from outside stator housing hole, through brush block assembly. Release both brush lead wires. See Figure 8-12.



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FIGURE 8-12. 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.
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 Service

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. Use the following procedure to service:

1. Remove the air cleaner cover and air cleaner filter.
2. Disconnect voltage regulator lead wires F1 and F2 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 rotor through-bolt and rotate engine and generator one full turn. While rotating, inspect condition of slip rings. If slip rings require refinishing, continue to next step. If slip rings do not require refinishing, follow steps 6 through 14 in the Brush Replacement section.
5. Press the Start-Stop switch to START position to crank the engine. During this step, only crank the engine for 3 to 6 second cranking periods with a rest period between so not to overheat starter.

During engine cranking, hold a commutator stone against rotating slip rings. Remove commutator stone after each cranking period and check that carbon is being removed and all grooves or roughness is smoothed out.

▲WARNING *Contact with rotating machinery can result in severe personal injury. Keep hands and fingers 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.

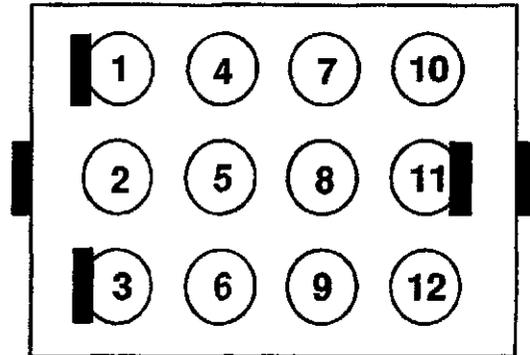
TESTING VOLTAGE REGULATOR VR1

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

1. Disconnect the negative (-) battery cable.
2. Remove the generator control box cover (Figure 8-1).
3. Disengage the wiring connector and remove the voltage regulator.
4. With the meter on "Diode Check", test between connector terminal pairs 5-9, 7-9, 10-9, 11-9, 12-9, 10-5, 5-11, 5-12 and 5-3 (Figure 8-13). It is important that the positive lead of the meter be connected

to the first terminal of each pair. Replace the voltage regulator if any reading indicates "short" or "open", except for pair 10-5, which should indicate "open".

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



ES-1952C

FIGURE 8-13. VOLTAGE REGULATOR CONNECTOR TERMINALS

GENERATOR TESTING

This section covers the test procedures for the generator rotor and stator windings. Follow the troubleshooting procedures in this section to locate the required corrective action.

Perform the Field Voltage Test to confirm that field voltage is available to the rotor brushes through the voltage regulator for field flashing and voltage buildup.

Check all wire harness connectors and leads for continuity prior to testing or generator disassembly. Refer to Figure 8-1 for wire locations.

Field Voltage Test

A voltage check can be made to determine if voltage is being supplied to the brushes from the voltage regulator for voltage buildup.

Connect a DC voltmeter positive (+) test lead into the voltage regulator plug (P1) at pin 9 and connect the negative (-) test lead into the voltage regulator plug at pin 10. The voltage regulator plug remains connected to the voltage regulator and test leads should be secured so they are not being held during testing. See Figure 8-13.

▲WARNING *Electrical shock can cause severe personal injury or death. Use extreme caution when working on electrical circuitry. Attach and remove meter leads only when generator set is not operating. Do not touch meter or meter leads during testing.*

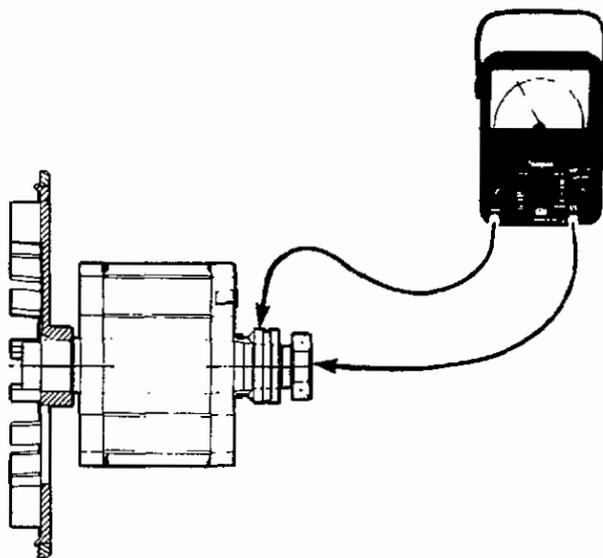
⚠ WARNING *Contact with rotating machinery can result in severe personal injury. Keep hands, clothing, jewelry and fingers clear while servicing slip rings.*

Start the generator set and allow it to stabilize. Measure the field voltage with no load applied and then with full load applied. Both readings should fall within a range of 18 to 60 volts DC. If the set cranks but will not run, check to see that battery voltage is being supplied to the voltage regulator pin 7 (positive lead) and ground (negative lead) during start up. If battery voltage (approximately 12 volts) is being supplied to the voltage regulator at pin 7, and no output voltage was measured, check the voltage at the brushes. If the voltage is zero, replace the voltage regulator and retest. If battery voltage is not supplied to the voltage regulator during starting, refer to Control section (7) for troubleshooting procedures.

Rotor Tests

The rotor can be tested for grounded, open, or shorted windings using an ohmmeter. Figures 8-14 and 8-15 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 of the slip rings during testing.

Ground Test: To test for grounds, set the ohmmeter for the highest resistance scale. Touch one test lead to the rotor shaft and hold it there. Touch the other test lead to one of the slip rings. See Figure 8-14. A reading less than one megohm indicates the rotor is grounded. Replace a grounded rotor with a new rotor.

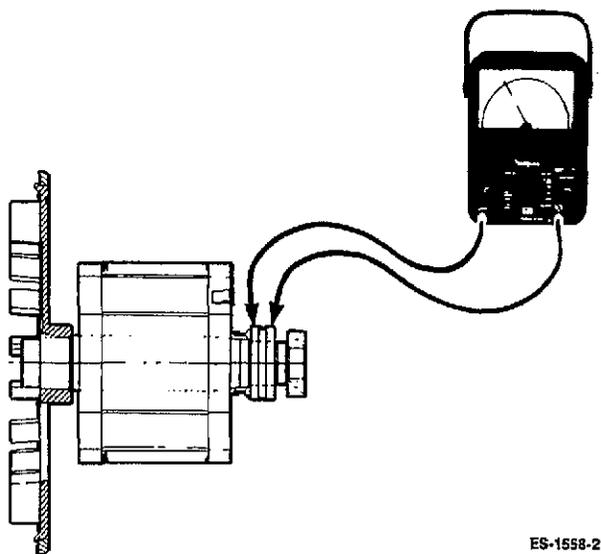


ES-1558-1

FIGURE 8-14. TESTING ROTOR FOR GROUNDS

Open or Shorted Windings Test: To test for open windings, set the ohmmeter for the highest resistance scale. Place test leads on the slip rings as shown in Figure 8-15. 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 rotor if the rotor winding is open.

To test for shorted windings, set the ohmmeter for the lowest scale. Place the test leads on the slip rings as shown in Figure 8-15. 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.



ES-1558-2

FIGURE 8-15. TESTING ROTOR FOR OPENS OR SHORTS

Stator Tests

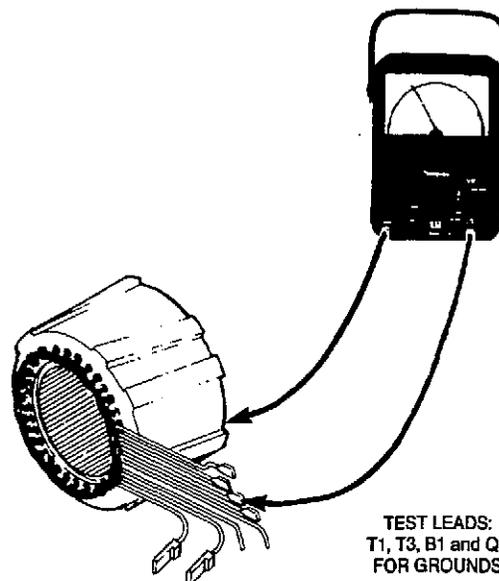
The stator can be tested for grounded or open windings using an ohmmeter. Testing for shorted windings requires a digital-type ohmmeter that can read to within 0.01 ohms.

Figures 8-16 and 8-17 show the stator removed from the generator for testing. However, it is possible to test the stator without disassembling the generator. Remove the control panel to obtain access to the specified lead wires during testing.

Ground Test: To test for grounds, disconnect the following stator leads:

- 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 are not touching the generator set housing or other components within control. Set the ohmmeter for the highest resistance scale and then connect one test lead to the generator housing. Touch the other test lead (see Figure 8-16) to the listed generator leads individually. A reading less than one megohm indicates a ground. Replace a grounded stator with a new stator.



G-1214

FIGURE 8-16. TESTING STATOR FOR GROUNDS

Open or Shorted Windings Test: To test for opens, disconnect stator leads; T1, T2, T3, and T4 from TB1, B1 and B2 from A1, and Q1 and Q2 from VR1. Set the ohmmeter for the highest resistance scale and then connect the test leads (see Figure 8-16) 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-type ohmmeter that reads to within 0.01 ohms. Disconnect the stator leads as specified in Open Test section. Connect the test leads (see Figure 8-17) to the leads in pairs as specified in the Open Test section. The reading for lead pairs should be as follows (plus or minus 10 %):

60 Hz Models

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

50 Hz Models

- Leads T1/T2 - 0.502 ohms
- Leads T3/T4 - 0.502 ohms
- Leads B1/B2 - 0.112 ohms
- Leads Q1/Q2 - 2.873 ohms

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

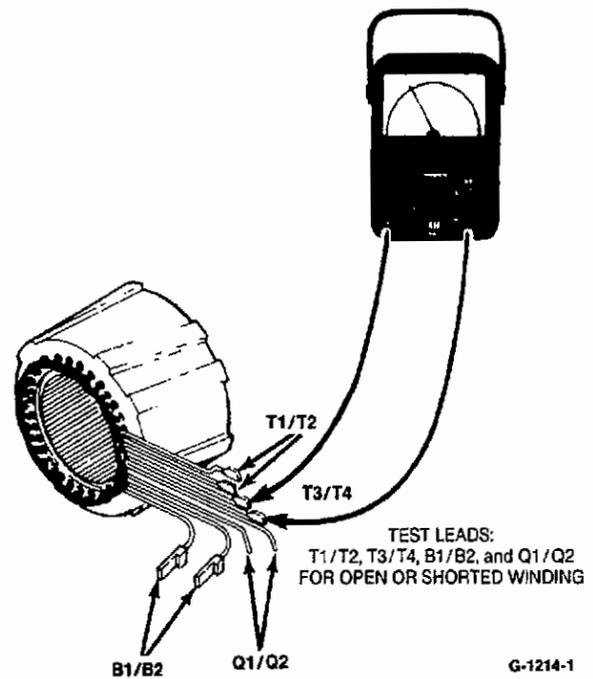


FIGURE 8-17. TESTING STATOR FOR OPENS OR SHORTS

Section 9. Engine - Block Assembly

GENERAL

The engine block assembly includes the pistons and connecting rods, crankshaft, camshaft, valves and lifters, cylinder heads, lubrication system, timing gears, governor mechanism, bearings, and cylinder block. Performing any major service on the block assembly will require that the generator set be removed from the coach (see *Set Removal* section). In addition, to gain complete access to the block assembly, the control, generator, and all primary engine systems must also be removed. Refer to the previous sections for the disassembly and removal procedures.

OIL FILTER AND ADAPTER

Open the oil drain valve and drain the crankcase oil. Remove the filter (see Figure 9-1) by turning counter-clockwise with a filter wrench. The low oil pressure cut-off switch is installed in a threaded hole in the filter adapter and may be removed if required. Loosen the two capscrews that secure the adapter to the engine block and remove the adapter and gasket.

Assembly is the reverse of disassembly. Use a new adapter gasket and install so the two small oil holes are aligned with the oil holes in the block. Gasket should be installed dry. Coat the threads of each capscrew with non-hardening sealer and tighten to recommended torque.

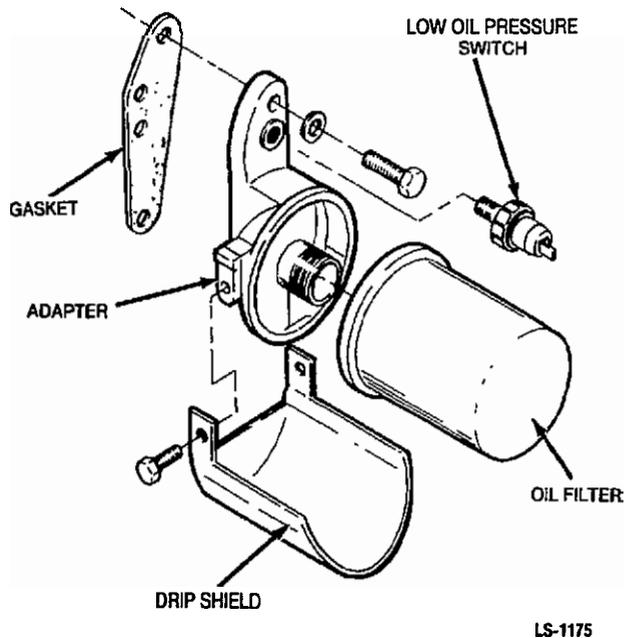


FIGURE 9-1. OIL FILTER & ADAPTER

CYLINDER HEADS

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

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

CAUTION *Warping can occur if the heads are removed while hot. Wait until engine has cooled before removing heads.*

2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.
4. Place heads in position and follow head torque tightening sequence shown in Figure 9-2. Start out tightening all capscrews, or stud nuts, to 5 ft-lbs (7 N•m), then 10 ft-lbs (14 N•m), etc., until all capscrews, or stud nuts, are tightened to the specified torque (see *Torque Specification* section).
5. Retorque before engine has run a total of 25 hours.

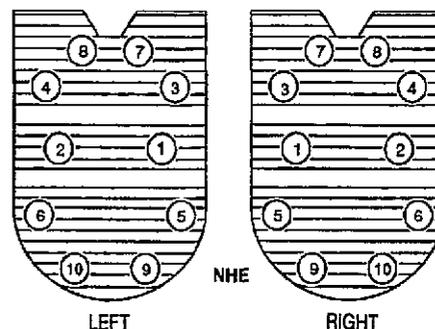
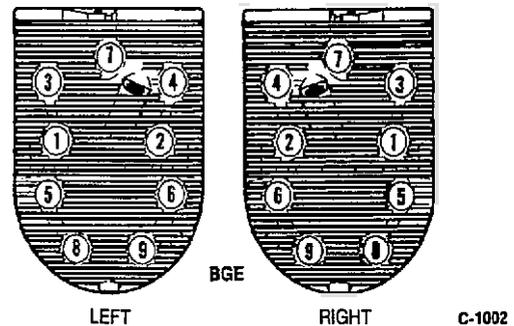


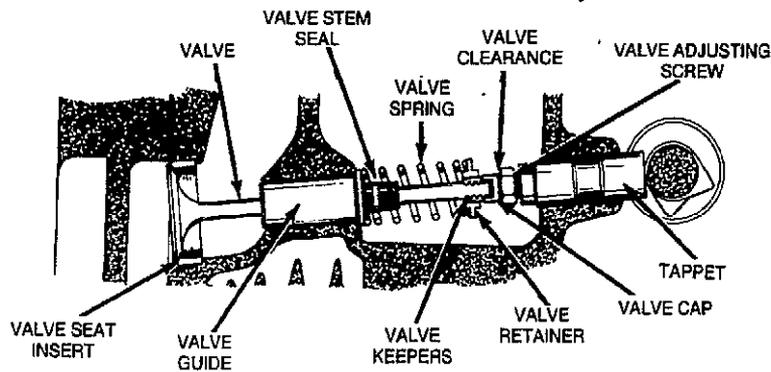
FIGURE 9-2. CYLINDER HEAD TIGHTENING SEQUENCE

VALVE SYSTEM

A properly functioning valve system is essential for good engine performance. All generator sets utilize an L-head type valve design as shown in Figure 9-3.

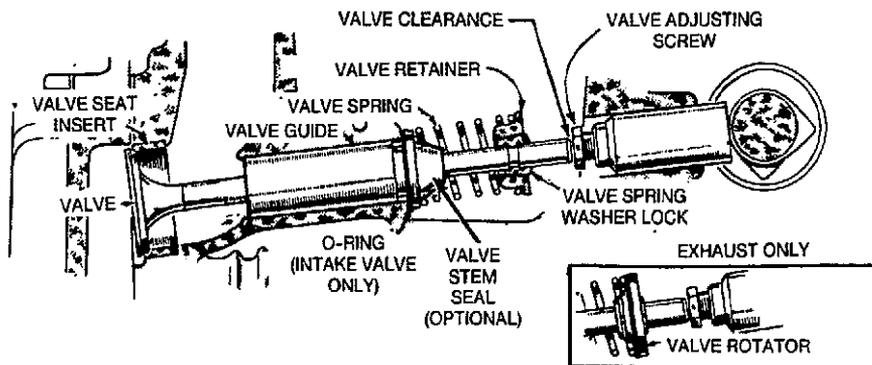
Access to the valve system can be obtained by removing the cylinder heads and the valve covers on top of the engine. A valve spring compressor must be used to remove valves (see Figure 9-4) from the cylinder block. Use the following procedures to inspect and service in the valve system.

