

TECHNICAL MANUAL

WESTERBEKE

4.5 KW BCG - 60 Hz

7.0 KW BCG - 60 Hz

7.0 KW BCGA - 60 Hz

3.5 KW BCG - 50 Hz

5.0 KW BCG - 50 Hz

MARINE GASOLINE

GENERATOR SETS

Publication #038747

Edition One

March 1990



WESTERBEKE CORPORATION • MYLES STANDISH INDUSTRIAL PARK
150 JOHN HANCOCK ROAD, TAUNTON, MA 02780-7319 U.S.A.
TEL: (508)823-7677 • FAX: (508)884-9688 • WEBSITE: WWW.WESTERBEKE.COM

Gasoline with an ETHANOL content higher than 10% (E10) is **not allowed and may void warranty.**



WESTERBEKE™
Engines & Generators

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.

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.

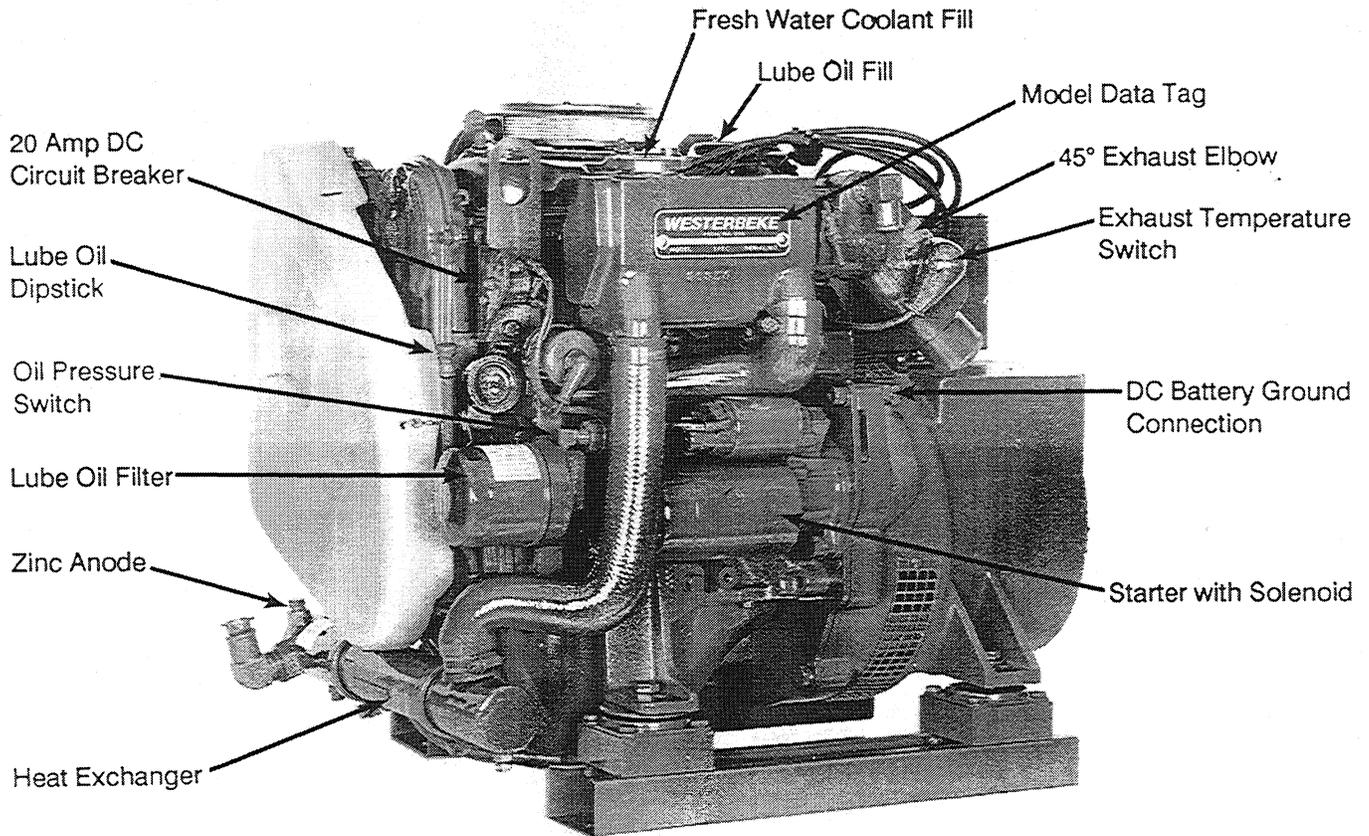
TABLE OF CONTENTS

Section	Page
4.5 KW BCG GENERAL SPECIFICATIONS	9
4.5 KW BCG SYSTEM SPECIFICATIONS.....	10
7.0 KW BCG & BCGA GENERAL SPECIFICATIONS.....	13
7.0 KW BCG & BCGA SYSTEM SPECIFICATIONS	14
4.5 KW BCG ENGINE SERVICE SPECIFICATIONS	17
7.0 KW BCG & BCGA ENGINE SERVICE SPECIFICATIONS	27
ENGINE DESCRIPTION	37
GENERATOR OVERHAUL.....	46
PREPARATIONS FOR OVERHAUL.....	47
DISASSEMBLY FOR OVERHAUL	48
ENGINE DISASSEMBLY.....	50
REMOVING THE CYLINDER HEAD FROM THE CYLINDER BLOCK.....	53
CYLINDER HEAD DISASSEMBLY	54
CYLINDER BLOCK DISASSEMBLY	57
SPECIAL SERVICE TOOLS	61
CYLINDER HEAD AND ENGINE BLOCK INSPECTION AND REPAIR.....	63
ENGINE INSPECTION AND REPAIR	64
SUBASSEMBLY INSPECTION, REPAIR AND ASSEMBLY	81
ENGINE ASSEMBLY.....	101
CYLINDER BLOCK ASSEMBLY	102

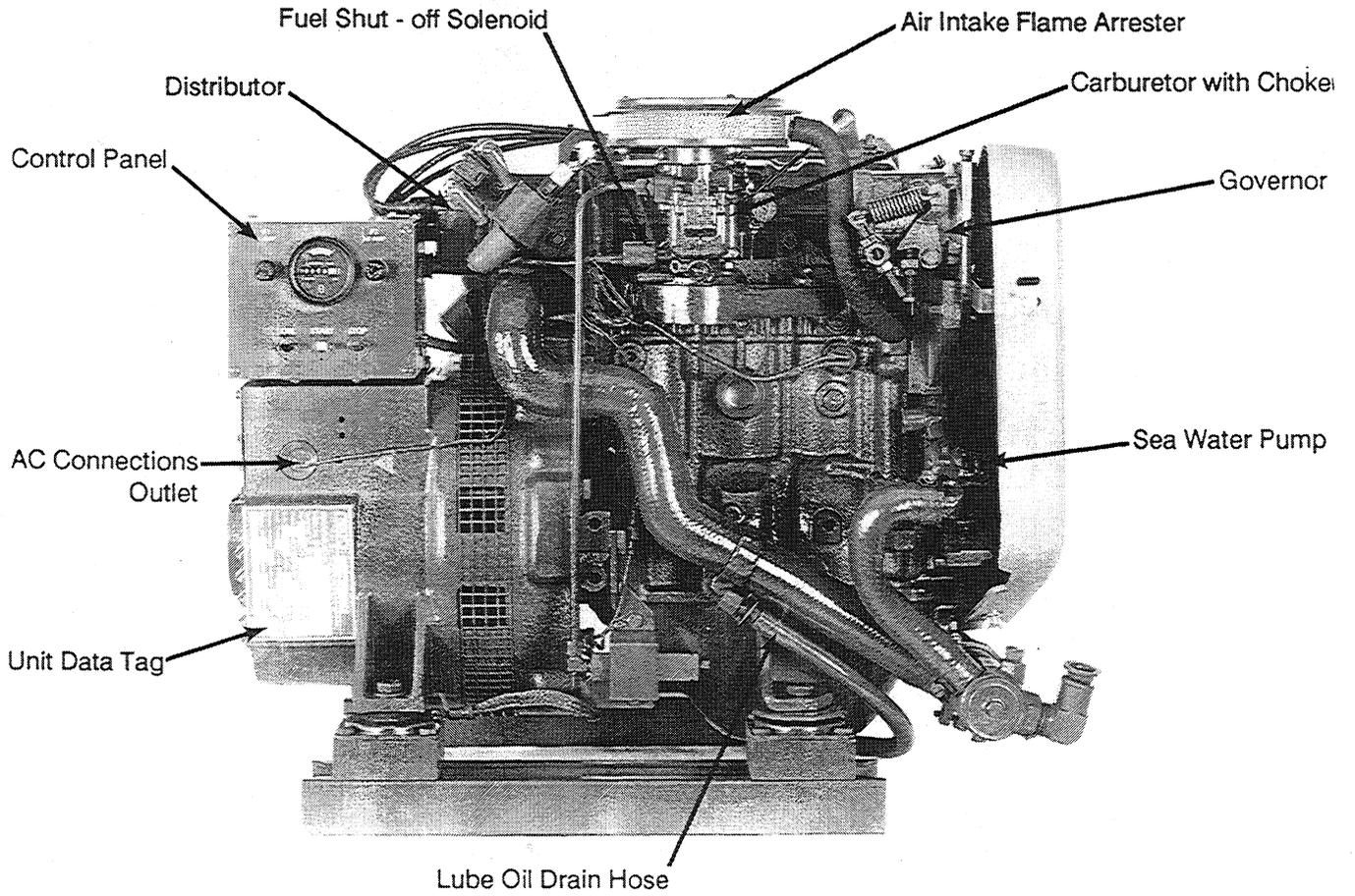
TABLE OF CONTENTS
(CONTINUED)

CYLINDER HEAD ASSEMBLY.....	109
LUBRICATION SYSTEM	119
GENERATOR DESCRIPTION AND MODEL RATING	130
TROUBLESHOOTING AND ADJUSTMENTS FOR THE BC GENERATOR.....	131
COMPONENT RESISTANCE VALUES.....	134
GENERATOR TROUBLESHOOTING	143
GENERATOR HERTZ (CYCLE) AND VOLTAGE CHANGES.....	145
FIELD FABRICATED TOOLS	147
INDEX	151

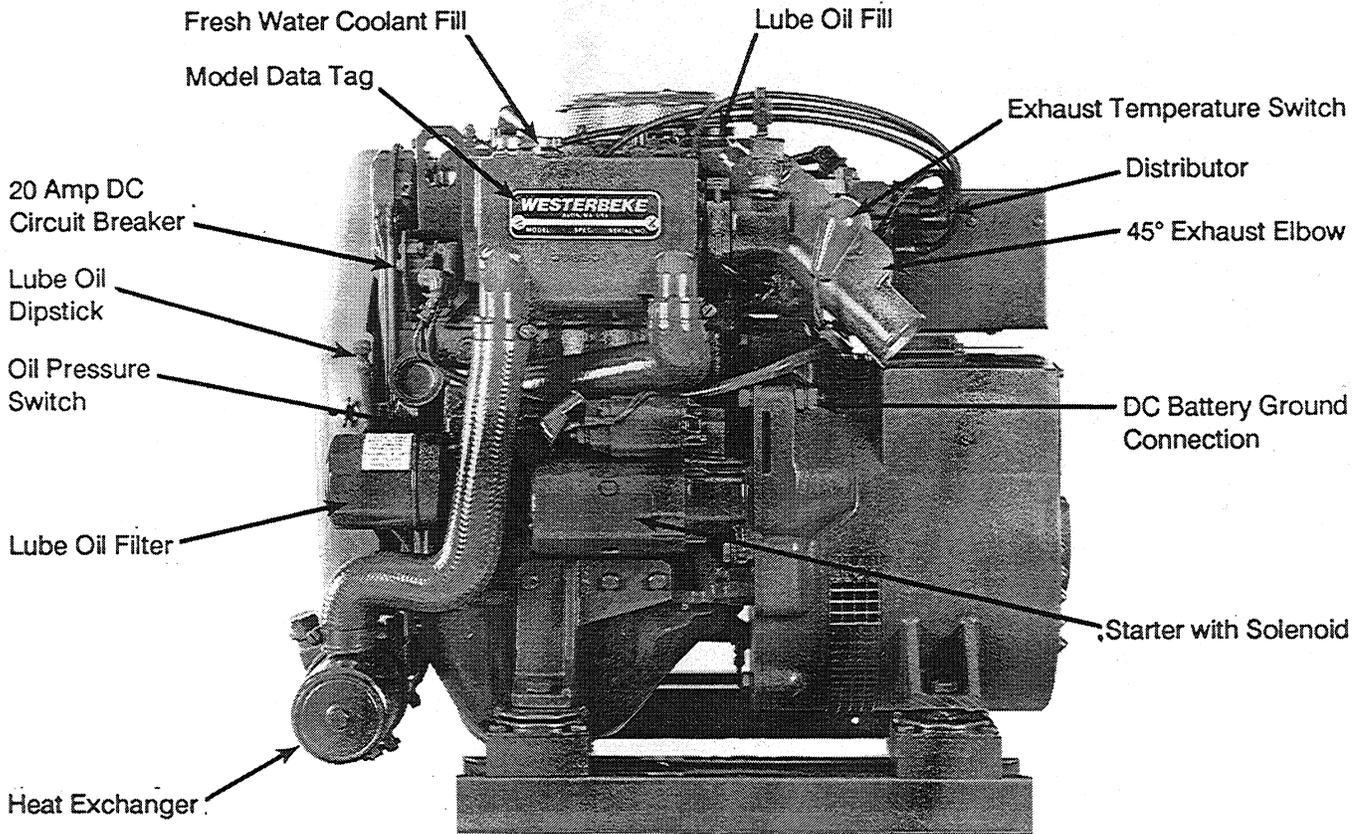
4.5 KW BCG Marine Gasoline Generator



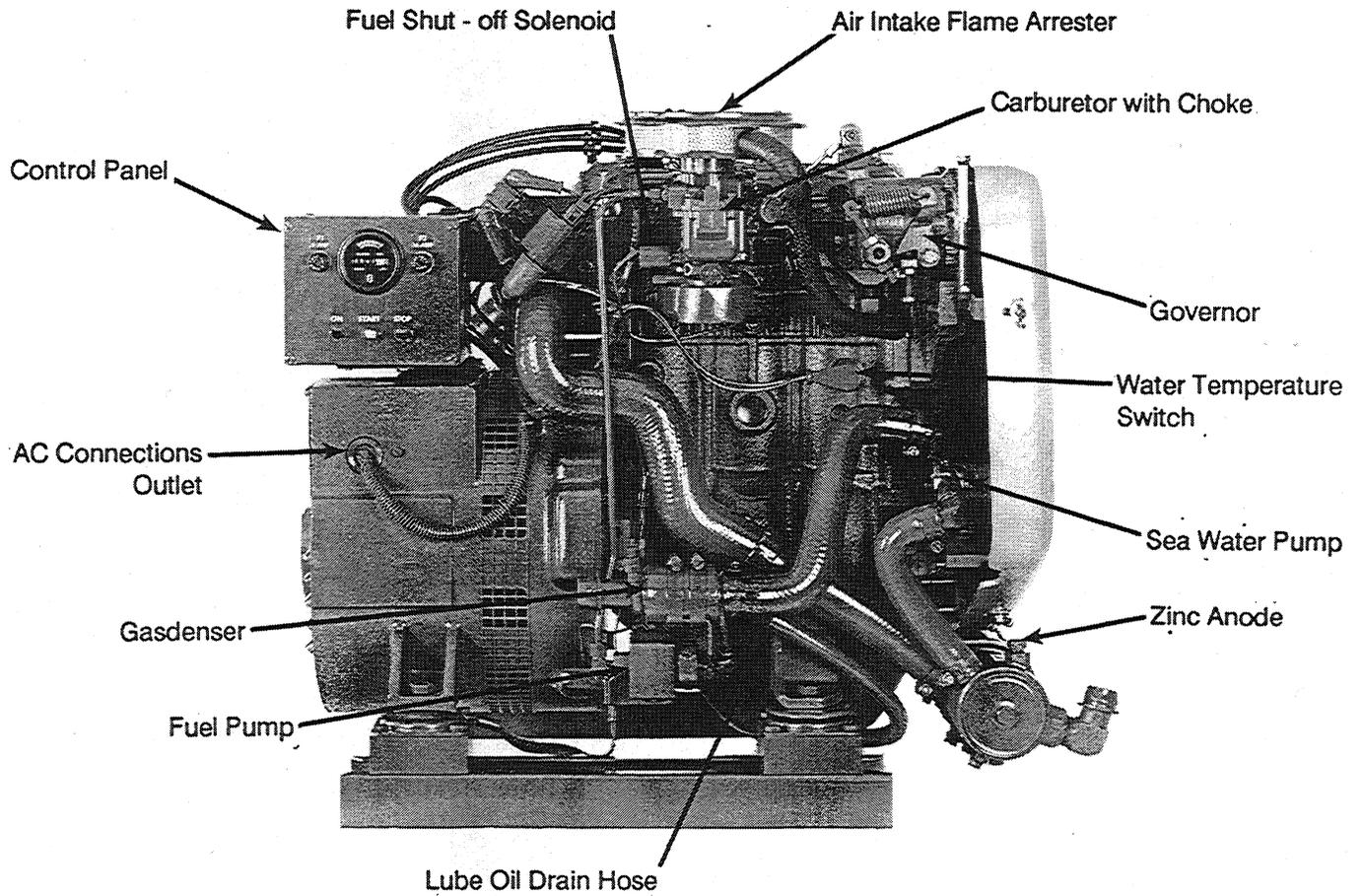
4.5 KW BCG Marine Gasoline Generator



7.0 KW BCG & BCGA Marine Gasoline Generator



7.0 KW BCG & BCGA Marine Gasoline Generator



UNIT I.D. PLATES

4.5 KW BCG - 614 (3.5 KW BCG - 514)

		WESTERBEKE	
<small>AVON INDUSTRIAL PARK, AVON, MASSACHUSETTS 02322</small>			
GENERATOR MODEL	4.5 BCG - 614		
Engine Ser. No.	[]		
Generator Ser. No.	[]		
KW	4.5	KVA	4.5
PF	1.0	Hertz	60
Phase	1	Wires	4
Rating	CONT.		
Volts	120/240	Amps	38/19
Frame	[]		
Insul. Class	F	Temp. Rise	80C @ 40C Ambient
Exciter Voltage	-	Amperes	-
Bat.	12VDC		
Engine HP	8	CID	33.4
RPM	1800		
[]			
24130			

7.0 KW BCG & BCGA - 614 (5.0 KW BCG - 514)

		WESTERBEKE	
<small>AVON INDUSTRIAL PARK, AVON, MASSACHUSETTS 02322</small>			
GENERATOR MODEL	7.0 BCG - 614		
Engine Ser. No.	[]		
Generator Ser. No.	[]		
KW	7.0	KVA	7.0
PF	1	Hertz	60
Phase	1	Wires	4
Rating	CONT.		
Volts	120/240	Amps	58/29
Frame	[]		
Insul. Class	F	Temp. Rise	92C @ 40C Ambient
Exciter Voltage	-	Amperes	-
Bat.	12VDC		
Engine HP	13.5	CID	51.6
RPM	1800		
[]			
24130			

These I.D. plate illustrations are provided for the owner/operator to fill in the unit serial number and generator serial number for future service and part needs.

NOTE: Output rating for 50 hertz units are reduced. Refer to System Specifications.

**4.5 KW BCG MARINE GASOLINE GENERATOR SET
GENERAL SPECIFICATIONS**

Engine Type	Gasoline, four-cycle, three-cylinder, fresh water-cooled Vertical, in-line overhead valve mechanism (6.0 bhp at 1800 rpm, maximum).
Governor	Hoof, flyball type, 5% speed regulation.
Combustion Chamber	Multi-sphere type.
Bore & Stroke	2.44 x 2.38 inches (62.0 x 60.5 mm)
Piston Displacement	33.4 cubic inches (.547 liter)
Firing Order	1-2-3
Direction of Rotation	Clockwise, when viewed from the front.
Maximum Torque (at 1800 rpm)	13.5 lbf-ft
Compression Ratio	10.0:1
Compression Pressure (Limit of difference between cylinders)	198.1 psi (14.0 kg/cm ²) at 400 rpm (28 psi [2.0 kg/cm ²])
Valve Timing	Intake Opens 32° BTDC Intake Closes 52° ABDC Exhaust Opens 56° BBDC Exhaust Closes 28° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine warm)	Intake 0.010 inches (0.25 mm) Exhaust 0.012 inches (0.30 mm)
Engine Speed	1800 rpm 60 hertz. 1500 rpm 50 hertz.
Dimensions	Length: 26.50 inches (673.1 mm) Width: 18.34 inches (465.8 mm) Height: 23.44 inches (595.4 mm)
Dry Weight	Approx. 303 lbs (137.4 kgs)
Fuel Consumption	0.9 U.S. gph (3.41 lph) at full rated output (approximate).
Inclination (all directions)	Continuous 14° Temporary 20° (not to exceed 20 min.)

4.5 KW BCG SYSTEM SPECIFICATIONS

INTAKE SYSTEM

Carburetor (STD type) PN 037832	Manual with butterfly shaped valve, single barrel with U.S.C.G. approved flame arrester.
Manifold	Naturally aspirated.

IGNITION SYSTEM

General	Battery ignition, 12-volts (negative ground), distributor with points condenser, ignition coil and spark plugs.
Distributor	Conventional, contact-points and condenser.
Spark Plug Thread Size	14 mm x 1.25 pitch (0.55 x 0.05 in.)
Spark Plug Type	Westerbeke part number 33805 (Always identify the generator model when ordering parts.)

FUEL SYSTEM

General	Conventional carburetor type with fuel pump.
Fuel	Regular or unleaded gasoline with an octane rating of 89 or higher.
Fuel Pump PN 037818	12-volt DC; lift capacity 5 ft (1.5 m)
Fuel Screens (on engine)	Reusable screen type (located at inlet to carburetor).
Air cleaner	Metal screen type - cleanable.
Air Flow (engine combustion)	18 cfm (0.509 cmm) at 1800 rpm.

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with a heat exchanger.
Operating Temperature	130 - 150°F (55 - 66°C)
Fresh Water Pump PN 037919	Centrifugal type, belt-driven, 1.13:1.

4.5 KW BCG SYSTEM SPECIFICATIONS

Raw Water Pump PN 032617	Positive displacement, rubber impeller, belt-driven.
Raw Water Flow, at 1800 rpm (measured before discharging into exhaust elbow)	3.75 - 4.0 U.S. gpm (14.19 - 15.14 lpm)
System Capacity (fresh water)	4.2 U.S. qts (3.9 liters)

LUBRICATION SYSTEM

General	Fully - Force fed type by Trochoid pump, crankshaft-driven.
Oil Filter PN 036918	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	3.0 qts (2.8 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, 24 A-H, (-) negative ground (recommended) (28 A-H in cold areas).
Battery Capacity	24 - 28 (ampere-hours)
DC Battery Charger	Integral controller 13-volt, 10 amp (located in the AC alternator).
Starter PN 034552	12-volt, 1.2 KW, Magneto engaging type.
DC No-Load Current	90 amp (max.) at 11.5 volts.
DC Cranking Current	100 - 125 amps (engine cold).

