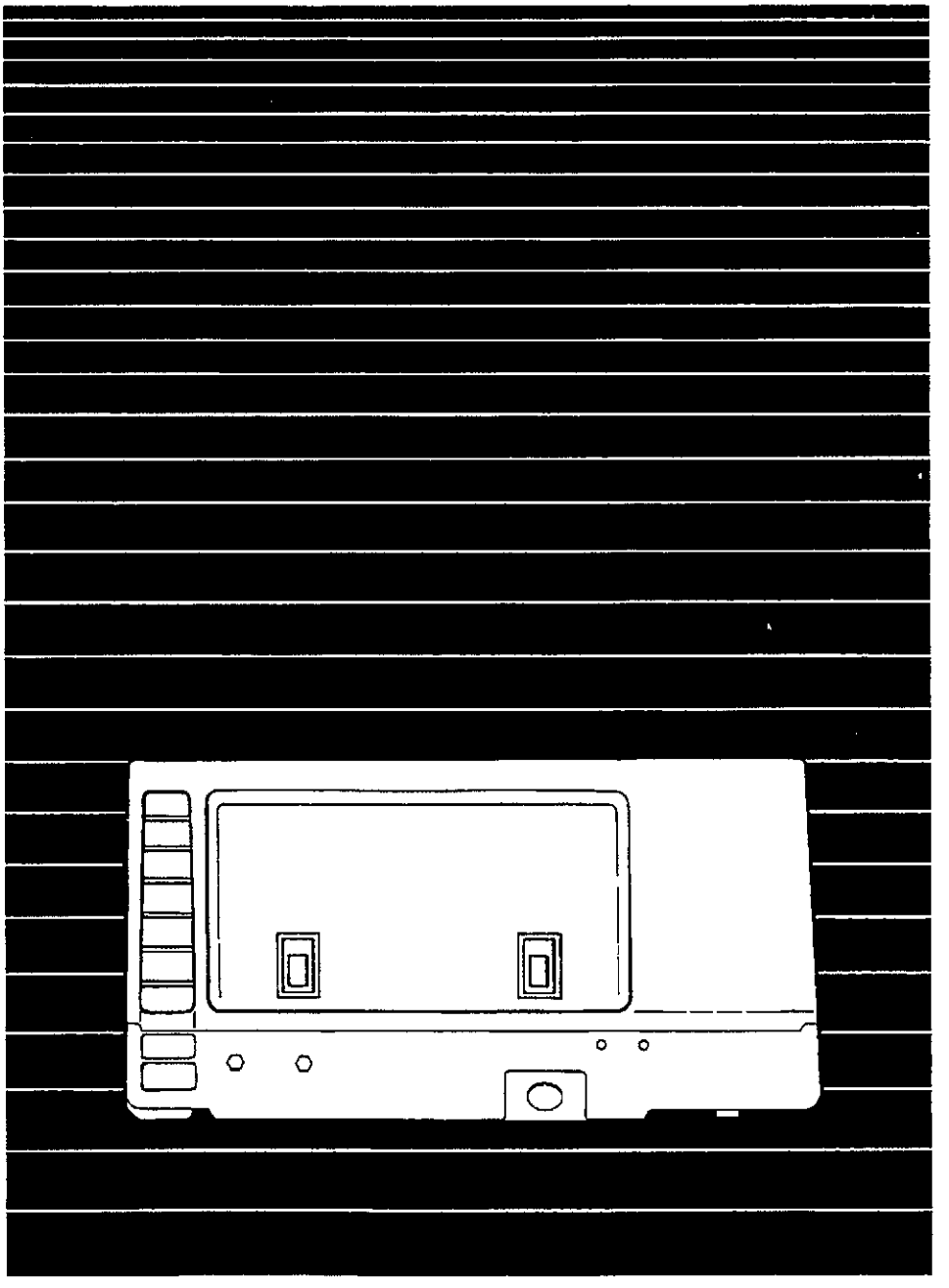
Onan RV GenSet

Service Manual

KV

MicroLite™ 2800 Series



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Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and the equipment. **Safe and efficient operation can be achieved only if the unit is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ DANGER ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

FUEL AND FUMES ARE FLAMMABLE. Fire, explosion, and personal injury can result from improper practices.

- DO NOT fill fuel tanks while engine is running. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT SMOKE OR USE AN OPEN FLAME near the generator set or fuel thank
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible, non–conductive line. Do not use copper piping on flexible lines as copper will work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.

GASOLINE AND LPG FUEL MAY BE ACCIDENTALLY IGNITED BY ELECTRICAL SPARKS, presenting the hazard of fire or explosion, which can result in severe personal injury or death. When installing the generator set:

- Do not tie electrical wiring to fuel lines.
- Do not run electrical lines and fuel lines through the same compartment openings.
- Keep electrical and fuel lines as far apart as possible.
- Place a physical barrier between fuel lines and electrical lines wherever possible.
- If electrical and fuel lines must pass through the same compartment opening, make certain that they are physically separated by running them through individual channels, or by passing each line through a separate piece of tubing.
- DO NOT SMOKE while servicing batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

- Never sleep in the vehicle with the generator set running unless vehicle is equipped with an operating carbon monoxide detector.
- Provide an adequate exhaust system to properly expel discharged gases. Inspect exhaust system daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Before starting work on the generator set, disconnect batteries. This will prevent accidental arcing.
- Keep your hands away from moving parts.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry while working on generator sets. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Disconnect starting battery before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved device and after building main switch is open. Consult an electrician in regard to emergency power use.

GENERAL SAFETY PRECAUTIONS

- Have a fire extinguisher nearby. Maintain extinguisher properly and become familiar with its use. Extinguishers rated ABC by the NFPA are appropriate for all applications. Consult the local fire department for the correct type of extinguisher for various applications.
- Hot coolants under pressure can cause severe personal injury. DO NOT open a radiator pressure cap while the engine is running. Stop the engine and carefully bleed the system pressure.
- Benzene and lead, found in some gasoline, have been identified by some state and federal agencies as causing cancer or reproductive toxicity. When checking, draining or adding gasoline, take care not to ingest, breathe the fumes, or contact gasoline.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage, which presents a potential fire hazard.
- DO NOT store anything in the generator compartment such as oil or gas cans, oily rags, chains, wooden blocks, portable propane cylinders, etc. A fire could result or the generator set operation (cooling, noise and vibration) may be adversely affected. Keep the compartment floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

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Section 1. Introduction

ABOUT THIS MANUAL

This manual provides service information for the Onan KV generator set. It is intended for the experienced serviceperson. This manual covers troubleshooting, disassembly, repair, reassembly, and adjustments for the engine, generator, and control. The serviceperson should be thoroughly familiar with the principles of gasoline engine operation and have a basic knowledge of electrical fundamentals. Other Onan publications such as Electrical/Mechanical Fundamentals (932-0408), Onan Generator Training Manual (932-0404), and KV Operator's Manual (981-0129) and Installation Manual (981-0626) are recommended as additional sources of information.

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

MODEL IDENTIFICATION

When contacting an Onan dealer or distributor, always supply the complete Model number and Serial number as shown on the Onan nameplate. This information is necessary to identify the set when ordering replacement parts. See Figure 1.

Always use genuine Onan replacement parts obtained from an authorized Onan dealer or distributor. Universal replacement type parts (usually intended for automotive use) often look similar but do not perform to Onan specifications. Only genuine Onan replacement parts are designed and tested for the application.

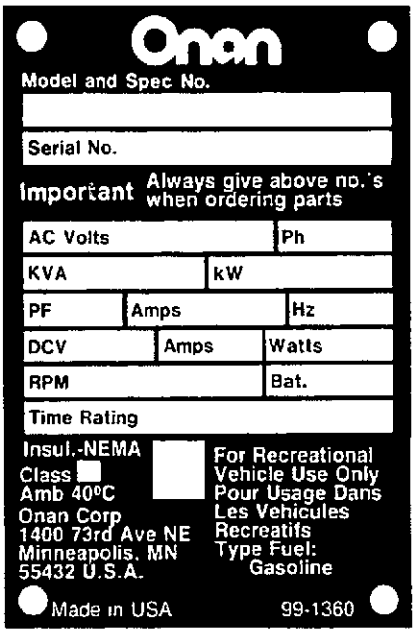

FIGURE 1. ONAN NAMEPLATE

⚠WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS CAN RESULT IN SEVERE PERSONAL INJURY, DEATH, AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

Section 2. Specifications

GENERAL

Engine Design	4-Cycle, Single Cylinder, Overhead Valve
Generator Design	Onan, Revolving Field, 2-Pole, Brushless AC
Starting System	12-Volt Electric Starter
Engine Speed	60 Hertz - 3600 r/min, 50 Hertz - 3000 r/min
Weight	110 lb (50 kg)

ENGINE DETAILS

Displacement	12 in³ (197 cm³)
Compression Ratio	8.5:1
Bore	2.64 in (67 mm)
Stroke	2.2 in (56 mm)
Oil Capacity	1.0 qt (0.95 L)
Ventilation (Free Area)	24 in² (154.8 cm²)
Fuel	Gasoline/Gasohol/LPG

TUNE-UP SPECS

Spark Plug Gap	0.025 in (0.64 mm)
Timing	25° BTC
Valve Lash (Intake and Exhaust)	0.002 in (0.05 mm)

GENERATOR DETAILS

Gasoline Models	1.7 KV	2.0 KV	2.2 KV	2.8 KV
Power (Watts)	1700	2000	2200	2800
Voltage	240	220	120	120
Amps	7.1	9.1	18.3	23.3
Frequency (Hertz)	50	50	60	60
Phase	1Ø	1Ø	1Ø	1Ø
Wires	2	2	2	2
Battery Charge	1 Amp	1 Amp	1 Amp	1 Amp

LPG Models	2.0 KV	2.5 KV
Power (Watts)	2000	2500
Voltage	220	120
Amps	9.1	20.8
Frequency (Hertz)	50	60
Phase	1Ø	1Ø
Wires	2	2
Battery Charge	1 Amp	1 Amp

Section 3. Dimensions and Clearances

ITEM			INCHES	MILLIMETERS
CYLINDER HEAD				
Cylinder Head Deformation Limit			0.00394/3.39370	0.100/100.0
Torque			(18-24 ft•lb)	(25-33 N•m)
VALVE				
Valve Face Angle		Intake	44.5°-45°	
		Exhaust	44.5°-45°	
Valve Stem Diameter		Intake	0.2153-0.2157	5.468-5.480
		Exhaust	0.2142-0.2150	5.440-5.460
Valve Guide Inside Diameter			0.2165-0.2170	5.500-5.512
Clearance Between Valve and Guide Stem				
Reference Valve		Intake	0.00079-0.00173	0.020-0.044
		Exhaust	0.00157-0.00283	0.040-0.072
Allowable Limit			0.0039	0.10
Valve Clearance		Intake	0.00079-0.0031	0.02-0.080
		Exhaust	0.00079-0.0031	0.02-0.080
Valve Opening Closing Timing (when cool)	Intake	Opening	78° (58°-70° before top dead center)	
		Closing	118° (98°-110° after bottom dead center)	
	Exhaust	Opening	118° (98°-110°after bottom dead center)	
		Closing	78° (58°-70° before top dead center)	
Valve Spring				
Free Height		Reference Value	1.299-1.319	33.0-33.5
		Allowable Limit	1.287	32.7
Load and Height		Reference Value	12.94 lb/0.8858 in	5.87 kgf/22.5 m
		Allowable Limit	11.64 lb/0.8858 in	5.28 kgf/22.5 m
Allowable Squareness Limit			0.0591	1.5
Valve Seat				
Valve Seat Angle		Intake	45°	
		Exhaust	45°	
Valve Seat Width		Reference Valve	0.0394-0.0512	1.0-1.3
		Allowable limit	0.0591	1.5

ITEM		INCHES	MILLIMETERS
Valve Lifter			
Outer Diameter		0.31	8
Clearance Between Valve Lifter And Guide	Reference Value	0.0014-0.0030	0.035-0.075
	Allowable Limit	0.0039	0.1
Camshaft			
Standard Journal Diameter		0.5892-0.5899	14.966-14.984
Clearance Between Camshaft Journal Bearing (Flywheel Side)		0.0006-0.0020	0.016-0.052
Cam Height	Reference Value Intake	0.9705	24.65
	Reference Value Exhaust	0.9705	24.65
	Allowable Limit Intake	0.9665	24.55
	Allowable Limit Exhaust	0.9665	24.55
Allowable Side Clearance Limit		0.0079	0.20
Bending Limit		0.0020	0.05
Timing Gear			
Backlash	Reference Value	0.0036-0.0056	0.092-0.141
	Allowable Limit	0.0079	0.20
Cylinder			
Inner Diameter	Reference Value	2.6378-2.6386	67.00-67.02
	Allowable Limit	0.0039	0.10
Minimum Clearance Between Cylinder and Piston		0.0016	0.04
Piston			
Outer Diameter (Skirt Diameter)		2.6354-2.6362	66.94-66.96
Piston Ring			
Gap	Reference Value	0.0079-0.0157	0.20-0.40
	Allowable Limit	0.0354	0.90
Clearance Between Ring And Ring Groove	Reference Limit	0.0008-0.0024	0.02-0.06
	Allowable Limit	0.0039	0.10

ITEM		INCHES	MILLIMETERS
Piston Pin	Outer Diameter	0.5906-0.5907	15.000-15.005
Connecting Rod (Small End) Inner Diameter	Reference Value	0.5911-0.5915	15.015-15.025
Clearance between small end And Piston Pin	Reference Value	0.0004-0.0010	0.010-0.025
	Allowable Limit	0.0039	0.10
Connecting Rod Bending Limit		0.0016	0.04
Torsion Limit		0.0016	0.04
Bolt Tightening Torque		(10.1-14.5 ft•lb)	(13.7-19.6 N•m)
Crankshaft Pin Diameter	Reference Value	1.1798-1.1804	29.967-29.982
	Wear Limit	1.1780	29.92
Crank pin oil Clearance	Reference Value	0.0007-0.0021	0.018-0.054
	Allowable Limit	0.0039	0.10
Journal Dia.	Reference Value	0.9835-0.9840	24.980-24.993
	Wear Limit	0.9803	24.9
Side Clearance	Reference Value	0.0008-0.0039	0.02-0.10
	Allowable Limit	0.0079	0.20
Bending Limit		0.0008	0.02
Axial Play	Reference Value	0-0.0039	0-0.10
	Allowable Limit	0.0079	0.20
Ignition Plug	Standard Gap	0.0236-0.0276	0.6-0.7

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Section 5. Preparing to Service

TROUBLESHOOTING

Before starting to service the generator set, follow a systematic troubleshooting procedure to locate and isolate the problem. For servicing purposes, the generator set can be divided into the following:

- Engine - Primary Systems
- Control
- Generator
- Engine - Block Assembly

This manual contains separate sections that cover each area.

Several troubleshooting guides are included in this manual to help the serviceperson locate the cause of various malfunctions. Note that some malfunctions might have several possible causes. For this reason, the serviceperson may have to investigate several likely problem areas in order to isolate the source of the malfunction. Because of the complexity of the product, a troubleshooting chart cannot list every malfunction and the cause. In some situations, the serviceperson will have to rely on experience and a knowledge of the product to locate the problem and service as required.

SPECIAL TOOLS

The following special tools may be required to service the generator set. Some of these tools may be purchased from Onan while others may be purchased from outside suppliers. A complete listing of the tools available from Onan is contained in the Tool Catalog (900-0019) which is available from Onan Dealers or Distributors.

Engine Tools

Torque wrench (0-50 Ft-Lbs or 0-70 N•m)
Feeler gauge
Pressure gauge
Spark plug gap gauge
Flywheel puller
Gear separator
Cylinder ridge reamer
Piston ring compressor
Piston ring spreader
Cylinder hone
Valve seat cutter
Wire brush
Piston groove cleaner
Outside micrometer set (0 to 4 in.)
Telescoping gauge set (1/2 in. to 6 in.)
Hole gauge (0.300 in. to 0.400 in.)
Valve Seal Replacement Tool

Generator and Control Tools

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

SAFETY CONSIDERATIONS

Always consider the safety aspects of any service procedure. Generator sets present several hazards that the serviceperson must be aware of to safely complete the job. Read through the safety precautions listed on the inside cover and familiarize yourself with the various hazards shown in Table 5-1. Once the hazards are known, approach the job with a safety conscious attitude. Being safety conscious is the most effective way to avoid injury to yourself or others. Reduce the chance that an accident will occur by adopting the following safeguards.

Safeguards to Avoid Hazards

- **Use Personal Protection -** Protect your body by wearing the appropriate safety equipment. Protective clothing includes safety shoes, gloves, safety glasses, and hard hats. Leave rings and jewelry off and do not wear loose clothing that might get caught on equipment.

- **Work to Reduce the Hazard -** The workshop area and all pieces of equipment used can contribute to reducing 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 open flame, spark, pilot light, cigarette, or other ignition source. Keep the workshop clean and well-lighted, and provide adequate ventilation. Keep fire extinguishers and safety equipment nearby and be prepared to respond to an emergency.

TABLE 5-1
HAZARDS AND THEIR SOURCE

- Fire and Explosions
  - —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 short in DC wiring system
- Poisonous Gases
  - —Carbon monoxide from faulty exhaust pipes, joints, or hangers
  - —Operating generator set where exhaust gases can accumulate
- Electrical Shock (AC)
  - —Improper generator set load connections
  - —Faulty RV wiring
  - —Faulty electrical appliance
  - —Faulty generator set wiring
  - —Working in damp conditions
  - —Jewelry touching electrical components
- Rotating Machinery
  - —Jewelry or loose clothing catching in moving parts
- Slippery Surfaces
  - —Leaking or spilled oil
- Heavy Objects
  - —Removing generator set from RV
  - —Removing heavy components

- **Develop Safe Work Habits** - Unsafe actions are identified as the cause of most accidents involving the use of 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. Observe the warnings and cautions 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 if an accident does occur. Numerous agencies such as the Red Cross and your local police and fire departments offer basic courses in first aid, mouth-to-mouth resuscitation, and fire control. Take advantage of these offerings so you are ready to respond when an accident happens. Learn to be safety conscious and make safe practices a part of your work routine. Do not work when tired or after consuming any alcohol or drug that makes the operation of equipment unsafe.

SET REMOVAL

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

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

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

⚠WARNING ***Generator sets are heavy and can result in severe personal injury if dropped during removal. Use adequate lifting devices to provide sufficient support for the set. Keep hands and feet clear while lifting.***

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

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

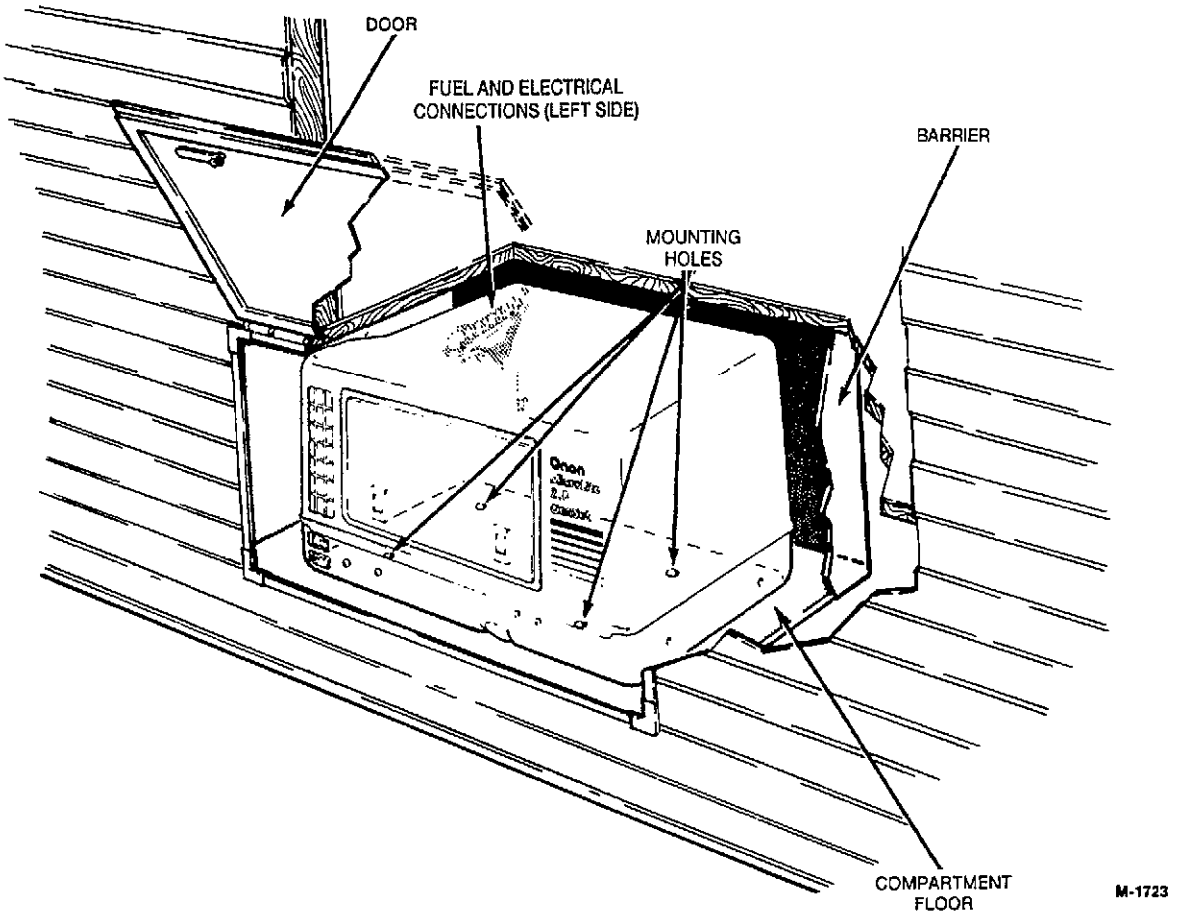

FIGURE 5-1. TYPICAL COMPARTMENT MOUNT INSTALLATION

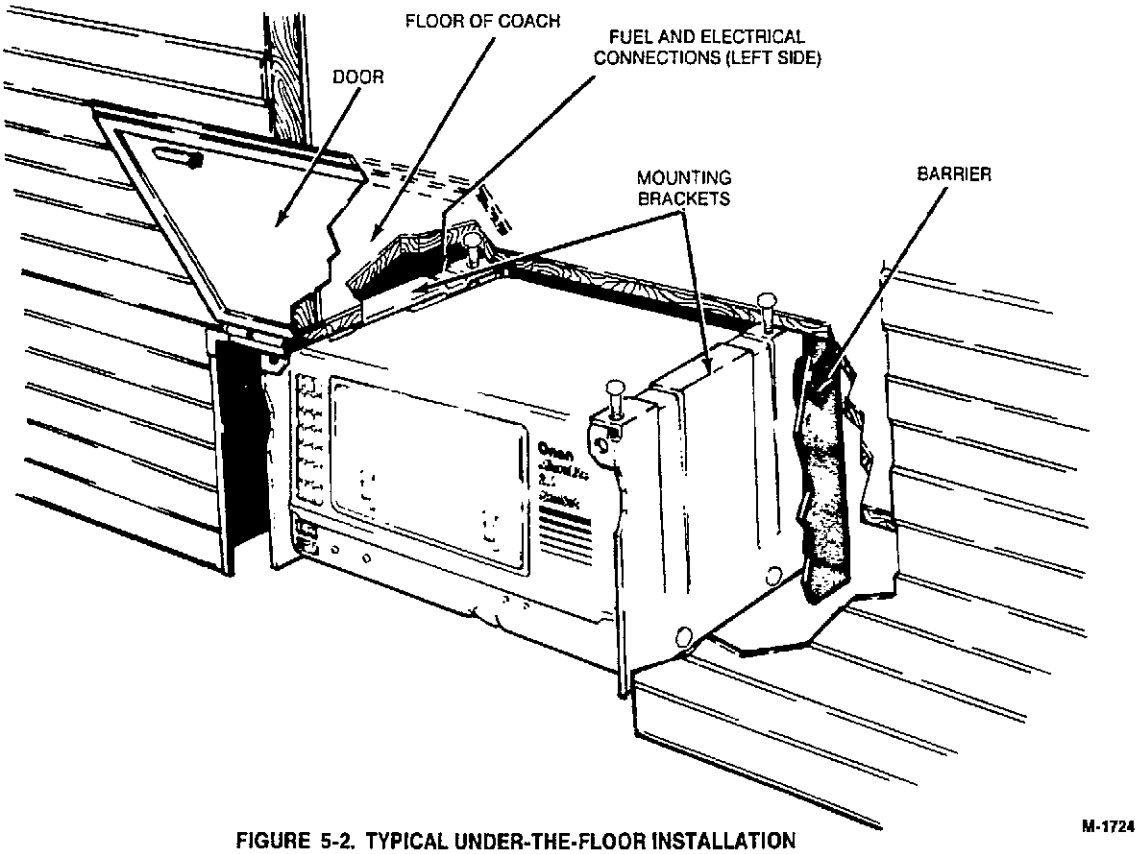

FIGURE 5-2. TYPICAL UNDER-THE-FLOOR INSTALLATION

Disconnecting Set from RV Systems

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

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

1. Disconnect the vehicle negative (-) battery cable at the battery terminal.
2. Disconnect the generator set negative (-) battery cable at the battery terminal.
3. Disconnect the generator set positive (+) battery cable from the wire harness.
4. Disconnect the remote control wire plug from the generator set housing.
5. Disconnect the generator load wires at the RV electrical system junction box. Tag the RV circuit wires for positive identification when reconnecting.
6. Loosen the conduit connector and pull the load wires and flexible conduit free of the junction box.
7. Disconnect the tailpipe from the muffler or disconnect any support brackets or hangers attached to the tailpipe to allow set removal.
8. Disconnect the fuel line at the generator set housing. Securely plug the end of the fuel line to prevent fuel leakage or an accumulation of explosive gasoline vapor.

⚠WARNING ***Gasoline vapor is extremely flammable and can result in severe personal injury or death if ignited. Make certain all fuel line openings are plugged to prevent gasoline vapor from accumulating. Before disconnecting the fuel line, be certain there are no ignition sources such as flame, spark, pilot light, cigarette, etc., near the generator set. Keep an ABC type fire extinguisher nearby.***

LP-Gas (Propane) Purging Procedure

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

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

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

Slightly open the fuel line where it connects to the generator set just enough to allow the LP-gas to slowly escape. Don't open the fitting too much or a large quantity of gas will be released.

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

Removing Conventional Compartment Mounted Set from RV

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

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

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

Removing Underfloor Mounted Set From RV

When the generator set has been disconnected from the electrical, exhaust, and fuel systems, the set may be removed for major service work. The generator set is mounted on support brackets that are bolted to the underside of the floor on the vehicle or trailer and to the generator set housing.

The generator set is completely suspended underneath the floor of the RV by the support brackets. To avoid dropping the set during removal, follow the recommended set removal procedures.

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

Park the recreational vehicle on as level a surface as possible. Then follow these steps very carefully.

1. Put the vehicle in its park position, lock the brakes, and remove the keys (if applicable). Make sure no one moves the vehicle while performing this procedure.

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

2. Use a forklift truck to support the weight of the generator set at the points shown in Figure 5-3.
3. Raise the forklift just so it makes contact with the bottom of the generator set housing, then put a little upward pressure under the set. Verify that the weight of the generator set is supported by the forks before proceeding.
4. Remove the bolts that secure the generator set to the side mounting brackets and rear mounting braces.
5. Slowly lower the generator set until it clears all obstructions and can be safely moved out from under the vehicle.
6. When reinstalling the generator set, be sure that all bolts, brackets, and electrical, exhaust, and fuel system components are connected exactly as they were before removal.

