



# **Service Manual**

## **Microlite™ 4000 Series**

### **Onan Generator Set for RV**

KY (Spec A-H)



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**⚠ WARNING: ⚠**

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

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# Safety Precautions

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Thoroughly read the **SERVICE MANUAL** before servicing the generator set. Reliable service can be obtained only with close adherence to the procedures in this manual.

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

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

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

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

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

## GENERAL PRECAUTIONS

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

## GENERATOR VOLTAGE IS DEADLY!

- Generator output connections must be made by a qualified electrician in accordance with applicable codes.

- The generator set must not be connected to the public utility or any other source of electrical power. Connection could lead to electrocution of utility workers, damage to equipment and fire. An approved switching device must be used to prevent interconnections.
- Use caution when working on live electrical equipment. Remove jewelry, make sure clothing and shoes are dry and stand on a dry wooden platform on the ground or floor.

## FUEL IS FLAMMABLE AND EXPLOSIVE

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

## ENGINE EXHAUST IS DEADLY!

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

## MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

## BATTERY GAS IS EXPLOSIVE

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



# 1. Introduction

This is the service manual for the KY 4000 Series MicroLite™ generator sets (generator sets). Read and carefully observe all of the instructions and precautions in this manual.

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

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

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

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

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

See the Parts Manual for parts identification numbers and required quantities and for exploded views of the generator set subassemblies. Genuine Cummins replacement parts are recommended for best results.

When contacting Cummins for parts, service or product information, be ready to provide the model number and the serial number, both of which appear on the generator set nameplate (Figure 1-1). Each character of these numbers is significant (Figures 1-2 and 1-3 on Page 1-2).

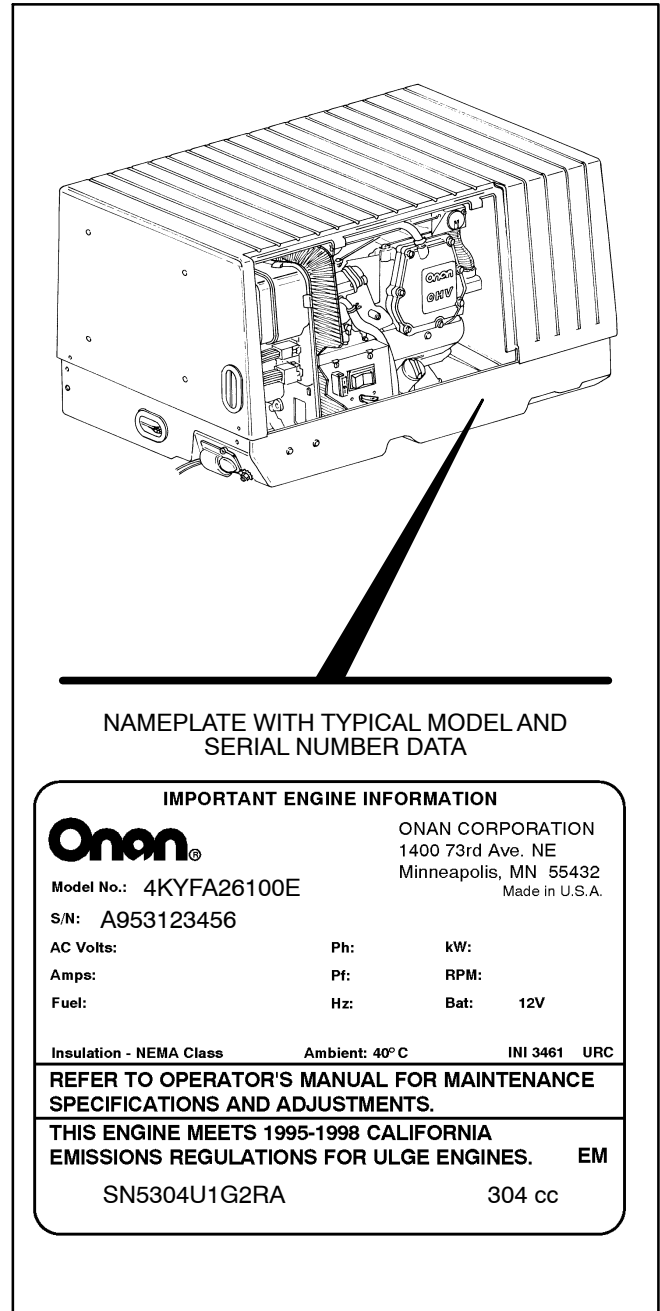
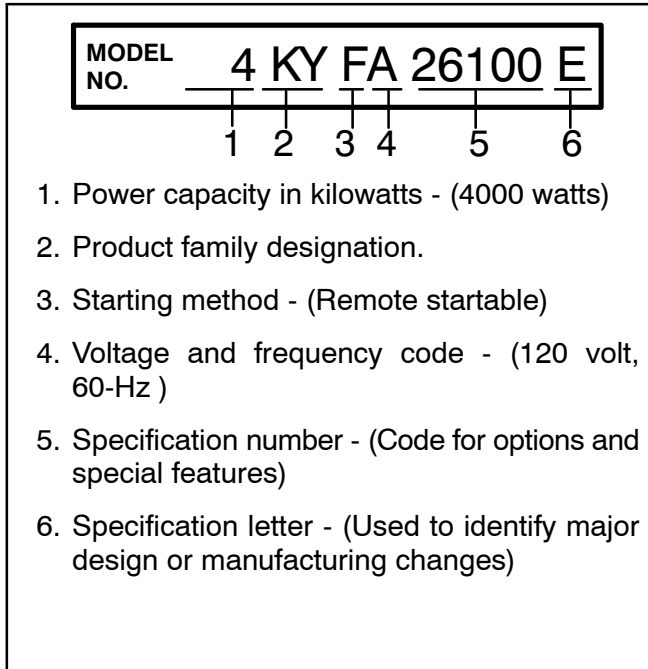


FIGURE 1-1. TYPICAL NAMEPLATE

### Model Number Identification

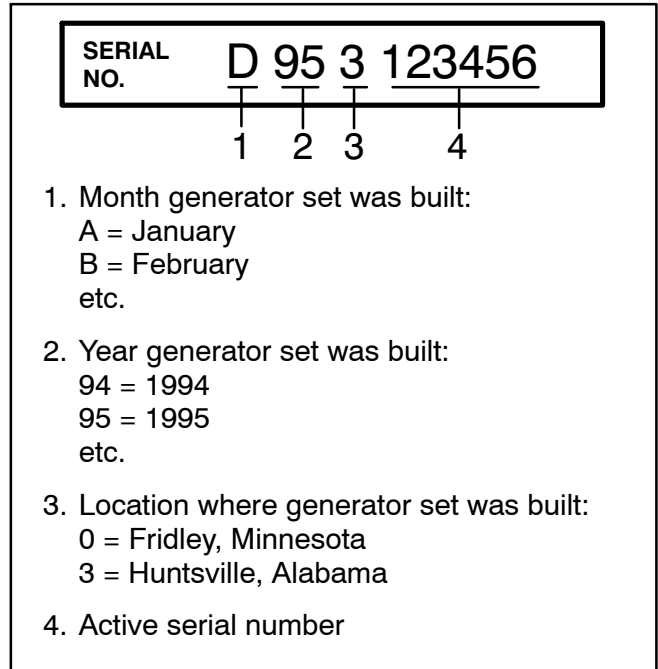
Figure 1-2 shows a breakdown of the model number for a typical generator set.



**FIGURE 1-2. MODEL NUMBER IDENTIFICATION**

### Serial Number Identification

Figure 1-3 shows a breakdown of the serial number for a typical generator set.



**FIGURE 1-3. SERIAL NUMBER IDENTIFICATION**



## 2. Specifications

	GASOLINE MODELS		LPG MODELS	
	4.0 KY	3.6 KY	3.6 KY	3.3 KY
<b>GENERATOR:</b> 2-Pole Revolving Field, Self-Excited, Electronically Regulated, 1-Phase				
Power	4000 watts	3600 watts	3600 watts	3300 watts
Frequency	60 Hertz	50 Hertz	60 Hertz	50 Hertz
Voltage	100/120 volts	100/220/230 volts	100/120 volts	100/220/230 volts
Current	40/33.3 amperes	36/16.4/15.7 amperes	36/30 amperes	33/15.0/14.3 amperes
Speed	3600 rpm	3000 rpm	3600 rpm	3000 rpm
<b>FUEL CONSUMPTION:</b>	Gasoline		LPG	
No load	0.29 gph (1.1 l/h)	0.21 gph (0.8 l/h)	1.5 lbs/h (0.7 kg/h)	1.1 lbs/h (0.5 kg/h)
Half load	0.48 gph (1.8 l/h)	0.37 gph (1.4 l/h)	2.4 lbs/h (1.1 kg/h)	2.2 lbs/h (1.0 kg/h)
Full load	0.71 gph (2.7 l/h)	0.58 gph (2.2 l/h)	3.1 lbs/h (1.4 kg/h)	2.9 lbs/h (1.3 kg/h)
<b>ENGINE:</b> 1-Cylinder, 4-Cycle, Spark-Ignited, OHV, Air Cooled				
Bore	3.11 inch (79 mm)		3.11 inch (79 mm)	
Stroke	2.44 inch (62 mm)		2.44 inch (62 mm)	
Displacement	18.5 inch <sup>3</sup> (304 cc)		18.5 inch <sup>3</sup> (304 cc)	
Compression Ratio	8.5 : 1		8.5 : 1	
Oil Capacity (Beginning Spec B)*	1.6 quart (1.5 l)		1.6 quart (1.5 l)	
Oil Capacity (Spec A)*	1.7 quart (1.6 l)		1.7 quart (1.6 l)	
Intake Valve Clearance (Cold)	0.002 inch (0.05 mm)		0.002 inch (0.05 mm)	
Exhaust Valve Clearance (Cold)	0.002 inch (0.05 mm)		0.002 inch (0.05 mm)	
Spark Plug Gap	0.025 inch (0.64 mm)		0.020 inch (0.51 mm)	
Spark Plug Tightening Torque	13 lbs-ft (17 N-m)		13 lbs-ft (17 N-m)	
Ignition Timing (magneto type ignition)	25° BTDC, non-adjustable		25° BTDC, non-adjustable	
LPG Vapor Supply Pressure (Range)	-		9 to 13 inch (229 to 330 mm) W.C. (water column)	
<b>DC SYSTEM:</b>				
Nominal Battery Voltage	12 volts		12 volts	
Minimum Battery Cold Cranking Capacity: Above/Below Freezing	360/450 amperes		360/450 amperes	
Control Fuse	5 amperes		5 amperes	
Maximum Regulated-Voltage Battery Charging Current	-	10 amperes	-	10 amperes
* -See <i>Periodic Maintenance</i> in the Operator's Manual for oil filling instructions.				



# 3. Dimensions and Clearances

All clearances are at 70° F (21°C) room temperature. All measurements are listed in inches with millimeter measurements in parentheses. Measurements are for standard size parts.

DESCRIPTION	FACTORY SPECIFICATION		ALLOWABLE LIMIT
	MIN.	MAX.	
<b>Cylinder Head</b>			
Cylinder Head Distortion	- -	- -	0.0157 (0.4)
<b>Cylinder Block</b>			
Cylinder Bore I.D.	3.1102 (79.00)	3.1110 (79.02)	3.1138 (79.09)
<b>Crankshaft</b>			
Connecting Rod Journal O.D.	1.3177 (33.47)	1.3181 (33.48)	1.3157 (33.42)
Side Clearance	- -	- -	0.0098 (0.25)
<b>Connecting Rod</b>			
Piston Pin Bore I.D.	0.7093 (18.015)	0.7096 (18.025)	0.7106 (18.050)
Large Bore I.D.	1.3189 (33.500)	1.3199 (33.525)	1.3204 (33.540)
Large Bore Clearance	0.0008 (0.020)	0.0022 (0.055)	0.0047 (0.120)
Side Clearance on Crankshaft	0.0157 (0.40)	0.0433 (1.10)	0.0590 (1.5)
<b>Camshaft</b>			
Lobe Height (Intake and Exhaust)	1.4035 (35.65)	1.4059 (35.71)	1.3997 (35.55)
<b>Piston</b>			
Piston Skirt O.D.	3.1089 (78.965)	3.1094 (78.98)	3.1063 (78.90)
Pin Bore I.D.	0.7084 (17.994)	0.7087 (18.002)	0.7084/0.7087 (17.994/18.002)

All clearances are at 70° F (21°C) room temperature. All measurements are listed in inches with millimeter measurements in parentheses. Measurements are for standard size parts.

DESCRIPTION	FACTORY SPECIFICATION		ALLOWABLE LIMIT
	MIN.	MAX.	
<b>Piston Pin</b>			
Piston Pin O.D. (Between Pin Bosses)	0.7087 (18.000)	0.7089 (18.005)	0.7067 (17.95)
<b>Piston Rings</b>			
Top Compression Ring Thickness	0.0579 (1.47)	0.0587 (1.49)	0.0563 (1.43)
Second Compression Ring Thickness	0.0579 (1.47)	0.0587 (1.49)	0.0570 (1.45)
Top Compression Ring to Ring Groove Clearance	0.0016 (0.04)	0.0032 (0.08)	0.0047 (0.12)
Second Compression Ring to Ring Groove Clearance	0.0008 (0.02)	0.0012 (0.06)	0.0039 (0.10)
Top Compression Ring End Gap	0.0120 (0.305)	0.0140 (0.356)	0.0197 (0.50)
Second Compression Ring End Gap	0.0120 (0.305)	0.0140 (0.356)	0.0197 (0.50)
Oil Ring Side Rail Gap	0.0120 (0.305)	0.0140 (0.356)	0.0197 (0.50)
<b>Intake Valve</b>			
Valve Stem O.D.	0.2740 (6.960)	0.2746 (6.975)	0.2732 (6.940)
Valve Guide I.D.	0.2756 (7.000)	0.2762 (7.015)	0.2768 (7.03)
Valve Stem to Guide Clearance	0.0010 (0.025)	0.0022 (0.055)	0.0002/0.0035 (0.005/0.09)
Valve Stem to Rocker Arm Clearance (Valve Lash)	0.0008 (0.02)	0.0032 (0.08)	0.0008/0.0032 (0.02/0.08)
Face Angle	45°		N/A

All clearances are at 70° F (21°C) room temperature. All measurements are listed in inches with millimeter measurements in parentheses. Measurements are for standard size parts.

DESCRIPTION	FACTORY SPECIFICATION		ALLOWABLE LIMIT
	MIN.	MAX.	
<b>Intake Valve Seat</b>			
Seat Width	0.0433 (1.1)		N/A
Seat Angle	45°		N/A
<b>Exhaust Valve</b>			
Valve Stem O.D.	0.2732 (6.940)	0.2740 (6.960)	0.2732 (6.940)
Valve Guide I.D.	0.2756 (7.000)	0.2762 (7.015)	0.2748/0.2768 (6.98/7.03)
Valve Stem to Guide Clearance	0.0016 (0.04)	0.0030 (0.075)	0.0002/0.0035 (0.005/0.090)
Valve Stem to Rocker Arm Clearance (Valve Lash)	0.0008 (0.02)	0.0032 (0.08)	0.0008/0.0032 (0.02/0.08)
Face Angle	45°		N/A
<b>Exhaust Valve Seat</b>			
Seat Width	0.0433 (1.1)		N/A
Seat Angle	45°		N/A
<b>Valve Springs</b>			
Free Length	1.8031 (45.8)	1.8228 (46.3)	1.6850 (42.8)
Distortion (Square)			0.0059 (1.5)
<b>Ignition System</b>			
Spark Plug Gap	0.025 (0.63)	0.020 (0.51)	0.031/0.043 (0.8/1.1)
Ignition Timing (BTDC)	25°		Not Adjustable



# 4. Torque Specifications

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Mounting screws and nuts must be tightened to the specified torque settings listed in the following tables. All threads must be clean and lubricated with new engine oil before tightening. The cylinder head mounting bolts must be tightened in the proper sequence, refer to Section 10. *Engine Block Assembly*. When tightening torques are not specified, tighten the screws and nuts according to Tables 4-3 and 4-4 on Page 4-2. The grade numbers are indicated on top of the screw or bolt head.

**TABLE 4-1. ENGINE TORQUE SPECIFICATIONS**

ITEM	POUND - FEET	NEWTON - METERS
Air Deflector Bolts	8 - 15	11 - 22
Connecting Rod Bolts	18 - 20	24 - 27
Cylinder Head Bolts (Cold)		
#1 and #6	12 - 16	16 - 22
#2 thru #5	31 - 37	42 - 50
Cylinder Air Housing Bolts		
M6 X 12	5 - 8	7 - 11
M8 X 10, M8 X 16	8 - 15	11 - 20
Gearcase Cover	12 - 16	16 - 22
Governor Lever Bolt	7	12
Intake Elbow Screws	8 - 12	11 - 16
Muffler to Engine (Spec A)	12 - 16	16 - 22
Muffler to Eng. (Begin Spec B)	8 - 11	11 - 15
Muffler to Base (Begin Spec B)	25 lb-in.	3
Oil Base Bolts	10 - 14	14 - 19
Oil Drain Screw	5 - 8	7 - 11
Rocker Arm Adjustment Nut	5 - 8	7 - 11
Spark Plug	7 - 18	10 - 24
Valve Cover	5 - 8	7 - 11

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**TABLE 4-2. GENERATOR TORQUE SPECIFICATIONS**

<b>ITEM</b>	<b>POUND - FEET</b>	<b>NEWTON - METERS</b>
Rotor Through-Bolt	40-50	54-68
Stator Through-bolt	5-8	7-11
Endbell to Stator Housing	5-8	7-11
Mount Assy. Bolt (Spec A)	38-43	52-58
Mount Assy. Bolt (Begin Spec B)	35-40	47-53
Stator Housing to Engine Block	15-18	21-24

**TABLE 4-3. METRIC BOLT TORQUE SPECIFICATIONS - NO GRADE OR 8.8 GRADE**

<b>SIZE</b>	<b>POUND - FEET</b>	<b>NEWTON - METERS</b>
M6	6 - 7	8 - 9
M8	13 - 15	18 - 21
M10	29 - 33	39 - 45
M12	46 - 54	63 - 73

**TABLE 4-4. METRIC BOLT TORQUE SPECIFICATIONS - 10.9 GRADE**

<b>SIZE</b>	<b>POUND - FEET</b>	<b>NEWTON - METERS</b>
M6	7 - 8	10 - 11
M8	17 - 20	24 - 27
M10	35 - 41	48 - 56
M12	57 - 67	77 - 90



# 5. Preparing for Service

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## TROUBLESHOOTING

Refer to *Section 6. Troubleshooting* and work through the appropriate subsections before starting work on the generator set. It has the following subsections:

- Control System
- Generator
- Primary Systems

The subsections list typical problems along with possible causes and corrective actions. Note that some problems might have several possible causes. It may be necessary to investigate several possible causes in order to isolate the actual source of the problem.

## SPECIAL TOOLS

The following special tools are required to service the generator set. See the Cummins Tool Catalog.

### Engine Tools

Torque wrench (0-75 lbs-ft or 0-100 N-m)  
Feeler gauge  
Leak Down Tester  
Spark plug gap gauge  
Cylinder compression tester  
Flywheel puller  
Snap ring pliers  
Cylinder ridge reamer  
Piston ring compressor  
Piston ring spreader  
Cylinder hone  
Valve seat cutter  
Valve spring compressor  
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

### Generator Tools

Lead or dead-blow hammer  
Steel rod (.45 inch dia. x 7.875 inch long)

Battery hydrometer  
VOM multi-tester  
Frequency meter  
Armature growler  
Load test panel  
Jumper wires

## SAFETY CONSIDERATIONS

Always consider the safety aspects of any service procedure. Servicing generator sets presents several hazards that the service technician must be aware of to safely complete the job. Study the safety precautions at the beginning of this manual and familiarize yourself with the hazards listed in Table 5-1 on Page 5-2. Approach the job in a safety-conscious manner. Being safety conscious is the most effective way to avoid injury to yourself and to others. Reduce the risk of an accident by adopting the following safeguards.

### Safeguards to Avoid Hazards

**Use personal protection:** Protect your body by wearing the appropriate safety equipment such as:

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

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

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

**TABLE 5-1. HAZARDS AND THEIR SOURCES**

<ul style="list-style-type: none"> <li>• <b>Fire and explosions</b> <ul style="list-style-type: none"> <li>Leaking or spilled fuel</li> <li>Hydrogen gas from charging battery</li> <li>Oily rags improperly stored</li> <li>Flammable liquids improperly stored</li> <li>Any fire, flame, spark, pilot light, arc-producing equipment or other ignition sources</li> </ul> </li> <li>• <b>Burns</b> <ul style="list-style-type: none"> <li>Hot exhaust pipes</li> <li>Hot engine and generator surfaces</li> <li>Hot engine oil</li> <li>Electrical short in DC wiring system</li> </ul> </li> <li>• <b>Poisonous gases</b> <ul style="list-style-type: none"> <li>Carbon monoxide from faulty exhaust</li> <li>Operating generator set where exhaust gases can accumulate</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>Electrical shock (AC)</b> <ul style="list-style-type: none"> <li>Improper generator set load connections</li> <li>Faulty RV wiring</li> <li>Faulty electrical appliance</li> <li>Faulty generator set wiring</li> <li>Working in damp conditions</li> <li>Jewelry touching electrical components</li> </ul> </li> <li>• <b>Rotating Machinery</b> <ul style="list-style-type: none"> <li>Jewelry or loose clothing catching in moving parts</li> </ul> </li> <li>• <b>Slippery Surfaces</b> <ul style="list-style-type: none"> <li>Leaking or spilled oil</li> </ul> </li> <li>• <b>Heavy Objects</b> <ul style="list-style-type: none"> <li>Removing generator set from vehicle</li> <li>Removing heavy components</li> </ul> </li> </ul>
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**Develop safe work habits:** Unsafe practices are the cause of most accidents involving tools or machinery. Be familiar with your tools and machines and learn how to use them safely. Use the right tool for the job, and check its condition before starting. Follow all warnings and cautions in this manual, and take extra precautions when working around electrical equipment. Avoid working alone, and do not take risks. Do not work when tired or after consuming any alcohol or drug that makes the operation of equipment unsafe.

**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.

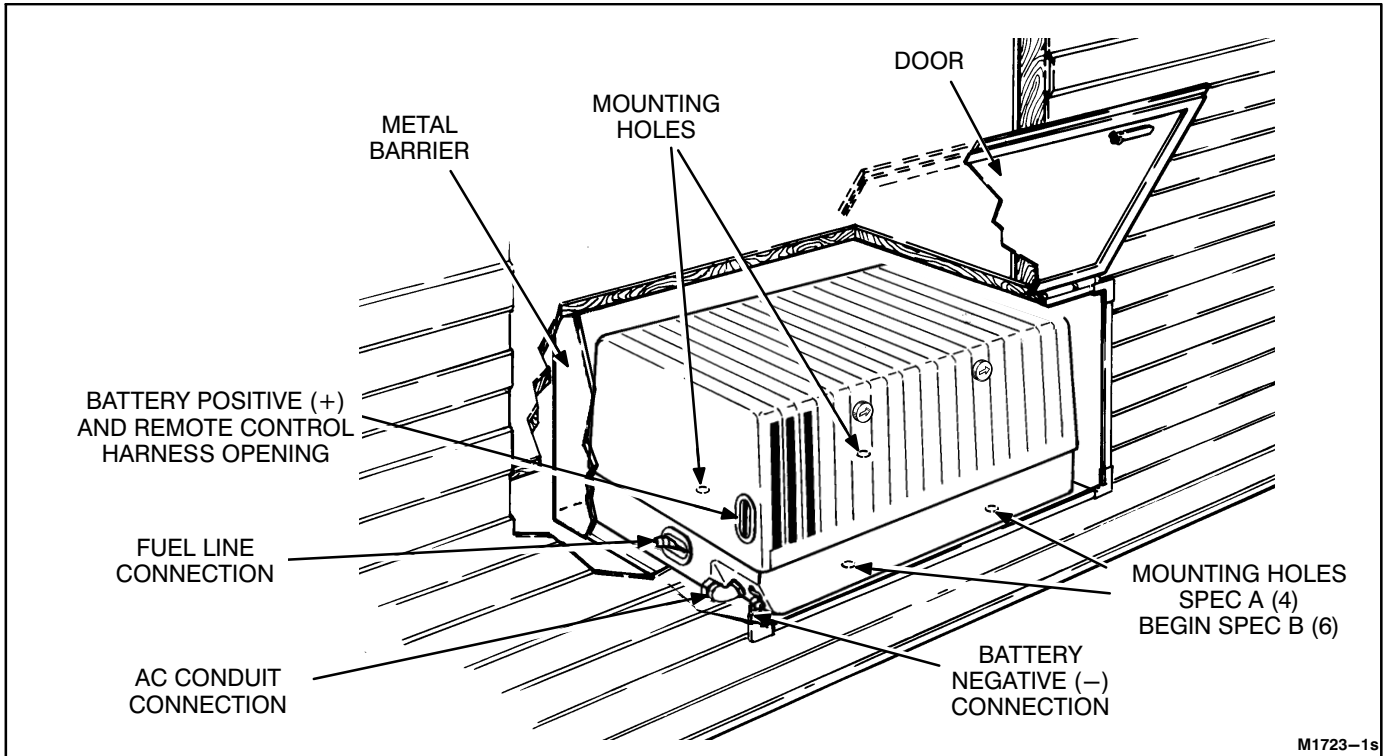
### SET REMOVAL GUIDELINES

Some service procedures will require removing the generator set from the coach. While there are many variations, generator set installations are generally classified as either conventional compartment mount or under-the-floor mount.

In a compartment mount installation, a special compartment is built into the coach to house the generator set (Figure 5-1 on Page 5-3). The compartment is constructed with a vapor-tight barrier that seals off the generator set from the coach interior. The generator set is usually mounted to the floor of the compartment. Access to the compartment is through a door located in the exterior of the coach.

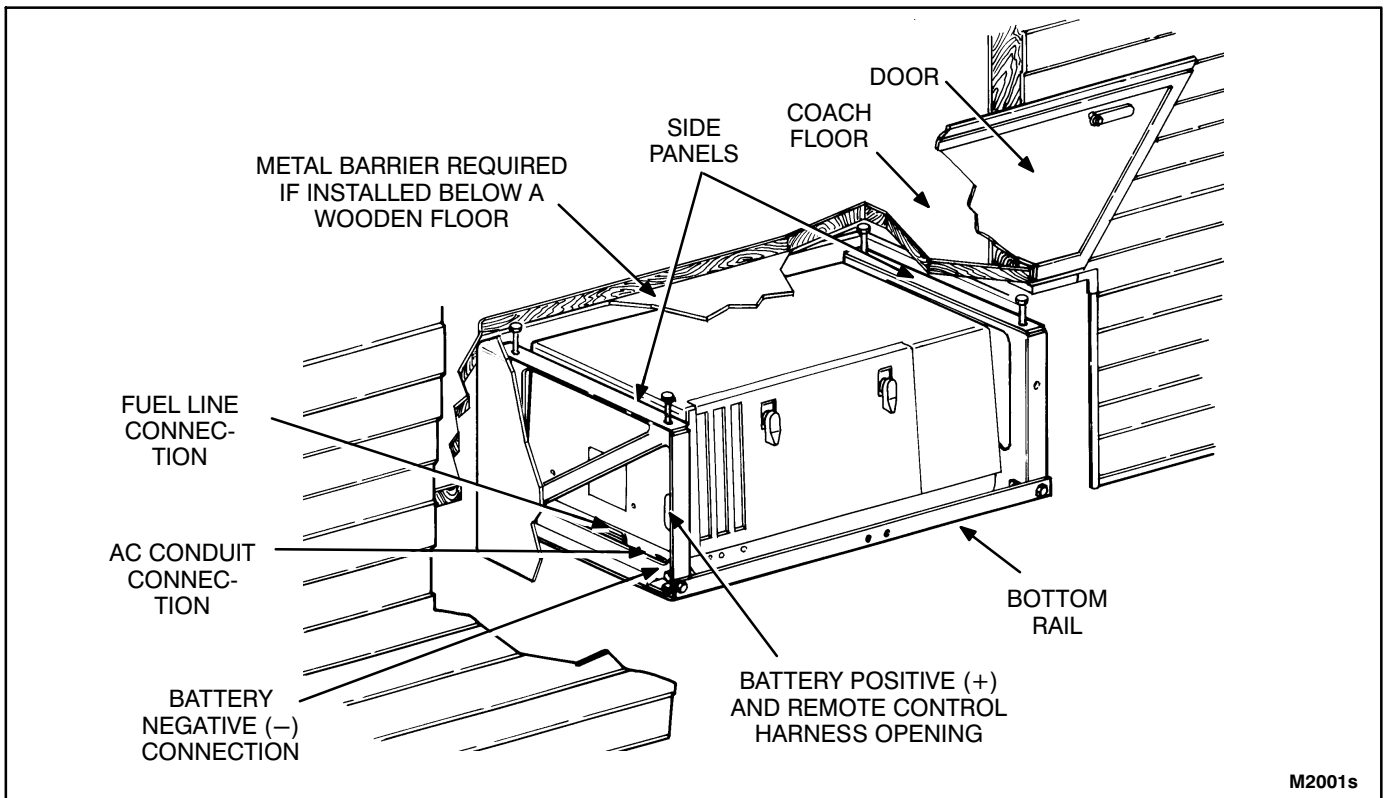
The under-floor-mount installation uses special brackets to suspend the generator set under the floor of the coach. The mounting brackets bolt to support members that are built into the vehicle framework (Figure 5-2). The generator set is mounted near the exterior of the vehicle. Access is provided through a door located in the exterior of the coach.

Due to the wide variety of coach designs, it is not possible to specify the exact removal procedures for each type of installation. If, after examining the following sections, a satisfactory method for removing the set cannot be determined, contact the coach manufacturer or set installer to obtain their recommendations before attempting set removal.



M1723-1s

**FIGURE 5-1. TYPICAL COMPARTMENT MOUNT INSTALLATION (SPEC A SHOWN)**



M2001s

**FIGURE 5-2. TYPICAL UNDER-FLOOR MOUNT INSTALLATION (BEGIN SPEC B SHOWN)**

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## Disconnecting Set from Vehicle Systems

Disconnect the following items from the generator set. Refer to Figures 5-1 and 5-2 on Page 5-3 for component locations in typical generator set installations.

Some installations may require partial removal of the set to gain access to the battery cable, fuel line and other connections. Read this section before starting set removal.

1. Disconnect the vehicle negative (-) battery cable at the battery terminal.

**⚠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 generator set.*

2. Remove the generator set negative (-) battery cable at the battery terminal.
3. Disconnect the generator set positive (+) battery cable from the B+ connection on the generator set.
4. Disconnect the remote control wire connector from the left side of the generator set housing.
5. Disconnect the generator load wires from inside the generator set. Remove the control assembly mounting bracket (Figure 6-1 on Page 6-2 or Figure 6-2 on Page 6-3). Raise the control assembly and disconnect the ground and neutral (L2) lead from the ground terminal. Disconnect the inline load (L1) lead connection. Tag the wires for identification when reconnecting.
6. Loosen the conduit connector elbow, and pull the load wires and flexible conduit free of the generator set.
7. Disconnect the exhaust tail pipe from the generator set. Disconnect any exhaust support brackets or hangers that restrict removal of the generator set.
8. Disconnect the fuel line from the generator set. Follow the applicable instructions depending on the fuel.

A. **Gasoline-fueled generator sets:** Disconnect the fuel line from the generator set and securely plug the end of the fuel line to prevent leakage or an accumulation of explosive gasoline vapor.

B. **LPG-fueled generator sets:** 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 most of the LPG from the fuel line and generator set, run the generator set (if it starts) until it runs out of fuel (LPG container valve closed). To purge some of the remaining LPG, press the regulator primer plunger (Figures 8-18 and 8-19 on Pages 8-22 and 8-23) while cranking the engine for 10 seconds. Disconnect the fuel line from the generator set and plug the end of the hose to prevent fuel from escaping if someone inadvertently opens the shutoff valve(s) at the LPG container(s).

**⚠WARNING** *Gasoline and LPG (liquefied petroleum gas) are flammable and explosive and can cause severe personal injury or death. Do not smoke. Keep flames, sparks, pilot lights, arc-producing and switching equipment, and all other sources of ignition away from fuel tank and system, and areas sharing ventilation. Have an ABC fire extinguisher handy.*

**⚠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” 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, basements, and other below-grade spaces where LPG could accumulate.*

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## Set Removal

After the generator set is disconnected from 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 housing will be mounted 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. Use a forklift to lift or move the set.

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

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

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

### **Compartment Mount:**

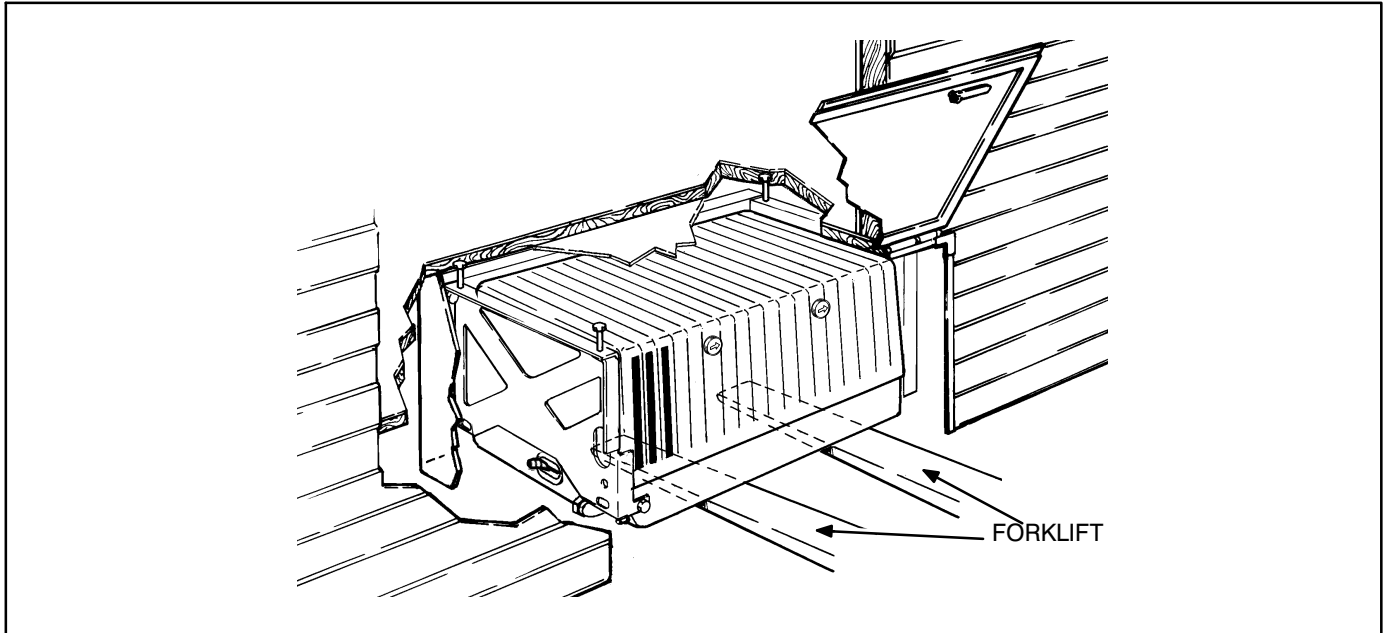
1. Use a forklift to support and move the generator set.
2. Make sure that the generator set is adequately supported before removing any of the mounting bolts.
3. Remove all mounting bolts then slide the generator set out of the compartment and onto the forklift. Slowly lower the generator set before moving it to the service area.

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***Under-Floor Mount:***

1. Use a forklift to support the generator set at the points shown in Figure 5-3.
2. Raise the lift so it contacts the bottom of the generator set housing, then place slight upward pressure on the set. Make certain that the generator set is fully supported by the lift before continuing.
3. Loosen bolts between generator set base pan and side mounting panels (loosen bolts about six turns).
4. Loosen bolts securing the side panels to the rear panel (note slotted holes) or braces and pull side panels away from generator set. Retighten side panels to back panel bolts.
5. Remove side and rear panel to generator set base mounting bolts. Slowly lower the generator set until it clears all obstructions and can be safely moved out from under the vehicle.

When reinstalling the generator set, be sure that all bolts, brackets, and electrical, exhaust, and fuel system components are connected exactly as they were before removal.



**FIGURE 5-3. COMPLETE generator set REMOVAL (SPEC A SHOWN)**

# 6. Troubleshooting

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## INTRODUCTION

Use the following troubleshooting guide to help diagnose generator set problems. The troubleshooting section is divided into four parts:

- Control – Spec A models (page 6-4)
- Control – Begin Spec B models (page 6-16)
- Generator – All specs Page 6-28)
- Engine Primary Systems – All Specs (page 6-32)

Common problems are listed with their possible causes. Refer to the Corrective Action column for the appropriate test or adjustment procedure. The section and page number in the right column lists the location of the test or adjustment procedure in this manual.

Refer to Figures 6-1 and 6-2 on Pages 6-2 and 6-3 to identify the component locations for the Spec A and Spec B models.

Conditional schematics are used to highlight the circuitry that is energized during the sequence of events. These conditional schematics are for a typical gasoline fueled generator set. Always refer to the wiring schematic and diagram in Section 12. *Wiring Diagram/Schematic* that corresponds to the model and spec of the generator set when troubleshooting.

Make a thorough inspection of the generator set wiring to make sure that good wire harness and ground connections are made. Correct wiring problems before performing tests or replacing any components.

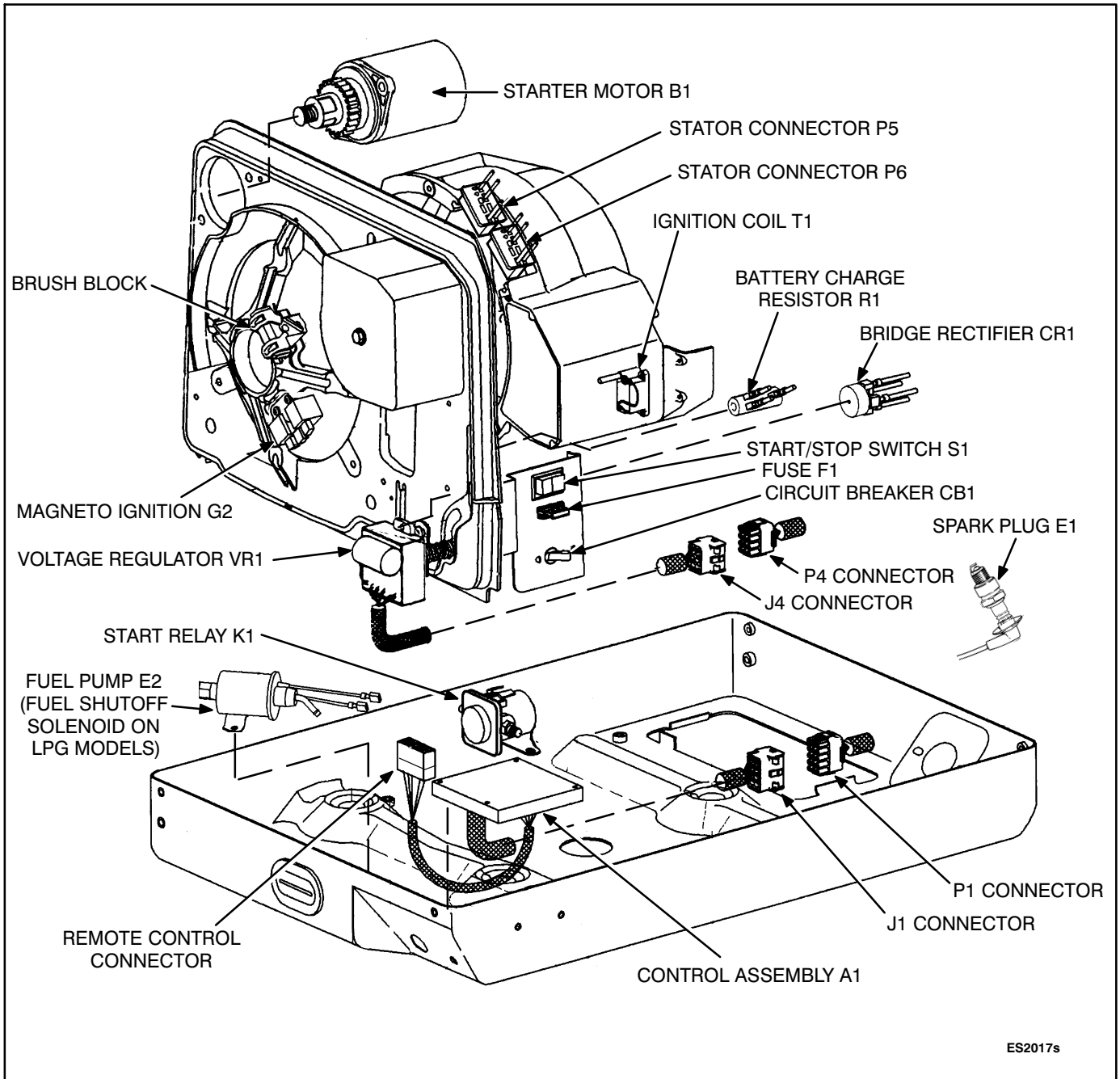
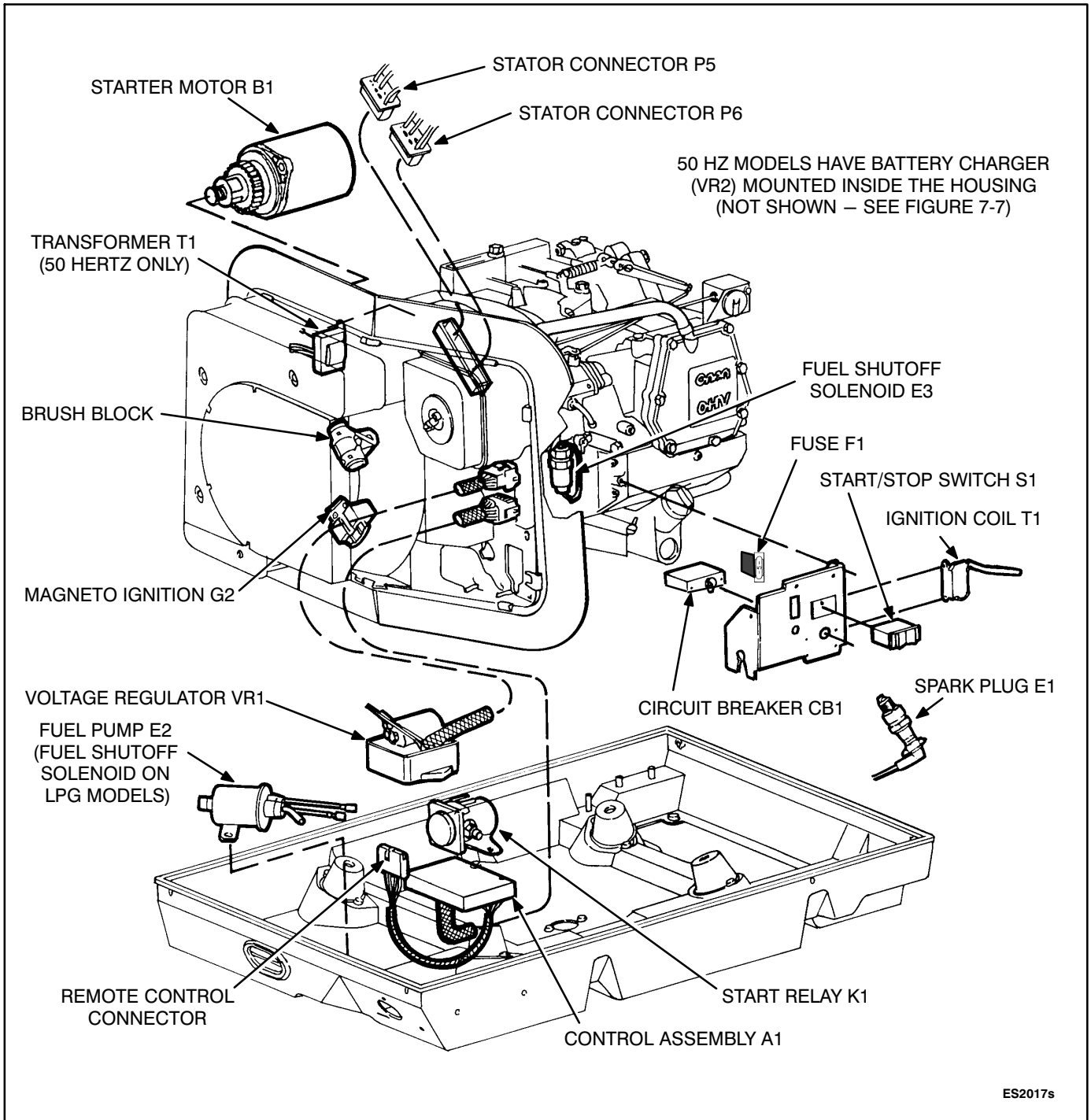


FIGURE 6-1. COMPONENT LOCATIONS - GASOLINE-FUELED SPEC A MODELS





**FIGURE 6-2. COMPONENT LOCATIONS – GASOLINE-FUELED MODELS, BEGINNING WITH SPEC B**

### Spec A Start - Cranking Mode

Battery positive (B+) is supplied to the control assembly (A1) through control fuse (F1). Holding the Start/Stop switch (S1) in the Start position activates control assembly (A1) by closing the start signal input circuit. While the Start/Stop switch is held, the control assembly supplies the following outputs:

- Battery positive (B+) is supplied to the start relay coil (K1). This energizes the start relay. The start relay contacts close supplying battery positive (B+) to the starter motor B1. The starter begins to crank the engine to initiate starting.

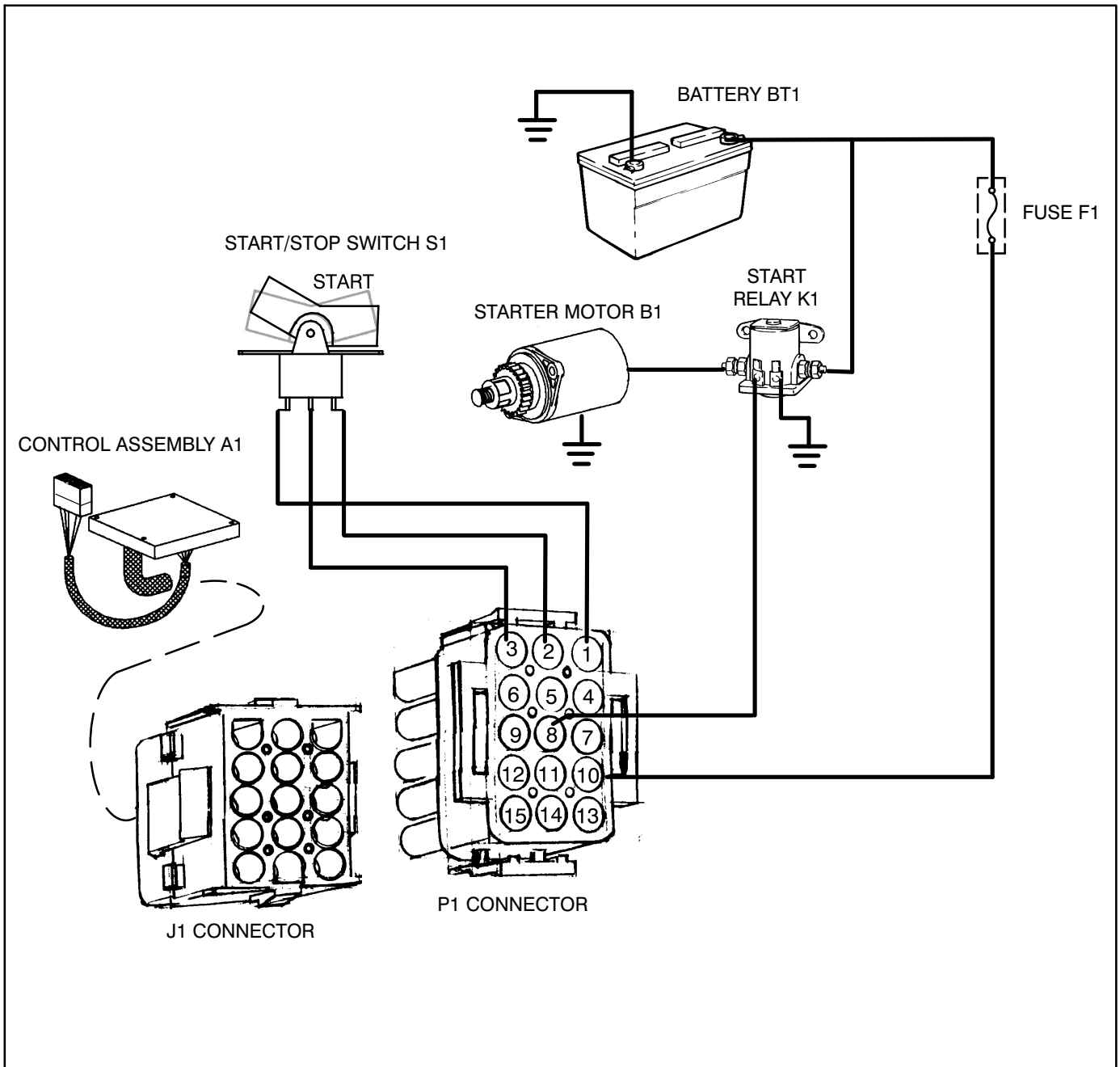


FIGURE 6-3. SPEC A START - CRANKING MODE

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-1. SPEC A CONTROL TROUBLESHOOTING – CRANKING MODE**

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Does Not Crank	<ol style="list-style-type: none"> <li>1. Open control fuse F1.</li> <li>2. Insufficient cranking voltage due to: (Also see Table 6-5 on page 6-13)               <ol style="list-style-type: none"> <li>a. Battery not charged.</li> <li>b. Battery connections loose or dirty.</li> <li>c. Battery cable size too small.</li> </ol> </li> <li>3. Start solenoid (K1) not energized due to:               <ol style="list-style-type: none"> <li>a. Open circuit to start solenoid coil.</li> <li>b. Defective start solenoid coil.</li> <li>c. Defective Start/Stop switch.</li> <li>d. Defective control assembly (A1).</li> </ol> </li> <li>4. Starter (B1) not energized due to:               <ol style="list-style-type: none"> <li>a. Open circuit to starter (B1).</li> <li>b. Open circuit between battery (B+) and the start solenoid contact (BAT).</li> <li>c. Defective start solenoid (K1) .</li> <li>d. Defective starter (B1).</li> </ol> </li> <li>5. If engine cranks from set but not from remote control panel, fault is due to:               <ol style="list-style-type: none"> <li>a. Open circuit between control assy. (A1) and remote Start/Stop switch.</li> <li>b. Remote Start/Stop switch faulty.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Check fuse. If open, locate and correct cause of overload. Replace fuse.</li> <li>2a. Check condition of battery and recharge or replace.</li> <li>2b. Clean and tighten all connections at battery, K1 start solenoid, and starter motor.</li> <li>2c. Increase starting battery cable size.</li> <li>3a. Check wiring continuity to the start solenoid (K1) coil from control assy. (A1) and from ground to start solenoid.</li> <li>3b. Test start solenoid (K1).</li> <li>3c. Test Start/Stop switch (S1).</li> <li>3d. Measure voltage between start solenoid terminal I and ground with switch (S1) held in the Start position. If voltage is not present and continuity and battery check OK, Cont. assy. (A1) is defective.</li> <li>4a. Check continuity between starter lead on start solenoid (S) and gnd. (4 ±1 ohm).</li> <li>4b. Check wiring continuity between battery (B+) and the start solenoid (BAT).</li> <li>4c. Measure voltage between starter terminal and ground with switch (S1) held in the Start position. If voltage is not present and continuity checks OK, start solenoid (K1) is defective.</li> <li>4d. If voltage is present in step 4c, starter is defective.</li> <li>5a. Check wiring continuity between control assembly (A1) and remote Start/Stop switch.</li> <li>5b. Test remote Start/Stop switch.</li> </ol>	<p>7-6</p> <p>7-5</p> <p>7-6</p> <p>7-6</p> <p>7-6</p> <p>8-26</p>

### Spec A Start - Ignition Mode

Holding the Start/Stop switch (S1) in the Start position activates the following ignition circuit:

- Control assembly (A1) enables the ignition circuit to open a ground path through the control assembly to the magneto assembly (G2) so that output from the magneto will energize the ignition coil (T1).
- With the engine cranking, a permanent magnet in the flywheel rotates, at the proper time, past the magneto to induce a voltage at the ignition coil (T1) that fires the spark plug (E1) for ignition.
- Battery positive (B+) is supplied to the fuel pump (E2) or fuel shutoff solenoid (E2) and regulator(K2) on LPG models. (Schematic for gasoline fueled model shown.)

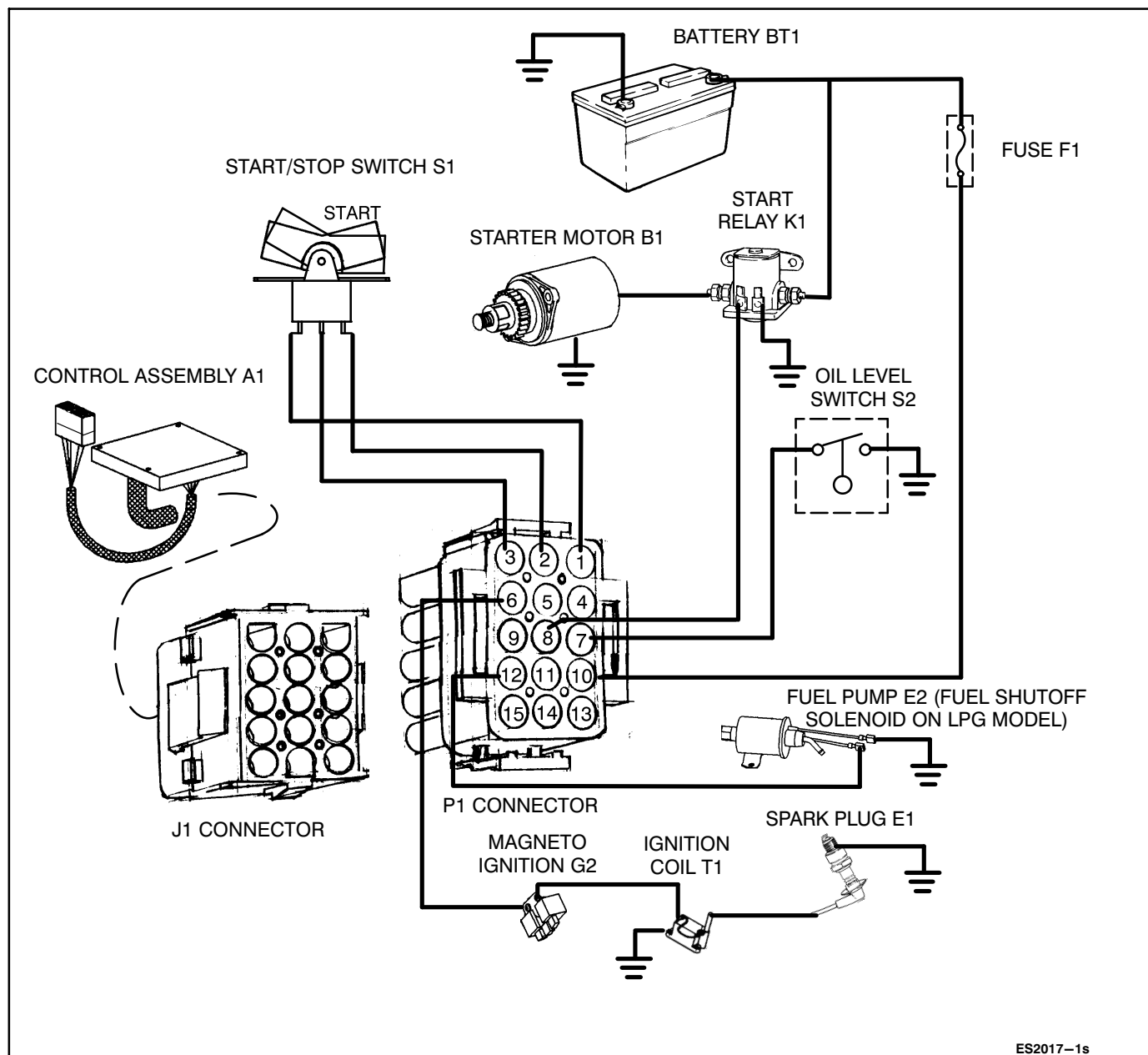


FIGURE 6-4. SPEC A START - IGNITION MODE

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-2. SPEC A CONTROL TROUBLESHOOTING – IGNITION MODE**

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Cranks But Does Not Start	1. Restricted fuel supply due to: a. Fuel level below pickup tube in tank. b. Fuel line supply valve closed. c. Fuel filter clogged.	1a. Add fuel if tank is low. 1b. Open fuel supply valve (if equipped). 1c. Replace clogged fuel filter and check fuel supply for contamination.	8-19
	2. Faulty ignition due to worn or fouled spark plug, faulty plug wire, faulty ignition coil or magneto.	2. Refer to <i>Ignition System</i> for test and service procedures.	8-6
	3. Sticking choke or carburetor mixture screws incorrectly adjusted.	3. Refer to <i>Gasoline Fuel System</i> for adjustments.	8-11
	4. Fuel pump (E2) not working due to: a. Fuel pump defective. b. Open circuit between fuel pump and control assembly (A1) or control assembly is defective.	4a. Measure voltage between fuel pump connector and ground with the engine cranking. If B+ voltage is not present, proceed to 4b. If voltage is present, (min. 6 VDC) fuel pump is defective.	8-19
		4b. Check continuity between control assembly and fuel pump. If connections are good and voltage was not measured in 4a, replace control assembly (A1).	8-19
	5. Faulty fuel solenoid, priming solenoid, or regulator on LPG models.	5. Refer to <i>LPG Fuel System</i> for service procedures.	8-22
	6. Governor linkage stuck or binding.	6. Check governor arm movement. See <i>Governor</i> section.	8-9
7. Oil level switch (S2) closed due to: a. Low oil level. b. Defective low oil level switch.	7a. Check oil level and add oil if low. 7b. Check low oil level switch.	10-2	

### Spec A Start - Field Flash Mode

Holding the Start/Stop switch (S1) in the Start position activates the following field flash circuit:

- Battery positive (B+) is supplied to the control assembly (A1) and the voltage regulator (VR1) at pin 7. From pins 9 and 10 of the voltage regulator, excitation voltage is sensed through the brushes to the rotor field winding.
- The excitation voltage flashes the generator field winding to ensure that there is adequate magnetism to induce generator voltage buildup.