OUTPUT LOSS BY ALTITUDE

8% at 3,281 ft (1,000 m)
16% at 6,562 ft (2,000 m)
25% at 9,843 ft (3,000 m)
35% at 13,124 ft (4,000 m)

4.5 KW BCG SYSTEM SPECIFICATIONS

TUNE-UP SPECIFICATIONS

Spark Plug Gap	0.028 - 0.031 inches (0.70 - 0.80 mm)
Contact Point Clearance	0.017 - 0.018 inches (0.4 - 0.5 mm)
Timing	11° ± .5° BTDC at 1800 rpm
Dwell Angle	58 - 66°

AC GENERATOR

General Brushless, four-pole, revolving field.
Self exciting. 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: ±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	37.5 amps
	120/240 volts	37.5/18.7 amps
50 Hertz (1500 rpm)	220 volts	16 amps

AC Circuit Breaker To be rated at 120% of the generator's rated
amperage and voltage output.

Generator Cooling
Air Requirements, (60 hertz),
at 1800 rpm 225 - 240 cfm (6.4 - 6.6 cmm)

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

Engine Combustion Air
Requirements, (60 hertz),
at 1800 rpm 18 cfm (0.509 cmm)

**7.0 KW BCG & BCGA MARINE GASOLINE GENERATOR SET
GENERAL SPECIFICATIONS**

Engine Type	Gasoline, four-cycle, three-cylinder, fresh water-cooled Vertical, in-line overhead valve mechanism (9.5 bhp at 1800 rpm, maximum).
Governor	Hoof, flyball type, 5% speed regulation.
Combustion Chamber	Multi-sphere type.
Bore & Stroke	2.62 x 3.19 inches (66.6 x 81 mm)
Piston Displacement	51.6 cubic inches (.846 liter)
Firing Order	1-2-3
Direction of Rotation	Clockwise, when viewed from the front.
Maximum Torque (at 1800 rpm)	13.5 lbf-ft
Compression Ratio	9.5:1
Compression Pressure (Limit of difference between cylinders)	213.3 psi (15.0 kg/cm ²) at 400 rpm (28 psi [2.0 kg/cm ²])
Valve Timing	Intake Opens 28° BTDC Intake Closes 62° ABDC Exhaust Opens 62° BBDC Exhaust Closes 28° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine warm)	Intake 0.010 inches (0.25 mm) Exhaust 0.012 inches (0.30 mm)
Engine Speed	1800 rpm 60 hertz. 1500 rpm 50 hertz.
Dimensions	Length: 26.50 inches (673.1 mm) Width: 18.34 inches (465.8 mm) Height: 23.44 inches (595.4mm)
Dry Weight	Approx. 328 lbs (148.8 kgs)
Fuel Consumption	1.3 U.S. gph (4.92 lph) at full rated output (approximate).
Inclination (all directions)	Continuous 14° Temporary 20° (not to exceed 20 min.)

7.0 KW BCG & BCGA SYSTEM SPECIFICATIONS

INTAKE SYSTEM

Carburetor (STD type) PN 037832	Manual with butterfly shaped valve, single barrel with U.S.C.G. approved flame arrester.
Manifold	Naturally aspirated.

IGNITION SYSTEM

General	Battery ignition, 12-volts (negative ground), distributor with points condenser, ignition coil and spark plugs.
Distributor	Conventional, contact-points and condenser type.
Spark Plug Thread Size	14 mm x 1.25 pitch (0.55 x 0.05 in.)
Spark Plug Type	Westerbeke part number 33805 (Always identify the generator model when ordering parts.)

FUEL SYSTEM

General	Conventional carburetor type with fuel pump.
Fuel	Regular or unleaded gasoline with an octane rating of 89 or higher.
Fuel Pump PN 037818	12-volt DC; lift capacity 5 ft (1.5 m)
Fuel Screens (on engine)	Reusable screen type (located at inlet to carburetor).
Air cleaner	Metal screen type - cleanable.
Air Flow (engine combustion)	26.8 cfm (0.758 cmm) at 1800 rpm.

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with a heat exchanger.
Operating Temperature	130 - 150°F (55 - 66°C)
Fresh Water Pump PN 037919	Centrifugal type, belt-driven, 1.13:1 to crankshaft.

7.0 KW BCG & BCGA SYSTEM SPECIFICATIONS

Raw Water Pump PN 032617	Positive displacement, rubber impeller, belt-driven.
Raw Water Flow, at 1800 rpm (measured before discharging into exhaust elbow)	3.75 - 4.0 U.S. gpm (14.19 - 15.14 lpm)
System Capacity (fresh water)	4.2 U.S. qts (3.9 liters)

LUBRICATION SYSTEM

General	Fully - Force fed type by Trochoid pump, crankshaft-driven.
Oil Filter PN 036918	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	3.0 qts (2.8 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, 24 A-H, (-) negative ground (recommended) (28 A-H in cold areas).
Battery Capacity	24 - 28 (ampere-hours)
DC Battery Charger	Integral controller 13-volt, 10 amp (located in the AC alternator).
Starter PN 034552	12-volt, 1.2 KW, Magneto engaging type.
DC No-Load Current	90 amp (max.) at 11.5 volts.
DC Cranking Current	100 - 125 amps (engine cold).

OUTPUT LOSS BY ALTITUDE

8% at 3,281 ft (1,000 m)
16% at 6,562 ft (2,000 m)
25% at 9,843 ft (3,000 m)
35% at 13,124 ft (4,000 m)

7.0 KW BCG & BCGA SYSTEM SPECIFICATIONS

TUNE-UP SPECIFICATIONS

Spark Plug Gap	0.028 - 0.031 inches (0.70 - 0.80 mm)
Contact Point Clearance	0.017 - 0.018 inches (0.4 - 0.5 mm)
Timing	10° ± .5° BTDC at 1800 rpm
Dwell Angle	58 - 66°

AC GENERATOR

General	Brushless, four-pole, revolving field. Self exciting. 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: ±5% no-load to full-load. Frequency regulation: ± 3 hertz (5%) no-load to full-load.

NOTE: BCGA models are 60 hertz only. This model cannot be converted to 50 hertz.

Rating (volts AC)

60 Hertz (1800 rpm)	120 volts	58 amps
	120/240 volts	58/29 amps
50 Hertz (1500 rpm)	220 volts	23 amps

AC Circuit Breaker To be rated at 120% of the generator's rated amperage and voltage output.

Generator Cooling
Air Requirements, (60 hertz),
at 1800 rpm 250 cfm (7.0 cmm)

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

Engine Combustion Air
Requirements, (60 hertz),
at 1800 rpm 26.8 cfm (0.758 cmm)

**4.5 KW BCG
ENGINE SERVICE SPECIFICATIONS**

NOTE: All dimensions and specifications contained in this section are given in inches then millimeters unless otherwise stated. For example, 0.002 (0.5 mm).

		Specified Value	Allowable Limit
Cylinder Head			
Lower gasket surface distortion		-	0.0039 (0.10 mm)
Lower surface grinding tolerance		9.9370 (100 mm)	3.9291 (99.8 mm)
Manifold gasket surface distortion		-	0.0039 (0.10 mm)
Valve Seat			
Width	(IN & EX)	0.0472 - 0.0630 (1.2 - 1.6 mm)	0.0906 (2.3 mm)
Angle	(IN) (OUT)	30° - 45° - 70° 25° - 45° - 70°	- -
Recession	(IN)	0.0591 - 0.0787 (1.5 - 2.0 mm)	0.0984 (2.5 mm)
	(EX)	0.0748 - 0.0945 (1.9 - 2.4 mm)	0.1142 (2.9 mm)
Valve Guide Bush			
Inner diameter	(IN & EX)	0.2756 - 0.2764 (7.000 - 7.020 mm)	0.2774 (7.045 mm)
Projection height		0.5984 - 0.6220 (15.2 - 15.8 mm)	- -
Valves			
Seat width	(IN & EX)	0.0472 - 0.0630 (1.2 - 1.6 mm)	0.0906 (2.3 mm)
Seat angle		44° 30'	-

	Specified Value	Allowable Limit
Valves (continued)		
Valve head stock thickness (IN)	0.0394 - 0.0551 (1.0 - 1.4 mm)	0.0354 (0.9 mm)
(EX)	0.0512 - 0.0669 (1.3 - 1.7 mm)	0.0433 (1.1 mm)
Valve stem outer diameter (IN)	0.2740 - 0.2746 (6.96 - 6.975 mm)	0.2732 (6.94 mm)
(EX)	0.2738 - 0.2744 (6.955 - 6.970 mm)	0.2730 (6.935 mm)
Overall length (IN)	4.4228 (112.34 mm)	-
(EX)	4.4346 (112.64 mm)	-
Stem head recession	-	0.008 (0.2 mm)
Valve Spring		
Free length	1.7795 - 1.8110 (45.2 - 46.0 mm)	1.7441 (44.3 mm)
Length as installed	1.4961 (38.0 mm)	-
Tension as installed	58.2 - 64.8 lb (26.4 - 29.4 kg)	50.7 lb (23.0 kg)
Squareness	0.0630 (1.6 mm)	-
Valve Rocker Shaft and Rocker Arm		
Rocker arm inner diameter	0.6299 - 0.6306 (16.000 - 16.018 mm)	0.6313 (16.035 mm)
Valve rocker shaft outer diameter	0.6287 - 0.6294 (15.968 - 15.988 mm)	0.6281 (15.955 mm)
Shaft to arm oil clearance	0.0005 - 0.0020 (0.012 - 0.050 mm)	0.0031 (0.08 mm)

	Specified Value	Allowable Limit
Cylinder Block		
Upper gasket surface distortion	0.0020 (0.05 mm)	0.0031 (0.08 mm)
Cylinder block height	8.6575 - 8.6653 (219.9 - 220.1 mm)	8.6535 (219.8 mm)
Cylinder bore	2.4409 - 2.4421 (62.00 - 62.03 mm)	0.0039 (0.1 mm)
Cylinder out of roundness and taper	- -	0.0012 (0.03 mm)
Piston, Piston Pin, and Piston Ring		
Piston to cylinder clearance	0.0014 - 0.0022 (0.035 - 0.055 mm)	0.0039 (0.10 mm)
Piston ring end gap compression No. 1	0.0098 - 0.0157 (0.25 - 0.40 mm)	0.0256 (0.65 mm)
Piston ring end gap compression No. 2	0.0079 - 0.0138 (0.20 - 0.35 mm)	0.0256 (0.65 mm)
Piston ring end gap oil	0.0079 - 0.0276 (0.20 - 0.70 mm)	0.0394 (1.00 mm)
Piston ring side clearance compression No. 1	0.0012 - 0.0028 (0.03 - 0.07 mm)	0.0047 (0.12 mm)
Piston ring side clearance compression No. 2	0.0008 - 0.0024 (0.02 - 0.06 mm)	0.0043 (0.11 mm)
Piston outer diameter	2.4392 - 2.4403 (61.955 - 61.985 mm)	- -
Piston inner diameter for piston pin	0.6299 - 0.6302 (15.999 - 16.008 mm)	- -
Piston pin outer diameter	0.6296 - 0.6299 (15.991 - 16.000 mm)	- -
Piston to piston pin clearance	0.0002 - 0.0004 (0.005 - 0.011 mm)	0.0020 (0.050 mm)

	Specified Value	Allowable Limit
Connecting Rod		
Rod bend	- -	0.0020 (0.05 mm)
Rod twist	- -	0.0020 (0.05 mm)
Pin portion width	0.7874 - 0.7894 (20.00 - 20.05 mm)	- -
Rod width	0.7795 - 0.7815 (19.80 - 19.85 mm)	- -
Big end thrust clearance	0.0059 - 0.0098 (0.15 - 0.25 mm)	0.0118 (0.30 mm)
Connecting rod bearing oil clearance	0.0008 - 0.0017 (0.020 - 0.044 mm)	0.0028 (0.07 mm)
Crankshaft		
Crankshaft bend	- -	0.0012 (0.03 mm)
Uneven wear of journal and pin section	- -	0.0008 (0.02 mm)
Main journal diameter	1.6526 - 1.6535 (41.976 - 42.000 mm)	- -
Crank pin diameter	1.4557 - 1.4567 (36.976 - 37.000 mm)	- -
Crankshaft bearing oil clearance	0.0008 - 0.0017 (0.020 - 0.044 mm)	0.0028 (0.07 mm)
Side clearance	0.0008 - 0.0087 (0.02 - 0.22 mm)	0.0118 (0.30 mm)
Camshaft		
Camshaft thrust clearance	0.0020 - 0.0118 (0.05 - 0.30 mm)	0.0177 (0.45 mm)
Camshaft bend	- -	0.0012 (0.03 mm)

	Specified Value	Allowable Limit
Camshaft (continued)		
Cam lobe height (IN)	1.3858 - 1.3913 (35.20 - 35.34 mm)	1.3819 (35.10 mm)
(EX)	1.3835 - 1.3890 (35.14 - 35.28 mm)	1.3799 (35.05 mm)
Camshaft journal diameter		
Front	1.6709 - 1.6717 (42.44 - 42.46 mm)	- -
Center	1.6512 - 1.6520 (41.94 - 41.96 mm)	- -
Rear	1.1791 - 1.1799 (29.95 - 29.97 mm)	- -
Cylinder head journal diameter		
Front	1.6732 - 1.6742 (42.500 - 42.525 mm)	- -
Center	1.6535 - 1.6545 (42.000 - 42.025 mm)	- -
Rear	1.1811 - 1.1819 (30.000 - 30.021 mm)	- -
Uneven wear of camshaft journal	- -	0.0016 (0.04 mm)
Camshaft journal section oil clearance		
Front and Center	0.0016 - 0.0033 (0.040 - 0.085 mm)	0.0051 (0.13 mm)
Rear	0.0012 - 0.0028 (0.030 - 0.071 mm)	0.0047 (0.12 mm)
Timing Belt Pulley		
Camshaft pulley outer diameter	4.3556 - 4.3627 (110.633 - 110.813 mm)	4.3531 (110.57 mm)
Crankshaft pulley outer diameter	2.1536 - 2.1575 (54.701 - 54.801 mm)	2.1512 (54.64 mm)

		Specified Value	Allowable Limit
Flywheel			
Runout		-	0.0039
		-	(0.10 mm)
STD Piston & O/S, U/S Parts List			
STD	Crankshaft thrust washer	Oversize	-
	Crankshaft bearing	Oversize	-
	Connecting rod bearing	Oversize	-
	Piston with pin	Oversize	-
	Piston ring	Oversize	-
	Valve guide bush	None	-
	O/S	Crankshaft thrust washer	Oversize
		0.0049 (0.125 mm)	-
		0.0098 (0.25 mm)	-
Crankshaft bearing		None	-
Connecting rod bearing		None	-
Piston with pin		Oversize	-
		0.0098 (0.25 mm)	-
		0.0197 (0.50 mm)	-
		0.0394 (0.75 mm)	-
		0.0039 (0.100 mm)	-
Piston ring		Oversize	-
		0.0098 (0.25 mm)	-
		0.0197 (0.50 mm)	-
		0.0394 (0.75 mm)	-
		0.0039 (0.100 mm)	-
Valve guide bush	Oversize	-	
	0.0012 (0.03 mm)	-	
U/S	Crankshaft thrust washer	None	-
	Crankshaft bearing	Oversize	-
		0.0098 (0.25 mm)	-
	Connecting rod bearing	Oversize	-
		0.0098 (0.25 mm)	-
	Piston with pin	None	-
	Piston ring	None	-
	Valve guide bush	None	-

		Specified Value	Allowable Limit
Crankshaft Thrust Washer			
STD	Thrust washer thickness	0.0764 - 0.0783 (1.940 - 1.990 mm)	- -
	No. 3 crank journal width	0.8661 - 0.8681 (22.00 - 22.05 mm)	- -
O/S 0.0049 (0.125 mm)	Thrust washer thickness	0.0813 - 0.0833 (2.065 - 2.115 mm)	- -
	No. 3 crank journal width	0.8760 - 0.8780 (22.25 - 22.30 mm)	- -
O/S 0.0098 (0.250 mm)	Thrust washer thickness	0.0862 - 0.0882 (2.190 - 2.240 mm)	- -
	No. 3 crank journal width	0.8858 - 0.8878 (22.50 - 22.55 mm)	- -
Crankshaft Bearing			
STD	Bearing center thickness	0.0783 - 0.0785 (1.990 - 1.994 mm)	- -
	Cylinder block journal section DIA	1.8110 - 1.8120 (46.000 - 46.024 mm)	- -
	Crank journal DIA	1.6526 - 1.6535 (41.976 - 42.000 mm)	- -
U/S 0.0098 (0.25 mm)	Bearing center thickness	0.0636 - 0.0637 (1.615 - 1.619 mm)	- -
	Cylinder block journal section DIA	None	-
	Crank journal DIA	1.6430 - 1.6434 (41.733 - 41.743 mm)	- -
U/S 0.0197 (0.50 mm)	Bearing center thickness	0.0685 - 0.0687 (1.740 - 1.744 mm)	- -
	Cylinder block journal section DIA	None	-
	Crank journal DIA	1.3969 - 1.3973 (35.482 - 35.492 mm)	- -

Connecting Rod		Specified Value	Allowable Limit
STD	Bearing center thickness	0.0587 - 0.0588 (1.490 - 1.494 mm)	- -
	Big end inner diameter	1.5748 - 1.5757 (40.000 - 40.024 mm)	- -
	Crank pin diameter	1.4557 - 1.4567 (36.976 - 37.000 mm)	- -
U/S 0.0098 (0.25 mm)	Bearing center thickness	0.0636 - 0.0637 (1.615 - 1.619 mm)	- -
	Big end inner diameter	None	-
	Crankpin diameter	1.4461 - 1.4465 (36.732 - 36.742 mm)	- -
U/S 0.0197 (0.50 mm)	Bearing center thickness	0.0685 - 0.0687 (1.740 - 1.744 mm)	- -
	Big end inner diameter	None	-
	Crank pin diameter	1.3969 - 1.3973 (35.482 - 35.492 mm)	- -

Piston

For each kind listed below, the cylinder bore finishing DIA = (O/S piston outer DIA) + (Oil clearance 0.0014 in. [0.035 mm] - 0.0022 in. [0.055 mm])

STD	Piston outer diameter	2.4396 - 2.4400 (61.965 - 61.975 mm)	- -
0.0098 (0.25 mm)	Piston outer diameter	2.4494 - 2.4498 (62.215 - 62.225)	- -
0.0197 (0.50 mm)	Piston outer diameter	2.4592 - 2.4596 (62.465 - 62.475 mm)	- -
0.0295 (0.75 mm)	Piston outer diameter	2.4691 - 2.4695 (62.715 - 62.725 mm)	- -
0.0394 (1.00 mm)	Piston outer diameter	2.4789 - 2.4793 (62.965 - 62.975 mm)	- -

		Specified Value	Allowable Limit
Valve Guide Bush			
STD	Bush outer diameter	0.4742 - 0.4748 (12.045 - 12.060 mm)	- -
O/S	Bush outer diameter	0.4754 - 0.4760 (12.075 - 12.090 mm)	- -
Oil Pump			
	Side clearance	0.0014 - 0.0028 (0.035 - 0.070 mm)	0.0059 (0.15 mm)
	Tip clearance	0.0067 - 0.0094 (0.17 - 0.24 mm)	0.0138 (0.35 mm)
	Drive to gear body clearance	0.0024 - 0.0047 (0.06 - 0.12 mm)	0.0098 (0.25 mm)
	Relief valve opening pressure	49.77 - 61.46 lbs/in ² (3.5 - 4.3 kg/cm ²)	- -
Ignition Coil			
	Primary resistance Ω	1.2 ±0.12 Ω	-
	Secondary resistance KΩ	26 ±3.9 KΩ	-
	External resistance Ω	1.7 ±0.17 Ω	-
Distributor			
	Heel gap	0.018 (0.45 mm)	- -
	Dwell angle	62° ±4°	-
	Condenser capacity μF	0.25 μF	-
Resistive Cord			
	Cord resistance KΩ/m	10 - 22 KΩ/m	-

V Belt	Specified Value	Allowable Limit
Belt deflection - inches (mm)	0.37 - 0.45/22.05 lb (9.5 - 11.5/10 kg)	- -

**7.0 KW BCG & BCGA
ENGINE SERVICE SPECIFICATIONS**

NOTE: All dimensions and specifications contained in this section are given in inches then millimeters unless otherwise stated. For example, 0.002 (0.5 mm).