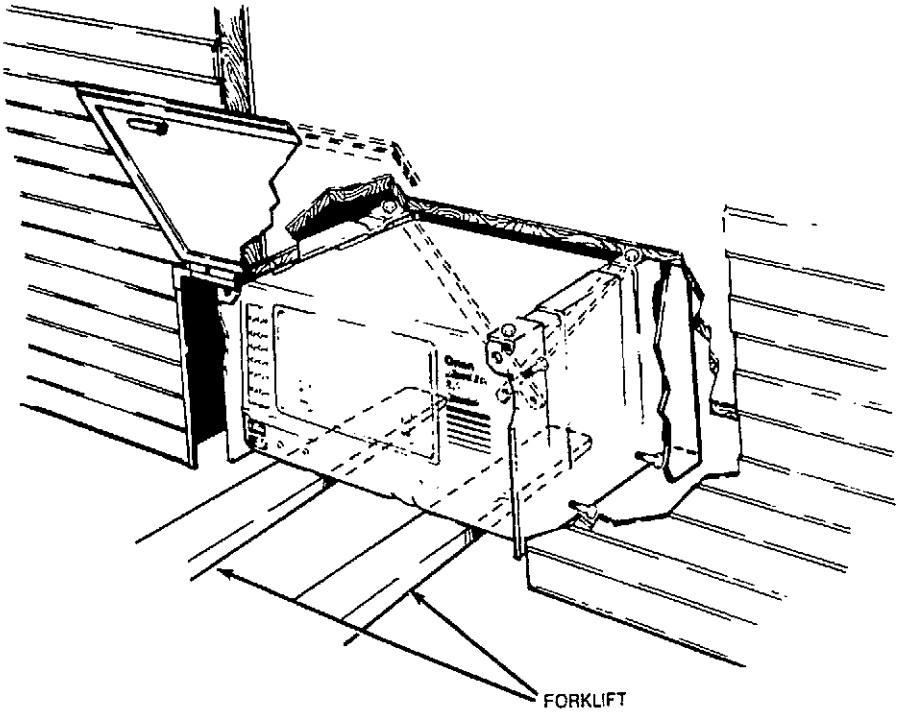

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FIGURE 5-3. COMPLETE SET REMOVAL

Section 6. Engine - Primary Systems

INTRODUCTION

The engine primary systems include the following:

- Exhaust System
- Cooling System
- Ignition System
- Crankcase Ventilation System
- Governor
- Fuel System
- Electric Starter

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

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Misfires	1. Faulty ignition due to: a. worn or fouled spark plug b. faulty magneto assembly c. faulty ignition coil d. faulty plug wire e. incorrect ignition timing	1a. Replace spark plug 1b. Replace magneto assembly 1c. Test coil and replace if necessary 1d. Check spark plug wire and replace coil assembly if necessary 1e. Rotor or fan hub improperly installed
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws *b. incorrect float level c. dirt in carburetor d. vacuum leak	2a. Adjust carburetor main and idle adjustment screws 2b. Adjust carburetor float level 2c. Disassemble carburetor and clean all passages 2d. Locate leak and correct as required
	3. Contaminated fuel	3. Drain fuel tank and refill with fresh fuel
	4.*Carburetor icing	4. In cold weather, place air preheater in winter position
	5. Incorrect timing due to: a. defective magneto b. incorrect flywheel or generator mounting *Gasoline sets only	5a. Replace magneto assembly 5b. Check for proper installation, see Generator Service section
Engine Backfires	1. Faulty ignition due to: a. incorrect spark plug gap b. incorrect ignition timing	1a. Reset spark plug gap 1b. Replace magneto assembly
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws *b. incorrect float level c. dirt in carburetor d. vacuum leak	2a. Adjust carburetor main and idle adjustment screws 2b. Adjust carburetor float level 2c. Disassemble carburetor and clean all internal passages 2d. Locate leak and correct as required
	3. Mechanical damage to engine *Gasoline sets only	3. See Engine Block Assembly section

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Lacks Power	1. Faulty ignition due to: a. incorrect spark plug gap b. incorrect ignition timing	1a. Reset spark plug gap 1b. Replace magneto assembly
	2. Dirty air cleaner	2. Replace air cleaner
	3. Restricted fuel flow due to: *a. Plugged fuel filter or *b. faulty fuel pump c. LPG - Regulator or fuel solenoid dirty or defective.	3a. Replace fuel filter 3b. Test fuel pump and replace if faulty 3c. Refer to *LPG Fuel* section.
	4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws *b. incorrect float level or c. dirt in carburetor d. vacuum leak	4a. Adjust carburetor main and idle adjustment screws 4b. Adjust carburetor float level 4c. Disassemble carburetor and clean all internal passages 4d. Repair vacuum leak.
	5. Exhaust system blocked or restricted	5. Locate and remove cause of blockage, remove and clean spark arresting screen
	6. Incorrect valve lifter clearance or defective valve(s)	6. Adjust valve lifters/inspect valves (see Engine Block Assembly section)
	7. No load speed set too low	7. Adjust governor setting
	8. Excessive engine wear or damage to engine	8. See Engine Block Assembly section
	*9. Carburetor air preheater set incorrectly *Gasoline sets only	9. In hot weather, place air preheater in summer position
Engine Overheats	1. Restricted air flow due to dirt or debris blocking air inlet or outlet	1. Clear away any debris that may restrict airflow to set and do not use compartment for storage area
	2. Dirt or oil covering engine cooling fins	2. Clean away all dirt and oil from engine cooling fins
	3. Incorrect ignition timing	3. Replace magneto assembly
	4. Cooling fan plugged or broken	4. Inspect cooling fan, see Generator Service section
	5. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws *b. incorrect float level c. dirt in carburetor *Gasoline sets only	5a. Adjust carburetor main and idle adjustment screws 5b. Adjust carburetor float level 5c. Disassemble carburetor and clean all internal passages

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Black Exhaust Smoke	1. Rich fuel mixture due to: a. dirty air cleaner *b. choke sticking c. incorrectly adjusted fuel mixture screws d. dirt in carburetor *Gasoline sets only	1a. Replace air cleaner 1b. Clean choke and adjust or replace linkage 1c. Adjust carburetor idle and main adjustment screws 1d. Disassemble carburetor and clean all internal passages
White or Blue Exhaust Smoke	1. Lean fuel mixture due to: *a. incorrect float level b. incorrectly adjusted fuel mixture screws c. dirt in the carburetor 2. Contaminated fuel 3. Excessive engine wear *Gasoline sets only	1a. Adjust carburetor float level 1b. Adjust carburetor idle and main adjustment screws 1c. Disassemble carburetor and clean all internal passages 2. Drain and replace fuel 3. See Engine Block Assembly section
Engine Hunts or Surges	1. Sticking or binding governor linkage 2. Incorrect governor adjustment 3. Faulty governor spring 4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws *b. incorrect float level or c. dirt in carburetor 5. Governor mechanism worn excessively or motion spring faulty 6. Fuel supply problem caused by: *a. Faulty fuel pump b. Contaminated fuel supply c. Vapor locking d. Plugged fuel filter 7. Carburetor icing *Gasoline sets only	1. Check linkage alignment and straighten or replace. Clean and lubricate governor linkage 2. Adjust governor speed and sensitivity 3. Replace governor spring 4a. Adjust carburetor main and idle adjustment screws 4b. Adjust carburetor float level 4c. Disassemble carburetor and clean all internal passages 5. See Engine Block Assembly section 6a. Check fuel pump and replace if defective 6b. Drain and refill fuel supply 6c. Check for cause of overheating 6d. Replace fuel filter *7. In cold weather, place air preheater in winter position

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
High Oil Consumption (Note: New engines sometimes have high oil consumption during break-in)	1. Oil viscosity is too light or oil is diluted	1. Drain oil and refill with correct viscosity oil
	2. Crankcase breather valve is dirty or defective	2. Clean crankcase breather and replace if defective
	3. Oil leaks	3. Locate source of leak and repair as required
	4. Excessive engine wear	4. See Engine Block Assembly section
	5. Intake valve seal worn or defective.	5. See Engine Block Assembly section
	6. Light loading	6. Do not run set at no load for long periods of time
Engine Shuts Down and Will Not Restart	1. Low oil level	1. Add oil as required
	2. Low oil level switch defective	2. Replace oil level switch (see Engine Block Assembly section)
	3. Worn spark plug	3. Clean or replace spark plug
	4. Faulty fuel system	4. Refer to Fuel System section for test and service procedures

EXHAUST SYSTEM

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

The exhaust system consists of the muffler and muffler support brackets, exhaust pipe, clamps, and hangers needed for installation of the exhaust pipe. Figure 6-1 shows a typical exhaust system for a compartment mount generator set. The following section covers the service procedures for the exhaust system.

The generator must be shut down and the exhaust system serviced immediately if inspection reveals leaking joints or connections, loose fasteners, or broken, corroded, or damaged components.

Always replace worn components with new original equipment replacement parts. Do not attempt to repair a broken exhaust pipe or manifold by welding and do not replace worn out components with parts that do not meet factory specifications. The muffler is a spark arrester type muffler that is 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 ***Inhalation of exhaust gases can result in severe personal injury or death. Modifying the exhaust system can allow poisonous exhaust gases to enter the coach. Use only original equipment replacement parts when servicing the exhaust system. Unauthorized modifications will also void the warranty and cancel the UL Listing/CSA Certification. Liability for injury or damages due to unauthorized modifications becomes the responsibility of the person making the change.***

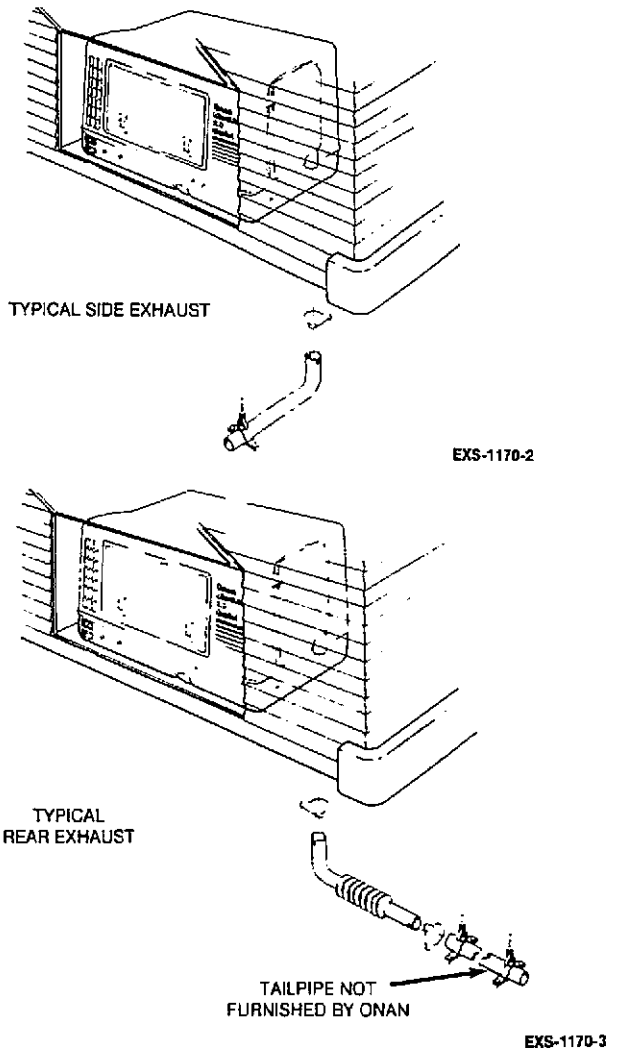

FIGURE 6-1. COMPARTMENT MOUNT EXHAUST SYSTEM

Disassembly:

1. Allow the exhaust system to cool down before servicing.
2. Loosen the exhaust pipe clamp securing the exhaust pipe to the muffler.
3. Remove exhaust pipe hanger(s) and lower exhaust pipe.
4. The generator set must be removed from the vehicle and the outer housing removed to access the muffler for servicing. See Set Removal, section 5.
5. Remove the mounting nuts securing the muffler flange to the engine and remove the exhaust gasket.
6. Remove the bolts securing the mounting brackets to the muffler.

Assembly: Obtain the required replacement parts then proceed as indicated.

⚠WARNING ***Exhaust gas can cause severe personal injury or death. To prevent exhaust leaks, install gaskets, clamps, straps, and hardware as specified. Inspect all components even if not replaced or worked on.***

1. Install a new exhaust gasket. Mount the muffler flange to the engine and tighten mounting nuts to the specified torque.
2. Install muffler support bracket mounting bolts and secure to the specified torque.
3. Install generator set housing and reinstall the generator set.
4. If replacing the original exhaust tailpipe, refer to the Tailpipe Recommendations section.

5. Attach the exhaust pipe to the outlet of the muffler using a U-bolt type automotive muffler clamp marked 1-1/8 inch I.D.
6. Attach an automotive type tailpipe hanger every 2 to 3 feet (0.6 to 0.9 meters). In addition, the exhaust system must be supported at or near the perimeter of the vehicle to prevent the tailpipe from being damaged and pushed up under the vehicle skirt.

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

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

Tailpipe Recommendations

Tailpipes must meet several design specifications to provide safe generator set operation. It is necessary to use an Onan-specified exhaust kit designed specifically for use with this generator set.

Kits are available in two exhaust lengths: 18 to 25 inches (457-635 mm) and over 25 inches (635 mm).

Refer to the following guidelines for selecting and locating the tailpipe.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Exhaust gases can enter the vehicle interior if the tailpipe is damaged, missing, or improperly installed. Use the appropriate Onan-specified exhaust kit and install according to the instructions provided with the kit.***

Use 1-1/2 inch O.D., 18 gauge aluminized or stainless steel tubing for tailpipe. Do not use flexible tailpipe since it might break due to road shock and vibration.

Install exhaust tailpipe at least 3 inches (76 mm) away from any combustible material (wood felt, cotton, organic fibers, etc.), or be so located, insulated, shielded, that it does not raise the temperature of any combustible material more than 117°F (65°C) above the ambient air inlet temperature.

The exhaust system must extend a minimum of 1 inch (25 mm) beyond the perimeter of the vehicle. If the generator set tailpipe is on the same side of the vehicle as the air intake, terminate the tailpipe downward and aft of the generator set air intake to reduce the possibility of recirculating exhaust gases.

⚠WARNING

EXHAUST GAS IS DEADLY!

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

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

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

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

1-RV

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

No part of the exhaust system shall intrude into the departure angle or approach angle unless it is adequately protected by a skid bar or other protection device. See Figure 6-2. Use a sufficient number of hangers to prevent damage or dislocation of the system.

⚠WARNING ***Exhaust gases present the hazard of of severe personal injury or death. Do not terminate tailpipe under the vehicle. Direct exhaust gases away from any vent, window, door, or any opening which can be opened and is not permanently sealed from the vehicle living space. Do not mount any protion of the exhaust system into the departure angle or approach angle unless it is adequately protected. Use sufficient number of hangers to prevent damage or dislocation of the exhaust system.***

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

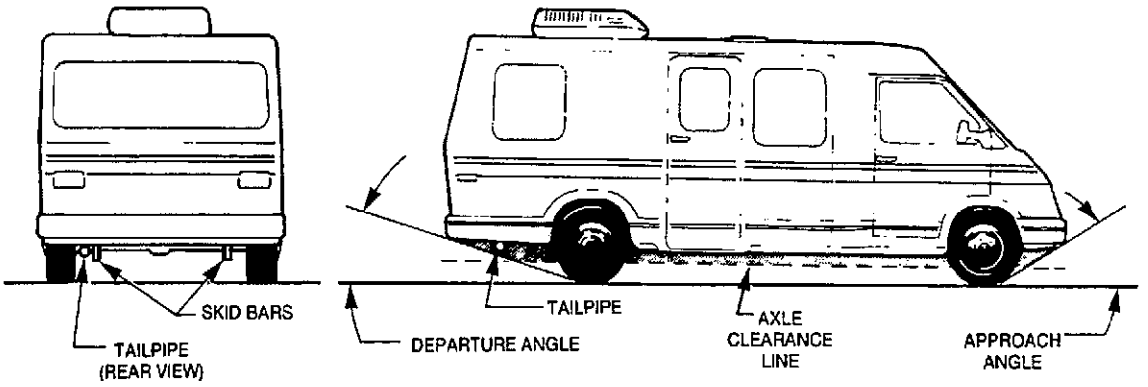

FIGURE 6-2. TAILPIPE INSTALLATION

COOLING SYSTEM

A constant airflow is critical for engine and generator cooling to prevent excessive heat build-up. A centrifugal fan on the generator end of the set provides the required airflow. The fan draws cooling air in through the air inlet, into the generator and across the engine cooling fins, then discharges the heated air through the air outlet. See Figure 6-3.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Never use discharged cooling air for heating the vehicle interior since discharged cooling air can contain poisonous exhaust gases.***

The generator housing air inlet is sized to allow the required flow rate of cooling air. The air inlet opening must be kept free of any obstructions to avoid restricting airflow. Dirt, dust, or other debris that may clog the air duct 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 if the fins are not cleaned.

The cooling system consists of the set housing and base assembly enclosure, insulation duct, scroll assembly, fan hub assembly, air duct, and air guide. The following section covers service procedures for the cooling system.

Inspection: Remove the spark plug boot and inspect the engine cooling fins by viewing the area around the spark plug. If the engine is clean in this area and the air inlet area is clean, disasembly for cleaning the engine will not be necessary. If debris is visible in the area of the spark plug or at the air inlet area, proceed to the Disassembly section.

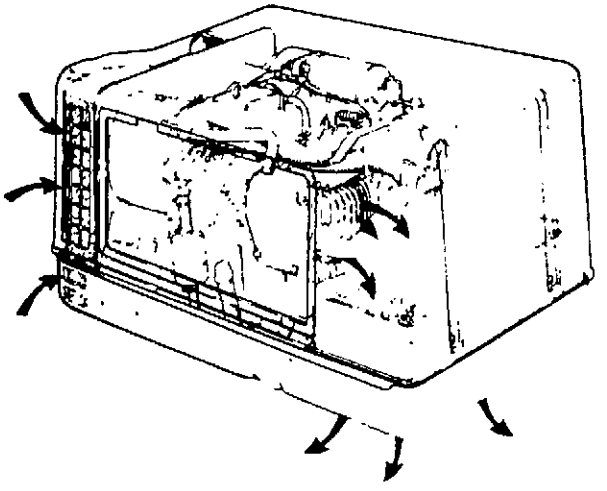

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FIGURE 6-3. COOLING AIRFLOW

Disassembly: Remove the generator set as described in the Set Removal section.

1. Follow the generator set disassembly procedures (section 8) through the scroll assembly removal.
2. Inspect and clean the fan hub assembly using a brush or low pressure (less than 30 psi) compressed air. If the fan blades are damaged, remove the fan hub assembly as described in section 8 and replace the fan.
3. Remove the top and bottom air guide housings (cowling) for access to the engine cooling fins for cleaning.
4. Use a brush or low pressure compressed air to remove any dirt or debris that may be lodged on the engine cooling fins.

Assembly: Cooling system assembly is in reverse order of disassembly. Follow the generator assembly instructions (section 8) for installing the fan hub assembly, if removed for cleaning or replacement.

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

IGNITION SYSTEM

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

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

Spark Plug (E2)

Remove the spark plug and inspect the electrode. If the spark plug has carbon deposits, use a wire brush to clean it. If the spark plug is badly fouled or deformed, replace it. Measure and reset the spark plug gap to 0.025 inches (0.64 mm). An examination of the spark plug can often help diagnose an engine problem. Refer to the following spark plug conditions:

- Carbon Fouled — Check for a poor high tension lead connection, faulty choke operation, rich fuel mixture or dirty air filter.
- Oil Fouled — Check for low compression.
- Burned or Overheated — Check for leaking intake manifold gasket, lean fuel mixture or incorrect spark plug type.

- Splash Fouled — Check for accumulated combustion chamber deposits. See Cylinder Head section.
- Light Tan or Gray Deposits — Normal plug color.

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

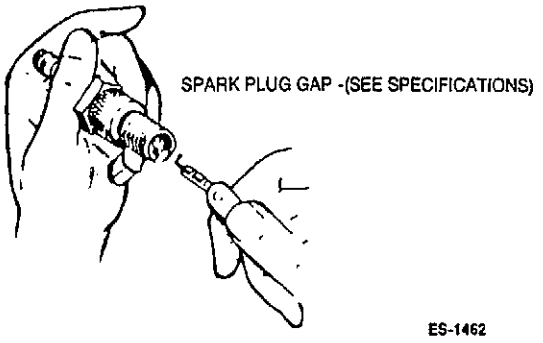


FIGURE 6-4. MEASURING PLUG GAP

Ignition Coil (T1)

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

Ignition Spark Check:

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

Coil Winding Check: The ignition coil is located below the lower right corner of the access cover. Disconnect the coil ground lead, primary lead and spark plug lead from the spark plug. The coil can be removed from the set for testing. See Figure 6-5.

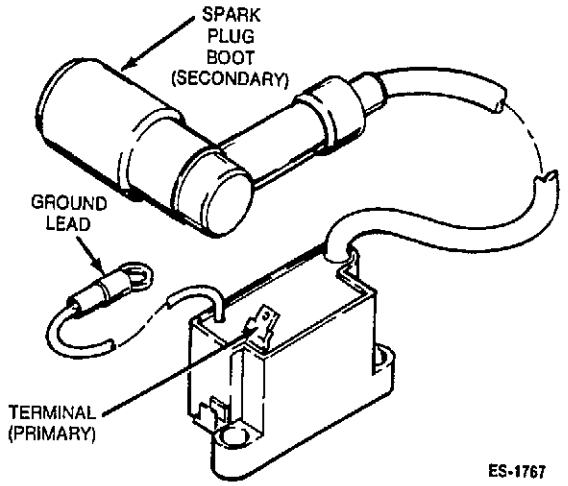


FIGURE 6-5. IGNITION COIL

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

If no spark is seen and the coil windings check good, proceed to the Ignition Wiring check.

Ignition Wiring

It will be necessary to remove the genset from the vehicle and remove the housing to inspect some of the wiring. The ignition wiring consists of one ground wire connected to the coil and one ground wire connected to the magneto assembly. One wire from the magneto to the ignition coil primary. One wire from the shut down circuit (connected to K3-30) to the magneto. One high tension lead from the ignition coil secondary to the spark plug. Refer to Figure 7-1. (Do not disassemble the set to check the wiring at the magneto at this time.)

Thoroughly inspect the ignition wiring for loose connections and cuts or breaks in the insulation. Test suspect leads for continuity with an ohmmeter. Use a megger to check for breaks in the spark plug lead. Also check control wiring and relays K3 and K5 for loose or grounded connections. If any problems are found, correct them and repeat the ignition spark check. If no problems are found proceed to the Magneto Assembly section.

Magneto Assembly (G2)

The magneto asembly is a noncontact (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 the coil of the magneto. The voltage from the magneto (approximately 16 to 60 VAC when measured with a digital voltmeter) is supplied to the primary of the ignition coil.

If no spark was seen in the Ignition Spark Check and all accessible ignition wiring checks good, perform the Magneto Assembly Check.

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

1. Make sure the cranking circuit and battery are in good condition.

2. Disconnect the ignition shut down circuit by locating relay K3 (Figure 7-3) and removing leads G2-1 and S2-1 from K3-30. Separate piggy backed leads G2-1 and S2-1 and insulate them from each other and from ground.
3. Remove the spark plug, reconnect the spark plug lead and ground the plug side electrode to bare metal on the engine.
4. Do not touch the plug or plug wire during testing. Crank the engine and observe the plug. A good spark should be observed. If no spark is observed, the magneto or wires connected to the magneto are the most likely cause. Refer to the *Generator* section 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 or 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 sticky 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

If the crankcase becomes pressurized, as evidenced by oil leaks at the seals, use the following procedures to service.

Remove the breather tube and the head cover (see Engine Block Assembly, Section 9) then remove the breather from the cylinder head and inspect it. The reed valve must be flat with no sign of creases or other damage. If the breather is defective, replace it. If the breather is dirty, clean it in parts cleaning solvent.

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

Check breather tube and air passages for clogging and clean as required.

GOVERNOR

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

Governor Adjustments

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

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

Before making governor adjustments, run the unit about 15 minutes under 50 percent load to reach normal operating temperature. If governor is completely out of adjustment, make a preliminary adjustment at no load to first attain a safe voltage and speed operating range.

An accurate voltmeter and frequency meter should be connected to the generator in order to correctly adjust the governor (accuracy of 0.3% on frequency and 0.5% on voltage). A small speed drop not noticeable without instruments will cause an objectionable voltage drop.

A binding in the governor shaft, governor linkage, or carburetor throttle will cause erratic governor action or alternate increase and decrease in the engine speed (hunting). A rich or lean carburetor adjustment can cause hunting and a fouled spark plug can cause missing and hunting. Springs tend to lose their calibrated tension through fatigue and after long usage and may require replacement.

If the governor action is erratic after adjustments are made, replace the spring. If this does not improve operation, the problem may be within the governor mechanism (see Engine Block Assembly, section 9).

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

1. The carburetor fuel mixture screws must be correctly adjusted before governor adjustments are made. If the carburetor needs adjusting, refer to the Mixture Screw Adjustments in this section before making any adjustments to the governor.
2. Set the carburetor throttle stop screw as specified in Carburetor Mixture Screw Adjustments (step 5).
3. Check the governor linkage for binding or excessive looseness. Check the motion spring for bending or damage and straighten or replace as needed.
4. With unit operating at no-load, adjust the speed adjustment screw (see Figure 6-6) on the governor linkage to obtain 62.5 ± 0.5 Hz, at between 120 and 126 volts on 60 hertz units. Set 50 hertz units to obtain 52.0 ± 0.5 Hz at between 220 and 231 volts for 220 volt units and 240 to 252 volts for 240 volt units.

5. Check the frequency and voltage first with a load applied and then with no load applied. The frequency and voltage should stay within the limits shown in table 6-1.
6. Adjust the governor sensitivity screw to give the closest regulation (least speed and voltage difference between no load and full load) without causing a hunting condition. To increase the sensitivity, turn the adjustment screw counterclockwise one to two turns only. To decrease sensitivity, turn the adjustment screw clockwise.
7. Recheck the speed setting made in step 3 and readjust if necessary.

TABLE 6-1
CHECKING VOLTAGE AND SPEED/FREQUENCY

	60 Hz (1Ø, 2-Wire) 120 V	50 Hz (1Ø, 2-Wire) 220 V	50 Hz (1Ø, 2-Wire 240 V
Voltage			
Maximum No-Load	126	231	252
(Typical No-Load)	(125)	(228)	(248)
Minimum Full-Load	108	205	224
(Typical Full-Load)	(118)	(215)	(236)
Speed/Frequency			
Maximum No-Load			
Speed (r/min)	3780	3150	3150
Frequency (Hz)	63	52.5	52.5
(Typical Frequency)	(62.5)	(52)	(52)
Minimum Full-Load			
Speed (r/min)	3570	2940	2940
Frequency (Hz)	59.5	49	49
(Typical Frequency)	(59.5-60.5)	(49.5-50.5)	(49.5-50.5)

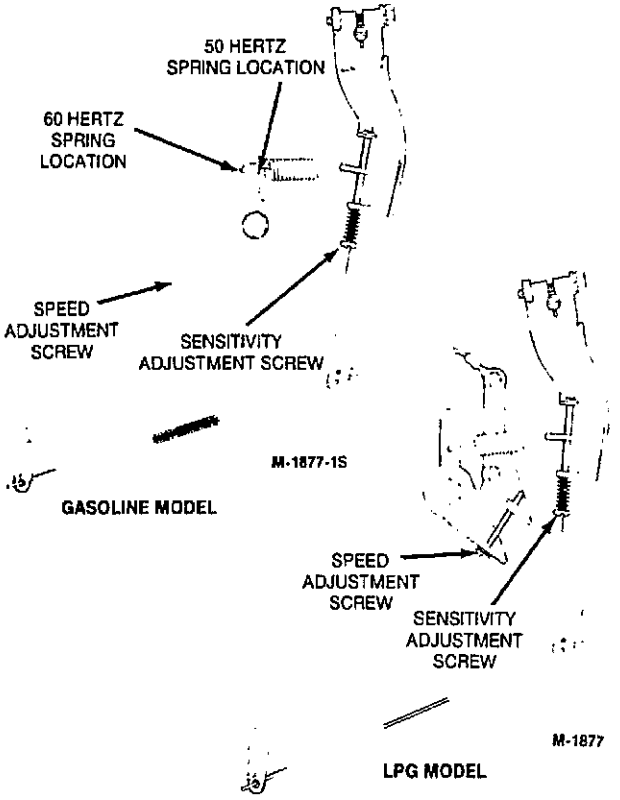


FIGURE 6-6. GOVERNOR ADJUSTMENTS

GASOLINE FUEL SYSTEM

The fuel system must be in good condition and be properly adjusted for efficient generator set operation. The main components of the fuel system are the air filter assembly, carburetor, choke, intake manifold, fuel filter, fuel pump, and air preheater. When servicing, use the procedures in the following sections.

