

TECHNICAL MANUAL

WESTERBEKE CORPORATION

**BCG 4.0 & 6.5 KW AND BTG 9.0 KW - 60 HERTZ
BCG 3.0 & 4.8 KW AND BTG 7.0 KW - 50 HERTZ
MARINE GASOLINE GENERATORS**

SINGLE PHASE

Publication #036209

Edition Three

December 1991



SAFETY PRECAUTIONS

The following symbols appear in this manual to call attention to and emphasize conditions potentially dangerous to the operator.

WARNING

The above symbol is used in the manual to warn of possible serious personal injury or loss of life.

CAUTION

The above symbol is used in the manual to caution personnel of possible damage to equipment.

Read the manual carefully and thoroughly before attempting to operate the equipment. Know when dangerous conditions can exist and take necessary precautions to protect personnel and equipment.

Fuels, exhaust gases, batteries, electrical equipment, and moving and hot parts are potential hazards that could result in serious personal injury or death. Follow recommended procedures carefully.

Always operate bilge blowers for at least five minutes before starting a gasoline-fueled engine; ensure no gasoline fumes are present before starting.

● Prevent Electric Shock

Shut off electric power before accessing electrical equipment.

Use insulated mats whenever working on electrical equipment.

Make sure your clothing is dry, not damp (particularly shoes), and keep your skin surfaces dry when handling electrical equipment.

Remove wristwatch and 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 is not done.

Be extremely careful when working on electrical components. High voltage can cause injury or death.

● Exhaust Gases Are Toxic

Ensure that the exhaust system is adequate to expel gases discharged from the engine. Check exhaust system regularly for leaks and make sure the exhaust manifolds are securely attached and no warping exists.

Be sure the unit and its surroundings are well-ventilated.

● Use Extreme Care When Handling Engine Fuel (A constant danger of explosion or fire exists)

Do not fill fuel tank(s) while the engine is running.

Do not smoke or use an open flame near the engine or the fuel tank.

● Do Not Alter or Modify the Fuel System

Be sure all fuel supplies have a positive shut-off 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.

● Use Extreme Care When Servicing Batteries

Wear rubber gloves, a rubber apron, and eye protection when servicing batteries.

Lead acid batteries emit hydrogen, a highly-explosive gas, which can be ignited by electrical arcing or by a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.

● Avoid Moving Parts

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

Do not wear loose clothing or jewelry when servicing equipment; avoid wearing loose jackets, shirts or sleeves, rings, necklaces, or bracelets that might be caught in moving parts.

Make sure all attaching hardware is properly tightened. Keep protective shields and guards in their respective place at all times.

Do not check fluid levels or the drive-belt's tension while the unit is operating.

Do not work on the equipment when mentally or physically incapacitated by fatigue.

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Declaration of Conformity

Application of Council Directive(s) **EMC 89/336/EEC**
ISO 8846 1990(E)

Standard(s) to Which Conformity is declared **EN50081-1**
EN50082-2
EN55020
ISO-8846-1990(E), Certification Numbers, IWES001 & IWES002

Manufacturers Name **Westerbeke Corporation**

Manufacturers Address **41 Ledin Drive**
Avon Industrial Park
Avon, Ma. 02322, USA

Type of Equipment **Marine Gasoline Generator**

Product Name **Westerbeke Marine Gasoline Generator**

Model(s) **3.0/4.5BCG, 5.0/7.0BCG**
7.0/9.0BTG

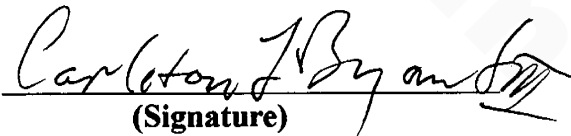
Product Options **All**

Supplementary Information

- 1.) The equipment listed is only for use in Marine Applications aboard boats.
- 2.) The equipment listed must be located below decks on the vessel and permanently installed in it's location.
- 3.) The equipment listed must be wired to the grounding system of the vessel.

I the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place Avon, Massachusetts, U.S.A.


(Signature)

Date: September 1, 1996

Carleton F. Bryant
(Full Name)

Chief Operating Officer
(Title)

042022



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CERTIFICATE

We hereby certify the component stated below is in accordance with ISO 8846 and has the following characteristics:

TYPE	Gasoline Marine Generators
MANUFACTURER:	Westerbeke Corporation
ADDRESS:	41 Ledin Drive
	Avon, MA 02322
	USA
MODEL NAME	7.9/9.0 BCG

Certification number	IWES002
Signed	
Name	Lars E. Granholm
Title	Managing Director
Date	27-Aug-96

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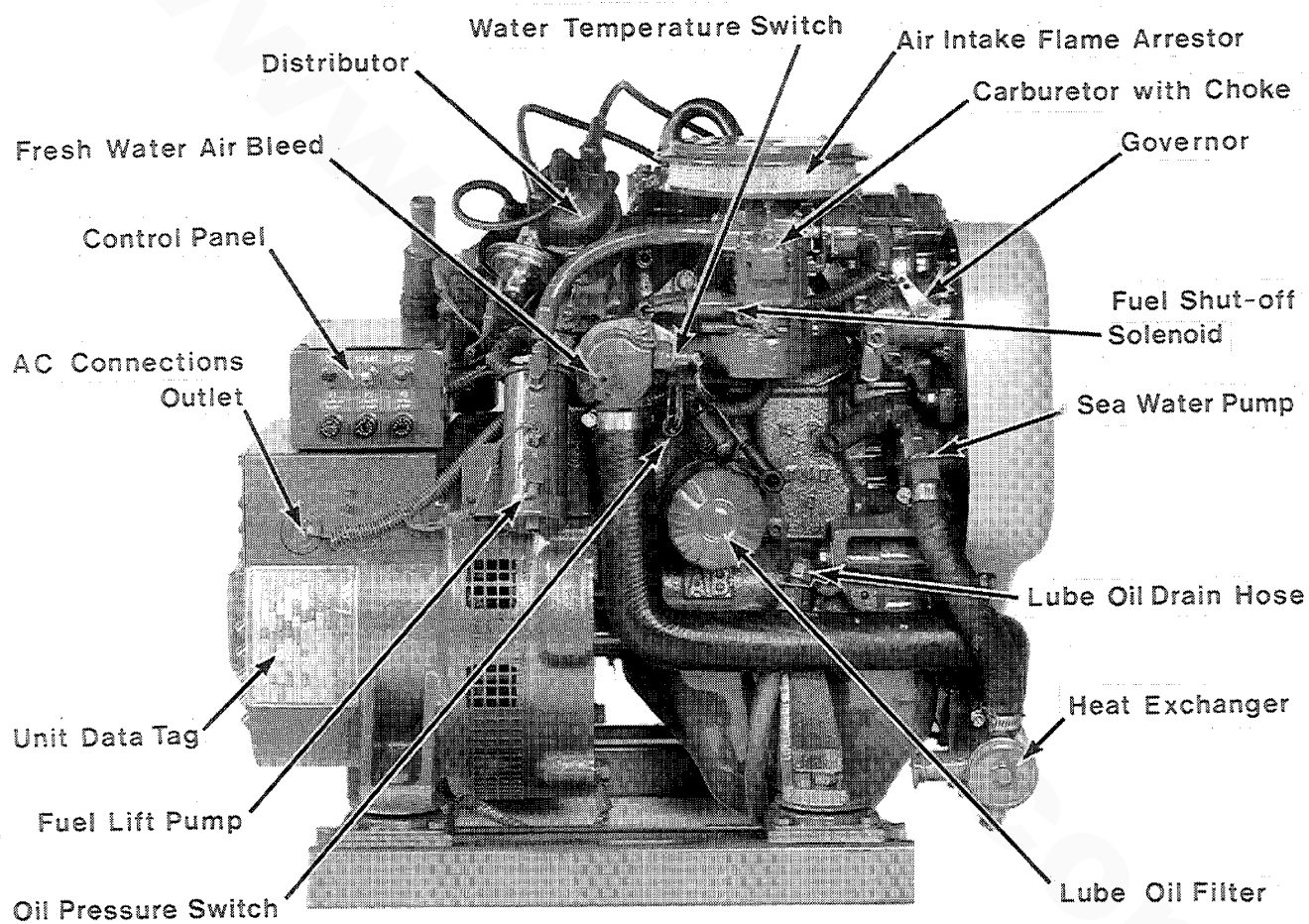
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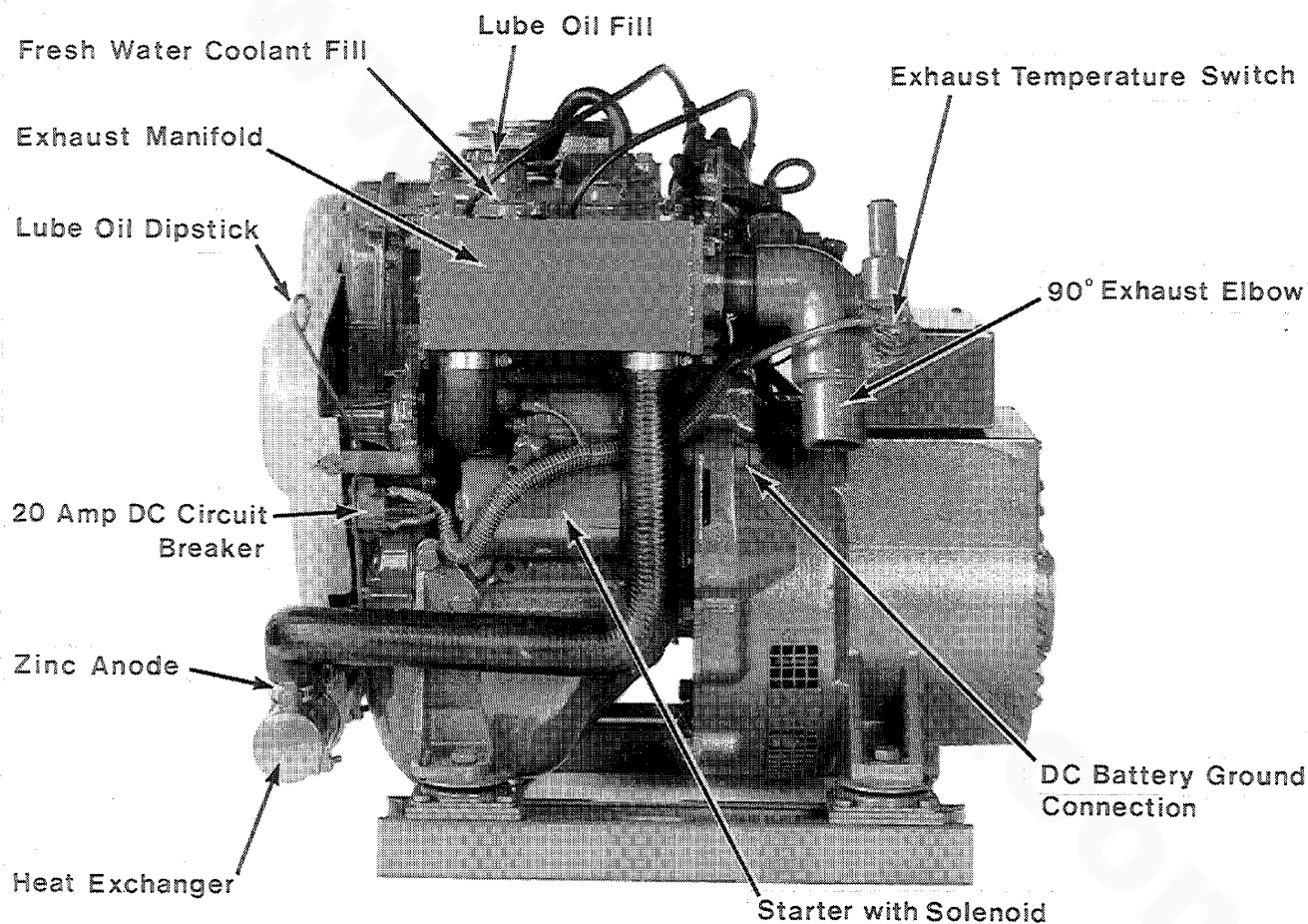
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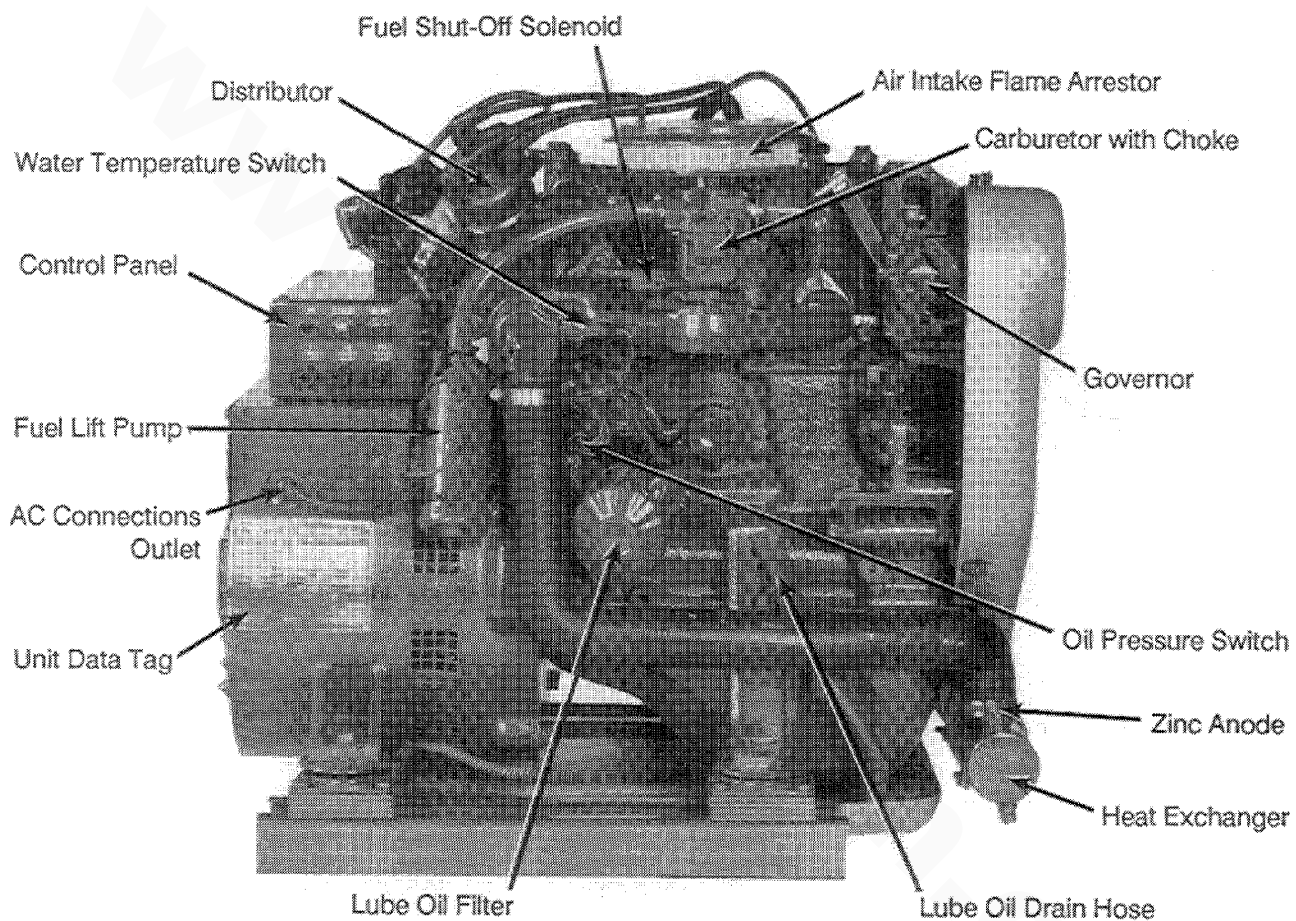
BCG 4.0KW Marine Gasoline Generator



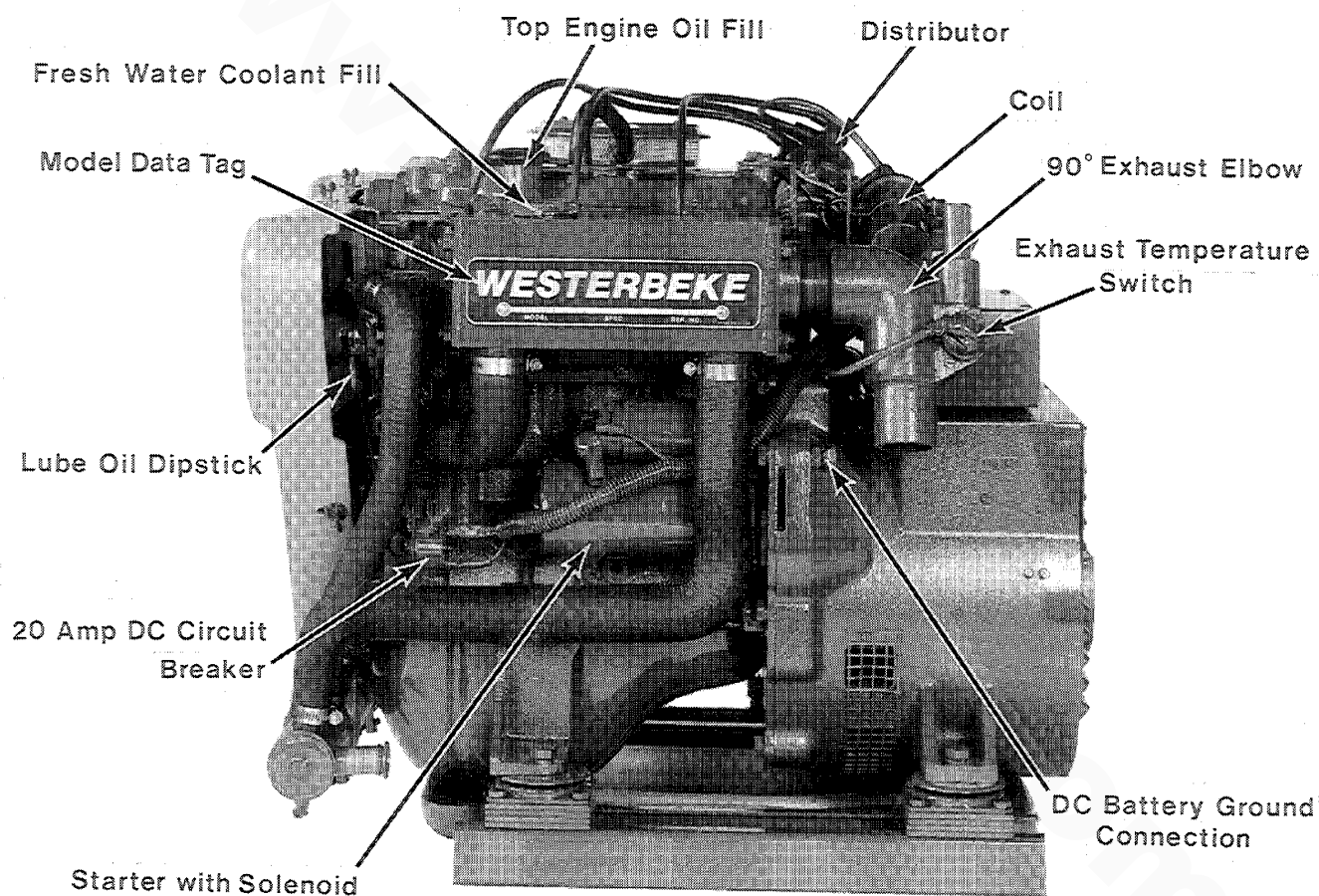
BCG 4.0KW Marine Gasoline Generator

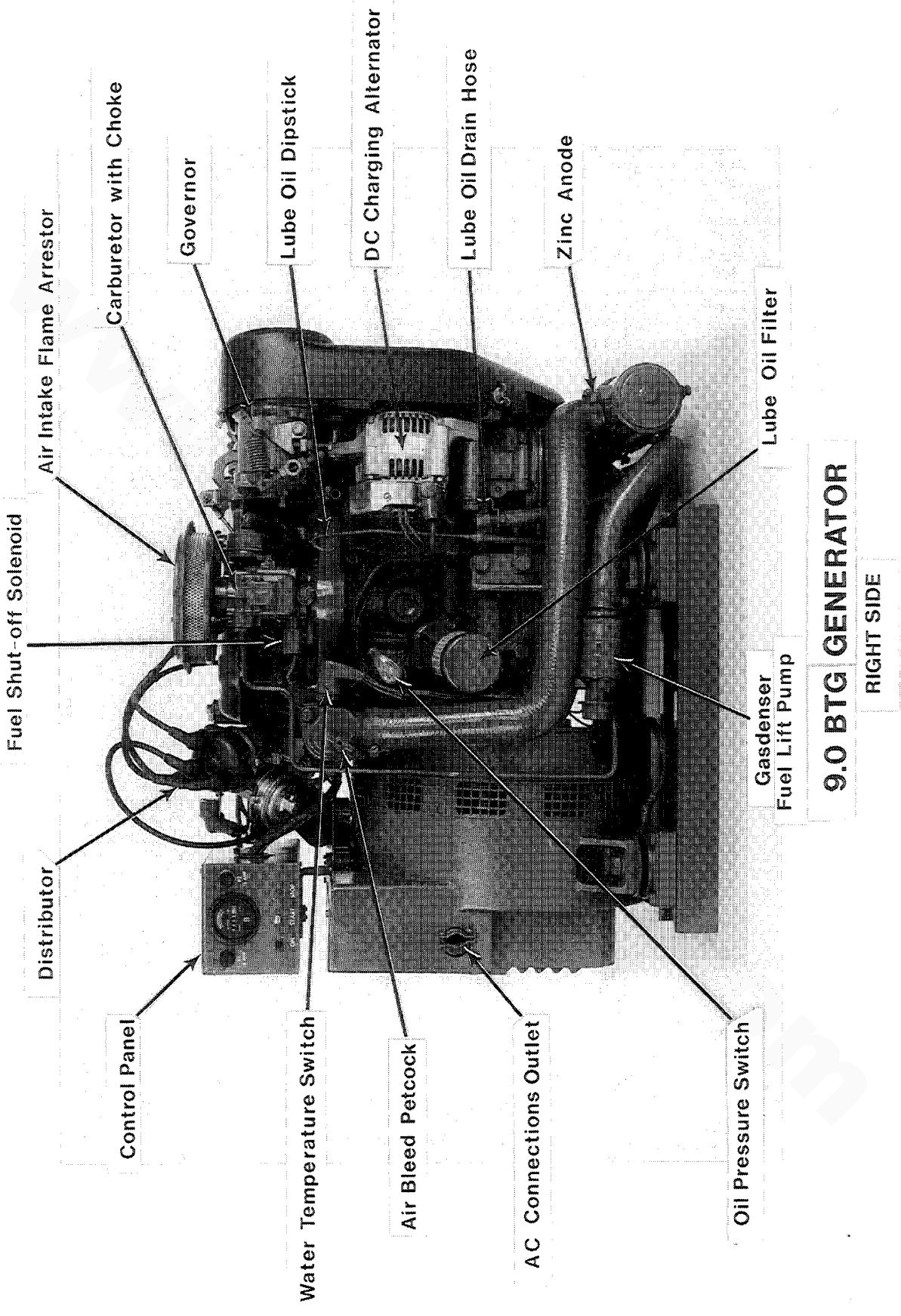


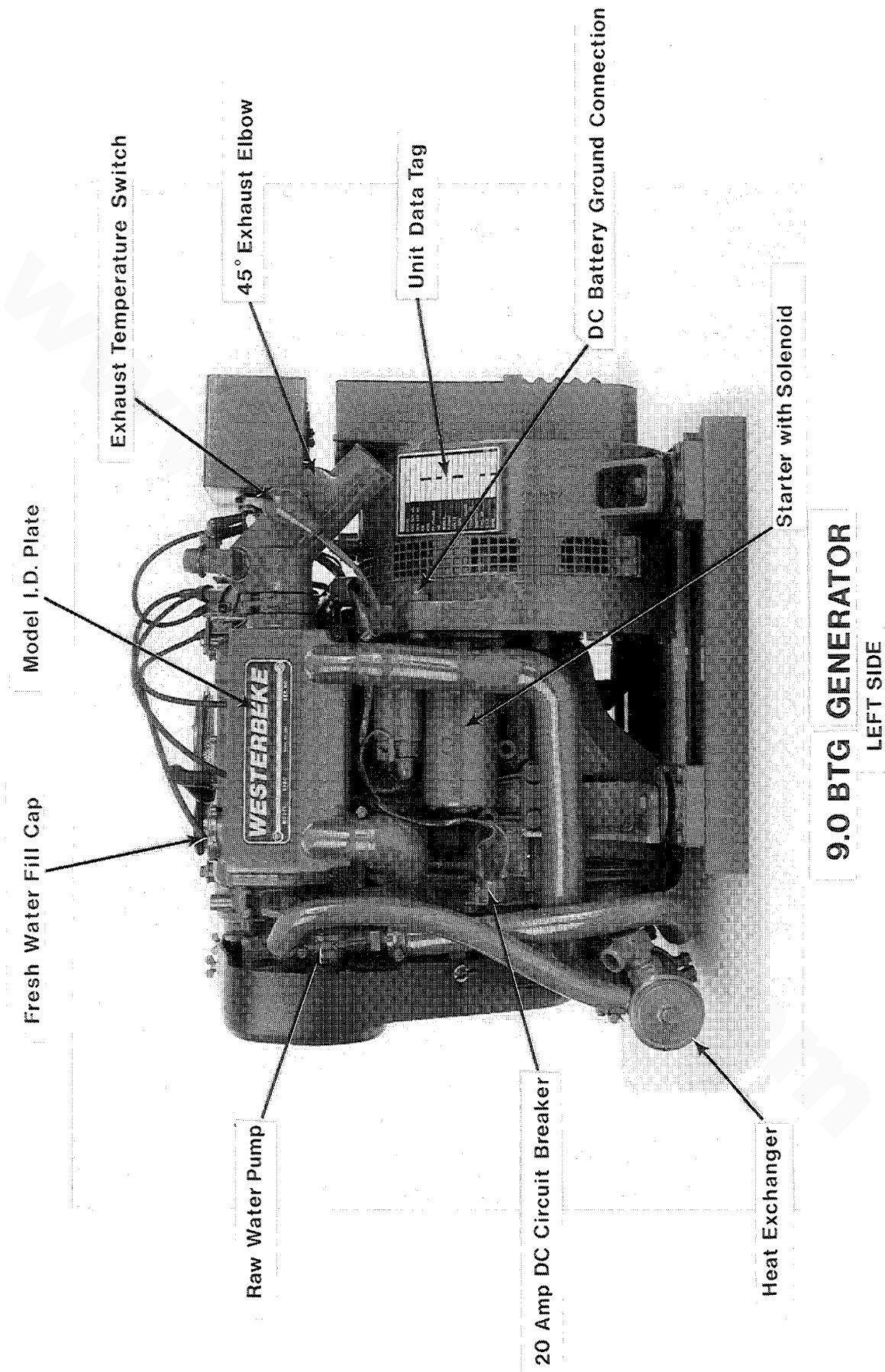
BCG 6.5KW Marine Gasoline Generator



BCG 6.5KW Marine Gasoline Generator







IMPORTANT

PRODUCT SOFTWARE DISCLAIMER

Product software of all kinds, such as brochures, drawings, technical data, operator's and workshop manuals, parts lists and parts price lists, and other information, instructions and specifications provided from sources other than Westerbeke, is not within Westerbeke's control and, accordingly, is provided to Westerbeke customers only as a courtesy and service. **Westerbeke cannot be responsible for the content of such software, makes no warranties or representations with respect thereto, including the accuracy, timeliness or completeness thereof, and will in no event be liable for any type of damages or injury incurred in connection with, or arising out of, the furnishing or use of such software.**

For example, components and subassemblies incorporated in Westerbeke's products and supplied by others (such as engine blocks, fuel systems and components, transmissions, electrical components, pumps and other products) are generally supported by their manufacturers with their own software, and Westerbeke must depend on such software for the design of Westerbeke's own product software. Such software may be outdated and no longer accurate. Routine changes made by Westerbeke's suppliers, of which Westerbeke rarely has notice in advance, are frequently not reflected in the supplier's software until after such changes take place.

Westerbeke customers should also keep in mind the time span between printings of Westerbeke product software, and the unavoidable existence of earlier, non-current Westerbeke software editions in the field. Additionally, most Westerbeke products include customer-requested special features that frequently do not include complete documentation.

In summation, 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 currency of the product software being consulted by the customer.

GENERAL

Introduction

This manual is a general guide to the installation, start-up, operation and maintenance of your Westerbeke marine gasoline engine-driven generator. The information contained in this manual is vital to your engine's dependable, long-term operation.

- A. Read it.
- B. Keep it in a safe, dry place.
- C. Keep it handy for reference at all times.

Understanding the Gasoline Driven Generator

The gasoline engine driving an AC generator is in many ways similar to a gasoline automobile engine. The cylinders are vertical in-line, and the engine's cylinder head has an overhead camshaft which is belt-driven. The engine utilizes a points and condenser type distributor which is vertically mounted and camshaft driven. The engine incorporates a pressure type lubrication system, and a fresh water-cooled engine block which is thermostat -controlled. To a large degree, the generator's engine requires the same preventive maintenance that is required of a gasoline automobile engine. The most important factors to the generator's longevity are proper ventilation, maintenance of the fuel system, ignition system, cooling system and the generator end.

Ordering Parts

Whenever replacement parts are needed, always provide the generator model number (i.e. 6.5 BC 3 cylinder gasoline generator), engine serial number, and generator serial number as they appear on the scarlet and gold name plate located on the generator end. You must provide us with this information so we may properly identify your generator set. In addition, include a complete part description and part number for each part needed (see the separately furnished Parts List). Also, be sure to insist upon Westerbeke factory packaged parts, because *will fit* or generic parts are frequently not made to the same specifications as original equipment.

Note that component locations in the manual are referenced from the front of the engine which is the pulley/drive belt end. (The flywheel/generator end is the rear end.) Left and right sides are determined by the engine; imagine straddling the engine and facing in the same direction as the front of the engine: the left side is at your left, the right side at your right.

Westerbeke generators sets are thoroughly checked and given a final run under various load conditions before leaving the factory. This is done to ensure dependable operation, long service, and a satisfied owner.

Care at the factory during assembly and thorough testing have resulted in a Westerbeke gasoline engine-driven generator capable of many thousands of hours of dependable service. However, the manufacturer cannot control is the treatment the unit receives in the field. That part is up to the owner/operator.

INSTALLATION CHECKS

General

Since the crafts in which Westerbeke generators are installed vary in design, installation procedures will vary according to your craft's specific design. The intent of this section is not to advise boatyards or installers on procedures already well-developed and well-understood. However, it is important that the owner/operator realize there are details of the installation which require periodic checks to ensure the best operating conditions for the equipment and safe operating conditions for the personnel on board. Proper location and installation of the gasoline generator in the vessel are of prime importance.

Installation factors that must be considered are ventilation which provides air for engine combustion, cools the generator's end, and removes heat produced by the engine during and after operation; the exhaust system which properly discharges raw cooling water (sea water), quiets the exhaust, expels exhaust gas, and cools the exhaust gases, the raw water supply and discharge circuit for the engine, fuel supply and AC and DC electrical connections.

CAUTION

For safety reasons, the generator's engine is **not** filled with lubricating oil for shipment. Before leaving the factory, however, each generator set is thoroughly tested with the proper amount of oil in its engine and with an antifreeze mixture used in both the raw and freshwater cooling systems. This testing, among other things, provides all internal parts with a coating of oil. This oil and antifreeze acts as a preservative to coat the inside of the engine, providing reliable protection against corrosion for at least one year if the generator is properly stored.

Inspection of Equipment

The generator is shipped from the factory securely mounted and properly crated. Accessory equipment is shipped in a separate small box, usually packed within the generator's crate.

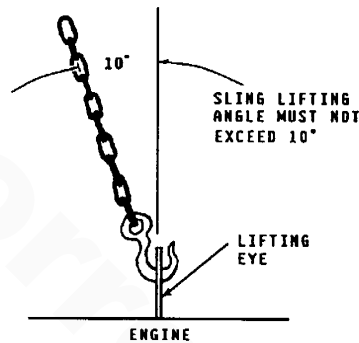
Before accepting shipment of the generator set from the transportation company, the crate should be opened and the contents inspected for concealed damage. If either visible or concealed damage is noted, you should require the delivery agent sign "Received in damaged condition" on the proper delivery receipt. Also check the contents of the shipment against the packing list and make sure that the proper notation is made if any discrepancies exist. These noted discrepancies are your protection against loss or damage. Claims concerning loss or damage must be made to the carrier, not to Westerbeke Corporation.

Rigging and Lifting

The generator is fitted with lifting eyes. Rope or chain slings capable of supporting the generator's weight should be attached to the eyes and the generator lifted by means of tackle attached to this sling. The lifting eyes have been designed to carry the full weight of the generator; therefore, auxiliary slings are not required or desired.

CAUTION

Slings must not be so short as to place significant stress on the generator's lifting eyes. Strain placed on the generator's lifting eyes by the lifting sling must not be in excess of 10° from the vertical plain.

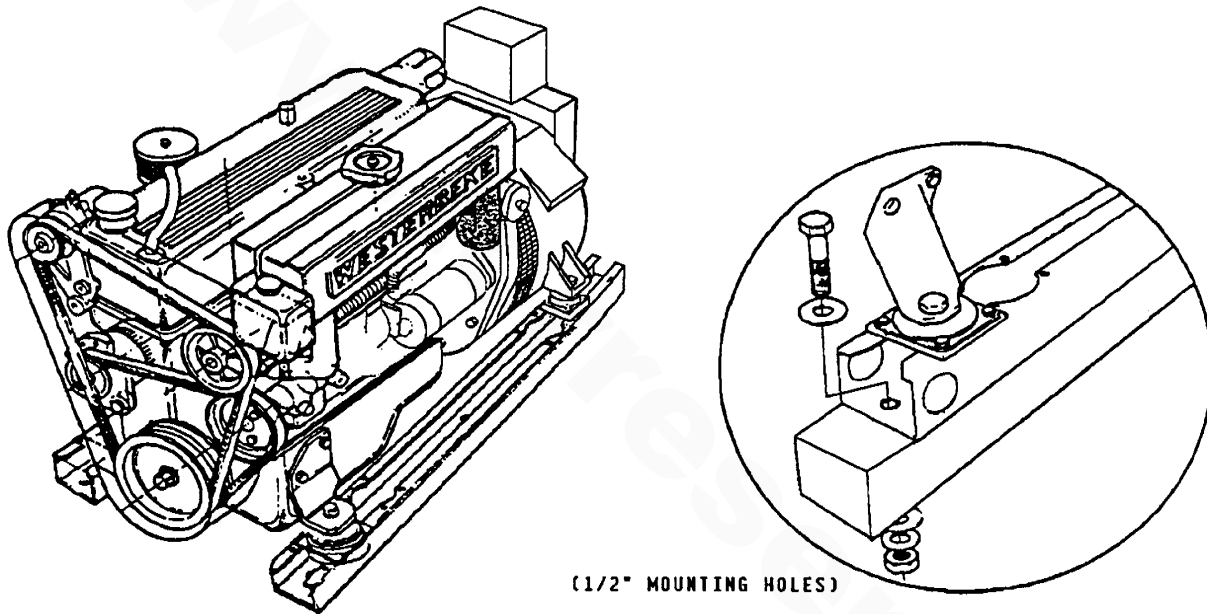


The general rule in moving generators is to see that all equipment used is amply strong and firmly fixed in place. Move the engine a little at a time and see that it is firmly supported. Eliminate the possibility of accidents by avoiding haste. **Do not** lift the generator by its crankshaft pulley. In certain situations it may be necessary to lift the engine in positions other than the horizontal position. Certain situations exist by which the engine must be lowered endwise through a small hatchway which cannot be made larger. Under these conditions, if the opening of the hatchway is extremely restrictive, it is possible to reduce, to some extent, the outside dimensions of the generator by removing external components such as the alternator, the cooling system's piping, the heat exchanger, certain filters, the mounting rails and other obstructive equipment. This accessory equipment should be removed by a competent mechanic and special care should be taken to avoid damage to any exposed parts. In addition, be careful not to allow contaminants to enter any opening created by the removal of equipment. Removed parts should be returned to their respective position once the generator has been placed in the compartment in which it will operate. Replace sealing gaskets of components removed as needed.

In case it becomes necessary to hoist the generator front-end upwards or generator-end upwards, the attachment of lifting slings must be done carefully to avoid the possibility of damaging the parts on which the weight of the slings may bear. Special rigging work is best done by someone experienced and competent in handling heavy machinery.

Generator Mounting - Location

The complete generator unit is mounted on lightweight rails by means of four flexible isolator mounts that help prevent the transfer of vibration from the generator to the rails. Each generator mounting rail has several 1/2 inch bolt holes so bolts can be employed to properly secure the generator to its mounting platform. These holes are on 14.5 inch mounting centers.



The location should be dry, above low-lying vapor areas, and away from being splashed by bilge water or water from above. It should be properly ventilated and accessible for minor servicing and repairs. Access for major repairs should be given consideration as well. The location should be properly ventilated to provide fresh cooling air for the generator end and for engine combustion. The generator set needs fresh cool air in whatever location in the vessel it is installed. Hot generator discharge air *must* be removed from the generator area. The platform on which the generator and its mounting rails are located should be strong enough to support the generator during all angles of vessel operation.

Air Requirements (Minimum Values)

<u>Model</u>	<u>Engine</u>	<u>Generator</u>
BCG 4.0KW	18 cu.ft./min.	225 cu.ft./min.
BCG 6.5KW	32 cu.ft./min.	250 cu.ft./min.
BTG 9.0KW	32 cu.ft./min.	250 cu.ft./min.

NOTE: Increase air supply 15% for 50-hertz operation (1500 rpm).

In confined compartments, fresh cool air *must* be brought into the generator compartment by means of an AC or DC blower along with the necessary ducting. This air should be directed at the generator end's bell opening and lower areas of the generator. unwanted hot air *must* be vented from the compartment, again, with the use of AC or DC exhaust blowers. Keep in mind that hot air rises so it is logical that exhaust ducting for the removal of hot air should be located in the upper areas of the compartment.

Sizing

A generator of sufficient output to maintain the average vessel load should be installed to avoid compromises when electrical loading will have to be worked out. Make an inventory of the vessel's AC loads, paying particular attention to motor loads that the generator will have to start and run. (The amperage draw of a motor when starting can be as much as 3 - 5 times its normal running amperage.) Determine the average AC load of the vessel and size the generator to handle this load with a 10% reserve.

<u>Model</u>	<u>Volts</u>	<u>Amps</u>
BCG 4.0KW (60 hertz)	120/240	34/17
(50 hertz) 3.0 KW	220	14
BCG 6.5KW (60 hertz)	120/240	54/27
(50 hertz) 4.8 KW	220	21.8
BTG 9.0KW (60 hertz)	120/240	75/37.5
(50 hertz) 7.0 KW	220	29

NOTE: 50 hertz units have a reduced KW rating and amperage output

Exhaust System

WARNING

Carbon monoxide exhaust gas is deadly! Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are listed below.

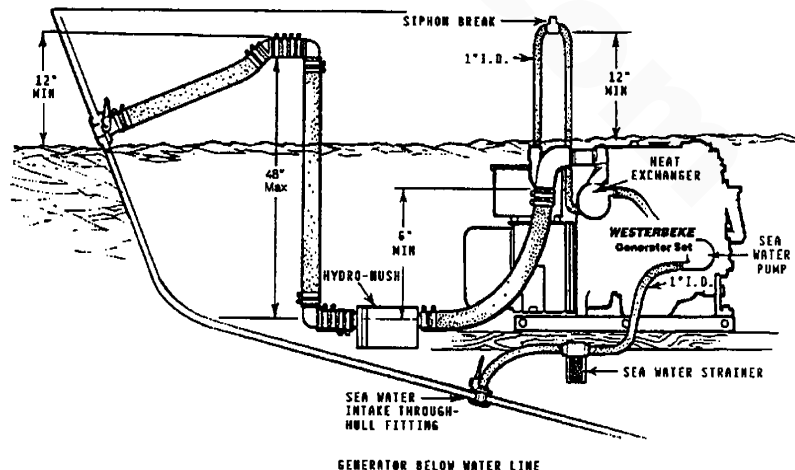
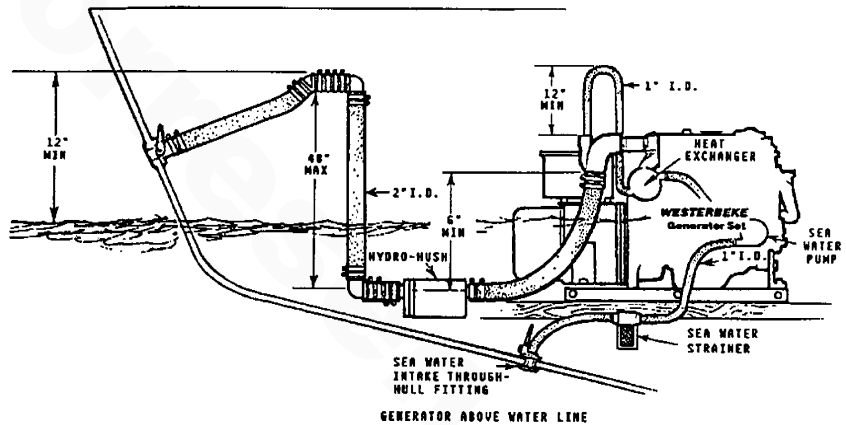
- o Dizziness
- o Intense Headache
- o Weakness and sleepiness
- o Vomiting
- o Muscular twitching
- o Throbbing in temples

The generator must have its own separate exhaust system and must be such that the entry of sea water into the engine's exhaust manifold and cylinders is prevented while the engine is not running, when the vessel is under sail or power, heaving, backing down, from following seas or any other conditions. Special attention must be made to ensure that the exhaust system is secure and tight and free of leaks.

The sea water supply thru-hull sea cock fittings *must* be of the flush-hull type. High-speed or weedless scoop type fittings should not be used, as they tend to pressurize the thru-hull and encourage siphoning.

When a water lift type exhaust system is used, the exhaust muffler should be mounted as close to the engine as practical. The exhaust discharge should always drop downward into the exhaust muffler. Loops in the exhaust hose between the water-injected exhaust elbow and the water lift muffler should be avoided as these will trap and hold water.

For installations where the exhaust manifold/water-injected exhaust elbow is at or below the vessel's water line, provisions *must* be made to install a siphon-break or a vent in the sea water supply hose to the water-injected exhaust elbow to stop the flow of raw water through the raw water cooling system, filling the exhaust and engine cylinders when the engine is shut down. This sea water supply hose must be looped above the water line and the siphon-break or vent installed in the high point of the loop above the water line. This siphon-break or vent must always be above the water line at all angles of vessel operation to prevent siphoning. The vent,



when used, must have its vent hose or tube routed so as to be above the water line and to remain empty of water when the engine is shut down to allow air to enter through this vent and prevent siphoning. The generator exhaust system must not be combined with other exhaust systems. The generator should have it's own system

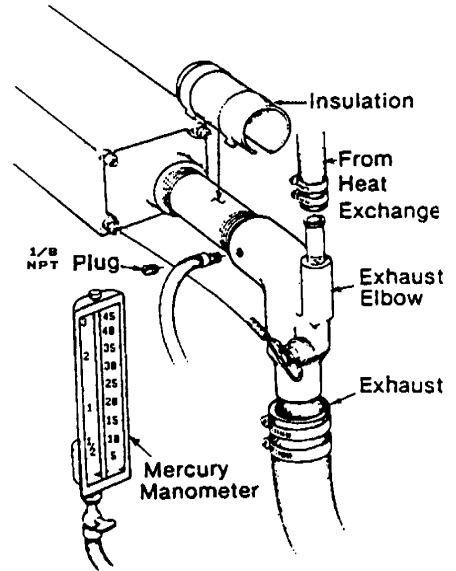
Exhaust Back-Pressure

The exhaust discharge hose must be of adequate size and minimal run to prevent excessive exhaust back-pressure. Exhaust back-pressure should be checked before a generator is put into service. (Refer to the illustration.) Excessive back-pressure will affect the engine's performance and the generator's power output.

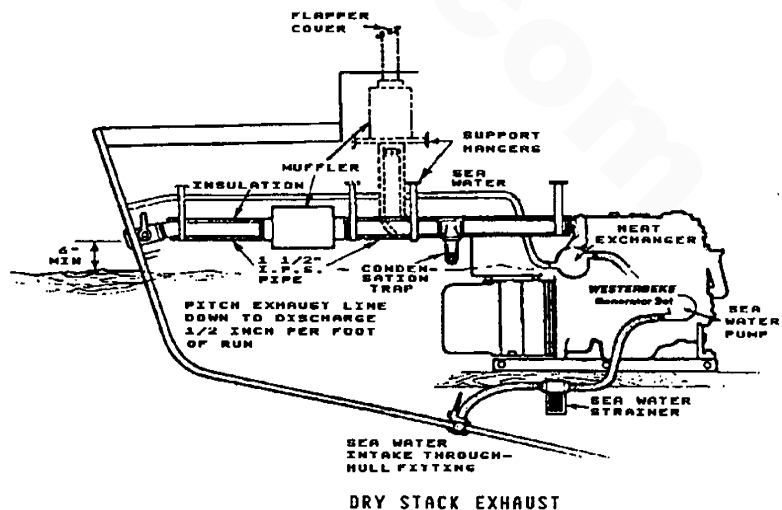
To measure the engine's back-pressure, either a mercury manometer, a water column, or another pressure measuring gauge has to be used. If the generator set does not have a tapped hole in its exhaust elbow, one must be drilled and tapped for a 1/8 inch NPT fitting.

Measure the engine's back-pressure at the exhaust elbow while the generator is under a full load. Back pressure, as measured by a gauge instrument, should not exceed the following specifications:

- 2 inches of mercury
- 27 inches of water in a water column
- 15.6 ounces PSI
- 1.0 PSI



Excessive back-pressure can be caused by a small diameter exhaust hose, a small muffler, sharp bends in the exhaust hose, fittings, water pockets, and a high volume of water in the exhaust system due to the length of the exhaust discharge hose. The use of elbows and fittings in the exhaust discharge hose's routing should be limited since these will create flow restrictions and contribute to exhaust back-pressure. The generator's exhaust system *must* be separate from any other engine's exhaust system. Dry portions of the exhaust system between the engine's exhaust manifold and the water injected exhaust elbow must be insulated to hold in the heat. Dry stack type exhaust systems must be attached to the generator engine's exhaust manifold by means of a flexible connector pipe. This system must be properly supported and insulated to prevent water entry into the engine's cylinders. Provisions must be made for the discharge of the engine's cooling sea water.



Exhaust System Failures

When engine sea water is fed into an exhaust system so that the full stream strikes a surface, erosion may cause premature failures.

Proper design of either a water jacketed or water injected "wet" exhaust system to prevent this problem requires that the sea water inlet be positioned so that the entering stream of sea water does not directly strike a surface. In addition, the velocity of the entering sea water stream should be as low as possible which is achieved by having inlet fittings as big in diameter as possible.

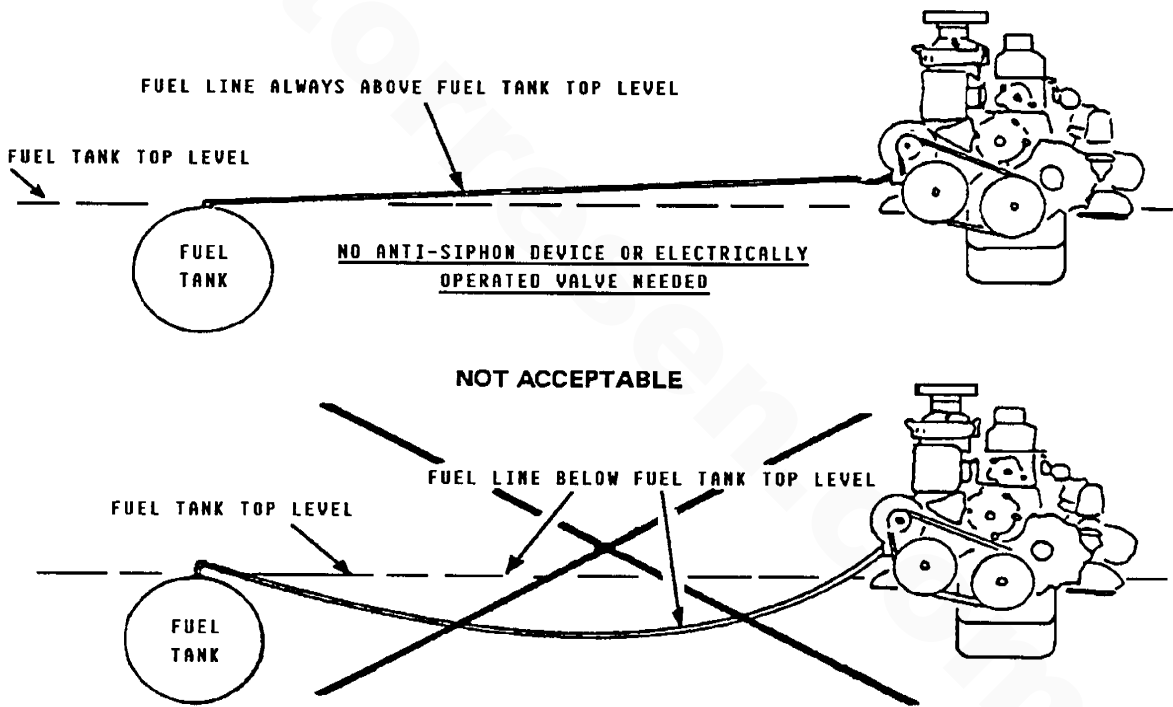
In addition to the above design considerations, dividing the sea water flow at the point of entry to the exhaust system so only a portion of this water enters the exhaust system is usually advantageous. The remainder of this sea water is usually piped over the side. The proper proportion of sea water flow to pass through the exhaust system can only be determined by trial and error. The goal is to prevent excessive exhaust temperatures with the least volume of sea water. This dividing of the raw water, some into the exhaust and some directly overboard, can be a means of reducing exhaust system back pressure.

Fuel System

The generator must have its own fuel supply line; in other words, it must have its own pickup tubes and primary filter/water separator. **Do not** tee off another engine's fuel supply. Installations with the fuel tank(s) at or above the generator with the fuel supply lines to the engine's carburetor routed below the level of the fuel tank's top must have a means of shutting off the fuel to the generator's engine when the engine is not running. This installation procedure helps guard against the possibility of gasoline siphoning through this supply line into the engine through the carburetor, should the carburetor float needle valve stick in the open position or not seat properly, or should the fuel line rupture between the engine and fuel tank.

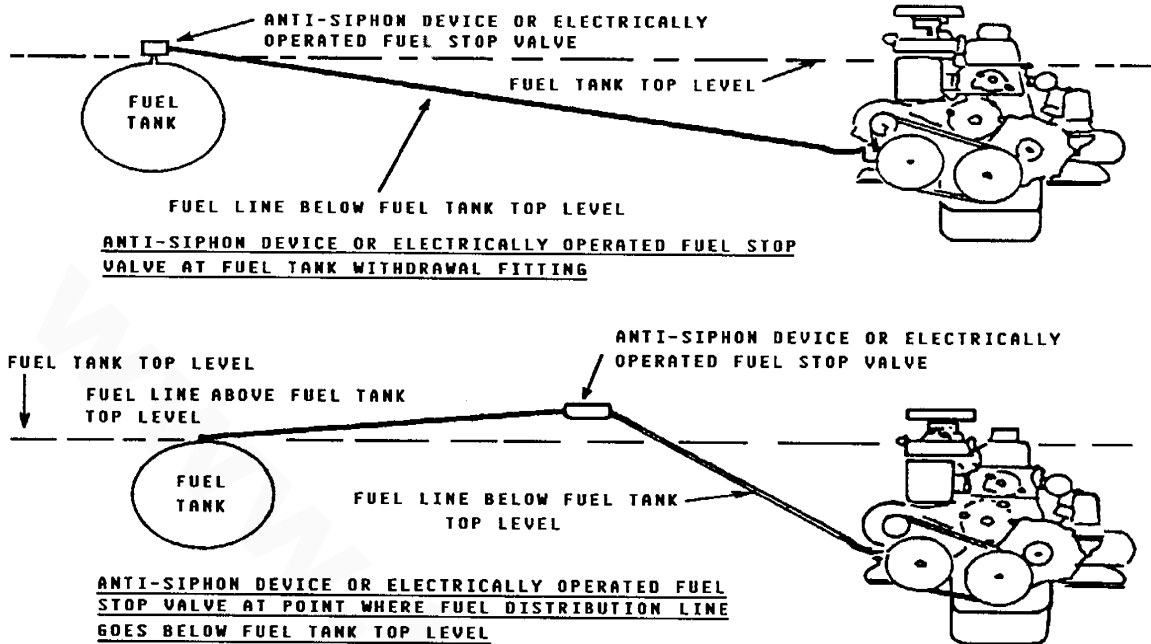
This (anti-siphon) shut-off valve can be electrically-operated (with manual override) to open when the generator's engine is started, or close when it is shut down. A manually-operated valve can also be installed and should be operationable from the generator's start/stop panel or from the vessel's deck. Installations where the generator is located above the fuel tank(s), whereby the routing of the fuel supply line to the generator's carburetor remains above the top level of the fuel tank, do not require this (anti-siphon) shut-off valve. A manually-operated service shut-off valve should be located between the fuel pickup at the tank and the service shut-off valve located at the fuel connection to the generator.

The two illustrations that follow were taken from the Coast Guard publication *Fuel System Compliance Guideline*. These illustrations show basic fuel system layouts that incorporate anti-siphon protection.



All fuel lines should be routed and supported to prevent leaks from vibration and chaffing. The line should be supported every 12 - 14 inches. Use as few connections as possible.

The fuel tank's vent should be located so that its discharge route cannot allow water to enter through to the fuel tank(s). Moisture must not be allowed to accumulate in the vent's line.



NOTE: The use of spring loaded check valves instead of solenoid shut off valves is not recommended for these may tax the fuel lift pump's ability to draw fuel. A check valve can trap debris under its seat which inhibits the valve's ability to close. In addition, if a check valve's cracking pressure is too high, it will contribute to vapor lock in the fuel lift pump.

It is recommended that an approved filter/separator be used in the fuel supply between the fuel tank and the generator's engine to help remove contaminants in the fuel before the fuel reaches the engine-mounted fuel lift pump and carburetor.

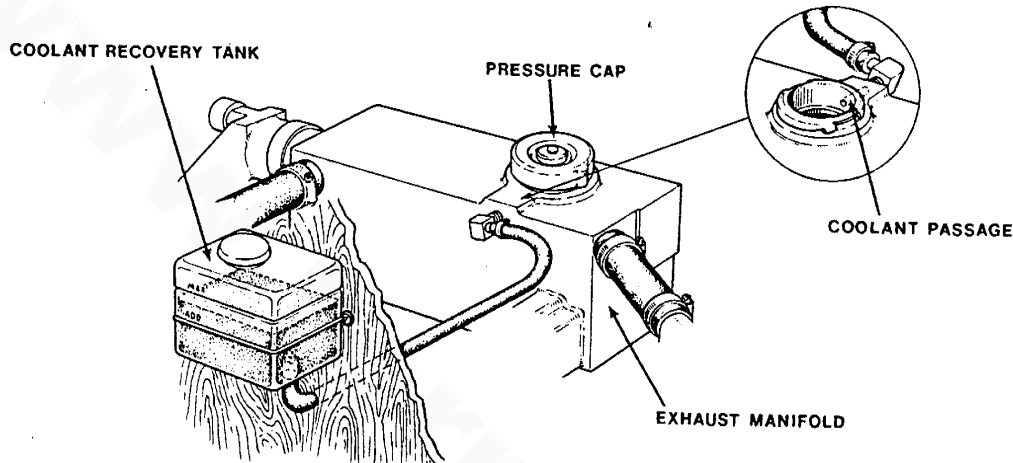
WARNING

Gasoline leakage in or around the generator compartment is a potential cause of fire and/or explosion. Repair leaks promptly and ensure that the compartment is properly ventilated.

Cooling System

A coolant recovery tank kit is supplied with each Westerbeke diesel generator. The purpose of this recovery tank is to allow for engine coolant expansion and contraction, during engine operation, without the loss of coolant and without introducing air into the cooling system.

This coolant recovery tank should be installed at, or above, engine manifold level, in a location where it can be easily monitored and where coolant can be easily added if needed (see the figure below). A stainless steel mounting bracket is supplied with each kit along with a 30-inch length of clear plastic hose and clamps to connect the hose between the engine's manifold fitting to the hose spud on the base of the recovery tank.



Coolant Recovery Tank, Recommended Installation

Coolant from the engine, when heated during the engine's operation, will expand, lift the spring-loaded manifold pressure cap, and enter the recovery tank via the hose connecting the recovery tank to the manifold.

When the engine is shut down and cools, a small check valve in the pressure cap is opened by the contraction of the engine's coolant, allowing some coolant in the recovery tank to be drawn back into the engine's cooling system, free of air and without loss.

An antifreeze mixture should be maintained in the engine's freshwater cooling circuit of adequate proportions to prevent freezing and compatible with aluminum engine components. This mixture should be checked seasonally for freeze protection, sampling both the mixture in the coolant recovery tank and that in the exhaust manifold/expansion tank. Maintain the manifold/expansion tank completely full.

The generator's engine is fresh water cooled by an engine-mounted heat exchanger. Sea water is used as the heat exchanger's cooling medium. Sea water is pumped through the heat exchanger by a belt-driven, positive displacement rubber impeller pump. After the sea water cools the fresh water that circulates through the heat exchanger, the sea water is then injected into the exhaust discharge, carrying with it the heat removed from the engine's fresh water system.

The engine's fresh water coolant is circulated by means of a belt-driven, centrifugal type metal impeller pump mounted on the side of the engine. The fresh water coolant's temperature is thermostatically controlled. A plastic fresh water system coolant recovery tank is supplied with each engine. It is mandatory that this coolant recovery tank be installed and used.

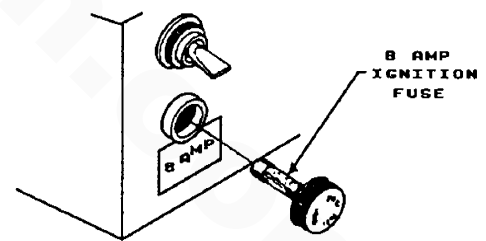
DC Control Circuit

This circuit is designed and manufactured in compliance with United States Coast Guard Standards (33 CFR PART 183). No modifications may be made to it by the installer or user. It is the installer's responsibility to assure that the installation of the generator set and any remote start panels or remote instrument panels are installed in compliance with the above Coast Guard Standards. Failure to observe these requirements could be the cause of injury.

Electrical System Characteristics

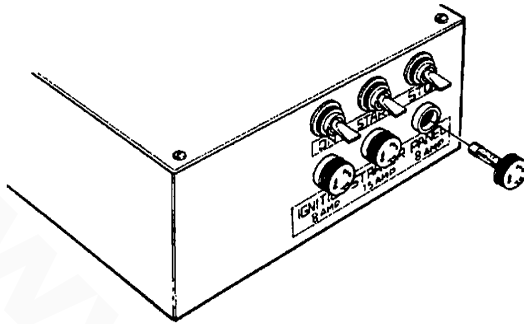
The generator is started by a conventional, separate cranking motor which includes a self-contained, positive-engaging starter solenoid. The starter is internally-grounded to the engine block. The BTG 9.0KW generator has an externally mounted alternator. This alternator provides approximately 35 amps of battery recharging capacity. The BTG 9.0's alternator is internally grounded to the engine block. The BCG 4.0 and 6.5KW generator sets have auxiliary windings built into the generator end which provide up to 10 amps for battery recharging. A 20 amp DC circuit breaker, located within 7 inches of the battery connection to the starter solenoid, protects all subsequent wiring. This circuit breaker is manually resettable. Three manually-operated momentary toggle switches are used to start and stop these model generator sets. To keep the control circuit simple and reliable in a marine environment, no relays have been incorporated in this electrical design.

On the BCG 4.0 and 6.5KW generator sets, three panel-mounted fuses are installed to protect the starter circuit, the running B+ circuit (which runs through the protective switches), and the remote panel circuit. On the BTG 9.0KW generator set, only two protective fuses are needed.

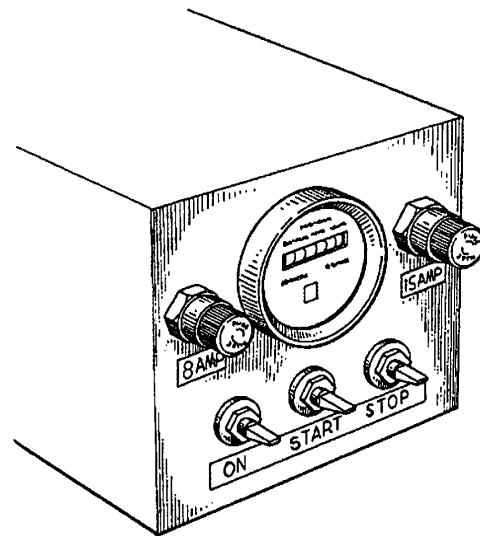


The choke is automatic and electrically operated. The ignition system has conventional points and condenser. An overspeed shut-down switch shuts off the generator set by grounding out the ignition system should the engine's rpms reach approximately 2175. This overspeed switch consumes 25 milliamps (.025 or 1/4th of an amp) at all times once the generator is connected to its battery. As this only amounts to about 18 amp-hours in a month, it is unnecessary to be concerned with this slight discharge during normal operation. If the generator set were to be unattended for many months, the two easiest ways to stop this slight drain is to first turn off the main battery switch providing 12 volts to the generator set, and second to remove the ignition fuse on the generator-mounted control panel.

Instrument Panels

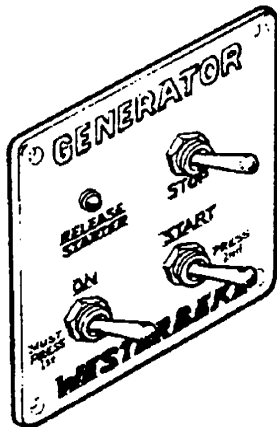


Standard BCG 4.0KW and BCG 6.5KW Panel

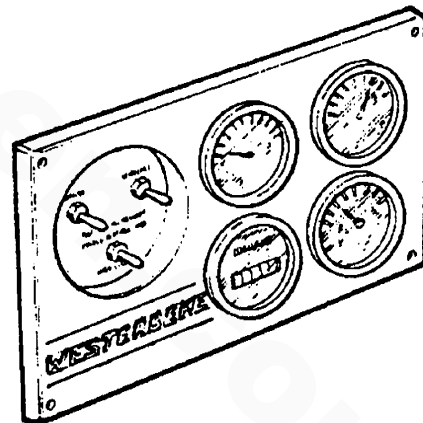


Standard BTG 9.0KW Panel

An optional remote start panel is available for controlling the generator from a remote location. Remote start panels include a green LED which lights when the engine runs at approximately 600 rpm. The purpose of the LED is to alert the operator to release the starter toggle switch in addition to continue indicating that the generator set is running.



REMOTE START PANEL



REMOTE INSTRUMENT PANEL

An optional remote instrument panel is available, which includes starting controls. This panel also includes a water temperature gauge, oil pressure gauge, battery voltmeter, operating hourmeter and start-stop control switches.

Troubleshooting the Water Temperature and Oil Pressure Gauges

Given a presumably faulty gauge indication while 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 there are 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, the normal reading for this situation.
2. Connect the sender terminal at the gauge to the ground and see if the gauge reads full scale, the normal reading for this situation.

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

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

Assuming the gauge is OK, proceed as follows. 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 positive [+] and negative [-]), then the ground side will not necessarily be connected to the block.

If the sender to the gauge conductor is OK and the engine block is grounded, the sender is probably defective and should be replaced.

Connecting Pressure Sensing Devices to Oil Galleries

Oil pressure sensing devices, such as senders and switches, must never be connected to any oil gallery of an engine with the use of tees or extended nipples. The reason is simply that continued engine vibration causes fatigue of the fittings used to make such a connection. If these fittings fail, the engine loses its oil and oil pressure and internal engine damage may result.

Such pressure sensing devices must be bulkhead-mounted and connected to the oil gallery using an appropriate grade of lubricating oil hose. Any fittings used to connect the hose to the gallery must be of steel or malleable iron composition. Brass must not be used for this application.

