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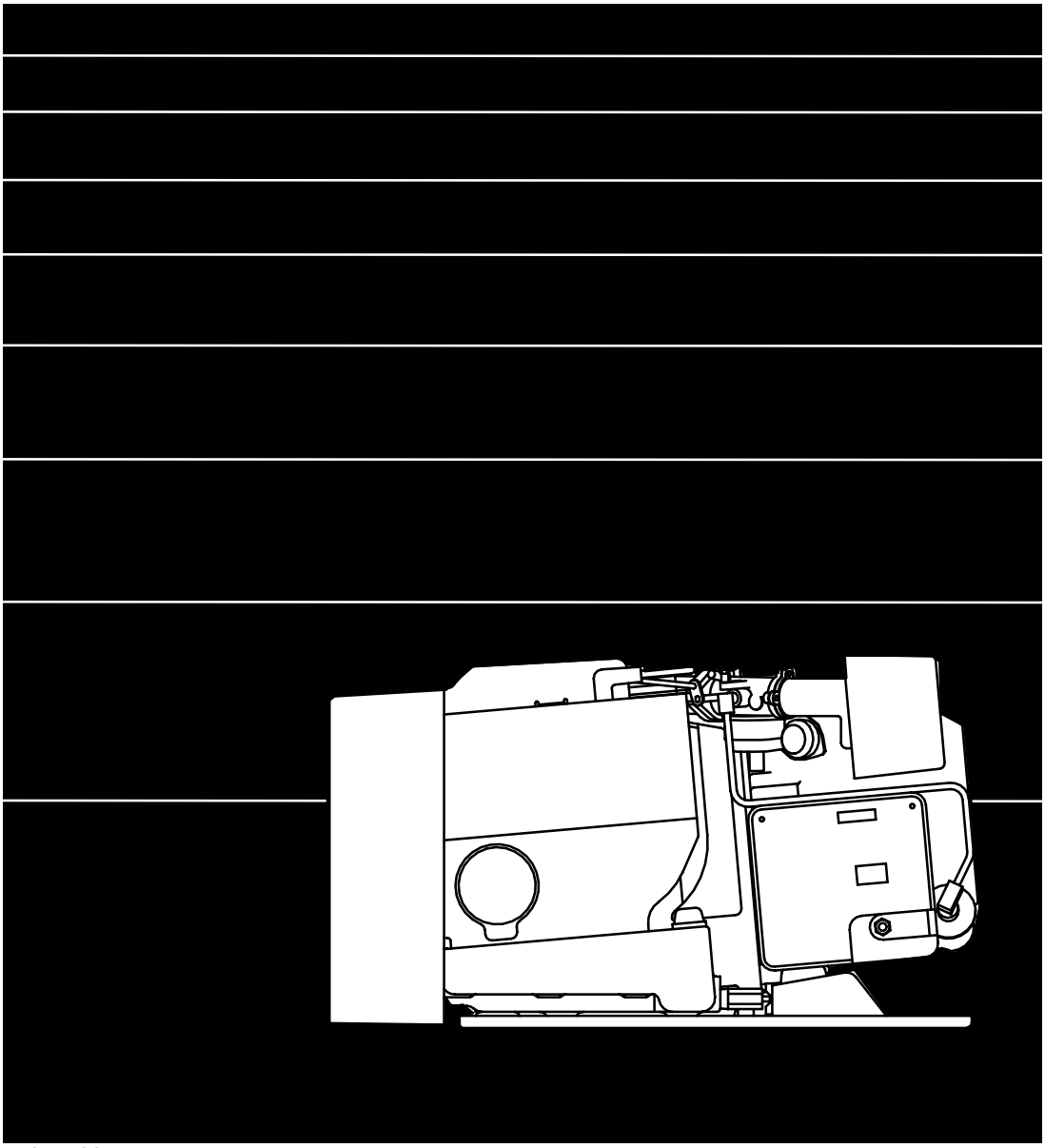
Service Manual

Model BGD and NHD Generator Sets, Beginning Spec H



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Safety Precautions

Thoroughly read the OPERATOR'S MANUAL before operating the genset. Safe operation and top performance can be obtained only with proper operation and maintenance.

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

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

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

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

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

GENERAL PRECAUTIONS

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

GENERATOR VOLTAGE IS DEADLY!

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

FUEL IS FLAMMABLE AND EXPLOSIVE

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

ENGINE EXHAUST IS DEADLY!

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

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

BATTERY GAS IS EXPLOSIVE

- WEAR SAFETY GLASSES and DO NOT SMOKE while servicing batteries.
- When disconnecting or reconnecting battery cables, always disconnect the negative (**-**) battery cable first and reconnect it last to reduce arcing.

Table of Contents

Introduction

This is the service manual for the Series BGD and NHD generator sets (gensets) for commercial vehicles. Read and carefully observe all of the instructions and precautions in this manual. Figure 2 illustrates a typical genset.

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

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

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

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

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

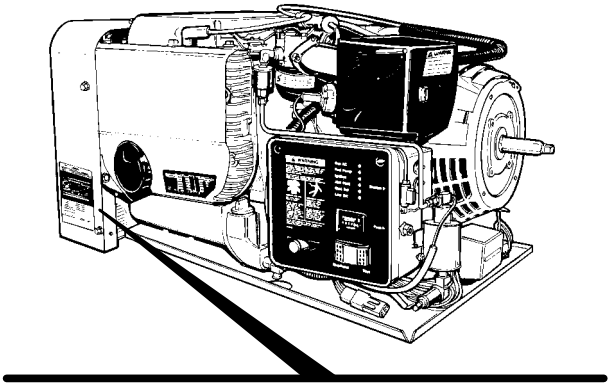
See the Parts Manual for parts identification numbers and required quantities and for exploded views of the genset subassemblies. Genuine Onan® replacement parts are recommended for best results.

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

TABLE 1. MODEL NUMBER

6.5	NHD	F	B	30502	L
1	2	3	4	5	6

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



IMPORTANT ENGINE INFORMATION

Onan®

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

Model No.: 6.5NHDFB30502L

S/N: A953123456

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

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

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

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

SN5980U1G2RA 980 cc

FIGURE 1. TYPICAL NAMEPLATE

⚠WARNING ***EXHAUST GAS IS DEADLY!***

All engine exhaust contains contain carbon monoxide, an odorless, colorless, poisonous gas that can cause unconsciousness and death. Symptoms of carbon monoxide poisoning include:

- ***Dizziness***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Nausea***
- ***Vomiting***
- ***Inability to Think Coherently***

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

Never sleep in the vehicle while the genset is running unless the vehicle has a working carbon monoxide detector. The exhaust system must be installed in accordance with the genset Installation Manual. Make sure there is ample fresh air when operating the genset in a confined area.

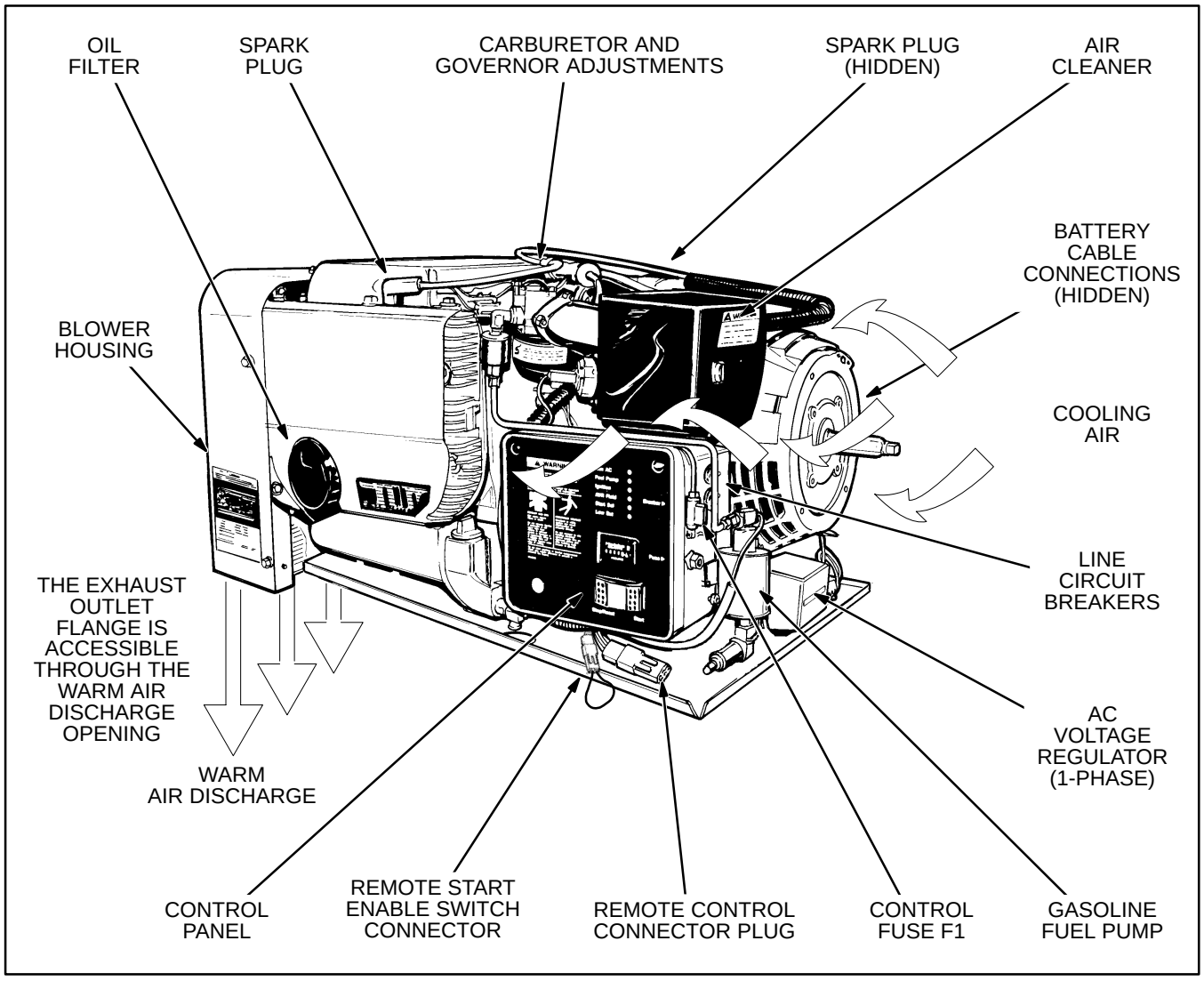


FIGURE 2. TYPICAL GENSET

Specifications

	GASOLINE MODELS			
	BGD		NHD	
GENERATOR: 4-Pole Revolving Field, Self-Excited, Electronically Regulated				
Power (watts)	4500	4000	6500	5000
Frequency (Hertz)	60	50	60	50
120/240 Volt Single-Phase Output Current (amperes @ 1.0 PF)	37.5/18.8	33.3/16.6	54/57	41.7/20.8
120/240 Volt Three-Phase Output Current (amperes @ 1.0 PF)	21.7/10.8	-	31.3/15.6	-
220/380 Volt Three-Phase Output Current (amperes @ 1.0 PF)	-	10.5/6.1	-	13.1/7.6
Speed (RPM)	1800	1500	1800	1500
FUEL CONSUMPTION:				
No load gph (l/h) Half load gph (l/h) Full load gph (l/h)	0.3 (1.1) 0.5 (1.9) 0.8 (3.0)	0.3 (1.1) 0.5 (1.9) 0.8 (3.0)	0.4 (1.5) 0.7 (2.6) 1.3 (4.9)	0.4 (1.5) 0.7 (2.6) 1.0 (3.8)
ENGINE: 2-Cylinder Opposed, 4-Cycle, Spark-Ignited, Side-Valve, Air Cooled				
Bore	3.250 inch (83 mm)		3.563 inch (90 mm)	
Stroke	2.875 inch (73 mm)		3.000 inch (76 mm)	
Displacement	48 inch^3 (782 cc)		60 inch^3 (980 cc)	
Compression Ratio	7.0 : 1		7.0 : 1	
Min. Cylinder Compression Test Pressure	75 psi (517 kPa)		75 psi (517 kPa)	
Oil Capacity (with filter)*	3.5 quart (3.3 l)		3.5 quart (3.3 l)	
Intake Valve Clearance (Cold)	0.005 inch (0.13 mm)		0.005 inch (0.13 mm)	
Exhaust Valve Clearance (Cold)	0.013 inch (0.33 mm)		0.013 inch (0.33 mm)	
Spark Plug Gap	0.025 inch (0.64 mm)		0.025 inch (0.64 mm)	
Spark Plug Tightening Torque	8 lbs-ft (10 N-m)		8 lbs-ft (10 N-m)	
Ignition Timing (Beginning Spec L)	12° BTDC non-adjustable		12° BTDC non-adjustable	
Ignition Timing (Prior to Spec L)	14°-18° BTDC non-adjustable		14°-18° BTDC non-adjustable	
Max. Fuel Supply Pressure at Carburetor	6 psi (41 kPa)		6 psi (41 kPa)	
Max. Fuel Pump Lift	3 feet (0.9 m)		3 feet (0.9 m)	
Fuel Fitting	5/16 inch OD Hose Barb		5/16 inch OD Hose Barb	
Exhaust Tailpipe Requirements	1-3/8 inch ID, 18 Ga Steel Tubing		1-3/8 inch ID, 18 Ga Steel Tubing	
CONTROL AND CRANKING SYSTEM: 12 VDC				
Nominal Battery Voltage	12 volts		12 volts	
Minimum Battery Cold Cranking Capacity: Above/Below Freezing	360/450 amperes		360/450 amperes	
Nominal Regulated-Voltage Battery Charging Output	10 amperes		10 amperes	
Control Fuse F1 (Beginning Spec J)	10 amperes mini-bayonet		10 amperes mini-bayonet	
Control Fuse F1 (Spec H only)	5 amperes slow-blow		5 amperes slow-blow	
Ignition/Choke F2 (Spec H only)	10 amperes mini-bayonet		10 amperes mini-bayonet	

* -See *Periodic Maintenance* for oil filling instructions.

	LPG MODELS			
	BGD		NHD	
GENERATOR: 4-Pole Revolving Field, Self-Excited, Electronically Regulated				
Power (watts)	4500	4000	6300	5000
Frequency (Hertz)	60	50	60	50
120/240 Volt Single-Phase Output Current (amperes @ 1.0 PF)	37.5/18.8	33.3/16.6	52.5/26.3	41.7/20.8
120/240 Volt Three-Phase Output Current (amperes @ 1.0 PF)	21.7/10.8	-	30.3/15.2	-
220/380 Volt Three-Phase Output Current (amperes @ 1.0 PF)	-	10.5/6.1	-	13.1/7.6
Speed (RPM)	1800	1500	1800	1500
FUEL CONSUMPTION:				
No load lbs/h (kg/h) Half load lbs/h (kg/h Full load lbs/h (kg/h	1.8 (0.8) 3.1 (1.4) 4.4 (2.0)	1.5 (0.7) 2.6 (1.2) 4.0 (1.8)	2.2 (1.0) 3.8 (1.7) 6.6 (3.0)	2.0 (0.9) 3.5 (1.6) 5.1 (2.3)
ENGINE: 2-Cylinder Opposed, 4-Cycle, Spark-Ignited, Side-Valve, Air Cooled				
Bore	3.250 inch (83 mm)		3.563 inch (90 mm)	
Stroke	2.875 inch (73 mm)		3.000 inch (76 mm)	
Displacement	48 inch^3 (782 cc)		60 inch^3 (980 cc)	
Compression Ratio	7.0 : 1		7.0 : 1	
Min. Cylinder Compression Test Pressure	75 psi (517 kPa)		75 psi (517 kPa)	
Oil Capacity (with filter)*	3.5 quarts (3.3 l)		3.5 quarts (3.3 l)	
Intake Valve Clearance (Cold)	0.005 inch (0.13 mm)		0.005 inch (0.13 mm)	
Exhaust Valve Clearance (Cold)	0.013 inch (0.33 mm)		0.013 inch (0.33 mm)	
Spark Plug Gap	0.025 inch (0.64 mm)		0.025 inch (0.64 mm)	
Spark Plug Tightening Torque	8 lbs-ft (10 N-m)		8 lbs-ft (10 N-m)	
Ignition Timing (Beginning Spec L)	12° BTDC non-adjustable		12° BTDC non-adjustable	
Ignition Timing (Prior to Spec L)	14°-18° BTDC non-adjustable		14°-18° BTDC non-adjustable	
LPG Vapor Supply Pressure Range (Vapor-Withdrawal Only)	9 to 13 inch (229 to 330 mm) W.C. (water column)		9 to 13 inch (229 to 330 mm) W.C. (water column)	
LPG Connection for Vapor Withdrawal	3/4 inch NPT Tapping		3/4 inch NPT Tapping	
LPG Connection for Liquid Withdrawal	1/4 inch NPTF Tapping		1/4 inch NPTF Tapping	
Exhaust Tailpipe Requirements	1-3/8 inch ID, 18 Ga Steel Tubing		1-3/8 inch ID, 18 Ga Steel Tubing	
CONTROL AND CRANKING SYSTEM: 12 VDC				
Nominal Battery Voltage	12 volts		12 volts	
Minimum Battery Cold Cranking Capacity: Above/Below Freezing	360/450 amperes		360/450 amperes	
Nominal Regulated-Voltage Battery Charging Output	10 amperes		10 amperes	
Control Fuse F1 (Beginning Spec J)	10 amperes mini-bayonet		10 amperes mini-bayonet	
Control Fuse F1 (Spec H only)	5 amperes slow-blow		5 amperes slow-blow	
Ignition/Choke F2 (Spec H only)	10 amperes mini-bayonet		10 amperes mini-bayonet	

* -See *Periodic Maintenance* for oil filling instructions.

Tolerances and Clearances

All dimensional tolerances and clearances are in inches (millimeters) unless otherwise indicated	MODEL BDG	MODEL NHD
Cylinder Bore (Standard Size)*	3.2490-3.2500 (82.52-82.55)	3.5625-3.5635 (90.49-90.51)
Cylinder Taper (maximum)	0.005 (0.13)	0.003 (0.08)
Cylinder Out of Round (maximum)	0.003 (0.08)	0.003 (0.08)
Clearance in Cylinder	0.0033-0.0053 (0.084-0.135)	0.0070-0.0090 (0.178-0.229)
Ring Gap	0.010-0.020 (0.25-0.50)	0.010-0.020 (0.25-0.50)
#1 (Top) Piston Ring Groove Width	0.0602-0.0612 (1.53-1.55)	0.0602-0.0612 (0.25-0.50)
#2 Piston Ring Groove Width	0.0602-0.0612 (1.53-1.55)	0.0602-0.0612 (1.53-1.55)
#3 Piston Ring Groove Width	0.1193-0.1203 (3.03-3.06)	0.1193-0.1203 (3.03-3.06)
#1 (Top) Piston Ring Groove Width Prior to Spec F	0.080-0.081 (2.03-2.06)	0.080-0.081 (2.03-2.06)
#2 Piston Ring Groove Width Prior to Spec F	0.080-0.081 (2.03-2.06)	0.080-0.081 (2.03-2.06)
#3 Piston Ring Groove Width Prior to Spec F	0.188-0.189 (4.78-4.80)	0.188-0.189 (4.78-4.80)
#1 (Top) Piston Ring Side Clearance	0.003-0.008 (0.076-0.203)	0.002-0.008 (0.051-0.203)
Piston Pin Diameter	0.6875-0.6877 (17.46-17.47)	0.7500-0.7502 (19.05-19.06)
Piston Pin Fit in Rod	0.0002-0.007 (0.005-0.018)	0.0002-0.0008 (0.005-0.020)
Connecting Rod Side Clearance	0.002-0.016 (0.051-0.406)	0.002-0.016 (0.051-0.406)
Connecting Rod Bearing Clearance	0.0020-0.0033 (0.051-0.084)	0.002-0.0033 (0.051-0.084)
Crankshaft Main Bearing Journal Diameter	1.9992-2.0000 (50.780-50.800)	1.9992-2.0000 (50.780-50.800)
Crankshaft Rod Journal Bearing Diameter	1.6252-1.6260 (41.280-41.300)	1.6252-1.6260 (41.280-41.300)
Crankshaft Main Bearing Diameter	2.0024-2.0034 (50.860-50.886)	2.0015-2.0040 (50.838-50.902)
Crankshaft Main Bearing Clearance	0.0024-0.0042 (0.061-0.107)	0.0024-0.0042 (0.061-0.107)
Crankshaft End Play	0.006-0.012 (0.15-0.30)	0.006-0.012 (0.15-0.30)
* - The bore is 0.005 inch oversize if the engine serial number has suffix “E”.		

All dimensional tolerances and clearances are in inches (millimeters) unless otherwise indicated	MODEL BDG	MODEL NHD
Camshaft Journal Diameter	1.3740-1.3745 (34.90-34.91)	1.3740-1.3745 (34.90-34.91)
Camshaft Bearing Diameter	1.376-1.377 (34.95-34.97)	1.376-1.377 (34.95-34.97)
Camshaft Bearing Clearance	0.0015-0.0030 (0.038-0.076)	0.0015-0.0030 (0.038-0.076)
Camshaft End Play	0.011-0.048 (0.28-1.2)	0.011-0.048 (0.28-1.2)
Valve Spring Free Length	1.600 (40.64)	1.662 (42.21)
Valve Spring Compressed Length (Valve Closed)	1.346 (34.19)	1.375 (34.92)
Valve Spring Tension Open	55 lbs (25 kg)	71 lbs (32 kg)
Valve Spring Tension Closed	25 lbs (11 kg)	38 lbs (17 kg)
Valve Face Angle	44°	44°
Valve Seat Angle	45°	45°
Valve Stem Diameter (Intake)	0.2795-0.2800 (7.099-7.112)	0.3425-0.3430 (8.700-8.712)
Valve Stem Diameter (Exhaust)	0.2780-0.2785 (7.061-7.074)	0.3410-0.3420 (8.661-8.687)
Intake Valve Guide Diameter	0.2810-0.280 (7.137-7.163)	0.344-0.346 (8.74-8.79)
Exhaust Valve Guide Diameter	0.2805-0.2815 (7.125-7.150)	0.344-0.346 (8.74-8.79)
Valve Stem Clearance (Intake)	0.0010-0.0025 (0.025-0.064)	0.0010-0.0025 (0.025-0.064)
Valve Stem Clearance (Exhaust)	0.0020-0.0035 (0.051-0.089)	0.0025-0.0040 (0.064-0.102)
Valve Lifter Diameter	0.74575-0.7480 (18.987-18.999)	0.7475-0.7480 (18.987-18.999)
Valve Lifter Bore Diameter	0.7500-0.7515 (19.050-19.088)	0.7500-0.7515 (19.050-19.088)
Valve Lifter To Block Clearance	0.0020-0.0040 (0.051-0.102)	0.0020-0.0040 (0.051-0.102)
Intake Valve Seat Diameter (Outside)	1.470-1.471 (37.34-37.36)	1.569-1.570 (39.85-39.88)
Exhaust Valve Seat Diameter (Outside)	1.192-1.193 (30.28-30.30)	1.255-1.256 (31.88-31.90)
Valve Seat Bore Diameter (Intake)	1.4395-1.4405 (36.563-36.588)	1.5645-1.5655 (39.738-39.764)
Valve Seat Bore Diameter (Exhaust)	1.189-1.190 (30.20-30.23)	1.2510-1.2520 (31.775-31.801)

Assembly Torques

Bolt torques are in lbs-ft (N-m)*	**MODEL BGD**	**MODEL NHD**
Cylinder Head Bolts (Cold)	15-17 (20-23)	15-17 (20-23)
Connecting Rod Bolts	12-14 (16-19)	27-29 (37-39)
Rear Bearing Plate Bolts	25-27 (34-37)	25-27 (34-37)
Flywheel Mounting Nut	50-55 (68-75)	50-55 (68-75)
Oil Base Bolts	18-23 (24-31)	18-23 (24-31)
Gearcase Cover Bolts	8-10 (11-14)	8-10 (11-14)
Spark Plug	8 (10)	8 (10)
Exhaust Manifold Bolts	9-11 (12-15)	20-23 (27-31)
Intake Manifold Bolts	6-10 (8-14)	15 (20)
Rotor Through-Bolt	45-55 (61-75)	45-55 (61-75)
Starter Mounting Bolts	30-33 (41-45)	30-33 (41-45)
Stator Clamp Screws	10-12 (11-16)	10-12 (11-16)
Adapter-Engine Mounting Bolts	25-27 (34-37)	25-27 (34-37)
Adapter-Generator Mounting Bolts	25 (34)	25 (34)
Rear Vibration Isolators Center Bolt Flange to Drip Tray Screws	 30-33 (41-45) 10-12 (11-16)	 30-33 (41-45) 10-12 (11-16)
Front Vibration Isolators Center Bolt Flange to Oil Base Screws	 28-32 (38-43) 19-22 (26-30)	 28-32 (38-43) 19-22 (26-30)
* - Use engine oil as a lubricant for all threads EXCEPT for spark plug and rotor through-bolt threads.		

Preparations

TROUBLESHOOTING

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

SAFETY

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

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

  Safety shoes

  Gloves

  Safety glasses

  Hard hats

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

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

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

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

TABLE 2. HAZARDS AND THEIR SOURCES

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

SPECIAL TOOLS

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

Engine Tools

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

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

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

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

Feeler gauge

Plasti-Gage bearing clearance guide

Spark plug gap gauge

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

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

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

Inclined Manometer (for LPG): 1 inch (25 mm) WC range with 0.01 inch (0.1 mm) WC divisions

Cylinder compression tester

Flywheel puller

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

Snap ring pliers

Combination main and cam bearing remover

Combination main and cam bearing driver

Oil seal loader and driver

Cylinder ridge reamer

Piston ring spreader

Piston groove cleaner

Piston ring compressor

Cylinder hone

Valve spring compressor

Valve lock replacer

Valve seat cutter kit

Valve guide driver

Slide hammer

Lead or dead-blow hammer

Generator and Control Tools

Rotor removal tool (headless bolt)

Commutator stone

Battery hydrometer

Frequency meter

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

Load test panel and leads

Voltage Regulator Testor and Adaptor (1-Ph)

Rotor and Stator Testor and Adaptor

REMOVING THE GENSET

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

Disconnections at the Genset

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

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

2. Disconnect the remote control wiring harness connector at the genset.
3. Disconnect the generator output wiring and conduit from the power distribution panel or box on the vehicle. Tag all wires to make reconnections easier.
4. Disconnect the exhaust tailpipe from the outlet of the muffler and then remove the muffler. See EXHAUST SYSTEM under *Engine Subsystems*.
5. Disconnect couplings, adapters, hydraulic lines and other power takeoff attachments on gensets so equipped.

6. Disconnect the fuel line from the genset. Follow the applicable instructions depending on the fuel.

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

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

   LPG Fueled Gensets: Close the fuel shutoff valve(s) at the LPG container(s) and move the vehicle outside and away from below-grade spaces where LPG could accumulate. To purge the fuel line and genset as much as possible, run the genset (if it starts) until it runs out of fuel with the LPG valve(s) closed.

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

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

   For LPG liquid-withdrawal systems (see Figure 28 on Page 35) press the regulator priming button while cranking for 10 seconds to purge some of the remaining LPG. Then loosen the threaded flexible fuel supply hose connector at the fuel filter on the genset just enough to hear gas escaping. Unthread the connector when no more gas is heard escaping. Finally, cap the end of the fuel supply hose with a 1/4 inch NPTF pipe cap to prevent fuel from escaping if someone inadvertently opens the shutoff valve(s) at the LPG container(s).

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

   For LPG vapor-withdrawal gensets (see Figure 32 on Page 38) disconnect the gas supply hose at the carburetor and the fuel solenoid shutoff valve leads at the control box on the genset. If the pressure regulator/solenoid valve assembly is also to be removed, cap the end of the fuel supply line with a threaded pipe cap to prevent fuel from escaping if someone inadvertently opens the shutoff valve(s).

Removal of the Genset from the Vehicle

See Figure 3. When the genset has been disconnected from the electrical, exhaust and fuel systems, examine its mounting bolts and support members. The genset drip tray is normally bolted to the vehicle framework. Make sure that the genset is firmly supported before loosening any mounting bolts or support members. A fork lift is recommended to lift or move the genset.

⚠WARNING ***Gensets are heavy and can cause severe personal injury if dropped during removal. Use adequate lifting devices. Keep hands and feet clear while lifting.***

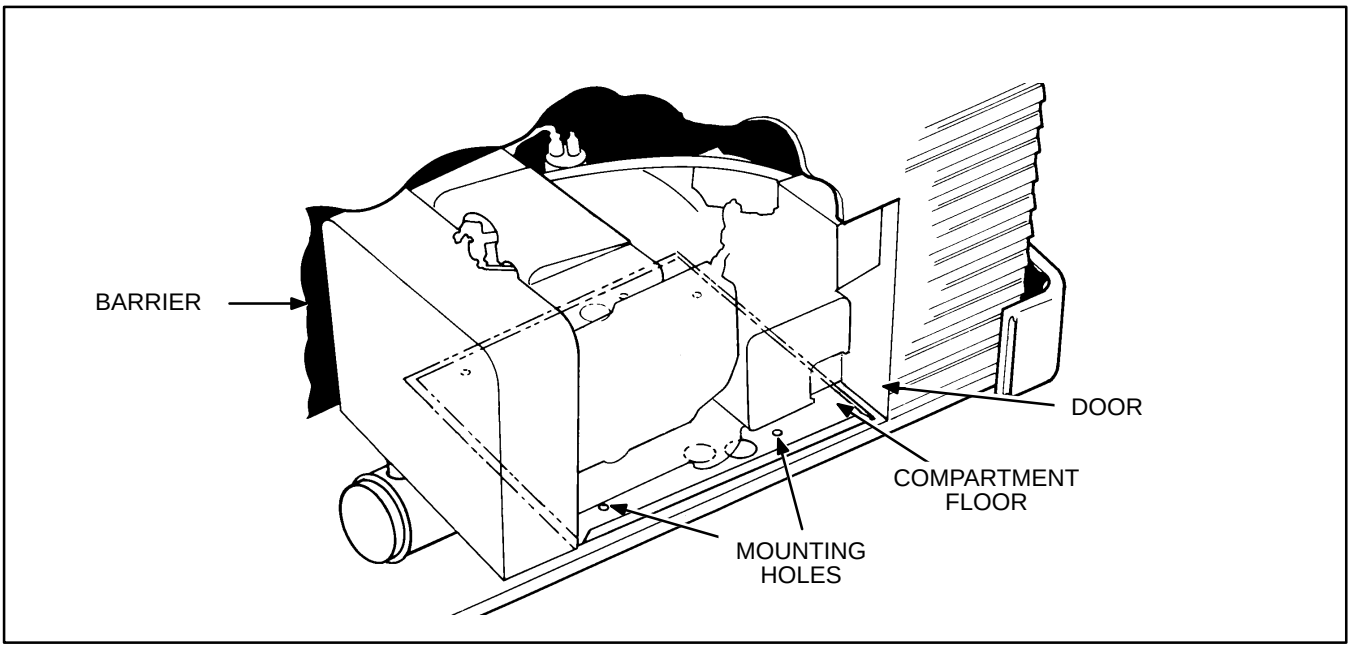


FIGURE 3. TYPICAL FLOOR-MOUNTED GENSET

Engine Subsystems

These engine subsystems or service procedures do not require removal of the cylinder heads, gearcase or main bearings for access and may be serviceable without removing the genset from the vehicle.

CYLINDER COMPRESSION TEST

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

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

VALVE CLEARANCE (LASH) ADJUSTMENT

See Figure 4. The engine is equipped with adjustable valve tappets. Adjust the valve clearance only when the engine is at ambient temperature:

1. Remove all parts that block access to the valve tappets.
2. Remove the spark plugs, to make turning the engine easier.
3. Place a socket wrench on the flywheel capscrew and rotate the crankshaft in a clockwise direction until the left intake valve (viewed from flywheel end) opens and closes. Continue turning the crankshaft until the TC mark on the flywheel is lined up with the TC mark on the gear cover. This should place the left piston at the top of its compression stroke. Verify that the left intake and exhaust valves are closed and that there is no pressure on the valve lifters.
4. See *Specifications* for valve clearance. When taking the clearance measurement, the feeler gauge should just pass between the valve stem and valve tappet.
5. To correct the valve clearance, turn the adjusting screw as needed. The screw is self-locking.
6. To adjust the valves on the right cylinder, turn the engine one complete revolution until the TC mark on the flywheel lines up again with the TC mark on the gear cover and then follow the same procedure as for the left cylinder.
7. Replace all parts removed. Tighten all screws securely. Torque the manifold bolts according to *Assembly Torques*.

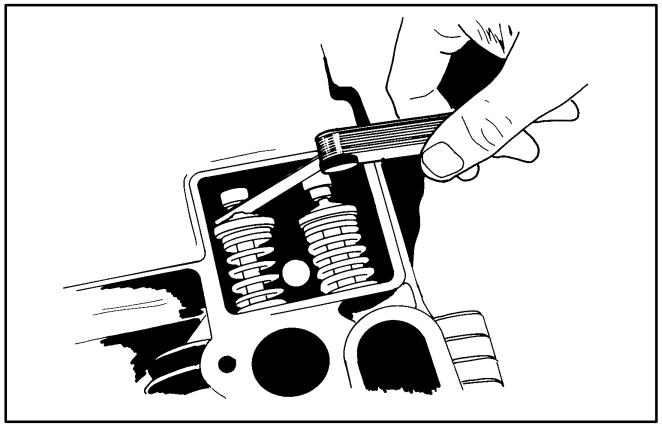


FIGURE 4. ADJUSTING VALVE CLEARANCE (LASH)

EXHAUST SYSTEM

See Figure 5. The exhaust system consists of the manifold, muffler, tailpipe and hardware for assembling and mounting the components.

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

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

Muffler

Replacement mufflers are available as kits that include all necessary hardware and gaskets. Follow the instructions in the kits exactly.

To remove the muffler remove the tail pipe, the muffler support strap screws and the inlet flange bolts and pull the muffler away.

Always reassemble with new muffler flange gaskets.

Tailpipe

The tailpipe is not supplied by Onan. If it is necessary to replace the tailpipe, use 1-3/8 inch I.D., 18 rigid steel tubing and 1-3/8 inch U-bolt muffler clamps and shock-mount hangers. Important safety warnings and information and instructions regarding the routing and termination of the tailpipe are included in the Installation Manual. The tailpipe must be mounted in such a way that it is protected from damage or dislocation and be terminated in such a way that exhaust gases will not recirculate back into the vehicle.

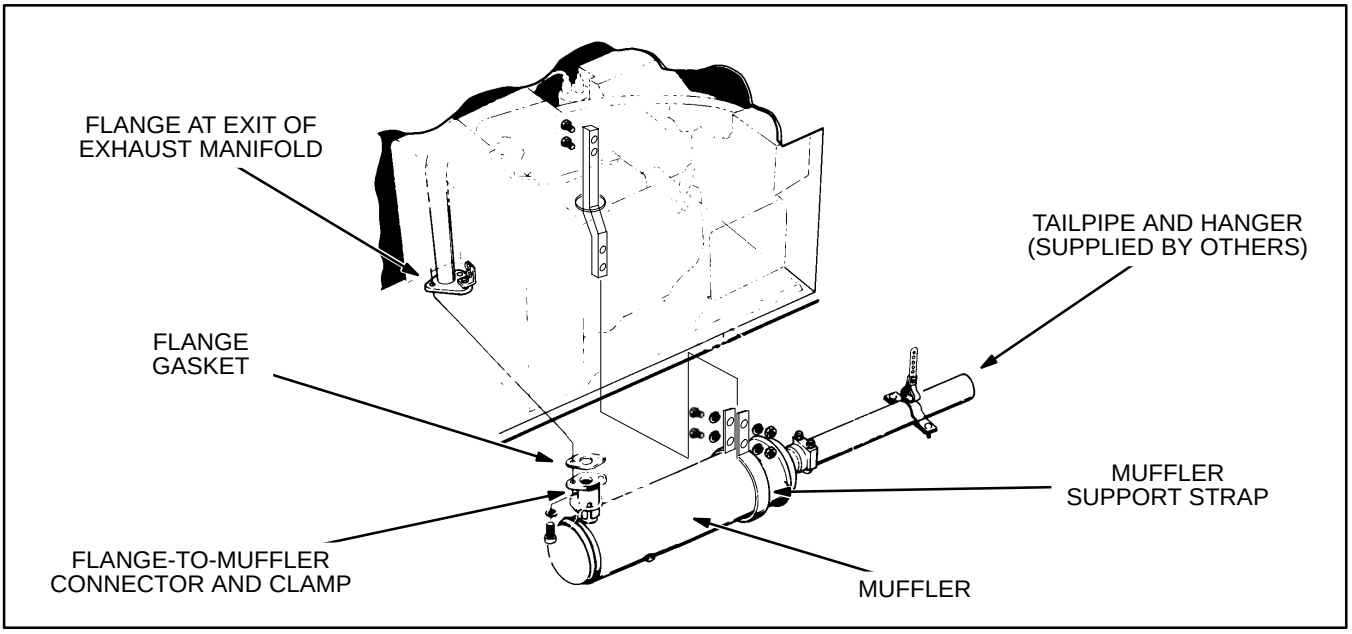


FIGURE 5. TYPICAL MUFFLER INSTALLATION

Exhaust Manifold

See Figure 6. To remove the exhaust manifold it will first be necessary to remove the muffler and then remove the genset from the vehicle. See *Preparations*.

1. Remove the cooling system noise shield, fan guard and scroll (Figure 7) to provide access to the exhaust manifold.
2. Remove the screw that secures the exhaust manifold outlet flange to the support bracket.
3. If this is a LPG genset equipped for liquid withdrawal, disconnect the fuel vaporizer (the tubing wrapped around the manifold) at both ends and remove the pressure regulator.

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

   Large volumes of LPG can be released in the process of disconnecting a liquid-withdrawal type of LPG supply system. See Preparations (Page 12) for the proper procedures and precautions.

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

Reassembly is the reverse of disassembly. Always use new manifold gaskets when reassembling and torque the manifold bolts according to *Assembly Torques.*

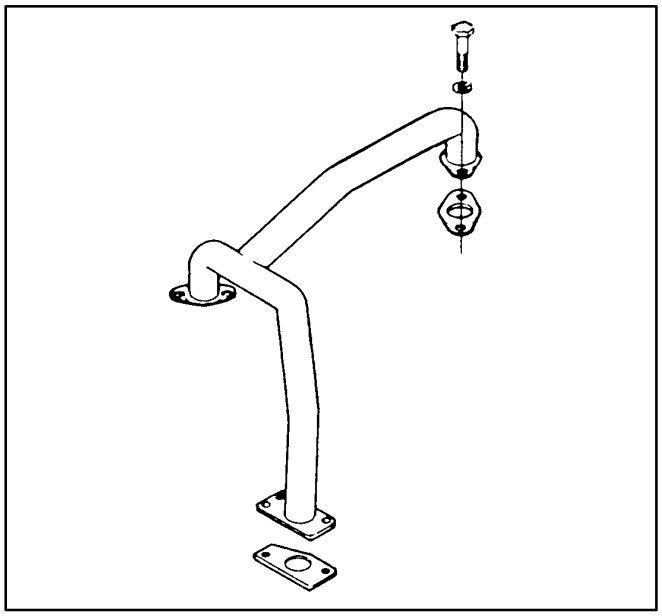


FIGURE 6. EXHAUST MANIFOLD

ENGINE COOLING SYSTEM

See Figure 7. These are air-cooled gensets. The engine flywheel is also a centrifugal blower that draws cooling air across the fins on the engine cylinders and heads and discharges the warm air downwards through the discharge grill.

Disassembly:

1. Remove the muffler (see EXHAUST SYSTEM).
2. Remove the capscrews that secure the noise shield and lift off the noise shield.
3. Remove the three nuts along the lower edge of the blower scroll that hold the discharge grill to the scroll.
4. Remove the capscrews that fasten the blower scroll to the backplate and pull away the scroll.
5. Remove the screws that fasten the cylinder shrouds to the back plate and cylinder heads and lift them off.
6. Loosen the flywheel capscrew and back it out several turns. See Figure 8.
7. Attach the puller tool to the flywheel. The tool has two jack screws that fit into the holes tapped in the flywheel.
8. Tighten the puller center screw until the flywheel comes loose. Remove the puller, flywheel center screw and washer. Remove the flywheel carefully so as not to damage the PMG. Inspect the flywheel and replace it if any air vanes are missing or magnets are loose or missing (Figure 9).
9. Remove the lead from the low oil pressure cutoff switch.
10. Remove the exhaust manifold (see EXHAUST SYSTEM).
11. Remove the capscrews that hold the backplate to the engine. Lift off the backplate.
12. Use a brush or low pressure compressed air to remove accumulated dust on the engine cooling fins.

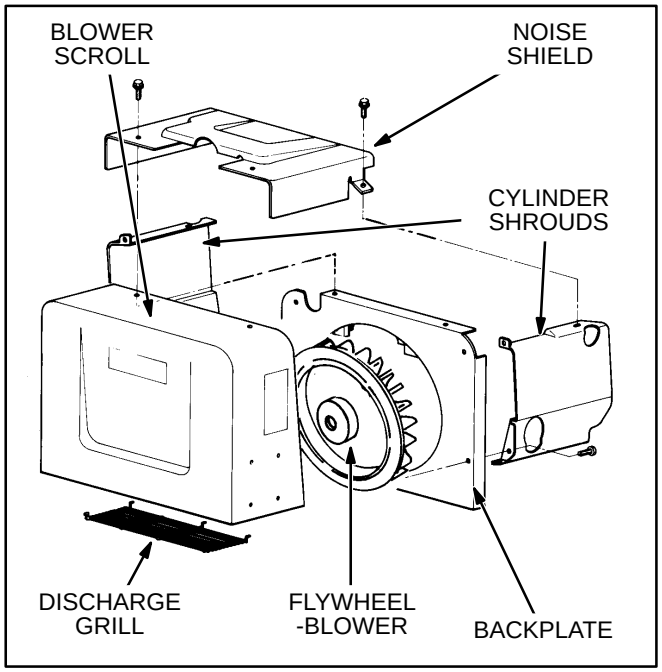


FIGURE 7. COOLING SYSTEM

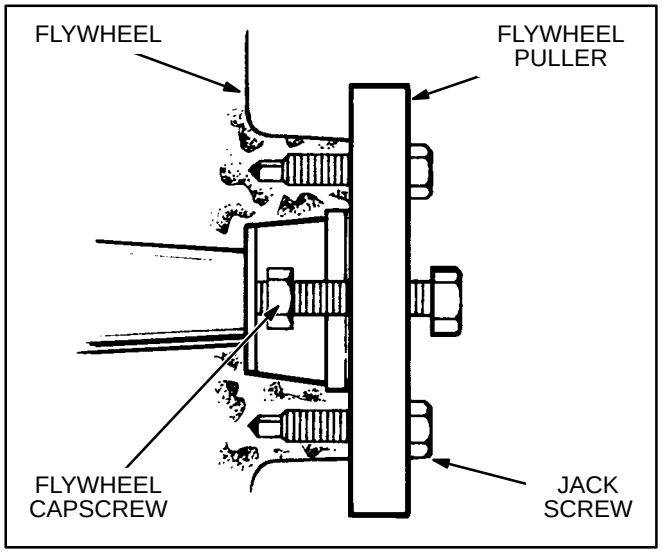


FIGURE 8. FLYWHEEL REMOVAL

Reassembly: Reassembly is the reverse of disassembly. When installing the flywheel, align its keyway with the woodruff key on the crankshaft. Use non-hardening sealer on the flywheel capscrew threads and torque to 50-55 lbs-ft (68-75 N-m).

