



SERVICE MANUAL

W-52/63B and 63C-FOUR MARINE DIESEL ENGINES

AND

15 KW - 60 Hz 12 KW - 50 Hz WTA

15 KW - 60 Hz 12 KW - 50 Hz WMF

15 KW - 60 Hz 12 KW - 50 Hz BTDA

15 KW - 60 Hz 12 KW - 50 Hz BTDB

MARINE DIESEL GENERATORS

SINGLE AND THREE PHASE

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 **Member National Marine Manufacturers Association**

**CALIFORNIA
PROPOSITION 65 WARNING**

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

 **WARNING**

Exhaust gasses contain Carbon Monoxide, an odorless and colorless gas. Carbon Monoxide is poisonous and can cause unconsciousness and death. Symptoms of Carbon Monoxide exposure can include:

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

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

SAFETY INSTRUCTIONS

INTRODUCTION

Read this safety manual carefully. Most accidents are caused by failure to follow fundamental rules and precautions. Know when dangerous conditions exist and take the necessary precautions to protect yourself, your personnel, and your machinery.

The following safety instructions are in compliance with the American Boat and Yacht Council (ABYC) standards.

PREVENT ELECTRIC SHOCK

⚠ WARNING: Do not touch AC electrical connections while engine is running, or when connected to shore power. Lethal voltage is present at these connections!

- Do not operate this machinery without electrical enclosures and covers in place.
- Shut off electrical power before accessing electrical equipment.
- Use insulated mats whenever working on electrical equipment.
- Make sure your clothing and skin are dry, not damp (particularly shoes) when handling electrical equipment.
- Remove wristwatch and all jewelry when working on electrical equipment.
- Do not connect utility shore power to vessel's AC circuits, except through a ship-to-shore double throw transfer switch. Damage to vessel's AC generator may result if this procedure is not followed.
- Electrical shock results from handling a charged capacitor. Discharge capacitor by shorting terminals together.

PREVENT BURNS — HOT ENGINE

⚠ WARNING: Do not touch hot engine parts or exhaust system components. A running engine gets very hot!

- Always check the engine coolant level at the coolant recovery tank.

⚠ WARNING: Steam can cause injury or death!

- In case of an engine overheat, allow the engine to cool before touching the engine or checking the coolant.

PREVENT BURNS — FIRE

⚠ WARNING: Fire can cause injury or death!

- Prevent flash fires. Do not smoke or permit flames or sparks to occur near the carburetor, fuel line, filter, fuel pump, or other potential sources of spilled fuel or fuel vapors. Use a suitable container to catch all fuel when removing the fuel line, carburetor, or fuel filters.
- Do not operate with a Coast Guard Approved flame arrester removed. Backfire can cause severe injury or death.
- Do not operate with the air cleaner/silencer removed. Backfire can cause severe injury or death.
- Do not smoke or permit flames or sparks to occur near the fuel system. Keep the compartment and the engine/generator clean and free of debris to minimize the chances of fire. Wipe up all spilled fuel and engine oil.
- Be aware — diesel fuel will burn.

PREVENT BURNS — EXPLOSION

⚠ WARNING: Explosions from fuel vapors can cause injury or death!

- Follow re-fueling safety instructions. Keep the vessel's hatches closed when fueling. Open and ventilate cabin after fueling. Check below for fumes/vapor before running the blower. Run the blower for four minutes before starting your engine.
- All fuel vapors are highly explosive. Use extreme care when handling and storing fuels. Store fuel in a well-ventilated area away from spark-producing equipment and out of the reach of children.
- Do not fill the fuel tank(s) while the engine is running.
- Shut off the fuel service valve at the engine when servicing the fuel system. Take care in catching any fuel that might spill. DO NOT allow any smoking, open flames, or other sources of fire near the fuel system or engine when servicing. Ensure proper ventilation exists when servicing the fuel system.
- Do not alter or modify the fuel system.
- Be sure all fuel supplies have a positive shutoff valve.
- Be certain fuel line fittings are adequately tightened and free of leaks.
- Make sure a fire extinguisher is installed nearby and is properly maintained. Be familiar with its proper use. Extinguishers rated ABC by the NFPA are appropriate for all applications encountered in this environment.

SAFETY INSTRUCTIONS

ACCIDENTAL STARTING

⚠ WARNING: Accidental starting can cause injury or death!

- Disconnect the battery cables before servicing the engine/generator. Remove the negative lead first and reconnect it last.
- Make certain all personnel are clear of the engine before starting.
- Make certain all covers, guards, and hatches are re-installed before starting the engine.

BATTERY EXPLOSION

⚠ WARNING: Battery explosion can cause injury or death!

- Do not smoke or allow an open flame near the battery being serviced. Lead acid batteries emit hydrogen, a highly explosive gas, which can be ignited by electrical arcing or by lit tobacco products. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.
- Never connect the negative (-) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb the battery charger connections while the battery is being charged.
- Avoid contacting the terminals with tools, etc., to prevent burns or sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling the battery.
- Always turn the battery charger off before disconnecting the battery connections. Remove the negative lead first and reconnect it last when disconnecting the battery.

BATTERY ACID

⚠ WARNING: Sulfuric acid in batteries can cause severe injury or death!

- When servicing the battery or checking the electrolyte level, wear rubber gloves, a rubber apron, and eye protection. Batteries contain sulfuric acid which is destructive. If it comes in contact with your skin, wash it off at once with water. Acid may splash on the skin or into the eyes inadvertently when removing electrolyte caps.

TOXIC EXHAUST GASES

⚠ WARNING: Carbon monoxide (CO) is a deadly gas!

- Ensure that the exhaust system is adequate to expel gases discharged from the engine. Check the exhaust system regularly for leaks and make sure the exhaust manifolds are securely attached and no warping exists. Pay close attention to the manifold, water injection elbow, and exhaust pipe nipple.
- Be sure the unit and its surroundings are well ventilated.
- In addition to routine inspection of the exhaust system, install a carbon monoxide detector. Consult your boat builder or dealer for installation of approved detectors.
- For additional information refer to ABYC T-22 (educational information on Carbon Monoxide).

⚠ WARNING: Carbon monoxide (CO) is an invisible odorless gas. Inhalation produces flu-like symptoms, nausea or death!

- Do not use copper tubing in diesel exhaust systems. Diesel fumes can rapidly destroy copper tubing in exhaust systems. Exhaust sulfur causes rapid deterioration of copper tubing resulting in exhaust/water leakage.
- Do not install exhaust outlet where exhaust can be drawn through portholes, vents, or air conditioners. If the engine exhaust discharge outlet is near the waterline, water could enter the exhaust discharge outlet and close or restrict the flow of exhaust. Avoid overloading the craft.
- Although diesel engine exhaust gases are not as toxic as exhaust fumes from gasoline engines, carbon monoxide gas is present in diesel exhaust fumes. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are:
 - Vomiting
 - Dizziness
 - Throbbing in temples
 - Muscular twitching
 - Intense headache
 - Weakness and sleepiness

AVOID MOVING PARTS

⚠ WARNING: Rotating parts can cause injury or death!

- Do not service the engine while it is running. If a situation arises in which it is absolutely necessary to make operating adjustments, use extreme care to avoid touching moving parts and hot exhaust system components.

SAFETY INSTRUCTIONS

- Do not wear loose clothing or jewelry when servicing equipment; tie back long hair and avoid wearing loose jackets, shirts, sleeves, rings, necklaces or bracelets that could be caught in moving parts.
- Make sure all attaching hardware is properly tightened. Keep protective shields and guards in their respective places at all times.
- Do not check fluid levels or the drive belt's tension while the engine is operating.
- Stay clear of the drive shaft and the transmission coupling when the engine is running; hair and clothing can easily be caught in these rotating parts.

HAZARDOUS NOISE

 **WARNING: High noise levels can cause hearing loss!**

- Never operate an engine without its muffler installed.
- Do not run an engine with the air intake (silencer) removed.
- Do not run engines for long periods with their enclosures open.

 **WARNING: Do not work on machinery when you are mentally or physically incapacitated by fatigue!**

OPERATORS MANUAL

Many of the preceding safety tips and warnings are repeated in your Operators Manual along with other cautions and notes to highlight critical information. Read your manual carefully, maintain your equipment, and follow all safety procedures.

ENGINE INSTALLATIONS

Preparations to install an engine should begin with a thorough examination of the American Boat and Yacht Council's (ABYC) standards. These standards are a combination of sources including the USCG and the NFPA.

Sections of the ABYC standards of particular interest are:

- H-2 Ventilation
- P-1 Exhaust systems
- P-4 Inboard engines
- E-9 DC Electrical systems

All installations must comply with the Federal Code of Regulations (FCR).

ABYC, NFPA AND USCG PUBLICATIONS FOR INSTALLING DIESEL ENGINES

Read the following ABYC, NFPA and USCG publications for safety codes and standards. Follow their recommendations when installing your engine.

ABYC (American Boat and Yacht Council)
"Safety Standards for Small Craft"

Order from:

ABYC
15 East 26th Street
New York, NY 10010

NFPA (National Fire Protection Association)
"Fire Protection Standard for Motor Craft"

Order from:

National Fire Protection Association
11 Tracy Drive
Avon Industrial Park
Avon, MA 02322

USCG (United States Coast Guard)
"USCG 33CFR183"

Order from:

U.S. Government Printing Office
Washington, D.C. 20404

INSTALLATION

When installing WESTERBEKE engines and generators it is important that strict attention be paid to the following information:

CODES AND REGULATIONS

Strict federal regulations, ABYC guidelines, and safety codes must be complied with when installing engines and generators in a marine environment.

SIPHON-BREAK

For installations where the exhaust manifold/water injected exhaust elbow is below the vessel's waterline, provisions must be made to install a siphon-break in the raw water supply hose to the exhaust elbow. This hose must be looped a minimum of 20" above the vessel's waterline. *Failure to use a siphon-break when the exhaust manifold injection port is at or below the load waterline will result in raw water damage to the engine and possible flooding of the boat.*

EXHAUST SYSTEM

The exhaust hose must be certified for marine use. The system must be designed to prevent water from entering the exhaust under any sea conditions and at any angle of the vessels hull.

A detailed 40 page Marine Installation Manual covering gasoline and diesel, engines and generators, is available from your WESTERBEKE dealer.

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INTRODUCTION

PRODUCT SOFTWARE

Product software (tech data, parts lists, manuals, brochures and catalogs) provided from sources other than WESTERBEKE are not within WESTERBEKE'S control.

WESTERBEKE CANNOT BE RESPONSIBLE FOR THE CONTENT OF SUCH SOFTWARE, MAKES NO WARRANTIES OR REPRESENTATIONS WITH RESPECT THERETO, INCLUDING ACCURACY, TIMELINESS OR COMPLETENESS THEREOF AND WILL IN NO EVENT BE LIABLE FOR ANY TYPE OF DAMAGE OR INJURY INCURRED IN CONNECTION WITH OR ARISING OUT OF THE FURNISHING OR USE OF SUCH SOFTWARE. WESTERBEKE customers should also keep in mind the time span between printings of WESTERBEKE product software and the unavoidable existence of earlier WESTERBEKE manuals. Product software provided with WESTERBEKE products, whether from WESTERBEKE or other suppliers, must not and cannot be relied upon exclusively as the definitive authority on the respective product. It not only makes good sense but is imperative that appropriate representatives of WESTERBEKE or the supplier in question be consulted to determine the accuracy and currentness of the product software being consulted by the customer.

NOTES, CAUTIONS AND WARNINGS

As this manual takes you through the disassembly, inspection and assembly procedure of your engine/generator, critical information will be highlighted by NOTES, CAUTIONS, and WARNINGS. An explanation follows:

NOTE: *An operating procedure essential to note.*

CAUTION: *Procedures, which if not strictly observed, can result in the damage or destruction of your engine/generator.*

WARNING: *Procedures, which if not properly followed, can result in personal injury or loss of life.*

ORDERING PARTS

Whenever replacement parts are needed, always provide the generator model number, engine serial number, and generator serial number as they appear on the silver and black name-plate located on the generator end. You must provide us with this information so we may properly identify your engine/generator. In addition, include a complete part description and part number for each part needed (see the separately furnished Parts List). Also insist upon WESTERBEKE packaged parts because *will fit* or generic parts are frequently not made to the same specifications as original equipment.

CUSTOMER IDENTIFICATION CARD



Customer Identification
WESTERBEKE OWNER
MAIN STREET
HOMETOWN, USA

Model 63B Ser. #A0000-D711
Expires 9/1/98

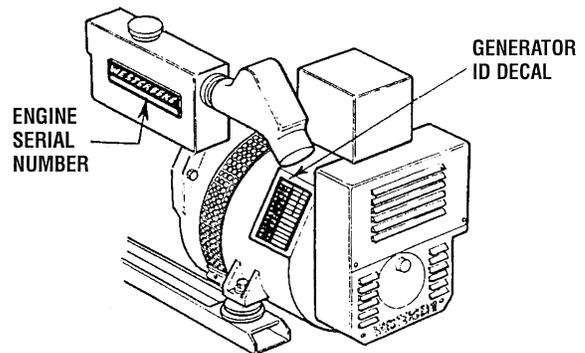
The WESTERBEKE serial number is an alphanumeric number that can assist in determining the date of manufacture of your WESTERBEKE engine/generator. The first character indicates the decade (A=1960s, B=1970s, C=1980s, D=1990s), the second character represents the year in the decade, and the fourth and fifth number represents the month of manufacture.

SERIAL NUMBER LOCATION

The engine and generator serial numbers and model numbers are located on a decal on the generator housing.

The engine serial number can also be found stamped into the engine block just above the injection pump. The generator serial number is stamped into the generator housing on the flat surface on the left side of the generator.

An identification plate on the engine manifold also displays the engine model and serial number.



ENGINE OVERHAUL

The following sections contain detailed information relating to the proper operation characteristics of the major components and systems of the engine. Included are disassembly, inspection and reassembly instructions for the guidance of suitable equipped and staffed marine engine service and rebuilding facilities. The necessary procedures should be undertaken only by such facilities.

Additional detailed information and specifications are provided in other sections of this manual, covering the generator, alternator, starter motor, engine adjustments, cooling pumps, etc.

ENGINE TROUBLESHOOTING

The following troubleshooting chart describes certain problems relating to engine service, the probable causes of these problems, and the recommendations to overcome these problems. This chart may be of assistance in determin-

ing the need for an engine overhaul.

NOTE: *The engine's electrical system is protected by a 20-ampere manual reset circuit breaker. The preheat solenoid is mounted on the same bracket.*

PROBLEM	PROBABLE CAUSE	VERIFICATION/REMEDY
HARD STARTING	LOW CRANKING SPEED <ol style="list-style-type: none"> 1. Engine oil viscosity too high. 2. Run-down battery. 3. Worn battery. 4. Battery terminals loosely connected. 5. Defective starter. 6. Defective main drive section. 	<ol style="list-style-type: none"> 1. Replace engine oil with less viscous oil. 2. Recharge battery. 3. Replace battery. 4. Clean terminals and correct cables. 5. Repair or replace starter. 6. Check clutch for disengagement.
	DEFECTIVE INJECTION SYSTEM <ol style="list-style-type: none"> 1. Air trapped in fuel passage. 2. Clogged fuel filter. 3. Low injection pressure. 4. Inadequate spray. 5. Injection pump delivering insufficient fuel. 6. Injection too early. 	<ol style="list-style-type: none"> 1. Bleed air from fuel system. 2. Clean or replace filter. 3. Adjust injection pressure. 4. Clean or replace nozzle. 5. Repair or replace injection pump. 6. Adjust injection timing.
	MAIN ENGINE TROUBLES <ol style="list-style-type: none"> 1. Low compression. <ol style="list-style-type: none"> a. Incorrect valve clearance. b. Inadequate contact of valve seat. c. Valve stem seized. d. Broken valve spring. e. Compression leaks through cylinder head gasket. f. Piston ring seized. g. Worn piston ring and cylinder. 2. Burnt glow plug. 3. Faulty glow plug operation. 4. Incorrect governor lever position. 5. Governor spring out of POSITION 	<ol style="list-style-type: none"> a. Adjust valve clearance. b. Lap valve. c. Replace valve and valve guide. d. Replace valve spring. e. Replace gasket. f. Replace piston and piston ring. g. Overhaul engine. 2. Replace glow plug. 3. Correct lead wire connection. 4. Set lever to starting position. 5. Correct spring
LOW OUTPUT	LOW COMPRESSION	See HARD STARTING
	INJECTION SYSTEM OUT OF ADJUSTMENT <ol style="list-style-type: none"> 1. Incorrect injection timing. 2. Insufficient injection. 3. Low injection pressure. 	<ol style="list-style-type: none"> 1. Adjust injection timing. 2. Repair or replace injection pump. 3. Check injection nozzle and adjust pressure.
	INSUFFICIENT FUEL <ol style="list-style-type: none"> 1. Air trapped in fuel system. 2. Clogged filter. 3. Contaminated fuel tank. 	<ol style="list-style-type: none"> 1. Check and retighten connector. 2. Clean or replace filter. 3. Clean tank.
	INSUFFICIENT INTAKE AIR <ol style="list-style-type: none"> 1. Clogged air cleaner. 	<ol style="list-style-type: none"> 1. Clean or replace air cleaner.

(continued)

ENGINE TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	VERIFICATION/REMEDY
LOW OUTPUT (cont.)	OVERHEATING 1. Low coolant level. 2. Loose V-belt. 3. Incorrect injection timing. 4. Low engine oil level.	1. Add coolant. 2. Adjust or replace V-belt. 3. Adjust injection timing. 6. Add engine oil.
EXCESSIVE OIL CONSUMPTION	OIL LEAKAGE 1. Defective oil seals. 2. Broken gear case gasket. 3. Loose gear case attaching bolts. 4. Loose drain plug. 5. Loose oil pipe connector. 6. Broken rocker cover gasket. 7. Loose rocker cover attaching bolts.	1. Replace oil seals. 2. Replace gasket. 3. Retighten bolts. 4. Retighten plug. 5. Retighten oil connections. 6. Replace gasket. 7. Retighten attaching bolts.
	OIL LEVEL RISING 1. Incorrectly positioned piston ring gaps. 2. Displaced or twisted connecting rod. 3. Worn piston ring. 4. Worn piston or cylinder.	1. Correct ring gap positions. 2. Replace connecting rod. 3. Replace ring. 4. Replace piston and rebore cylinder.
	OIL LEVEL FALLING 1. Defective stem seal. 2. Worn valve and valve guide.	1. Replace stem seal. 2. Replace a valve and valve guide.
EXCESSIVE FUEL CONSUMPTION	ENGINE BODY TROUBLES 1. Noisy knocking. 2. Smoky exhaust. 3. Moving parts nearly seized or excessively worn. 4. Poor compression. 5. Improper valve timing. 6. Improper valve clearance.	1. See <i>KNOCKING</i> . 2. See <i>SMOKY EXHAUST</i> . 3. Repair or replace. 4. See <i>LOW COMPRESSION; HARD STARTING</i> . 5. Adjust. 6. Adjust.
	INSUFFICIENT INTAKE AIR 1. Air intake obstructed.	1. Remove obstruction.
	NOZZLE TROUBLES 1. Seized nozzle. 2. Worn nozzle.	1. Replace. 2. Replace.
	IMPROPER FUEL	Replace with proper fuel.
SMOKY EXHAUST	FUEL LEAKS	Find fuel leaks.
	WHITISH OR PURPLISH 1. Excessive engine oil. 2. Excessive rise of oil into combustion chamber. a. Poor piston contact. b. Seized piston ring. c. Excessive piston-to-cylinder clearance.	1. Correct oil level. a. Check. b. Replace or clean. c. Replace or correct.

(continued)

ENGINE TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	VERIFICATION/REMEDY
SMOKY EXHAUST (cont.)	WHITISH OR PURPLISH (cont.) <ul style="list-style-type: none"> d. Worn valve stem and valve guide. e. Low engine oil viscosity. f. Excessive oil pressure. <ul style="list-style-type: none"> 3. Injection timing is too late. 4. Insufficient compression. 	<ul style="list-style-type: none"> d. Replace. e. Replace. f. Correct. <ul style="list-style-type: none"> 3. Adjust. 4. See <i>LOW COMPRESSION; HARD STARTING</i>.
	BLACKISH OR DARK GRAYISH <ul style="list-style-type: none"> 1. Engine body troubles. <ul style="list-style-type: none"> a. Poor compression. b. Improper valve clearance. 2. Insufficient intake air (air cleaner clogged). 3. Improper fuel. 	<ul style="list-style-type: none"> a. See <i>LOW COMPRESSION; HARD STARTING</i>. b. Adjust. <ul style="list-style-type: none"> 2. Clean air cleaner. 3. Replace with proper fuel.
ABNORMAL SOUND OR NOISE	CRANKSHAFT AND MAIN BEARING <ul style="list-style-type: none"> 1. Badly worn bearing. 2. Badly worn crankshaft. 3. Melted bearing. 	<ul style="list-style-type: none"> 1. Replace bearing and grind crankshaft. 2. Grind crankshaft. 3. Replace bearing and check lubrication system.
	CONNECTING ROD AND CONNECTING ROD BEARING <ul style="list-style-type: none"> 1. Worn connecting rod big end bearing. 2. Worn crankpin. 3. Bent connecting rod. 	<ul style="list-style-type: none"> 1. Replace bearing. 2. Grind crankshaft. 3. Correct bend or replace.
	PISTON, PISTON PIN, AND PISTON RING <ul style="list-style-type: none"> 1. Worn cylinder. 2. Worn piston pin. 3. Piston seized. 4. Piston seized and ring worn or damaged. 	<ul style="list-style-type: none"> 1. Rebore cylinder to oversize and replace piston. 2. Replace piston. 3. Replace piston and rebore cylinder. 4. Replace piston and rings.
	VALVE MECHANISM <ul style="list-style-type: none"> 1. Worn camshaft. 2. Excessive valve clearance. 3. Worn timing gear. 	<ul style="list-style-type: none"> 1. Replace. 2. Adjust. 3. Replace.
ROUGH OPERATION	INJECTION PUMP SYSTEM <ul style="list-style-type: none"> 1. Uneven injection. 2. Inadequate injection nozzle spray. GOVERNING SYSTEM <ul style="list-style-type: none"> 1. Governor lever malfunctioning. 2. Fatigued governor spring. 	<ul style="list-style-type: none"> 1. Adjust injection or replace parts. 4. Replace injection nozzle. <ul style="list-style-type: none"> 1. Check governor shaft and correct operation. 2. Replace.

(continued)

ENGINE TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	VERIFICATION/REMEDY
KNOCKING	ENGINE KNOCKS WITHOUT MUCH SMOKE 1. Main engine troubles. a. Overheated cylinder. b. Carbon deposits in cylinder. 2. Too early injection timing. 3. Too high injection pressure. 4. Improper fuel.	a. See <i>OVERHEATING; LOW OUTPUT.</i> b. Clean. 2. Correct. 3. Correct. 4. Replace with proper fuel.
	KNOCKING WITH DARK SMOKE 1. Poor compression. 2. Injection pump malfunctioning. 3. Improper nozzle. a. Poor spray. b. Poor chattering. c. After-injection drip. d. Nozzle needle valve seized.	1. See <i>LOW COMPRESSION; HARD STARTING.</i> 2. Adjust/Repair. a. Clean or replace nozzle. b. Repair or replace nozzle. c. Repair or replace nozzle. d. Replace.
INTERMITTENT EXHAUST SOUND	1. Fuel filter clogged. 2. Fuel pipe sucks air. 3. Water mixed in fuel	1. Clean or replace. 2. Retighten pipe joints or replace pipe. 3. Replace fuel.
OVERHEATING	1. V-belt slackening or slippery with oil. 2. Damaged water pump. 3. Lack of coolant. 4. Low oil level or poor oil quality. 5. Knocking. 6. Moving parts seized or damaged. 7. Defective thermostat.	1. Adjust, replace or clean. 2. Replace. 3. Add. 4. Add or change. 5. See <i>KNOCKING.</i> 6. Replace. 7. Replace.
LOW OIL PRESSURE	1. Worn Bearings. 2. Relief valve malfunction. 3. Clogged oil cooler. 4. Diesel dilution of the oil.	1. Engine overhaul replace bearings. 2. Overhaul oil pump. 3. Repair. 4. Injection pump repair.

TESTING FOR OVERHAUL

HOW TO DETERMINE ENGINE OVERHAUL PERIOD

Cause of Low Compression

Generally, the time at which an engine should be overhauled is determined by various conditions such as lowered engine power output, decreased compression pressure, and increased fuel and oil consumption. The lowered engine power output is not necessarily due to trouble with the engine itself, but is sometimes caused by injector nozzle wear or injection pump wear. The decrease in compression pressure is caused by many factors. It is, therefore, necessary to determine a cause or causes on the basis of data produced by periodic inspection and maintenance. Oil analysis on a seasonal basis is a good means of monitoring engine internal wear. When caused by worn cylinders or piston rings, the following symptoms will occur:

- 1 **Low engine power output**
- 2 **Increased fuel consumption**
- 3 **Increased oil consumption**
- 4 **Hard engine starting**
- 5 **Noisy engine operation**

These symptoms often appear together. Symptoms 2 and 4 can result also from excessive fuel injection, improper injection timing, and wear of plugs and nozzles. They are caused also by defective electrical devices such as the battery, alternator, starter and glow plugs. Therefore it is desirable to judge the optimum engine overhaul time by the lowered compression pressure caused by worn cylinders and pistons plus increased oil consumption. Satisfactory combustion is obtained only under sufficient compression pressure. If an engine lacks compression pressure, incomplete combustion of fuel will take place even if other parts of the engine are operating properly. To determine the period of engine overhaul, it is important to measure the engine compression pressure regularly. At the same time, the engine speed at which the measurement of compression pressure is made should be checked because the compression pressure varies with engine rpm. The engine rpm can be measured at the front end of the crankshaft.

NOTE: To test engine compression see the ENGINE ADJUSTMENT section of this manual.

OVERHAUL CONDITIONS

Compression pressure tends to increase a little in a new engine until piston rings and valve seats have been broken in. Thereafter, it decreases gradually with the progress of wear of these parts.

When decrease of compression pressure reaches the repair limit, the engine must be overhauled.

The engine requires overhaul when oil consumption is high, blowby evident, and compression values are at minimum or below. *Engine compression should be 30 kg/cm², 427 psi at 200 rpm.*

DISASSEMBLY

1. Before disassembly and cleaning, carefully check for defects which cannot be found after disassembly and cleaning.
2. Drain water, fuel and oil before disassembly.
3. Clean or wash the engine exterior.
4. Do not remove or disassemble the parts that require no disassembly.
5. Perform disassembly in a proper order using proper tools. Keep disassembled parts in order. Apply oil when necessary. Take special care to keep the fuel system parts from intrusion of dust and dirt.
6. Carefully check gaskets, packings and oil seals even if checking is not specified. Replace with new ones if defective.

ENGINE/GENERATOR MODELS

The W-52 Marine Diesel Engine has gone through several model designations. As the W-52 it provides power for the WTA and the WMF Marine Generators. Speed modifications to the W-52 produced the model designations 63B and 63C. The 63B model powers the BTDA Generator and the 63C model powers the BTDB Generator. Internally, the W-52/63B and 63C engines are identical. The generator back ends BTDA and BTDB are also the same.

WESTERBEKE's current production model in this series is the 63C Marine Engine and the 15Kw BTDB Generator.

ENGINE/GENERATOR DISASSEMBLY

GENERATOR

Disconnect the AC wiring and unplug the engine's DC wiring harness at the generator control panel. Disconnect the battery cable connections and the engine ground lines.

Separate the exhaust hose at the water injected elbow and disconnect the fuel supply and return lines.

NOTE: Label any lines, hoses or cables as you separate them.

Drain the engine oil and the coolant from the engine.

Carefully support and then unbolt the generator backend from the engine. See *SPECIAL TOOLS - GENERATOR* in this manual.

Additional generator information will be found in the *GENERATOR* section of this manual.

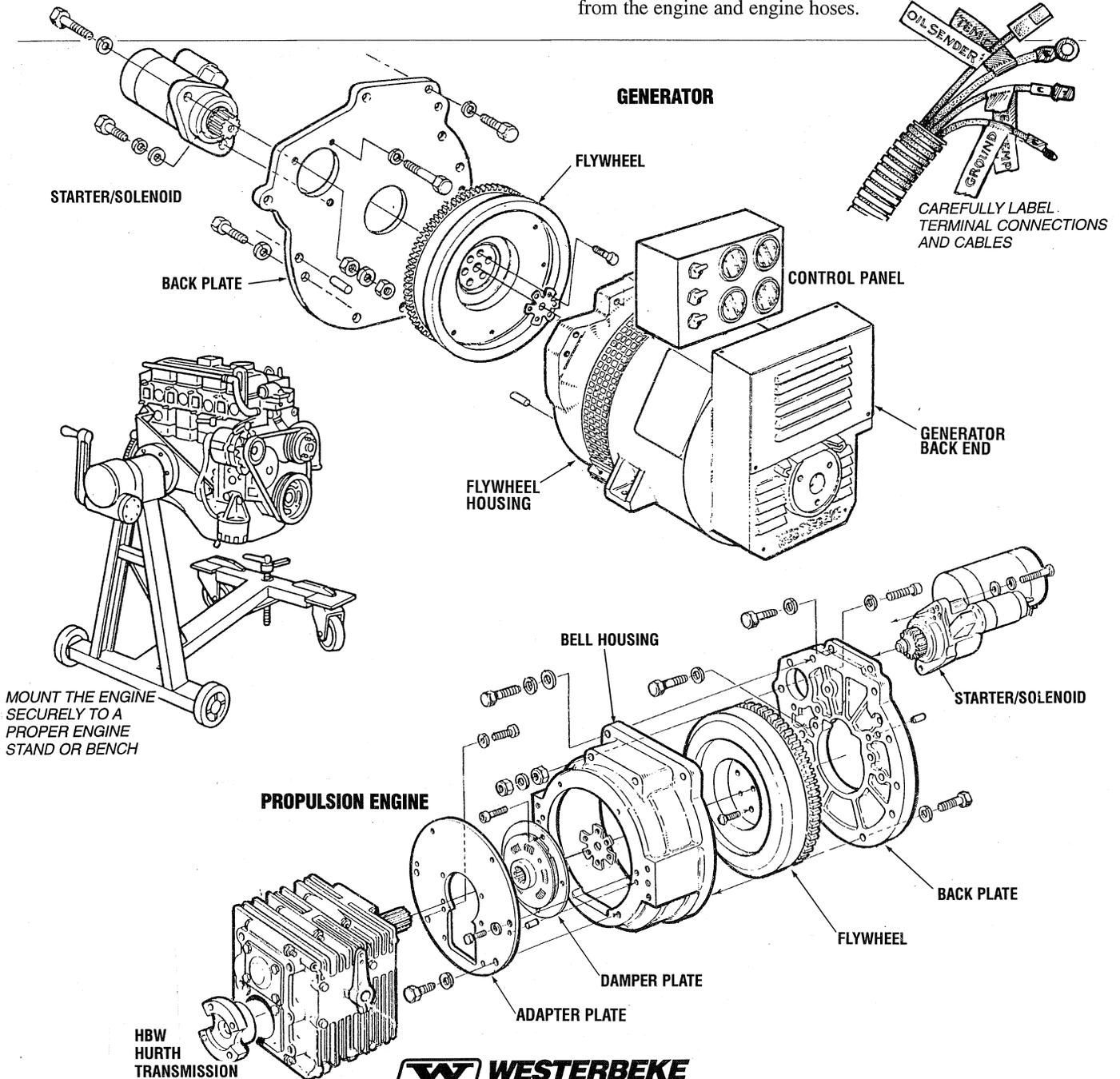
PROPULSION ENGINE

Unplug the instrument panel wiring harness. Drain the transmission fluid and the transmission oil cooler hoses, Detach the oil cooler hoses and unbolt the transmission from the engine.

If the transmission is not being rebuilt, it should be cleaned and repaired. Inspect the transmission coupling, vent, and shift link. Lubricate the moving parts and change the transmission fluid.

For transmission service and maintenance refer to your transmission manual. To rebuild a transmission contact your WESTERBEKE dealer or an authorized transmission service shop

Drain or pump out all the engine oil and drain the coolant from the engine and engine hoses.



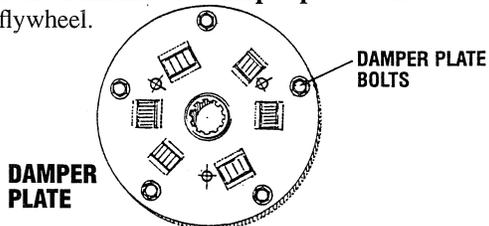
ENGINE DISASSEMBLY

DISASSEMBLING THE MAIN ENGINE

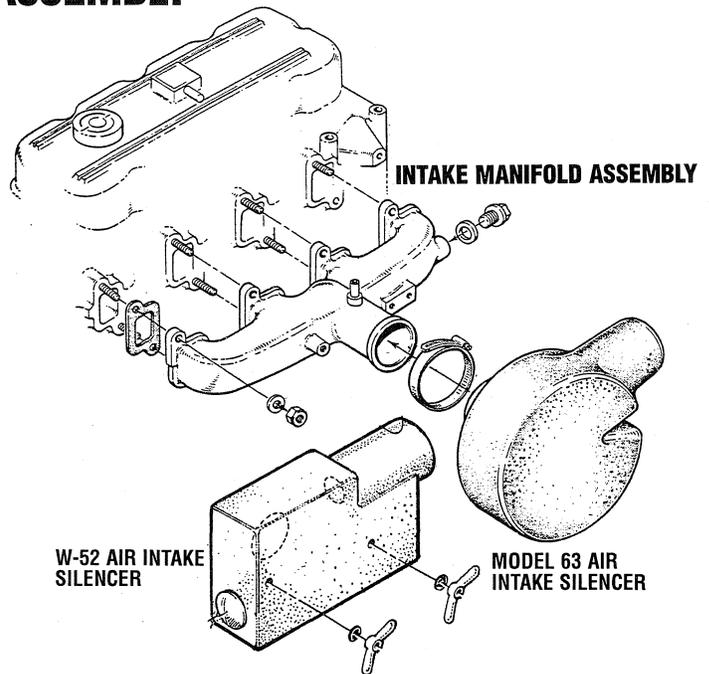
With the transmission/or generator separated from the engine, begin the following step by step procedure to disassemble the engine.

NOTE: Mount the engine on a suitable stand or work bench.

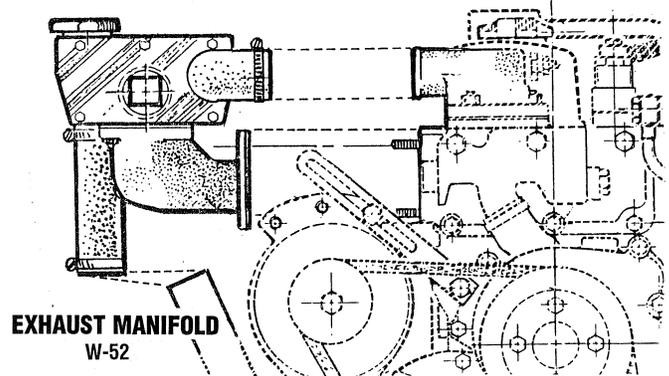
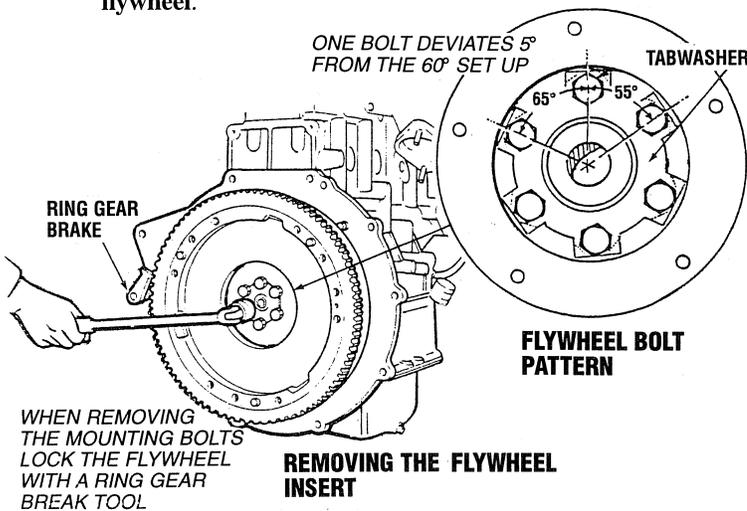
1. Remove the transmission damper plate from the engine flywheel.



2. Remove the engine oil cooler and oil hoses. Note oil hose connections from the oil cooler to the engine.
3. Remove the engine heat exchanger. If possible, leave one end of each hose connected to the part being removed.
4. Remove the bell housing (propulsion engine) and the circuit breaker/preheat solenoid mounting bracket..
5. Loosen the front crankshaft pulley bolt and remove the flywheel.



11. Remove the air intake silencer and the intake manifold.
12. Remove the oil filter and the mounting bracket from the engine block.
13. Unbolt the elbows and remove the exhaust manifold in its entirety. Note that the 63 Model exhaust manifold and elbows are all one casting.



6. Remove the engine back plate.
7. Remove the start motor, drive belt and the alternator. Label the wires and cables.
8. Remove the engine mounted raw water pump, adaptor mounting plate, and drive from the front cover. The drive is removed by turning in a counter clockwise direction. See RAW WATER PUMP for parts breakdown.
9. With the hoses disconnected, remove the thermostat housing and housing gasket, leaving the temperature sender in place.
10. Remove the coolant circulating pump. See COOLANT CIRCULATING PUMP for parts breakdown.

Injection Pump/Injectors Disassembly

14. Detach all the high pressure injection lines from the injection pump to the injectors. Leave the two upper line clamps in place.

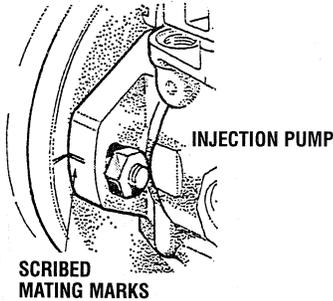
NOTE: Cap the ends of the lines and the connections at the injection pump and at the injectors to prevent entry of foreign material.

15. Remove the fuel return line from the top of the injectors and from the fuel injection pump by removing the four 12 mm attaching bolts. (Note the washer arrangement on fuel return line banjo bolts. Cap all the openings on the fuel return line, injectors and injection pump.)

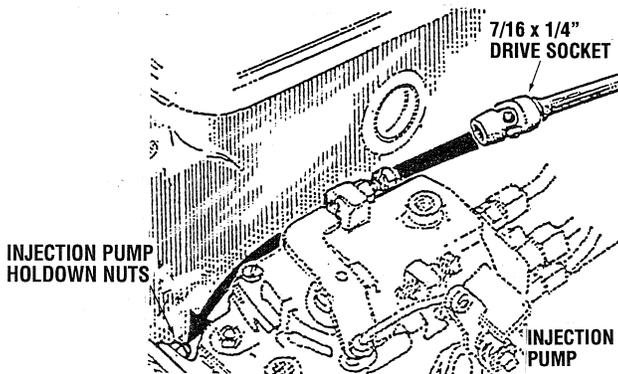
ENGINE DISASSEMBLY

16. Remove the fuel injectors, dust seals and sealing washers from the cylinder head.
17. Remove the glow plugs.
18. Remove the crankcase breather hose and rocker arm cover.
19. Remove the engine mounted fuel filter and fuel line to the injection pump. (Note the arrangement of the sealing washers on the banjo bolts at fuel filter and the injection pump.)
20. Remove the injection pump. Scribe the mating marks on the pump body flange and the timing gear case before removing.

REMOVING THE INJECTION PUMP



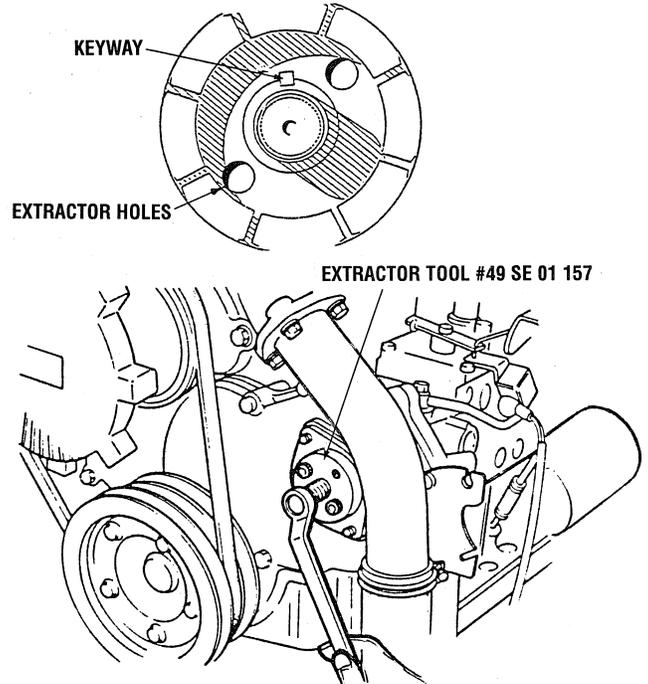
- a. Remove the cover and the lock nuts.
- b. Loosen the two injection pump hold down nuts. Do not remove entirely. The hold down nut on the engine side of the pump can be loosened by using a 1/4" universal socket and extension with ratchet.



- c. Remove the nut and lockwasher from the injection pump shaft.

NOTE: Take care not to drop the nut and the washer into the timing gear case.

- d. Place the keyway on the injection pump shaft in the 12:00 position with the aid of the front crankshaft pulley bolt before attempting to remove the injection pump.
- e. With the use of extractor #49 SE 01 157 apply sufficient pressure to loosen the pump from the keyed gear. The loose hold down nuts will prevent the pump from falling from the engine.



- f. Once loosened, remove the hold down nuts and washers and carefully withdraw the pump from the drive gear and engine so as to avoid losing the injection pump drive key inside the timing case.

NOTE: If an extractor is not available, replace the nut on the injection pump shaft loosely and with a nylon drift and hammer gently tap the injection pump shaft to dislodge it from the keyed drive gear.

If the injection pump requires service or adjustment it should be taken to an authorized diesel injection pump service shop. Contact your WESTERBEKE dealer.

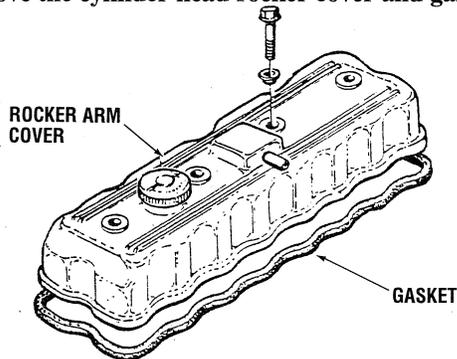
To adjust Injection Pump Timing refer to FUEL INJECTION PUMP in this manual.

ENGINE DISASSEMBLY

Engine Block Disassembly

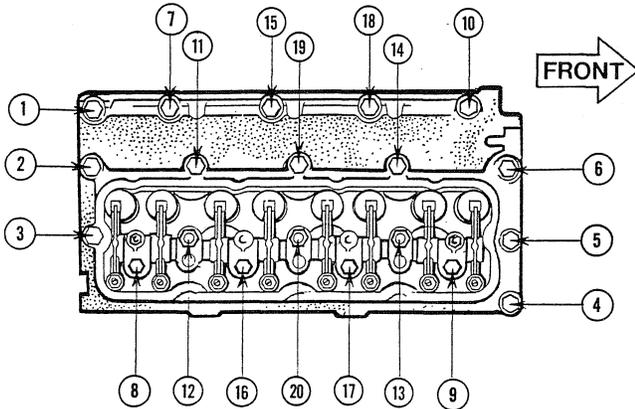
Disassemble the engine in the following order:

21. Remove the cylinder head rocker cover and gasket.



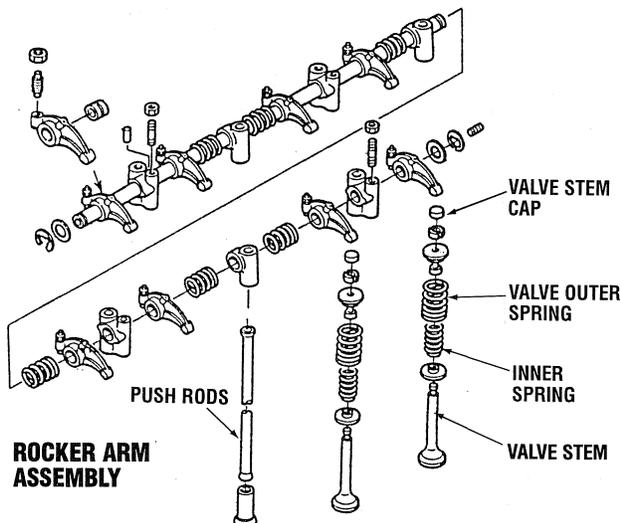
22. Remove the cylinder head.

NOTE: Loosen the cylinder head bolts equally and gradually in the order shown in the diagram.

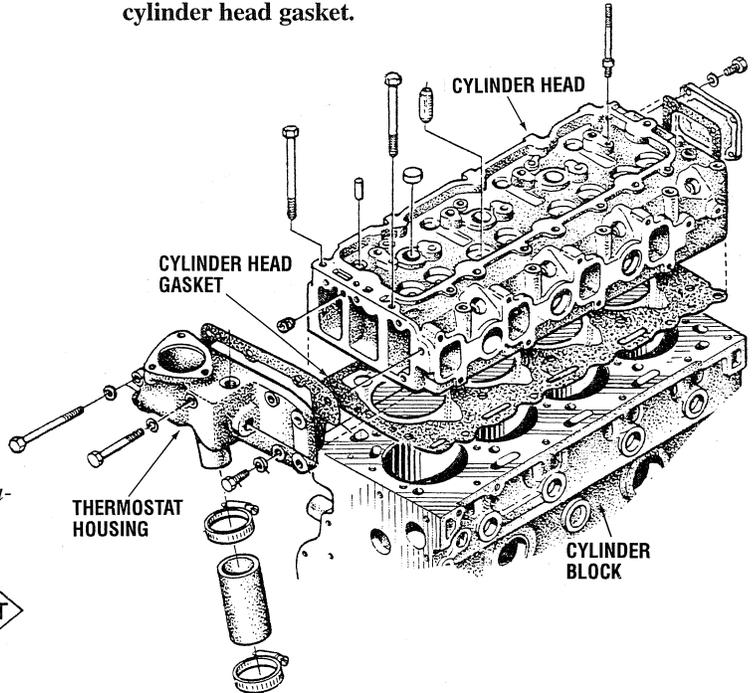


23. Remove the rocker arm assembly.

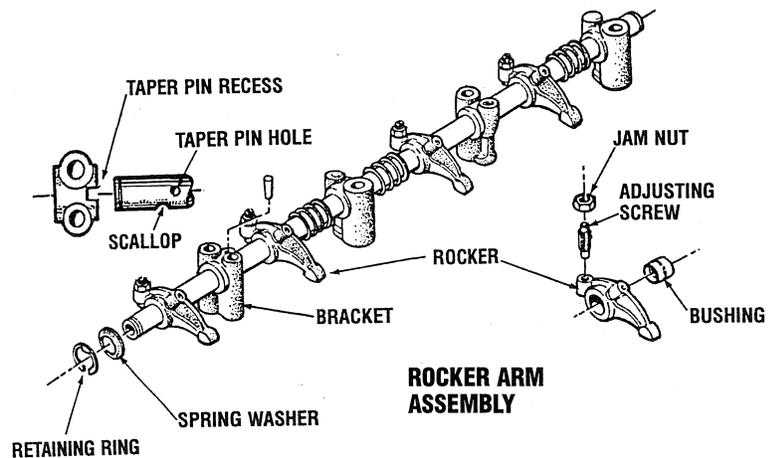
- a. Remove the valve stem caps so as not to lose them when removing the cylinder head.
Label each cap as to which valve it belongs.
- b. Remove the push rods.
Label each rod as to which valve it belongs.



24. Lift the cylinder head off the engine and remove the cylinder head gasket.

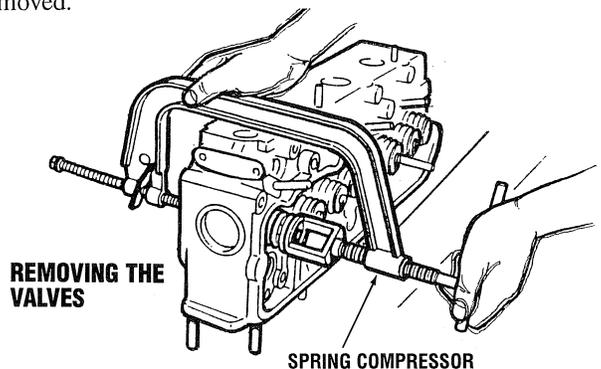


25. Disassemble the rocker arm assembly.

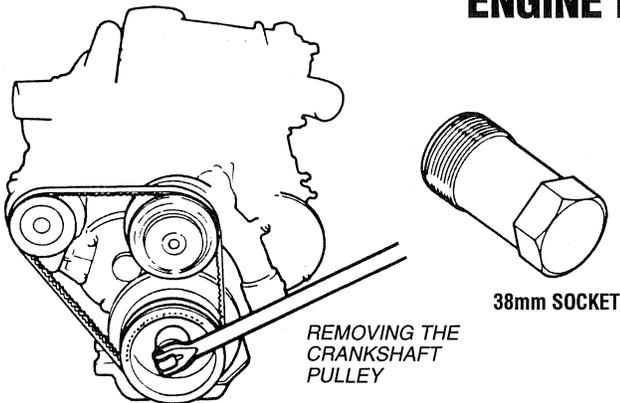


26. Remove each valve from the cylinder head assembly.

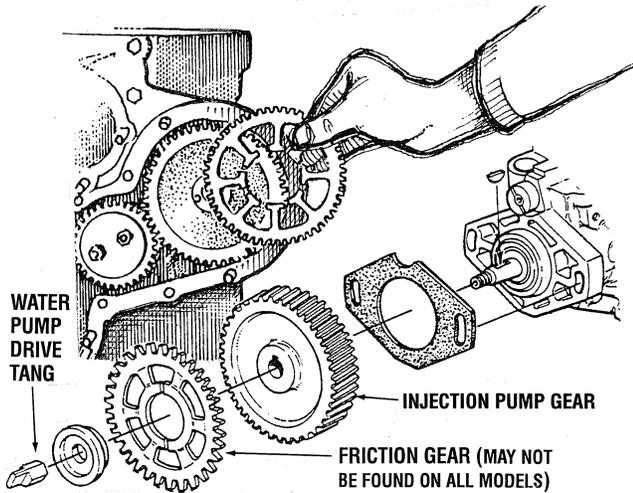
Use an appropriate valve spring compressor to aid in disassembly. Arrange or label the valves so as to replace them in the cylinder and guide from which they were removed.



ENGINE DISASSEMBLY



27. Remove the crankshaft pulley bolt with the aid of a 38 mm socket and draw the pulley off the front crankshaft.



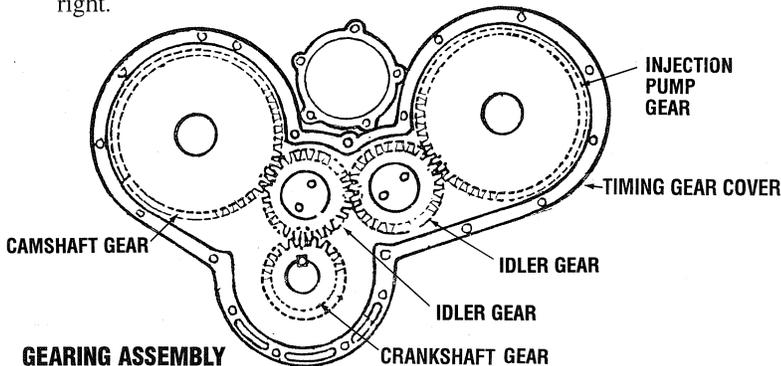
28. Remove the timing gear cover and remove the injection pump washer, injection pump friction gear and the injection pump drive gear.

29. Remove the camshaft gear.

- Wedge a clean cloth between the camshaft gear and the idler gear; remove the idler bolt.
- Remove the retaining plate, friction gear and, using a suitable bearing puller, the camshaft gear.

30. Remove the two idler gears.

- Remove the attaching nuts, thrust plates, idler gears and idler gear hubs.
- Keep the hubs and the idler gears arranged so that the combination of them is not confused between left and right.



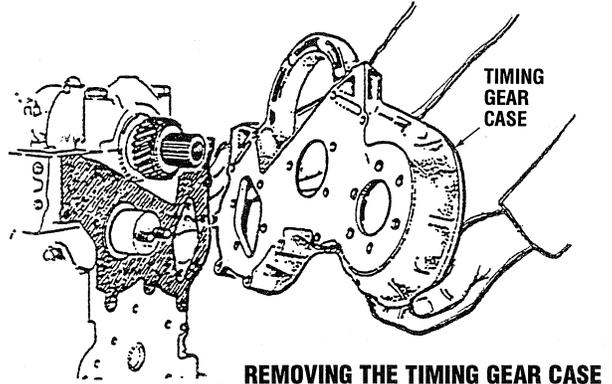
31. Remove the crankshaft gear.

- Remove the wave washer, the friction gear and, using a suitable puller, remove the crankshaft gear and its key.

32. Turn the engine over and remove the oil pan.

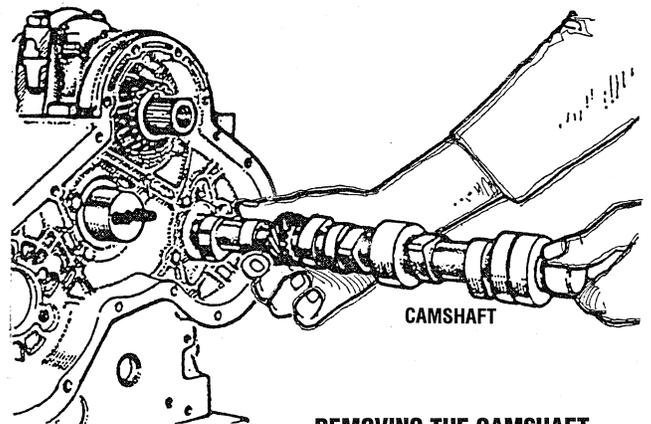
33. Loosen the oil pump assembly set screw, then remove the oil pump. For oil pump details see *OIL PUMP*.

34. Remove the timing gear case from the front of the engine block. Discard the old gasket.



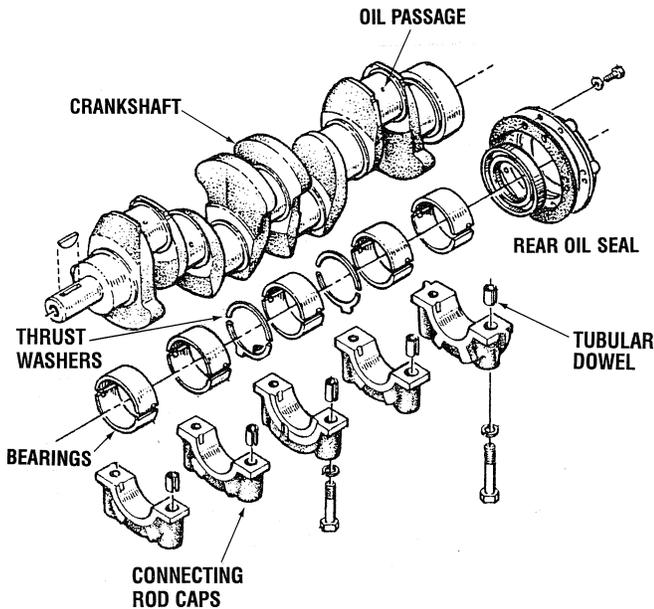
35. Remove the camshaft. Keep the engine upside down.

This allows the valve lifters to seat on the block bosses away from the cam lobes. Ensure that all the pushrod tappets are seated into the engine block prior to attempting to remove the camshaft from the block.



ENGINE DISASSEMBLY

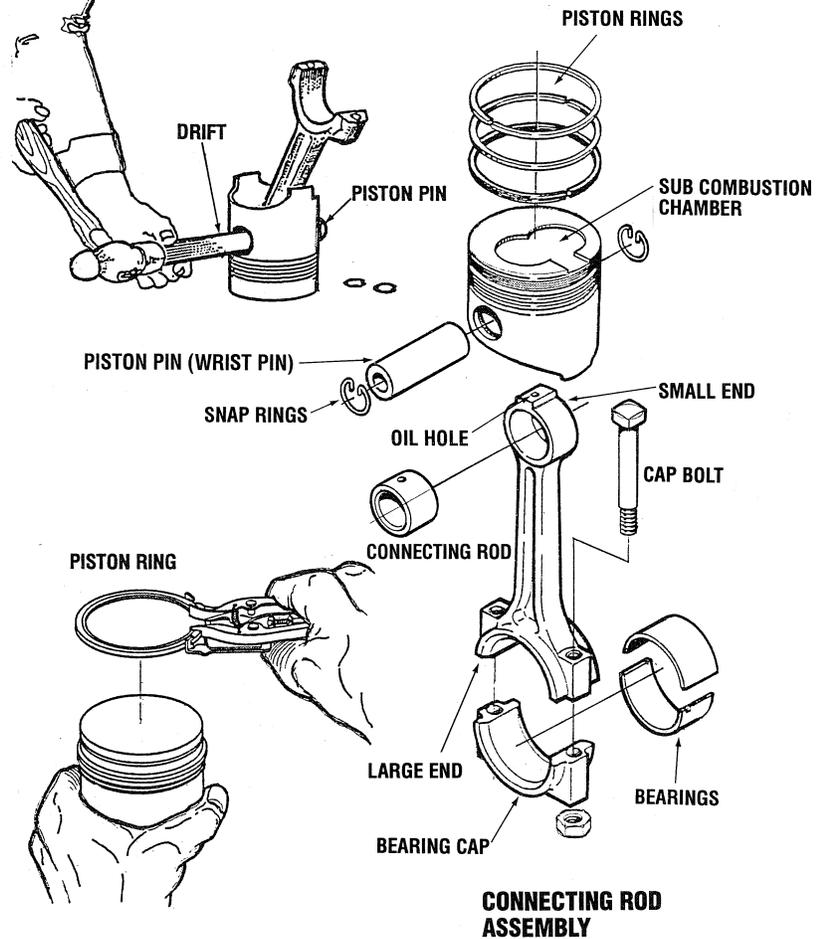
36. Remove the rear oil seal by striking out the old seal with a suitable mandrel.



37. Disassemble the connecting rod caps and line up the main bearing caps and bearings according to the order of bearing numbers. Also properly arrange the thrust washers, taking care not to change the combination.
38. Remove the piston and connecting rod assemblies. Temporarily install the connecting rod cap on the connecting rod so as to not mix the rods and caps.
39. Disassemble the piston assembly.

- Using the piston ring remover, remove the piston rings. While removing the piston rings, note the order they are removed and which side of the ring faces the piston crown.
- Remove the wrist pin snap rings.
- Using a nylon drift, drive the wrist pin from the piston and rod.
- Protecting your eyes with safety glasses, disengage and withdraw the snap rings. Although mechanics generally press out (and sometimes hammer out) pistons pins, these practices should be discouraged. Instead, take the time to heat the pistons, either with a heat gun or on a hot plate. Pins will almost fall out.
- While the piston is still warm, check for bore integrity. Insert the pin from each side. If the pin binds at the center, the bore might be tapered; if the bore is misaligned, the pin will click or bind as it enters the far boss.

NOTE: The number stamped on the rod shank and cap should correspond to the cylinder number. Sometimes these numbers are scrambled or missing, and the mechanic must supply them. Stamp the correct numbers on the pads provided and, to prevent confusion, deface the originals.



40. Remove the crankshaft.
41. Remove the tappets.

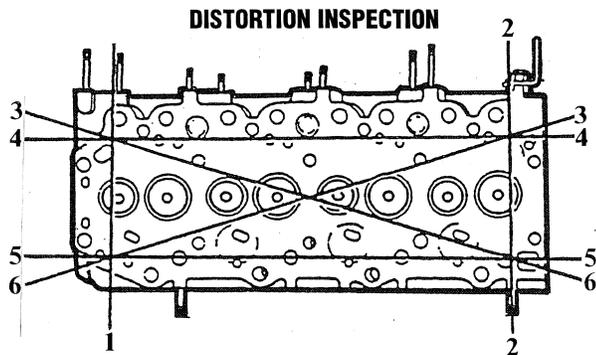
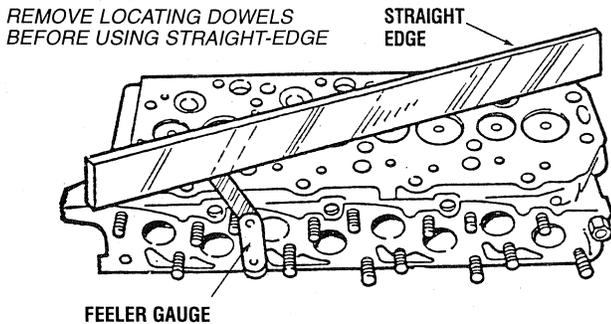
NOTE: After removing the main bearings and bearing caps arrange them in order of removal. Do not mix caps. After removing the thrust bearings, note their positioning for proper reinstallation.

