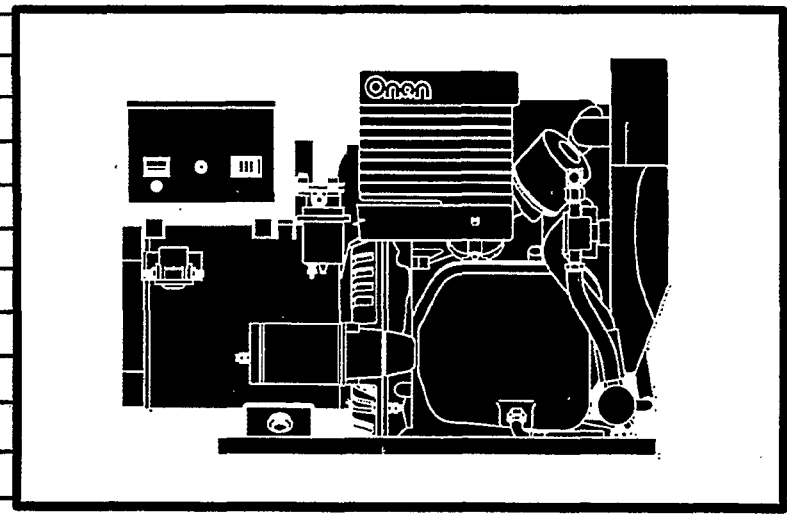
Onan

MARINE

Service Manual

MME



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Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and your unit. **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.

Throughout this manual you will notice symbols which alert you to potentially dangerous conditions to the operator, service personnel, or the equipment itself.

⚠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, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC. Fire, explosion, and personal injury can result from improper practices.

- 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.
- Do not fill fuel tanks with the engine running. Do not smoke around the generator set area. Wipe up any oil or gas spills. Do not leave oily rags in engine compartment or on the generator set. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip the engine fuel supply with a positive fuel shutoff.
- Always disconnect the battery ground (-) lead first and reconnect it last. Make sure you connect the battery correctly. A direct short across the battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is very explosive.
- Keep a fire extinguisher available in or near the engine compartment and in other areas throughout the vessel. Use the correct extinguisher for the area. For most types of fires, an extinguisher rated ABC by the NFPA is available and suitable for use on all types of fires except alcohol.

EXHAUST GASES ARE DEADLY

- Provide adequate ventilation. Equip the bilge with a power exhauster.
- Be sure propulsion and generator set engine exhaust systems are free of leaks. Perform thorough, periodic inspections of the exhaust system and repair leaks immediately. Exhaust gases are deadly.
- Never sleep in the vessel with the generator set running unless the vessel is equipped with an operating carbon monoxide detector.

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

- Do not remove any belt guards or covers with the unit running.
- Keep hands and loose clothing away from moving parts. Do not wear jewelry while servicing any part of the generator set.
- Never step on the generator set (as when entering or leaving the engine compartment). It can stress and break unit components, possible resulting in dangerous operating conditions. . . from leaking fuel, leaking exhaust fumes, etc.
- Before performing any maintenance on the generator set, disconnect its batteries to prevent accidental starting. Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the generator set compartment or bilge thoroughly with the power exhauster.

ELECTRICAL SHOCK WILL CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not make adjustments in the control panel or on engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel standing on dry surfaces to reduce shock hazard.
- DO NOT CONNECT THE GENERATOR SET TO THE PUBLIC UTILITY OR TO ANY OTHER ELECTRICAL POWER SYSTEM. Electrocution or damage to property can occur at a site remote from the boat where line or equipment repairs are being made if the set is connected to that power system. An approved transfer switch must be used if more than one power source is to be made available to service the boat.
- 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.

Copy and post these suggestions in potential hazard areas of the vessel.

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Section 1. Introduction

ABOUT THIS MANUAL

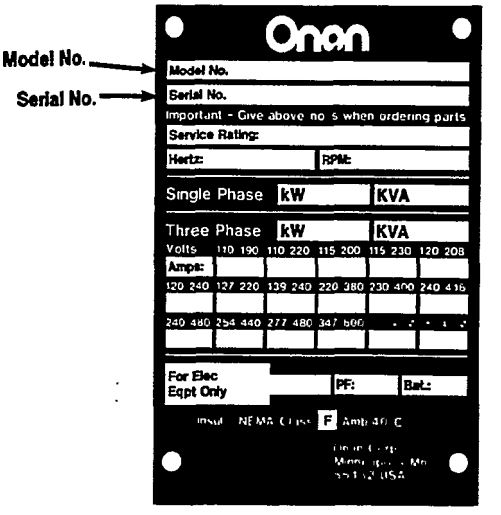
This manual provides service information for the MME series marine generator sets. This is a complete service manual for the experienced serviceperson covering troubleshooting, disassembly, repair, reassembly, and adjustments for the engine, generator, and control. It is recommended that the serviceperson be thoroughly familiar with the principles of gasoline engine operation and of electrical fundamentals. The Operator's Manual (918-0100) is recommended as an additional source 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 marine installations. The most **critical areas** of concern include the **exhaust system, fuel system, electrical wiring,** and **ventilation system.** Improper servicing can create an unsafe installation that can result in damage to the equipment or can cause severe personal injury or death to the users.

MODEL IDENTIFICATION

When contacting an Onan Dealer or Distributor always supply the complete Model Number and Serial Number as shown on the set nameplate. This information is necessary to identify your set when ordering replacement parts.

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 might not perform to Onan specifications. Only genuine Onan replacement parts are designed and tested for the application to provide reliable service and dependable operation.



M-1641

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	Four Cycle, Water-Cooled, Two Cylinder
Generator Design	Revolving Field, Four Pole
Output Ratings	Unity Power Factor
Starting System	Automotive Type Starter, 12 Volts
Engine Speed	1800 r/min
Weight	385 lbs (174 kg)
Air Required (Generator Cooling and Combustion)	125 ft^3/min (3.5 m^3/min)
ENGINE DETAILS	
Displacement	47.76 in^3 (783 cm^3)
Compression Ratio	9:1
Bore	3.07 in. (78 mm)
Stroke	3.23 in. (82 mm)
Oil Capacity (With Filter)	2.5 Qt. (2.4 L)
Fuel	Lead-Free Gasoline
GENERATOR DETAILS	
Type	Onan YK
Rating	See Nameplate
AC Voltage Regulation	±5%
Frequency	60 Hertz
Phase	1
Battery Charge Rate	1 Ampere
TUNE-UP SPECS	
Spark Plug Gap	0.043 in. (1.1 mm)
Timing	8° BTC (Vacuum Advance Disconnected, 1800 r/min)
Valve Lash (Hot Engine)	
Intake	0.006 in. (0.15 mm)
Exhaust	0.010 in. (0.25 mm)

Section 3. Dimensions and Clearances

DESCRIPTION	UNIT OF MEASURE U.S. (METRIC)	SPECIFICATIONS
ROCKER ARM		
Material		Aluminum die casting. slipper made from special sintered alloy
I.D.	in. (mm)	0.63 (16)
Oil clearance	in. (mm)	0.0004-0.0017 (0.012-0.043)
CAMSHAFT		
Driven by		Cogged type belt
Material		Cast iron, cam surface chilled
Cam height		
Inlet valve cam	in. (mm)	1.54-1.55 (39.1-39.3)
Exhaust valve cam	in. (mm)	1.54-1.55 (39.1-39.3)
Journal diameter	in. (mm)	1.26 (32)
Oil clearance	in. (mm)	0.0022-0.0035 (0.055-0.090)
CYLINDER HEAD		
Material		Aluminum alloy
Warp of gasket surface	in. (mm)	0.0020 (0.05) or less
Valve guide hole diameter	in. (mm)	
0.002 (0.05) O.S.		0.4744-0.4751 (12.050-12.068)
0.010 (0.25) O.S.		0.4823-0.4830 (12.250-12.268)
0.020 (0.50) O.S.		0.4921-0.4928 (12.500-12.518)
Inlet valve seat ring hole diameter	in. (mm)	
0.012 (0.3) O.S.		1.4094-1.4104 (35.800-34.825)
0.024 (0.6) O.S.		1.4213-1.4222 (36.100-36.125)
Exhaust valve seat ring hole diameter	in. (mm)	
0.012 (0.3) O.S.		1.2520-1.2530 (31.800-31.825)
0.024 (0.6) O.S.		1.2638-1.2648 (32.100-32.125)
Valve guide installing height	in. (mm)	0.512±0.012 (13±0.3)
INLET VALVE		
Material		Special heat resisting steel
Valve diameter	in. (mm)	1.38 (35)
Stem diameter	in. (mm)	0.260 (6.6)
Clearance (stem-to-guide)	in. (mm)	0.0008-0.0020 (0.020-0.050)
Margin	in. (mm)	0.039 (1.0)
Identification		2
EXHAUST VALVE		
Material		Special heat resisting steel
Valve diameter	in. (mm)	1.22 (31)
Stem diameter	in. (mm)	0.260 (6.6)
Clearance (stem-to-guide)	in. (mm)	0.0020-0.0033 (0.05-0.085)
Margin	in. (mm)	0.059 (1.5)
Identification		2S
VALVE SPRING		
Free height	in (mm)	1.755 (44.57)
Load	lbs./in. (kg/mm)	53.4/1.469 (24.2/37.3)
Square		Less than 1.3°
Identification color		White

DESCRIPTION	UNIT OF MEASURE U.S. (METRIC)	SPECIFICATIONS
TIMING BELT		
Type		Cogged
Number of teeth		92
Width	in. (mm)	0.752 (19.1)
BALANCER CHAIN		
Type		Single roller chain
Number of links		76
Pitch	in. (mm)	0.315 (8.0)
CRANKSHAFT SPROCKET		
Material		Ferrous sintered alloy
Number of teeth		20
CRANKSHAFT SPROCKET B		
Material		Carbon steel
Number of teeth		21
CAMSHAFT SPROCKET		
Material		Steel plate
Number of teeth		40
BALANCER SHAFT SPROCKET		
Material		Ferrous sintered alloy
Number of teeth		21
BALANCER SHAFT		
Driven by		Chain
Material		Carbon steel
Front journal diameter	in. (mm)	1.06 (27)
Rear journal diameter	in. (mm)	0.98 (25)
Oil clearance	in. (mm)	
Front		0.0010-0.0031 (0.025-0.079)
Rear		0.0010-0.0031 (0.025-0.079)
End Play		0.0048-0.0087 (0.12-0.22)
OIL PUMP		
Type		Internal gear
Drive		driven directly by crankshaft
Tip clearance	in. (mm)	0.0040-0.0077 (0.10-0.196)
Side clearance	in. (mm)	0.0016-0.0039 (0.04-0.10)
Relief valve opening pressure	psi (kg/cm²)	72-85 (5.0-6.0)
PISTON		
Material		Special aluminum alloy
Outside diameter	in. (mm)	3.07 (78)
Clearance (Piston-to-cylinder)	in. (mm)	0.0008-0.0015 (0.020-0.040)
Piston for service	in. (mm)	0.0098 (0.25), 0.0197 (0.50), 0.0295 (0.75), 0.0394 (1.00) oversize

DESCRIPTION	UNIT OF MEASURE U.S. (METRIC)	SPECIFICATIONS
PISTON RING		
Compression ring type		
No. 1		Barrel-faced spring steel ring, hard chromium plated
No. 2		Taper-faced special cast iron ring, hard chromium plated
Oil ring type		Compound ring (3-piece), hard chromium plated
Ring gap	in. (mm)	
No. 1		0.0099-0.0157 (0.25-0.40)
No. 2		0.0079-0.0137 (0.20-0.35)
Oil		0.0079-0.0275 (0.20-0.70)
Ring side clearance	in. (mm)	
No. 1		0.0012-0.0027 (0.030-0.070)
No. 2		0.0008-0.0023 (0.020-0.060)
Rings for service	in. (mm)	0.0098 (0.25), 0.0197 (0.50), 0.0295 (0.75), 0.0394 (1.00) oversize
CONNECTING ROD		
Length (Center to center)	in. (mm)	4.94 (125.5)
Piston pin bore diameter	in. (mm)	0.71 (18)
Side clearance (Big end)	in. (mm)	0.0040-0.0098 (0.10-0.25)
CRANKSHAFT		
Material		Carbon steel
Journal O.D.	in. (mm)	1.69 (43)
Pin O.D.	in. (mm)	1.57 (40)
Taper of journal	in. (mm)	0.0002 (0.005) or less
Eccentricity of journal and pin	in. (mm)	0.0004 (0.010) or less
Oil clearance	in. (mm)	
Journal		0.0014-0.0029 (0.034-0.076)
Pin		0.0013-0.0026 (0.031-0.067)
End play	in. (mm)	0.0020-0.0068 (0.050-0.175)
CYLINDER BLOCK		
Material		Cast iron
Water jacket		Full jacket type
Cylinder bore	in. (mm)	3.07 (78)
Out-of-round and taper	in. (mm)	0.0002 (0.005) or less
Maximum allowable oversize (Cylinder bore)	in. (mm)	0.039 (1.00)
Distortion of top surface	in. (mm)	0.0019 (0.05) or less

Section 4. Torque Specifications

ENGINE

DESCRIPTION	ft. lbs.	N•m
Cylinder head bolt (Cold engine)	51-54	69-73
(Hot engine)	58-61	79-83
Camshaft sprocket	47-54	64-73
Camshaft bearing cap	14-15	19-20
Rocker cover	3-4	4-5
Timing belt tensioner	15-19	20-26
Timing belt cover	7-8	10-11
Rocker arm adjustment nut	9-13	12-17
Main bearing cap	37-39	49-53
Connecting rod cap	24-25	32-34
Crankshaft pulley	9-10	12-14
Crankshaft sprocket	55-61	74-83
Front case (including water pump)	9-10	12-14
Balancer shaft sprocket	14-15	18-21
Balancer weight	19-21	25-29
Chain guide	7-8	10-11
Inlet manifold	7-9	10-12
Exhaust manifold	17-21	23-28
Flywheel bolt	62-72	84-98
Rear oil seal case	6-7	8-9
Oil pump cover	7-8	10-11
Oil screen	11-15	15-21
Oil pan	5-6	6-7
Oil filter stud	37-43	49-58
Oil relief valve plug	29-36	40-49
Water temperature gauge unit	19-25	25-34
Thermostat housing and fitting	7-9	10-12
Heater joint	15-28	20-39
Oil relief valve plug	29-36	40-49
Water temperature gauge unit	19-25	25-34
Thermostat housing and fitting	7-9	10-12

GENERATOR

Rotor Through Stud Bolt (1)	45	60
Generator Adapter to Engine Bolt (4)	19	26
Stator to Adapter through Stud Bolt (4)	28	38
End Bell Cover Screw (4)	3	4

STANDARD PARTS TIGHTENING TORQUE

TIGHTENING TORQUE OF BOLT OR NUT WITH SPRING WASHER

Classification / Thread Size mm (dia. x pitch) / Torque	Head Mark 4		Head Mark 7		Head Mark 10	
	ft. lbs.	N•m	ft. lbs.	N•m	ft. lbs.	N•m
5 x 0.8	—	—	3-4	4-5	—	—
6 x 1.0	—	—	6-7	8-9	8-9	10-12
8 x 1.25	8-9	10-12	11-15	15-21	18-25	25-34
10 x 1.25	13-18	18-24	22-30	30-41	37-50	49-68
12 x 1.25	22-30	30-41	40-54	54-73	69-86	94-117
14 x 1.5	37-50	49-68	58-79	79-107	73-137	98-186

TIGHTENING TORQUE OF FLANGE BOLT OR NUT

Classification / Thread size mm (dia. x pitch) / Torque	Head Mark 4		Head Mark 7	
	ft. lbs.	N•m	ft. lbs.	N•m
5 x 0.8	—	—	4-5	5-6
6 x 1.0	—	—	7.5-8.5	8-11
8 x 1.25	9-10	12-14	15-19	20-26
10 x 1.25	20-24	27-33	29-39	40-53
12 x 1.25	35-43	47-58	58-72	79-98

TIGHTENING TORQUE OF TAPER THREAD

Classification / Thread size / Torque	Aluminum Alloy		Cast Iron or Steel	
	ft. lbs.	N•m	ft. lbs.	N•m
NPTF 1/16	4-5	5-7	6-8	8-11
PT 1/8	6-8	8-11	11-15	15-21
PT 1/4, NPTF 1/4	15-21	20-29	26-32	35-44
PT 3/8	29-39	40-53	40-54	54-73
PT 1/2	51-72	69-98	87-115	118-156

Section 5. Preparing to Service

TROUBLESHOOTING

Before starting to service the generator set, follow a system 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

A separate section is contained in this manual that covers each area.

Several troubleshooting guides are included in this manual to help the serviceperson locate the cause of various malfunctions. It should be noted 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

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 tools available from Onan are contained in the Tool Catalog (900-0019) available from Onan Dealers or Distributors. Section 9 of this manual contains a listing of special tools required for engine service.

SAFETY CONSIDERATIONS

⚠WARNING ***Many troubleshooting and service 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 these procedures.***

Generator sets present several hazards that the serviceperson must be aware of if the job is to be completed safely. Always consider the safety aspects of any service procedure. 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 Risks of Personal Injury or Death

- ***Use Personal Protection:*** When the situation calls for it, protect your body by wearing the appropriate safety equipment. Protective clothing includes such items as 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. 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 fuel
  - -Hydrogen gas from battery
  - -Oily rags improperly stored
  - -Flammable liquids improperly stored
- Burns
  - -Hot exhaust pipes
  - -Hot engine and generator surfaces
  - -Hot engine oil/coolant
  - -Electrical short
- Poisonous Gases
  - -Carbon monoxide from faulty exhaust system
  - -Operating generator set where exhaust gases can accumulate
- Electrical Shock (AC)
  - -Improper generator set load connections
  - -Faulty wiring
  - -Faulty electrical appliance
  - -Faulty generator set wiring
- Rotating Machinery
  - -Belt guard not in place
  - -Generator end plate not in place
- Slippery Surfaces
  - -Leaking or spilled oil
  - -Water/coolant leaks
- Heavy Objects
  - -Removing generator set from boat
  - -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.

SET REMOVAL

Some service procedures will require the generator set be removed from the boat. While there are variations, marine generator sets generally are installed in tight quarters allowing limited access.

The generator set or housing is usually in the bilge area and secured to the boat stringers or other sturdy support. It may share the same compartment as the propulsion engine.

Because of the wide variety of boats and compartment sizes, it is not possible to specify the exact removal procedures for each installation. If, after examining the installations, a satsifactory method for removing the set cannot be determined, contact the boat manufacturer for their recommendations. The battery, (disconnect (-) terminal first), exhaust, sea water and fuel lines must be shut off and disconnected from the set. The generator set has a lifting eye to facilitate removal as shown in Figure 5-1.

⚠WARNING ***Gasoline vapor is extremely flammable and can result in severe personal injury or death if ignited. Make certain the fuel line valve is closed and fuel line opening plugged to prevent gasoline vapor accumulation. Make certain there are no sources of ignition present such as flames, cigarettes, pilot lights, or equipment or switches that may arc.***

⚠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.***

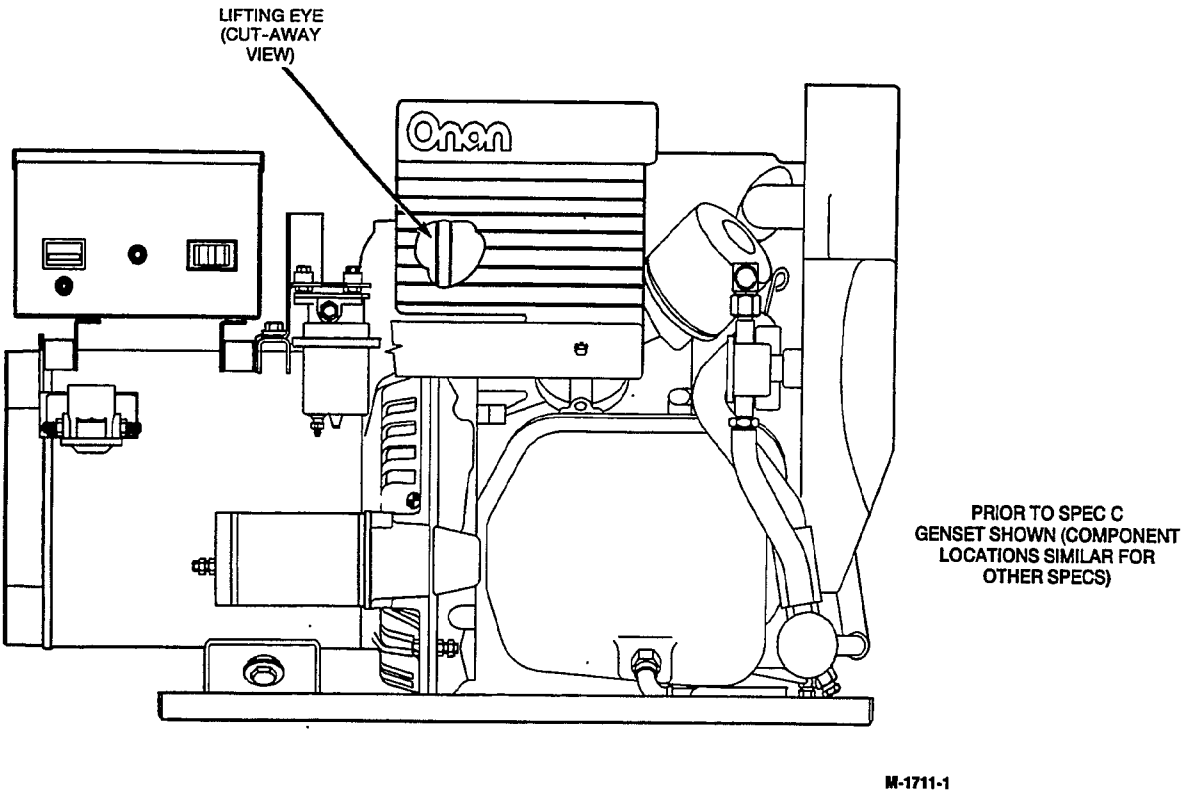


FIGURE 5-1. GENERATOR SET LIFTING EYE

Section 6. Engine - Primary Systems

CONTENTS

INTRODUCTION

The engine primary systems can often be serviced without removing the generator set from the boat 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 the generator set control Section 7 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 plugs. b. incorrect ignition timing. c. faulty ignition coil, d. faulty plug wires.	1a. Replace spark plugs. 1b. Set distributor. 1c. Test coil and replace if necessary. 1d. Test spark plug wires and replace if faulty.
	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. Contaminated fuel.	3. Drain fuel tank and refill with fresh fuel.
Engine Backfires	1. Faulty ignition due to: a. incorrect ignition timing. b. incorrect spark plug gap.	1a. Adjust distributor. 1b. Reset spark plug gap.
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws b. incorrect float level. c. dirt in carburetor.	2a. Adjust carburetor main and idle adjustment screws. 2b. Adjust carburetor float level. 2c. Disassemble carburetor and clean all internal passages.
	3. Mechanical damage to engine.	3. See *Section 9 - Engine Block Assembly section.*

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in 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 ignition timing. b. incorrect spark plug gap.	1a. Adjust distributor. 1b. Reset spark plug gap.
	2. Restricted fuel flow due to faulty fuel pump.	2. Test fuel pump and replace if faulty.
	3. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, or c. dirt in carburetor.	3a. Adjust carburetor main and and idle adjustment screws. 3b. Adjust carburetor float level. 3c. Disassemble carburetor and clean all internal passages.
	4. Exhaust system blocked or restricted.	4. Locate and remove cause of blockage.
	5. Incorrect valve clearance.	5. Adjust valve clearance (see *Section 9 - Engine Block Assembly*
	6. Excessive engine wear or damage to engine.	*6. See Section 9 - Engine Block Assembly*
Engine Overheats	1. Restricted airflow due to dirt or debris blocking air inlet or outlet.	1. Clear away any debris that may restrict airflow to set. 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. Adjust distributor.
	4. Lean fuel mixture due to: a. Incorrectly adjusted fuel mixture screws. b. incorrect float level, or c. dirt in carburetor.	4a. Adjust carburetor main and idle adjustment screws. 4b. Adjust carburetor float level. 4c. Disassemble carburetor and clean all internal passages.
	5. Defective sea water pump.	5. Check sea water flow rate. If low, pump impeller may be bad.
Black Exhaust	1. Rich fuel mixture due to: a. choke sticking. b. incorrectly adjusted fuel. c. dirt in carburetor. d. Misadjusted choke. e. Leaking pull-off diaphragm. f. Choke heater open. g. Choke bi-metal broken.	1a. Clean choke and choke linkage. 1b. Adjust carburetor idle and main adjustment screws. 1c. Disassemble carburetor and clean all internal passages. 1d. Adjust to spec. 1e. Test and replace if defective. 1f. Replace if open. 1g. Replace if broken.

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in 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 Hunts or Surges	1. Sticking or binding governor linkage.	1a. Clean governor linkage.
	2. Incorrect governor adjustment.	2. Adjust governor speed and sensitivity.
	3. Faulty governor spring (prior to Spec C gensets only).	3. Replace governor spring.
	4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, or c. dirt in carburetor.	4a. Adjust carburetor main and idle adjustment screws. 4b. Adjust carburetor float level. 4c. Disassemble carburetor and clean all internal passages.
High Oil Consumption (Note: New engines sometimes have high oil consumption during break-in)	1.Oil viscosity too light or oil is diluted.	1. Drain oil and refill with correct viscosity oil.
	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 *Section 9 - Engine Block Assembly*
	5. Light loading.	5. Don't run set at no load for long periods of time.
Low Oil Pressure	1. Oil viscosity too light or oil is diluted.	1. Drain oil and refill with correct viscosity oil.
	2. Low oil level.	2. Add oil as required.
	3. Low oil pressure switch defective.	3. Replace oil pressure switch (see *Section 9 - Engine Block Assembly)*
	4. Faulty oil bypass valve.	4. Inspect oil bypass valve and clean or replace as required (see *Section 9 Engine Block Assembly)*
	5. Excessive engine wear or defective oil pump.	5. See *Section 9 - Engine Block Assembly*

EXHAUST SYSTEM

The condition of the exhaust system is extremely critical on marine applications because of the possibility of exhaust gases and water entering compartments aboard the boat. The exhaust system must be serviced immediately if inspection reveals leaking joints or connections, loose fasteners, or broken or damaged components.

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

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Modifying the exhaust system might allow poisonous exhaust gases to enter the boat. Use only original equipment replacement parts when servicing the exhaust system. Liability for injury or damages due to unauthorized modifications becomes the responsibility of the person making the change.***

A high exhaust temperature shutdown switch on the exhaust manifold (Figure 6-1) shuts down the engine if the manifold temperature rises above normal [190° ±5°F (88° ±3°C]. The switch opens at 165° ±8° F (74° ±4°C). A shutdown can be caused by a defective sea water pump, drive belt, heat exchanger, inlet filter, or a closed sea water valve.

If the generator set shuts down due to high exhaust temperature, a complete exhaust system check is required according to previous paragraphs. Always replace the flexible exhaust component that connects directly to the exhaust manifold and any other parts that have been damaged.

Figure 6-1 shows a typical below waterline installation using a hydrodynamic marine muffler. An incorrectly designed exhaust system can cause engine operation problems such as abnormal temperature rise, low power output, high fuel consumption, burned valves and a flooded engine. These problems can relate to exhaust pressures exceeding 3 inches (76 mm) of mercury (10 kPa). The exhaust line must be installed to prevent backflow of water to the engine under all conditions.

Siphon Break

A siphon break must be installed if the exhaust water injection manifold is at or below the load water line. The siphon break must be at least 12 inches (305 mm) above the load waterline and in a vertical position. When properly installed, the valve prevents flotation water (sea water) from being siphoned into the exhaust manifold and cylinders of the engine.

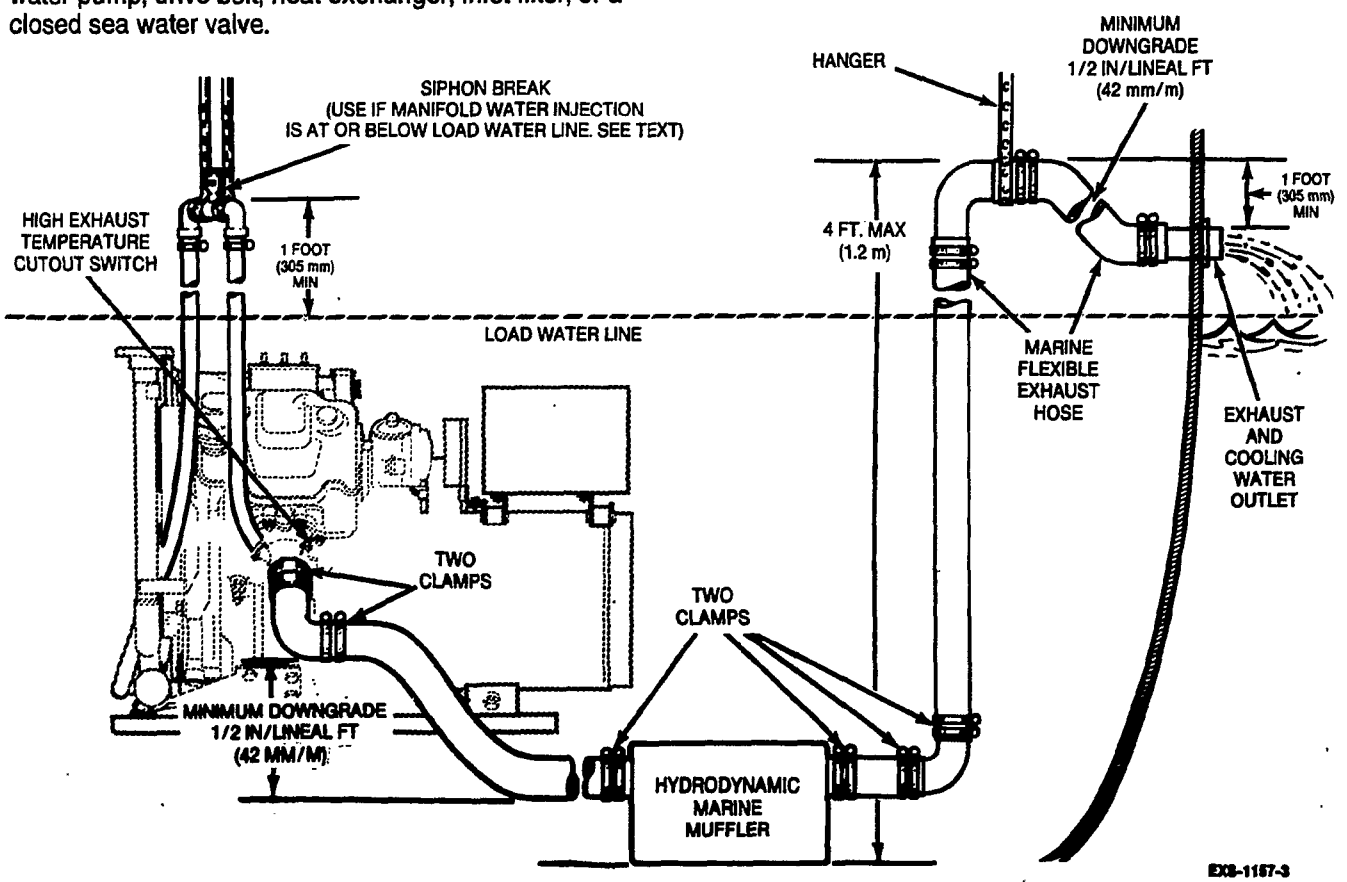


FIGURE 6-1. TYPICAL HYDRODYNAMIC MUFFLER EXHAUST SYSTEM

When in good operating condition, the siphon break valve is reliable. However, when used in contaminated waters or salt water for example, some corrosion may impair operation. The valve should be checked for free movement after unscrewing the top cover (Figure 6-2). If the valve sticks or the seat shows wear, it must be replaced (see Parts Manual).

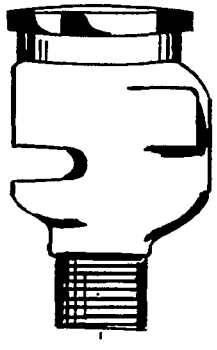


FIGURE 6-2. SIPHON BREAK VALVE

COOLING SYSTEM

This marine generator set uses flotation water for heat exchanger and exhaust cooling. Although flotation water may be an ocean, lake, or river, the term *"sea water"* is used in this manual to describe any flotation water that is drawn into the boat for cooling purposes. Engine coolant circulating through a closed system is called *"captive water"*.

Description

The generator set uses heat exchanger cooling. The captive water pump circulates coolant through the engine block, intake manifold and heat exchanger. Captive water temperature/flow rate is regulated by a thermostat. Sea water cools the captive water in the heat exchanger. Sea water and captive water are kept separated so the engine block is not exposed to sediment and corrosive properties typical of most sea water.

A sea water pump is used to constantly renew the water bath in the heat exchanger and discharge the heated sea water into the exhaust line. The maximum lift of the pump is 3 feet (0.9 m). The approximate flow rate is 3 gallons per minute (11 L/min).

Cooling system maintenance includes checking coolant level in the recovery tank, periodic inspection for leaks, inspection of the water pumps and drive belts, inspection of heat exchanger, and flushing and cleaning. The engine coolant is at proper level when the recovery tank level stabilizes between Full and Low (engine cold). Remove recovery tank cap and add coolant as required.

⚠WARNING ***Accidental starting of the set can cause severe personal injury or death. Disconnect the starting battery cables when repairs are made to the engine, controls, or generator.***

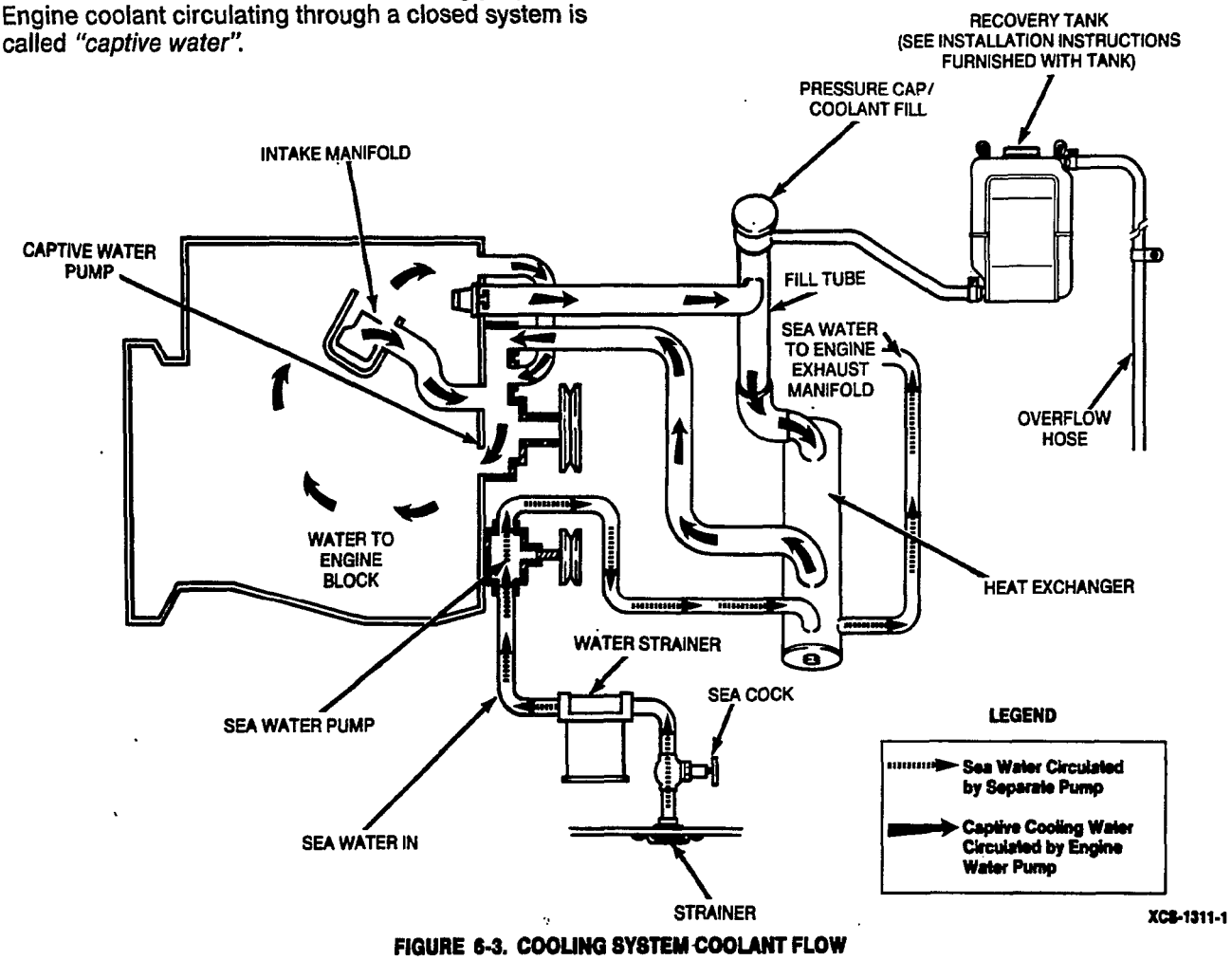


FIGURE 6-3. COOLING SYSTEM COOLANT FLOW

Coolant Requirements

A satisfactory engine coolant inhibits corrosion, lubricates and protects against freezing. A 50/50 solution of ethylene glycol anti-freeze and water is recommended for normal operation and storage periods. Choose only a reliable brand of anti-freeze that contains a rust and corrosion inhibitor but does not contain a stop-leak additive.

The water used for engine coolant should be clean, low in mineral content, and free of any corrosive chemicals such as chloride, sulphate, or acid. Use soft water whenever available. Well water often contains lime and other minerals which eventually may clog the heat exchanger core or reduce cooling efficiency. Distilled water from a local store may be used.

⚠CAUTION ***Do not exceed a 50-50 mixture of ethylene glycol and water. A stronger mixture will alter heat transfer properties of the coolant.***

⚠WARNING ***Contact with hot coolant can result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.***

Draining Cooling System

The following procedure should be followed to completely drain the captive water and sea water cooling systems.

Captive Water:

1. Remove the pressure cap from the fill tube. See Figure 6-4.
2. Open captive water drain valve on bottom of the heat exchanger; collect coolant in a suitable container.
3. Remove plug (or optional coolant sender) from the engine block.
4. Remove the recovery tank from its bracket and drain the coolant from it. Flush/clean the tank if required.

Sea Water: Refer to Filling Cooling System section for corrosion and freeze protection.

1. Close sea cock. Remove hoses from the sea water pump and drain hoses.
2. Remove sea water drain plug/zinc pencil on bottom of heat exchanger. Collect water in suitable container.
3. Remove end cap of the heat exchanger and check tubes for any debris that may prevent draining.

Filling the Cooling System

Verify that all drain plugs are tight and all hose clamps secure. Remove the cooling system pressure cap and sender or plug from the engine block. Slowly fill the cooling system with the recommended coolant until it starts running from the block. Install sender or plug and continue to fill system. Add coolant to the recovery tank to a couple of inches below the full level.

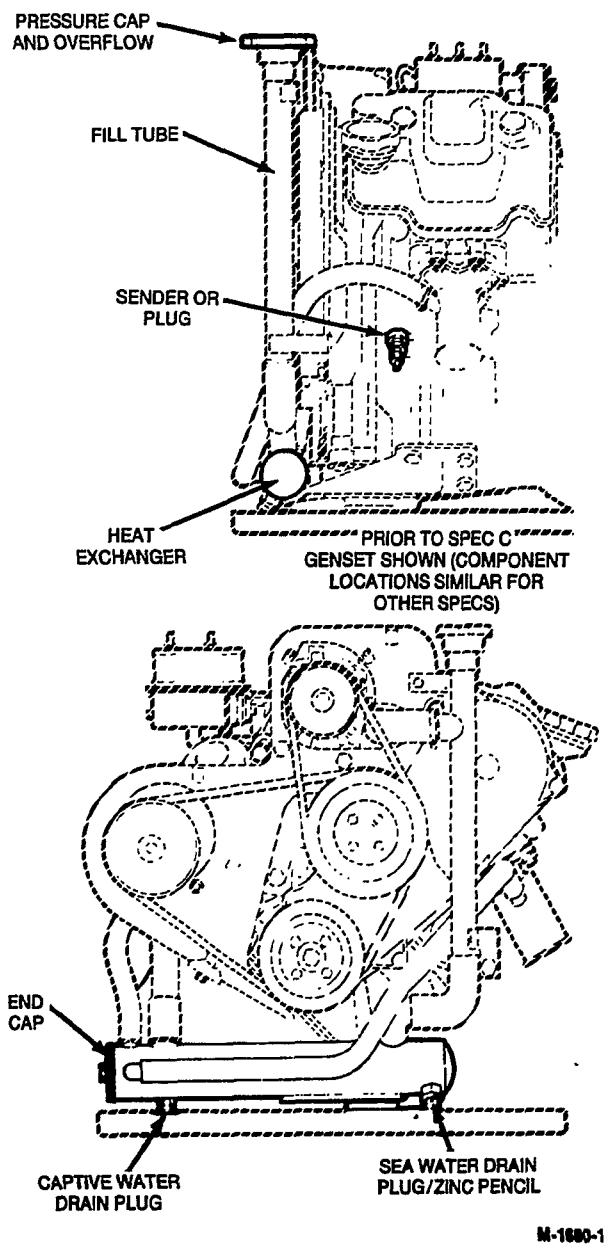


FIGURE 6-4. COOLANT DRAIN LOCATIONS

Start the engine and monitor the coolant level. As trapped air is expelled from the system, the coolant level will drop and additional coolant should be added. Replace the pressure cap when the coolant level is stable. Add coolant to the recovery tank to the full level.

Coolant Level

The coolant level can be checked without removing the pressure cap by observing the coolant recovery tank. The tank level changes between a hot and cold generator set. As long as there is a noticeable change and the level remains above *"Low"* when cold, the coolant level is okay.

Flushing and Cleaning

For efficient operation, the cooling system should be drained, flushed, and refilled once a year.

To drain the system completely, the heat exchanger and the cylinder block plug or sender must be removed. Remove the pressure cap to facilitate draining process.

Chemical Cleaning: Thoroughly clean the cooling system if rust and scale have collected on the engine water jacket or in the heat exchanger. Rust and scale slow down heat absorption and can block the coolant flow. Use a good cleaning compound in accordance with instructions furnished by the supplier.

Flushing: After cleaning or before filling the system with new coolant, drain the block and heat exchanger and fill with clean water. Operate the set for 10 minutes and then drain the system completely. Refill with the recommended coolant.

Pressure Cap

Closed cooling systems make use of a pressurized cap to increase the boiling point of the coolant and allow higher operating temperatures. Pressure cap should be replaced every two years or sooner if it malfunctions. The cap is rated at 7 psi (48 kPa).

Heat Exchanger Maintenance

The sea water side of the heat exchanger is protected from corrosion by a zinc pencil mounted on the sea water drain plug. See Figure 6-5. The pencil should be inspected every two months and replaced if deteriorated to less than 1/2 inch (13 mm).

If the sea water pump impeller failed due to deterioration or breakage, remove the end cap from the heat exchanger and check for debris. Use compressed air at the sea water drain to help facilitate cleaning.

Debris can cause cooling difficulty, and also change water path/velocity through the tubes and cause premature wear. Apply compressed air at the sea water drain plug opening to remove remaining water or debris. Install a new gasket when assembling the end cap.

If there is a lot of scale and debris in or on the tubes, remove the heat exchanger from the engine and take to a radiator shop for cleaning with chemicals.

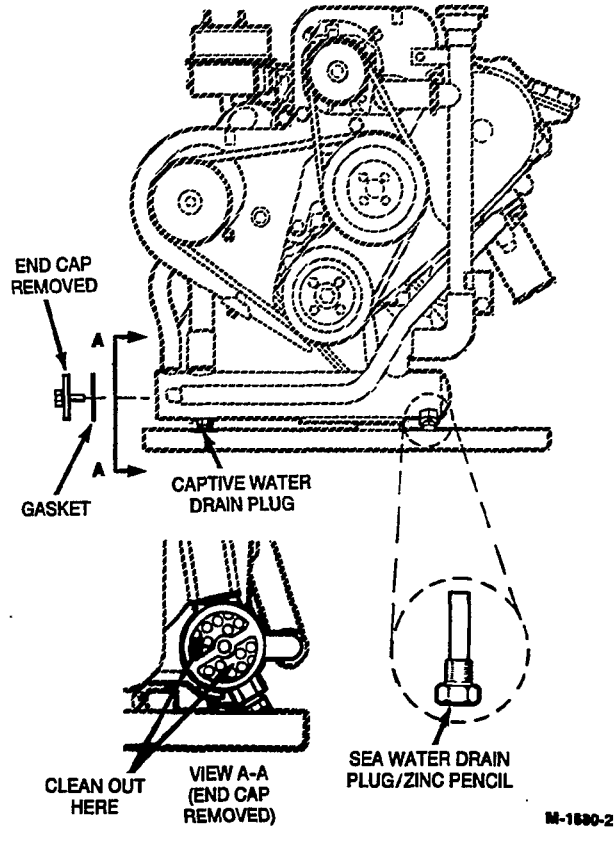


FIGURE 6-5. HEAT EXCHANGER

Engine Captive Water Pump

This centrifugal/impeller-type pump circulates the captive coolant through the cooling system (Figure 6-3). The pump is secured to the engine block with five capscrews and is driven from the crankshaft pulley. A gasket between the pump and head provides a watertight connection.