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

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

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

PMG

See Figure 9. Beginning Spec J, the genset is equipped with a PMG (permanent magnet generator). The PMG consists of a multi-pole stator bolted to the engine gear case, concentric with the crankshaft, and six rotating permanent magnets mounted in the flywheel. The stator leads exit around the bottom right-side of the engine and terminate in connector J8/P8 in the vicinity of the starter motor. PMG output is regulated by battery charging voltage regulator VR2. Output from the PMG recharges the cranking battery and provides the signal for the engine control board (A1) to disconnect the starter and to continue operation when the **START** switch (S1) is released.

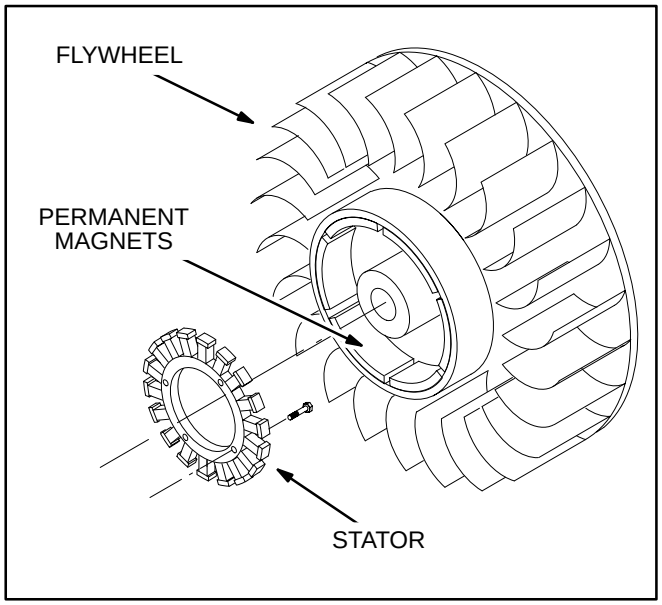


FIGURE 9. PMG (BEGINNING SPEC J)

IGNITION SYSTEM

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

Rotor

See Figure 10. The ignition rotor is keyed to the engine crankshaft. The ends have opposite magnetic polarity (north and south). One pole switches on the ignition module and the other pole switches it off, once each revolution of the crankshaft. The rotor should not normally require replacement.

Module

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

Coil

See Figure 11. The ignition coil is a transformer that fires the spark plugs at roughly 20,000 volts each revolution when the ignition module opens the primary circuit causing the coil field to collapse.

⚠ CAUTION ***The leads connected at the low voltage terminals of the ignition coil (Figure 11) should not be routed so as to pass between the high voltage terminal posts. Otherwise, false signals can be induced in the low voltage wires, leading to erratic operation.***

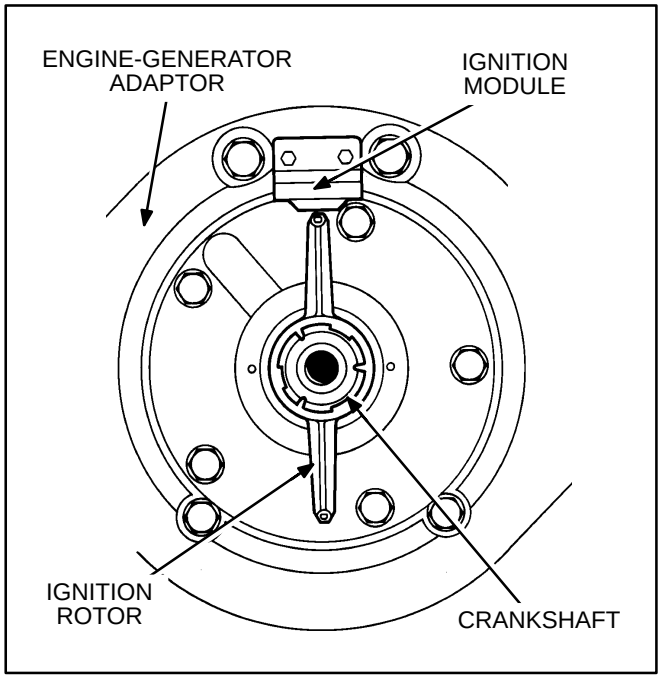


FIGURE 10. IGNITION ROTOR AND MODULE

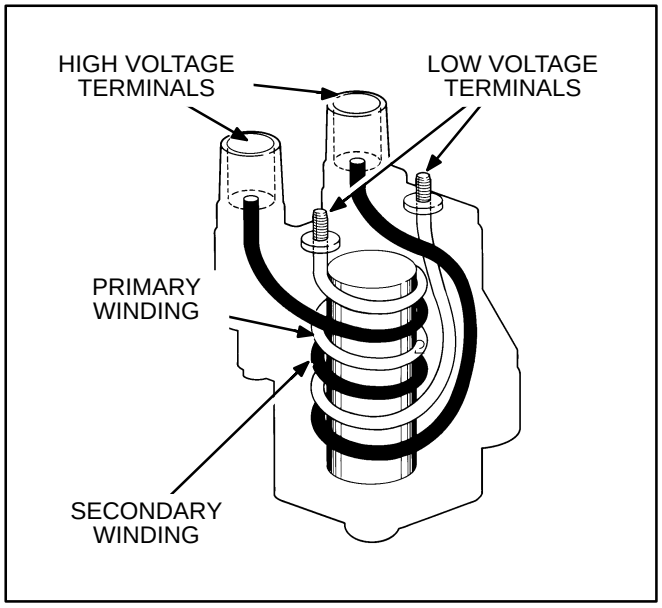


FIGURE 11. IGNITION COIL

Capacitor

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

Spark Plugs

The genset has two spark plugs. The spark plugs must be in good condition and have the proper gap for top engine performance. See *Specifications.*

To prevent crossthreading a spark plug, always thread it in by hand until it seats. Then tighten the spark plug according to *Assembly Torques.* Alternatively, if the spark plug is being reused, turn it with a wrench an additional 1/4 turn. If the spark plug is new, turn it an additional 3/8 to 1/2 turn.

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

Light tan, gray or reddish deposits - Normal

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

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

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

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

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

Worn - Spark plug service life used up.

Quick Ignition Test

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

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

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

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

Spark Plug Cable Resistance Tests

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

Ignition Module Test

1. Remove both spark plugs and the cooling discharge grill (Figure 7) so that the engine can be turned by hand.
2. Connect the positive (**+**) side of a voltmeter to the negative (**-**) terminal of the ignition coil (larger of the two screw terminals) and the negative (**-**) side of the voltmeter to engine ground.
3. Remove all leads from the positive (**+**) terminal of the coil.
4. Use a jumper to connect the red lead of the ignition module (the one just removed from the coil) to the battery positive terminal.
5. Rotate the flywheel clockwise by hand. Replace the ignition module if voltage does not jump from approximately 1 volt to approximately 12 volts, and then back again, each revolution.

Ignition Coil Test

1. Remove all wires attached to the ignition coil.
2. Remove the coil from the engine.
3. Inspect the terminals for corrosion, looseness, cracks or other damage. Look for carbon runners around the high tension terminals: these indicate electrical leakage. Replace a damaged or leaking coil.
4. Clean the outside of the coil with a cloth dampened in parts cleaning solvent.
5. Measure primary coil resistance (across the positive [**+**] and negative [**-**] terminals). Replace the ignition coil if primary resistance is not between 3 and 5 ohms.
6. Measure secondary coil resistance (across the spark plug cable terminals). Replace the ignition coil if secondary resistance is not between 10,000 and 40,000 ohms. See Figure 12.

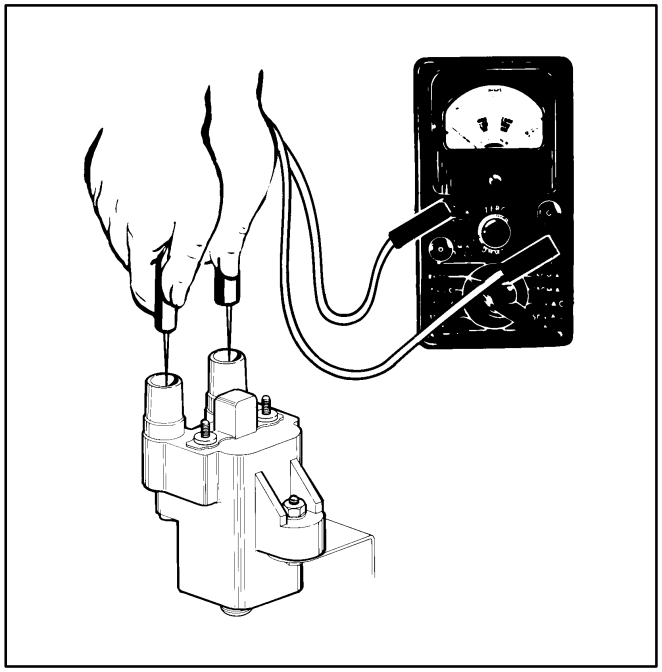


FIGURE 12. TESTING THE IGNITION COIL

CRANKCASE BREATHER ASSEMBLY

See Figure 13. The crankcase breather is a reed valve assembly that opens to discharge crankcase vapors on the piston down-stroke and closes on the up-stroke, resulting in a negative pressure in the crankcase when the engine is running. The crankcase vapors (blowby gases, gasoline vapors, moisture, air) are routed to the carburetor for burning in the cylinders. A dirty or sticking valve can cause oil leaks, high oil consumption, rough idle, reduced engine power and sludge formation within the engine.

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

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

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

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

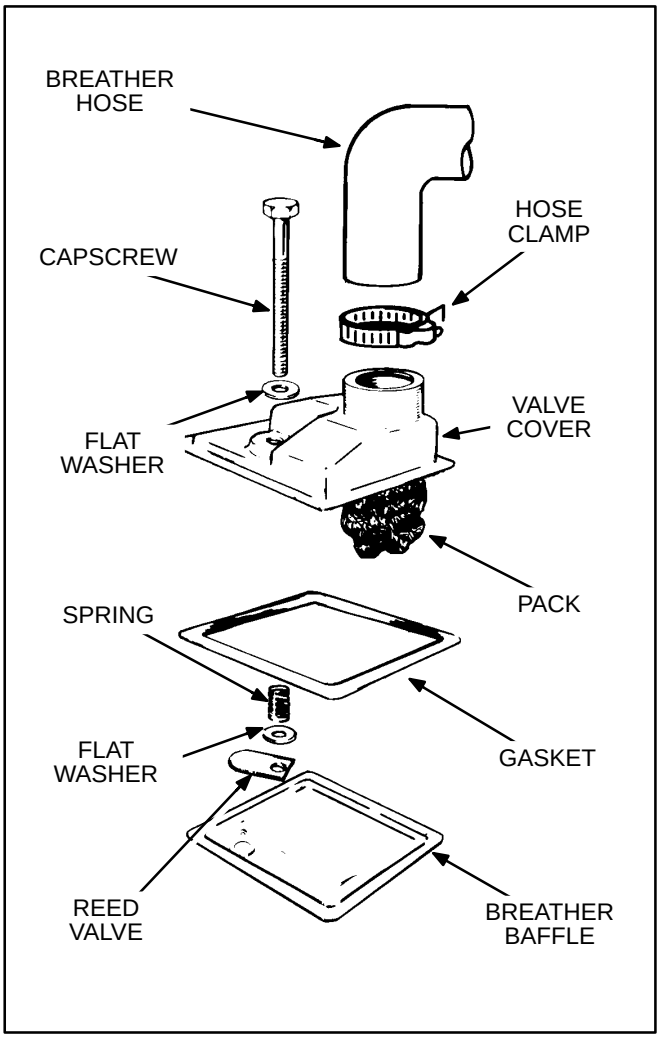


FIGURE 13. CRANKCASE BREATHER ASSEMBLY

LUBRICATION SYSTEM

Drain the oil before removing the oil base. Always use a new gasket when replacing the oil base.

An oil pump (See OIL PUMP under *Engine Block Assembly*) provides a constant flow of oil to the engine parts and a full-flow, spin-on filter keeps the oil clean. The oil collects in the oil base where it is picked up by the oil pump pick-up cup. An oil bypass valve is used to control oil pressure.

Oil pressure should be at least 13 psi (90 kPa) for Model BGD gensets and at least 20 psi (138 kPa) for Model NHD gensets when the engine is at normal operating temperature. If pressure drops below this value at governed speed, inspect the oil system for faulty components.

Oil Filter And Adapter

1. Open the oil drain valve and drain the crankcase oil.
2. Remove the filter by turning it counterclockwise with a filter wrench.
3. Loosen the two capscrews that secure the adapter to the engine block and remove the adapter and gasket. The low oil pressure cutoff switch is installed in a threaded hole in the filter adapter. See Figure 14.

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

Oil Bypass Valve

The bypass valve is located to the right and behind the gear cover (Figure 15). It controls oil pressure by allowing excess oil to flow back to the crankcase. It is non-adjustable and normally needs no maintenance. If it is suspected that it is the cause of high or low oil pressure, inspect it as follows:

1. Remove the 3/8 capscrew behind the gear cover and under the governor arm.
2. Remove the spring and plunger with a magnetic tool and clean them.
3. Replace the plunger if its diameter is not 0.3105 to 0.3125 inch (7.89 to 7.94 mm).
4. Replace the spring if its free length is not approximately 1 inch (25.4 mm) or if it takes other than 2.4-2.8 pounds (10.7-12.5 N) to compress it 0.5 inch (12.7 mm).
5. Check the bore and valve seat and clean away any debris.

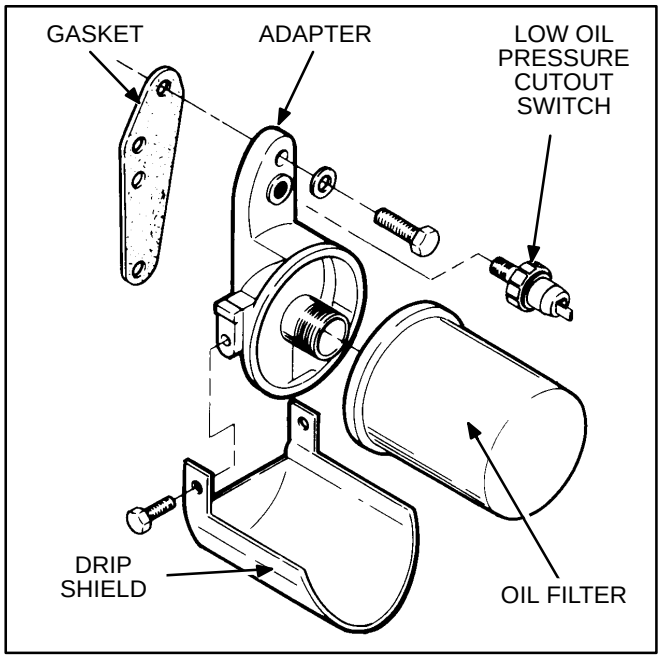


FIGURE 14. OIL FILTER AND ADAPTER

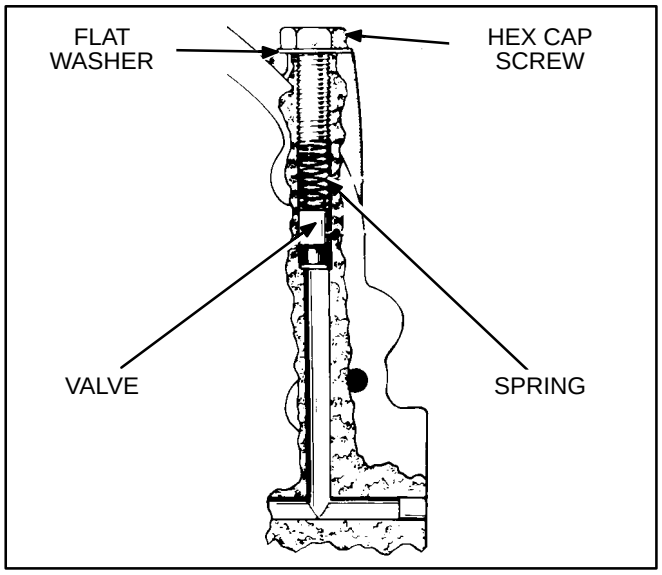


FIGURE 15. OIL BYPASS VALVE

FUEL SYSTEM

The carburetor mixes air and fuel in the correct proportion for good performance. The governor operates the throttle to maintain a nearly constant engine speed (frequency) as the load varies. Figure 16 is representative of most of the fuel system parts. LPG (liquified petroleum gas) systems do not use an air preheater or choke and have different fuel connections. See Automatic Choke, Fuel Pump and LPG System Components in this section for details of the other parts of the fuel system.

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

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

Air Cleaner Assembly

Disassembly:

1. Remove the crankcase breather hose and air preheater hose (gasoline gensets only) from the air cleaner housing.
2. Remove the air cleaner housing center capscrew and lift off the housing and air filter.
3. Remove the three capscrews that secure the air cleaner adapter to the carburetor and lift off the adapter. (One of the screws is inside the throat of the adapter.)
4. For LPG gensets (Spec H only), disconnect the leads at Relay K5 or remove the relay and bracket from the air cleaner adapter.

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

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

Carburetor And Intake Manifold Assembly

Disassembly:

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

   ⚠**WARNING** ***Large volumes of LPG can be released in the process of disconnecting a liquid-withdrawal type of LPG supply system. See Preparations (Page 12) for the proper procedures and precautions.***
3. Remove the intake manifold capscrews, the carburetor air preheater (gasoline gensets only) and the carburetor and intake manifold as an assembly. On **LPG** gensets equipped for **liquid withdrawal**, if will first be necessary to disconnect the fuel vaporizer (the tube wrapped around the exhaust manifold) at both ends, remove the pressure regulator, disconnect the vaporizer line from its support bracket and rotate the vaporizer line out of the way.

   ⚠**WARNING** ***Bending the fuel vaporizer tubing can weaken it to the point that it can crack allowing LPG under high pressure to escape, resulting in possible severe personal injury or death.***
4. Remove the two intake manifold gaskets and cover the intake ports to prevent loose parts from accidentally entering the ports.
5. Unbolt the carburetor from the intake manifold.

Reassembly: Reassembly is the reverse of disassembly. Use new gaskets between the intake manifold and the engine and between the intake manifold and the carburetor. Do not use sealer on the gaskets. Tighten all fasteners according to *Assembly Torques*.

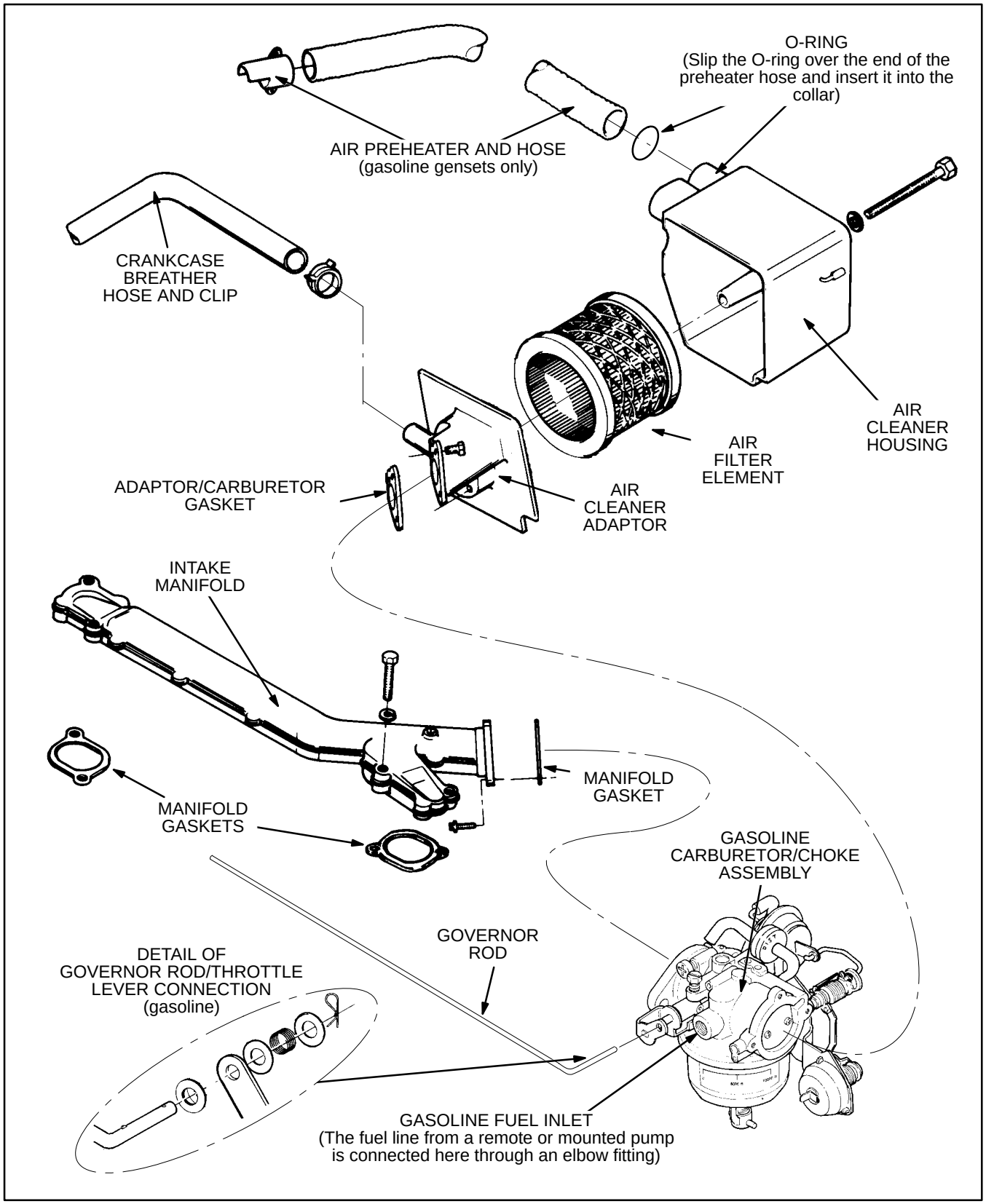


FIGURE 16. TYPICAL FUEL SYSTEM

Governor and Carburetor Adjustments

Careful adjustments of the carburetor and governor are essential for top performance. Perform all necessary engine and generator maintenance and repairs before making these adjustments.

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

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

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

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

Governor Rod Length Adjustment: The length of the governor rod (Figure 17) must be checked and adjusted as follows before other adjustments are attempted:

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

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

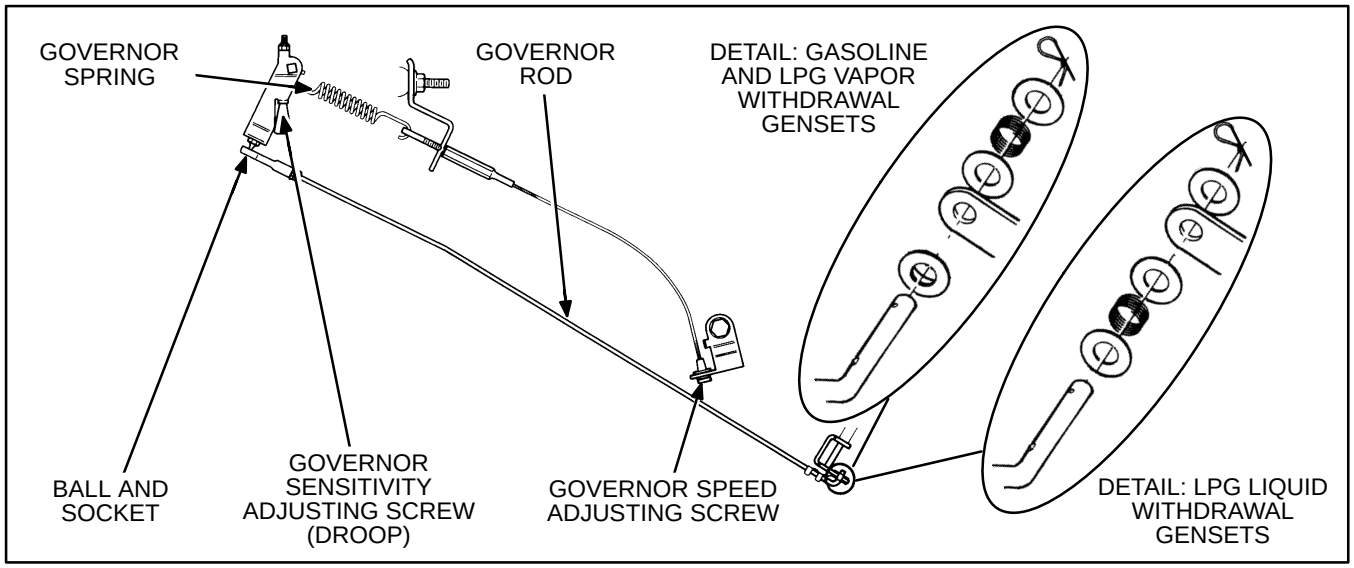


FIGURE 17. GOVERNOR ROD

Note: The following groups of adjustments must be performed in sequence. They apply to gensets BEGINNING SPEC L. For gensets PRIOR TO SPEC L, see Page 29.

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

1. Start the genset and let it warm up for ten minutes under 1/2 to 3/4 rated load. (On vapor withdrawal type LPG gensets it might be necessary to first adjust the supply pressure as instructed under LPG System Components to get the genset to start.)
2. Disconnect the load (check for zero amps). Pull the governor rod so that the tang on the throttle lever bears against the idle speed stop screw. Adjust the screw to obtain 54-56 Hz (44-46 Hz). (On LPG carburetors the stop screw has a locknut.)

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

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

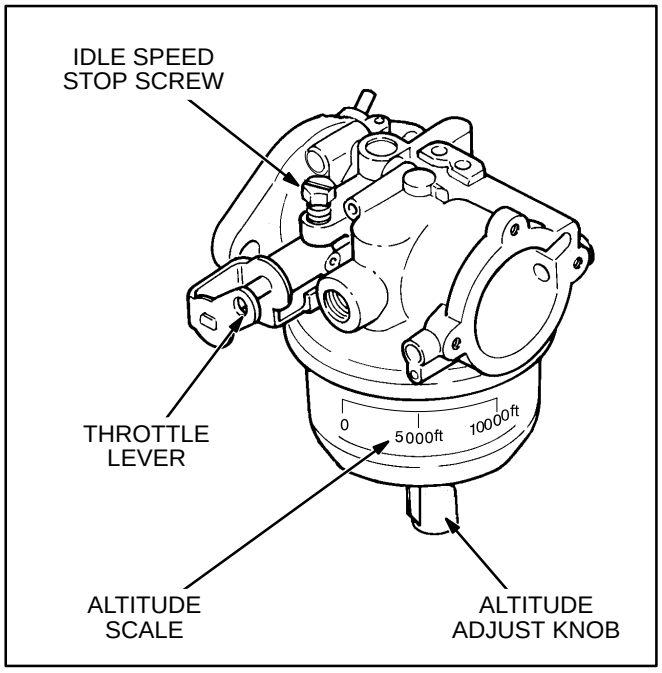


FIGURE 18. GASOLINE CARBURETOR (BEGINNING SPEC L)

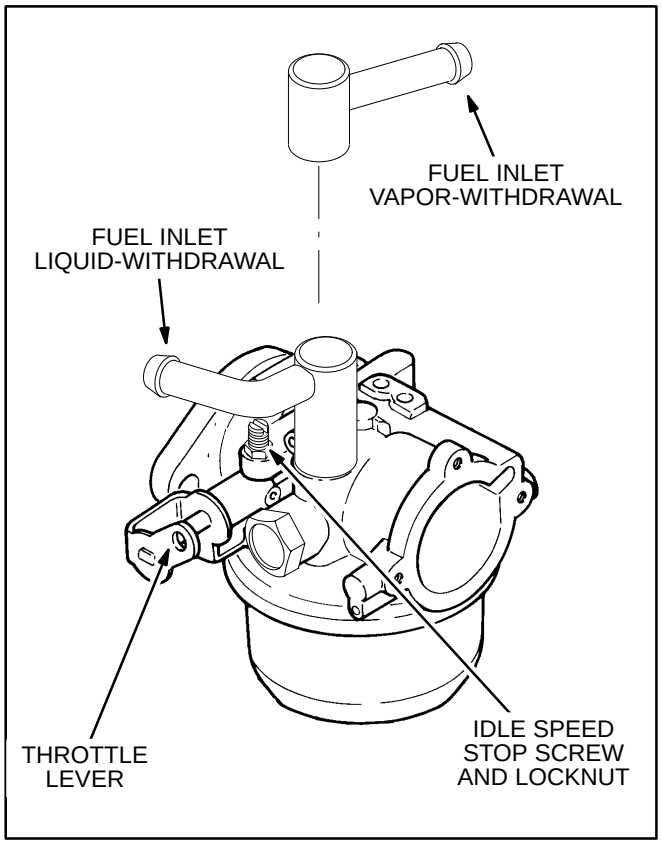


FIGURE 19. LPG CARBURETOR (BEGINNING SPEC L)

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

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

      For Single-phase Output:

      Load (watts) = V x A

      For Three-phase Output:

      Load (watts) = 1.73 x V x A*

      * average of the three phases

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

   B. See *Generator* if output voltage cannot be adjusted to within 10 percent of rated voltage (Table 3).

TABLE 3. VOLTAGE SPECIFICATION

RATED OUTPUT VOLTAGE	MAXIMUM NO-LOAD VOLTAGE	MINIMUM FULL-LOAD VOLTAGE
120V, 1PH	132	112
120/240V, 1PH	264	224
120/240V, 3PH	252	236
220/380V, 3PH	417	364
127/220V, 3PH	232	202
277/480V, 3PH	504	440

2. Check and adjust droop.
   A. If droop (from no-load frequency) is more than 3 Hz (3.5 Hz) for Model BGD or 4 Hz (3.5 Hz) for Model NHD, turn the governor sensitivity adjusting screw (Figure 17) one turn counterclockwise. Disconnect the load and, if necessary, readjust the governor speed adjusting screw to return to 62-63 Hz (51.5-52.5 Hz) no-load frequency. Check droop again and repeat the adjustments, if necessary.
   B. If droop (from no-load frequency) is less than 2 Hz (2 Hz) for Model BGD or 3 Hz (2 Hz) for Model NHD, turn the governor sensitivity adjusting screw (Figure 17) one turn clockwise. Disconnect the load and, if necessary, readjust the governor speed adjusting screw to return to 62-63 Hz (51.5-52.5 Hz) no-load frequency. Check droop again and repeat the adjustments, if necessary.
3. Check governor response under 1/4, 1/2 and 3/4 rated loads. See *Troubleshooting* if hunting is unacceptable.

Carburetor Replacement (Beginning Spec L)

Other than turning the altitude adjust knob shown in Figure 18, which changes the main fuel mixture within a limited range (gasoline carburetors only), fuel mixture adjustments should not be attempted on gasoline or LPG carburetors. Nor should the carburetor be overhauled. Instead, a malfunctioning carburetor should be replaced. Before replacing a carburetor, however, make certain 1) that all other necessary engine and generator adjustments and repairs have been performed and 2) that the carburetor is actually malfunctioning, by carefully following the troubleshooting procedures in *Troubleshooting*.

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

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

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

Note: The following groups of adjustments must be performed in sequence. They apply to gensets PRIOR TO SPEC L only. For gensets BEGINNING SPEC L, see Page 27.

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

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

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

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

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

2. Start the genset and let it warm up for ten minutes under 1/2 to 3/4 rated load. (On vapor withdrawal type LPG gensets it might be necessary to first adjust the demand regulator and supply pressure as instructed under LPG System Components to get the genset to start.)
3. Disconnect the load (check for zero amps). Pull the governor rod so that the tang on the throttle lever bears against the idle speed stop screw. Adjust the screw to obtain 54-56 Hz (44-46 Hz).

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

1. Disconnect all loads (check for zero amps). Then check no-load frequency. If necessary, turn the governor speed adjusting screw to obtain a no-load frequency of 62-63 Hz (51.5-52.5 Hz).

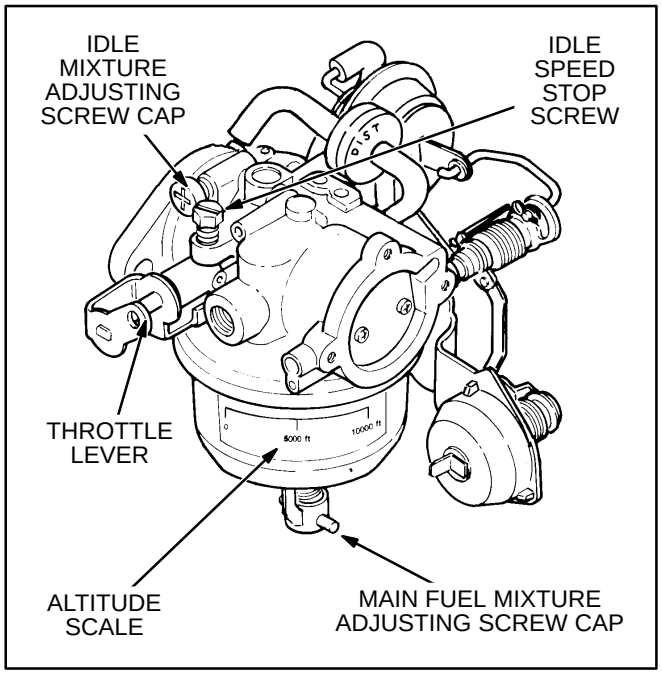


FIGURE 20. GASOLINE CARBURETOR (PRIOR TO SPEC L)

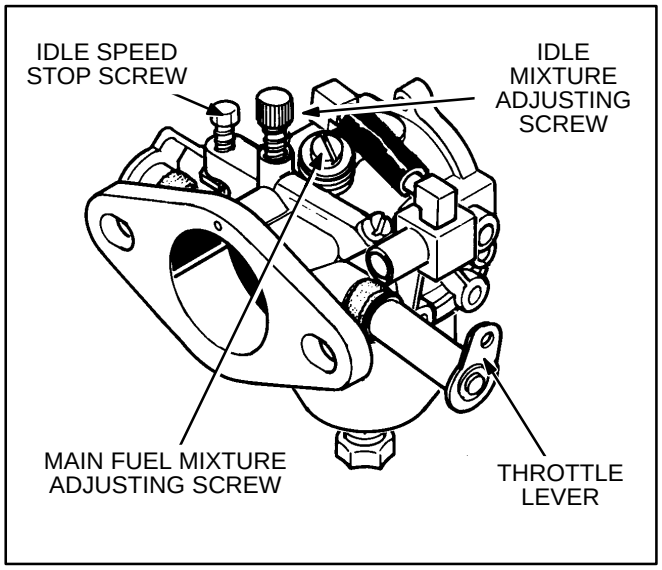


FIGURE 21. LPG CARBURETOR (PRIOR TO SPEC L)

2. Turn the idle mixture adjusting screw clockwise until the frequency drops and then counterclockwise until it drops again. Adjust it to obtain the highest possible stable frequency. Some “wander” is normal. For closer adjustments, use a CO meter to adjust to 6-8% CO (gasoline) or 4-6% CO (LPG). See *Troubleshooting* if the engine runs roughly.

3. Push the adjustment limiter cap on over the mixture screw head such that it will allow equal adjustment in either direction.

4. If no-load frequency has changed because of idle mixture adjustment, repeat Step 1.

5. Check output voltage. See *Generator* if output voltage cannot be adjusted to within 10 percent of rated voltage (Table 4).

Main Fuel Mixture and Droop Adjustments: The frequency specifications for 60 Hz gensets are followed in parentheses by the specifications for 50 Hz gensets.

1. Connect rated load.

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

   For Single-phase Output:

   Load (watts) = V x A

   For Three-phase Output:

   Load (watts) = 1.73 x V x A*

   * average of the three phases

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

   B. See *Generator* if output voltage cannot be adjusted to within 10 percent of rated voltage (Table 4).

TABLE 4. VOLTAGE SPECIFICATION

RATED OUTPUT VOLTAGE	MAXIMUM NO-LOAD VOLTAGE	MINIMUM FULL-LOAD VOLTAGE
120V, 1PH	132	112
120/240V, 1PH	264	224
120/240V, 3PH	252	236
220/380V, 3PH	417	364
127/220V, 3PH	232	202
277/480V, 3PH	504	440

2. Turn the main fuel mixture adjusting screw clockwise until the frequency drops and then counterclockwise until it drops again. Adjust it to obtain the highest possible stable frequency. For closer adjustments, use a CO meter to adjust to 6-8% CO (gasoline) or 2-4% CO (LPG). See *Troubleshooting* if the engine runs roughly.
3. Push the adjustment limiter cap on over the mixture screw head such that the cap pointer indicates the current altitude.
4. Disconnect the load and readjust the governor speed adjusting screw to return no-load frequency to 62-63 Hz (51.5-52.5 Hz).
5. Check and adjust droop.
   A. If droop (from no-load frequency) is more than 3 Hz (3.5 Hz) for Model BGD or 4 Hz (3.5 Hz) for Model NHD, turn the governor sensitivity adjusting screw (Figure 17) one turn counterclockwise. Disconnect the load and, if necessary, readjust the governor speed adjusting screw to return to 62-63 Hz (51.5-52.5 Hz) no-load frequency. Check droop again and repeat the adjustments, if necessary.
   B. If droop (from no-load frequency) is less than 2 Hz (2 Hz) for Model BGD or 3 Hz (2 Hz) for Model NHD, turn the governor sensitivity adjusting screw (Figure 17) one turn clockwise. Disconnect the load and, if necessary, readjust the governor speed adjusting screw to return to 62-63 Hz (51.5-52.5 Hz) no-load frequency. Check droop again and repeat the adjustments, if necessary.
6. Check governor response under 1/4, 1/2 and 3/4 rated loads. See *Troubleshooting* if hunting is unacceptable.

Carburetor Overhaul (Prior to Spec L) (See Page 28 for Spec L and Later)

See Figures 22 and 23. Carburetor problems not corrected by mixture or float adjustments are often caused by gummed-up fuel passages or worn internal parts. The most effective remedy is to replace or overhaul the carburetor. Overhauling a carburetor consists of complete disassembly, thorough cleaning and replacement of worn parts. Repair kits are available for gasoline carburetors that include new gaskets and float assembly parts.

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

1. Remove the air cleaner adapter and the automatic choke assembly (gasoline carburetors).
2. Remove the throttle and choke plate retaining screws, then remove the plates. Pull out the throttle and choke shafts, being careful not to damage the Teflon coating applied to the shafts.
3. Remove the main and idle mixture screw assemblies.
4. Separate the lower section of the carburetor (float bowl) from the body of the carburetor.
5. Carefully note the position of the float assembly parts, then remove the hinge pin, float and needle valve (gasoline carburetors).

Cleaning and Repair:

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

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

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

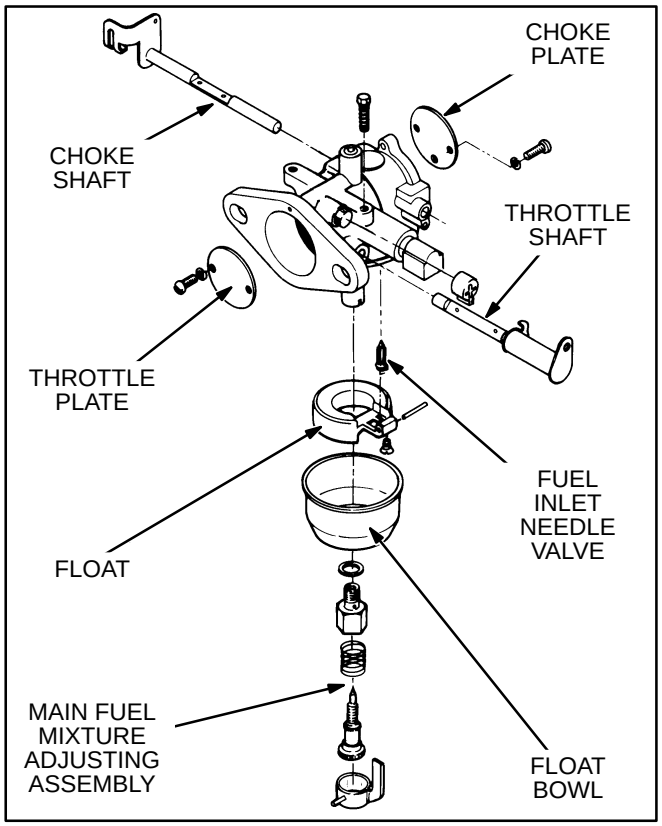


FIGURE 22. GASOLINE CARBURETOR (PRIOR TO SPEC L)

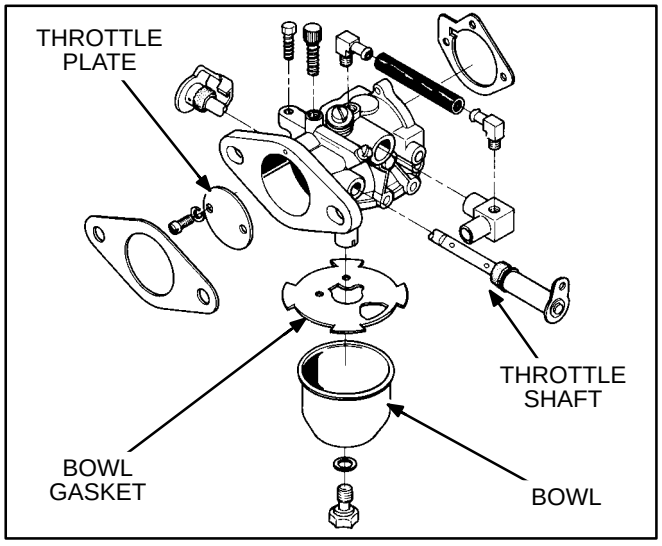


FIGURE 23. LPG CARBURETOR (PRIOR TO SPEC L)

Reassembly:

1. Slide in the throttle shaft and install the throttle plate using new screws, if they are furnished in the repair kit. Before tightening the screws, the plate must be centered in the bore. To do this, back off the throttle stop screw as necessary and completely close the throttle lever. Seat the plate by gently tapping it with a small screwdriver, then tighten the screws. Install the choke shaft and plate in the same manner.
2. See Figure 24. Turn the carburetor upside down and install the new needle valve, float, float hinge pin and fuel bowl gasket in the repair kit. Make sure the wire clip properly engages the groove around the end of the needle valve and loops around the metal tang of the float. (The clip pulls down on the needle valve when the float level drops, breaking the needle loose if it is stuck.) Check to see that the float moves freely without binding.
3. See Figure 25. Check float level as shown while the carburetor is still upside down. Measure the height above the bowl gasket flange on the side opposite the hinge. Make sure the full weight of the float is resting on the needle valve. Remove the float and bend the metal tang to adjust the height.