		Specified Value	Allowable Limit
Cylinder Head			
Lower gasket surface distortion		-	0.0039 (0.10 mm)
Lower surface grinding tolerance		9.9370 (100 mm)	3.9291 (99.8 mm)
Manifold gasket surface distortion		-	0.0039 (0.10 mm)
Valve Seat			
Width	(IN & EX)	0.0472 - 0.0630 (1.2 - 1.6 mm)	0.0906 (2.3 mm)
Angle	(IN) (OUT)	30° - 45° - 70° 25° - 45° - 70°	- -
Recession	(IN)	0.0787 - 0.0984 (2.0 - 2.5 mm)	0.1181 (3.0 mm)
	(EX)	0.1437 - 0.1634 (3.65 - 4.15 mm)	0.1831 (4.65 mm)
Valve Guide Bush			
Inner diameter	(IN & EX)	0.2756 - 0.2764 (7.000 - 7.020 mm)	0.2774 (7.045 mm)
Projection height		0.5984 - 0.6220 (15.2 - 15.8 mm)	- -
Valves			
Seat width	(IN & EX)	0.0472 - 0.0630 (1.2 - 1.6 mm)	0.0906 (2.3 mm)
Seat angle		44° 30'	-

	Specified Value	Allowable Limit
Valves (continued)		
Valve head stock thickness (IN)	0.0394 - 0.0551 (1.0 - 1.4 mm)	0.0354 (0.9 mm)
(EX)	0.0512 - 0.0669 (1.3 - 1.7 mm)	0.0433 (1.1 mm)
Valve stem outer diameter (IN)	0.2740 - 0.2746 (6.96 - 6.975 mm)	0.2732 (6.94 mm)
(EX)	0.2738 - 0.2744 (6.955 - 6.970 mm)	0.2730 (6.935 mm)
Overall length (IN)	4.3756 (111.14 mm)	-
(EX)	4.3480 (110.44 mm)	-
Stem head recession	-	0.008 (0.2 mm)
Valve Spring		
Free length	1.7795 - 1.8110 (45.2 - 46.0 mm)	1.7441 (44.3 mm)
Length as installed	1.4961 (38.0 mm)	-
Tension as installed	58.2 - 64.8 lb (26.4 - 29.4 kg)	50.7 lb (23.0 kg)
Squareness	0.0630 (1.6 mm)	-
Valve Rocker Shaft and Rocker Arm		
Rocker arm inner diameter	0.6299 - 0.6306 (16.000 - 16.018 mm)	0.6313 (16.035 mm)
Valve rocker shaft outer diameter	0.6287 - 0.6294 (15.968 - 15.988 mm)	0.6281 (15.955 mm)
Shaft to arm oil clearance	0.0005 - 0.0020 (0.012 - 0.050 mm)	0.0031 (0.08 mm)

	Specified Value	Allowable Limit
Cylinder Block		
Upper gasket surface distortion	0.0020 (0.05 mm)	0.0031 (0.08 mm)
Cylinder block height	9.2874 - 9.2953 (235.9 - 236.1 mm)	9.2834 (235.8 mm)
Cylinder bore	2.6220 - 2.6232 (66.60 - 66.63 mm)	0.0039 (0.1 mm)
Cylinder out of roundness and taper	- -	0.0012 (0.03 mm)
Piston, Piston Pin, and Piston Ring		
Piston to cylinder clearance	0.0016 - 0.0024 (0.040 - 0.060 mm)	0.004 (0.11 mm)
Piston ring end gap compression No. 1	0.0098 - 0.0157 (0.25 - 0.40 mm)	0.0256 (0.65 mm)
Piston ring end gap compression No. 2	0.0079 - 0.0138 (0.20 - 0.35 mm)	0.0256 (0.65 mm)
Piston ring end gap oil	0.0079 - 0.0276 (0.20 - 0.70 mm)	0.0394 (1.00 mm)
Piston ring side clearance compression No. 1	0.0012 - 0.0028 (0.03 - 0.07 mm)	0.0047 (0.12 mm)
Piston ring side clearance compression No. 2	0.0008 - 0.0024 (0.02 - 0.06 mm)	0.0043 (0.11 mm)
Piston outer diameter	2.6201 - 2.6213 (66.550 - 66.580 mm)	- -
Piston inner diameter for piston pin	0.7086 - 0.7090 (17.999 - 18.008 mm)	- -
Piston pin outer diameter	0.7083 - 0.7087 (17.991 - 18.000 mm)	- -
Piston to piston pin clearance	0.0002 - 0.0004 (0.005 - 0.011 mm)	0.0020 (0.050 mm)

	Specified Value	Allowable Limit
Connecting Rod		
Rod bend	- -	0.0020 (0.05 mm)
Rod twist	- -	0.0020 (0.05 mm)
Pin portion width	0.7874 - 0.7894 (20.00 - 20.05 mm)	- -
Rod width	0.7795 - 0.7815 (19.80 - 19.85 mm)	- -
Big end thrust clearance	0.0059 - 0.0098 (0.15 - 0.25 mm)	0.0118 (0.30 mm)
Connecting rod bearing oil clearance	0.0008 - 0.0017 (0.020 - 0.044 mm)	0.0028 (0.07 mm)
Crankshaft		
Crankshaft bend	- -	0.0012 (0.03 mm)
Uneven wear of journal and pin section	- -	0.0008 (0.02 mm)
Main journal diameter	1.8101 - 1.8110 (45.976 - 46.000 mm)	- -
Crank pin diameter	1.5739 - 1.5748 (39.976 - 40.000 mm)	- -
Crankshaft bearing oil clearance	0.0008 - 0.0017 (0.020 - 0.044 mm)	0.0028 (0.07 mm)
Side clearance	0.0008 - 0.0087 (0.02 - 0.22 mm)	0.0118 (0.30 mm)
Camshaft		
Camshaft thrust clearance	0.0020 - 0.0118 (0.05 - 0.30 mm)	0.0177 (0.45 mm)
Camshaft bend	- -	0.0012 (0.03 mm)

	Specified Value	Allowable Limit
Camshaft (continued)		
Cam lobe height (IN)	1.3752 - 1.3807 (34.93 - 35.07 mm)	1.3701 (34.80 mm)
(EX)	1.3728 - 1.3783 (34.87 - 35.01 mm)	1.3681 (34.75 mm)
Camshaft journal diameter		
Front	1.6709 - 1.6717 (42.44 - 42.46 mm)	- -
Center	1.6512 - 1.6520 (41.94 - 41.96 mm)	- -
Rear	1.1791 - 1.1799 (29.95 - 29.97 mm)	- -
Cylinder head journal diameter		
Front	1.6732 - 1.6742 (42.500 - 42.525 mm)	- -
Center	1.6535 - 1.6545 (42.000 - 42.025 mm)	- -
Rear	1.1811 - 1.1819 (30.000 - 30.021 mm)	- -
Uneven wear of camshaft journal	- -	0.0016 (0.04 mm)
Camshaft journal section oil clearance		
Front and Center	0.0016 - 0.0033 (0.040 - 0.085 mm)	0.0051 (0.13 mm)
Rear	0.0012 - 0.0028 (0.030 - 0.071 mm)	0.0047 (0.12 mm)
Timing Belt Pulley		
Camshaft pulley outer diameter	4.3556 - 4.3627 (110.633 - 110.813 mm)	4.3531 (110.57 mm)
Crankshaft pulley outer diameter	2.1536 - 2.1575 (54.701 - 54.801 mm)	2.1512 (54.64 mm)

	Specified Value	Allowable Limit
Flywheel		
Runout	-	0.0039
	-	(0.10 mm)

STD Piston & O/S, U/S Parts List

STD	Crankshaft thrust washer	Oversize	-
	Crankshaft bearing	Oversize	-
	Connecting rod bearing	Oversize	-
	Piston with pin	Oversize	-
	Piston ring	Oversize	-
	Valve guide bush	None	-
O/S	Crankshaft thrust washer	Oversize	-
		0.0049 (0.125 mm)	-
		0.0098 (0.25 mm)	-
	Crankshaft bearing	None	-
		None	-
	Connecting rod bearing	Oversize	-
		0.0098 (0.25 mm)	-
		0.0197 (0.50 mm)	-
		0.0394 (0.75 mm)	-
		0.0039 (0.100 mm)	-
	Piston ring	Oversize	-
		0.0098 (0.25 mm)	-
		0.0197 (0.50 mm)	-
		0.0394 (0.75 mm)	-
		0.0039 (0.100 mm)	-
Valve guide bush	Oversize	-	
	0.0012 (0.03 mm)	-	
U/S	Crankshaft thrust washer	None	-
		Oversize	-
	Crankshaft bearing	0.0098 (0.25 mm)	-
		Oversize	-
	Connecting rod bearing	0.0098 (0.25 mm)	-
		Oversize	-
	Piston with pin	None	-
		None	-
		None	-
Piston ring	None	-	
	None	-	
	None	-	
Valve guide bush	None	-	
	None	-	
	None	-	

		Specified Value	Allowable Limit
Crankshaft Thrust Washer			
STD	Thrust washer thickness	0.0764 - 0.0783 (1.940 - 1.990 mm)	- -
	No. 3 crank journal width	0.8661 - 0.8681 (22.00 - 22.05 mm)	- -
O/S 0.0049 (0.125 mm)	Thrust washer thickness	0.0813 - 0.0833 (2.065 - 2.115 mm)	- -
	No. 3 crank journal width	0.8760 - 0.8780 (22.25 - 22.30 mm)	- -
O/S 0.0098 (0.250 mm)	Thrust washer thickness	0.0862 - 0.0882 (2.190 - 2.240 mm)	- -
	No. 3 crank journal width	0.8858 - 0.8878 (22.50 - 22.55 mm)	- -
Crankshaft Bearing			
STD	Bearing center thickness	0.0783 - 0.0785 (1.990 - 1.994 mm)	- -
	Cylinder block journal section DIA	1.9685 - 1.9694 (50.000 - 50.024 mm)	- -
	Crank journal DIA	1.8101 - 1.8110 (45.976 - 46.000 mm)	- -
U/S 0.0098 (0.25 mm)	Bearing center thickness	0.0833 - 0.0834 (2.115 - 2.119 mm)	- -
	Cylinder block journal section DIA	None	-
	Crank journal DIA	1.8005 - 1.8009 (45.732 - 45.742 mm)	- -

Connecting Rod		Specified Value	Allowable Limit
STD	Bearing center thickness	0.0587 - 0.0588 (1.490 - 1.494 mm)	- -
	Big end inner diameter	1.6929 - 1.6939 (43.000 - 43.024 mm)	- -
	Crank pin diameter	1.5739 - 1.5748 (39.976 - 40.000 mm)	- -
U/S 0.0098 (0.25 mm)	Bearing center thickness	0.0636 - 0.0637 (1.615 - 1.619 mm)	- -
	Big end inner diameter	None	-
	Crankpin diameter	1.5642 - 1.5646 (38.732 - 39.742 mm)	- -

Piston

For each kind listed below, the cylinder bore finishing DIA = (O/S piston outer DIA) + (Oil clearance 0.0014 in. [0.035 mm] - 0.0022 in. [0.055 mm])

STD	Piston outer diameter	2.6201 - 2.6213 (66.55 - 66.58 mm)	- -
0.0098 (0.25 mm)	Piston outer diameter	2.6299 - 2.6311 (66.80 - 66.83 mm)	- -
0.0197 (0.50 mm)	Piston outer diameter	2.6398 - 2.6409 (67.05 - 67.08 mm)	- -
0.0295 (0.75 mm)	Piston outer diameter	2.6496 - 2.6508 (67.30 - 67.33 mm)	- -
0.0394 (1.00 mm)	Piston outer diameter	2.6594 - 2.6606 (67.55 - 67.58 mm)	- -

		Specified Value	Allowable Limit
Valve Guide Bush			
STD	Bush outer diameter	0.4742 - 0.4748 (12.045 - 12.060 mm)	- -
O/S	Bush outer diameter	0.4754 - 0.4760 (12.075 - 12.090 mm)	- -
Oil Pump			
	Side clearance	0.0014 - 0.0028 (0.035 - 0.070 mm)	0.0059 (0.15 mm)
	Tip clearance	0.0067 - 0.0094 (0.17 - 0.24 mm)	0.0138 (0.35 mm)
	Drive to gear body clearance	0.0024 - 0.0047 (0.06 - 0.12 mm)	0.0098 (0.25 mm)
	Relief valve opening pressure	49.77 - 61.46 lbs/in ² (3.5 - 4.3 kg/cm ²)	- -
Ignition Coil			
	Primary resistance Ω	1.2 \pm 0.12 Ω	-
	Secondary resistance K Ω	26 \pm 3.9 K Ω	-
	External resistance Ω	1.7 \pm 0.17 Ω	-
Distributor			
	Heel gap	0.018 (0.45 mm)	- -
	Dwell angle	62° \pm 4°	-
	Condenser capacity μ F	0.25 μ F	-
Resistive Cord			
	Cord resistance K Ω /m	10 - 22 K Ω /m	-

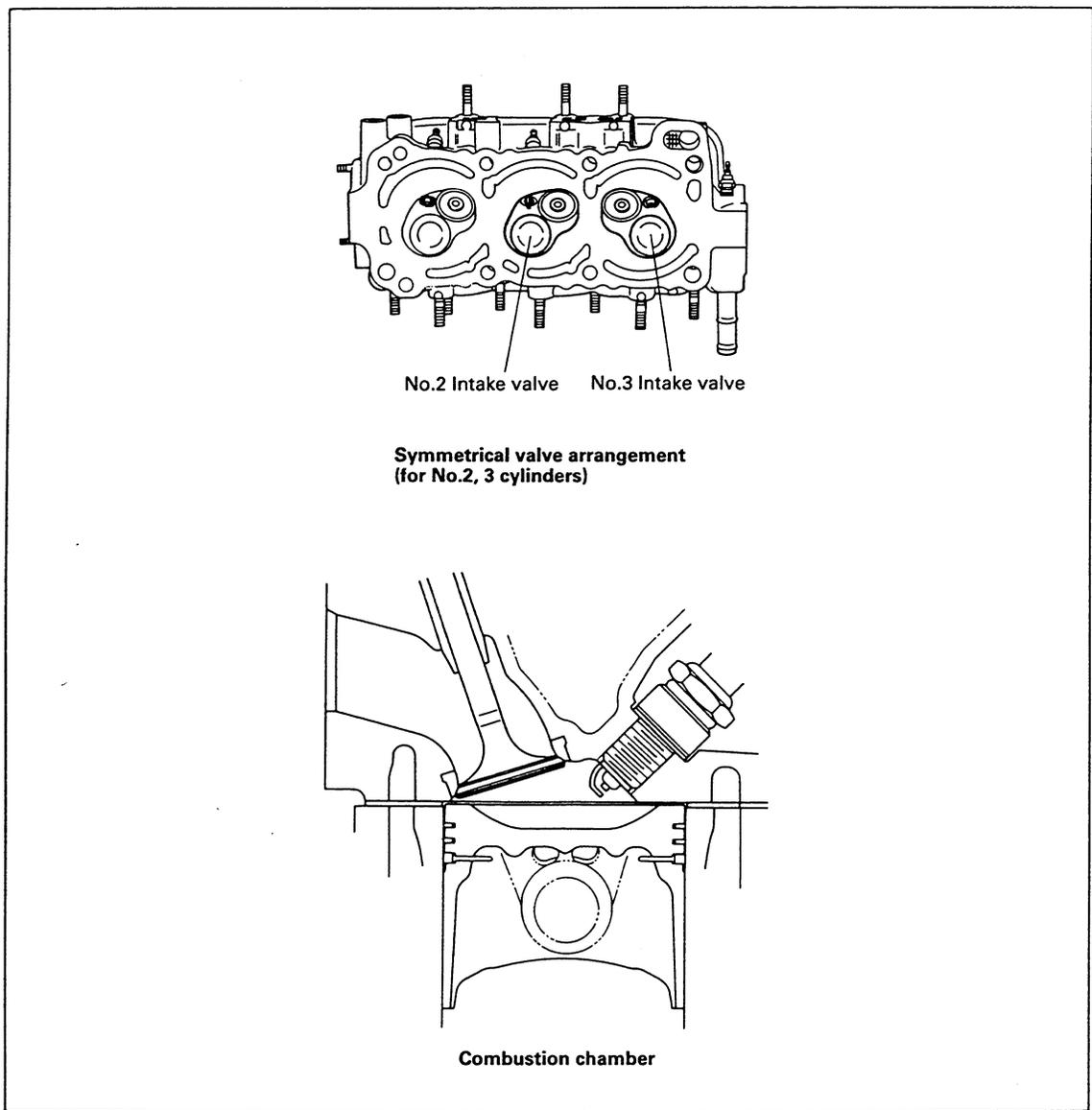
V Belt	Specified Value	Allowable Limit
Belt deflection - inches (mm)	0.37 - 0.45/22.05 lb (9.5 - 11.5/10 kg)	- -

ENGINE DESCRIPTION

Cylinder Head and Combustion Chamber

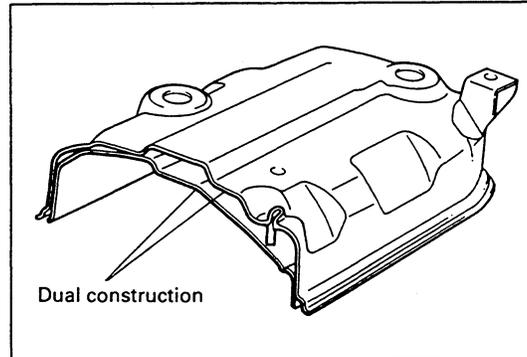
For improved fuel efficiency and increased engine output, the cylinder head and combustion chamber have been designed to incorporate the following constructional features.

1. With a view to obtaining a uniform and strong intake swirl, the valve (for No.2 and No.3 cylinders) has been arranged symmetrically.
2. The combustion chamber has been made compact. In addition, the compression ratio has been increased to 10.0.



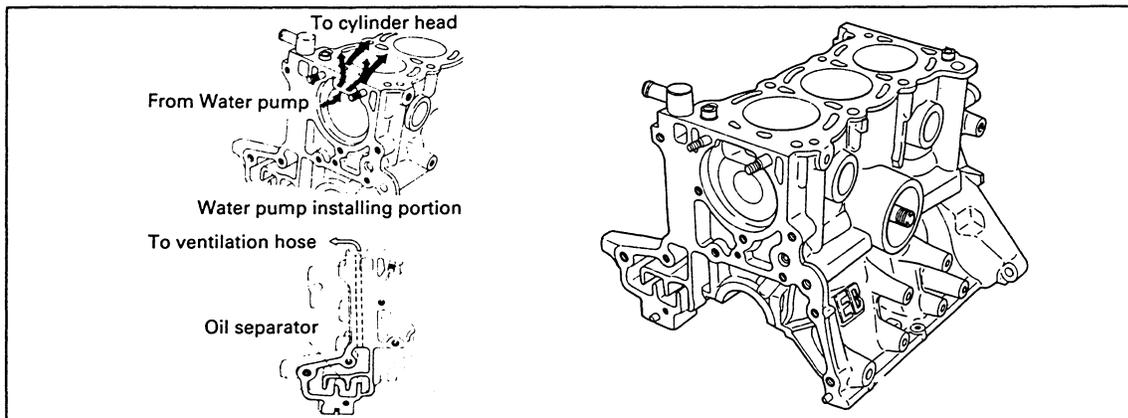
Cylinder Head Cover

The cylinder head cover is made of sheet metal. In addition, the entire head cover has dual construction; thereby, reducing the noise level. It also serves as an oil separator.



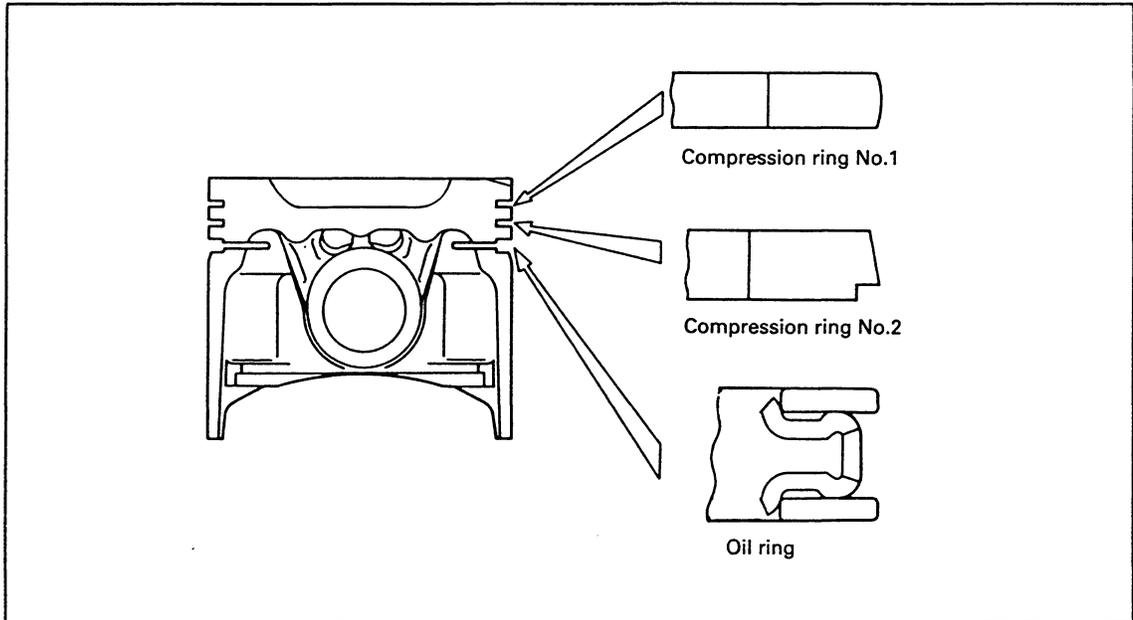
Cylinder Block

The skirt section of the cylinder block has employed a deep skirt type. The water jacket has adopted a full jacket which ensures good cooling performance. The water pump is located at the top gasket surface of the cylinder block. Furthermore, the upper section of the cylinder block has been so constructed that the cooling water directly flows to the cylinder head; thus, enhancing the cooling performance around the combustion chamber. Also, the oil separator and the passage of blow-by gas has been provided at the front of the cylinder block.



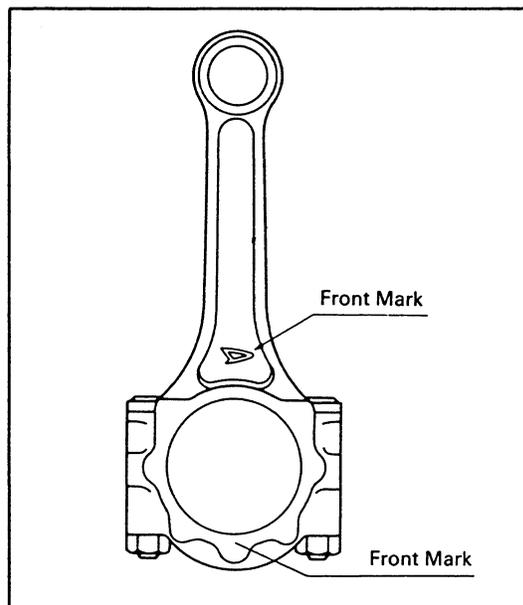
Pistons and Piston Rings

The piston rings have adopted steel rings. Moreover, the sliding surface with the cylinder has undergone a tufftriding treatment. The second ring is a tapered ring made of a special cast iron and has an undercut. In addition, the oil ring has employed a combination type.



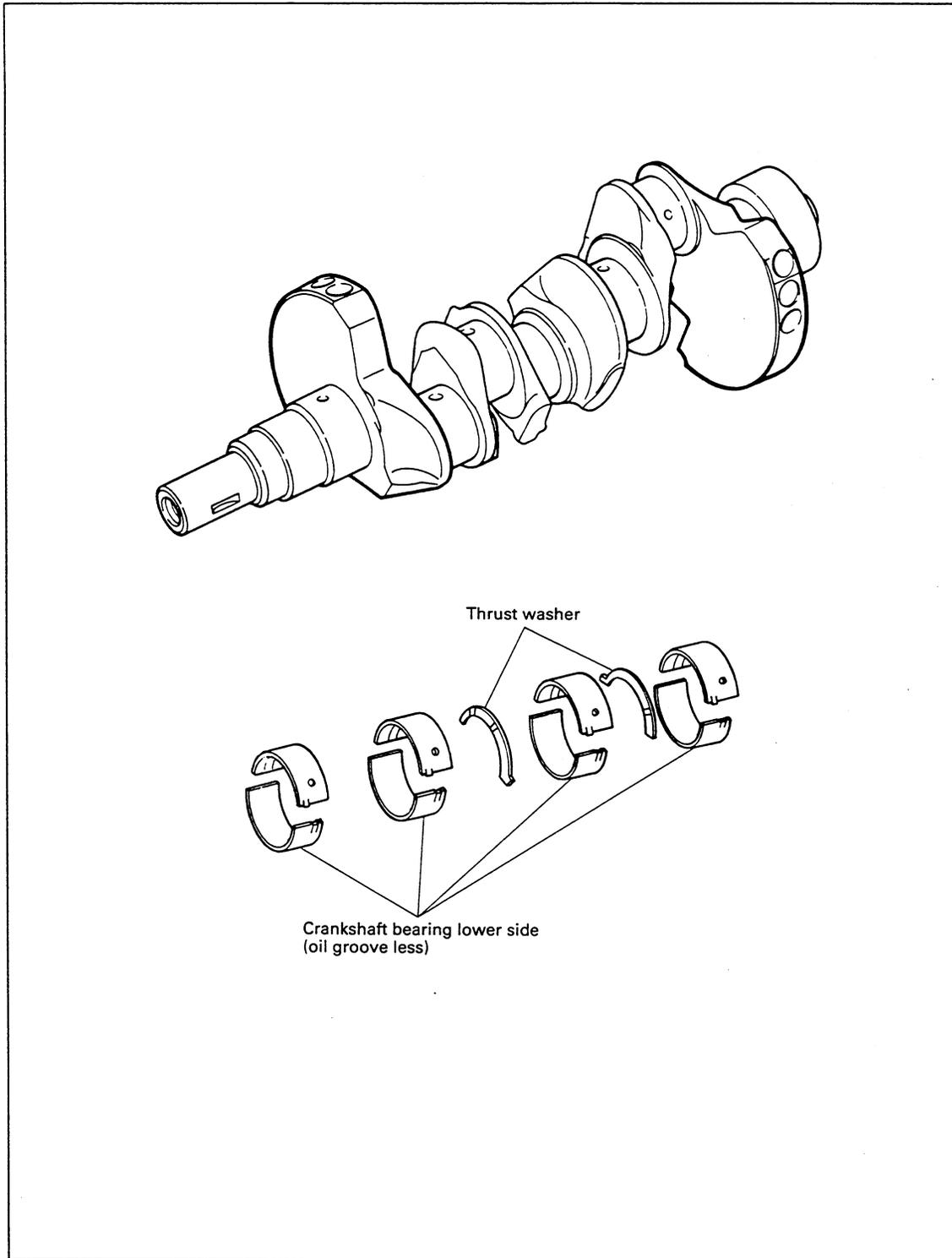
Connecting Rods

The connecting rod has an I-shaped sectional view. The connecting rod is assembled to the piston pin, using a press-fit method.