The water pump shaft and bearing is sealed and does not require additional lubrication. A drilled hole in the pump body allows a drain for any coolant which might leak past the seal assembly. This relieves pressure build-up and helps prevent coolant from coming in contact with the water pump bearing.

The pump will provide long life with a minimum amount of attention when proper corrosion preventive coolant is used (see Coolant Requirements section). A coolant containing grit or scale-forming materials is especially harmful to pump parts.

Inspection: The pump cannot be rebuilt and must be replaced as an assembly. The following checks or observations will indicate a defective pump.

- Coolant leakage from pump body drain hole.
- Cracked pump housing.
- Bearing feels rough or shaft binds when turned.
- Cracked or damaged impeller.
- Noisy operation.

Removal: Use the following procedure for pump removal. Step references to the mechanical pump belt and linkage do not apply to starting Spec C generator sets.

1. Drain cooling system. Refer to procedure earlier in this section.
2. Remove belt guard. Loosen governor and sea water pump mounting bolts and remove belts.
3. Remove hose clamps and hoses from pump.
4. Remove capscrews and pulleys from water pump hub.
5. Disconnect governor linkage to the carburetor.
6. Remove capscrews securing the governor and bracket to the engine. Remove assembly.
7. Remove capscrews securing timing belt cover.
8. Remove capscrews securing water pump to the engine block.

Installation: Use the following procedure for replacing the pump. Step references to the mechanical pump belt and linkage do not apply to starting Spec C generator sets.

1. Clean all gasket material from the engine block.
2. Install a new gasket with the water pump. To prevent the gasket from getting out of position, the bolts marked with an asterisk (*) in Figure 6-6 should be installed first. Be sure the correct length bolt is inserted in the respective holes as shown. Torque bolts to specified value.

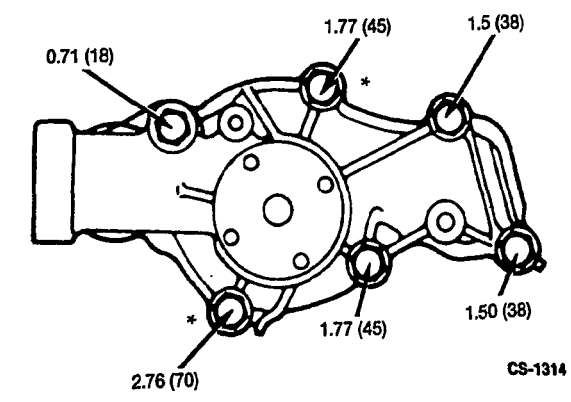


FIGURE 6-6. WATER PUMP INSTALLATION

3. Install timing belt cover and bolts. Torque bolts to 7 to 8 ft. lbs. (10 to 11 N•m).
4. Install governor bracket assembly to the engine. Connect carburetor linkage.
5. Install pulleys to water pump hub. Torque bolts 9 to 10 ft. lbs. (10 to 11 N•m).
6. Install hoses and clamps to the water pump.
7. Install belts and adjust tension to specs shown in Drive Belts Adjustment section (Figure 6-7). Tighten adjustment screws.
8. Install belt guard and secure screws.
9. Add coolant to system as described earlier. Operate the generator set and check for coolant leaks.

Drive Belts

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Disconnect the battery cables, negative (-) cable first, before removing belt guards to check drive belts.***

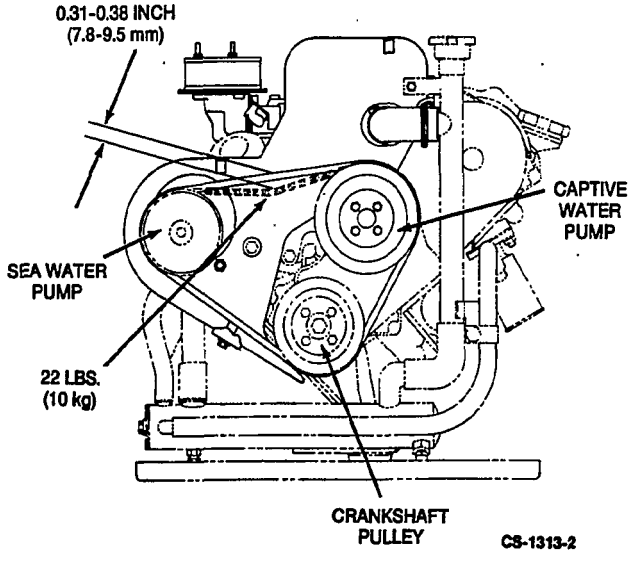
Starting Spec C: Figure 6-7 shows the single drive belt and pulleys for these units. The belt is driven by the engine crankshaft pulley and turns the captive coolant pump and the sea water pump. Remove the belt guard for belt inspection or replacement. A loose or defective belt can cause the engine to overheat. Belts should be checked for excessive slickness, oil soak, wear, tear, cracks and overstretching. Replace if needed.

Adjust belt tension as shown in Figure 6-7. Adjustment is correct when belt deflects 0.31 to 0.38 inch (7.8 to 9.5 mm) with a pressure of 22 pounds (10 kg) at midpoint between pulleys. Tighten adjustment capscrews when proper tension is achieved.

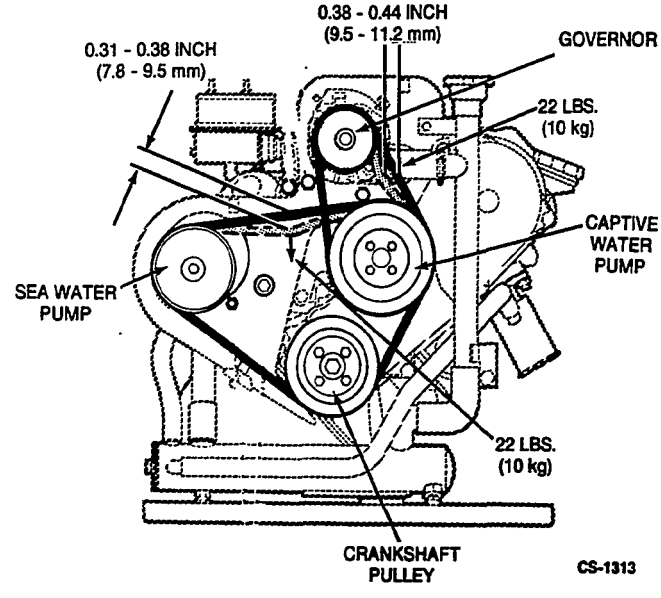
Prior to Spec C: Figure 6-7 shows arrangement of the two belts and pulleys used on these generator sets. The engine crankshaft pulley drives the longer belt which turns the captive coolant pump and the sea water pump. The shorter belt is driven by a second pulley on the captive water pump and turns the mechanical governor.

Remove the belt guard for belt inspection or replacement. A loose or defective belt can cause the engine to overheat, or cause poor speed regulation or an overspeed condition. Belts should be checked for excessive slickness, oil soak, wear, tear, cracks and overstretching. Replace if needed.

Proper tension is shown in Figure 6-7 with a specified deflection when the belts are pressed down with a pressure of 22 pounds (10 kg) at the midpoint between pulleys. Tighten adjustment capscrews when proper tension is achieved.



STARTING SPEC C
GENSETS



PRIOR TO SPEC C
GENSETS

TORQUE VALUES
CRANKCASE PULLEY 10 FT. LBS. (14 N•m)
CAPTIVE WATER PUMP PULLEY 7 FT. LBS. (9 N•m)
BELT ADJUSTMENT BOLTS TO 10 FT. LBS. (14 N•m)

FIGURE 6-7. DRIVE BELT ADJUSTMENTS

Thermostat

The thermostat is located in a housing mounted to the cylinder head as shown in Figure 6-8. If the engine overheats or does not reach and maintain a minimum operating temperature, the thermostat should be removed and tested as a possible cause.

Removal and Testing:

1. Drain cooling system and remove coolant hose from the thermostat housing.
2. Remove the two capscrews securing thermostat housing and thermostat to the cylinder head.
3. Visually examine the thermostat and replace if it is broken, deformed, corroded, or sticks in the open or closed position. A thermostat in which the valve is open even slightly at room temperature should be replaced.
4. Suspend thermostat in a container filled with clean water. Thermostat must be completely immersed but not touching bottom.
5. Apply heat to bottom of container and stir water while heating. Observe when temperature valve starts to open and when fully open with a reliable thermometer placed inside the container.
6. A good thermostat valve should start opening at 180°F (82°C), and be fully open at 203°F (95°C). If the wax element portion is broken, the valve will stay closed.
7. If thermostat valve does not operate within the above limits, it must be replaced.

Installation:

1. Clean cylinder head and mating thermostat housing of all old gasket material.
2. Put the thermostat in the cylinder head and position so that the jiggle valve is at the uppermost location (Figure 6-8). Ensure that the thermostat flange is properly seated in the face portion of the cylinder head.
3. Mount the new gasket and thermostat housing. Torque capscrews to 9 ft. lbs. (12 N•m).
4. Connect hose to the thermostat housing and add coolant to the cooling system. Be sure the hose is installed all the way to its stop on the housing and to weld on the fill tube to avoid interference between hose and the governor or belt.
5. Run generator set and check for coolant leakage. If leakage appears from around gasket, recheck the thermostat and gasket for proper installation.

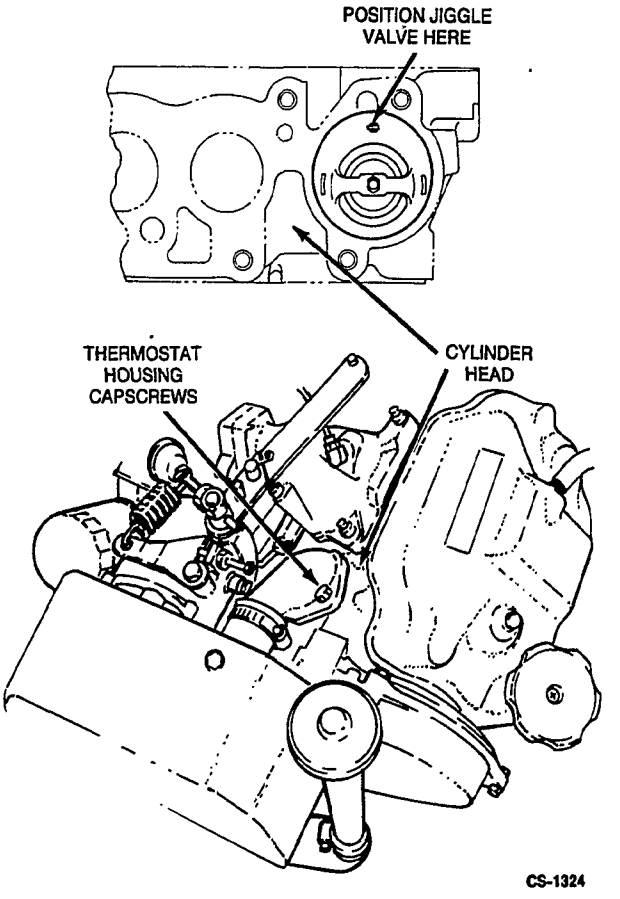


FIGURE 6-8. THERMOSTAT INSTALLATION

Sea Water Pump

This pump is a positive displacement, neoprene impeller type, used to pump sea water through the cooling system. The pump impeller, because of continuous flexing, will in time need replacement. If the impeller fails after short service (usually under 500 hours), check for severe pitting or abrasion caused by dirt in the cooling system. All installations should have a water filter installed ahead of the pump.

⚠WARNING ***Accidental starting of the set can cause severe personal injury or death. Disconnect the starting battery cables when repairs are made to the engine, controls, or generator.***

Inspection: Check sea water pump for wear or signs of leakage from the shaft seal. Loosen drive belt and move the water pump pulley back and forth. Pulley should be tight on the shaft and only a slight amount of bearing play should be felt. If leakage or wear is detected, remove the pump for repair or replacement.

A pump repair kit is available from Onan containing an impeller, seal, gasket and four cover screws. Refer to the parts catalog for the part number. Use only the first four steps of the Disassembly procedure for kit replacement.

Disassembly:

1. Remove belt guard, belt and pulley.
2. Remove 2 capscrews securing pump to it's bracket.
3. Remove the pump cover screws, cover, and gasket as shown in Figure 6-9.
4. Pull out neoprene impeller using 2 screwdrivers, or pliers.
5. Loosen the set screw on the pump body and tap it lightly to free the cam. Lift out cam and wear plate.
6. Remove plastic end cap/seal from pump body (pulley end of shaft).
7. Remove bearing and shaft retaining rings at pulley end of pump body.
8. Push shaft and bearing assembly out the pulley end of pump body.
9. To replace bearings, press bearing off pulley end of shaft. Do not remove bearings over sealing surface of shaft.
10. Remove seal from either end of pump body.

Assembly:

1. Press bearing over pulley end of shaft far enough to clear the shaft retaining ring groove.
2. Install new seal oriented as per drawing. Lubricate surfaces to assist assembly. Seal surface must be just below edge of impeller body.
3. Install plastic washer and O-ring over the impeller end of shaft.
4. Press shaft/bearing assembly into pump until it bottoms against pump body.
5. Install bearing and shaft retainer rings.
6. Install plastic end cap/seal over end of bearing (pulley drive end of shaft).
7. Install wear plate in impeller chamber. Be sure notch in plate fits over locator pin.
8. Install cam and cam set screw. Be sure only one copper washer is under the screw head.
9. Lubricate impeller ends and inside of pump body with vaseline or the like and fit it with a rotating movement in the direction of rotation.
10. Install new gasket, cover and four screws to pump. Tighten cover screws to 16 in. lbs. (1.8 N•m).
11. Secure pump to its bracket with two capscrews.
12. Install pulley, belt and belt guard. Be sure pulley is lined up with its driver.

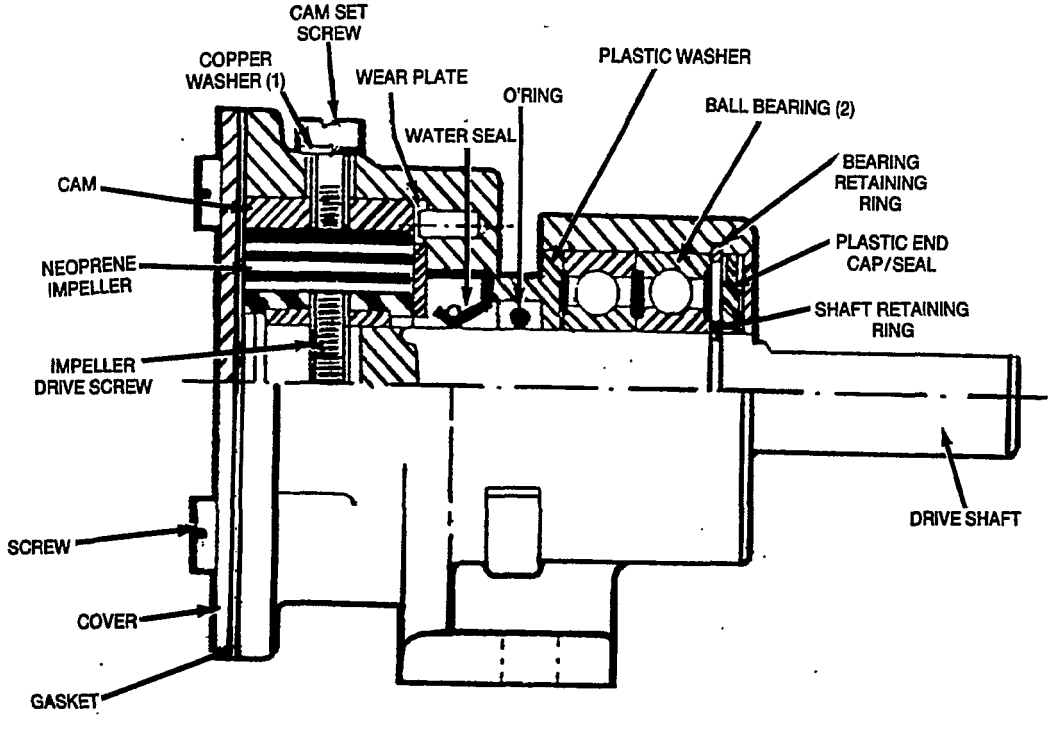


FIGURE 6-9. PARTIAL CUTAWAY SIDE VIEW OF SEA WATER PUMP

Water Pump Priming

A neoprene impeller pump should never be operated dry. If the generator set has not operated for an extended period of time, the water pump can lose its prime. Operation with a dry pump causes excessive wear or tearing of impeller blades.

Although a total loss of prime rarely occurs, a good practice after seasonal inactivity is to prime the pump. Remove the hose from the tapered connector (input side) and introduce a small amount of clean water to offer the necessary lubrication. A short length of hose and a small funnel works well for this purpose.

⚠CAUTION ***Operating water pump in a dry condition causes excessive impeller blade wear. Prime pump before putting genset into service and before the beginning of seasonal operation.***

High Coolant Temperature Cutout Switch

This switch is in the captive cooling system and the contacts will close to shut down the engine if temperature rises above 221°F (105°C) ±3%. The contacts open if temperature falls below 221°F (105°C) ±3%. The switch is located on the intake manifold as shown in Figure 6-10.

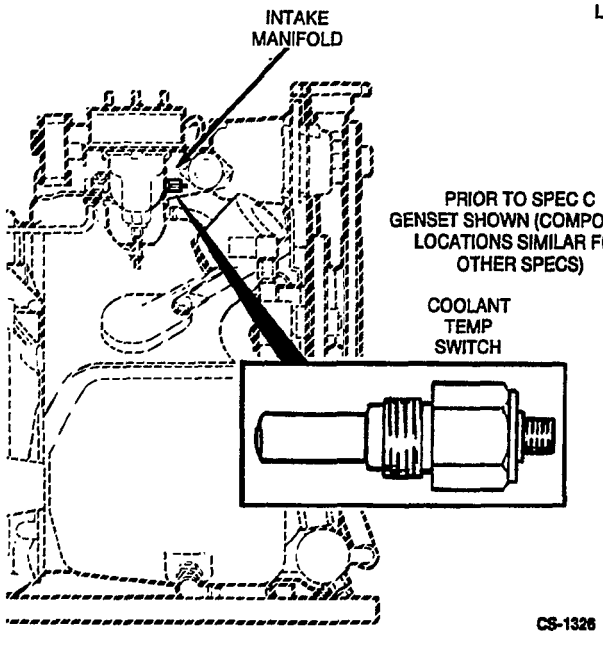


FIGURE 6-10. LOCATION OF HIGH TEMP CUTOUT SWITCH

Coolant Sender (Optional)

The sender is in series with the coolant temperature gauge B+ circuit. The resistance of the sender varies with coolant temperature and causes a corresponding reading on the gauge. At 200°F (93°C) the sender resistance should be 64.3 ohms ±10%. The sender is located on the exhaust manifold side of engine as shown in Figure 6-11.

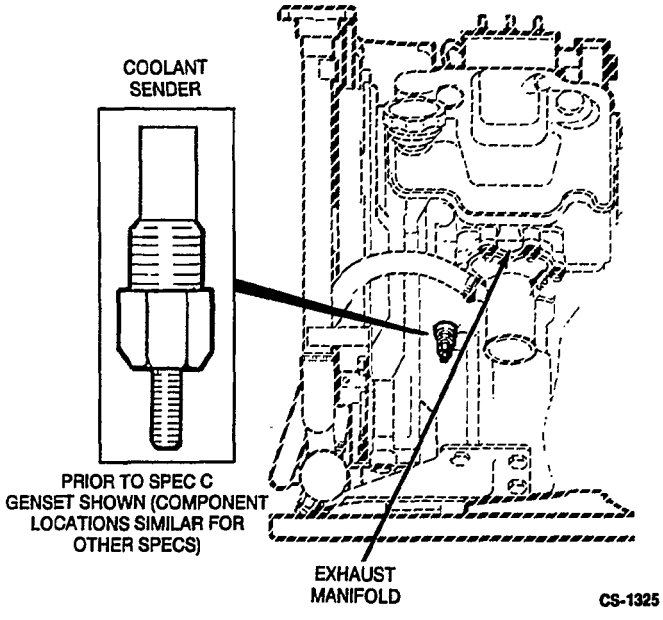


FIGURE 6-11. LOCATION OF COOLANT SENDER

IGNITION SYSTEM

The engine uses an electronic ignition system consisting of an electronic pick-up module, ignition coil, RFI condenser, spark plugs and wiring. For reliable generator set operation, the complete ignition system must be in good working order and properly adjusted. Many generator set "problems" can be traced to an improperly maintained ignition system. Refer to the following paragraphs when servicing or making adjustments.

Distributor

The electronic pick-up module is on the mounting plate inside the distributor; the RFI condenser on the coil mounting bracket. See Figure 6-12. Timing of the ignition spark occurs when the signal rotor is opposite the stator pole piece and is adjusted by turning the distributor assembly.

The distributor assembly must be in good condition and be correctly timed for easy starting, full power and proper cooling of the engine. A retarded ignition will reduce power, while an advanced ignition will cause preignition and overheating.

The condenser on the coil mounting bracket suppresses interference (RFI). A defective/open condenser can cause noise in radio and TV equipment. Replace the condenser if defects are suspected.

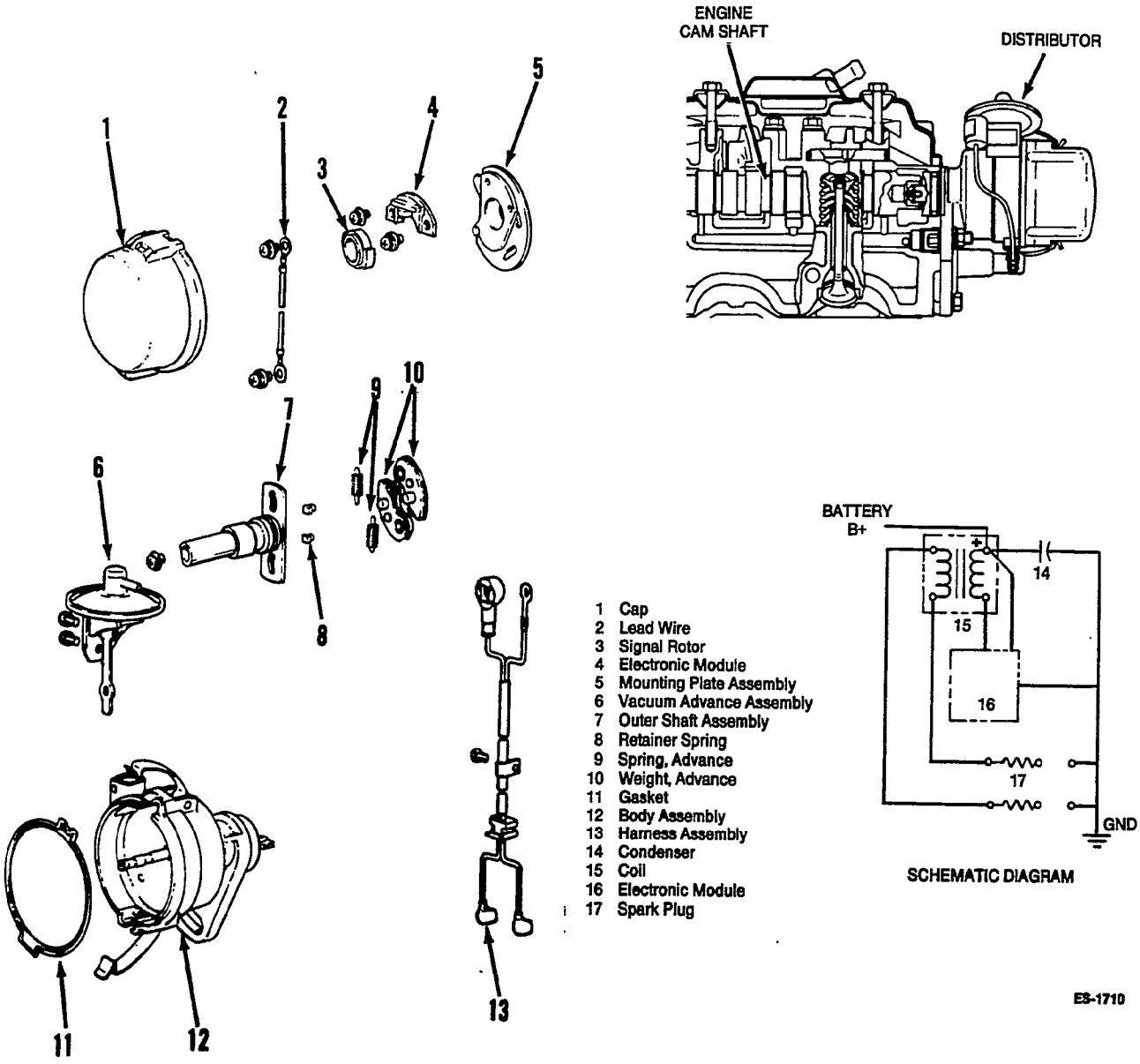


FIGURE 6-12. DISTRIBUTOR DISASSEMBLY, LOCATION AND SCHEMATIC DIAGRAM

Disassembly: Use the following procedure only when complete disassembly of the distributor is required (Figure 6-12).

1. Disconnect the generator set starting battery before removing distributor.
2. Lightly hold the distributor in a vice using a soft support.
3. Release the holding clips and remove the distributor cap and gasket.
4. Remove two screws and lock washers securing the vacuum advance assembly to the distributor body. The linkage detaches from the mounting plate stud with light downward pressure as the vacuum assembly is removed.
5. Remove wire connectors from the electronic module.
6. Remove harness clamp and harness from the distributor body.
7. Remove two screws, lock and flat washers securing the mounting plate assembly to the distributor body.
8. Remove the screw from the recess in the center shaft. Pull the loosened assembly up and away from the main drive shaft.
9. Remove two screws, flat and lock washers securing the electronic module to the mounting plate.
10. Pull the signal rotor off from the outer shaft (normally can be removed by hand).
11. Use a long nose plier to remove spring retainers and mechanical advance springs. Figure 6-13).
12. Remove the mechanical advance weights.

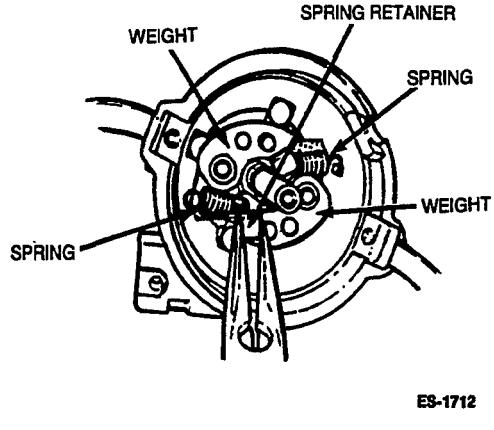


FIGURE 6-13. MECHANICAL ADVANCE

Inspection: Check the following items.

- Wiring

Check wires and harness for continuity and abrasion. Replace or repair as necessary.

- Pick-up Coil

Check the electronic module for external damage. Check the module resistance with an ohmmeter as shown in Figure 6-14. The module should measure very high resistance in both directions (0.5 megohm or more).

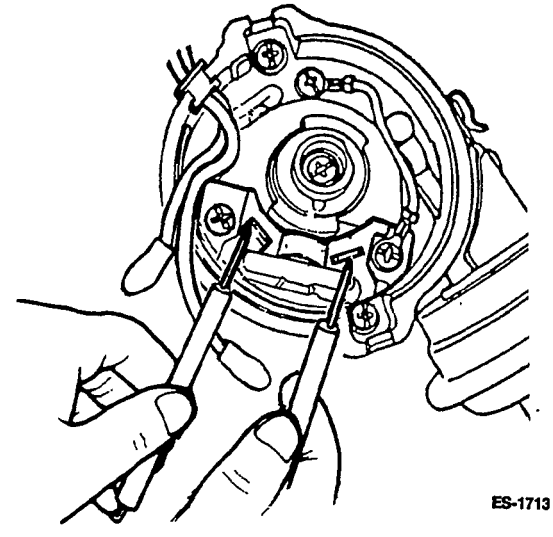


FIGURE 6-14. MEASURING MODULE RESISTANCE

- Distributor Shaft/Bearing

Check the shaft and bearing for wear. Replace the housing and shaft assembly if wear is evident. Individual components may not be available. See the parts catalog.

Assembly: Install components in the reverse order of the disassembly procedure. Perform the following during assembly.

1. Clean and inspect all components before assembling. Be sure all traces of metal flakes or filings are removed from the mounting plate.
2. Apply lubricant sparingly to rubbing surfaces and pivot points of the mechanical advance mechanism.
3. Install mounting plate with its projection in the groove of the housing (Figure 6-15).

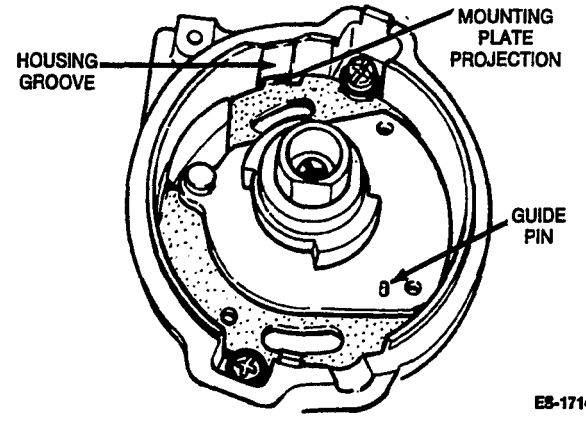


FIGURE 6-15. MOUNTING PLATE INSTALLATION

4. Place the pickup module over the guide pin on the mounting plate (Figure 6-15). Insert and start the threads of the mounting screws.
5. Install the pickup module and check clearance to the pole piece as shown in Figure 6-16. Clearance should be 0.02 ± 0.008 inch (0.5 mm ± 0.2mm.

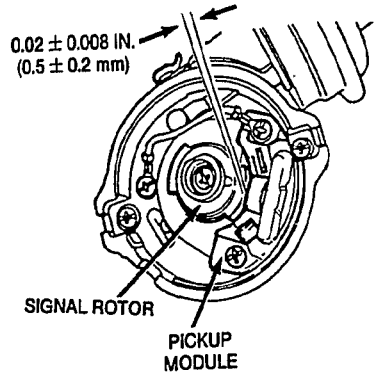


FIGURE 6-16. CHECKING ROTOR CLEARANCE

Installation: Use the following procedure to determine correct orientation of the distributor coupling after installation on the engine block.

1. Remove spark plugs and turn the crankshaft to place the No. 1 piston at top dead center on compression stroke. The timing notch on crankshaft pulley should be opposite the index mark on the belt guard backplate (Figure 6-19).
2. Position the coupling with the alignment marks on the distributor housing as shown in Figure 6-17. Note position of notches in coupling.
3. Place distributor onto the cylinder head with the distributor mounting slot centered over the mounting stud bolt (Figure 6-18).

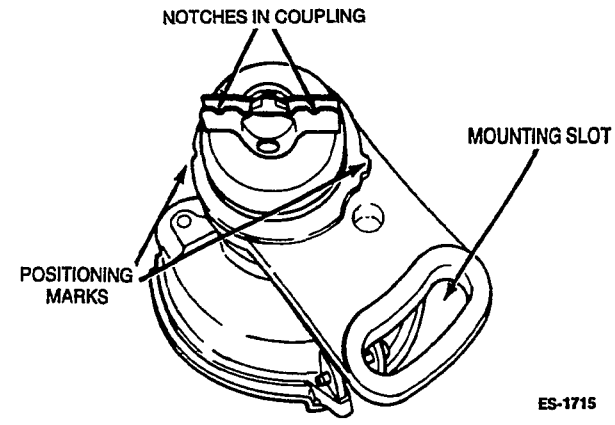


FIGURE 6-17. COUPLING ORIENTATION

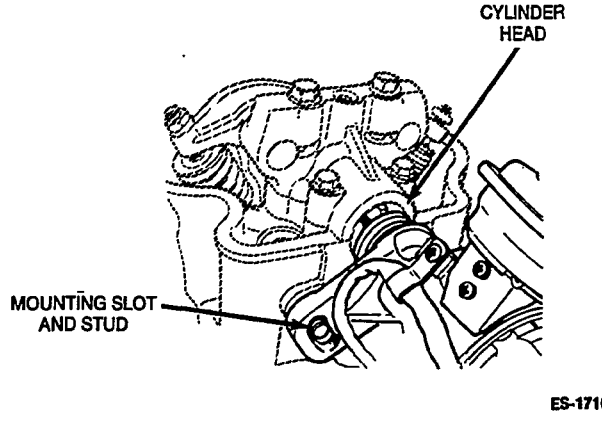


FIGURE 6-18. MOUNTING THE DISTRIBUTOR

4. Push the distributor in by hand until the distributor body end surface is tight against the cylinder head machined surface.
5. Install washer and nut on mounting stud. Do not tighten firmly until timing check/adjustment is made.
6. Install the cap on distributor and secure with the two spring clips.

Ignition Timing Adjustment

Ignition timing must be checked and adjusted to specification after servicing the distributor. Failure to do so can result in marginal or poor generator set performance. The belt guard must be removed. Use the following procedure to adjust ignition timing.

1. Connect a timing light to either spark plug cable.
2. Start the generator set and bring engine up to operating temperature (coolant thermostat setting).
3. Aim the timing light at the belt guard backplate as shown in Figure 6-19. The slot in crankshaft pulley should line up with the index pointer on the belt guard backplate.
4. If adjustment is necessary, loosen the distributor attaching nut sufficiently to allow rotation of the distributor. Counter-clockwise rotation will retard timing; clockwise rotation will advance timing.
5. Tighten the distributor attaching nut firmly after timing adjustment.

Wiring

This section tells how to check the secondary ignition cables and primary coil leads. When removing secondary cables, hold the rubber cap firmly. Do not hold the cable when pulling or it may be damaged.

Spark Plug Cables: Connect the leads of an ohmmeter (R x 1K scale) to the ends of each cable. Resistance should be 8,000 ohms ± 15%. With the leads still connected, shake the cable at the center by hand, or lightly press cable with fingers from end to end. If the ohmmeter needle does not move and the resistance reading is correct, the cable is usable. The cable insulation should be free of any cracks and not be damaged by abrasion or heat.

Primary Coil Leads: Check all low voltage wires for loose connections, cuts or breaks in the insulation. A frayed or pinched primary wire or broken insulation can cause misfiring. The mounting plate has a grounding wire to the distributor housing that must be in good condition. Clean terminals and connections and test for continuity with an ohmmeter.

Spark Plugs

Remove and inspect/replace the spark plugs at the intervals recommended in the Periodic Maintenance Schedule of the Operator's Manual. A careful examination of the plugs can often pin-point the source of an engine problem. The following covers some common spark plug conditions and the probable cause.

- ***One Plug Carbon Fouled:*** Check for an open ignition cable or low compression.
- ***Black Soot Deposits:*** Check for faulty choke operation, overly rich fuel mixture, or restricted air intake.
- ***Oil Fouled:*** Check for faulty crankcase breather hose, worn rings, or worn valve guides.
- ***Burned or Overheated:*** Check for leaking intake manifold gaskets, lean fuel mixture, or incorrect ignition timing. Be sure plug has correct heat range.

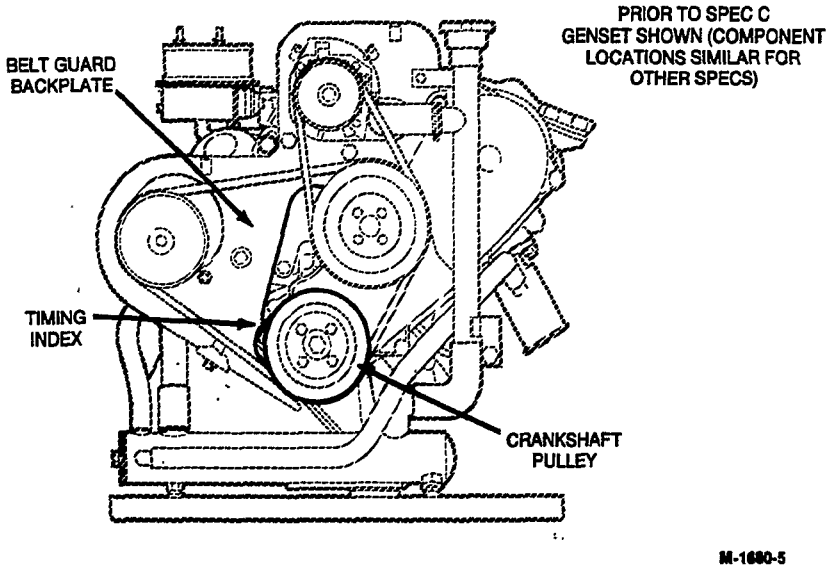


FIGURE 6-19. TIMING MARK LOCATION

- ***Chipped Insulator:*** Check for advanced timing. Bend only the side electrode when setting plug gap.
- ***Splash Fouled:*** Check for accumulated combustion chamber deposits. See Cylinder Head section.
- ***Light Tan or Gray Deposits:*** Normal plug color.

Spark plugs should be replaced at regular intervals. Replace plugs with the same type as specified in the Parts Catalog. Check and adjust plug gap to 0.043 inch (1.1 mm). See Figure 6-20.

Installation: A 13/16-inch hexagon spark plug socket is required to remove/install plugs. After normal service life of a spark plug, a plug may be difficult to remove, especially if it has been over-torqued (see Caution). The use of penetration oil is recommended if a plug appears to be dangerously tight. Apply steady pressure with a plug wrench until the plug loosens. Before removing the plug, blow any dirt from the port area to prevent it from getting into the combustion chamber.

Clean the plug gasket surface on the head with a clean cloth. Torque each spark plug to 18 foot pounds (24 N•m). Correct torque can be had only if the threads are clean.

⚠CAUTION ***The cylinder head is made of an aluminum alloy. Do not torque spark plugs beyond specs or remove plugs from a hot engine. Damage to the internal threads may result.***

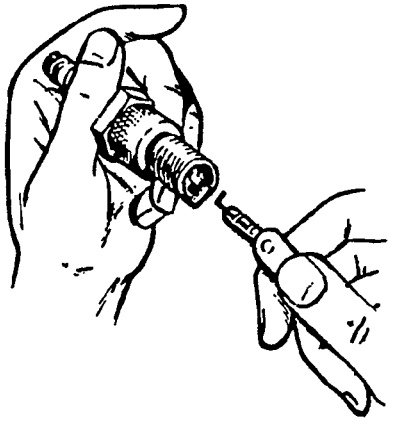


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FIGURE 6-20. CHECKING PLUG GAP

Ignition Coil

Ignition coils do not normally require any service other than to keep all terminals and connections clean and secure. Check for loose seams, dents, punctures, and other mechanical damage. If poor ignition performance is evident and other ignition components are not at fault, the coil can be tested with the specified procedures. When replacing the coil, observe proper polarity. The negative (-) terminal connects to the electronic module and the positive (+) terminal connects to a battery positive B+ source within the control.

A quick test of coil output can be made by checking the ignition spark. Remove one of the spark plugs. Reconnect the spark plug wire to the spark plug (Figure 6-21). Ground the spark plug to bare engine metal and crank the engine. A good spark should be observed across the plug electrodes. If the spark is weak, the coil, electronic module, or wiring is probably defective.

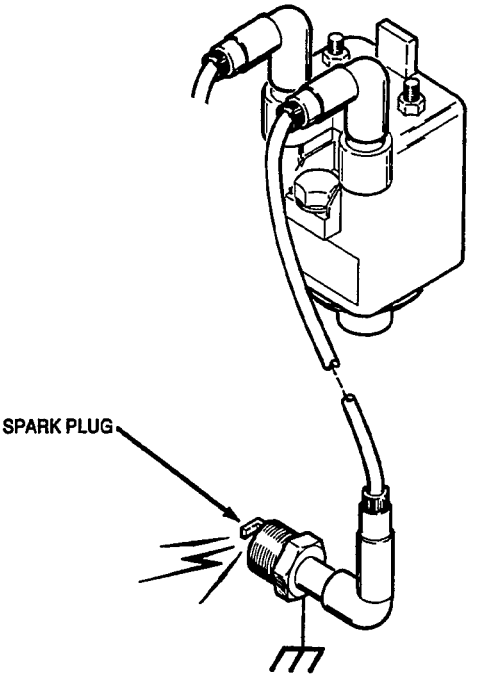

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FIGURE 6-21. COIL QUICK TEST

Testing with Ohmmeter: Remove all attached wires from the coil. Use the following test procedure.

1. To measure primary circuit, connect one ohmmeter lead to the positive (+) terminal and the other to the negative (-) terminal of the coil. Resistance should be between 2.9 and 3.6 ohms at 68°F (20°C). A high resistance indicates an open circuit or poor connection inside the coil. Replace the coil if not within specifications.
2. To measure secondary circuit, connect the ohmmeter leads across the high tension tower terminals (Figure 6-22). Resistance should be between 14,500 and 19,800 ohms at 68°F (20°C). A lower reading indicates a shorted secondary winding. A higher reading indicates the coil has excessive internal resistance or an open circuit. Resistance between any terminal and the coil case/housing should be infinite.

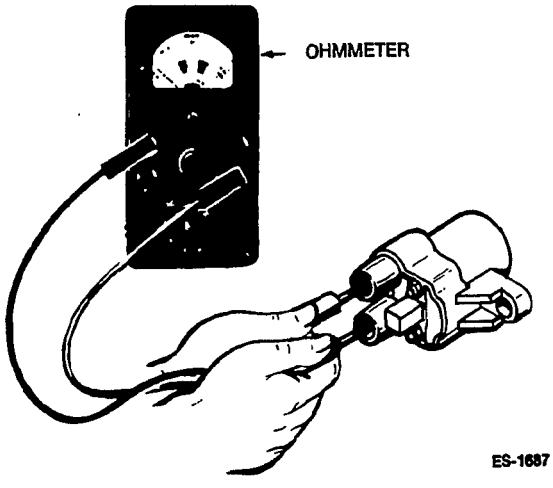

FIGURE 6-22. TESTING COIL RESISTANCE

STARTER MOTOR

A 12-volt, negative ground starter is used for cranking. When the starter is energized, an inertial engagement system causes the starter pinion gear to engage the ring gear/fan assembly. Because the starter is an integral part of the GenSet control system, check control operation before servicing the starter.

Use the following procedures to disassemble, inspect and assemble the starter.

Disassembly

1. Disconnect the generator set negative (-) battery cable from the set starting battery.
2. Disconnect the positive (+) lead from the starter input stud terminal.
3. Remove the starter mounting screws and disengage the starter from the engine.
4. Remove starter through-bolts and carefully separate the brush end cap, housing, and armature assembly. See Figure 6-23.
5. Use an impact wrench to remove the pinion gear stop nut from the armature assembly. Carefully separate the pinion gear assembly and drive end cap from the armature.

