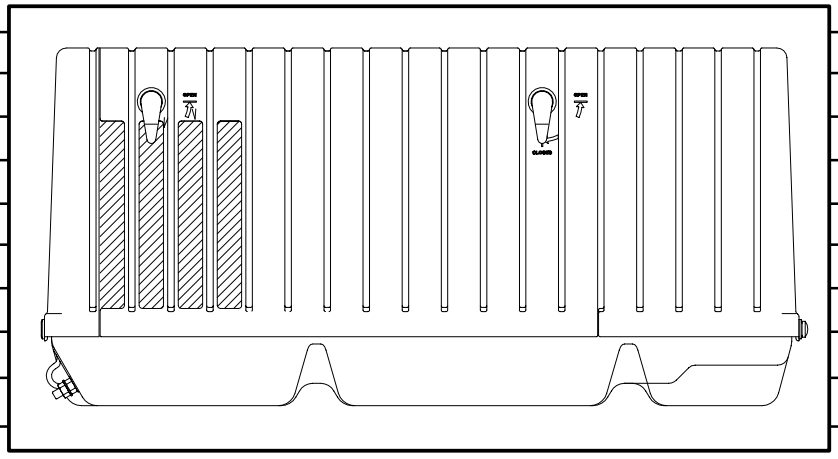
Onan

PONTOON GENSET

Service Manual

MKY



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981-0529

WARNING:

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

Table of Contents

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

GENERATOR VOLTAGE IS DEADLY!

- Generator output connections must be made by a qualified electrician in accordance with applicable codes.
- The genset must not be connected to the public utility or any other source of electrical power. Connection could lead to electrocution of utility workers 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 and stand on a dry wooden platform.

ENGINE EXHAUST IS DEADLY!

- Learn the symptoms of carbon monoxide poisoning in this manual and never sleep in the boat while the genset is running unless the boat is equipped with a working carbon monoxide detector.
- The exhaust system must be installed in accordance with the genset Installation Manual. Engine cooling air must not be used for heating a cabin or other compartment.
- Inspect for exhaust leaks at every startup and after every eight hours of running.
- Make sure there is ample fresh air when operating the genset in a confined area.
- See *The Hazards of Carbon Monoxide*.

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 all other sources of ignition well away.
- Fuel lines must be secured, free of leaks and separated or shielded from electrical wiring.

BATTERY GAS IS EXPLOSIVE

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

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

The Hazards of Carbon Monoxide

Most people know not to run a car in the garage. Many people know about the threat of carbon monoxide poisoning in the house. But few people are aware that this invisible killer is even more dangerous aboard a boat.

Engine-driven generators can produce harmful levels of carbon monoxide that can injure or kill you. The nature of boating is such that you can be harmed by this poisonous gas despite good generator set maintenance and proper ventilation.

WHAT IS CARBON MONOXIDE POISONING?

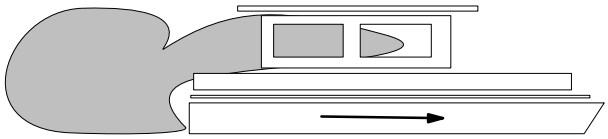
Carbon Monoxide (CO) is an odorless and colorless gas. You cannot see it or smell it. Red blood cells, however, have a greater affinity for CO than for Oxygen. Therefore, exposure even to low levels of CO for a prolonged period can lead to asphyxiation (lack of oxygen) resulting in death. Mild effects of CO poisoning include eye irritation, dizziness, headaches, fatigue and the inability to think clearly. More extreme symptoms include vomiting, seizures and collapse.

WHAT ARE THE SPECIAL RISKS OF CO ON PONTOON BOATS?

Depending on air temperature and wind, CO can accumulate between the pontoons, under an overhanging deck or rear swimming platform and in and around the boat. A swimmer can be exposed to lethal levels of CO when the genset is running. Passengers on deck and in the living quarters can also be exposed, especially when the boat is docked, beached or tied to a neighboring boat.

The risk of exposure to CO can be multiplied greatly by the “station wagon” effect, obstructions that block exhaust dissipation, and infiltration from neighboring boats. To protect against all three situations, Onan recommends that reliable CO detectors be installed on your boat.

- ***The Station Wagon Effect -*** A boat pushes aside the air through which it is moving, causing a zone of low pressure in the back of the boat and cabins into which exhaust gases can be drawn (see figure). A breeze across an anchored boat can have the same effect. Opening doors and windows so that air can flow through the boat can reduce the effect.



- ***Obstructions -*** Anchoring near a large object such as a boat house or sea wall or in a confined space such as a canyon can cause exhaust gases to accumulate in and around the boat despite good generator set maintenance and proper ventilation. Don’t run the generator set when anchored in such places.

- ***Exhaust from Neighboring Boats -*** When boats are anchored in close quarters exhaust from neighboring boats can accumulate in and around yours.

ONLY YOU CAN PROTECT YOURSELF FROM CO POISONING!

- Watch constantly for swimmers when the generator set is running.
- Make sure exhaust cannot get under the deck, between pontoons or enter the living quarters through a window, vent or door.
- Make sure all CO detectors are working.
- Pay attention to the signs of CO poisoning.
- Check the exhaust system for corrosion, obstruction and leaks each time you start the generator set and every eight hours if you run it continuously.

1. Introduction

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

⚠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.***

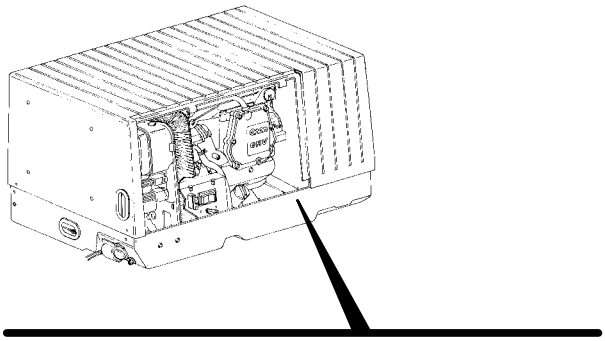
⚠WARNING ***Unauthorized modifications or replacement of fuel, exhaust, air intake or speed control system components that affect engine emissions are prohibited by law in the State of California.***

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

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

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

When contacting Onan for parts, service or product information, be ready to provide the model number and the serial number, both of which appear on the genset nameplate (Figure 1-1).



IMPORTANT ENGINE INFORMATION

Onan®

CUMMINS POWER GENERATION
1400 73rd Ave. NE
Minneapolis, MN 55432

Model No: 4MKYFA/1H — Made in U.S.A.

S/N: A18012345 — PH:

AC Volts: — kVA: — kW:

Amps: — Pf: — RPM:

Fuel: — Hz: — Bat:

Options: — Wiring Diagram:

Insulation - NEMA Class F — Ambient 40°C

THIS ENGINE MEETS U.S. EPA PH1 AND 1995-1999 CALIFORNIA EMISSION REGULATIONS FOR ULGE ENGINES

SN5304U1G2RA — 304 cc

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

99-2495 URC

(SERIAL NUMBER BAR CODE)

99-2495-05

(MODEL NUMBER BAR CODE)

99-2495-06

Model:

S/N:

1-800-888-ONAN

99-2495

FIGURE 1-1. TYPICAL NAMEPLATE

2. Specifications

	4MKY	3.6MKY
GENERATOR: 2-Pole Revolving Field, Self-Excited, Electronically Regulated, 1-Phase		
Power	4000 watts	3600 watts
Frequency	60 Hertz	50 Hertz
Voltage	120 volts	220 volts
Current	33.3 amperes	16.4 amperes
Speed	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)
ENGINE: 1-Cylinder, 4-Stroke Cycle, Spark-Ignited, OHV, Air Cooled		
Bore	3.11 inch (79 mm)	
Stroke	2.44 inch (62 mm)	
Displacement	18.5 $inch^3$ (304 cc)	
Compression Ratio	8.5 : 1	
Oil Capacity**	1.6 quart (1.5 l)	
Intake Valve Clearance (Cold)	0.002 inch (0.05 mm)	
Exhaust Valve Clearance (Cold)	0.002 inch (0.05 mm)	
Spark Plug Tightening Torque	13 lbs-ft (17 N-m)	
Ignition Timing (magneto ignition)	25° BTDC, non-adjustable	
Spark Plug Gap	0.025 inch (0.64 mm)	0.020 inch (0.51 mm)
DC SYSTEM:		
Control Fuse	5 amperes	
Nominal Battery Voltage	12 volts	
Minimum Battery Cold Cranking Capacity: Above/Below Freezing	360/450 amperes	
Battery Charging Current	-	10 amp, regulated voltage
INSTALLATION:		
Weight of Genset	185 pounds (84 Kg)	
Minimum Compartment Size (H x D x W)*	16.4 inch x 20.6 inch x 30.5 inch (420 mm x 523 mm x 775 mm)	
Minimum Free Air Inlet Area	40 $inch^2$ (258 cm^2)	
Muffler Outlet Collar O. D.	1.13 inch	
Fuel Connection	1/4 inch barb fitting for gasoline hose	

* See *Location and Mounting* and *Outline Drawings* for additional considerations when sizing the genset compartment.

** See *Periodic Maintenance* in the Operator's Manual for oil filling instructions.

3. Dimensions and Clearances

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

DESCRIPTION	FACTORY SPECIFICATION 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.	FACTORY SPECIFICATION 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 Clearancce	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)		
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 Section 10. *Engine Block Assembly)*. 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
Muffler to Engine	8 - 11	11 - 15
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 Section 6. *Troubleshooting* before starting work on the genset. Note that some problems have several possible causes.

SAFETY

There are hazards in servicing gensets. Study *Safety Precautions* 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

Contact the manufacturer of the pontoon boat or the installer if a good way to remove the genset is not obvious. There are four bolt holes for securing the genset to the floor or supporting structure of the pontoon boat.

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

Disconnect the following before removing the genset from the pontoon boat:

1. Battery cables (negative [**-**] cables first).

   ⚠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. Fuel lines. *First close all fuel shutoff valves.*

   ⚠WARNING ***Gasoline is highly flammable and explosive and can cause severe personal injury or death. Do not smoke near fuel tanks or fuel-burning equipment or in areas sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches and all other sources of ignition well away. Keep a type ABC fire extinguisher handy.***

3. Remote control wiring.

4. AC output wiring.

5. Exhaust tail pipe.

6. Troubleshooting

Use this section as a guide for troubleshooting. The tables use conditional schematics to highlight the circuitry that is energized during the sequence of events. See Figure 6-1 to locate components. Refer also to Section 12. *Wiring Diagram*.

Control Troubleshooting: Begins Page 6-2.

Generator Troubleshooting: Begins Page 6-14.

Engine Troubleshooting: Begins Page 6-17.

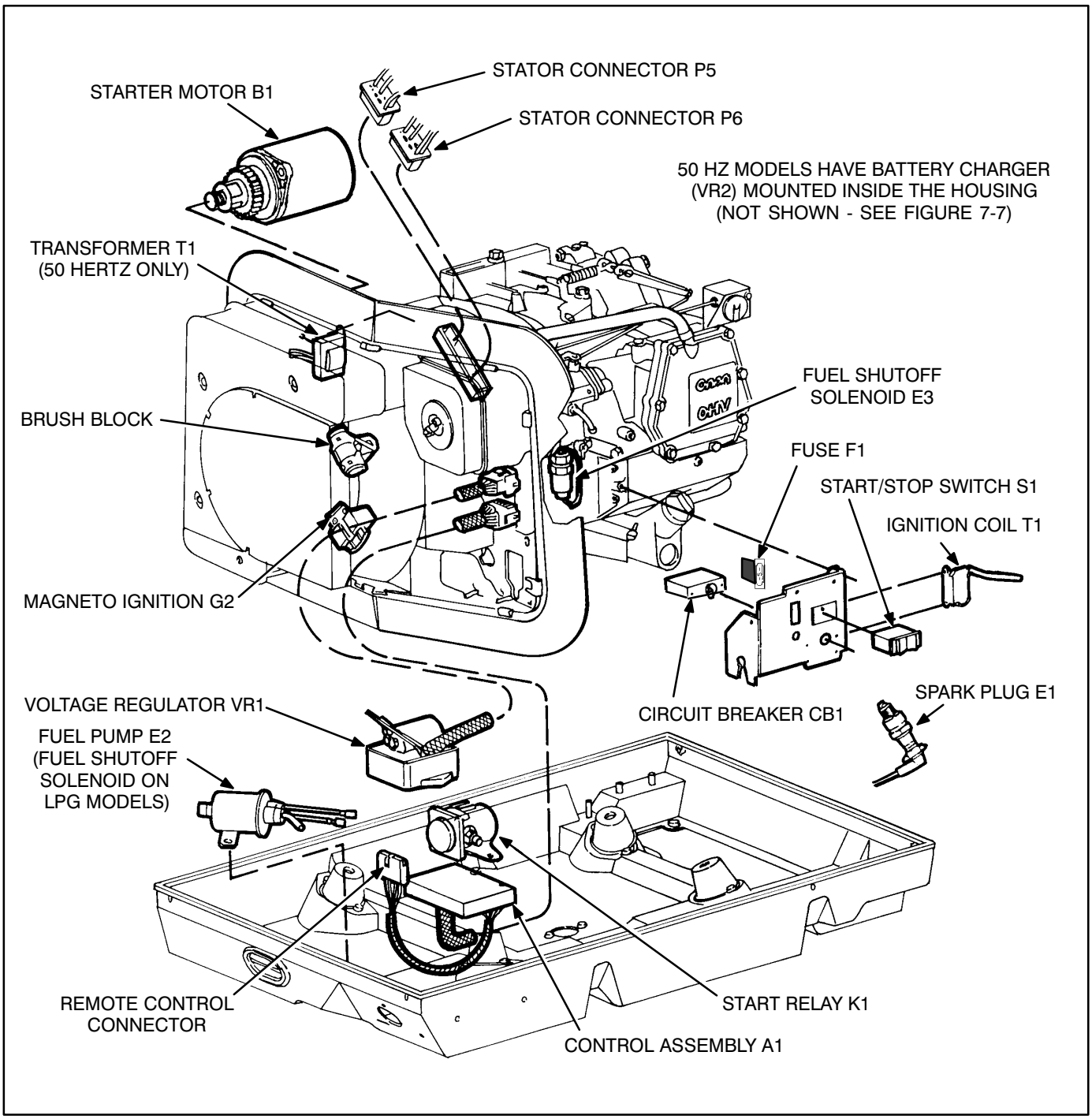


FIGURE 6-1. COMPONENT LOCATIONS

CONTROL TROUBLESHOOTING—CRANKING MODE

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

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

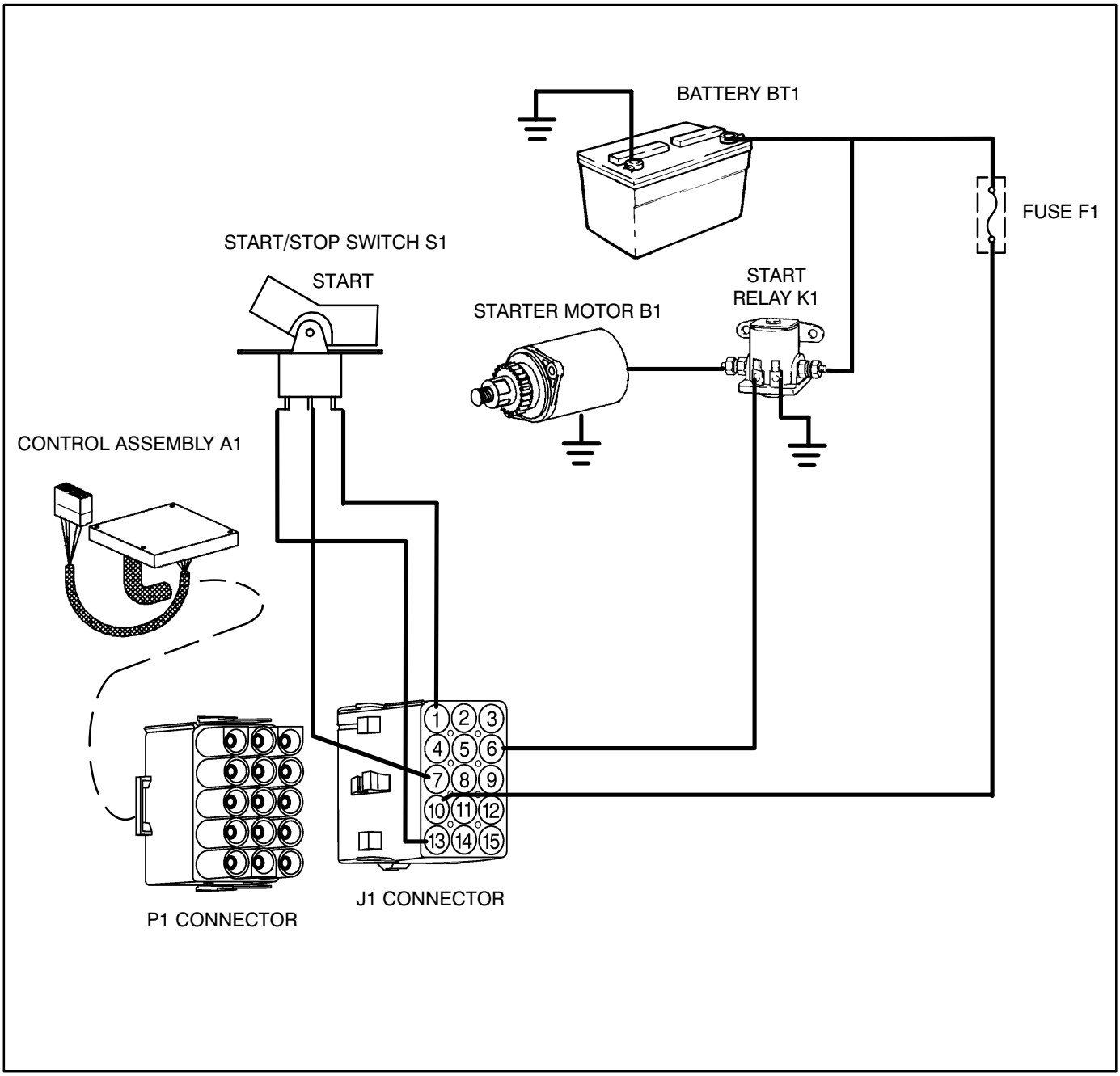


FIGURE 6-2. CONTROL TROUBLESHOOTING—CRANKING MODE

⚠WARNING ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions.***

TABLE 6-1. CONTROL TROUBLESHOOTING—CRANKING MODE

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Does Not Crank	1. Open control fuse F1.	1. Check fuse. If open, locate and correct cause of overload. Replace fuse.	
	2. Insufficient cranking voltage due to: (Also see Table 6-5) a. Battery not charged. b. Battery connections loose or dirty. c. Battery cable size too small.	2a. Check condition of battery and recharge or replace. 2b. Clean and tighten all connections at battery, K1 start solenoid, and starter motor. 2c. Increase starting battery cable size.	
	3. Start solenoid K1 not energized due to: a. Open circuit to start solenoid coil. b. Defective start solenoid coil. c. Defective Start/Stop switch. d. Defective control assembly A1.	3a. Check wiring continuity to start solenoid K1 coil from control assembly A1 and from ground to start solenoid. 3b. Test start solenoid K1. 3c. Test Start/Stop switch S1. 3d. Measure voltage between start solenoid terminal I and ground with switch S1 held in the Start position. If voltage is not present and continuity and battery check OK, control assy A1 is defective.	 7-4 7-3 7-4
	4. Starter B1 not energized due to: a. Open circuit to starter. b. Open circuit between battery (B+) and the start solenoid contact (BAT). c. Defective start solenoid K1. d. Defective starter.	4a. Check continuity between starter lead on start solenoid (S) and gnd. (4 ±1 ohm). 4b. Check wiring continuity between battery (B+) and the start solenoid (BAT). 4c. Measure voltage between starter terminal and ground with switch S1 held in the Start position. If voltage is not present and continuity checks OK, start solenoid K1 is defective. 4d. If voltage is present in step 4c, starter is defective.	 7-4 8-14
	5. If engine cranks from set but not from remote control panel, fault is due to: a. Open circuit between control assy A1 and remote Start/Stop switch. b. Remote Start/Stop switch faulty.	5a. Check wiring continuity between control assembly A1 and remote Start/Stop switch. 5b. Test remote Start/Stop switch.	

CONTROL TROUBLESHOOTING—IGNITION MODE

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

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

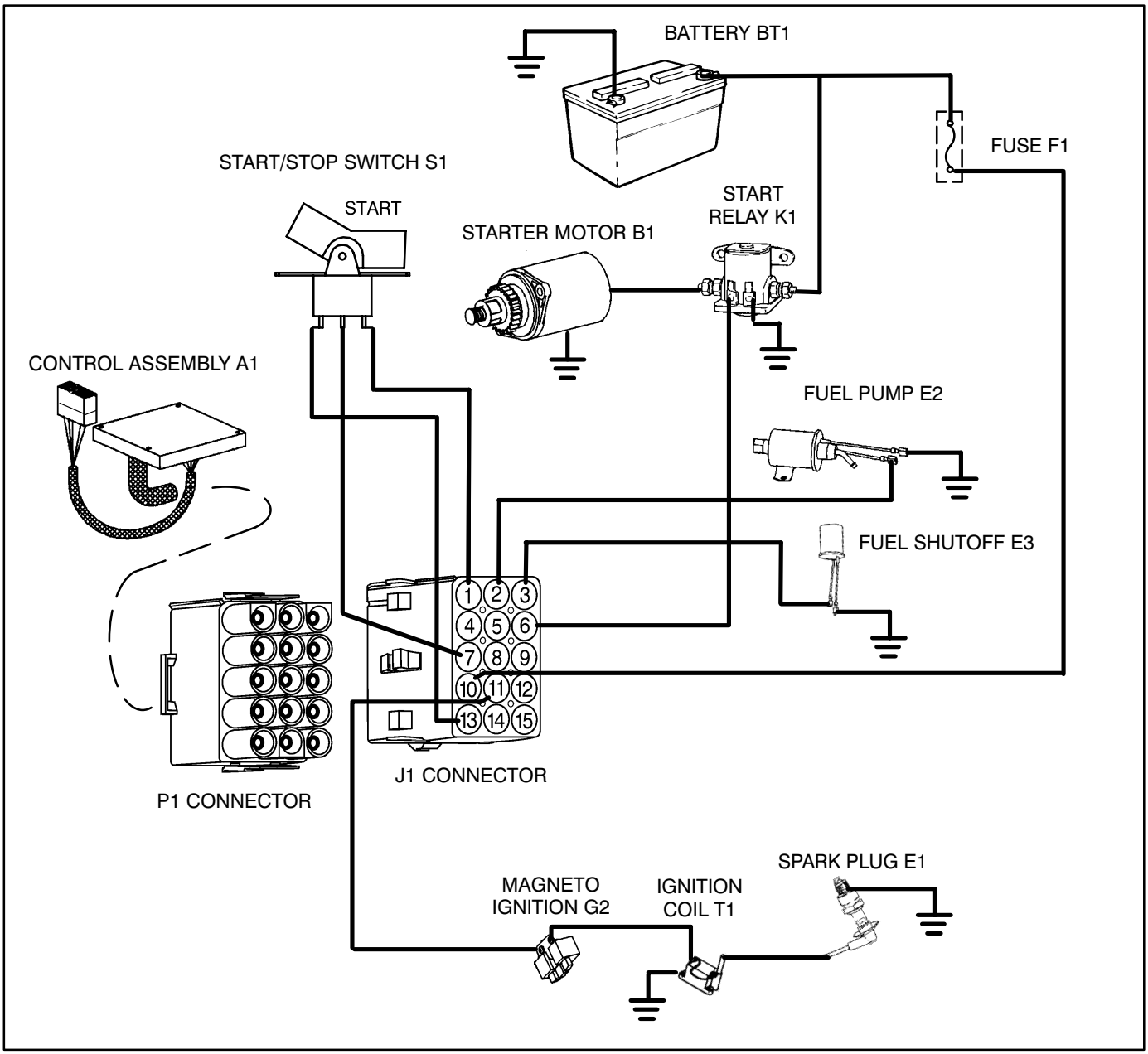


FIGURE 6-3. CONTROL TROUBLESHOOTING—IGNITION MODE

⚠WARNING ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions.***

TABLE 6-2. CONTROL TROUBLESHOOTING—IGNITION MODE

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Cranks But Does Not Start	1. Restricted fuel supply due to: a. Fuel level below pickup tube in tank. b. Fuel line supply valve closed. c. Fuel filter clogged.	1a. Add fuel if tank is low. 1b. Open fuel supply valve (if equipped). 1c. Replace clogged fuel filter and check fuel supply for contamination.	8-12
	2. Faulty ignition due to worn or fouled spark plug, faulty plug wire, faulty ignition coil or magneto.	2. See IGNITION SYSTEM.	8-3
	3. Sticking choke or dirty carburetor	3. See CHOKE ASSEMBLY	8-11
	4. Fuel pump E2 not working due to: a. Fuel pump defective. b. Open circuit between fuel pump and control assembly A1 or control assembly is defective.	4a. Measure voltage between fuel pump connector and ground with the engine cranking. If B+ voltage is not present, proceed to 4b. If voltage is present, (min. 6 VDC) fuel pump is defective. 4b. Check continuity between control assembly and fuel pump. If connections are good and voltage was not measured in 4a, replace control assembly A1.	8-13
	5. Fuel shutoff solenoid E3 not energized.	5. Measure voltage at the shutoff solenoid terminals with the engine cranking. If B+ voltage is not present, check the wiring connections and control assembly A1 output test. If voltage is present (min. 6 VDC) and engine is not receiving fuel, fuel shutoff solenoid is defective.	8-10
	6. Governor linkage stuck or binding.	6. See GOVERNOR.	8-6

CONTROL TROUBLESHOOTING—FIELD FLASH MODE

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

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

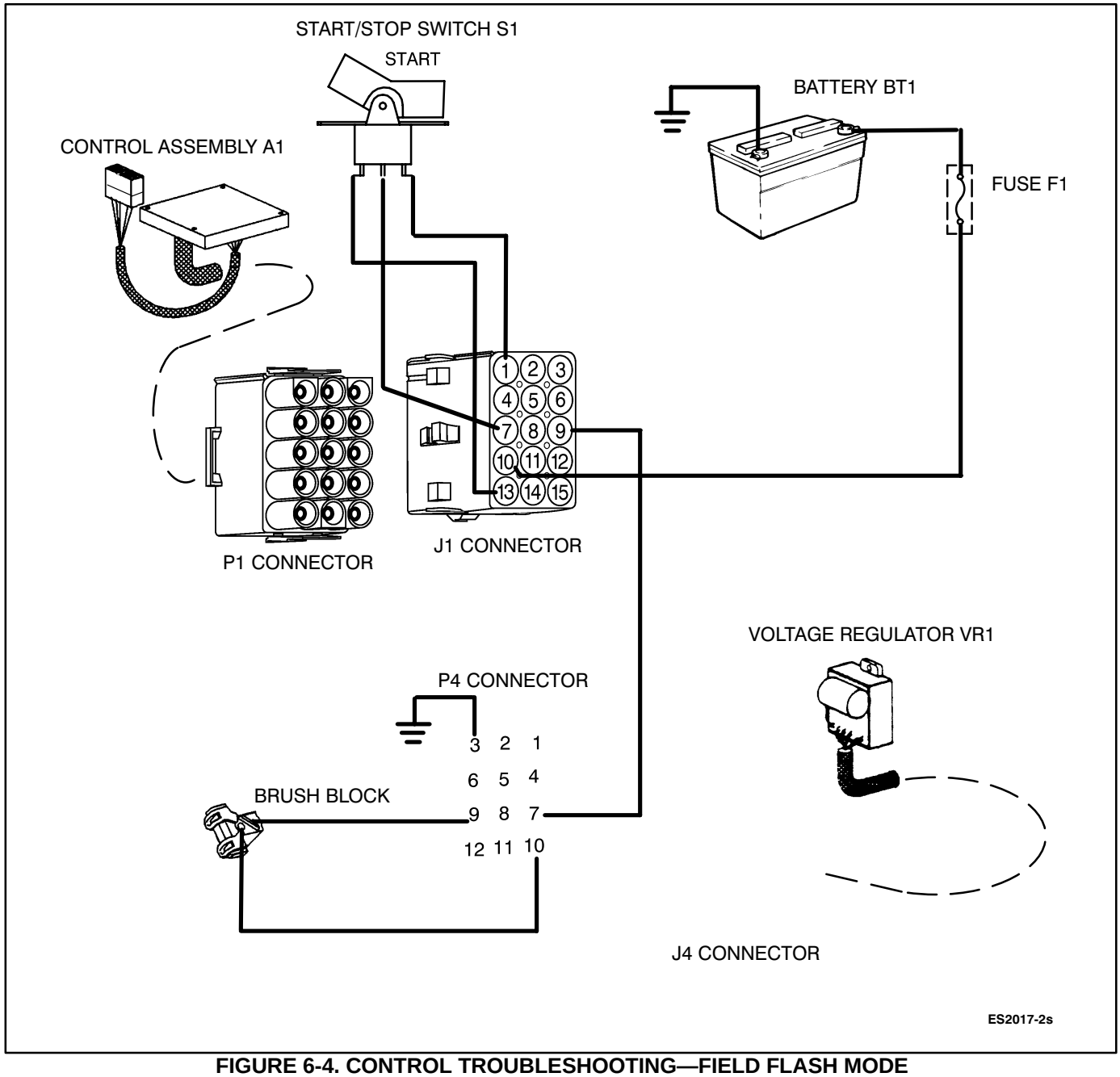


FIGURE 6-4. CONTROL TROUBLESHOOTING—FIELD FLASH MODE

⚠WARNING ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions.***

TABLE 6-3. CONTROL TROUBLESHOOTING—FIELD FLASH MODE

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Starts But Stops When Start Switch Is Released	1. No field flash voltage due to: a. Open circuit in wiring. b. Brushes not making good contact with slip rings. c. Slip ring surface is rough or pitted.	1a. Check wiring continuity to the brush block F1-F2, voltage regulator VR1, control assembly A1 and generator B1-B2 (50 Hz) and Q1-Q2 windings. Check connections of P5 and P6 connectors on the generator housing. 1b. Check brushes for wear and for contact with the slip rings. 1c. Check the slip rings.	9-6 9-10
	2. Defective generator, control assembly A1, or voltage regulator VR1.	2. Perform field voltage test.	9-6

CONTROL TROUBLESHOOTING—RUN MODE

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

- Control assembly A1 opens the circuit to start solenoid K1, which opens the circuit to starter motor B1 to stop cranking. Control assembly A1 also opens the field flash circuit to AVR pin 7.
- 50 Hz models only: Voltage from the battery, used to power control assembly A1 and fuel pump E2, is replaced with output voltage from the generator charge winding B1-B2. (Refer to *Battery Charge Mode* on page 6-10.)
- The control assembly senses output voltage from L1 (X1, 50-Hertz) for the start disconnect function.
- Remote run output is energized through control assembly A1 to power the time meter, battery condition meter and run lamp in the optional remote control.
- Voltage from the generator Q1-Q2 winding provides power to the voltage regulator VR1 to use for supplying field current to the generator.