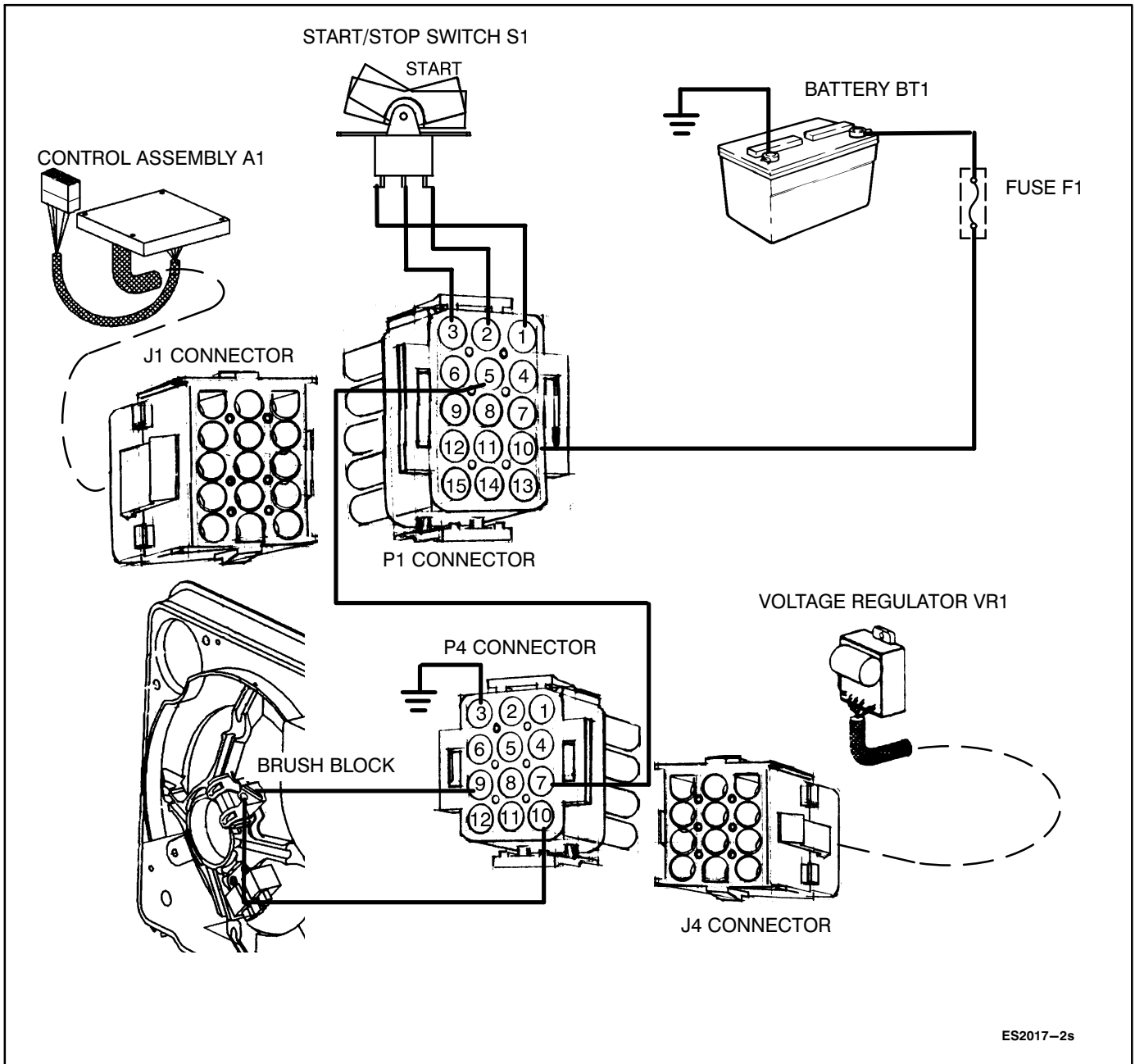


FIGURE 6-5. SPEC A START - FIELD FLASH MODE

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-3. SPEC A CONTROL TROUBLESHOOTING – FIELD FLASH MODE**

<b>Trouble</b>	<b>Possible Cause</b>	<b>Corrective Action</b>	<b>Section/ Page</b>
Engine Starts But Stops When Start Switch Is Released	1. Low oil level.	1. Check oil level and add oil if low.	10-2
	2. Defective low oil level switch.	2. Disconnect low oil level switch and check set operation. Replace if defective.	9-8
	3. No field flash voltage due to: a. Open circuit in wiring. b. Brushes not making good contact with slip rings. c. Slip ring surface is rough or pitted.	3a. Check wiring continuity to the brush block F1-F2, voltage regulator VR1, control assembly A1 and generator B1-B2 and Q1-Q2 windings. Check connections of P5 and P6 connectors on the generator housing. 3b. Check brushes for wear and for contact with the slip rings. 3c. Check slip rings	9-12
	4. Defective generator, control assembly A1, or voltage regulator VR1.	4. Perform field voltage test.	9-8

## Spec A Run Mode

When the engine starts, release the Start/Stop switch and it will return to the center Run position. The following events occur:

- Control assembly (A1) opens the circuit to the start solenoid (K1), which opens the circuit to the starter motor (M1) to stop cranking. Control assembly (A1) also opens the field flash circuit to AVR pin 7.
- Voltage from the battery, used to power the control assembly (A1) and the fuel pump (E2), is replaced with output voltage from the generator charge winding B1-B2. (Refer to *Battery Charge Mode* on page 6-12.) The control assembly senses this output for the start disconnect function.
- Remote run output is energized through the control assembly (A1) to power the time meter, battery condition meter and run lamp in the optional remote control.
- Voltage from the generator Q1-Q2 winding provides power to the voltage regulator VR1 to use for supplying field current to the generator. (Refer to *Generator AC Output Mode* on page 6-29.)

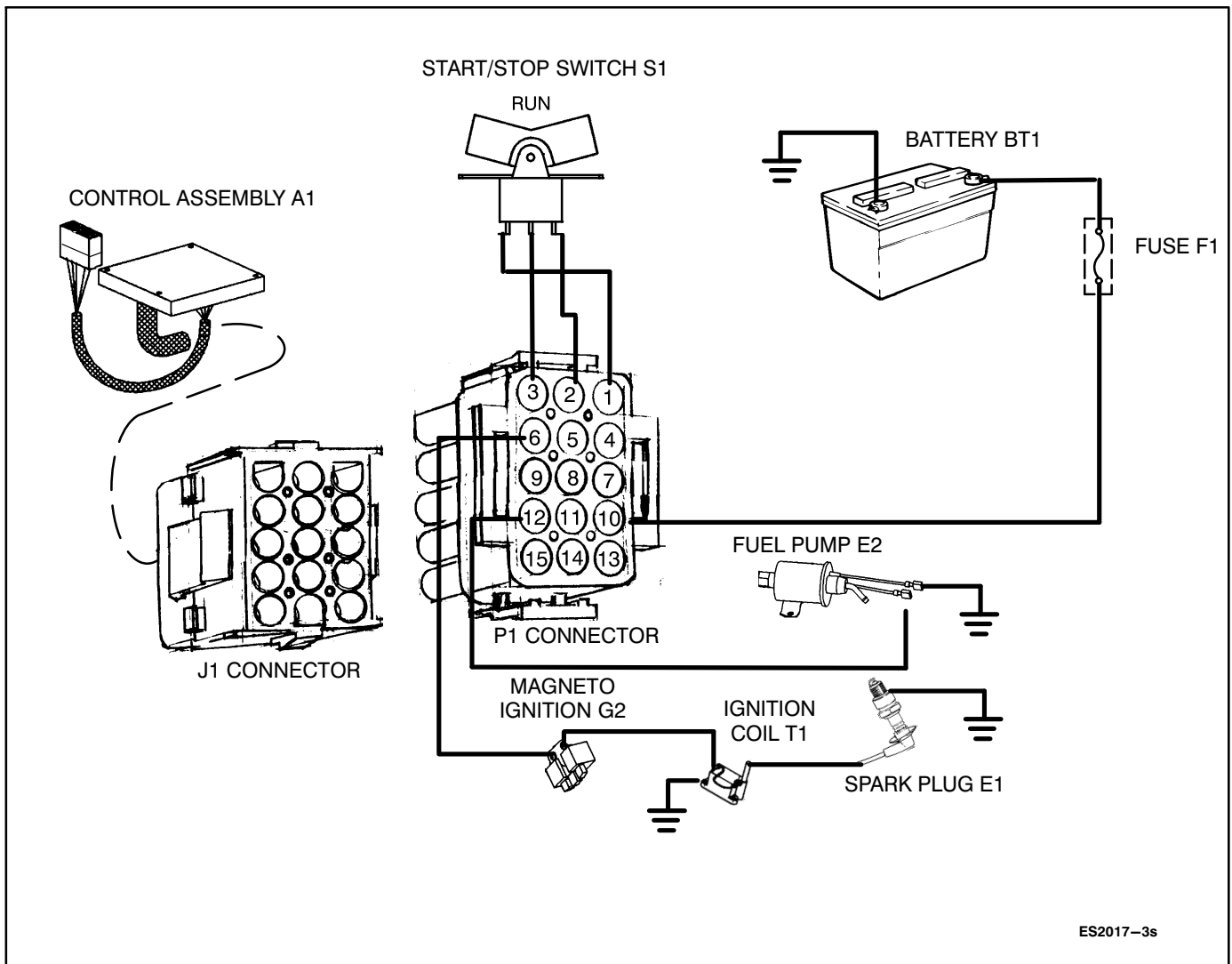


FIGURE 6-6. SPEC A RUN MODE



**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

TABLE 6-4. SPEC A CONTROL TROUBLESHOOTING – RUN MODE

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Starts and Runs, Then Stops. Set Restarts Immediately or After Cool Down.	<ol style="list-style-type: none"> <li>1. Fuel level is below generator set fuel pickup tube or oil level is low.</li> <li>2. Faulty choke operation.</li> <li>3. Vapor lock from high ambient temperature.</li> <li>4. Contaminated or incorrect fuel.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check fuel and oil level and refill if low.</li> <li>2. Refer to choke section for adjustments.</li> <li>3. Remove any objects or debris that may restrict airflow. Make sure fuel system is installed correctly.</li> <li>4. Refill tank with fresh fuel.</li> </ol>	8-17
Remote Control Run Lamp, Time Meter, or Battery Condition Meter Inoperative	<ol style="list-style-type: none"> <li>1. Open circuit in remote control wiring.</li> <li>2. If battery condition meter and run lamp work but time meter does not, time meter is defective.</li> <li>3. If time meter works but battery condition meter does not operate:               <ol style="list-style-type: none"> <li>a. Defective battery condition meter.</li> <li>b. Defective zener diode inside remote control.</li> </ol> </li> <li>4. Meters and switch function properly but run lamp does not illuminate. Lamp (internal to switch) is burned out.</li> <li>5. If remote switch functions properly for starting and stopping generator set but meters and run lamp do not operate, and step 1 checks OK, control assy. (A1) defective.</li> <li>6. Too much DC load (over 2–amps) connected to the remote output.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check continuity between remote control and control assembly (A1).</li> <li>2. Replace time meter.</li> <li>3a. Connect a voltmeter between the positive terminal on battery charge meter and ground. Use the following to determine fault: If reading equals battery voltage minus 10 volts, battery condition meter is defective.</li> <li>3b. If reading does not equal battery voltage minus 10 volts, zener diode is defective.</li> <li>4. Replace remote Start/Stop switch (S2).</li> <li>5. Check remote running output voltage (approximately 12 VDC) during run condition from control assembly J2-5 to ground and from J2-6 to ground. If voltage is not present, replace control assembly (A1). If voltage is present, check continuity of remote control wiring.</li> <li>6. Turn off the generator set, disconnect the remote control, and check for shorts or too many remote accessories.</li> </ol>	

### Spec A Battery Charge Mode

With the generator set running, AC voltage is produced in the B1-B2 windings for the battery charge circuit.

- The AC output voltage from the B1-B2 winding is converted to DC voltage when it passes through the full-wave rectifier bridge (CR1). The voltage is then supplied through battery charge resistor (R1). The 12-volt DC output (one-ampere maximum) is used to power the control assembly (A1), fuel pump (E2), the remote control, and to prevent discharge of the generator set starting battery during generator set operation. This output is not sufficient to charge a low or dead battery.

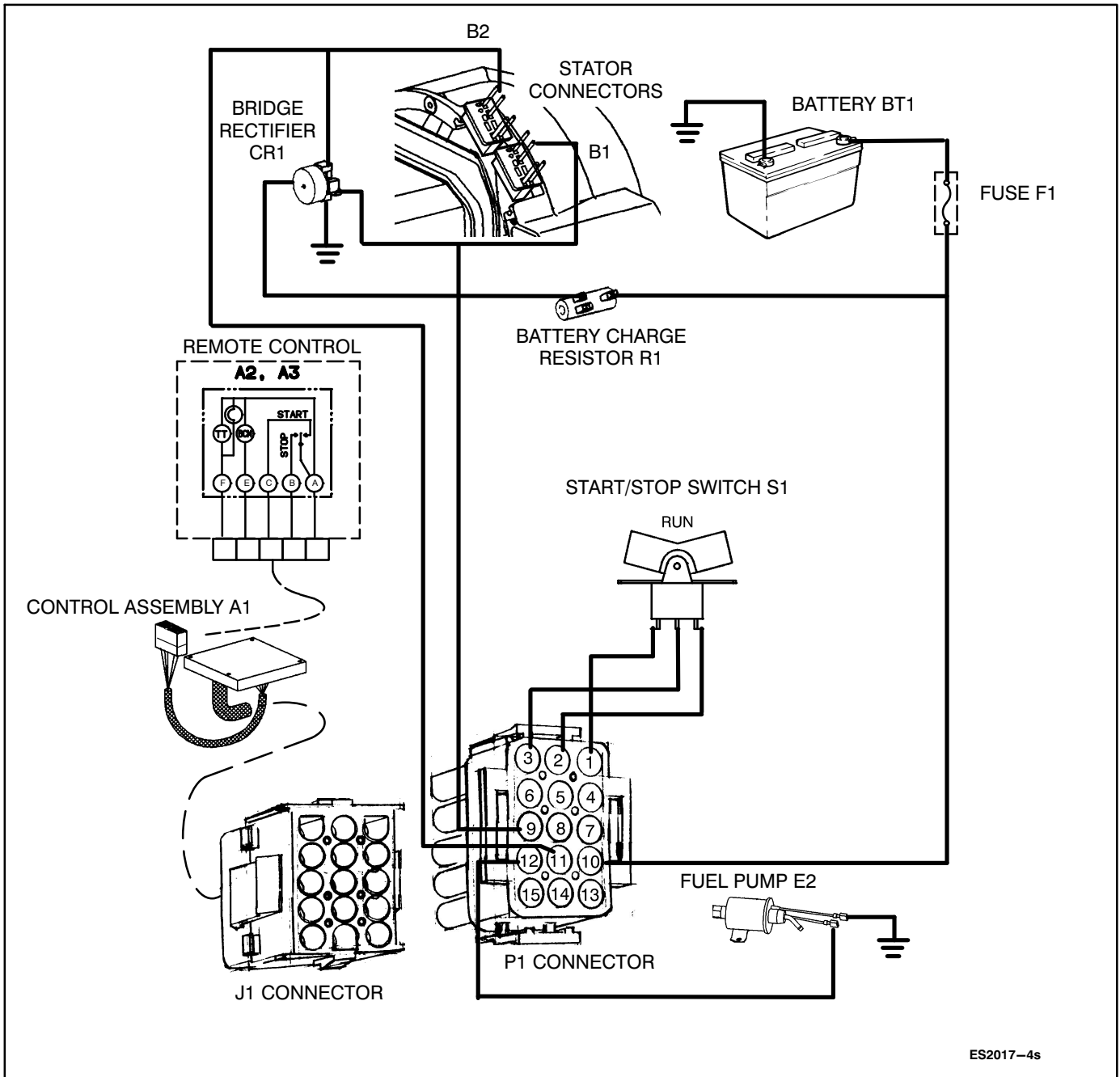


FIGURE 6-7. SPEC A BATTERY CHARGE MODE

**⚠ WARNING** *Many troubleshooting procedures present hazards that 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 page iii.*

**TABLE 6-5. SPEC A CONTROL TROUBLESHOOTING – BATTERY CHARGE MODE**

Trouble	Possible Cause	Corrective Action	Section/ Page
Low Battery Voltage	1. Weak or discharged battery due to: <ul style="list-style-type: none"> <li>a. Low electrolyte level in battery.</li> <li>b. Long periods of non-use.</li> <li>c. Improperly wired battery.</li> <li>d. Load connected to battery while set is turned off.</li> <li>e. Too much DC load on generator set starting battery.</li> </ul> 2. generator set charging circuit not functioning due to: <ul style="list-style-type: none"> <li>a. Open in circuit between generator B1-B2 winding and battery (B+).</li> <li>b. Open charging resistor (R 1).</li> <li>c. Diode bridge (CR1) defective.</li> <li>d. Generator B1–B2 defective.</li> </ul>	1a. Replenish electrolyte and recharge battery. 1b. Connect a separate battery charger to bring battery up to full charge. 1c. Reconnect and check battery connection. 1d. Disconnect load and recharge battery. 1e. Remove other DC loads from generator set starting battery.  2a. Check all wiring connections between the generator B1-B2 windings and the Battery B+ connection, including all connections to the diode bridge (CR1) and battery charge resistor (R1). 2b. Remove wires from the charge resistor (R1) and measure its resistance. A normal reading is 4 to 6 ohms. 2c. Refer to diode bridge (CR1) test. 2d. Refer to generator test section.	           7-8    7-8 9-8
<p><b>NOTE:</b> The battery charging circuit is designed to maintain the generator set starting battery. The charging circuit will not charge a low or bad battery. A low battery should be charged up with a battery charger.</p>			

### Spec A Stop Mode

Momentarily pushing the Start/Stop switch (S1) to the Stop position begins the stop mode with the following results:

- Control assembly (A1) de-energizes the ignition enable circuit, grounding the magneto (G2) ignition circuit to stop the engine.
- Control assembly (A1) also opens the circuit to the fuel pump (E2) and to the remote control.
- Control assembly (A1) start disconnect senses a drop in voltage from the battery charge winding B1-B2 and activates the remote stop latch to prevent restart during the stop mode.

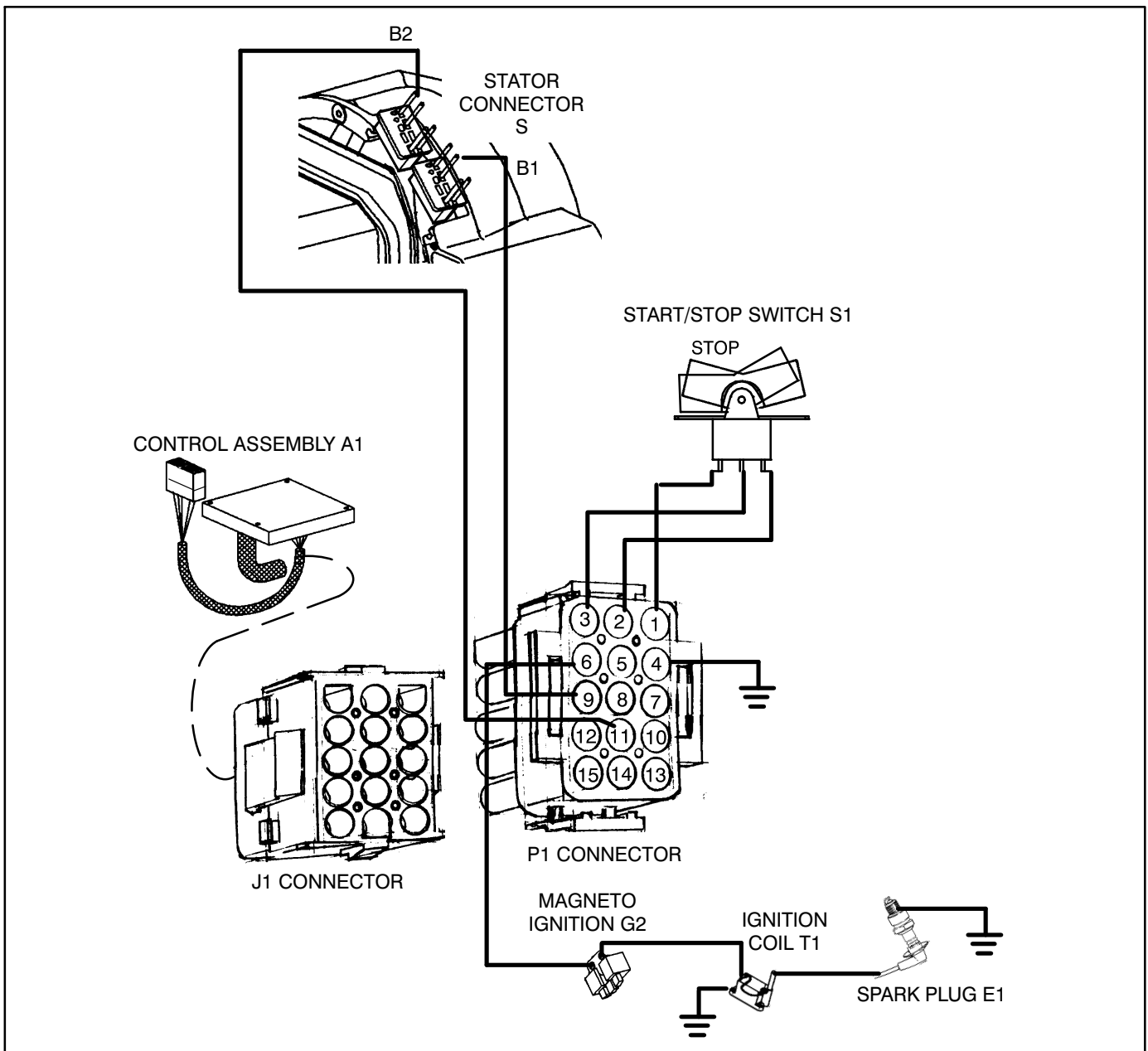


FIGURE 6-8. SPEC A STOP MODE

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-6. SPEC A CONTROL TROUBLESHOOTING – STOP MODE**

Trouble	Possible Cause	Corrective Action	Section/ Page
<p>generator set Does Not Stop When Switch Is Pushed To Stop</p> <p><b>Always remove the load a few wiring continuity minutes before control assembly (A1) and Start/ generator set to allow</b></p> <p>Check Start/Stop switch (S1). cool down.</p>	<p>1. If set can be stopped from set control but not from remote control panel, fault is due to:</p> <p>a. Open circuit between control assy. (A1) and remote Start/Stop switch. b. Remote Start/Stop switch faulty.</p> <p>2. If generator set can be stopped from remote control but not from generator set, fault due to:</p> <p>a. Open circuit between control assy. b. Start/Stop (S1) switch faulty.</p>	<p>1a. Check wiring continuity between control assembly (A1) and remote Start/Stop switch.</p> <p>1b. Check remote Start/Stop switch.</p> <p>2a. Stop switch (S1). (A1) and Start/Stop switch (S1).</p> <p>7-5</p>	<p>Check</p> <p>2b.</p>

### Begin Spec B Start - Cranking Mode

Battery positive (B+) is supplied to the control assembly (A1) through control fuse (F1). Holding the Start/Stop switch (S1) in the Start position activates control assembly (A1) by closing the start signal input circuit. While the Start/Stop switch is held, the control assembly supplies the following outputs:

- Battery positive (B+) is supplied to the start relay coil (K1). This energizes the start relay. The start relay contacts close supplying battery positive (B+) to the starter motor B1. The starter begins to crank the engine to initiate starting.

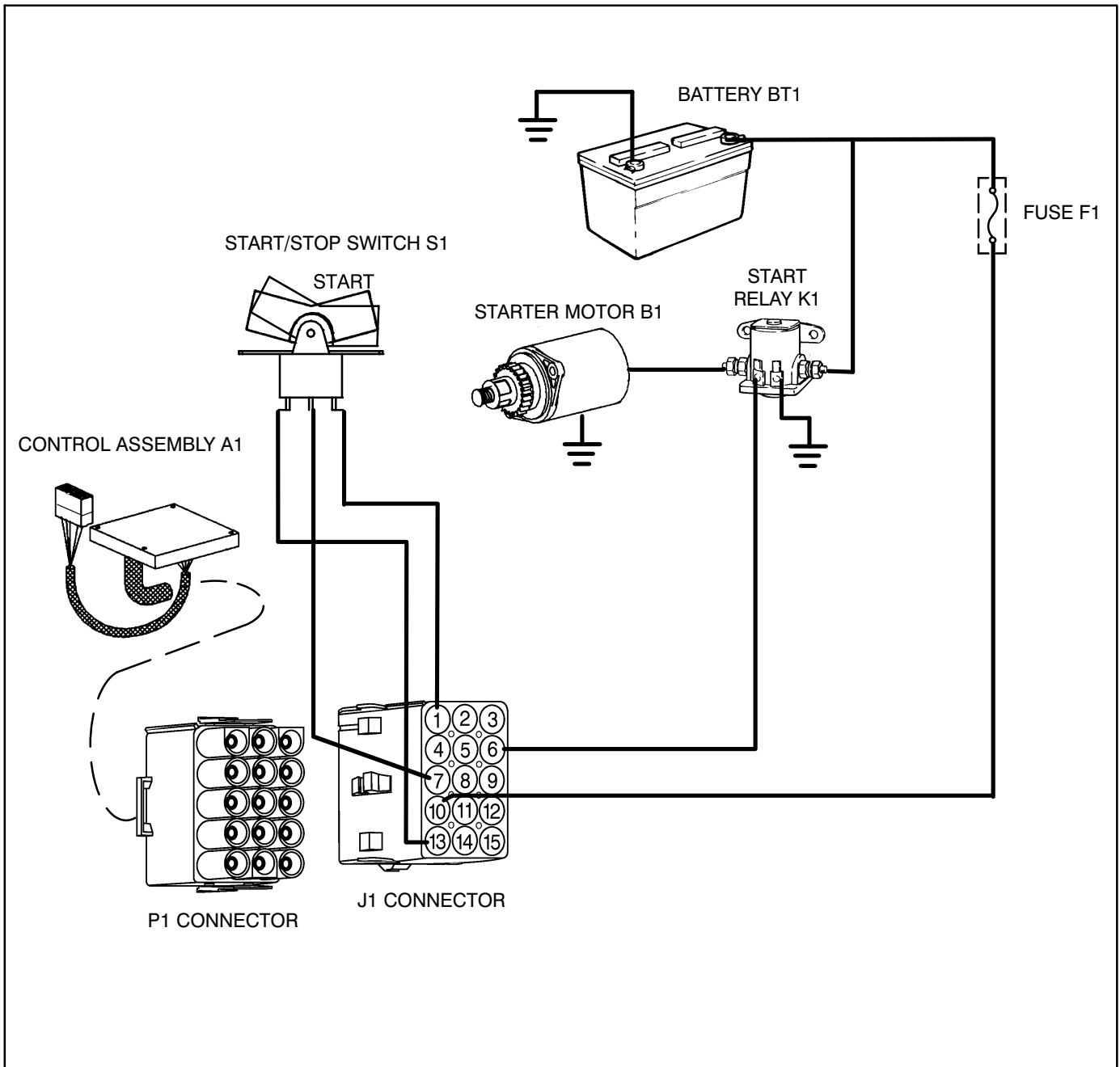


FIGURE 6-9. SPEC B START - CRANKING MODE

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-7. BEGIN SPEC B CONTROL TROUBLESHOOTING – CRANKING MODE**

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Does Not Crank	<ol style="list-style-type: none"> <li>1. Open control fuse F1.</li> <li>2. Insufficient cranking voltage due to: (Also see Table 6-11 on page 6-25)               <ol style="list-style-type: none"> <li>a. Battery not charged.</li> <li>b. Battery connections loose or dirty.</li> <li>c. Battery cable size too small.</li> </ol> </li> <li>3. Start solenoid (K1) not energized due to:               <ol style="list-style-type: none"> <li>a. Open circuit to start solenoid coil.</li> <li>b. Defective start solenoid coil.</li> <li>c. Defective Start/Stop switch.</li> <li>d. Defective control assembly (A1).</li> </ol> </li> <li>4. Starter (B1) not energized due to:               <ol style="list-style-type: none"> <li>a. Open circuit to starter (B1).</li> <li>b. Open circuit between battery (B+) and the start solenoid contact (BAT).</li> <li>c. Defective start solenoid (K1) .</li> <li>d. Defective starter (B1).</li> </ol> </li> <li>5. If engine cranks from set but not from remote control panel, fault is due to:               <ol style="list-style-type: none"> <li>a. Open circuit between control assy. (A1) and remote Start/Stop switch.</li> <li>b. Remote Start/Stop switch faulty.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Check fuse. If open, locate and correct cause of overload. Replace fuse.</li> <li>2a. Check condition of battery and recharge or replace.</li> <li>2b. Clean and tighten all connections at battery, K1 start solenoid, and starter motor.</li> <li>2c. Increase starting battery cable size.</li> <li>3a. Check wiring continuity to the start solenoid (K1) coil from control assy. (A1) and from ground to start solenoid.</li> <li>3b. Test start solenoid (K1).</li> <li>3c. Test Start/Stop switch (S1).</li> <li>3d. Measure voltage between start solenoid terminal I and ground with switch (S1) held in the Start position. If voltage is not present and continuity and battery check OK, Cont. assy. (A1) is defective.</li> <li>4a. Check continuity between starter lead on start solenoid (S) and gnd. (4 ±1 ohm).</li> <li>4b. Check wiring continuity between battery (B+) and the start solenoid (BAT).</li> <li>4c. Measure voltage between starter terminal and ground with switch (S1) held in the Start position. If voltage is not present and continuity checks OK, start solenoid (K1) is defective.</li> <li>4d. If voltage is present in step 4c, starter is defective.</li> <li>5a. Check wiring continuity between control assembly (A1) and remote Start/Stop switch.</li> <li>5b. Test remote Start/Stop switch.</li> </ol>	<p>7-6 7-5 7-6 7-6 8-26</p>

### Begin Spec B Start - Ignition Mode

Holding the Start/Stop switch (S1) in the Start position activates the following ignition circuit:

- Control assembly (A1) enables the ignition circuit to open a ground path through the control assembly to the magneto assembly (G2) so that output from the magneto will energize the ignition coil (T1).
- With the engine cranking, a permanent magnet in the flywheel rotates, at the proper time, past the magneto to induce a voltage at the ignition coil (T1) that fires the spark plug (E1) for ignition.
- Battery positive (B+) is supplied to fuel pump (E2), fuel shutoff solenoid (E3) and regulator (K2) on LPG models. (Schematic for gasoline fueled model shown.)

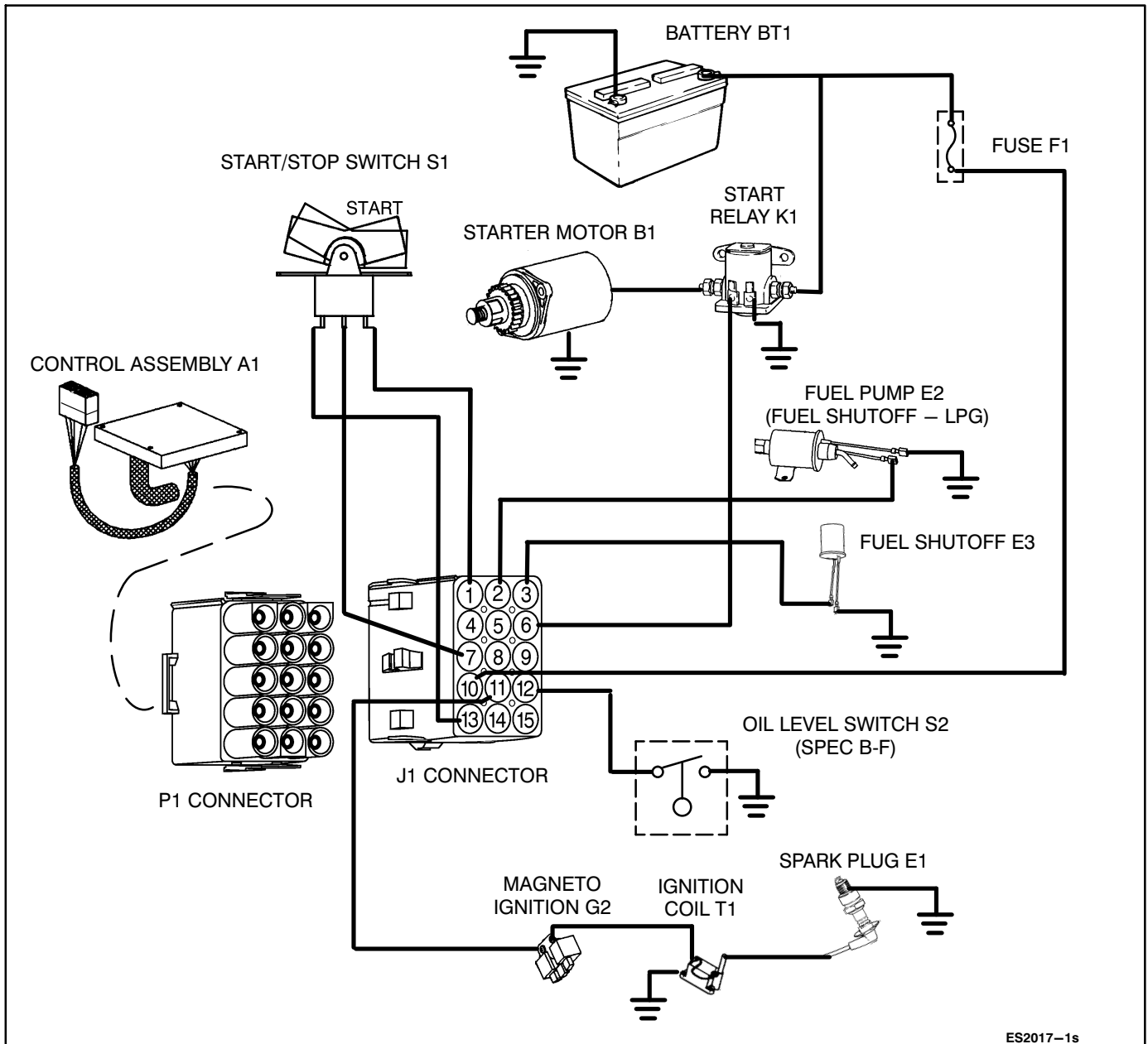


FIGURE 6-10. SPEC B START - IGNITION MODE



**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-8. BEGIN SPEC B CONTROL TROUBLESHOOTING – IGNITION MODE**

<b>Trouble</b>	<b>Possible Cause</b>	<b>Corrective Action</b>	<b>Section/ Page</b>
Engine Cranks But Does Not Start	1. Restricted fuel supply due to: a. Fuel level below pickup tube in tank. b. Fuel line supply valve closed. c. Fuel filter clogged.	1a. Add fuel if tank is low. 1b. Open fuel supply valve (if equipped). 1c. Replace clogged fuel filter and check fuel supply for contamination.	8-19
	2. Faulty ignition due to worn or fouled spark plug, faulty plug wire, faulty ignition coil or magneto.	2. Refer to <i>Ignition System</i> for test and service procedures.	8-6
	3. Sticking choke or carburetor mixture screws incorrectly adjusted.	3. Refer to <i>Gasoline Fuel System</i> for adjustments.	8-11
	4. Fuel pump (E2) not working due to: a. Fuel pump defective. b. Open circuit between fuel pump and control assembly (A1) or control assembly is defective.	4a. Measure voltage between fuel pump connector and ground with the engine cranking. If B+ voltage is not present, proceed to 4b. If voltage is present, (min. 6 VDC) fuel pump is defective. 4b. Check continuity between control assembly and fuel pump. If connections are good and voltage was not measured in 4a, replace control assembly (A1).	8-19
	5. Fuel shutoff solenoid (E3) not energized.	5. Measure voltage at fuel shutoff sol. (E3) terminals with the engine cranking. If B+ voltage is not present, check the wiring connections and control assembly A1 output test. If voltage is present (min. 6 VDC) and engine is not receiving fuel, fuel shutoff solenoid is defective.	8-24
	6. Faulty fuel solenoid, priming solenoid, or regulator on LPG models.	6. Refer to <i>LPG Fuel System</i> for service procedures.	8-22
	7. Governor linkage stuck or binding.	7. Check governor arm movement. See <i>Governor</i> section.	8-9
	8. Oil level switch (S2) (Spec B-F, if applicable) closed due to: a. Low oil level. b. Defective low oil level switch.	8a. Check oil level and add oil if low. 8b. Check low oil level switch.	10-2

### Begin Spec B Start - Field Flash Mode

Holding the Start/Stop switch (S1) in the Start position activates the following field flash circuit:

- Battery positive (B+) is supplied to the control assembly (A1) and the voltage regulator (VR1) at pin 7. From pins 9 and 10 of the voltage regulator, excitation voltage is sensed through the brushes at the rotor field winding.
- The excitation voltage flashes the generator field winding to ensure that there is adequate magnetism to induce generator voltage buildup.

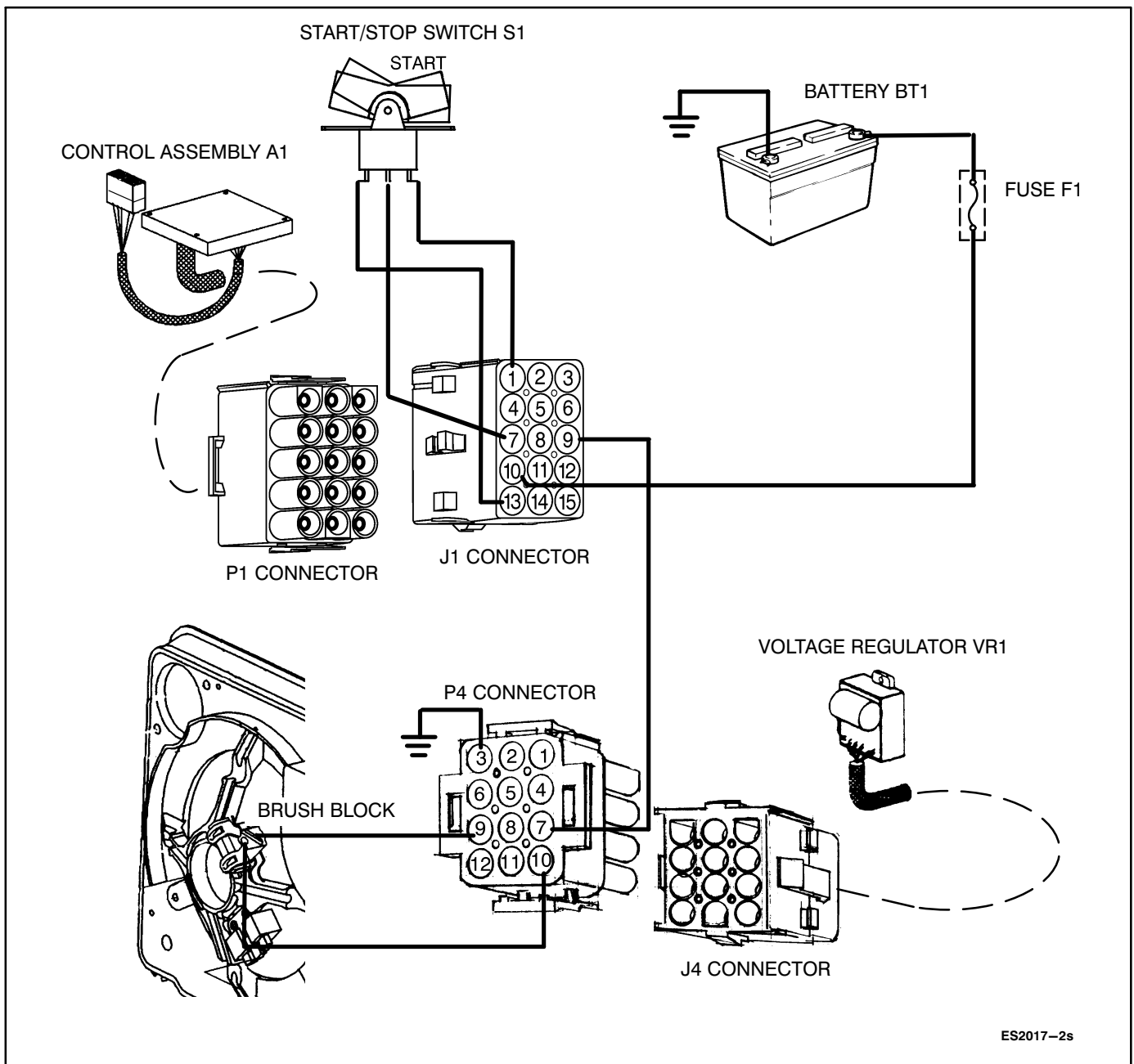


FIGURE 6-11. SPEC B START - FIELD FLASH MODE

**⚠ WARNING** *Many troubleshooting procedures present hazards that 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 page iii.*

**TABLE 6-9. BEGIN SPEC B CONTROL TROUBLESHOOTING – FIELD FLASH MODE**

<b>Trouble</b>	<b>Possible Cause</b>	<b>Corrective Action</b>	<b>Section/ Page</b>
Engine Starts But Stops When Start Switch Is Released	1. Low oil level.	1. Check oil level and add oil if low.	10-2
	2. Defective low oil level switch (Spec B-F, if applicable).	2. Disconnect low oil level switch and check set operation. Replace if defective.	
	3. No field flash voltage due to: a. Open circuit in wiring. b. Brushes not making good contact with slip rings. c. Slip ring surface is rough or pitted.	3a. Check wiring continuity to the brush block F1-F2, voltage regulator VR1, control assembly A1 and generator B1-B2 (50 Hz) and Q1-Q2 windings. Check connections of P5 and P6 connectors on the generator housing.	9-8
		3b. Check brushes for wear and for contact with the slip rings.	9-12
3c. Check the slip rings.			
4. Defective generator, control assembly A1, or voltage regulator VR1.	4. Perform field voltage test.	9-8	

### Begin Spec B Run Mode

When the engine starts, release the Start/Stop switch and it will return to the center Run position. The following events occur:

- Control assembly (A1) opens the circuit to the start solenoid (K1), which opens the circuit to the starter motor (M1) to stop cranking. Control assembly (A1) also opens the field flash circuit to AVR pin 7.
- 50 Hz models only: Voltage from the battery, used to power the control assembly (A1) and the fuel pump (E2), is replaced with output voltage from the generator charge winding B1-B2. (Refer to *Battery Charge Mode* on page 6-24.)
- The control assembly senses output voltage from L1 (X1 50-Hertz) for the start disconnect function.
- Remote run output is energized through the control assembly (A1) to power the time meter, battery condition meter and run lamp in the optional remote control .
- Voltage from the generator Q1-Q2 winding provides power to the voltage regulator VR1 to use for supplying field current to the generator. (Refer to *Generator AC Output Mode* on page 6-30.)

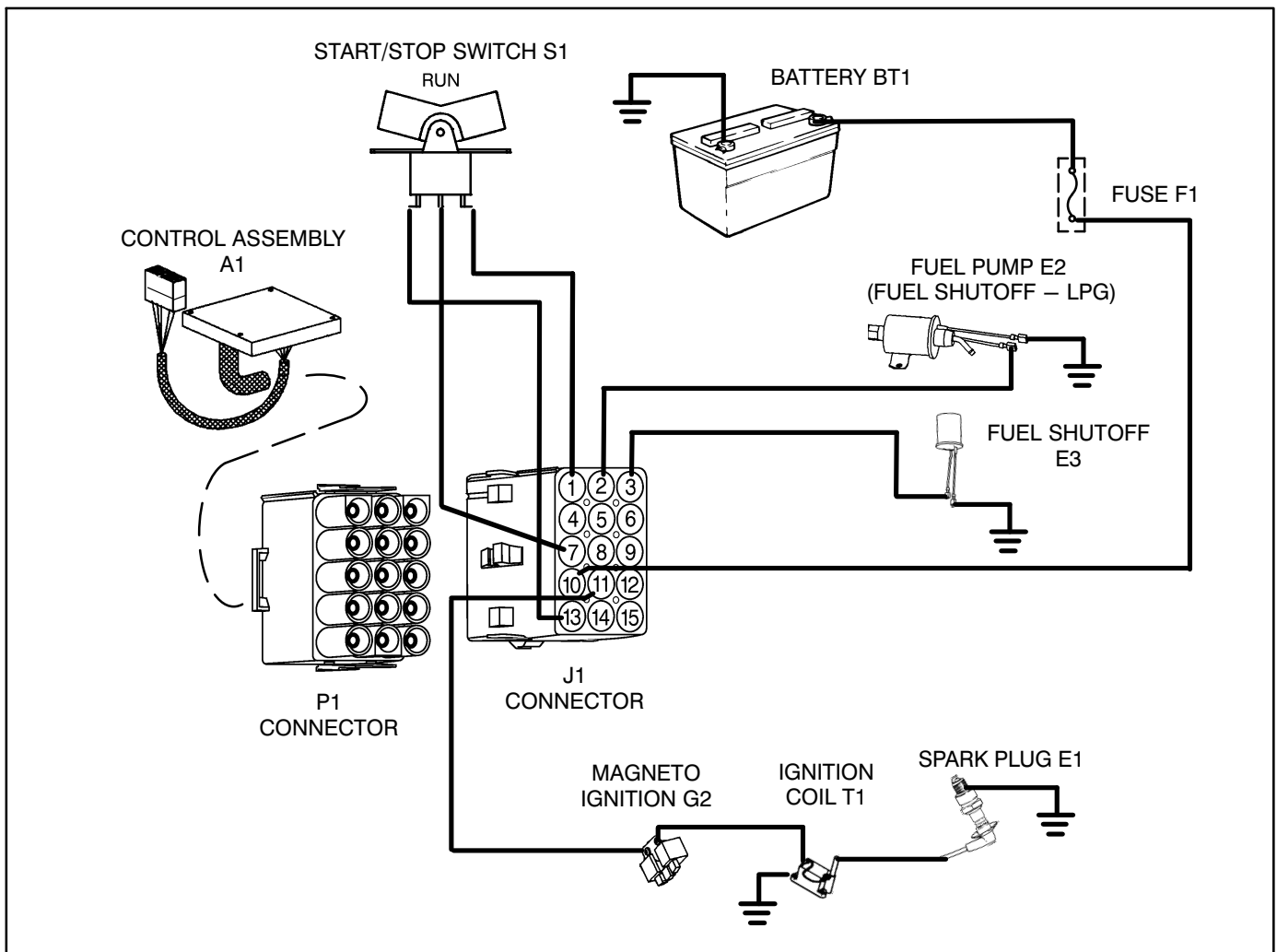


FIGURE 6-12. SPEC B RUN MODE

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-10. BEGIN SPEC B CONTROL TROUBLESHOOTING – RUN MODE**

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Starts and Runs, Then Stops. Set Restarts Immediately or After Cool Down.	<ol style="list-style-type: none"> <li>1. Fuel level is below generator set fuel pickup tube or oil level is low.</li> <li>2. Faulty choke operation.</li> <li>3. Vapor lock from high ambient temperature.</li> <li>4. Contaminated or incorrect fuel.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check fuel and oil level and refill if low.</li> <li>2. Refer to choke section for adjustments.</li> <li>3. Remove any objects or debris that may restrict airflow. Make sure fuel system is installed correctly.</li> <li>4. Refill tank with fresh fuel.</li> </ol>	8-17
Remote Control Run Lamp, Time Meter, or Battery Condition Meter Inoperative	<ol style="list-style-type: none"> <li>1. Open circuit in remote control wiring.</li> <li>2. If battery condition meter and run lamp work but time meter does not, time meter is defective.</li> <li>3. If time meter works but battery condition meter does not operate:               <ol style="list-style-type: none"> <li>a. Defective battery condition meter.</li> <li>b. Defective zener diode inside remote control.</li> </ol> </li> <li>4. Meters and switch function properly but run lamp does not illuminate. Lamp (internal to switch) is burned out.</li> <li>5. If remote switch functions properly for starting and stopping generator set but meters and run lamp do not operate, and step 1 checks OK, control assy. (A1) defective.</li> <li>6. Too much DC load (over 2–amps) connected to the remote output.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check continuity between remote control and control assembly (A1).</li> <li>2. Replace time meter.</li> <li>3a. Connect a voltmeter between the positive terminal on battery charge meter and ground. Use the following to determine fault: If reading equals battery voltage minus 10 volts, battery condition meter is defective.</li> <li>3b. If reading does not equal battery voltage minus 10 volts, zener diode is defective.</li> <li>4. Replace remote Start/Stop switch (S2).</li> <li>5. Check remote running output voltage (approximately 12 VDC) during run condition from control assembly J2-5 to ground and from J2-6 to ground. If voltage is not present, replace control assembly (A1). If voltage is present, check continuity of remote control wiring.</li> <li>6. Turn off the generator set, disconnect the remote control, and check for shorts or too many remote accessories.</li> </ol>	

### Begin Spec B Battery Charge Mode – 50 Hz Only

With the generator set running, AC voltage is produced in the B1-B2 windings for the battery charge circuit in the 50 Hz models only. The 60 Hz Spec B models do not have battery charging.

- The AC output voltage from the B1-B2 winding is converted to DC voltage when it passes through the battery charger assembly (VR2). The 12-volt DC output (ten-ampere maximum) is used to charge the battery and supply power to the control assembly (A1) and its outputs.

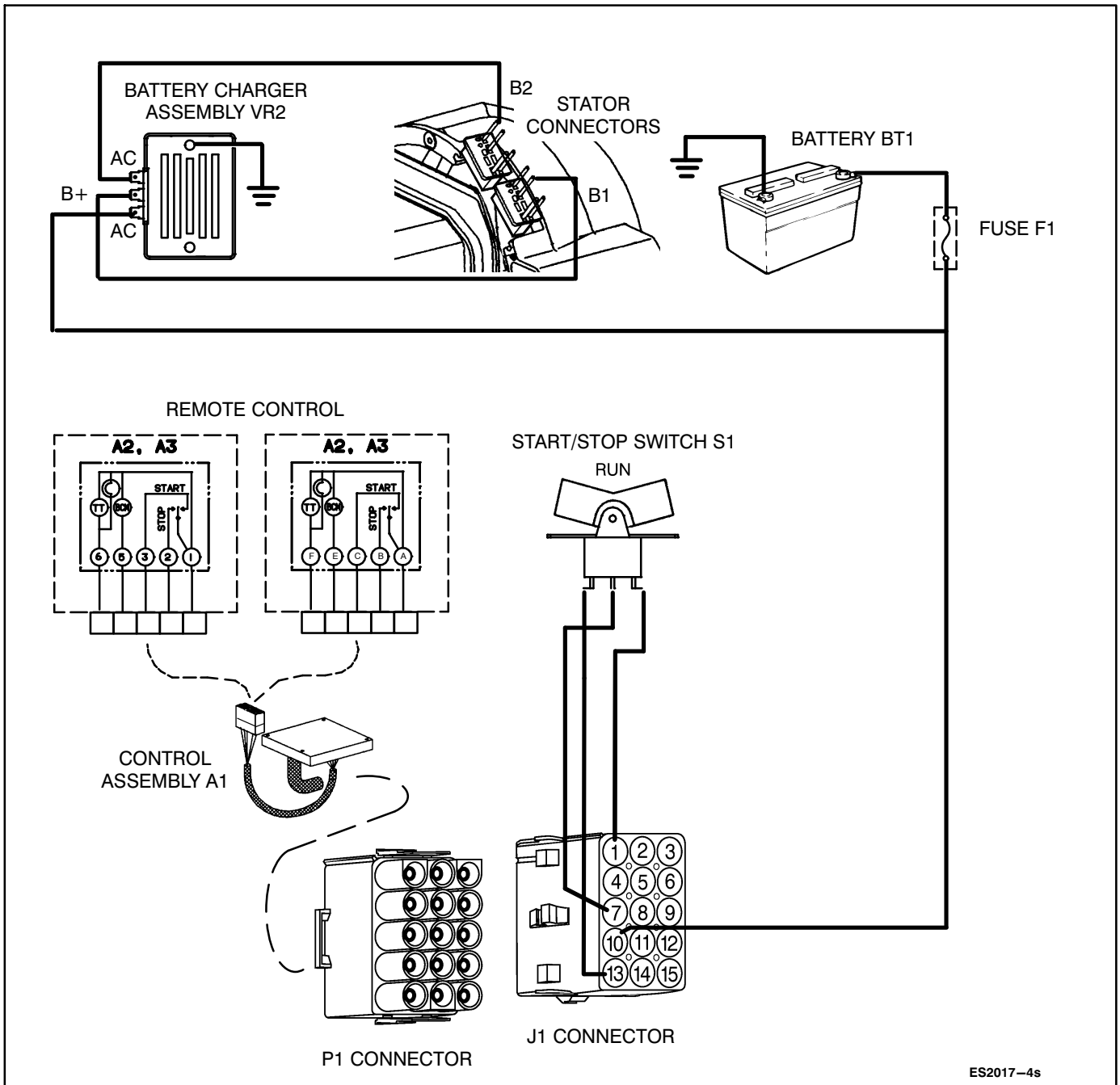


FIGURE 6-13. SPEC B BATTERY CHARGE MODE – 50 Hz MODELS ONLY

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-11. BEGIN SPEC B CONTROL TROUBLESHOOTING – BATTERY CHARGE MODE**

Trouble	Possible Cause	Corrective Action	Section/ Page
Low Battery Voltage	<p>1. Weak or discharged battery due to:</p> <ul style="list-style-type: none"> <li>a. No battery charging.</li> <li>b. Low electrolyte level in battery.</li> <li>c. Long periods of non-use.</li> <li>d. Improperly wired battery.</li> <li>e. Load connected to battery while generator set is turned off.</li> <li>f. Too much DC load on generator set starting battery.</li> </ul> <p>2. 50 Hertz only: generator set charging circuit not functioning due to:</p> <ul style="list-style-type: none"> <li>a. Open wire connection in charging circuit (see Figure 6-13).</li> <li>b. Battery Charger (ZR2) defective.</li> <li>c. Generator B1-B2 defective.</li> </ul>	<ul style="list-style-type: none"> <li>1a. Spec B 60-Hz models require a battery charger. These models do not have a battery charge winding.</li> <li>1b. Replenish electrolyte and recharge battery.</li> <li>1c. Connect a separate battery charger to bring battery up to full charge.</li> <li>1d. Reconnect and check battery connection.</li> <li>1e. Disconnect load and recharge battery.</li> <li>1f. Remove other DC loads from generator set starting battery.</li> <li>2a. Check all wiring connections between the generator B1-B2 windings and the Battery B+ connection, including all connections to battery charger (VR2).</li> <li>2b. Refer to battery charger (VR2) test.</li> <li>2c. Refer to generator test section.</li> </ul>	<p>7-9 9-8</p>
<p><b>NOTE: The battery charging circuit is not available on the Spec B (or later) 60 Hz models. Spec B 50 Hz models have a maximum 10-amp, 12-VDC output designed to maintain and charge the generator set starting battery.</b></p>			

### Begin Spec B Stop Mode

Momentarily pushing the Start/Stop switch (S1) to the Stop position begins the stop mode with the following results:

- Control assembly (A1) de-energizes the ignition enable circuit, grounding the magneto (G2) ignition circuit to stop the engine.
- Control assembly (A1) also opens the circuit to the fuel pump (E2), the fuel shutoff solenoid (E3), and to the remote control.
- Control assembly (A1) start disconnect senses a drop in voltage from the output voltage and activates the remote stop latch to prevent restart during the stop mode.

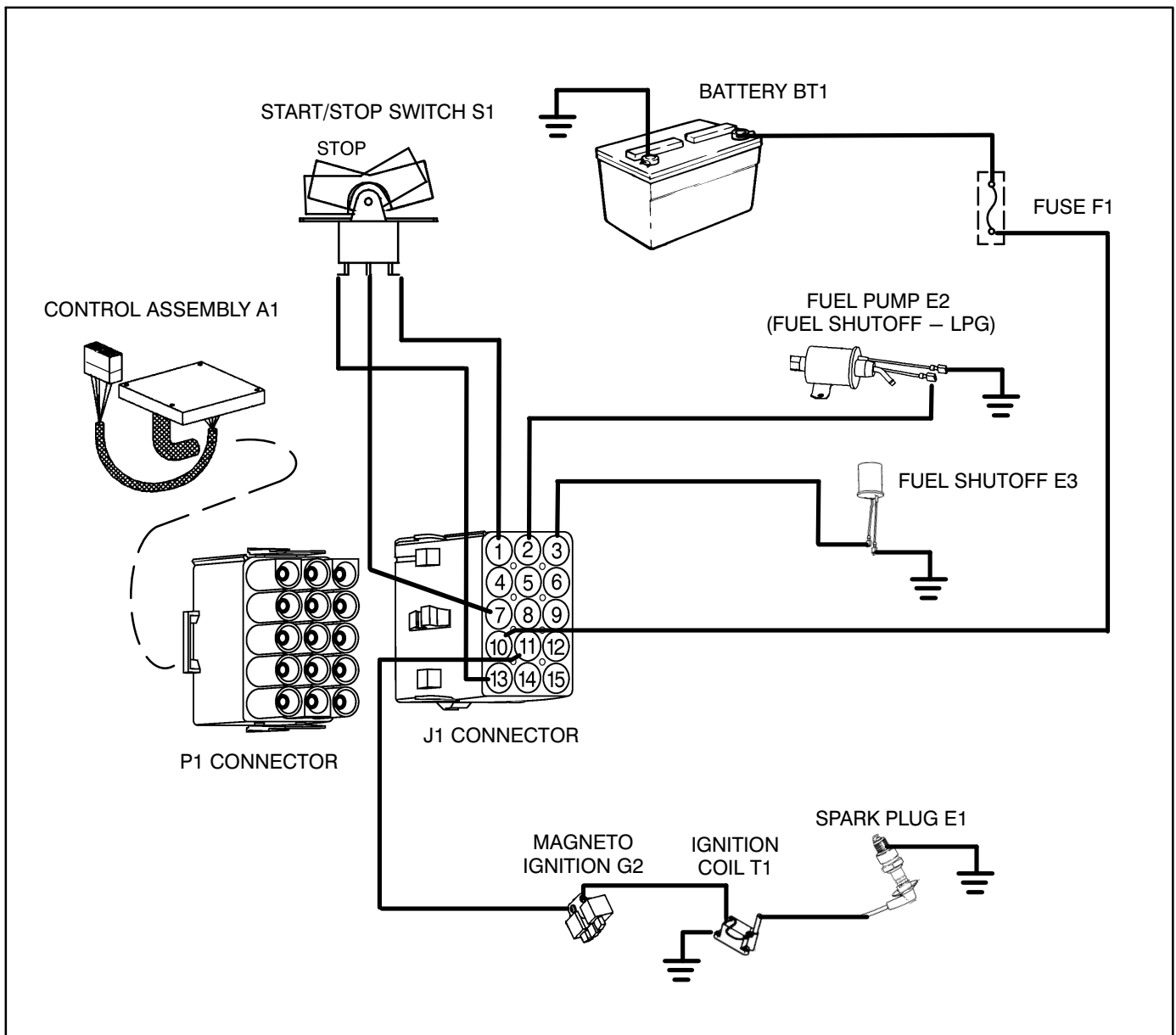


FIGURE 6-14. SPEC B STOP MODE



**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-12. BEGIN SPEC B CONTROL TROUBLESHOOTING – STOP MODE**

Trouble	Possible Cause	Corrective Action	Section/ Page
<p>generator set Does Not Stop When Switch Is Pushed To Stop</p> <p><b>Always remove the load a few wiring continuity minutes before control assembly (A1) and Start/ generator set to allow</b></p> <p>Check Start/Stop switch (S1). cool down.</p>	<p>1. If set can be stopped from set control but not from remote control panel, fault is due to:</p> <p>a. Open circuit between control assy. (A1) and remote Start/Stop switch. b. Remote Start/Stop switch faulty.</p> <p>2. If generator set can be stopped from remote control but not from generator set, fault due to:</p> <p>a. Open circuit between control assy. b. Start/Stop (S1) switch faulty.</p>	<p>1a. Check wiring continuity between control assembly (A1) and remote Start/Stop switch.</p> <p>1b. Check remote Start/Stop switch.</p> <p>2a. Stop switch (S1). (A1) and Start/Stop switch (S1).</p> <p>7-5</p>	<p>Check</p> <p>2b.</p>

## GENERATOR TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the generator. Figures 6-1

and 6-2 on pages 6-2 and 6-3 show the location of the generator components. Refer to the wiring diagrams in Section 12. *Wiring Schematic/Diagram* for wiring connections.