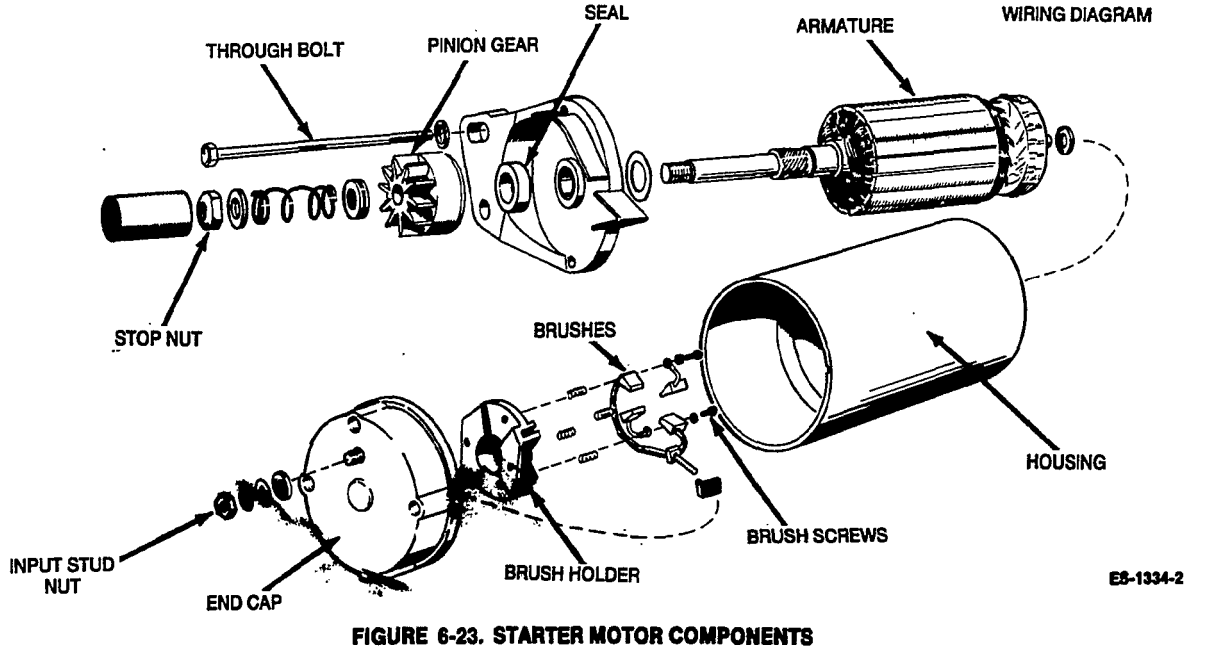

FIGURE 6-23. STARTER MOTOR COMPONENTS

Testing Armature for Grounds: Touch an ohmmeter lead to a commutator bar and then touch the other lead to the armature shaft and core laminations. A low resistance reading indicates a grounded armature. Replace grounded armature with a new one. See Figure 6-24.

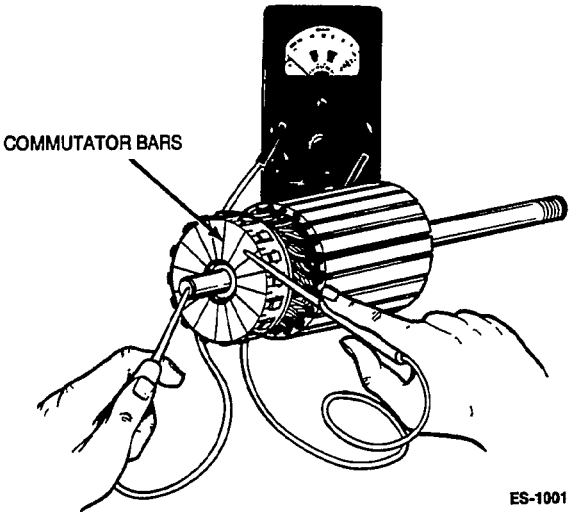

FIGURE 6-24. TESTING ARMATURE FOR GROUNDS

Testing For Shorts: Use a growler (Figure 6-25) for locating shorts in the armature. Place armature in growler and hold a thin steel blade (e.g. hacksaw blade) parallel to and just above the armature core while slowly rotating armature in growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace shorted armature.

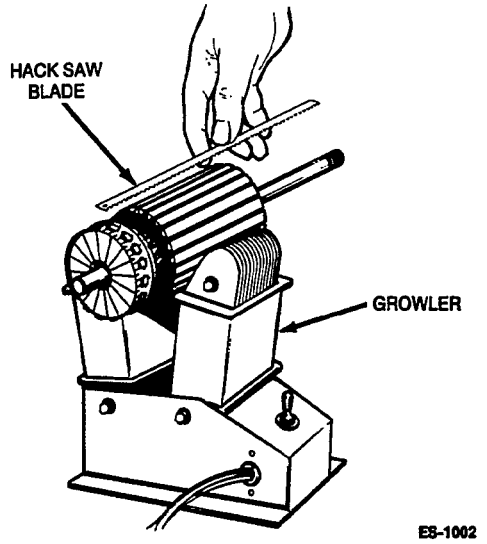

FIGURE 6-25. TESTING ARMATURE FOR SHORTS

Testing for Opens: Touch an 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 bar and armature winding. Replace an open armature with a new one.

Brush Inspection: Measure brushes and replace if worn to less than 1/4 inch (6.4 mm). See Figure 6-26. Check to see that brushes move smoothly in the brush holder assembly. Replace brushes that are burned.

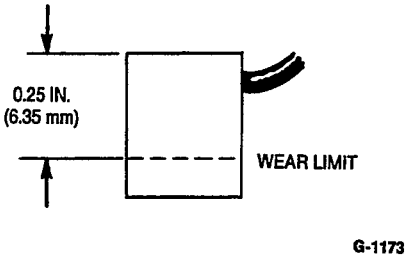

FIGURE 6-26. BRUSH INSPECTION

Housing Inspection: Inspect the inside of the starter housing. Magnets are glued to the housing and must be secure and free of cracks.

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 ***Do not immerse bearings in cleaning fluid. Use a brush dipped in clean engine oil for dirt removal.***

2. Assemble brushes in brush holder assembly so the chamfered edge is away from the brush springs. Make certain brush wires do not rub against commutator or end cap.
3. Torque brush screws to 3 to 3.5 ft-lbs (4 to 6 N•m).

4. Torque lug terminal nut to 4 to 5 ft-lbs (5 to 7 N•m).
5. Apply a thin film of silicone base grease (GE Versilube #22-L or equivalent) to the portions of the armature shaft that contact the bearings. Apply a heavy coat of silicone base grease to the starter drive section of the shaft.
6. Install the pinion gear stop nut and torque 20 to 25 ft-lbs (27 to 34 N•m). Apply a wrench to the hex nut welded on the rear of the pinion gear to keep the shaft from turning.
7. Place the armature end cap in position on the starter housing and then carefully insert the armature into the housing. Install starter through-bolts and tighten securely.
8. Mount starter on engine and secure using hex head capscrews, lockwashers, and nuts. Torque mounting screws to 30 to 33 ft-lbs (41 to 45 N•m).
9. Connect the positive (+) lead to the starter input stud terminal.
10. Connect generator set negative (-) battery cable to the generator set starting battery. Check starter operation.

CRANKCASE VENTILATION

Crankcase ventilation 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. The vapors are taken from the valve cover and routed by a breather hose to the carburetor. Here they are mixed with incoming air and burned in the combustion chamber.

Service: There are no periodic service items to the crankcase ventilation system other than checking the hose for deterioration, leaks, collapse or restriction. A pressurized crankcase can cause oil leaks, high oil consumption, reduced engine power and a rapid formation of sludge and varnish within the engine.

GOVERNOR/CARBURETOR

General

An isochronous electronic governor is used on generator sets starting with Spec C. Prior to Spec C, generator sets use a belt-driven, mechanical governor. Adjustments are covered under respective paragraph headings. Service and maintenance to the governor/s are covered separately under the heading GOVERNOR.

Adjustment of both the carburetor and governor are included here because each is dependent upon the other for proper operation. The governor controls the speed of the engine, and therefore the generator output frequency. Engine speed also affects AC output voltage. Use a frequency meter to check engine speed for proper governor/carburetor adjustment.

Be sure the bearing surfaces of governor linkage are clean. Do not use any lubricant on the nylon bearings. Metal bearing surfaces may be lubricated with powered graphite if necessary. Never use oil lubricants as they attract airborn dust.

The following adjustments should be performed in the order listed for the respective model specification.

Governor/Carburetor Adjustment
Starting Spec C

The following adjustments are made with the assumption that the carburetor main and idle screws are properly set. The factory settings with limiter caps in place normally should provide the proper adjustment. However, if the carburetor has been overhauled, preliminary settings should be made as instructed in the *Fuel System* section (Table 6-1.).

1. Set the carburetor throttle stop screw (Figure 6-27) as follows:
   A. Turn screw CCW (counterclockwise) to allow throttle plate to close fully against the carburetor bore.
   B. Turn screw CW (clockwise) until screw contacts the throttle lever, then turn an additional 1/2 turn.

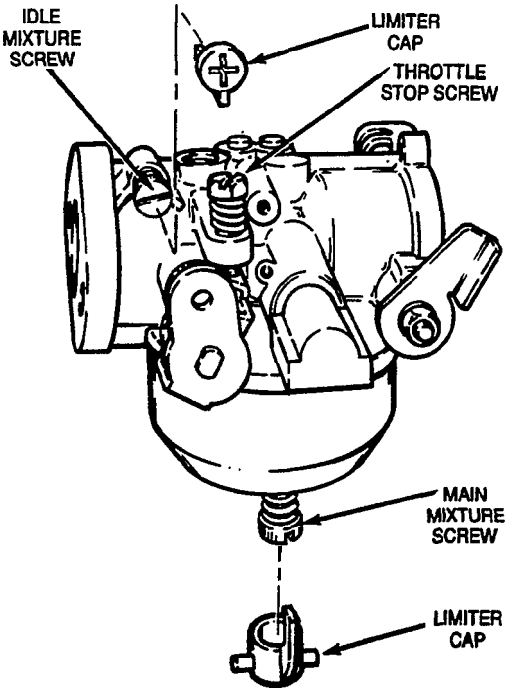

FIGURE 6-27. CARBURETOR FUEL ADJUSTMENTS

2. Set the GAIN control on the governor electronic controller to 35. See Figure 6-28.

3. Check the governor preload setting as shown in Figure 6-29. With the throttle held closed, the nylon bearing linkage should be displaced 0.09 ±0.03 inch (2.3 ±0.8 mm).

4. Start the generator set and apply at least ½ electrical load. Adjust SPEED screw on governor electronic controller to obtain 60 hertz nominal frequency. Allow the engine to reach normal operating temperature (minimum of 15 minutes).

5. Remove load. Frequency should still be at 60 hertz.

6. Fine tune the carburetor idle mixture screw for best operation.

7. Apply rated load. If frequency is below specification (59 hertz), or rated power cannot be obtained, check that throttle is at or near wide open position. If not, reduce the governor preload set in Step 3 (i.e. lengthen linkage slightly). Adjust main mixture screw to obtain maximum power.

8. The above procedure should allow the generator set to operate smoothly without hunting at no load to rated load (given other engine systems are functioning correctly).

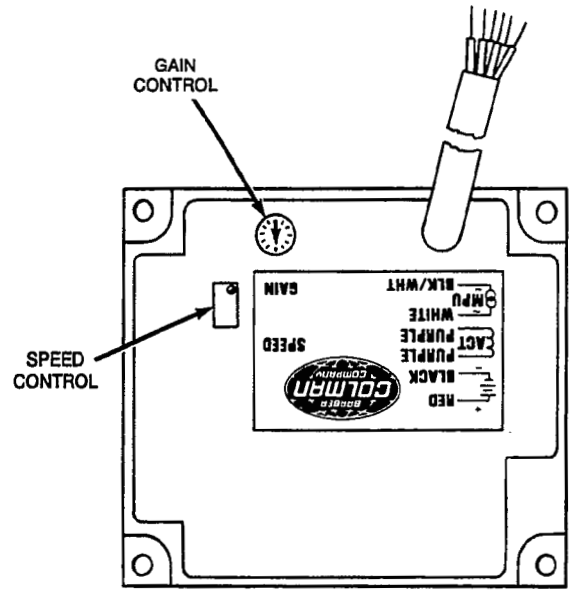

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FIGURE 6-28. GOVERNOR ELECTRONIC CONTROLLER

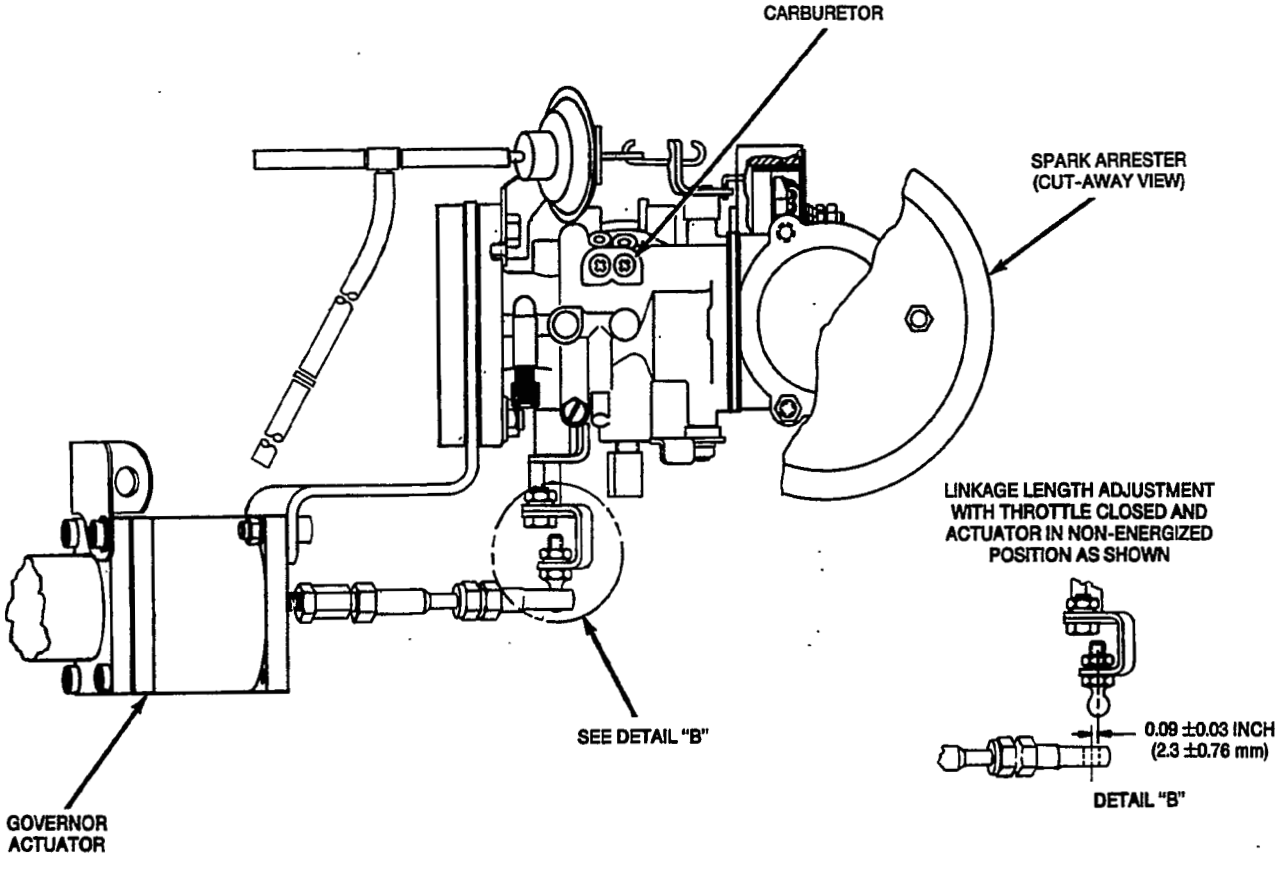


FIGURE 6-29. GOVERNOR ACTUATOR PRELOAD ADJUSTMENT M-1613

Governor/Carburetor Adjustment, Prior Spec C

The following adjustments are made with the assumption that the carburetor main and idle screws are properly set. The factory settings with limiter caps in place normally should provide the proper adjustment. However, if the carburetor has been overhauled, preliminary settings should be made as instructed in the *FUEL SYSTEM* section (Table 6-1).

Be sure the governor belt adjustment is correct before proceeding with adjustments. See Figure 6-7. Shifting the governor mounting for belt adjustment will change the linkage adjustment.

1. Adjust the governor linkage with the stop solenoid retracted, i.e., not contacting the throttle arm.

2. Remove the ball socket from the ball (Figure 6-30). Loosen the locknut and adjust the length to give wide open throttle at wide open governor position (normal non-running governor position is wide open throttle). The spring should be attached as shown in the drawing. Be careful when checking linkage length. Applying excess pressure against the governor arm or carburetor throttle arm can cause an incorrect length adjustment.

3. Start the generator set and apply at least ½ load. Allow the engine to reach normal operating temperature (minimum of 15 minutes).

4. Fine tune the carburetor main mixture and idle mixture screws within limits of plastic stop caps as follows:

   A. With full load applied, adjust the main mixture screw for maximum frequency (r/min).

   B. With no load applied, adjust the idle mixture screw for smoothest running.

   C. Repeat steps A and B.

5. Remove load from the generator and set the governor speed adjustment screw (Figure 6-31) for a nominal no load frequency of 62.5 hertz (63 hertz maximum). Turn the carburetor throttle stop screw clockwise until nominal frequency increases 1 hertz, then turn screw counterclockwise ½ turn.

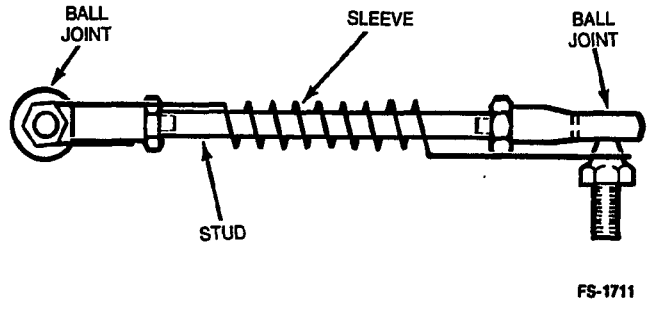


FIGURE 6-30. GOVERNOR/CARBURETOR LINKAGE

6. Turn the carburetor throttle stop screw (Figure 6-28) clockwise until the nominal frequency increases 1 hertz, then turn screw counterclockwise ½ turn.

7. Apply ½ rated load. If the frequency is less than 58 hertz, shorten the governor regulation screw slightly and tighten locknuts. If the frequency is greater than 61 hertz, lengthen the regulation screw. Readjust the no-load frequency with the governor speed adjustment screw.

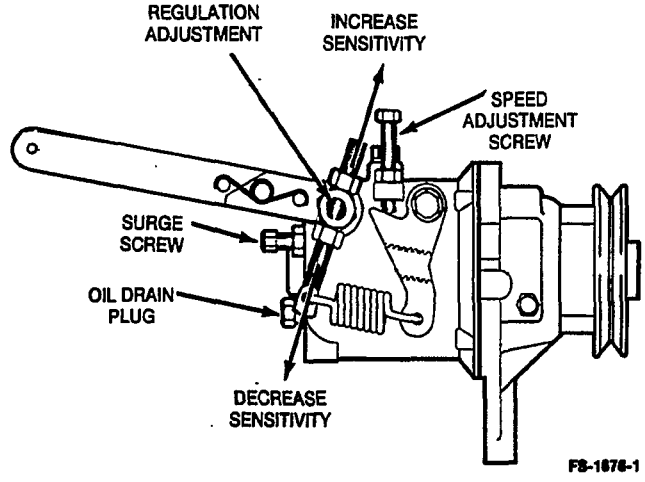


FIGURE 6-31. MECHANICAL GOVERNOR ASSEMBLY

8. Apply rated electric load. If frequency is below 58 hertz or rated power cannot be obtained, check the throttle to see if it is at, or near, wide open position.

   If not, increase boost spring tension (Figure 6-43) by changing the hole position on the mounting bracket above the carburetor.

   If frequency is greater than 61 hertz, decrease boost spring tension. If required, adjust carburetor main and idle mixture screws within limits of the plastic stop caps.

9. Check the AC output voltage at no load, and at rated load. Voltages should be within the following specifications:

   Minimum voltage 0.95 x rated
   Maximum voltage 1.08 x rated

   If rated power cannot be obtained, recheck the governor linkage adjustment. If okay, shorten the governor regulation screw slightly and retighten locknuts. Readjust no-load frequency with the governor speed adjustment screw.

⚠CAUTION ***Ensure all lock nuts are tightened as adjustments are completed. The governor cannot operate properly if there is binding, sticking, or excessive looseness in the connecting linkage or carburetor throttle assembly. A lean fuel mixture or a cold engine can cause hunting.***

FUEL SYSTEM

The fuel system must be in good condition and properly adjusted for efficient and proper generator set operation. The main component assemblies of the fuel system are listed below. Refer to these section headings to service, disasemble, assemble, and adjust these assemblies.

- Air Resonator Assembly
- Carburetor Assembly
- Intake Manifold
- Fuel Filter and Pump

Two genset specifications are covered in this section. These are "Starting Spec C", and "Prior to Spec C" gensets. Main differences are in the fuel pump, carburetor linkage, and governing covered in the previous Governor/Carburetor section. Component differences of the two specs are handled under separate sub-headings.

Be sure all linkage between the components of the carburetor assembly are clean and do not bind. Metal-to-metal bearing surfaces can be lubricated with powdered graphite. Do not use oil lubricants as they can attract air-born dust.

Air Resonator Assembly

The air resonator is used to silence the air pulsations before they enter the carburetor for engine combustion. The resonator does not require periodic maintenance other than to check the security of its mounting, and for damage.

The resonator is secured with three nuts and lock washers on the flame arrestor studs (Figure 6-32).

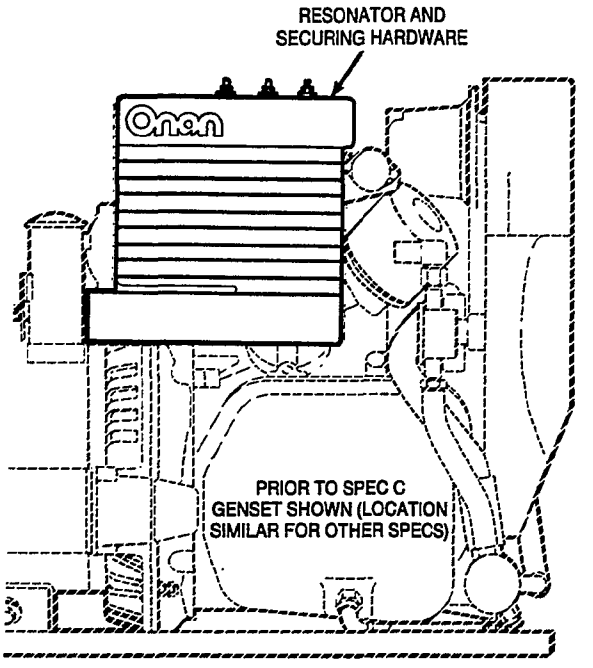


FIGURE 6-32. RESONATOR MOUNTING

Carburetor Assembly

Components of the two specification assemblies are shown in Figures 6-33. and 6-34. Service and adjustment information is listed under separate sub-headings.

Disassembly, Starting Spec C: Use the following procedures for complete disassembly of the carburetor components.

1. Remove three nuts and lockwashers securing the resonator assembly to the flame arrestor. Remove the assembly.
2. Disconnect the governor linkage arm at the carburetor.
3. Disconnect the vacuum line at the choke pull-off diaphragm.
4. Disconnect the leads from the choke terminals.
5. Disconnect the tube from bottom of the air intake elbow.
6. Disconnect the fuel inlet line at the carburetor. Plug the line to prevent any fuel spillage.

⚠WARNING Gasoline vapor is extremely flammable and can result in severe personal injury or death if ignited. Make certain the fuel line is plugged to prevent gasoline vapor accumulation. Make certain the area is well ventilated and that there are no sources of ignition present such as flames, cigarettes, pilot lights, equipment or switches that may arc.

⚠WARNING Asbestos has been identified by some state and federal agencies as causing cancer. Engine gaskets containing asbestos should be handled with care. Do not ingest, breathe, or contact dust from gaskets. Use adequate ventilation and wear protective gloves, mask and clothing.

7. Remove the two nuts and lockwashers securing the carburetor assembly to the intake manifold.
8. Remove the two capscrews and lockwashers securing the carburetor adapter and choke assembly bracket to the carburetor. Disengage the choke pull-off linkage from the carburetor and carefully separate the carburetor from the choke bracket assembly.
9. Disassemble the remaining components as needed for service procedure.

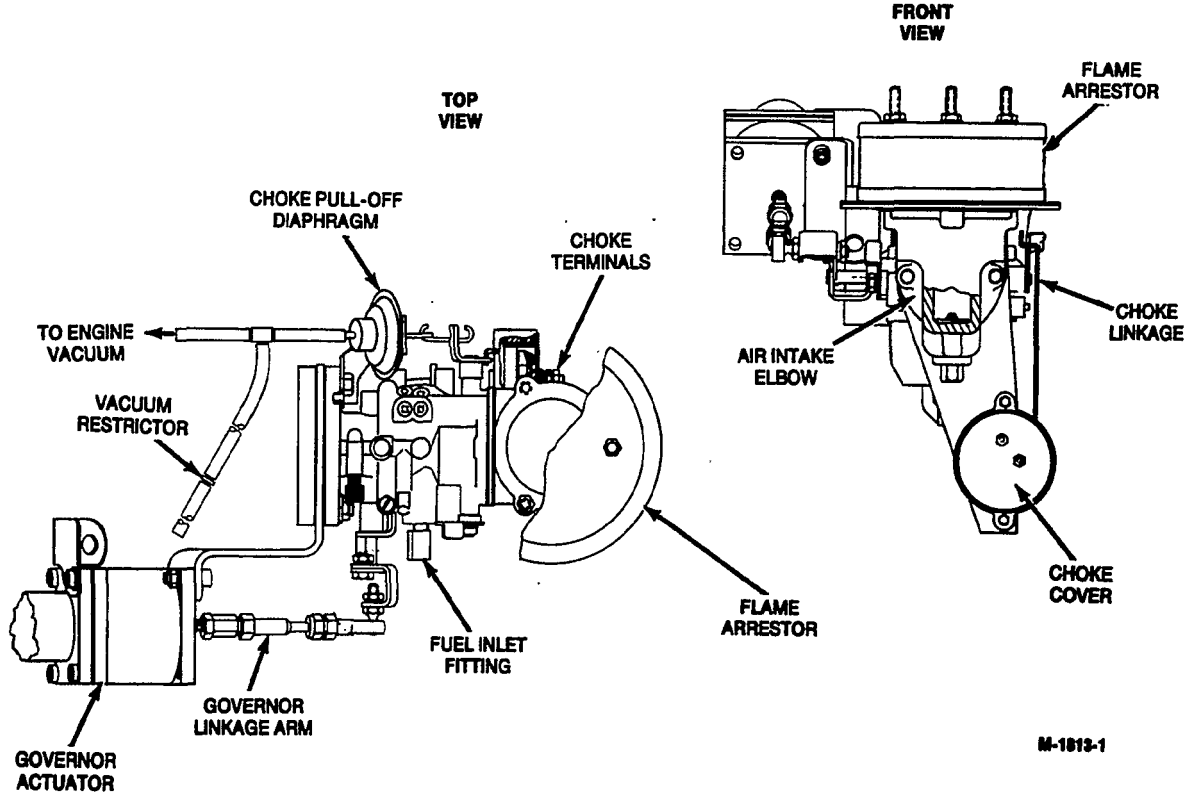


FIGURE 6-33. CARBURETOR ASSEMBLY, STARTING SPEC C

Disassembly, Prior Spec C: Use the following procedures for complete disassembly of the carburetor components.

1. Remove three nuts and lockwashers securing the resonator assembly and remove.

2. Disconnect the governor linkage arm either at the carburetor or governor.

3. Disconnect the vacuum lines from both of the vacuum diaphragms.

4. Disconnect the leads from component terminals of the stop solenoid and choke.

5. Disconnect the tube from bottom of the air intake elbow.

6. Disconnect the fuel inlet line at the carburetor. Plug the line to prevent any fuel spillage.

⚠WARNING ***Gasoline vapor is extremely flammable and can result in severe personal injury or death if ignited. Make certain the fuel line is plugged to prevent gasoline vapor accumulation. Make certain the area is well ventilated and that there are no sources of ignition present such as flames, cigarettes, pilot lights, equipment or switches that may arc.***

⚠WARNING ***Asbestos has been identified by some state and federal agencies as causing cancer. Engine gaskets containing asbestos should be handled with care. Do not ingest, breathe, or contact dust from gaskets. Use adequate ventilation and wear protective gloves, mask and clothing.***

7. Remove the two nuts and lockwashers securing the carburetor assembly to the intake manifold.

8. Remove the two capscrews and lockwashers securing the carburetor adapter and choke assembly bracket to the carburetor. Disengage the choke pull-off linkage from the carburetor and carefully separate the carburetor from the choke bracket assembly.

9. Disassemble the remaining components as needed for service procedure.

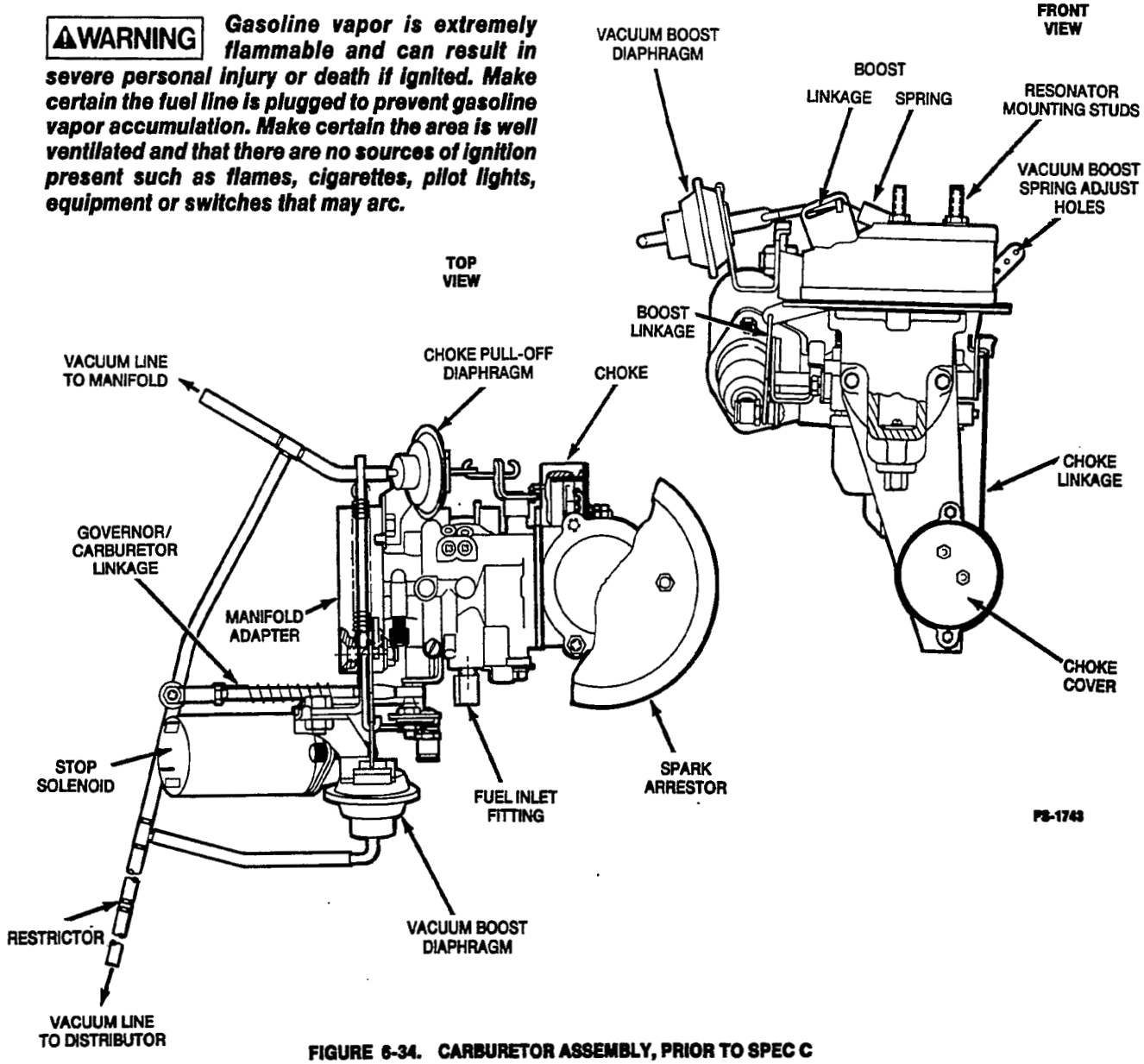


FIGURE 6-34. CARBURETOR ASSEMBLY, PRIOR TO SPEC C

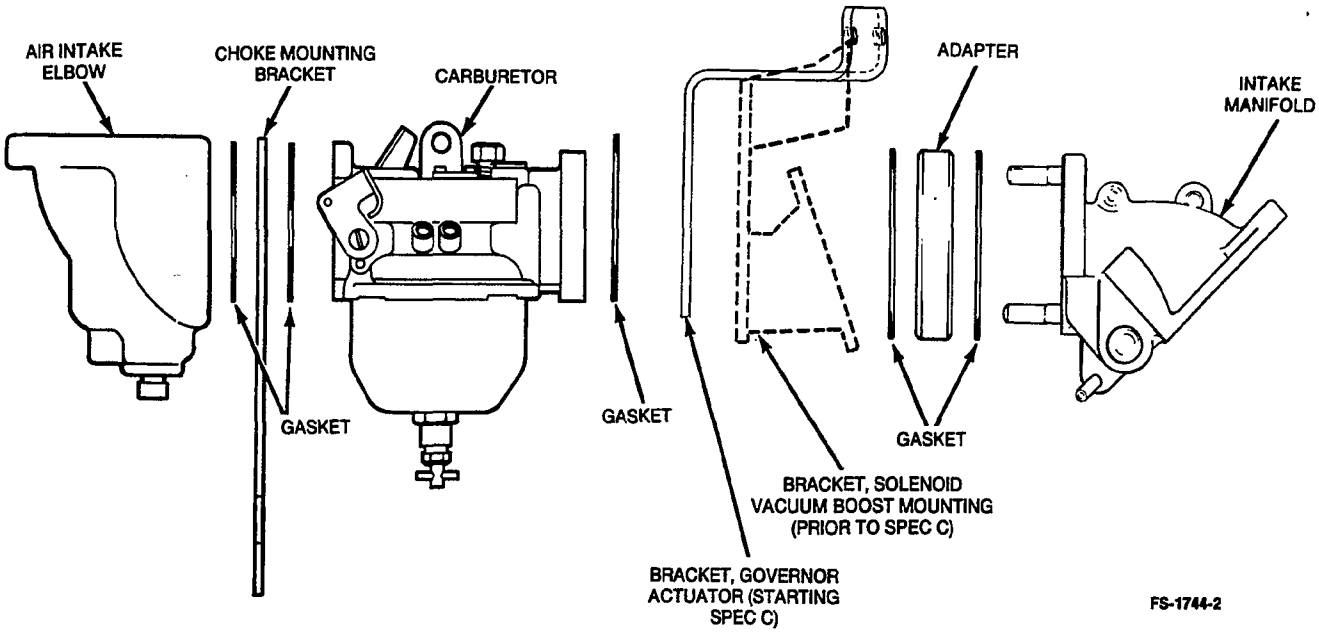


FIGURE 6-25. COMPONENT ASSEMBLY AND GASKETS

Assembly, General: Assemble components in the reverse order of disassembly. Use new gaskets at locations shown in Figure 6-35. Do not use any sealer on the gaskets. Tighten the intake manifold and elbow casting capscrews and nuts to the specified torque.

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 carburetor problem is suspected. Before fuel adjustments, be sure the float level is set to specification, and the ignition system and governor are working properly. Carburetor fuel adjustment procedures are given in the previous Governor section since they are interdependent on each other for proper operation.

If the carburetor is taken apart and overhauled, the float adjustment and preliminary setting of the fuel mixture screws are listed in Table 6-1. Turn the mixture screws in until lightly seated, then turn out the specified number of turns.

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

TABLE 6-1.
CARBURETOR ADJUSTMENT SPECIFICATIONS

MIXTURE SETTINGS FROM SEATED POSITION		FLOAT* LEVEL
IDLE	MAIN	
1 ± 1/4	1-1/4 ± 1/4	0.59 to 0.63 IN. (15 to 16 mm)

*Measured as shown in Figure 6-36.

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 given as follows: Carefuly 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 disassembled in Figure 6-36.

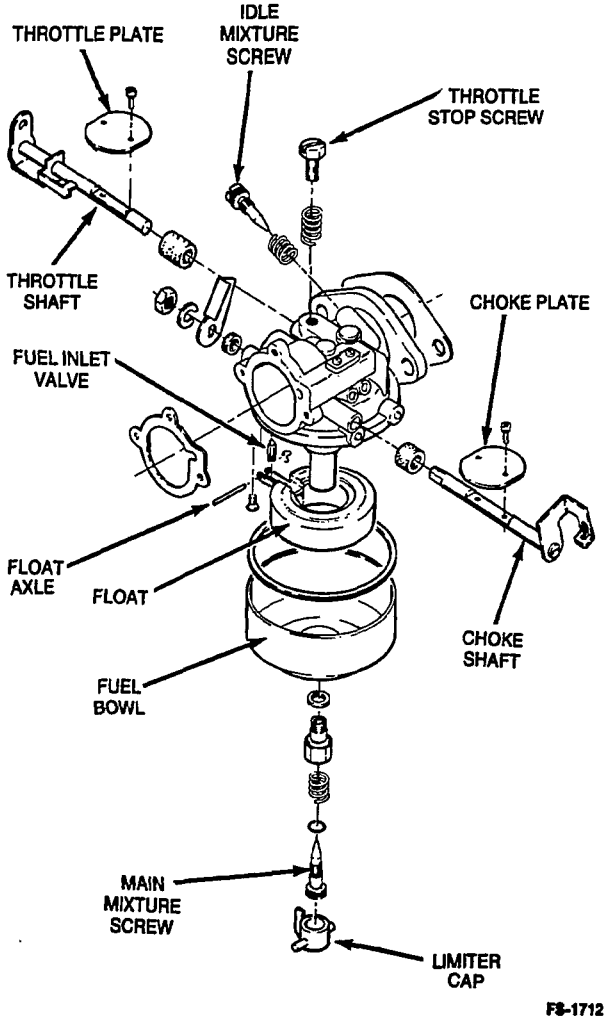


FIGURE 6-36. CARBURETOR DISASSEMBLY/OVERHAUL

Removal and Disassembly: Remove the carburetor from the intake manifold as specified in the *Carburetor Assembly section.* Disassemble the carburetor using the following procedure.

1. Remove throttle and choke plate retaining screws, then the plates. Pull out throttle shaft. Remove hex nut, lockwasher and choke indicator from end of choke shaft and remove from carburetor. Be careful not to damage the teflon coating applied to some throttle shafts.
2. Remove main and idle mixture screw assemblies.
3. Separate the fuel bowl from the upper section of the carburetor.
4. Carefully note position of float assembly parts, then slide out the float axle and remove the float assembly, buoyancy spring, and the needle valve.
5. Unscrew and remove the needle valve seat.

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.

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

2. 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 parts.
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 not included in repair kit and replace if damaged (Figure 6-37). Replace float if loaded with fuel or damaged.

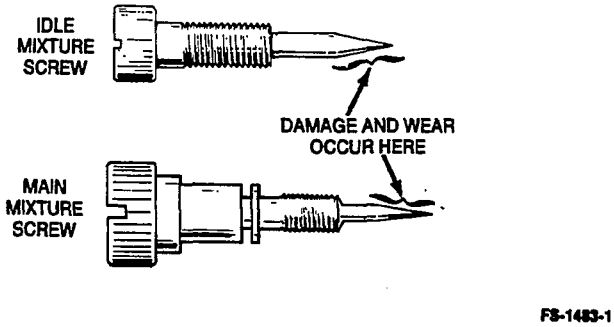


FIGURE 6-37. MIXTURE NEEDLE INSPECTION

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.

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

1. Slide in throttle shaft and install throttle plate (use new screws if furnished in repair kit). Before tightening the screws, the plate must be centered in the bore. To do so, completely close the throttle lever. Seat the plate by gently tapping with a small screwdriver, then tighten screws. Install the choke shaft and plate in the same manner.

2. Install idle mixture screw assembly. Turn in screw until lightly seated and then out the number of turns specified in Table 6-1.

⚠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, float, buoyancy spring and float axle. Make sure all springs are properly placed and the float moves freely without binding. See Figure 6-38.
4. Invert the float and needle valve assembly. Check the float level by measuring from the float top and inner gasket flange as shown in Figure 6-39. The full weight of the float should be resting on the needle valve. The correct distance is specified in Table 6-1. If the setting is incorrect, remove float and bend the float tang to adjust. Bend the tang only at the point indicated.

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

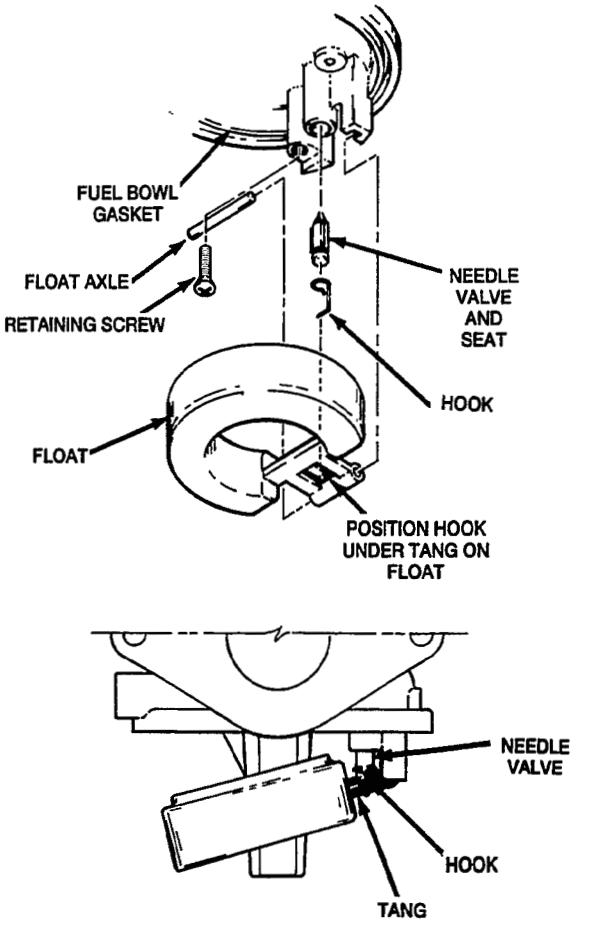


FIGURE 6-38. FLOAT INSTALLATION

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 6-1.

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

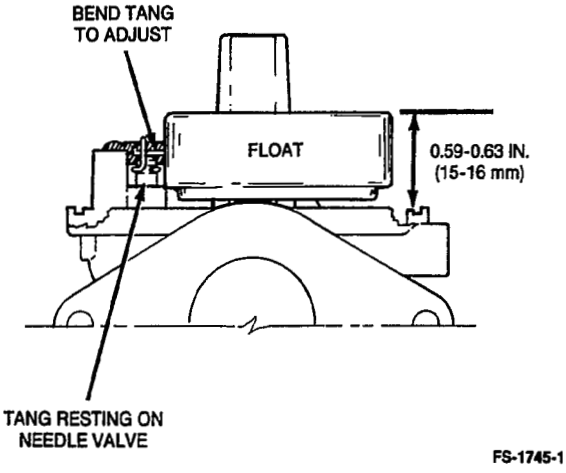


FIGURE 6-39. FLOAT LEVEL ADJUSTMENT

6. After the carburetor is installed, make final adjustments to mixture screws as described in the preceding Governor/Carburetor 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 and while the engine is running.

⚠WARNING ***The choke gets very hot during normal operation and can result in severe burns if touched. Do not remove the choke cover while the generator set is operating.***

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: Table 6-2 lists the choke settings for various ambient temperatures. Stop the set and allow it to cool down before making adjustments. Use the following procedures to adjust.

1. Remove the protective plastic choke cover (see Figure 6-40) and loosen the choke cover screws.
2. Slowly rotate the cover clockwise (rich) while tapping the choke lever and making the lever bounce. Continue rotation until tapping the choke lever no longer makes it bounce. This is the fully-closed position and becomes the reference position. Verify the reference point by going beyond and returning to it.
3. Refer to Table 6-2 to determine the number of degrees cover must be rotated counterclockwise (CCW) from the reference position per the current ambient temperature. Marks on choke housing are spaced at 5° intervals.

TABLE 6-2.
CHOKE ADJUSTMENTS

Ambient Air Temperature	Rotation From Reference Mark (CCW, Lean)
40°F (4°C)	0°
45°F (7°C)	4°
50°F (10°C)	8°
55°F (13°C)	12°
60°F (16°C)	16°
65°F (18°C)	20°
70°F (21°C)	24°
75°F (24°C)	27°
80°F (27°C)	32°
85°F (29°C)	35°
90°F (32°C)	39°
95°F (35°C)	43°
100°F (38°C)	47°

Each mark on choke housing equals 5° angular rotation.