DC Circuit Description

A two-pole ON switch is operated to bypass the protective shutdown switches during starting. The second pole provides a source of B + to the START toggle switch. While continuing to hold the ON switch, to provide B + to the start switch and to bypass the protective shutdown switches, the START switch is pressed to energize the starter to crank the engine. If you are starting the generator at the generator set, release the START switch when the generator is running. If starting the generator at a remote location, release the START switch when the green LED lights, but continue depressing the ON switch. After releasing the START switch continue holding the ON switch for a few seconds until oil pressure is sufficient to close the oil pressure safety switch, providing the normal B + path to the ignition system. Note that it is now impossible to energize the starter while the generator is running until someone again operates the ON switch first. Should the generator shut down from an overspeed condition, the overspeed circuit *must* be reset before attempting to restart the generator. This is done by simply depressing the STOP switch momentarily and then proceeding with the normal starting procedure.

WARNING

It is very important that the overspeed shutdown always be installed and functioning. Any tampering with the overspeed shutdown module, which would cause it to malfunction, could be a cause of injury should the generator's belt-driven governor fail and cause the generator to run away.

To STOP the generator, depress the STOP switch, which opens the normally closed B + path through the ON switch. The STOP switch must be held open until the generator comes to a complete stop. Remote start panels may be connected to the generator set as indicated. A jumper has to be removed between the connections in the generator control panel connection terminal board. (Refer to the wiring diagram in the "DC ELECTRICAL SYSTEM" section of this manual, page 169 - 174.)

WARNING

When installing the optional remote start panel or the optional remote instrument panel, it is the installer's responsibility to comply with U.S. Coast Guard Standards 33 CFR PART 183.

Generator AC Load Connections

CAUTION

All 120/240 volt loads must be divided up and connected in such a manner that current flowing in any of the hot legs does not exceed the lowest amperage rating on the generator's data plate.

The generator's data plate gives the voltage, amperage and hertz rating of the generator. The generator set AC wiring decal located on the cover of the generator-mounted control panel shows the electrical connections for 120 or 240-volt AC output.

These generator sets have a single phase, 4 lead with voltage combinations of 120-volt, two wire, or 120/240-volt, three wire. All 120-volt devices must be connected to one of the two 120-volt sources and all 240-volt devices must be connected to the 240-volt source. For all 120-volt loads, half of the generator's rated capacity may be taken from leads L1 and half from L2. 240-volt loads are connected to L1 and L2 at full generator rated capacity.

NOTE: It is recommended that the installer offer instrumentation (that is, an AC ampmeter which is optional equipment) so the operator can monitor and determine the load while it is taken from the generator .

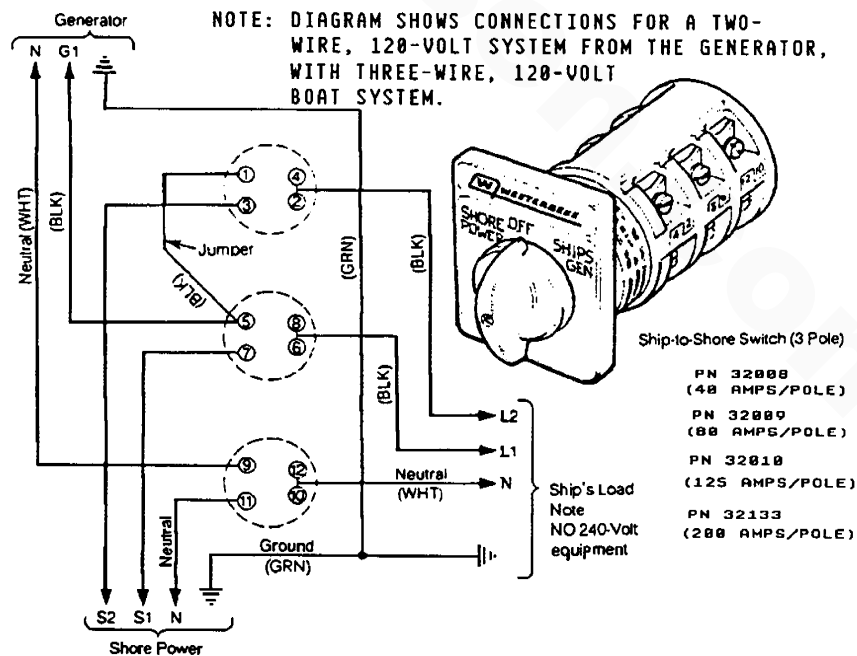
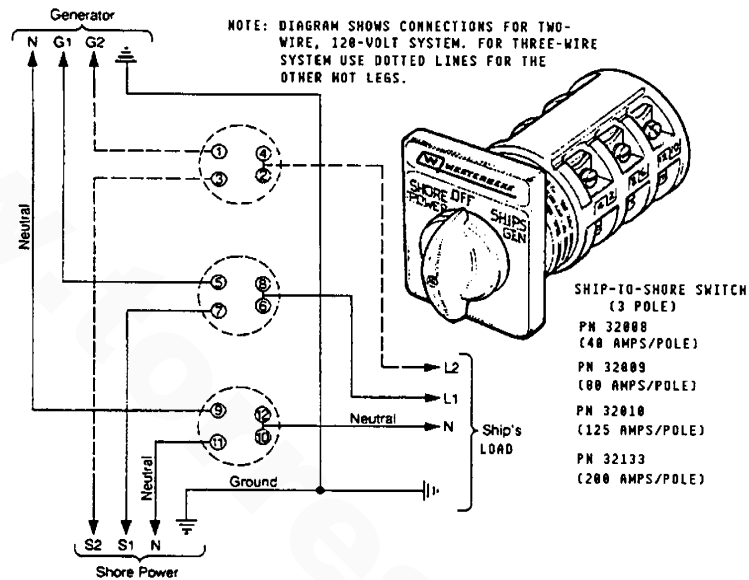
A circuit breaker should be installed between the generator and the AC load. This circuit breaker should be rated for the generator's AC output and be able to react quickly to overloads, subject to motor starting considerations.

Shore Power Connections

If the installer connects shore power into the vessel's AC circuit, this must be done by means of the SHORE POWER/OFF/SHIPS GEN., center position-off transfer switch as shown below.

CAUTION

Damage to the generator can result if utility shore power and generator output are connected at the same time. This type of generator damage is not covered under the warranty; it is the installer's responsibility to ensure that all AC connections are correct.



Shore Power Switch Connection Diagram

NOTES

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IMPORTANT RULES

Important

Important

Important

Always:

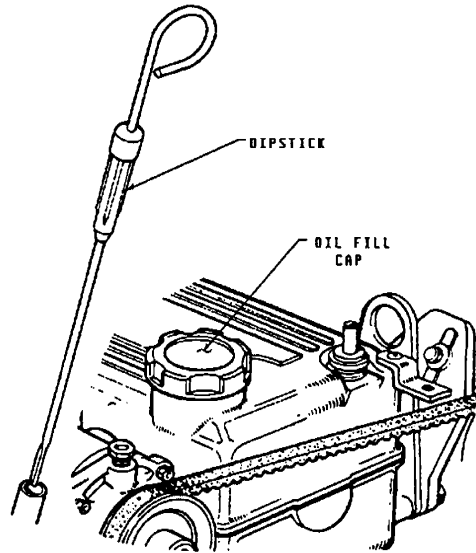
1. Ventilate the generator compartment before attempting to start the generator.
2. Keep this manual handy for reference whenever in doubt.
3. Check the engine's coolant level before each day's use.
4. Check the engine's lubricating oil level before each day's use.
5. Avoid moving parts, and keep the engine's belt guard in place. (Remove only when servicing the front of the engine.)
6. When working on electrical equipment, beware of electrical shock. **Do not** wear jewelry. Disconnect electrical power before working on electrical equipment. Use properly insulated tools and equipment.
7. Beware of exhaust gas leaks. **Carbon monoxide exhaust gas can be deadly.** Carbon monoxide is a colorless and odorless gas, a product of combustion from a gasoline engine. To protect yourself from this gas, inspect the exhaust system regularly and repair any exhaust leaks immediately.
8. **Do not** overload the generator.
9. Allow the generator's engine to warm up and stabilize before applying heavy loads.
10. Maintain your generator in a **dry, well-ventilated** environment.

OPERATION

Preparing the Engine for Initial Start-Up

The generator's engine is shipped dry with the lubricating oil and coolant drained from the engine. Therefore be sure to follow these recommended procedures carefully before attempting to start the engine for the first time.

1. Remove the oil fill cap from the engine's rocker shaft cover and fill the engine's oil sump with the proper amount of lubricating oil as specified in the "ENGINE SPECIFICATION" section of this manual, page 57. Use a good brand of lubricating oil having an API specification of SD, SE, or SF.

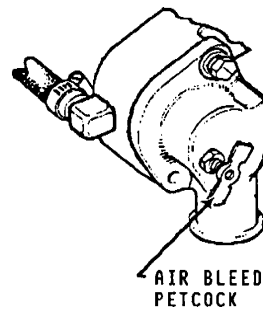


2. Fill the fresh water cooling system with a mixture of antifreeze and freshwater. Refer to the ANTIFREEZE ADDITION DATA chart below. Make sure that the engine's cooling system is well-cleaned before adding antifreeze. Recommended antifreeze for year round use is ZEREX or PRESTONE with ALUMAGUARD and rust inhibitors. **Do not** use an overconcentration of antifreeze. To properly fill the engine's fresh water cooling system, remove the manifold fill cap and open the air bleed petcock that may be found on the thermostat housing.

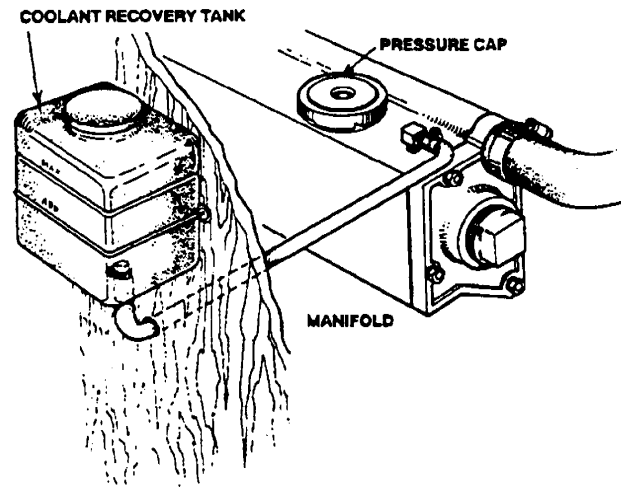
ANTIFREEZE ADDITION CHART

Antifreeze Concentration	%	13	23	30	35	45	50	60
Freezing Temperature	° F	23	14	5	- 4	- 22	- 40	- 58
	(° C)	(- 5)	(- 10)	(- 15)	(- 20)	(- 30)	(- 40)	(- 50)

Mix your antifreeze solution and slowly pour it into the manifold's filler neck. While filling the manifold, open the petcock on the thermostat housing. When coolant begins to flow out of this petcock opening, close the petcock.



Continue filling the system at the filler neck and the manifold until the coolant level is approximately 1/2-inch from the base of the filler neck. Operate the engine and observe the coolant flow. Add coolant when needed as trapped air is expelled and operating temperature is reached. Once all air is expelled and coolant flow is taking place through the manifold, top off the manifold with coolant and install the pressure cap. Fill the coolant recovery tank halfway between the **ADD** and **MAX** mark. Observe that the level in the recovery tank rises as the engine is run and lowers when the engine is shut down and cools. This will indicate the recovery system is working. Monitor engine coolant level by way of this recovery tank and add antifreeze mixture as needed. Periodically clean the passage between the filler neck and the 90° fitting on the manifold for the recovery tank hose attachment.



3. Check all AC electrical connections coming from the generator's AC terminal block. An AC wiring schematic is affixed to the louvered cover on the back of the generator for reference when making these connections. Ensure that these connections are secure and properly insulated to prevent shorts and that any leads routed through the generator's metal housing are routed through grommetted holes to protect the AC leads against chaffing.
4. Connect all DC starting battery leads securely to the tagged connection points on the engine. Always connect the ground lead last. The starting battery switch should be in the OFF position and the fuses in the control panel removed from their respective holders when making these connections. Reinstall the fuses in their respective holders after the connections have been made.
5. Fill the fuel tanks with a good grade of gasoline (unleaded or regular). The engine has mounted on it a 12-Volt electric fuel pump. This pump can be used to prime the engine's fuel system. The pump is activated by depressing the ON switch on the control panel. When using the electric pump for this purpose, unplug the + lead on the carburetor electric choke to prevent activation of the choke during system priming. Reconnect this lead after the system is primed.

NOTE: The choke may have to be readjusted for the climate in which the generator will be operating.

6. The sea water supply should be connected to the engine's sea water pump using a good grade of wire-reinforced hose. Sea water pump suction can collapse hose having a soft wall construction.
7. Connect the engine to the exhaust system. Check that all connections are tight and there is no likelihood of an exhaust leak.

WARNING

Carbon monoxide exhaust gas is deadly!

Check the exhaust system carefully for leaks, once the engine is started, and correct them.

Starting the Generator's Engine

(Ventilate the Generator Compartment for 5 minutes prior to attempting to start the engine).

1. Depress and hold the ON switch (black). If the generator's engine has not been operated for a period of time allow a few seconds with the ON switch depressed 5 - 10 seconds to prime the carburetor.
2. Depress the START switch (white). This will engage the starter and crank the engine.
3. If the engine fails to start in 20 - 30 seconds, release the two switches. Check for fuel and choke operation. Then repeat steps 1 and 2.

NOTE: Starter overheating and damage can occur from excessive cranking.

CAUTION

Prolonged cranking intervals without the engine starting can result in filling the exhaust system, attached to the engine, with sea water coolant. This may happen because the sea water pump is pumping sea water through the sea water cooling system during cranking. This sea water can enter the engine's cylinders by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the sea water supply thru-hull shutoff, drain the exhaust muffler, and correct the cause for the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of sea water entry is not a warrantable issue; the owner/operator should keep this in mind.

When the Generator's Engine Starts

1. When the generator's engine starts, release the START switch and continue to hold the ON switch depressed for 4 - 5 seconds. This allows oil pressure to build up and activate the oil pressure switch, which maintains the ignition circuit.
2. Check to see if sea water flow is discharged with the exhaust.

NOTE: There will be some hunting evident when initially starting a cold engine. This will subside once the engine warms up.

3. Allow the engine to run and warm up (initial commissioning). Check the AC output. Once the engine is warmed, shut the engine down by depressing the red STOP switch. Keep this switch depressed until engine stops completely. Check the engine's lubricating oil level and fresh water coolant level (initial start). Add oil as needed to replenish oil that is now filling the internal oil galleries and the filter. Coolant is needed to replace air that has been expelled from the fresh water cooling system. Top off the cooling system by adding coolant through the manifold fill cap if needed and fill the plastic recovery tank half-full.

WARNING

The fresh water cooling system is under pressure when the engine is running and hot. Any time the manifold's pressure cap is removed while the engine is hot, ensure that the cap is removed slowly and that your hands are protected from escaping hot coolant. Depress the pressure cap slightly and rotate it counterclockwise until the resistance of the safety stops are felt. Carefully release pressure from the cap and allow the system's pressure to bleed off. Once again press the cap down, now more firmly to clear the safety stops, and rotate it counterclockwise to remove and lift the cap off the manifold. Always fill the system full before replacing the cap. Check the plastic recovery tank's coolant level, and add coolant if needed.

NOTE: Coolant recovery tanks mounted above the manifold fill cap will drain into the manifold when the pressure cap is removed. To prevent this, pinch off the clear plastic hose running from the manifold to the plastic recovery tank.

4. Restart the generator. Check the AC output. Load the generator. (Check data tag for rating). During generator break in (first 50 hours), avoid light loads. Vary the loads. Load the generator gradually.

Stopping the Generator

1. Remove all the AC load from the generator.
2. Allow the engine to run for 5 minutes to dissipate engine heat and stabilize temperature.
3. Depress the red STOP switch and hold it until the engine stops completely.

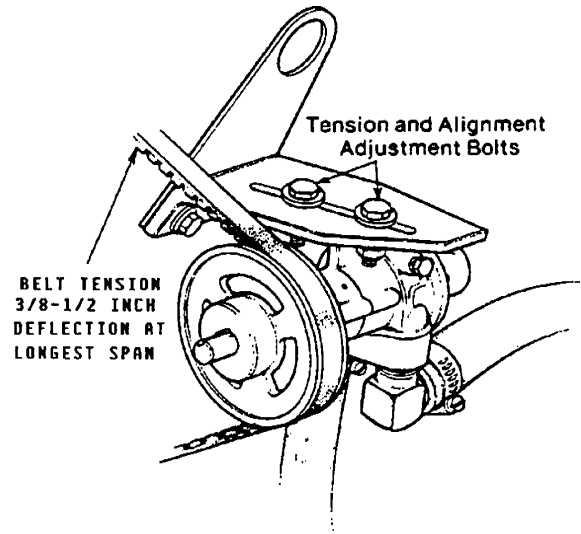
NOTES

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MAINTENANCE

Daily Checks (before initial daily start-up)

1. Check the level of lubrication oil in the engine's oil sump with the dipstick. Keep the oil level near the upper mark of the dipstick.
2. Check the engine's fresh water coolant level in the plastic coolant recovery tank. (Maintain the coolant level halfway between the **ADD** and **MAX** marks when cold.) Periodically check that the manifold is full of coolant.
3. Periodically remove the generator's belt guard and check the belt's tension. The belt's tension should be between 3/8 to 1/2 inch deflection between the widest span of the belt. Since belts stretch slightly, this stretching will, to some degree, affect the governor's action, the engine's ability to cool, and with the 9.0 BTG, the alternator's ability to charge.



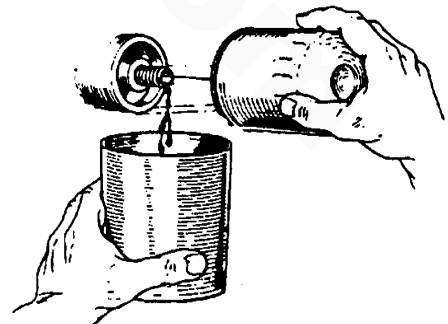
4. Visually inspect the generator and engine; check for loose belts, chafed or broken wires, loose brackets and fittings, damaged hoses, loose clamps, and any other equipment not properly secured.
5. Check the primary fuel filter/water separator. Drain and service as required. (A primary fuel filter/water separator is optional, but strongly recommended.)

Monthly

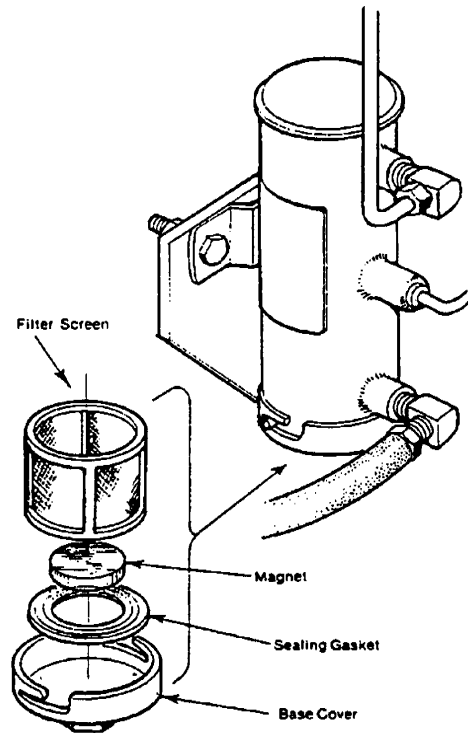
Check the condition of the zinc anode in the heat exchanger's sea water circuit. Clean the anode, as required. Keep the area inside the heat exchanger clean of zinc anode debris.

Fifty-Hour Service Check

1. Change the engine's lubrication oil and oil filter. Use a good brand of oil with an SAE number suitable for your area's temperature. The oil must have an API specification SC or SD.
2. Retorque the cylinder head hold-down bolts (engine cold).

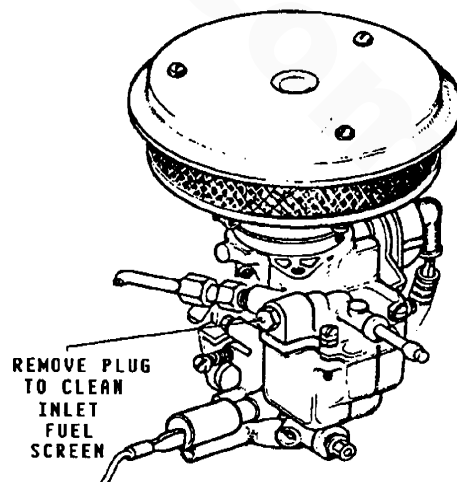


3. Adjust the valve clearances (engine cold).
4. Clean and regap each spark plug. Check distributor cap, rotor and point gap.
5. Check the condition of the zinc anode in the heat exchanger. Clean and replace the zinc anode as needed. If the zinc anode is flaking, scrape it clean. Check that end of the heat exchanger which holds the zinc anode for pieces of zinc and remove any in the heat exchanger.
6. Check the engine's belt tension, allowing a deflection between 3/8- to 1/2-inch along the widest span of the belt.
7. Clean the filter screen found in the base of the engine-mounted electric fuel pump. Remove the base by placing a wrench on the base's hex nut and twisting it loose. **Be careful to catch any gasoline that may leak from within the fuel pump.** A new base sealing gasket must be installed each time the pump base is removed and reinstalled. Refer to the Parts List for the proper part number. Maintain a spare fuel filter screen and sealing gasket for use when needed.
8. Check hose clamps, fittings, nuts and bolts for security and tightness.
9. Ensure that all electrical connections are secure and that they possess the proper insulation material. Make sure that all wires, both DC and AC, are protected from chafing.
10. Inspect the exhaust system for leaks. Repair any leaks immediately.
11. Remove the carburetor's air filter/flare arrester and clean it in kerosene if needed.
12. Clean and lubricate the linkage between the governor and the throttle. Ensure that the throttle moves freely without binding.
13. Adjust the carburetor's choke if needed. The choke's index mark is located on the lower right inboard side of the choke's cover.
14. Adjust the engine belt driven governor to produce correct no-load speed and regulation with load changes if needed.



Seasonal Servicing

1. Change engine's lubrication oil and oil filter every 100 hours of engine operation or once a season, whichever occurs first. Maintain a spare oil filter for use when needed.
2. Clean the fuel filter screen in the electric fuel pump and the inlet filter screen in the carburetor every 300 hours.



3. Check the zinc anode in the engine's heat exchanger periodically through the season; clean and replace it as needed.
4. Check the belt's tension, allowing a deflection between 3/8 to 1/2 inch along the widest span of the belt. Replace the belt if it becomes worn.
5. Check for loose fittings, clamps, electrical connections, nuts and bolts and coolant circulating hoses for good condition.
6. Clean and/or replace the primary fuel filters.
7. Check the condition and strength of the antifreeze mixture in the fresh water cooling circuit. Sample the mixture from both the recovery tank and manifold. Strengthen the mixture as needed. Drain the coolant and replenish it should the coolant become discolored.
8. Clean the carburetor's flame arrester every 300 hours of engine operation or more frequently as needed.
9. Check the ignition circuit every 300 - 400 hrs.
 - A. Clean the rotor and cap.
 - B. Check points and condenser. Adjust point gap.
 - C. Adjust the carburetor.
 - D. Check the coil and plug leads.
 - E. Clean and gap each spark plug.
 - F. Check the engine's timing.
10. Torque the cylinder head hold-down bolts and adjust the valves every 500 hours of engine operation.
11. Check the condition of the sea water pump's impeller and replace it if needed. Check the sea water pump for internal wear. Replace worn pump components as needed.

End-of-Season Service (Lay-up)

1. Check the engine's fresh water coolant antifreeze mixture for the correct amount of antifreeze. Drain and add additional antifreeze/fresh water mixture as needed. Operate the engine to ensure the complete circulation of the antifreeze mixture through the cooling system and then recheck the concentration of the mixture.
2. Inspect the condition of the zinc anode in the engine's heat exchanger. Clean or replace the zinc anode as needed. (Keep Spares).
3. Clean the filter screen in the engine-mounted electric fuel pump.

NOTE: The electric fuel pump's base gasket must be replaced.
4. Clean the carburetor's air filter and flame arrester.
5. Change the engine's lubrication oil and oil filter.

6. Flush the sea water circuit with fresh water and then run an antifreeze mixture through the sea water circuit to protect it against freezing.

NOTE: Feed the sea water circuit out of a 5-gallon bucket to flush both the circuit and supply it with an antifreeze mixture.

Fogging the engine should be done as the last of the antifreeze mixture is drawn into the sea water circuit. Remove the air intake screen (the air filter) and spray Marvel Mystery Oil or another commercially available fogging oil into the carburetor while the engine is running. Spray enough oil to stall the engine. This will coat the walls of the cylinders, pistons, and valve surfaces with this protective oil. Remove the spark plugs and spray a small amount of this oil into each spark plug hole and turn the engine over two or three complete revolutions by hand. Reinstall, but do not tighten, the spark plugs as these will need to be cleaned and gapped prior to recommissioning. Close off the carburetor's air filter with an oily rag.

7. Remove the impeller from the sea water pump and inspect its condition. Do not reinstall the impeller in the pump until the engine is recommissioned.
8. Check the alternator and the sea water pump's drive belts.
9. Ensure that the fuel tanks are near full. When filling the fuel tanks, add any gasoline stabilizers, conditioners or carburetor conditioners that are desired. Please follow the additive manufacturer's instructions.

10. Lubricate the linkage between the carburetor throttle and the governor arm.

11. Remove the starter motor and clean and lubricate the drive pinion.

NOTE: Remove the DC power to the engine prior to removing the starter motor.

12. Check over the engine and see if external items, such as hoses or belts, will need replacing come recommissioning. Check over your basic spares kit and order those items not on hand or that were used during this lay-up, such as filters and zinc anodes.
13. The generator engine's starting battery, if left on board during this lay-up period, should be in a full charged state to prevent the battery from freezing. If the battery is not fully charged, it is wise to remove the battery and place it in a warmer location.

NOTE: For a more detailed description of the End-of-Season Service instructions, see the Operator's Manual.

BCG 4.0 KW MARINE GASOLINE GENERATOR SET

GENERAL SPECIFICATIONS

Engine Type	Gasoline, four-cycle, two-cylinder, fresh water-cooled Vertical, in-line overhead valve mechanism (8 hp at 1800 rpms maximum).
Governor	Hoof, flyball type, 5% speed regulation
Combustion Chamber	Multi-sphere type
Bore & Stroke	2.827 x 2.68 inches (71.6 x 68 mm)
Piston Displacement	33.4 cubic inches (0.547 liters)
Firing Order	1-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 1800 rpm)	33 lb-ft (4.91 kg-m)
Compression Ratio	9.2:1
Compression Pressure (Limit of difference between cylinders)	177.8 psi (12.5 kg/cm ²) at 400 rpm (28.0 psi [2.0 kg/cm ²])
Valve Timing	Intake Opens 21° BTDC Intake Closes 59° ABDC Exhaust Opens 59° BBDC Exhaust Closes 21° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.0098 inches (0.25 mm) Exhaust 0.0098 inches (0.25 mm)
Engine Speed	1800 rpm 60 hertz 1500 rpm 50 hertz
Dimensions	Height: 23.00 inches (584.20 mm) Width: 18.75 inches (476.25 mm) Length: 25.00 inches (647.7 mm)
Weight	309 lbs (140.1 kgs)
Fuel Consumption	0.8 gph (3.02 lph) at full rated output (approximate)
Inclination	Continuous 15° Temporary 20° (not to exceed 20 min.)

BCG 4.0 KW SYSTEM SPECIFICATIONS

INTAKE SYSTEM

Carburetor (STD type)	Down draft type, single barrel with U.S.C.G. approved flame arrester.
Air-Fuel Ratio	13 - 15%

IGNITION SYSTEM

General	Battery ignition, 12-volts, negative ground, distributor with points, ignition coil, spark plugs, and condenser.
Distributor	Conventional, contact-point type
Spark Plug Thread Size	0.55 x 0.05 inches (14 x 1.25 mm)
Spark Plug Type	Westerbeke P.N. 035666

FUEL SYSTEM

General	Conventional carburetor type
Fuel	Regular or unleaded gasoline with an octane rating of 89 or better.
Lift Pump	12-volt DC; lift capacity 6 ft (1.8 m)
Fuel Screens (on engine)	Reusable screen type (one in Carburetor and one in electric fuel pump).
Flame Arrester	Metal screen type - cleanable
Air Flow (engine combustion)	20 cfm (.56 cmm)

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.
Operating Temperature	130-150° F (55-66° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, belt-driven.

BCG 4.0 KW SYSTEM SPECIFICATIONS

Sea Water Flow, at 1800 rpm
(measured before discharging
into exhaust elbow) 3.75 - 4.0 gpm (14.19 - 15.14 lpm)

System Capacity (fresh water) 3.3 qts (3.2 liters)

LUBRICATION SYSTEM

General Pressure type by Trochoid pump,
chain-driven through balance shafts.

Oil Filter Full flow, paper element, spin-on type.

Sump Capacity (not including filter) 3.0 qts (2.9 liters)

Operating Oil Pressure (engine hot) 50 - 70 psi (3.5 - 4.9 kg/cm²)

Oil Grade API SPECIFICATION OF SE, SF, SG OR SJ.

ELECTRICAL SYSTEM

Starting Battery 12-volt, 26 A-H, (-) negative ground
(recommended) (35 A-H in cold areas)

Battery Capacity 90 - 125 (ampere-hours)

DC Battery Charger Integral controller 13 volts, 0 - 10 amps.

Starter 12-volt, 1.2 KW, reduction type,
solenoid-mounted.

DC No-Load Current 90 amp (max.) at 11.5 volts.

DC Cranking Current 175 - 200 amps (engine cold)

BCG 4.0 KW SYSTEM SPECIFICATIONS

AC GENERATOR

General
 Brushless, four-pole, revolving field.
 Self exciting, self regulating, capacitor saturated field excitation.
 Pre-lubricated single-bearing design.
 Reconnectable 120 volts or 120/240 volts, single phase

Voltage
 120 or 120/240 volts - 60 hertz
 220 volts - 50 hertz.
 Voltage regulation: $\pm 5\%$ no-load to full-load.
 Frequency regulation: ± 3 hertz (5%) no-load to full-load.

Rating (volts AC)

60 Hertz (1800 rpm)	120 volts	34 amps
	120/240 volts	34/17 amps

50 Hertz (1500 rpm)	220 volts	14 amps
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Generator Cooling
 Air Requirements, (60 hertz),
 at 1800 rpm

225 cfm (6.37 cmm)

NOTE: Increase generator cooling air supply 15% for 50 hertz operation (1500 rpm).

Engine Combustion Air
 Requirements, (60 hertz),
 at 1800 rpm

20 cfm (.56 cmm)

TUNE-UP SPECIFICATIONS

Spark Plug Gap

0.028 - 0.036 inches (0.7 - 0.9 mm)

Contact Point Clearance

0.016 - 0.020 inches (0.4 - 0.5 mm)

Dwell Angle

95 - 101°

Condenser Capacity

.225 - .275 microfarads (uF)

Timing

13° \pm 1° BTDC at 1800 rpm
 12° \pm 1° BTDC at idle speed (1000 rpm)

BCG 6.5 KW MARINE GASOLINE GENERATOR SET

GENERAL SPECIFICATIONS

Engine Type	Gasoline, four-cycle, three-cylinder, fresh water-cooled. Vertical, in-line overhead valve mechanism (14 hp at 1800 rpms maximum).
Governor	Hoof, flyball type, 5% speed regulation
Combustion Chamber	Multi-sphere type
Bore & Stroke	2.99 x 2.87 inches (76 x 73 mm)
Piston Displacement	60.6 cubic inches (0.993 liters)
Firing Order	1-2-3
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 1800 rpm)	41 lb-ft (65.1 kg-m)
Compression Ratio	9.5:1
Compression Pressure (Limit of difference between cylinders)	177.8 psi (12.5 kg/cm ²) at 350 rpm (28.0 psi [2.0 kg/cm ²])
Valve Timing	Intake Opens 19° BTDC Intake Closes 51° ABDC Exhaust Opens 51° BBDC Exhaust Closes 19° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.008 inches (0.20 mm) Exhaust 0.008 inches (0.20 mm)
Engine Speed	1800 rpm 60 hertz 1500 rpm 50 hertz
Dimensions	Height: 23.38 inches (593.85 mm) Width: 18.69 inches (474.73 mm) Length: 26.75 inches (679.45 mm)
Weight	332 lbs (150.5 kgs)
Fuel Consumption	1.1 gph (4.16 lph) at full rated output (approximate)
Inclination	Continuous 15° Temporary 20° (not to exceed 20 min.)

BCG 6.5 KW SYSTEM SPECIFICATIONS

INTAKE SYSTEM

Carburetor (STD type)	Down draft type, single barrel with U.S.C.G. approved flame arrester.
Air-fuel Ratio	13 - 15%

IGNITION SYSTEM

General	Battery ignition, 12-volt, negative ground, distributor with points, ignition coil and spark plugs.
Distributor	Conventional, contact-point type.
Spark Plug Thread Size	0.55 x 0.05 inches (14 x 1.25 mm)
Spark Plug Type	Westerbeke P.N. 033805

FUEL SYSTEM

General	Conventional carburetor type
Fuel	Regular of unleaded gasoline with an octane rating of 89 or better.
Lift Pump	12-volt; lift capacity 6 ft (1.8 m)
Fuel Screens (on engine)	Reusable screen type (one in carburetor and one in electric fuel pump).
Flame Arrester	Metal screen type - cleanable
Air Flow (engine combustion)	34 cfm (0.96 cmm)

COOLING SYSTEM

General	Fresh water-cooled block thermostatically-controlled with heat exchanger.
Operating Temperature	130 - 150° F (55-66° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven

BCG 6.5 KW SYSTEM SPECIFICATION

Sea Water Pump	Positive displacement, rubber impeller, belt-driven.
Sea Water Flow, at 1800 rpm (measured before discharging into exhaust elbow)	3.75 - 4.0 gpm (14.19 - 15.14 lpm)
System Capacity	5.2 qts (4.9 liters) approximate.

LUBRICATION SYSTEM

General	Pressure type by Trochoid pump chain-driven through balance shafts.
Oil Filter	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	3.0 qts (2.9 liters)
Operating Oil Pressure (engine hot)	50 - 70 psi (3.5 - 4.9 kg/cm ²)
Oil Grade	API SPECIFICATION OF SE, SF, SG OR SJ.

ELECTRICAL SYSTEM

Starting Battery	12-volt, 30 A-H, (-) negative ground. (recommended) (45 A-H in cold areas)
Battery Capacity	90 - 125 (ampere-hours)
DC Battery Charger	Integral controller 13 volts, 0 - 10 amps.
Starter	12-volt, 1.2KW, reduction type, solenoid-mounted.
DC No-Load Current	90 amp (max.) at 11.5 volts.
DC Cranking Current	175 - 200 amps (engine cold)

BCG 6.5 KW SYSTEM SPECIFICATIONS

AC GENERATOR

General	Brushless, four-pole, revolving field. Self exciting, self regulating capacitor saturated field excitation. Pre-lubricated, single-bearing design.	
Voltage	120 or 120/240 volts - 60 hertz 220 volts - 50 hertz. Voltage regulation: \pm 5% no-load to full-load. Frequency regulation: \pm 3 hertz (5%) no-load to full-load.	
Rating (volts AC)		
60 Hertz (1800 rpm)	120 volts 120/240 volts	54 amps 54/27 amps
50 Hertz (1500 rpm)	220 volts	21.8 amps
Generator Cooling Air Requirements, (60 Hertz), at 1800 rpm	250 cfm (7.08 cmm)	

NOTE: Increase generator cooling air supply 15% for 50 hertz operation (1500 rpm).

Engine Combustion Air Requirements, (60 hertz), at 1800 rpm	34 cfm (0.96 cmm)
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TUNE-UP SPECIFICATIONS

Spark Plug Gap	0.028 - 0.036 inches (0.7 - 0.9 mm)
Contact Point Clearance	0.016 - 0.020 inches (0.4 - 0.5 mm)
Dwell Angle	58 - 66°
Condenser Capacity	.225 - .275 microfarads (uF)
Timing	11° \pm 1° BTDC at 1800 rpm 10° \pm 1° BTDC at idle speed (900 rpm)

BTG 9.0 KW MARINE GASOLINE GENERATOR SET

GENERAL SPECIFICATIONS

Engine Type	Gasoline, four-cycle, three-cylinder, fresh water-cooled Vertical, in-line overhead valve mechanism (14 hp at 1800 rpms maximum)
Governor	Hoof, flyball type, 5% speed regulation
Combustion Chamber	Multi-sphere type
Bore & Stroke	2.99 x 2.87 inches (76 x 73 mm)
Piston Displacement	60.6 cubic inches (0.993 liters)
Firing Order	1-2-3
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 1800 rpm)	41 lb-ft (65.1 kg-m)
Compression Ratio	9.5:1
Compression Pressure (Limit of difference between cylinders)	177.8 psi (12.5 kg/cm ²) at 350 rpm (28.0 psi [2.0 kg/cm ²])
Valve Timing	Intake Opens 19° BTDC Intake Closes 51° ABDC Exhaust Opens 51° BBDC Exhaust Closes 19° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.0098 inches (0.25 mm) Exhaust 0.0098 inches (0.25 mm)
Engine Speed	1800 rpm 60 hertz 1500 rpm 50 hertz
Dimensions	Height: 23.38 inches (593.85 mm) Width: 18.69 inches (474.73 mm) Length: 28.25 inches (717.55 mm)
Weight	386 lbs (175 kgs)
Fuel Consumption	1.5 gph (5.68 lph) at full rated output (approximate)
Inclination	Continuous 15° Temporary 20° (not to exceed 20 min.)

BTG 9.0 KW SYSTEM SPECIFICATIONS

INTAKE SYSTEM

Carburetor (STD type)	Down draft type, single barrel with U.S.C.G. approved flame arrester.
Air-fuel Ratio	13 - 15%

IGNITION SYSTEM

General	Battery ignition, 12-volts, negative ground, distributor with points, ignition coil spark plugs.
Distributor	Conventional, contact-point type
Spark Plug Thread	0.55 x 0.05 inches (14 x 1.25 mm)
Spark Plug Type	Westerbeke P.N. 033805

FUEL SYSTEM

General	Conventional carburetor type
Fuel	Regular or unleaded gasoline with an octane rating of 89 or better.
Lift Pump	12-volt DC; lift capacity 6 ft (1.8 m)
Fuel Screens (on engine)	Reusable screen type (one in carburetor and one in electric fuel pump).
Flame Arrester	Metal screen type - cleanable
Air Flow (engine combustion)	34 cfm (0.96 cmm)

COOLING SYSTEM

General	Fresh water-cooled block thermostatically-controlled with heat exchanger
Operating Temperature	130 - 150° F (55 - 66° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven

BTG 9.0 KW SYSTEM SPECIFICATIONS

Sea Water Pump	Positive displacement, rubber impeller, belt-driven.
Sea Water Flow, at 1800 rpm (measured before discharging into exhaust elbow)	4.5 - 5.0 gpm (17.03 - 18.92 lpm)
System Capacity (fresh water)	5.7 qts (5.39 liters)

LUBRICATION SYSTEM

General	Pressure type by Trochoid pump, chain-driven through balance shafts.
Oil Filter	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	3.0 qts (2.9 liters)
Operating Oil Pressure (engine hot)	50 - 70 psi (3.5 - 4.9 kg/cm ²)
Oil Grade	API SPECIFICATION OF SE, SF, SG OR SJ.

ELECTRICAL SYSTEM

Starting Battery	12-volt, 30 A-H, (-) negative ground (recommended) (45 A-H in cold areas)
Battery Capacity	90 - 125 (ampere-hours)
DC Battery Charger	35 amp DC alternator.
Starter	12-volt, 1.2KW, reduction type, solenoid-mounted.
DC No-Load Current	90 amp (max.) at 11.5 volts.
DC Cranking Current	175 - 200 amps (engine cold)

BTG 9.0 KW SYSTEM SPECIFICATIONS

AC GENERATOR

General 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
220 volts - 50 hertz.
Voltage regulation: $\pm 5\%$ no-load to full-load.
Frequency regulation: ± 3 hertz (5%) no-load to full-load.

Rating (volts AC)

60 Hertz (1800 rpm)	120 volts	75 amps
	120/240 volts	75/37.5 amps
50 Hertz (1500 rpm)	220 volts	29 amps

Generator Cooling
Air Requirements, (60 hertz),
at 1800 rpm 225 - 250 cfm (6.37 - 7.08 cmm)

NOTE: Increase generator cooling air supply 15% for 50 hertz operation (1500 rpm).

Engine Combustion Air
Requirements, (60 hertz),
at 1800 rpm 34 cfm (0.96 cmm)

TUNE-UP SPECIFICATIONS

Spark Plug Gap	0.028 - 0.036 inches (0.7 - 0.9 mm)
Contact Point Clearance	0.016 - 0.020 inches (0.4 - 0.5 mm)
Dwell Angle	58 - 66°
Condenser Capacity	.225 - .275 microfarads (uF)
Timing	11° \pm 1° BTDC at 1800 rpm 10° \pm 1° BTDC at idle speed (900 rpm)

BCG 4.0KW, BCG 6.5KW AND BTG 9.0KW

ENGINE SERVICE SPECIFICATIONS

	Specified Value	Allowable Limit
Cylinder Head		
Lower gasket surface distortion - inches (mm)		
BCG 4.0KW	-	0.0020 (0.05 mm)
BCG 6.5KW and BTG 9.0KW	-	0.0039 (0.10 mm)
Grinding tolerance inches (mm)		
BCG 4.0KW	0.0118 (0.3 mm)	4.949 (Height) (125.50 mm)
Manifold gasket surface distortion - inches (mm)	-	0.0039 (0.10 mm)
Valve seat width (Intake and Exhaust)		
BCG 4.0KW	0.0472 - 0.0629 (1.2 - 1.6 mm)	- -
BCG 6.5KW and BTG 9.0KW	0.039 - 0.071 (1.0 - 1.8 mm)	- -
Valve seat angle	45°	
Valve seat recession allowable limit - inches (mm)	-	0.020 (0.5 mm)
Valve Guide Bushing		
Valve stem-to-bushing clearance - inches (mm)		
Intake		
BCG 4.0KW	0.0016 - 0.0020 (0.040 - 0.070 mm)	0.0031 (0.08 mm)
BCG 6.5KW and BTG 9.0KW	0.0016 - 0.0028 (0.040 - 0.070 mm)	0.0035 (0.09 mm)
Exhaust	0.0018 - 0.0030 (0.045 - 0.075 mm)	0.0039 (0.10 mm)
Valves		
Valve seat width (Intake and Exhaust) - inches (mm)		
BCG 4.0KW	0.0472 - 0.0629 (1.2 - 1.6 mm)	-
BCG 6.5KW and BTG 9.0KW	0.039 - 0.071 (1.0 - 1.8 mm)	-

	Specified Value	Allowable Limit
Valves (continued)		
Valve seat angle		
BCG 4.0KW	45°	-
BCG 6.5 KW and BTG 9.0KW	45° 30'	-
Valve head stock thickness - inches (mm)		
Intake	0.035 - 0.059 (0.9 - 1.5 mm)	0.031 (0.8 mm)
Exhaust	0.047 - 0.071 (1.2 - 1.8 mm)	0.039 (1.0 mm)
Valve stem outer diameter - inches (mm)		
Intake	0.2734 - 0.2740 (6.945 - 6.960 mm)	0.2724 (6.920 mm)
Exhaust	0.2732 - 0.2738 (6.940 - 6.955 mm)	0.2720 (6.910 mm)
Valve Spring		
Free length - inches (mm)		
BCG 4.0KW (outer spring)	1.6460 (41.8 mm)	1.5945 (40.5 mm)
(inner spring)	1.6141 (41.0 mm)	1.5669 (39.8 mm)
BCG 6.5KW and BTG 9.0KW	1.7047 (43.3 mm)	1.6535 (42.0 mm)
Length as installed - inches (mm)		
BCG 4.0KW (outer spring)	1.3740 (34.9 mm)	-
(inner spring)	1.2559 (31.9 mm)	-
BCG 6.5KW and BTG 9.0KW	1.3740 (34.9 mm)	
Tension as installed - lbs (kg)		
BCG 4.0KW (outer spring)	52.91 (24.0 kg)	51.37 (23.3 kg)
(inner spring)	18.74 (8.5 kg)	18.3 (8.3 kg)
Out-of-squareness -inches (mm)	-	0.059 (1.5 mm)
Valve Rocker Shaft and Rocker Arm		
Rocker shaft-to-rocker arm clearance -inches (mm)		
BCG 4.0KW	0.0006 - 0.0024 (0.016 - 0.060 mm)	0.0031 (0.08 mm)
BCG 6.5KW and BTG 9.0KW	0.0006 - 0.0024 (0.16 - 0.060 mm)	0.0035 (0.09 mm)

	Specified Value	Allowable Limit
Cylinder Block		
Top gasket surface distortion - inches (mm)	-	0.0020 (0.05mm)
Cylinder bore wear - inches (mm)		
BCG 4.0KW	-	0.0031 (0.08 mm)
BCG 6.5KW and BTG 9.0KW	-	0.0039 (0.10 mm)
Cylinder bore out-of-roundness, taper	-	0.0031 (0.08 mm)
Piston, Piston Pin, and Piston Ring		
Piston-to-cylinder clearance - inches (mm)		
BCG 4.0KW	0.0018 - 0.0026 (0.045 - 0.065 mm)	0.0039 (0.10 mm)
BCG 6.5KW and BTG 9.0KW	0.0014 - 0.0022 (0.035 - 0.055 mm)	0.0039 (0.10 mm)
Piston ring end gap - inches (mm)		
Compression No.1 and No.2	0.0079 - 0.0157 (0.2 - 0.4 mm)	0.0276 (0.70 mm)
Oil	0.0079 - 0.0315 (0.2 - 0.8 mm)	0.0433 (1.10 mm)
Piston ring side clearance -inches (mm)		
Compression No.1	0.0012 - 0.0026 (0.03 - 0.07 mm)	0.0047 (0.12 mm)
Compression No.2	0.0008 - 0.0024 (0.02 - 0.06 mm)	0.0047 (0.12 mm)
Piston outer diameter - inches (mm)		
BCG 4.0KW	2.8167 - 2.8179 (71.545 - 71.575 mm)	-
BCG 6.5KW and BTG 9.0KW	2.9903 - 2.9915 (75.955 - 75.985 mm)	-
Piston-to-piston pin clearance - inches (mm)	0.0002 - 0.0004 (0.005 - 0.011 mm)	0.0008 (0.02 mm)

	Specified Value	Allowable Limit
Connecting Rod		
Bend of rod per 3.94 inches (100 mm)		
BCG 4.0KW	-	0.0031 (0.08 mm)
BCG 6.5KW and BTG 9.0KW	-	0.0020 (0.05 mm)
Twist of rod per 3.94 inches (100 mm)		
BCG 4.0KW	-	0.0039 (0.10 mm)
BCG 6.5KW and BTG 9.0KW	-	0.0020 (0.05 mm)
Connecting rod bearing oil clearance - inches (mm)		
BCG 4.0KW	0.0008 - 0.0017 (0.020 - 0.0444 mm)	0.0031 (0.08 mm)
BCG 6.5KW and BTG 9.0KW	0.0008 - 0.0017 (0.020 - 0.044 mm)	0.0028 (0.07 mm)
Big end thrust clearance - inches (mm)		
BCG 4.0KW	0.0059 - 0.0098 (0.150 - 0.250 mm)	0.0118 (0.30 mm)
BCG 6.5KW - BTG 9.0KW	0.0059 - 0.0087 (0.150 - 0.220 mm)	0.0118 (0.30 mm)
Crankshaft		
Crankshaft run-out - inches (mm)	-	0.0012 (0.03 mm)
Uneven wear of journal section - inches (mm)	-	0.0008 (0.02 mm)
Crankshaft bearing oil clearance - inches (mm)		
BCG 4.0KW	0.0008 - 0.0017 (0.020 - 0.044 mm)	0.0031 (0.08 mm)
BCG 6.5KW - BTG 9.0KW	0.0008 - 0.0017 (0.020 - 0.044 mm)	0.0028 (0.07 mm)
Side clearance - inches (mm)		
BCG 4.0KW	0.0008 - 0.0087 (0.020 - 0.220 mm)	0.0118 (0.30 mm)
BCG 6.5KW - BTG 9.0KW	0.0004 - 0.0063 (0.010 - 0.160 mm)	0.0118 (0.30 mm)
Balance Shaft		
Thrust clearance - inches (mm)		
BCG 4.0KW	0.0012 - 0.0047 (0.03 - 0.12 mm)	0.0079 (0.20 mm)
BCG 6.5KW and BTG 9.0KW	0.0012 - 0.0051 (0.03 - 0.13 mm)	0.0039 (0.10 mm)
Balance shaft bearing oil clearance - inches (mm)	0.0010 - 0.0026 (0.025 - 0.066 mm)	0.0039 (0.10 mm)

Camshaft	Specified Value	Allowable Limit
Thrust clearance - inches (mm)		
BCG 4.0KW	0.0019 - 0.0114 (0.050 - 0.290 mm)	0.0157 (0.40 mm)
BCG 6.5KW and BTG 9.0KW	0.0402 - 0.0496 (1.020 - 1.260 mm)	0.0551 (1.40 mm)
Cam lobe height - inches (mm)		
BCG 4.0KW	1.5592 - 1.5631 (39.604 - 39.704 mm)	1.5571 (39.55 mm)
BCG 6.5KW and BTG 9.0KW	1.5743 - 1.5822 (39.987 - 40.187 mm)	1.5630 (39.70 mm)
Fuel pump driving cam height - inches (mm)		
BCG 4.0KW	1.1701 - 1.1740 (29.72 - 29.82 mm)	1.1642 (29.57 mm)
Camshaft journal uneven wear - inches (mm)		
BCG 4.0KW	-	0.0012 (0.03 mm)
BCG 6.5KW and BTG 9.0KW	-	0.0016 (0.04 mm)
Camshaft bearing oil clearance - inches (mm)		
BCG 4.0KW (front)	0.0012 - 0.0030 (0.030 - 0.75 mm)	0.0047 (0.12 mm)
(rear)	0.0020 - 0.0039 (0.050 - 0.100 mm)	0.0059 (0.15 mm)
BCG 6.5KW and BTG 9.0KW (front)	0.0016 - 0.0035 (0.04 - 0.09 mm)	0.0055 (0.14 mm)
(center)	0.0035 - 0.0055 (0.09 - 0.14 mm)	0.0075 (0.19 mm)
(rear)	0.0024 - 0.0043 (0.06 - 0.11 mm)	0.0063 (0.16 mm)
Timing Belt Pulley		
Pulley outer diameter - inches (mm)		
Camshaft pulley	4.7189 - 4.7260 (119.86 - 120.40 mm)	4.7165 (119.80 mm)
Crankshaft pulley	2.3331 - 2.3370 (59.26 - 59.36 mm)	2.3307 (59.20 mm)
Manifold		
Intake manifold gasket surface distortion - inches (mm)	-	0.0039 (0.10 mm)
Exhaust manifold gasket surface distortion - inches (mm)	-	0.0039 (0.10 mm)

	Specified Value	Allowable Limit
Flywheel		
Flywheel run-out - inches (mm)		
BCG 4.0KW	-	0.0079 (0.20 mm)
BCG 6.5KW and BTG 9.0KW	-	0.0039 (0.10 mm)
Electrical System		
Starting battery (recommended)		
BCG 4.0KW	12-volt, 26 A-H	(35 A-H in cold areas)
BCG 6.5 and BTG 9.0KW	12-volt, 30 A-H	(45 A-H in cold areas)
Starter	12-volt, 1.2KW, reduction type, solenoid-mounted.	
No-load performance	Less than 50 amp at 11 volts	
Alternator (9.0 BTG ONLY)		
No-load performance (Engine speed at 1800 rpm)		
Regulated voltage BTG 9.0KW	13.9 - 15.1 volts	-
Regulator current	Less than 10 amps	-
Load performance (Engine speed at 1800 rpm)		
Regulated voltage BTG 9.0KW	13.9 - 15.1KW	-
Brush length - inches (mm) BTG 9.0KW	0.413 (10.5 mm)	0.117 (4.5 mm)
Stator resistance - Ω (ohms) BTG 9.0KW	Less than 1 Ω	-
Rotor resistance - Ω (ohms) BTG 9.0KW	2.9 Ω	-

	Specified Value	Allowable Limit
Ignition System		
Distributor		
Condenser capacity - uf (microfarads)		
BCG 4.0KW	0.225 - 0.275	-
BCG 6.5KW and BTG 9.0KW	0.27	-
Contact point clearance - inch (mm)	0.016 - 0.020 (0.4 - 0.5 mm)	-
Dwell angle - degrees		
BCG 4.0KW	95 - 101	
BCG 6.5KW and BTG 9.0KW	58 - 66	
Ignition coil		
Primary coil resistance	ohms 0.98 ± 0.1	
Secondary coil resistance	ohms 17.5 ± 2.6	
Resistor resistance	ohms 1.92 ± 0.2	
Lubricating System		
General	Pressure type with Trochoid pump, chain-driven through balance shaft.	
Oil filter	Full flow, paper element, spin-cartridge.	
Oil sump capacity (filter not included) - qts (liters)	3.0 (2.9 liters)	-
Oil pressure at 1800 rpm engine speed (engine hot)	50 - 70 psi 3.5 - 4.9 kg/cm ²	- -
Oil pump		
Oil pump chain deflection - inches (mm)	-	0.275 (7 mm)
Shaft-to-body clearance - inches (mm)	0.008 - 0.0033 (0.045 - 0.085 mm)	0.0039 (0.10 mm)
Tip clearance (inner to outer rotor) - inches (mm)	0.0059 (0.15 mm)	0.0098 (0.25 mm)
Side clearance (rotor end float)	0.0012 - 0.0035 (0.03 - 0.09 mm)	0.0079 (0.20 mm)
Body clearance (outer rotor- to-body) - inches (mm)	0.0039 - 0.0063 (0.10 - 0.16 mm)	0.0118 (0.30 mm)

Lubricant: API specification of SC or SD, grade in accordance with thermal environment (see table).

TEMPERATURE	C°	-30	-20	-10	0	10	20	30	40	50
	F°	-20	0	20	40	60	80	100	120	
ENGINE OIL		5W-30		10W-30		15W-30				
		5W-20		10W-20		15W-20		40		
				10W-30						
				10W-40		15W-50				
						20W-40		20W-50		

TIGHTENING TORQUE REQUIREMENTS

	Lb-ft	Kg-m
Cylinder head to cylinder block		
BCG 4.0KW	28.9 - 39.8	4.0 - 5.0
BCG 6.5KW and BTG 9.0KW	36.2 - 43.4	5.0 - 6.0
Crankshaft pulley to crankshaft		
BCG 4.0KW	36.2 - 43.4	5.0 - 6.0
BCG 6.5KW and BTG 9.0KW	65.2 - 72.4	9.0 - 10.0
Manifold to cylinder head		
BCG 4.0KW	10.8 - 18.1	1.5 - 2.5
BCG 6.5KW and BTG 9.0KW	7.2 - 11.6	1.0 - 1.6
Main bearing caps to cylinder block		
BCG 4.0KW	34.0 - 42.7	4.7 - 5.9
BCG 6.5KW and BTG 9.0KW	39.1 - 47.7	5.4 - 6.6
Connecting rod bearing caps to connecting rod	15.2 - 21.0	2.1 - 2.9
Balance shaft thrust plate		
BCG 4.0KW	3.6 - 7.2	0.5 - 1.0
BCG 6.5KW and BTG 9.0KW	7.2 - 10.8	1.0 - 1.5
Spark plug to cylinder head		
BCG 4.0KW	13.1 - 17.4	1.8 - 2.4
BCG 6.5KW and BTG 9.0KW	10.8 - 15.9	1.5 - 2.2
Rocker cover to cylinder head		
BCG 4.0KW	5.1 - 9.4	0.7 - 1.3
BCG 6.5KW and BTG 9.0KW	5.8 - 8.7	0.8 - 1.2
Flywheel to crankshaft	28.9 - 36.2	4.0 - 5.0
Timing belt cover to cylinder head		
All Engines	1.4 - 2.9	0.2 - 0.4
Timing belt cover to cylinder block		
All Engines	7.2 - 11.6	1.0 - 1.6
Valve adjusting screw locknut		
All Engines	9.4 - 13.0	1.3 - 1.8
Camshaft timing belt pulley to camshaft	21.7 - 32.5	3.0 - 4.5
Fuel pump drive cam to camshaft (BCG 6.5KW and BTG 9.0KW ONLY)	7.2 - 10.8	1.0 - 1.5

TIGHTENING TORQUE REQUIREMENTS
(continued)

	Lb-ft	Kg-m
Timing belt tensioner to cylinder block		
BCG 4.0KW	7.2 - 11.6	1.0 - 1.6
BCG 6.5KW and BTG 9.0KW	21.7 - 32.5	3.0 - 4.5
Oil pan to cylinder block	2.9 - 5.1	0.4 - 0.7
Oil pan drain plug	18.1 - 25.3	2.5 - 3.5
Oil pump to cylinder block	10.8 - 15.9	1.5 - 2.2
Oil pump drive shaft sprocket to oil pump rotor (BCG 6.5KW and BTG 9.0KW ONLY)	7.2 - 11.6	1.0 - 1.6
Balance shaft gear cover to cylinder block All Engines	7.2 - 11.6	1.0 - 1.6
Distributor housing to cylinder block All Engines	10.8 - 15.9	1.5 - 2.2
Oil seal retainer to cylinder block (BCG 6.5KW and BTG 9.0KW ONLY)	7.2 - 11.6	1.0 - 1.6
Backplate to cylinder block		
BCG 4.0KW		
M8	7.2 - 11.6	1.0 - 1.6
M10	13.7 - 22.4	1.9 - 3.1
BCG 6.5KW and BTG 9.0KW	7.2 - 11.6	1.0 - 1.6
Fuel line to pump	10.8 - 14.5	1.5 - 2.0
Fuel line to carburetor	10.8 - 14.5	1.5 - 2.0
Generator drive disc to flywheel	14.5 - 21.7	2.0 - 3.0
Generator drive disc to rotor shaft	28.9 - 39.8	4.0 - 5.5

NOTE: Hardware listed in the **Flywheel Housing to Cylinder Block** specification are metric, with values given as in the following example: Flywheel bolt M10 (17)

M10 indicates Metric thread diameter; (17), if given, indicates 17 mm across the flats of the bolt head.

TABLE OF STANDARD HARDWARE TIGHTENING TORQUES

Unless stated for a specific assembly, use the following torque values when tightening standard hardware.

	Pitch	lb-ft	kg-m
<u>Grade 4T</u>			
6mm bolt head/nut	1	2.9 - 5.1	0.4 - 0.7
8mm bolt head/nut	1.25	7.2 - 11.6	1.0 - 1.6
10mm bolt head/nut	1.25	13.7 - 22.4	1.9 - 3.1
10mm bolt head/nut	1.5	13.0 - 21.7	1.8 - 3.0
12mm bolt head/nut	1.25 (ISO)	25.3 - 39.8	3.5 - 5.5
12mm bolt head/nut	1.5	25.3 - 39.8	3.5 - 5.5
12mm bolt head/nut	1.75	21.7 - 36.2	3.0 - 5.0
13mm bolt head/nut	1.5	32.5 - 50.6	4.5 - 7.0
14mm bolt head/nut	1.5	36.2 - 57.9	5.0 - 8.0
14mm bolt head/nut	2	34.0 - 55.7	4.7 - 7.7
16mm bolt head/nut	1.5	54.2 - 79.6	7.5 -11.0
16mm bolt head/nut	2	51.4 - 76.7	7.1 -10.6
<u>Grade 6T</u>			
6mm bolt head/nut	1	4.3 - 6.5	0.6 - 0.9
8mm bolt head/nut	1.25	10.8 - 15.9	1.5 - 2.2
10mm bolt head/nut	1.25	21.7 - 32.5	3.0 - 4.5
10mm bolt head/nut	1.5	19.5 - 30.4	2.7 - 4.2
12mm bolt head/nut	1.25 (ISO)	36.2 - 57.9	5.0 - 8.0
12mm bolt head/nut	1.5	36.2 - 50.6	5.0 - 7.0
12mm bolt head/nut	1.75	34.7 - 49.2	4.8 - 6.8
<u>Grade 7T, 8T and 8.8</u>			
6mm bolt head/nut	1	5.8 - 8.7	0.8 - 1.2
8mm bolt head/nut	1.25	14.5 - 21.7	2.0 - 3.0
10mm bolt head/nut	1.25	28.9 - 39.8	4.0 - 5.5
10mm bolt head/nut	1.5	26.8 - 37.6	3.7 - 5.2
12mm bolt head/nut	1.25 (ISO)	54.2 - 75.9	7.5 -10.5
12mm bolt head/nut	1.5	50.6 - 65.1	7.0 - 9.0
12mm bolt head/nut	1.75	43.4 - 61.5	6.0 - 8.5
13mm bolt head/nut	1.5	57.9 - 86.8	8.0 -12.0
14mm bolt head/nut	1.5	72.3 -108.5	10.0 -15.0
14mm bolt head/nut	2	68.7 -101.3	9.5 -14.0
16mm bolt head/nut	1.5	108.5 - 166.4	15.0 -23.0
16mm bolt head/nut	2	101.3 - 159.1	14.0 -22.0
<u>Grade 5 capscrew</u>			
1/4 UNC		9 - 11	1.2 - 1.5
1/4 UNF		11 - 13	1.5 - 1.8
5/16 UNC		18 - 20	2.5 - 2.8
5/16 UNF		21 - 23	2.9 - 3.2
3/8 UNC		28 - 33	3.7 - 4.6
3/8 UNF		30 - 35	4.1 - 4.8
7/16 UNC		44 - 49	6.1 - 6.8
7/16 UNF		50 - 55	6.9 - 7.6
1/2 UNC		68 - 73	9.4 -10.1
1/2 UNF		73 - 80	10.1 -11.1

NOTES

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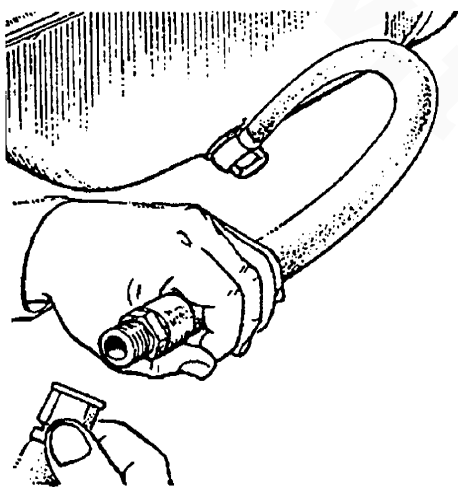
GENERATOR OVERHAUL

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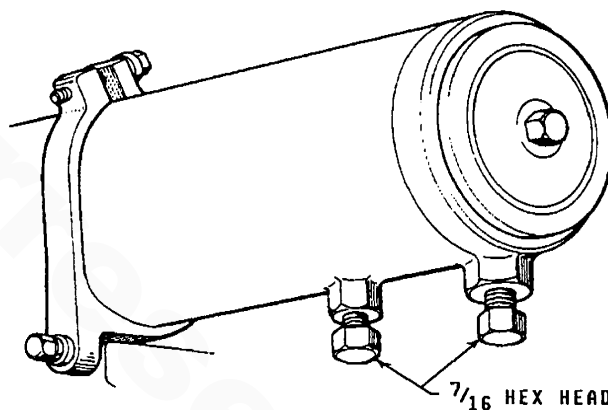
NOTE: Special Service Tools are available to help in the removal or installation of engine parts. Refer to the "SPECIAL SERVICE TOOLS" section of this manual, page 84, for illustrations and part numbers for each tool.

PREPARATIONS

1. Remove all AC and DC power connections from the unit.
2. Shut off and disconnect all fuel lines, sea water and exhaust connections.
3. Unbolt the unit and carefully move it to the overhaul shop.
4. Once at the overhaul shop, drain all lubricating oil and coolant from the engine and exchanger system.
5. Clean the exterior of the generator of all oil and dirt deposits.