   ⚠CAUTION ***Remove the float before bending the tang so as not to damage the soft nose of the needle valve.***
4. Install the float bowl and the main mixture screw assembly.
5. Install the idle and main fuel mixture screws. Turn them lightly by hand until they seat. Then:

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

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

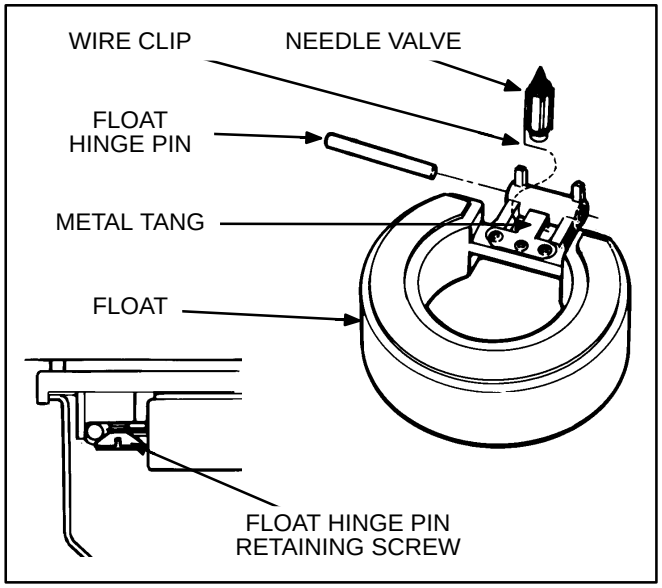


FIGURE 24. FLOAT INSTALLATION (GASOLINE)

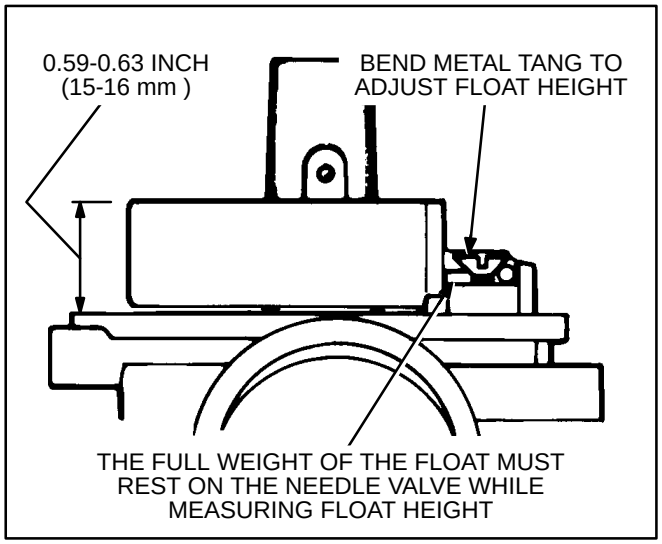


FIGURE 25. FLOAT LEVEL (GASOLINE)

Automatic Choke (Gasoline Sets)

See Figure 26.The automatic choke is operated by a bi-metal/heater assembly and a vacuum breaker assembly. Replace faulty choke components and reassemble as shown. Adjust the choke breaker assembly each time it is assembled to the carburetor, as follows:

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

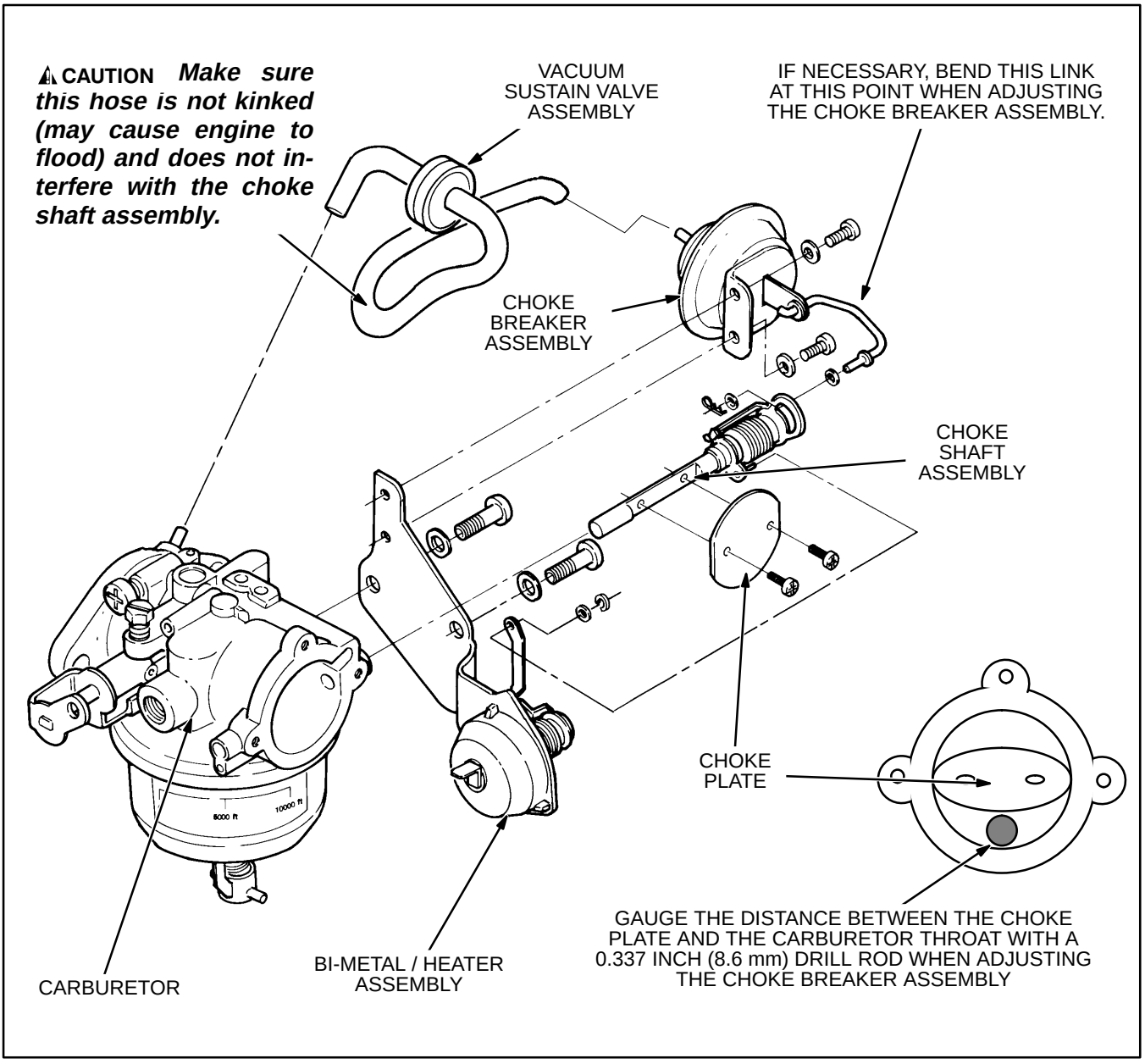


FIGURE 26. CHOKE ASSEMBLY

Fuel Pump (Gasoline Gensets)

See Figure 27. The fuel pump might be mounted on the genset or at a remote location on the vehicle. The pump delivers fuel to the carburetor at 3.5-5 psi (24-35 kPa) and has a lift capacity (suction) of 3 feet (0.9 meters).

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

Fuel Pressure Test:

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

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

If the fuel pressure is less than 3.5 psi (24 kPa), check for fuel restrictions in the system. The pump will have to be relocated closer to the fuel tank if it is located more than 3 feet (0.9 meters) above the end of the fuel pickup tube in the fuel tank. If the pump is defective, replace it with the appropriate Onan pump. The pump is not serviceable.

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

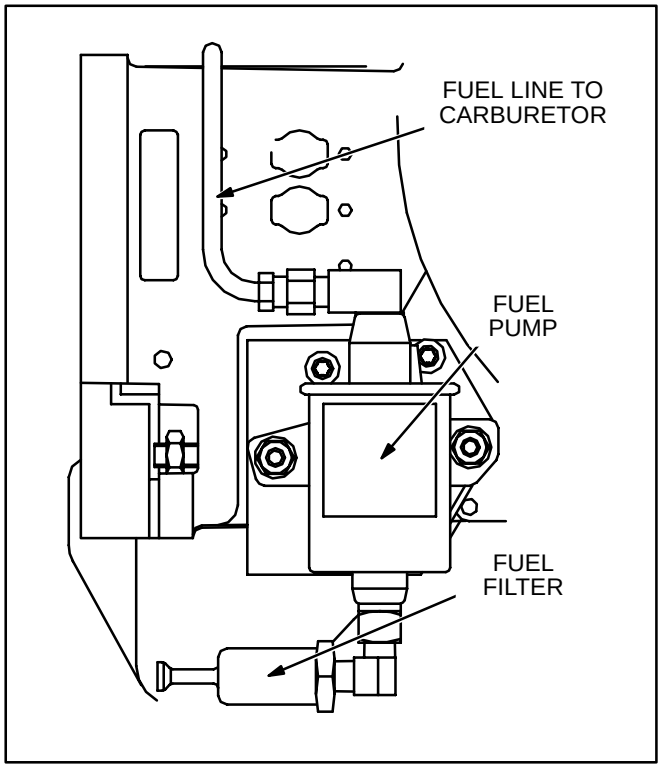


FIGURE 27. MOUNTED FUEL PUMP

LPG System—Liquid Withdrawal

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

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

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

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

⚠WARNING ***Large volumes of LPG can be released in the process of disconnecting a liquid-withdrawal type of LPG supply system. See Preparations (Page 12) for the proper procedures and precautions.***

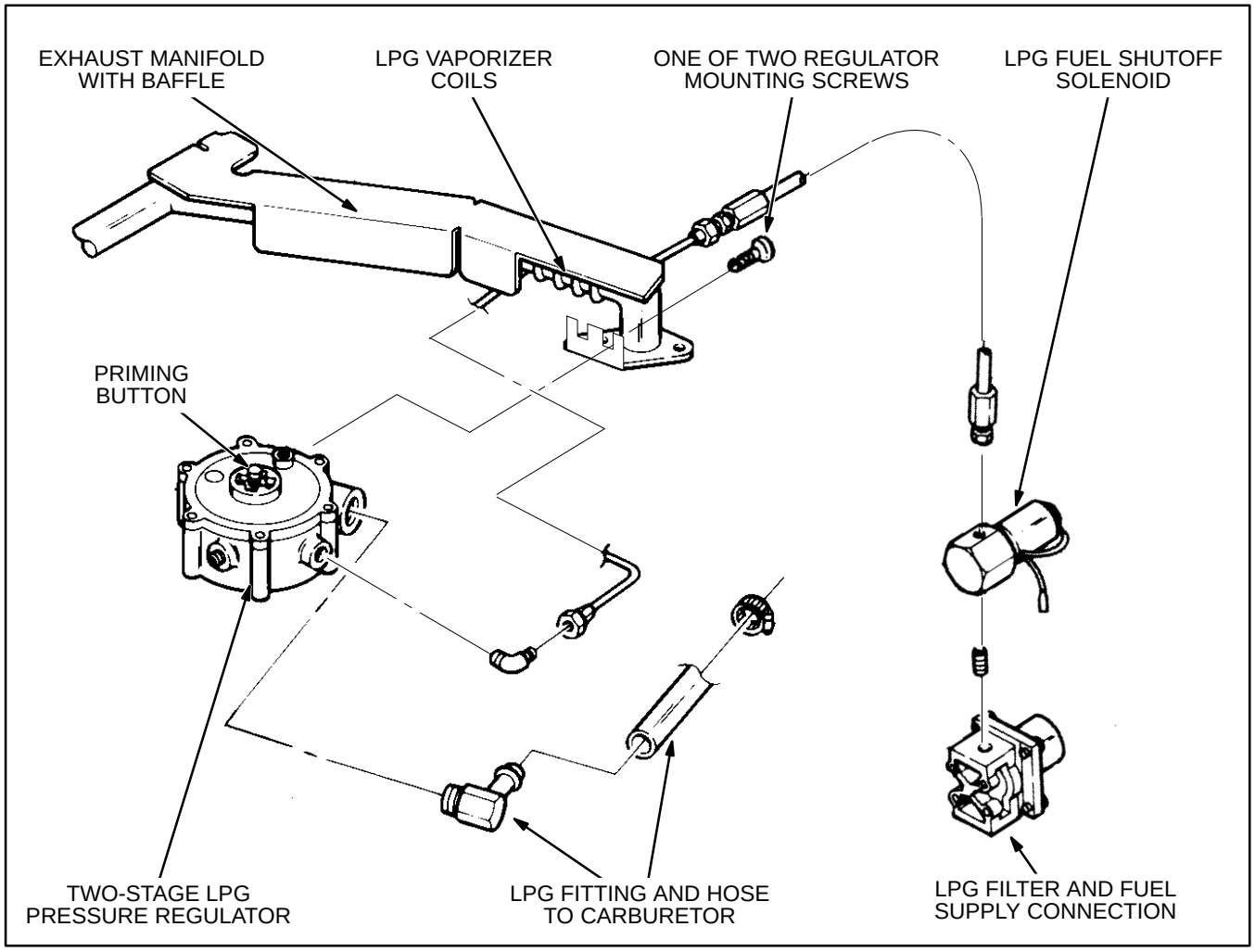


FIGURE 28. LPG SYSTEM COMPONENTS FOR LIQUID WITHDRAWAL

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

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

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

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

1. Connect a pressure gauge to the test port on the back of the regulator.
2. Connect a source of compressed air (at least 80 psi [550 kPa]) to the inlet opening and open the air pressure valve.
3. If the primary valve is sound, the gauge will indicate approximately 1.5 psi (10.3 kPa) and the pressure will remain constant. Fluctuating pressure indicates a leaking primary valve seat.
4. Close the air pressure valve and observe the pressure gauge. The pressure should remain constant. If the pressure drops, the secondary valve seat is leaking.
5. Disassemble and clean the regulator assembly if it does not pass either test. Replace the regulator if it still does not pass either test.

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

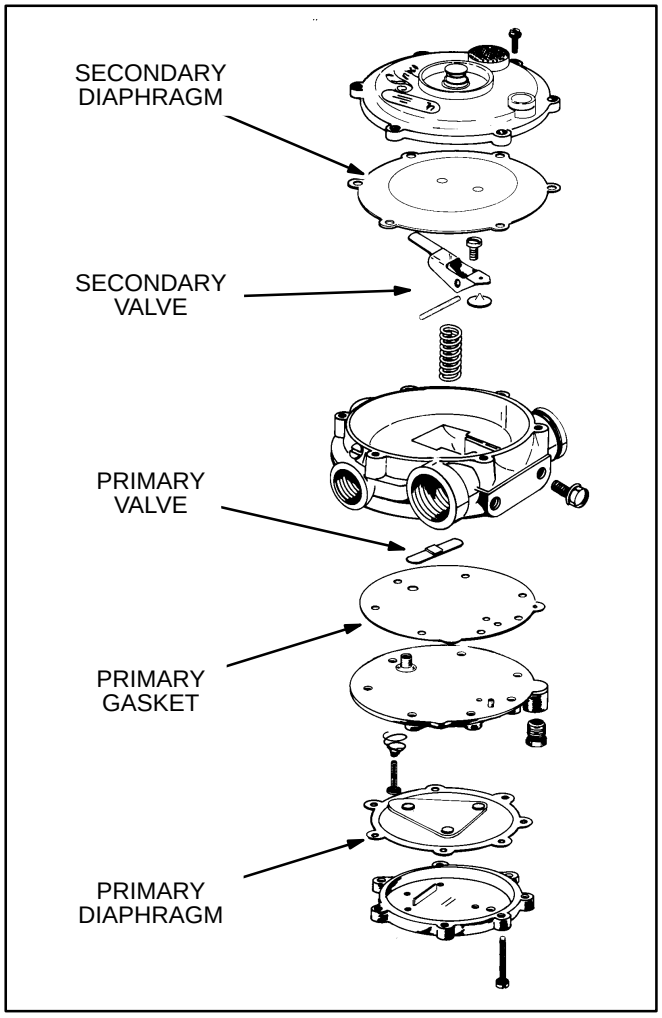


FIGURE 29. DEMAND REGULATOR ASSEMBLY

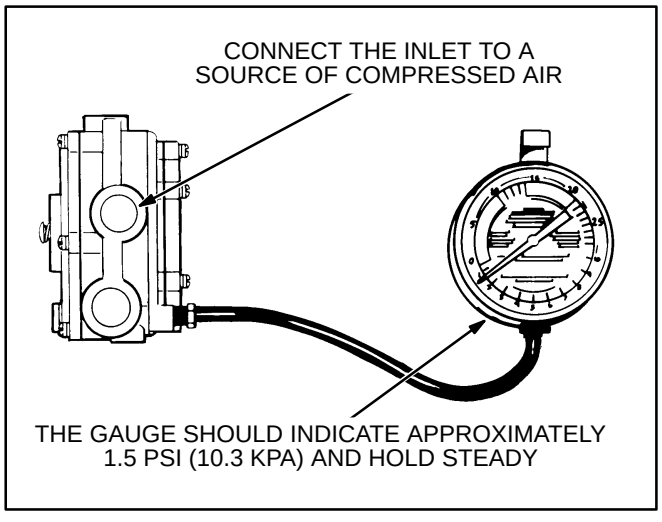


FIGURE 30. TESTING THE DEMAND REGULATOR (LIQUID-WITHDRAWAL SYSTEM)

Fuel Filter: See Figure 31. The fuel filter removes rust and scale and other solid particles from the LPG liquid to keep them from embedding in the valve seats of the shutoff valve and pressure regulator and causing them to leak. A magnet traps iron and rust particles and a filter element traps non-magnetic particles.

Disassembling and Cleaning the Fuel Filter:

1. Purge the LPG system as instructed on Page 12 before beginning disassembly.
2. Remove the four capscrews and lock washers that hold the filter bowl to the filter body.
3. Separate the filter bowl from the filter body and discard the O-ring seal.
4. Remove the nut and washer from the center stud and pull out the filter element.
5. Wash the filter element in kerosene to remove the particles it has collected. Blow it dry with low pressure (30 psi / 207 kPa) compressed air. Replace the filter element if damaged.
6. Wipe the magnet clean of the particles it has collected.
7. Install a clean filter element using two new gaskets and securely tighten the center stud nut.
8. Place a new O-ring in the filter bowl sealing groove.
9. Align the reference mark on the filter bowl with the reference mark on the filter body and torque the capscrews to 65 lbs-in (7.2 N-m). Check for and fix leaks at the filter when connections have been made to the fuel supply system. **The fuel filter operates at fuel supply tank pressure.**

Fuel Vaporizer: The fuel vaporizer consists of several wraps of tubing around the exhaust manifold. Exhaust heat vaporizes the LPG liquid. The vaporizer is not removable from the exhaust manifold.

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

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

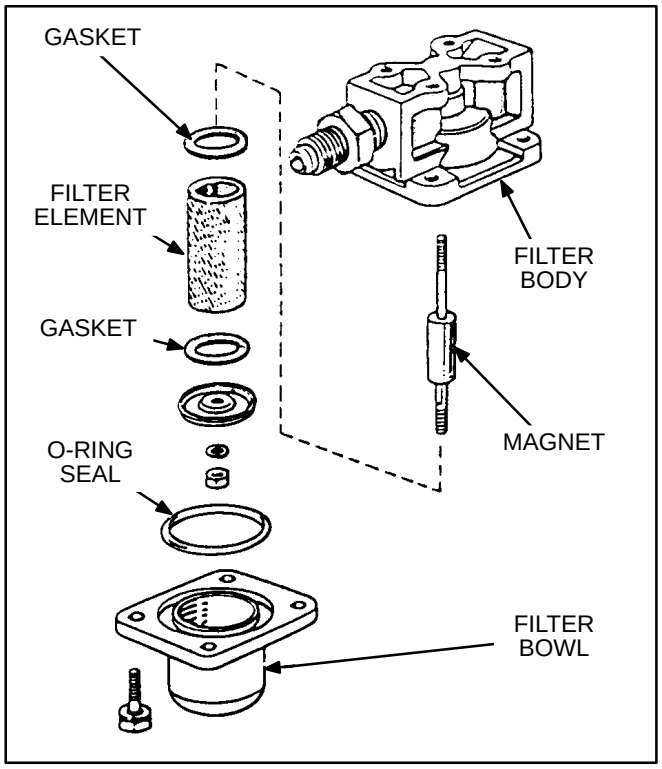


FIGURE 31. LPG FUEL FILTER (LIQUID WITHDRAWAL SYSTEM)

LPG System—Vapor Withdrawal

See the Installation Manual for important recommendations regarding the installation of an LPG vapor withdrawal type of fuel supply system. Gensets equipped for vapor withdrawal of LPG must be equipped with a fuel shutoff solenoid valve and demand regulator. These are available as a kit for mounting near the genset. See Figure 32.

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

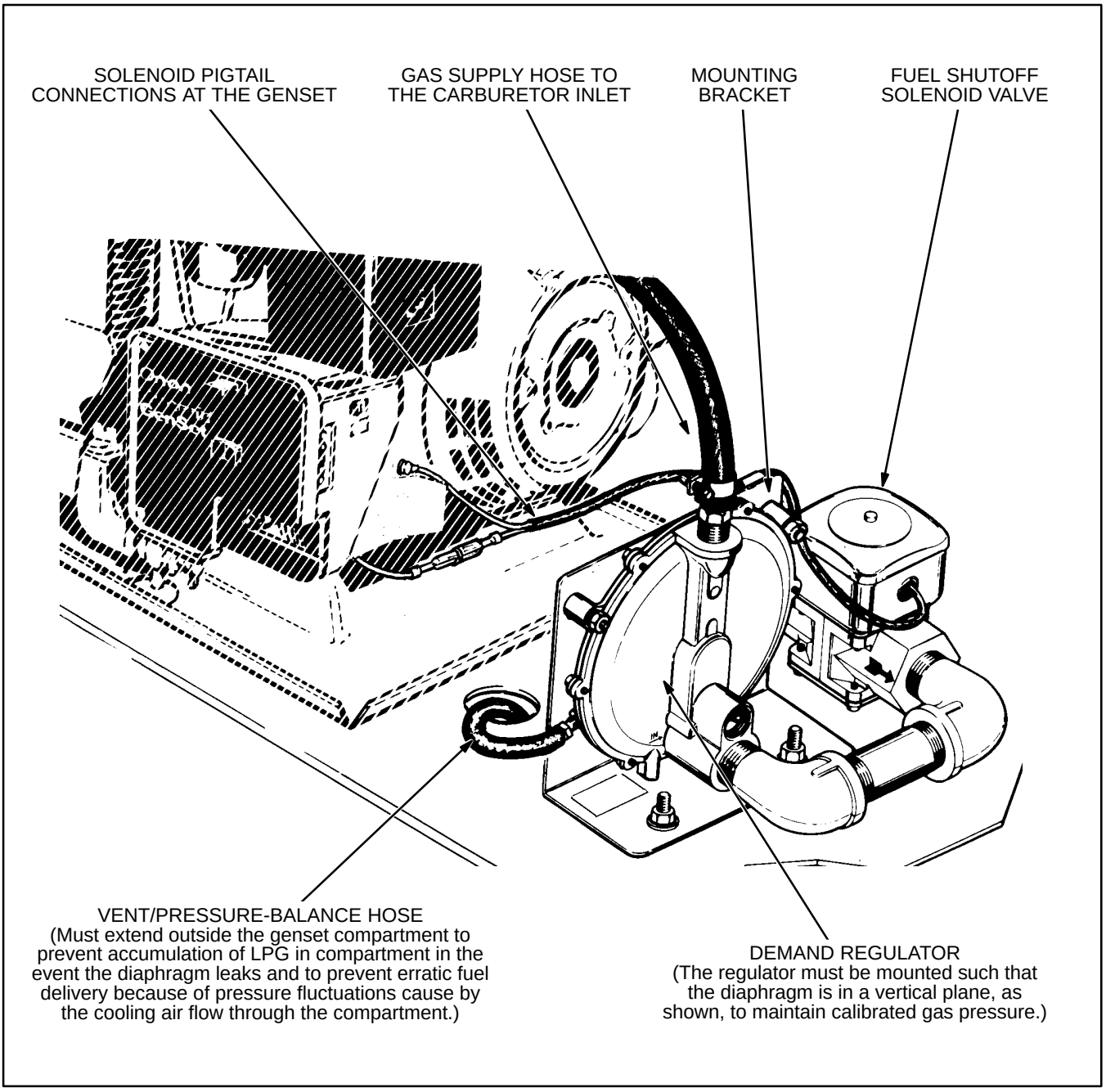


FIGURE 32. LPG SYSTEM COMPONENTS FOR VAPOR WITHDRAWAL

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

1. Close the gas shutoff valve(s) at the LPG container(s).
2. Remove the 1/8 inch pipe plug from the regulator test port (Figure 33) and connect a manometer calibrated in inches or mm WC having a scale range of at least 14 inches (350 mm).
3. Open the LPG container shutoff valve and try starting the genset.
4. While the genset is running, check the manometer and adjust the LPG supply pressure regulator to obtain 11 inches (279 mm) WC. (If there is a secondary pressure regulator in the supply line, adjust the secondary regulator instead of the primary regulator at the LPG container.)
5. If the genset will not start, jumper the fuel solenoid to the battery cable connections on the genset so that it stays open (the regulator will keep gas from flowing)and then check and adjust the LPG supply pressure.
6. If the genset is operable, check LPG supply pressure under full load. If it drops below the minimum required pressure, either the LPG container is too small to provide the rate of vaporization necessary or it is less than half full or the supply line is too restrictive.
7. Disconnect any jumpers which may have been used to energize the fuel solenoid and thread in and tighten the pressure test port plug unless tests are going to be continued.

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

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

1. Continue with the test setup for adjusting LPG supply pressure shown in Figure 33. If the regulator is being tested on the bench, connect it to a source of air pressure regulated to 11 inches (280 mm) WC.

   ⚠CAUTION ***If this is a bench test of the regulator, make sure the diaphragm is in a vertical plane (see Figure 32), otherwise the weight of the diaphragm will cause erroneous readings of lock-off pressure.***

2. "T" in two hoses to the end of the hose connected to the regulator vent fitting (3/8 inch I. D.). Use one hose to provide the test pressure and the other to measure pressure by connecting it to an inclined manometer calibrated with 0.01 inch or 0.1 mm divisions and having a range of at least 1 inch (25 mm).
3. Disconnect the hose to the carburetor and attach a soap bubble to the regulator outlet hose fitting. While reading the pressure indicated by the inclined manometer and watching the soap bubble, blow lightly into the hose being used to pressurize the regulator. Regulator lock-off pressure is the minimum pressure that will cause gas to flow through the regulator, as indicated by the expanding soap bubble. (At first the soap bubble may expand due to diaphragm movement but will stop expanding if gas or air is not flowing through the regulator.)

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

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

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

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

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

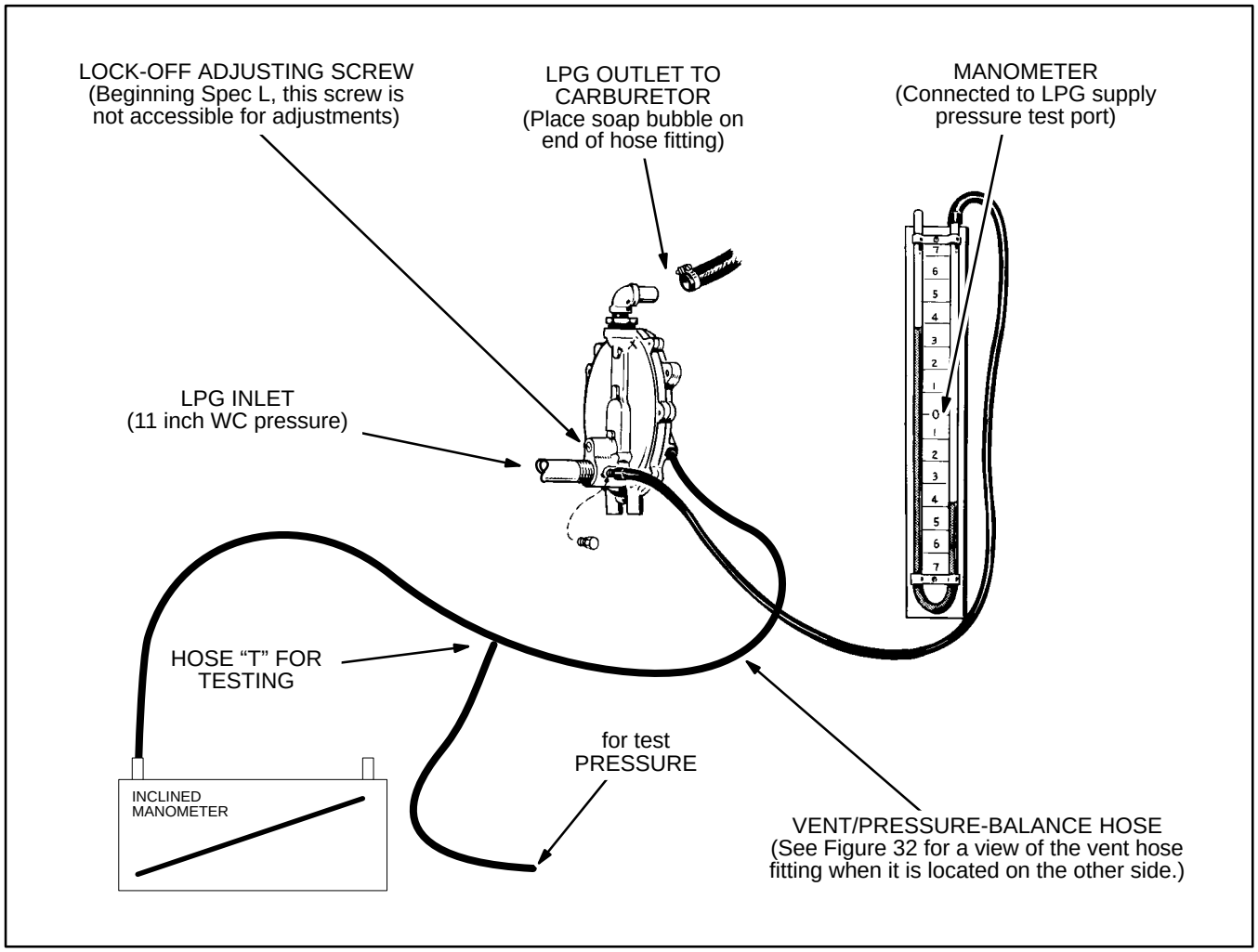


FIGURE 33. LPG SUPPLY PRESSURE AND REGULATOR LOCK-OFF PRESSURE

ELECTRIC STARTER

Starter motor parts replacement kits are available for Spec J gensets. Starter motor assembles for Spec H gensets do not have any replaceable or serviceable parts, requiring that the entire starter motor assembly be replaced if it does not work.

Starter Removal and Replacement

To remove the starter for service or replacement:

1. Disconnect the negative (**-**) cable from the starting battery.
2. Disconnect all wires and cables from the motor terminals.
3. Remove the two starter mounting bolts and remove the starter.

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

Starter Assembly and Disassembly (Beginning Spec J)

See Figure 34. Remove the starter from the genset. Remove the solenoid before disassembling the motor and remount if after assembling the motor. When mounting the solenoid make sure the plunger is hooked by the shift fork. The drive housing, motor frame and end bell are separable after the motor through bolts have been removed. Before loosening the through bolts, however, scratch register lines on the drive housing, motor frame and end bell so that these parts can be easily reassembled the same way relative to each other. While removing the end bell, be prepared to catch the brush springs, which tend to spring loose.

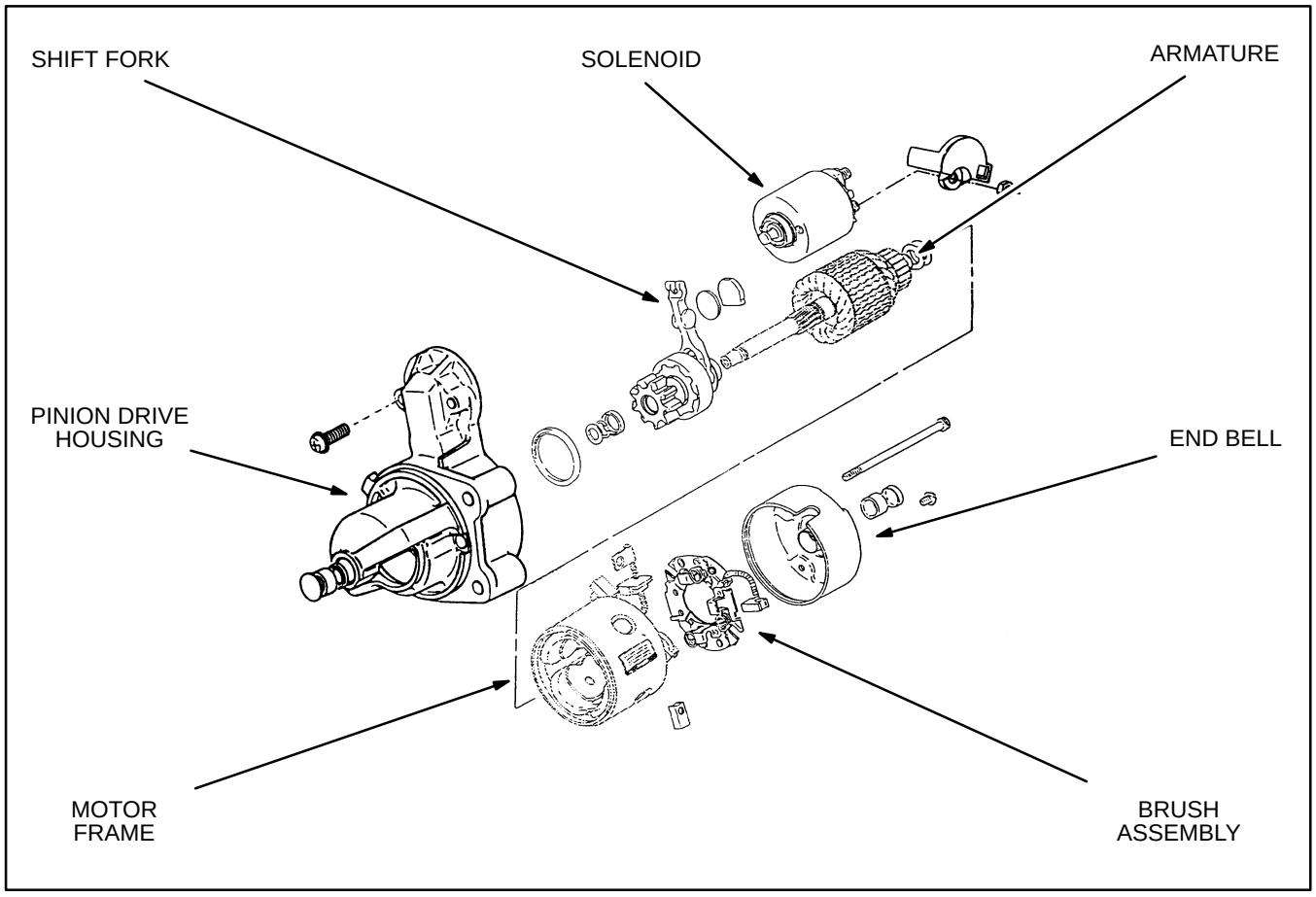


FIGURE 34. SOLENOID SHIFT STARTER (BEGINNING SPEC J)

Solenoid

Refer to Figure 35. Before replacing the solenoid, confirm that it is the cause of the starter not working by removing it from the starter assembly and conducting the following tests.

1. Connect **6 volt** battery positive (**+**) to solenoid terminal **S** and battery negative (**-**) to solenoid terminal **M**. The plunger should pull in and hold in strongly. If it does not, replace the solenoid.
2. Connect **6 volt** battery positive (**+**) to solenoid terminal **S** and battery negative (**-**) to the body of the solenoid. Push the plunger in and release it. The plunger should stay in. If it does not, replace the solenoid.
3. Connect **12 volt** battery positive (**+**) to solenoid terminal **M** and battery negative (**-**) to the solenoid body (reversed from normal polarity). Push the plunger in and release it. The plunger should push back out immediately. If it does not, replace the solenoid.

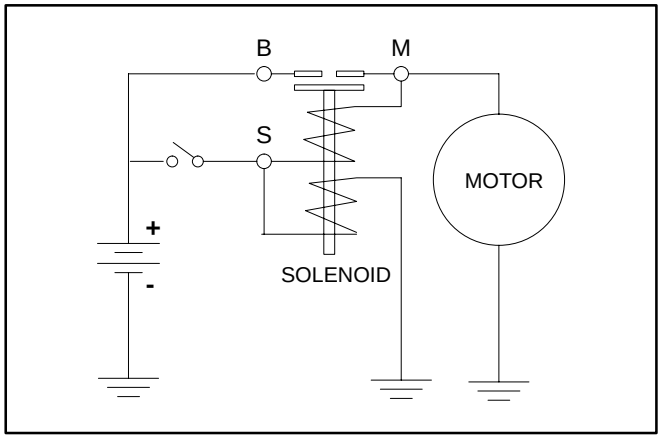


FIGURE 35. SOLENOID-MOTOR CIRCUITS

Armature

Winding Integrity: Refer to Figure 36. Use an ohmmeter to check for electrical continuity between pairs of commutator segments all the way around the commutator. Make sure each segment is checked. Replace the armature if a winding is open (high resistance) at any segment.

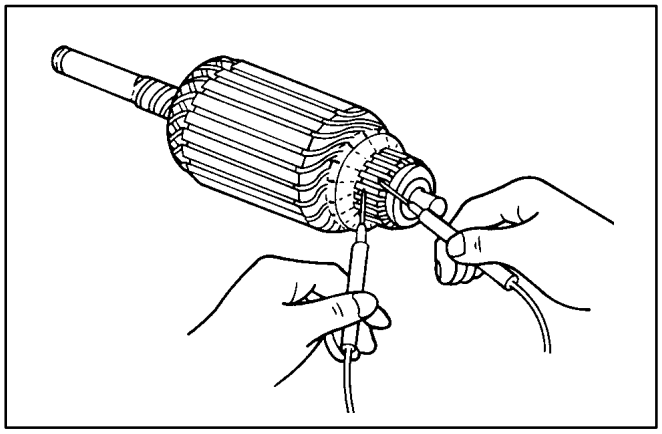


FIGURE 36. CHECKING WINDING INTEGRITY

Winding Insulation: Refer to Figure 37. Use an ohmmeter to check for winding insulation breakdown between the windings and the rotor laminations. Replace the armature if the ohmmeter does not indicate high resistance on its highest scale between any commutator segment and the rotor laminations.

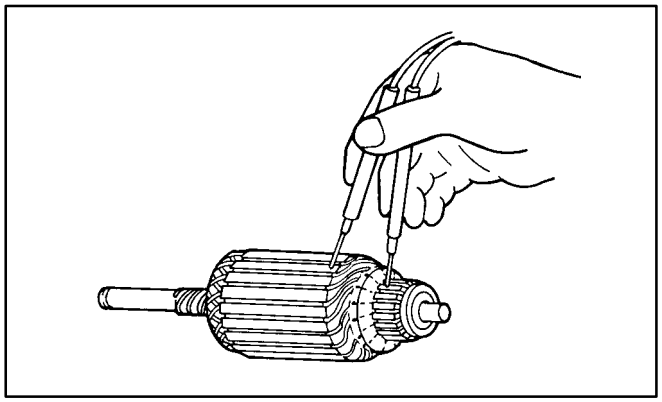


FIGURE 37. CHECKING WINDING INSULATION

Commutator: Clean the commutator surface with sandpaper. Measure the diameter at several locations around the commutator. Turn the commutator in a lathe if it is not round or has deep pits. Replace the armature if it is necessary to turn the diameter of the commutator to less than 1-1/16 inch (27 mm).

Using a hacksaw blade, undercut the mica between the commutator segments by 1/32 inch and chamfer the edges of the segments slightly. See Figure 38.

Brush Assembly

Replace the motor frame and brush assembly if any brush is less than 0.43 inch (11 mm) long.

Motor Frame and Stator

Refer to Figure 39. Two of the four brushes are connected directly to the stator windings, one to each pair of windings. The other ends of the two pairs of stator windings are crimped to the motor frame (grounded). To check the integrity of each winding pair, use an ohmmeter to check for continuity between its brush and the motor frame. Replace the motor frame if either winding pair is open (high resistance). (This test will not detect if a single winding of a pair is open. If the windings look burnt or smell bad, it is recommended that the motor frame be replaced.)