Air Filter and Preheater Assembly

The air filter and preheater assembly consists of the air filter cover, air filter, scroll assembly, preheat door, preheat linkage, preheat hose and intake air stove portion of the muffler assembly. See Figure 6-7.

The air filter, preheat linkage, preheat door, and preheat air hose can be checked without removing the generator set from the vehicle. Remove the access cover and the air filter cover. Remove the air filter retainer and pull out the air filter. Inspection of the air filter and preheater operation can be made at this point.

If a problem exists with operation of the preheat door, remove the generator set (see Set Removal, section 5) and remove the enclosure assembly. Check preheater linkage and adjust as required. If the problem is within the scroll assembly, follow the Generator Removal procedures (Section 8) through the scroll removal step and repair or replace as required.

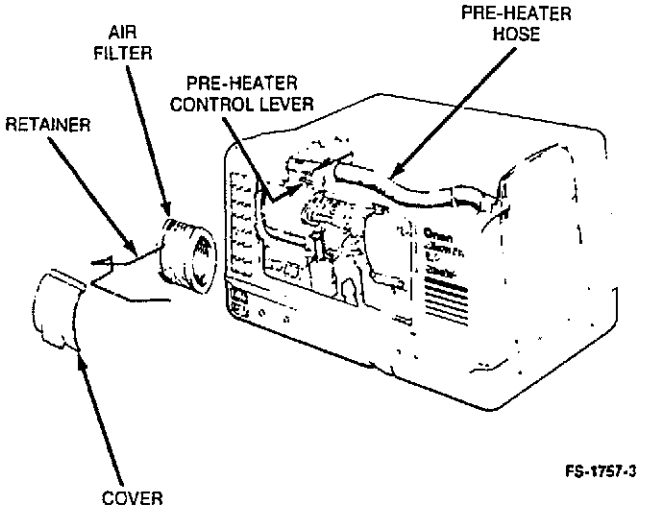


FIGURE 6-7. AIR FILTER AND PREHEATER ASSEMBLY

Carburetor and Intake Manifold Assembly

⚠WARNING ***Fuel presents the hazard of fire or explosion which can cause severe personal injury or death. Plug fuel lines when servicing the fuel system to prevent fuel leakage. Do not permit any flame, spark, pilot light, cigarette, or other ignition source near the fuel system. Keep an ABC type fire extinguisher nearby.***

The carburetor and intake manifold assembly consists of the intake manifold, carburetor, choke pulloff and governor control linkages. See Figure 6-8.

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

1. Remove the generator set from the vehicle (see Set Removal, section 5) and remove the set enclosure.
2. Remove the choke assembly mounting bolts and disconnect the choke linkage from the carburetor. Remove the vacuum hose from the intake manifold.
3. Remove the governor control linkage and spring attached to the carburetor.
4. Disconnect the fuel line and plug to prevent fuel leakage.
5. Remove the two bottom intake manifold mounting bolts that connect the intake manifold to the cylinder head.
6. Remove the carburetor and intake manifold as an assembly.
7. Remove the intake manifold gaskets and plug the intake port to prevent loose parts from accidentally entering the engine.
8. Remove the two screws that secure the carburetor to the intake manifold and carefully separate the carburetor from the intake manifold.

Assembly: Reverse order of disassembly. Use new gaskets between the intake manifold and engine and between the carburetor and the intake manifold. Tighten mounting screws to specified torque.

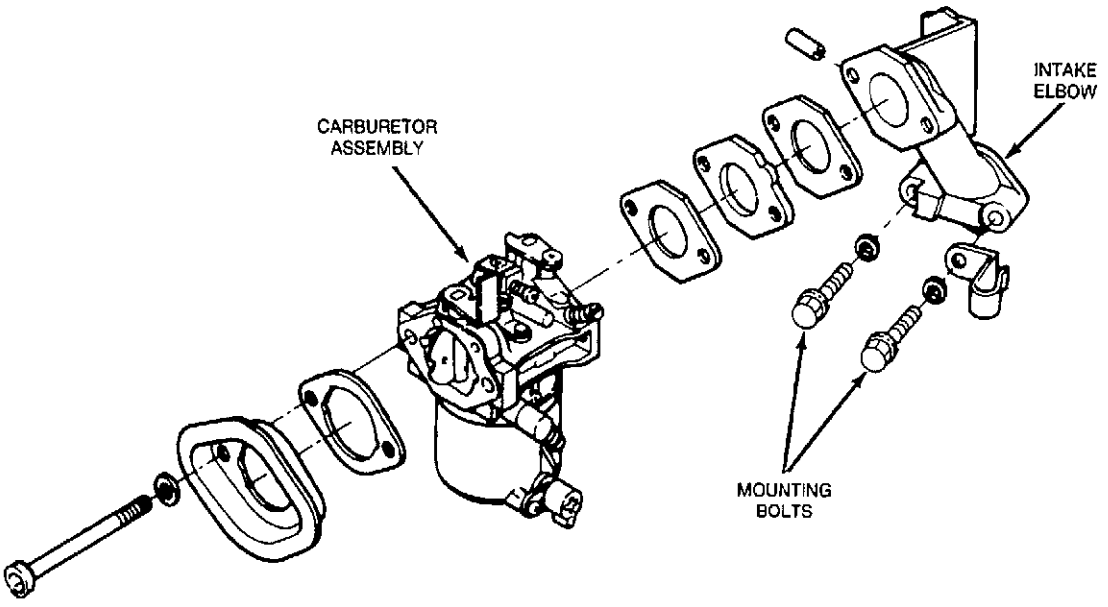


FIGURE 6-8. CARBURETOR AND INTAKE MANIFOLD ASSEMBLY

Carburetor Mixture Screw Adjustments

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

Mixture screw adjustment should be checked with every engine tune-up and whenever a carburetion problem is suspected. Before adjusting, be sure the ignition system is working properly and the governor is correctly set. The limiter cap on the main mixture screw should not be removed unless the carburetor is totally out of adjustment or has been overhauled. With the limiter cap removed, use the mixture settings in Table 6-2 for preliminary adjustments. Turn the mixture screws in until lightly seated, then turn out the specified number of turns.

TABLE 6-2.
CARBURETOR ADJUSTMENT SPECIFICATIONS

MIXTURE SETTING		FLOAT LEVEL
IDLE	MAIN	
1-1/2 ± 1/4	1-3/4 ± 1/4	9/16 ± 1/16 in. (14 ± 2 mm)

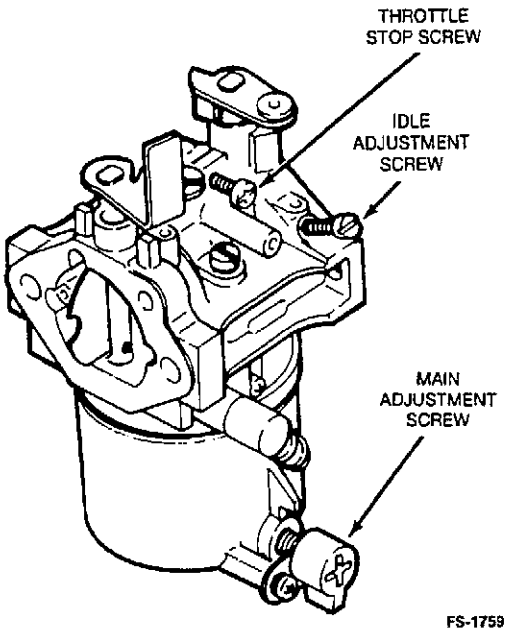


FIGURE 6-9. MIXTURE SCREW ADJUSTMENT

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

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

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

Start the engine and allow it to run for about 10 minutes. The location of the adjustment screws is shown in Figure 6-9. Use the following procedure to adjust:

1. Stop the set and connect a voltmeter, frequency meter, and load bank to the generator output leads.
2. Start the generator set and apply a full load. Verify that the frequency is within 60.5 ± 1 hertz (50.0 ± 1 hz on 50 hertz units) and adjust the governor speed adjustment screw if necessary to obtain required frequency.
3. Turn the main adjustment screw inward until voltage or frequency drop and then outward until voltage or frequency drop again. Locate the point where the voltage and frequency are highest. From this setting turn the main adjustment screw out an additional 1/4 turn.
4. Remove the load and verify that frequency is within 62.5 ± 0.5 hertz (52.0 ± 0.5 hz on 50 hertz units). Adjust governor speed adjustment nut if necessary to obtain required frequency.
5. When the engine is warm, and the set is running at no load, turn the speed adjustment screw (Figure 6-6) so that the throttle lever on the carburetor is resting against the throttle stop screw. Adjust the stop screw to obtain a setting of 55 ± 1 hertz (45.0 ± 1 hz on 50 hertz units).
6. Turn the idle adjustment screw inward until voltage and frequency drop and engine begins to run rough or starts hunting. Back out idle adjustment screw as required for smoothest operation without hunting. Recheck setting in step 5.
7. Release the governor linkage and observe the stability of the set. Set the voltage and frequency and adjust the sensitivity of the governor as specified in *Governor* in this section. Add and remove a full load several times to make certain the set does not bog down or hunt.

Carburetor Overhaul

Carburetion problems not corrected by mixture or float adjustments are usually a result of gummed-up fuel passages or worn internal parts. The most effective solution is a complete carburetor overhaul.

In general, overhauling a carburetor consists of complete disassembly, a thorough cleaning, and replacement of worn parts. Carburetor repair kits are available that supply new gaskets and replacements for those parts most subject to wear.

General instructions for overhauling a carburetor are as follows: Carefully note the position while removing all parts to ensure correct placement when reassembling. Read through all the instructions before beginning for a better understanding of the procedures involved. Carburetor components are shown in Figure 6-10.

Removal and Disassembly: Remove the carburetor and intake manifold assembly as specified in the Carburetor and Intake Manifold Assembly in this section. Remove the carburetor from the intake manifold and disassemble using the following procedure.

1. Remove the main and idle mixture screw assemblies.
2. Separate the lower section of the carburetor. Remove the float chamber by removing the bolt from the bottom of the carburetor.
3. Carefully note position of the float assembly parts, then slide out retaining pin and remove the float and needle valve.
4. Unscrew and remove the main nozzle.

Do not remove the choke or throttle plates, shafts, arms or governor link bushing unless they are defective.

Clean and Repair: When the carburetor is completely disassembled, clean and repair using the following procedure.

1. Soak all metal components not replaced by repair kit in carburetor cleaner. Do not soak non-metal floats or other non-metal parts. Follow the cleaner manufacturer's recommendations.
2. Clean all carbon from the carburetor bore, especially where the throttle and choke plates seat. Be careful not to plug the idle or main fuel ports.
3. Blow out all passages with compressed air. Avoid using wire or other objects for cleaning that might increase the size of critical passages.
4. Check the condition of any needle valve and replace if damaged (Figure 6-11). Replace float if loaded with fuel or damaged.
5. Check the choke and throttle shafts for excessive play in their bore and replace if necessary.
6. Replace old components with new parts included in repair kit.

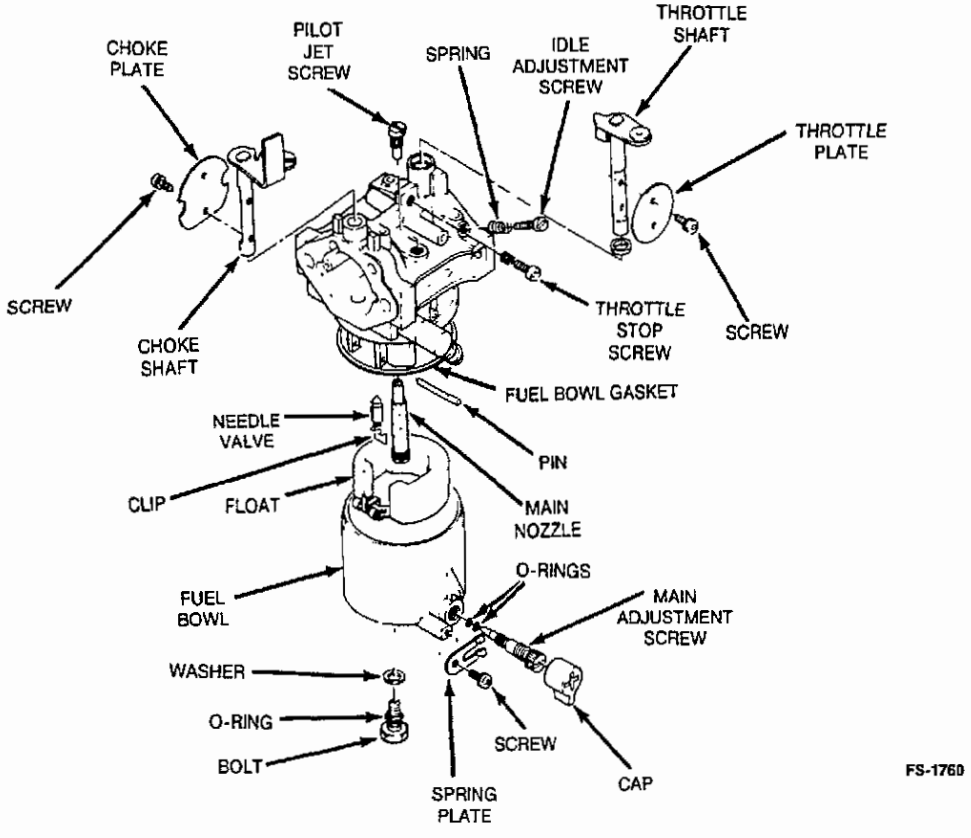


FIGURE 6-10. CARBURETOR OVERHAUL

Reassembly and Installation: When the carburetor parts are clean and dry, reassemble using the following procedure.

1. If removed during overhaul, slide in the throttle shaft and install the throttle plate using new screws, if necessary. Before tightening the screws, the throttle plate must be centered in the bore. To do so, remove the throttle stop screw and completely close the throttle lever. Seat the plate by gently pressing with fingers into place, then tighten screws. Install the choke shaft and plate in the same manor.

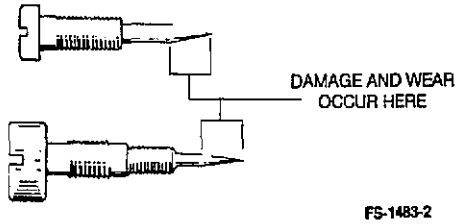


FIGURE 6-11. MIXTURE NEEDLE INSPECTION

2. Install idle mixture screw assembly. Turn in screw until lightly seated and then out the number of turns specified in Table 6-2.

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

3. Install needle valve and seat, fuel bowl gasket and float assembly. Make sure all clips and springs are properly placed and the float moves freely without binding (See Figure 6-12).

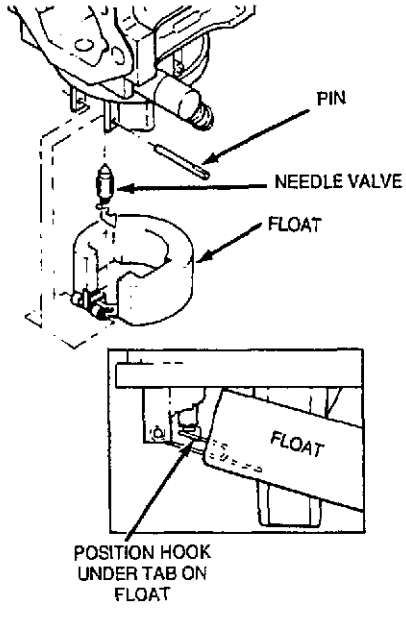


FIGURE 6-12. FLOAT INSTALLATION

4. Invert the float and needle valve assembly and check float level by measuring between the float and carburetor at the point shown in Figure 6-13. The full weight of the float should be resting on the needle valve and spring. The correct distance is specified in Table 6-2. If the setting is incorrect, remove float and bend tab to adjust. Bend the float only at the point indicated.

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

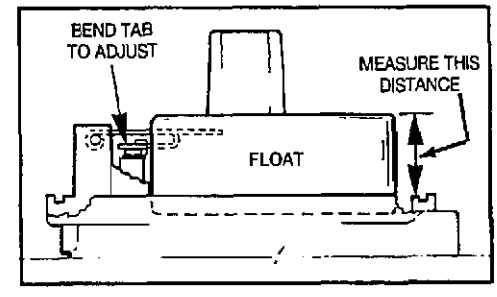


FIGURE 6-13. FLOAT LEVEL

5. Install float bowl and main mixture screw assembly. Turn screw in until lightly seated and then turn out the number of turns specified in Table 6-2.

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

6. When carburetor is installed on set, make final adjustments to mixture screws as described in Carburetor Mixture Screw Adjustments section.

Choke

The choke consists of a bi-metal, spiral strip, electric heating element, and choke pulloff diaphragm. The bi-metal coil is connected to the choke shaft and holds the choke plate nearly closed when the engine is cold. When the engine starts, vacuum from the intake manifold causes the pulloff diaphragm to pull in and partially open the choke. As the engine continues to run, electric current is supplied to the heating element. Heat from the element causes the bi-metal strip to coil. The coiling action of the bi-metal strip turns the choke shaft and gradually opens the choke plate. Heat from the element keeps the choke open while the engine is running.

⚠WARNING ***The choke gets very hot during normal operation and can cause severe burns if touched. Do not touch the choke assembly during and after set operation. Allow the set to cool down before working on the choke assembly.***

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

Choke Adjustment: An adjustment screw is mounted on the bottom of the choke assembly (see Figure 6-14) for making choke setting adjustments. Turn the adjustment screw clockwise to lean the system and counterclockwise to increase richness.

If the choke has been replaced or is way out of adjustment, use the following procedures to establish an initial choke setting.

1. Allow the generator set to cool down (an ambient temperature of approximately 75°F [24°C] is required) before making initial setting.
2. Move the choke lever back and forth to check for free movement. Verify that choke does not bind or stick.
3. Slowly rotate the adjustment screw on the bottom of the choke assembly so that the choke lever is held in the center of its travel.
4. Move the choke lever back and forth to check for smooth operation. Choke lever should return automatically to the center position when released from the open position without sticking or binding.

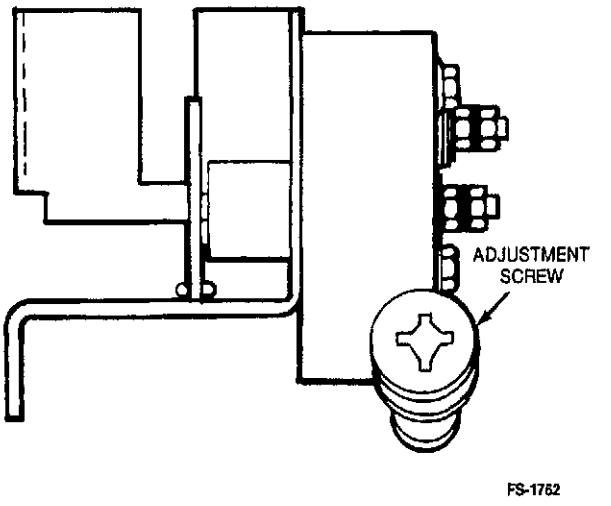


FIGURE 6-14. CHOKE ASSEMBLY

Choke Replacement: If the choke fails to open, check to see if the heating element is working. The heating element cover should become hot after a few minutes of operation. If the element cover does not get hot, start the set and then use an AC voltmeter to check for voltage (approximately 20 VAC) at the element cover terminals. If voltage is not present, check for opens or shorts in the control wiring.

If the voltage is present at the heating element cover terminals, stop the set and remove the heating element cover. Inspect the heating element and replace if burned out or broken. Also inspect the bi-metal spiral strip and replace if damaged, deteriorated, or dragging in the housing.

When installing a new bi-metal strip, maintain the original direction of spiral (see Figure 6-15). The outer tab must point in a clockwise direction. Make sure the coil rests squarely in the housing and the inner end of the coil engages the slot in the choke shaft. When installing the element cover, make sure the slotted tang on the cover engages the bi-metal strip.

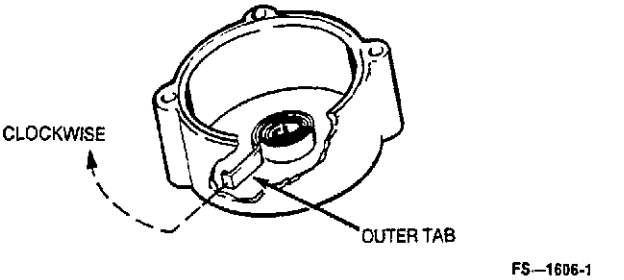


FIGURE 6-15. BI-METAL SPIRAL STRIP

Choke Pulloff Diaphragm Adjustments: The choke pulloff diaphragm partially opens the choke plate following engine startup. This helps prevent flooding and provides for smoother engine operation as the set is warming up. Use the following procedure to adjust.

1. Disconnect the diaphragm hose from the rear side of the intake manifold and apply 1 to 2 inches (25.4 to 50.8 mm) Hg vacuum to the diaphragm. Diaphragm stem should pull in and remain in while vacuum is applied.
2. Apply finger pressure lightly against the choke lever to take up the free play in the pulloff linkage (see Figure 6-16).
3. Check linkage alignment (as viewed from the top) of diaphragm stem, pulloff linkage, and choke linkage. Correct alignment as required to obtain one-half travel at choke lever.
4. Move the choke lever back and forth to check for free movement. Verify that choke does not bind or stick.
5. Remove vacuum supply and reconnect the diaphragm hose to rear side of intake manifold.

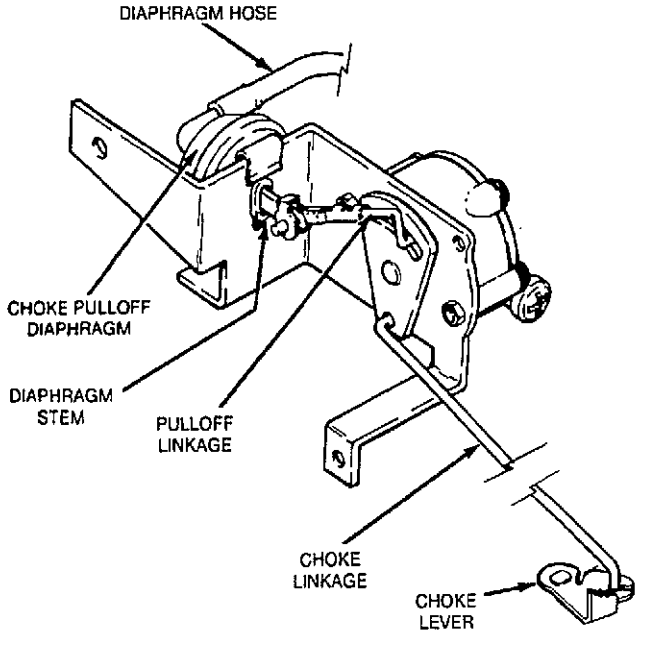


FIGURE 6-16. CHOKE PULLOFF DIAPHRAGM

Fuel Pump

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

⚠WARNING ***Do not substitute automotive type electric fuel pumps for standard Onan supplied electric fuel pumps. The output pressure 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 pump outlet pressure as follows:

1. Remove fuel line from carburetor inlet and install a pressure gauge.
2. Press start switch and hold it for several seconds, until pressure reading is constant.
3. The pressure reading for a good pump should fall within 3-1/2 to 5 psi (17.2 to 34.4 kPa). The pressure should stay constant or drop off very slowly.

- If pressure reading is below 3 1/2 psi (17.2 kPa), replace fuel pump.
- If pressure reading is at zero, stop engine cranking and check electrical connections. Press the Start switch and recheck pressure reading.
- There are no serviceable components in the fuel pump. Replace complete fuel pump assembly if defective.

LPG FUEL SYSTEM

The LPG-fueled models use a low-pressure vapor withdrawal system that must be properly adjusted and be in good working condition. Components unique to the fuel system are:

- Demand Regulator with Automatic Priming Solenoid
- LPG Carburetor
- Fuel Solenoid

Special precautions must be taken to avoid releasing large quantities of highly flammable LP gas when servicing the fuel system. Use the LP gas purging procedure described in the *Preparing to Service* section to purge the fuel system of LP gas before servicing any fuel system components.

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

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

⚠WARNING ***LP gas presents the hazard of fire or explosion and it is poisonous. These hazards can result in severe personal injury or death. If flameout occurs with an unvented appliance, LP gas can accumulate inside the vehicle and create a safety hazard. If the generator set fuel supply line is shared with any appliance, do not continue with any further service procedures. Correct as necessary to comply with applicable codes before continuing service work.***

Demand Regulator with Automatic Priming Solenoid

The demand regulator is designed for low pressure vaporized fuel. An automatic priming solenoid allows fuel to pass through the regulator during cranking. Service is limited to replacing the complete assembly if it malfunctions. The regulator assembly is usually not the cause of engine performance problems. All other possible causes should be checked before replacing the regulator assembly. Refer to Figure 6-17. The regulator should be periodically inspected for fuel leakage past the valve seat and to make sure that the vent is clean.

The priming solenoid can be bench tested by connecting battery positive (B+) to the orange lead and battery negative (B-) to the green lead. The solenoid should energize and press in on the regulator diaphragm.

The priming solenoid can be adjusted by manually holding in the plunger disk and then rotating the adjustment dial clockwise to increase fuel flow or counterclockwise to decrease fuel flow. Refer to Figure 6-18.

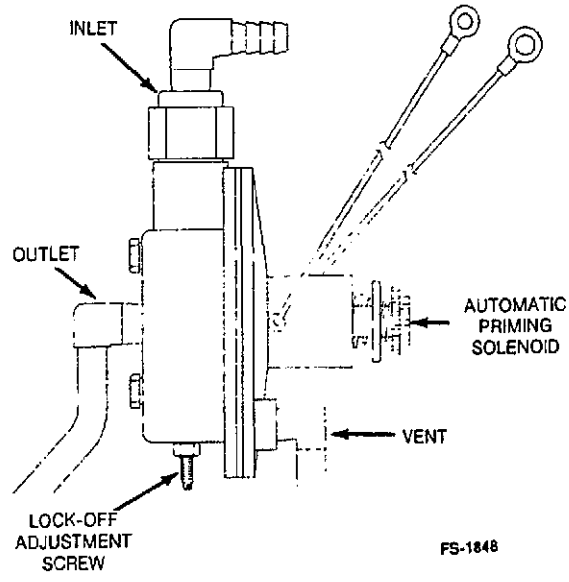
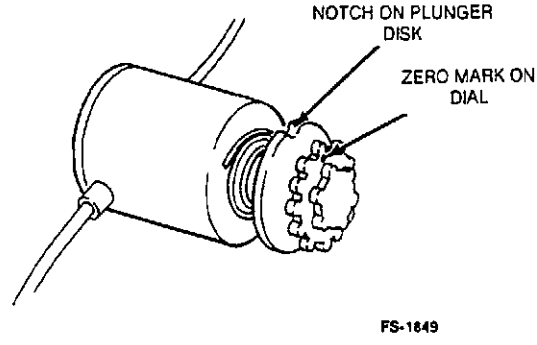


FIGURE 6-17. DEMAND REGULATOR WITH AUTOMATIC PRIMING SOLENOID



At this position there is no fuel flow when the Auto Prime is energized. To start and increase fuel flow, turn dial clockwise while manually depressing plunger.