Oil Sump Drain



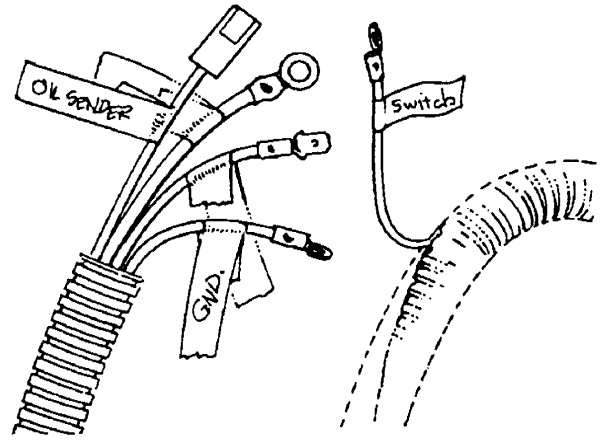
Heat Exchanger Drains

DISASSEMBLY FOR OVERHAUL

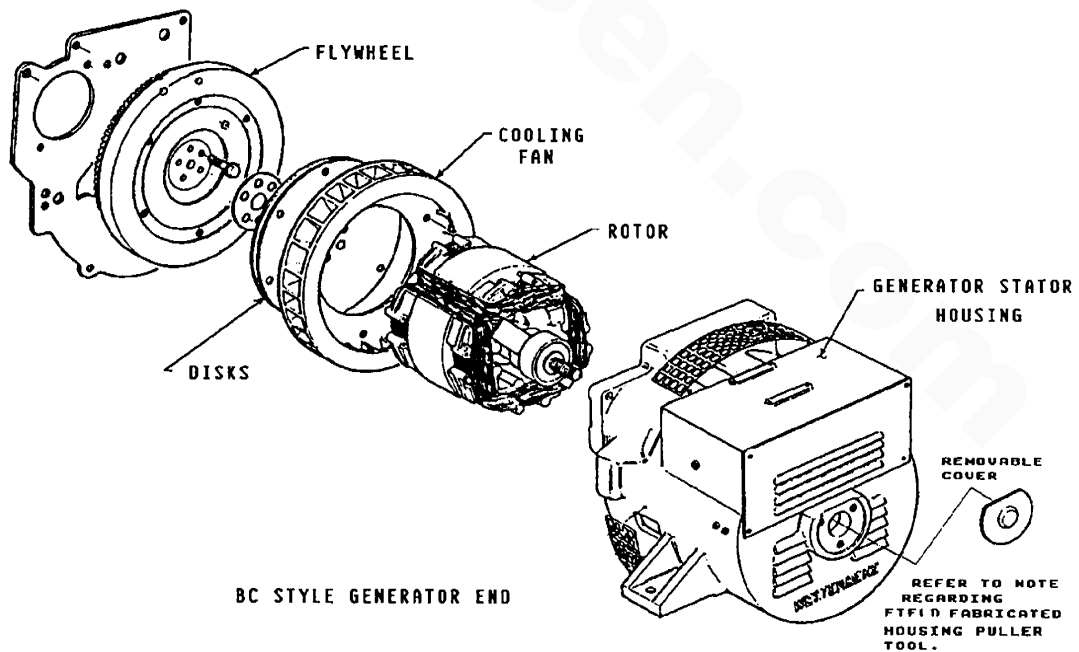
Removing the Generator End from the Engine

1. Disconnect harness leads from the engine connections, and tag and mark all harness connections. Unbolt the control panel from generator's control panel as one assembly.
2. Supporting the rear of the engine, unbolt the generator end's bell cover.

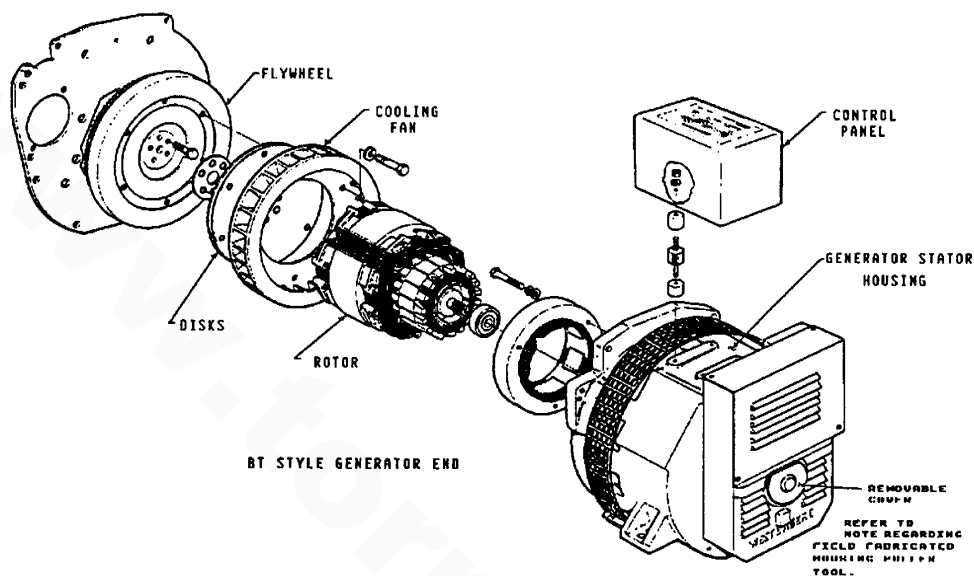
NOTE: The Housing Puller Tool listed in the "FIELD FABRICATED TOOLS" section of this manual, page 222, will help make the removal of the generator's stator housing much easier.



3. With the aid of the Housing Puller Tool attached to the end bearing support web and armature shaft, carefully draw the generator's stator housing off the rear support bearing. In some cases, the rear support bearing may be pulled off the armature shaft along with the generator housing.
4. When clear of the bearing and/or shaft, manually slide the generator's stator housing carefully off the armature. Refer to the illustration on the next page for the BTG 9.0KW generator end. The illustration below shows the generator end for the BCG 4.0KW and BCG 6.5KW models.



The illustration below shows the generator end for the BTG 9.0KW.



5. For all generator models, remove the fan assembly
6. Remove the drive disks with the rotor attached.
7. Remove the rotor from the drive disks and store both the rotor and the drive disks in a safe place.
8. Remove the engine's flywheel.

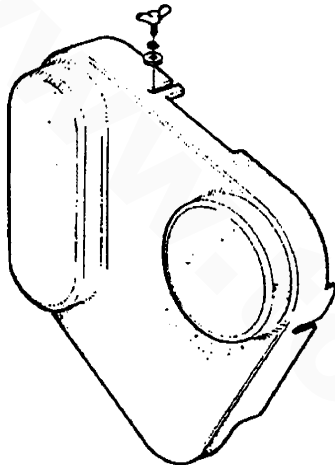
Now that the generator end has been removed, the engine can be disassembled.

ENGINE DISASSEMBLY

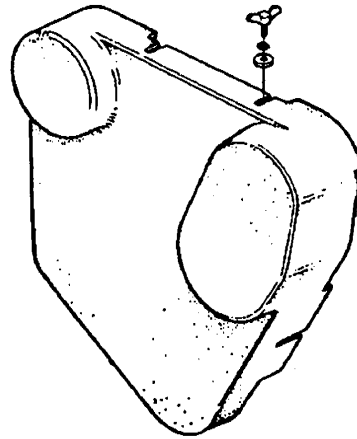
This section describes the disassembly of the engine when performing a complete overhaul of the unit. The procedures which follow include the disassembly of subassemblies, inspection of their components parts, repair or replacement of these parts (if necessary), and the reassembly of the subassemblies.

Removal of External Parts and Subassemblies

1. Loosen the belt guard's thumbscrews and remove the engine's belt guard from its brackets at the front of the engine.



BCG 4.0KW BELT GUARD



BCG 6.5KW AND BTG 9.0KW
BELT GUARD

2. Remove the starter motor and circuit breaker assembly. Examine the starter and have it repaired or replaced if necessary.
3. Remove the heat exchanger and its related hoses and mounts from the front of the engine. Have the heat exchanger cleaned and tested at a local automotive radiator repair shop, or replace it if necessary.
4. Remove the exhaust manifold and related hoses as a unit. Disassemble and inspect these parts.
5. Remove the sea water pump, the drive belt, and the sea water pump's mounting brackets.
6. On the BCG 6.5KW engine, remove the idler pulley and the fresh water pump's drive belt.
7. On the BTG 9.0KW engine, remove the alternator, the fresh water pump's drive belt, and the alternator's mounting bracket.
8. Disconnect the linkage arm between the governor and the carburetor at the ball joint (carburetor end of arm); remove the governor and its mounting bracket.
9. Remove the fresh water circulating pump's pulley.
10. Remove the fresh water circulating pump.

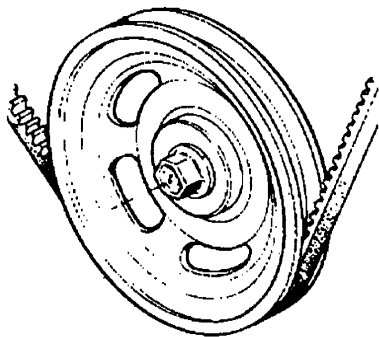
11. Remove the fuel line, the carburetor, the fuel pump (including the push rod on the BCG 4.0KW engine), and the intake manifold.
12. Remove the ignition coil and its mounting bracket.
13. Remove the engine's backplate.
14. Remove the water temperature switch and the water temperature sender.
15. Remove the oil pressure switch, the oil pressure sender, the oil filter, and the oil filter bracket.
16. Remove the thermostat housing and the thermostat.
17. Remove the crankshaft pulley from the crankshaft.
18. Remove the spark plugs from the cylinder head.
19. Remove the distributor from the right rear of the engine.

The basic engine assembly is now ready for disassembly, cleaning, inspection, and repair if necessary.

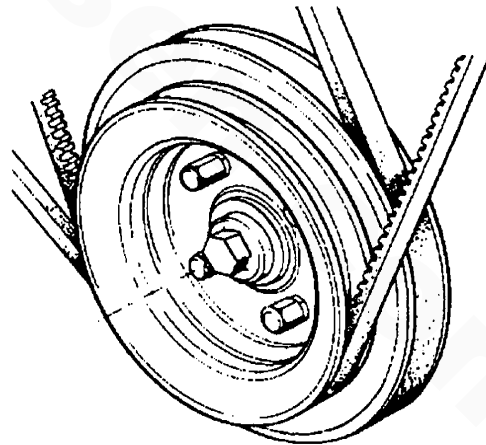
Since the BCG 4.0KW, the BCG 6.5KW and the BTG 9.0KW generator engines are not as bulky nor as heavy as an automobile engine, the engines may be laid on a sturdy bench while they are disassembled and repaired.

Timing Belt Removal

1. Remove the crankshaft pulley from the crankshaft.

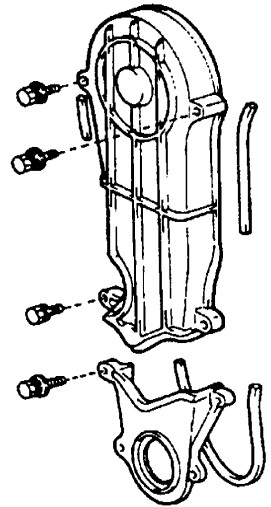
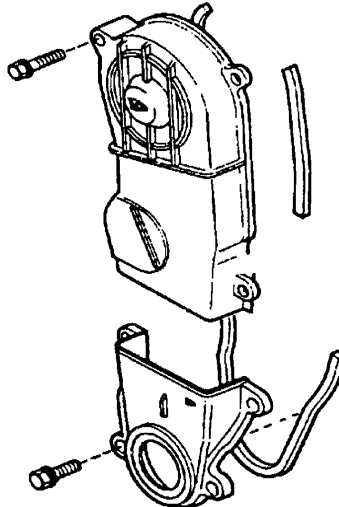


**BCG 4.0KW
CRANKSHAFT PULLEY**



**BCG 6.5KW AND BTG 9.0KW
CRANKSHAFT PULLEY**

2. Remove the rocker cover and gasket from the cylinder head. Inspect the gasket for cuts and breaks. Replace the gasket if necessary, or keep it for reinstallation.

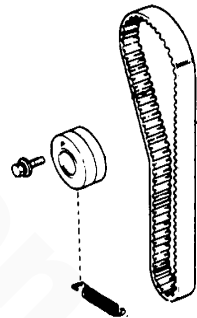
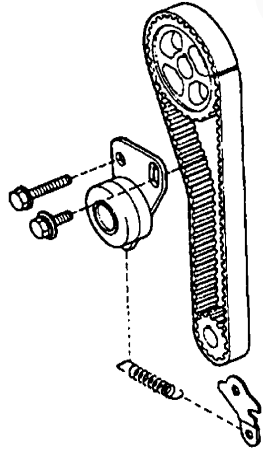


TIMING BELT COVERS
BCG 4.0KW

TIMING BELT COVERS
BCG 6.5KW AND BTG 9.0KW

3. Remove the upper and lower timing belt covers along with their associated dust covers.

4. Remove the tension spring from the timing belt tensioner and the tension spring bracket, and remove the timing belt tensioner.



BCG 4.0KW

BCG 6.5KW and BTG 9.0KW

CAUTION

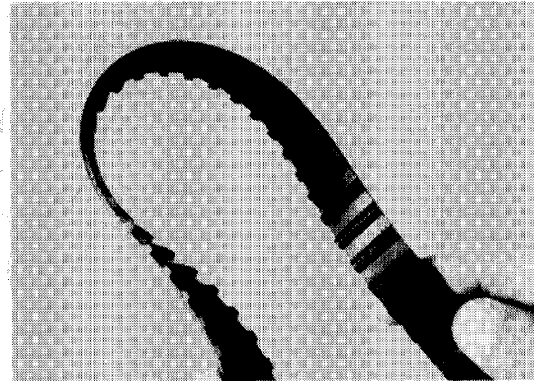
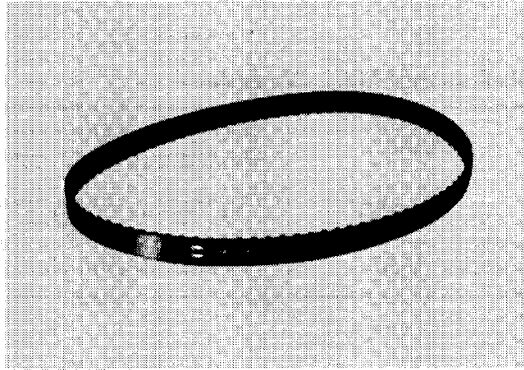
When removing the timing belt, be sure **not** to bend the belt sharply (that is, do not bend the belt into a small radius). The cablecord contained in the timing belt is extremely durable against tensile forces. However, the cablecord is susceptible to breakage when the belt is sharply bent. Bending reduces the belt's overall strength.

5. Carefully remove the timing belt from its pulleys.

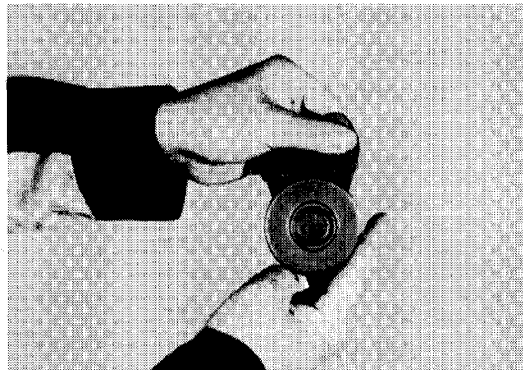
CAUTION

The timing belt must be kept free of oil, grease, water or other substances which may cause the belt to deteriorate or swell.

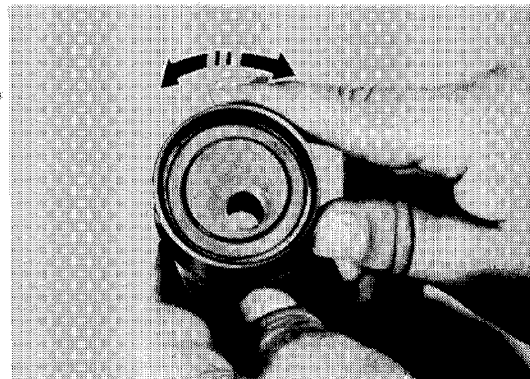
6. Inspect the timing belt for deterioration, swelling, cracking, and peeling or deformed teeth; replace the belt if it is found to be faulty or after 1000 hours of operating service. Refer to the pictures below.



7. Inspect the timing belt tensioner for abnormal noise and/or damage at the belt contact point. If the timing belt tensioner is excessively worn, replace it.



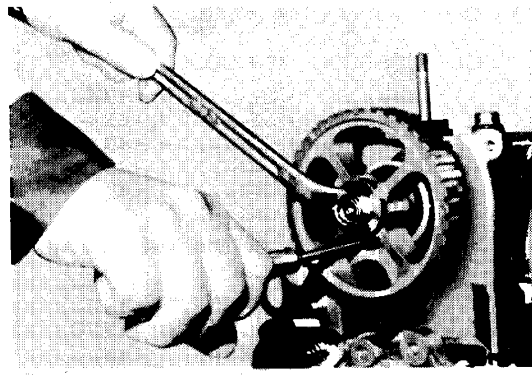
Checking the BCG 4.0KW Belt Tensioner



Checking the BCG 6.5KW and BTG 9.0KW Belt Tensioner

8. Remove the camshaft timing belt pulley.

NOTE: When removing the camshaft timing belt pulley, insert a screwdriver between the spokes of the pulley to prevent the camshaft rotating while loosening the pulley's screw.

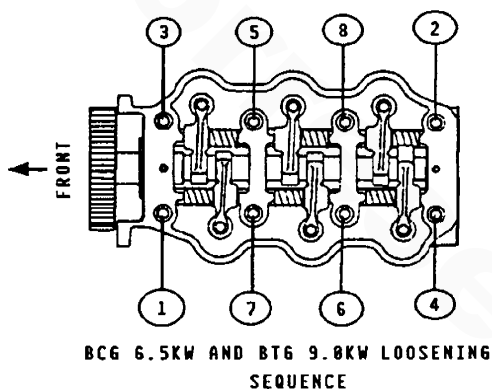
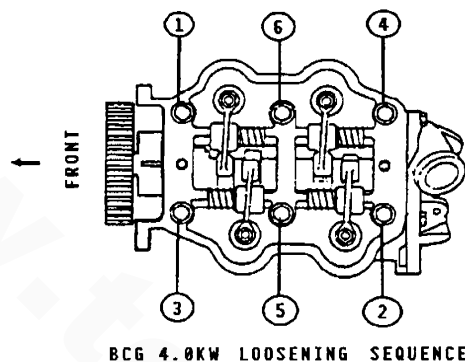


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REMOVING THE CYLINDER HEAD FROM THE CYLINDER BLOCK

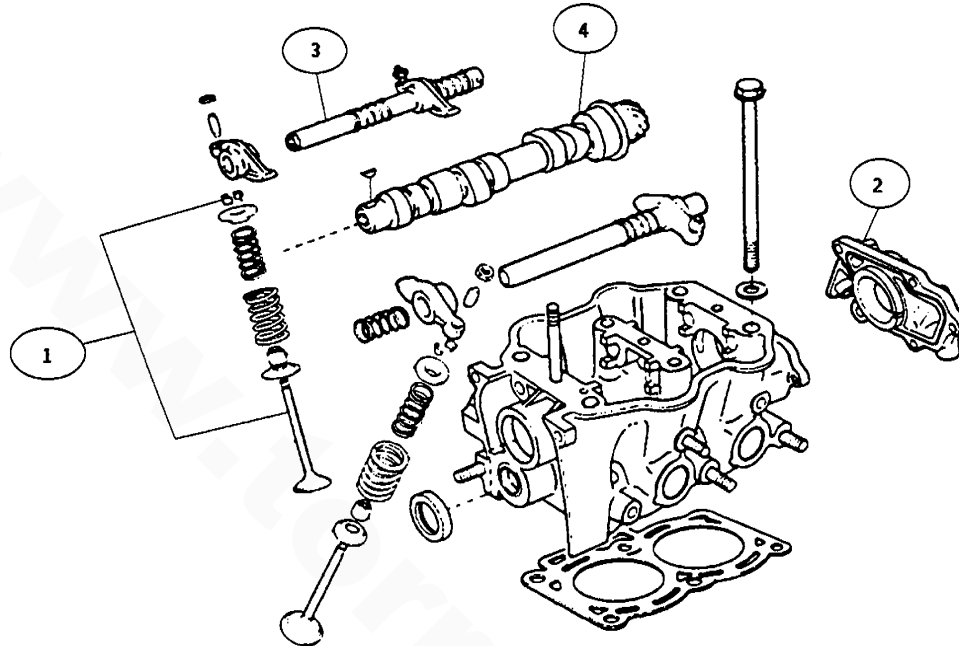
To avoid the possibility of distorting the cylinder head, loosen each of the cylinder head bolts, a little at a time, in the sequence shown below. Repeat this sequence several times until the bolts are unfastened. Remove the cylinder head and cylinder head's gasket.

NOTE: Discard the cylinder head gasket when it is removed. When reassembling the cylinder head to the cylinder block, install a new cylinder head gasket.



CYLINDER HEAD DISASSEMBLY

Disassemble the cylinder head by removing parts in the order indicated. The figure below presents the relationship of parts for the BCG 4.0KW engine's cylinder head.

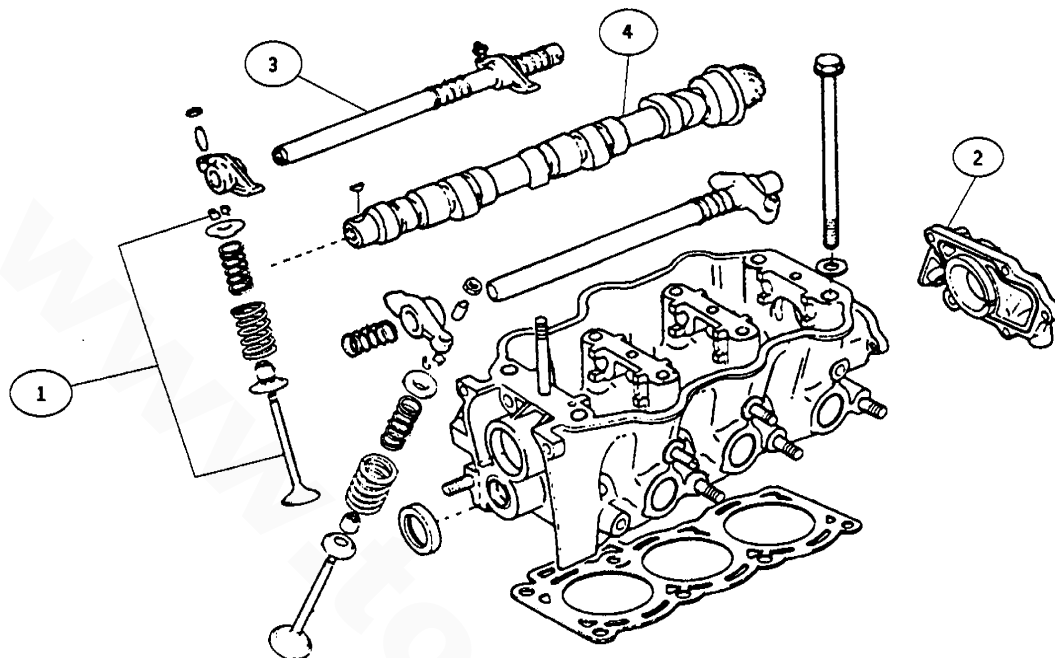


BCG 4.0 KW DISASSEMBLY ORDER

- | | |
|------------------------|-------------------|
| *1. Valves | (page 75, step 1) |
| 2. Distributor Housing | |
| *3. Rocker Arms | (page 76, step 3) |
| *4. Camshaft | (page 76, step 4) |

*Denotes that disassembly instructions for these parts follow on the indicated pages.

The figure below presents the relationship of parts (and the order in which those parts are disassembled) for the BCG 6.5KW and the BTG 9.0KW engines' cylinder heads.

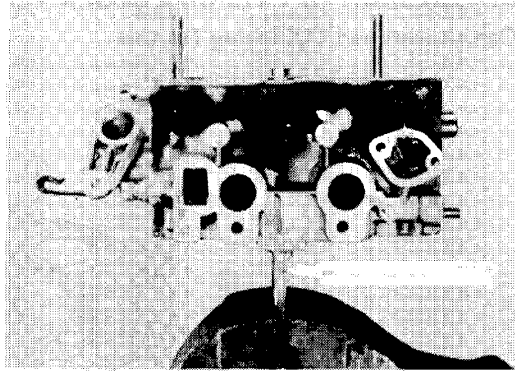


BCG 6.5 KW and BTG 9.0 KW DISASSEMBLY ORDER

- *1. Valves (page 75, step 1)
- 2. Distributor housing
- *3. Rocker Arms (page 76, step 3)
- *4. Camshaft (page 76, step 4)

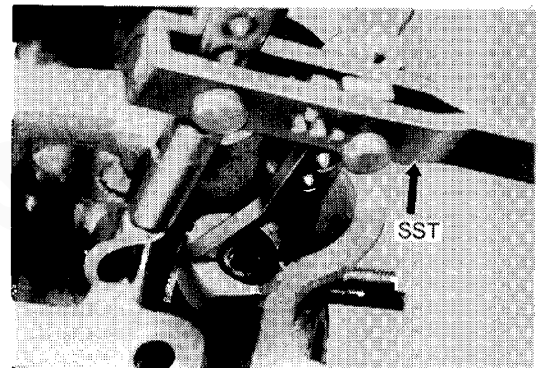
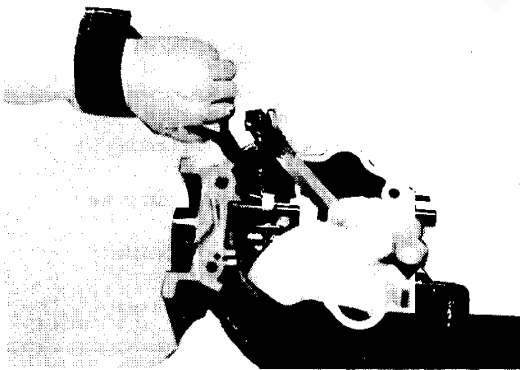
*Denotes that disassembly instructions for these parts follow on the indicated pages.

1. Mount the cylinder head, while supporting it in an appropriate holder, to allow for the removal of the valve springs, valves and guides as needed.



Remove the valves and their associated parts using the valve spring replacer (special service tool [SST] #37728 for the BCG 4.0KW engine, the BCG 6.5KW and the BTG 9.0KW engines).

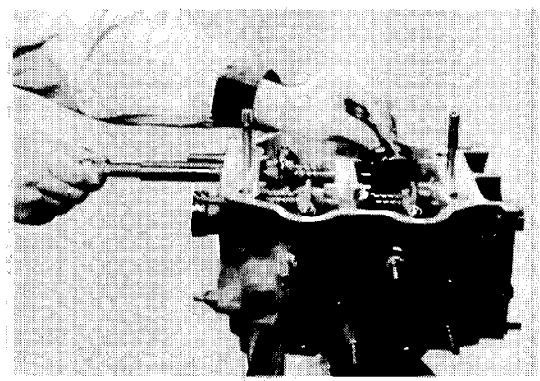
NOTE: As the valves and their associated parts are removed, keep valve sets together and in correct order with respect to their placement in the cylinder head. Unless any of the parts are replaced, they must be returned to the same locations from which they were removed.



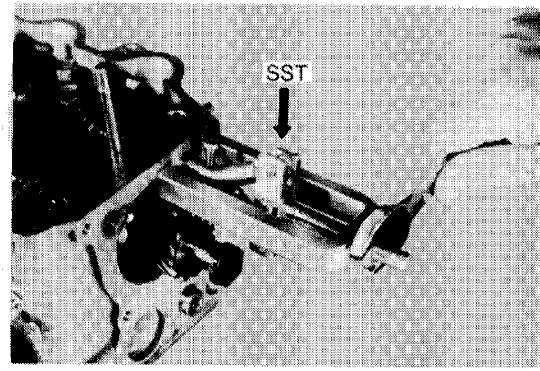
2. Remove the distributor housing.

3. Loosen the lock nuts and back the adjusting screws off the valve rocker arms. Remove the rocker shafts as follows.

A. For the BCG 4.0KW cylinder head, remove the rocker shaft plug and screw a bolt into the rear end of the No. 1 rocker shaft; pull out the bolt, drawing the rocker shaft with it; repeat this process for the No. 2 rocker shaft.

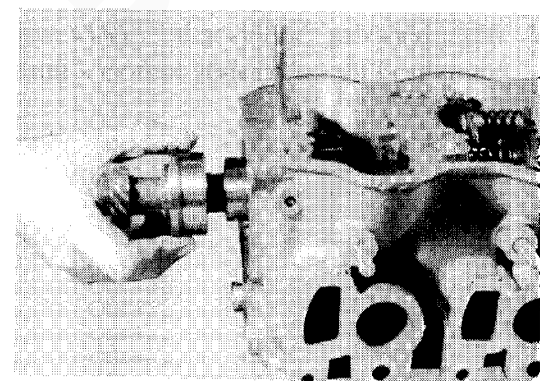


B. For the BCG 6.5KW and BTG 9.0KW cylinder heads, remove the rocker shaft plug from the rear end of the No. 1 rocker shaft and use the valve shaft puller (special service tool [SST] # 37729) to extract the rocker shaft; repeat this process for the No. 2 rocker shaft.



NOTE: At the same time the rocker shaft is extracted, remove the valve rocker arms and compression springs associated with the shaft.

4. Extract the camshaft from the rear end of the cylinder head.

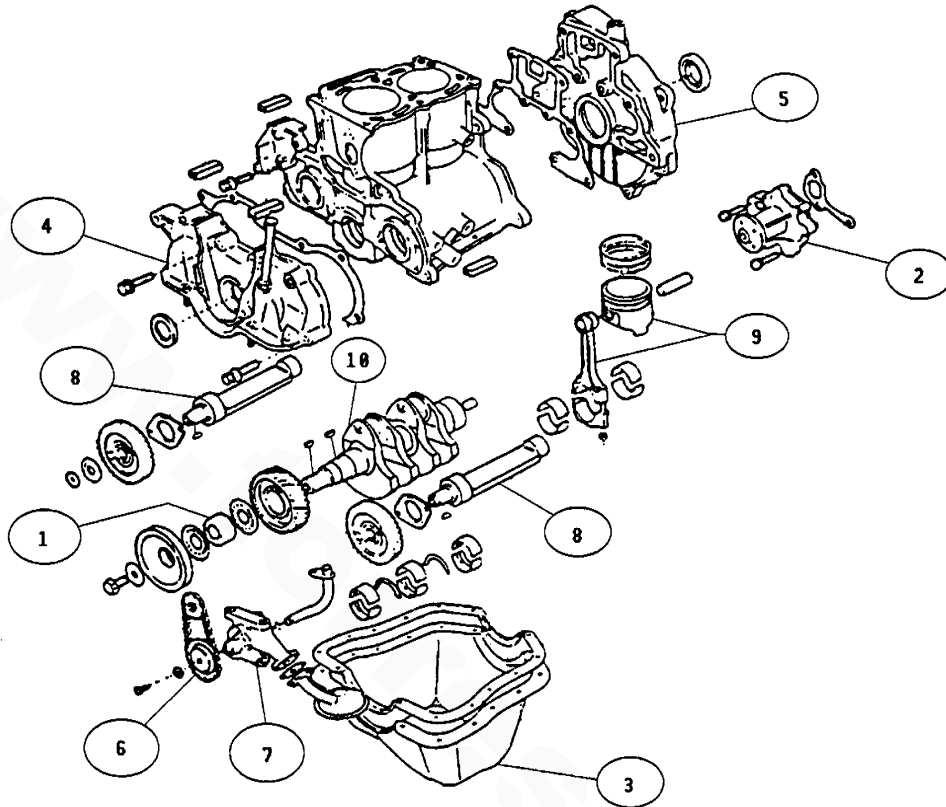


CAUTION

Exercise care when removing the camshaft to avoid damaging the bearing journals or cam lobe surfaces of the camshaft.

CYLINDER BLOCK DISASSEMBLY

Disassemble the cylinder block by removing parts in the order indicated. The figure below presents the relationship of parts for the BCG 4.0KW engine's cylinder block.

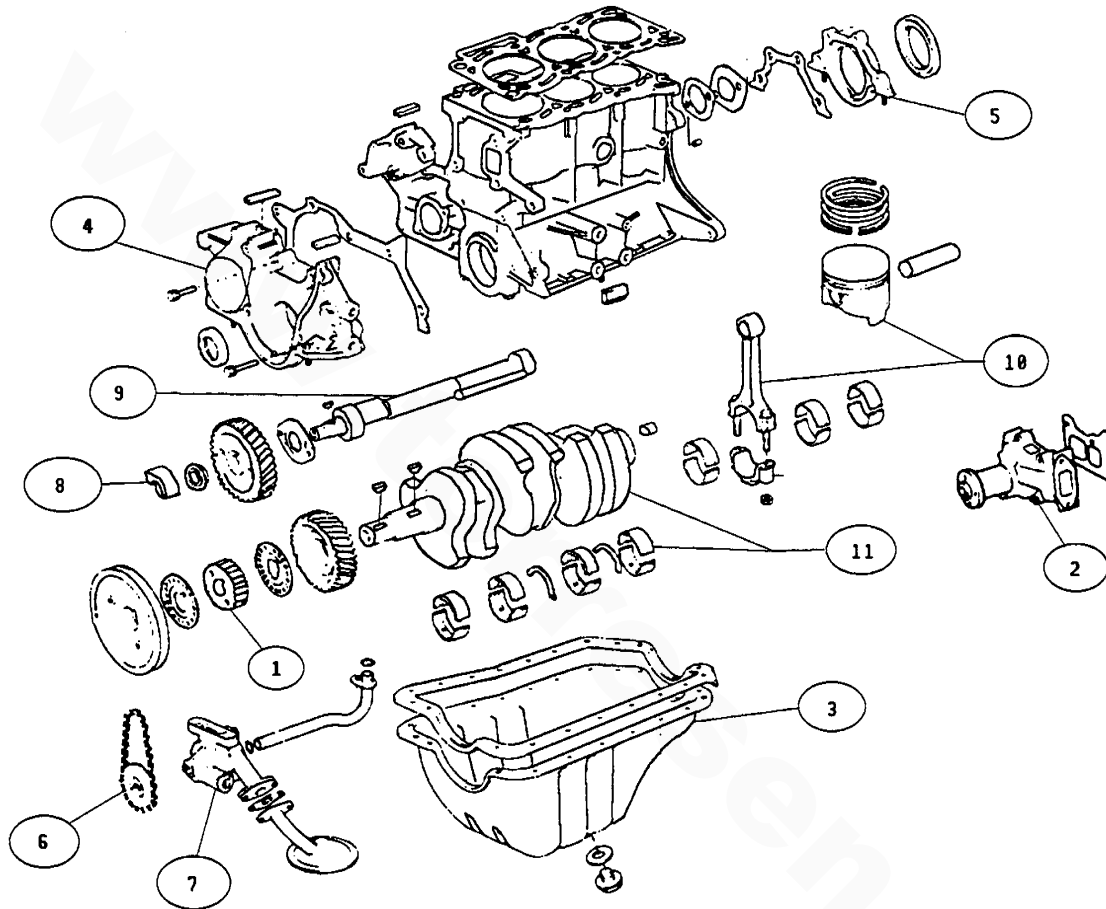


BCG 4.0 KW DISASSEMBLY ORDER

- *1. Crankshaft Timing Belt Pulley (page 79, step 1)
- 2. Fresh Water Pump (page 79)
- 3. Oil Pan and Gasket (page 79)
- 4. Balance Shaft Gear Cover
- 5. Rear Oil Seal Retainer
- 6. Oil Pump Drive Sprocket and Chain
- 7. Oil Pump
- *8. Balance Shaft and Pulley (page 79, step 8)
- *9. Pistons and Connecting Rod Assembly (page 80, step 9-10)
- *10. Crankshaft and Bearings (page 81, step 12-15)

*Denotes that disassembly instructions for these parts follow on the indicated pages.

The figure below presents the relationship of parts (and the order in which those parts are disassembled) for the BCG 6.5KW and the BTG 9.0KW engines' cylinder blocks.



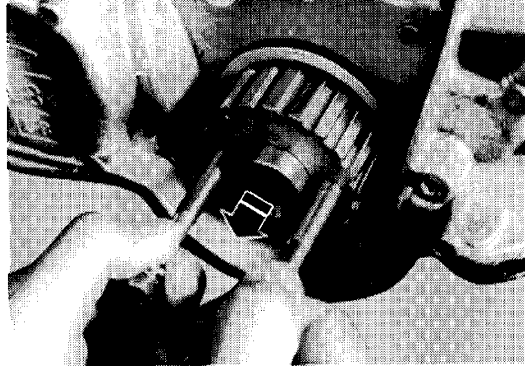
BCG 6.5 and 9.0 KW DISASSEMBLY ORDER

- *1. Crankshaft Timing Belt Pulley (page 79, step 1)
- 2. Fresh Water Pump (page 79)
- 3. Oil Pan and Gasket (page 79)
- 4. Balance Shaft Gear Cover
- 5. Rear Oil Seal Retainer
- 6. Oil Pump Drive Sprocket and Chain
- 7. Oil Pump
- 8. Balance shaft Weight (page 79, step 8)
- *9. Pistons and Connecting Rod Assembly (page 80, step 9-10)
- *10. Crankshaft and Bearings (page 81, step 12-15)

*Denotes that disassembly instructions for these parts follow on the indicated pages.

1. Remove the crankshaft's timing belt pulley and the crankshaft timing belt pulley's flanges.

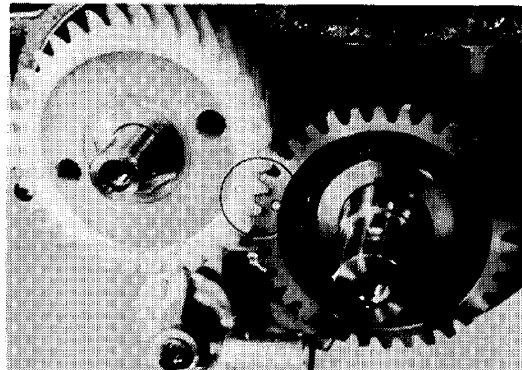
NOTE: If the crankshaft's timing belt pulley is difficult to remove, screw a pair of bolts into the threaded holes in the face of the pulley as shown in the illustrations below. Withdraw the pulley with the two bolts.



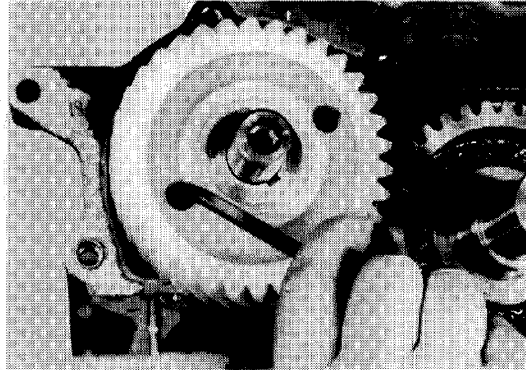
2. Remove the fresh water pump assembly and gasket.
3. Remove the oil pan and gasket.
4. Remove the balance shaft's gear cover, gasket, and dust seals.
5. Remove the rear oil seal retainer.
6. Remove the oil pump's drive sprocket from the right side balance gear; remove the oil pump's drive shaft sprocket and oil pump drive chain from the oil pump's drive shaft.
7. Remove the oil pump together with the oil pump outlet pipe.

NOTE: The oil pump is fastened to the cylinder block with hexagon socket head cap screws. Use a 6-mm hexagon wrench (commercially available) to remove the oil pump.

8. Remove the balance shaft as follows.
 - A. Align the stamped mark on the balance shaft's drive gear. This aligns the holes in the face of the balance shaft's gear with the hexagon socket head cap screws which fasten the balance shaft's thrust plate to the cylinder block.



- B.** Remove the hexagon socket head cap screws from the cylinder block using a 6-mm hexagon wrench; extract the balance shaft and balance shaft gear toward the front of the cylinder block taking care to avoid damaging the bearing journals. Repeat this process for the left side balance shaft on the BCG 4.0KW engine.



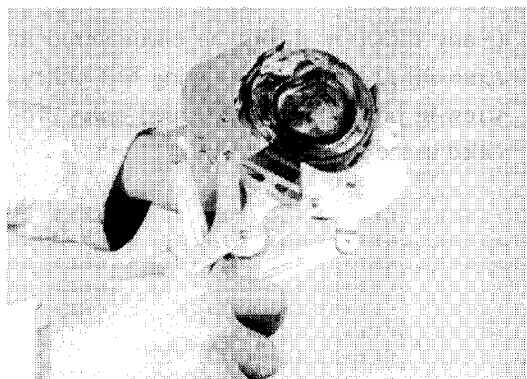
- 9.** Remove the connecting rod cap screws and detach the connecting rod cap. Push the connecting rod and piston assembly upward, out of the top of the cylinder block, using the handle of a hammer (or similar nonmetallic tool).

NOTE: Temporarily reassemble the connecting rod and cap to keep the parts together for later reassembly of the cylinder block components in the same locations from which they were removed.

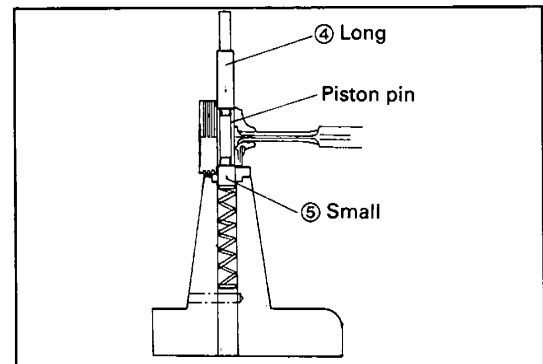
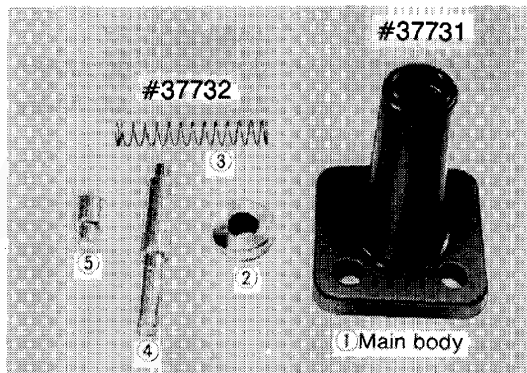
Repeat this procedure for each cylinder.

- 10.** Remove the piston rings from each piston as follows.

- A.** Remove the No. 1 and No. 2 piston rings using a commercially-available piston ring expander. Refer to the illustration shown to the right.
- B.** Remove the combination-type oil ring by hand.



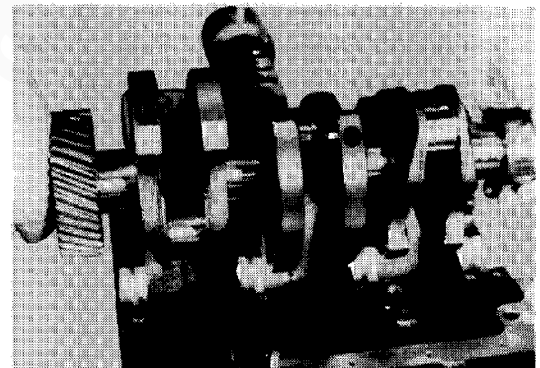
11. Remove the piston pin from each piston and connecting rod assembly using the piston pin removal tools (special service tools # 37731 and # 37732 for the BCG 4.0KW, the BCG 6.5KW and the BTG 9.0KW engines) as follows.



- A. Attach the fitting piece (2) into the main body (1).
- B. Place the spring (3) and the small bar (5) into the main body (1).
- C. Position the piston/rod assembly on the main body (1).
- D. Insert the large bar (4) into the piston over the piston pin.
- E. Use a soft-metal pin punch or a bearing press to drive the piston pin from the piston.

NOTE: Take care to keep the related pins and pistons in their proper order so that the pins are replaced in the same pistons from which they were removed, and the pistons replaced in the same cylinders from which they were removed.

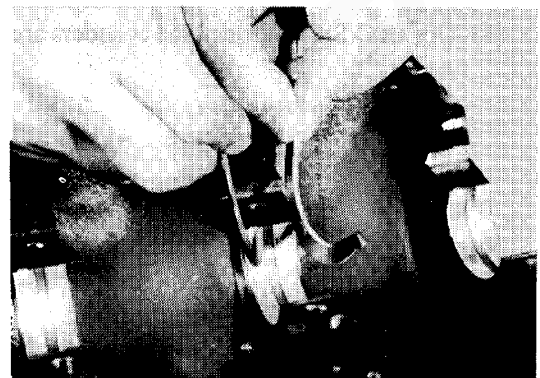
12. Remove the crankshaft's bearing caps.



13. Remove the crankshaft.

14. Remove the crankshaft's bearing sets and the No. 3 thrust bearing.

NOTE: the crankshaft's bearing sets must be kept in proper order so they can be reassembled in the same locations from which they were removed.



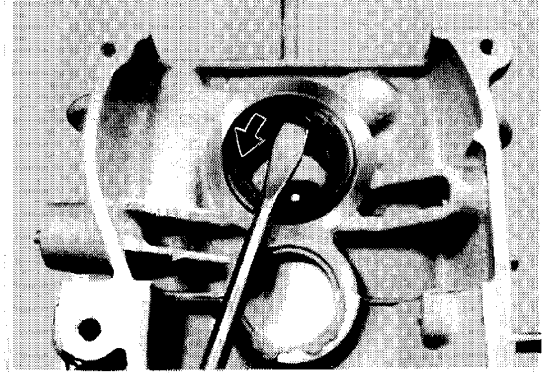
15. Remove the studs and other small parts as required.

Camshaft Oil Seal and Crankshaft Front Oil Seal Removal

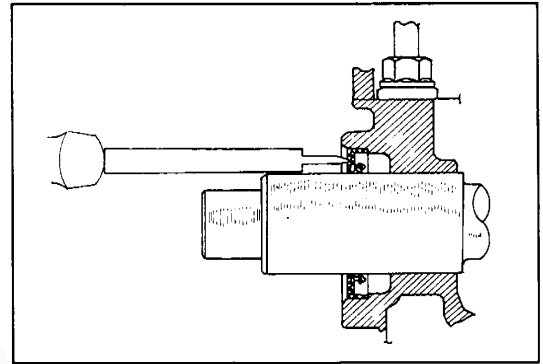
1. Remove the camshaft's oil seal from the cylinder head using a large screwdriver.

- A. For removing the camshaft's oil seal with a screwdriver, insert the screwdriver in the inner groove of the seal and gently pry the seal out while turning the seal with the screwdriver. Refer to the illustration to the right.

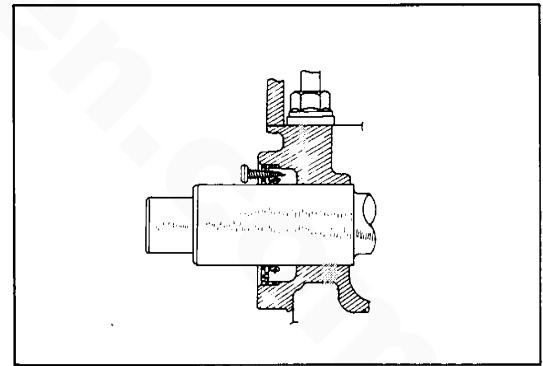
NOTE: Be extremely careful not to damage the oil seal journal's surface. Damaging this surface could cause excessive oil leaks even when a new oil seal has been installed.



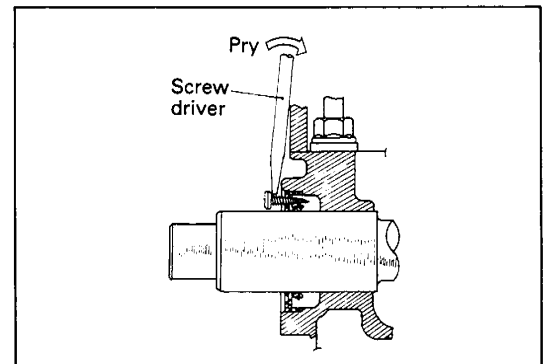
- A-1. For removing the camshaft's oil seal with the camshaft in place, punch a small hole in the flat surface of the seal with an awl.



- B. Place a self tapping screw into the hole punched into the seal in step A-1.



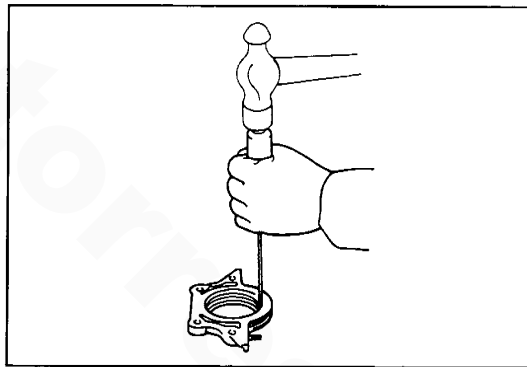
- C. Remove the oil seal by prying against the head of the self tapping screw. If needed, repeat steps A-1 and B with other screws around the circumference of the seal.



2. On the BCG 4.0KW engine, remove the crankshaft's front oil seal from the balance shaft's gear cover by inserting a screwdriver in the notch located in the rear of the balance shaft's gear cover and tap the oil seal out the front of the cover.
3. On the BCG 6.5KW and BTG 9.0KW engines, remove the crankshaft's front oil seal from the balance shaft's gear cover in the same manner as described in step 2.

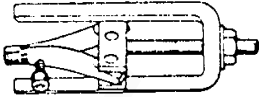
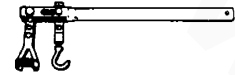
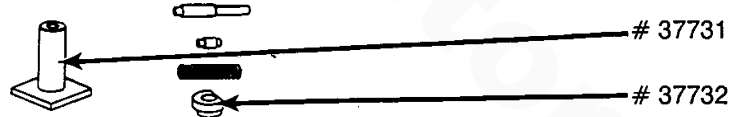

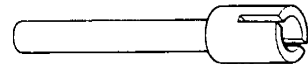
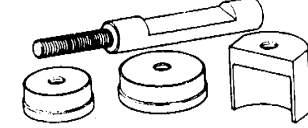
Crankshaft Rear Oil Seal Removal

1. On the BCG 4.0KW engine, remove the crankshaft's rear oil seal from the rear block housing by inserting a screw driver in the notch in the rear of the rear block housing and tap the oil seal out the front of the housing.
2. On the BCG 6.5KW and BTG 9.0KW engines, remove the crankshaft's rear oil seal from the oil seal retainer in the same manner as described in step 1.



SPECIAL SERVICE TOOLS

NOTE: Special Service Tools are listed in the same order as they appear in the manual.

Illustration	Tool No.	Tool Name
	# 37729	Valve rocker shaft puller
	BCG 4.0KW BCG 6.5KW BTG 9.0KW # 37728	Valve spring replacer
	# 37731	Piston pin remover and replacer
	# 37732	
	# 37725	Valve guide remover and replacer
	BCG 4.0KW # 37727	Valve stem oil seal replacer
	BCG 6.5KW BTG 9.0KW # 37726	
	#37730	Balance shaft gear bearing remover and replacer

**CYLINDER HEAD AND ENGINE BLOCK
INSPECTION AND REPAIR**

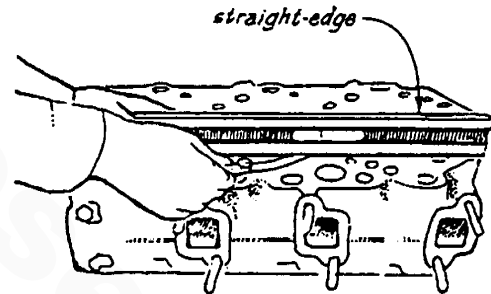
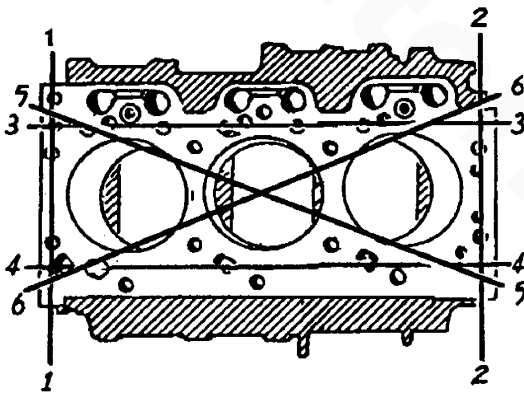
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ENGINE INSPECTION AND REPAIR

NOTE: Before washing the cylinder head and block, check them for indications of water leaks, gas leaks, damage or cracks. After checking these components, wash each part to remove any adhered matter such as pieces of gasket, dust, oil, carbon, and scale. Since the cylinder head, cylinder head cover, timing chain cover and other engine parts are made of aluminum, handle them carefully to ensure against damage. Do not use cleaning solutions that will be harmful to the aluminum.

Checking the Cylinder Head

1. Replace the cylinder head if it shows signs of water leaks, gas leaks or cracks.
2. Measure the extent of warping (flatness) on the lower surface that mates with the cylinder block. If the warping exceeds the allowable limit of distortion, grind the surface to within the specified grinding tolerance. If the warping exceeds the allowable grinding tolerance, then replace the cylinder head.



Specified Cylinder Head Height:	BCG 4.0KW 4.953 inches (125.8 mm)
	BCG 6.5KW and BTG 9.0KW 4.953 inches (125.8 mm)
Allowable Limit of Distortion:	BCG 4.0KW 0.002 inches (0.05 mm)
	BCG 6.5KW and BTG 9.0KW 0.0039 inches (0.10 mm)
Grinding Tolerance:	BCG 4.0KW 0.0118 inches (0.30 mm)
	BCG 6.5KW and BTG 9.0KW 0.0118 inches (0.30 mm)

Checking Valve Guides

Measure the clearance between the valve and guide bushing. If the clearance exceeds the specified limit, replace those parts that have worn beyond the allowable limit.

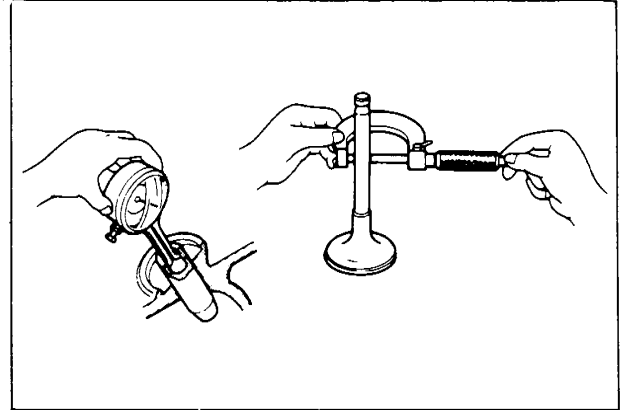
Specified Limit:

Intake 0.0016 - 0.0028 inches (0.040 - 0.070 mm)
Exhaust 0.0018 - 0.0030 inches (0.045 - 0.075 mm)

Allowable Limit:

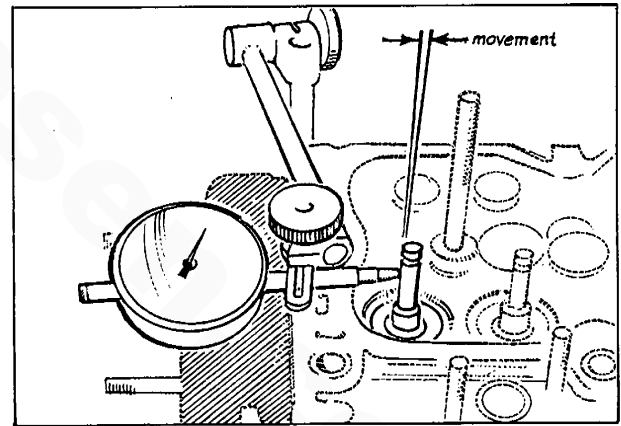
Intake 0.0031 (0.080 mm)
Exhaust 0.0039 (0.100 mm)

Measuring Method #1: Check the difference between the inner diameter of the guide bushing and the diameter of the valve stem.



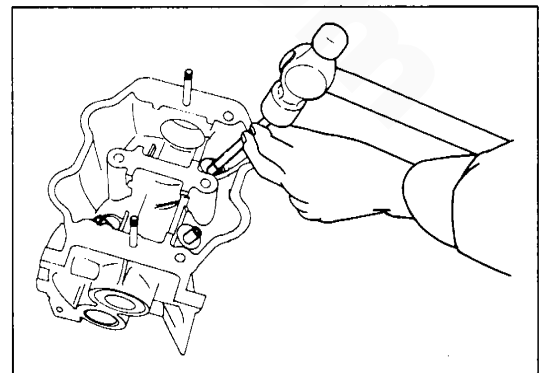
Measuring Method #2: Check each valve's deflection with a mounted dial indicator by moving the valve stem from side to side.

NOTE: Separate the valve from the valve seat before measuring. Measure at a position closest to the valve guide bushing.



Replacing the Valve Guides

1. Remove the valve seal from the valve guide.
2. Knock the guide out toward the opposite side of the combustion chamber with a valve guide installer. (Special Service Tool # 37725)



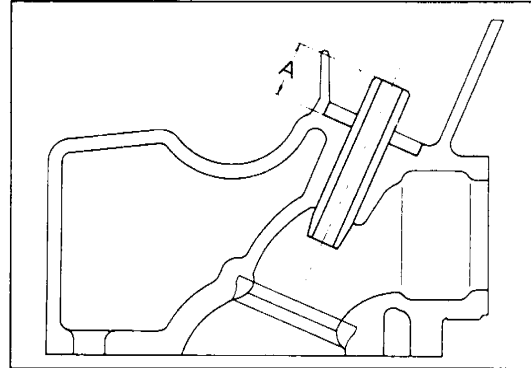
3. Place a clip on the new valve guide and drive it in from the opposite side of the combustion chamber with the valve guide installer.

NOTE: The shape of the intake valve guides differs from that of the guides on the exhaust side.

4. Install the valve seal on the valve guide with a valve seal pusher.
5. Check the clearance for each new valve guide bushing.

Projection Height (Dimension **A**):

0.598 - 0.622 inches (15.2 - 15.8 mm)



Checking Valves

1. Check the contact surface of the valve face and valve seat for damage. Minor or rough surface may be repaired with a valve grinder.
2. If the valve stem is worn, damaged, bent or the end surface of the stem is dented, replace the valve.
3. Check the valve stem's diameter with a micrometer; if the stem is worn beyond the allowable limit, replace the valve.

Valve stem diameter limit:

Specified Limit

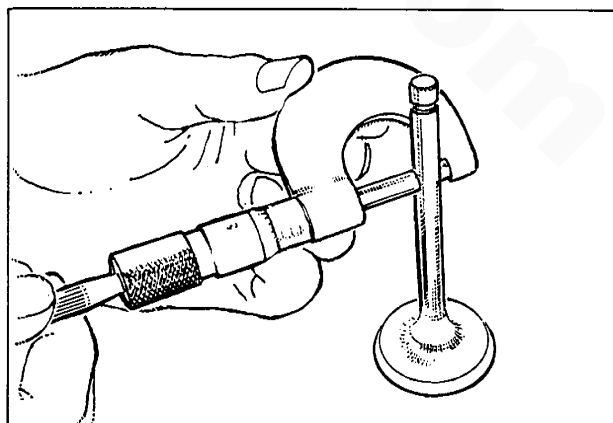
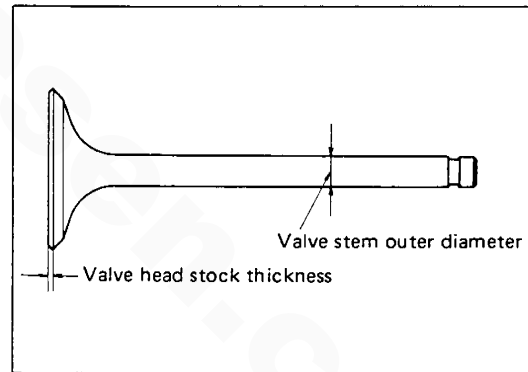
Intake: 0.2734 - 0.2740 inches
(6.945 - 6.960 mm)

Exhaust: 0.2732 - 0.2738 inches
(6.940 - 6.955 mm)

Allowable Limit

Intake: 0.2724 inches
(6.920 mm)

Exhaust: 0.2720 inches
(6.910 mm)



4. Check of each valve's head stock thickness. Replace the valve if it is beyond the allowable limit.

**Valve Head Stock Thickness Limit
Specified Limit**

Intake: 0.35 - 0.59 inches
(0.9 - 1.5 mm)

Exhaust: 0.047 - 0.071 inches
(1.2 - 1.8 mm)

5. Check for excessive grooves at the end of the valve stem.

Valve Seats

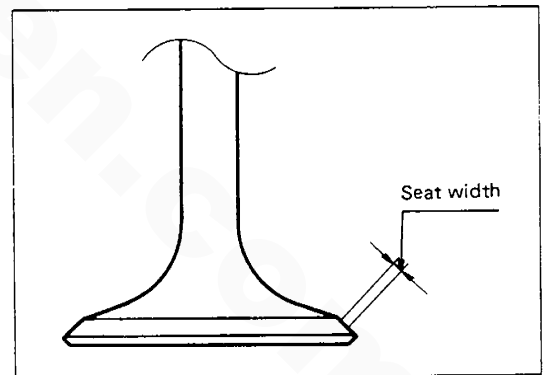
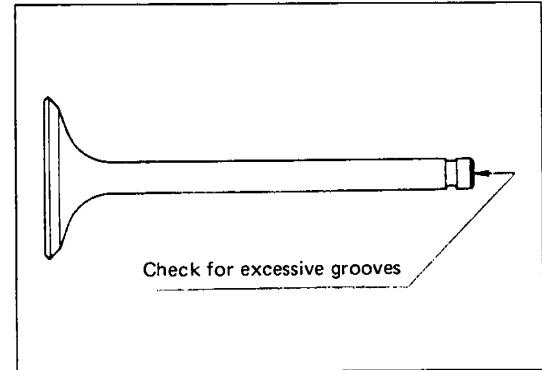
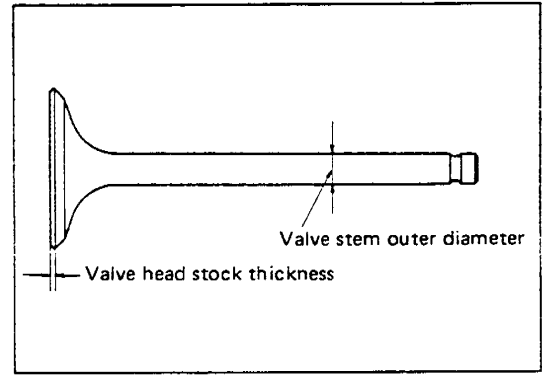
1. Inspect the valve's contact surface for pitting and damage.
2. Measure each valve's contact width.

Contact Width (Both Intake and Exhaust)
BCG 4.0KW 0.047 - 0.063 inches
(1.2 - 1.6 mm)

BCG 6.5KW and BTG 9.0KW
0.39 - 0.071 inches
(1.0 - 1.8 mm)

NOTE: Check the valve's contact area and position by applying a thin coat of Prussian Blue or red lead to the valve's seat and push the valve upward into cylinder head's seat (apply only enough pressure to assure a press fit). Under its own weight, let the valve drop away from the cylinder head. Perform this operation two or three times until the valve's contact surface can be accurately measured.

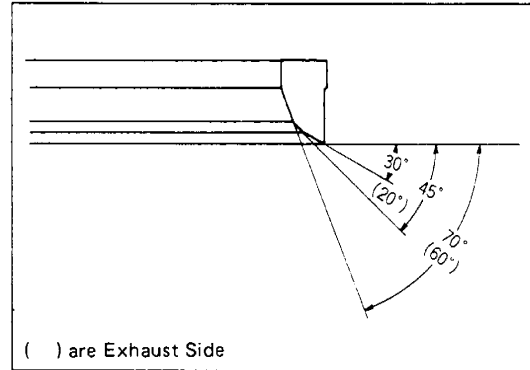
Check if the valve seat's contact face contacts the center position of the valve's contact face. **Do not** rotate the valve.



Refacing the Valve and Valve Seat

To reface the valve and cylinder head valve seats, follow the steps below.

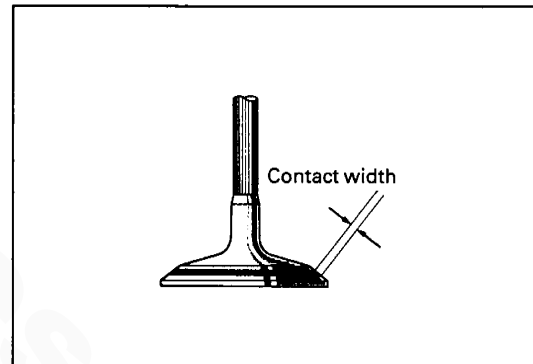
1. For the intake port in the cylinder head, use a 30° cutter to bring back the valve seat's shoulder. Then use a 45° cutter to recondition the valve seat contact face.
2. For the exhaust port in the cylinder head, use a 20° cutter to bring back the valve seat's shoulder. Then use a 45° cutter to recondition the valve seat contact face.
3. Grind each valve's contact face to 45°. Match each valve to its respective cylinder head port and check to ensure that both the cylinder's contact face and the valve's contact face are perfectly matched.
4. After each valve is reconditioned, hand lap each valve onto its seat with a good brand of lapping compound.



