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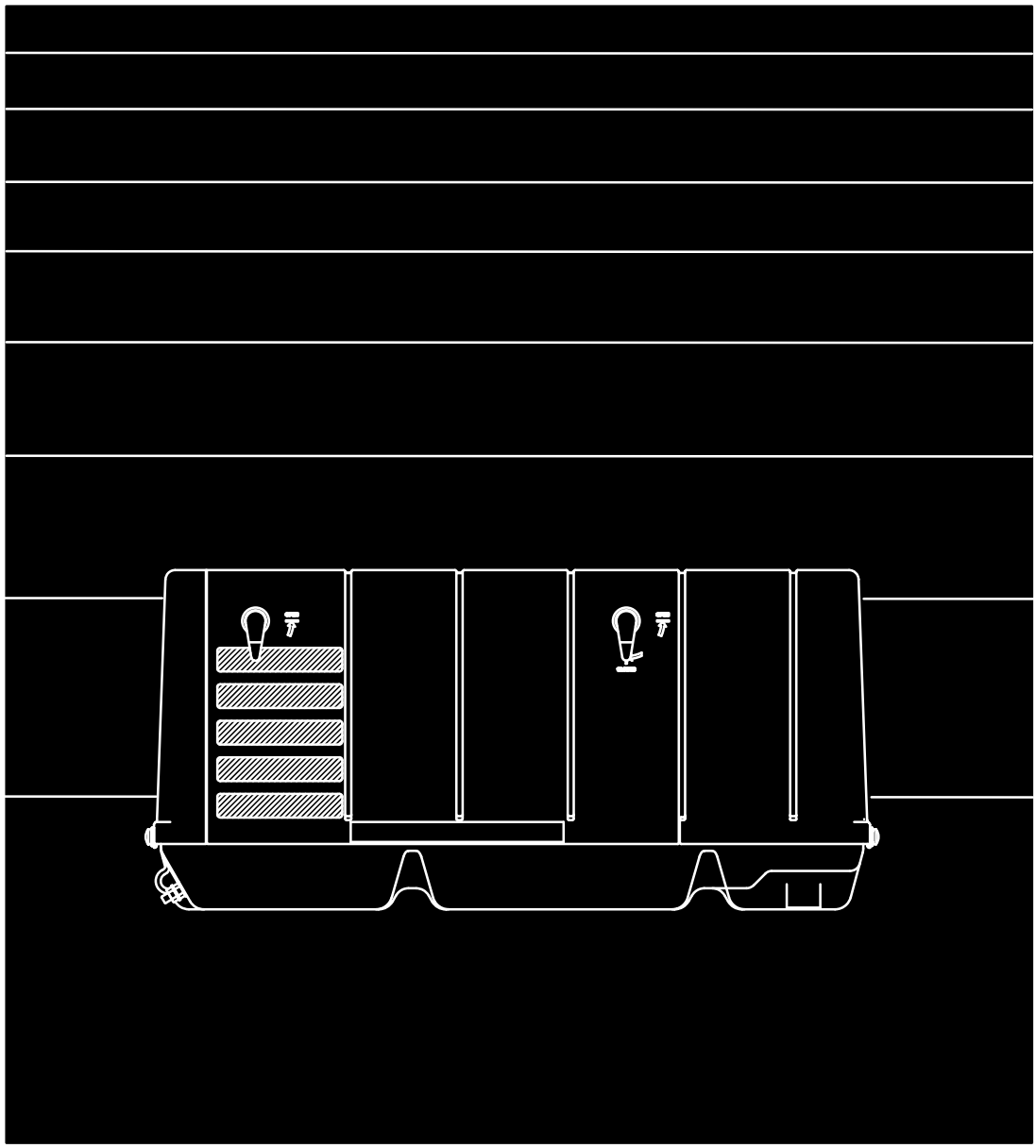
Onan

RV GenSet

Service Manual

KY
KYD



Printed in U.S.A. Beginning KY Spec J, KYD Spec A 01-06 981-0530C

⚠ WARNING: ⚠

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

⚠ WARNING ⚠

Do not use this genset on a boat
Such use may violate U. S. Coast Guard regulations and can result in severe personal injury or death from fire, electrocution, or carbon monoxide poisoning

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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 when equipment is operated and maintained properly.

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 children away from the genset.
- Do not use evaporative starting fluids. They are highly explosive.
- To prevent accidental or remote starting while working on the genset, disconnect the negative (–) battery cable at the battery.
- 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.
- Make sure all fasteners are secure and torqued properly.
- Do not work on the genset when mentally or physically fatigued or after consuming alcohol or drugs.
- You must be trained and experienced to make 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.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10)
- Genset installation and operation must comply with all applicable local, state and federal codes and regulations.

GENERATOR VOLTAGE IS DEADLY!

- Disable the automatic genset starting feature of an inverter-charger or other automatic starting device before servicing the genset.
- Generator electrical output connections must be made by a trained and experienced electrician in accordance with applicable codes.
- The genset must not be connected to shore power or to any other source of electrical power. Back-feed to shore power can cause electric shock resulting in severe personal injury or death and damage to equipment. 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, stand on a dry wooden platform or rubber insulating mat and use tools with insulated handles.

ENGINE EXHAUST IS DEADLY!

- Inspect for exhaust leaks at every startup and after every eight hours of running.
- Learn the symptoms of carbon monoxide poisoning in this manual.
- Never sleep in the vehicle while the genset is running unless the vehicle is equipped with a working carbon monoxide detector.
- Make sure there is ample fresh air when operating the genset in a confined area.
- Disable the automatic genset starting feature of an inverter-charger or other automatic starting device before storing the vehicle or parking it in a garage or other confined space.
- The exhaust system must be installed in accordance with the genset Installation Manual.
- Engine cooling air must not be used for heating the working or living space or compartment.

FUEL IS FLAMMABLE AND EXPLOSIVE

- Do not smoke or turn electrical switches ON or OFF where fuel fumes are present or in areas sharing ventilation with fuel tanks or equipment. Keep flame, sparks, pilot lights, arc-producing equipment and switches and all other sources of ignition well away.
- Fuel lines must be secured, free of leaks and separated or shielded from electrical wiring.
- Leaks can lead to explosive accumulations of gas. Natural gas rises when released and can accumulate under hoods and inside housings and buildings. LPG sinks when released and can accumulate inside housings and basements and other below-grade spaces. Prevent leaks and the accumulation of gas.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses.
- Do not smoke.
- To reduce arcing when disconnecting or reconnecting battery cables, always disconnect the negative (–) battery cable first and reconnect it last.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Disable the automatic genset starting feature of an inverter-charger or other automatic starting device before servicing the genset.
- 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, and other moving parts.

1. Introduction

This is the service manual for the generator set (genset) model series listed on the front cover. Read and carefully observe all of the instructions and precautions in this manual.

Model KY gensets differ from Model KYD gensets mainly by having an internally mounted muffler.

⚠WARNING ***Improper service or replacement of parts 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 ***This genset is not a life support system. It can stop without warning. Children, persons with physical or mental limitations, and pets could suffer severe personal injury or death. A personal attendant, redundant power or an alarm system must be used if genset operation is critical.***

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 that 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 and product information, be ready to provide the model and serial numbers on the genset nameplate (Figure 1-1). Every character in these numbers is significant. (The last character of the model number is the specification letter, which is important for obtaining the right parts.)

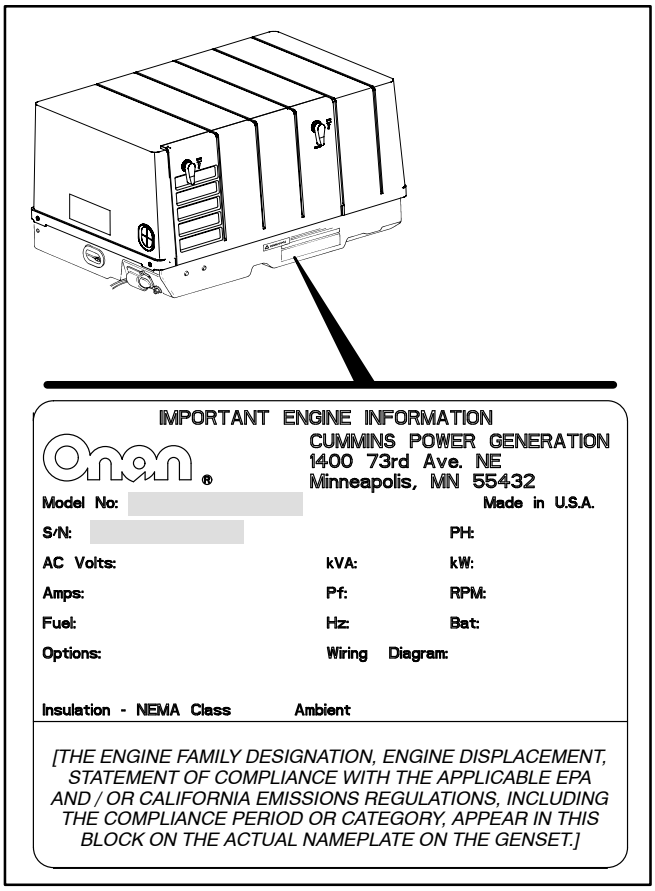


FIGURE 1-1. TYPICAL NAMEPLATE

2. Specifications

	GASOLINE MODELS		LPG MODELS	
	4KY	**3.6KY**	**3.6KY**	**3.3KY**
GENERATOR: 2-Pole Revolving Field, Self-Excited, 1-Phase, Microprocessor Regulated				
Power	4000 watts	3600 watts	3600 watts	3300 watts
Frequency	60 Hertz	50 Hertz	60 Hertz	50 Hertz
Voltage	120 volts[1]	230 volts[1, 2]	120 volts	230 volts[2]
Current	33.3 amperes	15.7 amperes	30 amperes	14.3 amperes
Speed	3600 rpm	3000 rpm	3600 rpm	3000 rpm
FUEL CONSUMPTION:				
No load	0.29 gph (1.1 l/h)	0.21 gph (0.79l/h)	1.5 lbs/h (0.7 kg/h)	1.1 lbs/h (0.5 kg/h)
Half load	0.48 gph (1.8 l/h)	0.37 gph (1.4 l/h)	2.2 lbs/h (1.0 kg/h)	2.0 lbs/h (0.9 kg/h)
Full load	0.71 gph (2.7 l/h)	0.58 gph (2.2 l/h)	3.3 lbs/h (1.5 kg/h)	2.9 lbs/h (1.3 kg/h)
ENGINE: 1-Cylinder, 4-Stroke Cycle, Spark-Ignited, OHV, Air Cooled, Mechanically Governed				
Bore	3.11 inch (79 mm)		3.11 inch (79 mm)	
Stroke	2.44 inch (62 mm)		2.44 inch (62 mm)	
Displacement	18.5 inch^3 (304 cc)		18.5 inch^3 (304 cc)	
Compression Ratio	8.5 : 1		8.5 : 1	
Oil Capacity	1.6 quart (1.5 l)		1.6 quart (1.5 l)	
Intake Valve Lash (Cold)	0.002 inch (0.05 mm)		0.002 inch (0.05 mm)	
Exhaust Valve Lash (Cold)	0.002 inch (0.05 mm)		0.002 inch (0.05 mm)	
Spark Plug Tightening Torque	13 lbs-ft (17 N-m)		13 lbs-ft (17 N-m)	
Ignition Timing (magneto)	25° BTDC, non-adjustable		25° BTDC, non-adjustable	
Ignition Coil Air Gap	0.009-0.015 inch (0.23-0.38 mm)		0.009-0.015 inch (0.23-0.38 mm)	
Spark Plug Gap	0.025 inch (0.64 mm)		0.020 inch (0.51 mm)	
DC SYSTEM:				
Nominal Battery Voltage	12 volts		12 volts	
Min. Battery Rating: Cold Cranking Amps (CCA) @ 0° F (–18° C)	450		450	
Battery Charging Current	–	10 amp (regulated)	–	10 amp (regulated)
INSTALLATION:				
Weight (with engine oil)	174 pounds (79 Kg)	184 pounds (84 Kg)	174 pounds (79 Kg)	184 pounds (84 Kg)
Minimum Compartment Size (H x D x W)[3]	14.4 inch x 20 inch x 30.5 inch (366 mm x 508 mm x 775 mm)		14.4 inch x 20 inch x 30.5 inch (366 mm x 508 mm x 775 mm)	
Minimum Free Air Inlet Area	40 inch^2 (258 cm^2)		40 inch^2 (258 cm^2)	
Muffler Outlet Collar O. D.	1.13 inch		1.13 inch	
Fuel Connection	1/4 inch barb fitting for gasoline hose		5/8-18UNC, SAE 45° Flare Fitting	
LPG Vapor Supply Pressure	–		9-13 inch (228-330 mm) Water Column (WC)	

1. Also available for 100 volts, with grounded or isolated neutral.
2. Reconnectable. See the Installation Manual.
3. See the Installation Manual for additional considerations when sizing the genset compartment.

	GASOLINE MODELS		LPG MODELS	
	4KYD	**3.6KYD**	**3.6KYD**	**3.3KYD**
GENERATOR: 2-Pole Revolving Field, Self-Excited, 1-Phase, Microprocessor Regulated				
Power	4000 watts	3600 watts	3600 watts	3300 watts
Frequency	60 Hertz	50 Hertz	60 Hertz	50 Hertz
Voltage	120 volts	230 volts	120 volts	230 volts
Current	33.3 amperes	15.7 amperes	30 amperes	14.3 amperes
Speed	3600 rpm	3000 rpm	3600 rpm	3000 rpm
FUEL CONSUMPTION:				
No load Half load Full load	0.29 gph (1.1 l/h) 0.48 gph (1.8 l/h) 0.71 gph (2.7 l/h)	0.21 gph (0.79l/h) 0.37 gph (1.4 l/h) 0.58 gph (2.2 l/h)	1.5 lbs/h (0.7 kg/h) 2.2 lbs/h (1.0 kg/h) 3.3 lbs/h (1.5 kg/h)	1.1 lbs/h (0.5 kg/h) 2.0 lbs/h (0.9 kg/h) 2.9 lbs/h (1.3 kg/h)
ENGINE: 1-Cylinder, 4-Stroke Cycle, Spark-Ignited, OHV, Air Cooled, Mechanically Governed				
Bore	3.11 inch (79 mm)		3.11 inch (79 mm)	
Stroke	2.44 inch (62 mm)		2.44 inch (62 mm)	
Displacement	18.5 inch^3 (304 cc)		18.5 inch^3 (304 cc)	
Compression Ratio	8.5 : 1		8.5 : 1	
Oil Capacity	1.6 quart (1.5 l)		1.6 quart (1.5 l)	
Intake Valve Lash (Cold)	0.002 inch (0.05 mm)		0.002 inch (0.05 mm)	
Exhaust Valve Lash (Cold)	0.002 inch (0.05 mm)		0.002 inch (0.05 mm)	
Spark Plug Tightening Torque	13 lbs-ft (17 N-m)		13 lbs-ft (17 N-m)	
Ignition Timing (magneto)	25° BTDC, non-adjustable		25° BTDC, non-adjustable	
Magneto Air Gap	0.009-0.015 inch (0.23-0.38 mm)		0.009-0.015 inch (0.23-0.38 mm)	
Spark Plug Gap	0.025 inch (0.64 mm)		0.020 inch (0.51 mm)	
DC SYSTEM:				
Nominal Battery Voltage	12 volts		12 volts	
Min. Battery Rating: Cold Cranking Amps (CCA) @ 0° F (–18° C)	450		450	
Battery Charging Current	–	10 amp (regulated)	–	10 amp (regulated)
INSTALLATION:				
Weight with Muffler	172.6 lb (78.3 Kg)		172.6 lb (78.3 Kg)	
Minimum Compartment Size (H x D x W)[1]	14.55 inch x 20.13 inch x 26.31 inch (369.25 mm x 511.3 mm x 668.3 mm)		14.55 inch x 20.13 inch x 26.31 inch (369.25 mm x 511.3 mm x 668.3 mm)	
Minimum Free Air Inlet Area	40 inch^2 (258 cm^2)		40 inch^2 (258 cm^2)	
Muffler Outlet Collar O. D.	1.13 inch		1.13 inch	
Max. Exhaust Back Pressure	32 inch WC		32 inch WC	
Fuel Connection	1/4 inch barb fitting for gasoline hose		5/8-18UNC, SAE 45° Flare Fitting	
LPG Vapor Supply Pressure	–		9-13 inch (228-330 mm) Water Column (WC)	

1. See the Installation Manual for additional considerations when sizing the genset compartment.

3. Dimensions and Clearances

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

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

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

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

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

DESCRIPTION	FACTORY SPECIFICATION MIN.	FACTORY SPECIFICATION MAX.	ALLOWABLE LIMIT
Intake Valve Seat			
Seat Width	0.0433 (1.1)		N/A
Seat Angle	45°		N/A
Exhaust Valve			
Valve Stem O.D.	0.2732 (6.940)	0.2740 (6.960)	0.2732 (6.940)
Valve Guide I.D.	0.2756 (7.000)	0.2762 (7.015)	0.2748/0.2768 (6.98/7.03)
Valve Stem to Guide Clearance	0.0016 (0.04)	0.0030 (0.075)	0.0002/0.0035 (0.005/0.090)
Valve Stem to Rocker Arm Clearance (Valve Lash)	0.0008 (0.02)	0.0032 (0.08)	0.0008/0.0032 (0.02/0.08)
Face Angle	45°		N/A
Exhaust Valve Seat			
Seat Width	0.0433 (1.1)		N/A
Seat Angle	45°		N/A
Valve Springs			
Free Length	1.8031 (45.8)	1.8228 (46.3)	1.6850 (42.8)
Distortion (Square)			0.0059 (1.5)
Ignition System			
Spark Plug Gap	0.025 (0.63)		
Coil Air Gap	0.009 (0.23)	0.015 (0.38)	
Ignition Timing (BTDC)	25°		Not Adjustable

4. Torque Specifications

Mounting screws and nuts must be tightened to the specified torques in the following tables. All threads must be clean and lubricated with new engine oil before tightening. The cylinder head mounting bolts must be tightened in the proper sequence. See *Engine Block Assembly,* Section 9. When tightening torques are not specified, tighten the screws and nuts according to Tables 4-3 and 4-4. The grade numbers are indicated on top of the screw or bolt head.

TABLE 4-1. ENGINE TORQUE SPECIFICATIONS

ITEM	POUND - FEET	NEWTON - METERS
Air Deflector Bolts	8 - 15	11 - 22
Connecting Rod Bolts	18 -20	24 - 27
Cylinder Head Bolts (Cold)		
#1 and #6	12 - 16	16 - 22
#2 thru #5	31 - 37	42 - 50
Cylinder Air Housing Bolts		
M6 X 12	5 - 8	7 - 11
M8 X 10, M8 X 16	8 - 15	11 - 20
Gearcase Cover	12 - 16	16 - 22
Governor Lever Bolt	7	12
Intake Elbow Screws	8 - 12	11 - 16
Exhaust Flange Nuts	18-22	25-30
Muffler to Base	25 lb-in.	3
Oil Base Bolts	10 - 14	14 - 19
Oil Drain Screw	5 - 8	7 - 11
Rocker Arm Adjustment Nut	5 - 8	7 - 11
Spark Plug	7 - 18	10 - 24
Valve Cover	5 - 8	7 - 11

TABLE 4-2. GENERATOR TORQUE SPECIFICATIONS

ITEM	POUND - FEET	NEWTON - METERS
Rotor Through-Bolt	40-50	54-68
Stator Through-bolt	5-8	7-11
Endbell to Stator Housing	5-8	7-11
Mount Assy. Bolt	35-40	47-53
Stator Housing to Engine Block	15-18	21-24

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

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

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

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

5. Preparing for Service

TROUBLESHOOTING

Refer to *Troubleshooting,* Section 10, before starting work on the genset. Note that some problems have several possible causes.

SAFETY

There are hazards in servicing gensets. Study *Safety Precautions* (p. iv) and become familiar with the hazards listed in Table 5-1. Note the following safeguards and ways of avoiding hazards:

- ***Use personal protection:*** Wear protective safety equipment, such as safety shoes and safety glasses.
- Do not wear rings or jewelry and do not wear loose or damp clothing that might get caught in equipment or conduct electricity.
- ***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 do not take risks.
- ***Be prepared for an accident:*** Keep fire extinguishers and safety equipment nearby. Agencies such as the Red Cross and public safety departments offer courses in first aid, CPR and fire control. Take advantage of this information to be ready to respond to an accident. Learn to be safety-conscious and make safety procedures part of the work routine.

TABLE 5-1. 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 boat • Removing heavy components

SPECIAL TOOLS

The following special tools are required to service the genset. See the Onan Tool Catalog.

Engine Tools

Torque wrench (0–75 lbs-ft or 0–100 N-m)
Feeler gauge
Leak down tester
Spark plug gap gauge
Cylinder compression tester
Flywheel puller
Snap ring pliers
Cylinder ridge reamer
Piston ring compressor
Piston ring spreader
Cylinder hone
Valve seat cutter
Valve spring compressor
Piston groove cleaner
Outside micrometer set (1–4 in.)
Telescoping gauge set (0.500–4.000 in.)
Hole gauge (0.300–0.400 in.)
Plasti-Gage bearing clearance guide

Generator Tools

Lead or dead-blow hammer
Steel rod (0.45 inch OD x 7–7/8 inch long)
VOM Multi-Tester
Frequency Meter
Load test panel and leads

REMOVING GENSET

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

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

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

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

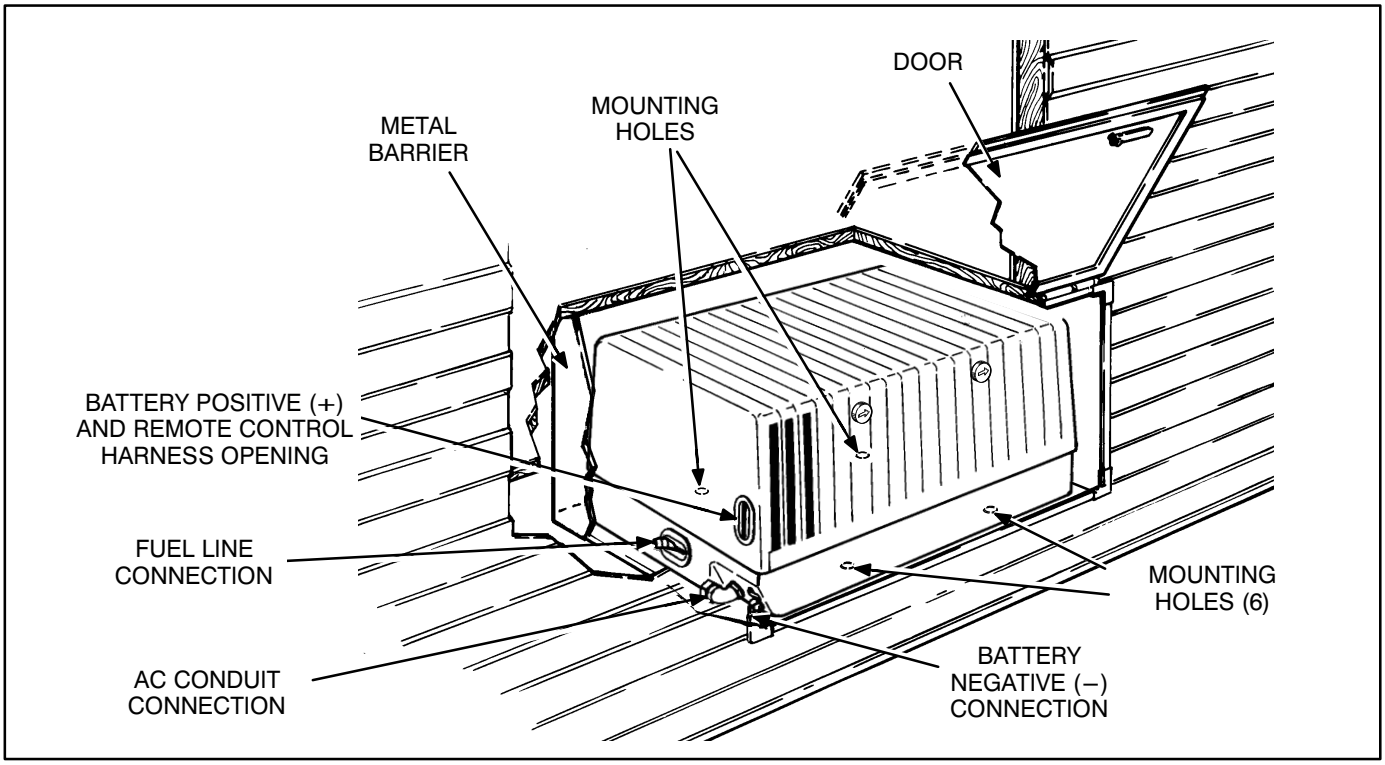


FIGURE 5-1. TYPICAL COMPARTMENT MOUNT INSTALLATION

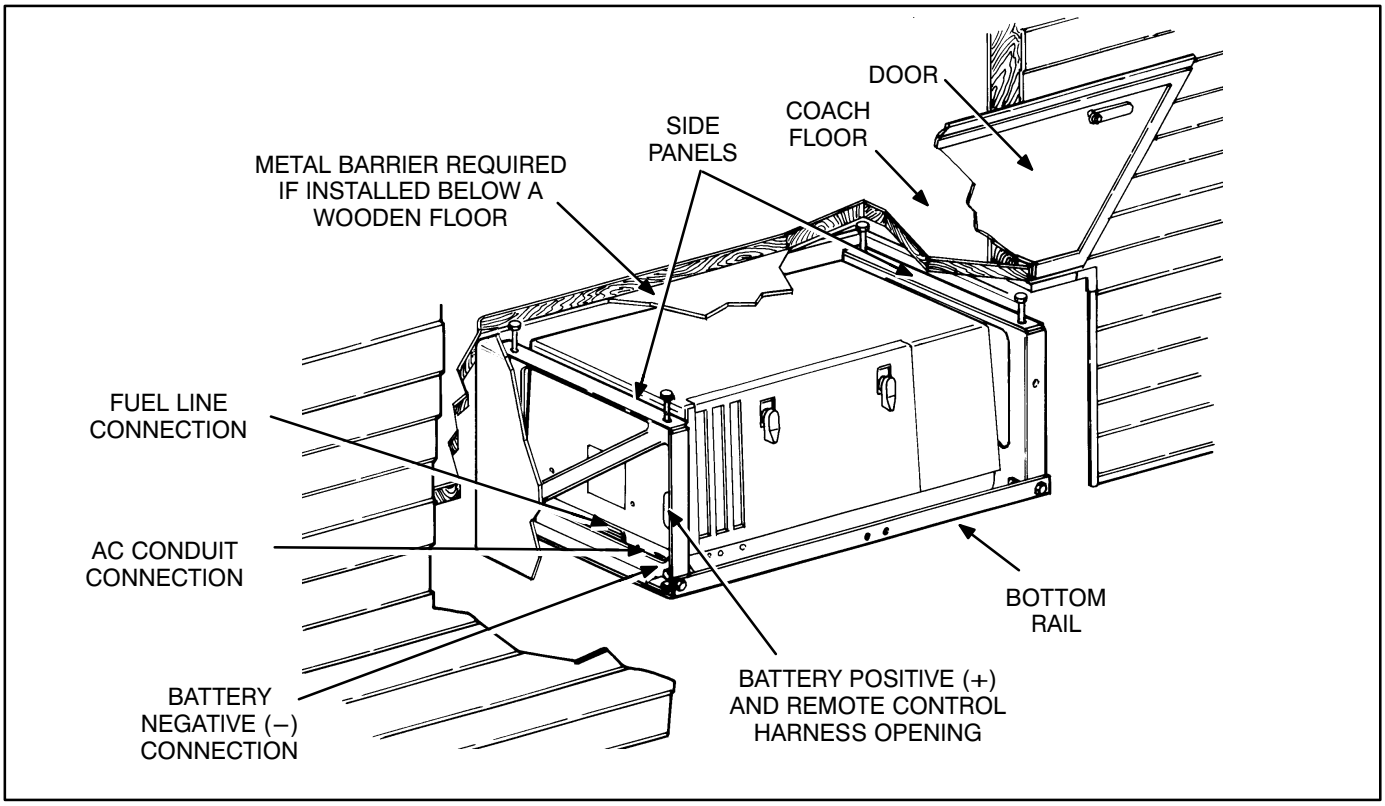


FIGURE 5-2. TYPICAL UNDER-FLOOR MOUNT INSTALLATION

Disconnecting Set from Vehicle Systems

Disconnect the following items from the genset. Refer to Figures 5-1 and 5-2 for component locations in typical genset installations.

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

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

   ⚠WARNING ***Arcing at battery terminals or in a light switch or other equipment, flames and sparks can ignite battery gas causing severe personal injury. Ventilate the battery compartment before connecting or disconnecting battery cables—Disconnect the negative (–) cable first and reconnect it last—Wear safety glasses—Do not smoke—Switch lights ON and Off away from the battery.***

2. Remove the genset negative (–) battery cable at the battery terminal.
3. Disconnect the genset positive (+) battery cable from the B+ connection on the genset.
4. Disconnect the remote control wire connector from the left side of the genset housing.
5. Disconnect the generator load wires inside the genset. To do this, first move the controller/start relay assembly aside (p. 6-3) and then disconnect the ground and neutral (L2) lead from the ground terminal. Disconnect the inline load (L1) lead connection. Tag the wires for identification when reconnecting.
6. Loosen the conduit connector elbow, and pull the load wires and flexible conduit free of the genset.
7. Disconnect the exhaust tail pipe from the genset. Disconnect any exhaust support brackets or hangers that restrict removal of the genset.
8. Disconnect the fuel line from the genset. Follow the applicable instructions depending on the fuel.

A. ***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.

B. ***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 most of the LPG from the fuel line and genset, run the genset (if it starts) until it runs out of fuel (LPG container valve closed). To purge some of the remaining LPG, press the regulator primer plunger (Figures 8-13 and 8-14) while cranking the engine for 10 seconds. Disconnect the fuel line from the genset and plug the end of the hose to prevent fuel from escaping if someone inadvertently opens the shutoff valve(s) at the LPG container(s).

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

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

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

Set Removal

After the genset is disconnected from electrical, exhaust and fuel systems, examine the set mounting and support system. Locate all mounting bolts and support members for the set. In most installations the generator housing will be mounted to the coach framework. Depending on the installation, the set may be removable from the side, back or bottom.

Verify that the genset is adequately supported before loosening any of the mounting bolts or support members. Use a forklift to lift or move the set.

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

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

Compartment Mount:

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

Under-Floor Mount:

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

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

REINSTALLING GENSET

Generally reinstallation is the reverse of removal. Perform the service checklist before placing the genset back into service (*Service Checklist,* Section 11).

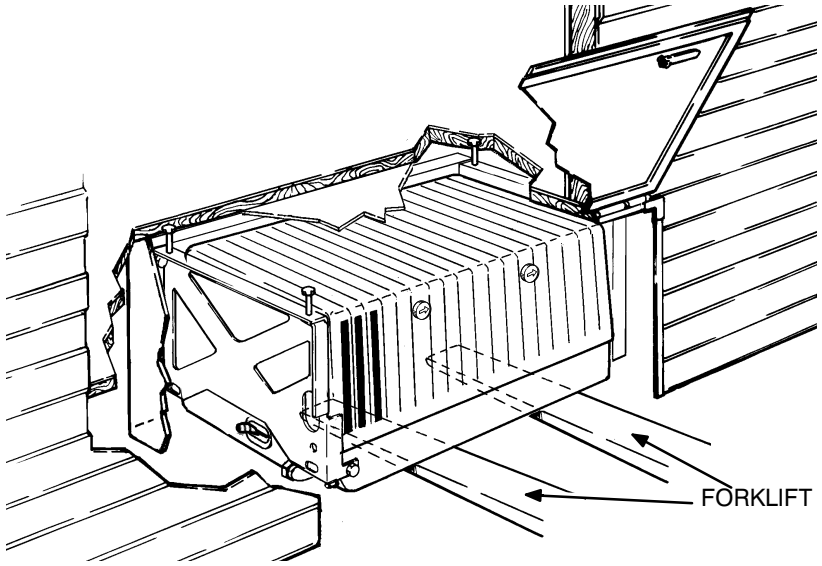


FIGURE 5-3. COMPLETE GENSET REMOVAL

6. Control

CONTROLLER A1

Controller A1 is an integrated microprocessor-based engine and generator control. It provides all the control, monitoring and diagnostics functions required to operate the genset. Figure 6-1 is an illustration of the components with which it interfaces. Figure 6-2 is a block diagram of its functions. All connections to the controller are through connector **P1** (23-pin) which plugs into the bottom of the controller.