**⚠️WARNING** *Many troubleshooting procedures present hazards that 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 page iii.*

**TABLE 6-13. GENERATOR TROUBLESHOOTING**

Trouble	Possible Cause	Corrective Action	Section/ Page	
<p>No AC Output Voltage</p> <p>Note: This condition may cause the generator set to stop when start switch S1 is released.</p>	1. Open circuit breaker.	1. Locate cause of overload and correct as required. Reset breaker.		
	2. Open circuit between voltage regulator and brush block.	2. Check for good wiring connections between regulator and brush block.		
	3. Open circuit between stator connections Q1 or Q2 and voltage regulator. (This condition will give approx. 30 VAC output voltage in start mode.)	3. Check for good wiring connections between regulator and stator.		
	4. Open circuit between battery Pos. (+) and voltage regulator pin 7 for field flash.	4. Check for continuity between control connector P1-5 and regulator connector P4-7 (Spec A) or J1-9 to P4-7 (Spec B) If connections are good and 12 VDC is not present at voltage regulator pin 7 during start, control assembly A1 is defective.		
	5. Brushes not making good contact with slip rings.	5. Check brushes for wear and for contact.		9-12
	6. Slip ring surface is rough or pitted.	6. Check slip rings.		
	7. Defective generator, control assembly A1, or voltage regulator VR1.	7. Perform field voltage test.		9-8
<p>AC Output Voltage Too Low</p>	1. Engine governor out of adjustment.	1. Refer to governor adjustments in Section 8.	8-9	
	2. Brushes worn or not making good contact with slip rings.	2. Check length of brushes and replace if worn excessively. Check slip rings.	9-12	
	3. Poor wiring connections to voltage regulator.	3. Check for good wiring connections between the voltage regulator and the brush block and between stator connections Q1 and Q2. Correct if required.		
	4. If generator frequency is within specified limits but voltage is incorrect, voltage regulator is defective.	4. Replace electronic voltage regulator.		

### Spec A Generator AC Output Mode

When the engine starts and begins to come up to speed, AC voltage is produced in the battery charge winding B1-B2, the quadrature winding Q1-Q2 and in the AC windings T1-T2. These outputs perform the following functions:

- The battery charge winding B1-B2 is used to power the control assembly (A1), fuel pump (E2), the remote control, and to prevent discharge of the generator set starting battery during generator set operation. This output is not sufficient to charge a low or dead battery. The control assembly A1 monitors this voltage as part of the start disconnect function.
- The quadrature winding Q1-Q2 output voltage is fed to the voltage regulator VR1 where it is rectified into DC voltage and fed back to the rotor through the brushes to cause further voltage buildup. Voltage buildup is controlled by the voltage regulator that senses the AC output voltage. The regulator continually measures the output voltage and compares it to an internal reference voltage. When the output voltage exceeds the reference, the regulator causes the current in the rotor to decrease until the proper voltage is obtained.
- The AC windings T1-T2 provide the 120 VAC output voltage through the circuit breaker CB1.

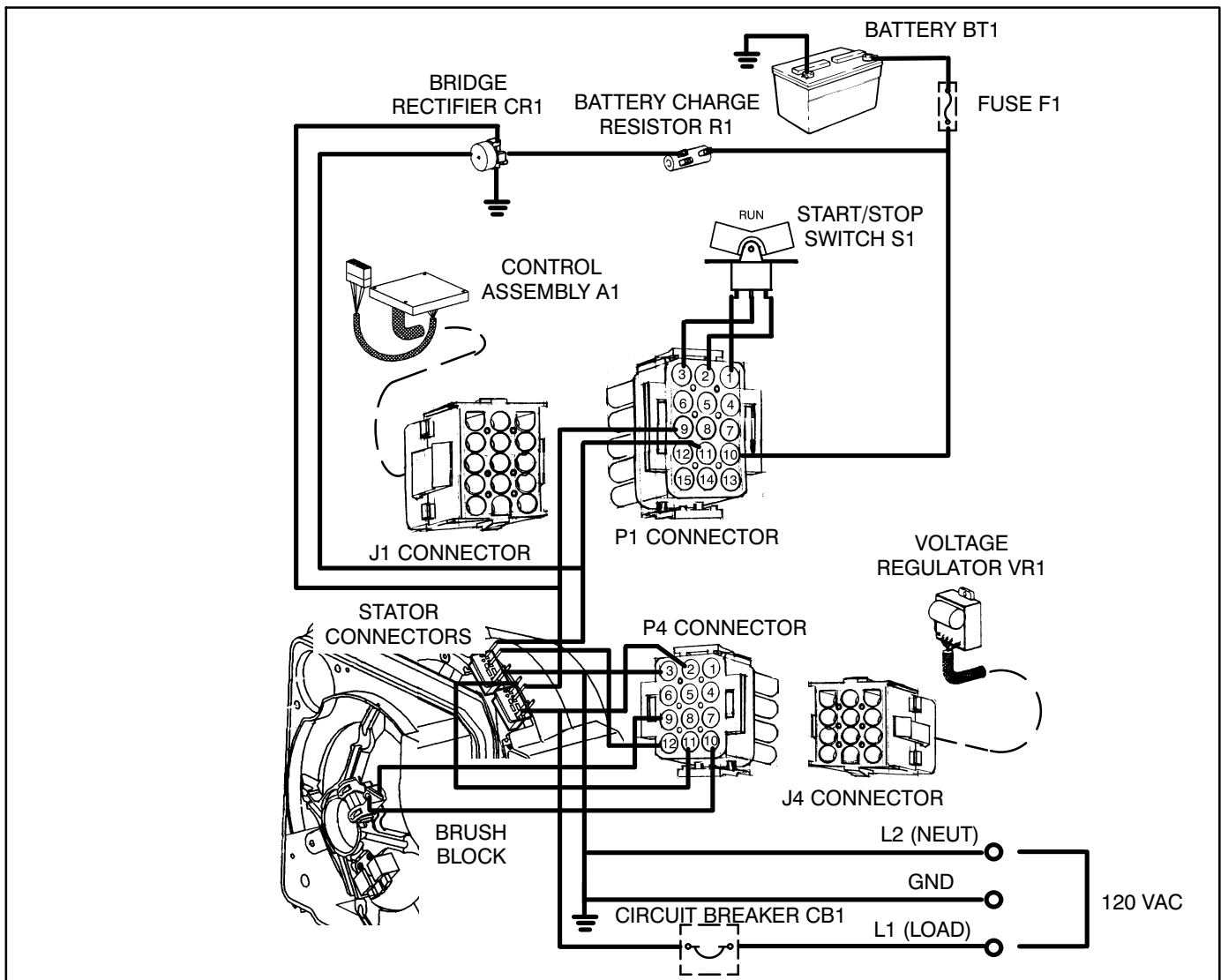


FIGURE 6-15. SPEC A GENERATOR OUTPUT MODE

### Spec B Generator AC Output Mode

When the engine starts and begins to come up to speed, AC voltage is produced in the battery charge winding B1-B2 (50 Hz only), the quadrature winding Q1-Q2 and in the AC windings T1-T2 (T3-T4 50 HZ). These outputs perform as follows:

- The battery charge winding B1-B2 is provided on the 50 Hz models only to power battery charger (VR2).
- The quadrature winding Q1-Q2 output voltage is fed to the voltage regulator VR1 where it is rectified into DC voltage and fed back to the rotor through the brushes to cause further voltage buildup. Voltage buildup is controlled by the voltage regulator that senses the AC output voltage. The regulator continually measures the output voltage and compares it to an internal reference voltage. When the output voltage exceeds the reference, the regulator causes the current in the rotor to decrease until the proper voltage is obtained.
- The AC windings T1-T2 provide the output AC voltage (60 Hz models) or T1-T2, T3-T4 (50 Hz models) through the circuit breaker CB1.

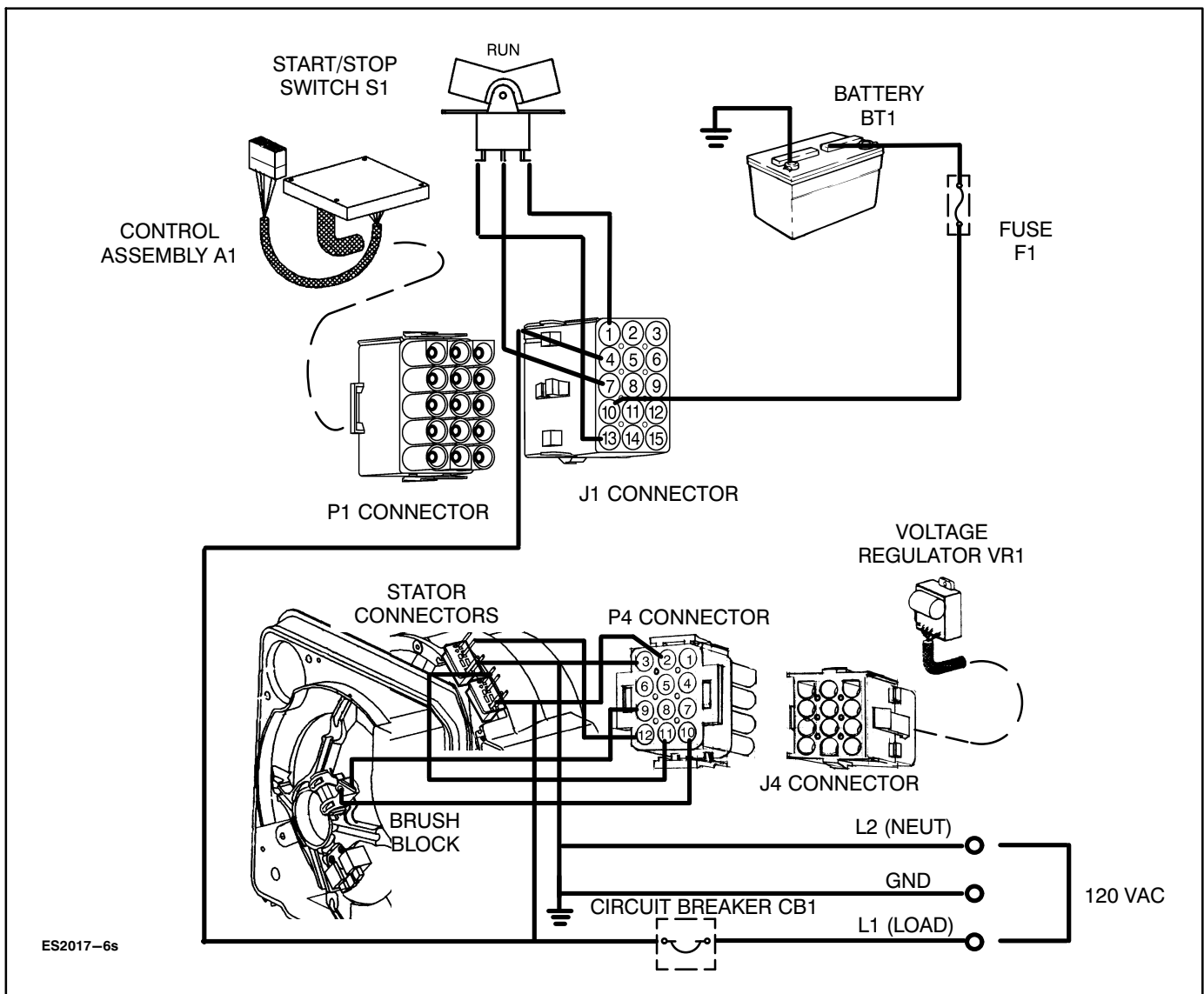


FIGURE 6-16. SPEC B GENERATOR OUTPUT MODE (60 HERTZ MODEL SHOWN)

**⚠️ 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 page iii.

**TABLE 6-14. GENERATOR TROUBLESHOOTING**

<b>Trouble</b>	<b>Possible Cause</b>	<b>Corrective Action</b>	<b>Section/ Page</b>
AC Output Voltage Too High	<ol style="list-style-type: none"> <li>1. Engine governor out of adjustment.</li> <li>2. If generator frequency is within specified limits but voltage is incorrect, electronic voltage regulator is defective.</li> </ol>	<ol style="list-style-type: none"> <li>1. Refer to <i>Governor Adjustments</i></li> <li>2. Refer to Table 8-1 for voltage/frequency specs. Replace electronic voltage regulator.</li> </ol>	8-9
Noisy Generator	<ol style="list-style-type: none"> <li>1. Loose brush holder.</li> <li>2. Worn rotor bearing.</li> <li>3. Rotor and stator rubbing together due to:               <ol style="list-style-type: none"> <li>a. Varnish lumps.</li> <li>b. Rotor misaligned with crankshaft.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Tighten brush holder.</li> <li>2. Replace rotor bearing.</li> <li>3a. Check for varnish lumps between rotor and stator, remove as required.</li> <li>3b. Follow specified assembly procedures to correct rotor to crankshaft alignment.</li> </ol>	9-13    9-7
Generator Overheats	<ol style="list-style-type: none"> <li>1. Generator overloaded due to defective circuit breaker.</li> <li>2. Airflow restricted due to dirt or debris covering vent openings in stator housing.</li> <li>3. Stator windings covered with oil or dirt.</li> <li>4. Defective rotor or stator windings.</li> <li>5. Loose or missing service access cover or improper seal around the endbell assembly.</li> <li>6. Improper installation due to:               <ol style="list-style-type: none"> <li>a. Insufficient air inlet size.</li> <li>b. Air inlet location allowing recirculation.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Replace circuit breaker. Do not exceed specified load when operating generator set.</li> <li>2. Clear away all dirt or debris as required.</li> <li>3. Clean stator windings.</li> <li>4. Test each component for open, grounded, or shorted windings and replace if defective.</li> <li>5. Check for proper fit of service access cover and check seal around endbell.</li> <li>6a. Make sure air inlet is not blocked and that it is properly sized (refer to Installation Manual).</li> <li>6b. Make sure that air outlet is not blocked and check for recirculation of outlet air.</li> </ol>	9-8

## ENGINE PRIMARY SYSTEMS TROUBLESHOOTING

Use the following troubleshooting guide to locate problems with the engine primary systems. Many of the primary systems can be serviced without removing the generator set from the vehicle.

**⚠ WARNING** *Many troubleshooting procedures present hazards that 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 page iii.*

Poor engine performance is often caused by a dirty carburetor. Make certain that the carburetor is clean before troubleshooting for performance problems.

**TABLE 6-15. TROUBLESHOOTING ENGINE PRIMARY SYSTEMS**

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Runs Rough:	1. Dirty air or fuel filter.	1. Check and replace if necessary.	
	2. Contaminated fuel.	2. Drain fuel tank, clean the fuel system and refill with fresh fuel.	
	3. Lean fuel mixture due to: a. Incorrectly adjusted Fuel mixture screws. b. Dirt in carburetor. c. Vacuum leak.	3a. Adjust carburetor main and idle adjustment screws. 3b. Disassemble carburetor and clean all internal passages. Replace filter. 3c. Locate and correct leak. 3d. Replace gasket.	8-14 8-15
	4. Faulty ignition due to: a. Worn or fouled spark plug. b. Poor magneto or coil connections. c. Faulty ignition components. d. Faulty plug wire. e. Incorrect ignition timing.	4a. Replace spark plug. 4b. Check magneto and coil connections. 4c. Perform Ignition Spark Check. 4d. Check spark plug wire and boot. 4e. Rotor or fan hub improperly installed.	8-6
Engine Backfires Through Carburetor	1. Lean fuel mixture due to: a. Incorrectly adjusted fuel adjustment screws. b. Dirt in carburetor. c. Vacuum leak.	1a. Adjust carburetor main and idle mixture screws. 1b. Disassemble carburetor and clean all internal passages. 1c. Locate and correct leak.	8-14 8-15
	2. Mechanical engine defect (intake valve defect).	2. Perform Leak Down Test.	10-1
	3. Faulty ignition due to: incorrect spark plug gap.	3. Reset spark plug gap.	

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-16. TROUBLESHOOTING ENGINE PRIMARY SYSTEMS**

<b>Trouble</b>	<b>Possible Cause</b>	<b>Corrective Action</b>	<b>Section/ Page</b>
Engine Backfires Through Muffler When Running	1. Rich fuel mixture due to: a. Incorrectly adjusted fuel adjustment screws. b. Choke sticking or out of adjustment. c. Restricted air filter (LPG models).	1a. Adjust carburetor main and idle mixture screws.	8-14
		1b. Check choke assembly.	8-17
		1c. Replace air filter.	8-11
	2. Mechanical engine defect (exhaust valve defect).	2. Perform Leak Down Test.	10-1
	3. Faulty ignition due to: Incorrect spark plug gap.	3. Reset spark plug gap.	
Engine Lacks Power	1. Dirty air filter.	1. Replace air filter.	8-11
	2. Restricted fuel flow due to: a. Plugged fuel filter or b. Faulty fuel pump c. LPG - regulator or fuel solenoid dirty or defective.	2a. Replace fuel filter.	8-19
		2b. Test fuel pump and replace if faulty.	8-19
		2c. Refer to LPG Fuel System, section 8.	
	3. Exhaust system blocked or restricted.	3. Locate and remove blockage, clean spark arrester screen.	
	4. Carburetor air preheater set incorrectly.	4. Check automatic preheater setting.	8-11
	5. No load speed set too low.	5. Adjust governor setting.	8-9
	6. Incorrect fuel mixture due to: a. Incorrectly adjusted fuel mixture screws. b. Dirt or varnish in carburetor.	6a. Adjust carburetor main and idle adjustment screws.	8-14
6b. Disassemble carburetor and clean all internal passages.		8-15	
7. Incorrect valve lifter clearance or defective valve.	7. Adjust valve clearance, if problem continues inspect valves.	10-7	
8. Excessive engine wear.	8. Perform Leak Down Test.	10-1	

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

**TABLE 6-17. TROUBLESHOOTING ENGINE PRIMARY SYSTEMS**

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Overheats	<ol style="list-style-type: none"> <li>1. Restricted airflow due to dirt, debris or insulation blocking air inlet or outlet.</li> <li>2. Dirt or oil on engine cooling fins.</li> <li>3. mCooling fan plugged or broken.</li> <li>4. Lean fuel mixture due to:               <ol style="list-style-type: none"> <li>a. Incorrectly adjusted fuel mixture screws.</li> <li>b. Dirt or varnish in carburetor.</li> </ol> </li> <li>5. Loose or missing service access cover or improper seal around the endbell assembly.</li> <li>6. Improper installation due to:               <ol style="list-style-type: none"> <li>a. Insufficient air inlet size.</li> <li>b. Air inlet location allowing recirculation.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Clear air inlet and outlet areas. Do not store anything in compartment area.</li> <li>2. Clean all dirt and oil from engine cooling fins.</li> <li>3. Inspect cooling fan, clean or replace as needed,</li> <li>4a. Adjust carburetor main and idle adjustment screws.</li> <li>4b. Disassemble carburetor and clean all internal passages.</li> <li>5. Check for proper fit of service access cover and check seal around endbell.</li> <li>6a. Make sure air inlet is not blocked and that it is properly sized (refer to Installation Manual).</li> <li>6b. Make sure that air outlet is not blocked and check for recirculation of outlet air.</li> </ol>	<p>8-14</p> <p>8-15</p>
Black Exhaust Smoke	<ol style="list-style-type: none"> <li>1. Rich fuel mixture due to:               <ol style="list-style-type: none"> <li>a. Dirty air filter.</li> <li>b. Choke sticking.</li> <li>c. Incorrectly adjusted fuel mixture screws.</li> <li>d. Dirt or varnish in carburetor.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1a. Replace air filter.</li> <li>1b. Clean choke and choke linkage.</li> <li>1c. Adjust carburetor idle and main adjustment screws.</li> <li>1d. Disassemble carburetor and clean all internal passages.</li> </ol>	<p>8-11</p> <p>8-14</p> <p>8-15</p>
White or Blue Exhaust Smoke	<ol style="list-style-type: none"> <li>1. Oil level too high.</li> <li>2. Contaminated fuel.</li> <li>3. Excessive engine wear.</li> </ol>	<ol style="list-style-type: none"> <li>1. Lower oil level.</li> <li>2. Drain and refill fuel tank.</li> <li>3. Perform Leak Down Test.</li> </ol>	<p>10-1</p>



**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

TABLE 6-18. TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Hunts or Surges	1. Fuel supply problem caused by: a. Faulty fuel pump. b. Contaminated fuel supply. c. Vapor locking.  d. Plugged fuel filter. e. Carburetor passages plugged.	1a. Check fuel pump and replace if defective.	8-19
		1b. Drain and refill fuel supply.	
		1c. Let generator set cool down. Check for blockage air inlet or outlet or improper fuel system installation.	
		1d. Replace fuel filter.	
		1e. Clean passages or replace pilot jet.	
	2. Incorrect fuel mixture due to: a. Incorrectly adjusted fuel mixture screws. b. Dirt or varnish in carburetor.	2a. Adjust carburetor main and idle adjustment screws.	8-13
		2b. Disassemble carburetor and clean all internal passages.	8-14
	3. Governor problem due to: a. Sticking or binding governor linkage. b. Incorrect governor adjustment. c. Faulty governor spring. d. Governor mechanism worn excessively.	3a. Check linkage alignment. Make sure it does not touch other parts. Clean and lubricate linkage.	8-9
		3b. Adjust speed and sensitivity settings.	8-9
		3c. Replace governor spring.	10-8
3d. See <i>Governor</i> in Section 10. <i>Engine Block Assembly</i> .			
High Oil Consumption (Note: New engines can have high oil consumption during break-in)	1. Oil viscosity too light or oil is diluted.	1. Drain oil and refill with correct viscosity oil.	8-8
	2. Crankcase breather valve is dirty, faulty or improperly installed.	2. Clean crankcase breather and replace if defective.	
	3. Oil leaks.	3. Locate source of leak and repair as required.	
	4. Excessive engine wear.	4. See Section 10. <i>Engine Block Assembly</i> .	
	5. Light loading.	5. Do not run generator set at no-load for long periods of time.	
	6. Intake valve seal worn or defective.	6. Replace intake valve seal.	

**⚠ WARNING** Many troubleshooting procedures present hazards that 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 page iii.

TABLE 6-19. TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Shuts Down and Will Not Restart  (Also see Control Troubleshooting table 6-4)	<ol style="list-style-type: none"> <li>1. Low oil level.</li> <li>2. Low oil level switch is defective (Spec A-F, if applicable).</li> <li>3. Worn spark plug.</li> <li>4. Faulty fuel system - flooded.</li> <li>5. Choke not opening.</li> <li>6. Faulty ignition system.</li> </ol>	<ol style="list-style-type: none"> <li>1. Add oil as required.</li> <li>2. Check low oil level switch.</li> <li>3. Clean or replace spark plug.</li> <li>4. Refer to <i>Gasoline Fuel System</i>.</li> <li>5. Check choke operation.</li> <li>6. Check for spark.</li> </ol>	     8-11  8-17 8-6
Engine Runs On After Shutdown	<ol style="list-style-type: none"> <li>1. Fouled spark plug.</li> <li>2. Engine carbon build-up.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean or replace spark plug.</li> <li>2. Remove carbon from engine.</li> </ol>	

# 7. Control

## INTRODUCTION

This section covers control operation, component locations, basic troubleshooting and test procedures. The control consists of the circuitry used for starting, monitoring fault conditions, instrumentation, battery charging, and stopping.

## CONTROL DESCRIPTION

The control circuitry consists of the following components. See Figure 7-1.

- Panel mounted Start/Stop Switch (S1)
- Start Solenoid (K1)
- Control Fuse (F1)
- Circuit Breaker (CB1)

- Control Assembly (A1)
- Optional Remote Start/Stop Control (A2, A3)
- Battery Charge Resistor (R1)
- Rectifier Bridge (CR1)
- Battery Charger Assembly (VR2)
- Transformer (T1)

### Start/Stop Switch (S1)

The Start/Stop switch (S1) is a single-pole double-throw (SPDT) rocker type switch used for starting or stopping the generator set. Holding the switch in the Start position will initiate engine cranking. Pushing the switch to the Stop position will initiate the stop function. The switch will automatically return to the center (Run) position when released.

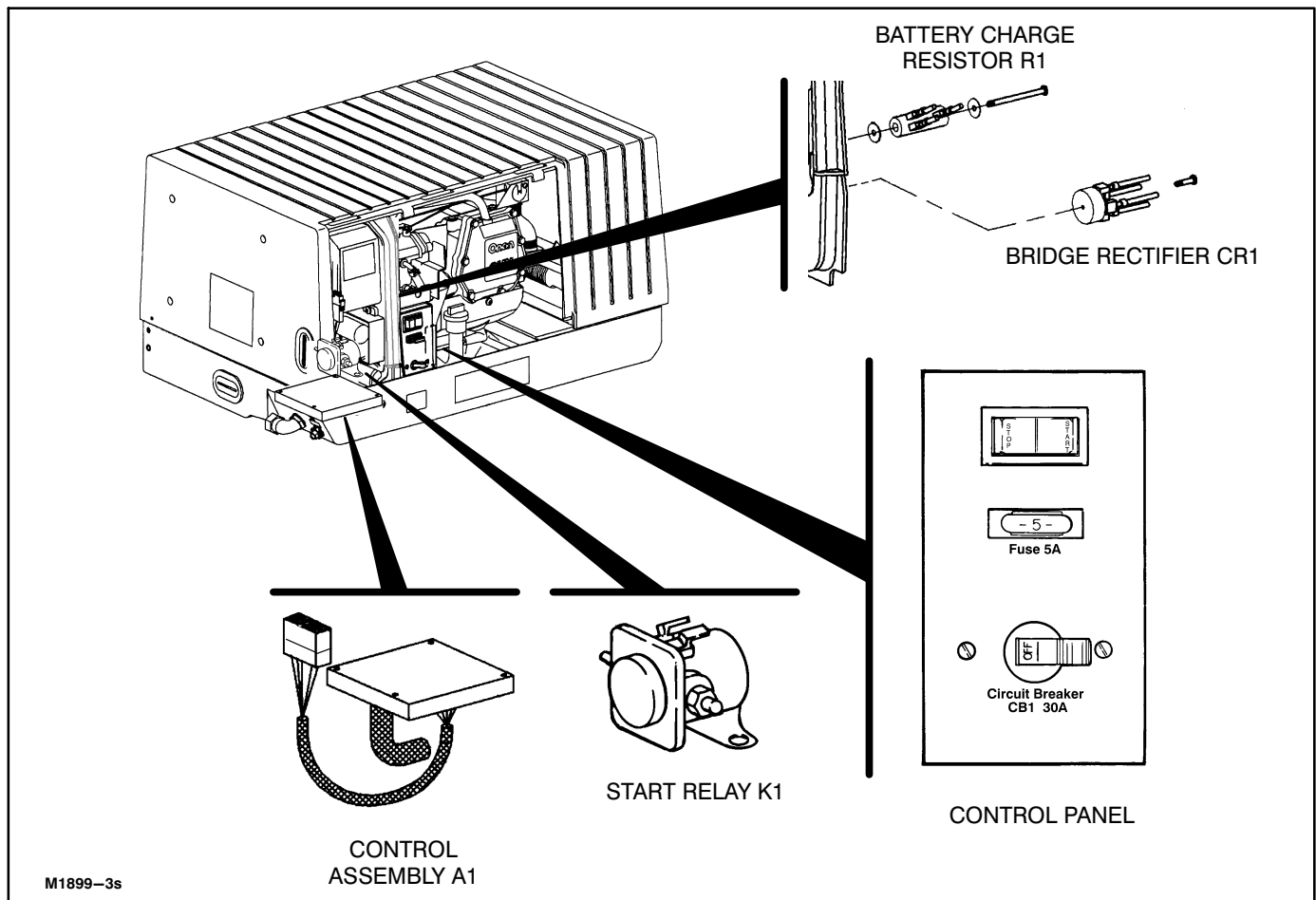


FIGURE 7-1. SPEC A CONTROL COMPONENT LOCATIONS

### Start Solenoid (K1)

The start solenoid (K1) is used for closing and opening the circuit between the battery and the starter motor. The start solenoid has heavy duty contacts that handle the high current draw of the starter during cranking.

### Control Fuse (F1)

A 5-amp fuse provides protection for the control wiring and remote wiring from a short circuit. The control fuse is mounted on the front of the control panel.

### Circuit Breaker (CB1)

The standard 30-amp circuit breaker protects the generator AC windings from a short circuit or overload. The circuit breaker is located on the control panel. If an overload occurs, the breaker can be re-

set after all loads are removed from the generator set.

### Control Assembly (A1)

The control assembly consists of a printed circuit board with components and relays that are potted (encapsulated in a nonconductive material) to protect them from moisture. The control assembly is mounted near the air inlet for cooling. See Figure 7-1 on Page 7-1 and Figure 7-2.

The control provides the following functions:

- Starter Solenoid Output
- Fuel Pump Output
- AVR Field Flash Output
- Remote Running Output
- Ignition Enable

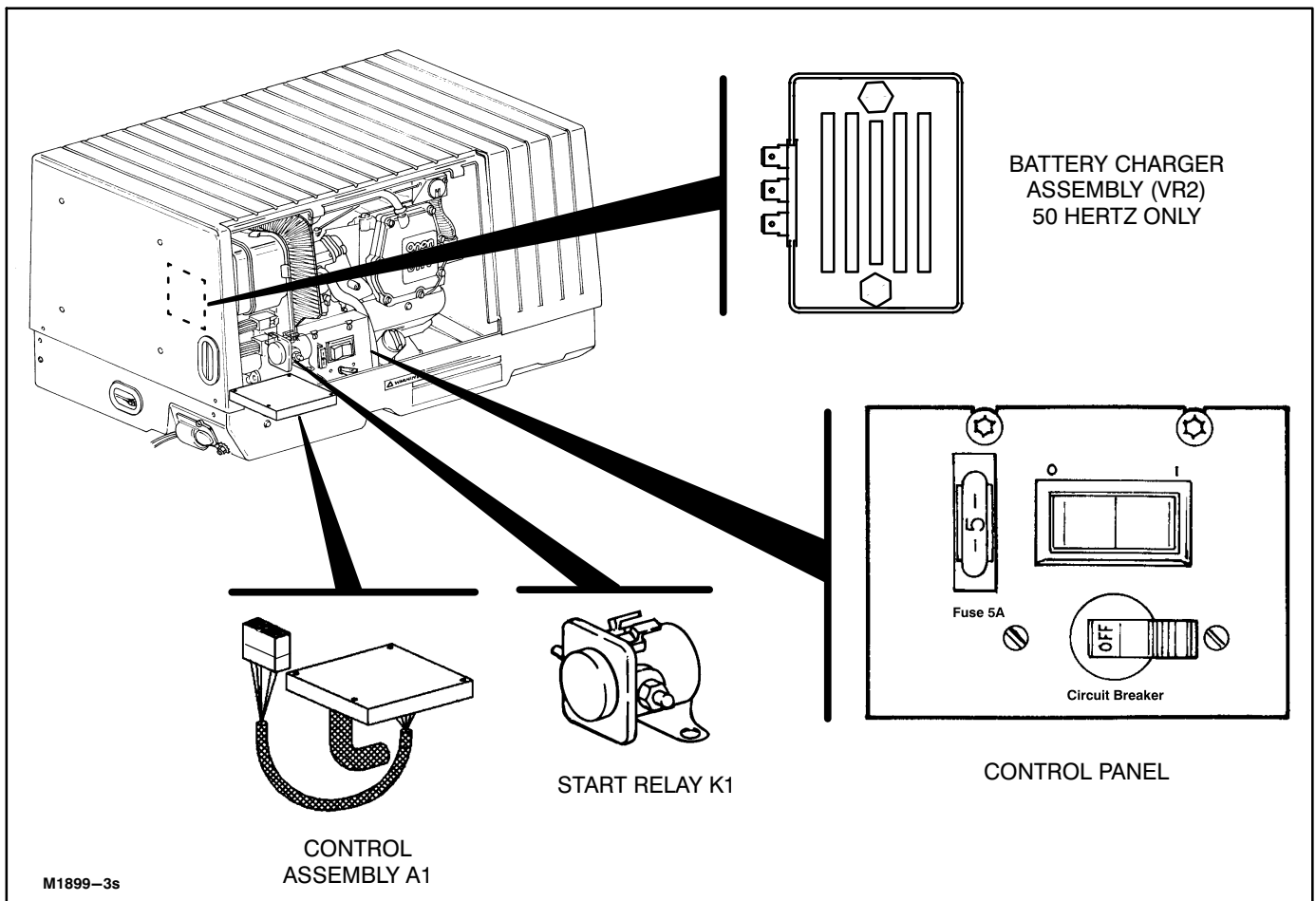


FIGURE 7-2. BEGIN SPEC B CONTROL COMPONENT LOCATIONS

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## Optional Remote Control (A2, A3)

The remote control is an optional accessory that allows the generator set to be started, monitored, and stopped from a remote location. The deluxe control (A3) includes a running time meter and a battery condition meter. Remote control panels are mounted inside the vehicle.

## Rectifier Bridge (CR1) – Spec A Only

The rectifier bridge consists of four diodes connected in a bridge circuit to form a full-wave voltage rectifier. The bridge circuit rectifies the AC voltage from the generator battery winding (B1-B2) to supply DC voltage for battery charging.

## Battery Charge Resistor (R1) – Spec A Only

The battery charge resistor limits the battery charge rate to a maximum of one ampere.

## Battery Charger Assembly (VR2) – Begin Spec B 50 Hz Only

The battery charger assembly rectifies the AC voltage from the generator battery winding (B1-B2) to supply DC voltage for battery charging.

## Transformer (T1) – Begin Spec B 50 Hz Only

The transformer provides isolation required for some 50 Hz reconnection applications. (See Figure 6-2 on Page 6-3 for transformer location.)

## CONTROL OPERATION

The schematic diagrams in Section 12. *Wiring Schematic/Diagram* can be used to help follow the circuit description. Always refer to the specific wiring diagram that corresponds to the model and spec number of the generator set when troubleshooting.

### Start Mode

Holding the Start/Stop switch (S1) in the Start position activates the control assembly (A1) by closing the start signal input circuit. While the Start/Stop switch is held, the control assembly supplies the following outputs and results:

- Energizes the start solenoid (K1) causing the start solenoid contacts to close energizing the starter. The starter begins to crank the engine to initiate starting.
- Energizes the fuel pump (E2), the fuel pump begins pumping fuel to the carburetor for engine operation.

Begin Spec B models: the fuel shutoff solenoid E3 is energized allowing fuel to pass through the carburetor.

LPG models: the fuel shutoff solenoid (E2) and priming solenoid (K3) are energized to allow fuel flow to the carburetor.

- Flashes the generator field winding to ensure that there is adequate magnetism to induce generator voltage buildup.
- Enable the ignition circuit, this opens a ground path through the control assembly to the magneto assembly (G2) so output from the magneto will energize the ignition coil (T1). The ignition coil energizes the spark plug (E1) for ignition.

---

## Run Mode

When the engine starts, release the Start/Stop switch and it will return to the center Run position. The following control assembly functions occur:

- Voltage from the battery is replaced by output voltage from the generator (when the engine comes up to speed) so the control remains energized on Spec A and begin Spec B 50 Hz only.
- Start solenoid (K1) is de-energized, opening the circuit to the starter motor (M1) to stop cranking. (The start disconnect is activated at approximately 2500 rpm.)
- Fuel Pump (E2) remains energized during the run condition. Fuel shutoff solenoid (E3) remains energized on begin Spec B models.
- LPG model: Priming solenoid (K2) is de-energized.
- Field flash is no longer required and is turned off.
- Ignition Enable remains on. Output from the magneto assembly (G2) energizes the ignition coil (T1) to provide spark.
- Remote run output energizes the running time meter and the battery condition meter in the optional deluxe remote control (A2).

A low oil level will cause the low oil level switch (S2) to close. This closes a ground path to the magneto assembly (G2) eliminating ignition spark and preventing the engine from operating. If the oil level goes below the low oil level during operation, the generator set will shut down.

## Charging Circuit

A 12-volt DC output (one-ampere maximum on Spec A or ten-ampere maximum Spec B 50 Hz) from the generator is used to prevent discharge of the generator set starting battery during generator set operation. Spec B 60-Hz models do not have a battery charge winding.

## Stopping

Pressing the Start/Stop switch (S1) to the Stop position de-energizes the ignition enable circuit and grounds the magneto assembly (G2) output. This causes the engine to stop running. The Stop position also activates the remote stop latch feature preventing restart. At the same time the fuel pump is de-energized.

LPG models: the fuel shutoff solenoid (E2) is de-energized stopping fuel flow to the carburetor.

## CONTROL COMPONENT TESTS

The following control component checks can be made to verify if components are defective. Disconnect the starting battery cables, negative (-) cable first, before performing these tests.

**⚠WARNING** *Accidental starting or electrical shock can cause severe personal injury or death. Disconnect both generator set starting battery cables before performing maintenance. Remove the negative (-) battery cable first and connect it last to reduce the risk of arcing.*

### Start/Stop Switch (S1)

Disconnect the P1 (or J1 for Spec B) connector from control assembly (A1). See Figure 7-3. Continuity should be measured between pin 1 and pin 3 (pin 13 and pin 7 for Spec B) when the switch is held in the Start position. Continuity should be measured between pin 2 and pin 3 (pin 1 and pin 7 for Spec B) when the switch is held in the Stop position. An open circuit should be measured between pins 1, 2, and 3 (13, 7 and 1 Spec B) when the switch is in the center Run position.

If the switch tests good also check the control connector P1 to J1 connections to make sure they are making a good connection.

If an abnormal reading is obtained, check the continuity between the connector pins and the switch. (Use an ohmmeter with pointed test leads to pierce the insulation at the back of the switch on Spec A models).

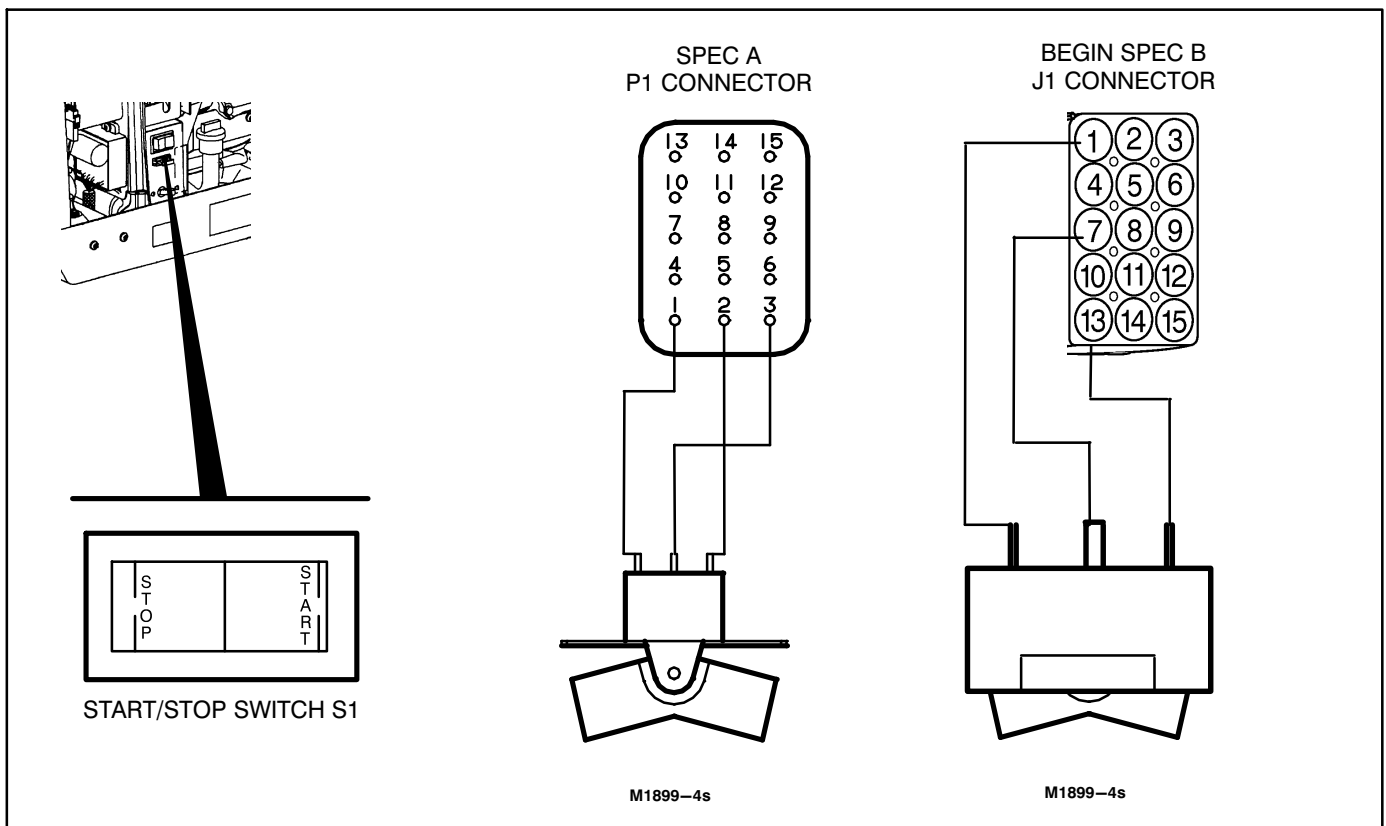


FIGURE 7-3. START/STOP SWITCH

## Start Solenoid (K1)

A check can be made by measuring the resistance of the coil terminals I and S (Figure 7-4). With the harness leads removed, the coil should read between 3 and 5 ohms. If an abnormal reading is measured, replace the Start Solenoid.

If the coil checks good and a problem with the solenoid is still suspected, remove the leads from the side terminal posts. An open circuit should be measured between the side terminal posts with the coil de-energized. With 12 VDC applied across the coil (I and S terminals) the solenoid should be energized and continuity should be measured between the side posts.

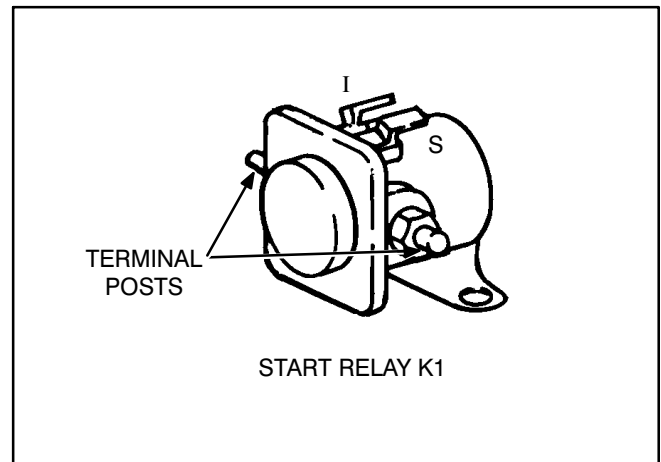
## Control Assembly (A1)

The Control Assembly consists of a printed circuit board with components and relays that are potted (encapsulated in a nonconductive material) to protect them from moisture. It is difficult to isolate individual components on the control assembly for testing. Use Section 6. *Troubleshooting* to identify possible problems in the control circuit. If a problem with the Control Assembly is suspected, use the control circuit board tester if available, or check the control outputs with a voltmeter. Figure 7-5 on Page 7-7 shows the Control Assembly and the P1/J1 connectors. Voltages can be checked using a voltmeter with long test prods.

**⚠WARNING** *Electrical shock can cause severe personal injury or death. Do not touch the voltmeter or any wiring when the generator set is operating. Attach and remove meter leads only when the generator set is stopped.*

Tables 7-1 and 7-2 on Page 7-7 list the control outputs at the P1/J1 connector plug for each control mode. Measure control output voltages between the connector pin listed and ground. Refer to the correct chart for Spec A and for Spec B models.

Battery B+ voltage must be present at the Control Assembly J1-10/P1-10 at all times. If battery voltage is present at the J1-10/P1-10 connector and the control outputs are not present, check the J1/P1 connector and the Start/Stop switch (S1). If the connector and switch check good, replace the Control Assembly with a new Control Assembly and re-check generator set operation.



**FIGURE 7-4. SOLENOID CHECK**

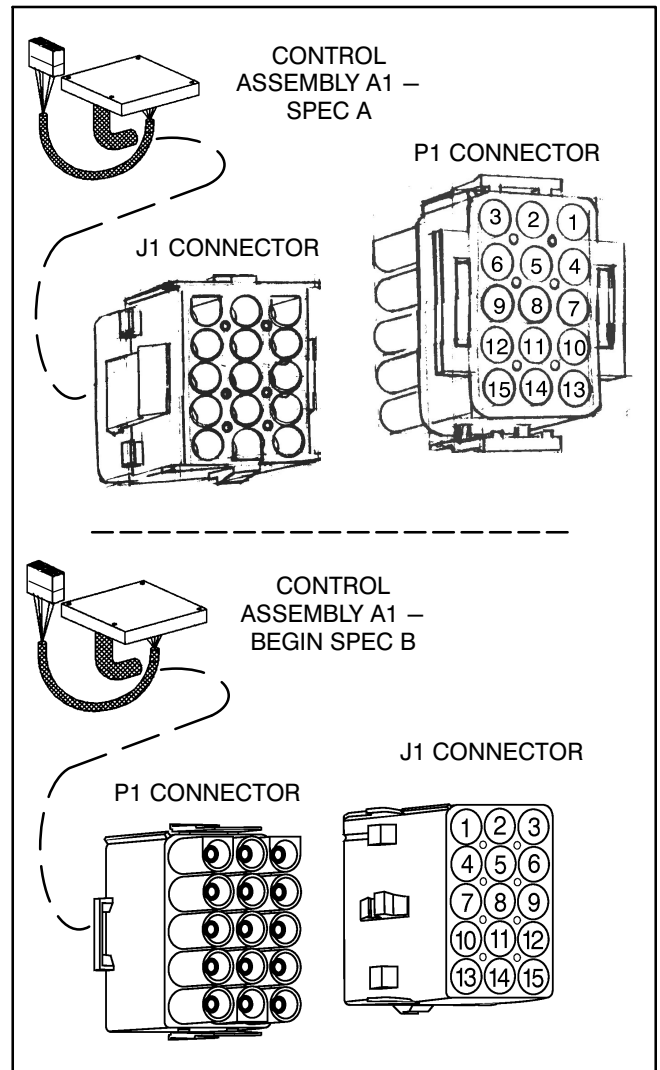


**TABLE 7-1. SPEC A CONTROL OUTPUTS**

CONTROL OUTPUT (CONNECTOR PIN)	CONTROL MODE		
	CRANK	RUN	STOP
STARTER SOLENOID (J1-8/P1-8)	≥9 VDC	0 VDC	0 VDC
FUEL PUMP (J1-12/P1-12)	≥9 VDC	≥9 VDC	0 VDC
AVR FIELD FLASH (J1-5/P1-5)	≥9 VDC	0 VDC	0 VDC
REMOTE RUN (J2-5, J2-6)	0 VDC	≥9 VDC	0 VDC

**TABLE 7-2. BEGIN SPEC B CONTROL OUTPUTS**

CONTROL OUTPUT (CONNECTOR PIN)	CONTROL MODE		
	CRANK	RUN	STOP
STARTER SOLENOID (J1-6/P1-6)	≥9 VDC	0 VDC	0 VDC
FUEL PUMP (J1-2/P1-2)	≥9 VDC	≥9 VDC	0 VDC
FUEL SHUTOFF SOL. (J1-3/P1-3)	≥9 VDC	≥9 VDC	0 VDC
AVR FIELD FLASH (J1-9/P1-9)	≥9 VDC	0 VDC	0 VDC
REMOTE RUN (J2-5, J2-6)	0 VDC	≥9 VDC	0 VDC



**FIGURE 7-5. CONTROL ASSEMBLY (A1) CHECK**

### Resistor (R1) – Spec A Only

The battery charge resistor can be checked with an ohmmeter. Disconnect the leads from the resistor and measure the resistance between terminals on one end to the resistor and the terminals on the other end. The resistor should measure between 4 and 6 ohms. If an abnormal reading is measured, replace the resistor.

### Diode Bridge (CR1)

The diode bridge consists of four diodes connected in a bridge circuit (Figure 7-6). The diode bridge can be checked with a diode checker. Remove all of the leads from the diode bridge and check each diode individually. Continuity should be indicated in the forward bias direction and an open circuit should be indicated in the reverse bias direction (refer to your meter instruction manual). If any of the diodes check bad, replace the diode bridge.

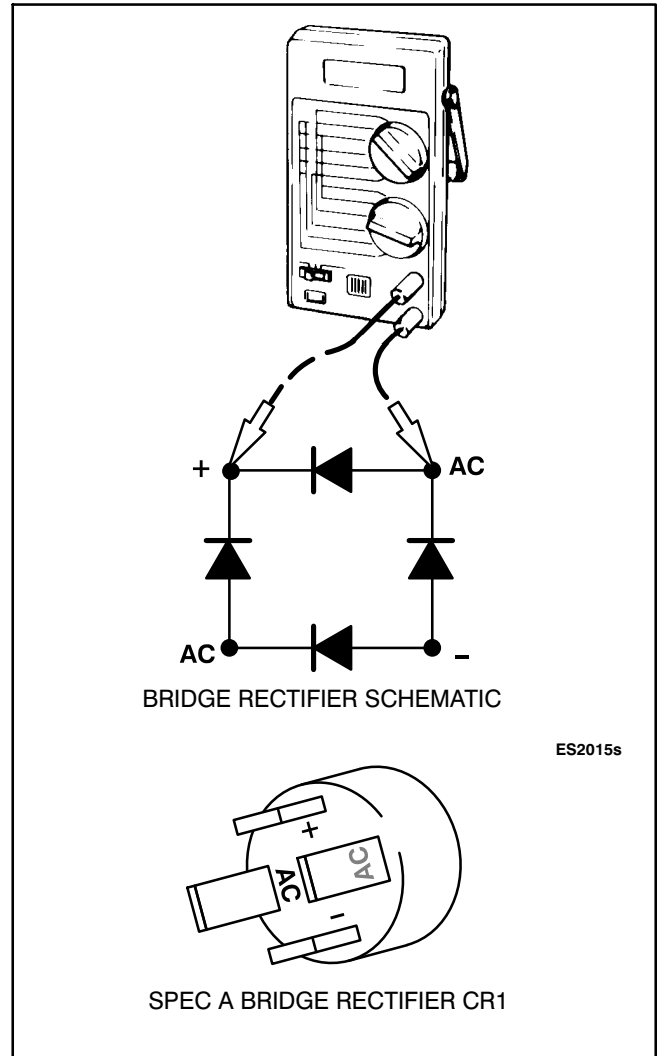


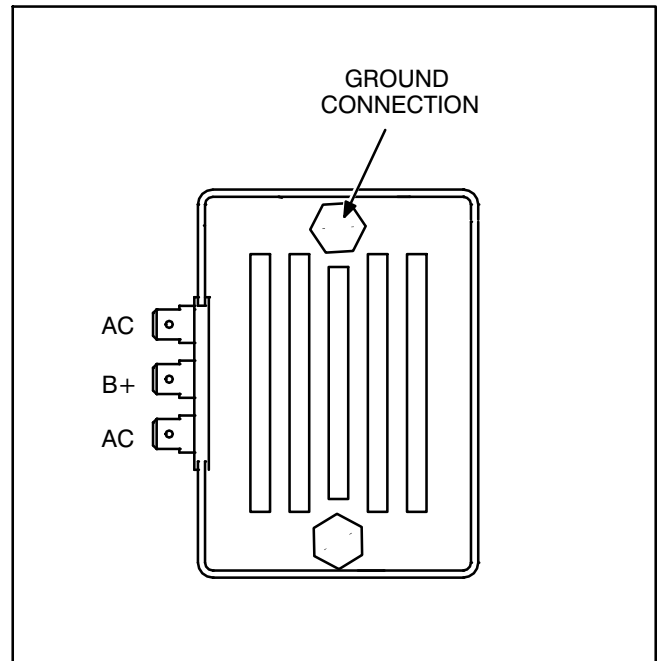
FIGURE 7-6. DIODE BRIDGE CR1 CHECK

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**Battery Charger Assembly (VR2)**  
– Begin Spec B, 50 Hz Only

The battery charger is located on the left side of the generator set housing. The battery charger can be checked with a voltmeter. A voltage measurement between the B+ terminal and ground (Figure 7-7), with the generator set off should read the starting battery voltage (approximately 12 VDC). With the generator set running a reading between the B+ terminal and ground should be slightly more than the first reading (12.5 to 14 VDC).

If the same or less voltage is measured, connect the voltmeter between the two AC terminals to measure the input voltage from the B1-B2 battery charge winding. During set operation voltage from the B1-B2 battery charge winding should be approximately 17 to 19 VAC. If this reading is obtained and charger output voltage does increase when the generator set is started, replace the battery charger. If low or no voltage is measured between the AC terminals, check the wiring harness connections and refer to the generator test section.



**FIGURE 7-7. BATTERY CHARGER ASSEMBLY (VR2)**

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### Transformer (T1) – Begin Spec B, 50 Hz Only

The transformer (see /Figure 7-8) is located on the backside of the generator set (see Figure 6-2 on Page 6-3). The transformer can be checked with an ohmmeter. Isolate the transformer leads from the circuit and measure the resistance between H1 - H2 primary winding. The primary should measure 440 to 540 ohms. Measure the resistance between X1 - X2 secondary winding. The secondary should measure 225 to 275 ohms. If an abnormal reading is measured, replace the transformer.

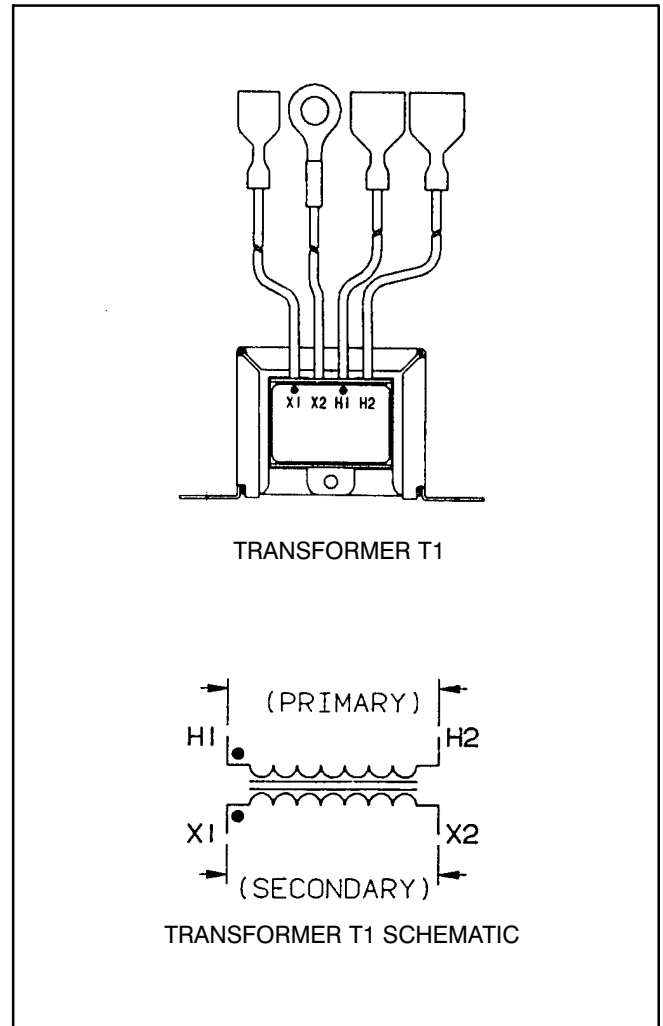


FIGURE 7-8. TRANSFORMER (T1)

# 8. Primary Engine Systems

## INTRODUCTION

This section describes the engine primary systems service procedures. Many of the primary systems can be serviced without removing the generator set from the vehicle. Poor engine performance is often caused by a dirty carburetor. Make certain that the carburetor is clean before troubleshooting for performance problems.

Primary engine systems include:

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

## COOLING SYSTEM

The generator set requires a constant airflow to cool the engine and generator during operation. A centrifugal fan on the generator end of the generator set provides the required airflow. The fan draws cooling air through the air inlet, into the generator and forces it across the engine cooling fins. The air is discharged through the air outlet. See Figure 8-1.

**⚠WARNING** *Cooling air can contain poisonous exhaust gases that can result in severe personal injury or death. Never use discharged cooling air to heat the vehicle interior.*

The air inlet is sized to allow the required flow rate of cooling air. The air inlet opening and the air discharge opening must be kept free of any obstructions to avoid restricting airflow. Dirt, dust, or other debris that clog the air openings should be removed during periodic maintenance. Dirt might also become lodged between the cooling fins on the engine block and cylinder head. If this happens, heat transfer is greatly reduced and overheating can occur. The cooling system consists of the generator set housing and base assembly enclosure, insulation duct, scroll assembly, fan hub assembly, and air duct. The following section covers service procedures for the cooling system .

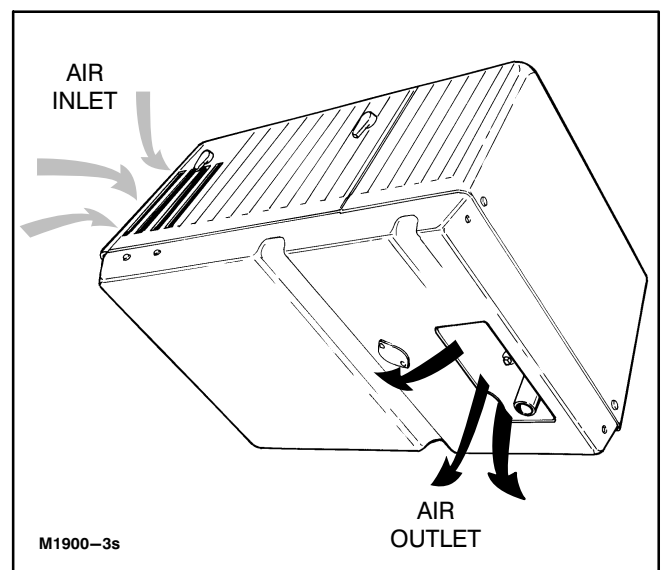
## Inspection

Inspect the air inlet and outlet passages. Remove the access panel and inspect the engine and control area. If the engine is clean and the air inlet area is clean, disassembly for engine cleaning will not be necessary. If debris is visible, proceed to the *Disassembly* section following.

## Disassembly

Remove the generator set as described in *Set Removal Guidelines* on Page 5-2.

1. Follow the generator set disassembly procedures in Section 9. *Generator* through the scroll assembly removal.
2. Inspect and clean the fan hub assembly using a brush or low pressure compressed air. If the cooling fins are damaged, replace the fan hub assembly as described in Section 9. *Generator*.
3. Remove the top and bottom air guide housings (cowling) to access the engine cooling fins for cleaning.
4. Use a brush or low pressure compressed air to remove any dirt or debris that may be lodged on the engine cooling fins.



**FIGURE 8-1. COOLING AIRFLOW (SPEC B SHOWN)**

---

## Assembly

Assemble cooling system in reverse order of disassembly. Follow the generator assembly instructions (Section 9. *Generator*) for installing the fan hub assembly.

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

## EXHAUST SYSTEM

The condition of the exhaust system is extremely critical on RV generator sets because of the possibility of exhaust gases entering the vehicle. The exhaust system must not have any leaks and it must be well supported. The tailpipe must extend 1 inch (25.4 mm) beyond the the perimeter of the vehicle and it must not terminate so exhaust can enter the vehicle.

**⚠ WARNING** *Exhaust gasses contain carbon monoxide, an odorless and colorless gas that can cause severe personal injury or death. Make certain that the exhaust components are in good condition and that there are no leaks.*

The exhaust system consists of the muffler, the exhaust pipe, and the clamps and hangers needed for installation of the exhaust pipe. On Begin Spec B, the muffler has a flexible inlet pipe. On Spec A, the muffler has a flexible outlet pipe. Figure 8-2 on Page 8-3 shows a typical exhaust system for a compartment mount generator set. The following section covers the service procedures for the exhaust system.

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

Always replace worn components with new original equipment replacement parts. Do not attempt to repair a broken exhaust pipe or manifold by welding

and do not replace worn out components with parts that do not meet factory specifications.

It may be necessary to clean out the spark arrester if the generator set is experiencing low power. Park the vehicle away from grass, brush or debris that could be ignited by sparks expelled during this procedure. The spark arrester meets U.S. Forest Service requirements.

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

## Muffler Disassembly

1. Allow the exhaust system to cool down before servicing.
2. Loosen the exhaust pipe clamp securing the exhaust pipe to the generator set.
3. Remove exhaust pipe hanger(s) and lower exhaust pipe.
4. Remove the generator set from the vehicle and remove the outer housing. See *Set Removal Guidelines* on Page 5-2.