ENGINE INSPECTION

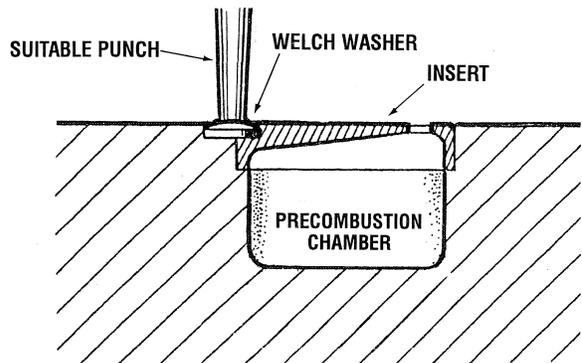
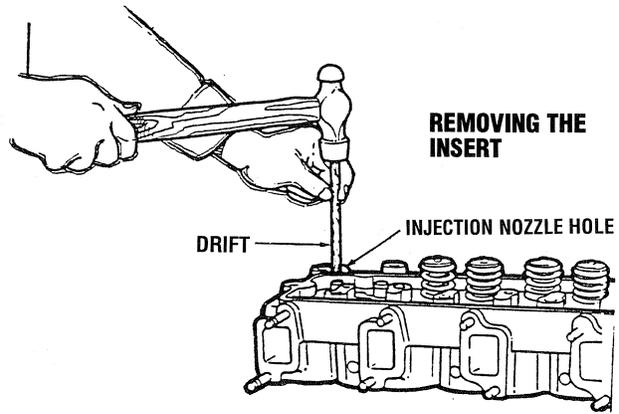
INSPECTING THE CYLINDER HEAD

- 1. Visual Inspection.** Check the cylinder head for cracks or any other damage and, if necessary, repair or replace it.
- 2. Distortion Inspection.** Measure the cylinder head surface distortion with a straight edge and the thickness gauge. Take 6 measuring positions as shown in the diagram. If the distortion exceeds permissible limit, replace the cylinder head. (The head has no allowance for planing and must be replaced, not renewed.)

Position	Cylinder Head Distortion Limit
1, 2	0.10 mm (0.004 in)
3, 4, 5, 6	0.25 mm (0.010 in)



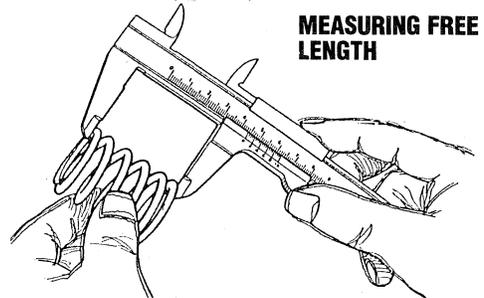
- 3. Insert Inspection.** Check for cracks or damage on the insert and, if detected, replace it.
- 4. Insert Replacement.** To remove the insert, place a suitable drift into the glow plug hole, then tap the drift with a hammer. To install, set the insert in position and insert the welch washer into the insert guide hole. Secure the welch washer by tapping the raised center of the welch washer.
 - Use a new welch washer.
 - Insert the welch washer so that its convex surface is toward the cylinder head gasket.
 - After installation, check to see if the insert is completely fixed in place.



VALVE SPRING

- 1. Free Length Check.** Measure the free length of the valve spring and if free length is less than the limit, replace it.

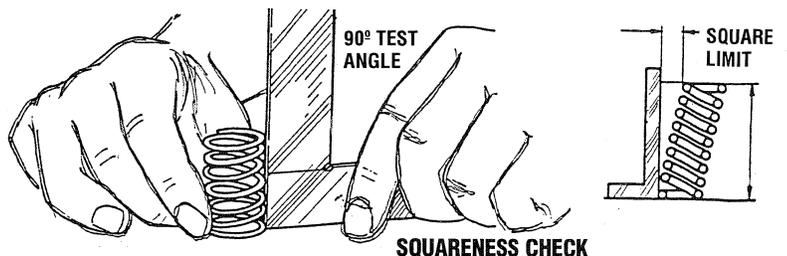
Valve Spring	Inner 42 mm (1.654 in)
	Outer 43.6 mm (1.717 in)



- 2. Squareness Check.** Check the squareness of the valve spring and, if it is more than the limit, replace the spring.

Squareness Limit	Inner 1.25 mm (0.049 in)
	Outer 1.37 mm (0.054 in)

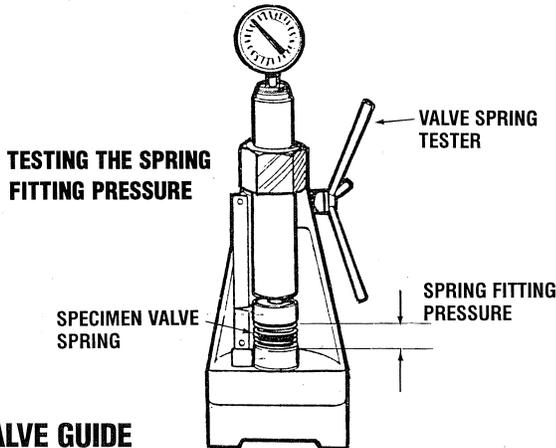
- 3. Fitting Pressure Check.** Check the valve spring fitting pressure with a valve spring tester and, if the pressure is less than the limit, replace the spring.



ENGINE INSPECTION

NOTE: Measure the fitting pressure after compressing the spring several times.

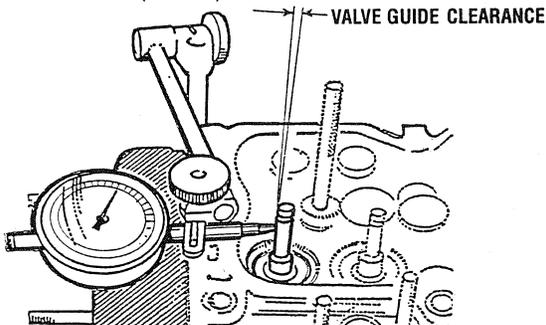
Spring Fitting Pressure	Inner	Outer
Fitting Length	37.8 mm (1.49 in)	40.3 mm (1.59 in)
Fitting Pressure Limit	10/3 kg (22.7 lb)	14.5 kg (32.0 lb)



VALVE GUIDE

- 1. Inspecting clearance between valve and guide.** Set a dial gauge with a magnet and check the clearance between the valve stem and the valve guide. If the clearance is more than the limit, replace the valve or valve guide.

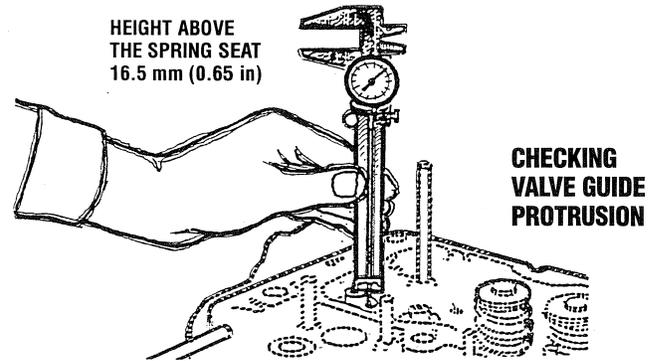
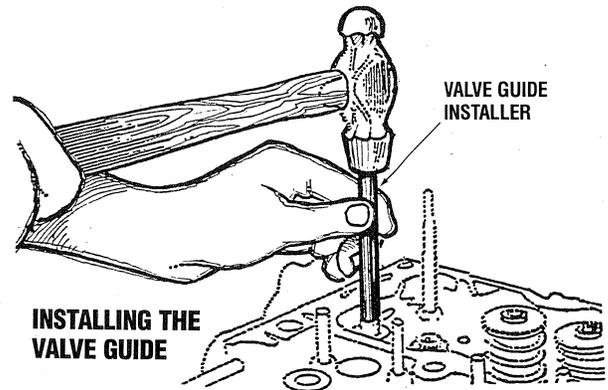
Clearance Limit 0.127 mm (0.005 in)



- 2. Valve guide replacement.** To remove the valve guide, press out the valve guide towards the combustion chamber side, using the valve guide installer (49 0636 165A). Again using the valve guide installer, press in the valve guide into the cylinder head until the valve guide height reaches the indicated scale on the valve guide installer.

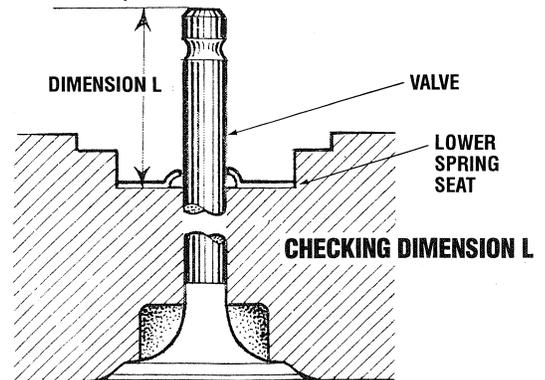
NOTE: Be sure to press in the valve guide so that the inside chamber on the valve guide end faces to the combustion chamber side. After the pressure fit, check the length of the protruding portion of the valve guide.

Protrusion Standard 16.5 mm (0.650 in)



- 3. Dimension L.** Check the protruding length of the valve stem, if it exceeds the specification, correct it as follows:
Dimension L Standard 48.0 mm (1.890 in)

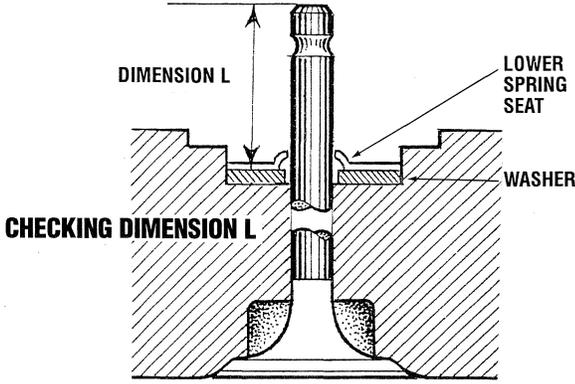
- When dimension L becomes large 0 - 0.5 mm (0 - 0.0202 in) from the standard, it is possible to use both the valve and the cylinder head.



- When dimension L becomes to large 0.5 - 1.5 mm (0.20 - 0.059 in) from the standard, adjust the dimension L to the standard by adding some washers (inner diameter 12.8 mm (0.504 in), outer diameter 39 mm (1.535 in)) between the lower spring seat and the cylinder head.
- When dimension L becomes to large (more than 1.5 mm, 0.059 in) from the standards, install the valve with a new one, and recheck dimension L.
- When dimension L becomes to large 0 - 0.5 mm (0 - 0.0202 from the standard, replace the valve.

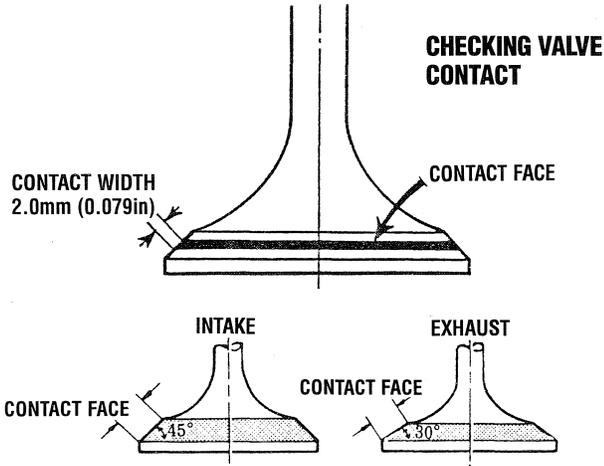
ENGINE INSPECTION

- e. When dimension L becomes to large 0.5 - 1.5 mm (0.020 - 0.059 in) from the standard, replace the valve and adjust the dimension L to the standard by adding some washers between the lower spring seat and the cylinder head.
- f. When dimension L becomes to large (more than 1.5 mm (0.059 in) from the standard, replace both the valve and the cylinder head.



- g. Check for contact between the valve and valve seat by applying a thin coat of Prussian Blue (or Redlead) on the valve seat contact face, then insert the valve into the valve guide and press fit the valve on the valve seat.

NOTE: Do not rotate the valve!

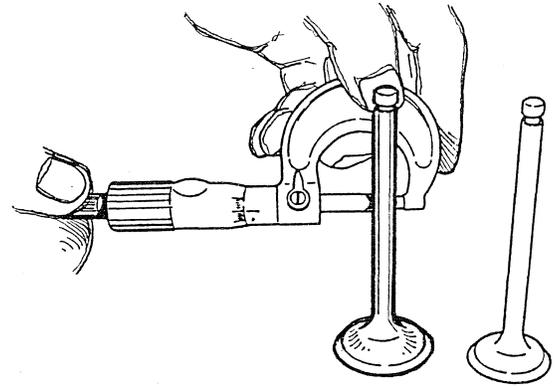


- h. Check if the valve seat contact face contacts the center position of the valve contact face. If the contact position is not centered, recut and surface the valve seat and valve.

4. Stem Wear Inspection.

If the valve stem is bent or its diameter is less than the limit, replace the valve.

Stem diameter limit	Intake	7.880 mm (0.3102 in)
	Exhaust	7.867 mm (0.3097 in)

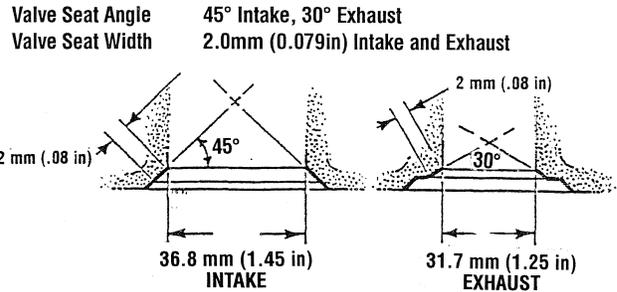


CHECKING VALVE STEM WEAR

VALVE SEAT

1. **Valve Seat Angle.** Valve seat angle is 45° and 30° respectively for intake and exhaust sides. The standard contact width of the valve seat is 2.0 mm (0.079 in) for both intake and exhaust sides. If the valve margin is less than the permissible limit, replace the valve.
2. **Refacing the Valve and Valve Seat.** Reface in the following order:
 - a. Reface the valve with a valve grinder to the specified angle.
 - b. Reface the valve seat with a valve seat cutter while checking the contact between the valve and the valve seat.

NOTE: Reface the valve seat taking care that the valve seat contacts the center position of the valve.

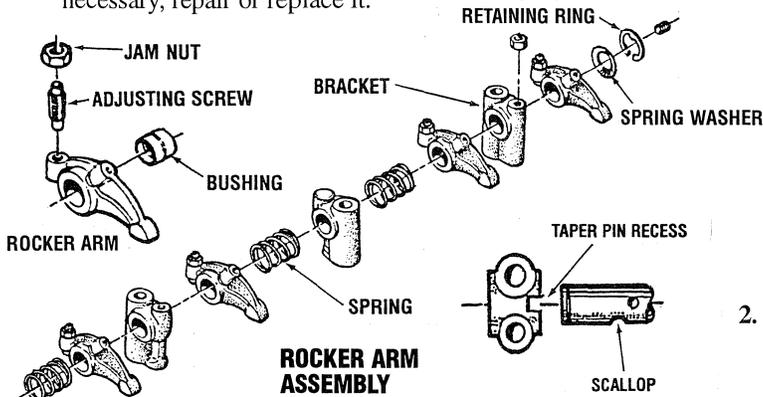


- c. Reface the valve and valve seat with a valve tapping compound.
- d. Remeasure dimension "L".
- e. Adjust dimension "L" to the standard by adding some washers between the lower spring seat and cylinder head.

ENGINE INSPECTION

ROCKER ARM

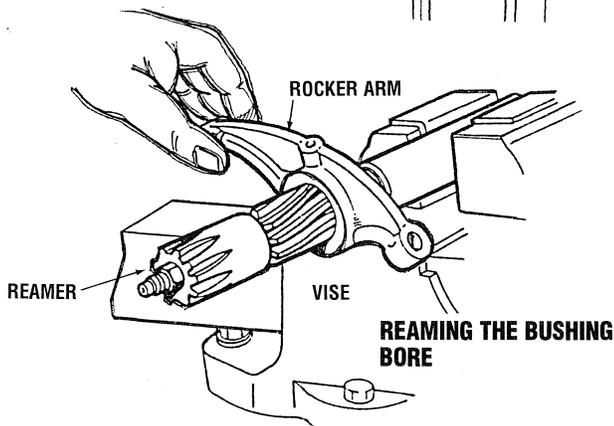
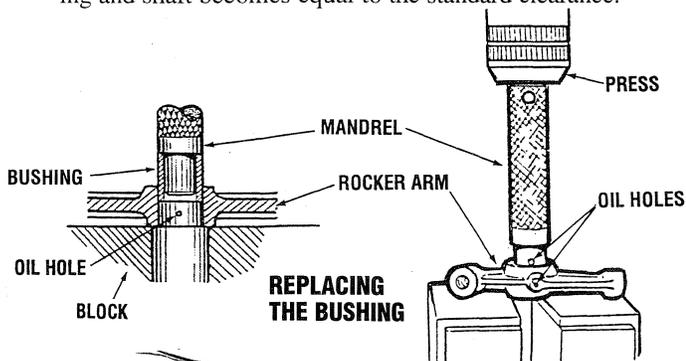
- Visual Inspection.** Check each component part of rocker arm assembly for cracks or other damage. Check if the oil passages of the rocker arm and shaft are clogging and, if necessary, repair or replace it.



- Inspecting clearance between rocker arm and shaft.** Check the clearance between the rocker arm and shaft and, if it exceeds the limit, replace the rocker arm bushing or shaft.

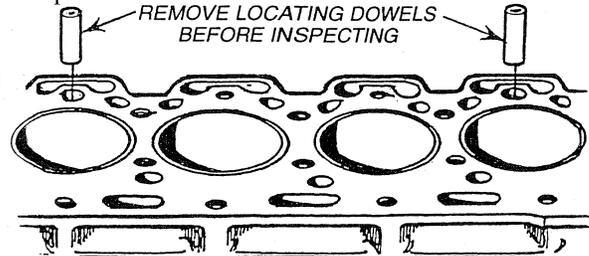
Clearance Standard 0.0006 - 0.0024 in (0.016 - 0.061mm)
Limit 0.003 in (0.07mm)

- Rocker Arm Bushing Replacement.** Using a suitable mandrel and press, press out the old bushing. Aligning the oil passages of the rocker arm bushing, press the new bushing into the rocker arm. After the rocker arm bushing has been replaced, ream the bushing bore with a spiral expansion reamer so that the clearance between the bushing and shaft becomes equal to the standard clearance.



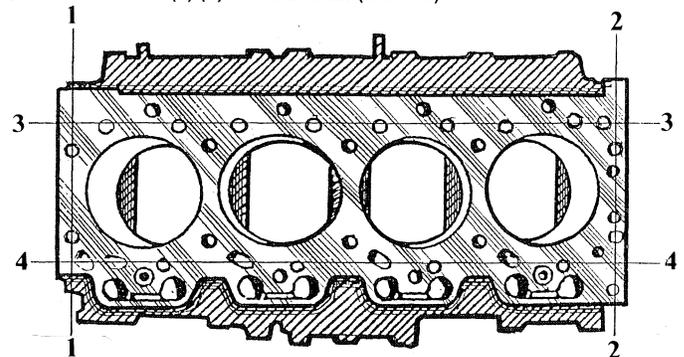
CYLINDER BLOCK

- Visual Inspection.** Check the cylinder block for cracks and damage. If necessary, repair or replace it entirely. Check to see that oil or cooling water passages are not clogged and, if clogged, remove with compressed air or a wire probe.



- Distortion Inspection.** Check the gasket face distortion of the cylinder block and if it exceeds the limit, repair or replace it.

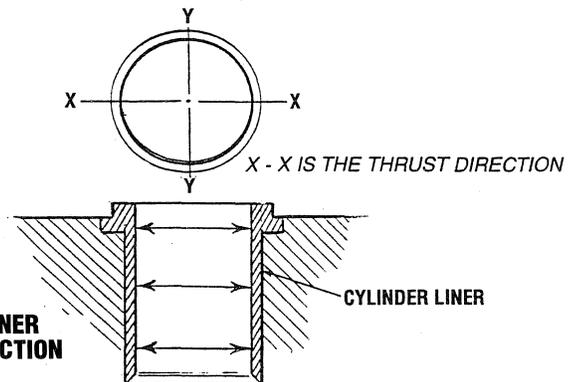
Distortion limit: (1) (2) 0.10 mm (0.004 in)
(3) (4) 0.25 mm (0.010 in)



CYLINDER LINER

- Wear Inspection.** Measure the liner bore at three positions of upper, middle and lower portions with a cylinder gauge in X-X and Y-Y directions as shown. If wearing exceeds the limit, replace the liner.

Cylinder Liner Bore 88.925 - 88.950 mm (3.5010 - 3.5020 in)
Wear Limit 0.20 mm (0.008 in)



ENGINE INSPECTION

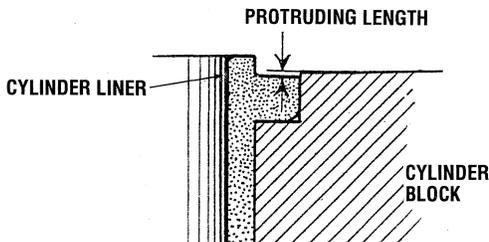
2. **Cylinder Liner Replacement.** Hydraulic press or similar device is needed.

- a. Attach the cylinder liner puller and installer to the lower rim of the cylinder liner, then press out the liner.
- b. Check for scratches on the cylinder block side and, if any, remove them by using extremely fine emery paper with engine oil.
- c. To install the liner, apply engine oil on the cylinder block bore and the liner exterior, then set the liner on the cylinder block. Using the cylinder liner puller and installer, press the liner into the cylinder block.

NOTE: Press the liner in straight. When press fitting the liner, keep the pressure within a range of 2,200 - 6,600 lb.

Measure the liner protrusion and correct it if necessary.

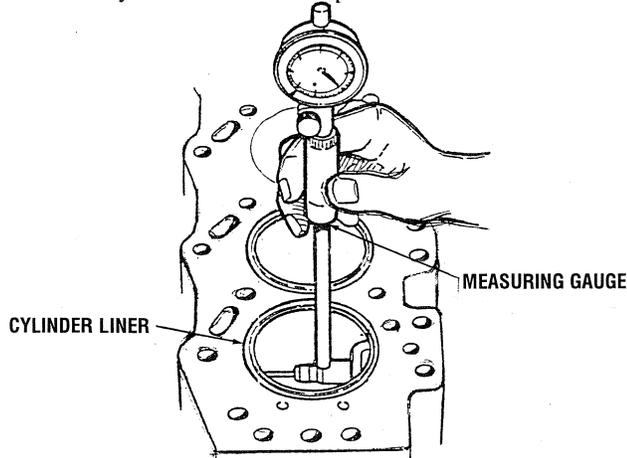
Protrusion Limits 0.026 - 0.031 in (0.659 - 0.790 mm)



PISTON AND PISTON RING

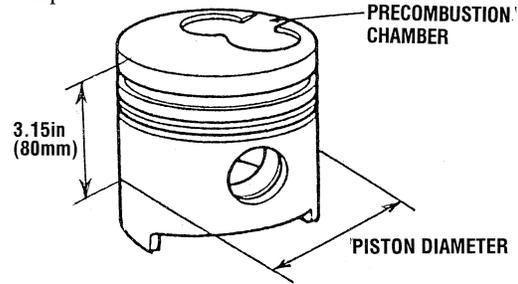
1. **Visual Inspection.** Check the sliding surface and ring groove of the piston for wear, scratches or any other damage.

- a. Inspecting the clearance between the piston and the cylinder liner.
- b. Check the clearance between the piston and the cylinder liner by measuring the cylinder bore and the piston diameter and, if the clearance exceeds the limit, replace the cylinder liner and the piston.



Side Clearance 0.0017 - 0.0028 in (0.044 - 0.70 mm)

c. Measure the piston diameter at 90° (perpendicular) to the pin bore axis and 3.15in (80mm) below the piston top.

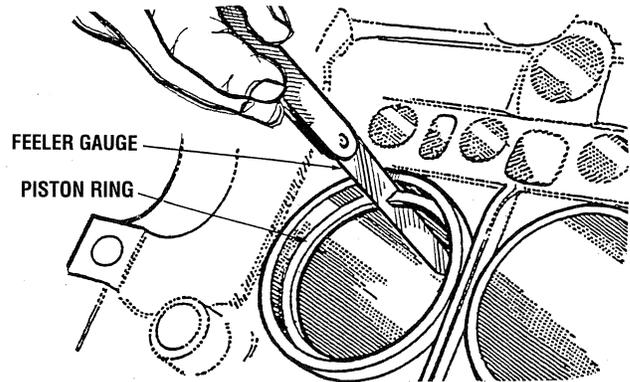


Standard Piston Diameter 3.4987 - 3.4797 in (88.867 - 88.893mm)

2. **Piston Ring Inspection.** Check the piston ring for breaks, seizure and wear and, if any of these conditions exist, replace the ring. Check the clearance between the piston ring and the ring groove and, if it exceeds the limit, replace the ring.

Side Clearance Limit 0.012 in (0.30 mm)

3. **Inspecting the piston ring end gap.** Position the piston ring into the bottom of the cylinder liner. Measure the piston ring end gap and, if it exceeds the limit, replace the ring. Be sure to position the piston ring below the ring sliding surface of the cylinder liner.

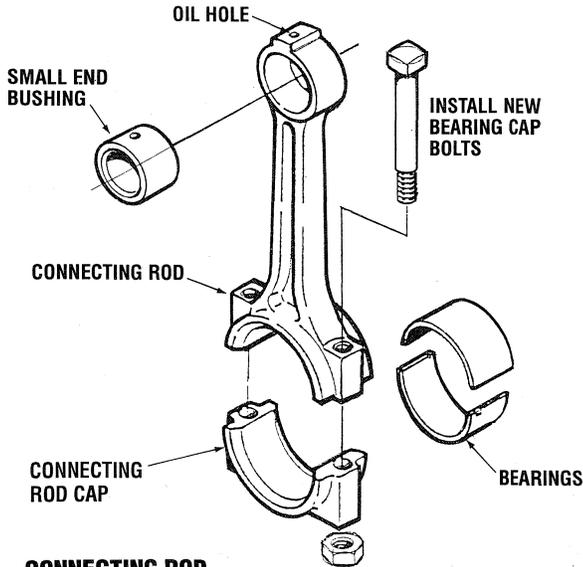


Piston Ring End Gap Limit 0.591 in (1.5mm)

ENGINE INSPECTION

CONNECTING ROD

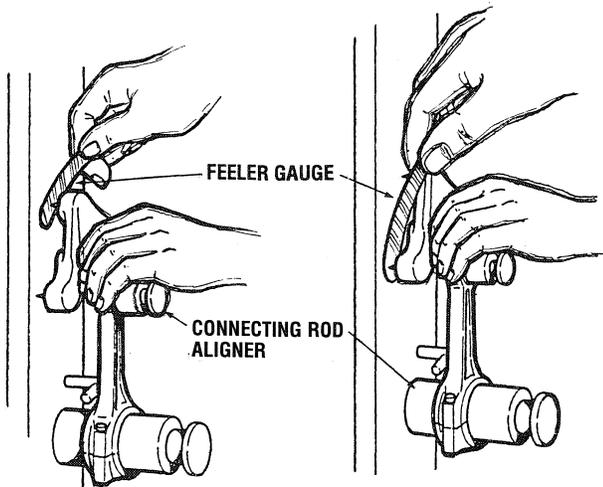
- 1. Visual Inspection.** Check the connecting rod for cracks or other damage and, if necessary, replace it.



CONNECTING ROD ASSEMBLY

- 2. Bend Inspection.** Using a connecting rod aligner, check the bend and twist of the connecting rod and, if exceeding the limit, repair it with a press or replace it.

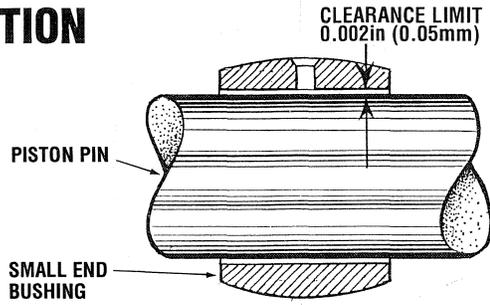
Bend Limit 0.002 in per 3.9 in (0.05 mm per 100 mm)



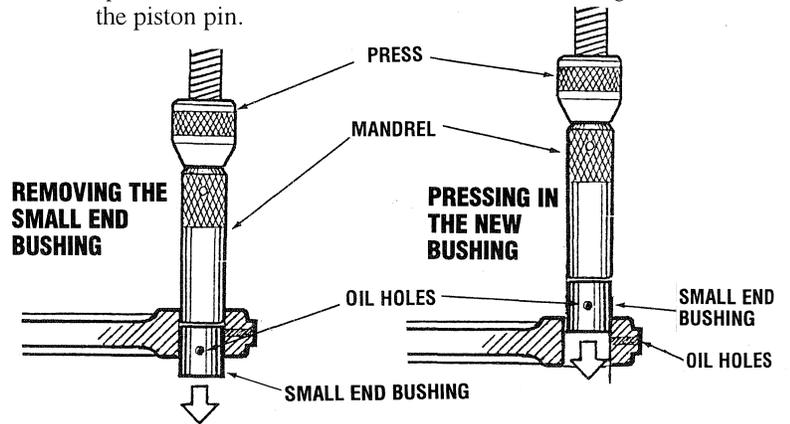
- 3. Inspect the clearance between the piston pin and small end bushing.** Check the clearance between the piston pin and the small end bushing and, if it exceeds the limit, replace the piston pin or small bushing.

Clearance Standard: 0.0006 - 0.0016 in (0.014 - 0.041 mm)

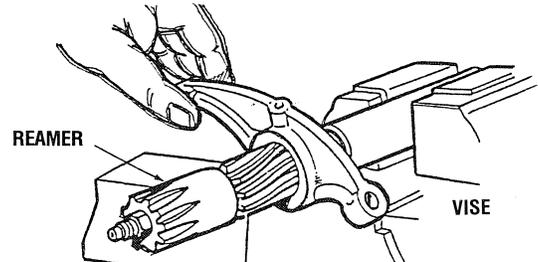
Clearance Limit: 0.002 in (0.05 mm)



- 4. Small end bushing replacement.** Using a press, press out the old bushing. Align the oil passages of the connecting rod and the small end bushing; press in the new bushing to the connecting rod bore. After a small end bushing has been replaced, ream the bushing bore to obtain the specified clearance between the small end bushing and the piston pin.

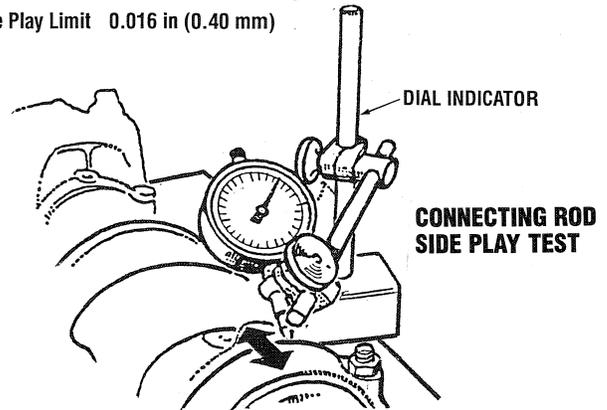


NOTE: When reaming the bushing, correctly insert the reamer in the bushing. In order to prevent unevenness on the bushing surface, the reaming should always be made in the cutting direction. Make certain the reamer is stopped at different positions at all times.



- 5. Inspecting connecting rod side play.** Check the connecting rod side play with the dial gauge and, if it exceeds the limit, replace the connecting rod and crankshaft.

Side Play Limit 0.016 in (0.40 mm)



ENGINE INSPECTION

- Inspecting connecting rod bearing.** Check the connecting rod bearing for peeling and thermal damage. If it is severe, replace the bearing.
- Inspecting connecting rod bearing clearance.** Using the plastigauge, measure the oil clearance of the connecting rod bearing and, if it exceeds the limit, replace the connecting rod bearing.

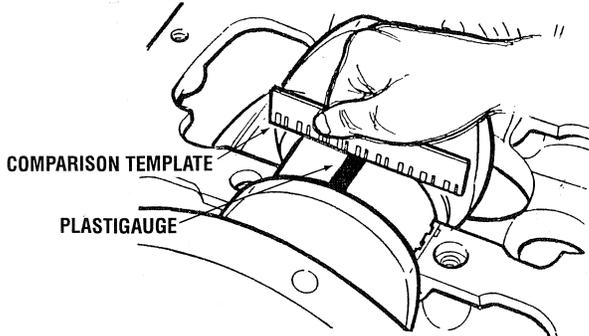
Connecting Rod Cap Torque 50 - 54 ft-lb (6.9 - 7.5 m·kg)

Connecting Rod Bearing Clearance

Standard: 0.0014 - 0.0030 in (0.036 - 0.076 mm)
Limit: 0.0039 in (0.10 mm)

Undersize Bearing: 0.010 in (0.254 mm)
0.020 in (0.508 mm)
0.030 in (0.762 mm)

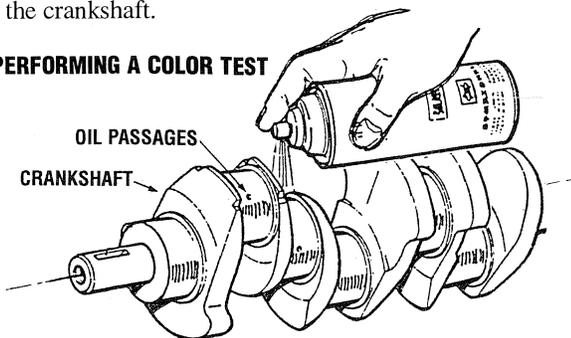
CONNECTING ROD BEARING CLEARANCE



CRANKSHAFT

- Visual Inspection.** Check the crankshaft for cracks or other damage. If cracking is suspected, thoroughly clean the crankshaft and perform a color test on the shaft, or run a candle flame over the crankshaft and look for oil seepage from cracks. If any cracks are detected, replace the crankshaft.

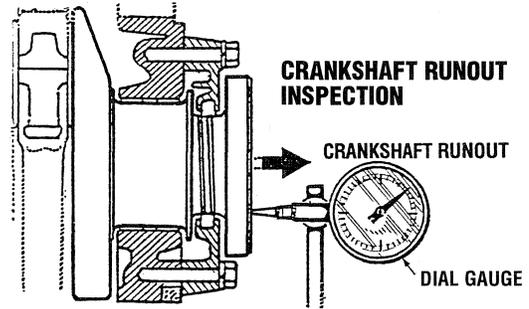
PERFORMING A COLOR TEST



Check for clogging of oil passages and, if clogged, remove with compressed air or wire.

- Runout inspection.** Check the crankshaft runout and, if it exceeds the limit, replace the crankshaft.

Runout Limit 0.0020 in (0.05 mm)



- Inspecting crank pin and journal.** Support the crankshaft on both ends using V-blocks. Measure the diameter of each crank pin and crankshaft main journal and, if the diameter is less than the limit, refinish the crank pin and main journal to size for the next undersize bearing.

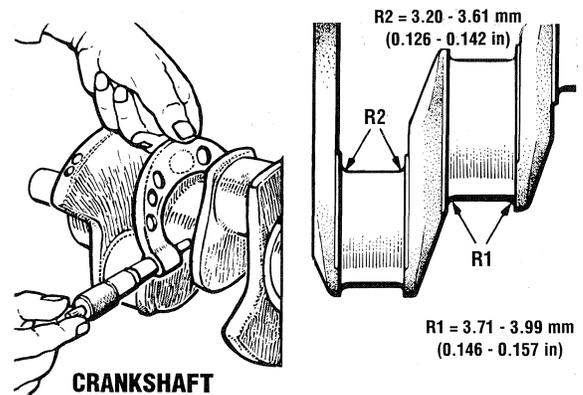
Crank pin diameter

Standard 2.0861 - 2.0866 in (52.987 - 53.000 mm)
Wear limit 0.002 in (0.05 mm)

Main journal diameter

Standard 2.5585 - 2.5591 in (64.987 - 65.000 mm)
Wear limit 0.002 in (0.05 mm)

- For the measurement on both the crank pin and the main journal, measure them at vertical and horizontal directions on front and rear places.
- When refinishing the crankshaft, it's finish to R1 mm as shown in the diagram.
- Refer to the chart for refinishing dimensions of the crankshaft where an undersize bearing is used.



Undersize bearing

0.01 in (0.254 mm)
0.02 in (0.508 mm)
0.03 in (0.762 mm)

Main journal diameter

2.5485 - 2.5491 in (64.733 - 64.746 mm)
2.5385 - 2.5391 in (64.479 - 64.492 mm)
2.5285 - 2.5291 in (64.225 - 64.238 mm)

Undersize bearing

0.01 in (0.254 mm)
0.02 in (0.508 mm)
0.03 in (0.762 mm)

Crankpin diameter

2.0761 - 2.0766 in (52.733 - 52.746 mm)
2.0661 - 2.0666 in (52.479 - 52.492 mm)
2.0561 - 2.0566 in (52.225 - 52.238 mm)

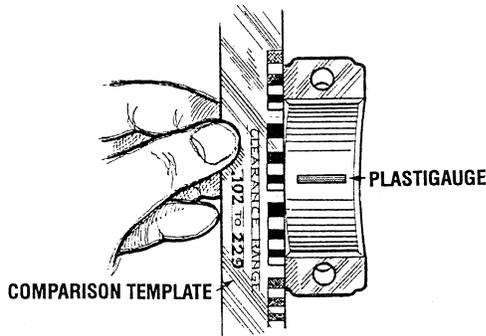
ENGINE INSPECTION

4. **Inspecting crankshaft end play.** Check the end play of the crankshaft and, if the end play exceeds the limit, replace the thrust washer with 0.007 in (0.178 mm) over-size. Crankshaft end play is measured by setting a dial gauge on the rear end of the crankshaft and moving the crankshaft in the axial direction.

Crankshaft End Play Standard: 0.0055 - 0.0153 in (0.14 - 0.39 mm)
 Crankshaft End play limit: 0.0157 in (0.40 mm)

MAIN BEARING

1. **Inspecting main bearing.** Check the main bearing for peeling, seizure or fusion and, if necessary, replace the bearing.
2. **Inspecting main bearing clearance.** Using the plastigauge, measure the oil clearance and, if it exceeds the limit, replace the main bearing.

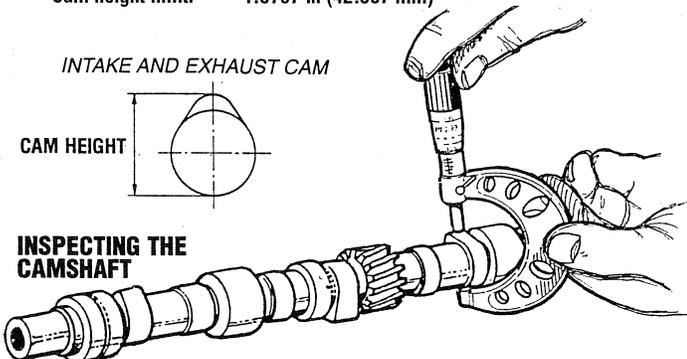


Oil Clearance Standard: 0.0016 - 0.0036 in (0.040 - 0.091 mm)
 Oil Clearance Limit: 0.005 in (0.12 mm)

CAMSHAFT

1. **Visual Inspection.** Check the camshaft for cracks and damage. If necessary, replace the camshaft.
NOTE: If the damage is slight, you may be able to correct the camshaft with an oil soaked fine emery grindstone. Take special care to not damage the original cam form.
2. **Inspecting cam height.** Measure the cam height and, if it is less than the limit, replace the camshaft.

Cam height limit: 1.6767 in (42.587 mm)



3. **Inspecting camshaft journal.** Check the camshaft journal and, if wearing exceeds the limit, replace the camshaft.

	Diameter of Journal	Wear Limit
No. 1	2.0437 - 2.0449 in (51.910 - 51.940 mm)	0.008 mm
No. 2	2.0339 - 2.0350 in (51.660 - 51.690 mm)	(0.0003 in)
No. 3	2.0142 - 2.0154 in (51.160 - 51.190 mm)	

4. **Inspecting camshaft oil clearance.** Check the clearance between the camshaft journal and the camshaft support bore as follows:

- a. Measure the camshaft journal diameter and the camshaft support bore.
- b. Calculate the clearance and replace the camshaft or cylinder block if the clearance exceeds the limit.

Oil clearance limit 0.0057 in (0.145 mm)

5. **Checking camshaft alignment,** and, if it exceeds the limit, replace the camshaft.

Maximum allowable runout 0.0031 in (0.08 mm)

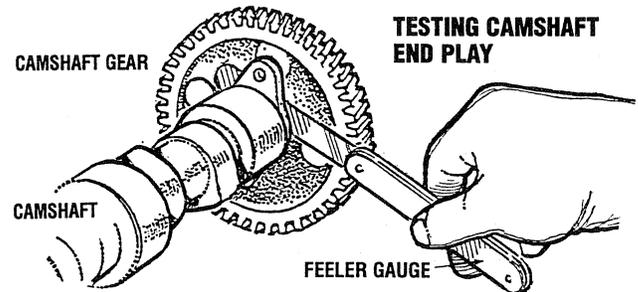
6. **Inspecting camshaft end play.**

- a. Install the thrust plate, camshaft gear, friction gear, lock plate and camshaft gear lock bolt on the camshaft.
- b. Tighten the lock bolt to the specified torque.

Lock Bolt Torque (19mm socket) 45 - 51 lb/ft (6.2 - 7.0 kg/m)

- c. Measure the clearance between the thrust plate and camshaft. If it exceeds the limit, replace the thrust plate.

End play limit 0.0118 in (0.3 mm)

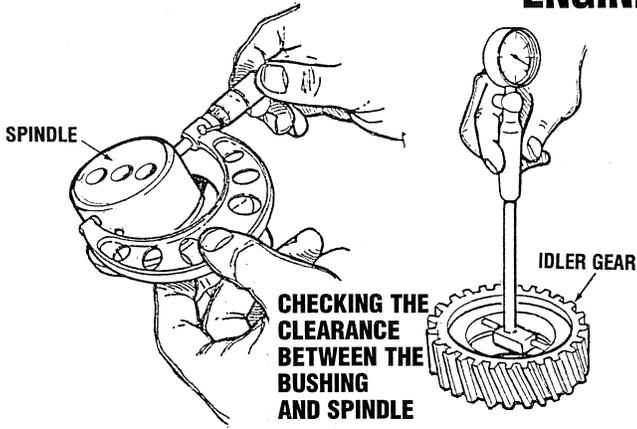


IDLER GEAR BUSHING AND IDLER GEAR SPINDLE

1. **Visual inspection.** Check for damage on the bushing inner surface of the idler gear and the spindle sliding surface and, if necessary, replace the idler gear or spindle. Check the oil passage for clogging and, if necessary, clean the passage with compressed air or wire.
2. **Inspecting clearance between bushing and spindle.** Check the clearance between the idler gear bushing and the spindle and, if it exceeds the limit, replace the idler gear or spindle.

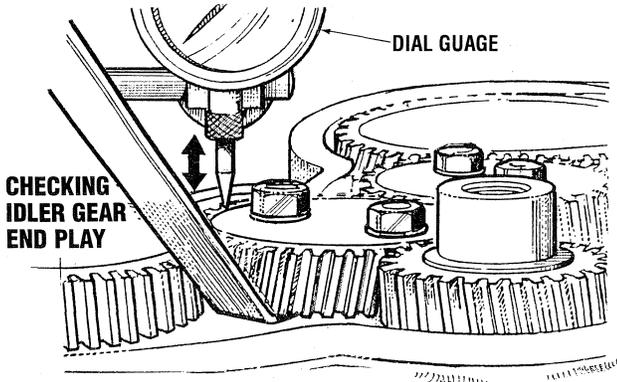
Clearance Standard: 0.0013 - 0.0033 in (0.034 - 0.084 mm)
 Clearance Limit: 0.006 in (0.15 mm)

ENGINE INSPECTION



CHECKING THE GEARS

1. **Visual Inspection.** Check each gear (idler gears, injection pump drive gear, crankshaft gear, camshaft gear) for cracks or other damage. If necessary, replace as required.
2. **Inspecting end play of idler gear.** Check the end play of the idler gear with a dial indicator as shown. If it exceeds the specified limit, replace the thrust plate or idler gear.



NOTE: Measure the end play after tightening the idler gear attaching nuts to the specified torque value.

Thrust plate torque (1/2" socket) 17 - 23 ft-lb (2.3 - 3.2 kg/m)
Standard end play 0.0079 - 0.0118 in (0.20 - 0.30 mm)

3. **Check backlash between gears.** Check the backlash between each gear with a dial indicator.

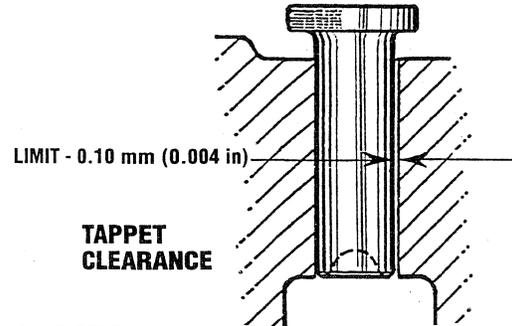
NOTE: Check the backlash after assuring that the idler gear end play and the clearance between the idle gear bushing and spindle are within the standard.

Backlash Standard 0.0039 - 0.0067 in (0.10 - 0.17 mm)
Backlash Limit 0.0118 in (0.30 mm)

TAPPET

1. **Visual inspection.** Check the tappet for cracks and other damage and, if damaged replace the tappet. Check for abnormal wear of the portion of the tappets that make contact with the cam, and if any one is abnormally worn, replace the tappet.
2. **Inspecting Clearance Between Tappet and Tappet Bore.** Check the clearance between the tappet and tappet bore and, if the clearance is greater than the limit, replace the tappet or cylinder block.

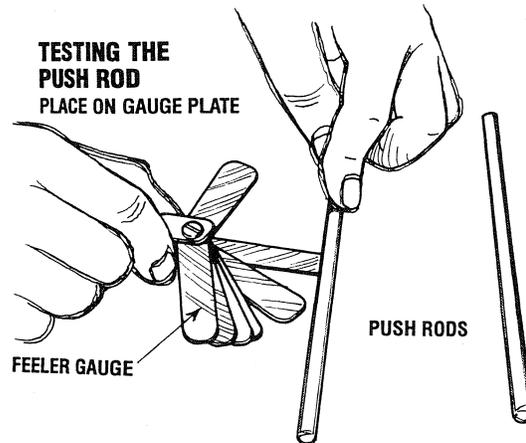
Clearance Limit 0.0039 in (0.10 mm)



PUSH RODS

1. **Visual Inspection.** Check each push rod for damage to either end. If damage is severe, replace the push rod.
2. **Bend Inspection.** Check the push rod for bend and, if it exceeds the limit, replace it. Place the push rod on a flat surface and measure the clearance between the center of the push rod and the flat surface. Replace the push rod if the wear limit is exceeded.

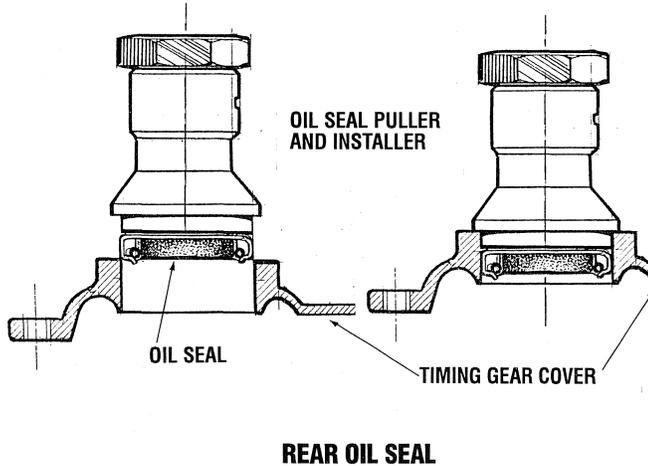
Bend limit: 0.0075 in (0.19 mm)



ENGINE INSPECTION

TIMING GEAR COVER OIL SEAL

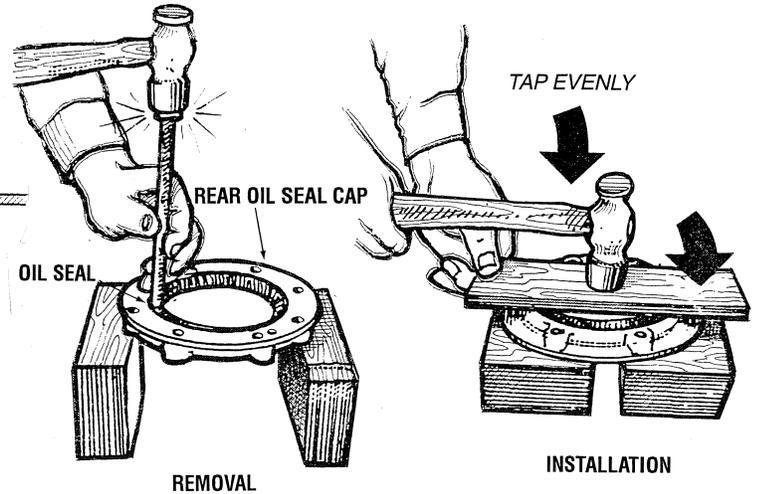
1. **Inspecting timing gear cover oil seal.** Check the timing gear cover and the lip of the oil seal for any damage. If necessary, replace the cover or oil seal.
2. **Oil seal replacement.** To remove the oil seal, use the oil seal puller and installer and pull out the oil seal. To install, apply engine oil on the outside of a new oil seal, then press fit the oil seal with oil seal puller and installer until the installer comes in contact with the cover.



REAR OIL SEAL

1. **Inspecting oil seal.** Check the oil seal lip for wear, fraying or other damage and, if necessary, replace it.
2. **Oil seal replacement.**
 - a. Strike out the old rear oil seal with a suitable mandrel.
 - b. Apply engine oil onto the outside of a new seal and press fit the seal in the rear oil seal cap equally.

NOTE: In case the crankshaft is worn, the oil seal must be fitted on the oil seal cap with its fitting position moved by approximately 0.1181 in (3 mm) so that the seal does not touch the worn down portion of the crankshaft.



TIMING GEAR COVER OIL SEAL

ENGINE ASSEMBLY

Reassembly Precautions

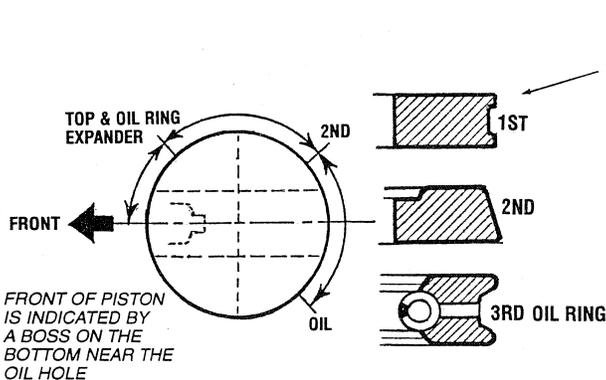
- Be careful not to mix bolts and nuts. Metric and S.A.E. bolts are used on various engine assemblies.
- During assembly, recheck clearances and insure that parts are being assembled in their proper order and facing in the correct direction in relation to the engine block, such as, pistons, piston rings, bearings and bearing caps.
- Apply lubricating oil to moving parts during assembly. Insure that moving parts, when assembled on the engine, rotate or slide and are not subject to binding or excessive tension.
- If there are mating marks scribed during disassembly, reference them correctly for assembly.
- Use new gaskets, lockwashers, o-rings, etc.
- Tighten the bolts and nuts on important parts of engine to specified torques using a reliable torque wrench.
- Use liquid sealants when required on nuts, bolts and gaskets. Refrain from using tape sealants.

Be aware of these common problems that can occur during assembly.

Insufficient Lubrication. Heavily oil sliding and reciprocating parts, lightly oil head bolts and other fasteners, except those that penetrate into the water jacket. These fasteners should be sealed with Permatex No. 2 or the high-tack equivalent.

Reversed orientation. Most gaskets, many bolt washers, and all thermostats are asymmetrical.

Mechanical damage. Run fasteners down in approved torque sequences and in three steps—1/2, 2/3, and 1/1 torque. Exceptions are torque-to-yield bolts and rocker arm shaft fasteners. The former are torqued as indicated. The latter—rocker shaft fasteners—should be brought down in very small increments, working from the center bolts out. Gaskets, especially head gaskets, might be damaged during assembly, they should be positioned with great care.



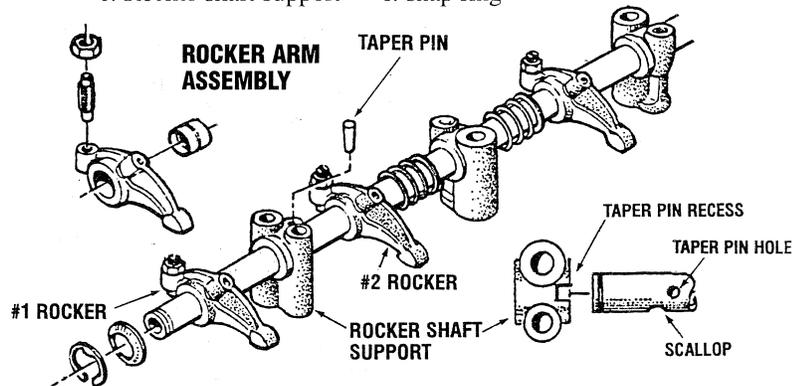
ENGINE ASSEMBLY

1. **Install the valves in cylinder head.** Using the valve spring lifter arm and pivot, assemble the valve, lower spring seat, oil deflector, inner valve spring, outer valve spring, upper spring seat and taper sleeve in this order.

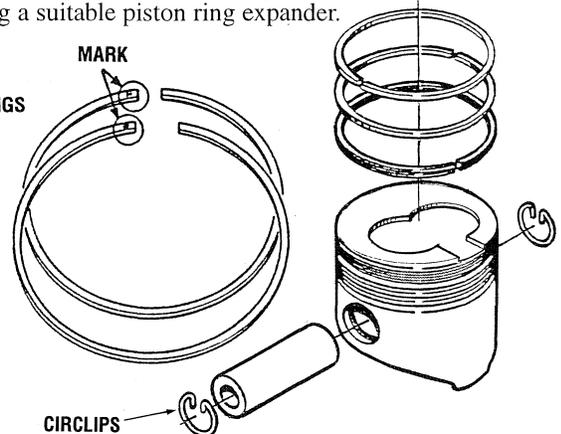
NOTE: The oil deflector should be installed on the intake valve only.

2. **Assemble the rocker arm shaft, rocker shaft brackets and rocker arms.** Note that the front end of the rocker shaft is identified by a pin protruding from the top and a larger oil hole between the supply holes serving #1 and #2 rocker arms. This pin fits a slot in the #1 rocker shaft support which prevents the shaft from turning and cutting off the lube oil to the rocker arms and valves. Use the following order of assembly:

- a. Spring
- b. Rocker
- c. Rocker shaft support
- d. Rocker
- e. Wave washer
- f. snap ring



3. **Assemble the connecting rod, piston and piston rings.** Arrange the piston and the connecting rod as shown and, using the piston pin installer, insert the piston pin through the piston and connecting rod until the piston pin (wrist pin) snap rings can be fitted. Fit the piston pin snap rings to their respective grooves. Install the piston rings to ring grooves on the piston with the inscription mark on ring upward using a suitable piston ring expander.



CHECK THE PISTON RING GAPS WITH CARE. NEW RINGS ARE PACKAGED WITH DETAILED INSTRUCTIONS THAT OFTEN SUPERSEDE THE SERVICE MANUAL.

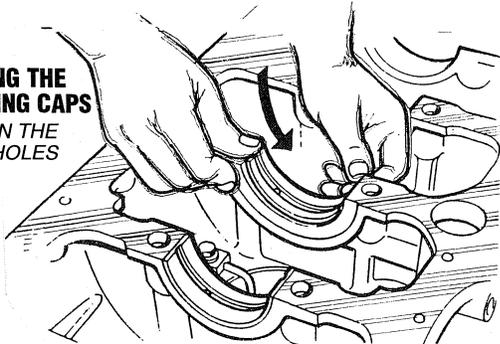
ENGINE ASSEMBLY

4. Main Bearings and Bearing Caps.

NOTE: Do not apply oil to the backsides of the main bearing shells.

- Fit the main bearings on the cylinder block and the bearing caps respectively. Check that the oil ways align perfectly with those in the block.
- Fit the thrustwashers to the cylinder block so that the oil grooves on thrustwashers face to crankshaft side.
- Position the crankshaft to the cylinder block, being careful not to drop the thrustwashers as the crankshaft settles into place.

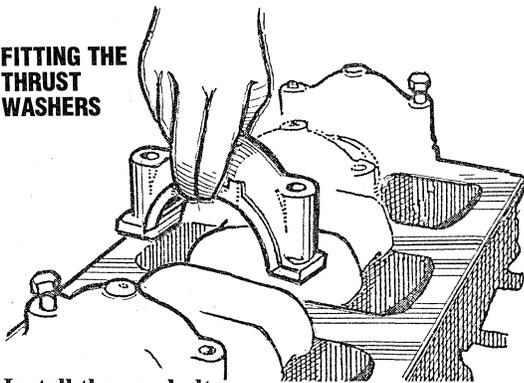
FITTING THE BEARING CAPS
ALIGN THE OIL HOLES



- Fit the thrust washer to the main bearing cap so that the oil grooves on thrust washer face to crankshaft side. Then install the main bearing cap to the cylinder block with arrow mark of the main bearing cap facing the crankshaft pulley side.

Main Bearing Cap Torque 11.0 - 11.7 m-kg (80 - 85 ft-lb)

FITTING THE THRUST WASHERS



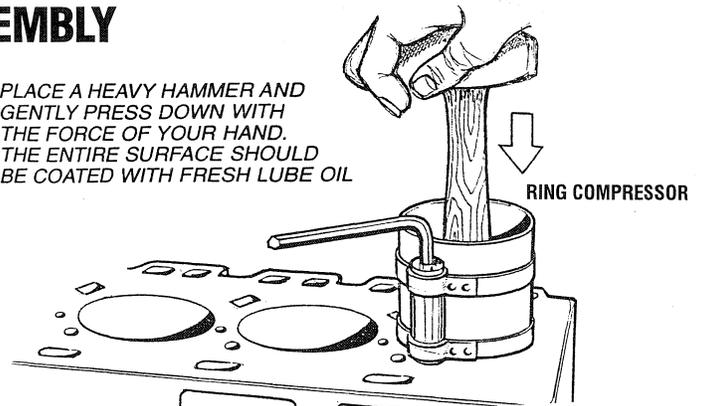
5. Install the cap bolts.

NOTE: Ensure the crankshaft rotates smoothly after installing.

- Install the rear oil seal. Apply oil to the oil seal lip.
- Install the piston and connecting rod assembly.

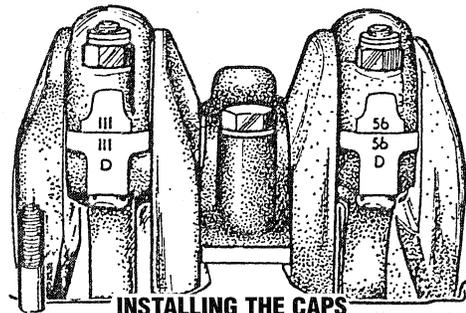
- Place the piston rings so that the ring ends are properly spaced around the circumference of the piston as shown on the previous page.
- Using a ring compressor, fit the piston into the cylinder in the position as is shown. Apply oil onto the sliding face of the piston and the cylinder bore.

PLACE A HEAVY HAMMER AND GENTLY PRESS DOWN WITH THE FORCE OF YOUR HAND. THE ENTIRE SURFACE SHOULD BE COATED WITH FRESH LUBE OIL



- Install the caps to the connecting rods, ensuring that the identification numbers on the cap and connecting rod are matched.

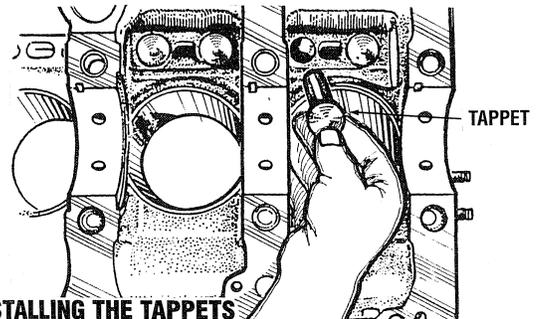
Cap Torque (14 mm socket) 50 - 54 ft-lb (6.9 - 7.5 m-kg)
(install new connecting rod bolts)



INSTALLING THE CAPS

8. Installation of the crankshaft.

- Insert the tappets into the cylinder block. Apply engine oil to the sliding face of the tappet.

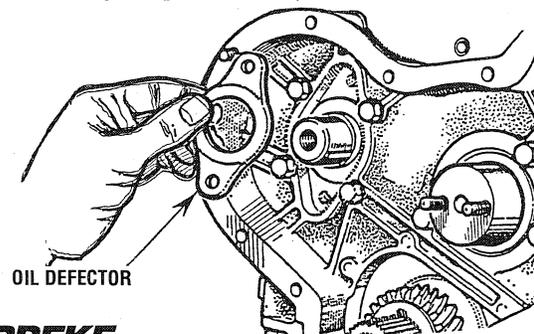


INSTALLING THE TAPPETS

- Insert the camshaft into the cylinder block. Apply oil to the camshaft journal and bearing surfaces.
- Install the camshaft thrust plate.

Thrust Plate Torque (1/2 in socket) 11.6 - 17.4 ft-lb (1.6 - 2.4 m-kg)

- Install the idler gear spindle. Align the oil passages of the idler gear spindle and cylinder block.