⚠ CAUTION ***Makeshift meter test probes used for testing Control Board connections during troubleshooting can damage pin sockets by spreading or dislodging the contact wiper arms, resulting in an open or intermittent electrical connection. Use a mating pin (PN 323–1605) or a test probe that is 0.045 inches in diameter. Replace damaged pin sockets (PN 323–1614–01). Make sure the pin sockets are fully seated and can't be pulled out.***

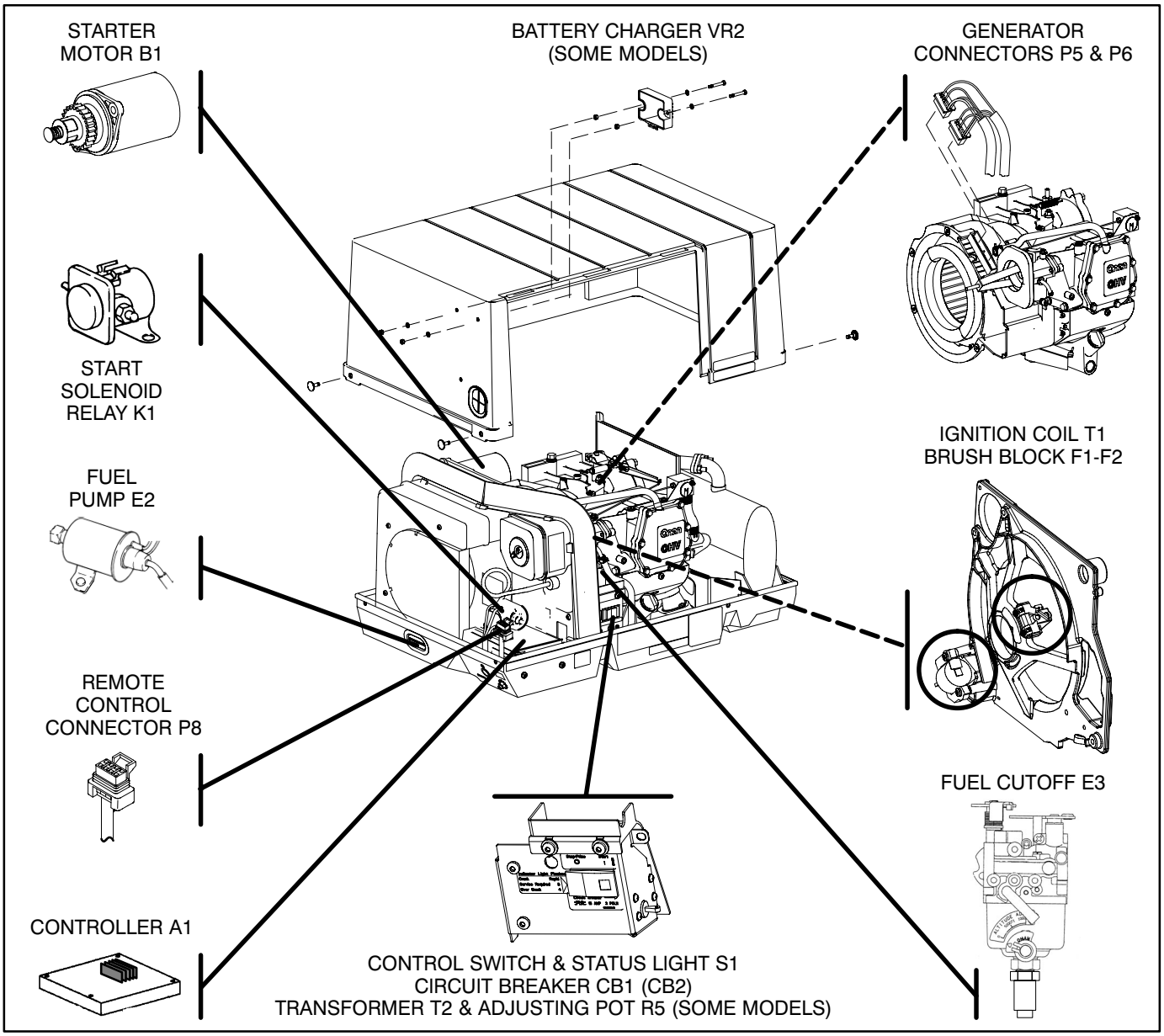


FIGURE 6-1. CONTROLLER A1 AND INTERFACING COMPONENTS AND THEIR LOCATIONS

Major Functions of Controller A1

Initialization: Control initialization consists of checking memory (RAM, ROM, EEPROM) and genset configuration.

Fuel Prime(Gasoline Gensets): Press and hold the stop switch for more than 3 seconds to cause the fuel pump to pump.

Startup: Press and hold the start switch until the genset starts. The controller:

1. Enables cranking (start relay K1)
2. Energizes fuel pump E2 and fuel cutoff solenoid E3
3. Flashes the field (F1-F2)
4. Flashes status indicator light during cranking
5. Disconnects the starter at 2500 rpm
6. Lights status indicator at start disconnect
7. Turns on Switched B+ (remote pin J8-F)
8. Enables output voltage

Stop: Press the stop switch momentarily. The controller:

1. Disables output voltage
2. Deenergizes the fuel pump and the fuel cutoff solenoid
3. Enables ignition kill
4. Turns off the status indicator light
5. Writes session data (number of cranks, minutes of operation, last fault, etc.) to non-volatile memory (NVM)
6. Removes processor power when idle 5 minutes (battery saver function).

Note: Stop takes precedence over Start if both present due to a faulty switch or other cause.

Voltage Control: The controller maintains nominal AC output voltage during steady state operation by varying field current. In response to transient loads it lowers the voltage setpoint to allow engine recovery. Field power (DC) is supplied by the quadrature windings (AC) through the controller.

Fault Monitoring, Shutdown and Diagnostics: See *Troubleshooting*, Section 10.

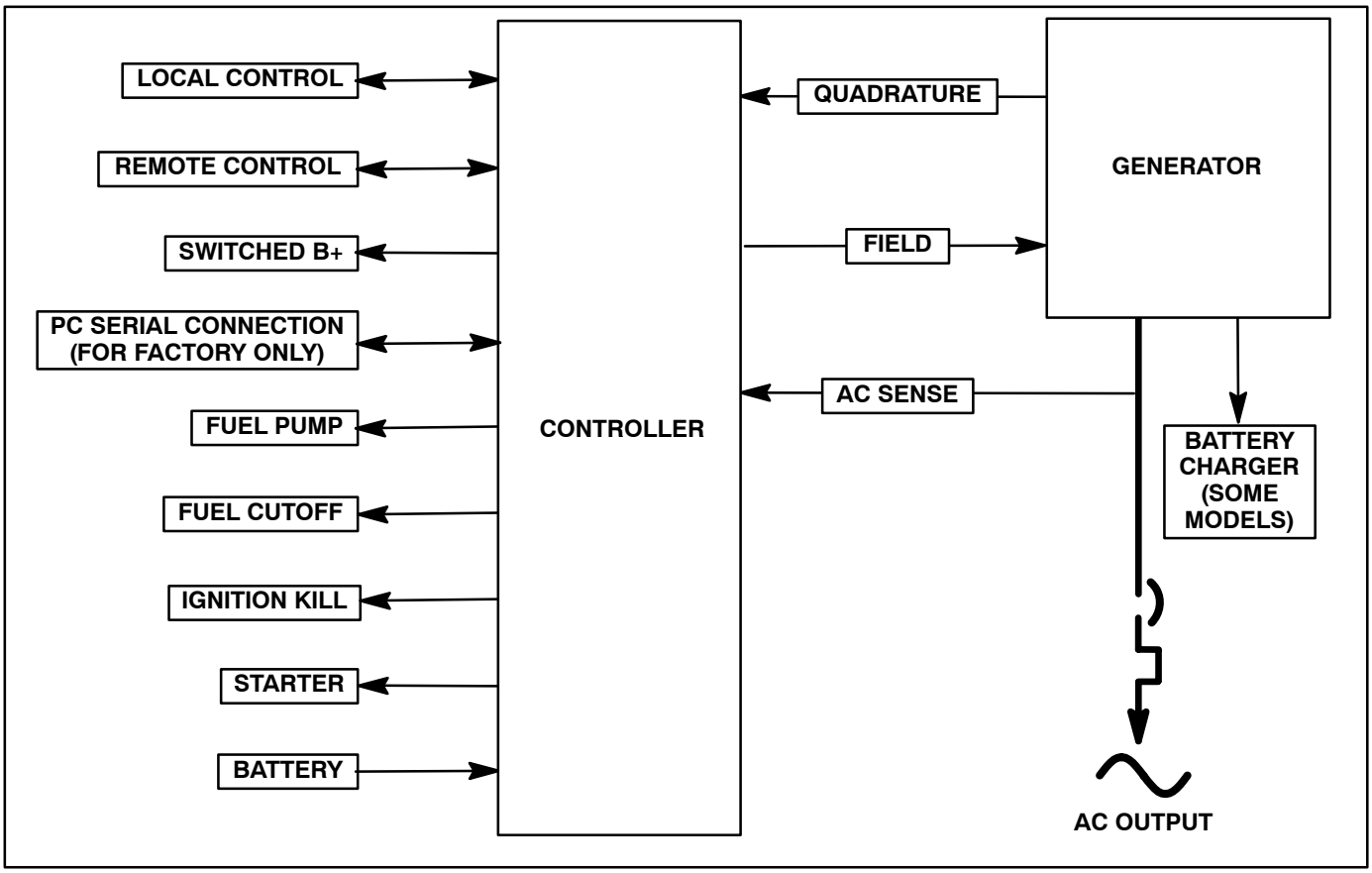


FIGURE 6-2. CONTROLLER A1 BLOCK DIAGRAM

Removing Controller A1

To remove the controller, remove it and start solenoid relay K1 as an assembly with their mounting bracket. The bracket is secured by two screws through the front of the base pan and a foot that catches under a tab in the bottom of the base pan.

To disconnect the connector, use a small flat-bladed screwdriver to lever the catch out, as shown in Figure 6-3, while pulling the connector apart.

⚠ CAUTION ***Makeshift meter test probes used for testing Control Board connections during troubleshooting can damage pin sockets by spreading or dislodging the contact wiper arms, resulting in an open or intermittent electrical connection. Use a mating pin (PN 323–1605) or a test probe that is 0.045 inches in diameter. Replace damaged pin sockets (PN 323–1614–01). Make sure the pin sockets are fully seated and can't be pulled out.***

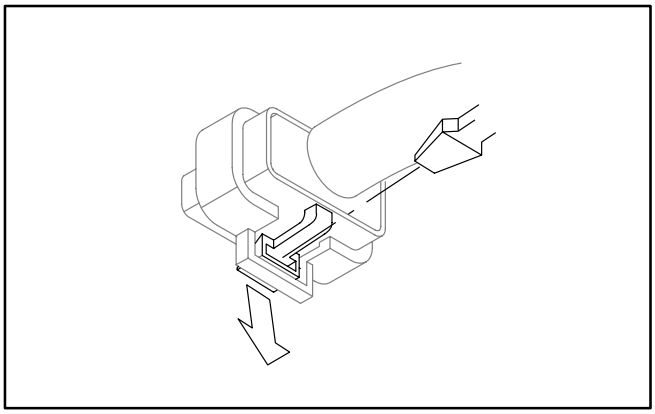


FIGURE 6-3. DISCONNECTING P1

CONTROL COMPONENT TESTS

Control Switch S1

The switch is located as shown in Figure 6-4. Unsnap connector P9 from the back of the switch for access to its terminals. Replace the switch if it does not: close across terminals 2 and 3 when the switch is held in the Start position, close across terminals 1 and 2 when held in the Stop position, or the status indicator light does not light when 12 VDC is connected across terminals 7 (–) and 8 (+).

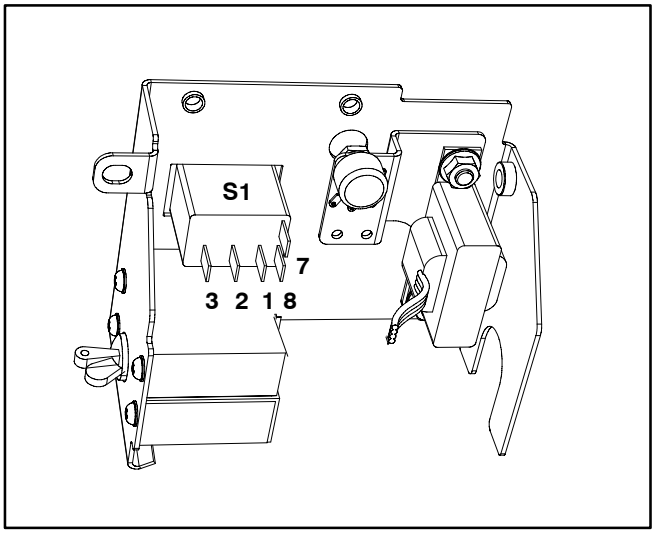


FIGURE 6-4. CONTROL SWITCH S1

Start Solenoid Relay K1

A check can be made by measuring the resistance of coil terminals I and S (Figure 6-5). With the harness leads removed, the coil should read 3–5 ohms. If an abnormal reading is measured, replace start solenoid relay K1.

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

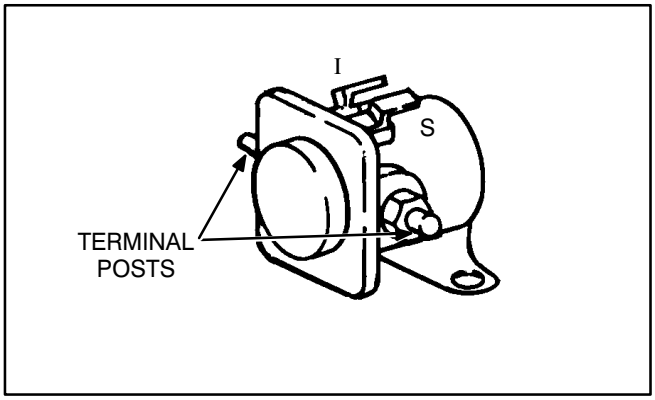


FIGURE 6-5. START SOLENOID RELAY K1

Line Circuit Breaker CB1 (CB2)

The line circuit breakers are located as shown in (Figure 6-6). Disconnect all connectors at the terminals and check resistance. Replace a circuit breaker that does not reset or that does not close and open across its terminals as the handle is turned ON and OFF.

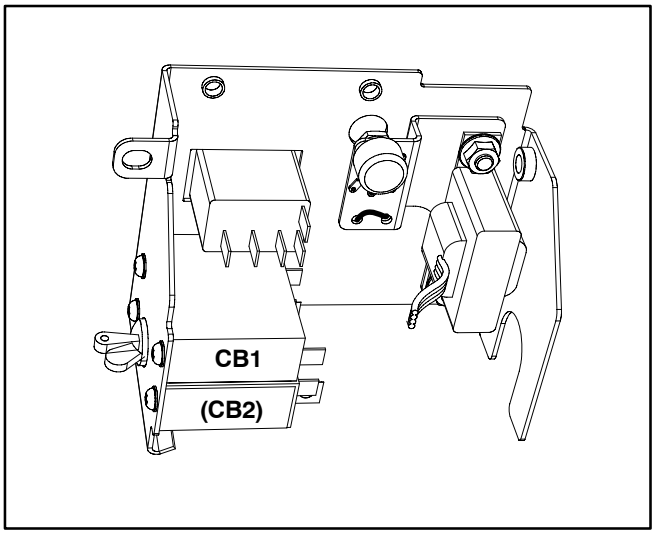


FIGURE 6-6. LINE CIRCUIT BREAKERS CB1 (CB2)

Battery Charger VR2 (Some Models)

The battery charger is located on the left side of the genset housing (Figure 6-1). The battery charger can be checked with a voltmeter. A voltage measurement between the B+ terminal and ground (Figure 6-7), with the genset off should read the starting battery voltage (approximately 12 VDC). With the genset running a reading between the B+ terminal and ground should be slightly more than the first reading (12.5–14 VDC).

If the same or less voltage is measured, connect the voltmeter between the two AC terminals to measure the input voltage from the B1–B2 battery charge winding. During set operation voltage from the B1–B2 battery charge winding should be 17–19 VAC. If this reading is obtained and charger output voltage does not increase when the genset is started, replace the battery charger. If low or no voltage is measured between the AC terminals, check the wiring harness connections and refer to the generator test section.

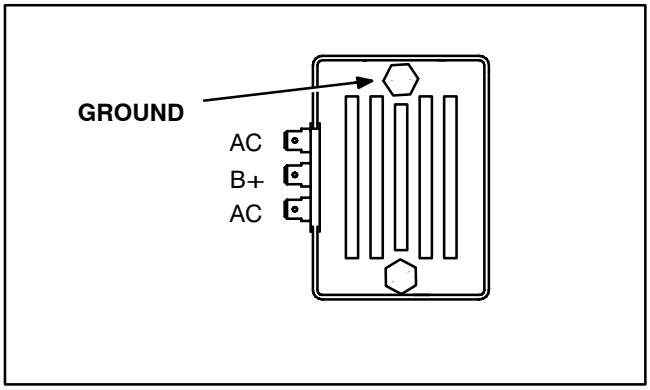


FIGURE 6-7. BATTERY CHARGER VR2

Transformer T2 (Some Models)

The transformer is located as shown in (Figure 6-8). Isolate the transformer leads from the circuit and measure the resistance between **H1** and **H2** of the primary winding. The primary should measure 440–540 ohms. Measure the resistance between **X1** and **X2** of the secondary winding. The secondary should measure 225–275 ohms. If an abnormal reading is measured, replace the transformer.

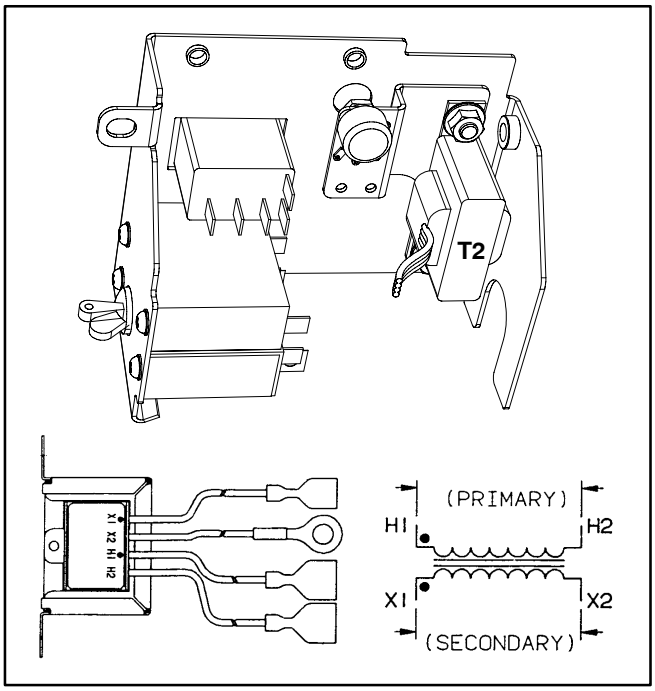


FIGURE 6-8. TRANSFORMER T2

Voltage Trim Potentiometer R5 (Some Models)

The voltage trim potentiometer is located as shown in (Figure 6-9). Disconnect the potentiometer leads from the engine harness and measure resistance across its connectors while slowly rotating the adjusting screw from one end to the other and then back. Replace potentiometer R5 if resistance does not increase or decrease smoothly and continuously from 0 to 25K ohms.

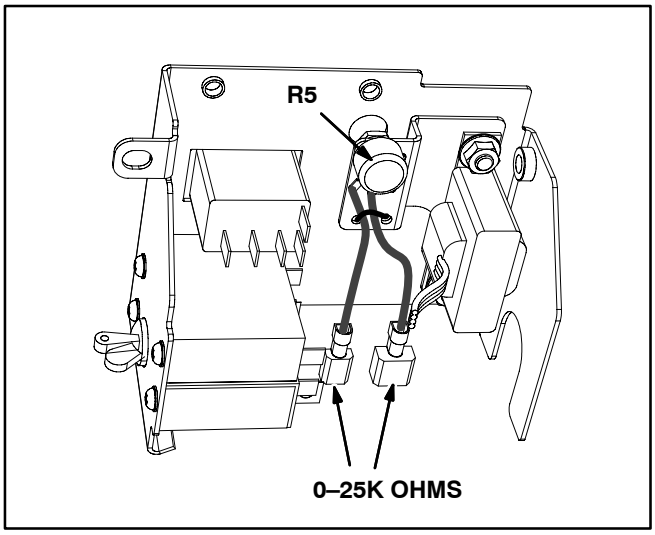


FIGURE 6-9. VOLTAGE TRIM POTENTIOMETER R5

7. Generator

GENERATOR DESCRIPTION

These are 2-pole, revolving field generators with brushes and slip rings (Figure 7-1). Output voltage is regulated by microprocessor-based genset controller A1.

Stator

The stator consists of steel laminations with two or three sets of windings wound into slots in the laminations. The main winding set (T1–T2, T3–T4) is for powering the connected loads. The quadrature winding (Q1–Q2) is for field excitation. The battery charging winding (B1–B2) is provided on some models.

Rotor

The rotor consists of steel laminations on the rotor shaft. The field windings wrap around the rotor laminations. The rotor shaft also carries the molded slip ring assembly and pressed-on bearing. The rotor shaft is secured to the tapered engine crankshaft by means of a through bolt. The rotor bearing supports the other end in the generator endbell.

Genset Cooling Fan

The genset cooling fan is mounted on the end of the generator rotor shaft. A portion of the airflow from the fan is directed through the generator to cool the stator and rotor windings.

Brush Block

The brush block is a one-piece molded assembly mounted on the endbell. It carries two spring-loaded carbon brushes that make contact with the slip rings on the rotor. The field current passes through the brushes and slip rings.

Voltage Regulator

Genset controller A1 maintains constant output voltage under varying load conditions by varying field current. Field excitation power is supplied by the quadrature winding (Q1–Q2).

Line Circuit Breaker

Line circuit breaker CB1 is mounted on the control panel to protect the generator leads and provide a means for disconnecting the generator from the load.

Principle of Operation

Refer to the schematic that corresponds to your genset (p. A-1 or A-3). During startup the controller connects the field winding to the battery to provide magnetism for voltage buildup. As the engine starts and speed increases, the rotating field induces an AC voltage in the stator windings. AC voltage from quadrature winding Q1–Q2 is fed to the controller where it is rectified into DC voltage and fed to the rotor through the brushes and slip rings to cause further voltage buildup. This process continues as the engine picks up speed.

During operation the controller continually monitors output voltage (L1–L2). When additional load is applied to the generator, the output voltage starts to decrease. The controller senses this decrease and increases the field current until the reference voltage and the output voltage match. Similarly, when the load is decreased the output voltage begins to increase and the controller senses this increase. In this case, the controller decreases the amount of current to the field until the output voltage again matches the reference voltage. By continually measuring the output voltage and compensating for load changes, the controller keeps the voltage of the generator constant under varying load conditions.

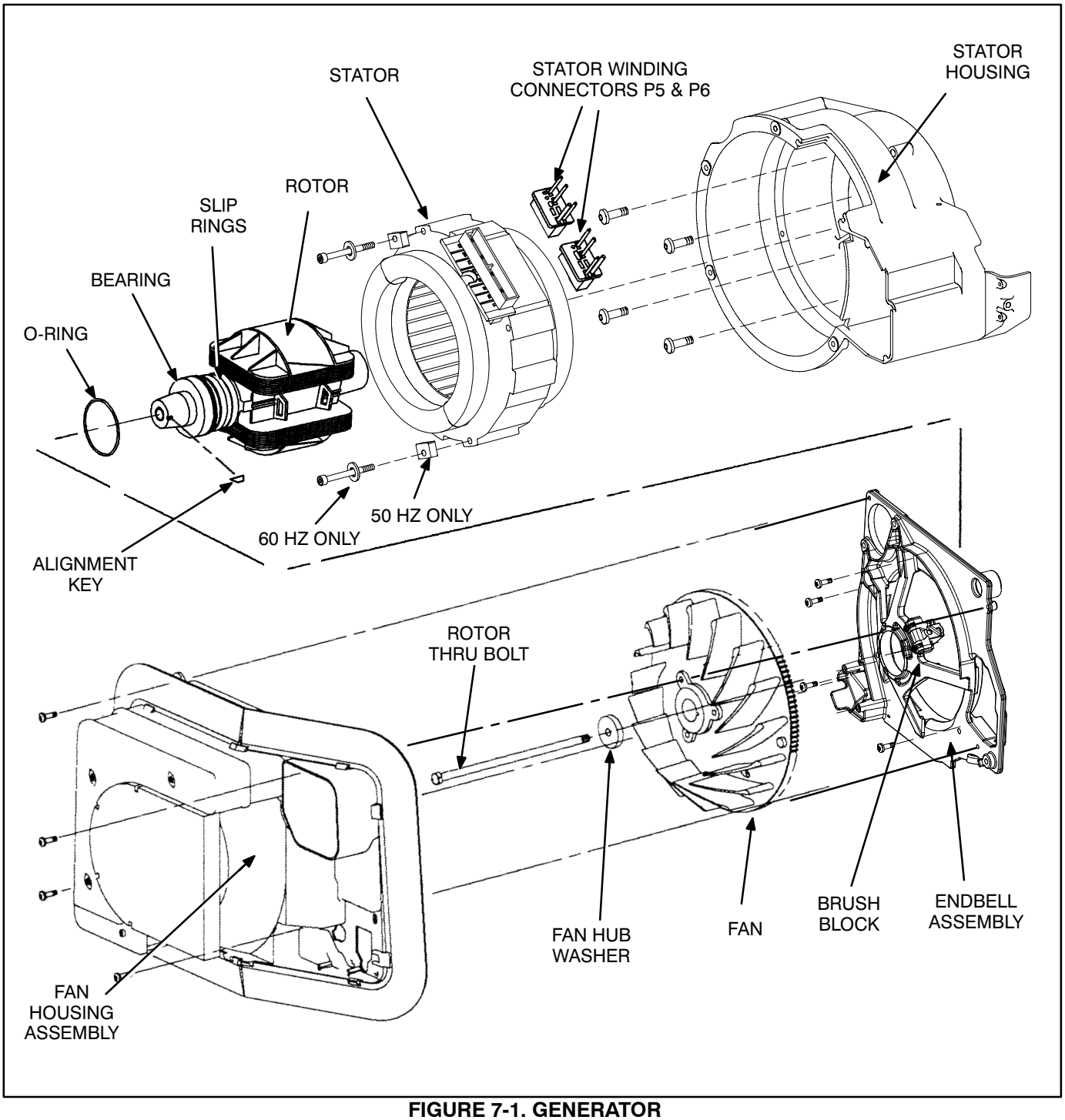


FIGURE 7-1. GENERATOR

GENERATOR SERVICE

Refer to Figure 7-1 to identify the various generator components described in each section. Raising the generator and engine assembly above the base assembly is necessary to disassemble the generator. A lifting hoist will be required for this step.

Generator Disassembly

1. First drain the engine oil and then remove the genset from the installation and place it on a sturdy work bench (see *Preparing for Service*, Section 5).
2. Remove the cover from the genset. (Remove the leads from the battery charger assembly mounted to the left side of the housing if the genset is so equipped.)
3. Remove the exhaust manifold-to-engine mounting nuts and muffler-to-base mounting screws and slide the muffler to the right so that the exhaust manifold pipe clears the engine.
4. Remove the engine/generator-to-base mounting bolts (4). (Apply antiseize lubricant to the threads of these bolts before reinstallation.)
5. Disconnect all leads from the start relay and remove the controller and start solenoid relay as an assembly (p. 6-3).
6. Carefully lift the generator end of the genset and place a wooden block under the stator housing to support the genset.

   NOTE: For access to the air preheat door, remove the air housing assembly cover at this point.
7. Remove the fan housing assembly from the endbell.
8. Secure the fan so that it cannot rotate and remove the rotor through bolt and washer.
9. Use a magnet to pull out the fan-to-shaft alignment key and save it for reassembly. Remove the fan with a wheel puller (Figure 7-2) Attach the wheel puller to the fan hub with three 5/16-inch thread tapping cap screws (or tap fan hub with 3/8-inch tap and use 3/8-inch cap screw).

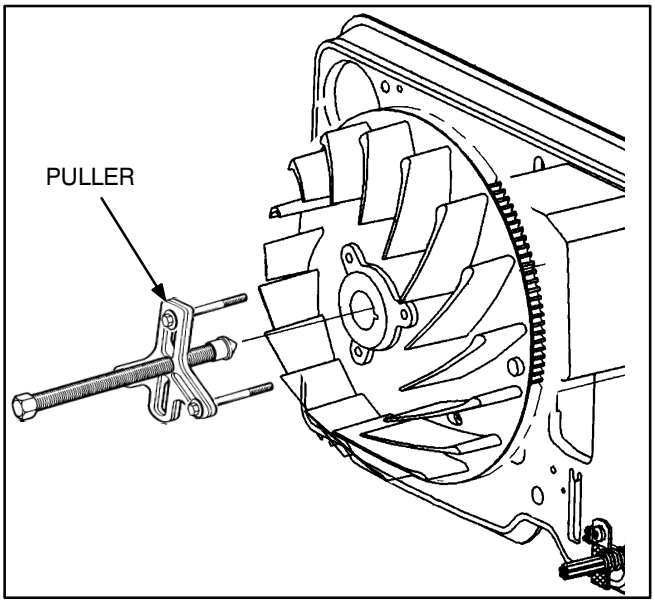


FIGURE 7-2. PULLING THE FAN

10. Disconnect the wire harness leads from the brush block and pull each brush outward from the holder while inserting a wire into the small hole in the endbell at the bottom of the brush block (Figure 7-3). Release the brushes and check that each brush is being held off the slip rings by the wire. Remove the wires from the magneto assembly. Loosen the two screws holding the brush block to the endbell.

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

11. Disconnect the starter bracket from the rear of the starter. Remove the endbell mounting screws and place the endbell along side the front of the genset to reduce the number of leads that need to be disconnected.

12. Pull outward on the rotor shaft to remove it. If the rotor does not come loose from the tapered engine crankshaft, install a solid round bar 7-7/8 inches (200 mm) long by 0.45 inches (11 mm) in diameter into the rotor through bolt hole (Figure 7-4). Thread a 9/16-12 x 1 inch bolt into the end of the rotor shaft and slowly tighten the bolt until the rotor comes loose.

   ⚠CAUTION ***Careless handling of rotor or stator can damage winding insulation. Touching the slip rings can cause corrosion.***

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

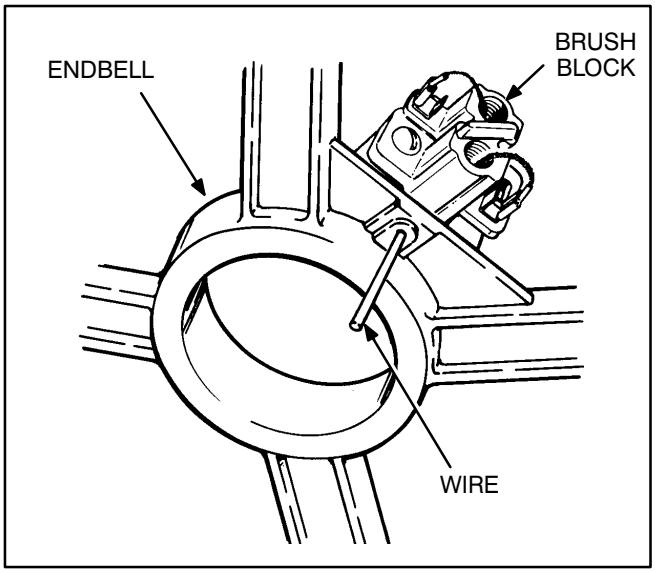


FIGURE 7-3. BRUSH BLOCK

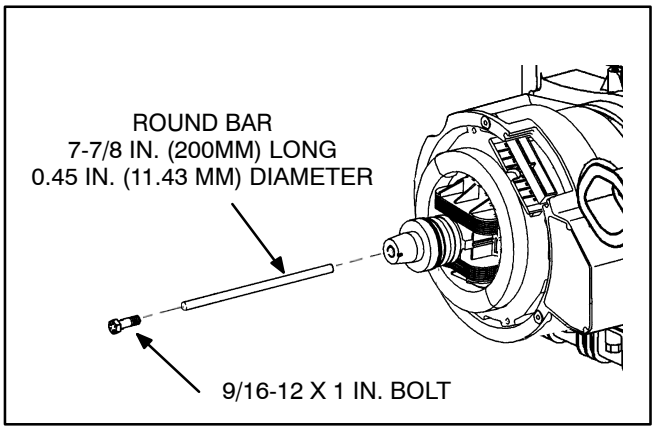


FIGURE 7-4. ROTOR REMOVAL

Generator Assembly

Use the following procedures to assemble the generator:

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

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

2. Align the pin in the rotor shaft with the notch in the crankshaft and slide the rotor onto the crankshaft. Make sure that the rotor is seated.
3. Plug in both stator wire connectors.
4. Prepare the endbell for installation. Lubricate the O-ring on the bearing. Verify that the brushes are held inside the holder with a piece of wire and that the brush block is loose. See Figure 7-3. Install the endbell onto the rotor bearing and secure to the stator housing with the endbell mounting screws.

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

5. Center the brush block on the slip rings and tighten the mounting screws. Remove the piece of wire holding the brushes off the slip rings. Connect the F2 lead wire to the outer brush terminal (near bearing) and the F1 lead wire to the inner brush terminal. Connect the magneto assembly wires.
6. Install the fan onto the rotor shaft and align the key slot on the fan hub with the key slot in the rotor shaft. Install the key into the key slot. Install the rotor through bolt and washer. Verify alignment of the rotor shaft and the fan hub, then secure the fan hub assembly and tighten the rotor through bolt to specified torque.
7. Install the fan housing assembly.
8. Remove the wooden block from under the stator housing and slowly lower the genset.
9. Install the muffler assembly ***using new gaskets***. Install the generator/engine-to-base mounting bolts (use antiseize lubricant on bolt threads). Tighten the bolts to specified torque.
10. Reconnect the load, fuel pump, and ground leads, and connect and reinstall the controller and start solenoid relay assembly (p. 6-3).
11. Inspect the assembly, check all electrical and mechanical connections for correct fit and location. Place the enclosure cover on the genset and secure with the side mounting screws. (Reconnect the leads to the battery charger assembly mounted to the left side of the housing if the genset is so equipped.)
12. Install the genset, securely fastening all mounting screws and hardware. Reconnect the fuel, exhaust, and electrical systems in reverse order of disassembly (see *Preparing for Service*, Section 5).
13. Fill the crankcase with oil (see the Operator's Manual).