5. Remeasure the contact width of both the valves and each cylinder head valve seat and ensure that they conform to the following specifications.

Contact Width (Both Intake and Exhaust)
 BCG 4.0KW 0.047 - 0.063 inches
 (1.2 - 1.6 mm)

BCG 6.5KW and BTG 9.0KW
 0.039 - 0.071 inches
 (1.0 - 1.8 mm)



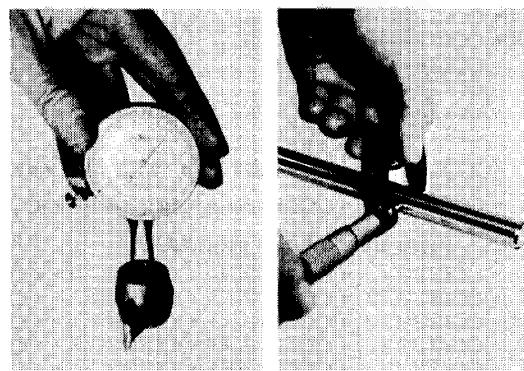
Checking Rocker Arms and the Rocker Shaft

1. Check each component of the rocker arm assembly for damage or cracks. If necessary, replace it with a new one.
2. Check to see that the oil passages of the rocker arm and shaft are open. If any clogs are found, remove them or replace the unit.
3. Measure the clearance between each rocker arm's bore and the shaft. If this measurement exceeds the allowable limit, replace the worn rocker arm bushings and shaft.

Arm Inner Diameter: 0.6300 - 0.6307 inches
 (16.000 - 16.018 mm)

Shaft Outer Diameter: 0.6283 - 0.6293 inches
 (15.958 - 15.984 mm)

(See next page)



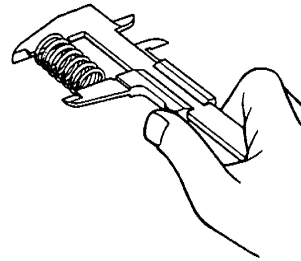
Clearance

Specified Limit: 0.0006 - 0.060 inches
(0.016 - 0.060 mm)

Allowable Limit: 0.003 inches (0.08 mm)

Checking Valve Springs

All models covered by this manual have two springs for each valve, an inner spring and an outer spring.



1. Check the valve spring for corrosion or damage and replace, if necessary.
2. Check each spring for free length and squareness; replace the spring if the free length is less than the free length limit specified below.

Free Length Standard

Outer: 1.646 inches (41.8 mm)
Inner: 1.614 inches (41.0 mm)

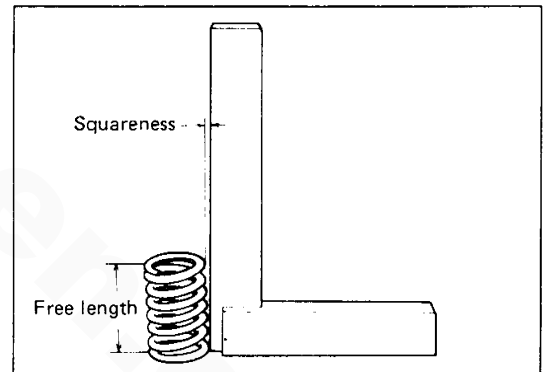
Free Length Limit

Outer: 1.594 inches (40.5 mm)
Inner: 1.567 inches (39.8 mm)

3. Check the squareness of the valve spring. If it exceeds the limit, replace with a new one.

Squareness limit

Outer: 0.059 inches (1.5 mm)
Inner: 0.059 inches (1.5 mm)



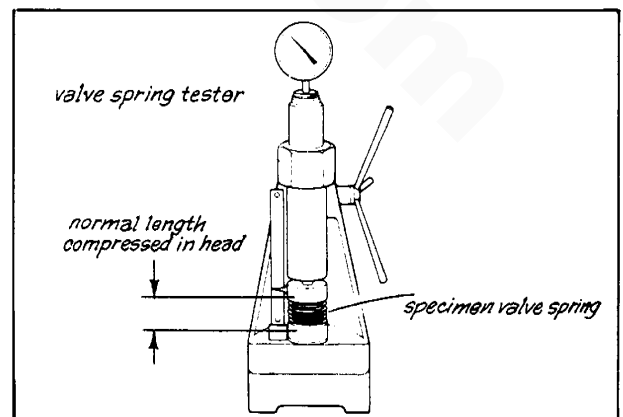
4. Using a spring tester, measure each spring's tension at the specified installed length. Replace the springs if they prove to be weakened.

Installed Length: 1.374 inches (34.9 mm)

Installed Load

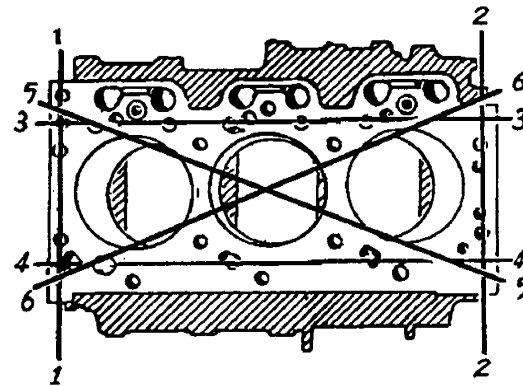
Standard: 62.8 - 69.0 lbs
(28.5 - 31.3 kgs)

Allowable Limit: 56.7 lbs
(25.7 kgs)



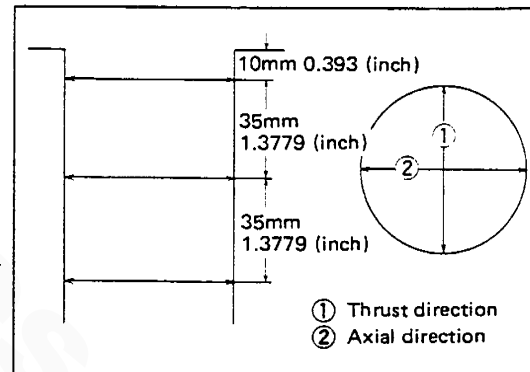
Checking the Cylinder Block

1. Check the cylinder block for damage or cracks. If necessary, repair or replace the cylinder block.
2. Check to see that the oil passages and coolant passages of the cylinder block are open. If clogged, remove with compressed air or a wire probe.
3. Check the cylinder block for distortion. If it exceeds the allowable limit of distortion, repair or replace the cylinder block.



Allowable Limit of Distortion: 0.002 inches (0.05 mm)

4. Check for scratches or burns on the cylinder walls. If necessary, repair by boring each cylinder or replace the cylinder block.
5. Measure the wear on the cylinder bores at the six positions shown in the figure to the right with an inside micrometer. (The wear is the difference between the maximum and minimum diameters.) If the cylinder bores have worn beyond the specified wear limit, the cylinder block requires boring to restore each cylinder's true wall surface.

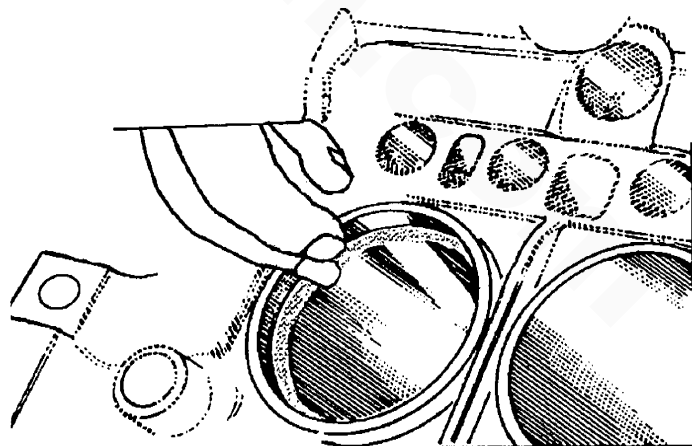


Standard Bore Diameter: 2.9921 - 2.9933 inches (76.00 - 76.03 mm)

Out-of-Roundness, Taper Limit: 0.0031 inches (0.08 mm)

Wear limit: 0.0039 inches (0.10 mm)

6. Check the ridge in the cylinder. If the engine has a large number of hours on it, a large cylinder ridge most likely will be present. If a ridge exists, have the cylinders reamed to remove these ridges. Leaving these ridges in the cylinder can break piston rings when the pistons are installed in the engine. In addition, if new piston rings are to be installed, have the cylinder walls deglazed (roughed up) so the rings may seat properly.



Checking the Pistons

1. Check all pistons carefully, and replace those that exhibit severe burns or scratches on the external circumference of the piston are found.
2. Measure each piston's diameter 0.7087 inches (18 mm) under the oil ring groove, at right angles to the piston pin's location (that is, in the thrust direction) without the pin in place.
3. Check the clearance between the piston and the cylinder wall.

Piston Diameter (Dimension A):

BCG 4.0KW 2.8167 - 2.8179 inches
(71.545 - 71.575 mm)

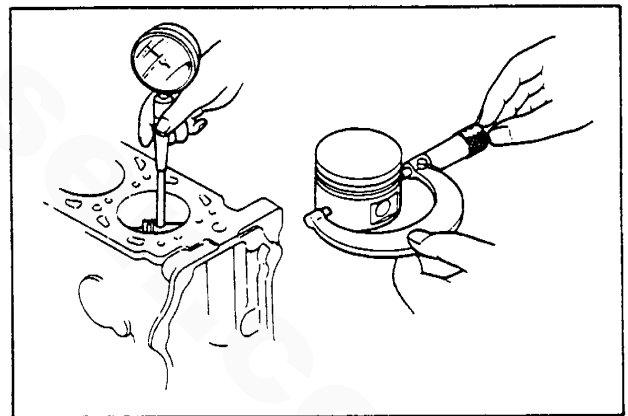
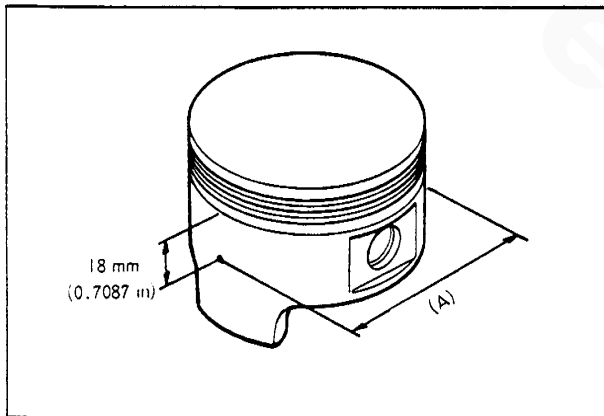
BCG 6.5KW and BTG 9.0KW
2.9903 - 2.9915 inches
(75.955 - 75.985 mm)

Standard Cylinder-to-Piston Clearance:

BCG 4.0KW 0.0018 - 0.0026 inches
(0.045 - 0.065 mm)

BCG 6.5KW and BTG 9.0KW
0.0014 - 0.0022 inches
(0.035 - 0.055 mm)

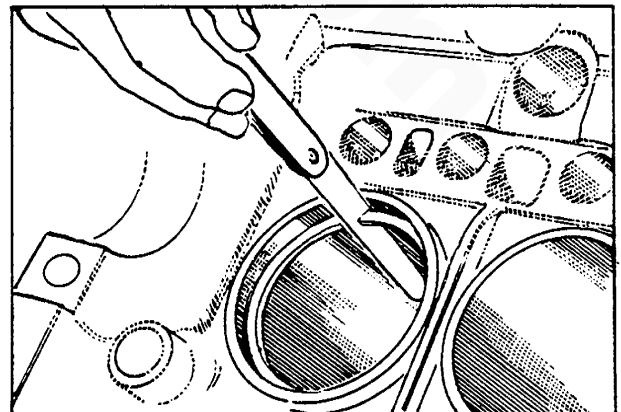
Allowable Cylinder-to-Piston Limit: (all Models) 0.0039 inches (0.10 mm)



Checking Piston Rings

1. Check the piston rings for cracks, burning or wear and replace, if necessary.
2. Measure each piston ring's end gap. Replace the ring if the gap exceeds the allowable end gap limit.

NOTE: Push a ring into the cylinder with a piston until it is about 2 inches from the block's top surface.



Standard End Gap Clearance

Compression ring No.1: 0.0079 - 0.0157 inches (0.20 - 0.40 mm)

Compression ring No.2: 0.0079 - 0.0157 inches (0.20 - 0.40 mm)

BCG 4.0KW Oil ring: 0.0079 - 0.0354 inches (0.20 - 0.90 mm)

BCG 6.5KW and BTG 9.0KW Oil ring: 0.0079 - 0.0315 inches (0.20 - 0.80 mm)

3. Measure the side clearance between the piston ring and ring groove.

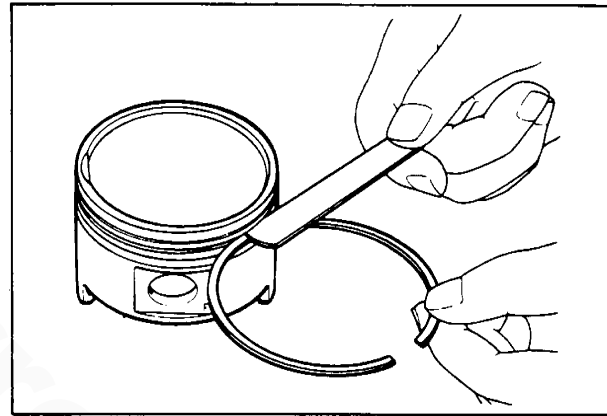
NOTE: Measure the clearance around the total circumference of the ring groove.

Standard Side Clearance

Compression Ring No.1:
0.0012 - 0.0028 inches
(0.03 - 0.07 mm)

Compression Ring No.2:
0.0008 - 0.0014 inches
(0.02 - 0.06 mm)

Allowable Side Clearance Limit:
0.0047 inches (0.12 mm)



Checking the Connecting Rods

1. Check the side of each connecting rod's small end and large end for cracks or damage. If necessary, replace damaged connecting rods.
2. Check the connecting rod for bends or twists with a suitable alignment fixture. If realignment is necessary, place the connecting rod in a press and apply a gradual pressure to the rod or replace the connecting rod.

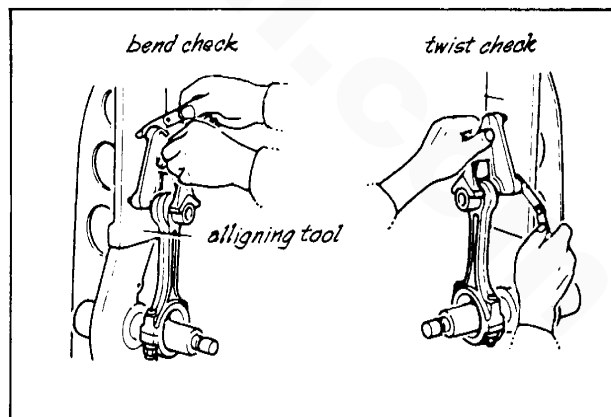
Allowable Limit (per 3.937 inches (100 mm))

Bend: BCG 4.0KW 0.0031 inches
(0.08 mm)

BCG 6.5KW and BTG 9.0KW
0.0020 inches (0.05 mm)

Twist: BCG 4.0KW 0.0039 (0.10 mm)

BCG 6.5KW and BTG 9.0KW
0.0020 inches (0.05 mm)

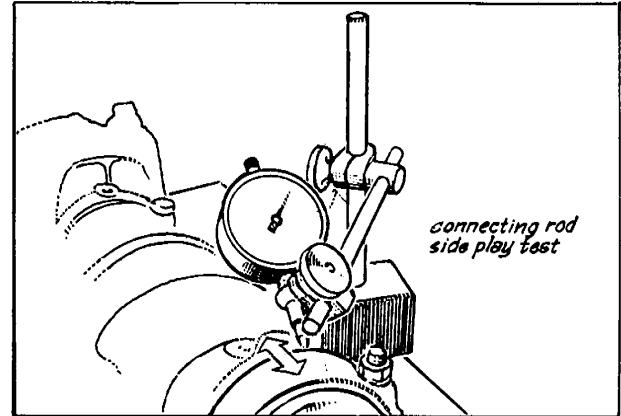


3. Check the connecting rod's side play with a dial indicator or a feeler gauge as shown in the figure. If it exceeds the limit, replace the connecting rod or crankshaft.

Side play

Standard: 0.150-0.250 mm
(0.006-0.0098 inch)

Limit: 0.30 mm
(Replace) (0.012 inch)



Checking the Piston Pins

1. Check each piston pin's oil clearance.
 - A. Measure each piston pin's bore diameter.

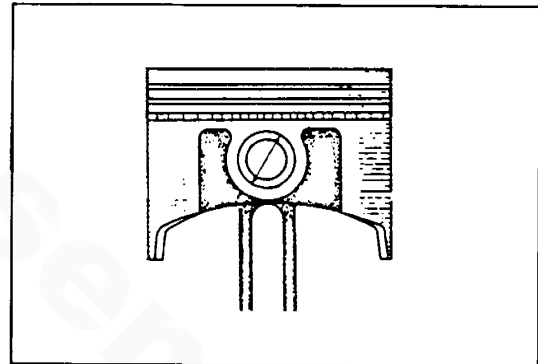
Standard Bore Diameter: 0.7086 - 0.7089 inches (17.999 - 18.008 mm)
 - B. Measure each piston pin's diameter.

Standard Pin Diameter: 0.7083 - 0.7087 inches (17.991 - 18.000 mm)

Standard Oil Clearance: 0.0002 - 0.0004 inches (0.005 - 0.011 mm)

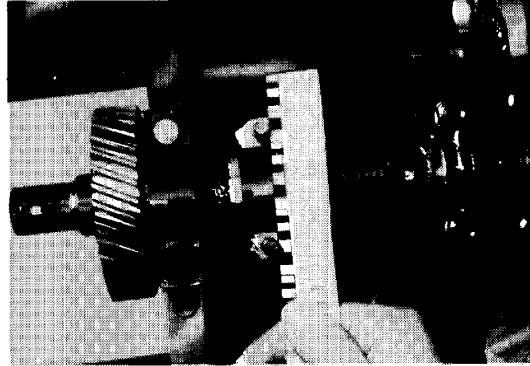
2. Replace the piston and piston pin if the pin's oil clearance exceeds the allowable limit specified below.

Allowable Limit: 0.0004 - 0.0008 inches (0.011 - 0.020 mm)



Checking the Connecting Rod Bearings

1. Check each connecting rod bearing carefully and replace it if it is worn, scored or flaked.
2. Check each connecting rod bearing's oil clearance with a "plastigauge." If the clearance for these bearings exceed the allowable limit, replace all the connecting rod bearings. If the connecting rod journals are scored or flaked, grind the crankshaft's connecting rod journals and install an undersize bearing.



Bearing Oil Clearance:

Specified Limit: 0.0008 - 0.0016 inches
(0.020 - 0.044 mm)

Allowable Limit: 0.0031 inches (0.08 mm)

Kinds of Connecting Rod Bearings:

Standard Repair

1.5739 - 1.5748 inches (39.976 - 40.000 mm)

Undersize 0.0098 inches (0.25 mm)

1.5642 - 1.5646 inches (39.732 - 39.742 mm)

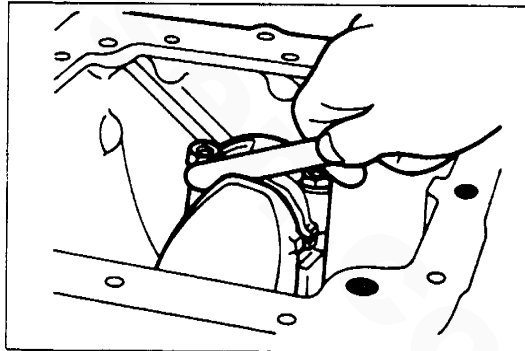
Undersize 0.0196 inches (0.50 mm)

1.5544 - 1.5548 inches (39.482 - 39.492 mm)

3. Check each connecting rod's thrust clearance.

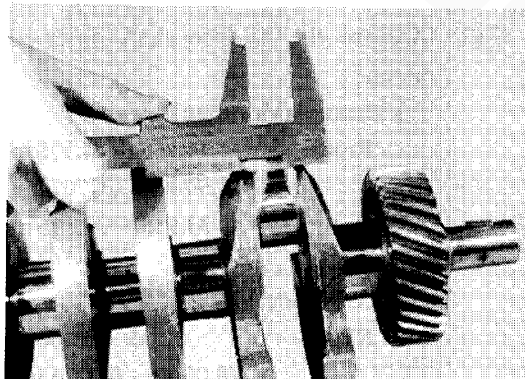
Specified Limit: 0.0059 - 0.0098 inches
(0.150 - 0.250 mm)

Allowable Limit; 0.0012 inches (0.03 mm)



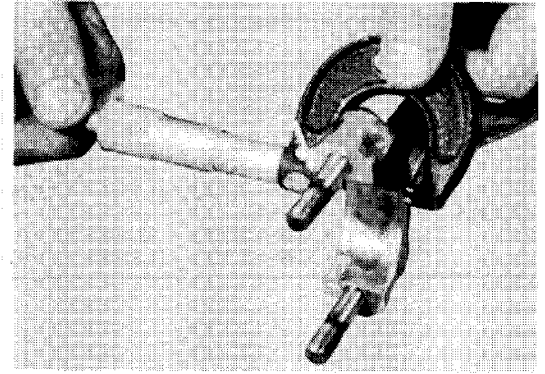
4. Check each connecting rod's journal width.

Journal Width: 0.8661 - 0.8681 inches
(22.00 - 22.05 mm)



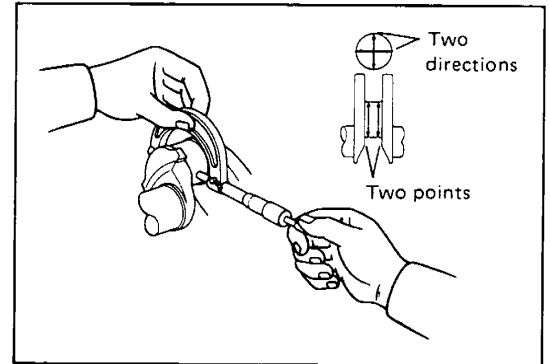
5. Measure the connecting rod width.

Standard Rod Width: 0.8583 - 0.8602 inches
(21.80 - 21.85 mm)



Checking the Crankshaft

1. Check the crankshaft for cracks or other damage. If necessary, replace the crankshaft.
2. Check to see that the oil passages of the crankshaft are open. If any clogs are found, remove them with compressed air or a suitable wire.
3. Check the crankshaft for eccentric wear; that is, see if the journals have become elliptical or tapered. If it exceeds the allowable limit, compensate for this wear by grinding the bearing journals and replace the bearings with undersized bearings.



NOTE: Measure the diameter of each of the crankpins and main journals at two points (the front and rear portions) at 90 degrees to the crankshaft axis, as shown in the figure.

Allowable elliptical or tapered Limit: 0.0008 inches (0.02 mm)

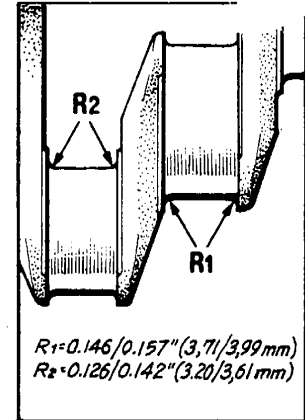
Specified Oil Clearance: (All Models) 0.008 - 0.0017 inches (0.020 - 0.044 mm)
Allowable Limit: BCG 4.0KW: 0.0031 inches 90.08 mm)

BCG 6.5KW and BTG 9.0KW:
0.0028 inches (0.07 mm)

4. If the journals must be ground because of severe burning or scoring, grind the crankshaft and replace the crankshaft bearings with undersized bearings.

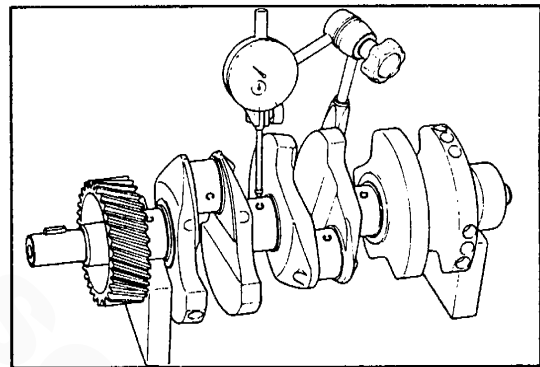
	Main Journal Outer Diameter	Crankpin Journal Outer Diameter
Standard Repair limit	1.6526 - 1.6535 inches (41.976 - 42.000 mm)	1.5739 - 1.5748 inches (39.976 - 40.000 mm)
Undersize 0.0098 inches (0.25 mm)	1.6430 - 1.6434 inches (41.732 - 41.742 mm)	1.5642 - 1.5646 inches (39.732 - 39.742 mm)
Undersize 0.0196 inches (0.50 mm)	1.6331 - 1.6335 inches (41.482 - 41.492 mm)	1.5544 - 1.5548 inches (39.482 - 39.492 mm)

NOTE: When grinding the crankshaft, the corner sections of the main journals and crank pin journals must be ground to a radius of 0.25 (R1 and R2). Any crankshaft grinding should be done by a qualified machine shop.



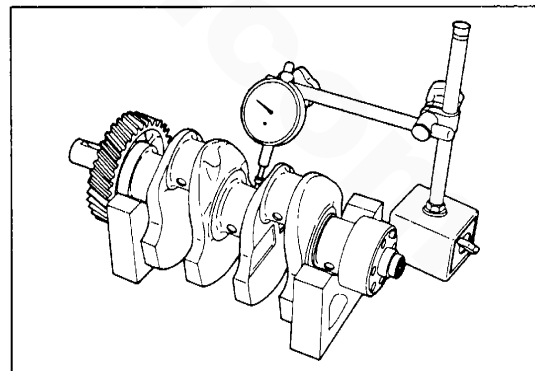
5. Measure the crankshaft's runout.

Runout Limit: 0.0012 inches (0.03 mm)

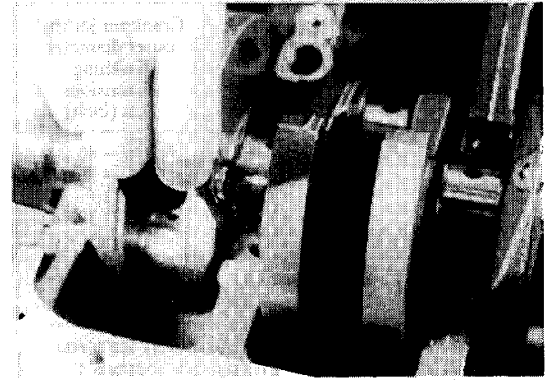


6. Measure the crankshaft for bend by placing a dial gauge at the center bearing journal and turning the crankshaft, as shown in the illustration to the right.

Bend Limit: 0.0012 inches (0.03 mm)



7. Check the crankshaft's thrust clearance with a feeler gauge, as shown in the figure. If it exceeds the allowable limit, replace the thrust washer.



Specified Limit

BCG 4.0KW: 0.0008 - 0.0086 inches
(0.020 - 0.044 mm)

BCG 6.5KW and BTG 9.0KW:
0.0004 - 0.0063 inches
(0.010 - 0.160 mm)

Allowable Limit

BCG 4.0KW: 0.0118 inches (0.30 mm)

BCG 6.5KW and BTG 9.0KW:
0.0118 inches (0.30 mm)

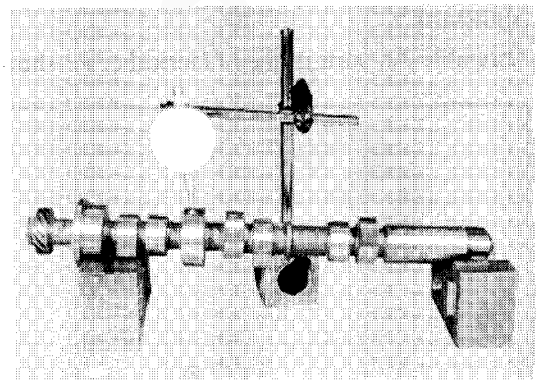
Kinds of Thrust Washers:

Standard Repair	0.0764 - 0.0783 inches (1.940 - 1.990 mm)
Over size 0.0049 inches (0.125 mm)	0.0813 - 0.0833 inches (2.065 - 2.115 mm)
Oversize 0.0098 inches (0.250 mm)	0.0862 - 0.0882 inches (2.190 - 2.240 mm)

Checking the Camshaft

1. Check the camshaft for cracks, wear or damage and replace it if necessary.
2. Measure the runout. If it exceeds the allowable limit, replace the camshaft.

Allowable Limit of Runout: 0.0012 (0.03 mm)



3. Measure the camshaft's lobe height. Replace the camshaft if the wear limit is exceeded.

Cam Height (Both Intake and Exhaust)

Specified Limit

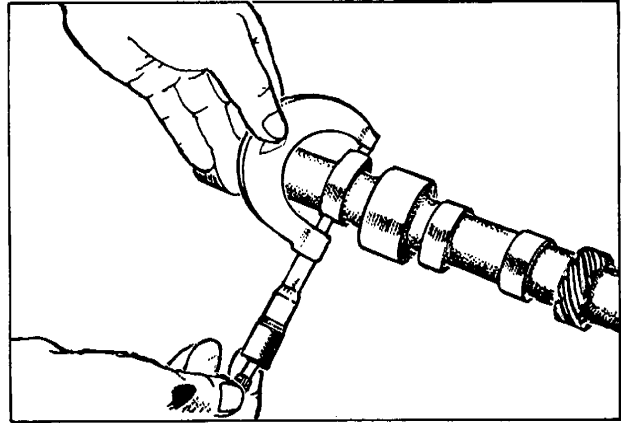
BCG 4.0KW: 1.559 - 1.563 inches
(39.604 - 39.704 mm)

BCG 6.5KW and BTG 9.0KW
1.5743 - 1.5822 inches
(39.987 - 40.187 mm)

Allowable Limit

BCG 4.0KW: 1.557 inches
(39.550 mm)

BCG 6.5KW and BTG 9.0KW
1.563 inches
(39.7 mm)



4. Measure the camshaft journal-to-cylinder head journal clearance. Replace the part that exhibits the most wear.

BCG 4.0KW Engine only

Camshaft Diameter

Specified Limit

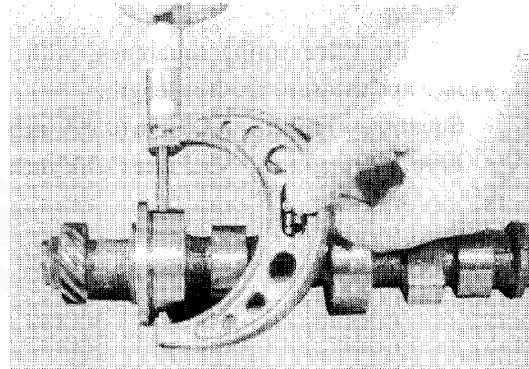
Front: 1.2578 - 1.2586 inches
(31.950 - 31.970 mm)

Rear: 1.8872 - 1.8882 inches
(47.935 - 47.960 mm)

Allowable Limit

Front: 1.2559 inches (31.900 mm)

Rear: 1.8850 inches (47.880 mm)



Cylinder Head Bearing Diameter

Specified Limit

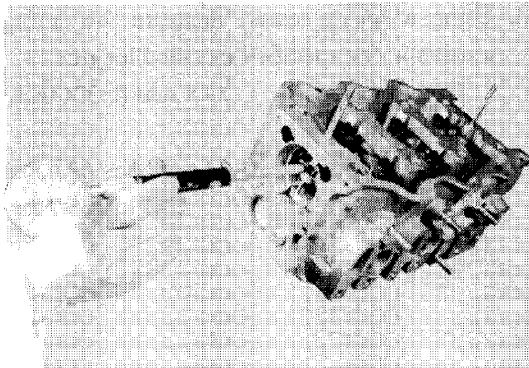
Front: 1.2598 - 1.2608 inches
(32.000 - 32.025 mm)

Rear: 1.8902 - 1.8911 inches
(48.010 - 48.035 mm)

Allowable Limit

Front: 1.2626 inches (32.070 mm)

Rear: 1.8929 (48.080 mm)



BCG 4.0KW Engine (continued)

Oil Clearance between Camshaft Journals and Cylinder Head Journals

Specified Limit

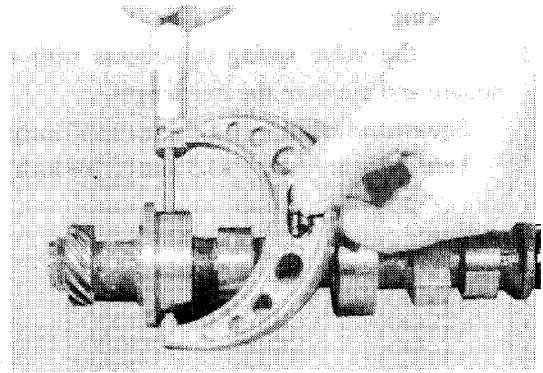
Front: 0.0012 - 0.0030 inches
(0.030 - 0.075 mm)

Rear: 0.0019 - 0.0039 inches
(0.050 - 0.100 mm)

Allowable Limit

Front: 0.0047 inches (0.12 mm)

Rear: 0.0059 inches (0.15 mm)

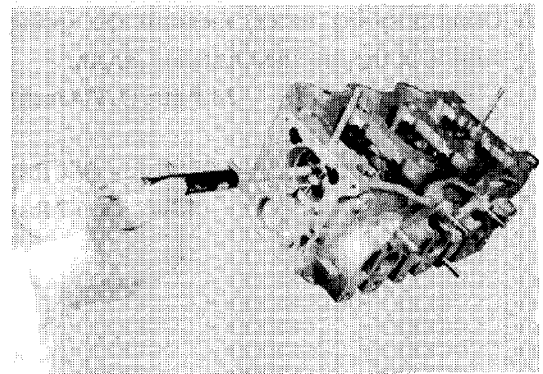


BCG 6.5KW and BTG 9.0KW Engines only
Camshaft Diameter (Specified Limit)

Front: 1.2583 - 1.2591 inches
(31.96 - 31.98 mm)

Center: 1.8655 - 1.8665 inches
(47.385 - 47.410 mm)

Rear: 1.9061 - 1.9071 inches
(48.415 - 48.440 mm)



Cylinder Head Bearing Diameter (Specified Limit)

Front: 1.2606 - 1.2616 inches
(32.020 - 32.045 mm)

Center: 1.8701 - 1.8711 inches
(47.500 - 47.525 mm)

Rear: 1.9094 - 1.9104 inches
(48.500 - 48.525 mm)

Oil Clearance between Camshaft Journals and Cylinder Head Journals

Specified Limit:

Front: 0.0016 - 0.0035 inches (0.04 - 0.09 mm)

Center: 0.0035 - 0.0055 inches (0.09 - 0.14 mm)

Rear: 0.0024 - 0.0043 inches (0.06 - 0.11 mm)

Allowable Limit

0.0055 inches (0.14 mm)

0.0075 inches (0.19 mm)

0.0063 inches (0.16 mm)

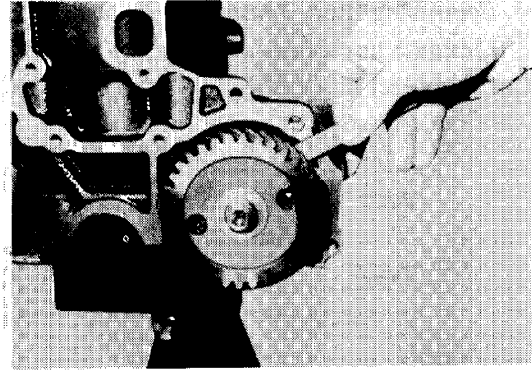
Checking the Balance Shaft Thrust Bearing

1. For the BCG 4.0KW, tighten the thrust plate to 3.6 - 7.2 lb-ft (0.5 - 1.0 kg-m) and measure the clearance.

Thrust Bearing Clearance

Specified Limit: 0.0012 - 0.0047 inches (0.03 - 0.12 mm)

Allowable Limit: 0.0079 inches (0.20 mm)

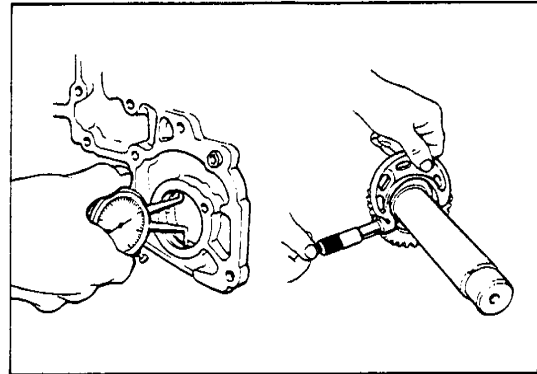


2. For the BCG 4.0KW, measure the balance shafts' oil clearance.

Oil Clearance

Specified Limit: 0.0010 - 0.0026 inches (0.025 - 0.066 mm)

Allowable Limit: 0.0039 inches (0.10 mm)

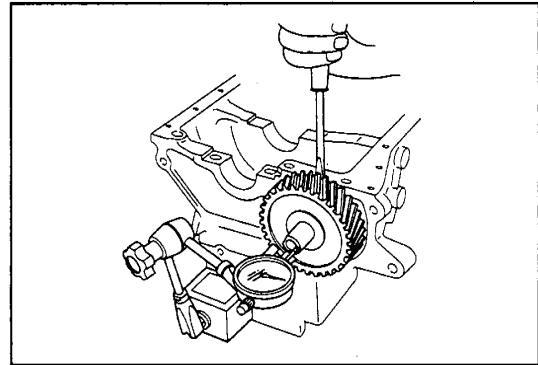


If the oil clearance is not within the allowable limit, replace the bearings or refinish the balance shaft.

Shaft Journal Finish Dimensions

Type of finish	Balance Shaft's front outside finish diameter dimension	Balance Shaft's rear outside finish diameter dimension
Standard Repair	1.7700 - 1.7707 inches (44.959 - 44.975 mm)	1.3370 - 1.3376 inches (33.959 - 33.975 mm)
Undersize 0.50	1.7516 - 1.7520 inches (44.490 - 44.500 mm)	1.3185 - 1.3189 inches (33.490 - 33.500 mm)

3. For the BCG 6.5KW and BTG 9.0KW, tighten the thrust plate to 3.6 - 7.2 lb-ft (0.5 - 1.0 kg-m) and measure the clearance.

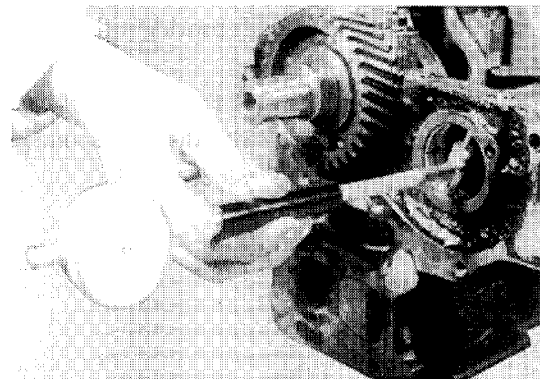


Thrust Bearing Clearance

Specified Limit: 0.0012 - 0.0051 inches
(0.15 - 0.25 mm)

Allowable Limit: 0.0118 inches (0.30 mm)

4. For the BCG 6.5KW and BTG 9.0KW, measure the balance shaft's oil clearance.



Oil Clearance

Block Inner Bearing Diameter

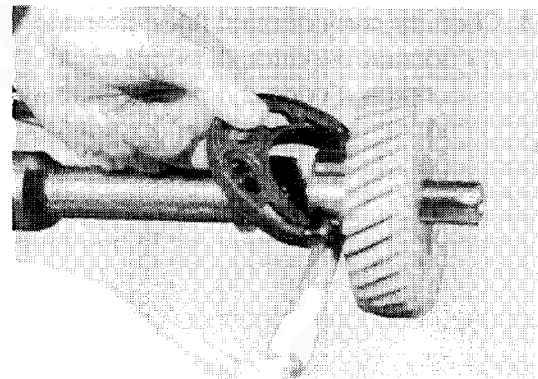
Front: 1.7717 - 1.7726 inches
(45.000 - 45.025 mm)

Rear: 1.3386 - 1.3396 inches
(34.000 - 34.025 mm)

Balance Shaft Outer Diameter

Front: 1.7700 - 1.7707 inches
(44.959 - 44.975 mm)

Rear: 1.3370 - 1.3376 inches
(33.959 - 33.975 mm)



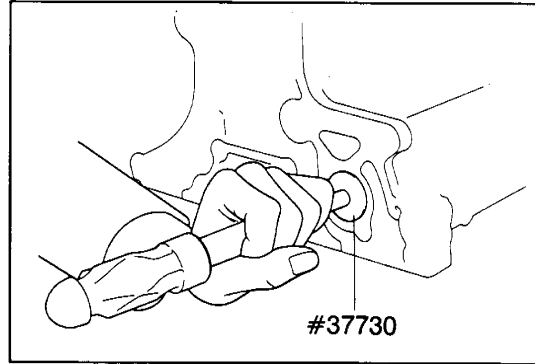
If the oil clearance is not within the allowable limit, replace the bearings or refinish the balance shaft.

Bearing Size (Under Size 0.0196 inches [0.5 mm])

	Block's inner diameter	Balance Shaft's outer diameter
Front Bearing	1.7530 - 1.7542 inches (44.526 - 44.556 mm)	1.7516 - 1.7520 inches (44.490 - 44.500 mm)
Rear Bearing	1.3199 - 1.3211 inches (33.526 - 33.556 mm)	1.3185 - 1.3189 inches (33.490 - 33.500 mm)

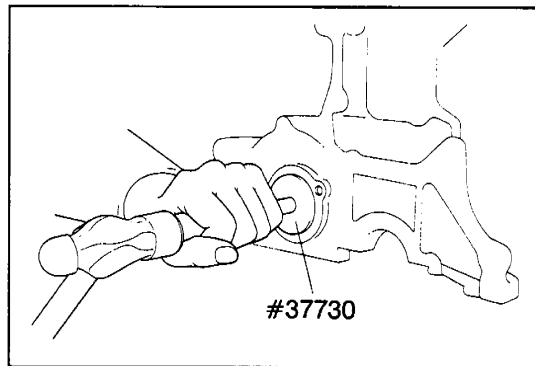
Replacing the Balance Shaft Bearing

1. Remove the balance shaft's bearing with special service tool # 37730.

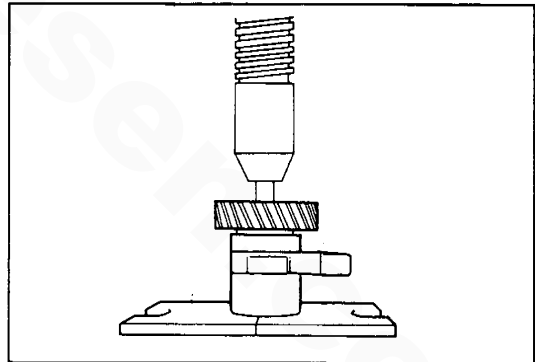


2. Install a new, or undersized bearing depending on the journal conditions, with the same special service tool used to remove the bearing.

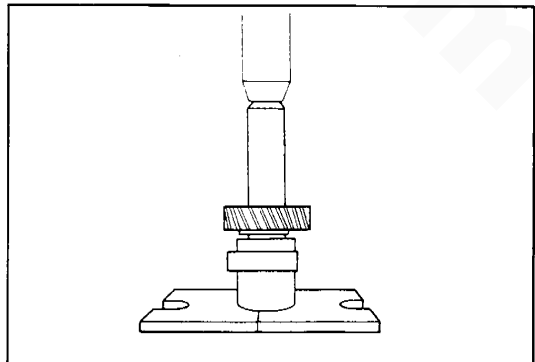
NOTE: Make sure that the oil hole of each bearing aligns with its corresponding oil passage in the block.



3. In order to refinish the balance shaft, the balance shaft's gear must be pressed off the shaft using an appropriate support and an arbor press.



4. Replace the shaft's gear after the shaft has been refinished. Use an appropriate support and an arbor press. Ensure the bearing seats properly on the shaft.



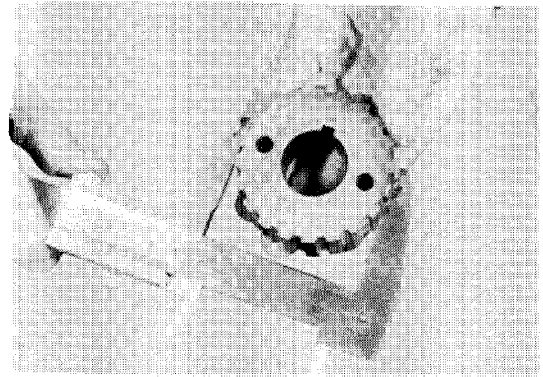
Checking the Crankshaft Timing Belt Pulleys

Measure the outside diameter of both the crankshaft and camshaft pulleys. Replace those pulleys that have worn beyond the allowable limit.

Crankshaft Pulley

Specified Limit: 2.3331 - 2.3370 inches
(59.26 - 59.36 mm)

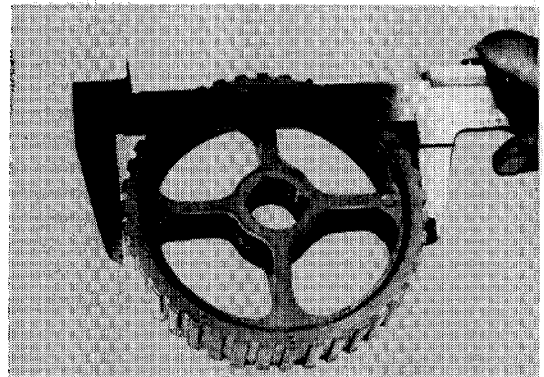
Allowable Limit: 2.3307 inches (59.20 mm)



Camshaft Pulley

Specified Limit: 4.7189 - 4.7260 inches
(119.86 - 120.04 mm)

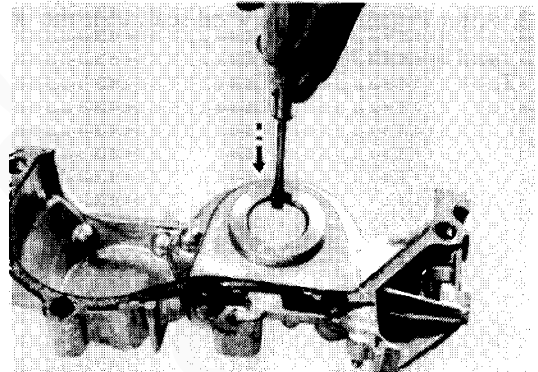
Allowable Limit: 4.7165 inches (119.80 mm)



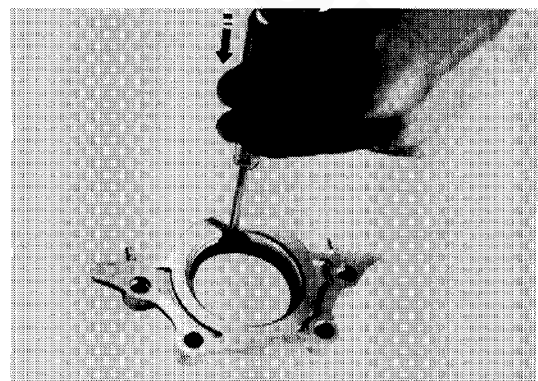
Replacing Front and Rear Crankshaft Oil Seals

1. Remove both front and rear oil seals with a screwdriver. Be careful not to scratch the journal that holds the seal.

Front Oil Seal

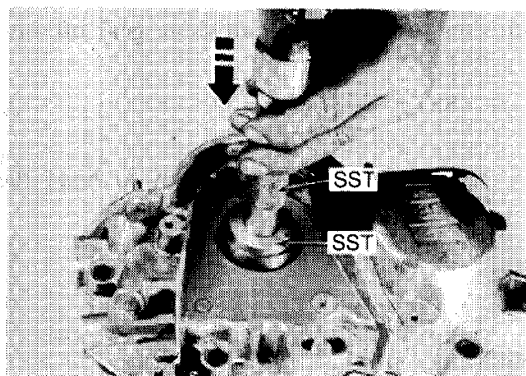


Rear Oil Seal

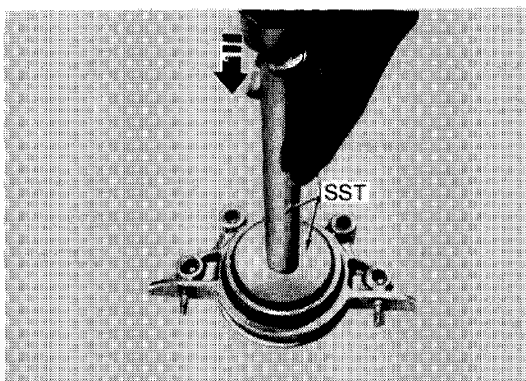


2. Install a new front oil seal using a drift that will catch the seals outer diameter and drive it squarely into the seal's boss.

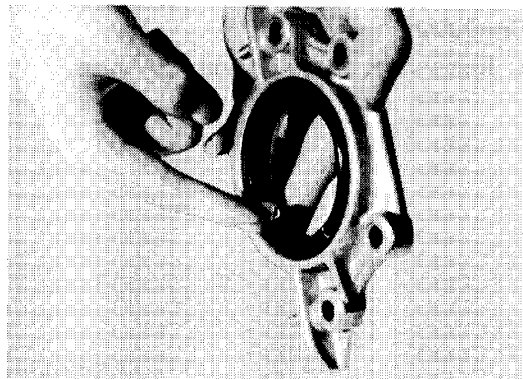
Front Oil seal



Rear Oil Seal



3. After installing new front and rear oil seals, coat them with multi - purpose grease or white lube.



Checking the Flywheel and Ring Gear

1. Check the flywheel for damage or wear. Check the ring gear's teeth for wear. Replace the ring gear if it is badly worn.

2. Check the runout limit on the flywheel.

Runout Limit: 0.0079 inches (0.20 mm)

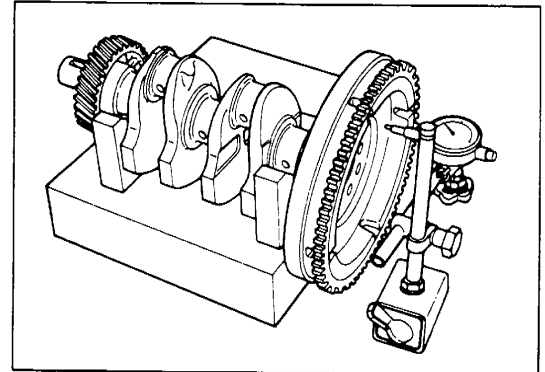
2. Replace the ring gear by the following procedure:

A. Heat the ring with a torch.

B. Remove the ring gear by striking its circumference.

C. Heat the new ring gear to 250 - 300° C (480 - 570° F) on a hot plate or in an oven. Before slipping it onto the flywheel, make sure that the chamfered side of the ring gear is directed toward the engine.

NOTE: Excessive heat may destroy the original heat treatment and cause premature failure of the ring gear.



NOTES

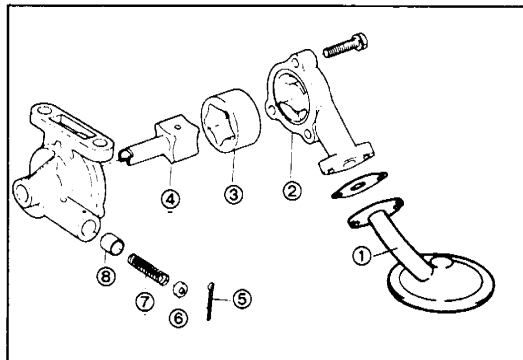
www.torresen.com

SUBASSEMBLY INSPECTION, REPAIR, AND ASSEMBLY

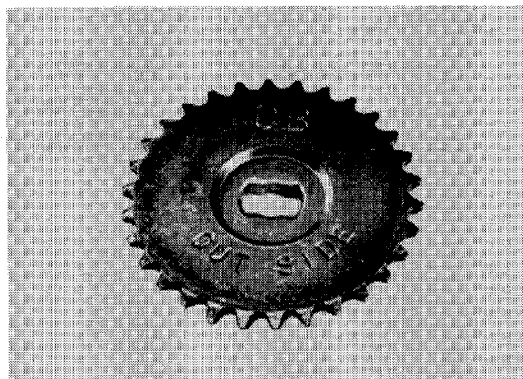
Section.....	Page
Disassembling and Inspecting the Oil Pump.....	110
Assembling the Oil Pump	112
Fresh Water Pump	114
Thermostat Removal and Inspection	115
Disassembling and Inspecting the Sea Water Pump	116
Testing and Disassembling the Electric Fuel Pump	117
Disassembling and Rebuilding the Carburetor	118
Inspecting the Distributor and its Components	125
Testing the Ignition Coil	126
Inspecting the Spark Plugs.....	126
Testing the Alternator (BTG 9.0KW only)	127
Testing the Starter	128

Disassembling and Inspecting the Oil Pump

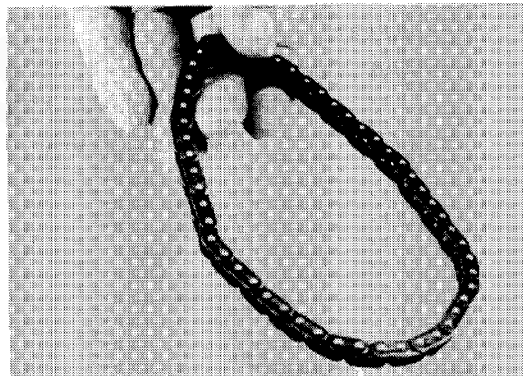
1. Disassemble the parts according to the numerical order presented in the illustration to the right.



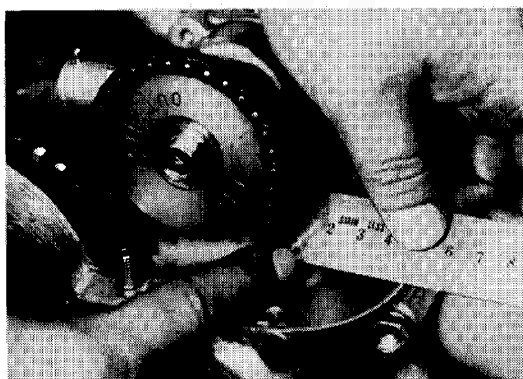
2. Inspect the oil pump's drive shaft sprocket. Check for cracks, worn teeth, or any damage.



3. Check the oil pump's drive chain for wear.



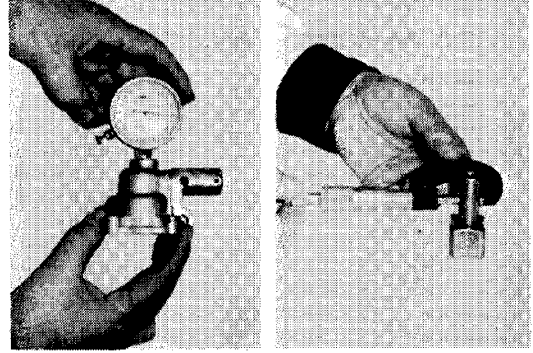
When the oil pump is installed, check the deflection of the oil pump's chain. Measure the chain's deflection at the center of the chain along the widest span between the two sprockets.



4. Measure the rotor shaft's clearance. If it has worn beyond the allowable limit, replace the rotor and the rotor housing.

Specified Limit: 0.0018 - 0.0033 inches
(0.045 - 0.085 mm)

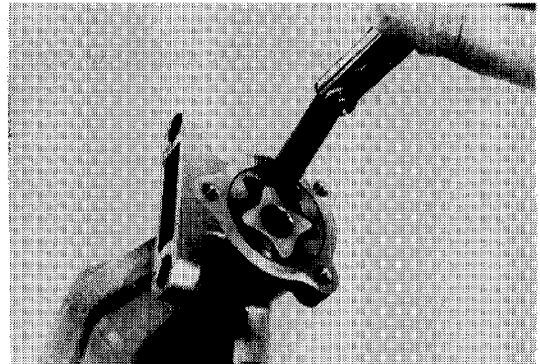
Allowable Limit: 0.0039 inches (0.10 mm)



5. Measure the tip clearance.

Specified Limit: 0.0059 inches (0.15 mm) or less

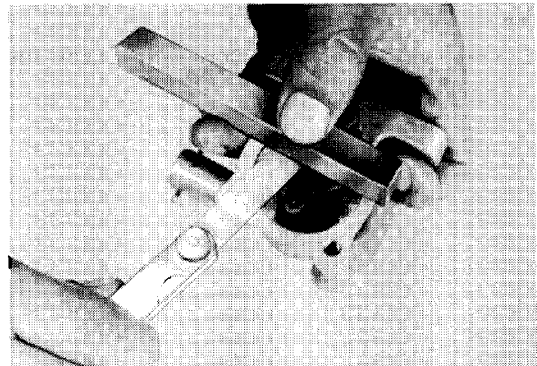
Allowable Limit: 0.0079 inches (0.20 mm)



6. Measure side clearance.

Specified Limit: 0.0012 - 0.0035 inches
(0.03 - 0.09 mm)

Allowable Limit: 0.0079 inches (0.20 mm)



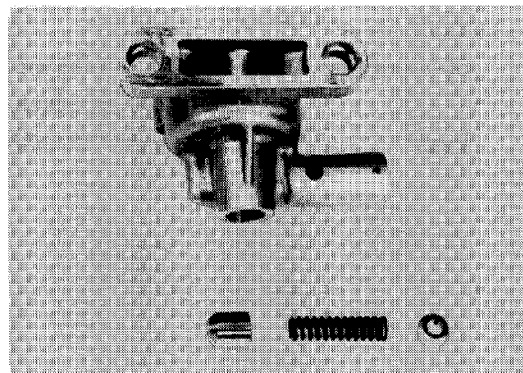
7. Measure the body clearance.

Specified limit: 0.0039 - 0.0063 inches
(0.10 - 0.16 mm)

Allowable Limit: 0.0118 inches (0.30 mm)



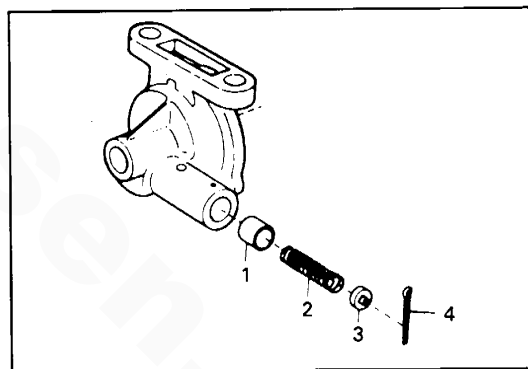
8. Check the relief valve's oil passage and sliding surface for damage.



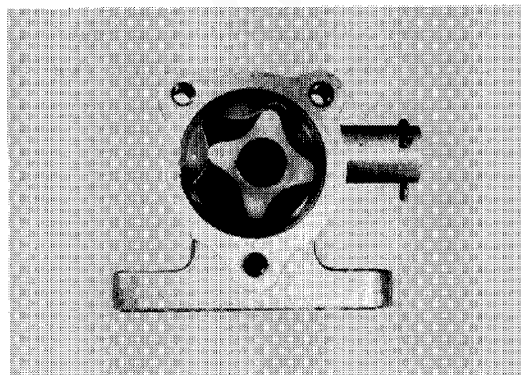
Assembling the Oil Pump

NOTE: Coat each sliding part with engine oil before it is assembled with its mating part.

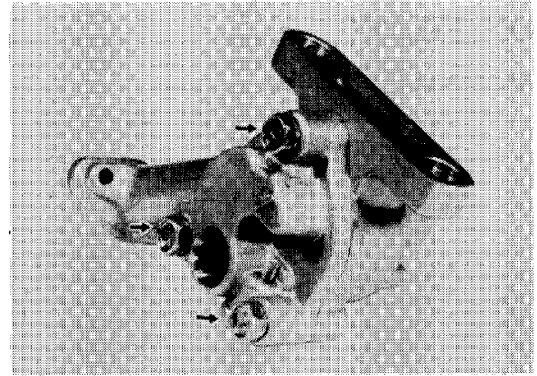
1. Assemble the relief valve in the numerical order shown in the illustration to the right.



2. Assemble the rotor and rotor housing, aligning the punched marks so that they face each other and also face toward you. Refer to the illustration to the right.

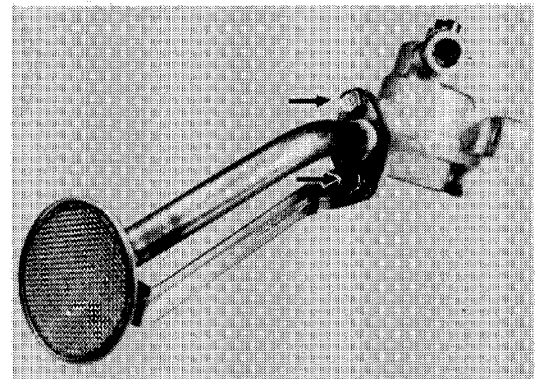


3. Assemble the pump cover and body. Tighten the bolts between 2.9 to 5.1 lb-ft (0.4 - 0.7 kg-m).



4. Attach the oil pump pickup strainer. Tighten the bolts between 2.9 to 5.1 lb-ft (0.4 - 0.7 kg-m)

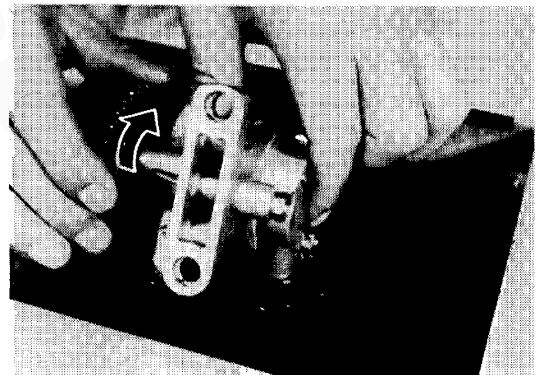
NOTE: Replace the gasket with a new one.



5. Check the oil pump's operation.

- A. After assembling the oil pump, immerse the pump's strainer into a pail of clean engine oil, and hand turn the pump's sprocket counterclockwise.

Oil should be discharged from the oil pump's outlet port.



6. Block the outlet port with your finger and perform the same test as described in step #5. Confirm that the oil pump's shaft becomes harder to turn until it cannot be turned any more.



Fresh Water Pump

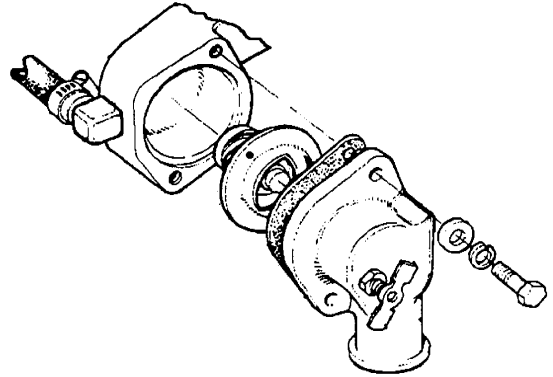
No rebuilding kit is offered for the fresh water circulating pumps on the 4.0 BCG, 6.5 BCG or the 9.0 BTG. Removal and replacement of the defective or worn pump is, therefore, necessary.

www.torresen.com

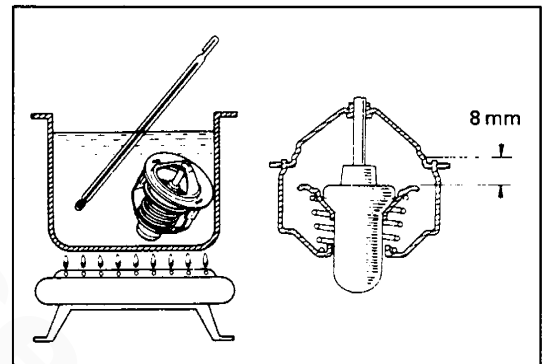
Thermostat Removal and Inspection

The thermostat is located toward the rear of the intake manifold within the thermostat housing.