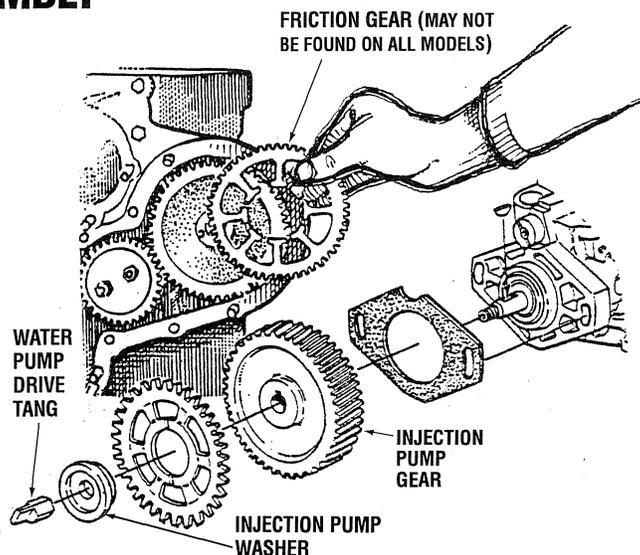
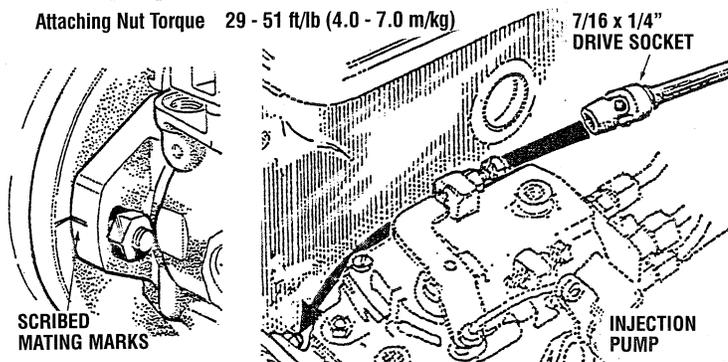
ENGINE ASSEMBLY

10. Fuel Injection Pump.

NOTE: It is easier to first install the injection pump to the timing gear case and the entire assembly onto the engine. Install the injection pump aligning the identification marks.

Mount the injection pump on the gear case, then tighten the pump drive gear attaching nuts.

Attaching Nut Torque 29 - 51 ft/lb (4.0 - 7.0 m/kg)



11. Install the timing gear case. Attach the straight edge on the cylinder block, then match the surfaces of the timing gear case end and that of the cylinder block. If the gasket protrudes from the mating surface, cut away the excess with a knife.

Attaching Bolt Torque (1/2 in socket) 12 - 17 ft/lb (1.6 - 2.4 m/kg)

12. Install each gear. While aligning the timing mark of each gear, install the following gears on each position:

- Camshaft gear;
- Idler gears;
- Injection pump drive gear;
- Install the idler gear thrust plate, then tighten the nuts.

Idler Gear Thrust Plate

Nut Torque (1/2 in socket) 2.3 - 3.2 m/kg (16.6 - 23.1 ft-lb)

- Tighten the camshaft gear attaching bolts.

Camshaft Gear Attaching

Bolt Torque (19 mm socket) 45 - 51 ft-lb (6.2 - 7.0 m/kg)

13. Install the friction gear.

NOTE: The friction gears are not found on all models.

14. Install the camshaft gear lock bolt.

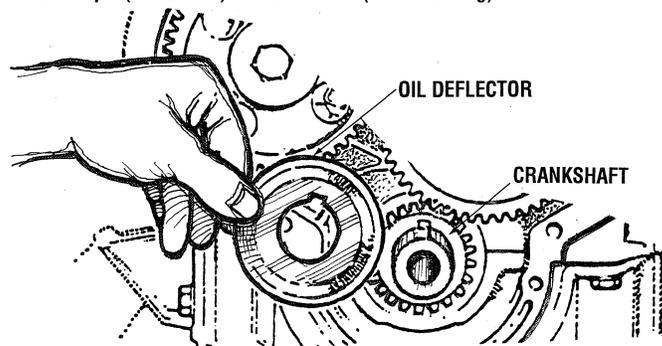
NOTE: Wedge a clean cloth between the camshaft gear and the idler gear.

Lock Bolt Torque (19 mm socket) 45 - 51 ft-lb (6.2 - 7.0 m/kg)

15. Install the inject pump drive gear lock nut.

NOTE: Wedge a clean cloth between the injection pump drive gear and the idler gear.

Lock Bolt Torque (1 in socket) 29 - 51 ft-lb (4.0 - 7.0 m/kg)



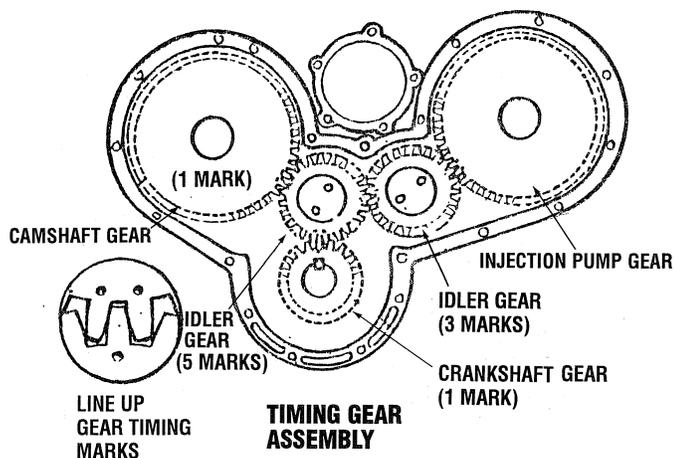
16. Install the oil deflector on the crankshaft.

17. Install the timing gear cover.

- Install the bearing housing cover on the timing gear cover.
- Install the injection pump drive gear cover on the timing gear cover.
- Install the timing gear cover and tighten the timing gear cover attaching nuts and bolts after the crankshaft pulley has been installed temporarily to center the seal.

Timing Gear Cover Torque 1.6 - 2.4 m/kg (11.6 - 17.4 ft-lb)

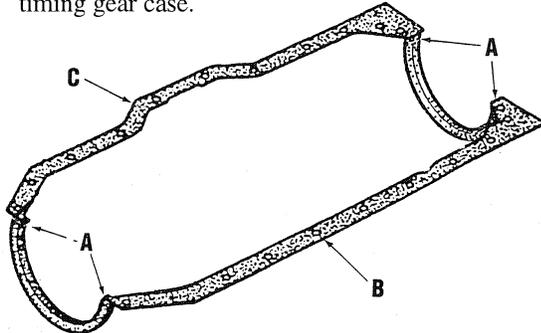
18. Mount the oil pump assembly. Apply the sealing agent on the set screw thread and tighten the screw. Ensure the oil pump drive gear and the driven gear mesh.



ENGINE ASSEMBLY

19. Position the new oil pan gasket set.

- Position the gasket ends (A) on the gaskets (B) and (C).
- Apply a silicon sealing agent on the mating surfaces of the gasket and that between the cylinder block and the timing gear case.



20. Install the oil pan.

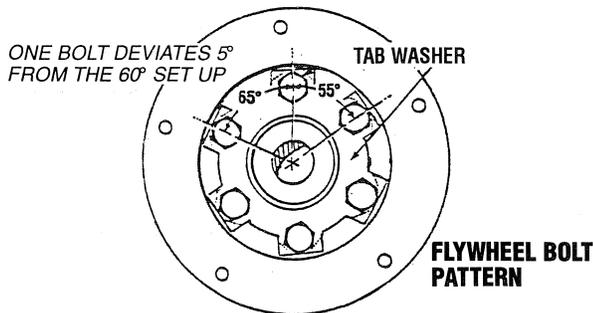
Oil Pan Bolts Torque (1/2 in socket) 5 - 9 ft-lb (0.7 - 1.2 m-kg)

21. Attach the back plate.

Back Plate Torque (9/16 in socket) 23.9 - 35 ft-lb (3.3 - 4.8 m-kg)

- ## 22. Install the flywheel.
- Install the flywheel onto the rear end of the crankshaft by placing it on the crankshaft and rotating it to properly align the mounting bolt holes. Install the tabwasher and the attaching bolts. After torquing, bend one tab against the flat of each attaching bolt.

Flywheel Bolts Torque (19 mm socket) 95 ft-lb (13.1 m-kg)



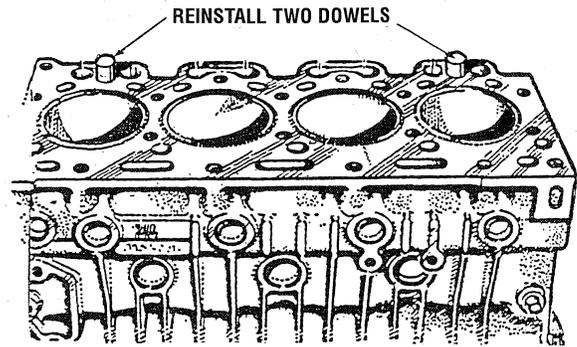
- ## 23. Install the raw water pump.
- Mount the raw water pump on its adapter plate and assemble it to the engine. Do not tighten.

- ## 24. Install the crankshaft pulley.
- Apply engine oil onto the lip of the oil seal. Carefully slide the front crankshaft pulley onto the crankshaft ensuring that the key in the crankshaft and the keyway in the pulley mate properly. Apply Loctite (high temperature) to the threads of the front crankshaft pulley holddown bolt when installing it. Ensure the flat washer is under the head of the bolt.

Front Crankshaft Pulley

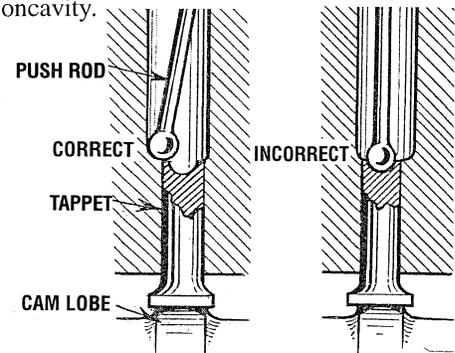
Bolt Torque (38 mm socket) 145 - 181 ft-lb (20 - 25 m-kg)

- ## 25. Install the two tubular dowels adjacent to cylinders 1 and 4 if they were removed earlier during disassembly.
- Position the gasket on cylinder block. Do not use any liquid seal or cement.



26. Position the cylinder head.

- ## 27. Insert the pushrod.
- Check if the push rod is securely set in the tappet concavity.



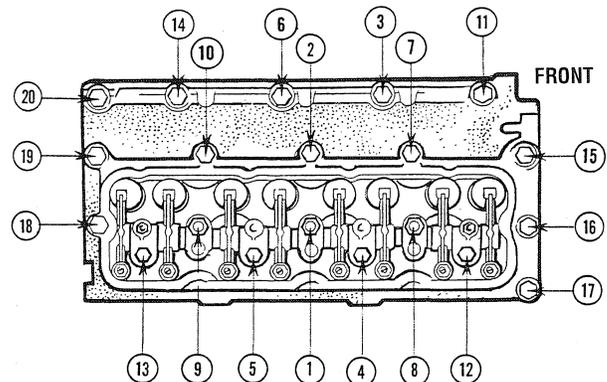
- ## 28. Position the valve cap on the top of the valve stem.
- It should be set squarely on the valve stem.

- ## 29. Install the rocker arm assembly onto the cylinder head.
- Remember that the end of the rocker shaft having the pin occupying the slot in #1 rocker support points toward the front (pulley) end of the engine.

- ## 30. Tighten the cylinder head bolts.
- Tighten the cylinder head bolts evenly in the sequence shown. After tightening the cylinder head bolts, make certain the rocker arms move smoothly.

Cylinder Head Bolts

Torque (3/4 in socket) 80 - 85 ft-lb (11.0 - 11.7 m-kg)

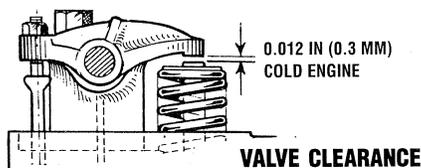
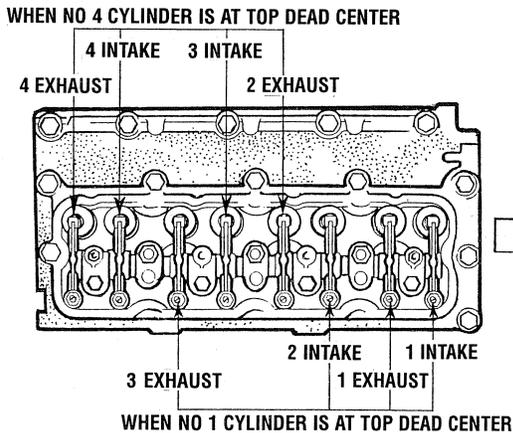


CYLINDER HEAD BOLT PATTERN

ENGINE ASSEMBLY

- 30. Adjust the valve clearance.** Adjust the No. 1, 2, 3, and 6 valves when the No. 1 piston is on Top Dead Center (TDC) or the compression stroke.

Turn the crankshaft once, setting the No. 4 cylinder piston at TDC (compression) and adjust the No. 4, 5, 7, and 8 valves. The valves are numbered 1 - 8 from front of the engine.



- 31. Adjust each valve's clearance** by inserting a 0.012 in (0.03 mm) feeler gauge between the rocker arm and the valve stem.

Valve Clearance 0.30 mm (.12 in) cold

NOTE: When the engine overhaul is complete, run the engine under load to check its performance. Allow the engine to cool to room temperature and retorque the cylinder head hold-down nuts and readjust valves. The cylinder head hold-down bolts and valve adjustment should be rechecked again after 50 hours and periodically thereafter.

- 32. Install the cylinder head cover.**

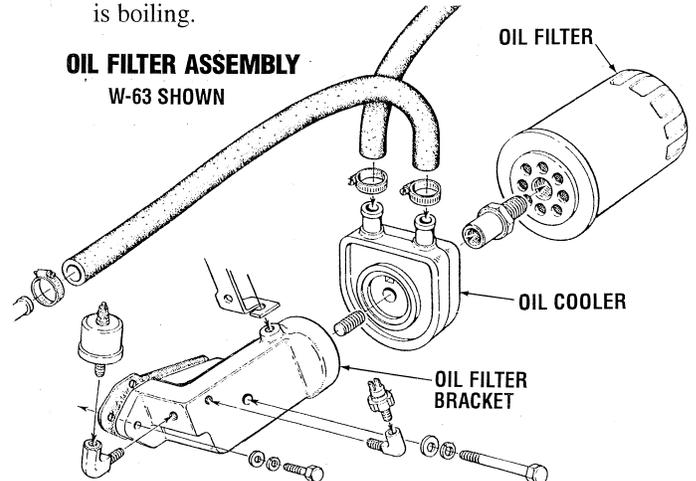
Cylinder Head Cover Bolts Torque 0.3 - 0.4 m-k (2 - 3 ft-lb)

NOTE: After the engine has been reassembled, readjust the valve clearances with a warm engine, see ENGINE ADJUSTMENTS.

- 33. Install the thermostat and thermostat housing.**

- Inspect the thermostat housing and the housing gasket. Apply some sealant to the gasket when reassembling.
- Install the temperature switch and sender and reconnect their wires.

- Install a new thermostat and gasket (the old thermostat can become a spare). When installing the new thermostat and gasket, apply a thin coat of sealant to both sides of the gasket.
- The old thermostat can be checked for proper operation by placing it in a pan of cold water and then raising the temperature of the water to a boil. The thermostat should open noticeably (with travel on the order of 1/4 in - 1/2 in) and be fully opened when the water is boiling.



- 34. Attach the engine coolant circulating pump.**

Coolant Pump Assembly

Bolts Torque (use 1/2" socket) 12 - 17 ft-lb (1.6 2.3 m-k)

A complete breakdown of the COOLANT PUMP ASSEMBLY is covered elsewhere in this manual.

- 35. Adjust the injection timing.**

Refer to INJECTION TIMING elsewhere in this manual.

- 36. Mount the oil filter bracket and install a new filter.**

When installing the new filter apply a thin coat of clean engine oil to the rubber gasket. Tighten by hand.

- 37. Mount the front engine mounting bracket.**

Mounting Bracket Torque 33 - 49 ft-lb (4.6 - 6.8 m-k)

- 38. Install the intake manifold.** Replace the four gaskets.

Intake Manifold Torque 11.6 - 17.4 ft-lb (1.6 - 2.4 m-k)

- 39. Mount the fuel filter assembly.**

Attaching Nuts Torque 33 - 49 ft-lb (4.6 - 6.8 m-k)

- 40. Mount the rocker arm cover using a new gasket.**

Apply sealant to that portion of the gasket that contacts the gasket only.

Rocker Arm Cover Torque 1.8 - 2.9 ft-lb (0.25 - 0.40 m-k)

- 41. Attach the crankcase vent hose.**

ENGINE ASSEMBLY

42. **Install the fuel injection nozzles and return lines.** Use new sealing washers throughout, in the same order as were the old washers.

Injector Torque (27mm deep socket) 43 - 51 ft-lb (6.0 - 7.0 m-kg)

See *FUEL INJECTORS*

43. **Install the glow plugs and connectors.** Use anti-seize compound on the threads.

Glow Plug Torque 7.2 - 10.8 ft-lb (1.0 - 1.5 m-kg)

To test the glow plugs, see *GLOW PLUGS*.

44. **Connect the fuel line to the engine mounted fuel filter and the injection pump.** Use new sealing washers.

45. **Connect the high pressure injector lines from the injection pump to injectors.** Reinstall the line clamp.

Attaching Nuts Torque 18 - 22 ft-lb (2.5 - 3.0 m-kg)

46. **Install the bellhousing.**

47. **Mount the engine heat exchanger.**

The heat exchanger should be serviced at engine overhaul. Refer to *HEAT EXCHANGER*.

48. **Install the intake manifold.** Replace the four gaskets.

49. **Assemble the engine oil cooler.** Install a new oil filter, tightening the filter by hand.

50. **Install the alternator and drive belt.**

 **CAUTION: Connect the alternator properly. Should the polarity be reversed, a powerful current would flow from the battery into the alternator, damaging the diodes and wiring harness.**

- a. Install the alternator support bolt through the alternator leg (underside) into the engine casting.
- b. Swing the alternator into position on the adjusting bracket and fasten. Lightly tighten.
- c. Adjust belt tension.
- d. Tighten both bolts and recheck belt tension.

Support bolt Torque and

Adjusting bracket bolt Torque 27 - 38 ft-lbs (3.8 - 5.3 mKg)

NOTE: Make certain the belts are perfectly aligned with the alternator and engine pulleys. If not, insert or remove spacers as needed, to align the alternator.

See *ALTERNATOR* for testing.

51. **Install the raw water pump and drive belt.** Insure it is in proper alignment with the crankshaft pulley. Check the belt tension.

Refer to *RAW WATER PUMP*

52. **Install the oil and water sender and switch.**

53. **Install the starter motor.**

54. **Install the breaker panel and the preheat solenoid.**

55. **Reinstall the engine electrical harness.**

56. **Mount the complete exhaust manifold and the expansion tank to the cylinder head.**

Manifold Mounting Bolts Torque 12 - 17 ft-lb (1.6 - 2.4 m-kg)

See *EXHAUST MANIFOLD* for service and inspection.

57. **Install the pre-formed metal tube that connects the cooling system.** Inspect the pipe before installing. If it is corroded, it should be replaced.

ENGINE ASSEMBLY

MARINE TRANSMISSION

58. Assemble the damper plate to the flywheel.
59. Reinstall the marine transmission and fill with ATF Dextron III.

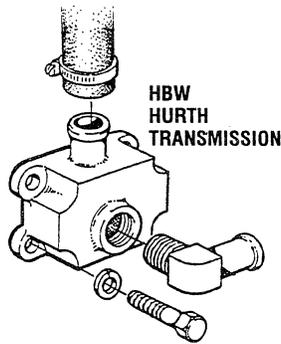
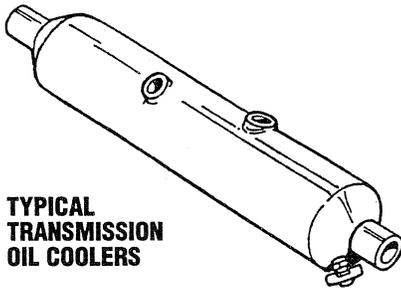
NOTE: Some transmissions, such as the Borg Warner Velvet Drive require oil coolers. Oil coolers should be cleaned, pressure tested and repainted at engine overhaul. The transmission oil cooler hoses should also be inspected. Refer to the text on Heat Exchangers.

- 60 Fill the engine cooling system with antifreeze mixture and the engine oil sump with lube oil (A.P.I. spec. CF or CG-4).

The engine should be test run under load prior to re-installing. At this time readjust the valve clearances on the hot engine.

Allow the engine to cool to room temperature and retorque the cylinder head bolts and re-check the valve clearances.

See *ENGINE ADJUSTMENTS*.



GENERATOR

58. Mount the generator back end assembly with its control panel. Reconnect all DC wiring and reconnect all AC connections.

CAUTION: Check all AC and DC wiring connections to WESTERBEKE wiring schematics and diagrams.

59. Fill the engine cooling system with antifreeze mixture and the engine oil sump with lube oil (A.P.I. spec. CF or CG-4).

The engine should be test run under load prior to re-installing. At this time readjust the valve clearances on the hot engine.

Allow the engine to cool to room temperature and retorque the cylinder head bolts and re-check the valve clearances.

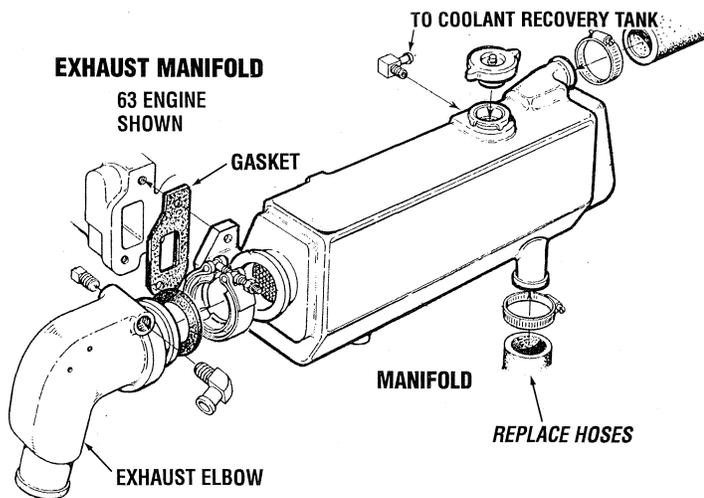
See *ENGINE ADJUSTMENTS*.

EXHAUST MANIFOLD / HEAT EXCHANGER

EXHAUST MANIFOLD

The exhaust manifold, which was disassembled from the cylinder head, should be inspected before reassembly.

1. Remove the exhaust elbows from the lower surface of the manifold. Clean and inspect for cracks and defects. Replace as needed.
2. Remove the exhaust nipples, elbows and plugs from the manifold.
3. Remove water connectors from the ends of the manifold and the end plates (W-52). Be sure to note the proper location and arrangement of each for proper alignment.
4. Examine all parts for defects, corrosion and wear and replace as needed.
5. Flush out the manifold's interior with a liquid cleaner and rinse thoroughly with fresh water.
6. Use a pipe cleaner to clear the passage that connects the coolant recovery tank tubing.
7. Flush out the coolant recovery tank and its connecting tube.



ASSEMBLY

1. If the manifold was removed as an assembly and left intact, it can be replaced on the cylinder head in the reverse order of removal. Do not reuse the gaskets; install new ones.
- Manifold Mounting Bolts Torque 10 - 12 ft-lb (1.3 - 1.6 m-kg)**
2. If the manifold has been disassembled, follow the steps below.
 - a. Loosely attach the elbows to the cylinder head and the manifold using new gaskets. Do not use any gasket sealant on these gaskets.
 - b. Gradually tighten each fitting to make sure of proper alignment of all the parts. This should be done in three steps.

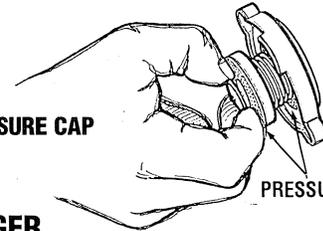
Manifold Mounting Bolts Torque 10 - 12 ft-lb (1.3 - 1.6 m-kg)

- c. Reassemble the manifold end plates (W-52) and the connectors to the manifold. Be sure to use new gaskets and coat the gasket surfaces with a suitable gasket cement such as High Tack.

Manifold End Plate Bolts Torque 8 - 10 ft-lb (1.1 - 1.3 m-kg)

- d. Reinstall the exhaust connections and plugs into the manifold using Loctite-Anti-Seize on the threads.

3. Check the manifold pressure cap. Open the valve by pulling it and make sure it closes when released. Make certain the upper and lower seals are in good condition. If in any doubt, replace the cap.



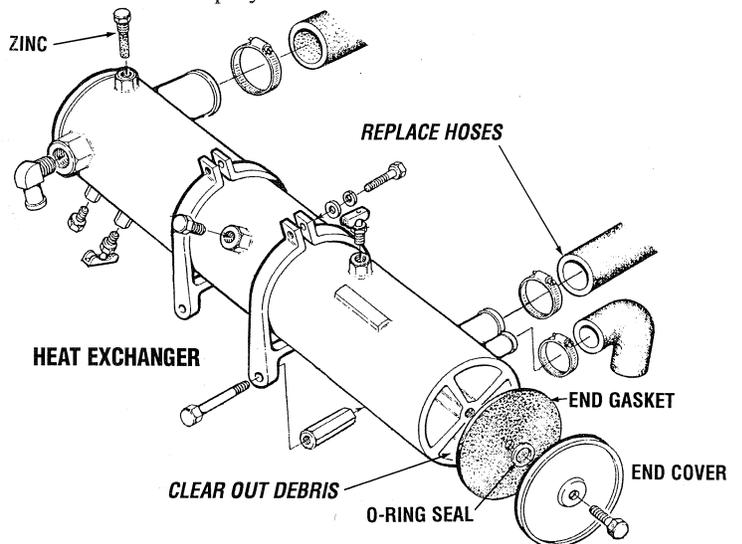
HEAT EXCHANGER

The heat exchanger should be inspected and serviced during an engine overhaul.

1. Disconnect the hoses and remove the hose fittings, petcock, drain plugs and zinc anode. Also, remove the end fittings and gaskets.
2. Inspect the tube (casing) for wear and dents, if at all suspect replace the heat exchanger.
3. Clean out any zinc debris and pressure test the coolant and raw water passages.
4. When reassembling, install new gaskets and O-rings. Apply some lubricant to the new gaskets and to the petcocks and fittings as you install them.
5. Install a new zinc anode.

NOTE: All of the above can be accomplished by sending the heat exchanger to a heat exchanger service shop. They will also service transmission and engine oil coolers.

6. Repaint the assembled heat exchanger with Westerbeke heat resistant spray enamel.



7. Reconnect all hoses, replacing them as needed.
8. Refill the system with coolant as detailed above.
9. Pressure test system and check for leaks.

FUEL INJECTION PUMP

TESTING INJECTION TIMING

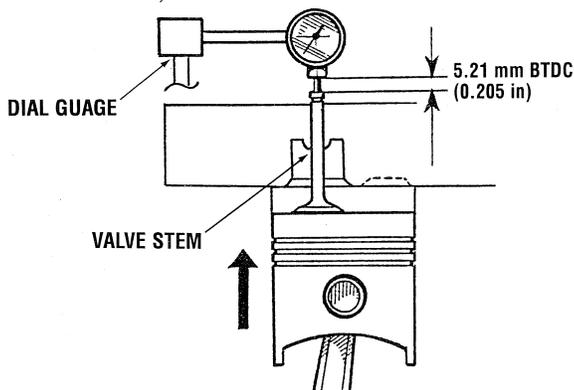
1. Remove the air intake/silencer assembly.
2. Remove the four high pressure injector lines that connect between the injection pump and injectors.
3. Remove the bolt and gasket installed on the distributor head of the injection pump.
4. Remove the valve rocker cover.
5. Rotate the crankshaft in normal direction of rotation using the front crankshaft pulley nut and place the No. 1 piston at TDC of its compression stroke.

NOTE: To verify, the rocker arms of No. 4 cylinder should be rocking, one opening, one closing.

6. Remove the snap ring from the end of the rocker shaft at cylinder No. 1 along with the retaining washer.
7. Loosen the rocker arm adjusting bolt so as to allow the arm to be removed from the push rod and slide it off the rocker shaft.
8. Press down on the valve and spring assembly and ensure the valve is hitting the top of the No. 1 piston. Then remove the cap, keepers and valve springs from the No. 1 valve.

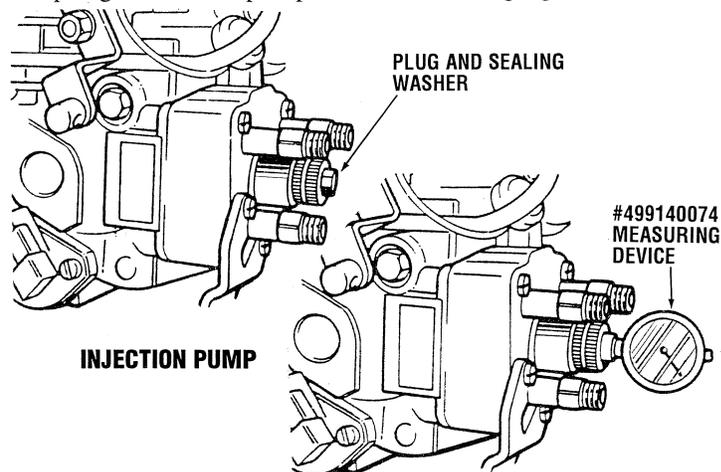
NOTE: Ensure the valve moves freely in its guide. Take care to not drop the keepers down the push rod hole.

9. Position a dial indicator gauge on the valve stem and, using the front crankshaft pulley nut, rock the crankshaft counterclockwise and clockwise to locate the exact TDC of the compression stroke for the No. 1 piston. Then zero the indicator gauge to the valve stem (the gauge should be able to measure up to 0.3 inch of valve movement).



10. Slowly turn the crankshaft in the opposite direction of normal rotation until the indicator reads 0.207 inches BTDC. It is advisable to go slightly more than 0.207 inches and then return to that figure to remove gear lash. The No. 1 piston is now at 30° BTDC. Verify the scribe mark on the injection pump outboard mounting flange is properly aligned with the scribe mark on the engine mounting case. At the six o'clock position on the outboard side of the injection pump is a semi-oval cover with two screws. Remove this cover and locate the sealing O-ring and timing washer 0.032 inches in thickness. Remove this washer and replace the cover.

12. Remove the plug and sealing washer from the aft center of the injection pump. The plug is centrally located where the four high pressure injector lines attach to the pump. In place of the plug install the #49 9140 074 measuring device. Ensure the measuring device rod contacts the plunger inside the pump and then zero the gauge.



NOTE: When setting the dial gauge, confirm that the dial gauge pointer does not deviate from the scale mark of zero by slightly turning the engine crankshaft from left to right.

Turn the engine crankshaft in the normal direction of rotation to bring the No. 1 piston up to TDC. The dial indicator on the valve stem should zero and the indicator on the injection pump should show 0.039 inches (1 mm) of movement.

ADJUSTING INJECTION TIMING

1. Loosen the nuts holding the injection pump to the engine. (The high pressure injector lines should not be attached to the injection pump.)
2. Make the adjustment by moving the injection pump itself. When the amount of movement of the measuring device indicator on the injection pump is too large, first turn the injection pump in the reverse direction of the engine rotation so that the dial gauge pointer indicates less than the scale mark of 0.039 inches (1 mm). These adjustments are to tighten the gear backlash.

Injection Pump Gear Lock Nut Torque 29 - 51 ft-lb (4.0 - 7.4 m-kg)

When the amount of the measuring device indicator on the injection pump is too small, turn the injection pump in the direction of normal engine rotation so that the measuring device indicator points to the scale mark of 0.039 inches (1 mm).

3. After the adjustment, tighten the injection pump hold-down nuts, and then confirm again that the adjustment has been done correctly.

FUEL INJECTION PUMP / FUEL LIFT PUMP

CHECKING CAM LIFT

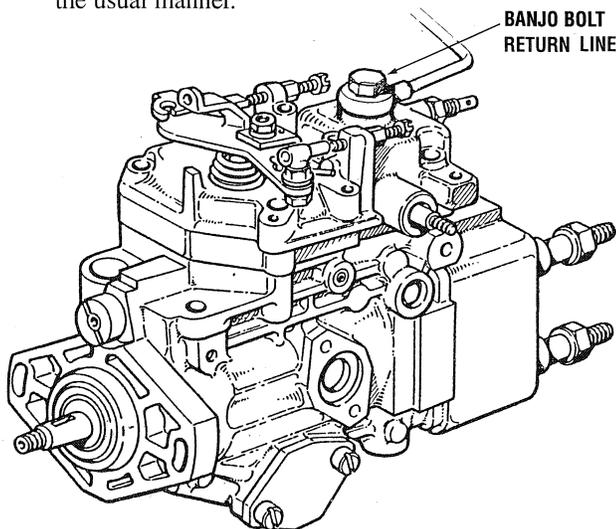
1. Turn the crankshaft in the direction of normal engine rotation and read the maximum value which the dial indicator pointer on the measuring device shows. This value is cam lift.

Amount of Cam Lift 0.08 in (2.2 mm)

2. After this check, remove the measuring device and install the plug and sealing washer.
3. Reinstall the 0.032 inch thick timing washer in the injection pump.

BLEEDING THE INJECTION PUMP

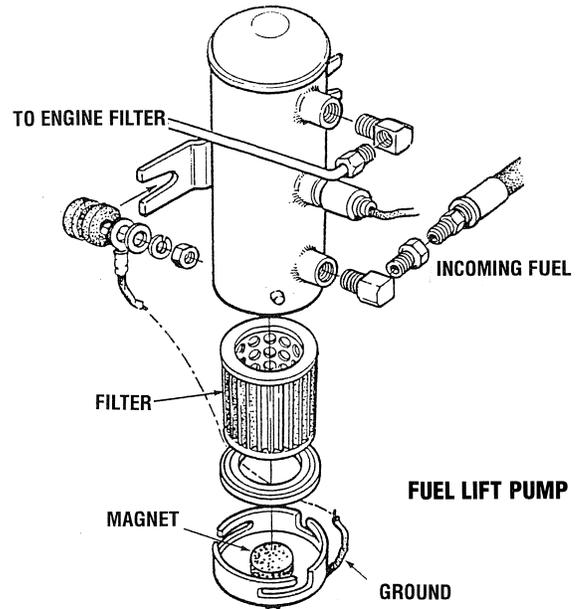
1. The injector pump and injector high pressure lines will have to be bled of air after the lines have been reinstalled. To bleed the injection pump, first loosen the return connection. Then, by priming with the lever on the engine mounted fuel filter, supply fuel to the injection pump to remove the air from the injection pump. Continue until fuel clear of air passes out of the loosened return connection.
2. Next, bleed the high pressure lines by loosening them at their attachment to the fuel injectors. Loosen the attaching nuts (one to two turns) on all four fuel lines. Turn the key on and crank the engine with the starter until fuel spurts by the loosened connections. Stop cranking the engine. Tighten the attaching nuts and start the engine in the usual manner.



TYPE VE INJECTION PUMP

FUEL LIFT PUMP (Early Models)

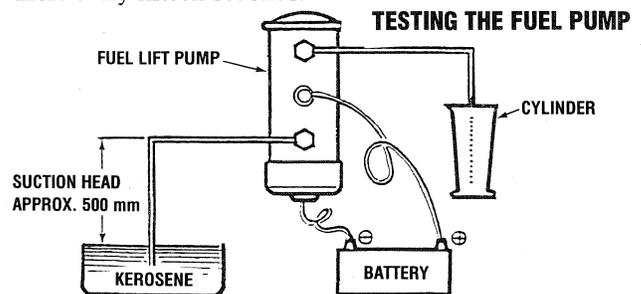
The fuel lift pump should be cleaned and repainted. Install a new filter as illustrated and clean the ground wire terminal.



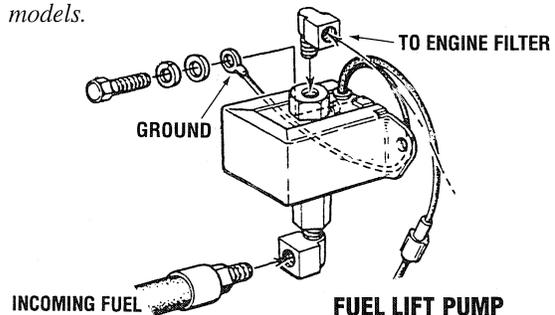
Troubleshooting

This pump operates during the start sequence when preheat is pressed. Simulate a start and depress preheat, the pump should produce a clicking sound indicating the piston in the pump is working. If no clicking is heard, check that 12 volts are present at the pump connection and the pump is properly grounded.

1. Test the pump by connecting a battery and fuel line as illustrated. Fuel delivery must be 0.5 pints (225 cc) or more every fifteen seconds.



NOTE: Later model WESTERBEKE engines and generators use a solid state fuel lift pump that requires no maintenance. The above tests can be performed on these models.



FUEL INJECTORS

REMOVING THE INJECTORS

NOTE: Injector must be serviced in a "clean room" environment.

1. Disconnect the high pressure lines from the injectors and loosen the lines at their attachment to the injection pump and move them out of the way of the injectors. Avoid bending the lines.
2. Remove the fuel return line in its entirety from the top of the injectors. Take care not to lose the two sealing washers and banjo bolt that attaches the fuel return line to each injector.
3. Unscrew the injector from the cylinder head using a suitable 27 mm deep socket.

NOTE: Clean the area around the base of the injector prior to lifting it out of the cylinder head to help prevent any rust or debris from falling down into the injector hole. If the injector will not lift out easily and is held in by carbon build up or the like, work the injector side to side with the aid of the socket wrench to free it and then lift it out.

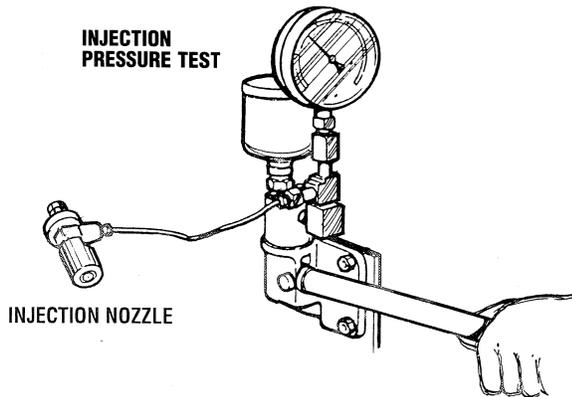
4. The injector seats in the cylinder head on a copper sealing washer. This washer should be removed with the injector and replaced with a new washer when the injector is reinstalled.

INJECTION TESTING/ADJUSTMENT

1. Using the nozzle tester, check the spray pattern and injection starting pressure of nozzle and, if it exceeds the limit, adjust or replace the nozzle. When using nozzle tester, take the following precautions:

CAUTION: The spray injected from the nozzle is of such velocity that it may penetrate deeply into the skin of fingers and hands, destroying tissue. If it enters the bloodstream, it may cause blood poisoning.

- a. If the diesel fuel of the nozzle tester is discolored, replace it. At the same time, clean or replace the filter.
- b. Set the nozzle tester in a clean place where there is no dust or dirt.

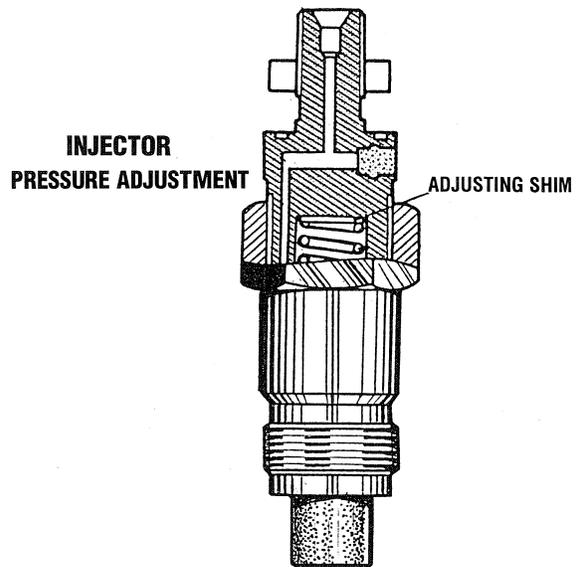


- c. Mount the nozzle and nozzle holder on the nozzle tester.
- d. Use the fuel at the approximate temperature of 68° F (20° C).
- e. Operate the hand lever of nozzle tester several times to bleed the air in the nozzle line, then move the hand lever at intervals of one stroke per second while reading the injection starting pressure.

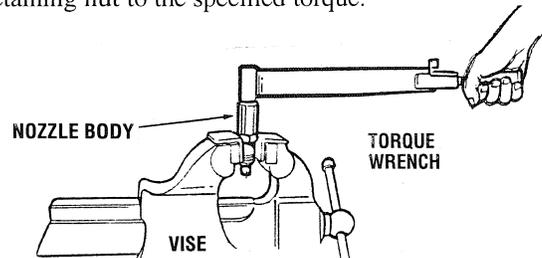
Injector Starting Pressure 1,920 lb/in² (135 kg/cm²)

- f. If the fuel injection starting pressure is not within the specification, it can be adjusted by removing or adding shims in the injector body to achieve proper pressure.

NOTE: The shims are available in 53 kinds ranging from 0.5 mm to 1.54 mm at 0.02 increments. An increment of 0.02 mm causes the starting pressure to rise by approximately 34 lb/in² (2.4 kg/cm²).



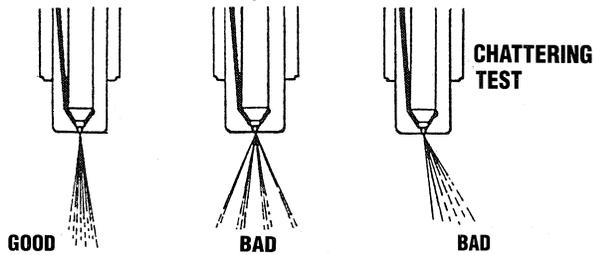
When replacing the shim, grip the retaining nut in a vise and remove the body with a wrench. Tighten the retaining nut to the specified torque.



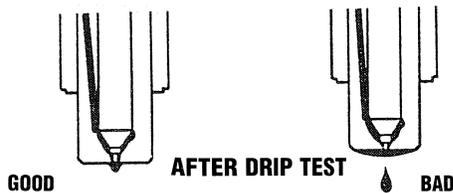
FUEL INJECTORS

INSPECTING SPRAY PATTERN

1. Operate the hand lever of the nozzle tester at intervals of one stroke per second to check if the fuel is injected correctly in its axial direction. A nozzle is defective if it injects fuel in an oblique direction or in several separate strips. Also, a spray in the form of particles indicates a defect. These defects may sometimes be caused by clogging with dust and, therefore, all parts should be carefully cleaned before reassembly.



2. Operate the hand lever to raise the pressure up to 1635 lb/in² (115 kg/cm²), which is 280 lb/in² (20 kg/cm²) lower than the starting pressure. If, with pressure applied, fuel does not drip from the nozzle, oil tightness is satisfactory. Dripping of fuel with pressure applied, is indicative of damage to the needle valve or valve body or poor contact between both. In that event, both needle valve and valve body should be considered defective and replaced.



DISASSEMBLY AND INSPECTION

1. Clamp the nozzle holder in a vise, remove the nozzle nut and disassemble the nozzle body, spring, and needle.
2. Clean the disassembled parts with clean diesel fuel.

NOTE: Greatest possible care should be taken in handling the nozzles as they are precisely machined. The nozzle and the needle valve are matched parts. Do not mix their original combinations. Disassemble and wash each nozzle assembly separately.

Carbon deposits on the nozzle body must be removed with a piece of hard wood. However, it would be advisable not to clean the surrounding area of the nozzle orifice to avoid possible damage to the orifice.

Iron dust on the magnetic filter top must be removed completely.

5. Assure the needle valve, when it is pushed in the nozzle body, comes down into the valve seat by its weight about 0.0708 in (18 mm). If it does not, replace the assembly. If any defect is found, always replace the needle valve and the nozzle body as a unit.
6. Check that there is no flaw or other damage on mating surfaces and sliding surfaces of the nozzle body and the needle valve and, if present, replace the nozzle assembly.

ASSEMBLING THE INJECTOR

1. Assemble in the reverse order of disassembly.

NOTE: After assembling the injector, test it.

2. Tighten the nozzle body on the nozzle holder to the specified torque.

Nozzle Body Torque (24 mm socket) 43 - 51 lb/ft (6.0 - 7.0 kg/m)

INSTALLING

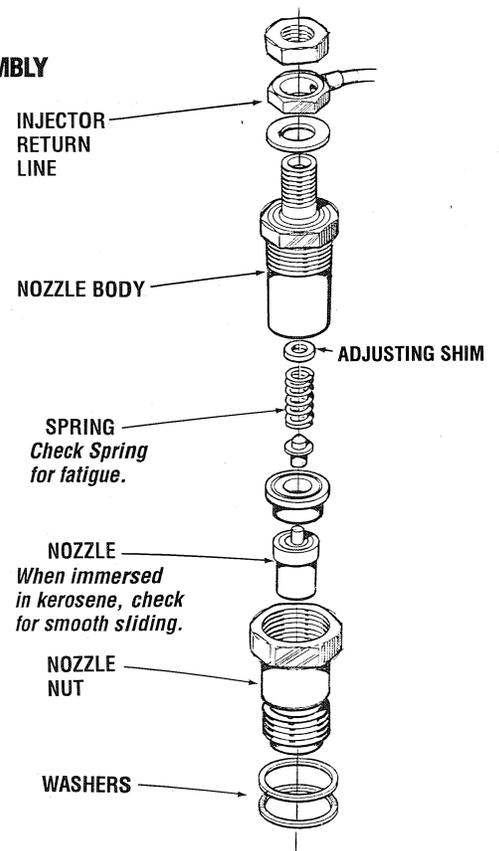
1. Install in the reverse order of removal.

NOTE: The copper washers should not be reused. Replace with new washers.

2. Tighten the nozzle on the cylinder head to the specified torque.

Nozzle Torque (27 mm socket) 43 - 51 lb/ft (6.0 - 7.0 kg/m)

INJECTOR ASSEMBLY



FUEL SYSTEM TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	VERIFICATION/REMEDY
Engine hard to start or fails to start.	<ol style="list-style-type: none"> 1. No fuel at injectors. <ol style="list-style-type: none"> a. No fuel in fuel tank and/or fuel shut off. b. Fuel filter clogged. c. Fuel filter clogged. d. Fuel shutoff solenoid not working. e. Injection pump faulty. 2. Fuel injectors faulty. 3. Water and/or air in fuel filters. 4. Injection timing incorrect. 5. Glow plugs not working. 	<ol style="list-style-type: none"> 1. Check causes a through e. <ol style="list-style-type: none"> a. Fill tank. Open shutoff and bleed system. b. Replace filter and bleed. c. Bleed pump. Check fittings for suction leak on fuel supply. d. Trouble shoot as described in previous section. e. Inspect pump. Repair or replace pump as needed. 2. Remove and test nozzles. Repair nozzles as needed 3. Remove water and/or bleed air from system. Check system for leaks and fuel tank for water contamination. 4. Check and adjust the timing. 5. Check glow plug circuit and repair as needed.
Large amount of black exhaust smoke.	<ol style="list-style-type: none"> 1. Clogged fuel filter. 2. Restricted air intake. 3. Engine overloaded. 4. Injection timing. 5. Fuel injectors not operating properly. 	<ol style="list-style-type: none"> 1. Replace the fuel filter and bleed the system. 2. Remove air obstruction. 3. Check engine propeller size and engine performance no load through fully loaded. 4. Check the injection pump timing and adjust as needed. 5. Check nozzle spray pressure.setting.
Engine idling too low.	<ol style="list-style-type: none"> 1. Idle speed too low. 2. Fuel filter clogged. 3. Incorrect injection pump timing. 4. High pressure injection line leaking. 5. Fuel injector leaking at sealing gasket in head. 6. Injection nozzle not operating properly. 7. Engine air intake obstructed. 	<ol style="list-style-type: none"> 1. Adjust idle stop as needed. 2. Replace filter and bleed fuel system. 3. Check timing and adjust as needed. 4. Slacken attaching nut and retighten. 5. Retighten injector and/or replace sealing washer. 6. Check nozzle and adjust as needed. 7. Check air flow intake silencer and air flow into engine compartment.
Fuel consumption too high.	<ol style="list-style-type: none"> 1. Idle speed too high. 2. Engine air intake restricted. 3. Injection timing incorrect. 4. Injector nozzle leaking. 5. Injector not operating properly. 6. Engine overloaded. 	<ol style="list-style-type: none"> 1. Check engine speed. 2. Check intake and correct. 3. Check timing and readjust pump as needed. 4. Tighten nozzle or replace sealing gasket. 5. Remove injector and adjust nozzle spray pressure. 6. Check propeller size and engine performance at rated rpm.

(continued)

FUEL SYSTEM TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	VERIFICATION/REMEDY
Engine output and performance poor.	<ol style="list-style-type: none"> 1. Contaminated or inferior fuel. 2. Fuel filter obstructed. 3. Air in fuel system. 4. Injection pump timing incorrect. 5. Injector high pressure lines leaking. 6. Injectors not operating properly. 7. Shaft stuffing box too tight. 8. Valves improperly adjusted. 	<ol style="list-style-type: none"> 1. Purge fuel system and replace with quality fuel. 2. Remove and replace filter element. 3. Bleed and check for source. 4. Check the timing and adjust pump as needed. 5. Loosen and then retighten injector line attachment nut or replace the complete line. 6. Remove injectors and adjust spray pressure to proper setting. 7. Check shaft free movement and for heat. 8. Check valve adjustment and maintain.
Abnormal noise from engine	<ol style="list-style-type: none"> 1. Poor quality and/or incorrect fuel. 2. Incorrect injection timing. Timing too advanced. 3. Fuel injector stuck open. 	<ol style="list-style-type: none"> 1. Use No. 2 diesel fuel. 2. Check injection timing. 3. Locate and remove faulty injector. Replace or rebuild.

GLOW PLUGS

DESCRIPTION

The glow plugs are wired through the preheat solenoid. When PREHEAT is pressed at the control panel this solenoid should "click" on and the glow plug should begin to get hot.

INSPECTION

To inspect the plug, remove the electrical terminal connections, then unscrew or unclamp each plug from the cylinder head. Thoroughly clean each plug's tip and threads with a soft brush and cleaning solution to remove all the carbon and oil deposits. While cleaning, examine the tip for wear and burn erosion; if it has eroded too much, replace the plug.

TESTING

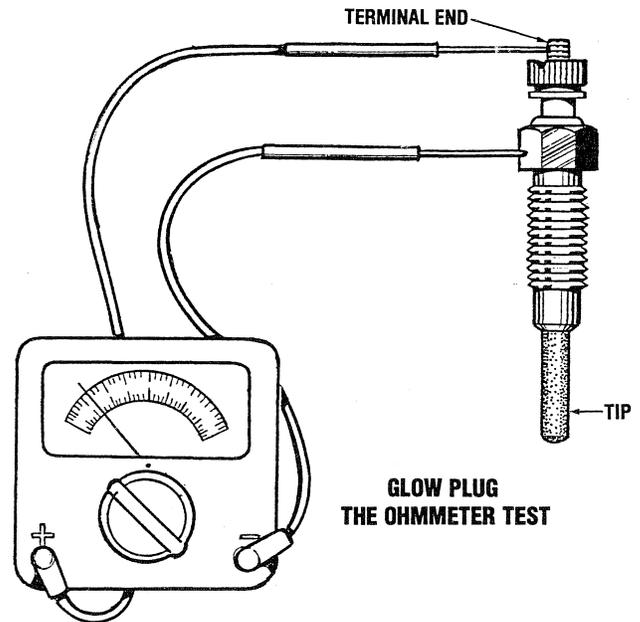
An accurate way to test glow plugs is with an ohmmeter. Touch one prod to the glow plug's wire connection, and the other to the body of the glow plug, as shown. A good glow plug will have a 1.0- to 1.5-ohm resistance. This method can be used with the plug in or out of the engine. You can also use an ammeter to test the power drain (8 to 9 amps per plug).

WARNING: *These glow plugs will become very hot to the touch. Be careful not to burn your fingers when testing the plugs.*

Re-install the plugs in the engine and test them again. The plugs should get very hot (at the terminal end) within 20 to 25 seconds. If the plugs don't heat up quickly, check for a short circuit. When reinstalling the glow plugs, use anti-seize compound on the threads

WARNING: *Do not keep a glow plug on for more than 30 seconds.*

Glow Plug Tightening Torque 7 - 11 ft-lb (1.0 - 1.5 m-kg)



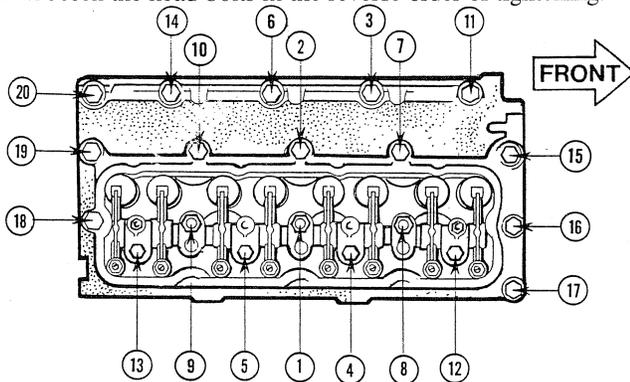
ENGINE ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

1. Warm the engine to normal operating temperature.
2. Pull off the air breather pipe from the rocker cover. Remove the rocker cover bolts and remove the rocker cover to expose the rocker shaft and valve assembly.
3. Remove the glow plugs from each of the cylinders to enable the crankshaft to be easily rotated by hand to position each cylinder for valve adjustment. Valves are adjusted with the piston in the cylinder being adjusted at TDC of its compression stroke.

NOTE: Retorque the cylinder head bolts before adjusting the engine's valves.

4. Loosen the head bolts in the reverse order of tightening.

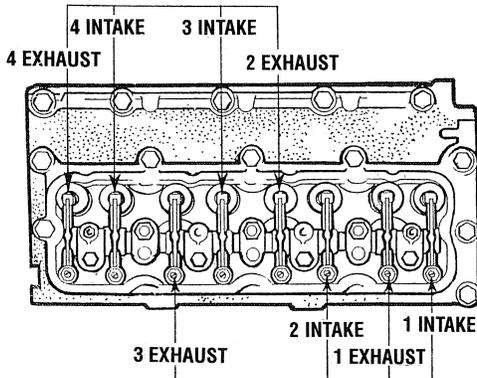


5. Tighten the head bolts in the order shown.

Cylinder Head Bolt Torque 80 - 85 ft -lb (11.0 - 11.7 m·kg)

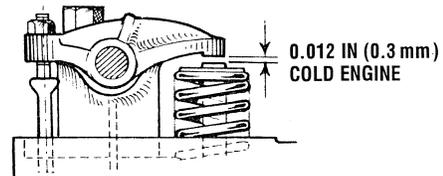
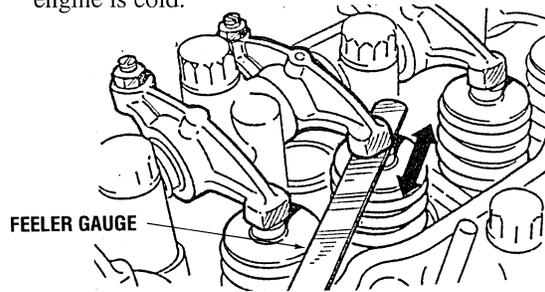
6. Set the piston of No. 1 cylinder to TDC (compression) and check the valve clearance at each position indicated. If the clearance is incorrect, adjust to specifications:
Intake - No. 1 and No. 2 cylinders; and
Exhaust - No. 1 and No. 3 cylinders.
7. Turn the crankshaft once, setting the piston of No. 4 cylinder at TDC (compression) and adjust to the following specifications:
Intake - No. 3 and No. 4 cylinders; and
Exhaust - No. 2 and No. 4 cylinders.

WHEN NO 4 CYLINDER IS AT TOP DEAD CENTER



WHEN NO 1 CYLINDER IS AT TOP DEAD CENTER

8. Adjust each valve's clearance by inserting a 0.012 in (0.03 mm) feeler gauge between the rocker arm and the valve stem. Make sure to adjust all valves when the engine is cold.



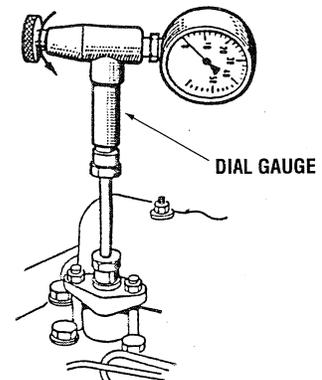
9. Install the cylinder head cover.

Head Cover Bolt Torque 2 - 3 ft -lb (0.3 - 0.45 m·kg)

ENGINE COMPRESSION

Check the compression pressure. To do this warm the engine, remove all fuel injectors, or glow plugs, disconnect the fuel shut-off solenoid wire, and install a compression adapter in the injector hole or glow plug hole. Connect a compression tester on the adapter and crank the engine with the starter motor until the pressure reaches a maximum value. Repeat this process for each cylinder. Look for cylinders with dramatically (at least 20%) lower compression than the average of the others. Compression pressure should not differ by more than 42.7 psi (3.0 kg/cm²) at 200 rpm.

MEASURING COMPRESSION



Compression pressure standard 427 psi at 200 rpm (30.0 kg/cm²)
Compression pressure limit 384 psi at 200 rpm (27.0 kg/cm²)

If a weak cylinder is flanked by healthy cylinder, the problem is either valve or piston related. Check the valve clearances for the weak cylinder, adjust as needed and test again. If the cylinder is still low, apply a small amount of oil into the cylinder to seal the rings and repeat the test. If compression comes up - the rings are faulty.

ENGINE ADJUSTMENTS

Abnormally high readings on all cylinders indicates heavy carbon accumulations, a condition that might be accompanied by high pressures and noise.

NOTE: In case of severe vibrations and detonation noise, have the injectors checked and overhauled by an authorized fuel injection service center. Poor fuel quality, contaminates and loss of positive fuel pressure to the injection pump will result in injector faults.

When re-installing the glow plugs use anti-seize compound.

SETTING THE IDLE SPEED (PROPULSION ENGINE)

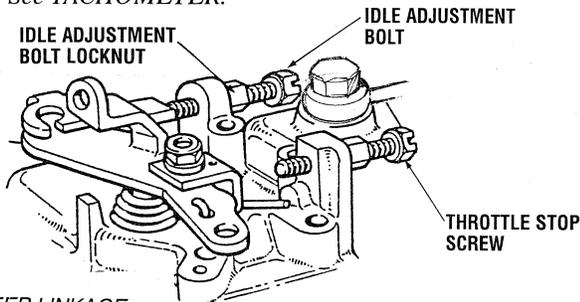
1. Warm the engine to normal operating temperature.
2. Stick a piece of suitable reflecting tape on the crankshaft pulley.
3. Idle the engine.
4. Use the light of a photoelectric strobe type tachometer on the reflecting tape and check the value shown by the tachometer.

Normal idle speed 580 - 630 rpm

NOTE: The idle speed may vary according to the transmission and propeller.

5. To adjust the engine idle speed, loosen the lock nut of the idle adjustment bolt and turn the bolt clockwise to increase idle speed and counterclockwise to reduce.

NOTE: Should engine rpm be in question, verify tachometer readings as shown at the instrument panel. See TACHOMETER.



ADJUSTING IDLE SPEED

SPEED ADJUSTMENT (GENERATOR)

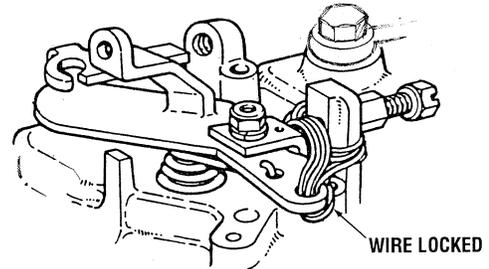
NOTE: Speed adjustment of the generator (hertz) is controlled by the electronic governor see ELECTRONIC GOVERNOR for speed and gain adjustments.

Early Models Without Electronic Governing

Engine speed is maintained by the governor mechanism inside the fuel injection pump (61.5 - 62.0 hertz at no-load and 58.5 - 59.0 hertz at full rated generator output). Engine no-load speed is adjusted by positioning the throttle lever against the adjustable throttle stop screw, lock wiring it at that position, and tensioning the throttle stop screw against the throttle lever and securing it with its lock nut.

When servicing the injection pump, the service shop must be advised if the pump is to be used in a generator application. The service shop will have to remove and replace the governor spring with a propulsion spring. Once the pump is set to propulsion specifications, the generator spring is reinstalled in the injection pump and the pump remounted on the engine. The throttle is then set for the proper engine no-load speed (hertz).

For disassembly, inspection, reassembly and internal adjustments of the injection pump, it is recommended the pump be taken to a qualified injection service shop authorized to service Diesel KiKi injection equipment.



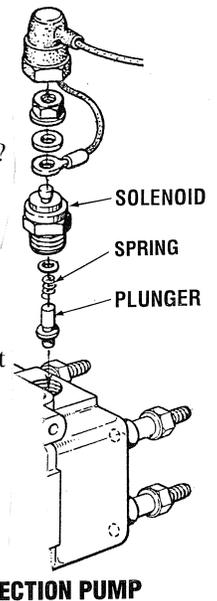
ENGINE STOP SOLENOID

This solenoid is installed on the top rear of the injection pump and is activated by 12 VDC electrical current.

NOTE: To service generator applications, refer to the GENERATOR section of this manual.