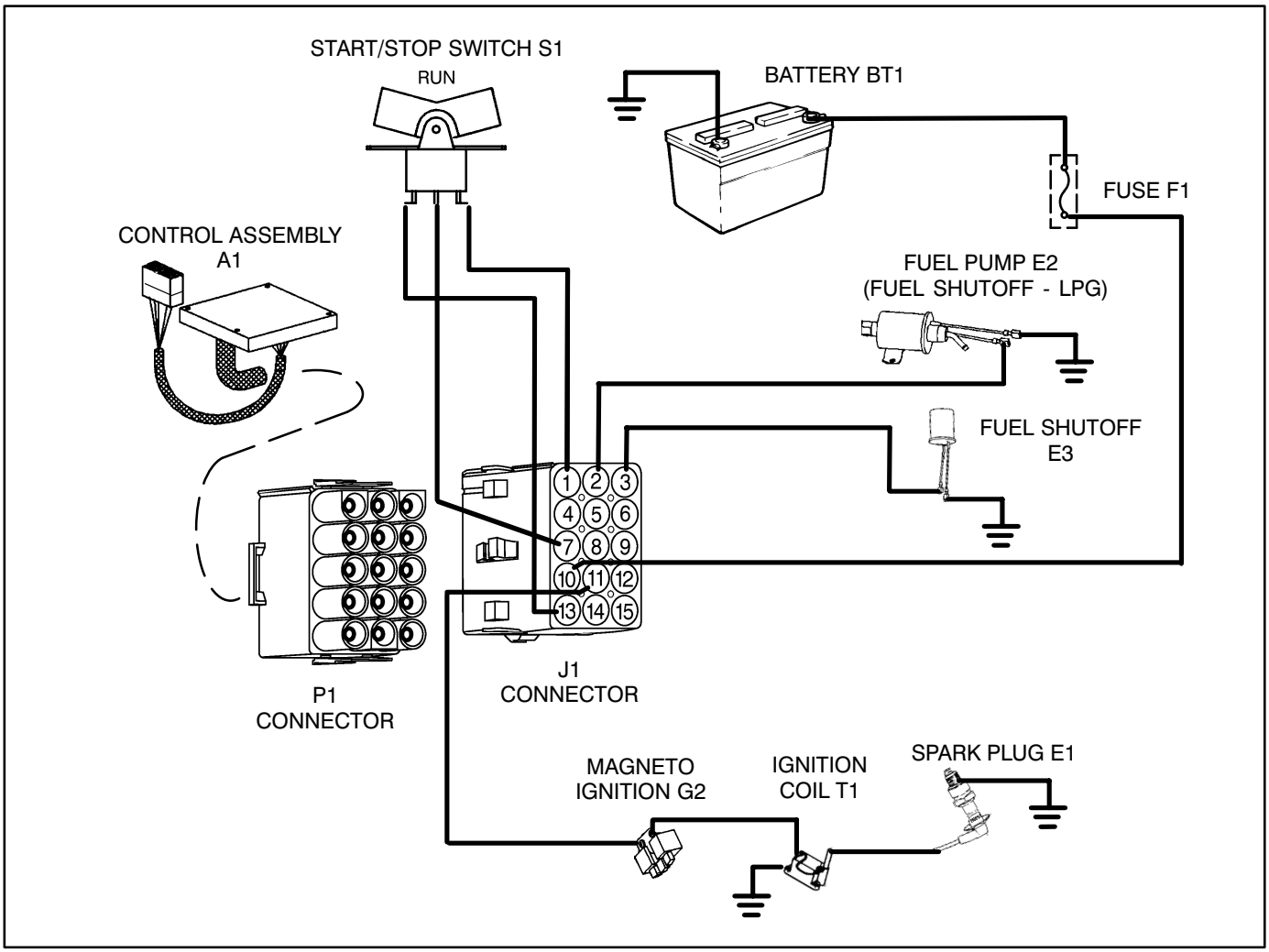


FIGURE 6-5. CONTROL TROUBLESHOOTING—RUN MODE

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TABLE 6-4. CONTROL TROUBLESHOOTING—RUN MODE

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Starts and Runs, Then Stops. Set Restarts Immediately or After Cool Down.	1. Fuel level is below genset fuel pickup tube. 2. Faulty choke operation. 3. Vapor lock from high ambient temperature. 4. Contaminated or incorrect fuel.	1. Check fuel and oil level and refill if low. 2. Refer to choke section for adjustments. 3. Remove any objects or debris that may restrict airflow. Make sure fuel system is installed correctly. 4. Refill tank with fresh fuel.	8-11
Remote Control Run Lamp, Time Meter, or Battery Condition Meter Inoperative	1. Open circuit in remote control wiring. 2. If battery condition meter and run lamp work but time meter does not, time meter is defective. 3. If time meter works but battery condition meter does not operate: a. Defective battery condition meter. b. Defective zener diode inside remote control. 4. Meters and switch function properly but run lamp does not illuminate. Lamp (internal to switch) is burned out. 5. If remote switch functions properly for starting and stopping genset but meters and run lamp do not operate, and step 1 checks OK, control assembly A1 defective. 6. Too much DC load (over 2-amps) connected to the remote output.	1. Check continuity between remote control and control assembly A1. 2. Replace time meter. 3a. Connect a voltmeter between the positive terminal on battery charge meter and ground. Use the following to determine fault: If reading equals battery voltage minus 10 volts, battery condition meter is defective. 3b. If reading does not equal battery voltage minus 10 volts, zener diode is defective. 4. Replace remote Start/Stop switch S2. 5. Check remote running output voltage (approximately 12 VDC) during run condition from control assembly J2-5 to ground and from J2-6 to ground. If voltage is not present, replace control assembly A1. If voltage is present, check continuity of remote control wiring. 6. Turn off the genset, disconnect the remote control, and check for shorts or too many remote accessories.	

CONTROL TROUBLESHOOTING—BATTERY CHARGE MODE (50 HZ ONLY)

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

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

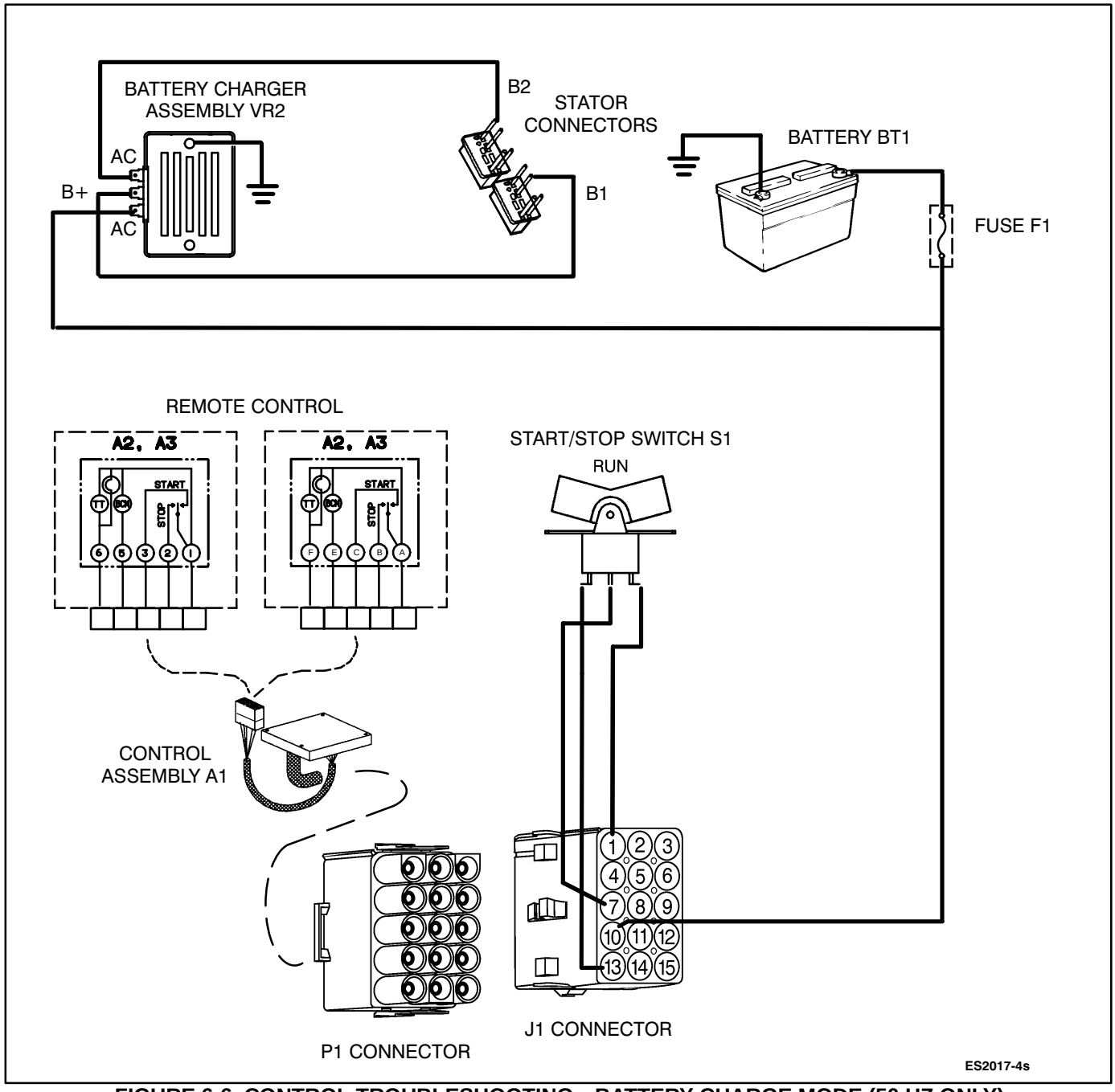

FIGURE 6-6. CONTROL TROUBLESHOOTING—BATTERY CHARGE MODE (50 HZ ONLY)

⚠WARNING ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions.***

TABLE 6-5. CONTROL TROUBLESHOOTING—BATTERY CHARGE MODE (50 HZ ONLY)

Trouble	Possible Cause	Corrective Action	Section/ Page
Low Battery Voltage	1. Weak or discharged battery due to: a. No battery charging. b. Low electrolyte level in battery. c. Long periods of non-use. d. Improperly wired battery. e. Load connected to battery while genset is turned off. f. Too much DC load on genset starting battery.	1a. 60-Hz models require a battery charger. These models do not have a battery charge winding. 1b. Replenish electrolyte and recharge battery. 1c. Connect a separate battery charger to bring battery up to full charge. 1d. Reconnect/check battery connections. 1e. Disconnect load and recharge battery. 1f. Remove other DC loads from genset starting battery.	
	2. 50 Hertz only: Genset charging circuit not functioning due to: a. Open wire connection in charging circuit (see Figure 6-6). b. Battery Charger VR2 defective. c. Generator winding B1-B2 defective.	2a. Check all wiring connections between the generator B1-B2 windings and the Battery B+ connection, including all connections to battery charger VR2. 2b. Refer to battery charger VR2 test. 2c. Refer to generator test section.	 7-5 9-6

CONTROL TROUBLESHOOTING—STOP MODE

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

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

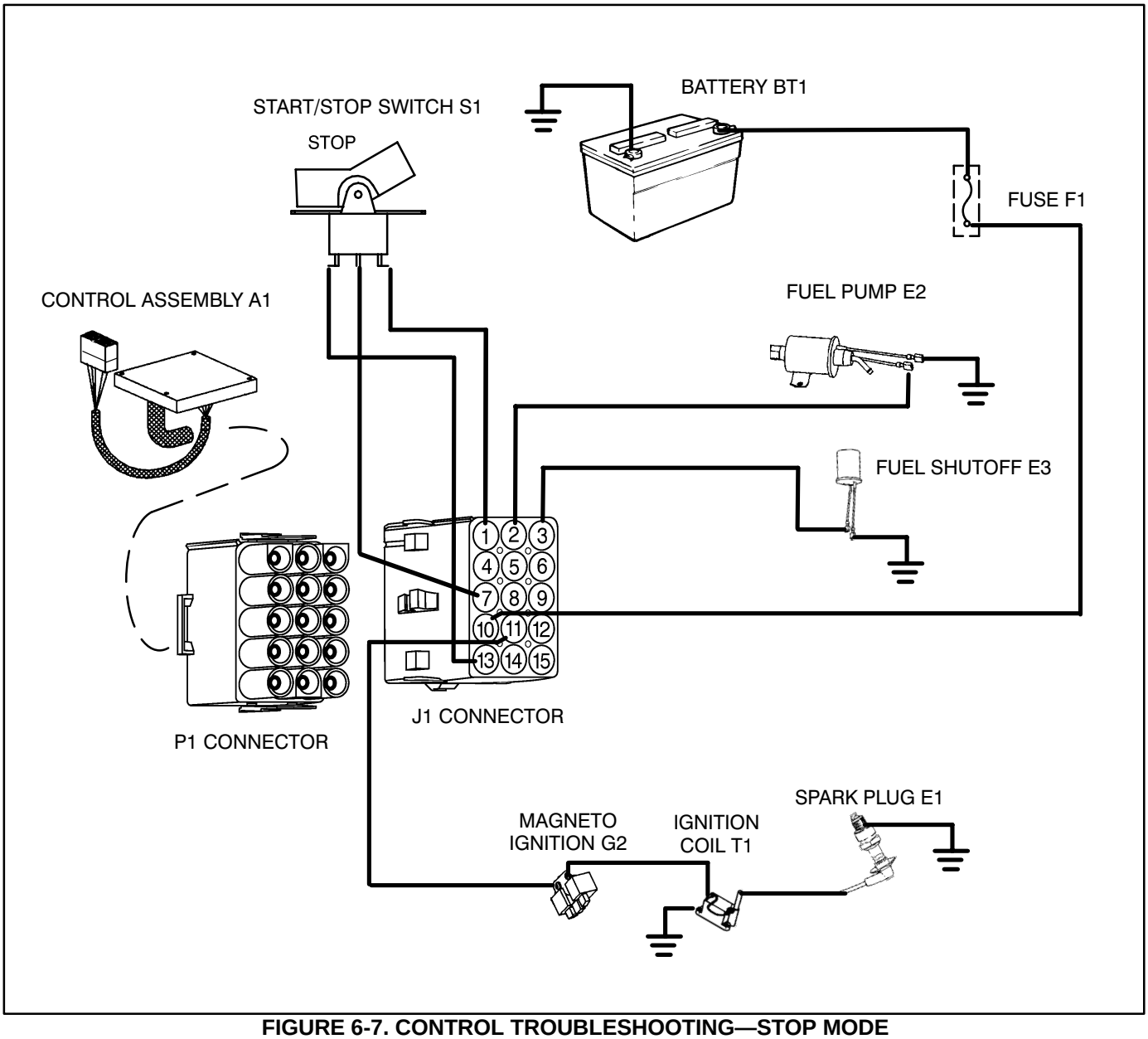

FIGURE 6-7. CONTROL TROUBLESHOOTING—STOP MODE

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TABLE 6-6. CONTROL TROUBLESHOOTING—STOP MODE

Trouble	Possible Cause	Corrective Action	Section/ Page
Genset Does Not Stop When Switch Is Pushed To Stop **Always remove the load a few minutes before stopping the genset to allow cool down.**	1. If set can be stopped from set control but not from remote control panel, fault is due to: a. Open circuit between control assy A1 and remote Start/Stop switch. b. Remote Start/Stop switch faulty. 2. If genset can be stopped from remote control but not from genset, fault due to: a. Open circuit between control assy A1 and Start/Stop switch S1. b. Start/Stop S1 switch faulty. 3.Genset cannot be stopped from remote control or genset panel. Fault due to open circuit between control assy A1 and magneto.	1a. Check wiring continuity between control assembly A1 and remote Start/Stop switch. 1b. Check remote Start/Stop switch. 2a. Check wiring continuity between control assembly A1 and Start/Stop switch S1. 2b. Check Start/Stop switch S1. 3. Check wiring continuity between control assembly A1 and magneto. Check for ground at magneto G2 terminal 1 when Stop Switch is depressed. Replace control assy A1 if terminal 1 not grounded.	7-3

GENERATOR TROUBLESHOOTING

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

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

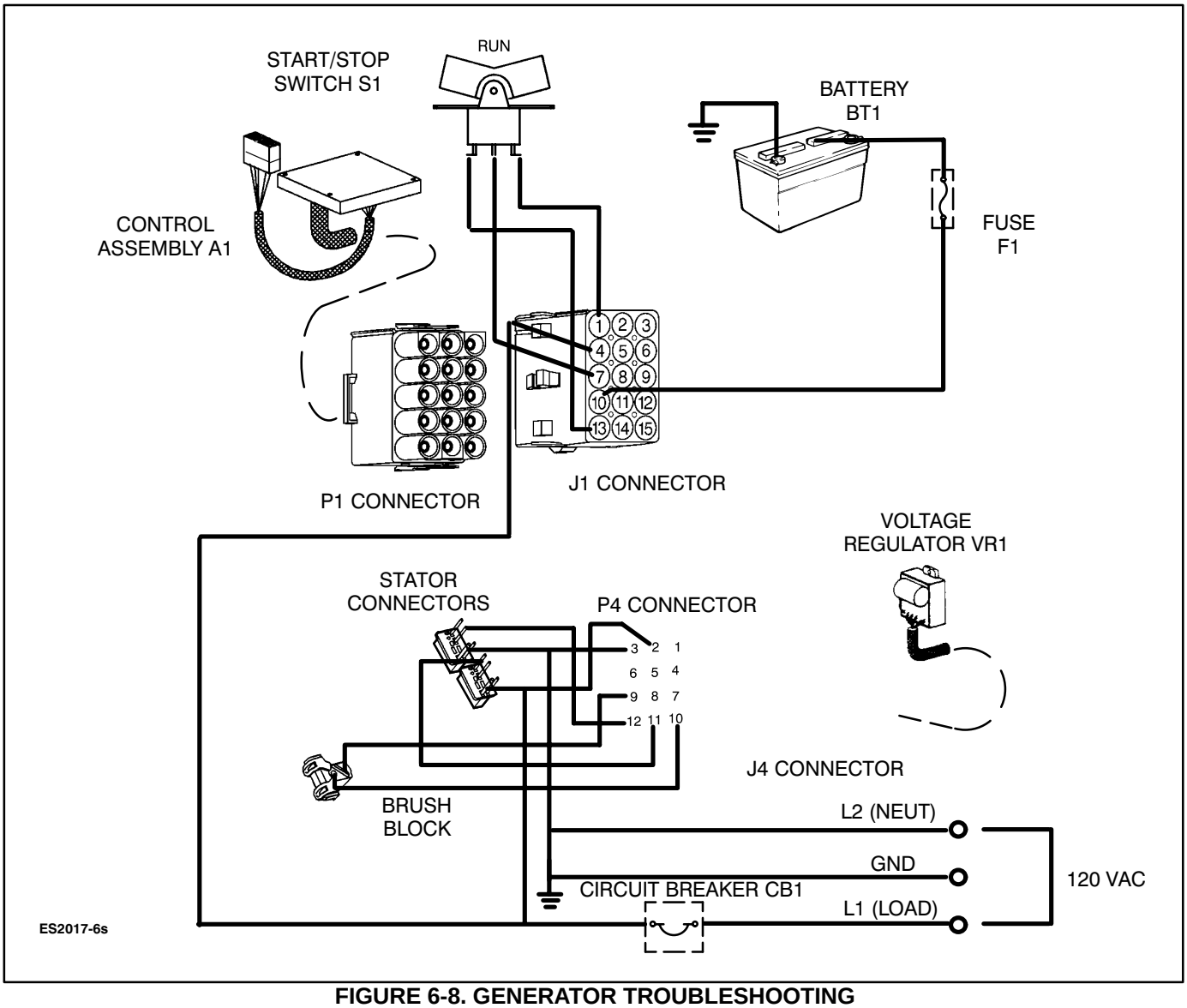

FIGURE 6-8. GENERATOR TROUBLESHOOTING

⚠WARNING ***Many troubleshooting procedures present hazards that can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review Safety Precautions.***

TABLE 6-7. GENERATOR TROUBLESHOOTING

Trouble	Possible Cause	Corrective Action	Section/ Page
No AC Output Voltage Note: This condition may cause the genset to stop when start switch S1 is released.	1. Open circuit breaker. 2. Open circuit between voltage regulator and brush block. 3. Open or shorted rotor. 4. Open circuit between stator connector Q1 or Q2 and voltage regulator. (This condition will give approximately 30 VAC output voltage in start mode.) 5. Open circuit between battery Pos. (+) and voltage regulator pin 7 for field flash. 6. Brushes not making good contact with slip rings. 7. Slip ring surface is rough or pitted. 8. Defective generator, control assembly A1, or voltage regulator VR1.	1. Locate cause of overload and correct as required. Reset breaker. 2. Check for good wiring connections between regulator and brush block. 3. Check rotor. 4. Check for good wiring connections between regulator and stator. 5. Check for continuity between control connector P1-5 and regulator connector J1-9 to P4-7. If connections are good and 12 VDC is not present at voltage regulator pin 7 during start, control assembly A1is defective. 6. Check brushes for wear and for contact. 7. Check slip rings. 8. Perform field voltage test.	 9-7 9-10 9-6
AC Output Voltage Too Low	1. Engine governor out of adjustment. 2. Brushes worn or not making good contact with slip rings. 3. Poor wiring connections to voltage regulator. 4. If generator frequency is within specified limits but voltage is incorrect, voltage regulator is defective. 5. Shorted rotor.	1. See GOVERNOR. 2. Check length of brushes and replace if worn excessively. Check slip rings. 3. Check for good wiring connections between voltage regulator and brush block and between stator connections Q1 and Q2. Correct if required. 4. Replace electronic voltage regulator. 5. Check rotor winding resistance.	8-6 9-10 9-7

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TABLE 6-8. GENERATOR TROUBLESHOOTING

Trouble	Possible Cause	Corrective Action	Section/ Page
AC Output Voltage Too High	1. Engine governor out of adjustment. 2. If generator frequency is within specified limits but voltage is incorrect, electronic voltage regulator is defective. 3. Field flash voltage not turned off at voltage regulator connector P4-7. 4. Open in sense circuit at P4-2 or P4-3.	1. See GOVERNOR. 2. Refer to Table 8-1 for voltage/frequency specs. Replace electronic voltage regulator. 3. If voltage present at P4-7, replace control assembly A1. 4. Check connections. Voltage at P4-2 and P4-3 should be same as L1 and L2.	8-6 8-7
Noisy Generator	1. Loose brush holder. 2. Worn rotor bearing. 3. Rotor and stator rubbing together due to: a. Varnish lumps. b. Rotor misaligned with crankshaft.	1. Tighten brush holder. 2. Replace rotor bearing. 3a. Check for varnish lumps between rotor and stator, remove as required. 3b. Follow specified assembly procedures to correct rotor-crankshaft alignment.	9-11 9-5
Generator Overheats	1. Generator overloaded due to defective circuit breaker. 2. Airflow restricted due to dirt or debris covering stator housing vent openings. 3. Stator windings covered with oil/dirt. 4. Defective rotor or stator windings. 5. Loose or missing service access cover or improper seal around endbell assembly. 6. Improper installation due to: a. Insufficient air inlet size. b. Air inlet location allowing recirculation.	1. Replace circuit breaker. Do not exceed specified load when operating genset. 2. Clear away all dirt or debris as required. 3. Clean stator windings. 4. Test each component for open, grounded, or shorted windings and replace if defective. 5. Check for proper fit of service access cover and check seal around endbell. 6a. Make sure air inlet is not blocked and that it is properly sized (refer to Installation Manual). 6b. Make sure that air outlet is not blocked and check for recirculation of outlet air.	9-6

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TABLE 6-9. ENGINE TROUBLESHOOTING