### **Spec A:**

5. Remove the bolts securing the muffler flange to the engine and the muffler outlet pipe to the base.
6. Remove the hardware securing the muffler bracket to the engine bracket. Remove the muffler and the exhaust gasket.

### **Begin Spec B:**

5. Remove the bolts securing the flexible exhaust manifold to the muffler.
6. Remove the screws securing the muffler to the base. Remove the muffler and the exhaust gasket.

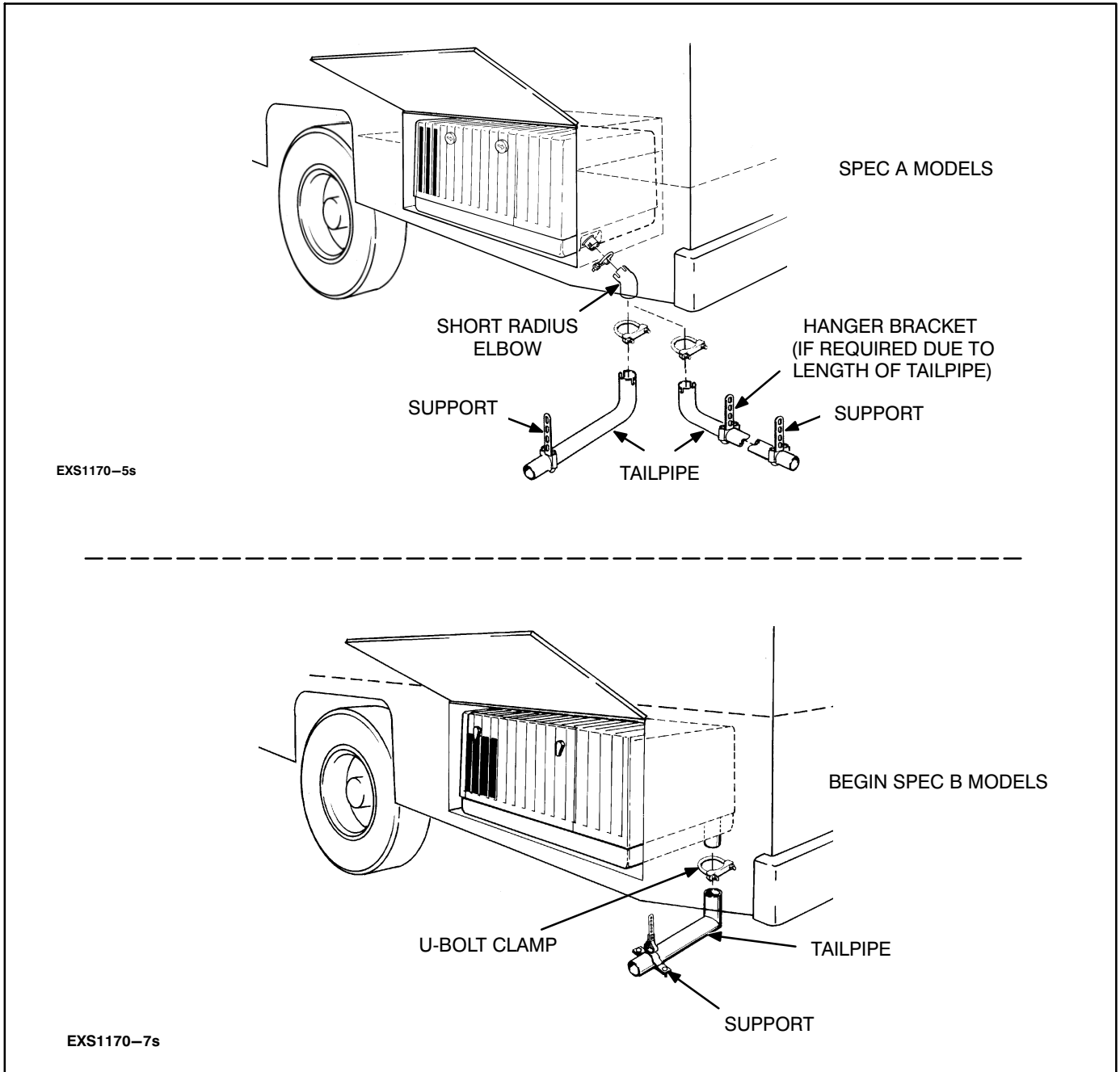


FIGURE 8-2. COMPARTMENT MOUNT EXHAUST SYSTEM

### Muffler Assembly

Obtain the required replacement parts including a new exhaust gasket. Install the muffler in reverse order of removal.

1. Install a new exhaust gasket. Secure the

mounting hardware to the specified torque.

**⚠️WARNING** Exhaust gas can cause severe personal injury or death. To prevent exhaust leaks, always install a new exhaust gasket, and replace corroded or worn clamps, straps, and hardware before leaks occur.

- 
2. Install the generator set housing and reinstall the generator set.
  3. If replacing the original exhaust tailpipe, refer to the Tailpipe Recommendations section.
  4. Attach the exhaust pipe to the exhaust outlet using a U-bolt type automotive muffler clamp marked 1-3/8 inch I.D. (Spec A) or 1-1/4 inch I.D. (Begin Spec B).
  5. Attach an automotive type tailpipe hanger every 2 to 3 feet (0.6 to 0.9 meters). In addition, the exhaust system must be supported at or near the perimeter of the vehicle to prevent the tailpipe from being damaged and being pushed up under the vehicle skirt.

**⚠ CAUTION** *Excessive vibration transfer and exhaust pipe damage can be caused by angular mounting. Tailpipe hanger clamps must be mounted directly above the component being supported and not at an angle.*

6. Run the generator set for five minutes and check the entire exhaust system (visually and audibly) for leaks or excessive noise. Correct any problems immediately.

## Tailpipe Recommendations

Tailpipes 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.

**⚠ WARNING** *Inhalation of exhaust gases can result in severe personal injury or death. Exhaust gases can enter the vehicle interior if the tailpipe is damaged, missing, or improperly installed. Follow the recommended exhaust system replacement procedures.*

**Spec A:** Use 1-1/2 inch O.D., 18-gauge aluminized or stainless steel tubing for tailpipe.

**Begin Spec B:** Use 1-1/4 inch O.D. (1-1/8 inch I.D.) 18-gauge aluminized steel or stainless steel tubing for tailpipe.

Do not use flexible tailpipe since it might break due to road shock and vibration.

**⚠ WARNING** *Hot exhaust components present the risk of fire that can result in severe personal injury, death or equipment damage. Follow the recommended clearances between the exhaust system and any combustible materials.*

The exhaust system must be placed no closer than 3 inches (76 mm) from combustible material (wood, felt, cotton, organic fibers, etc.), or be so located, insulated or shielded that it does not raise the temperature of any combustible material more than 117° F (65° C) above the ambient air inlet temperature.

The exhaust system must extend a minimum 1 inch (25 mm) beyond the perimeter of the vehicle. Do not terminate the exhaust tailpipe under the vehicle. Be aware that any vent, window, storage compartment or opening that can be opened and that is not permanently sealed from the vehicle living space can be an avenue for carbon monoxide.

The tailpipe must not terminate so that any vent, window, or opening into the living area is within a six inch (152.4 mm) radius of the tail pipe as shown in Figure 8-3 on Page 8-5.

**⚠ WARNING** *Exhaust gas presents the hazard of severe personal injury or death. Do not terminate an exhaust pipe under the vehicle. The tailpipe must not terminate so that any vent, window, or opening into the living area is within a six inch (152.4 mm) radius of the tail pipe as shown in Figure 8-3 on Page 8-5. Keep all openings closed when the generator set is running.*

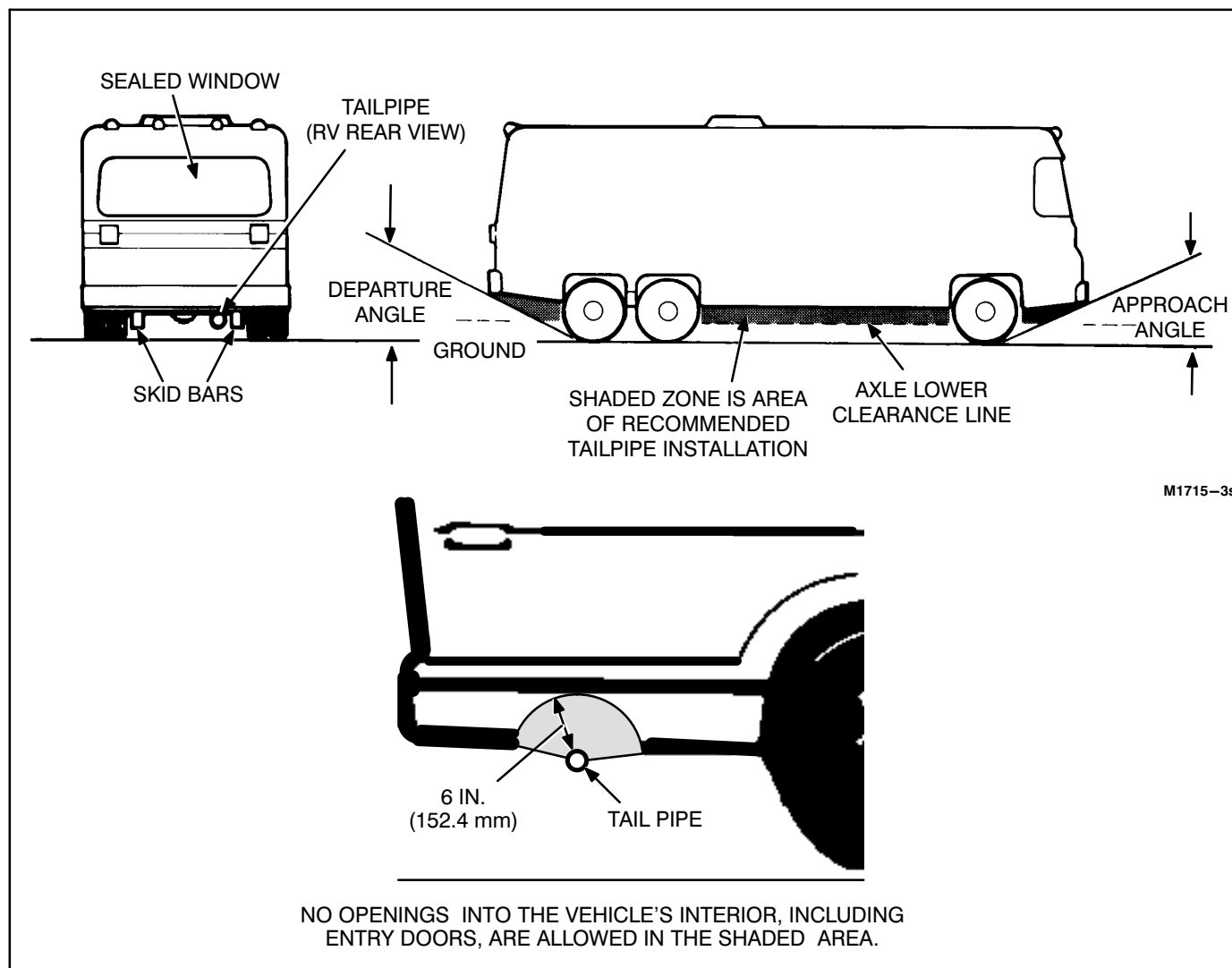
To reduce the chance of damaging the tailpipe and emitting exhaust gases under the vehicle, make certain that no part of the exhaust system intrudes into the departure angle or approach angle of the vehicle, unless it is protected by a skid bar or other protection device. The shaded areas in Figure 8-3 illustrate typical mounting locations.



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

Do not terminate the exhaust tailpipe under the fuel tank fill spout to prevent spilled fuel from being ignited by a hot tailpipe.

**⚠ CAUTION** Excessive exhaust back pressure can cause engine damage. If tailpipe deflector is used, make sure it is large enough to prevent back pressure.



**FIGURE 8-3. DEPARTURE ANGLE AND RAMP ANGLE**

## IGNITION SYSTEM

The ignition system consists of the magneto assembly, ignition coil, spark plug and ignition wiring. If a problem with the ignition system is suspected, the spark plug can be inspected and an ignition spark check can be made without removing the generator set from the vehicle. Perform the spark plug, ignition coil and ignition wiring checks before proceeding to the Magneto Assembly section.

**⚠WARNING** *Electrical shock can cause severe personal injury or death. Do not touch electrical wiring or components during testing. Disconnect electrical power by removing the starting battery negative (-) cable before handling electrical wiring or components. Do not connect meters while circuit is energized. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when testing electrical equipment. Do not wear jewelry or damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.*

### Spark Plug (E2)

Remove the spark plug and inspect the electrode. If the spark plug has carbon deposits, use a wire brush to clean it. If the spark plug is badly fouled or deformed, replace it. Measure and reset the spark plug gap as shown in Figure 8-4. See Section 2. *Specifications*. An examination of the spark plug can often help diagnose an engine problem. Refer to the following spark plug conditions:

- Carbon Fouled – Check for a poor high tension lead connection, faulty choke operation, rich fuel mixture or dirty air filter.
- Oil Fouled – Check for low compression.
- Burned or Overheated – Check for leaking intake manifold gasket, lean fuel mixture or incorrect spark plug type.
- Splash Fouled – Check for accumulated combustion chamber deposits. See *Rocker Arms, Push Rods and Cylinder Head* section on Page 10-3.
- Light Tan or Gray Deposits – Normal plug color.

If the spark plug is in good condition, proceed to the *Ignition Coil* section, following.

### Ignition Coil (T1)

The ignition coil is a transformer that steps up the magneto output voltage to about 20,000 volts for spark plug firing. The coil consists of a primary and a secondary winding. Perform the following checks:

**⚠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.*

**Ignition Spark Check:** This checks all of the ignition system components and wiring.

1. Make sure the engine oil level is adequate and that the generator set is level.
2. Remove the spark plug, reconnect the spark plug lead and ground the plug side electrode to bare metal on the engine.
3. Do not touch the plug or plug wire during testing. Crank the engine and observe the plug. If a good spark is observed, the ignition system is good. If no spark, or a weak spark is observed, proceed to the coil winding check.

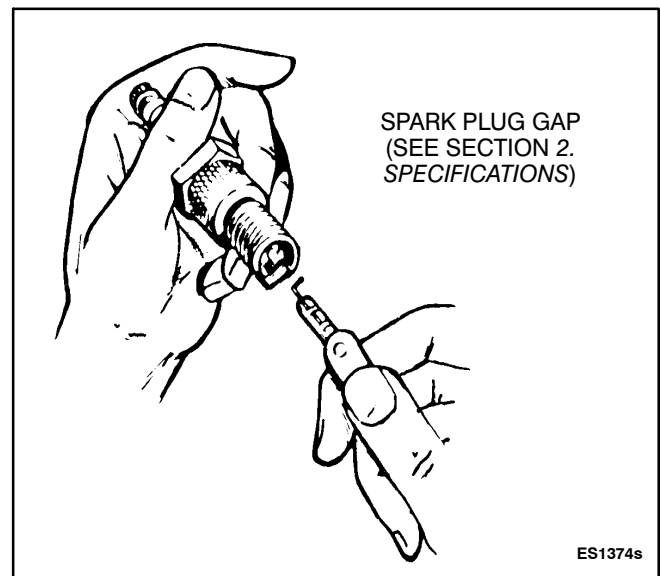


FIGURE 8-4. MEASURING PLUG GAP

**Ignition Coil Ohmmeter Check:** Remove the control panel mounting screw (Torx T-30) to access the ignition coil. Check the ground lead for continuity between the ground lead terminal and a clean ground point on the intake manifold.

Disconnect the spark plug lead from the spark plug and disconnect the primary lead from the terminal on the coil. Remove the ignition coil mounting screws and remove the ignition coil from the generator set for testing. See Figure 8-5.

1. Inspect the terminal and leads for signs of corrosion or looseness and look for cracks or other damage. Look for evidence of electrical leakage around the high tension connection (indicated by carbon tracking). Replace a coil with any defects.
2. Measure the primary winding resistance. Connect one ohmmeter lead to the primary terminal and the other lead to the ground lead ring terminal. The resistance should be approximately 0.5 ohms at 75°F (24°C). Replace the coil if a high or low reading is measured.
3. Measure the secondary winding resistance. Connect one ohmmeter lead to the spark plug connector, inside the boot, and the other lead to the ground lead ring terminal. The resistance should be approximately 1,100 ohms at 75°F (24°C). Replace the coil if a high or low reading is measured.

If the coil windings check good, proceed to the Ignition Wiring check.

## Ignition Wiring

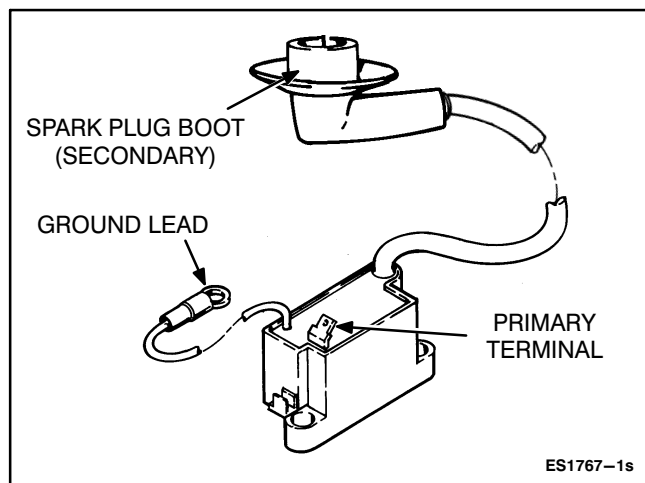
The ignition wiring consists of the following:

- One ground wire connected to the ignition coil and one ground wire connected to the magneto assembly.

- One wire from the magneto to the ignition coil primary.
- One ignition enable wire from the control assembly to the magneto.
- One wire from the low oil level switch to the control assembly. (Spec A-F only, if applicable.)
- One high tension lead from the ignition coil secondary to the spark plug.

Refer to the figure in Section 12. *Wiring Schematic/Diagram* that corresponds to your particular generator set. (Do not disassemble the generator set to check the magneto wiring at this time.)

Thoroughly inspect the ignition wiring for loose connections and cuts or breaks in the insulation. Test suspect leads for continuity with an ohmmeter. Use a megger to check for breaks in the spark plug lead. Also check control wiring for loose or grounded connections. If any problems are found, correct them and repeat the ignition spark check. If no problems are found proceed to the *Magneto Assembly* section, following.



**FIGURE 8-5. IGNITION COIL**

## Magneto Assembly (G2)

The magneto assembly is a noncontact capacitive discharge (breakerless) type that is mounted to the generator endbell. As the engine cranks, two permanent magnets on the fan hub assembly pass very close to the magneto inducing a voltage in two coils in the magneto. One coil charges a capacitor that discharges a voltage to the coil when triggered. The other coil powers the circuit that triggers the charge circuit. The discharge voltage from the magneto (approximately 16 to 60 VAC when measured with a digital voltmeter) is supplied to the primary of the ignition coil.

If no spark was seen in the *Ignition Spark Check* on Page 8-6 and all accessible ignition wiring checks good, perform the *Magneto Assembly Check*, next.

**Magneto Assembly Check:** Use a known good (new) ignition coil.

1. Make sure the cranking circuit and battery are in good condition.
2. Disconnect the low oil level shut down circuit. Locate the lead from the low oil level switch that comes out of the top the oil base below the spark plug. Separate the in-line quick connect where lead S2 J1-7 connects to the low oil level switch.
3. Remove the spark plug, reconnect the spark plug lead and ground the plug side electrode to bare metal on the engine.
4. Do not touch the plug or plug wire during testing. Crank the engine and observe the plug. A good spark should be observed. If no spark is observed, the magneto or wires connected to the magneto are the most likely cause. Refer to Section 9. *Generator* for generator disassembly to access the magneto assembly.

## CRANKCASE VENTILATION SYSTEM

The crankcase breather prevents pressure from building up in the crankcase. It also prevents oil contamination by removing moisture, gasoline vapors and other harmful blow-by materials from the crankcase. These vapors are routed to the carburetor where they are mixed with the incoming air and

burned in the combustion chamber. A stuck or damaged breather valve can cause oil leaks, high oil consumption, rough idle, reduced engine power, and a rapid formation of sludge and varnish within the engine.

## Crankcase Breather Service Procedure

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

1. Remove the breather tube from the valve cover (see Figure 8-6).
2. Remove the head cover and breather assembly.
3. Inspect the reed valve. It must be flat with no signs of creases or other damage. Replace a defective reed valve. If the breather is dirty, clean it in parts cleaning solvent.
4. Check the breather tube and air passages for clogging and clean as required.

**⚠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.*

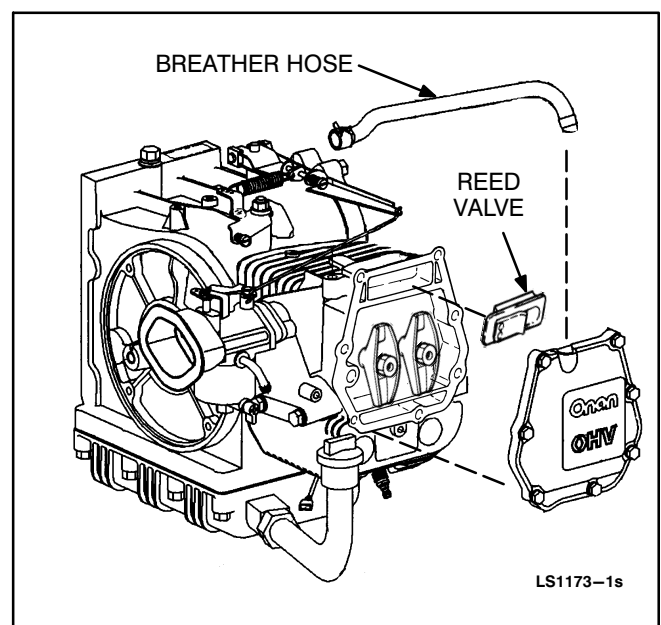


FIGURE 8-6. CRANKCASE BREATHER SYSTEM

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## GOVERNOR

The governor controls engine speed, which directly affects the frequency and voltage output of the generator. The governor reacts to the speed/frequency differential between no-load and full-load conditions, known as “droop”. Good overall governor operation requires a proper amount of governor droop. Too large a droop, and generator set voltage/frequency control may be adversely affected. Too small a droop may cause erratic governor action or alternately increase and decrease engine speed, “hunting” for the proper speed.

### Governor Adjustments

This procedure is used to adjust the governor to bring frequency and voltage within the specified range, and to set governor stability.

**⚠ WARNING** *Contact with moving parts can cause severe personal injury. Keep clothing, hair, jewelry, and fingers clear when adjusting the governor.*

**⚠ WARNING** *A hot generator set can cause severe burns. Always allow the generator set to cool before touching any components or removing any parts.*

**⚠ CAUTION** *An accurate voltmeter, frequency meter and a load bank capable of providing a load of 4000 watts are needed to properly set the governor adjustments.*

Equipment required for governor adjustment includes:

- Digital frequency/voltmeter with 0.3% frequency accuracy, 0.5% voltage accuracy. Recommended: Fluke 8060A or 85 series
- Digital ammeter. Recommended: Beckman 4410
- Variable load bank with 4 kW capacity

Connect an accurate voltmeter, ammeter and frequency meter to the generator. A small speed drop, not noticeable without instruments, will cause an objectionable voltage drop.

If a carburetion problem is suspected, make certain that the carburetor is adjusted correctly before at-

tempting to adjust the governor (see the *Gasoline Fuel System* section on Page 8-11).

A binding governor shaft, governor linkage, or carburetor throttle will cause hunting. Also a fouled spark plug can cause missing and hunting. Check for these conditions before making governor 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 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.*

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

1. Run the generator set at least 10 minutes at 50% to 75% of its rated load. Check that the choke is completely open. If the governor is completely out of adjustment, make a preliminary adjustment at no load to attain a safe voltage and speed operating range.
2. Check the governor linkage for binding or excessive looseness. Check the motion spring for bending or damage and straighten or replace as needed.
3. With unit operating at no-load, adjust the speed adjustment screw (see Figure 8-7 on Page 8-10) on the governor linkage to obtain 62 Hz, and  $127.5 \pm 4.5$  volts. Set 50 hertz units to obtain  $52.0 \pm 0.5$  Hz at between 220 and 231 volts for 220 volt units and 240 to 252 volts for 240 units. To increase the engine speed, turn the adjustment screw clockwise. To decrease the engine speed, turn the adjustment counter-clockwise.
4. Check the frequency and voltage first with a load applied and then with no load applied. The frequency and voltage should stay within the limits shown in Table 8-1 on Page 8-10.

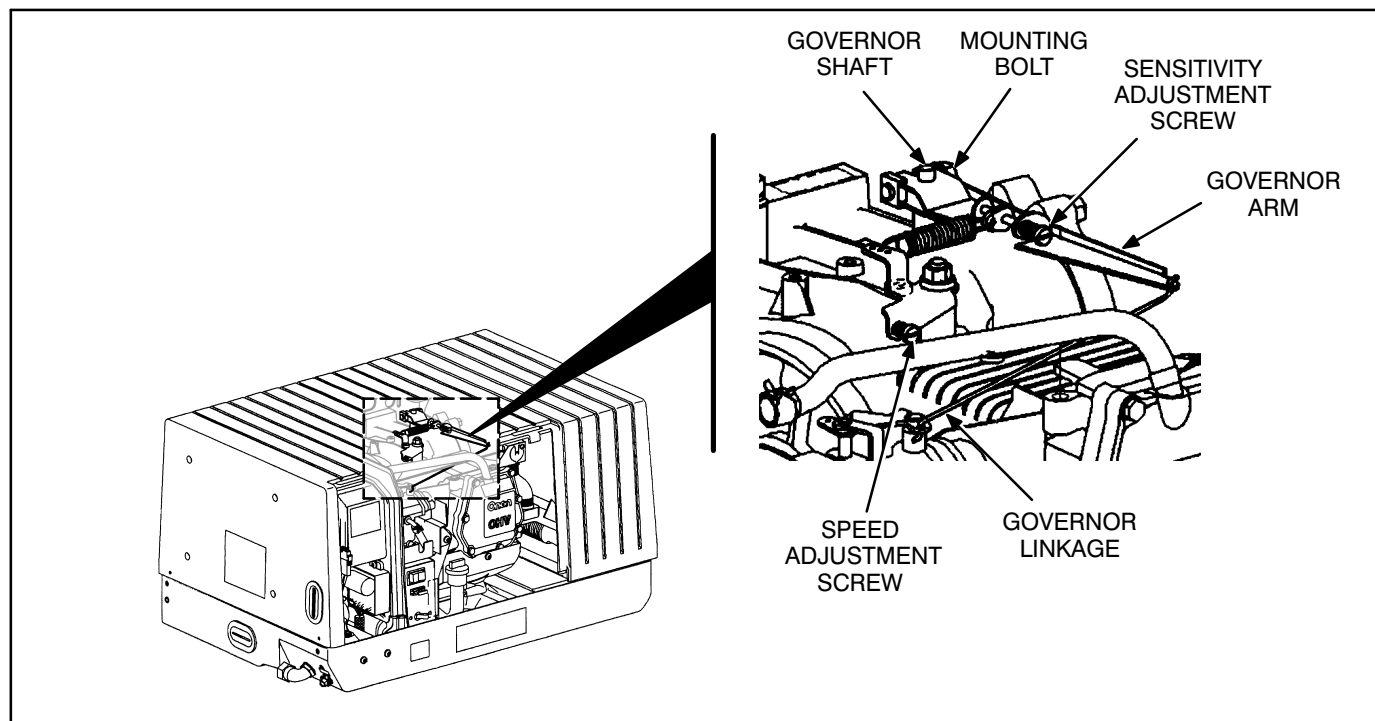
5. Adjust the governor sensitivity to give the closest regulation (least speed and voltage difference between no-load and full-load) without causing a hunting condition. To increase the sensitivity, turn the adjustment screw counter-clockwise. To decrease the sensitivity, turn the adjustment screw clockwise.
6. Recheck the speed setting made in step 3 and readjust if necessary.
7. Set the carburetor throttle stop screw as specified in the Fuel System section.

If the governor action is erratic after adjustments are made, loosen the governor arm mounting bolt and rotate the shaft fully clockwise, then retighten the bolt. Reset the governor adjustments and recheck speed and droop. Springs tend to lose their calibrated tension through fatigue after long usage. It may be necessary to put the stationary end of the spring in a different hole to change the tension, or replace the spring altogether. If this does not improve operation, the problem may be within the gov-

ernor mechanism (see Section 10. *Engine Block Assembly*).

**TABLE 8-1 CHECKING VOLTAGE AND SPEED/FREQUENCY**

	60 Hz 1Ø, 2-Wire 120 V	50 Hz 1Ø, 2-Wire 220 V	50 Hz 1Ø, 2-Wire 240 V
<b>Voltage</b>			
Maximum No-Load (Typical No-Load)	126 (125)	235 (228)	256 (248)
Minimum Full Load (Typical Full-Load)	108 (118)	205 (215)	224 (236)
<b>Speed/Frequency</b>			
Maximum No-Load Speed (rpm)	3780	3150	3150
Frequency (Hz) (Typical Frequency)	63 (62.5)	52.5 (52)	52.5 (52)
Minimum Full-Load Speed (rpm)	3570	2940	2940
Frequency (Hz) (Typical Frequency)	59.5 (59.5 - 60.5)	49 (49.5 - 50.5)	49 (49.5 - 50.5)



**FIGURE 8-7. GOVERNOR ADJUSTMENTS**

## GASOLINE FUEL SYSTEM

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

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

### Air Filter and Preheater Assembly

This assembly consists of the air filter housing, air filter, and preheat door assembly. See Figure 8-8.

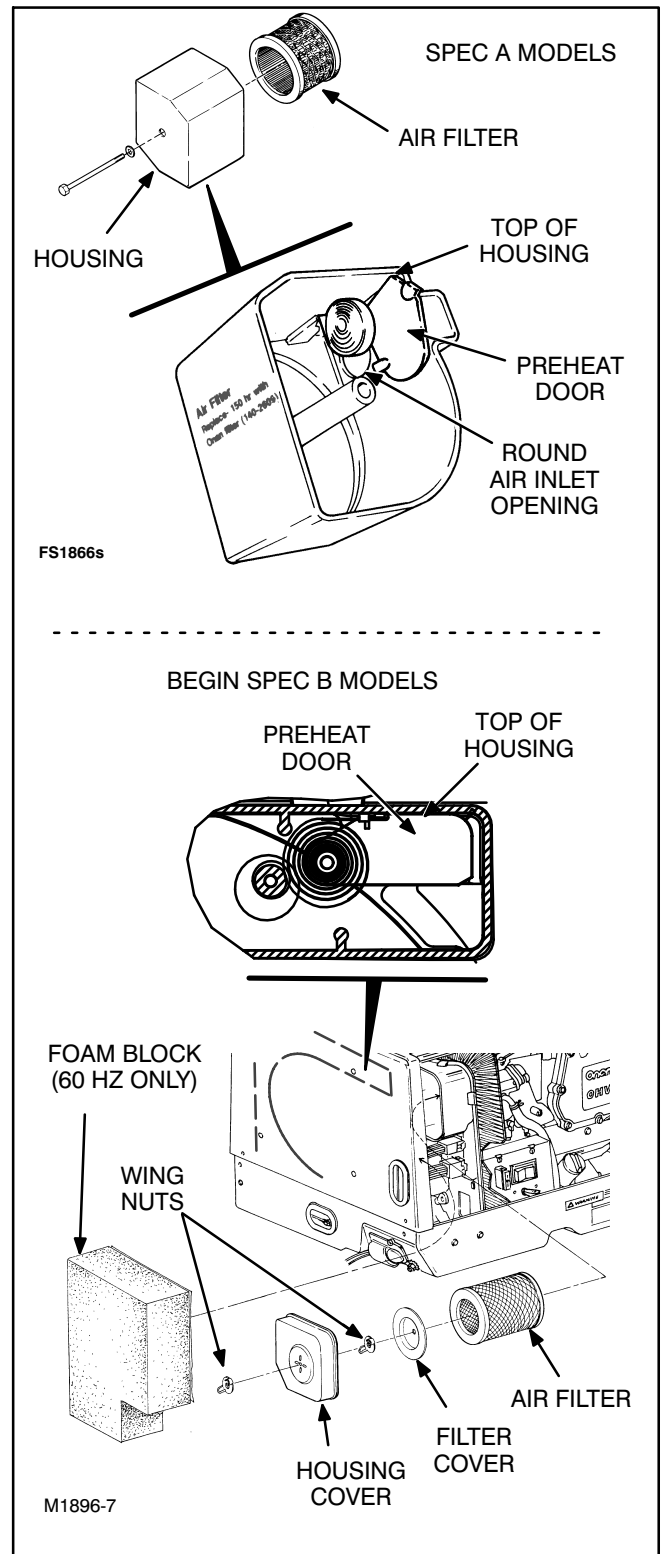
**⚠WARNING** *Fuel presents the hazard of fire or explosion that can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, arc-producing equipment, and electrical switches from the work area and rooms with common ventilation, when performing the following procedures.*

The air filter can be serviced without removing the generator set from the vehicle. Remove the service access cover and the air filter housing/cover. Remove the air filter. If the air filter is dirty, replace it.

**Spec A:** The preheat door assembly is located inside the air filter housing. Inspection of the preheater door operation can be made at this point.

**Spec B:** The preheat door assembly is located inside the air housing assembly. If a problem with the preheat door assembly is suspected, refer to Section 9, *Generator* for details on removing the air housing assembly.

The preheater door should be fully open at 70°F (21°C) and should align with the top of the housing. Rotate the door down over the round air inlet opening in the housing, then release it. The door should move freely back to the open position. If the door does not move freely, clean the spring and housing with low pressure compressed air and retest.



**FIGURE 8-8. AIR FILTER AND PREHEATER ASSEMBLY**

## Carburetor and Intake Manifold Assembly

This assembly consists of the carburetor and the intake manifold assembly. See Figure 8-9. It is easier to disconnect the carburetor linkages if the generator set housing is removed.

**⚠WARNING** *Fuel presents the hazard of fire or explosion that can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, arc-producing equipment, and electrical switches from the work area and rooms with common ventilation. Keep a type ABC fire extinguisher nearby.*

**Disassembly:** Use the following procedures to remove the carburetor and intake manifold assembly.

1. Disconnect the fuel line and plug it to prevent fuel spill and fuel vapor accumulation. (Begin Spec B models: Disconnect the fuel solenoid leads.)
2. Remove the air filter assembly.

3. Remove the carburetor mounting screws from the left side of the endbell.
4. Close the choke and throttle plates by rotating their shafts in a counterclockwise direction. Pull the carburetor with its gaskets out slowly.
5. Disengage the governor and choke linkages from the carburetor (it may be necessary to remove the automatic choke assembly mounting screw to remove its linkage).
6. Remove the intake manifold mounting nuts and lift off the manifold. Remove the intake manifold gasket and plug the intake port with a rag to prevent loose parts from accidentally entering the port.

**Assembly:** Perform the assembly steps in reverse order of disassembly. Use new gaskets between the intake manifold and the engine, between the intake manifold and the carburetor, and between the carburetor and the air cleaner adapter. Do not use sealer on the gaskets. Tighten the intake manifold capscrews to the specified torque.

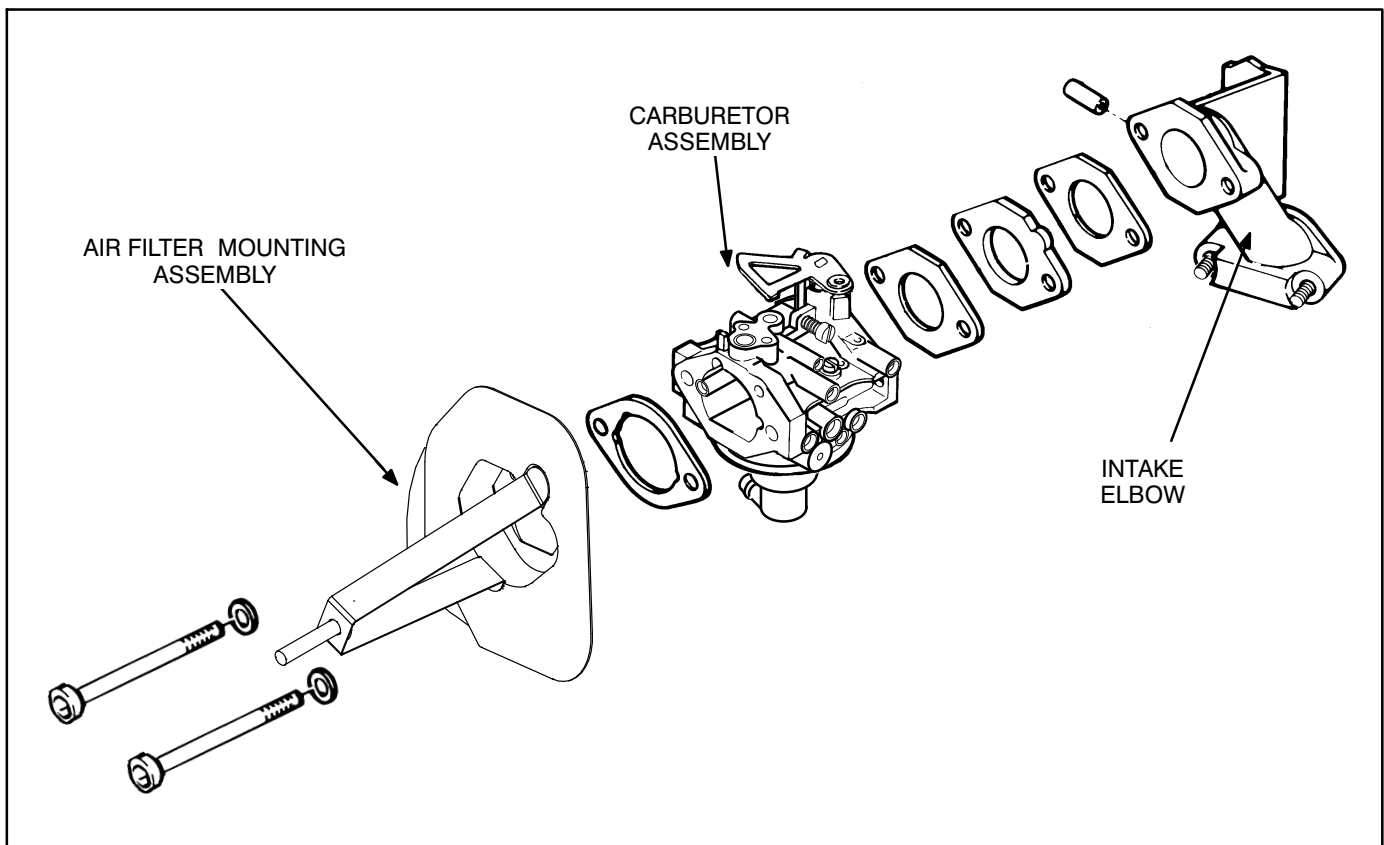


FIGURE 8-9. CARBURETOR AND INTAKE MANIFOLD ASSEMBLY



## Carburetor Replacement (Beginning Spec D)

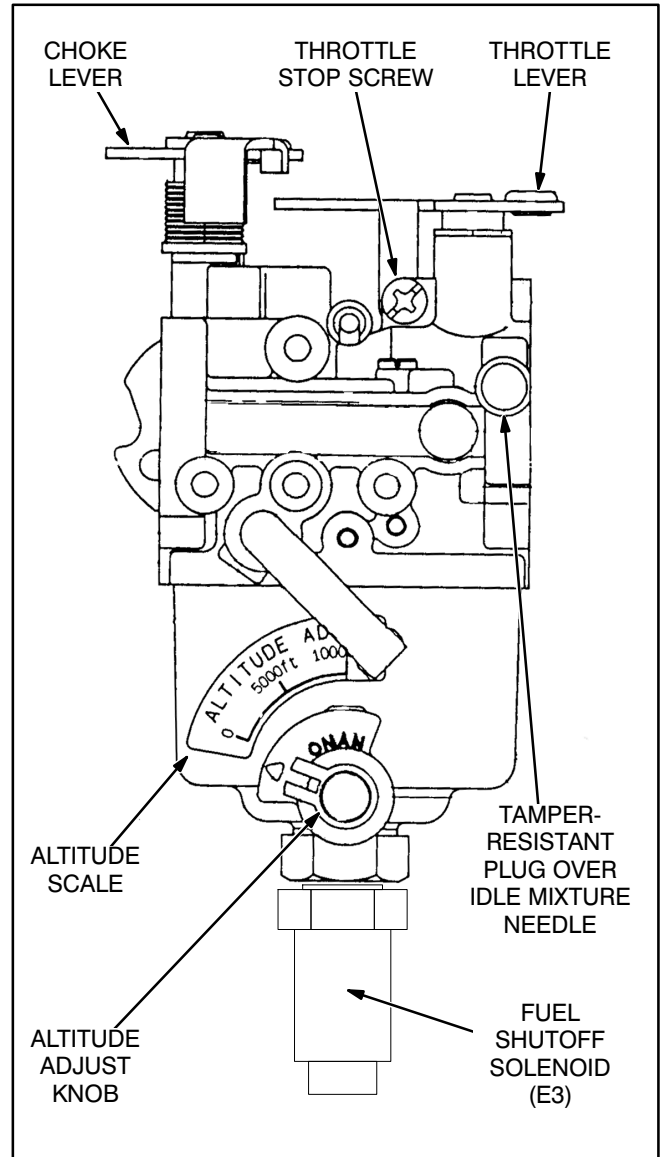
Other than turning the altitude adjust knob shown in Figure 8-10 (which changes the main fuel mixture within a limited range), fuel mixture adjustments should not be attempted. Nor should the carburetor be overhauled. Instead, a malfunctioning carburetor should be replaced. Before replacing a carburetor, however, make certain that:

- All other necessary engine and generator adjustments and repairs have been performed.
- The carburetor is actually malfunctioning, by carefully following the troubleshooting procedures in Section 6. *Troubleshooting*.

See the instructions on how to remove and replace the carburetor under the subheadings *Air Filter and Preheater Assembly* on Page 8-11 and *Carburetor and Intake Manifold Assembly* on Page 8-12.

A throttle stop screw is provided for adjusting the “closed” position of the throttle plate to obtain proper governor response when loads are being disconnected. (See *Governor Adjustments* on Page 8-9) To adjust the throttle stop screw:

1. Connect a frequency meter and start and run the generator set until it has warmed up to normal operating temperature.
2. Disconnect all loads. Pull the governor linkage toward the front of the generator set so that the tang on the throttle lever bears against the throttle stop screw. Adjust the stop screw to obtain a frequency of 54 to 56 Hz on 60 Hz generator sets (44 to 46 Hz on 50 Hz generator sets).



**FIGURE 8-10. CARBURETOR ADJUSTMENTS  
(BEGINNING SPEC D)**

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## Carburetor Mixture Screw Adjustments (Does Not Apply to Spec D and Later)

The most common causes of poor carburetion are the idle and main mixture screws being out of adjustment and contamination in the carburetor. Variation from the correct mixture settings can cause serious engine problems. Too rich a mixture wastes fuel and increases engine wear by washing the lubricant from the cylinder walls and diluting the crankcase oil. Too lean a mixture causes power loss, flat spots in acceleration, and a tendency to burn valves and spark plugs.

Unless a carburetion problem is indicated, the mixture screw settings should not be changed. This does not include problems due to high altitude, which can usually be corrected with a small adjustment of the main mixture screw within the range provided by the limiter cap. The limiter cap on the main mixture screw should not be removed unless the carburetor has been overhauled or is way out of adjustment. Before making adjustments, make sure the ignition system is working properly.

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

**To make preliminary mixture screw settings:** Remove the limiter cap from the main adjustment screw. Turn both of the mixture screws in until lightly seated (Figure 8-11), then turn the main screw out 2 turns and the idle screw out 2-1/2 turns.

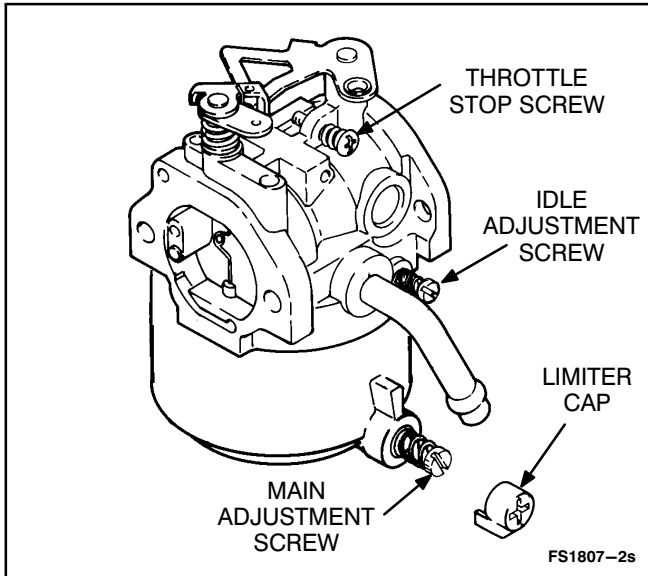
**⚠ CAUTION** *A hot generator set can cause severe burns. Always allow the generator set to cool before touching any components or removing any parts.*

Start the engine and allow it to run for ten minutes. Use the following procedure to adjust the mixture screws:

1. Stop the generator set and connect a voltmeter, frequency meter and load bank to the generator output leads.
2. Start the generator set and apply the rated load. Verify that the frequency is within  $60.5 \pm 1$  Hz. Adjust the governor speed adjustment screw if necessary to obtain the required frequency.
3. Turn the main adjustment screw inward until voltage or frequency drop and then outward until voltage or frequency drop again. Locate the point where voltage and frequency are the highest. From this point turn the main adjustment screw out an additional 1/4 turn. Install the limiter cap so it is vertical.
4. Remove the load and verify that the frequency is within  $62.5 \pm 0.5$  Hz on 60 Hz models or  $52 \pm 0.5$  Hz on 50 Hz models. Adjust the governor speed adjustment screw if necessary to obtain required frequency.
5. Turn the idle adjust screw inward until voltage and frequency drop and the engine begins to run rough or hunt. Back the idle screw out until the engine runs smooth without hunting.
6. Pull the governor linkage toward the front of the generator set so that the throttle lever on the carburetor is resting against the throttle stop screw (Figure 8-11). Adjust the stop screw to obtain a setting of  $55 \pm 1$  Hz ( $45 \pm 1$  Hz on 50 Hz units).
7. Readjust the governor speed screw to within  $62.5 \pm 0.5$  Hz on 60 Hz models or  $52 \pm 0.5$  Hz on 50 Hz models at no-load. Observe the sensitivity of the generator set. If necessary, adjust

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the governor sensitivity as specified in *Governor* on Page 8-9.



**FIGURE 8-11. MIXTURE SCREW ADJUSTMENT  
(PRIOR TO SPEC D)**

## Carburetor Overhaul (Does Not Apply to Spec D and Later)

Carburetion problems that cannot be corrected by mixture screw adjustments are usually a result of gummed-up fuel passages or worn internal parts. The most effective remedy is a complete carburetor overhaul.

Overhauling a carburetor consists of complete disassembly, a thorough cleaning, and replacement of worn parts. The carburetor repair kit includes new gaskets and replacements for the parts that are most subject to wear.

Carefully note the location of carburetor parts for correct reassembly. Review these instructions before starting. The carburetor components are illustrated in Figure 8-12.

Gasoline fuels deteriorate over time causing fuel system corrosion and the formation of gum and varnish-like deposits. If the generator set will not be operated for more than 120 days, a fuel preservative and stabilizer such as OnaFresh™ should be used to protect the fuel system. Follow the label instructions for using a fuel additive.

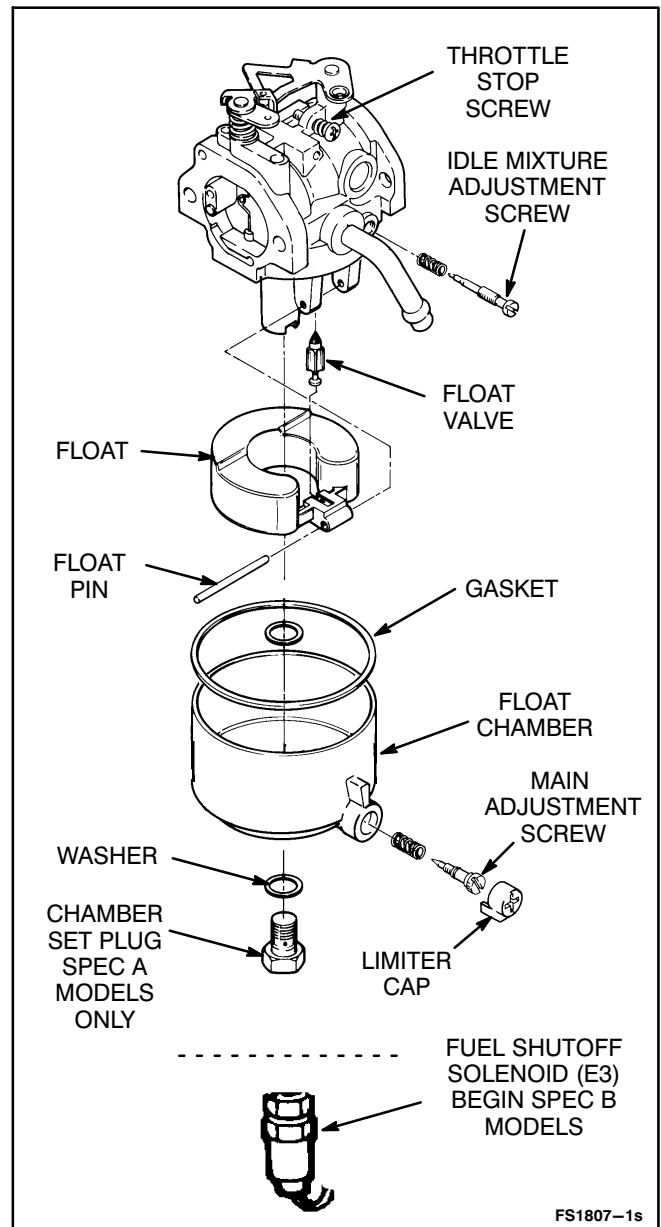
**⚠ WARNING** *Gasoline is extremely flammable. Severe personal injury or death can result if it is ignited. Eliminate all possible sources of ignition including fire, flame, spark, pilot light, cigarettes, arc-producing equipment, electrical switch, or other ignition sources before performing this procedure.*

**Removal and Disassembly:** Remove the carburetor and intake manifold assembly, as specified in the *Carburetor and Intake Manifold Assembly* on Page 8-12. Remove the carburetor from the intake manifold. Carburetor parts are fragile and they must be handled with care. Never force a part when disassembling or assembling. Disassemble the carburetor as follows:

1. Remove the main and idle mixture screws.
2. Separate the lower section of the carburetor. Remove the float chamber and gasket by removing the chamber set plug.

3. Slide the float pin out of the float passage. Remove the float and float valve.

**NOTE:** The throttle plate screws are secured with epoxy. Do not remove the choke or throttle plates, shafts, arms or governor link bushing unless they are defective.



**FIGURE 8-12. CARBURETOR OVERHAUL  
(PRIOR TO SPEC D)**

### Cleaning and Repair Procedure:

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

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

2. Remove the carbon from the carburetor bore, especially where the throttle and choke plates seat. Be certain not to plug the idle or main fuel ports.
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 8-13). 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.

### Carburetor Reassembly:

1. If removed during overhaul, slide in the throttle shaft and install the throttle plate using new screws (if needed). 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.
2. Screw in the main nozzle. Install the float valve into the slot in the float and install the float with the float pin (Figure 8-14). Make sure that the float moves freely without binding.
3. Install the main mixture screw assembly and the idle mixture screw assembly.

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

4. Adjust the idle and main mixture screws as described in this section.

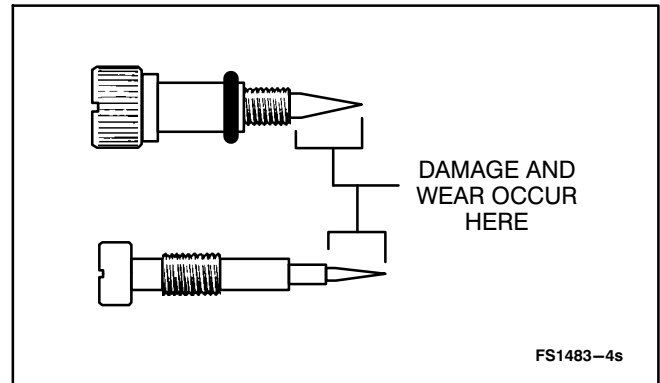


FIGURE 8-13. MIXTURE NEEDLE INSPECTION

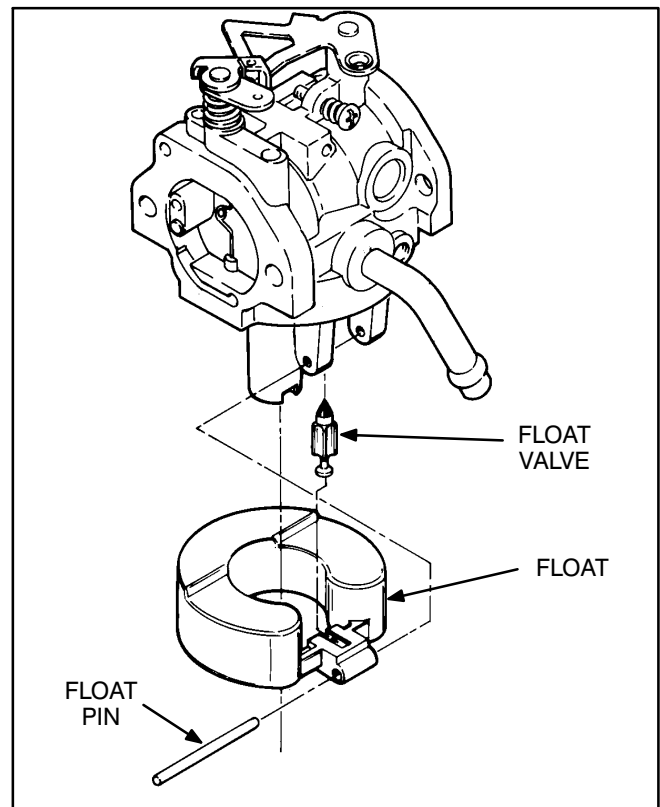


FIGURE 8-14. FLOAT INSTALLATION

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## Choke Assembly

The generator set has an automatic choke assembly that consists of a bimetal choke coil, coil housing, heater tube (from the exhaust tube), and choke linkage. The choke linkage connects to the choke shaft lever on the carburetor.

When the engine is cold, the choke coil position causes the linkage to hold the choke nearly closed. When the engine starts, hot air from the exhaust manifold enters the coil housing. The choke coil expands pulling the linkage to partially open the choke. As the engine warms up, the coil continues to expand and gradually opens the choke and holds it open while the engine is operating. This action varies the fuel/air mixture as the engine warms up to provide smooth engine operation.

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

**Choke Adjustment:** Check the choke linkage to make sure it is not bent or rubbing. Rotate the choke lever on the carburetor. The choke shaft should move freely and it should return to its original position when released. Inspect the heater hose to make sure it is installed properly and in good condition. Refer to Figure 8-15 on Page 8-19.

**⚠WARNING** *The choke housing becomes very hot during operation and can cause severe burns if touched. Allow the generator set to cool down before handling the choke assembly.*

1. Allow the generator set to cool down. The temperature inside the housing must be the same as the ambient temperature.
2. Loosen the adjustment screw holding the adjustment plate.
3. Slowly rotate the adjustment plate until the bimetal choke shaft connection is visible in the sight window. This is the correct setting for an ambient temperature of 70°F (21°C).

If the ambient temperature is higher or lower than 70°F (21°C), make a mark on the choke coil housing opposite the center mark on the adjustment plate. Each mark on the adjustment plate is equal to 10°F (12.2°C) of difference from 70°F (21°C). If it is warmer than 70°F (21°C), rotate the plate clockwise. If the temperature is less than 70°F (21°C), rotate the plate counterclockwise. Tighten the adjustment screw.

*Example:* If the ambient temperature is 90°F (32°C), rotate the adjustment plate two marks clockwise from the 70°F (21°C) position marked on the housing.

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

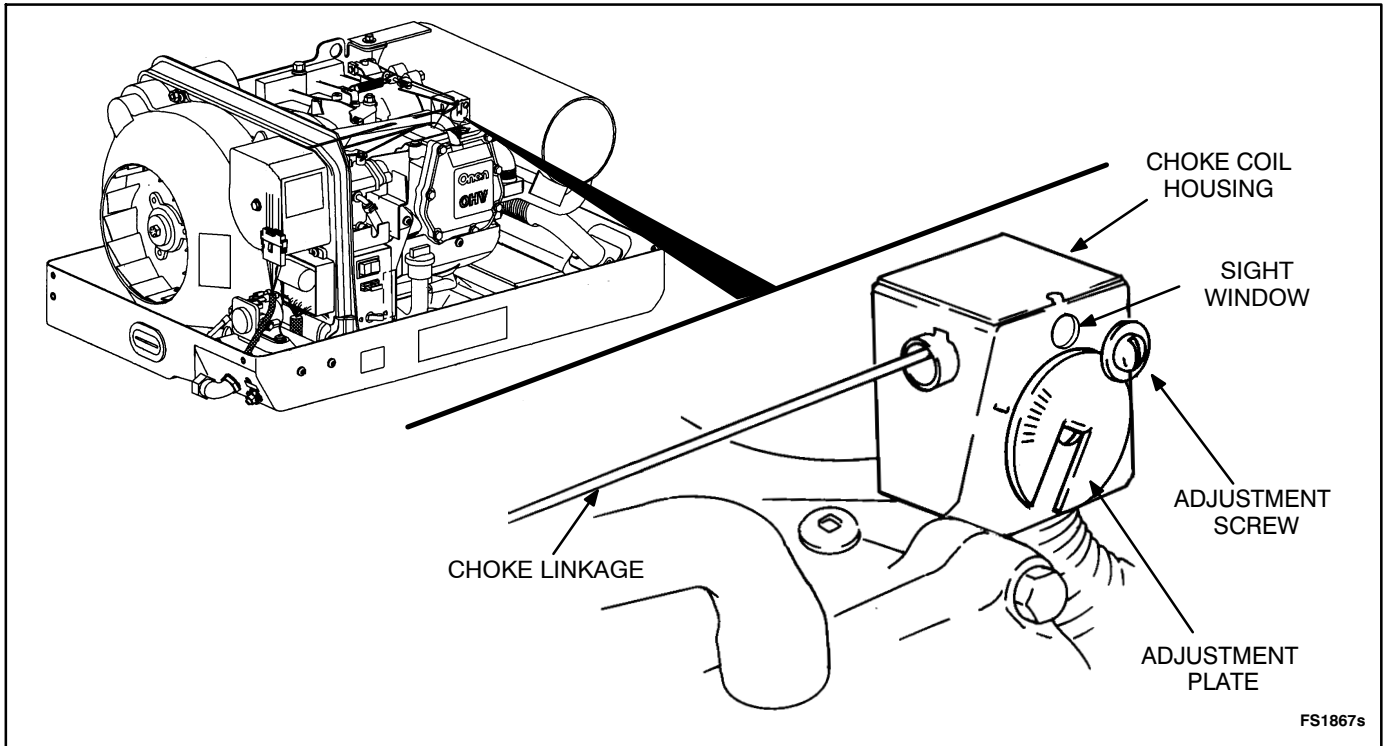


FIGURE 8-15. CHOKE ASSEMBLY

**Bimetal Coil Replacement:** After making the choke adjustment, start the generator set and observe engine operation. If the choke does not open properly, replace the bimetal coil in the choke housing as follows. Refer to Figure 8-15.