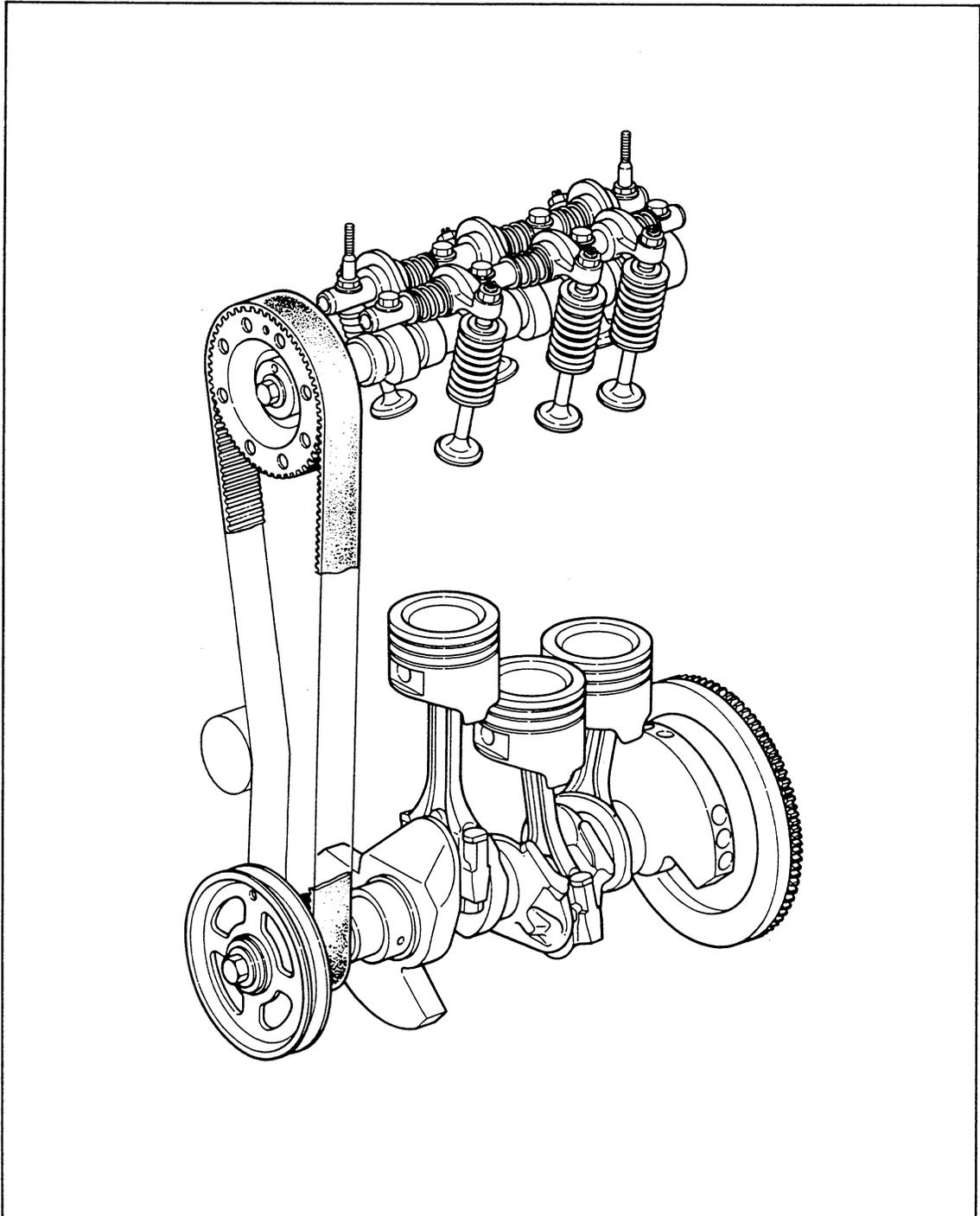
Crankshaft and Bearings

The crankshaft has employed a total balance type, counter weight. Furthermore, for reduced metal-tapping noise level, the crankshaft bearing has adopted a bearing having no oil groove at the lower surface.



Valve Actuating Mechanism

The valve actuating mechanism is of a single overhead camshaft. For increased engine output, the valves for the No.2 and No.3 cylinders are arranged symmetrically, and the intake valves have been enlarged. In order to cope with higher-speed rotation of the engine, unequally pitched valve springs and aluminum rocker arms have been employed. In addition, the valve rocker shafts are mounted directly to the cylinder head by means of bolts.



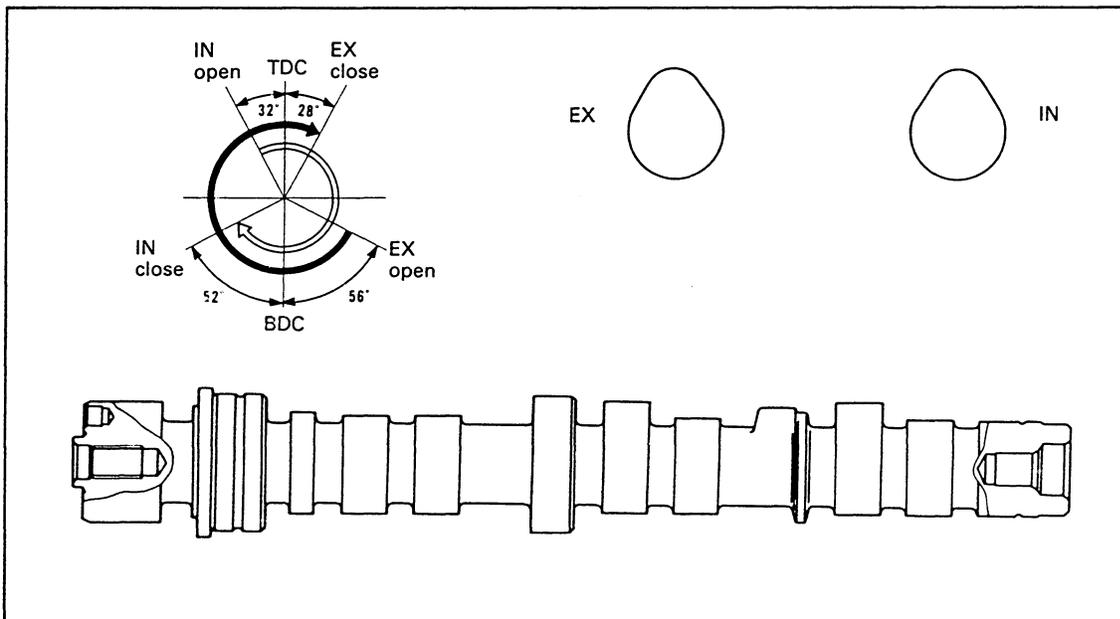
Camshaft

The improved cam profile, in combination with an appropriate valve timing, has made possible the high speed operation of the camshaft.

Dog clutch grooves for driving the distributor have been provided at the rear end of the camshaft. The thrust force of the camshaft has been sustained by a camshaft thrust ring.

mm (inch)

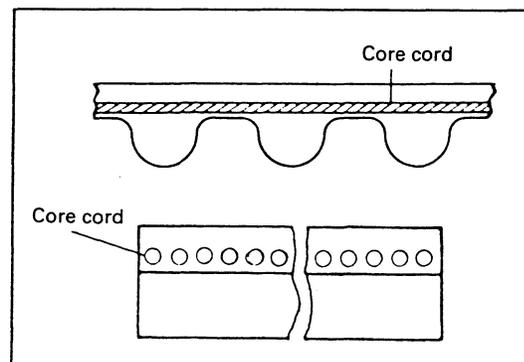
Camshaft journal No.1	42.5 (1.67)
Camshaft journal No.2	42.0 (1.65)
Camshaft journal No.3	30.0 (1.18)
Cam lift (intake)	5.27 (0.207)
Cam lift (exhaust)	5.31 (0.209)
Fuel pump cam lift	2.0



Timing Belt

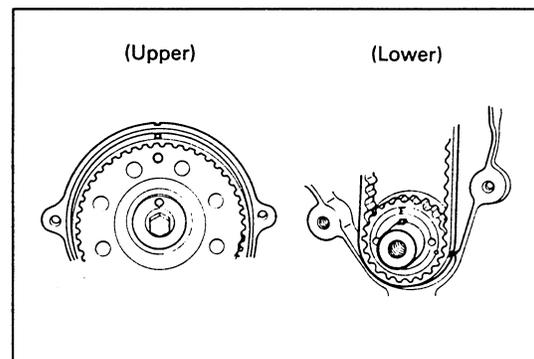
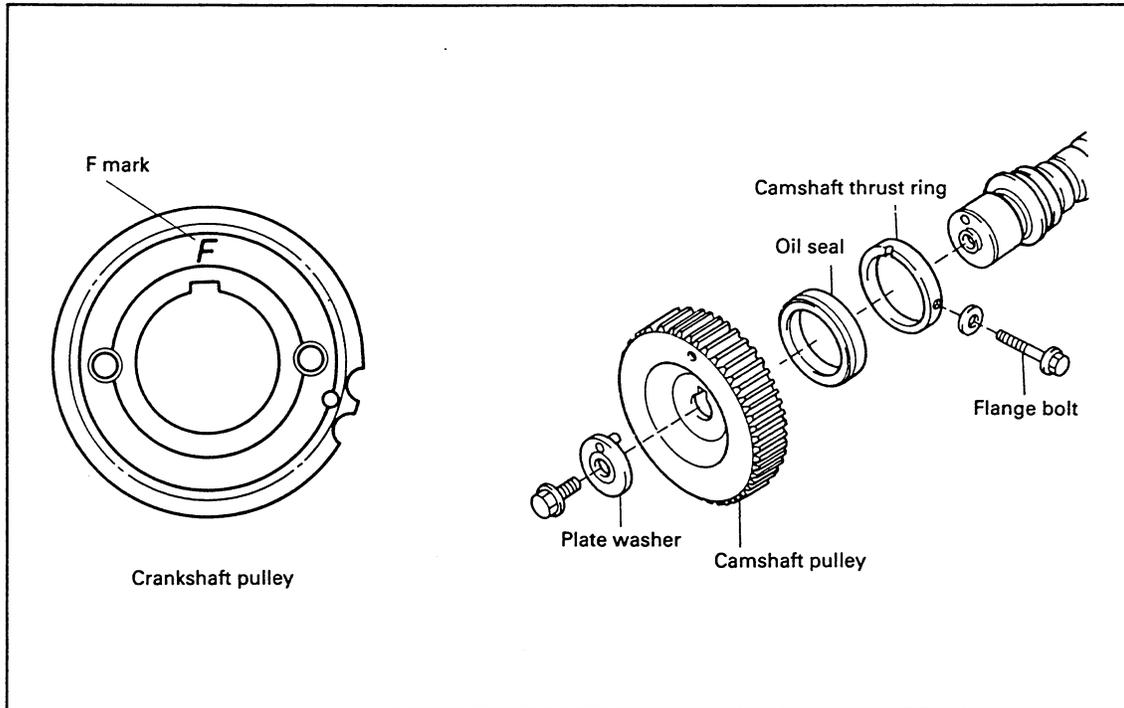
For improved reliability, a round toothed timing belt has been installed.

Nominal name of belt	99Y16
Pitch peripheral length mm (inch)	792 (31.18)
Pitch mm (inch)	8 (0.31)
Tooth number	99
Belt width mm (inch)	16.0



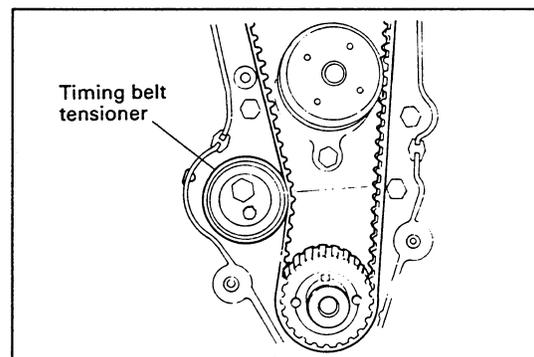
Timing Belt Pulley

For reduced weight, the timing belt pulley at the camshaft side has been made using sheet metal.



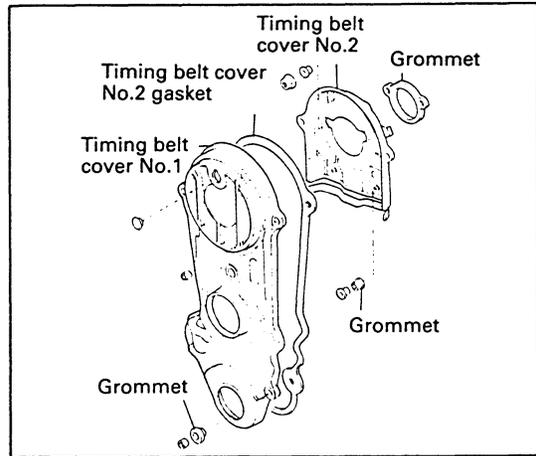
Timing Belt Tensioner

The timing belt tensioner has employed a method in which no tensioner spring is used. Because of this design, the tension adjustment can be performed easily by means of general bolts (M6) during disassembly and reassembly.



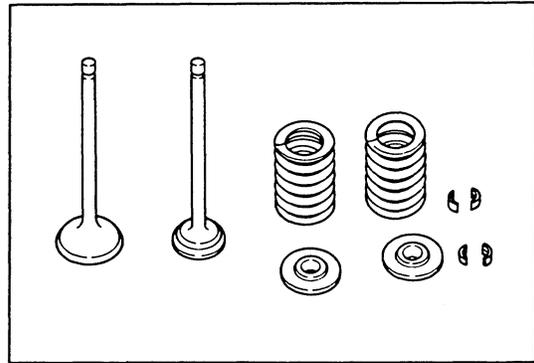
Timing Belt Cover

The timing belt cover consists of No.1 and No.2 sections. Rubber bushes have been provided at all the mating sections with the engine proper; thereby, preventing vibration from transmitting from the engine proper.



Valves and Valve Springs

Both intake and exhaust valves have adopted heat-resistant steel. In addition, the valve springs have employed an unequally pitched type with an unconventional cross-section; thus, preventing the occurrence of surging.



Valve Specifications

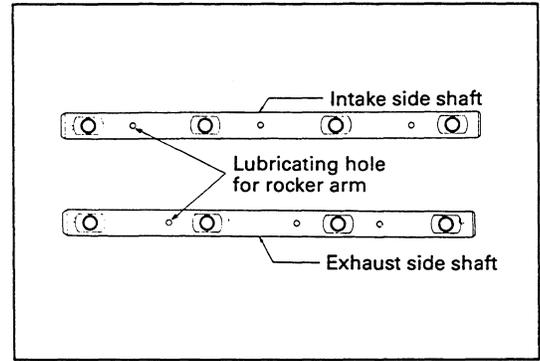
Item		IN	EX
Diameter of valve head section	mm (inch)	30 (1.18)	26 (1.02)
Overall length	mm (inch)	112.34 (4.42)	112.64 (4.43)
Diameter of valve stem section (central section)	mm (inch)	7.0 (0.28)	←

Valve Spring Specifications

Free length	mm (inch)	45.6 (4.35)
Wire diameter	mm (inch)	4.0 (0.16)
Effective winding number		5.75
Coil outer diameter	mm (inch)	27.5 (1.08)
Spring constant	kg/mm (lb/inch)	3.67/4.3 (8.092/0.169)

Valve Rocker Shafts

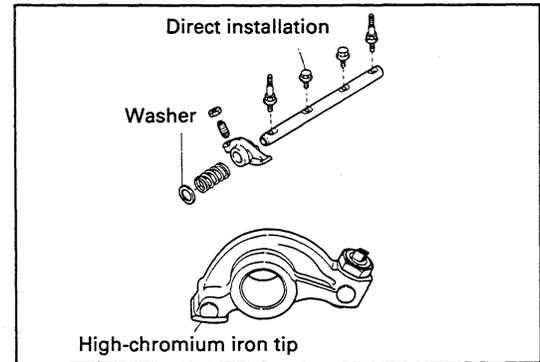
The valve rocker shafts have been installed by means of bolts. The positions of the oil-lubricating holes for the rocker arm differ between the intake and exhaust valve side.



Valve Rocker Arms

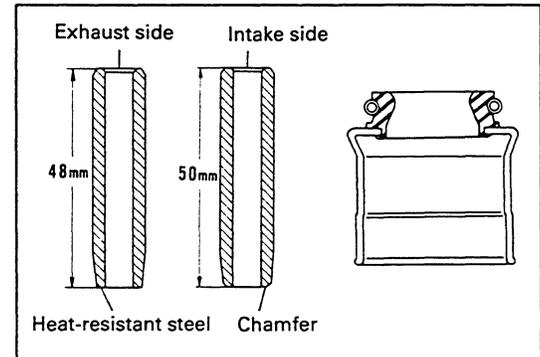
For reduced weight, the valve rocker arm has been made of aluminum. High-chromium iron has been casted on the contact section with the camshaft.

Item	Classification	IN	EX
Valve clearance (during hot)		0.25	0.30
	mm (inch)	(0.0098)	(0.0118)



Valve Guide Bushes and Stem Oil Seals

The valve guide bushes differ in their material and overall length between the intake and exhaust valve sides.



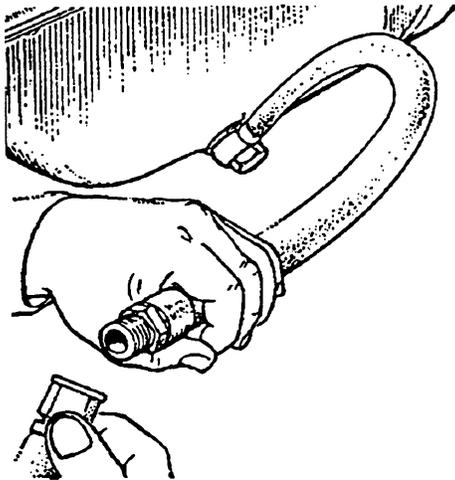
GENERATOR OVERHAUL

Section	Page
PREPARATIONS FOR OVERHAUL.....	47
DISASSEMBLY FOR OVERHAUL	48
Removing the Generator End from the Engine	48
ENGINE DISASSEMBLY.....	50
Removal of External Parts and Subassemblies.....	50
Timing Belt Removal	51
REMOVING THE CYLINDER HEAD FROM THE CYLINDER BLOCK.....	53
CYLINDER HEAD DISASSEMBLY	54
CYLINDER BLOCK DISASSEMBLY	57
SPECIAL SERVICE TOOLS	61

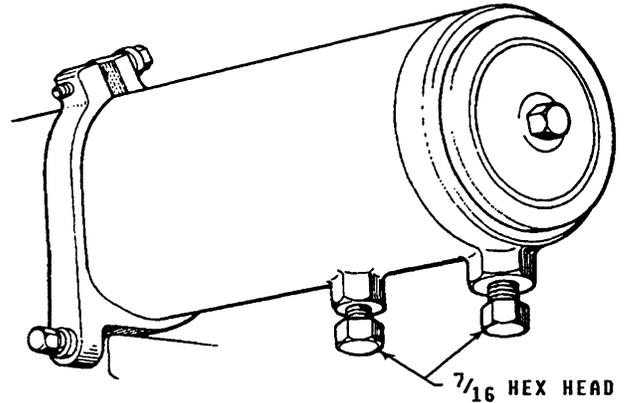
NOTE: Special Service Tools are available to help in the removal or installation of engine parts. Refer to the "SPECIAL SERVICE TOOLS" section of this manual for illustrations and part numbers for each tool.

PREPARATIONS FOR OVERHAUL

1. Remove all AC and DC power connections from the unit.
2. Shut off and disconnect all fuel lines, raw 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



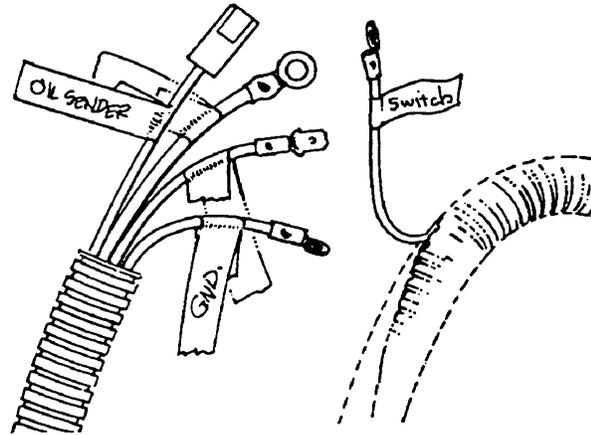
Heat Exchanger Drains

DISASSEMBLY FOR OVERHAUL

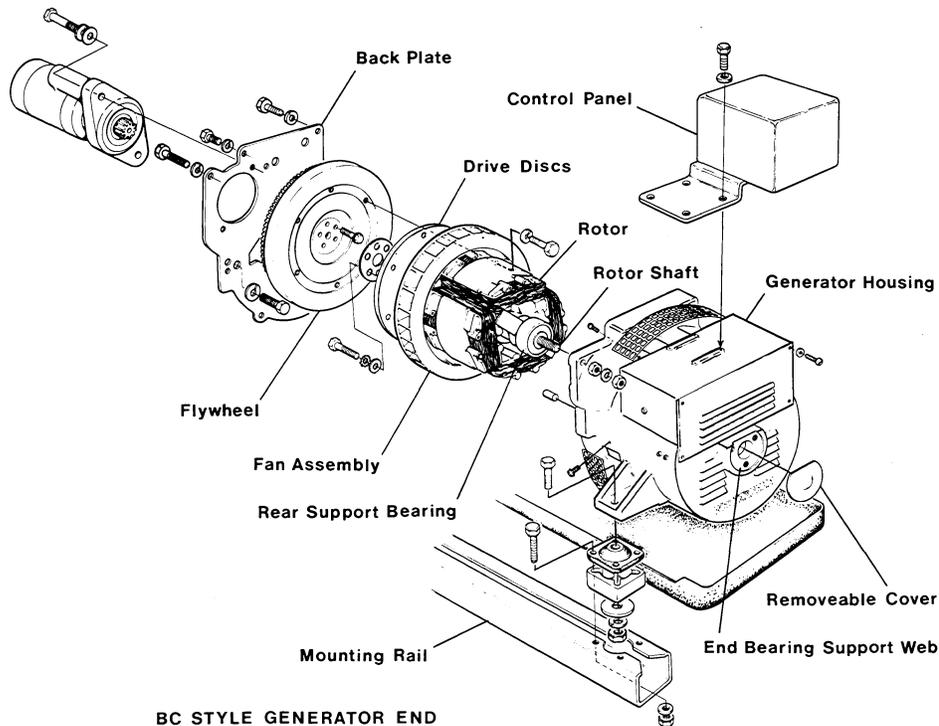
Removing the Generator End from the Engine

1. Disconnect harness leads from the engine connections, and tag and mark all harness connections. Unbolt the control panel from generator housing as one assembly.
2. Supporting the rear of the engine, unbolt the generator housing from the back plate and mounting rails.