FIGURE 6-18. AUTOMATIC PRIMING SOLENOID

Regulator Lock-off Adjustment

The regulator lock-off setting is used to set the valve opening pressure. The lock-off can be checked and adjusted as follows:

1. Connect the regulator inlet (Figure 2) to a source of air pressure regulated to 6 oz. (11 inches of water column).

2. Connect a "T" in the balance line hose and connect one leg of the "T" to an incline monometer that reads from 0 to 2 inches of water column. Connect a hose to the other side of the "T".

3. Put a soap bubble over the outlet opening of the regulator. Lightly blow into the hose connected to the "T" in the balance line. Slowly apply pressure until the soap bubble continues to grow because of air flowing through the regulator. Approximately 0.25 to 0.35 inches of water column should cause air to flow through the regulator. (When air is first blown into the balance line the soap bubble may enlarge due to diaphragm movement, this is not an indication that air is flowing through the regulator.

4. If more than 0.35 inches of water column pressure is required to induce flow, loosen the lock nut on the 1/4-28 lock-off adjusting screw, back out the screw until air will flow in the 0.25 to 0.35 water column pressure range. If air flows through the regulator without any pressure being applied to the balance line, the lock off adjustment screw must be turned in to increase spring pressure. When the proper setting is achieved, hold the lock off adjusting screw in position and tighten the locking nut. If adjustments do not resolve problems see step 5.

5. If the inlet pressure is too high or if there is dirt on the regulator inlet seat, the regulator will flow air even though the adjusting screw is turned all the way in. The regulator should not be disassembled or repairs attempted by anyone except the equipment manufacturer's factory trained service technicians.

Fuel Solenoid Valve

The fuel solenoid valve (Figure 6-19) provides a positive fuel shutoff whenever the generator set is stopped. The solenoid must be energized before fuel will flow to the regulator. Service is limited to replacing the complete valve assembly if it does not operate properly. The fuel solenoid can be bench tested by connecting battery positive (B+) to the top terminal and battery negative (B-) to the grounded terminal. The plunger assembly should withdraw and open the valve when the solenoid is energized. Replace the solenoid valve if it does not operate properly.

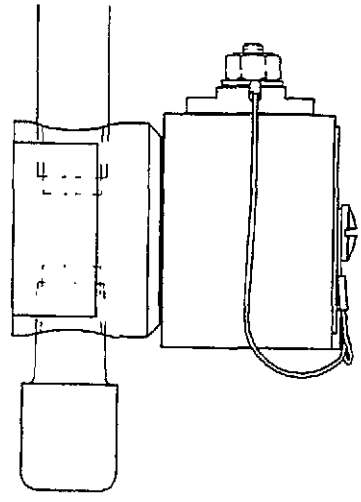


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FIGURE 6-19. FUEL SOLENOID VALVE

LPG Carburetor

LP-gas carburetors have three adjustment screws that must be properly set for satisfactory operation. The throttle stop screw controls how much the throttle plate remains open when the throttle is pulled back to the closed position. The idle adjustment screw controls the fuel mixture when the set is operating at no load. The main adjustment screw controls the fuel mixture when the set is operating at full load. No other adjustments are required with an LP-gas carburetor since there are no float or choke adjustments.

Carburetor Mixture Screw Adjustments

Mixture screws should not be adjusted until the ignition system, governor, and other fuel system components have been checked for correct operation. If the carburetor is totally out of adjustment, turn the mixture screws in until lightly seated. For a preliminary adjustment turn the main adjustment screw out 4 to 5 turns and the idle adjustment screw out 2 to 3 turns.

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

Start the engine and allow it to run for about 15 minutes at half load. Figure 6-20 shows the location of the adjustment screws. Use the following procedure to adjust:

1. Stop the set and connect a voltmeter, frequency meter, and load bank to the generator output leads.

2. Start the generator set and apply a full load. Verify that the frequency is within 60 ± 0.5 Hz (50 ± 1 on 50 Hz units) and adjust the governor speed adjustment nut if necessary to obtain required frequency.

3. Turn the main adjustment screw inward until voltage or frequency drops and then outward until voltage or frequency drops again. Set the main adjustment screw at the point where the voltage and frequency are highest.

4. Remove the load and verify that frequency is within 62.5 ± 0.5 Hz (52 ± 0.5 on 50 Hz units). Adjust governor speed adjustment nut if necessary to obtain required frequency.

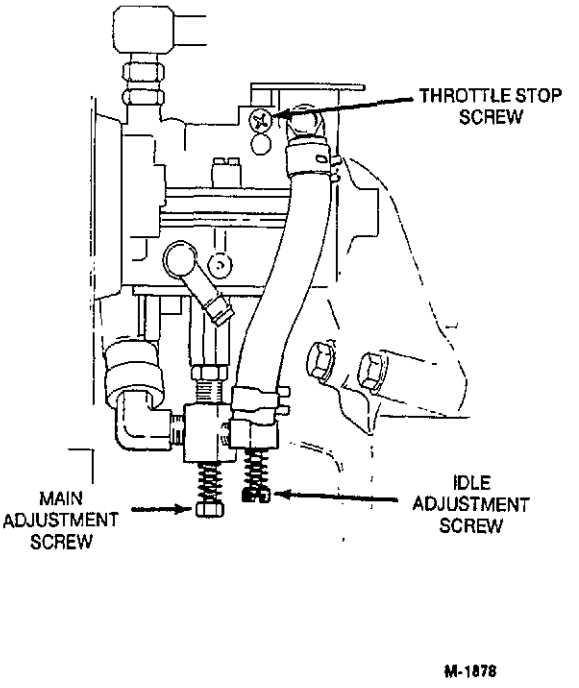


FIGURE 6-20. LPG CARBURETOR ADJUSTMENTS

5. Turn the idle adjustment screw inward until voltage and frequency drops and engine begins to run rough or starts hunting. Back out idle adjustment screw until engine runs smoothly without hunting.

6. Pull the governor linkage toward the front of the set so that the throttle lever on the carburetor is resting against the throttle stop screw. Adjust the stop screw to obtain a setting of 55 ± 1 Hz (45 ± 1 Hz on 50 Hz units).
7. Release the governor linkage and observe the stability of the set. Set the voltage and frequency and adjust the sensitivity of the governor as specified in *Governor* in this section. Add and remove a half load several times to make certain the set does not bog down or hunt.

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

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

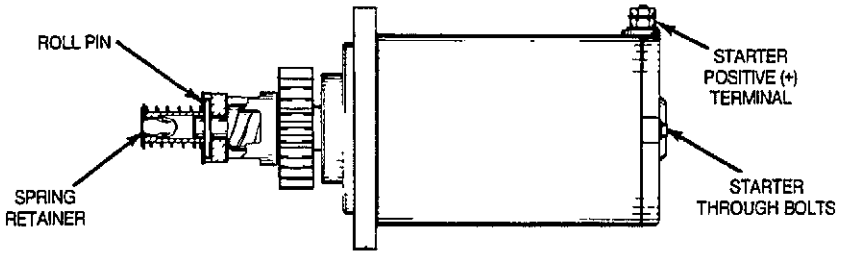
ELECTRIC STARTER

A 12-volt electric starter with negative ground is used for cranking the generator set. When the starter is energized, an inertial engagement system causes the starter pinion gear to engage the ring gear on the fan hub assembly. As the starter spins, the starter pinion gear drives the ring gear causing the generator set to crank. Because the starter is an integral part of the set control system, check the complete control before servicing the starter. Use the following procedures to disassemble, inspect, and assemble the starter.

It is necessary to remove the generator set from the vehicle before the starter can be serviced. Refer to Set Removal instructions in section 5.

Disassembly

1. Verify that the generator set starting battery has been disconnected, negative (-) cable first, before proceeding. Remove the generator set outer housing and disconnect the positive (+) cable from the starter lug.
2. Remove the starter mounting bolts. Remove the rear support mounting nut and loosen the rear starter support bracket mounting bolt.
3. Carefully disengage the starter from the end bell.
4. Use a 1/8 to 5/32 inch nail set to remove the roll pin from the armature shaft. Remove the return spring, gear and clutch assembly as required. When reassembling always use a new roll pin. See Figure 6-21.
5. Remove the starter through bolts and carefully separate the brush end cap housing and armature assembly.



STARTER

ES-1608

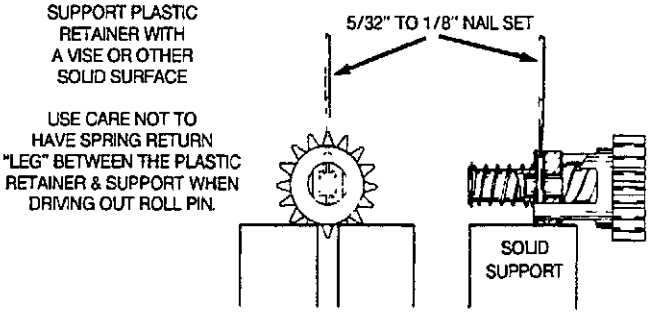


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FIGURE 6-21. DRIVING ROLL PIN OUT

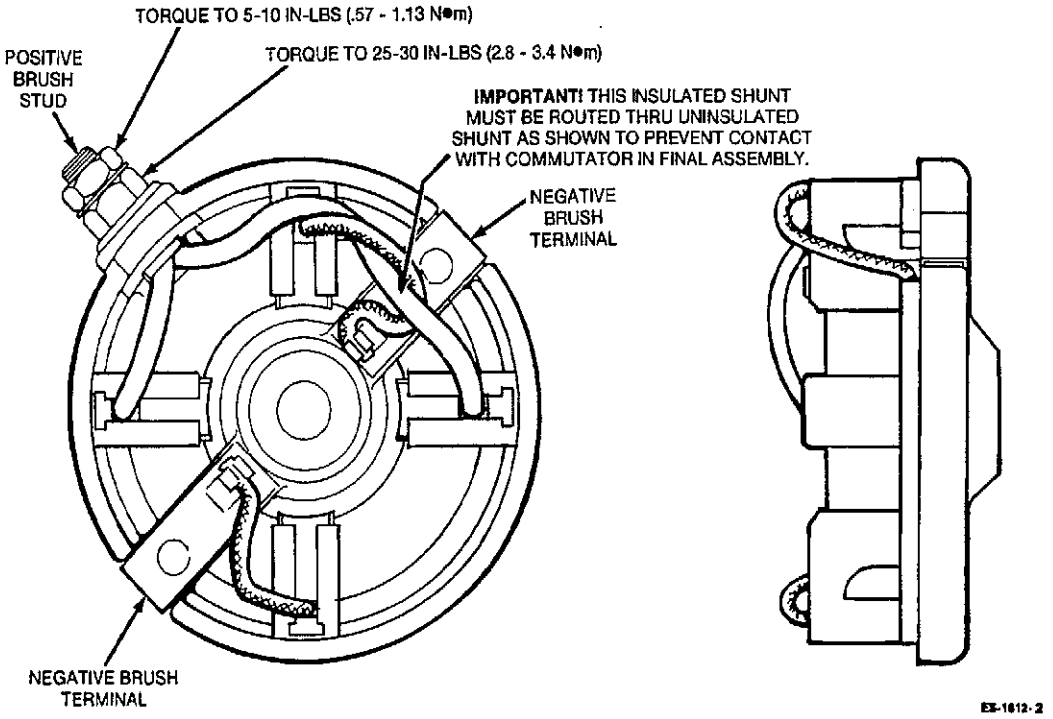


FIGURE 6-22. BRUSH ENDCAP

Assembly

1. Wipe off all dirt and oil from starter components using a clean cloth or blow off dirt with filtered, low pressure compressed air.

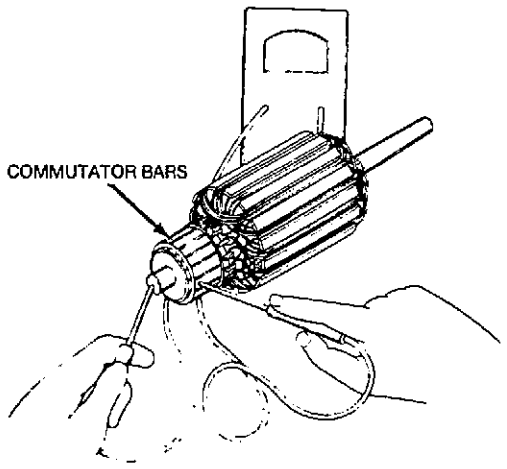
   ⚠CAUTION ***Oil on armature will damage starter. Do not immerse bearings in cleaning fluid. Use a brush dipped in clean engine oil for removing dirt from bearings. Avoid getting oil on brushes or commutator.***

2. Push negative brush terminals over through-bolt holes on brush endcap. See Figure 6-22.
3. Insert positive brush stud into hole and torque to 25-30 in-lb (2.8 - 3.4 N•m).
4. Place brush springs into brush holders. Insert brush tabs into spring ends and slide brushes into brush holders in endcap. Be sure all brush wires are facing up.
5. Place washer on commutator end of shaft and put armature into brush endcap. Push the four brushes toward commutator, making sure springs are properly positioned on brushes.

   Replacement brushes are supplied preassembled in the endcap. Remove brush retainers after installing armatures.

6. Make sure all brush wires are clear of commutator and that uninsulated portions of insulated wires do not touch inside diameter of housing. Uninsulated portions of wires must also not touch adjacent brush boxes.
7. Place magnetic housing over armature. Use a nut driver over the end of shaft to hold down armature and endcap.
8. Place spring washer and flat washer on shaft as shown in Figure 6-26.
9. Place mounting bracket on motor with through-bolt "lead-ins" to the inside of motor. The "flat" near one mounting hole should line up with the positive stud on end cap so through-bolt will line up.
10. Insert the through-bolts and torque to 35-45 in-lb (3.4-5 N•m).
11. Wipe dust from helix and gear and apply a light coat of GE Versilube 322-L on outside diameter of helix, inside diameter of gear and unchamfered end of gear. Place clutch and helix assembly on motor shaft with flats engaged in clutch hole.

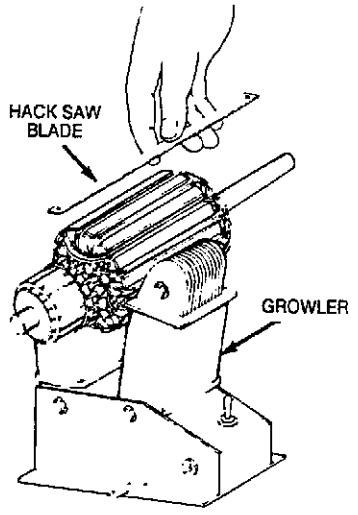
Testing Armature for Grounds: Touch one ohmmeter lead to a commutator bar and then touch the other lead to armature shaft and core laminations. A low resistance reading indicates a grounded armature. Replace grounded armature with a new part. See Figure 6-23.



ES-1614

FIGURE 6-23. TESTING ARMATURE FOR GROUNDS

Testing for Shorts: Use a growler (Figure 6-24) for locating shorts in the armature. Place armature in growler and hold a thin steel blade (e.g. hacksaw blade) parallel to the core and just above the armature while slowly rotating armature in growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace a shorted armature with a new part.

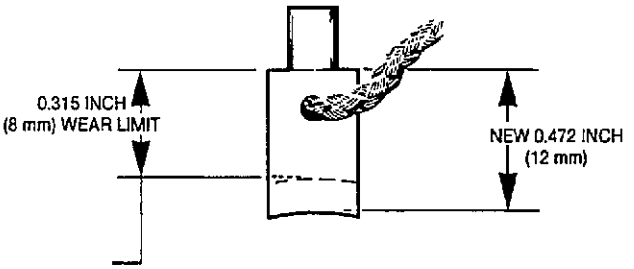


ES-1615

FIGURE 6-24. TESTING ARMATURE FOR SHORTS

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

Brush Inspection: Measure brushes (Figure 6-25) and replace if worn less than 0.425 (11 mm).



ES-1763

FIGURE 6-25. BRUSH INSPECTION

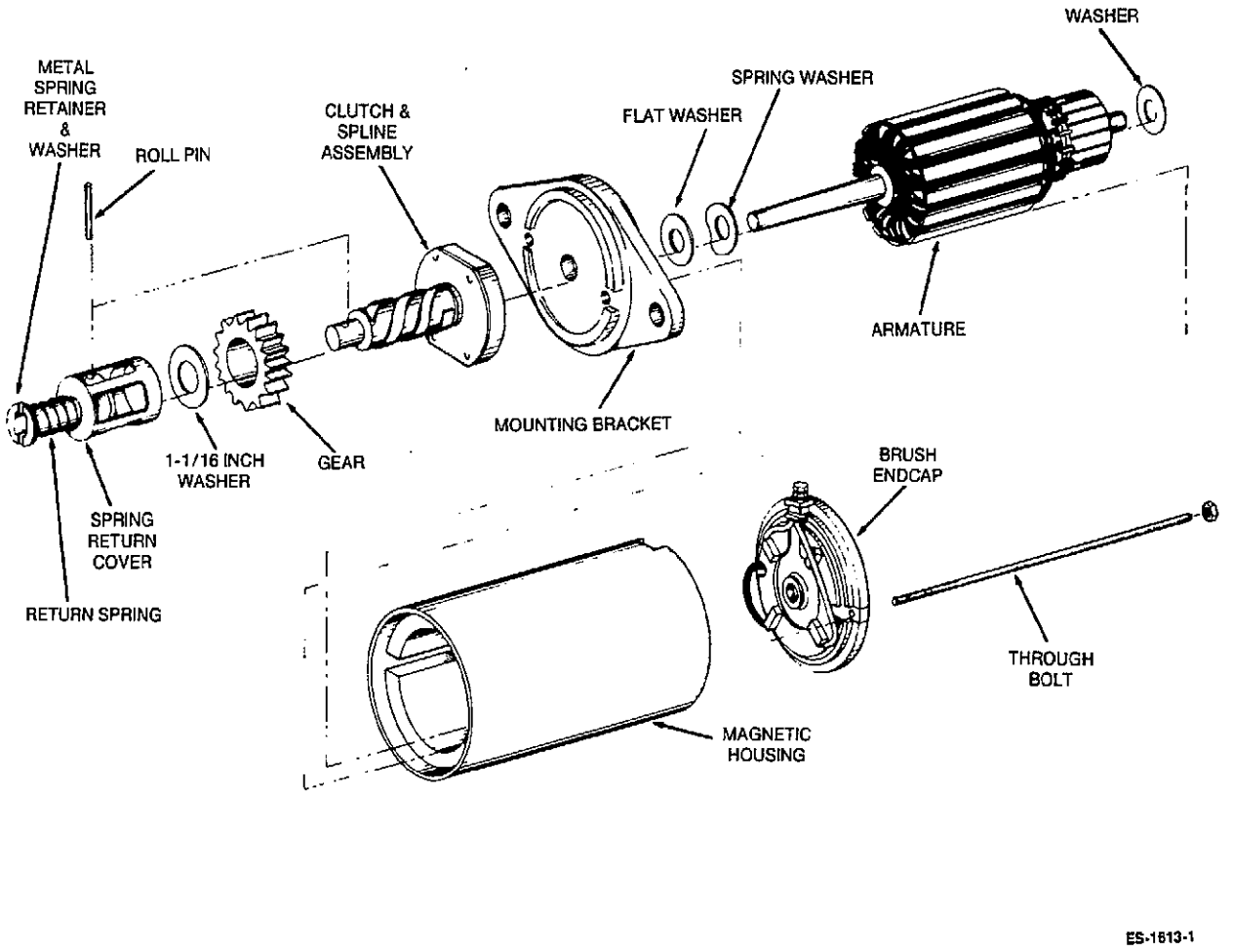


FIGURE 6-26. STARTER ASSEMBLY

12. ***If Return Spring is Unassembled:***

    A. Place 1-1/16 inch O.D. washer over end of shaft. See Figure 6-26.

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

    C. Support the plastic retainer with a vise or other solid surface. Using a 5/32 to 1/8 inch nail set and hammer, drive in a new roll pin. The pin should be driven in about 1/10th of an inch (2.5 mm) from the edge of the plastic retainer or so it is evenly spaced from each side.

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

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

13. Carefully mount the starter on the end bell and tighten the mounting bolts and rear support bracket mounting bolt and nut to the specified torque.

14. Connect the positive (+) cable to the starter lug terminal.

15. Mount outer housing on the generator set and install set into vehicle.

16. Reconnect generator set starting battery, negative (-) cable last.

Section 7. Control

INTRODUCTION

The control system includes all functions that relate to starting, monitoring for fault conditions, instrumentation, battery charging, and stopping. This section covers how the control operates, where the components are located, and basic troubleshooting procedures.

CONTROL DESCRIPTION

The generator set control consists of the following components:

- Panel mounted Start/Stop Switch (S1)
- Start Solenoid (K1)
- Start Disconnect Relay (K2)
- Control Fuses (F1 & F2)
- Battery Charge Resistor (R1)
- Shutdown Circuit (K3, K4, K5)*
- Optional Remote Start Control

Start/Stop Switch

The start/stop switch (S1) is a single pole, double throw (SPDT), rocker-type switch used for starting or stopping the generator set. Placing the switch in either the start or stop position will initiate the appropriate control function. The switch will automatically return to the center (Run) position when released. The switch is mounted on the control panel and is removable for service replacement.

Start Solenoid

The start solenoid (K1) is used for opening and closing the circuit between the starter motor and the battery. The start solenoid is used because of the high current load imposed during starting. The solenoid is made with heavy duty contacts to withstand high current draw during start-up. The start solenoid is located on the left side of the unit near the base and is not serviceable through the removable access cover.

Start Disconnect Relay

The start disconnect relay (K2) energizes once the generator set output reaches 70 volts AC. This opens the circuit between the start solenoid (K1) and the battery and causes the starter motor (B1) to stop cranking. The start disconnect relay also closes the circuit between the battery and the fuel pump (E2)** and the K3* relay during generator set operation. The start disconnect relay is located on the control panel and is removable for service replacement.

Control Fuses

Provide protection for the control box wiring and remote wiring from short circuit or other overload. The cranking fuse provides protection during start-up, and the running fuse provides protection while the generator set is running. The control fuses are mounted on the front of the control panel and are removable for service replacement.

Battery Charge Resistor

The battery charge resistor limits the battery charge rate to no more than 1 ampere. The resistor mounts on top of the generator and is removable for service replacement.

Shutdown Circuit*

The shutdown circuit consists of two relays (K3, K5) and a solenoid (K4). These components work together to prevent the generator set from running once the start/stop switch is placed in the stop position.

Both relays are mounted to the back side of the set on the generator end. The solenoid is mounted on top the engine. These components are removable for service replacement.

Optional Remote Start/Stop Control

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

CONTROL OPERATION - GASOLINE FUELED

The following section covers the control operation. The schematic diagram shown in Figure 7-1 can be used to help follow the circuit description. Always refer to the specific wiring diagram that corresponds to the model and spec number of the generator set when troubleshooting.

*Gasoline sets only

**E2 is the fuel pump on gasoline sets and the fuel solenoid on LPG sets.

Starting

Placing the start/stop switch (S1) in the start position connects battery negative (B-) to the start relay coil (K1). This energizes the start relay, which closes the K1-1/K1-2 relay contacts that connect battery positive (B+) to the starter motor (B1). It also connects B+ to the fuel pump (E2) and the K3 relay, through fuse F2 and diode CR1. (The fuel pump is energized through diode CR3, used to bypass ballast resistor R2, on initial production sets. CR3 and R2 may not be used on later production sets. Battery positive (B+) is also supplied to the voltage regulator (pin 7), for the generator field winding, through the start disconnect relay (K2) normally closed contacts (K2-2/K2-6).

Connecting battery positive (B+) as described produces the following control responses:

- Flashes the generator field winding to ensure that there is adequate residual magnetism to induce voltage buildup.
- Energizes the starter motor (B1).
- Energizes the fuel pump (E2) which begins pumping fuel to the carburetor.
- Energizes relay K3.

Closing the start solenoid (K1) contacts connects the battery positive (B+) to the starter motor, which begins to crank the engine to initiate starting.

Starter Lockout-Run

As the engine comes up to speed, the power output from the generator is applied to the start disconnect relay (K2) and causes it to energize. Engergizing the K2 relay opens the K2-1/K2-5 and K2-2/K2-6 contacts and closes the K2-3/K2-5 contacts. This produces the following control responses:

- Opening the K2-1/K2-5 contacts disconnects B+ from the start solenoid (K1) de-energizing it and causing the K1-1/K1-2 contacts to open. This disconnects B+ from the start motor (B1).
- Opening the K2-2/K2-6 contacts disconnects B+ from the voltage regulator
- Closing the K2-3/K2-5 contacts applies B+ to the fuel pump (E2) and to the K3 relay, through fuse F1, providing fuel flow to the carburetor and ignition voltage from the magneto assembly (G2) to the spark plug (E1).

As the engine begins to run, the start/stop switch should be released. The switch will automatically return to the center (Run) position and the engine will continue to run. The start disconnect relay (K2) will remain energized and the start solenoid (K1) remains de-energized.

Charging Circuit

The charging circuit supplies voltage to the choke heater element (H1), which activates the heating element and opens the choke. The charging circuit also supplies generator battery charge voltage (20 ± 2 volts) that is rectified to DC by diode (CR2) and supplied to the battery through the charge resistor (R1). This charges the battery at a variable rate (1 ampere maximum) during set operation. The charge rate varies with the generator load and battery condition.

Stopping

Placing the start/stop switch (S1) in the stop position energizes the K5 relay, which opens K5-30/K5-87A relay contacts. This removes B+ from the fuel pump (E2), stopping fuel flow to the carburetor. B+ is also removed from relay K3, which causes the K3-30/K3-87A contacts to close and ground the output from the magneto assembly (G2). Placing the start/stop switch in the stop position also energizes solenoid K4, which pushes against the governor arm causing it to close the throttle. Each of these actions work together to shut down the generator set.

As the generator output voltage drops, the start disconnect relay (K2) de-energizes, opening contacts K2-3/K2-5.

Diode CR2 prevents the battery from discharging through the generator windings when the set is not running.

CONTROL OPERATION - LPG FUELED

Starting

Placing the start/stop switch (S1) in the start position connects battery negative (B-) to the start relay coil (K1). This energizes the start relay, which closes the K1-1/K1-2 relay contacts that connect battery positive (B+) to the starter motor (B1). It also connects B+ to the K4 priming solenoid and E2 fuel solenoid, through fuse F2 and diode CR1. Battery positive (B+) is also supplied to the voltage regulator (pin 7), for the generator field winding, through the start disconnect relay (K2) normally closed contacts (K2-2/K2-6).

Connecting battery positive (B+) as described produces the following control responses:

- Flashes the generator field winding to ensure that there is adequate residual magnetism to induce voltage buildup.
- Energizes the starter motor (B1).
- Energizes the priming solenoid (E4) and the fuel solenoid (E2) allowing fuel to flow to the carburetor.

Closing the start solenoid (K1) contacts connects the battery positive (B+) to the starter motor, which begins to crank the engine to initiate starting.