1. Remove the thermostat from its housing.



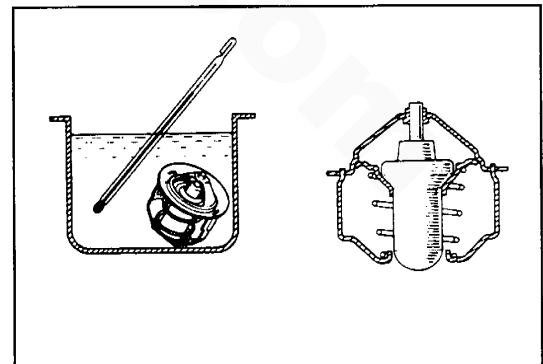
2. To test the thermostat, immerse it in water and gradually heat the water. The thermostat should start to open when the water temperature reaches 130 to 140° F (55-60° C). The thermostat should open by more than 0.31 inches (8 mm) when the water temperature reaches 150° F (64° C).



3. Replace the thermostat if the valve remains open at normal temperatures or if the valve is loose when the valve is fully closed.

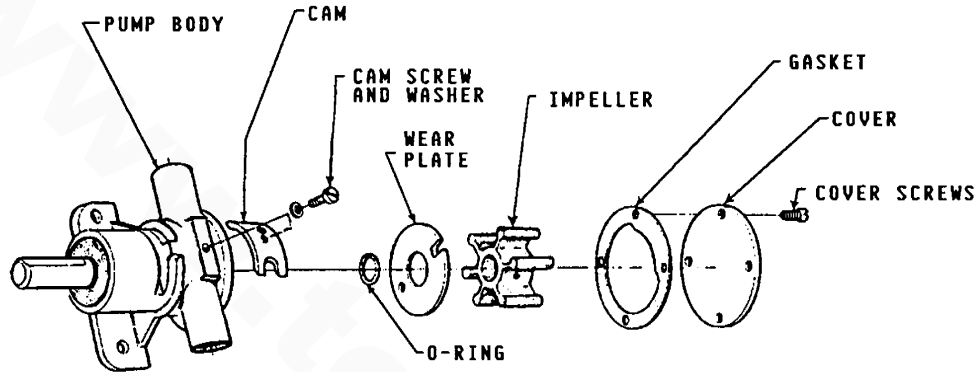
CAUTION

When replacing the thermostat, use genuine Westerbeke thermostats. These thermostats are designed specifically for the engines covered in this manual. Other, generic thermostats will not work in these engines, and may seriously damage the engine should they be installed.



Disassembling and Inspecting the Sea Water Pump

When disassembling the sea water pump for inspection, an impeller kit (part # 032620) should be purchased so the impeller can be replaced along with a new gasket at the time of inspection as needed. Although the impeller is a small part, it plays an important role in the proper operation of the engine. Replacing the impeller at the time of the sea water pump's inspection can only improve the sea water pump's pumping ability. In addition, a new impeller is accompanied with a new gasket, an item that is needed to assemble the sea water pump. See the note below.



1. To disassemble the sea water pump, remove the four cover screws.
2. Remove the cover and the gasket.
3. Remove the rubber impeller and the wear plate.
4. Remove the rubber O-ring.
5. Remove the cam screw and washer and the cam.

Now the sea water pump is stripped far enough to be inspected.

Inspect the sea water pump by rotating the pump's drive shaft. If it excessive play exists in it, or if it sound rough or is frozen, replace the entire pump.

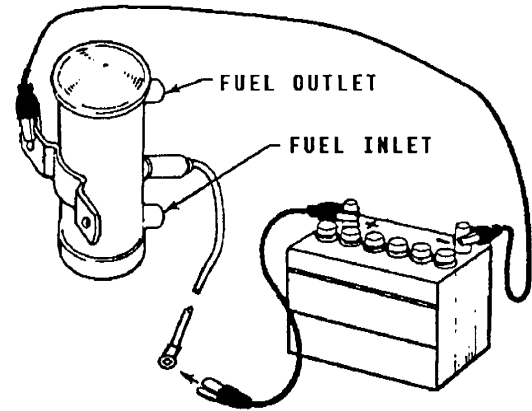
Since rebuilding a damaged or worn pump from individually purchased pieces would almost match the price of a new pump, we recommend that a new pump be purchased instead of rebuilding one.

NOTE: When reassembling the sea water pump with a new impeller kit, wipe a little petroleum jelly around the impeller. This ensures that when the engine is started the impeller will not run dry until sea water reaches the impeller as it draws a prime.

Testing and Disassembling the Electric Fuel Pump

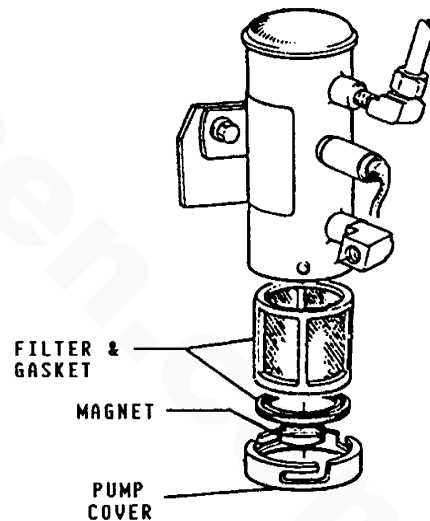
To test the electric lift pump, follow the steps below.

1. Working from a workbench, place the pump's inlet line into a clean tank of gasoline. Use caution with gasoline being used.
2. Place the outlet fuel line into a measuring container such as a beaker.
3. Using a fully-charged 12-volt battery, connect a negative (-) wire to the fuel pump's body. Energize the fuel pump by connecting the pump's positive (+) lead to the battery's positive terminal. Refer to the illustration to the right
4. When the pump is energized, it should pump a minimum of 1 gallon per 3 minutes at 3.5 psi (3.7 liters per 3 minutes). A pumping rate below this is not adequate. If the pump's pumping rate is below this rating, perform the following steps.



POSITIVE (+) CONNECTION

- A. Replace the pump's filter and gasket. A clogged filter may be restricting the flow of fuel.
- B. Retest the pump as described in steps # 3-4.
- C. If the pump fails to meet the specified 1 gallon per 3 minutes minimum, replace the fuel lift pump.



Disassembling and Rebuilding the Carburetor

To rebuild the carburetor, first purchase a carburetor rebuilding kit. Make sure that the rebuild kit contains all of the following rebuild parts. Refer to the illustration below the list.

Two (2) copper accelerator pump gaskets

One (1) needle valve and seat (two pieces to the set)

One (1) main body gasket

One (1) aluminum seat gasket

One (1) choke lever spring

One (1) idle mixture screw O-ring

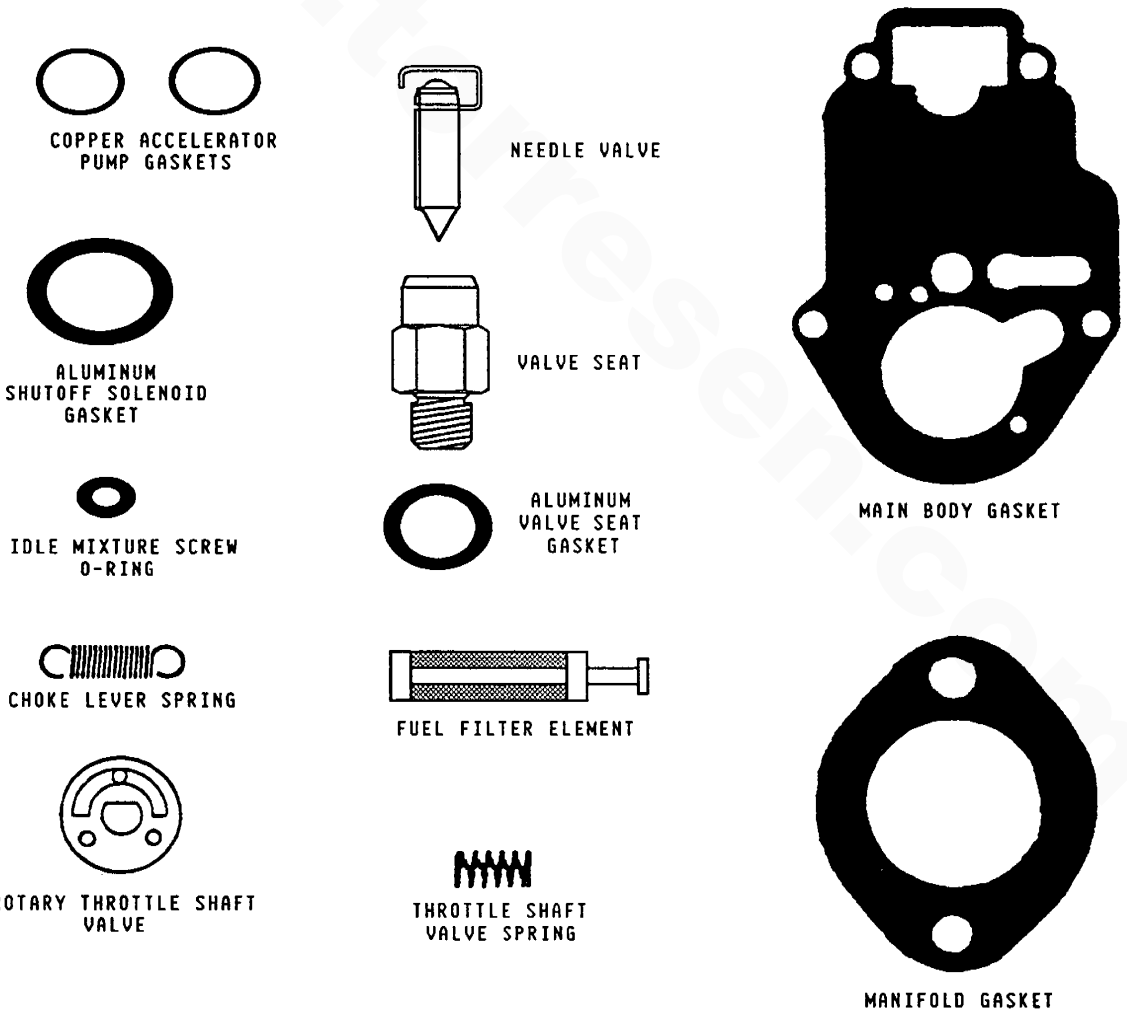
One (1) rotary throttle shaft valve

One (1) throttle shaft valve spring

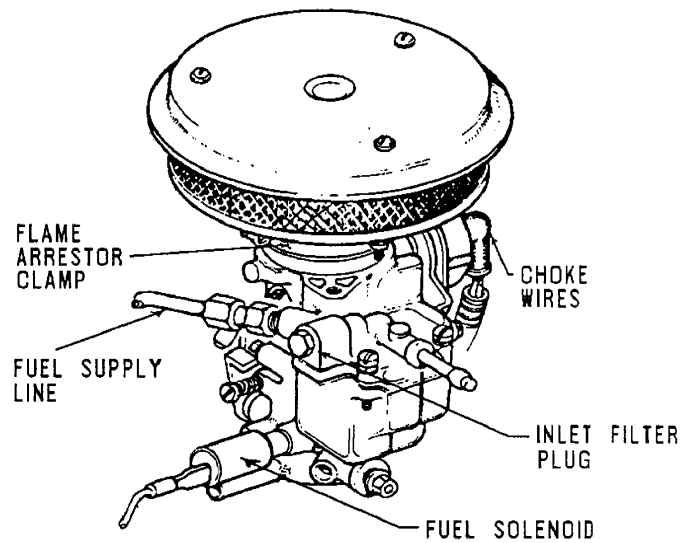
One (1) fuel filter element

One (1) aluminum shutoff solenoid gasket

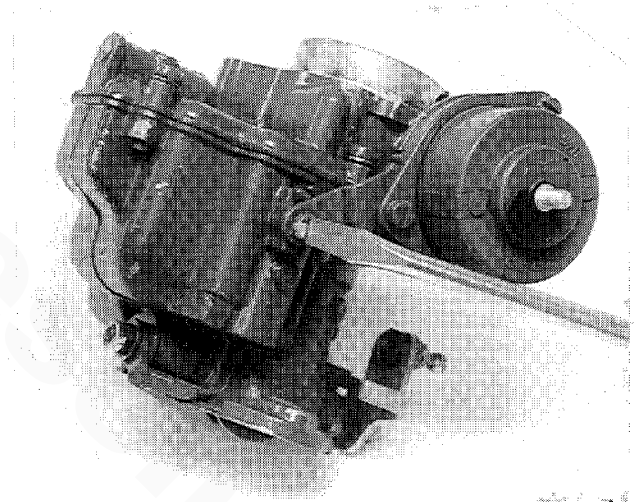
One (1) manifold gasket



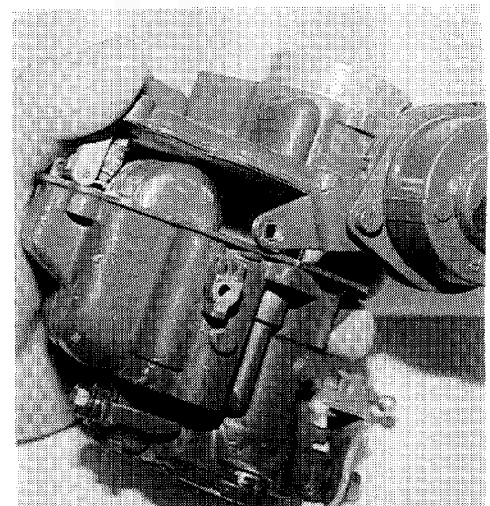
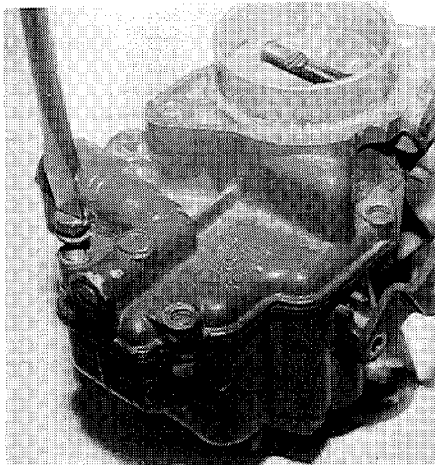
1. Remove the flame arrestor's clamp and ar-
restor, the fuel solenoid wire, the electric
choke wires, the fuel supply line, and the
throttle control linkage.
2. Remove the carburetor from the intake
manifold.



3. Remove the electric choke's stabilizing
screw.

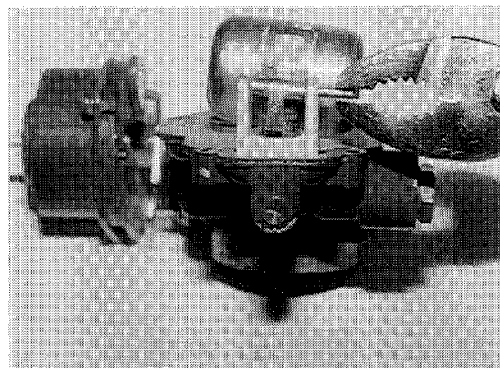


4. Remove the four cover screws, and lift the top
portion of the carburetor straight up and
away from the carburetor base. See pictures
below.

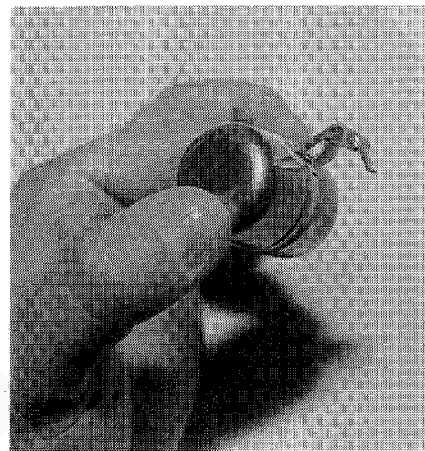


5. Remove all of the old cover gasket from both halves of the carburetor.

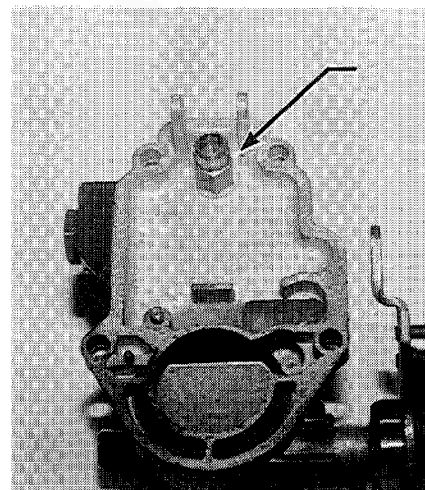
6. On the cover, gently punch out the float retaining pin, and remove the float. Make sure you catch the needle valve that hangs from the retaining hook under the float's pivot arm and place it aside.



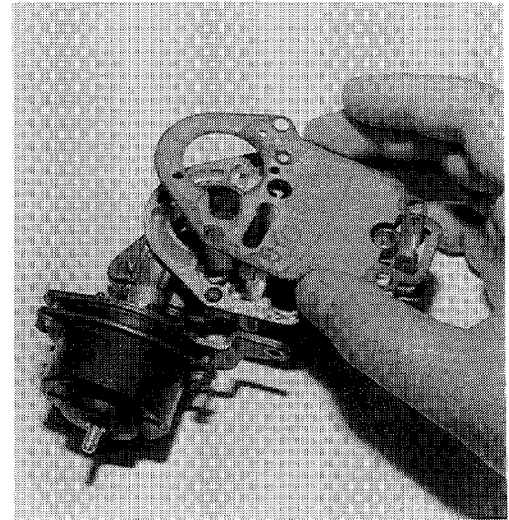
7. Shake the float. If you can hear any sand-like particles moving inside the float, replace the float.



8. Remove the needle valve's seat. Make sure that the seat's aluminum gasket is removed at this time. Screw in the new seat along with a new gasket.

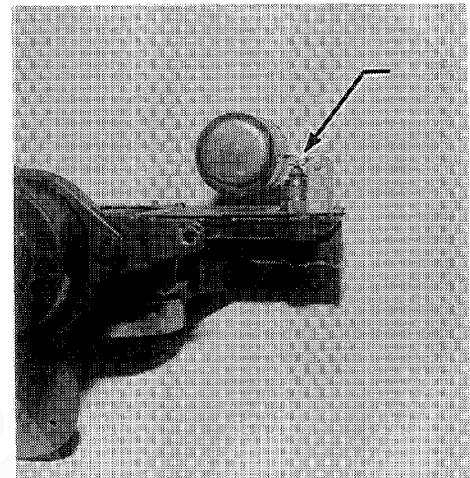
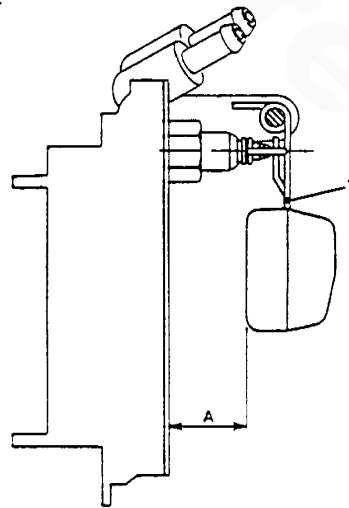


9. Place a new body gasket on the carburetor base. Do not use any gasket sealer on this gasket.

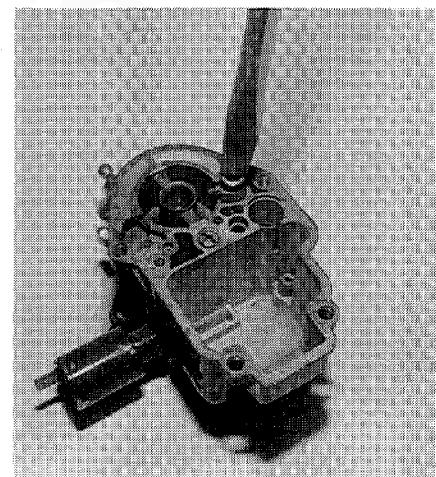


10. Gently place the needle valve in the seat. Replace the float so that the needle valve's wire retaining loop hooks onto the float's retaining hook. Now check float level distance from the housing mating surface with the housing held vertical.

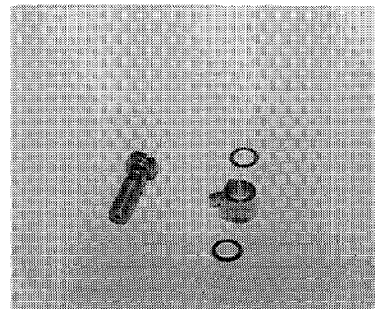
Distance "A" from mating surface: 3/16 inches (4.76 mm).



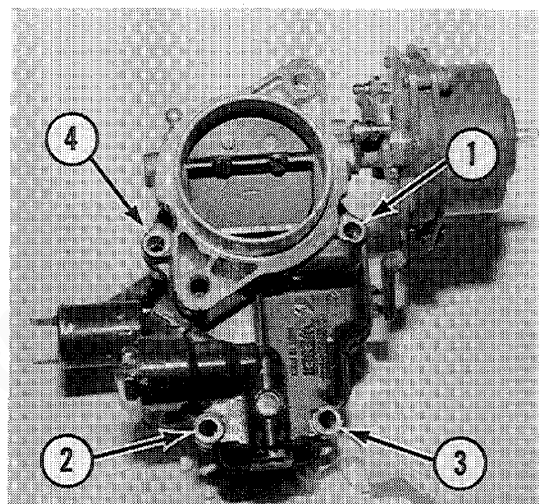
11. On the carburetor base, remove the accelerator pump nozzle.



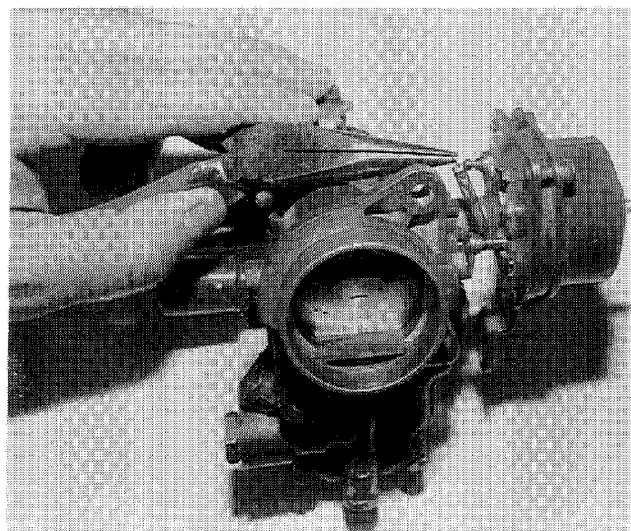
12. Replace the two copper washers - one is placed above the nozzle and the second is placed below the nozzle. Snug down the nozzle's retaining screw. Do not over tighten the screw.



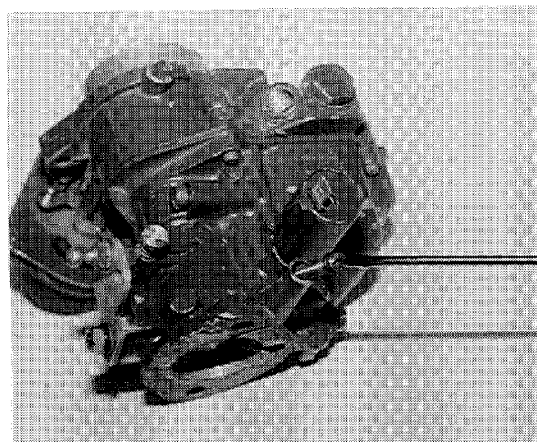
13. Replace the cover straight down on the carburetor, and hand tighten the cover screws as indicated in the photograph shown to the right. Snug down each screw. Over tightening these screws can strip the threads in the carburetor. Replace the electric choke's stabilizing screw.



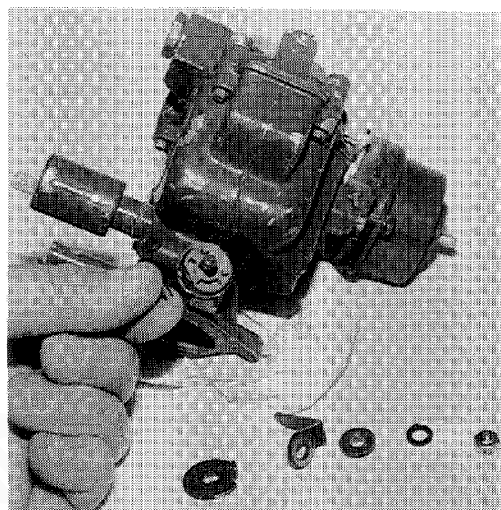
14. Replace the choke lever spring.



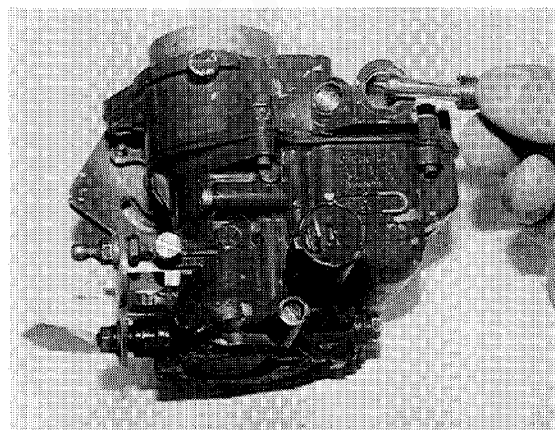
15. Replace the idle mixture screw's O-ring.



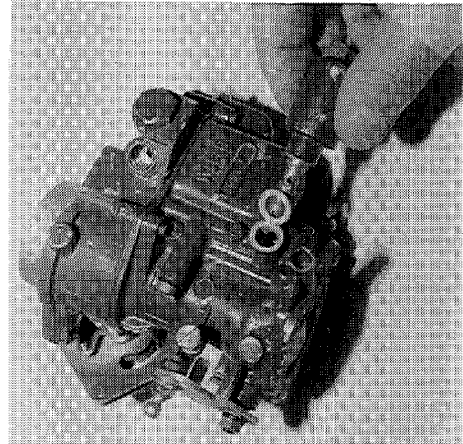
16. Replace the rotary throttle shaft valve and the throttle shaft valve spring.



17. Remove the fuel filter element plug and replace the fuel filter element.



18. Unscrew the shutoff solenoid and replace the aluminum gasket. Screw in the solenoid.



Now the carburetor is rebuilt. Make sure all the screws on the carburetor are properly tightened, and replace the carburetor on the intake manifold using a new manifold gasket along with a gasket sealant.

IGNITION COIL (LATE MODELS)

Specifications

Primary resistance	(Ω)	1.2 ± 0.12
Secondary resistance	($k\Omega$)	26 ± 3.9
External resistance	(Ω)	1.7 ± 0.17

3. Ignition coil

Primary coil resistance Measurement. Between positive *B* and negative *C* terminal.

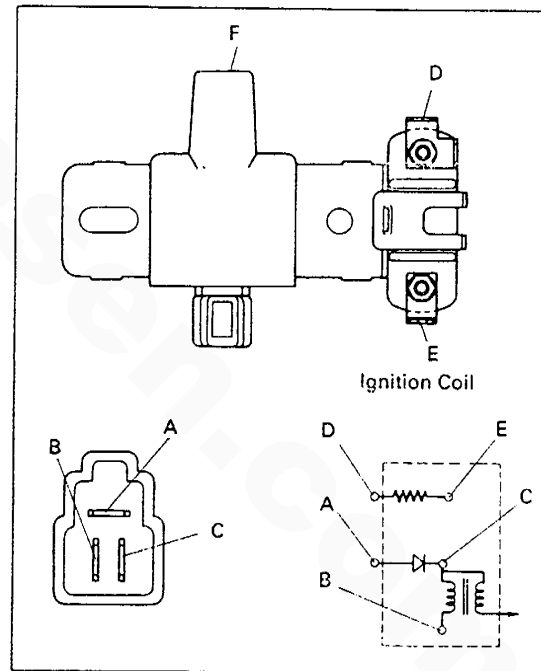
Resistance: $1.08 \sim 1.32 \Omega$

Secondary coil resistance measurement. Between positive *C* terminal and high tension terminal *F*.

Resistance: $22.1 \sim 29.9 k\Omega$

Resister resistance measurement. *D* to *E*

Resistance: $1.53 \sim 1.87 \Omega$

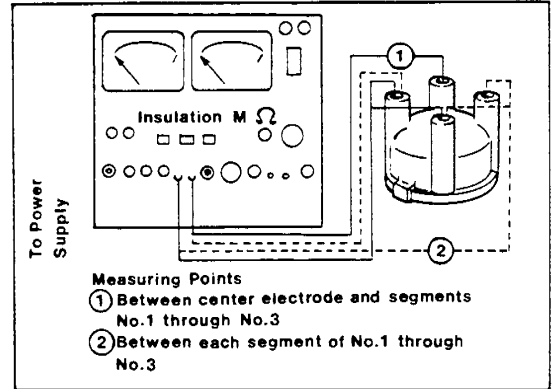


Inspecting the Distributor and its Components

1. Inspect the rotor and cap for cracks, wear, rust, dirt or salt deposits.

2. Check the cap with an electronic tester, as illustrated in the diagram to the right.

Prior to testing the distributor cap, apply your breath inside of the cap to dampen the interior of the cap. Set the range of the ohm tester to **INSULATION M Ohm**. If the cap's resistance is less than 20M ohms, clean the cap using a neutral detergent. After drying the cap, remeasure the insulation resistance. If the insulation resistance is still less than 20M ohms, replace the cap.



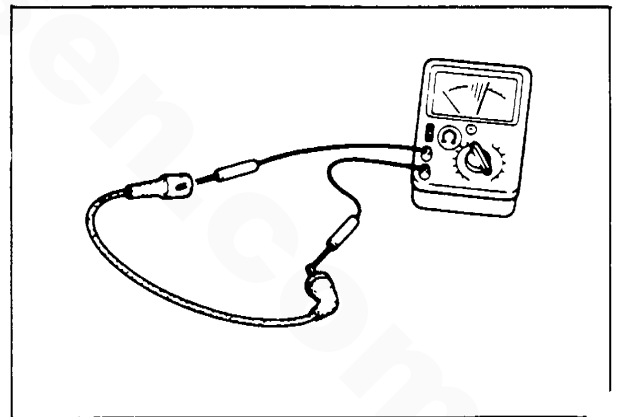
3. Check the the distributor shaft for wear or damage. Replace all damaged parts.

4. Measure the condenser capacity with a circuit tester. If the reading does not fall within the specified range, replace the condenser.

Specified range:
(Condenser Capacity)

0.225 - 0.275 microfarads (uF)

5. Test each spark plug wire and the coil wire. Connect the leads of a circuit tester to each end of the spark plug wire. Check the continuity of the spark plug wire while gently waving the center portion of the spark plug wire. If the pointer on the tester deflects while the wires are waved, then the wires are satisfactory.

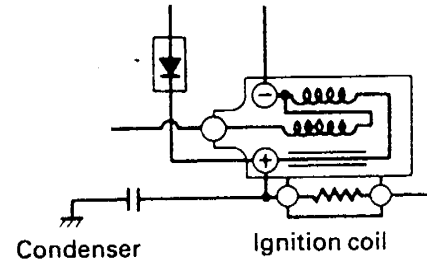


Resistance: No.1 cord 6 ~ 14 kΩ
 No.2 cord 6 ~ 16 kΩ
 No.3 cord 5 ~ 12 kΩ
 Center cord 4 ~ 9 kΩ

Testing the Ignition Coil (EARLY MODELS)

Measure the Ignition coil's primary and secondary resistance and capacitance as follows. Replace the coil if any test fails to meet the resistance value given.

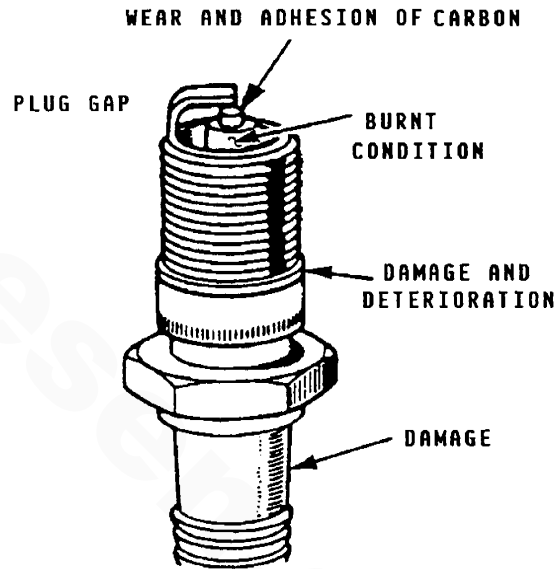
Primary Coil Resistance:	0.98 ± 0.1 ohm
Secondary Coil Resistance:	17.5 ± 2.6 ohm
Resistor Resistance: (Replace only the resistor if it fails this test.)	1.92 ± 0.2 ohm



Inspecting the Spark Plugs

Inspect each spark plug for cracks, chips, or for fouling. Clean or replace the spark plugs if necessary. Make sure that new or used spark plugs are gapped before they are installed in the engine.

Spark Plug Gap: 0.028 - 0.036 inches (0.7 - 0.9 mm)

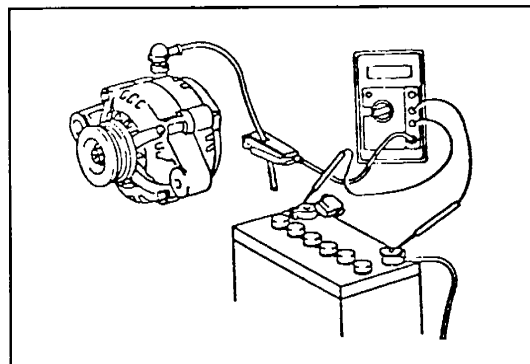


Testing the Alternator (BTG 9.0KW only)

1. For the no-load performance inspection, start the engine and test the alternator's regulated voltage.

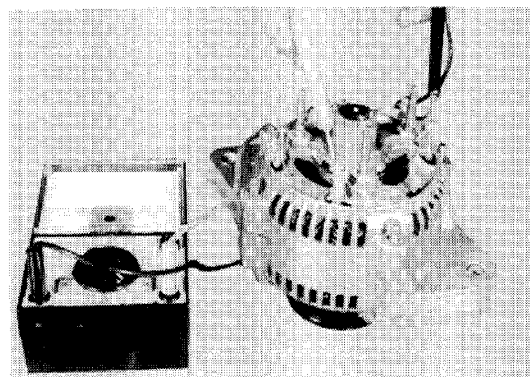
Regulated voltage: 13.9 - 15.1 volts

Current: Less than 10 amps



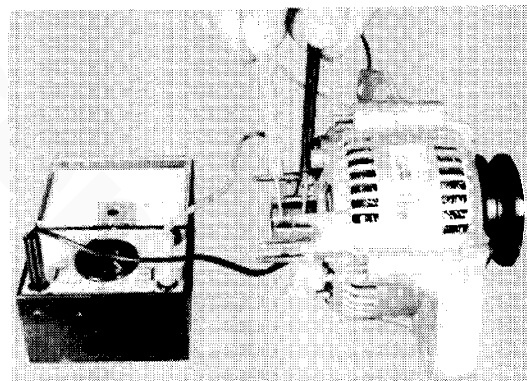
2. To test the stator, use an ohmmeter to check the resistance between each terminal.

Resistance: Less than 1 ohm



3. To test the rotor, use an ohmmeter to check the resistance between the slip rings.

Resistance: 2.9 ohm



Testing the Starter

The starter motor is a reduction gear type with activation solenoid mounted on it.

Performance Specifications

	Voltage	Current	Torque	Speed
No-load Performance	11.5 V	Max 90 A		Min. 3300 rpm
Loaded Performance	7.7 V	300 A	Min. 0.93 kg-m	Min. 850 rpm
Stall Performance	4 V	Max 570 A	Min. 2.5 kg-m	
Rated Output	12 kw (12 V)			
	435 kg			

CAUTION

If an engine fails to turn over when the starter circuit is energized, it's not always a starter problem. The cause of the problem may be related to something else, such as water in the cylinders causing a hydraulic lock or a faulty starter switch in the panel. In the event the starter fails to turn the engine over, check the engine and starter circuit. If no fault is found, remove the starter and test it.

1. Starter Circuit

- A. Charged condition of battery
- B. Tightened condition of battery terminals
- C. Tightened condition of starter terminals
- D. Condition of wiring (grounded or broken)
- E. Grounded condition of starter

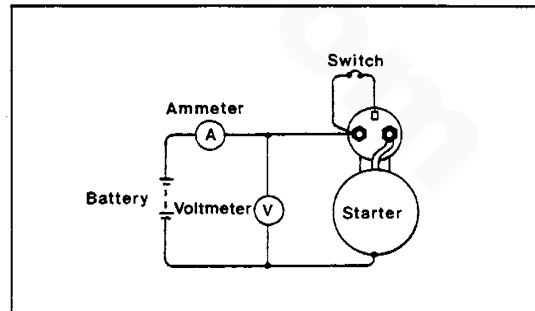
Description	Standard Value	
	Current	Speed
No-load characteristics of starter (Battery voltage: 11.5 V)	1.6 KW 100 A or less	3,000 rpm or more
	2.0 KW 180 A or less	3,300 rpm or more

2. No-load Test

Connect the starter with the battery as illustrated and close the switch to turn the starter.

The starter must turn lightly at the current and speed shown at the right when the battery voltage is 11.5 volts.

If any abnormality has been found, make the following inspections.



3. Brushes and Brush Holders

- A. Check brushes. If the brushes are worn over the service limit, replace them.
- B. With the brush holders assembled to the commutator, check the brush spring tension. If the spring tension has decreased over the service limit, replace it.
- C. Check continuity between the positive brush holder and the brush holder base. In case of continuity, replace the holder assembly.
- D. Check the brush holder caulk.

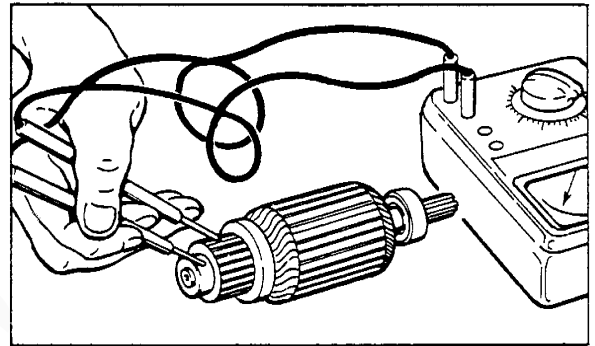
Description	Standard Value	Service Limit
Bush spring tension 1.6 KW	1.5 kg (3.31 lbs.)	0.7 kg (1.54 lbs.)
Bush length	1.7 mm (0.67 in.)	11.5 mm (0.45 in.)

4. Armature

- A. Check the armature coil using a growler tester. If the armature is shorted, replace it.

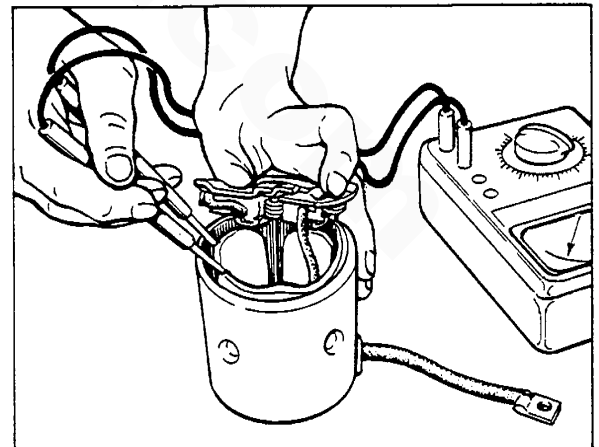
Also check for continuity between the armature and the commutator shaft. Replace if defective.

- B. Measure the commutator O.D. and the depth of undercut. Correct or replace the commutator if defective. Also check the commutator outside surface for dirtiness and roughness. Polish the commutator, if rough, with sand paper No. 300 to 400.



5. Field Coil

- A. Check for continuity at both ends of the coil (between brushes). If no current is flowing, the coil is broken. Replace the yoke assembly.
- B. Check for continuity between the connector and the yoke. If current is flowing, the coil is grounded. In this case, check the insulated condition and correct it. Replace the yoke assembly if not repairable.
- C. Check the staked condition of poles and check the coil and other parts for looseness.



6. Solenoid

The solenoid must be conducting between S and M terminals and between S terminal and body.

7. Overrunning Clutch

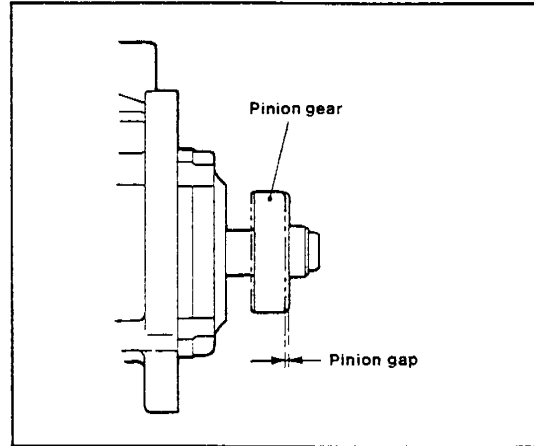
If the pinion is worn or damaged, replace it.

8. Reduction Gear

Replace the reduction gear if it is worn or damaged.

9. Front Bracket

If the ball bearing or bushing is worn, replace the bracket assembly.



10. Pinion Gap

A. Remove the connector from M terminal.

B. Insert the battery between the S terminal and the starter motor (connect the positive cable of battery to the S terminal), and the pinion moves out and stops. Lightly push the pinion back toward the armature to measure a pinion gap. If the pinion has no standard gap, adjust by increasing or reducing the adjusting washer between the solenoid and the front bracket. Increasing the number of washers reduces the gap.

Description	Standard Value
Starter pinion gap 1.6 KW	0.5 to 2.0 mm (0.0197 to 0.0787 in.)

CAUTION

In this check, do not apply the current for over 20 seconds to prevent switch coil overheat.

If the pinion does not move out, or if the pinion gap is too large or too small, the shift lever has been installed in a wrong direction or the magnet switch is defective.

11. Pinion Shaft Thrust Gap

A pinion shaft thrust gap is an axial play of the shaft. Adjust the gap to a value less than the standard

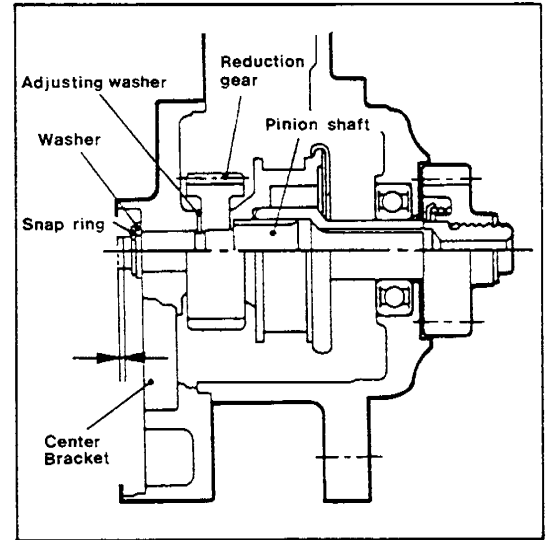
value by the adjusting washer between the center bracket and the reduction gear.

A. When Pinion has been Removed

After installing the reduction gear to the pinion shaft, insert the pinion shaft into the center bracket and then fix the pinion shaft with a washer and a snap ring. With the pinion shaft pressed to one side, measure the thrust gap and adjust by the adjusting shim.

B. When Pinion has not been Removed

Insert the pinion shaft and reduction gear between the front bracket and the center bracket and tighten the bolt. Move the pinion shaft to one side and measure the thrust gap.



CAUTION

Prior to measuring the thrust gap in the above paragraph, remove the lever spring.

Description	Standard Value
Starter thrust gap	0.5 mm (0.0197 in.) max.

12. Solenoid

A. Attraction Test

Connect the battery between the S and M terminals of the solenoid. If the plunger is attracted and the pinion moves out, then the solenoid is good.

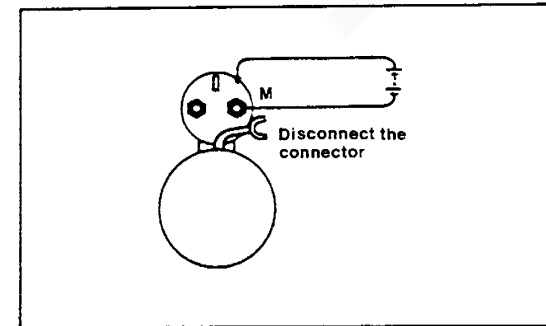
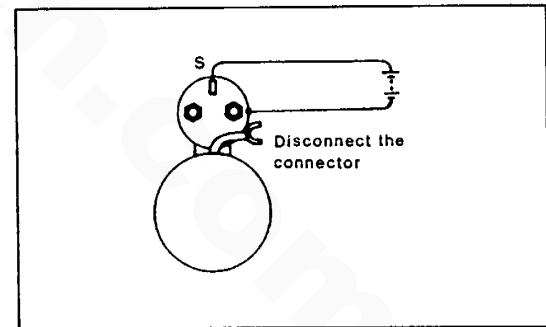
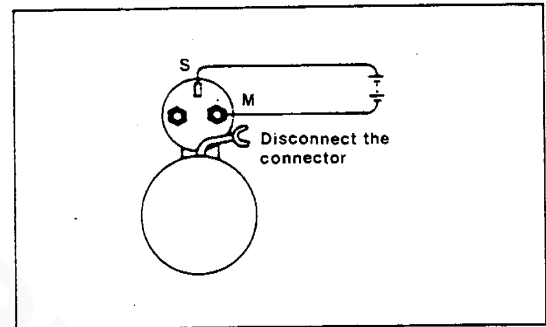
B. Holding Test

With the battery connected between the S terminal of the solenoid and the body, manually move the pinion out to the stopper position. If the pinion does not move back to its original position, the solenoid is good.

C. Return Test

With the battery connected between the M terminal of the solenoid and the body, manually move the pinion out to the stopper position. If the pinion returns to its original position as soon as it is released, the solenoid is good.

In the above three tests, do not supply current for more than 10 seconds.



NOTES

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ENGINE ASSEMBLY

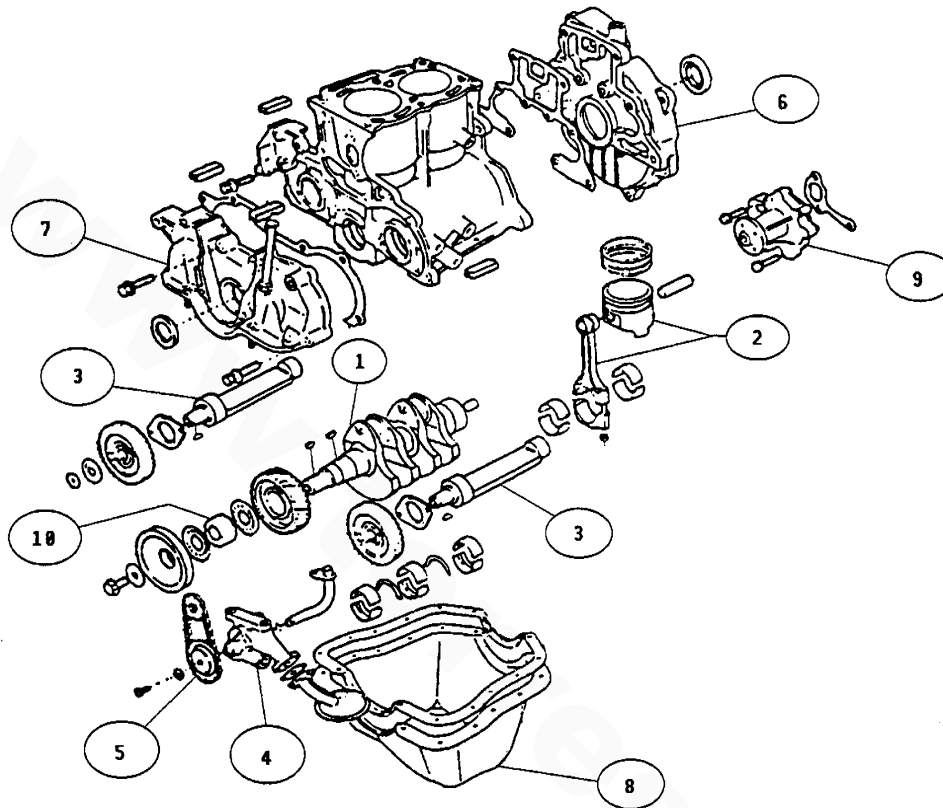
Take the following precautions when assembling the engine:

- A. Make sure that all parts to be assembled are thoroughly cleaned.
- B. Be careful not to mix nuts and bolts. Metric and SAE bolts are used on various engine assemblies.
- C. During the assembly, recheck clearances and ensure that all parts are assembled in their proper order and face the correct direction in relation to the engine block; that is, pistons, piston rings, bearings and bearing caps.
- D. Apply lubricating oil to moving parts during the assembly. Ensure that moving parts, when assembled on the engine, rotate or slide and are not subject to binding or excessive tension.
- E. If there are mating marks scribed during disassembly, reference them correctly for assembly.
- F. Use new gaskets, lockwashers, and O-rings.
- G. Tighten the bolts and nuts on important parts of the engine to specified torques using a reliable torque wrench.
- H. Use liquid sealants when required on nuts, bolts and gaskets. Refrain from using tape sealants.

Section.....	Page
CYLINDER BLOCK ASSEMBLY (Illustration and Numerical Order).....	134
Assembling the Crankshaft.....	136
Piston and Connecting Rod Assembly.....	137
Piston Ring Installation.....	138
Installing the Crankshaft Timing Belt Pulley.....	141
CYLINDER HEAD ASSEMBLY (Illustration and Numerical Order).....	142
BOLTING THE CYLINDER HEAD TO THE CYLINDER BLOCK.....	147
TIMING BELT ASSEMBLY	148
ADJUSTING VALVE CLEARANCES	153
Installing the Distributor	154
Installing External Parts and Subassemblies	155

CYLINDER BLOCK ASSEMBLY

For the BCG 4.0KW engine, assemble the components in the order indicated below.

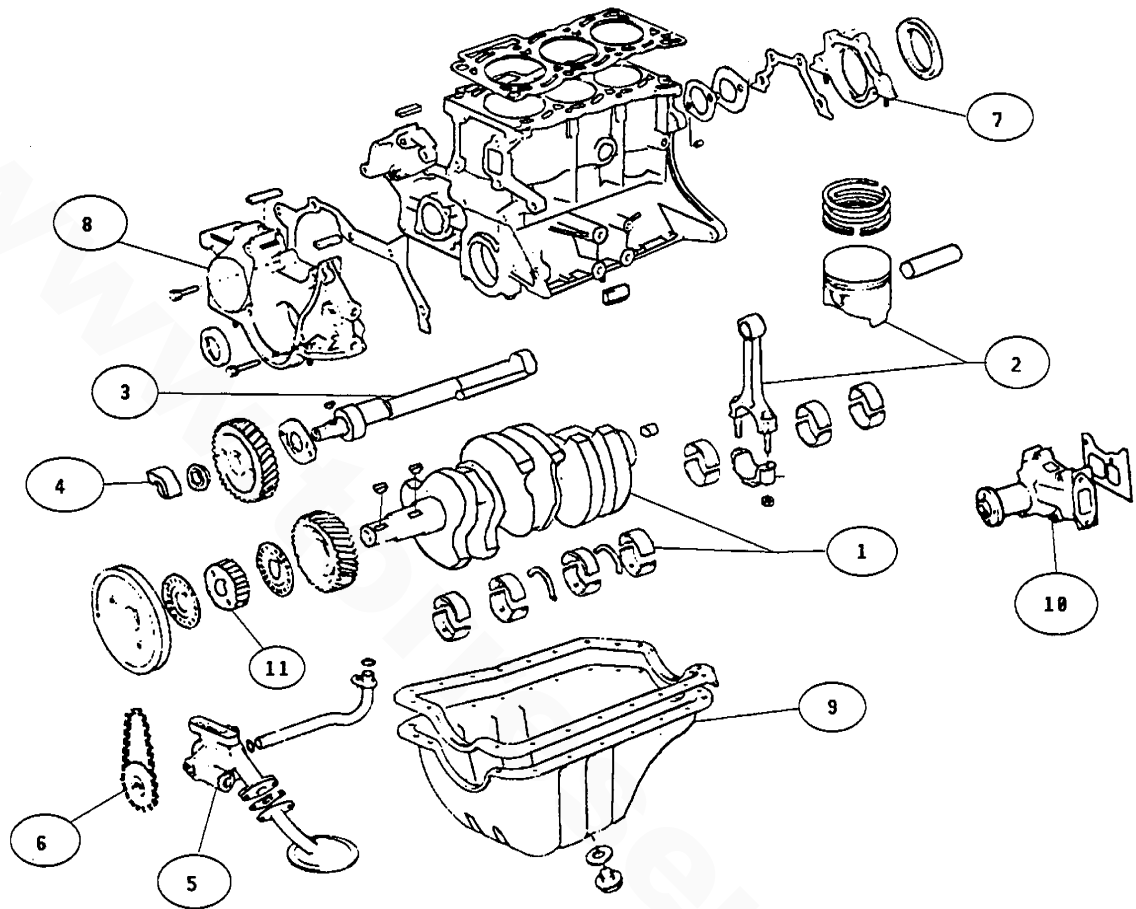


BCG 4.0 KW ASSEMBLY ORDER

- | | |
|--|-------------------------|
| *1. Crankshaft and Bearings | (page 136) |
| *2. Piston and Connecting Rod Assembly | (page 137) |
| *3. Balance Shaft | (page 139, step # 7-8) |
| 4. Oil Pump | |
| *5. Oil pump Drive Sprocket and Chain | (page 139, step # 9-10) |
| *6. Rear Oil Seal Retainer | (page 140) |
| *7. Balance Shaft Gear Cover | (page 140, step 11-12) |
| *8. Oil Pan | (page 140, step 13-14) |
| *9. Crankshaft Timing Belt Pulley | (page 141) |

*Denotes that assembly instructions for these parts follow on the indicated pages.

For the BCG 6.5KW and BTG 9.0KW engines, assemble the components in the order indicated below.



BCG 6.5 KW and BTG 9.0 KW ASSEMBLY ORDER

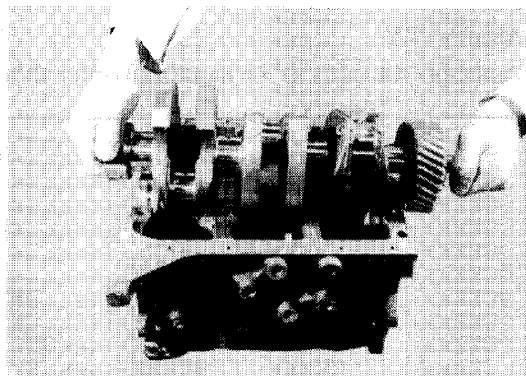
- *1. Crankshaft and Bearings (page 136)
- *2. Piston and Connecting Rod Assembly (page 137)
- *3. Balance Shafts (page 139, step # 7-8)
- 4. Balance Weight
- 5. Oil Pump
- *6. Oil Pump Drive Sprocket and Chain (page 139, step # 9-10)
- *7. Rear Oil Seal Retainer (page 140)
- *8. Balance Shaft Gear Cover (page 140, step # 11-12)
- *9. Oil Pan (page 140, step # 13-14)
- *10. Crankshaft Timing Belt Pulley (page 141)

*Denotes that assembly instructions for these parts follow on the indicated pages.

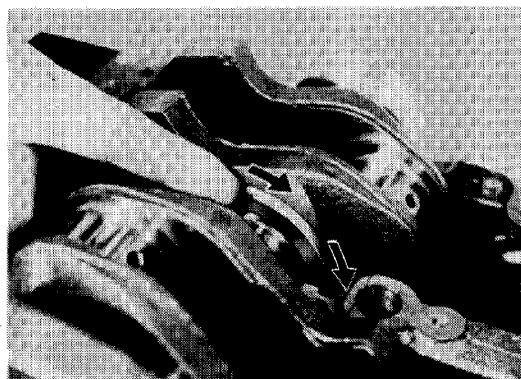
Assembling the Crankshaft

1. Before each bearing cap is installed, coat the crankshaft's bearing cap bolts (threaded portion) with engine oil.

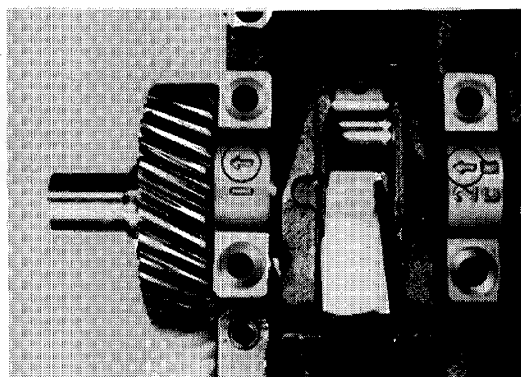
NOTE: Do not allow any oil to get on the back-side of the bearing inserts.



2. Attach the thrust washers on the cylinder block at the front and rear sides of the No. 3 bearing



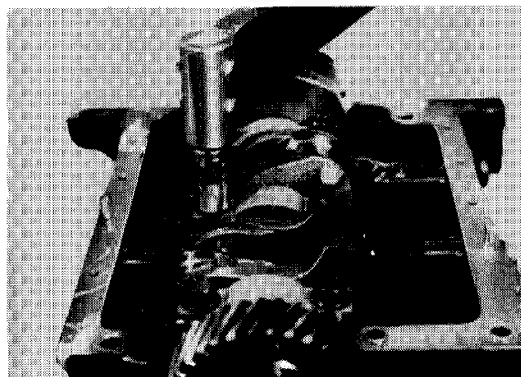
3. When installing the bearing caps, be certain that their arrowheads face toward the front of the cylinder block, respectively. After the bearing cap bolts have been torqued to the proper specification, ensure that the crankshaft can rotate lightly.



4. Tighten the bearing caps.

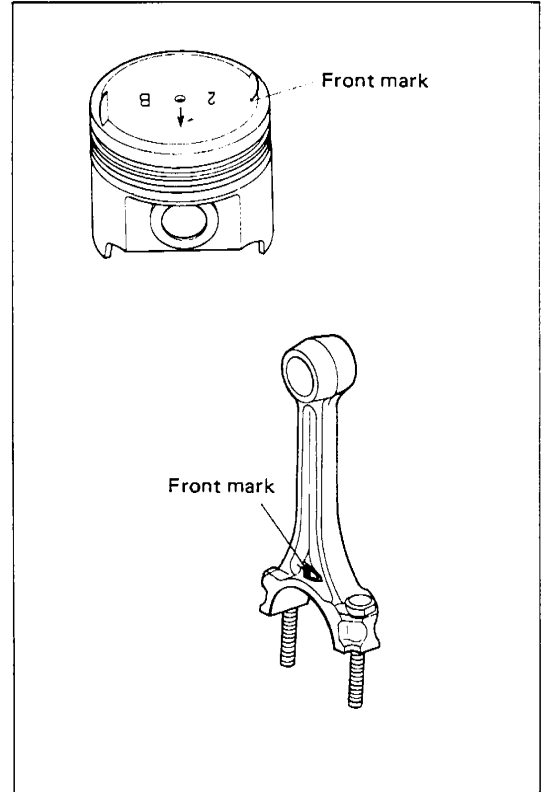
BCG 4.0KW: 34.0 - 42.7 lb-ft (4.7 - 5.9 kg-m)

BCG 6.5KW and BTG 9.0KW:
40 - 47 lb-ft (5.4 - 6.6 kg-m)

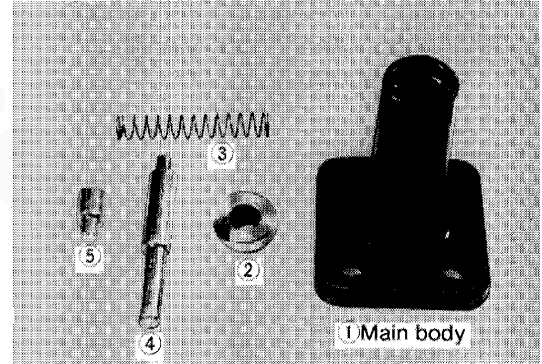


Piston and Connecting Rod Assembly

1. Assemble the pistons and connecting rods so that the front mark located at the side of the connecting rod and the front mark provided on the top of the piston come on the same side.

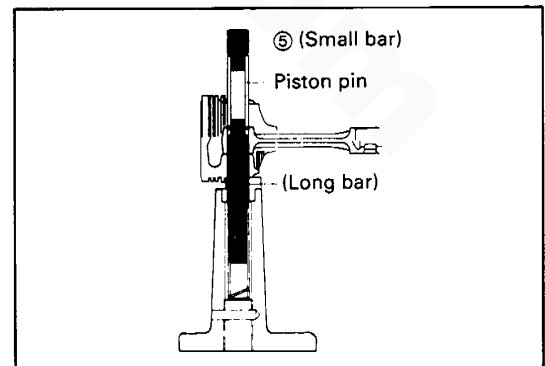


2. Using the special service tool # 37731 (Main body) and 37732, attach the fitting piece (2) onto the stand (1), and place the long bar (4) into position.



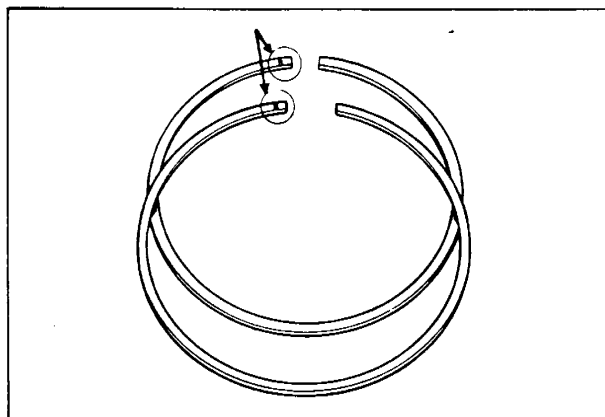
3. Place the small bar (5) into the piston pin. Then press the piston pin into position using a press.

NOTE: After the connecting rod has been assembled in the piston, ensure that the piston can move lightly back and forth.



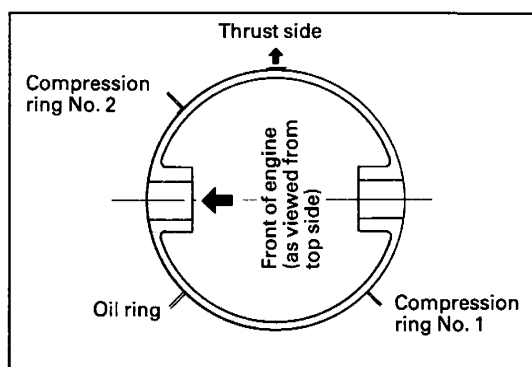
Piston Ring Installation

1. When installing the piston rings, make sure that the marks stamped on the rings by the manufacturer face upward towards the piston crown.

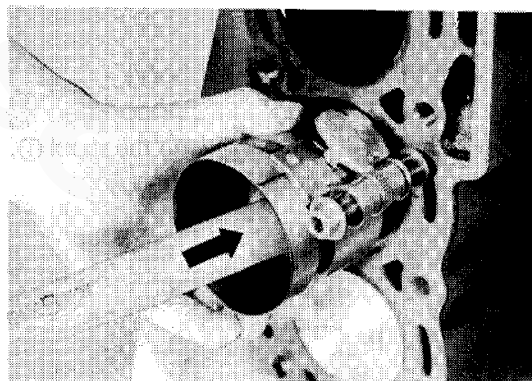


2. Make sure that the ring openings **do not** align when they are on the piston. Position the ring gaps in the direction shown in the figure.

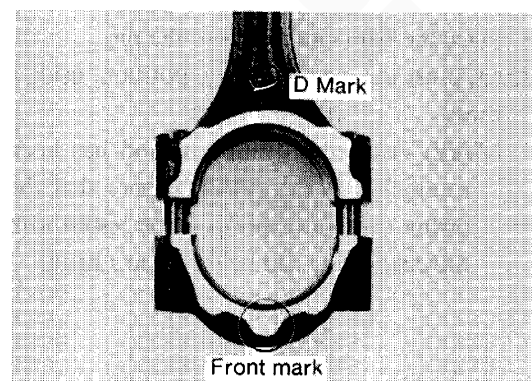
3. Apply engine oil to the external circumference of piston pin.



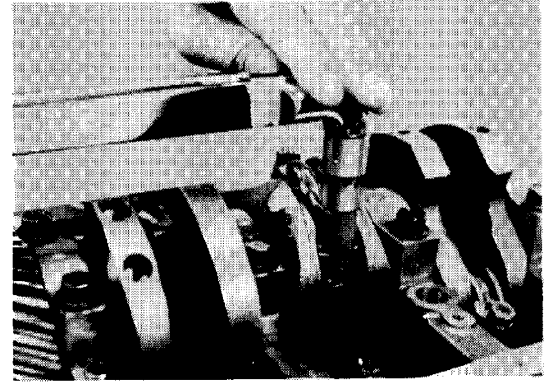
4. Insert the connecting rod and piston assembly into the cylinder block with a piston ring compressor attached.