BGE



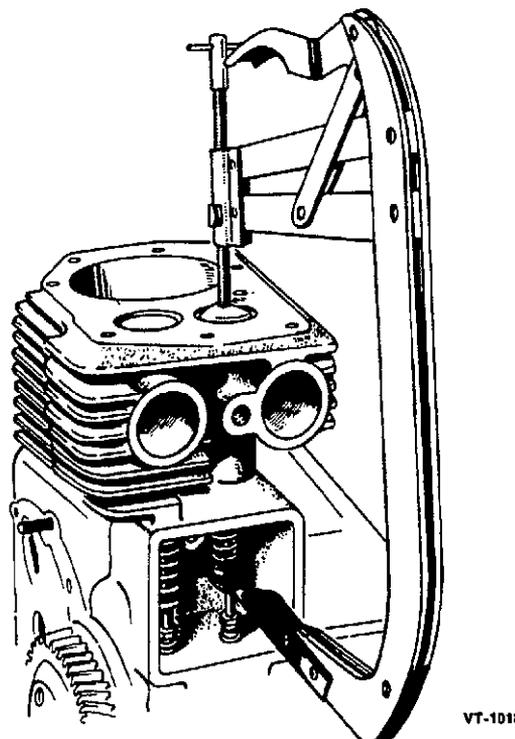
VT-1034

NHE



VT-1005

FIGURE 9-3. VALVE SYSTEM



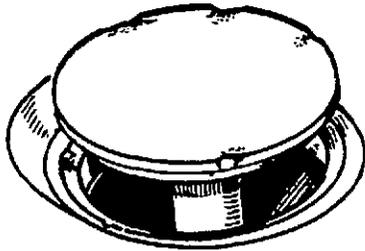
VT-1018

FIGURE 9-4. VALVE SPRING COMPRESSOR

Inspection

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

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



VT-1017

FIGURE 9-5. VALVE FACE

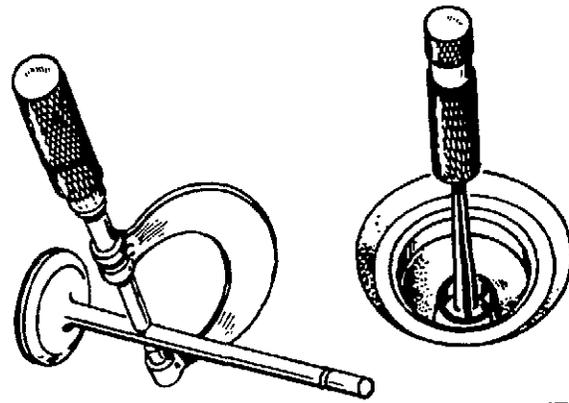
Warpage occurs chiefly in the upper stem due to its exposure to intense heat. Out-of-round wear follows when the seat is pounded by a valve whose head is not in line with the stem and guide. If a valve face is burned or warped, or the stem worn, install a new one.

Too much clearance in the intake guide admits air and oil into the combustion chamber, upsetting carburetion, increasing oil consumption, and 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 which causes warping and burning.

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

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

Stems and Guides: Always check valve stems and guides for wear as shown in Figure 9-6. Use a hole gauge to measure the valve guide. When clearance with stem exceeds original clearance by 0.002 inch (0.05 mm), replace either valve or guide or both, as may be necessary. Always regrind seat to make concentric with the newly installed guide.



VT-1020

FIGURE 9-6. VALVE STEM & VALVE GUIDE INSPECTION

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

Valve Rotators (NHE exhaust only): Positive type valve rotators prolong valve life and decrease valve repairs. When functioning properly, the valve is rotated a fraction of a turn each time it opens. While at open position, the valve must rotate freely. There is no easy way to determine if a valve rotator is good or bad. Onan recommends that valve rotators be replaced at each major overhaul or if a build-up of carbon is noted on valve face and valve seat. See Figure 9-3 (NHE).

Reconditioning Valves and Valve Seats

The interference angle method of valve seating is used on all B and N series generator set engines. With this method, different seat and face angles are used and line contact between the valve face and seat occurs.

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 top of the valve seat (see Figure 9-7).

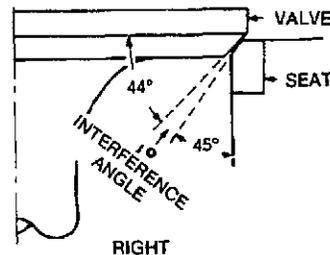
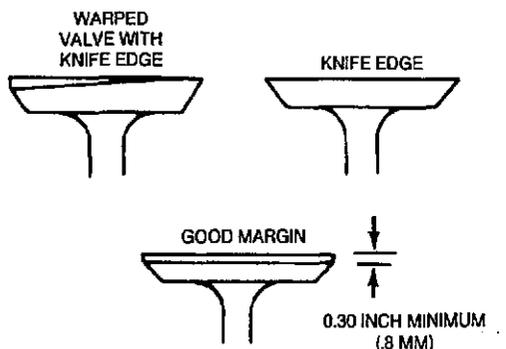


FIGURE 9-7. VALVE INTERFERENCE ANGLE

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

Every valve must have a minimum of 1/32-inch (0.8 mm) margin, Figure 9-8. If the valve has less margin than this, it will heat up excessively. It will retain that 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.



M-1184

FIGURE 9-8. VALVE MARGIN

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

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

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

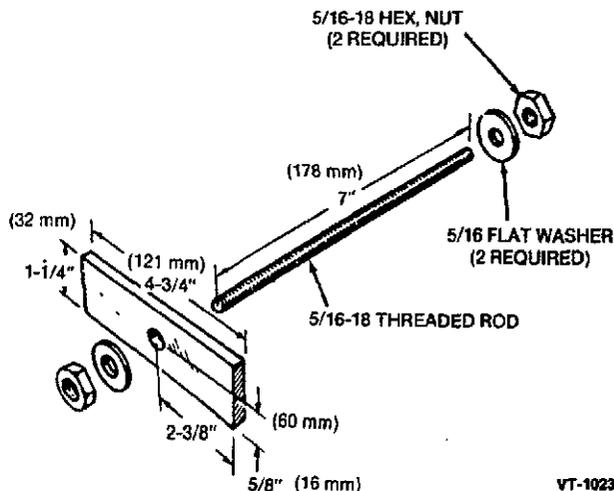
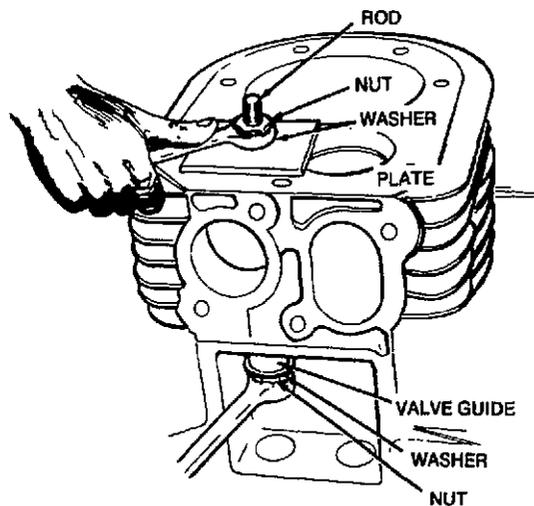
Valve Guide Replacement

Worn valve stem guides can be replaced from inside the valve chamber (a seal is provided behind the intake valve guides only). The smaller diameter of the tapered valve guides must face toward the valve head. Tappets are also replaceable from the valve chamber after first removing the valve assemblies.

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

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

Installation: Run a small polishing rod with crocus cloth through valve guide holes to clean out carbon and other foreign materials. Place a new gasket on the intake valve guide and coat the outer edge of each new guide with oil. Place guide, notch up, in cylinder block and press in until shoulder of guide rests against the cylinder block. A suggested method of installation is shown in Figure 9-9.



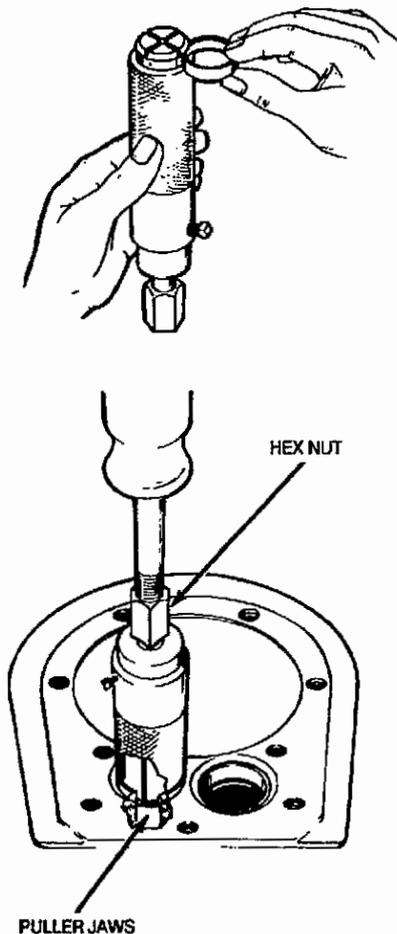
VT-1023

FIGURE 9-9. VALVE GUIDE INSTALLATION

Valve Seat

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

Removal: Remove carbon and combustion deposits from valve seat. Select the proper size puller (determined by the inside diameter of the valve seat). The puller jaws must expand into the cylinder block at the point where the bottom of the valve seat insert rests on the cylinder block (Figure 9-10). Using the new seat insert as a guide, adjust the puller depth. Position the puller on the valve seat and tighten hex nut. Clamp cylinder block to a solid bench. Attach slide hammer to puller. Between blows with the slide hammer, tighten the hex nut.



CT-1104

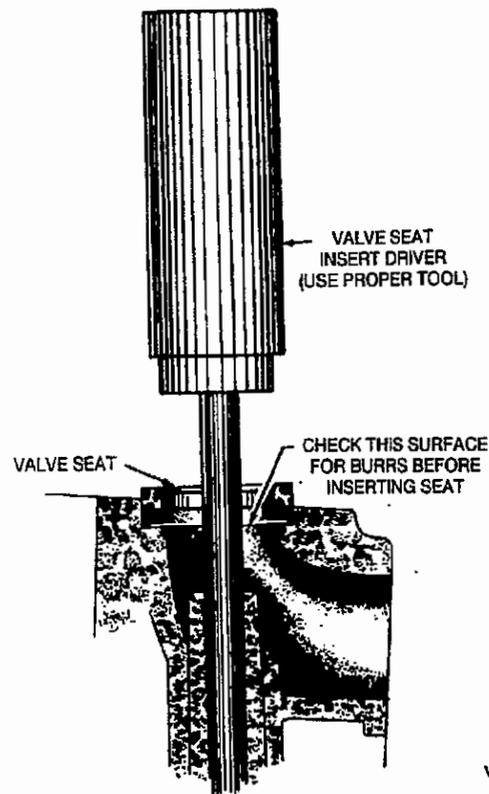
FIGURE 9-10. VALVE SEAT REMOVAL

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

Insert the pilot of the tool into the valve guide hole in the cylinder block. Quickly drive the valve seat insert in so that the insert goes evenly to the bottom of the recess in the cylinder block. Make certain that the valve seat insert rests solidly on the bottom of the recess all the way around its circumference (Figure 9-11).

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

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



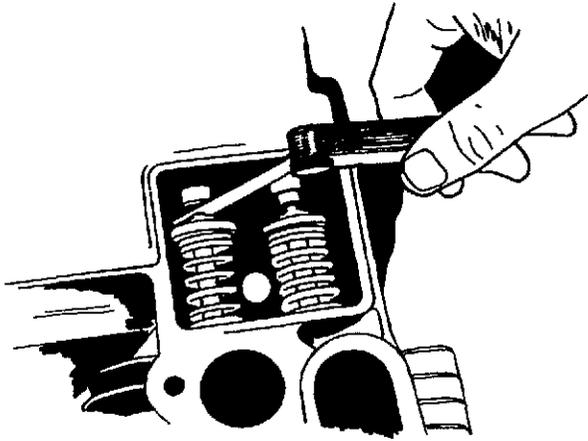
VT-1025

FIGURE 9-11. INSERTING NEW VALVE SEAT

Tappet Adjustment

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

1. Remove all parts necessary to gain access to valve tappets.
2. Remove spark plugs to make turning the engine easier.
3. Place a socket wrench on the flywheel capscrew and rotate the crankshaft in a clockwise direction until the left intake valve (viewed from flywheel end) opens and closes. Continue turning the crankshaft until the TC mark on the flywheel is lined up with the TC mark on the gear cover. This should place the left piston (#1) at the top of its compression stroke. Verify the left intake and exhaust valves are closed and there is no pressure on the valve lifters.
4. Clearances are shown in the *Specifications* section. For each valve, the gauge should just pass between the valve stem and valve tappet (see Figure 9-12).



VT-1026

FIGURE 9-12. VALVE CLEARANCE ADJUSTMENT

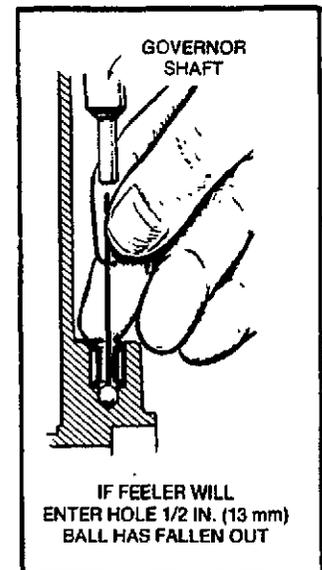
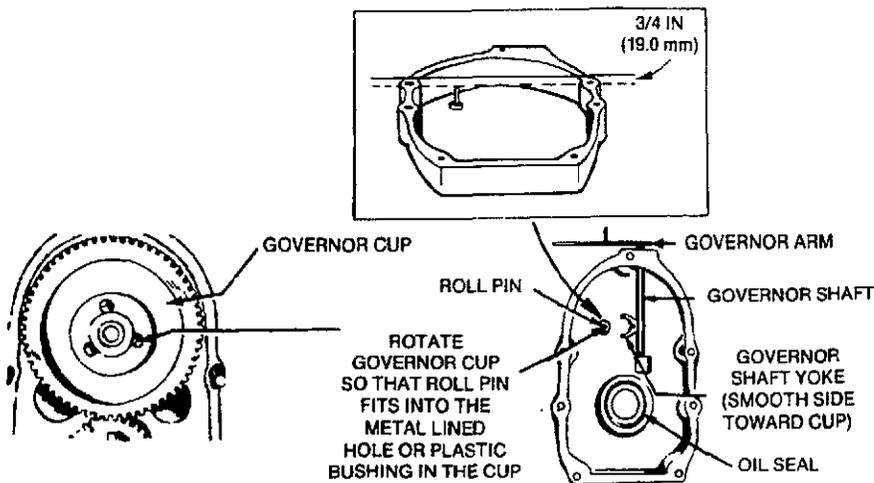
5. To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking.
6. To adjust valves on the right cylinder, turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment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

GEAR COVER

Remove the flywheel key and gear cover mounting screws. Gently tap the gear cover with a plastic-faced hammer to loosen it (see Figure 9-13).

When installing the gear cover, make sure that the pin in the gear cover engages the nylon lined (smooth) hole in the governor cup. Turn the governor cup so the nylon lined hole is at the three o'clock position. Use a small amount of grease to assist in holding governor cup in position. The rounded side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal.

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



VT-1027

FIGURE 9-13. GEAR COVER ASSEMBLY

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin, see Figure 9-14. Catch the flyballs while sliding the cup off.

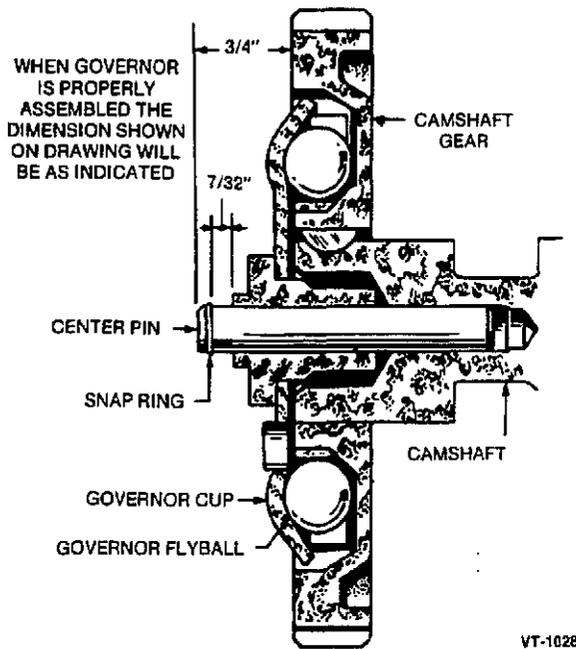


FIGURE 9-14. GOVERNOR CUP

Replace with a new part any flyball which is grooved or has a flat spot; the ball spacer if its arms are worn or otherwise damaged; the gear/spacer assembly if loose on gear hub, and the governor cup if the race surface is grooved or rough. The governor cup must be a free-spinning fit on the camshaft center pin, but without any excessive play.

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

The camshaft center pin extends out 3/4-inch (19 mm) from the end of the camshaft. This distance provides an in and out travel distance of 7/32-inch (5.6 mm) for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less, the engine may race, especially at no load. Remove the center pin and press in a 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 replacement of either the crankshaft gear or the camshaft gear becomes necessary, it is recommended that both gears be replaced.

To remove the crankshaft gear, first remove the snap ring and retainer washer; then attach the gear pulling ring using two No. 10-32 screws (Figure 9-15). Tighten the screws alternately until both are tight. Attach a gear puller to the puller ring and remove the gear.

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

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

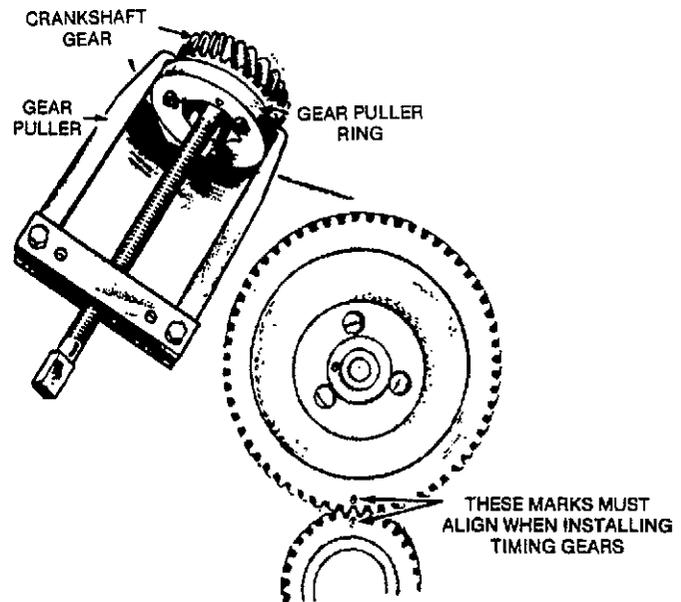


FIGURE 9-15. TIMING GEAR REMOVAL AND INSTALLATION

LUBRICATION SYSTEM

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

Oil Pump

The oil pump (Figure 9-16) is mounted on the front of the crankcase behind the gear cover and is driven by the crankshaft gear. The inlet pipe and screen assembly is attached directly to the pump body. A discharge passage in the cover of the pump registers with a drilled passage in the crankcase. Parallel passages distribute oil to the front main bearing, rear main bearing and pressure control bypass valve.