Pinion

Refer to Figure 40. Replace the pinion assembly if the pinion teeth and armature shaft splines are worn or damaged. Check the over-running clutch by rotating the pinion clockwise and counterclockwise. Replace the pinion assembly if it does not turn smoothly counterclockwise or lock clockwise.

⚠WARNING ***Do not clean the pinion overrunning clutch with any kind of cleaning solution, otherwise it may be damaged.***

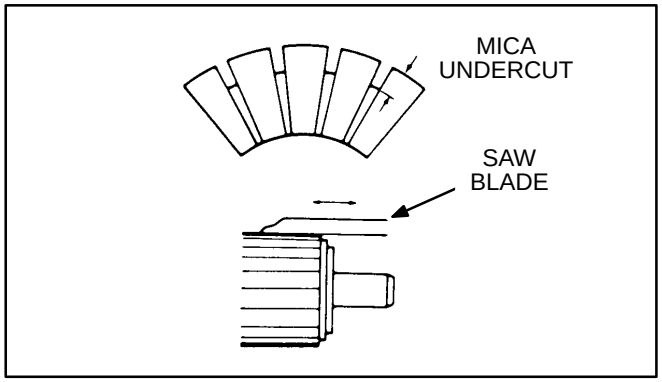


FIGURE 38. COMMUTATOR MICA UNDERCUT

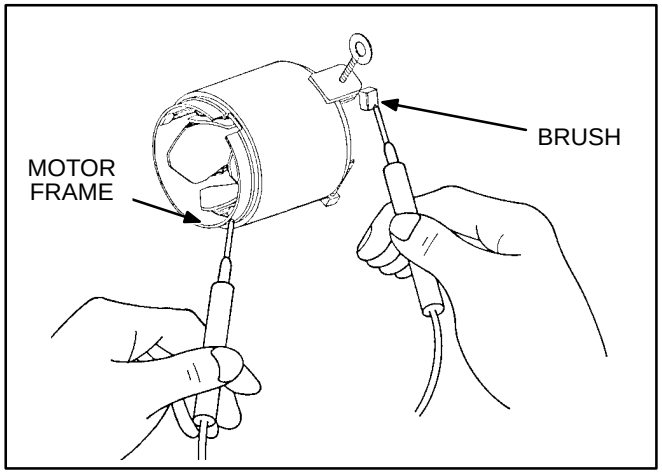


FIGURE 39. CHECKING MOTOR FRAME WINDINGS

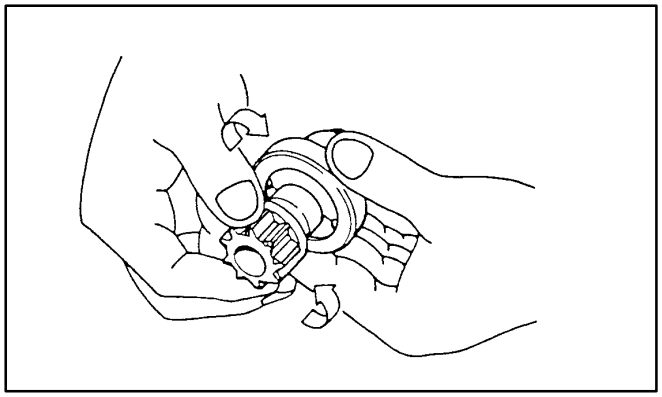


FIGURE 40. CHECKING OPERATION OF THE PINION OVER-RUNNING CLUTCH

Engine Control

The engine control system provides a means to start, run and stop the engine, automatically disengage the starter, recharge the battery, automatically shut down the genset in the event of low oil pressure and start, stop and monitor the genset from the cab or other location.

CONTROL SYSTEM (BEGINNING SPEC J)

See *Wiring Diagrams* for the appropriate schematic and connection diagrams.

Control Components

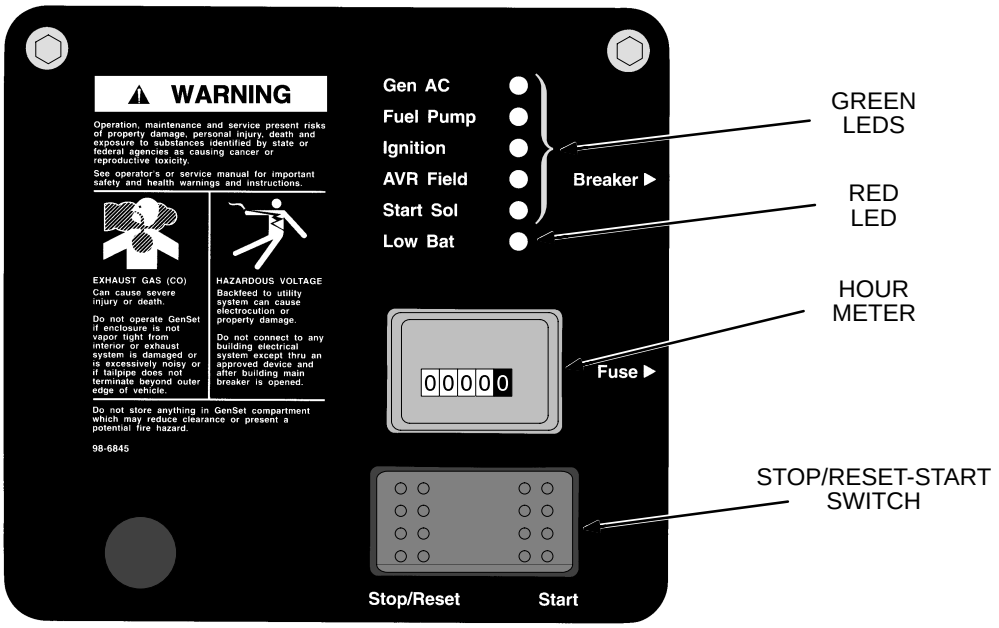
The control system consists of the following components:

Control Panel: See Figure 41. The Start-Stop/Reset switch, hour meter and indicator lights are mounted on the control panel. Control board A1 and start relay K5 are mounted on the back of the control panel. Only start relay K5 is separable from the control panel assembly for replacement.

Start-Stop/Reset Switch (S1): This is a momentary-contact type switch mounted as an integral part of the control panel.

Fuse (F1): This is a 10 amp mini-bayonet type fuse mounted on the side of the control box to protect printed circuit board A1 from overcurrent.

Start Relay (K5): The starter solenoid (K6) is energized by the control board (A1) through this relay. It is mounted in a socket on the back of the control panel.



Cranking:
- **Gen AC** LED (green) will be **OFF**
- **Fuel Pump** LED (green) will be **ON**
- **Ignition** LED (green) will be **ON**
- **AVR Field** LED (green) will be **ON**
- **Start Sol** LED (green) will be **ON**
- **Low Bat** LED (red) MAY flash **ON**

Genset started and running:
- **Gen AC** LED (green) will be **ON**
- **Fuel Pump** LED (green) will be **ON**
- **Ignition** LED (green) will be **ON**
- **AVR Field** LED (green) will be **OFF**
- **Start Sol** LED (green) will be **OFF**
- **Low Bat** LED (red) will be **OFF**

FIGURE 41. CONTROL PANEL (BEGINNING SPEC J)

Starter Solenoid (K6): The starter solenoid is part of the starter motor assembly. It engages the starter pinion and connects the starter motor to the battery for cranking.

Hour Meter: The hour meter is mounted as an integral part of the control panel. It is not resettable.

Ignition Coil T1: The ignition coil provides spark for igniting the fuel.

Gasoline Fuel Pump (E2): The fuel pump lifts gasoline from the supply tank and delivers it under pressure to the carburetor. A fuel shutoff solenoid may also have been connected in parallel to the fuel pump by the customer to prevent fuel spillage in the event the vehicle rolls over.

LPG Shutoff Solenoid (FS): The LPG shutoff solenoid closes against fuel supply pressure when it is de-energized.

Choke Heater H1: The choke heater opens the choke to the full-open run position (gasoline gensets only).

Low Oil Pressure Cutout Switch (S2): This switch opens in the event engine lubricating oil pressure drops below 5 psi (34 kPa) to de-energize the run relay and shutdown the genset.

PMG: The PMG provides power for recharging the cranking battery (through VR2) during operation of the genset and a signal for the control board (A1) for start disconnect. See *Engine Subsystems* for details.

Battery Charging Regulator (VR2): The battery charging regulator recharges the battery while the genset is running. It is connected to the PMG. The regulator limits output to 14.2 volts and 10 amps.

Remote Control (A2, A3—Optional): The remote control is an optional accessory that enables the genset to be operated from a remote location.

Sequence Of Operation

See *Wiring Diagrams* for the appropriate wiring schematic while working through the following description.

1. Holding Start-Stop switch **S1** at **Start** causes:

   Start Relay K5 to energize starter motor solenoid K6 to crank the engine. (Green light)

   Fuel Pump E1 or Fuel Solenoid FS to pump fuel or open to allow fuel to flow. (Green light)

   Ignition Coil T1 to provide ignition spark. The engine should start. (Green light)

   Battery Current to build up the generator field (through AC voltage regulator VR1) for fast build-up of generator output voltage. (Green light)

   Choke Heater H1 to start opening the choke to the full-open running position.

2. Low oil pressure cutout switch **S2** should close as soon as the engine starts up. It must close before the genset can continue to run.
3. PMG output builds up right away and provides a signal for the control board to disconnect the starter even if the Start switch is still being held in the start position.
4. The genset will continue to run when Start-Stop switch **S1** is released. The green Generator AC light should come on.
5. The red Low Battery light will probably come on during cranking, but should go off during operation.
6. Momentarily pushing Start-Stop switch **S1** to **Stop** deactivates the ignition and fuel systems to cause the genset to shut down.

Troubleshooting

The indicator lights on the control panel should be used in conjunction with *Troubleshooting* to narrow the search for the problem. If, for example, the Fuel Pump or Ignition light is on but it has been determined that there is no fuel or no ignition spark, the problem is not in the control board but in the rest of the circuit.

CONTROL SYSTEM (SPEC H ONLY)

See Figure 42 and *Wiring Diagrams*. The control system consists of the following components:

Printed Circuit Board (A1): The printed circuit board includes the relays (K2, K3 and K4), switch (S1) and circuits necessary to start, run and stop the genset, automatically disconnect the starter, shutdown the genset in the event of low oil pressure and connect to a remote control circuit. It is mounted on the back of the control panel.

Start-Stop Switch (S1): This is a rocker switch mounted on the printed circuit board to start and stop the genset. The switch returns to the center (run) position when released. It is not separately replaceable.

Fuse (F1): This is a 5 amp fuse to protect printed circuit board A1 from overcurrent. It is removable from the front of the control panel. Spare fuses are inside the fuse holder.

Fuse (F2): This is a 10 amp fuse to protect the ignition and choke heater circuits.

Start Solenoid (K1): The start solenoid closes the battery to the starter motor during cranking, handling up to 300 amps. It includes the battery **B+** terminal which is readily accessible from the front for connecting the positive (**+**) battery cable.

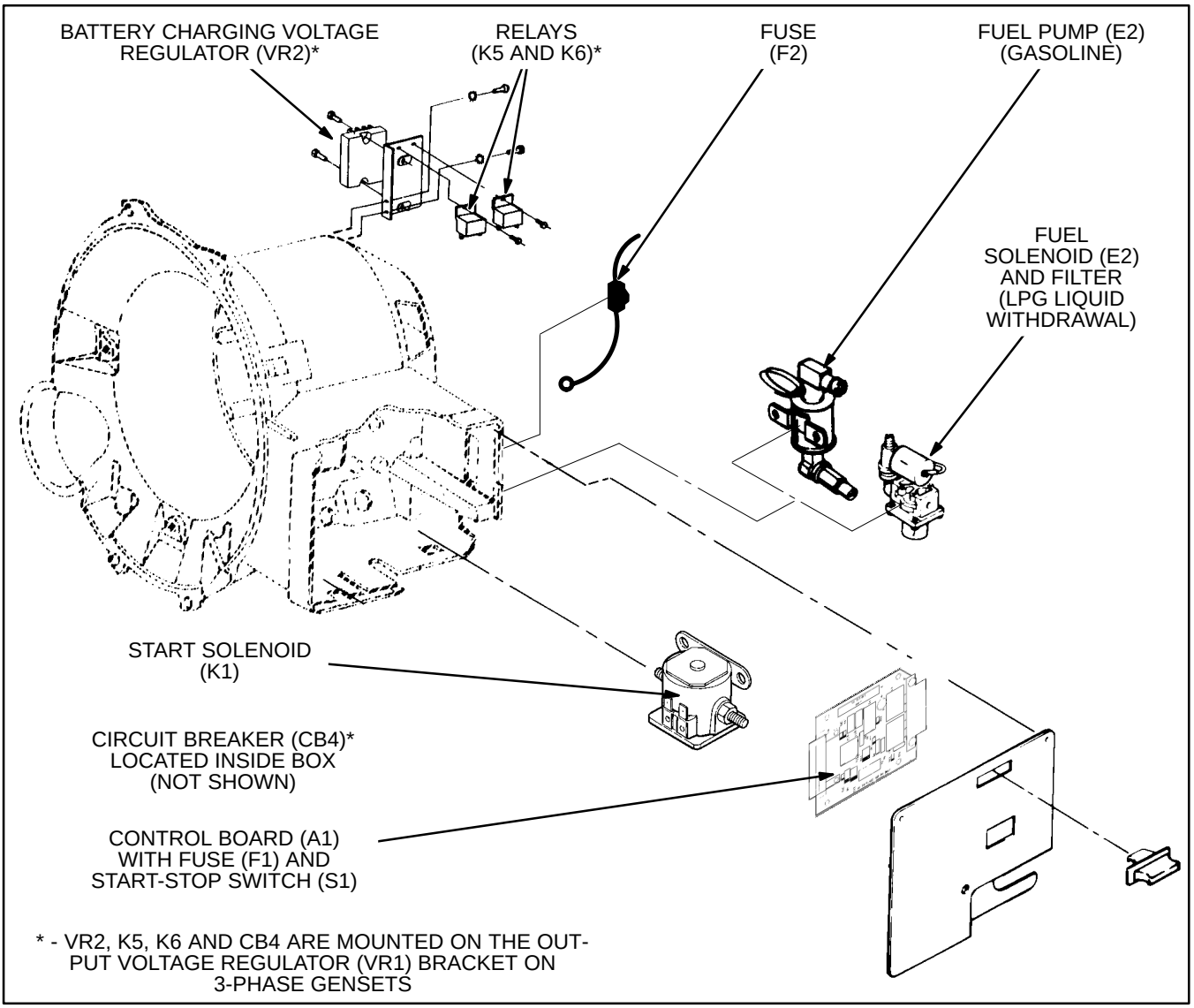


FIGURE 42. TYPICAL CONTROL COMPONENTS (SPEC H ONLY)

Stop Relay (K5): This relay latches the control to prevent the genset from restarting when the Start-Stop switch is momentarily pushed to STOP and then released.

Ignition Relay (K6): This relay closes to energize the ignition and choke heater circuits. It is not provided on LPG gensets.

Gasoline Fuel Pump (E2): The fuel pump lifts gasoline from the supply tank and delivers it under pressure to the carburetor.

LPG Shutoff Solenoid (FS): The LPG shutoff solenoid closes against fuel supply pressure when it is de-energized.

Battery Charging Regulator (VR2): The battery charging regulator recharges the battery while the genset is running. It is connected to generator terminals B1 and B2 which provide power to the regulator at 19-21 VAC. The regulator limits output to 10 amps.

Low Oil Pressure Cutout Switch (S2): This switch opens in the event engine lubricating oil pressure drops below 5 psi (34 kPa) to de-energize the run relay and shutdown the genset.

Battery Charging Circuit Breaker (CB4): This is a thermal-type, automatic-reset circuit breaker to protect the charging circuit. On 1-phase gensets it is located inside the control box and is tied to the leads from battery charging regulator VR2. On 3-phase gensets it is mounted on the bracket for output voltage regulator VR1.

Remote Control (A2, A3—Optional): The remote control is an optional accessory that enables the genset to be operated from a remote location. The deluxe control includes a running time meter and battery condition meter.

Sequence Of Operation

See *Wiring Diagrams* for the appropriate wiring schematic while working through the following description.

1. Holding Start-Stop switch **S1** at **Start** causes relay **K4** on control board A1 to pull in, causing the following components to be energized by the battery:

   Start Solenoid K1 - The engine should crank.

   Fuel Pump E1 or Fuel Solenoid FS - The electric fuel pump should start pumping gasoline or the LPG fuel solenoid should open.

   Relay K5 - Relay K5 opens to energize run relay K3.

   Relay K6 - Relay K6 closes to energize the ignition (T1) and choke heater (H1) circuits. The engine should start.

   Generator Field - Battery current energizes the generator field (through AC voltage regulator VR1) for fast build-up of generator output voltage.

2. Low oil pressure cutout switch **S2** should close as soon as the engine starts up. It must be closed before run relay **K3** can be energized and must stay closed to keep the engine running.

3. Start disconnect relay **K2** on control board A1 pulls in as soon as generator voltage builds up. It causes start relay **K4** to drop out, disconnects the field from the battery and causes run relay **K3** to pull in. When **K4** drops out, it cause **K1** to drop out, disconnecting the starter. When **K3** pulls in, it keeps the fuel and ignition circuits active so that the genset will continue to run.

4. The genset will continue to run when Start-Stop switch **S1** is released and returns to its center (run) position. If the switch is held in after the genset has started, relay **K2** will still cause the starter to be disconnected.

5. Momentarily pushing Start-Stop switch **S1** to **Stop** causes run relay **K3** to drop out, causing the ignition and fuel circuits to deactivate, shutting down the genset. Relay **K5** also drops out, closing its contacts to keep relay **K3** out, preventing the genset from restarting if it has not stopped before **S1** is released.

Testing Control Board A1 (Spec H Only)

Confirm that control board **A1** (Figure 43) is faulty before replacing it. Use a DC voltmeter and an ohmmeter to perform the following tests:

1. Disconnect the negative (-) battery cable.
2. Remove the control panel and separate control board **A1** from it by removing the four mounting screws.
3. With an ohmmeter check for good electrical contact between each pin and jack of connector P1-J1. To test a connection, touch one meter probe to the back of the pin, which is bare. Disconnect the fast-on connector on the other end of the lead connected to the J1 jack and touch the other meter probe to the connector.

   Reconnect the lead before checking the next connection to minimize the possibility of making wrong reconnections.

   Replace the connector jack/lead assembly if the jacks are corroded or there is measurable resistance (greater than zero ohms) at any connection.
4. Reconnect the battery and try to start and run the genset.
5. If the engine does not crank, disconnect the fast-on connector on the end of the connector PI-J1 lead marked **K1-S/J1-9**. Measure voltage between the connector on the end of the lead and a good engine ground while pressing the panel start switch. If the voltmeter indicates zero volts, check fuse **F1** on the control board. If it is good, replace control board **A1**. If the voltmeter indicates at least 9 volts, the problem is not in the control board. Go to *Troubleshooting.*
6. If the engine cranks but does not start, disconnect the fast-on connectors on the ends of the connector P1-J1 leads marked **J6/J1-6** and **E2/J1-12**. Measure voltage between the connector on the end of each lead and a good engine ground while pressing the panel start switch. Replace control board **A1** if the voltmeter indicates zero volts at either connector. If the voltmeter indicates at least 9 volts at both connectors, the problem is not in the control board. Go to *Troubleshooting.*
7. If the engine starts but stops when the panel start switch is released, the problem could be low oil pressure, a faulty low oil pressure cutoff switch or no generator output voltage. Go to *Troubleshooting.* Replace control board **A1** if oil pressure, switch and generator are normal.

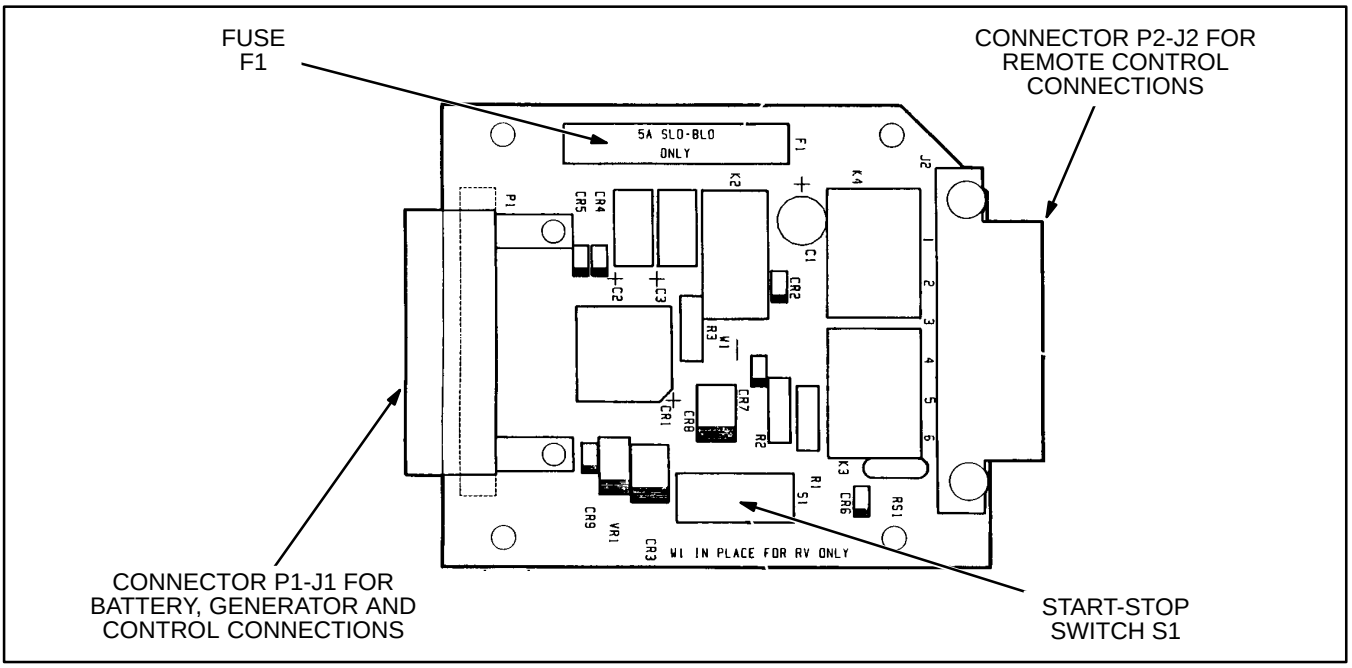


FIGURE 43. CONTROL BOARD A1 (SPEC H ONLY)

Generator

These are 4-pole, revolving-field generators with slip rings and electronic voltage regulators. Single-phase generators have quadrature windings and three-phase generators main winding taps for field excitation. Spec H generators have auxiliary windings for battery charging. The generator rotor and engine crankshaft have a tapered coupling secured by the rotor through-bolt. The other end of the rotor is supported in a sealed, pre-lubricated ball bearing assembly. The cooling blower wheel and starter ring gear are part of the rotor assembly. See Figure 44.

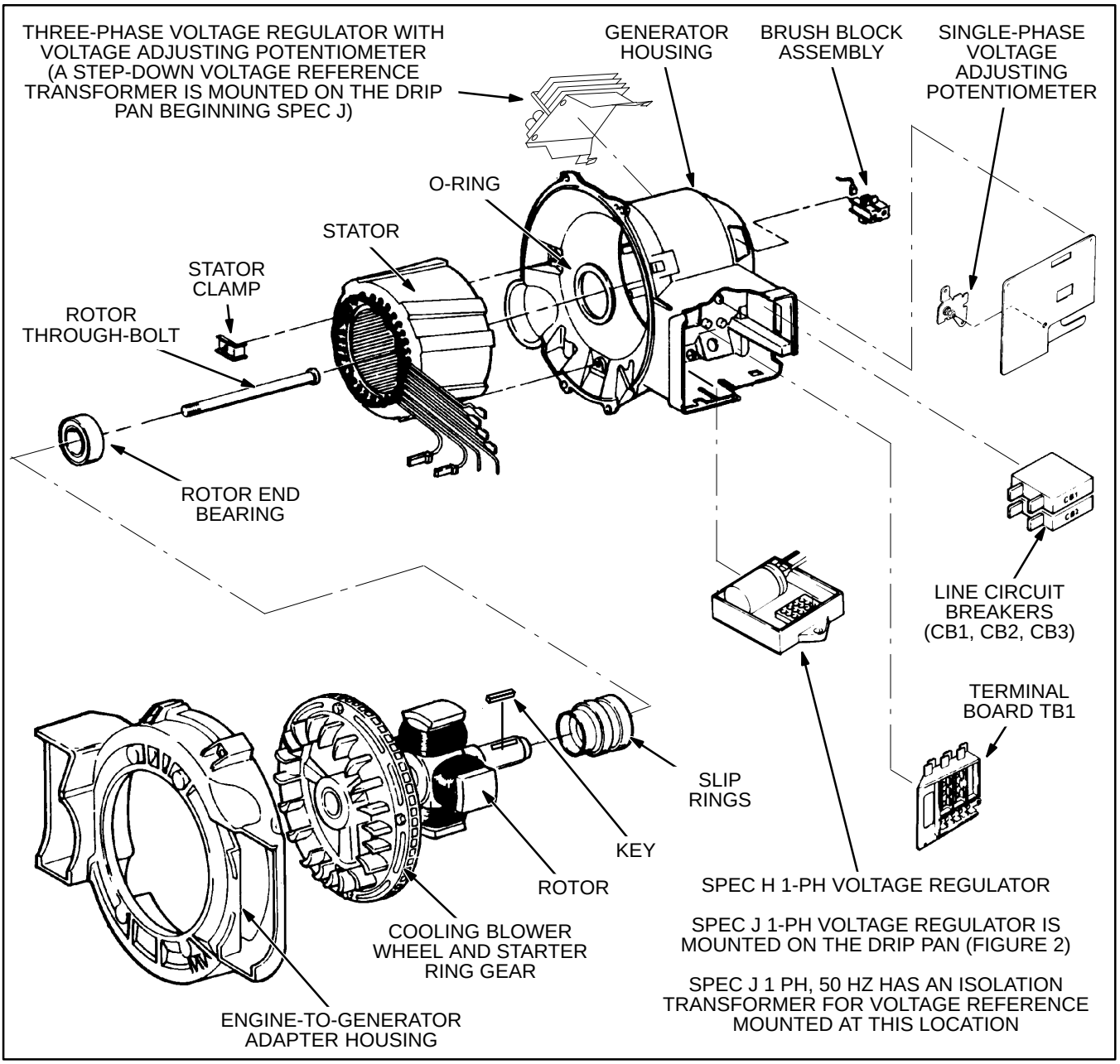


FIGURE 44. GENERATOR COMPONENTS

BASIC GENERATOR OPERATION

Refer to Figure 45 and to *Wiring Diagrams* while working through the following description of operation:

1. Voltage regulator VR1 supplies DC power to the main rotor (field) windings through the brushes and slip rings. A rotating, four-pole magnetic field is thereby established that induces AC in the stator windings. Quadrature windings are provided for single-phase generators to power the voltage regulator. The main windings provide power for the voltage regulator on three-phase generators.
2. While the governor matches engine output to the load, maintaining a constant speed (frequency), the voltage regulator senses output voltage and adjusts field current to maintain a constant output voltage.
3. During startup, the voltage regulator is powered by the battery for fast generator voltage buildup. Control board A1 disconnects the voltage regulator from the battery at the same time that it disconnects the starter. See *Engine Control*.
4. Beginning Spec J, a PMG on the other end of the engine crankshaft from the generator supplies power for charging the battery through voltage regulator VR2. Spec H gensets have separate generator stator windings for charging the battery through voltage regulator VR2. The battery charging output signal is also used for start disconnect. See *Engine Control*.

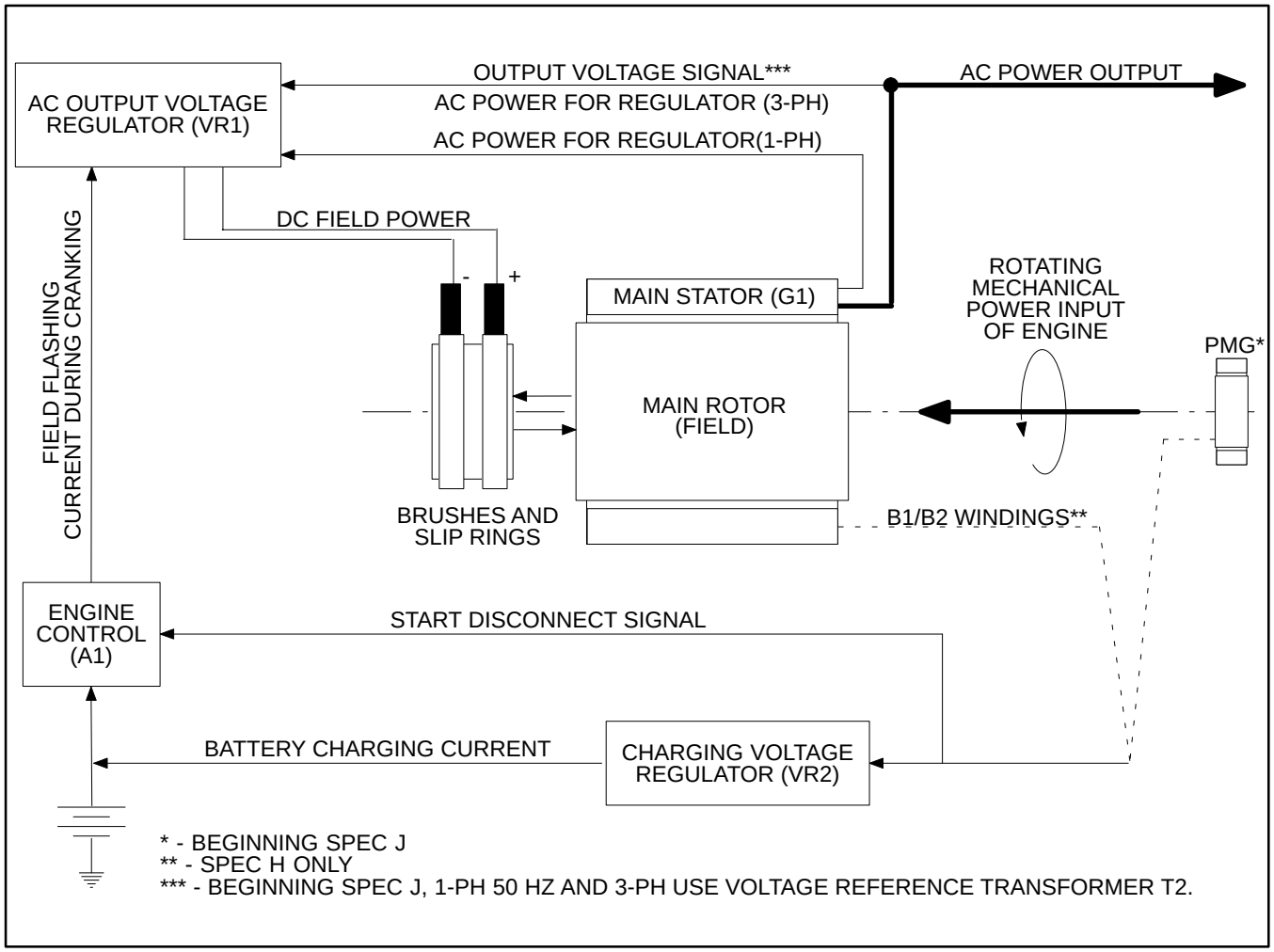


FIGURE 45. SCHEMATIC OF GENERATOR OPERATION

SERVICING BRUSHES AND SLIP RINGS

Remove the air cleaner and the brush block cover and inspect for burned brushes and grooved or pitted slip rings and any other damage. (Turn the rotor with a 3/8 inch allen wrench to be able to inspect all the way around the slip rings.)

If everything looks good, check brush wear with a piece of wire marked off as shown in Figure 46. Replace the brushes and brush springs if the wire can be inserted more than 1 inch (25 mm) into the hole in the brush holder. (Make sure the wire rests on top of the brush and not on part of the brush spring.)

If the slip rings are grooved or pitted it might be possible to clean them up with a commutator stone. If the slip rings are worn and need to be replaced, see Removing and Replacing the Slip Ring Assembly under GENERATOR ASSEMBLY/DISASSEMBLY in this section.

To replace the brushes or to clean up the slip rings:

1. Disconnect the leads marked **F1** and **F2** from the brush block terminals.
2. Remove the brush block mounting screws and lift out the brush block assembly.
3. If the slip rings need to be cleaned up, insulate the ends of leads **F1** and **F2**, disconnect all leads from the positive (**+**) terminal of the ignition coil to keep the engine from starting, hold the commutator stone lightly against the slip rings and crank the engine for 3 to 6 seconds. Check the slip rings and repeat the procedure as necessary until the pits and groves have been removed.
4. Replace the brushes and brush springs with new parts. Connect each brush pigtail to the terminal on its side of the insulating divide (Figure 47).
5. Remount the brush block. Center the brushes on the slip rings before tightening the mounting screws.
6. Reconnect the lead marked **F1** to the outboard brush terminal and the lead marked **F2** to the inboard brush terminal and secure the cover and air cleaner.

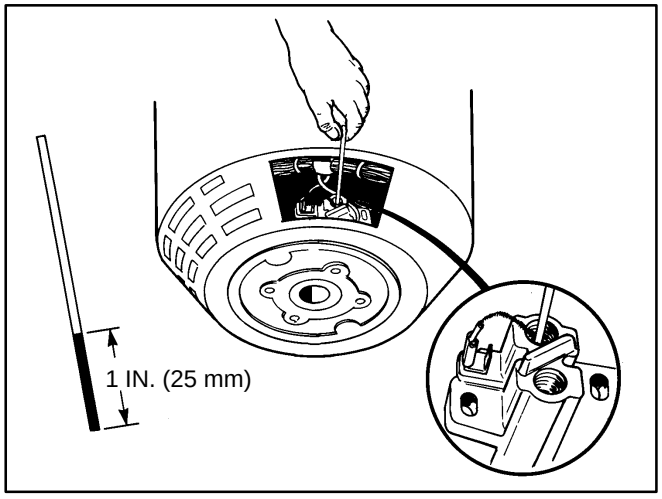


FIGURE 46. CHECKING BRUSH WEAR

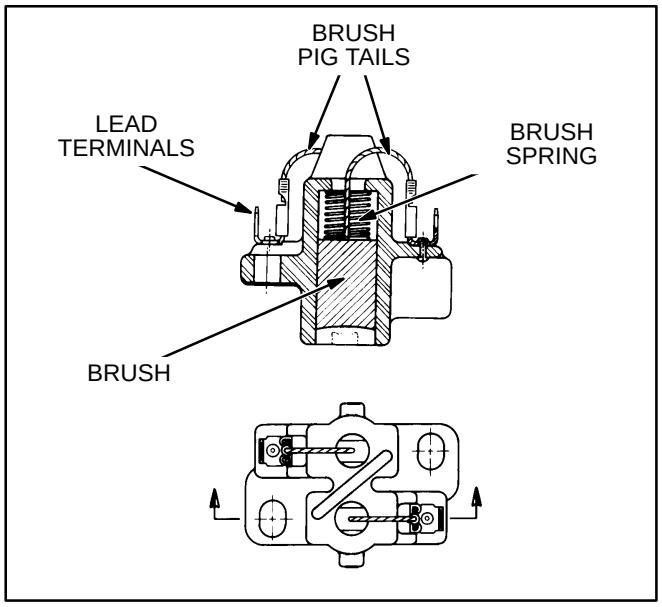


FIGURE 47. BRUSH BLOCK ASSEMBLY

REMOVING/REMOUNTING GENERATOR

Removing the Generator from the Genset

1. Drain the engine oil while the genset is mounted in the vehicle. (Oil will spill out when the genset is tipped up on end to remove the generator unless the oil has been drained.)
2. Remove the genset from the vehicle and place it on a sturdy work bench. See *Preparing for Service*.
3. Remove the blower housing so that the genset can be rested flat on the blower wheel. See ENGINE COOLING SYSTEM in *Engine Subsystems* for instructions.
4. Disconnect the fuel line at the carburetor.
5. Disconnect the leads at the low oil pressure cut off switch and **B+** terminal of the ignition coil.
6. Use a 3/8 inch allen wrench and rubber mallet to remove the rotor through-bolt.
7. Thread a 9/16-12 eyebolt into the end of the rotor and tip the genset up with a hoist until it rests squarely on the blower wheel. See Figure 48.

   ⚠CAUTION ***Do not lift the genset with the eyebolt. The weight of the genset could cause the tapered crankshaft-rotor fit to break loose, leading to generator damage.***
8. Disconnect the ground strap from the drip tray, remove the four vibration isolator center-bolts (for reassembly, note the locations of the large flat washers) and pull the tray away.
9. Remove the four bolts, nuts and lock washers that secure the generator housing to the genset.
10. Remove the eyebolt and insert the rotor removal rod (headless bolt, Figure 49) and thread it in with a screwdriver until it bottoms. Thread in and tighten a 9/16-12x1-3/4 bolt against the rod until the rotor breaks loose from the crankshaft.

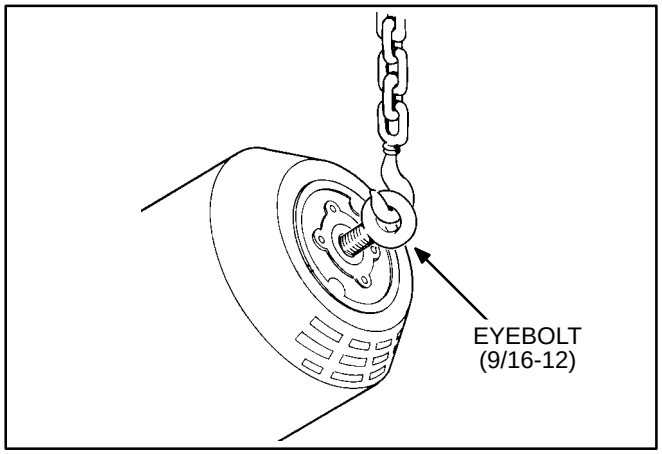


FIGURE 48. GENERATOR LIFT

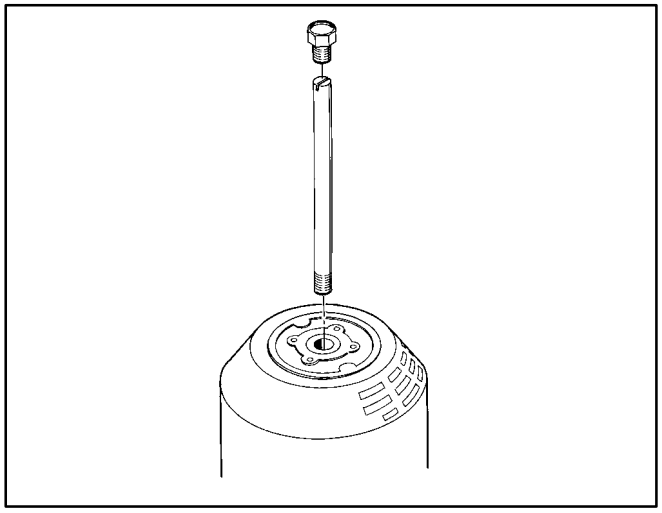


FIGURE 49. ROTOR REMOVAL TOOL

Remounting the Generator on the Genset

Essentially, remounting is the reverse of removal. Note the following:

1. First reassemble the generator housing, stator and rotor as instructed, if they have been taken apart.
2. It is recommended that the rotor removal tool be threaded into the crankshaft to guide the rotor into the crankshaft as the assembly is lowered, using an eyebolt (Figure 48) and hoist.
3. The lock washers go under the bolt heads of the generator mounting bolts.
4. Locate the large flat washers at the locations noted when disassembling the vibration isolators (Step 8 under Removal).
5. Torque the generator housing, rotor throughbolt and vibration isolator center-bolts to *Assembly Torques*.
6. Make sure to secure the ground strap to the drip tray using one EIT (external and internal toothed) lock washer on each side of the strap terminal for a good electrical connection.
7. Reconnect or reassemble all other parts that were disconnected or removed. **Do not forget to refill the crankcase with the appropriate grade of engine oil after the genset has been re-installed in the vehicle. See the Operator's Manual for engine oil recommendations.**

GENERATOR ASSEMBLY/DISASSEMBLY

Removing the Rotor from the Generator

1. Remove the generator from the genset, as instructed under Removing the Generator from the genset.
2. To keep from damaging the brushes and to keep them from interfering when inserting the rotor, either:
   A. Remove the brush block assembly by disconnecting the leads marked **F1** and **F2** from the brush block terminals and then removing the two mounting screws.
   B. Insert a stiff wire into the small hole in the end of the stator housing to hold the brushes up and out of the way (Figure 50). To do this, first pull both brush pigtails to lift the brushes off the slip rings.
3. Turn the generator over onto its bearing end and withdraw the rotor straight up. It may be necessary to have an assistant hold down the generator housing.