BRUSHES AND SLIP RINGS

Brush Replacement

Remove the fan (p. 7-3). Inspect the brushes and brush block for burn marks or other damage. If the brushes appear to be in good condition, use a piece of wire (modified as shown in Figure 7-5) to check for excessive brush wear (minimum brush length is 0.375 inches [9.5 mm]). Insert the painted end of the wire through the hole above each brush. Make sure the wire is resting on the brush and not on the spring. If the painted part of the wire is not visible, the brush is excessively worn and must be replaced. Always replace the brush springs when installing new brushes to maintain proper tension on the brushes. Clean carbon deposits from brushes and slip rings. Use the following procedures to replace the brushes:

1. Remove the brush block mounting screws and lift out the brush block.
2. Remove the brushes and springs from the holder and replace with new parts (Figure 7-6).
3. Push each brush into the brush holder and insert a stiff wire through the small hole in the base of the holder (Figure 7-7). The wire holds the brushes off the slip rings during assembly.
4. Install the brush block in the endbell but do not tighten the mounting screws.
5. Remove the wire holding the brushes off the slip rings. Adjust the brush block so that the brushes are centered on the slip rings and tighten the mounting screws.
6. Reassemble the generator (p. 7-5).

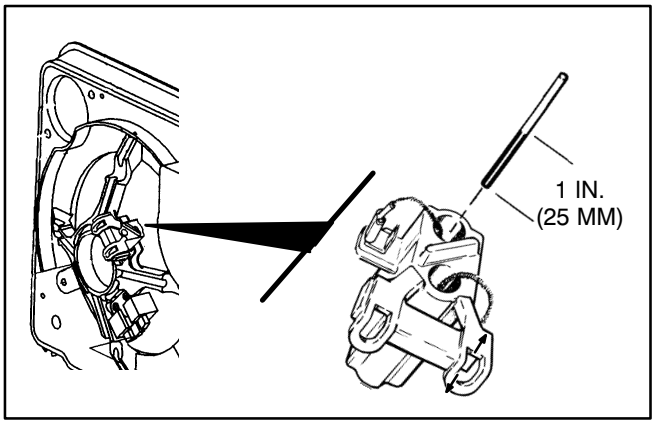


FIGURE 7-5. BRUSH WEAR CHECK

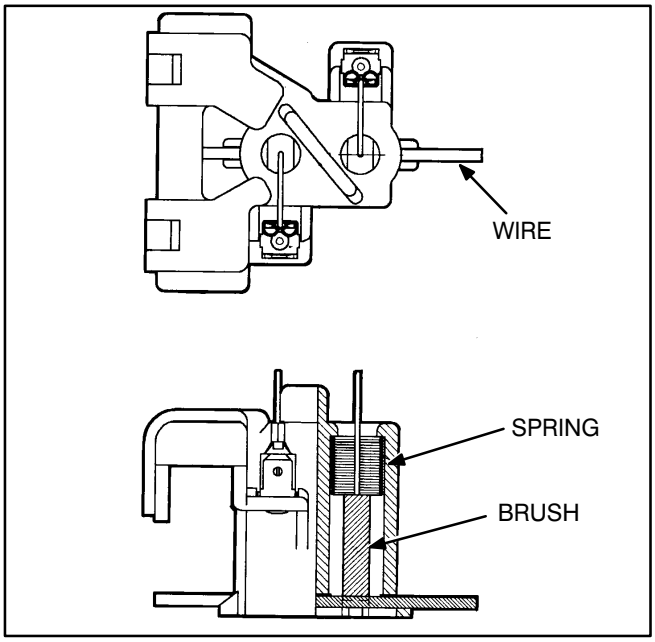


FIGURE 7-6. BRUSH REPLACEMENT

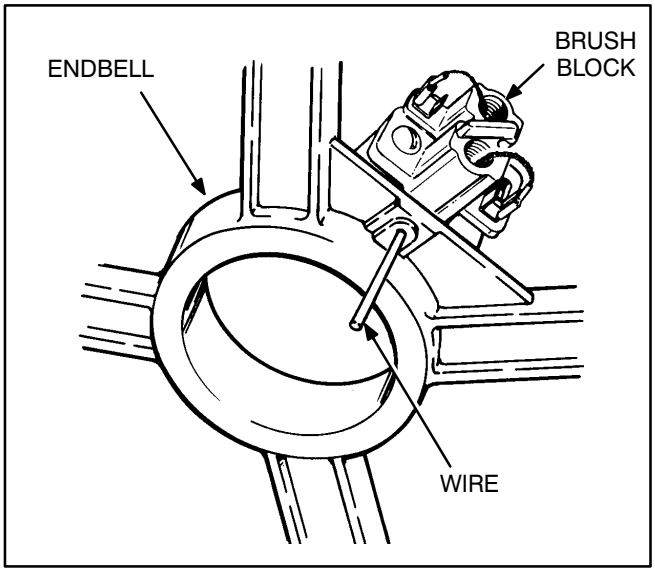


FIGURE 7-7. BRUSH BLOCK

Slip Ring Service

Remove the fan (p. 7-3). Inspect the slip rings for grooves, pits, or other damage. A Scotch Brite pad can be used to remove light wear and for surface finishing. If the slip rings are rough, pitted, or out of round by more than 0.002 inches, recondition them in a lathe with a commutator stone. Use the following procedure to service:

1. Remove the endbell and rotor (p. 7-4).
2. Replace the rotor in the machine lathe and center. Turn the rotor and use a commutator stone (Onan tool #420–0259) against the rotating slip rings to clean and true the slip rings. Turn the rotor until all grooves or roughness are smoothed out. Run-out must be less than 0.0001 inch, and surface finish must be less than 32 micro inch.

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

3. Clean and reinstall the rotor (p. 7-5).

GENERATOR TESTING

This section covers test procedures for the rotor and stator windings. Check all wire harness connectors and leads for continuity prior to generator testing (p. A-2 or A-4).

Rotor Test

The rotor can be tested for grounded, open, or shorted windings using an ohmmeter. Figures 7-8 and 7-9 show the rotor removed from the genset for testing. Remove the fan (p. 7-3) to gain access to the slip rings. Use a stiff wire to hold the brushes off the slip rings during testing (p. 7-6).

Ground Test: Set the ohmmeter to the highest resistance scale or use a megger. Touch one test prod to the rotor shaft and hold it there. Touch the other test prod to one of the slip rings (Figure 7-8). A reading of infinity should be measured. A reading of less than one megohm (one million ohms) indicates the rotor is grounded. Replace a grounded rotor.

Winding Resistance Test: Use an ohmmeter to measure winding resistance. Place the test prods on the slip rings (Figure 7-9). Replace the rotor if winding resistance is not as specified in Table 7-1.

TABLE 7-1. ROTOR WINDING RESISTANCES

RESISTANCE (OHMS) @ 77° F (25° C) ± 10%	
60 HZ	**50 HZ**
21.8	23.0
Note: Even though winding resistance may be within the tolerance of this Table, replace the Rotor if winding-to-ground resistance (winding ***insulation*** resistance) is less than 1 megohm. (An ohmmeter must indicate an *open circuit* or *infinite resistance* between the winding and ground.)	

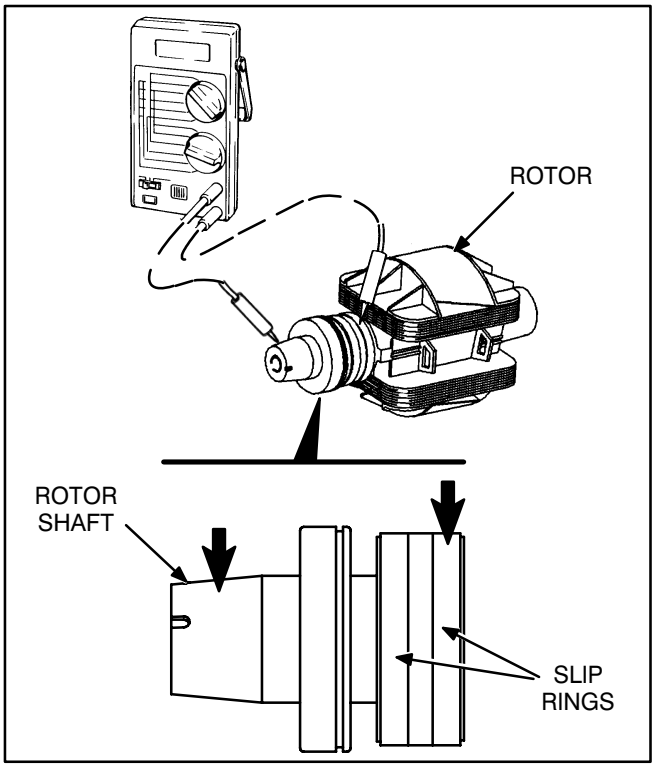


FIGURE 7-8. GROUNDED ROTOR TEST

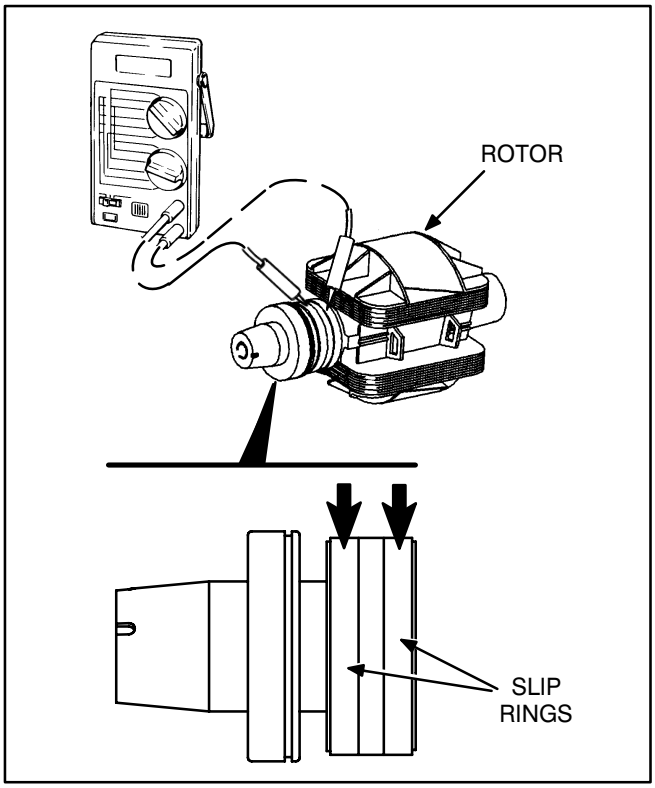


FIGURE 7-9. OPEN OR SHORTED ROTOR TEST

Stator Tests

The stator can be tested for grounded or open windings using an ohmmeter. Testing for shorted windings requires a digital type ohmmeter that can read to within 0.01 ohms. To perform the stator tests, remove both connector plugs from the stator (Figure 7-10).

Ground Test: Set the ohmmeter for the highest resistance scale and then connect one test prod to the generator housing (or stack, if stator is removed). Touch the other test prod (Figure 7-10) to each terminal on the stator connector. A reading of less than one megohm indicates a ground. Replace a grounded stator with a new stator.

Winding Resistance: To test for open windings, set the ohmmeter for the highest resistance scale and then connect the test prods (Figure 7-10) to the terminals specified in Table 7-2. The ohmmeter should indicate continuity between terminals. A high resistance reading indicates an open winding. If an open circuit is measured replace the stator.

To test for shorted windings, use a digital type ohmmeter that reads to within 0.001 ohms. Connect the test prods to the terminals specified in Table 7-2. A reading of less than the value shown in Table 7-2 at 77° F (25° C) indicates a shorted winding. If stator tests indicate a shorted winding, replace the stator. If stator tests good, check stator connectors and leads for continuity, and for good electrical connection with the stator terminals.

TABLE 7-2. STATOR WINDING RESISTANCES

WINDING	RESISTANCE (OHMS) @ 77° F (25° C) ± 10%		
	60 HZ, 120V	60 HZ, 100V	50 HZ
T1–T2	0.330	0.431	0.690
T3–T4	0.330	0.431	0.690
Q1–Q2	3.47	3.47	3.87
B1–B2	–	0.114	0.117

Note: Even though winding resistance may be within the tolerances of this Table, replace the Stator if winding-to-winding or winding-to-ground resistance (winding ***insulation*** resistance) is less than 1 megohm. (An ohmmeter must indicate an *open circuit* or *infinite resistance* between windings or between any winding and ground.)

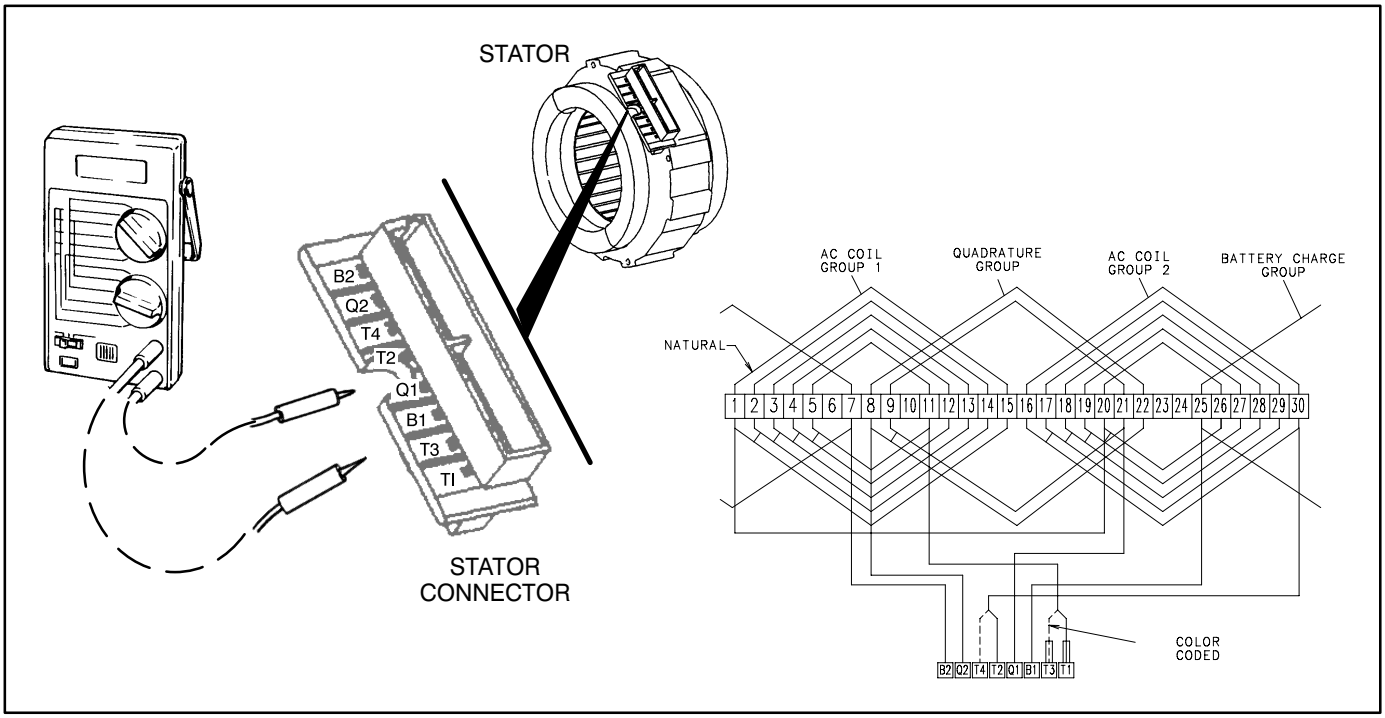


FIGURE 7-10. STATOR ASSEMBLY

ROTOR BEARING REPLACEMENT

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

1. Measure and record the distance between the bearing and the collector ring assembly. See Figure 7-11.

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

2. Use a small puller with grips that will fit between the bearing and the collector ring assembly (Figure 7-12) or use an arbor press to remove the bearing. Cover the end of the rotor shaft with a steel plate to prevent deformation of the shaft during removal.

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

3. Place the rotor, engine end down, in an arbor press. Protect the end of the rotor shaft taper by placing it on a flat steel plate.

4. Refer to the measurement taken in Step 1. Press the bearing onto the rotor shaft (**press on inner race only**) until it rests at the same distance from the collector ring as the original bearing. Check the bearing seal for damage after installation.

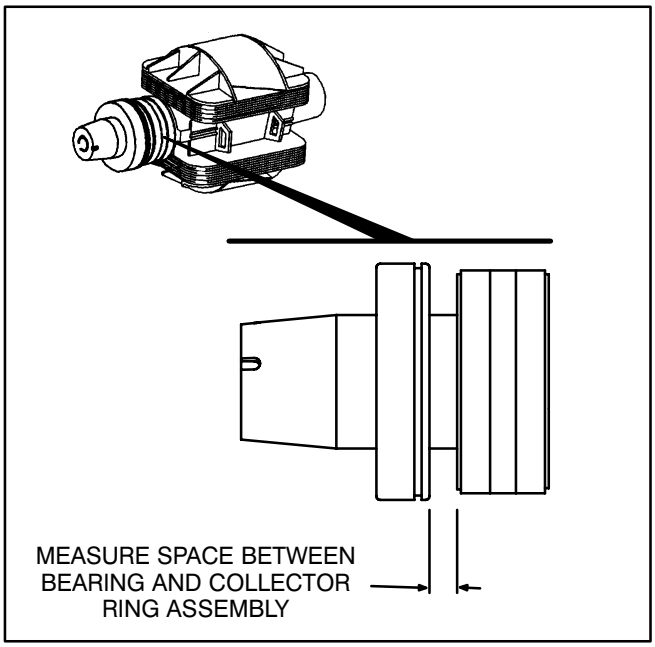


FIGURE 7-11. ROTOR BEARING SPACING

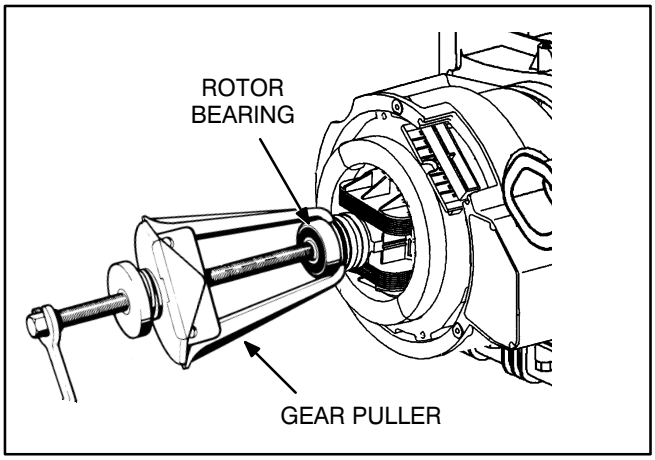


FIGURE 7-12. ROTOR BEARING REMOVAL

8. Primary Engine Systems

INTRODUCTION

Some of the primary engine systems can be serviced without removing the genset from the vehicle. Poor engine performance is often caused by a dirty carburetor. Make certain that the carburetor is clean before troubleshooting for performance problems.

Primary engine systems include:

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

COOLING SYSTEM

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

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

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

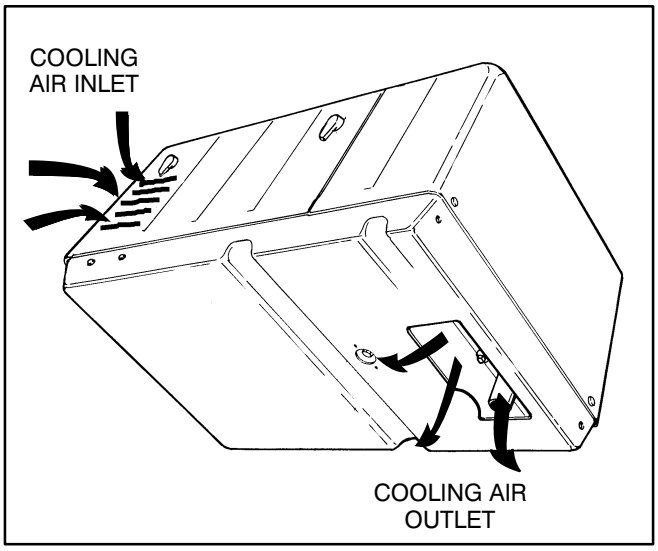


FIGURE 8-1. MODEL KY COOLING AIRFLOW

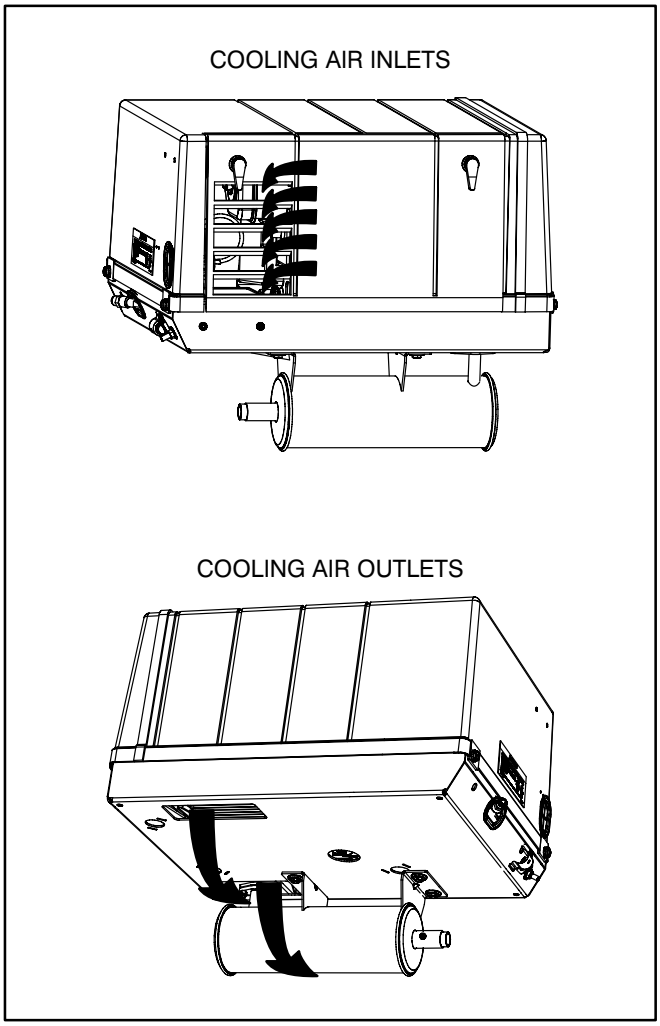


FIGURE 8-2. MODEL KYD COOLING AIRFLOW

Inspection

Inspect the air inlet and outlet passages. Remove the access panel and inspect the engine and control area. If the engine is clean and the air inlet area is clean, disassembly for engine cleaning will not be necessary.

Disassembly

Remove the genset if cleaning is necessary (see *Preparing for Service*, Section 5).

1. Remove the fan housing assembly (p. 7-3).
2. Use a brush or low pressure compressed air to clean the fan hub assembly. Replace the fan hub assembly if the fan blades are damaged.
3. Remove the top and bottom air guide housings (cowlings) to access the engine cooling fins.
4. Use a brush or low pressure compressed air to clean the engine cooling fins.

Assembly

Assemble cooling system in reverse order of disassembly.

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

EXHAUST SYSTEM

The exhaust system consists of the muffler and tail pipe with the clamps and hangers needed for installation of the tail pipe.

The condition of the exhaust system is extremely critical on gensets because of the possibility of exhaust gases entering the living space. The exhaust system must not have any leaks and it must be well supported. See the Installation Manual for important considerations concerning the installation of an exhaust system.

Do not run the genset if inspection reveals leaking exhaust connections, loose fasteners, or broken or damaged components. Always replace worn components with new original equipment replacement parts that meet factory specifications. Do not repair a broken exhaust pipe or manifold by welding.

⚠WARNING ***EXHAUST GAS IS DEADLY! Modifying the exhaust system may let poisonous exhaust gases enter the living space. Use only Onan replacement parts to service the exhaust system. Unauthorized modifications will void the Onan warranty. Liability for injury or damages due to unauthorized modifications becomes the responsibility of the person making the modification.***

Model KYD Muffler

The muffler is mounted externally. When replacing the muffler, follow the instructions in the muffler kit. Also replace the spark arrestor on the end of the tail pipe if rusted or damaged.

Model KY Muffler

The muffler (Figure 8-3) is a spark arrester type muffler that is US Forest Service Approved and meets code requirements. Failure to provide and maintain a spark arrester muffler can be in violation of the law. Contact an Onan distributor for approved replacement exhaust parts.

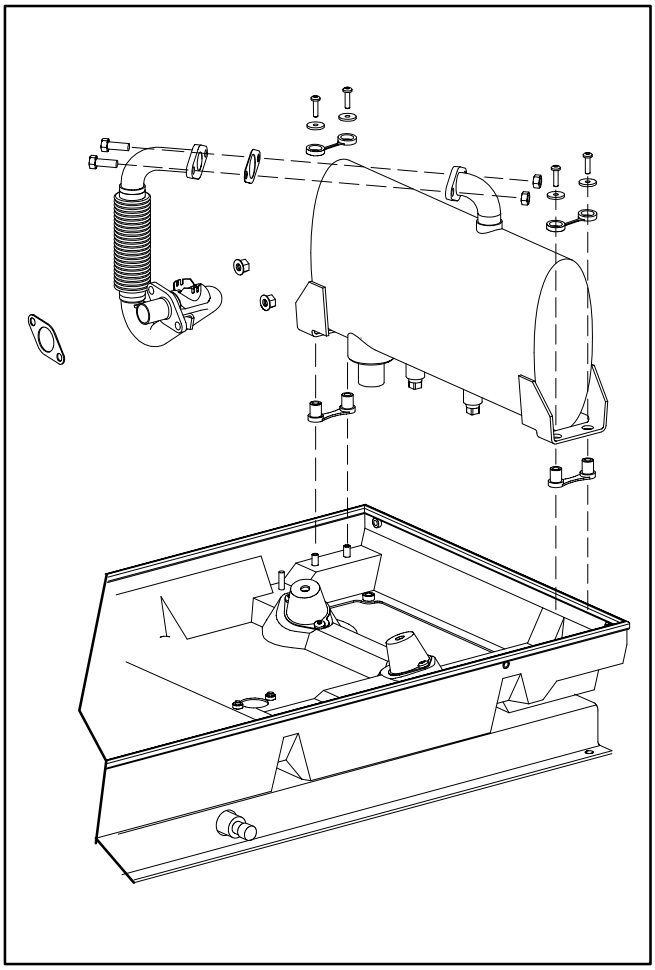


FIGURE 8-3. MODEL KY MUFFLER

Muffler Disassembly:

1. Remove the genset from the installation and remove the outer housing. See *Preparing for Service*, Section 5.
2. Remove the bolts securing the flexible exhaust manifold to the muffler.
3. Remove the screws securing the muffler to the base. Remove the muffler and the exhaust flange gasket.

Muffler Assembly: Install the muffler in reverse order of removal. Use a new exhaust flange gasket and torque to specifications. Run the genset and look and listen for leaks. Repair leaks before placing the genset in service.

IGNITION SYSTEM

The ignition system (Figure 8-4) consists of the flywheel magnet, ignition coil assembly and one spark plug. If the engine does not start, first check to see that the spark plug cable boot is secure on the spark plug. Then proceed in the following order of inspections if an ignition problem is still suspected.

Spark Plug Inspection

Remove the spark plug and inspect the electrode. If the spark plug has carbon deposits, use a wire brush to clean it. Replace a badly fouled or burned spark plug. Reset the spark plug gap according to *Specifications,* Section 2. Diagnose engine problems by examining the spark plug as follows:

- Carbon Fouled—Check for a poor high tension lead connection, faulty choke operation, rich fuel mixture or dirty air filter.
- Oil Fouled—Check for low compression.
- Burned or Overheated—Check for leaking intake manifold gasket, lean fuel mixture or incorrect spark plug type.
- Splash Fouled—Check for accumulated combustion chamber deposits. See Rocker Arms, Push Rods and Cylinder Head on Page 9-4.
- Light Tan or Gray Deposits—Normal plug color.

Spark Check

⚠WARNING ***Gasoline is flammable and explosive and can cause severe personal injury or death. Make certain that no gasoline or other flammable fumes are present and that the area is well ventilated. Leave the genset compartment door open for several minutes before performing this test.***

1. Remove the spark plug, reconnect the spark plug cable and ground the plug side electrode to bare metal on the engine.
2. Do not touch the spark plug or cable during testing. Crank the engine and look for the spark. If the spark is strong and consistent, the ignition system is good. If spark is absent or weak, see Disassembly.

Disassembly

1. Remove the genset from the installation and remove the outer housing. See *Preparing for Service*, Section 5.
2. Loosen the six mounting isolators so that the generator end can be tipped up high enough to remove the fan housing.
3. Loosen the controller bracket and pull it out.
4. Tip the assembly up and remove the fan housing.
5. Loosen the two ignition coil mounting screws, if the ignition coil is to be removed.
6. Check that the ignition kill lead in the wiring harness is connected to the ignition-coil assembly. Repair as necessary.
7. Replace the assembly if cable or ignition coil insulation is defective or there are signs of electrical leakage, such as carbon tracks, corrosion or other damage.
8. Measure electrical resistance across the secondary circuit (between spark plug connector and magneto laminations). Replace the assembly if resistance is not between 12,000 to 23,900 ohms.

Reassembly

Reassembly is the reverse of assembly. ***Check the ignition coil to flywheel magnet air gap and reset it, if necessary.*** Make sure to tie the spark plug cable and ignition kill lead together with nylon wire ties, at the points shown in Figure 8-4, to keep them from rubbing against the base pan.

Resetting Air Gap

To reset the air gap, hold the ignition coil assembly tight up against the magnet on the flywheel, with a feeler gauge of proper thickness in between, while tightening the two mounting screws.

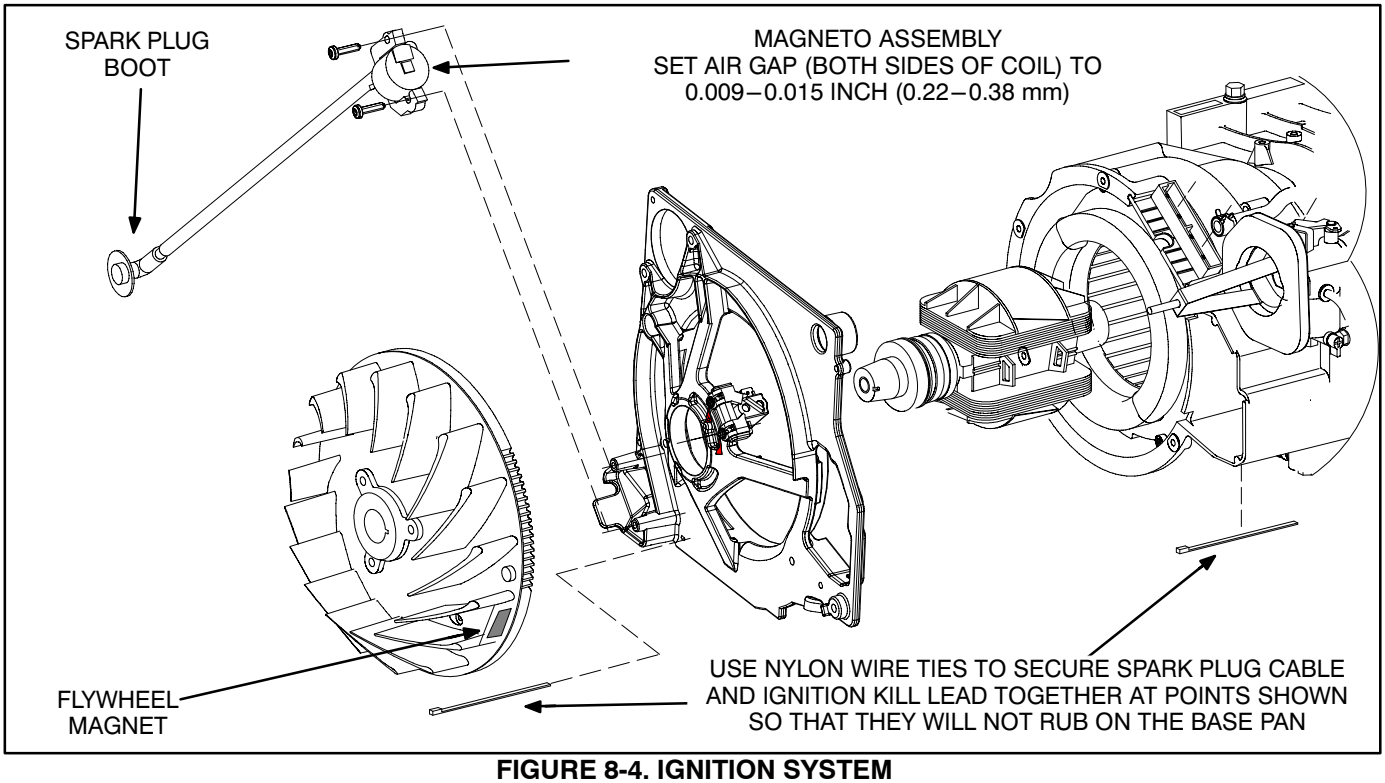


FIGURE 8-4. IGNITION SYSTEM

CRANKCASE VENTILATION SYSTEM

The crankcase breather prevents pressure from building up in the crankcase. It also prevents oil contamination by removing moisture, gasoline vapors and other harmful blow-by materials from the crankcase. These vapors are routed to the carburetor where they are mixed with the incoming air and burned in the combustion chamber. A stuck or damaged breather valve can cause oil leaks, high oil consumption, rough idle, reduced engine power, and a rapid formation of sludge and varnish within the engine.

Crankcase Breather Service

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

1. Remove the breather tube from the valve cover (Figure 8-5).
2. Remove the head cover and breather assembly.
3. Inspect the reed valve. It must be flat with no signs of creases or other damage. Replace a defective reed valve. If the breather is dirty, clean it in parts cleaning solvent.
4. Check the breather tube and air passages for clogging and clean as required.