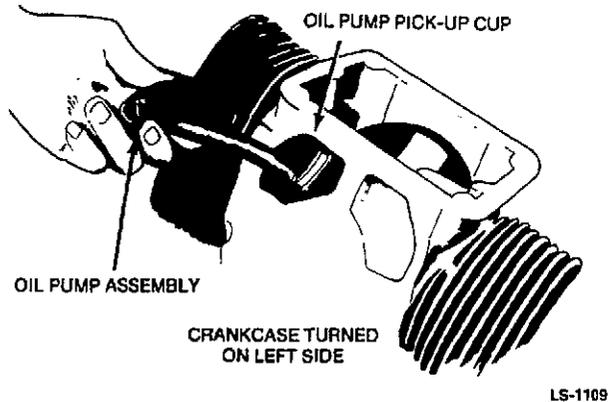


FIGURE 9-16. OIL PUMP ASSEMBLY

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

Normal oil pressure should be 13-14 psi (89.6-96.5 kPa) or higher when the engine is at normal operating temperature. If pressure drops below this value at governed speed, inspect the oil system for faulty components.

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

Oil Bypass Valve

The bypass valve (located to the right and behind gear cover, Figure 9-17) controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open about 13-14 psi (89.6-96.5 kPa).

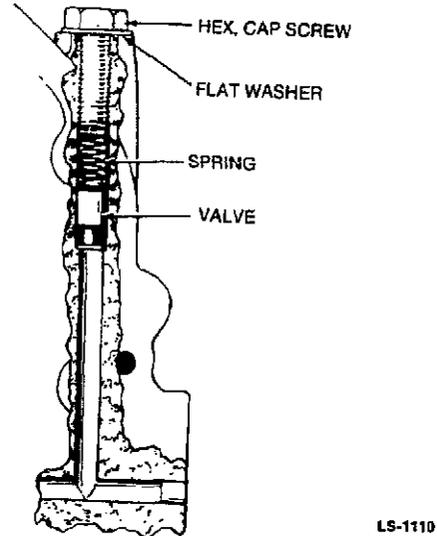


FIGURE 9-17. OIL BY-PASS VALVE

The 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 3/8-24 capscrew located behind gear cover and under governor arm.
2. Remove spring and plunger with a magnetic tool.
3. Determine proper valve operation by checking the spring and plunger according to the following measurements.

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

Spring
Free Length 1.00 in. (25.4 mm)
Load 2.6±0.2 lbs (11.6±0.9N)
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 plunger and spring in parts cleaning solvent and install.

PISTON ASSEMBLY

The piston assembly consists of the 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 replacing.

Removal and Disassembly

Remove carbon from top of cylinder bore and check for a ridge. Remove ridge (see Figure 9-18) with a ridge reamer before attempting piston removal.

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

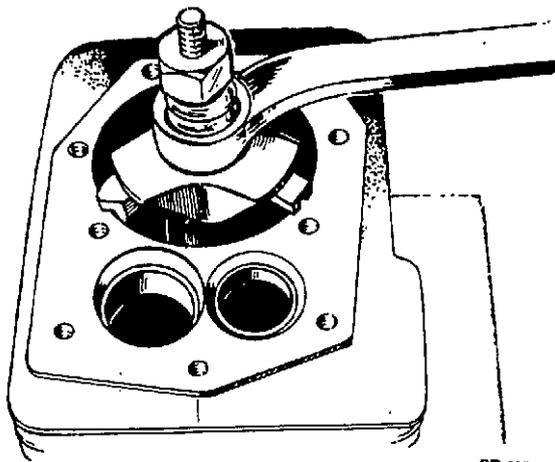


FIGURE 9-18. REMOVING WEAR RIDGE

To remove the piston and connecting rod assemblies, turn the crankshaft until a piston is at the bottom of the stroke. Remove the nuts from the connecting rod bolts.

Lift the rod bearing cap from the rod and push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep connecting rod bearing caps with their respective rods.

The pistons are fitted with two compression rings and one oil control ring. Remove these rings from the piston using a piston ring spreader as shown in Figure 9-19.

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

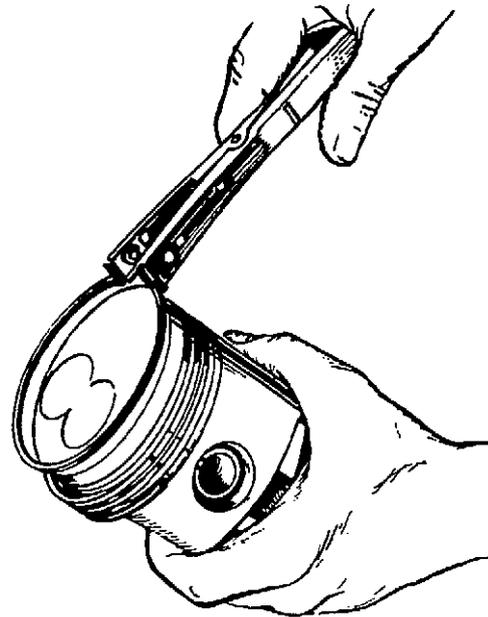


FIGURE 9-19. REMOVING PISTON RINGS

Remove dirt and deposits from the piston surfaces with an approved cleaning solvent. Clean the piston ring grooves with a groove cleaner or the end of a piston ring filed to a sharp point (Figure 9-20). Care must be taken not to remove metal from the groove sides.

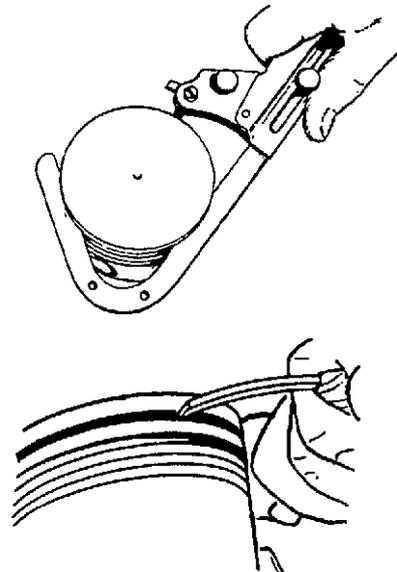


FIGURE 9-20. CLEANING RING GROOVES

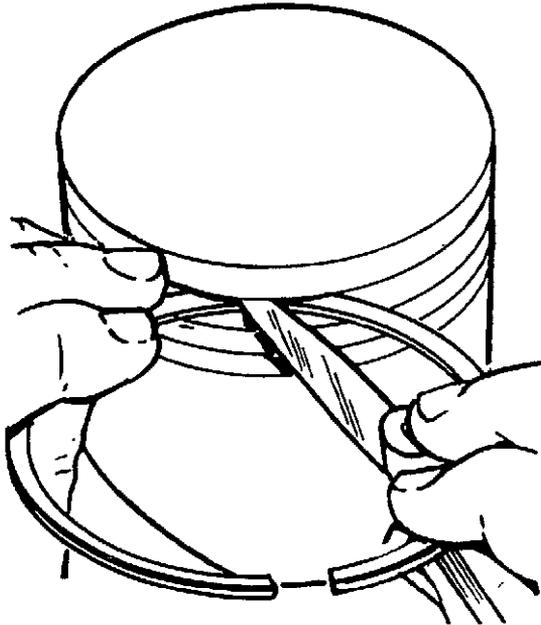
CAUTION *Using a caustic cleaning solvent or wire brush for cleaning pistons will cause piston damage. Use only parts cleaning solvent.*

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

Inspection

The following covers inspection procedures for pistons and connecting rods.

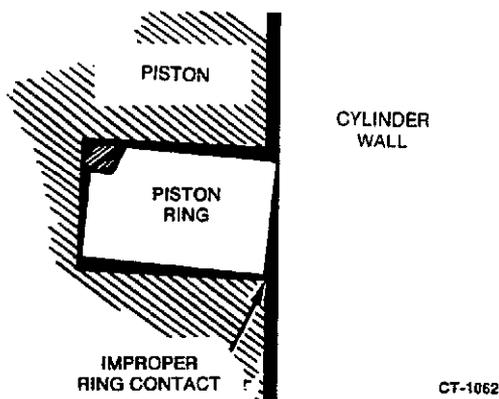
Piston Inspection: Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge as shown in Figure 9-21. Replace the piston when the side clearance of the top compression ring reaches 0.008 inch (0.20 mm).



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FIGURE 9-21. CHECKING RING LAND

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves do not have good cylinder wall contact (Figure 9-22).



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FIGURE 9-22. NEW RING IN WORN RING GROOVE

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

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

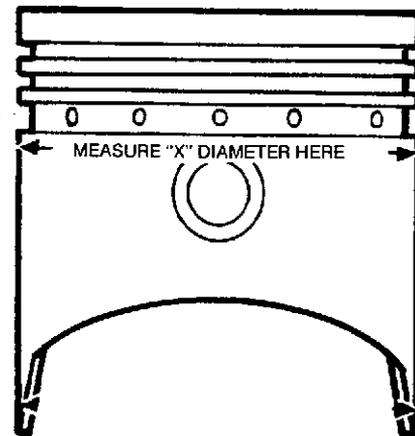
Use a new piston pin to check connecting rod for wear. A push fit clearance is required and varies from engine to engine. If a new piston pin falls through a dry rod pin bore as a result of its own weight, replace the rod or bushing as required.

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 that are scored, have the overlay wiped out, show fatigue failure, or are badly scratched. If bearings appear to be serviceable, check them for proper clearance.

Piston Clearance

Proper piston tolerances must be maintained for satisfactory operation. Use a micrometer to measure the piston diameter at the point shown in Figure 9-23. When the cylinder bore is measured (see *Cylinder Block* section), subtract the piston diameter from the cylinder bore diameter to obtain the piston to cylinder wall clearance. Refer to the *Dimensions and Clearances* section for the recommended piston clearance.



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FIGURE 9-23. PISTON CLEARANCE MEASUREMENT

Fitting Piston Rings

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder, at a position corresponding to the bottom of its travel (Figure 9-24). The gap between the ends of the ring is given in *Dimensions and Clearances* section for the recommended piston clearance.

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

Rings that are 0.005, 0.010, 0.020, 0.030 and 0.040 inch (0.13, 0.25, 0.51, 0.76 and 1.02 mm) oversize are to be used on corresponding oversize pistons. Rings of the tapered type 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.

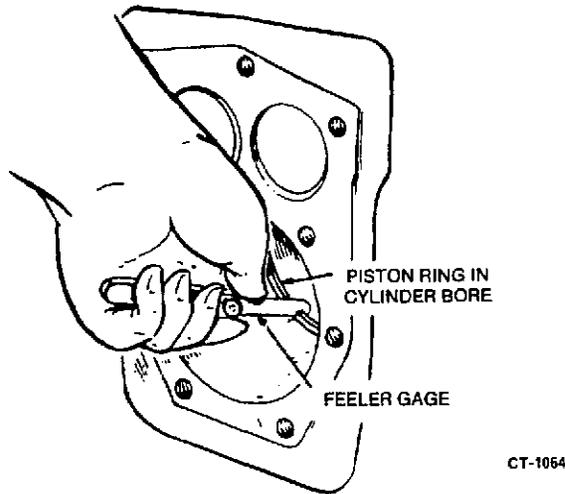


FIGURE 9-24. CHECKING RING GAP

Piston Assembly Installation

1. Lubricate all parts with engine oil.
2. Position piston on its respective rod and install the pin.
3. Install the rings on the pistons starting with the oil control ring (Figure 9-25). Use a piston ring spreader to prevent twisting or excessive expansion of the ring. Compression rings have a dot or the word "top" on one side of the ring to indicate which side faces the top of the piston. Unmarked piston rings can be installed either way. The oil control ring has an expander, install the expander first and then close until the expander ends butt. The joint should be 180 degrees from the gap of that ring.

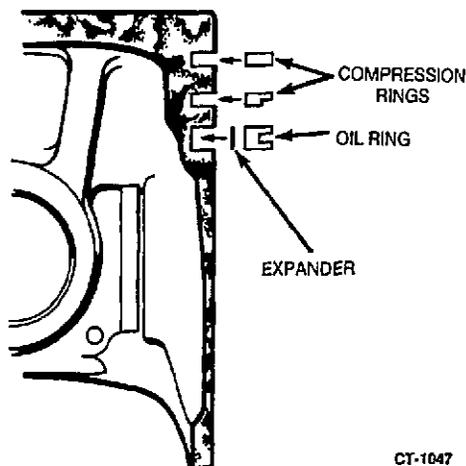


FIGURE 9-25. PISTON RINGS

Installing Piston in Cylinder:

1. Turn the crankshaft to position on the number one rod bearing journal at the bottom of its stroke.
2. Lubricate the number one piston assembly and inside of the cylinder. Compress the rings with a ring compressor as shown in Figure 9-26.
3. Position the piston and rod assembly in the cylinder block. Notched side of connecting rod must face camshaft.

Rod bolts are off-set toward outside of block.

4. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the journal. Check bearing clearance before proceeding with step 5 (see *Rod Bearing Clearance* section).
5. Install the bearing on the rod. Install one fastener and tighten to 5 ft-lbs (7 N•m). Repeat this for the other fastener. Tighten both fasteners down to 14 ft-lbs (19 N•m).
6. Install the remaining piston and rod in the same manner. Crank the engine over by hand to see that all bearings are free.

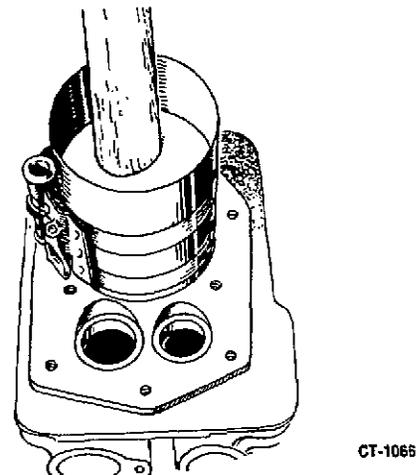
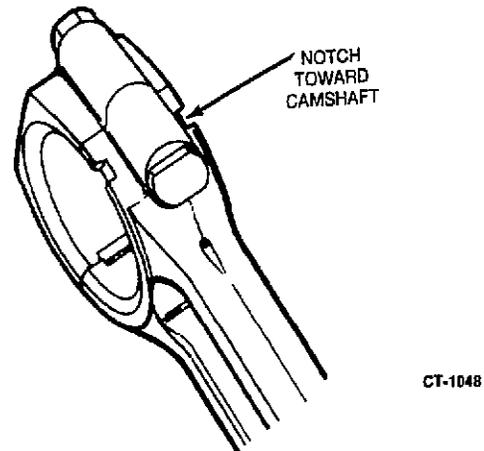


FIGURE 9-26. INSTALLING PISTON AND CONNECTING ROD

Rod Bearing Clearance

1. Mark all parts so they can be installed in their original positions, and wipe all parts clean of any oil or grease.
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 9-27) to determine the bearing clearance.

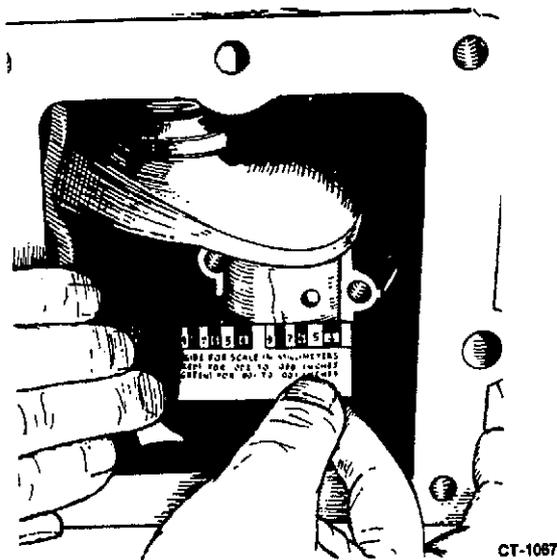


FIGURE 9-27. MEASURING BEARING CLEARANCE

CRANKSHAFT

To remove the crankshaft, loosen the rear bearing plate screws and remove the bearing plate, gasket, thrust washer, and shims. Turn the crankshaft so the crank throw is aligned with the notch in the rear opening of the crankcase. Carefully slide the crankshaft out of the crankcase.

Inspection

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

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

Lubrication

Lubricate the front and rear main bearings with engine oil. 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.

Position the crankshaft so 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.

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.

Use oil or gear lubricant to hold the shim(s) and rear thrust washer in position on the rear bearing plate (see Figure 9-32). The shim goes against the bearing plate and the flat surface of the thrust washer goes against the shim.

Place the bearing plate gasket in position on the block, making sure the oil hole on the back of the block is exposed. 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.

Checking Endplay

After tightening two rear bearing plate nuts (or capscrews) to the specified torque, check the crankshaft endplay at the point shown in Figure 9-28 using a feeler gauge. 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. If necessary, remove the rear bearing end plate and add or remove shims as required. Install the end plate and tighten all nuts (or capscrews) to the specified torque. Make sure the shim and thrust washer are in place, and recheck crankshaft endplay. Verify that the crankshaft turns freely without binding.