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



3. Take off the removable cover and, with the aid of the Housing Puller Tool attached to the end bearing support web and rotor shaft, carefully draw the generator housing off the rear support bearing. In some cases, the rear support bearing may be pulled off the rotor shaft along with the generator housing.
4. When clear of the bearing and/or shaft, manually slide the generator housing carefully off the rotor.



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.

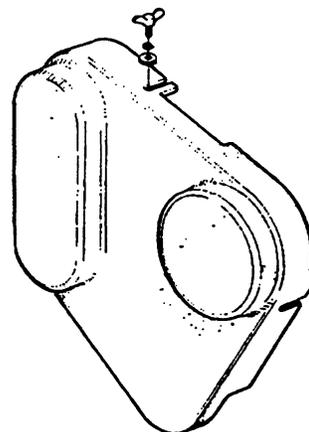
Now that the generator end has been removed, the engine can be disassembled.

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.
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 raw water pump, the drive belt, and the raw water pump's mounting brackets.
6. Set the raw water pump to one side for inspection and overhaul as needed.
7. 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.
8. Remove the fresh water circulating pump's pulley.
9. Remove the fresh water circulating pump.
10. Remove the fuel line, the carburetor, the fuel pump, gasdenser assembly, and the intake manifold.
11. Remove the ignition coil/ballast resistor and its mounting bracket.
12. Remove the engine's backplate.
13. Remove the water temperature switch and the water temperature sender (if installed).
14. Remove the oil pressure switch, the oil pressure sender (if installed), the oil filter, and the oil filter bracket.
15. Remove the thermostat housing and the thermostat.
16. Remove the crankshaft pulley from the crankshaft.
17. Remove the spark plugs from the cylinder head.
18. Remove the distributor assembly from the right rear of the engine.



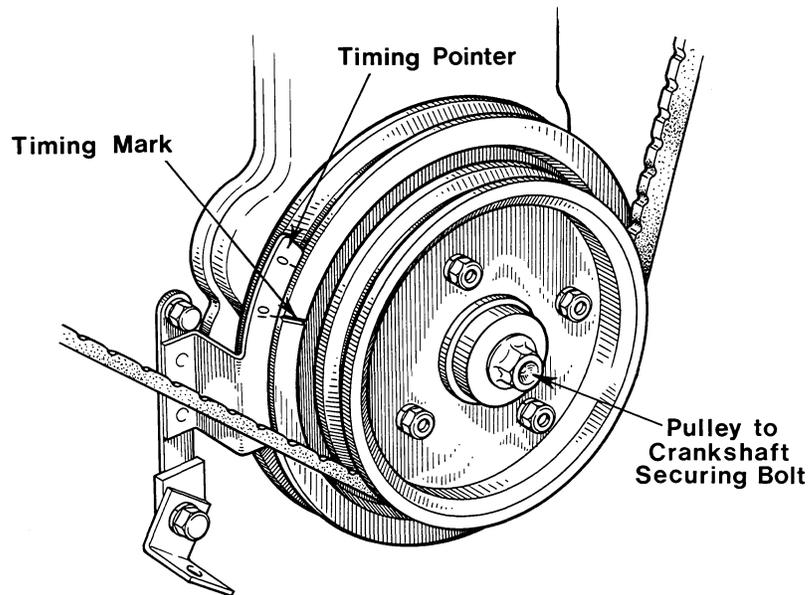
BELT GUARD

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

Since the 4.5 KW BCG and the 7.0 KW BCG & BCGA generator engines are small, three cylinder engines they are not as bulky or as heavy as some automobile engines, the engines may be laid on a sturdy bench while they are disassembled and repaired.

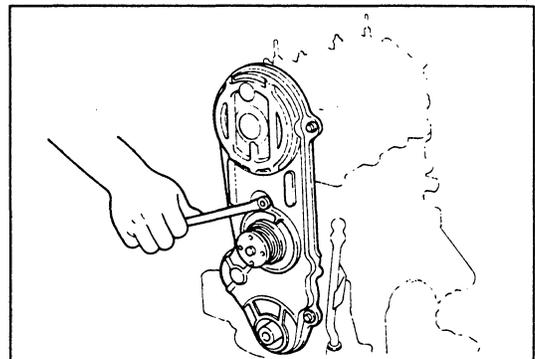
Timing Belt Removal

1. Remove the crankshaft pulley from the crankshaft.



4.5 KW BCG, 7.0 KW BCG & BCGA
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.
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.

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.

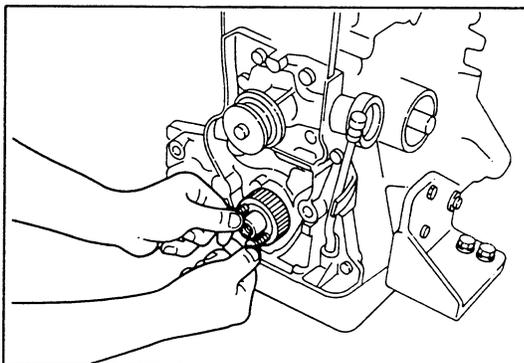
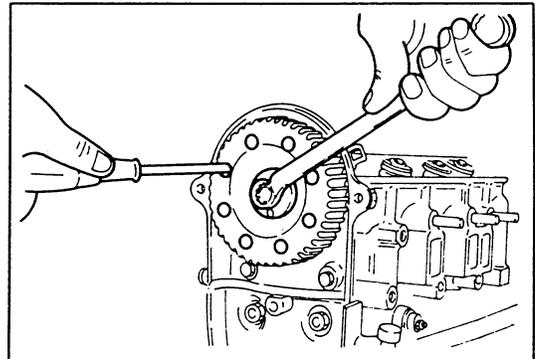
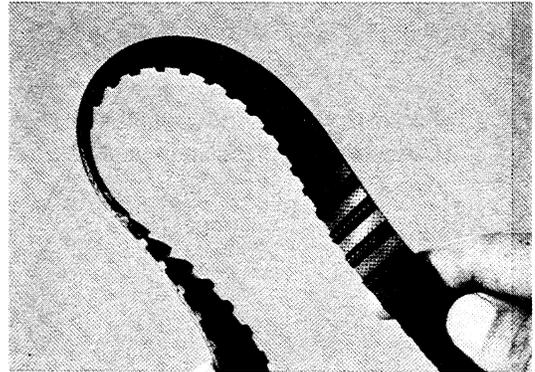
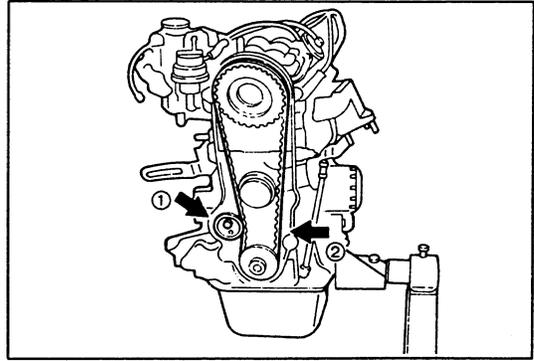
5. Carefully remove the timing belt from its pulleys.

CAUTION

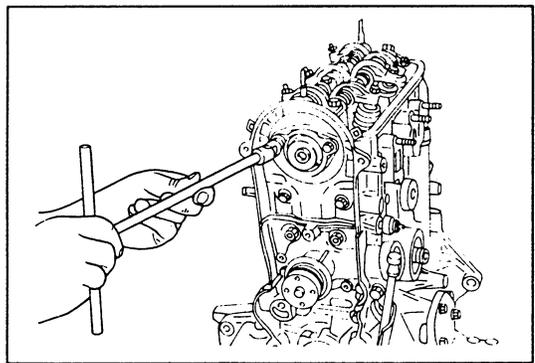
The timing belt *must* be kept free of oil, grease, water or other substances which may cause the belt to deteriorate or swell.

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.
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.



9. Remove the crankshaft timing belt pulley.

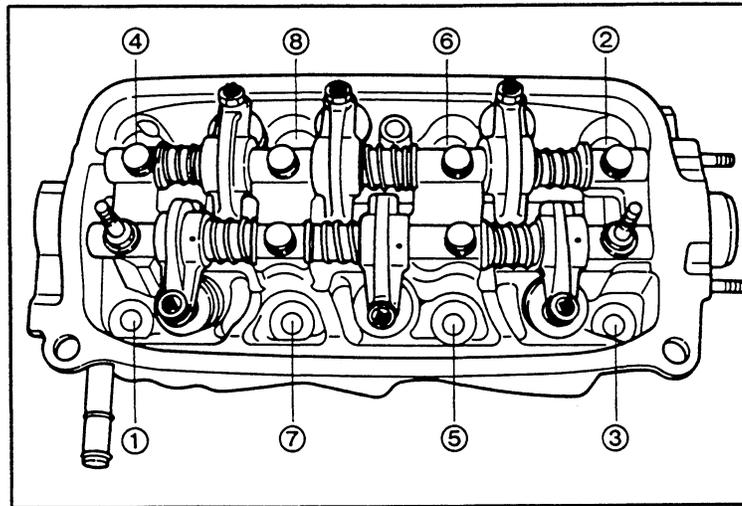


10. Remove the timing belt cover No. 2.

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.

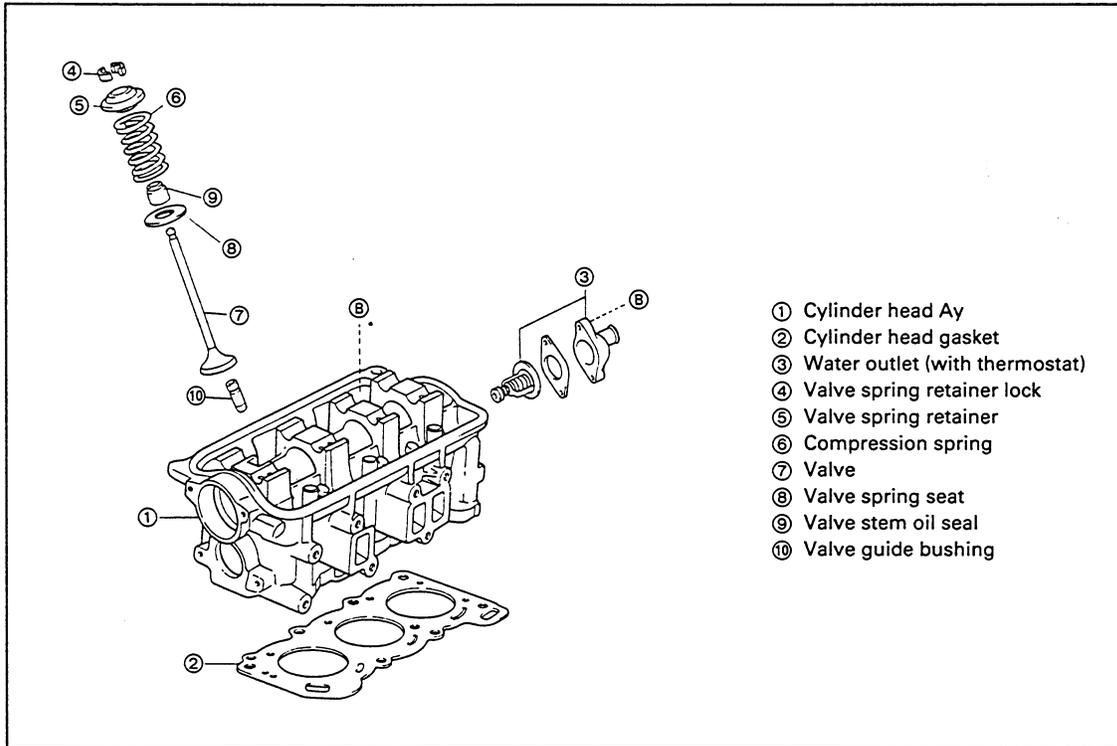
NOTE: Discard the cylinder head gasket when it is removed. When reassembling the cylinder head to the cylinder block, install a new cylinder head gasket.



4.5 KW BCG and 7.0 KW BCG & BCGA
Loosening Sequence

CYLINDER HEAD DISASSEMBLY

Disassemble the cylinder head by removing parts in the order indicated. The figure below presents the relationship of parts for the 4.5 KW BCG and 7.0 KW BCG & BCGA engine's cylinder head.



4.5 KW BCG and 7.0 KW BCG & BCGA DISASSEMBLY ORDER

1. Cylinder Head Ay
2. Cylinder Head Gasket
3. Water Outlet (with thermostat)
4. Valve Spring Retainer Lock
5. Valve Spring Retainer
6. Compression Spring
7. Valve
8. Valve Spring Seat
9. Valve Stem Oil Seal
10. Valve Guide Bushing

*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.

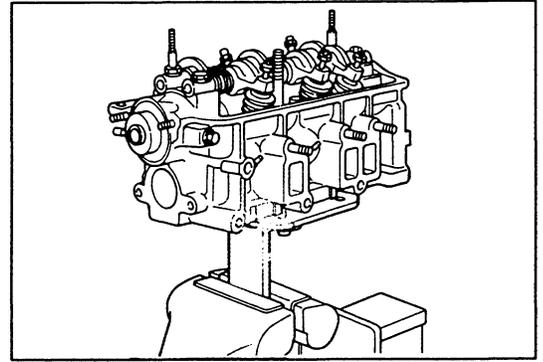


Fig. 3-34 SST Installation

WI-03038

2. Be sure to fully slacken the adjusting screws first. Then, remove the valve rocker shaft.

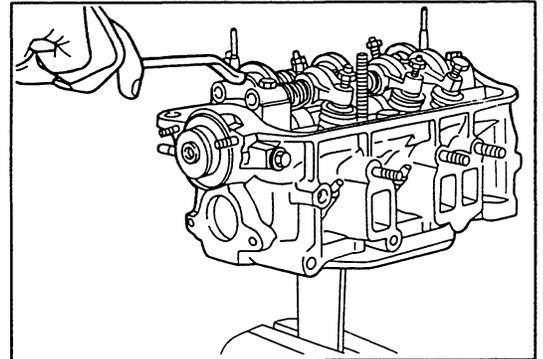


Fig. 3-35 Valve Rocker Shaft Removal

WI-03039

3. Remove the flange bolt for camshaft thrust ring.

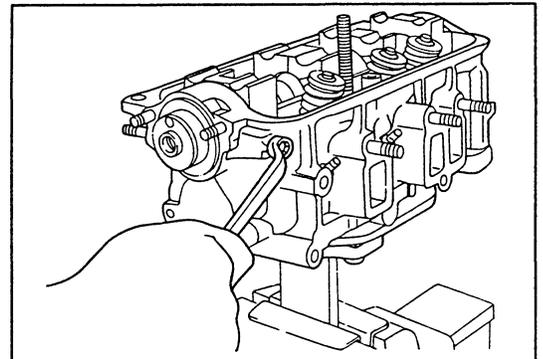


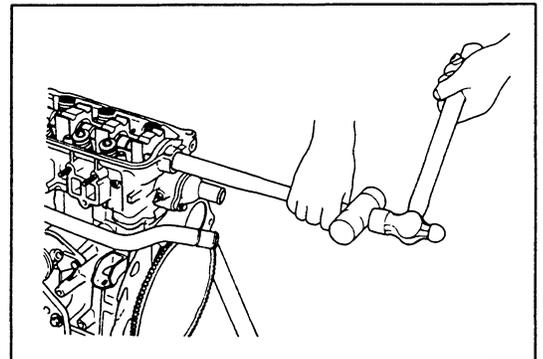
Fig. 3-36 Flange Bolt Removal

WI-03040

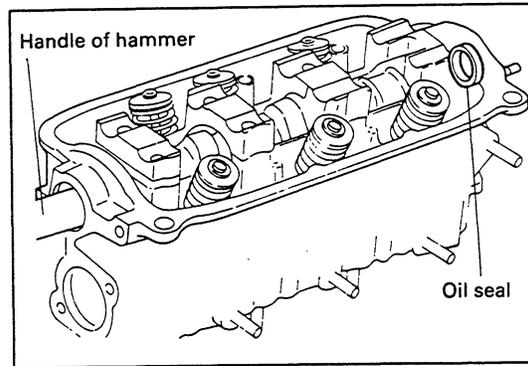
4. Remove the camshaft. Using a wooden dowel placed at the rear end of the camshaft, drive out the camshaft by tapping it with a hammer.

CAUTION

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

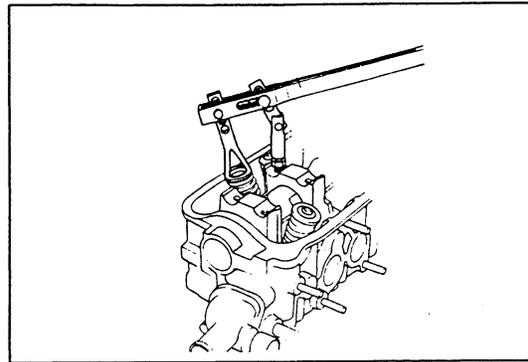


5. Remove the oil seal and camshaft thrust ring. Place the wooden pole to the rear surface of the camshaft. Then, tap the handle to drive out the oil seal. At this time, make sure that the flange bolt has been removed.



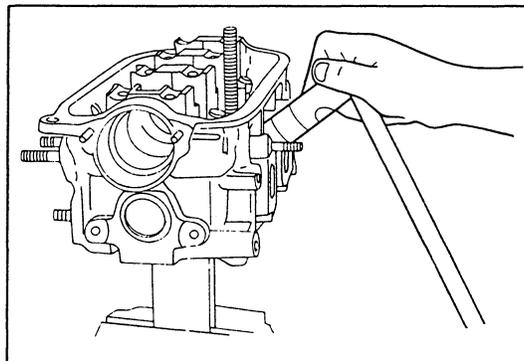
6. Using the valve spring compressor tool PN 37728 or equivalent (snap-on, Craftsman SK), remove the following parts:

- 1) Valve spring retainer lock.
- 2) Compression spring.
- 3) IN and EX valve.



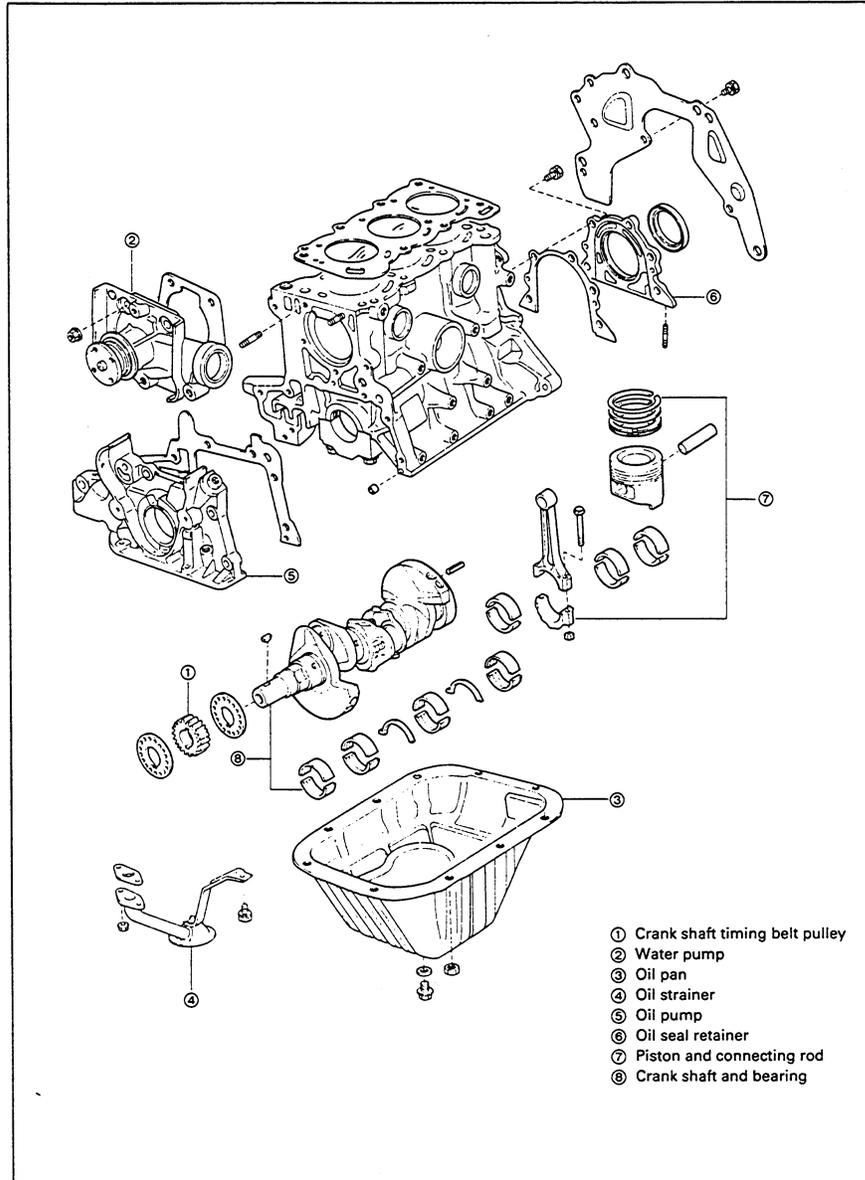
NOTE: As the valves and their associated parts are removed, keep valve sets together and in correct order with respect to their placement in the cylinder head. Unless any of the parts are replaced, they must be returned to the same locations from which they were removed.

7. Remove the spark plug.



CYLINDER BLOCK DISASSEMBLY

Disassemble the cylinder block by removing parts in the order indicated. The figure below presents the relationship of parts for the 4.5 KW BCG and 7.0 KW BCG & BCGA engine's cylinder block.