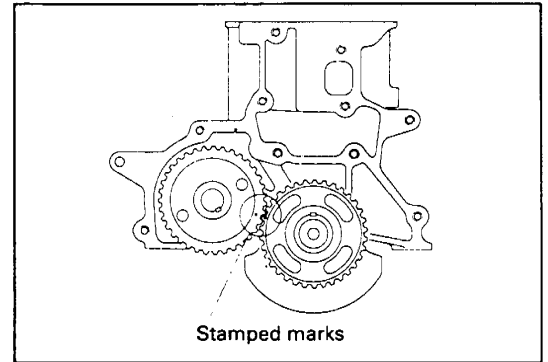
5. Install the cap on the connecting rod, making sure that the front mark (projected) on the bearing caps are aligned with the mark provided on the connecting rod.



6. Tighten the connecting rod caps (all models) between 15.2 - 21.0 lb-ft (2.1 - 2.9 kg-m)



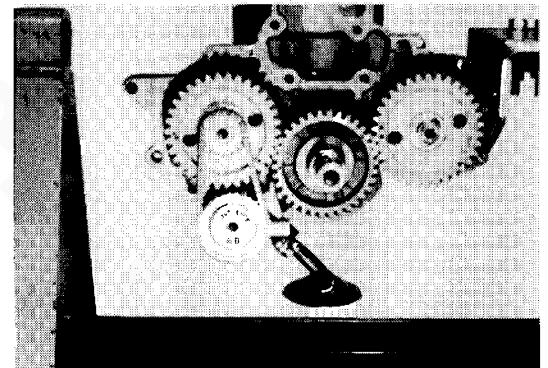
7. On the BCG 4.0KW engine, install balance shaft No. 1 on the left side, as viewed from the front of the engine. Align the balance shaft's drive gear with the punched mark when they are assembled.



8. On the BCG 6.5KW and BTG 9.0KW engines, install the balance shaft. Align the stamped mark on the balance shaft's drive gear with the stamped mark on the balance gear. (BCG 6.5KW and BTG 9.0KW shown right.)

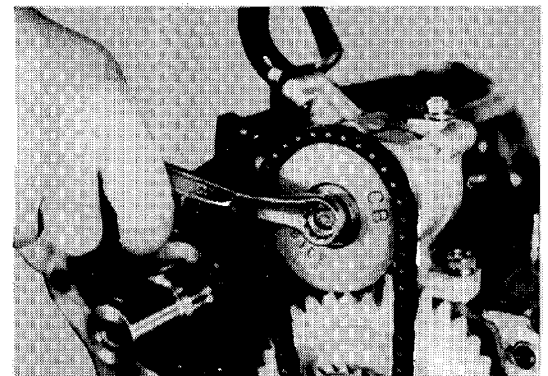
9. On the BCG 4.0KW engine, install the oil pump's drive chain, as shown in the illustration to the right.

NOTE: The sprocket at the oil pump side must be attached so that the stamped mark **AB-OUTSIDE** faces away from the engine.



10. On the BCG 6.5KW and BTG 9.0KW engines, install the oil pump's drive chain.

NOTE: The sprocket that attaches to the balance shaft must be attached so that the stamped mark **CB-OUTSIDE** faces away from the engine.



11. On the BCG 4.0KW engine, install the balance shafts' gear cover and the rear oil seal retainer.

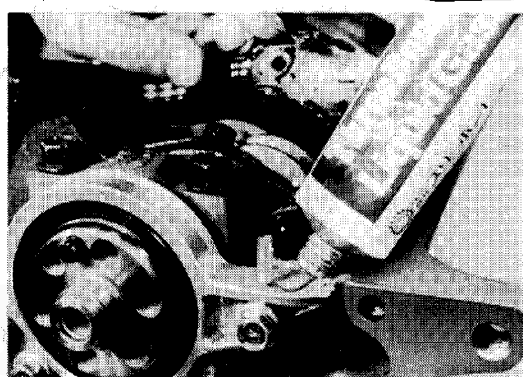
CAUTION

Make sure that the lip section of the oil seal by the key groove of the crankshaft is not damaged during the installation of the gear cover.

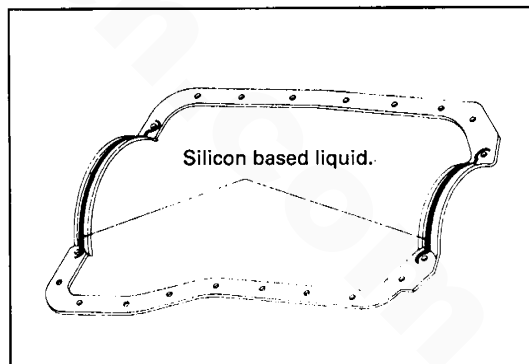
- A. Use a new gasket for this assembly.
- B. After the gasket has been installed, cut any protruding gasket material along the balance shafts' gear cover and the lower edge of the cylinder block.

12. On the BCG 6.5KW and BTG 9.0KW engines, install the balance shaft's gear cover.

13. Replace the old oil pan gasket with a new one. Prior to installing the oil pan, apply silicon bond sealer to the gasket.

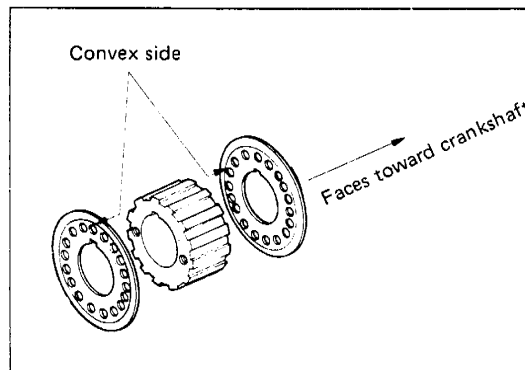


14. Place the gasket on the cylinder block and attach the oil pan. Tighten the oil pan bolts between 2.9 - 5.1 lb-ft (0.4 - 0.7 kg-m).



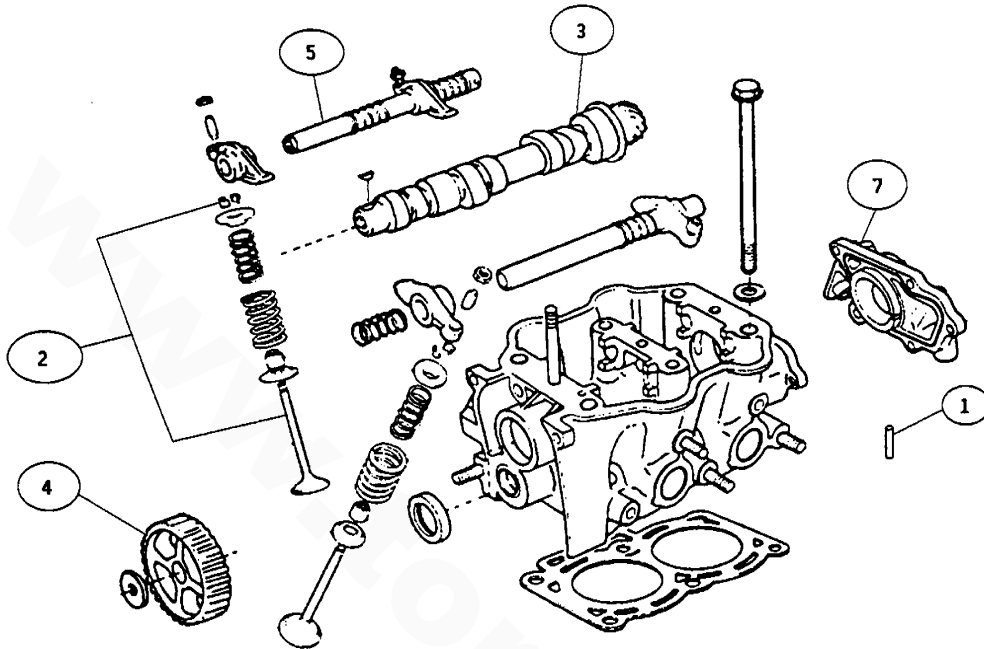
Installing the Crankshaft Timing Belt Pulley

After the balance shaft drive gear has been installed on the crankshaft, place the two crankshaft timing belt pulley flanges (convex side toward the crankshaft) on both sides of the crankshaft timing belt pulley. Refer to the illustration to the right.



CYLINDER HEAD ASSEMBLY

For the BCG 4.0KW cylinder head, assemble the components in the order indicated below.

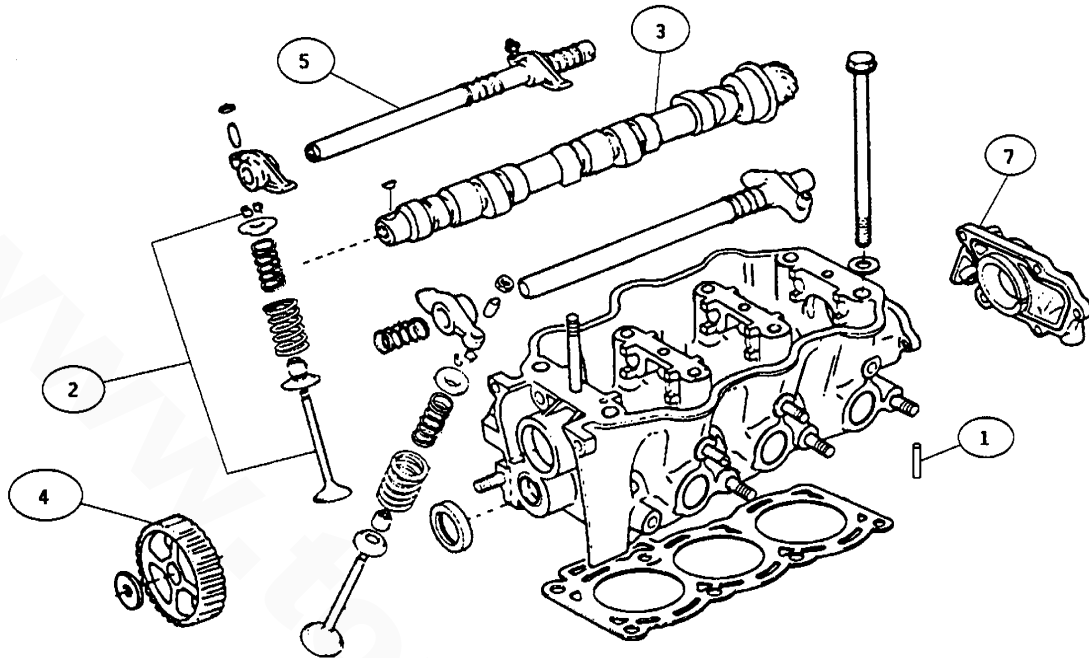


BCG 4.0 KW ASSEMBLY ORDER

- *1. Valve Guide Bushings (page 144, step 1)
- *2. Valves (page 144, step 2)
- *3. Camshaft (page 144, step 3)
- *4. Timing Belt Pulley (page 144, step 3)
- *5. Rocker Arm Shafts (page 145, step 4)
- *6. Wave Washer (not shown) (page 145, step 5)
- *7. Distributor Housing (page 145, step 6)

*Denotes that assembly instructions for these parts follow on the indicated pages.

For the BCG 6.5KW and BTG 9.0KW cylinder heads, assemble the components in the order indicated below.

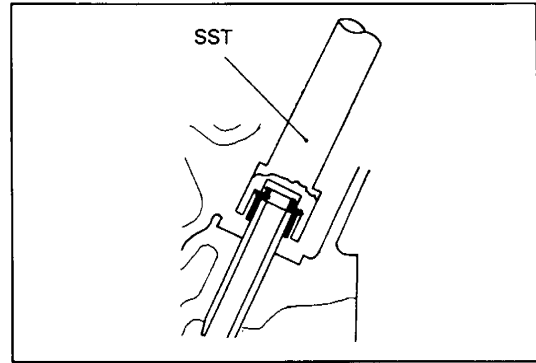


BCG 6.5 KW and BTG 9.0 KW ASSEMBLY ORDER

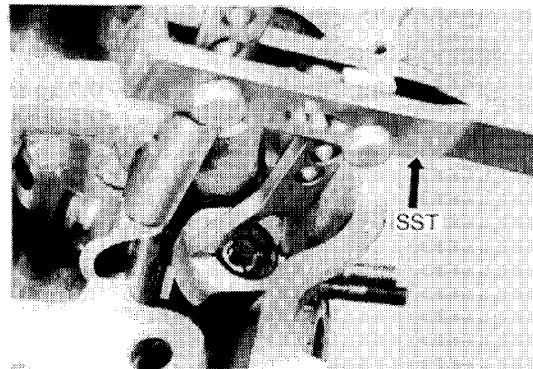
- | | |
|-----------------------------|--------------------|
| *1. Valve Guide Bushings | (page 144, step 1) |
| *2. Valves | (page 144, step 2) |
| *3. Camshaft | (page 144, step 3) |
| *4. Timing Belt Pulley | (page 144, step 3) |
| *5. Rocker Arm Shafts | (page 145, step 4) |
| *6. Wave Washer (not shown) | (page 145, step 5) |
| *7. Distributor Housing | (page 145, step 6) |

*Denotes that assembly instructions for these parts follow on the indicated pages.

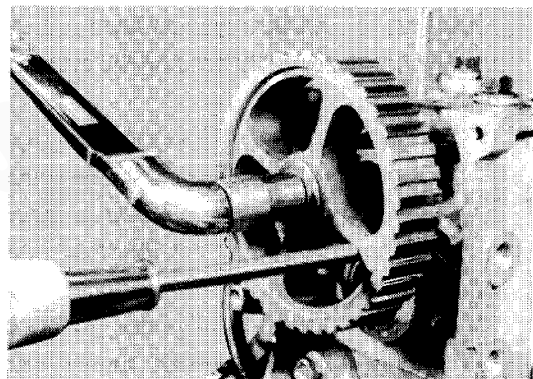
1. If the cylinder head had its valve guide bushings removed, insert new valve guide bushings using the special service tool [SST] # 37726. Replace the plate washer.



2. NOTE: For this step, temporarily insert the rocker arm shafts (see step# 4). Insert a valve, compress the valve springs, using special service tool #37726, and install the spring retainer locks. Repeat this process for each valve.

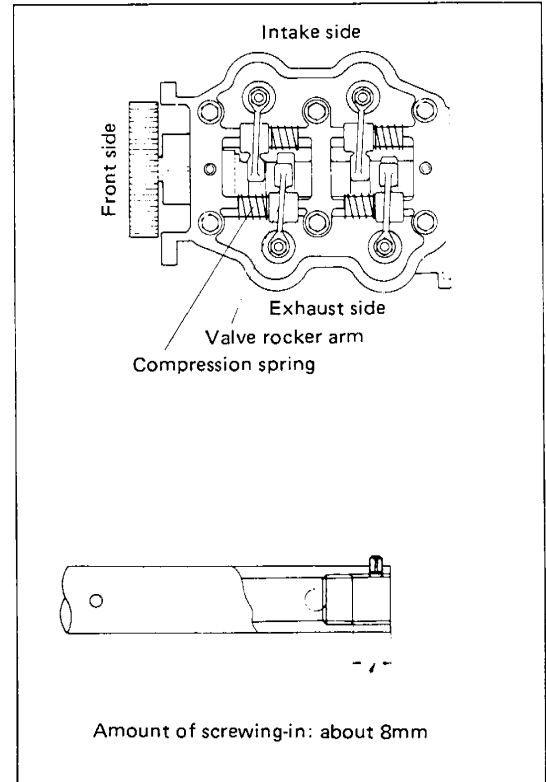


3. Install the camshaft and timing belt pulley. During the installation, the camshaft can be prevented from rotating by inserting a screw driver through the opening of the pulley. Tighten the timing belt pulley bolt between 21.7 to 32.5 lb-ft (3.0 - 4.5 kg-m).

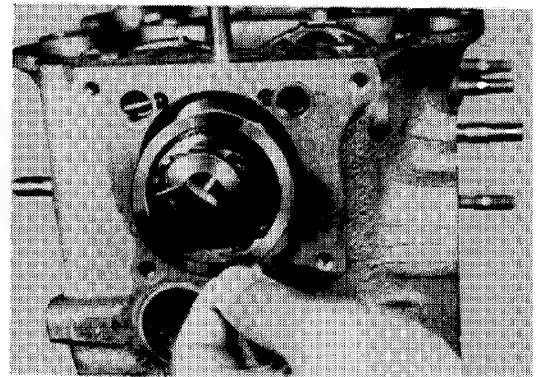


4. The rocker arm shaft for the exhaust side, which is the longest rocker shaft, must be installed in the cylinder head's right side, as viewed from the front. The shaft is inserted from the back of the cylinder head. The dowel pin at the end of the rocker arm shaft fits into a slot at the rear of the cylinder head. This pin aligns the oil ports in the rocker shaft to those in the cylinder head.

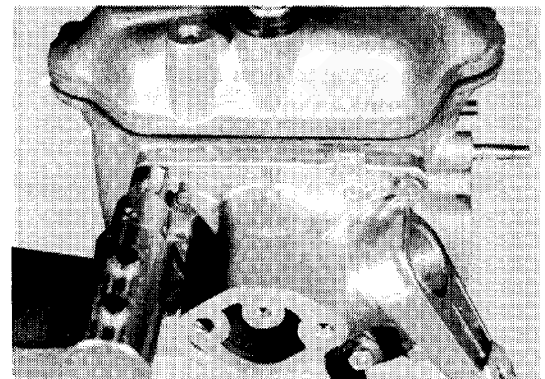
NOTE: If the set screws at the end of the rocker arm shafts were removed so the center of the shafts could be cleaned, do not screw the set screw in so far as to block the first oil port in the rocker arm shaft (allow dimension **B** to be 0.314 inches [8 mm]).



5. Insert the wave washer (see right).



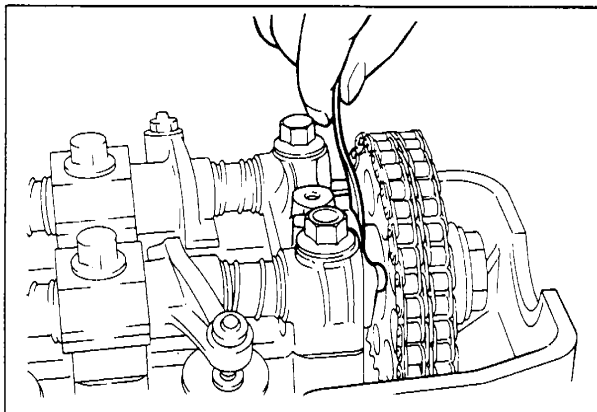
6. Install the distributor housing along with a new O-ring gasket. Tighten the bolts between 2.9 to 5.1 lb-ft (0.4 - 0.7 kg-m).



7. Measure the play in the camshaft's thrust direction. Next check the camshaft's end play in the axial direction (that is, movement from side to side).

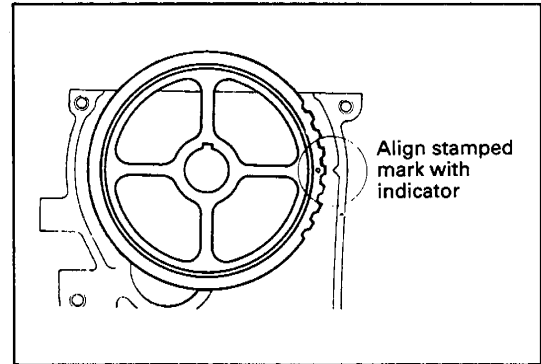
Specified Limit: 0.002 - 0.011 inches
(0.05 - 0.29 mm)

Allowable Limit: 0.0157 inches (0.4 mm)

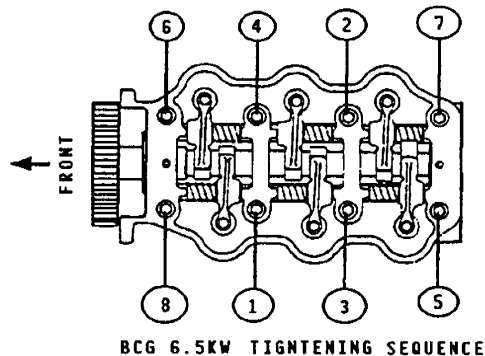
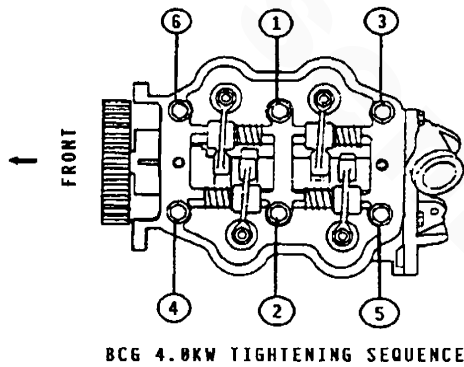


BOLTING THE CYLINDER HEAD TO THE CYLINDER BLOCK

1. Make sure none of the pistons come to their Top Dead Center (TDC) position. This allows the cylinder head to be mounted on the cylinder block without the valves interfering with the pistons. Be sure to align the stamped mark on the camshaft timing belt pulley with the indicator on the cylinder head.

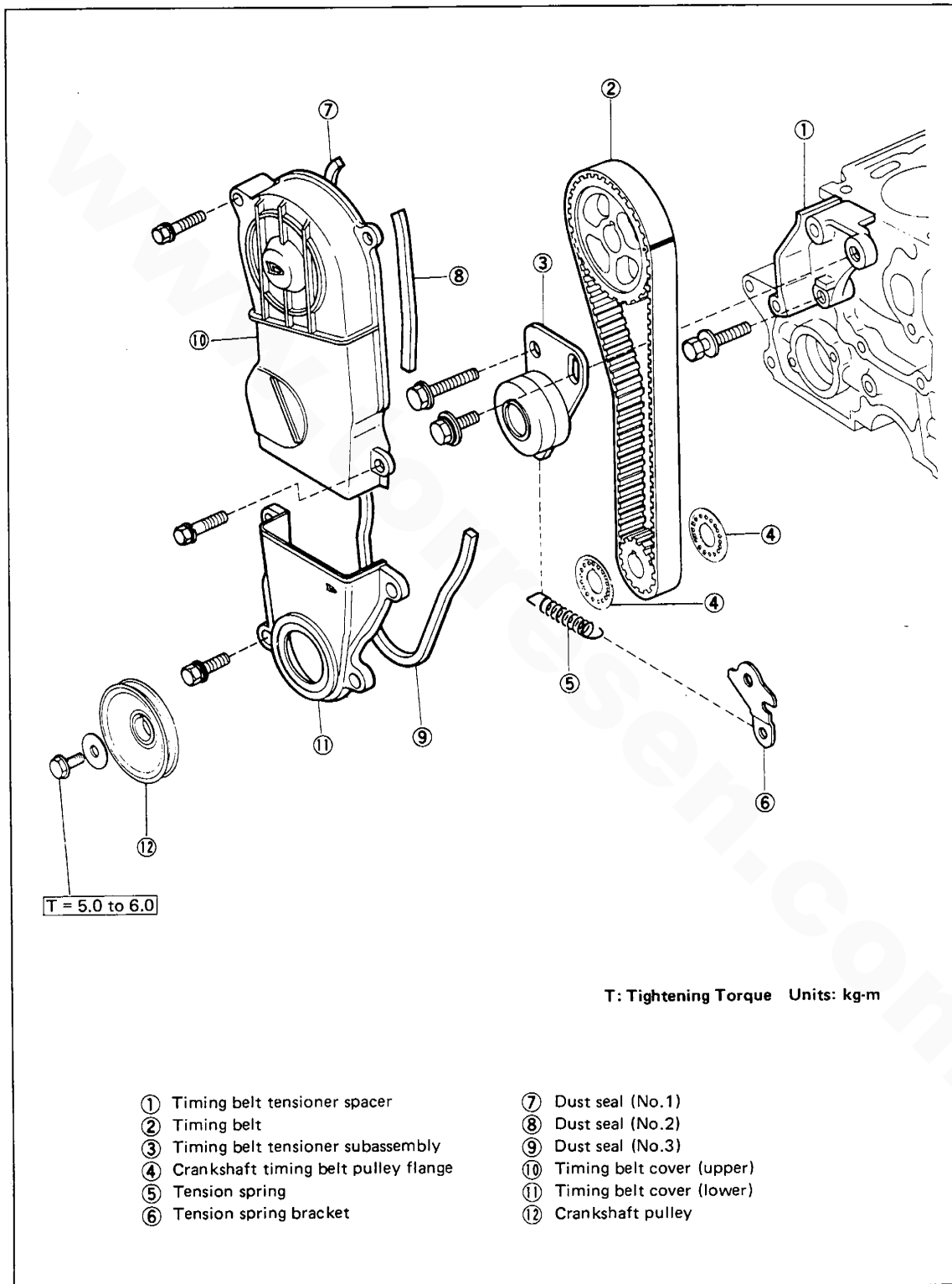


2. Make sure the mating surface of the cylinder head and cylinder block are clean of old gasket material, oil or grease. Use a new cylinder gasket when installing the cylinder head on the cylinder block. **Do not** use any gasket sealer on this gasket.
3. Mount the cylinder head on the cylinder block and tighten the cylinder head bolt between 28.9 to 36.2 lb-ft (4.0 - 5.0 kg-m).

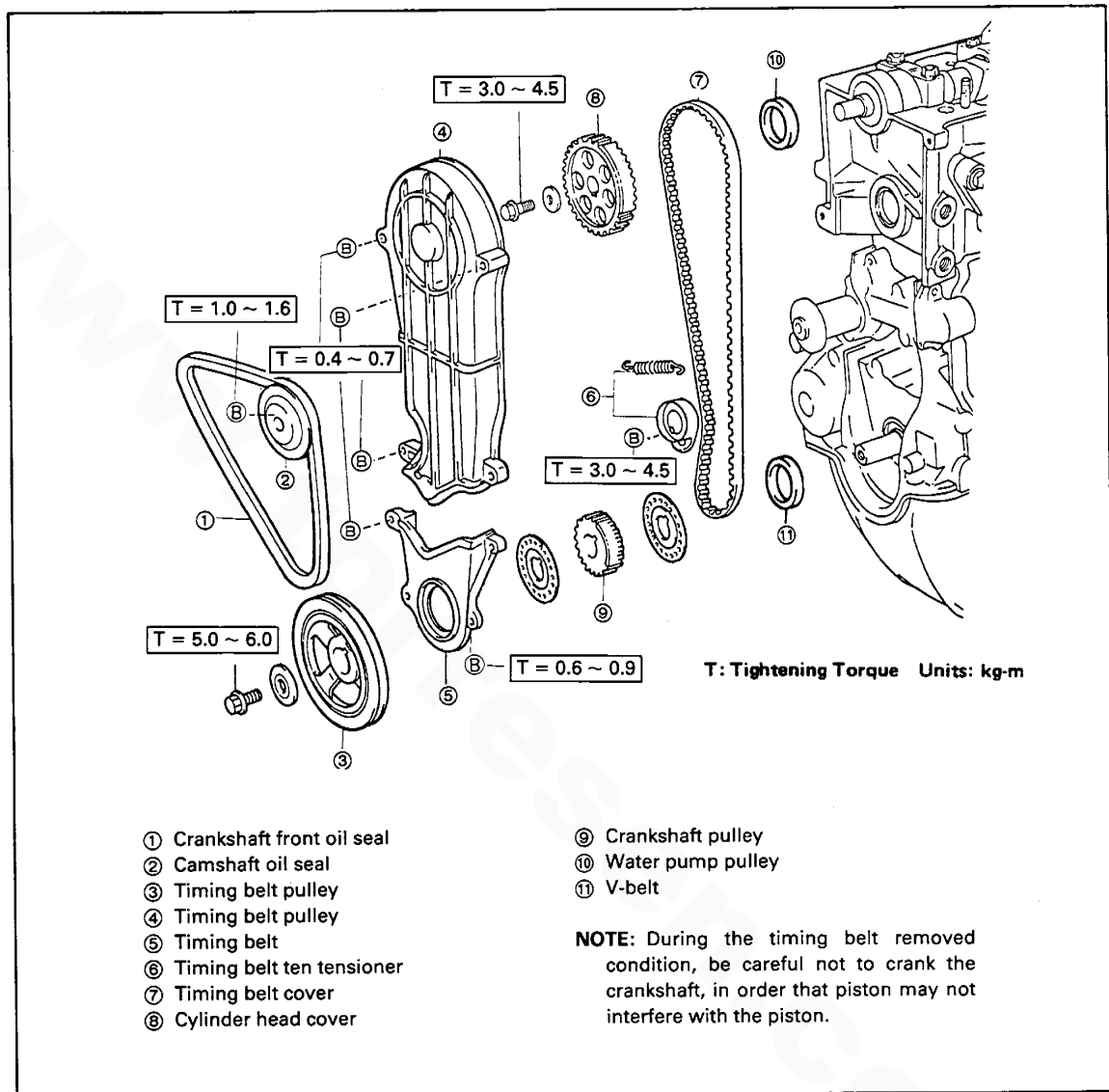


TIMING BELT ASSEMBLY

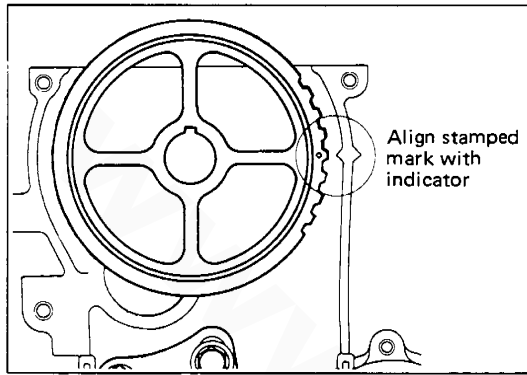
For the BCG 4.0KW engine, assemble the timing belt components in the numerical order indicated below.



For the BCG 6.5KW and BTG 9.0KW engines, assemble the timing belt components in the numerical order indicated below.

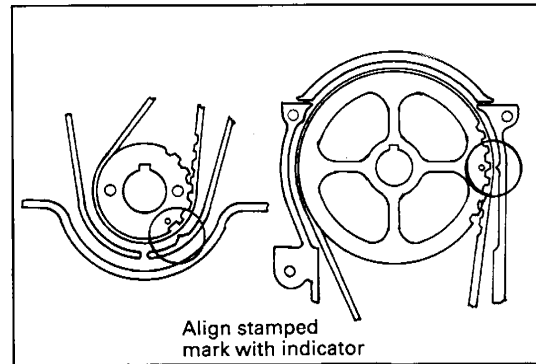


1. Make sure that the stamped marks on the camshaft and crankshaft timing belt pulleys are aligned with their respective indicators (pointers) on the cylinder head and bearing shaft gear cover (camshaft pulley mark is at 3 o'clock; crankshaft pulley mark is between 4 and 5 o'clock, when pulley keyways are at 12 o'clock).



Aligning Mate Marks

BCG 4.0KW



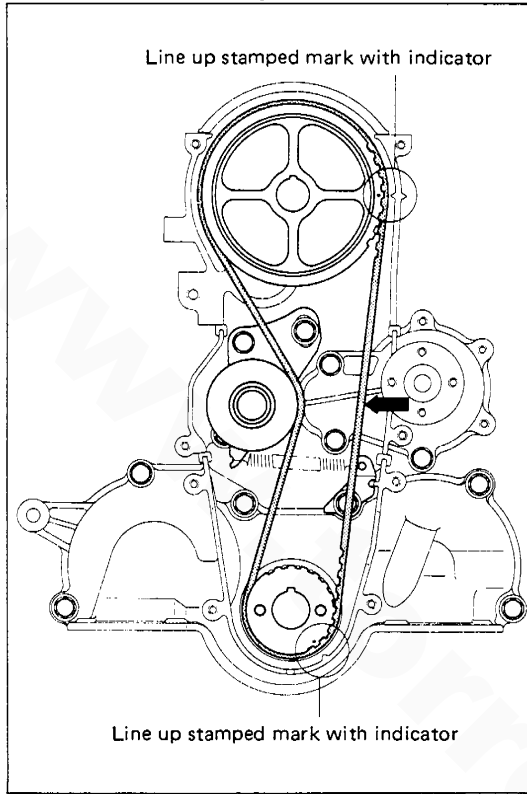
BCG 6.5KW and BTG 9.0KW

2. Temporarily attach the timing belt tensioner, leaving its setting bolt backed off one half turn.
3. Install the tension spring.
4. If the crankshaft timing belt pulley was removed during disassembly, make sure the crankshaft timing belt pulley flanges are properly placed on either side of the pulley (convex surface of flange toward pulley).

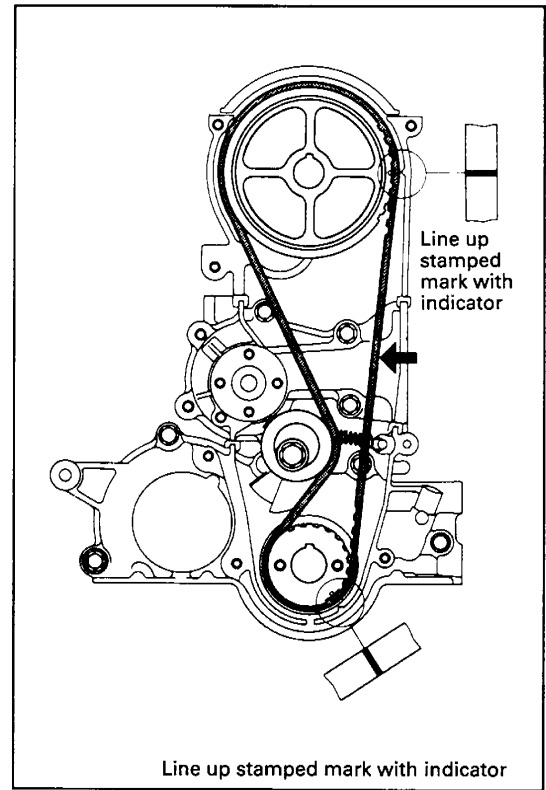
CAUTION

When installing the timing belt, **do not** pry the belt with a screwdriver or similar tool. Damage to the belt will result.

5. Install the timing belt by hand, making sure that there is no slack between the pulleys on the side of the belt away from the tensioner and that the stamped marks on the two pulleys are still properly aligned with their respective indicators.

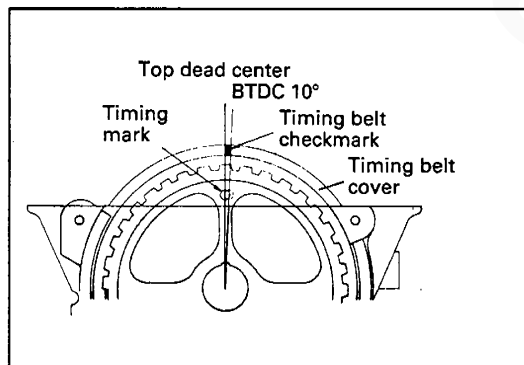


BCG 4.0KW



BCG 5.6KW and BTG 9.0KW

6. Rotate the crankshaft two complete turns in the normal direction of rotation until the No. 1 piston returns to Top Dead Center (TDC). Check that the timing belt pulleys again are properly aligned with their respective indicators, as indicated in step 5.



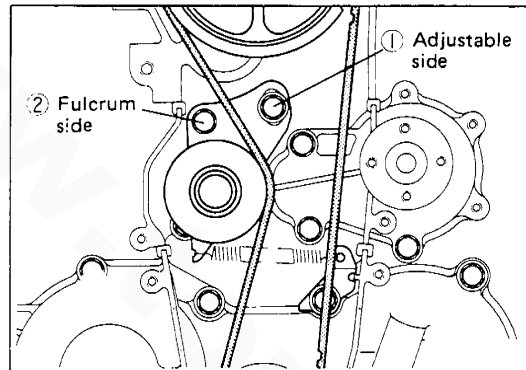
BCG 4.0KW, BCG 6.5KW and BTG 9.0KW

CAUTION

Ensure that no other force save that of the tensioner spring is applied to the tensioner when tightening the setting bolts.

7. On the BCG 4.0KW engine, with the timing belt aligned and checked, tighten the adjustable slide setting bolt (in the elongated hole of the tensioner), and then tighten the fulcrum side bolt (in the hole away from the tension spring).

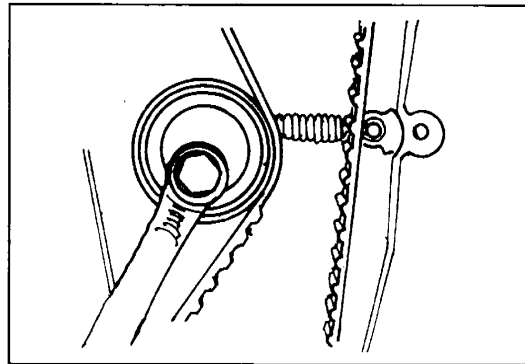
Tightening Torque: 13.7 - 22.4 lb-ft
(1.9 - 3.1 kg-m)



Timing Belt Tensioner Tightening Sequence

BCG 4.0KW

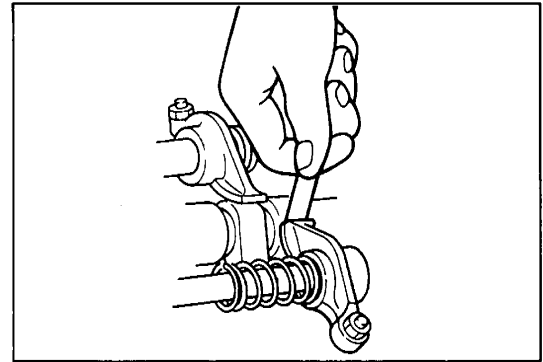
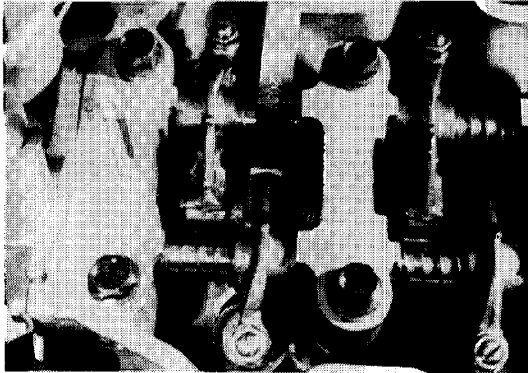
8. On the BCG 6.5KW and the BTG 9.0KW engines, with the timing belt aligned and checked, tighten the single setting bolt with the same tightening torque specifications as given in step 7.



BCG 6.5KW and BTG 9.0KW

ADJUSTING VALVE CLEARANCES

1. Adjust the valve clearances according to the following specifications. (Adjustments are made using the appropriate feeler gauge between the rocker arm and its associated cam lobe on the cam shaft, as shown in the figures below.)



Adjusting Valve Clearances

- A. On the two-cylinder BCG 4.0KW engine, adjust the valve clearances as follows:

1. Set the piston of the No. 1 cylinder at the end of its compression stroke. Adjust the No. 1 intake and exhaust valve clearances as specified below.

Valve Clearance
(engine cold)

Intake 0.0098 inches (0.25 mm)
Exhaust 0.0098 inches (0.25 mm)

2. Rotate crankshaft 360°. Adjust the No. 2 intake and exhaust valve clearances as specified above.

- B. On the three-cylinder BCG 6.5KW and the BTG 9.0KW engines, adjust valve clearances as follows:

1. Set the piston of the No. 1 cylinder at the end of its compression stroke. Adjust the No. 1 and No. 3 intake valve clearances and the No. 1 and No. 2 exhaust valve clearances as specified below.

Valve Clearances
(engine cold)

Intake 0.0071 inches (0.20 mm)
Exhaust 0.0071 inches (0.20 mm)

2. Set the piston of the No. 1 cylinder at the top of its intake and the end of its exhaust stroke (rotate the crankshaft 360°). Adjust the No. 2 intake and the No. 3 exhaust valve clearances as specified above.

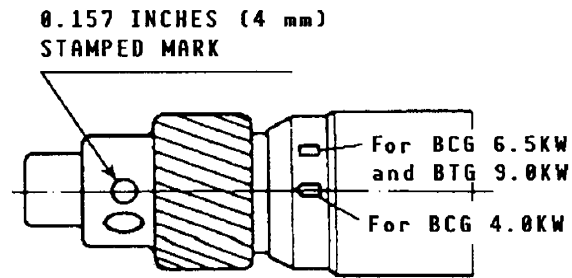
2. Install the upper and lower timing belt covers, ensuring that the associated dust seals are properly installed and that the crankshaft timing belt pulley flange is properly positioned in front of the pulley.

Tightening Torque:

1.4 - 2.9 lb-ft (0.2 - 0.4 kg-m)

Installing the Distributor

1. Set the No. 1 piston at Top Dead Center (TDC) at the end of the compression stroke.
2. Turn the distributor shaft until the stamped mark located at the end of the distributor shaft is aligned with the recessed mark, as indicated in the illustration to the right.

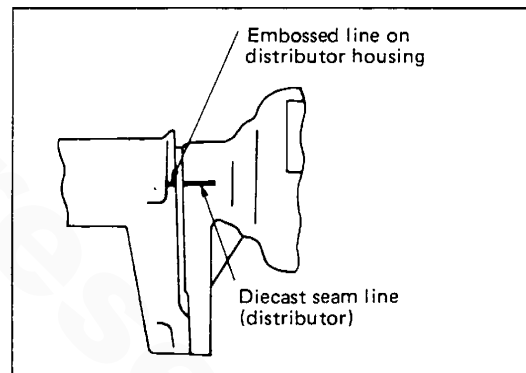


ALIGNING STAMPED MARKS ON DISTRIBUTOR

At this point, the distributor is correctly aligned for installation.

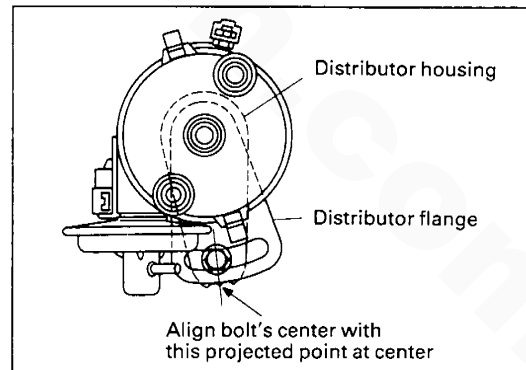
NOTE: At this point, fill the distributor housing with approximately 30 cc of engine oil.

3. Install the distributor into the cylinder block in such a way that the mold seam line provided on the distributor body is lined up with the embossed line located on the distributor housing.



4. Temporarily tighten the distributor retaining bolt.

NOTE: Make sure to tighten the distributor retaining bolt after the engine tune-up operation has been completed.



Installing External Parts and Subassemblies

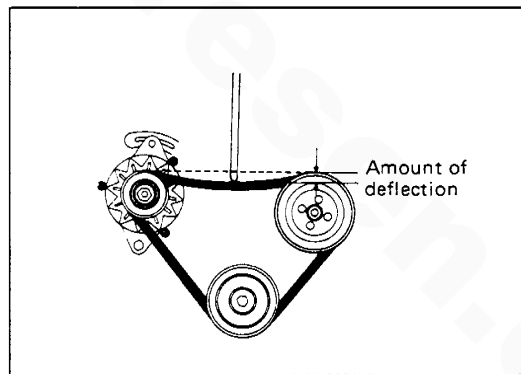
1. Install the exhaust manifold.
2. Install the intake manifold.
3. Attach the cylinder head cover, ensuring that the cylinder head cover gasket is properly positioned in its groove in the cover before installing the cover's cap nuts and seal washers.

Tightening Torque: 5.1 - 9.4 lb-ft (0.7 - 1.3 kg-m)

4. Install the crankshaft pulley to the crankshaft.

Tightening Torque: 36.2 - 43.4 lb-ft (5.0 - 6.0 kg-m)

5. Install the fresh water circulating pump and the fresh water circulating pump's pulley.
6. Install the governor's mounting bracket and the governor; attach the linkage arm to the carburetor.
7. Install the alternator's mounting bracket and the alternator on the BTG 9.0KW engine; install the fresh water pump's drive belt and adjust the belt so that it deflects between 0.43 to 0.51 of an inch (11 to 13 mm). Refer to the illustration below.



Checking "V" Belt Tension

8. Install the idler pulley on the BCG 6.5KW engine; install the fresh water pump's drive belt and adjust the belt so that it deflects between 0.43 to 0.51 of an inch (11 to 13 mm).
9. Install the sea water pump's mounting bracket and the sea water pump; install the drive belt and adjust the belt so that it deflects between 0.43 to 0.51 of an inch (11 to 13 mm).
10. Install the belt guard at the front of the engine.

NOTES

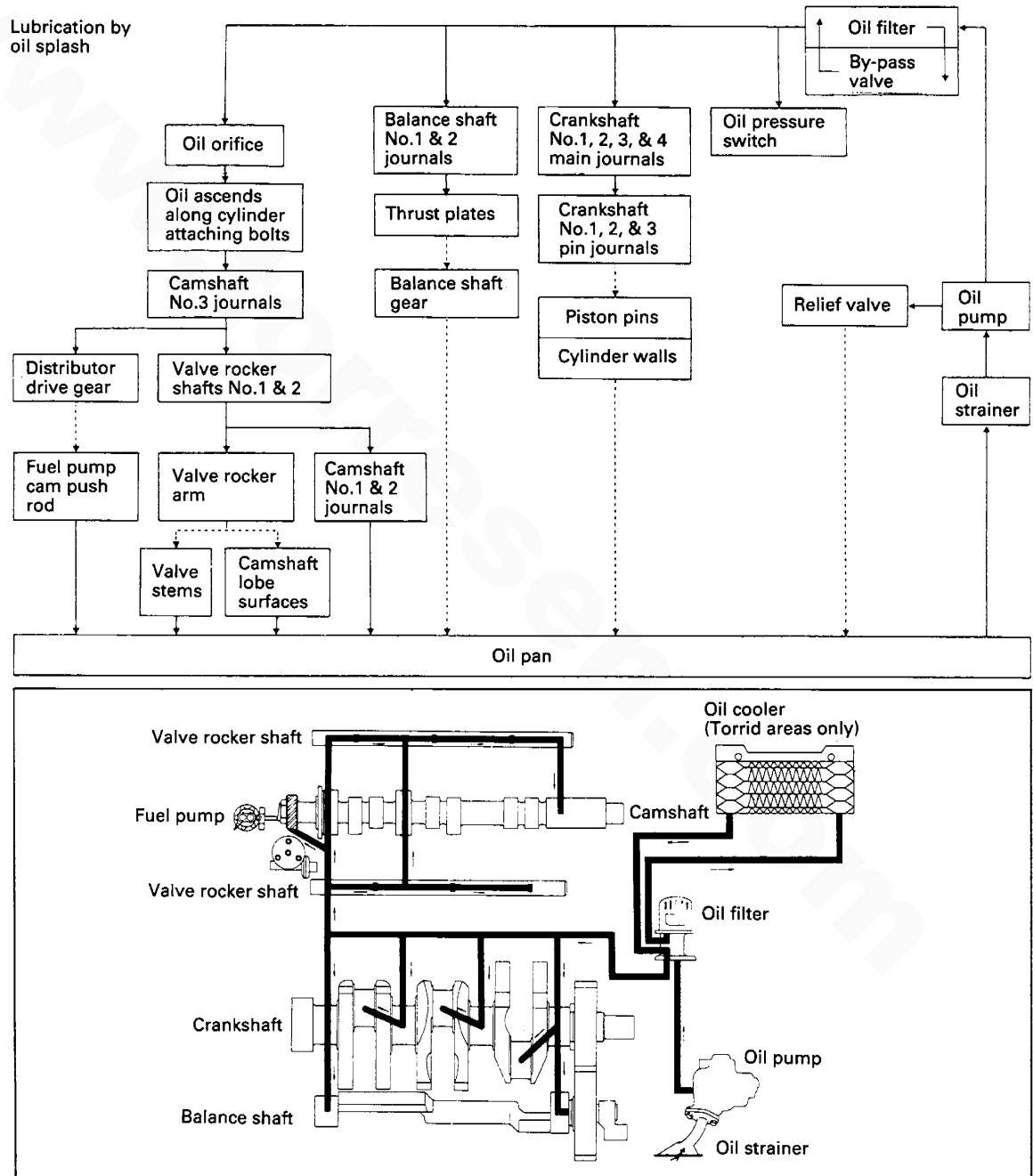
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LUBRICATION SYSTEM

Operation

The lubricating system is a pressure feeding system using an oil pump. The engine oil forced out of the oil pump is passed through the oil filter. The oil passes through the oil filter and then to the various lubricating points in the engine and then returns to the lubrication oil sump.

When the oil pressure exceeds the specified pressure, the oil pushes open the relief valve in the oil pump and returns to the oil pan, thereby keeping the oil pressure within its specified range.



Schematic Diagram of Lubrication System

Checking the Engine’s Lubricating Oil

1. Check for any engine oil leakage. Should an oil leak be detected, inspect the engine to locate the leak and correct it. Tightening of fittings and bolts is considered normal maintenance and is the responsibility of the owner.
2. Check engine’s oil level with the oil dipstick at least once daily prior to engine usage. Add oil as needed.
3. Make sure the engine’s oil level is maintained near, but not over, the **F** mark on the dipstick. If the engine’s oil drops close to the **L** mark, add the engine oil until the oil level reaches the **F** mark. Keep an eye on the engine’s oil level. After the engine is broken in, if the engine continues to consume a noticeable quantity of engine oil, consult a competent marine mechanic.

NOTE: Maintaining the engine’s oil level with the proper lubricating oil, and making sure that the oil is changed at the proper intervals, is the responsibility of the owner/operator. Engine damage resulting from the lack of engine oil, from the wrong type of oil, or from unclean oil is not a warrantable issue.

Engine oil capacity:
(not including filter)

BCG 4.0KW	3.0 quarts (2.9 liters)
BCG 6.5KW	3.0 quarts (2.9 liters)
BTG 9.0KW	3.0 quarts (2.9 liters)

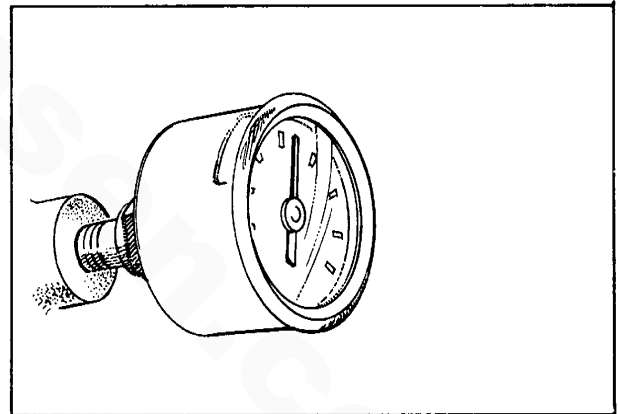
Troubleshooting the Oil System

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
Oil leak	1. Loose oil drain hose.	1. Tighten or replace.
	2. Oil pan to cylinder block leakage.	2. Tighten securing belts or replace pan gasket.
	3. Damaged or loose timing chain cover or rocker cover.	3. Replace or tighten bolts.
	4. Damaged or loose cylinder head gasket.	4. Tighten or replace.
	5. Loose or damaged oil filter.	5. Tighten or replace.
	6. Loose or damaged pressure switch or sender.	6. Tighten or replace.

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
Low Oil Pressure (unit shutdown)	1. Oil leaks.	1. Refer to page 158.
	2. Low oil level or incorrect grade.	2. Add oil to proper level or change.
	3. Faulty oil pressure switch.	3. Test and replace.
	4. Clogged oil filter.	4. Remove and replace oil filter. Change oil.
	5. Clogged oil pump strainer.	5. Remove and clean.
	6. Worn or fatigued oil pressure relief valve spring.	6. Remove and replace.
	7. Faulty electrical circuit.	7. Check circuit and repair as needed.

Checking Oil Pressure with a Mechanical Gauge

1. Remove the oil pressure switch and connect a mechanical oil pressure gauge in its place.
2. Electrically jump the oil pressure switch's connections.
3. Start the engine, letting it operate at 1800 rpm, and allow engine to warm up.
4. Measure the oil pressure. If it is less than the specification listed below, check the engine's lubricating system.



Oil pressure: 50 - 70 psi
(3.5 - 4.0 kg/cm²)

NOTE: Ensure that the engine's oil meets all temperature requirements and the API specification of SD or SE.

COOLING SYSTEM

Description

Westerbeke marine gasoline engines are designed and equipped for fresh water cooling. Heat produced in the engine by combustion and friction is transferred to the fresh water which circulates throughout the engine. This circulating fresh water cools the engine block and its internal moving parts. The heat is transferred externally from the fresh water to sea water by means of a heat exchanger, similar in function to an automotive radiator. Sea water flows through the tubes of the heat exchanger while fresh water flows around the tubes; engine heat transferred to fresh water is conducted through the tube walls to the sea water which is pumped into the exhaust system and discharged overboard. In basic terms, the engine is cooled by fresh water, the fresh water is cooled by sea water, and the sea water carries the transferred heat over the side through the exhaust system. The fresh water and sea water circuits are independent of each other. Using only fresh water within the engine allows the cooling water passages to stay clean and free from harmful deposits. The two independent circuits and their components are discussed in the following paragraphs.

Fresh Water Circuit

Fresh water is pumped through the engine by a belt-driven circulating pump, absorbing heat created by internal combustion and by friction. The fresh water coolant circulates throughout the engine block absorbing heat, then passes through the thermostat into the exhaust manifold, then to the heat exchanger where it is cooled, and then is returned to the engine block through the suction side of the fresh water circulating pump. When the engine is started cold, external fresh water flow is prevented by the closed thermostat (although some fresh water flow is bypassed around the thermostat to prevent the exhaust manifold from overheating). As the engine warms up, the thermostat gradually opens, allowing the engine's fresh water coolant to flow unrestricted to the external portion of the cooling system.

Sea Water Circuit

The sea water flow is created by a positive displacement neoprene impeller pump. Normally the pump draws sea water directly from the ocean through a flush-hull sea cock and sea water strainer. Sea water then flows directly from the discharge of the sea water pump to the heat exchanger sea water inlet. Here it passes through the tubes of the heat exchanger where it removes heat from the engine's fresh water cooling system that is circulating around the outside of these tubes. The sea water then exits the exchanger and is directed with wire reinforced hosing through a syphon break fitting, when needed, to the inlet of the water injected exhaust elbow where it mixes with and cools the exhaust gases and then is passed through the exhaust system and discharged overboard.

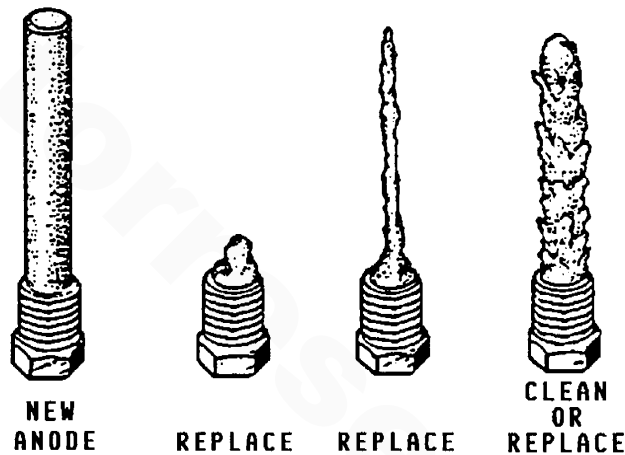
Sea Water Pump

The sea water pump is self priming and positive displacement. This rotary sea water pump has a non-ferrous housing and a neoprene impeller. The impeller has flexible vanes which wipe against a curved cam plate within the impeller housing, producing a pumping action. **On no account should this pump be run dry.** There should always be a spare impeller and impeller cover gasket aboard (an impeller kit).

Zinc Anodes

A zinc anode, or pencil, is located in the sea water cooling circuit within the heat exchanger. The purpose of the zinc anode is to sacrifice itself to electrolysis action taking place in the sea water cooling circuit, thereby reducing the effects of electrolysis on other components of the system. The condition of the zinc anode should be checked monthly and the anode cleaned or replaced, as required. Spare anodes should be carried on board.

If the zinc pencil needs replacement, **hold the hex boss into which the zinc pencil is threaded with a wrench while loosening the anode with another wrench.** This prevents the hex boss from possibly tearing off the exchanger shell. After removing the zinc, note the condition of it. If the zinc is in poor condition, there are probably a lot of zinc flakes within the exchanger. Remove the end of the heat exchanger and clean the inside of all zinc debris. **Always have a spare heat exchanger end gasket in case the present one becomes damaged when removing the end cover.** Replace the gasket (refer to your engine model's heat exchanger end gasket part number), cover, and install a new zinc pencil.



Cooling System Troubleshooting

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
	2. Leaking pressure cap.	2. Test with above unit and/or replace.
	3. Faulty plastic coolant recovery tank.	3. Check and tighten connections or replace tank or hose.
Overheating (Fresh Water System)	1. Insufficient coolant.	1. Replenish coolant and check for cause of loss.
	2. Loose or broken water pump drive belt.	2. Adjust or replace.
	3. Faulty thermostat	3. Remove and replace.
	4. Faulty overheat switch.	4. Remove and replace.
	5. Scale and sediment in cooling system.	5. Flush engine cooling system and heat exchanger; replenish coolant.
	6. Faulty circulating pump.	6. Remove and replace.
Overheating (Sea Water System)	1. Loose or broken sea water pump drive belt.	1. Adjust or replace.
	2. Faulty sea water pump.	2. Check sea water pump for wear, defective impeller. Repair or replace as needed.
	3. Clogged heat exchanger.	3. Remove exchanger, clean and flush.
	4. Scale in exhaust..	4. Remove elbow and clean

Other causes of engine overheating may be caused from faults in the sea water circuit supplying coolant to the sea water pump on the engine. Examine the off circuit for possible contributing faults.

GOVERNOR

Governor Description

The belt-driven, mechanically operated governor maintains the engine's rpm under various load conditions. Engine speed determines the hertz and voltage output of the generator.

NOTE: Periodically adjust the governor's belt tension. The belt's tension should be between 3/8 to 1/2 inch deflection between the widest span of this belt. Since belts stretch slightly, this stretching will, to some degree, affect the governor's action. Maintain a 22 pound pressure to the belt's outer face for proper governor operation. Replace this drive belt when it becomes worn, frayed or cracked.

CAUTION

Do not over tighten the governor's drive belt. Over tightening causes premature wear of the governor, the belt, or could bend the governor's shaft.

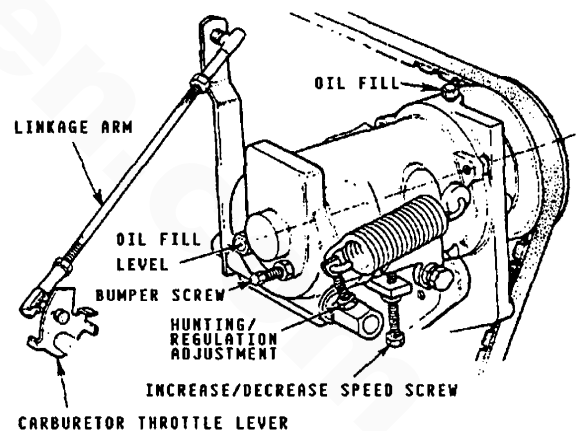
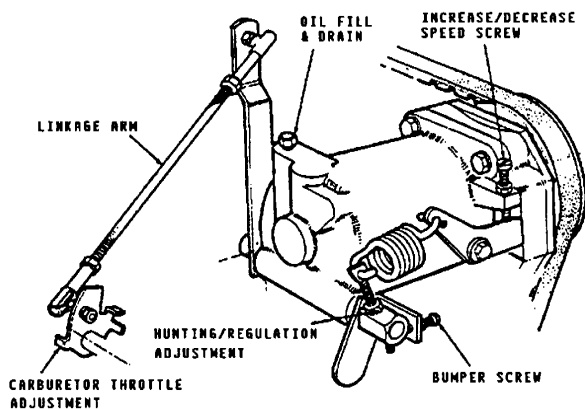
The governor will maintain engine speed to within 3 hertz of generator frequency output from no-load to full rated load of the generator. (See the generator's scarlet and gold Data Plate)

Governor Adjustments

Operate the generator set to bring the unit up to its operating temperature before attempting an adjustment.

NOTE: If the governor is severely out of adjustment, manually adjust the linkage without any load on the generator to obtain a safe output voltage before proceeding with the adjustment.

Three adjusting points are on the governor. (Refer to the following illustrations.)



1. Increase/Decrease Speed This adjusting bolt sets the no load speed of the engine. (The linkage arm between the governor arm and throttle lever should be adjusted to hold the throttle full open when the engine is not running.) Make sure this linkage moves freely and that the ball joint connectors are properly lubricated. Use graphite lubricant at this connection. Disconnect the ball joint and apply a graphite lubricant to the inside of the joint.

2. Hunting/Regulation If the variation in engine speed between no-load and full-load is too great, adjust this eye bolt to draw the spring closer to the lever hub. The increase/decrease speed bolt may need to be adjusted as well.

If the governor surges while under a load, adjust this eye bolt to move the spring away from the lever hub. (Check the speed adjustment.)

3. Bumper Screw This screw is used to remove a no-load surge **only**. **Never** turn the bumper screw into the governor far enough so that it increases the no-load speed.

Governor Maintenance

1. Periodically lubricate the attaching points at both ends of the governor arm. Use a graphite lubricant or an equivalent.

NOTE: Free movement of this linkage arm is important for proper governor/throttle operation.

2. Governor oil capacity -

6.5 BCG and 9.0 BTG - 3 ounces (98 milliliters) of SAE #10/30 motor oil.

4.0 and early 6.5 BCG - 1.5 ounces (49 milliliters) of SAE # 10/30 motor oil.

NOTE: **Do not** overfill governor.

3. Change the governor's oil every 500 hours of operation.
4. If the drive belt should be maintained in good condition. Replace the belt if it becomes worn or shows signs of cracking.

To change the oil, remove the governor from engine and remove the oil fill and fill level plug and drain all the oil from the governor. Reinstall the governor on the engine and fill it with 3 ounces (89 milliliters) of SAE 10/30 engine oil for the 6.5 BCG and 9.0 BTG or 1.5 ounces (49 milliliters) of SAE # 10/30 motor oil for the 4.0 or early 6.5 BCG. Replace the plugs.

CARBURETOR AND FUEL SYSTEM

Carburetor

The carburetor is a single barrel down draft type with a metal screened air intake filter which is cleanable.

The carburetor has two metering jets, one of which is adjustable (the idle mixture). The other fast running jet is set at the factory and will accept no adjustment.

Any adjustment to the idle mixture jet should be done with the engine warmed up and without any load on the generator.

Carburetor Adjustment

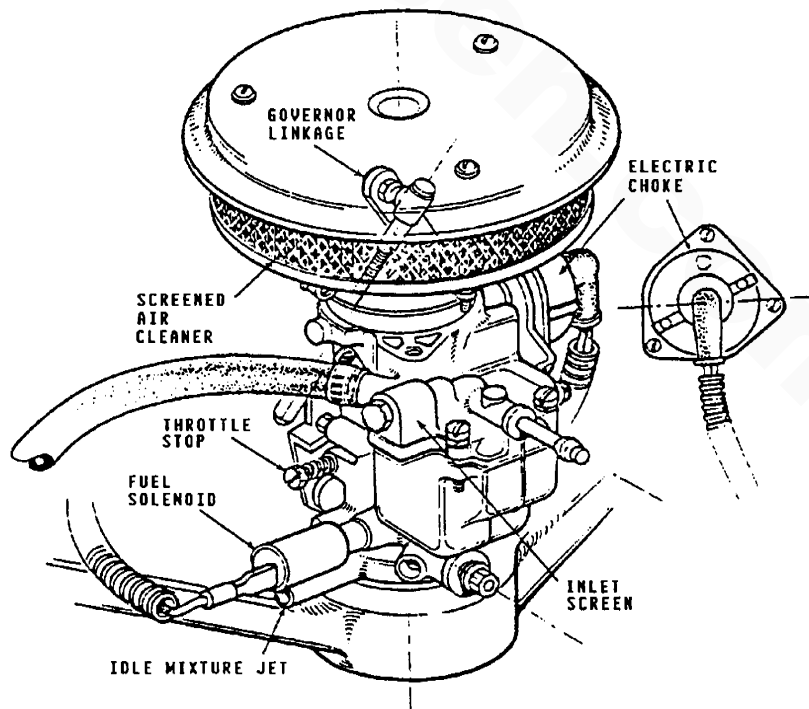
1. Idle Mixture Jet

Disconnect the throttle linkage arm from the governor control arm and reduce the engine's speed with the idle stop screw. Turn the idle mixture screw clockwise (in) until the engine skips; back the screw out (counterclockwise) slowly until the engine smooths then skips again; then turn the screw clockwise (in) one-quarter to one-half of a turn. The idle mixture should be satisfactory at this setting.