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Runs Rough	1. Dirty air or fuel filter. 2. Contaminated fuel. 3. Lean fuel mixture due to: a. Incorrectly adjusted/dirty carburetor. b. Vacuum leak. c. Gasket failure. 4. Faulty ignition due to: a. Worn or fouled spark plug. b. Poor magneto or coil connections. c. Faulty ignition components. d. Faulty plug wire. e. Incorrect ignition timing. 5. Poor ignition coil ground. 6. Poor connection between cont assy A1 and engine block.	1. Check and replace if necessary. 2. Drain, clean and refill fuel tank. 3a. See CARBURETOR. 3b. Locate and correct leak. 3c. Replace gasket. 4a. Replace spark plug. 4b. Check magneto and coil connections. 4c. Perform Ignition Spark Check. 4d. Check spark plug wire and boot. 4e. Rotor or fan hub improperly installed. 5. Check connection. 6. Check connection.	 8-10 8-3
Engine Backfires Through Carburetor	1. Lean fuel mixture due to: a. Incorrectly adjusted/dirty carburetor. b. Vacuum leak. 2. Mechanical engine defect (intake valve). 3. Incorrect spark plug gap. 4. Incorrect ignition timing.	 1a. See CARBURETOR. 1b. Locate and correct leak. 2. Perform Leak Down Test. 3. Reset spark plug gap. 4. Check generator rotor to crankshaft and flywheel to rotor alignment.	 8-10 10-1
Engine Backfires Through Muffler When Running	1. Rich fuel mixture due to: a. Incorrectly adjusted carburetor. b. Choke sticking or out of adjustment. 2. Mechanical engine defect (exhaust valve). 3. Incorrect spark plug gap. 4. Incorrect ignition timing.	 1a. See CARBURETOR. 1b. Check choke assembly. 2. Perform Leak Down Test. 3. Reset spark plug gap. 4. Check generator rotor to crankshaft and flywheel to rotor alignment.	 8-10 8-11 10-1
Engine Lacks Power	1. Dirty air filter. 2. Restricted fuel flow due to: a. Plugged fuel filter or b. Faulty fuel pump 3. Exhaust system blocked or restricted. 4.Carburetor air preheater set incorrectly. 5. No load speed set too low. 6. Incorrectly adjusted/dirty carburetor. 7. Incorrect valve lifter clearance or defective valve. 8. Excessive engine wear.	1. Replace air filter. 2a. Replace fuel filter. 2b. Test fuel pump and replace if faulty. 3. Locate and remove blockage, clean spark arrester screen. 4. Check automatic preheater setting. 5. Adjust governor setting. 6. See CARBURETOR. 7. Adjust valve clearance, if problem continues inspect valves. 8. Perform Leak Down Test.	8-8 8-12 8-13 8-8 8-6 8-10 10-6 10-1

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TABLE 6-10. ENGINE TROUBLESHOOTING

Trouble	Possible Cause	Corrective Action	Section/ Page
Engine Overheats	1. Restricted airflow due to dirt, debris or insulation blocking air inlet or outlet.	1. Clear air inlet and outlet areas. Do not store anything in compartment area.	
	2. Dirt or oil on engine cooling fins.	2. Clean all dirt and oil from engine cooling fins.	
	3. Cooling fan plugged or broken.	3. Inspect cooling fan, clean or replace as needed.	
	4. Loose or missing service access cover or improper seal around the endbell assembly.	4. Check for proper fit of service access cover and check seal around endbell.	
	5. Incorrectly adjusted/dirty carburetor.	5. See CARBURETOR.	8-10
	6. Improper installation due to: a. Insufficient air inlet size. b. Air inlet location allowing recirculation.	6a. Make sure air inlet is not blocked and that it is properly sized (refer to Installation Manual). 6b. Make sure that air outlet is not blocked and check for recirculation of outlet air.	
	7. Incorrect ignition timing.	7. Check generator rotor-to-crankshaft and flywheel-to-rotor alignment.	
Black Exhaust Smoke	1. Rich fuel mixture due to: a. Dirty air filter. b. Choke sticking. c. Incorrectly adjusted/dirty carburetor.	1a. Replace air filter. 1b. Clean choke and choke linkage. 1c. See CARBURETOR.	8-8 8-10
White or Blue Exhaust Smoke	1. Oil level too high. 2. Contaminated fuel. 3. Excessive engine wear.	1. Drain excess oil. 2. Drain, clean and refill fuel tank. 3. Perform Leak Down Test.	 10-1
Engine Hunts or Surges	1. Fuel supply problem caused by: a. Faulty fuel pump. b. Contaminated fuel supply. c. Vapor locking. d. Plugged fuel filter.	1a. Check fuel pump and replace if defective. 1b. Drain, clean and refill fuel tank. 1c. Let genset cool down. Check for blockage air inlet or outlet or improper fuel system installation. 1d. Replace fuel filter.	8-13 8-12
	2. Incorrectly adjusted/dirty carburetor.	2. See CARBURETOR.	8-10
	3. Governor problem due to: a. Sticking or binding governor linkage. b. Incorrect governor adjustment. c. Faulty governor spring. d. Governor mechanism worn.	3a. See GOVERNOR. 3b. See GOVERNOR. 3c. Replace governor spring. 3d. See *Governor* in Section 10.	8-6 8-6 10-7

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TABLE 6-11. ENGINE TROUBLESHOOTING

Trouble	Possible Cause	Corrective Action	Section/ Page
High Oil Consumption (Note: New engines can have high oil consumption during break-in)	1. Oil viscosity too light or oil is diluted. 2. Crankcase breather valve is dirty, faulty or improperly installed. 3. Oil leaks. 4. Excessive engine wear. 5. Light loading. 6. Intake valve seal worn or defective.	1. Drain and refill with correct viscosity oil. 2. Clean crankcase breather and replace if defective. 3. Locate and repair leak. 4. See Section 10. 5. Do not run at light load for long periods. 6. Replace intake valve seal.	 8-5 10-6
Engine Shuts Down and Will Not Restart (Table 6-4)	1.Worn spark plug. 2. Faulty fuel system—flooded. 3. Choke not opening. 4.Faulty ignition system.	1. Clean or replace spark plug. 2. See FUEL SYSTEM. 3. Check choke operation. 4. Check for spark.	 8-8 8-11 8-3
Engine Runs On After Shutdown	1. Fouled spark plug. 2. Engine carbon build-up. 3. Fuel solenoid E3 is faulty.	1. Clean or replace spark plug. 2. Remove carbon from engine. 3. Replace fuel solenoid E3 if it does not close when deenergized.	

7. Control

INTRODUCTION

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

CONTROL DESCRIPTION

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

- Panel mounted Start/Stop Switch S1
- Start Solenoid K1
- Control Fuse F1
- Line Circuit Breaker CB1
- Control Assembly A1
- Optional Remote Start/Stop Control A2, A3
- Battery Charger Assembly VR2
- Transformer T1

Start/Stop Switch S1

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

Start Solenoid K1

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

Control Fuse F1

A 5-amp fuse is mounted on the control panel and protects the control circuits against accidental shorts and shorts due to faulty wiring.

Line Circuit Breaker CB1

The line circuit breaker(s) is mounted on the control panel and protects the generator AC output leads against overcurrent.

Control Assembly A1

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

The control provides the following functions:

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

Remote Control Panel (A2, A3)

Various remote control panels for control and monitoring are available for connection to the genset.

Battery Charger VR2—50 Hz Only

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

Transformer T1—50 Hz Only

The transformer provides isolation required for some 50 Hz reconnection applications. (See Figure 6-1 for transformer location.)

CONTROL OPERATION

The schematic diagrams in Section 12. *Wiring Diagrams* can be used to help follow the circuit description.

Start Mode

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

- Energizes start solenoid K1 causing the start solenoid contacts to close energizing the starter. The starter cranks the engine to initiate starting.
- Energizes fuel pump E2 which pumps fuel to the carburetor for engine operation.
- Energizes fuel shutoff solenoid E3 allowing fuel to pass through to the carburetor.
- Flashes the generator field winding for fast generator voltage buildup.
- Enables the ignition circuit by opening a ground path through the control assembly to magneto assembly G2 so output from the magneto will energize ignition coil T1. The ignition coil energizes spark plug E1 for ignition.

Run Mode

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

- Start solenoid K1 is de-energized, opening the circuit to starter motor B1 to stop cranking, at approximately 2500 rpm.
- Fuel Pump E2 and fuel shutoff solenoid E3 remain energized during run.
- Field flash is turned off.
- Ignition Enable remains on. Output from magneto assembly G2 energizes ignition coil T1 to provide spark.
- Remote run output is available for remote running time and battery condition meters.

Battery Charging

A 50 Hz genset has a 10 amp regulated voltage battery charging circuit.

Stopping

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

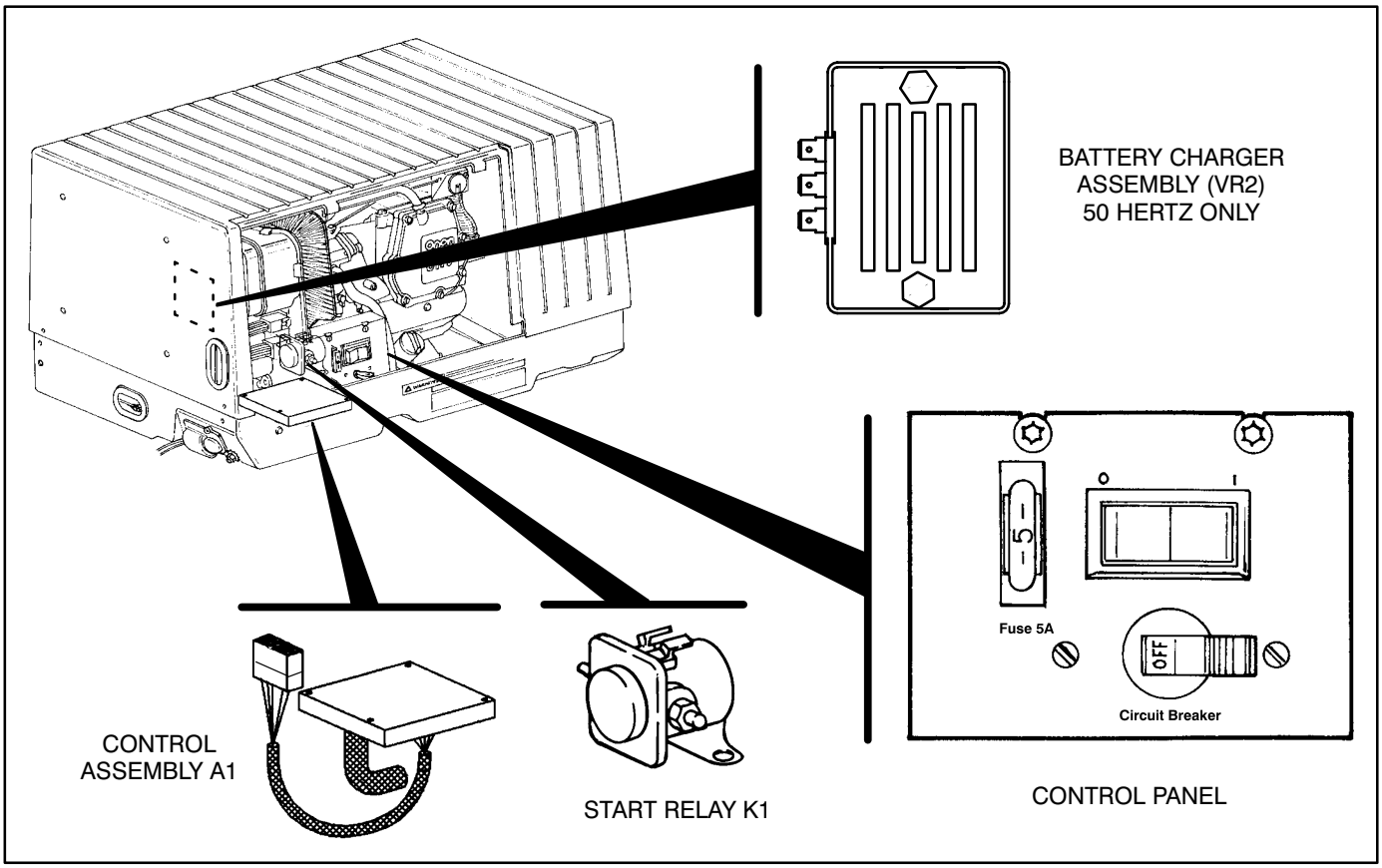


FIGURE 7-1. LOCATIONS

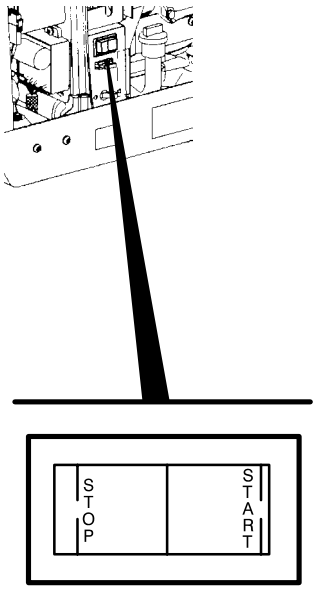
CONTROL COMPONENT TESTS

The following control component checks can be made to verify if components are defective.

Start/Stop Switch S1

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

If the switch tests good, also check the control connector P1 to J1 connections to make sure they are making a good connection. If an abnormal reading is obtained, check the continuity between the connector pins and the switch.



START/STOP SWITCH S1

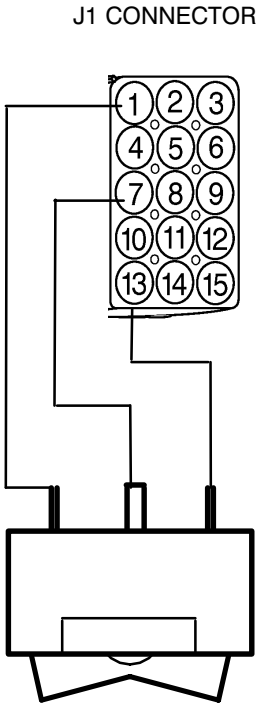


FIGURE 7-2. START/STOP SWITCH

Start Solenoid K1

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

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

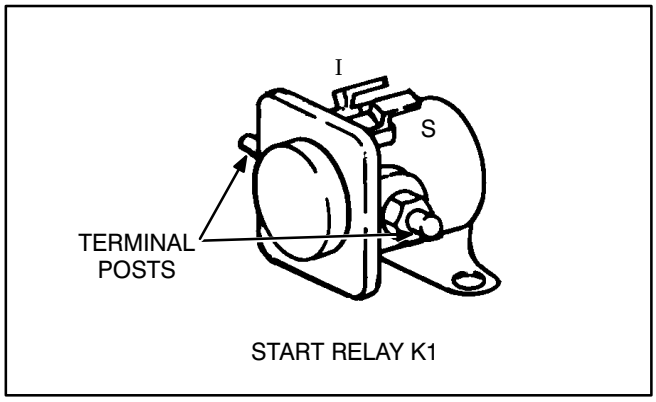


FIGURE 7-3. SOLENOID CHECK

Control Assembly A1

The Control Assembly consists of a printed circuit board with components and relays that are potted (encapsulated in a nonconductive material) to protect them from moisture. It is difficult to isolate individual components on the control assembly for testing. Use Section 6. *Troubleshooting* to identify possible problems in the control circuit. If a problem with the Control Assembly is suspected, use the control circuit board tester if available, or check the control outputs with a voltmeter. Figure 7-4 shows the Control Assembly and the P1/J1 connectors. Voltages can be checked using a voltmeter with long test prods.

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

Table 7-1 lists the control outputs at the P1/J1 connector plug for each control mode. Measure control output voltages between the connector pin listed and ground.

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

TABLE 7-1. CONTROL OUTPUTS

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

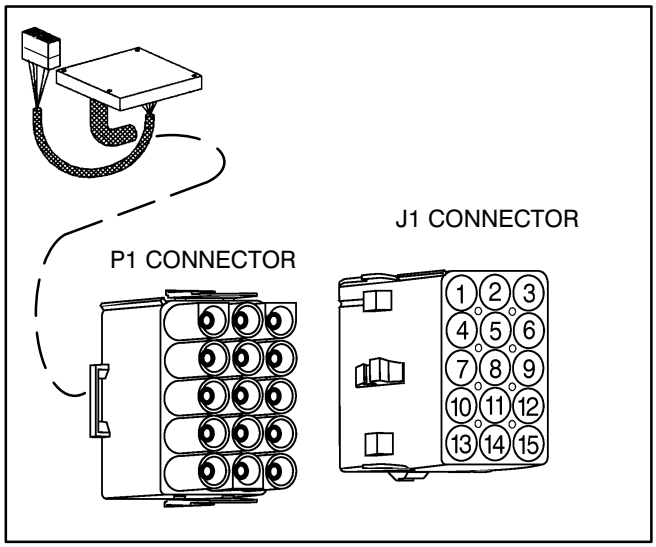


FIGURE 7-4. CONTROL ASSEMBLY A1

Battery Charger VR2—50 Hz Only

The battery charger is located on the left side of the genset housing. The battery charger can be checked with a voltmeter. A voltage measurement between the B**+** terminal and ground (Figure 7-5), 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 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.

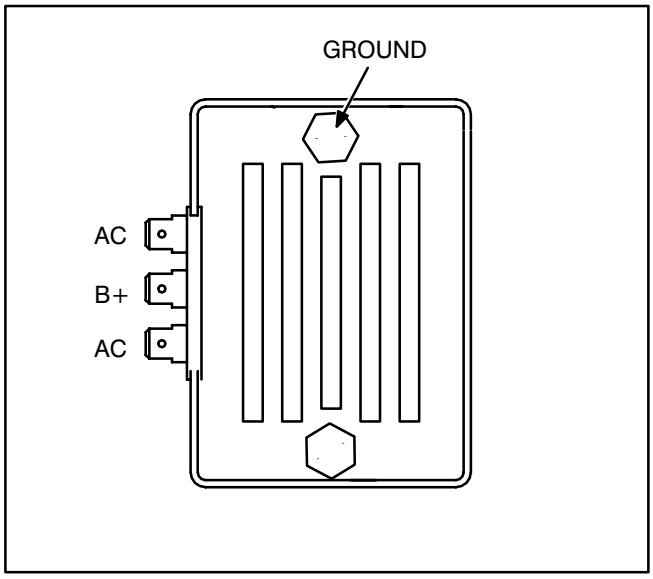


FIGURE 7-5. BATTERY CHARGER VR2

Transformer T1-50 Hz Only

The transformer (Figure 7-6) is located on the backside of the genset (Figure 6-1). The transformer can be checked with an ohmmeter. 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.

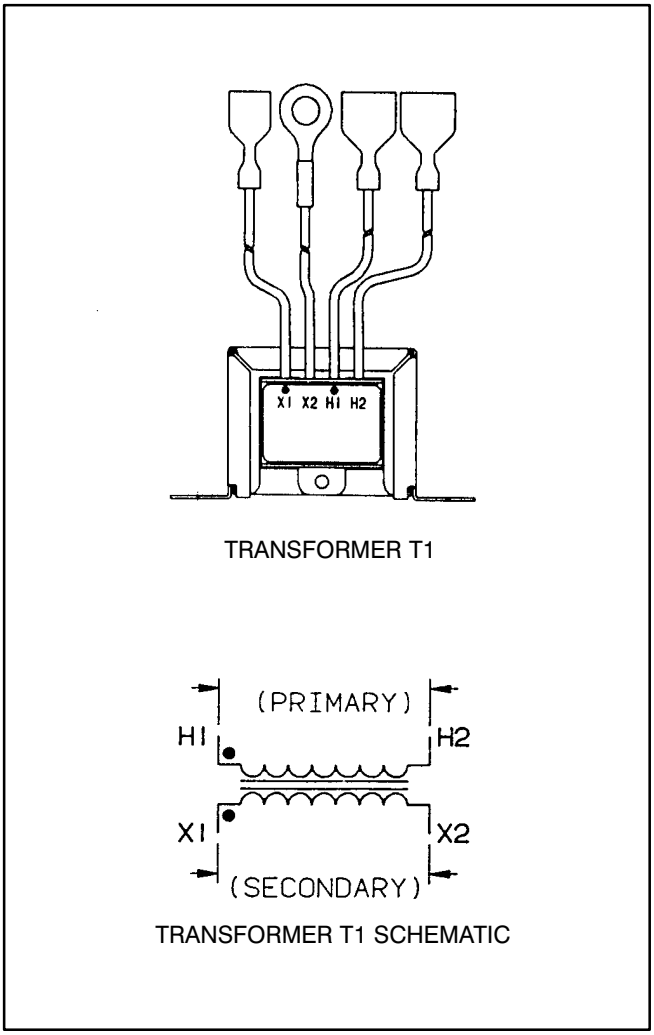


FIGURE 7-6. TRANSFORMER T1

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 vehicle interior.***

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 hub assembly, and air duct.

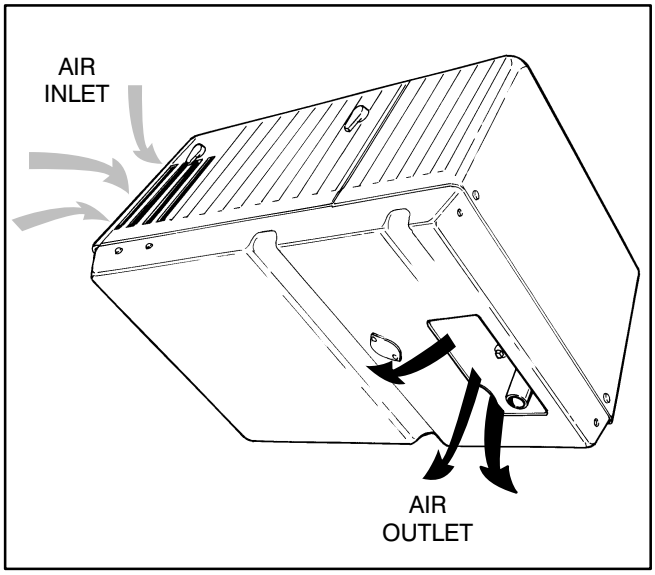


FIGURE 8-1. COOLING AIRFLOW

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 Section 5. *Preparing for Service.*

1. Follow the genset disassembly procedures in Section 9. *Generator* through to scroll assembly removal.
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 condition of the exhaust system is extremely critical on gensets because of the possibility of exhaust gases entering the pontoon boat. The exhaust system must not have any leaks and it must be well supported. The tailpipe must extend 1 inch (25.4 mm) beyond the the perimeter of the boat and not near any vents or openable windows or doors. See the Installation Manual for important considerations concerning the installation of an exhaust system, including the value of a CO alarm on board.

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

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.

The muffler 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.

⚠ WARNING ***EXHAUST GAS IS DEADLY! Modifying the exhaust system may let poisonous exhaust gases enter the boat. 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.***

Muffler Disassembly

1. Remove the genset from the pontoon boat and remove the outer housing (see Section 5. *Preparing to Service*).
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 consists of the magneto assembly, ignition coil, spark plug and ignition wiring. If a problem with the ignition system is suspected, the spark plug can be inspected and an ignition spark check made without removing the genset from the pontoon boat.

Perform the ignition spark, coil and wiring checks before proceeding to the Magneto Assembly.

Spark Plug E2

Remove the spark plug and inspect the electrode. If the spark plug has carbon deposits, use a wire brush to clean it. Replace a badly fouled or burned spark plug. Reset the spark plug gap (Figure 8-2) according to Section 2. *Specifications*. 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 10-3.
- Light Tan or Gray Deposits—Normal plug color.

Ignition Coil T1

The ignition coil (Figure 8-3) is a transformer that steps up the magneto output voltage to about 20,000 volts for spark plug firing. The coil consists of a primary and a secondary winding. Perform the following checks:

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

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

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

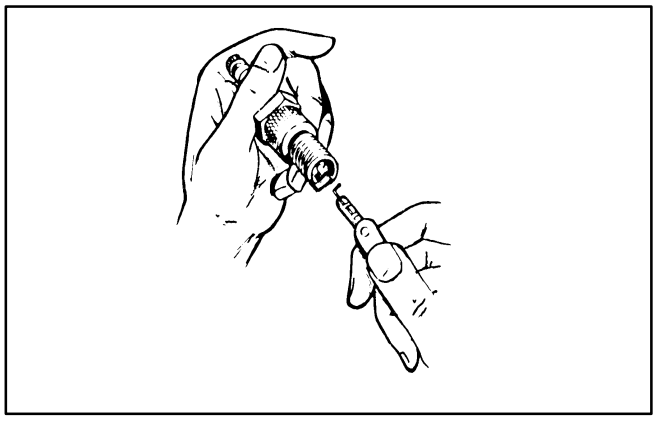


FIGURE 8-2. MEASURING PLUG GAP

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

Disconnect the spark plug lead from the spark plug and disconnect the primary lead from the terminal on the coil. Remove the ignition coil mounting screws and remove the ignition coil from the genset for testing. See Figure 8-3.

1. Inspect the terminal and leads for signs of corrosion or looseness and look for cracks or other damage. Look for evidence of electrical leakage around the high tension connection (indicated by carbon tracking). Replace a coil with any defects.
2. Measure the primary winding resistance. Connect one ohmmeter lead to the primary terminal and the other lead to the ground lead ring terminal. The resistance should be approximately 0.5 ohms at 75° F (24° C). Replace the coil if a high or low reading is measured.
3. Measure the secondary winding resistance. Connect one ohmmeter lead to the spark plug connector, inside the boot, and the other lead to the ground lead ring terminal. The resistance should be approximately 1100 ohms at 75° F (24° C). Replace the coil if a high or low reading is measured.

Ignition Wiring Check: Ignition wiring consists of:

- One ground wire connected to the ignition coil and one ground wire connected to the magneto assembly.
- One wire from magneto to ignition coil primary.
- One ignition enable wire from the control assembly to magneto.
- One high tension lead from ignition coil secondary to spark plug.

Refer to Section 12. *Wiring Diagrams*. (Do not disassemble the genset to check the magneto wiring at this time.)

Inspect ignition wiring for loose connections and cuts or breaks in insulation. Test suspect leads for continuity with an ohmmeter. Use a megger to check for breaks in the spark plug lead. Also check control wiring for loose or grounded connections. If any problems are found, correct them and repeat the ignition spark check.

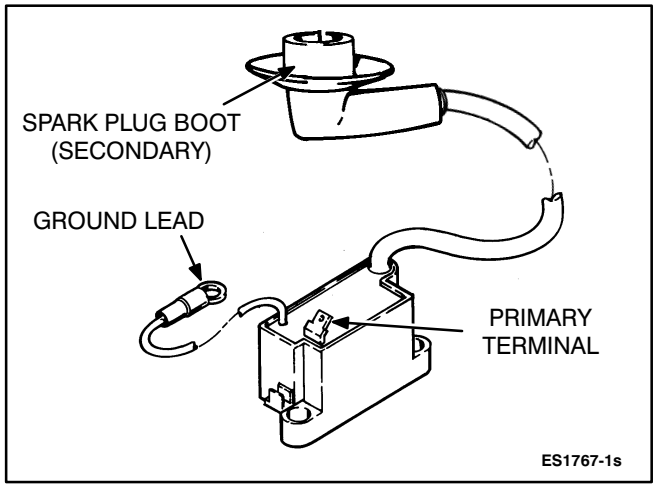


FIGURE 8-3. IGNITION COIL

Magneto Assembly G2

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

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

1. Make sure the cranking circuit and battery are in good condition.
2. Remove the spark plug, reconnect the spark plug lead and ground the plug side electrode to bare metal on the engine.
3. Do not touch the plug or plug wire during testing. Crank the engine and observe the plug. A good spark should be observed. If no spark is observed, the magneto or wires connected to the magneto are the most likely cause. Refer to Section 9. *Generator* for generator disassembly to access the magneto assembly.