Troubleshooting

1. The solenoid does not operate when the keyswitch is turned "ON".
 - a. Are the engine batteries turned "ON"?
 - b. Is the 20 amp circuit breaker set?
 - c. Is 12 VDC present at the solenoid connection?
2. The solenoid does not stop the engine when the keyswitch is switched "OFF".
 - a. Check to see if 12 VDC is still present at the solenoid electrical lead with the key off.
 - b. Remove solenoid from injection pump and ensure plunger and spring in the solenoid are not sticking.



INJECTION PUMP

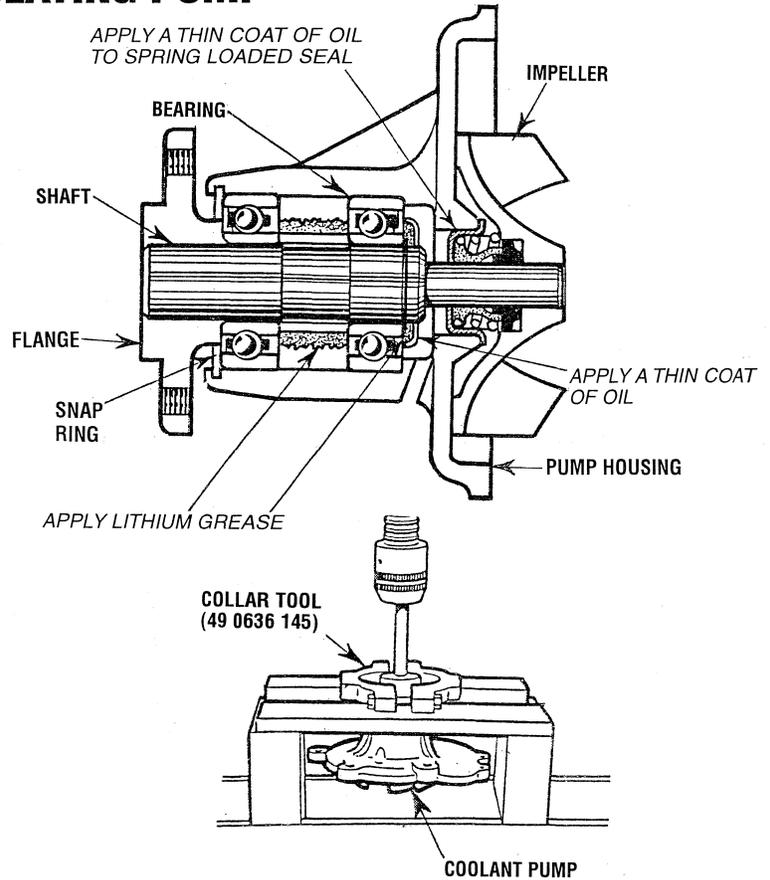
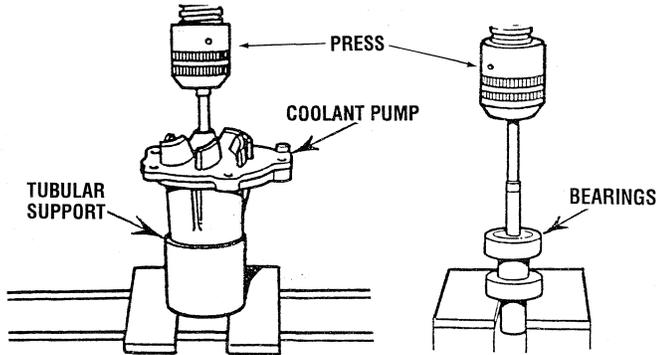
COOLANT CIRCULATING PUMP

REMOVING THE PUMP

Remove in the following order: coolant (drain as needed); V-belt; water hoses; water pump attaching nuts; and water pump.

DISASSEMBLY

1. Remove the pump pulley boss by using a support and press.
2. Remove the bearing shaft from the impeller and bearing housing by using a support block and press.
3. Remove the snap ring with snap ring pliers and press out the water pump shaft from the bearings.



INSPECTION

Inspect the shaft, bearings and impeller. Look for cracks and damage. Check the housing gasket and inspect the rear seals and small end gaskets.

Replace any parts that show wear.

ASSEMBLY

Assemble the water pump in the reverse order of disassembly, using the following procedure:

1. Fill lithium grease (lithium base NLGI No. 2) into the following positions.
 - Ball bearings
 - Approximately 1/3 space between both ball bearings
 - Space between the ball bearing and water baffle plate.
2. Apply a thin coat of engine oil to the press fit surface of the water seal and press the larger end into the proper aperture of the pump using a tubular mandrel. (49 0636 145)

NOTE: Do not allow oil or grease to contaminate the surfaces of the ceramic ring or the graphite (small end) of the spring-loaded seal.

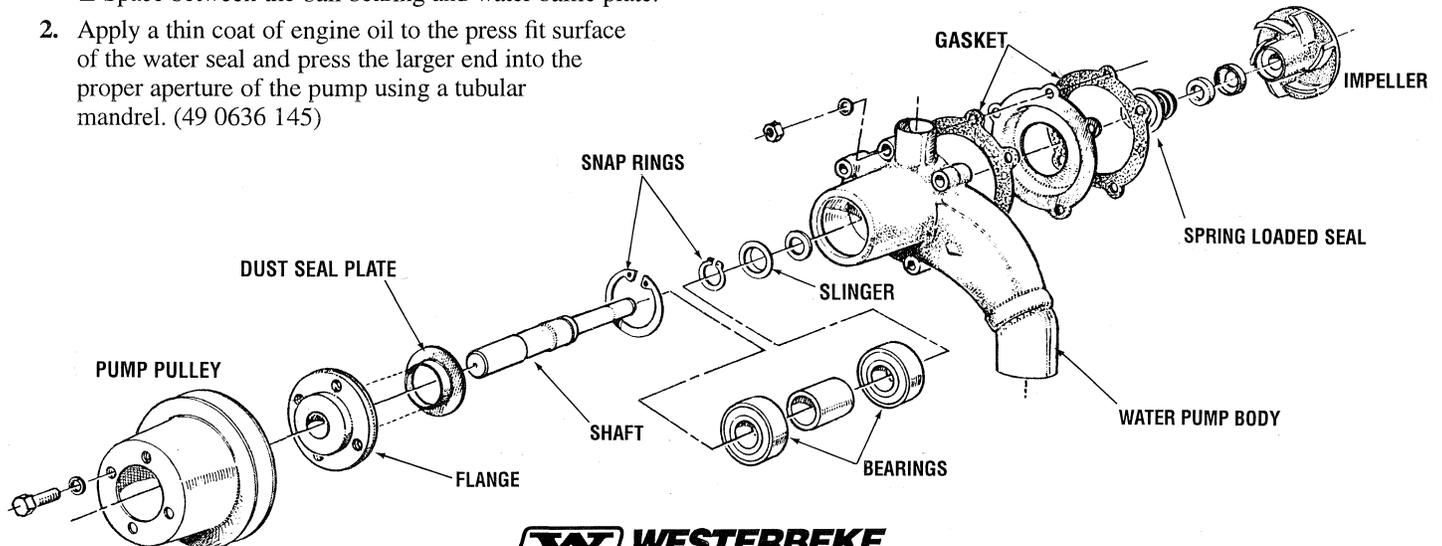
3. After the water pump has been assembled, check if the pump shaft rotates smoothly.

INSTALLING THE PUMP

1. Install in the reverse order of removal.

NOTE: Use a new gasket.

2. After installing the pump, fill the system with coolant and operate the engine to check for leaks.



LUBRICATING OIL PUMP

REMOVING THE OIL PUMP

Remove in the following order:

1. Oil Pan;
2. Oil Pump Set Screw;
3. Oil Pipe Attaching Bolts; and
4. Oil Pump

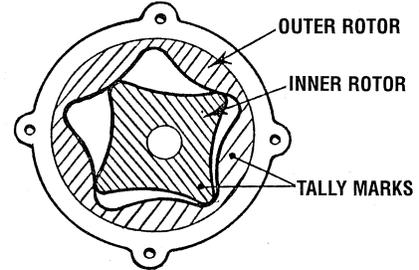
DISASSEMBLY

Disassemble in the following order: Oil Pipe and Gasket; Oil Strainer and Gasket; Oil Pump Cover; Drive Gear (use a press and suitable mandrel); Inner Rotor and Shaft Assembly; Outer Rotor; Relief Valve Assembly; and Oil Pump Body.

INSPECTION

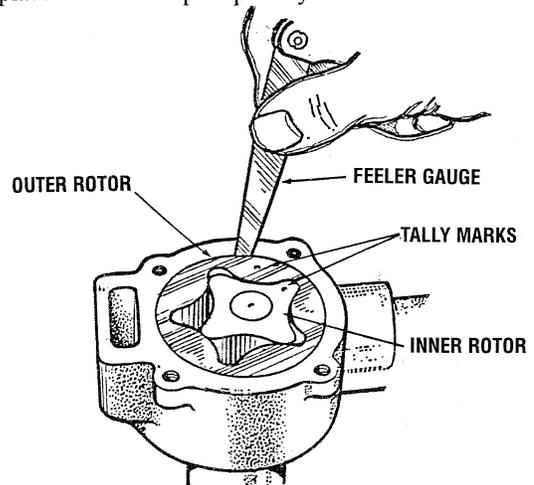
1. Visually check the disassembled parts and replace faulty parts. Check the sliding surface of pump cover with special care and replace the cover if the surface has steps or excessive streaks. (Minor steps streaks may be repaired by rubbing them with a compound on a surface plate.)

3. **Clearance between inner rotor and outer rotor.** Check the clearance between the lobes of the rotors with a feeler gauge. If the clearance exceeds the limit, replace both rotors.



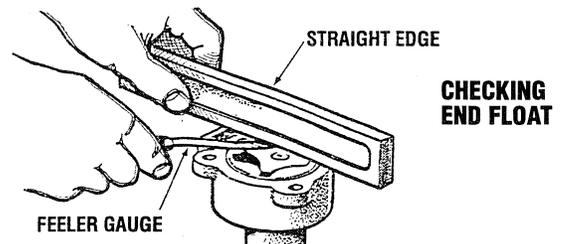
Clearance Limit 0.012 in (0.3 mm)

4. **Clearance between outer rotor and pump body.** Check the clearance between the outer rotor and pump body with a feeler gauge. If the clearance exceeds the limit, replace the rotor or pump body.



Clearance Limit 0.012 in (0.3 mm)

5. **Clearance between rotor and pump cover.** Check the end float of the rotors. Place a straightedge across the pump body and measure the clearance between the rotor and straight edge with a feeler gauge. If the clearance exceeds the limit, replace the drive gear, drive shaft, inner rotor, outer rotor and pump body.

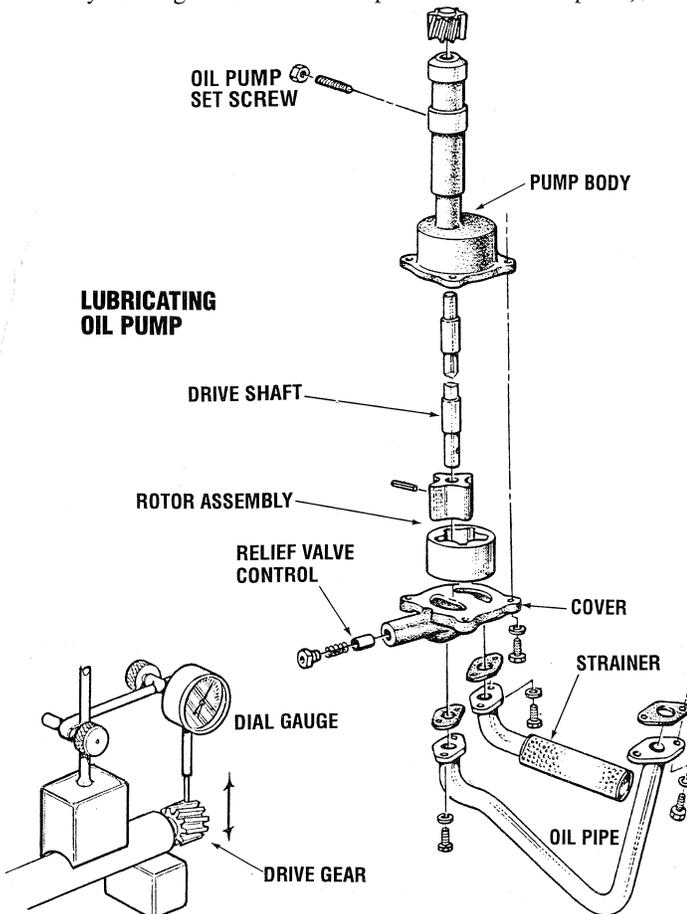


Clearance Limit 0.006 in (0.15 mm)

2. **Clearance between pump body and shaft.** Measure the above clearance with a dial gauge and magnet base.

Clearance Limit 0.0039 in (0.1 mm)

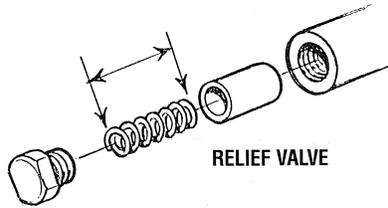
When the clearance exceeds the limit, replace the pump drive shaft inner rotor, pump body and drive gear.



LUBRICATING OIL PUMP

6. Measure the free length of the plunger spring. Check the relief valve for worn plunger and fatigued spring.

Spring free Limit 1.82 in (46.2 mm)



ASSEMBLY

7. Assemble in the reverse order of disassembly.

NOTE: When installing the rotors into the body, be sure that the tally marks on the rotors are positioned toward the cover.

Cover Tightening Torque (7/16" socket) 5.8 - 8.7 ft-lb (0.8 - 1.2 m-kg)

INSTALLING THE OIL PUMP

1. Install in reverse order of removal.

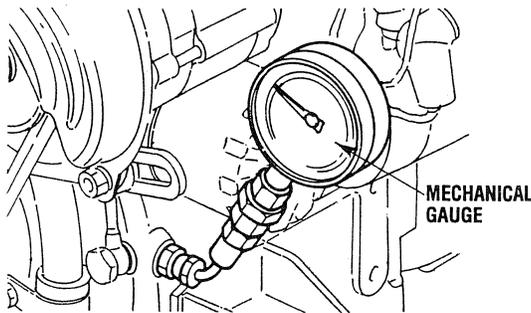
NOTE: When installing the set screw, apply sealing compound on the set screw threads.

OIL PRESSURE

TESTING OIL PRESSURE

The lubricating system is a pressure feeding system using an oil pump. The engine oil is drawn from the oil sump by the oil pump, which drives the oil, under pressure, through the oil filter, oil cooler and various lubricating points in the engine. The oil then returns to the oil sump to repeat the continuous cycle. When the oil pressure exceeds the specified pressure, the oil pushes open the relief valve in the oil pump and returns to the oil sump, keeping the oil pressure within its specified range.

To test the oil pressure, remove the oil pressure sender, then install a mechanical oil pressure gauge in its place. After warming up the engine, set the engine speed at 3600 rpm and read the oil pressure gauge.



Oil Pressure 54.04 lb/in² (3.8 kg/cm²) or more at 3600 rpm

LOW OIL PRESSURE

The specified safe minimum oil pressure is 4.3 + 1.4 psi (0.3 + 0.1 kg/cm²). A gradual loss of oil pressure usually indicates a worn bearings. For additional information on low oil pressure readings, see the *ENGINE TROUBLESHOOTING* chart.

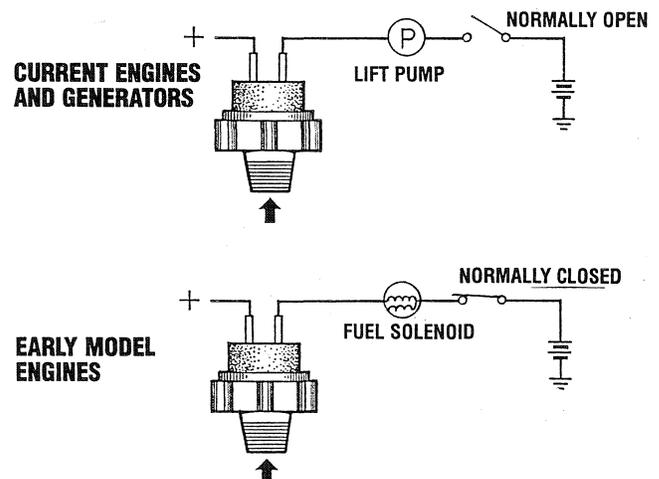
OIL PRESSURE SWITCH/SENDER

When performing an engine overhaul, replace the oil pressure switch and the oil pressure sender.

When installing the new parts apply a teflon sealant to the threaded ends being careful not to close off the oil hole in the sender.

Oil Pressure Sender and Switch Torque 9 - 13 ft-lb (1.2 - 1.8 m-kg)

CAUTION: Oil Pressure Switch - Do not use lock pliers, vise grips or pipe wrenches on the oil pressure switch. Use the correct socket which is available from Snap-On, Proto, New Britain and others. Damage to the switch will cause oil leaks and/or switch failure.



RAW WATER PUMP

PUMP OVERHAUL

Disassembly

The pump, as removed from the engine, will have hose attachment nipples threaded into its inlet and outlet port. They may be left in place or removed if they interfere with the pump disassembly. Note the port location and positioning if removed.

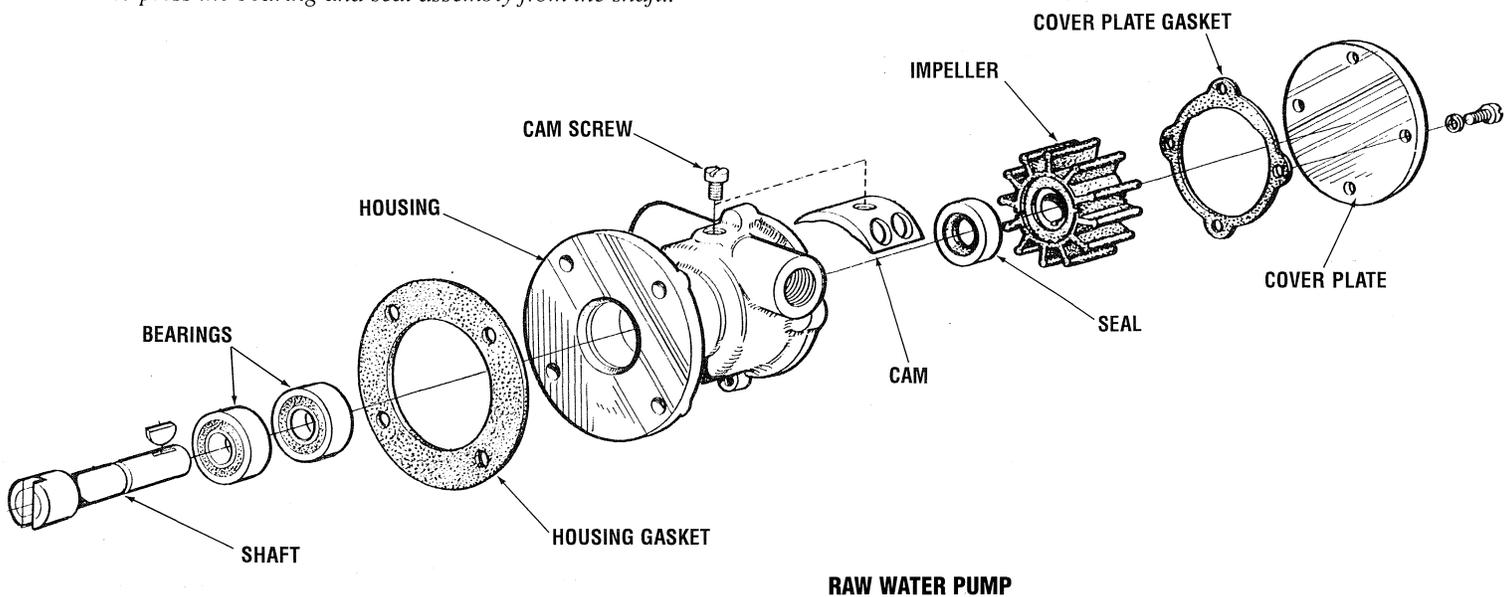
1. Loosen the set screw with an allen wrench and remove the water pump pulley from the shaft.
2. Remove the four cover plate screws, the cover plate and the cover plate gasket.

NOTE: Replacement of the cover plate gasket is recommended; however, if you are going to reuse it, keep the gasket well lubricated until the pump is reassembled. If it's allowed to dry, the gasket will shrink and not be reusable.

3. Pull out the impeller with long nose pliers or pry out with a pair of screwdrivers.
4. Remove the bearing assembly, releasing the shaft, bearing and seal assembly. This will allow the bearings and seals to be disassembled for inspection..

NOTE: It may be necessary to use a drift and arbor press to press the bearing and seal assembly from the shaft..

5. Inspect all parts and replace those showing wear or erosion.
6. Use the illustration to assist in reassembling the raw water pump.
 - a. Apply a small amount of petroleum jelly to the seal's inner race and to the impeller shaft at reassembly.
 - b. When positioning the cam in the housing use a small amount of Permatex #1 on the inner cam surface and cam screw heads, remove any excess from the impeller housing.
 - c. Apply a light film of silicon or petroleum jelly to the inner surface of the housing for the impeller.
7. When the pump is assembled, reposition and tighten the hose nipples. Assemble the pump to the engine and attach the hoses and the belt.



STARTER MOTOR

DESCRIPTION

The *starter* can be roughly divided into the following sections:

- A motor section which generates a drive power.
- An overrunning clutch section which transmits an armature torque, preventing motor overrun after starting.
- A switch section (solenoid) which is operated when actuating the overrunning clutch through a lever and which supplies load current to the motor.

The starter is a new type, small, light-weight and is called a high-speed internal-reduction starter. The pinion shaft is separate from the motor shaft; the pinion slides only on the pinion shaft. A reduction gear is installed between the motor shaft and a pinion shaft. The pinion sliding part is not exposed outside the starter so that the pinion may slide smoothly without becoming fouled with dust and grease. The motor shaft is supported at both ends on ball bearings. The lever mechanism, switch and overrunning clutch inner circuit are identical to conventional ones.

ADJUSTMENT AND REPAIR

If any abnormality is found by the following tests, the starter should be disassembled and repaired.

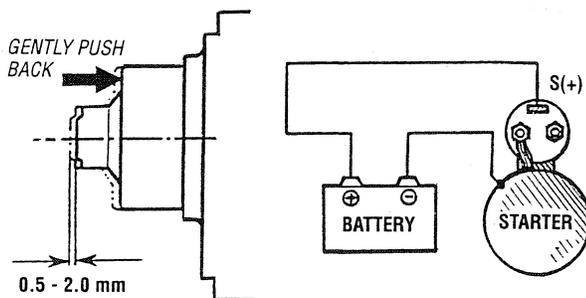
NOTE: Early model engines were equipped with DELCO starter motors. If a DELCO starter needs serving contact a DELCO-REMY service shop or your WESTERBEKE dealer.

Pinion Gap Inspection

1. Connect a battery (12V) between the starter terminal S and the starter body, and the pinion drive should rotate out and stop.

CAUTION: Never apply battery voltage for over 10 seconds continuously.

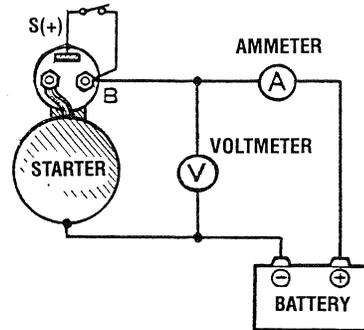
2. Lightly push the pinion back and measure the return stroke (called pinion gap).
3. If the pinion gap is not within the standard range, 0.0197 - 0.0788in (0.5 to 2.0mm), adjust it by increasing or decreasing the number of shims on the solenoid. The gap is decreased as the number of shims increases.



PINION GAP

No-Load Test

1. Connect the ammeter, voltmeter, and battery to the starter as illustrated.
2. When the switch is closed, the pinion must protrude and the starter must run smoothly (at 3000 rpm or more). If the current or starter speed is out of specification, disassemble the starter and repair it.

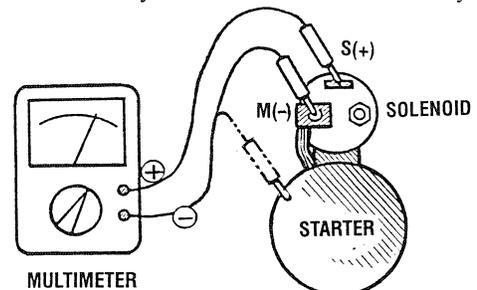


CAUTION: Use thick wires as much as possible and tighten every terminal securely. This is a solenoid shift-type starter which makes a rotating sound louder than that of a direct-drive type starter. When detecting starter rotation at the pinion tip, be careful not to come in contact with the pinion gear when it protrudes.

SOLENOID

Perform the following tests. If any test result is not satisfactory, replace the solenoid assembly.

1. Inspect the solenoid for continuity between terminals (+) and (-) and between terminals S and the body and M and the body. There should be no continuity found between terminals S and M. Continuity will be found between terminals S and the body and terminal M and the body.

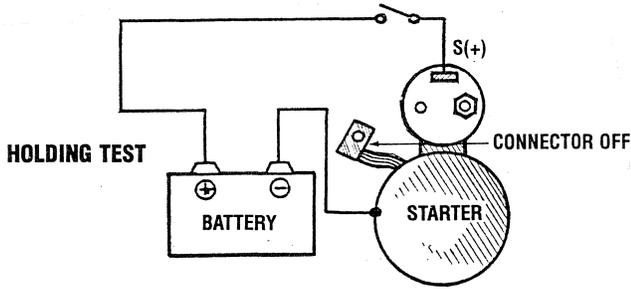


NOTE: Disconnect the wire from terminal M.

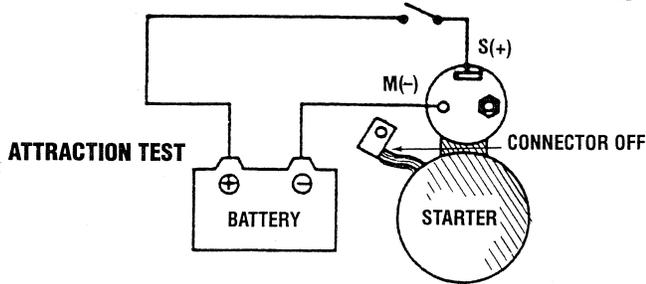
2. Connect a battery to the solenoid's terminal S for (+) and M for (-). Have a switch in the + lead and close it. The pinion drive should extend fully out.

CAUTION: Do not apply battery current for more than 10 seconds when testing the solenoid.

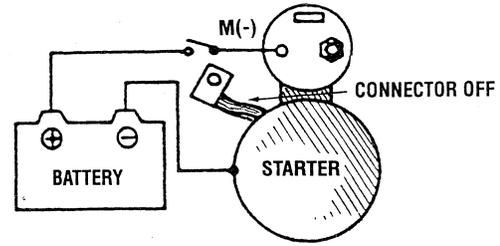
STARTER MOTOR



3. *Holding test.* With a battery connected to the solenoid terminal S (+) and to the starter body, manually pull out the pinion fully. The pinion must remain at that position even when released from holding with your hand.



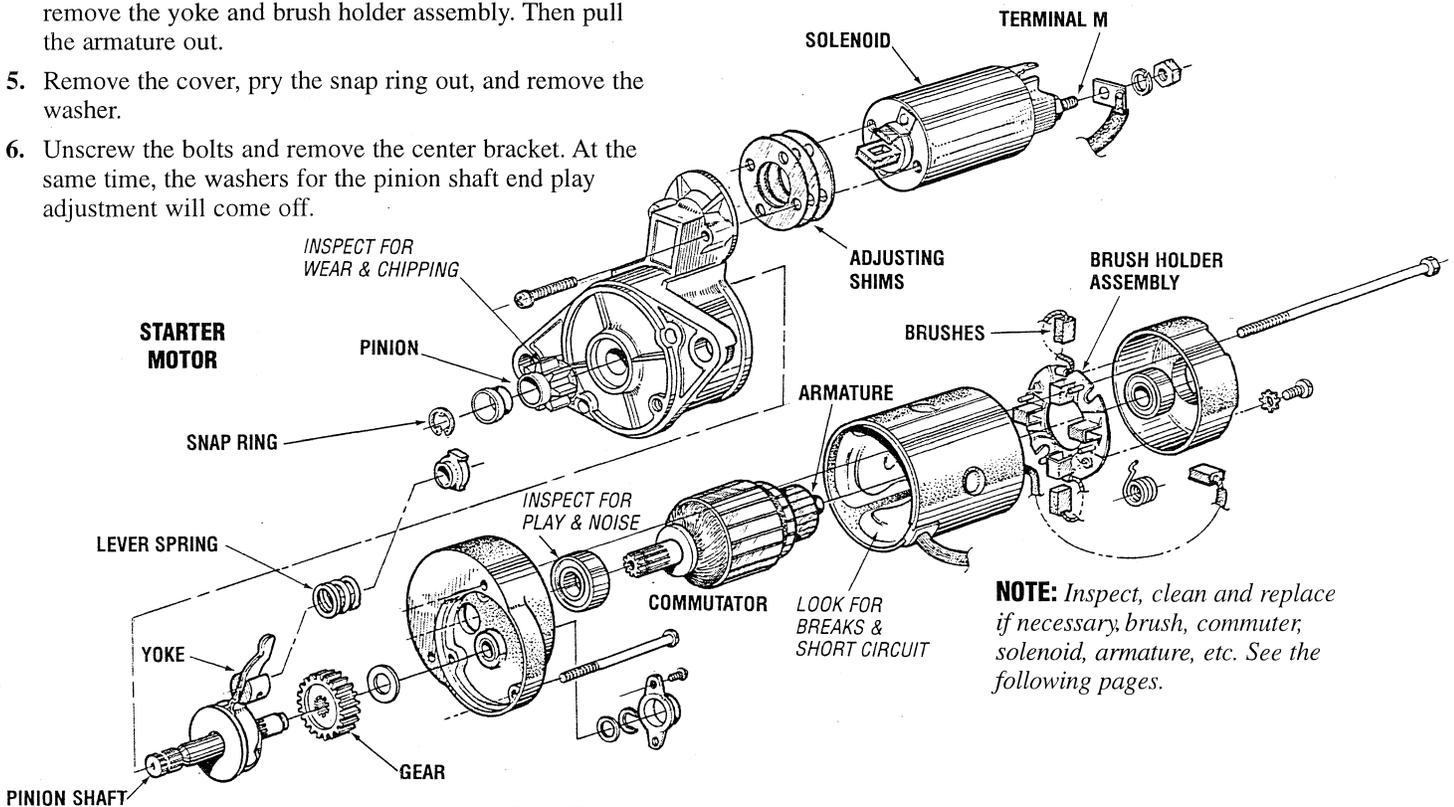
4. *Return test:* With a battery connected to the solenoid terminal M (-) and to the starter body, manually pull out the pinion fully. The pinion must return to its original position when released from holding by hand.



STARTER ASSEMBLY

1. Disconnect the wire from the solenoid terminal M (-).
2. Loosen the two screws fastening the solenoid. Remove the solenoid assembly.
3. Remove the two long through bolts and two screws fastening the brush holder. Remove the rear bracket.
4. With the brushes pulled away from the armature, remove the yoke and brush holder assembly. Then pull the armature out.
5. Remove the cover, pry the snap ring out, and remove the washer.
6. Unscrew the bolts and remove the center bracket. At the same time, the washers for the pinion shaft end play adjustment will come off.

7. Pull out the reduction gear lever and lever spring from the front bracket.
8. On the pinion side, pry the snap ring out, and pull out the pinion and pinion shaft.
9. At each end of the armature, remove the ball bearing with a bearing puller. It is impossible to replace the ball bearing press-fitted in the front bracket. If that bearing has worn off, replace the front bracket assembly.

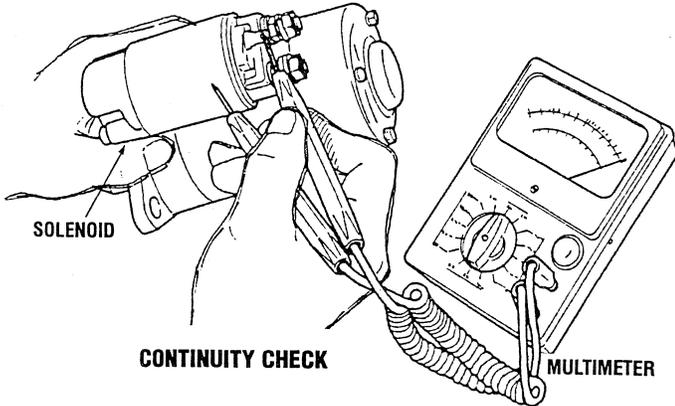


STARTER MOTOR

STARTER INSPECTION

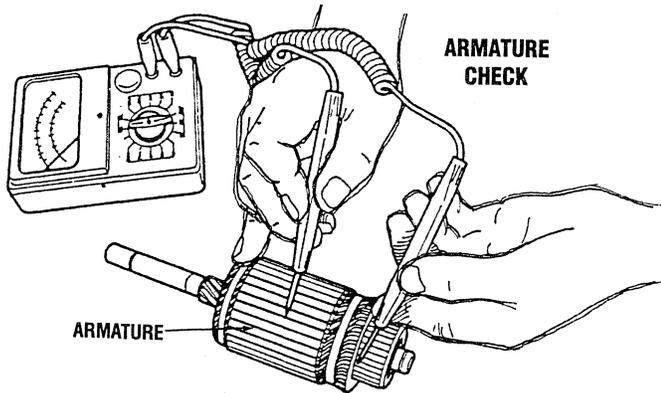
Solenoid

Inspect the solenoid for continuity between terminals S and M and between terminals S and body. No continuity should be found between S and M. Continuity should be found between S and the body and M and the body.

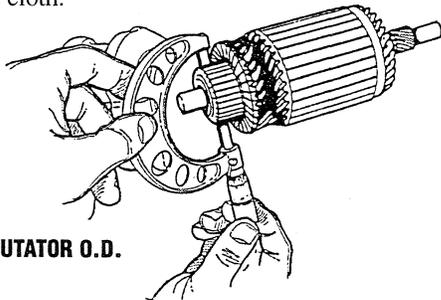


Inspecting The Armature

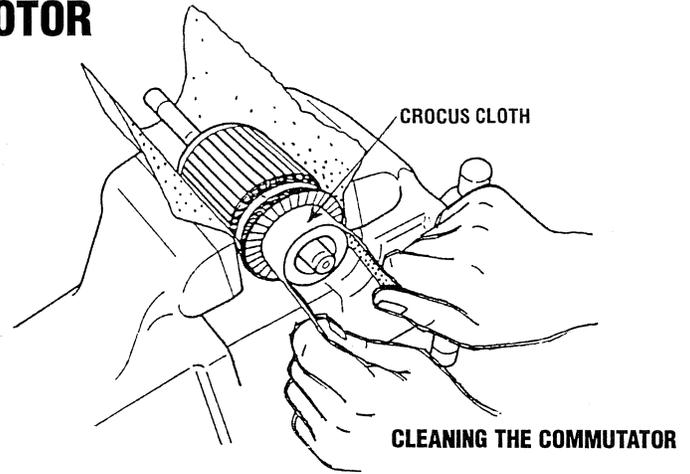
1. Check the armature with a growler tester. If it's short circuited, replace the armature. Also check for insulation between the commutator and its shaft. If poorly insulated, replace the armature.



2. Measure the commutator O.D. and the depth of undercut. Repair or replace it if the service limit is exceeded. Also check the commutator outside surface for dirtiness and roughness. If rough, polish the commutator with fine crocus cloth.

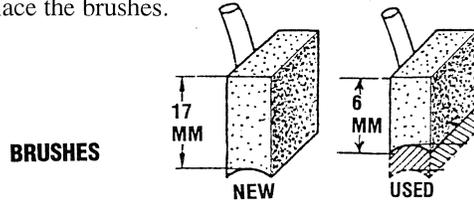


Commutator Outside Diameter Standard	38.7 mm (1.523 in)
Commutator Outside Diameter Limit	-1.0 mm (-0.039 in)



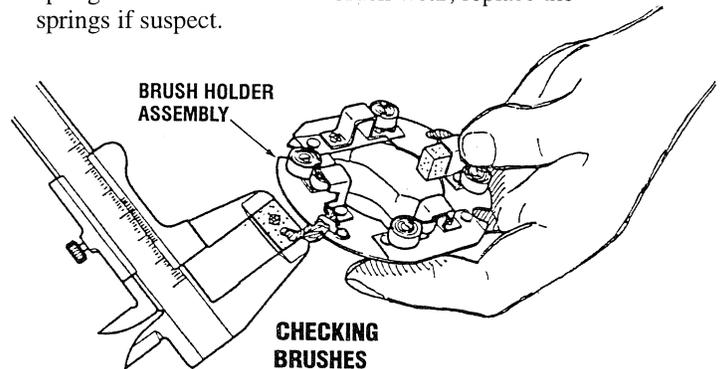
Brush and Brush Holder Inspection

1. Check the brushes. If worn out beyond the service limit, replace the brushes.

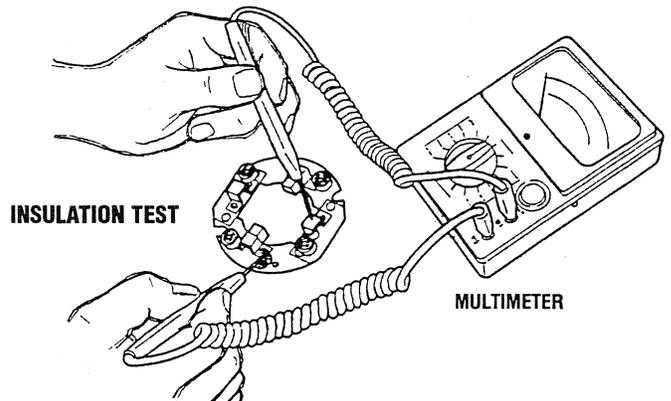


Brush Height Standard	0.669 in (17 mm)
Brush Height Limit	0.2363 in (6 mm)

2. Check the brush spring tension. A weak or defective spring will cause excessive brush wear; replace the springs if suspect.



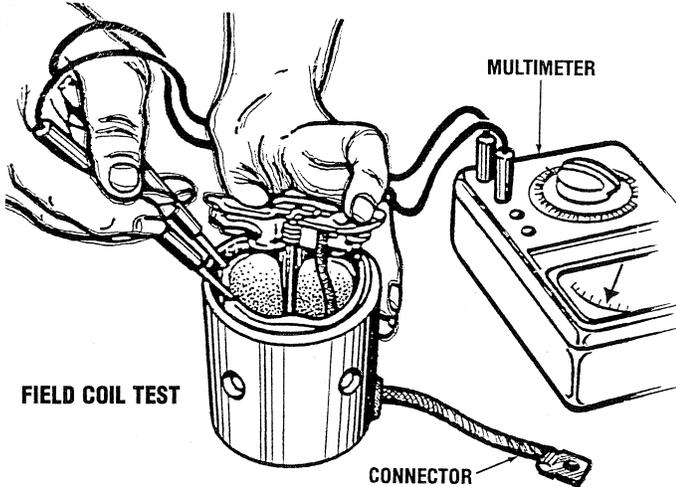
3. Check for insulation between the positive brush holder and holder base. If poorly insulated, replace the holder assembly. Also check the brush holders for proper staking.



STARTER MOTOR

Field Coil Inspection

1. Check for insulation between one end (brush) of the coil and yoke.
2. Check for continuity between both ends (brushes) of the coil
3. Check the poles and coil for tightness.



STARTER ADJUSTMENT AND REASSEMBLY

CAUTION: Before installing, thoroughly clean the starter flange and mounting surfaces, remove all oil, old paint, and rust. Starter performance largely depends on the quality of the wiring. Use wire of sufficient size and grade between the battery and starter and fully tighten to the terminal.

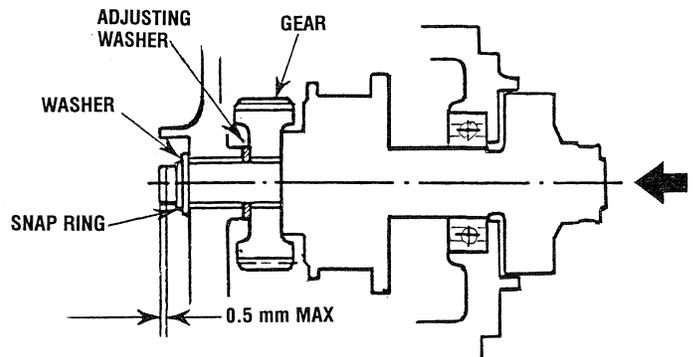
Reassemble the starter assembly in the reverse order of disassembly, making sure of the following:

1. **Pinion shaft end play adjustment.** Set the end play (thrust gap) to between 0.0197 - 0.0788in (0.5 to 2mm) by inserting an adjusting washer between the center bracket and the reduction gear.
 - a. Fit the pinion shaft, reduction gear washer and snap ring to the center bracket.
 - b. Measure end play by moving the pinion shaft in the axial direction. If the end play exceeds 0.0788in (0.5mm), increase the number of adjusting washers inserted.

2. **Greasing.** Whenever the starter has been overhauled, apply grease to the following parts:
 - a. Armature shaft gear and reduction gear.
 - b. All bearings.
 - c. Bearing shaft washers and snap rings.
 - d. Bearing sleeves.
 - e. Pinion.
 - f. Sliding portion of lever.

CAUTION: Never smear the starter fitting surface, terminals, brushes, or commutator with grease.

3. After reassembly, check by conducting a no-load test again.



PINION SHAFT END PLAY

TACHOMETER

TACHOMETER/HOUR METER

The tachometer/hour meter used in propulsion engine instrument panels contains two separate electrical circuits with a common ground. One circuit operates the hour meter and the other the tachometer. The hour meter circuit operates on 12 volts alternator charging voltage supplied to the (+) terminal on the back of the instrument.

The tachometer circuit operates on AC voltage 6-8 volts, fed from one of the diodes in the alternator and supplied to the tachometer input terminal while the engine is running, and the alternator producing battery charging voltage 13.0-14.8 volts DC.

The following are procedures to follow when troubleshooting a fault in either of the two circuits in a tachometer/hour meter.

Hour meter Inoperative

Check for the proper DC voltage between (+) and (-) terminals.

1. Voltage present - meter is defective - repair or replace.
2. Voltage not present - trace (+) and (-) electrical connections for fault. (Jump 12 volts DC to meter (+) terminal to verify the operation.)

Tachometer Inoperative

Check for the proper AC voltage between tachometer input terminal and (-) terminal with the engine running.

1. Voltage present - attempt adjusting meter through calibration access hole. No results, repair or replace meter.
2. AC voltage not present - check for proper alternator DC output voltage.
3. Check for AC voltage at tach terminal on alternator to ground.
4. Check electrical connections from tachometer input terminal to alternator connection.

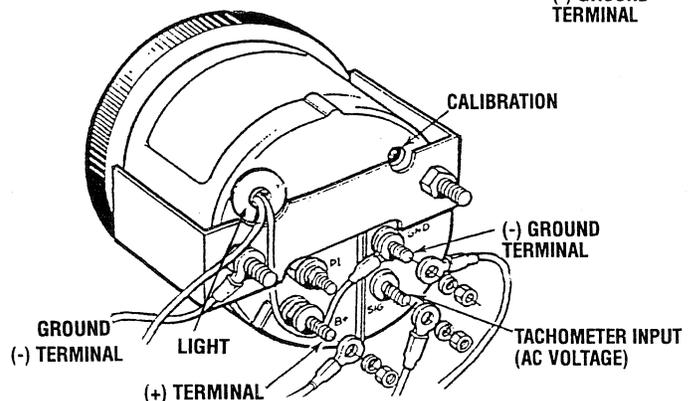
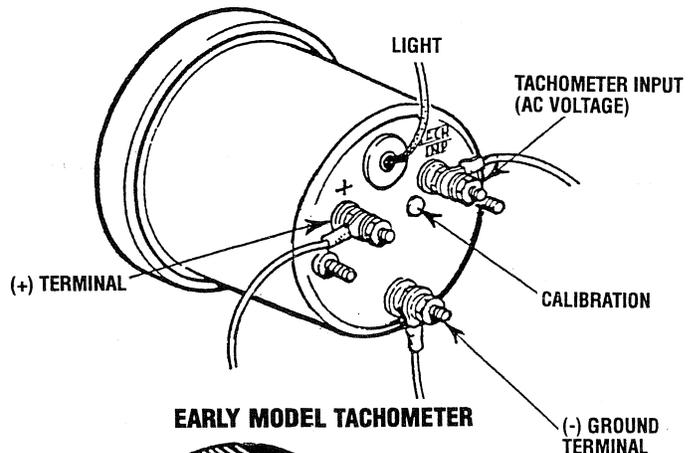
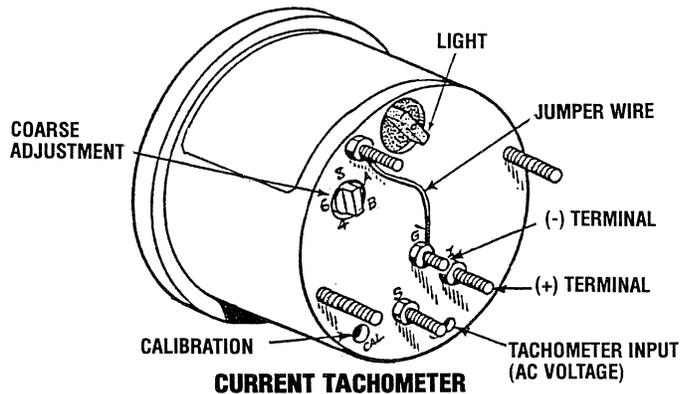
Tachometer Sticking

1. Check for proper AC voltage between "tach inp." terminal and (-) terminal.
2. Check for good ground connection between meter (-) terminal and alternator.
3. Check that alternator is well grounded to engine block at alternator pivot bolt.

Tachometer Inaccurate

- a. With a hand-held tach on the front of the crankshaft pulley retaining nut or with a strobe-type tach, read the front crankshaft pulley rpm at idle.
- b. Adjust the tachometer with a small Phillips type screwdriver through the calibration access hole in the rear of the tachometer. Zero the tach and bring it to the rpm indicated by the strobe or hand tach. (Verify the rpm at idle and at high speed 2500-3000 rpm). (Adjust the tach as needed.)

NOTE: Current model tachometers use a coarse adjustment dial to set the tachometer to the crankshaft pulley rpms. The calibrating screw is then used for fine tuning.

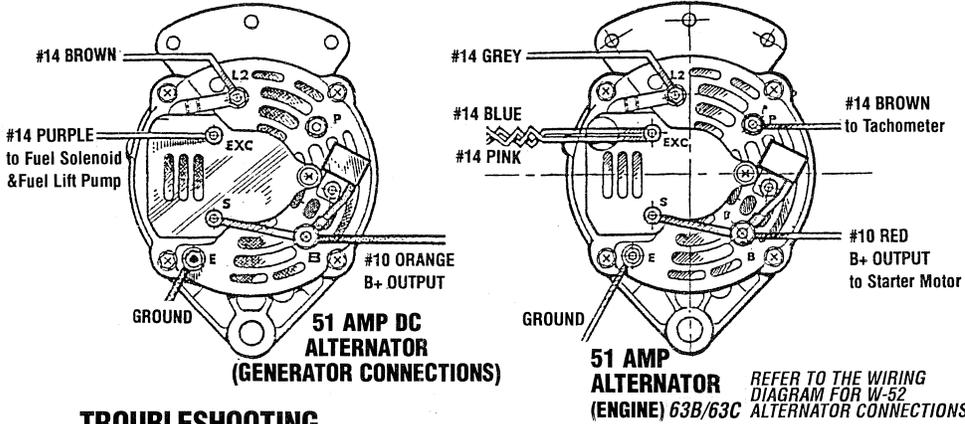


EARLY MODEL TACHOMETER

ALTERNATOR TESTING

DESCRIPTION

The charging system consists of an alternator with a voltage regulator, an engine DC wiring harness, a mounted DC circuit breaker and a battery with connecting cables. Because of the use of integrated circuits (IC's) the electronic voltage regulator is very compact and is mounted internally or on the back of the alternator.



TROUBLESHOOTING

WARNING: A failed alternator can become very hot. Do not touch until the alternator has cooled down.

This troubleshooting section is to determine if a problem exists with the charging circuit or with the alternator. If it is determined that the alternator or voltage regulator is bad, it is best to have a qualified technician check it out.

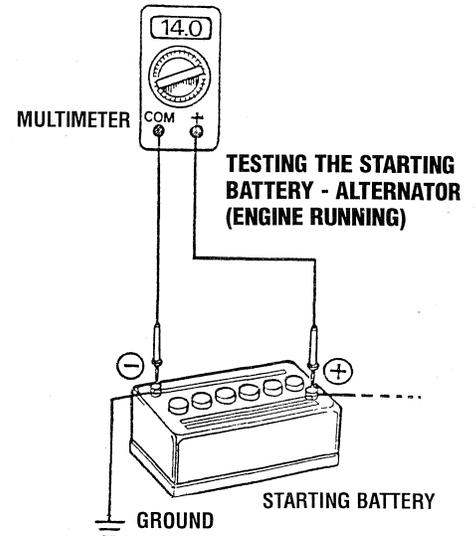
The alternator charging circuit charges the starting battery and the service battery. An isolator with a diode, a solenoid, or a battery selector switch is usually mounted in the circuit to isolate the batteries so the service battery is not discharged along with the service battery. If the alternator is charging the starting battery but not the service battery, the problem is in the service battery charging circuit and not with the alternator.

Testing the Alternator

WARNING: Before starting the engine make certain that everyone is clear of moving parts! Keep away from sheaves and belts during test procedures.

WARNING: MULTIMETERS AND DC CIRCUITS: DC and AC circuits are often mixed together in marine applications. Always disconnect shore power cords, isolate DC and AC converters and shut down generators before performing DC testing. No AC tests should be made without proper knowledge of AC circuits.

1. Start the Engine.
2. After a few minutes of running measure the starting battery voltage at the battery terminals using a multi-meter set on DC volts. The voltage should be increasing toward 14 volts. If it is, **the alternator is working.** Turn to Step 4 .



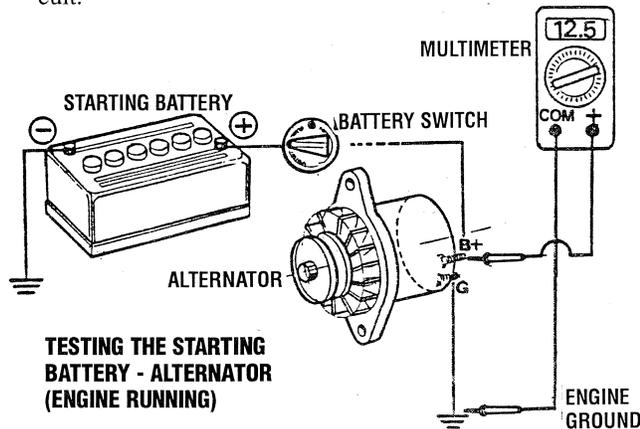
3. If the starting battery voltage remains around 12 volts after the engine is started and run for a few minutes, a problem exists with the alternator or the charging circuit.
 - a. Turn off the engine. Inspect all wiring and connections. Ensure that the battery terminals and the engine ground connections are tight and clean.

CAUTION: To avoid damage to the battery charging circuit, never shut off the engine battery switch when the engine is running!

- b. If a battery selector switch is in the charging circuit, ensure that it is on the correct setting.
- c. Turn on the ignition switch, but do not start the engine.
- d. Check the battery voltage. If your battery is in good condition the reading should be 12 to 13 volts.

ALTERNATOR TESTING

- e. Now check the voltage between the alternator output terminal (B+) and ground. If the circuit is good, the voltage at the alternator should be the same as the battery, or if an isolator is in the circuit the alternator voltage will be zero. If not, a problem exists in the circuit between the alternator and the battery. Check all the connections - look for an opening in the charging circuit.

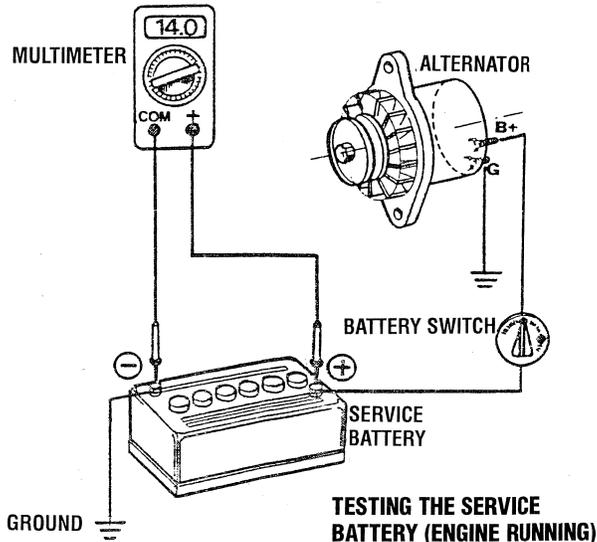


- f. Start the engine again. Check the voltage between the alternator output and ground. The voltage reading for a properly operating alternator should be between 13.5 and 14.5 volts. If your alternator is over- or under-charging, have it repaired at a reliable service shop.

NOTE: Before removing the alternator for repair, use a voltmeter to ensure that 12 volts DC excitation is present at the EXC terminal if the previous test showed only battery voltage at the B output terminal. If 12 volts are not present at the EXC terminal, trace the wiring looking for breaks and poor connections.

Alternator is Working

4. Check the voltage of the service battery. This battery should have a voltage between 13 and 14 volts when the engine is running. If not, there is a problem in the service battery charging circuit. Troubleshoot the service battery charging circuit by checking the wiring and connections, the solenoid, isolator, battery switch and the battery itself.



CAUTION: When performing tests on the alternator charging circuit do not use a high voltage tester (i.e. Megger). You can damage the alternator diodes.

ALTERNATOR INSPECTION

When rebuilding the engine, the alternator should be cleaned and inspected. The housing can be wiped off with a solvent and the alternator terminal studs should be cleaned with a wire brush. Make certain the studs are tight and clean the wiring connections that connect to the wiring harness.

Turn the rotor pulley by hand. It should turn smoothly.

Depending on when the alternator was last serviced, the brushes may need replacing. If the alternator is at all suspect, send it to a service shop for testing and overhaul.

SERVICE DATA / STANDARDS AND LIMITS - W-52 / 63B / 63C ENGINES

Component	Specified Value / Standard inches(mm)	Repair Limit inches(mm)
COMPRESSION / TIMING		
Cylinder Compression Pressure	427 psi at 200 rpm (30.0 kg/cm ²)	384 psi (27.0 kg/cm ²)
Difference between Cylinders (max)	42.7 psi (3.0kg/cm ²)	
Injection Timing at BTDC on compression stroke	19° ± 1.5	19° ± 2
Spill Timing (static)		
Injector Spray Pressure	1920 psi + 71 - OPSI (135± 5.0kg/cm ²)	
CYLINDER HEAD		
Surface Distortion		0.004 (0.1)
Valve Guide I.D. (Intake & Exhaust)	0.260 (6.6)	
Intake Valve Guide Angle	45°	
Exhaust Valve Guide Angle	30°	
Intake Valve Seat Width	0.079 (2.0)	0.004 (0.1)
Exhaust Valve Seat Width	0.079 (2.0)	0.004 (0.1)
Valve Clearance (Intake & Exhaust)	0.012 (0.30) [Warm]	
VALVES		
Valve Head Diameter (Intake)	1.594 (40.5)	± 0.004 (± 0.1)
(Exhaust)	1.417 (36)	± 0.005 (± 0.13)
Overall Length (Intake)	4.508 (114.5)	
(Exhaust)	4.512 (114.6)	
Valve Stem O.D. Intake	0.3120 - 0.3130 (7.925 - 7.950)	0.3102 (7.880)
Exhaust	0.3115 - 0.3125 (7.912 - 7.937)	0.3097 (7.867)
Stem to Guide Clearance Intake & Exhaust	0.0015 - 0.0035 (0.038 - 0.089)	0.0050 (0.127)
Valve Contact Width	0.079 (2.0)	
Valve Face Angle Intake	45°	
Exhaust	30°	
Valve Guide Protrusion from Cylinder Head		0.65 (16.5)
Dimension L (sinking)	1.890 (48.0)	1.949 (49.5)
Valve Spring (outer)		
Wire diameter	0.117 (4.5)	
Outer coil diameter	1.496 (38.0)	
Free Length	1.807 (45.9)	1.717 (43.6)
Fitting Length	1.587 (40.3)	
Preload	39.7 ± 2.0 lb/18.0 ± 0.9 kg	32.0 lb/14.5 kg
Squareness		0.054 (1.37)
Valve Spring (inner)		
Wire diameter	0.138 (3.5)	
Outer coil diameter	1.083 (27.5)	
Free Length	1.736 (44.1)	1.654 (42.0)
Fitting Length	1.488 (37.8)	
Preload	28.0 ± 1.3 lb/12.7 ± 0.6 kg	22.7 lb/10.3 kg
Squareness		0.049 (1.25)

Component	Specified Value / Standard inches(mm)	Repair Limit inches(mm)
TIMING GEARS		
Backlash between Gears in Mesh	0.0039 - 0.0067 (0.10 - 0.17)	0.012 (0.3)
Idler Gear Bushing - Clearance between Bushing and Shaft	0.001 - 0.010 (0.03 - 0.07)	0.0078 (0.2)
ROCKER ARM		
Rocker Arm Bore	0.7188 - 0.7196 (18.258 - 18.278)	
Rocker Arm Bushing Inner diameter	0.6250 - 0.6258 (15.876 - 15.896)	
Outer diameter	0.7200 - 0.7208 (18.288 - 18.309)	
Rocker Arm Shaft Outer diameter	0.6234 - 0.6244 (15.835 - 15.860)	
Clearance	0.0006 - 0.0024 (0.016 - 0.061)	0.0028 (0.07)
TAPPET		
Outer diameter	0.5600 - 0.5610 (14.224 - 14.249)	
Bore in cylinder block	0.5625 - 0.5637 (14.288 - 14.319)	
Clearance In Cylinder Block bore	0.0015 - 0.0037 (0.0039 - 0.10)	0.0039 (0.10)
VALVE CAMSHAFT		
Journal diameter No. 1 (Front)	2.0437 - 2.0449 (51.910 - 51.940)	
No. 2 (Center)	2.0339 - 2.0351 (51.660 - 51.690)	
No. 3 (Rear)	2.0142 - 2.0154 (51.160 - 51.190)	
Wear limit		0.0003 (0.008)
Cam Elevation Intake and Exhaust	1.6767 (42.587)	1.6728 (42.485)
Camshaft End Play	0.0008 - 0.0071 (0.020 - 0.180)	0.0118 (0.30)
Camshaft Run-Out		0.0031 (0.08)
Camshaft Support Bore No. 1 (Front)	2.0473 - 2.0485 (52.000 - 52.030)	
No. 2 (Center)	2.0374 - 2.0386 (51.750 - 51.780)	
No. 3 (Rear)	2.0177 - 2.0189 (51.250 - 51.280)	
Oil Clearance No. 1 (Front)	0.0024 - 0.0047 (0.060 - 0.120)	0.0057 (0.145)
No. 2 (Center)	0.0024 - 0.0047 (0.060 - 0.120)	0.0057 (0.145)
No. 3 (Rear)	0.0024 - 0.0047 (0.060 - 0.120)	0.0057 (0.145)
Backlash between gears	0.0039 - 0.0067 (0.10 - 0.17)	0.0118 (0.30)
PUSH RODS		
Bend Limit		0.0075 (0.19)
IDLER GEAR		
Boss bore	1.8898 - 1.8908 (48.000 - 48.025)	
Boss bore limit	0.0079 - 0.0118 (0.20 - 0.30)	
Bushing Inner Diameter	1.7327 - 1.7336 (44.009 - 44.034)	
Outer Diameter	1.8915 - 1.8925 (48.043 - 48.068)	
Spindle Length	1.1398 - 1.1437 (28.95 - 29.05)	
Outer Diameter	1.7303 - 1.7313 (43.950 - 43.975)	
Spindle and Bushing Clearance	0.0013 - 0.0033 (0.034 - 0.084)	0.0059 (0.15)
Backlash between gears	0.0039 - 0.0067 (0.10 - 0.17)	0.0118 (0.30)

SERVICE DATA / STANDARDS AND LIMITS - W-52 / 63B / 63C ENGINES

Component	Specified Value / Standard inches(mm)	Repair Limit inches(mm)
CONNECTING ROD		
Bend and Twist	0.002 in 4 (0.05 in 100)	
Side Play	0.0094 - 0.0134 (0.239 - 0.340)	0.0157 (0.40)
Small End Bore	1.2205 - 1.222 (31.000 - 31.039)	
CONNECTING ROD BEARING		
Oil Clearance	0.0014 - 0.0030 (0.036 - 0.076)	0.039 (0.10)
Available undersize	0.01, 0.02, 0.03 (0.255, 0.508, 0.762)	
PISTON		
Diameter	3.4987 - 3.4997 (88.867 - 88.893)	
Piston Ring Hole Bore	1.1024 - 1.1028 (28.00 - 28.01)	
Piston to Liner Clearance		
Side Clearance	0.0017 - 0.0028 (0.044 - 0.70)	
Ring Groove Width		
Top	0.0958 - 0.966 (2.433 - 2.453)	
Second	0.0954 - 0.962 (2.423 - 2.443)	
Oil	0.1887 - 0.1895 (4.793 - 4.813)	
PISTON RINGS		
Width		
Top	0.1374 - 0.1382 (3.49 - 3.51)	
Second	0.1350 - 0.1400 (3.429 - 3.556)	
Oil	0.1083 - 0.1240 (2.750 - 3.150)	
Thickness		
Top	0.0930 - 0.938 (2.363 - 2.383)	
Second	0.0930 - 0.938 (2.363 - 2.383)	
Oil	0.1867 - 0.1875 (4.743 - 4.763)	
Side Clearance		
Top	0.0020 - 0.0035 (0.050 - 0.090)	0.0591 (1.5)
Second	0.0016 - 0.0031 (0.040 - 0.080)	0.0591 (1.5)
Oil	0.0012 - 0.0028 (0.030 - 0.070)	0.118 (0.30)
End Gap		
Top	0.0157 - 0.0217 (0.40 - 0.55)	0.0591 (1.5)
Second	0.0118 - 0.0157 (0.30 - 0.40)	0.0591 (1.5)
Oil	0.0138 - 0.0217 (0.35 - 0.55)	0.0591 (1.5)
PISTON PIN		
Diameter	1.1021 - 1.1024 (27.994 - 28.000)	
Pin to Piston Clearance	0 - 0.006 (0 - 0.016)	
CRANKSHAFT		
Main Journal diameter	2.5585 - 2.5591 (64.987 - 65.000)	0.002 (0.05)
Crankpin diameter	2.0861 - 2.0866 (52.987 - 53.000)	0.002 (0.05)
Processing diameter	0.030 (0.762)	
End play	0.0055 - 0.0154 (0.140 - 0.390)	0.0157 (0.40)
Run-out		0.0020 (0.05)

Component	Specified Value / Standard inches(mm)	Repair Limit inches(mm)
MAIN BEARING		
Clearance	0.0016 - 0.0036 (0.040 - 0.091)	0.0047 (0.12)
Available undersize	0.01, 0.02, 0.03 (0.254, 0.508, 0.762)	
CYLINDER BLOCK		
Cylinder Bore	3.8125 - 3.8135 (96.838 - 96.863)	
Warpage limit	0.004 (0.10)	
Cylinder Liner		
Length	6.3976 - 6.4075 (162.50 - 162.75)	
Inner diameter	3.5010 - 3.5020 (88.925 - 88.950)	
Outer diameter	3.8145 - 3.8155 (96.888 - 96.914)	
Protrusion	0.0259 - 0.0311 (0.659 - 0.790)	
Flywheel to Crankshaft run-out		0.0079 (0.20)
FUEL SYSTEM		
Idle speed	580 - 630 rpm	
Fuel Injection Pump		
Plunger diameter	0.393 (10.0)	
Cam Lift	0.08 (2.2)	
Injector		
Nozzle diameter	0.031 (0.80)	
Injection Pressure	1920 + 71/-0 psi (135 + 5/-0 kg/cm ²)	
LUBRICATION SYSTEM		
Oil Pressure	57 psi (4.0 kg/cm ²)	
Min Safe pressure (idle)	4.3 ± 1.4 psi (0.3 ± 0.1 kg/cm ²)	
Oil Capacity (sump)	5.3 Qts (5.0 L)	
Oil Pump		
Outer Rotor and		
Body Clearance	0.0055 - 0.0079 (0.14 - 0.20)	0.012 (0.3)
Rotor Lobe		
Clearance	0.0016 - 0.0079 (0.04 - 0.20)	0.012 (0.3)
Rotor End Float	0.0016 - 0.0039 (0.04 - 0.10)	0.0059 (0.15)
Pump Shaft and Body Clearance		0.0039 (0.10)
Spring Free Length		1.82 (46.2)
STARTER MOTOR		
Depth of Brush Undercut	0.019 (0.5)	0.008 (0.2)
Height of Brush	0.669 (17)	0.236 (6)
Spring Pressure	43 lb/in ² (3 kg/cm ²)	
Commutator O.D.	1.523 (38.7)	-0.039 (-1.0)
Pinion Shaft End Play	0.014 (0.5)	

TORQUE SPECIFICATIONS - W-52 / 63B / 63C ENGINES

COMPONENT	FT-LB (M-KG)	COMPONENT	FT-LB (M-KG)
Alternator Bracket	27 - 38 (3.8 - 5.3)	Injection Pipe Flare Nut	18 - 22 (1.6 - 3.0)
Back Plate	24 - 35 (3.3 - 4.8)	Injection Pump Delivery Valve Holder M16 (17)	25.3 - 28.2 (3.5 - 3.9)
Camshaft Gear	45 - 51 (6.2 - 7.0)	Injection Pump Locknut Gear	29 - 51 (4.0 - 7.0)
Camshaft Thrust Plate.....	12 - 17 (1.6 - 2.4)	Injectors	36 - 38 (5.0 - 6.0)
Connecting Rod Cap	50 - 54 (6.9 - 7.5)	Intake Manifold	12 - 17 (1.6 - 2.4)
Coolant Pump	12 - 17 (1.6 - 2.4)	Main Bearing Cap	80 - 85 (11.0 - 11.7)
Coolant Pump Pulley.....	12 - 17 (1.6 - 2.4)	Oil Pan	5 - 9 (0.7 - 1.2)
Coolant Temperature Sender	9 - 13 (1.2 - 1.8)	Oil Pan Pipe	12 - 17 (1.6 - 2.3)
Coolant Temperature Switch.....	9 - 13 (1.2 - 1.8)	Oil Pressure Sender	9 - 13 (1.2 - 1.8)
Crankshaft Pulley Nut	145 - 181 (20 - 25)	Oil Pressure Switch.....	9 - 13 (1.2 - 1.8)
Cylinder Head Bolts	85 - 90 (11.8 - 12.5)	Oil Pump Cover	6 - 9 (0.8 - 1.2)
Cylinder Head Cover	2 - 3 (0.3 - 0.45)	Oil Pump Pipe	6 - 9 (0.8 - 1.2)
Damper Plate	14 - 20 (1.9 - 2.7)	Rear Oil Seal Cap.....	11 - 15 (1.5 - 2.0)
Engine Mounts	23 - 34 (3.2 - 4.7)	Rocker Arm Assembly	80 - 85 (11.0 - 11.7)
Exhaust Manifold.....	12 - 17 (1.6 - 2.4)	Rocker Arm Cover	1.8 - 2.9 (0.25 - 0.40)
Fuel Solenoid Locknut M30 (36) ..	28.9 - 36.2 (4.0 - 5.0)	Thermostat Housing	6 - 8 (0.8 - 1.1)
Flywheel bolt M10 (12)	61 - 68 (8.5 - 9.5)	Thrust Plate	16 - 23 (2.3 - 3.2)
Glow Plug	7 - 11 (1.0 - 1.5)	Timing Gear Case	12 - 17 (1.6 - 2.4)
Idler Gear	17 - 23 (2.2 - 3.2)	Timing Gear Cover.....	12 - 17 (1.6 - 2.4)
Injection Nozzle	12.0 - 17.0 (1.6 - 2.4)		

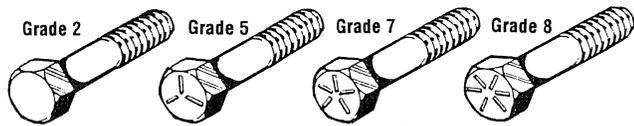
NOTE: Formula to convert Ft-Lbs to Nm (Newton Meters) is multiply Ft-Lbs by 1.356.
Example: 45 Ft-Lbs. $45 \times 1.356 = 61 \text{ Nm}$.