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

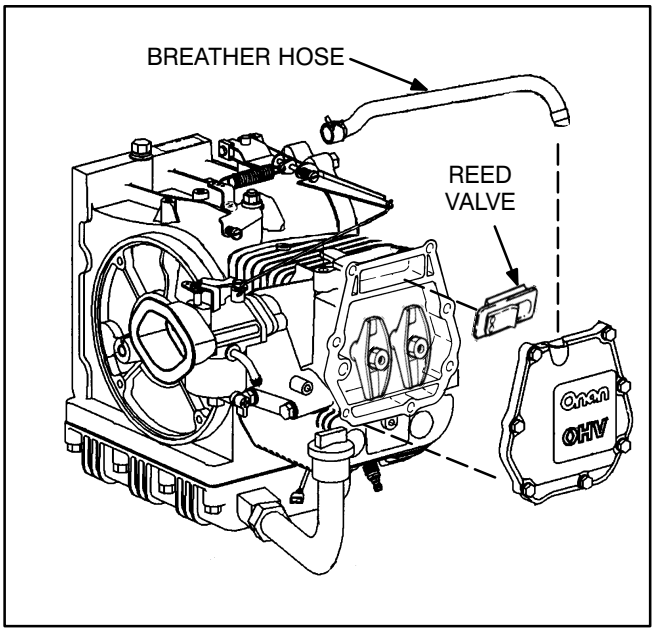


FIGURE 8-5. CRANKCASE BREATHER SYSTEM

GOVERNOR

The governor controls engine speed (frequency) within specified limits of “droop” between no-load and full-load (Table 8-1). Too large a droop will result in objectionable voltage and frequency drops. Too small a droop will result in hunting.

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

Governor Adjustments

Before making governor adjustments, check out other conditions that could also be causing hunting or droop, such as binding in the governor linkage, a fouled spark plug or dirty fuel filter.

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

A small speed drop, not noticeable without instruments, can cause an objectionable voltage drop. Accurate governor adjustments require a:

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

Adjust the governor in the following sequence of steps.

1. Run the genset at least 10 minutes at 3/4- rated load. Check that the choke is completely open. If the governor is completely out of adjustment, make a preliminary adjustment at no-load to attain a safe voltage and speed operating range. Note the initial governor spring hole.
2. Check the governor linkage for binding or excessive looseness. Check the motion spring for bending or damage and straighten or replace as needed.
3. With the genset operating at no-load, turn the speed adjustment screw (Figure 8-6) on the governor linkage to obtain 62–63 Hz for a 60 Hz genset or 51.5–52.5 Hz for a 50 Hz genset. Turn the screw clockwise to increase speed and counterclockwise to decrease speed.

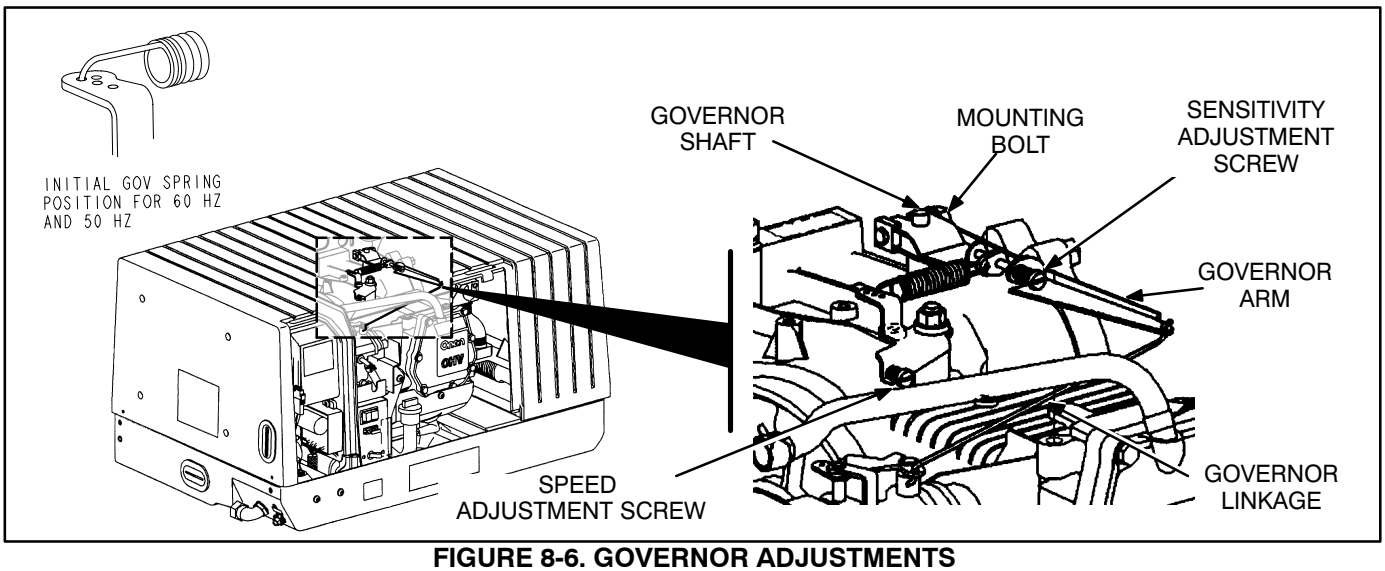


FIGURE 8-6. GOVERNOR ADJUSTMENTS

4. Check frequency and voltage first with load applied and then with no load applied. Frequency and voltage should stay within the limits shown in Table 8-1.
5. ***50 Hz and 60 Hz, 100V only:*** Adjust frequency as appropriate under full load and then turn the voltage trim potentiometer (p. 6-5) to obtain the specified voltage.
6. Adjust governor sensitivity to give the closest regulation (least speed and voltage difference between no-load and full-load) without causing hunting. To increase sensitivity, turn the adjustment screw counterclockwise. To decrease sensitivity, turn the adjustment screw clockwise.
7. Recheck the speed setting made in Step 3 and readjust if necessary.
8. Set the carburetor throttle stop screw as specified in FUEL SYSTEM.

If governor action is erratic after these adjustments, loosen the governor arm mounting bolt and rotate the shaft fully clockwise and then retighten the bolt. Reset the governor adjustments and recheck speed and droop. Springs tend to lose their calibrated tension through fatigue after long usage. It may be necessary to put the stationary end of the spring in a different hole to change the tension, or replace the spring altogether. If this does not improve operation, the problem may be within the governor mechanism (*Engine Block Assembly*, Section 9).

TABLE 8-1 VOLTAGE / FREQUENCY

Rated Voltage	Voltage		Frequency	
	Max No Load	Min Full Load	No Load	Droop
60 HERTZ GENSETS				
100	108	93	63/62	2–4
120	125	112	63/62	2–4
200	216	186	63/62	2–4
240	250	224	63/62	2–4
50 HERTZ GENSETS				
100	108	93	52.5/51.5	2–4
200	216	186	52.5/51.5	2–4
220	238	205	52.5/51.5	2–4
230	249	215	52.5/51.5	2–4
240	250	224	52.5/51.5	2–4

GASOLINE FUEL SYSTEM

⚠WARNING ***Gasoline is flammable and explosive and can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, arc-producing equipment, and electrical switches from the work area and rooms with common ventilation. Keep a type ABC fire extinguisher handy.***

The fuel system must be in good condition for efficient genset operation. The main components of the fuel system include:

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

Air Filter and Preheater Assembly

This assembly consists of the air filter housing, air filter, and preheat door assembly. See Figure 8-7.

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

The preheat door assembly is located inside the air housing assembly. If a problem with the preheat door assembly is suspected, remove the fan housing assembly (p. 7-3). The preheater door should be fully open at 70° F (21° C) and should align with the top of the housing. Rotate the door down over the round air inlet opening in the housing, then release it. The door should move freely back to the open position. If the door does not move freely, clean the spring and housing with low pressure compressed air and retest.

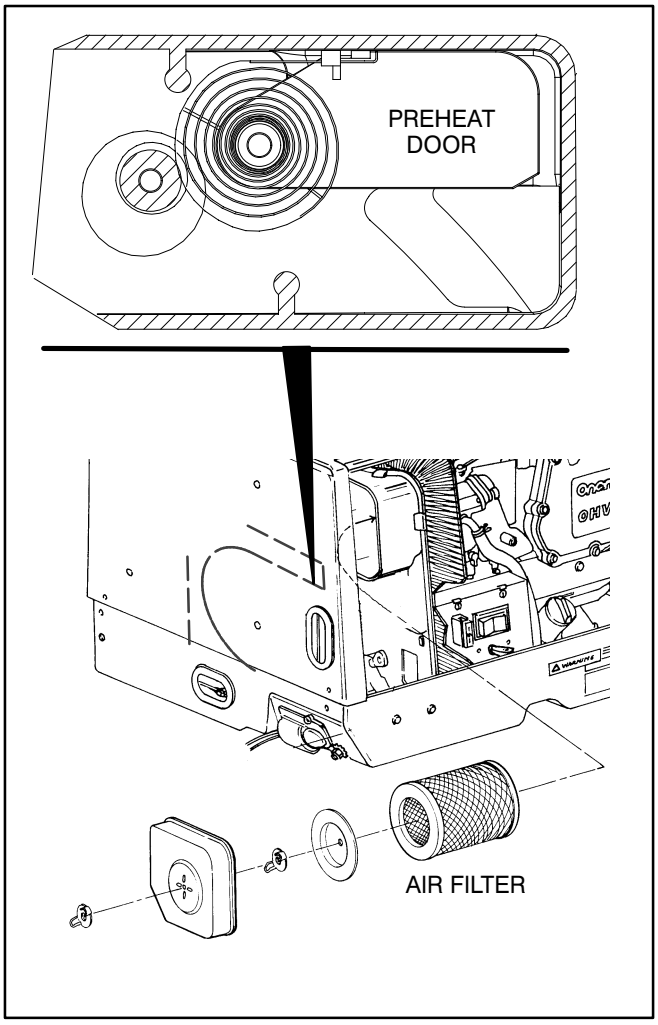


FIGURE 8-7. AIR FILTER AND PREHEATER ASSEMBLY

Carburetor and Intake Manifold Assembly

This assembly consists of the carburetor and the intake manifold assembly (Figure 8-8). It is easier to disconnect the carburetor linkages if the genset housing is removed.

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

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

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

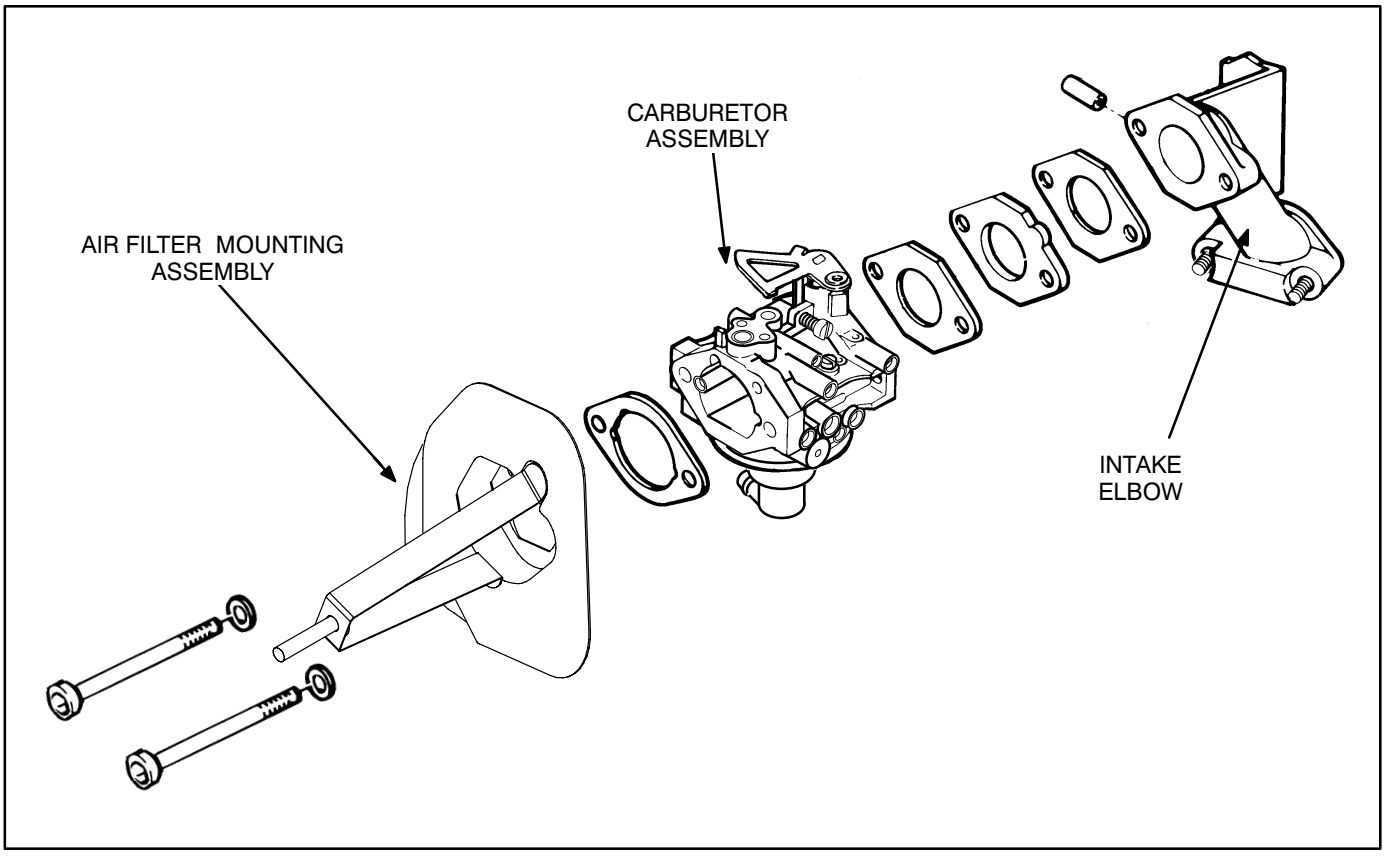


FIGURE 8-8. CARBURETOR AND INTAKE MANIFOLD ASSEMBLY

Carburetor

Other than turning the altitude adjust knob shown in Figure 8-9 (which changes the main fuel mixture within a limited range), fuel mixture adjustments should not be attempted. Nor should the carburetor be overhauled. Instead, a malfunctioning carburetor should be replaced (Page 8-10). Before replacing a carburetor, however, make certain that:

- All other necessary engine and generator adjustments and repairs have been performed.
- The carburetor is actually malfunctioning.

A throttle stop screw is provided for adjusting the "closed" position of the throttle plate to obtain proper governor response when loads are being disconnected. (See Governor Adjustments, Page 8-7.) To adjust the throttle stop screw:

1. Connect a frequency meter and start and run the genset for 10 minutes at 3/4-rated load until it has warmed up and is stabile.
2. Disconnect all loads. Pull the governor linkage gently towards the front of the genset so that the tang on the throttle lever bears against the throttle (idle) stop screw. Adjust the stop screw to obtain a frequency of 44–46 Hz for 60 Hz gensets (29–31 Hz for 50 Hz gensets). (If the adjustment takes longer than 30 seconds the controller may shut down the genset and display Fault Code No. 15. Simply restart the genset and resume adjustments.)

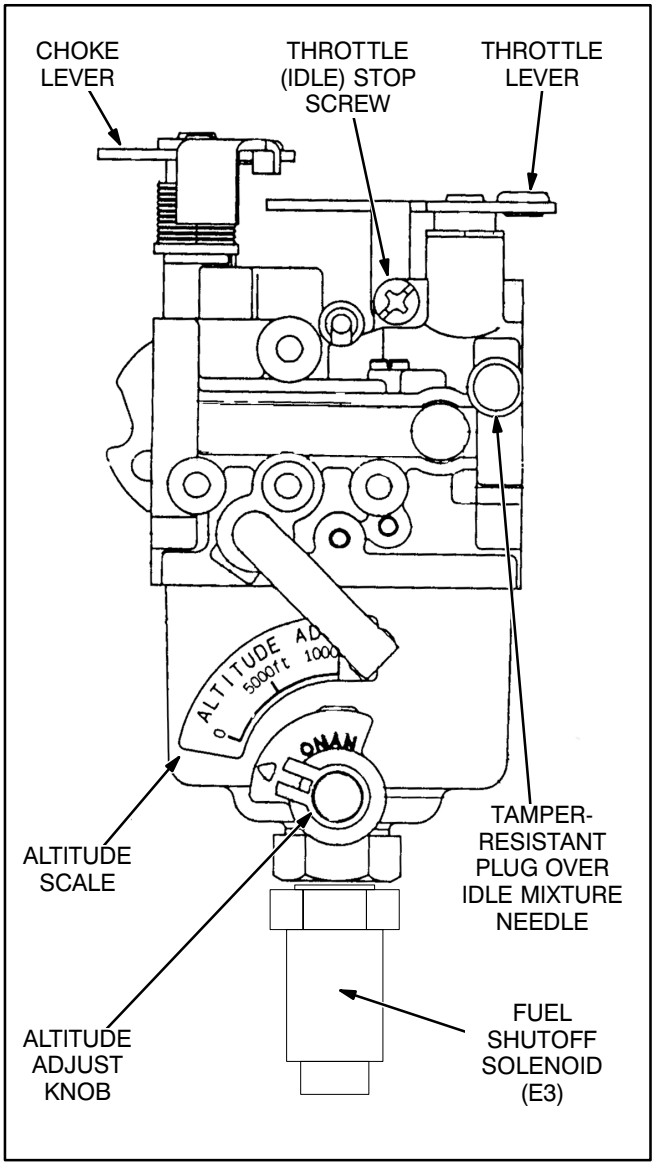


FIGURE 8-9. CARBURETOR ADJUSTMENTS

Choke Assembly

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

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

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

Choke Adjustment: Check the choke linkage to make sure it is not bent or rubbing. Rotate the choke lever on the carburetor. The choke shaft should move freely and it should return to its original position when released. Inspect the heater hose to make sure it is installed properly and in good condition. Refer to Figure 8-10.

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

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

   If the ambient temperature is higher or lower than 70° F (21° C), make a mark on the choke coil housing opposite the center mark on the adjustment plate. Each mark on the adjustment plate is equal to 10° F (6° C) of difference from 70° F (21° C). If it is warmer than 70° F (21° C), rotate the plate clockwise. If the temperature is less than 70° F (21° C), rotate the plate counterclockwise. Tighten the adjustment screw.

   Example: If the ambient temperature is 90° F (32° C), rotate the adjustment plate two marks clockwise from the 70° F (21° C) position marked on the housing.
4. Move the choke lever back and forth to check for free movement. Verify that the choke does not bind or stick.

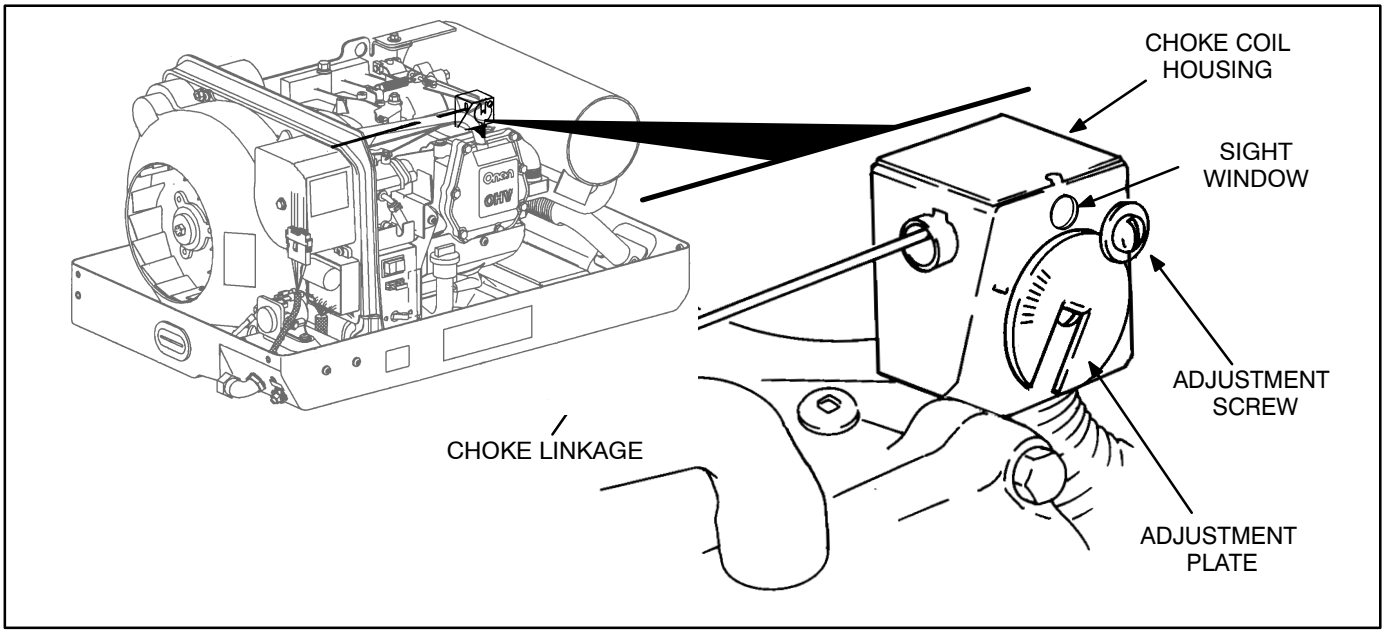


FIGURE 8-10. CHOKE ASSEMBLY

Bimetal Coil Replacement: After making the choke adjustment, start the genset and observe engine operation. If the choke does not open properly, replace the bimetal coil in the choke housing as follows. Refer to Figure 8-10.

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

Fuel Filter

⚠WARNING ***Gasoline is flammable and explosive and can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, arc-producing equipment, and electrical switches from the work area and rooms with common ventilation. Keep a type ABC fire extinguisher handy.***

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

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

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

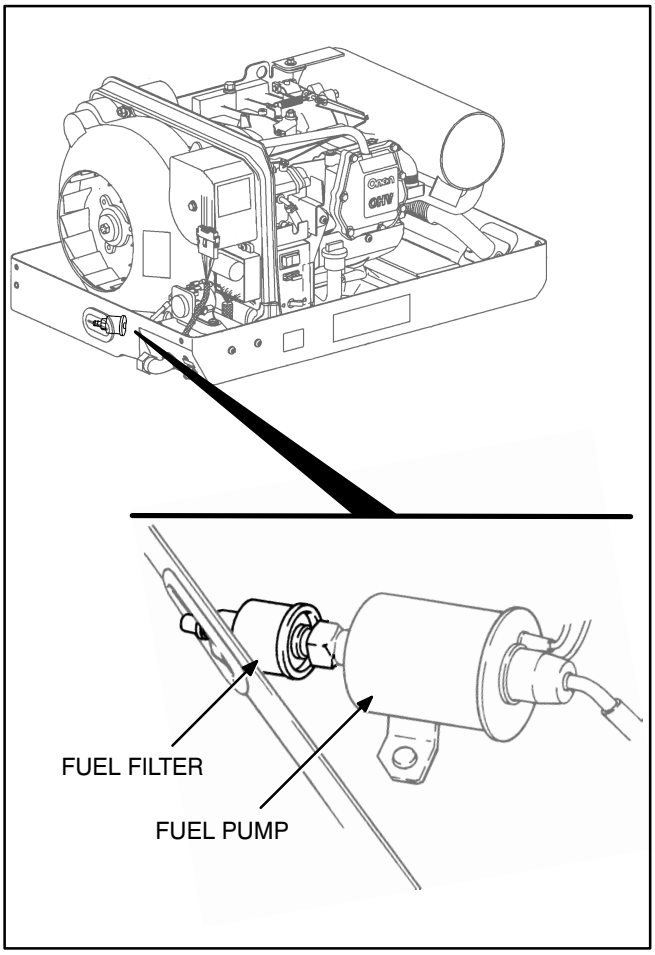


FIGURE 8-11. FUEL FILTER REPLACEMENT

Fuel Pump

⚠WARNING ***Gasoline is flammable and explosive and can cause severe personal injury or death. Eliminate all possible ignition sources such as open flame, sparks, cigarettes, pilot lights, arc-producing equipment, and electrical switches from the work area and rooms with common ventilation. Keep a type ABC fire extinguisher handy.***

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

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

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

1. Make sure the fuel tank has sufficient fuel to supply the genset. The genset fuel pick-up tube ends well above the bottom of the vehicle fuel tank. The genset can be out of fuel even when the tank is partly full.
2. Check the the genset starting battery voltage when cranking and running the genset. Measure battery voltage between the brown lead and ground (Figure 8-12). The pump will not work properly if the cranking or running voltage is less than 6 VDC. If the battery voltage is low, charge the battery and retest.
3. Remove the fuel line from the carburetor inlet and install a pressure gauge.
4. Press the stop switch and hold it for several seconds until the pressure stabilizes.
5. The pressure reading should be 2.5–4 psi (17–27 kPa). The pressure should hold constant or drop off very slowly.

If the pressure reading is below 2.5 psi (17 kPa), tap the pump body with a screw driver handle to free the piston from fuel deposits. If the pump still does not work and the battery voltage is adequate, replace fuel pump with an Onan-supplied pump.

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

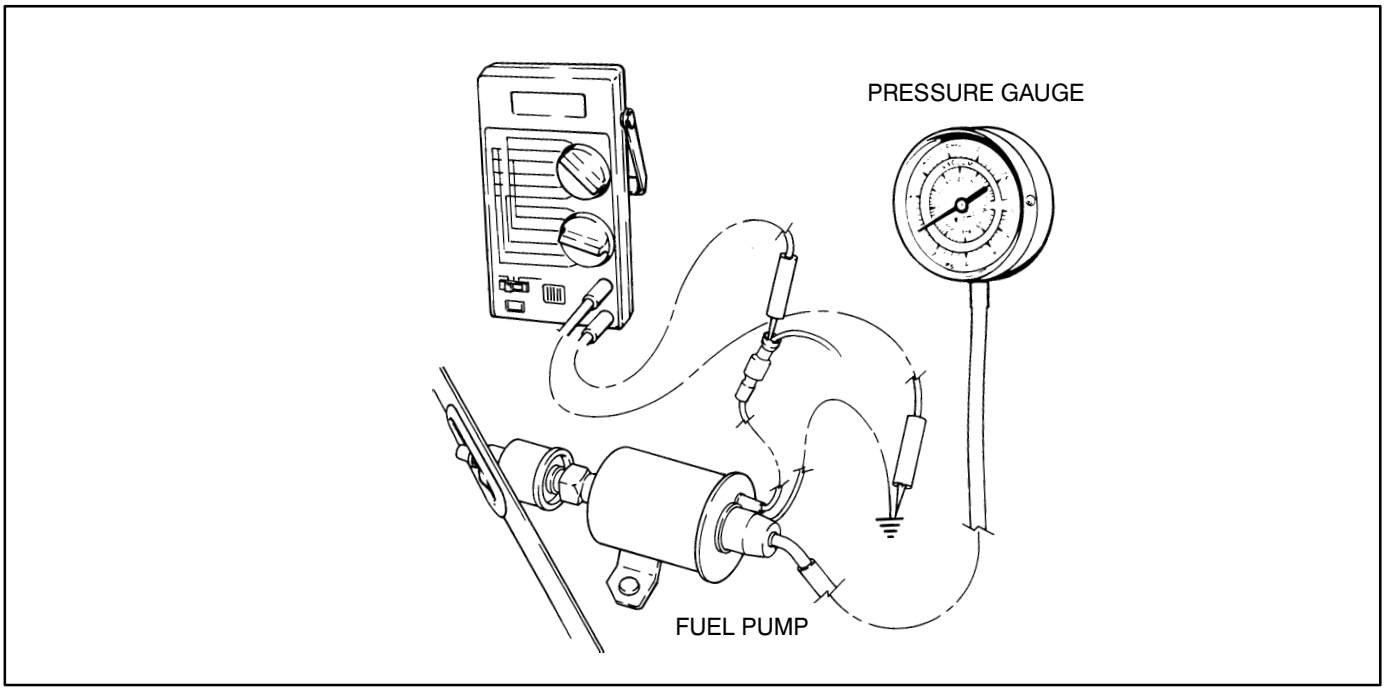


FIGURE 8-12. FUEL PUMP TEST

LPG FUEL SYSTEM

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

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

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

The components of the genset LPG system include:

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

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

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

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

See the instructions on how to remove and replace the carburetor under the subheadings *Air Filter Assembly* on Page 8-9 and *Carburetor and Intake Manifold Assembly* on Page 8-10. ***References to preheaters and chokes are not applicable to LPG carburetors.***

Isolating Fuel System Problem

To isolate the problem to the genset or to the fuel supply system, perform the following test:

1. Close the vehicle gas supply tank valve and disconnect the gas hose at the carburetor (fuel-air mixer).
2. Connect a shop tank (at least 30 lb) through a primary regulator and demand regulator adjusted for 11 inches WC.
3. If the genset can be started and runs properly, the problem is in the gas supply system up to the connection at the carburetor.
4. If the genset cannot be started or does not run properly, the problem is in the genset, starting at the connection to the carburetor.

Demand Regulator

The demand regulator assembly supplies fuel to the carburetor. It is usually not the cause of fuel system problems. All other possible causes should be checked out before adjusting or replacing the demand regulator assembly. Figure 8-13 illustrates the regulator with priming solenoid used prior to Spec L on Model KY or Spec B on Model KYD. The demand regulator on later models does not have a priming solenoid.

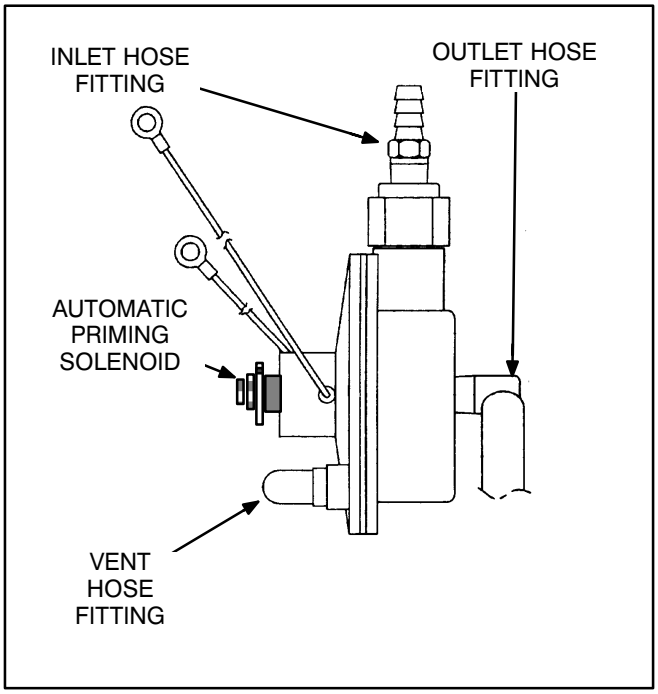


FIGURE 8-13. TOP VIEW OF DEMAND REGULATOR WITH AUTOMATIC PRIMING SOLENOID (PRIOR TO SPEC L (MODEL KY) OR SPEC B (MODEL KYD)

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

1. Connect the regulator inlet (Figure 8-13 on Page 8-15) to a source of air pressure regulated to 11 inches WC (Water Column).
2. Disconnect from the carburetor the LPG supply hose, which comes from the regulator.
3. "T" in two hoses to the end of the hose connected to the regulator vent fitting (3/8 inch I. D.). Use one hose to measure pressure by connecting it to an inclined manometer that reads 0 to 2 inches WC and the other to provide the test pressure.
4. Attach a soap bubble to the end of the LPG supply hose which was disconnected from the carburetor. While reading the pressure indicated by the manometer and watching the soap bubble, blow lightly into the hose being used to pressurize the regulator. Regulator lock-off pressure is the minimum pressure that will cause air to flow through the regulator, as indicated by the expanding soap bubble. (At first the soap bubble may expand due to diaphragm movement but will stop expanding if air is not flowing through the regulator.)

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

- **Prior to Spec L on Model KY or Spec B on Model KYD –** Replace the demand regulator assembly if the lock-off pressure does not fall between 0.10 and 0.30 inches WC.
- **Beginning Spec L on Model KY or Spec B on Model KYD –** Replace the demand regulator assembly if the lock-off pressure does not fall between 0.05 and 0.42 inches WC.

Priming Solenoid (Prior to Spec L on Model KY or Spec B on Model KYD)

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

Priming Solenoid Adjustment: See Figure 8-14. If the genset does not start when it is hot, rotate the dial counterclockwise—the fuel mixture could be too rich. If the genset does not start when it is at ambient temperature, rotate the dial clockwise—the fuel mixture could be too lean.

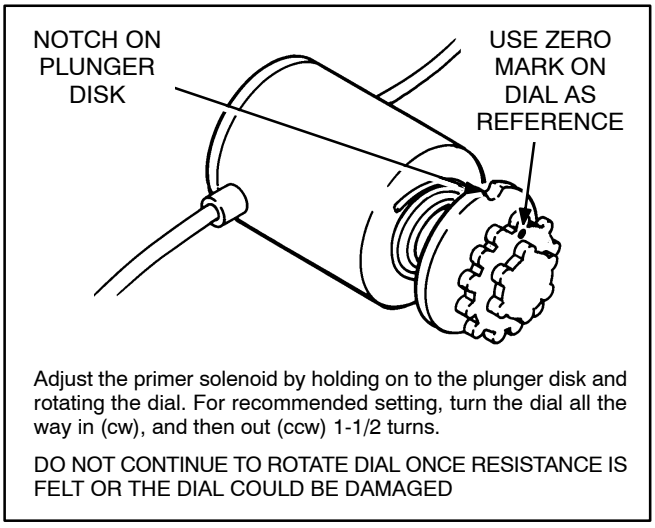


FIGURE 8-14. AUTOMATIC PRIMING SOLENOID (PRIOR TO SPEC L (MODEL KY) OR SPEC B (MODEL KYD)

Fuel-Shutoff Solenoid Valve

Leak Test: See Figure 8-15. If there is a smell of gas when the genset is not running, or any other reason to suspect that the valve is leaking, connect the inlet of the valve to a source of air pressure regulated to not more than 14 inches WC (356 mm WC) and disconnect the outlet hose. Replace the solenoid if it leaks, as checked by a soap bubble.

Operation Test: If the genset cranks, but does not start (first see *Troubleshooting*, Section 10), determine whether or not the valve is opening. With the source of air still connected, energize the valve by connecting battery positive (+) to the top terminal and battery negative (–) to the grounded terminal. Replace the solenoid valve if it does not open when it is energized.