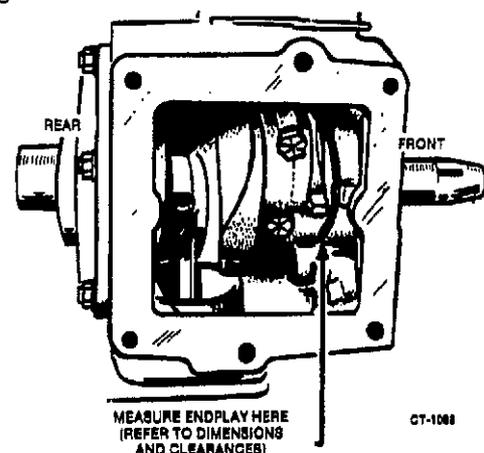


FIGURE 9-28. CHECKING ENDPLAY

CYLINDER BLOCK

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

Cleaning

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

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

Inspection

When rebuilding the engine, thoroughly inspect block for any condition that would make it unfit for further use. This inspection must be made after all parts have been removed and 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. 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 top of block for flatness with a straight edge and a feeler gauge.

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

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

1. Check cylinder bore for taper, out-of-round, and wear with a cylinder bore gauge, telescope gauge, or inside micrometer. These measurements should be taken at four places, top and bottom of piston ring travel and parallel and perpendicular to axis of crankshaft.
2. Record measurements taken at top and bottom of piston travel as follows (see Figure 9-29).

- A. Measure and record as "A" the cylinder bore diameter (parallel to crankshaft) near the top of cylinder bore where greatest amount of wear occurs.
- B. Also measure and record as "B" cylinder bore diameter (parallel to crankshaft) at the bottom of piston travel.
- C. Measure and record as "C" cylinder bore diameter (perpendicular to crankshaft) near the top of cylinder bore where greatest amount of wear occurs.
- D. Also measure and record as "D" 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 cylinder taper.
- F. Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicates whether or not cylinder is out-of-round. If out-of-round exceeds 0.003 inch (0.08 mm), the cylinders must be rebored and honed to the next oversize. A reboring machine is used when going to oversize pistons. The following repair data covers honing to oversize by use of a hone.

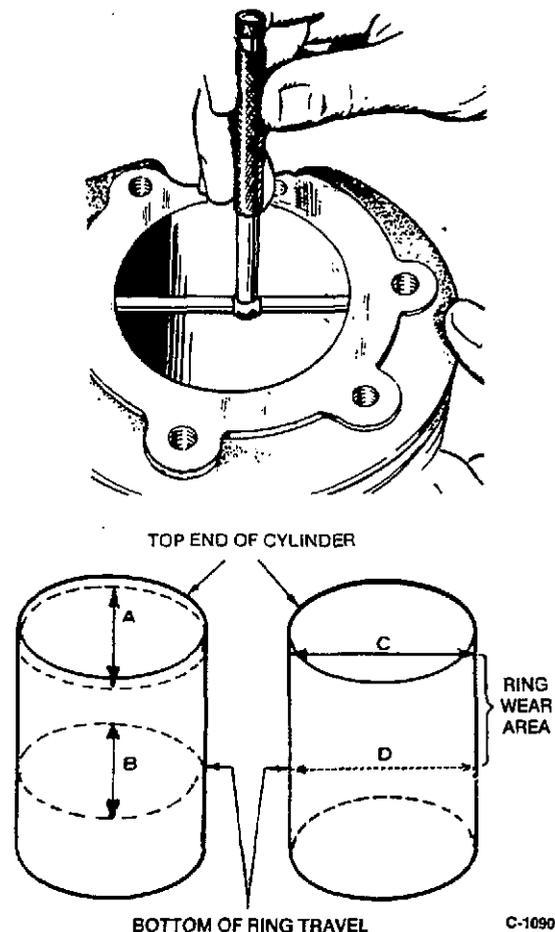


FIGURE 9-29. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

Reboring the Cylinder

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

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

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

When reboring cylinders, take the following precautions:

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

Honing Cylinders (Using Precision Hones)

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

1. Position block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at approximately 250 to 450 rpm.
2. Follow hone manufacturer's instructions for the use of oil or lubricant on stones. Do not use lubricants with a dry hone.
3. Insert hone in bore and adjust stone to fit snugly to the narrowest section. When adjusted correctly, the hone should not shake or chatter in cylinder bore, but will drag freely up and down when hone is not running.
4. Connect drill to hone and start drill. Feel out bore for high spots, which cause an increased drag on stones. Move hone up and down in bore with short overlapping strokes about 40 times per minute. Usually bottom of cylinder must be worked out first because it is smaller. As cylinder takes a uniform diameter, move hone up and down all the way through cylinder bore.

5. Check diameter of the cylinder regularly during honing. A dial bore gauge is the easiest method, but a telescoping gauge can be used. Check size at six places in bore; measure twice at top, middle, and bottom at 90-degree angles.
6. 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 cylinder bore about 40 times per minute.
7. Clean cylinder bores thoroughly with soap, water and clean rags. A clean white rag should not become soiled on wall after cleaning is complete. Do not use a solvent or gasoline, since they wash oil from the walls but leave metal particles.
8. Dry crankcase and coat with oil.

Deglazing Cylinder Bores

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

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

1. Wipe cylinder bores with a clean cloth which has been dipped in clean, light engine oil.
2. Use a brush type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.
3. The deglazing tool should be driven by a slow speed drill. Move deglazing tool up and down in cylinder (10 to 12 complete strokes) rapidly enough to obtain a crosshatch pattern as shown in Figure 9-30.

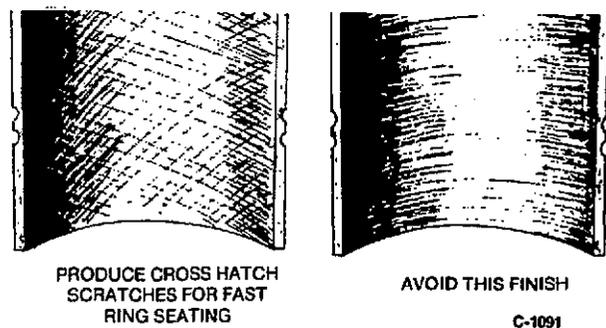


FIGURE 9-30. CROSSHATCHING

CAUTION

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

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

BEARINGS

With camshaft and crankshaft removed, use a micrometer to measure diameter of bearing journals. Use a dial bore gauge or a telescopic gauge and micrometer to measure inside diameter of bearings. Refer to *Dimension and Clearance* section to determine if clearances are within specifications.

Any bearing that is scored, chipped, pitted or worn beyond the specified limits must be replaced.

Camshaft Bearings

Replacement camshaft bearings are precision type and do not require line reaming or line boring after installation. Coat the bearing with lubricating oil. Position the front bearing so the oil hole in the bearing is aligned with the oil hole see (Figure 9-31) in the block. Position the rear bearing so the elongated slot is aligned with the breaker point plunger hole in the top of the block.

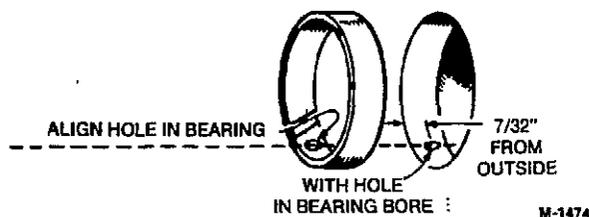


FIGURE 9-31. CAMSHAFT BEARING

Use the combination main and cam bearing driver and 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

New crankshaft main bearings are precision type which 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.

For putting in either the front or rear main bearing, always align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore. The oil passage must be at least 1/2 open.

Before installing main bearings, expand bearing bore by placing the casting in an oven heated to 200°F (94°C). If practical, cool the precision bearing to shrink it.

Rear Bearing: Use the combination main and cam bearing driver and a press to install the rear main bearing. Push the bearing into the bearing plate from the inner side (see Figure 9-32) to the depth allowed by the flange on the driver.

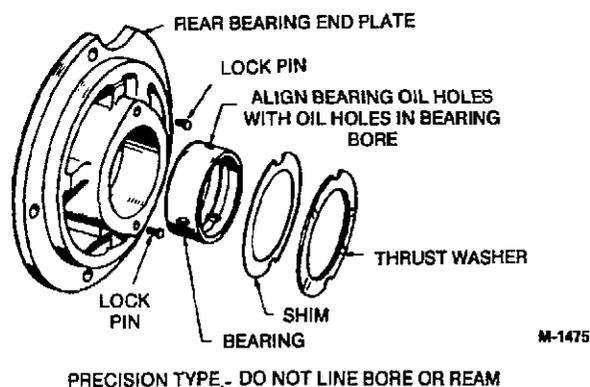


FIGURE 9-32. REAR BEARING

Front Bearing: Lockite 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. Allow three to four minutes for drying.

WARNING Breathing vapor from towelette and prolonged contact with skin can be harmful. Use only in well ventilated area and avoid prolonged contact with skin.

Apply the Locktite Bearing Mount to the mating surfaces of the bearing and bearing bore. 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 driver. Wipe off any excess Locktite 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. Front bearing replacement part is one piece bearing (with attached thrust washer) as shown in Figure 9-33. Do not add an additional thrust washer to this front bearing.

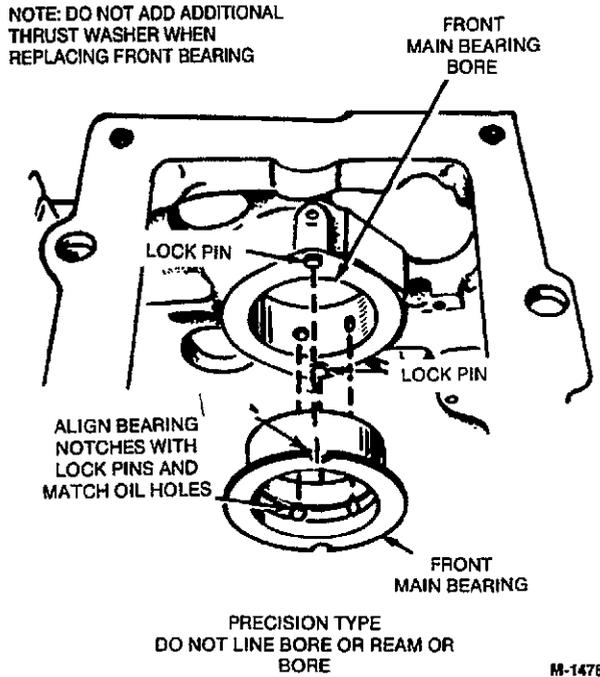


FIGURE 9-33. FRONT BEARING

OIL SEALS

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 removed to pry out the front or rear oil seal.

Use an oil seal guide and driver to press or drive the rear seal into the rear bearing plate until it bottoms against the shoulder of the plate (see Figure 9-34). Press or drive the front 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.

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

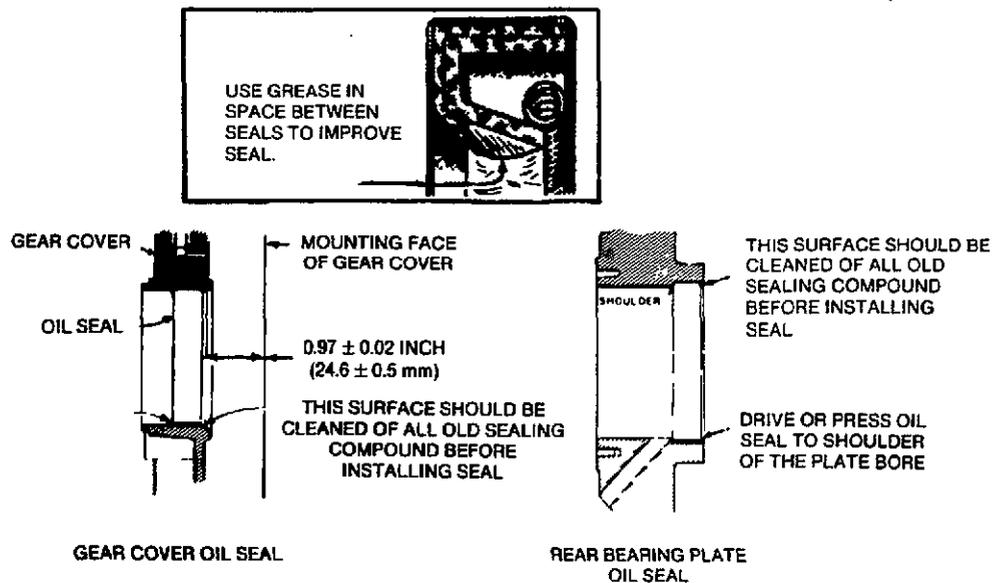


FIGURE 9-34. OIL SEALS

Section 10. Service Checklist

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

MOUNTING

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

LUBRICATION

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

WIRING

Verify that all wiring connections are correct and secure. Check each of the following:

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

INITIAL START ADJUSTMENTS

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

CAUTION Before attempting any carburetor/governor adjustments, disconnect all devices which are voltage or frequency sensitive. Some solid-state devices, such as TV's or VCR's, are powered whenever connected to an AC outlet even if the device is not in actual operation. If disconnecting the devices is not possible, open the circuit breaker(s) at the distribution panel or at the genset, if so equipped.

Failure to heed this advisory may result in consequential damage to voltage/frequency sensitive equipment such as VCR's, TV's, computers, etc. Repair/replacement of damaged devices is not covered under Onan warranty policy.

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

FUEL SYSTEM

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

CAUTION Leaking fuel will create a fire hazard which can result in severe personal injury or death if ignited by a spark, flame, or other ignition source. If leaks are detected, correct immediately.

OUTPUT CHECK

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

EXHAUST SYSTEM

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

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

CONTROL

Stop and start the generator set several times at the set control and remote control (if equipped) to verify the control functions properly.

MECHANICAL

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

▲WARNING

EXHAUST GAS IS DEADLY!

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

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

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

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

1-RV

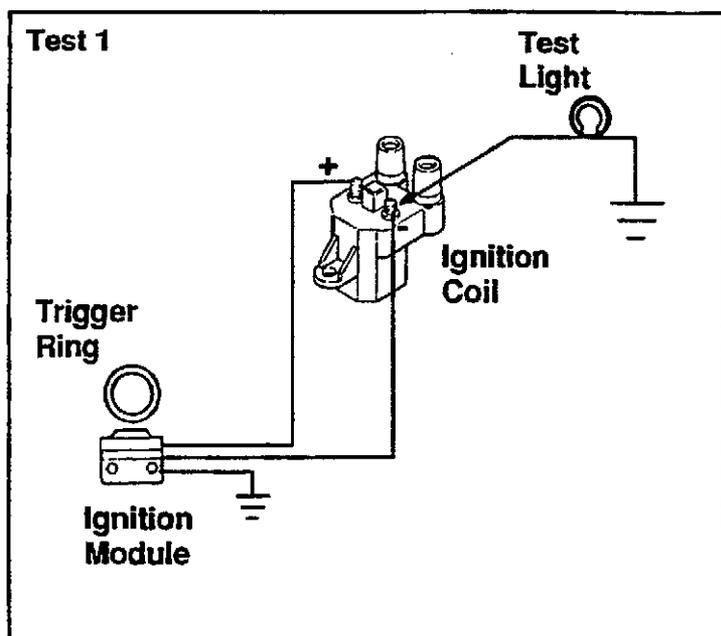
Appendix A. Troubleshooting Charts

These pages form an appendix to the service manual. This information was prepared by the Onan Service Training Department in the form of simplified guides to troubleshooting a variety of the circuit boards used on the BGE/NHE generator sets. While this information is accurate, make sure to follow the complete procedures outlined in the appropriate service manual sections for reasons of safety and product integrity.

- A-2: "Troubleshooting Electronic Ignition Module"
- A-3, A-4: "Emerald™ Control Functions"
- A-5, A-6: "Emerald Control Board Checkout (300-2784)"
- A-7, A-8: "Emerald Control Board Checkout (300-3056/3687)"
- A-9, A-10: "Emerald Control Board Checkout (300-3763-01, -02)"

Troubleshooting Electronic Ignition Module

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

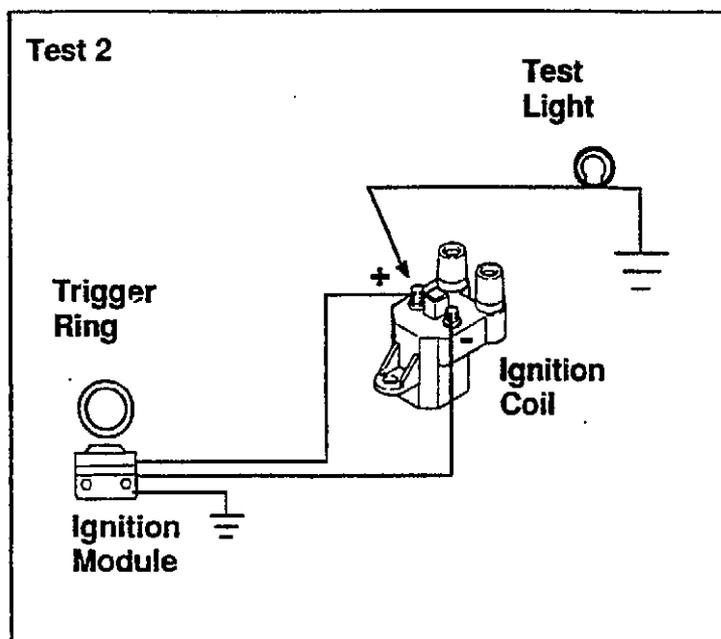


1. Check wiring: red lead to positive (+); black lead to negative (-).
2. Connect a DC powered test light from the negative (-) coil terminal to ground.
3. Turn the ignition switch on and crank the engine over. Does the test light flash, bright then dim?

Yes - The module is ok; do not replace the module.

No - Go to Test 2.

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



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

Yes - Crank the engine over. Does the light stay on while cranking?

Yes - Replace the module and the trigger ring as a set if the coil tests good.