Starter Lockout-Run

As the engine comes up to speed, the power output from the generator is applied to the start disconnect relay (K2) and causes it to energize. Engergizing the K2 relay opens the K2-1/K2-5 and K2-2/K2-6 contacts and closes the K2-3/K2-5 contacts. This produces the following control responses:

- Opening the K2-1/K2-5 contacts disconnects B+ from the start solenoid (K1) de-energizing it and causing the K1-1/K1-2 contacts to open. This disconnects B+ from the start motor (B1) and the K4 priming solenoid.
- Opening the K2-2/K2-6 contacts disconnects B+ from the voltage regulator
- Closing the K2-3/K2-5 contacts applies B+ to the fuel solenoid (E2) through fuse F1, providing fuel flow to the carburetor.

As the engine begins to run, the start/stop switch should be released. The switch will automatically return to the center (Run) position and the engine will continue to run. The start disconnect relay (K2) will remain energized and the start solenoid (K1) remains de-energized.

Charging Circuit

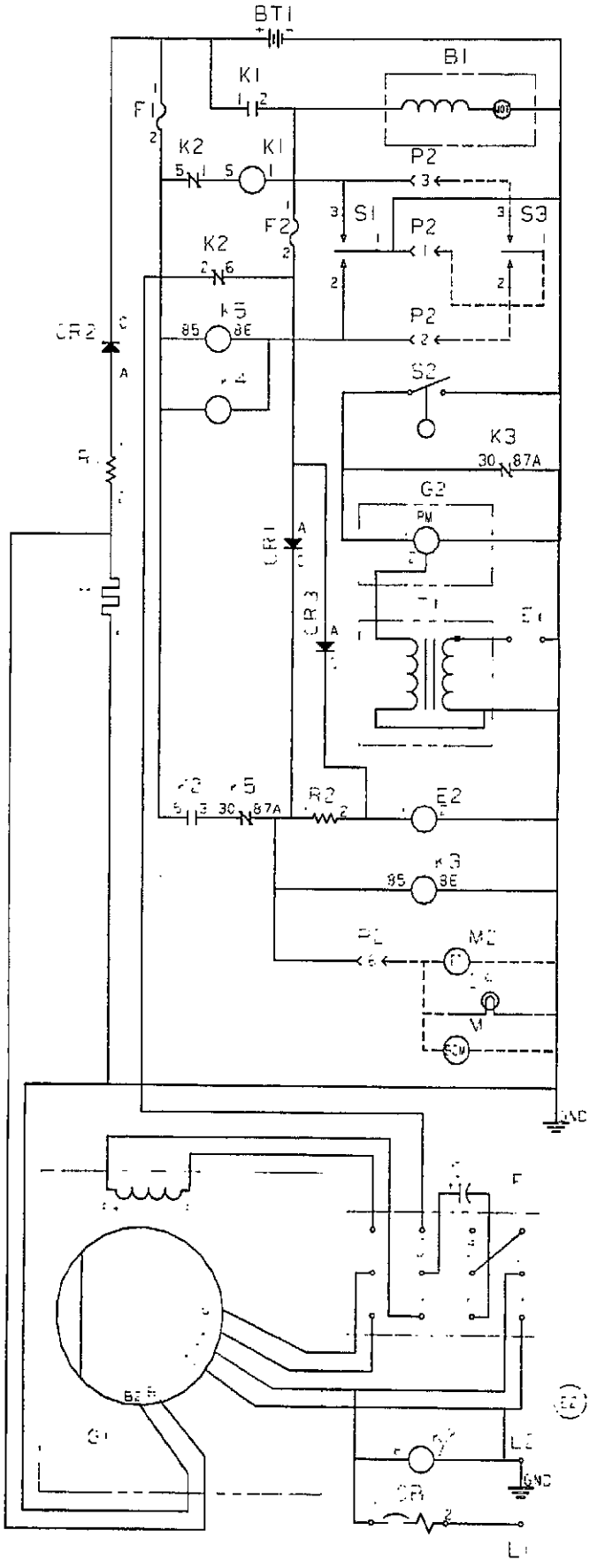
The charging circuit supplies generator battery charge voltage (20 ± 2 volts) that is rectified to DC by diode (CR2) and supplied to the battery through the charge resistor (R1). This charges the battery at a variable rate (1 ampere maximum) during set operation. The charge rate varies with the generator load and battery condition.

Stopping

Placing the start/stop switch (S1) in the stop position energizes the K3 relay, which causes the K3-30/K3-87 contacts to close and ground the output from the magneto assembly (G2) and stops the engine.

As the generator output voltage drops, the start disconnect relay (K2) de-energizes, opening contacts K2-3/K2-5. This causes the E2 fuel solenoid to open and stop fuel flow to the regulator.

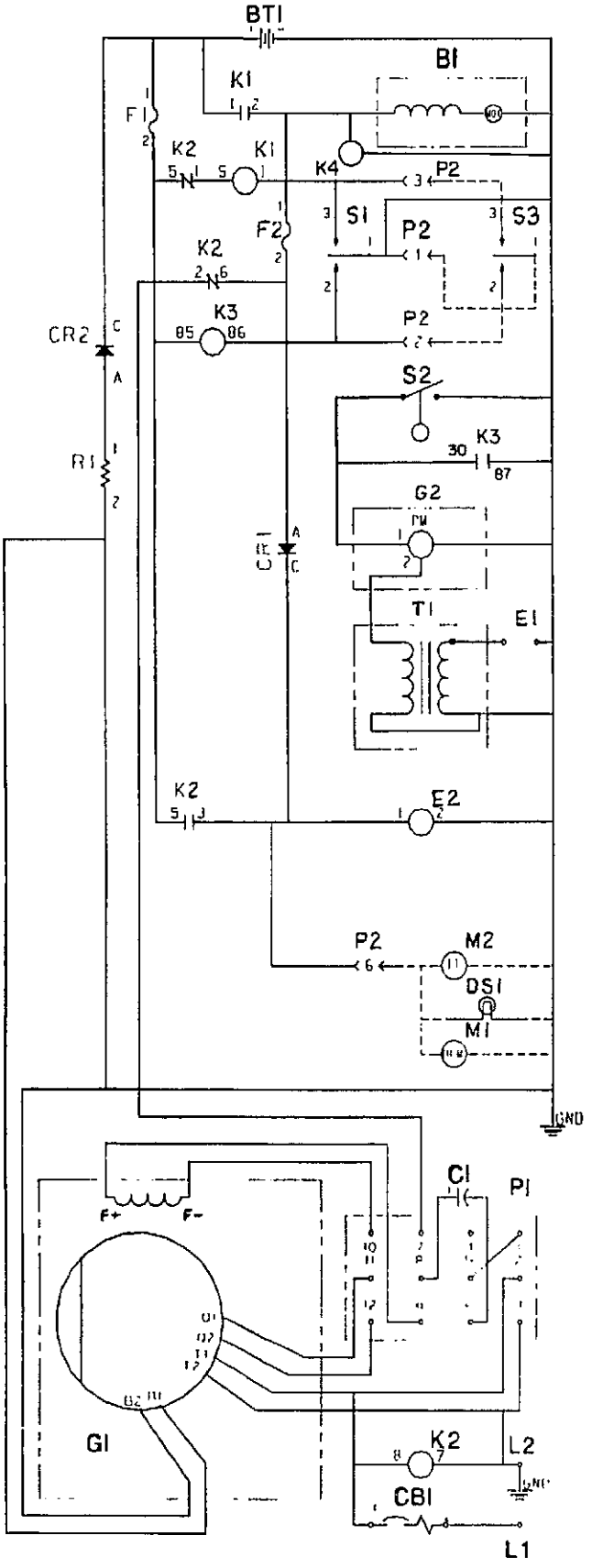
Diode CR2 prevents the battery from discharging through the generator windings when the set is not running.



K5	Relay
K4	Solenoid
K3	Relay
R2	Resistor - Ballast
Z	Splice
T1	Ignition Coil
S3	Switch-Start/Stop Remote
S2	Switch-Low Oil Level
S1	Switch-Start/Stop
R1	Resistor-Charging
P2	Plug-Remote
P1	Plug-Voltage Regulator
M2	Meter-Total Run Time
M1	Meter-Battery Condition
K2	Start Disconnect Relay
K1	Start Solenoid
H1	Choke
G2	Magneto-Ignition
G1	Generator
F1,F2	Fuse-5A
E2	Fuel Pump
E1	Spark Plug
DS1	Lamp-Remote
CR3	Diode
CR2	Diode
CR1	Diode
CB1	Circuit Breaker
C1	Capacitor
BT1	Battery
B1	Starter Motor
A2	Deluxe Remote Control
A1	Standard Remote Control

*R2 and CR3 may not be used in later production sets.

FIGURE 7-1. SCHEMATIC - 60 HERTZ



K3	RELAY-IGNITION STOP
K4	SOLENOID-PRIMING
Z	Splice
T1	Ignition Coil
S3	Switch-Start/Stop Remote
S2	Switch Low Oil Level
S1	Switch-Start/Stop
R1	Resistor-Charging
P2	Plug-Remote
P1	Plug-Voltage Regulator
M2	Meter Total Run Time
M1	Meter Battery Condition
K2	Start Disconnect Relay
K1	Start Solenoid
G2	Magneto Ignition
G1	Generator
F1,F2	Fuse
E2	FUEL SOLENOID
E1	Spark Plug
DS1	Lamp Remote
CR2	Diode
CR1	Diode
CB1	Circuit Breaker
C1	Capacitor
BT1	Battery
B1	Starter Motor
A2	Deluxe Remote Control
A1	Standard Remote Control

FIGURE 7-2. LPG GENERATOR SET SCHEMATIC - 60 HERTZ

CONTROL TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the control. Figure 7-2 shows the location of most of the control components. Refer to the wiring diagram in Figures 8-1 or 8-2 for location of wiring terminals.

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

TROUBLESHOOTING THE CONTROL

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Does Not Crank	1. If engine cranks at set but not at remote control panel, fault is due to: a. open circuit in remote control wiring b. faulty remote start/stop switch	1a. Check for continuity and correct if circuit is open. 1b. Replace remote control start/stop switch (S3).
	2. If engine cranks at remote control panel but no at set, fault is due to: a. open circuit in set control panel wiring b. faulty set control start/stop switch (S1)	2a. Check for continuity and correct if circuit is open. 2b. Replace set control start/stop switch.
	3. Insufficient voltage for cranking due to: a. battery not charged, or b. terminal connections loose or dirty c. insufficient battery cable size	3a. Check condition of battery and recharge or replace. 3b. Clean and tighten all connections at start solenoid (K1), starter motor (B1), and ground connections. 3c. Increase cable size.
	4. Control fuse F1 is open.	4. Locate cause of overload and correct as required. Replace fuse.
	5. Start disconnect relay K2 defective.	5. Check for continuity at normally closed contacts K2-1/K2-5 and replace if defective.
	6. Start solenoid K1 not energizing due to: a. Open circuit between K1 and K2 or K1 and ground b. defective K1 relay c. defective start/stop switch	6a. Check for continuity and correct if circuit is open. 6b. Replace K1 relay. 6c. Check start/stop switch and replace if defective.
	7. Defective starter (B1)	7. Refer to electric starter section for test and service procedures.

TROUBLESHOOTING THE CONTROL (Continued)

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Cranks But Does Not Start	1. Faulty ignition due to worn or fouled spark plug or faulty plug wire. Faulty magneto or ignition coil.	1. Refer to Ignition System section for test and service procedures.
	2. Control fuse F2 is open.	2. Locate cause of overload and correct as required. Replace fuse.
	3. Faulty CR1 diode, (open).	3. Test CR1 diode and replace if defective.
	4. Faulty fuel system due to sticking choke, faulty fuel pump — gasoline sets (faulty priming solenoid, fuel solenoid, or regulator - LPG sets) or carburetor mixture screws incorrectly adjusted.	4. Refer to Fuel System section for test and service procedures.
	5. Low oil level switch (S2) is not open due to: a. low oil level b. faulty low oil level switch	5a. Check oil level and add oil if low. 5b. Replace oil level switch.
	6.*Defective K5 relay contacts	6. Check normally-closed contacts K5-30/K5-87A, replace relay if defective.
	7.*K3 relay not energizing due to: a. open circuit to K3 relay coil b. faulty K3 relay.	7a. Check for continuity and correct if circuit is open. 7b. Check K3 relay coil (85 ±5 ohms) and contacts, replace if defective.
	8. Governor linkage or *K4 solenoid stuck or binding. *Gasoline sets only	8. Check for free movement of governor arm and solenoid. Repair as necessary.
Engine Starts But Stops When Switch is Released	1. Output voltage from generator not being supplied to control due to: a. open circuit in wiring between generator and control b. no output voltage from generator	1a. Check for continuity and correct if circuit is open. 1b. Refer to Generator section for test and service procedures.
	2. Start disconnect relay K2 not energizing due to: a. open circuit to K2 relay coil b. faulty K2 relay	2a. Check for continuity and correct if circuit is open 2b. Test K2 relay and replace if defective.
	3.*Fuel pump not energized due to faulty ballast resistor R2 (if used).	3. Check resistance of ballast resistor R2 for approximately 1.2 ohms and replace if defective. (R2 is not used in later production sets.)
	4. Corroded slip rings.	4. Refer to *Generator* section for slip ring service.
	5. Defective voltage regulator. *Gasoline sets only	5. Refer to *Generator* section for voltage regulator test.

TROUBLESHOOTING THE CONTROL (Continued)

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Starts and Runs, Then Stops, Set Restarts Immediately or Set Restarts After Cooling Down	1. Fuel level is low or oil level is low.	1. Check fuel and oil level and refill as necessary.
	2.*Faulty choke operation due to sticking choke linkage, incorrect choke adjustment, open circuit in wiring between choke heater and generator, or defective choke heater.	2. Refer to Fuel System section for testing and service procedures.
	3.*Vapor lock due to: a.high ambient air temperature b.faulty fuel pump	3a. Remove any objects or debris that may restrict airflow. 3b. Refer to Fuel System section for testing and service procedures.
	4. Contaminated or incorrect fuel.	4. Refill tank with fresh fuel.
	*Gasoline sets only	
Low Battery	1. Weak or discharged battery. Generator set charger will not recharge a battery that is in a very low state of charge.	1. Connect a separate battery charger to bring battery up to full charge.
	2. Load connected to battery while set is turned off.	2. Turn off load.
	3. Disconnect the negative (-) battery cable at the battery and remove lead marked F1-1 to CR2-C from control fuse F1 terminal 1. Connect a DC ammeter and a 5-ampere fuse in series between control fuse F1, terminal 1, and the disconnected lead marked F1-1 to CR2-C. Reconnect battery negative (-) cable. With set running, the ammeter should read between 0 to 1 ampere. If meter shows battery is discharging, fault is due to: a. defective generator charge winding b. defective diode CR2 c. defective resistor R1	3a. Refer to Generator section for testing and service. 3b. Test CR2 diode and replace if defective. 3c. Test resistor R1 and replace if defective.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Run Lamp, Time Meter, or Battery Condition Meter Inoperative	1. Open circuit between terminal 6 on remote connector plug and terminal 6 on remote start/stop switch.	1. Check for continuity and correct if circuit is open.
	2. Open circuit between ground terminals on lamp or meters and terminal 1 on remote start/stop switch and remote connector terminal 1.	2. Check for continuity and correct if circuit is open.
	3. If battery condition meter works but time meter does not operate, time meter is defective.	3. Replace time meter.
	4. If time meter works but battery condition meter does not operate verify that jumper wire is connected between terminals 5 and 6 on remote start/stop switch. If jumper is in place, connect a voltmeter between the positive terminal on battery charge meter and ground. Use the following to determine fault: a. If reading equals battery voltage minus 10 volts, battery meter is defective b. if reading does not equal battery voltage minus 10 volts, zener diode in remote control is defective.	4a. Replace battery condition meter. 4b. Replace zener diode.
Generator Set Does Not Stop After Start/Stop Switch is Pushed to Off Position **(Note: Always remove load a few minutes before stopping to allow set to cool down.)**	1. Faulty set control start/stop switch (S1)	1. Check start/stop switch and replace if defective.
	2.*K5 relay not energizing due to: a. open circuit to K5 relay coil b. faulty K5 relay	2a. Check for continuity and correct if circuit is open. 2b. Check K5 relay coil (85 ±5ohms) and contacts, replace if defective.
	3.*K4 solenoid not energizing due to: a. open circuit to K4 solenoid a. faulty K4 solenoid	3a. Check for continuity and correct if circuit is open. 3b. Replace K4 solenoid.
	4.*K4 solenoid out of adjustment.	4. Adjust K4 solenoid mounting bracket so solenoid causes governor arm to completely close throttle when energized.
	5. Defective K3 relay contacts	5. Gasoline-fueled sets: Check normally-closed contacts K3-30/K3-87A, replace relay if defective. LPG fueled sets: Check K3 relay coil and K3 normally-open contacts K3-30/K3-87, replace relay if defective.
	*Gasoline sets only	

Note: A ballast resistor (R2) is used inline with the fuel pump to reduce the voltage to approximately 9 volts, to increase pump life. During cranking, the ballast resistor is bypassed through diode CR3 for low voltage operation of the pump. Resistor R2 and diode CR3 are not used in later production sets.

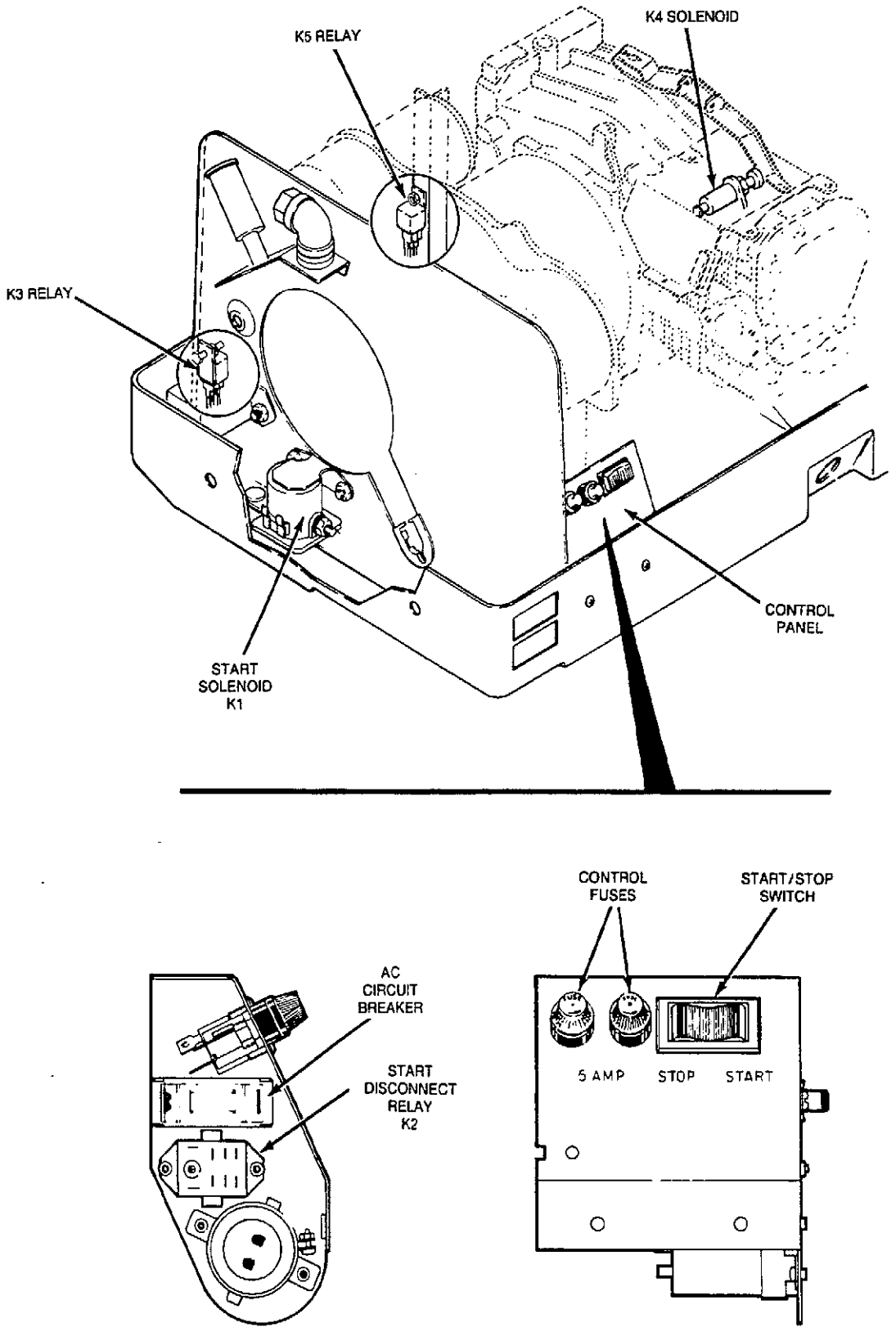


FIGURE 7-3. CONTROL COMPONENT LOCATIONS

Section 8. Generator

INTRODUCTION

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

GENERATOR DESCRIPTION

The generator consists of the following major components:

- Stator and housing
- Rotor
- Electronic Voltage Regulator
- Brushes
- Wiring Harness

The stator consists of a number of steel laminations stacked together, with three separate windings wound onto it in a torroidal fashion. 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. The stator mounts inside the generator.

Rotor

The rotor consists of a number of laminations stacked together, a field winding wrapped around the laminations, a shaft through the laminations, molded slip rings on the shaft and a bearing pressed on the shaft. The entire assembly is connected directly to the tapered engine crankshaft by means of a throughbolt. The rotor is supported on the other end by the endbell, which is placed over the bearing and secured to the housing.

The rotor field winding provides the rotating magnetic field which in turn generates the voltage and current 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 airflow for the generator is provided by a centrifugal fan mounted on the shaft behind the bearing. A portion of the airflow from the fan is directed into the generator. Part of this air flows down the rotor cooling the rotor winding, and the rest flows over the stator windings cooling them.

Electronic Voltage Regulator

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

Brushes and Brush Block

The brush block is a one piece molded part that mounts inside the endbell. There are two carbon brushes in the brush block which ride on the slip rings and provide the means by which the controlled DC current from the regulator is conducted into and out of the rotor. Each brush is kept in contact with its slip ring by a spring mounted inside the brush block behind the brush. The spring exerts just the right amount of pressure to provide good contact and long brush life.

Wiring Harness

A separate wiring harness is provided for connecting the generator set to the RV electrical system. All lead wires are stranded copper wire to withstand vibration. The lead wires must be protected with flexible conduit which must be provided by the RV manufacturer or generator set installer. A 1/2 inch conduit elbow is provided to facilitate installation. The load wire conductor is black, the neutral conductor is white, and the ground conductor is green.

GENERATOR OPERATION

The schematic shown in Figure 8-1 is provided to help follow the generator operating description. Always refer to the specific schematic that corresponds to the model and spec number of the generator set when troubleshooting problems.

When the start/stop switch is placed in the start position, the rotor begins to turn and is momentarily connected to the battery. This provides a current in the rotor field winding which induces a voltage in the stator windings, in particular the excitation winding Q1-Q2. The regulator takes this voltage and rectifies it and feeds it back into the rotor which causes the voltage to increase further. This process continues as the engine picks up speed. The voltage does not increase uncontrollably because the regulator is connected to the power output leads (L1-L2) and constantly 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 constantly 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, but is noticed by the regulator. In this case, the regulator decreases the amount of current to the field until the output voltage. again matches the reference voltage. In this manner the electronic voltage regulator keeps the voltage of the generator constant with varying load conditions.

GENERATOR TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the generator. Figure 8-3 shows the location of most of the generator components. Refer to the wiring diagram in Figures 8-1 and 8-2 for reference to the generator wiring. Always refer to the specific wiring diagram that corresponds to the model and spec number of the generator set when troubleshooting. The troubleshooting guide is divided into five sections. After identifying the problem, refer to the guide for the possible cause and the recommended corrective action.