1. Remove the adjustment screw and washer from the choke coil housing.
2. Remove the housing. Straighten the tab from the adjustment plate to release the bimetal coil.
3. Remove choke linkage from the bimetal coil and install linkage on the new coil.
4. Assemble the new coil to the adjustment plate and bend the tab on the adjustment plate to secure coil.
5. Install choke coil housing and secure with screw and washer. Perform the choke adjustment procedure.

## Fuel Filter

Change the fuel filter at the interval recommended in the Operator's Manual, or if performance problems occur and bad fuel is suspected.

**⚠ WARNING** *Fuel presents the hazard of fire or explosion that can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, arc-producing equipment, electrical switch, or other ignition source near the fuel system. Keep a type ABC fire extinguisher nearby.*

1. Close the fuel supply valve (if equipped) or remove the fuel line from the fuel filter. Plug the end of the fuel line to prevent fuel leakage and vapor accumulation. See Figure 8-16.
2. Run the generator set until it runs out of fuel. Allow the generator set to cool down before replacing the fuel filter.
3. Use a deep 11/16-inch socket to unscrew the filter from the fuel pump.
4. Install a new fuel filter and tighten it securely to prevent fuel leakage.
5. Connect the fuel line to the new filter. Open the fuel valve (If equipped). Start the generator set and check for fuel leaks. Repair any leaks immediately.

**⚠ CAUTION** *Incorrect replacement of service parts can result in damage to equipment. Use genuine Cummins replacement fuel filter only.*

## Fuel Pump

An electric fuel pump is used to supply fuel to the carburetor. If the pump malfunctions or if insufficient fuel delivery is suspected, use the following procedures to test the fuel pump.

**⚠ WARNING** *Do not substitute an automotive electric fuel pump for the Cummins-supplied fuel pump. The output pressure from an automotive pump is much higher and can cause carburetor flooding or fuel leakage, creating a fire hazard.*

**⚠ WARNING** *Fuel presents the hazard of fire or explosion that can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, arc-producing equipment, electrical switch, or other ignition source near the fuel system. Keep a type ABC fire extinguisher nearby.*

**Fuel Pump Test:** Test the fuel pump by checking the fuel pump outlet pressure as follows:

1. Make sure the fuel tank has sufficient fuel to supply the generator set. The generator set fuel pick-up tube ends well above the bottom of the vehicle fuel tank. The generator set can be out of fuel even when the tank is partly full.

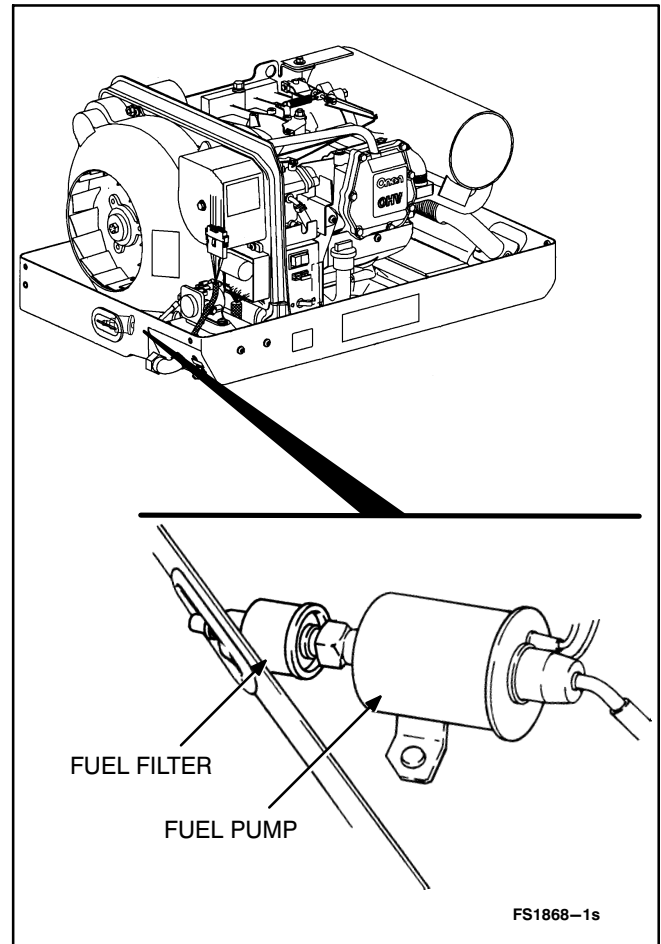


FIGURE 8-16. FUEL FILTER REPLACEMENT



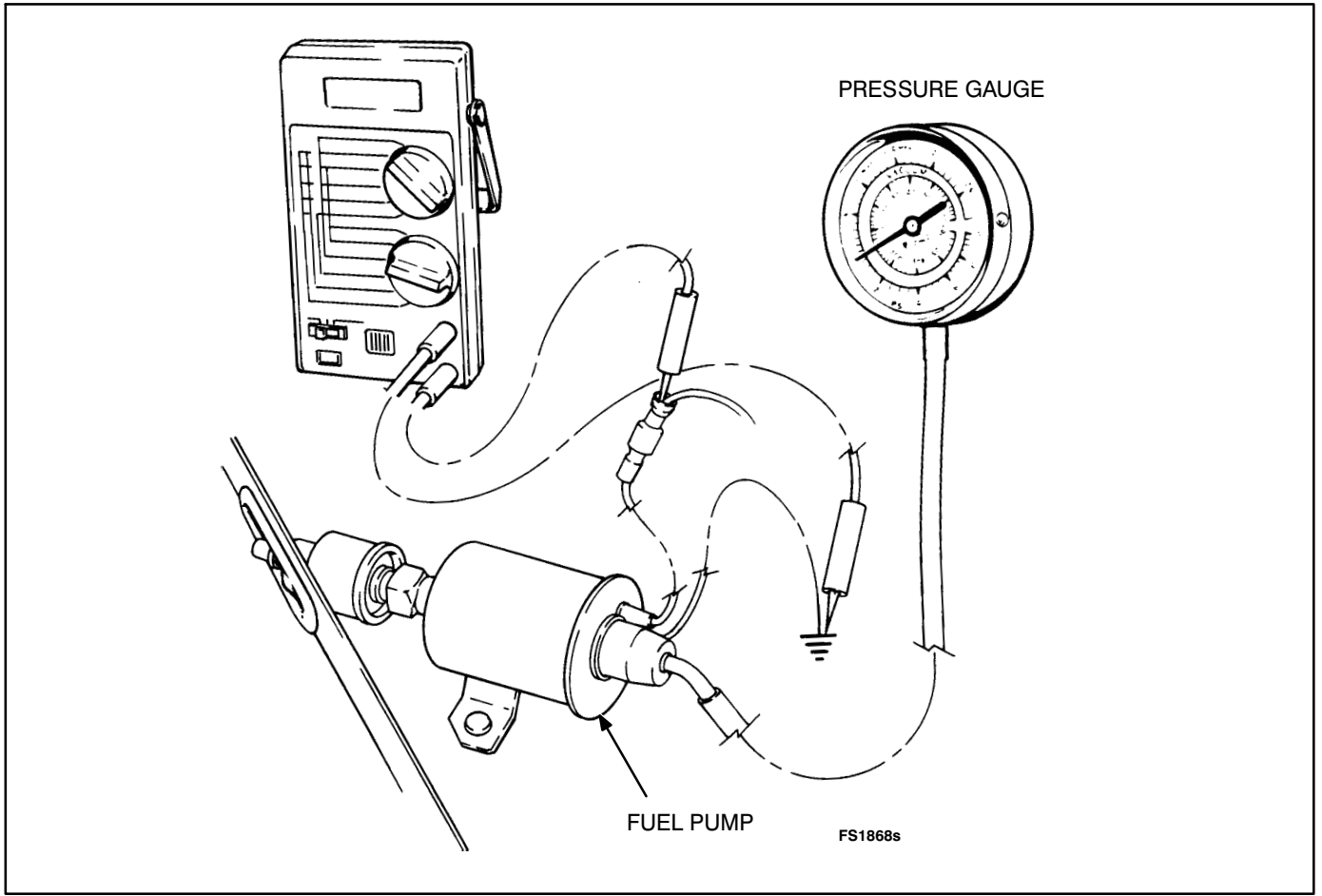
- 
2. Check the the generator set starting battery voltage when cranking and running the generator set. Measure battery voltage between the brown lead and ground (Figure 8-17). The pump will not work properly if the cranking or running voltage is less than 6 VDC.

If the battery voltage is low, charge the battery and retest.

3. Remove the fuel line from the carburetor inlet and install a pressure gauge.
4. Press the Start switch and hold it for several seconds, until the pressure reading stabilizes.
5. The pressure reading should be 3.25 psi (22.4 kPa) to 4 psi (27.5 kPa). The pressure should hold constant or drop off very slowly.

If the pressure reading is below 3.25 psi (22.4 kPa), tap the pump body with a screw driver handle to free the piston from fuel deposits. If the pump still does not work and the battery voltage is adequate, replace fuel pump with a Cummins-supplied pump.

If the pressure is higher than 4 psi (27.5 kPa), fuel can overcome the needle and float assembly and cause flooding. A negative fuel supply line pressure (more than minus 1.3 psi or three feet of lift) will prevent the pump from delivering enough fuel. Measure the pressure at the pump inlet. Inlet pump pressure must be between a minus 1.3 psi and a positive 1.5 psi (minus 8.3 kPa and positive 10.3 kPa). If an abnormally high or low inlet pressure is measured the fuel line installation is improper. Refer to the *Fuel System* section of the Installation Manual.



**FIGURE 8-17. FUEL PUMP TEST**

## LPG FUEL 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.*

***Do not smoke if you smell gas or are near LPG containers or LPG-burning equipment or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot lights, electrical arcs, arc-producing equipment, electrical switches and all other sources of ignition well away. Have an ABC fire extinguisher handy.***

LPG models are designed for a low-pressure vapor-withdrawal type of LPG supply system. *LPG supply pressure at the inlet to the demand regulator must be 9 to 13 inches (229 to 330 mm) water column (WC) when the generator set is running under full load.*

The components of the generator set LPG system include:

- A fuel-shutoff solenoid valve
- A demand regulator with a built-in automatic priming solenoid which allows fuel to pass through during cranking
- An LPG carburetor and air filter

*Before servicing the LPG fuel system, check to see that the LPG container(s) is at least half full. The problem may be that there is not enough LPG to provide the rate of vaporization necessary to meet generator set demand, especially on cold days and/or when the generator set is under full load.*

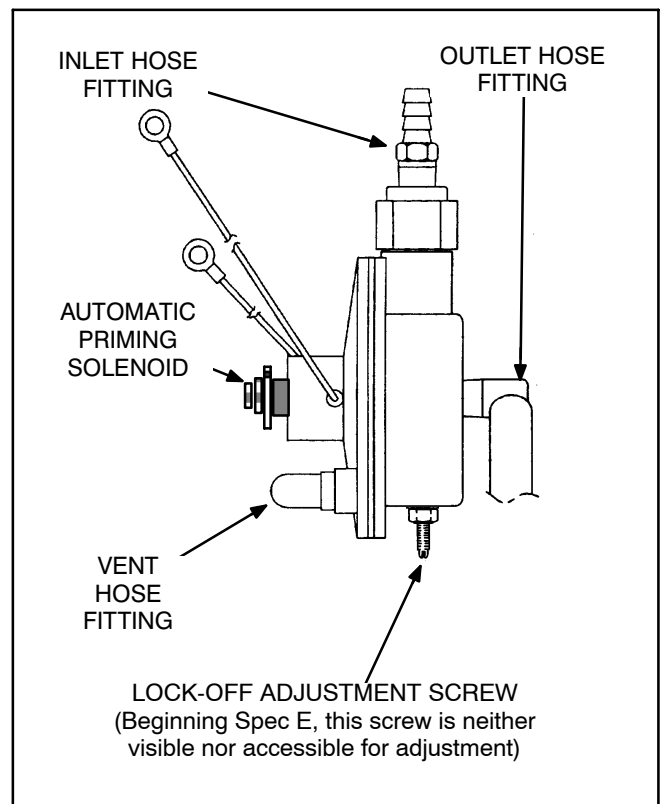
Carefully follow the instructions for disconnecting the LPG fuel line from the generator set under *Disconnecting Set from Vehicle Systems* on Page 5-4.

**⚠WARNING** *LPG “sinks” 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.*

See the instructions on how to remove and replace the carburetor under the subheadings *Air Filter and Preheater Assembly* on Page 8-11 and *Carburetor and Intake Manifold Assembly* on Page 8-12. References to preheaters and chokes are not applicable to LPG carburetors.

### Demand Regulator with Automatic Priming Solenoid

See Figure 8-18. The demand regulator assembly supplies fuel to the carburetor. It is usually not the cause of fuel system problems. All other possible causes should be checked out before adjusting or replacing the demand regulator assembly.



**FIGURE 8-18. TOP VIEW OF DEMAND REGULATOR WITH AUTOMATIC PRIMING SOLENOID**

### **Checking and Adjusting Regulator Lock-off**

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

1. Connect the regulator inlet (Figure 8-18 on Page 8-23) to a source of air pressure regulated to 11 inches WC (280 mm WC).
2. Disconnect from the carburetor the LPG supply hose, which comes from the regulator.
3. “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 measure pressure by connecting it to an inclined manometer that reads 0 to 2 inches WC (0 to 50 mm WC) and the other to provide the test pressure.
4. Attach a soap bubble to the end of the LPG supply hose which was disconnected from the carburetor. While reading the pressure indicated by the 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 air 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 air is not flowing through the regulator.)

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

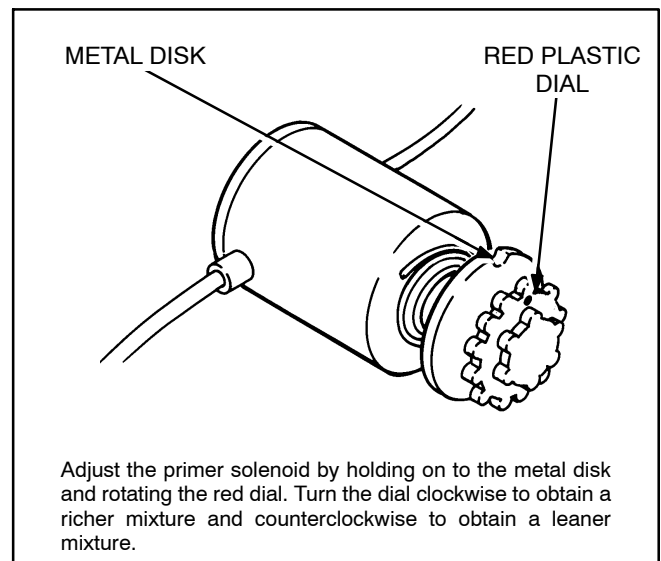
- **For generator sets Beginning Spec E:** Replace the demand regulator assembly if the lock-off pressure does not fall between 0.10 and 0.30 inches WC (2.5 and 7.6 mm WC).
- **For generator sets Prior to Spec E:** Adjust lock-off pressure as follows:
  - If the lock-off pressure is greater than 0.30 inches (7.6 mm) WC, loosen the lock nut on the lock-off adjusting screw and back out the screw (counterclockwise) until the lock-off pressure falls between 0.10 and 0.30 inches WC (2.5 and 7.6 mm WC). Set

the adjusting screw locknut and test lock-off pressure again. Repeat the procedure if necessary.

- If the lock-off pressure is less than 0.10 inches WC (2.5 mm WC), loosen the lock nut on the lock-off adjusting screw and turn in the screw (clockwise) until the lock-off pressure falls between 0.10 and 0.30 inches WC (2.5 and 7.6 mm WC). Set the adjusting screw locknut and test lock-off pressure again. Repeat the procedure if necessary.
- Replace the demand regulator if it continues to leak after lock-off pressure adjustments have been attempted.

**Priming Solenoid Test:** Upon completing the lock-off pressure test, energize the priming solenoid by connecting battery positive (+) to the orange lead and battery negative (–) to the green lead. Replace the regulator assembly if the priming solenoid does not cause the regulator to open.

**Priming Solenoid Adjustment:** See Figure 8-19. If the generator set does not start when it is hot, rotate the dial counterclockwise—the fuel mixture could be too rich. If the generator set does not start when it is at ambient temperature, rotate the dial clockwise—the fuel mixture could be too lean.



**FIGURE 8-19. AUTOMATIC PRIMING SOLENOID**

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## Fuel-Shutoff Solenoid Valve

**Leak Test:** See Figure 8-20. If there is a smell of gas when the generator set is not running, or any other reason to suspect that the valve is leaking, connect the inlet of the valve to a source of air pressure regulated to not more than 14 inches WC (356 mm WC) and disconnect the outlet hose. Replace the solenoid if it leaks, as checked by a soap bubble.

**Operation Test:** If the generator set cranks, but does not start (first see Section 6. *Troubleshooting*), determine whether or not the valve is opening. With the source of air still connected, energize the valve by connecting battery positive (+) to the top terminal and battery negative (-) to the grounded terminal. Replace the solenoid valve if it does not open when it is energized.

## LPG Carburetor (Beginning Spec E)

See Figure 8-21. An LPG carburetor is not likely to cause problems and should be replaced only after all other causes have been eliminated (see Section 6. *Troubleshooting*). It is not necessary to adjust fuel mixture. These carburetors are calibrated at the factory and the adjustments are sealed.

A throttle stop screw is provided for adjusting the “closed” position of the throttle plate to obtain proper governor response when loads are being disconnected. (See *Governor Adjustments* on Page 8-9) To adjust the throttle stop screw:

1. Connect a frequency meter and start and run the generator set until it has warmed up to normal operating temperature.
2. Disconnect all loads. Pull the governor linkage toward the front of the generator set so that the tang on the throttle lever bears against the throttle stop screw. Adjust the stop screw to obtain a frequency of 44 to 46 Hz on 60 Hz generator sets (36 to 38 Hz on 50 Hz generator sets).

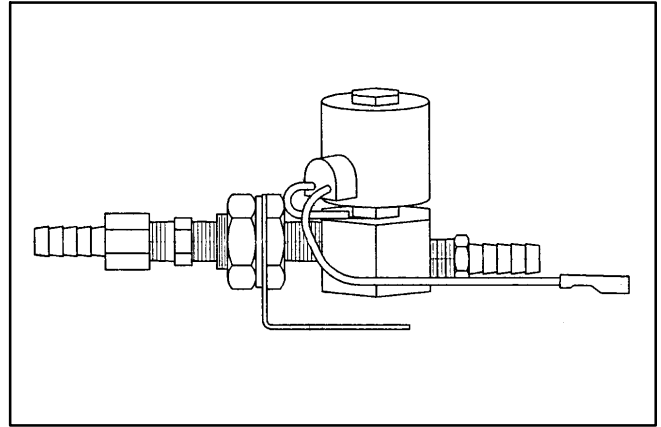


FIGURE 8-20. FUEL SOLENOID VALVE

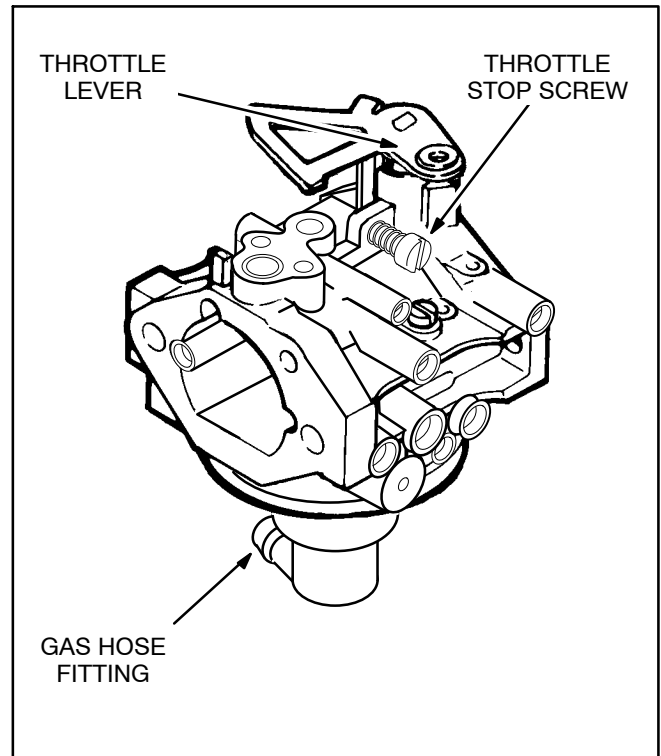


FIGURE 8-21. LPG CARBURETOR (BEGINNING SPEC E)

## LPG Carburetor (Prior to Spec E)

See Figure 8-22. LPG carburetors prior to Spec E have two adjustment screws that must be properly set for satisfactory operation. The throttle stop screw controls how much the throttle plate remains open when the governor closes the throttle. The main adjustment screw controls the fuel mixture. No other adjustments are required with an LPG carburetor since there are no float or choke adjustments.

**Mixture Screw Adjustment:** The mixture screw should not be adjusted until the ignition system, governor, and other fuel system components have been checked for correct operation. If the carburetor is totally out of adjustment, turn the mixture screw in until lightly seated. For a preliminary adjustment turn the screw out 2 turns.

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

Start the engine and allow it to run for about 15 minutes at half load. Figure 8-22 shows the location of the adjustment screw. Use the following procedure to adjust:

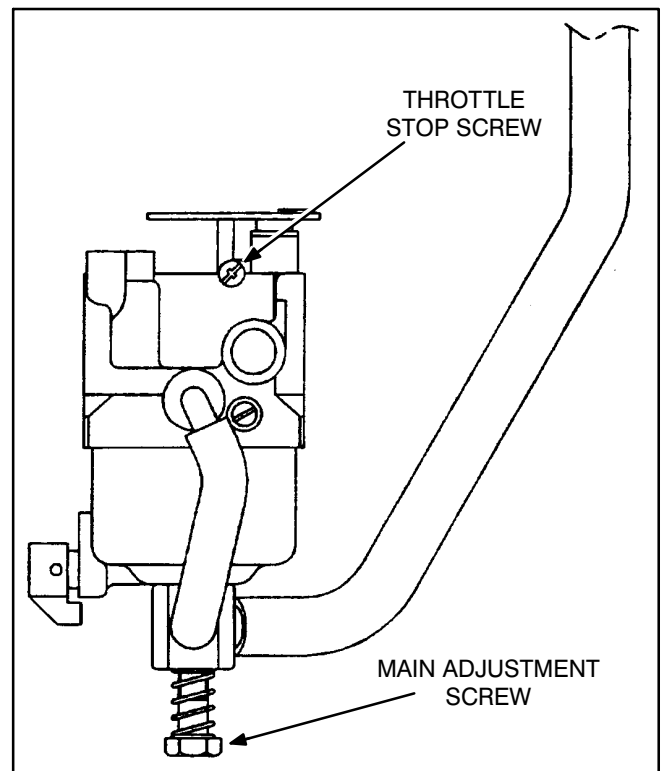
1. Stop the generator set and connect a voltmeter, frequency meter, and load bank to the generator output leads.
2. Start the generator set and apply full rated load. Verify that the frequency is within  $60 \pm 0.5$  Hz ( $50 \pm 1$  on 50 Hz units) and adjust the governor speed adjustment nut if necessary to obtain required frequency.
3. Turn the main adjustment screw inward until voltage or frequency drops and then outward until voltage or frequency drops again. Set the main adjustment screw at the point where the voltage and frequency are highest. If a CO meter is available, follow the manufacturer's instructions for use and adjust the main adjustment screw to obtain 1 to 2 percent CO.
4. Remove the load and verify that frequency is within  $62.5 \pm 0.5$  Hz ( $52 \pm 0.5$  on 50 Hz units). Adjust governor speed adjustment nut if necessary to obtain required frequency.
5. Pull the governor linkage toward the front of the generator set so that the throttle lever on the

carburetor is resting against the throttle stop screw. Adjust the stop screw to obtain a setting of  $55 \pm 1$  Hz ( $45 \pm 1$  Hz on 50 Hz units).

6. Release the governor linkage and observe the stability of the generator set. Set the voltage and frequency and adjust the sensitivity of the governor as specified under *Governor* on Page 8-9. Add and remove a half load several times to make certain the generator set does not bog down or hunt.

Carburetor problems not corrected by the adjustments may be caused by dirt in fuel passages or worn internal parts. Under normal conditions, the carburetor should seldom require cleaning since LP-gas vaporizes completely before reaching the carburetor and leaves no residue. However, a bad fuel supply may allow dirt or oil to collect in the carburetor. This may require carburetor cleaning to restore satisfactory operation.

Cleaning the carburetor includes complete disassembly, thoroughly cleaning, and replacement of parts and gaskets.



**FIGURE 8-22. LPG CARBURETOR ADJUSTMENTS (PRIOR TO SPEC E)**

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## ELECTRIC STARTER

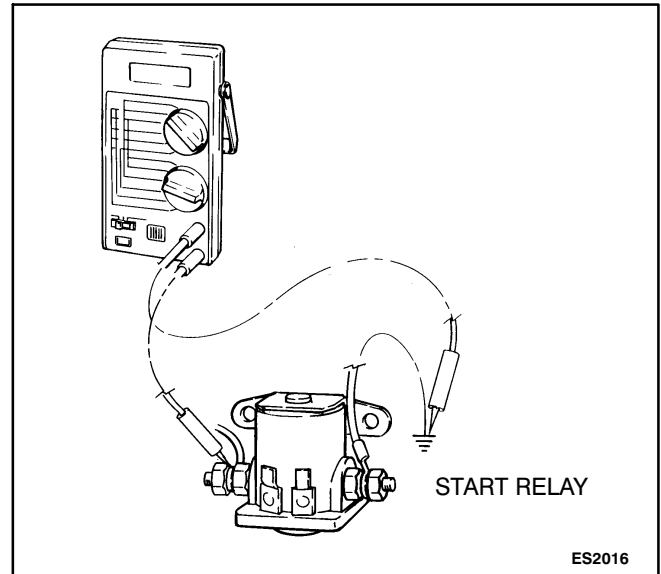
A 12-volt electric starter with a negative ground is used for cranking the generator set. When the starter is energized, an inertial engagement system causes the starter pinion gear to engage the ring gear on the fan hub assembly. As the starter spins, the starter pinion gear drives the ring gear causing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

### Starter Voltage Check

Before removing the starter for service, perform the following starter check to make sure the starter is getting voltage from the control circuit.

1. Connect a voltmeter between the output terminal on the start relay (opposite the BAT terminal with the starter motor lead connected) and ground. See Figure 8-23.
2. Press the start switch and observe the meter reading. If approximately 12 VDC is measured and the starter does not crank, the starter is defective. Proceed to the starter disassembly

section. If low or no voltage is measured check the starting battery, start solenoid, and control wiring.



**FIGURE 8-23. STARTER VOLTAGE CHECK**

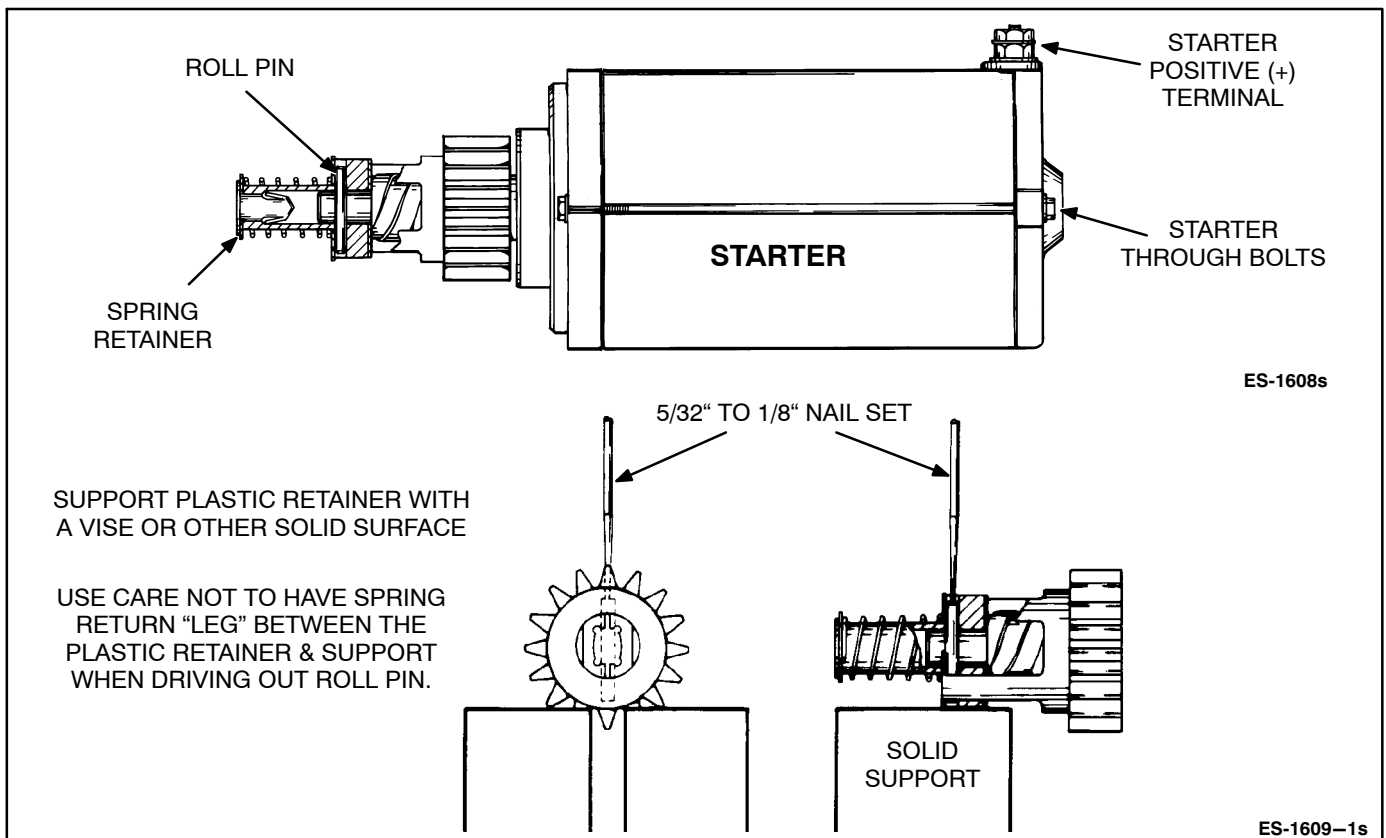
## Starter Disassembly

The generator set must be removed from the vehicle before the starter can be serviced. See Section 5. *Preparing for Service*.

1. Disconnect the generator set starting battery cables. Disconnect the negative (-) cable first, to reduce the risk of arcing.
2. Remove the generator set outer housing. Disconnect the positive (+) cable from the starter lug terminal.
3. Remove the rear mounting nut from the starter.

Remove the engine bracket behind the starter from the engine (Torx T-30) and muffler.

4. Remove the starter mounting nuts (bolts on Spec A). Carefully disengage the starter from the end bell.
5. Use a 1/8 to 5/32 inch nail set to remove the roll pin from the armature shaft. (When reassembling, use a new roll pin.) Remove the return spring, gear and clutch assembly as required. See Figure 8-24.
6. Remove the starter through-bolts. Carefully separate the brush end cap housing from the armature assembly.



**FIGURE 8-24. DRIVING ROLL PIN OUT OF STARTER ASSEMBLY**



### Testing Armature for Grounds

Touch one ohmmeter lead to a commutator bar, 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 8-25.

### Testing Armature for Shorts

Use a growler (Figure 8-26) 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.

### Testing Armature for Opens

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

### Brush Inspection

Measure brushes (Figure 8-27) and replace them if worn to less than 0.315" (8 mm).

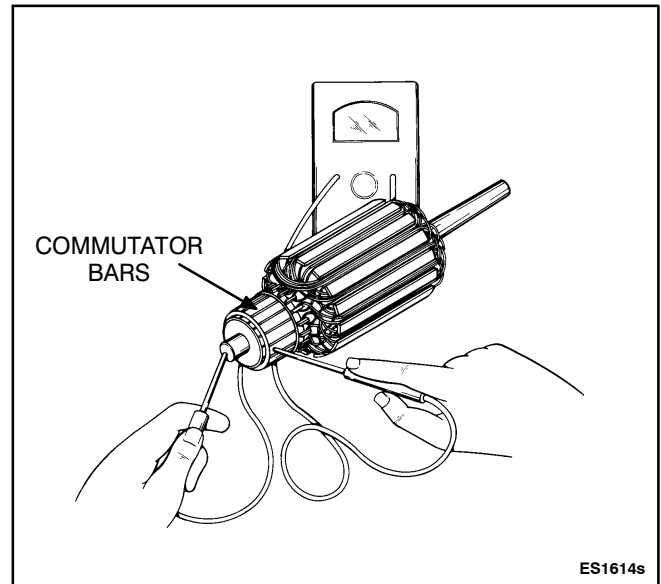


FIGURE 8-25. TESTING ARMATURE FOR GROUNDS

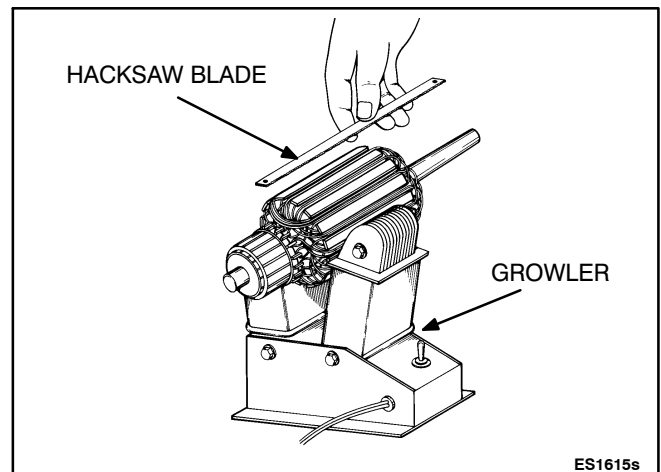


FIGURE 8-26. TESTING ARMATURE FOR SHORTS

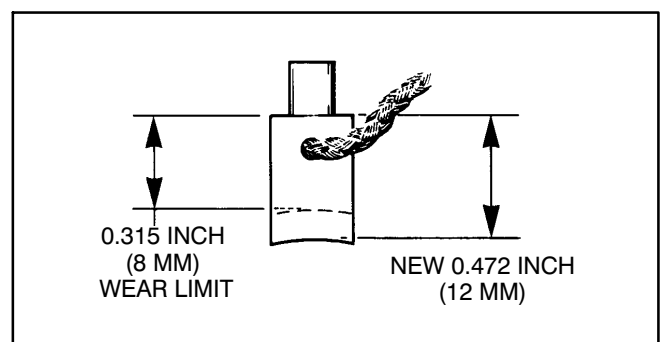


FIGURE 8-27. BRUSH INSPECTION

## Starter Re-assembly

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

1. Wipe all of the dirt and oil from the starter components with a clean cloth. Blow off dust with filtered low-pressure compressed air.

**⚠ CAUTION** *Oil on the armature will damage the 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. Push the negative brush terminals over the through-bolt holes on the brush endcap (Figure 8-28).
3. Insert the positive brush stud into the hole, and torque to 25-30 lb-in. (2.83 - 3.39 Nm).

4. Insert the brush springs into brush holders. Insert the brush tabs into the spring ends and slide brushes into brush holders in endcap. Make sure all brush wires are facing up.

5. Place a washer on the commutator end of the shaft, then put the armature into the brush endcap. Push the four brushes toward the commutator, make sure that the springs are correctly positioned on the brushes.

**NOTE:** Replacement brushes are supplied preassembled in the endcap. Remove the brush retainers after installing armature.

6. Make sure that all brush wires are clear of the commutator, and that uninsulated sections of wires do not touch the inside of the housing, or adjacent brush boxes.

7. Place the magnetic housing over the armature. Hold down the armature and the end cap by pressing a nut driver over the end of the shaft.

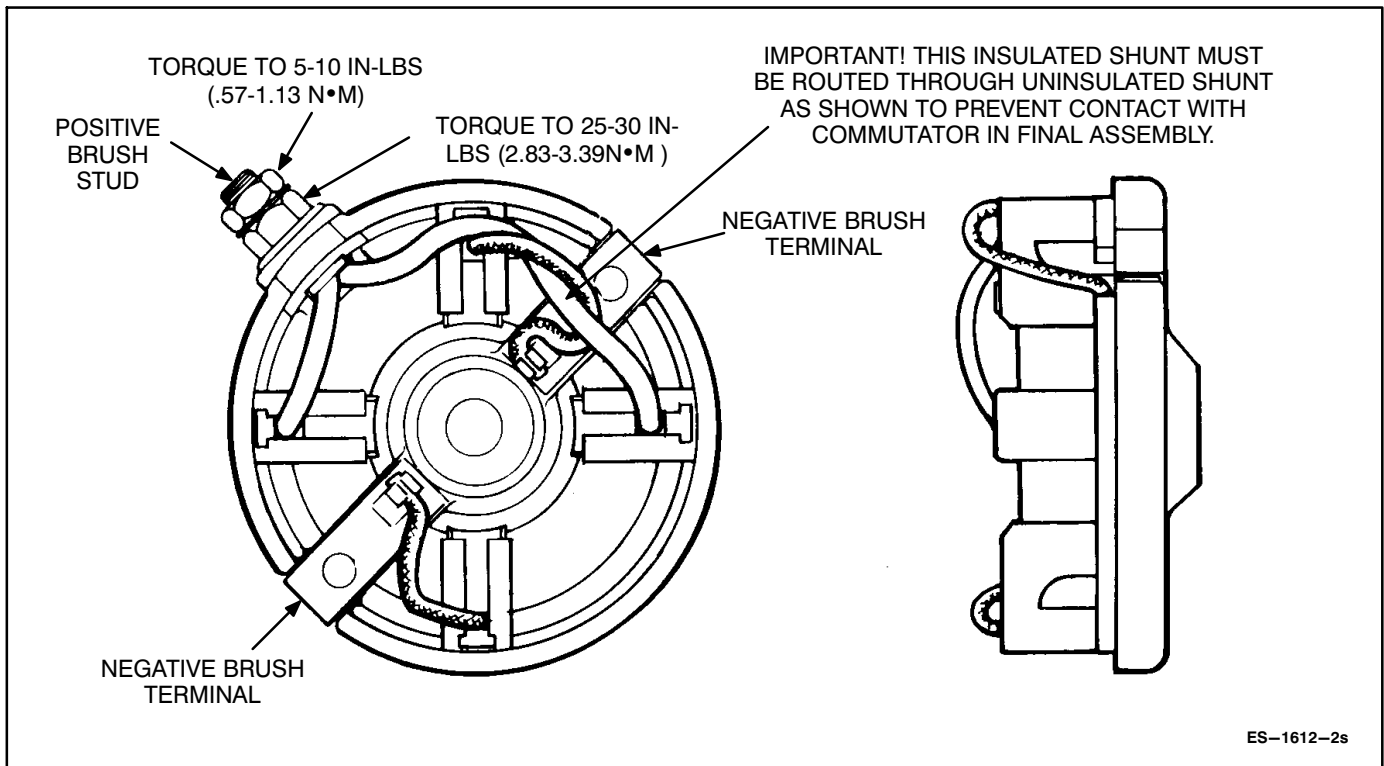


FIGURE 8-28. BRUSH ENDCAP

1. Place a spring washer and a flat washer on the shaft, as shown in Figure 8-29.
2. Place the mounting bracket on the motor with the through-bolt lead-ins to 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 line up.
3. Insert the through-bolts, and torque to 35-45 lb-in. (3.96 - 5.09 Nm).
4. 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.
5. If the return spring is unassembled:
  - A. Place a 1-1/16 inch O.D. washer over the end of the shaft.
- B. With the chamfered side of the shaft hole facing up, place a plastic retainer on the shaft and line up the hole with a hole in the shaft.
- C. Support the plastic retainer with a vise or other solid surface. Using a 5/32 or 1/8 inch nail set and hammer, drive in a new roll pin. The pin should be driven about 1/10th of an inch (2.5 mm) from the edge of the plastic retainer, or in such a way that it is evenly spaced from each side.
- D. Place the spring cover over the top of the plastic retainer, then place the return spring on top of the retainer.
- E. With a washer placed over the point of the plastic retainer, push the metal retainer into the hole of the plastic retainer as far as it will go.

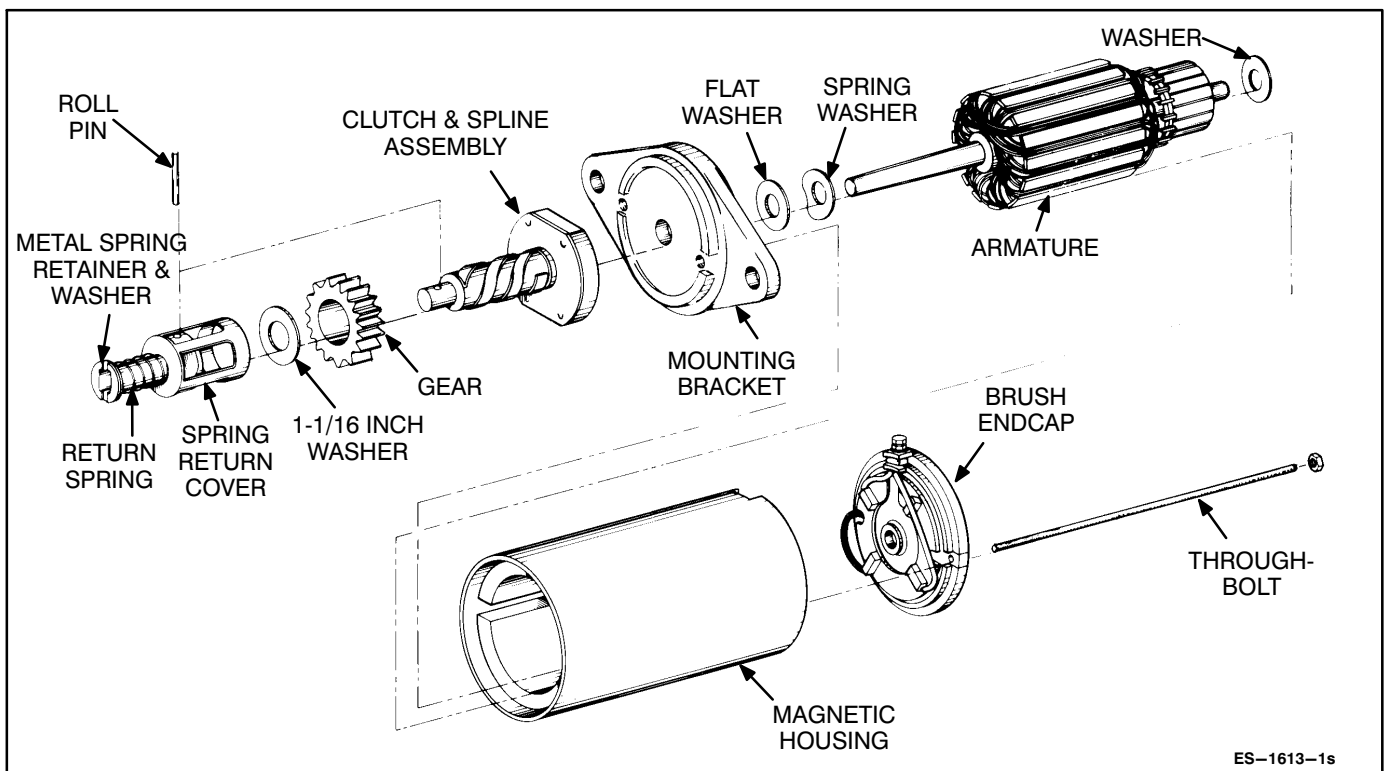


FIGURE 8-29. STARTER ASSEMBLY

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1. Carefully mount the starter on the endbell and tighten the mounting bolts to 30-33 lb-ft (41-45 Nm).
  2. Install the engine bracket to the engine and install the muffler bracket hardware. Install the rear starter mounting nut.
  3. Connect the positive (+) cable to the starter terminal.
  4. Mount the housing on the generator set and install the generator set into the vehicle.
  5. Reconnect the generator set starting battery, negative (-) terminal last.



# 9. Generator

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## GENERATOR DESCRIPTION

The KY generator set uses a 2-pole, revolving field, generator design. Output voltage is controlled by an electronic voltage regulator. A circuit breaker provides overcurrent protection for the generator and also functions as an on/off switch in the load circuit. AC load connections are made through generator lead wires that connect directly to a customer supplied junction box.

The generator section consists of the following components and controls:

- Stator and housing
- Rotor
- Brushes
- Electronic Voltage Regulator (VR1)
- Circuit Breaker (CB1)
- Wiring Harness

### Stator and Housing

The stator consists of steel laminations stacked together, with three separate windings wound into slots in the laminations. Winding T1-T2 is the main power winding that provides the voltage and current to operate the connected loads. Winding B1-B2 is for battery charging and internal low voltage loads. Winding Q1-Q2 is an excitation winding that provides power to the voltage regulator for the rotor field winding. The stator assembly mounts inside the stator housing. Refer to Figure 9-1 on Page 9-3.

### Rotor

The rotor consists of steel laminations stacked together on a shaft. A field winding is wrapped around the laminations. The rotor shaft also has molded slip rings and a pressed on bearing. The entire assembly is connected directly to the tapered engine crankshaft by means of a through bolt. The rotor is supported by the engine bearing and by the endbell.

The rotor field winding provides the rotating magnetic field which in turn generates the voltage in the stator windings to power the connected loads. The magnetic field is established by a DC current flowing from the brushes through the slip rings and the field winding.

## Generator Cooling

Cooling air for the generator is provided by a centrifugal fan mounted on the rotor shaft next to the bearing. A portion of the airflow from the fan is directed into the generator. Airflow through the generator cools the rotor and stator windings.

## Brushes and Brush Block

The brush block is a one piece molded part that mounts on the endbell. There are two carbon brushes in the brush block that make contact with the slip rings on the rotor. The brushes provide the path for the controlled DC current from the regulator to the rotor field winding. Each brush is kept in contact with a slip ring by a spring located inside the brush block, behind the brush. The spring exerts the right amount of pressure to provide good contact and long brush life.

## Electronic Voltage Regulator (VR1)

The electronic voltage regulator controls the output of the generator so the voltage remains constant under any load condition. The electronic voltage regulator takes power from the stator excitation winding, rectifies it, and feeds it into the field winding through the brushes and slip rings. The regulator continually measures the output of the power winding and regulates how much current should be fed into the field winding to maintain the proper output at various load levels.

## Circuit Breaker (CB1)

AC output from the generator is supplied to a circuit breaker located along side the control panel. The circuit breaker protects the generator windings from an overload or short circuit.

## Wiring Harness

A 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 that must be provided by the RV manufacturer or generator set installer. A 1/2-inch conduit elbow is provided to facilitate installation. The load wire conductor is black, the neutral conductor is white, and the ground conductor is green.

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## GENERATOR OPERATION

Refer to the schematic in Section 12. *Wiring Schematic/Diagram* that corresponds to your generator set to follow the generator operating description. Always refer to the specific schematic that corresponds to the model and spec number of the generator set when troubleshooting problems.

When the Start/Stop switch is placed in the START position, the rotor begins to turn and the field winding is momentarily connected to the battery. This provides a current in the field winding to provide magnetism for voltage buildup. As the engine starts and speed increases, the rotating field induces an AC voltage in the stator windings. AC voltage from the excitation winding (Q1-Q2) is fed to the voltage regulator where it is rectified into DC voltage and fed back into the rotor to cause further voltage buildup. This process continues as the engine picks up speed. Voltage buildup is controlled by an electronic voltage regulator that is connected to the power output leads (L1-L2). The regulator continually measures the output voltage and compares it to an internal reference voltage. When the output voltage exceeds the reference, the regulator causes the current in the rotor to decrease until the proper voltage is obtained.

During operation, the regulator is continually monitoring the output voltage. When additional load is applied to the generator, the output voltage starts to decrease. The regulator senses this decrease and increases the field current until the reference voltage and the output voltage match. Similarly, when the load is decreased the output voltage begins to increase and the voltage regulator senses this increase. In this case, the regulator decreases the amount of current to the field until the output voltage again matches the reference voltage. By continually measuring the output voltage and compensating for load changes, the electronic voltage regulator keeps the voltage of the generator constant with varying load conditions.

## GENERATOR SERVICE

This section covers generator disassembly and assembly procedures. Refer to Figure 9-1 on Page

9-3 and Figure 9-2 on Page 9-4 to identify the various generator components described in each section. Raising the generator and engine assembly above the base assembly is necessary to disassemble the generator. Lifting eyes are provided on the starter bracket and endbell assembly on the Spec A models. A lifting hoist will be required for this step.

### Generator Disassembly / Base Removal

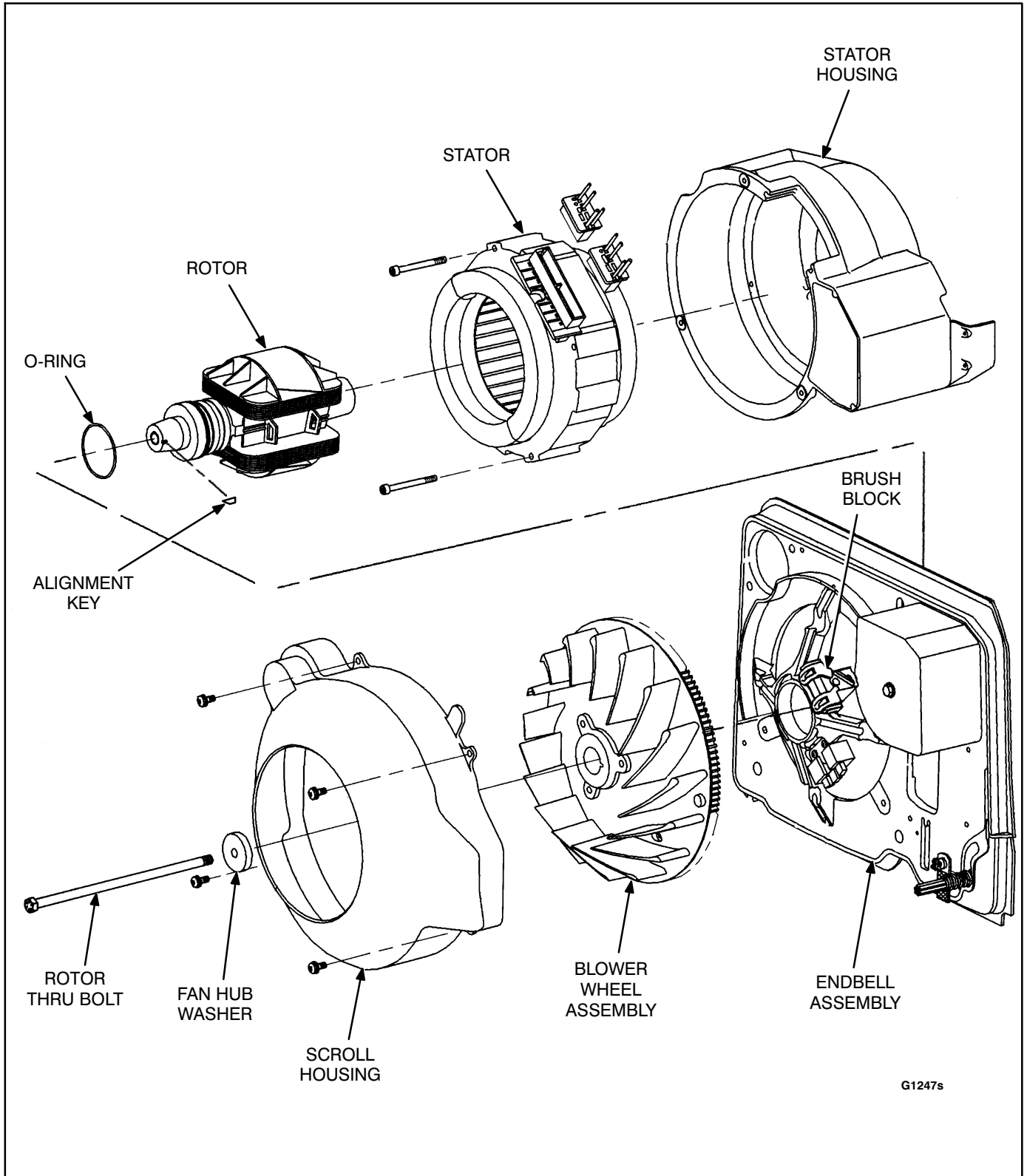
1. Drain the engine oil while the generator set is still mounted in the vehicle.
2. Remove the generator set from the vehicle and place it on a sturdy work bench. Refer to *Set Removal Guidelines* on Page 5-2 for the recommended generator set removal procedures.

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

3. Remove the side mounting screws from the enclosure cover and lift cover off generator set. (Begin Spec B, 50 Hz models: Remove the leads from the battery charger assembly mounted to the left side of the housing.)

### Spec A Instructions:

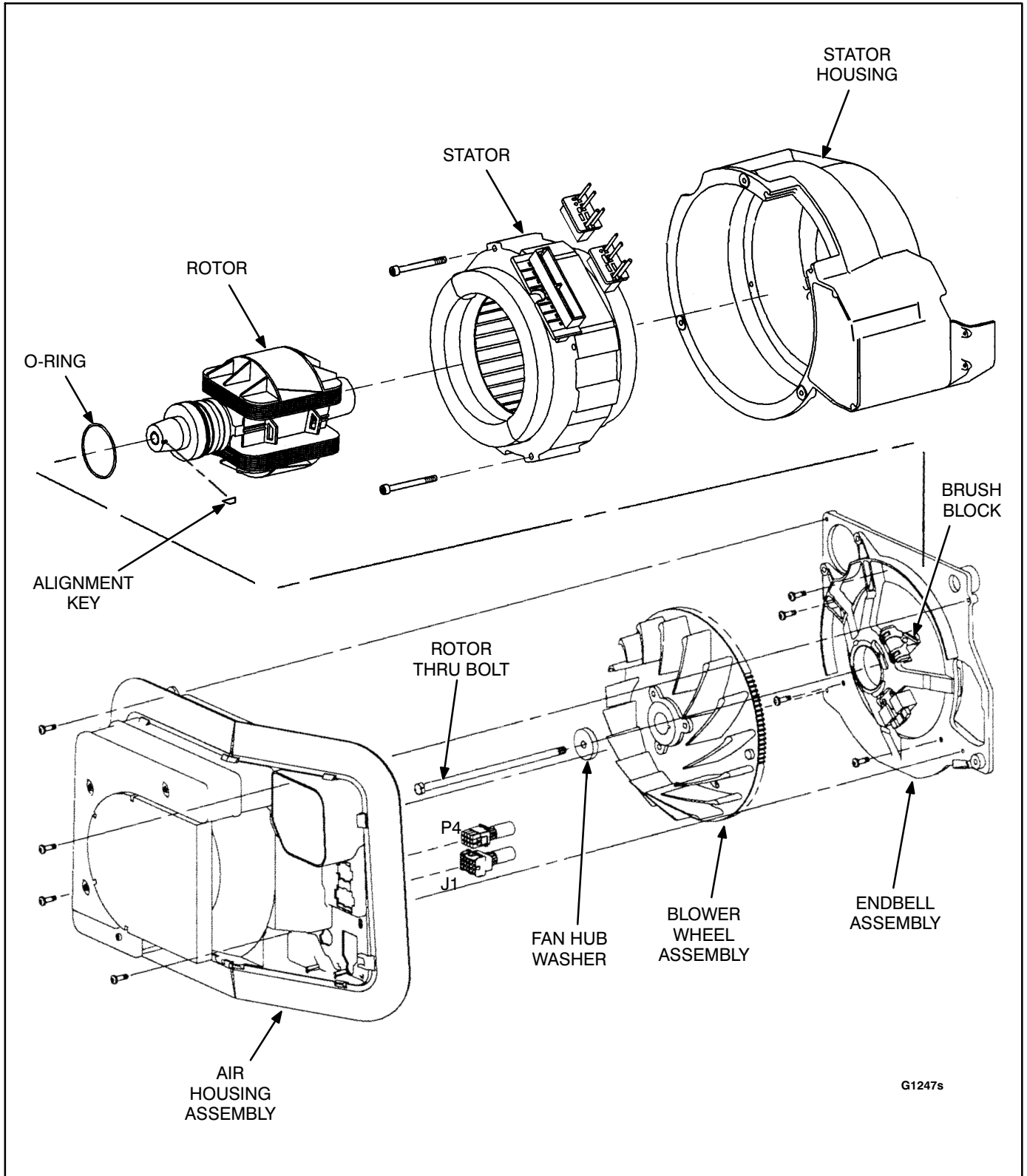
4. Remove the engine mounting bolt and two generator mounting bolts (T-55 driver) from under the base assembly. (Apply antiseize lubricant to the treads of these bolts before reinstallation.)
5. Remove the muffler exhaust mounting bolts from the base assembly.
6. Remove the mounting screws from the voltage regulator, the control panel and the solenoid/control module bracket.
7. Lift the solenoid/control module bracket and remove the ground terminal block from the left side of the base assembly. Disconnect the fuel pump leads. Disconnect the AC ground, neutral (L2) and load (L1) leads if they were not disconnected during generator set removal.



G1247s

**FIGURE 9-1. SPEC A GENERATOR COMPONENTS**





G1247s

FIGURE 9-2. BEGIN SPEC B GENERATOR COMPONENTS

8. Connect a lifting hoist to the lifting eye on the top of the endbell and slowly raise the generator end of the generator set so the bottom of the endbell is higher than the side of the base assembly. Place a wooden block under the stator housing to support the generator set. (Use the endbell and engine lifting eye if the generator set is to be moved away from the base.) Remove the scroll housing from the endbell.

**Begin Spec B Instructions:**

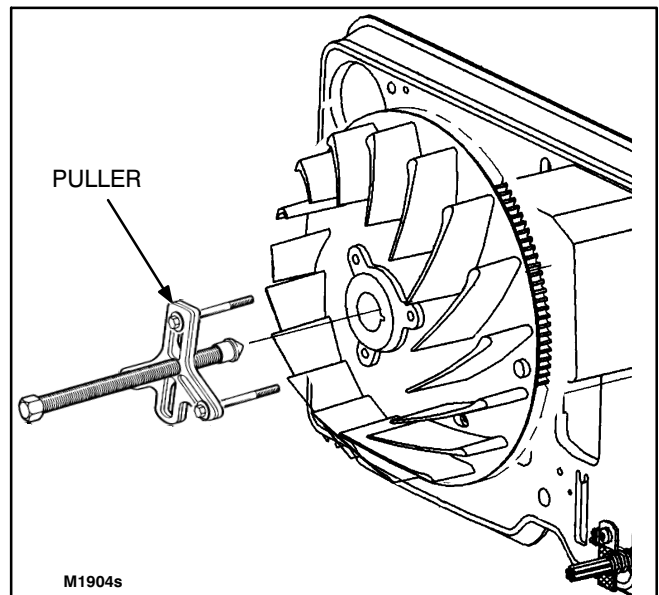
4. Remove the exhaust manifold to engine mounting nuts. Remove the muffler to base mounting screws and slide the muffler to the right so the exhaust manifold pipe clears the engine.
5. Remove the engine and generator to base mounting bolts (4). (Apply antiseize lubricant to the treads of these bolts before reinstallation.)
6. Disconnect the J4 and P1 harness connectors at the air housing assembly. Remove the leads from the start solenoid. Remove the control assembly (A1) mounting bracket with the voltage regulator, control assembly and start solenoid attached. Disconnect the remaining harness connections to the fuel pump, ground terminal and load connections.
7. Carefully lift the generator end of the generator set and place a wooden block under the stator housing to support the generator set.

**NOTE:** For access to the air preheat door, remove the air housing assembly cover at this point.

8. Remove the air housing assembly from the endbell (Figure 9-2 on Page 9-4).

**Spec A and Begin Spec B:**

9. Secure the fan hub assembly and remove the rotor through bolt and washer.
10. Remove the alignment key from the end of the rotor shaft and save for reassembly. Remove fan hub assembly with a wheel puller (Figure 9-3) Attach the wheel puller to the fan hub assembly with three 5/16-inch thread tapping cap screws (or tap fan hub with 3/8-inch tap and use 3/8-inch cap screw).