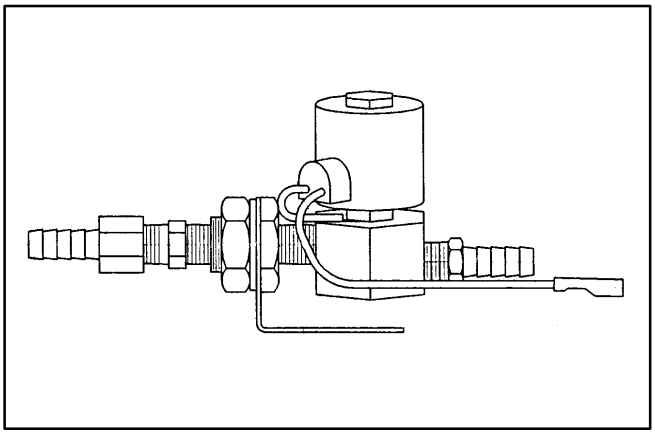


FIGURE 8-15. FUEL SOLENOID VALVE

LPG Carburetor

See Figure 8-16. An LPG carburetor is not likely to cause problems and should be replaced only after all other causes have been eliminated (see *Troubleshooting*, Section 10). It is not necessary to adjust fuel mixture. These carburetors are calibrated at the factory and the adjustments are sealed.

A throttle stop screw is provided for adjusting the "closed" position of the throttle plate to obtain proper governor response when loads are being disconnected. (See *Governor Adjustments* on Page 8-7) To adjust the throttle stop screw:

1. Connect a frequency meter and start and run the genset for 10 minutes at 3/4-rated load until it has warmed up and is stabile.
2. Disconnect all loads. Pull the governor linkage gently towards the front of the genset so that the tang on the throttle lever bears against the throttle (idle) stop screw. Adjust the stop screw to obtain a frequency of 44–46 Hz for 60 Hz gensets (29–31 Hz for 50 Hz gensets). (If the adjustment takes longer than 30 seconds the controller may shut down the genset and display Fault Code No. 15. Simply restart the genset and resume adjustments.)

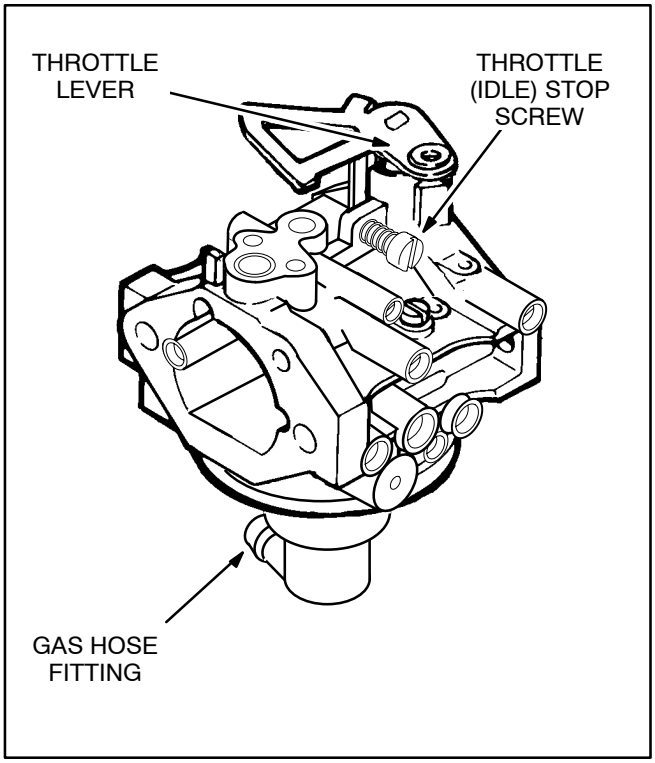


FIGURE 8-16. LPG CARBURETOR

ELECTRIC STARTER

A 12-volt electric starter with a negative ground is used for cranking the engine. The starter has an inertial engagement system.

Starter Voltage Check

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

1. Connect a voltmeter between the output terminal on the start relay (opposite the BAT terminal with the starter motor lead connected) and ground. See Figure 8-17.
2. Press the start switch. If there is approximately 12 VDC but the starter does not crank, the starter is defective or the engine is binding. Go to Starter Disassembly. If there is no voltage, check battery, start solenoid and control wiring.

Starter Disassembly

Remove the genset from the installation. See *Preparing for Service*, Section 5.

1. Remove the genset outer housing. Disconnect the positive (+) cable from the starter lug.
2. Turn the fan by hand. See *Engine Block* Assembly, Section 9, if it does not turn freely. Otherwise, go to Step 3.
3. Remove the rear mounting nut from the starter. Remove the engine bracket behind the starter from the engine (Torx T-30) and muffler.
4. Remove the starter mounting nuts. Carefully disengage the starter from the end bell.
5. Use a 1/8 inch nail set to remove the roll pin in the armature shaft. Remove the return spring, gear and clutch assembly (Figure 8-18).
6. Remove the starter through-bolts. Carefully separate the brush end cap housing from the armature assembly.

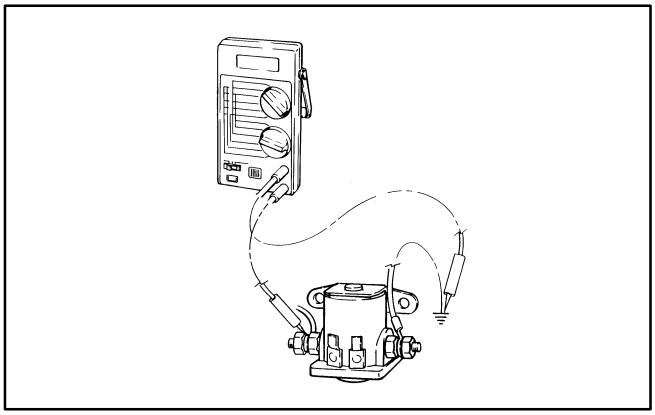


FIGURE 8-17. STARTER VOLTAGE CHECK

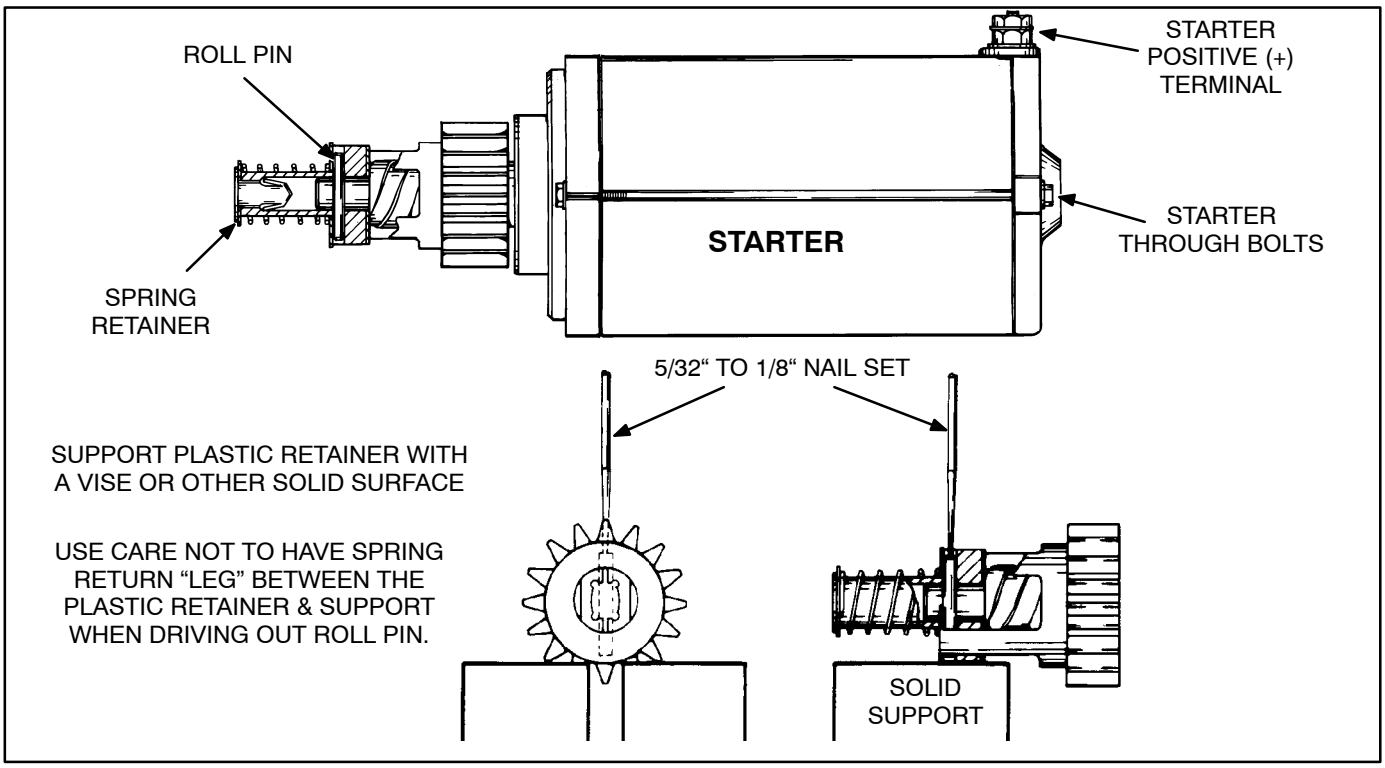


FIGURE 8-18. DRIVING ROLL PIN OUT OF STARTER ASSEMBLY

Testing Armature for Grounds

Touch one ohmmeter lead to a commutator bar, touch the other lead to the armature shaft and the core laminations. A low resistance reading indicates a grounded armature. Replace a grounded armature with a new one. See Figure 8-19.

Testing Armature for Shorts

Use a growler (Figure 8-20) to locate shorts in the armature. Place the armature in the growler and hold a thin steel blade (hacksaw blade) parallel to the core and just above the armature, while slowly rotating the armature in the growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace a shorted armature with a new one.

Testing Armature for Opens

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

Brush Inspection

Measure brushes (Figure 8-21) and replace them if worn to less than 0.315 inch (8 mm).

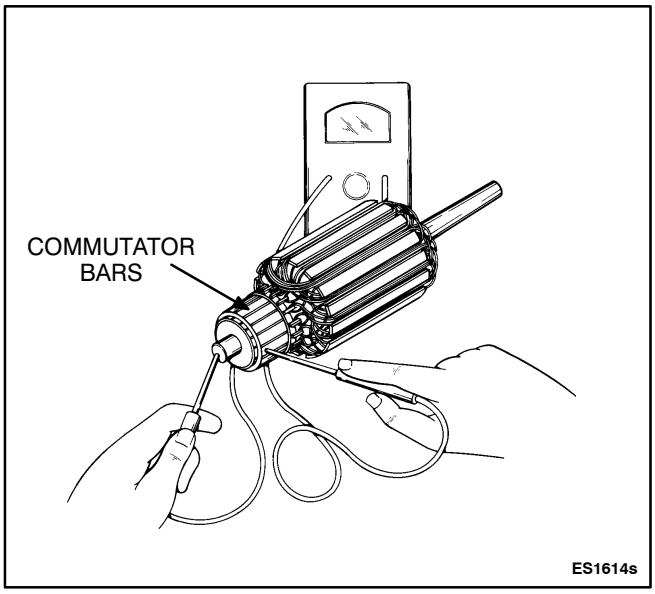


FIGURE 8-19. TESTING ARMATURE FOR GROUNDS

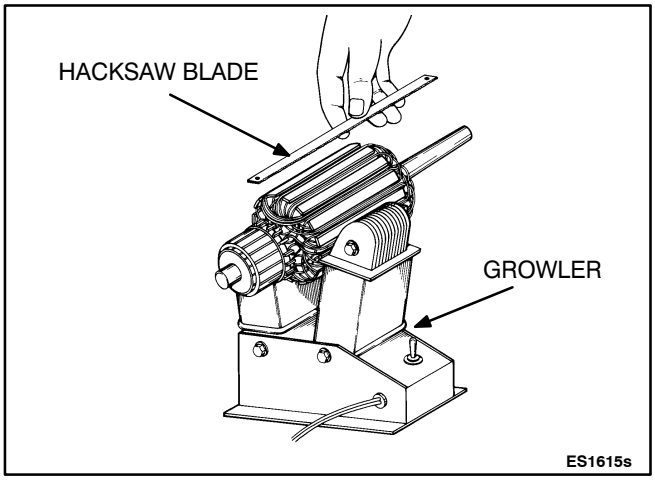


FIGURE 8-20. TESTING ARMATURE FOR SHORTS

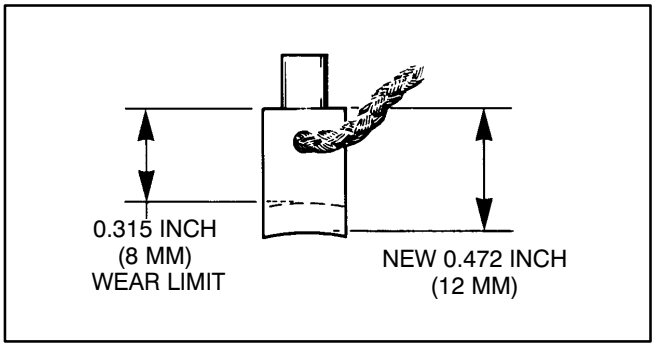


FIGURE 8-21. BRUSH INSPECTION

Starter Reassembly

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

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

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

2. Push the negative brush terminals over the through-bolt holes on the brush endcap (Figure 8-22).
3. Insert the positive brush stud into the hole, and torque to 25–30 lb-in. (2.83–3.39 N-m).
4. Insert the brush springs into brush holders. Insert the brush tabs into the spring ends and slide brushes into brush holders in endcap. Make sure all brush wires are facing up.
5. Place a washer on the commutator end of the shaft, then put the armature into the brush endcap. Push the four brushes toward the commutator, make sure that the springs are correctly positioned on the brushes.

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

6. Make sure that all brush wires are clear of the commutator, and that uninsulated sections of wires do not touch the inside of the housing, or adjacent brush boxes.
7. Place the magnetic housing over the armature. Hold down the armature and the end cap by pressing a nut driver over the end of the shaft.

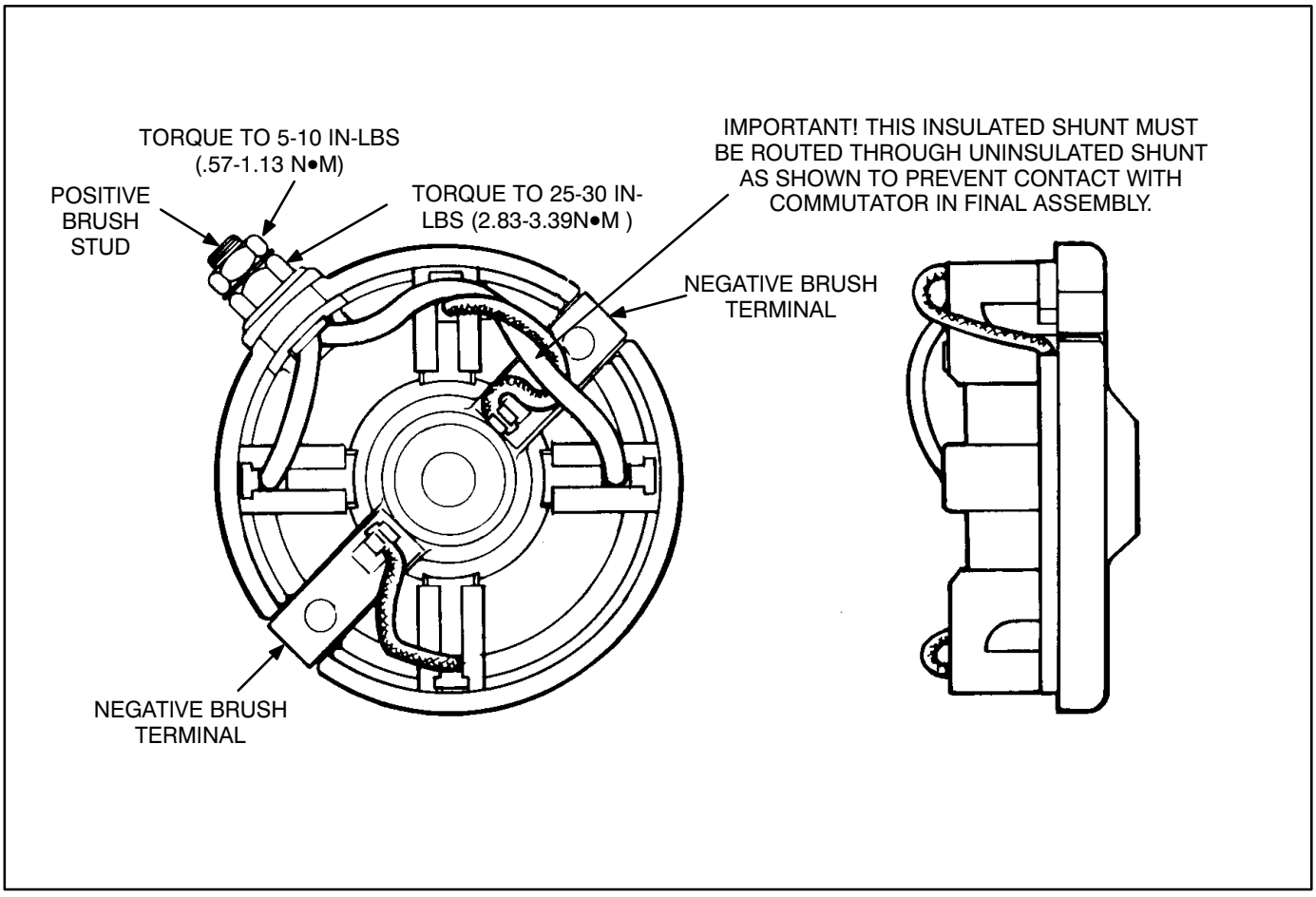


FIGURE 8-22. BRUSH ENDCAP

8. Place a spring washer and a flat washer on the shaft, as shown in Figure 8-23.
9. Place the mounting bracket on the motor with the through-bolt lead-ins to the inside of the motor. The “flat” near one mounting hole should line up with the positive stud on the end cap, so the through-bolts line up.
10. Insert the through-bolts, and torque to 35–45 lb-in. (3.96–5.09 N-m).
11. Wipe dust from the helix and gear, and apply a light coat of GE Versilube 322-L to the outside diameter of the helix, the inside diameter of the gear and the unchamfered end of the gear. Place the clutch and helix assemblies on the motor shaft, with flats engaged in the clutch hole.
12. If the return spring is unassembled:

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

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

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

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

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

13. Carefully mount the starter on the endbell and tighten the mounting bolts to 30–33 lb-ft (41–45 N-m).
14. Install the engine bracket to the engine and install the muffler bracket hardware. Install the rear starter mounting nut.
15. Connect the positive (+) cable to the starter terminal.
16. Mount the housing on the genset and install the genset into the vehicle.
17. Reconnect the genset starting battery, negative (–) terminal last.

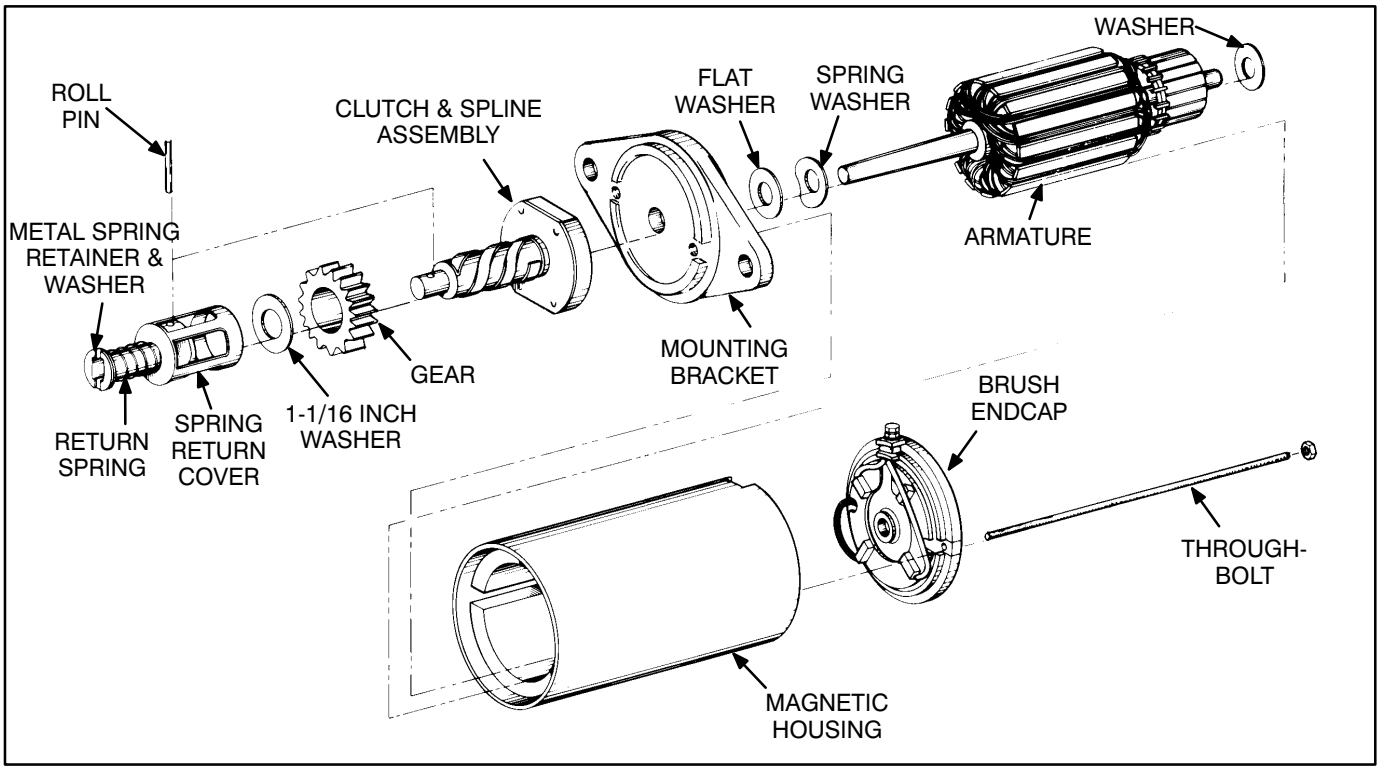


FIGURE 8-23. STARTER ASSEMBLY

9. Engine Block Assembly

INTRODUCTION

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

Performing any major service will require genset removal from the vehicle. See *Preparing for Service*, Section 5. To gain access to the engine block assembly, the generator and primary engine systems must be removed. Refer to the previous sections for the disassembly procedures.

A suggested order of disassembly for the engine block follows:

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

LEAK DOWN TEST

Perform the leak down test if performance problems or high oil consumption occur and poor compression is suspected. Follow each of these steps and refer to the test equipment manufacturer's instructions. A typical tester is shown in Figure 9-1.

1. Start the engine and allow it to warm up for ten minutes. If the engine will not start, continue to the next step.
2. Disconnect the battery negative (–) cable to prevent accidental starting and remove the spark plug.
3. Manually rotate the the engine in the direction of normal operation by turning the fan hub assembly. Stop turning the engine when it reaches top dead center (TDC) on the compression stroke. TDC can be determined by:

   A. Removing the head cover and observing the valve overlap on the compression stroke.

   B. Feeling compression air escaping the spark plug hole.

   C. Using a tester with a TDC indicator feature.
4. Connect the tester to shop air and set calibration. Perform the leak down test according to the manufacturer's instructions. Secure the fan wheel to prevent the piston from moving during this test.
5. Screw the air fitting into the spark plug hole. Attach plug fitting to tester.
6. The tester needle indicates the percentage of cylinder leakdown. The following describes the general condition of the engine:

   - 0–10 Percent leak down—Excellent
   - 10–20 Percent leak down—Normal
   - 20–30 Percent leak down—Service limit
7. If leakage is greater than 30 percent, the engine could need major service work. With the tester still connected, listen for air leakage at the points listed in Table 9-1 and note probable cause of the engine problem.

TABLE 9-1. LEAK DOWN CHECK POINTS

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

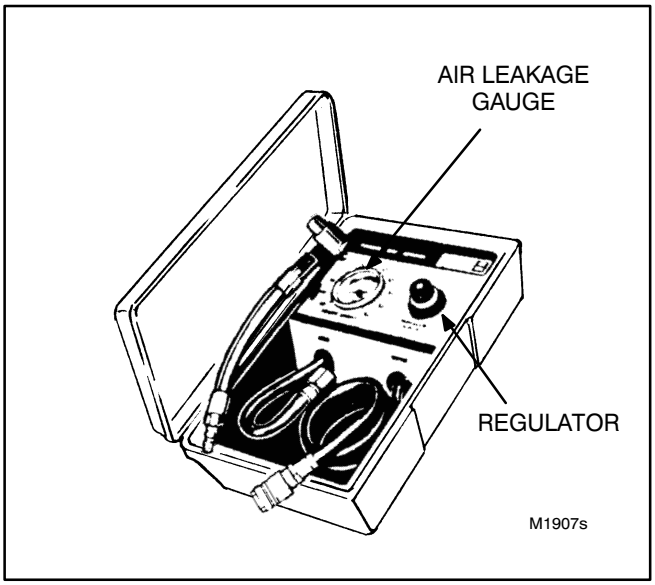


FIGURE 9-1. TYPICAL LEAK DOWN TESTER

OIL PAN

Remove the oil plug and drain the crankcase oil. Remove the oil pan mounting bolts and pan (Figure 9-2).

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

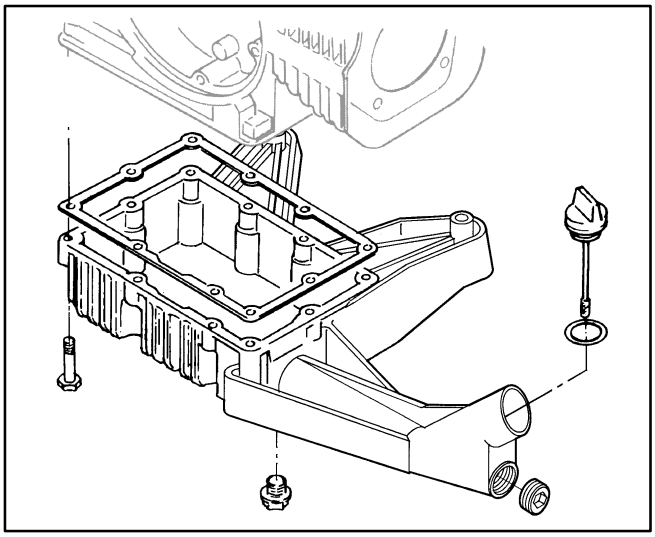


FIGURE 9-2. OIL PAN

HEAD COVER

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

1. Remove the head cover mounting bolts and pull off the head cover (Figure 9-3).
2. Clean the head cover. Be careful not to damage the surface of the cover where the gasket mounts.
3. Clean the cylinder head and cover thoroughly in the cover gasket mating area. Make sure the breather assembly is correctly seated in the cylinder head cavity.
4. Install a new head cover gasket.
5. Place the head cover in position and install the mounting bolts. Torque all of the bolts in a star pattern until they are tightened to the specified torque.

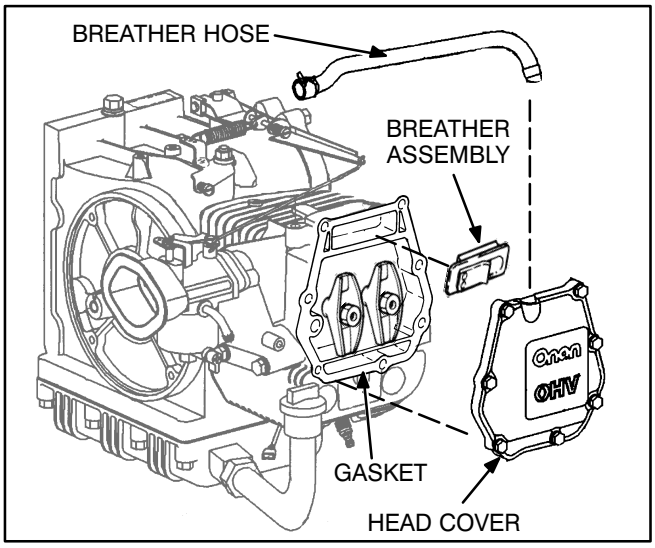


FIGURE 9-3. HEAD COVER

ROCKER ARMS, PUSH RODS AND CYLINDER HEAD

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

1. Remove the rocker arm mounting nuts, rocker arms and push rods (Figure 9-4).
2. Remove the spark plug.
3. Remove the cylinder head mounting bolts and pull off the cylinder head.

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

4. Remove all carbon deposits from the cylinder head. Handle the cylinder head carefully because it can be easily damaged.
5. Clean the cylinder block and cylinder head thoroughly in the head gasket mating area. Install a new head gasket on the block.
6. Place the head in position and follow the head torque tightening sequence shown in Figure 9-5. Start out tightening all bolts to 11 lb-ft (15 N-m), then tighten to the specified torque (see *Torque Specifications*, Section 4).

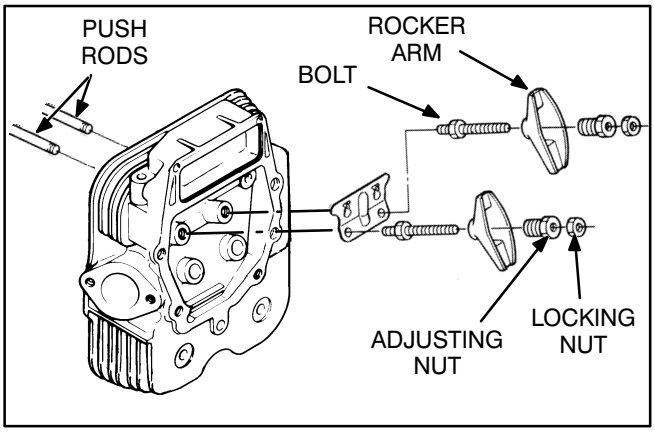


FIGURE 9-4. ROCKER ARM AND PUSH ROD REMOVAL

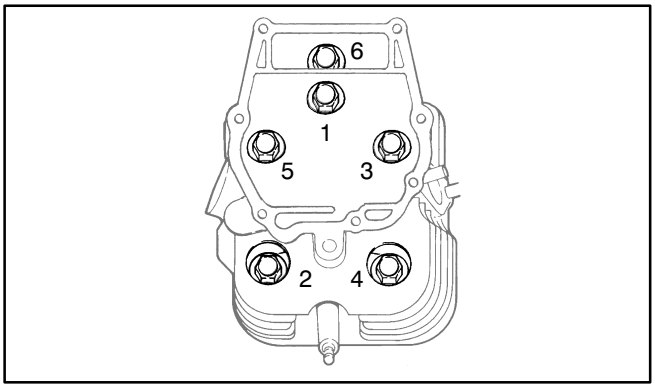


FIGURE 9-5. HEAD TIGHTENING SEQUENCE

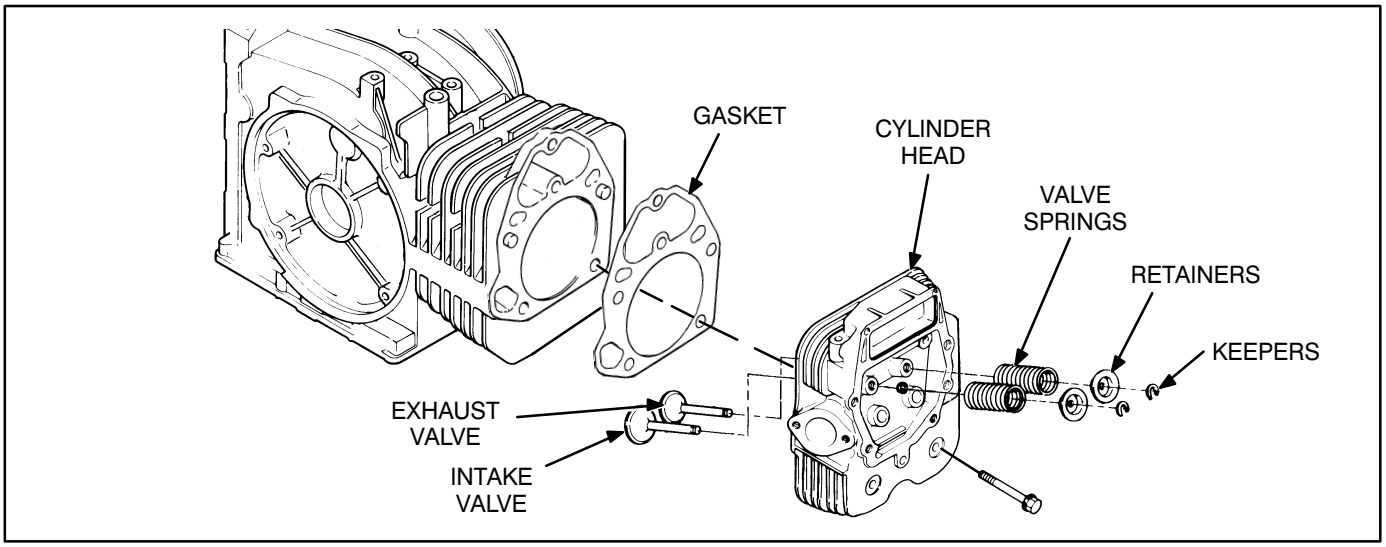


FIGURE 9-6. OVERHEAD VALVE SYSTEM

VALVE SYSTEM

This engine uses an overhead valve design (Figure 9-6). A properly functioning valve system is essential for good engine performance. Access to the valve system is gained by removing the head cover and cylinder head.