STANDARD HARDWARE

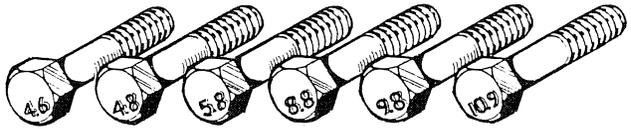
BOLT HEAD MARKINGS

Bolt strength classes are embossed on the head of each bolt.

Customary (inch) bolts are identified by markings two to grade eight (strongest). The marks correspond to two marks less than the actual grade, i.e.; a grade seven bolt will display five embossed marks.



Metric bolt class numbers identify bolts by their strength with 10.9 the strongest.



- NOTES:**
1. Use the torque values listed below when specific torque values are not available.
 2. These torques are based on clean, dry threads. Reduce torque by 10% when engine oil is used.
 3. Reduce torques by 30% or more, when threading capscrews into aluminum.

STANDARD BOLT & NUT TORQUE SPECIFICATIONS			
Capscrew Body Size (Inches) - (Thread)	SAE Grade 5 Torque Ft-Lb (Nm)	SAE Grade 6-7 Torque Ft-Lb (Nm)	SAE Grade 8 Torque Ft-Lb (Nm)
1/4 - 20 - 28	8 (11) 10 (14)	10 (14)	12 (16) 14 (19)
5/16 - 18 - 24	17 (23) 19 (26)	19 (26)	24 (33) 27 (37)
3/8 - 16 - 24	31 (42) 35 (47)	34 (46)	44 (60) 49 (66)
7/16 - 14 - 20	49 (66) 55 (75)	55 (75)	70 (95) 78 (106)
1/2 - 13 - 20	75 (102) 85 (115)	85 (115)	105 (142) 120 (163)
9/16 - 12 - 18	110 (149) 120 (163)	120 (163)	155 (210) 170 (231)
5/8 - 11 - 18	150 (203) 170 (231)	167 (226)	210 (285) 240 (325)
3/4 - 10 - 16	270 (366) 295 (400)	280 (380)	375 (508) 420 (569)
7/8 - 9 - 14	395 (536) 435 (590)	440 (597)	605 (820) 675 (915)
1 - 8 - 14	590 (800) 660 (895)	660 (895)	910 (1234) 990 (1342)

METRIC BOLT & NUT TORQUE SPECIFICATIONS					
Bolt Dia.	Wrench Size	Grade 4.6 Ft-Lb (Nm)	Grade 4.8 Ft-Lb (Nm)	Grade 8.8 - 9.8 Ft-Lb (Nm)	Grade 10.9 Ft-Lb (Nm)
M3 M4 M5	5.5 mm 7 mm 8 mm	0.3 (0.5) 0.8 (1.1) 1.5 (2.5)	0.5 (0.7) 1 (1.5) 2 (3)	1 (1.3) 2 (3) 4.5 (6)	1.5 (2) 3 (4.5) 6.5 (9)
M8 M9 M10	10 mm 13 mm 16 mm	3 (4) 7 (9.5) 14 (19)	4 (5.5) 10 (13) 18 (25)	7.5 (10) 18 (25) 37 (50)	11 (15) 35 (26) 55 (75)
M12 M14 M16	18 mm 21 mm 24 mm	26 (35) 37 (50) 59 (80)	33 (45) 55 (75) 85 (115)	63 (85) 103 (140) 159 (215)	97 (130) 151 (205) 232 (315)
M18 M20 M22	27 mm 30 mm 33 mm	81 (110) 118 (160) 159 (215)	118 (160) 166 (225) 225 (305)	225 (305) 321 (435) 435 (590)	321 (435) 457 (620) 620 (840)
M24 M27 M30	36 mm 41 mm 46 mm	203 (275) 295 (400) 402 (545)	288 (390) 417 (565) 568 (770)	553 (750) 811 (1100) 1103 (1495)	789 (1070) 1154 (1565) 1571 (2130)
M33 M36	51 mm 55 mm	546 (740) 700 (950)	774 (1050) 992 (1345)	1500 (2035) 1925 (2610)	2139 (2900) 2744 (3720)

SEALANTS & LUBRICANTS

GASKETS/SEALANTS

Oil based PERMATEX #2 and it's HIGH TACK equivalent are excellent all purpose sealers. They are effective in just about any joint in contact with coolant, raw water, oil or fuel.

A light coating of OIL or LIQUID TEFLON can be used on rubber gaskets and O-rings.

LOCTITE hydraulic red sealant should be used on oil adapter hoses and the oil filter assembly.

Coat both surfaces of the oil pan gasket with high temp RED SILICONE sealer.

When installing gaskets that seal around water (coolant) passages, coat both sides with WHITE SILICONE grease.

High-copper ADHESIVE SPRAYS are useful for holding gaskets in position during assembly.

Specialized gasket sealers such as HYLOMAR work well in applications requiring non-hardening properties. HYLOMAR is particularly effective on copper cylinder-head gaskets as it resists fuel, oil and water.

Use LIQUID TEFLON for sealing pipe plugs and fillings that connect coolant passages. **Do not use tape sealants!**

BOLTS & FASTENERS/ASSEMBLIES

Lightly oil head bolts and other fasteners as you assemble them. Bolts and plugs that penetrate the water jacket should be sealed with PERMATEX #2 or HIGH TACK.

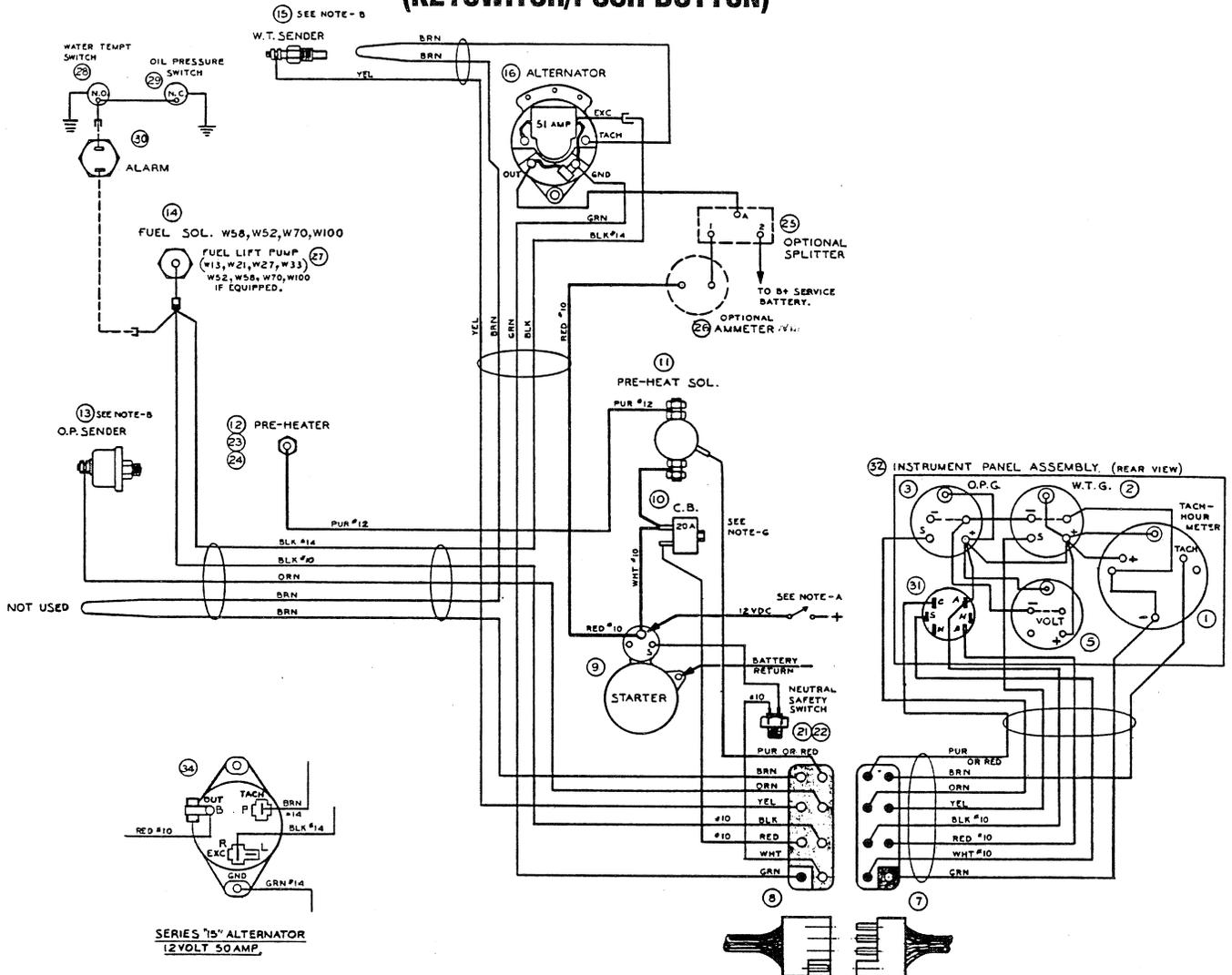
When assembling the flywheel, coat the bolt threads with LOCTITE blue.

Anti-seize compounds and thread locking adhesives such as LOCTITE protect threaded components yet allows them to come apart when necessary. LOCTITE offers levels of locking according to the job.

LITHIUM based grease is waterproof, ideal for water pump bearings and stuffing boxes.

Heavily oil all sliding and reciprocating components when assembling. **Always use clean engine oil!**

W-52 MARINE ENGINE WIRING DIAGRAM #33685 (KEYSWITCH/PUSH BUTTON)

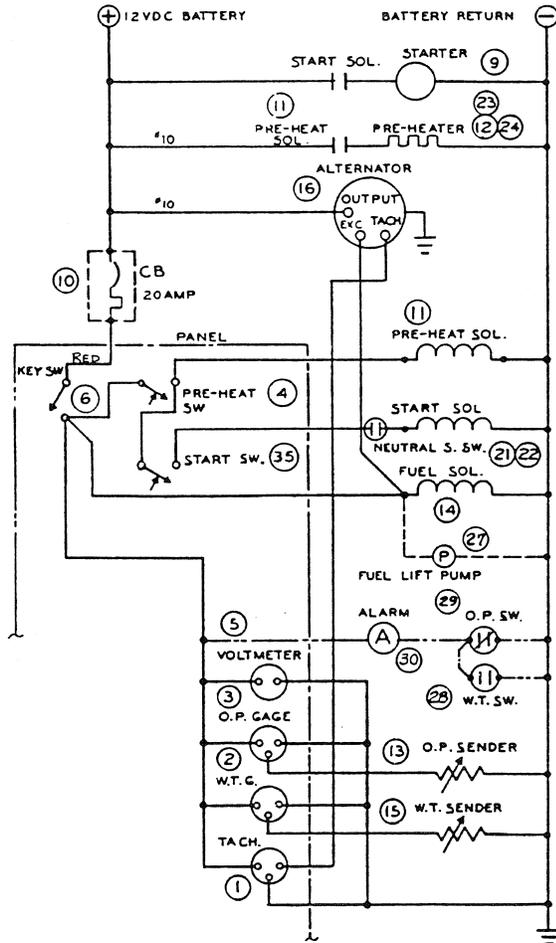


34	30594	ALTERNATOR, 12V. 50A.	1		
33	24751	PANEL, LESS INSTRUMENTS	1		
32	24880	PANEL, COMPLETE	1		
31	24777	KEY SWITCH	1		
30	13355	ALARM		1	
29	30944	OIL PRESS. SW. N.C.			1
28	30125	WATER TEMPT. SW. N.O.			1
27	24831	FUEL LIFT PUMP	1		
26	11381	AMMETER (OPTIONAL)			1
25	20654	SPLITTER (OPTIONAL)			1
24	14529	GLOW PLUGS W30E W50 4EA/CH			
23	11530	GLOW PLUGS W40	1		
22	2	NEUTRAL SAFETY SW. PARAGON	1		
21	23433	NEUTRAL SAFETY SW. WARNER	1		
20	24628	PANEL, LESS INSTRUMENTS	1		
19	24660	PANEL, COMPLETE	1	1	
18	11532	SUPPRESSION KIT. ALT.	1		
17	12959	TACH. KIT. ALTERNATOR	1		
16	24684	ALTERNATOR, 51 A.	1		
15	23571	SENDER, WATER TEMP.	1		
14	24339	SOLENOID, FUEL	1		
13	24132	SENDER, OIL PRESSURE	1		
12	24333	PRE-HEATER (W58)	4		
11	24639	SOLENOID, PRE-HEAT	1		
10	24683	CIRCUIT BREAKER 20AMP	1		
9	16762	STARTER, MARINE ENGINE	1		
8	30092	HARNESSE, ENGINE		1	
7	30148	HARNESSE, PANEL		1	
6	11956	KEY SWITCH	1		
5	23090	VOLTMETER	1		
4	11957	SWITCH, PRE-HEAT	1		
3	24133	OIL PRESSURE GAUGE	1		
2	11545	WATER TEMP. GAUGE	1		
1	11917	TACHOMETER	1		
ITEM	PART NO.	DESCRIPTION	QTY	ASSY	OPTION ASSY

W-52 MARINE ENGINE

WIRING SCHEMATIC #33685

(KEYSWITCH/PUSH BUTTON)



NOTES:

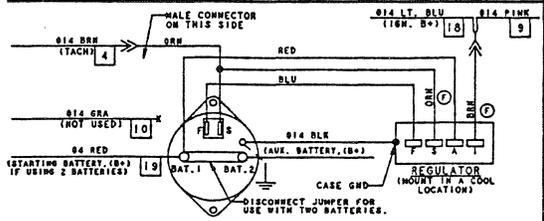
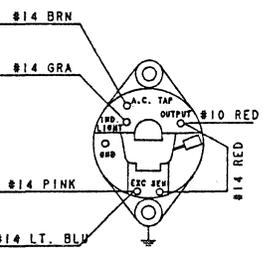
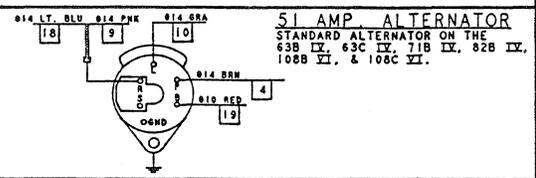
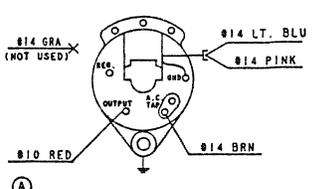
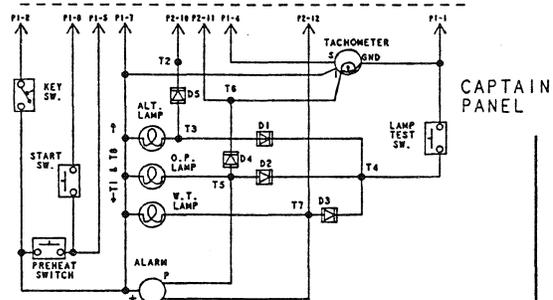
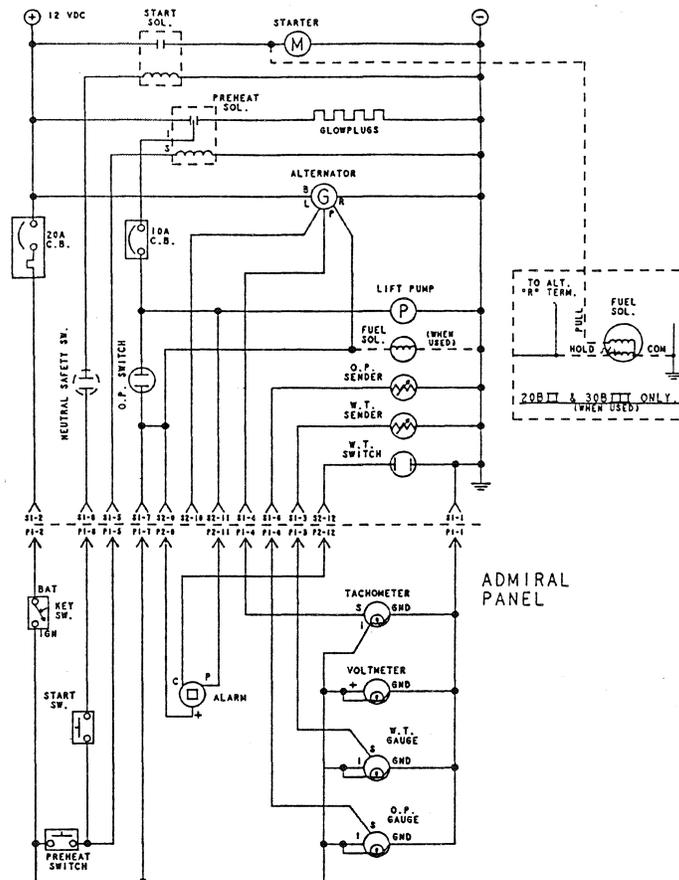
NOTES ON BUILDER/OWNERS RESPONSIBILITY.

- (A) AN ON-OFF SWITCH MUST BE INSTALLED IN THIS LINE TO DISCONNECT THE STARTER CIRCUIT FROM THE BATTERY IN AN EMERGENCY & WHEN LEAVING THE BOAT. 12VOLT DIESEL ENGINE STARTERS TYPICALLY DRAW 200 TO 300AMPS WHEN CRANKING. THE DURATION OF INDIVIDUAL CRANKING CYCLES SHOULD NOT EXCEED 30 SECONDS. A SWITCH WITH CONTINUOUS RATING OF 175 AMPS AT 12VDC WILL NORMALLY SERVE THESE FUNCTIONS, BUT SUCH A SWITCH MUST NEVER BE USED TO "MAKE" THE STARTER CIRCUIT.

OTHER NOTES:

- (B) **WARNING ; SENDER CONNECTION:**
CONTACT WITH B+ MAY DAMAGE SENDER.
- (C) ALL RETURNS ARE THROUGH ENGINE BLOCK.
- (D) FOR WIRING OF AUXILIARY ALTERNATORS SEE THE FOLLOWING DIAGRAMS.
MOTOROLA 85 AMP, 11232
MOTOROLA 120 AMP, 11231
LEECE-NEVILLE 53 AMP, 16535
LEECE-NEVILLE 105 AMP, 16614.
- (E) IF ADDITIONAL PRESSURE SWITCHES ARE REQ'D TO START BOAT ACCESSORIES A FLEXIBLE HOSE MUST BE RUN FROM THE OIL PRESSURE MANIFOLD TO A NEARBY BULKHEAD AND ALL PRESSURE SWITCHES MOUNTED AT THE BULKHEAD.
- (F) APPLY SILASTIC OR TIGHT WOUND PLASTIC/SPLICE ELECTRICAL TAPE AROUND CONNECTORS CONNECTED.
- (G) **CAUTION:**
THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER AND AS CLOSE TO THE SOURCE OF CURRENT AS POSSIBLE. EXCESSIVE CURRENT DRAIN ANYWHERE IN THE INSTRUMENT PANEL, WIRING, OR ENGINE WILL CAUSE THE BREAKER TO TRIP. IN THIS EVENT, MOST ENGINE MODELS WILL SHUT DOWN BECAUSE THE OPENED BREAKER DISCONNECTS THEIR FUEL SUPPLY. THEREFORE THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL, WIRING AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SALT WATER.

63B/63C MARINE ENGINES WIRING SCHEMATIC #039144



OPTIONAL ALTERNATORS ©

AVAILABLE ON THE 63B IX, 63C IX, 71B IX, 82B IX, 108B VI, & 108C VI ONLY.

SPECIFICATIONS W-52, 63B AND 63C ENGINE

ENGINE SPECIFICATIONS

Engine Type	Diesel, four-cylinder, four-cycle, fresh water-cooled, vertical in-line overhead valve mechanism (52 hp at 3000 rpm maximum). (63 hp at 3600 rpm maximum)
Displacement	134.8 cu.in. (2.21 Liter)
Aspiration	Naturally aspirated
Governor	Centrifugal type
Combustion Chamber	Swirl type
Bore & Stroke	3.50 x 3.51 inches (88.9 x 89.1 mm)
Piston Displacement	134.8 cubic inches (2.21 liters)
Firing Order	1 - 3 - 4 - 2
Direction of Rotation	Clockwise, when viewed from the front
Compression Ratio	21 : 1
Dimensions	Height: 24.93 inches (633.2 mm) Width: 22.63 inches (574.6 mm) Length: 38.75 inches (984.3 mm)
Weight	614 lbs (278.7 kgs)
Fuel Consumption	1.8 US gph (6.81 lph) at 2500 rpm
Inclination	Continuous 15° Temporary 25° (not to exceed 30 min.)
Power Take Off	30 HP maximum (Generator end)

TUNE-UP SPECIFICATIONS

Compression Pressure Minimum	427 psi (30 kg/cm ²) at 280 rpm limit 384 psi (27 kg/cm ²)
Valve Timing	Intake Opens 17° BTDC Intake Closes 47° ABDC Exhaust Opens 51° BBDC Exhaust Closes 13° ATDC
Spill Timing (Static)	19°±1.5
Valve Seat Angle	Intake 45° Exhaust 45°
Engine Speed	1800 rpm 60 Hertz 1500 rpm 50 Hertz
Valve Clearance (warm engine)	Intake 0.012 inches (0.30 mm) Exhaust 0.012 inches (0.30 mm)
Injector Pressure	1920 + 71 - 0 psi (135 + 5 - 0 kg/cm ²)
Engine Timing	Static timed - drop valve method 0.205 ± .005 in BTDC or 0° TDC #1 cylinder. 1mm of cam lift using measuring device for injection pump.

FUEL SYSTEM

General	Open flow, self priming - one bleed point.
Fuel	No. 2 diesel oil (cetane rating of 45 or higher)
Fuel Injection Pump	Distributor Type (VE) Diesel KiKi - Zexel
Fuel Injection Timing	0° TDC (Top Dead Center)
Nozzle	Throttle type
Fuel Filter	Spin-on (Replaceable) PN#024363
Air cleaner	Metal screen type - cleanable
Air Flow (engine combustion)	70.0 cfm (1.9 cmm)

ELECTRICAL SYSTEM

Starting Battery	12-Volt, (-) negative ground
Battery Capacity	400 - 600 Cold Cranking Amps (CCA)
DC Charging Alternator	51 Amp rated, belt driven
Starter	12-Volt, reduction gear,
Starting Aid	Glow plugs, sheathed type
DC No-Load Current	± 2% of rated Amps
DC Cranking Current	280 Amps (engine cold)

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.
Operating Temperature	170 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Raw Water Pump	Positive displacement, rubber impeller, gear-driven.
Raw Water Flow, at 3600 rpm	6.0 US gpm (22.7 lpm) (measured before discharging into exhaust elbow).
System Capacity (fresh water)	10.0 qts (9.46 liters)

LUBRICATION SYSTEM

General	Pressure fed system
Oil Filter	Full flow, paper element, spin-on type PN# 035828
Sump Capacity (not including filter)	5.3 U.S. qts (5.0 liters) plus filter/cooler assembly
Operating Oil Pressure (engine hot)	50 - 65 psi (3.5 - 4.57 kg/cm ²)
Oil Grade	API Specification CF or CG-4, SAE 30, 10W-30, 15W-40

GENERATOR INFORMATION

USE OF ELECTRIC MOTORS

The power required to start an electric motor is considerably more than is required to keep it running after it is started. Some motors require much more current to start than others. Split-phase (AC) motors require more current to start, under similar circumstances, than other types. They are commonly used on easy-starting loads, such as washing machines, or where loads are applied after the motor is started, such as small power tools. Because they require 5 to 7 times as much current to start as to run, their use should be avoided, whenever possible, if the electric motor is to be driven by a small generator. Capacitor and repulsion-induction motors require from 2 to 4 times as much current to start as to run. The current required to start any motor varies with the load connected to it. An electric motor connected to an air compressor, for example, will require more current than a motor to which no load is connected.

In general, the current required to start 115-Volt motors connected to medium starting loads will be approximately as follows:

MOTOR SIZE (HP)	AMPS FOR RUNNING (AMPERES)	AMPS FOR STARTING (AMPERES)
1/6	3.2	6.4 to 22.4*
1/4	4.6	9.2 to 32.2*
1/3	5.2	10.4 to 72.8*
1/2	7.2	14.4 to 29.2*
3/4	10.2	20.4 to 40.8*
1	13	26 to 52

***NOTE:** In the above table the maximum Amps for Starting is more for some small motors than for larger ones. The reason for this is that the hardest starting types (split-phase) are not made in larger sizes.

Because the heavy surge of current needed for starting motors is required for only an instant, the generator will not be damaged if it can bring the motor up to speed in a few seconds. If difficulty is experienced in starting motors, turn off all other electrical loads and, if possible, reduce the load on the electric motor.

Required Operating Speed

Run the generator first with no load applied, then at half the generator's capacity, and finally loaded to its full capacity as indicated on the generator's data plate. The output voltage should be checked periodically to ensure proper operation of the generating plant and the appliances it supplies. If an AC voltmeter or ampmeter is not installed to monitor voltage and load, check it with a portable meter and amp probe.

NOTE: When the vessel in which the generator is installed contains AC equipment of 120 volts only, it is recommended that the generator's AC terminal block be configured to provide one 120 volt AC hot leg for the vessel's distribution panel. This will ensure good motor starting response from the generator.

Generator Frequency Adjustment

Frequency is a direct result of engine/generator speed, as indicated by the following:

- When the generator is run at 1800 RPM, the AC voltage output frequency is 60 Hertz.
- When the generator is run at 1500 RPM, the AC voltage output frequency is 50 Hertz.

Therefore, to change the generator's frequency, the generator's drive engine's speed must be changed. Along with a reconfiguring of the AC output connections at the generator, a regulator board voltage output adjustment must also be made. See *ELECTRONIC GOVERNOR* in this manual.

GENERATOR MAINTENANCE

- Maintaining reasonable cleanliness is important. Connections of terminal boards and rectifiers may become corroded, and insulation surfaces may start conducting if salts, dust, engine exhaust, carbon, etc. are allowed to build up. Clogged ventilation openings may cause excessive heating and reduced life of windings.
- Inspect the exhaust elbow for corrosion and soot. Check the tightness of the mounting flange and exhaust manifold. Inspect the exhaust hose and tighten the hose clamps.
- The drive discs on single bearing generators should be checked periodically if possible for tightness of screws and for any evidence of incipient cracking failure. Discs should not be allowed to become rusty because rust may accelerate cracking. The bolts which fasten the drive disc to the generator shaft must be hardened steel SAE grade 8, identified by 6 radial marks, one at each of the 6 corners of the head.
- The rear armature bearing is lubricated and sealed; no maintenance is required. However, if the bearing becomes noisy or rough-sounding, have it replaced.
- Examine bearing at periodic intervals. No side movement of shaft should be detected when force is applied. If side motion is detectable, bearings are wearing or wear on shaft of bearing socket outside bearing has occurred. Repair must be made quickly or major components will rub and cause major damage to generator.

Carbon Monoxide Detector

WESTERBEKE recommends mounting a carbon monoxide detector in the vessels living quarters. **Carbon monoxide, even in small amounts is deadly.**

The presence of carbon monoxide indicates an exhaust leak from the engine or generator, from the exhaust elbow/exhaust hose, or that fumes from a nearby vessel are entering your boat.

If carbon monoxide is present ventilate the area with clean air and correct the problem immediately!

GENERATOR CONTROL PANEL SWITCHES

DESCRIPTION

This manually controlled series of WESTERBEKE marine diesel generators is equipped with toggle switches on the engine control panel and, optionally, at remote panels. The following instructions and methods of correcting minor problems apply only to such toggle switch controls.

All three switches are momentary contact type and serve the following functions:

1. **PREHEAT:** The PREHEAT toggle switch is a double pole, single throw switch. The switch serves two purposes: preheating the engine for easy starting and defeating of bypassing the engine oil pressure switch. The defeat function turns on the fuel solenoid, instrument power and alternator excitation.

When the PREHEAT switch is depressed, the voltmeter, panel lights, gauges and meters and fuel solenoid will activate. The PREHEAT switch should be depressed for twenty seconds.

2. **STOP:** The STOP toggle switch is a single pole, single throw, normally closed switch. The switch provides power to the fuel solenoid, instrument cluster and alternator excitation, after the oil pressure switch has closed upon starting. Opening of this switch opens the power circuit to the fuel solenoid, stopping the flow of fuel to the engine and shuts down the engine.

To stop the engine, depress the STOP switch. When the STOP switch is depressed, the power feed to the fuel solenoid is opened, and the fuel flow to the engine is stopped. The STOP switch should be depressed until the generator stops rotating.

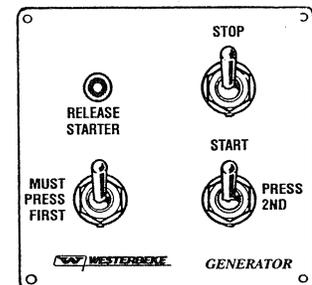
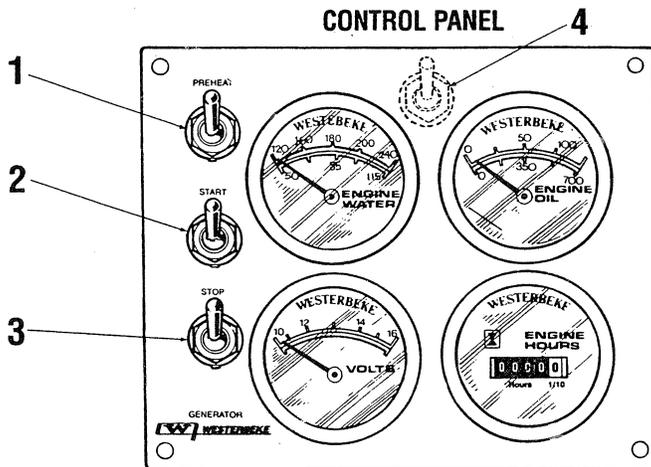
3. **START:** The START toggle switch is a double pole, single throw switch. The switch serves two purposes: starting the engine and defeating of bypassing the engine oil pressure switch. The defeat function turns on the fuel solenoid, instrument power and alternator excitation. While the PREHEAT switch is still depressed, depressing the START switch engages the start solenoid. Panel power and the fuel solenoid will be activated. When the engine begins to fire, the START switch should be released. The PREHEAT switch should not be released until the oil pressure reaches alarm stops.

NOTE: When the engine is shut down, the water temperature gauge and the oil pressure gauge will continue to register the last temperature and oil pressure readings displayed. They will return to zero once electrical power is restored.

4. **EMERGENCY STOP:** The EMERGENCY stop switch at the rear of the control box is normally closed. When depressed, it will open the DC circuit to the control panel and shut the engine down. As the switch is not toggled it can be used when performing maintenance.

REMOTE PANEL

For remote operation of the generator system, the same three switches are used. The PREHEAT and START switches are connected in parallel with the gauge panel's switches and serve the same functions as in the gauge panel. The STOP switch is in series with the gauge panel's STOP switch and serves the same function.



REMOTE PANEL (OPTIONAL)

CONTROL PANEL TROUBLESHOOTING

MANUAL STARTER DISCONNECT (TOGGLE SWITCHES)

NOTE: *The engine control system is protected by a 20 amp manual reset circuit breaker located on the engine as close as possible to the power source.*

Problem	Probable Cause	Verification/Remedy
PREHEAT depressed, no panel indications electric fuel pump and preheat solenoid not energized.	<ol style="list-style-type: none"> 1. Oil Pressure switch. 2. 20 amp circuit breaker tripped. 	<ol style="list-style-type: none"> 1. Check switches and/or battery connections. 2. Reset breaker. If it opens again, check preheat solenoid circuit and run circuit for shorts to ground.
START SWITCH DEPRESSED , no starter engagement.	<ol style="list-style-type: none"> 1. Connection to solenoid faulty. 2. Faulty switch. 3. Faulty solenoid. 4. Loose battery connections. 5. Low battery. 	<ol style="list-style-type: none"> 1. Check connection. 2. Check switch with ohmmeter. 3. Check that 12 volts are present at the solenoid connection. 4. Check battery connections. 5. Check battery charge state.
ENGINE CRANKS , does not start.	<ol style="list-style-type: none"> 1. Faulty fueling system. 2. Check for air in the fuel system. 3. Faulty fuel lift pump. 	<ol style="list-style-type: none"> 1. Check for fuel. 2. Allow system to bleed. 3. Replace fuel lift pump.
NOT CHARGING BATTERY	<ol style="list-style-type: none"> 1. Faulty alternator drive. 	<ol style="list-style-type: none"> 1. Check the drive belt and its tension. Be sure the alternator turns freely. Check for loose connections. Check the output with a voltmeter. Ensure 12V are present at the regulator terminal.
BATTERY RUNS DOWN	<ol style="list-style-type: none"> 1. Oil pressure switch. 2. High resistance leak to ground. 3. Low resistance leak to ground. 4. Faulty alternator. 	<ol style="list-style-type: none"> 1. Observe if the gauges and panel lights are activated when the engine is not running. Test the oil pressure switch. 2. Check the wiring. Insert sensitive (0-.25 amp) meter in battery lines (Do NOT start engine). Remove connections and replace after short is located. 3. Check all wires for temperature rise to locate the fault. 4. After a good battery charging, disconnect alternator at output. If leakage stops. Remove alternator and bench test. Repair or replace.

TROUBLESHOOTING WATER TEMPERATURE AND OIL PRESSURE GAUGES

If the gauge reading is other than what is normally indicated by the gauge when the instrument panel is energized, the first step is to check for 12 volts DC between the ignition (B+) and the Negative (B-) terminals of the gauge.

Assuming that there is 12 volts as required, leave the instrument panel energized and perform the following steps:

1. Disconnect the sender wire at the gauge and see if the gauge reads zero, which is the normal reading for this situation.
2. Remove the wire attached to the sender terminal at the gauge and connect it to ground. See if the gauge reads full scale, which is the normal reading for this situation.

If both of the above gauge tests are positive, the gauge is undoubtedly OK and the problem lies either with the conductor from the sender to the gauge or with the sender.

If either of the above gauge tests are negative, the gauge is probably defective and should be replaced.

Assuming the gauge is OK, check the conductor from the sender to the sender terminal at the gauge for continuity.

Check that the engine block is connected to the ground. Some starters have isolated ground terminals and if the battery is connected to the starter (both plus and minus terminals), the ground side will not necessarily be connected to the block.

ELECTRONIC GOVERNOR KIT INSTALLATION

Model WTA, WTF & WMF - Single and Three Phase Models

INSTALLATION INSTRUCTIONS

Injection Pump

The injection pump governor spring must be changed to the propulsion style spring. A propulsion spring is enclosed with this kit along with a new cover gasket.

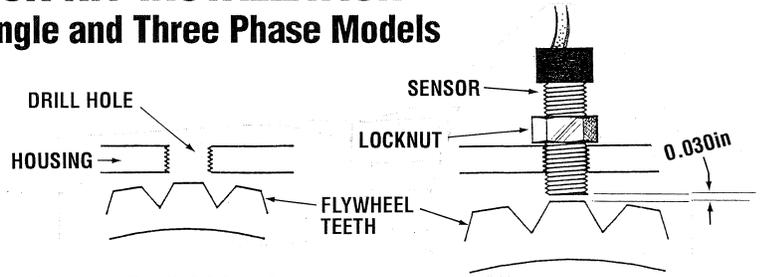
To change the governor spring remove the lock wire presently securing the throttle arm. Remove the heavy duty throttle return spring that is attached to the throttle arm. Do not remove the throttle arm from the splined shaft to do this, just disconnect the spring so it has no effect on the arm.

Back off and remove the two throttle stop screws.

There are four heavy duty slotted machine screws that secure the pump cover to the pump housing. Loosen and remove these four screws. Lift the cover carefully. It is positioned on the housing by a dowel at one of the machine screw holes. The cover will move towards the engine bellhousing when lifted beyond the dowel due to tension from the throttle plate against the fuel screw in the cover.

Lift the cover up and back slightly to expose the governor spring. The spring is connected between the control lever shackle and the idle spring pin. With long, thin needle nose pliers unhook the spring from the throttle shackle and lift the cover away.

Remove the other end of the governor spring from the idle spring pin. Take care that this pin and spring do not fall out of the plate and into the pump. With the cover in hand inspect the gasket in the cover recess. A replacement is with the kit. Replace the gasket. Install the gasket so it sits squarely in the recess and that it is not twisted, otherwise a leak will result once installed and the pump is primed with diesel. Connect the replacement governor spring (propulsion) to this idle spring pin and the other end to the throttle shackle. Take care not to stretch the spring. Position the cover on the pump with the fuel screw against the connector lever and move the cover towards the front of the engine slightly until the dowel fits and seats in the machine screw hole. Hold the cover in position and install the machine screws securely.



Sensor PN# 039172

The sensor is installed in the bellhousing over the flywheel teeth. This is a small threaded device with a lock nut. The threads are 3/8 x 24. Use an "R" drill and a bottoming tap. Be careful when drilling the hole not to put too much pressure on the drill for when you go through the housing you do not want to break the drill bit. The hole for the sensor is located on the bellhousing on the side opposite the starter motor at about 10:00 o'clock when you view the bellhousing looking from the generator end. In this area you will note a raised area on the side of the bellhousing. Measure in on this area from the flat surface of the bellhousing that mates against the engine block 1 1/4 inches and drill and tap a hole as perpendicular to the flywheel as you can. Once the hole is drilled, look through the hole at the flywheel teeth and, if needed, turn the engine to position the teeth with the space in the middle of the hole. This will allow the tap to go well through the hole to open the threads up. Once the hole is tapped, turn the engine by hand to position the flat of one of the flywheel teeth in the middle of the hole. Thread the sensor into the hole, it should thread smoothly, until it touches the flat on the flywheel tooth. Then back it out 1/2 - 3/4 of a turn and secure it in position with the lock nut. This will position the end of the sensor approximately 0.030 inches away from the flats of the ring gear teeth.

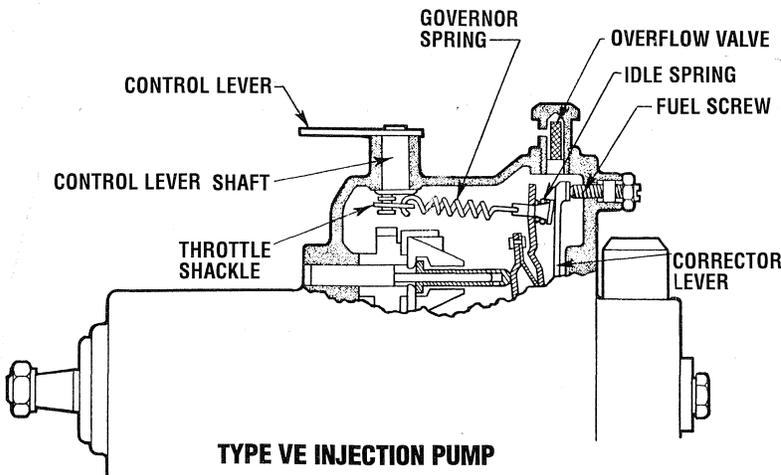
NOTE: To ensure the sensor is positioned correctly, slowly rotate the crankshaft 360° by hand and assure there is no physical contact between the sensor and the ring gear teeth. If contact is felt between the sensor and the flywheel teeth, remove the sensor and repeat the above procedures.

NOTE: This sensor has a grey covering on it and two connection points on the terminal block. Note the connection points when you remove the sensor to install it.

Actuator PN# 303007

The actuator is already mounted on a bracket. This bracket mounts on the front gear case cover on the two studs sticking out of the cover. Remove the nuts and lock washers already on the studs and slide the bracket on with the arm and linkage towards to injection pump. The bolt with spacer will attach to the outer hole of the throttle arm. Connect the bracket and spacer from the actuator swivel to the outer hole of the throttle arm. When connected the throttle levers idle stop should almost be touching the open boss where the idle stop screw was removed.

NOTE: Ensure that the return spring for the throttle arm is disconnected because it applies too much tension on the throttle arm and the actuator cannot work against it. Do not remove the throttle arm from the throttle shaft to do this.



ELECTRONIC GOVERNOR KIT INSTALLATION

Model WTA, WTF & WMF - Single and Three Phase Models

Controller PN# 303008

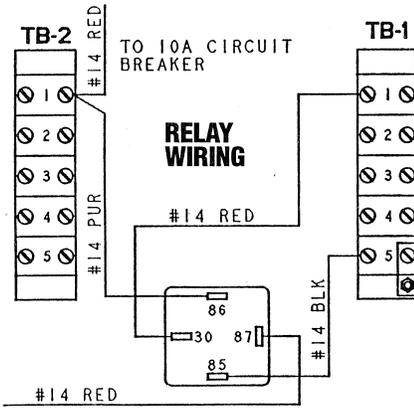
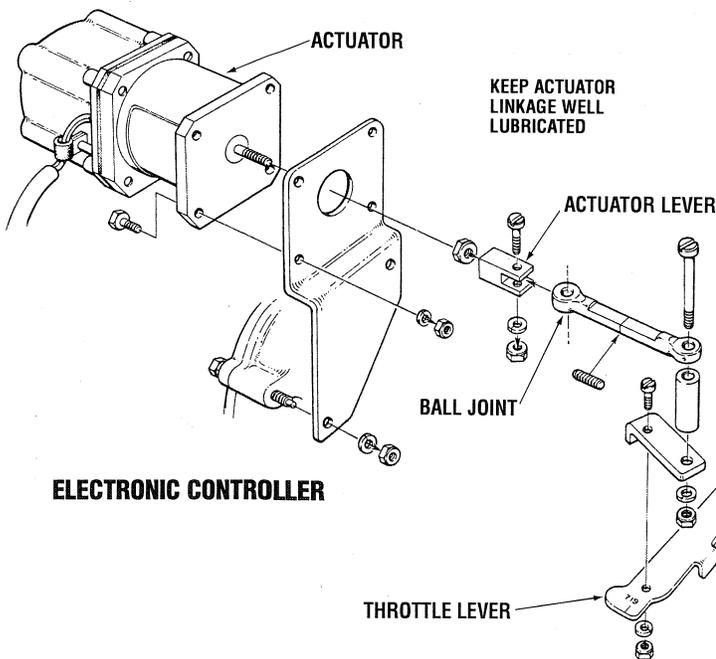
The controller and terminal board can be mounted in the control panel box. Use the controller and terminal block as a template to mark mounting holes on the outside of the panel box to be drilled then mount the components on the inside of the box.

If you need to remove wire connections from the terminal block, note their position for correct re-connection. A drawing of the wire positions on the terminal block is attached.

12VDC Wires to the Controller

There is a red, positive wire and a black, negative wire for 12VDC to the controller. These are tagged and marked. They should be attached on the positive and negative side of the panel's DC volt meter.

NOTE: The controller operates on 12VDC. The voltage range is $\pm 20\%$ (9.6 VDC 12VDC 14.4VDC). If voltage varies above or below these ranges the controller will not operate and the engine will run in an idle mode until proper voltage is supplied to the controller.



Preparation to Start

Push the exciter circuit breaker so it will pop out. This is located on the side of the control panel box on the generator. This will eliminate AC output from the generator other than residual voltage. The controller in the control panel has two adjustment pods. You need a mini screw driver to adjust these. One is speed and the other gain. These are noted on the drawing of the controller.

When you press the preheat switch the actuator linkage attached to the throttle arm of the injection pump should move outward towards the injection pump and return back into the actuator in a quick motion.

Start the engine. The speed should be in the low idle range 600-700 rpm. If the engine speed is higher than this idle range, shut the engine down. Check the linkage between the actuator and throttle arm. The throttle arm stop should be about touching the open idle stop screw boss. Adjust the linkage to position the throttle lever. The controller has an adjustment screw for speed adjustment. Turn this screw outward (counter clockwise) a few turns. Restart the engine.

NOTE: If there is any oscillating of the actuator linkage producing hunting, adjust the gain towards zero "0" until this hunting is removed.

Increase the engine speed slowly with the speed adjusting screw turning it inward (clockwise). In some instances this screw may need to be turned 6-10 turns before an increase in engine speed is noted. Bring the engine speed to 1800 rpm (60 Hz), 1500 rpm (50 Hz). Momentarily push the actuator linkage towards the actuator and release. The actuator should quickly regain proper speed. If there is any hunting adjust the gain towards zero "0" until this hunting is removed.

When the gain is adjusted you may need to readjust the speed at no load, shut the generator down.

Push the DC exciter circuit breaker in. Start the generator.

Check speed (Hertz) set at 60 Hz.

Load the generator.

If the governor is slow to react and maintain 60 Hertz adjust the gain clockwise. Again you may need to adjust the speed at no load.

You will find the governor will maintain 60 ± 0.5 Hertz right up to the full rated amperage output for the generator.

ELECTRONIC GOVERNOR

Electronic Governor System

The system is composed of three basic components:

1. **Controller.** Mounted in the instrument panel.
2. **Sensor.** Installed on the bellhousing over the flywheel ring gear.
3. **Actuator.** Mounted at the front of the engine and attached with linkage to the throttle arm of the injection pump.

Controller Adjustment

1. **Speed.** This adjustment is used to raise or lower the engine's speed to the desired hertz.
2. **Gain.** This adjustment affects the reaction time of the actuator to the generator/engine load changes.

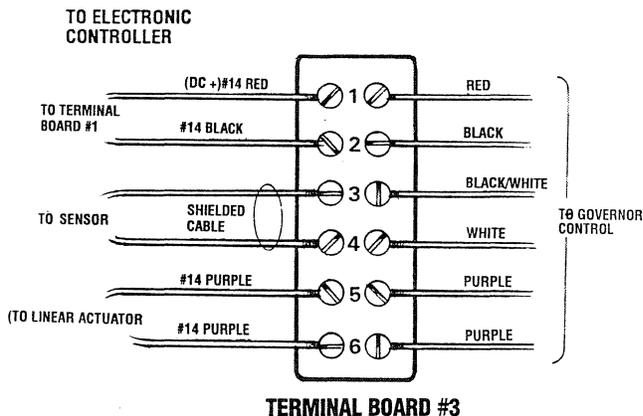
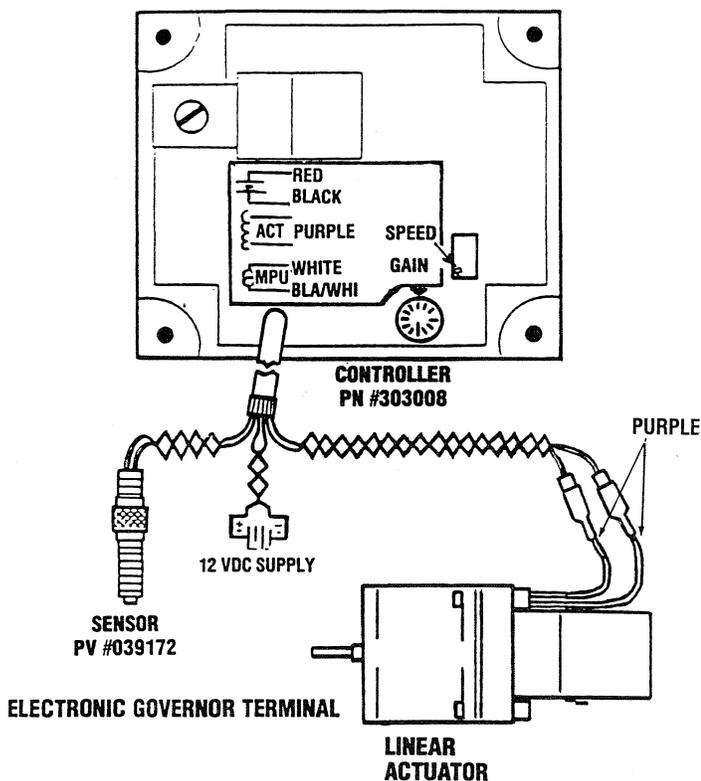
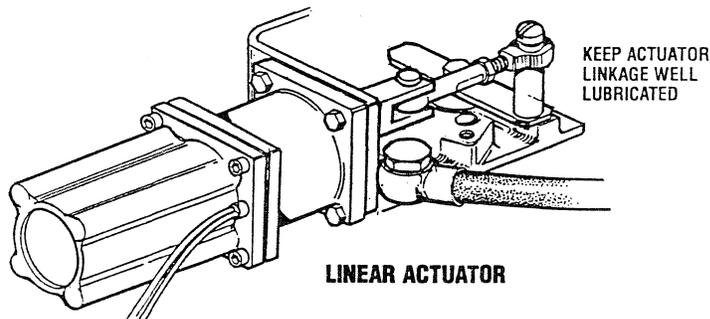
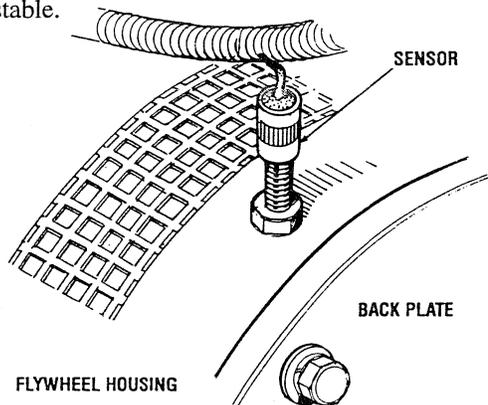
NOTE: A high gain adjustment can induce an oscillating of the actuator producing a hunting mode. In such cases, lessen the gain adjustment.

Calibration

1. With no power to the governor, adjust the GAIN to 9:00 o'clock.
2. Start the engine and adjust the speed by turning the speed pot clockwise to desired speed.

NOTE: Controllers are factory adjusted to minimum rpm. However, for safety, one should be capable of disabling the engine if an overspeed should exist.

3. At no-load, turn the GAIN potentiometer clockwise until the engine begins to hunt. If the engine does not hunt, physically upset the governor linkage.
4. Turn the GAIN potentiometer counterclockwise until stable.



TROUBLESHOOTING THE ELECTRONIC GOVERNOR

Problem	Probable Cause	Verification/Remedy
System appears dead (Engine runs at idle.)	<ol style="list-style-type: none"> 1. Low battery voltage at controller. 2. Stuck linkage. 3. No signal or weak signal from sensor. (Measure AC voltage from sensor while engine is running at idle. Voltage should be 2.5 volts or greater. 4. Check Actuator – depress PREHEAT and check for battery voltage between negative black lead at terminal block. <ol style="list-style-type: none"> a. Purple lead to black. b. Second purple to black. 5. Perform the following check between terminals at the actuator and the negative DC lead at the controller terminal block. (Preheat depressed). <ol style="list-style-type: none"> a. Low voltage (1.20-2.0 VDC) at either actuator connection. b. Battery voltage at both actuator connections. c. Battery voltage at one actuator lead but not the other. 	<ol style="list-style-type: none"> 1. Check wiring for cause. Check battery state of charge. 2. Lubricate, free up linkage between controller and throttle arm. 3. Check for improperly installed or damaged sensor in flywheel housing. Replace or adjust. 4. Replace controller if battery voltage is not present at both leads. <ol style="list-style-type: none"> a. Broken actuator lead. b. Broken actuator lead. c. Replace the actuator.
Actuator fully extends when PREHEAT is depressed and stays extended.	<ol style="list-style-type: none"> 1. Check controller. Lift one of the purple actuator leads from the terminal block. Depress PREHEAT. <ol style="list-style-type: none"> a. Actuator fully extends. b. Actuator does not fully extend and connections. <p>NOTE: Release PREHEAT and reconnect the purple lead.</p>	<ol style="list-style-type: none"> a. Short in lead to actuator. b. Replace controller.
Actuator hunts (oscillates) and engine running.	<ol style="list-style-type: none"> 1. Linkage between actuator and throttle binding. 2. Improper adjustment of GAIN on controller. 3. Inadequate DC power supply to controller, complete the following tests: Connect a DC voltmeter across the plus and negative leads at the controller terminal block. Lift both purple leads from the terminal block. Connect one purple lead to the C plus terminal and the other to the DC negative. Momentarily depress PREHEAT. The actuator should fully extend. <p>3a. Sensor positioned marginally too far away from flywheel teeth giving erratic signal voltage to controller.</p>	<ol style="list-style-type: none"> 1. Lubricate/free-up. 2. Lessen GAIN adjustment (Recalibrate the Controller). 3. If actuator does not fully extend, check the actuator leads. If the voltage is less than specified, check for loose or poor connections, low battery voltage, voltage drop in DC circuit due to remote panel installation and small wire sizes making connections. DC voltage registering on the meter should be: 12 VDC System – 9.6 VDC or higher 24 VDC System – 19.2 VDC or higher NOTE: Reconnect actuator leads properly after making this test. <p>3a. Check the position of the sensor.</p>

WMF ELECTRONIC REGULATED BRUSHLESS GENERATOR

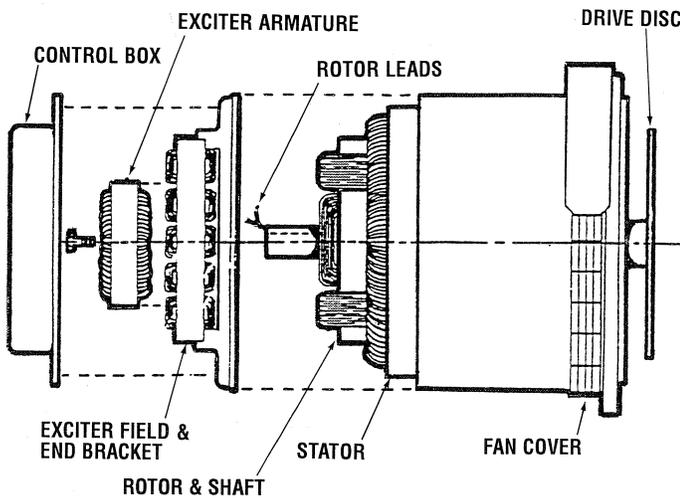
General Data

Construction:	Brushless Rotating Field
Speed:	60Hz, 1800 rpm 50Hz, 1500 rpm
Cooling:	Fan cooled
Max. Ambient Temp.:	40 degrees C
Insulation:	Class "H"

NOTE: If the generator is operated at 1500 rpm, the voltage and kW rating will be 5/6 of the 1800 rpm rating. Consult the manufacture if a higher voltage or kW rating is required at 50 Hz (1500 rpm).