NOTE: At idle speed, oil pressure will be lower than the rating of the oil pressure switch. Jump this switch to prevent engine shutdown at idle speed.

2. Run Mixture Jet

This mixture jet is presized at the factory and is not adjustable. **The idle mixture jet adjustment can be made in the 1800 rpm range to improve engine performance.** Refer to the "Governor Adjustments" section of this manual for instructions on how to adjust the engine's speed, page 163-164.



Electric Choke

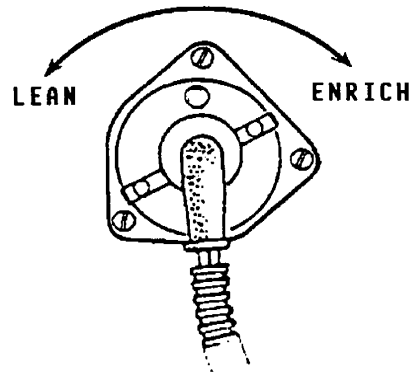
The electric choke uses a 12 volt heating element which opens the choke automatically once the engine starts and is running.

NOTE: Some hunting will be present when the generator is first started, when the choke is on, and when the generator has no load on it.

The choke is adjusted with the engine **off** and cooled. Adjust the choke by loosening the three cover-securing screws and rotating the cover clockwise to **ENRICH** the choke and counterclockwise to **LEAN** the choke. The choke is initially set at the factory for an average of 70° F (21° C) room temperature.

The choke may need readjustment at engine commissioning for the ambient temperature of the area the engine is operating in.

The choke index mark is located on the choke cover lower right inboard side.



CAUTION

The choke housing will normally get hot during engine operation.

NOTE: When initially starting the engine (commissioning) or after servicing the fuel system, prime the engine's fuel system by using the engine mounted fuel pump. Prime the fuel system by depressing the control panel's ON switch. To prevent the unwanted activation of the carburetor's electric choke, unplug the 12 volt (+) lead at the electric choke during this priming operation and reconnect it after priming to start the engine.

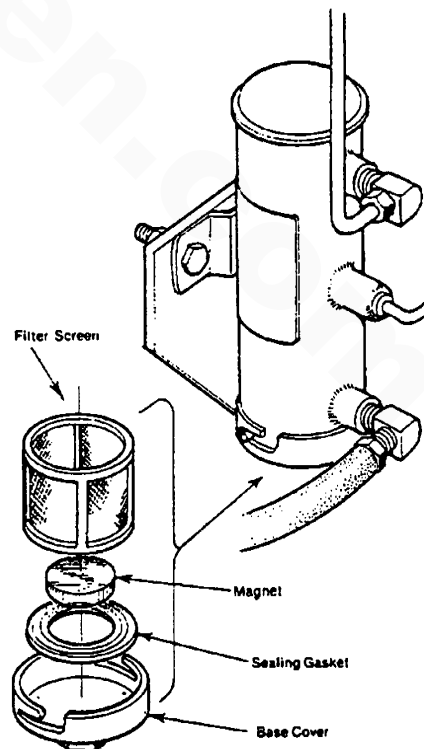
Electric Fuel Pump

The engine-mounted electric fuel pump supplies fuel to the engine's carburetor during engine operation. A cleanable filter screen is contained in the pump's base.

Remove the base by placing a wrench on the hex nut and twisting it loose from the bayonet fittings. Clean the screen as needed. A new base gasket #34706 *must* be installed each time the pump base is removed and reinstalled.

WARNING

Shut off the fuel service valve at the engine when servicing the fuel system. Take care in catching any fuel that may spill from within the pump when the base is removed. **Do not** allow any smoking, open flames, sparks or other sources of fire near the fuel system when servicing. Ensure proper ventilation exists when servicing the fuel system.



Troubleshooting the Fuel System

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
Hard starting	1. Faulty choke.	1. Check choke adjustment, cam and operation .
	2. Fuel.	2. Check fuel supply and correct type.
	3. Fuel pump.	3. Check pump operation and clean filter screen.
	4. Faulty idle jet adjustment	4. Adjust idle jet.
Flooded	1. Carburetor float needle valve open or damaged.	1. Clean or replace the needle valve.
	2. Float in carburetor leaking.	2. Repair or replace float.
	3. Float chamber gasket damaged or securing screws are loose.	3. Replace gasket and/or tighten screws.
Poor performance at generator speed	1. Main jet clogged.	1. Remove and clean.
	2. Carburetor inlet filter clogged.	2. Remove and clean.
	3. Fuel pump filter clogged.	3. Remove and clean.
	4. Air intake filter screen dirty.	4. Remove and clean.

NOTES

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DC ELECTRICAL SYSTEM

Safety Information

This circuit is designed and manufactured in compliance with United States Coast Guard Standards (33 CFR PART 183). No modifications may be made to it by the installer or user. It is the installer's responsibility to assure that the installation of the generator set and any remote start panels or remote instrument panels are installed in compliance with the above Coast Guard Standards. Failure to observe these requirements could be the cause of injury.

DC Circuit Description

The two-pole ON switch is operated to bypass the protective shutdown switches during starting. The second pole provides a source of B + to the START toggle switch. While continuing to hold the ON switch, to provide B + to the start switch and to bypass the protective shutdown switches, the START switch is pressed to energize the starter to crank the engine. If you are starting the generator at the generator set, release the START switch when the generator is running. If starting the generator at a remote location, release the START switch when the green LED lights, but continue depressing the ON switch. After releasing the START switch continue holding the ON switch until oil pressure is sufficient to close the oil pressure safety switch, providing the normal B + path to the ignition system. Note that it is now impossible to energize the starter while the generator is running until someone again operates the ON switch first. Should the generator shut down from an overspeed condition, the overspeed circuit *must* be reset before attempting to restart the generator. Resetting the overspeed circuit is done by simply depressing the STOP switch momentarily and then proceeding with the normal starting procedure.

WARNING

It is very important that the overspeed shutdown always be installed and functioning. Any tampering with the overspeed shutdown module, which would cause it to malfunction, could be a cause of injury should the generator's belt-driven governor fail and cause the generator engine to run uncontrolled.

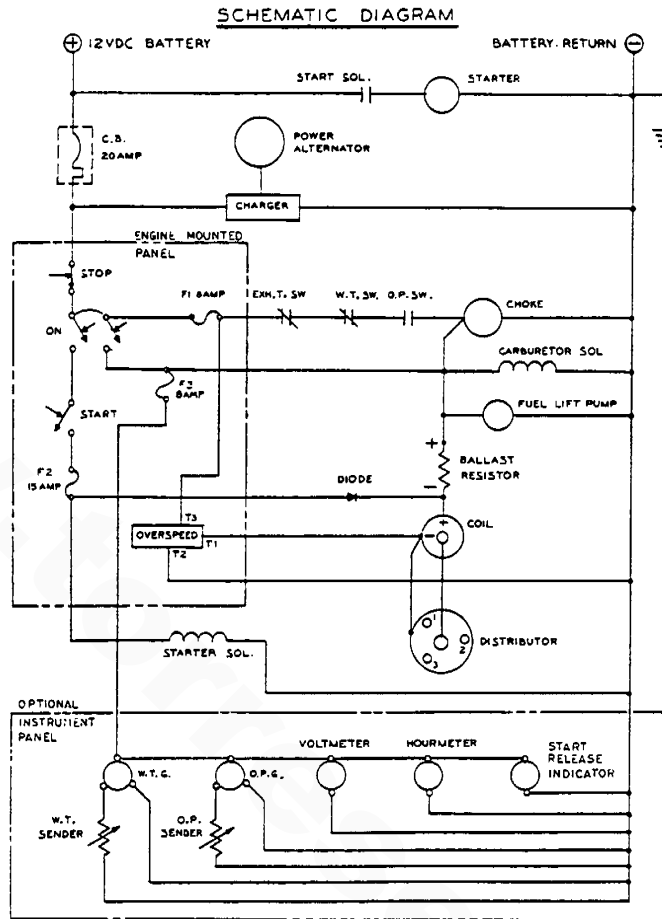
To STOP the generator, depress the STOP switch, which opens the normally closed B + path on the ON switch. The STOP switch must be held open until the generator comes to a complete stop. Remote start panels may be connected to the generator set as indicated. A jumper has to be removed between the T1 and T2 connections at the panel connection terminal board in the generator mounted control panel.

WARNING

When installing the optional remote start panel or the optional remote instrument panel, it is the installer's responsibility to comply with U.S. Coast Guard Standards 33 CFR PART 183.

BCG 4.0 KW and BCG 6.5 KW DC WIRING DIAGRAM #35439

page 2 of 2



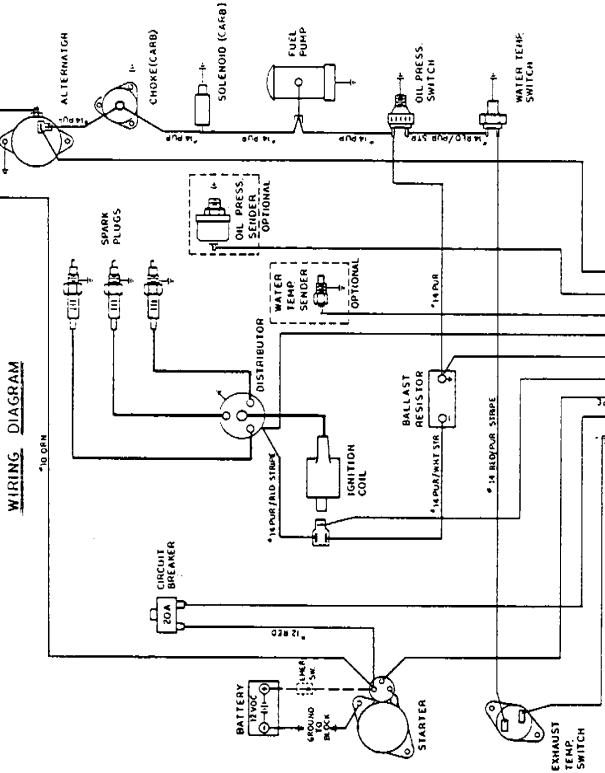
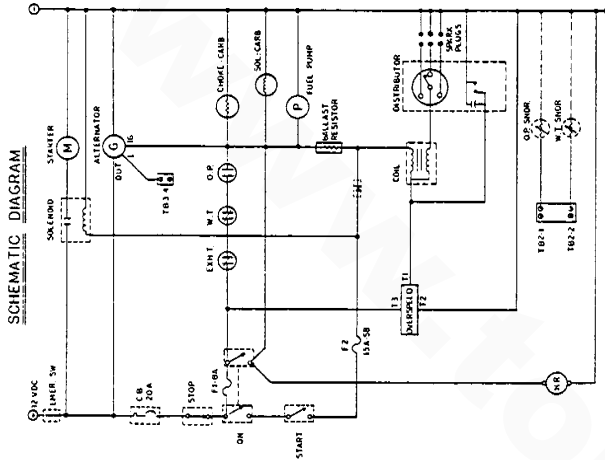
RESPONSIBILITY FOR SAFETY REGULATIONS

1. THE MINIMUM VOLTAGE REQUIRED AT THE STARTER SOLENOID IS 9 VOLTS, THEREFORE, WIRE GAUGES FROM TB1-1 TO TB3-1 AND TB1-2 TO TB3-2 SHOULD BE SELECTED TO GIVE A MAXIMUM VOLTAGE DROP OF 1 VOLT OR LESS, THIS WILL PROVIDE 9 VOLTS AT THE STARTER SOLENOID WHEN BATTERY TERMINAL VOLTAGE IS DOWN TO 10 VOLTS, INDICATIVE OF A DEEPLY DISCHARGED BATTERY.
 2. BATTERY CHARGER CAUSES A 9ma DRAIN AND OVERSPEED MODULE CAUSES A 15ma DRAIN WHEN GENERATOR IS NOT OPERATING. THEREFORE, WHEN LEAVING BOAT FOR AN EXTENDED PERIOD, DISCONNECT THE BATTERY.
 3. WESTERBEKE GASOLINE MARINE GENERATORS, AS SHIPPED FROM THE FACTORY AND EXCLUSIVE OF OPTIONAL REMOTE INSTRUMENT OR CONTROL PANELS, COMPLY WITH U.S. COAST GUARD 33CFR-183. ACCESSORY INSTRUMENT AND CONTROL PANELS DO NOT NECESSARILY SO COMPLY AND ARE INTENDED TO BE INSTALLED ABOVE DECK AND ISOLATED FROM GASOLINE SOURCES IN ACCORDANCE WITH 33CFR-183.410(b).
- IT IS THE RESPONSIBILITY OF THE BOAT MANUFACTURER TO INSURE THAT THE INSTALLATION OF THESE GENERATORS AND OPTIONALLY THEIR REMOTE INSTRUMENT OR CONTROL PANELS, COMPLY WITH 33 CFR-183.
4. SENDERS SUPPLIED WITH OPTIONAL INSTRUMENT PANEL.

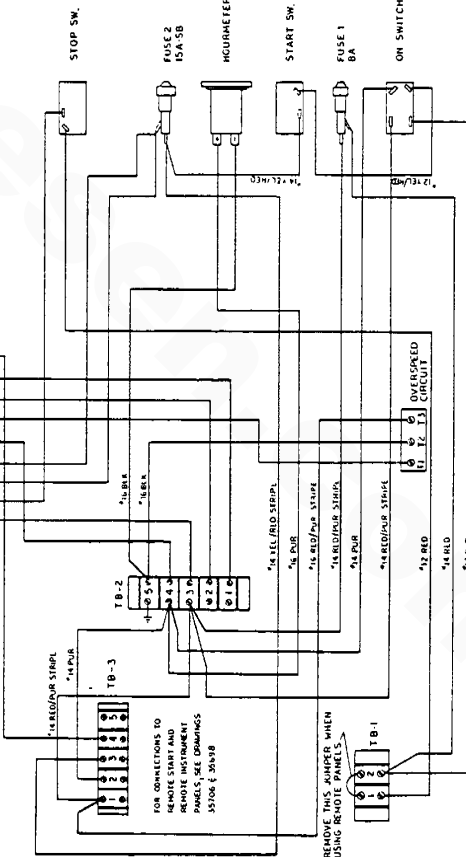
MINIMUM WIRE GAUGES (AWG)

TERMINALS	WIRE LENGTH FROM GENERATOR TO REMOTE PANEL						
	0-16'	16-20'	20-25'	25-32'	32-40'	40-50'	50-65'
TB1-1 TO TB3-1	12	10	10	9	8	7	6
TB1-2 TO TB3-2	14	12	12	10	10	9	8
TB2-1 TO TB4-1	12	10	10	9	8	7	6
TB2-2 TO TB4-2	14	14	14	14	14	14	14
TB2-3 TO TB4-3	14	14	14	14	14	14	14
TB2-4 TO TB4-4	14	14	14	14	14	14	14
TB2-5 TO TB4-5	14	14	14	14	14	14	14

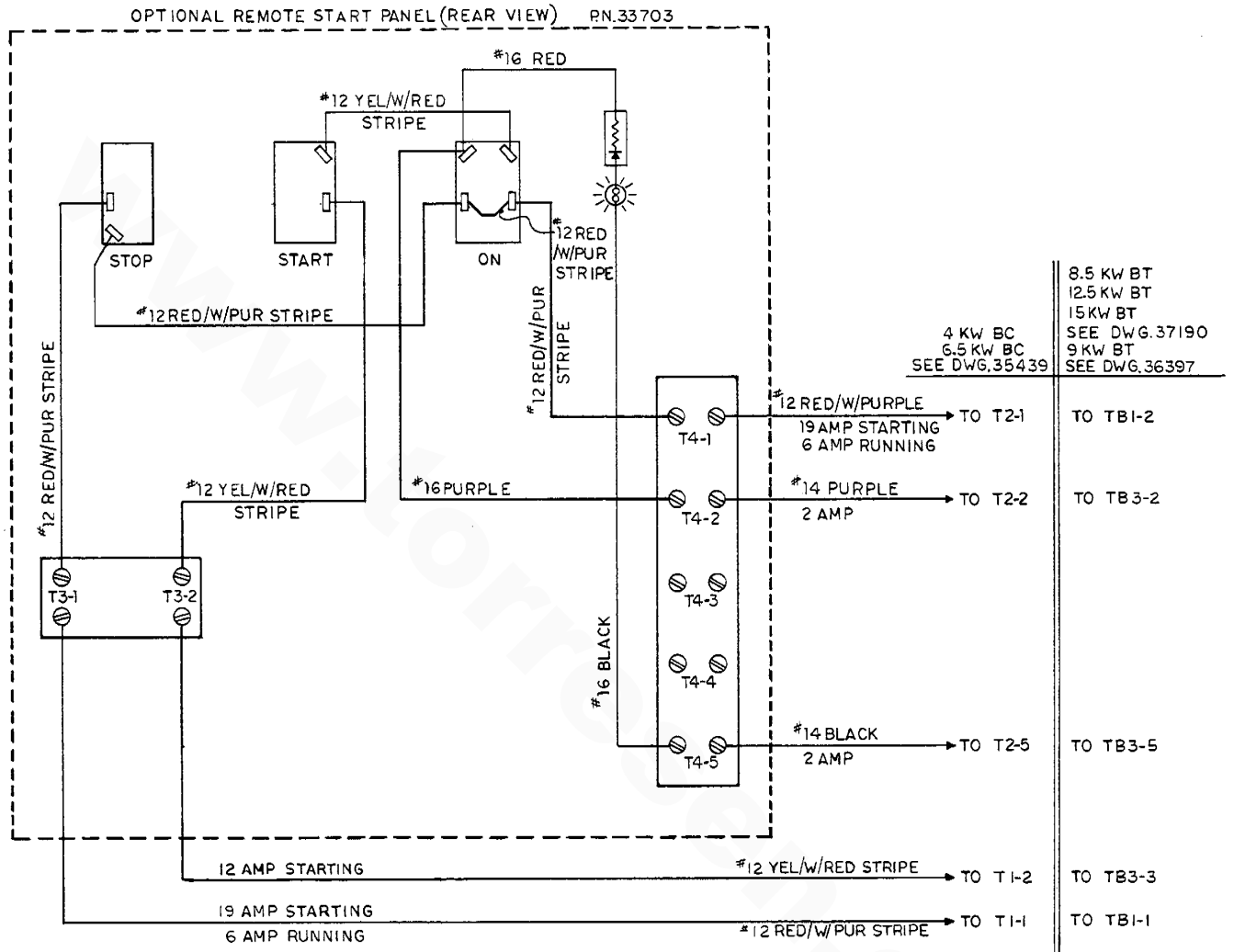
BTG 9.0 KW DC Wiring Diagram #36397



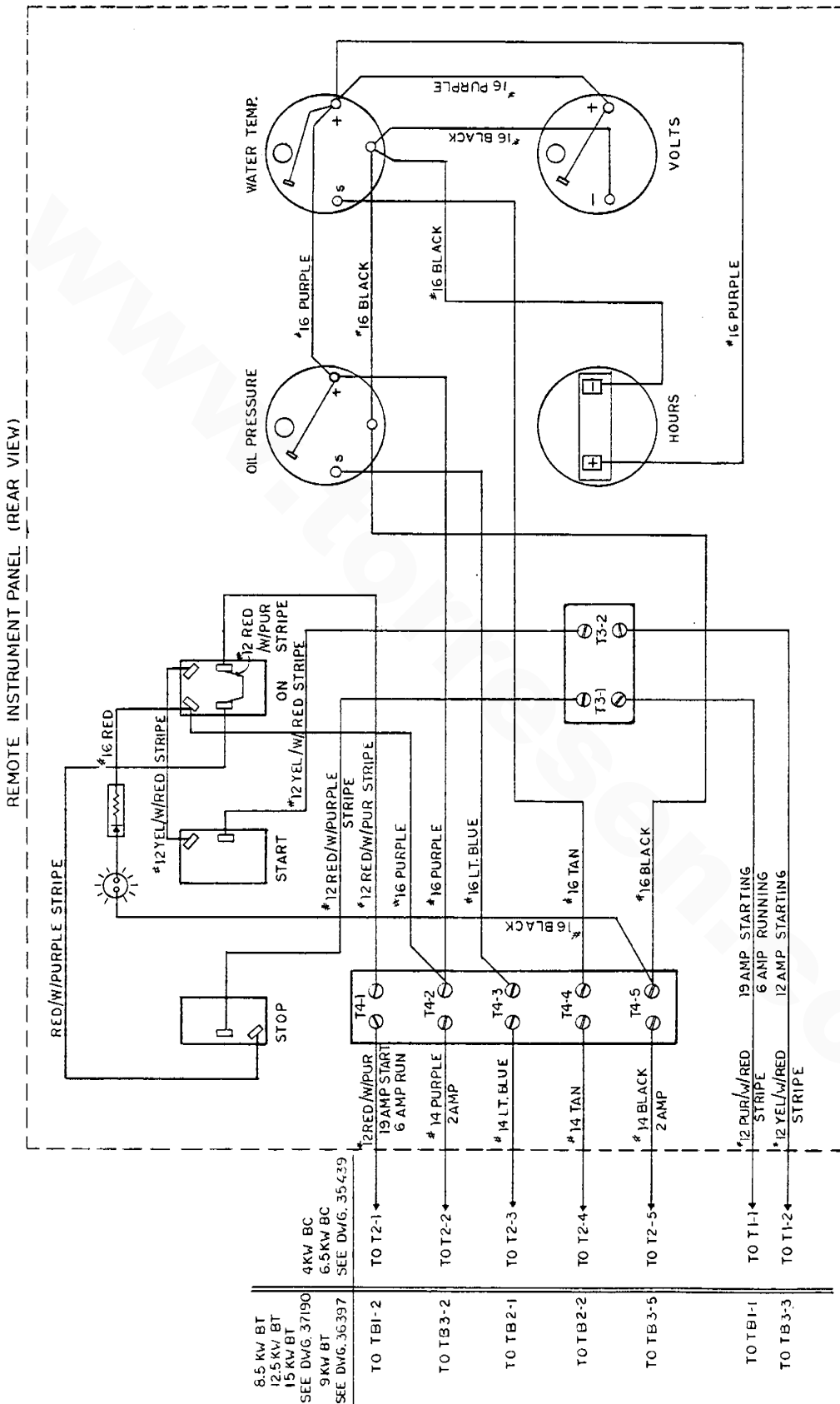
- NOTES:**
1. WESTERBEKE GASOLINE MARINE GENERATORS AS SHIPPED FROM THE FACTORY AND EXCLUSIVE OF OPTIONAL REMOTE INSTRUMENT OR CONTROL PANELS COMPLY WITH U.S. COAST GUARD 33CFR 183, ACCESSORY INSTRUMENT AND CONTROL PANELS DO NOT NECESSARILY SO COMPLY AND ARE INTENDED TO BE INSTALLED ABOVE DECK AND ISOLATED FROM GASOLINE SOURCES IN ACCORDANCE WITH 33CFR 183.410(Q). IT IS THE RESPONSIBILITY OF THE BOAT MANUFACTURER TO INSURE THAT THE INSTALLATION OF THESE GENERATORS, AND OPTIONALLY, THEIR REMOTE INSTRUMENT OR CONTROL PANELS COMPLY WITH 33CFR 183.
 2. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER AND AS CLOSE AS POSSIBLE TO THE SOURCE OF CURRENT. EXCESSIVE CURRENT DRAIN ANYWHERE IN THE INSTRUMENT PANEL WIRING OR ENGINE WILL CAUSE THE BREAKER TO TRIP. IN THIS EVENT THE ENGINE WILL SHUT DOWN BECAUSE THE OPENED BREAKER WILL DISCONNECT THE 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.
 3. AN ON-OFF SWITCH MUST BE INSTALLED TO DISCONNECT THE STARTER FROM THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. TWELVE VOLT STARTERS TYPICALLY DRAW 200 TO 500 AMPS WHEN CRANKING. THE DURATION OF INDIVIDUAL CRANKING CYCLES SHOULD NOT EXCEED 30 SECONDS. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12 VOLTS WILL NORMALLY SERVE THIS FUNCTION, BUT A SWITCH MUST NOT BE USED TO MAKE THE CIRCUIT.
 4. SENDERS ARE SUPPLIED WITH OPTIONAL INSTRUMENT PANEL.



REMOTE START PANEL WIRING DIAGRAM #35706



REMOTE INSTRUMENT PANEL WIRING DIAGRAM #35698



REMOTE PANEL INSTALLATION

INSTALLER'S/OWNER'S RESPONSIBILITY

1. Wiring between the generator set and either a remote start panel or remote instrument panel must comply with U.S. Coast Guard Safety Regulations 33 CFR-183.
2. The minimum voltage required at the starter solenoid is 9 volts. Therefore, wire gauges TB3-1 and TB3-2 should be selected to give a maximum voltage drop of 1 volt or less. This will provide 9 volts at the starter solenoid when battery terminal voltage is down to 10 volts, indicative of a deeply discharged battery.

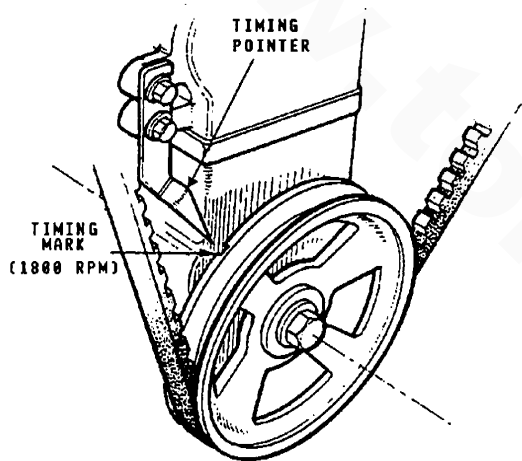
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Distributor

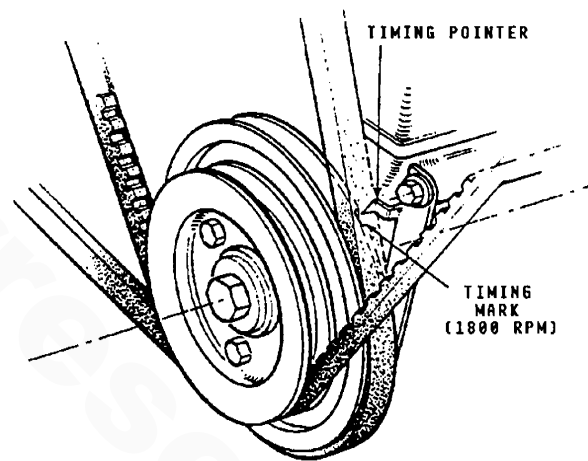
The distributor is a conventional type consisting of a cap, rotor, breaker points and condenser; therefore, it requires adjustment.

Ignition Timing

1. Attach a timing light to the #1 spark plug and mark the front crankshaft timing groove and the timing mark on the scale embossed on the engine's front cover.
2. Start the engine and warm it up to its normal operating temperature.
3. Using the timing light, align the timing groove in the front crankshaft pulley with the proper timing mark on the ignition timing scale embossed on the engine's front cover. Do this by loosening and slowly rotating the distributor body.



BCG 4.0KW



BCG 6.5KW AND BTG 9.0KW

Timing Specifications:

BCG 4.0KW
BCG 6.5KW
BTG 9.0KW

$13^{\circ} \pm 1^{\circ}$ BTDC at 1800 rpm
 $11^{\circ} \pm 1^{\circ}$ BTDC at 1800 rpm
 $11^{\circ} \pm 1^{\circ}$ BTDC at 1800 rpm

Refer to the "ENGINE TUNE-UP SPECIFICATIONS" section of this manual for additional information regarding tune-up specifications, page 42, 46 and 50.

Spark Plugs

Service spark plugs, clean gap or replace as needed.

Spark plug gap: 0.028 - 0.036 inches
(0.7 - 0.9 mm)

Spark plug torque

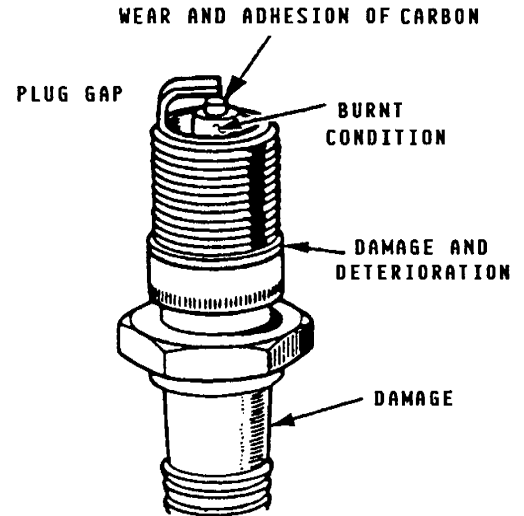
BCG 4.0KW: 13.1 - 17.4 lb-ft (1.8 - 2.4 kg-m)

BCG 6.5KW and BTG 9.0KW:

10.8 - 15.9 lb-ft (1.5 - 2.2 kg-m)

Check plugs for damage and/or wear.

NOTE: Loc-tite "Anti-Seize" applied to the threaded portion of the spark plugs will retard corrosion, making future removal of the spark plugs easier.



DC Voltmeter

The DC voltmeter in the remote instrument panel can be a useful instrument in determining the status of your electrical system and in warning you when an abnormality occurs. The voltmeter will indicate differently, depending when the readings are taken.

Fully charged batteries that are in a static state should read between 12.3 and 12.6 volts on the dial. The term static means that the battery has not been charged or discharged for at least 2 hours. If the reading is between 11 and 11.5 volts, then the battery is about half discharged and should be charged to ensure its usefulness. If the engine is started and the needle does not go up, this would indicate that no charge is presently delivered to the battery.

When the battery is charging, the needle should be between 12.6 and 13 volts. The needle may move up to about the 14.6 volt range toward the end of the charge cycle, at which time the needle drops back to the 12.6 to 13 volt range, as voltage regulation controls this function. If the battery's voltage exceeds 15 volts, this indicates that the battery is being overcharged and the battery will be damaged if left unchecked. The voltage regulator is most likely at fault when this happens.

When the battery is discharging (having electrical loads placed upon it and no charging current applied), it is normal for the needle to indicate between 11.4 and 12.6 volts.

Electrical System Troubleshooting

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
ON switch depressed, electric fuel pump not energized.	1. Battery switch or power not on.	1. Check switch and/or battery connections.
	2. 20 amp circuit breaker tripped.	2. Reset breaker if it trips again, check on and start circuits for shorts to ground.
No ignition, cranks, does not start.	1. Overspeed module tripped.	1. Reset circuit by depressing stop switch.
	2. Fuse blown.	2. Check fuses; replace if necessary.
	3. Lack of fuel.	3. Check for fuel to generator set. Check fuel lift pump.
	4. Choke faulty.	4. Check to see that it is not jammed. Should be closed if engine is cold.
	5. Coil faulty .	5. Check coil.
	6. Distributor faulty.	6. Check distributor, points, condenser, cap and wires.
	7. Wiring faulty.	7. Check wires and connections for shorts, breaks and corrosion.
Starts, stops when ON switch released .	1. Safety circuit switch or wiring faulty.	1. Inspect all wiring for shorts, corrosion or loose connections. Check operation of switches.
	2. Fuse blown.	2. Check fuses.
	3. Overspeed module faulty.	3. Check module. Do by-pass test.

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
Engine stops.	<ol style="list-style-type: none"> 1. Low oil pressure or overheated. 2. Low oil pressure switch fails to close. 3. High water or exhaust temperature switches open at too low a temperature. 4. Overspeed module. 5. Switch and wiring. 	<ol style="list-style-type: none"> 2. Check oil, fresh water and sea water cooling. 2. Check for satisfactory operation with switch bypassed. 3. Same as above. 4. Check engine speed. Check module for proper operation. 5. Inspect all wiring for loose connections and short circuits.
Not charging battery or battery runs down.	<ol style="list-style-type: none"> 1. Alternator drive. (9.0 BTG) 2. Oil pressure switch. 3. High resistance leak to ground. 4. Low resistance leak to ground. 	<ol style="list-style-type: none"> 1. Check drivebelt and its tension. Be sure alternator turns freely. Check for loose connections. 2. Observe if gauges and light are on when engine is not running. Test the normally open oil pressure switch by disconnecting one lead. If lights go out, replace oil pressure switch. 3. Check wiring. Insert sensitive (0-.25 amp) meter in battery lines. (Do not start engine.) Remove connections and replace until short is located 4. Check all wires for temperature rise to locate fault.

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
Not charging battery or battery runs down. (continued)	5. Alternator. (9.0 BTG)	5. Disconnect alternator at output, after a good battery charging. If leakage stops, replace alternator's protective diode plate. That failing, replace alternator.
	6. Overspeed circuit drained battery.	6. Unit not run for months and fuse left in circuit drawing 0.025 amp.
	7. Integral controler circuit faulty. (4.0 & 6.5 BCG)	7. Check functioning of circuitry and components in the battery charging circuit pages 207-210.

GENERATOR DESCRIPTION AND MODEL RATING

Characteristics

Design: Four pole revolving armature, inherently regulated, self limiting, rectifier excited, AC slip rings, single bearing designs.

Voltage Regulation: $\pm 5\%$ no-load to full-load.

Frequency Regulation: 3 hertz (5%) no-load to full-load.

Insulation: Class F as defined by NEMA MGI-1.65.

Temperature Rise: Within NEMA MGI-22.40 definition when operating at full-load.

Cooling: Centrifugal blower, directly connected.

Radio Interference Level: Capacitors minimize interference within the limits of most marine applications.

Armature: Balanced laminated steel, double dipped and baked.

Ratings

120/240 volts AC (60 hertz) or 220 volts (50 hertz) AC, single phase, 2 wire, 1.0 power factor, 1800 rpm at 60 hertz, 1500 rpm at 50 hertz.

<u>Model</u>	<u>Amp</u>	<u>Hertz</u>	<u>KW</u>
BCG 4.0-614	34/17	60	4.0
BCG 3.0-514	14	50	3.0
BCG 6.5-614	54/27	60	6.5
BCG 4.8-514	21.8	50	4.8
BTG 9.0-614	75/37.5	60	9.0
BTG 7.0-514	29	50	7.0

Deratings

A. 3.5 percent for each 1000 feet above sea level.

B. 1 percent for each 10° Fahrenheit above 85° F ambient.

C. 10 percent for continuous duty.

NOTES

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TROUBLESHOOTING AND ADJUSTMENT FOR THE BT GENERATOR

The following trouble shooting guide is designed to give insight into problems which may be encountered with the BTG 9.0KW Westerbeke brushless generator. 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 guide; however, should an omission or an error be found, we would greatly appreciate your notifying us of it.

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 working on or troubleshooting a generator.

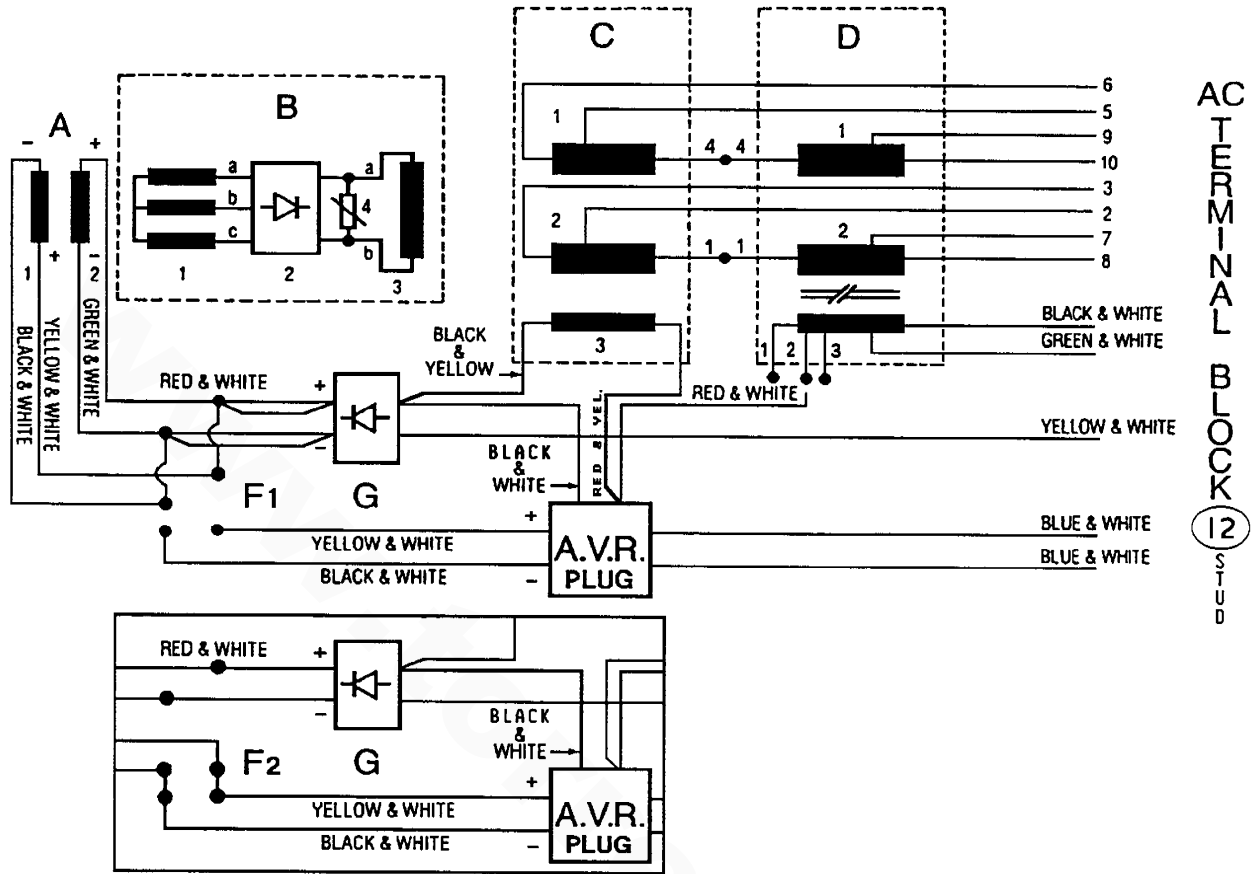
Only a few basic tools are necessary for diagnosis and repair. These are hand tools: an amp probe and a quality volt-ohmmeter capable of reading less than one ohm due to the precision required in reading component winding resistances.

NOTE: Do not always rely on the vessel's instruments for accurate readings; try to bring your own.

Before attempting any repairs, 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 when installed, 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.

The internal and external wiring diagrams are important tools in troubleshooting this generator or any generator model.



INTERNAL WIRING SCHEMATIC

A. EXCITER STATOR WINDINGS 1 & 2

- F1. Exciter Stator Windings (Selector in Compound)
- F2. Exciter Stator Windings (Selector in Electronic)

B. EXCITER ROTOR

- 1. Auxiliary Windings (a - b - c)
- 2. Diodes (6)
- 3. Rotating Field Windings
- 4. Pozi 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

F. SELECTOR SWITCH

- 1. Compound
- 2. Electronic and Compound

G. BRIDGE RECTIFIER

A.V.R. -Automatic Voltage Regulator

AC TERMINAL BLOCK 12 STUD

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 18 - 22 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 Neutral and Hot leg(s) with no load on the generator, with it running at rated rpm.

The presence of residual voltage is an indication that the following generator components are O.K.

1. Exciter Rotor (B-1)
2. Rotating Field (B-3)
3. Main Stator (C-1 & 2)
4. Compound Transformer (D-1 & 2)

The fault lies in one or more of the following components in the exciter circuit:

- A. Exciter Stator (A-1 & 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 with the selector switch in **COMP** should cause the generator to produce between 125 - 135 volts AC between each hot lead and the neutral. (Twelve 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 125 - 135 volts AC, then include A and C.

The following is a list of faults with the generator operation on compound (**COMP**) transformer regulation. (No A.V.R. installed)

FAULT	CAUSE	CORRECTION
Correct voltage at N/L 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 at N/L 125 -135 volts with correct voltage 115 - 120 at F/L.	1. Generator's engine speed (rpm) high at N/L.	1. Check N/L speed and adjust voltage.
High voltage at N/L and F/L.	1. Generator's engine speed (rpm) is too high.	1. Check N/L rpm and adjust N/L voltage

FAULT	CAUSE	CORRECTION
High voltage at N/L and F/L. (continued)	2. Short in compound transformer auxiliary windings D-3.	2. Check continuity and connections of D-3 windings.
Low voltage at N/L (0 - 50 volts) with growling noise from generator and loss of engine speed when load is applied.	1. Main stator windings shorted C-1, C-2.	1. Check continuity and resistance values of C-1, C-2 windings and connections.
Generator does not excite; voltage is 0 volts at N/L.	1. Generator's engine speed (rpm) is slow. 2. Short in main stator windings or in transformer.	1. Adjust engine's speed and adjust N/L voltage. 2. Check main stator and transformer winding resistances. Artificially excite the generator and note the results.
Low voltage at N/L; when load is applied, voltage drops.	1. Diode(s) in rotating exciter (B-2)shortened 2. Bridge rectifier defective. 3. Auxiliary windings B-1 shorted. 4. Auxiliary windings D-3 and /or C3 open.	1. Check diodes in rotating exciter as explained later in this manual, pages 191-192. 2. Follow test procedure for bridge rectifier. 3. Check continuity and resistance values. 4. Check continuity and resistance values of windings and connections.
Low voltage at N/L and F/L 50 - 70 volts.	1. Exciter stator windings A-1 & A-2 are open. 2. Generator's engine speed (rpm) is low.	1. Check continuity and resistance values of A-1 and A-2 windings. 2. Check generator N/L rpm and adjust N/L voltage.

FAULT	CAUSE	CORRECTION
Voltage correct at N/L but at F/L with loss of engine rpm (Hertz).	<ol style="list-style-type: none"> 1. Generator overload. 2. Low power factor load (motor loads). 	<ol style="list-style-type: none"> 1. Check data plate and monitor load on generator with amp-probe. 2. Check type of load applied. Consider use of optional regulator board.
Unstable voltage.	<ol style="list-style-type: none"> 1. Engine's rpm fluctuating. 	<ol style="list-style-type: none"> 1. Check engine operation and fuel system.
<p>The following is a list of faults with the generator operating on electronic (ELEC) regulation. Selector switch is in the ELEC position with an A.V.R installed.</p>		
Voltage correct at N/L and loss of voltage at F/L.	<ol style="list-style-type: none"> 1. Diode in exciter rotor B-2 shorted. 	<ol style="list-style-type: none"> 1. Check diodes as explained later in this manual, pages 191-192.
High voltage at N/L with no adjustment from regulator potentiometer.	<ol style="list-style-type: none"> 1. Regulator board defective. 	<ol style="list-style-type: none"> 1. Replace regulator board. Adjust N/L voltage with transformer; then switch to ELEC and adjust with A.V.R potentiometer.
Low voltage at N/L and F/L. No adjustment from regulator board 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 regulator board and adjust voltage as above. 2. Check resistance values of C-3 and D-3 windings and their connections.
Low voltage at N/L (0 - 50 volts) with growling noise from generator and loss of engine speed when load is applied.	<ol style="list-style-type: none"> 1. Main stator windings shorted, C-1, C-2. 	<ol style="list-style-type: none"> 1. Check continuity and resistance values of C-1 and C-2 windings and their connections.

FAULT	CAUSE	CORRECTION
Generator does not excite; 0 volts at N/L.	<ol style="list-style-type: none"> 1. Diode(s) in exciter rotor shorted (B-2). 2. Generator's speed is low. 	<ol style="list-style-type: none"> 1. Check diodes in exciter rotor as illustrated later in this manual, pages 191-192. 2. Check the engine's speed (hertz).
Low voltage at N/L and voltage drops further as a load is applied.	<ol style="list-style-type: none"> 1. Diodes in exciter rotor shorted (B-2). 2. Auxiliary windings in exciter rotor shorted (B-2). 	<ol style="list-style-type: none"> 1. Check diodes in exciter rotor as illustrated later in this manual, pages 191-192. 2. Check 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 B-1 shorted. 2. Exciter stator winding A-2 is open. 3. Auxiliary winding D-3 or C-3 open. 	<ol style="list-style-type: none"> 1. Check resistance values and continuity to ground. 2. Check continuity and connection of windings. 3. Check continuity and connection of winding.
Voltage unstable.	<ol style="list-style-type: none"> 1. Defective regulator board. 	<ol style="list-style-type: none"> 1. Check stability of DC voltage from regulator to exciter stator windings. Operate unit on COMP. Replace regulator board.
Voltage unstable.	<ol style="list-style-type: none"> 1. Engine is hunting. 2. Electrical connections. 	<ol style="list-style-type: none"> 1. Check engine operation and fuel system. 2. Check for clean and secure connections.

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 listed below.

<u>120 Volts</u>	<u>120/240</u>
N/L F/L 11 - 21 Volts AC	N/L F/L 11 - 21 Volts AC

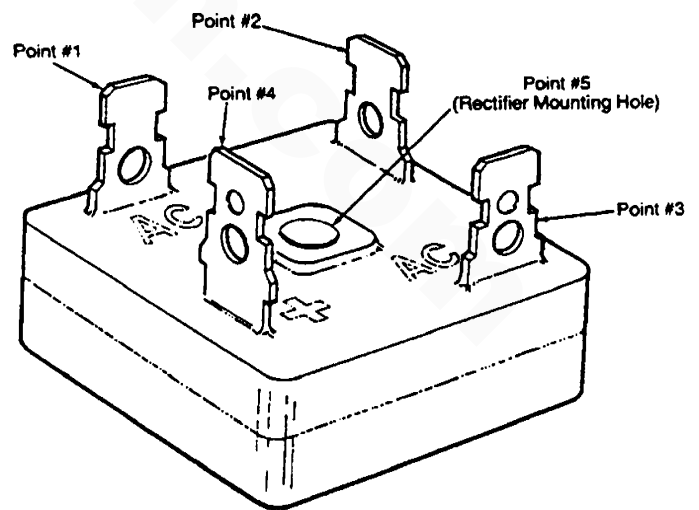
Diodes in the rectifier convert this AC voltage to DC and supply it to the windings (A-2) of the exciter stator to induce a field through which the exciter rotor revolves. The DC voltage measured across the (+) and (-) terminals of the bridge rectifier during engine operation is listed below.

<u>120 Volts</u>	<u>120/240</u>
N/L F/L 8 - 17 Volts DC	N/L F/L 8 - 17 Volts DC

Failure of the bridge rectifier will result in no strong 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 as discussed earlier in this text, page 185.

Testing the Bridge Rectifier for Fault(s) with an Ohmmeter

- (1) Set ohmmeter scale on Rx1 (+DC). Zero the meter.
- (2) Connect the (+) lead from the meter to Point #4. With the (-) lead from the meter, momentarily contact points #1, #2, #3 and #5. No deflection of the needle should occur showing infinite resistance.
- (3) Remove the (+) lead from Point #4 and connect the (-) lead to Point #4 and, with the (+) lead, momentarily touch Points #1, #2 and #3. Points #1 and #3 should show an 8-ohm resistance ± 2 ohms. Point #2 should show a 40-ohm resistance ± 5 ohms.
- (4) Touch Point #5 with the (+) lead. No deflection of the needle should occur.
- (5) Place the (+) lead of the meter on Point #1 and the (-) on Point #3. No deflection of the needle should occur (infinite resistance). Reverse the connections and the same should occur.



Should the rectifier fail any of the above tests, it is defective and should be replaced.

RESISTANCE VALUES - at 70° F (21° C)
(Simpson Meter 260 Model)

A. EXCITER STATOR WINDINGS

(A Windings, 1 & 2)

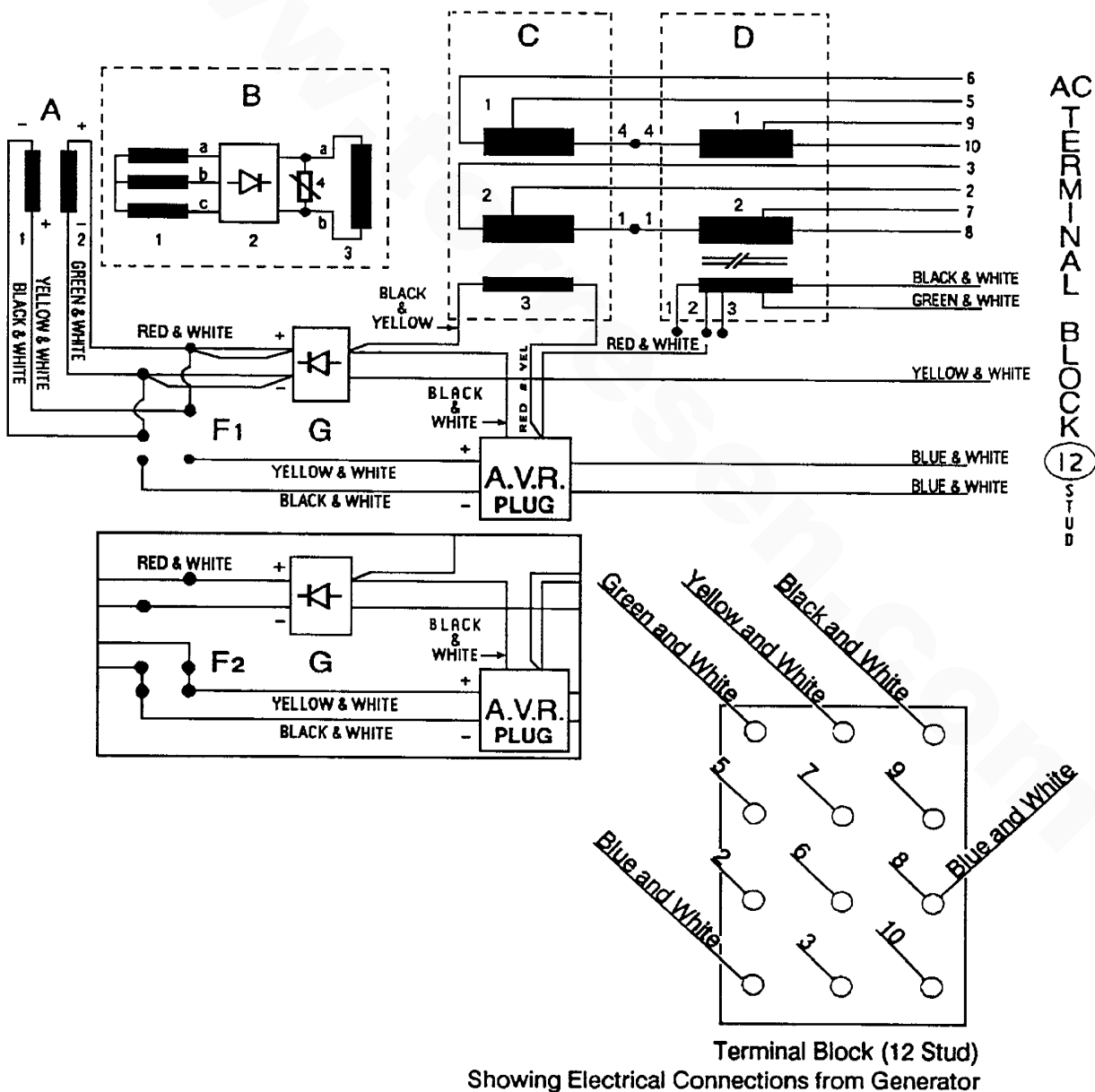
Exciter windings A - 1 & A - 2 (Compound F1) 8.5 - 9.0 ohm. (Reading taken between positive (+) and negative (-) leads lifted off the bridge rectifier with the selector switch in the **COMP** position.) Either of the two leads should have no continuity to the case/ground.

(A Winding, 1)

Exciter windings A - 1 (Elec - F1) 30.0 - 30.5 ohm. (Selector switch in the **ELEC** position, with readings taken between the yellow and white and black and white-striped wire leads at the regulator plug.)

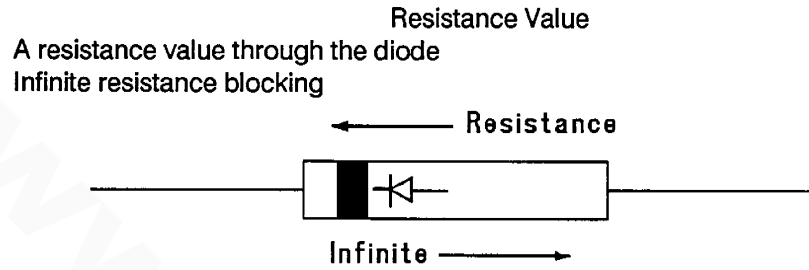
(A Winding, 2)

Exciter windings A-2 (Elec - F2) 12.5 - 13.0 ohm. (Reading taken between positive (+) and negative (-) leads lifted off the bridge rectifier.)



B. EXCITER ROTOR

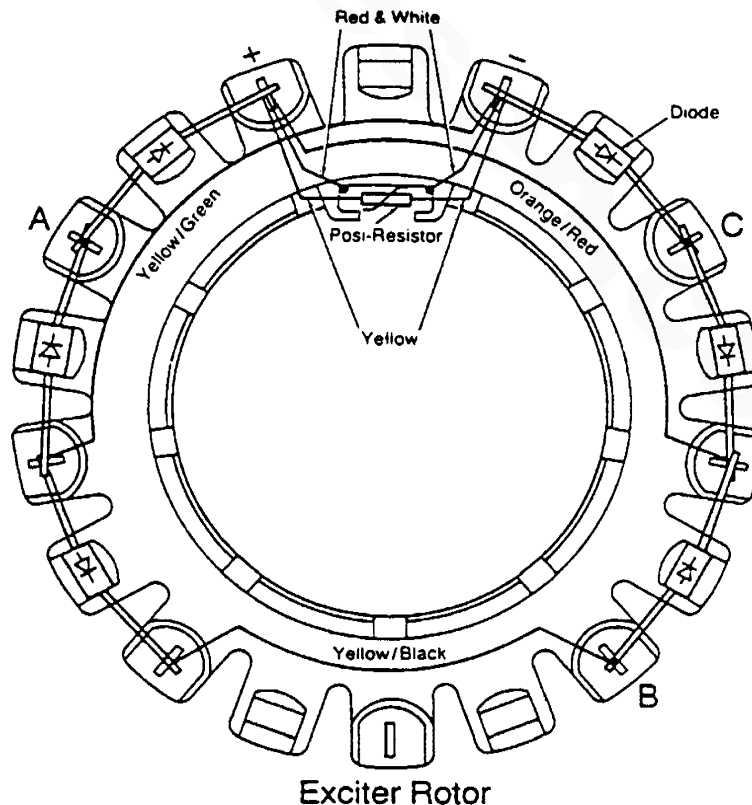
1. Auxiliary windings 1.0 - 1.2 ohm. (Readings taken between each pair of windings: a + b, b + c, c + a.) Winding connections can be left soldered at their connection points. If the readings are believed to be incorrect, unsolder the connections and recheck for resistance readings.
2. Diodes (six diodes 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.)

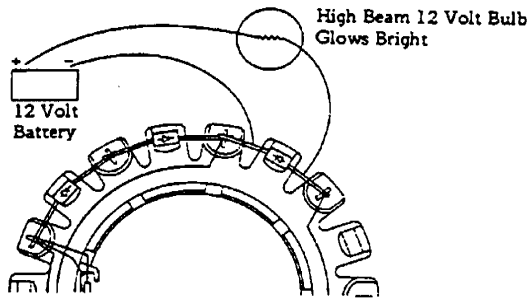


The diodes can be easily checked in place with the use of a common automotive 12-volt high beam headlight bulb, some jumper leads and the generator's 12-volt starting battery. (See the next page.)

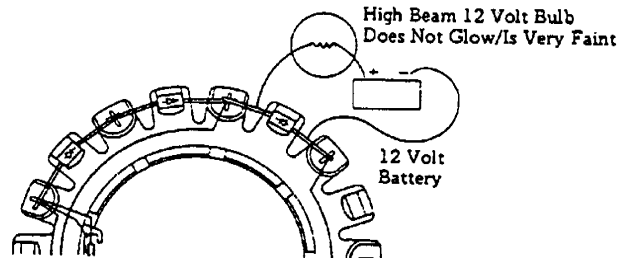
A short or an open in a diode can easily be found with the above without having to unsolder and isolate each diode to check it with an ohmmeter.

NOTE: Attempting to check diodes in place with an ohmmeter will give erroneous readings on the diodes due to the auxiliary windings connections.





3. When leads are put across the diode, as illustrated, voltage passes through the diode allowing the head light to glow brightly.



4. Reverse the leads across the diode. The diode should block voltage passing through it and the head light should not glow, or it may glow faintly.

- A. Should the bulb not glow with leads connected in both directions, the diode is open internally.
- B. Should the bulb glow bright with the leads connected in both directions, the diode is shorted internally.

In both A and B above, the diode should be replaced. Check resistance values of rotating field windings and the integrity of the posi-resistor connected between field windings.

- 5. Rotating Field Windings 7.0 - 8.0 ohm. (Readings taken between the two red and white wires connected to the (+) and (-) terminals of the exciter rotor as shown on the illustration on the previous page.)
- 6. Posi-Resistor. (Infinite readings between both yellow leads lifted from the (+) and (-) terminals on the exciter rotor.)

C. MAIN STATOR WINDINGS

1 & 2. Main stator windings .20 - .22 ohm

Group 1 - measured between Lead #6 at the AC terminal block and Lead #4 at the junction block. Lift both leads along with lead #5 at the terminal block to totally isolate group #1.

Group 2 - measured between Lead #3 at the AC terminal block and Lead #1 at the junction block. Lift both leads along with lead #2 at the terminal block to totally isolate group #2.

NOTE: The *Junction Block* for connections #4 and #1 from the main stator windings and to the transformer windings is found just below and to the left of the compound transformer.

3. Main Stator Auxiliary Windings 1.5 - 1.8 ohm. (Measured between the double leads on the AC terminal of the bridge rectifier, unplugged from the rectifier and the double lead central prong connection of the regulator plug.)

No continuity should be found between either of these three winding groups or to the generator's case.

D. COMPOUND TRANSFORMER

1 & 2. - Compound Transformer Windings: .019 - .021 ohm

Group 1 measured between Lead #10 at the AC terminal block and Lead #4 at the junction box. Lift both leads along with lead #9 at the terminal block.

Group 2 measured between Lead #8 at the AC terminal block and Lead #1 at the junction block. Lift both leads along with lead #7 at the terminal block.

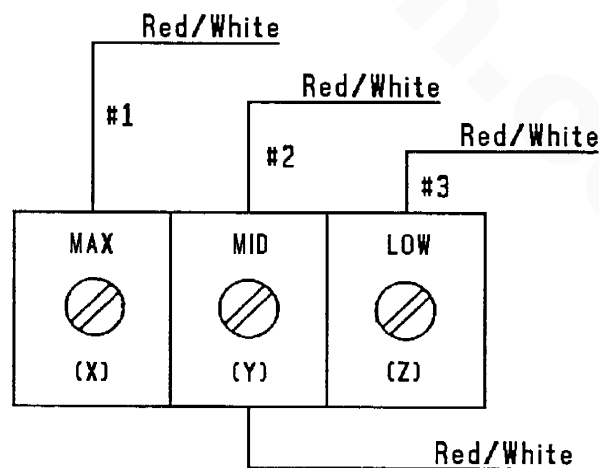
3. Transformer Auxiliary Windings: 4.0 - 4.5 ohm.

A. Serial # 1001 - 1040: These very early model units transformer auxiliary winding's resistance value is measured between the black and white wire, lifted from the AC terminal block, and the red and white striped wire at the regulator plug. To totally isolate these windings for the above measurement, lift also from the AC terminal block the green and white-striped wire.

B. Serial # 1041 and up: A three connection terminal strip was added to this circuit located just below the AC terminal block at the lower left. Isolate the three numbered #1, #2, and #3 red and white-striped wires coming onto each of the three terminals. Lift the black and white and green and white leads off their connections on the AC terminal block. Measure the resistance value between the #1 red and white lead lifted from the terminal strip and the black and white lead lifted from the AC terminal block.

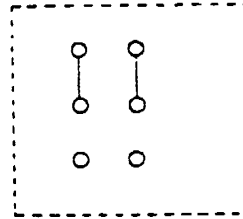
NOTE: The addition of the three connection terminal strip is for the increase or decrease of full-load voltage output. Should full-load voltage fall below 108 volts, selecting X, Y, or Z terminal strip lead to connect the lead (red and white) that is routed to the regulator plug and the exciter circuit, will supply a higher AC voltage to the exciter circuit during full-load conditions, bringing the output voltage of the generator up.

No-load voltage should be properly adjusted by shimming the compound transformer: 121-124 volts at 61.5 - 62.0 hertz. Note that the above should not be used as a means of compensating for incorrectly adjusting the generator's no-load voltage.

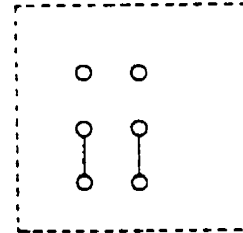


E. SELECTOR SWITCH

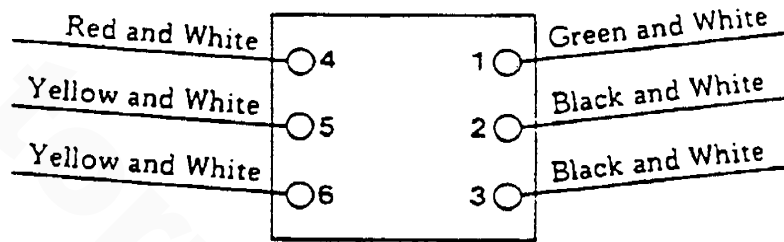
1. Selector Switch in Compound



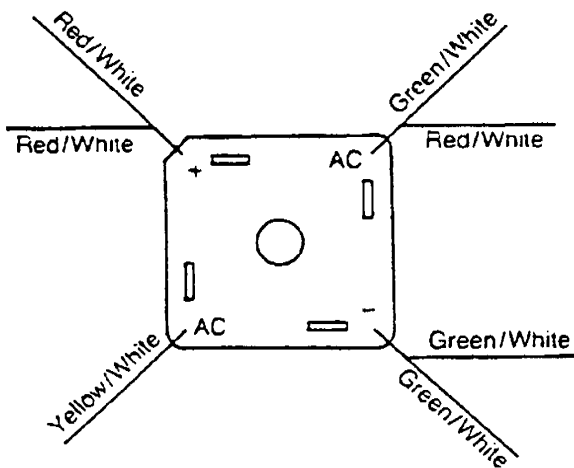
2. Selector Switch in Compound with A.V.R.