**FIGURE 9-3. PULLING THE FAN HUB ASSEMBLY**

11. Prepare the brushes for endbell removal. Carefully disconnect the wire harness leads from the brush block and pull each brush outward from the holder and at the same time insert a piece of wire into the small hole in the endbell at the bottom of the brush block. See Figure 9-4. 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 wire. Remove the wires from the magneto assembly. Loosen the two screws holding the brush block to the endbell.

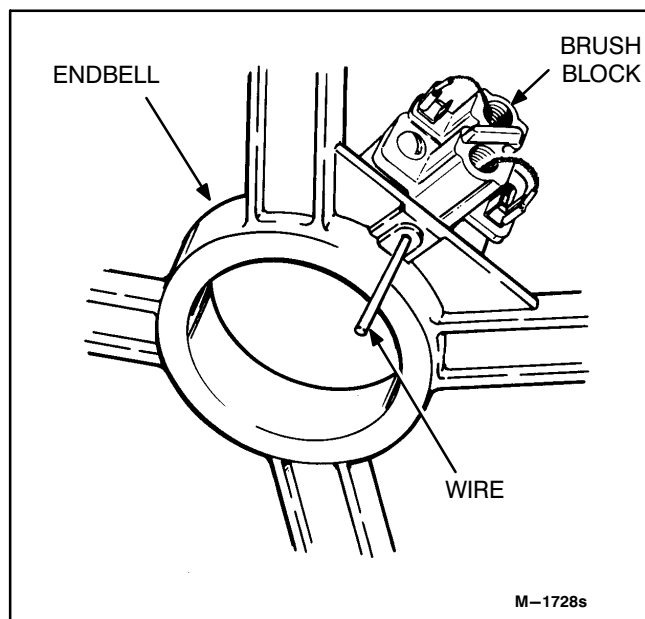
**CAUTION** *The brushes will be damaged during disassembly if not held off the slip rings. Make certain wire is in place before removing the generator endbell. Also the brush block must be loose so it will clear the bearing when the endbell is removed.*

12. Disconnect the starter bracket from the rear of the starter. Remove the endbell mounting screws and place the endbell along side the front of the generator set to eliminate more wire removal.
13. Pull outward on the rotor shaft to remove it. If the rotor does not come loose from the tapered engine crankshaft, install a solid round bar stock 7-7/8 inches (200mm) long by 0.45 inches (11.43 mm) in diameter into the rotor through bolt hole (Figure 9-5). Thread a 9/16-12 x 1-inch bolt, into the end of the rotor shaft and slowly tighten the bolt until the rotor comes loose.

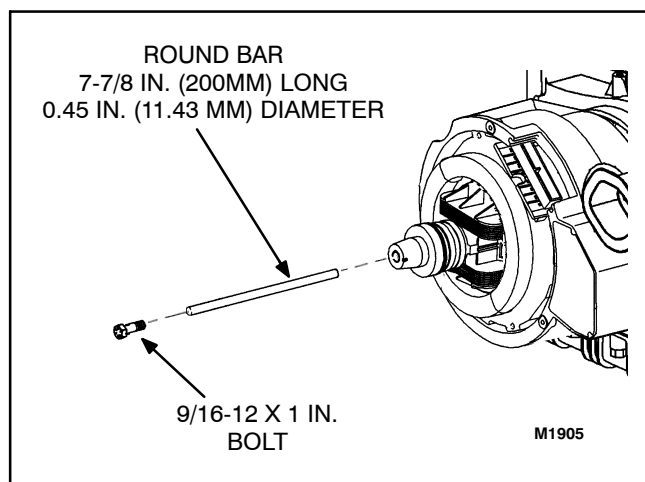
**CAUTION** *Careless handling of rotor or stator can damage the insulation on the windings. Do not allow windings to be brushed or scraped during removal. Do not touch the slip rings or corrosion will occur.*

14. Wear gloves to protect hands from sharp edges on the stator assembly. Remove the stator mounting screws. Carefully pull the stator straight out from the housing. If the stator will not slide out, tap on generator housing while pulling on the stator to remove.

sembly. Remove the stator mounting screws. Carefully pull the stator straight out from the housing. If the stator will not slide out, tap on generator housing while pulling on the stator to remove.



**FIGURE 9-4. BRUSH BLOCK**



**FIGURE 9-5. ROTOR REMOVAL**

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## Generator Assembly

Use the following procedures to assemble the generator:

1. Position the stator so the output connector aligns with the opening in the stator housing. Carefully slide the stator into the generator housing. If necessary the stator can be lightly tapped on the laminations so that the stator is seated into the housing. Insert and tighten the two stator through bolts.

**⚠ CAUTION** *Careless handling of the stator can damage the insulation on the stator windings. Do not brush windings against the housing or strike windings during installation.*

2. Align the pin in the rotor shaft with the notch in the crankshaft and slide the rotor onto the crankshaft. Make sure that the rotor is seated.
3. Plug in both stator wire connectors.
4. Prepare the endbell for installation. Lubricate the o-ring on the bearing. Verify that the brushes are held inside the holder with a piece of wire and that the brush block is loose. See Figure 9-4 on Page 9-6. Install the endbell onto the rotor bearing and secure to the stator housing with the endbell mounting screws.

**⚠ CAUTION** *The brushes will be damaged during assembly if not held off the slip rings and the brush block is loose enough to clear the bearing. Make certain wire is in place before installing the generator endbell.*

5. Center the brush block on the slip rings and tighten the mounting screws. Remove the piece of wire holding the brushes off the slip rings. Connect the F2 lead wire to the outer brush terminal (near bearing) and the F1 lead wire to the inner brush terminal. Connect the magneto assembly wires.

6. Install the fan hub assembly onto the rotor shaft and align the key slot on the fan hub with the key slot in the rotor shaft. Install the key into the key slot. Install the rotor through bolt and washer. Verify alignment of the rotor shaft and the fan hub, then secure the fan hub assembly and tighten the rotor through bolt to the specified torque.
7. Spec A: Assemble the starter bracket to the starter. Install the scroll housing.  
Begin Spec B: Install the air housing assembly.
8. Remove the wooden block from under the stator housing and slowly lower the generator set.
9. Install the muffler assembly and make sure new gaskets are used. Install the generator and engine to base mounting bolts (use anti-seize lubricant on bolt threads). Secure all hardware to the specified torque.
10. Reconnect the load leads, the fuel pump leads, and ground terminal block or connections. Install the control panel on Spec A. Install the voltage regulator and control assembly. On Begin Spec B models: reconnect the start solenoid leads and the P4 and J1 connectors.
11. Inspect the assembly, check all electrical and mechanical connections for correct fit and location. Place the enclosure cover on the generator set and secure with the side mounting screws. (Begin Spec B, 50 Hz models: Connect the leads to the battery charger assembly mounted to the left side of the housing.)
12. Install the generator set in the vehicle and securely fasten all mounting screws and hardware. Connect the fuel line, exhaust system and electrical systems in reverse order of disassembly. Refer to *Set Removal Guidelines* on Page 5-2 for the recommended generator set removal procedures.
13. Fill the crankcase with oil of the recommended classification and viscosity (refer to the Operator's Manual).

## GENERATOR TESTING

This section covers test procedures for the rotor and stator windings. Begin with the *Field Voltage Test*, following, to help locate possible problems.

Check all wire harness connectors and leads for continuity prior to generator testing. Refer to Section 12. *Wiring Schematic/Diagram*.

### Field Voltage Test

Perform the Field Voltage Test if low or no generator output voltage is produced to confirm that field voltage is available to the rotor brushes through the

voltage regulator for field flashing and voltage build-up.

**⚠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 tests.*

The voltage regulator plug J4 remains connected to wire harness plug P4 for Test A and B. The voltmeter leads should be secured so that they are not being held during testing. (Use long pointed test leads or paper clips connected with alligator clips to the test leads.) Refer to Figure 9-6.

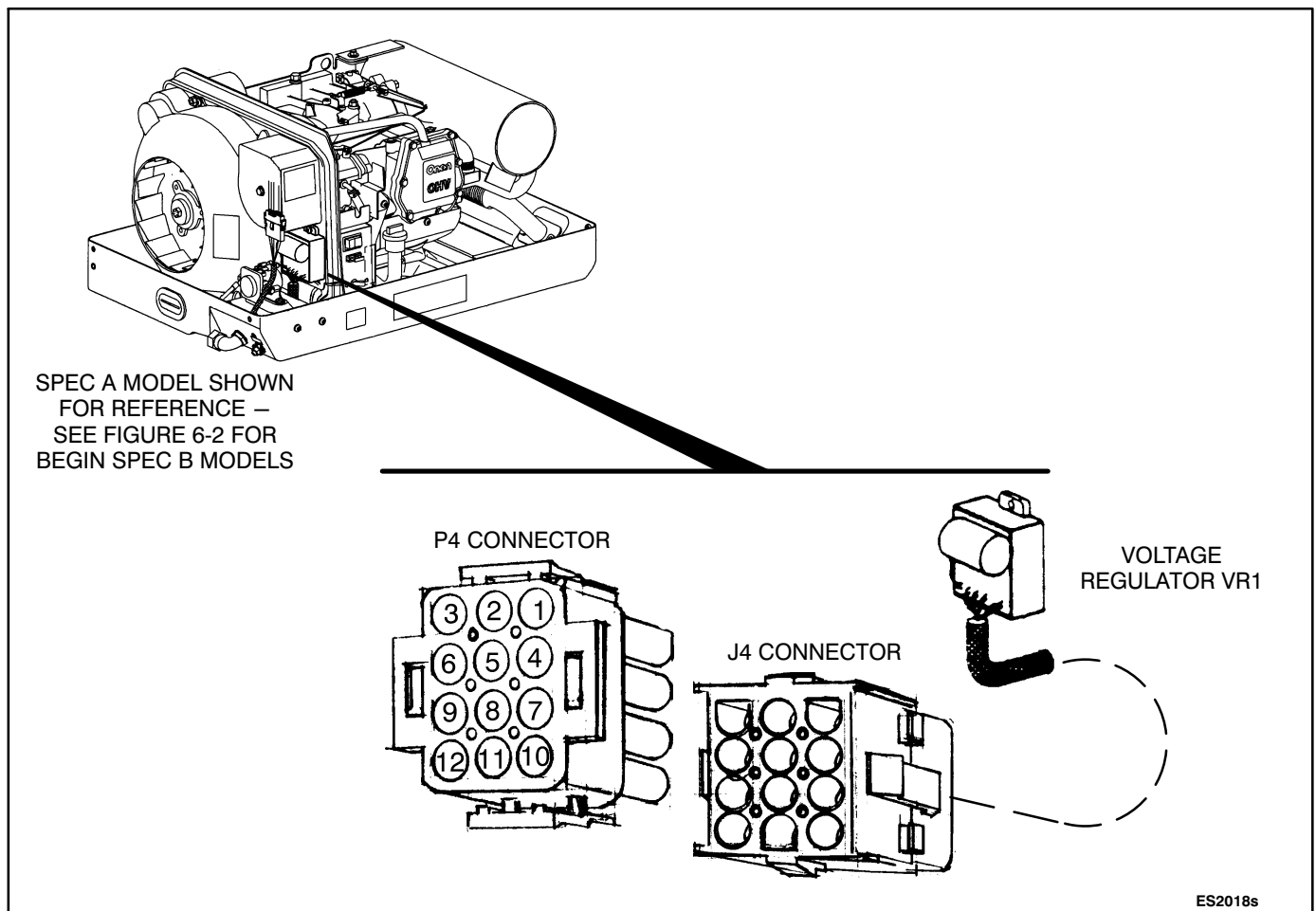


FIGURE 9-6. VOLTAGE REGULATOR CONNECTOR PLUG (P1)

**Test A:** Connect a DC voltmeter into the back side of the voltage regulator connector J4 as follows: Attach the positive (+) meter lead to J4 pin 7 and the negative (-) meter lead to J4 pin 3.

Push the start switch and observe the voltmeter reading. If approximately 12 VDC is measured field flash voltage is available, proceed to Test B. If no voltage is measured, check for a poor connection at the P4-J4 connectors and at the P1-J1 connectors. If connections check good, refer to Section 6. *Troubleshooting* for procedures.

**Test B:** Move the positive (+) meter lead to pin 9 and connect the negative (-) meter lead to pin 10.

Start the generator set and allow engine speed to stabilize. Measure the field voltage with no load applied and then with full load applied. If both readings fall within a range of 40 VDC no load to 100 VDC full load, voltage build up is OK and the brushes, rotor and stator are working properly.

If no voltage is measured when the start switch is pushed, proceed to the *Voltage Regulator (VR1) Test* on Page 9-12.

If 7 to 13 VDC is measured when the start switch is pushed and the generator set stops running when the switch is released, proceed to Test C.

**Test C:** Disconnect the voltage regulator connector plug J4 from the harness connector P4. Attach an AC voltmeter to the generator output leads L1 and L2. Apply 12 VDC to the P4 connector at pins 9 (positive [+]) and 10 (negative [-]).

Start the generator set and observe the voltmeter reading. If approximately 40 VAC is measured, the generator brushes, rotor, and stator are working properly, proceed to the *Voltage Regulator (VR1) Test* on Page 9-12.

If no voltage is measured, proceed to *Brushes and Slip Rings* on Page 9-12.

## Rotor Test

The rotor can be tested for grounded, open, or shorted windings using an ohmmeter. Figure 9-7,

and Figure 9-8 on Page 9-10 show the rotor removed from the generator set for testing. The rotor can be tested without removing it from the generator. To gain access to the slip rings, follow the *Generator Disassembly / Base Removal* procedures on Page 9-2 through the fan hub assembly removal procedure. Use a stiff wire to hold the brushes off the slip rings during testing. Refer to the *Brushes and Slip Rings* section on Page 9-12 for the procedures for inserting the wire.

**Ground Test:** Set the ohmmeter to the highest resistance scale or use a megger. Touch one test prod to the rotor shaft and hold it there. Touch the other test prod to one of the slip rings as shown in Figure 9-7 on Page 9-9. A reading of infinity should be measured. A reading of less than one megohm (one million ohms) indicates the rotor is grounded. Replace a grounded rotor with a new rotor.

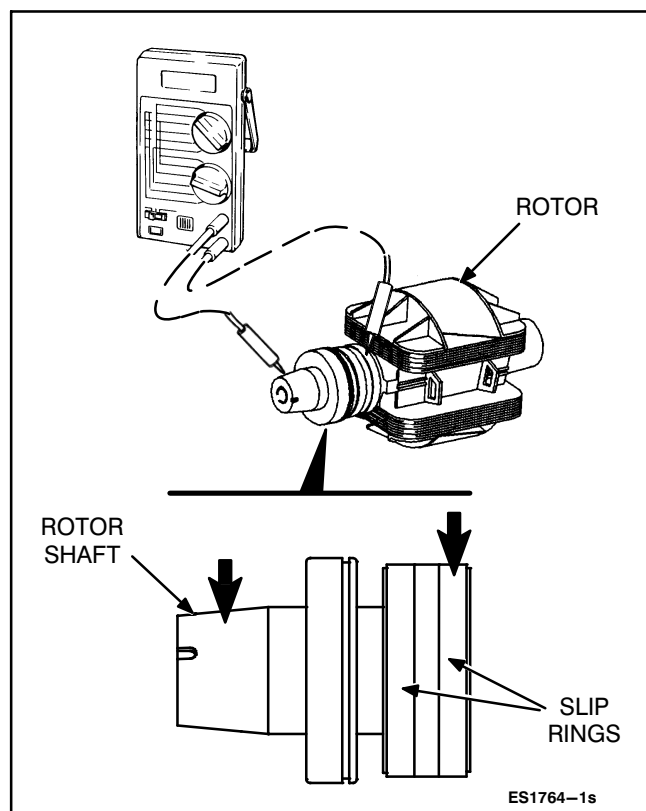


FIGURE 9-7. GROUNDED ROTOR TEST

**Open or Shorted Test:** To test for open windings, set the ohmmeter on the highest resistance scale. Place the test prods on the slip rings as shown in Figure 9-8. The ohmmeter should indicate continuity between the slip rings of approximately 19 to 27 ohms. A high resistance reading indicates a poor connection or an open winding. Check the connection between the slip rings and rotor lead wires. Replace the rotor if a winding is open.

To test for a shorted winding, set the ohmmeter on the lowest scale. Place the test prods on the slip rings as shown in Figure 9-8. A reading of less than 17 ohms at 77°F (25°C) indicates shorted windings. Replace the rotor if a winding is shorted.

Open or shorted tests can also be performed by removing the P4 plug from the regulator J4 connector and measuring across the P4-9 and P4-10 connections. If an abnormal reading is measured, recheck by measuring at the collector rings.

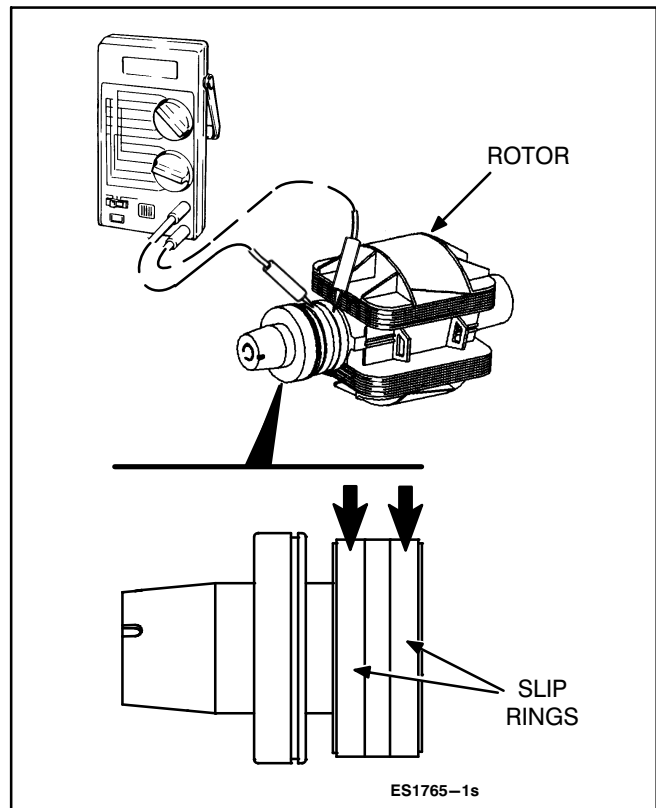
If the rotor tests good proceed to *Stator Test*, following.

### Stator Test

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. Figure 9-9 on Page 9-11 shows the stator removed from the generator for testing. The stator can be tested without removing it from the generator.

To perform the stator test, carefully remove both connector plugs from the stator.

**Ground Test:** Set the ohmmeter for the highest resistance scale and then connect one test prod to the generator housing (or stack, if stator is removed). Touch the other test prod (see Figure 9-9 on Page 9-11) to the terminals specified in Table 9-1 on Page 9-11. A reading of less than one megohm indicates a ground. Replace a grounded stator with a new stator.



**FIGURE 9-8. OPEN OR SHORTED ROTOR TEST**

**TABLE 9-1. STATOR GROUND TEST**

TEST POINT	OHMMETER READING
T1 to ground	INFINITY
T2 to ground	INFINITY
B1 to ground	INFINITY
B2 to ground	INFINITY
Q1 to ground	INFINITY
Q2 to ground	INFINITY

**Open Or Shorted Stator Windings Test:**

To test for open windings, set the ohmmeter for the highest resistance scale and then connect the test prods (see Figure 9-9) to the terminals specified in Table 9-2. The ohmmeter should indicate continuity between terminals. A high resistance reading indicates an open winding. If an open circuit is measured replace the stator.

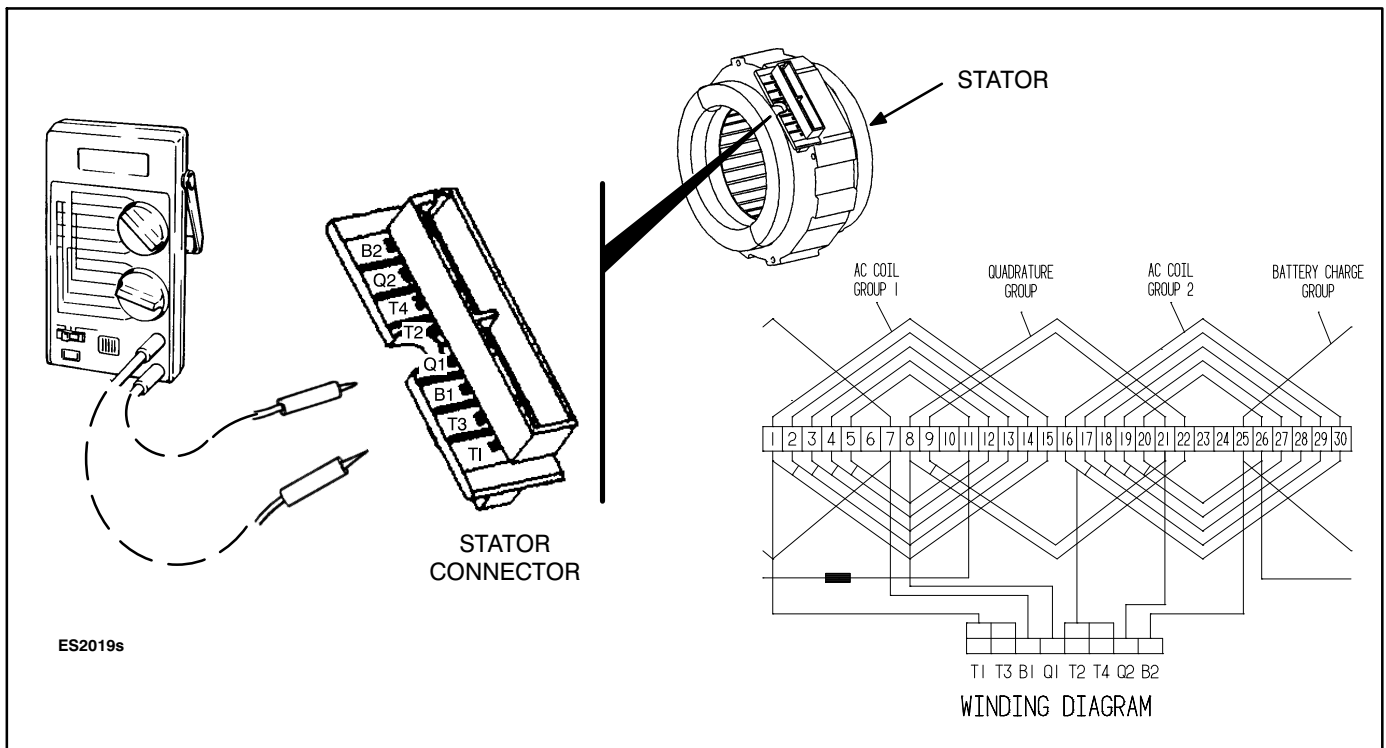
To test for shorted windings, use a digital type ohmmeter that reads to within 0.001 ohms. Connect the

test prods to the terminals specified in Table 9-2. A reading of less than the value shown in Table 9-2 at 77°F (25°C) indicates a shorted winding. If stator tests indicate a shorted winding, replace the stator. If stator tests good, check stator connectors and leads for continuity, and for good electrical connection with the stator terminals.

**TABLE 9-2. STATOR OPEN OR SHORTED WINDING TEST**

TEST POINT	OHMMETER READING AT 77°F (25°C) ± 10%	
	60 Hz	50 Hz
T1 to T2	0.271	0.653
T3 to T4	-	0.653
B1 to B2	0.085*	0.114
Q1 to Q2	1.985	2.373

\*Spec A 60 Hz Only



**FIGURE 9-9. STATOR ASSEMBLY**



## VOLTAGE REGULATOR (VR1) TEST

Confirm that the voltage regulator is faulty before replacing it. Use a meter with a diode checking function (Fluke model 73 or equivalent multimeter) to perform the following tests.

1. Disengage the J4 wiring connector and remove the voltage regulator (Figure 9-6 on Page 9-8).
2. With the meter set 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. The positive (+) meter lead must be connected to the first terminal of each pair.
3. Replace the voltage regulator if any reading indicates a "short" or "open", except for pair 10-5, which should indicate an "open".

**NOTE: "Short" is indicated by zero or a number very near zero. Meters of different make indicate "open" differently, read the meter instruction manual. If in doubt, compare with readings of a regulator of the same part number that is known to be good.**

4. If the regulator checks "good", there is a chance that the regulator could still be bad. Verify that the connector pins are making good contact. If voltage regulation problems continue, replace the voltage regulator with a known good regulator and recheck operation.

## BRUSHES AND SLIP RINGS

This section covers brush replacement and slip ring service.

### Brush Replacement

Follow *Generator Disassembly / Base Removal* procedures on Page 9-2 through fan hub assembly removal. Inspect the brushes and brush block 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 9-10) to check for excessive brush wear (minimum brush length is 0.375 inches [9.5 mm]). Insert the painted end of the wire through the hole above each brush. Make sure the wire is resting on the brush and not on the spring. If

the painted part of the wire is not visible, the brush is excessively worn and must be replaced. Always replace the brush springs when installing new brushes to maintain proper tension on the brushes. Clean carbon deposits from brushes and slip rings (see *Slip Ring Service* section on Page 9-13). Use the following procedures to replace the brushes:

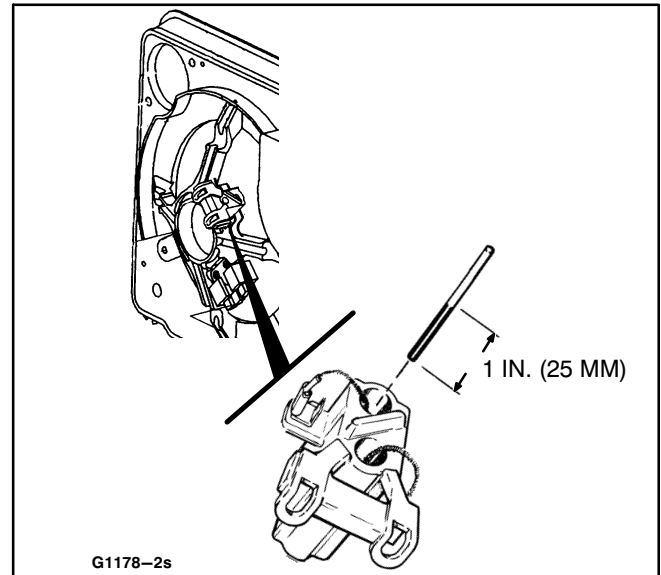


FIGURE 9-10. BRUSH WEAR CHECK

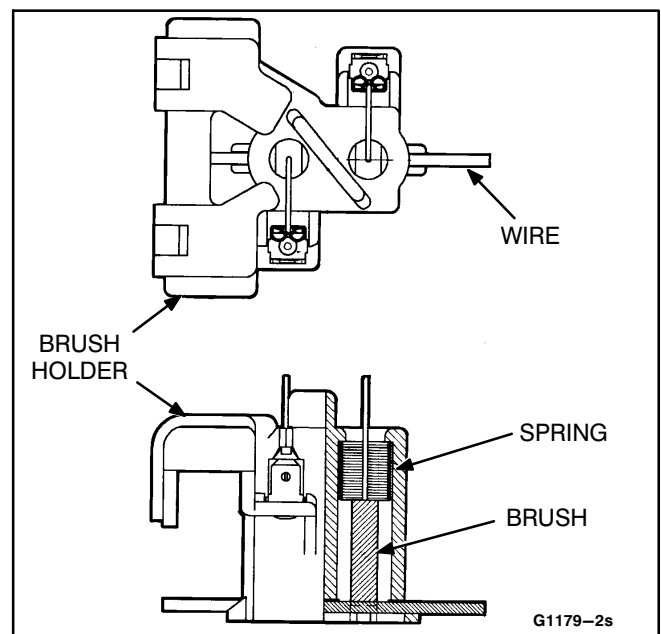


FIGURE 9-11. BRUSH REPLACEMENT

1. Remove the brush block mounting screws and lift out the brush block.
2. Remove the brushes and springs from the holder and replace with new parts (see Figure 9-11 on Page 9-12).
3. Push each brush into the brush holder and insert a stiff wire through the small hole in the base of the holder. See Figure 9-4 on Page 9-6. The wire holds the brushes off the slip rings during assembly.

**NOTE: Inspect slip rings before installing brush block. See *Slip Ring Service* following.**

4. Install the brush block in endbell but do not tighten the mounting screws.
5. Remove the wire holding the brushes off the slip rings. Adjust the brush block so that the brushes are centered on the slip rings, then tighten the mounting screws.
6. Follow *Generator Assembly* procedures on Page 9-7 to reinstall the fan hub and remaining generator components.

### Slip Ring Service

Follow *Generator Assembly* procedures on Page 9-7 through fan hub assembly removal. Inspect the slip rings for grooves, pits, or other damage. A Scotch Brite pad can be used to remove light wear and for surface finishing. If the slip rings are rough, pitted, or out of round by more than 0.002 inches, recondition them in a lathe with a commutator stone. Use the following procedure to service:

1. Follow *Generator Disassembly* on Page 9-2 to remove the generator endbell and rotor.
2. Place the rotor in the machine lathe and center. Turn the rotor and use a commutator stone (Cummins tool #0420-0259) against the rotating slip rings to clean and true the slip rings. Turn the rotor until all grooves or roughness are smoothed out. Rub out must be less than 0.0001 inch, and surface finish must be less than 32 micro inch.

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

**⚠CAUTION** *Careless handling of rotor can damage the insulation on the windings. Place rotor on protected surface when setting down.*

3. Clean the rotor and prepare for reinstallation. Follow *Generator Assembly* procedures on Page 9-7 to reinstall the rotor and remaining generator components.

### ROTOR BEARING REPLACEMENT

The rotor bearing is pressed onto the rotor shaft. This bearing must be replaced very carefully to avoid damaging the collector ring assembly and the rotor shaft. Use the following procedures to replace the rotor bearing.

1. Measure and record the distance between the bearing and the collector ring assembly. See Figure 9-12.

**⚠CAUTION** *Heating the rotor bearing for removal or installation can cause damage to the bearing and the collector ring. Do not heat rotor bearing.*

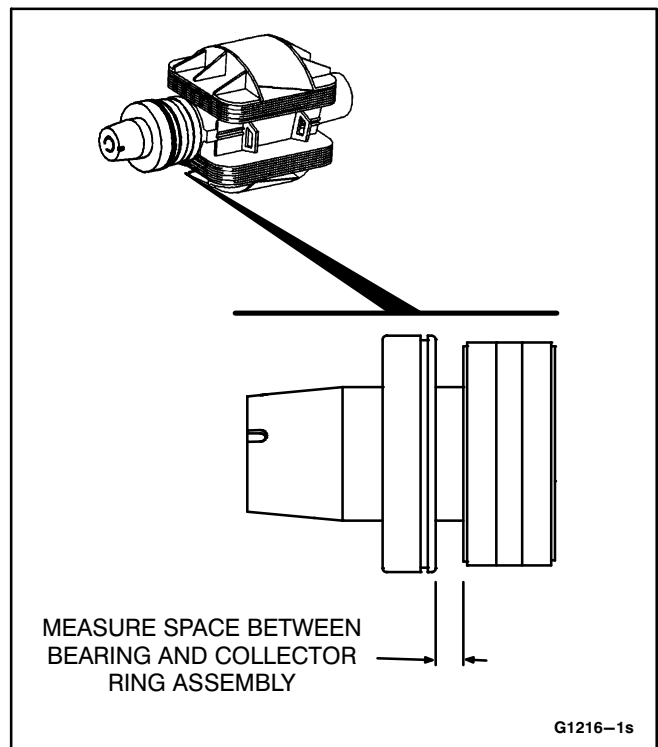
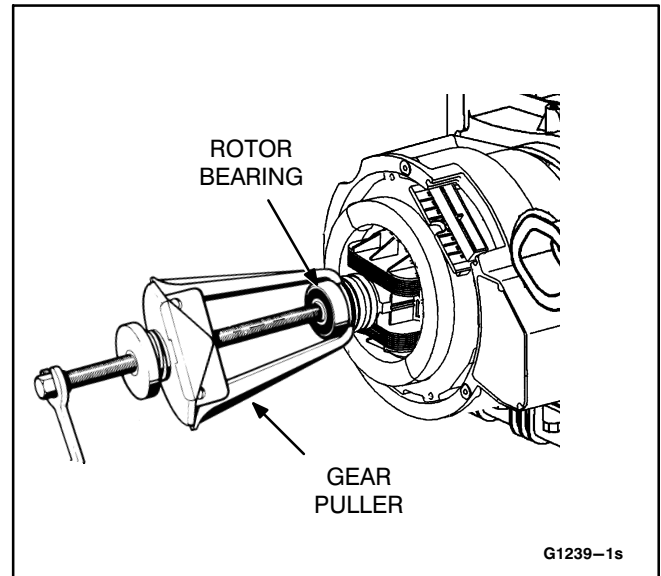


FIGURE 9-12. ROTOR BEARING SPACING

2. Use a small puller with grips that will fit between the bearing and the collector ring assembly (Figure 9-13) or use an arbor press to remove the bearing. Cover the end of the rotor shaft with a steel plate to prevent deformation of the shaft during removal.

**NOTE: Inspect the rotor shaft for dirt or corrosion. If necessary, clean with emery cloth before installing new bearing.**

3. Place the rotor, engine end down, in an arbor press. Protect the end of the rotor shaft taper by placing it on a flat steel plate.
4. Refer to the measurement taken in Step 1. Press the bearing onto the rotor shaft (**press on inner race only**) until it rests at the same distance from the collector ring as the original bearing. Check the bearing seal for damage after installation.



**FIGURE 9-13. ROTOR BEARING REMOVAL**

# 10. Engine Block Assembly

## INTRODUCTION

This section covers service procedures for the engine block assembly. A leak down test can be performed to determine the condition of the engine. Use the procedures in the following section to perform the leak down test.

Performing any major service will require generator set removal from the vehicle (see *Set Removal Guidelines* on Page 5-2). To gain access to the engine block assembly, the generator and primary engine systems must be removed. Refer to the previous sections for the disassembly procedures.

A suggested order of disassembly for the engine block follows:

1. Oil pan and oil level switch
2. Head cover and breather
3. Rocker arms and push rods
4. Cylinder head, valve springs and valves
5. Crankcase cover, camshaft and balancer
6. Connecting rod and piston
7. Crankshaft and governor lever shaft

## LEAK DOWN TEST

Perform the leak down test if performance problems or high oil consumption occur and poor compression is suspected. Follow each of these steps and refer to the test equipment manufacturer's instructions. A typical tester is shown in Figure 10-1.

1. Start the engine and allow it to warm up for ten minutes. If the engine will not start, continue to the next step.
2. Disconnect the battery negative (-) cable to prevent accidental starting and remove the spark plug.
3. Manually rotate the the engine in the direction of normal operation by turning the fan hub assembly. Stop turning the engine when it reaches top dead center (T.D.C.) on the compression stroke. T.D.C. can be determined by:
  - A. Removing the head cover and observing the valve overlap on the compression stroke.
  - B. Feeling compression air escaping the spark plug hole.
  - C. Using a tester with a T.D.C. indicator feature.

4. Connect the tester to shop air and set calibration. Perform the leak down test according to the manufacturer's instructions. Secure the fan wheel to prevent the piston from moving during this test.
5. Screw the air fitting into the spark plug hole. Attach plug fitting to tester.
6. The tester needle indicates the percentage of cylinder leakdown. The following describes the general condition of the engine:
  - 0-10 Percent leak down – Excellent condition
  - 10-20 Percent leak down – Normal condition
  - 20-30 Percent leak down – Nearing service limit
7. If leakage is greater than 30 percent, the engine could need major service work. With the tester still connected, listen for air leakage at the points listed in Table 10-1 on Page 10-2 and note probable cause of the engine problem.

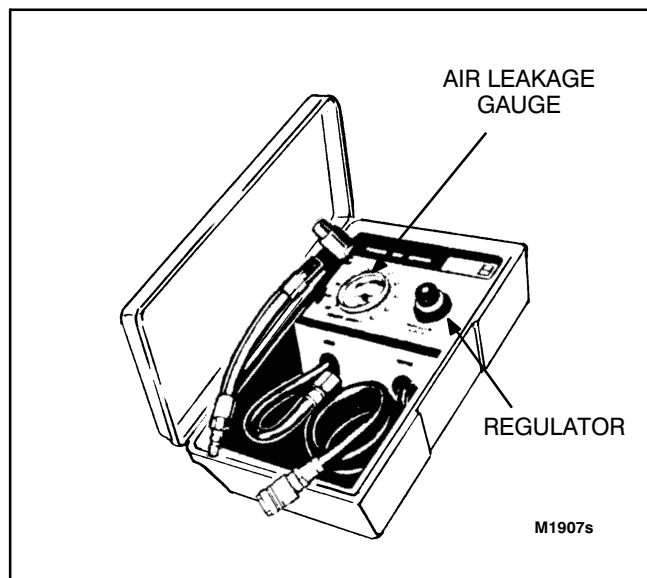


FIGURE 10-1. TYPICAL LEAK DOWN TESTER

**TABLE 10-1. LEAK DOWN CHECK POINTS**

AIR LEAKAGE AT:	PROBABLE CAUSE
1. Dipstick hole or Breather valve	1a. Broken Ring 1b. Worn cylinder bore/rings
2. Carburetor throat	2a. Intake valve stuck 2b. Broken intake valve 2c. Damaged intake valve seat
3. Muffler/Exhaust pipe outlet	3a. Exhaust valve stuck open 3b. Damaged exhaust valve 3c. Damaged exhaust valve seat

### OIL PAN AND OIL LEVEL SWITCH

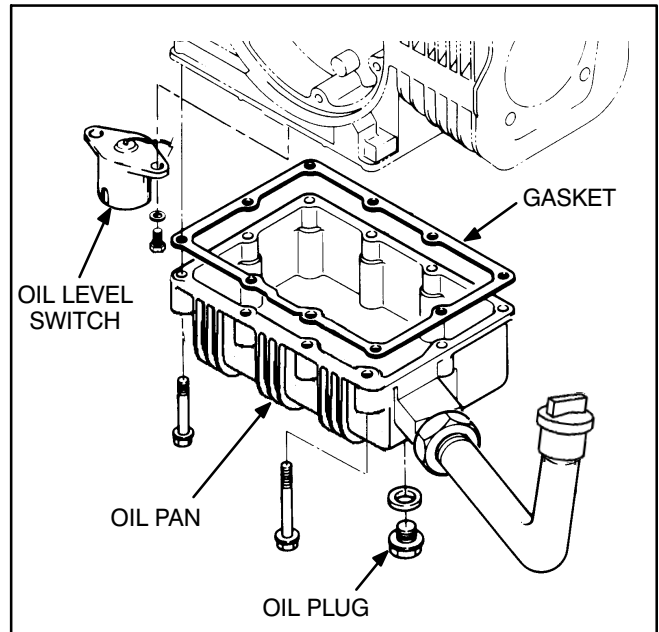
Remove the oil plug and drain the crankcase oil. Remove the oil pan mounting bolts and pan (Figure 10-2). Remove the oil level switch mounting bolts and switch assembly (Spec A-F only, if applicable).

Clean the oil pan and use a new gasket when reinstalling. Torque all mounting bolts to the specified torque (see Section 4: *Torque Specifications*).

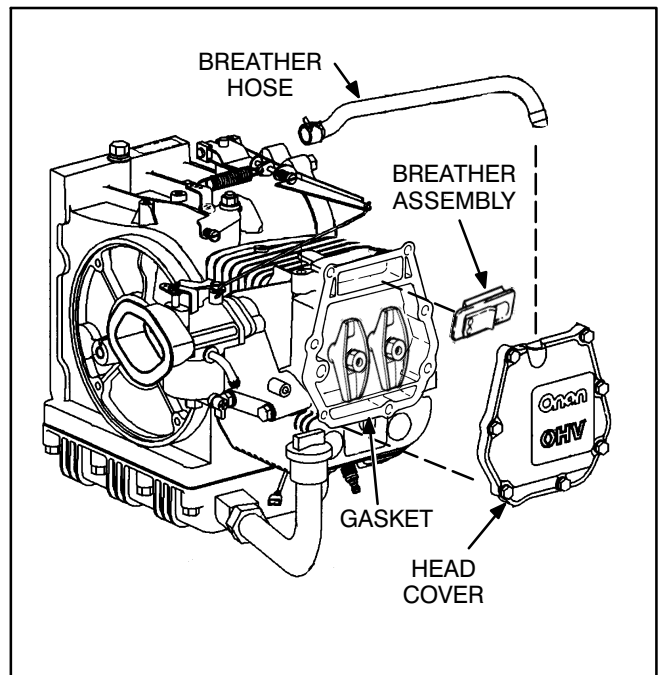
### HEAD COVER

Remove the head cover to gain access to the cylinder head, breather assembly and valve system.

1. Remove the head cover mounting bolts and pull off the head cover (Figure 10-3).
2. Clean the head cover. Be careful not to damage the surface of the cover where the gasket mounts.
3. Clean the cylinder head and cover thoroughly in the cover gasket mating area. Make sure the breather assembly is correctly seated in the cylinder head cavity.
4. Install a new head cover gasket.
5. Place the head cover in position and install the mounting bolts. Torque all of the bolts in a star pattern until they are tightened to the specified torque.



**FIGURE 10-2. OIL PAN REMOVAL (SPEC A SHOWN)**



**FIGURE 10-3. HEAD COVER REMOVAL**

## ROCKER ARMS, PUSH RODS AND CYLINDER HEAD

Remove the cylinder head for cleaning when poor engine performance is noticed or to inspect the valves.

1. Remove the rocker arm mounting nuts. Remove the rocker arms and push rods (Figure 10-4).
2. Remove the spark plug.
3. Remove the cylinder head mounting bolts and pull off the cylinder head.

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

4. Remove all carbon deposits from the cylinder head. Handle the cylinder head carefully because it can be easily damaged.
5. Clean the cylinder block and cylinder head thoroughly in the head gasket mating area. Install a new head gasket on the block.
6. Place the head in position and follow the head torque tightening sequence shown in Figure 10-5. Start out tightening all bolts to 11 lb-ft (15 Nm), then tighten to the specified torque (see Section 4. *Torque Specifications*).

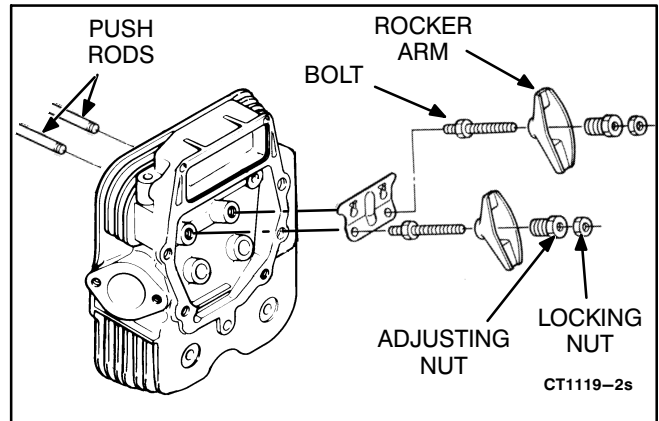


FIGURE 10-4. ROCKER ARM AND PUSH ROD REMOVAL

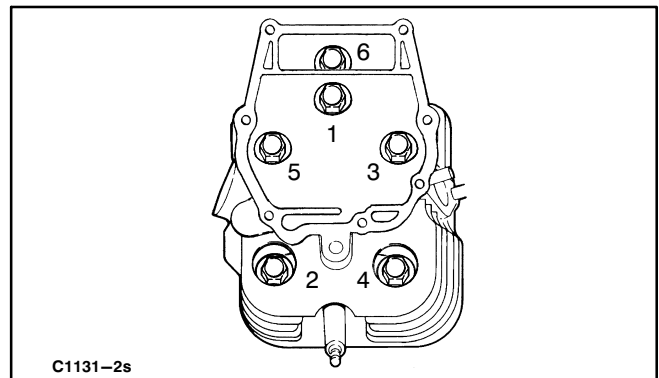
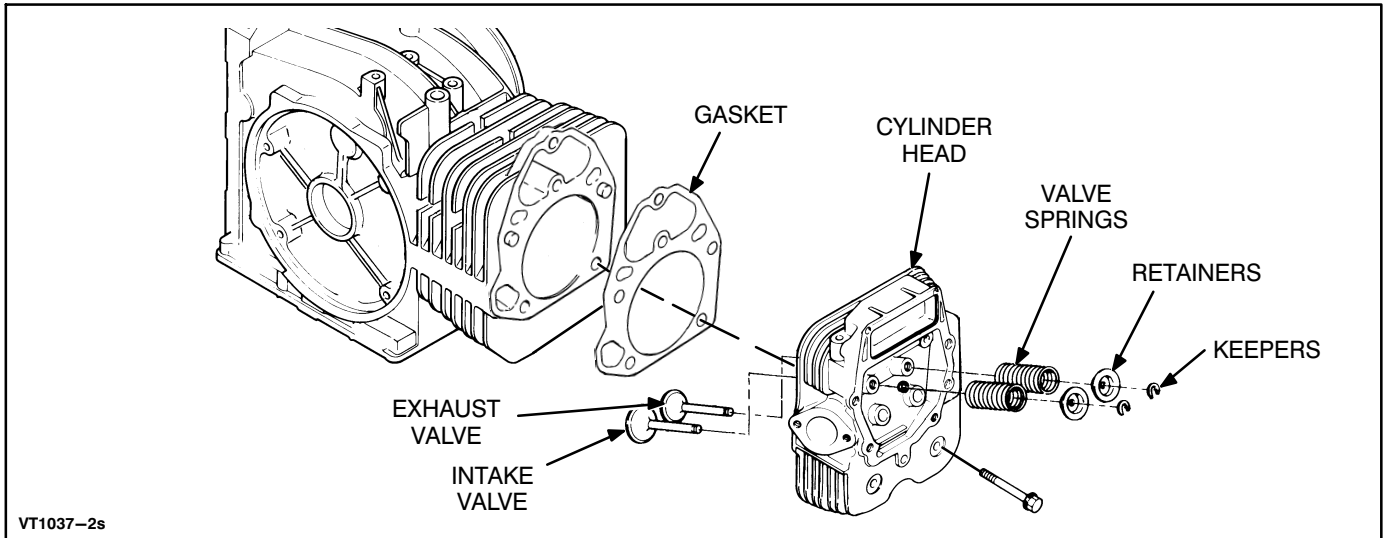


FIGURE 10-5. CYLINDER HEAD TIGHTENING SEQUENCE



**FIGURE 10-6. OVERHEAD VALVE SYSTEM**

## VALVE SYSTEM

This engine uses an overhead valve design, as shown in Figure 10-6. A properly functioning valve system is essential for good engine performance. Access to the valve system is gained by removing the head cover and cylinder head. Use the following procedures to inspect and service the valve system.

### Valve Removal

The intake and exhaust valves can be removed from the cylinder head without the use of special tools. Depress the valve spring retainer using a 9/16 inch crows foot on a 6 inch extension, then remove the keeper (Figure 10-7). Remove the spring retainer, spring and valve.

**⚠WARNING** *Always wear safety glasses with side shields when removing springs to prevent severe eye damage.*

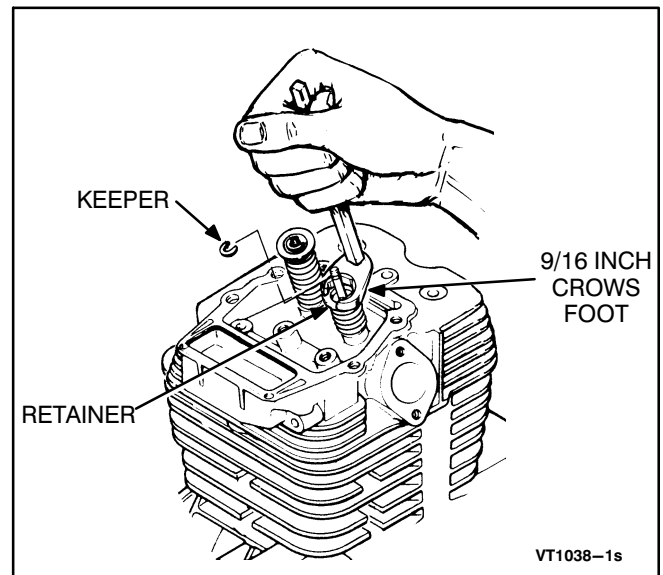
### Inspection

**Valve Face:** Check the valve face for evidence of burning, warping, out-of-round, and carbon deposits (see Figure 10-8 on Page 10-5).

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, warping, and misalignment.

Warping occurs mainly due to 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.



**FIGURE 10-7. VALVE REMOVAL**

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

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

**Stems and Guides:** Always check the stems and guides for wear as shown in Figure 10-8. Use a micrometer to measure the valve stem diameter in at least three locations. Use a hole gauge to measure the valve guide at several depths. When clearance with stem exceeds original clearance by 0.002 inch (0.05 mm), replace the valve or cylinder head, which includes the valve guide, or both.

**Springs:** Check the valve springs for cracks, worn ends, and distortion. If the spring ends are worn, check valve retainer for wear. Check for spring distortion by placing the spring on a flat surface next to a square. Measure the height of spring (A) and rotate it against a square to measure distortion (B), see Figure 10-9. Replace any valve spring that is weak, cracked, worn, or distorted.

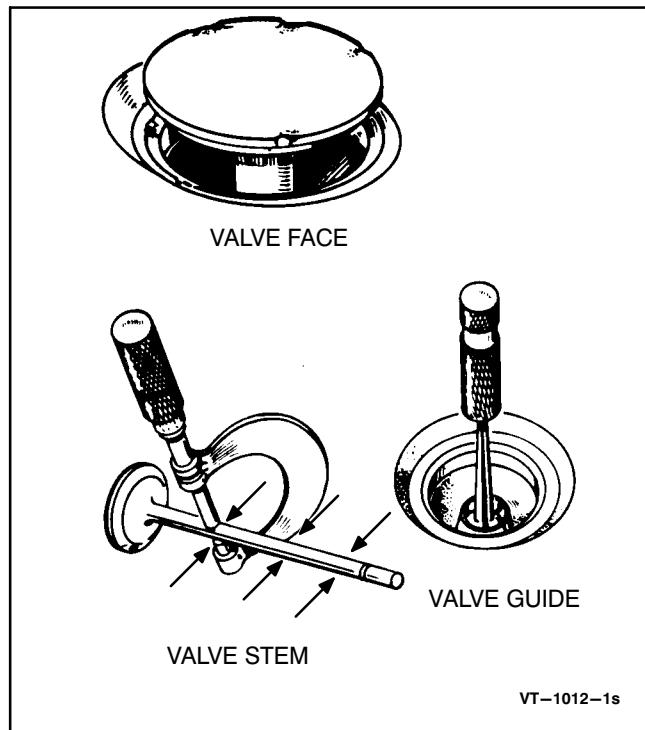


FIGURE 10-8. VALVE FACE, STEM, AND GUIDE

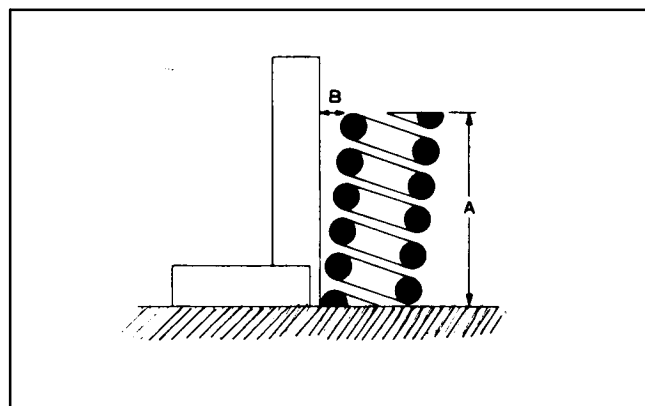


FIGURE 10-9. VALVE SPRING CHECKS



## Valve Seat Surface Width

1. Clean the valve seat surface.
2. Use a vernier caliper to measure the valve seat width (Figure 10-10). (See Section 3. *Dimensions and Clearances* for seat width allowable limit.)
3. Apply red lead to the valve surface to check for scratches or unevenness.
4. When the measurement is within the allowable limit, check the seating ratio. If the ratio is less than 70%, the valve seat needs to be reground.
5. If the measurement exceeds the allowable limit, replace the valve and regrind the valve seat (see *Regrinding Seat Surface* on Page 10-6).

## Regrinding Seat Surface

1. Grind the valve seat surface with a 45° cutter. Use a cutter appropriate for the valve seat surface and valve guide diameter (Figure 10-10).

**⚠WARNING** Always wear safety glasses with side shields when grinding to prevent severe eye damage.

2. Install the valve and check for contact between the valve face and the valve seat with red lead. (If the valve has been in use for a long time, the seat tends to come in contact with the upper side of the valve face.)
3. Cut and readjust the width using a 15° cutter so the valve seat width makes contact in the same dimension as the valve face width.
4. Cut the valve seat surface again with a 45° cutter and recheck the contact between the valve and seat.
5. Repeat steps three and four until the correct contact is achieved.
6. Lap the valve seat until the seated rate is more than 70% of the total contact area.

7. Use a grinding compound to finish the seat surface.

Valve stem guides or valve seats that are worn, loose, cracked, or severely pitted should be replaced. The valve guide and seat have to be pressed out of the cylinder head and replacement parts must be pressed in. The replacement cylinder head assembly includes the valve stems and seats.

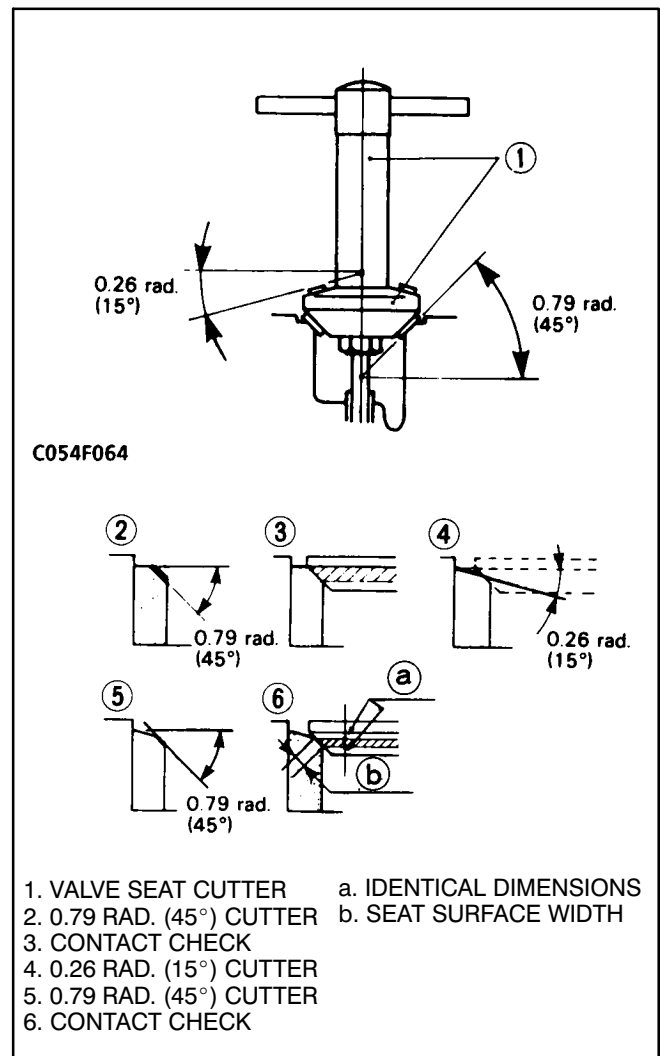


FIGURE 10-10. REGRINDING VALVE SEAT

## Valve Clearance Adjustment

The valve clearance can be checked and adjusted. Adjust the valve clearance only when the engine is at ambient temperature.

1. Follow head cover removal instructions in the *Head Cover* section on Page 10-2. Inspect the valve stems for proper alignment with the rocker arms.
2. Advance the engine until both of the valves are closed and there is no pressure on the valve lifters (piston at top dead center).
3. Clearances are shown in Section 3. *Dimensions and Clearances*. For each valve, the gauge should just pass between the top of the valve stem and the rocker arm. (See Figure 10-11.)
4. To correct the valve clearance, place a wrench on the adjusting nut and a wrench on the outer locking nut. Loosen the outer locking nut and turn the adjusting nut as needed to obtain the correct clearance. Tighten locking nut after adjustment is made.
5. Recheck the valve clearance after adjustment has been made and also check the rocker arm bolts to see that they have not loosened as a result of adjusting the valve lash.
6. Reinstall the head cover and torque the head cover bolts to the specified torque.

## Intake Valve Seal Replacement

A worn or cracked intake valve seal can cause high oil consumption and spark plug fouling. Replace a defective intake valve seal as follows:

1. Pull the old valve seal out carefully to avoid damaging the valve guide.
2. Coat the intake valve stem with engine oil and insert it into the valve guide.
3. Press the valve seal into the valve guide by hand until the shoulder of the seal rests against the cylinder head (Figure 10-12).

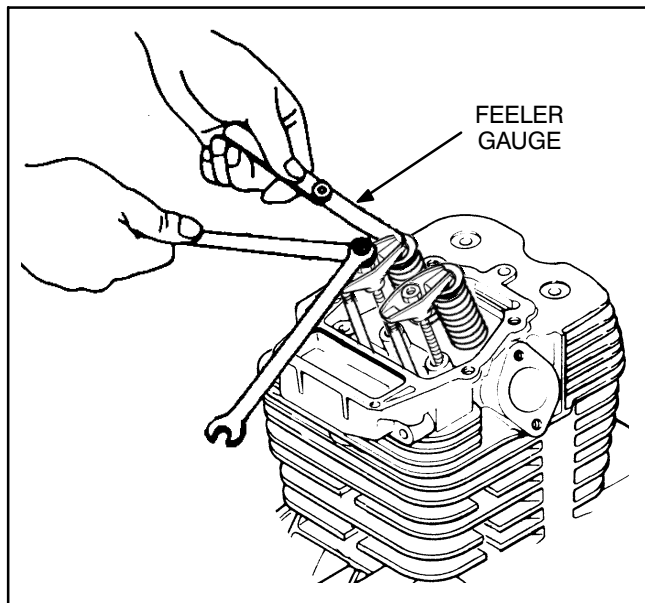


FIGURE 10-11. VALVE CLEARANCE ADJUSTMENT

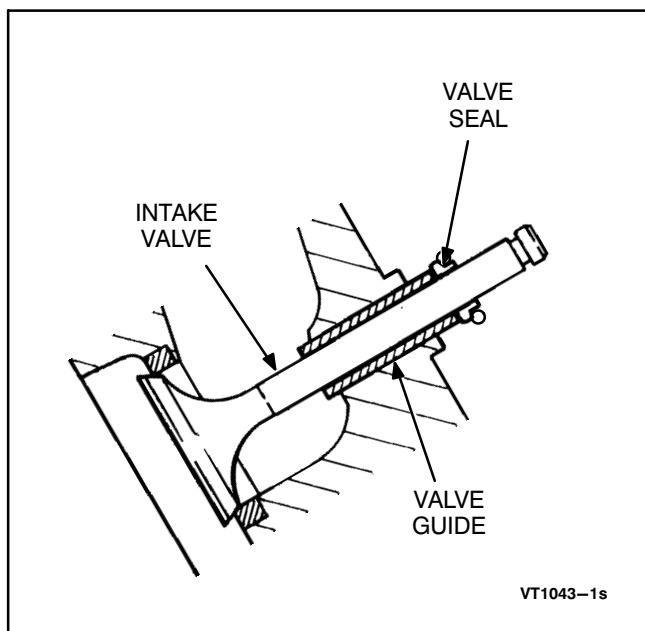


FIGURE 10-12. VALVE SEAL INSTALLATION

## CRANKCASE COVER

1. The crankcase cover is located in two places with dowel pins (Figure 10-13). Do not attempt to pry the crankcase cover off or damage can result. Remove the crankcase cover mounting bolts. Hold the crankcase cover and lightly tap the end of the crankshaft with a plastic hammer.
2. Remove the crankcase cover very carefully to prevent the shaft from scraping the lip surface of the oil seal.
3. Remove and tag shims from the crankshaft, camshaft, and balancer shaft. Shim thicknesses differ and they must be reassembled in their original positions.
4. Make sure the governor shaft is properly positioned when installing the cover. Use a new gasket and clean the crankcase cover and the engine block gasket mating surfaces. Place crankcase cover in position and secure all bolts in a star pattern to the specified torque (see Section 4. *Torque Specifications*).