Valve Removal

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

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

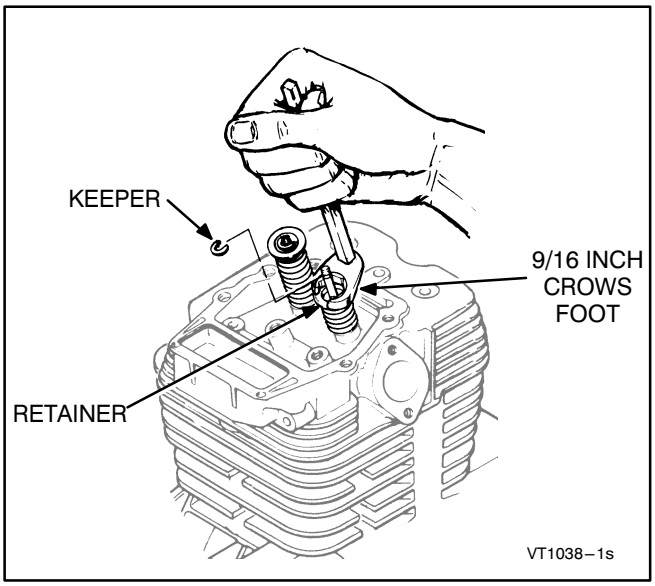


FIGURE 9-7. VALVE REMOVAL

Inspection

Valve Face: Check the valve face for evidence of burning, warping, out-of-round, and carbon deposits (see Figure 9-8).

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

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

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

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

Stems and Guides: Always check the stems and guides for wear as shown in Figure 9-8. Use a micrometer to measure the valve stem diameter in at least three locations. Use a hole gauge to measure the valve guide at several depths. When clearance with stem exceeds original clearance by 0.002 inch (0.05 mm), replace the valve or cylinder head, which includes the valve guide, or both.

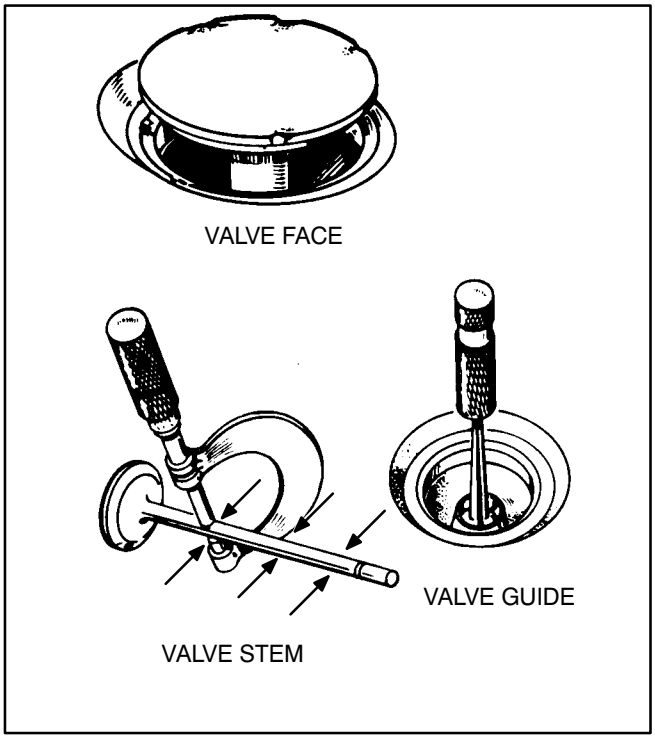


FIGURE 9-8. VALVE FACE, STEM, AND GUIDE

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

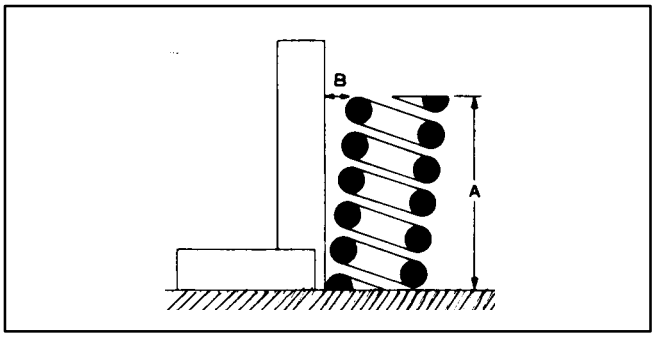


FIGURE 9-9. VALVE SPRING CHECKS

Valve Seat Surface Width

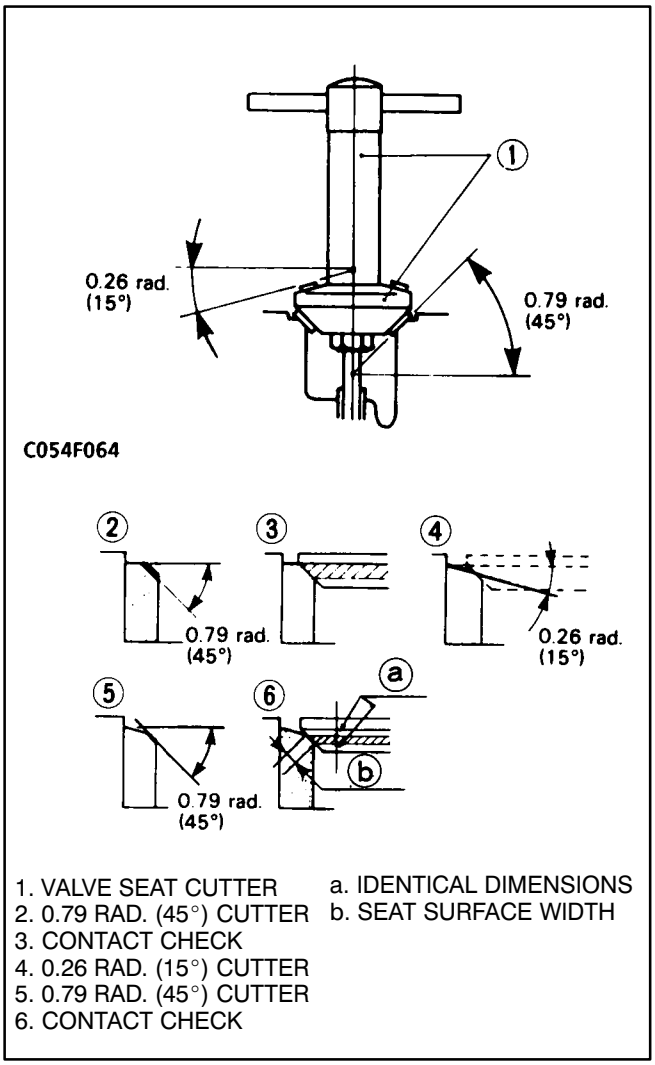
1. Clean the valve seat surface.
2. Use a vernier caliper to measure the valve seat width (Figure 9-10). (See *Dimensions and Clearances*, Section 3, for seat width allowable limit.)
3. Apply red lead to the valve surface to check for scratches or unevenness.
4. When the measurement is within the allowable limit, check the seating ratio. If the ratio is less than 70%, the valve seat needs to be reground.
5. If the measurement exceeds the allowable limit, replace the valve and regrind the valve seat.

Regrinding Seat Surface

1. Grind the valve seat surface with a 45° cutter. Use a cutter appropriate for the valve seat surface and valve guide diameter (Figure 9-10).

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

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



1. VALVE SEAT CUTTER
2. 0.79 RAD. (45°) CUTTER
3. CONTACT CHECK
4. 0.26 RAD. (15°) CUTTER
5. 0.79 RAD. (45°) CUTTER
6. CONTACT CHECK

a. IDENTICAL DIMENSIONS
b. SEAT SURFACE WIDTH

FIGURE 9-10. REGRINDING VALVE SEAT

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

Valve Lash (Clearance) Adjustment

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

1. Remove the head cover (Page 9-3). Inspect the valve stems for proper alignment with the rocker arms.
2. Advance the engine until both of the valves are closed and there is no pressure on the valve lifters (piston at top dead center).
3. Clearances are shown in *Dimensions and Clearances*, Section 3, for seat width allowable limit. For each valve, the gauge should just pass between the top of the valve stem and the rocker arm. (See Figure 9-11.)
4. To correct the valve clearance, place a wrench on the adjusting nut and a wrench on the outer locking nut. Loosen the outer locking nut and turn the adjusting nut as needed to obtain the correct clearance. Tighten locking nut after adjustment is made.
5. Recheck the valve clearance after adjustment has been made and also check the rocker arm bolts to see that they have not loosened as a result of adjusting the valve lash.
6. Reinstall the head cover and torque the head cover bolts to the specified torque.

Intake Valve Seal Replacement

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

1. Pull the old valve seal out carefully to avoid damaging the valve guide.
2. Coat the intake valve stem with engine oil and insert it into the valve guide.
3. Press the valve seal into the valve guide by hand until the shoulder of the seal rests against the cylinder head (Figure 9-12).

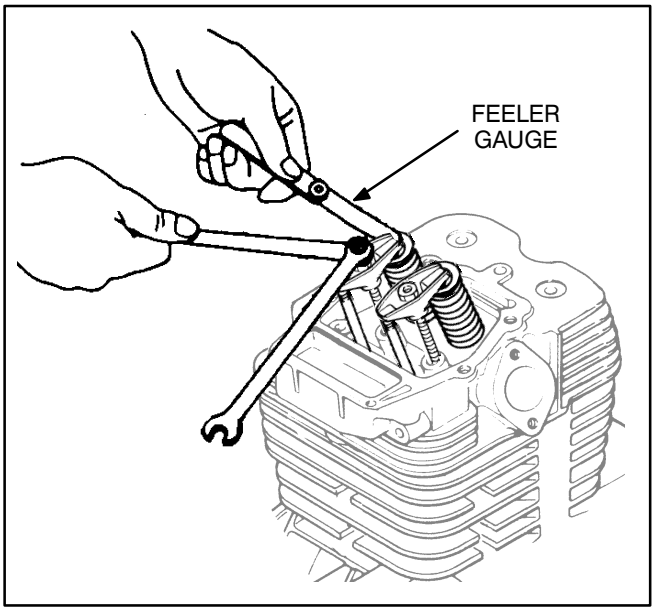


FIGURE 9-11. VALVE CLEARANCE ADJUSTMENT

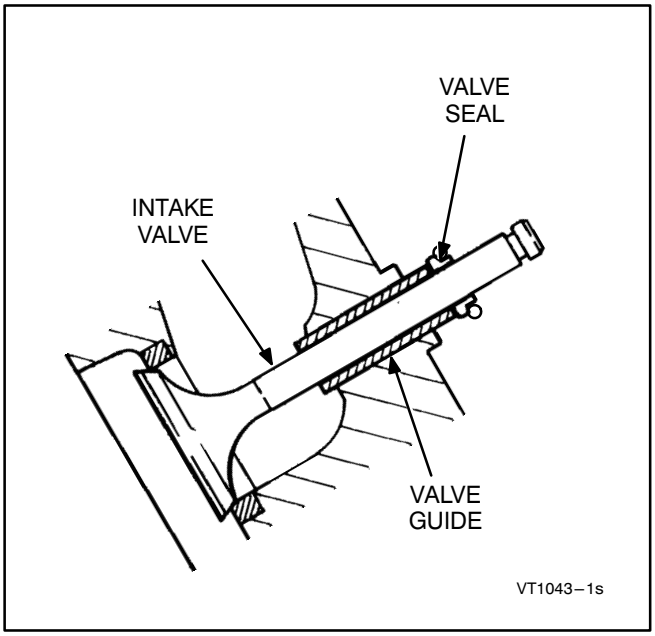


FIGURE 9-12. VALVE SEAL INSTALLATION

CRANKCASE COVER

1. The crankcase cover is located in two places with dowel pins (Figure 9-13). Do not attempt to pry the crankcase cover off or damage can result. Remove the crankcase cover mounting bolts. Hold the crankcase cover and lightly tap the end of the crankshaft with a plastic hammer.

2. Remove the crankcase cover very carefully to prevent the shaft from scraping the lip surface of the oil seal.

3. Remove and tag shims from the crankshaft, camshaft, and balancer shaft. Shim thicknesses differ and they must be reassembled in their original positions.

4. Make sure the governor shaft is properly positioned when installing the cover. Use a new gasket and clean the crankcase cover and the engine block gasket mating surfaces. Place crankcase cover in position and secure all bolts in a star pattern to the specified torque (see *Torque Specifications*, Section 4).

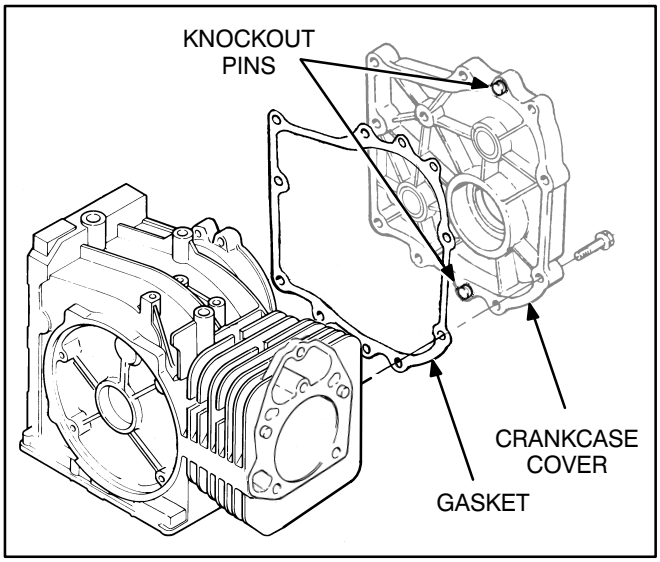


FIGURE 9-13. CRANKCASE COVER

GOVERNOR

With the crankcase cover removed, the governor can be inspected or disassembled for service. The governor assembly must spin freely on the center pin without excessive looseness or wobble. Sleeve tip wear is the most common cause of governor failure. Check for flat spots on the sleeve tip. If the governor sleeve, gear, or flyweights are worn or otherwise damaged, replace them. (The sleeve, stop, flat washer and shaft are a matched set and need to be replaced as a set if any part in the set needs to be replaced. The set is available as a replacement kit for installation in accordance with the kit instruction sheet.)

To disassemble, remove the snap ring from the governor center pin and slide the governor gear assembly off the mounting shaft. Be careful not to lose the outer washer. See Figure 9-14. To install the governor, assemble in reverse order of removal (see inset drawing, Figure 9-14, for position of flyweight and sleeve). The snap ring can be installed by placing it over the end of the shaft, then use the sleeve to push it into position. To remove the governor shaft, remove the retainer clip outside the block and then lower the governor shaft into the crankcase.

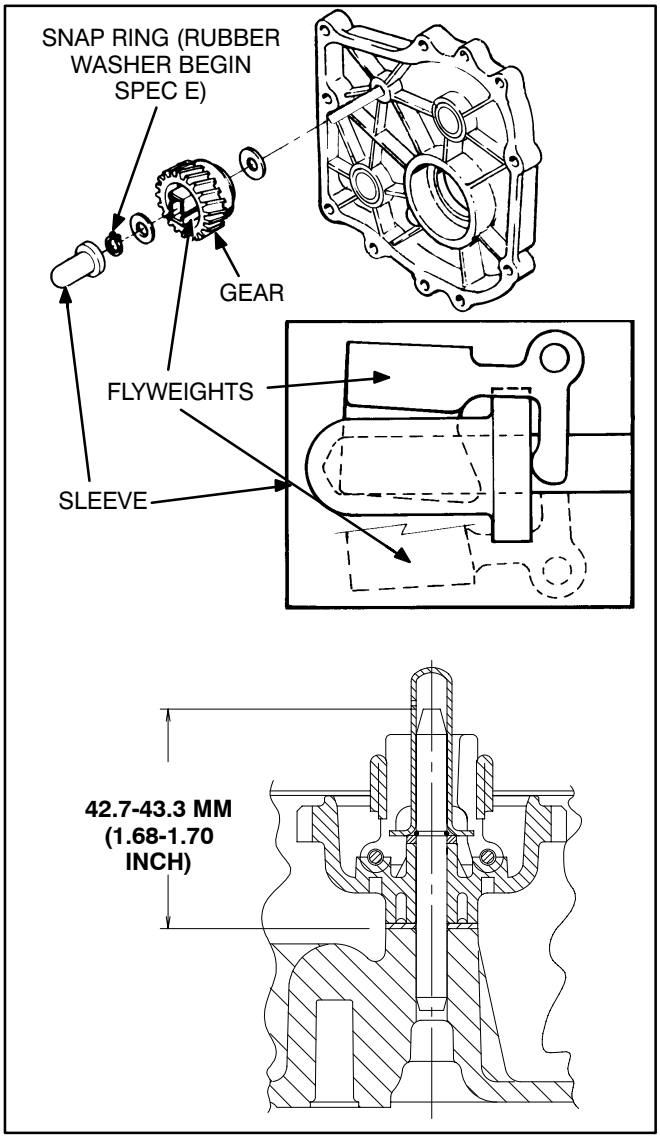


FIGURE 9-14. GOVERNOR

CAMSHAFT, TAPPET AND BALANCER REMOVAL

1. Place the engine cylinder down on a clean flat surface (Figure 9-15).
2. Carefully pull out the camshaft assembly.
3. Remove the valve tappets. Mark the tappets because tappet clearances differ and the tappets must be reassembled in their original positions.
4. Pull out the balancer shaft assembly.
5. For installation, apply oil to the tappets and the tooth surface of the gears. Align the marks on the cam gear and crank gear and also on the balancer gear and crank gear as shown in Figure 9-16.

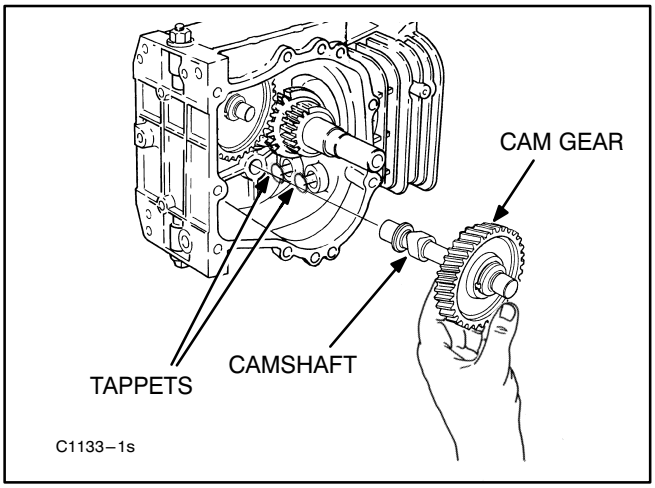


FIGURE 9-15. CAMSHAFT AND TAPPETS

PISTON AND CRANKSHAFT

The piston assembly consists of the piston, piston pin, and connecting rod assembly. After piston removal, all parts must be carefully inspected for damage and wear before reinstalling. Remove the carbon from the top of the cylinder bore and check for a ridge. Remove ridge with a ridge reamer (see Figure 9-17) before attempting piston removal. Remove the piston as follows:

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

1. Remove the two bolts from the connecting rod cap. Mark direction of assembly for connecting the rod, cap, and splasher.
2. Remove the rod cap from the rod and push the piston assembly out the top of the cylinder (Figure 9-18). Be careful not to scratch the crank pin or the cylinder wall when removing the piston.
3. Carefully pull the crankshaft out of the oil seal and bearing.

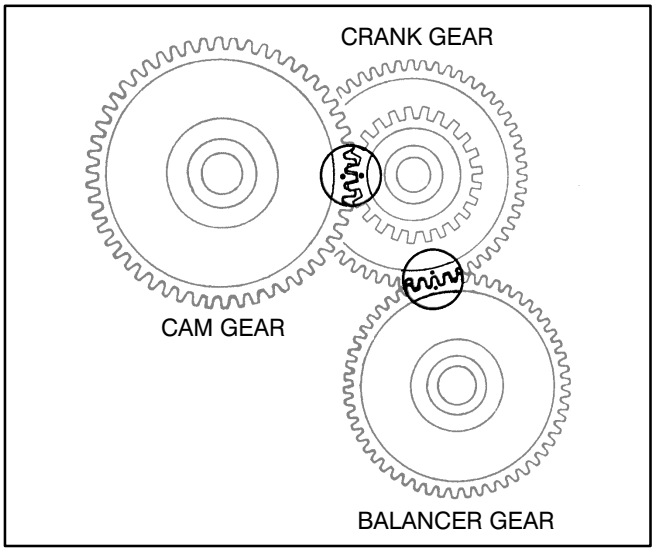


FIGURE 9-16. CAM, CRANK AND BALANCER GEAR ALIGNMENT

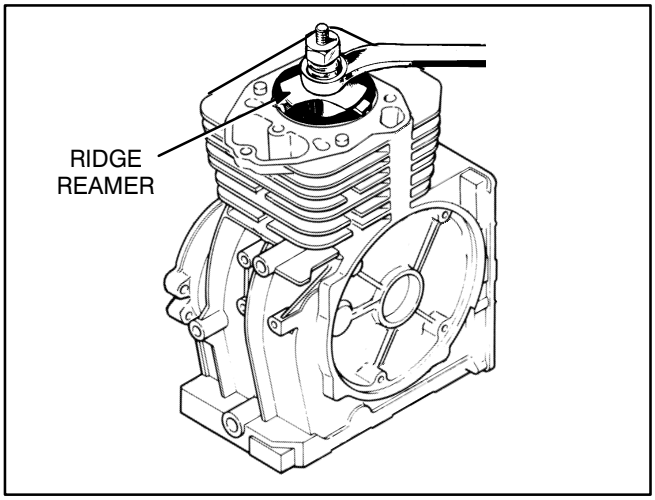


FIGURE 9-17. REMOVING WEAR RIDGE

INSPECTING ENGINE PARTS

Cylinder Head

1. Clean the cylinder head surface and measure flatness with a straight edge and feeler gauge (Figure 9-19).
2. Replace the cylinder head if flatness is not within specifications (see *Dimensions and Clearances*, Section 3).

Cylinder Block

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

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

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

1. Make a thorough check for cracks. One way is to coat the suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coat of zinc oxide (white lead) dissolved in wood alcohol. Cracks, if present will show up as discolored lines. Replace a cracked cylinder block.
2. Inspect all machined surfaces and threaded holes. Carefully remove any nicks or burrs from machined surfaces. Clean out tapped holes and clean up any damaged threads.
3. Check the cylinder head mounting area for flatness with a straight edge and a feeler gauge.

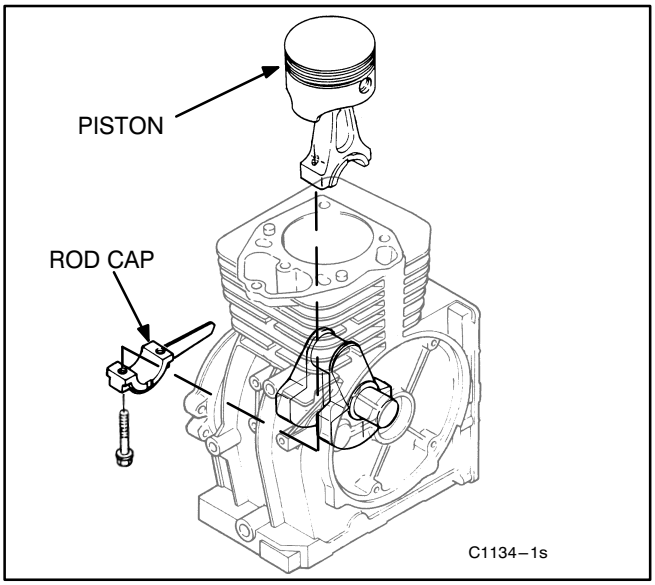


FIGURE 9-18. PISTON REMOVAL

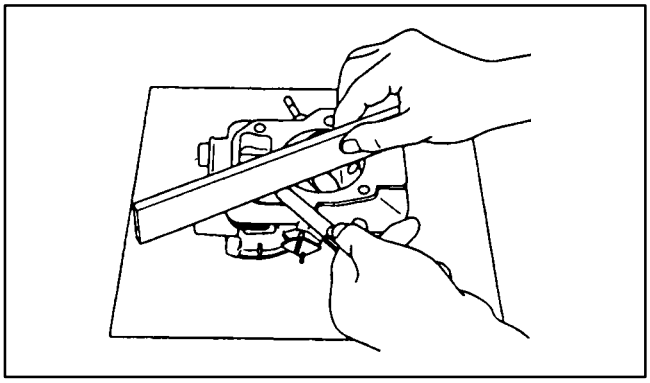


FIGURE 9-19. CYLINDER HEAD FLATNESS

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

1. Measure the ID of the cylinder at six points (Figure 9-20).
2. Have the cylinder bored and honed to the next oversize if out-of-round and taper are out of specifications.

Cylinder Bore Deglazing

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

1. Wipe the cylinder bore with a clean cloth that has been dipped in clean, light engine oil.
2. Use a brush type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.
3. Drive the deglazing tool with a slow speed drill. Move the deglazing tool up and down in the cylinder rapidly enough to obtain a crosshatch pattern (Figure 9-21).
4. Clean the cylinder bore thoroughly with soap, water, and clean rags. Continue cleaning until a clean white rag shows no discoloring when wiped through the cylinder bore.

⚠ CAUTION ***Thoroughly remove all abrasive particles to prevent abnormal ring, cylinder and bearing wear. Use soap and water and clean rags—neither gasoline nor commercial cleaners are good for removing abrasives from the engine.***

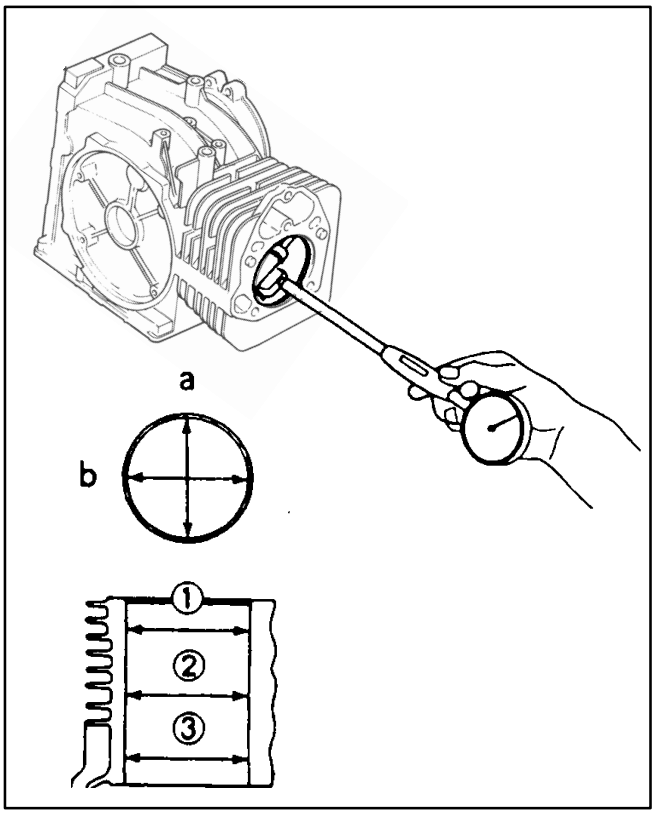


FIGURE 9-20. MEASURING CYLINDER WEAR

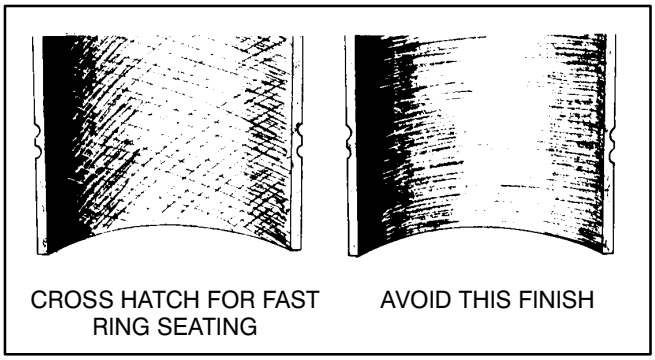


FIGURE 9-21. CROSSHATCHING

Piston, Rings, and Connecting Rod

The piston has two compression rings and one oil control ring. Remove these rings from the piston using a piston ring expander (Figure 9-22).

Remove the piston pin retainer from each side, heat the piston to 300° F (149° C) and push the piston pin out. Remove dirt and deposits from the piston surfaces with parts cleaning solvent. Clean the piston ring grooves with a groove cleaner (Figure 9-23) or the end of a piston ring filed to a sharp point. Take care not to remove metal from the groove sides.

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

Piston and Connecting Rod Inspection

Piston Inspection: Inspect the piston for fractures at the ring lands, skirt, and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge (Figure 9-24). Replace the piston if ring side clearance exceeds specifications.

Piston Skirt O.D. Measurement:

1. Measure the piston skirt O.D. with an outside micrometer (Figure 9-25).
2. If the measurement is less than the allowable limit, replace the piston.

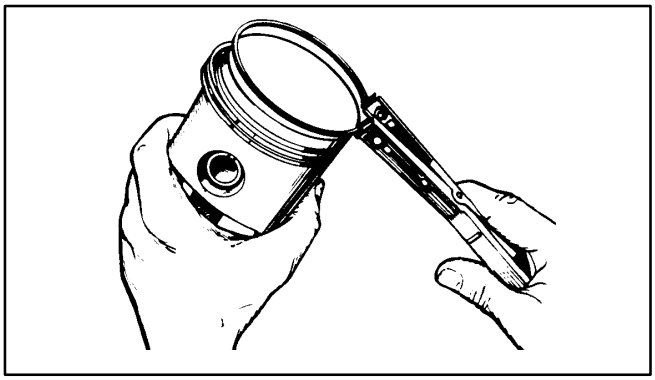


FIGURE 9-22. REMOVING PISTON RINGS

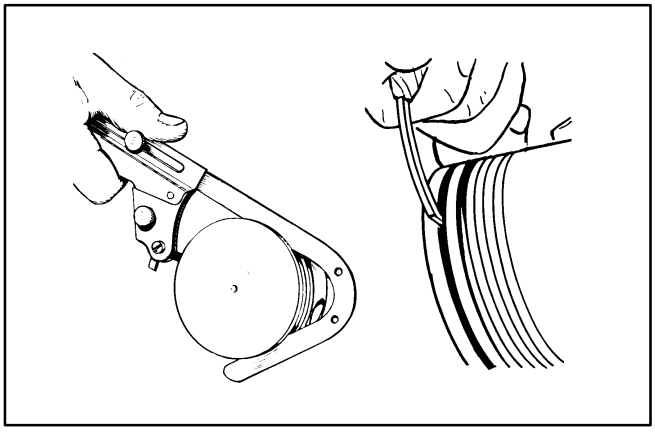


FIGURE 9-23. CLEANING RING GROOVES

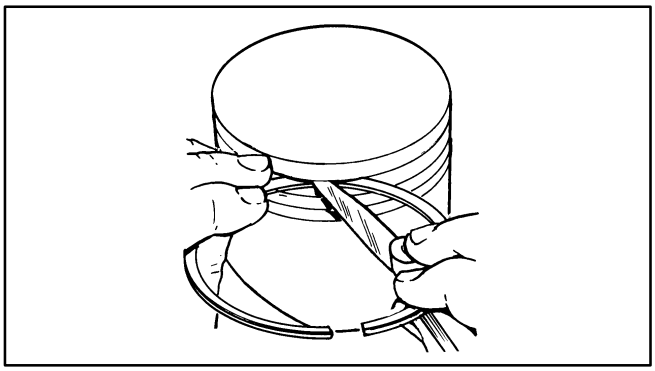


FIGURE 9-24. CHECKING RING LAND

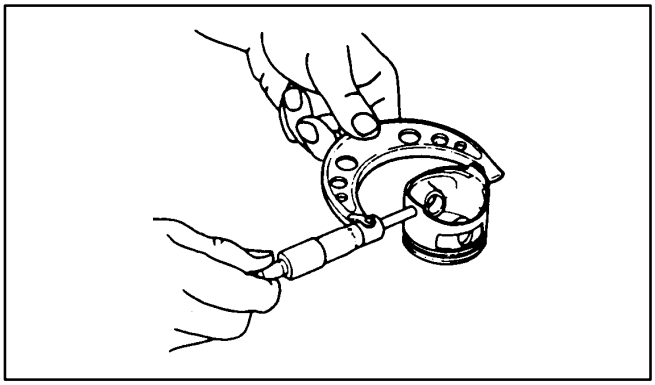


FIGURE 9-25. PISTON SKIRT MEASUREMENT

Piston Boss I.D. Measurement:

1. Measure the piston boss ID in both the vertical and horizontal direction (Figure 9-26).

2. If the measurement exceeds the allowable limit, replace the piston.

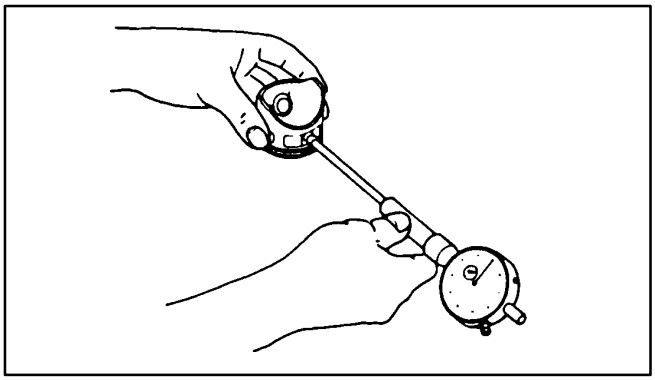


FIGURE 9-26. PISTON BOSS I.D.