4.5 KW BCG and 7.0 KW BCG & BCGA DISASSEMBLY ORDER

- | | |
|------------------------------------|-------------------------------|
| 1. Crank shaft timing belt pulley. | 5. Oil pump. |
| 2. Water pump. | 6. Oil seal retainer. |
| 3. Oil pan. | 7. Piston and connecting rod. |
| 4. Oil strainer. | 8. Crank shaft and bearing. |

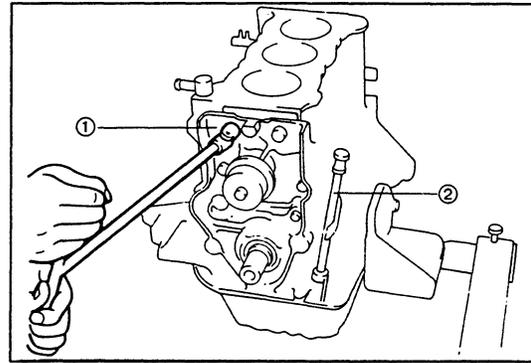
*Denotes that disassembly instructions for these parts follow on the indicated pages.

1. Remove the cylinder head, IN & EX manifold and flywheel related parts.

2. Remove the oil filter element.

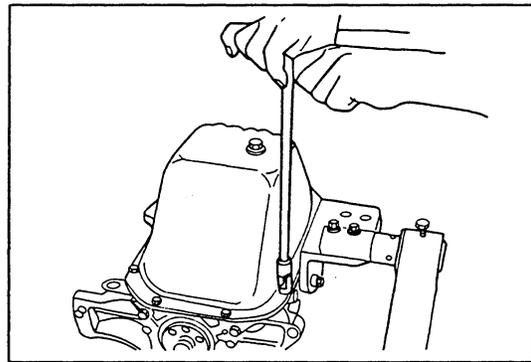
3. Remove the water pump (1) together with the oil level gauge guide (2).

(#1,2, and 3 may have been removed earlier.)

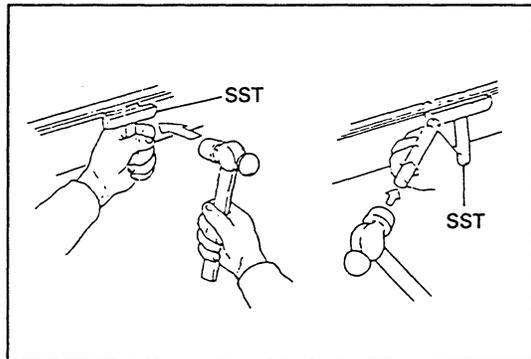


4. Remove the oil pan.

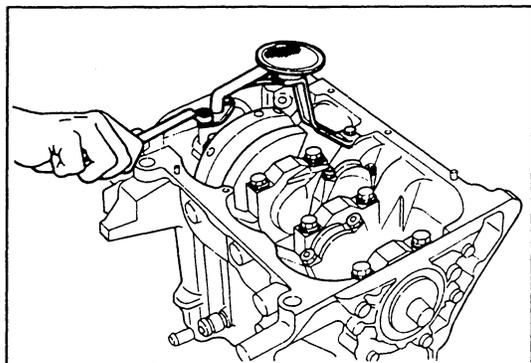
a. Loosen the oil pan attaching bolts.



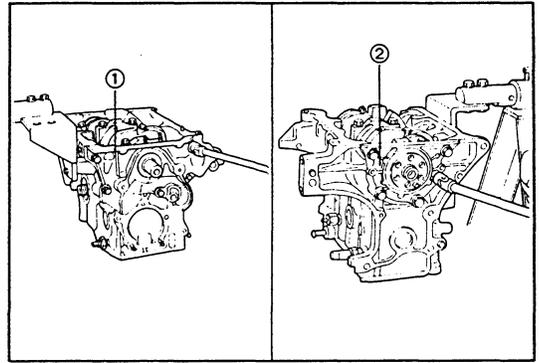
b. Using a putty knife or firm gasket scraper, separate the oil pan from the cylinder block.



5. Remove the oil strainer.

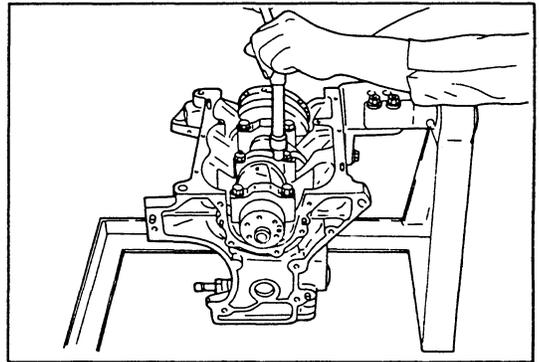


6. Remove the oil pump (1) and oil seal retainer (2).

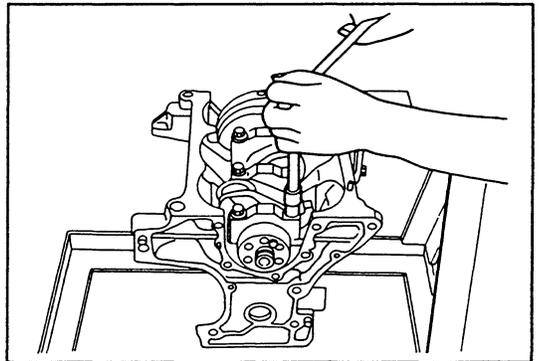


7. Remove the connecting rod cap bolts. Detach the connecting rod cap. Push the connecting rod and piston assembly upward out the top of the cylinder block.

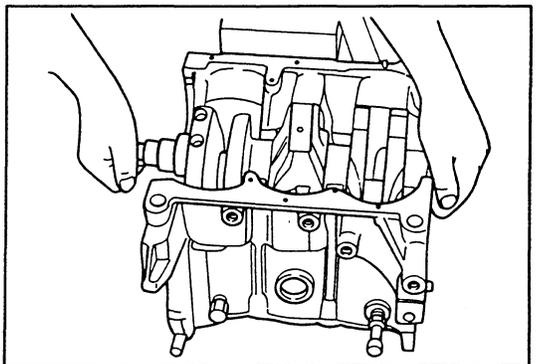
NOTE: Temporarily assemble the connecting rod and cap so as not to disturb the correct combination.



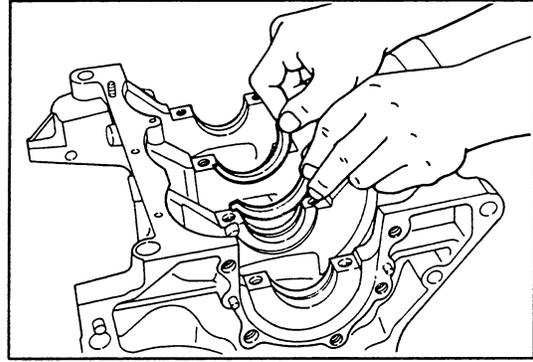
8. Remove the crankshaft bearing cap.



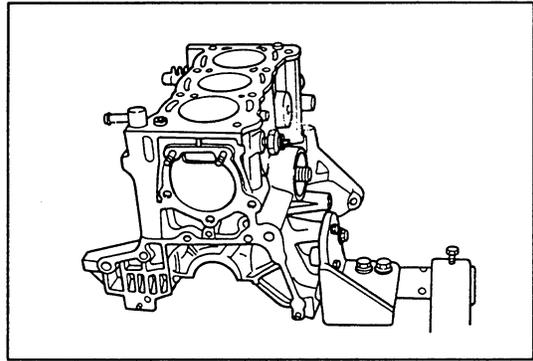
9. Remove the crankshaft.



10. Remove the crankshaft bearing & thrust washer.

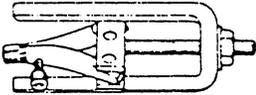
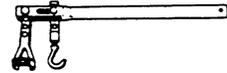
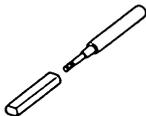
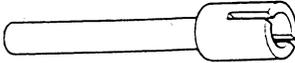
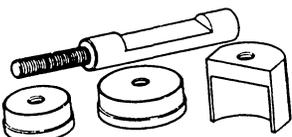


11. Remove the stud bolt, oil pressure switch etc. as required.



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
	4.5 KW BCG 7.0 KW BCG & BCGA # 37728	Valve spring replacer
	# 37731	Piston pin remover and replacer
	# 37732	
	# 37725	Valve guide remover and replacer
	4.5 KW BCG # 37727	Valve stem oil seal replacer
	7.0 KW BCG & BCGA # 37726	
	#37730	Balance shaft gear bearing remover and replacer

NOTES

CYLINDER HEAD AND ENGINE BLOCK INSPECTION AND REPAIR

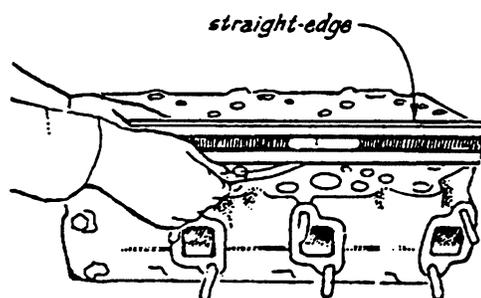
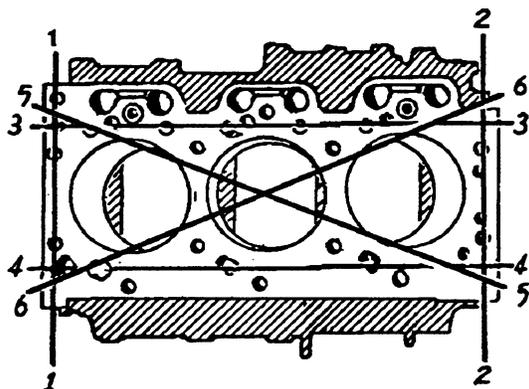
Section.....	Page
ENGINE INSPECTION AND REPAIR	64
Checking the Cylinder Head.....	64
Checking the Valve Guides.....	65
Replacing the Valve Guides.....	65
Checking Valves.....	66
Refacing the Valve and Valve Seat.....	68
Checking Rocker Arms and the Rocker Shaft	68
Checking Valve Springs.....	69
Checking the Cylinder Block	69
Checking the Pistons	71
Checking Piston Rings.....	71
Checking the Connecting Rods.....	72
Checking the Piston Pins.....	73
Checking the Connecting Rod Bearings.....	73
Checking the Crankshaft	74
Checking the Camshaft.....	76
Checking the Crankshaft Timing Belt Pulleys	78
Replacing Front and Rear Crankshaft Oil Seals	79
Checking the Flywheel and Ring Gear.....	80

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:

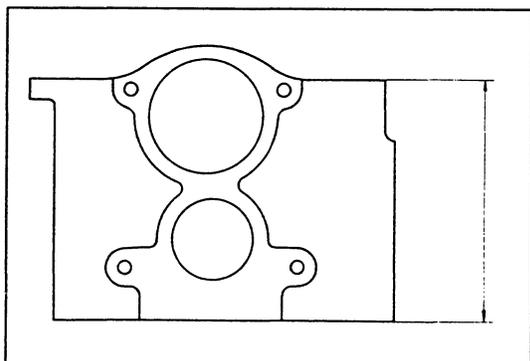
4.5 KW BCG and 7.0 KW BCG & BCGA
3.9370 in. (100 mm)

Allowable Limit of Distortion:
(warpage)

4.5 KW BCG and 7.0 KW BCG & BCGA
0.0039 in. (0.1 mm)

Grinding Limit:

4.5 KW BCG and 7.0 KW BCG & BCGA
3.9291 in. (99.8 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.

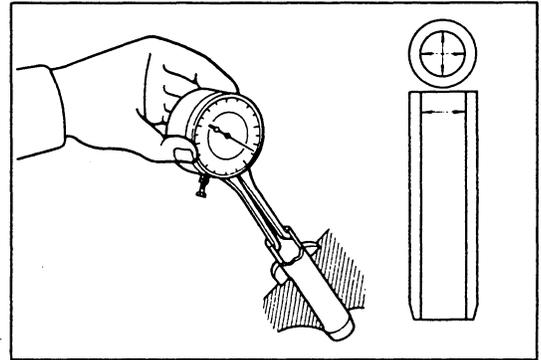
Allowable Limit:

Intake 0.2774 in. (7.045 mm)

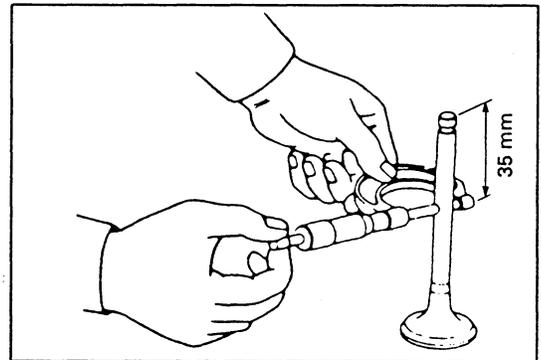
Exhaust 0.2774 in. (7.045 mm)

Measuring Method #1: 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.

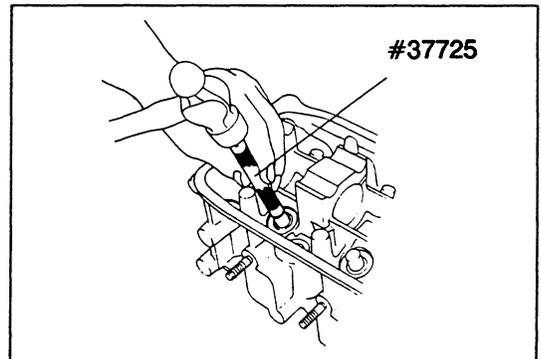


Measuring Method #2: Check the difference between the inner diameter of the guide bushing and the diameter of the valve stem.



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)



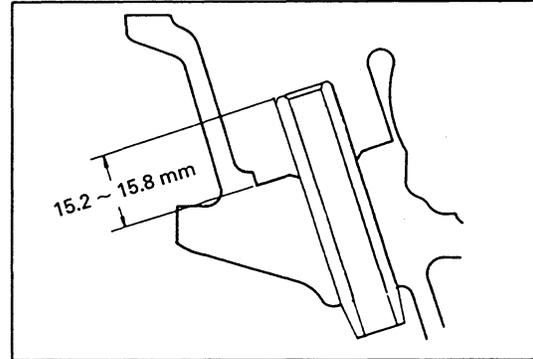
3. Place a clip on the new valve guide and drive it in from the opposite side of the combustion chamber with the valve guide installer.

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

4. Install the valve seal on the valve guide with a valve seal pusher or tool #37727 - 4.5 KW BCG and 7.0 KW BCG & BCGA.
5. Check the clearance for each new valve guide bushing.

Projection Height

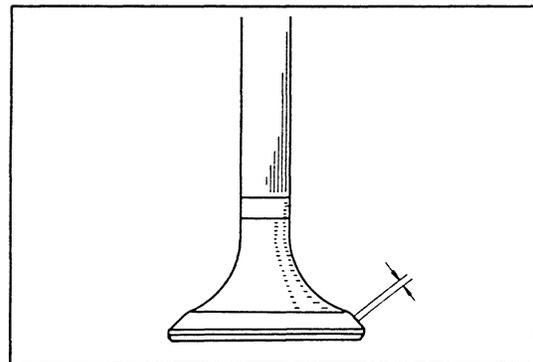
0.5984 - 0.6220 in. (15.2 - 15.8 mm)



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.

Contact width 0.0472 - 0.0630 in.
(1.2 - 1.6 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.

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 outer diameter limit:

Specified value:

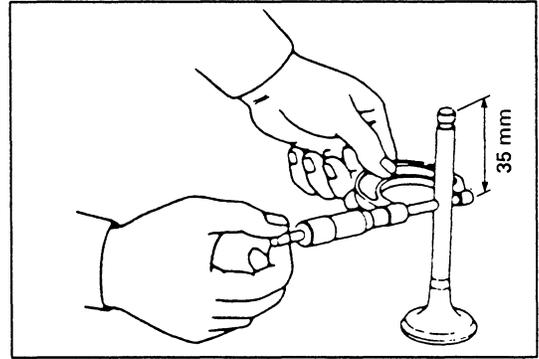
Intake: 0.2740 - 0.2746 in.
(6.96 - 6.975 mm)

Exhaust: 0.2738 - 0.2744 in.
(6.955 - 6.970 mm)

Allowable Limit

Intake: 0.2732 in.
(6.940 mm)

Exhaust: 0.2730 in.
(6.935 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 Value

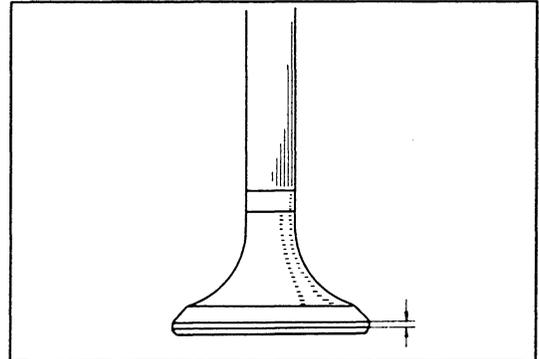
Intake: 0.0394 - 0.0551 in.
(1.0 - 1.4 mm)

Exhaust: 0.0512 - 0.0669 in.
(1.3 - 1.7 mm)

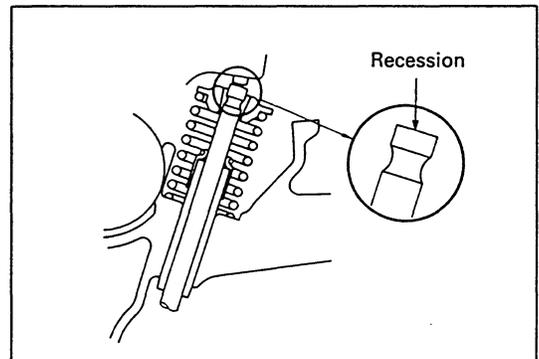
Specified Limit

Intake: 0.0354 in.
(0.9 mm)

Exhaust: 0.0433 in.
(1.1 mm)



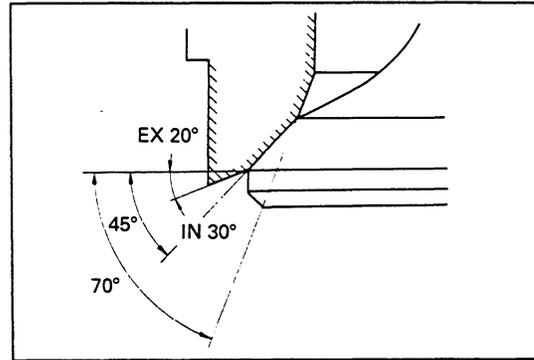
5. Check for excessive grooves at the end of the valve stem.



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 specifications.



Checking Rocker Arms and the Rocker Shaft

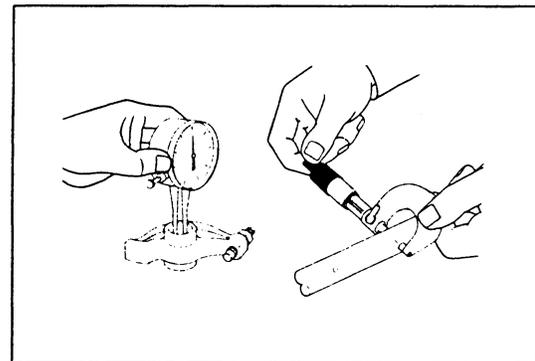
1. Check each component of the rocker arm assembly for damage or cracks. If necessary, replace it with a new one.
2. Check to see that the oil passages of the rocker arm and shaft are open. If any clogs are found, remove them or replace the unit.
3. Measure the clearance between each rocker arm's bore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

Arm Inner Diameter: 0.6299 - 0.6306 in.
(16.000 - 16.018 mm)

limit: 0.6313 in. (16.035 mm)

Shaft Outer Diameter: 0.6287 - 0.6294 in.
(15.968 - 15.988 mm)

limit: 0.6281 in. (15.955 mm)



Checking Valve Springs

1. Check the valve spring for corrosion or damage and replace it, 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
1.779 - 1.811 in.
(45.2 - 46.0 mm)

Free Length Limit
1.7441 in. (44.3 mm)

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

Squareness Limit
0.063 in. (1.6 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: 1.4961 in. (38.0 mm)

Installed Load
Standard: 58.2 - 64.8 lbs (26.4 - 29.4 kgs)

Allowable Limit: 50.7 lbs (23.0 kgs)

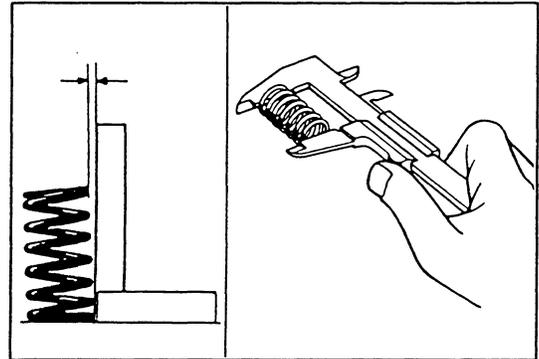
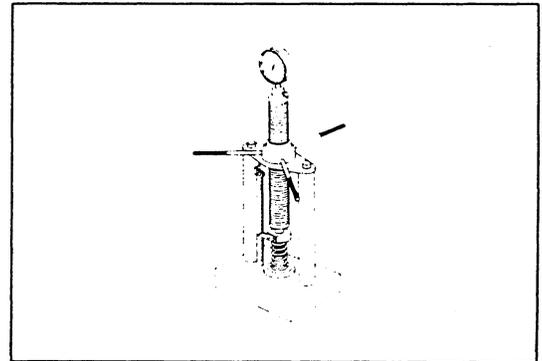


Fig. 3-52 Valve Spring Check

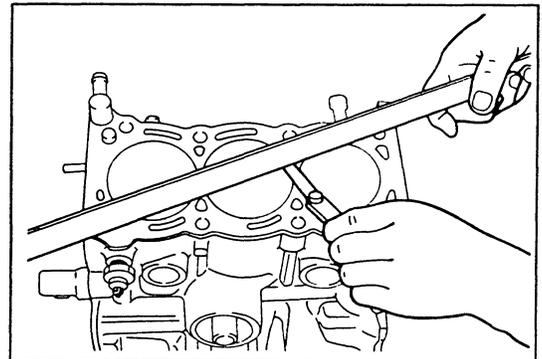
WI-03056



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: 0.0031 in.
(0.08 mm)



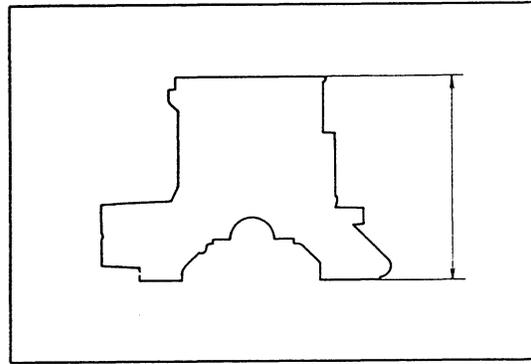
Grinding tolerance for cylinder block upper surface.