CRANKCASE VENTILATION SYSTEM

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

Crankcase Breather Service

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 8-4).
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.***

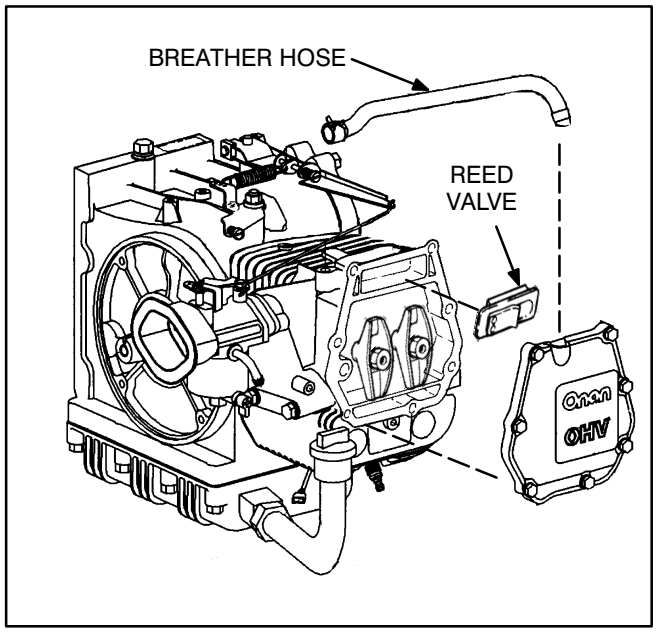


FIGURE 8-4. CRANKCASE BREATHER SYSTEM

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/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 50% to 75% of rated load. Check that the choke is completely open. If the governor is completely out of adjustment, make a preliminary adjustment at no-load to attain a safe voltage and speed operating range.
2. Check the governor linkage for binding or excessive looseness. Check the motion spring for bending or damage and straighten or replace as needed.
3. With the genset operating at no-load, turn the speed adjustment screw (Figure 8-5) on the governor linkage to obtain 62 Hz for a 60 Hz genset. Output voltage should be 123-132 VAC. (Adjust a 50 Hz genset to obtain 51.5-52.5 Hz. Output voltage should be 220-231 VAC if rated 220 VAC or 240-252 VAC if rated 240 VAC.) Turn the screw clockwise to increase speed and counterclockwise to decrease speed.

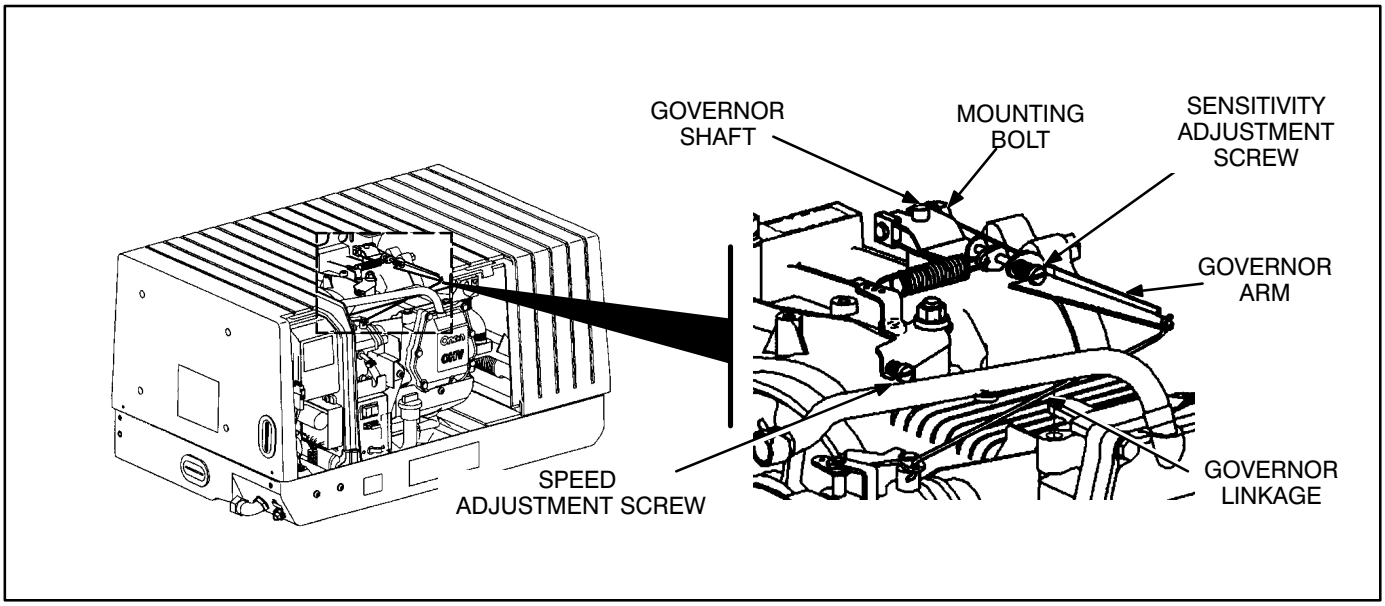


FIGURE 8-5. GOVERNOR ADJUSTMENTS

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. 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.
6. Recheck the speed setting made in step 3 and readjust if necessary.
7. 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 (Section 10*. Engine Block Assembly*).

TABLE 8-1 VOLTAGE / FREQUENCY

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

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 8-6.

The air filter can be serviced without removing the genset from the pontoon boat. 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, refer to Section 9. *Generator* for details on removing the air housing assembly.

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

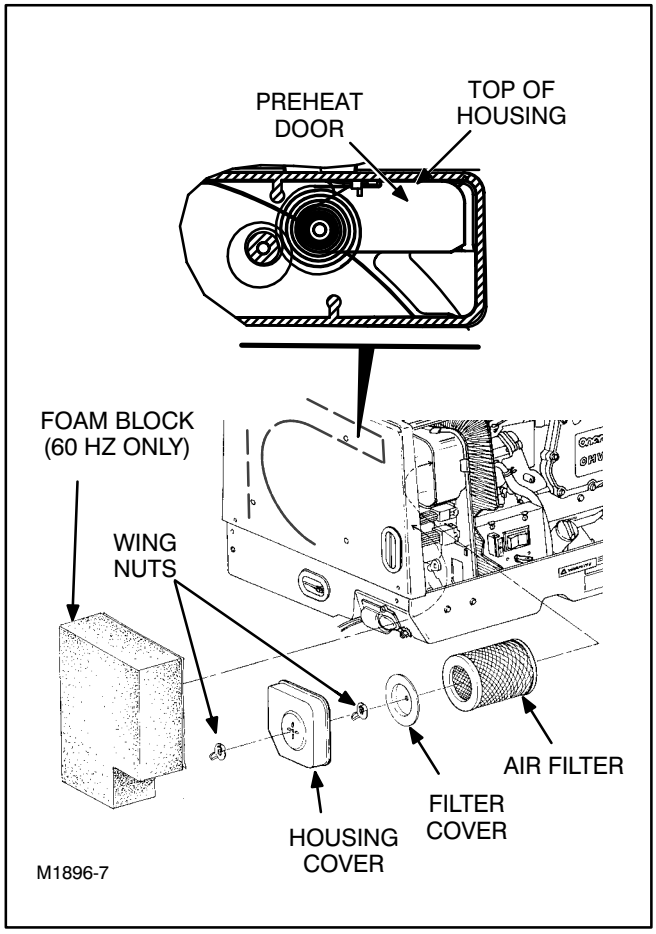


FIGURE 8-6. AIR FILTER AND PREHEATER ASSEMBLY

Carburetor and Intake Manifold Assembly

This assembly consists of the carburetor and the intake manifold assembly (Figure 8-7). 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.

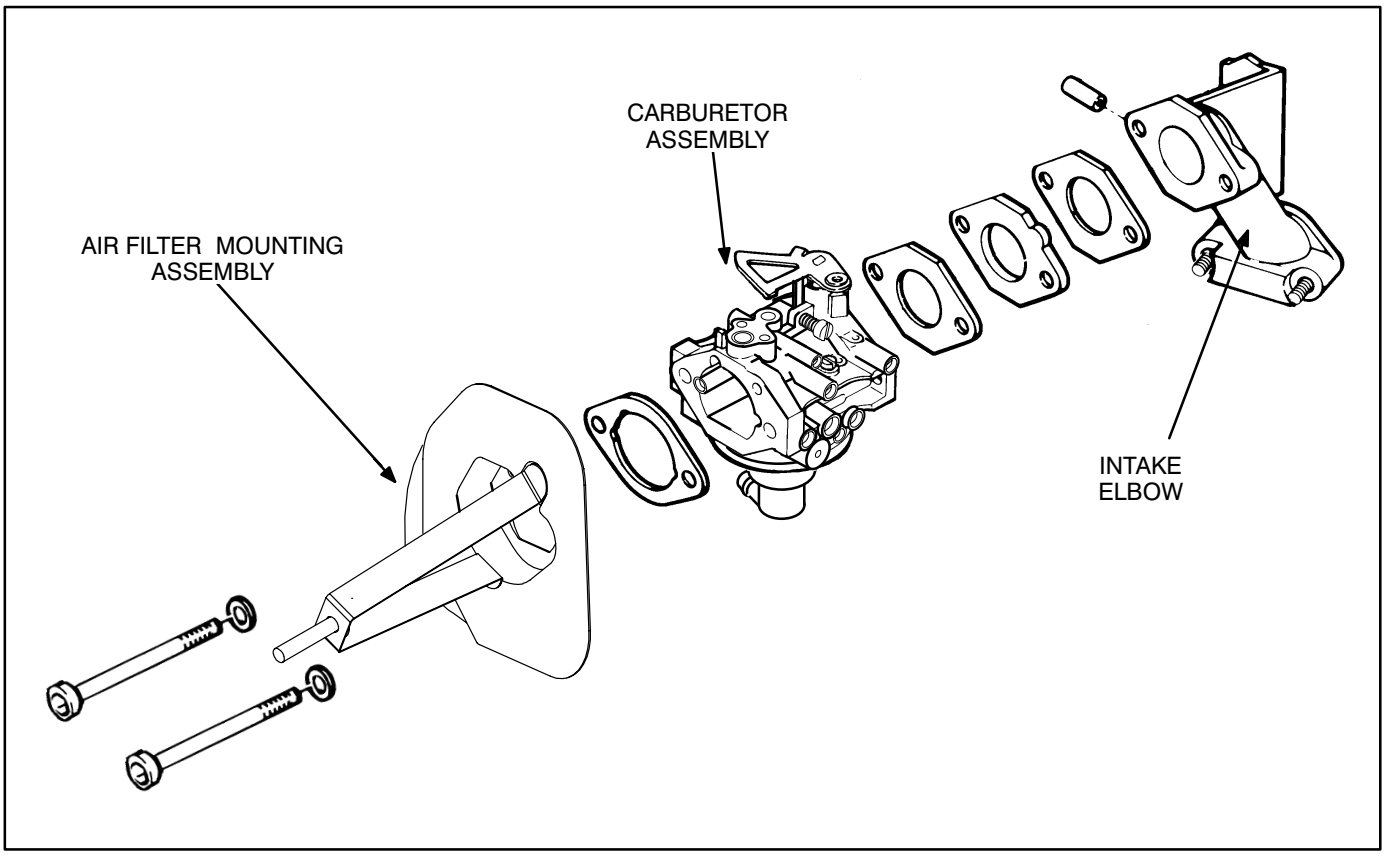


FIGURE 8-7. CARBURETOR AND INTAKE MANIFOLD ASSEMBLY

Carburetor

Other than turning the altitude adjust knob shown in Figure 8-8 (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 8-9). Before replacing a carburetor, however, make certain that:

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

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 8-6.) To adjust the throttle stop screw:

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

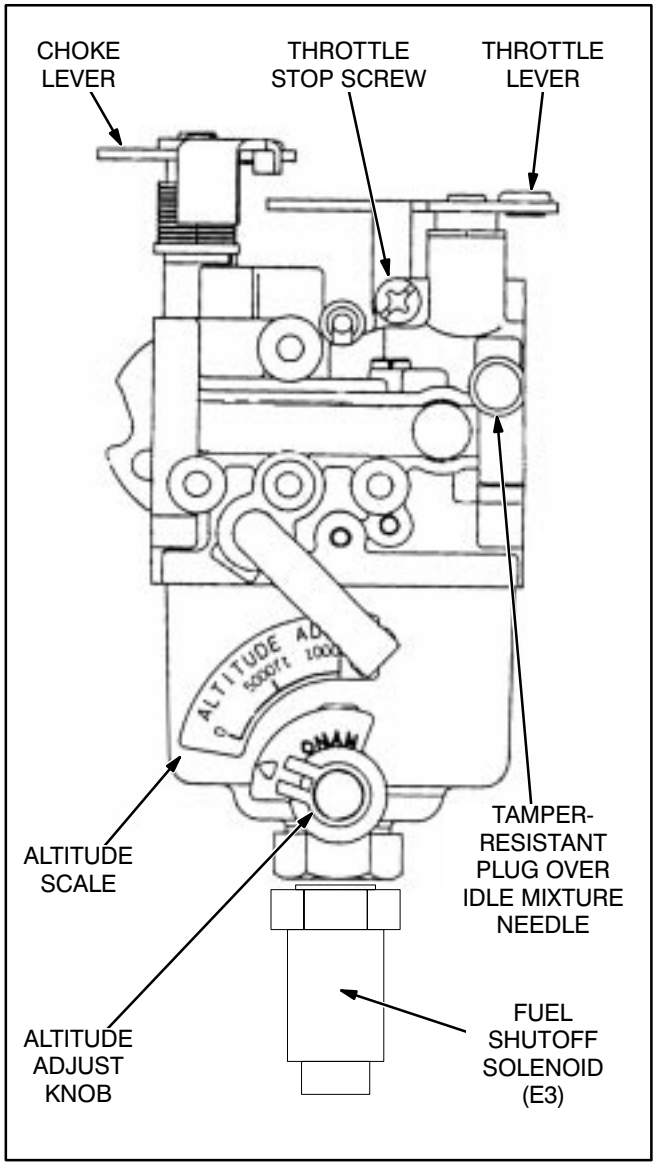


FIGURE 8-8. CARBURETOR ADJUSTMENTS

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 8-9.

⚠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.

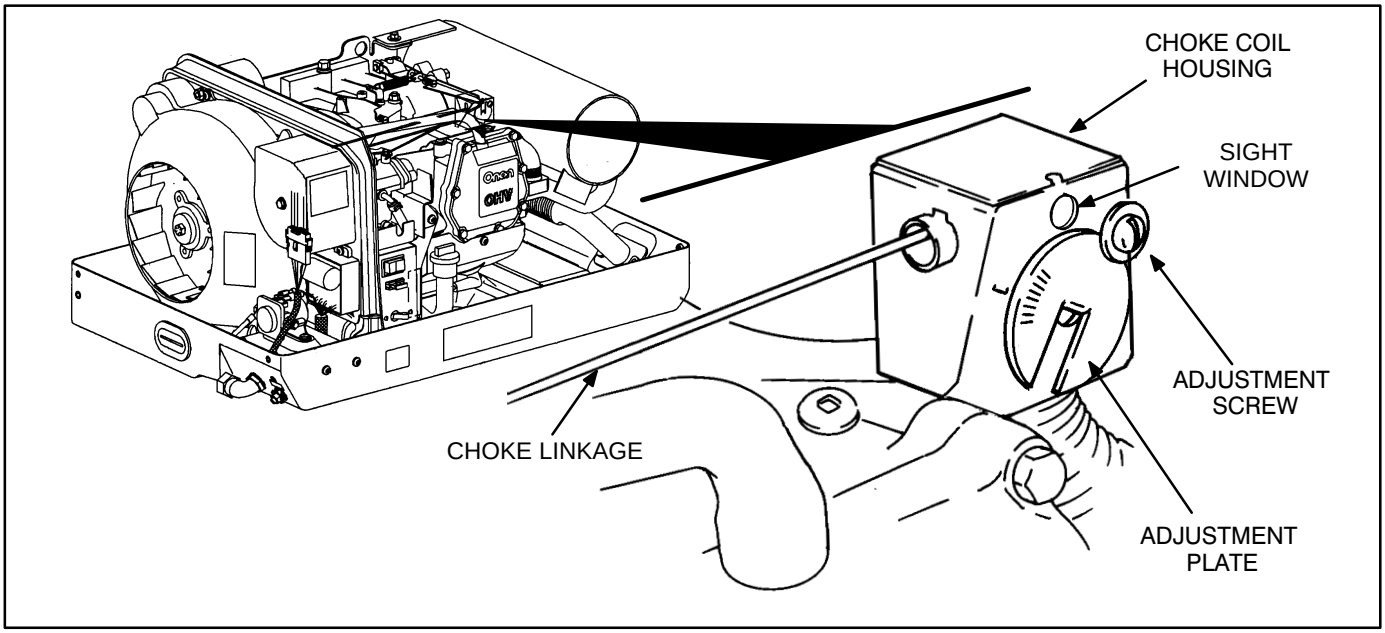


FIGURE 8-9. CHOKE ASSEMBLY

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 8-9.

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 8-10.
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.***

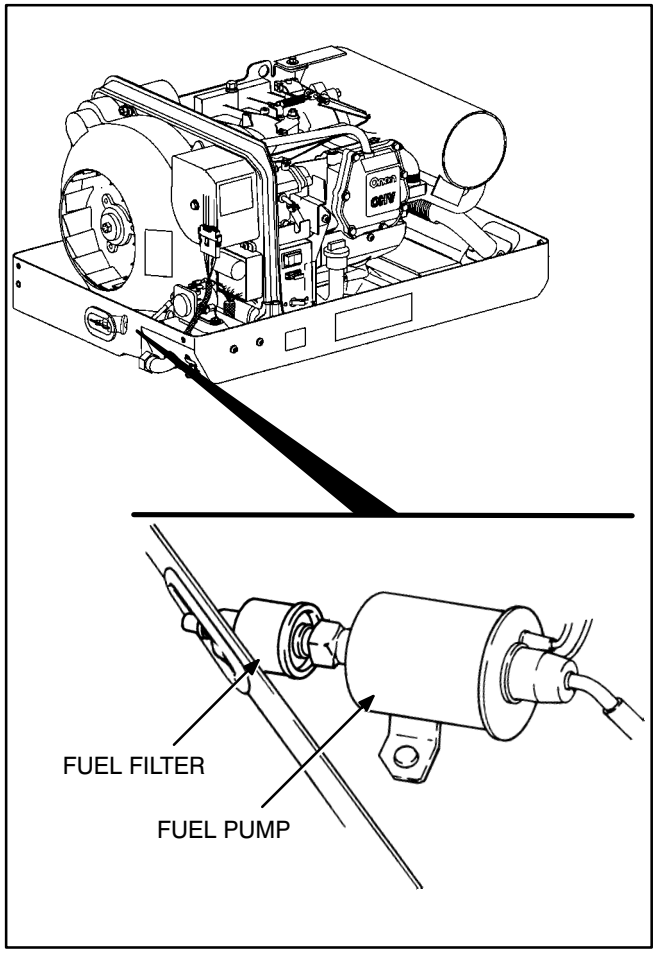


FIGURE 8-10. FUEL FILTER REPLACEMENT

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 8-11). The pump will not work properly if the cranking or running voltage is less than 6 VDC. If the battery voltage is low, charge the battery and retest.
3. Remove the fuel line from the carburetor inlet and install a pressure gauge.
4. Press the Start switch and hold it for several seconds until the pressure stabilizes.
5. The pressure reading should be 3.25-4.00 psi (22.4-27.5 kPa). The pressure should hold constant or drop off very slowly.

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

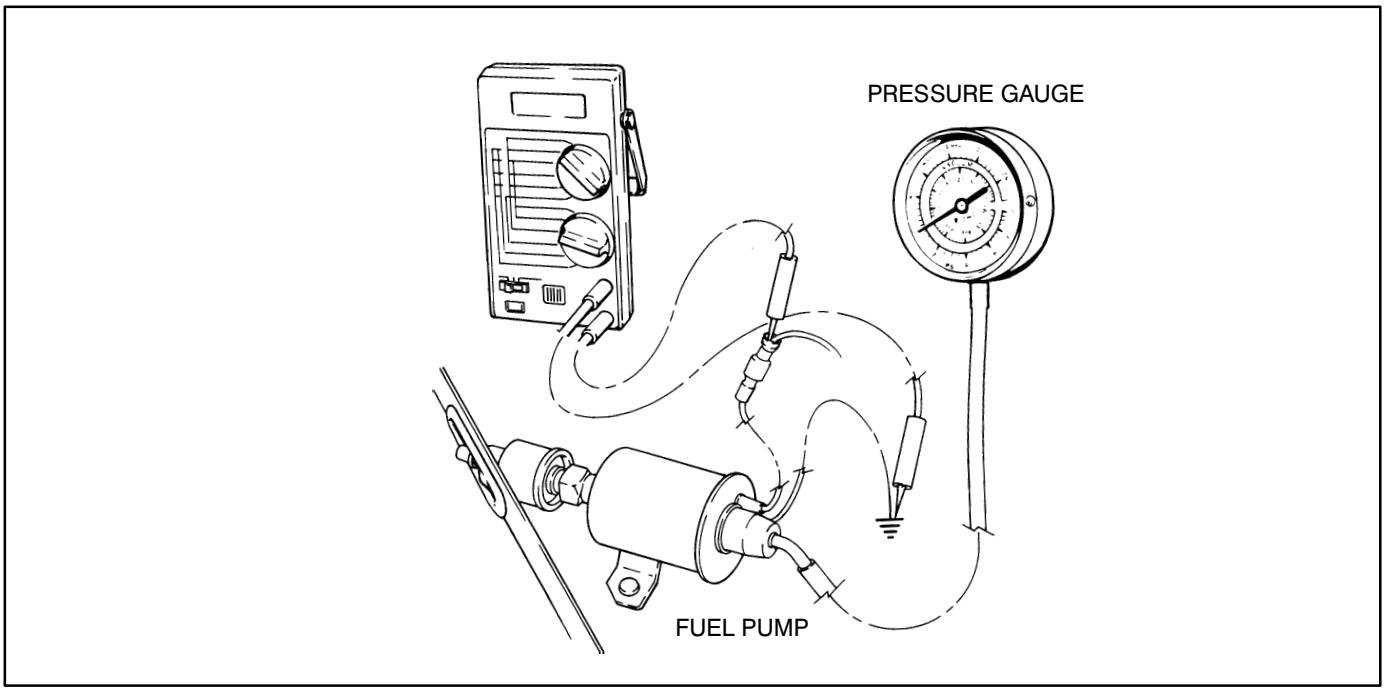


FIGURE 8-11. FUEL PUMP TEST

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 8-12.
2. Press the start switch. If there is approximately 12 VDC but the starter does not crank, the starter is defective. Go to Starter Disassembly. If there is no voltage, check the battery, start solenoid and control wiring.

Starter Disassembly

Remove the genset from the pontoon boat (Section 5. *Preparing for Service*).

1. Remove the genset outer housing. Disconnect the positive (+) cable from the starter lug.
2. Remove the rear mounting nut from the starter. Remove the engine bracket behind the starter from the engine (Torx T-30) and muffler.
3. Remove the starter mounting nuts. Carefully disengage the starter from the end bell.
4. 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 8-13).
5. Remove the starter through-bolts. Carefully separate the brush end cap housing from the armature assembly.

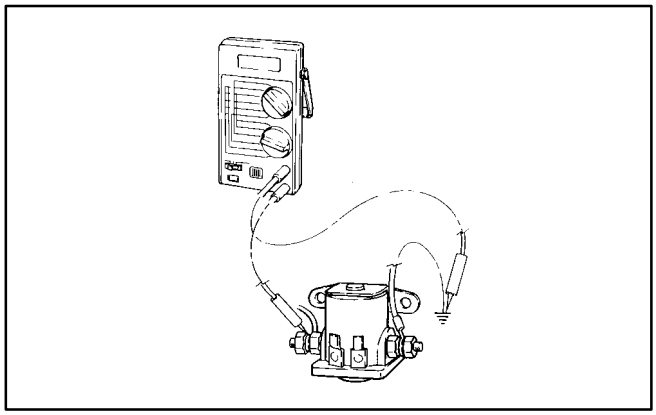


FIGURE 8-12. STARTER VOLTAGE CHECK

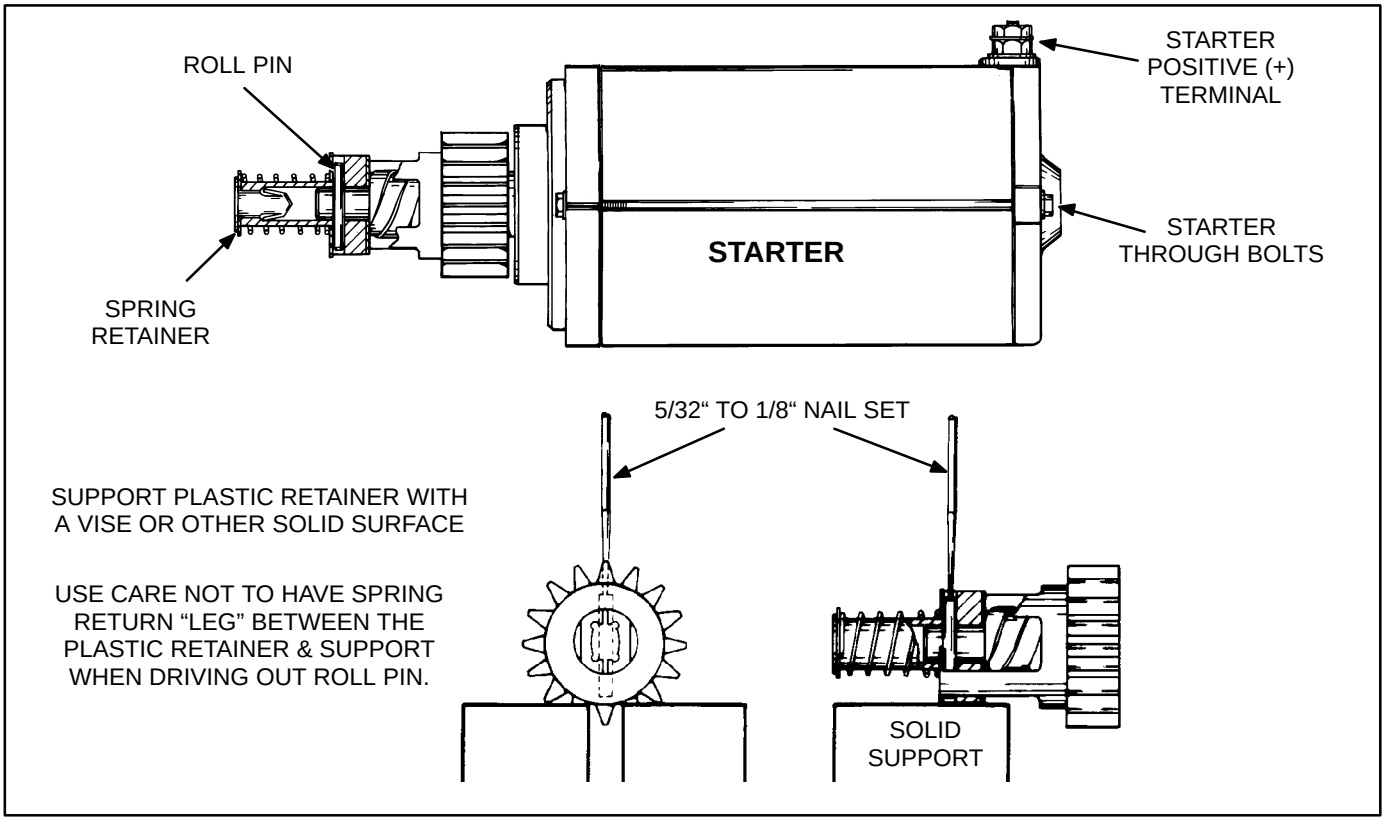


FIGURE 8-13. DRIVING ROLL PIN OUT OF STARTER ASSEMBLY

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 8-14.