No - It is not a module problem. Check the wiring and connections to the coil and the ignition switch, then retest the module.

⚠ WARNING

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



Emerald™ Control Functions

(A1 Control Board 300-3056/3687)

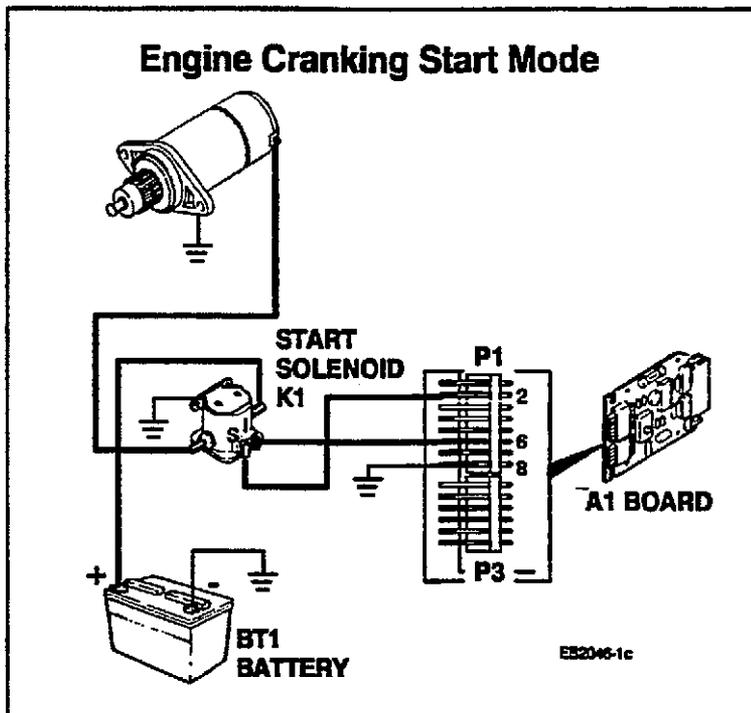
Sequence of Events:

Battery + (pos) at P1-6,
Battery - (neg) at P1-8.

Operator pushes start button at A1.

B+ from P1-2 to start solenoid
(S terminal).

Solenoid contacts close send B+ to
starter.



Sequence of Events:

Operator pushes start button on A1.

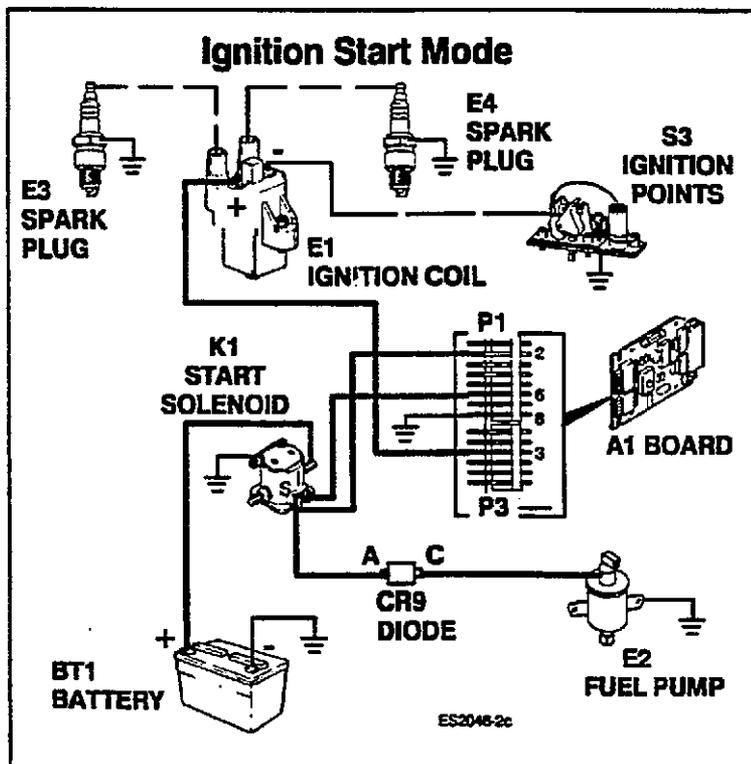
Safeties are bypassed.

B+ from P3-3 to ignition coil.

Breaker points open/close path to
ground.

High voltage jumps spark plug gap.

B+ supplied to fuel pump from P1-2.



⚠ 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.

Generation

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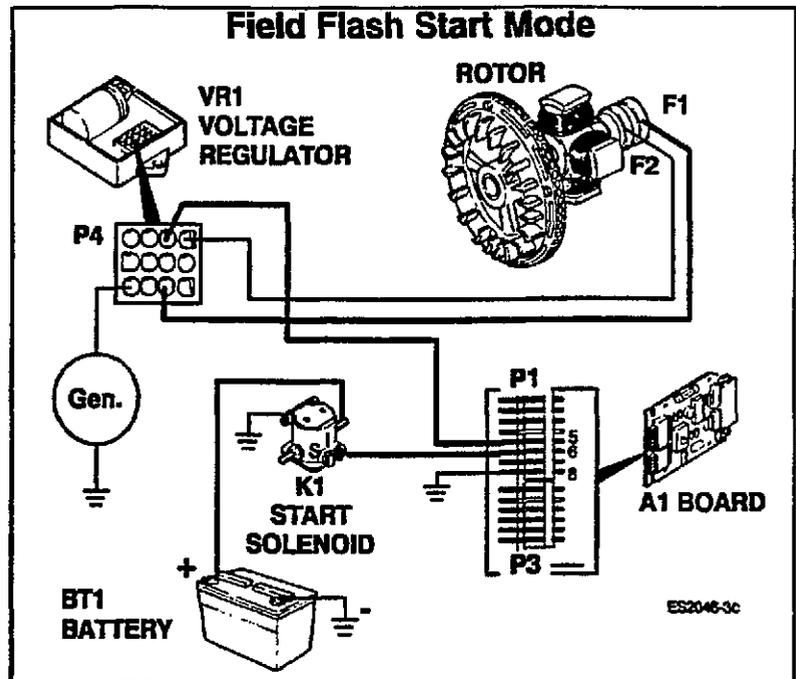
Sequence of Events:

Operator pushes start button on A1.

B+ from P1-5 to voltage regulator P4-7.

B+ from voltage regulator P4-9 to positive brush (F1).

B- from voltage regulator P4-10 to negative brushes (F2).



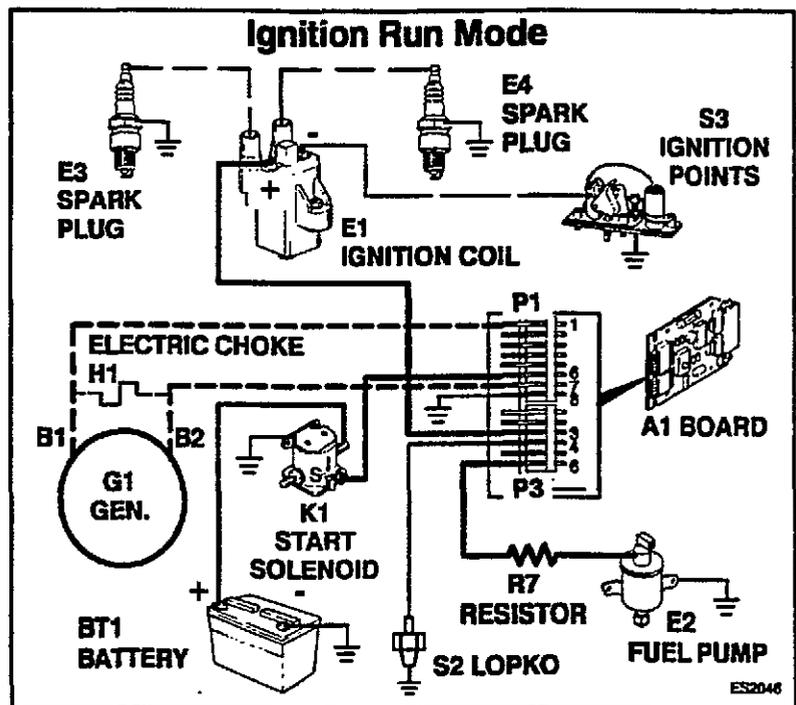
Sequence of Events:

Engine starts, oil pressure causes LOPKO to close sending ground signal to P3-4.

AC from generator B1-B2 winding enter board at P1-1 and P1-7.

These two inputs cause the control to switch from start mode to run mode.

Starter automatically disengages. Field flash automatically removed. Start switch released. Safeties enabled. B1-B2 powers choke heater (H1). Pump power now from P3-6 through R7.



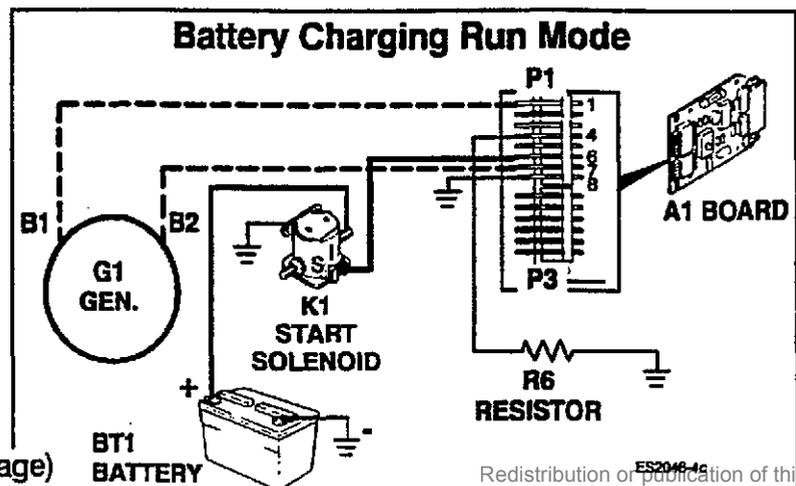
Sequence of Events:

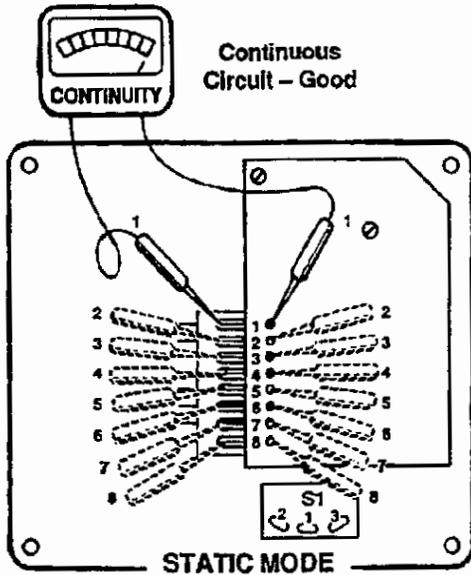
AC voltage from B1-B2 windings enter board at P1-1, P1-7.

Board rectifies AC input to DC output.

B+ charge current from P1-6 flows to battery.

R6 on ground side limits charging current to 1 amp maximum.

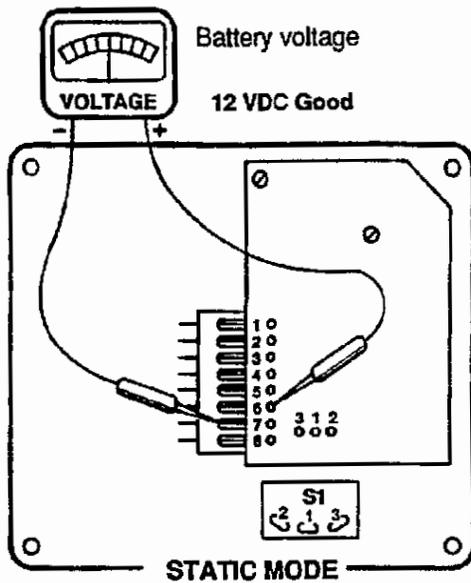




EMERALD CONTROL BOARD CHECK-OUT

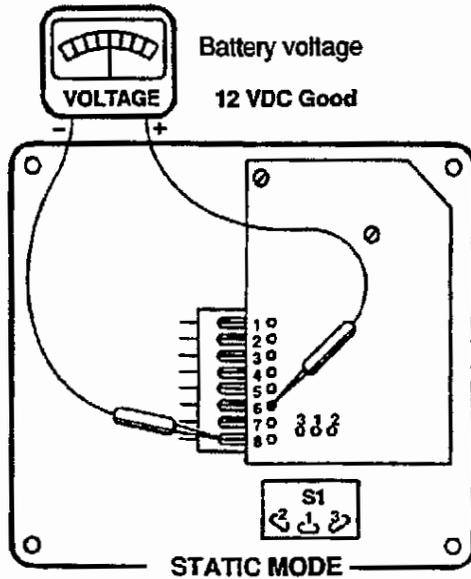
(300-2784)

Many Emerald control problems are caused by a bad connection between the PC board and the wiring harness. Check continuity at the eight terminals.



STATIC MODE

B+ at P1-6. BATTERY POSITIVE INTO BOARD
Ground at P1-7 & 8.

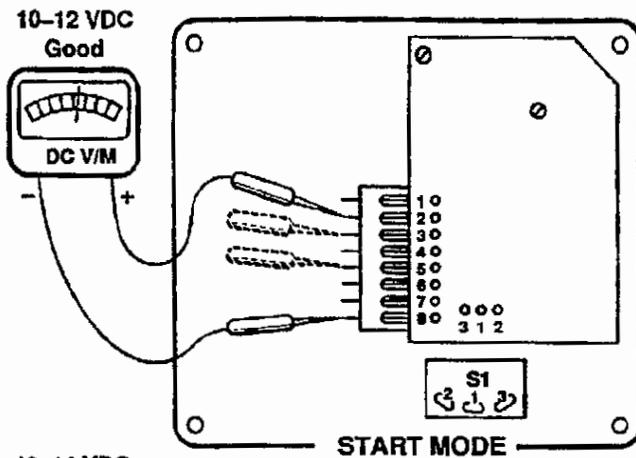


Required: 12-14 VDC

WARNING

Working on 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.

ES2050a

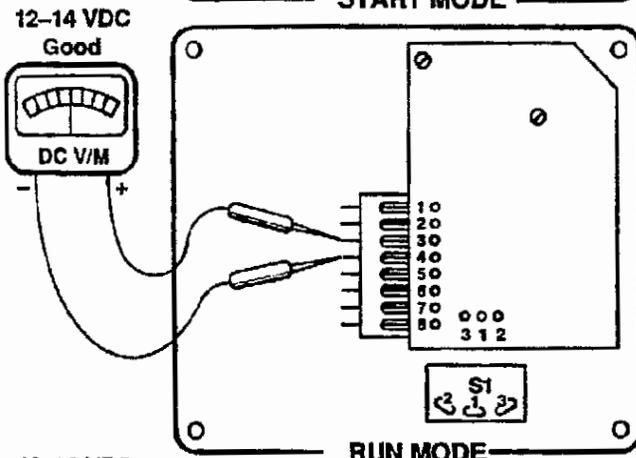


START MODE

Push S1 switch to start.
B+ at P1-2, P1-3 and P1-5.

Required: 10-12 VDC

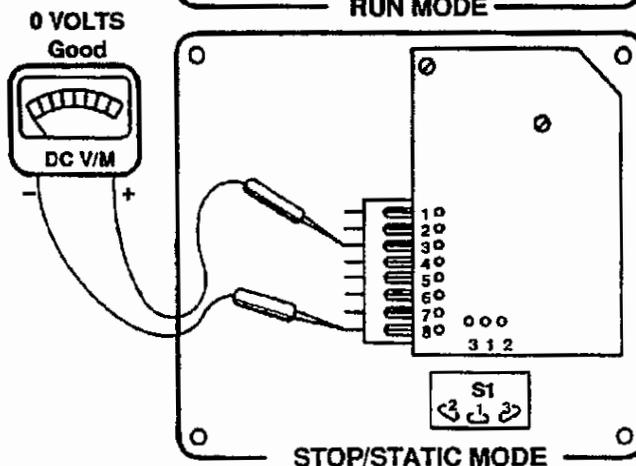
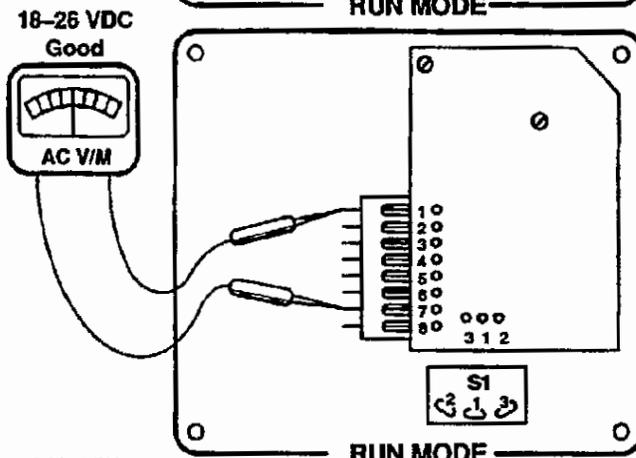
B+ AT P1-2 TO START SOLENOID
b+ AT P1-3 TO IGNITION COIL
B+ AT P1-5 TO POS BRUSH
(FIELD FLASH)



RUN MODE

1. AC voltage at P1-1 to P1-7 (18-26 VAC) BAT CHARGER
2. B+ at P1-3 to IGNITION COIL
3. Ground at P1-4 FROM LOPKO

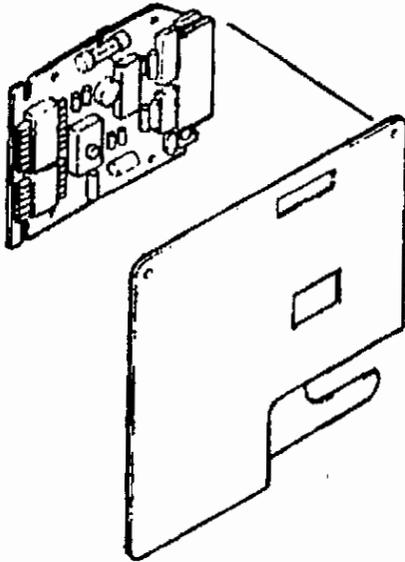
Required: 18-26 VAC
12-14 VDC



STOP MODE

Push S1 switch to stop.
0 volts at P1-3

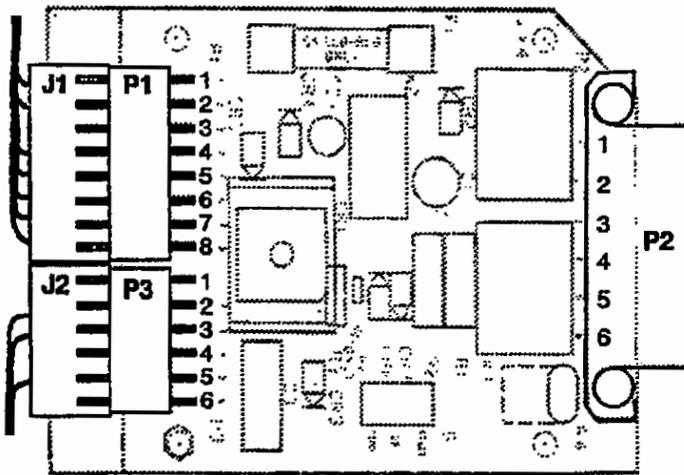
ES2050-1a



EMERALD CONTROL BOARD CHECK-OUT (300-3056/3687)

REMOVE CIRCUIT BOARD

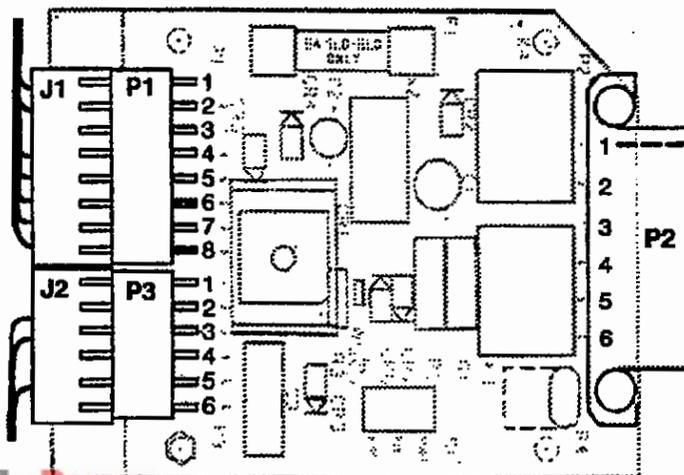
To perform the following tests the circuit board must be removed from the control cover.