⚠ CAUTION ***Be careful not to nick the stator windings with the rotor while withdrawing the rotor.***

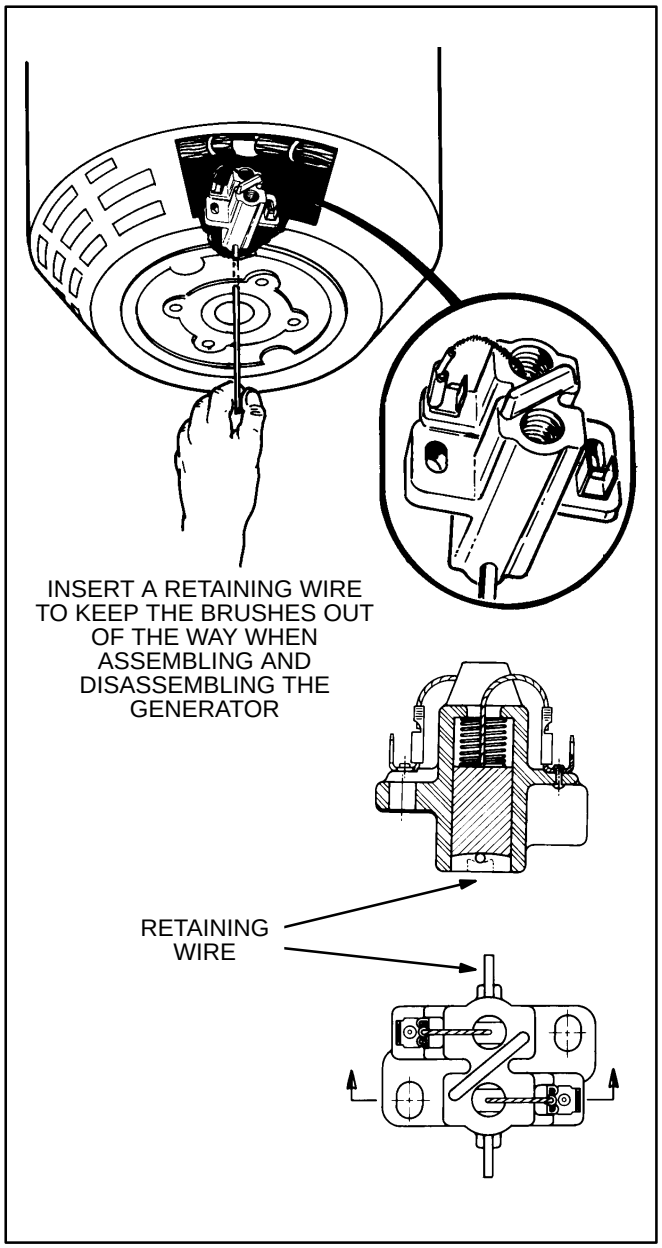


FIGURE 50. BRUSH BLOCK ASSEMBLY

Re-installing the Rotor in the Generator

It is recommended that the rotor be re-installed in the generator first and then that the entire generator be mounted on the genset as instructed under Re-mounting the Generator on the genset.

Re-installation of the rotor is the reverse of removal. Note the following:

1. Replace the slip ring assembly, rotor bearing and stator, if necessary.
2. Make sure the brush block assembly has been removed or that the wire is holding both brushes up and out of the way.
3. Make sure the rubber O-ring is in place in the bearing bore and then carefully lower the rotor into the generator. The rotor bearing should fit snugly into the bearing bore.
4. Install the brush block assembly if it was removed. If it was left in place, pull the brush pig tails and remove the retaining wire. If necessary, loosen the brush block mounting screws, align the brush block so that the brushes are centered on the slip rings and retighten the mounting screws.
5. Connect the lead marked **F1** to the outboard brush terminal and the lead marked **F2** to the inboard brush terminal and snap the cover on.

Removing the Stator from the Generator

See Figure 51. To remove the stator from the generator housing:

1. Upend the generator as shown.
2. Remove the rotor as instructed under Removing the Rotor from the Generator.
3. Disconnect all the stator leads and pull them from the control box.
4. Remove the three stator clamps.
5. Lift the stator straight up and out of the housing.

⚠CAUTION ***Careless handling of the stator can damage the insulation on the stator windings.***

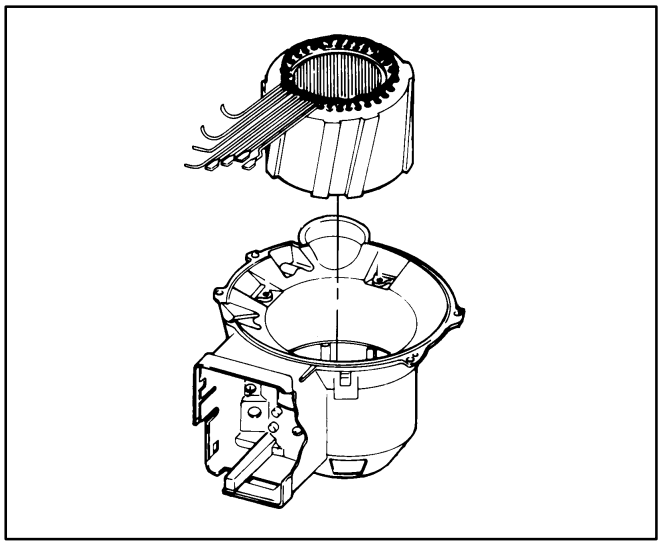


FIGURE 51. REMOVING THE STATOR

Re-installing the Stator in the Generator

Re-installing the stator is the reverse of removal. Make sure the stator leads line up with the exit hole in the housing while lowering the stator into the housing. Connect the leads according to the appropriate connection diagram in Figure 59, 60 or 61.

Removing and Replacing the Rotor Bearing

Use a gear puller to remove the bearing from the rotor shaft if it or the slip ring assembly is to be replaced, otherwise leave it in place. See Figure 52. If the bearing is to be reused, make sure the fingers of the gear puller bear on the inner race of the bearing only.

⚠CAUTION ***The bearing will be damaged and become unusable if force is applied to the outer race either when pulling it off or pressing it on.***

Replace the bearing as follows:

1. Replace the slip ring assembly first, if necessary.
2. Press the bearing on with a press, making sure to bear down on the inner race only.

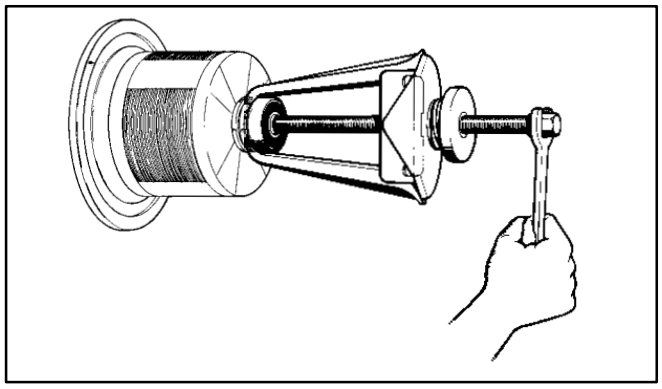


FIGURE 52. BEARING REMOVAL

Removing and Replacing the Slip Ring Assembly

Unsolder the two rotor leads from the slip ring assembly and pull the slip ring assembly off with a gear puller. Tape the key to the shaft to keep from loosing it if a new assembly is not going to be installed right away.

Press on a new slip ring assembly with a press, making sure the key is in place and the assembly is aligned with the key. Solder the two rotor leads to the solder terminals on the slip ring assembly.

TESTING THE GENERATOR

Testing the Rotor

It is possible to test the rotor without removing it from the generator by removing the brush block assembly.

Testing for a Grounded Winding: A digital ohmmeter is recommended for this test. Select the highest resistance scale on the meter and touch one test probe to the rotor shaft and the other to either slip ring as shown in Figure 53. Replace the rotor assembly if the meter does not indicate an open circuit to ground (the same high resistance as when the meter probes are separated by an air gap).

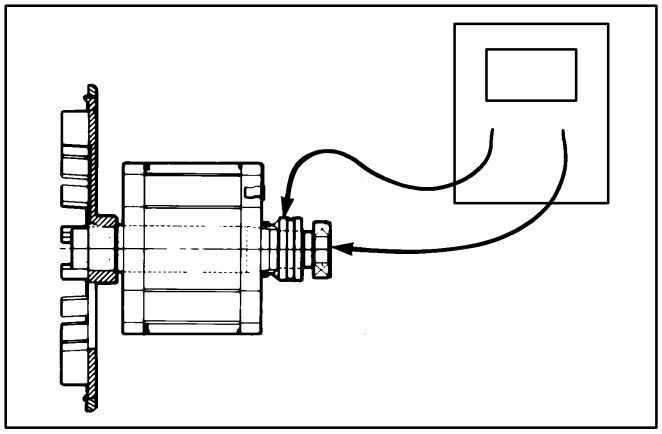


FIGURE 53. ROTOR INSULATION RESISTANCE

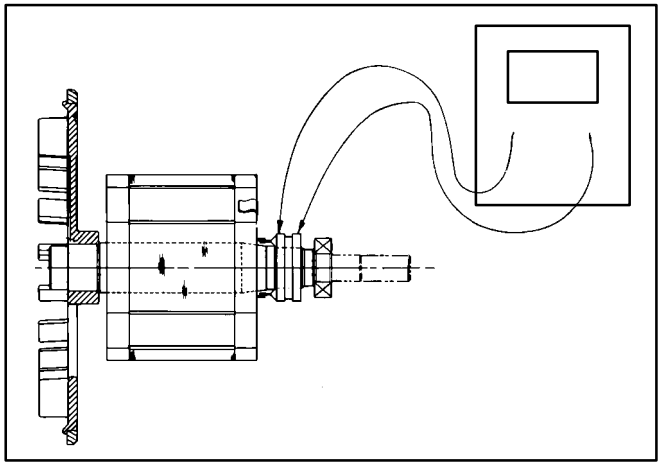


FIGURE 54. ROTOR WINDING RESISTANCE

Testing Winding Resistance: A digital ohmmeter is recommended for measuring rotor winding resistance. Select the best scale for measuring a 20 to 25 ohm value. Touch the test probes to the slip rings as shown in Figure 54.

If the meter indicates a high resistance, first check the connection between the slip rings and the rotor leads and resolder if necessary. Replace the rotor assembly if the connections are good but the winding does not meet the resistance specification in Table 5 or 6, as appropriate.

Testing the Stator

These tests can be done by disconnecting all the **Tx** winding leads from terminal block **TB1** and the **Bx** and **Qx** winding leads from their connectors. Single-phase generators have winding lead pairs **T1-T2**, **T3-T4** and **Q1-Q2**. Three-phase generators have lead pairs **T1-T4**, **T2-T5**, **T3-6**, **T7-T10**, **T8-T11** and **T9-T12**. Spec H generators also have lead pair **B1-B2**. Alternatively, a plug-in tester is available for conducting stator winding tests.

Testing for a Grounded Winding: A digital ohmmeter is recommended for this test. Select the highest scale on the meter. Test each lead as shown in Figure 55. Replace the stator assembly if any reading is low indicating a breakdown in the winding insulation.

Testing Winding Resistance: A digital ohmmeter can be used to determine if a stator winding is open, as shown in Figure 56. A Wheatstone (Kelvin) bridge should be used to measure stator winding resistance. Replace the stator assembly if any winding is open or does not meet the resistance specification in Table 5 or 6, as appropriate.

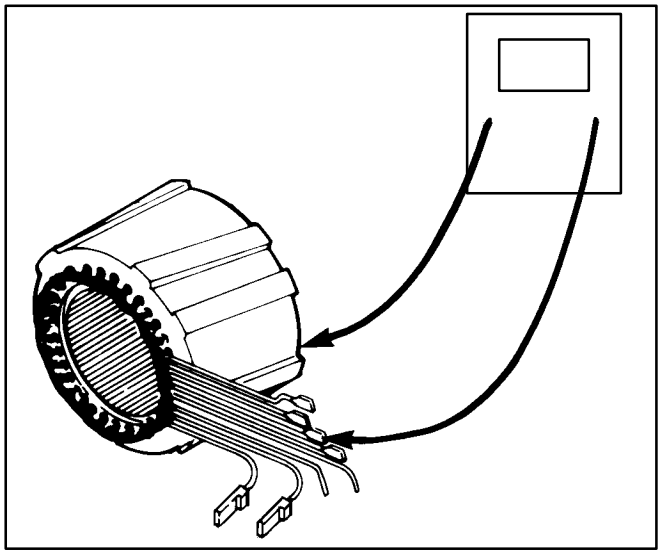


FIGURE 55. STATOR INSULATION RESISTANCE

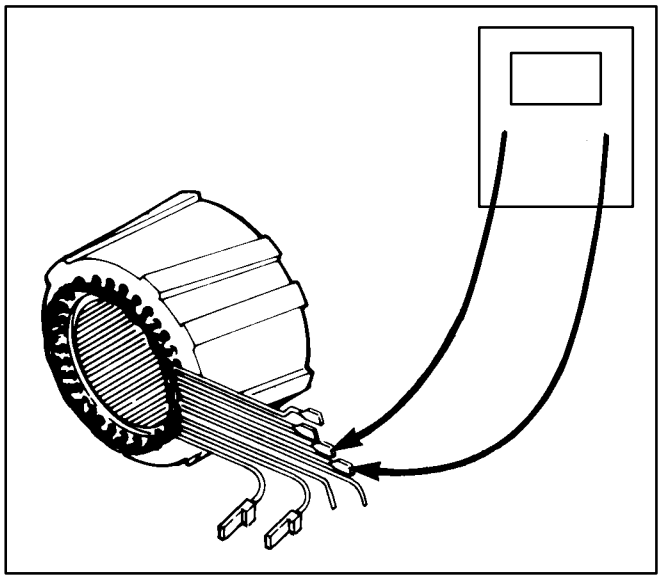


FIGURE 56. STATOR WINDING CONTINUITY

Checking Open-Circuit Output Voltage: Alternatively, check the open-circuit output voltage (VAC) of each stator winding as follows:

1. If necessary, service the brushes, slip rings and rotor and adjust for rated frequency.
2. Disconnect leads **F1** and **F2** from the brush block terminals.
3. Connect brush block terminal **B-** (inboard) to the negative (**-**) battery terminal on the genset.
4. Connect brush block terminal **B+** (outboard) to the positive (**+**) battery terminal on the genset (**K1-B+**). **This jumper should have a 10 amp fuse and switch**.
5. Measure the output across each lead pair while running the genset.

Replace the stator assembly if any winding does not meet the output specification in Table 5 or 6, as appropriate.

TABLE 5. SINGLE-PHASE GENERATOR STATOR SPECIFICATIONS

WINDING RESISTANCES* (OHMS)				
FREQUENCY (Hz)	LEAD PAIRS T1-T2, T3-T4	LEAD PAIR B1-B2	LEAD PAIR Q1-Q2 (SPEC H ONLY)	ROTOR WINDING
60	0.327	0.058	2.089	22.5
50	0.502	0.112	2.873	22.5
OPEN-CIRCUIT WINDING VOLTAGE (VAC) WHEN FIELD VOLTAGE IS 12 VDC				
FREQUENCY (Hz)	LEAD PAIRS T1-T2, T3-T4	LEAD PAIR B1-B2	LEAD PAIR Q1-Q2 (SPEC H ONLY)	ROTOR WINDING
60	49	7	58	-
50	49	7	58	-
* - These values are approximate, plus or minus 10 percent at 68° F (20° C).				

TABLE 6. THREE-PHASE GENERATOR STATOR SPECIFICATIONS

WINDING RESISTANCES* (OHMS)				
FREQUENCY (Hz)	LEAD PAIRS T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, T9-T12	LEAD PAIR B1-B2	LEAD PAIR Q1-Q2 (SPEC H ONLY)	ROTOR WINDING
60	1.089	0.101	-	24.78
50	1.625	0.114	-	24.78
60**	0.716	0.101	-	24.78
OPEN-CIRCUIT WINDING VOLTAGE (VAC) WHEN FIELD VOLTAGE IS 12 VDC				
FREQUENCY (Hz)	LEAD PAIRS T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, T9-T12	LEAD PAIR B1-B2	LEAD PAIR Q1-Q2 (SPEC H ONLY)	ROTOR WINDING
60	60	7	65	-
50	60	7	65	-
60**	60	7	65	-
* - These values are approximate, plus or minus 10 percent at 68° F (20° C). ** - 120/240 DELTA				

TESTING FOR FIELD VOLTAGE

To check the field voltage, remove the brush block cover and connect a DC voltmeter to the brush block terminals. See Figure 57. Connect the positive lead to the **B+** (outboard) terminal and the negative lead to the **B-** (inboard) terminal.

Start the genset and allow it to stabilize. Measure the field voltage with no load applied and then with full load applied. Both readings should fall between 25 and 100 volts DC and be stable at constant load. If field voltage fluctuates at constant load, a possible governor or voltage regulator problem exists. See *Troubleshooting.*

TESTING 1-PH VOLTAGE REGULATORS

See Figure 58. Confirm that the voltage regulator (VR1) is faulty before replacing it. Use the tester available or a meter with a diode checking function (Fluke Model 73 Multimeter, for example) to perform the following tests:

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

   A good reading is approximately 0.5, which is the voltage drop across a diode. “Short” is indicated by zero or a number very nearly zero. Meters of different type may indicate “open” differently. Read the meter instructions. If in doubt, compare readings with a regulator of the same part number known to be good.

GENERATOR RECONNECTIONS

When it is necessary to reconnect a generator, remove the control panel and reconnect the leads at terminal block **TB1** and circuit breakers **CB1**, **CB2** and **CB3** as shown in the appropriate diagram in Figure 59, 60 or 61. It should be noted that other leads are also connected to terminal block **TB1** in the control box and that they should be reconnected as marked, if inadvertently disconnected.

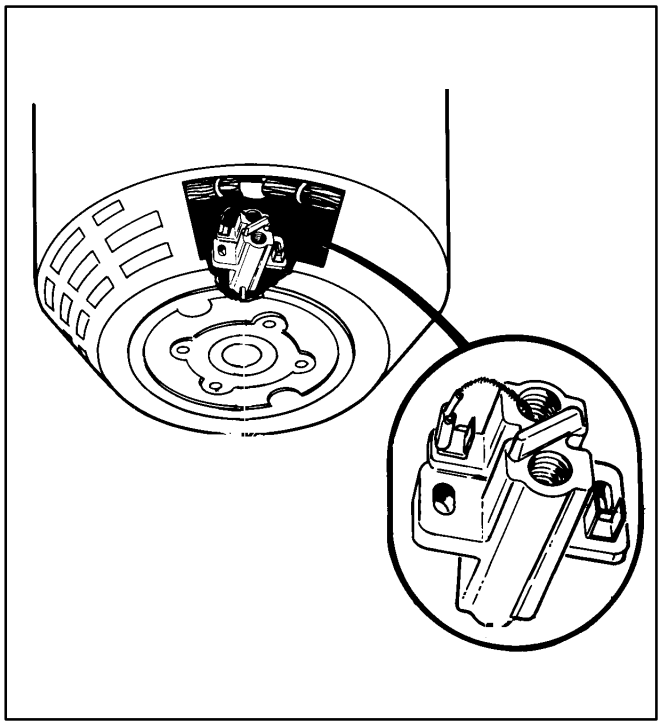


FIGURE 57. BRUSH BLOCK ASSEMBLY

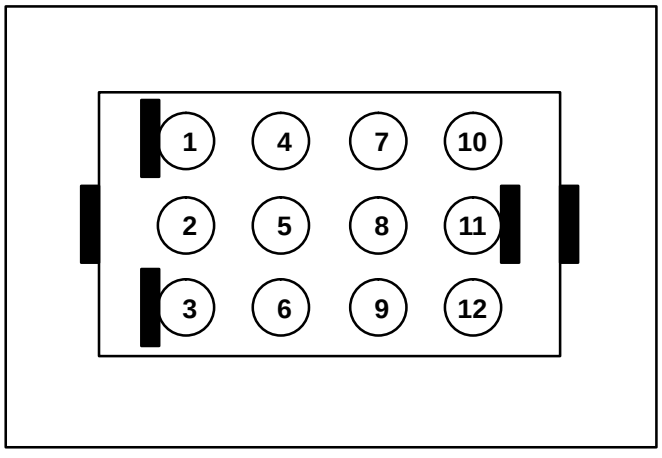
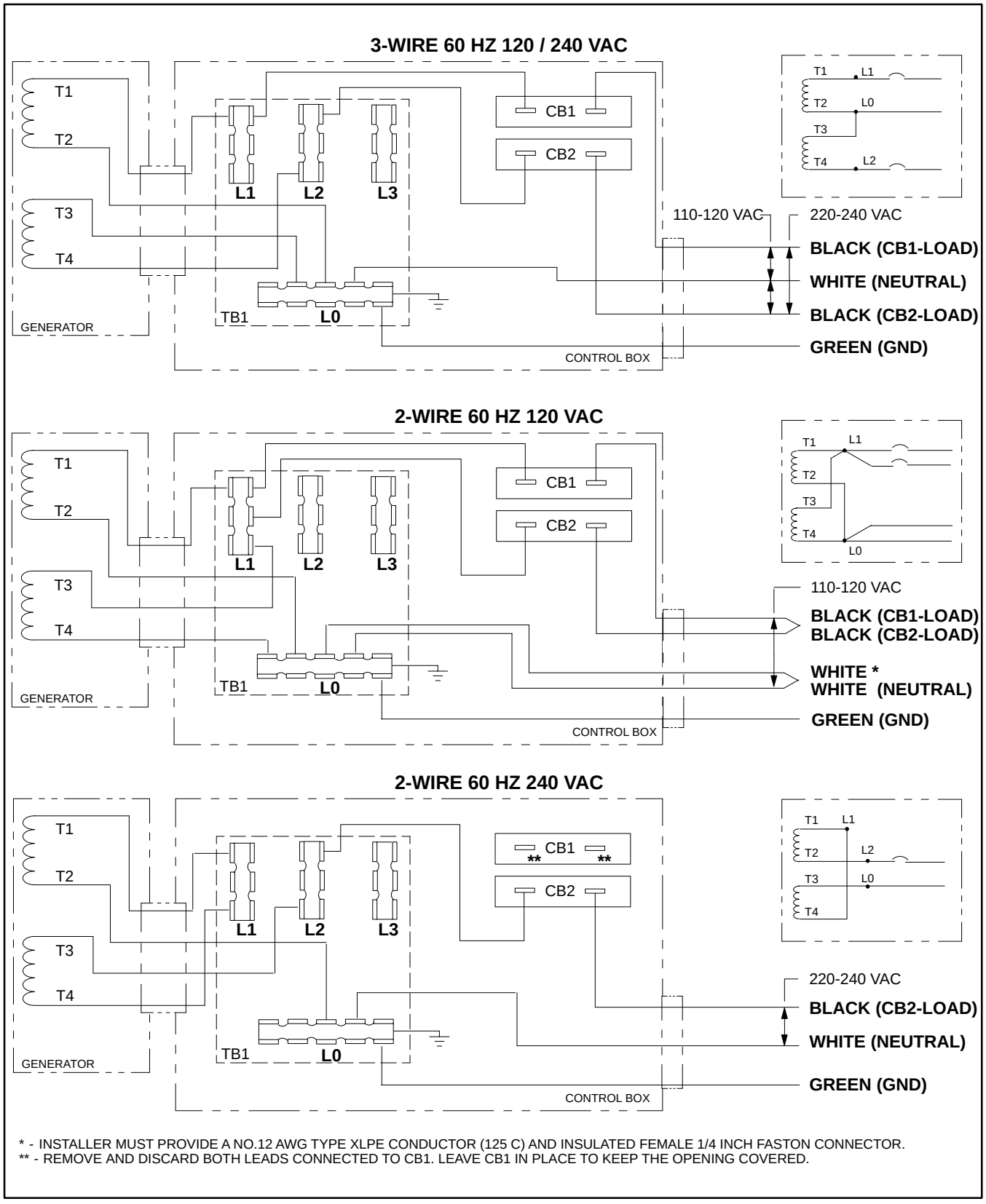
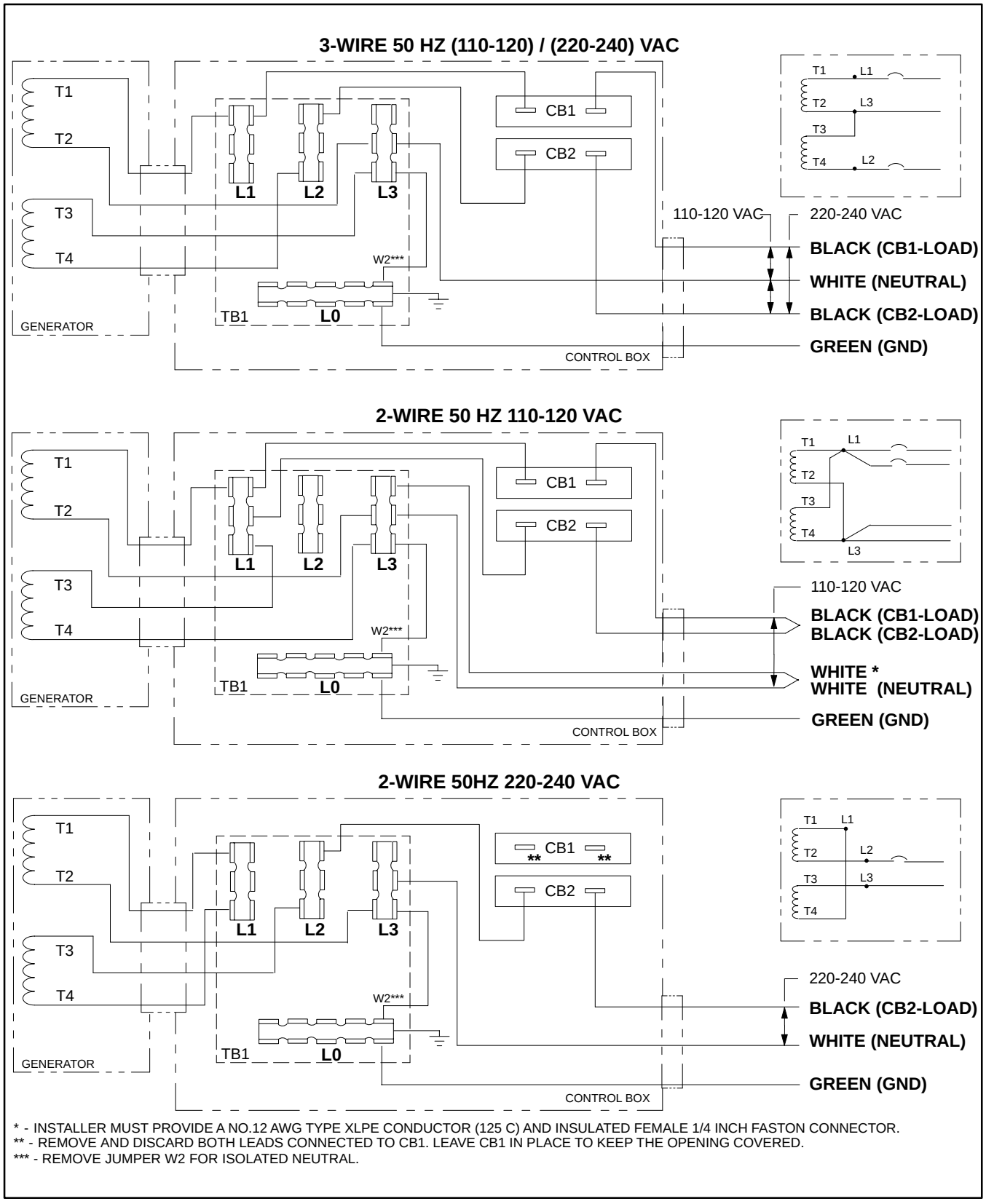


FIGURE 58. VOLTAGE REGULATOR TERMINALS (1-PHASE GENSETS)



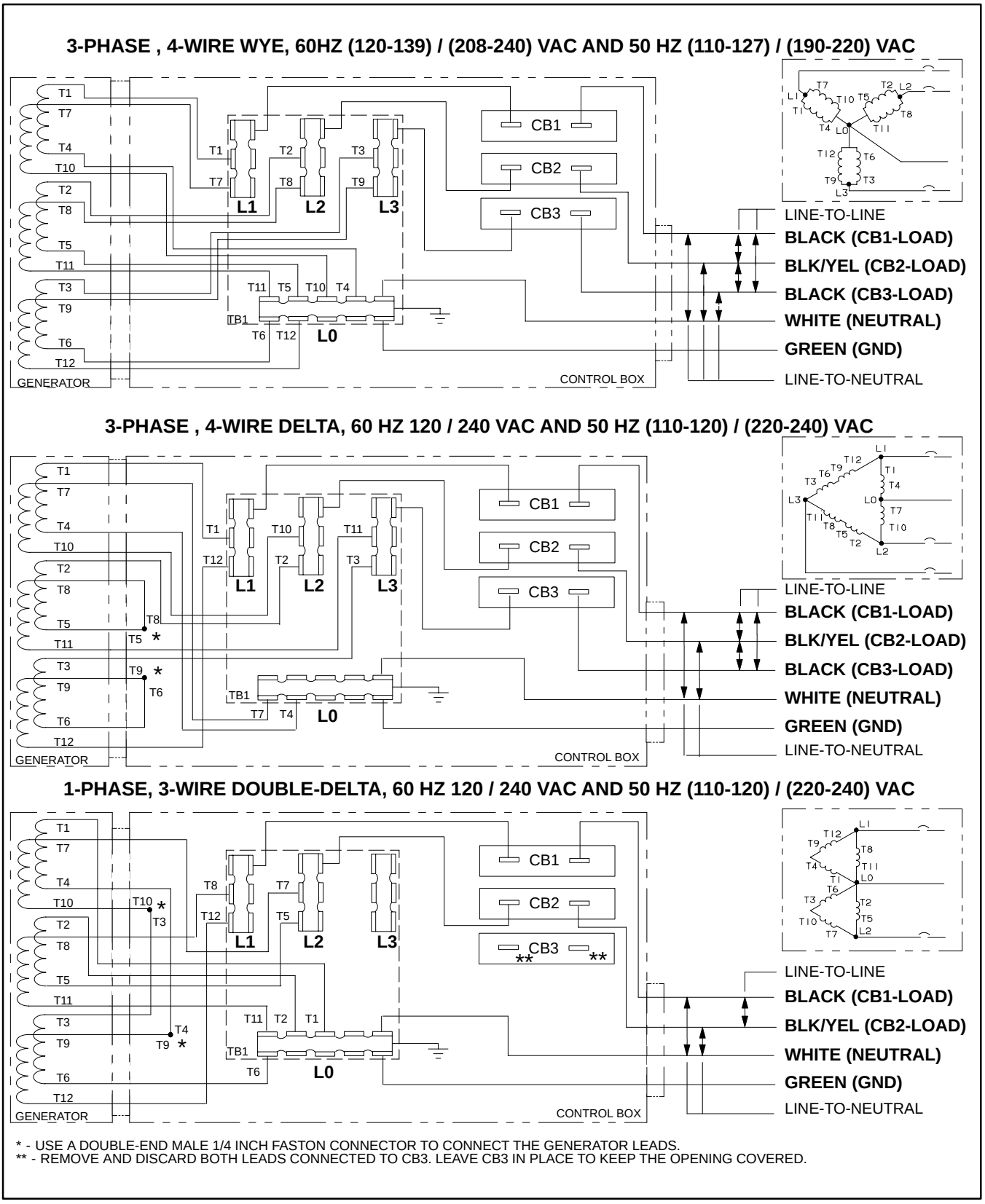
* - INSTALLER MUST PROVIDE A NO.12 AWG TYPE XLPE CONDUCTOR (125 C) AND INSULATED FEMALE 1/4 INCH FASTON CONNECTOR.
** - REMOVE AND DISCARD BOTH LEADS CONNECTED TO CB1. LEAVE CB1 IN PLACE TO KEEP THE OPENING COVERED.

FIGURE 59. SINGLE-PHASE (4-LEAD) 60 Hz GENERATOR RECONNECTIONS



* - INSTALLER MUST PROVIDE A NO.12 AWG TYPE XLPE CONDUCTOR (125 C) AND INSULATED FEMALE 1/4 INCH FASTON CONNECTOR.
** - REMOVE AND DISCARD BOTH LEADS CONNECTED TO CB1. LEAVE CB1 IN PLACE TO KEEP THE OPENING COVERED.
*** - REMOVE JUMPER W2 FOR ISOLATED NEUTRAL.

FIGURE 60. SINGLE-PHASE (4-LEAD) 50 Hz GENERATOR RECONNECTIONS



* - USE A DOUBLE-END MALE 1/4 INCH FASTON CONNECTOR TO CONNECT THE GENERATOR LEADS.
** - REMOVE AND DISCARD BOTH LEADS CONNECTED TO CB3. LEAVE CB3 IN PLACE TO KEEP THE OPENING COVERED.

FIGURE 61. THREE-PHASE (12-LEAD) GENERATOR RECONNECTIONS

Engine Block Assembly

Performing major service on the engine block assembly requires that the genset be removed from the vehicle. See *Preparations*. The control, generator and all engine subsystems must also be removed for complete access to the block assembly. Refer to the previous sections for disassembly and removal procedures.

CYLINDER HEADS

See Figures 62 and 63. Remove and clean the cylinder heads as follows when poor engine performance is noticed:

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

   ⚠ CAUTION ***The heads may warp if they are removed while hot. Wait until the engine has cooled before removing the heads.***

2. After removing the heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where the gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. It is a good idea to also remove the valves and clean carbon deposits from the valves and the intake and exhaust ports. See VALVE SYSTEM.
4. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the gaskets rest.
5. Place the heads in position and torque the head bolts in steps of 5 lbs-ft (7 N-m) in the numbered sequence shown in Figure 62 or 63 up to the specified torque of 15-17 lbs-ft (20-23 N-m).
6. Retorque the head bolts before the engine has run a total of 25 hours.

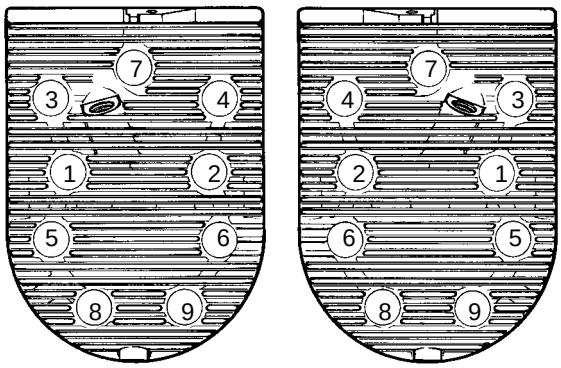


FIGURE 62. MODEL BGD CYLINDER HEAD BOLT TORQUE SEQUENCE

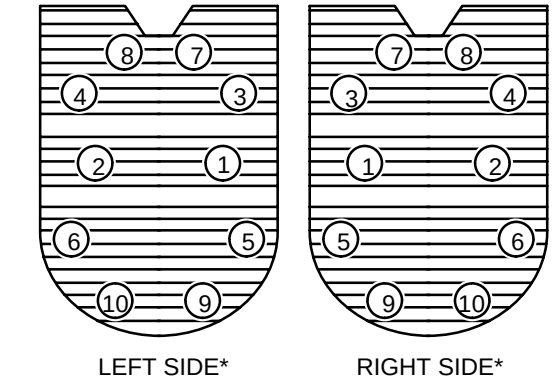


FIGURE 63. MODEL NHD CYLINDER HEAD BOLT TORQUE SEQUENCE

VALVE SYSTEM

See Figures 64 and 65 for the valve system layouts of the respective engines. This engines have a “side valve” type of valve system layout. A properly functioning valve system is essential for top engine performance.

See VALVE CLEARANCE (LASH) ADJUSTMENT under *Engine Subsystems* for instructions on how to adjust valve clearance.

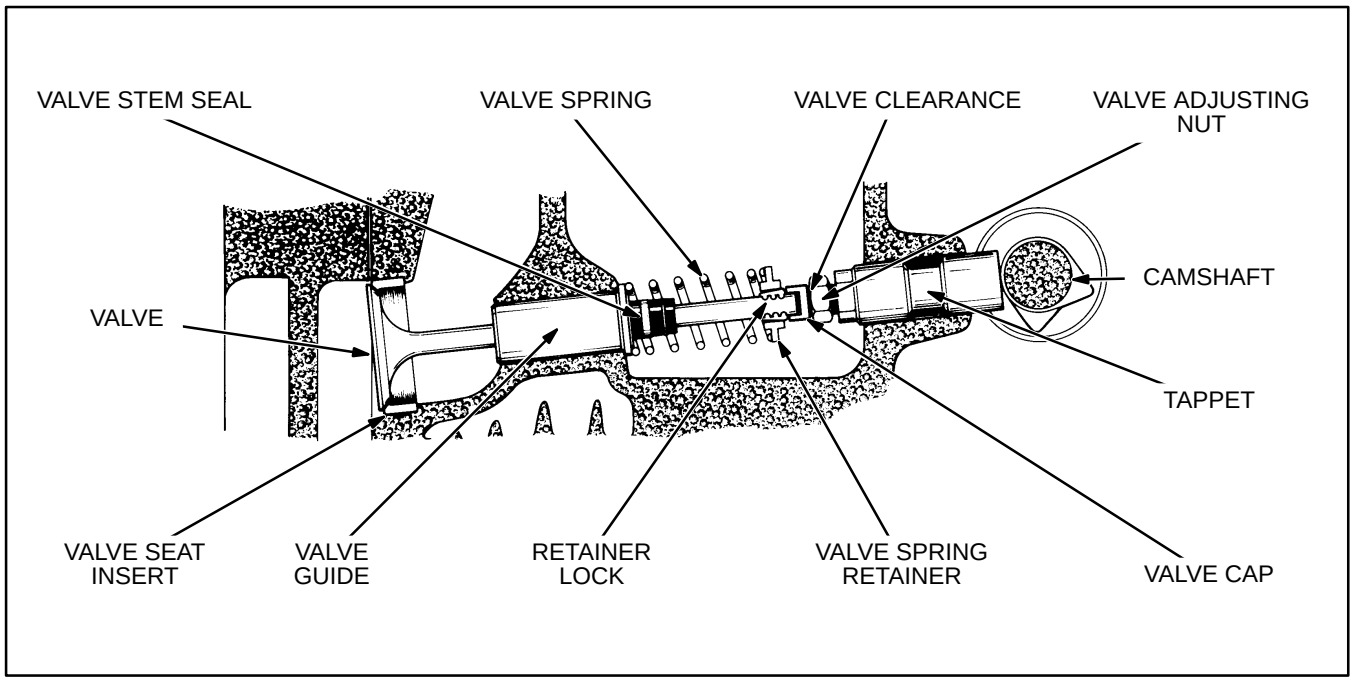


FIGURE 64. MODEL BGD VALVE SYSTEM

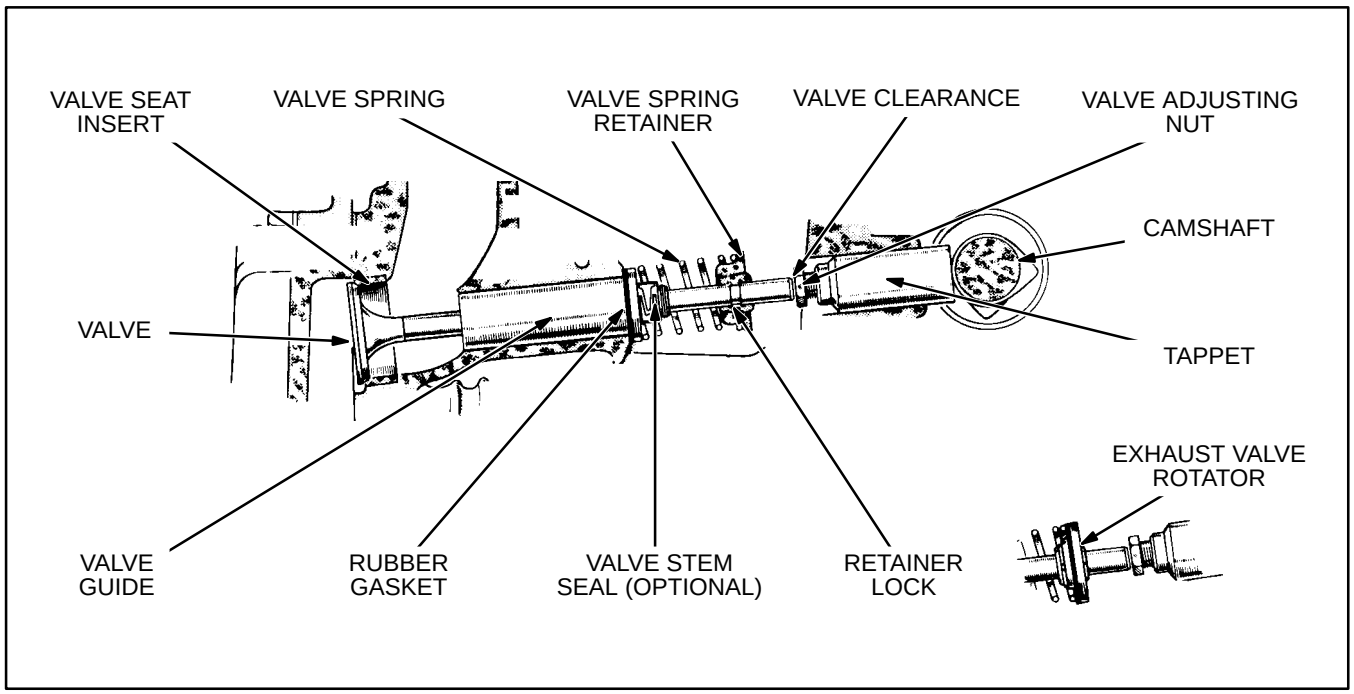


FIGURE 65. MODEL NHD VALVE SYSTEM

Inspecting the Valve System

The valve system is accessible by removing the cylinder heads and the valve covers on top of the engine. Use a valve spring compressor (Figure 66) to remove and replace the valves from the cylinder block. Make sure to first plug the breather hole in the Number 1 cylinder valve box (opposite oil filter side) to prevent the valve keepers from falling into the crankcase.

Valve Face: Check the valve face for evidence of burning, warping, out-of-roundness and carbon deposits (Figure 67).

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

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

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

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

Valve Stems and Guides: Check valve stems and guides for wear (Figure 68). Use a hole gauge to measure the valve guide bore diameter. When valve clearance with the stem exceeds the original clearance by 0.002 inch (0.05 mm), replace either the valve or guide or both, as necessary. Always regrind the seat to make it concentric with the newly installed guide.