## GOVERNOR

With the crankcase cover removed, the governor can be inspected or disassembled for service. The governor assembly must spin freely on the center pin without excessive looseness or wobble. Sleeve tip wear is the most common cause of governor failure. Check for flat spots on the sleeve tip. If the governor sleeve, gear, or flyweights are worn or otherwise damaged, replace them.

To disassemble, remove the snap ring from the governor center pin and slide the governor gear assembly off the mounting shaft. Be careful not to lose the outer washer. See Figure 10-14. To install the governor, assemble in reverse order of removal (see inset drawing, Figure 10-14, for position of flyweight and sleeve). The snap ring can be installed by placing it over the end of the shaft, then use the sleeve to push it into position. To remove the governor shaft, remove the retainer clip outside the block and then lower the governor shaft into the crankcase.

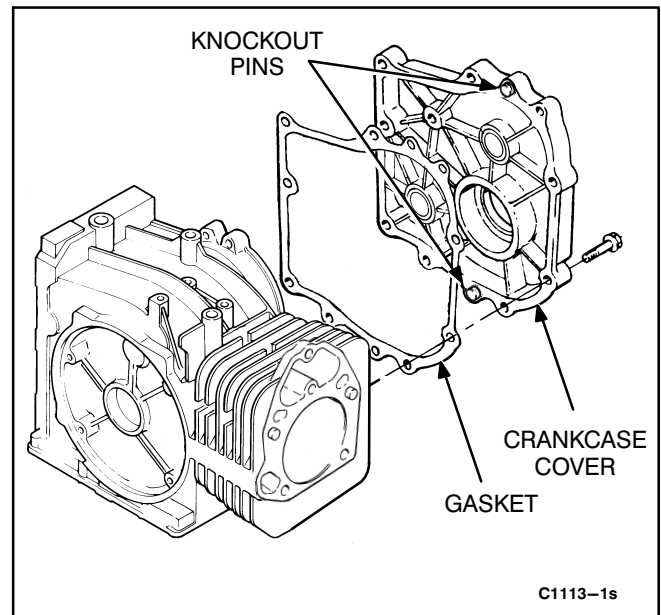


FIGURE 10-13. CRANKCASE COVER

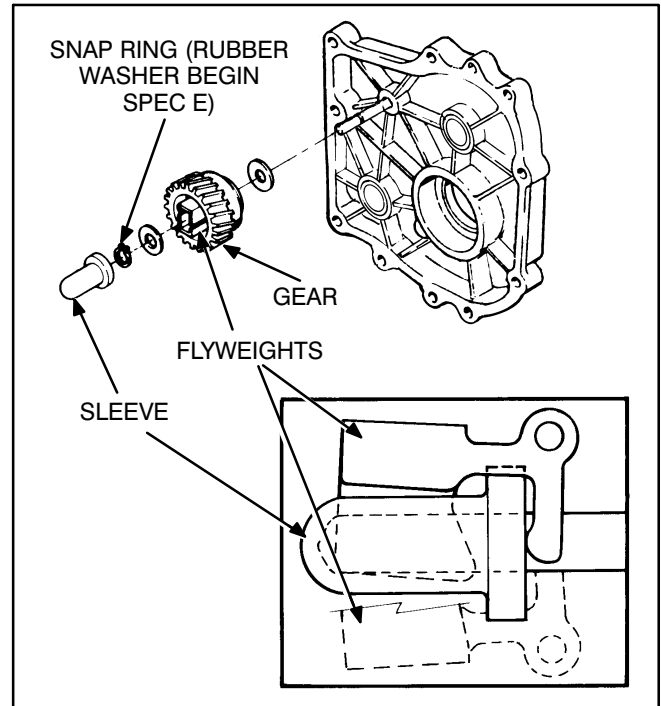


FIGURE 10-14. GOVERNOR

## CAMSHAFT, TAPPET AND BALANCER REMOVAL

1. Place the engine cylinder down on a clean flat surface (Figure 10-15).
2. Carefully pull out the camshaft assembly.
3. Remove the valve tappets. Mark the tappets because tappet clearances differ and the tappets must be reassembled in their original positions.
4. Pull out the balancer shaft assembly.
5. For installation, apply oil to the tappets and the tooth surface of the gears. Align the marks on the cam gear and crank gear and also on the balancer gear and crank gear as shown in Figure 10-16.

## PISTON AND CRANKSHAFT

The piston assembly consists of the piston, piston pin, and connecting rod assembly. After piston removal, all parts must be carefully inspected for damage and wear before reinstalling. Remove the carbon from the top of the cylinder bore and check for a ridge. Remove ridge with a ridge reamer (see Figure 10-17) before attempting piston removal. Remove the piston as follows:

**⚠ CAUTION** *Improper use of a ridge reamer can damage the cylinder bore. Follow tool manufacturer's instructions and be careful when using a ridge reamer.*

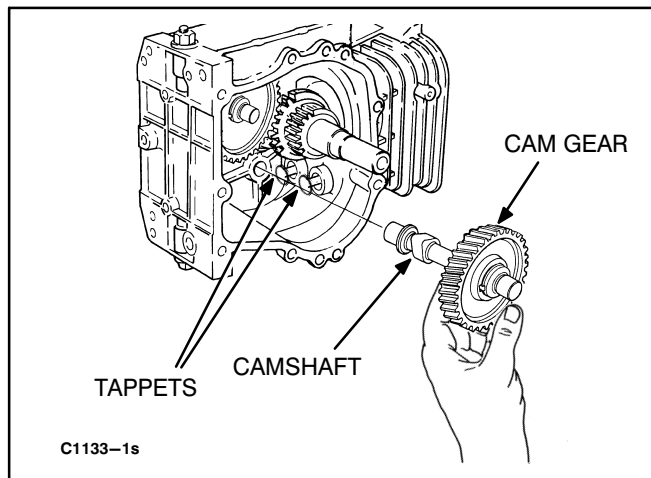


FIGURE 10-15. CAMSHAFT AND TAPPETS

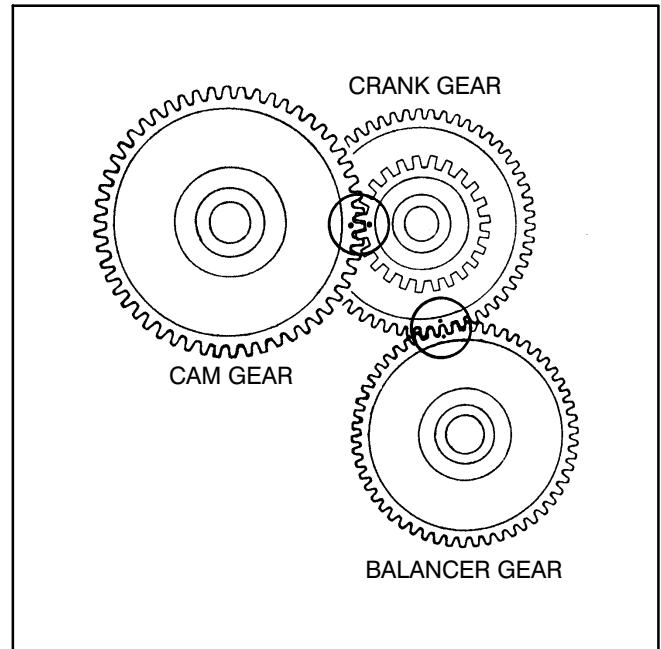


FIGURE 10-16. CAM, CRANK AND BALANCER GEAR ALIGNMENT

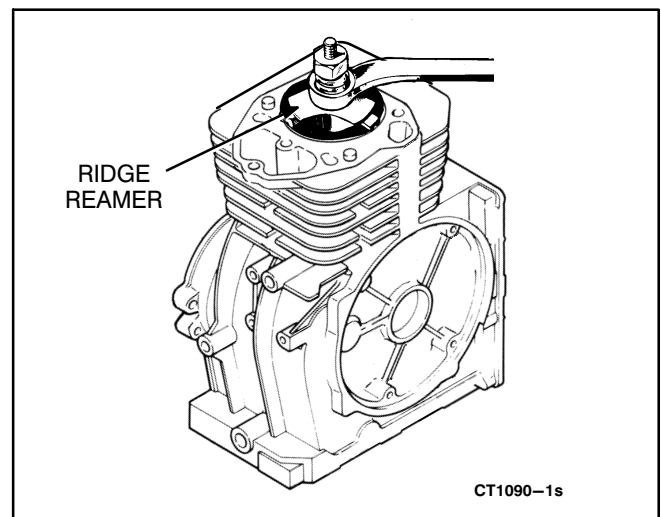


FIGURE 10-17. REMOVING WEAR RIDGE

1. Remove the two bolts from the connecting rod cap. Mark direction of assembly for connecting the rod, cap, and splasher.
2. Remove the rod cap from the rod and push the piston assembly out the top of the cylinder (Figure 10-18). Be careful not to scratch the crank pin or the cylinder wall when removing the piston.
3. Carefully pull the crankshaft out of the oil seal and bearing.

### INSPECTION OF ENGINE PARTS

The following section describes procedures for inspecting each of the major engine components.

#### Cylinder Head

1. Clean the cylinder head surface.
2. Place a straight edge on the top of the cylinder head as shown in Figure 10-19. Use a feeler gauge to measure the amount of distortion.
3. If the measurement exceeds the specified limit, replace the cylinder head (see Section 3. *Dimensions and Clearances*).

#### Cylinder Block

**Cleaning:** After removing the piston, crankshaft, cylinder head; etc., inspect the block for cracks and extreme wear. If the block is still serviceable, prepare it for cleaning as follows:

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

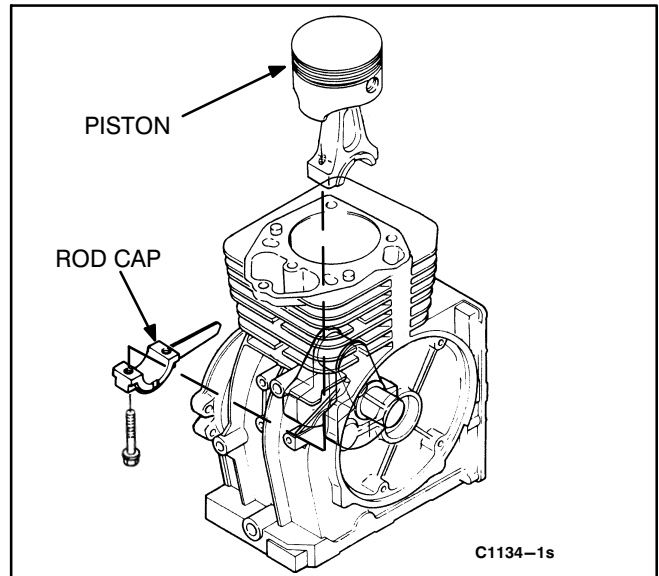


FIGURE 10-18. PISTON REMOVAL

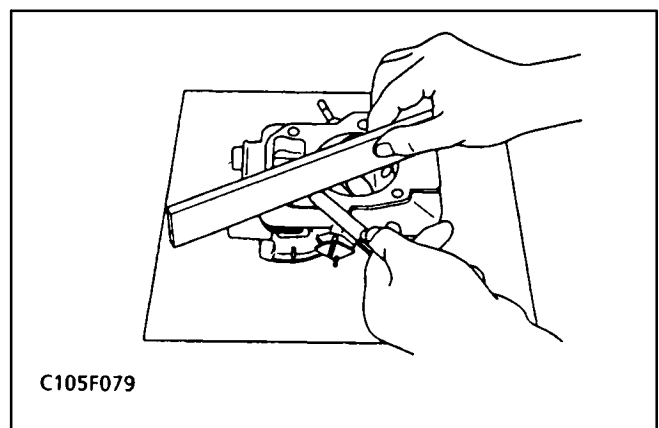


FIGURE 10-19. CYLINDER HEAD SURFACE FLATNESS

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

1. Make a thorough check for cracks using any standard method of crack detection. One method of crack detection follows:

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. Replace a cracked cylinder block.

2. Inspect all machined surfaces and threaded holes. Carefully remove any nicks or burrs from machined surfaces. Clean out tapped holes and clean up any damaged threads.
3. Check the cylinder head mounting area for flatness with a straight edge and a feeler gauge.

**Cylinder Bore Inspection:** Inspect the cylinder bore for scuffing, scratches, wear, and scoring. If the cylinder bore is scuffed, scratched, scored, or worn, the block must be bored to an oversize or replaced. When the appearance of the cylinder bore is good and there are no scuff marks, check the cylinder bore for wear or out-of-round as follows:

1. Measure the I.D. of the cylinder liner with a cylinder gauge at six points as shown in Figure 10-20.
2. If the measurement exceeds the allowable limit, the cylinder will need to be bored to an oversize and then be honed.

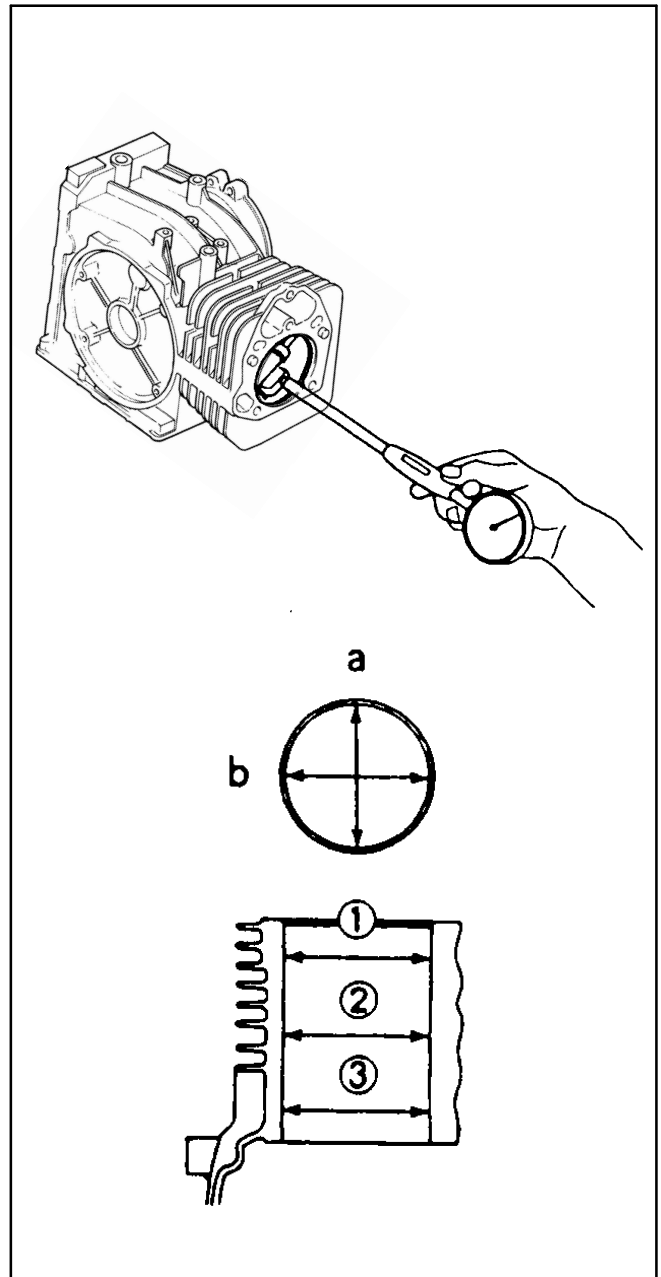


FIGURE 10-20. MEASURING CYLINDER WEAR

## Cylinder Bore Deglazing

Before installing new rings, deglaze the cylinder bore. Make sure that there are no scuff marks and no wear or out-of-round beyond the specifications. Deglazing gives a fine finish but does not enlarge the cylinder diameter, so the original pistons with new rings can be used.

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

1. Wipe the cylinder bore with a clean cloth that has been dipped in clean, light engine oil.
2. Use a brush type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.
3. The deglazing tool should be driven by a slow speed drill. Move the deglazing tool up and down in the cylinder rapidly enough to obtain a crosshatch pattern as shown in Figure 10-21.

**⚠ CAUTION** *Never use gasoline or commercial cleaners to clean cylinder bore after deglazing or honing. These solvents will not remove abrasives from cylinder wall. Abrasives that are not removed from the cylinder will rapidly wear rings, cylinder wall and bearing surfaces of all lubricated parts.*

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

## Piston, Rings, and Connecting Rod

The piston has two compression rings and one oil control ring. Remove these rings from the piston using a piston ring expander as shown in Figure 10-22.

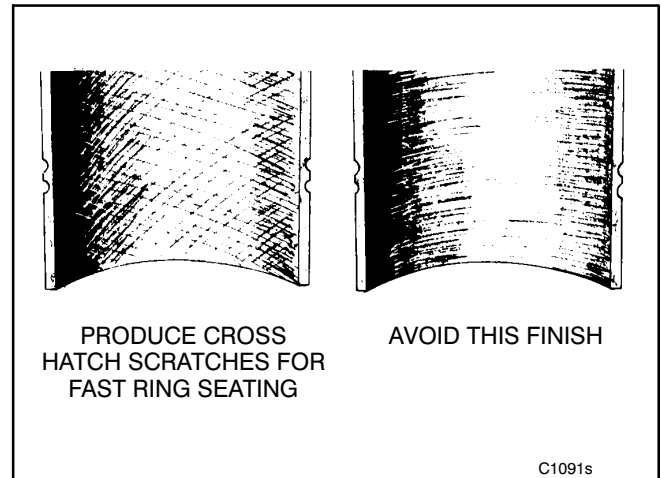


FIGURE 10-21. CROSSHATCHING



FIGURE 10-22. REMOVING PISTON RINGS

Remove the piston pin retainer from each side, heat the piston to 300°F (149°C) and push the piston pin out. Remove dirt and deposits from the piston surfaces with parts cleaning solvent. Clean the piston ring grooves with a groove cleaner (Figure 10-23) or the end of a piston ring filed to a sharp point. Care must be taken not to remove metal from the groove sides.

**CAUTION** *Using caustic cleaning solvent or wire brush for cleaning pistons will damage piston. Use parts cleaning solvent only. When cleaning the connecting rod in solvent, include the rod bore. Blow out all passages with low pressure compressed air.*

### Piston and Connecting Rod Inspection

**Piston Inspection:** Inspect the piston for fractures at the ring lands, skirt, and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge as shown in Figure 10-24. Replace the piston when the side clearance of the rings exceed the specified limit.

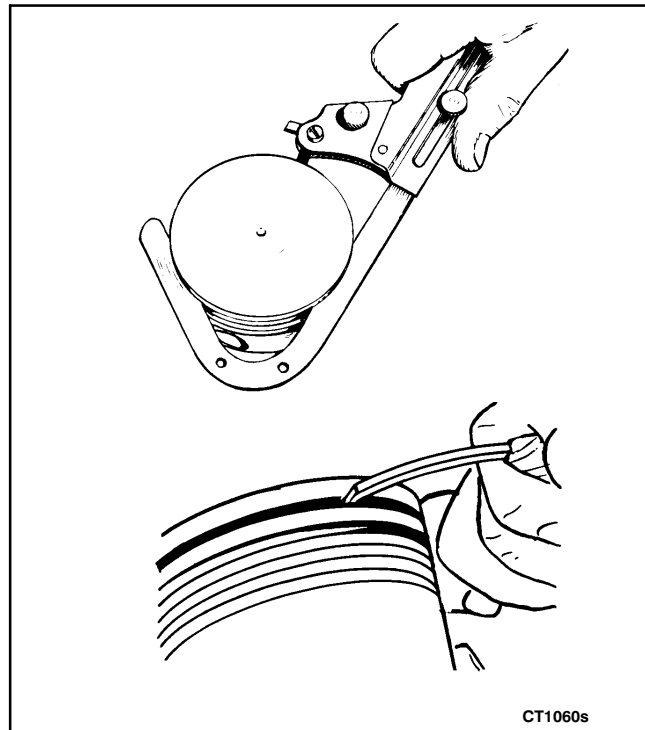


FIGURE 10-23. CLEANING RING GROOVES

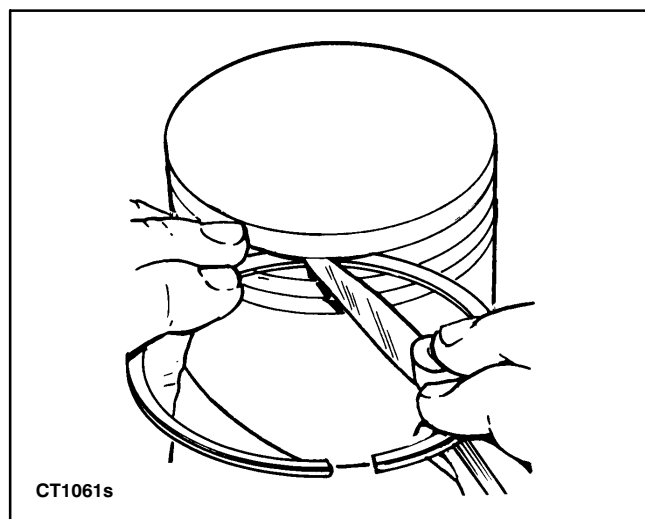


FIGURE 10-24. CHECKING RING LAND



**Piston Skirt O.D. Measurement:**

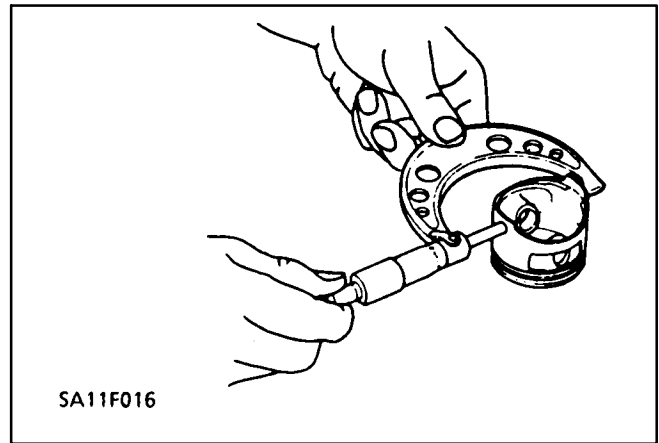
1. Measure the piston skirt O.D. with an outside micrometer (Figure 10-25).
2. If the measurement is less than the allowable limit, replace the piston.

**Piston Boss I.D.:**

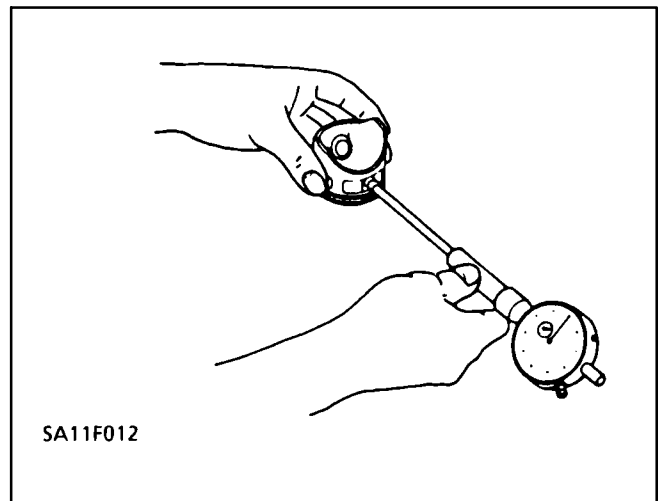
1. Measure the piston boss I.D. in both the vertical and horizontal direction with a cylinder gauge (Figure 10-26).
2. If the measurement exceeds the allowable limit, replace the piston.

**Piston Ring Gap:**

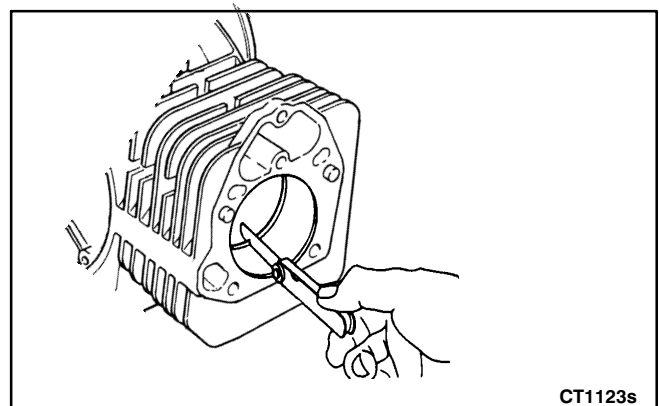
1. Insert piston ring into cylinder. Use piston head to push ring down to bottom of cylinder.
2. Measure the ring gap with a feeler gauge as shown in Figure 10-27.
3. If the ring gap exceeds the allowable limit, replace the ring.



**FIGURE 10-25. PISTON SKIRT MEASUREMENT**



**FIGURE 10-26. PISTON BOSS I.D.**



**FIGURE 10-27. MEASURING RING GAP**

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### ***Piston Ring Thickness:***

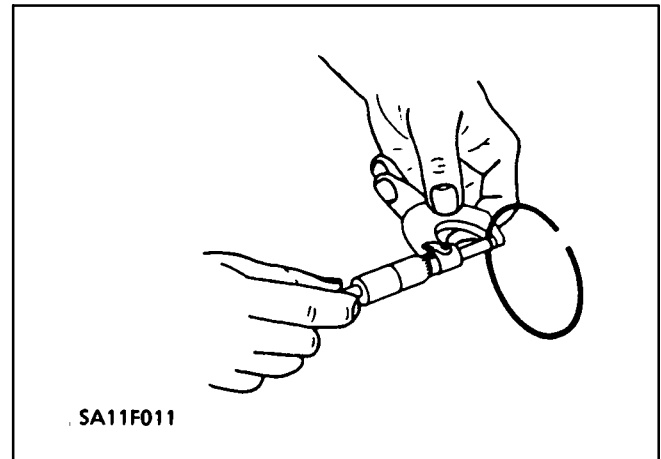
1. Measure the piston ring thickness with an outside micrometer (see Figure 10-28).
2. If the thickness is less than the allowable limit, replace the ring.

### **Piston Assembly**

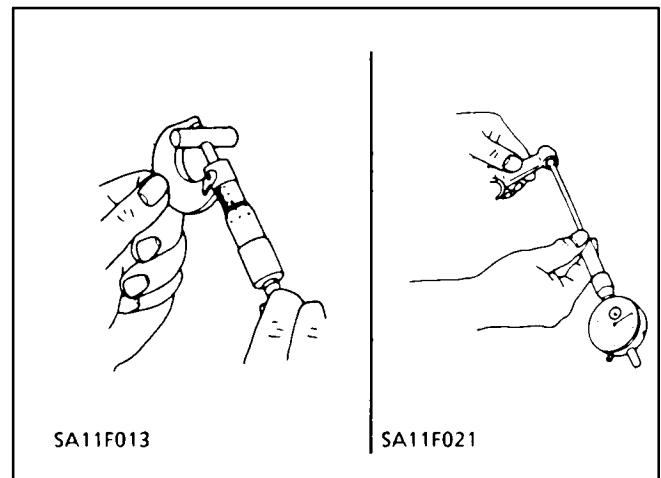
Install the rings on the piston beginning with the oil control ring. Use a piston ring spreader to prevent twisting or excessive expansion of the ring. Compression rings are marked with the word top or a mark on one side of the ring to indicate which side faces the top of the piston. Oil ring rails may be installed either way. Stagger ring gaps 120 degrees apart. Do not position ring gaps on thrust face of cylinder.

### **Clearance between Piston Pin and Connecting Rod Small End Bore**

1. Measure the piston pin O.D. and connecting rod small end bore with a micrometer (Figure 10-29). Then calculate the difference.
2. If the clearance exceeds the allowable limits, replace them.



**FIGURE 10-28. RING THICKNESS**



**FIGURE 10-29. PISTON PIN AND CONNECTING ROD CLEARANCE**

### Clearance between Crank Pin and Connecting Rod Big End Bore

1. Measure the crank pin O.D. and the connecting rod big end bore with a micrometer, and calculate the difference (Figure 10-30).
2. If the clearance exceeds the allowable limits, replace them.

### Side Clearance of Connecting Rod on Crank Pin

1. Assemble the connecting rod to the crank pin.
2. Measure the side clearance with a feeler gauge (Figure 10-31).
3. If the clearance exceeds the allowable limits, replace them.

### Cam Heights for Intake and Exhaust

1. Measure the height of the cam at its highest point with an outside micrometer (Figure 10-32).
2. If the measurement is less than the allowable limit, replace the camshaft.

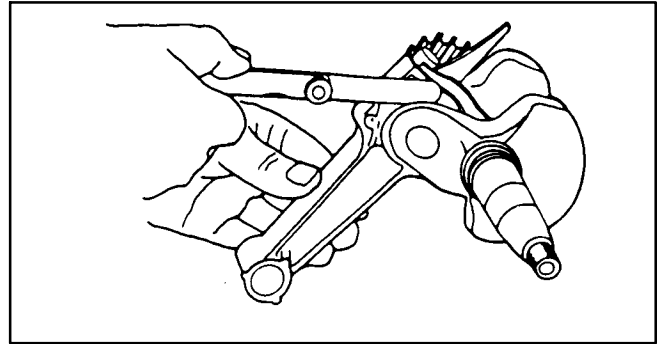


FIGURE 10-31. SIDE CLEARANCE OF CONNECTING ROD ON CRANK PIN

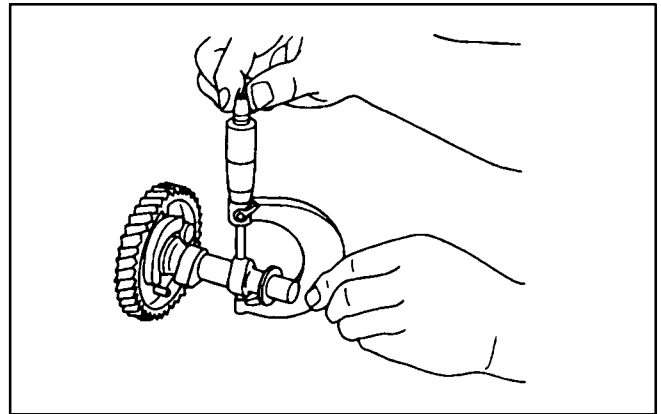


FIGURE 10-32. INTAKE AND EXHAUST CAM HEIGHTS

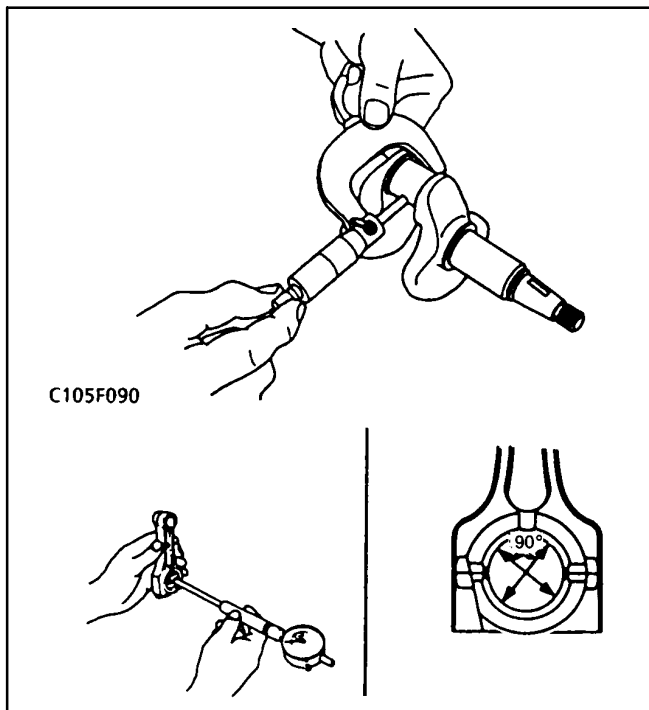


FIGURE 10-30. CRANK PIN AND CONNECTING ROD CLEARANCE

## PISTON AND CRANKSHAFT INSTALLATION

Lubricate the bearings with engine oil. Slide the crankshaft into the bearing and add shim(s). Install the crankcase cover and check to see that the crankshaft turns freely. Measure the side clearance of the crankshaft as follows:

### Side Clearance of Crankshaft

1. Set a dial gauge, as shown in Figure 10-33, push the shaft in and measure the clearance.
2. If the side clearance exceeds the allowable limits, adjust with shims.

Remove the crankcase cover and assemble the piston to the connecting rod. Heat the piston to 300°F (149°C). Position the piston on the connecting rod. Install the piston pin. Install the lock rings on each side of the piston pin.

**Installing the Piston in Cylinder:** When installing the piston assembly, observe the markings on the connecting rod, cap and splasher. See Figure 10-34.

1. Turn the crankshaft to position the crankpin at the bottom of its stroke.
2. Lubricate the piston assembly and inside of cylinder wall. Compress the rings with a ring compressor as shown in Figure 10-35.
3. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the crankpin.

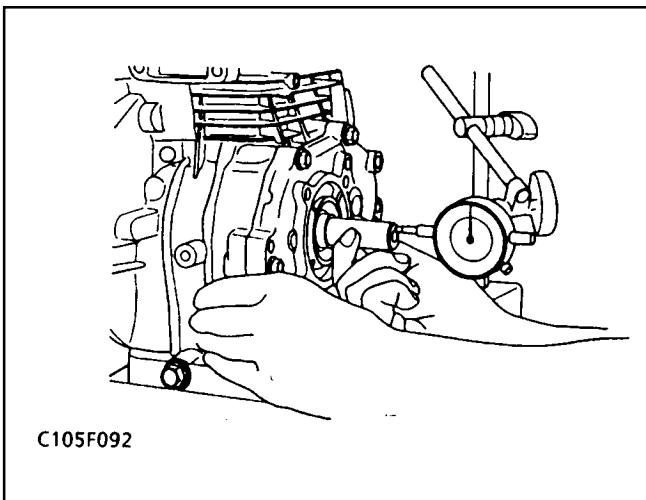


FIGURE 10-33. SIDE CLEARANCE OF CRANKSHAFT

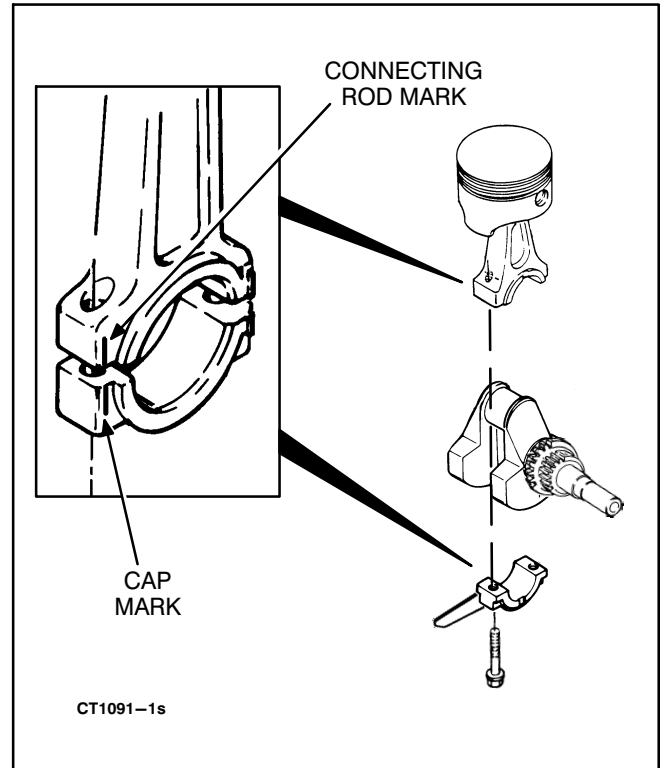


FIGURE 10-34. ROD CAP ASSEMBLY

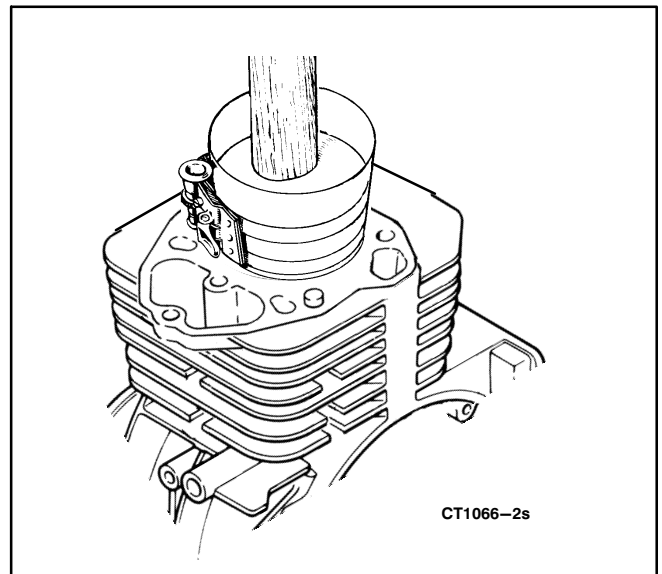


FIGURE 10-35. INSTALLING PISTON

## Crankpin Clearance

1. Wipe the oil off the rod cap and crankpin.
2. Place a piece of the correct size Plasti-gage across the full width of the rod cap about 1/4 inch (6 mm) off center (Figure 10-36).
3. Install the rod cap and tighten to the specified torque. Do not rotate crankshaft after the rod cap is in place.
4. Remove the rod 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 to determine the crankpin clearance.

5. Remove the Plasti-gage. Lubricate the rod crankpin and cap. Install the connecting rod cap. The rod cap must be tapped several times to properly align it with the connecting rod. Tighten the connecting rod bolts to the specified torque.
6. Crank the engine several times to see that the crankshaft turns freely.

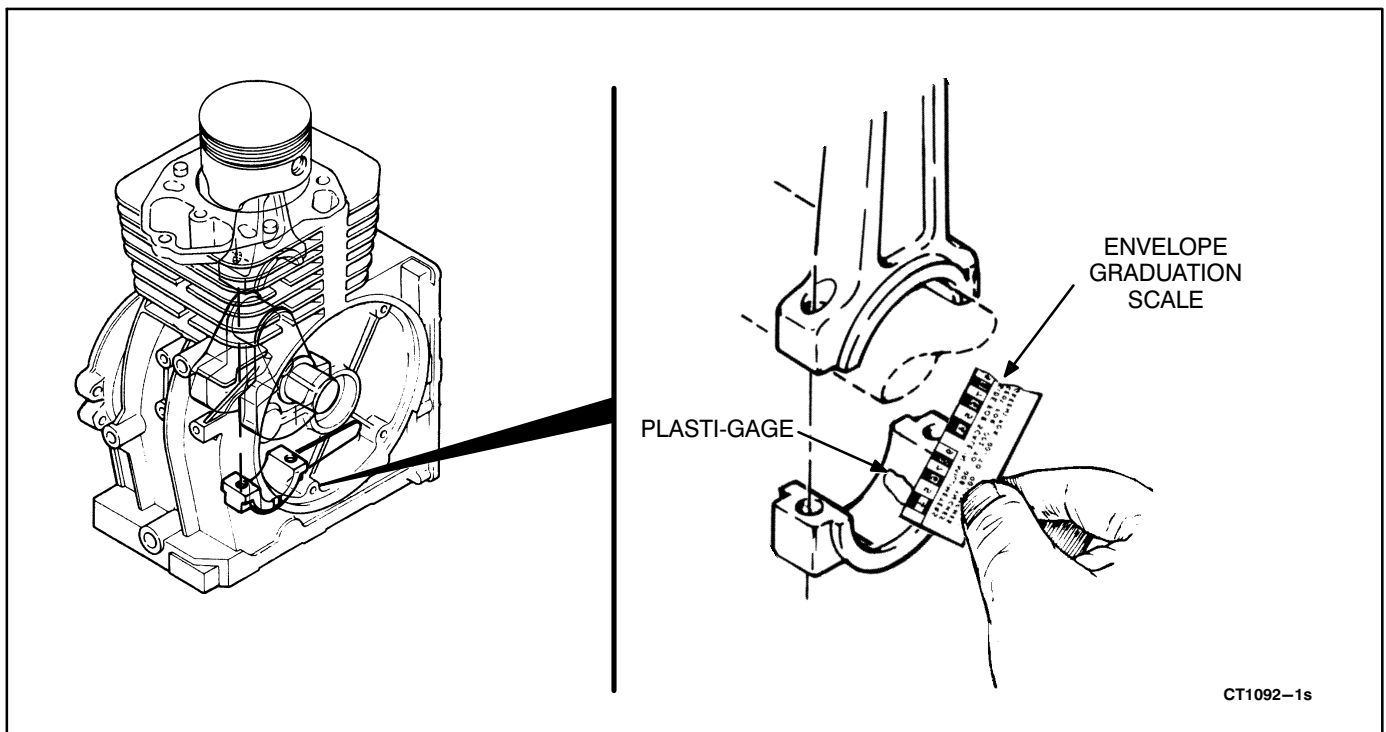


FIGURE 10-36. MEASURING CRANKPIN CLEARANCE

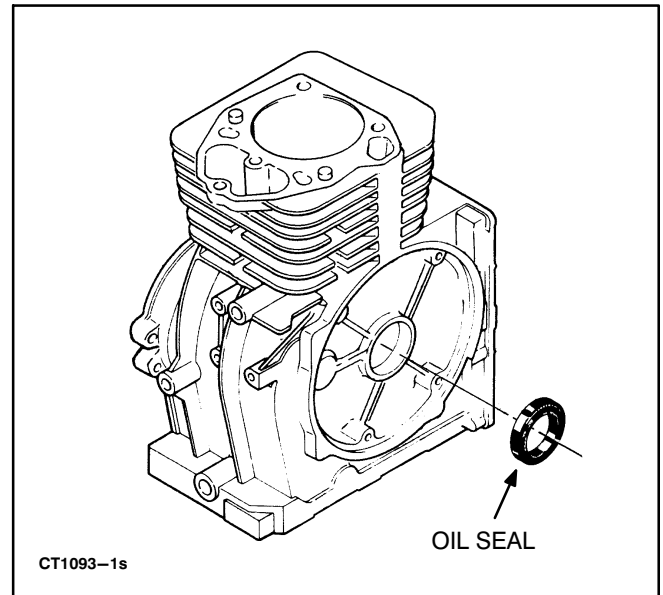
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## BEARINGS

The crankshaft bearing is pressed into the engine block and three bearings are pressed into the crankcase cover. The bearing in the engine block can be pressed out after the oil seal is removed (following section). The bearings in the crankcase cover can be pulled out using a puller. Clean the bearing mounting surfaces and press new bearings back in.

## OIL SEAL

Use an oil seal remover to pry the oil seal out of the engine block. Clean the oil seal resting surface and lubricate surface before installing new oil seal. Press new oil seal into the engine block until oil seal is flush with cylinder block boss (see Figure 10-37). Lubricate the lips of the oil seal with a light coating of grease. This provides initial lubrication until engine oil reaches the seal.



**FIGURE 10-37. OIL SEAL**

## COMPRESSION RELEASE SYSTEM (SPEC A-D ONLY)

This engine has a compression release system that decreases the amount of effort required to start the engine and reduces engine run-on when stopping (Figure 10-38).

The system works as follows:

1. As the engine is started, a spring holds in the flyweight which in turn pushes a decompression pin upward.
2. The decompression pin pushes up on the exhaust tappet and opens the exhaust valve momentarily to release compression and make starting easier.
3. As the engine speeds up, the flyweight is forced outward by centrifugal force and the decompression pin moves down so that it no longer opens the exhaust valve.
4. When the engine is stopped, engine speed drops and the flyweight pulls in and the decompression pin moves up. The pin opens the exhaust valve again releasing compression.

The most common cause of problems with this system is a faulty spring, the spring may be too long or it may not be connected. A spring that is too long will reduce the decompression cutoff speed. Make sure that the spring is properly attached. If a problem with the cutoff speed is still suspected, replace the spring.

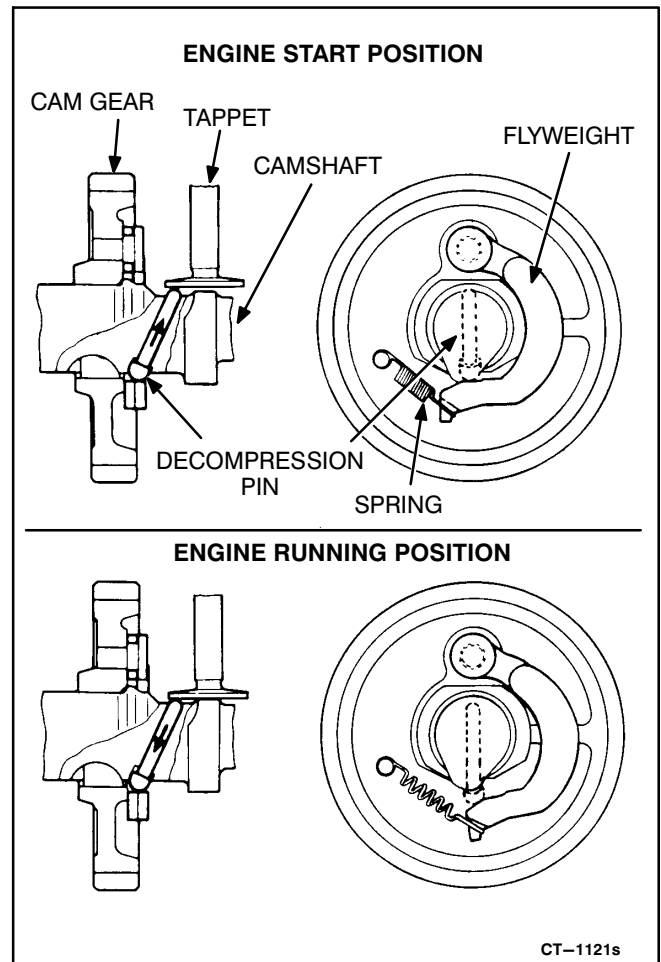


FIGURE 10-38. COMPRESSION RELEASE SYSTEM

# 11. Service Checklist

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## **EXHAUST GAS IS DEADLY!**

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

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

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

**Never sleep in the 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

## **GENERAL**

After the generator set has been serviced and reinstalled in the vehicle, inspect the installation and test the generator set to confirm that the generator set will operate properly and produce its full rated load capacity. Check each of the following areas before putting the generator 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 tight and installed properly. Make certain that wires do not run over hot, sharp or rough surfaces and are not kinked or worn. Check each of these connections:

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

## **INITIAL START ADJUSTMENTS**

**CAUTION** *Voltage/frequency-sensitive equipment such as VCRs, televisions, computers, etc. can 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 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.*



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If the fuel system was worked on, check that the idle and main adjustment screws are adjusted as described in the fuel system sections of Section 8. *Primary Engine Systems* before starting the generator set. Reinstall adjustment screw limiter caps.

Start the generator set, then immediately adjust the governor speed for a safe no-load operating speed. With no load applied, listen for unusual sounds or vibrations. Warm up the generator set for at least 15 minutes at 50% to 75% of rated load and check that the choke is completely open. Adjust the carburetor and governor as specified in the governor and fuel system sections of Section 8. *Primary Engine Systems*.

### EXHAUST SYSTEM

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

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

### FUEL SYSTEM

With the generator set operating, inspect the fuel supply line and fittings for leaks. Check flexible sec-

tion for cuts, cracks and abrasions and make sure it is not rubbing against anything that could cause damage.

**⚠WARNING** *Leaking fuel creates a fire hazard which can result in severe personal injury or death if ignited by flame, spark, pilot light, cigarette, arc-producing equipment, electrical switch, or other ignition source. If fuel leaks are detected, shut off the generator set and correct leak immediately.*

### OUTPUT CHECK

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

### CONTROL

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

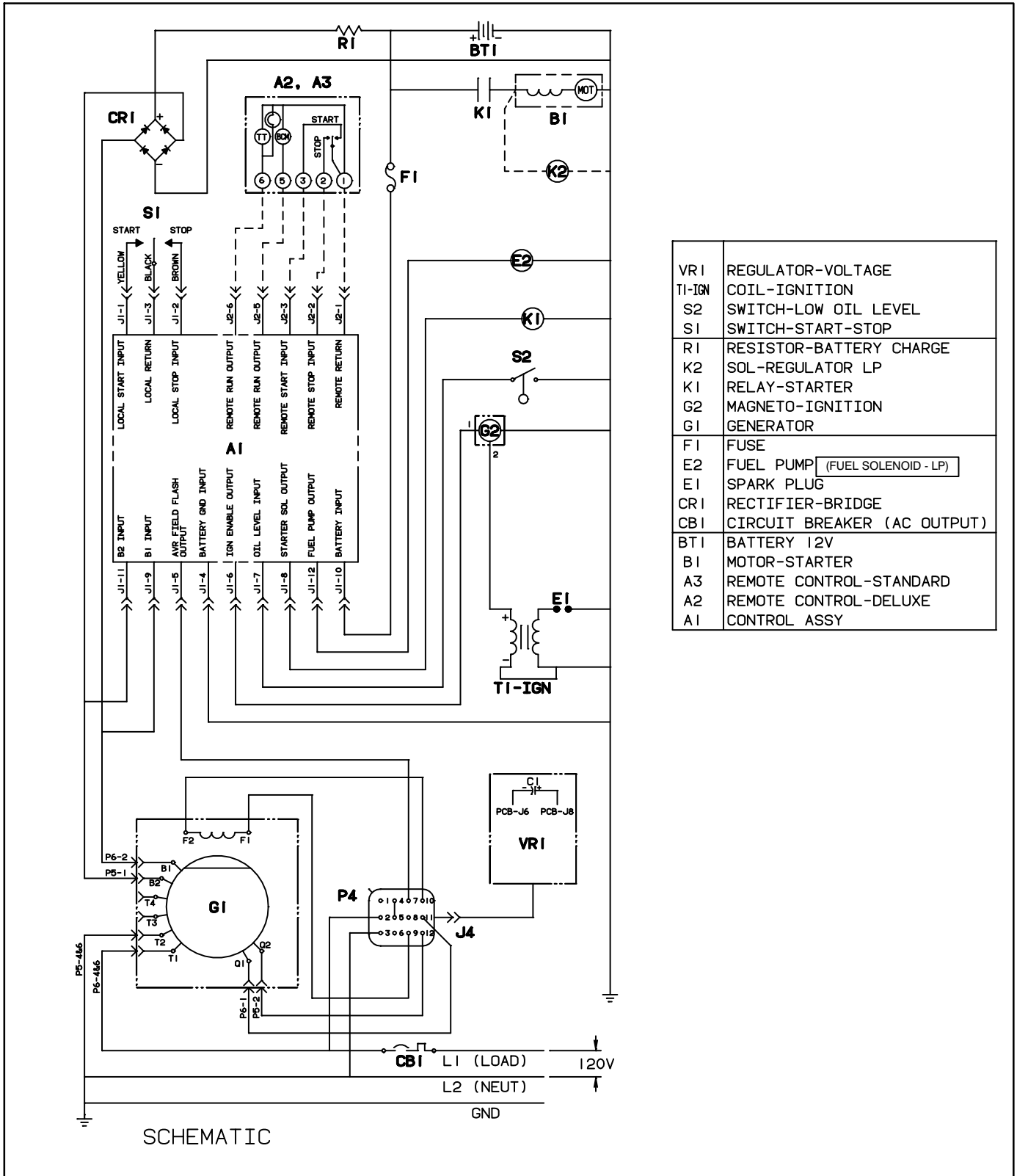
### MECHANICAL

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

# 12. Wiring Schematic/Diagram

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<b>DRAWING NO.</b>	<b>DESCRIPTION</b>	<b>FIG NO.</b>
611-1194	Wiring Schematic - MicroLite, Spec A (60 Hertz) . . . . .	12-1
611-1194	Wiring Diagram - MicroLite, Spec A (60 Hertz) . . . . .	12-2
611-1225	Wiring Schematic - MicroLite, Spec B through E (60 Hertz) . . . . .	12-3
611-1225	Wiring Diagram - MicroLite, Spec B through E (60 Hertz) . . . . .	12-4
611-1226	Wiring Schematic - MicroLite, Spec B through E (50 Hertz) . . . . .	12-5
611-1226	Wiring Diagram - MicroLite, Spec B through E (50 Hertz) . . . . .	12-6
611-1226	Voltage Reconnection - MicroLite, Spec B through E (50 Hertz) . .	12-7
611-1245	Wiring Schematic - MicroLite, Begin Spec F (50 Hertz) . . . . .	12-8
611-1245	Wiring Diagram - MicroLite, Begin Spec F (50 Hertz) . . . . .	12-9
611-1245	Voltage Reconnection - MicroLite, Begin Spec F (50 Hertz) . . . . .	12-10
611-1246	Wiring Schematic - MicroLite, Begin Spec F (60 Hertz) . . . . .	12-11
611-1246	Wiring Diagram - MicroLite, Begin Spec F (60 Hertz) . . . . .	12-12
611-1255	Wiring Schematic - MicroLite, Begin Spec F (60 Hz/100 V) . . . . .	12-13
611-1255	Wiring Diagram - MicroLite, Begin Spec F (60 Hz/100 V) . . . . .	12-14
611-1255	Voltage Reconnection - MicroLite, Begin Spec F (60 Hz/100 V) . .	12-15
611-1264	Wiring Schematic - MicroLite, Begin Spec G (50 Hertz) . . . . .	12-16
611-1264	Wiring Diagram - MicroLite, Begin Spec G (50 Hertz) . . . . .	12-17
611-1264	Voltage Reconnection - MicroLite, Begin Spec G (50 Hz/100 V) . .	12-18
611-1265	Wiring Schematic - MicroLite, Begin Spec G (60 Hz) . . . . .	12-19
611-1265	Wiring Diagram - MicroLite, Begin Spec G (60 Hz) . . . . .	12-20



VR1	REGULATOR-VOLTAGE
TI-IGN	COIL-IGNITION
S2	SWITCH-LOW OIL LEVEL
S1	SWITCH-START-STOP
R1	RESISTOR-BATTERY CHARGE
K2	SOL-REGULATOR LP
K1	RELAY-STARTER
G2	MAGNETO-IGNITION
G1	GENERATOR
F1	FUSE
E2	FUEL PUMP (FUEL SOLENOID - LP)
E1	SPARK PLUG
CR1	RECTIFIER-BRIDGE
CB1	CIRCUIT BREAKER (AC OUTPUT)
BT1	BATTERY 12V
B1	MOTOR-STARTER
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY

FIGURE 12-1. WIRING SCHEMATIC 611-1194 (MICROLITE, SPEC A - 60 HERTZ)



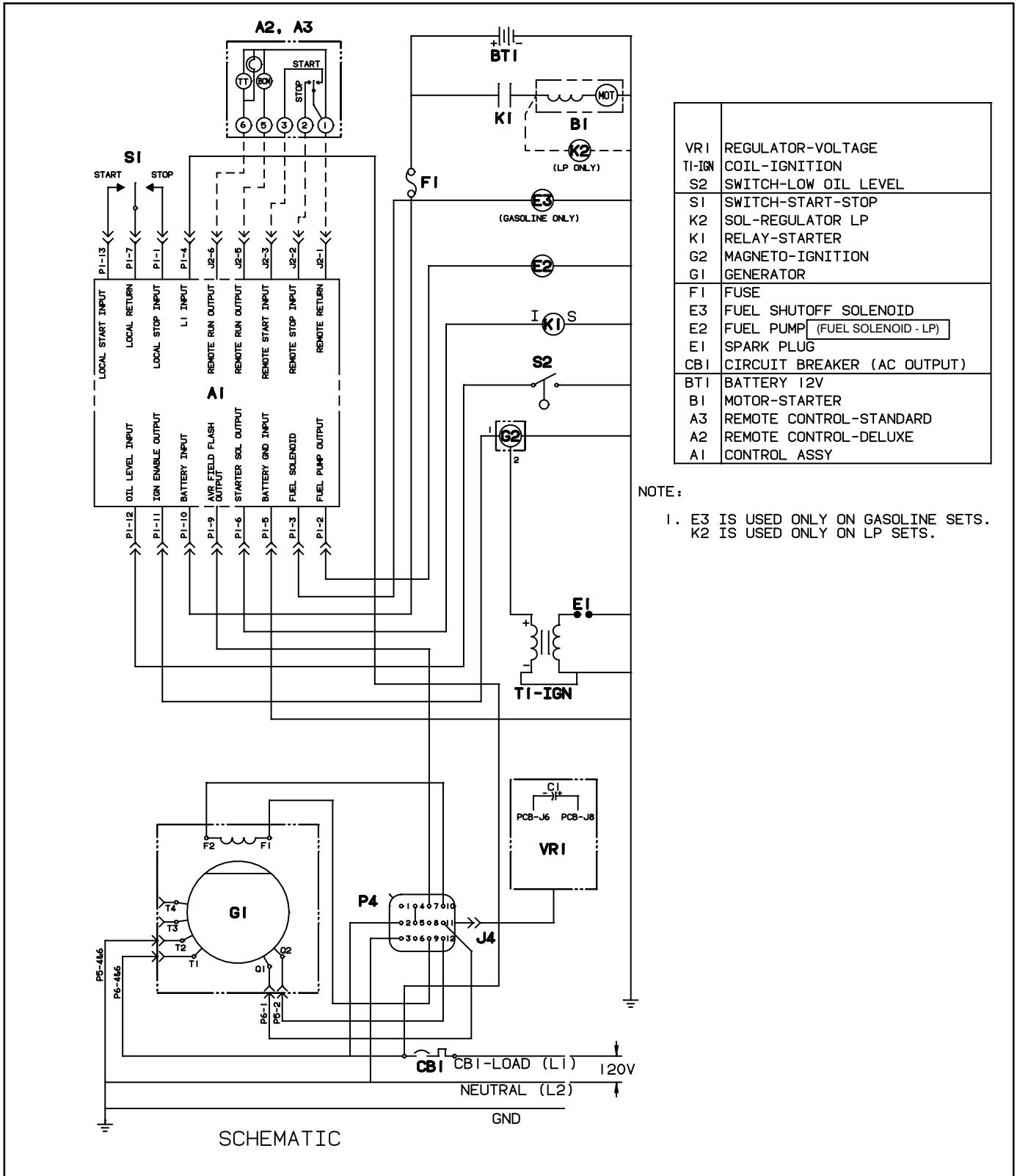


FIGURE 12-3. WIRING SCHEMATIC 611-1225 (MICROLITE, SPEC B THROUGH E - 60 HERTZ)