CONTINUITY TEST

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

Check for a good circuit between the board and the wiring by checking continuity between the J and P connectors with the battery disconnected.

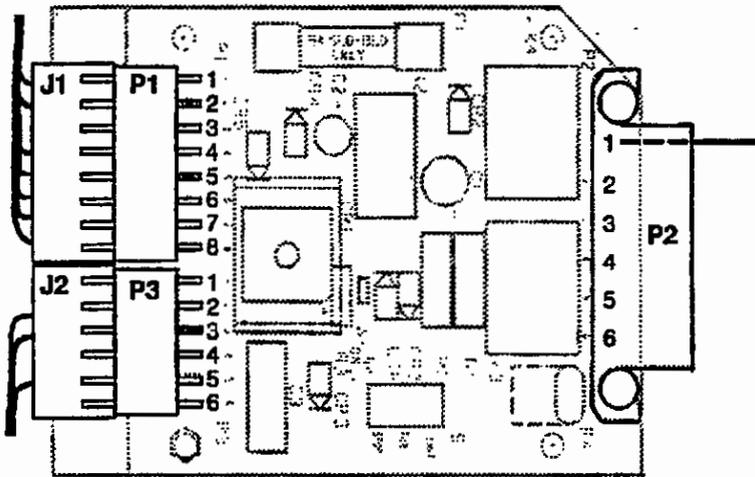


For the following tests, the battery must be connected.

STATIC MODE

(With the switch in the Center position)

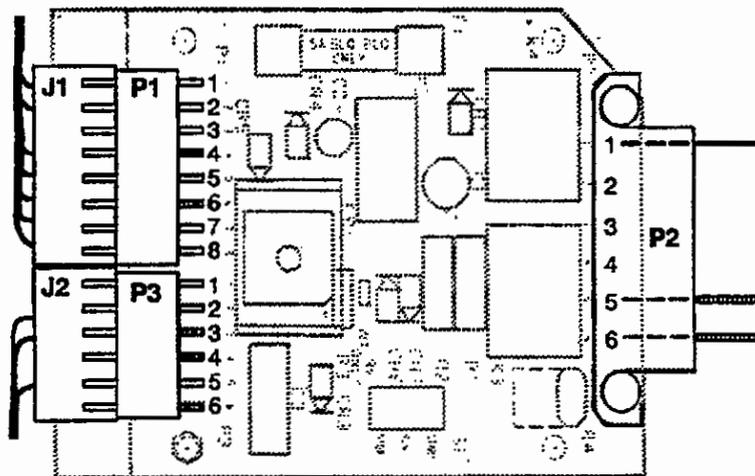
Meter Test Lead	Meter Reading
+ P1-6 P1-8	12 VDC
- P1-6 P2-1	12 VDC



CRANK & START MODE

(With the switch pressed to the Start position)

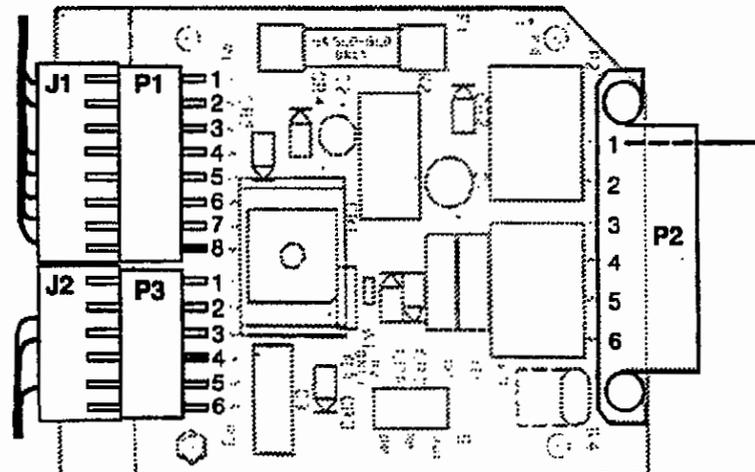
Meter Test Lead	Meter Reading
+ -	
P1-2 P2-1	9-10 VDC
P1-5 P2-1	10-11 VDC
P3-3 P2-1	9-10 VDC



RUN & GENERATE MODE

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

Meter Test Lead	Meter Reading
+ -	
P1-6 P2-1	12-13 VDC
P1-6 P1-4	18-20 VDC
P2-5 P2-1	12-13 VDC
P2-6 P2-1	12-13 VDC
P3-3 P2-1	10-12 VDC
P3-4 P2-1	0 VDC
P3-6 P2-1	10-12 VDC
P1-1 P1-7	18-22 VAC

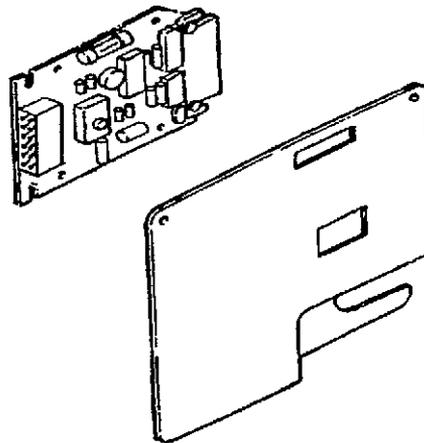


STOP MODE

(With the switch pressed to the Stop position)

Meter Test Lead	Meter Reading
+ -	
P3-4 P1-8	0 VDC
P3-4 P2-1	0 VDC

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

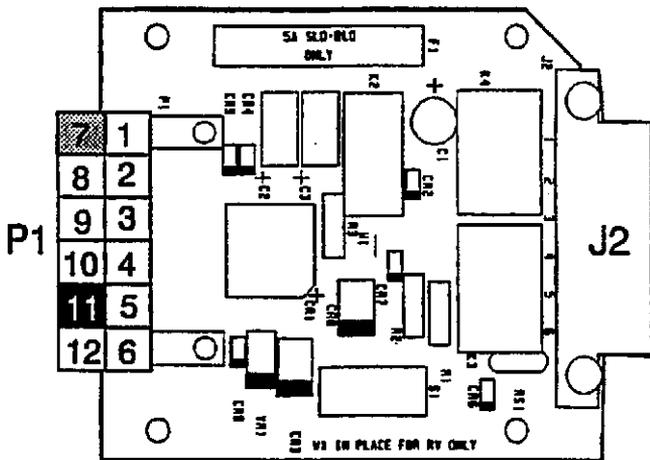


MODELS:

- 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**

REMOVE CIRCUIT BOARD

P1 plug turned for better viewing.



ES2051a

⚠ WARNING

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

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 Reading
+ -	
P1-7 P1-11	12 VDC
P1-7 J2-1	12 VDC

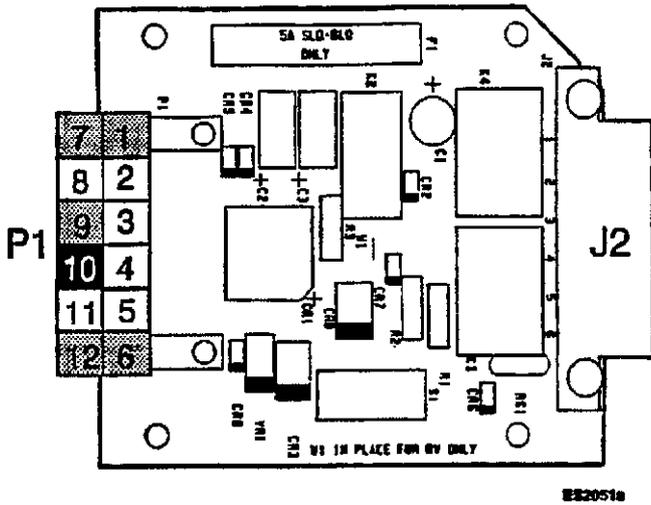
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CRANK & START MODE

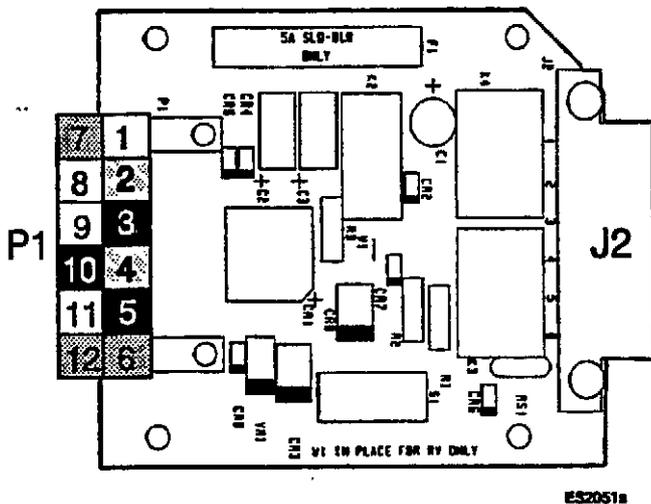
(With the switch pressed to the Start position)



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

RUN & GENERATE MODE

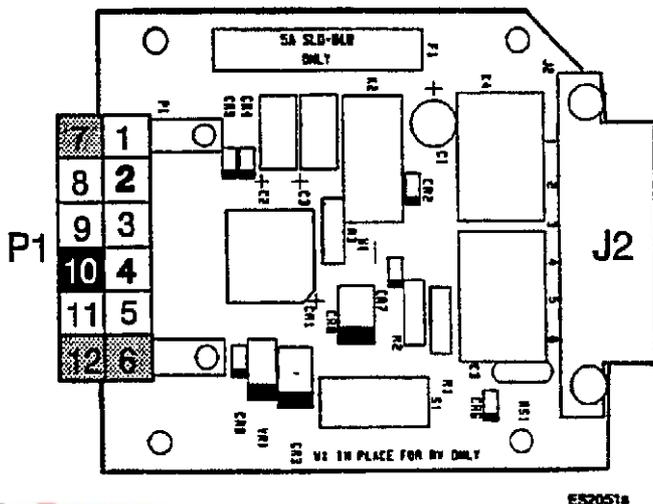
(With the generator set running and the switch in the Center position)



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 <u>VAC</u>

STOP MODE

(With the switch pressed to the Stop position)



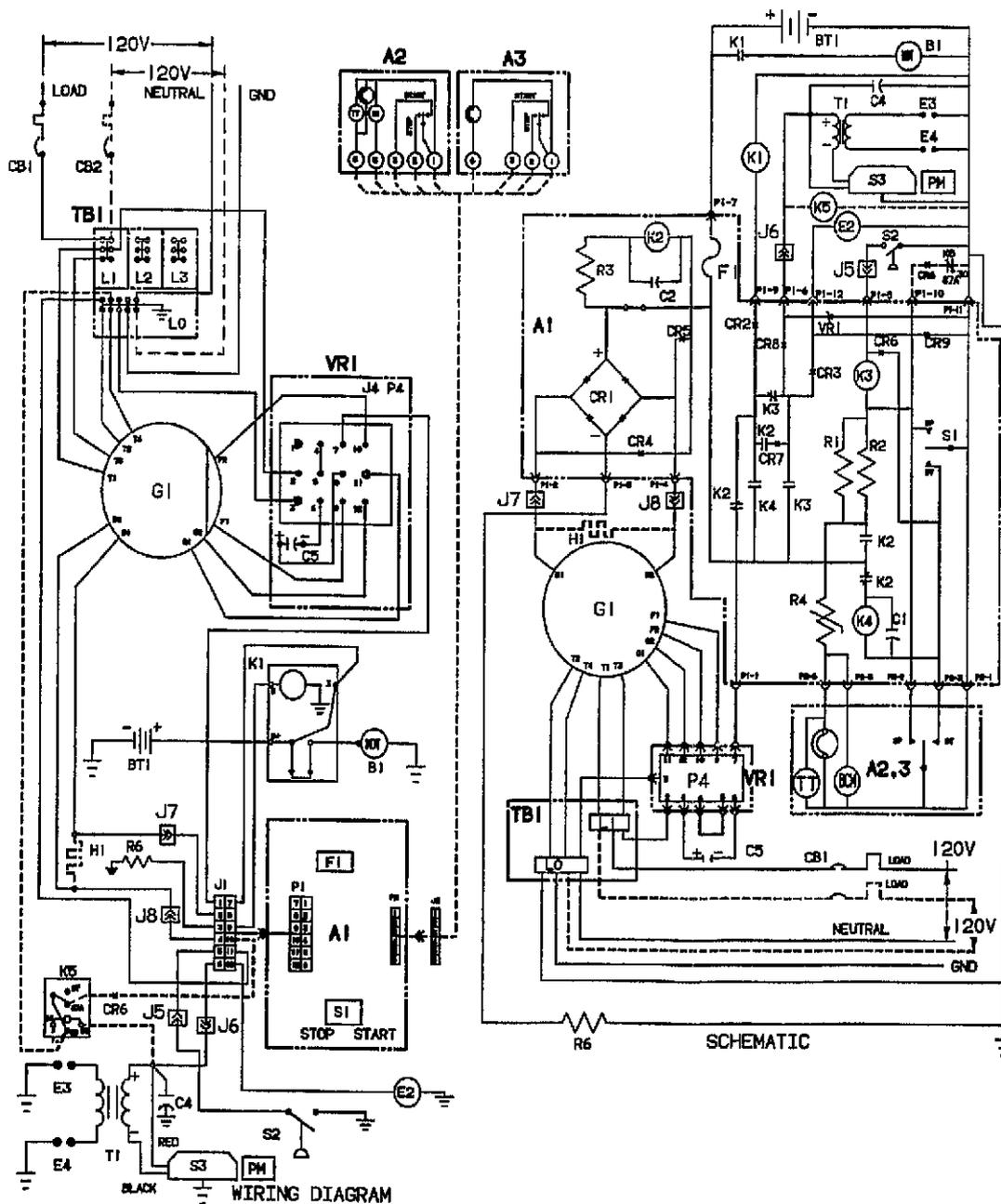
Meter Test Lead		Meter Reading
+	-	
P1-6	J2-1	0 VDC
P1-12	J2-1	0 VDC
* P1-7	P1-10	12 VDC

* Gensets with K5 relay

Appendix B. Spec J and K Diagrams

This appendix contains DC control schematic and wiring diagrams for the Spec J and Spec K BGE and NHE generator sets.