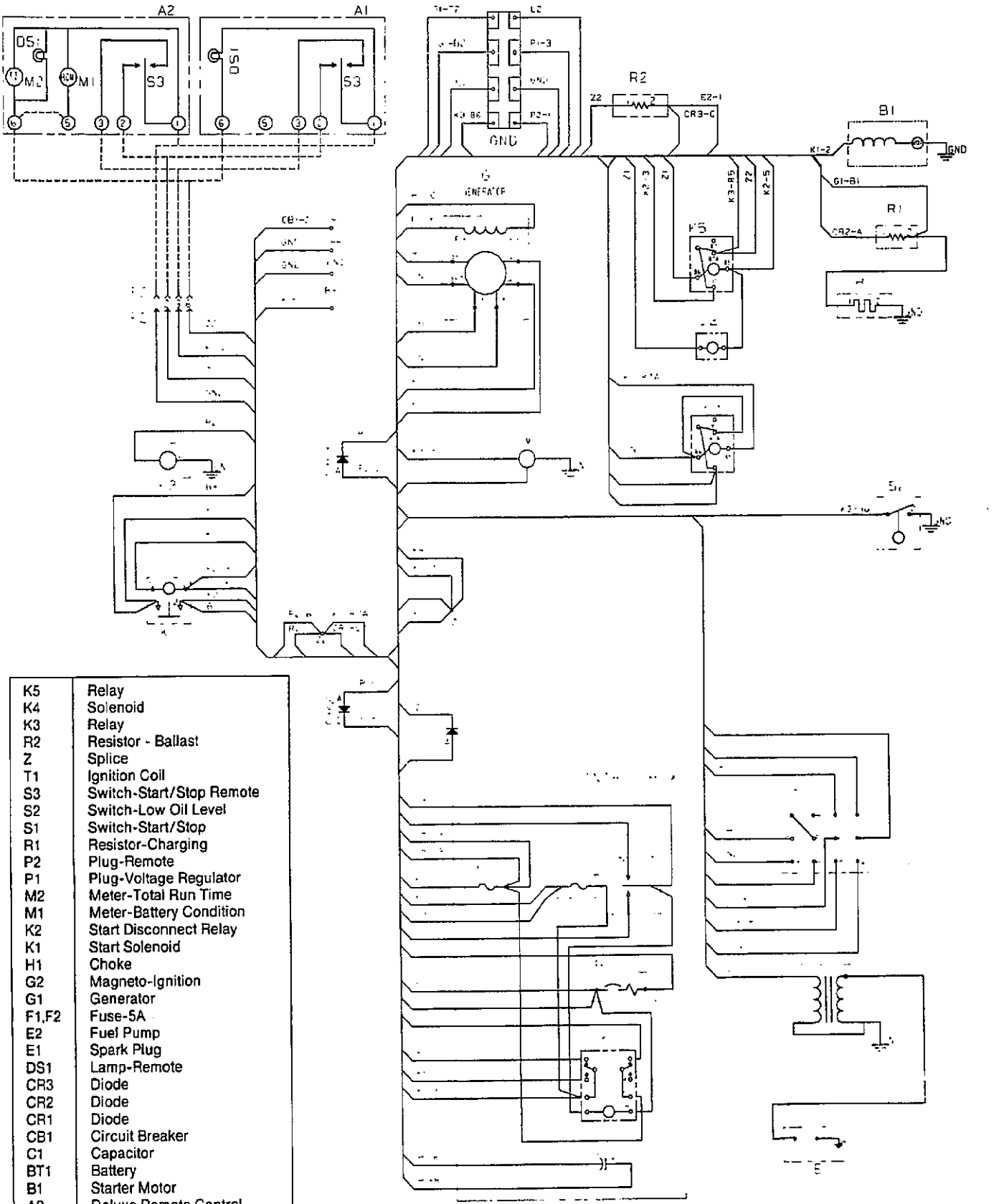
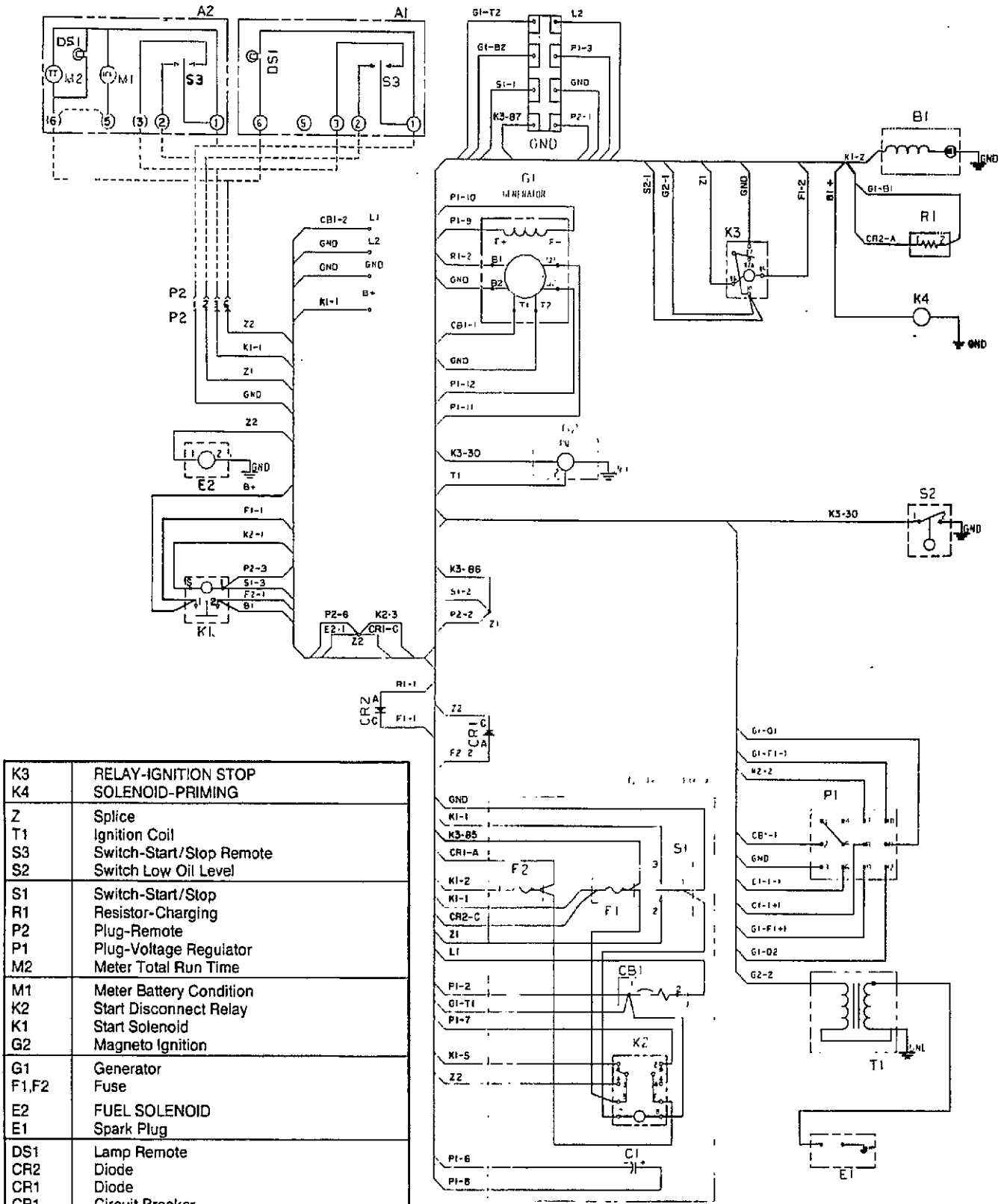


FIGURE 8-1. GENERATOR SET WIRING DIAGRAM - 60 HERTZ



K3	RELAY-IGNITION STOP
K4	SOLENOID-PRIMING
Z	Splice
T1	Ignition Coil
S3	Switch-Start/Stop Remote
S2	Switch Low Oil Level
S1	Switch-Start/Stop
R1	Resistor-Charging
P2	Plug-Remote
P1	Plug-Voltage Regulator
M2	Meter Total Run Time
M1	Meter Battery Condition
K2	Start Disconnect Relay
K1	Start Solenoid
G2	Magneto Ignition
G1	Generator
F1,F2	Fuse
E2	FUEL SOLENOID
E1	Spark Plug
DS1	Lamp Remote
CR2	Diode
CR1	Diode
CB1	Circuit Breaker
C1	Capacitor
BT1	Battery
B1	Starter Motor
A2	Deluxe Remote Control
A1	Standard Remote Control

FIGURE 8-2. LPG GENERATOR SET WIRING DIAGRAM - 60 HERTZ

TROUBLESHOOTING THE GENERATOR

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
No AC Output voltage Note: This condition may cause the generator set to stop when the start switch is released.	1. Open circuit breaker	1. Locate cause of overload and correct as required. Reset breaker.
	2. Open circuit between brush block and regulator or start disconnect relay contacts K2-2/K2-6 and the regulator	2. Check for continuity and correct if circuit is open.
	3. Brushes stuck in holder or not making good contact with slip rings	3. Release brushes if jammed in holder. Clean slip rings if dirty.
	4. Capacitor (C1) shorted	4. Check capacitor and replace if defective.
	5. Faulty start disconnect relay (K2)	5. Check start disconnect relay (K2) normally closed contacts K2-2/K2-6. Replace if defective.
	6. Open, grounded, or shorted rotor or stator.	6. Test each component for open, grounded, or shorted windings and replace if defective.
	7. Faulty electronic voltage regulator	7. If other possible causes check good, replace voltage regulator.
AC Output Voltage Too Low	1. Engine governor incorrectly adjusted	1. Refer to *Governor* section
	2. Brushes worn or not making good contact with slip rings	2. Check length of brushes and replace if worn excessively. Clean or replace slip rings.
	3. Jumper lead not making contact on voltage regulator terminals 1 and 5	3. Check for jumper lead in regulator connector terminals 1 and 5 and correct if not attached.

TROUBLESHOOTING THE GENERATOR

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
AC Output Voltage Too High	1. Engine governor incorrectly adjusted. 2. Faulty electronic voltage regulator	1. Refer to *Governor* section. 2. Check output voltage, if voltage is over 135 on 120 volt units, 242 on 220 volt units, or 264 on 240 volt units, and frequency is correct, replace the electronic voltage regulator.
Noisy Generator	1. Loose brush holder 2. Worn generator end bearing 3. Rotor and stator rubbing together due to: a. varnish lumps b. rotor misaligned with crankshaft	1. Tighten brush holder. 2. Replace end bearing. 3a. Check for varnish lumps between rotor and stator and remove as required. 3b. Follow specified assembly procedures to correct rotor to crankshaft alignment.
Generator Overheats	1. Generator overloaded due to defective circuit breaker 2. Airflow restricted due to dirt or debris covering vent openings in stator housing 3. Stator windings covered with oil or dirt 4. Open, grounded, or shorted circuit in rotor or stator	1. Replace circuit breaker. Do Not exceed specified load when operating set. 2. Clean 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.

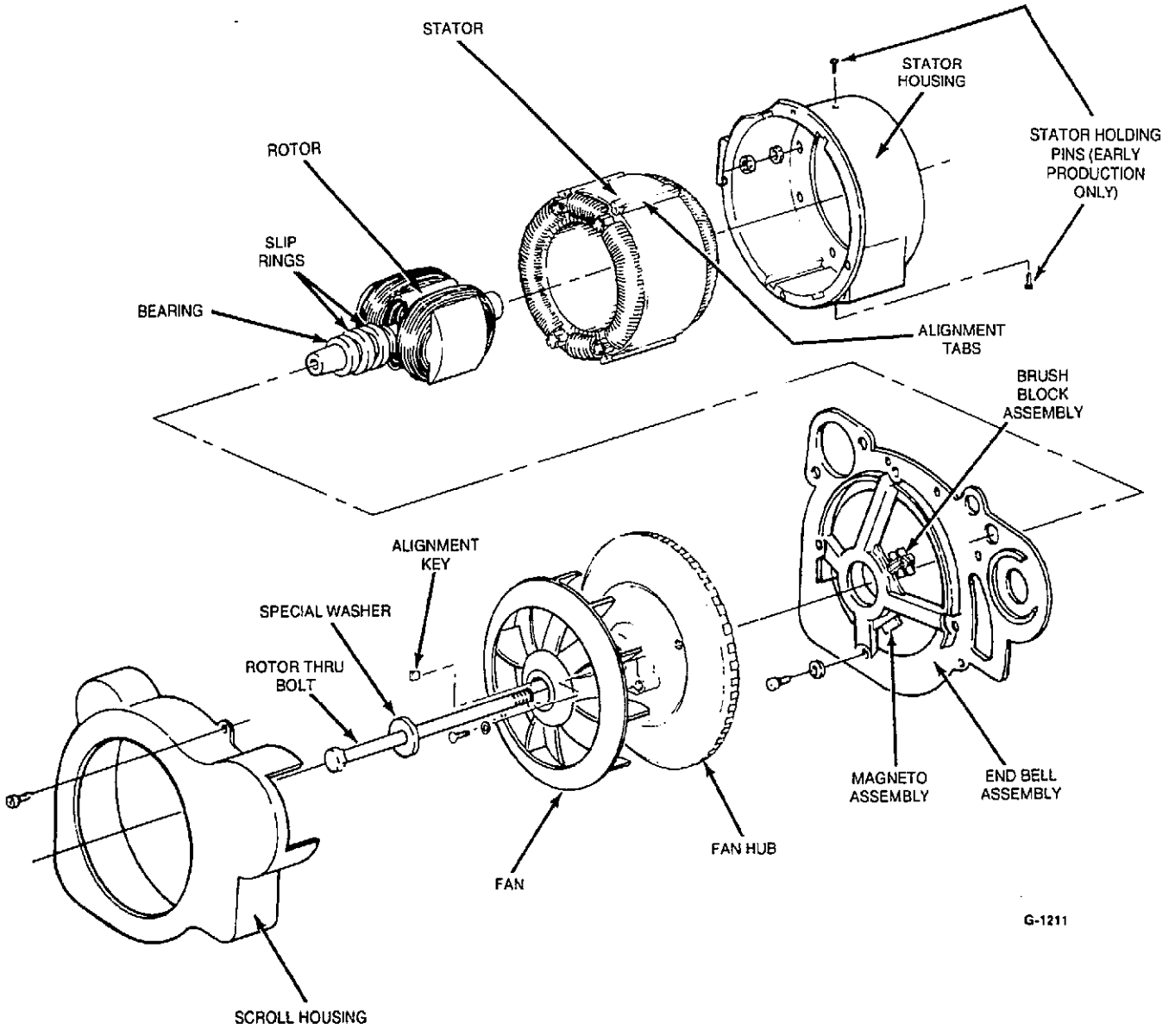


FIGURE 8-3. GENERATOR

GENERATOR SERVICE

This section covers generator disassembly and assembly procedures. Refer to Figure 8-3 to identify the various generator components described in each subsection.

Generator Disassembly

Use the following procedures to disassemble the generator:

1. Drain the engine oil while the generator set is still mounted in the vehicle.

   ⚠WARNING ***Hot oil can cause severe burns if spilled or splashed on skin. Keep hands clear when removing oil drain plug and wear protective clothing.***

2. Remove the generator set from the vehicle and place it on a sturdy workbench. Refer to Set Removal (section 5) for the recommended set removal procedures.

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

3. Remove side mounting screws from enclosure cover and lift cover off set.

4. Disconnect the fuel line from the fuel pump. Plug fuel lines to keep fuel from escaping.

   ⚠WARNING ***Fuel presents the hazard of fire or explosion which can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, or other ignition source near the generator set. Keep a type ABC fire extinguisher nearby.***

5. Remove the K3 relay from the inlet baffle assembly (Figure 7-2). Disconnect the B+ lead from the start solenoid.

6. Remove the control panel mounting screws and lower the control panel.

7. Remove the two bottom mounting nuts securing the inlet baffle assembly. Lift the inlet baffle up and move it to the right side.

8. Remove the air filter cover, retainer, and filter (Figure 6-7). Remove the three bolts securing the plastic fan to the fan hub assembly and remove the fan and the scroll housing together (Figure 8-3).

9. Attach a special tool to the fan hub to keep it from rotating (Figure 8-4). Remove the rotor through-bolt. Be careful not to lose the alignment key behind the rotor through-bolt washer (Figure 8-3).

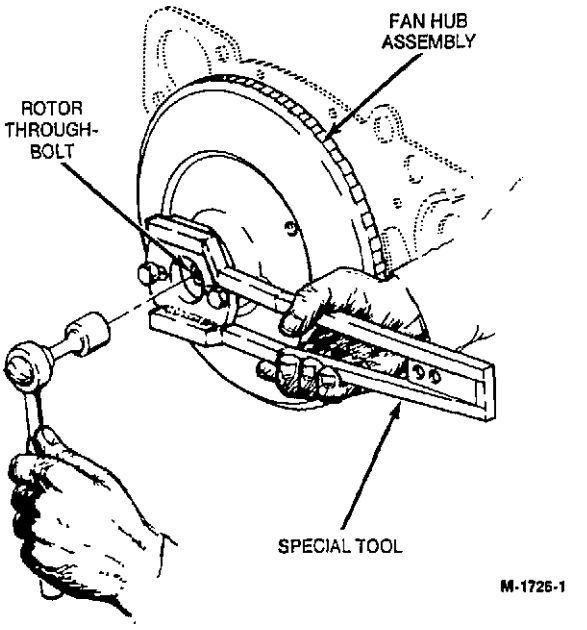


FIGURE 8-4. SECURING FAN HUB ASSEMBLY FOR REMOVAL

10. Install a puller on the end of the fan hub as shown in Figure 8-5. Use two 1/4 inch thread cutting capscrews to secure the puller to the fan hub. Place a washer on the end of the rotor shaft to protect it from the puller center screws. Tighten puller center screw against washer until fan hub pulls free of rotor shaft. Remove puller when complete.

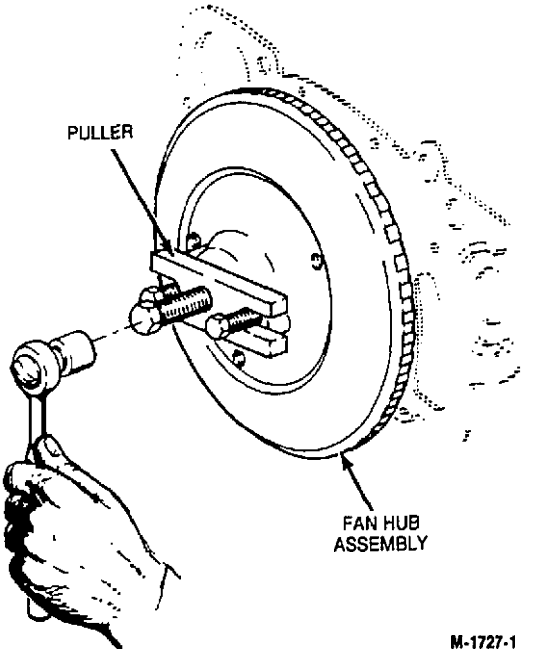


FIGURE 8-5. PULLING THE FAN HUB ASSEMBLY

11. Prepare the brushes for endbell removal. Disconnect wire harness leads from brush block and pull each brush outward from the holder and at the same time insert a piece of wire into the small hole in the endbell at bottom of brush block. See Figure 8-6. Carefully guide the wire through the brush block and then release each brush. Verify that each brush is held off the slip rings by the wire.

⚠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.***

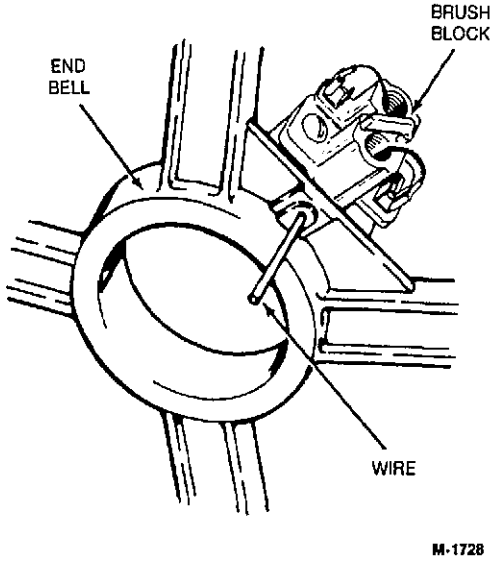


FIGURE 8-6. BRUSH BLOCK

12. Remove the two starter mounting bolts that secure the starter to the endbell. Remove the choke assembly from the generator endbell and disconnect the leads attached to the resistor at the top of the endbell. Remove endbell mounting screws and remove the endbell. Secure springs for reinstallation.

⚠WARNING ***Sharp edges can cause severe personal injury. Wear gloves when handling components with sharp edges.***

⚠CAUTION ***Careless handling of rotor or stator can damage the insulation on the windings. Do not allow windings to be brushed or scraped during removal.***

Inspect stator housing for stator holding pins (2) used on some early production units produced before serial number 126644 (Figure 8-2). Remove holding pins by gripping pin head with a locking pliers and pull outward with a slight counterclockwise twist. Stator holding pins are not required to reassemble the generator and should be discarded.

13. Remove each of the wire connectors from the stator assembly. Wear gloves when handling the stator for protection from sharp edges. Insert two 6-inch screw drivers into the holes on opposite sides of the stator laminations next to the alignment tabs (Figure 8-3). Squeeze screw driver handles together and carefully pull stator straight out of the endbell. If stator will not slide out, tap on generator housing while pulling on stator to remove. Do not bend or flex stator wire terminals or damage can occur.

⚠CAUTION ***Bending or flexing the stator terminals can cause breakage of the terminals. Use caution when removing the stator wires and when handling the stator.***

14. Place a wooden shim between the bottom of the stator housing and the base assembly to prevent movement between the generator and the base. Carefully tap on the rotor shaft with a lead hammer to free tapered rotor shaft from the crankshaft. Be careful to avoid striking the collector rings. Pull the rotor straight out and locate the Woodruff key used to align the rotor shaft with the crankshaft.

⚠CAUTION ***The collector rings will be damaged if struck during rotor removal. Use caution to avoid hitting collector rings when using lead hammer on rotor shaft.***

Generator Assembly

Use the following procedures to assemble the generator:

1. Prepare the set for stator and rotor installation. The stator and rotor must be installed while the set is standing vertically on the engine end for correct alignment of the rotor shaft to the crankshaft. Raise the generator end of the set and allow it to rest on the engine end. Place a wooden block under the muffler to hold the set level. Support the set to prevent it from falling during service.

⚠WARNING ***The generator set is heavy and can result in severe personal injury if dropped during service. Support the generator set during service to prevent it from falling.***

2. Check to see that Woodruff key is installed properly on engine crankshaft.

3. Check the generator housing for burrs in the aluminum slots that the stator slides into. Remove burrs and clean housing if required.

4. Position the stator so the output connector terminals face outward from generator housing and orient stator lamination alignment tabs with mounting grooves in housing, as shown in Figure 8-3. Carefully lower stator into generator housing. If necessary the stator can be lightly tapped on the lamination mounting tabs until the stator seats into the housing.

⚠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.***

5. Align slot in rotor shaft with Woodruff key on crankshaft and lower rotor onto crankshaft. Make sure that the rotor is seated.

⚠CAUTION ***Misalignment of the rotor shaft and the crankshaft can cause damage to the rotor and stator assembly.Use care when installing the rotor shaft to align the crankshaft and rotor shaft with the Woodruff key in the crankshaft.***

6. Attach the stator wire harness connectors to the stator. Be careful not to bend connector terminals or damage may occur. Refer to Figures 8-1 and 8-2 for wiring locations. Use wire ties to secure stator leads away from rotor and fan hub to prevent rubbing.

7. Prepare endbell for installation. Place springs on studs and lubricate o-ring. Verify that brushes are held in holder with piece of wire. See Figure 8-6. Install endbell onto rotor bearing and secure with endbell mounting screws.

⚠CAUTION ***The brushes will be damaged during assembly if not held off the slip rings. Make certain wire is in place before installing the generator endbell.***

8. Remove the piece of wire holding the brushes off the slip rings. Connect the F- lead wire to the outboard brush terminal and the F+ lead wire to the inboard brush terminal.

9. Install fan hub onto rotor shaft and align key slot on fan hub with key slot in end of rotor shaft. Install alignment key. Insert washer on rotor through-bolt and install into rotor shaft. Verify alignment of rotor shaft and fan hub. Use special tool to secure fan hub assembly (Figure 8-4) and tighten the rotor through-bolt to the specified torque.

10. Lower the generator end of the set and allow set to rest on base.

11. Attach choke assembly to endbell. Install two starter mounting bolts through endbell and attach starter at specified torque. Attach connectors to resistor on endbell (Figure 8-1).

12. Attach fan to fan hub with three bolts and install scroll housing. Install air filter, retainer, and filter cover.

13. Install air inlet baffle assembly and tighten mounting nuts to specified torque.

14. Connect fuel line to fuel pump and inspect the fuel supply line for cuts cracks and abrasions. Make sure fuel supply line does not rub against anything that could cause breakage.

⚠WARNING ***Leaking fuel will create a fire hazard which can result in severe personal injury or death. If leaks are detected correct immediately. Replace worn fuel line components before leaks occur.***

15. Connect the B+ lead to the start solenoid. Attach K3 relay to the inlet baffle assembly (Figure 7-3).

16. Install the control panel. Inspect assembly, check all electrical and mechanical connections for correct fit and location. Place enclosure cover on set and secure with side mounting screws.

17. Install the generator set in the vehicle and securely fasten all mounting screws and hardware. Connect the fuel line, exhaust system and electrical systems in reverse order of disassembly. Refer to Set Removal (section 5).

18. Fill crankcase with oil of the recommended classification and viscosity.

BRUSHES AND SLIP RINGS

This section covers brush replacement and slip ring service.

Brush Replacement

Follow Generator Disassembly procedures (this section) 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 8-7) to check for excessive brush wear. Insert the painted end of the wire through the hole above each brush. Make sure the wire is resting on the brush and not on the spring. If the painted part of the wire is not visible. The brush is excessively worn and must be replaced. Always replace the brush springs when installing new brushes to maintain proper tension on the brushes. Clean carbon deposits from brushes and slip rings (see Slip Ring Service section). Use the following procedure to replace the brushes:

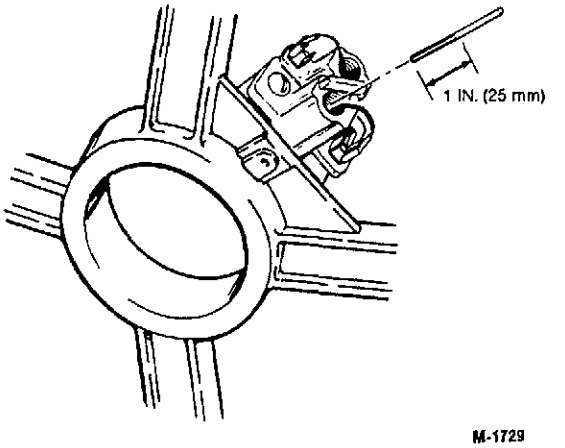


FIGURE 8-7. BRUSH WEAR CHECK

1. Remove the brush block mounting screws and lift out the brush block.
2. Remove brushes and springs from holder and replace with new parts (see Figure 8-8).

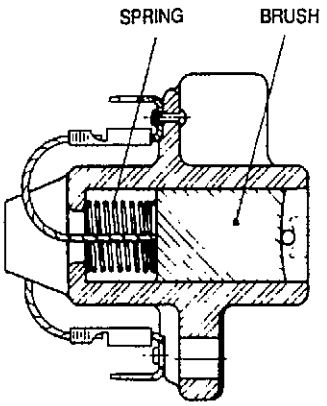


FIGURE 8-8. BRUSH REPLACEMENT

3. Pull each brush outward from brush holder and insert a stiff wire through the small hole in the base of the holder. See Figure 8-6. The wire holds the brushes off the slip rings during assembly.

Inspect slip rings before installing brush block. See Slip Ring Service (this section).

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

Slip Ring Service

Follow Generator Disassembly procedures (this section) 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 in bad condition and there is no power build-up, refinish using a fine sandpaper. Use the following procedure to service:

1. Follow Generator Disassembly (this section) to remove generator endbell and rotor.
2. Place rotor in machine lathe and center. Turn rotor and use fine sandpaper against rotating slip rings to clean and true slip rings. Turn rotor until all grooves or roughness are smoothed out.

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

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

3. Clean rotor and prepare for reinstallation. Follow Generator Assembly procedures (this section) to reinstall rotor and remaining generator components.

VOLTAGE REGULATOR (VR1) TEST

Confirm that voltage regulator VR1 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 wiring connector and remove the voltage regulator (Figure 8-9).
2. With the meter on "Diode Check", test between connector terminal pairs 5-9, 7-9, 10-9, 11-9, 12-9, 10-5, 5-11, 5-12 and 5-3. (Figure 8-9). It is important that the positive lead of the meter be connected to the first terminal of each pair.
3. Replace the voltage regulator if any reading indicates "short" or "open", except for pair 10-5, which should indicate "open".

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

4. If the regulator checks "good", there is a small chance that it may be "bad". Recheck it on a genset. Also check that the connector pins are secure in both connector ends.

GENERATOR TESTING

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

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

Check all wire harness connectors and leads for continuity prior to testing or generator disassembly. Refer to Figures 8-2 and 8-3 wire locations.

Field Voltage Test

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

Connect a DC voltmeter positive (+) test lead into the voltage regulator plug (P1) at pin 9 and connect the negative (-) test lead into the voltage regulator plug at pin 10. The voltage regulator plug remains connected to

the voltage regulator and test prods should be secured so that they are not being held during testing. See Figure 8-9.