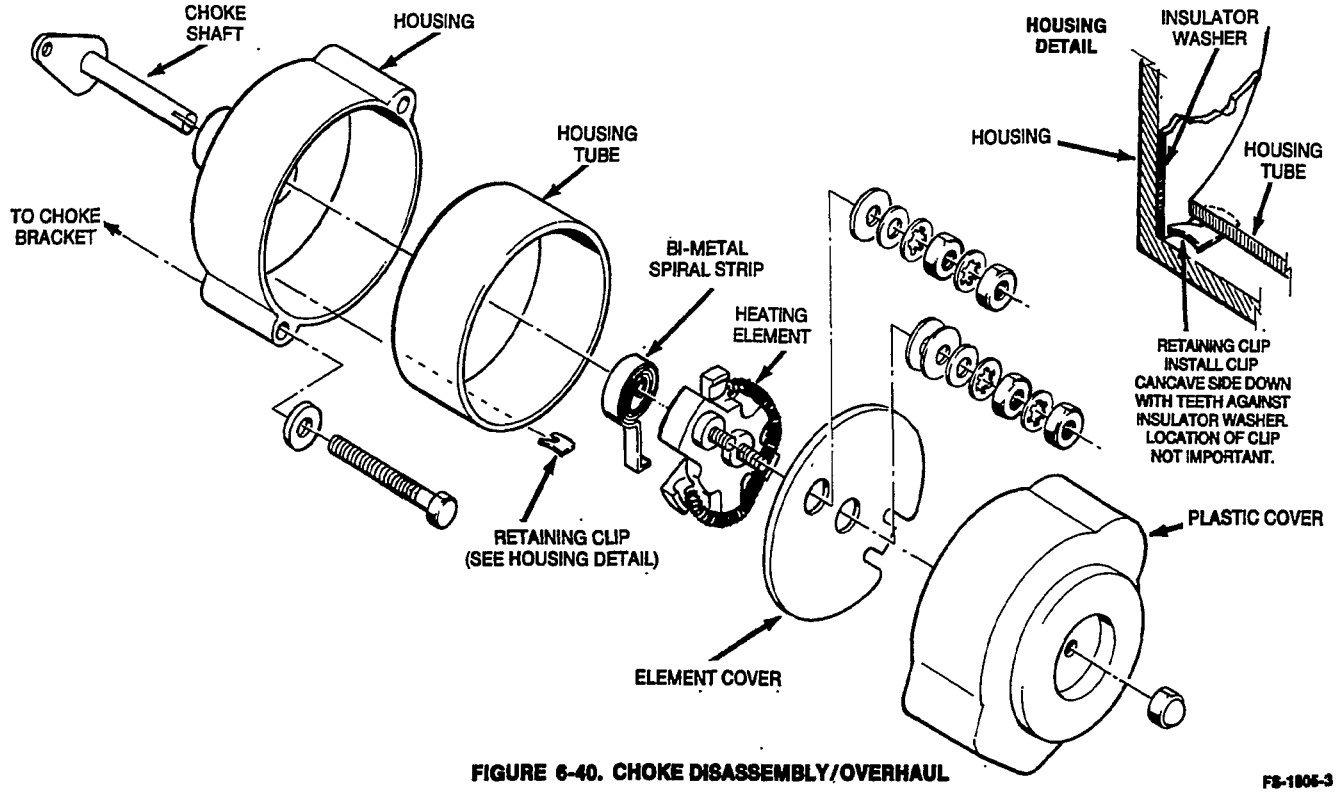


FIGURE 6-40. CHOKE DISASSEMBLY/OVERHAUL FS-1805-3

4. When the cover is at the proper position, tighten the mounting screws and replace the protective plastic choke cover.
5. Move the choke lever back and forth to check for smooth operation. The choke lever should return automatically to the free position when moved to choke position and released. Binding or sticking is not allowed and must be corrected (binding linkage or shafts, linkage misalignment, etc.). Keep wires free of the choke linkage. Change wire orientation if necessary with a cable tie.

Choke Replacement: If the choke fails to open, remove the protective plastic cover and 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, 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. The element should have about 20 ohms ± 0.5 ohm. Also inspect the bi-metal coil 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 6-41). The outer tab must point in a counterclockwise direction. Make sure the coil sets 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.

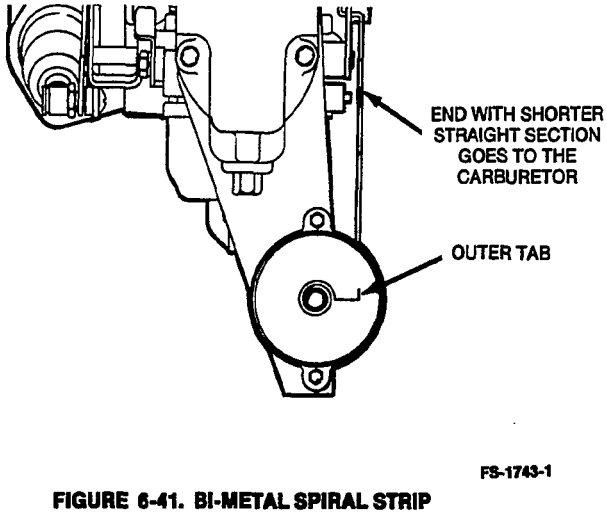


FIGURE 6-41. BI-METAL SPIRAL STRIP AND LINKAGE

Choke Pull-Off Diaphragm: If the engine fails to start, or it starts and runs poorly, the cause may be a defective choke diaphragm. See Figure 6-42. The choke linkage should also be checked for free movement without binding.

The diaphragm can be checked for correct operation by applying specific vacuum and checking the stem travel. The stem should reach full travel with 3.0 inches Hg (10 kPa) vacuum. Travel must be free of binding. A diaphragm not confirming to this standard should be replaced.

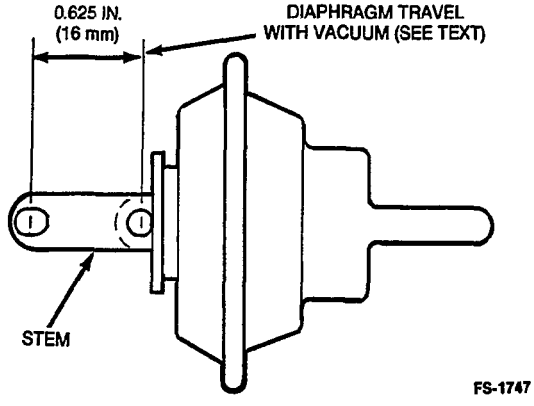


FIGURE 6-42. CHOKE DIAPHRAGM

Choke Pull-Off Adjustment: Use the following procedure for checking and adjusting the choke pull-off assembly shown in Figure 6-43.

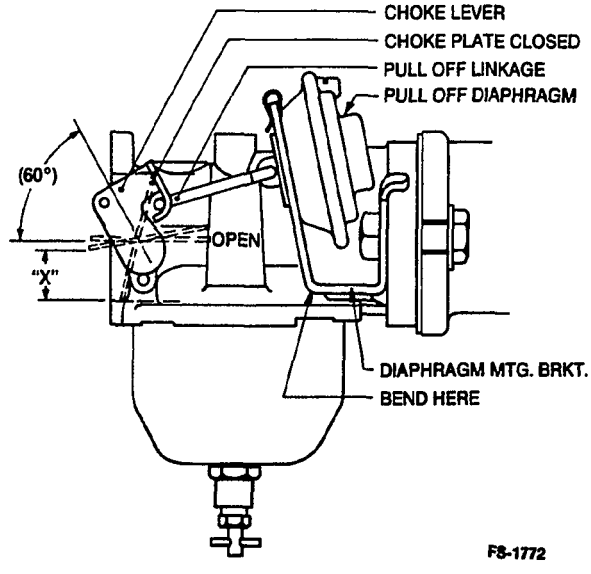


FIGURE 6-43. CHOKE PULL-OFF ASSEMBLY

1. Apply a vacuum source of 4-18 in. Hg (14-61 kPa) to the vacuum diaphragm.
2. Apply light finger pressure against the choke lever.
3. Check proper alignment of the diaphragm stem, pull off linkage and slot in choke lever (as viewed from top). Correct alignment as required.
4. Check dimension "X" between the lower edge of the choke plate and bottom of carburetor. If necessary bend diaphragm mounting bracket to obtain 0.39 -0.43 inch (10-11 mm).
5. Remove the vacuum source and check and move the choke lever back and forth to check for free movement. No binding or sticking is permitted.

Vacuum Assist Assembly, Prior to Spec C: This assembly consists of a vacuum diaphragm and spring connected to the throttle shaft by a series of linkages. See Figure 6-44. During engine operation this assembly assists the governor to assure full-throttle opening during heavy load application.

From zero to about 1/2 load, the vacuum diaphragm stem is retracted and does not allow the spring to apply an assist to the throttle linkage. At greater loads [or when the manifold vacuum drops below 3 inches Hg (10 kPa)] the diaphragm stem extends and allows the spring to assist throttle opening.

A component failure would result in a lack of power at upper load limits with a corresponding drop in frequency (droop). The linkage and linkage bracket must have free movement without binding, and the vacuum diaphragm operating correctly for proper operation. Figure 6-41 shows the proper assembly of components.

The diaphragm can be checked for correct operation by applying specific vacuum and checking the stem travel. See Figure 6-44. The stem should reach full travel with 3.0 inches Hg (10 kPa) vacuum. Travel must be free of binding. A diaphragm not conforming to this standard should be replaced.

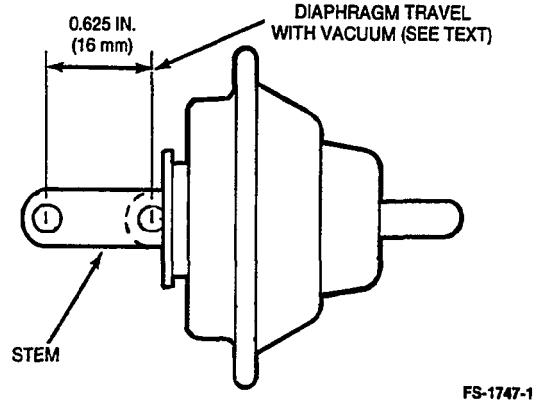
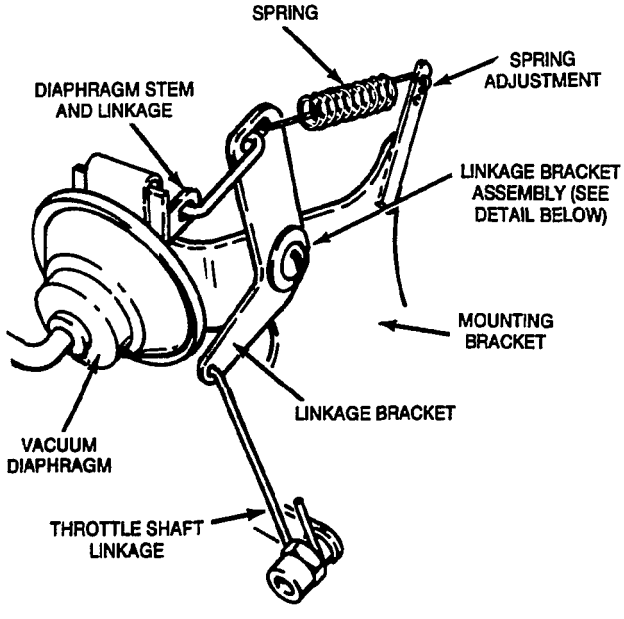


FIGURE 6-45. VACUUM ASSIST DIAPHRAGM, PRIOR TO SPEC C



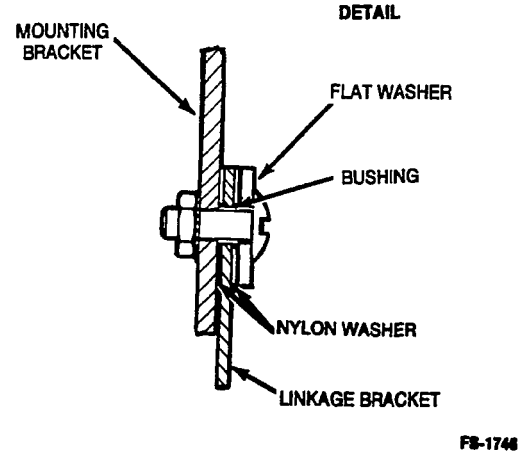


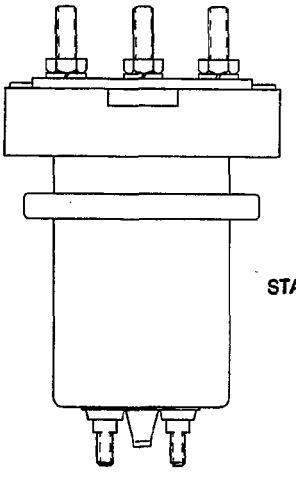
FIGURE 6-44. VACUUM ASSIST ASSEMBLY, PRIOR TO SPEC C

Fuel Pump

All gasoline fueled generator sets are equipped with an electric fuel pump. All fuel pumps have an integral shut-off valve that prevents fuel flow to the carburetor when the set is not in operation.

Figure 6-46 shows two different pumps, one for starting Spec C gensets, and one for prior to Spec C gensets. If the pump malfunctions or insufficient fuel delivery is suspected, use the following procedures for testing.

⚠WARNING ***Ignition of gasoline fuel can cause severe personal injury or death. Do not substitute automotive type electric fuel pumps for an Onan replacement pump. The output pressure is much higher and can cause carburetor flooding or fuel leakage, creating a fire hazard.***



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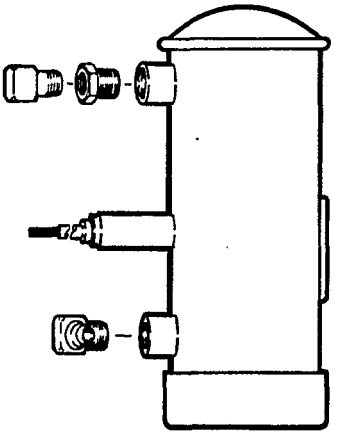

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FIGURE 6-46. FUEL PUMP ASSEMBLY

Pump Test: The fuel pump can be tested by checking the output pressure. Use the following procedure.

1. Remove the carburetor fuel line from the pump outlet fitting and install a pressure gauge.
2. Disconnect the battery B+ lead from the starter solenoid to prevent engine cranking or starting.
3. Press the Start switch and hold for several seconds until pressure reading is constant.
4. The pressure reading for a good pump should be 4 to 5.5 psi (28 to 38 kPa). Other readings indicate a questionable pump. The pumps are not serviceable and must be replaced when defective.
5. Replace B+ lead on the starter solenoid.

Stopping Solenoid, Prior to Spec C

The solenoid is rated at 12 VDC and has a combined coil resistance (not energized) of about 0.4 ohms. The pull-in coil is switched out of the circuit by an internal switch when the solenoid is energized. Momentary pull-in current is 30 amperes; hold coil current is 0.7 amperes.

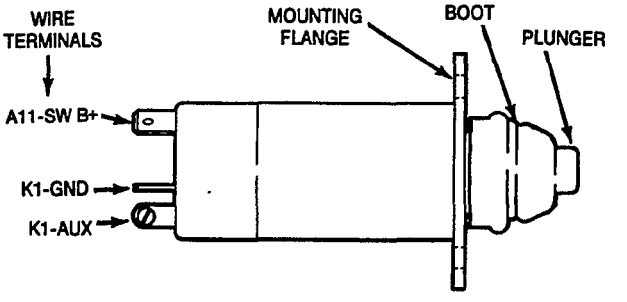

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FIGURE 6-47. STOP SOLENOID, PRIOR TO SPEC C

If the solenoid plunger movement is restricted from binding or corrosion, the coil can become quite warm, and may blow the control fuse. A unit with an open coil will not allow the generator set to start.

There are no adjustments to the solenoid. A unit that does not function properly, or has a deteriorated boot over the plunger, should be replaced.

GOVERNOR

General

The governor maintains engine speed under changing load conditions so that the generator voltage and frequency do not vary. Service to two governors are covered here under respective paragraph headings.

Electronic Governor, Starting Spec C

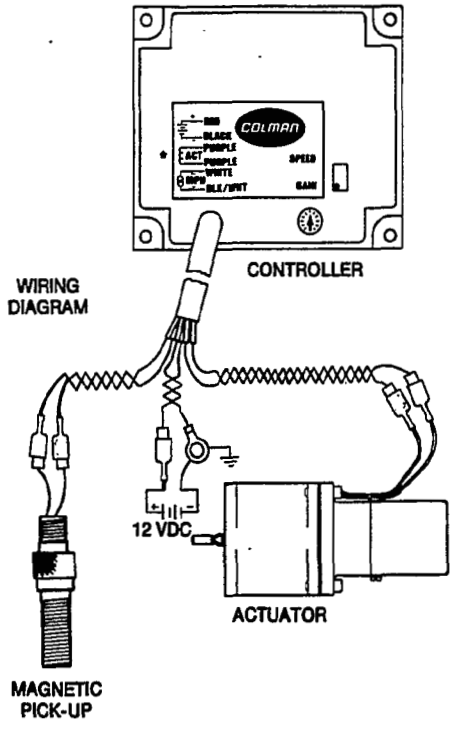
The electronic governor consists of three major components as shown in Figure 6-48. These are the Magnetic Pickup (MPU), Controller, and Actuator. The 12-volt source shown on the drawing is the genset starting battery. The following service information and checkouts are for isolating the cause of a governing system malfunction.

Magnetic Pickup (MPU): The pickup is threaded into the top of the flywheel housing and secured with a lock nut. The flywheel teeth moving past the magnetic face of the MPU generates an AC voltage that is coupled to the Controller. The following checks will establish a functioning unit as follows:

- At cranking speed the voltage should be 2 VAC RMS or more. If not, remove the MPU and clean. It is very important that any magnetic particles be completely removed. Turn the MPU into the flywheel housing until it contacts a flywheel tooth (positioned directly below). Then turn out from tooth 1/2 to 3/4 turn and tighten the locknut.
- The DC resistance of the MPU coil should be 850 ohms ±6%. Resistance from the leads to the case should be infinity.

Actuator: The actuator controls the carburetor throttle valve and maintains constant engine speed at varying loads. It receives input voltage from the Controller which in turn receives input from the Magnetic Pickup. A few operational checks will establish a functioning unit as follows:

- Wipe the actuator shaft if dirty with a clean, dry rag.
- The Actuator and bracket must be mouted securely.
- Check the nylon bearing at the carburetor linkage. If worn, replace.
- Check the wiring for poor connections.
- Measure resistance of the actuator coil with the leads disconnected. Reading should be 1.8 ohms ±10%. Resistance to the case should be infinity.



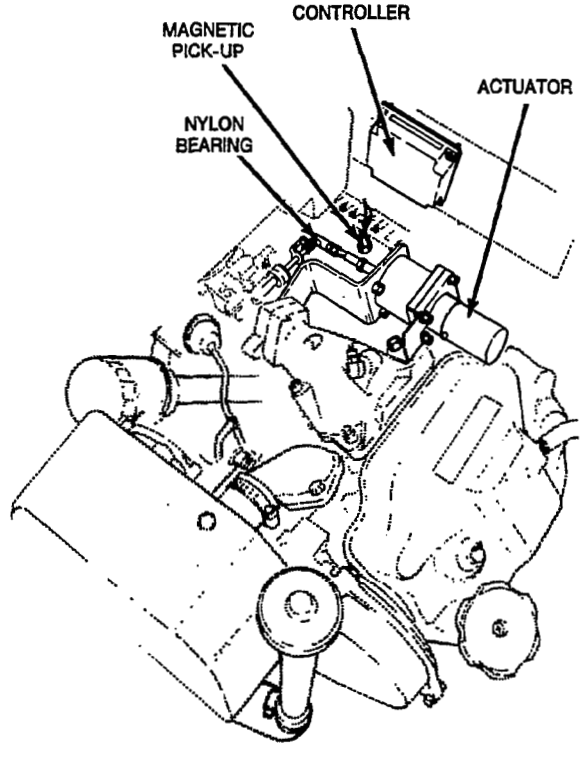


FIGURE 6-48. ELECTRONIC GOVERNOR COMPONENTS

- This test should not be performed below deck where explosive gases can be ignited by a spark (see warning below). Disconnect the Actuator leads and apply 12 VDC from a battery. The Actuator should go full fuel. If not, replace.

⚠WARNING ***The ignition of explosive fuel or fumes can result in severe personal injury or death. Do not permit any flame, spark, cigarette, pilot light, or other ignition source near the generator set compartment.***

Controller: This unit contains the electronics for driving the Actuator. It has two adjustments (Gain and Speed) that are covered in a previous section titled Governor/ Carburetor. Two checks that can be made are a follows:

- Check for battery voltage going into the Controller at the red lead during cranking. If not present, check for wiring problems.

- With all components connected, check output voltage across the actuator leads during cranking. Voltage should be a minimum of 6 VDC. If not present, the Controller may be at fault.

Mechanical Governor, Prior to Spec C

The mechanical governor cannot be serviced beyond changing the oil, checking of the drive belts, and making adjustments covered previously in section titled Governor/Carburetor.

Lubrication: The governor does not require the oil be changed at regular intervals except at engine overhaul. At this time, remove the governor and drain the oil and flush with clean oil. Install 2.75 to 3 ounces (78 to 85 g) of SAE 10W-30 viscosity motor oil. There is no oil level plug on the governor, so it is important to add the correct quantity at this time.

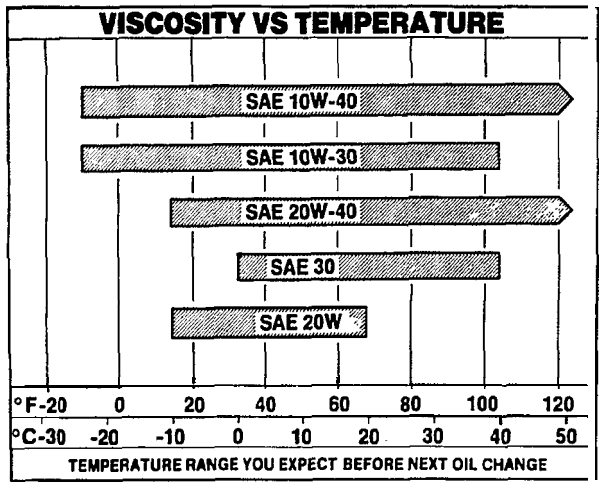
Driving Belt Adjustment: The water pumps are driven by a single belt on the crankshaft drive pulley. A separate belt is used to drive the governor from the water pump. Maintain correct adjustment of these belts to provide proper engine cooling and governor operation. See drive belt adjustment and replacement procedures in the *Cooling System* section.

LUBRICATION SYSTEM

The proper operation and maintenance of the lubrication system is very important for obtaining long engine life and satisfactory performance. The lubricating oil must be multifunctional and perform the primary functions of lubrication, cooling, sealing, cleaning, cushioning, and protection of engine internal components from oxidation or corrosion. Oil contamination is a normal result of engine operation. Lubricating oil must be changed when it no longer can efficiently perform its functions within the engine.

Oil Recommendations

Use oils with the American Petroleum Institute (API) classification SF/CD in viscosities per temperature as shown in the chart below.



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When selecting the oil viscosity, pick the viscosity that is right for the lowest temperature expected. Oil that is too thick may result in a lack of lubrication when the engine is started. Use a lower viscosity oil as the ambient temperature reaches the lower end of the scale.

Do not use synthetic oil or non-detergent oil; and do not mix different brands of oil.

The engine oil system consists of the oil pan, oil screen, oil pump and relief valve, oil filter, oil galley (distribution), oil pressure switches and sender (part of gauge option). This section covers service to components accessible externally on the generator set shown in Figure 6-49. Service to internal components such as the oil pump and relief valve are covered in *Section 9 Engine Block Assembly*. Operation and function of oil pressure switches and sender are in *Section 7 Control*.

Engine Oil Change: Run the engine until thoroughly warm before draining oil. Stop engine, open the drain valve (Figure 6-49) and drain oil into a container. When completely drained, close valve and refill crankcase with oil of the correct API classification and appropriate SAE viscosity.

Oil Filter Change: Spin off oil filter and discard it. Thoroughly clean filter mounting surface (Figure 6-49). Apply a thin film of oil to filter gasket and spin filter on by hand until gasket just touches mounting pad, Then turn an additional 1/2 turn. Do not overtighten.

With oil in crankcase, start engine and check for leaks around filter gasket. Retighten only as much as necessary to eliminate leaks.

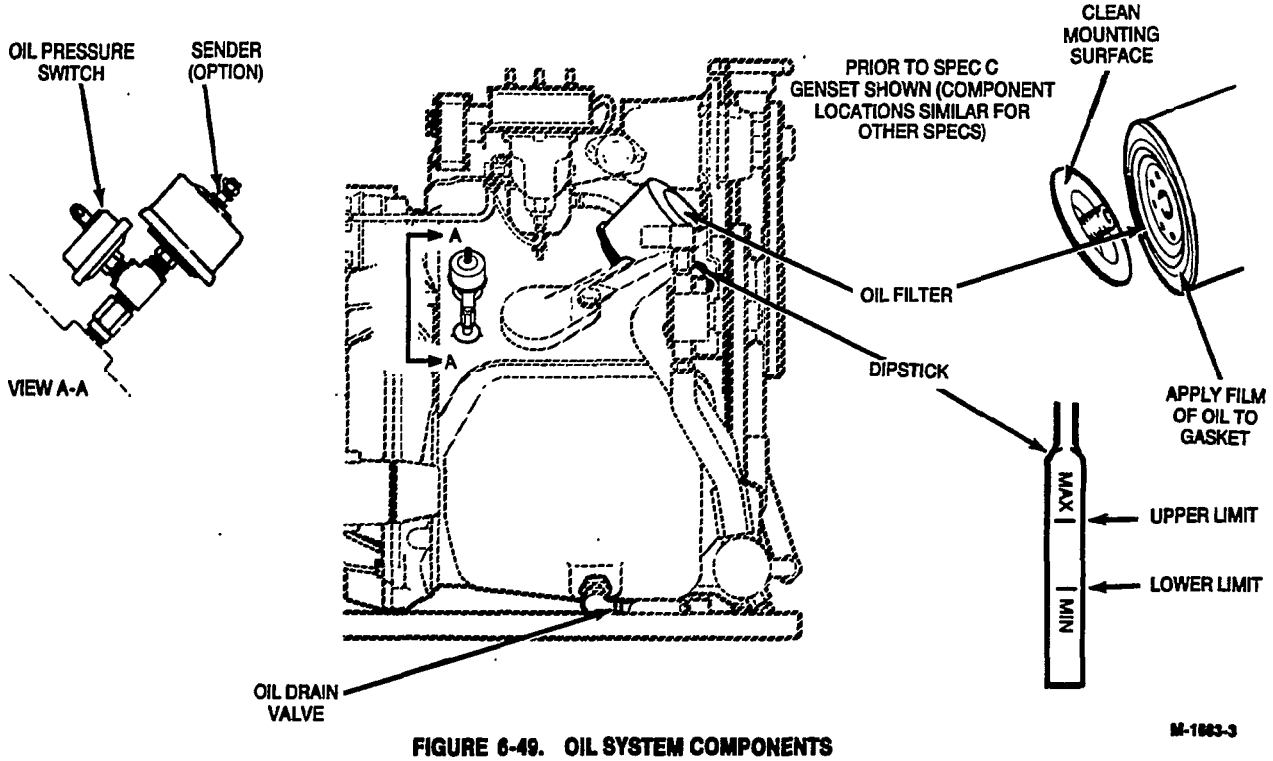

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FIGURE 6-49. OIL SYSTEM COMPONENTS

Section 7. Control

CONTENTS

INTRODUCTION

The DC control 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

Figure 7-1 is a typical control box and panel showing standard components and optional instrumentation. Some components are mounted externally of the control box as shown.

The following sections provide a general description of these components and how they function:

- Engine Monitor Board Assembly (A11)
- Panel Mounted Components
- Start Solenoid (K11)
- Optional Remote Start/Stop Control

Engine Monitor Board Assembly (A11)

The engine monitor board assembly is the center of the engine control system. The board circuitry controls the engine start, starter disconnect, run, stop, and fault system functions. Primary components of the PC board include two non-serviceable relays soldered to the board.

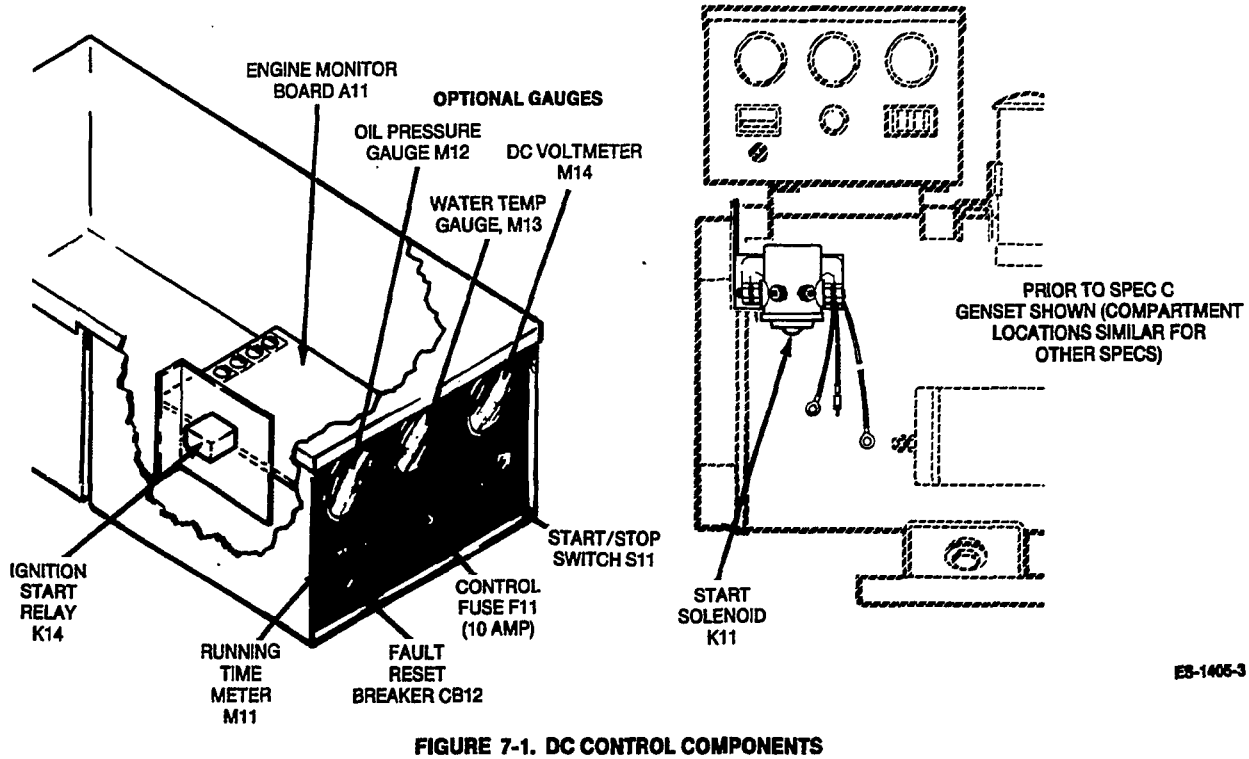


FIGURE 7-1. DC CONTROL COMPONENTS

Power relay A11K12 maintains battery B+ to the fuel pump E5, fuel stop solenoid K1, ignition system (T1 and S4), and optional control meters during operation. Starter protection relay A11K15 operates on the generator AC output. When the start switch is actuated, B+ is connected to the K11 start solenoid through the K15 NC contacts until generator output reaches about 90 VAC. At this voltage, K15 activates and disconnects B+ to the K11 start solenoid coil.

The board assembly is protected by a 10 ampere fuse (F11) so it will not be damaged by a short in the wiring or remote start control. The relays are sealed and filled with dry nitrogen for longer contact life.

Panel Mounted Components

Oil Pressure Gauge (Optional): Shows engine lubricating oil pressure. The gauge dual scale has a range of 0 to 100 psi (0 to 600 kPa). The gauge is connected to the engine oil pressure sensor and switched B+. See Figure 7-1.

Coolant Temperature Gauge (Optional): The water temperature gauge has a scale range of 100°-250°F (40°-120°C). Actual reading depends on the load and ambient temperature, but should be in the range of 180°-203°F (82°-95°C).

DC Voltmeter (Optional): Normal battery B+ voltage during operation should be 13 to 15 VDC depending upon the battery state-of-charge. The charge rate is fixed by the charge resistor R1 located inside the generator end bell.

Start/Stop Switch (S11): This switch is a single pole, double throw, momentary on rocker-type used for starting and stopping the generator set. Pushing the switch in either the Start or Stop position will initiate the appropriate control functions. The switch automatically returns to the center position when released. The switch is mounted on the control panel and is removable for service replacement.

Fuse, Control (F11): This fuse is located in the center of the control panel. It protects the engine monitor board, remote start circuit (if used) and associated wiring. The fuse is rated at 10 amperes. If replacement is required, be sure to use the same rating and type.

Fault Reset (CB12): A manual reset breaker that shuts down the engine for low oil pressure, high coolant temperature, and high exhaust temperature. A fault detected by any of these sensors places a short at terminal 2A of the breaker (see schematic diagram Figure 7-2). A shunt in the breaker causes it to open the B+ circuit to the ignition circuit, fuel pump and fuel stop solenoid to cause shutdown.

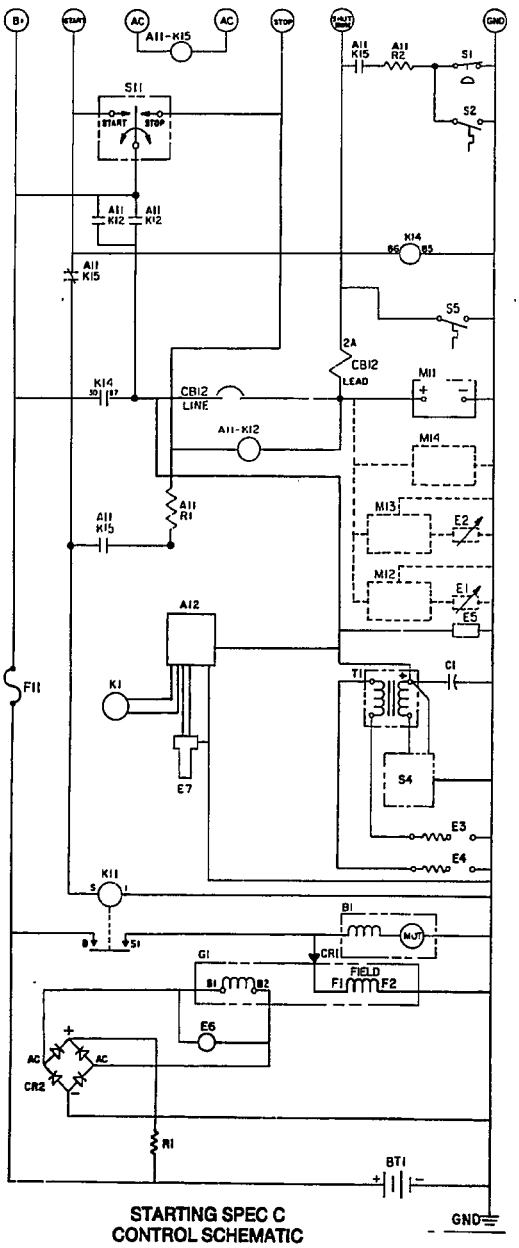
Running Time Meter: Registers the total number of hours that the generator set has run. It is useful to determine when periodic maintenance is required. Time is cumulative and the meter cannot be reset.

Start Solenoid K11

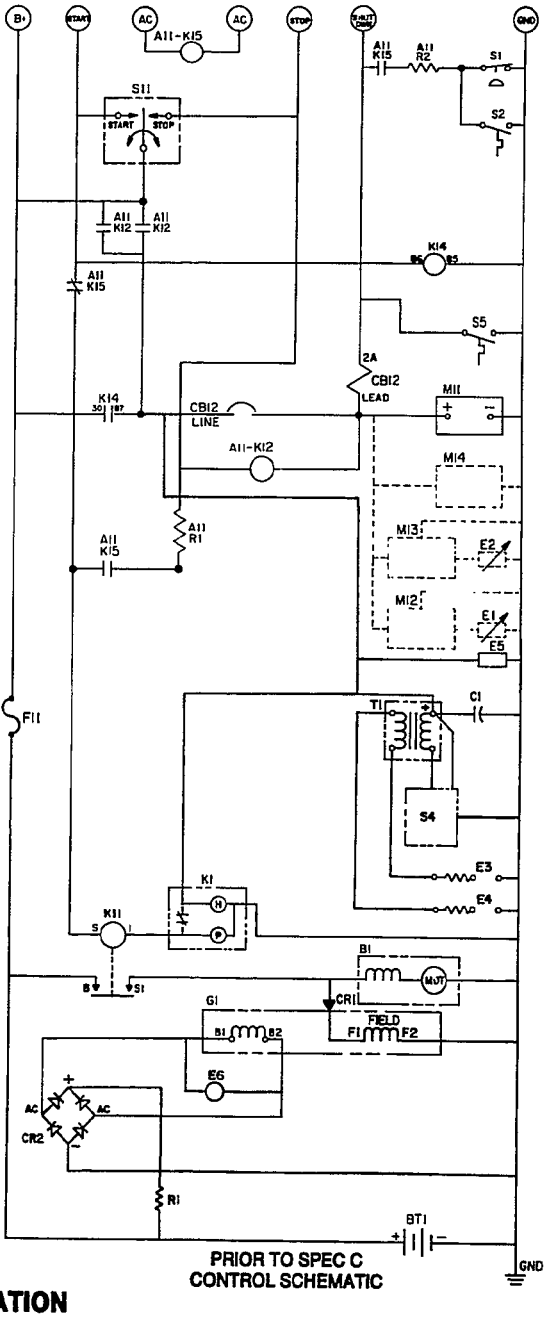
The K11 start solenoid closes and opens the battery B+ circuit to the starter motor and the generator field. It is located on a bracket below the control panel on the service side of the generator set (Figure 7-1). The rotor field winding is flashed during cranking (through CR1) to ensure AC voltage buildup in the generator stator.

Optional Remote 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 battery condition meter. Remote control panels are usually mounted on the instrument console.



STARTING SPEC C
CONTROL SCHEMATIC



PRIOR TO SPEC C
CONTROL SCHEMATIC

COMPONENT IDENTIFICATION

A11	PCB Assy, Engine Monitor
A11-K12	Relay, Power
A11-K15	Relay, Starter Disconnect
A11-R1	Resistor (K12)
A11-R2	Resistor (LOP, HET Timing)
A12	Controller, Gov. Start Spec C
B1	Starter and Solenoid
BT1	Battery
C1	Condenser
CB12	Circuit Breaker
CR2	Bridge Rectifier
E1	Sender, Oil Pressure
E2	Sender, Coolant Temp
E3, E4	Spark Plug
E5	Fuel Pump, Electric
E6	Choke
E7	Pickup, Mag, Start Spec C

F11	Fuse, 10 Amp
K1	Actuator, Start Spec C Fuel Stop Sol. Prior to Spec C
K11	Start Solenoid
K14	Relay, Ignition Start
M11	Meter, Time Totalizing
M12	Meter, Oil Pressure
M13	Meter, Coolant Temp
M14	Meter, Volt
R1	Charge Resistor
S1	Switch, Low Oil Pressure
S2	Switch, High Coolant Temp
S4	Electronic Module
S5	Switch, High Exh. Temp
S11	Switch, Start-Stop
T1	Coil, Ignition

FIGURE 7-2. DC CONTROL SCHEMATIC

CONTROL OPERATION

Service personnel must understand how the control operates; know how to troubleshoot, make the proper adjustments, replacements, or repairs in a reasonable amount of time.

The schematic diagram shown in Figure 7-2 is intended as an example 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 problems.

Text references N.O. (normally open) and N.C. (normally closed) refer to relay contacts with the unit at rest (not energized).

Starting

Holding the Start/Stop switch S11 in the Start position connects battery B+ (through A11K15 N.C. contacts) to K14 ignition start relay and to K11 start solenoid. Connecting B+ as described produces the following responses:

Starting Spec C: K14 contacts close and connect B+ during starting to fault circuit breaker CB12, ignition coil T1, fuel pump E5, and governor controller A12.

Energizing the coil of start relay K11 closes the contacts which connect battery B+ to the starter motor B1 and diode CR1. During cranking the generator field is flashed (through CR1) to ensure generator voltage buildup.

Prior to Spec C: K14 contacts close and connect B+ to fault circuit breaker CB12, ignition coil T1, fuel pump E5, and fuel shut-off solenoid K1.

Battery B+ applied to the "H" (hold) and "P" (pull-in) coils of K1 causes its plunger to retract. At the bottom of the plunger stroke the N.C. contacts are opened, disconnecting the "P" coil from B+. The N.C. contacts allow start solenoid K11 to energize by providing a ground path through the K1 "P" coil.

Relay K11 connects battery B+ to the starter motor B1 and flashes the generator field through diode CR1 to ensure voltage buildup.

Starter Lockout-Run

As the generator gains speed and output voltage, relay A11-K15 energizes at about 90 VAC. The N.C. contact opens and de-energizes the K11 start solenoid. One N.O. contact closes and connects S1 and S2 sensors into the fault circuit. Resistor A11R12 provides a time delay to compensate for momentary closing of S1 and S2. This time delay allows oil pressure to open S1, and circulating coolant to open S2 (if closed) before being connected into the fault circuit.

The oil pressure latch switch S6 (used on early production generator sets) provides a secondary ground path for the A11K12 power relay. Since this function was already provided by A11-K15, S6 was deleted.

Stopping Sequence

Placing the Start/Stop switch S11 in the Stop position puts B+ on the ground side of A11-K12 power relay coil. A11 de-energizes and disconnects B+ from CB12, fuel pump E5, ignition coil T1, and governor controller A12 (starting Spec C), or fuel stop solenoid K1 (prior to Spec C), to stop the engine.

Fault Shutdown

Fault breaker CB12 opens to stop the engine anytime a fault sensor closes the ciruit to ground. The fault sensors as referenced in Figure 7-1 are:

- S1 low oil pressure
- S2 high coolant temperature
- S5 high exhaust temperature

CB12 should not be reset for starting until the fault is located and corrected.

CONTROL TROUBLESHOOTING

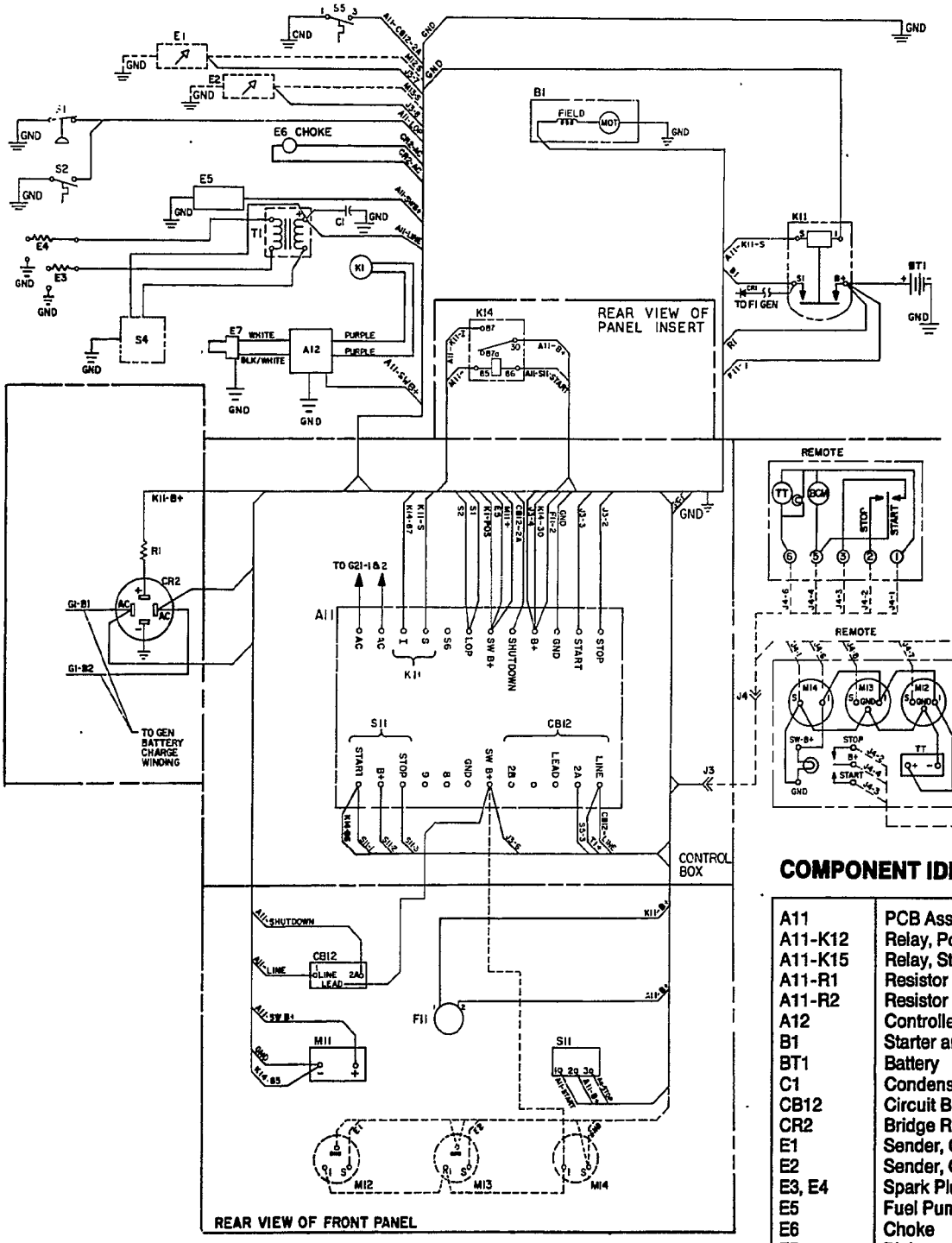
Use the following troubleshooting guide to help locate problems related to the control. Figure 7-1 shows the location of most control components. Refer to the control wiring diagram in Figure 7-3 and 7-4 for location of terminal connections.