Testing Armature for Shorts

Use a growler (Figure 8-15) 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 8-16) and replace them if worn to less than 0.315 inch (8 mm).

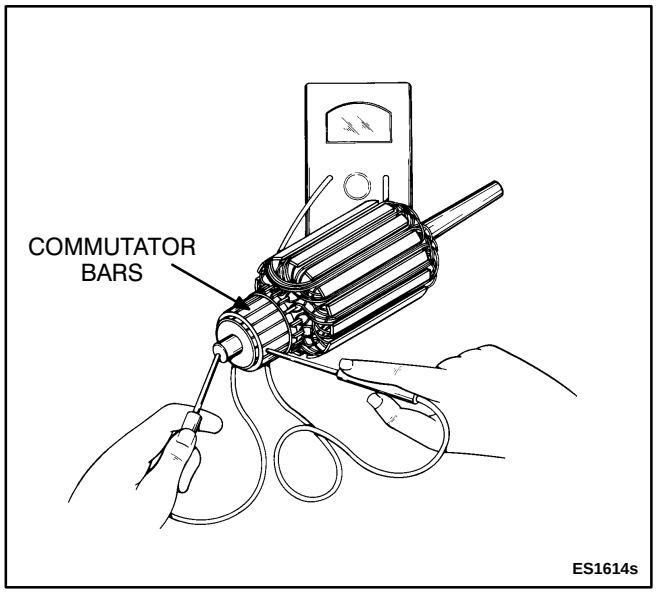


FIGURE 8-14. TESTING ARMATURE FOR GROUNDS

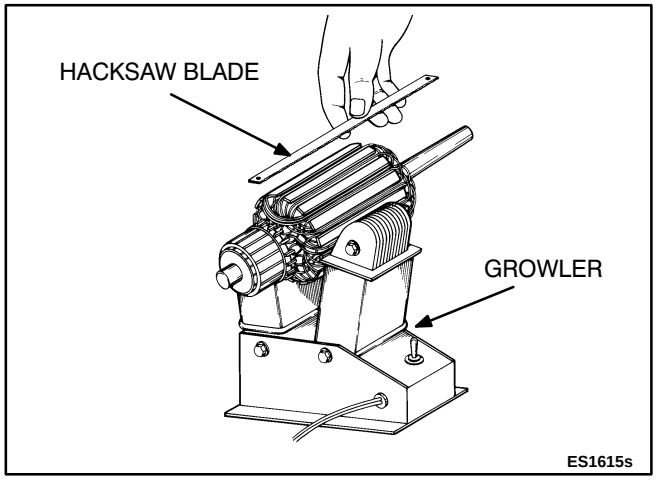


FIGURE 8-15. TESTING ARMATURE FOR SHORTS

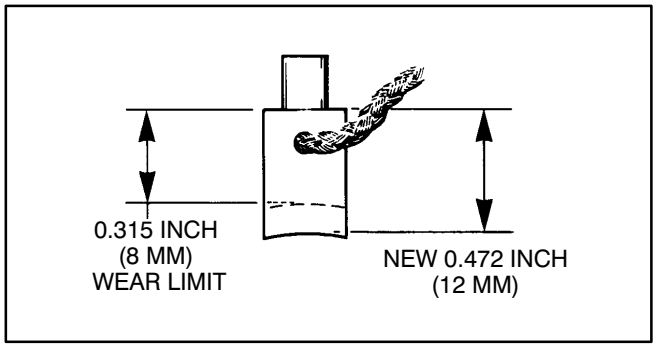


FIGURE 8-16. BRUSH INSPECTION

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 8-17).
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.

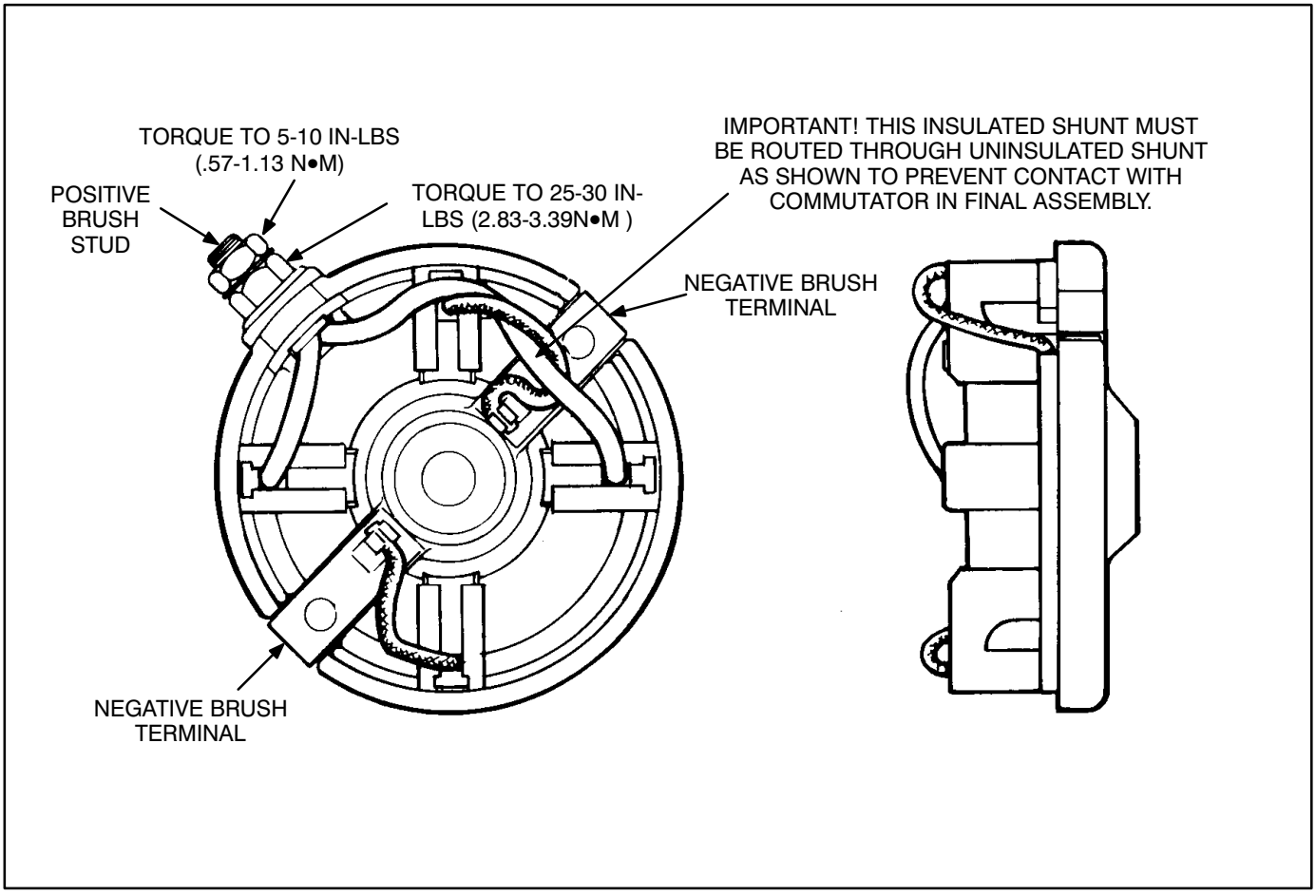


FIGURE 8-17. BRUSH ENDCAP

8. Place a spring washer and a flat washer on the shaft, as shown in Figure 8-18.
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.

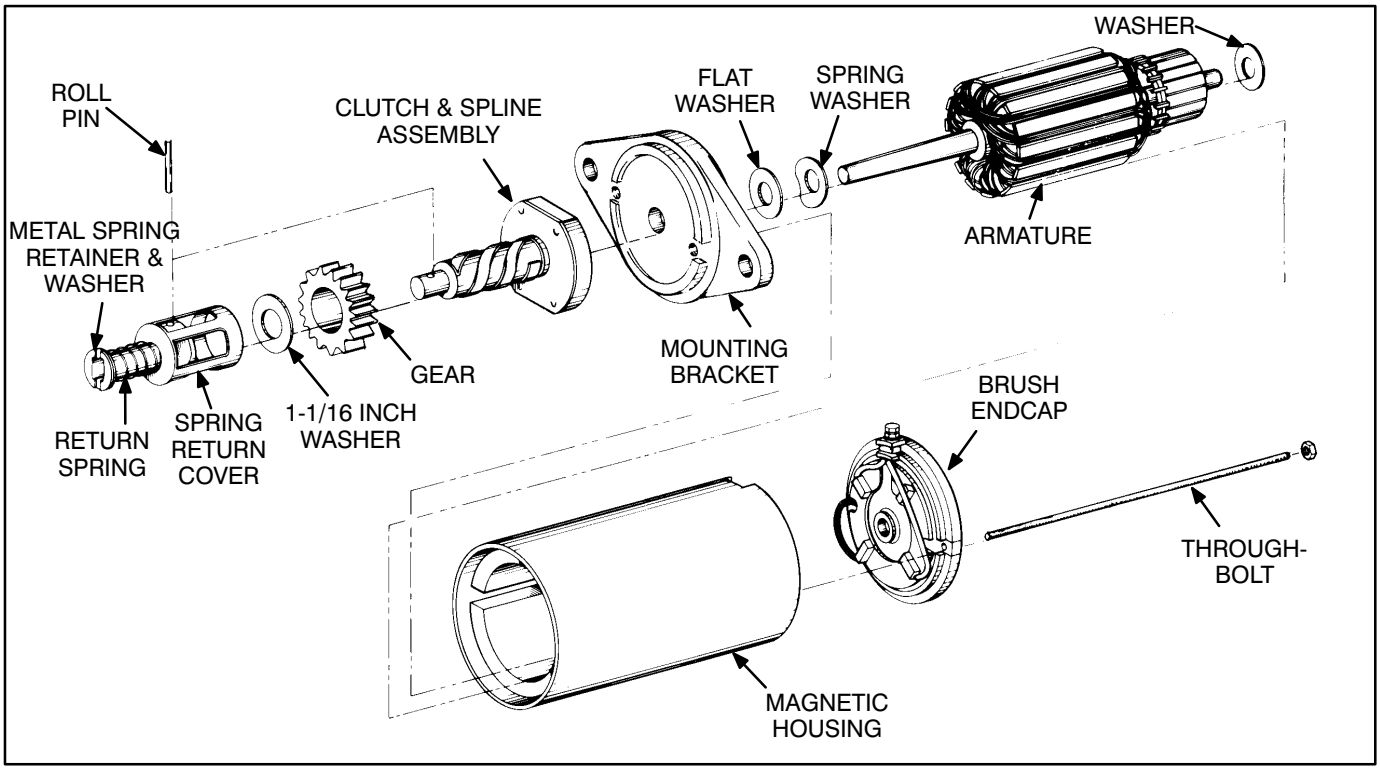


FIGURE 8-18. STARTER ASSEMBLY

9. Generator

GENERATOR DESCRIPTION

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

The generator section consists of the following components and controls:

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

Stator and Housing

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

Rotor

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

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

Generator Cooling

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

Brushes and Brush Block

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

Electronic Voltage Regulator VR1

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

Circuit Breaker CB1

AC output from the generator is supplied to a circuit breaker located along side the control panel. The circuit breaker protects the generator leads.

Wiring Harness

A wiring harness is provided for connecting the genset to the electrical loads. All lead wires are stranded copper wire to withstand vibration. The lead wires must be protected with flexible conduit. A 1/2-inch conduit elbow is provided to facilitate installation. The load wire conductor is black, the neutral conductor is white, and the ground conductor is green.

GENERATOR OPERATION

Refer to the schematic in Section 12. *Wiring Diagrams* that corresponds to your genset to follow the generator operating description.

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

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

GENERATOR SERVICE

This section covers generator disassembly and assembly procedures. Refer Figure 9-1 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 boat and place it on a sturdy work bench (Section 5. *Preparing for Service*.)
2. Remove the cover from the genset. (50 Hz models: Remove the leads from the battery charger assembly mounted to the left side of the housing.)
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 the J4 and P1 harness connectors at the air housing assembly. Remove the leads from the start solenoid. Remove the control assembly A1 mounting bracket with the voltage regulator, control assembly and start solenoid attached. Disconnect the remaining harness connections to the fuel pump, ground terminal and load connections.
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 air housing assembly from the endbell.
8. Secure the fan hub assembly and remove the rotor through bolt and washer.

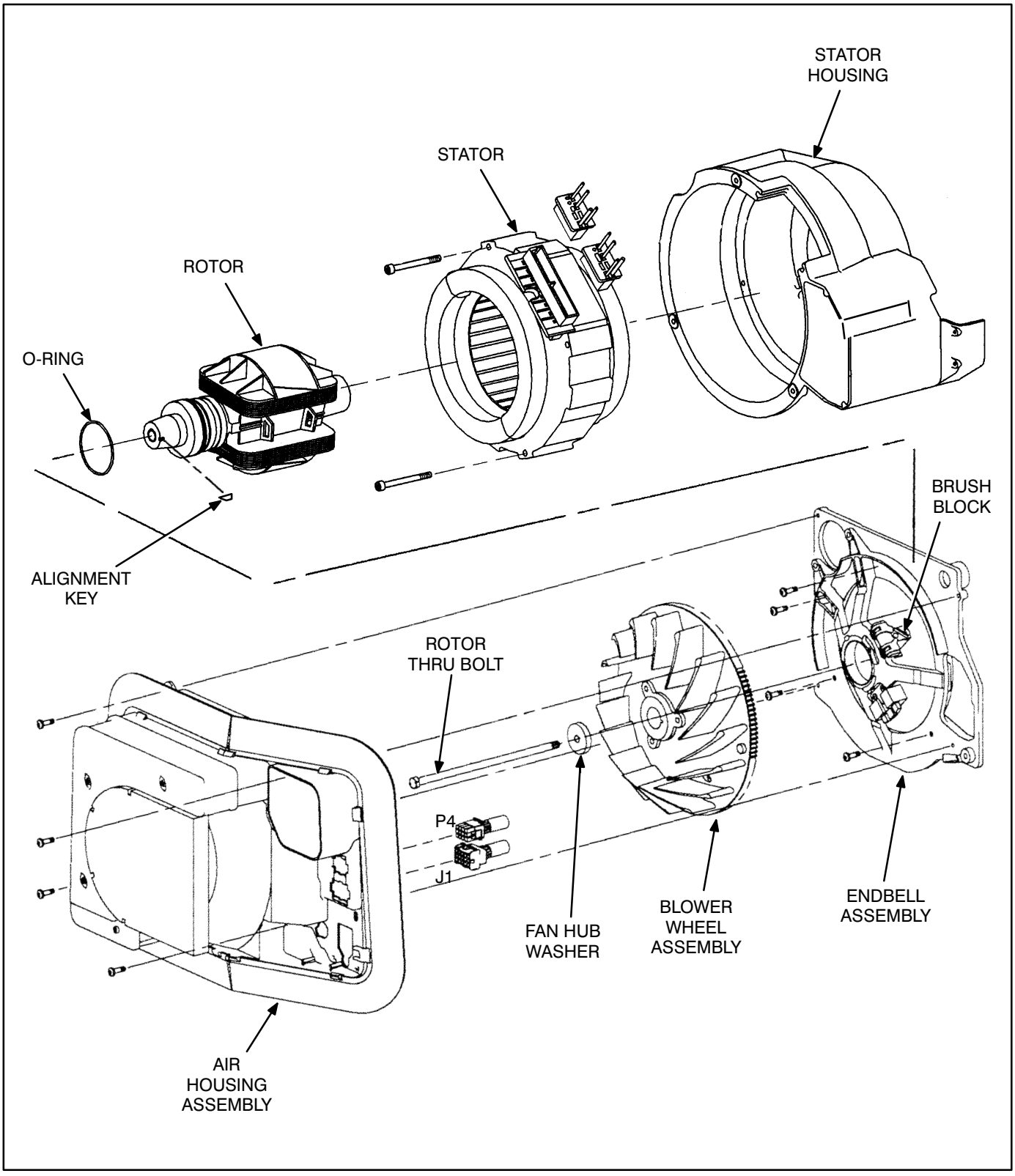


FIGURE 9-1. GENERATOR COMPONENTS

9. Remove the alignment key from the end of the rotor shaft and save for reassembly. Remove the fan hub assembly with a wheel puller (Figure 9-2) Attach the wheel puller to the fan hub assembly with three 5/16-inch thread tapping cap screws (or tap fan hub with 3/8-inch tap and use 3/8-inch cap screw).
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 9-3). 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 eliminate more wire removal.
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 9-4). 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.

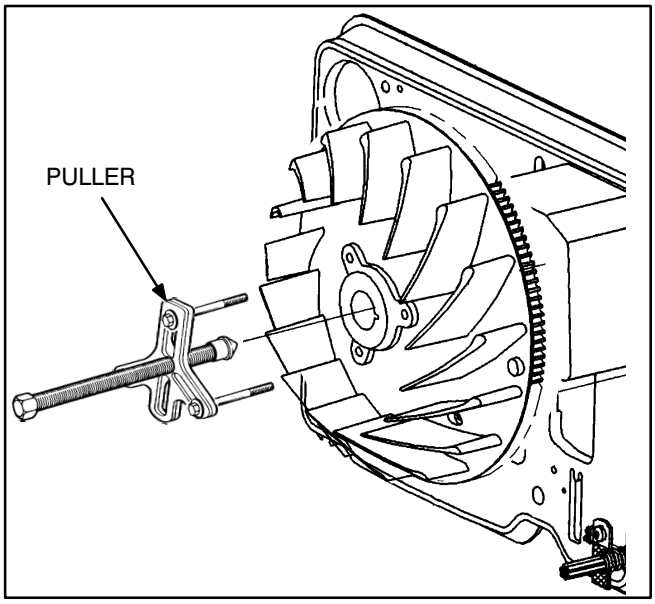


FIGURE 9-2. PULLING THE FAN HUB ASSEMBLY

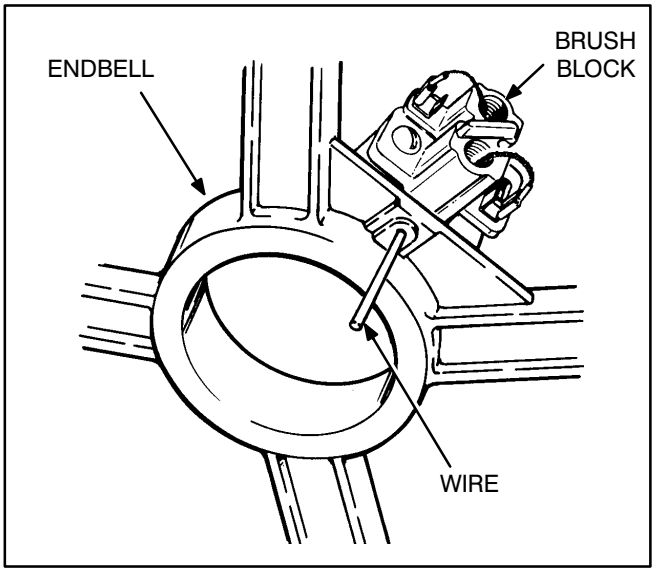


FIGURE 9-3. BRUSH BLOCK

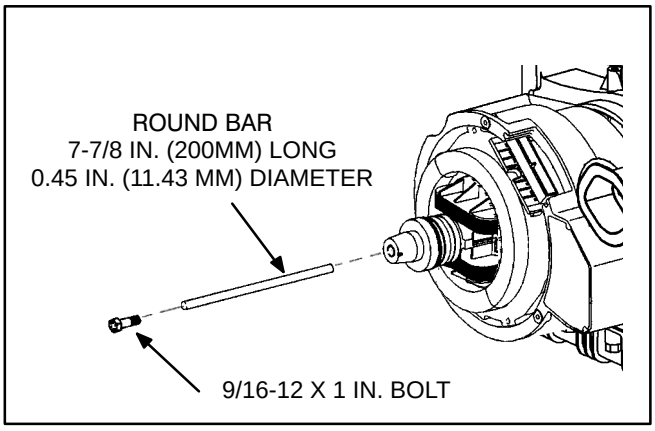


FIGURE 9-4. ROTOR REMOVAL

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 9-3. 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 hub assembly onto the rotor shaft and align the key slot on the fan hub with the key slot in the rotor shaft. Install the key into the key slot. Install the rotor through bolt and washer. Verify alignment of the rotor shaft and the fan hub, then secure the fan hub assembly and tighten the rotor through bolt to the specified torque.
7. Install the air housing assembly.
8. Remove the wooden block from under the stator housing and slowly lower the genset.
9. Install the muffler assembly and make sure new gaskets are used. Install the generator and engine to base mounting bolts (use antiseize lubricant on bolt threads). Secure all hardware to the specified torque.
10. Reconnect the load leads, the fuel pump leads, and ground terminal block or connections. Install the voltage regulator and control assembly. Reconnect the start solenoid leads and the P4 and J1 connectors.
11. Inspect the assembly, check all electrical and mechanical connections for correct fit and location. Place the enclosure cover on the genset and secure with the side mounting screws. (50 Hz models: Connect the leads to the battery charger assembly mounted to the left side of the housing.)
12. Install the genset in the boat, securely fastening all mounting screws and hardware. Reconnect the fuel, exhaust, and electrical systems in reverse order of disassembly (Section 5. *Preparing to Service.*)
13. Fill the crankcase with oil (see the Operator's Manual).

GENERATOR TESTING

This section covers test procedures for the rotor and stator windings. Begin with Field Voltage Test.

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

Field Voltage Test

Perform the Field Voltage Test if low or no generator output voltage is produced to confirm that field voltage is available to the rotor brushes through the voltage regulator for field flashing and voltage buildup.

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

The voltage regulator plug J4 remains connected to wire harness plug P4 for Test A and B. The voltmeter leads should be secured so that they are not being held during testing. (Use long pointed test leads or paper clips connected with alligator clips to the test leads.) Refer to Figure 9-5.

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

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

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

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

If no voltage is measured when the start switch is pushed, proceed to the VOLTAGE REGULATOR TEST (Page 9-9).

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

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

Start the genset and observe the voltmeter reading. If approximately 40 VAC is measured, the generator brushes, rotor, and stator are working properly, proceed to the VOLTAGE REGULATOR TEST (Page 9-9).

If no voltage is measured, proceed to BRUSHES AND SLIP RINGS (Page 9-10).

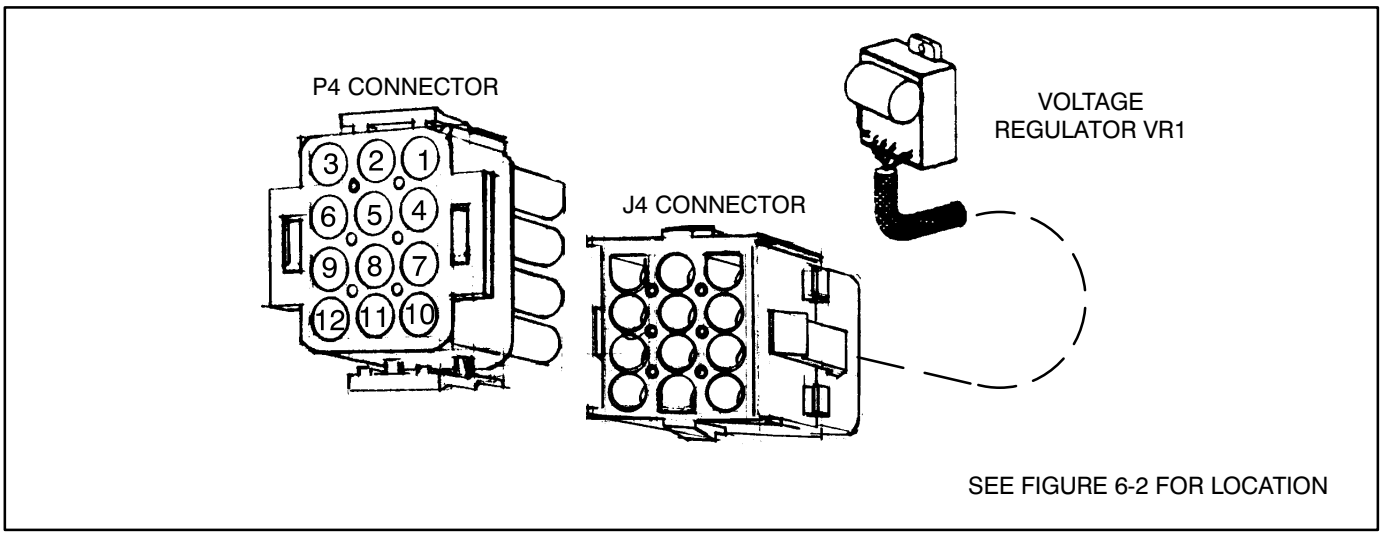


FIGURE 9-5. VOLTAGE REGULATOR CONNECTOR PLUG (P1)

Rotor Test

The rotor can be tested for grounded, open, or shorted windings using an ohmmeter. Figures 9-6 and 9-7 show the rotor removed from the genset for testing. The rotor can be tested without removing it from the generator. To gain access to the slip rings, follow GENERATOR DISASSEMBLY (Page 9-2) through the fan hub assembly removal procedure. Use a stiff wire to hold the brushes off the slip rings during testing. Refer to BRUSHES AND SLIP RINGS (Page 9-10) for the procedures for inserting the wire.

Ground Test: Set the ohmmeter to the highest resistance scale or use a megger. Touch one test prod to the rotor shaft and hold it there. Touch the other test prod to one of the slip rings (Figure 9-6). 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.

Open or Shorted Test: To test for open windings, set the ohmmeter on the highest resistance scale. Place the test prods on the slip rings (Figure 9-7). The ohmmeter should indicate continuity between the slip rings of 19-27 ohms. A high resistance reading indicates a poor connection or an open winding. Check the connection between the slip rings and rotor lead wires. Replace the rotor if a winding is open.

To test for a shorted winding, set the ohmmeter on the lowest scale. Place the test prods on the slip rings (Figure 9-7). A reading of less than 17 ohms at 77° F (25° C) indicates shorted windings. Replace the rotor if a winding is shorted.