Reinstallation

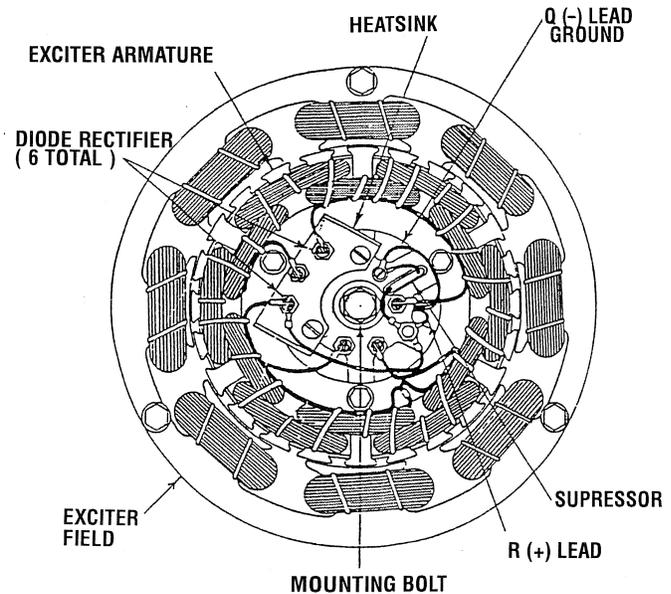
When reinstalling the generator, the generator must be mounted securely. Use shims as necessary under the generator feet to ensure the feet are uniformly supported before tightening the hold-down bolts. If the generator is not uniformly supported, the frame could become distorted resulting in noise and vibration that could damage the generator.



Mechanical Mounting

To mount a single-bearing generator to an engine. Follow the instructions below.

1. Disconnect the positive (+) terminal from battery.
2. Place a jack or other support under the engine flywheel.
3. Remove the pot cover or control box cover from the back of the generator and disconnect all incoming power leads.
4. Detach the ground lead "Q"(-) and "R"(+) lead from the rotor, on the exciter armature.
5. Remove the armature fastening bolt from the center of the shaft (mark the position of the armature so it can be replaced in the same position).
6. Remove the armature from the shaft (take care not to damage the lamination).
7. Remove the fan cover.
8. Use a strap around the generator rotor and shaft assembly and support from hoist.

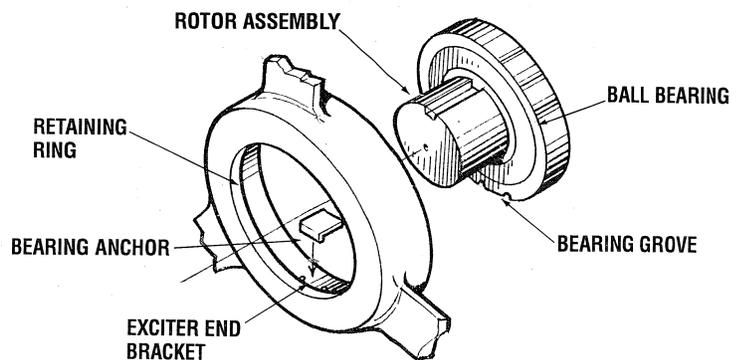


9. After the armature is removed, the rotor, shaft, and drive disk assembly can be pulled from the frame.

CAUTION: Do not scratch or cut the copper stator windings when removing rotor.

10. DO NOT LOSE the bearing anchor when the bearing is removed from exciter end bracket.
11. Bolt the rotor and drive disk to the engine flywheel, using the proper size lock washers and SAE grade 8 bolts.
12. Push the generator frame assembly carefully back over the rotor. Replace the bearing anchor and carefully align the groove in the bearing with the bearing anchor before the bearing enters the bearing bracket.
13. Mount the frame assembly to the engine flywheel housing with the proper size bolts, lock washers and nut.
14. Remount the fan cover and hood.
15. To reassemble the exciter armature, pull the rotor leads through the opening in the armature spider. Turn the armature until it slips over the pins in the shaft.

CAUTION: Do not pinch rotor leads.



WMF ELECTRONIC REGULATED BRUSHLESS GENERATOR

16. Reassemble the armature to the shaft with the bolt and lock washer using *LOCTITE*. Use a 9/16" socket on the torque wrench and torque to 25 ft. lb.
17. Reconnect the "Q" and "R" leads to the proper connections.
18. Reconnect all incoming power leads to their proper connections, as shown on the wiring diagram.
19. Return pot cover or control box cover.
20. Remove the jack support from under engine flywheel housing.
21. Reconnect the positive (+) battery terminal lead.

Electrical Connections

The proper electrical connections required for your Single Phase or Three Phase generator can be found on the *SCHEMATIC WIRING DIAGRAM*.

NOTE: Be sure all electrical connections are correct before starting the generator.

Initial Start-up

Carefully inspect the unit before start-up. Check all electrical connections and be sure that all bolts have been securely mounted.

1. Rotate the shaft by turning the armature bolt, the shaft and rotor assembly are balanced and should turn freely.
2. Start engine.
3. Check vibration. If excessive, check all mechanical J connections.

The generator voltage is adjusted at the factory to a specified speed; however, verify upon installation. To supply 60 Hz, the speed should be 1800 to 1860 rpm at no load and should not fall below 1800 rpm by more than one percent at full load. To supply 50 Hz, the speed should be 1500 to 1550 rpm at no load and 1500 rpm at full load. The generator voltage should build to its rated value within 5 seconds after rated speed is attained. If voltage does not build, the cause may be loss of residual magnetism in the exciter field, due to improper installation. See the *TROUBLESHOOTING* section of this manual for more information. To ensure that the generator voltage will always build, the generator should operate at full load before being installed in service.

Observe and record the generator voltage at no load and at full load. Immediately after start-up (cold) and after 30 minutes of full load (hot). The voltage is easily adjusted to optimum values at no load and full load. See the *ELECTRONIC REGULATION* section. Test at actual load if possible. If the voltage cannot be adjusted, refer to the *TROUBLESHOOTING* section of this manual.

Check the temperature rise after running for 30 minutes at full load. If excessive, examine the generator for obstructed air flow, hot air feeding into the inlet of the generator or bypassed air (air not pulled through generator) because of air opening into un baffled fan at engine side of generator fan.

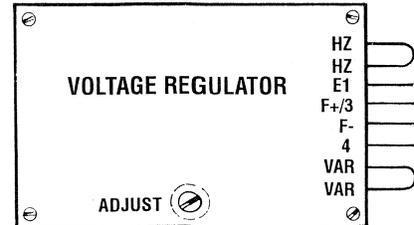
Examine ratings and actual load applied to determine if the generator rating may be too low for the load applied.

The ambient temperature must not exceed 104°F(40°C) For operation at ambient temperatures above 104°F(40°C), derate kW rating 1 percent for each degree (C) above 40°C.

For operations at high altitudes, ratings must be derated 2 percent for each 1000 ft. above sea level.

Frame temperatures above 140°F (60°C) are too high and indicate a temperature rise in the copper windings of 221°F (105°C) or higher.

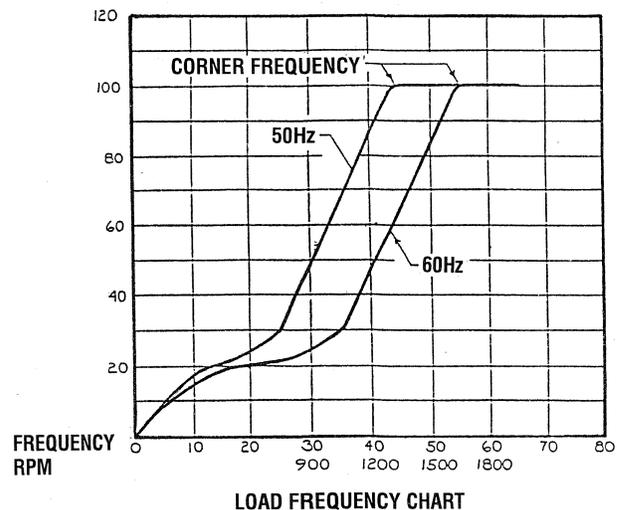
ELECTRONIC VOLTAGE REGULATOR



ELECTRONIC REGULATION

An electronically regulated generator has superior voltage regulation than other types, $\pm 2\%$ within rated loads.

The electronic voltage regulator regulates the voltage using a solid-state electronic circuit of transistors, integrated circuits, SCR's, resistors, etc. The electronic voltage regulator senses the generator voltage and feeds a DC current into the exciter field of the proper average value to hold the generator voltage constant from no-load to full rated load and above.



Characteristics of the 34615 Regulator

1. Overload Protection:

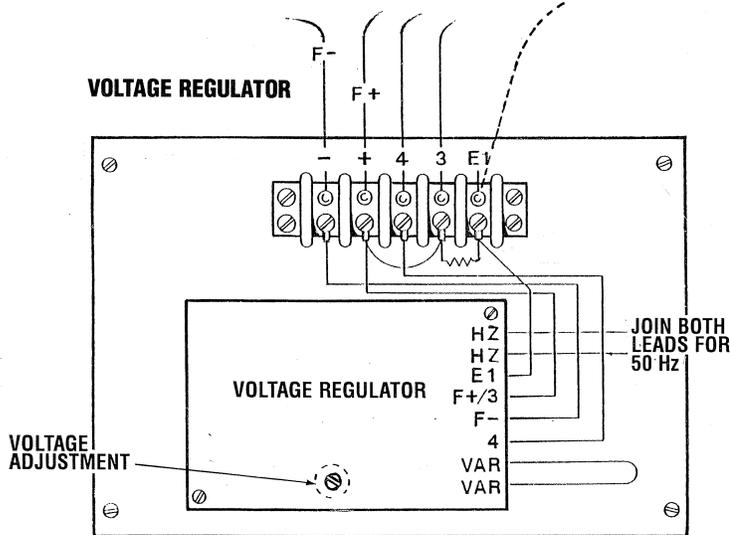
To prevent damage to devices receiving electrical power from the generator. The regulator provides both under load frequency and over load protection. The voltage regulator operates at 50 Hz or 60 Hz, or both. If the frequency and engine speed falls below the rated value, the generator voltage decreases to provide under frequency protection, but if the engine is over the speed required to give 50 Hz or 60 Hz, the voltage does not rise above that value set at the proper frequency (proper engine speed).

WMF ELECTRONIC REGULATED BRUSHLESS GENERATOR

2. AC Power Input:

All EVR's must supply up to 4 amperes of DC output current into the exciter field at a voltage up to 70 volts DC. This voltage and current constitutes a power output of about 280 watts. This output power must come from the generator. The exciter field input power must be supplied at 190 to 240 volts AC at a volt-ampere burden of 500 VA maximum.

When the generator is operated at 208 volts to 240 volts this power comes from the generator load lines. When the generator is connected to deliver 120 volts, a separate winding in the stator provides 208 to 240 volts for the voltage regulator power input. When a generator delivers 390 volts to 480 volts, center taps on the phase windings provide 190 volts to 240 volts for both voltage sensing and power input for the exciter field. The AC power input always has one terminal common with one of the sensing voltage terminals. This common lead is identified by the lead or terminal label "4" in the drawing below.



3. DC Output Power for the Exciter Field:

The EVR rectifies the AC power input with a full wave rectifier to provide DC current (a series of half sine waves) with a high ripple content at a frequency of 120 Hz. This DC current is fed to the exciter field through one or two SCR's to provide a pulsed output in one direction only. The resistance and impedance within the regulator is very low and the peak value of the current into the exciter field is limited only by the impedance and resistance of the exciter field. For this reason the exciter fields must have a minimum specified resistance or the peak current delivered by the regulator will be so high that the regulator components will be damaged. The regulator is commonly designed for a minimum exciter field resistance of 20 ohms 8-10kW & 25 ohms 12-50kW, although sometimes a slightly lower resistance can be tolerated. Connections to the exciter field are made at two DC output terminals, F+ and F-.

TROUBLESHOOTING

This section is intended to help the user isolate the cause of the most common generator malfunctions.

Visual Examination

Inspect the generator visually. Look for obvious evidence, burned areas, pinched wires, cracked insulation, all connections should be fastened securely. Check the operating speed and see that the unit has been reassembled and reconnected correctly.

Very Low Voltage Output or No Voltage Build-up

1. Loose or Broken Lead wires:

Check lead wires and connections. Tighten securely. Compare connections with the wiring diagram supplied with unit.

2. Rotor Opened or Shorted:

Measure the resistance between "R" and "Q" leads. (see chart for normal ohm ratings).

3. Stator Ground or Shorted:

Run the generator for 5 minutes.

(Stop immediately if smoke or a hot smell is detected).

If the voltage does not build and the generator is hot, there is a short circuit in the stator windings. Examine the stator for burned insulation.

(DO NOT REMOVE from the frame).

Measure stator resistance T1 and T2 and from T3 to T4, each should have equal resistance. See *WIRING SCHEMATICS*. (Disconnect leads at the terminal board and measure).

If one of the voltage readings is lower than the other, the low voltage winding is shorted. Replace stator.

4. Exciter Field Opened or Shorted:

Measure the resistance at 77 degrees F. (see *GENERATOR RESISTANCE VALUES* for normal ohm ratings).

5. Defective Diodes in the Armature: See Section 10.

6. Defective Voltage Regulator: See Section 9.

High Voltage Output

1. Defective 165K ohm Resistor: (on 120/240 volts only.)

Test and replace if necessary.

2. Defective Electronic Regulator: Replace (do not flash).

Voltage Builds But Oscillates Excessively

1. Defective Electronic Regulator.

Generator Resistance Values

Armature: .470 - .520 ohms per phase, 5 - 10 kW
.655 - .720 ohms per phase, 12.5 - 50 kW

Field: 18 - 22 ohms 5 - 10 kW
23 - 28 ohms 12.5 - 50 kW

Stator: ohms vary with XW rating,
but less than 1.0 ohm per phase.

Rotor:

kWs	8	10	12.5	15	17.5	20	25	30 to 50
ohms	11.47	1.58	1.73	1.84	2.00	2.1	2.2	2.5 to 3.8

WMF ELECTRONIC REGULATED BRUSHLESS GENERATOR

Flashing The Field

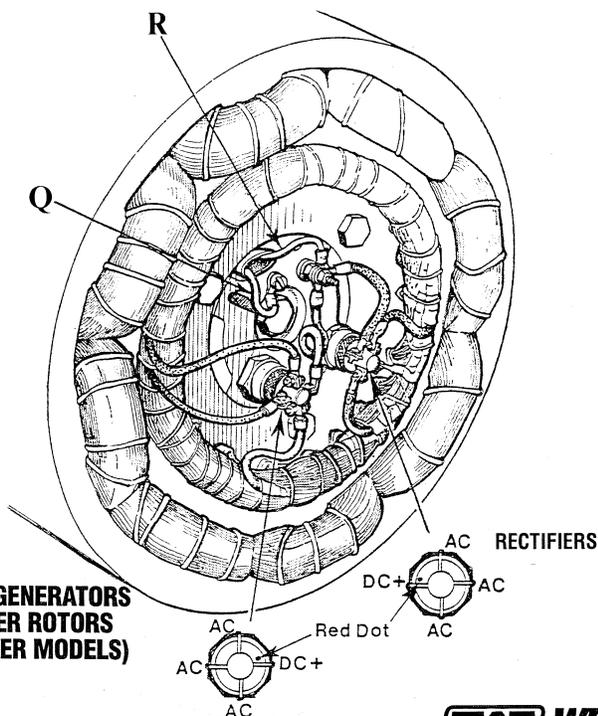
To determine if the regulator is defective, disconnect the "F" and "C" leads from the exciter field and open the circuit breaker/switch in lead 3 or 4 to the regulator. Using a 12 volt battery, connect the battery (+) to the regulator 3/F(+). Connect the battery (-) to the regulator F(-). Run generator at 1800 rpm. See *WIRING SCHEMATICS*.

1. If the residual voltage is now normal, the electronic regulator is defective and must be replaced.
2. If there is no voltage, check the exciter field.
3. If the voltage reading differs from what would be a normal reading, the electronic regulator is working properly and the problem is elsewhere.
Return to the *TROUBLESHOOTING* section.

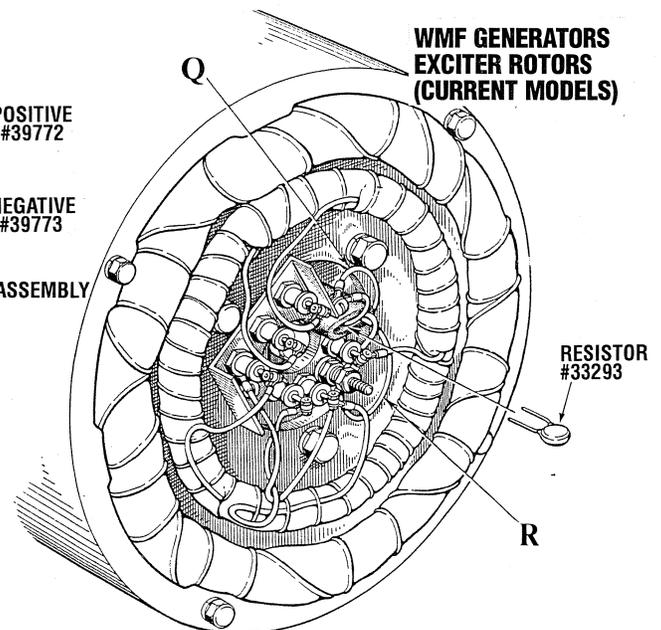
Checking Diodes In The Armature

All Fidelity Electric armatures have (6) diode rectifiers arranged in a full wave pattern. Three forward biased diodes are mounted on a heat sink and three reversed biased diodes mounted on the armature hub.

1. Use a Basic Analog ohmmeter and set to R*1 scale. (ohmmeter leads (+) red, (-) black.
2. Check the diodes as a group with the following connections:
(-) ohmmeter lead to "R" terminal on armature hub.
(+) ohmmeter lead to "Q" ground.
Diodes are good if the resistance reading is approximately 50 ohms.
3. Check for leakage in the diodes by reversing their polarity. Diodes are good if the resistance reading is infinite.
4. Resistance values other than those indicated suggest one or more faulty diodes. Check each diode separately to isolate the defective diode.



WMF GENERATORS
EXCITER ROTORS
(EARLIER MODELS)



WMF GENERATORS
EXCITER ROTORS
(CURRENT MODELS)

5. Disconnect terminals to each diode. Check the Forward Biased Diode "FWD" group first. (3 diodes on heat sink).
(-) ohmmeter lead to "R" terminal on armature hub.
(+) ohmmeter lead to the (+) on diode (indicated by red dot).
6. Check for leakage in each diode by reversing polarity. Resistance = infinite.
7. Check Reversed Biased Diode "RVS" group.
(-) ohmmeter lead to "Q" ground on armature hub.
(+) ohmmeter lead to the (+) on each diode. Resistance = infinite.
8. Check for leakage in each diode by reversing polarity. Resistance = 10 ohms.

NOTE: Resistance values other than those indicated means that the diode is defective. Replace the defective diode and reconnect terminals to each diode.

Maintenance and Repair

1. Periodic Cleaning and Inspection

Clean and inspect the generator every 200 hours of normal operating time. If the generator is housed in a harsh environment clean and inspect more frequently. If dirt and grease is allowed to build-up, the generator will run hotter, loose efficiency and reduce the life of the generator.

2. Cleaning

Remove all dust, dirt, oil and grease build-up from all external surfaces. Use a low pressure air hose (25 PSI maximum) to blow dirt and grease from the internal components through the fan opening. Clean inside the control box. Check for loose or damaged lead wires and loose components mounted in the box. Do not remove internal generator parts or the warranty is void.

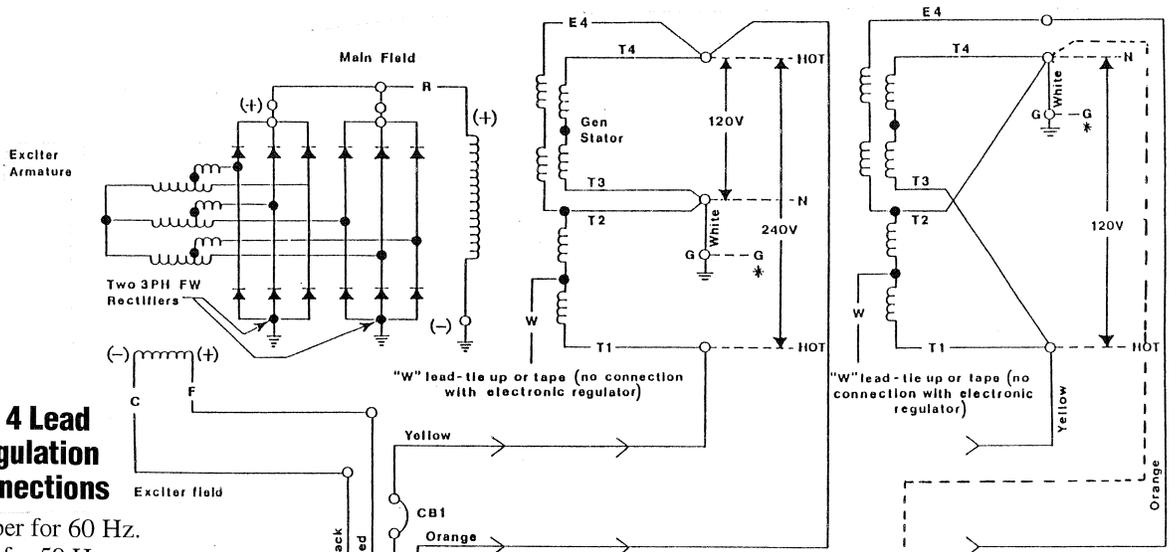
3. Inspection

With the pot cover or control box cover removed, examine rotor, shaft and bearing for excessive wear. Replace bearings after 10,000 hours of normal operating time or sooner if wear is evident.

WMF GENERATOR WIRING SCHEMATICS

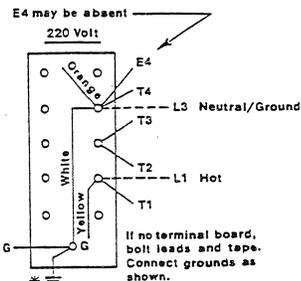
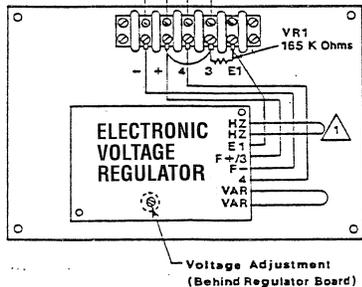
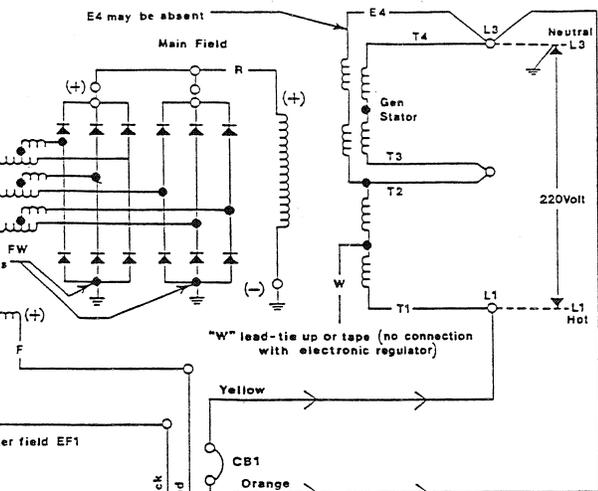
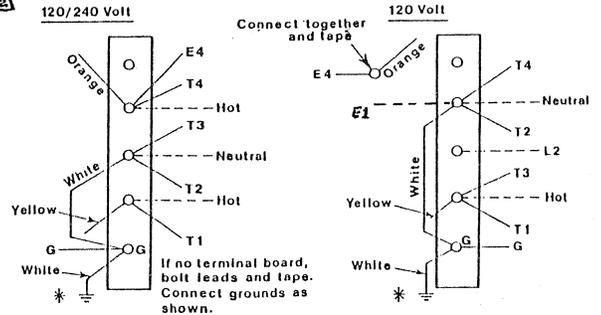
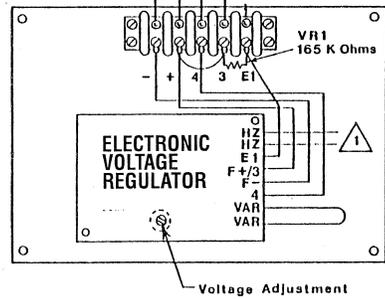
Single Phase, 4 Lead Electronic Regulation 120/240V Connections

1. Cut Hz jumper for 60 Hz. Leave intact for 50 Hz.
2. Remove resistor when wired for 120V output.

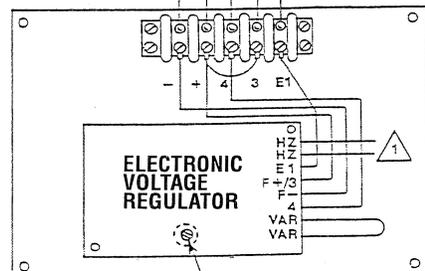
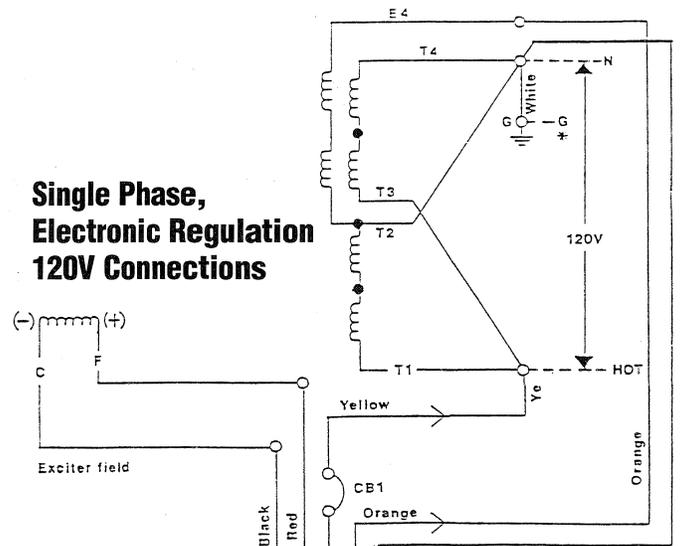


Single Phase, 4 Lead Electronic Regulation 220V Connections

1. Join both leads together for 50 Hz



Single Phase, Electronic Regulation 120V Connections



WTA GENERATORS - SINGLE AND THREE PHASE

INTRODUCTION

The WTA generator is a brushless, self-excited type requiring only driving force.

One permanent magnet in the six pole exciter stator is responsible for the self-exciting feature of the alternator. Its magnetic field causes a voltage to be induced into the associated exciter rotor coils during rotation. This AC voltage is full wave rectified and applied to the main rotating field coil. The resulting electro-magnetic field induces an alternating voltage into the associated main stator coils and a resulting current will flow to the output terminals.

Simultaneously, an auxiliary coil on the main stator generates an AC voltage which is full wave rectified and employed as a source of supply for the remaining five electro-magnetic poles on the exciter stator. The voltage regulator controls the current to these poles, regulating the voltage generated.

Installation

1. The generator air intake and exhaust airways must be kept free of obstructions. If the flow of cooling intake air or heated exhaust air is inhibited, eventual generator overheating and subsequent failure of the generator may occur.
2. Care should be exercised when installing the electrical connections to the generator output, to avoid damaging the voltage regulating circuits found in the control box. Refer to the generator control diagrams.

Operation

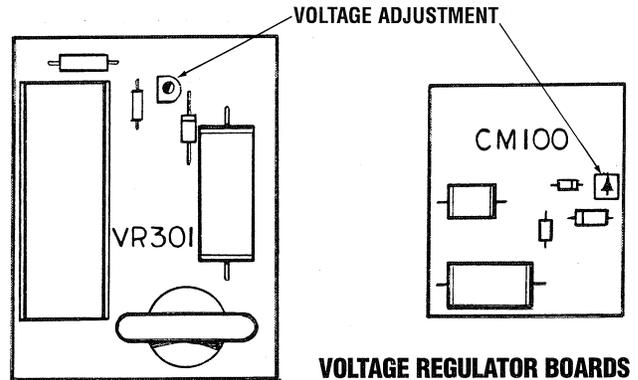
1. Do not exceed the maximum generator shaft speed of 2200 rpm as permanent generator damage may result.
2. If there are unusual noises from the generator at any time during its operation, shut it down and check for internal mechanical wear and/or damage.
3. For the protection of line frequency sensitive loads that may be connected to the generator, only operate at a generator shaft speed of 1800 rpm (60 Hz).

These generators are classified as drip proof. The air intake and outlets are covered with an expanded metal screen to protect against the ingestion of airborne litter. **Do not** operate the generator without these screens in place.

Output Voltage Adjustment

There are no setup adjustments for the generator. However, if the value of the output voltage is inconsistent with given specific requirements, it may be adjusted over a narrow $\pm 5\%$ range and will not normally require readjustment.

To adjust the output voltage, remove the cover from the control box and locate the voltage setting control. Using an insulated tool, operate this control to obtain the desired output voltage. Right hand rotation of this control increases the output voltage.



⚠ WARNING: *Terminals and components carrying line voltage may be exposed within the control box and voltage regulating circuits when the generator is operating. Therefore the use of non-conducting tools is essential for safety reasons. Only qualified electricians or persons thoroughly familiar with electrical equipment should attempt this adjustment.*

The generator is virtually maintenance free. Periodic inspection is suggested to assure the generator airways do not become obstructed.

WTA GENERATOR TROUBLESHOOTING

DESCRIPTION

The following text is designed to give insight into problems which may be encountered with the WESTERBEKE WTA brushless generators. Owing to the simplicity of the equipment and controls, troubleshooting is relatively easy, once the relationship between cause and effect is understood.

Keep in mind that basic fundamental knowledge of electricity is required for this troubleshooting and always remember that lethal voltages are present in the circuitry and therefore extreme caution is essential when working on or troubleshooting a generator.

Only a few basic tools are necessary for diagnosis and repair. These are hand tools: an amp probe and a quality volt-ohmmeter capable of reading less than one ohm due to the precision required in reading component winding resistances.

Before attempting repair, get as clear an explanation of the problem as possible, preferably from an individual witnessing the problem. In some cases, this may bring to light a problem which is related to the method of operation rather than equipment fault.

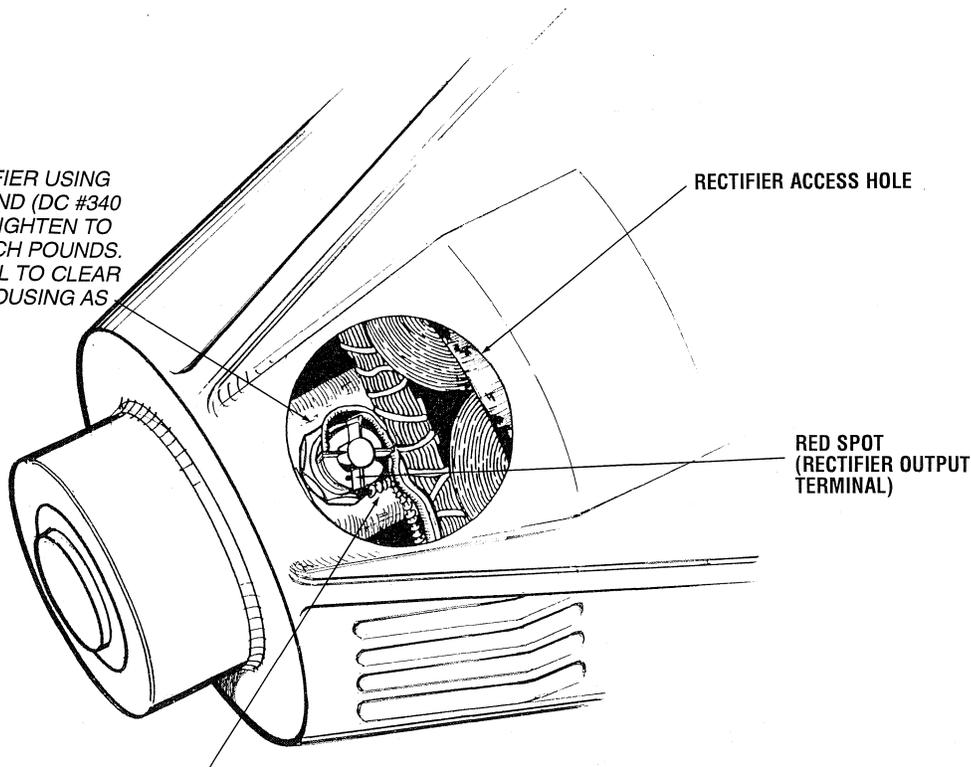
Bring basic repair parts with you on the initial trip to the problem equipment such as a regulator board, housing diode and bridge rectifier so that, if the problem should be found in one of these easily replaceable parts, the problem can be remedied early and efficiently.

Should a situation arise where the generator fails to operate properly and all mechanical conditions are found to be satisfactory, refer to *ELECTRICAL FAULT ANALYSIS*.

Replacing the Shaft Mounted Rectifier

1. Remove the hole cover on top of the anti-drive end of the generator.
2. Crank the engine until the rectifier comes into view and lock it to prevent the engine from turning the shaft.
3. Unsolder the four wires from the rectifier.
4. Remove the rectifier by unscrewing in a counter-clockwise direction then follow the testing and replacement procedures described in *GENERATOR DISASSEMBLY*.
5. Replace or reinstall the rectifier by reversing the above procedures.

INSTALL THE RECTIFIER USING HEATSINK COMPOUND (DC #340 OR EQUIVALENT). TIGHTEN TO A TORQUE OF 30 INCH POUNDS. BEND THE TERMINAL TO CLEAR THE GENERATOR HOUSING AS NEEDED.

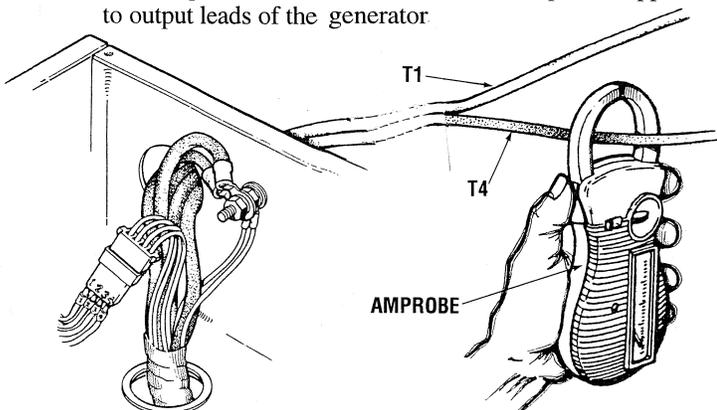


THE RECTIFIER OUTPUT LEAD HAS A TWIN SOLID MAGNET WIRE AND TAN COLORED INSULATION SLEEVE AND SHOWS A LOW ELECTRICAL RESISTANCE WHEN MEASURED TO THE SHAFT.

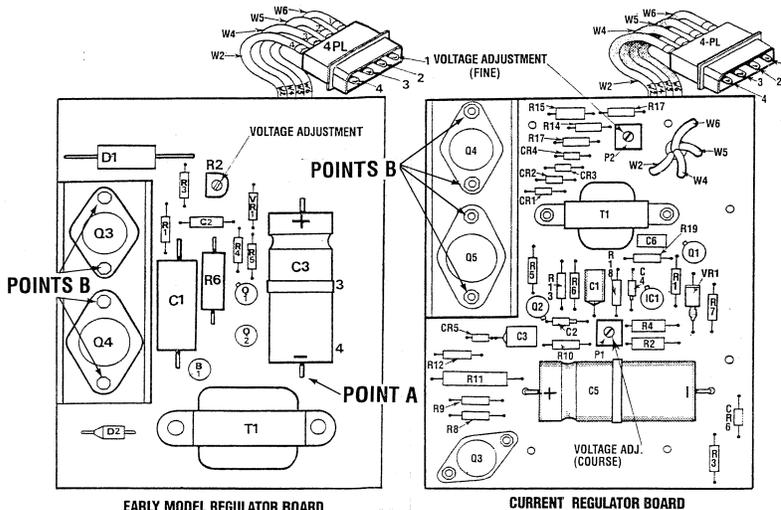
WTA GENERATOR TROUBLESHOOTING

Check for Overload

1. Check the generator data plate and load the generator per the data plate. Monitor the load with an amprobe clipped to output leads of the generator



2. If an amprobe isn't available, the generator load can be checked for possible overload with a voltage regulator board/field saturation check.



With the generator loaded and displaying low voltage symptoms, check the DC voltage present in the field circuit for a possible indication of generator overload when an amprobe or ammeter for the system is not available or suspect for inaccuracy.

For a better understanding of this check, refer also to the generator internal schematic.

NOTE: F3 and F4 are tied together with the butt connector in a harness from the generator to the control panel. A1 and A2 are accessible only at diodes located in the generator housing. F1 black is a #16 wire connected to a ground stud. #3 white is a #16 wire which originates at the regulator plug and connects to the ground stud.

Field voltage, supplied to the exciter field via the voltage regulator, will always be greater in an overload condition than in normal operating conditions. When only a small difference or no difference between the auxiliary voltage (pin #2) and the exciter field voltage (pin #1) is found, it could be an indication of a generator overload. (On a fully loaded generator, normal auxiliary voltage is between 27-29 volts DC and normal exciter field voltage is between 15-20 volts DC.)

The DC voltage measurements being discussed here are the simplest indication (although not completely accurate) that a low level power factor overload (motor load) is present. The low power factor (motor load) portion of the load is not felt by the engine and is indicated only partially in output current, but is indicated clearly and relative to rotor current by measuring the exciter field voltage.

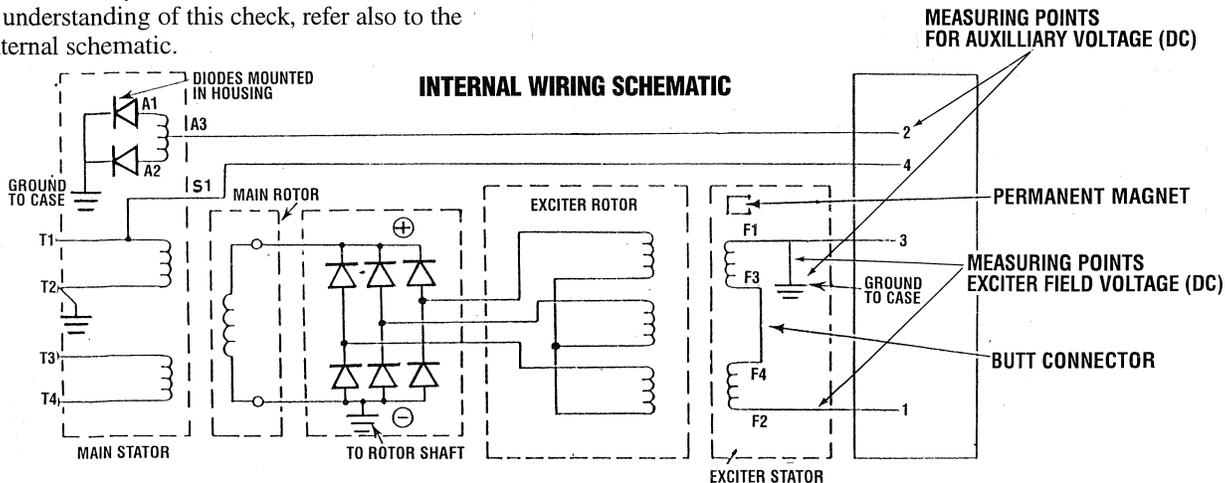
STEP ONE:

Measure the auxiliary voltage of the loaded alternator. Place the plus of the meter (DC scale 50 volts) to the generator case or common ground stud and the negative to point "A" on the regulator board (refer to the illustrations) or Pin #2 of the generator/regulator plug. This voltage (DC) at rated full-load should be approximately 27-29 volts.

STEP TWO:

Measure the field voltage of the loaded alternator. Check the voltage between the plus lead, remaining as ground on the generator case, or the common ground stud and place the negative lead on one of the screws Point B holding Q3 or Q4 to the heatsink on the regulator board, or Pin #1 of the generator/regulator plug. This voltage (DC) should read between 17-20 volts DC at full rated load on the generator.

NOTE: If removal of the load corrects the voltage problem, an overload or a problem in the load is likely to be the problem.



WTA GENERATOR TROUBLESHOOTING

NOTE: Voltage adjustment potentiometer(s) are located on the early and present regulator boards. Refer to the diagram for locations. These potentiometers allow for a no-load voltage adjustment for the rated voltage (AC) of the generator 120/240 (60 Hertz). The potentiometer adjusters should be used to adjust to these exact voltages. The regulator board should maintain this voltage within $\pm 2\%$ from no-load to full-load.

Check for under-speed condition at a full rated load. The injection pump governor should maintain engine rpm and generator frequency to $\pm 2\%$. Should the frequency drop as the load is being applied, this may be an indication of contaminated or poor quality fuel, clogged filters, air or faulty injection pump governor. Check system as needed. Running at less than rated speed can damage electrical loads.

Check for an unbalanced load being taken off the generator output leads. No-load being taken off the "sensed" lead T1, with the "unsensed" T4 line loaded, would show as a low voltage on the loaded "unsensed" line T4.

NOTE: Generator output voltage is "sensed" off output lead T1 through Pin #4 on the generator/regulator plug to ground. The regulator senses 120 volts only.

If no problems are found to this point, disconnect the load from the generator and measure the residual voltage output of the generator. This is best done right at the output lead at the generator. Try to insure that no load is on the generator. Any circuit breaker or ship to shore switch between the generator and load must be open.

Auxiliary Voltages (Regulator board plugged in)

Model	No-Load	Full-Load	
WTA-15	Measured between Aux diodes	39.0 VAC	40.5 VAC
	Measured Aux Diode to ground	26.5 VDC	27.5 VDC

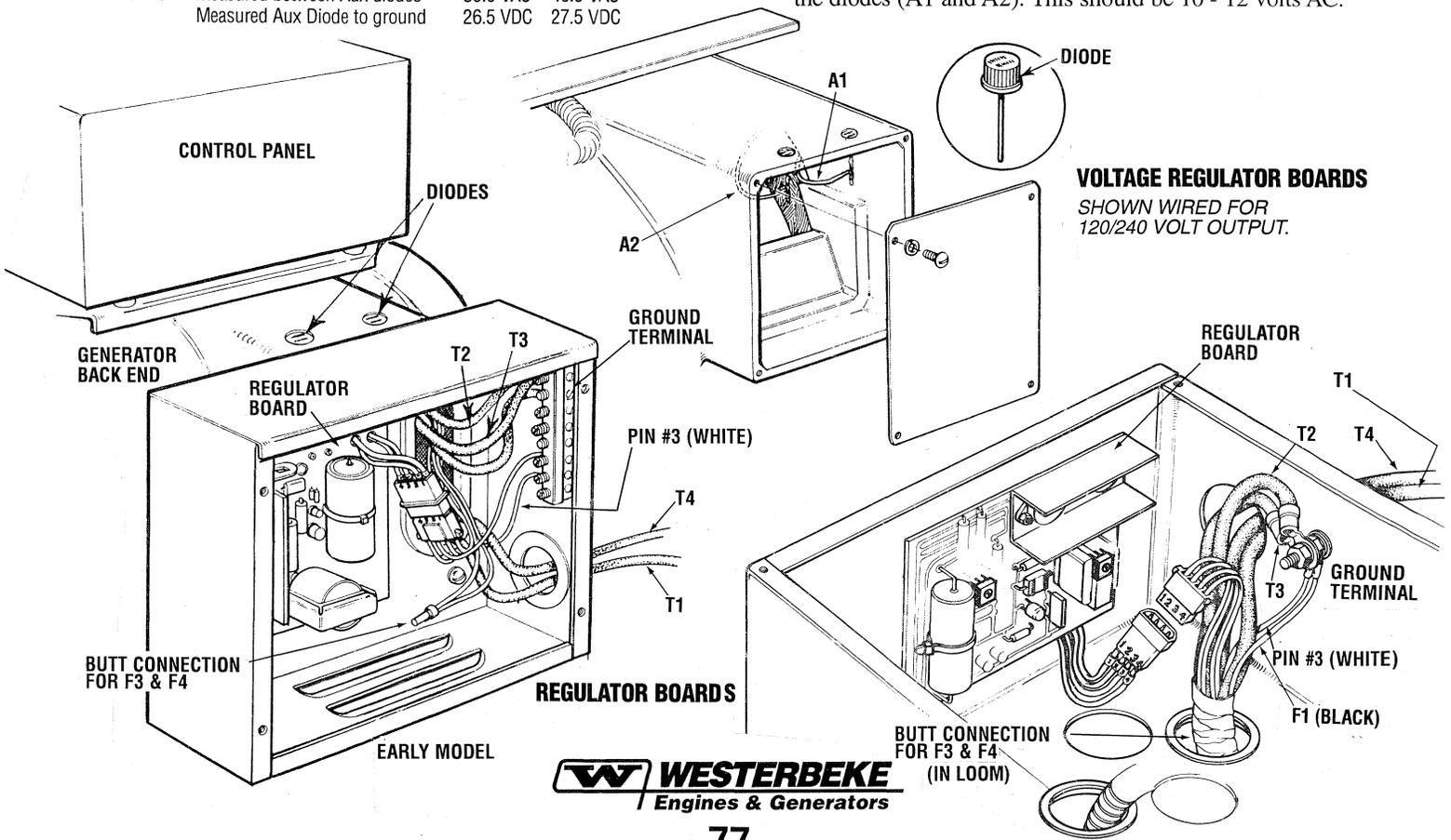
Restart the unit and check for balanced voltages off all main output leads T1 - T2 and T3 - T4 (120 volts AC for each pair). Unbalanced voltages indicate a problem within the main stator output leads or connections. Check resistance values and tighten connections as needed.

Residual Voltage Measurement

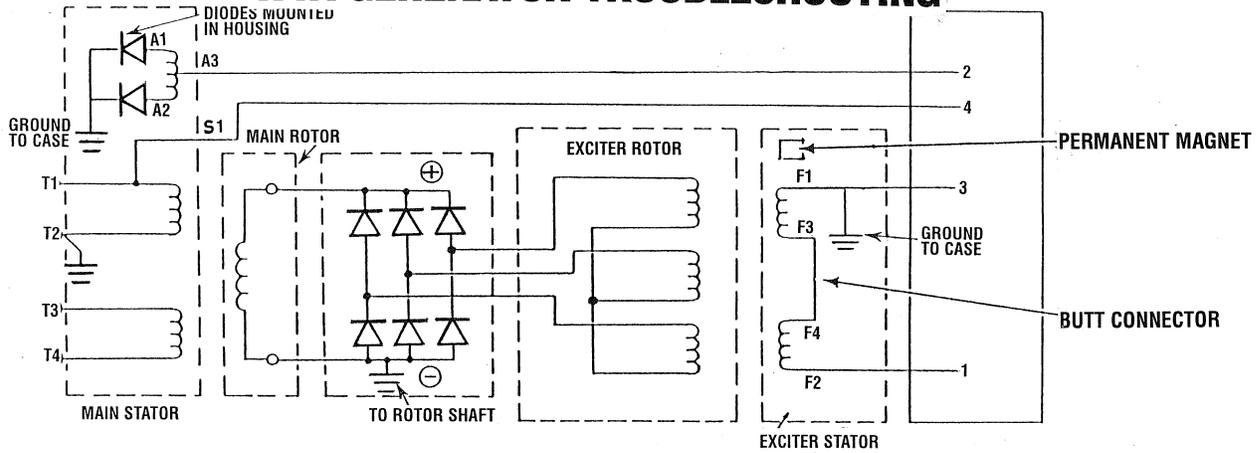
This refers to the measurement of auxiliary and main output voltages while the generator is operating with the regulator disconnected, and is under the influence of its internal permanent magnets only. Comparison of residual voltages to the voltages attained while flashing the exciter field (see FLASHING THE FIELD) can give valuable insight in troubleshooting a defective generator.

Main output residual voltages are best measured as individual groups of coils (T1 and T2) (T3 and T4) - the 120 volt leads. This avoids the possibility of mistaking an open coil as no output for both groups.

1. With the generator stopped, unplug the regulator board and expose the two generator output lines (T1 and T4) so that measurements can be read from them. Start the generator and measure the AC voltage found between leads T1 - T2 and T3 - T4. This should be 25 - 35 volts AC between each of these two pairs of leads with no load on the generator.
2. Measure auxiliary voltage next. Measure DC voltage between Pin #2 (generator/regulator plug) and the ground. This voltage should be between 5 - 6 volts DC (no-load on the generator). If access to the diodes in the generator housing is available, measure directly at each diode to the generator case (ground). Measure the AC voltage across the diodes (A1 and A2). This should be 10 - 12 volts AC.



WTA GENERATOR TROUBLESHOOTING



Moderately Low Voltage (50-70 Volts)

Main stator residual voltage check indicates a moderately low voltage: 50 - 70 volts AC measured between T1 - T4 or 25 - 35 volts AC measured between T1 - T2 and T3 - T4.

1. This indicates that a fault is preventing the energizing of the stationary exciter field and that only the permanent magnets in the stationary exciter field are having an effect on voltage output from the generator's rotating parts.

NOTE: F3 and F4 are tied together with a butt connector in harness from the generator to the control panel. A1 and A2 are accessible only at the diodes located in the generator housing. F1 black is a #16 wire connected to the ground stud. #3 is a white #16 wire from the regulator plug connected to the ground stud.

2. Check continuity and resistance of the field windings between F1 and F2 in the exciter stator. This resistance check is best made between the heatsink on the voltage regulator board and the alternator's common ground stud in the control box (early models). This check takes into consideration all connections within the stationary field circuit of the exciter stator. Total resistance is 5-6 ohm. Should an *open* be found (infinite resistance), refer to the generator internal schematic to check further and locate the *open*. Should less than 5 ohm be measured, indicating a short or partial short to ground, unplug the regulator and measure between Pin #1 of the generator plug and the common ground stud. If low ohms are still measured, lift the F1 ground connection from the common ground stud isolating the exciter field coil windings of the generator. If low ohms are still measured, the windings are shorted to the generator case. Refer to the internal generator schematic to determine which pair of windings is shorted to ground. Some shorts are undetectable with a VOM or DMM. In some cases, a winding repair shop may have to be consulted for insulation testing.
3. If the stationary field windings (F1 - F3 and F2 - F4) are found to be OK, the problem could be in the auxiliary circuit supplying DC power to the voltage regulator through Pin #2 of the generator/regulator plug. Check the resistance of the diodes in this circuit by placing an ohmmeter between the negative side of the large capacitor on the regulator board Pin #2 and the case of the generator. Resistance should be 8.5 ohm in one direction and, with reversing the ohmmeter leads, infinite in the other.

NOTE: This check does not draw reference to the possibility of one diode being open (these diodes are in parallel), therefore, if this check does not show any problems, it is best to check the diodes individually with their leads unsoldered.

If continuity is indicated both ways or not at all, you should check the diodes individually by unsoldering the lead A1 and A2 at the diodes. Also check the resistance values of the auxiliary coil windings. (A1 & A2, A2 & A3, A1 & A3).

NOTE: A chart of complete resistance values for the WTA 15 kW, 20 kW, and 25 kW generators, both early and late models, is found at the end of this text. Check the resistance of these auxiliary coil windings by placing your ohmmeter leads between Points (A1 & A2), (A2 & A3) and (A1 & A3).

Two diodes (#32609) are pressed into the alternator housing behind the cover on later models and behind the regulator/output box on early models located on the left-hand side (generator viewed from the rear). These diodes rectify AC power from an auxiliary single phase winding within the main stator to supply DC power through Pin #2 on the generator/regulator plug to the regulator board for the field windings of the stationary exciter stator.

NOTE: Early model generators had the regulator board and output leads located in a box in place of the cover shown.

The diodes are pressed into the generator housing to achieve good electrical contact. In replacing them, the diode should be driven out with a suitable drift and the diode replaced with the aid of a deep well socket that will catch the outside edge of the diode. A C-clamp should be used to press it into the generator housing and to aid in maintaining good alignment and diode contact with the housing.

4. If both the auxiliary coil and exciter field winding's circuits check O.K. but the alternator's output voltage is still low, flashing the field is recommended. This is outlined in FIELD FLASHING.

WTA GENERATOR TROUBLESHOOTING

Main Output Voltage Is Extremely Low

Less than 50 volts AC (T1-T4) or 25 volts AC (T1-T2 and T3-T4)

1. This could be the result of very weak or loose permanent magnets in the stationary exciter stator. These can be viewed and checked with the aid of a steel screw driver through the access hole in the rear of the generator housing. The stator exciter has six poles, one of which is a permanent magnet.
2. Field flashing can rectify a weak magnet. Loose or dislodged magnets will have a tendency to fall onto the rotating exciter and short out its windings as it wears on the exciter rotor surface. Magnets can be weakened either by opening the field circuit while the unit is operating or by prolonged storage. Weakened magnets should charge themselves sufficiently under normal operation to prevent future needs for flashing.
3. Check the voltage regulator visually including the plug connection. Look for any burned components, foil strips or dislodged parts.
4. Record auxiliary DC voltage and main output line voltage before field flashing with the generator running. DC auxiliary voltage should be measured from Pin #2 at the generator/regulator plug and the common ground stud. Main output voltage AC should be measured from each hot line to neutral T1 & T2 and T3 & T4. This is to avoid measuring an open main stator coil as having no voltage.

Field Flashing

Apply 12 VDC to the stationary exciter stator windings. This is done by connecting the DC battery negative to the heatsink of the regulator board and the positive DC connection to the generator case. These connections need only be made for a few seconds while the generator is running for field flashing.

⚠ WARNING: *The DC battery used for field flashing must be completely independent from the generator's DC starting battery to prevent a short circuit in the regulator board from damaging it.*

During flashing using 12 volts DC, AC output voltage from each line to neutral should peak at 140 - 150 volts. When flashing voltage is removed, it should drop back to 120 volts as the regulator board maintains to generator output. If voltage is maintained by the board, all is well, except that the permanent magnets are weak, voltage adjustment with the potentiometers may be needed to finally adjust the AC voltage to 120 volts.

Apply load several times and allow the unit to run loaded for some time. Shut the unit down and restart to assure proper start-up in the future.

Refer to the *TROUBLESHOOTING CHART* for comparison to actual results if normal operation is not restored.

Symptoms Experienced While Field Flashing

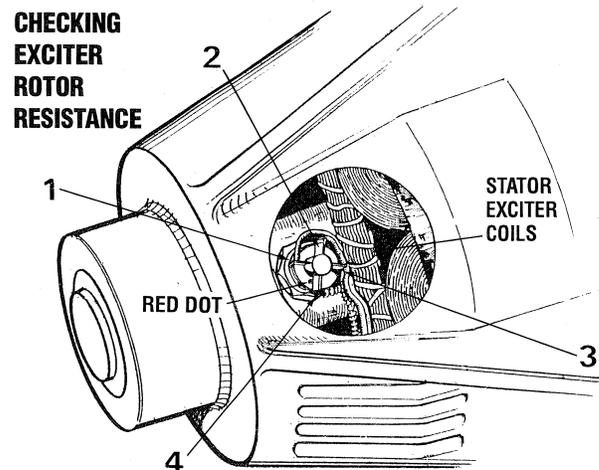
AUXILIARY VOLTAGE INCREASE	MAIN LINE VOLTAGE INCREASE	PROBABLE CAUSE AND ITEMS TO CHECK
NO	YES	Auxiliary winding circuit problem. Check diodes and winding resistances. Normal auxiliary voltage should be approximately 1/4 line to neutral voltage in DC.
YES	NO	If all lines are same, check for short circuit or all lines open. If only some lines are affected, check for open or shorted coils.
NO YES (PARTIAL)	NO YES (PARTIAL)	Check stationary exciter for open or short. If O.K., check all rotating components (Resistance or exciter and main rotor bridge rectifier current test of main rotor).
YES	YES	If voltages drop after flashing is removed, voltage regulator needs replacement.
YES	YES	If normal operation is restored, permanent magnets have been weakened. Normal operation should restore charge.

NOTE: *A 9 volt power source capable of 2 amps applied to the field is sufficient to duplicate a normal generator output voltage at no-load. If output voltage increase is only partial, this would indicate a problem. Refer to bridge rectifier test procedures and main rotor test procedures.*

Checking Exciter Rotor Resistance

This can be done with the bridge rectifier still connected. Measure the resistance of the exciter rotor windings with an ohmmeter measuring between points 1 & 2, 2 & 3, and 3 & 1 (0.7 - 0.8 ohm). If 0 ohm (short) or infinite (open) exist in the windings, unsolder the leads from the bridge rectifier connections and check the windings individually.

The DC connection to the rotating field identified by the red dot on the winding and the two solid wires connected to it. (This unit is with a stationary armature. Brush type units have a rotating armature.)

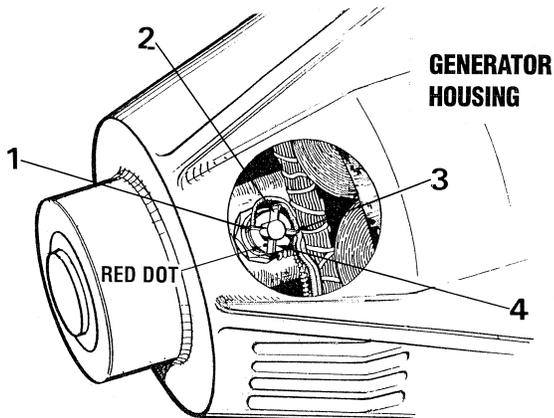


WTA GENERATOR TROUBLESHOOTING

Checking the Main Rotor Winding Resistance

With an ohmmeter Rx1 scale, place the plus (+) lead on the connection to the DC output connection on the bridge rectifier (red dot) point #4 and the negative (-) lead to the rotor shaft or rotor ground terminal when accessible. (3.0 - 3.2 ohm should be read.) Please bear in mind that a shorted bridge rectifier can influence this reading.

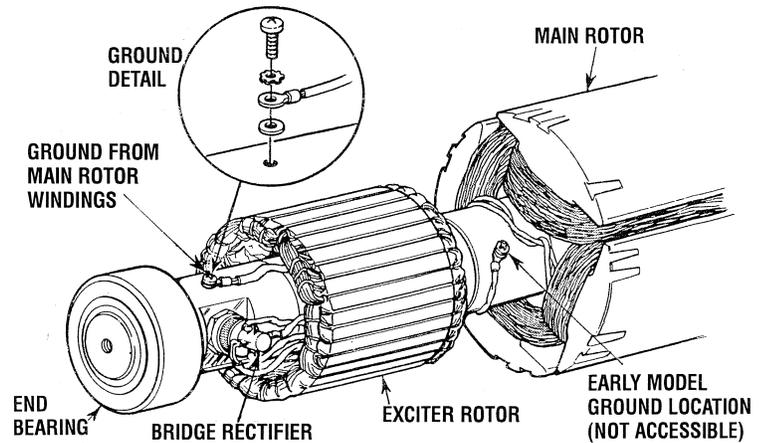
If any variation in the above readings are found, isolate the rotor windings by unsoldering the DC lead from the rectifier and lifting the ground lead from the shaft, if accessible, and measure the resistance with the rectifier removed from the circuit. If ground connection to shaft (early models) is not accessible, measure resistance from DC lead to shaft. With the ground lead disconnected from the shaft, there should be no continuity to the shaft from these windings.



Checking Main Rotor Windings For A Short With Outer Generator Housing Removed

Make this check by disconnecting the two main rotor winding leads (DC leads off the bridge rectifier and the ground lead from the rotor shaft) and attach a 24 volt DC source across these leads ([+] to the DC lead and [-] to the ground lead off the shaft). This will create a magnetic field in the windings of the main rotor. Pass a long metal scale or hacksaw blade around the armature outer surface and observe for an obvious difference in the magnetic strength that may indicate a shorted area. Allow the DC voltage passing through the armature windings to heat the windings until they become uncomfortable to the touch, then remove the DC source and measure the resistance of the windings again. If some of the poles in the armature showed a noticeable weakness and the resistance measured hot is much lower than the cold measurement, the main rotor most likely has shorted windings. Note that this is intended only as a final check to confirm suspicions of a rotor winding defect.

NOTE: The possibility of thermal damage from the 24 volt DC battery does exist if not monitored and controlled during the test.



Bridge Rectifier Test Procedures

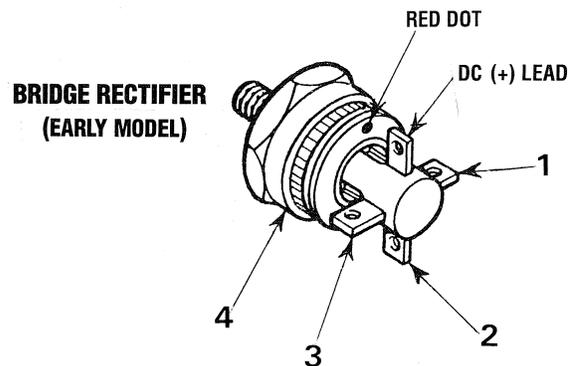
In order to test the rectifier without removing it from the circuit, the main rotor DC connection must be completely removed either at the ground connection to the main rotor shaft (late model units) or from the soldered DC output connection on the bridge rectifier (marked with a red dot).

Test the rectifier with an ohmmeter set on low scale Rx1 as follows (refer to the illustration). Readings are taken using a Simpson Meter #260 analog.