Piston Ring Gap:

1. Insert piston ring into cylinder. Use piston head to push ring down to bottom of cylinder.

2. Measure ring gap (Figure 9-27).

3. If the ring gap exceeds the allowable limit, replace the ring.

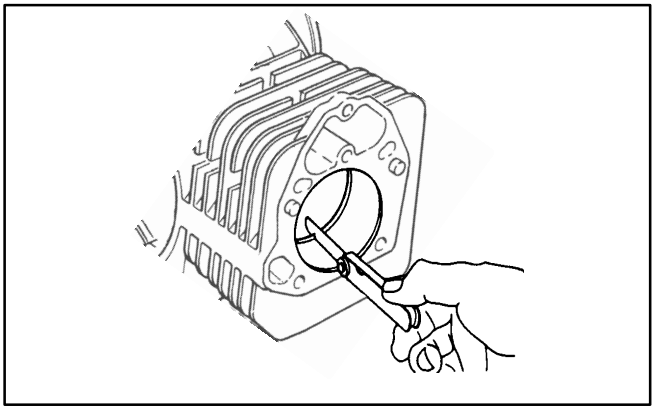


FIGURE 9-27. MEASURING RING GAP

Piston Ring Thickness:

1. Measure the piston ring thickness with an outside micrometer (see Figure 9-28).

2. If the thickness is less than the allowable limit, replace the ring.

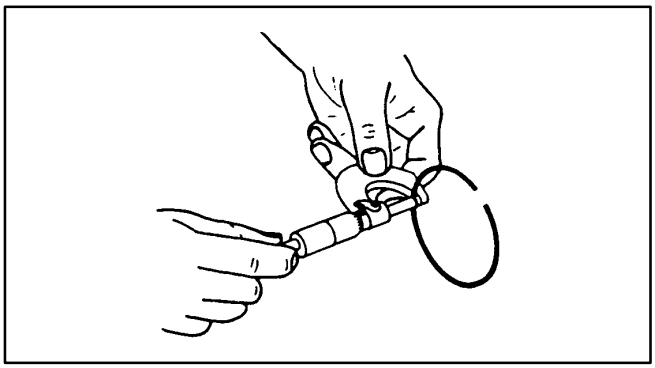


FIGURE 9-28. RING THICKNESS

Piston Assembly

Install the rings on the piston beginning with the oil control ring. Use a piston ring spreader to prevent twisting or excessive expansion of the ring. Compression rings are marked with the word top or a mark on one side of the ring to indicate which side faces the top of the piston. The top ring has a band of red paint and the bottom ring a band of white paint. Follow the instructions, if any, for the ring set. Oil ring rails may be installed either way. Stagger ring gaps 120 degrees apart. Do not position ring gaps on thrust face of cylinder.

Clearance between Piston Pin and Connecting Rod Small End Bore

1. Measure the piston pin OD and connecting rod small end bore with a micrometer (Figure 9-29). Then calculate the difference.

2. If the clearance exceeds the allowable limits, replace them.

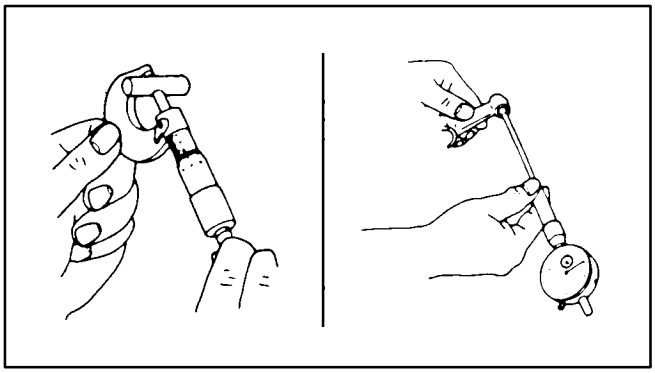


FIGURE 9-29. PISTON PIN TO CONNECTING ROD CLEARANCE

Clearance between Crank Pin and Connecting Rod Big End Bore

1. Measure the crank pin OD and the connecting rod big end bore with a micrometer, and calculate the difference (Figure 9-30).
2. If the clearance exceeds the allowable limits, replace them.

Side Clearance of Connecting Rod on Crank Pin

1. Assemble the connecting rod to the crank pin.
2. Measure the side clearance with a feeler gauge (Figure 9-31).
3. If the clearance exceeds the allowable limits, replace them.

Cam Heights for Intake and Exhaust

1. Measure the height of the cam at its highest point with an outside micrometer (Figure 9-32).
2. If the measurement is less than the allowable limit, replace the camshaft.

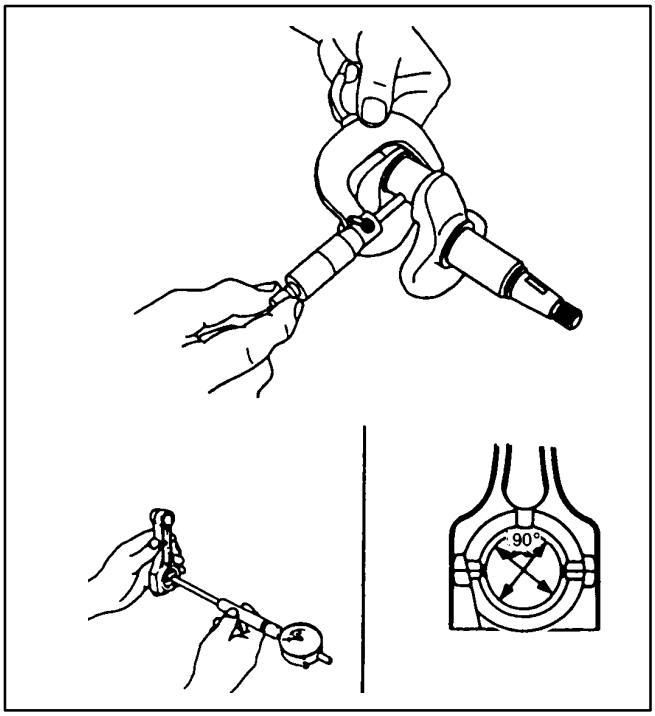


FIGURE 9-30. CRANK PIN AND CONNECTING ROD CLEARANCE

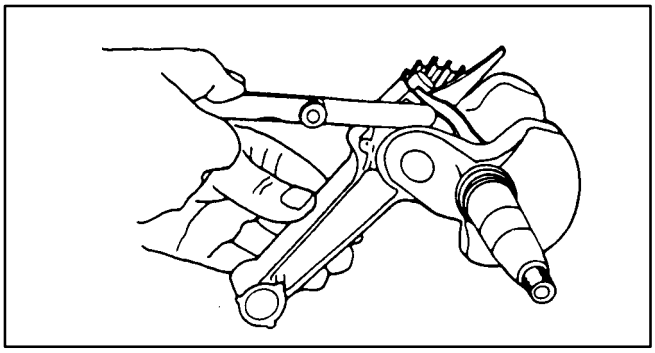


FIGURE 9-31. SIDE CLEARANCE OF CONNECTING ROD ON CRANK PIN

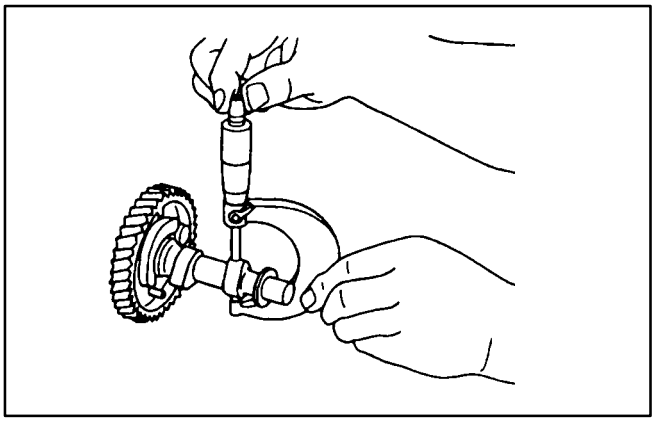


FIGURE 9-32. INTAKE AND EXHAUST CAM HEIGHTS

PISTON AND CRANKSHAFT INSTALLATION

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

Side Clearance of Crankshaft

1. Set a dial gauge, as shown in Figure 9-33, push the shaft in and measure the clearance.
2. If the side clearance exceeds the allowable limits, adjust with shims.

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

Installing the Piston in Cylinder: When installing the piston assembly, observe the markings on the connecting rod, cap and splasher. See Figure 9-34.

1. Turn the crankshaft to position the crankpin at the bottom of its stroke.
2. Lubricate the piston assembly and inside of cylinder wall. Compress the rings with a ring compressor as shown in Figure 9-35.
3. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the crankpin.

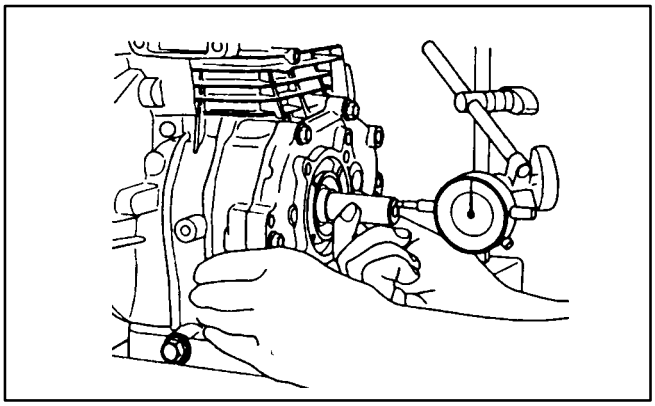


FIGURE 9-33. SIDE CLEARANCE OF CRANKSHAFT

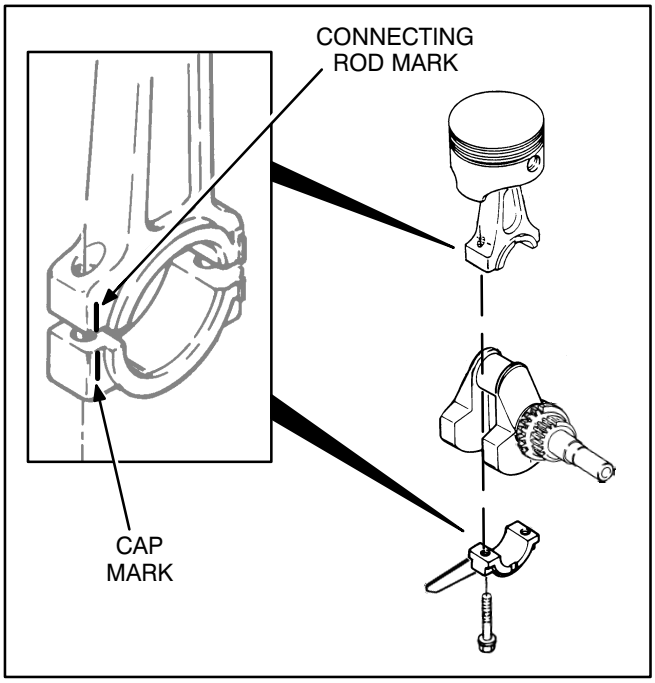


FIGURE 9-34. ROD CAP ASSEMBLY

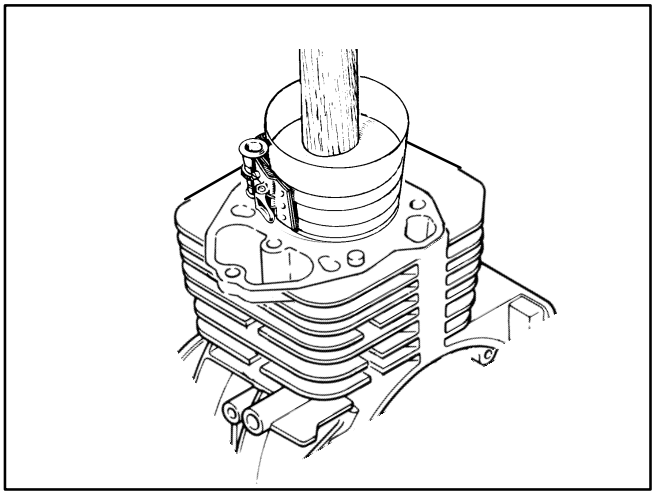


FIGURE 9-35. INSTALLING PISTON

Crankpin Clearance

1. Wipe the oil off the rod cap and crankpin.
2. Place a piece of the correct size Plasti-gage across the full width of the rod cap about 1/4 inch (6 mm) off center (Figure 9-36).
3. Install the rod cap and tighten to the specified torque. Do not rotate crankshaft after the rod cap is in place.
4. Remove the rod cap and leave the flattened Plasti-gage on the part to which it adheres. Compare the widest point of the flattened Plasti-gage with the graduations on the envelope to determine the crankpin clearance.
5. Remove the Plasti-gage. Lubricate the rod crankpin and cap. Install the connecting rod cap. The rod cap must be tapped several times to properly align it with the connecting rod. Tighten the connecting rod bolts to the specified torque.
6. Crank the engine several times to see that the crankshaft turns freely.

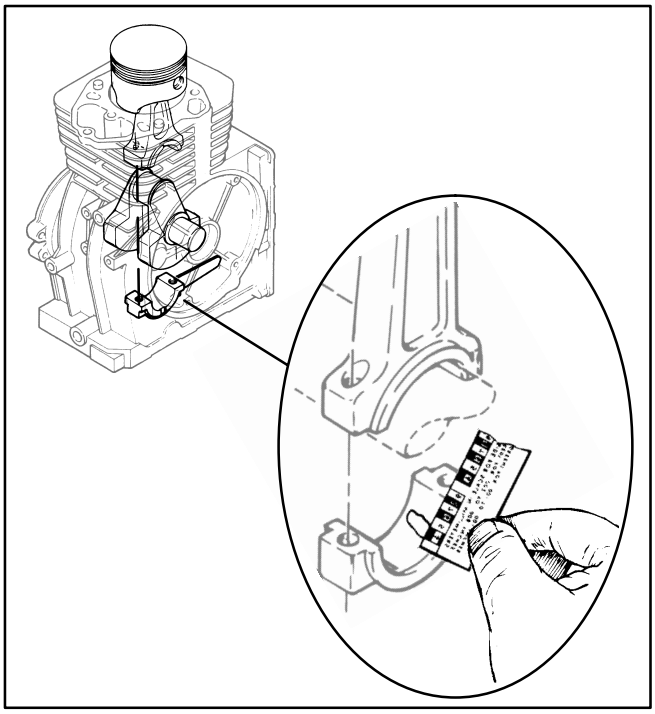


FIGURE 9-36. USING PLASTI-GAGE TO MEASURE CRANKPIN CLEARANCE

BEARINGS

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

OIL SEAL

Use an oil seal remover to pry the oil seal out of the engine block. Clean the oil seal resting surface and lubricate surface before installing new oil seal. Press new oil seal into the engine block until oil seal is flush with cylinder block boss (see Figure 9-37). Lubricate the lips of the oil seal with a light coating of grease. This provides initial lubrication until engine oil reaches the seal.

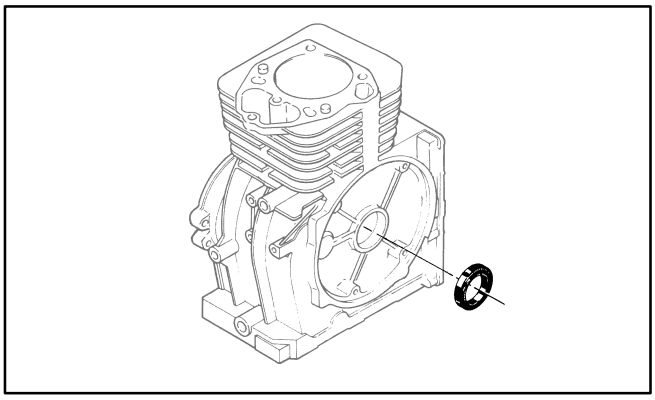


FIGURE 9-37. OIL SEAL

10. Troubleshooting

⚠WARNING ***Hot engine parts can cause severe burns. Always allow the engine time to cool before performing any maintenance or service.***

The Fault Codes are listed in numerical order along with step-by-step instructions for corrective action.

First note the following:

- Maintaining engine oil level, keeping battery connections clean and tight, watching the fuel gauge, not overloading the genset, etc. will prevent most shutdowns.
- When the genset and propulsion engine share a common fuel tank the fuel dip tubes are usually arranged so that the genset will run out of fuel first. Marking the genset empty point on the fuel gauge will make it easier to tell when to stop the genset before running it out of fuel.

FAULT CODES

The genset controller provides extensive diagnostics by causing the status indicator light on the Control Switch to blink in a coded fashion. Following a fault shutdown, the indicator light will repeatedly blink 3 or 4 blinks at a time.

- **Three blinks** indicates a service fault. Press **Stop** once to cause the two-digit, second-level fault code to blink. (Pressing **Stop** again will stop the blinking.)The two-digit code consists of 1, 2, 3 or 4 blinks, a brief pause, and then 1 to 9 blinks. The first set of blinks represents the tens digit and the second set of blinks the units digit of the fault code number. For example, **Fault Code No. 36** appears as:

  blink-blink-blink—*pause*—blink-blink-blink-blink-blink-blink...

- **Four blinks** indicates that cranking exceeded 15 to 20 seconds without the engine starting.
- **Note: Fault Code Nos. 3 and 4 are first level faults. Avoid interpreting them as second-level Fault Code Nos. 33 and 44, which have not been assigned as fault codes.**

Restoring Fault Code Blinking – The fault code stops blinking after five minutes, or after clearing the fault by pressing Stop once for a Level 1 fault or twice for a Level 2 fault. Press Stop three times within five seconds to restore blinking. *Note that the last fault logged will blink, even after the condition that caused the shutdown has been corrected.*

GENSET STARTS OR STOPS WITHOUT COMMAND – NO FAULT CODE

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: To start or stop – control receives ground at start or stop input on control, DC voltage drops below 9V and controller de–energizes (shuts down in sleep mode)

Possible Cause: Low battery voltage, shorted harness connection, faulty start/stop switch, Auto Gen Start (AGS) is enabled

Diagnosis and Repair:

1. Check last fault and record.
2. Measure battery voltage at battery and genset.
3. Inspect battery connections and cables for cleanliness, tightness and damage: clean, tighten and repair connections and cables as necessary.
4. Check electrolyte level and hydrometer reading in maintenance type batteries: replace electrolyte and recharge or replace battery as necessary.
5. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run genset for symptom: repair or replace pins in connector as necessary.
7. Measure battery voltage at genset while attempting to start from local or remote switch: recharge or replace battery if voltage drops below 9 VDC, test and service genset battery charger if so equipped, increase battery cable size or run parallel cables.
8. Measure battery voltage and check for charger increase while genset is running.
9. Measure for continuity change across start/stop switch between neutral and start position and neutral and stop position at switches and at connector P1: reconnect or repair connections, replace switches as necessary.
10. Measure for continuity from start and stop inputs to ground at switches and at connector P1: Repair or replace damaged harness.
11. Determine if AGS is installed and enabled (AGS will command start and stop based on its own settings): disable AGS or explain AGS function to customer (see PSB-666).

NO RESPONSE – STATUS INDICATOR LIGHT DEAD

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: To start – control receives ground via start/stop switch to start or stop input on control

Possible Cause: Low/No battery voltage, poor battery connection, faulty battery, open harness connection, faulty start/stop switch, faulty LED

Diagnosis and Repair:

1. Measure battery voltage at battery, at genset and at connector P1: reconnect, clean, repair and replace connections as necessary.
2. Measure battery voltage at genset while attempting to start or prime from local or remote switch: recharge or replace battery if voltage drops below 9 VDC, test and service genset battery charger if so equipped, increase battery cable size or run parallel cables.
3. Measure for continuity change across start/stop switch between neutral and start position and neutral and stop position at switches and at connector P1: reconnect or repair connections, replace switches as necessary.
4. Test switches LED by energizing with 12 VDC: replace switches as necessary.
5. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run genset for start and prime operation: replace control as necessary.

STARTING BATTERIES RUN DOWN

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Low/No battery voltage

Possible Cause: Battery connections, battery, charging system, excessive cranking, excessive priming

Diagnosis and Repair:

1. Measure battery voltage at battery and genset.
2. Inspect battery connections and cables for cleanliness, tightness and damage: clean, tighten and repair connections and cables as necessary.
3. Check electrolyte level and hydrometer reading in maintenance type batteries: replace electrolyte and recharge or replace battery as necessary.
4. Verify battery charger is on and check operation.
5. Measure battery voltage and check for charging increase while genset is running.
6. Check last fault and record: troubleshoot as necessary.
7. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
8. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
9. Measure for continuity change across start/stop switch between neutral and stop position at switches and P1 connector: replace switches as necessary or disconnect external stop device if so equipped.
10. Measure for voltage at fuel pump while genset is not running or being primed: replace control as necessary.

STARTER ENGAGES – DISENGAGES

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Cranking voltage dips below 6 VDC: microprocessor aborts start attempt

Possible Cause: Battery connections, battery, charging system, start/stop switches, engine compression

Diagnosis and Repair:

1. Measure battery voltage at battery and genset.
2. Inspect battery connections and cables for cleanliness, tightness and damage: clean, tighten and repair connections and cables as necessary.
3. Check electrolyte level and hydrometer reading in maintenance type batteries: replace electrolyte and recharge or replace battery as necessary.
4. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
6. Measure battery voltage at genset while attempting to start from local or remote switch: recharge or replace battery if voltage drops below 9 VDC, test and service genset battery charger if so equipped, increase battery cable size or run parallel cables.
7. Measure battery voltage and check for charger increase while genset is running.

NO AC POWER – GENSET RUNNING, STATUS LED ON STEADY

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Genset control in normal run mode

Possible Cause: Circuit breakers

Diagnosis and Repair: Measure AC output at genset circuit breaker: reset or turn on genset circuit breaker, diagnose faulty loads as necessary

GENSET CRANKS BUT DOES NOT START – NO FAULT CODE

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Fault codes are based on time lapse between events

Possible Cause: Not holding start switch long enough to cause fault

Diagnosis and Repair:

1. Check and record last fault code.
2. Crank genset and hold switch until control stops cranking and displays fault code (approximately 30 seconds): troubleshoot fault code and reference last fault code recorded above if necessary.

GENSET RUNS BUT STOPS WHEN SWITCH IS RELEASED – NO FAULT CODE

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Fault codes are based on time lapse between events

Possible Cause: Not holding start switch long enough to cause fault

Diagnosis and Repair:

1. Check and record last fault code.
2. Start genset and hold switch until control shuts down and displays fault code (approximately 30 seconds): troubleshoot fault code and reference last fault code recorded above if necessary.

SERVICE CHECK FAULT – FAULT CODE 3

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Single-Digit Fault to indicate shutdown due to a Two-Digit Fault

Possible Cause: Any Two-Digit Fault Code

Diagnosis and Repair:

1. Verify that Last Fault is FC 3: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. While LED is flashing three times press stop once (1 second duration): trouble shoot Two-Digit Fault Code.

OVERCRANK – FAULT CODE 4

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Controller unable to sense genset frequency after 20 seconds of holding start switch

Possible Cause: Faulty switch, faulty external start command, fuel supply, air fuel mixture, exhaust system, wire connections, starter, ignition system

Diagnosis and Repair:

1. Verify that Last Fault is FC 4: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure for continuity change across start/stop switch between neutral and start position at switches and P1 connector: replace switches as necessary or disconnect external start device if so equipped.
3. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
4. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
5. Verify engine rotation manually: repair engine damage as necessary.
6. Measure DC voltage at starter during start attempt: repair wire connections, replace start solenoid and starter as necessary.
7. Check air filter cleanliness; replace air filter as necessary.
8. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
9. Verify genset operation and outputs with Break-Out Tool 420–0603 and Instruction Sheet R1098.
10. **Gasoline Models**
    A. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
    B. Measure steady DC voltage at fuel pump while genset is cranking: repair wiring as necessary.
    C. Try to start genset on shop fuel supply: verify tank level and fuel line condition in vehicle.
    D. Verify carburetor altitude setting: readjust as necessary.
    E. Verify choke operation, setting and linkage damage: readjust, repair or replace as necessary.
    F. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.
    G. Inspect carburetor butterfly for binding: replace carburetor as necessary.
11. **Propane Models**
    A. When ambient temperatures are less than 40°F vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
    B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
    C. Measure steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is cranking; repair wiring as necessary.
    D. Verify clear vent hose.
    E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.

F. Check genset fuel lines for damage: replace fuel line as required.

G. Measure regulator lock off pressure.

H. Verify priming solenoid operation, if so equipped.

12. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
13. Verify that spark plug cable is secure on spark plug: reconnect or replace as necessary.
14. Measure DC voltage from ignition kill lead greater than 1 VDC: repair or replace leads, pins or magneto as necessary.
15. Inspect ignition kill lead in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
16. Test magneto:
    A. Disconnect Connector P1.
    B. Connect positive(+) meter lead to chassis ground.
    C. Measure continuity to negative lead at pin P1–15: replace magneto as necessary.
17. Measure spark plug gap: set gap or replace spark plug as necessary.
18. Verify ignition spark condition.
19. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magneto as necessary.
20. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
21. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
22. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
23. Check brush alignment per PSB-682a.
24. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

OVERVOLTAGE – FAULT CODE 12

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Instantaneous Fault – AC voltage S1–S2 greater than 150 VAC
Delayed Fault – AC voltage S1–S2 greater than 138 VAC, but less than 150 VAC for 3 continuous minutes

Possible Causes: Genset loads, Inverter/Charger, wire connections, AC sense transformer, windings

Diagnosis & Repair:

1. Verify that Last Fault is FC 12: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC voltage.
3. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
4. Cycle loads to determine if a particular load causes fault: diagnose faulty load as necessary.
5. Determine Inverter/Charger battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
6. Verify balanced loads in 120/240 VAC applications: balance loads within 10 percent line–to–line as required.
7. If the genset will not stay running measure genset frequency, quadrature winding and main winding voltages using Break-Out Tool 420–0603 and Instruction Sheet R1098.
8. Remove connector P1 from control and re-install and try to start genset: inspect, repair or replace P1 connector pins as necessary.
9. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
10. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
11. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
12. Check brush alignment per PSB-682a.
13. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

UNDERVOLTAGE – FAULT CODE 13

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: AC voltage S1–S2 less than 108 VAC for 5 continuous seconds

Possible Causes: Genset loads, Inverter/Charger, wire connections, generator drive system, windings, AC sense transformer, windings

Diagnosis & Repair:

1. Verify that Last Fault is FC 13: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC voltage.
3. Measure AC voltage in and out of sense transformer (if so equipped): repair wire connection, replace sense transformer as necessary.
4. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
5. Cycle loads to determine if a particular load will cause fault: diagnose faulty load as necessary.
6. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
7. Verify balanced loads in 120/240 VAC applications: balance loads within 10 percent line–to–line as required.
8. If the genset will not stay running measure genset frequency, quadrature winding and main winding voltages using Break-Out Tool 420–0603 and Instruction Sheet R1098.
9. Remove connector P1 from control and re-install and try to start genset: inspect, repair or replace P1 connector pins as necessary.
10. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
11. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
12. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
13. Check brush alignment per PSB-682a.
14. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

OVERFREQUENCY – FAULT CODE 14

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Instantaneous Fault – Frequency greater than 70Hz
Delayed Fault – Frequency greater than 66Hz, but less than 70Hz, for 3 continuous seconds

Possible Causes: Genset loads, Inverter/Charger, engine governor function, fuel supply, air fuel mixture, exhaust system, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 14: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC current while running genset with vehicle loads: identify faulty or short cycling loads.
3. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
4. Measure genset load capability with shop load bank (derate for altitude and temperature as necessary).
5. Measure genset frequency and droop while running.
6. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
7. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
8. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
9. Check all grounds and neutral leads for looseness at battery, genset, inverter/converter; run genset on separate battery: tighten or replace terminals and leads as necessary.
10. Check air filter cleanliness; replace air filter as necessary.
11. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
12. If the genset will not stay running measure genset frequency, quadrature winding and main winding voltages using Break-Out Tool 420–0603 and Instruction Sheet R1098.
13. **Gasoline Models**
    A. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
    B. Verify steady DC voltage at fuel pump while genset is running; repair wiring as necessary.
    C. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
    D. Verify carburetor altitude setting; readjust as necessary.
    E. Verify choke operation, setting and linkage damage; readjust, repair or replace as necessary.
    F. Measure throttle stop frequency; readjust as necessary.
    G. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.

14. **Propane Models**
    A. When ambient temperatures are less than 40°F, vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
    B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
    C. Verify steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is running; repair wiring as necessary.
    D. Verify clear vent hose.
    E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
    F. Measure throttle stop frequency; readjust as necessary.
    G. Check genset fuel lines for damage: replace fuel line as required.
    H. Measure regulator lock off pressure.
    I. Verify priming solenoid operation, if so equipped.
15. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
16. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
17. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
18. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
19. Check brush alignment per PSB-682a.
20. Verify that spark plug cable is secure on spark plug: reconnect or replace as necessary.
21. Inspect ignition kill lead in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
22. Test magneto:
    A. Disconnect Connector P1.
    B. Connect positive(+) meter lead to chassis ground.
    C. Measure continuity to negative lead at pin P1–15: replace magneto as necessary.
23. Measure spark plug gap: set gap or replace spark plug as necessary.
24. Verify ignition spark condition.
25. Inspect spark plug cable, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magneto as necessary.
26. Measure temperature of air intake and temperature rise across genset; remove blockage or prevent air recirculation.
27. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

UNDERFREQUENCY – FAULT CODE 15

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Frequency less than 54Hz for 30 continuous seconds

Possible causes: Genset loads, Inverter/Charger, engine governor function, fuel supply, air fuel mixture, exhaust system, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 15: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC current while running genset with vehicle loads: identify faulty or short cycling loads.
3. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
4. Measure genset load capability with shop load bank (derate for altitude and temperature as necessary).
5. Measure genset frequency and droop while running.
6. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
7. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
8. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
9. Check air filter cleanliness; replace air filter as necessary.
10. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
11. If the genset will not stay running measure genset frequency, quadrature winding and main winding voltages using Break-Out Tool 420–0603 and Instruction Sheet R1098.
12. **Gasoline Models**
    A. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
    B. Verify steady DC voltage at fuel pump while genset is running; repair wiring as necessary.
    C. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
    D. Verify carburetor altitude setting; readjust as necessary.
    E. Verify choke operation, setting and linkage damage; readjust, repair or replace as necessary.
    F. Measure throttle stop frequency; readjust as necessary.
    G. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.

13. **Propane Models**
    A. When ambient temperatures are less than 40°F, vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
    B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
    C. Verify steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is running; repair wiring as necessary.
    D. Verify clear vent hose.
    E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
    F. Measure throttle stop frequency; readjust as necessary.
    G. Check genset fuel lines for damage: replace fuel line as required.
    H. Measure regulator lock off pressure.
    I. Verify priming solenoid operation, if so equipped.
14. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
15. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
16. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
17. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
18. Check brush alignment per PSB-682a.
19. Verify that spark plug cable is secure on spark plug: reconnect or replace as necessary.
20. Inspect ignition kill lead in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
21. Test magneto:
    A. Disconnect Connector P1.
    B. Connect positive(+) meter lead to chassis ground.
    C. Measure continuity to negative lead at pin P1–15: replace magneto as necessary.
22. Measure spark plug gap: set gap or replace spark plug as necessary.
23. Verify ignition spark condition.
24. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magneto as necessary.
25. Measure temperature of air intake and temperature rise across genset; remove blockage or prevent air recirculation.
26. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

VOLTAGE SENSE LOST – FAULT CODE 27

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: No Sense Voltage (0 VAC across S1–S2) for 1 continuous second after start disconnect

Possible Causes: Genset loads, Inverter/Charger, VAC sense transformer, engine governor function, fuel supply, choke, demand regulator, carburetor, generator windings, ignition, wire connections, temperature

Diagnosis & Repair:

1. Verify that Last Fault is FC 27: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure AC voltage.
3. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
4. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
6. Check air filter cleanliness; replace air filter as necessary.
7. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
8. If the genset will not stay running measure genset frequency, quadrature winding and main winding voltages using Break-Out Tool 420–0603 and Instruction Sheet R1098.
9. **Gasoline Models**
   A. Under high ambient conditions or heat soak conditions vapor lock may occur, operate less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
   B. Verify steady DC voltage at fuel pump while genset is running; repair wiring, verify proper installation to prevent air recirculation as necessary.
   C. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
   D. Verify carburetor altitude setting; readjust as necessary.
   E. Verify choke operation, setting and linkage damage; readjust, repair or replace as necessary.
   F. Measure throttle stop frequency; readjust as necessary.
   G. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.
10. **Propane Models**
   A. When ambient temperatures are less than 40°F, vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
   B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
   C. Verify steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is running; repair wiring as necessary.
   D. Verify clear vent hose.
   E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
   F. Measure throttle stop frequency; readjust as necessary.

G. Check genset fuel lines for damage: replace fuel line as required.
H. Measure regulator lock off pressure.
I. Verify priming solenoid operation, if so equipped.

11. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
12. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
13. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
14. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
15. Check brush alignment per PSB-682a.
16. Verify that spark plug cable is secure on spark plug: reconnect or replace as necessary.
17. Inspect ignition kill lead in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
18. Test magneto:
    A. Disconnect Connector P1.
    B. Connect positive(+) meter lead to chassis ground.
    C. Measure continuity to negative lead at pin P1–15: replace magneto as necessary.
19. Measure spark plug gap: set gap or replace spark plug as necessary.
20. Verify ignition spark condition.
21. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magneto as necessary.
22. Measure temperature of air intake and temperature rise across genset; remove blockage or prevent air recirculation.
23. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

HIGH BATTERY VOLTAGE – FAULT CODE 29

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: DC voltage to controller greater than 19 VDC when pressing start or stop

Possible Causes: Incorrect battery configuration, wire damage, faulty charger, control

Diagnosis & Repair:

1. Verify that Last Fault is FC 29: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure DC voltage at battery, genset and connector P1: reconnect battery or repair wiring as necessary.
3. Measure DC voltage with battery charger on: reduce boost charge rate or diagnose faulty charger as necessary.
4. If genset shares batteries with propulsion engine, check for fault using shop battery (voltage spike may cause fault): diagnose fault or voltage spikes from propulsion engine charging system.
5. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run genset for fault occurrence: replace controller.