Cylinder Block Height 4.5 KW BCG
STD: 8.6575 - 8.6653 in.
(219.9 - 220.1 mm)

Limit: 8.6535 in. (219.8 mm)

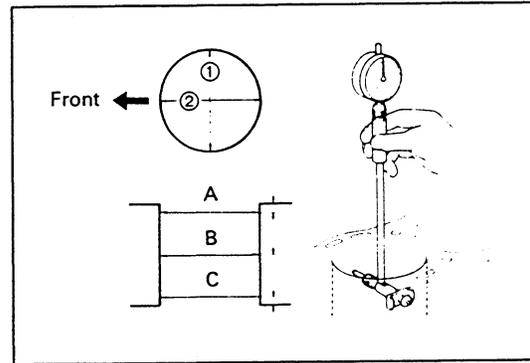
Cylinder Block Height 7.0 KW BCG & BCGA
STD: 9.2874 - 9.2953 in.
(235.9 - 236.1 mm)

Limit: 9.2834 in. (235.8 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.



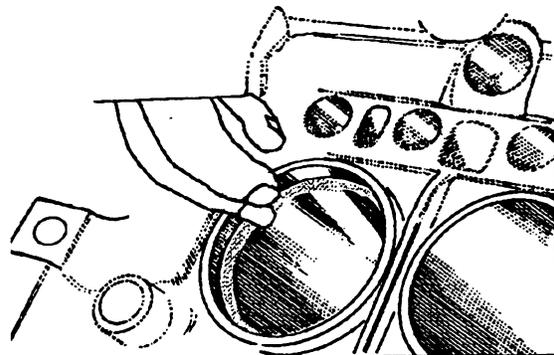
Standard Bore Diameter

4.5 KW BCG: 2.4409 - 2.4421 in.
(62.00 - 62.03 mm)

7.0 KW BCG: 2.6220 - 2.6232 in.
& BCGA (66.60 - 66.63 mm)

Wear limit: 0.0039 in. (0.10 mm)

Out-of-Roundness, Taper Limit:
0.0012 in. (0.03 mm)

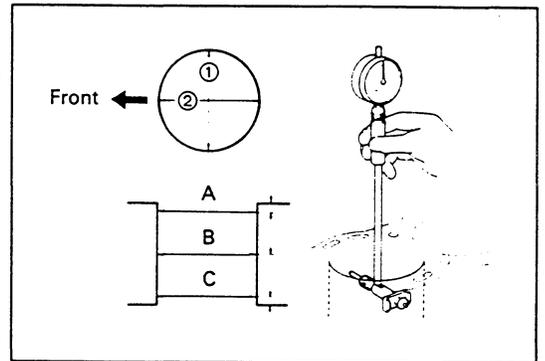
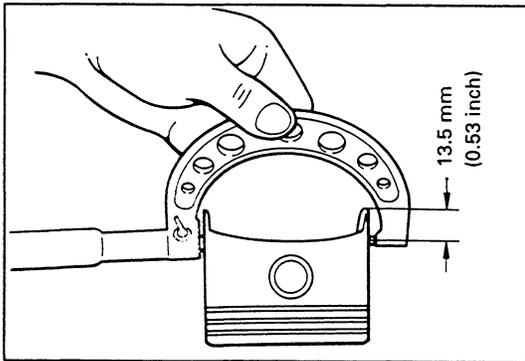


6. Check the ridge in the cylinder. If the engine has a large number of hours on it, a large cylinder ridge most likely will be present. If a ridge exists, have the cylinders reamed to remove these ridges. Leaving these ridges in the cylinder can break piston rings when the pistons are installed in the 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.
2. Measure each piston's diameter 0.0016 - 0.0024 in. (0.04 - 0.06 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.

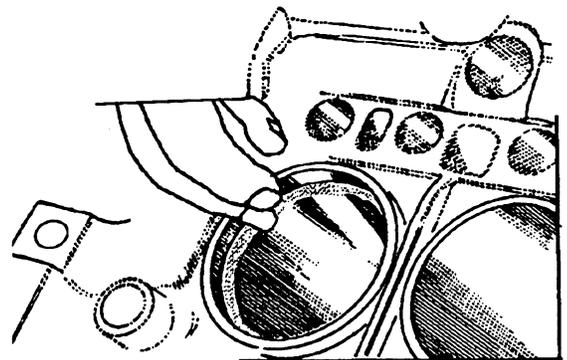
Piston Diameter:	4.5 KW BCG	2.4392 - 2.4403 in. (61.955 - 61.985 mm)
	7.0 KW BCG & BCGA	2.6201 - 2.6213 in. (66.550 - 66.580 mm)
Standard Cylinder-to-Piston Clearance:	4.5 KW BCG	0.0014 - 0.0022 in. (0.035 - 0.055 mm)
	7.0 KW BCG & BCGA	0.0016 - 0.0024 in. (0.040 - 0.060 mm)
Allowable Cylinder-to-Piston Limit:	4.5 KW BCG	0.0039 in. (0.10 mm)
	7.0 KW BCG & BCGA	0.0043 in. (0.11 mm)



Checking Piston Rings

1. Check the piston rings for cracks, burning or wear and replace them, 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:	0.0098 - 0.0157 in. (0.25 - 0.40 mm)	limit: 0.0256 in. (0.65 mm)
Compression ring No. 2:	0.0079 - 0.0138 in. (0.20 - 0.35 mm)	limit: 0.0256 in. (0.65 mm)
Oil ring:	0.0079 - 0.0276 in. (0.20 - 0.70 mm)	limit: 0.0394 in. (1.00 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

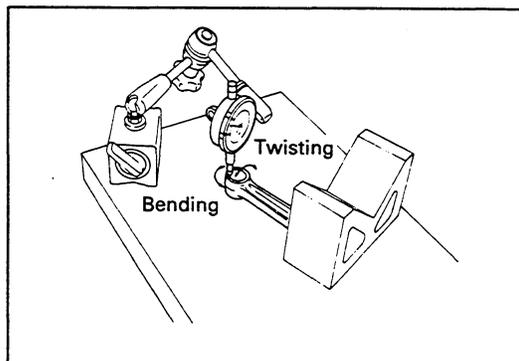
Compression ring No. 1:	0.0012 - 0.0028 in. (0.03 - 0.07 mm)	limit: 0.0047 in. (0.12 mm)
Compression ring No. 2:	0.0008 - 0.0024 in. (0.02 - 0.06 mm)	limit: 0.0043 in. (0.11 mm)

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.

Twist limit: 0.0020 in. (0.05 mm)

Bend limit: 0.0020 in. (0.05 mm)



Checking the Piston Pins

1. Check each piston pin's oil clearance.

A. Measure each piston pin's bore diameter.

Standard Bore Diameter: 0.6299 - 0.6302 in.
4.5 KW BCG (15.999 - 16.008 mm)

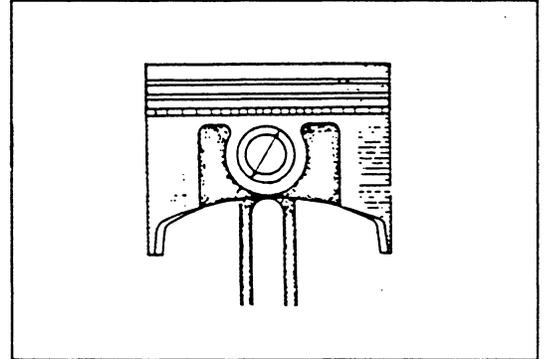
Standard Bore Diameter: 0.7086 - 0.7090
7.0 KW BCG & BCGA (17.999 - 18.008 mm)

B. Measure each piston pin's diameter.

Standard Pin Diameter: 0.6296 - 0.6299 in.
4.5 KW BCG (15.991 - 16.000 mm)

Standard Pin Diameter: 0.7083 - 0.7087 in.
7.0 KW BCG & BCGA (17.991 - 18.000 mm)

Standard Oil Clearance: 0.0002 - 0.0004 in.
(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: 0.0020 in. (0.050 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 - 0.0017 in.
(0.020 - 0.044 mm)

Allowable Limit: 0.0028 in. (0.07 mm)

Kinds of Connecting Rod Bearings:

Standard

Undersize 0.0098 in. (0.25 mm)

Undersize 0.0197 in. (0.50 mm)

3. Check each connecting rod's thrust clearance.

Specified Limit: 0.0059 - 0.0098 in.
(0.15 - 0.25 mm)

Allowable Limit: 0.0118 in. (0.30 mm)

4. Check each connecting rod's journal width.

Journal Width 4.5 KW BCG:

STD 1.4557 - 1.4567 in.
(36.976 - 37.000 mm)

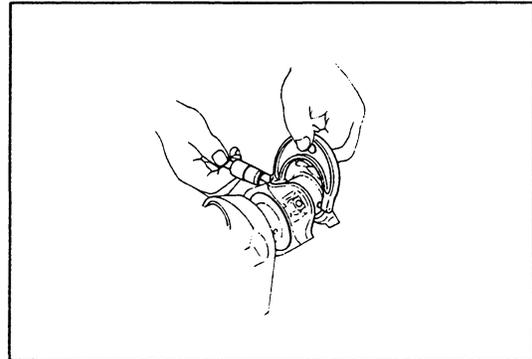
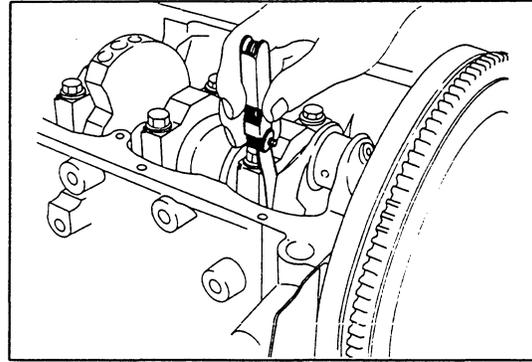
U/S 0.0098 in. 1.4461 - 1.4465 in.
(0.25 mm) (36.732 - 36.742 mm)

U/S 0.0197 in. 1.3969 - 1.3973 in.
(0.50 mm) (35.482 - 35.492 mm)

Journal Width 7.0 BCG & 7.0 BCGA:

STD 1.5739 - 1.5748 in.
(39.976 - 40.000 mm)

U\S 0.0098 in. 1.5642 - 1.5646 in.
(0.25 mm) (38.732 - 39.742 mm)



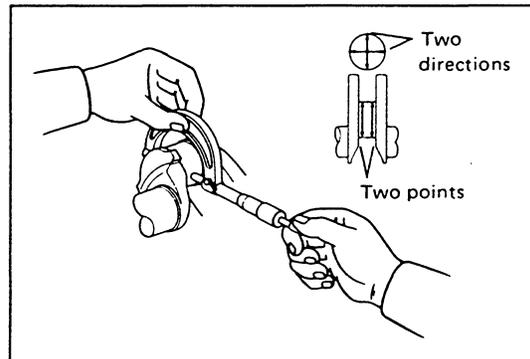
5. Measure the connecting rod width.

Standard Rod Width: 0.7795 - 0.7815 in.
(19.80 - 19.85 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.

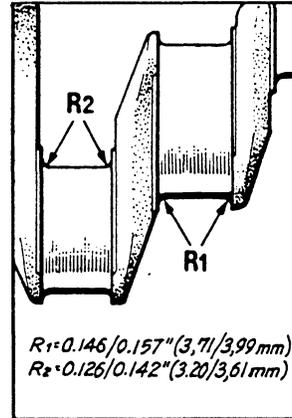
NOTE: Measure the diameter of each of the crankpins and main journals at two points (the front and rear portions) at 90 degrees to the crankshaft axis, as shown in the figure.



Allowable elliptical or tapered Limit:	0.0008 in. (0.02 mm)
Specified Oil Clearance:	0.0008 - 0.0017 in. (0.020 - 0.044 mm)
Allowable Limit:	0.0028 in. (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.

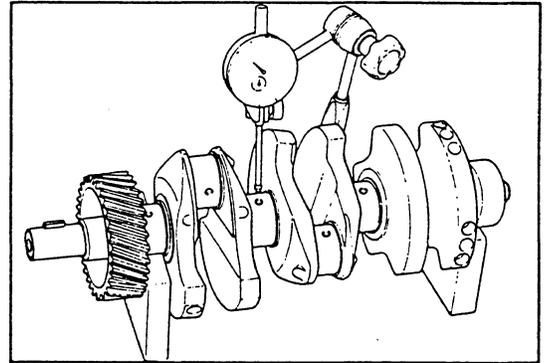
4.5 KW BCG:	
Main Journal DIA.	1.6526 - 1.6535 in. (41.976 - 42.000 mm)
Crankpin DIA.	1.4557 - 1.4567 in. (36.976 - 37.000 mm)
7.0 KW BCG & BCGA:	
Main Journal DIA.	1.8101 - 1.8110 in. (45.976 - 46.000 mm)
Crankpin DIA.	1.5739 - 1.5748 in. (39.976 - 40.000 mm)



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.

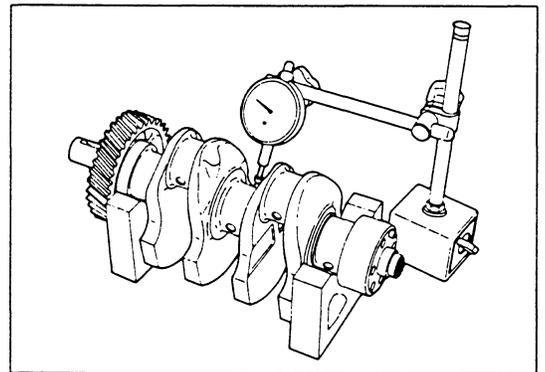
5. Measure the crankshaft's runout (uneven wear).

Runout Limit: 0.0008 in. (0.02 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 in. (0.03 mm)



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

Camshaft Journal Diameter:

Specified Valve

Front: 1.6709 - 1.6717 in.
(42.44 - 42.46 mm)

Center: 1.6512 - 1.6520 in.
(41.94 - 41.96 mm)

Rear: 1.1791 - 1.1799 in.
(29.95 - 29.97 mm)

Cylinder Head Journal Diameter:

Specified Valve

Front: 1.6732 - 1.6742 in.
(42.500 - 42.525 mm)

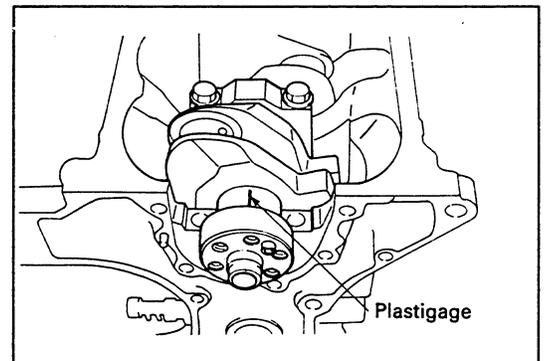
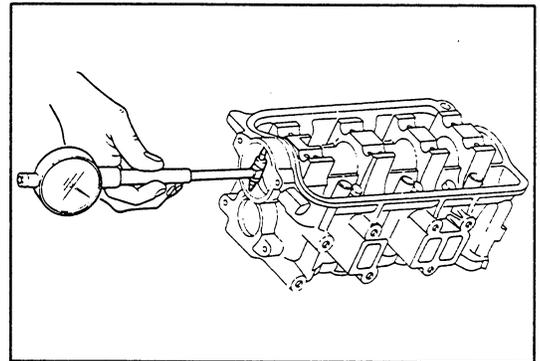
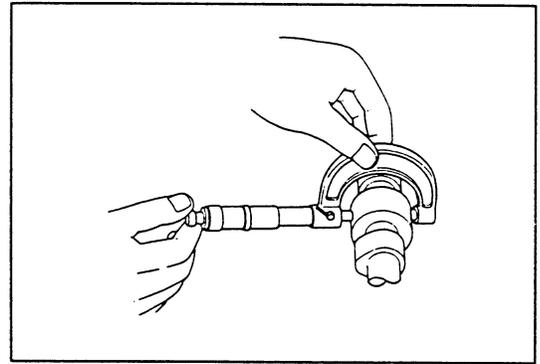
Center: 1.6535 - 1.6545 in.
(42.000 - 42.025 mm)

Rear: 1.1811 - 1.1819 in.
(30.000 - 30.021 mm)

Uneven Wear of Camshaft Journal
0.0016 in. (0.04 mm)

5. Measure the crankshaft oil clearance.

- a. Lay a strip of plastigage across the journal or crank pin, but not over the oil hole.



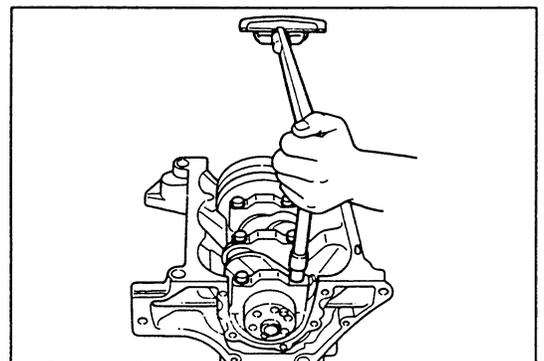
Oil clearance measurement (1)

- b. Tighten the crankshaft bearing cap and connecting rod bearing cap bolts to the specified torque.

Tightening Torque:

Crankshaft Bearing Cap 39.1 - 47.7 ft-lb
(5.4 - 6.6 kg-m)

Connecting Rod Bearing Cap 15.2 - 21.0 ft-lb
(2.1 - 2.9 kg-m)



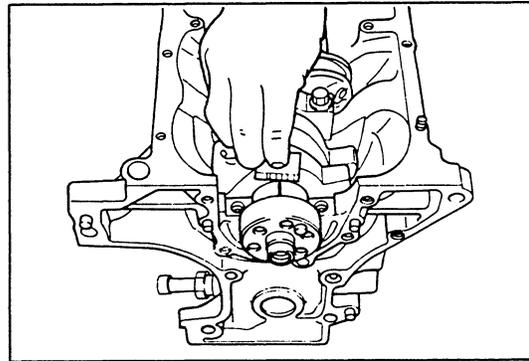
Oil clearance measurement (2)

c. Remove the bearing cap. Measure the plastigauge at its widest point. If the clearance is not within specification, replace the bearings.

Crankshaft Main Journal & Crank Pin Oil Clearance:

STD 0.0008 - 0.0017 in.
(0.020 - 0.044 mm)

Limit 0.0028 in. (0.07 mm)



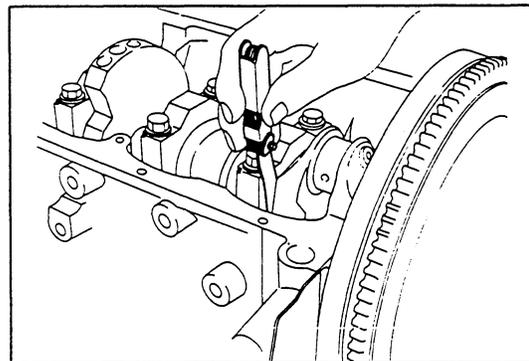
Oil clearance measurement (3)

d. Check the crankshaft thrust clearance. If the clearance exceeds the limit, replace the thrust washer.

Thrust Clearance:

STD 0.0008 - 0.0087 in.
(0.02 - 0.22 mm)

Limit 0.0118 in. (0.30 mm)



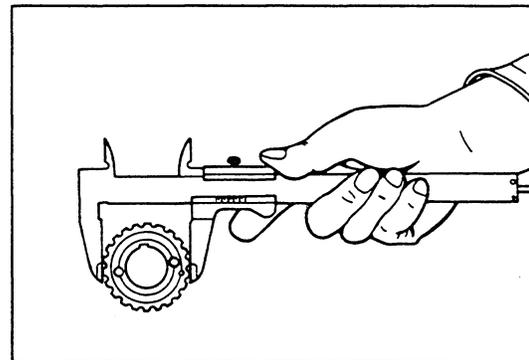
Checking the Crankshaft Timing Belt Pulleys

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

Crankshaft Pulley:

Pulley Diameter 2.154 - 2.158 in.
(54.701 - 54.801 mm)

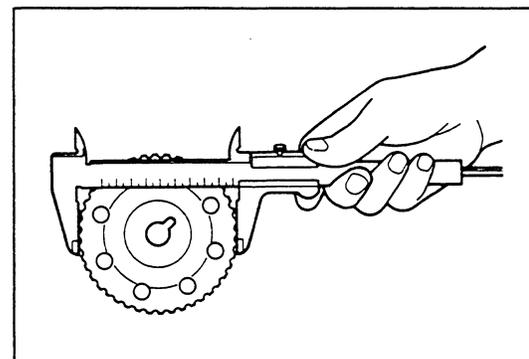
Allowable Limit 2.151 in. (54.64 mm)



Camshaft Pulley:

Pulley Diameter 4.3556 - 4.3627 in.
(110.633 - 110.813 mm)

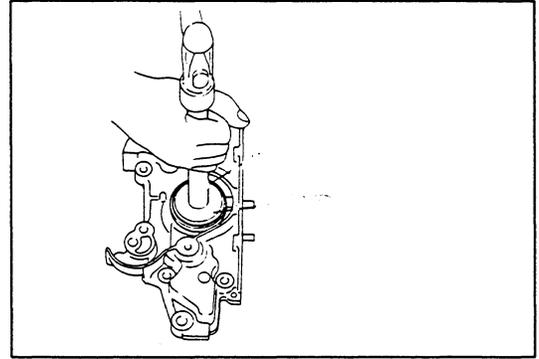
Allowable Limit 4.3531 in. (110.57 mm)



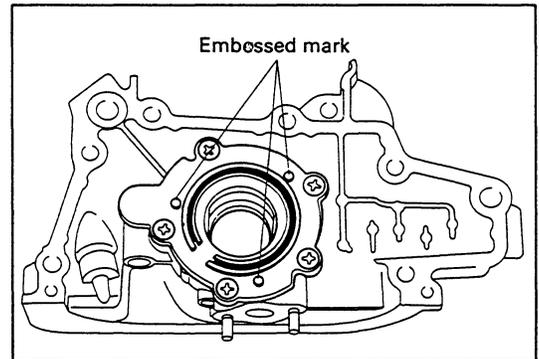
Replacing Front and Rear Crankshaft Oil Seals

Replace the oil seal and O-ring.

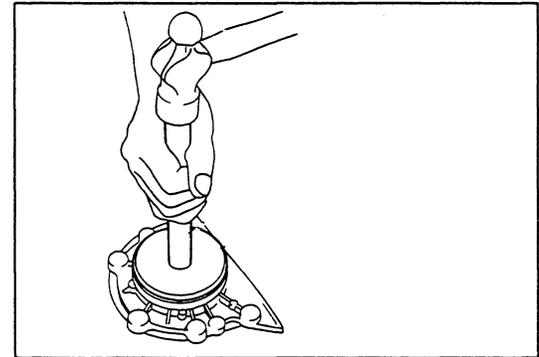
1. Type T oil seal. (Crankshaft front oil seal.) Using an appropriate seal tool (snap-on, Craftsman), install the oil seal. Apply engine oil to the lip portion of the oil seal.



2. Install the oil pump O-ring to the oil pump cover. To ensure the seating of the O-ring, push the O-ring at the position of the 3 embossed marks on the cover as indicated in the figure.