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

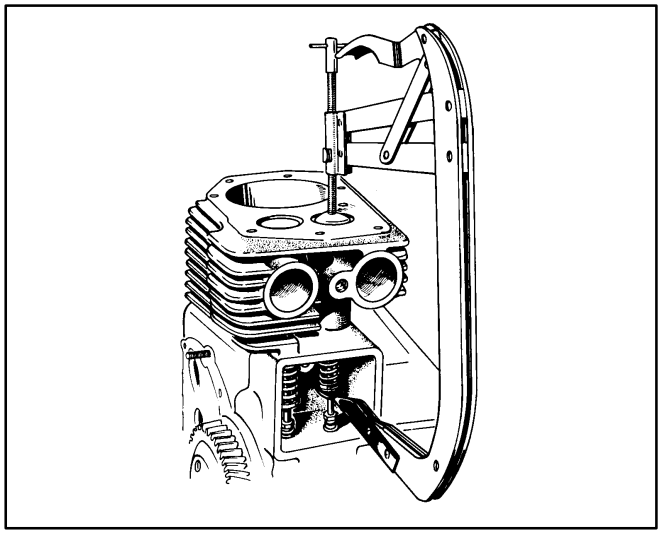


FIGURE 66. VALVE SPRING COMPRESSOR

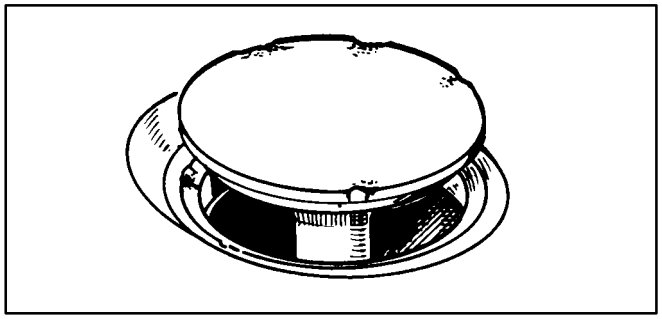


FIGURE 67. BURNED VALVE FACE

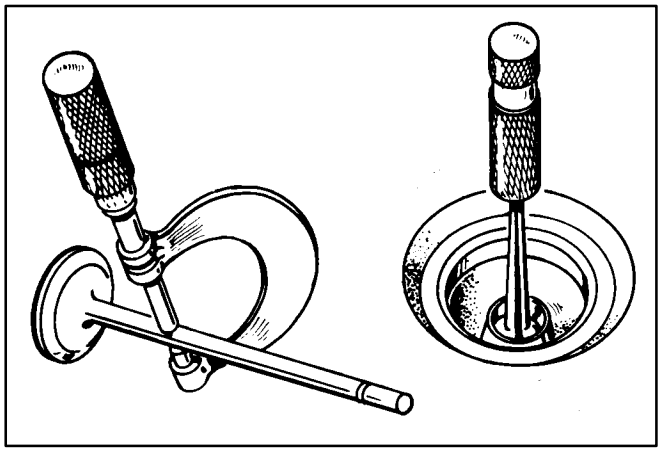


FIGURE 68. VALVE STEM AND VALVE GUIDE BORE DIAMETERS

Springs: Check the valve springs for free-height, squareness, end wear and tension. If the spring ends are worn, check the valve spring retainer for wear. Check for height and squareness by placing the spring on a flat surface next to a square. Rotate the spring against the square edge to measure its distortion. Check the spring tension at the installed height in both the valve open and closed positions, using a valve spring tester. Replace a weak, broken, worn or distorted spring.

Reconditioning Valves and Valve Seats

See Figure 69. The interference angle method of valve seating is used on these engines. The valve face angle is 44 degrees. The valve seat angle is 45 degrees. This 1-degree interference angle results in a sharp seating surface between the valve and the top of the valve seat.

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

Each valve must have a minimum of 1/32 inch (0.8 mm) margin (Figure 70). If the valve has less margin than this it will heat up excessively. It will retain this heat during the compression stroke and pre-ignite the mixture, causing loss of power and economy. This valve is also susceptible to warping and breakage.

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

Grind or cut the valve seats at 45 degrees. The seat band should be 1/32-3/64 inch (0.79-1.2 mm) wide. Remove only enough material to ensure proper valve seating. If a valve seat is cracked or loose or does not have enough material left to seat the valve properly, replace the entire block assembly.

Check each valve for a tight seat. Make several marks at regular intervals across the valve face using machinist's bluing. The marks should rub off uniformly when the valve is rotated a quarter-turn against the seat, indicating even contact all the way around. The line of contact should be at the center of the valve face.

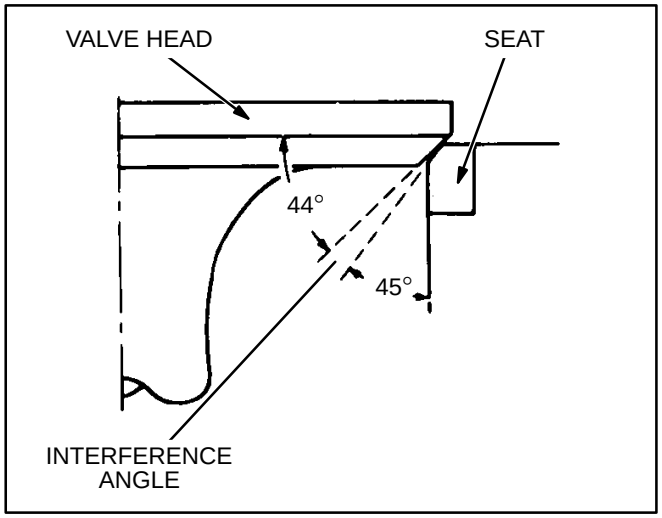


FIGURE 69. VALVE INTERFERENCE ANGLE

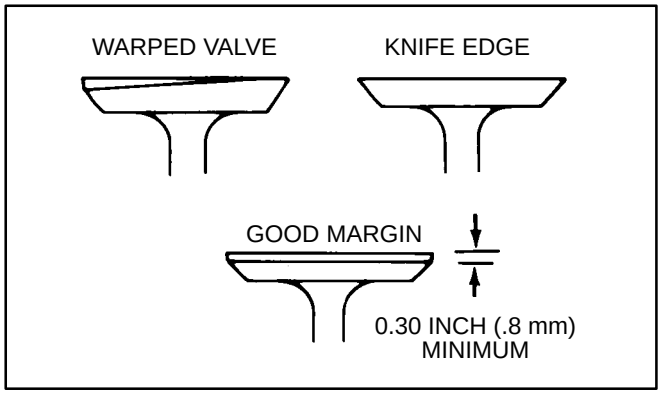


FIGURE 70. VALVE MARGIN

Replacing the Valve Guides

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

Removal:

1. Before removing the valve guides, use an electric drill with a wire brush to remove carbon and other foreign material from the top surface of the guides. Failure to do this may result in damage to the guide bores.

2. Drive the guides out with a hammer and a valve guide driver.

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

Installation:

1. Run a small polishing rod with crocus cloth through the valve guide holes, to clean out carbon and other foreign materials.

2. Place a new gasket on the intake valve guide and coat the outer edge of each new guide with anhydrous lanolin (available at the drugstore).

3. Place the guide, notch up, in the cylinder block and press it in until the shoulder of the guide rests against the cylinder block (Figure 71).

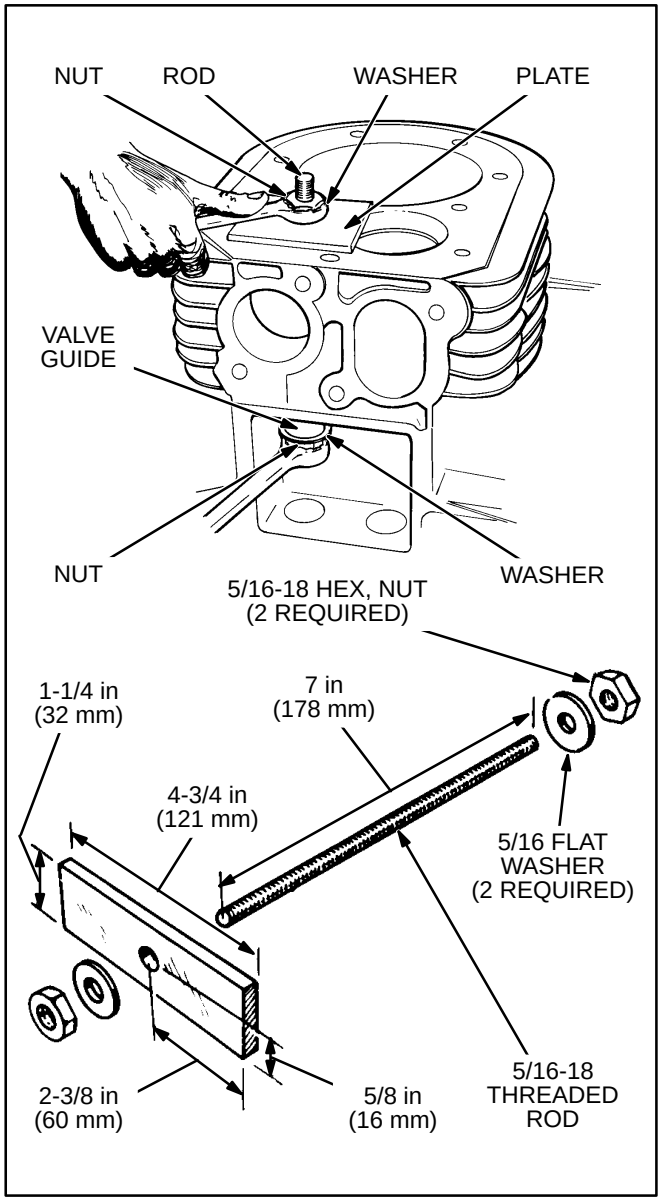


FIGURE 71. SUGGESTED TOOL FOR INSTALLING THE VALVE GUIDES

GEAR COVER

Removal

See Figure 72. Remove the flywheel, flywheel key and the gear cover mounting screws. See ENGINE COOLING SYSTEM under *Engine Subsystems*. Gently tap the gear cover with a leather or plastic mallet to loosen it.

Installation

1. When installing the gear cover, make sure that the pin in the gear cover engages the hole with the nylon grommet in the governor cup. See OIL SEALS in this section for replacing the gear cover oil seal.
2. Turn the governor cup so the hole with the nylon grommet is at the three o'clock position. Use a small amount of grease to help hold the cup in position. The rounded side of the governor yoke must ride against the governor cup.
3. Turn the governor arm and shaft clockwise as far as possible and hold it in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal.

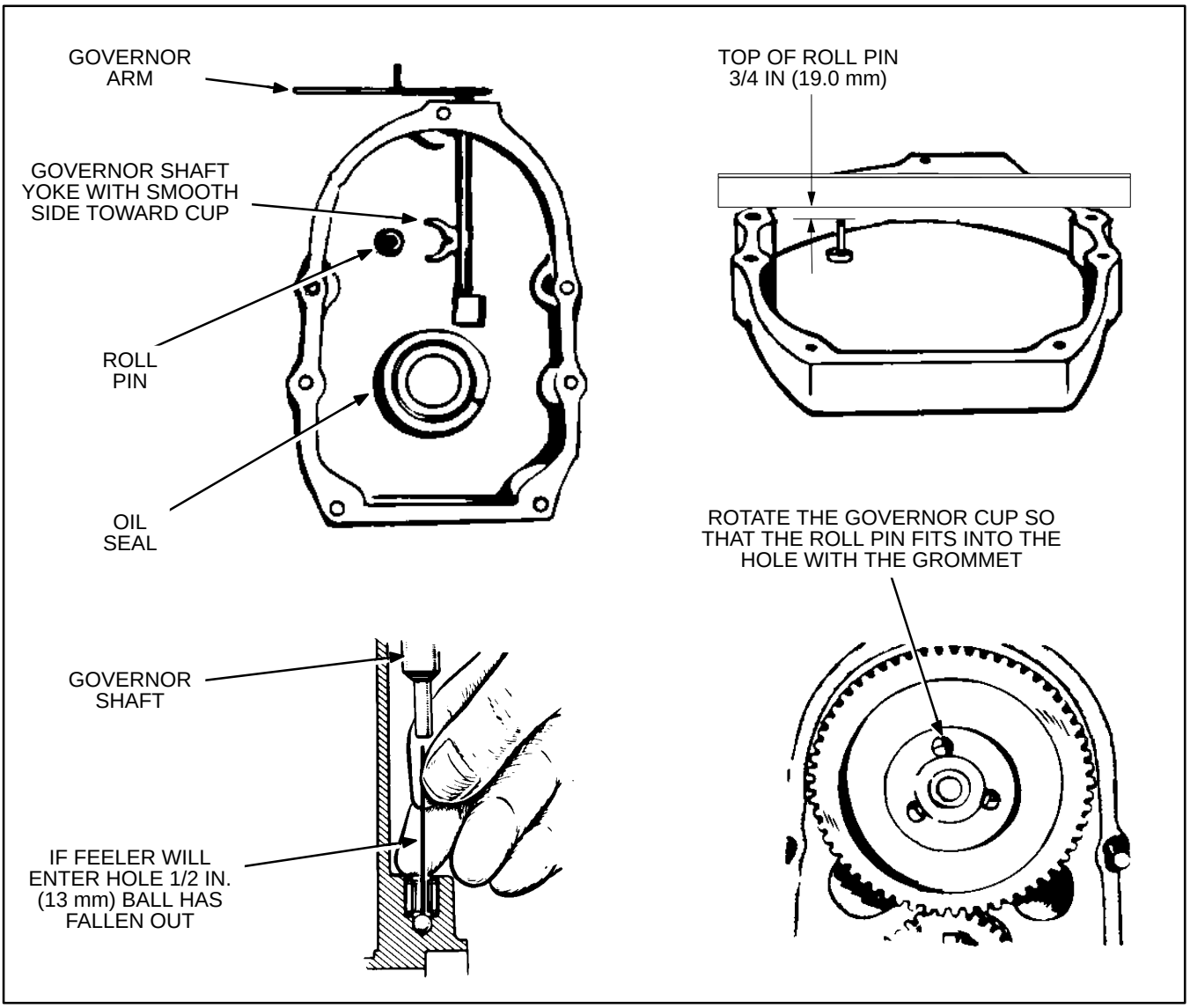


FIGURE 72. GEAR COVER ASSEMBLY

GOVERNOR CUP

Removal

1. Remove the gear cover. See GEAR COVER.
2. Remove the snap ring from the camshaft center pin (Figure 73).
3. Slide the governor cup off, making certain to catch the flyballs. Replace any flyball that is grooved or has a flat spot.
4. Examine the ball spacer. If the arms of the ball spacer are worn or otherwise damaged, remove the spacer by splitting it with a chisel. Use a press to install a new spacer on the camshaft gear.
5. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

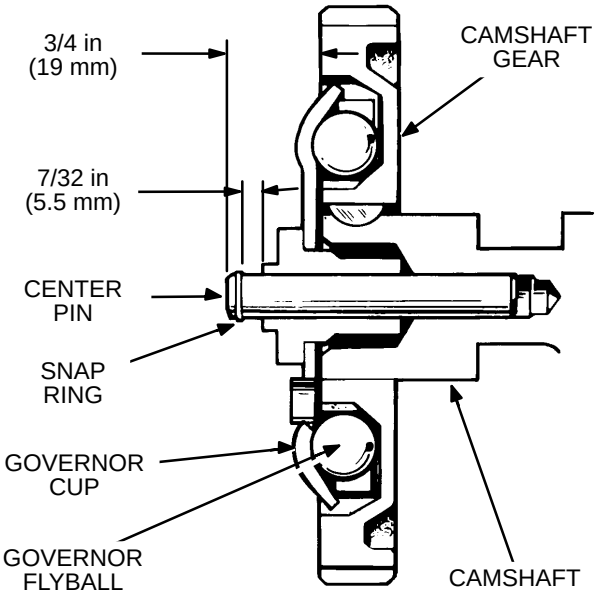
Installation

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

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

Camshaft Center Pin Installation

1. The camshaft center pin extends 3/4 inch (19 mm) from the end of the camshaft. This distance provides 7/32 inch (5.5 mm) travel for the governor cup, as shown. Measure this distance while holding the cup against the flyballs. If the distance is less, the engine may race, especially at no load.
2. Remove the center pin and press in a new pin the specified amount. Do not hammer the new pin into place, or it will be damaged. The camshaft center pin cannot be pulled outward or removed without damage. If the center pin extends too far, the cup will not hold the flyballs properly.



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

FIGURE 73. GOVERNOR CUP

TIMING GEARS AND CAMSHAFT

If either timing gear needs replacement, both gears should be replaced. Also, the camshaft and its gear are replaceable only as an assembly. See Figure 74.

Removal

1. Remove the valve tappets so that the camshaft can be withdrawn.
2. Remove the snap ring and retainer washer in front of the crankshaft timing gear.
3. Withdraw the camshaft/timing gear assembly.
4. Remove the oil pump.
5. Bolt the gear pulling ring to the crankshaft timing gear using two Grade 8, 1/4-20x1 inch bolts (lesser grade bolts will snap off) and remove the gear with a gear puller as shown. Alternatively, special shoulder bolts are available for use with the flywheel puller to remove the crankshaft gear.

Installation

1. Service the crankshaft as necessary and reinstall it. See CRANKSHAFT in this section.
2. Preheat the crankshaft timing gear in an oven to 325° F (168° C).
3. Make sure the key is in place in the crankshaft and then tap the gear down to the shoulder on the crankshaft.
4. Install the camshaft assembly. Make sure the thrust washer is in place between the back of the timing gear and the block and that the “0” marks on the timing gears line up as shown in Figure 74.
5. Install the oil pump assembly.
6. Install the retainer washer and snap ring in front of the crankshaft timing gear.

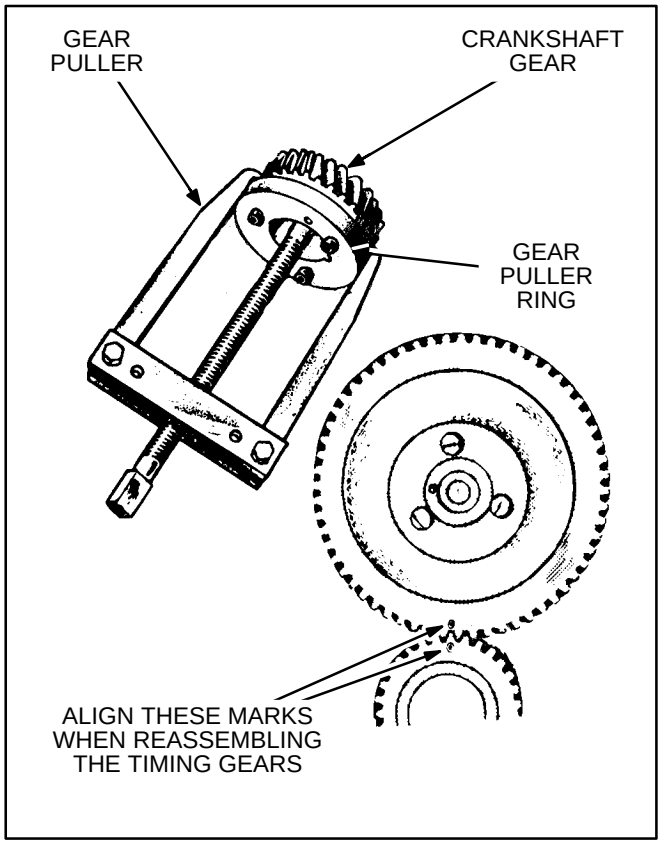


FIGURE 74. TIMING GEAR REMOVAL AND INSTALLATION

OIL PUMP ASSEMBLY

The oil pump is mounted on the front of the crankcase behind the gear cover and is driven by the crankshaft gear. The inlet pipe and screen assembly is attached to the pump body. A discharge passage in the pump cover is aligned with a passage drilled in the crankcase that leads to the front main bearing via the oil filter. A circumferential groove in the front main bearing allows oil to cross over to a drilled passage that leads to the front camshaft bearing. A copper colored crossover tube carries oil to the rear main bearing. The connecting rod journals are lubricated through drilled passages from the main journals. The oil overflow from the bypass valve lubricates the camshaft drive gears.

Replace the oil pump if the crossover tube is tight and the oil bypass valve is functioning properly but the oil pressure is below specification. The gasket and pick-up cup are the only individually replaceable parts. Oil the pump generously when reassembling it so that it will prime faster when the engine is first started.

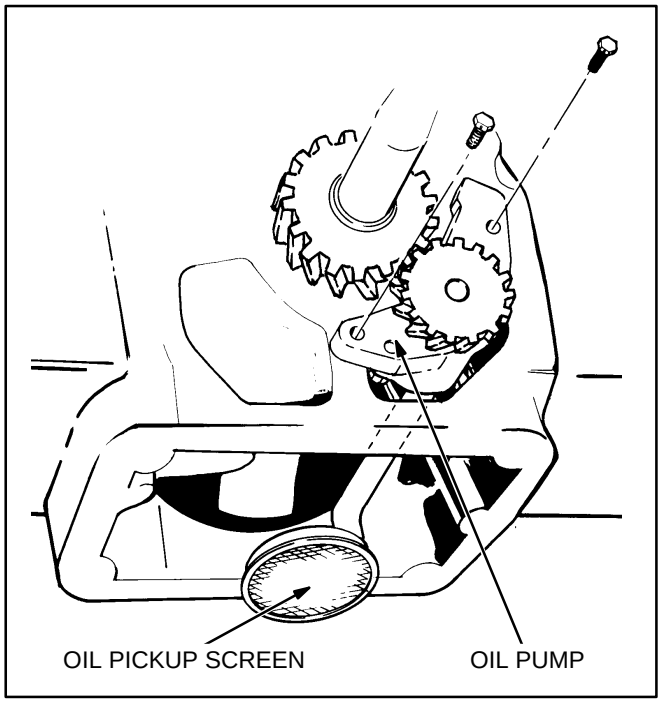


FIGURE 75. OIL PUMP ASSEMBLY

PISTON ASSEMBLY

The piston assembly consists of the piston, rings and connecting rod assembly. After removal from the engine, all parts must be carefully inspected for damage and wear before they are replaced.

Removal and Disassembly

1. Remove the ridge at the top of the cylinder with a ridge reamer before attempting to remove the piston (Figure 76).

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

2. Turn the crankshaft until a piston is at the bottom of its stroke.
3. Remove the bearing caps from the connecting rods and push the rods and pistons out the top of the cylinders. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.
4. Mark each piston, rod and bearing cap so that they can be reassembled together in the same cylinder.
5. The pistons are fitted with two compression rings and one oil control ring. Remove these rings from the piston using a piston ring spreader (Figure 77).
6. Remove the piston pin retainer from each side and push the pin out.
7. Remove dirt and deposits from the piston surfaces with an approved cleaning solvent. Clean the piston ring grooves with a groove cleaner, or with the end of a piston ring filed to a sharp point (Figure 78). Take care not to remove metal from the sides of the grooves.

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

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

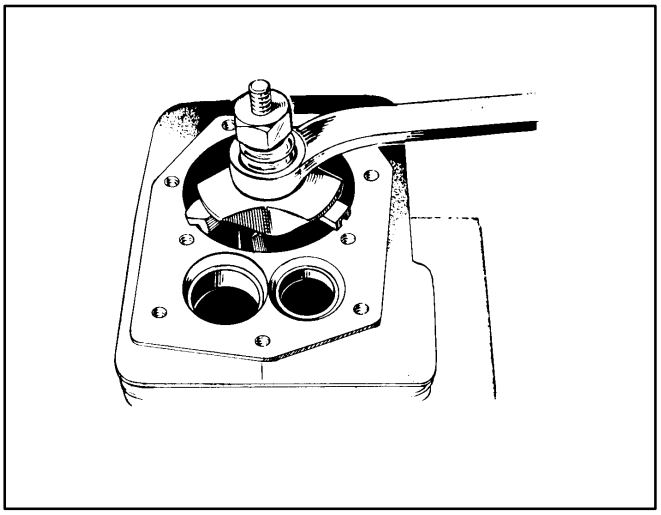


FIGURE 76. CYLINDER RIDGE REAMER

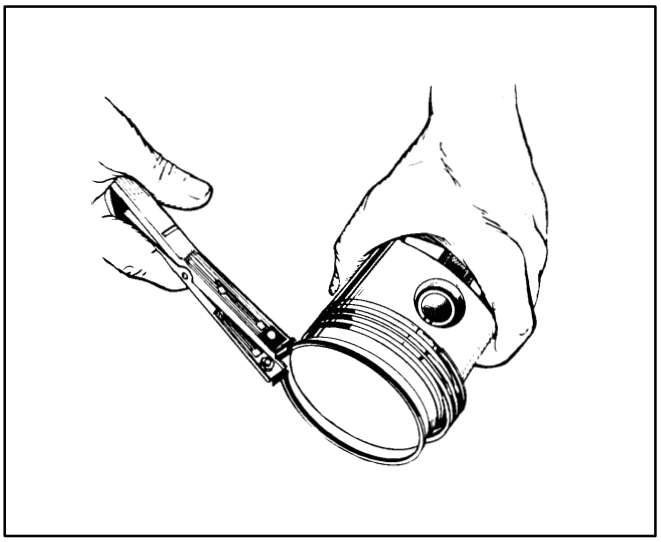


FIGURE 77. PISTON RING SPREADER

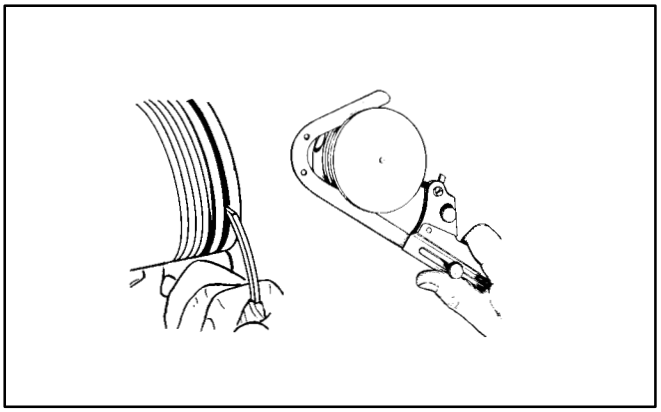


FIGURE 78. PISTON RING GROVE CLEANER

Piston and Connecting Rod Inspection

Piston Inspection: Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands, using a new ring and feeler gauge (Figure 79). Replace the piston if the side clearance of the top compression ring is 0.008 inch (0.20 mm) or more.

Improper ring width or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves do not make adequate contact with the cylinder wall (Figure 80).

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

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

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

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

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

Piston Clearance

Correct piston tolerances must be maintained. Use a micrometer to measure the piston diameter at the point shown in Figure 81. When the cylinder bore is measured (see CYLINDER BLOCK), subtract the piston diameter from the cylinder bore diameter to obtain the piston-to-cylinder wall clearance. See *Tolerances and Clearances*.

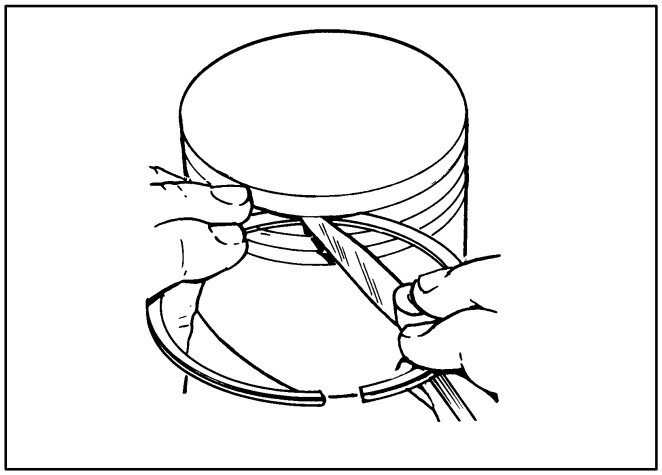


FIGURE 79. CHECKING RING LAND

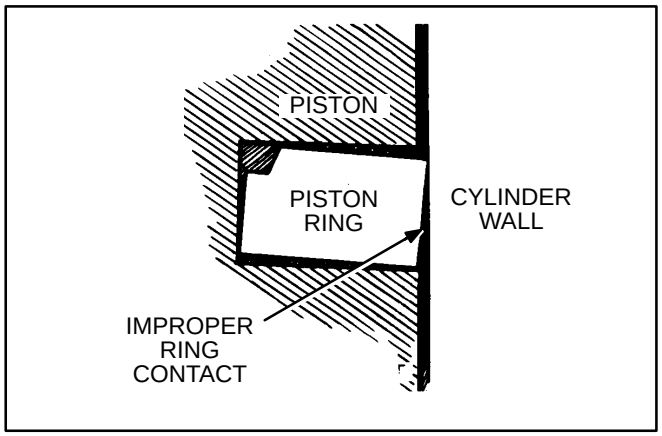


FIGURE 80. NEW RING IN WORN RING GROVE

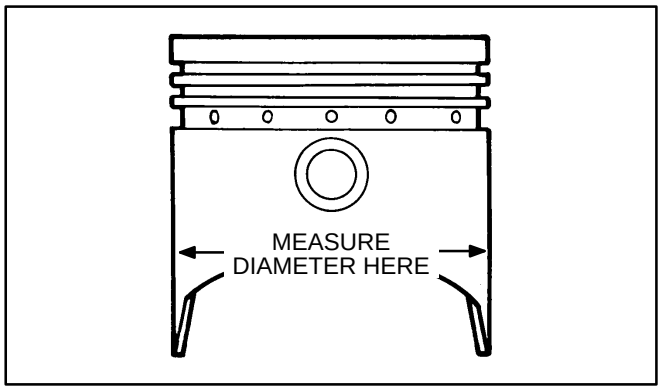


FIGURE 81. MEASURING PISTON DIAMETER

Piston Ring Gap

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder, at a position corresponding to the bottom of its travel (Figure 82). The gap should be 0.010-0.020 inch (0.25-0.50 mm).

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

Rings that are 0.010, 0.020, 0.030 and 0.040 inch (0.25, 0.51, 0.76 and 1.02 mm) oversize should be used on corresponding oversize pistons.

Piston Assembly

1. Lubricate all parts with clean engine oil.
2. Line up the piston and connecting rod and insert the piston pin. The piston pin is a full-floating type kept in place by a lock ring on each side. Push the lock rings in by thumb pressure or pry them in with a small screwdriver. Make sure they are properly seated.

   ⚠CAUTION ***Wear safety glasses and hold your thumb over the lock ring to keep it from flying out and getting lost or causing personal injury.***
3. Refer to Figure 83. Use a piston ring spreader to install the piston rings to prevent twisting or excessive expansion. Follow the instructions in the ring kit exactly. Note which ring goes in which groove and which side of the ring is “up”. Also note that the oil control ring is an assembly.

Piston Installation

1. The crankshaft must be in place and should have been serviced already if crankshaft service was required. See CRANKSHAFT.
2. Turn the crankshaft to position the Number 1 rod bearing journal (side opposite oil filter side) at the bottom of its stroke.
3. Lubricate the Number 1 piston assembly and cylinder with engine oil. Compress the rings with a ring compressor as shown in Figure 85. Install the bearing insert in the piston rod.
4. Position the piston and rod assembly in the cylinder block with the connecting rod oil hole up (Figure 84).

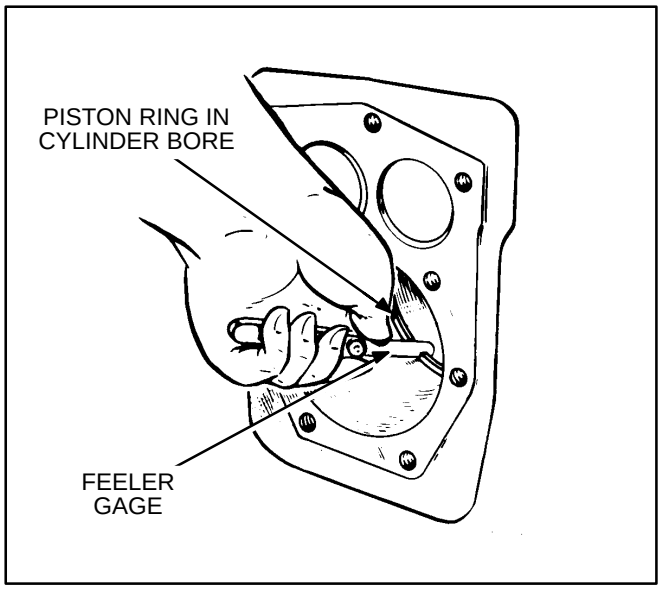


FIGURE 82. CHECKING RING GAP

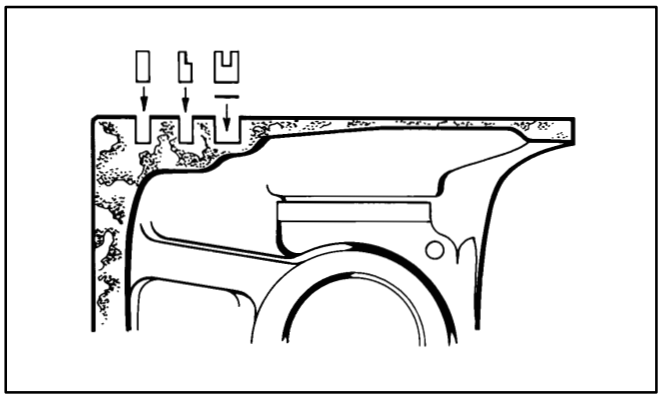


FIGURE 83. PISTON RINGS

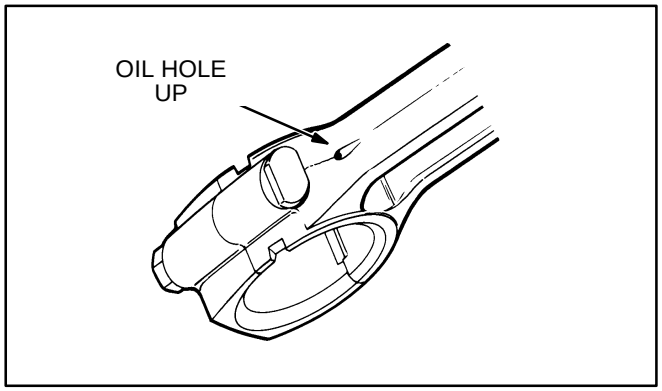


FIGURE 84. CONNECTING ROD OIL HOLE

5. Tap the piston into the bore with the handle end of the hammer until the connecting rod is seated on the crankshaft journal (Figure 85). If the crankshaft has been reground and/or new rods are being installed, check the bearing clearance with Plasti-gage as instructed below under Rod Bearing Clearance.

6. Install the rod bearing cap as follows:

   A. Lubricate the cap bolts with engine oil and torque to 5 lbs-ft (7 N-m).

   B. Strike the cap/rod joint using a hardwood block and a leather or plastic mallet to remove any misalignment (Figure 86).

   C. Torque the cap bolts to 14 lbs-ft (19 N-m). Recheck the torque on each bolt after both bolts have been torqued.

   ⚠CAUTION ***Failure to align the rod and cap can result in high engine oil temperature and failure of the rod.***

7. Install the other piston assembly and crank the engine by hand to see that all bearings are free.

Connecting Rod Bearing Clearance

1. Wipe all parts clean of oil and grease.

2. Select Plasti-gage that corresponds to the connecting rod bearing clearance specification (0.0020-0.0033 inch [0.051-0.084 mm]). Place the piece of Plasti-gage across the full width of the bearing cap, about 1/4 inch (6 mm) off-center (Figure 87).

3. Install the rod bearing caps as instructed in Step 6 of Piston Installation above. Make sure not rotate the crankshaft or the Plasti-gage will smear.

4. Remove the bearing cap, leaving the Plasti-gage on the part it sticks to. Check the widest part of the flattened Plasti-gage with the graduations on the envelope to determine the bearing clearance.

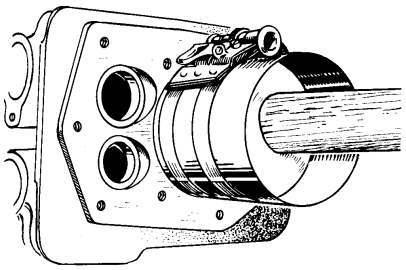


FIGURE 85. INSERTING PISTON

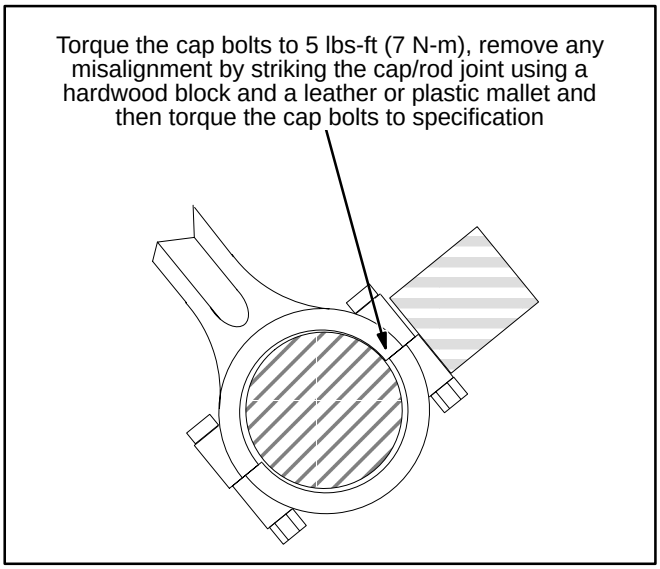


FIGURE 86. ALIGNING CONNECTING ROD CAP

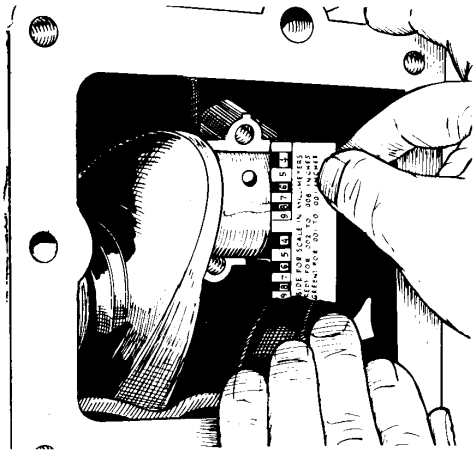


FIGURE 87. USING PLASTI-GAGE

CRANKSHAFT

Removal

1. Remove the piston/rod assemblies if they have not already been removed.
2. Remove the gear cover and crankshaft timing gear. See GEAR COVER and TIMING GEARS in this section.
3. Loosen the rear bearing plate screws and remove the bearing plate, gasket, thrust washer and shims. See BEARINGS in this section.
4. Turn the crankshaft so the crankthrow is aligned with the notch in the rear opening of the crankcase and carefully slide the crankshaft out.

Inspection

Inspect the rod and main bearing journals. If they are worn or scored and cannot be smoothed by polishing, either the journals should be reground to the next undersize, or the crankshaft should be replaced.

Clean out the drilled oil passages in the crankshaft.

Installation

1. Lubricate the front and rear main bearings with engine oil.
2. Use oil or gear lubricant to hold the front thrust washer in place against the engine block (see Figure 90). The flat side of the thrust washer goes against the block.
3. Position the crankshaft so that the crank throw is aligned with the notch at the rear of the crankcase and install the crankshaft. Make sure the front thrust washer did not slip out of place during installation.
4. Place the oil seal loader on the oil seal guide and driver and insert it into the rear bearing plate. Remove the seal guide and driver leaving the loader in the bearing plate. The loader prevents the seal from being cut on the crankshaft keyway during installation of the rear bearing plate.
5. Use oil or gear lubricant to hold the shim(s) and rear thrust washer in position on the rear bearing plate (see Figure 89). The shim goes against the bearing plate and the flat surface of the thrust washer goes against the shim.
6. Place the bearing plate gasket in position on the block, making sure the oil hole on the back of the block is exposed.
7. Install the rear bearing plate and fasten with two nuts (or capscrews) tightened to the specified torque. Make sure the rear thrust washer and shim(s) did not slip out of place during installation. The crankshaft should turn freely by hand.

Crankshaft Endplay

See Figure 88. After tightening two rear bearing plate nuts (or capscrews) to the specified torque, check the crankshaft endplay at the point shown using a feeler gauge.

1. Lightly tap the front of the crankshaft with a plastic-faced hammer to take up the endplay. The endplay should be 0.006-0.012 inch (0.15-0.30 mm).
2. If necessary, remove the rear bearing end plate and add or remove shims.
3. Install the end plate and tighten all nuts (or capscrews) to the specified torque.
4. Make sure the shim and thrust washer are in place and recheck crankshaft endplay. Verify that the crankshaft turns freely without binding.

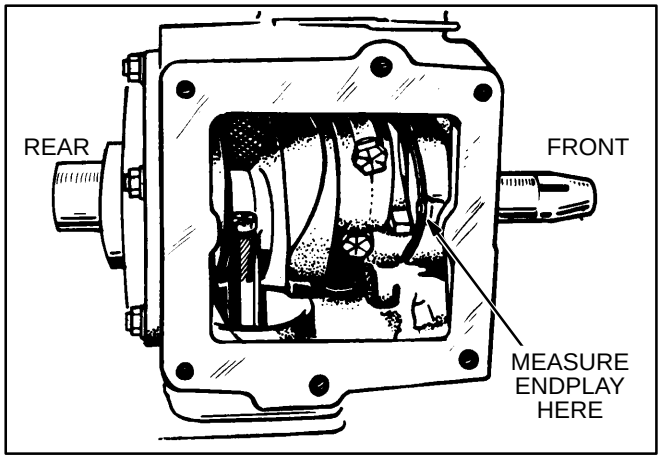


FIGURE 88. CHECKING CRANKSHAFT ENDPLAY

BEARINGS

To replace the crankshaft and camshaft bearings, the engine must be completely disassembled. Use the special drivers available to drive out the old bearings and drive in the new. Support the engine casting so as not to cause distortion or damage to the bore or casting.

Crankshaft Bearings

Crankshaft bearings are available in standard size, 0.002, 0.010, 0.020 or 0.030 inch undersize.

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

Rear Bearing: Use the special driver available to drive in the rear main bearing. Push the bearing into the bearing plate from the inner side to the depth allowed by the flange on the driver. See Figure 89.

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

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

Use the special driver available to drive in the front bearing. Push the bearing in to the depth allowed by the flange on the driver. Wipe off any excess Loctite and allow one hour for hardening at room temperature. See Figure 90.