LOW CRANKING SPEED SENSE – FAULT CODE 32

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic:
Prior to 2003 – quadrature frequency less than 1.7Hz for 2 continuous seconds after pressing start.
After 2003 – quadrature frequency less than 1.7Hz for 12 continuous seconds after pressing start

Possible Causes: Cylinder at TDC, fuel supply, air fuel mixture, exhaust system, starter, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 32: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure battery voltage at battery and genset: recharge or replace battery as necessary.
3. Verify engine rotation manually: repair engine damage as necessary.
4. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
6. Measure DC voltage at starter during start attempt: repair wire connections, replace start solenoid and starter as necessary.
7. Check air filter cleanliness; replace air filter as necessary.
8. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
9. Verify genset operation and outputs with Break-Out Tool 420–0603 and Instruction Sheet R1098.
10. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
11. **Gasoline Models**
    A. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
    B. Measure steady DC voltage at fuel pump while genset is cranking: repair wiring as necessary.
    C. Try to start genset on shop fuel supply: verify tank level and fuel line condition in vehicle.
    D. Verify carburetor altitude setting: readjust as necessary.
    E. Verify choke operation, setting and linkage damage: readjust, repair or replace as necessary.
    F. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.
    G. Inspect carburetor butterfly for binding: replace carburetor as necessary.

12. **Propane Models**
    A. When ambient temperatures are less than 40°F, vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
    B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
    C. Measure steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is running; repair wiring as necessary.
    D. Verify clear vent hose.
    E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
    F. Check genset fuel lines for damage: replace fuel line as required.
    G. Measure regulator lock off pressure.
    H. Verify priming solenoid operation, if so equipped.
13. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
14. Verify that spark plug cable is secure on spark plug: reconnect or replace as necessary.
15. Inspect ignition kill lead in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
16. Test magneto
    A. Disconnect Connector P1.
    B. Connect positive(+) meter lead to chassis ground.
    C. Measure continuity to negative lead at pin P1–15 and P1–20: replace magneto as necessary.
17. Measure spark plug gap: set gap or replace spark plug as necessary.
18. Verify ignition spark condition.
19. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magneto as necessary.
20. Measure temperature of air intake and temperature rise across genset; remove blockage or prevent air recirculation.
21. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

FAULT CODE 33 – FAULT CODE 33

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Single-Digit Fault to indicate shutdown due to Two-Digit Fault Code

Possible Cause: Fault Code 3 interpreted as a non-assigned Fault Code 33

Diagnosis & Repair:

1. Verify that Last Fault is FC 3 Yes, continue diagnosis; No, troubleshoot actual last fault.
2. While LED is flashing three times press stop once (1 second duration): trouble shoot Two-Digit Fault Code.

CONTROL CARD FAILURE – FAULT CODE 35

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: EEPROM (programming variables) error during self test

Possible Causes: Faulty program

Diagnosis & Solution:

1. Verify that Last Fault is FC 35: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Replace control.

GENSET STOPPED WITHOUT FAULT CONDITION – FAULT CODE 36

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Quadrature frequency was less than 17 Hz (1020 rpm) when no other fault condition occurred

Possible Causes: Auto Gen Start (AGS), fuel supply, air fuel mixture, exhaust system, loads, Inverter/Charger, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 36: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Verify whether AGS stopped genset: Yes, disable AGS or explain AGS function to customer (see PSB-666); No, continue diagnosis.
3. Verify engine rotation manually: repair engine damage as necessary.
4. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
6. Check air filter cleanliness; replace air filter as necessary.
7. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
8. Measure AC current while running genset with vehicle loads: identify faulty or short cycling loads.
9. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
10. Measure genset load capability with shop load bank.
11. Verify genset operation and outputs with Break-Out Tool 420–0603 and Instruction Sheet R1098.
12. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.

13. **Gasoline Models**
    A. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
    B. Measure steady DC voltage at fuel pump while genset is cranking: repair wiring as necessary.
    C. Try to start genset on shop fuel supply: verify tank level and fuel line condition in vehicle.
    D. Verify carburetor altitude setting: readjust as necessary.
    E. Verify choke operation, setting and linkage damage: readjust, repair or replace as necessary.
    F. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.
    G. Inspect carburetor butterfly for binding: replace carburetor as necessary.
14. **Propane Models**
    A. When ambient temperatures are less than 40°F, vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
    B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
    C. Measure steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is running; repair wiring as necessary.
    D. Verify clear vent hose.
    E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
    F. Check genset fuel lines for damage: replace fuel line as required.
    G. Measure regulator lock off pressure.
    H. Verify priming solenoid operation, if so equipped.
15. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
16. Verify that spark plug cable is secure on spark plug: reconnect or replace as necessary.
17. Inspect ignition kill lead in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
18. Test magneto
    A. Disconnect Connector P1.
    B. Connect positive(+) meter lead to chassis ground.
    C. Measure continuity to negative lead at pin P1–15 and P1–20: replace magneto as necessary.
19. Measure spark plug gap: set gap or replace spark plug as necessary.
20. Verify ignition spark condition.
21. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magneto as necessary.
22. Measure temperature of air intake and temperature rise across genset; remove blockage or prevent air recirculation.
23. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

FIELD OVERLOAD (OVERVOLTAGE) – FAULT CODE 38

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Field voltage (F1–F1) greater than 150 VDC for 10 continuous seconds

Possible Causes: Loads, Inverter/Charger, windings, fuel supply, governor system

Diagnosis & Repair:

1. Verify that Last Fault is FC 38: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure F1–F2 DC voltage.
3. Measure AC current while running genset with vehicle loads: identify faulty or short cycling loads.
4. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
5. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
7. Measure genset load capability with shop load bank (derate for altitude and temperature as necessary).
8. Measure genset frequency and droop while running.
9. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
10. Check air filter cleanliness; replace air filter as necessary.
11. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
12. **Gasoline Models**
    A. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
    B. Verify steady DC voltage at fuel pump while genset is running; repair wiring as necessary.
    C. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
    D. Verify carburetor altitude setting; readjust as necessary.
    E. Verify choke operation, setting and linkage damage; readjust, repair or replace as necessary.
    F. Measure throttle stop frequency; readjust as necessary.
    G. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.
13. **Propane Models**
    A. When ambient temperatures are less than 40°F vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
    B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
    C. Verify steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is running; repair wiring as necessary.
    D. Verify clear vent hose.

E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.

F. Measure throttle stop frequency; readjust as necessary.

G. Check genset fuel lines for damage: replace fuel line as required.

H. Measure regulator lock off pressure.

I. Verify priming solenoid operation, if so equipped.

14. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
15. If the genset will not stay running measure genset frequency, quadrature winding and main winding voltages using Break-Out Tool 420–0603 and Instruction Sheet R1098.
16. Remove connector P1 from control and re-install and try to start genset: inspect, repair or replace P1 connector pins as necessary.
17. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
18. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
19. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
20. Check brush alignment per PSB-682a.
21. Measure temperature of air intake and temperature rise across genset; remove blockage or prevent air recirculation.
22. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

GENERATOR ROTOR FAULT – FAULT CODE 41

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Field Voltage F1–F2 at 0 VDC and Sense Voltage S1–S2 at 0 VAC for 1 continuous second

Possible Causes: Loads, windings, fuel supply

Diagnosis & Repair:

1. Verify that Last Fault is FC 41: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Measure F1–F2 DC voltage.
3. Measure AC current while running genset with vehicle loads: identify faulty or short cycling loads.
4. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
5. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
6. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
7. Measure genset load capability with shop load bank (derate for altitude and temperature as necessary).

8. **Gasoline Models**
   A. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
   B. Verify steady DC voltage at fuel pump while genset is running; repair wiring as necessary.
   C. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
   D. Verify carburetor altitude setting; readjust as necessary.
   E. Verify choke operation, setting and linkage damage; readjust, repair or replace as necessary.
   F. Measure throttle stop frequency; readjust as necessary.
   G. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.
9. **Propane Models**
   A. When ambient temperatures are less than 40°F vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
   B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
   C. Verify steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is running; repair wiring as necessary.
   D. Verify clear vent hose.
   E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
   F. Measure throttle stop frequency; readjust as necessary.
   G. Check genset fuel lines for damage: replace fuel line as required.
   H. Measure regulator lock off pressure.
   I. Verify priming solenoid operation, if so equipped.
10. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
11. If the genset will not stay running measure genset frequency, quadrature winding and main winding voltages using Break-Out Tool 420–0603 and Instruction Sheet R1098.
12. Remove connector P1 from control and re-install and try to start genset: inspect, repair or replace P1 connector pins as necessary.
13. Measure field, quadrature and main winding resistance: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
14. Measure field, quadrature and main winding resistance to ground: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
15. Measure field, quadrature and main winding resistance to each other: clean slip rings, replace brushes, repair harness and replace rotor or stator as necessary.
16. Check brush alignment per PSB-682a.
17. Measure temperature of air intake and temperature rise across genset; remove blockage or prevent air recirculation.
18. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

PROCESSOR FAULT – FAULT CODE 42

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: ROM (programming variables) error during self test

Possible Causes: Faulty program

Diagnosis & Solution:

1. Verify that Last Fault is FC 42: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Replace control.

PROCESSOR FAULT – FAULT CODE 43

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: RAM (programming variables) error during self test

Possible Causes: Faulty program

Diagnosis & Solution:

1. Verify that Last Fault is FC 43: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Replace control.

SPEED SENSE FAULT – FAULT CODE 45

⚠WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: While running quadrature frequency dropped to 0Hz for 1 continuous second

Possible Causes: Auto Gen Start (AGS), fuel supply, air fuel mixture, exhaust system, loads, Inverter/Charger, choke, demand regulator, carburetor, generator drive system, generator windings, ignition, wire connections

Diagnosis & Repair:

1. Verify that Last Fault is FC 45: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Verify whether AGS stopped genset: Yes, disable AGS or explain AGS function to customer (see PSB-666); No, continue diagnosis.
3. Verify engine rotation manually: repair engine damage as necessary.
4. Disconnect genset control P1 connector, verify P1 pins are fully inserted and inspect pin condition per PSB–676: insert, repair or replace pins as necessary.
5. Reconnect P1 connector and test run genset for fault occurrence: repair or replace pins in connector as necessary.
6. Check air filter cleanliness; replace air filter as necessary.
7. Check for blocked or damaged exhaust system: repair or replace exhaust components as necessary.
8. Measure AC current while running genset with vehicle loads: identify faulty or short cycling loads.
9. Determine battery charge rate (typical default is 80 percent): if adjustable reduce to 30 percent.
10. Measure genset load capability with shop load bank (derate for altitude and temperature as necessary).
11. Verify genset operation and outputs with Break-Out Tool 420–0603 and Instruction Sheet R1098.
12. Measure genset frequency and droop while running.
13. Measure AC frequency while changing engine rpm to determine if frequency response matches engine rpm response: repair damaged generator drive system as necessary.
14. **Gasoline Models**
    A. Vapor lock may occur in high ambient temperatures: operate in ambients at less than 120°F; verify proper installation to prevent air recirculation; correct as necessary.
    B. Measure steady DC voltage at fuel pump while genset is cranking: repair wiring as necessary.
    C. Try to start genset on shop fuel supply: verify tank level and fuel line condition in vehicle.
    D. Verify carburetor altitude setting: readjust as necessary.
    E. Verify choke operation, setting and linkage damage: readjust, repair or replace as necessary.
    F. Measure fuel pump pressure/flow: replace fuel filter or pump as necessary.
    G. Inspect carburetor butterfly for binding: replace carburetor as necessary.

15. **Propane Models**
    A. When ambient temperatures are less than 40°F vapor-withdrawal Propane tanks should be at least half full to provide proper vaporization rate.
    B. Propane having more than 2.5 percent Butane will not vaporize in ambients at less than 32°F; use HD–5 grade Propane.
    C. Measure steady DC voltage at fuel solenoid and priming solenoid (if so equipped) while genset is running; repair wiring as necessary.
    D. Verify clear vent hose.
    E. Run genset on shop fuel supply; verify tank level and fuel line condition in vehicle.
    F. Check genset fuel lines for damage: replace fuel line as required.
    G. Measure regulator lock off pressure.
    H. Verify priming solenoid operation, if so equipped.
16. Check governor, actuator, linkage and spring for debris, damage and looseness: readjust and repair as necessary.
17. Verify that spark plug cable is secure on spark plug: reconnect or replace as necessary.
18. Test magneto
    A. Disconnect Connector P1.
    B. Connect positive(+) meter lead to chassis ground.
    C. Measure continuity to negative lead at pin P1–15: replace magneto as necessary.
19. Inspect ignition kill lead in harness and at connector P1: repair or replace lead, terminal or pins as necessary.
20. Measure spark plug gap: set gap or replace spark plug as necessary.
21. Verify ignition spark condition.
22. Inspect spark plug lead, kill lead terminal at magneto and measure magneto air gap: replace terminals, set gap or replace magneto as necessary.
23. Measure temperature of air intake and temperature rise across genset; remove blockage or prevent air recirculation.
24. Dealers contact Distributor for technical support, Distributors contact factory for technical support.

FIELD SENSE FAULT – FAULT CODE 48

WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Controller unable to sense field voltage

Possible Causes: Faulty control

Diagnosis & Solution:

1. Verify that Last Fault is FC 48: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Replace control.

PROCESSOR FAILURE – FAULT CODE 51

WARNING ***Some genset service procedures present hazards that can result in severe personal injury or death. Only trained and experienced persons with knowledge of fuels, electricity, and machinery hazards should perform genset service. See Safety Precautions.***

Logic: Processor error

Possible Causes: Faulty control

Diagnosis & Solution:

1. Verify that Last Fault is FC 51: Yes, continue diagnosis; No, troubleshoot actual last fault.
2. Replace control.

11. Service Checklist

⚠WARNING ***EXHAUST GAS IS DEADLY!***

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

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

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

Never sleep in the vehicle with the genset running unless the vehicle is equipped with a working carbon monoxide detector. Primary protection against inhaling carbon monoxide, however, is proper installation of the exhaust system, daily (every eight hour) inspection for visible and audible exhaust system leaks.

GENERAL

After the genset has been serviced and reinstalled, inspect the installation and test the genset to confirm that the genset will operate properly and produce rated power. Check each of the following areas before putting the genset into service.

MOUNTING

Examine all mounting bolts and supporting members to verify that the genset is properly mounted. Tighten all fasteners securely.

LUBRICATION

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

WIRING

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

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

INITIAL START ADJUSTMENTS

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

Start the genset, then immediately adjust the governor speed for a safe no-load operating speed. With no load applied, listen for unusual sounds or vibrations. Warm up the genset for at least 15 minutes at 50% to 75% of rated load and check that the choke is completely open. Adjust the governor if necessary (see *Primary Engine Systems*, Section 8).

EXHAUST SYSTEM

With the genset operating, inspect the entire exhaust system. Make certain that the exhaust tail pipe terminates beyond the perimeter of the vehicle and not near vents or openable windows or doors. Look and listen for leaks at all connections, welds, gaskets, and joints. Also make sure that exhaust pipes do not heat surrounding areas excessively. If leaks are detected, correct immediately. Test the on-board CO alarm(s). See the Installation Manual

for important considerations concerning the installation of an exhaust system.

FUEL SYSTEM

With the genset operating, inspect the fuel supply line and fittings for leaks. Check flexible section for cuts, cracks and abrasions and make sure it is not rubbing against anything that could cause damage.

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

OUTPUT CHECK

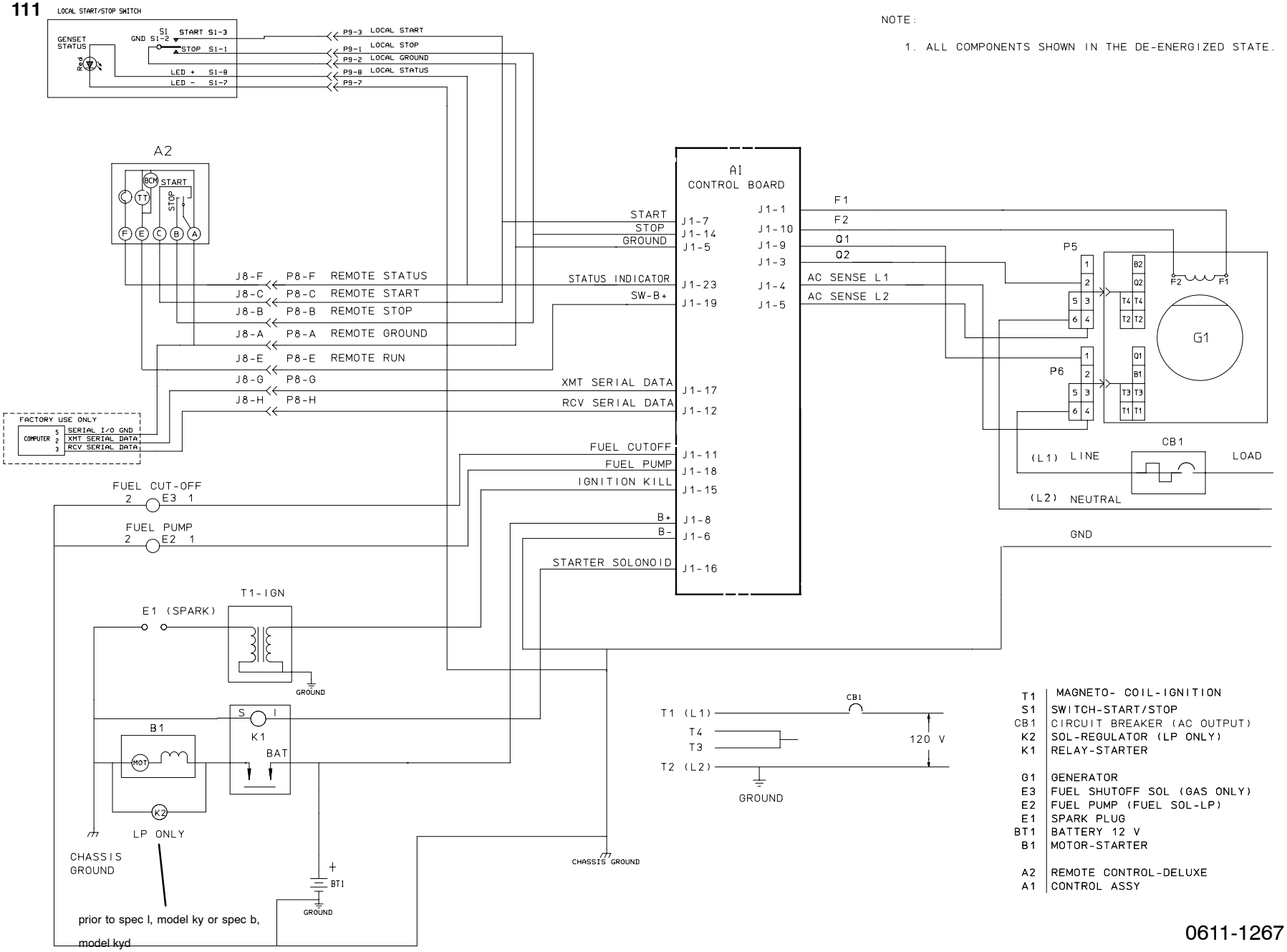
Apply a full load to make sure the genset can produce its full rated output. Use a load test panel to apply a progressively greater load until full load is reached.

CONTROL

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

MECHANICAL

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



NOTE:

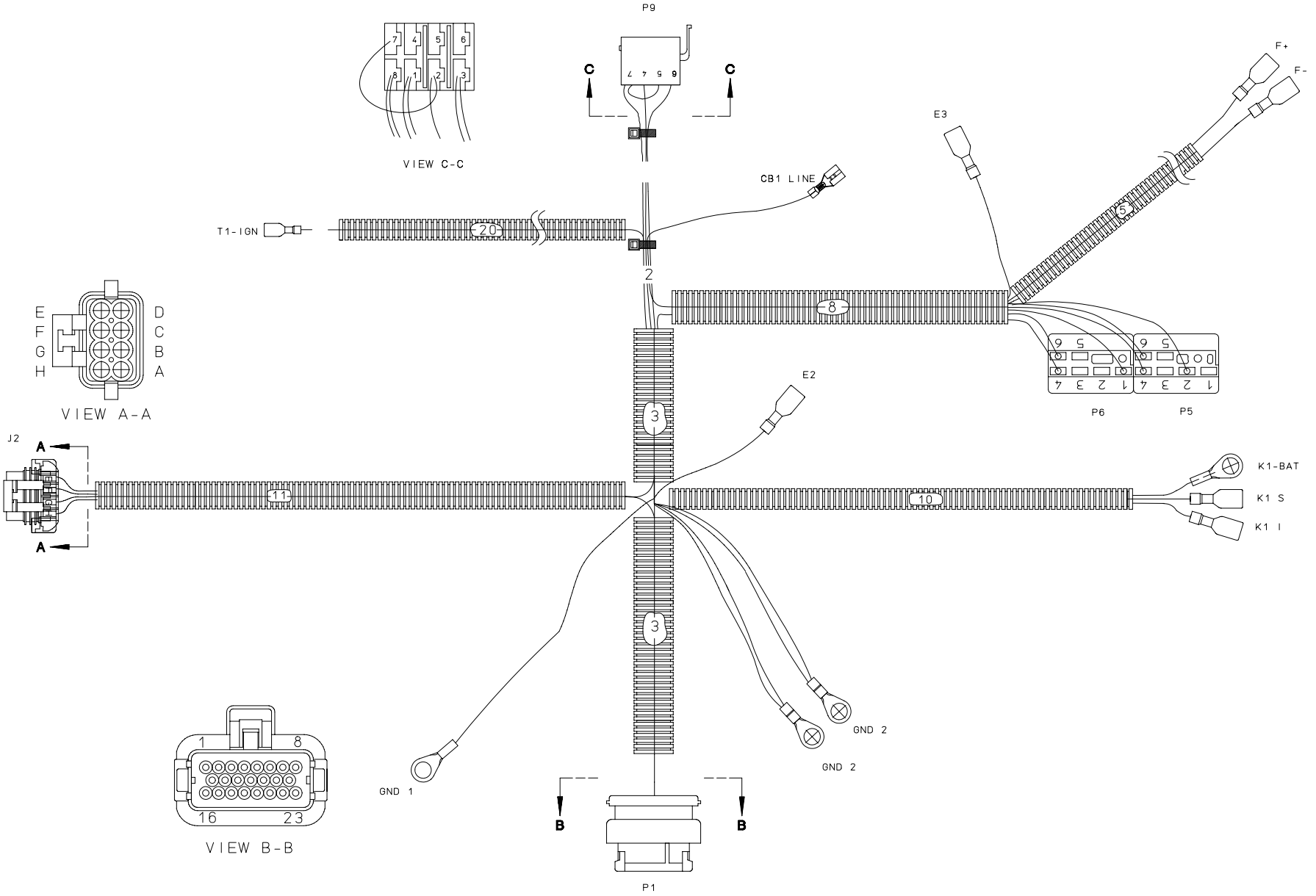
1. ALL COMPONENTS SHOWN IN THE DE-ENERGIZED STATE.

T1	MAGNETO- COIL-IGNITION
S1	SWITCH-START/STOP
CB1	CIRCUIT BREAKER (AC OUTPUT)
K2	SOL-REGULATOR (LP ONLY)
K1	RELAY-STARTER
G1	GENERATOR
E3	FUEL SHUTOFF SOL (GAS ONLY)
E2	FUEL PUMP (FUEL SOL-LP)
E1	SPARK PLUG
BT1	BATTERY 12 V
B1	MOTOR-STARTER
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY

0611-1267

WIRING DIAGRAM—60 HERTZ, 120V

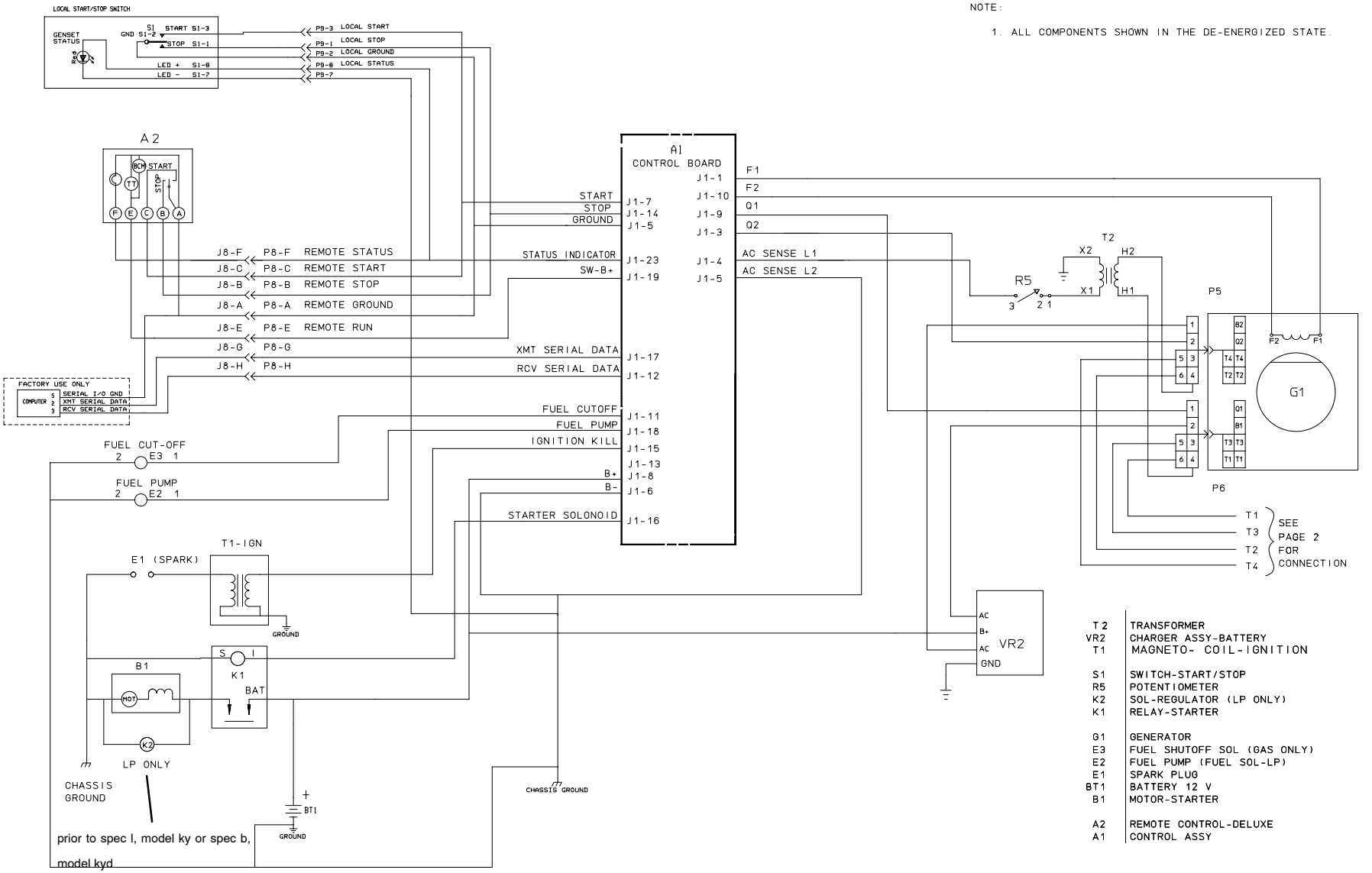
A-1



0338–3812

ENGINE WIRING HARNESS—60 HERTZ, 120V

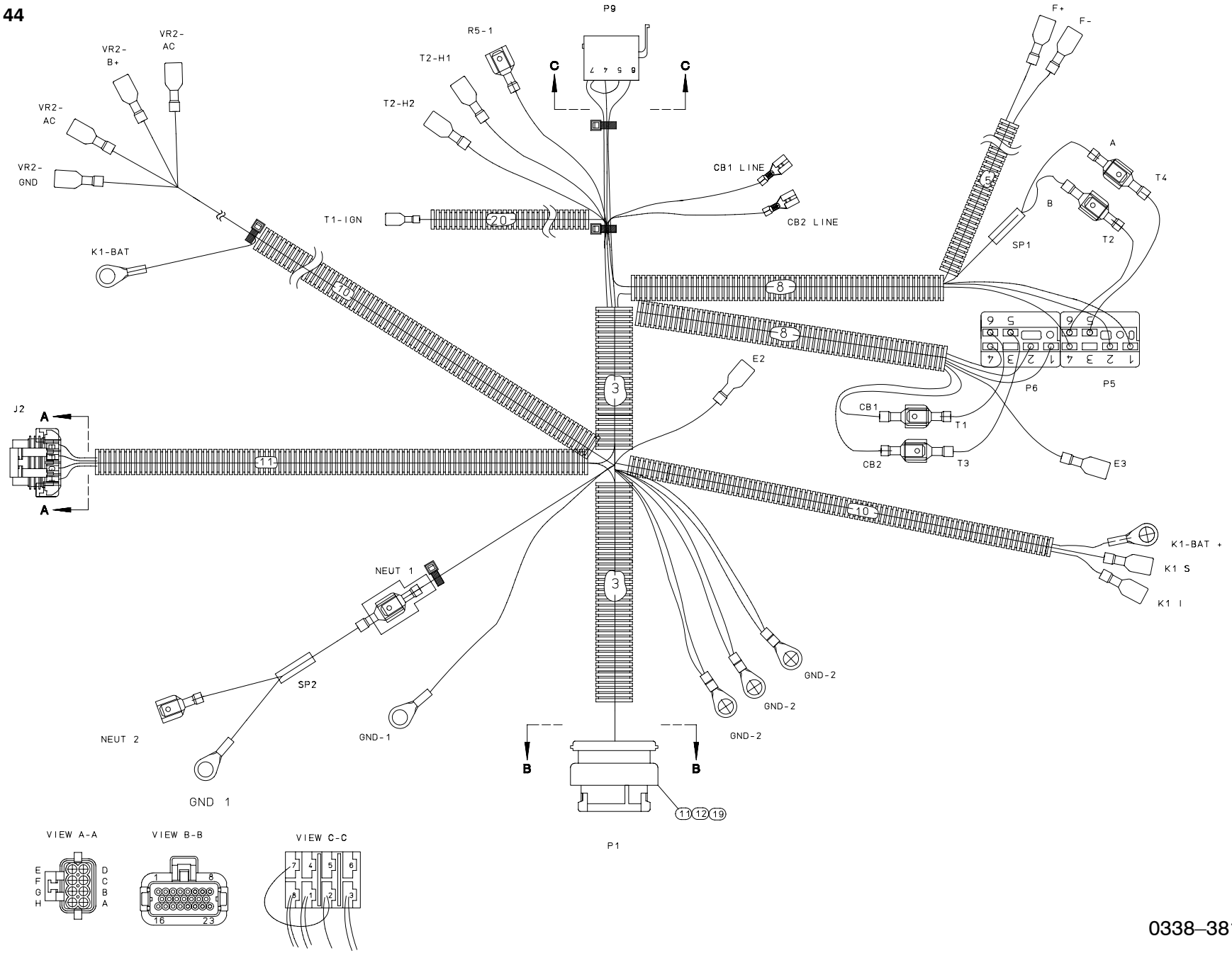
A-2



A-3

0611-1268-1

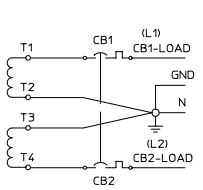
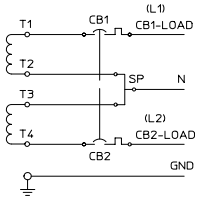
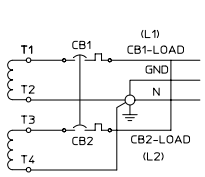
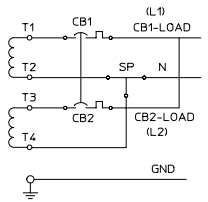
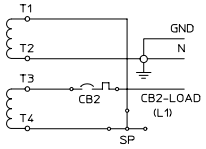
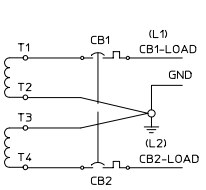
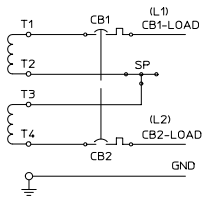
WIRING DIAGRAM—50 HERTZ AND 60 HERTZ, 100V



0338–3813

ENGINE WIRING HARDNESS—50 HERTZ AND 60 HERTZ, 100V

A-4

FROM:	TO:						
	3 WIRE 100/200, 110/220 OR 120/240V		2 WIRE 100, 110 OR 120V		2 WIRE 200, 220 OR 240V		
	NEUTRAL GROUNDED	NEUTRAL ISOLATED	NEUTRAL GROUNDED	NEUTRAL ISOLATED	LINE TO GND=200 OR 220V NEUTRAL GROUNDED	LINE TO GND=100 OR 110V NEUTRAL GROUNDED	NEUTRAL ISOLATED
T1-LINE T2-LINE T3-LINE T4-LINE	CB1-LINE GROUND GROUND CB2-LINE	CB1-LINE SPLITTER SPLITTER CB2-LINE	CB1-LINE GROUND CB2-LINE GROUND	CB1-LINE SPLITTER CB2-LINE SPLITTER	SPLITTER GROUND CB1-LINE SPLITTER	CB1-LINE GROUND GROUND CB2-LINE	CB1-LINE SPLITTER SPLITTER CB2-LINE
CB1-LOAD (L1) NEUTRAL(N) CB2-LOAD (L2) GROUND (GND)	CB1-LOAD GROUND CB2-LOAD GROUND	CB1-LOAD SPLITTER CB2-LOAD GROUND	CB1-LOAD GROUND CB2-LOAD GROUND	CB1-LOAD SPLITTER CB2-LOAD GROUND	CB1-LOAD GROUND OPEN GROUND	CB1-LOAD OPEN CB2-LOAD GROUND	CB1-LOAD OPEN CB2-LOAD GROUND
SPECIAL INSTRUCTIONS	SPLITTER NOT USED		CONNECT L1-L2 AT JUNCTION BOX SPLITTER NOT USED	CONNECT L1-L2 AT JUNCTION BOX		SPLITTER NOT USED	
100 120V 200 240V	L1-N, L2-N L1-L2	L1-N, L2-N L1-L2	(L1,L2)-N N/A	(L1,L2)-N N/A	N/A L1-N	N/A L1-L2	N/A L1-L2
RECONNECTION DIAGRAMS							

A-5

0611-1268-2

RECONNECTION DIAGRAMS

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