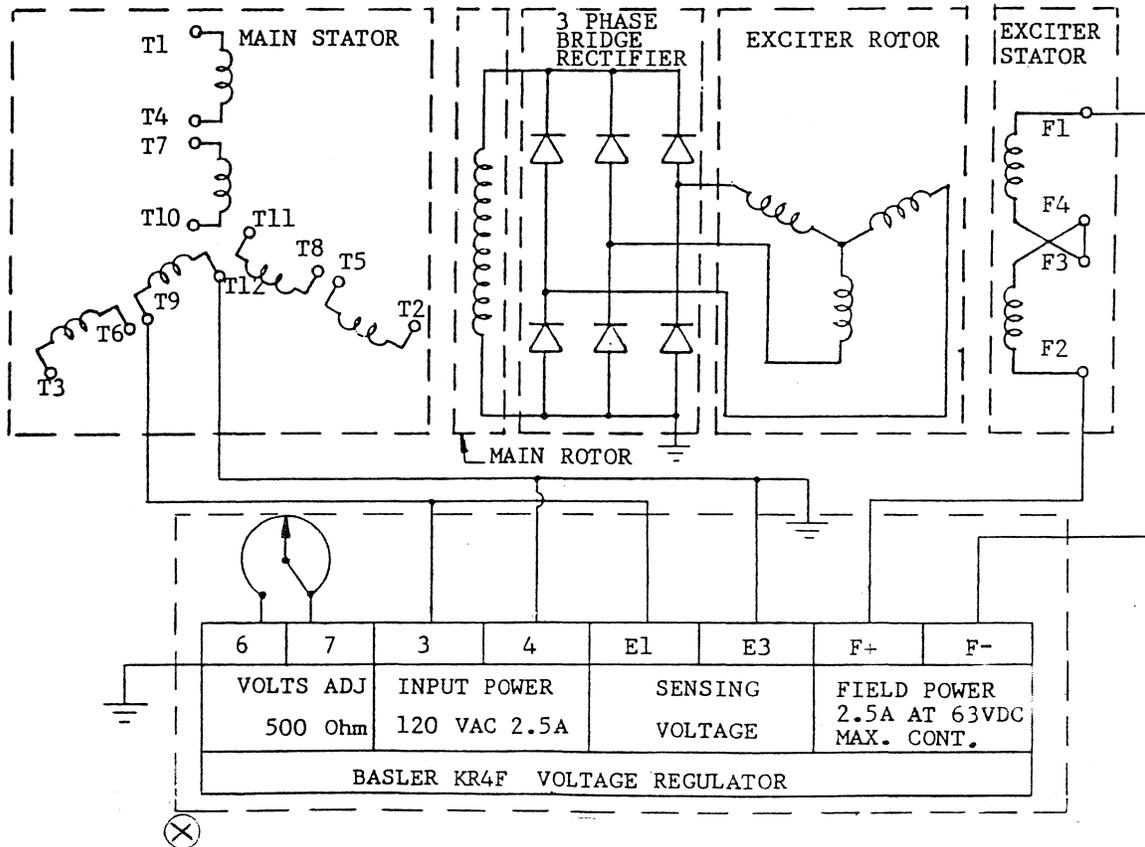
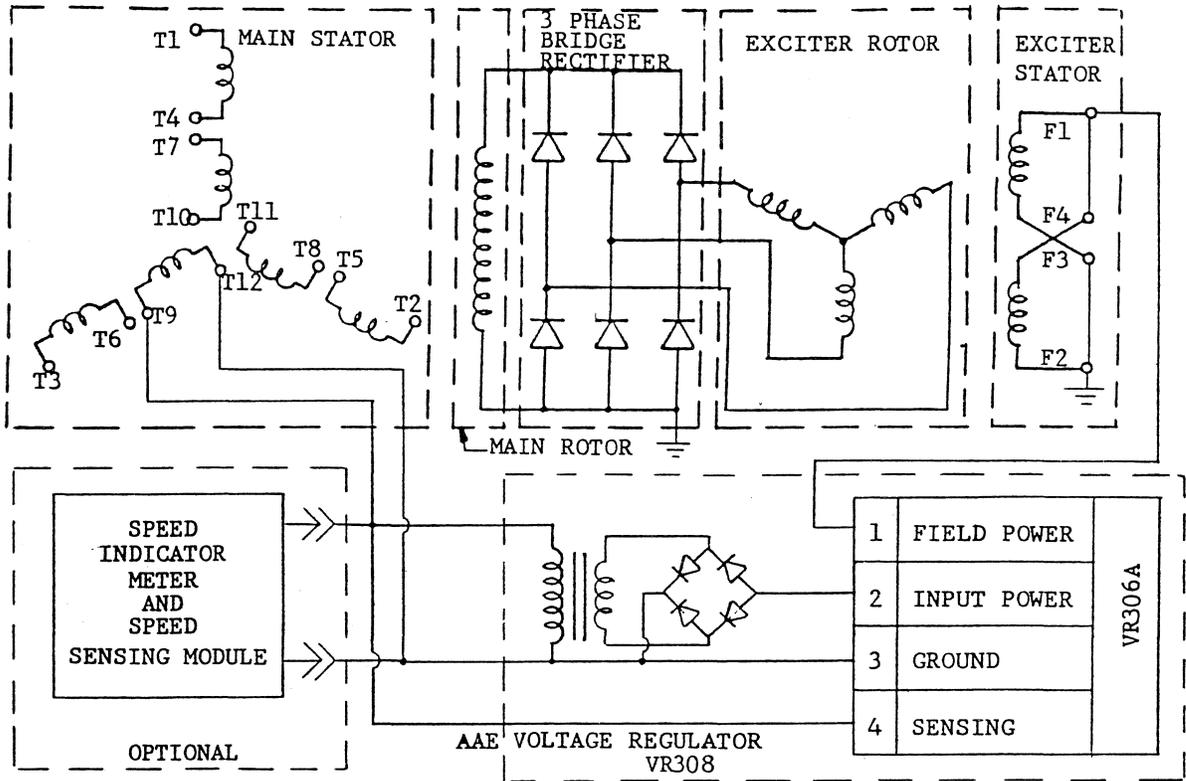
1. Connect the [+] lead of the ohmmeter to the DC lead of the rectifier (red dot) and with the negative lead, contact points 1,2,3, and 4. No deflection of the meter should occur.
2. Reverse the connections and with the (+) lead, contact points 1,2,3, and 4. Half to three-quarter scale deflection of the meter needle should occur.

Points 1, 2, 3 (8 - 9 ohm)
Point 4 (30 - 40 ohm)

Readings are approximate and may vary with meter. If readings between points 1, 2, and 3 vary, the bridge rectifier should be removed, tested independently and then resistance between the three rotor rectifier leads should be checked for similarity.



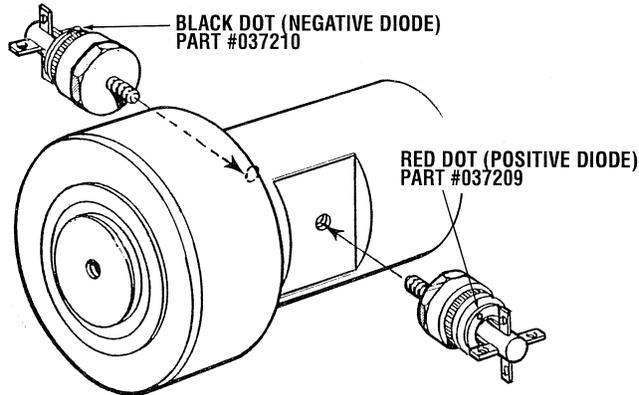
WTA 50Hz/60Hz SERIES SCHEMATICS



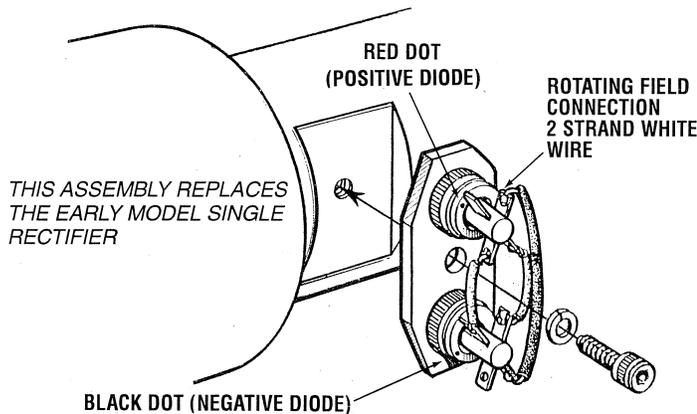
WTA GENERATOR TROUBLESHOOTING

Replacing the Bridge Rectifier

To replace the early single style rectifier, use the dual rectifier assembly #035301 as shown below.



The single style three phase full wave Bridge Rectifier has been obsoleted by two separate and different low power rectifiers in one assembly. See *ROTATING BRIDGE RECTIFIER..*



NOTE: Solder one of the auxiliary winding leads to each of the three separate interconnect wires between the three terminals of the two rectifiers.

Special Considerations for Low Voltage Problems

- 1. Voltage drops under load but corrects when load is removed.** This symptom could be caused by an overload condition (check load with amprobe, field saturation check, shorts in generator components or electrical shorts in or to the load). Check resistance of windings in generator components.
- 2. Voltage drops under load and stays low when the load is removed but normal voltage is restored when the generator is cool.** This symptom would indicate a high probability of a heat-sensitive short. Cold and hot resistances should be checked for all components, concentrating on the main rotor windings since these are susceptible to heat damage from overloadings.

Fluctuating Voltage

Voltage fluctuation can be caused usually by one of these problems:

- 1.** Check for an overload condition. Check load with the amprobe off each lead. Measure the exciter field as shown in Section A (low voltage). If the alternator is being operated in an overloaded condition and the voltage regulator is operating at its maximum capacity to try and maintain AC Voltage output, the variations in the engine's speed, (in some cases the engine horsepower output can no longer support the overload demands on the generator) as it goes through its power cycles, will be observed as a voltage variation with a regular characteristic and can be very visible when lights are part of the load. This type of overload condition must be corrected; otherwise generator damage will result.
- 2.** A defective voltage regulator can also cause output voltage to fluctuate. This can be checked by replacing the voltage regulator with a DC power source to excite the field (9 volts DC). This DC voltage applied to the exciter field (generator plug #1 pin [+]) and the common ground stud [-]) should produce 120 volts AC output from each lead T1 and T4 under no-load conditions. Replacing the voltage regulator board will accomplish the same.
- 3.** Voltage fluctuation can also be the result of loose electrical connections or electrical shorts. A thorough check of all connections and component resistances can often find the cause of this problem once the possibility of a defective voltage regulator is eliminated. Voltage fluctuation with engine rpm variations (cycles) and no overload condition can be the result of inadequate fuel delivery to the engine, clogged fuel filters, air in the fuel system, poor fuel quality, injectors misfiring or a faulty injection pump.

High Voltage 130 Volts +

- 1.** This is most likely to be a voltage regulator related problem. If sensing voltage is not present at Pin #4 of the voltage regulator (this senses AC voltage from T1), the voltage regulator will attempt to bring up the voltage by going into full power operation. Consequently, the line voltage will increase without the voltage regulator sensing it. Check the sensing circuit for an open and correct as needed.
- 2.** If sensing voltage (120 volts AC) is present at Pin #4 of the voltage regulator and this is the same as found on output lead T1, the voltage regulator is most likely defective and should be replaced.
As a precautionary step to prevent installing a new voltage regulator board into a defect-causing environment, it is wise to check that the auxiliary circuit diodes found pressed in the generator housing are OK and that the auxiliary residual voltage (10 - 12 volts AC across these diodes) is present when the generator is running with the voltage regulator unplugged.
- 3.** Incorrectly isolating neutral from ground.

ROTATING BRIDGE RECTIFIER

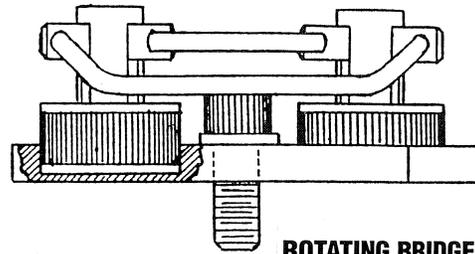
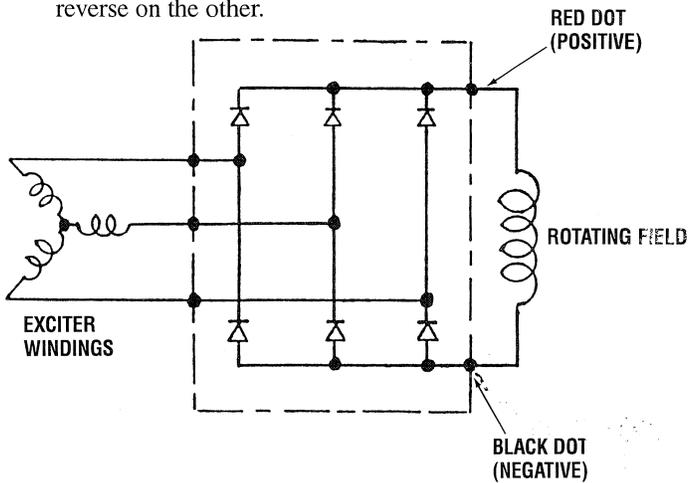
The Rotating Bridge Rectifier uses a tandem assembly of two low power half wave components, these components are mounted 180° apart on the rotor shaft assembly.

Available as a field service kit, the Rotating Bridge Rectifier consists of two rectifiers that are mounted and prewired, no drilling or remilling is necessary.

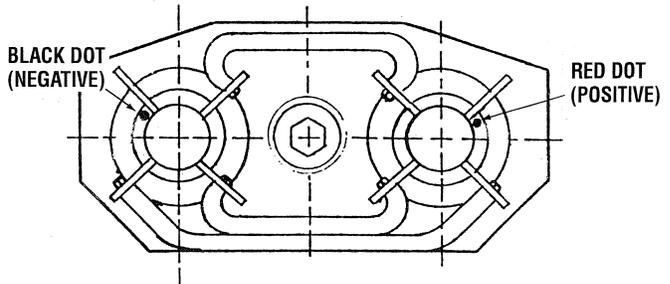
The rotating bridge rectifier kit is a replacement for the R6245 three phase full wave bridge rectifier used in all 1800 rpm Generators.

Test Procedure

1. Disconnect either rotating field connection.
2. With or without the exciter connected, test each semiconductor by measuring from the marked terminal to the other three terminals on the same device.
3. Polarity will be indicated as forward on one device, reverse on the other.



ROTATING BRIDGE RECTIFIER



WTA GENERATOR TROUBLESHOOTING

Voltage Regulator Troubleshooting

The voltage regulator can be bench checked only for proper operation. Without elaborate equipment, the actual detailed defects possible in a voltage regulator cannot be accurately diagnosed. A simple "Go-No Go" tester schematic for function testing follows.

The easiest and most accurate method would be to check the voltage regulator on an generator known to be operating properly. Some possible defects and symptoms follow.

1. EARLY MODEL REGULATOR BOARD:

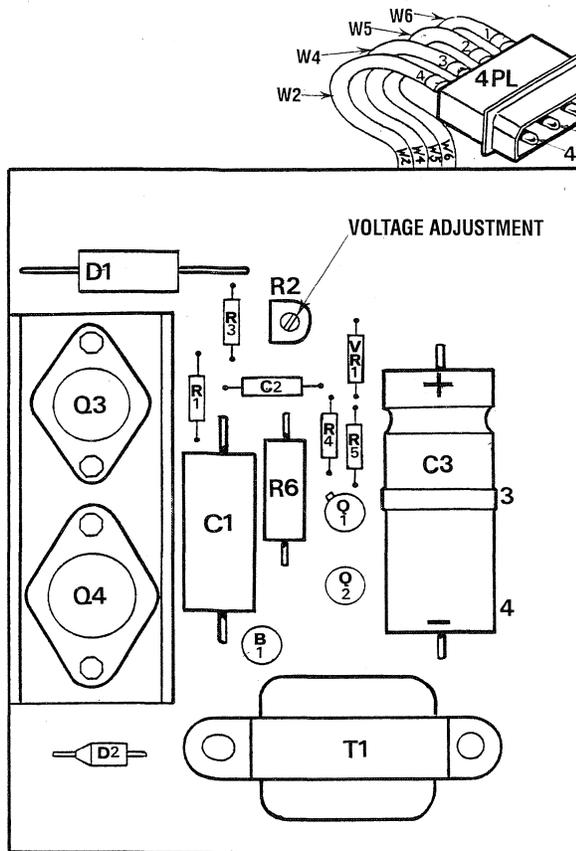
a. HIGH OUTPUT VOLTAGE can be caused by:

1. Misadjusted Potentiometer.
2. Defective transformer T1.
3. Shorted Q3 and/or Q4.
4. Open R1, R2, VR1, R4.
5. Open Q1, Q2.
6. No connection pin #4.

Check for line voltage at circuit board.

b. LOW OUTPUT VOLTAGE can be caused by:

1. Misadjusted potentiometer.
2. Shorted Q1, Q2.
3. Open Q3, Q4, D1, R6.
4. No Connection Pins 1, 2, or 3.



EARLY MODEL REGULATOR BOARD

2. LATE MODEL REGULATOR BOARD:

a. HIGH OUTPUT VOLTAGE:

1. Misadjusted P1.
2. No Connection to pin #4.
3. Shorted Q2, Q3, Q4, Q5.
4. Any open component from T1 to IC1.
(lower part of circuit diagram)

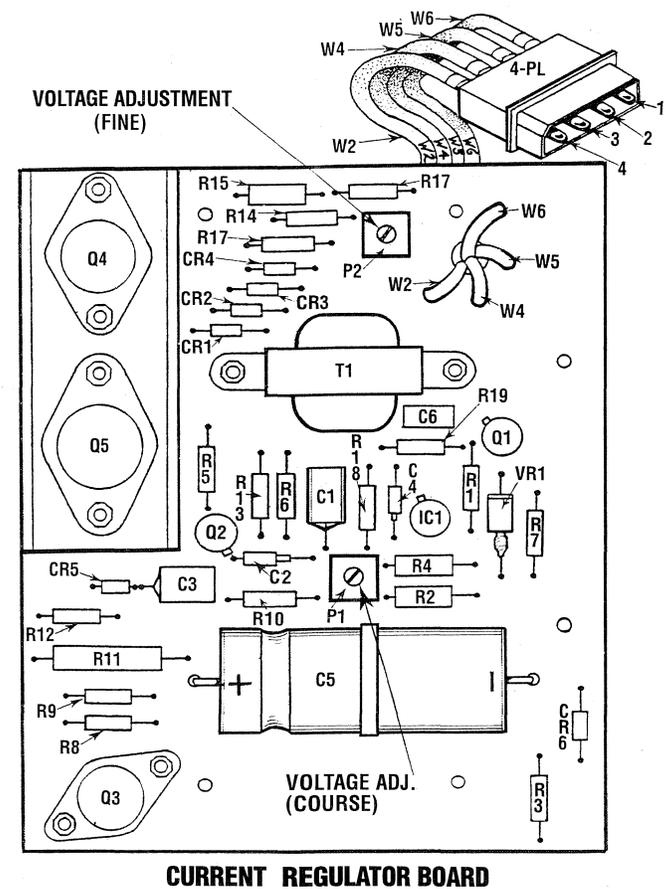
b. LOW OUTPUT VOLTAGE:

1. Misadjusted P1.
2. No connection to pins 1, 2, or 3.
3. Open Q2, Q3, Q4, Q5.
4. Defective IC1.
5. Defective C5

c. FLUCTUATING VOLTAGE

(not due to generator saturation):

1. C1 defective.
2. IC1 defective.
3. Q1 defective.



CURRENT REGULATOR BOARD

WTA GENERATOR TROUBLESHOOTING

RESISTANCE VALUES

Single Phase Electrical Resistances for 15kW WTA Generators

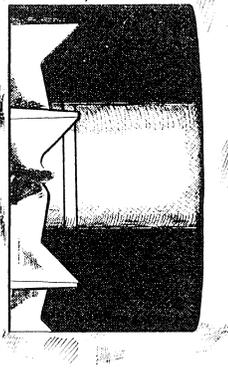
Model WTA	Main Stator		Aux. Coils			Exc. Stator		Main Rotor	Main Rotor
	T1-T2	T3-T4	A1-A2	A2-A3	A1-A3	F1-F3	F2-F4		
15 & 20	0.05	0.05	0.15	0.09	0.09	2.0	3.0	3.2*	0.7*
15, 20, 25	0.04	0.04	0.14	0.08	0.08	2.3	3.4	3.0*	0.8*

(Refer to GENERATOR SCHEMATIC)
(Values are in Ohms)

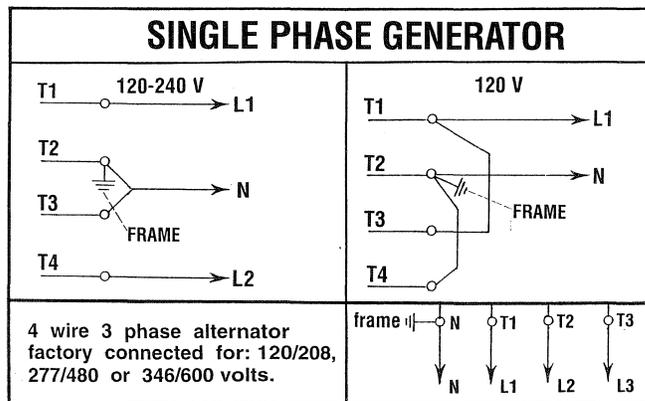
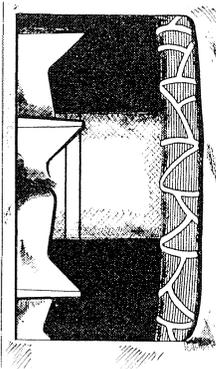
NOTE: These values represent measurements taken with leads connected to the bridge rectifier. Measurements for the main rotor are taken from the red dot terminal on the rectifier to the ground. Exciter measurements can be taken from the terminal. Refer to the preceding pages for rectifier testing.

1. This chart is intended for reference use only, as a ten percent tolerance on these figures is common. Comparison of ratios of actual readings to the above figures is often a more accurate method of troubleshooting.
2. If any abnormal variations cannot be isolated and symptoms are still evident, contact your WESTERBEKE distributor.
3. Early model WTA generators can be distinguished from later model WTA generators when checking resistance values by removing one of the screens from the generator exhaust fan area and visually looking squarely into the generator. On early model WTA no windings will be visible extending beyond the opening exposed when this screen is removed. Later model WTA generators will have about 1/2 to 5/8 inches of windings visible in the opening as shown.

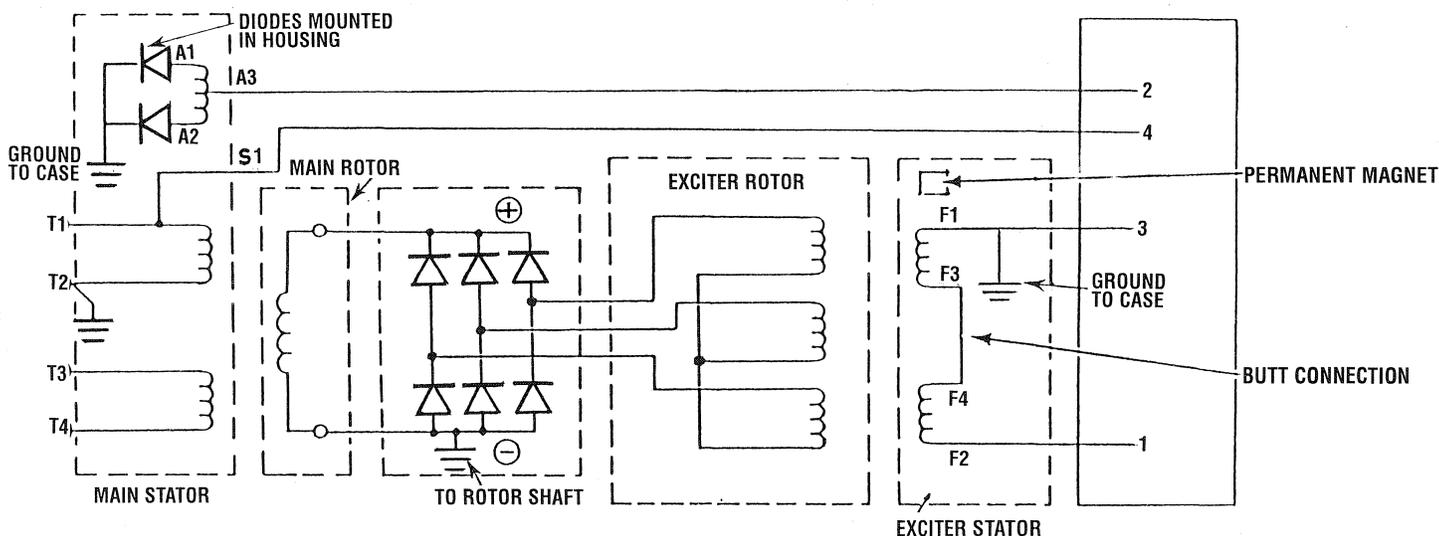
EARLY MODEL WTA GENERATORS (NO WINDINGS VISIBLE)



LATER MODEL WTA GENERATOR (WINDINGS VISIBLE)



GENERATOR CONNECTION DIAGRAM



INTERNAL WIRING SCHEMATIC

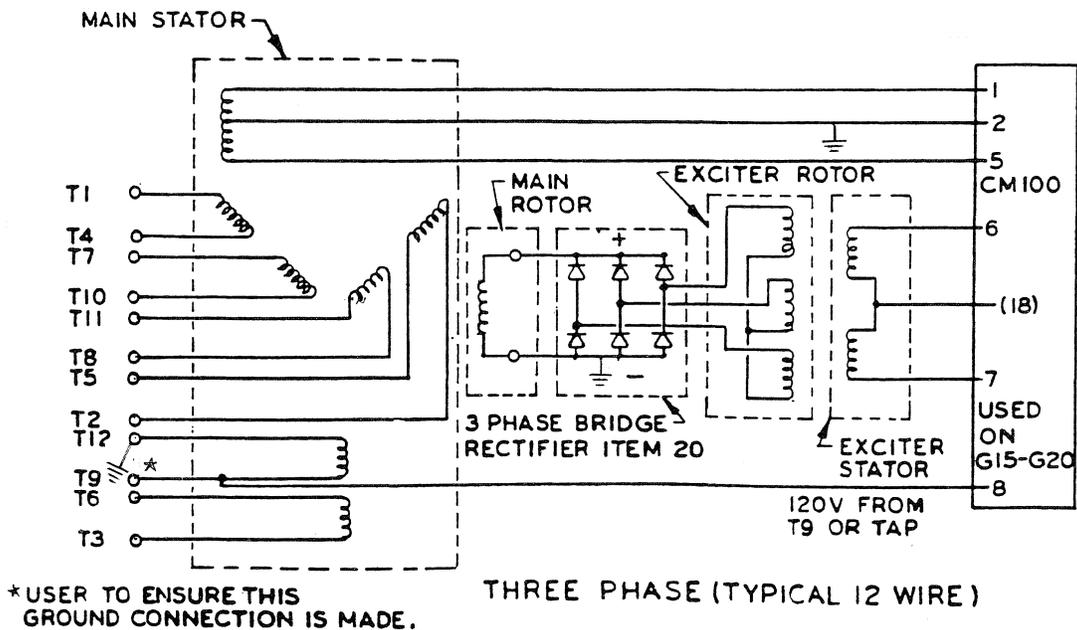
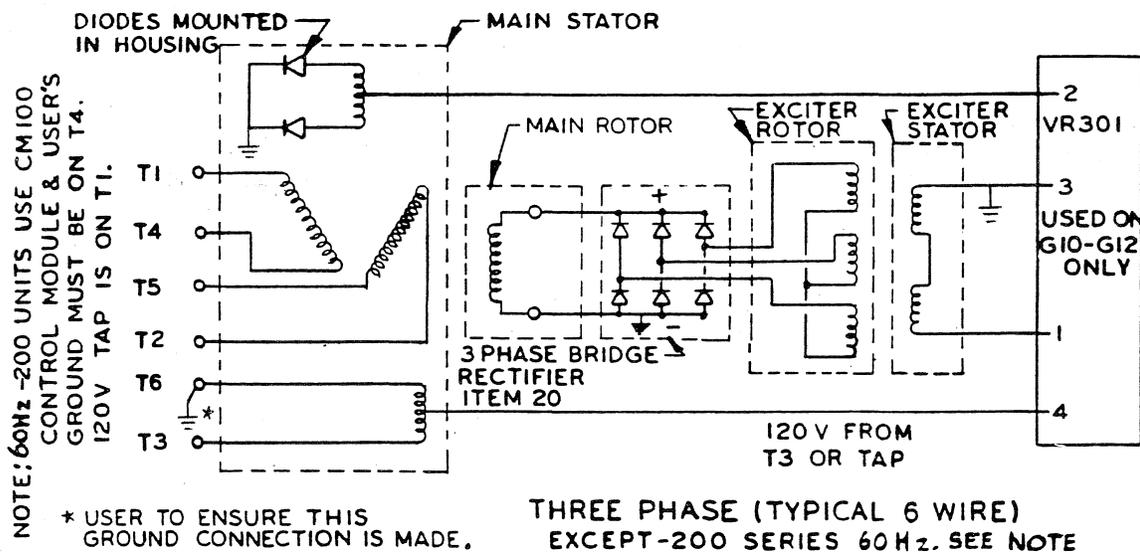
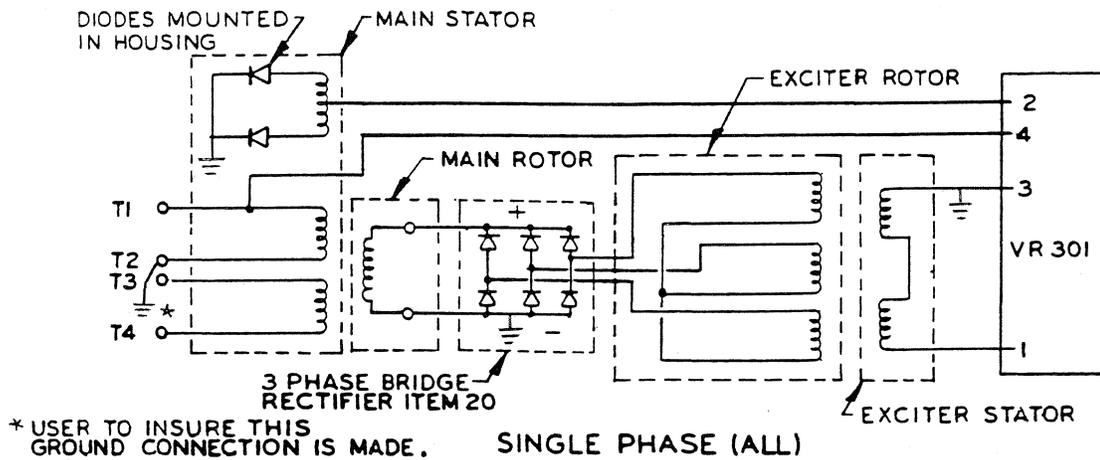
WTA GENERATOR ELECTRICAL FAULT ANALYSIS

An understanding of the generator's operation may be useful before attempting to analyze an electrical failure. Refer to *INTRODUCTION*, *ADJUSTMENT* and *OPERATION* in the

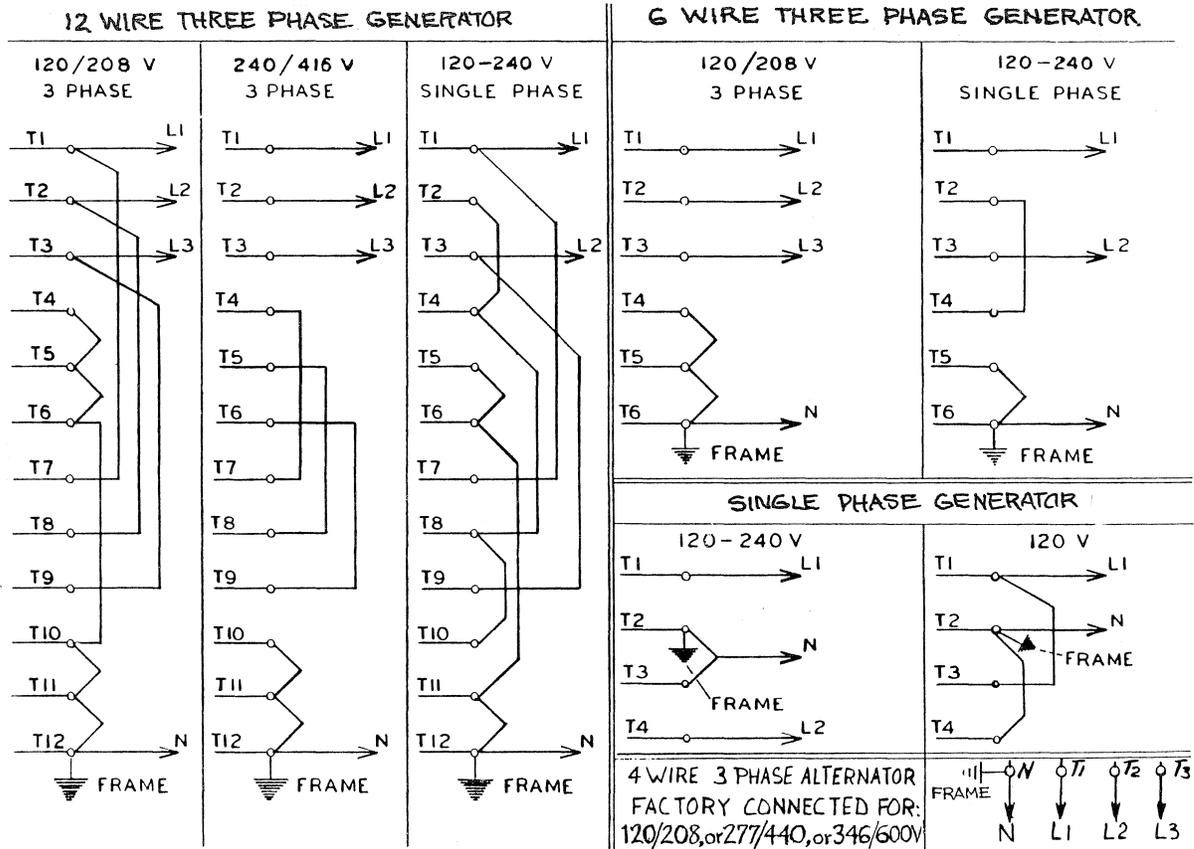
beginning of the *WTA GENERATOR SECTION*. Also refer to the *ELECTRICAL DIAGRAMS* and *SCHEMATICS* in this manual.

PROBLEM	PROBABLE CAUSE	VERIFICATION/REMEDY
Mechanical Noise	<ol style="list-style-type: none"> 1. Defective bearing. 2. Worn bearing. 3. Loose or misaligned coupling. 4. Foreign objects within. 	<ol style="list-style-type: none"> 1. Replace bearing. 2. Replace bearing. 3. Align and/or tighten. 4. Remove and check further for possible damage.
No Output	<ol style="list-style-type: none"> 1. Short or open circuits in any stator, rotor coil or associated leads. 2. Defective bridge rectifier on shaft. 3. Faulty voltage regulating circuit. 	<ol style="list-style-type: none"> 1. Contact WESTERBEKE if repair is beyond local facilities. Check grounding lead and terminal on shaft behind main rotor coil. 2. Replace if faulty and check further for cause. 3. Repair or replace if faulty and check further for cause.
High Voltage Output	<ol style="list-style-type: none"> 1. Misadjusted output voltage control. 2. Wire T2 (120/240V), T6 (120/208) or T12 (120/416 - 140/240) ungrounded. 3. Faulty voltage regulating circuit. 	<ol style="list-style-type: none"> 1. Set output voltage to desired value. CAUTION: <i>Some components carry live voltage and the use of insulated tools is recommended.</i> 2. Clean and remake this ground connection. 3. Repair or replace if faulty and check further for cause.
Low Output Voltage	<ol style="list-style-type: none"> 1. Misadjusted output voltage control. 2. High line loss if the voltage is low only at load. 3. Partially shorted main rotor field coil. 4. Electrical overload and/or poor power factor connected to alternator. 5. Alternator shaft rpm too low. 6. Faulty voltage regulating circuit. 	<ol style="list-style-type: none"> 1. Set the output voltage to the desired value. CAUTION: <i>Some components carry live voltage and the use of insulated tools is recommended.</i> 2. Increase the size of the wiring leading to the load as required. Load wires should not run hot at continuous full load if properly sized. Do not run a greater length of wire than required as losses increase with distance. If wire is correctly sized and run is not too long, check for poor connections and/or partly broken wires that may be indicated by hot spots in the wire or at terminals of switches, etc. 3. Contact your WESTERBEKE Dealer if repair is beyond local facilities. 4. The total load at the prescribed power fact (see identification plate on generator) should not be exceeded. 5. Check engine speed. 6. Repair or replace if faulty and check further for cause.
Unstable Output Voltage	<ol style="list-style-type: none"> 1. Irregular engine speed. 2. Loose electrical connections. 3. Faulty voltage regulating circuit or connector. 4. Higher than required engine speed. 	<ol style="list-style-type: none"> 1. Check the engine and loads for transient operation and/or overloads. 2. Tighten connections as required in load wiring and voltage regulating connector. 3. Repair or replace if faulty and check further for cause. 4. Check speed is 1800 rpm.
Overheating	<ol style="list-style-type: none"> 1. Airways blocked. 2. High ambient temperature. 3. Electrical overload and/or poor power factor connected to the generator. 4. The engine exhaust is being drawn into the generator air intake. 	<ol style="list-style-type: none"> 1. Remove obstructions. 2. Do not permit ambient temperature to exceed 104°F (40°C) and operate in a well ventilated area. 3. The total load at the prescribed power factor.(see the identification plate on the generator) should not be exceeded. 4. Redirect the engine exhaust as necessary.
Generator Housing Live.	<ol style="list-style-type: none"> 1. Static charge. 2. Open the circuit at the ground terminal in the control box. 	<ol style="list-style-type: none"> 1. Properly ground the frame of the generator. 2. Ensure the generator neutral has continuity from the stator to the ground. CAUTION: <i>Some components carry live voltage and the use of insulated tools is recommended.</i>

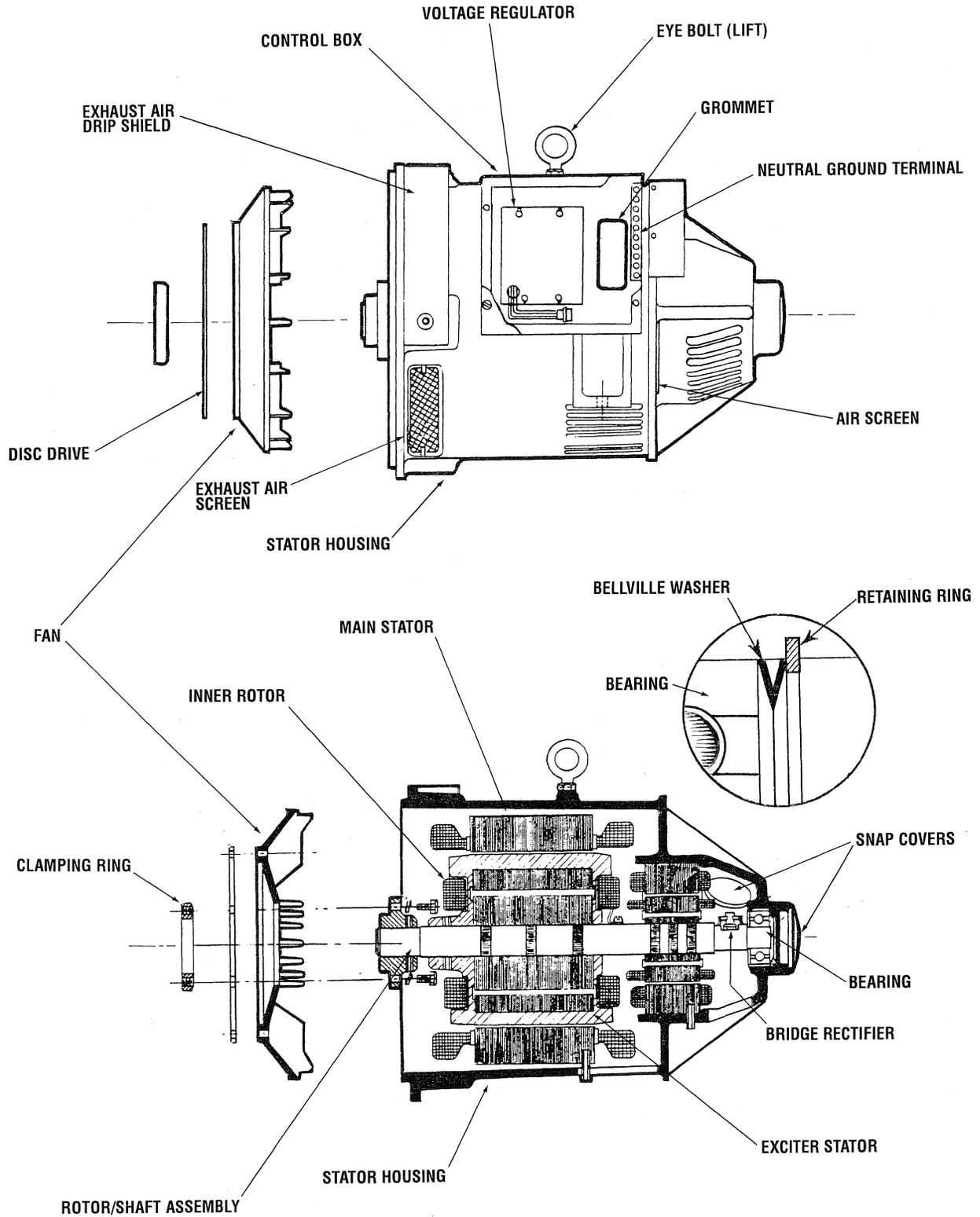
WTA GENERATOR INTERNAL WIRING SCHEMATICS



WTA GENERATOR CONNECTION SCHEMATICS



WTA GENERATOR PARTS IDENTIFICATION

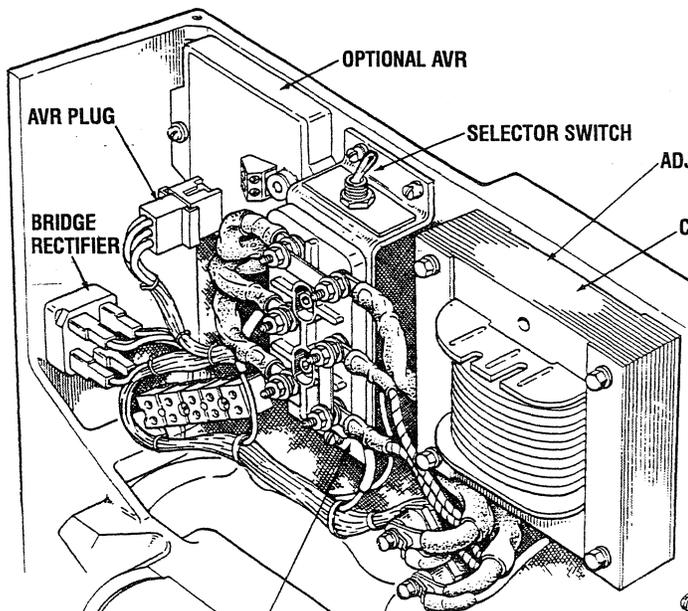
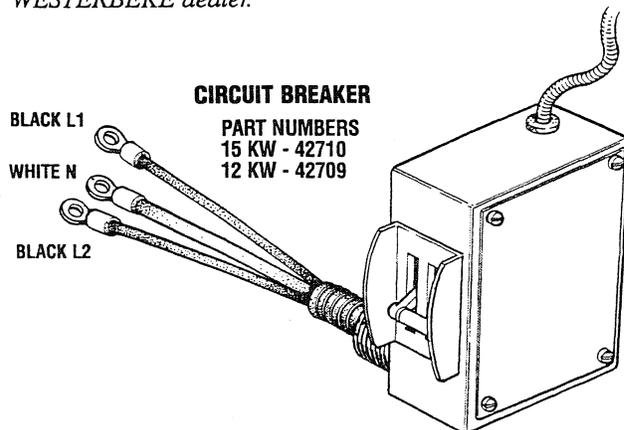


BT GENERATOR SINGLE/THREE PHASE

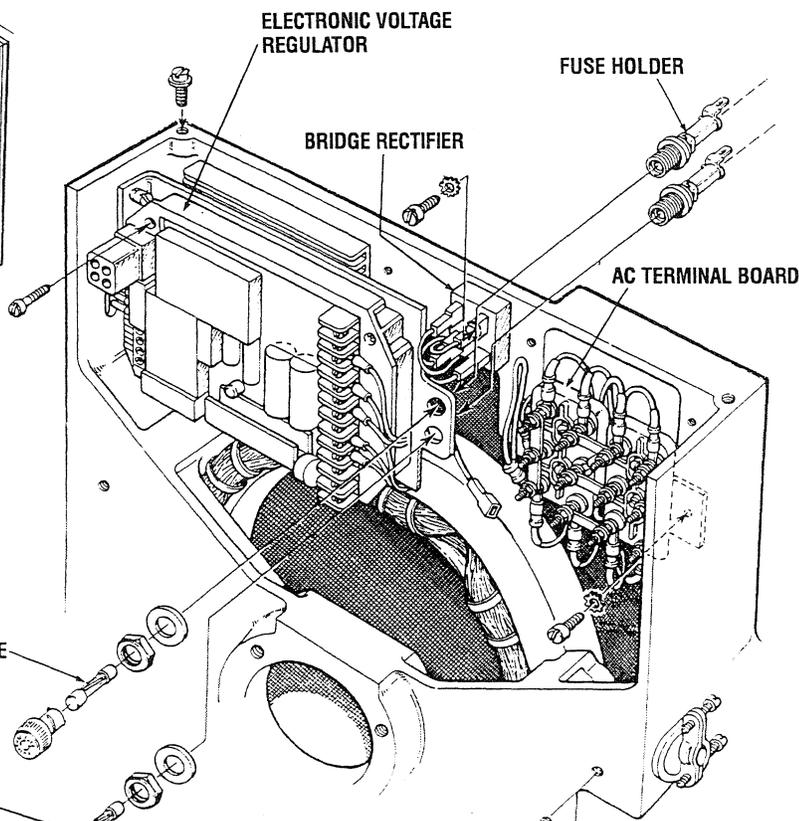
This generator is a four-pole, brushless, self-excited generator which requires only the driving force of the engine to produce AC output. The copper and laminated iron in the exciter stator are responsible for the self-exciting feature of this generator. The magnetic field produced causes an AC voltage to be induced into the related exciter rotor windings during rotation. Diodes located in the exciter rotor rectify this voltage to DC and supply it to the windings of the rotating field. This creates an electromagnetic field which rotates through the windings of the main stator, inducing an AC voltage which is supplied to a load. A step down transformer is connected in parallel to the AC output of the main stator. An AC voltage is produced in the auxiliary windings of the transformer and the main stator and is, in turn, supplied to a full-wave bridge rectifier. The rectifier produces a DC voltage to further excite the exciter stator windings, enabling the generator to produce a rated AC output. An optional solid-state voltage regulator is available to work in tandem with the transformer regulator to produce a more stable AC output.

A circuit breaker is installed on all WESTERBEKE generators. This circuit breaker will automatically disconnect generator power in case of an electrical overload. The circuit breaker can be manually shut off when servicing the generator to ensure no power is coming into the boat.

NOTE: This circuit breaker is available as a WESTERBEKE add-on kit for earlier model generations; contact your WESTERBEKE dealer.

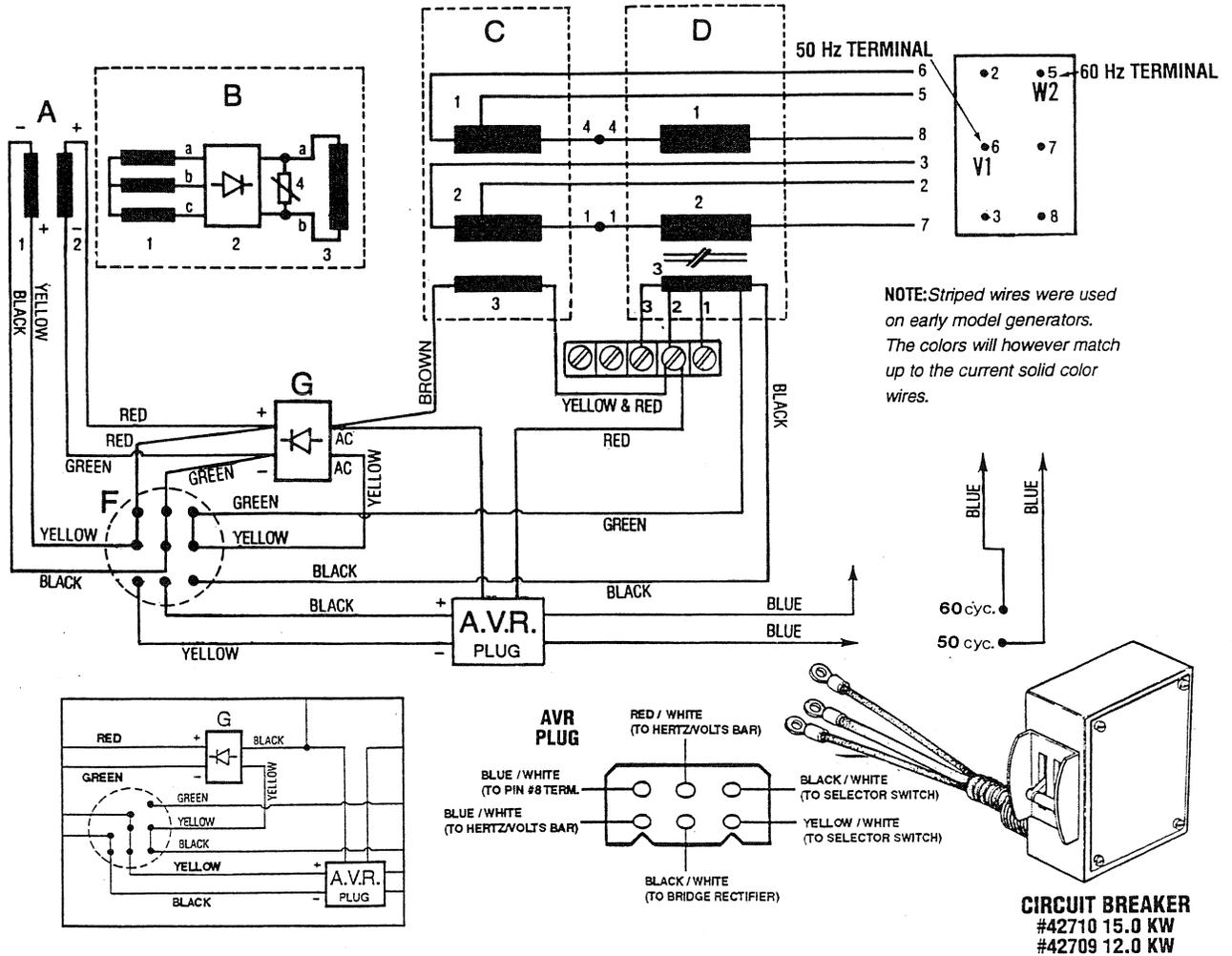


BT GENERATOR SINGLE PHASE



BT GENERATOR THREE PHASE

BT GENERATOR/SINGLE PHASE



INTERNAL WIRING SCHEMATIC (SIX STUD) W/OPTIONAL VOLTAGE REGULATOR

A. EXCITER STATOR WINDINGS 1 & 2
A - 1 and A - 2 Exciter Stator Windings
(Selector in **COMP** position)

B. EXCITER ROTOR and FIELD
1. Auxiliary Windings (A - B - C)
2. Diodes (6)
3. Rotating Field Windings
4. Posi Resistor

C. MAIN STATOR
1. Main Stator Windings
2. Main Stator Windings
3. Main Stator Auxiliary Windings

D. COMPOUND TRANSFORMER
1. Compound Transformer Windings
2. Compound Transformer Windings
3. Compound Transformer Auxiliary Windings

Resistance readings and voltage checks can be accessed easily for the components in the exciter circuit A, G, C-3 and D-3 by locating the color coded wires at the connection points shown on the above schematic. When checking winding resistance values be sure to lift both of the component's electrical connections.

G. BRIDGE RECTIFIER

A.V.R.

Optional Automatic Voltage Regulator Plug (6 Prong).

BT GENERATOR TROUBLESHOOTING CHART

The following troubleshooting chart is designed to give insight into problems which may be encountered with the BT brushless generators operating on compound transformer regulation. Owing to the simplicity of the equipment and controls, troubleshooting is relatively easy, once the relationship between cause and effect is understood. Most potential problems are covered in the text of this manual

Keep in mind that a basic fundamental knowledge of electricity is required for this troubleshooting, and always remember that lethal voltages are present in the circuitry; therefore, extreme caution is essential when troubleshooting a generator. Only a few basic tools are necessary for diagnosis and repair.

These are hand tools: an amprobe and a quality volt-ohm-meter capable of reading less than one ohm due to the precision required in reading component winding resistances.

Before attempting any repairs, get a clear explanation of the problem as possible, preferably from an individual witnessing the problem. In some cases, this may bring to light a problem which is related to the method of operation rather than equipment fault. Bring basic repair tools with you on the initial trip to the problem equipment, such as: diodes and bridge rectifier, so that if the problem should be found in one of these easily replaceable parts, the problem can be remedied early and efficiently.

Problem	Probable Cause	Verification/Remedy
Low voltage (70 volts) at N/L with and loss of voltage as load is applied. No loss of engine speed and hertz.	1. Selector switch in wrong position.	1. Place selector switch in COMP position.
High voltage (125 - 135 volts) at N/L with correct voltage when loaded (115 - 120 volts).	1. Generator's engine speed (rpm) high at N/L.	1. Check N/L speed and adjust N/L voltage.
High voltage at N/L and F/L.	1. Generator's engine speed (rpm) high. 2. Short in compound transformer auxiliary windings D-3.	1. Check N/L rpm and adjust N/L voltage. 2. Check continuity and connections of D-3 windings.
Low voltage (0 - 5 volts) at N/L with growling noise from generator and loss of engine speed when load is applied.	1. Main stator windings shorted C-1, C-2. 2. Compound transformer windings shorted D-1, D-2.	1. Check continuity and resistance values of C-1, C-2 windings and connections. 2. Check continuity and resistance values of D-1, D-2 windings.
Generator does not excite; voltage is 0 volts at N/L.	1. Generator's engine speed is slow. 2. Short in the main stator windings or transformer.	1. Adjust the engine's speed and adjust N/L voltage. 2. Check the diodes as shown in this manual.
Low voltage (10 - 20 volts) at N/L, when load is applied, voltage drops.	1. Diodes(s) in rotating exciter (B-2) shorted. 2. Bridge rectifier defective. 3. Auxiliary windings B-1 shorted. 4. Auxiliary windings D-3 and/or C-3 open.	1. Check B-1 and B-2 in the rotating exciter as explained in this section. 2. Follow test procedure for the bridge rectifier. 3. Check the continuity and resistance values. 4. Check the continuity and resistance values of windings and connections.
Low voltage at N/L and F/L (50 - 70 volts).	1. Exciter stator windings (A) are open. 2. Generator's engine speed (rpm) is too low.	1. Check the continuity and resistance values of the windings. 2. Check the N/L rpm and adjust the N/L voltage. Check and adjust the engine's rpm.
Voltage correct at N/L, but not at F/L with loss of engine rpm (hertz).	1. Generator overload. 2. Rotating diode failing. 3. Generator's engine speed is low. 4. Low power load factor.	1. Monitor the load. 2. Check the diode. 3. Check the electronic governor operation. 4. Check the type of load applied. Consider use of optional regulator board.
Voltage correct at N/L and loss of voltage at F/L. High voltage at N/L with no adjustment from regulator potentiometer.	1. Diode in exciter rotor B-2 shorted. 1. Regulator board defective.	1. Check the diodes in the exciter rotor. 1. Replace the regulator board. Adjust N/L voltage with transformer; then switch to ELEC and adjust with A.V.R. potentiometer.

(continued)

BT GENERATOR TROUBLESHOOTING CHART

Problem	Probable Cause	Verification/Remedy
Low voltage at N/L and F/L. No adjustment from regulator potentiometer.	<ol style="list-style-type: none"> 1. Regulator board defective. 2. Exciter stator winding A-1 open. 	<ol style="list-style-type: none"> 1. Replace the regulator board. Adjust N/L voltage with transformer; then switch to ELEC and adjust with A.V.R. potentiometer. 2. Check resistance values of C-3 and D-3 windings and their connections.
Low voltage at N/L and voltage drops further as a load is applied.	<ol style="list-style-type: none"> 1. Diode(s) in exciter rotor shorted (B-2). 2. Auxiliary windings in exciter rotor shorted (B-2). 	<ol style="list-style-type: none"> 1. Check the diodes in the exciter rotor. 2. Check the resistance values and continuity to ground.
Voltage OK at N/L and low at F/L.	<ol style="list-style-type: none"> 1. Auxiliary windings in the exciter rotor. 2. Exciter stator compound winding A-2 is open 3. Auxiliary windings D-3 or C-3 open. 	<ol style="list-style-type: none"> 1. Check the resistance values and continuity to ground. 2. Check the continuity and the connection of the winding. 3. Check the continuity and the connection of the winding.
Voltage unstable.	<ol style="list-style-type: none"> 1. Defective regulator board. 2. Engine is hunting. Engine's rpm fluctuating. 3. Electrical connections. 	<ol style="list-style-type: none"> 1. Check the stability of DC voltage from the regulator to the exciter stator windings. Operate the unit on COMP. Replace the regulator board. 2. Check the engine operation and the fuel system. 3. Check for clean and secure connections. <p style="text-align: right;"><i>See ENGINE ADJUSTMENTS.</i></p>

BT GENERATOR TROUBLESHOOTING

Testing Residual Voltage

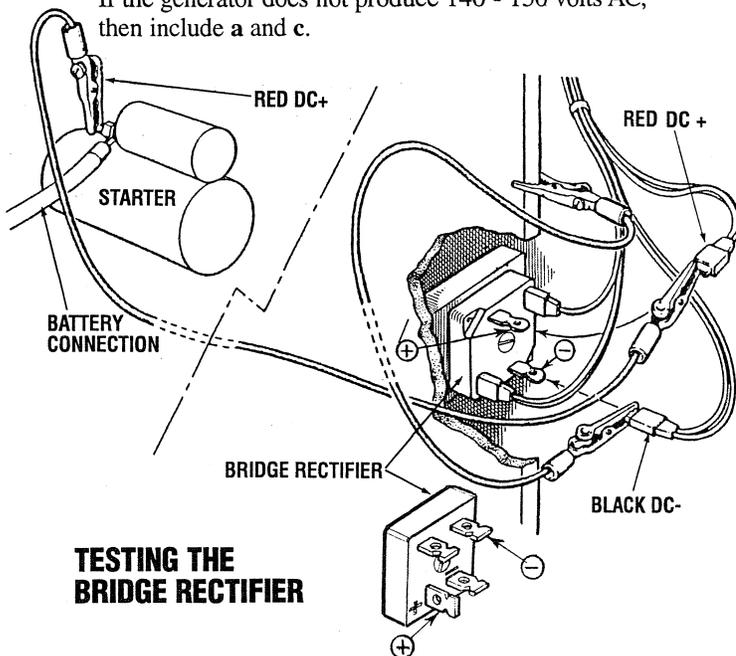
1. The amount of no-load voltage produced by the generator can be an indicator of where in the generator the problem/fault may lie.

Residual Voltage 10-14 volts AC

This voltage is the AC voltage produced by the generator from magnetism in the exciter stator field. This voltage is measured between the AC Neutral and Hot leg(s) with no-load on the generator running at 60 hertz.

The presence of residual voltage is an indication that the following generator components are OK. Refer to *INTERNAL WIRING SCHEMATICS*.

- a. Exciter Rotor (B-1 a, b, & c) & (B-2);
 - b. Rotating Field (B-3);
 - c. Main Stator (C-1 & C-2); and
 - d. Compound Transformer (D-1 & D-2).
- The fault lies in one or more of the following components in the exciter circuit:
- a. Exciter Stator (A-1 & A-2)
 - b. Bridge Rectifier (G)
 - c. Selector Switch (F)
 - d. Main Stator Auxiliary Windings (C-3)
 - e. Compound Transformer Auxiliary Winding (D-3)
2. Twelve (12) volt DC excitation of the exciter stator windings should cause the generator to produce between 140 - 150 volts AC between each hot lead and the neutral (12 volts DC is applied between the lifted (+) and (-) leads of the bridge rectifier, + to + and - to -).
Correct voltage produced with twelve volts DC excitation indicates the fault is in one or more of the above listed components **b, d** or **e**.
If the generator does not produce 140 - 150 volts AC, then include **a** and **c**.



TESTING THE BRIDGE RECTIFIER

NOTE: Current BT Generators use a bridge rectifier that is configured differently, connections are the same.

3. The absence of any voltage from the generator indicates a fault with the main stator windings C-1 and C-2 and/or the compound transformer windings D-1 and D-2.
Apply 12 volt DC excitation to the exciter stator windings as explained in paragraph 2. A fault in the main stator and/or compound transformer windings such as a short will cause the generator engine to load down and the shorted windings to eventually produce smoke as the excitation is continued.
4. Voltage output greater than residual and less than rated output (25 - 100 volts) indicates a fault in the exciter rotor/field B-1, B-2 or B-3. Excitation of the generator as explained in paragraph 2 should produce a partial rise in voltage output and, when removed, the voltage will return to the original low output.

BRIDGE RECTIFIER

The bridge rectifier is supplied AC voltage from the auxiliary windings in the generator stator (C-3) and the compound transformer (D-3). The AC voltage measured across the AC terminals of the rectifier during engine operation is as follows:

120 Volts	120/240
N/L F/L	N/L F/L
11 - 20 volts AC	11 - 20 volts AC

Diodes in the rectifier convert this AC voltage to DC and supply it to the windings of the exciter stator to induce a field through which the exciter rotor revolves. The DC voltage measured across the (+) and (-) terminals of the bridge rectifier during engine operation is as follows:

120 Volts	120/240
N/L F/L	N/L F/L
8 - 15 volts AC	8 - 15 volts AC

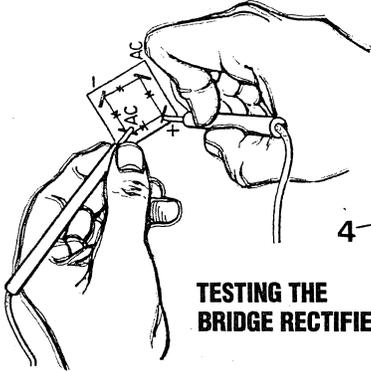
Failure of the bridge rectifier will result in a weak field being produced by the exciter stator windings. A weak field is present, due to the magnetism in the exciter stator, which will cause the generator to produce residual voltage.