GENERATOR SET	DIAGRAM NUMBER	PAGE
Spec J BGE/NHE 60 Hz	611-1206	B-2
Spec J BGE/NHE 50 Hz	611-1207	B-3
Spec J BGE, 60 Hz, 100 V	611-1208	B-4
Spec K BGE/NHE 60 Hz	611-1220	B-5
Spec K BGE/NHE 50 Hz	611-1221	B-6
Spec K BGE 60 Hz/100 V	611-1222	B-7

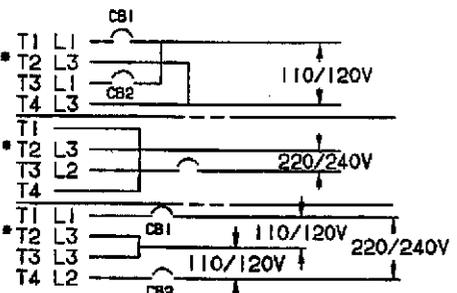
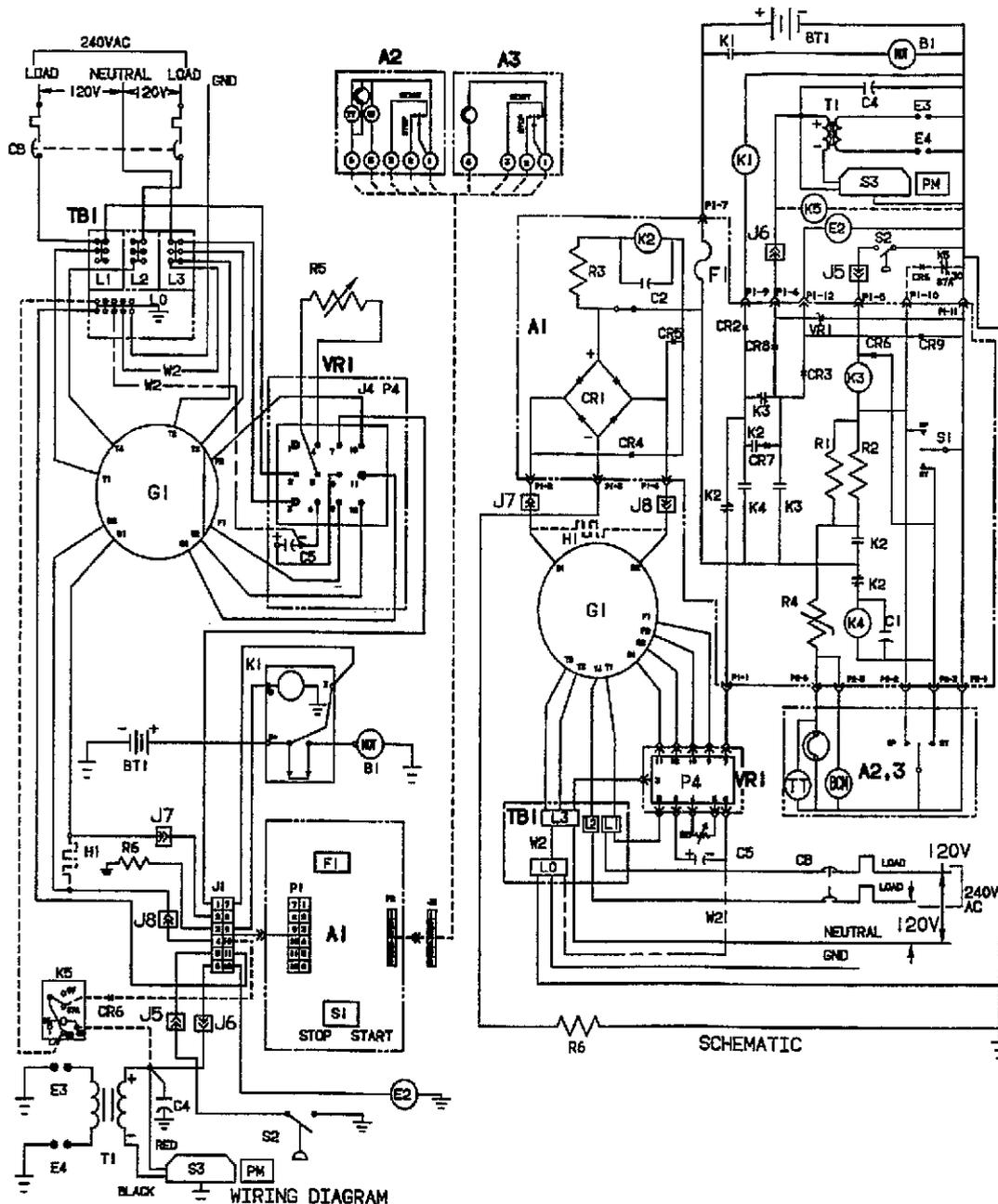


VR1	VOLTAGE REGULATOR
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R6	RESISTOR-BATTERY CHARGE
R5	POTENTIOMETER
K5	RELAY-LPG ONLY
K1	RELAY-START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 5A
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOL
CR6	RECTIFIER-LPG ONLY
CB1,3	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY-NHE/NHEL
A1	CONTROL ASSY-BGE/BGEL

XXXX DESCRIPTION OR SYMBOL

SPEC J BGE/NHE 60 HZ WIRING DIAGRAM/SCHEMATIC

NO. 611-1206
REV. A
MODIFIED



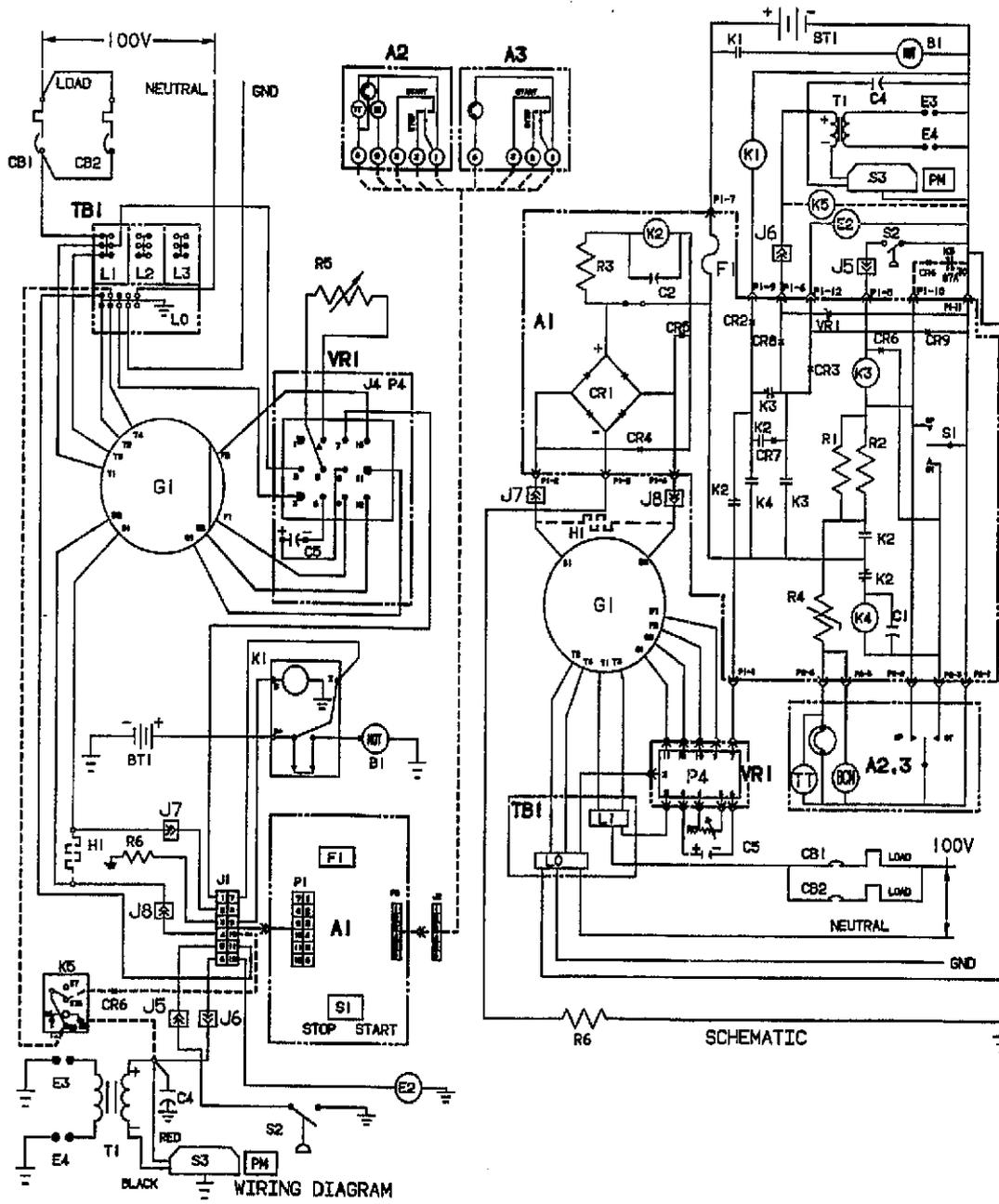
- NOTES:
1. 120V MAX ACROSS VR1 CONNECTIONS 2,3
 2. GROUNDED AC LEAD- FOR ISOLATED NEUTRAL, REMOVE JUMPER (W2) TB1-L3, L0 AND CONNECT JUMPER TB1-L0, VR1-C5 NEG(-)

VR1	VOLTAGE REGULATOR
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R6	RESISTOR-BATTERY CHARGE
R5	POTENTIOMETER
K5	RELAY-LPG ONLY
K1	RELAY-START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 5A
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOL
CR6	RECTIFIER-LPG ONLY
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUGE
A1	CONTROL ASSY-NHE/NHEL
	CONTROL ASSY-BGE/BGEL

ITEM DESCRIPTION OR MATERIAL

SPEC J BGE/NHE 50 HZ WIRING DIAGRAM/SCHEMATIC

NO. 611-1207
REV. A
MODIFIED

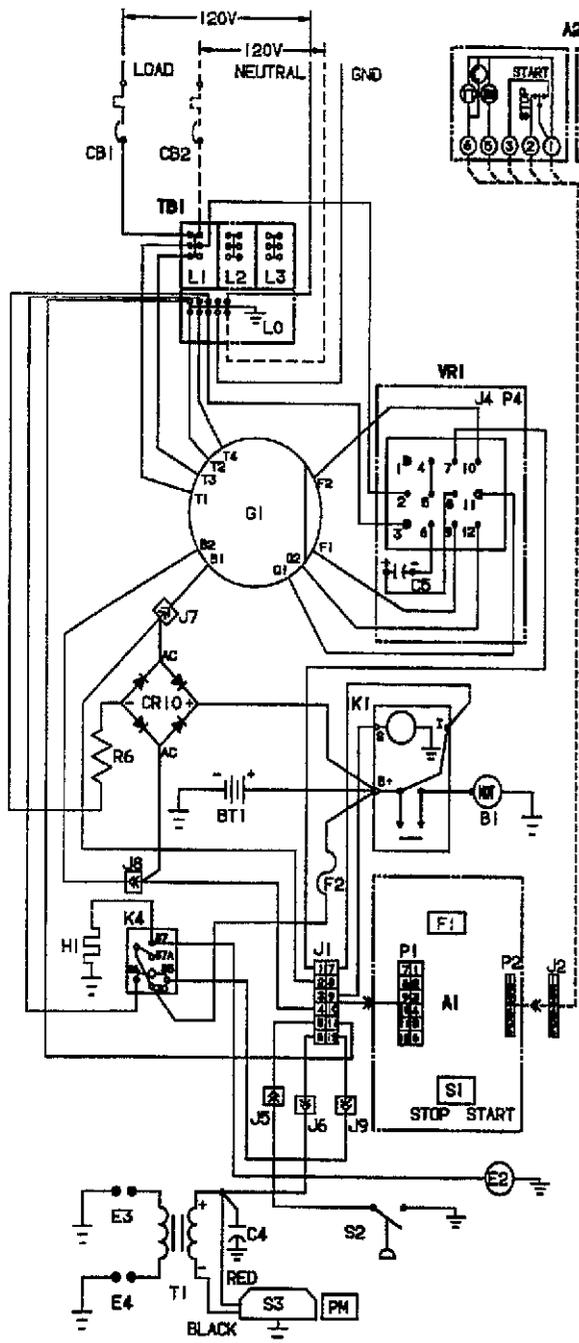


VR1	VOLTAGE REGULATOR
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R6	RESISTOR-BATTERY CHARGE
R5	POTENTIOMETER
K5	RELAY-LPG ONLY
K1	RELAY-START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 5A
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOL
CR6	RECTIFIER-LPG ONLY
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY-BGE

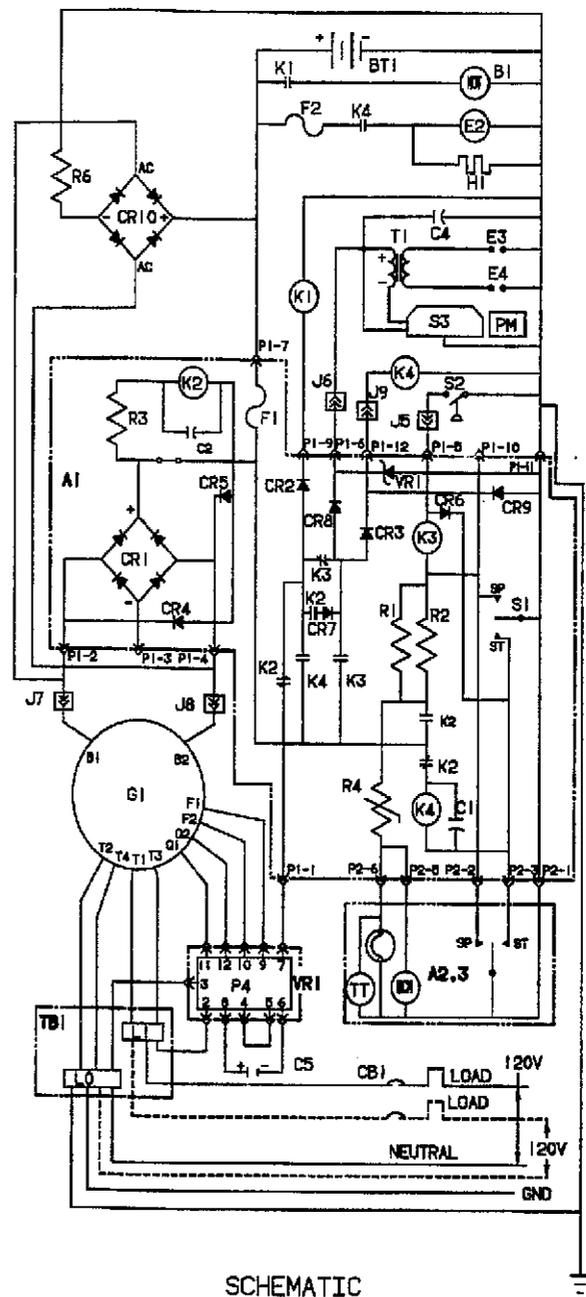
ITEM DESCRIPTION OR SYMBOL

SPEC J BGE 60 HZ/100 V WIRING DIAGRAM/SCHEMATIC

NO. 611-1208
REV. A
MODIFIED



WIRING DIAGRAM

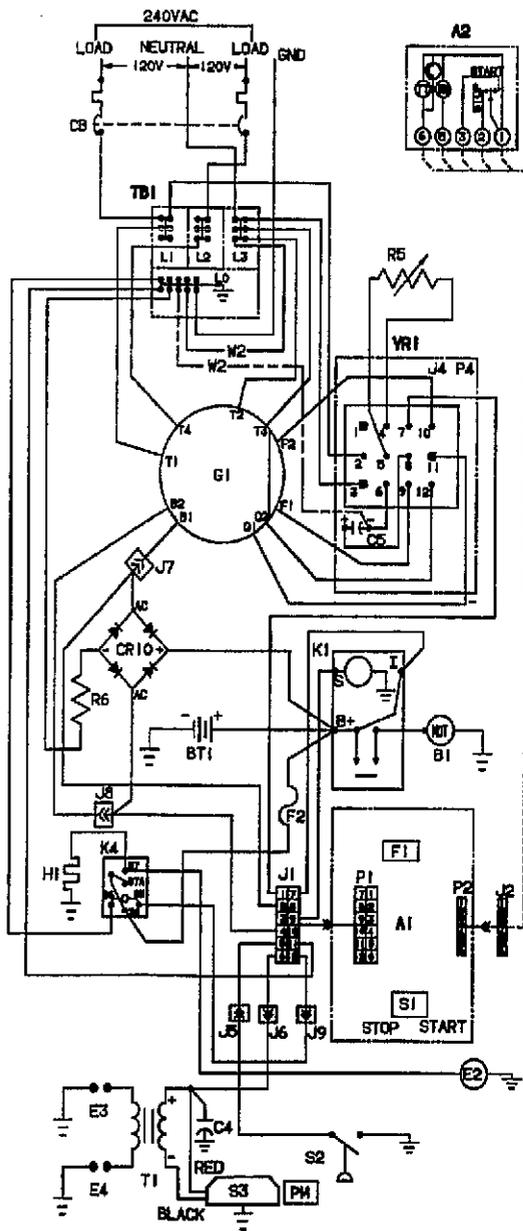


SCHEMATIC

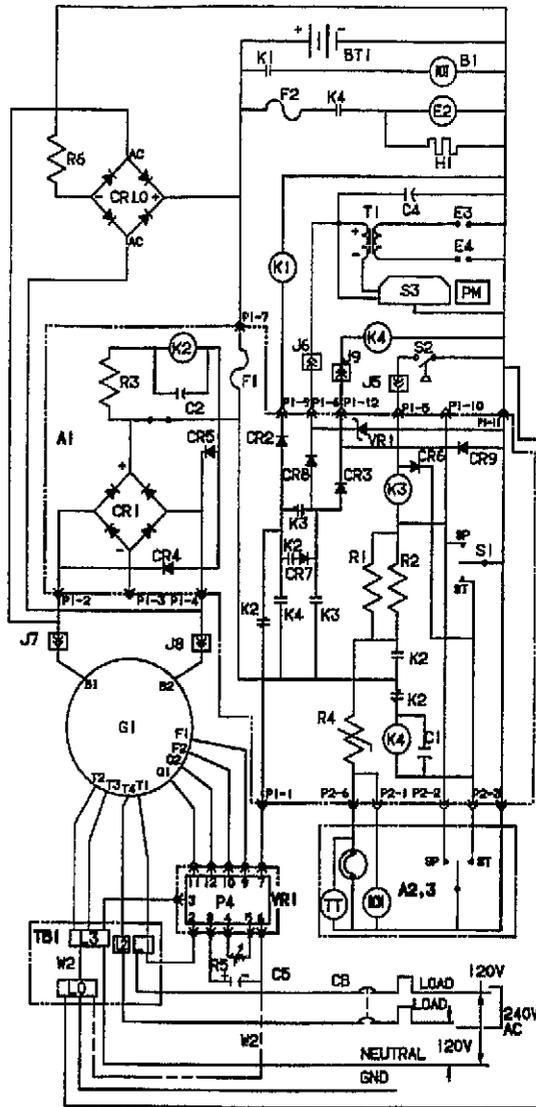
VRI	VOLTAGE REGULATOR
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R6	RESISTOR-BATTERY CHARGE
K4	RELAY-CHONE & FUEL PUMP
K1	RELAY-START SOLENOID
H1	CHONE
G1	GENERATOR
F2	FUSE-10A
F1	FUSE-10A
E3,4	SPARK PLUGS
E2	FUEL PUMP
CR10	RECTIFIER-BATTERY CHARGE
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY-NHE
A1	CONTROL ASSY-BGE
ITEM	DESCRIPTION OR MATERIAL