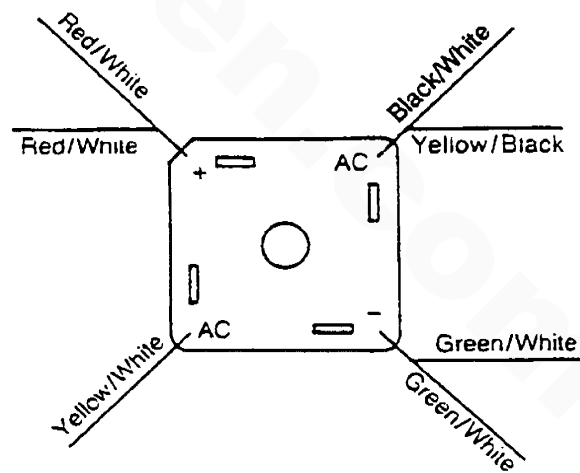
F. SELECTOR SWITCH WIRING



G. BRIDGE RECTIFIER WIRING



GENERATORS #1001 - 1040



GENERATORS 1041 - UP

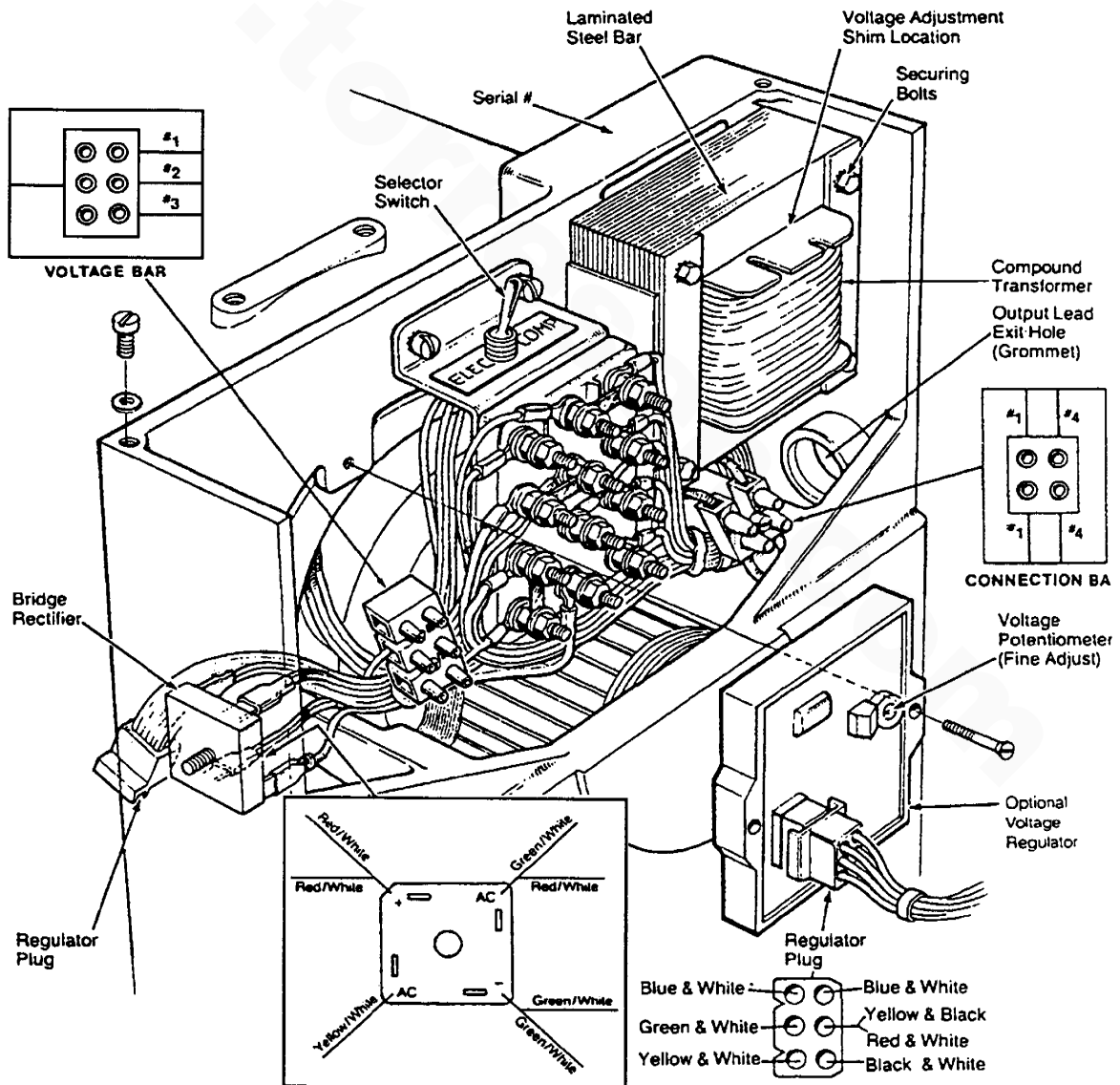
No-Load Voltage Adjustment

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. Operate the generator and apply a moderate load momentarily and remove it. Note the voltage output from the generator's 120 volt leg(s) (110 volt 50 hertz). The no-load voltage should be between 121 - 124 volts at 61.5 - 62 hertz (111 - 113 volts at 51.5 - 52 hertz).

NOTE: The no-load voltage should be adjusted to the voltage produced by the generator once started and a momentary load applied to excite the transformer and then removed. The voltage produced by the generator after this momentary load is removed is no-load voltage.

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 sometimes be accomplished by gently tapping the top of the laminated steel bar to reduce the air gap between the existing shims and the transformer core.



CAUTION

Under no circumstances attempt to increase the no-load voltage by increasing the gap between the laminated steel bar and the transformer core without the use of shims. Magnetic forces created within the transformer during generator operation may close the air gap and reduce no-load voltage output.

- To remove the laminated steel bar, remove the two upper securing bolts from the compound transformer and lift the bar from the transformer. The addition of shim thickness will raise the no-load voltage and, conversely, the removal of shim thickness will lower the no-load voltage.

Varying shim thickness by .001 inch (0.025 mm) will change the no-load voltage by 4 to 6 volts.

Optional Voltage Regulator

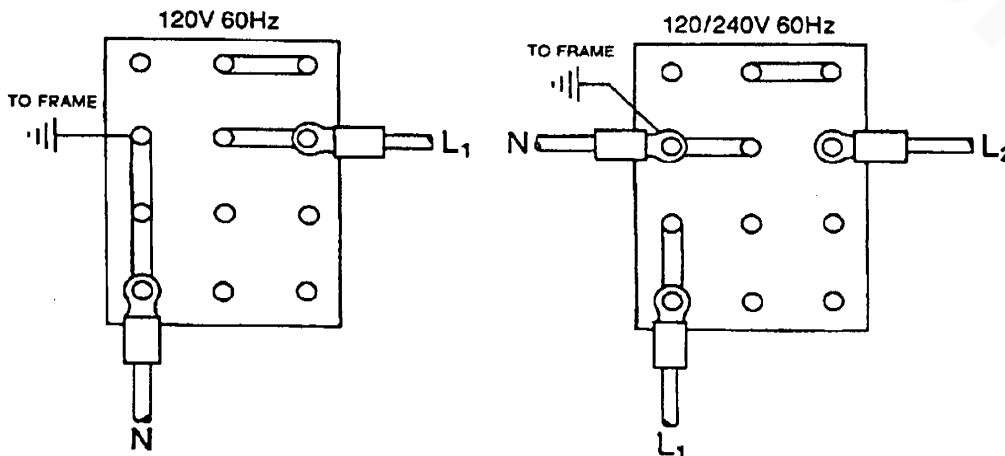
An optional solid state voltage regulator board #34410 is available for use with the BTG 9.0KW generator. When this board is installed and the regulation switch is moved to the **ELEC** position, the regulator works together with the standard compound transformer regulator to regulate generator voltage output. Refer to the wiring diagram on page 184-(F2).

Installation

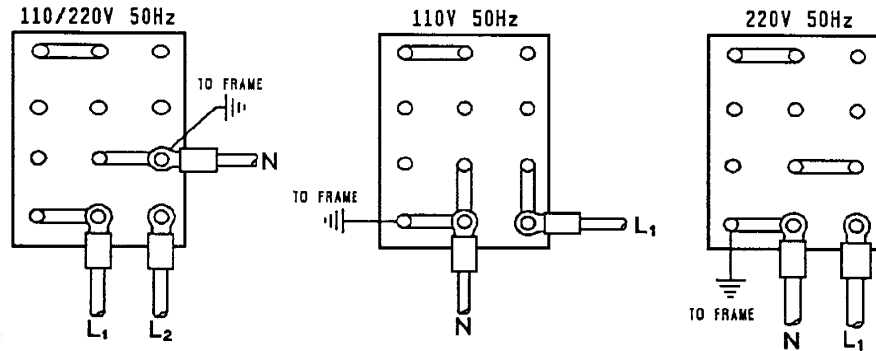
- The regulator is mounted using existing tapped holes in generator case. Use (2) M4 x 0.7 millimeter screws, each 15 mm long, with lock washers to mount the regulator board.
- Take the 6-prong generator plug and plug it into the receptacle on the regulator board.

NOTE: The plug is shaped so it will only engage in the regulator's receptacle in one direction. Check this and insert correctly.

- Before moving the selector switch to **ELEC**, ensure the no-load voltage produced by the generator is properly adjusted with the selector in **COMP** position, following procedures for no-load voltage adjustment.
- With generator no-load voltage adjusted to 112-116 volts, move the selector switch into the **ELEC** position. Adjust the regulator board potentiometer to set no-load voltage at 120 volts, 61.5-62 hertz (110 volts, 51.5-52 hertz). Generator voltage output should be within ± 5 percent from no-load to full-rated generator output.



BT GENERATOR AC VOLTAGE CONNECTIONS



NOTE 1: The frame ground wire must be moved when changing from 110 volts 50 hertz to 110/220 volts 50 hertz. For making connections to the AC terminal block, use terminal ends for #10 studs that will accept #6 multi-strand wire when the generator is wired for 120 volts, or use #8 when the generator is wired for 120/240 volts. Use an approved cable clamp to protect and secure the wire from chafing where it exits the generator housing.

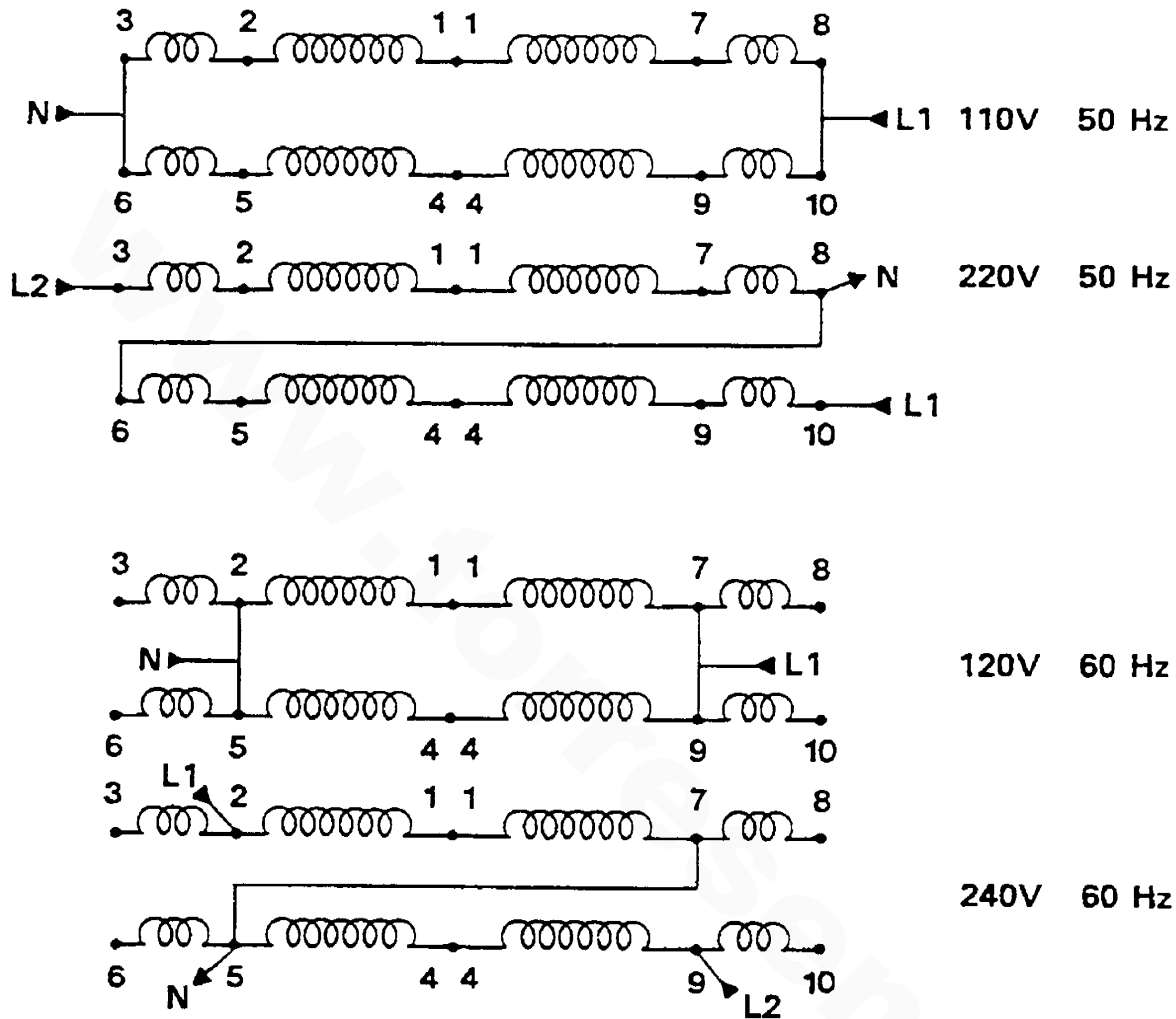
NOTE 2: The neutral and frame ground (-), which are normally combined, can be separated for those systems requiring a separate neutral from common ground. The generator's frame must be connected to the vessel's common ground for safety reasons.

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 illustrations on the preceding page.
 - B. Adjust the engine's speed to obtain the frequency corresponding to the voltage selected.
 - C. Adjust the no-load voltage if it is needed by the compound transformer.
 - D. Load the generator to the new amperage rating and reposition the loaded voltage tap to position X, Y, or Z as needed to maintain acceptable voltage output at full rated amperage output.

NOTE: Volts x Amperage = Kilowatts

Engine speed is increased or decreased by adjusting the length of the linkage between the throttle arm and solenoid plunger with the plunger completely bottomed in the solenoid.



12 TERMINAL BLOCK
winding connections needed to obtain
the voltage and related frequency.

Gasoline Model Governor Adjustments

Operate the generator set to bring the unit up to its operating temperature before attempting an adjustment.

NOTE: If the governor is severely out of adjustment, manually adjust the linkage without any load on the generator to obtain a safe output voltage before proceeding with the adjustment.

Three adjusting points are on the governor.

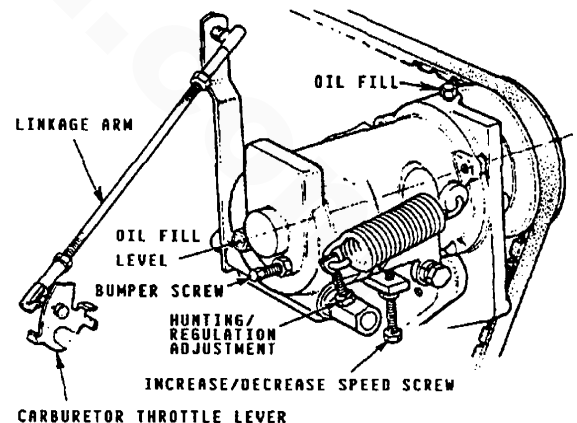
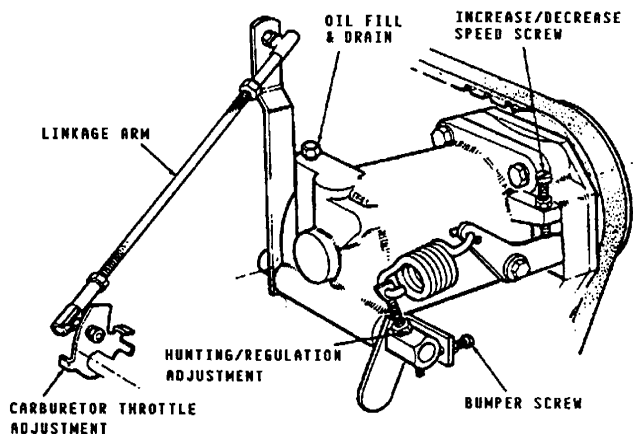
1. **Bumper Screw:** This screw is used to remove a no-load surge **only**. **Never** turn the bumper screw into the governor far enough so that it increases the no-load speed. To adjust the governor, turn the bumper screw in until the engine stops surging. Now bring the Increase\Decrease Screw (on the governor) up until the generator runs between 61.5 and 62.0 cycles no-load. Apply a 1/4, 1/2, and 3/4 load to the generator and ensure the generator does not surge under these three load intervals.

NOTE: Only if the generator surges at any of these load intervals are you to follow steps #2 and #3 below.

2. **Increase/Decrease Speed:** This adjusting bolt sets the no-load speed of the engine. (The linkage arm between the governor arm and throttle lever should be adjusted to hold the throttle full open when the engine is not running.) Make sure this linkage moves freely and that the ball joint connectors are properly lubricated. Use graphite lubricant at this connection. Disconnect the ball joint and apply a graphite lubricant to the inside of the joint.
3. **Hunting/Regulation:** If the variation in engine speed between no-load and full-load is too great, adjust this eye bolt to draw the spring closer to the lever hub. The increase/decrease speed bolt may need to be adjusted as well.

If the governor surges while under a load, adjust this eye bolt to move the spring away from the lever hub. (Check the speed adjustment.)

To increase or decrease the speed of a diesel engine-driven generator, adjust the linkage between the throttle arm and the solenoid plunger with the plunger completely bottomed in the solenoid.



NOTES

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TROUBLESHOOTING AND ADJUSTMENTS FOR THE BC GENERATOR

The following trouble shooting guide is designed to give insight into problems which may be encountered with the BCG 4.0KW and the BCG 6.5KW Westerbeke brushless generators. 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 this guide; however, should an omission or an error be found, we would greatly appreciate your notifying us of it.

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 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.

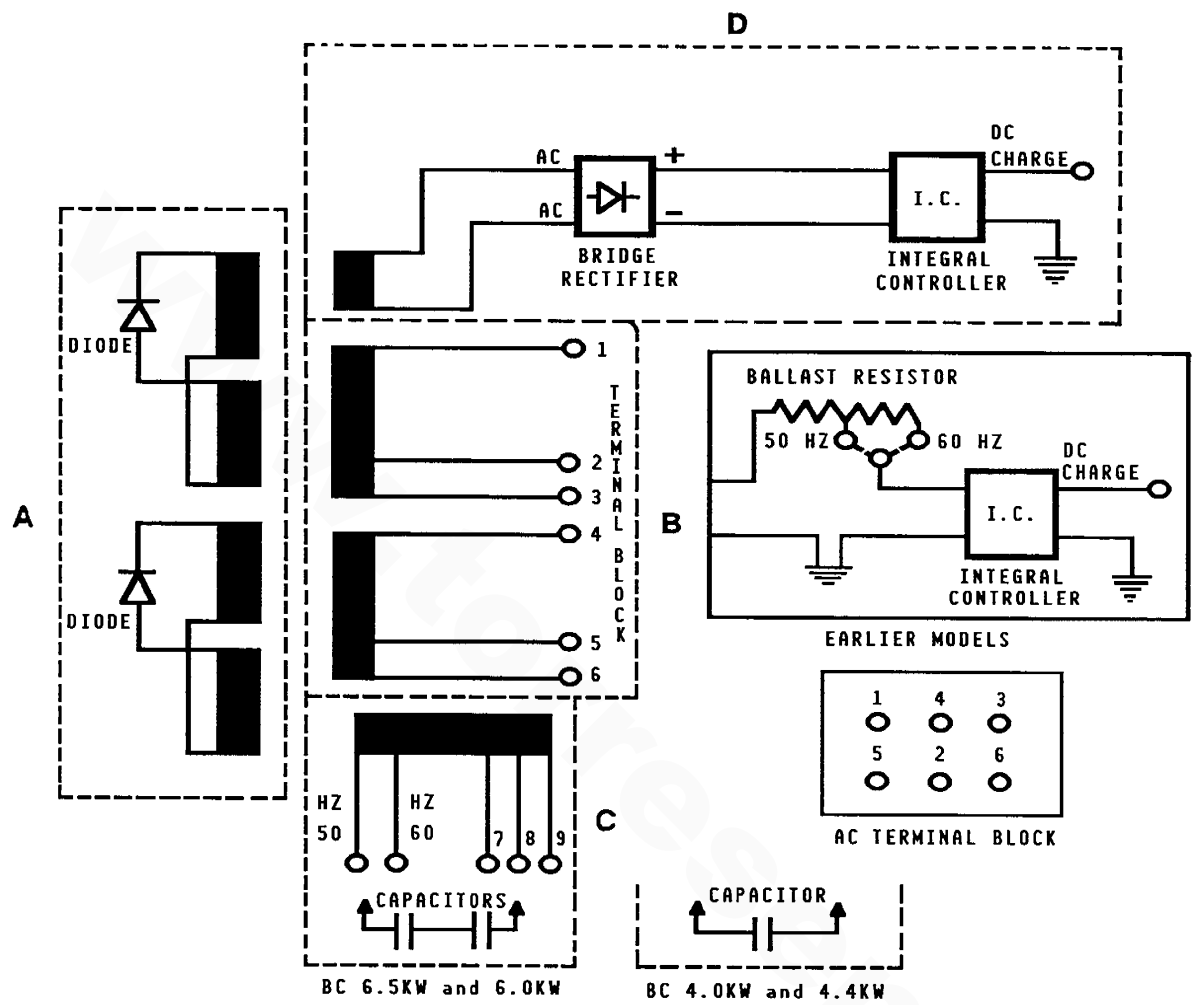
NOTE: Do not always rely on the vessel's instruments for accurate readings; try to bring your own.

Before attempting any repairs, 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 when installed, diodes and bridge rectifier, so if the problem should be found in one of these easily replaceable parts, the problem can be remedied early and efficiently.

The internal and external wiring diagrams are important tools in troubleshooting this generator or any generator model.

Generator Internal Wiring Schematic With Battery DC Charging Circuit.



Components

- A. Rotating Field and Diodes** (page 203)
- B. Main Stator Windings** (page 204)
- C. Exciter Windings and Capacitor(s)** (page 205)
- D. Battery Charging Circuit** (page 207)

A description of each component follows.

RESISTANCE VALUES OF COMPONENTS

(BCD and BCG models, as noted)

A. Rotating Field/Auxiliary Windings and Diodes

Two sets of windings are found on the rotating field

An electrical field is produced around these windings by the passing of DC voltage through them. As these windings rotate, this field passes through the main stator windings inducing an AC voltage that is available at the terminal block to be directed to a load. A separate group of windings for the battery charging circuit is effected by this rotating field. These windings produce an AC voltage that is directed into the bridge rectifier that converts it to DC voltage for the battery charging controller.

1. Rotating Field/Auxiliary Windings

BCG 4.0KW: 3.8 Ohm

BCG 6.5KW: 4.0 Ohm

BCD 4.4KW: 3.8 Ohm

BCD 6.0KW: 4.0 Ohm

To check the resistance values, rotate the engine's crankshaft to position the diode(s) on the generator's shaft at 12:00 o'clock. To make a quick check of these windings, presume the diode is OK, and place one of the ohmmeter's leads on the connection at the top of the diode and the other lead at the connection at the base of the diode. Compare readings with the value above. If a distinct difference is noted in the ohm value, carefully unsolder the lead on the top of the diode and remove the diode from the rotor using a thin walled, deep well 11 mm socket (7/16 inch equivalent).

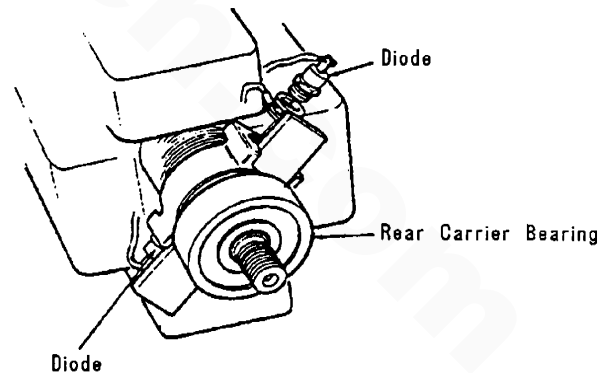
NOTE: The shield in front of the diode can be bent carefully out board to make access to the diode better.

With the diode removed, both leads for the first group of rotating field/auxiliary windings will be isolated with no interference from a possibly faulty diode.

Check the resistance value of the rotating windings by placing the ohmmeter's leads across the two exposed leads.

Also verify that no continuity exists between these windings and the rotor shaft by leaving one ohmmeter lead attached to the winding lead and the other ohmmeter lead touching the shaft: no continuity should exist. If continuity is found, a short exists.

Repeat this same check on the second group of windings. Rotate the engine's crankshaft 180° to position the second diode and connections at 12:00 o'clock.



2. Diodes 8 - 9.5 Ohm (approximate) using a 260 Simpson Analog Meter

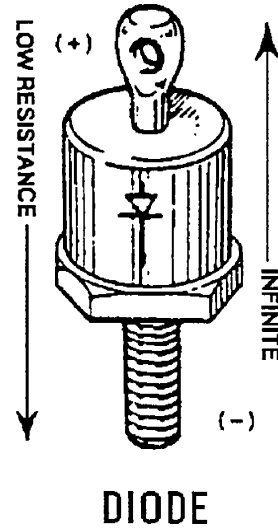
To check the diode, unsolder the connection from the top of the diode. Place one ohmmeter lead on the connection at the top of the diode and the other ohmmeter lead to the diode's base. Then reverse the position of the ohmmeter leads.

A low resistance should be found with the leads in one direction, and infinite resistance (blocking) in the other direction.

Diode Rating:

1600 Volts

26 Amps



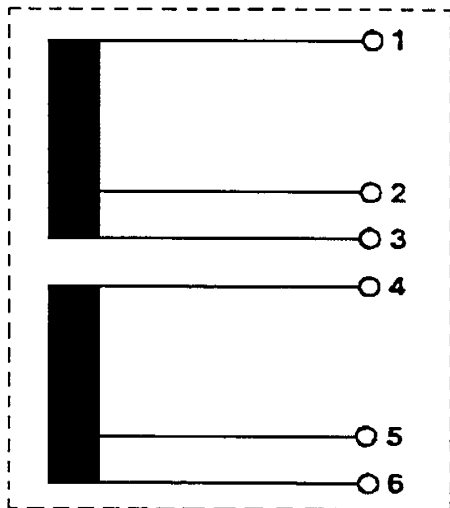
The diode's rating is far in excess of the circuit's requirements. Most likely a diode failure will result from an overspeed or load surge. A diode failure would be attributed to a manufacturing defect.

B. Main Stator Windings

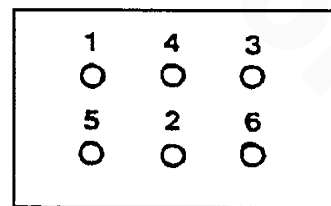
BCG 4.0KW: 0.6 Ohm
BCD 4.4KW: 0.6 Ohm

BCG 6.5KW: 0.4 Ohm
BCG 6.0KW: 0.4 Ohm

To check main stator winding values at the AC terminal block, first remove all AC output leads, the ground connection, and all brass interconnects from the terminals on the block. This will isolate the 6 leads on the terminal block which make up the two main stator groups.



NOTE: The numbered leads on the terminal block are not in any numerical order. They are as shown below.



TERMINAL BLOCK

Group # 1 - Measure resistance value between terminal with lead # 1, and terminal with lead # 3. (Check that there is no continuity of Group # 1 windings to the case ground.)

Group #2 - Measure resistance value between terminal with lead # 4, and terminal with lead # 6. (Check that there is no continuity of Group #2 windings to the case ground.)

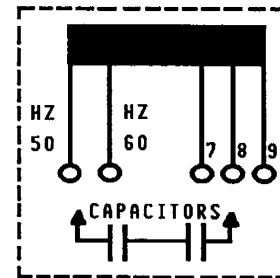
Check for a possible short between the two groups of stator windings by placing one lead of the ohmmeter on the terminal with stator lead 3 and the other ohmmeter lead on the terminal with stator lead # 6. There should be no continuity between the two groups of stator windings.

C. Exciter Windings

BCG 4.0KW: 1.9 Ohm
BCD 4.4KW: 1.9 Ohm

BCG 6.5KW: 2.2 Ohm
BCD 6.0KW: 2.2 Ohm

An AC voltage is induced in these windings by the rotating field. (Residual voltage measured between #9 and the 50 hertz leads unplugged from the capacitor - BCG 4.0KW & BCD 4.4KW: 6 - 8 volts AC; BCG 6.5KW & BCD 6.0KW: 8 - 10 volts AC.) This residual voltage must be present for the exciter circuit to function. **Do not** unplug capacitor leads while the generator is operating.



An AC voltage can be measured across the capacitor(s) while the generator is operating. This voltage may be as high as 450 to 500 volts AC. This voltage buildup is accomplished as the exciter windings charge the capacitor(s) and the capacitor(s) discharge back into the exciter windings. This AC voltage reading is taken between the #50 hertz connector and the #9 connection between the capacitor(s) while the generator is operating at its rated hertz (60.5 - 61.5 for gasoline models, and 61.5 - 62.0 for diesel models).

This flow of saturating AC voltage in the exciter windings produces a phase-imbalance type of field that effects the rotating auxiliary windings: A beneficial result that produces good motor starting characteristics for this type of generator.

To measure the resistance value of the exciter windings, locate the #9 and the #50 hertz capacitor connections.

NOTE: Three numbered capacitor connections exist: #7, #8, and #9; and two hertz connections, #50 and #60.

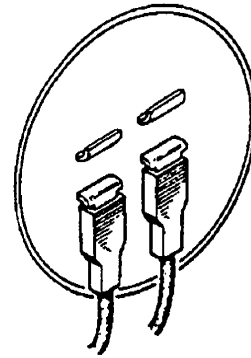
Unplug any other connections from the capacitor(s) noting their position on the capacitor.

Place one lead of the ohmmeter on plug connection #9 and the other lead on plug connection #50 hertz. Measure the resistance value of the exciter windings. Check to make sure there is no continuity to the ground/generator case from either of the two leads. Also check that no continuity exist between either the #50 hertz plug or the #9 plug and any of the main stator winding leads on the AC terminal block (refer to paragraph B). If continuity is found here, a fault exists between these two winding groups.

1. Capacitor (Field Testing of the Capacitor[s])

One capacitor is used in the BCG 4.0KW & BCD 4.4KW generator sets, and two capacitors in series are used in the BCG 6.5KW & BCD 6.0KW generator sets.

With a capacitor meter, test the capacitor following the instructions found with the meter, and compare the results with the value shown on the capacitor.



Field Testing Capacitor(s)

When a capacitor meter is not available, follow the following simple field test.

- a. Unplug connections from the capacitor. (NOTE: Mark on the connections so they can be reinstalled correctly.)
- b. With a jumper, short across the two connections on each capacitor that the two leads in step a were unplugged from. This will make sure the capacitor is discharged as it should be at shutdown.
- c. With your ohmmeter set on the high **R** scale, place its plus (+) lead on one capacitor connection and the negative (-) lead on the other capacitor connection. A resistance should be read and should rise slowly as the meter attempts to charge the capacitor. This indicates a presumably good capacitor.
- d. Indications of a defective capacitor:
 1. Zero resistance - no rise in resistance value (shorted capacity).
 2. Infinite resistance - (open capacitor).
 3. No continuity should be found between the capacitor's connections and the capacitor's case or base.

2. Capacitor Ratings (Capacitor Meter)

*BCG 4.0KW: 31.5 microfarads (uF) $\pm 5^\circ$

*BCD 4.4KW: 31.5 microfarads (uF) $\pm 5^\circ$

BCG 6.5KW: 31.5 microfarads (uF) $\pm 5^\circ$

BCD 6.0KW: 31.5 microfarads (uF) $\pm 5^\circ$

NOTE: Ratings are found on the capacitor case. Early model 4.0 BCG and 4.4 BCD had 25.0 microfarad (uF) capacitors.

* NOTE: The older BCG 4.0KW and BCD 4.4KW models had 25.0 microfarad capacitors. All new models now have 31.5 microfarad capacitors as standard equipment. When replacing an older model's capacitor, be sure to replace it with the same rated capacitor that was removed. Then perform a no-load voltage check as described on page 217.

D. Battery Charging Circuit

NOTE: This circuit is totally separate from the AC output of the generator. The AC output of the generator affects this circuit's output, but not the reverse.

1. Bridge Rectifier

Normal AC voltage to rectifier - (engine operating at 1800 rpm). This voltage is measured across the two AC connections on the bridge rectifier.

AC Voltage to the bridge rectifier (approximate):

- a. No-load off generator - 16.0 volts AC
- b. Full-load off generator - 17.5 volts AC

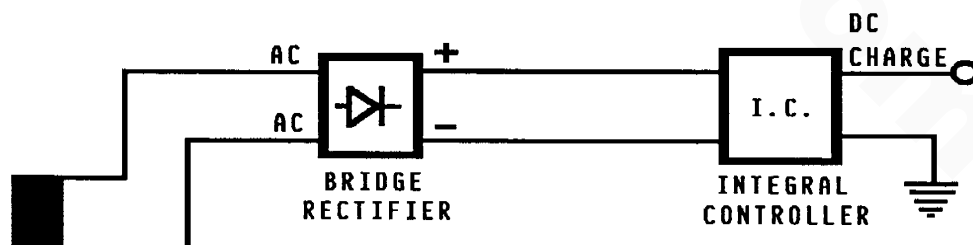
Normal DC voltage out of rectifier - volts DC. This voltage is measured across the two DC connections of the bridge rectifier, + to + and - to - .

DC voltage from the rectifier (approximate):

- a. No-load off generator - 17.0 volts DC
- b. Full-load off generator - 18.5 volts DC

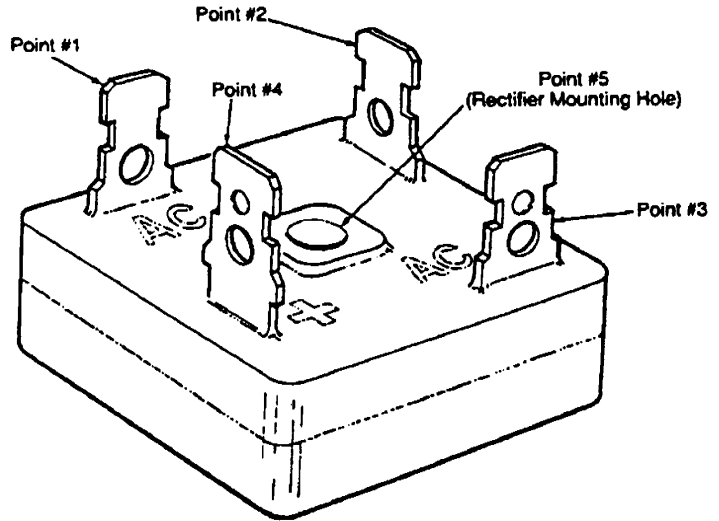
2. AC Stator Winding: 0.14 Ohm

Lift the two AC leads off the bridge rectifier and measure with an ohmmeter the resistance value between these two leads. This measurement should register 0.14 ohm. No continuity should exist between either of these two leads and the ground.



To test the bridge rectifier, if it is believed to be faulty, follow the test directions below.

- a. Set the ohmmeter scale on RX1 (+ DC). Set the meter to zero.
- b. Connect the positive (+) lead from the meter to point #4. With the negative (-) lead from the meter, momentarily contact points #1, #2, #3 and #5. The needle should not move, showing infinite resistance.
- c. Remove the positive (+) lead from point #4 and connect the negative (-) lead to point #4, and with the positive (+) lead from the meter momentarily touch points #1, #2 and #3. The needle should deflect showing passage through the diodes in the rectifier.
- d. With then negative (-) lead still attached to point #4, touch point #5 with the positive (+) lead. The needle should not deflect.
- e. Place the positive (+) lead of the meter on point #1 and the negative (-) lead on point #3. The needle should not deflect (infinite resistance). Reverse the leads to #1 and #3. Again there should be no deflection **If the rectifier fails any of the above tests (a through e), the rectifier is defective and should be replaced.**

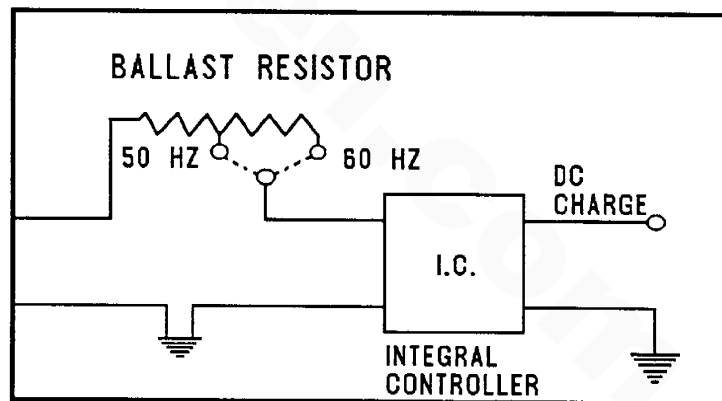


Note: Some ohmmeters will reverse steps b and c.

3. Ballast Resistor: 0.3 Ohm

Early model integral controllers have a ballast resistor installed along the DC plus (+) lead running from the bridge rectifier to the integral controller. This coil-type resistor functions to suppress high amperage draw coming from the controller when it is trying to charge a discharged starting battery.

Early controllers having this resistor in the DC charging circuit are of the three lead type. These three lead types consist of either three spade plugs in connections, or consist of three wire leads coming from the controller.



EARLIER MODELS

The resistance value of the ballast coil is measured between the lifted (+) lead at the bridge rectifier and the 60 hertz connection unplugged from the controller (that is, controllers having plugs in the connector).

Controllers with three leads coming from the controller measure resistance between the unplugged 60 hertz connection at the bridge rectifier and the brown lead connection on the coil resistor terminal block.

4. Integral Controller (I.C.)

The integral controller is an encapsulated solid state unit that supplies a DC charging voltage to the generator's starting battery while the generator is operating.

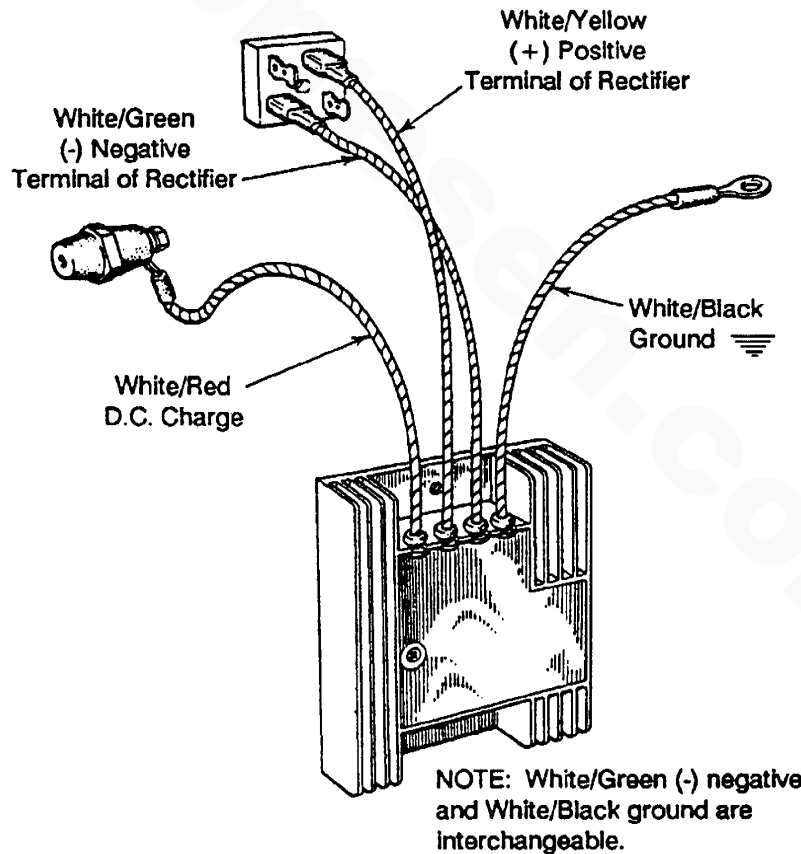
Charging Voltage: 13.0 - 14.0 Volts DC

Charging Amperage: 0 - 10 Amps DC

A separate group of stator windings supplies AC voltage to a bridge rectifier that converts the AC current to DC current to supply the integral controller unit. The integral controller unit senses the starting battery's needs and supplies a DC charge as needed. If the integral controller is believed to be faulty, resulting in a low starting battery, check the charging circuit components (D) and all connections in the circuit and to the battery for cleanliness and for tightness including the ground before replacing the integral controller unit.

NOTE: When first started, the integral controller unit will produce a low charging rate. This charging rate will rise as the unit is operated.

New four wire controllers eliminate the ballast resistor circuit since the ballast resistor's function is now handled internally. When replacing an early style controller with the newer four wire model, remove the ballast resistor and its wiring.



Four Wire Controller Showing its Connections

The BC generator is a self exciting, self regulating, brushless type unit. These three features help make the BC a basic unit to understand and troubleshoot. Frequency and voltage output depends directly on the engine/generator speed. Therefore, proper adjustment and maintenance of the belt-driven governor on gasoline models and internal governor action on diesel models is of prime importance.

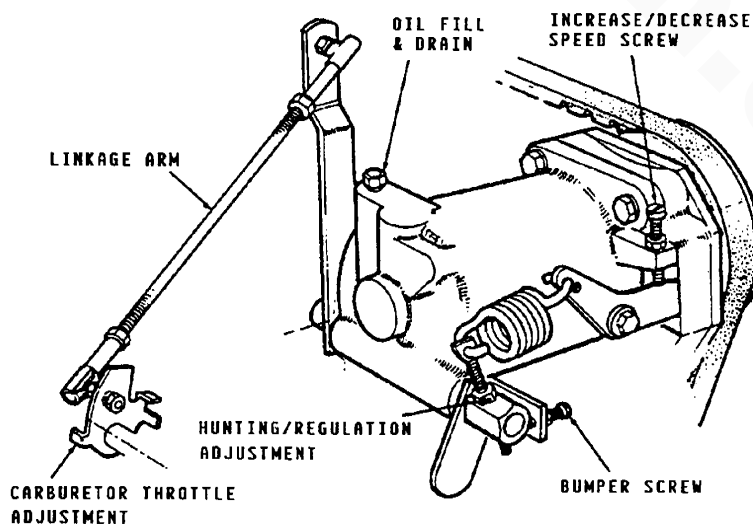
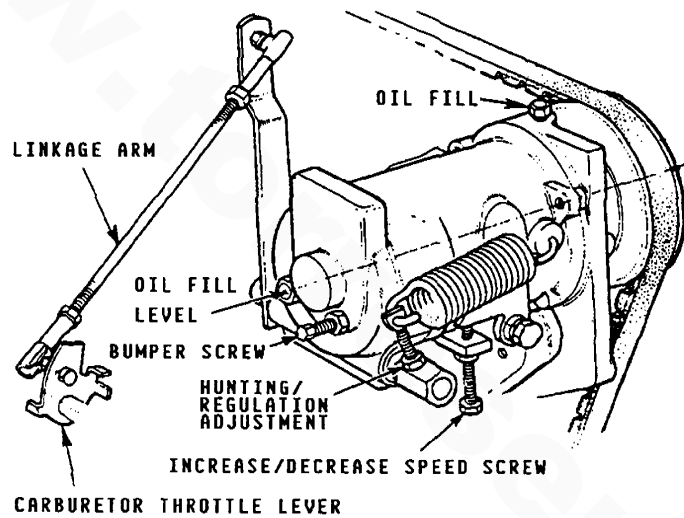
Gasoline Models:

No-Load	Hertz	60.5 - 61.5	Voltage	115 - 124
Full-Load	Hertz	59.0 - 60.0	Voltage	118 - 122

Diesel Models:

No-Load	Hertz	61.5 - 62.0	Voltage	118 - 127
Full-Load	Hertz	58.0 - 59.0	Voltage	115 - 120

The Governor/ Speed Adjustment may be the source of no AC output, low AC output, or high AC output.



Belt-Driven Governors

Gasoline Model Governor Adjustments

Operate the generator set to bring the unit up to its operating temperature before attempting an adjustment.

NOTE: If the governor is severely out of adjustment, manually adjust the linkage without any load on the generator to obtain a safe output voltage before proceeding with the adjustment.

Three adjusting points are on the governor.

1. **Bumper Screw** This screw is used to remove a no-load surge **only**. **Never** turn the bumper screw into the governor far enough so that it increases the no-load speed. To adjust the governor, turn the bumper screw in until the engine stops surging. Now bring the Increase/Decrease Screw (on the governor) up until the generator runs between 60.5 to 61.5 cycles no-load. Apply a 1/4, a 1/2 and a 3/4 load to the generator and ensure the generator does not surge under these three load intervals.

NOTE: Only If the generator surges at any of these load intervals are you to follow steps #2 and #3 below.

2. **Increase/Decrease Speed** This adjusting bolt sets the no-load speed of the engine. (The linkage arm between the governor arm and throttle lever should be adjusted to hold the throttle full open when the engine is not running.) Make sure this linkage moves freely and that the ball joint connectors are properly lubricated. Use graphite lubricant at this connection. Disconnect the ball joint and apply a graphite lubricant to the inside of the joint.
3. **Hunting/Regulation** If the variation in engine speed between no-load and full-load is too great, adjust this eye bolt to draw the spring closer to the lever hub. The increase/decrease speed bolt may need to be adjusted as well.

If the governor surges while under a load, adjust this eye bolt to move the spring away from the lever hub. (Check the speed adjustment.)

NOTES

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GENERATOR TROUBLESHOOTING

FAULT	CAUSE	CORRECTION
Low or no AC voltage output at no-load.	1. Engine speed is too slow.	1. Adjust the governor to obtain the correct hertz and voltage output.
	2. Faulty capacitor.	2. Perform field test explained on page 206.
	3. Faulty electrical connections.	3. Make sure the connections are clean and secure.

WARNING

Stop the generator before checking the connections

Low or no AC voltage at no-load. (continued)	4. Faulty generator windings (A-B-C).	4. Check resistance values of components.
	5. Faulty diode(s) in rotating field (A).	5. Isolate diode and check values.

High no-load AC voltage output.	1. Engine speed is too fast.	1. Adjust governor to obtain the correct hertz and voltage output.
	2. Capacitor is faulty (high capacitance).	2. Perform capacitor field check.

Correct no-load voltage, but low voltage output when load applied.	1. Poor governor reaction.	1. Adjust hunting/regulation on the governor.
	2. Overload on generator.	2. Check the load that is applied to the generator with an amp-probe.
	3. Diode(s) in rotating field shorted.	3. Isolate diode(s) and check values.

FAULT	CAUSE	CORRECTION
Correct no-load voltage, but high voltage output when load applied.	Engine speed is too fast.	Adjust hunting/regulation on the governor. Adjust to proper no-load voltage hertz.
Unstable voltage output.	1. Poor governor reaction.	1. Adjust hunting/regulation on the belt-driven governor.
	2. Loose electrical connections.	2. Check the security and cleanliness of electrical connections.

WARNING

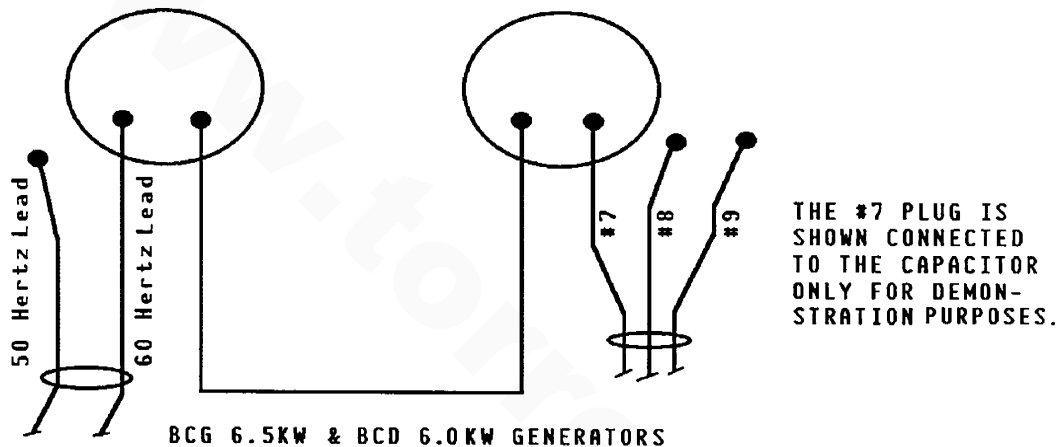
Stop the generator before checking the connections.

Noisy generator.	1. Unbalanced load (120/240 wired).	1. Check each load as it is taken off each 120 volt leg with an amp-probe.
	2. Rear support bearing is faulty.	2. Check each load as it is taken off each 120 volt leg with an amp-probe.
	3. Generator connection to engine is loose.	3. Stop the generator and check the connection.

B. The BCG 6.5KW and BCD 6.0KW generators have two capacitors in the exciter circuit. The capacitor on the left side of the generator end contains the connections corresponding to the hertz (speed) produced by the generator. These connections are labeled #60 (60 hertz) and #50 (50 hertz). Unplug the hertz connection that needs to be changed and plug in the hertz connection required for the desired hertz rating.

CAUTION

Make sure the insulating covers on the unused leads are in place and that the leads never come in contact with each other or come in contact with the case.



3. Integral Controller (3 Wire)

Early model integral controllers of the 3 wire type had a 60 or 50 hertz connection. The plug-in type had a #60 or # 50 lead plugged into the controller that corresponded to the hertz produced. Change this connection when changing the generator's hertz rating.

4. Speed Adjustment - Hertz

Gasoline Models:

Start the generator and adjust the speed screw on the governor to produce the generator's no-load hertz.

Diesel Models:

Adjust the linkage between the throttle arm and fuel solenoid on the diesel models to produce the correct no-load hertz.

No-Load Voltage Adjustment

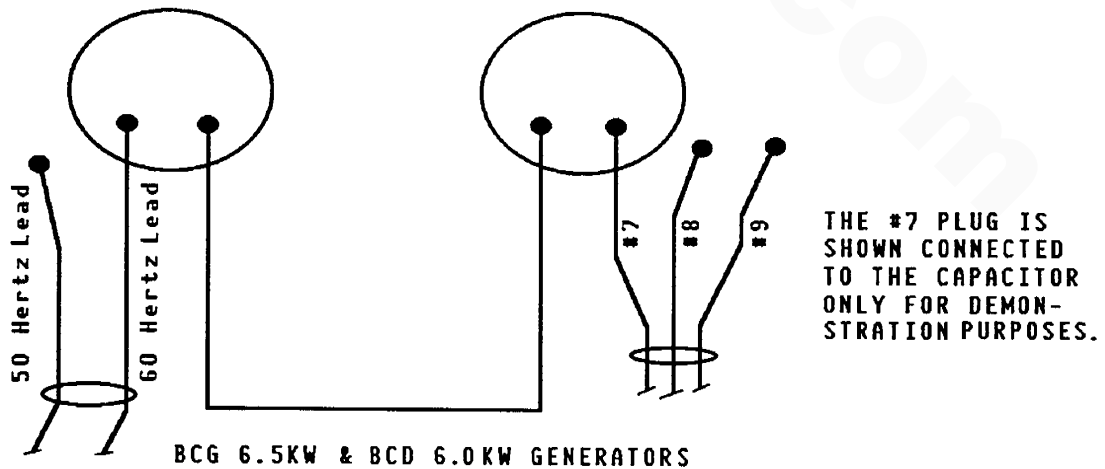
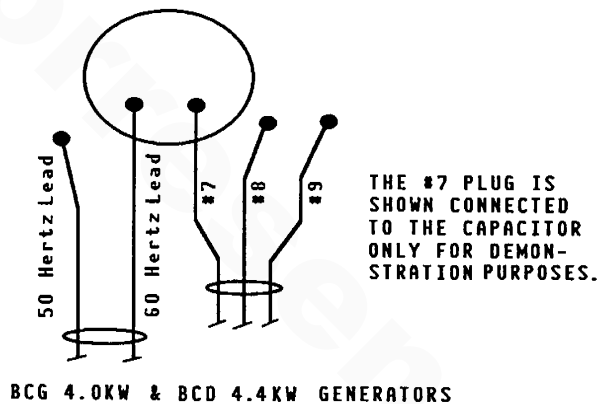
If the generator was producing the correct no-load voltage before the hertz change, this adjustment may not be necessary. In the event a no-load adjustment is needed, proceed as follows.

- A. Shut off the generator.

WARNING

Do not attempt to make a no-load voltage adjustment while the generator is operating. The capacitor can hold a 450 - 500 volt charge. Touching any wiring can result in a severe electrical shock. In addition, attempting to make a no-load voltage adjustment while the generator is operating can cause fingers to be caught in the generator's rotor.

- B. Refer to the illustrations below before making any adjustments. Note that there are three plugs grouped for the right capacitor terminal, #7, #8, and #9.. If the generator's no-load voltage is low, then disconnect the lower number plug and connect the plug with the next higher number. If the generator's no-load voltage is high, then disconnect the higher numbered plug and connect the plug with the next lower number. Note that the plug presently connected to this terminal may be any one of the three plugs available.



NOTES

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SERVICE BULLETINS

The following bulletins contain supplementary and updated information about various components and service procedures which are important to the proper functioning of your engine and its support systems.

You should familiarize yourself with the subjects and make sure that you consult the appropriate bulletin(s) whenever your engine requires service or overhaul.

Service Bulletin Number: 167

Date:	January 6, 1987
Model:	All Gasoline Models
Subject:	Fuel System Components

Installers are advised that with the increased availability and use of butane/alcohol blended gasolines, fuel system components *must* be compatible with these types of blended gasolines. Failure to insure compatibility will result in the component's failure and possible injury to the user.

Service Bulletin Number: 168

Date: May 6, 1987
Model: BC Generators
Subject: Integral Controller #35981

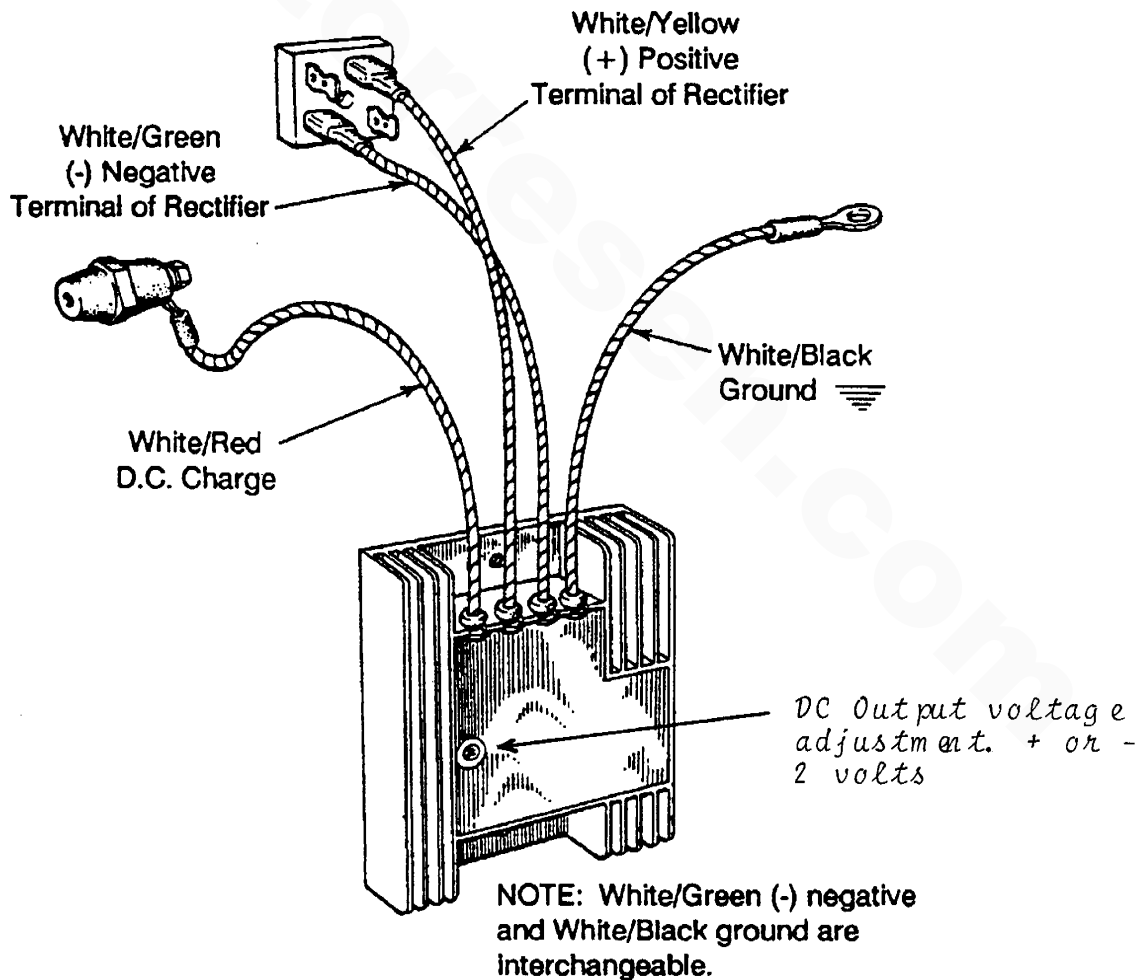
An improved version of the Integral Control #35981 is being introduced with production units and being made available through our parts department.

The improved controller has designed into its circuitry a ballast resistor circuit which previously was a separate component in the DC charging circuit of the BC generator models.

The separate ballast resistor, along with its wiring harness, must be removed from the generator DC charging circuit and discarded when the improved controller is used as a field replacement for earlier model controllers.

NOTE: On early models with plug-in connections, remove negative ground connection harness from both controller and rectifier to case ground and discard.

The illustration shows the improved Integral Controller with its four color coded electrical leads and their connection points in the DC charging circuit



Service Bulletin Number: 171

Date: May 17, 1988
Model: All Gasoline and Diesel Generator Models
Subject: Raw Water Through-Hull Fitting

The raw water through-hull fitting used in the raw water supply to any Westerbeke Gasoline or Diesel Model Generator *must* be of the Flush-Hull type and of no smaller inside diameter than the recommended I.D. hose size for the inlet to the units raw water pump.

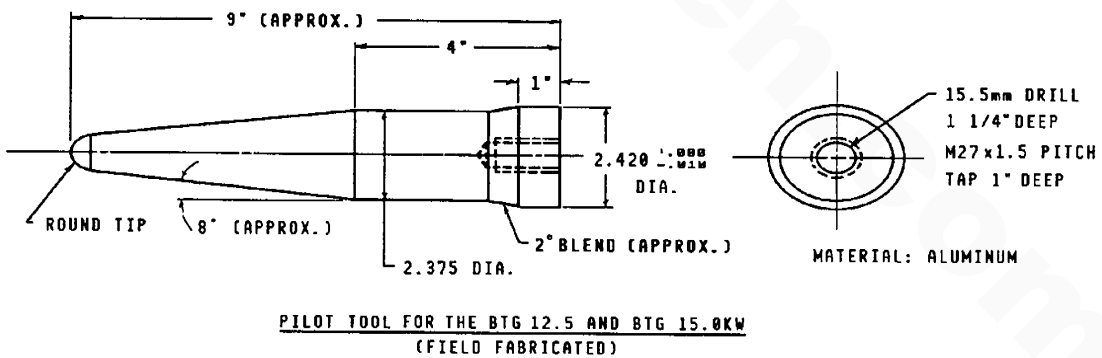
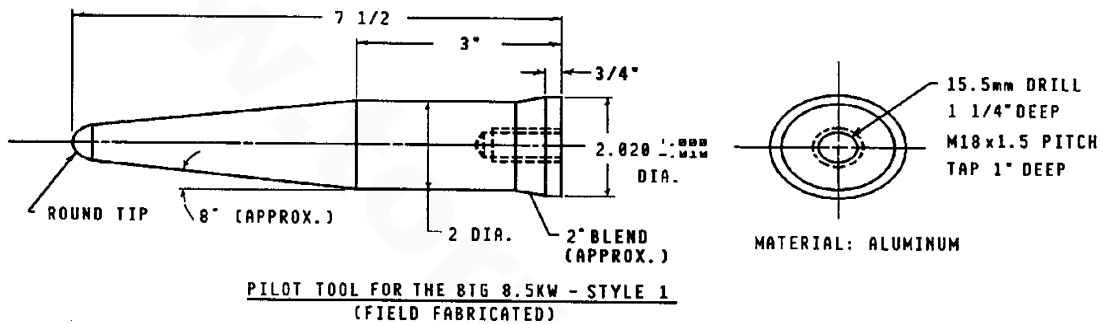
The use of high speed scoops or weedless scoop type raw water through-hull fittings is not approved or recommended. These types of raw water through-hull fittings tend to encourage raw water siphoning through the sea water circuit when the vessel is under way and the generator not in operation. This type of siphoning can fill the units exhaust system with raw water and enter the engine cylinders through the exhaust manifold and open cylinder valves, causing eventual damage to the engine. Raw water entry into the cylinders of the engine, whether resulting in damage or not, is not considered a warrantable problem but rather a fault in the installation, the responsibility of the installer.

Westerbeke presumes the marine installer to have as basic knowledge of the requirements and safeguards needed in the installation and plumbing of the raw water supply and exhaust system of a marine generator unit.

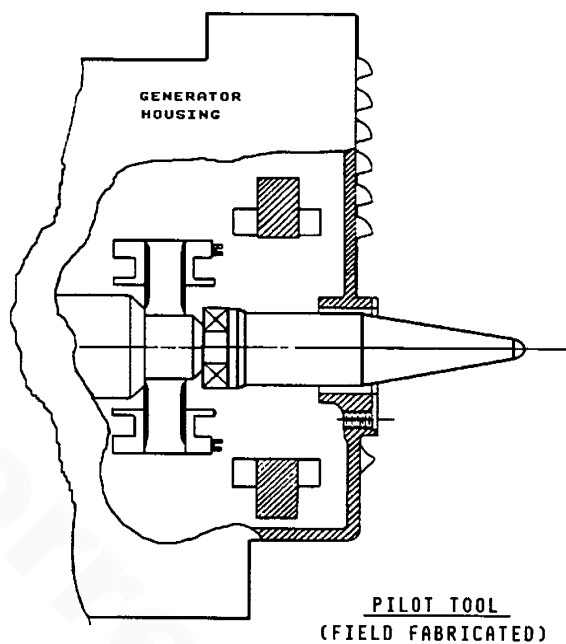
FIELD FABRICATED TOOLS

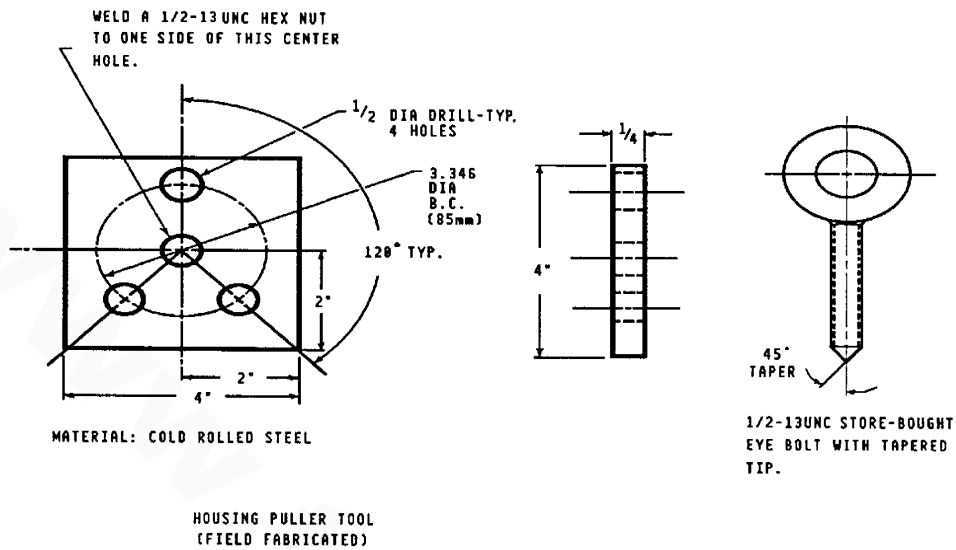
The mechanical drawings that follow provide a means by which simple tools can be made to assist in the removal of the generator end from the engine and in the replacement of the generator end on the engine. A local machine shop should be able to manufacture these tools at a modest price, but first check with your local Westerbeke dealer to see if these tools are on hand for loan.

The tool below helps keep the rotor from damaging the windings in the generator housing by allowing 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 on the next page.

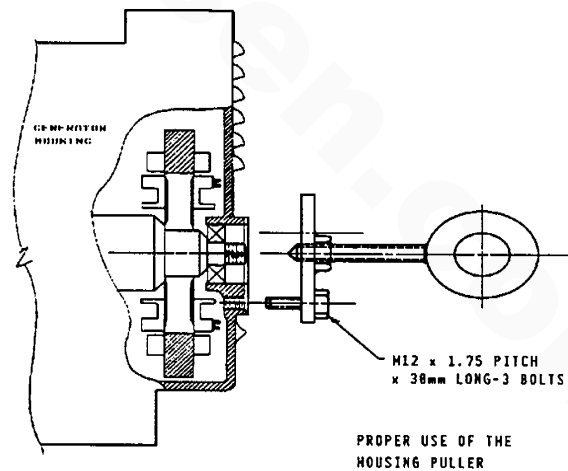


This tool allows the generator housing to be either removed or replaced without damaging the generator windings.

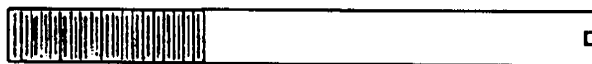




This tool allows the bearing in the generator housing to be gently pushed straight off the housing without any twisting. If a nut of the same specifications as that of the tapped hole in the pilot tool were to be welded on the end of the eye bolt, this tool would be able to pull the bearing back into place without any twisting. Please refer to these drawings before the generator end is removed.



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 drive plate's weight while removing or replacing these parts.



Material: One M8 bolt with the hex head machined off and a screw driver slot cut in the machined end.

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