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

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

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

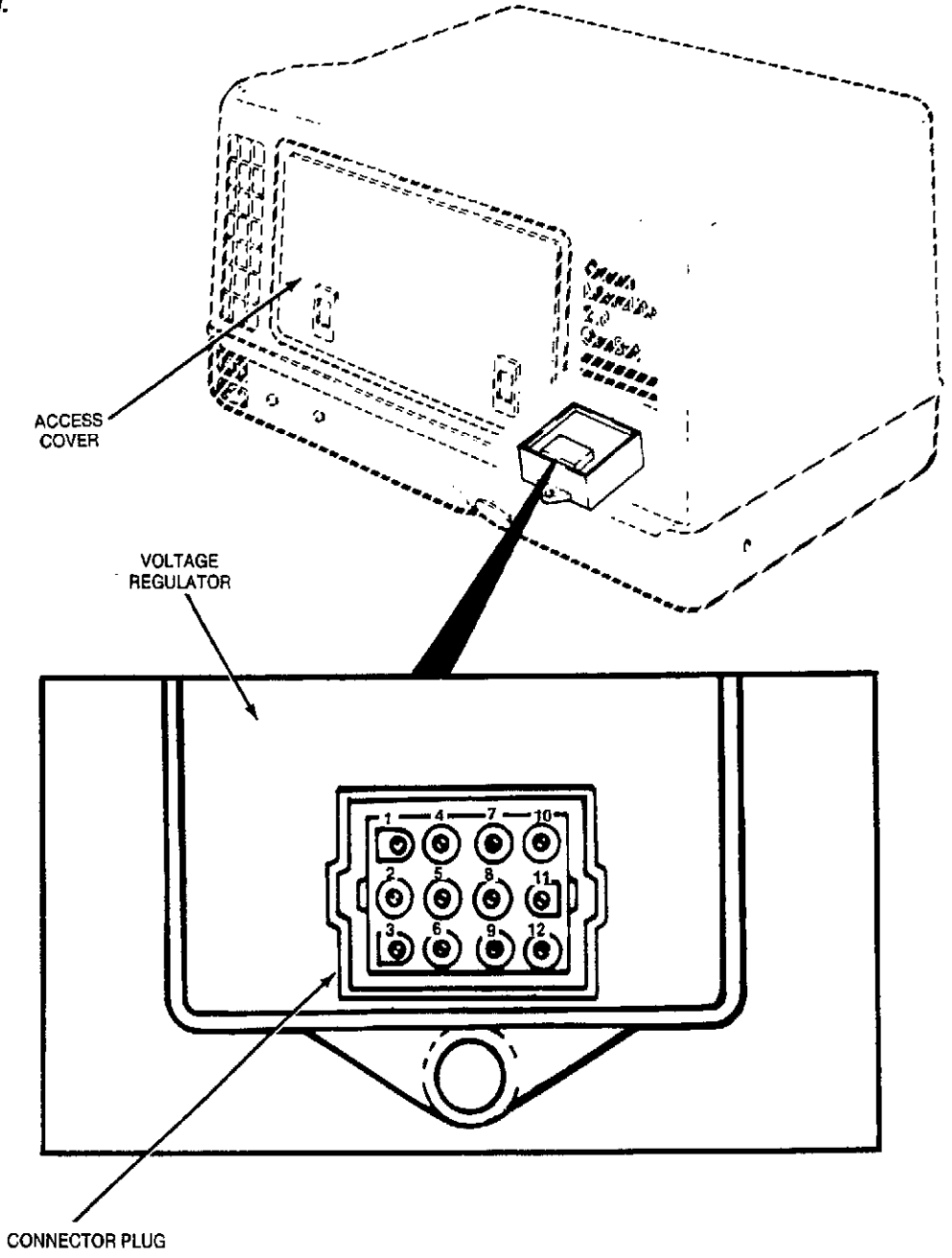


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FIGURE 8-9. VOLTAGE REGULATOR CONNECTOR PLUG (P1)

Rotor Test

The rotor can be tested for grounded, open, or shorted windings using an ohmmeter. Figures 8-10 and 8-11 show the rotor removed from the generator set for testing. The rotor can be tested without removing it from the generator. To gain access to the slip rings, follow the Generator Disassembly procedures (this section) through the fan hub assembly removal procedure. Use a stiff wire to hold the brushes off the slip rings during testing. Refer to the Brushes and Slip Ring section for the procedures to use for inserting the wire.

If available, it is recommended that a megger or insulation resistance meter be used for ground tests.

Ground Test:

To test for grounds, set the ohmmeter for the highest resistance scale. Touch one test prod to the rotor shaft and hold it there. Touch the other test prod to one of the slip rings as shown in Figure 8-10. A reading of less than one megohm indicates the rotor is grounded. Replace a grounded rotor with a new rotor.

Open or Shorted Test: To test for open windings, set the ohmmeter on the highest resistance scale. Place test prods on the slip rings as shown in Figure 8-11. The ohmmeter should indicate continuity between the slip rings. A high resistance reading indicates a poor connection or an open winding. Check the connection between the slip rings and rotor lead wires. Replace rotor if rotor winding is open.

To test for shorted winding, set the ohmmeter on the lowest scale. Place the test prods on the slip rings as shown in Figure 8-11. A reading of less than 16 ohms at 77°F (25°C) indicates shorted windings. Replace rotor if winding is shorted. If rotor tests good proceed to stator tests.

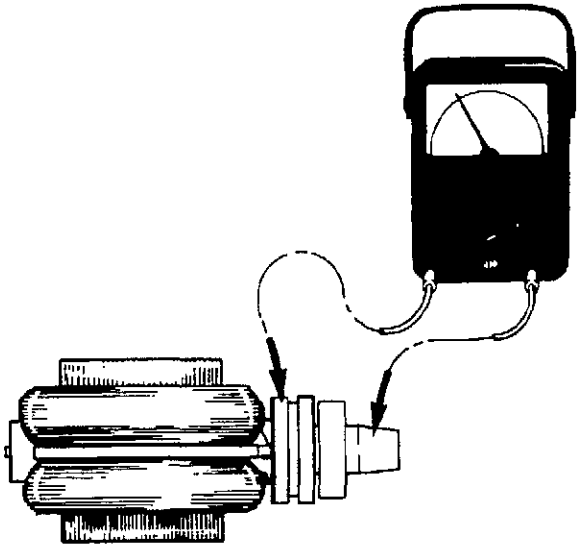

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FIGURE 8-10. GROUNDED ROTOR TEST

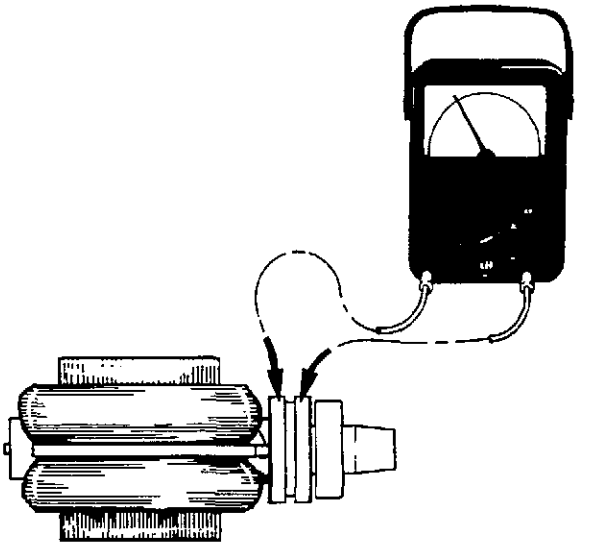

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FIGURE 8-11. OPEN OR SHORTED ROTOR TEST

Stator Test

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

Figure 8-12 shows the stator removed from the generator for testing. The stator can be tested without removing it from the generator. If generator is assembled, gain access to the stator by following the Generator Disassembly procedures (this section) through the fan hub assembly removal procedure.

To perform stator tests, carefully remove all four connector plugs from the stator.

⚠CAUTION ***Do not bend or flex stator wire terminals or breakage can occur.***

If available, it is recommended that a megger or insulation resistance meter be used for ground tests.

Ground Test: Set the ohmmeter for the highest resistance scale and then connect one test prod to the generator housing or stack if removed. Touch the other test prod (see Figure 8-12) to the terminals specified in Table 8-1. A reading of less than one megohm indicates a ground. Replace a grounded stator with a new stator.

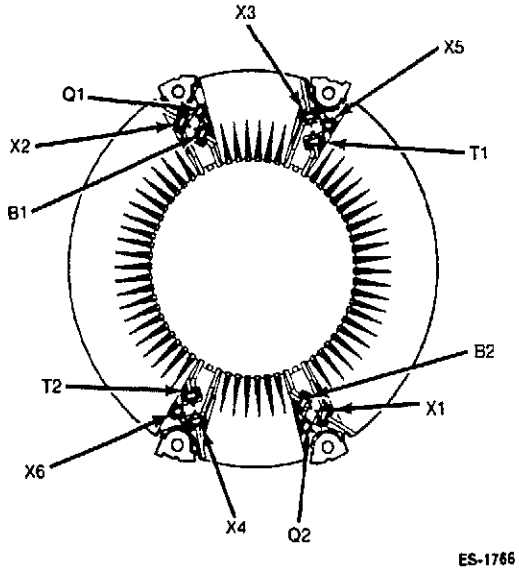


FIGURE 8-12. STATOR ASSEMBLY

TABLE 8-1
STATOR GROUND TEST

TEST LEAD LOCATION	OHMMETER READING
T1 to Ground	Infinity
T2 to Ground	Infinity
B1 to Ground	Infinity
B2 to Ground	Infinity
Q1 to Ground	Infinity
Q2 to Ground	Infinity

Open or Shorted Stator Windings Test: To test for open windings, set the ohmmeter for the highest resistance scale and then connect the test prods (see Figure 8-12) to the terminals specified in Table 8-2. 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 0.01 ohms. Connect the test prods to the terminals specified in Table 8-2. A reading of less than the value shown in Table 8-2 at 77°F (25°C) indicates a shorted winding. If stator tests indicate a shorted winding, replace the stator.

If stator tests good, check jumper leads X1-X2, X3-X4, and X5-X6 for continuity, and for good electrical connection with the stator terminals. Also check remaining stator wire connections for continuity and good electrical contact with stator. See Figures 8-1 and 8-2 for wire locations.

TABLE 8-2
STATOR OPEN AND SHORTED WINDING TEST

TEST LEAD LOCATION	OHMMETER READING (ACCEPTABLE RESISTANCE RANGE) AT 77°F [25°C])
	60 HERTZ STATOR
T1-X1	0.191 to 0.233
T2-X2	0.191 to 0.233
B1-X3	0.024 to 0.030
B2-X4	0.024 to 0.030
Q1-X5	0.615 to 0.751
Q2-X6	0.615 to 0.751
	50 HERTZ STATOR
T1-X1	1.013 to 1.238
T2-X2	1.013 to 1.238
B1-X3	0.090 to 0.110
B2-X4	0.090 to 0.110
Q1-X5	0.738 to 0.902
Q2-X6	0.738 to 0.902

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, (referenced later for reassembling). See Figure 8-13.

⚠WARNING ***The bearing casing is made of hardened steel. When struck, it will shatter into small pieces and can cause severe personal injury. Use protective eye wear and clothing when replacing the rotor bearing.***

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

2A. If available, use a small puller with grips that will fit between the bearing and the collector ring assembly. Cover the end of the rotor shaft with a steel plate to prevent deformation of the shaft during removal.

2B. If a suitable puller is not available, wrap the collector ring with a cloth for protection and cut off the outer race of the bearing using a small hand grinder with a cutting wheel. Be careful to avoid cutting the collector ring assembly. Remove the bearings and make two cuts approximately halfway through the inner race 180° apart. See Figure 8-14. Place rotor with one cut face down on a hard surface and center a cold chisel on the other cut and strike to split apart. Be careful not to damage the rotor shaft. The bearing casing is made of hardened steel that can shatter into small pieces. Use protective eye wear and clothing to protect yourself from injury when striking the bearing casing.

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

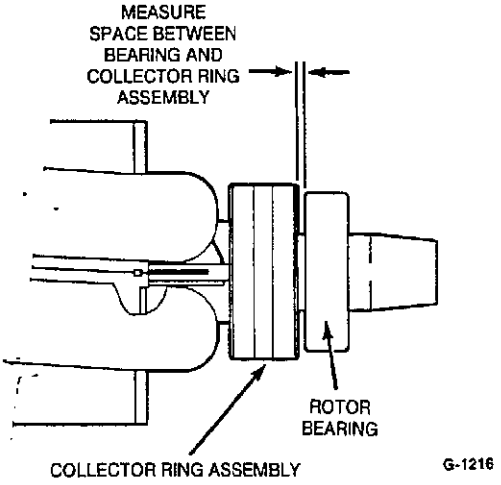


FIGURE 8-13. ROTOR BEARING SPACING

3. Place the rotor shaft, engine end down, onto a 1-1/16 inch (27 mm) O.D. steel shaft or use a plug mated to the engine end of the rotor shaft to protect the shaft taper from damage when pressing bearing into place.
4. Refer to measurement taken in step 1. Press bearing onto rotor shaft (press on inner race only) until it rests at the same distance from the collector ring assembly as the original bearing. Do not place bearing closer than 0.14 inches (3.5 mm) to the collector ring or arcing can result. Check bearing seal for damage after installation.

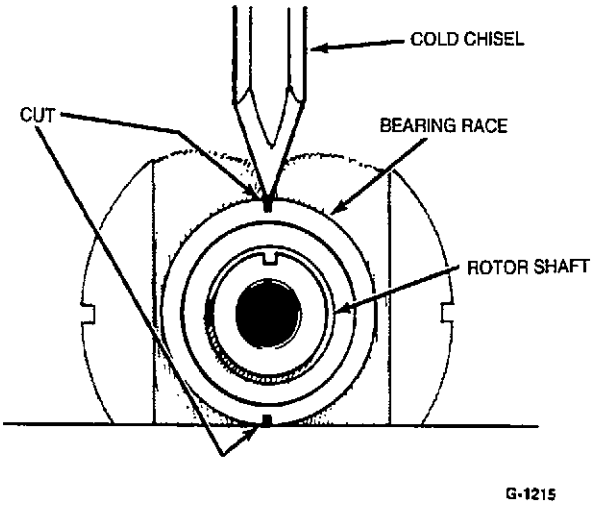


FIGURE 8-14. ROTOR BEARING REMOVAL

Section 9. Engine - Block Assembly

INTRODUCTION

This section covers service procedures for the engine block assembly. This assembly includes the cylinder block, cylinder head, valve system, piston and connecting rod, crankshaft, camshaft, and oil pan. Performing any major service will require generator set removal from the vehicle (see Set Removal, section 5). To gain access to the engine block assembly, the generator and primary engine systems must be removed. Refer to the previous sections for the disassembly procedures.

A suggested order of disassembly for the engine block assembly follows:

1. oil pan and oil level switch
2. head cover, breather and cowling
3. rocker arms and push rods
4. cylinder head, valve springs and valves
5. crankcase cover and camshaft,
6. connecting rod and piston
7. crankshaft and governor lever shaft

OIL PAN AND OIL LEVEL SWITCH

Remove the oil plug and drain the crankcase oil (if not previously drained).

Remove the oil pan mounting bolts and remove pan (see Figure 9-1).

Remove oil level switch mounting bolts and remove switch.

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

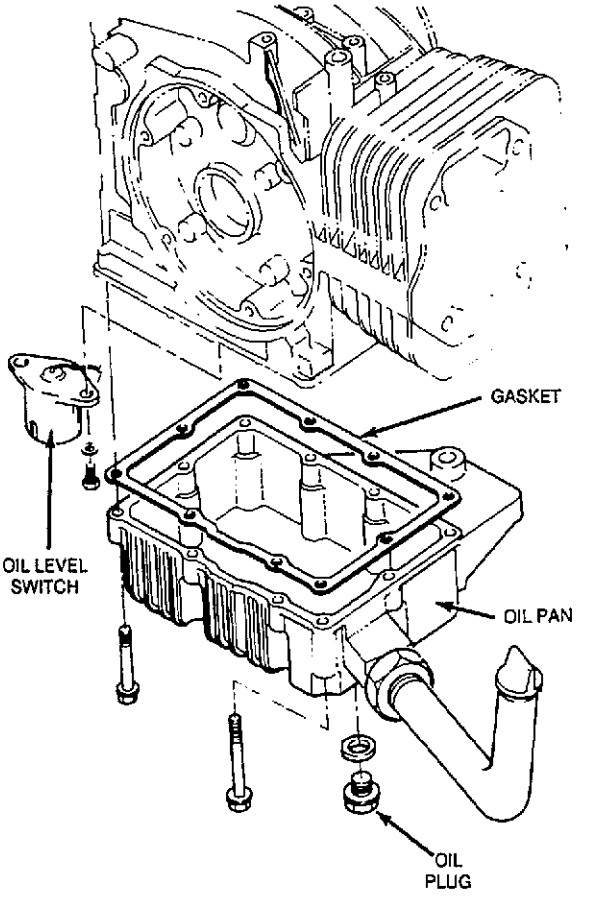


FIGURE 9-1. OIL PAN REMOVAL

HEAD COVER

Remove the head cover to gain access to the cylinder head and valve system. Use the following procedure to service.

1. Use a 10 mm socket wrench to remove head cover mounting bolts and pull off head cover. See Figure 9-2.
2. Clean head cover. Be careful not to damage outer sealing edge where gasket fits.
3. Clean cylinder head cover and cylinder head thoroughly where gasket rests. Use new gasket when reinstalling and make sure breather assembly is correctly installed in cylinder head cavity.
4. Place head cover in position and torque until all bolts are tightened to the specified torque.

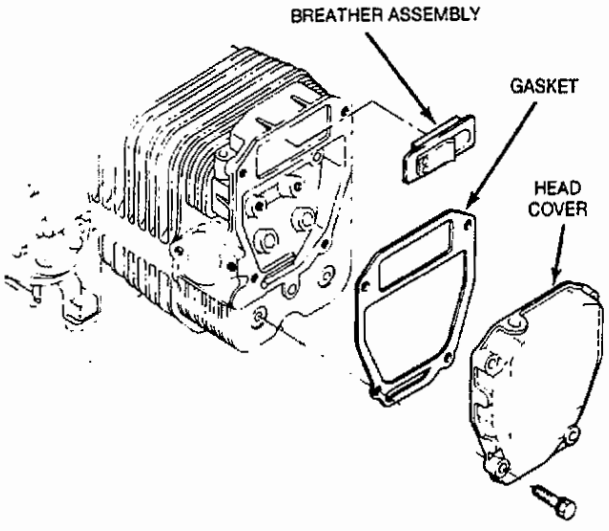


FIGURE 9-2. HEAD COVER REMOVAL

CYLINDER HEAD

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

1. Lift breather out of cavity in cylinder head.
2. Remove lock nut and adjusting bolts from rocker arms, then remove rocker arms and push rods.
3. Remove cowling mounting bolts and lift off cowling.
4. Use a 12 mm socket wrench to remove the cylinder head mounting bolts and lift off the head.

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

5. Clean out all carbon deposits. Be careful not to damage outer sealing edge where gasket fits. The head is made of aluminum and can be damaged by careless handling.
6. Use new head gasket and clean both cylinder head and cylinder block thoroughly where gasket rests.
7. Place head in position and follow head torque tightening sequence shown in Figure 9-3. Start out tightening all bolts to 11 ft-lb (15 N•m), then tighten to the specified torque (see Torque Specification section).

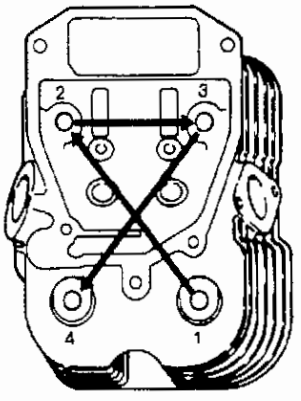


FIGURE 9-3. CYLINDER HEAD TIGHTENING SEQUENCE

VALVE SYSTEM

The engine in the KV generator set uses an overhead valve design as shown in Figure 9-4. A properly functioning valve system is essential for good engine performance. Access to the valve system can be gained by removing the head cover and the cylinder head. Use the following procedures to inspect and service the valve system.

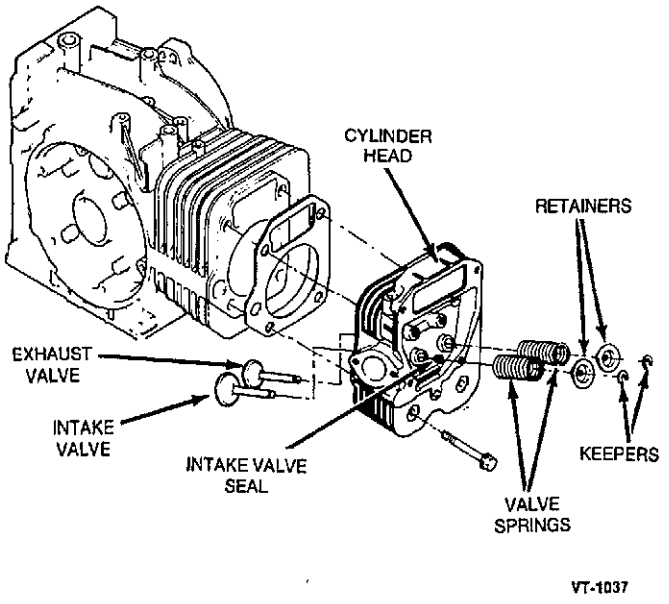


FIGURE 9-4. OVERHEAD VALVE SYSTEM

Valve Removal

The 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 and remove keeper. See Figure 9-5. Remove spring retainer and spring, then remove valve.

Inspection

Valve Face: Check the valve face for evidence of burning, warping, out-of-round, and carbon deposits (see Figure 9-6).

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 with sharp points projecting become white hot and cause pre-ignition and pinging.

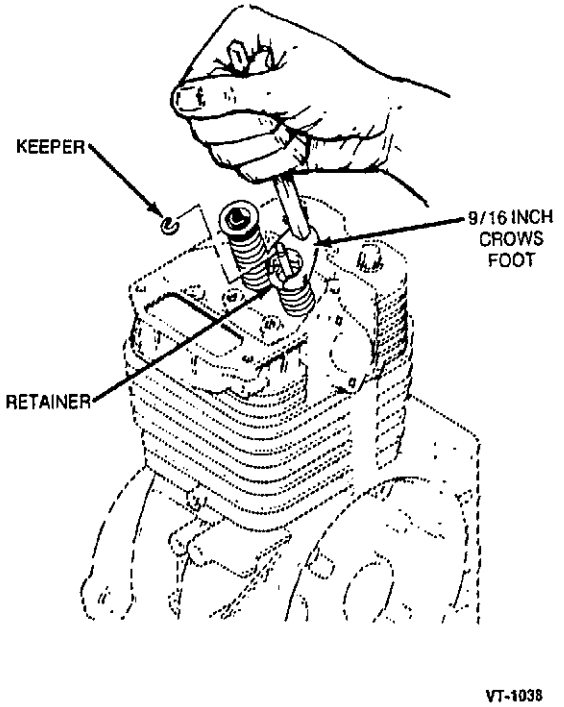


FIGURE 9-5. VALVE REMOVAL

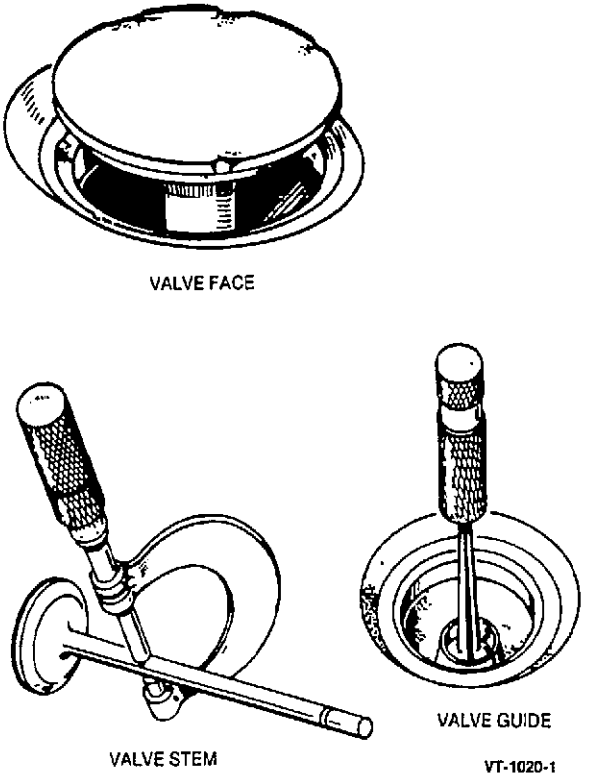


FIGURE 9-6. VALVE FACE, VALVE STEM AND VALVE GUIDE INSPECTION

Stems and Guides: Always check stems and guides for wear as shown in Figure 9-6. Use a hole gauge to measure the valve guide. When clearance with stem exceeds original clearance by 0.002 inch (0.05 mm), replace the valve or cylinder head, which includes the valve guide, or both.

Springs: Check valve springs for cracks, worn ends, and distortion. If spring ends are worn, check valve retainer for wear. Check for spring distortion by placing spring on a flat surface next to a square. Measure height of spring and rotate it against a square to measure distortion, see Figure 9-7. Replace any valve spring that is weak, cracked, worn, or distorted.

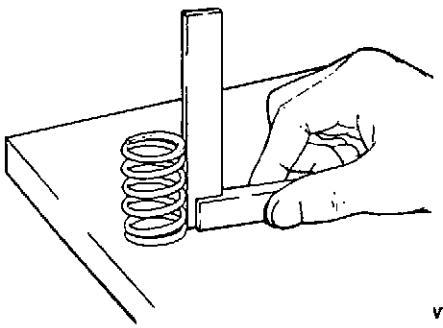


FIGURE 9-7. VALVE SPRING CHECKS

Reconditioning Valves and Valve Seats

Valves should not be hand lapped because the sharp contact made between the valve face and valve seat will be destoryed. Valve faces must be finished in a machine at 44.5 to 45 degrees. Each valve must have a minimum of 1/16 inch (1.6 mm) margin, Figure 9-8. If the valve has less margin than this it will heat up during the compression stroke and pre-ignite the mixture, causing loss of power and economy. This valve is also susceptible to warping and breakage.

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

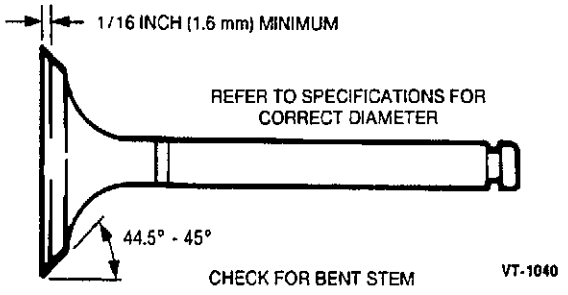


FIGURE 9-8. VALVE MARGIN

Valve seats should be ground with a 45° degree stone to the specified width. Grind only enough to provide proper seating. See Figure 9-9.

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

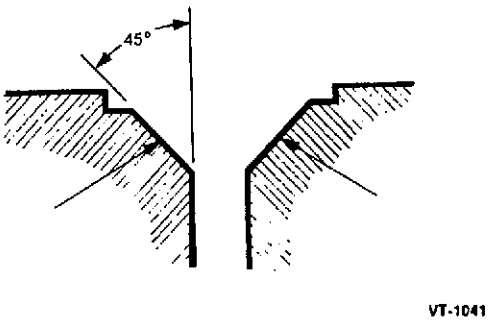


FIGURE 9-9. VALVE SEAT

Intake Valve Seal Replacement

A worn or cracked 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 valve seal into valve guide by hand.
4. After insertion, use a special tool made for installing the seal (Figure 9-10) to press the seal into the valve guide until the shoulder of the seal rests against the cylinder head.

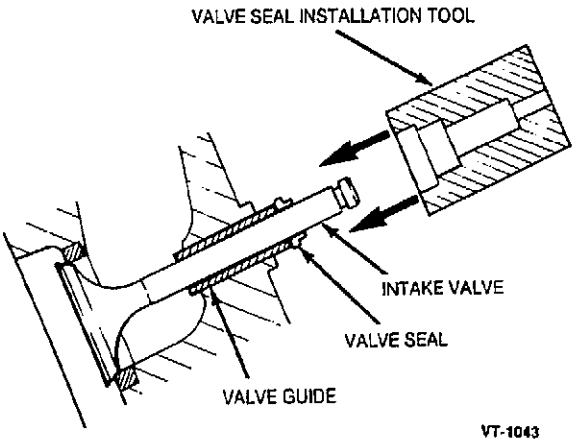


FIGURE 9-10. VALVE SEAL INSTALLATION

Valve Seat and Valve Guide Replacement

Worn valve stem guides or valve seats that are loose, cracked, or severely pitted should be replaced by replacing the cylinder head assembly. Both the valve stem guides and the valve seats are available only as part of the cylinder head assembly.

Valve Lash Adjustment

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

1. Follow head cover removal instructions (this section). Inspect valve stems for proper alignment with tappets.
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 the Specifications section. For each valve, the gauge should just pass between the top of the valve stem and the rocker arm. (see Figure 9-11).
4. Check the cylinder head mounting bolt torque (see Cylinder Head, this section) before performing valve lash adjustment.
5. To correct the valve clearance, place a 14 mm wrench on the adjusting nut and a 10 mm 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.
6. 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.
7. Reinstall the head cover and torque head cover bolts to specified torque.