SPEC K BGE/NHE 60 HZ WIRING DIAGRAM/SCHEMATIC

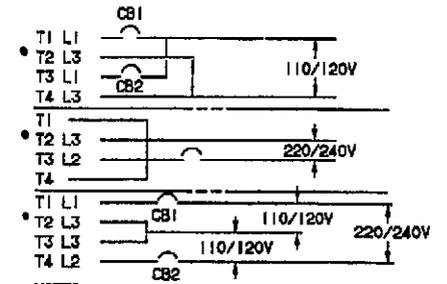
NO. 611-1220
REV. A
MODIFIED



WIRING DIAGRAM



SCHEMATIC

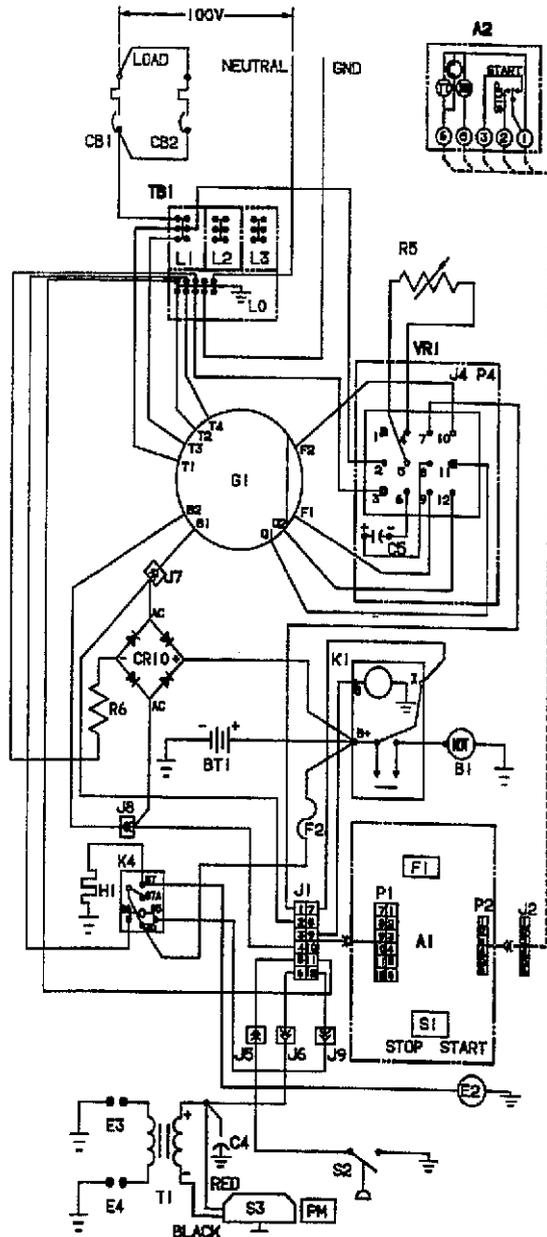


- NOTES:
- 120V MAX ACROSS VR1 CONNECTIONS 2,3
 - GROUND AC LEAD- FOR ISOLATED NEUTRAL, REMOVE JUMPER (W2) TB1-L3, L0 AND CONNECT JUMPER TB1-L0, VR1-C5 NEG(-)

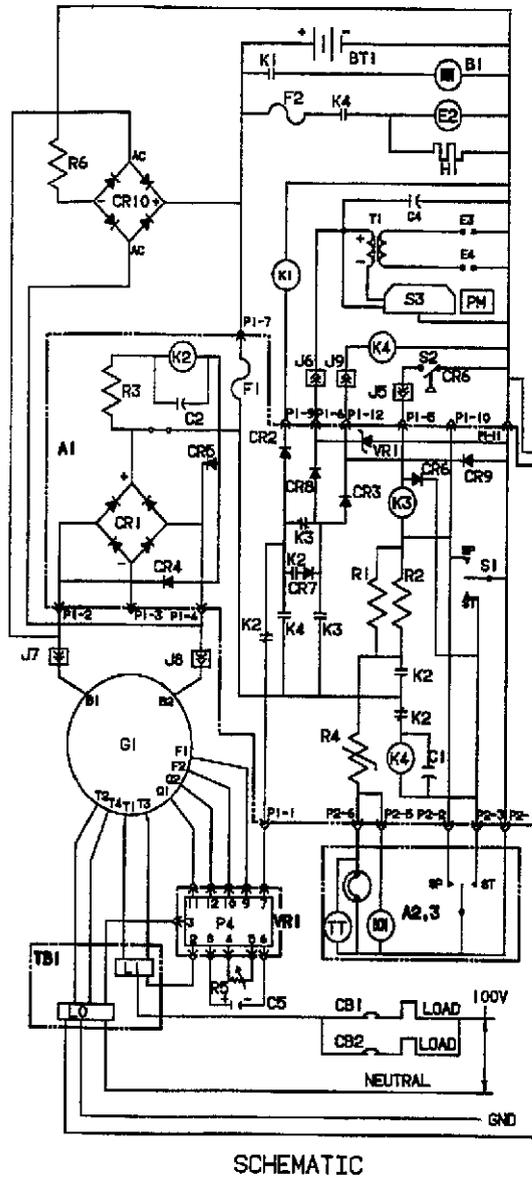
VR1	VOLTAGE REGULATOR
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R6	RESISTOR-BATTERY CHARGE
R5	POTENTIOMETER
K4	RELAY-CHOKE & FUEL PUMP
K1	RELAY-START SOLENOID
H1	CHOKE
G1	GENERATOR
F2	FUSE-10A
F1	FUSE-10A
E3,4	SPARK PLUGS
E2	FUEL PUMP
CR10	RECTIFIER-BATTERY CHARGE
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY-NHE
A1	CONTROL ASSY-BGE
ITEM	DESCRIPTION OR MATERIAL

SPEC K BGE/NHE 50 HZ WIRING DIAGRAM/SCHEMATIC

NO. 611-1221
REV. A
MODIFIED



WIRING DIAGRAM



SCHEMATIC

VR1	VOLTAGE REGULATOR
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R6	RESISTOR-BATTERY CHARGE
R5	POTENTIOMETER
K4	RELAY-CHOKE & FUEL PUMP
K1	RELAY-START SOLENOID
H1	CHOKE
G1	GENERATOR
F2	FUSE-10A
F1	FUSE-10A
E3,4	SPARK PLUGS
E2	FUEL PUMP
CR10	RECTIFIER-BATTERY CHARGE
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY-NHE
A1	CONTROL ASSY-BGE
ITEM	DESCRIPTION OR MATERIAL

SPEC K BGE 60 HZ/100 V WIRING DIAGRAM/SCHEMATIC

NO. 611-1222
REV. A
MODIFIED

Installation of Control Board Replacement Kit 300-3950

PURPOSE OF KIT

These instructions describe the removal and replacement of the Control Circuit board used on the following generators.

BGE	Spec F and G
BGEL	Spec E and G
NHE, NHEL	Spec D, E and G
BGM, NHM	Spec A only
BGD	Spec A and B
NHD	Spec A, B and C

SAFETY PRECAUTIONS

Read these instructions completely and become familiar with safety warnings, cautions, and procedures before starting the installation.

⚠ CAUTION *Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.*

⚠ WARNING *Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [-] first).*

KIT PARTS

Prior to installation, verify receipt of the proper parts from the table below.

Part Description	QTY.
Splice, Window; 22-16	6
Screw, Pan Head; 6-32 x .38	4
Harness, Wire, PCB	1
PCB, Control Assembly	1

BGM/NHM MOUNTING CONSIDERATIONS

If installing the kit on a BGM/NHM (Marquis) generator set, note the following change:

The lead marked J1-12-E2 MUST be connected to K5, pin 85 instead of the marked connection. Disregard the wire routing labels in this instance only.

Consult Figure 3 (J1 diagram) for more information.

This note applies **only** to technicians installing the Control Board kit on the BGM/NHM (Marquis) gensets.

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

INSTALLATION

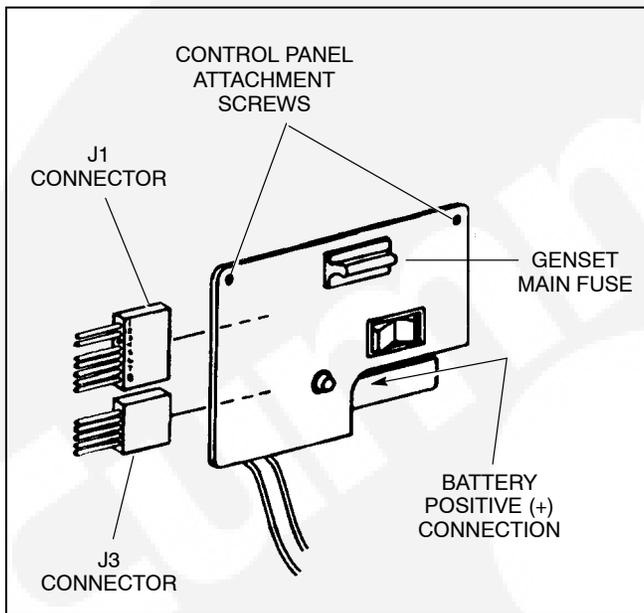
Tools Required

- Wire stripping and splicing tool
- Torx screwdriver kit
- Needle-nose pliers
- Conventional screwdriver kit

Procedure

1. Disconnect the generator set starting battery cables (negative [-] cable first) to prevent the genset from starting.
2. Turn off and disconnect battery charger (if equipped).
3. Pull the genset fuse from the control panel and set it aside. Disconnect the remote cable, if present.
4. Remove the two screws from the top of the control panel. Pull the panel down and away from the control box.

5. Pull connectors J1 and J3 off the edge of the Control Circuit board. Remove the wires from the control panel wire retainer (Figure 1).
6. Remove the four screws securing the circuit board to the control panel and pull the board off the panel. Discard the old board and screws.
7. Mount the new circuit board from the kit onto the control panel using the no. 6 screws in the kit.



**FIGURE 1: CONTROL PANEL ASSEMBLY
(EARLIER VERSION w/J1 and J3 CONNECTORS)**

Build New Connector

1. Cut connectors J1 and J3 from the wires extending into the generator set control. Clip wires as close to the connector as possible.

Make sure the routing labels on the wires remain intact.

If the routing labels are missing, refer to Figure 3 and Table 1, and refer to the wiring diagram/schematic for the genset.

2. Using the stripping/splicing tool, crimp the 6 splices to the wires extending from the new J1 connector supplied in the kit. Insert the wires one-by-one into the connectors, then crimp the connectors firmly onto the wires using the splicing tool.

Wiring

Wires on the new connector are labeled for connecting wires in the control box. **Connect the wires one at a time. Do not cut away or obscure the labels on the wires, wherever possible.**

1. Attach the new connector J1 to the wires in the control box as follows:
 - A. Using the stripping/splicing tool, strip 1/4 inch off one of the wires from the control box.
 - B. Insert the end of the wire into one of the wire splice connectors.
 - C. Crimp the connector firmly onto the wire using the splicing tool.
 - D. Repeat this step for each of the wires attached to new J1 connector.

NOTE: Wire J1-3 is not used. Use a tie wrap to coil and secure this wire, or remove the wire.

CAUTION When installing on a Marquis (Models BGM and NHM) be sure to connect J1-12 to K5, pin 85. Connecting this lead to E2 as marked, will short out the control board, and the genset will not run.

2. Remove the remaining non-terminated wires one at a time, replacing them with new wires from J1.
3. Connect the five push-on terminals from connector J1 to the designated connectors inside the genset using the needle-nose pliers (Table 1).
4. The terminal marked K1-s may have two wires. Clip the wire tie holding them together to connect the new K1-S. Secure the terminal with a new wire tie.
5. Plug new J1 connector onto the control board.
6. Tuck all wires neatly back into the control box. if possible, pull the wires back into the control box from the rear of the box.
7. Four of the wires connecting to new J1 pass through the front of the control box. Clip these wires to the retainer located on the lower, inside edge of the control board to secure them in place (Figure 2).

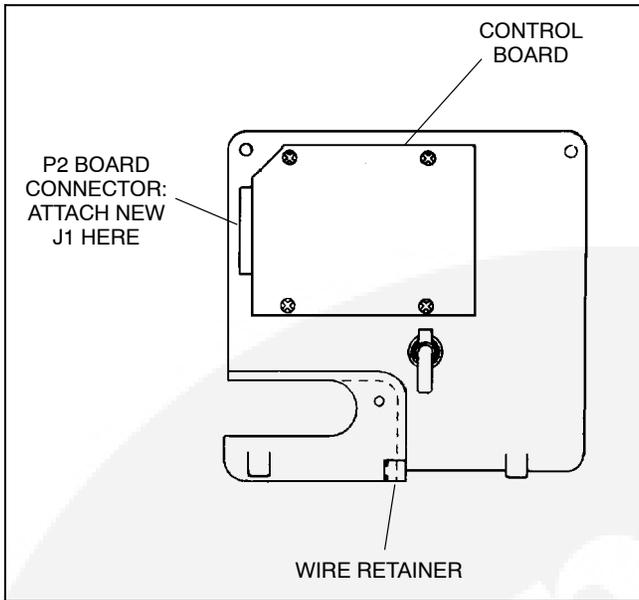


FIGURE 2: BACK OF CONTROL PANEL (REPLACEMENT PANEL)

Reassemble

1. Position the control panel on front of the control box. Reattach the control panel using the two screws removed in Step 4.
2. Connect the positive (+) battery cable to the terminal at the front of the control box.
3. Connect the negative (-) battery cable to the terminal on the generator set.
4. Reconnect the battery charger (if equipped).
5. Install the main fuse in the control panel.
6. Start and test the genset according to the appropriate operator's manual.

⚠WARNING *Electrical shock can cause severe personal injury or death. Do not touch electrical wiring or components during testing. Disconnect electrical power by removing starting battery negative (-) cable before handling electrical wiring or components.*

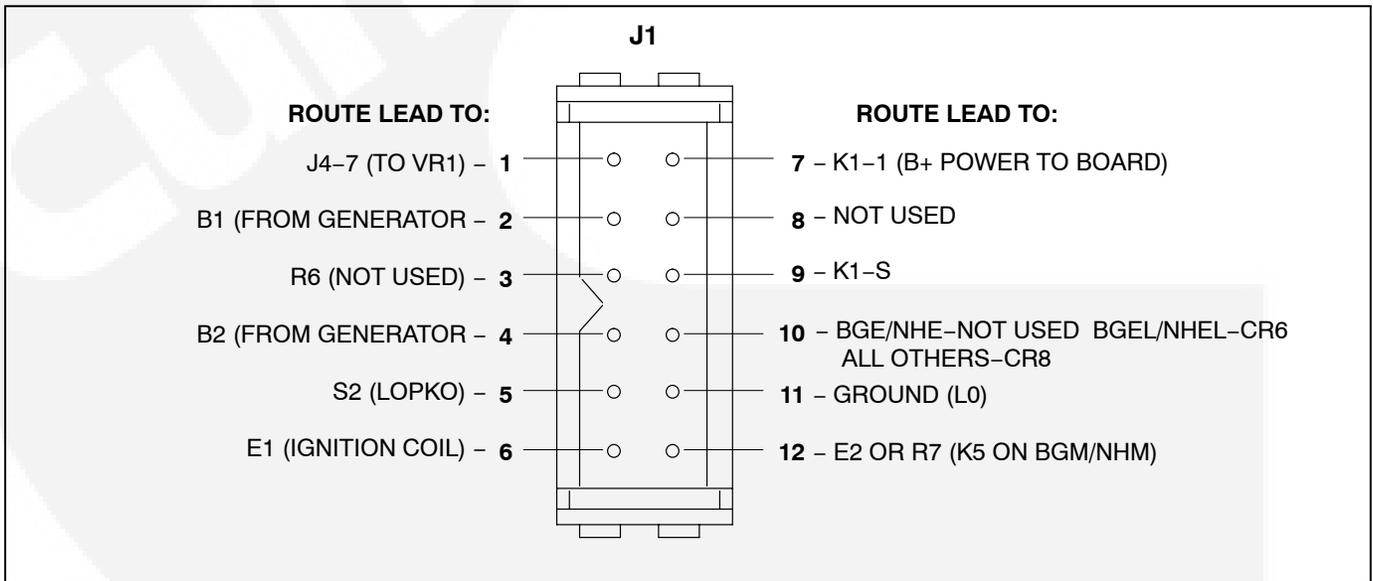


FIGURE 3. J1 PIN CONNECTIONS

TABLE 1. LABELS ON HARNESS LEADS

New Wire Labels Near Connector J1	Original Wire Labels Furthest From Connector	Component Connection
J1-1	J1-5	J4-7 (to VR1)
J1-2	J1-1	B1
J1-3	J1-4	Not used on 3951 board; R6 on 3950 board
J1-4	J1-7	B2

J1-5	J3-4	S2 (LOPKO)
New Wire Labels Near Connector J1	Original Wire Labels Furthest From Connector	Component Connection
J1-6	J3-3	E1 (Ignition coil +)
J1-7	J1-6	K1-1
J1-8	---	Not used
J1-9	J1-2	L1-S (May be piggybacked to CR9-E2 or K6-85)
J1-10	J3-2	BGE/NHE - Not used; BGEL/NHEL - CR6; BGM/NHM and BGD/NHD - CR8
J1-11	J1-8	GND (L0)
J1-12	J3-6	BGM/NHM - K5-85; Models with R7 resistor - R7; All others - Pump E2

Onan

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