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

TROUBLESHOOTING GUIDE

⚠WARNING ***Many troubleshooting procedures present hazards which can result in 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.***

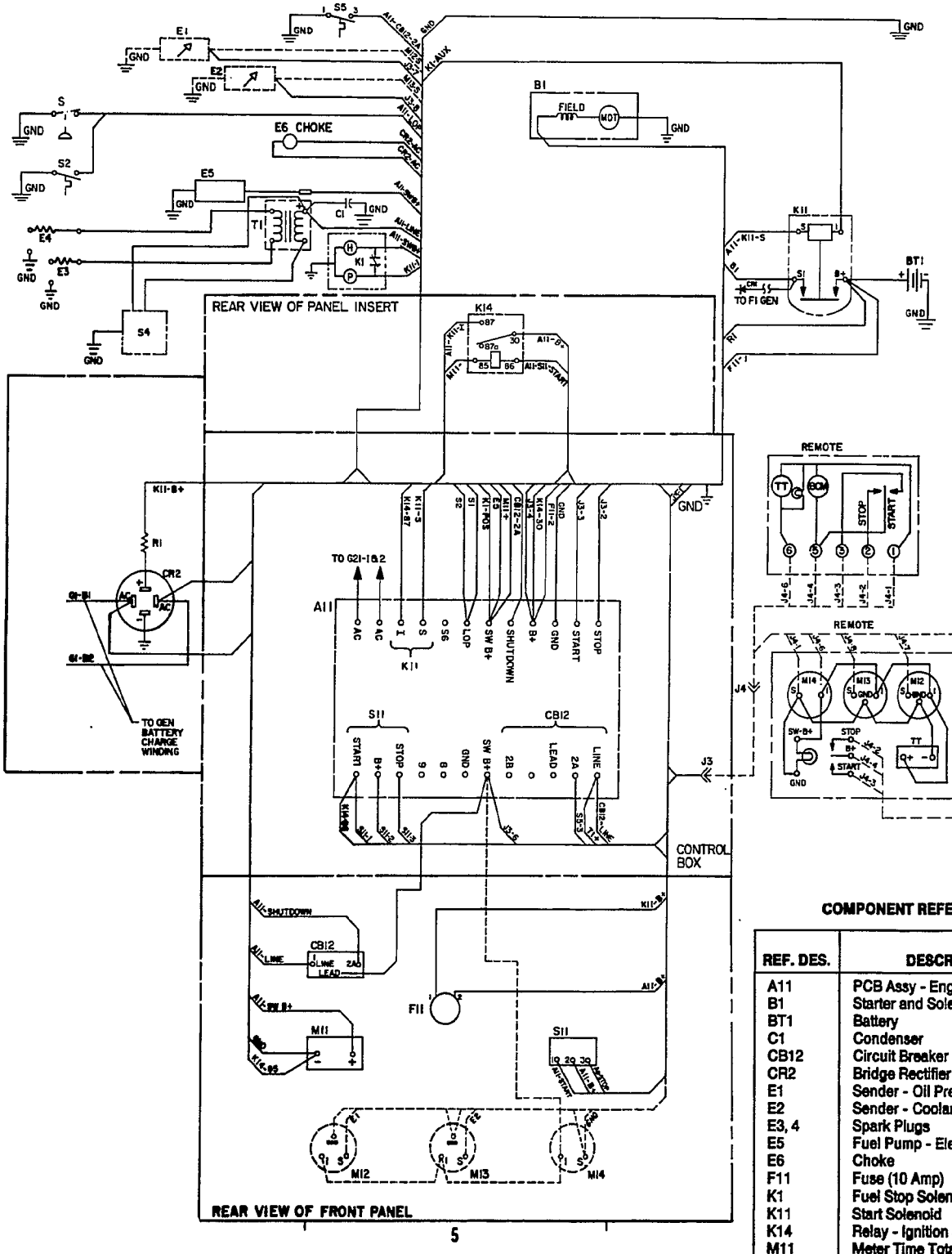
Trouble	Possible Cause	Corrective Action
Engine Does Not Crank	1. Control fuse F11 open.	1. Replace fuse (10 ampere)
	2. Insufficient voltage for cranking due to:	
	A. Terminal connection loose or corroded.	2A. Clean and tighten connections at battery, K11 start solenoid, and the starter motor.
	B. Battery dead or not charged	2B. Check condition of battery and recharge or replace.
	3. If engine cranks at set but not at the remote control panel, cause may be:	
	A. Open circuit in remote control.	3A. Check for continuity and correct if circuit is open.
	B. Fault with remote start switch.	3B. Replace remote start switch.
	4. If engine cranks at remote control panel but not at set, cause may be:	
	A. Open circuit in wiring between S11 switch and engine monitor board A11.	4A. Check for continuity and correct if circuit is open.
	B. Fault in S11 switch.	4B. Replace S11 switch.
	5. Connect a voltmeter between terminal S on the start solenoid and ground. Check for battery voltage with S11 in Start position. if present, fault may be:	
	A. Defective K11 solenoid.	5A. Replace K11 start solenoid.
	B. Defective starter B1.	5B. Refer to Starter Motor in *Section 6* for test and service procedures.
	C. K1 solenoid does not pull in and open its N.C. contact (prior to Spec C only).	5C. Replace K1 fuel shut-off. solenoid (prior to Spec C only).



COMPONENT IDENTIFICATION

A11	PCB Assy, Engine Monitor
A11-K12	Relay, Power
A11-K15	Relay, Starter Disconnect
A11-R1	Resistor (K12)
A11-R2	Resistor (LOP, HET Timing)
A12	Controller, Gov. Start Spec C
B1	Starter and Solenoid
BT1	Battery
C1	Condenser
CB12	Circuit Breaker
CR2	Bridge Rectifier
E1	Sender, Oil Pressure
E2	Sender, Coolant Temp
E3, E4	Spark Plugs
E5	Fuel Pump, Electric
E6	Choke
E7	Pick-up, Magnetic
F11	Fuse, 10 Amp
K1	Actuator, Governor
K11	Start Solenoid
K14	Relay, Ignition Start
M11	Meter, Time Totalizing
M12	Meter, Oil Pressure
M13	Meter, Coolant Temp
M14	Meter, Volt
R1	Charge Resistor
S1	Switch, Low Oil Pressure
S2	Switch, High Coolant Temp
S4	Electronic Module
S5	Switch, High EXH Temp
S11	Switch, Start-Stop
T1	Coil, Ignition

FIGURE 7-3. DC CONTROL WIRING DIAGRAM, STARTING SPEC C



COMPONENT REFERENCE

REF. DES.	DESCRIPTION
A11	PCB Assy - Engine Monitor
B1	Starter and Solenoid
BT1	Battery
C1	Condenser
CB12	Circuit Breaker (Fault)
CR2	Bridge Rectifier
E1	Sender - Oil Pressure
E2	Sender - Coolant Temp
E3, 4	Spark Plugs
E5	Fuel Pump - Electric
E6	Choke
F11	Fuse (10 Amp)
K1	Fuel Stop Solenoid
K11	Start Solenoid
K14	Relay - Ignition Start
M11	Meter Time Totalizing, 4-40V
M12	Gauge - Oil Pressure
M13	Gauge - Coolant Temp
M14	Voltmeter
R1	Charge Resistor
S1	Switch - Low Oil Pressure
S2	Switch - High Coolant Temp
S4	Electronic Module
S5	Switch - High Exhaust Temp
S11	Switch - Start, Stop
T1	Coil, Ignition

FIGURE 7-4. DC CONTROL WIRING DIAGRAM, PRIOR TO SPEC C

⚠WARNING ***Many troubleshooting procedures present hazards which can result in 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	6. If voltage is not present as described in step 5, cause may be: A. Open circuit between K11 solenoid and engine monitor PC board A11. B. Defective PC board A11.	6A. Check for continuity and correct if circuit is open. 6B. Replace PC board A11.
Engine Cranks But Does Not Start	1. Faulty ignition due to defective spark plugs, plug wires, coil, electronic module, or incorrect ignition timing. 2. Faulty fuel system due to sticking choke, faulty fuel pump, plugged filter, or carburetor misadjusted. 3. Connect a voltmeter between positive (+) terminal on coil and ground. Check for battery voltage with S11 in the Start position. If voltage is not present, fault may be: A. Open circuit between coil and control. B. Defective PC board A11. 4. Defective K14 ignition start relay (starting Spec C only).	1. Refer to Ignition System section for test and service procedures. 2. Refer to Fuel System section for test and service procedures. 3A. Check for continuity and correct if circuit is open. 3B. Replace PC board A11. 4. Replace relay K14.
Engine Starts But Stops When Start Switch is Released	1. Fault breaker CB12 not completing circuit due to: A. Defective breaker. B. Fault condition. C. Defective sensor. D. Open circuit. E. Defective A11-K12 relay.	1A. Check continuity through breaker and replace if defective. 1B. Check oil level coolant level, and sea water cooling system. See applicable section in Primary Systems. 1C. Check sensors per Primary Systems checkout procedures. 1D. Check wiring for open or loose connections. 1E. Replace PC board A11.

⚠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 But Stops When Start Switch is Released (Continued)	2. AC voltage (min 90 VAC) from generator leads 1 and 2 not being supplied to AC terminals of PC board A11 due to: A. Defective flash diode CR1 B. Defective generator rotor or stator. 3. If voltage is present as specified in step 2, cause may be monitor board A11.	2A. Test diode CR1 for open 2A. condition and replace if defective 2B. Refer to *Section 8 - Generator* for testing and service. 3. Replace monitor board A11.
Low Battery, Generator Set Does Not Recharge	1. Weak or discharged battery. 2. Load connected to battery while set is turned off. 3. Generator set not run long enough for built-in charger to recharge battery. 4. Defective CR2 bridge rectifier. 5. Defective stator winding (B1-B2).	1. Connect a separate battery charger to bring battery up to full charge. If battery will not take charge, replace it. 2. Turn off load. 3. Supplement charging with a battery charger when boat is at dockside. 4. Test CR2 bridge and replace if defective. 5. Refer to *Section 8 - Generator* for testing and service
Engine overspeeds, or speed is erratic.	1. Defective or loose belts (prior to Spec C). 2. Defective component in electronic governing system (starting Spec C).	1. Replace defective belts or adjust tension. 2. See Governor service procedures in *Section 6.*

Section 8. Generator

CONTENTS

INTRODUCTION

The generator is a 4-pole, revolving field type using two slip rings for field excitation. AC load connections are made at the generator control box and connect to a circuit breaker and common ground. The 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 items:

- Stator and Housing Assembly
- Rotor and End Bell Assembly
- Voltage Regulating Components

Stator and Housing

During generator set operation, AC current is produced in the stator windings. Two AC power output windings (T1-T2 and T3-T4) are reconnectible to satisfy voltage requirements of the load. Six smaller leads (tapped from the AC power output windings) provide the following basic functions.

- B1, B2: Battery Charging
- T21-X, CR21-AC: AC Regulation
- 1, 2: Starter Disconnect Protection

The stator mounts inside the generator housing and is held in position with four clamps and four capscrews. A series of air-intake openings in the end of the housing allow air to be drawn inside the housing for generator cooling. The housing also provides a mounting for the control box, fuel pump, ignition coil, start solenoid and DC charging resistor. The complete stator/housing assembly bolts to the engine-to-generator adapter with four long stud bolts.

Rotor and End Bell Assembly

The 4-pole rotor provides the rotating magnetic field that is required for generating AC voltage in the stator windings. The DC current required for field excitation is coupled by two brushes riding on two slip rings on the rotor shaft.

The rotor shaft is connected directly to the engine crankshaft using a tapered seat/shaft coupling and through-bolt. The outer end of the rotor is supported by a single bearing pressed onto the rotor shaft. The bearing fits inside the generator end bell casting.

Airflow for generator cooling is provided by a centrifugal fan that mounts on the inner end of the rotor shaft. The fan is also part of the starter ring gear.

Voltage Regulation Components

The voltage regulation circuit helps to provide stable generator output voltage under varying load conditions. It consists of the following items.

Voltage Regulating Transformer: This transformer is located inside the control box. It is constructed with two primary windings and a single, tapped secondary winding. Each primary winding (H1-H2 and H3-H4) is connected in series with one of the generator AC output windings. The transformer secondary winding is connected in series with the field circuit. Taps on the secondary allow for field current/output voltage adjustments.

Field Current Rectifier (CR21): This full wave bridge rectifier is used to rectify a portion of the generator AC output voltage for field excitation. The positive and negative terminals of the rectifier are connected to the rotor slip rings. The rectifier is located inside the AC control box.

GENERATOR OPERATION

Generator operation involves the stator, rotor, brushes, voltage regulating transformer, and full wave bridge rectifier. The schematic shown in Figure 8-1 is intended to help follow generator operation. Always refer to the specific schematic that corresponds to the model spec number of the generator set when troubleshooting problems.

The rotor is connected to the battery during cranking to ensure magnetism for voltage build-up. As the engine starts and speed increases, the rotating field induces an AC voltage in the stator windings. A portion of the AC in the stator windings is rectified to DC by the bridge rectifier (CR21). The DC current is supplied to the rotor field winding by the slip rings to create the rotating magnetic field. The AC voltage build-up stabilizes at approximately 128 volts when the engine reaches governed speed.

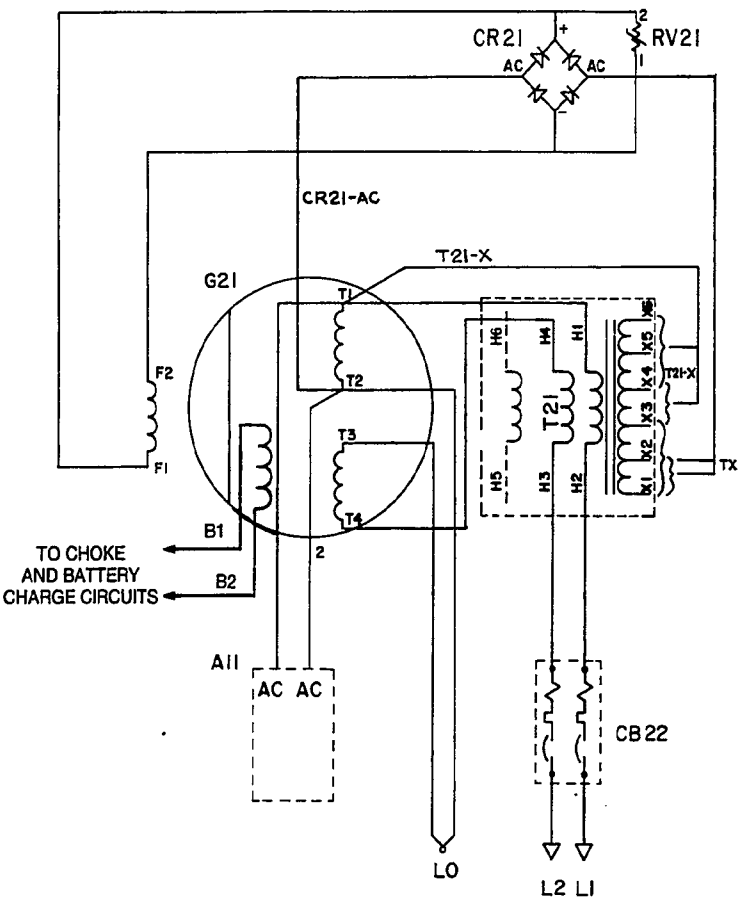
To prevent an excessive voltage drop when a load is applied to the generator, a method for regulating the AC output voltage is required. The voltage regulating transformer allows the generator to provide a stable AC output voltage under varying load conditions. Each transformer primary winding (H1-H2 and H3-H4) is connected in series with one of the stator AC output windings. The full AC output current produced by the generator flows through these two primary windings. Increasing or decreasing the current output from the transformer winding produces a corresponding increase or decrease in the current produced in the secondary winding. The secondary winding is connected in series with the circuit that supplies AC current for rectification to DC field current.

During operation, adding load increases the current flow through the transformer primary windings which causes a corresponding increase in the current output from the transformer secondary winding. This boosts the DC field current to a higher level to offset the voltage drop that would normally occur when a load is applied. In the same manner, decreasing the load reduces the DC field current to offset the voltage rise that would normally occur when a load is removed. Continuously adjusting the field current as the load changes is how voltage regulation is achieved.

GENERATOR TROUBLESHOOTING

Use the following troubleshooting guide to help locate problems related to the generator. Figure 8-3 shows the location of most generator components. Refer to the wiring diagram in Figure 8-2 for the location of all terminal connections. The troubleshooting guide is divided into four sections. After identifying the problem, refer to the guide for the possible cause and the recommended corrective action.

AC SCHEMATIC
SINGLE PHASE TRANSFORMER REG



NOTES:

To adjust output voltage, move taps on T21 according to the table.

1. In all voltage connections, leave T1 and T4 connected to H1 and H4 respectively.
2. For 60 hertz, use TX lead on taps X1-2 (4 taps). Use S1 lead (from generator) on taps X3-4.
3. Unless otherwise noted, all components are shown in the de-energized position.
4. Dashed lines indicate when used.

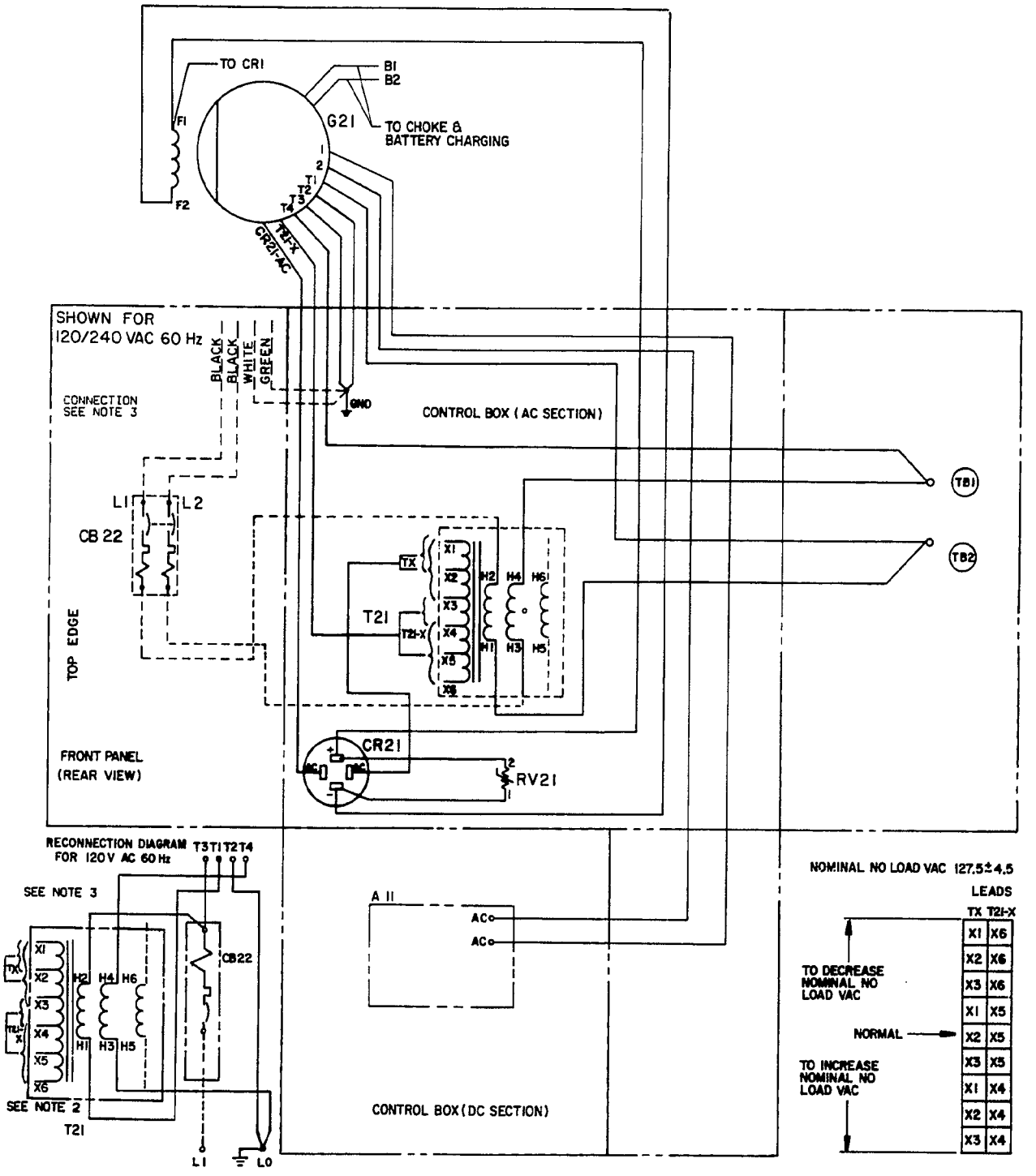
NOMINAL NO LOAD VAC · 127.5 ± 4.5

	LEADS TX	T21-X
TO DECREASE NOMINAL NO LOAD VAC	X1	X6
	X2	X6
	X3	X6
	X1	X5
NORMAL →	X2	X5
	X3	X5
TO INCREASE NOMINAL NO LOAD VAC	X1	X4
	X2	X4
	X3	X4

COMPONENT REFERENCE

REF. DES.	DESCRIPTION
A11	PCB ASSY. - ENGINE MONITOR
CB22	CIRCUIT BREAKER (LOAD)
CR21	BRIDGE RECTIFIER
G21	GENERATOR, AC
RV21	SUPPRESSOR ASSY.
T21	TRANSFORMER, VOLTAGE REG.

FIGURE 8-1. TYPICAL SCHEMATIC



COMPONENT REFERENCE

REF. DES.	DESCRIPTION
A11	PCB ASSY. - ENGINE MONITOR
CB22	CIRCUIT BREAKER (LOAD)
CR21	BRIDGE RECTIFIER
G21	GENERATOR, AC
TB1,2	STANDOFF INSULATOR
RV21	SUPPRESSOR ASSY.
T21	TRANSFORMER, VOLTAGE REG.

NOTES:

1. TO ADJUST OUTPUT VOLTAGE, MOVE TAPS ON T21 ACCORDING TO TABLES.
2. IN ALL VOLTAGE CONNECTIONS LEAVE T1 AND T4 CONNECTED TO H1 AND H4 RESPECTIVELY.
3. FOR 60Hz: USE TX LEAD ON TAPS X1-2 (4 TAPS) USE T2I-X (FROM GEN) LEAD ON TAPS X3-4
4. UNLESS OTHERWISE NOTED, ALL COMPONENTS ARE SHOWN IN THE DE-ENERGIZED POSITION
5. DASHED LINES INDICATE WHEN USED

FIGURE 8-2. TYPICAL WIRING DIAGRAM

TROUBLESHOOTING GUIDE

⚠WARNING ***Many troubleshooting procedures present hazards which can result in 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. 2. Open circuit between brush block and CR21 rectifier. 3. Brushes stuck in holder or not making good contact with slip rings. 4. Defective CR21 bridge rectifier 5. Open, grounded, or short circuit in rotor, stator, or transformer.	1. Locate cause of overload and correct as required. Reset breaker. 2. Check for continuity and correct if circuit is open. 3. Release brushes if jammed in holder. Clean slip rings if dirty. 4. Test rectifier and replace if defective. 5. Test each component for open, grounded, or shorted windings and replace if defective.
AC Output Voltage Too Low Or Too High	1. Engine governor incorrectly adjusted. *2. Open diode in CR21 bridge rectifier. *3. Brushes worn or not making good contact with slip rings. 4. If generator frequency is within specified limits but voltage is incorrect, transformer is incorrectly connected or defective. *5. Open, grounded, or short circuit in rotor, stator, or transformer.	1. Refer to Governor section. 2. Test CR21 rectifier and replace if defective. 3. Check length of brushes and replace if worn excessively. Clean slip rings. 4. Adjust tap connections on transformer secondary windings windings to obtain correct voltage. Replace transformer if voltage cannot be corrected with adjustments. 5. Test each component for open, grounded, or shorted windings and replace if defective.
Noisy Generator	1. Loose brush holder. 2. Worn generator end bearing. 3. Rotor and stator rubbing together due to: a) varnish lumps, or 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.

*Causes low AC output voltage.

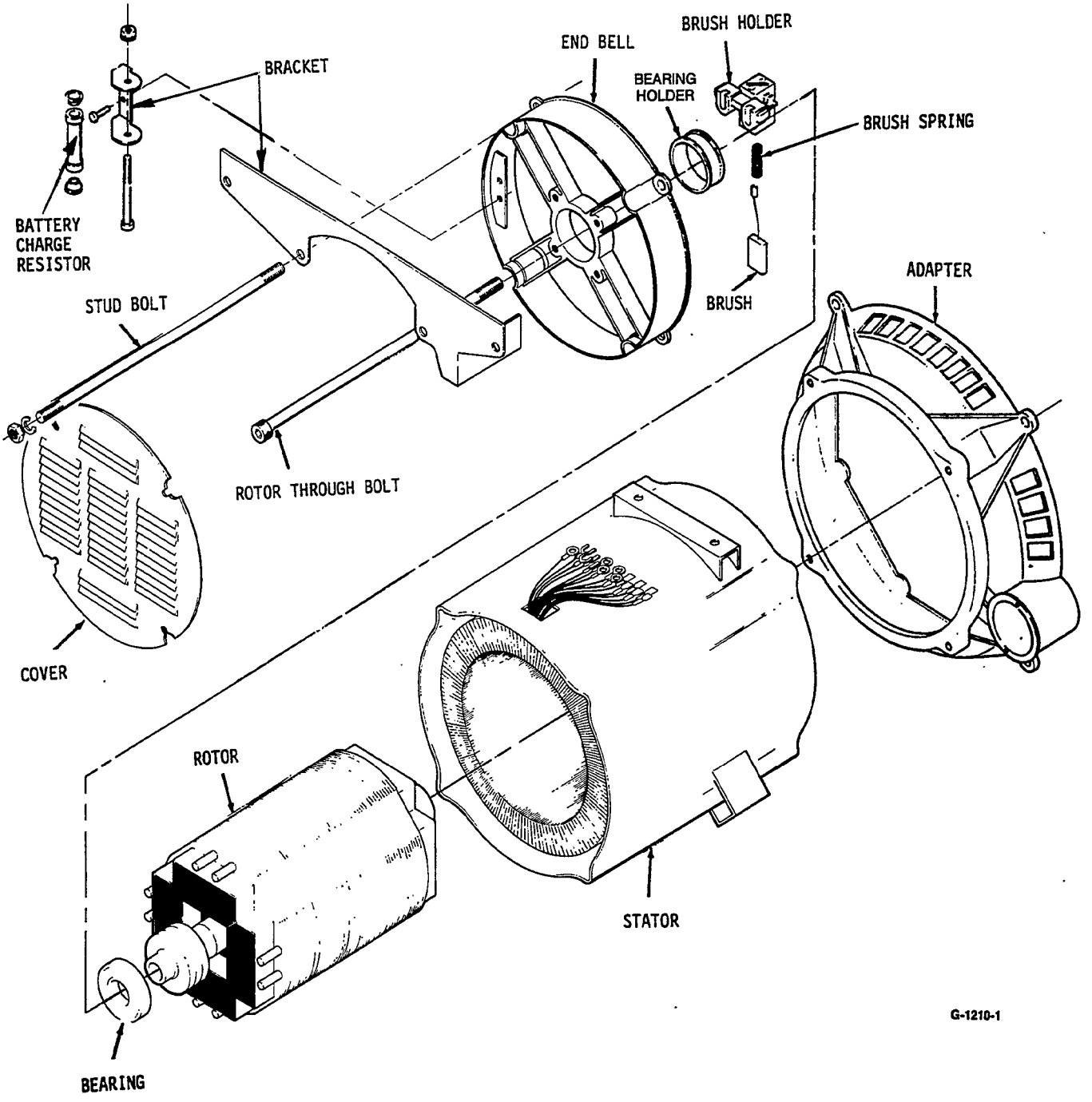


FIGURE 8-3. GENERATOR COMPONENTS

⚠WARNING ***Many troubleshooting procedures present hazards which can result in 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
Generator Overheats	1. Generator overloaded due to defective circuit breaker CB22.	1. Replace circuit breaker.
	2. Airflow restricted due to dirt or debris covering vent openings in stator housing.	2. Clear away all dirt or debris as required.
	3. Stator windings covered with oil or dirt.	3. Clean stator windings.
	4. Open, grounded, or short circuit in rotor, stator, or transformer.	4. Test each component for open, grounded, or shorted windings and replace if defective.
	5. Incorrect transformer connection.	5. Refer to Transformer Voltage Adjustments section.

GENERATOR SERVICE

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

Generator Disassembly

Use the following procedures to disassemble the generator.

1. Remove the generator set from the boat and place it on a sturdy work bench. Refer to Set Removal in Section 5 for the recommended removal procedures.
2. Remove the control box cover and disconnect all stator leads (T1-T4, T21X, CR21-AC, B1-B2, and 1-2). Mark leads for location with tape as needed for reassembly.
3. Disconnect control leads at all external components such as choke, coil B+, fuel pump, shut down sensors and meter senders (if used).
4. Disconnect fuel line from carburetor at the fuel pump.
5. Disconnect lead between starter and starter solenoid.
6. Remove end bell cover and disconnect F1 (outer) and F2 (inner) lead wires from the brush holder terminals.
7. Pull each brush away from the commutator rings and insert a piece of stiff wire into the small hole in brush holder. See Figure 8-4.

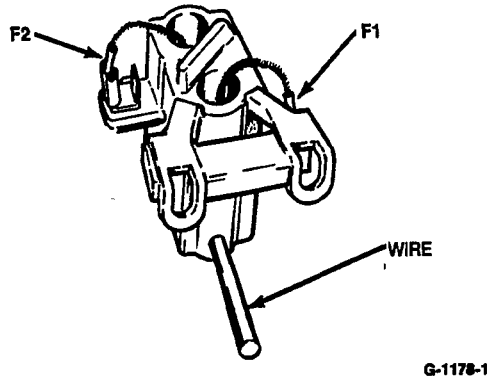


FIGURE 8-4. BRUSH HOLDER ASSEMBLY

8. Remove four nuts and lockwashers from the generator stud bolts. Pry the end bell free of the rotor bearing. Be careful not to damage the brush holder.
9. Place a support block under the generator adapter casting and blocks (or other support) on each side of the engine to prevent it from tipping. When the stator is removed the engine has only one front support mount.

⚠WARNING ***Falling heavy objects can cause severe personal injury or death. Be sure to use good supports to prevent an accident.***

10. Remove two capscrews securing coil and control box brackets to the stator housing. Lift control box free of generator housing using care not to damage leads.
11. Remove a capscrew from each of the stator housing mounts on the drip pan.
12. Use a hoist and safe lifting device (stator handling tongs, nylon lifting strap or chain and lift hooks) to support the stator assembly.
13. Slide the stator assembly back and free of the rotor. Be careful not to damage stator windings. Lay stator down in the horizontal direction.
14. Use a 3/8 inch hex socket wrench and loosen the through bolt at the rear of rotor.
15. Jar rotor free from engine crankshaft by hitting laminations with a lead hammer.
16. Support the rotor with a hoist and lifting straps. Remove through bolt and lift rotor free of the engine.

Generator Reassembly

After necessary service checks and repairs are made, the generator is reassembled using the reverse procedure of disassembly except for the rotor as noted below. Apply required torque values as shown in Figure 8-5.

Rotor Reassembly: Do not apply specified torque values to the rotor through bolt until stator and end bell assemblies are torqued in place. Tighten the rotor through bolt just enough to hold rotor in place while assembling the other components.

⚠CAUTION ***Tightening the rotor through-bolt to specified torque before the stator and end bell assemblies are installed can result in rotor shaft misalignment. Follow recommended installation procedure to avoid possibility of shaft misalignment.***

Brushes and Slip Rings

This section covers brush replacement and slip ring service.

Brush Replacement: Disconnect the negative (-) battery cable at the battery terminal. Remove the end bell cover and inspect the brushes and brush holder for burn marks or other damage. If the brushes appear to be in good condition, use a piece of wire (modified with paint as shown in Figure 8-5) to check for excessive brush wear. Insert the wire through the hole above each brush. Make sure the wire is resting on the brush and not on part of 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 insure that proper tension is maintained. Use the following procedure to replace the brushes.

1. Disconnect the F1 (outboard) and F2 (inboard) lead wires from the brush holder terminals.
2. Remove the brush holder mounting screws and lift out the brush holder.
3. Remove brushes and brush springs from holder and replace with new parts.
4. Pull each brush out from the brush holder and at the same time insert a stiff wire through the small holes in the base of the holder (Figure 8-6). The wire holds the brushes off the slip rings during assembly.
5. Install brush holder in housing but do not tighten mounting screws.
6. Remove the wire that is holding the brushes off the slip rings. Adjust brush holder so that brushes are centered on the slip rings and then tighten the mounting screws.
7. Connect the F1 lead wire to the outboard brush terminal and the F2 lead wire to the inboard brush terminal.
8. Install end bell cover and mounting screws.
9. Connect negative (-) battery cable to the battery terminal.

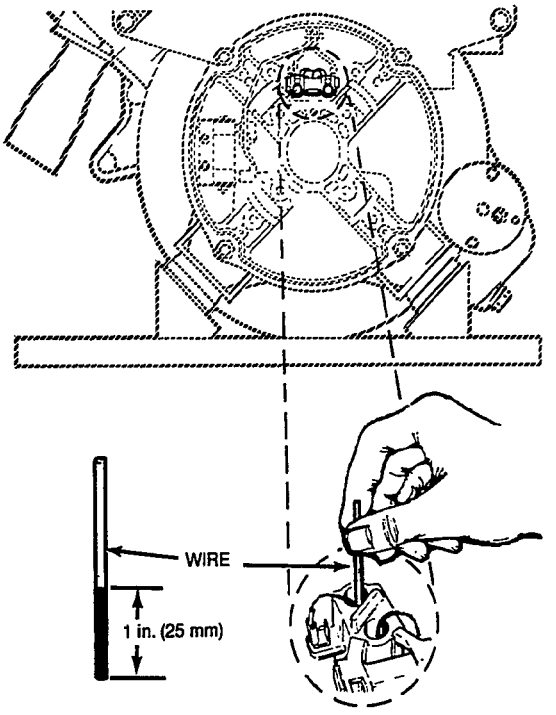


FIGURE 8-5. CHECKING BRUSH WEAR

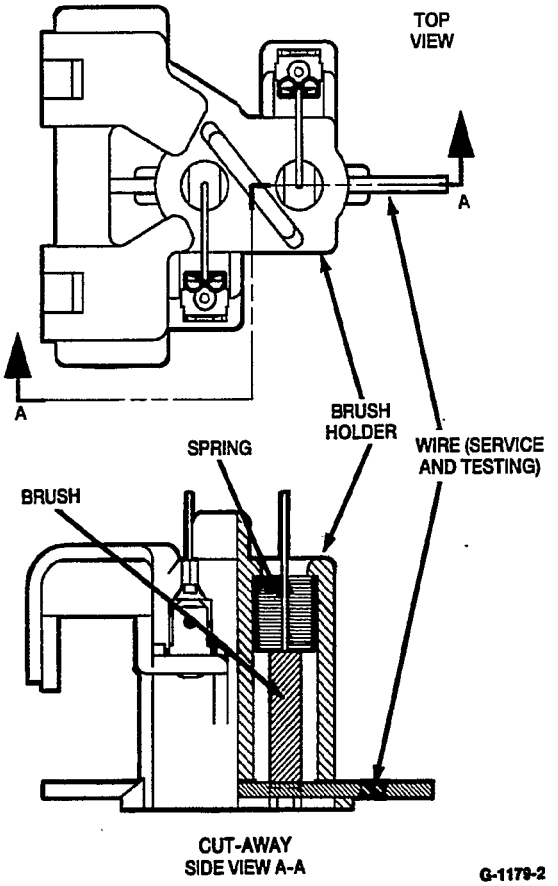


FIGURE 8-6. BRUSH REPLACEMENT

Slip Ring Service: Remove the end bell cover and inspect the slip rings for grooves, pits, or other damage. If the slip rings are not in good condition, they may be refinished using a commutator stone. Use the following procedure to service.

1. Remove negative (-) battery cable at the starting battery.
2. Disconnect the lead wires from the brush holder terminals and then insulate the lead wire terminals. Tie the lead wires to one side to allow clear access to the slip rings.
3. Remove the brush holder mounting screws and lift out the brush block.
4. Reconnect the negative (-) battery cable and start the generator set.
5. Hold a commutator stone (Onan tool #420-0259) against rotating slip rings until carbon is removed and all grooves or roughness is smoothed out.

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

6. Stop the generator set and disconnect the negative (-) cable from the starting battery terminal.
7. Reassemble generator following steps 5 through 9 in the Brush Replacement section.

TRANSFORMER VOLTAGE ADJUSTMENTS

The generator output voltage may be adjusted by changing the connections to the transformer secondary taps. This is necessary if the set voltage falls outside the recommended range when operating at the specified frequency and load. Use the following procedures to adjust.

1. Adjust the governor as specified in Section 6 before making adjustments to the transformer.
2. Check for generator voltage with the warmed-up set operating at no load and 62 hertz. The nominal voltage should be 127.5 volts ± 4.5 volts AC.
3. Stop the set and adjust the transformer tap connections as shown in Figures 8-1 and 8-2 to increase or decrease the voltage as required.
4. Repeat the voltage check and continue to make adjustments until voltage is within range specified.
5. Check the no load and full load frequency as specified in Section 6 for the Governor. Frequency should stay within the limits listed in step 3 of the governor adjustment.

GENERATOR TESTING

This section covers the test procedures for the stator, rotor, regulator transformer, and bridge rectifier. It is preferred that ground tests/insulation tests of the generator rotor, stator and transformer be done with a meggar or insulation resistance meter. These instruments apply 500 VDC or more to the test leads and can detect grounds often missed with an ohmmeter. Be sure to completely isolate each component before applying the test leads. Failure to do so can damage control components.

Use a digital-type ohmmeter that can read to within 0.01 ohms for testing resistance values of windings.

Field Voltage Test

To check the field voltage, connect a DC voltmeter to the brush block terminals. Connect the positive lead to the F1 (outboard) terminal and the negative lead to the F2 (inboard) terminal.

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. Actual readings are dependent on the transformer adjustment. Remove test leads and replace end bell cover when test is complete.

Rotor Test

The following covers testing of the rotor for grounds, open or shorted windings. Figures 8-7 and 8-8 show the rotor removed from the generator for testing. However, it is possible to test the rotor without removing it from the generator. Use a stiff wire to hold the brushes off the slip rings during testing. Refer to the Brushes and Slip Rings section for the procdures to use for inserting the wire.

Ground Test: Use a megger or insulation resistance meter for this test. Touch one prod to the rotor shaft and touch the other test prod to one of the slip rings. A reading less than 100,000 ohms indicates the rotor is questionable. Oven dry the rotor and retest/ Replace a grounded rotor with a new identical part.

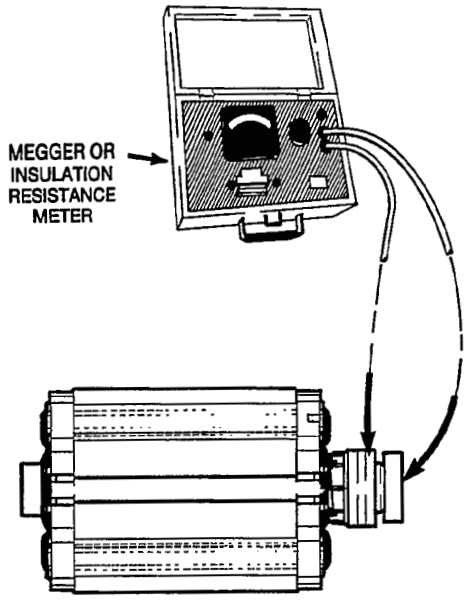


FIGURE 8-7. TESTING ROTOR FOR GROUNDS

Open or Shorted Windings Test: To test for open windings, set the ohmmeter for the low resistance scale. Place test prods on the slip rings as shown in Figure 8-8. At 77°F (25°C) the ohmmeter should read 13.4 ohms ± 10% 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 winding is open or shorted with an identical replacement part.

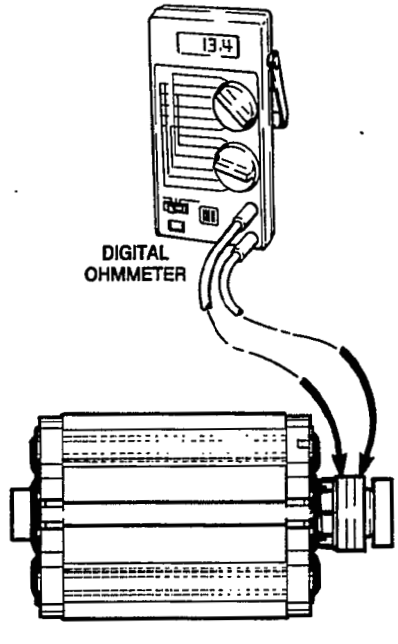


FIGURE 8-8. TESTING ROTOR FOR OPENS OR SHORTS

Stator Test

Figure 8-9 shows the stator removed from the generator for testing. However, it is possible to test the stator without doing so. Remove the control box cover to obtain access to the leads. Be sure the leads are isolated from other wiring to prevent damage to other components during the ground test.

Ground Test: To test for grounds, disconnect the following stator leads. Use an insulation resistance meter or megger for the test.

- Stator lead T1 from T21-H1
- Stator lead T4 from T21-H4
- Stator lead CR21-AC from CR21
- Stator lead T21-X from T21 Secondary
- Stator lead B1 from connector
- Stator lead B2 from connector
- Stator leads 1 & 2 from A11-AC terminals

Isolate or position the lead wire ends so they are not touching the generator set housing. Connect one test prod to the generator housing and touch the other test prod to the lead pairs listed above (see Figure 8-9). A reading less than 100,000 ohms indicates a questionable stator. Oven dry the stator and retest. Replace a grounded stator with a new identical part.

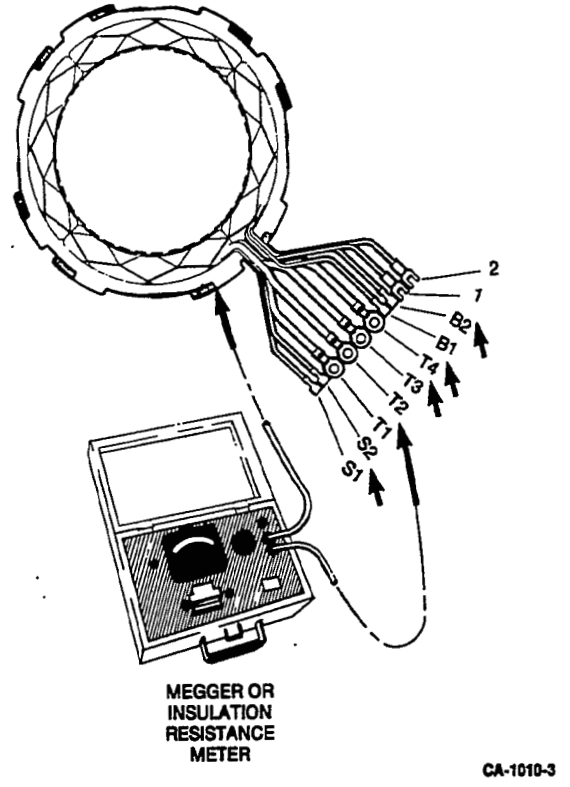


FIGURE 8-9. TESTING STATOR FOR GROUNDS

Open or Shorted Windings Test: To test for opens or shorted windings, disconnect the stator leads as specified in the Ground Test section. Set the digital ohmmeter for the low resistance scale and then connect the test prods to the leads specified in Table 8-1 (see Figure 8-10). The ohmmeter should read as shown. A high resistance indicates an open winding. A low resistance reading indicates a shorted winding. Replace stator if a winding is open or shorted with an identical replacement part.