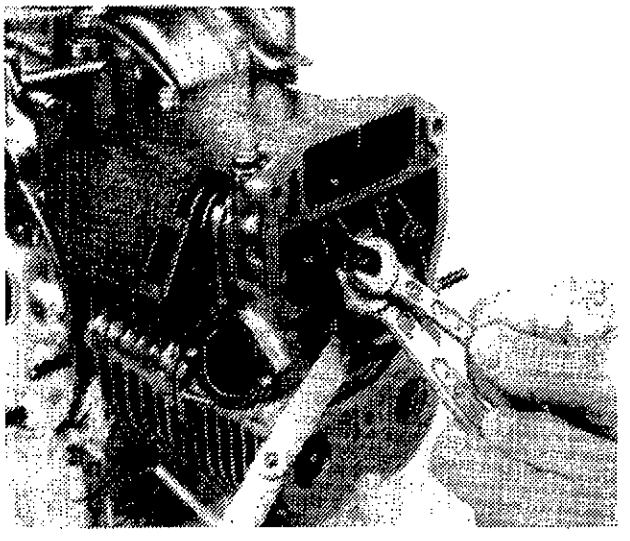


FIGURE 9-11. VALVE LASH ADJUSTMENT

CRANKCASE COVER

Remove the crankcase cover mounting bolts and lightly tap cover with plastic faced hammer to loosen. Be careful not to lose crankshaft and camshaft shims. When installing the cover make sure the governor shaft is properly positioned. Use a new gasket and clean the crankcase cover and the engine block where the gasket rests. Place crankcase cover in position and torque until all bolts are tightened to the specified torque (see Torque Specifications section).

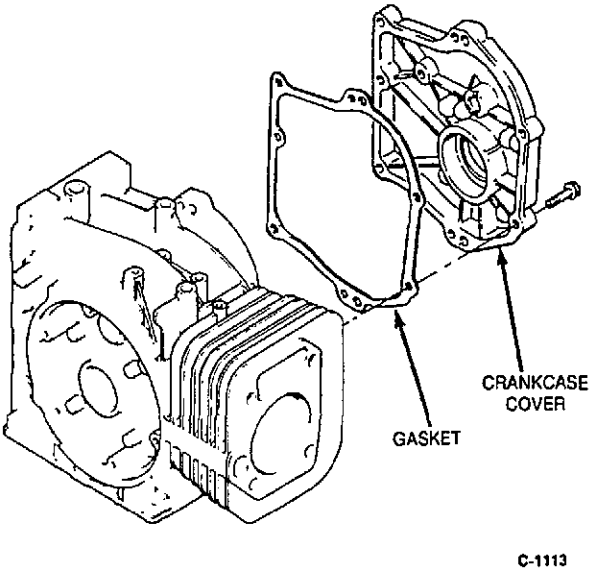


FIGURE 9-12. CRANKCASE COVER

CAMSHAFT AND TAPPET REMOVAL

The camshaft gear is pressed onto the camshaft and should be removed from the engine as a set. Check for matching mark with crankshaft before removing camshaft. The tappets can be removed after camshaft removal. See Figure 9-13.

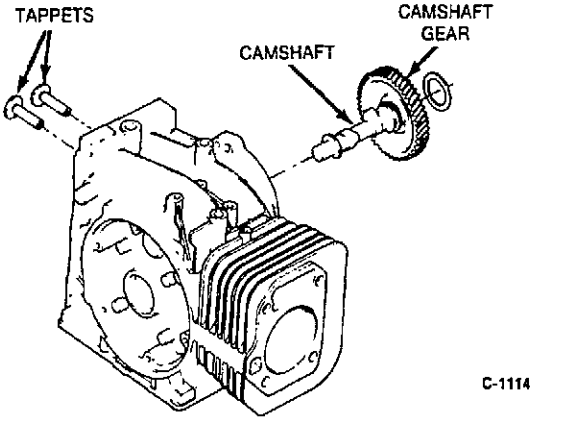
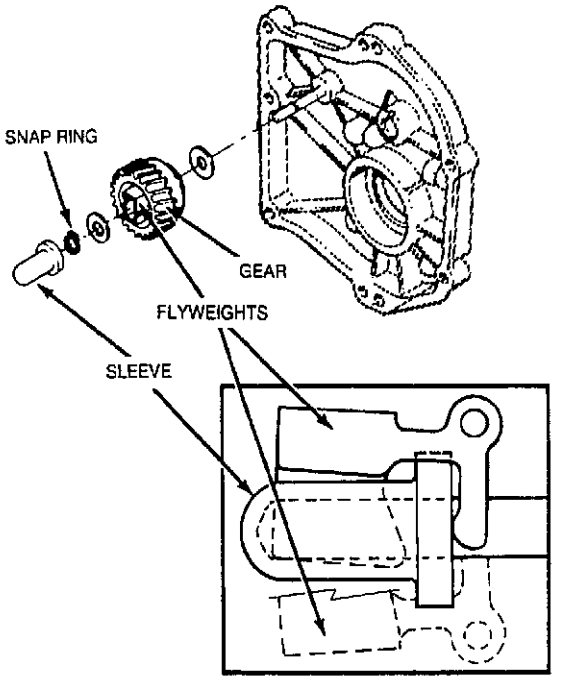


FIGURE 9-13. CAMSHAFT AND TAPPETS

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. If 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 governor gear assembly off mounting shaft being careful not to lose outer washer. See Figure 9-14. To install governor, assemble in reverse order of removal (see inset drawing, Figure 9-14, for position of flyweight and sleeve).

To remove the governor shaft, remove the retainer clip outside the block, then lower the governor shaft into the crankcase.



CT-1089

FIGURE 9-14. GOVERNOR

PISTON ASSEMBLY REMOVAL AND SERVICE

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 replacing. Remove the carbon from the top of the cylinder bore and check for a ridge. Remove ridge with a ridge reamer (see Figure 9-15) 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.***

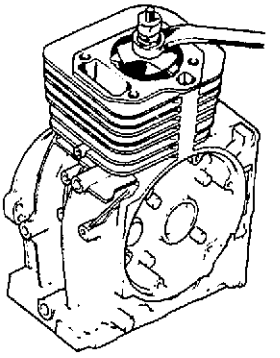


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FIGURE 9-15. REMOVING WEAR RIDGE

1. Remove two bolts from connecting rod. Mark direction of assembly for connecting rod, cap, and splasher.
2. Lift the rod cap from the rod and push the piston assembly out of the top of the cylinder with the handle of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing.

The piston is fitted with two compression rings and one oil control ring. Remove these rings from the piston using a piston ring expander as shown in Figure 9-16.

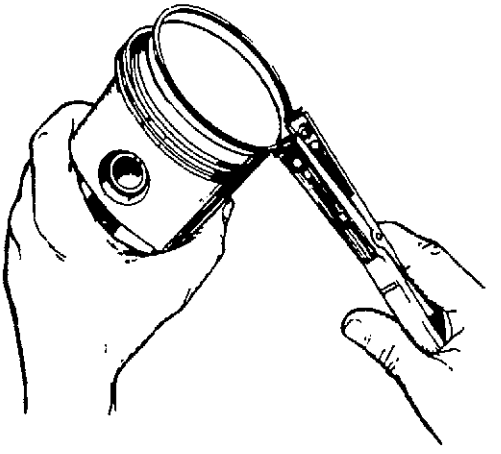

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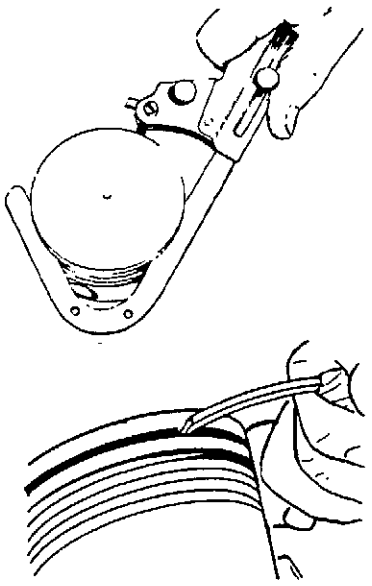
FIGURE 9-16. REMOVING PISTON RINGS

Remove the piston pin retainer from each side and push the piston pin out. Remove dirt and deposits from the piston surfaces with an approved cleaning solvent. Clean the piston ring grooves with a groove cleaner (Figure 9-17) or the end of a piston ring filed to a sharp point. Care must be taken not to remove metal from the groove sides.

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

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



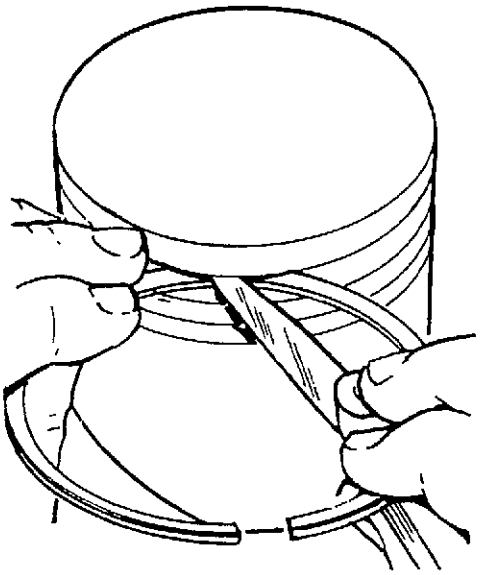
CT-1060

FIGURE 9-17. CLEANING RING GROOVES

Inspection

The following covers inspection procedures for piston and connecting rod.

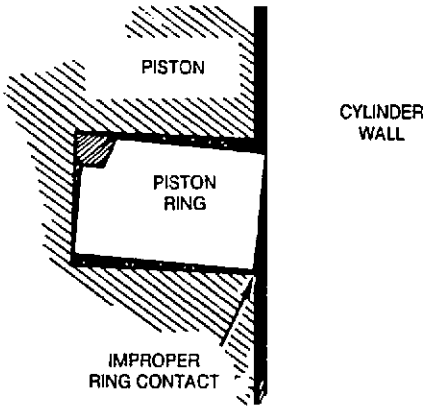
Piston Inspection: Inspect the piston for fractures at the ring lands, skirt, and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge as shown in Figure 9-18. Replace the piston when the side clearance of the top compression ring reaches 0.0039 inch (0.1 mm).



CT-1061

FIGURE 9-18. CHECKING RING LAND

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves do not have good cylinder wall contact (Figure 9-19).



CT-1062

FIGURE 9-19. NEW RING IN WORN RING GROOVE

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

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

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

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

Piston Clearance

Proper piston tolerances must be maintained for satisfactory operation. Use a micrometer to measure the piston diameter at the point shown in Figure 9-20. When the cylinder bore is measured (see *Cylinder Block section*), subtract the piston diameter from the cylinder bore diameter to obtain the piston pin to cylinder wall clearance. Refer to the Dimensions and Clearances section for the recommended piston clearance.

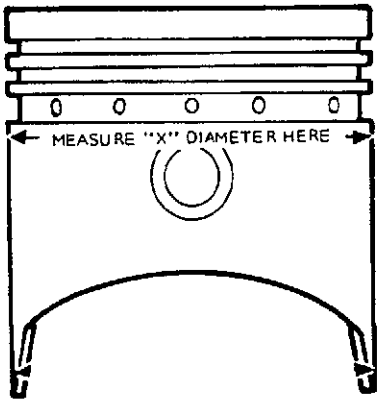


FIGURE 9-20. PISTON CLEARANCE MEASUREMENT

Fitting Piston Rings

Before installing new rings on the piston, check the ring gap by placing each ring squarely in the cylinder, at a position corresponding to the bottom of its travel (Figure 9-21). The gap between the ends of the ring is given in Dimensions and Clearances section.

The practice of filing ring ends to increase the end gap is not recommended. If the ring end gap does not meet specifications, check for the correctness of ring and bore sizes.

Rings of the tapered type are usually marked TOP on one side, or identified in some other manner. Install these rings with the identification mark toward the closed end of the piston.

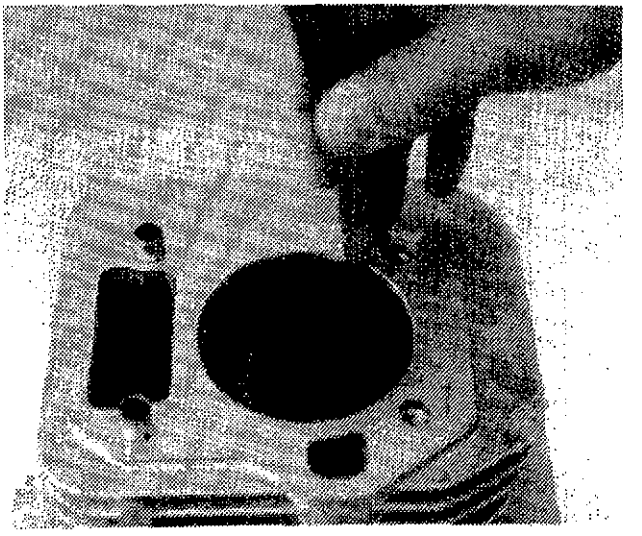


FIGURE 9-21. CHECKING RING GAP

Piston Assembly Installation

Lubricate all parts with clean engine oil. Position the piston on the connecting rod. Install the piston pin. The piston pin is a full-floating type and must be kept in place (in the piston) with two lock rings, one at each side. Install the lock rings and see that they are properly in place before installing the piston and connecting rod in the engine.

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 a dot or the word "top" on one side of the ring to indicate which side faces the top of the piston. Unmarked piston rings can be installed either way.

Stagger ring gaps 120 degrees apart. Do not position ring gaps on thrust face of cylinder.

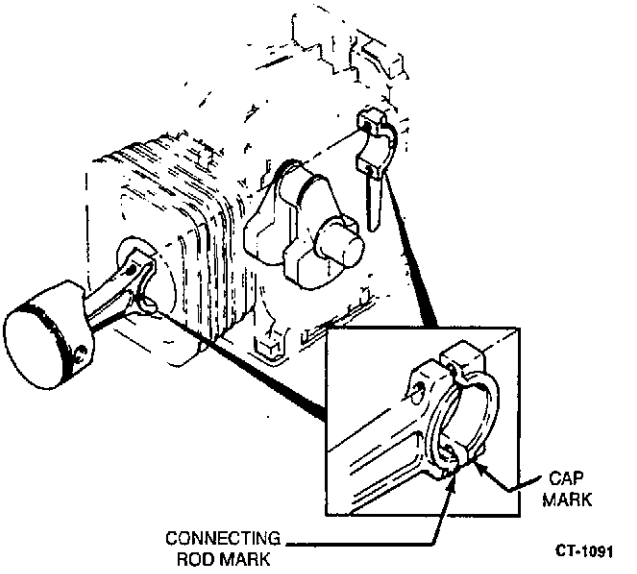


FIGURE 9-22. ROD CAP ASSEMBLY

Installing Piston in Cylinder: When installing the piston assembly, observe markings on the connecting rod, cap, and splasher and assemble in correct position. See Figure 9-22.

1. Turn crankshaft to position crankpin at bottom of its stroke.
2. Lubricate piston assembly and inside of cylinder. Compress rings with a ring compressor as shown in Figure 9-23.

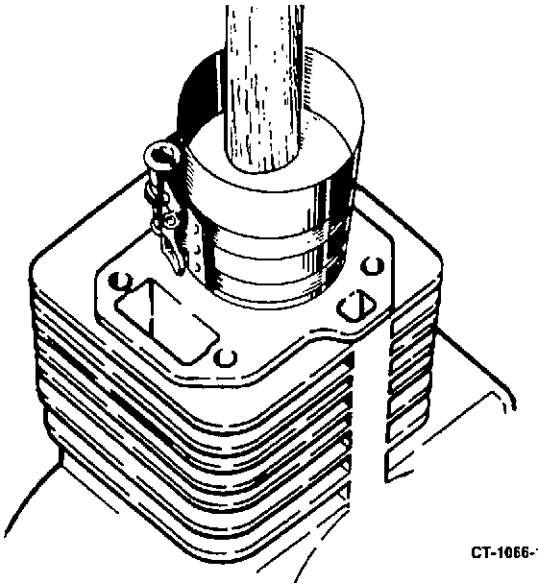


FIGURE 9-23. INSTALLING PISTON

3. Tap piston down into bore with handle end of hammer until connecting rod is seated on crankpin. Check crankpin clearance before proceeding to #4 step (see Crankpin Clearance section).
4. Lubricate the rod crankpin and install the connecting rod cap. Tighten connecting rod bolts to specified torque.

The bearing cap must be tapped several times to properly align it with the connecting rod. Clearance varies on the crankpin if this is not done. Crank the engine by hand to see that the crankshaft turns freely without binding.

Crankpin Clearance

1. Mark parts so they can be installed in their original positions, and wipe all parts clean of any oil or grease.
2. Place a piece of the correct size Plasti-gage across the full width of the rod cap about 1/4 inch (6 mm) off center.
3. Install the rod cap and tighten to the specified torque. Do not rotate the crankshaft after the 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 (see Figure 9-24) to determine the crankpin clearance.

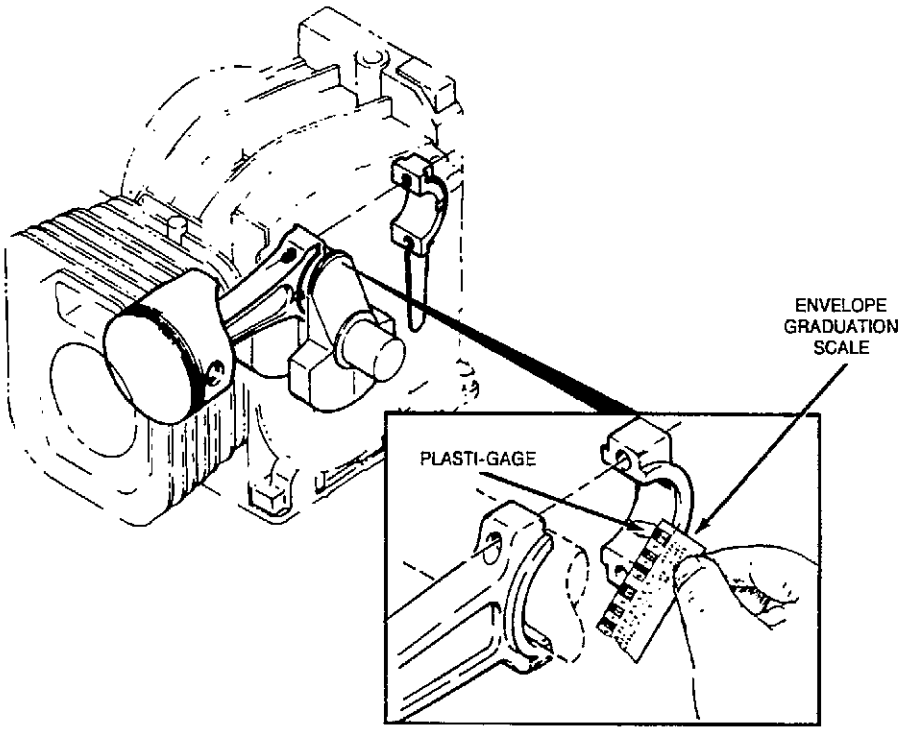


FIGURE 9-24. MEASURING CRANKPIN CLEARANCE

CRANKSHAFT

Remove the crankshaft after the connecting rod and piston have been removed, carefully pull the crankshaft out of the oil seal and bearing.

Inspection

Check the crankpin O.D. and finish. If it is worn or scored and cannot be smoothed out by polishing or if it exceeds the allowable size limit, the crankshaft should be replaced.

Installation

Lubricate the bearings with engine oil. Slide the crankshaft into the bearing. Install the crankcase cover and check to see that the crankshaft turns freely.

Checking Endplay

With the crankcase cover installed, check the crankshaft endplay at the point shown in Figure 9-25. Refer to the Dimensions and Clearances section for the recommended crankshaft endplay. If necessary add or remove shims as required and recheck endplay. Verify that the crankshaft turns freely without binding.

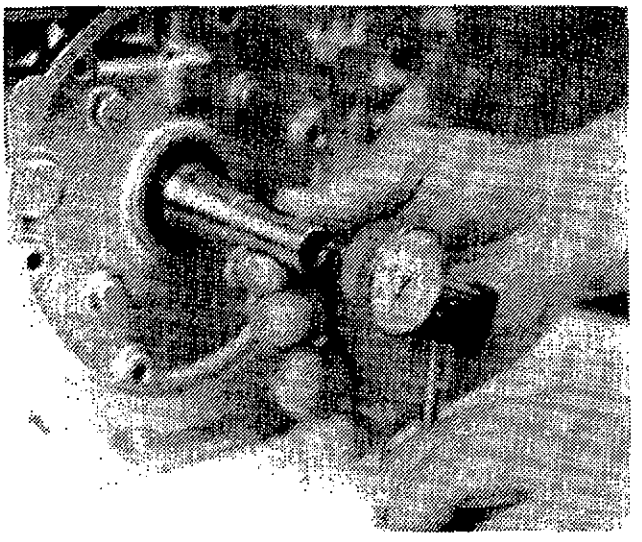


FIGURE 9-25. CHECKING ENDPLAY

CYLINDER BLOCK

Cleaning

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

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

Inspection

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

1. Make a thorough check for cracks using any standard method of crack detection. One method of crack detection follows: Minute cracks may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at the defective area. Always replace a cracked cylinder block. Clean the block and proceed.
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 cylinder head mounting area for flatness with a straight edge and a feeler gauge.

Cylinder Bore Inspection: Inspect cylinder bore for scuffing, scratches, wear, and scoring. If cylinder bore is scuffed, scratched, scored, or worn, the block must be replaced.

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

1. Check cylinder bore for taper, out-of-round, and wear with a dial bore gauge, telescope gauge, or inside micrometer. These measurements should be taken at four places, top and bottom of piston ring travel and parallel and perpendicular to axis of crankshaft.
2. Record measurements taken at top and bottom of piston travel as follows (see Figure 9-26).
   A. Measure and record as "A" the cylinder bore diameter (parallel to crankshaft) near the top of cylinder bore where greatest amount of wear occurs.
   B. Also measure and record as "B" cylinder bore diameter (parallel to crankshaft) at the bottom of piston travel.

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

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

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

F. Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicates whether or not cylinder is out-of-round.

If out-of-round exceeds 0.0039 inch (0.10 mm) the cylinder block must be replaced.

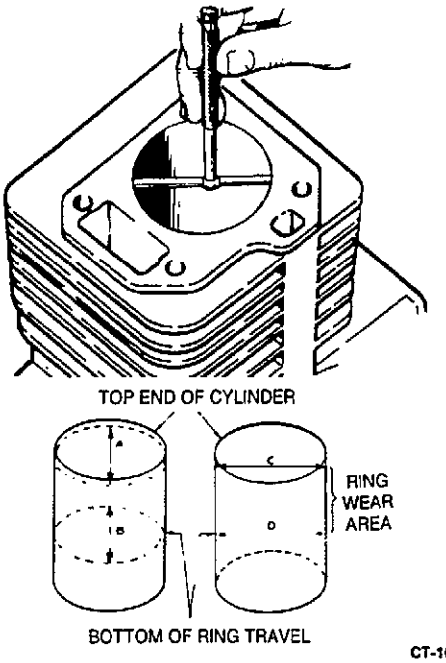


FIGURE 9-26. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

Deglazing Cylinder Bores

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

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

1. Wipe cylinder bores with a clean cloth which has been dipped in clean, light engine oil.
2. Use a brush type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.
3. The deglazing tool should be driven by a slow speed drill. Move deglazing tool up and down in cylinder rapidly enough to obtain a a crosshatch pattern as shown in Figure 9-27.

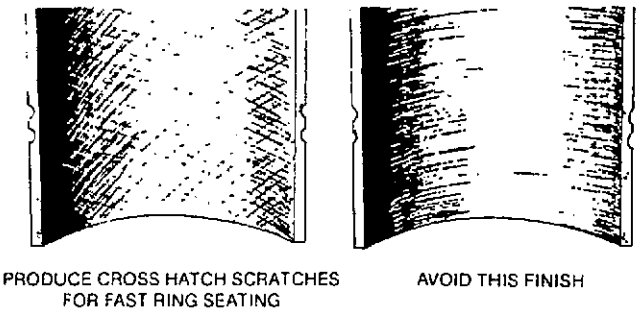


FIGURE 9-27. CROSSHATCHING

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

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

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, it is recommended that both gears be replaced. Each of these gears are pressed on. The crankshaft gear requires a gear separator and puller to remove and the camshaft gear requires a press to remove. Both gears can be installed using a press. These gears use a Woodruff key to provide correct positioning on the shaft.

Each timing gear is stamped with an "O" near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. See Figure 9-28.

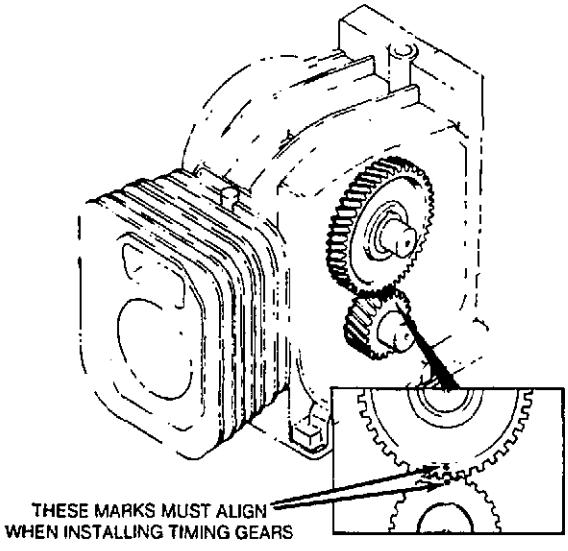


FIGURE 9-28. TIMING GEAR ALIGNMENT

BEARINGS

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

OIL SEAL

Use an oil seal remover to pry the oil seal out of the engine block. Clean the oil seal resting surface and lubricate surface before installing new oil seal. Press new oil seal into the engine block until oil seal is flush with cylinder block boss (see Figure 9-29). Lubricate the lips of the oil seal with a light coating of grease. This provides initial lubrication until engine oil reaches the seal.

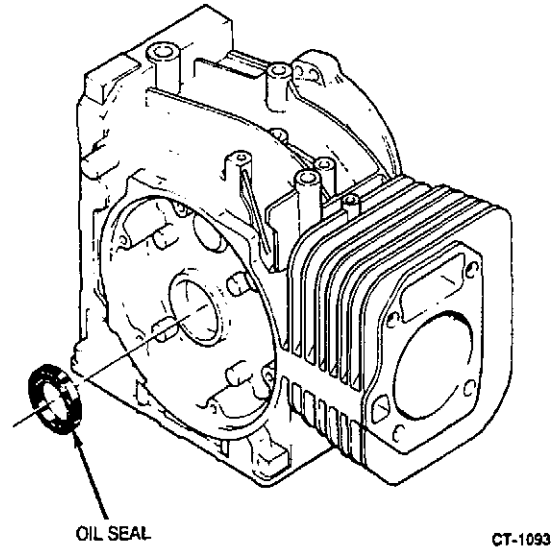


FIGURE 9-29. OIL SEAL

Section 10. Service Checklist

⚠WARNING

EXHAUST GAS IS DEADLY!

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

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

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

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

1-RV

GENERAL

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

MOUNTING

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

LUBRICATION

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

WIRING

Verify that all wiring connections are tight and hooked up properly. Check each of the following:

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

INITIAL START ADJUSTMENTS

Adjust the carburetor idle adjustment screw and main adjustment screw as specified in the Fuel System section to allow starting.

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

OUTPUT CHECK

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

EXHAUST SYSTEM

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

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

FUEL SYSTEM

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

⚠WARNING ***Leaking fuel will create a fire hazard which can result in severe personal injury or death if ignited by a spark. If leaks are detected, shut generator set down and correct leak immediately.***

CONTROL

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

MECHANICAL

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

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