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

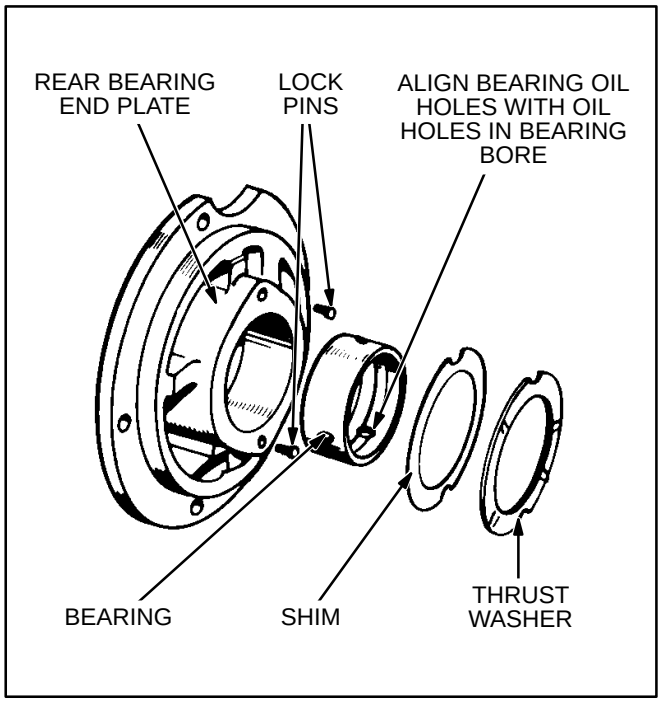


FIGURE 89. REAR CRANKSHAFT BEARING

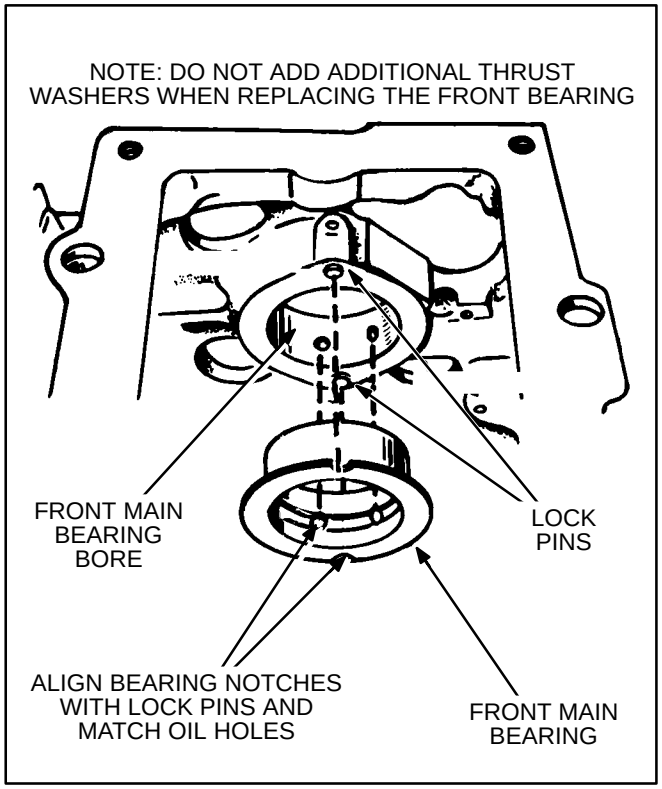


FIGURE 90. FRONT CRANKSHAFT BEARING

Camshaft Bearings

It should be noted that identical bearings are used for replacing the front and rear camshaft bearings and that they may look different from the old bearings.

1. Clean the outside of each bearing and the bearing bore in the block and coat the outside of the bearing with Loctite brand Bearing Mount or equivalent just before pressing it into its bore.
2. Press the front bearing in so that the oil hole in the bearing lines up with the oil hole in the bore (Figure 91).
3. Press the rear bearing in so that it is positioned 1/2 inch (12.7 mm) from the outside edge of the bore. There is no oil hole in the rear bore with which to line up the hole in the bearing (Figure 92).
4 Coat the bearing surfaces with engine oil after installation.

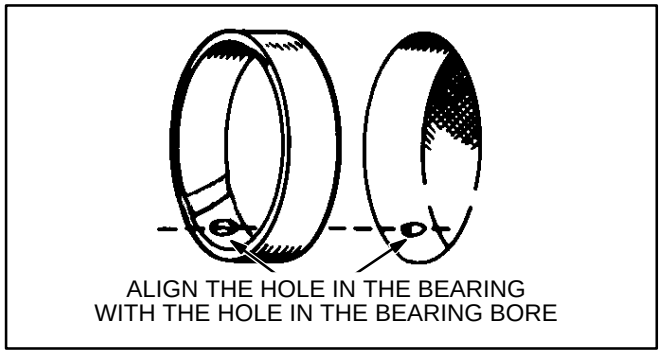


FIGURE 91. FRONT CAMSHAFT BEARING

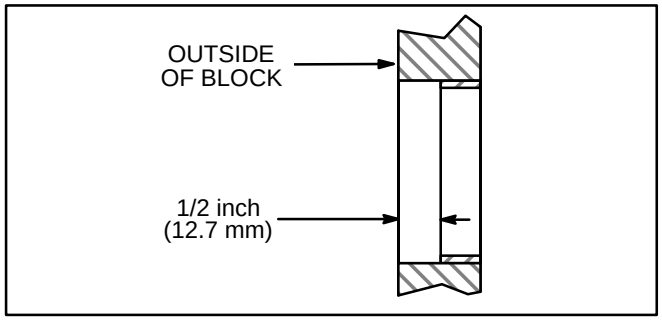


FIGURE 92. REAR CAMSHAFT BEARING

OIL SEALS

Remove the rear bearing plate to replace the rear oil seal (Figure 93) and the gear cover to replace the front oil seal (Figure 94). Use an oil seal remover to pry out the oil seals. Clean the bores of all old sealing compound before installing the new seals.

Use an oil seal guide and driver to drive the rear seal into the rear bearing plate until it bottoms against the shoulder of the plate.

Drive the front oil seal into the gear cover until it is 0.95-0.99 inch (24.1-25.1 mm) from the mounting face of the cover.

Place a light coating of grease on the lips of the seals before installing the rear bearing plate and gear cover. This provides initial lubrication until engine oil reaches the seal. Refer to CRANKSHAFT for the rear bearing plate installation procedure. Refer to GEAR COVER for the gear cover installation procedure.

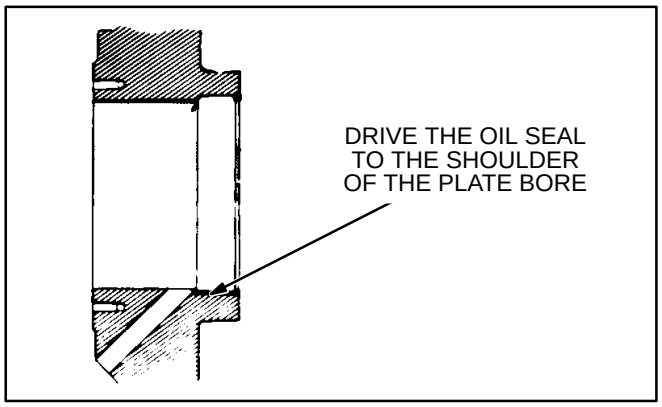


FIGURE 93. REAR CRANKSHAFT OIL SEAL

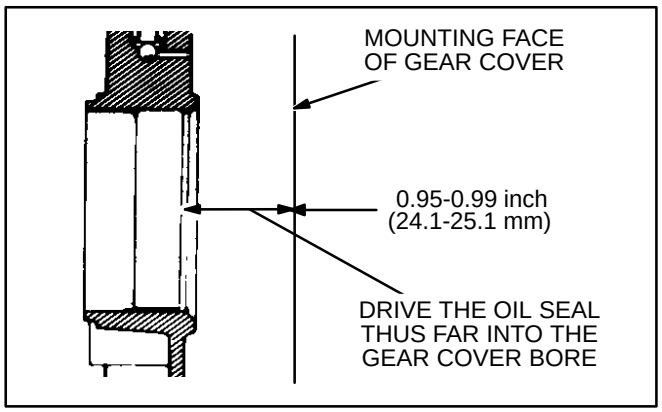


FIGURE 94. FRONT (GEARCASE) CRANKSHAFT OIL SEAL

ENGINE BLOCK

The engine block is the main support for all other basic engine parts and subassemblies.

Cleaning

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

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

Inspecting the Block

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

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

Inspecting the Cylinder Bores

Inspect the cylinder bores for scuffing, scratches, wear and scoring. If these conditions exist, the cylinders must be rebored and honed for the next oversize piston.

If the cylinder bores look good and there are no scuff marks, check the bores for wear and out-of-roundness as follows:

1. Check cylinder bore for taper, out-of-roundness and wear with a cylinder bore gauge, telescope gauge or inside micrometer. These measurements should be taken at four places: the top and bottom of piston ring travel, and parallel and perpendicular to the axis of the crankshaft. See Figure 95.

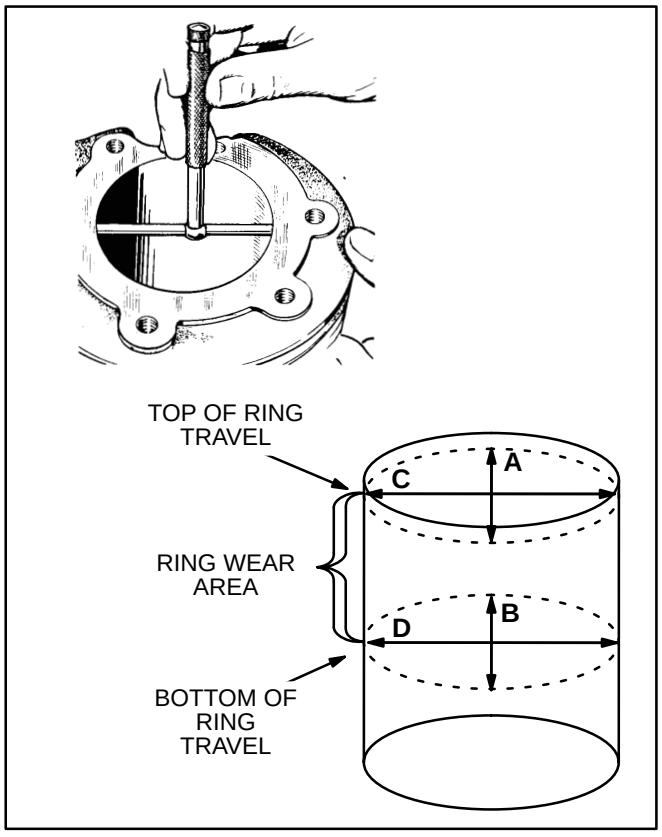


FIGURE 95. MEASURING CYLINDER BORE

2. Record the measurements taken at the top and bottom of the piston travel as follows:

   A. Measure and record as A the cylinder bore diameter (parallel to crankshaft) near the top of cylinder bore where the greatest amount of wear occurs.

   B. Measure and record as B the cylinder bore diameter (parallel to crankshaft) at the bottom of piston travel.

   C. Measure and record as C the cylinder bore diameter (perpendicular to crankshaft) near the top of cylinder bore where the greatest amount of wear occurs.

   D. Measure and record as D the cylinder bore diameter (perpendicular to crankshaft) at the bottom of piston travel.

   E. Reading A subtracted from reading B and reading C subtracted from reading D indicates the cylinder taper.

   F. Reading A compared to reading C and reading B compared to reading D indicates whether or not the cylinder is out-of-round. If the out-of-round exceeds 0.003 inch (0.08 mm), the cylinders must be rebored and honed to the next oversize. A reboring machine is used when changing to oversize pistons. The following repair data describes the honing procedure.

Machining the Cylinder Bores

The available oversize pistons and rings will fit with the required clearance in cylinders machined to the matching oversize (standard bore plus 0.005, 0.010, 0.020, 0.030 and 0.040 inch). There is no need to adjust or to "fit" pistons and rings. Piston and ring size should be checked as described below to confirm that they are correct for the standard bore oversize. Boring and honing must be accurate and remove just enough metal for the smallest oversize possible. The finish hone should leave a 20 to 40 micro-inch crosshatch finish having an included angle of 20 to 25 degrees. The crosshatch finish is necessary for fast piston ring break-in. See Figure 96.

Clean the cylinder bore with hot, soapy water and a brush after machining. A clean white rag will not soil when the cylinder bore is clean. Dry the bores and coat them with oil.

⚠ CAUTION ***Do not use gasoline or commercial cleaning solvents to clean the cylinder bores after honing—they do not remove abrasives.***

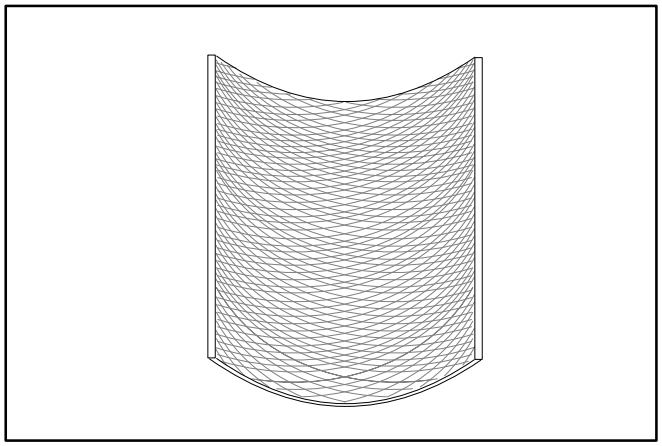


FIGURE 96. PROPER HONE CROSSHATCH IN CYLINDER BORE

Deglazing the Cylinder Bores

Deglaze the cylinder bores for fast piston ring break-in if the bores look good and there is not enough wear, taper and out-of-roundness to warrant machining. Deglazing should not increase the bore diameter, permitting the use of the original pistons (if they are good) with new rings. To deglaze the cylinder bores:

1. Wipe the cylinder bores with a clean cloth that has been dipped in light engine oil.
2. Use a brush-type deglazing tool with coated bristle tips.
3. Drive the tool with a slow-speed drill. Move the tool up and down in the cylinder bores fast enough to obtain the crosshatch pattern shown (Figure 96). Ten to twelve strokes should be sufficient.
4. Clean the cylinder bore with hot, soapy water and a brush after deglazing. A clean white rag will not soil when the cylinder bore is clean. Dry the bores and coat them with oil.

Service Checklist

After servicing, inspect and test the installation to confirm that the genset will operate as intended. Check each of the areas described below before putting the genset into service.

Mounting

Examine all mounting bolts and supporting members to verify that the genset 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, refill as instructed in the Operator's Manual.

Wiring

Verify that all wiring connections are tight and installed properly. Check each of these connections:

- Load wires
- Control wires
- Ground straps
- Battery cables

Initial Start Adjustments

Perform governor and carburetor adjustments according to *Engine Subsystems* if they have not been done already.

Output Check

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

Exhaust System

While the genset is running inspect the entire exhaust system, including the exhaust manifold, muffler and exhaust pipe. Look and listen for leaks at all connections, welds, gaskets and joints. Also make sure the exhaust pipe is not overheating adjacent materials or equipment. Do not run the genset until all exhaust leaks have been repaired.

⚠WARNING ***Exhaust gas is deadly. The exhaust system must not leak and must discharge all exhaust away from the vehicle. Do not run the genset until the exhaust leaks have been repaired.***

Fuel System

While the genset is running, inspect the fuel supply lines, return lines, filters and fittings for leaks. Check flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause leakage. Repair all fuel leaks immediately.

⚠WARNING ***Gasoline and LPG are flammable and explosive. Leaking fuel could lead to fire and to severe personal injury or death. Repair fuel leaks immediately.***

Control

Stop and start the genset several times at the control panel on the genset and at the remote control board (if provided) to verify that they work properly.

Mechanical

Stop the genset and inspect it for leaking gaskets, loose fasteners, damaged components and interference with other equipment. Repair as necessary. Inspect the generator 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 necessary. Make sure that all soundproofing material is in place.

Troubleshooting

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

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

THE ENGINE DOES NOT CRANK

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The remote enable switch (if supplied) is **OFF**.	Turn the key switch **ON**. If necessary, verify that the switch works and that the customer connected it according to the appropriate wiring diagram in *Wiring Diagrams*.
2. Control fuse **F1** on the side of the control box has blown. (Beginning Spec J)	Check for and repair ground faults in the choke heater (H1), fuel pump/solenoid (E2/FS), ignition coil (T1) and remote control connector (P2-5 and P2-6) circuits. See *Wiring Diagrams*. Replace the fuse with a 10 amp slow-blow mini-bayonet type.
3. Control board fuse **F1** has blown. (Spec H Only)	Check for and repair ground faults in the starter relay (K1), fuel pump/solenoid (E2/FS) and relay K5/K6 circuits. See *Wiring Diagrams*. Replace the fuse with an Onan supplied fuse only.
4. The remote control circuit (if provided) is faulty.	Try starting with the local **Start** switch. If the engine cranks, find and repair the fault in the remote control circuit.
5. The local **Start** switch circuit is faulty.	Try starting with the remote **Start** switch (if provided). If the engine cranks, replace control board **A1** (Spec H only) or the control panel assembly (Beginning Spec J).

THE ENGINE DOES NOT CRANK (CONTINUED)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
6. Cranking voltage is too low to crank the engine.	a. Clean and tighten or replace the battery cable connectors and cables at the battery and the genset. See the Installation Manual to verify that the battery cable sizes are adequate. b. Recharge or replace the battery. Specific gravity for a fully charged battery is approximately 1.260 at 80° F (27° C). c. If the genset is in standby service, install a battery charger. d. Once the genset has been started, troubleshoot the battery charging circuit according to THE GENERATOR DOES NOT CHARGE THE BATTERY. Beginning Spec J, if the **Low Bat** indicator stays on during operation, recheck all of the above steps.
Beginning Spec J	
7. The **starter motor** assembly is malfunctioning or not connected properly.	Check and tighten connections at starter solenoid terminals **S** and **M** and push and hold in the **Start** switch. If the **Start Sol** indicator does not light, go to Step 8. If the **Start Sol** indicator on the control panel lights, measure voltage at solenoid terminal **M**. If there is at least 9 VDC but the motor does not function properly, service or replace the motor assembly. If there is not at least 9 VDC, replace the solenoid. See ELECTRIC STARTER in *Engine Subsystems.*
8. Control **A1** or start relay **K5** are faulty or not properly connected.	Remove the control panel and check for B+ at relay **K5** terminal **30**. (K5 is mounted in a socket on the back of the panel.) If there is no voltage, reconnect wiring as necessary. See *Wiring Diagrams*. If there is B+ at terminal **30**, remove the relay from its socket and apply battery voltage across coil terminals **85** and **86**. If the coil does not function or if there is no electrical continuity between terminals **30** and **87** when the relay is energized, replace the relay. If the relay is good, replace the control panel assembly.

THE ENGINE DOES NOT CRANK (CONTINUED)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
Spec H Only	
9. Control board **A1** or start relay **K1** is faulty.	Remove the control panel. Push the **Start-Stop** switch to **Start** and measure voltage at start solenoid terminal **S**. If there is not at least 9 VDC, see TESTING CONTROL BOARD A1 in *Engine Control*. Replace parts or reconnect leads as necessary. If there is at least 9 volts at terminal **S**, push the **Start-Stop** switch to **Start** again and measure voltage at the motor terminal on the start solenoid. If there is no voltage at the motor terminal, replace relay **K1**.
10. The cable between start relay **K1** and the **starter motor** is loose, damaged or missing.	Service as necessary.
11. The **starter motor** is malfunctioning.	Push the **Start-Stop** switch to **Start** and measure voltage at the starter motor terminal. If there is at least 9 VDC but the motor does not function, replace the starter motor. See ELECTRIC STARTER in *Engine Subsystems.*

THE ENGINE CRANKS BUT DOES NOT START	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. Fuse **F2** on the side of the control box has blown. (Spec H, Gasoline only)	Check for and repair ground faults in the choke heater (H1) and ignition coil (T1) circuits. See *Wiring Diagrams*. Replace the fuse with a 10 amp slow-blow mini-bayonet type.
2. The fuel supply shutoff valve is closed or the fuel tank is empty.	Service as necessary.
3. Cranking voltage is too low to reach require cranking speed.	a. Clean and tighten or replace the battery cable connectors and cables at the battery and the genset. See Installation Manual to verify that the battery cable sizes are adequate. b. Recharge or replace the battery. Specific gravity for a fully charged battery is approximately 1.260 at 80° F (27° C). c. If the genset is in standby service, install a battery charger. d. Once the genset has started, troubleshoot the battery charging circuit according to THE GENERATOR DOES NOT CHARGE THE BATTERY.
4. Low engine temperature is causing too low a cranking speed for starting.	Replace the engine oil if it is not of the recommended viscosity for the ambient temperature. See the Operator's Manual.
5. The ignition system is weak or has poor connections or the control is faulty. (Beginning Spec J)	a. If the **Ignition** indicator lights when the **Start** switch is held in, check and tighten the connections at the **+** and **-** terminals of the ignition coil (T1). Do the Quick Ignition Test under IGNITION SYSTEM in *Engine Subsystems*. If the spark is weak or there is no spark at all, service the ignition system as necessary. b. If the **Ignition** indicator does not light, replace the control assembly.

THE ENGINE CRANKS BUT DOES NOT START (CONTINUED)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
6. The ignition system is weak or has poor connections. (Spec H Only)	Do the Quick Ignition Test under IGNITION SYSTEM in *Engine Subsystems*. If there is only a weak spark, service the ignition system as necessary. If there is no spark, hold in the **Start** switch and measure the voltage at the positive (**+**) terminal on the ignition coil. If there is at least 9 VDC, service the ignition system as necessary. If there is not at least 9 VDC, go to Step 7 or 8, as appropriate.
7. Control board **A1** is faulty. (Spec H, LPG)	If there is not at least 9 VDC at the ignition coil during cranking (Step 6), see TESTING CONTROL BOARD A1 in *Engine Control*. Replace parts or reconnect leads as necessary.
8. Relay **K6** or control **A1** is faulty. (Spec H, Gasoline)	If there is not at least 9 VDC at the ignition coil during cranking (Step 6), remove the lead at terminal **85** on relay **K6**. Hold in the **Start** switch and measure the voltage at the end of the lead just disconnected. If there is at least 9 VDC, verify that all the leads at relay **K6** are connected according to the appropriate connection diagram in *Wiring Diagrams*. If they are, replace relay **K6**. If there is not at least 9 VDC at the end of the lead marked **K6-85**, check all the connections back to control board **A1** and see TESTING CONTROL BOARD A1 in *Engine Control.* Replace parts or reconnect leads as necessary.
9. The choke is not closing properly in colder weather.	Service as instructed in FUEL SYSTEM in *Engine Subsystems.* (Gasoline carburetors only.)
10. The engine is not getting fuel because the fuel solenoid is not opening, the fuel pump is not pumping or the control is faulty. (Beginning Spec J)	If the **Fuel Pump** indicator lights during cranking but you cannot hear or feel the solenoid open or the pump vibrate, test the fuel solenoid or pump according to FUEL SYSTEM in *Engine Subsystems*. If the **Fuel Pump** indicator does not light during cranking, replace the control board assembly.

THE ENGINE CRANKS BUT DOES NOT START (CONTINUED)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
11. The engine is not getting fuel because the fuel solenoid is not opening, the fuel pump is not pumping or the control is faulty. (Spec H Only)	If you cannot hear or feel the solenoid open or the pump vibrate, disconnect the lead to the fuel pump and/or solenoid and and measure voltage at the end of the lead during cranking. If there is at least 9 VDC, test the fuel solenoid or pump according to FUEL SYSTEM in *Engine Subsystems*. If there is not at least 9 VDC, see TESTING CONTROL BOARD A1 in *Engine Control*.
12. The engine is not getting fuel because the fuel pump and/or fuel solenoid is not installed properly.	a. Verify that the LPG fuel solenoid and gasoline fuel pump are connected properly, especially where the customer has mounted the fuel pump remote from the genset and added a fuel tank shutoff solenoid. The remote pump and solenoid must be connected to the genset using insulated conductors of at least 16 AWG, have adequate bonding paths to the negative (**-**) terminal of the battery and have corrosion-free connections. b. Verify that the fuel pump (gasoline gensets only) is not more than 3 feet (.9 M) in elevation above the pickup tube in the fuel supply tank. If it is, relocate the fuel pump according to the instructions in the Installation Manual.
13. The fuel mixture screws are not adjusted properly. (Prior to SPEC L only)	Adjust as instructed in FUEL SYSTEM in *Engine Subsystems*.
14. The LPG demand regulator is malfunctioning.	Test and adjust (prior to SPEC L only) and/or replace as instructed in FUEL SYSTEM in *Engine Subsystems*.
15. The engine is worn or malfunctioning mechanically.	Do the CYLINDER COMPRESSION TEST in *Engine Subsystems* and service as necessary.

THE ENGINE STOPS WHEN THE START SWITCH IS RELEASED (BEGINNING SPEC J)

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
Go to Step 1 if the engine stops when the **Start** switch is released but the starter disengages normally when the **Start** switch is held in. The problem is probably low oil pressure or a faulty pressure sender. Go to Step 2 if the starter does not disengage when the **Start** switch is held in. The problem is probably in the PMG or its connections.	
1. The engine oil pressure is low or the cutout switch is faulty. (The starter disengages normally when the **Start** switch is held in.)	a. Check engine oil level and fill as necessary. Go to the next step if the engine still does not continue to run when the start switch is released. b. Bypass low oil pressure cutout switch **S2** by disconnecting the lead to it and grounding it. (For access, remove the cylinder head shroud on the oil filter side.) Start the genset. If oil pressure is at least 12 psi, replace low oil pressure cutout switch **S2**. If oil pressure is less than 12 psi, service the engine according to LUBRICATION SYSTEM in *Engine Block Assembly*.
2. The PMG is faulty or not connected properly. (The starter does not disengage when the **Start** switch is held in.)	a. Disconnect connector J8/P8 in the wiring harness in the vicinity of the ignition coil and connect an ohmmeter to check PMG stator winding continuity. Replace the PMG stator if the windings are open (normal winding resistance is approximately 0.13 ohms). See PMG in *Engine Subsystems*. b. If winding continuity is good, connect an AC volt meter to the PMG stator leads, start the engine, hold in the **Start** switch and immediately pull off the wire connector at starter solenoid terminal **S** to disengage the starter. Replace the flywheel assembly (Figure 9) if the output is less than 29 VAC.

THE ENGINE STOPS WHEN THE START SWITCH IS RELEASED (SPEC H ONLY)

⚠ **WARNING** ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
In normal operation, run relay **K3** on control board **A1** must remain powered in order to keep the genset running when the start switch is released. See *Wiring Diagrams*. Three things must occur to keep run relay **K3** powered: 1) engine oil pressure must be sufficient to close low oil pressure cutout switch **S2**, 2) stop relay **K5** must open and 3) output from generator winding **B1-B2** must be sufficient to pull in start disconnect relay **K2** on control board **A1**. **To isolate the problem**, plug a test lamp or voltmeter into a convenient power receptacle on the vehicle. Start the genset and keep it running by holding in the **Start** switch and go to NORMAL OUTPUT VOLTAGE or NO (LOW) OUTPUT VOLTAGE, as appropriate.	
Normal Output Voltage	
1. The engine oil level is low.	Check engine oil level and fill as necessary.
2. The engine oil pressure is low or the cutout switch is faulty.	Bypass low oil pressure cutout switch **S2** by disconnecting control board **A1** connector lead **J1-5 / J5** from connector **J5** and grounding it and start the genset. If bypassing switch S2 allows the engine to continue running, remove the pressure switch (for access, remove the cylinder shroud on the oil filter side), install an oil pressure gauge and run the genset. If oil pressure is at least 12 psi, replace low oil pressure cutout switch **S2**. If oil pressure is less than 12 psi, service the engine according to LUBRICATION SYSTEM in *Engine Block Assembly*.
3. Stop Relay **K5** is faulty.	Disconnect stop relay **K5** by disconnecting engine control board **A1** connector lead **J1-10 / CR6** from **CR6** (inside the control box) and start the genset. If disconnecting relay K5 allows the engine to continue running, check wiring in the stop relay **K5** circuit against the appropriate wiring diagram in *Wiring Diagrams*. If the wiring is good, replace relay **K5**.

THE ENGINE STOPS WHEN THE START SWITCH IS RELEASED (SPEC H ONLY) (CONTINUED)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
4. Winding **B1-B2** is faulty.	Isolate the **B1-B2** winding lead pair (orange striped leads) by disconnecting connectors **J7** and **J8** (inside the control box) and the two leads at the **AC** terminals on battery charging voltage regulator **VR2** (mounted on a bracket on the generator) and test the winding as instructed under TESTING THE GENERATOR in *Generator*. If the **B1-B2** winding is faulty, replace the entire stator assembly.
5. Control Board **A1** is faulty.	Check the control board connector according to TESTING CONTROL BOARD A1 in *Engine Control* and replace control board **A1** if cleaning the connector does not help.
No (Low) Output Voltage	
6. Field voltage is low.	Measure field voltage while cranking the engine. See TESTING FOR FIELD VOLTAGE in *Generator*. If there is at least 9 VDC across the brush block terminals, test and service or replace the brushes, slip rings, rotor and stator according to SERVICING THE BRUSHES AND SLIP RINGS and TESTING THE GENERATOR in *Generator*.
7. Control Board **A1** is faulty.	Measure voltage between output voltage regulator **VR1** connector pin **7** (connector **J9** on 3-phase gensets) and ground while cranking the engine. If there is less than 9 VDC, check the control board connector according to TESTING CONTROL BOARD A1 in *Engine Control* and replace engine control board **A1** if cleaning the connector does not help.

THE ENGINE STOPS WHEN THE START SWITCH IS RELEASED (SPEC H ONLY) (CONTINUED)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
8. Voltage Regulator **VR1** is faulty.	Measure voltage between **VR1** connector pin **9** (connector **J10** on 3-phase gensets) and ground while cranking the engine. If there is less than 9 VDC, replace output voltage regulator **VR1**. If there is at least 9 VDC, measure resistance between **VR1** connector pin **10** (connector **J11** on 3-phase gensets) and ground. Replace output voltage regulator **VR1** if there is measurable resistance (greater than zero).
9. Generator output too low.	See OUTPUT VOLTAGE IS TOO HIGH OR TOO LOW

THE ENGINE MISFIRES OR BACKFIRES	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The ignition system if faulty.	Service the ignition system as necessary according to IGNITION SYSTEM in *Engine Subsystems.*
2. The fuel mixture is too lean.	a. Adjust fuel mixture (prior to Spec L only) according to FUEL SYSTEM in *Engine Subsystems.* b. Check for and repair a vacuum leak. c. Overhaul (prior to Spec L only) or replace the carburetor according to FUEL SYSTEM in *Engine Subsystems.*

THE ENGINE MISFIRES OR BACKFIRES (CONTINUED)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
3. The fuel (gasoline) is contaminated.	Connect the genset to a container of fuel of known quality and run the genset under various loads. Replace the contents of the fuel supply tank if there is a noticeable improvement in performance.
4. The engine is malfunctioning mechanically.	Service as necessary according to *Engine Block Assembly*.

THE ENGINE LACKS POWER	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. There is carbon build-up in the cylinder heads.	Remove the heads and clean using Onan “4C” according the Operator’s Manual.
2. The ignition system is faulty.	Service the ignition system as necessary according to IGNITION SYSTEM in *Engine Subsystems.*
3. Fuel mixture and governor adjustments are incorrect.	a. Adjust according to Governor and Carburetor Adjustments under FUEL SYSTEM in *Engine Subsystems.* b. Check for and repair a vacuum leak. c. Overhaul (prior to Spec L only) or replace the carburetor according to FUEL SYSTEM in *Engine Subsystems.*
4. The gasoline fuel pump is not installed properly.	Verify that the fuel pump is not more than 3 feet (.9 m) in elevation above the pickup tube in the fuel supply tank. If it is, relocate the fuel pump according to the instructions in the Installation Manual.
5. The fuel filter(s) is clogged.	Replace clogged gasoline filters and clean out LPG filters and regulators. See LPG System—Liquid Withdrawal under FUEL SYSTEM in *Engine Subsystems.*

THE ENGINE LACKS POWER (CONTINUED)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
6. The fuel (gasoline) is contaminated.	Connect the genset to a container of known fuel quality and run the genset under various loads. Replace the contents of the fuel supply tank if there is a noticeable improvement in performance.
7. The engine air filter element is dirty.	Replace the air filter element.
8. The exhaust system is restricted.	Service as necessary.
9. The valve adjustment is incorrect.	Adjust according to Adjusting Valve Clearance (Lash) under VALVE SYSTEM in *Engine Block Assembly*.
10. The engine is worn or malfunctioning mechanically.	Do the CYLINDER COMPRESSION TEST in *Engine Subsystems* and service as necessary according to *Engine Block Assembly*.

THE ENGINE HUNTS	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. Fuel mixture (prior to Spec L only) and governor adjustments are incorrect.	Adjust according to Governor and Carburetor Adjustments under FUEL SYSTEM in *Engine Subsystems.*
2. The governor spring is weak.	Replace the spring.
3. The governor mechanism is worn.	Service as necessary according to GEAR COVER and GOVERNOR CUP in *Engine Block Assembly*.

THE ENGINE OVERHEATS

⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The fuel mixture is too lean.	Adjust according to Governor and Carburetor Adjustments under FUEL SYSTEM in *Engine Subsystems* (prior to Spec L only).
2. The engine cooling fins are oily and dirty.	Clean as necessary.
3. The installation restricts cooling air.	Verify that the installation is in accordance with the Installation Manual.

THE ENGINE HAS HIGH OIL CONSUMPTION

⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***

Possible Cause	Corrective Action
1. The oil is diluted or has too light a viscosity.	Replace the oil in the crankcase with oil of correct viscosity. See the Operator's Manual for engine oil recommendations.
2. The crankcase breather valve is dirty or defective.	Service or replace the breather valve according to CRANKCASE BREATHER ASSEMBLY in *Engine Subsystems*.
3. There are oil leaks.	Service as necessary.
4. The oil bypass valve is faulty.	Service as necessary according to LUBRICATION SYSTEM in *Engine Block Assembly*.
5. The engine is worn or malfunctioning mechanically.	Do the CYLINDER COMPRESSION TEST in *Engine Subsystems* and service as necessary according to *Engine Block Assembly*.

THE GENSET RUNS BUT THERE IS NO OUTPUT VOLTAGE	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The line circuit breakers are **OFF** or have **TRIPPED**. (Beginning Spec J the **Gen AC** indicator light will be on if generator output voltage—ahead of the circuit breakers—is normal.)	Find out why the circuit breakers were turned **OFF**, make sure it is safe to reconnect power, and then throw the circuit breaker **ON**. If the circuit breakers have tripped, shut down the genset and service as necessary to clear the short circuit or ground fault that caused tripping and then **RESET** the circuit breakers and restart the genset.
2. A line circuit breaker is faulty.	Shut down the genset, make sure the power output lines from the genset have been disconnected from all other sources of power, attempt to **RESET** the circuit breaker and throw it **ON** and check for electrical continuity across its terminals. Replace the circuit breaker if there is measurable resistance.
3. The generator is connected wrong.	Remove the control panel and verify that all generator connections are according to the appropriate connection diagram in *Generator.*
4. A main stator winding is open. (Beginning Spec J, if the **Gen AC** indicator light is not on, there is a problem in the generator or voltage regulator.)	Test and service according to TESTING THE GENERATOR in *Generator*.
5. The quadrature winding of the stator is open (single-phase gensets only).	Test and service according to TESTING THE GENERATOR in *Generator*.
6. Voltage regulator **VR1** is faulty.	Test and service according to TESTING THE VOLTAGE REGULATOR in *Generator*.

THE OUTPUT VOLTAGE IS TOO HIGH OR TOO LOW	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. Voltage has been adjusted incorrectly.	Adjust the voltage as required. For single-phase gensets, the adjusting rheostat is on the control panel (inside the control box on Spec J) and for three-phase gensets on the voltage regulator.
2. Frequency has been adjusted incorrectly.	Adjust according to Governor and Carburetor Adjustments under FUEL SYSTEM in *Engine Subsystems.*
3. The brushes are not making good contact with the slip rings.	Service as necessary according to SERVICING THE BRUSHES AND SLIP RINGS in *Generator*.
4. The generator is connected wrong.	Remove the control panel and verify that all generator connections are according to the appropriate connection diagram in *Generator*.
5. The rotor winding is shorted.	Test and service according to TESTING THE GENERATOR in *Generator*.
6. A main stator winding is shorted or grounded.	Test and service according to TESTING THE GENERATOR in *Generator*.
7. Voltage regulator **VR1** is faulty.	Test and service according to TESTING THE VOLTAGE REGULATOR in *Generator*.

THE GENERATOR IS NOISY	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The brush block is loose.	Tighten the mounting screws as necessary.
2. The generator bearing is worn.	Replace according to ASSEMBLING AND DISASSEMBLING THE GENERATOR in *Generator*.
3. The rotor and crankshaft are misaligned.	Service according to ASSEMBLING AND DISASSEMBLING THE GENERATOR in *Generator*.

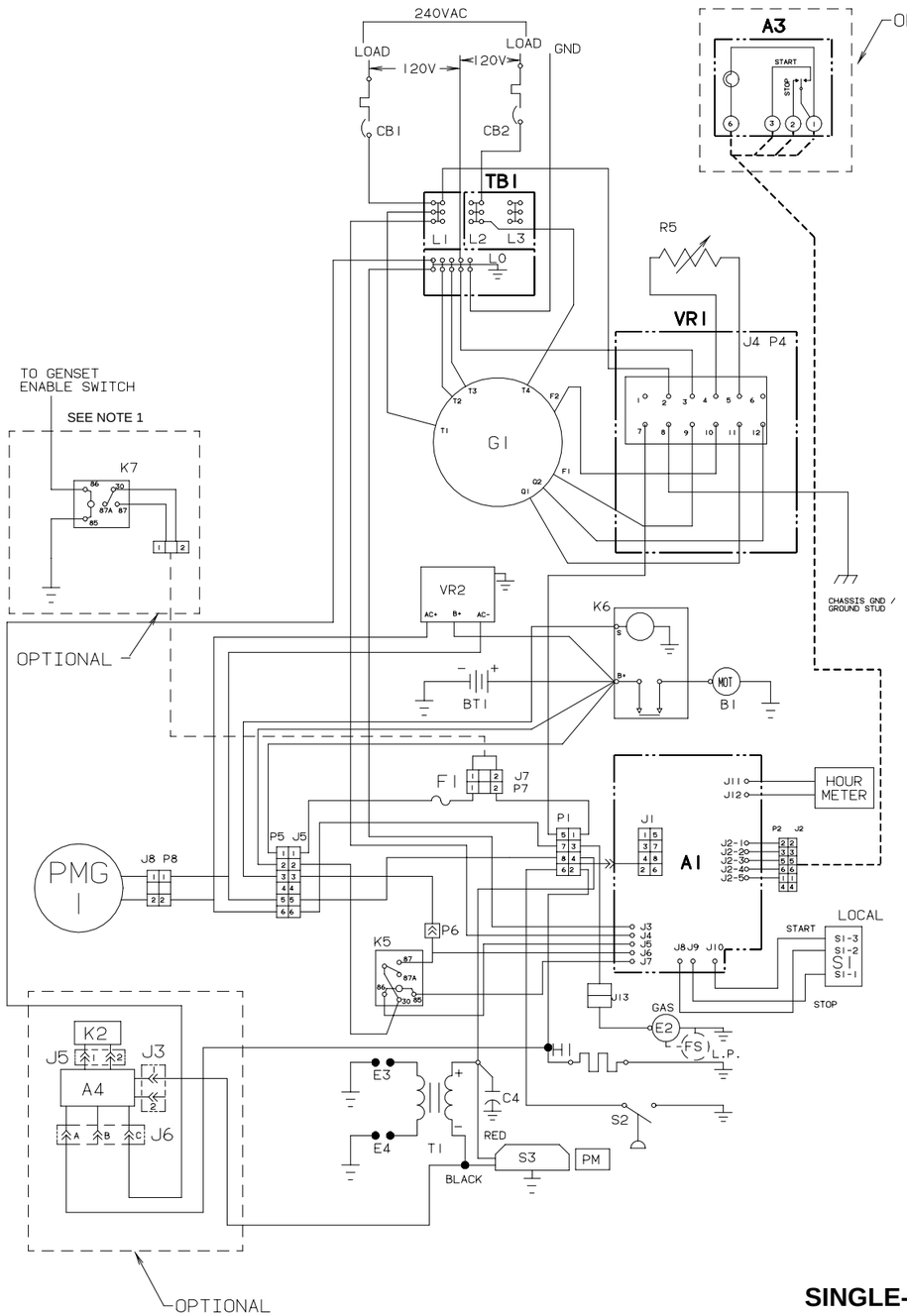
THE GENERATOR OVERHEATS	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The vent openings in the stator are restricted with oil and dirt.	Clean as necessary.
2. The generator windings are covered with oil and dirt.	Clean as necessary.
3. A rotor or stator winding is shorted or grounded.	Test and service according to TESTING THE GENERATOR in *Generator*.
4. Voltage regulator **VR1** is faulty.	Test and service according to TESTING THE VOLTAGE REGULATOR in *Generator*.

THE PHASES ARE UNBALANCED (3-PHASE GENSETS)	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. The connected loads are distributed unevenly among the phases.	Shut down the genset and redistribute the loads so that there is a difference of less than 10 percent between phases.
2. Improper connections have been made at terminal block **TB1** or the power output circuit breakers **CB1**, **CB2** and/or **CB3**.	Shut down the genset and reconnect according to the appropriate connection diagram in *Generator.*
3. A main stator winding is shorted or grounded.	Test and service according to TESTING THE GENERATOR in *Generator*.
4. A load has a ground fault or short circuit.	Service the faulty equipment as necessary.