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

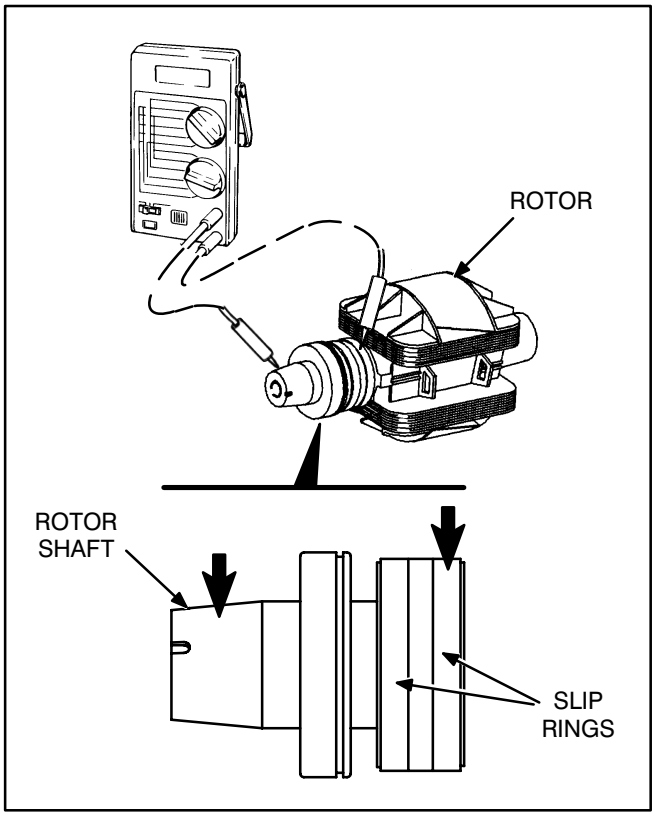


FIGURE 9-6. GROUNDED ROTOR TEST

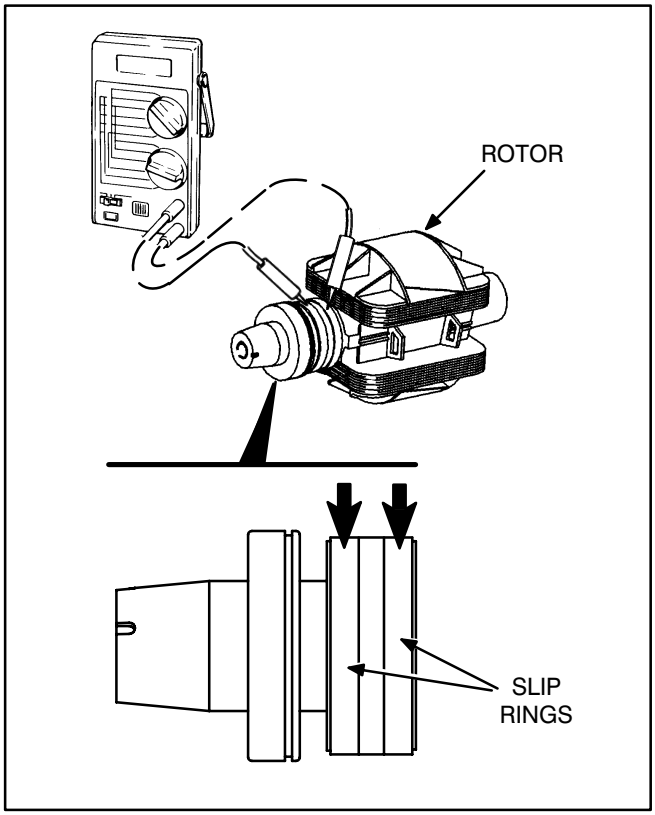


FIGURE 9-7. OPEN OR SHORTED ROTOR TEST

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. Figure 9-8 shows the stator removed from the generator for testing. The stator can be tested without removing it from the generator. To perform the stator test, carefully remove both connector plugs from the stator.

Ground Test: Set the ohmmeter for the highest resistance scale and then connect one test prod to the generator housing (or stack, if stator is removed). Touch the other test prod (Figure 9-8) to the terminals specified in Table 9-1. A reading of less than one megohm indicates a ground. Replace a grounded stator with a new stator.

TABLE 9-1. STATOR GROUND TEST

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

Winding Resistance: To test for open windings, set the ohmmeter for the highest resistance scale and then connect the test prods (Figure 9-8) to the terminals specified in Table 9-2. The ohmmeter should indicate continuity between terminals. A high resistance reading indicates an open winding. If an open circuit is measured replace the stator.

To test for shorted windings, use a digital type ohmmeter that reads to within 0.001 ohms. Connect the test prods to the terminals specified in Table 9-2. A reading of less than the value shown in Table 9-2 at 77° F (25° C) indicates a shorted winding. If stator tests indicate a shorted winding, replace the stator. If stator tests good, check stator connectors and leads for continuity, and for good electrical connection with the stator terminals.

TABLE 9-2. STATOR WINDING RESISTANCE

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

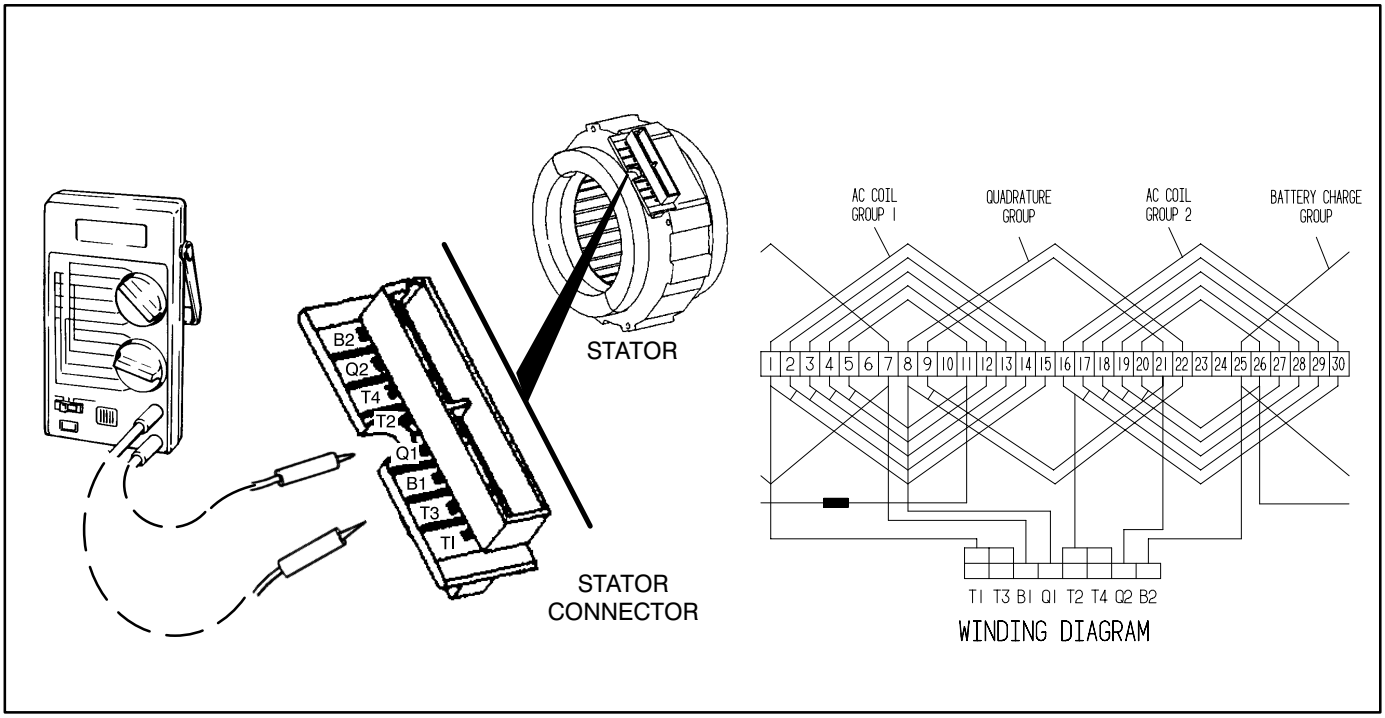


FIGURE 9-8. STATOR ASSEMBLY

VOLTAGE REGULATOR TEST

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

1. Disengage the J4 wiring connector and remove the voltage regulator (Figure 9-5).
2. With the meter set on “Diode Check”, test between connector terminal pairs: 5-9, 7-9, 10-9, 11-9, 12-9, 10-5, 5-11, 5-12, and 5-3. The positive (+) meter lead must be connected to the first terminal of each pair.
3. Replace the voltage regulator if any reading indicates a “short” or “open”, except for pair 10-5, which should indicate an “open”.

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

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

BRUSHES AND SLIP RINGS

Brush Replacement

Follow GENERATOR DISASSEMBLY procedures on Page 9-2 through fan hub assembly removal. Inspect the brushes and brush block for burn marks or other damage. If the brushes appear to be in good condition, use a piece of wire (modified as shown in Figure 9-9) 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 9-10).
3. Push each brush into the brush holder and insert a stiff wire through the small hole in the base of the holder (Figure 9-3). 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. Follow GENERATOR ASSEMBLY procedures (Page 9-5) to reinstall the fan hub and remaining generator components.

Slip Ring Service

Follow GENERATOR ASSEMBLY procedures (Page 9-5) through fan hub assembly removal. Inspect the slip rings for grooves, pits, or other damage. A Scotch Brite pad can be used to remove light wear and for surface finishing. If the slip rings are rough, pitted, or out of round by more than 0.002 inches, recondition them in a lathe with a commutator stone. Use the following procedure to service:

1. Follow GENERATOR DISASSEMBLY on Page 9-2 to remove the generator endbell and rotor.
2. Place the rotor in the machine lathe and center. Turn the rotor and use a commutator stone (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. Rub 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 the rotor and prepare for reinstallation. Follow GENERATOR ASSEMBLY procedures (Page 9-5) to reinstall the rotor and remaining generator components.

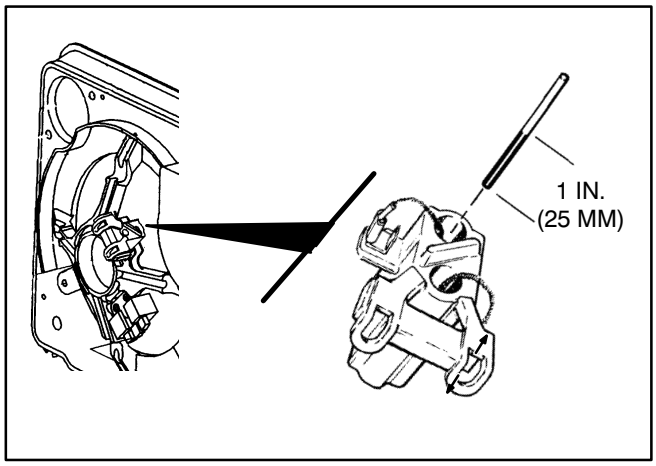


FIGURE 9-9. BRUSH WEAR CHECK

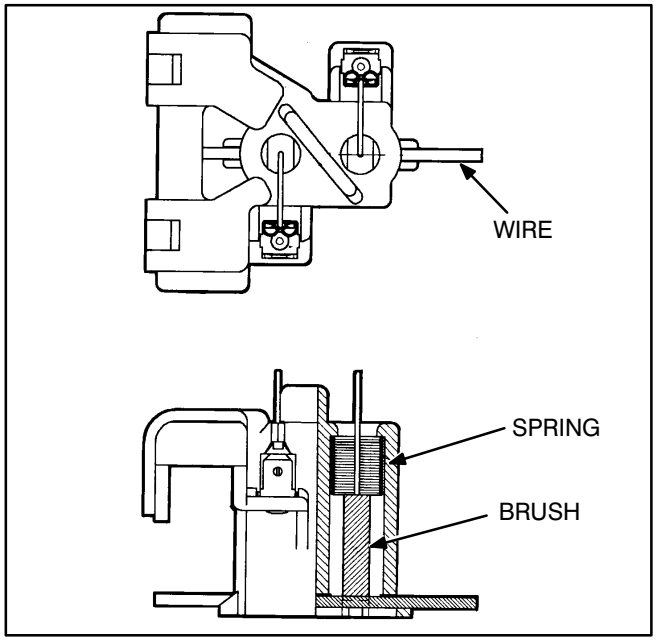


FIGURE 9-10. BRUSH REPLACEMENT

ROTOR BEARING REPLACEMENT

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

1. Measure and record the distance between the bearing and the collector ring assembly. See Figure 9-11.

   ⚠ 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 9-12) 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.

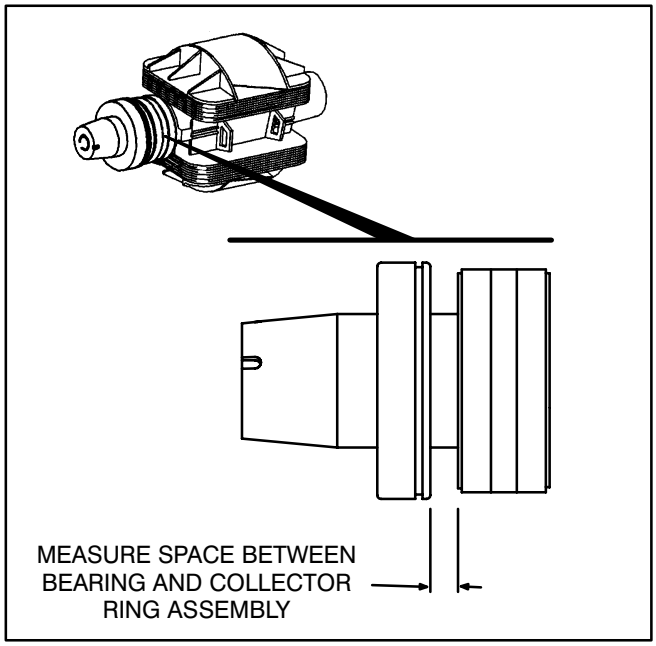


FIGURE 9-11. ROTOR BEARING SPACING

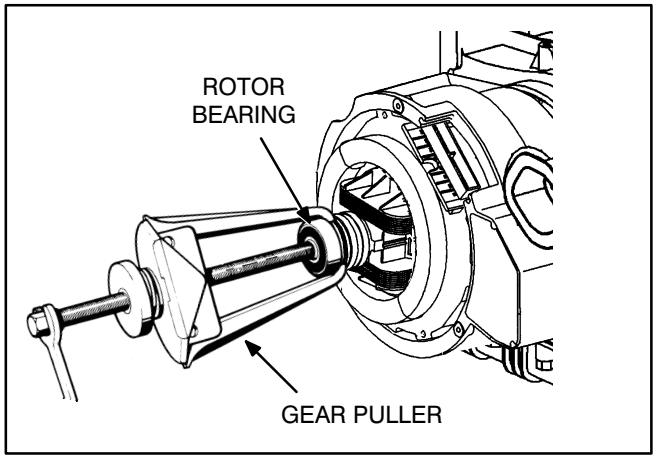


FIGURE 9-12. ROTOR BEARING REMOVAL

10. Engine Block Assembly

INTRODUCTION

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

Performing any major service will require genset removal from the pontoon boat (see Section 5. *Preparing for Service*). 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 10-1.

1. Start the engine and allow it to warm up for ten minutes. If the engine will not start, continue to the next step.
2. Disconnect the battery negative (-) cable to prevent accidental starting and remove the spark plug.
3. Manually rotate the the engine in the direction of normal operation by turning the fan hub assembly. Stop turning the engine when it reaches top dead center (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 condition
   - 10-20 Percent leak down—Normal condition
   - 20-30 Percent leak down—Nearing service limit

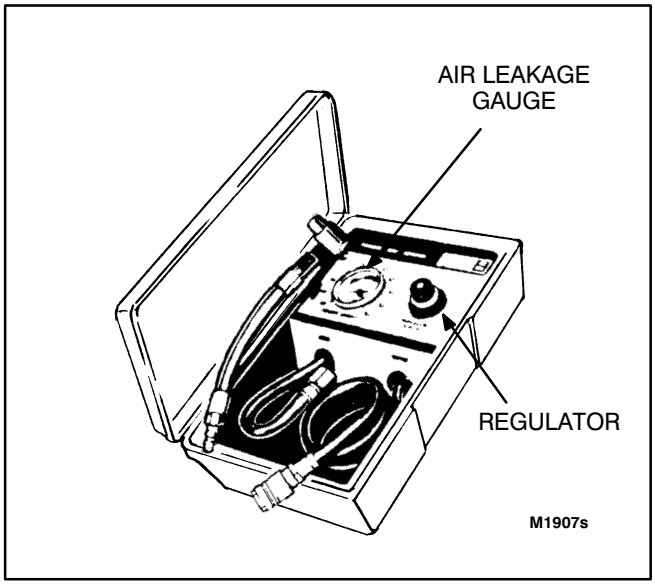


FIGURE 10-1. TYPICAL LEAK DOWN TESTER

7. If leakage is greater than 30 percent, the engine could need major service work. With the tester still connected, listen for air leakage at the points listed in Table 10-1 and note probable cause of the engine problem.

OIL PAN

Remove the oil plug and drain the crankcase oil. Remove the oil pan mounting bolts and pan (Figure 10-2).

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

HEAD COVER

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

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

TABLE 10-1. LEAK DOWN CHECK POINTS

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

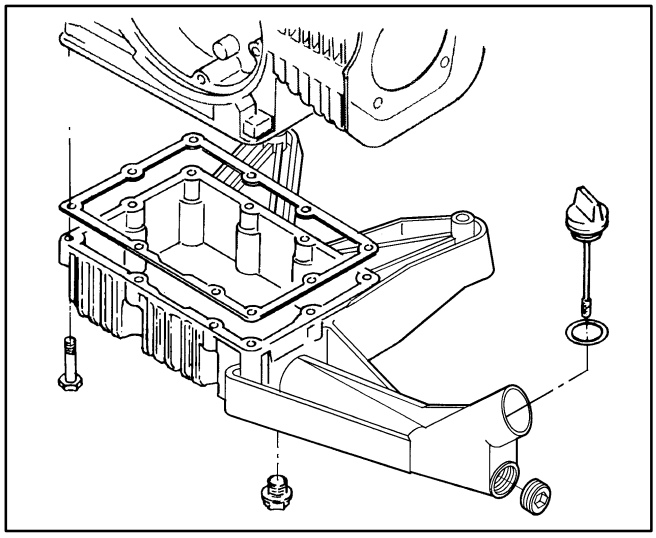


FIGURE 10-2. OIL PAN

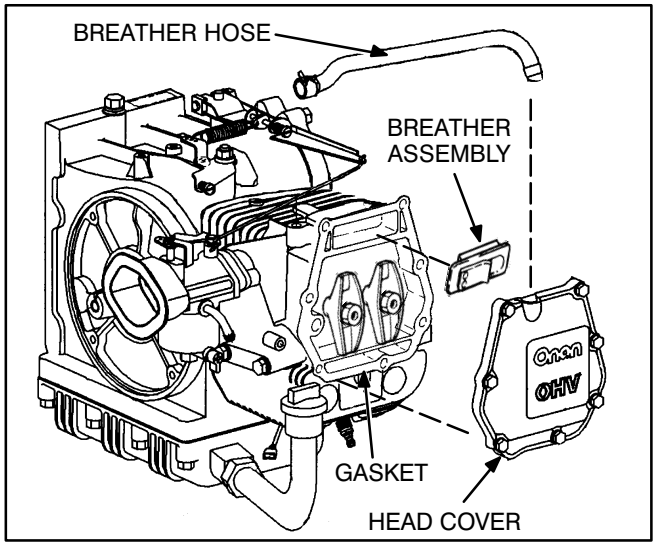


FIGURE 10-3. HEAD COVER

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 10-4).
2. Remove the spark plug.
3. Remove the cylinder head mounting bolts and pull off the cylinder head.

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

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

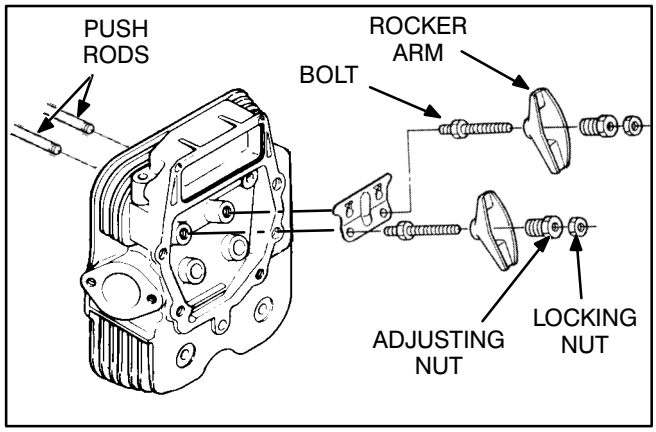


FIGURE 10-4. ROCKER ARM AND PUSH ROD REMOVAL

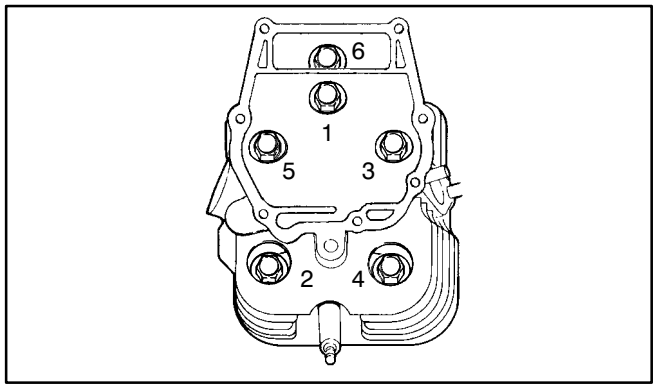


FIGURE 10-5. HEAD TIGHTENING SEQUENCE

VALVE SYSTEM

This engine uses an overhead valve design (Figure 10-6). A properly functioning valve system is essential for good engine performance. Access to the valve system is gained by removing the head cover and cylinder head.

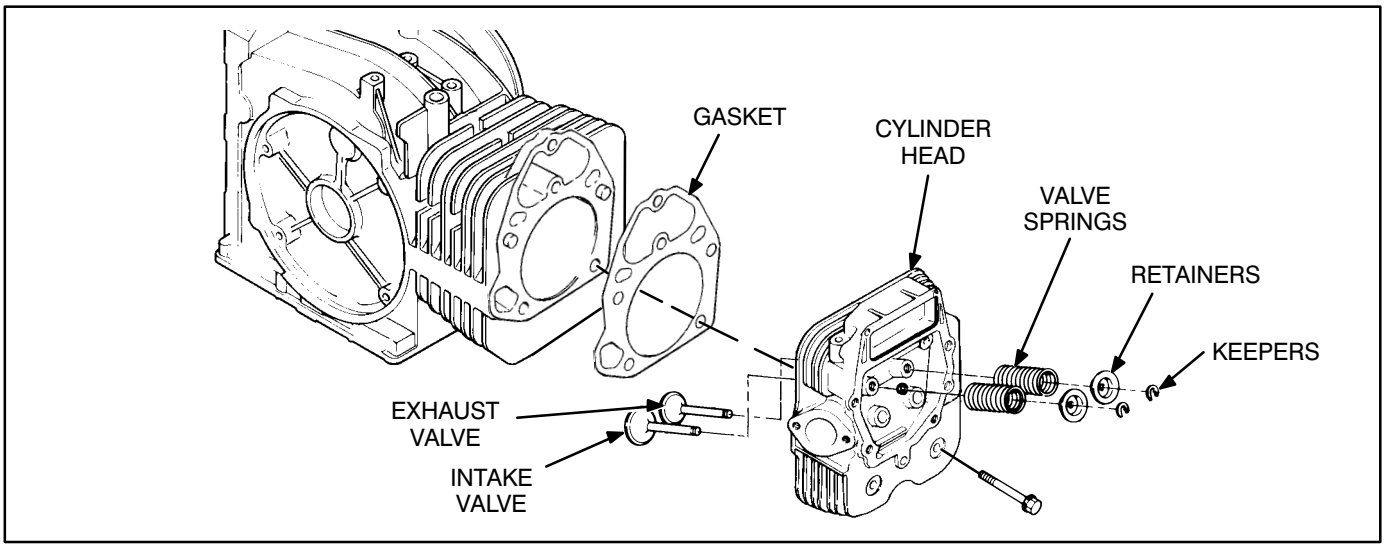


FIGURE 10-6. OVERHEAD VALVE SYSTEM

Valve Removal

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

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

Inspection

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

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 10-8. Use a micrometer to measure the valve stem diameter in at least three locations. Use a hole gauge to measure the valve guide at several depths. When clearance with stem exceeds original clearance by 0.002 inch (0.05 mm), replace the valve or cylinder head, which includes the valve guide, or both.

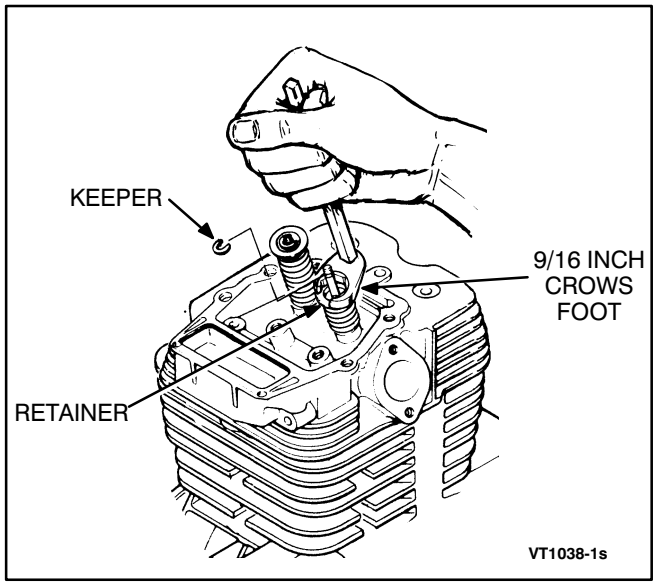


FIGURE 10-7. VALVE REMOVAL

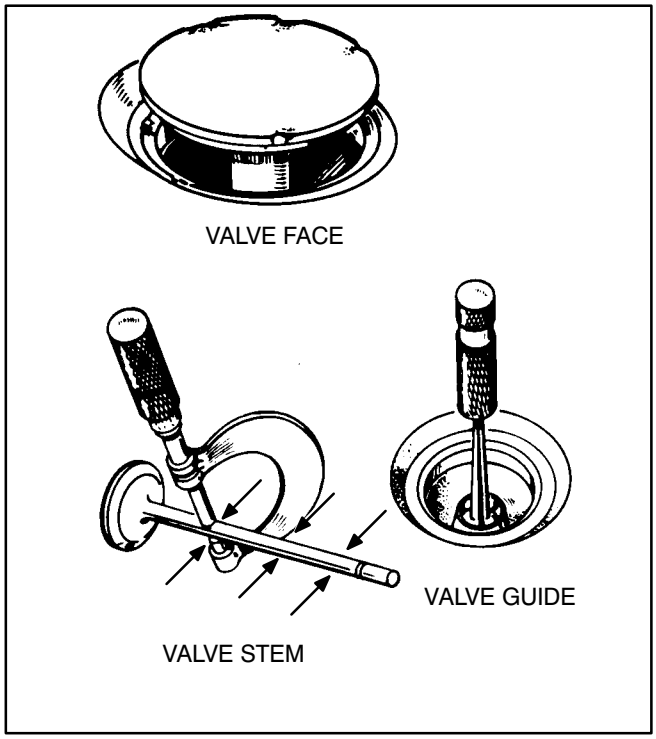


FIGURE 10-8. VALVE FACE, STEM, AND GUIDE

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 10-9. Replace any valve spring that is weak, cracked, worn, or distorted.