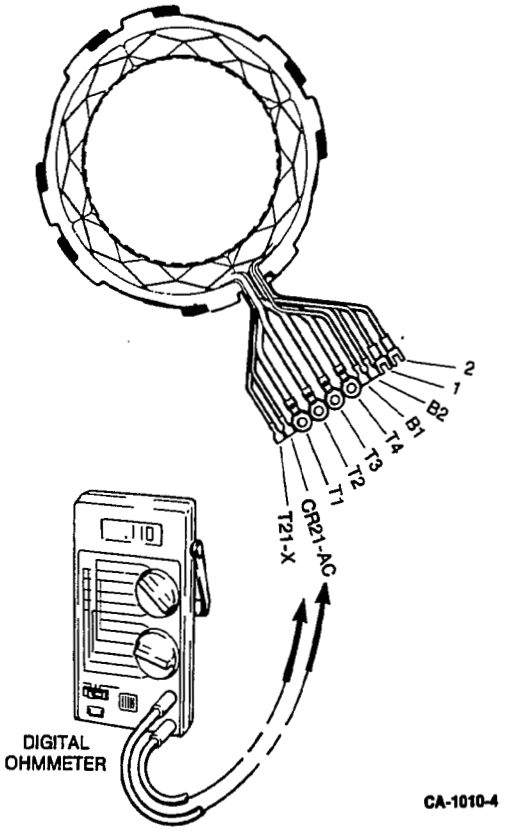


FIGURE 8-10. TESTING STATOR FOR OPENS OR SHORTS

TABLE 8-1. STATOR RESISTANCE VALUES

WINDING	VOLTAGE/FREQ.	OHMS
T1-T2, T3-T4, T21X-CR21AC, 1-2	120/240V, 60 Hz	0.110
B1-B2	110/220V, 50 Hz	0.123
	120/240V, 50 Hz	0.132
	120/240V, 60 Hz	0.033
	110/220V, 50 Hz	0.038
	120/240V, 50 Hz	0.038

Transformer Test

The transformer leads must be isolated for testing as shown in Figure 8-11. Use an insulation resistance meter or megger when testing for grounds, and a digital ohmmeter for the open or shorted winding test.

Ground Test: Connect one test prod to the transformer laminations and the other test prod to each of the primary windings, then to a secondary terminal. A good transformer should measure 100,000 ohms or higher. A low reading indicates a shorted transformer. Replace a grounded transformer with a new identical part.

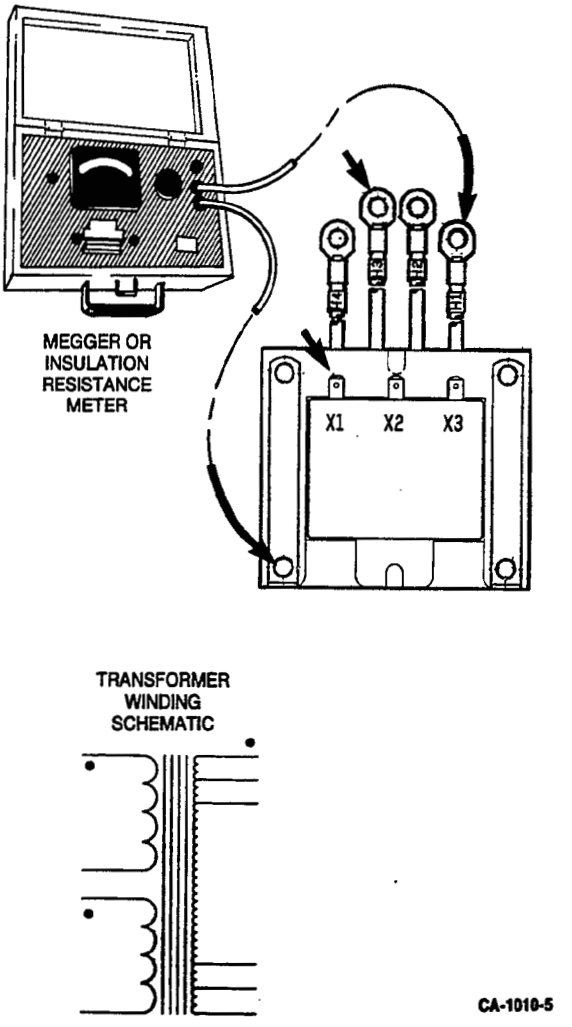


FIGURE 8-11. TESTING TRANSFORMER FOR GROUNDS

Open or Shorted Winding Test: For this test isolate all transformer leads. Set the digital ohmmeter for the low resistance scale and connect test prods to the winding leads and terminals shown in the schematic Figure 8-12. The ohmmeter should read resistance of each winding as listed in Table 8-2. A high resistance reading indicates an open winding. A low resistance reading indicates a shorted winding. Replace an open or shorted transformer with an identical replacement part.

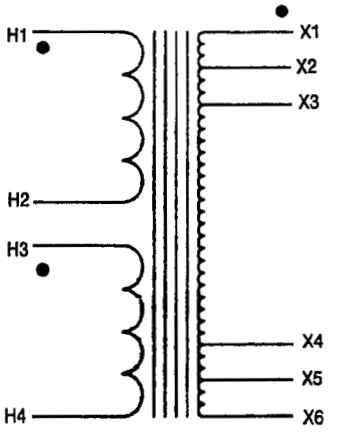


FIGURE 8-12. TESTING TRANSFORMER FOR OPENS OR SHORTS

TABLE 8-2. TRANSFORMER RESISTANCE VALUES

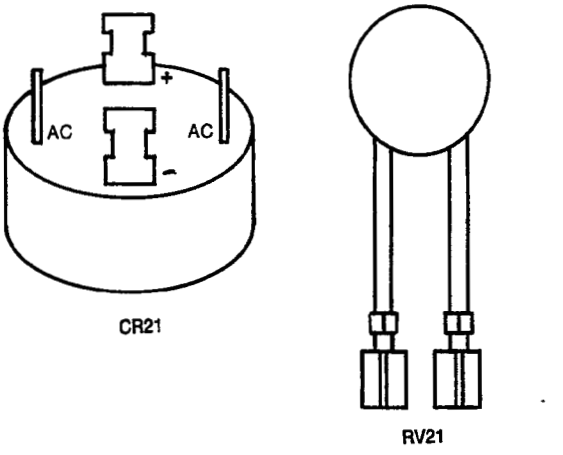
TERMINAL CONNECTION	OHMS RESISTANCE @77°F (25°C)
H1 to H2	0.004 ±20%
H3 to H4	0.004 ±20%
X1 to X6	0.493 ±10%
X1 to X5	0.464 ±10%
X1 to X4	0.436 ±10%
X1 to X3	0.022 ±10%
X1 to X2	0.012 ±10%

Testing Bridge Rectifier CR21 and Suppressor RV21

The rectifier bridge and suppressor are located within the control box. The bridge contains four diodes as shown in Figure 8-13. They are encapsulated within a hermetically sealed block, and failure of any diode means replacement of the entire bridge.

Disconnect wires from the bridge prior to testing. Check forward resistance with an ohmmeter on the R X 1 scale; reverse resistance on the R X 10K scale. Forward resistance should be 6 to 50 ohms, and reverse resistance infinity.

If CR21 is defective, the suppressor RV21 should also be replaced. RV21 should have infinite ohmmeter readings in both directions.



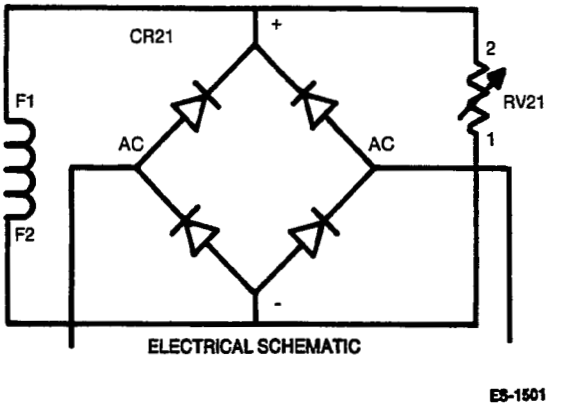


FIGURE 8-13. RECTIFIER BRIDGE, SUPPRESSOR ASSEMBLY

Section 9. Engine - Block Assembly

CONTENTS

GENERAL INFORMATION

The engine block assembly includes the pistons and connecting rods, crankshaft, camshaft, valves and lifters, cylinder head, lubrication system, timing belt, bearings, and cylinder block. Performing any major service on the block assembly will require generator set removal from the boat (see Set Removal, *Section 5 - Preparing to Service*).

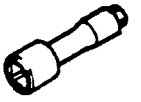
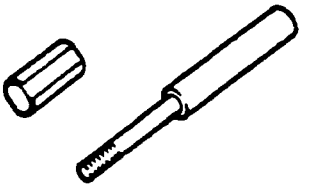
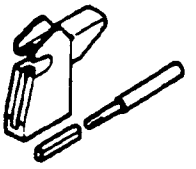
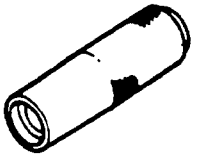
To gain complete access to the block assembly, most primary engine systems must be removed. Refer to the previous sections for the disassembly and removal procedures when necessary.

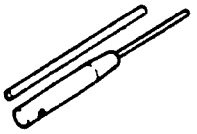
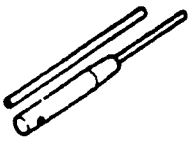
Refer to *Sections 2 - Specifications, Section 3 - Dimensions and Clearances,* and *Section 4 - Torque Specifications.* Engine section component drawings also have torque values on them. All torque values are for hardware with clean threads lightly lubricated.

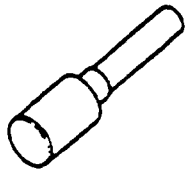
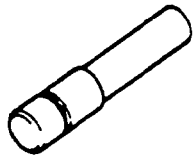
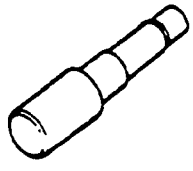
⚠WARNING ***Asbestos has been identified by some state and federal agencies as causing cancer. Engine gaskets containing asbestos should be handled with care. Do not ingest, breathe, or contact dust from gaskets. Use adequate ventilation and wear protective gloves, mask and clothing.***

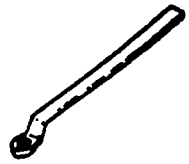
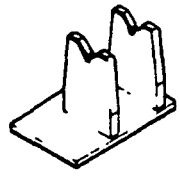
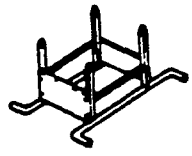
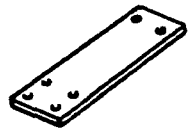
SPECIAL TOOLS

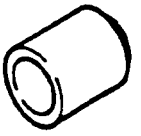
The following tools (or their equivalents) are required to facilitate a complete overhaul of the engine. See the Onan Tool Catalog (900-0019) for part numbers of any needed tools.

NAME	SKETCH	USE
Cylinder head bolt wrench		For removal, installation and retightening of cylinder head bolts
Push rod guide set		For removal and installation of piston pin (to be used with body of piston pin setting tool below).
Piston pin setting tool		For removal and installation of piston pin
Valve guide installer		For removal and installation of valve guide
Valve stem seal installer		For installation of valve stem seal

NAME	SKETCH	USE
Valve seat cutter (45°)		For correcting valve seat
Valve seat cutter (65°)		For correcting valve seat
Valve seat cutter (20°)		For correcting valve seat
Valve seat cutter pilot A		Handle for cutter in special tools
Valve seat cutter pilot B		Handle for commercially available cutter
Rocker arm shaft puller		For removing and installation of rocker arm shaft

NAME	SKETCH	USE
Balancer shaft front bearing installer		For installation of balancer shaft front bearing
Balancer shaft front bearing remover		For removing balancer shaft front bearing
Balancer shaft rear bearing installer		For installation of balancer shaft rear bearing
Balancer shaft rear bearing remover		For removal of balancer shaft rear bearing
Flywheel stopper		For blocking crankshaft when crankshaft pulley and flywheel are removed

NAME	SKETCH	USE
Cranking wrench		For cranking engine when valve clearance and ignition timing are adjusted
Crankshaft checking stand		For supporting crankshaft when taking measurements
Engine stand		For disassembly and assembly of engine
Engine stand side plate		For disassembly and assembly of engine
Camshaft oil seal installer		For installation of camshaft oil seal

NAME	SKETCH	USE
Crankshaft front oil seal installer		For installation of crankshaft front oil seal

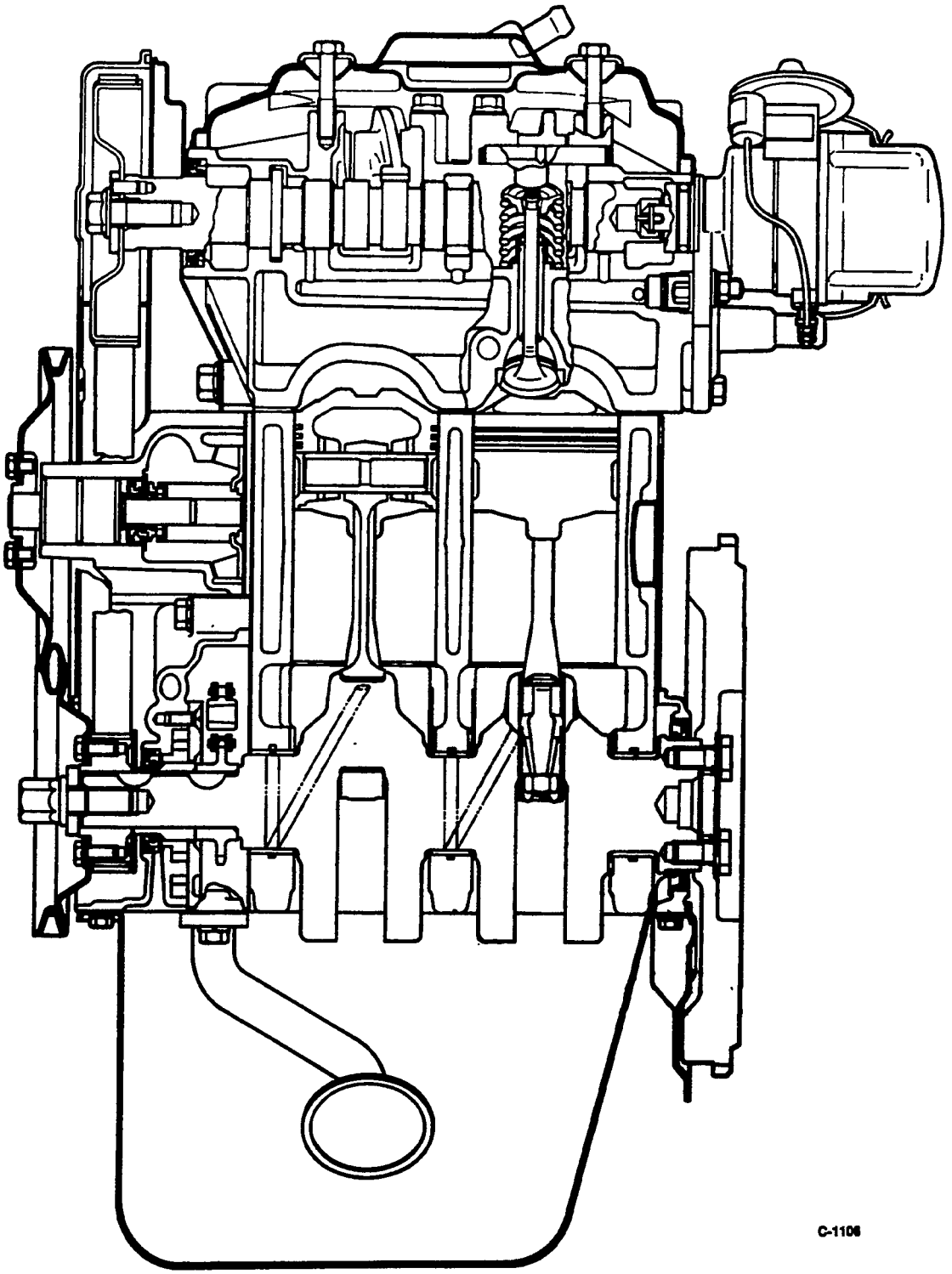


FIGURE 9-1. ENGINE LONGITUDINAL SECTION VIEW

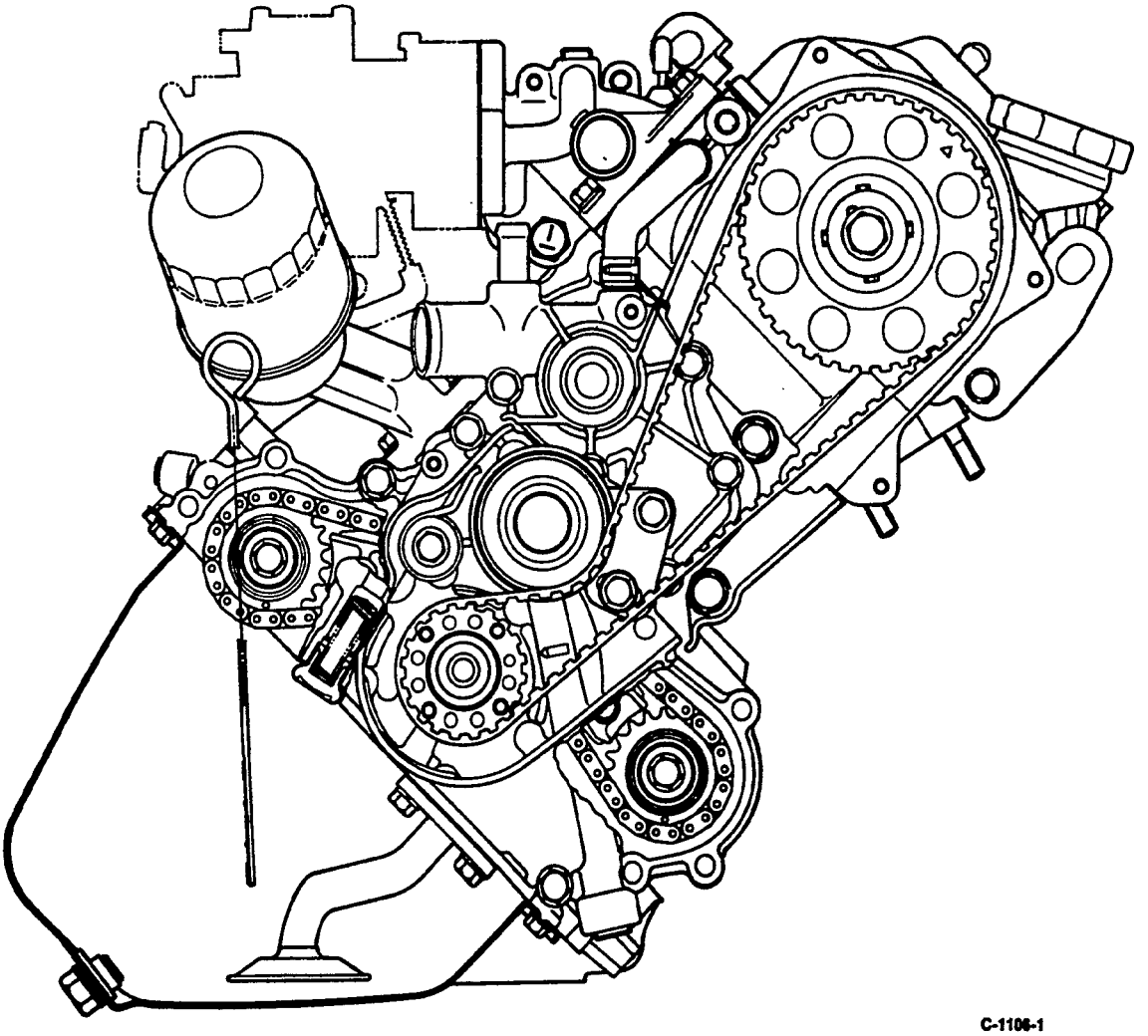


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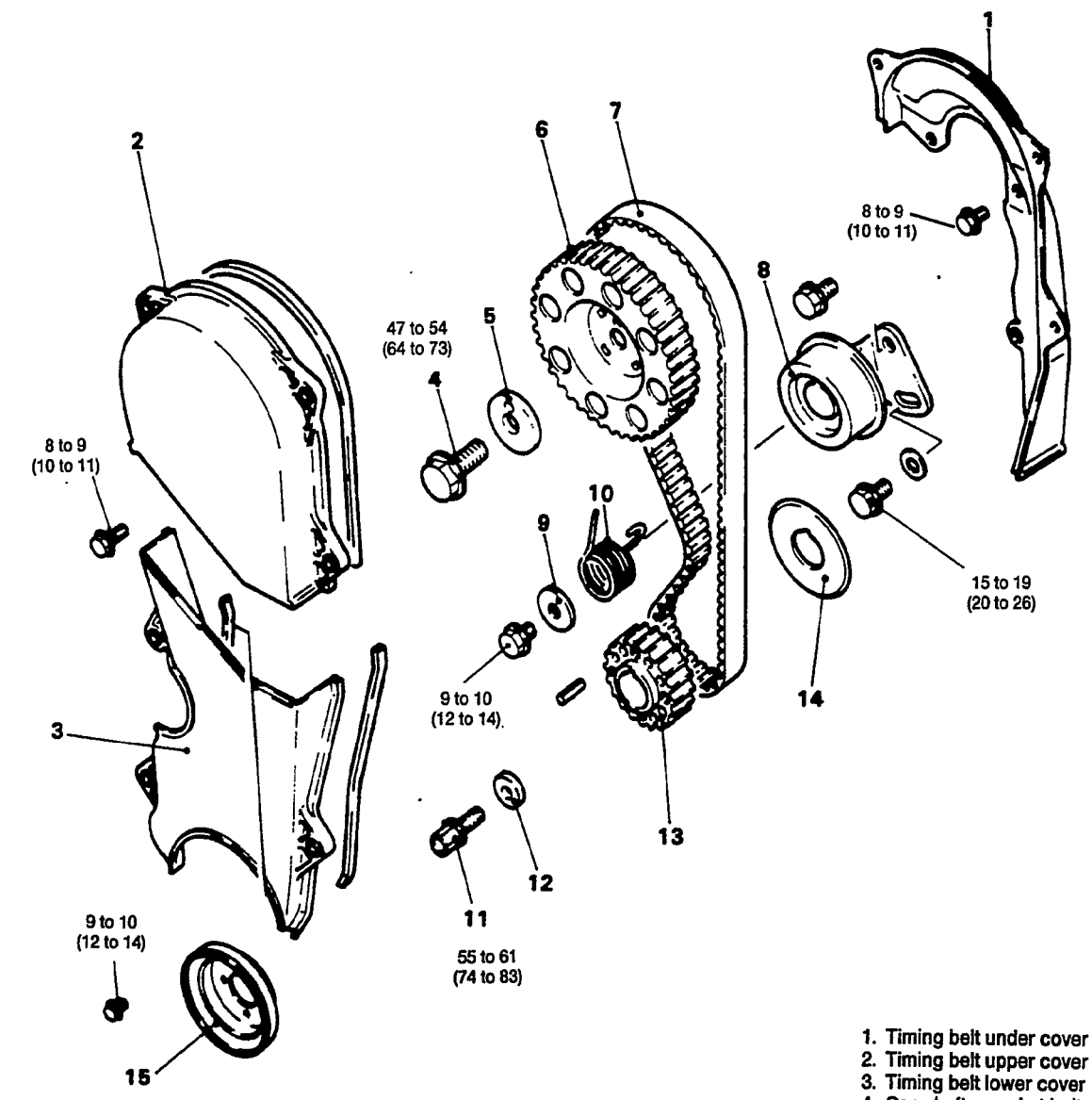
FIGURE 9-2. ENGINE CROSS SECTION VIEW



1. Timing belt under cover
2. Timing belt upper cover
3. Timing belt lower cover
4. Camshaft sprocket bolt
5. Camshaft sprocket spacer
6. Camshaft sprocket
7. Timing belt
8. Timing belt tensioner
9. Tensioner spacer
10. Tensioner spring
11. Crankshaft sprocket bolt
12. Crankshaft sprocket spacer
13. Crankshaft sprocket
14. Flange
15. Crankshaft pulley

FIGURE 9-3. TIMING BELT COMPONENTS

Removal

1. Before the timing belt is removed, mark an arrow with a chalk on the back side of belt to indicate the turning direction. This gives a reference to reinstall the belt in the same direction.
2. Loosen the tensioner bracket adjust bolts. Insert a screwdriver between the boss marked with an asterisk(*) in Figure 9-4 and the bracket and pry to move the pulley until it touches the front case rib. Temporarily fix tensioner in this position by tightening the bolt in the slot.

⚠CAUTION ***Do not contaminate removed parts with oil and grease. The timing belt, sprocket and tensioner must not be washed. Wipe off light contaminates with a clean cloth. An oil or grease ladened belt should be replaced.***

Inspection

Perform the following checks and replace defective components.

Timing Belt

1. Deposited oil or grease.
2. Damage, wear, peeling, cracks or hardening.

Timing Belt Tensioner

1. Pulley rotating condition.
2. Excess play in bearing or strange sound.

Timing Belt Cover

1. Deformation or cracks.
2. Peeled or damaged seal.

⚠CAUTION ***If there is oil on any parts, check the front case oil seal and camshaft oil seal for leakage.***

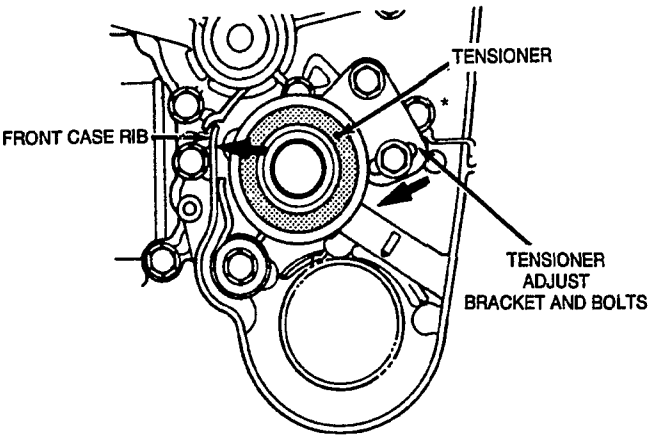


FIGURE 9-4. TEMPORARY POSITIONING OF TENSIONER

Installation

Use the following procedures to assemble the timing belt components.

1. Install the camshaft sprocket ensuring that it fits the dowel pin. Tighten the bolt to specified torque.
2. Install the crankshaft flange and sprocket. The chamfered edge of the flange must face outward from the engine (Figure 9-5). Tighten bolt to the specified torque.

⚠CAUTION ***When the camshaft sprocket is installed, ensure that it fits the dowel pin. When the crankshaft flange is installed, ensure the chamfered edge faces outward from the engine.***

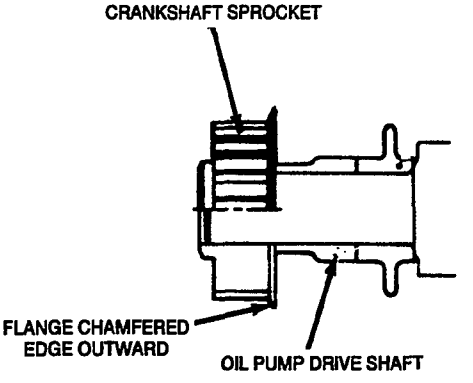


FIGURE 9-5. INSTALLING CRANKSHAFT SPROCKET

3. Install the timing belt tensioner.
4. Insert a screwdriver between the boss marked with an asterisk (*) in Figure 9-4 and the tensioner bracket. Pry to move the tensioner until it touches the front case rib. Temporarily fix the tensioner there by tightening the bolt in the slot.
5. Line up the timing marks of the camshaft sprocket and crankshaft sprocket (Figure 9-6). This position places the No. 1 piston at top dead center on the compression stroke.
6. Install the timing belt (Figure 9-6). While making the tension side tight by turning the camshaft sprocket in the opposite direction, reconfirm that the timing marks are in correct alignment.
7. Loosen the tensioner bolt to allow the tensioner spring to exert pulley pressure on the belt.
8. Turn the crankshaft clockwise for two teeth (18°) of the camshaft sprocket.

⚠CAUTION ***The amount of rotation in Step 8 must be strictly observed. The purpose is to apply a constant tension to the tension side of the belt by causing the intake valve of No.2 cylinder to be on the cam.***

9. Secure the tensioner bracket by tightening the slot bolt first, and then the fixed bolt to the specified torque.
10. Check belt tension with hand squeeze of about 11 pounds (5 kg) in a horizontal direction over the tensioner adjustment bolt (Figure 9-7). Belt cogs should deflect to the center of bolt head as shown.

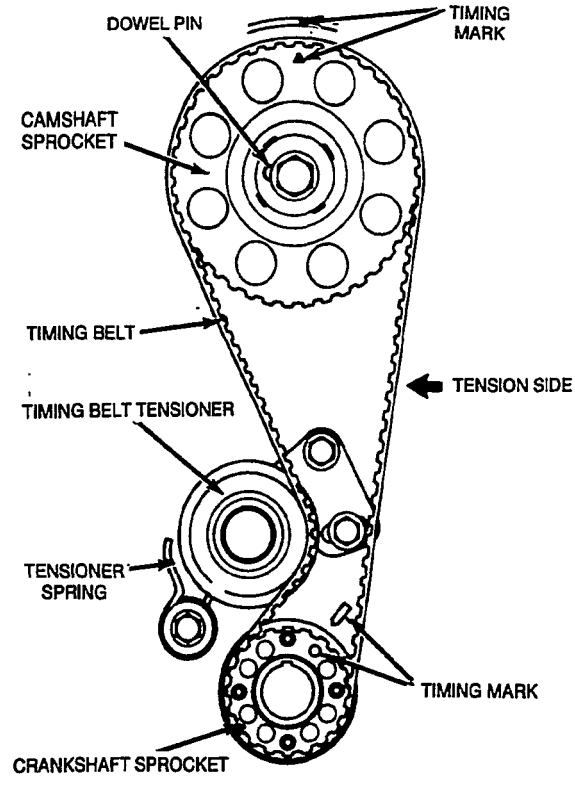


FIGURE 9-6. INSTALLING TIMING BELT

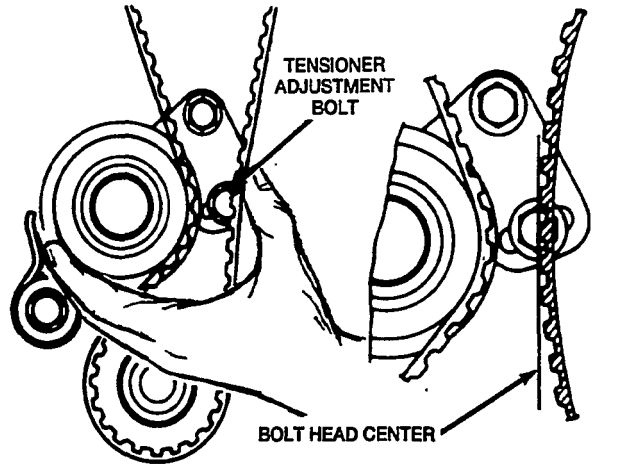
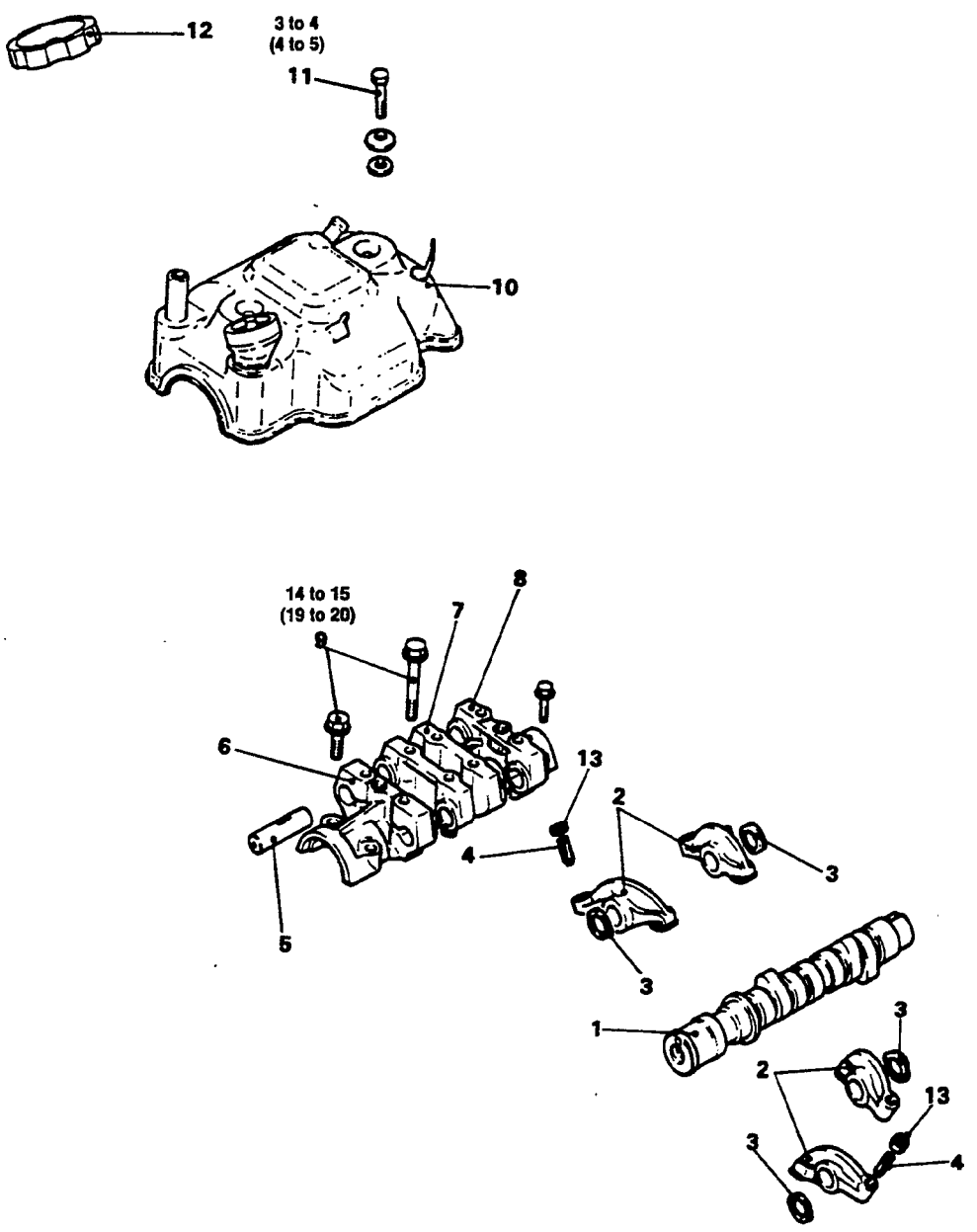


FIGURE 9-7. CHECKING TENSION OF TIMING BELT

ROCKER ARM, ROCKER SHAFT, CAMSHAFT



1. CAMSHAFT
2. ROCKER ARM
3. WAVED WASHER
4. ADJUSTING SCREW
5. ROCKER ARM SHAFT
6. CAMSHAFT FRONT BEARING CAP
7. CAMSHAFT CENTER BEARING CAP
8. CAMSHAFT REAR BEARING CAP
9. CAMSHAFT BEARING CAP BOLT
10. ROCKER COVER
11. ROCKER COVER BOLT
12. OIL FILLER CAP
13. LOCK NUT

FIGURE 9-8. ROCKER ARM, ROCKER SHAFT, CAMSHAFT COMPONENTS

Removal

1. Remove the timing belt per the preceeding section.
2. Remove the rocker cover (Figure 9-8).
3. Remove the front, center and rear camshaft bearing caps from the cylinder head.
4. When removing the rocker arm shafts, use the special tool "Rocker Arm Shaft Puller" (Figure 9-9). The shafts are press fit into the center camshaft bearing cap.

Inspection

- **Rocker Cover**

1. Check for cracks, deformation and damage. Replace if defective.

- **Camshaft**

1. Measure the camshaft journal diameter (the oil clearance between the bearing and journal) and replace if badly worn or damaged.
2. Check the cam surface for abnormal wear and damage. Replace if defective.

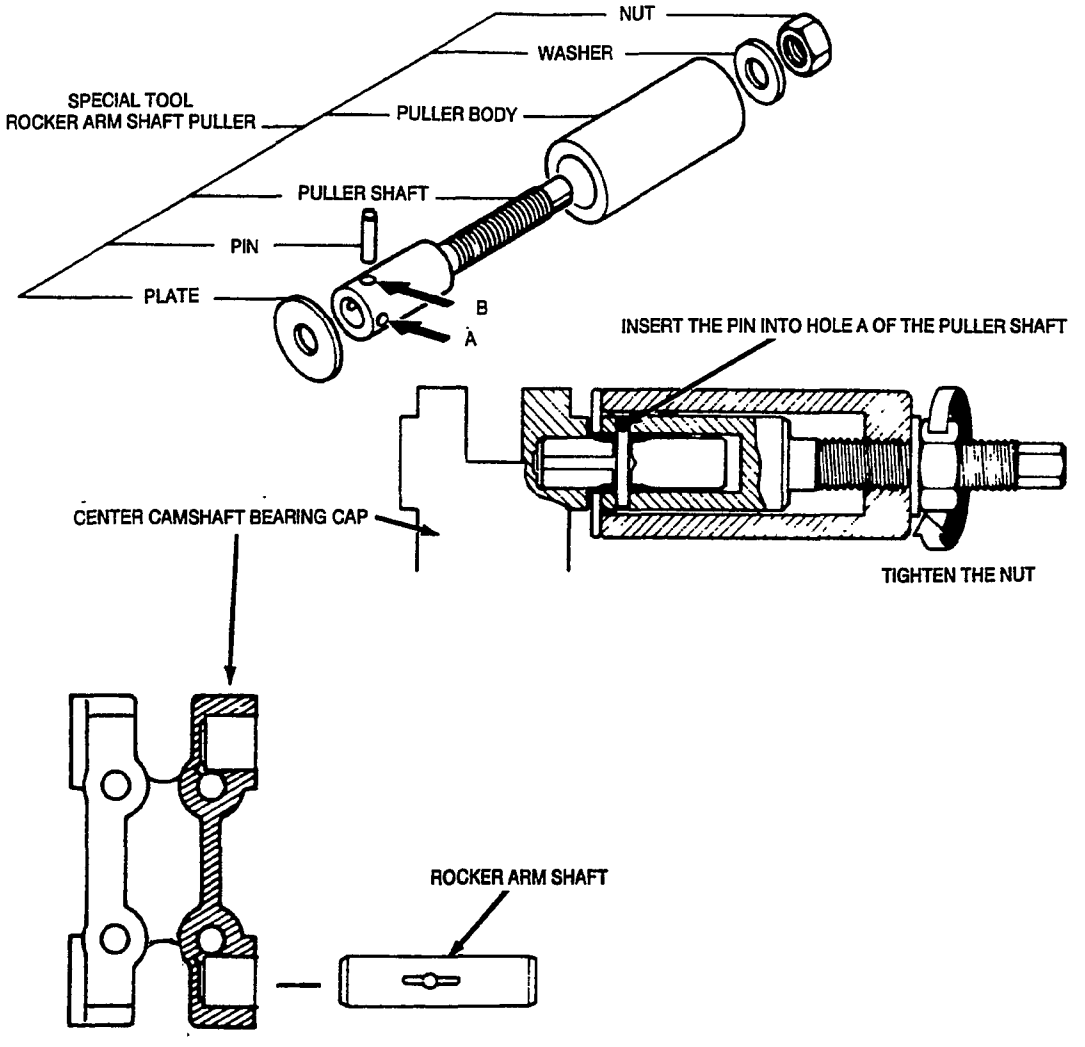


FIGURE 9-9. REMOVING ROCKER ARM SHAFTS

- **Rocker Arms and Rocker Arm Shaft**

1. Check the rocker arm surfaces indicated by arrows in Figure 9-10. If severely worn or damaged, replace.
2. Check the rocker for wear and damage at the points indicated by arrows in Figure 9-10. Replace if worn or damaged.

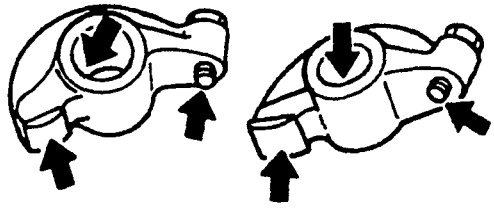


FIGURE 9-10. CHECKING ROCKER ARMS

Installation

Clean all parts and reinstall by the following procedures.

1. Apply engine oil to the camshaft journals and cams, then install the camshaft to the cylinder head.
2. Install the center camshaft bearing cap with the embossed arrow on its top toward the front (Figure 9-11).
3. Assemble the rocker arms as shown according to the identification marks stamped on the ribs of the rocker arms.

⚠CAUTION ***Be sure to apply engine oil to the inside surfaces when assembling the rocker arms to prevent damage and to facilitate assembly.***

4. Mount the front end cap and the rear end cap with the embossed arrows facing front. Be sure the convex surfaces of the waved washers face toward the rocker arms (Figure 9-11).

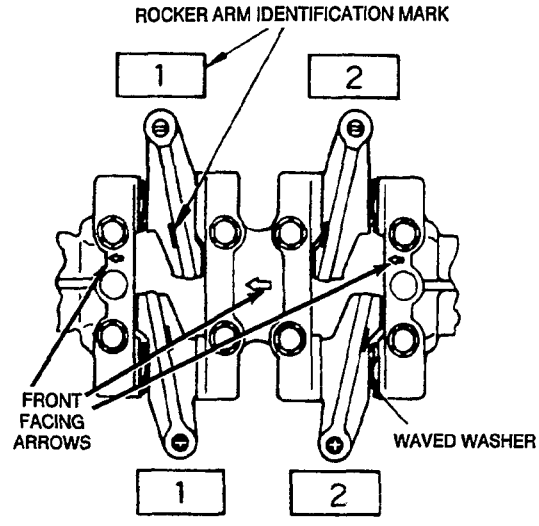


FIGURE 9-11. INSTALLING ROCKER ARMS

5. Tighten the center, front and rear camshaft bearing caps in the order mentioned. Tighten the caps in two or three steps. In the last step, tighten the caps to the specified torque.
6. Apply engine oil to the camshaft front oil seal lips and the outside circumference of the guide, then install the oil seal on the camshaft (Figure 9-12). Install the oil seal in the cylinder head using special tool "Camshaft Oil Seal Installer".