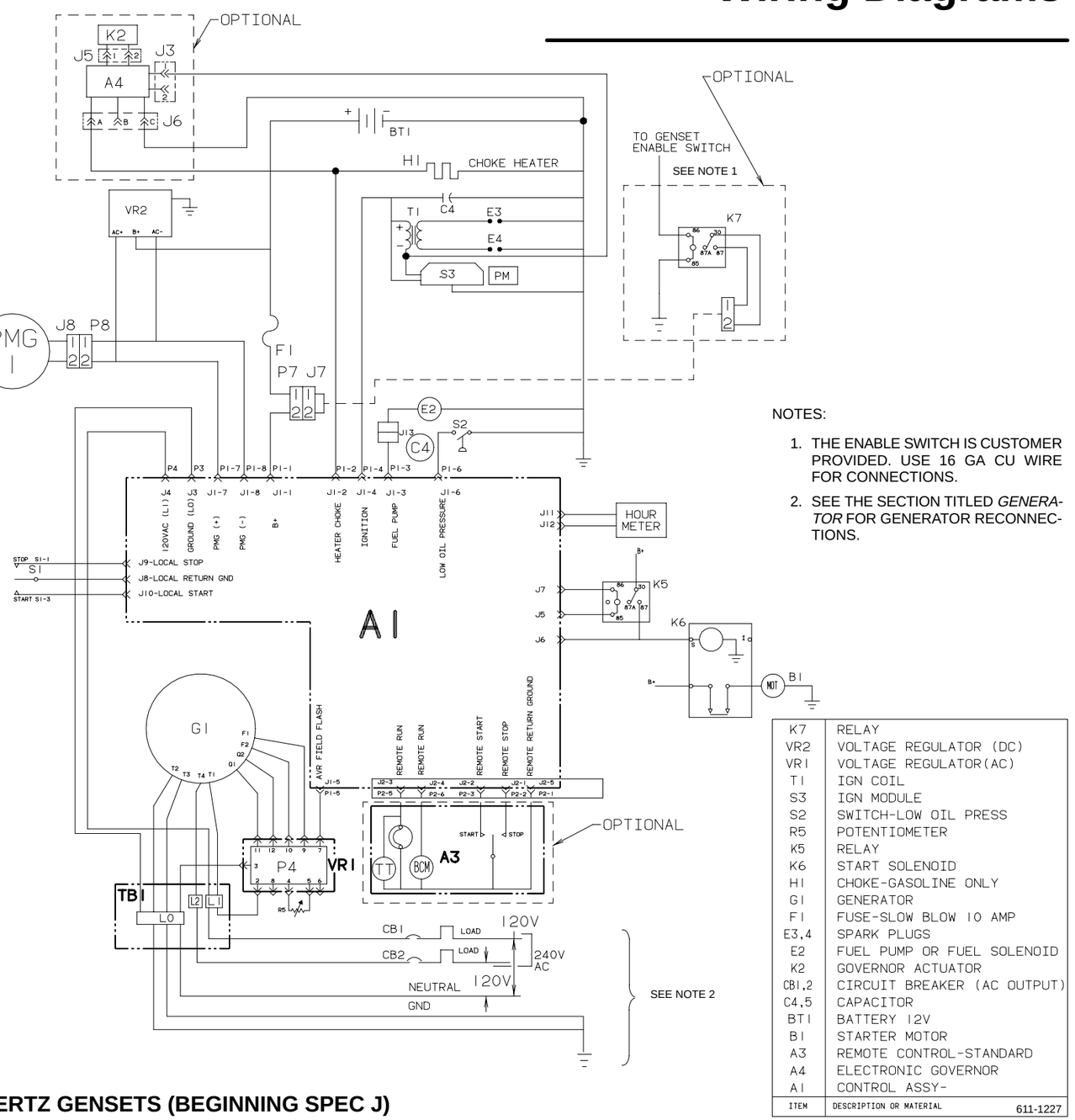
THE GENSET DOES NOT CHARGE THE BATTERY	
⚠ WARNING ***There are hazards present in troubleshooting that can cause equipment damage, severe personal injury or death. Troubleshooting must be performed by qualified persons who know about the hazards of fuel, electricity and machinery. Read Safety Precautions inside the front cover and observe all instructions and precautions in this manual.***	
Possible Cause	**Corrective Action**
1. Circuit breaker **CB4** is faulty (Spec H only).	Check for continuity across the terminals. Replace if resistance is greater than zero ohms.
2. PMG leads **J8-1** and **J8-2** (beginning Spec J) or Generator winding leads **B1** and **B2** (Spec H only), battery charging voltage regulator **VR2** and circuit breaker **CB4** (Spec H only) are not connected properly.	Remove the control panel and verify that all generator connections are according to the appropriate connection diagram in *Generator.*
3. Battery charging voltage regulator **VR2** is faulty.	Disconnect the lead at terminal **B+** on voltage regulator **VR2** and measure voltage (VDC) while the genset is running. If all wiring corrections are correct, replace voltage regulator **VR2** if output is less than 12 VDC.

Wiring Diagrams

WIRING DIAGRAM



SCHEMATIC



NOTES:

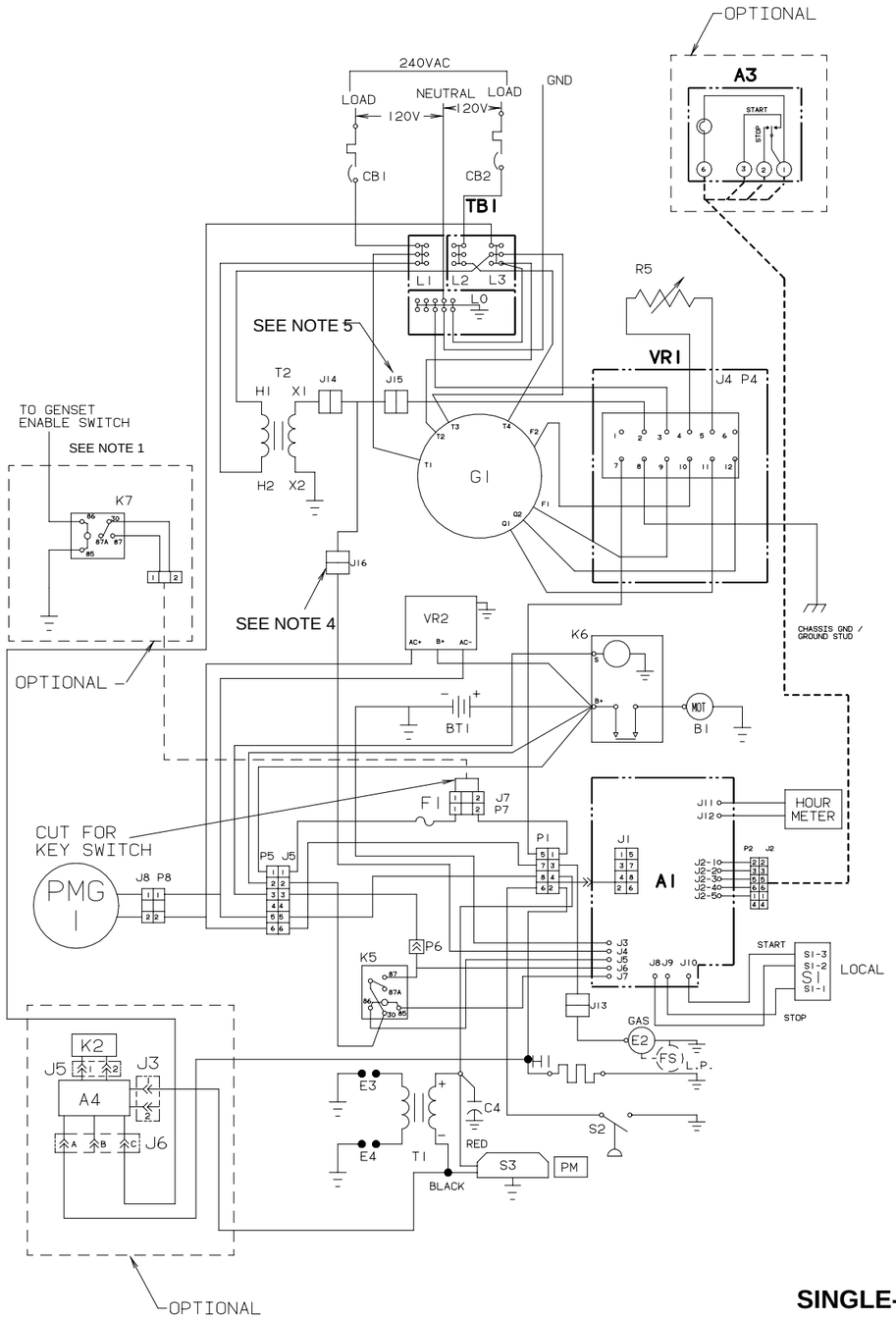
1. THE ENABLE SWITCH IS CUSTOMER PROVIDED. USE 16 GA CU WIRE FOR CONNECTIONS.
2. SEE THE SECTION TITLED *GENERATOR* FOR GENERATOR RECONNECTIONS.

K7	RELAY
VR2	VOLTAGE REGULATOR (DC)
VR1	VOLTAGE REGULATOR(AC)
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R5	POTENTIOMETER
K5	RELAY
K6	START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 10 AMP
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOLENOID
K2	GOVERNOR ACTUATOR
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A4	ELECTRONIC GOVERNOR
A1	CONTROL ASSY-
ITEM	DESCRIPTION OR MATERIAL

611-1227

SINGLE-PHASE 60 HERTZ GENSETS (BEGINNING SPEC J)

WIRING DIAGRAM



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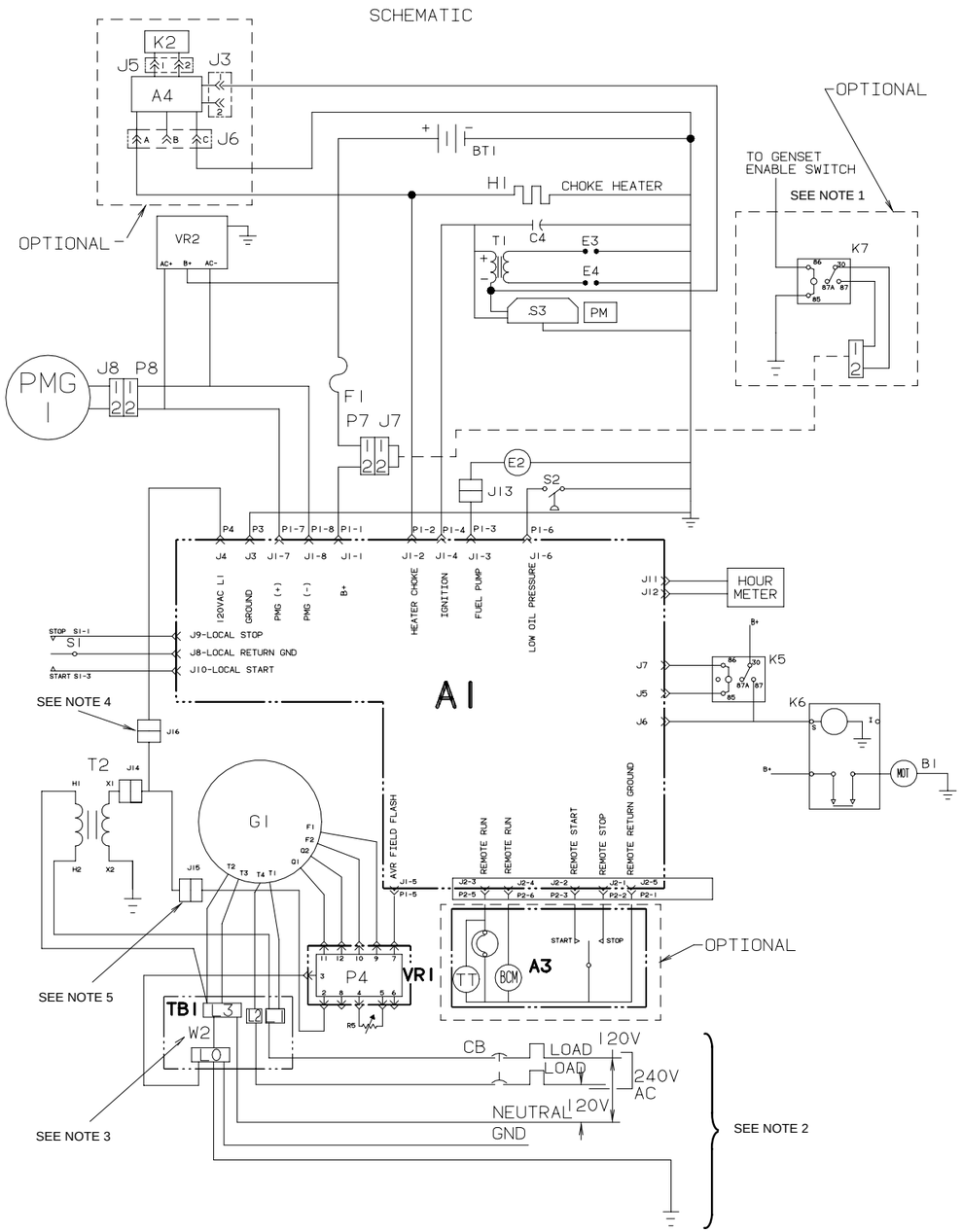


NOTES:

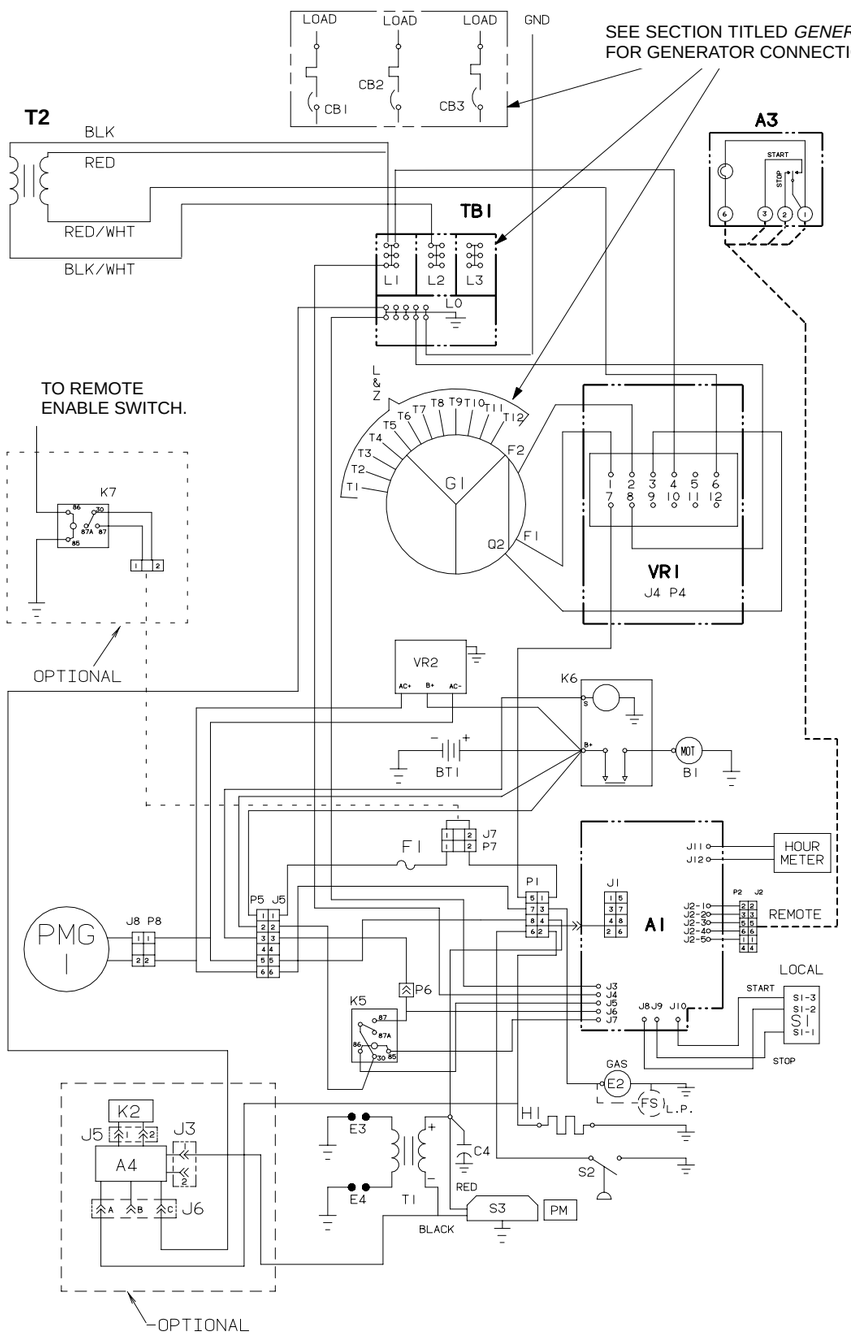
1. THE ENABLE SWITCH IS CUSTOMER PROVIDED. USE 16 GA CU WIRE FOR CONNECTIONS.
2. SEE THE SECTION TITLED *GENERATOR* FOR GENERATOR RECONNECTIONS.
3. FOR ISOLATED NEUTRAL REMOVE JUMPER W2 BETWEEN TB1-L3 AND TB1-L0.
4. LEAD L1-J4 CONNECTS TO J16.
5. LEAD L1 P4-2 CONNECTS TO J15.

T2	TRANSFORMER-VOLTAGE REF.
K7	RELAY
VR2	VOLTAGE REGULATOR (DC)
VR1	VOLTAGE REGULATOR(AC)
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
R5	POTENTIOMETER
K5	RELAY
K6	START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 10 AMP
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOLENOID
K2	GOVERNOR ACTUATOR
CB1,2	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A4	ELECTRONIC GOVERNOR
A1	CONTROL ASSY
ITEM	DESCRIPTION OR MATERIAL

SINGLE-PHASE 50 HERTZ GENSETS (BEGINNING SPEC J)

611-1234

WIRING



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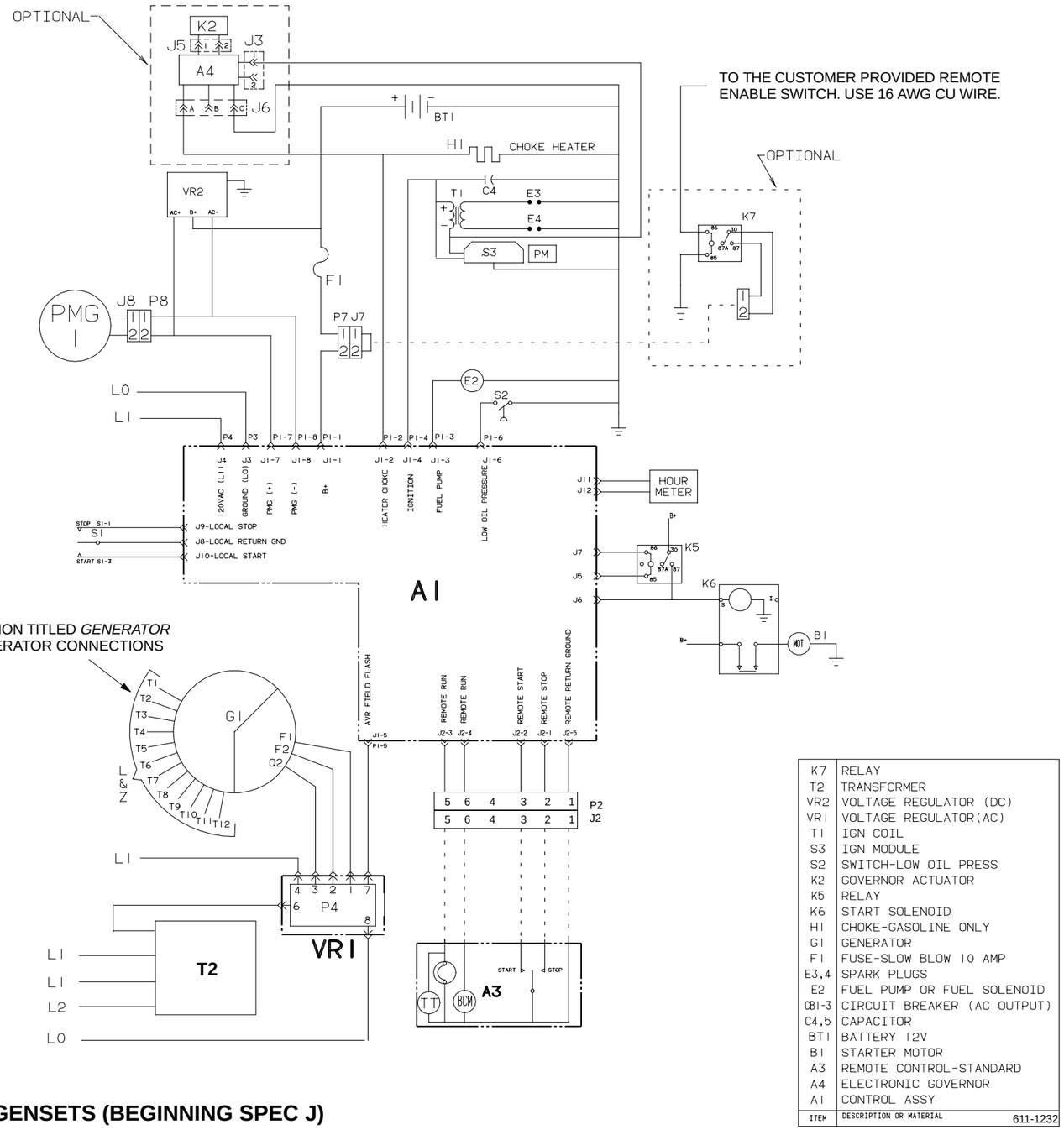
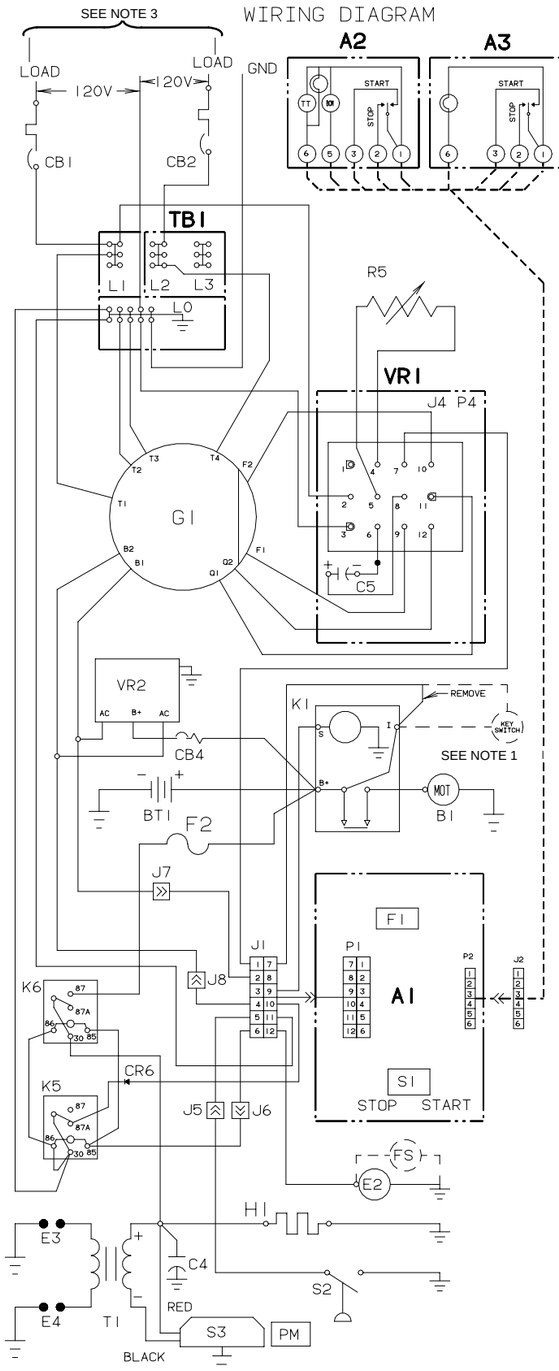


K7	RELAY
T2	TRANSFORMER
VR2	VOLTAGE REGULATOR (DC)
VR1	VOLTAGE REGULATOR(AC)
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESS
K2	GOVERNOR ACTUATOR
K5	RELAY
K6	START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 10 AMP
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOLENOID
CB1-3	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTOR
A3	REMOTE CONTROL-STANDARD
A4	ELECTRONIC GOVERNOR
A1	CONTROL ASSY
ITEM	DESCRIPTION OR MATERIAL

611-1232

THREE-PHASE GENSETS (BEGINNING SPEC J)

WIRING DIAGRAM



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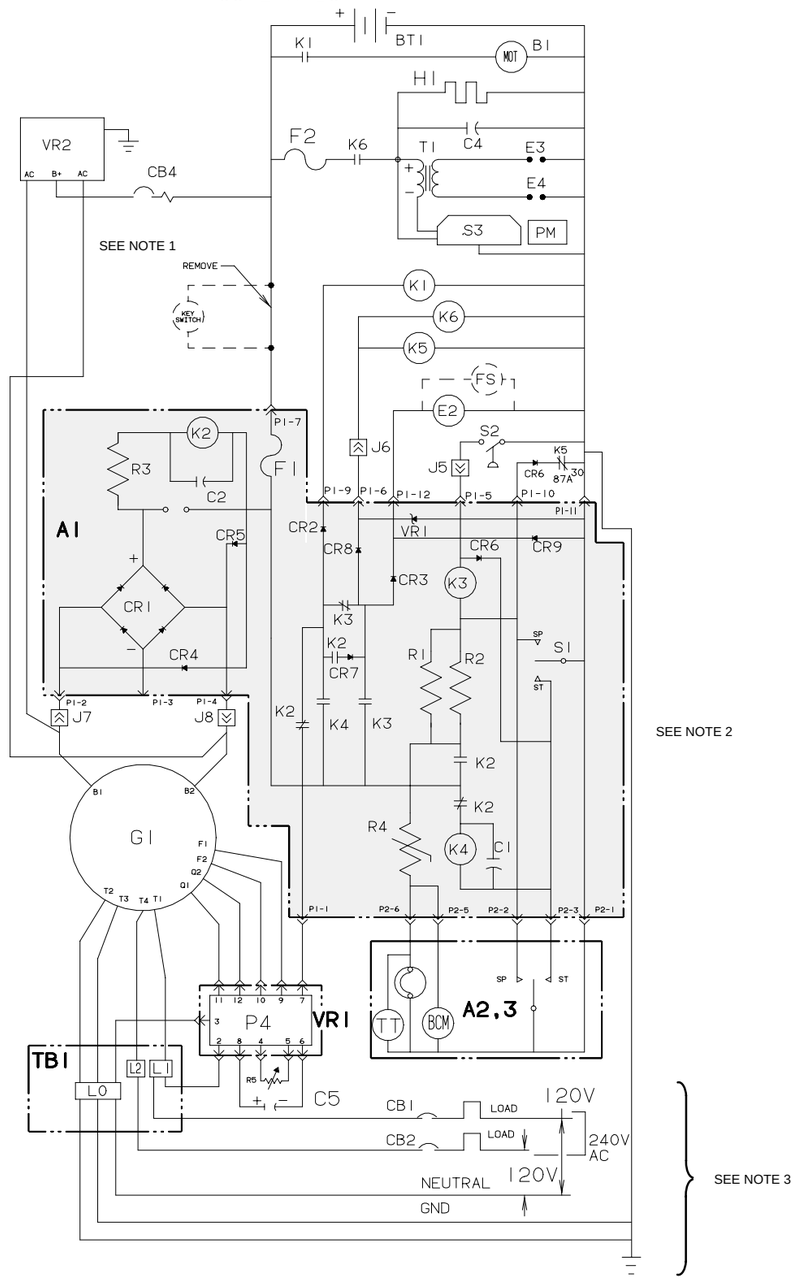


NOTES:

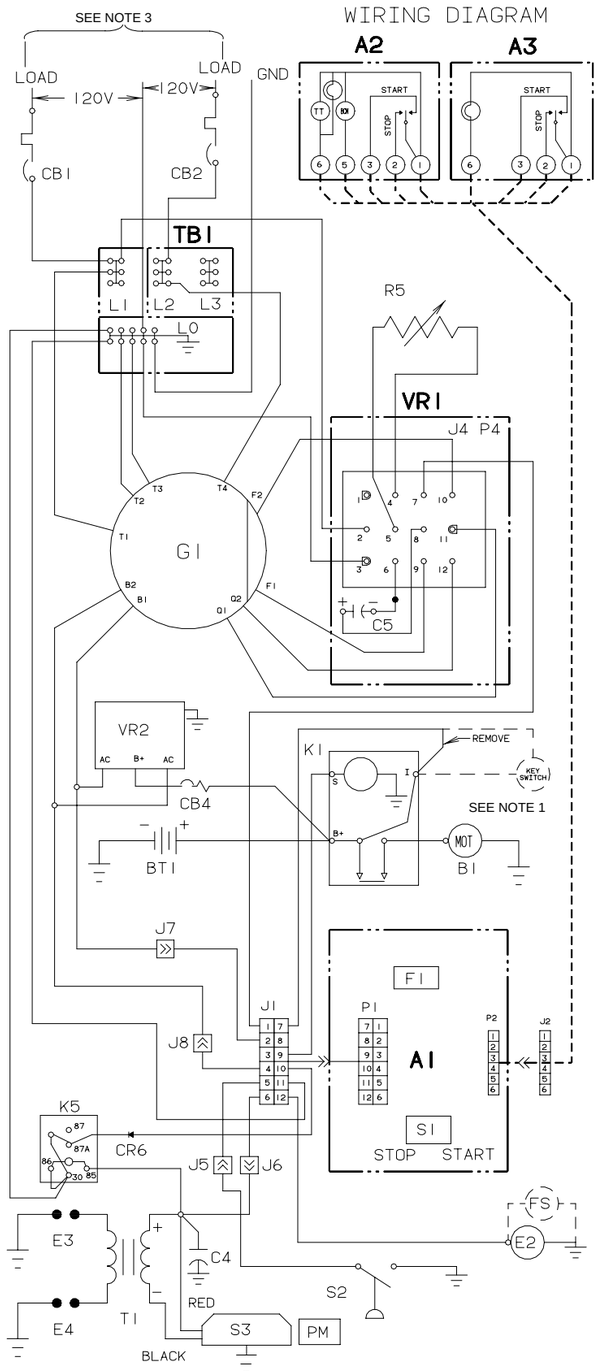
1. DISARM SWITCH BY CUSTOMER/INSTALLER NOT SUPPLIED BY ONAN. REQUIRES CONNECTING WITH NECESSARY EXTENSION LEADS FROM J1-6 TO KEY SWITCH AND CONNECTING FROM KEY SWITCH TO K1-I AND DISCONNECTING LEAD AT K1-I. USE 16 GA Cu WIRE.
2. THE COMPONENTS ON CONTROL BOARD A1 (SHADED AREA) ARE NOT SEPARATELY REPLACEABLE, EXCEPT FOR FUSE F1, AND ARE SHOWN FOR REFERENCE ONLY.
3. SEE THE SECTION TITLED *GENERATOR* FOR GENERATOR RECONNECTIONS.

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

611-1215

SINGLE-PHASE GASOLINE-FUELED GENSETS (SPEC H ONLY)

WIRING DIAGRAM



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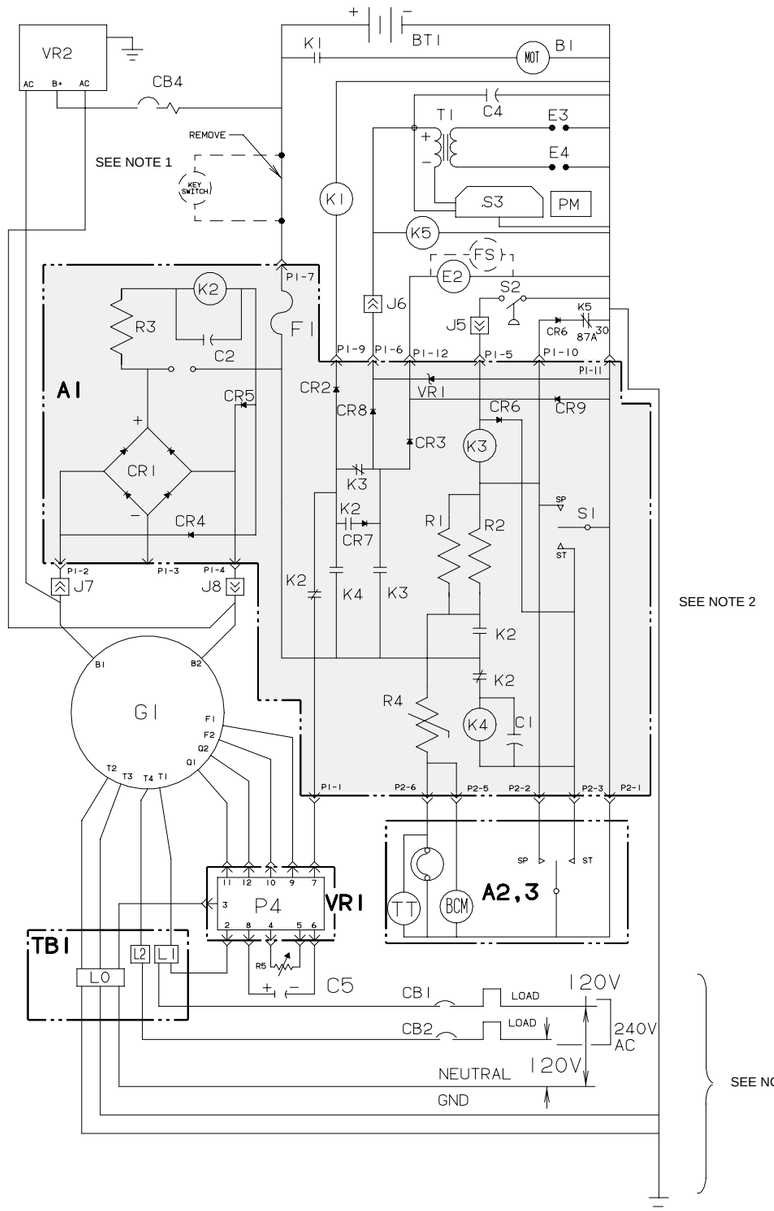


NOTES:

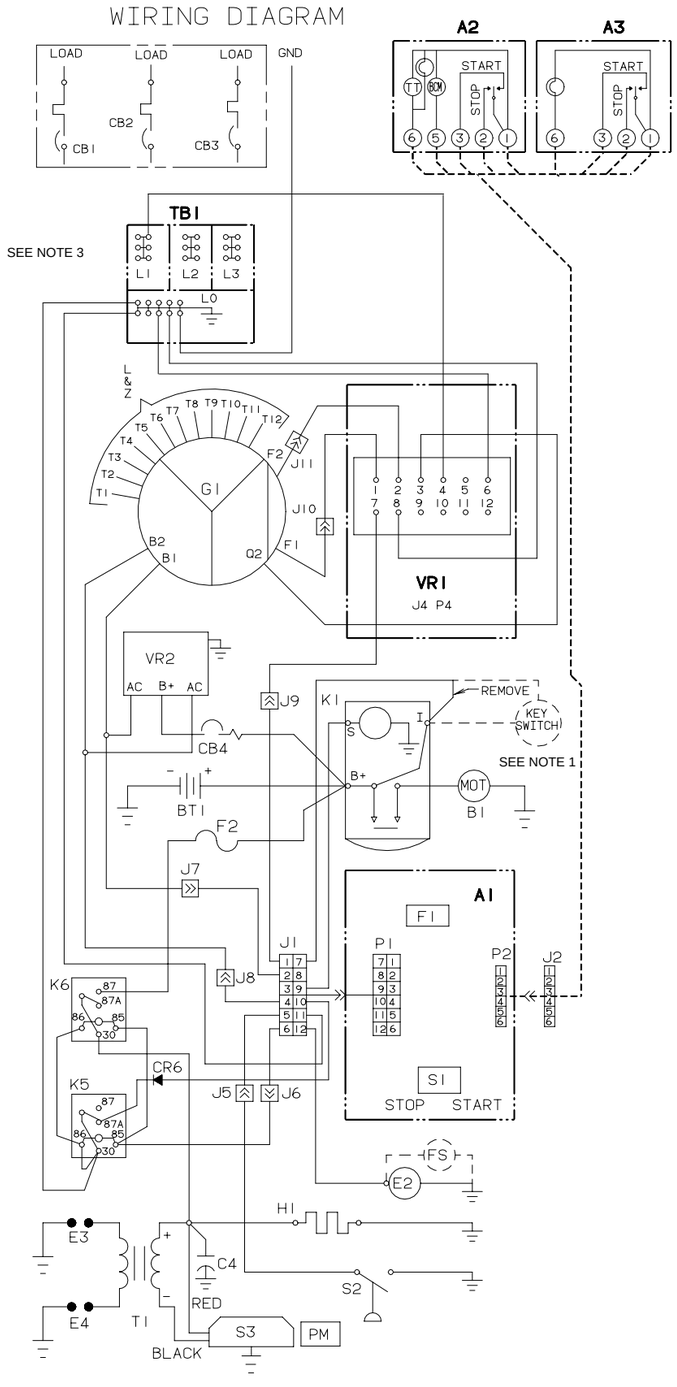
1. DISARM SWITCH BY CUSTOMER/INSTALLER NOT SUPPLIED BY ONAN. REQUIRES CONNECTING WITH NECESSARY EXTENSION LEADS FROM J1-6 TO KEY SWITCH AND CONNECTING FROM KEY SWITCH TO K1-I AND DISCONNECTING LEAD AT K1-I. USE 16 GA Cu WIRE.
2. THE COMPONENTS ON CONTROL BOARD A1 (SHADED AREA) ARE NOT SEPARATELY REPLACEABLE, EXCEPT FOR FUSE F1, AND ARE SHOWN FOR REFERENCE ONLY.
3. SEE THE SECTION TITLED *GENERATOR* FOR GENERATOR RECONNECTIONS.

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

ITEM | DESCRIPTION OR MATERIAL — 611-1210

SINGLE-PHASE LPG-FUELED GENSETS (SPEC H ONLY)

WIRING DIAGRAM



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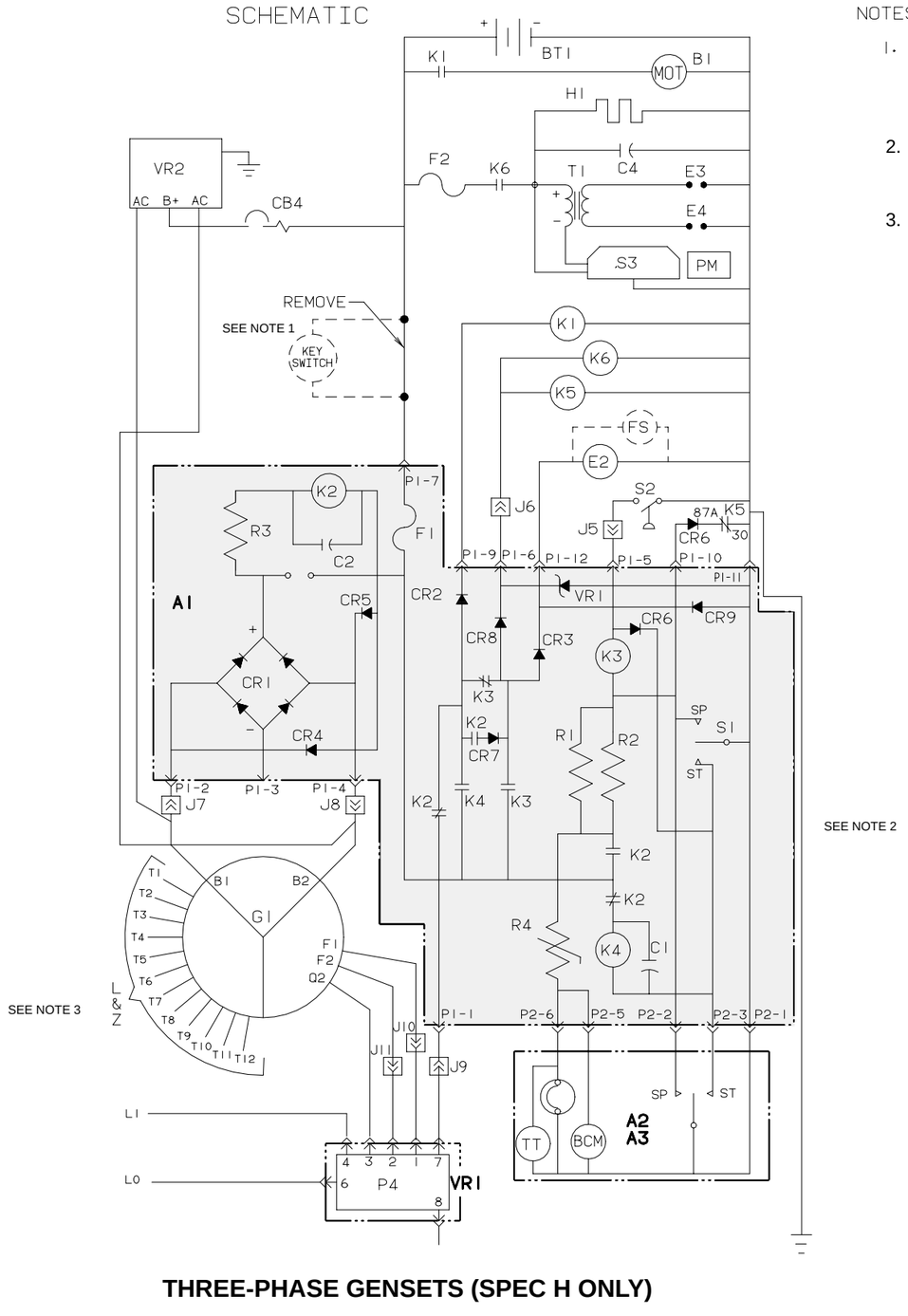

THREE-PHASE GENSETS (SPEC H ONLY)

NOTES:

1. DISARM SWITCH BY CUSTOMER/INSTALLER NOT SUPPLIED BY ONAN. REQUIRES CONNECTING WITH NECESSARY EXTENSION LEADS FROM J1-6 TO KEY SWITCH AND CONNECTING FROM KEY SWITCH TO K1-I AND DISCONNECTING LEAD AT K1-I. USE 16 GA Cu WIRE.
2. THE COMPONENTS ON CONTROL BOARD A1 (SHADED AREA) ARE NOT SEPARATELY REPLACEABLE, EXCEPT FOR FUSE F1, AND ARE SHOWN FOR REFERENCE ONLY.
3. SEE THE SECTION TITLED *GENERATOR* FOR GENERATOR RECONNECTIONS.

ITEM	DESCRIPTION
K6	RELAY, IGN
VR2	VOLTAGE REGULATOR (DC)
VR1	VOLTAGE REGULATOR (AC)
T1	IGN COIL
S3	IGN MODULE
S2	SWITCH-LOW OIL PRESSURE
F2	FUSE
K5	RELAY
K1	RELAY-START SOLENOID
H1	CHOKE-GASOLINE ONLY
G1	GENERATOR
F1	FUSE-SLOW BLOW 5A
E3,4	SPARK PLUGS
E2	FUEL PUMP OR FUEL SOLENOID
CR6	RECTIFIER
CB4	CIRCUIT BREAKER (THERMAL)
CB1,2,3	CIRCUIT BREAKER (AC OUTPUT)
C4,5	CAPACITOR
BT1	BATTERY 12V
B1	STARTER MOTER
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY

611-1224

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