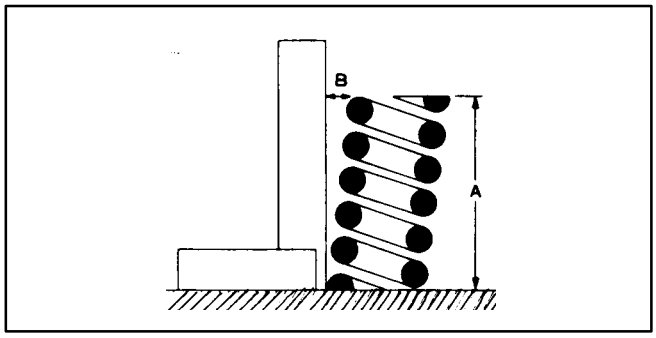


FIGURE 10-9. VALVE SPRING CHECKS

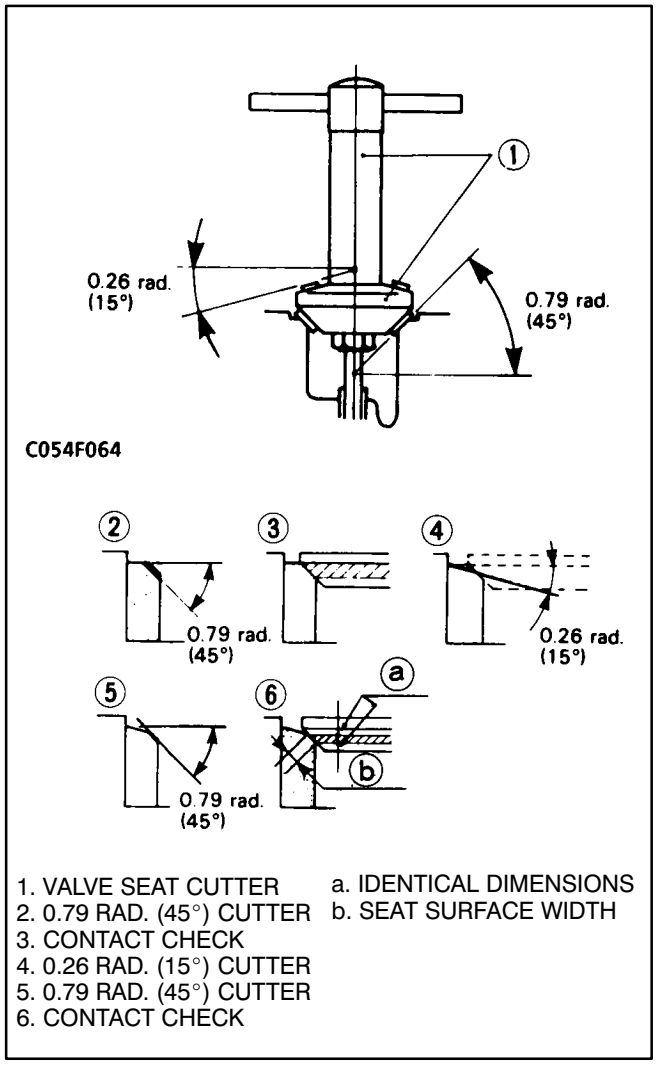
Valve Seat Surface Width

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

Regrinding Seat Surface

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

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



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

Intake Valve Seal Replacement

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

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

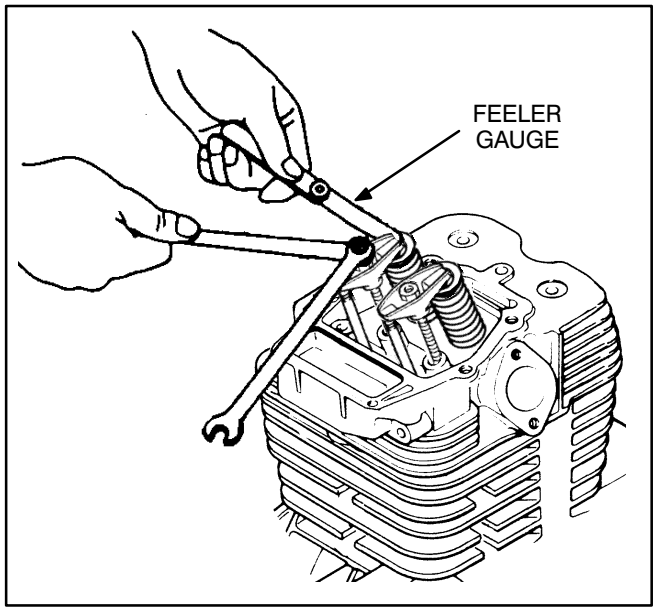


FIGURE 10-11. VALVE CLEARANCE ADJUSTMENT

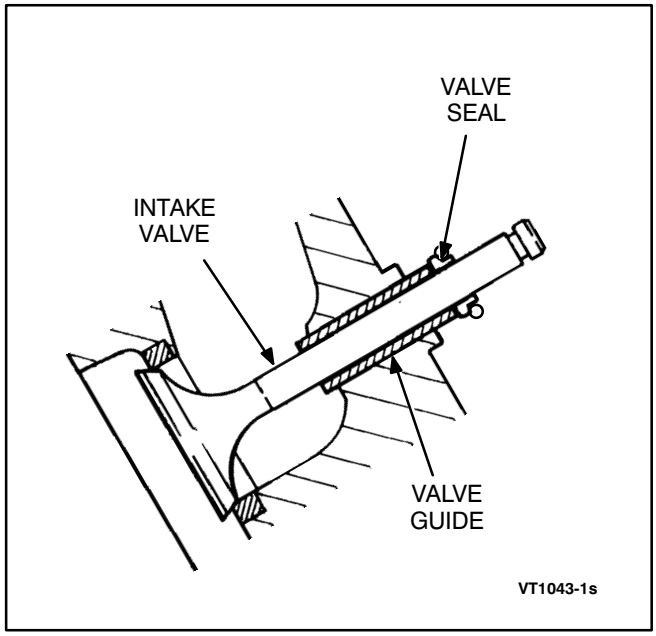


FIGURE 10-12. VALVE SEAL INSTALLATION

CRANKCASE COVER

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

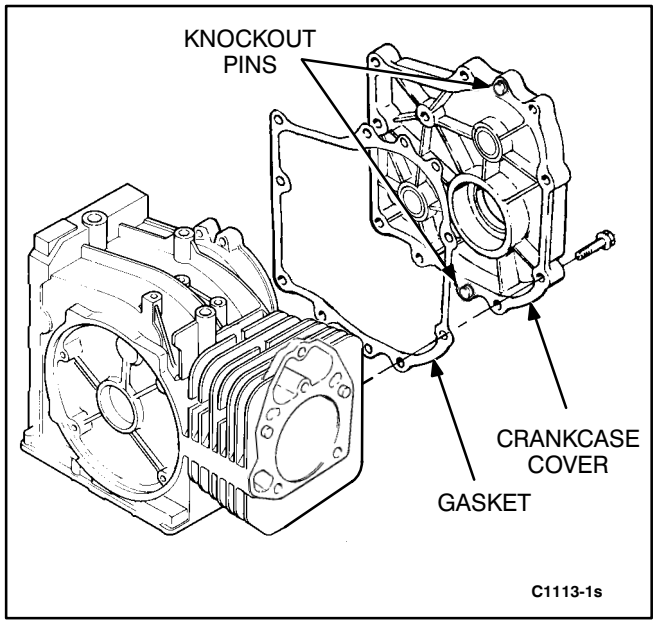


FIGURE 10-13. CRANKCASE COVER

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.

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

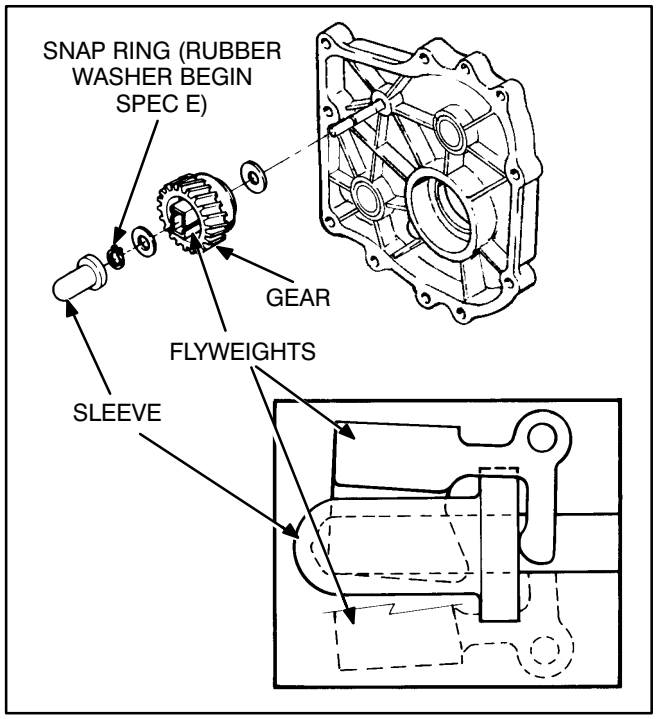


FIGURE 10-14. GOVERNOR

CAMSHAFT, TAPPET AND BALANCER REMOVAL

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

PISTON AND CRANKSHAFT

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

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

1. Remove the two bolts from the connecting rod cap. Mark direction of assembly for connecting the rod, cap, and splasher.

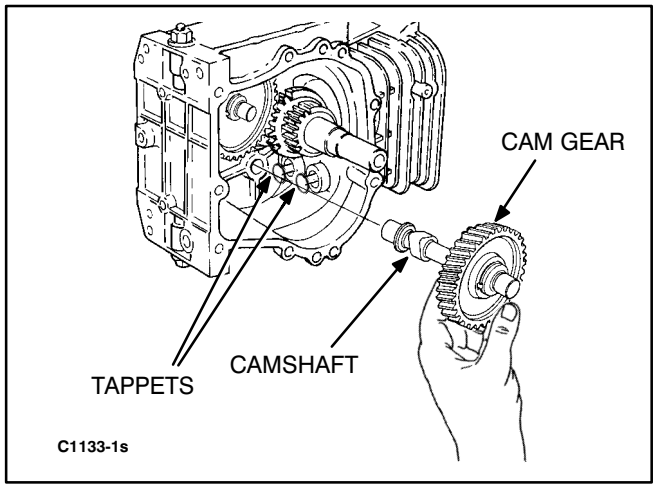


FIGURE 10-15. CAMSHAFT AND TAPPETS

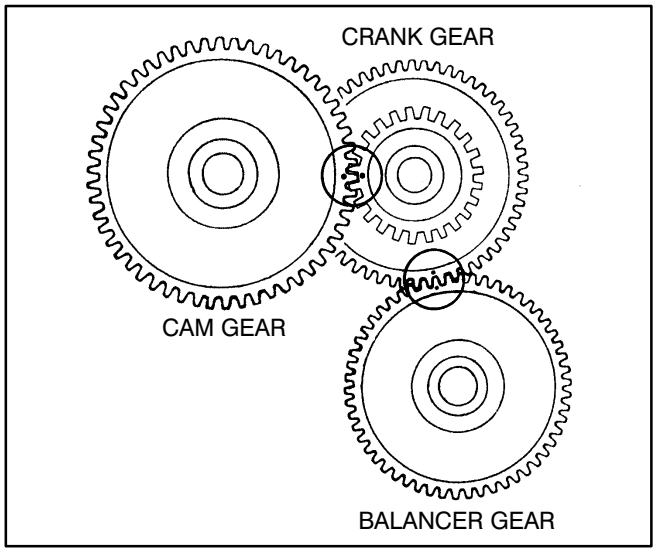


FIGURE 10-16. CAM, CRANK AND BALANCER GEAR ALIGNMENT

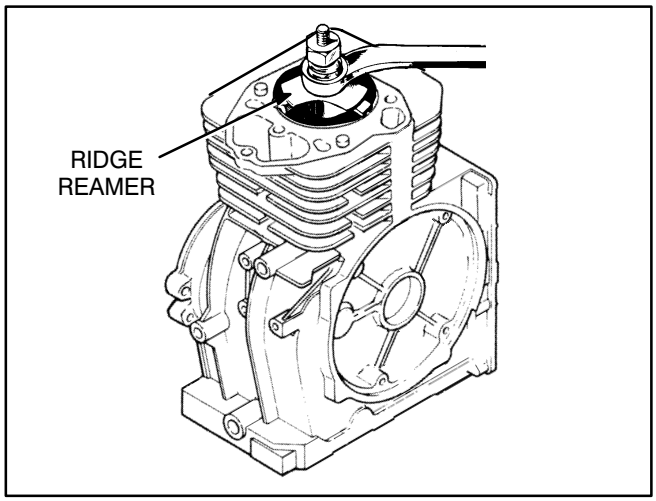


FIGURE 10-17. REMOVING WEAR RIDGE

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

INSPECTION OF ENGINE PARTS

Cylinder Head

1. Clean the cylinder head surface and measure flatness with a straight edge and feeler gauge (Figure 10-19).
2. Replace the cylinder head if flatness is not within specifications (see Section 3*. Dimensions and Clearances*).

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.

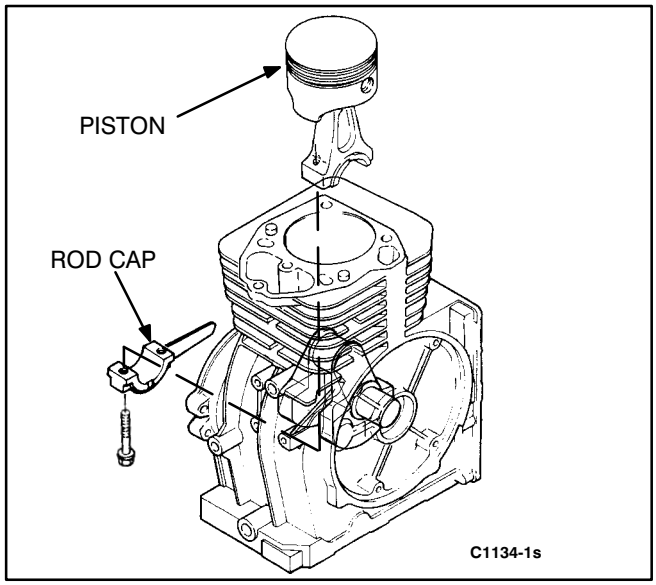


FIGURE 10-18. PISTON REMOVAL

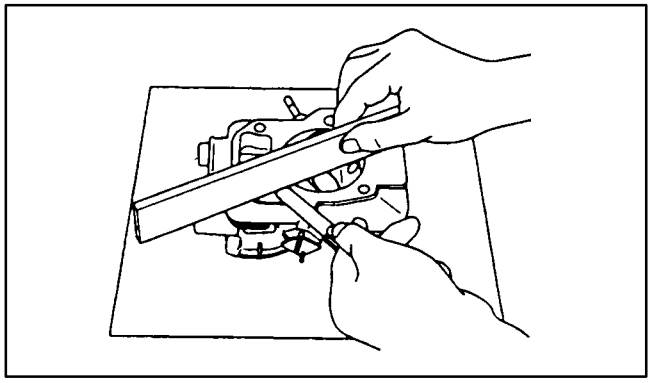


FIGURE 10-19. CYLINDER HEAD FLATNESS

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 10-20).
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 10-21).
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.***

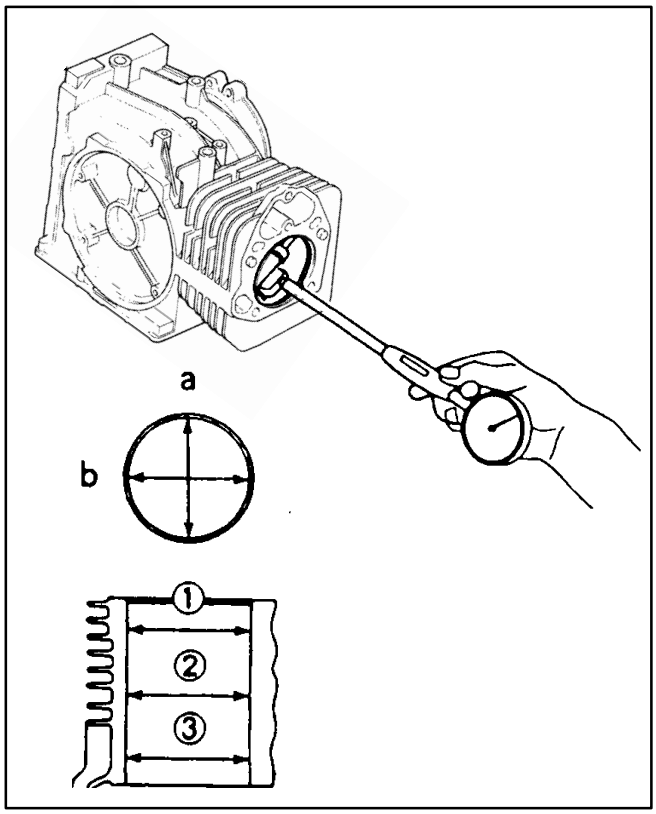


FIGURE 10-20. MEASURING CYLINDER WEAR

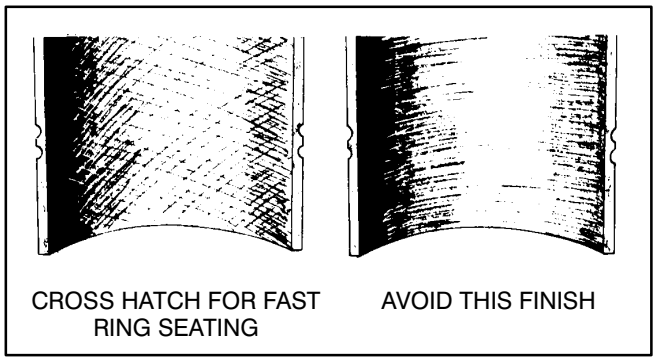


FIGURE 10-21. CROSSHATCHING

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 10-22).

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 10-23) 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 10-24). 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 10-25).
2. If the measurement is less than the allowable limit, replace the piston.

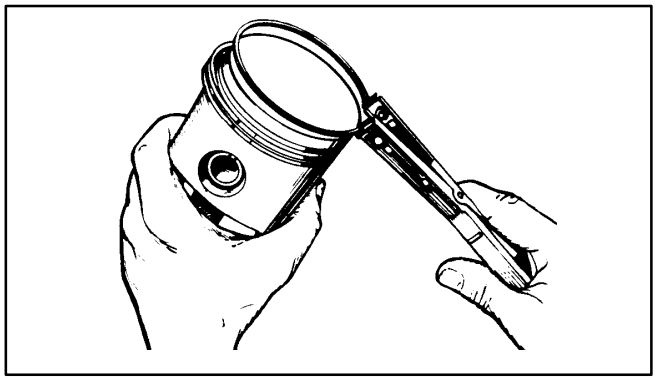


FIGURE 10-22. REMOVING PISTON RINGS

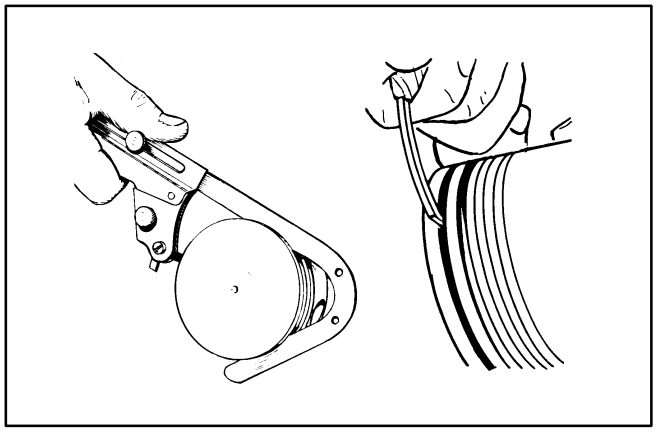


FIGURE 10-23. CLEANING RING GROOVES

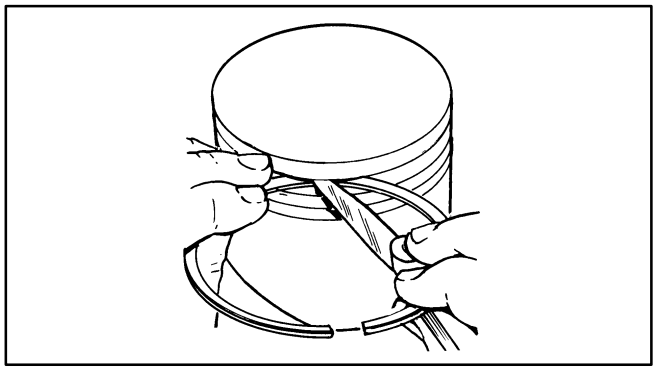


FIGURE 10-24. CHECKING RING LAND

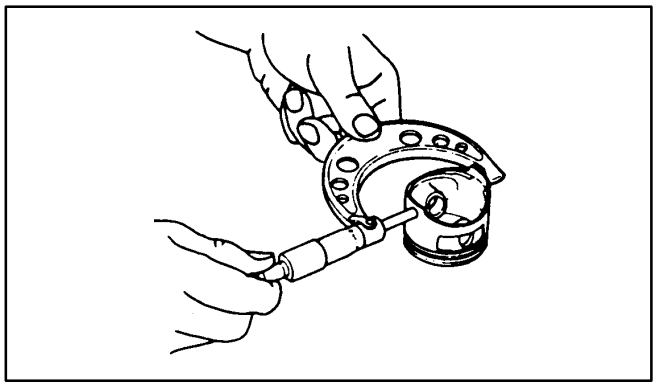


FIGURE 10-25. PISTON SKIRT MEASUREMENT

Piston Boss I.D. Measurement:

1. Measure the piston boss ID in both the vertical and horizontal direction (Figure 10-26).
2. If the measurement exceeds the allowable limit, replace the piston.

Piston Ring Gap:

1. Insert piston ring into cylinder. Use piston head to push ring down to bottom of cylinder.
2. Measure ring gap (Figure 10-27).
3. If the ring gap exceeds the allowable limit, replace the ring.

Piston Ring Thickness:

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

Piston Assembly

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

Clearance between Piston Pin and Connecting Rod Small End Bore

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

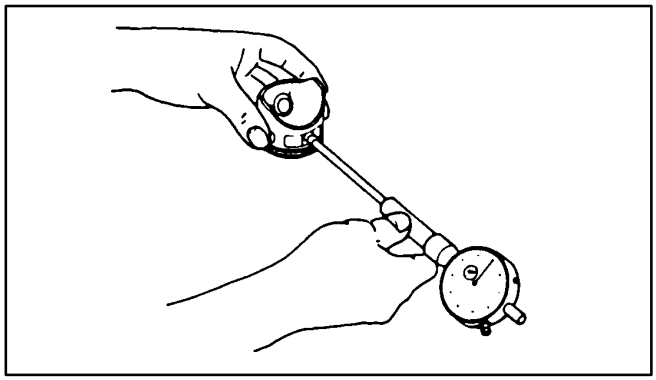


FIGURE 10-26. PISTON BOSS I.D.

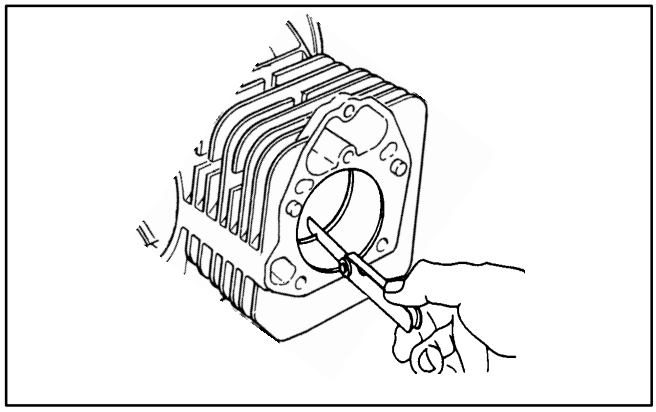


FIGURE 10-27. MEASURING RING GAP

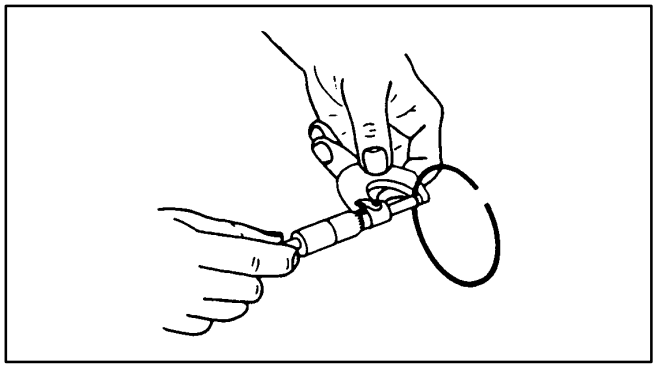


FIGURE 10-28. RING THICKNESS

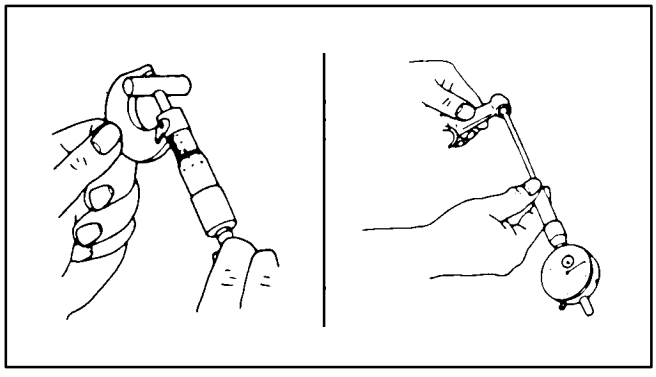


FIGURE 10-29. PISTON PIN TO CONNECTING ROD CLEARANCE

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 10-30).
2. If the clearance exceeds the allowable limits, replace them.

Side Clearance of Connecting Rod on Crank Pin

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

Cam Heights for Intake and Exhaust

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

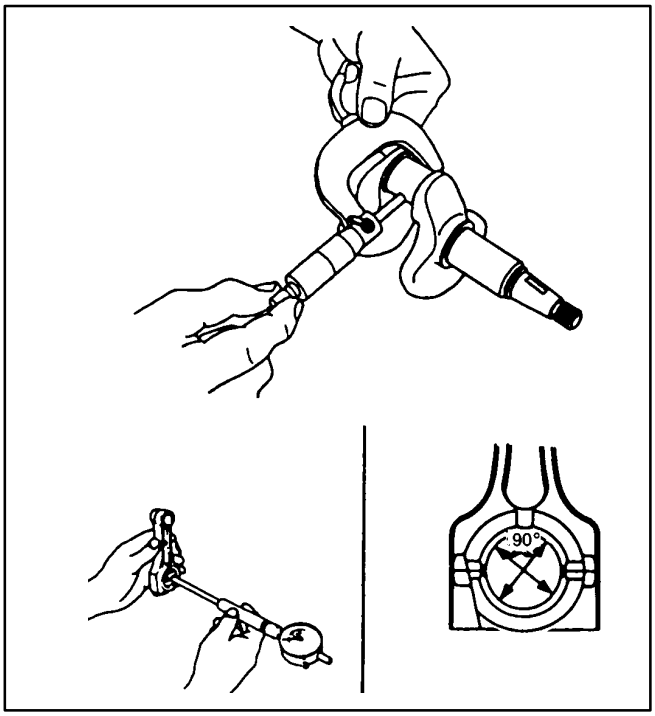


FIGURE 10-30. CRANK PIN AND CONNECTING ROD CLEARANCE

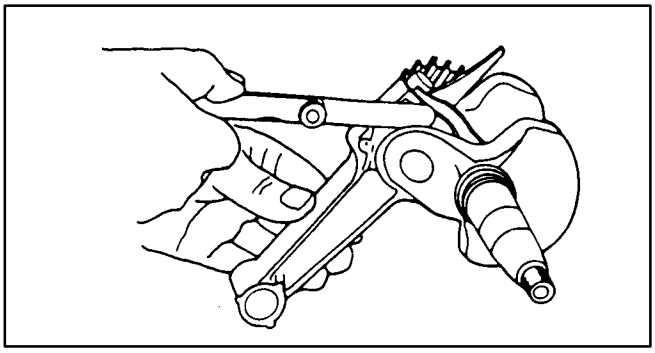


FIGURE 10-31. SIDE CLEARANCE OF CONNECTING ROD ON CRANK PIN

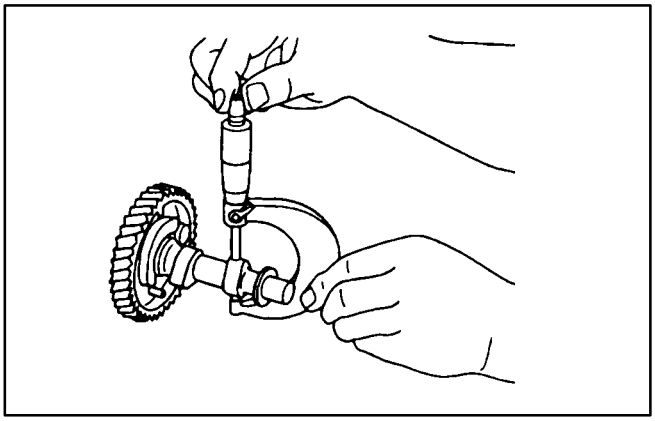


FIGURE 10-32. INTAKE AND EXHAUST CAM HEIGHTS

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 10-33, push the shaft in and measure the clearance.
2. If the side clearance exceeds the allowable limits, adjust with shims.