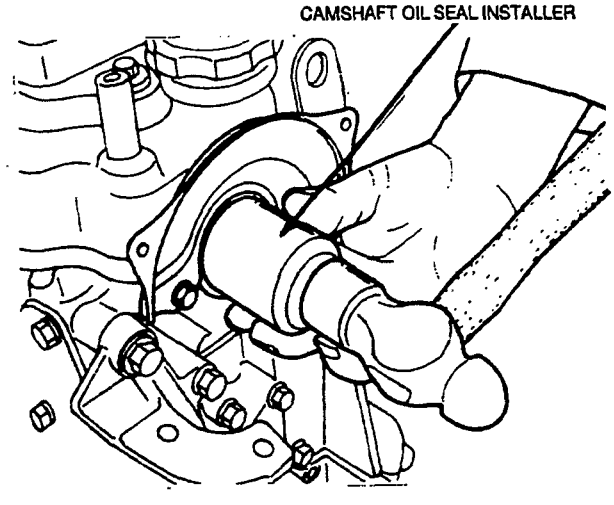
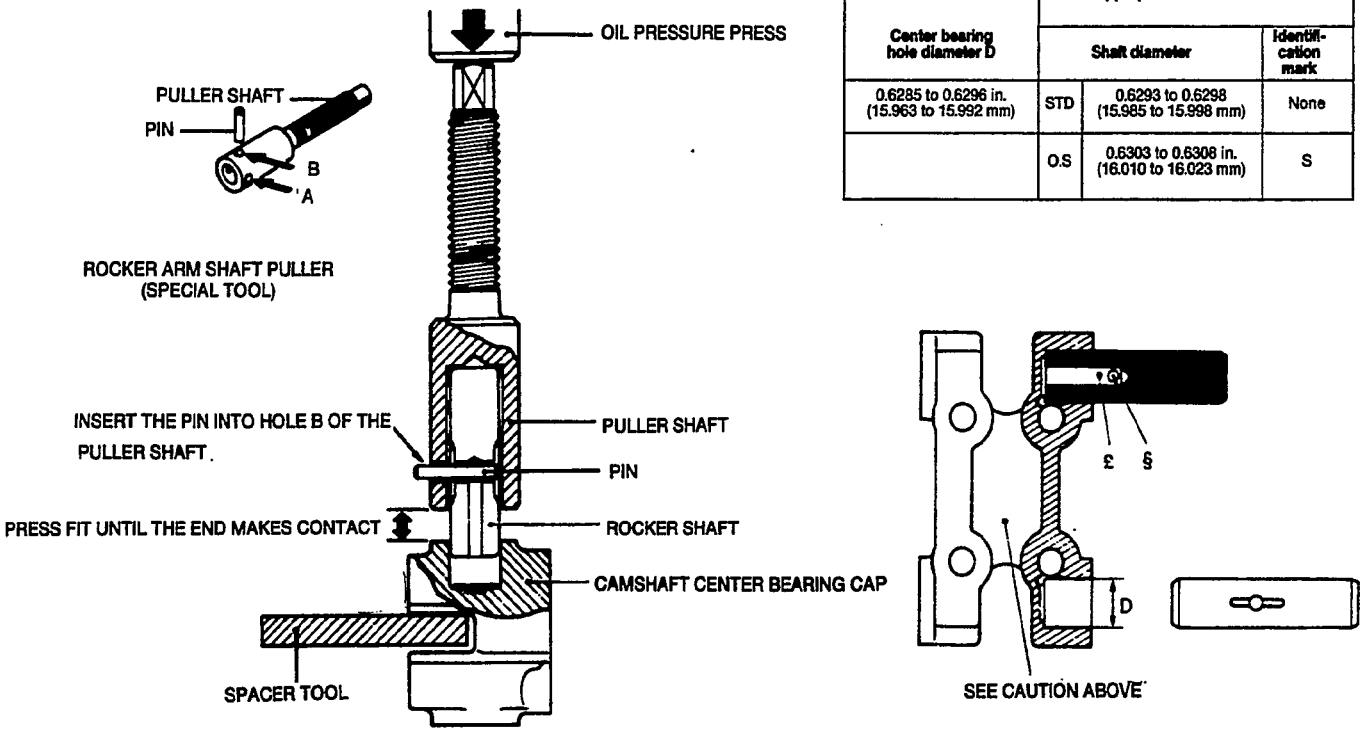


FIGURE 9-12. INSTALLING CAMSHAFT OIL SEAL

7. Assemble the rocker arm shafts to the camshaft center housing cap. Lubricate the shafts and press fit them with special tools "Rocker Arm Shaft Puller" and spacer tool (Figure 9-11). **Note Cautions below.**

⚠CAUTION ***Be sure to insert the pin of the special tool Rocker Arm Shaft Puller into hole B of the puller shaft. If the pin is inserted into hole A and the press fitting is done, the depth of the rocker arm shaft press fitting will be excessive and damage to the bearing cap or other problems will result.***

⚠CAUTION ***When press fitting the rocker arm shafts, the oil hole marked £ should face the camshaft center bearing cap and the oil marked § should be vertical as shown.***



Center bearing hole diameter D	Appropriate rocker arm shaft		
	Shaft diameter		Identification mark
0.6285 to 0.6296 in. (15.963 to 15.992 mm)	STD	0.6293 to 0.6298 (15.985 to 15.998 mm)	None
	O.S	0.6303 to 0.6308 in. (16.010 to 16.023 mm)	S

FIGURE 9-13. PRESS FITTING OF ROCKER ARM SHAFTS

INTAKE AND EXHAUST MANIFOLDS

Removal

The intake manifold is secured by two nuts and two capscrews with lock washers. The exhaust manifold is secured by 4 nuts and lock washers. All gasket material must be removed from mating surfaces before inspection is performed.

Inspection

Perform the following checks and correct or replace if defective.

1. Check parts for damage and cracks.
2. Check for clogged vacuum port, water and gas passages.
3. Check mating surfaces on cylinder head and manifold for distortion.

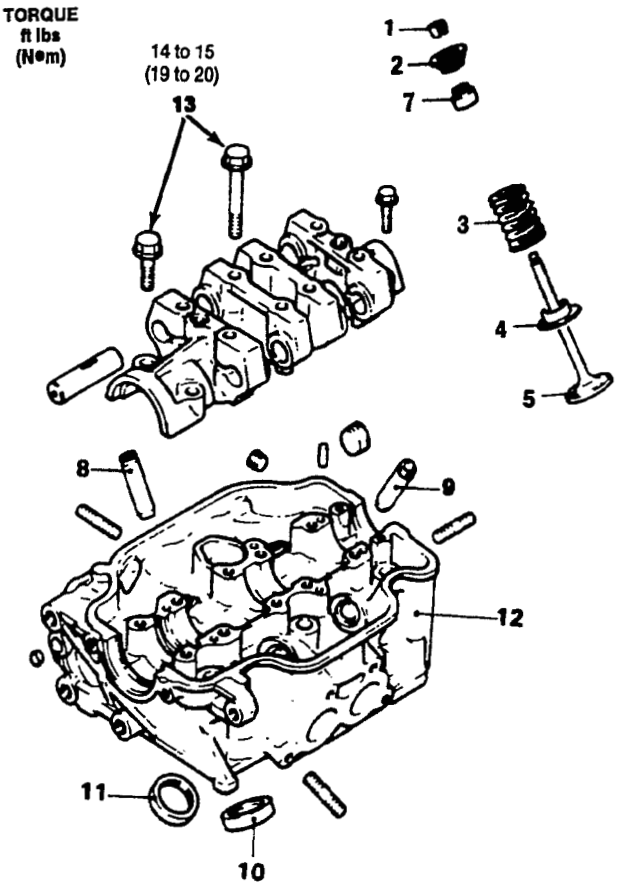
- **Exhaust Manifold**

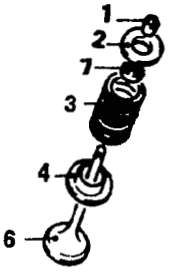
1. Check for damage, cracks or leaks.
2. Check for restrictions to water and gas passage.
3. Check closing and opening temperature of the high exhaust temperature shutdown switch (see Exhaust System, Section 6).
4. Check mating surfaces on cylinder head and manifold for distortion.

⚠WARNING ***Exhaust gas can cause severe personal injury or death. Check all components of the exhaust system carefully for damage or leaks if the engine shuts down from a high exhaust temperature condition.***

Installation

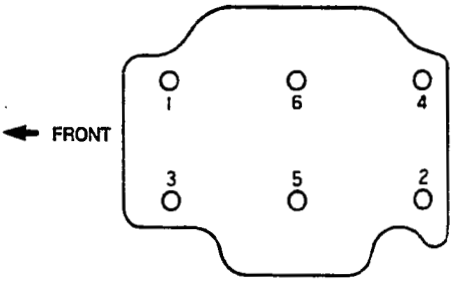
Always use a new gasket when installing the intake or exhaust manifold. Torque nuts or capscrews to the specified values.





1. RETAINER LOCK
2. SPRING RETAINER WASHER
3. VALVE SPRING
4. SPRING RETAINER
5. INTAKE VALVE
6. EXHAUST VALVE
7. STEM SEAL
8. INTAKE VALVE GUIDE
9. EXHAUST VALVE GUIDE
10. INTAKE VALVE SEAT
11. EXHAUST VALVE SEAT
12. CYLINDER HEAD
13. CAMSHAFT BEARING CAP BOLT

FIGURE 9-14. CYLINDER HEAD AND VALVES



Removal

1. Using the special tool "Cylinder Head Bolt Wrench", remove the cylinder head bolts in the sequence shown in Figure 9-15. The head bolts should be loosened in two or three stages before removal.
2. Remove the cylinder head and the cylinder head gasket. The gasket should not be reused.

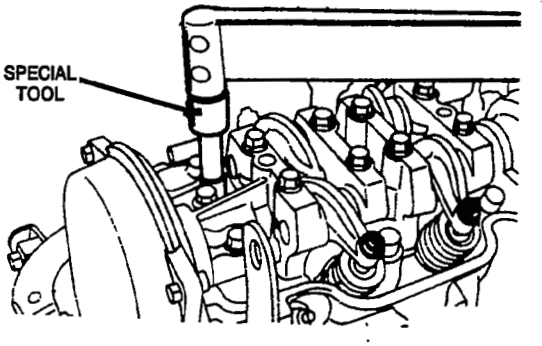


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FIGURE 9-15. LOOSENING CYLINDER HEAD BOLTS

3. Compress the valve spring using a commercially available tool (Figure 9-16). Remove the valve spring retainer lock, the valve spring retainer, valve spring and valve. Attach a tag to removed valves to clearly indicate the cylinder number when re-assembling.

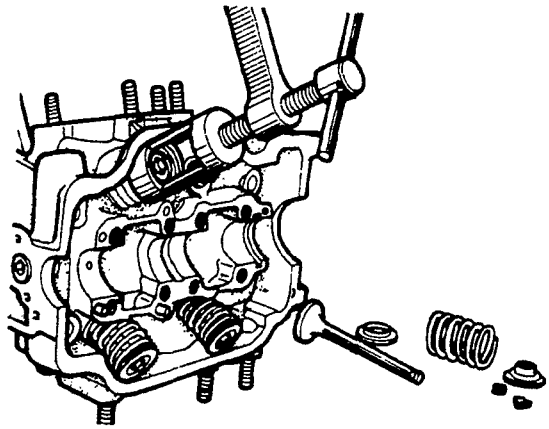


FIGURE 9-16. REMOVING VALVES AND PARTS

Inspection

Perform the following checks. Correct or replace if defective.

- **Cylinder Head**

1. Check the cylinder head for water leakage, gas leakage, damage or cracks before washing.
2. After the oil and air passages have been washed, blow air into the passages to check for clogging.
3. Measure the flatness of the cylinder head bottom surface by using a straight edge and thickness gauge (Figure 9-17). The flatness should be measured by holding a straight edge to the positions A, B, etc. as shown. When checking flatness, be sure that there are no broken pieces of gasket on the bottom surface of the cylinder head.
4. Check the camshaft bearing surface for scratches or seizure. If excessive damage is evident, replace the cylinder head assembly.
5. Measure the clearance to the camshaft journal. If the clearance is excessive, replace the camshaft or cylinder head, whichever is worn more.

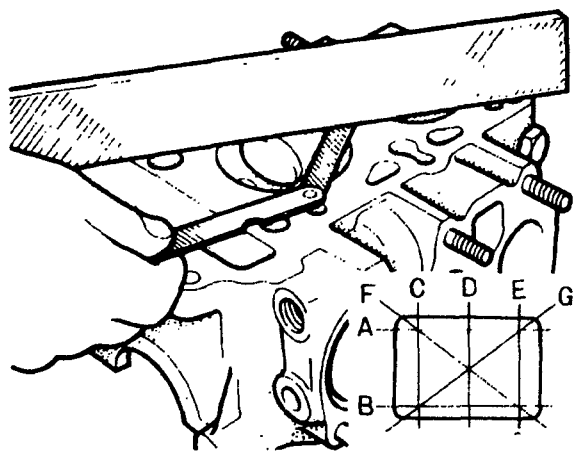


FIGURE 9-17. CHECKING CYLINDER HEAD DISTORTION

- **Valves**

1. Check the valve stem for ridge wear, damage or bend. Replace if defective. Also check the stem end surface (the surface which makes contact with the rocker arm adjusting screw) and replace if badly dented.
2. Check the valve face contact area. Correct with a valve refacer if defective. If the margin (valve head thickness) is in excess of the service limit, replace (Figure 9-18).

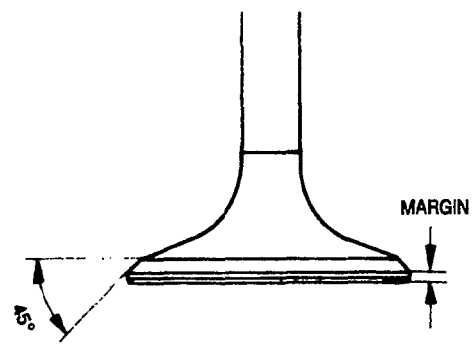


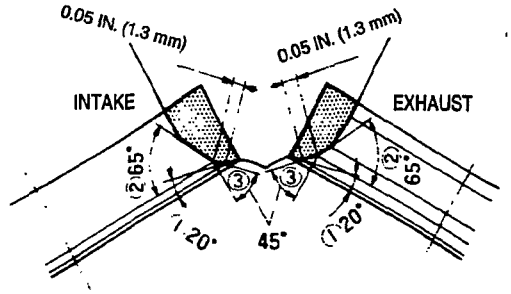
FIGURE 9-18. CHECKING VALVE FACE CONTACT

• Valve Springs

1. Check the free length and tension of each valve spring. If the service limit is exceeded, replace the spring.
2. Check the spring for squareness using a square on a surface plate. If excessively out of square, replace the spring.
3. A cracked or damaged valve spring should be replaced.

• Valve Guide

Measure the clearance between the valve guide and valve stem. If the clearance is beyond the service limit, replace the valve guide and / or the valve. See the following sections.



CUT IN THE NUMBERED SEQUENCE [(1) - (3)]

FIGURE 9-19. CORRECTION OF VALVE SEAT

Correction of Valve Seat

1. Before the valve seat is correct, check the clearance between the valve guide and valve. Replace the valve guide and / or valve if necessary.
2. Using special tool "Valve Seat Cutter and Pilot" or a seat grinder (see Table 9-1), correct the seat width and seat angle to the specified shape (Figure 9-19).

TABLE 9-1. SPECIAL VALVE SEAT TOOLS

Tool Name	Tool Specification		Use
	Cutter Angle	Cutter O.D. In. (mm)	
Valve Seat Cutter	45°	1.34 (34)	To chamfer exhaust valve seat.
	Commercially available cutter	1.57 (40)	To chamfer intake valve seat.
	65°	1.26 (32)	To chamfer inside of exhaust valve seat.
		1.73 (44)	To chamfer inside of intake valve seat.
	20°	1.30 (33)	To chamfer inside of exhaust valve seat.
	Commercially available cutter	1.42 (36)	To chamfer inside of intake valve seat.
Valve Seat Cutter Pilot	Taper: Small Pilot Pin Diameter: 0.26 (6.6)		Handle for cutter as special tool.
	Commercially Available Taper: Medium Pilot Pin Diameter: 0.26 (6.6)		Handle for commercially available cutter.

3. After correction with a cutter, apply a compound and reface.
4. After lapping the valve with a lapping compound, apply red lead to the seat to check for proper contact with the valve throughout the width of contact and the circumference. If contact is insufficient, recondition the valve seat by means of a seat cutter.

Replacing the Valve Guides

Valve guides have been shrink-fitted. When replacing them, proceed as follows:

1. Heat the cylinder head up to about 482°F (250°C). Insert the bar of special tool "Valve Guide Installer" into the valve guide and drive out the guide towards the bottom of the head (Figure 9-20).
2. After allowing cylinder head to cool, ream each guide hole to the specified size.
3. Heat the cylinder head to about 482°F (250°C) and insert the guides quickly. Then use the special tool "Valve Guide Installer" to drive them into the specified position. Each guide is stopped at the specified position by means of the special tool.
4. After driving the valve guide, inspect the guide inside diameter and ream if necessary.

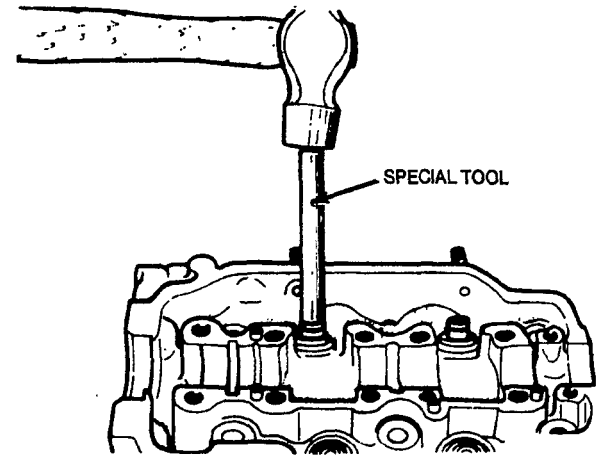


FIGURE 9-20. REMOVING THE VALVE GUIDE

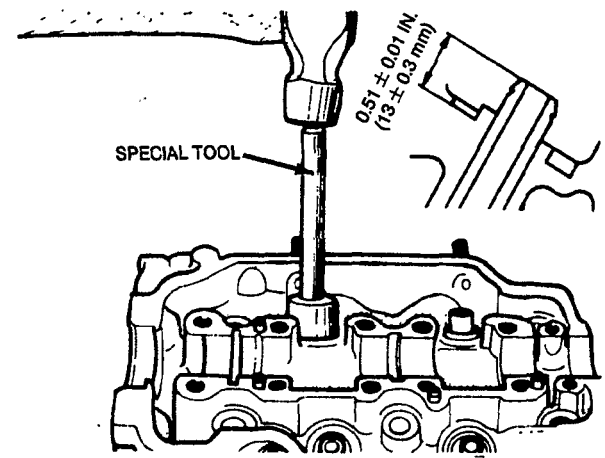


FIGURE 9-21. INSTALLING THE VALVE GUIDE

Replacing the Valve Seat

1. Any valve seat that has been worn away over the service limit should be removed after thinning down the seat by a cutter as shown in Figure 9-22.
2. Correct the valve seat installation bore in cylinder head to match the oversize valve seat diameter. Make sure that the valve seat center coincides with the valve guide center.
3. Heat the cylinder head up to about 482°F (250°C) and press in an oversize seat which fits the seat bore in the cylinder head. After installation, correct the valve seat with valve seat cutter (see "Correction of Valve Seat".

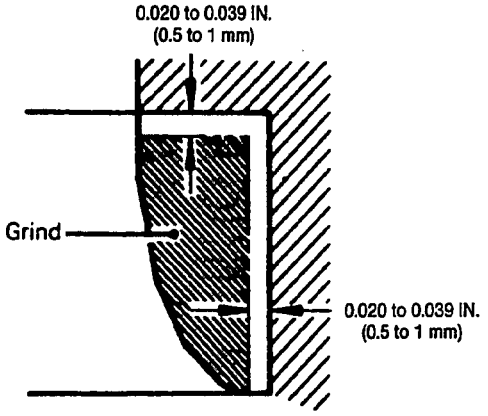


FIGURE 9-22. REMOVING THE VALVE SEAT

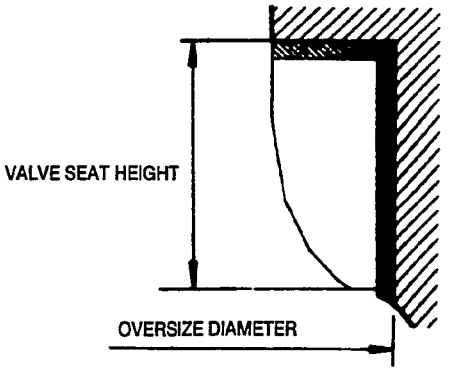


FIGURE 9-23. CORRECTION OF VALVE SEAT BORE

Installation

⚠CAUTION ***Make sure that all rotating and sliding surfaces are clean by washing all parts before installation. Apply clean engine oil to these surfaces at time of installation.***

1. Install the valve stem seal in the valve guide using special tool "Valve Stem Seal Installer" (Figure 9-24). Do not reuse an oil seal.

⚠CAUTION ***Be sure to use the special tool when valve stem seal is installed. Improper installation will result in oil working its way down into the combustion chamber.***

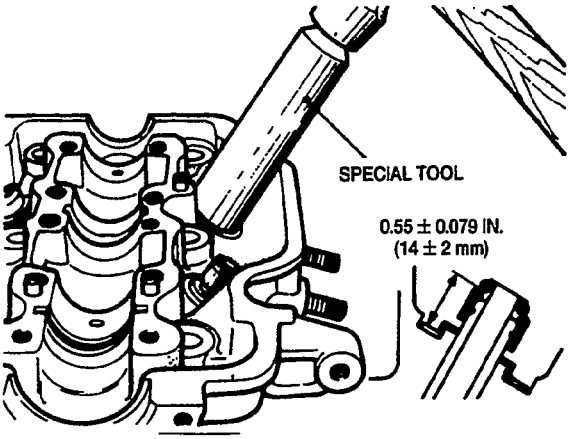


FIGURE 9-24. INSTALLING THE VALVE STEM SEAL

2. Install the intake and exhaust valves, valve springs and spring retainers (Figure 9-25). Install valve spring with the white enamel coated side up.
3. Using a valve spring compressor, compress the valve spring and insert the retainer lock.
4. Install the camshaft to the cylinder head. Confirm the camshaft end play tolerance.
5. Clean gasket pieces, oil, etc. from the cylinder block and head gasket surfaces.
6. Place a new cylinder head gasket on the top surface of the cylinder block. Since the gasket surface is coated with a special sealant, there is no need for applying a sealant.
7. Install the cylinder head assembly to the cylinder block and tighten the head bolts with special tool "Cylinder Head Bolt Wrench". Tighten the bolts in two or three steps in the numbered sequence shown in Figure 9-26. In the last step, tighten the bolts to the specified torque.

⚠CAUTION ***Apply oil to the threaded portion of the head bolts before installation to assure correct torque.***

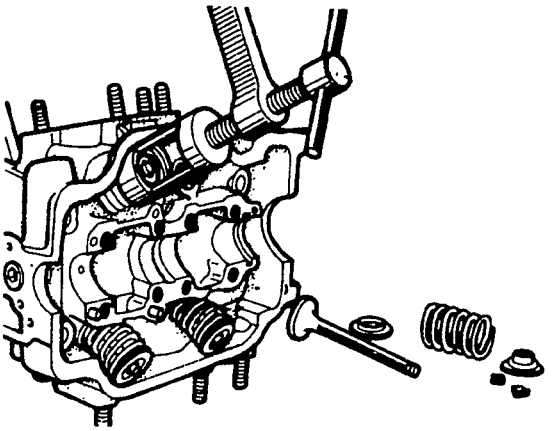


FIGURE 9-25. ASSEMBLING VALVES

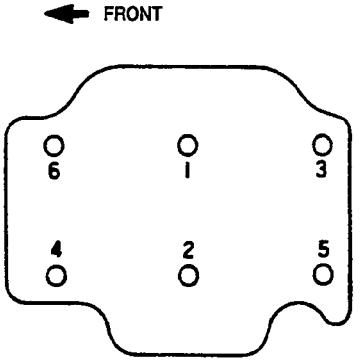
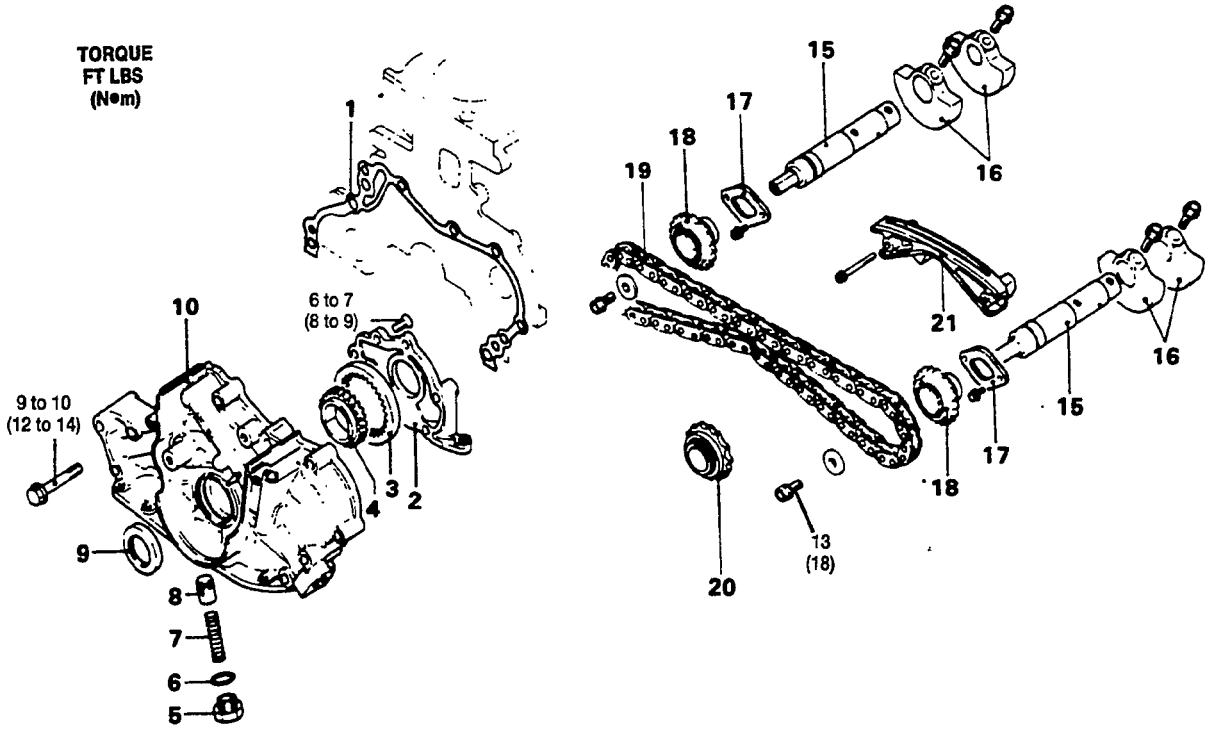
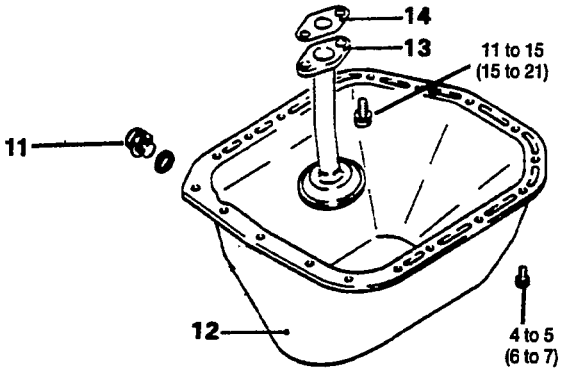


FIGURE 9-26. HEAD BOLT TIGHTENING SEQUENCE

Components





1. FRONT CASE GASKET
2. OIL PUMP COVER
3. OIL PUMP OUTER GEAR
4. OIL PUMP INNER GEAR
5. PLUG
6. GASKET
7. RELIEF SPRING
8. RELIEF PLUNGER
9. FRONT OIL SEAL
10. FRONT CASE
11. DRAIN
12. OIL PAN
13. OIL SCREEN
14. OIL SCREEN GASKET
15. BALANCER SHAFT
16. BALANCER WEIGHT
17. THRUST PLATE
18. SPROCKET
19. CHAIN
20. CRANKSHAFT SPROCKET
21. CHAIN GUIDE

FIGURE 9-27. FRONT CASE, BALANCER SHAFTS, OIL PUMP

Inspection

After all parts have been washed, perform the following checks and replace defective components.

- **Front Case and Oil Pump Cover**

Check the gear contacting surfaces for wear (ridge wear) or damage.

- **Gear**

1. Check the gear tooth surfaces for wear and damage.
2. Check the clearance between the outer gear outside circumference and front case (Figure 9-28).
3. Check the clearance between the outer gear tooth and crescent (Figure 9-29).
4. Check the clearance between the inner gear tooth end and crescent (Figure 9-30).

- **Relief Valve and Spring**

1. Check to ensure that the relief valve inserted into the front case slides freely.
2. Check the relief spring for deterioration or breakage.

- **Front Oil Seal**

1. Check the lips for wear, deformation or damage.
2. Check spring ring for elongation.

- **Oil Screen and Pan**

1. Check for damage and cracks.
2. Check the screen for damage and clogging.
3. Check oil pan attaching surface for deformation and damage.

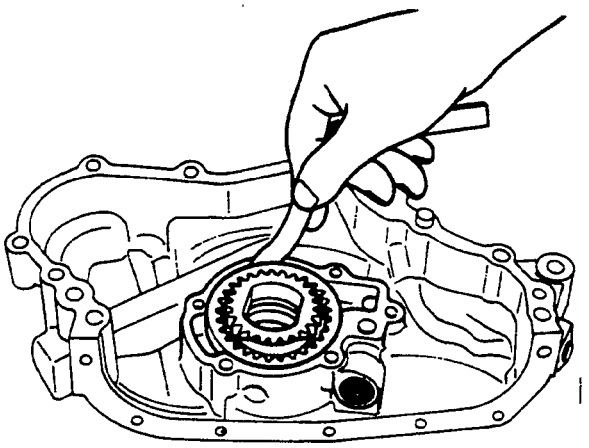


FIGURE 9-28. CHECKING CLEARANCE BETWEEN OUTER GEAR AND FRONT CASE

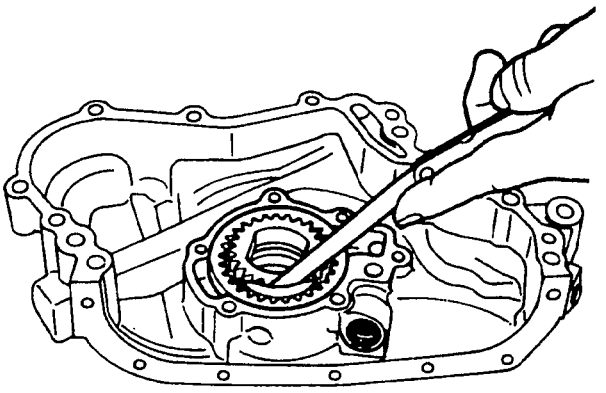


FIGURE 9-29. CHECKING CLEARANCE BETWEEN OUTER GEAR TOOTH END AND CRESCENT

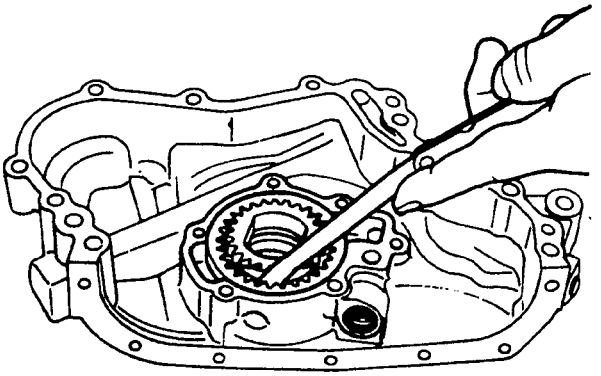


FIGURE 9-30. CHECKING CLEARANCE BETWEEN INNER GEAR TOOTH END AND CRESCENT

- **Balancer Shafts**

1. Check for proper lubrication, oil passages, etc.
2. Check the journal/bearing for seizure, damage, or improper contact with bearing. If defective, replace both the balancer shaft and bearing.
3. Measure the balancer shaft O.D. and bearing I.D. Check the oil clearance. The bearing I.D. should be checked at two points, front and rear, in the directions A and B as shown in Figure 9-31.

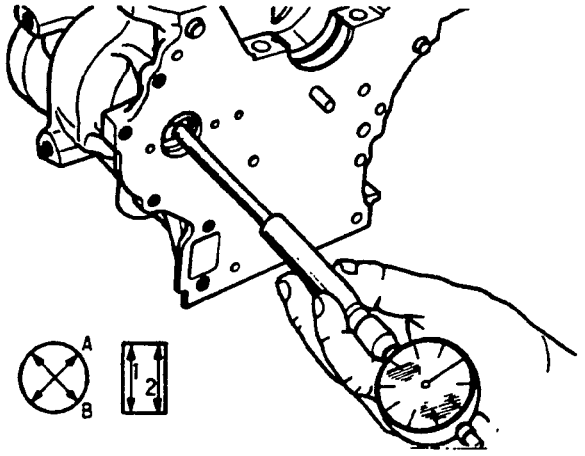


FIGURE 9.31. MEASURING BALANCER SHAFT BEARING I.D.

4. Measure the balancer shaft end play. Attach a dial indicator and measure the end play (Figure 9-32). If the end play is beyond the service limit, check the thrust plate, sprocket and balancer shaft. Replace if worn.

⚠CAUTION ***Hold the probe of the dial indicator to the position shown for accurate readings.***

Replacement of Balancer Shaft Bearing

1. Loosen balance weight attaching bolt, then remove the balance weight and the balancer shaft (Figure 9-33).
2. Remove the balancer shaft rear bearing using special tool "Balancer Shaft Bearing Remover" as shown in Figure 9-34. Remove the bearing by tightening the nut.

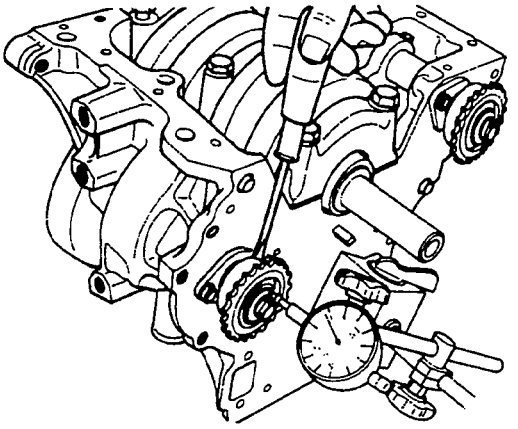


FIGURE 9-32. MEASURING THE BALANCER SHAFT END PLAY

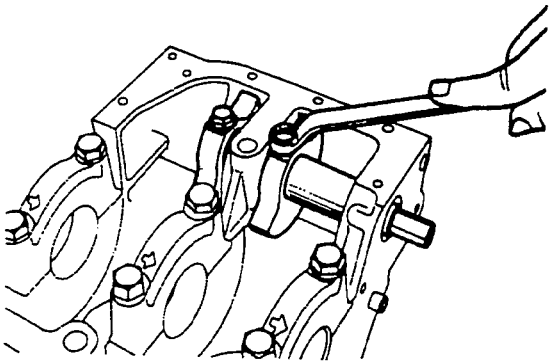


FIGURE 9-33. REMOVING BALANCE WEIGHTS

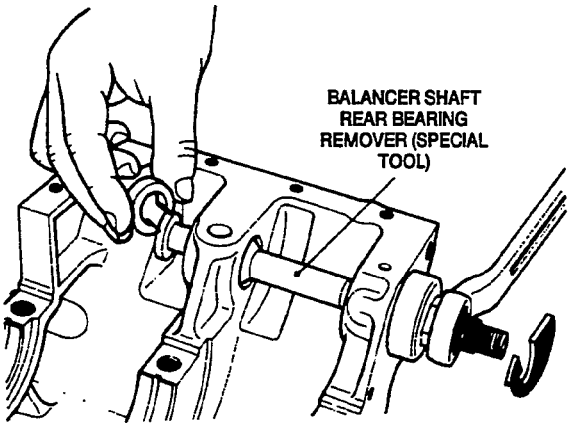


FIGURE 9-34. REMOVING BALANCE SHAFT REAR BEARING

3. To remove the balancer shaft front bearing, insert the special tool "Balancer Shaft Bearing Remover" and drive out the bearing (Figure 9-35).
4. Replace the rear bearing first, then the front bearing. Use special tools "Balancer Shaft Bearing Front Installer" and "Balancer Shaft Bearing Rear Installer". Observe cautions listed below.

⚠CAUTION ***Note the following for proper assembly:***

- ***Apply oil to the bearing external engine surface and the cylinder block bearing bore.***
- ***Install the rear bearing first, then the front bearing.***
- ***Do not use the bearing if load required to install them is less than 882 pounds (400 kg).***
- ***When installing the front bearing, align the bearing oil hole in the cylinder block bearing bore.***
- ***Do not use a bearing that has galling or burrs.***

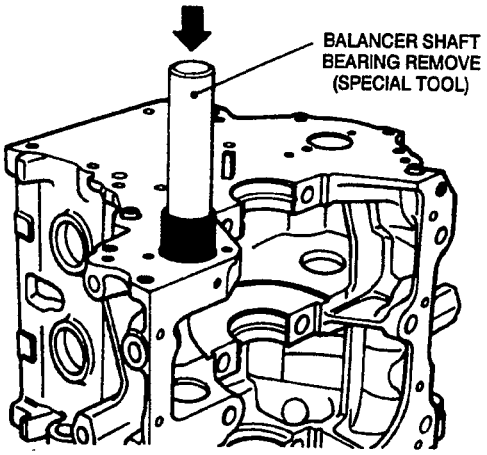


FIGURE 9-35. REMOVING BALANCER SHAFT FRONT BEARING

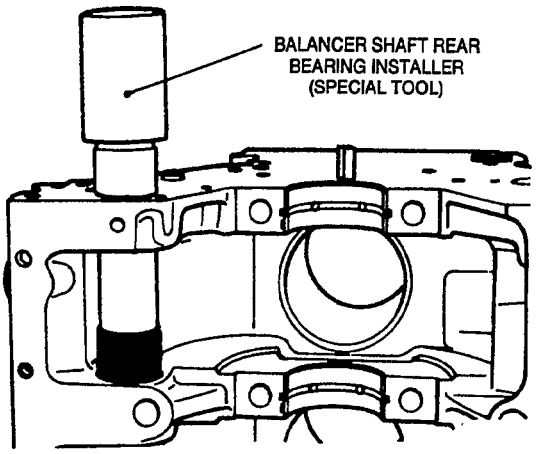


FIGURE 9-36. INSTALLING BALANCER SHAFT BEARING

Installation

1. Install the balancer shafts. Apply engine oil to the shaft journals and bearing surfaces.
2. Fit the balancer shafts in the cylinder block/bearing hole, and install the balance weights. The weights must be installed with the embossed marks (triangle) at front as shown in Figure 9-37.

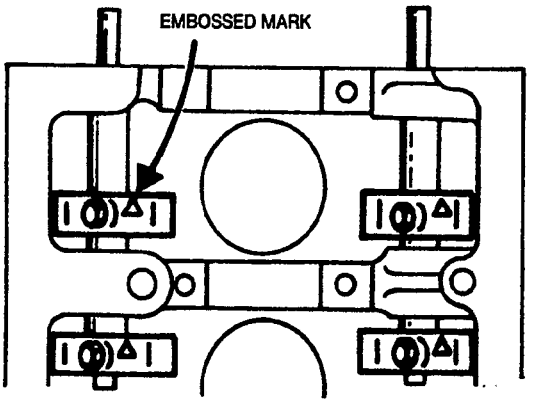


FIGURE 9-37. INSTALLING BALANCER WEIGHTS IN PROPER DIRECTION

3. Before installing the chain and sprockets, turn the crankshaft to place the No. 1 cylinder piston at bottom dead center. Note that the cylinder block is upside down and the balance weights and crankshaft are in the positions shown in Figure 9-38.

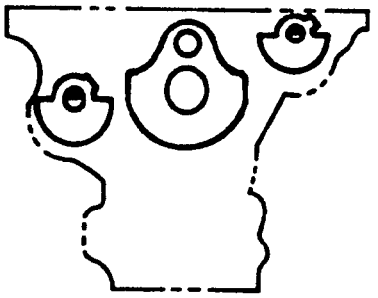


FIGURE 9-38. ORIENTATION OF BALANCE WEIGHTS AND CRANKSHAFT

4. Align the mating marks (yellow links) of the chain with the mating marks (notchs) in the crankshaft and balancer shaft sprockets (Figure 9-39).

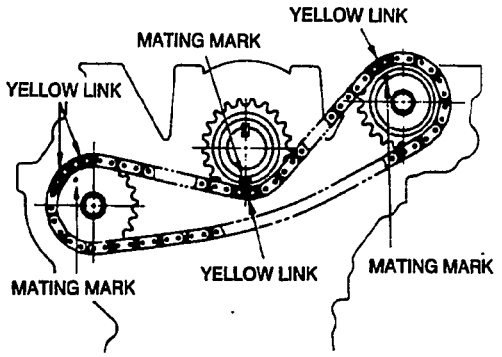


FIGURE 9-39. PROPER SPROCKET AND CHAIN ALIGNMENT

5. With mating marks aligned, fit the crankshaft sprocket about 1/8 inch (3 mm) deep onto their shaft ends (Figure 9-40).

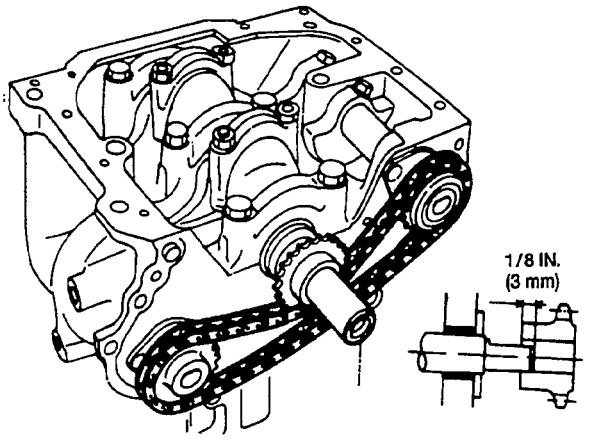


FIGURE 9-40. CHAIN AND SPROCKET ASSEMBLY

6. After confirming that the three sprocket mating marks and chain are all properly aligned, push all three sprockets and the chain into position simultaneously.
7. Tighten the sprocket lock bolts to the specified torque.
8. Install the oil pump outer and inner gear in the front case after applying engine oil to all gear surfaces.
9. Install the oil pump cover and tighten the attaching bolts to the specified torque. Check to ensure that the gear rotates smoothly.
10. Apply engine oil to the relief valve and spring. Install and tighten the plug to the specified torque.

11. Install the front case assembly and gasket. Install the correct bolt length at locations shown in Figure 9-41 and tighten to the specified torque.
12. Install a new crankshaft oil seal (Figure 9-42). Apply engine oil to the oil seal lips and insert the oil seal by hand until it touches the front case. Install in case using special tool "Crankshaft Oil Seal Installer".
13. Install the flange and crankshaft sprocket as shown. The chamfered edge of the flange must face the front as shown inFigure 9-43.
14. Install the oil screen.
15. Clean gasket mounting surface of the cylinder block and oil pan.
16. Install the gasket and the oil pan and tighten to specified torque. Do not overtorque.

⚠CAUTION ***Observe specified torque values. Overtightening of bolts can cause stripping of the threads.***

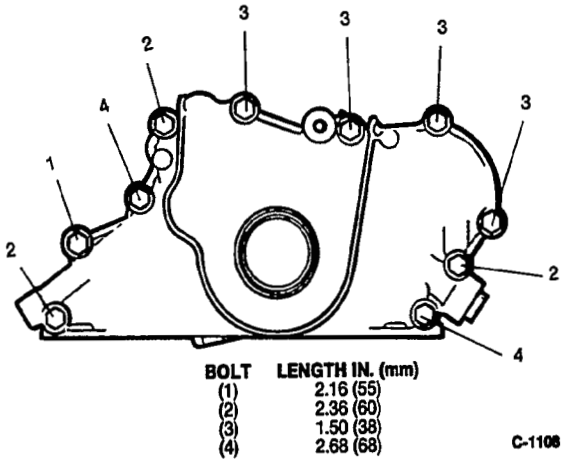


FIGURE 9-41. FRONT CASE BOLT PLACEMENT

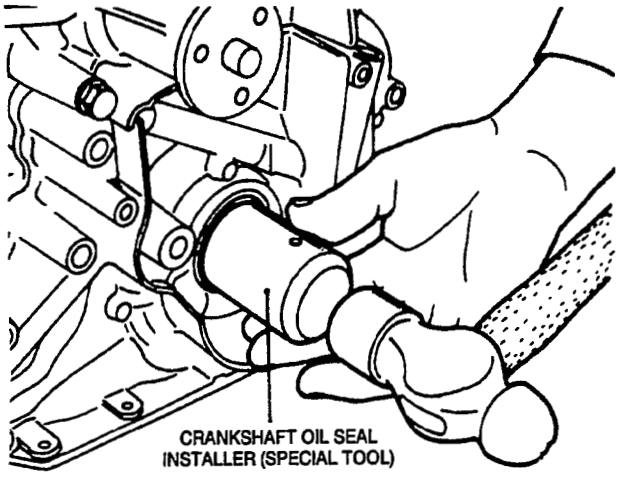


FIGURE 9-42. INSTALLING FRONT OIL SEAL

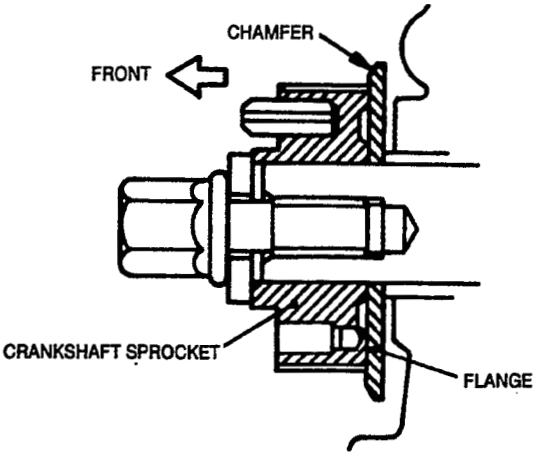


FIGURE 9-43. PROPER INSTALLATION OF FLANGE AND SPROCKET

Components

TORQUE
ft lbs
(Nem)

1. Piston ring No. 1
2. Piston ring No. 2
3. Oil ring
4. Piston
5. Piston pin
6. Bolt
7. Connecting rod
8. Connecting rod bearing
9. Connecting rod cap
10. Nut

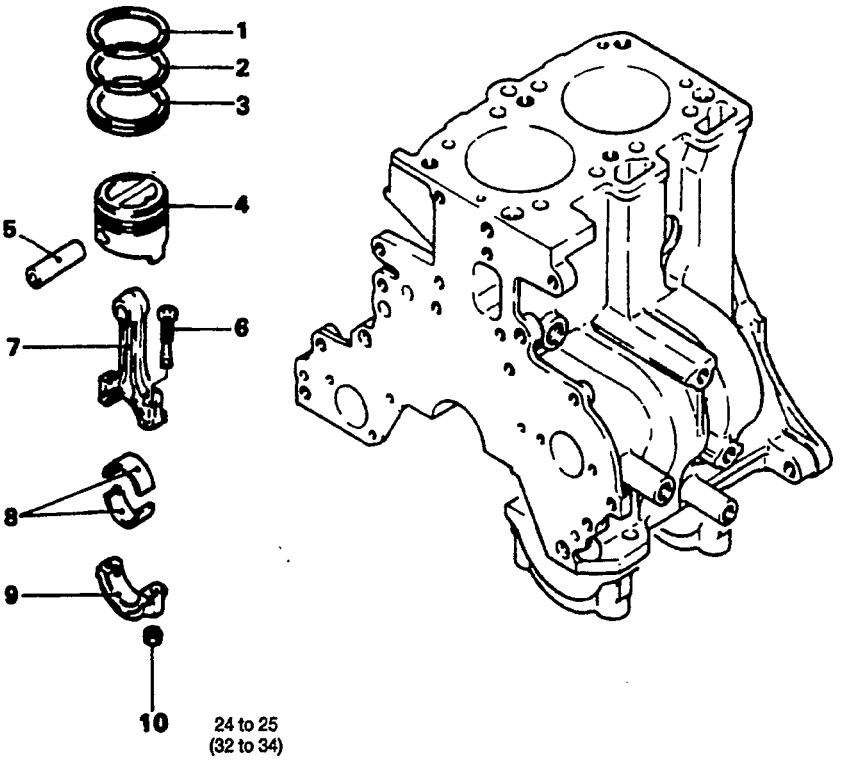


FIGURE 9-44. PISTON, CONNECTING ROD

Removal

1. Remove the cylinder head assembly. (Refer to the section Cylinder Head and Valves).
2. Remove the oil pan.
3. With the crankshaft in bottom dead center, loosen the bolts and then remove the connecting rod caps.
4. Remove the piston and connecting rod upward from the cylinder. Note cautions below.