Testing the Bridge Rectifier for Faults with an Ohmmeter

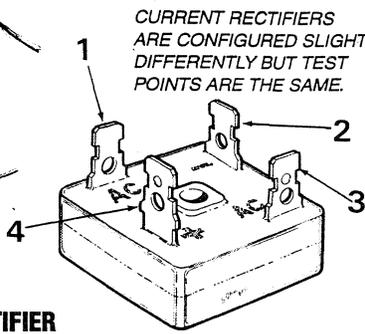
(Meter used: *Simpson 260* at 70°F (21°C))

1. Set the ohmmeter scale on RX1 (+ DC) and set the needle to zero.
2. Connect the positive (+) lead from the ohmmeter to point #4. Taking the ohmmeter's negative (-) lead, momentarily contact points #1, #2, #3, and #5. The ohmmeter should register no deflection for any of the points touched.
3. Remove the positive (+) lead from point #4 and connect the negative (-) lead to point #4 and, with the positive (+) lead, momentarily touch points #1, #2, and #3. The ohmmeter's needle should deflect when each point is touched, showing a passage of meter voltage through the diodes in the rectifier.

BT GENERATOR TROUBLESHOOTING/SINGLE PHASE



TESTING THE BRIDGE RECTIFIER



CURRENT RECTIFIERS ARE CONFIGURED SLIGHTLY DIFFERENTLY BUT TEST POINTS ARE THE SAME.

- Leaving the negative (-) ohmmeter lead on point #4, touch point #5 with the positive (+) lead. No deflection of the needle should occur.
- Place the positive (+) lead of the ohmmeter on point #1 and the negative (-) lead on point #3. The ohmmeter should not register any deflection of the needle (no deflection indicates infinite resistance). Reverse these connections and the ohmmeter should again register no deflection.

If the rectifier fails any of the previous tests (1 - 4) it is defective and should be replaced.

NOTE: Different style/model meters may produce opposite results from the above tests.

Component Resistance Values

A. Exciter Stator	B. Exciter Rotor/Field
A-1 & A-2 11.5 ohm	B-1 1.05 ohm,
A-1 49.4 ohm	B-2 8.9 ohm
A-2 12.9 ohm	
C. Main Stator	D. Compound Transformer
C-1 0.089 ohm	D-1 0.007 ohm
C-2 0.089 ohm	D-2 0.007 ohm
Auxiliary Windings	Auxiliary Windings
C-3 0.85 ohm	D-3 5.02 ohm

- E. A.C. Terminal Board
- F. Selector Switch
- G. Bridge Rectifier
- H. Optional AVR (early models)

The model code number is found stamped in the generator housing on a flat surface above the rear generator carrier bearing.

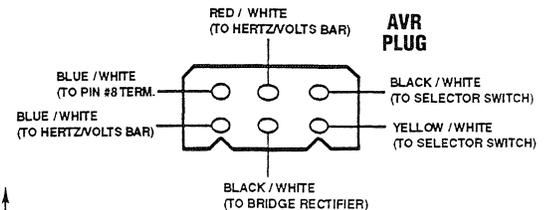
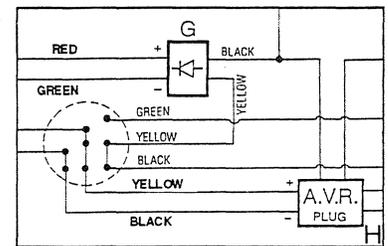
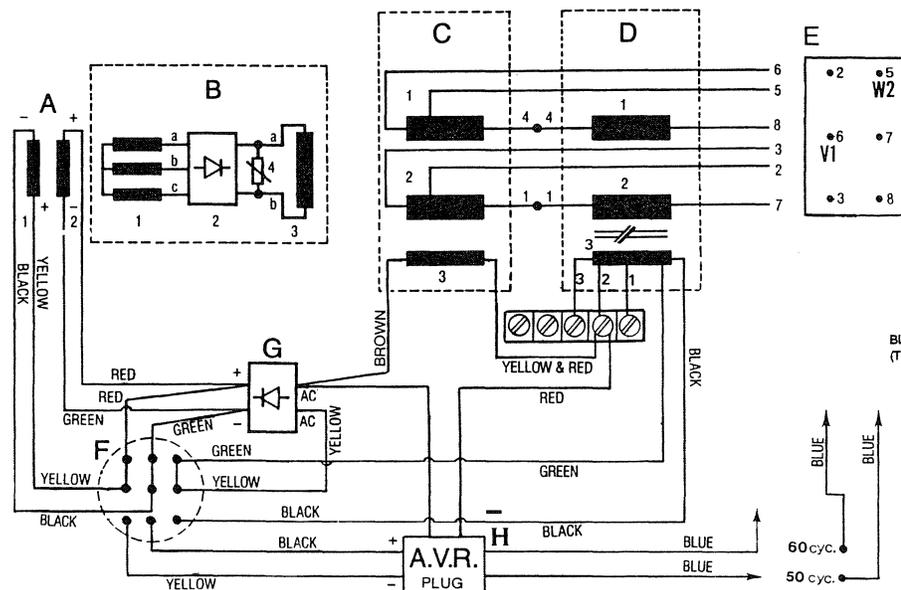
NOTE: These two model BT generators are used on models rated lower than the capabilities of the generator. However, the generator is rated according to the capabilities of the drive engine since horsepower produces kilowatts.

COMPONENT RESISTANCE CHECKS

Exciter Stator Windings

- Windings A-1 and A-2**
Resistance readings for exciter windings A-1 and A-2 with the selector switch in the COMP position are taken between the positive (+) and negative (-) leads lifted off the bridge rectifier (G). Neither of these two leads should have the continuity to the generator case/ground.
- Winding A-1**
Resistance readings for exciter windings A-1 with the selector switch in the ELEC position is taken between the yellow wire and the black at the A.V.R. plug (G).
- Winding A-2**
Resistance readings for exciter winding A-2 with the selector switch in the ELEC position is taken between the green wire lifted off the negative (-) terminal of the bridge rectifier (G) and the red wires lifted off the positive (+) terminal of the bridge rectifier (G).

NOTE: The white striped wiring on earlier model generators has been changed to solid colors on current generators, the colors, however, remain the same.



BT GENERATOR INTERNAL WIRING SCHEMATIC (W/OPTIONAL AVR)

NOTE: Striped wires were used on early model generators. The colors will, however, matchup to the current solid color wires.

BT GENERATOR TROUBLESHOOTING/SINGLE PHASE

Main Stator Windings

- Group #1.** The resistance value is measured between the lifted lead #4 from the insulated terminal below the transformer and lead #6 lifted from the AC terminal block. Lead #5 should be lifted from the terminal block in order to totally isolate the stator windings of group #1, .
- Group #2.** The resistance value is measured between the lifted lead #1 from the insulated terminal below the transformer and lead #3 lifted from the AC terminal block. In order to totally isolate the stator windings of group #2, lead #2 should be lifted from the terminal block.

NOTE: No continuity should be found between any of the lifted stator leads and the case ground or between the connections of the two groups.

Main Stator Windings 20 - 22 Ohms

- Main Stator Auxiliary Windings.** The resistance values for these windings are measured between the black double lead connection lifted off the AC terminal of the bridge rectifier (G) and the red #3 lead lifted off the Voltage/Hertz connection bar.

NOTE: No continuity should be found between either of these winding groups or to the generator case.

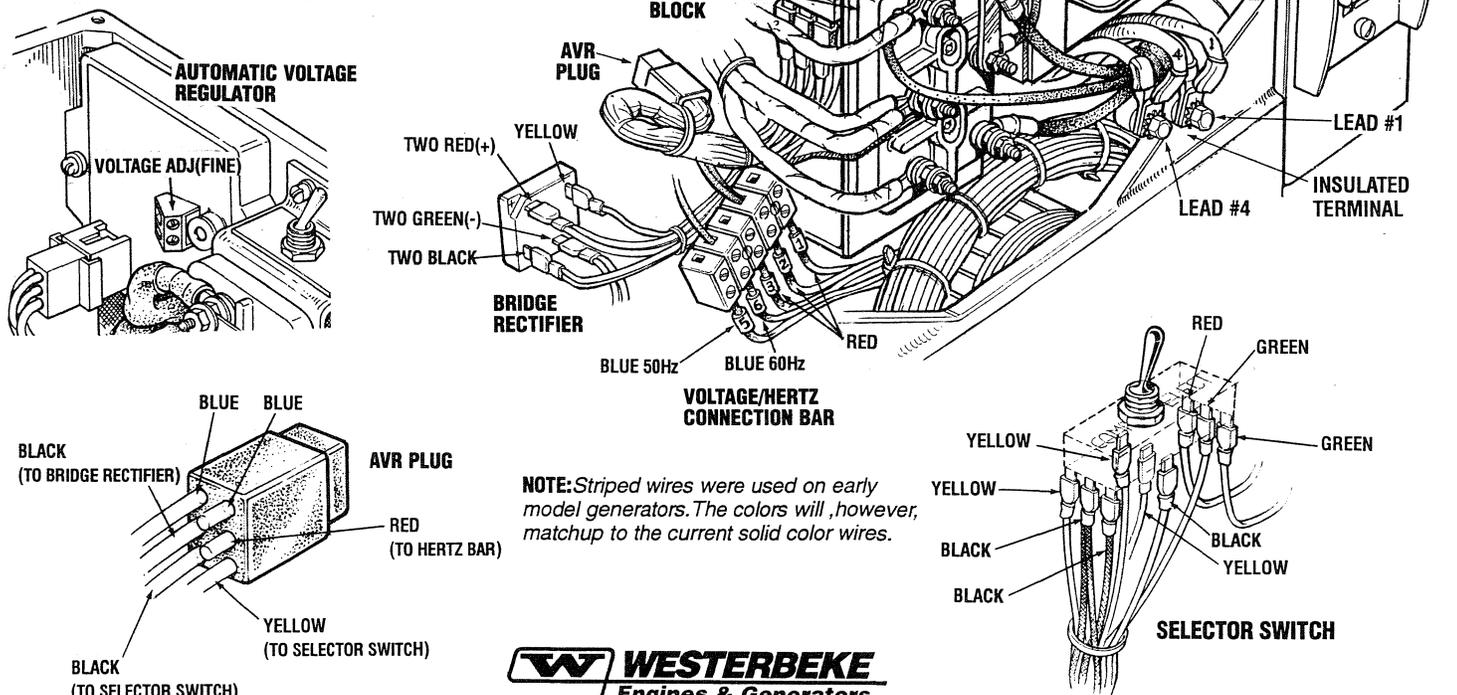
Main Stator Auxiliary Windings 1.5 - 1.8 Ohms

Compound Transformer

- Group 1.** Resistance value is measured between lifted lead #4 from the red insulated terminal stud below the transformer and lead #8 lifted off the AC terminal block.
- Group 2.** Resistance value is measured between lifted lead #1 from the red insulated terminal stud below the transformer and lead #7 lifted off the AC terminal block.

NOTE: No continuity should be found between either of these lifted leads or to the generator case/ground.

Compound Transformer Windings 0.019 - 0.021 Ohms



- Transformer Auxiliary Windings.** Resistance is measured between the yellow wire lifted off the AC terminal block of the bridge rectifier (G) with the selector switch in the ELEC position and the #1 red lead lifted off the Voltage/Hertz connection bar. Off this same bar, lift the #2 and #3 red leads that come from the auxiliary windings to totally isolate these windings. There should be no continuity found from either of these connections to the case/ground or to either of the transformer groups.

Selector Switch

This switch is normally set in the COMP position. If an optional AVR is installed, the switch is toggled to the ELEC position.

NOTE: With the selector switch in ELEC position the exciter stator windings are divided, one group is excited through the bridge rectifier and the other group through the A.V.R.

Bridge Rectifier Wiring

The illustration below shows the color coded wires at the two AC terminals and the color coded wires at the (+) and (-) DC terminals.

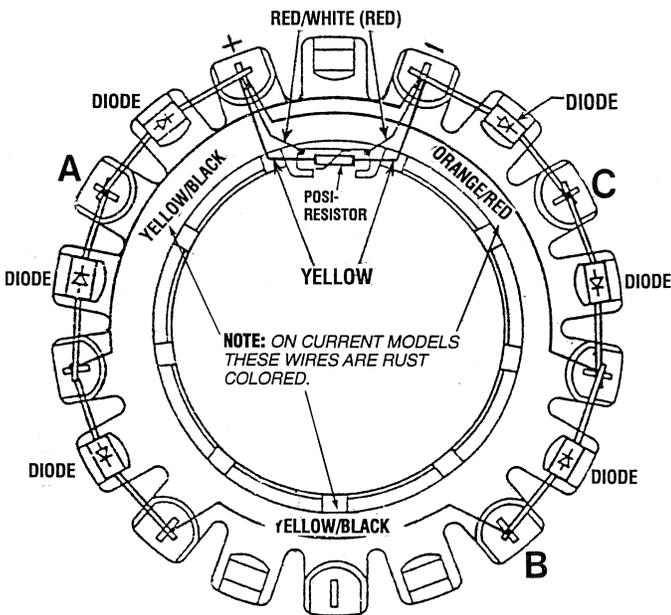
NOTE: When removing or reinstalling connections, maintain correct polarity connection on the (+) and (-) DC terminals.

BT GENERATOR TROUBLESHOOTING

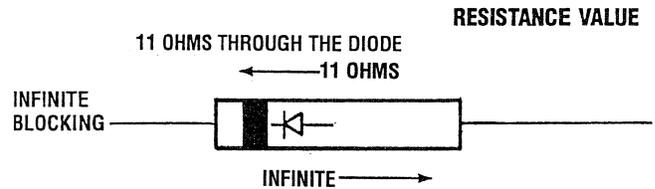
Exciter Rotor/Field

- Auxiliary windings group a, b and c.** Locate the three terminal points on the exciter rotor for these auxiliary winding groups. Position the exciter rotor as shown in the illustration and count off the porcelain knobs from the 12 o'clock point either left or right to locate terminal points a, b and c. Measure the resistance value between the pairs of terminal points A & B, B & C, and C & A. There is no need to unsolder these connections unless a faulty reading appears. If this occurs, unsolder and verify the winding fault. There should be no continuity found between any of the three terminal points and the rotor shaft/case ground.

Auxiliary Windings 1.0 - 1.2 Ohms

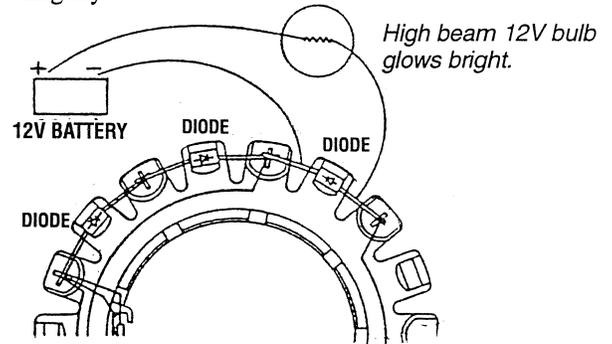


- Rotating Field Windings.** Refer to the illustration above of the exciter rotor. The field winding connections are noted as the (+) and (-) connections of the red & white striped wires. Measure the resistance value with your ohmmeter between these two connection points. These connections need not be unsoldered unless a faulty reading appears. If this occurs unsolder the connection and verify the resistance reading. With these connections lifted, there should be no continuity to the rotor shaft. This would indicate a short to ground with these field windings.
- Diodes.** Six diodes are mounted on the exciter rotor; they rectify the AC voltage produced by the three groups of auxiliary windings to DC voltages and supply this DC voltage to the rotating field windings. The diodes can be easily checked in place with the use of a common automotive 12-volt high beam headlight bulb, some jumper leads and the generator's 12 volt starting battery. A short or an open in a diode can easily be found with the above without having to unsolder and isolate each diode to check it with an ohmmeter.

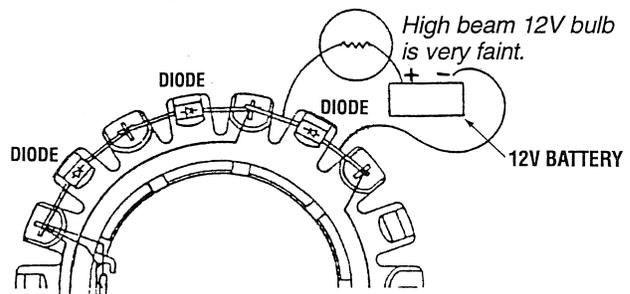


NOTE: Attempting to check diodes in place with an ohmmeter will give erroneous readings on the diodes due to the auxiliary winding's connections.

- When leads are put across the diode, as illustrated, voltage passes through the diode allowing the headlight to glow brightly.



- Reverse the leads across the diode.** The diode should block voltage passing through it, and the headlight should not glow, or it may glow faintly.
 - Should the bulb not glow with leads connected in both directions, the diode is open internally.
 - Should the bulb glow with leads connected in both directions, the diode is shorted internally.
 In both **a** and **b** above, the diode should be replaced. Check the resistance values of the rotating field windings and the integrity of the resistors connected between the field windings.



- Rotating Field Windings 7.0-8.0 ohm.** Readings taken between the two red & white wires connected to the (+) and (-) terminals of the exciter rotor as shown.
- Posi-resistor.** Infinite readings between both yellow leads lifted from the (+) and (-) terminals on the exciter rotor. A short in the posi-resistor will cause a loss of the rotating field. AC output voltage will drop to zero.

BT GENERATOR TROUBLESHOOTING/SINGLE PHASE

No-Load Voltage Adjustment

Voltage adjustment is made with the generator regulation being governed by the compound transformer.

1. The selector switch *must* be in the COMP position.
2. To confirm no-load voltage, start the generator and apply a momentary (moderate) load to excite the transformer. The voltage produced by the generator after the momentary load is removed is no-load voltage. Note the voltage output from the generators 120 volt leg(s) (230 volt 50 hertz). The no-load voltage should be between 121-124 volts at 61.5-62 hertz (232-236 volts at 51.5-52 hertz).
3. To raise or lower the voltage, shims of varying thickness (non-conductive material) are placed or removed from under the steel laminated bar on top of the compound transformer. The material used for shimming should not soften at temperatures in the 176° F (80° C) range. A small reduction in no-load voltage (1 to 3 volts) can some times be accomplished by gently tapping the top of the laminated steel bar to reduce the gap between the existing shims and the transformer core.

VOLTAGE/HERTZ CONNECTION BAR

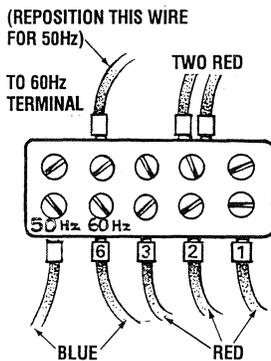
If there is no automatic voltage regulator (AVR) installed, do not change the wiring on the Voltage/Hertz Connection Bar. Simply reconfigure the AC voltage connections at the AC terminal for the hertz change.

The blue or blue/white lead should be connected to the Hertz terminal that the generator will be set to produce.

The order of the numbered connections on some Voltage/Hertz Connection Bars may be reversed (as in the diagrams below). To ensure a proper connection follow the blue/white or blue lead to the AC terminal block, it should connect to the correct terminal: stud 6(V1) for 50 Hz, 5(W2) for 60 Hz. See the *BT WIRING SCHEMATIC*.

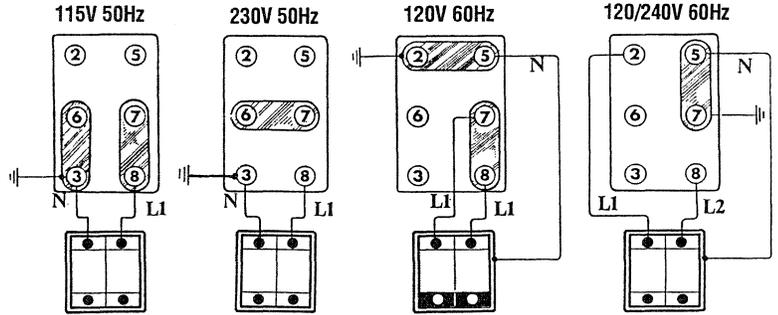
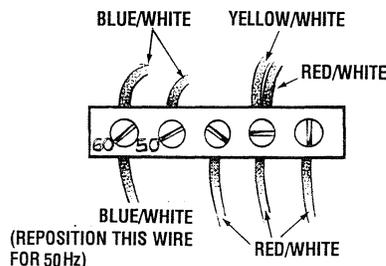
NOTE: When the optional voltage regulator is installed and if the Blue/White (Blue) lead is not correctly positioned to correspond to the Hertz the unit is operating at, the regulator will sense incorrect voltage and cause the generator to produce abnormally high output voltage.

CURRENT MODELS



VOLTAGE/HERTZ CONNECTION BAR

EARLY MODELS



BT Generator Six Stud AC Voltage Connections

NOTE: The frame ground wire must be moved when changing from 110 volts and 110/220 volts 50 hertz to 230 volts 50 hertz. For output leads from the AC terminal block, use terminal ends for 1/4 inch studs that will accept multi-strand copper wire sized for the amperage rating from the hot lead connection. The frame ground wire connects between the neutral stud and the generator frame.

Generator Frequency

1. Frequency is a direct result of engine/generator speed:
 - 1800 rpm = 60 hertz;
 - 1500 rpm = 50 hertz.
2. To change generator frequency follow the steps below.
 - a. Connect the AC output leads to the AC terminal block, following the correct diagram above..
 - b. If an AVR is installed, reposition the blue or blue/white lead to correspond to the hertz selected on the Voltage/Hertz Connection Bar.
 - c. Start the engine, monitor voltage and adjust engine no-load speed. Adjust diesel units by the linkage between the throttle arm and fuel solenoid or the throttle lever on the injection pump.
 - 60 hertz: no-load speed, 61.5-62.0 hertz.
 - 50 hertz: no-load speed, 51.5-52.0 hertz.
 - d. After the no-load hertz adjustment is made, the no-load voltage may need to be readjusted. In most cases, if the generator was producing the correct no-load voltage at the previous hertz setting, it would be correct at the changed hertz setting.

In the event it needs adjustment, adjust the shim thickness under the laminated steel bar of the transformer.

 - 60 hertz: no-load voltage, 121-124 volts
 - 50 hertz: no-load voltage, 232-236 volts,
 - e. Load the generator to the rated amperage output corresponding to the hertz speed of the generator.

Rated Loaded Speed

 - 60 hertz: loaded speed, 58.5-59.0 hertz
 - 50 hertz: loaded speed, 48.5-49.0 hertz

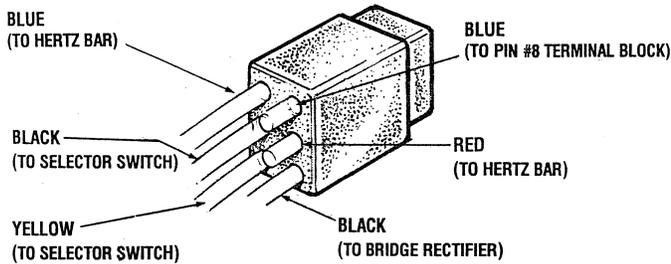
The lowest acceptable voltage at full rated output (amps)

 - 60 hertz: 108-110 volts
 - 50 hertz: 205-210 volts

BT GENERATOR TROUBLESHOOTING

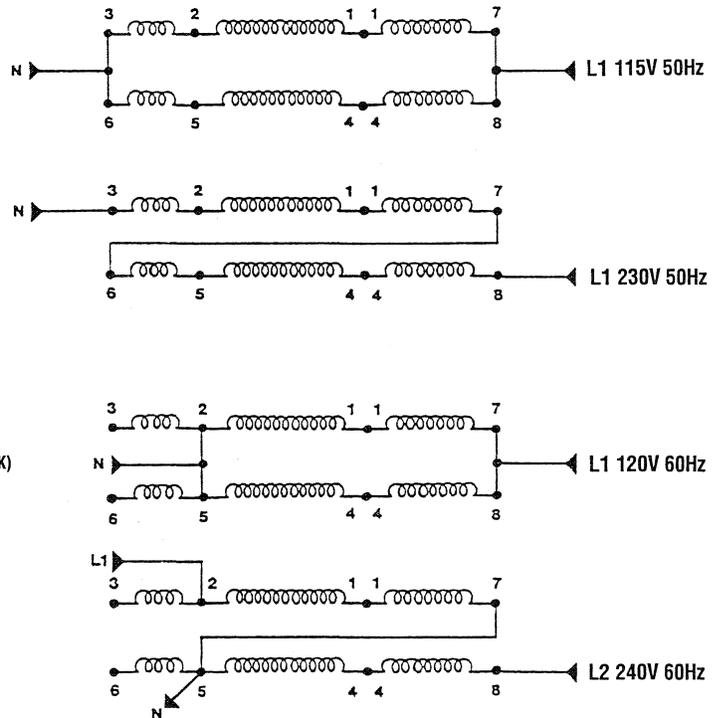
f. Should the voltage drop below the proper rate, loaded excitation can be increased to raise this voltage by repositioning connections on the Voltage/Hertz Connection Bar. Repositioning the two leads (red/white and yellow/white) from (1) to (2) or (3) terminals will increase the loaded voltage out progressively in that order.

NOTE: No-load voltage may be effected needing readjustment with the compound transformer. **Do not** use these adjustments to compensate for overload conditions being placed on the generator/engine (inductive-motor type loads). Loss of generator hertz/speed, the result of overload, will cause a drop in voltage output.



NOTE: Striped wires were used on early model generators. The colors will, however, matchup to the current solid color wires.

A.V.R. Plug and Connections



Terminal Block Wiring Connections

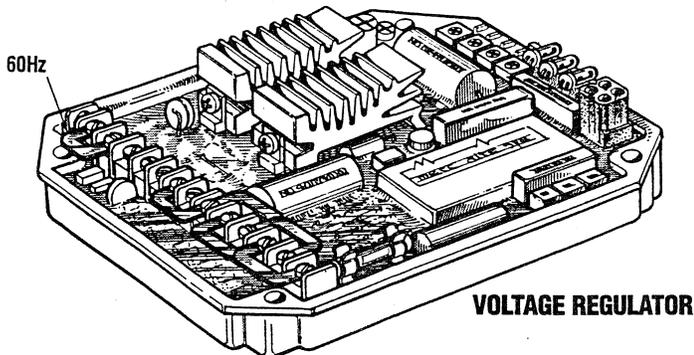
Wiring connections needed to obtain proper voltage and frequency are illustrated in the diagrams above.

NOTE: Connections 1 and 4 are located on two red terminals below the compound transformer.

BT GENERATOR VOLTAGE REGULATOR ADJUSTMENTS

Description

The voltage regulator is an advanced design which ensures optimum AC generator performance. It is equipped with complete protection circuitry to guard against operating conditions that could be detrimental to the AC generator.



Volts

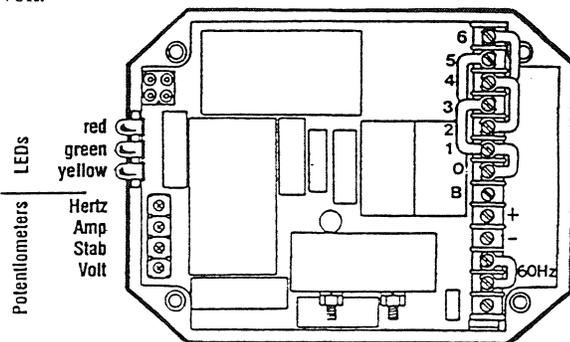
This potentiometer is used to adjust output voltage. At proper engine operating speed the output voltage should be held at $\pm 1\%$ from a no-load condition to a full rated generator output and from power factor 1.0 - 0.8 with engine drive speed variations up to -6%. Prior to starting the engine, turn the VOLT and STAB trimmers (using a mini phillips screwdriver) fully in a counter clockwise (Minimum) direction until you feel them hit their stops. Turn the AMP and HERTZ trimmers completely clockwise (Maximum) in the same manner. With the generator running at no-load, at normal speed, and with VOLT adjust at minimum, it is possible that output voltage will oscillate. Slowly rotate the VOLT adjust clockwise. The voltage output will increase and stabilize. Increase the voltage to the desired value. In this situation, only the green LED will stay lit.

Stability

This potentiometer permits variation of the regulator's response to generator load changes so as to limit overcompensation and obtain a minimum recovery time to the normal voltage output.

In order to adjust the regulator stability the generator must be running at no-load and the output must be monitored.

Turn the STAB adjust slowly clockwise until the voltage starts to fluctuate. At this point rotate the STAB adjust counterclockwise until the voltage is stable within 1 or 2 tenths of a volt.



VOLTAGE REGULATOR DIAGRAM

Amp-Hertz

These two adjustments are used in conjunction with the two protection circuits in the voltage regulator that are indicated by the illumination of colored LED lights.

1. Delayed overload protection (yellow LED).
2. Low speed protection (red LED).

Both systems have an intervention threshold which can be adjusted using the respective potentiometer. Each of the two circuits are able to cause an adequate reduction in excitor voltage to safeguard the excitor windings and prevent their overheating.

The overload protection system has a delay which permits temporary overloading of the generator during times such as motor start-up or other similar load surge demands. The regulator also has a third LED (green), that glows during generator operation to indicate correct operation of the regulator with the generator.

Setting the Overload Protection

In order to set the AMP overload protection, the generator must be loaded to its full output rating.

1. Load the generator to its rating, then decrease the speed of the engine by 10.10% (54 Hertz on 60 hertz units, 45 hertz on 50 hertz units).
2. Rotate the AMP adjustment counterclockwise until it hits its stop. Wait about 15-20 seconds after which the AC output of the generator should drop and the yellow LED light should come on.
3. Slowly rotate the AMP adjustment clockwise until the output voltage increases to approximately 97% of the voltage output at the start of the adjustment. At this point the yellow LED light should come on.
4. Return to nominal speed, the yellow LED will turn off and the generator voltage will rise to its normal value. Should this not happen, repeat the adjustment.

NOTE: When changing from 60 hertz to 50 hertz operation, remove the 60 hertz jumper bar from the regulator board.

Setting the Underspeed Protection

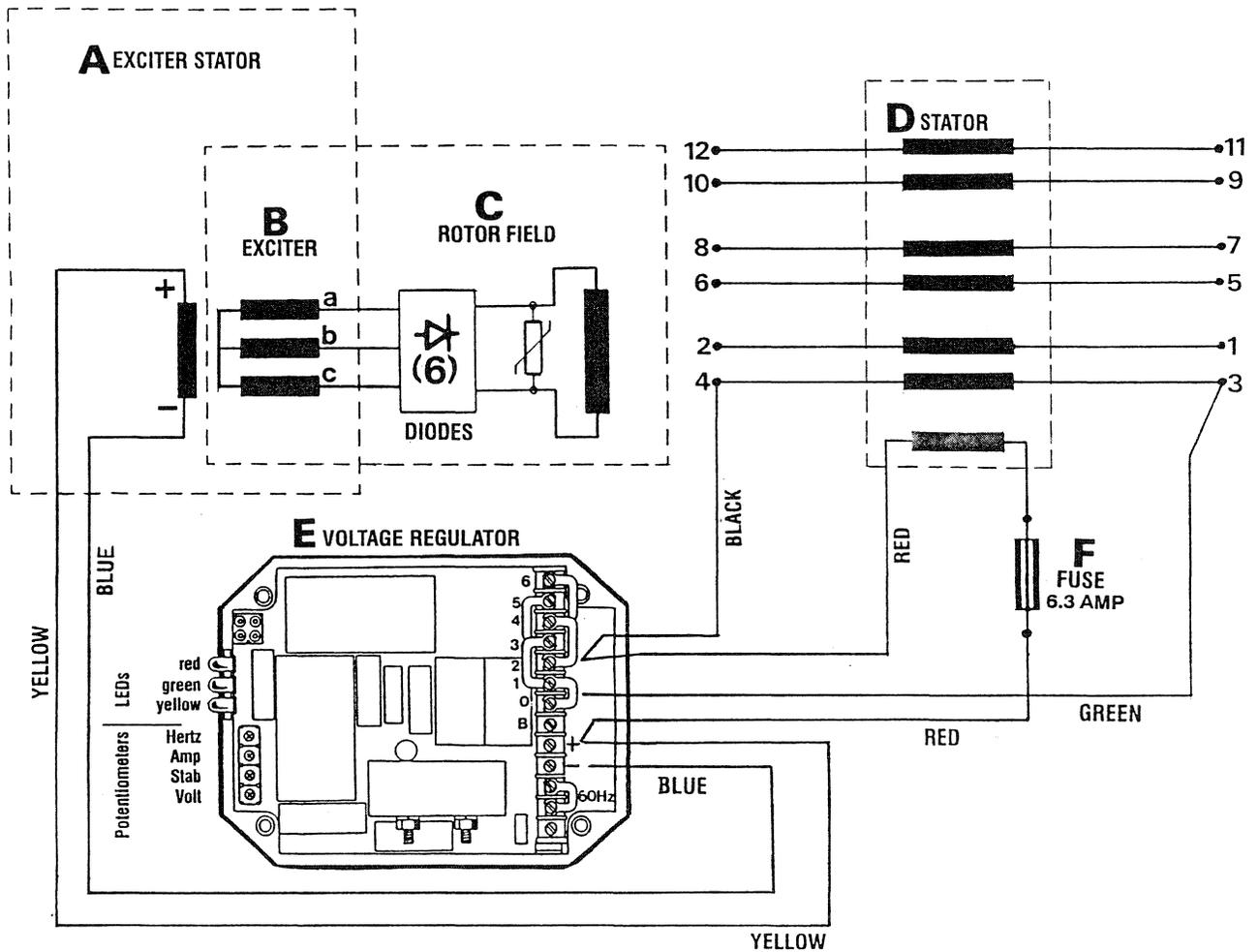
NOTE: If the unit is operating at 60 Hertz ensure that the jumper strap is in place on the regulator board between the two 60 Hertz terminals. In order to adjust the underspeed setting, the generator should be running at no-load.

1. To adjust the underspeed (low frequency) protection circuit, lower the engine speed at 90% of its normal running speed (54 hertz on 60 hertz units, 45 hertz on 50 hertz units).
2. Rotate the Hertz adjustment counterclockwise slowly until the generator's AC output voltage starts to decrease and at the same time the red "LED" light comes on.
3. Increase the engine speed to its normal speed (frequency). The red "LED" light will go out and the AC voltage output will return to normal.

With the above adjustments made, the regulator should function normally.

BT GENERATOR INTERNAL WIRING

3 PHASE TWELVE WIRE RECONNECTABLE



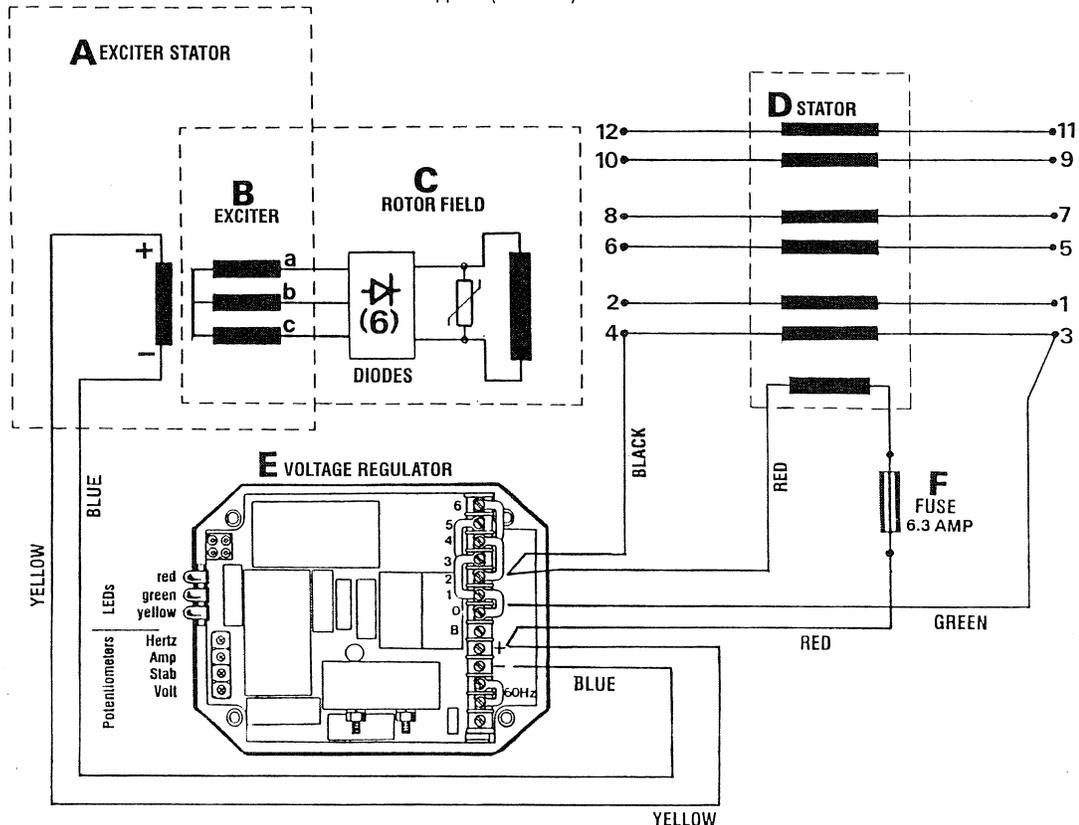
Resistance Values

- | | |
|---|---|
| <p>A. EXCITER STATOR (17.9 ohm)</p> <p>B. EXCITER ROTOR WINDINGS a b c (0.6 ohm)</p> <p>C. ROTATING FIELD (2.49 OHM)</p> | <p>D. MAIN STATOR-WINDINGS (0.05 OHM)
AUXILIARY WINDING (1.2 OHM)</p> <p>E. VOLTAGE REGULATOR</p> <p>F. AUXILIARY CIRCUIT FUSE</p> |
|---|---|

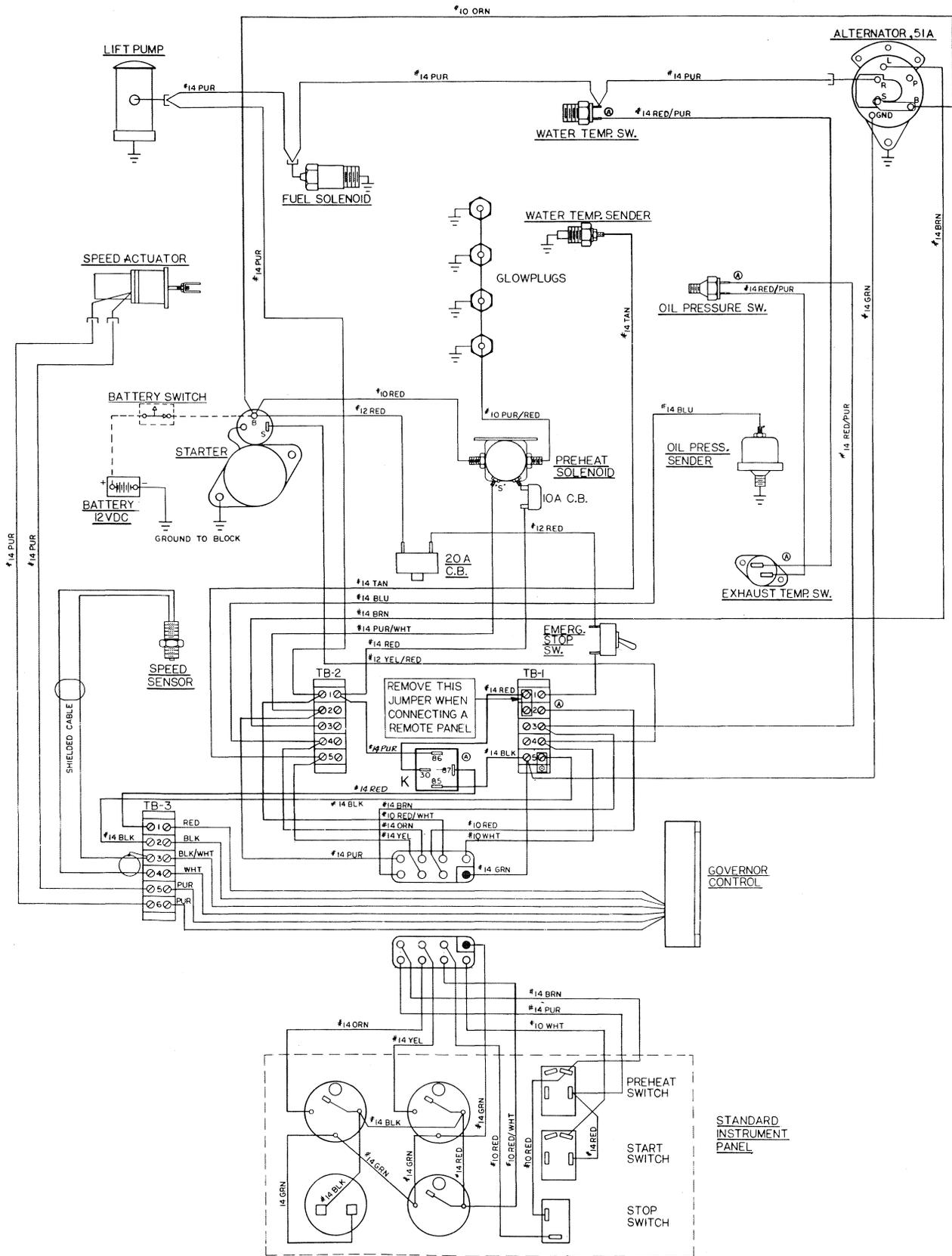
BT GENERATOR TROUBLESHOOTING/3 PHASE

NOTE: AC GENERATOR TROUBLESHOOTING MUST BE PERFORMED WITH ENGINE OPERATING AT 60 HERTZ.

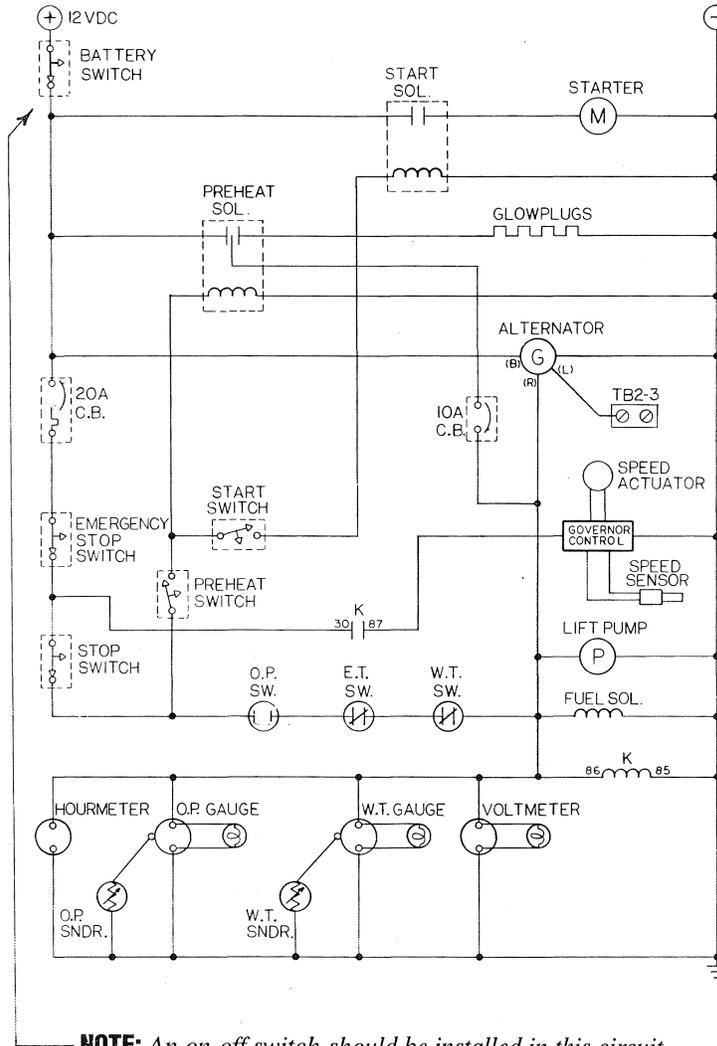
FAULT	PROBABLE CAUSE	
No AC voltage output at no load.	<ol style="list-style-type: none"> 1. Short or open in the main stator winding. 2. Shorted pozi-resistor on exciter rotor. 3. Four or more shorted or open diodes on exciter rotor. 	<ol style="list-style-type: none"> 4. Short or open in exciter stator winding. 5. Short or open in rotating field winding.
Residual voltage produced at no load 15 - 20 volts AC.	<ol style="list-style-type: none"> 1. Blown 6 AMP buse fuse auxiliary circuit feed to AVR. 2. Faulty voltage regulator. 	<ol style="list-style-type: none"> 3. Shorted or open main stator auxiliary winding.
Low AC voltage output at no load 60 - 100 VAC.	<ol style="list-style-type: none"> 1. Open or shorted diodes in exciter rotor 1 to 3 diodes. 2. Open or shorted exciter rotor winding. 	<ol style="list-style-type: none"> 3. Faulty voltage regulator.
High AC output voltage 150 VAC or higher.	<ol style="list-style-type: none"> 1. Faulty voltage regulator. 	
Unstable voltage output.	<ol style="list-style-type: none"> 1. STB pod on regulator needs adjustment. 	<ol style="list-style-type: none"> 2. Faulty voltage regulator.
AC voltage drop under load 60 - 100 volts AC.	<ol style="list-style-type: none"> 1. Diode(s) on exciter rotor breaking down when load is applied (inductive) 1-3 diodes. 	



BT GENERATOR WIRING DIAGRAM #039422 WITH ELECTRONIC GOVERNOR

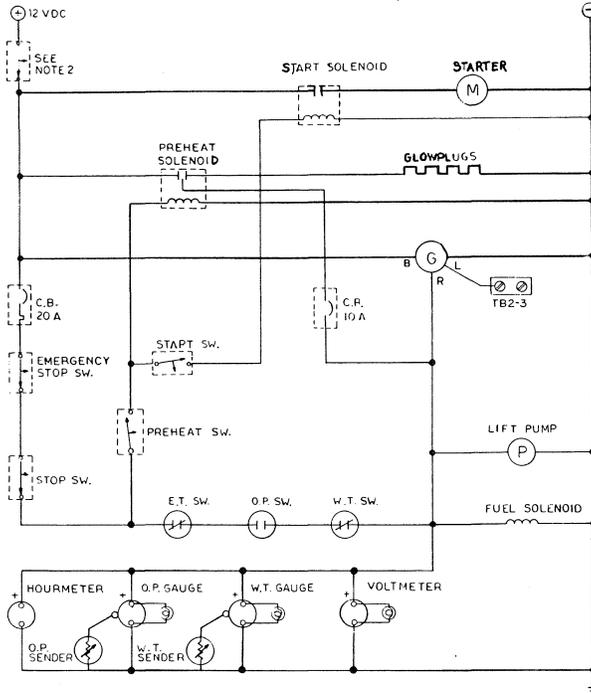


BT GENERATOR WIRING SCHEMATIC #039422 WITH ELECTRONIC GOVERNOR



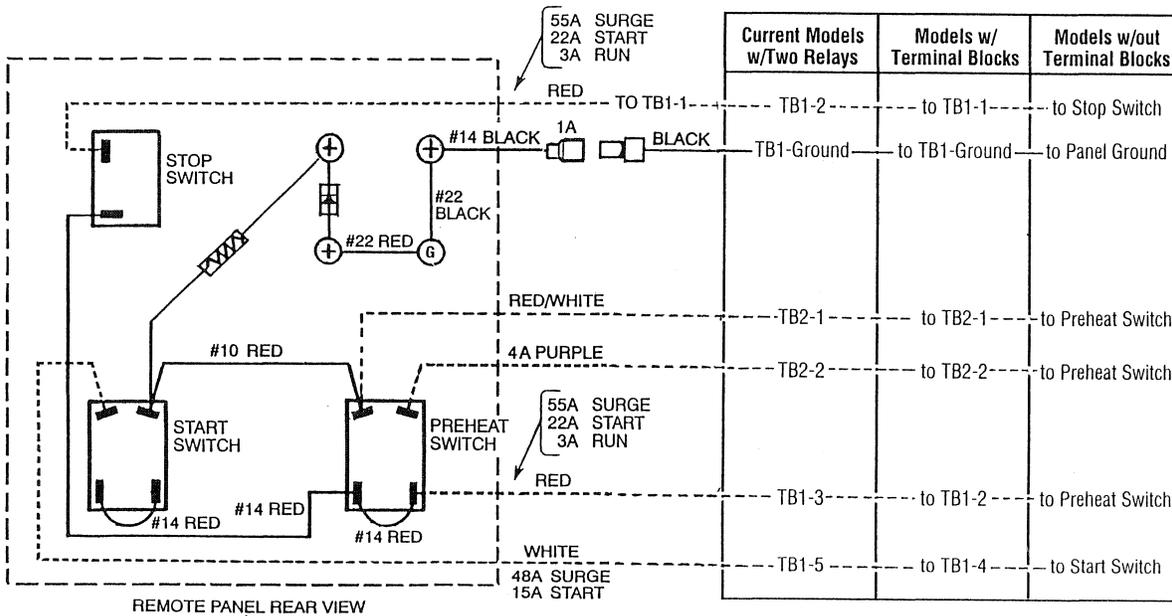
NOTE: An on-off switch should be installed in this circuit to disconnect the starter from the battery in an emergency and when leaving the boat. Twelve volt diesel engine starters typically draw 200 to 300 amps when cranking. A switch with a continuous rating of 175 amps at 12 VDC will normally serve this function, but a switch must never be used to "make" the starter circuit.

BT GENERATOR WIRING SCHEMATIC #36411 W/OUT ELECTRONIC REGULATION



NOTE: An on-off switch should be installed in this circuit to disconnect the starter from the battery in an emergency and when leaving the boat. Twelve volt diesel engine starters typically draw 200 to 300 amps when cranking. A switch with a continuous rating of 175 amps at 12 VDC will normally serve this function, but a switch must never be used to "make" the starter circuit.

REMOTE START/STOP PANEL



GENERATOR SPECIFICATIONS

AC GENERATOR (Single Phase)	
Single Phase	Brushless, four-pole, revolving field. Pre-lubricated, single-bearing design. Reconnectable, single-phase transformer regulation (optional solid-state voltage regulation).
Voltage	120 or 120/240 Volts - 60 Hertz 230 Volts - 50 Hertz.
Voltage regulation:	±5% no load to full load.
Frequency regulation:	3 Hertz (5%) no load to full load. (Electronic Governed) Non-Electric ±3 Hertz
Rating (Volts AC)	60 Hertz (1800 rpm) 120 Volts 125 Amps 120/240 Volts 125/62.5 Amps 50 Hertz (1500 rpm) 230 Volts 60 Amps
Generator Cooling Air Requirements (60 Hertz) at 1800 rpm	225 - 250 cfm (6.37 - 7.08 cmm) NOTE: Increase air supply 15% for 50 Hertz operation (1500 rpm).
Engine Combustion Air Requirements (60 Hertz), at 1800 rpm	70 cfm (1.89 cmm)
Generator Compartment Ambient Temperature Recommendations	104°F (40°C) maximum NOTE: Forced ventilation should be provided to maintain generator compartment temperatures below 104°F (40°C).

AC GENERATOR (3 Phase)	
Three Phase 15.0 Kw - 60 Hertz 12.0 Kw - 50 Hertz	Brushless, six-pole, revolving field. Sealed lubricated, single-bearing design. 12 Lead reconnectable for low voltage WYE, high voltage Delta. Solid state voltage regulator with protection circuitry
Voltage - 3 phase 50 Hertz	Low Voltage WYE 208 Volts High Voltage WYE 480 Volts DELTA 240 Volts
Voltage - 3 Phase 50 Hertz	High Voltage WYE 380 Volts DELTA 230 Volts
Amperage - 3 phase 60 Hertz	Low Voltage WYE 52 Amps High Voltage WYE 22 Amps DELTA 45 Amps
Amperage - 3 phase 50 Hertz	High Voltage WYE 22 Amps DELTA 39 Amps
Generator Compartment Ambient Temperature Recommendations	104°F (40°C) maximum NOTE: Forced ventilation should be provided to maintain generator compartment temperatures below 104°F (40°C).

For WTA Generator Resistance Values, see page 86. For WMF Generator Resistance Values, see page 70.

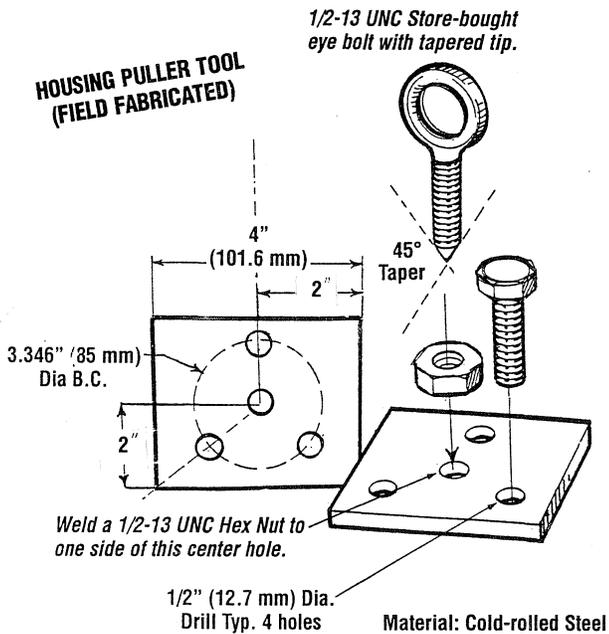
SPECIAL TOOLS - GENERATOR

FIELD FABRICATED TOOLS

These drawings provide a means by which simple tools can be made to assist in the removal of the generator end from the engine and in the replacement of the generator end on the engine. A local machine shop should be able to fabricate these tools at a modest price, but first check with your local WESTERBEKE dealer to see if these tools are on hand for loan.

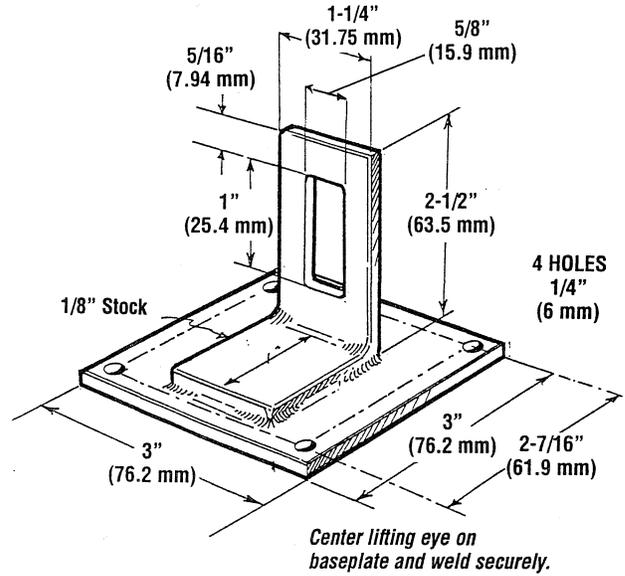
Housing Puller Tool

This tool allows the bearing in the generator housing to be gently pushed straight off the housing without any twisting. If a nut of the same specifications as that of the tapped hole in the pilot tool were to be welded on the end of the eye bolt, this tool would be able to pull the bearing back into place without any twisting. Please refer to these drawings before the generator end is removed.



Lifting Eye Tool

This tool allows a mechanic to safely remove the generator end from the engine by attaching this Generator End Lifting Eye to the four screw holes located under the control panel. To use this Lifting Eye, remove the generator's control panel and screw the Lifting Eye to the generator end.



Disk Alignment Tool

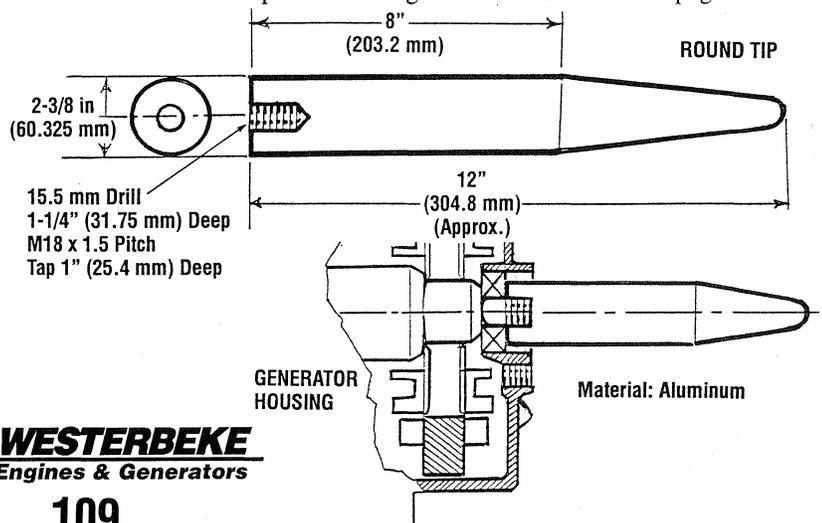
This tool allows a mechanic to safely remove and install the generator drive disks by aligning the disks with the Drive Plate Guide Pin. The Pin screws into the flywheel and acts as a guide. Also the pin helps to support some of the rotor and the drive plate's weight while removing or replacing these parts.



Material: One M8 bolt with the hex head machined off and a screwdriver slot cut in the machined end.

Pilot Tool

The tool below helps keep the rotor from damaging the windings in the generator housing to be removed straight off the engine or to be placed straight on the engine. Refer to the removal and replacement diagram at the bottom of the page.



PROPER USE OF HOUSING PULLER

METRIC CONVERSIONS

INCHES TO MILLIMETERS

MILLIMETERS TO INCHES

Inches	mm	Inches	mm	mm	Inches	mm	Inches
1	25.40	15	381.00	1	0.0394	15	0.5906
2	50.80	20	508.00	2	0.0787	20	0.7874
3	76.20	25	635.00	3	0.1181	25	0.9843
4	101.60	30	762.00	4	0.1575	30	1.1811
5	127.00	35	889.00	5	0.1969	35	1.3780
10	254.00	40	1016.00	10	0.3937	40	1.5748

10 MILLIMETERS = 1 CENTIMETER, 100 CENTIMETERS = 1 METER = 39.37 INCHES (3.3 FEET)

INCHES TO METERS

METERS TO INCHES

Inches	Meters	Inches	Meters	Meters	Inches	Meters	Inches
1	0.0254	7	0.1778	0.1	3.937	0.7	27.559
2	0.0508	8	0.2032	0.2	7.874	0.8	31.496
3	0.0762	9	0.2286	0.3	11.811	0.9	35.433
4	0.1016	10	0.2540	0.4	15.748	1.0	39.370
5	0.1270	11	0.2794	0.5	19.685	1.1	43.307
6	0.1524	12	0.3048	0.6	23.622	1.2	47.244

TO CONVERT METERS TO CENTIMETERS, MOVE DECIMAL POINT TWO PLACES TO THE RIGHT

YARDS TO METERS

METERS TO YARDS

Yards	Meters	Yards	Meters	Meters	Yards	Meters	Yards
1	0.91440	6	5.48640	1	1.09361	6	6.56168
2	1.82880	7	6.40080	2	2.18723	7	7.65529
3	2.74320	8	7.31520	3	3.28084	8	8.74891
4	3.65760	9	8.22960	4	4.37445	9	9.84252
5	4.57200	10	9.14400	5	5.46807	10	10.93614

MOVE DECIMAL POINT FOR HIGHER VALUES — e.g. 6,000 METERS = 6,561.68 YARDS

POUNDS TO KILOGRAMS

KILOGRAMS TO POUNDS

lb	kg	lb	kg	kg	lb	kg	lb
1	0.454	6	2.722	1	2.205	6	13.228
2	0.907	7	3.175	2	4.409	7	15.432
3	1.361	8	3.629	3	6.614	8	17.637
4	1.814	9	4.082	4	8.818	9	19.842
5	2.268	10	4.536	5	11.023	10	22.046

GALLONS TO LITERS

LITERS TO GALLONS

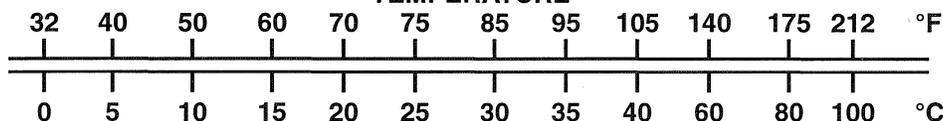
Gallons	Liters	Gallons	Liters	Liters	Gallons	Liters	Gallons
1	3.79	10	37.86	1	0.26	60	15.66
2	7.57	20	75.71	2	0.53	90	23.77
3	11.36	30	113.57	5	1.32	120	31.32
4	15.14	40	151.42	10	2.64	150	39.62
5	18.93	50	189.28	20	5.28	180	47.54

PINTS TO LITERS

LITERS TO PINTS

Pints	Liters	Pints	Liters	Liters	Pints	Liters	Pints
1	0.47	6	2.84	1	2.11	6	12.68
2	0.95	7	3.31	2	4.23	7	14.79
3	1.42	8	3.79	3	6.34	8	16.91
4	1.89	9	4.26	4	8.45	9	19.02
5	2.37	10	4.73	5	10.57	10	21.13

TEMPERATURE



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