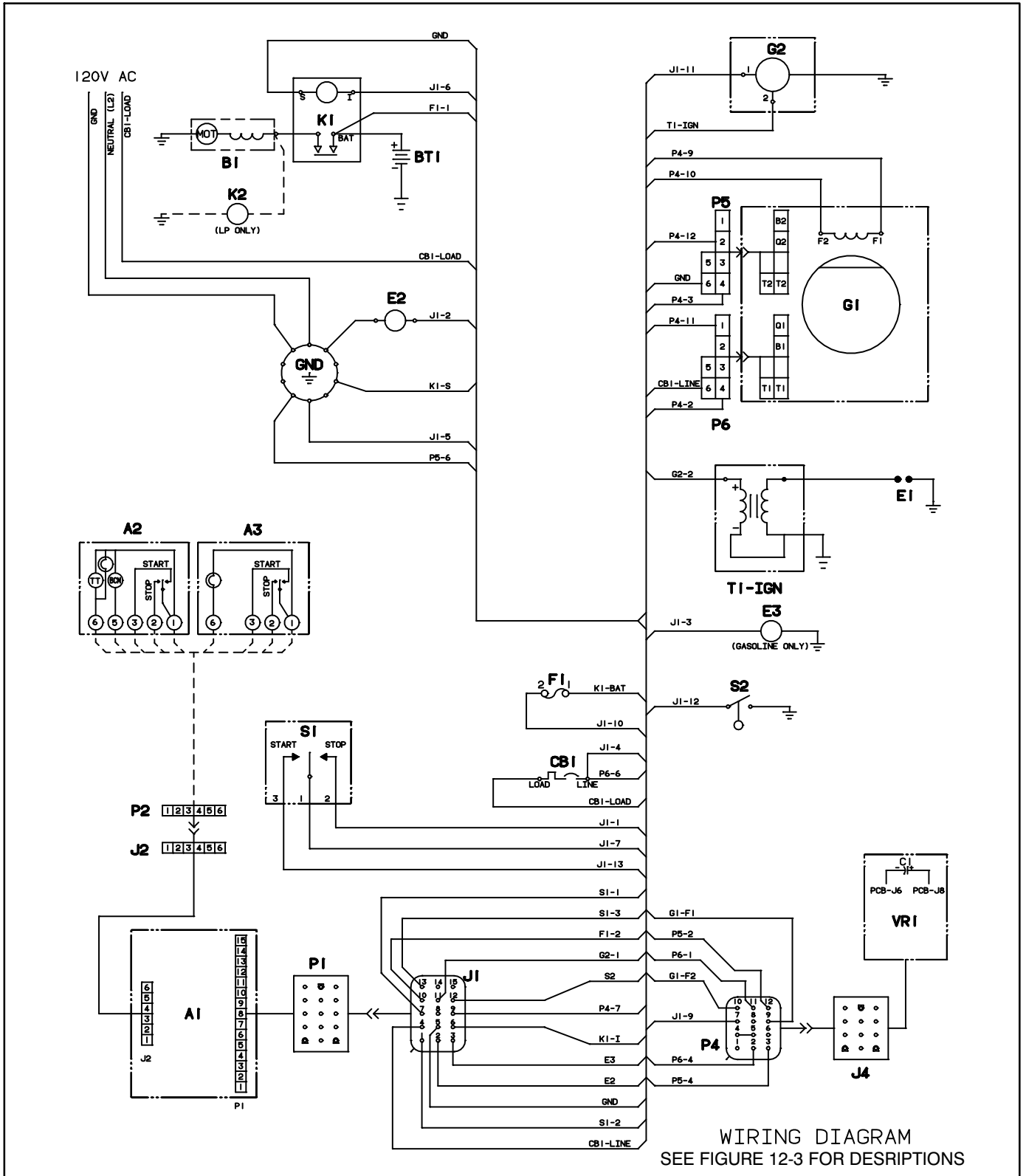


FIGURE 12-4. WIRING DIAGRAM 612-1225 (MICROLITE, SPEC B THROUGH E - 60 HERTZ)

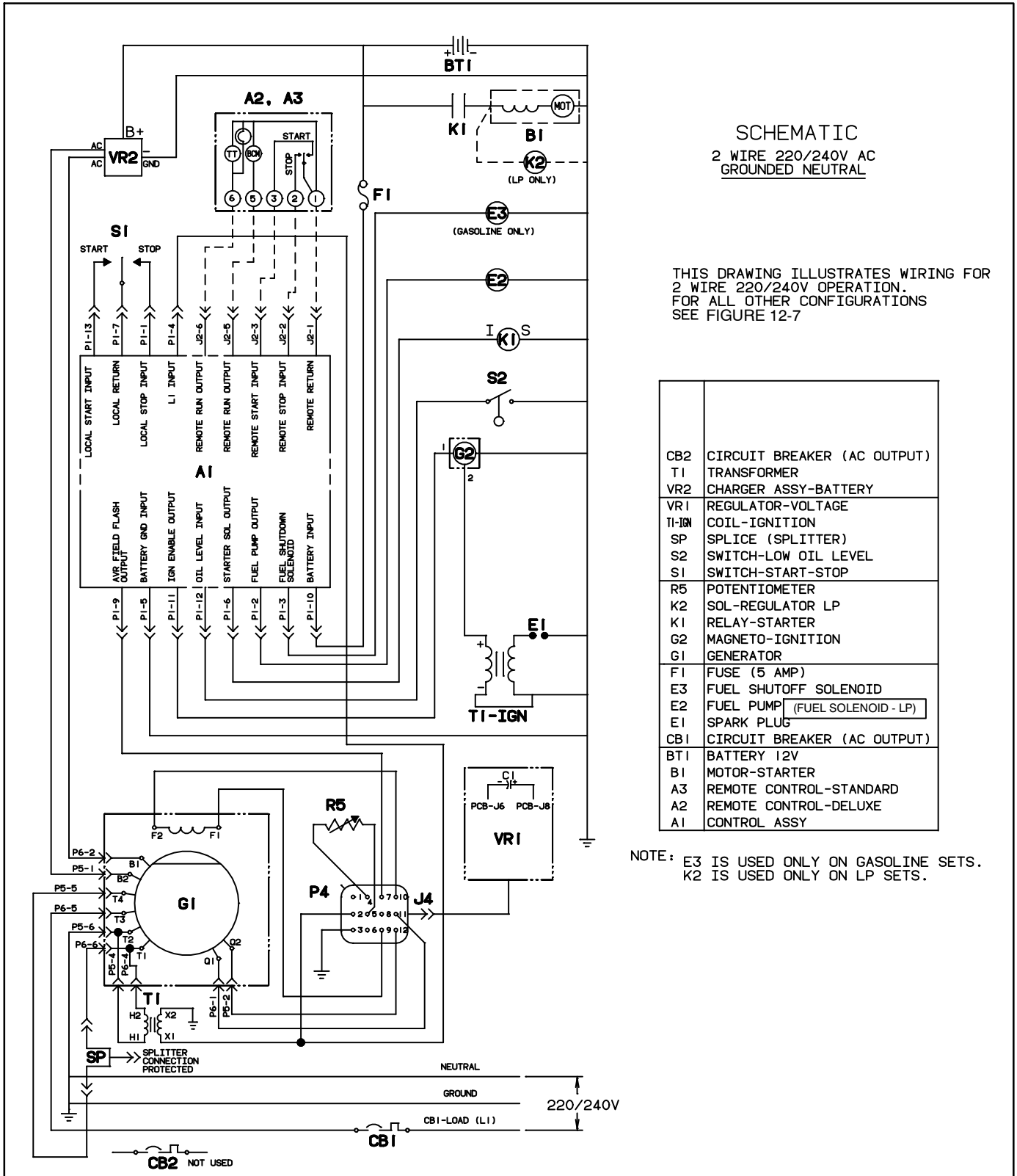


FIGURE 12-5. WIRING SCHEMATIC 611-1226 (MICROLITE, SPEC B THROUGH E - 50 HERTZ)

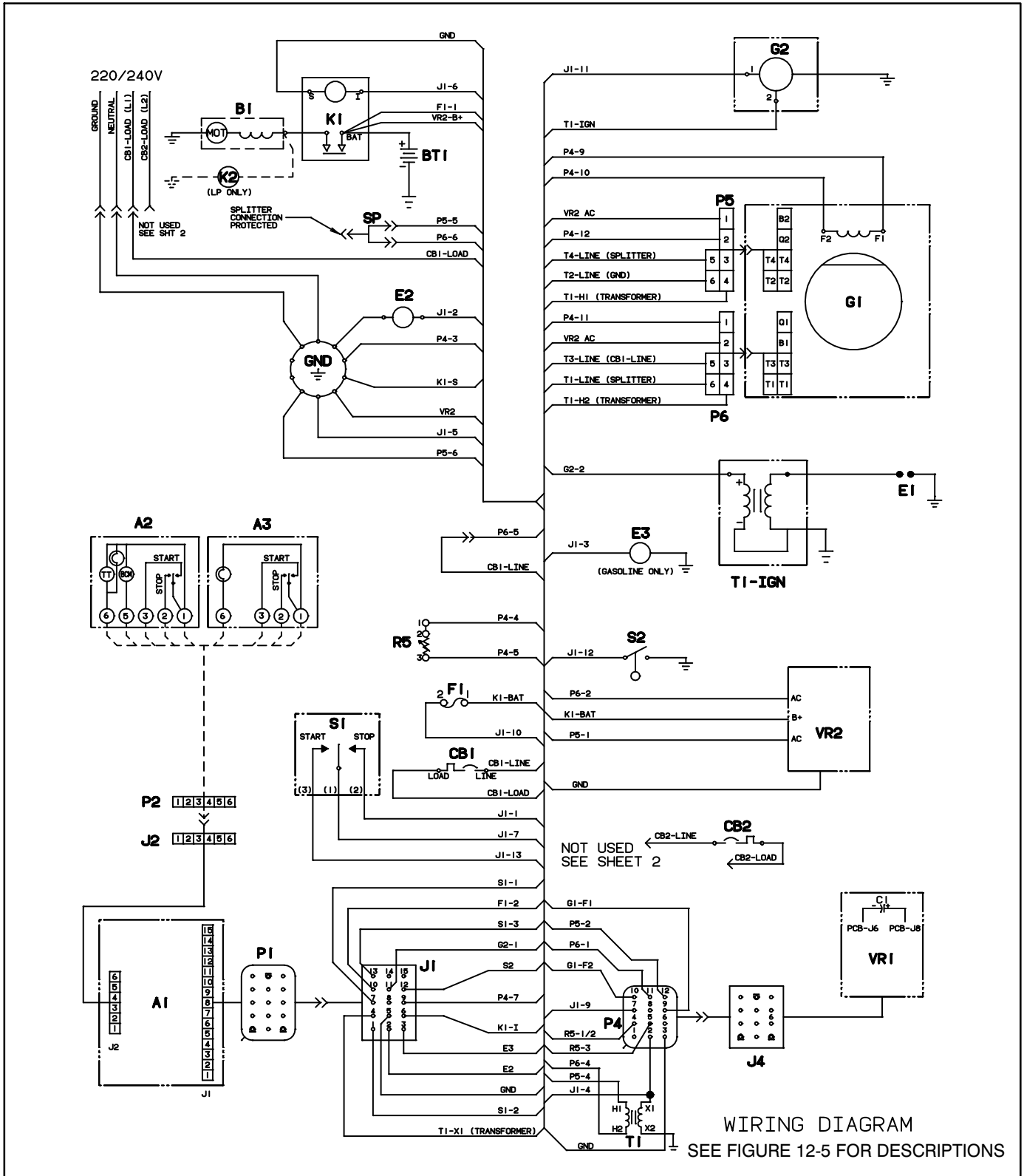


FIGURE 12-6. WIRING DIAGRAM 612-1226 (MICROLITE, SPEC B THROUGH E - 50 HERTZ)

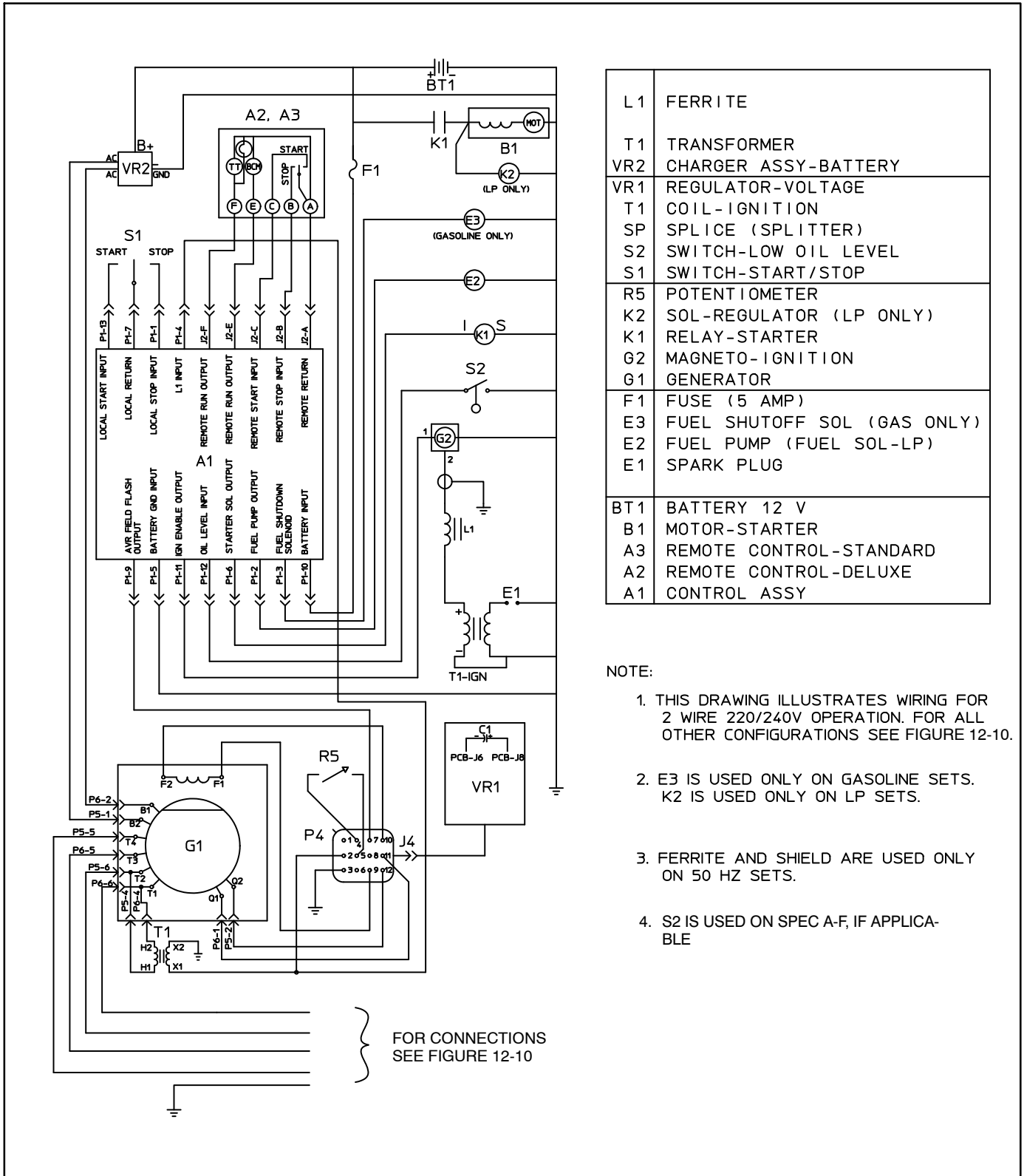


## RECONNECTION CHART FOR MICROLITE 3600 50 HZ

FROM:	TO:			
	3 WIRE 110/220 OR 120/240V	2 WIRE 110 OR 120V	2 WIRE 220V LINE TO GND=220V NEUTRAL GROUNDED	2 WIRE 220 OR 240V LINE TO GND=110V NEUTRAL GROUNDED
T1-LINE T2-LINE T3-LINE T4-LINE	NEUTRAL GROUNDED CB1-LINE GROUND SPLITTER GROUND CB2-LINE GROUND	NEUTRAL GROUNDED CB1-LINE GROUND SPLITTER CB2-LINE GROUND	SPLITTER GROUND CB1-LINE SPLITTER GROUND	NEUTRAL GROUNDED CB1-LINE GROUND SPLITTER CB2-LINE GROUND
CB1-LOAD (L1) NEUTRAL (N) CB2-LOAD (L2) GROUND (GND)	NEUTRAL ISOLATED CB1-LINE SPLITTER SPLITTER CB2-LINE	NEUTRAL ISOLATED CB1-LINE SPLITTER SPLITTER SPLITTER	NEUTRAL ISOLATED CB1-LINE SPLITTER SPLITTER SPLITTER	NEUTRAL ISOLATED CB1-LINE SPLITTER SPLITTER SPLITTER
SPECIAL INSTRUCTIONS	CONNECT L1-L2 AT JUNCTION BOX SPLITTER NOT USED	CONNECT L1-L2 AT JUNCTION BOX	CONNECT L1-L2 AT JUNCTION BOX	SPLITTER NOT USED
110 OR 120V 220 OR 240V	L1-N, L2-N L1-L2	(L1, L2)-N N/A	N/A L1-N	N/A L1-L2
RECONNECTION DIAGRAMS				

NOTE: OUTPUT VOLTAGE CAN BE ADJUSTED BY USE OF THE ADJUSTMENT POT ON THE FRONT OF THE CONTROL PANEL. CLOCKWISE ROTATION WILL INCREASE THE VOLTAGE BY A MAXIMUM INCREASE OF 20 VAC.

**FIGURE 12-7. VOLTAGE RECONNECTION DIAGRAM 612-1226 (MICROLITE, SPEC B THROUGH E - 50 HERTZ)**



L1	FERRITE
T1	TRANSFORMER
VR2	CHARGER ASSY-BATTERY
VR1	REGULATOR-VOLTAGE
T1	COIL-IGNITION
SP	SPLICE (SPLITTER)
S2	SWITCH-LOW OIL LEVEL
S1	SWITCH-START/STOP
R5	POTENTIOMETER
K2	SOL-REGULATOR (LP ONLY)
K1	RELAY-STARTER
G2	MAGNETO-IGNITION
G1	GENERATOR
F1	FUSE (5 AMP)
E3	FUEL SHUTOFF SOL (GAS ONLY)
E2	FUEL PUMP (FUEL SOL-LP)
E1	SPARK PLUG
BT1	BATTERY 12 V
B1	MOTOR-STARTER
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY

- NOTE:
1. THIS DRAWING ILLUSTRATES WIRING FOR 2 WIRE 220/240V OPERATION. FOR ALL OTHER CONFIGURATIONS SEE FIGURE 12-10.
  2. E3 IS USED ONLY ON GASOLINE SETS. K2 IS USED ONLY ON LP SETS.
  3. FERRITE AND SHIELD ARE USED ONLY ON 50 HZ SETS.
  4. S2 IS USED ON SPEC A-F, IF APPLICABLE

FIGURE 12-8. WIRING SCHEMATIC 611-1245 (MICROLITE, BEGIN SPEC F - 50 HERTZ)

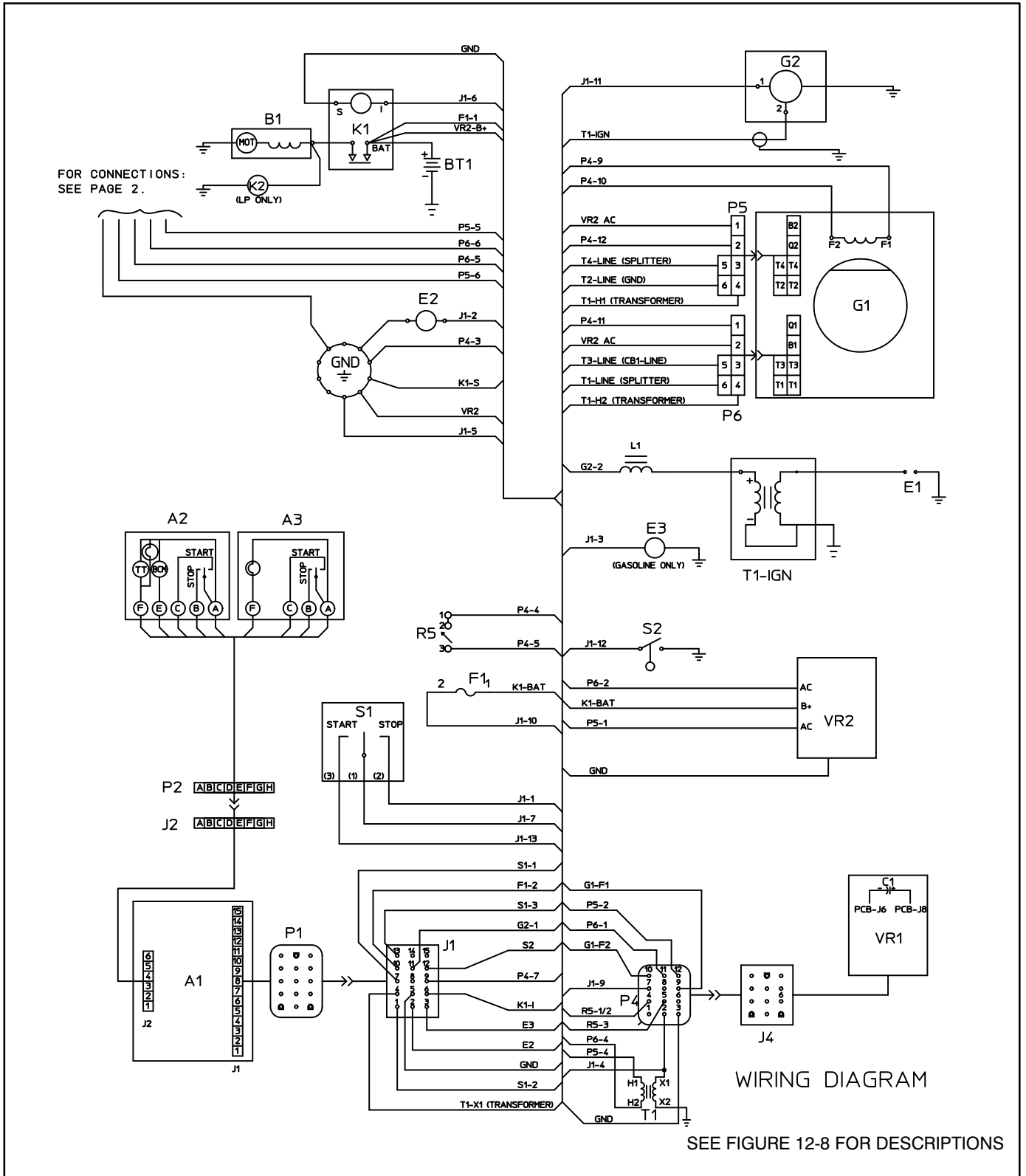


FIGURE 12-9. WIRING DIAGRAM 611-1245 (MICROLITE, BEGIN SPEC F - 50 HERTZ)

## RECONNECTION CHART FOR MICROLITE 3600 50 HZ

FROM:	TO:			
	3 WIRE 110/220 OR 120/240V	2 WIRE 110 OR 120V	2 WIRE 220 OR 240V	
	NEUTRAL GROUNDED	NEUTRAL GROUNDED	LINE TO GND-220V NEUTRAL GROUNDED	NEUTRAL GROUNDED
	NEUTRAL ISOLATED	NEUTRAL ISOLATED	LINE TO GND-110V NEUTRAL GROUNDED	NEUTRAL ISOLATED
T1-LINE T2-LINE T3-LINE T4-LINE	CB1-LINE SPLITTER GROUND CB2-LINE	CB1-LINE GROUND CB2-LINE GROUND	SPLITTER GROUND CB1-LINE SPLITTER	CB1-LINE SPLITTER GROUND CB2-LINE
CB1-LOAD (L1) NEUTRAL (N) CB2-LOAD (L2) GROUND (GND)	CB1-LOAD SPLITTER GROUND CB2-LOAD GROUND	CB1-LOAD GROUND CB2-LOAD GROUND	CB1-LOAD GROUND OPEN GROUND	CB1-LOAD OPEN CB2-LOAD GROUND
SPECIAL INSTRUCTIONS	SPLITTER NOT USED	CONNECT L1-L2 AT JUNCTION BOX SPLITTER NOT USED	SPLITTER NOT USED	
110 OR 120V 220 OR 240V	L1-N, L2-N L1-L2	(L1,L2)-N N/A	N/A L1-N	N/A L1-L2
RECONNECTION DIAGRAMS				

NOTE: OUTPUT VOLTAGE CAN BE ADJUSTED BY USE OF THE ADJUSTMENT POT ON THE FRONT OF THE CONTROL PANEL. CLOCKWISE ROTATION WILL INCREASE THE VOLTAGE BY A MAXIMUM INCREASE OF 20 VAC.

FIGURE 12-10. VOLTAGE RECONNECTION DIAGRAM 612-1245 (MICROLITE, BEGIN SPEC F - 50 HERTZ)

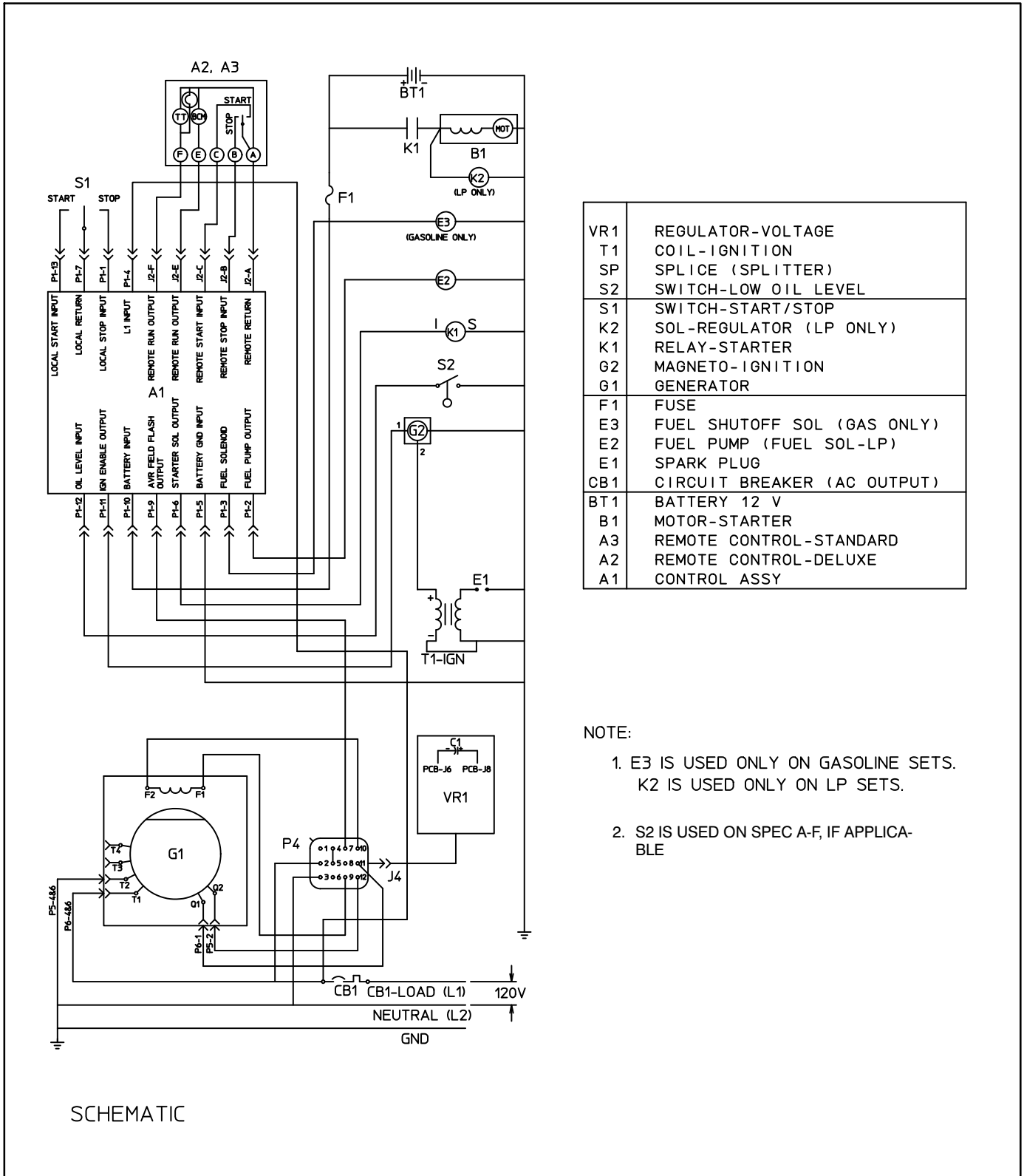


FIGURE 12-11. WIRING SCHEMATIC 612-1246 (MICROLITE, BEGIN SPEC F - 60 HERTZ)

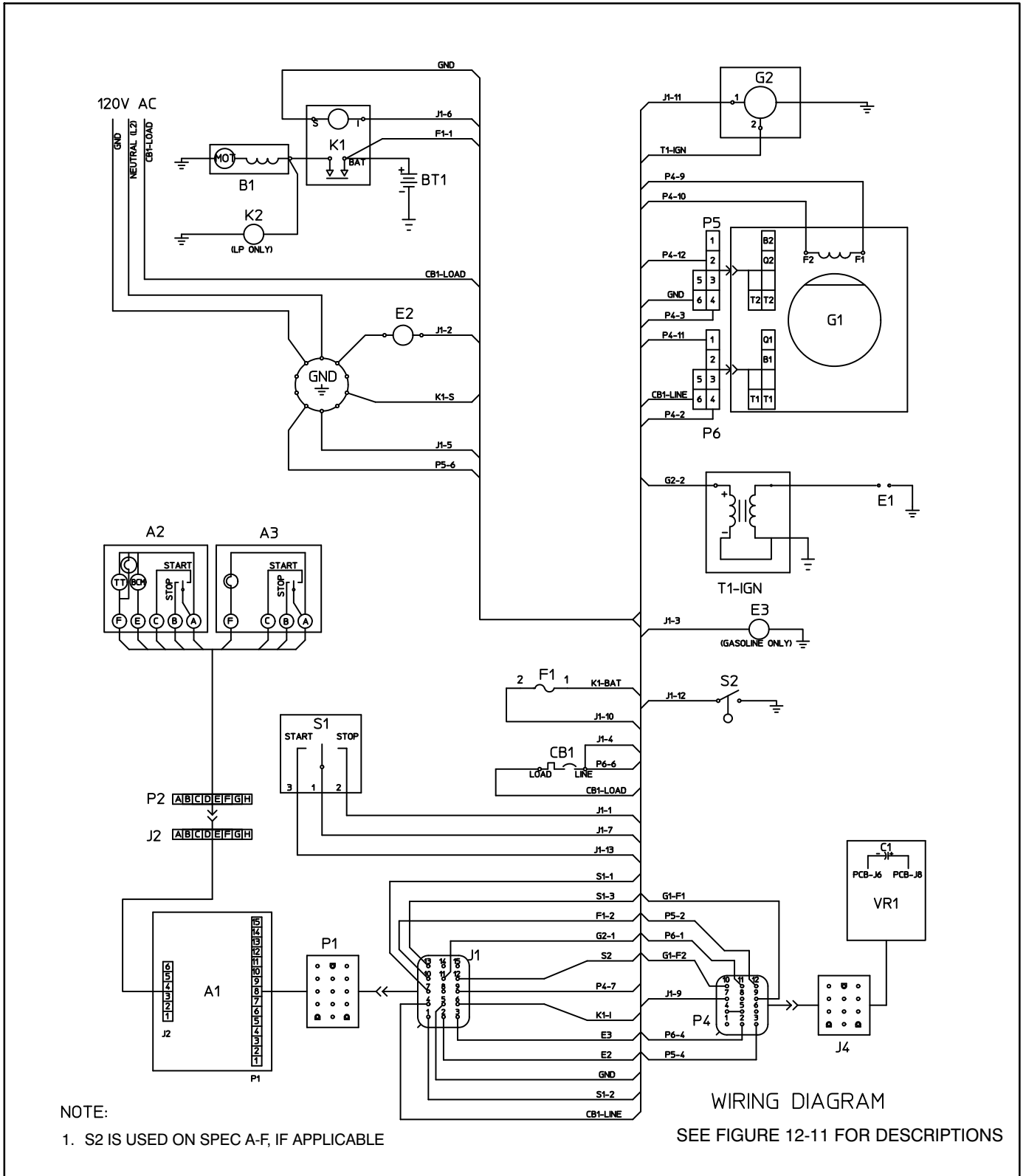


FIGURE 12-12. WIRING DIAGRAM 612-1246 (MICROLITE, BEGIN SPEC F - 60 HERTZ)

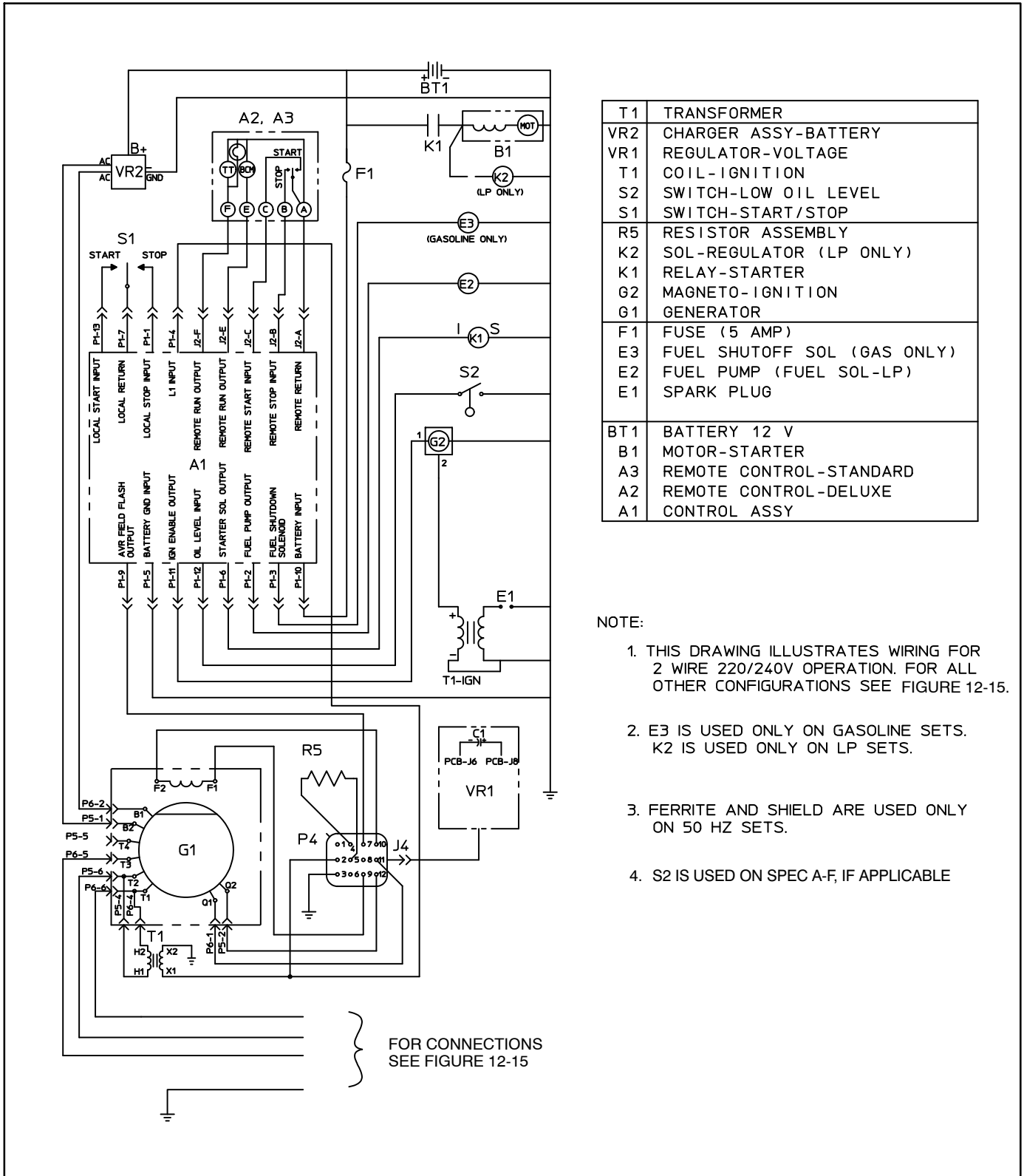


FIGURE 12-13. WIRING SCHEMATIC 612-1255 (MICROLITE, BEGIN SPEC F - 60 HZ/100 V)

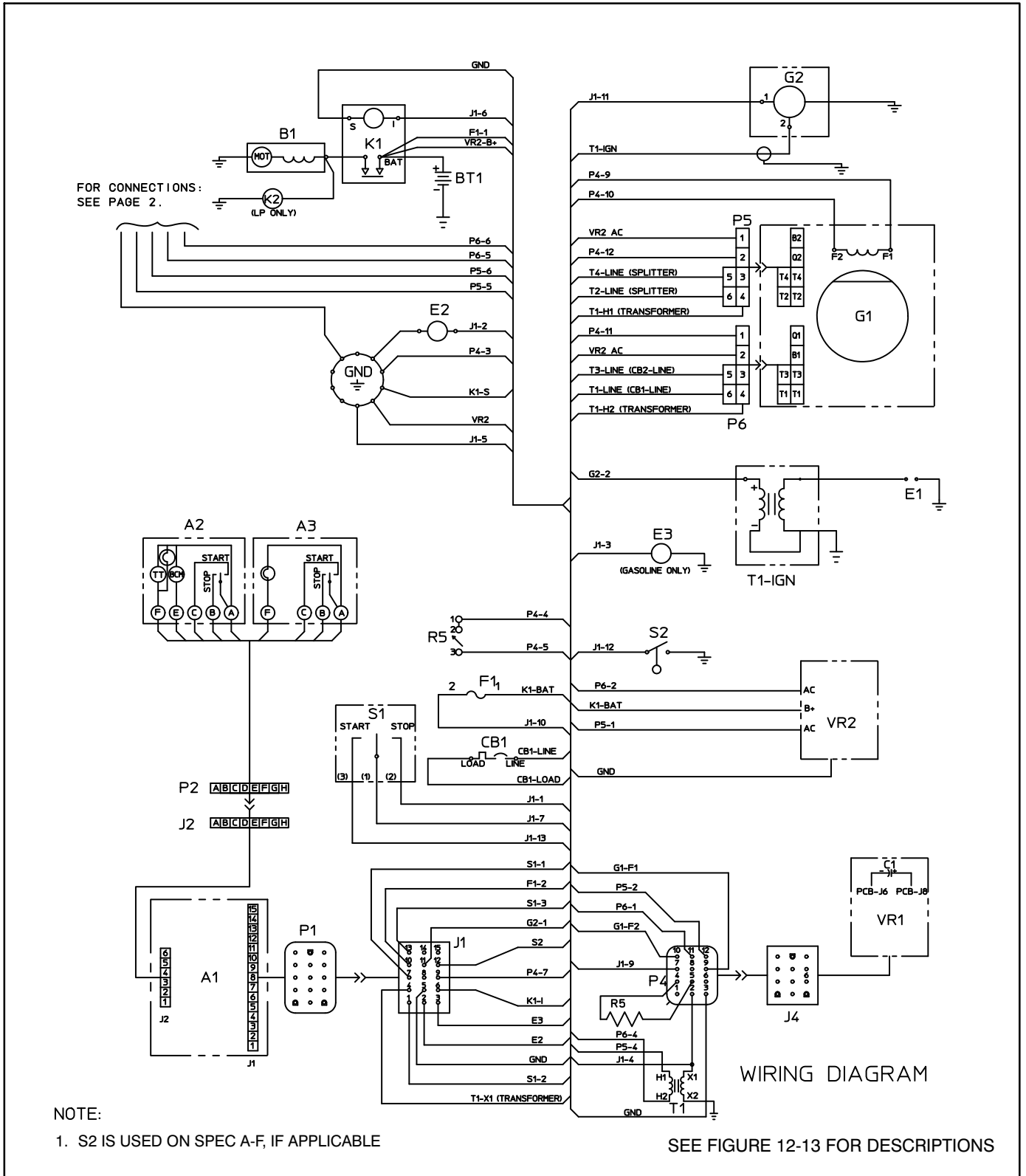


FIGURE 12-14. WIRING DIAGRAM 612-1255 (MICROLITE, BEGIN SPEC F - 60 HZ/100 V)

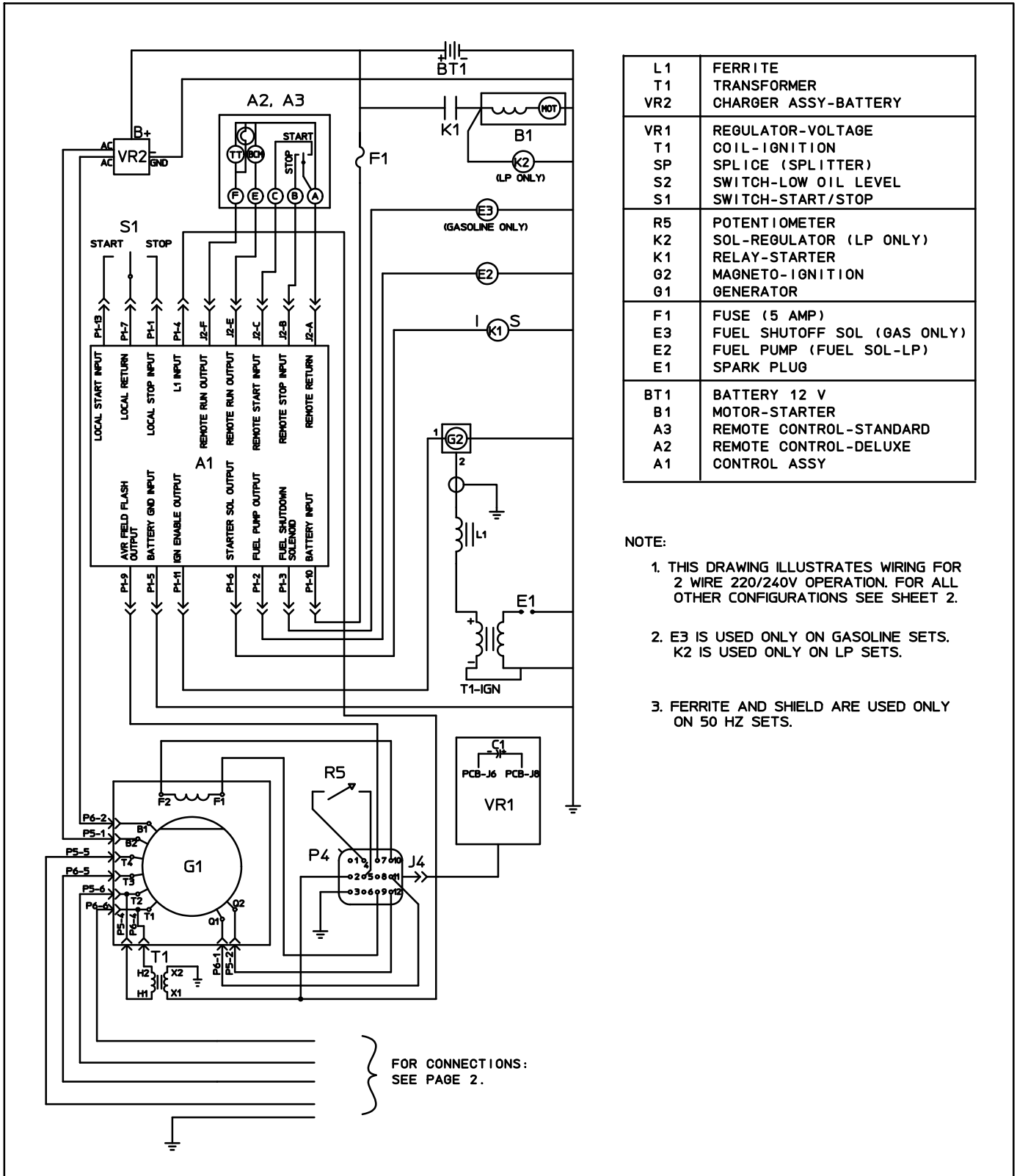


## RECONNECTION CHART FOR MICROLITE 4000 60 HZ/100V

FROM:	TO:			
	3 WIRE 100/200		2 WIRE 100	
	NEUTRAL GROUNDED	NEUTRAL ISOLATED	NEUTRAL GROUNDED	NEUTRAL ISOLATED
T1-LINE T2-LINE T3-LINE T4-LINE	CB1-LINE GROUND GROUND CB2-LINE	CB1-LINE SPLITTER SPLITTER CB2-LINE	CB1-LINE GROUND CB2-LINE GROUND	CB1-LINE SPLITTER SPLITTER CB2-LINE
CB1-LOAD (L1) NEUTRAL (N) CB2-LOAD (L2) GROUND (GND)	CB1-LOAD GROUND CB2-LOAD GROUND	CB1-LOAD SPLITTER CB2-LOAD GROUND	CB1-LOAD GROUND CB2-LOAD GROUND	CB1-LOAD OPEN CB2-LOAD GROUND
SPECIAL INSTRUCTIONS	SPLITTER NOT USED	CONNECT L1-L2 AT JUNCTION BOX	SPLITTER NOT USED	SPLITTER NOT USED
100V 200V	L1-N, L2-N L1-L2	L1-N, L2-N L1-L2	(L1,L2)-N N/A	N/A L1-L2
RECONNECTION DIAGRAMS				

NOTE: OUTPUT VOLTAGE CAN BE ADJUSTED BY USE OF THE ADJUSTMENT POT ON THE FRONT OF THE CONTROL PANEL. CLOCKWISE ROTATION WILL INCREASE THE VOLTAGE BY A MAXIMUM INCREASE OF 20 VAC.

FIGURE 12-15. VOLTAGE RECONNECTION DIAGRAM 612-1255 (MICROLITE, BEGIN SPEC F - 50 HZ/100 V)



L1	FERRITE
T1	TRANSFORMER
VR2	CHARGER ASSY-BATTERY
VR1	REGULATOR-VOLTAGE
T1	COIL-IGNITION
SP	SPLICE (SPLITTER)
S2	SWITCH-LOW OIL LEVEL
S1	SWITCH-START/STOP
R5	POTENTIOMETER
K2	SOL-REGULATOR (LP ONLY)
K1	RELAY-STARTER
G2	MAGNETO-IGNITION
G1	GENERATOR
F1	FUSE (5 AMP)
E3	FUEL SHUTOFF SOL (GAS ONLY)
E2	FUEL PUMP (FUEL SOL-LP)
E1	SPARK PLUG
BT1	BATTERY 12 V
B1	MOTOR-STARTER
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY

NOTE:

1. THIS DRAWING ILLUSTRATES WIRING FOR 2 WIRE 220/240V OPERATION. FOR ALL OTHER CONFIGURATIONS SEE SHEET 2.
2. E3 IS USED ONLY ON GASOLINE SETS. K2 IS USED ONLY ON LP SETS.
3. FERRITE AND SHIELD ARE USED ONLY ON 50 HZ SETS.

FIGURE 12-16. WIRING SCHEMATIC 611-1264 (MICROLITE, BIGIN SPEC G - 50 HERTZ)

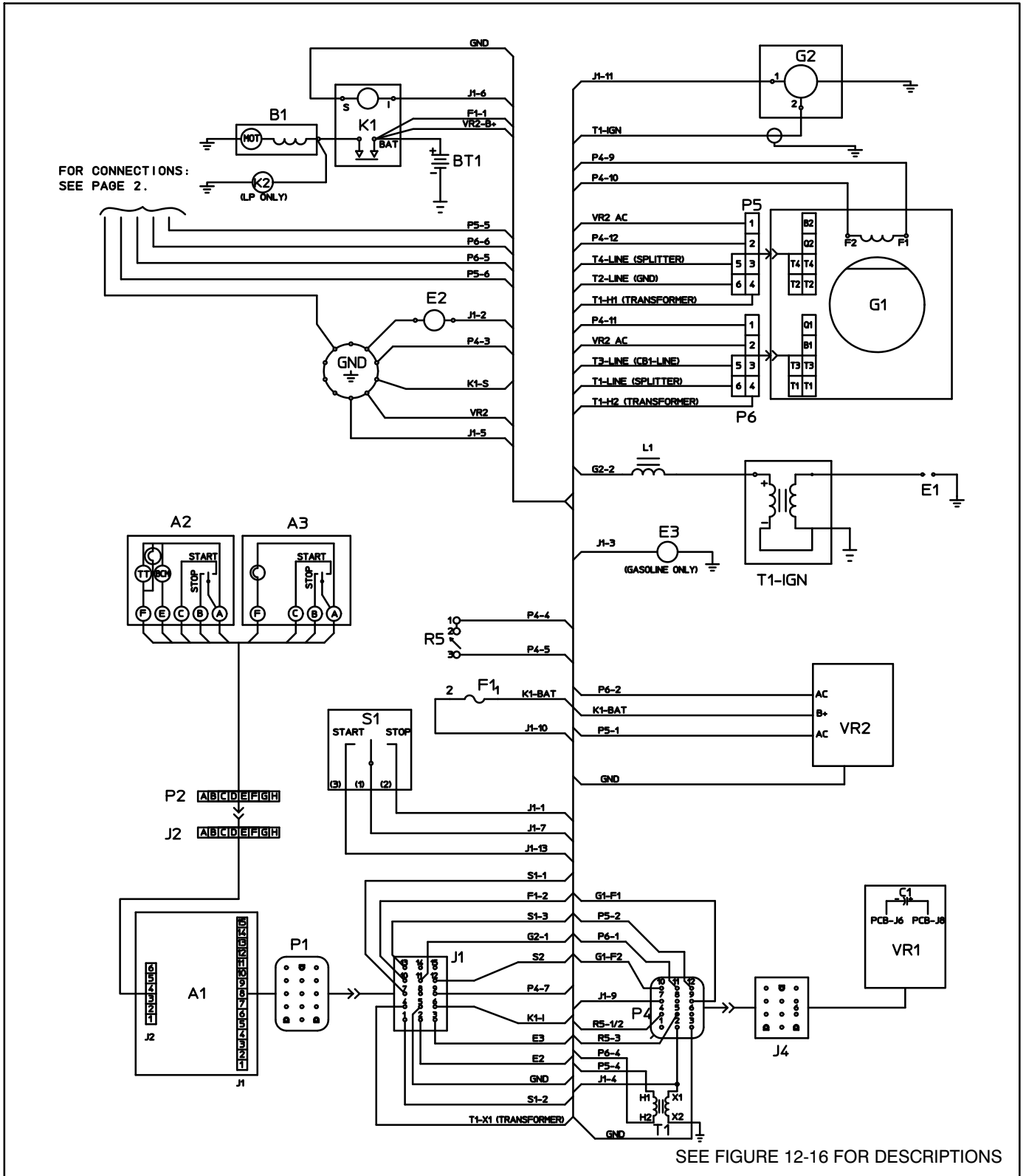


FIGURE 12-17. WIRING DIAGRAM 611-1264 (MICROLITE, BEGIN SPEC G - 50 HERTZ)

## RECONNECTION CHART FOR MICROLITE 3600 50 HZ

FROM:	TO:		2 WIRE 110 OR 120V		2 WIRE 220 OR 240V	
	3 WIRE 110/220 OR 120/240V	NEUTRAL ISOLATED	NEUTRAL GROUNDED	NEUTRAL ISOLATED	LINE TO GND=220V NEUTRAL GROUNDED	LINE TO GND=110V NEUTRAL GROUNDED
T1-LINE T2-LINE T3-LINE T4-LINE	NEUTRAL GROUNDED CB1-LINE GROUND CB2-LINE	NEUTRAL ISOLATED CB1-LINE SPLITTER CB2-LINE	NEUTRAL GROUNDED CB1-LINE GROUND CB2-LINE	NEUTRAL ISOLATED CB1-LINE SPLITTER CB2-LINE	SPLITTER GROUND CB1-LINE SPLITTER	CB1-LINE GROUND CB2-LINE
CB1-LOAD (L1) NEUTRAL(N) CB2-LOAD (L2) GROUND (GND)	CB1-LOAD GROUND SPLITTER CB2-LOAD GROUND	CB1-LOAD SPLITTER CB2-LOAD GROUND	CB1-LOAD GROUND CB2-LOAD GROUND	CB1-LOAD SPLITTER CB2-LOAD GROUND	CB1-LOAD GROUND OPEN CB2-LOAD GROUND	CB1-LOAD OPEN CB2-LOAD GROUND
SPECIAL INSTRUCTIONS	SPLITTER NOT USED	CONNECT L1-L2 AT JUNCTION BOX	CONNECT L1-L2 AT JUNCTION BOX SPLITTER NOT USED	CONNECT L1-L2 AT JUNCTION BOX	SPLITTER NOT USED	
110 OR 120V 220 OR 240V	L1-N, L2-N L1-L2	L1-N, L2-N L1-L2	L1-L2-N N/A	L1-L2-N N/A	N/A L1-L2	N/A L1-L2
RECONNECTION DIAGRAMS						
TABULATION	-01	-02	-03	-04	-05	-06
						-07

FIGURE 12-18. VOLTAGE RECONNECTION DIAGRAM 611-1264 (MICROLITE, BEGIN SPEC G - 50 HERTZ)

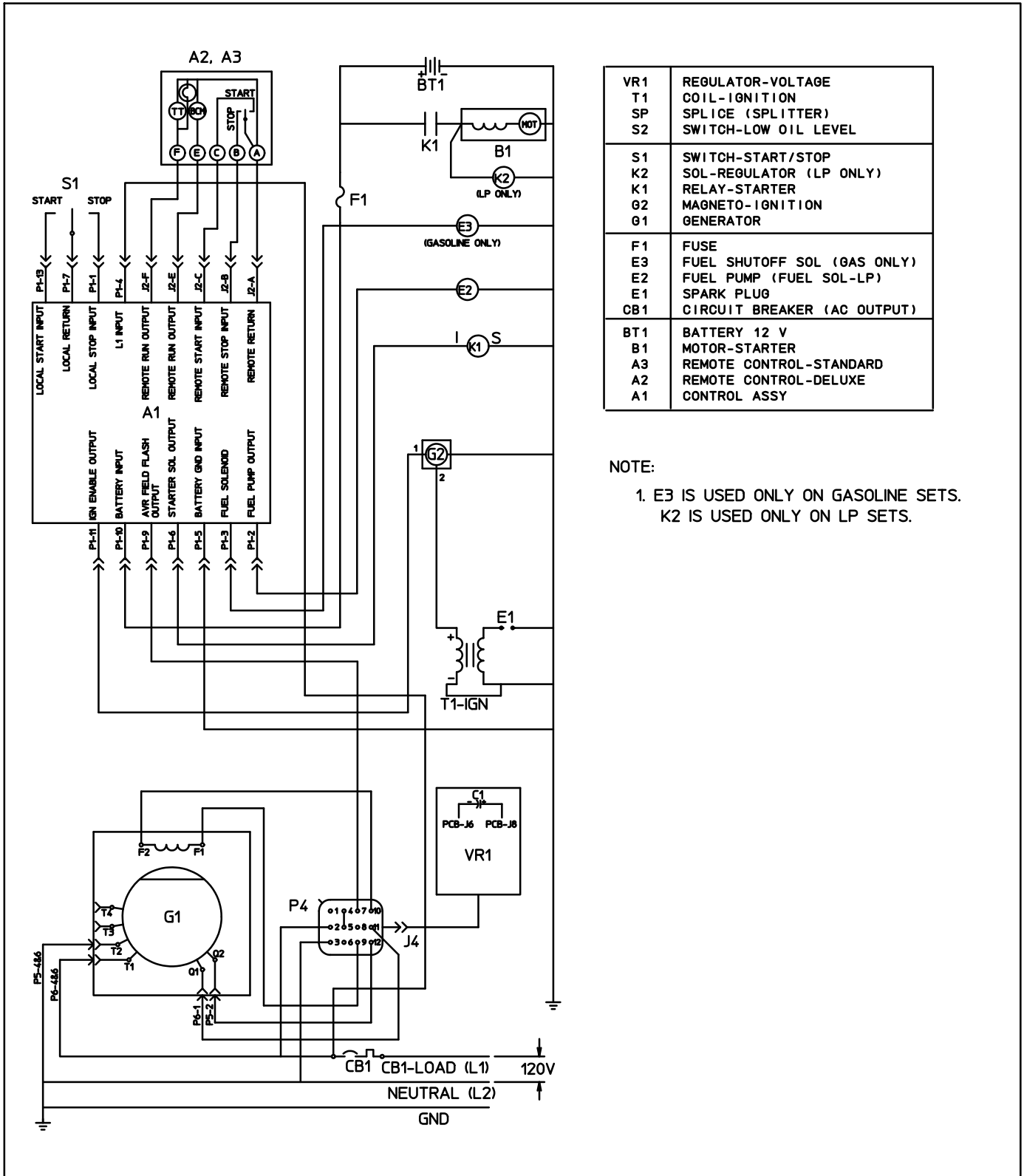
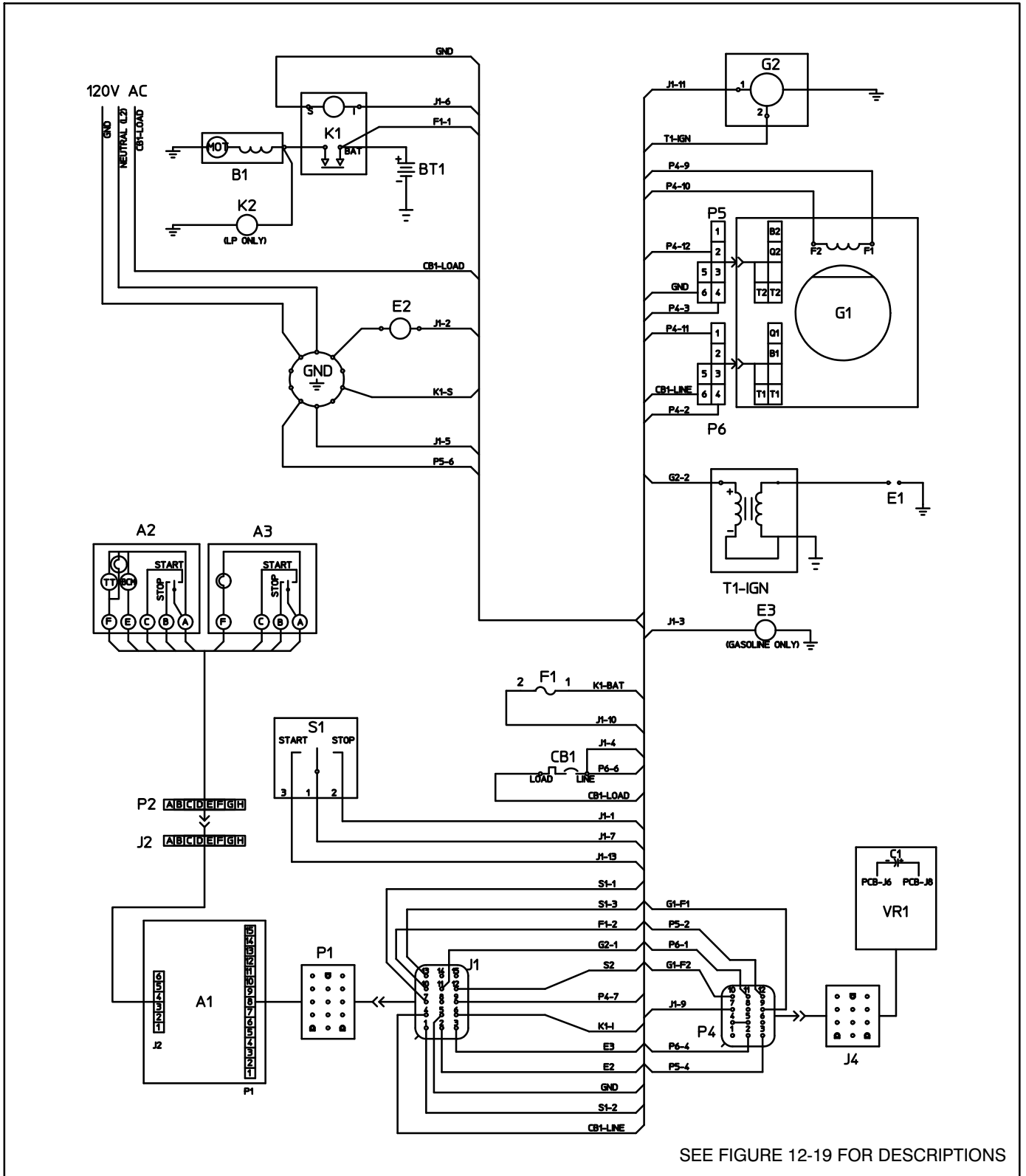


FIGURE 12-19. WIRING SCHEMATIC 611-1265 (MICROLITE, BEGIN SPEC G - 60 HERTZ)



SEE FIGURE 12-19 FOR DESCRIPTIONS

FIGURE 12-20. WIRING DIAGRAM 611-1265 (MICROLITE, BEGIN SPEC G - 60 HERTZ)



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