⚠CAUTION ***When removing the piston and connecting rod, use care not to damage the cylinder liner with the connecting rod and bolts. The assembly cannot be taken out downward because the piston and rings will interfere with the cylinder block.***

5. To disassemble the piston and connecting rod, remove the piston pin with a press. Use special tool "Piston Pin Setting Tool" (push rod) shown in Figure 9-45. Bé sure that the front mark (▲) on the top surface of the piston and the front mark "F" of the connecting rod face upward.

⚠CAUTION ***Place the lower surface of the connecting rod in firm contact with the top of the special tool body or damage can occur.***

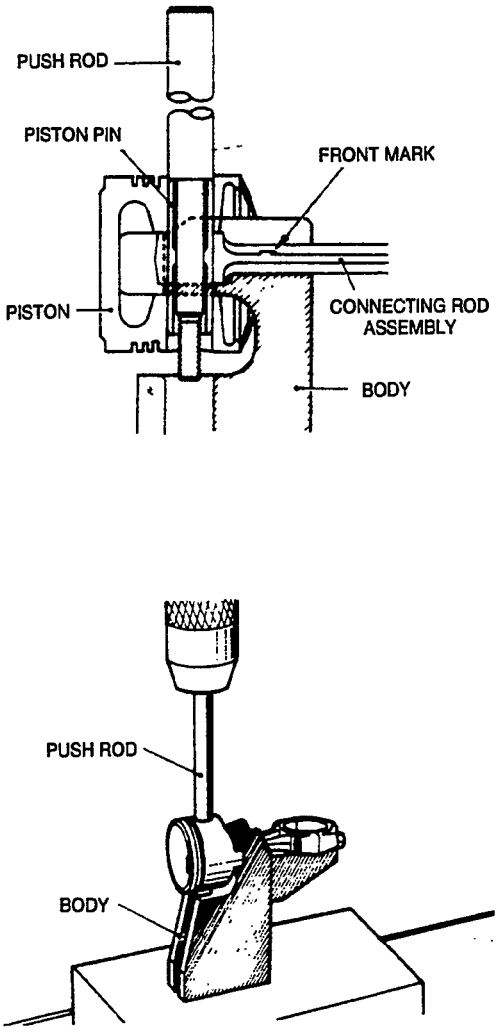


FIGURE 9-45. DISASSEMBLY OF PISTON

Inspection

Perform the following checks and replace parts if defective.

- **Piston**

1. Check the outside circumference of piston for seizure, scratches (scores) or wear.
2. Check to ensure that the piston pin when inserted into the piston is not loose, or can be pushed in by thumb without resistance. The piston and pin should be replaced as one assembly.

- **Piston Rings**

1. Check the piston rings for damage, abnormal wear or breakage. When the piston is replaced, the piston rings should also be replaced.
2. Check the clearance between the piston ring and ring groove (Figure 9-46). If the service limit is exceeded, replace the ring and/or piston.

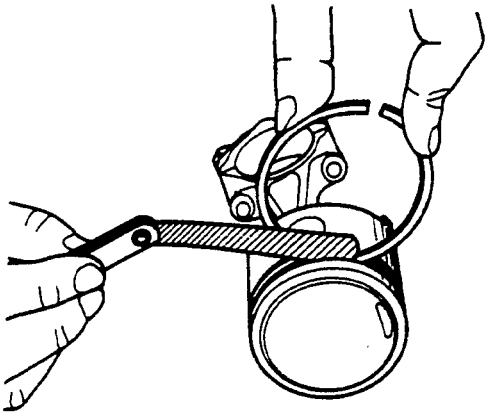


FIGURE 9-46. MEASURING PISTON RING TO GROOVE CLEARANCE

3. Measure the piston ring gap by inserting ring into the cylinder. Use the piston to assure alignment and measure gap with a thickness gauge (Figure 9-47). If the gap exceeds the service limit, insert a new ring in the cylinder and measure gap. If the gap is still out of specification, check the cylinder wall for wear.

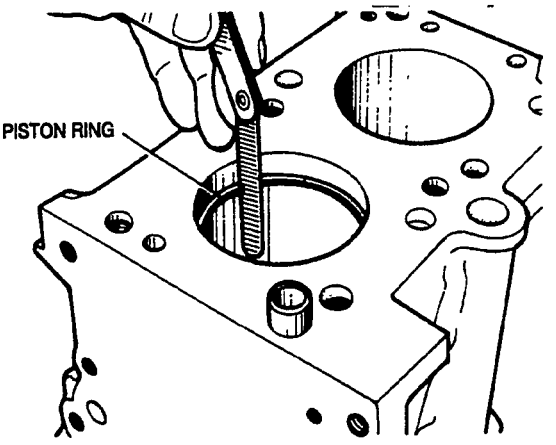


FIGURE 9-47. MEASURING PISTON RING GAP

- **Connecting Rod Bearing**

1. Check for improper contact, seizure, flaking and melting.
2. Check the oil clearance.

- **Connecting Rods**

1. Check the connecting rods for bend and distortion by using a connecting rod aligner. If the rod is bent or twisted in excess of the standard value, correct or replace.
2. With the connecting rods installed on crankpins, check side clearance. If the side clearance exceeds the service limit, replace the connecting rod.

Installation

1. Install the piston to the connecting rod by the following procedure.

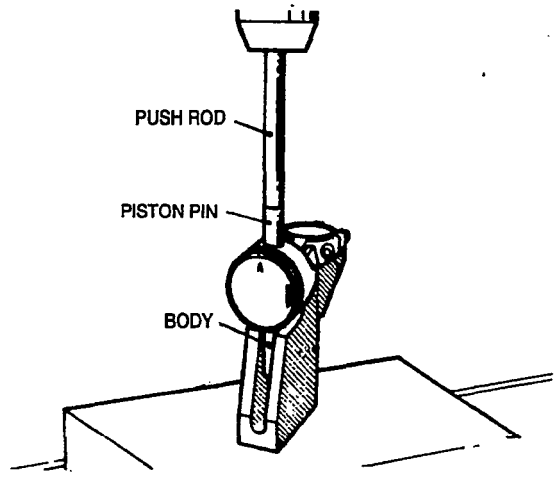
   A. Set the piston pin securely between the push rod and guide bar of special tool "Push Rod Guide Set", "Piston Pin Setting Tool" and "Push Rod Guide Set" (Figure 9-48).

   B. Set the connecting rod in piston and insert the piston pin assembled on special tools in Step A.

   ⚠CAUTION ***Apply engine oil to both the external surface of piston pin and the small end bore of connecting rod.***

   When setting the connecting rod in the piston, be sure the front marks on the connecting rod ("F") and the piston end surface mark (▲) both face upward.

   C. Insert the tool body into the piston from the skirt side and set it in such a manner that the lower side of the connecting rod is in firm contact with the support surface of the tool body. While holding the push rod, turn the guide bar a quarter turn so that the guide bar will not slip off the body notch.



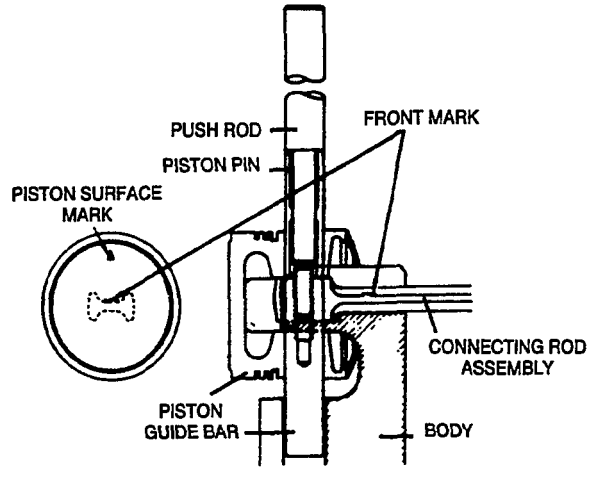


FIGURE 9-48. ASSEMBLING PISTON AND CONNECTING ROD

   D. Set the special tool and piston/connecting rod assembly on a press stand. Apply 1100 to 3300 pound (500 to 1500 kg) load to the push rod until the lower end of the guide bar bottoms the special tool body. The piston pin is installed in the specified position by pressing until the guide bar bottom surface is seated on the stopper. If the press-in load is out of the standard value, replace the piston or connecting rod.

2. Install the piston rings (No. 1 and No. 2) in the top and middle grooves. Be sure that the side which bears the size and manufacturer's mark face upward (toward the cylinder head). See Figure 9-49.

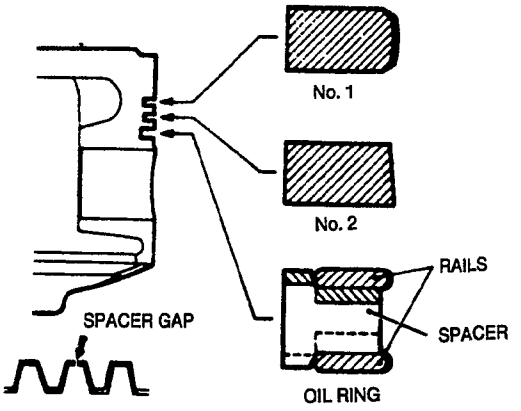


FIGURE 9-49. SEQUENCE OF RING INSTALLATION

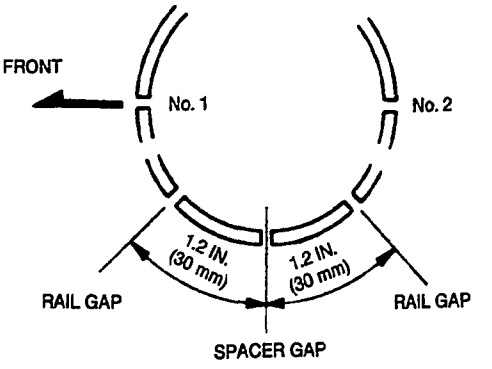


FIGURE 9-50. PISTON RING GAP POSITION

⚠CAUTION ***When the oil ring side rails are installed, do not expand the open ends with a piston ring expander like the other piston rings. It is very thin and might be broken if expanded. Place one end between the groove and spacer, hold it firmly with the thumb and slide the other thumb down on the ring. See Figure 9-49.***

The manufacturer's mark is stamped at the open ends of the side rail and rings. When the side rail and rings are installed in the piston, face the stamped surface up (toward the cylinder head.

After the three-piece oil ring has been installed on the piston, check to ensure that the side rails turn smoothly in both directions.

3. The oil ring should be rotated so that the spacer gap is 1.2 inch (30 mm) apart from each of the upper and lower rail gaps and that the gaps or these parts are apart from one another. See Figure 9-50. Piston ring gaps must not be in line with each other and must be off the thrust direction as shown.
4. Fit the connecting rod bearing on the connecting rod. Clean the bearing surface and apply engine oil.
5. Hold each piston/connecting rod assembly with the front mark "F" toward the front of the engine (Figure 9-51). Insert into cylinders from above the block (cylinder head side) as shown.

⚠CAUTION ***Insert the piston assembly with the mark "1" on connecting rod bearing end into the front cylinder and the other assembly with no mark into the rear cylinder.***

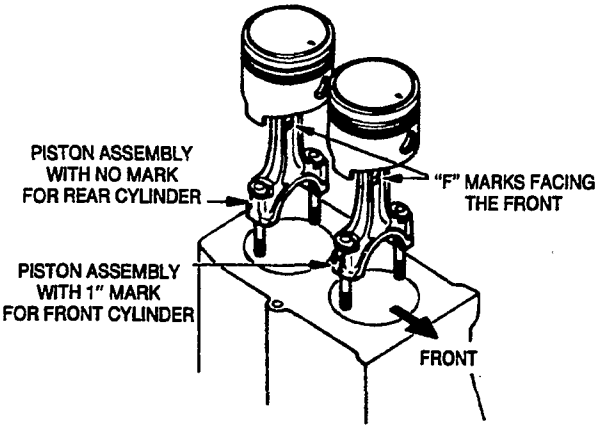


FIGURE 9-51. DIRECTION OF ROD INSTALLATION

6. Compress the piston rings with a ring band and insert the piston and connecting rod assembly while lightly pushing the top of the piston (Figure 9-52).

⚠CAUTION ***If the piston is forced in by striking with undue force, the piston rings (side rail) could be broken or the crankshaft damaged.***

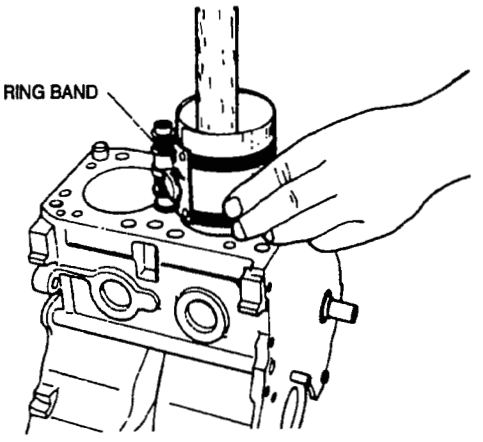


FIGURE 9-52 INSERTING PISTON

7. Fit the bearing in the connecting rod cap. Clean the bearing surface and apply engine oil.
8. Install the connecting rod cap marked "1" to the connecting rod in the front cylinder, and the cap without mark on the rod in the rear cylinder. Be sure the cap notches align with notches of the connecting rod bearing cap.
9. Tighten the cap bolts to specified torque (Figures 9-53 and 9-44). Check bearing free movement. If there is any binding, find cause and correct before proceeding.

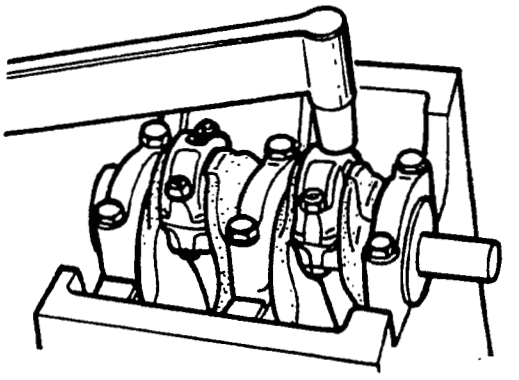


FIGURE 9-53. TIGHTENING CONNECTING ROD GAP

10. Install a new oil pan gasket and torque pan bolts to specified torque.
11. Install the cylinder head assembly on the cylinder block (refer to the section "Cylinder Head and Valves").

Components

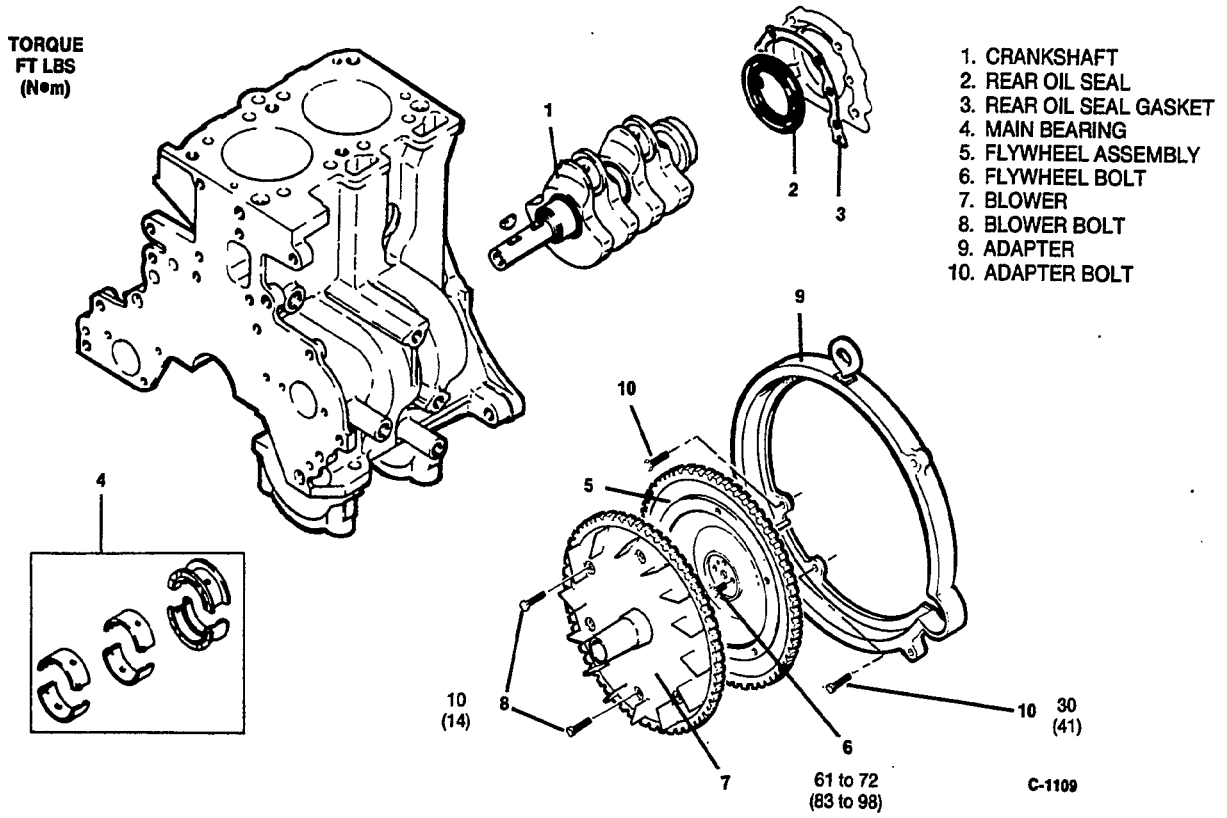


FIGURE 9-54. CRANKSHAFT, FLYWHEEL, BLOWER, ADAPTER

Inspection

Perform the following checks. Replace parts if defective.

- **Crankshaft**

1. Remove the blower, generator adapter and flywheel from the engine in the order listed. When removing the flywheel, use special tool "Flywheel Stopper" if necessary to keep the assembly from turning (Figure 9-61).
2. With the crankshaft and bearing caps still in the cylinder block, check the crankshaft end play by means of a dial indicator shown in Figure 9-55. If the end play exceeds the service limit, replace the rear bearing.

A bent crankshaft may give inaccurate readings. If the crankshaft is repaired or replaced, repeat this step after reassembly.

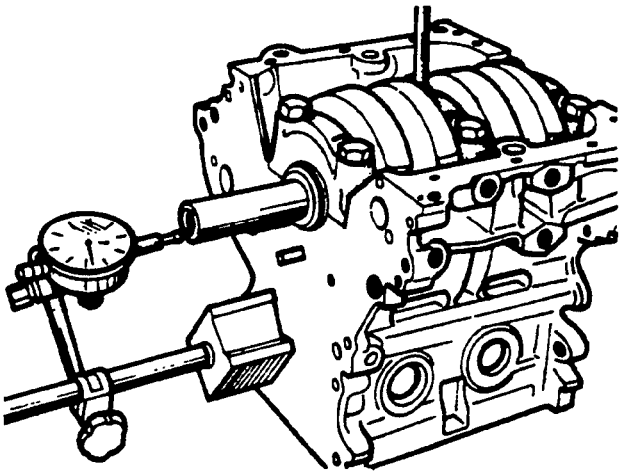


FIGURE 9-55. CHECKING THE CRANKSHAFT END PLAY

3. Place the crankshaft on a checking stand as shown in Figure 9-56 (special tool). Check the journals and pins for damage, uneven wear, cracks and clogged oil holes. Correct or replace the crankshaft if defective.
4. Measure the runout of the crankshaft as shown in Figure 9-56. If the runout is excessive, correct or replace.

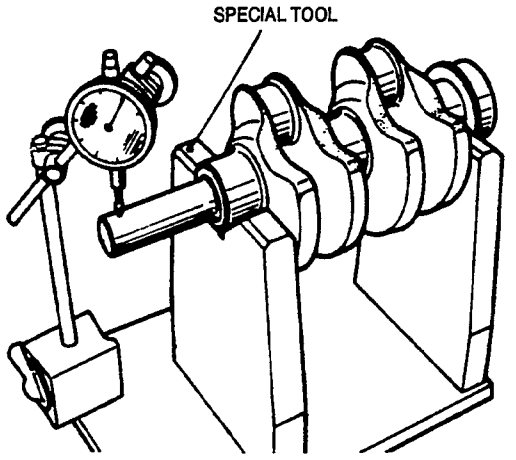


FIGURE 9-56. MEASURING CRANKSHAFT RUNOUT

5. Measure the outside diameter of the journals and pins (Figure 9-57). If excessive taper and wear are evident, machine to undersize.

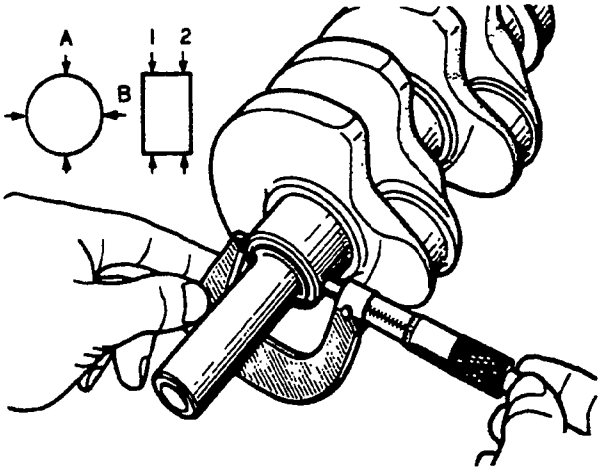


FIGURE 9-57. MEASURING JOURNAL OUTSIDE DIAMETER

⚠CAUTION ***When the crankshaft is ground to undersize, note the fillets of the journal and pin to maintain the radius indicated in Figure 9-58.***

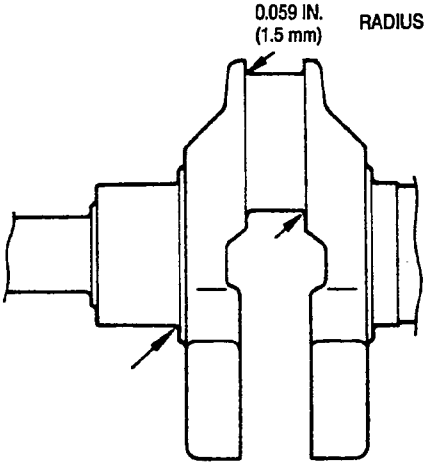


FIGURE 9-58. FILLET RADIUS

- **Crankshaft Oil Clearance**

1. Measure the journal outside diameter and main bearing inside diameter and calculate the oil clearance from the difference (Figure 9-59). Obtain the oil clearance between the crank pin and the connecting rod bearing by the same procedure.

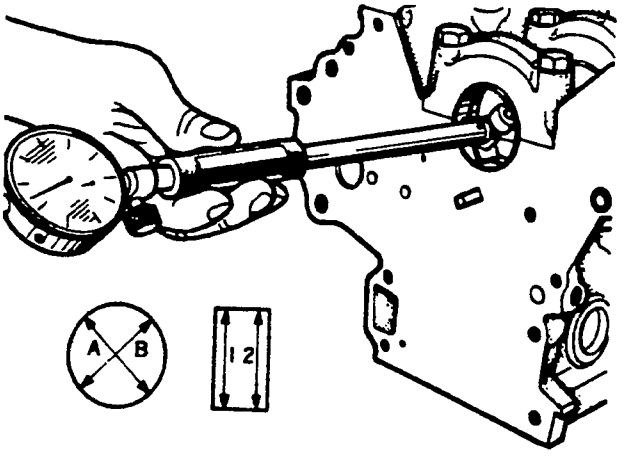


FIGURE 9-59. MEASURING MAIN BEARING I.D.

2. If the oil clearance is too large after installation of a new standard size bearing, grind the crankshaft to undersize. The bearing should also be replaced with one of corresponding undersize. The final oil clearance must be as shown in Table 9-2.

⚠CAUTION ***When replacing the bearing, use one of the sizes shown in Table 9-2.***

When using undersize bearing, grind the journals or pins to obtain the oil clearance shown in Table 9-2.

TABLE 9-2. MAIN BEARING OIL CLEARANCE

Size of spare parts	Identification mark	Oil Clearance (In. mm)	
		Crankshaft journal	Connecting rod pin
STD	Brown	0.0014 to 0.0031 (0.036 to 0.078)	0.0011 to 0.0026 (0.029 to 0.067)
0.25 U.S	U.S25	0.0014 to 0.0038 (0.036 to 0.097)	0.0011 to 0.0033 (0.028 to 0.083)
0.50U.S	U.S50		
0.75U.S	U.S75		

Installation

⚠CAUTION ***All parts should be washed before assembling. Apply clean engine oil to sliding and rotating surfaces.***

1. Install the upper main bearing to the cylinder block. The upper main bearing has an oil groove. When the main bearing is reused, make sure that it is installed in the same position as before disassembly.
2. Apply clean engine oil to the bearing surface.
3. Install the lower main bearing (having no oil groove) to the cap.
4. Install the bearing caps to the cylinder block. Note the Cap No. and arrow marks when the caps are installed (Figure 9-60).

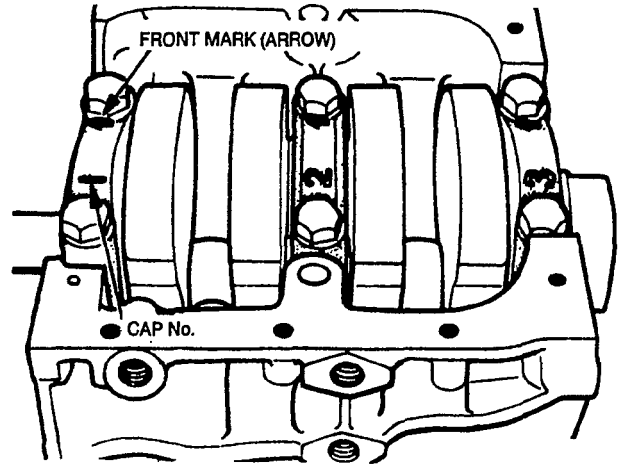


FIGURE 9-60. INSTALLING MAIN BEARING CAPS

5. Tighten cap bolts to the specified torque.
6. Check to ensure that the crankshaft rotates lightly and smoothly. Check the crankshaft end play to see if it is to specification.
7. Install the oil seal in the crankshaft rear oil seal case. When inserting the oil seal into the case, press the flange uniformly until it is in firm contact with the case. Use care not to bend the oil seal.
8. Install the oil seal case assembly to the cylinder block rear surface with a gasket between. At this time apply engine oil to the oil seal lips. Ensure that the lips are not turned up when the assembly is installed.
9. Install the rear plate.
10. Install the flywheel and tighten the flywheel bolts (bolts with a flange) to the specified torque. Use special tool "Flywheel Stopper" to keep the assembly from turning (Figure 9-61).

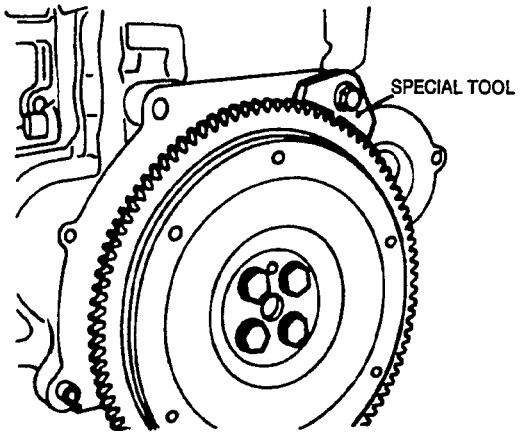


FIGURE 9-61. LOCATION OF FLYWHEEL STOPPER

11. Install the generator adapter. Note: two bolt lengths are used and must be installed as shown in Figure 9-62. Tighten to specified torque.
12. Install blower to the flywheel. For proper orientation, align mark on the blower with timing mark on the engine flywheel (Figure 9-62). Install the two place bolts at locations marked x (two smaller holes).
13. Install the remaining four standard bolts to blower and at this time, tighten bolts only until they are snug.
14. Use a dial indicator and check blower runout. If necessary, loosen bolts and shift the assembly slightly as required.
15. Tighten bolts to specified torque.

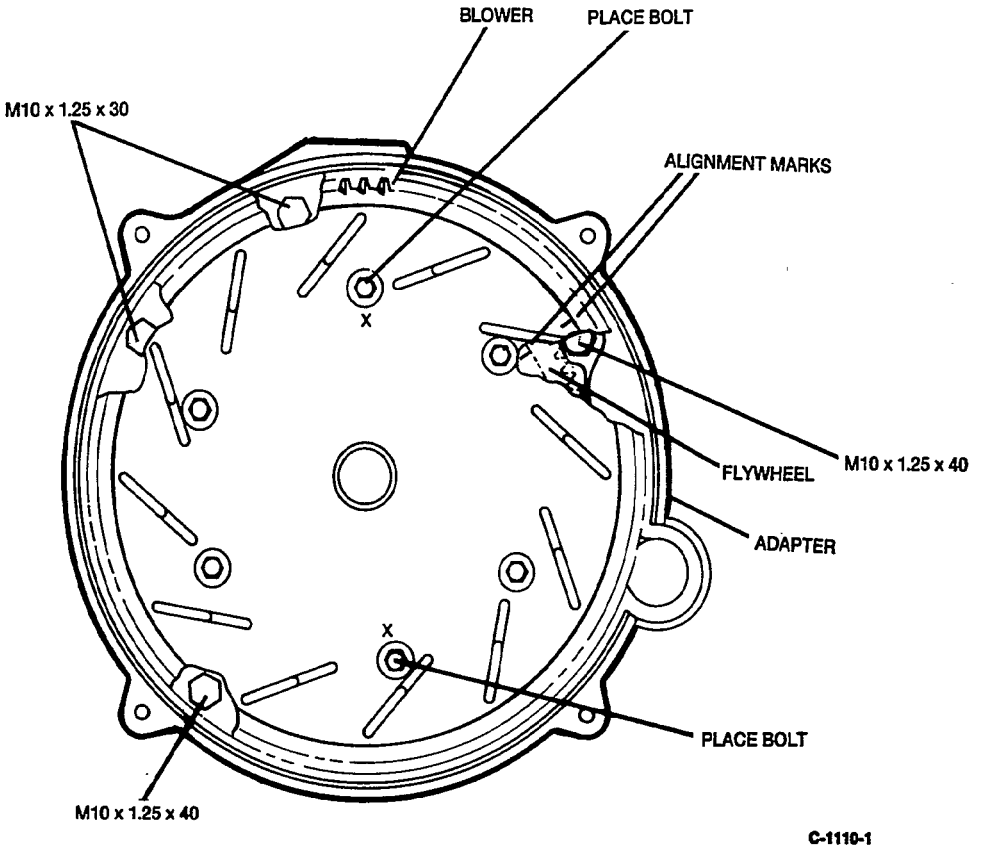
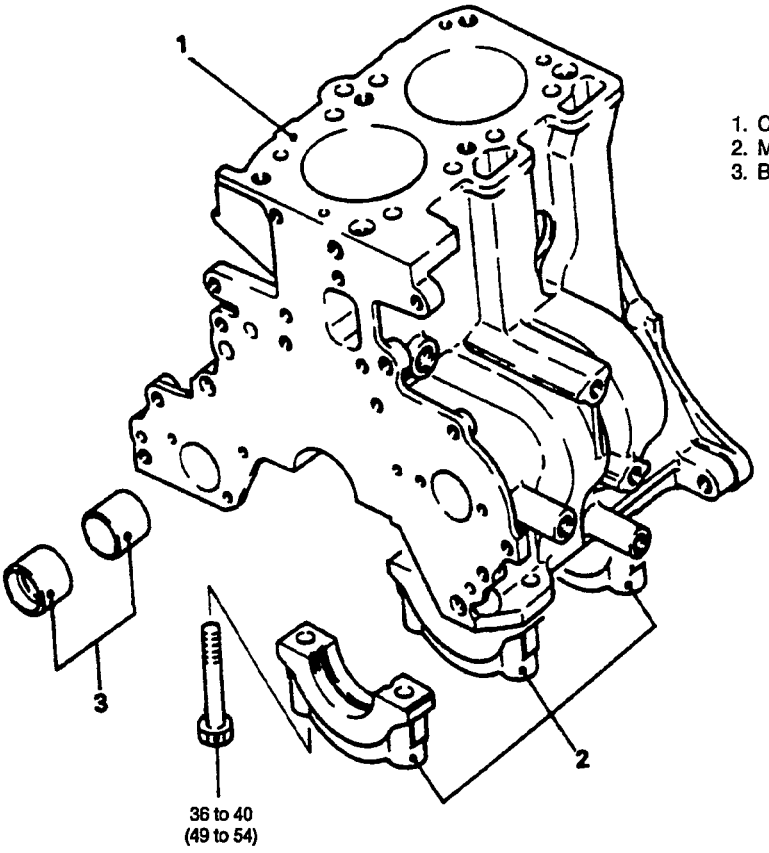


FIGURE 9-62. ADAPTER, BLOWER ASSEMBLY

Components

TORQUE
FT LBS
(N•m)



1. CYLINDER BLOCK
2. MAIN BEARING CAP
3. BALANCER SHAFT BEARING

FIGURE 9-63. CYLINDER BLOCK COMPONENTS

Inspection

Perform the following component checks. Correct or replace parts if defective.

⚠CAUTION ***Check the cylinder for water leakage and damage before washing.***

Carefully wash each part to remove dirt, oil, carbon and scales before inspection and repair.

Apply compressed air to each oil hole to remove dirt. Make sure the holes are not blocked.

• Cylinder Block

1. Visually check the cylinder block for presence of scratches, rust, and corrosion. Also check for flaws by using a flaw detecting agent. Repair or replace a block that is defective.
2. Using a straight edge and thickness gauge, measure flatness on the top surface of cylinder block (Figure 9-64). If the top surface is distorted beyond limit, correct by grinding. When flatness is measured, check to ensure that there are no gasket pieces and other deposits on the top surface of the cylinder block.

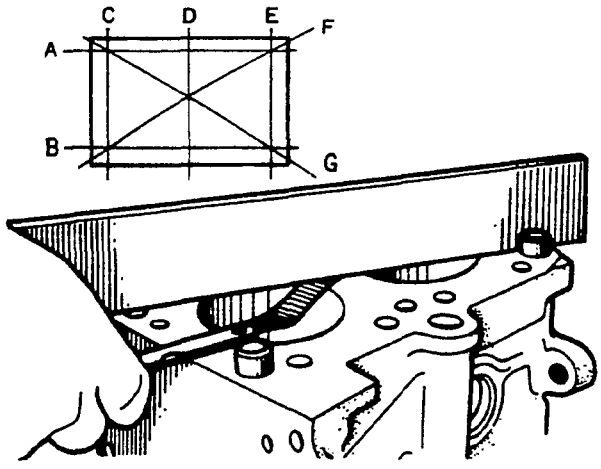


FIGURE 9-64. MEASURING FLATNESS OF BLOCK

3. Check the cylinder wall for scratches or seizure. If defective, correct (grind or oversize) or replace.
4. Using a cylinder gauge, measure the cylinder bore for eccentricity. If excessive wear is evident, correct the cylinder to oversize and replace the piston and piston rings. The measuring points are shown in Figure 9-65.

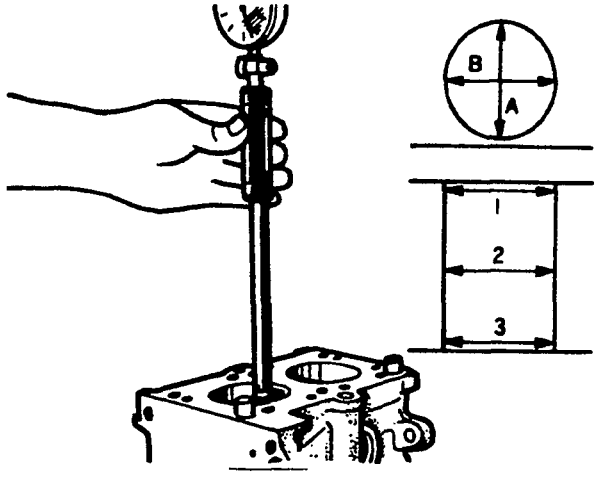


FIGURE 9-65. MEASURING CYLINDER BORE

- **Boring of Cylinder**

1. Check the bore of each cylinder. If any of the cylinders need boring, bore both of them and use oversize pistons.
2. If the cylinders are not badly worn and only the piston rings need replacing, grind the cylinder top ridge with a ridge reamer and perform honing as necessary.
3. Oversize pistons come in four sizes. Pistons to be used should be determined by the cylinder having the largest bore size.

   A. Measure the outside diameter of each piston at the skirt and across the thrust faces. The outside diameter of the piston should be checked at a point 0.59 inch (15 mm) above the bottom of the piston across the thrust faces (Figure 9-66).

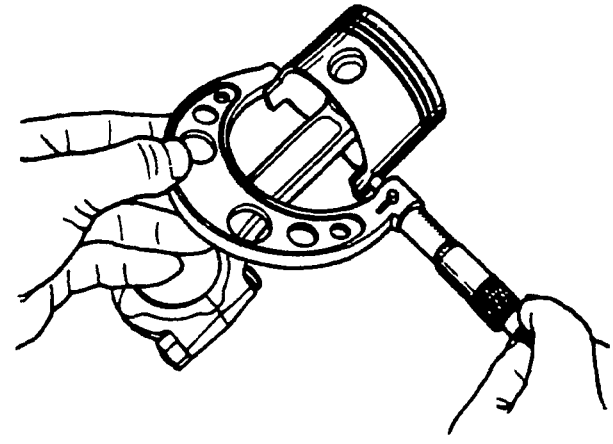


FIGURE 9-66. MEASURING PISTON O.D.

   B. The cylinder bore size for reboring is obtained as follows:

      a. Measured value of piston O.D. that has been determined to be used.
      b. Clearance between piston and cylinder wall = 0.0008 to 0.0016 inch (0.02 to 0.04 mm).
      c. Honing margin 0.0008 inch (0.02 mm) or less.

      Finished bore size after reboring
      = a + b - c
      = a + 0 to 0.0008 in. (0 to 0.02 mm)

   C. The cylinder should be rebored to the finish size obtained by calculation.

⚠CAUTION ***The finish cutting margin is about 0.0020 inch (0.05 mm). Do not cut too much at a time.***

The cylinder bore measurement can vary due to heat resulting from cutting. Do not measure immediately after reboring.

   D. Hone the bore accurately to the finished size. It is advisable to perform honing to such an extent that no trace of the cutting tool can be seen. Honing angle shall be 30° to 45°.
   E. Measure piston-to-cylinder wall clearance.

Retightening Cylinder Head Bolts

To retighten the cylinder head bolts, use special tool "Cylinder Head Bolt Wrench". First slightly loosen and then retighten the bolts to the specified torque.

The bolts should be tightened in the numbered sequence shown in Figure 9-67.

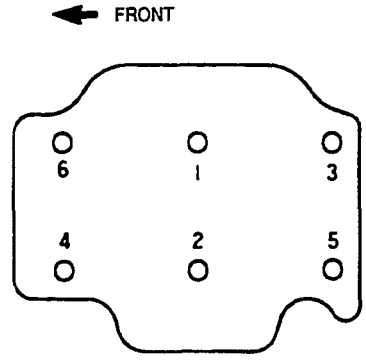


FIGURE 9-67. CYLINDER HEAD BOLT TIGHTENING SEQUENCE

Valve Clearance Adjustment

⚠CAUTION ***Make adjustment of the valve clearance after the cylinder head bolts have been tightened to the specified torque. Failure to do so will result in misadjustment.***

1. Warm up the engine until the cooling water temperature reaches 176° to 194° F (80° to 90° C).
2. Make the adjustment at top dead center on the compression stroke of each cylinder in accordance with the sequence indicated below.
3. Loosen the lock nuts.
4. Make the adjustment by turning the adjusting screws while using a thickness gauge to measure the clearance (Figure 9-68). Secure the following values.

   Intake Valve = 0.0059 in. (0.15 mm)

   Exhaust Valve = 0.0098 in. (0.25 mm)

5. Hold the adjusting screw with a screwdriver and tighten the lock nut securely.

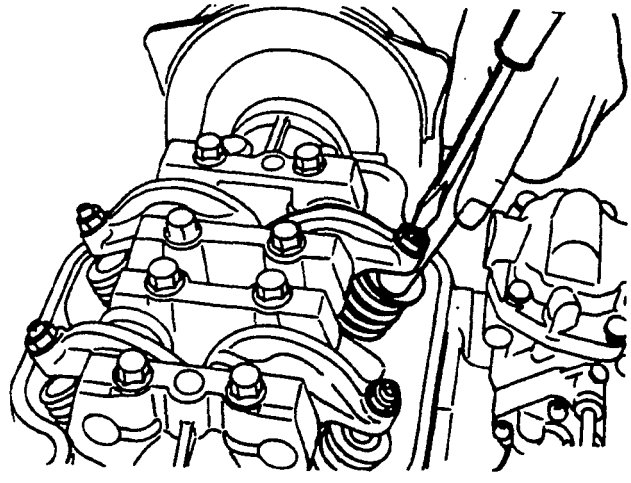


FIGURE 9-68. VALVE CLEARANCE ADJUSTMENT

Section 10. Service Checklist

After servicing, inspect and test the completed installation to confirm that the generator set will operate properly and supply 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 and movement.

LUBRICATION/COOLING

If the engine oil was drained, fill the crankcase with oil of the recommended classification and viscosity. If the coolant was drained, replace with ethylene glycol and water mixture. Prime the sea water pump if dry. The pump impeller can be damaged if it is run dry. Refer to the Operator's Manual for specific recommendations and procedures.

WIRING

Verify that all wiring connections are tight and correct. Check each of the following:

- Load Wires
- Control Wires
- Ground Straps
- Battery Cables

INITIAL START ADJUSTMENTS

Adjust the carburetor idle adjustment screw and main adjustment screw as specified in the Fuel System portion of Section 6 to allow starting. Open the sea cock and fuel shut-off valves.

When starting the set for the first time, listen for any unusual sounds or vibrations. Adjust carburetor fuel adjustments as necessary to keep the engine running smoothly. When the engine has reached operating temperature, make final adjustments to the carburetor and governor.

⚠WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas formed during the combustion of hydrocarbon fuels. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning are the following:

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

If you or anyone else experience any of these symptoms, shut down the unit and get out into the fresh air immediately. If symptoms persist, seek medical attention. DO NOT OPERATE THE UNIT UNTIL IT HAS BEEN INSPECTED AND REPAIRED.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent visual and audible inspections of the complete exhaust system.

EXHAUST SYSTEM

With the generator set operating, inspect the entire exhaust system including the exhaust manifold, muffler, and hose connections. If leaks are detected, stop the set and correct immediately.

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

OUTPUT CHECK

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

FUEL SYSTEM

With the generator set operating, inspect the fuel supply line, filters, 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, correct immediately.***

CONTROL

Stop and start the generator set several times at the set control and remote control 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 bulkhead or wall that separates the compartment from the interior living quarters. Seal openings as required.

Onan

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