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

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

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

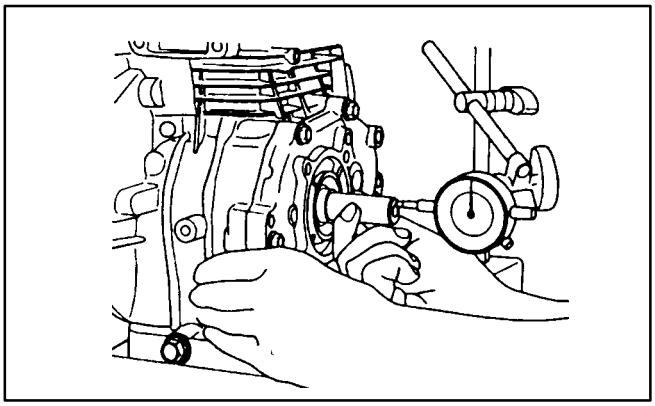


FIGURE 10-33. SIDE CLEARANCE OF CRANKSHAFT

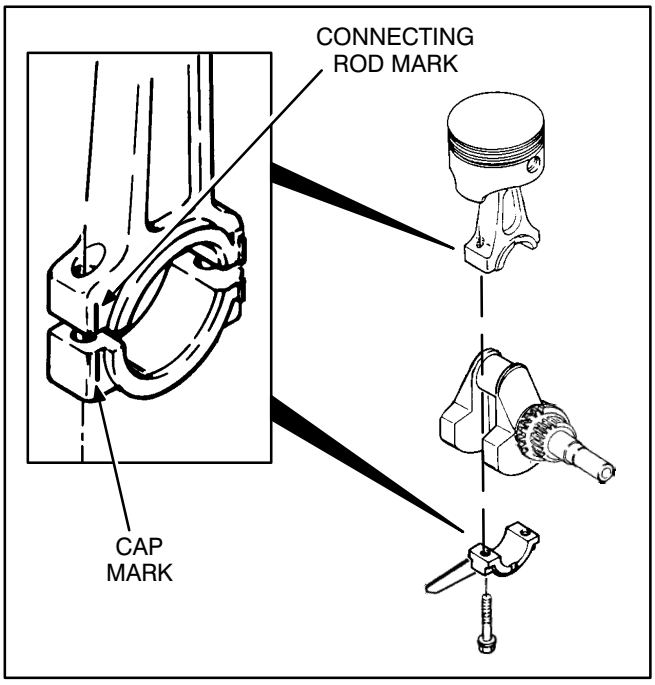


FIGURE 10-34. ROD CAP ASSEMBLY

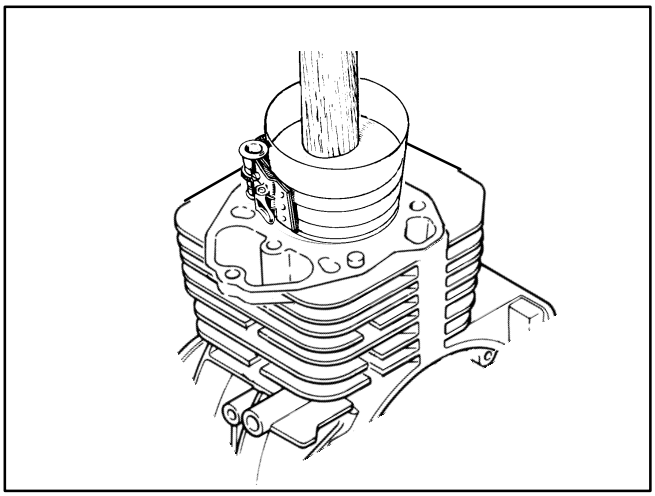


FIGURE 10-35. INSTALLING PISTON

Crankpin Clearance

1. Wipe the oil off the rod cap and crankpin.
2. Place a piece of the correct size Plasti-gage across the full width of the rod cap about 1/4 inch (6 mm) off center (Figure 10-36).
3. Install the rod cap and tighten to the specified torque. Do not rotate crankshaft after the rod cap is in place.
4. Remove the rod cap and leave the flattened Plasti-gage on the part to which it adheres. Compare the widest point of the flattened Plasti-gage with the graduations on the envelope to determine the crankpin clearance.
5. Remove the Plasti-gage. Lubricate the rod crankpin and cap. Install the connecting rod cap. The rod cap must be tapped several times to properly align it with the connecting rod. Tighten the connecting rod bolts to the specified torque.
6. Crank the engine several times to see that the crankshaft turns freely.

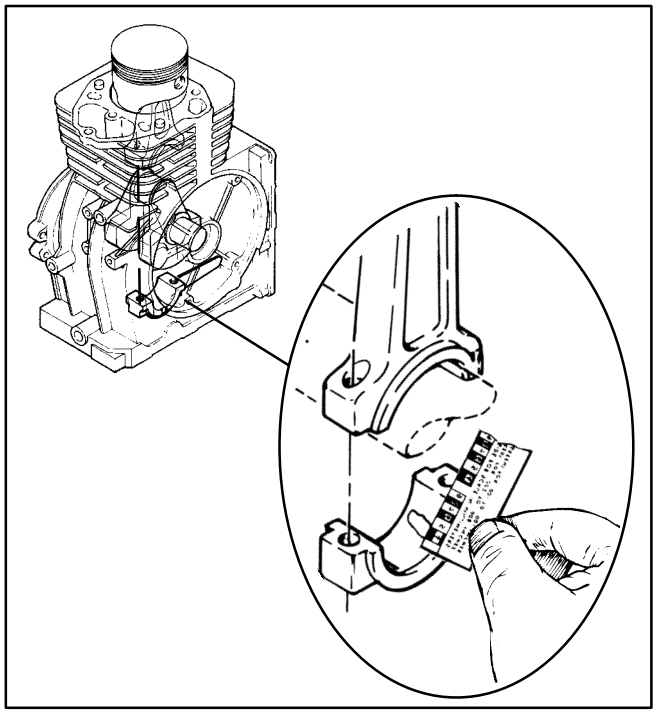


FIGURE 10-36. USING PLASTI-GAGE TO MEASURE CRANKPIN CLEARANCE

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 10-37). Lubricate the lips of the oil seal with a light coating of grease. This provides initial lubrication until engine oil reaches the seal.

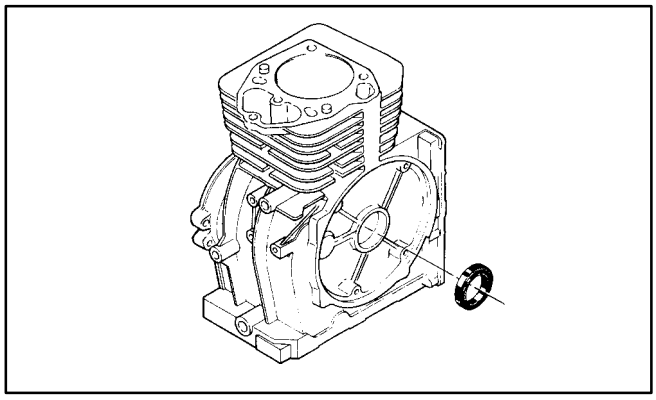


FIGURE 10-37. OIL SEAL

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 boat with the genset running unless the boat 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 and keeping swimmers away from areas where exhaust can accumulate.

GENERAL

After the genset has been serviced and reinstalled in the pontoon boat, 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/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 Section 8. *Primary Engine Systems*).

EXHAUST SYSTEM

With the genset operating, inspect the entire exhaust system. Make certain that the exhaust tail pipe terminates beyond the perimeter of the pontoon boat 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).

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.

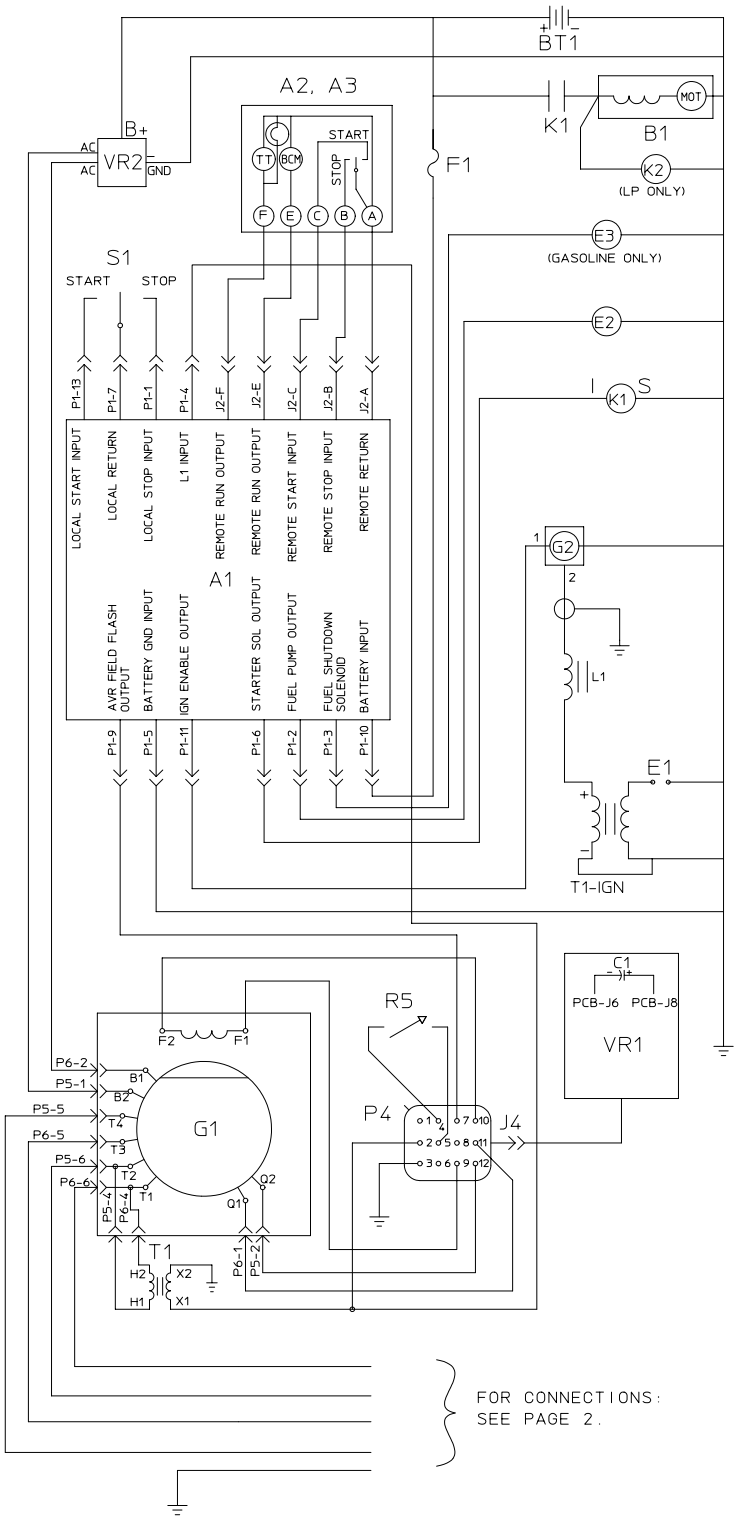
CONTROL

Stop and start the genset several times at the genset control and remote control (if 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.

12. Wiring Diagrams



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

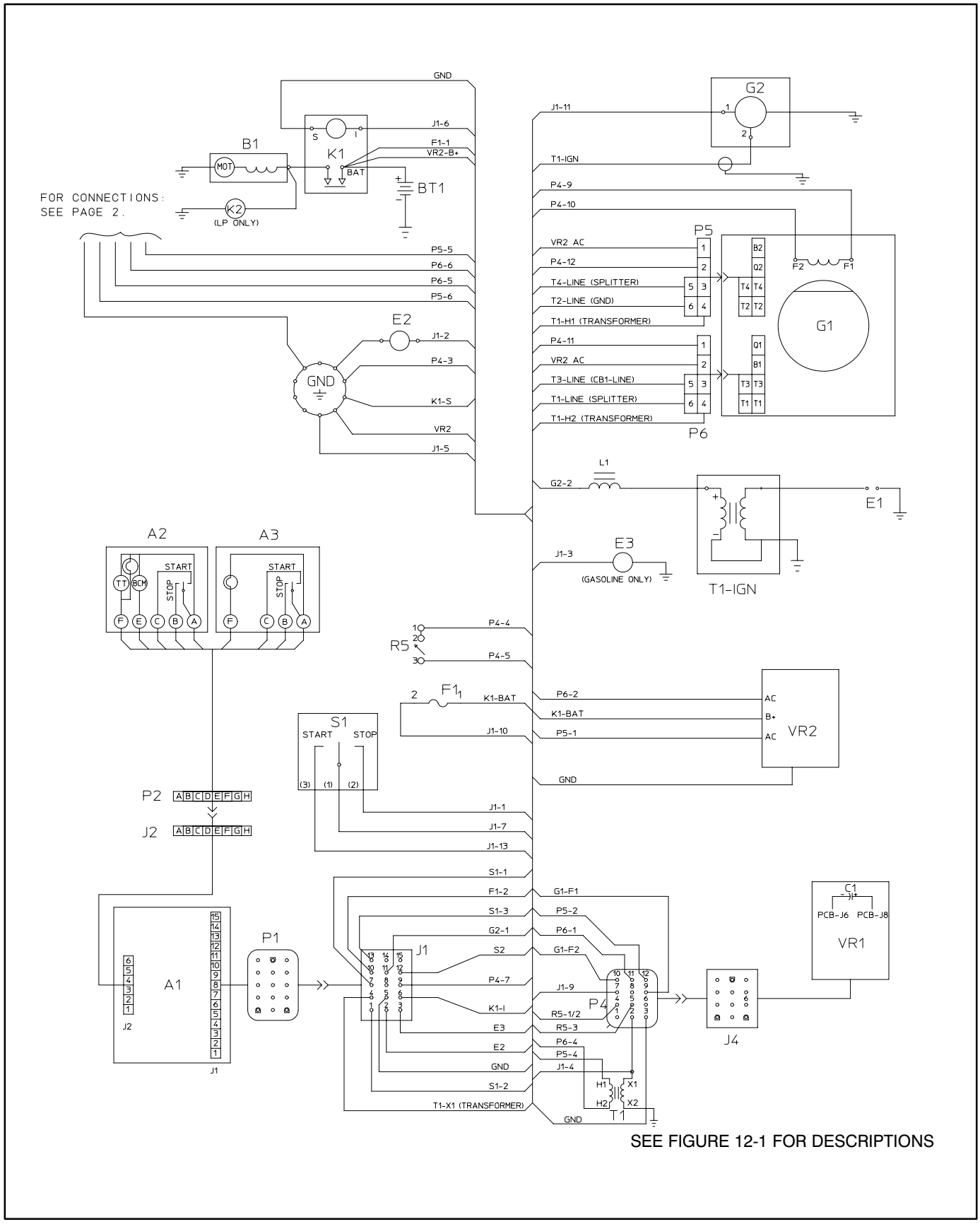
NOTE:

1. THIS DRAWING ILLUSTRATES WIRING FOR 2 WIRE 220/240V OPERATION. FOR ALL OTHER CONFIGURATIONS SEE SHEET 2.

2. E3 IS USED ONLY ON GASOLINE SETS. K2 IS USED ONLY ON LP SETS.

3. FERRITE AND SHIELD ARE USED ONLY ON 50 HZ SETS.

FIGURE 12-1. WIRING SCHEMATIC—50 HERTZ



SEE FIGURE 12-1 FOR DESCRIPTIONS

FIGURE 12-2. WIRING DIAGRAM—50 HERTZ

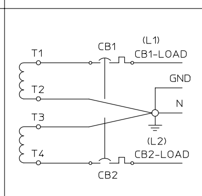
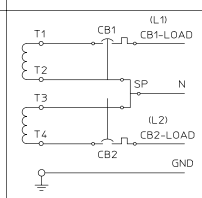
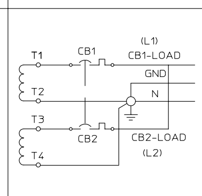
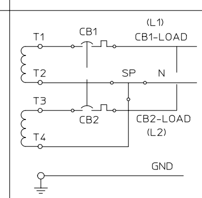
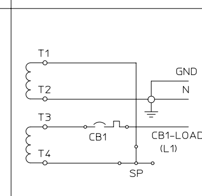
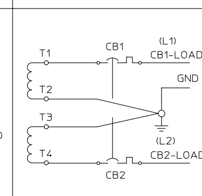
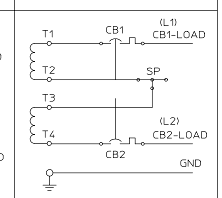
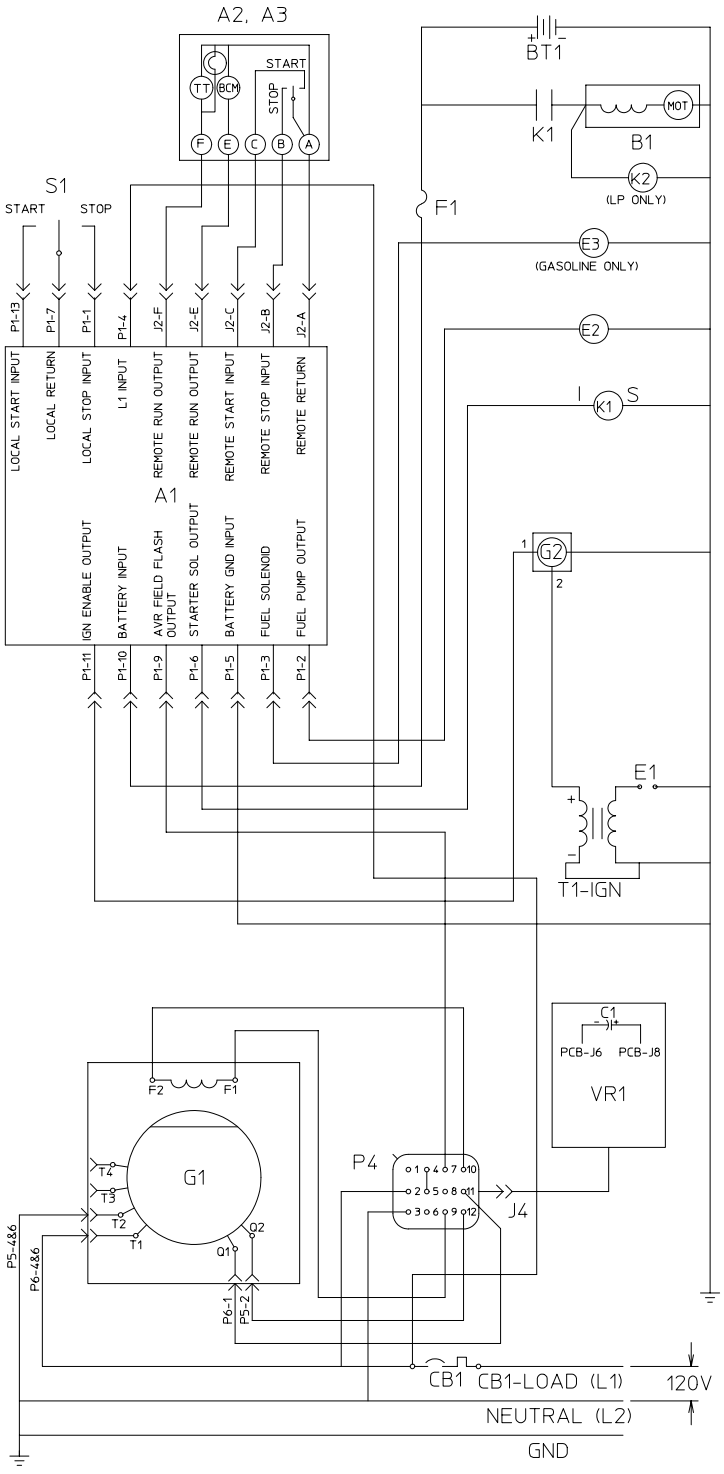
FROM:	TO:						
	3 WIRE 110/220 OR 120/240V		2 WIRE 110 OR 120V		2 WIRE 220 OR 240V		
	NEUTRAL GROUNDED	NEUTRAL ISOLATED	NEUTRAL GROUNDED	NEUTRAL ISOLATED	LINE TO GND=220V NEUTRAL GROUNDED	LINE TO GND=110V NEUTRAL GROUNDED	NEUTRAL ISOLATED
T1-LINE T2-LINE T3-LINE T4-LINE	CB1-LINE GROUND GROUND CB2-LINE	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	
110 OR 120V 220 OR 240V	L1-N, L2-N L1-L2	L1-N, L2-N L1-L2	(L1,L2)-N N/A	(L1,L2)-N N/A	N/A L1-N	N/A L1-L2	N/A L1-L2
RECONNECTION DIAGRAMS							
TABULATION	-01	-02	-03	-04	-05	-06	-07

FIGURE 12-3. VOLTAGE RECONNECTION DIAGRAM—50 HERTZ

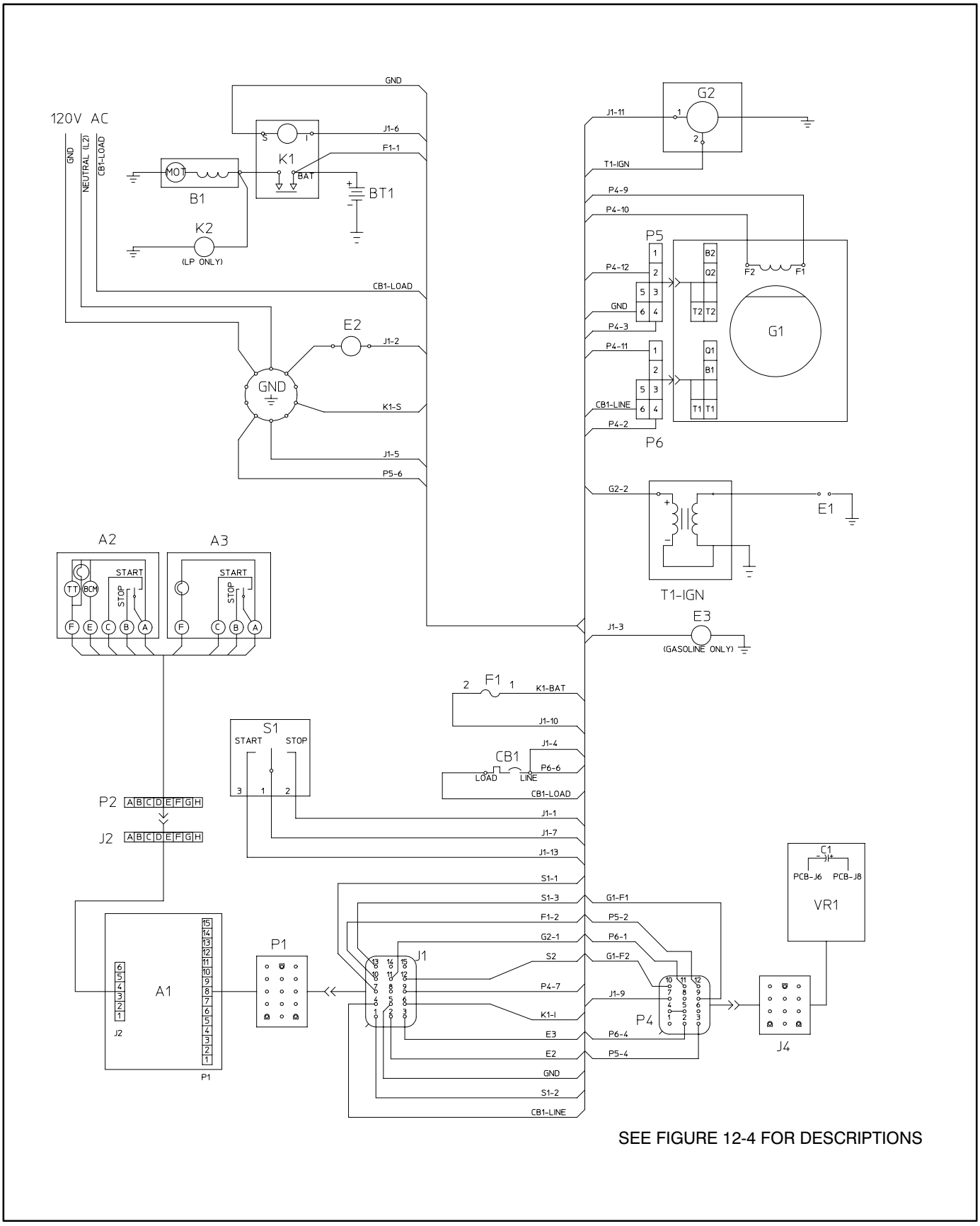


VR1	REGULATOR-VOLTAGE
T1	COIL-IGNITION
SP	SPLICE (SPLITTER)
S2	SWITCH-LOW OIL LEVEL
S1	SWITCH-START/STOP
K2	SOL-REGULATOR (LP ONLY)
K1	RELAY-STARTER
G2	MAGNETO-IGNITION
G1	GENERATOR
F1	FUSE
E3	FUEL SHUTOFF SOL (GAS ONLY)
E2	FUEL PUMP (FUEL SOL-LP)
E1	SPARK PLUG
CB1	CIRCUIT BREAKER (AC OUTPUT)
BT1	BATTERY 12 V
B1	MOTOR-STARTER
A3	REMOTE CONTROL-STANDARD
A2	REMOTE CONTROL-DELUXE
A1	CONTROL ASSY

NOTE:

1. E3 IS USED ONLY ON GASOLINE SETS. K2 IS USED ONLY ON LP SETS.

FIGURE 12-4. WIRING SCHEMATIC—60 HERTZ



SEE FIGURE 12-4 FOR DESCRIPTIONS

FIGURE 12-5. WIRING DIAGRAM—60 HERTZ

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