3. Type T oil seal (crankshaft rear oil seal). Using an appropriate tool, install the oil seal. Apply engine oil to the lip portion of the oil seal.

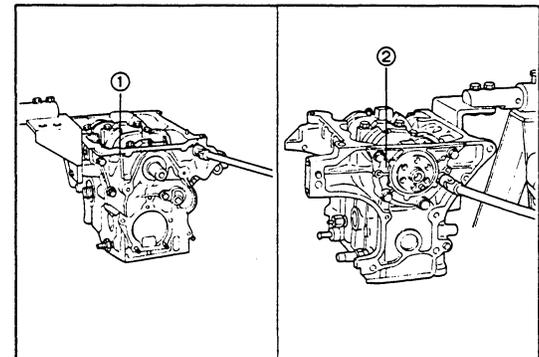


4. Assemble the oil pump assembly and rear oil seal retainer.

Tightening torque:

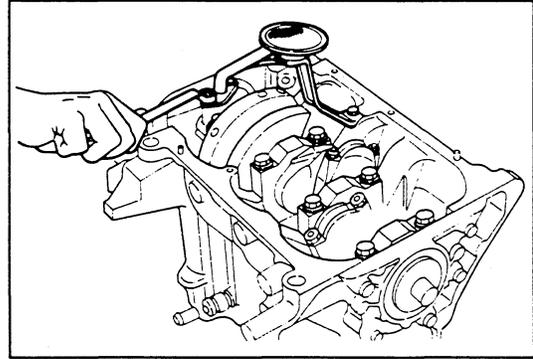
Rear oil seal retainer 7.2 - 11.6 ft-lb
(1.0 - 1.6 kg-m)

Oil pump assembly 11.3 - 16.9 ft-lb
(1.56 - 2.34 kg-m)



5. Assemble the oil strainer.

Tightening torque bolt, nut: 4.62 - 6.93 ft-lb
(0.64 - 0.96 kg-m)



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.

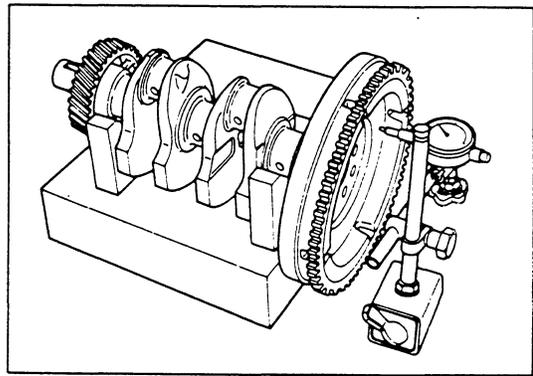
Runout Limit: 0.0039 in. (0.10 mm)

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.

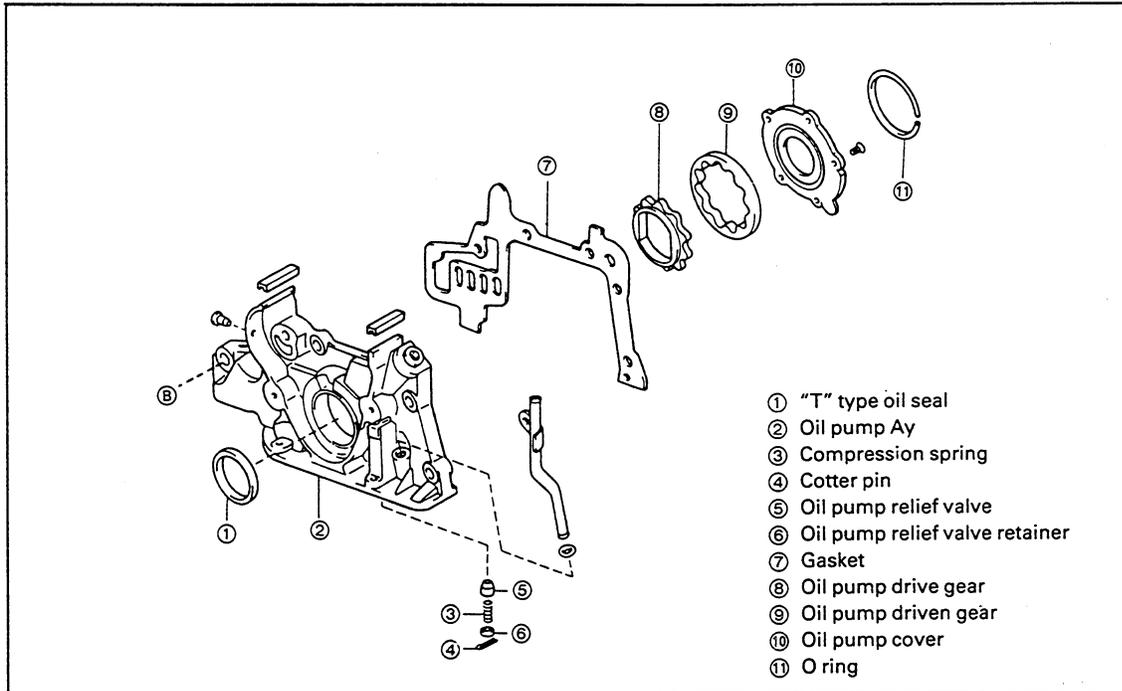


NOTE: Excessive heat may destroy the original heat treatment and cause premature failure of the ring gear.

SUBASSEMBLY INSPECTION, REPAIR, AND ASSEMBLY

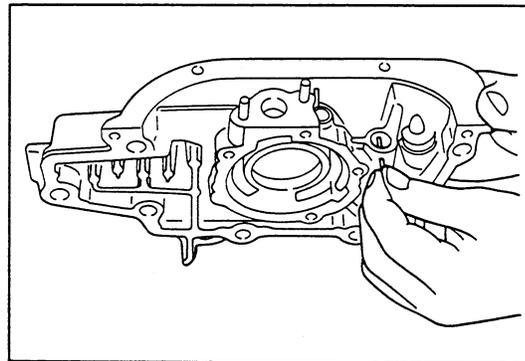
Section.....	Page
Disassembling and Inspecting the Oil Pump	82
Assembling the Oil Pump	84
Fresh Water Pump	84
Thermostat Removal and Inspection	85
Disassembling and Inspecting the Raw Water Pump.....	86
Electric Fuel Pump.....	87
Disassembling and Rebuilding the Carburetor	88
Inspecting the Distributor and its Components	94
Testing the Ignition Coil	95
Inspecting the Spark Plugs.....	95
Testing the Starter	96

Disassembling and Inspecting the Oil Pump



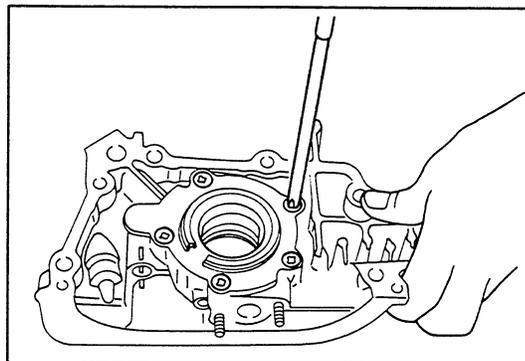
1. Remove the relief valve.

- a. Using pliers, remove the cotter pin.
- b. Remove the retainer, spring and relief valve.



2. Remove the drive and driven gear.

- a. Remove the 5 bolts and oil pump cover.
- b. Remove the drive and driven gear.

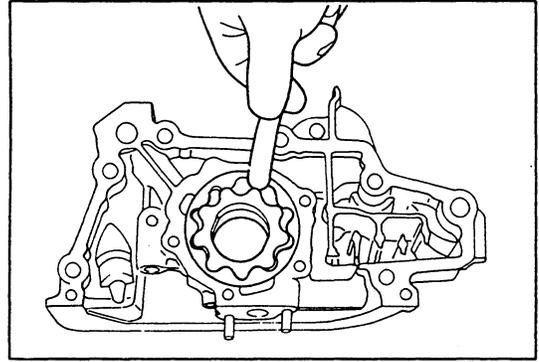


3. Using a feeler gauge, measure the tip clearance of the drive and driven gears.

Tip Clearance:

STD 0.0067 - 0.0094 in. (0.17 - 0.24 mm)

Limit 0.0138 in. (0.35 mm)

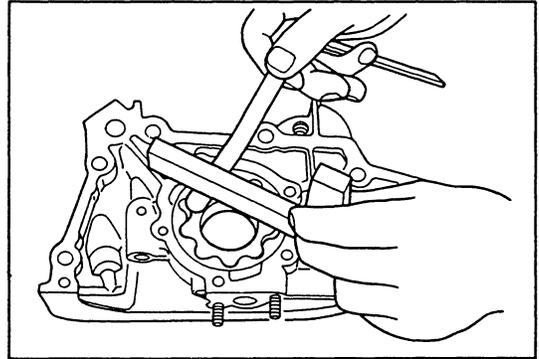


4. Using a feeler gauge and flat block, measure the side clearance as shown.

Side Clearance:

STD 0.0014 - 0.0028 in. (0.035 - 0.07 mm)

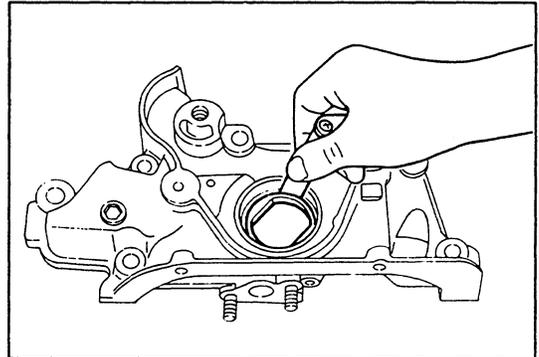
Limit 0.0059 in. (0.15 mm)



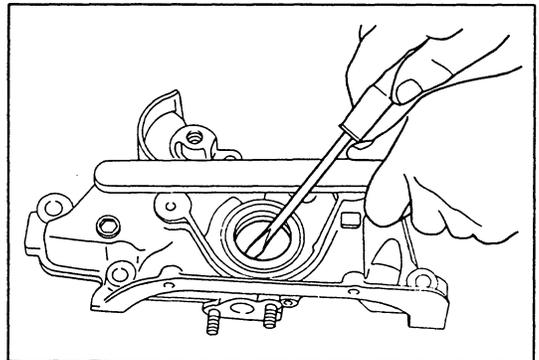
5. Using a feeler gauge, measure the clearance between the drive gear and body.

STD 0.0024 - 0.0047 in. (0.06 - 0.12 mm)

Limit 0.0098 in. (0.25 mm)



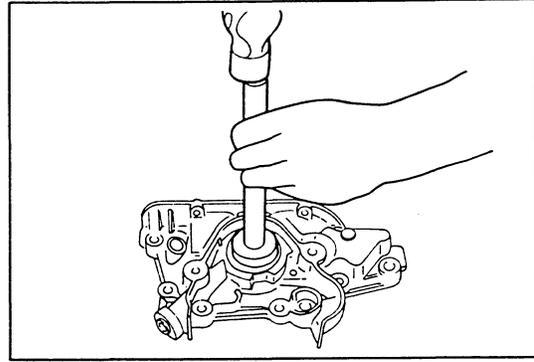
6. Using a screw driver, pry out the oil seal.



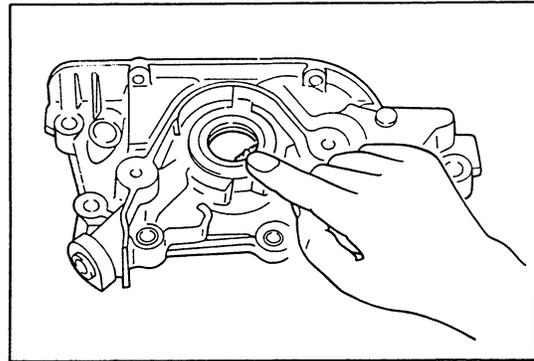
7. Install the new oil seal using an appropriate service tool.

a. Using the tool, install the new oil seal.

NOTE: Be careful not to install the new oil seal slanted.



b. Coat the oil seal lightly with engine oil.



Assembling the Oil Pump

1. Install the relief valve.

a. Install the relief valve, spring and retainer to the pump body.

b. Install the cotter pin.

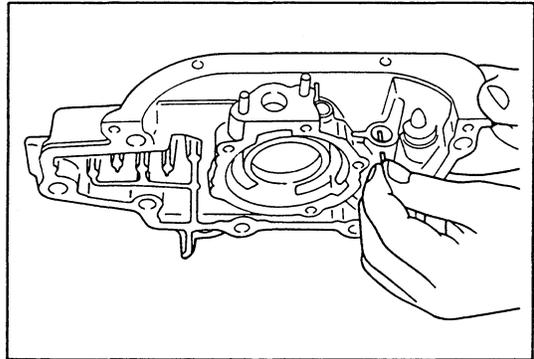
2. Install the drive and driven gears.

a. Insert the drive and driven gear to the body.

b. Install the pump cover, tighten the 5 screws.

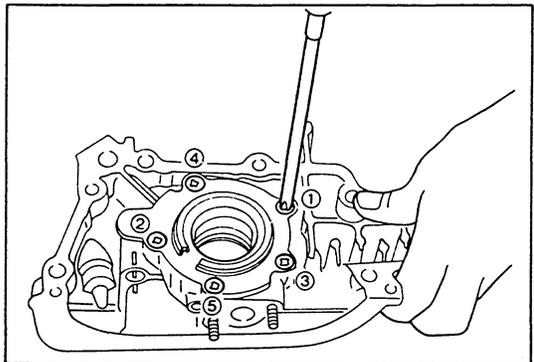
Tightening Torque: 5.8 - 9.4 ft-lb (0.8 - 1.3 mm)

3. Install the O-ring.



Fresh Water Pump

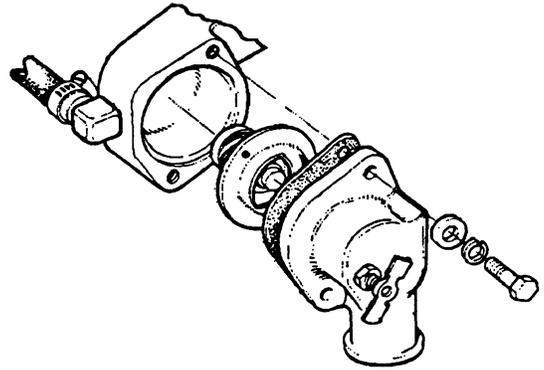
No rebuilding kit is offered for the fresh water circulating pumps on the 4.5 KW BCG, 7.0 KW BCG & BCGA. Removal and replacement of the defective or worn pump is, therefore, necessary.



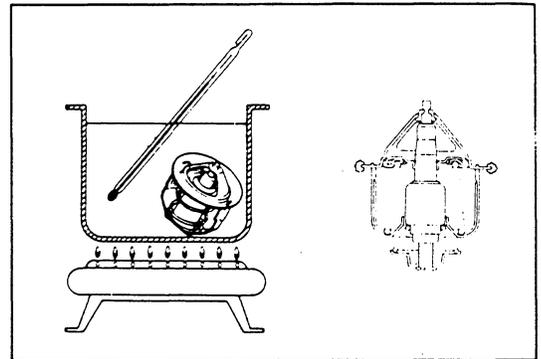
Thermostat Removal and Inspection

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

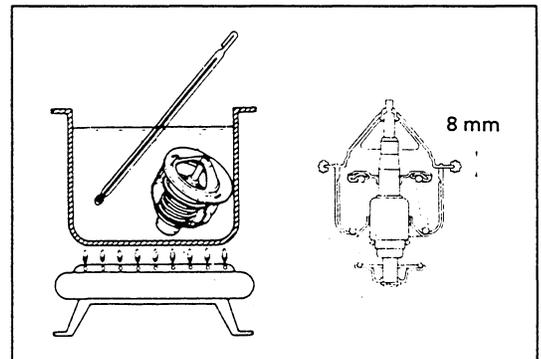
1. Remove the thermostat from its housing.



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).



Thermostat Inspection (1)

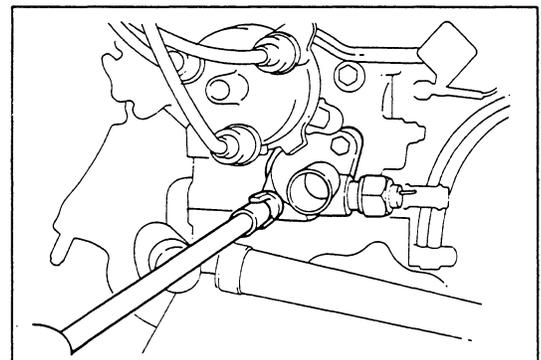


Thermostat Inspection (2)

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

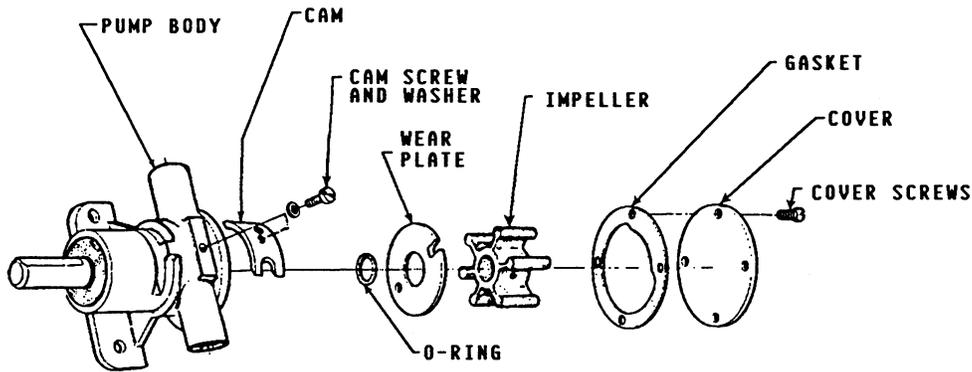
CAUTION

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 Raw Water Pump

When disassembling the raw water pump for inspection, an impeller kit 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 raw water pump's inspection can only improve the raw water pump's pumping ability. In addition, a new impeller is accompanied with a new gasket, an item that is needed to assemble the raw water pump. See the note below.



1. To disassemble the raw 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, washer and the cam.

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

Inspect the raw water pump by rotating the pump's drive shaft. If excessive play exists in it, or if its sound is rough or 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 raw 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 raw water reaches the impeller as it draws a prime.

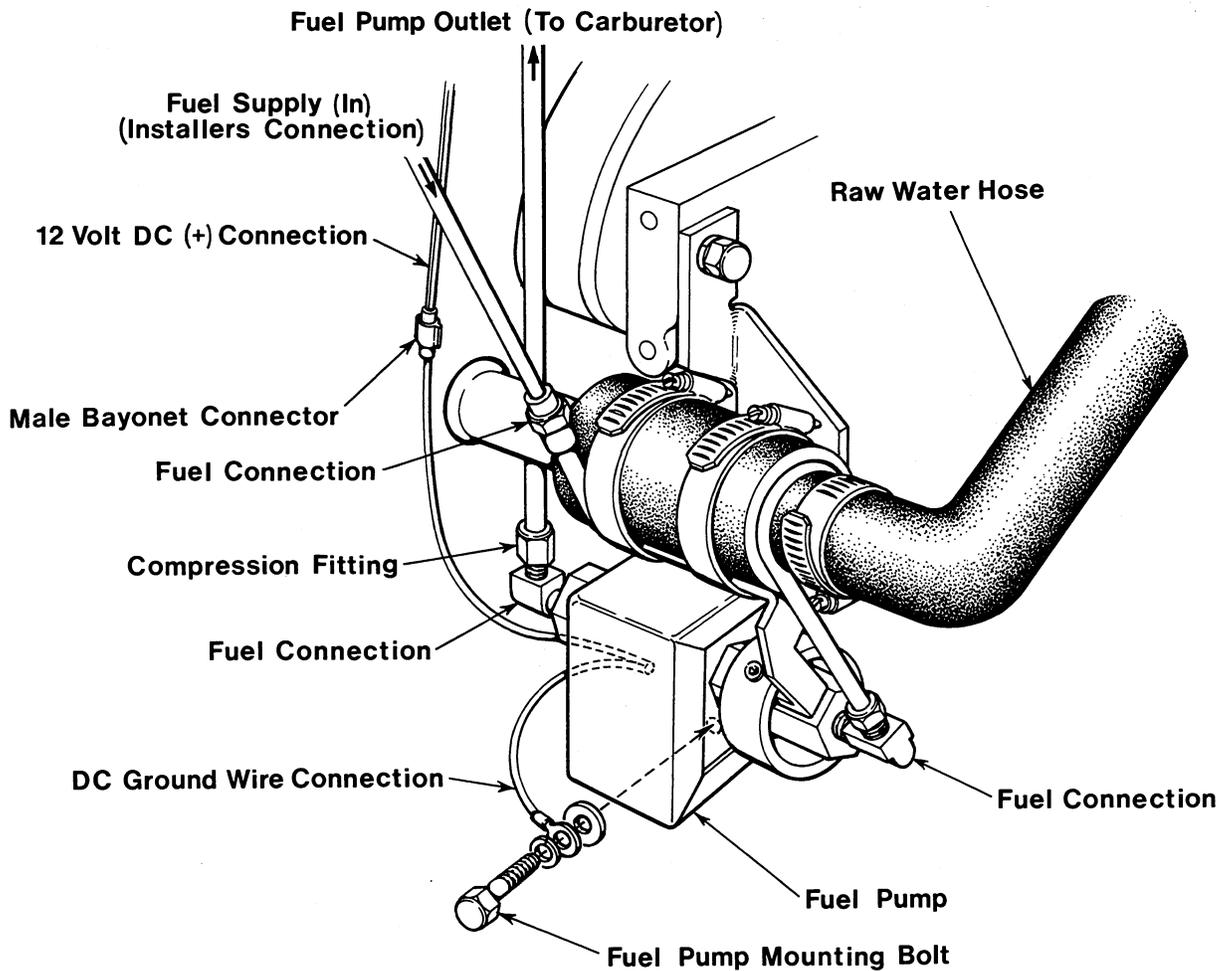
Electric Fuel Pump

Later models are equipped with a Solid State interrupter type fuel pump that operates well under high ambient temperature condition; however, it does not incorporate any fuel filter/screen in its construction.

Installers/operators must ensure that fuel being supplied to this pump is free of water or other types of contaminants that will hinder the pumps operation or affect the carburetor further down stream.

The fuel pump and Gasdenser are replaceable components; but not overhauled.

Periodically, check the fuel connections to and out of the pump and make sure that no leakage is present and that the fittings are tight and secure. Also, check that the DC electrical connection supplying 12 volts DC to the pump is clean, tight, and secure. The DC ground connection at one of the pumps mounting bolts should be clean and well secured by the mounting bolt to ensure proper pump operation.



WARNING

Fuel leakage at the fuel pump or its connections is a fire hazard and should be corrected. Make sure proper ventilation exists whenever servicing fuel system components.

Disassembling and Rebuilding the Carburetor

To rebuild the carburetor, first purchase a carburetor rebuilding kit PN 036450. 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) main body gasket

One (1) choke lever spring

One (1) rotary throttle shaft valve

One (1) fuel filter element

One (1) manifold gasket

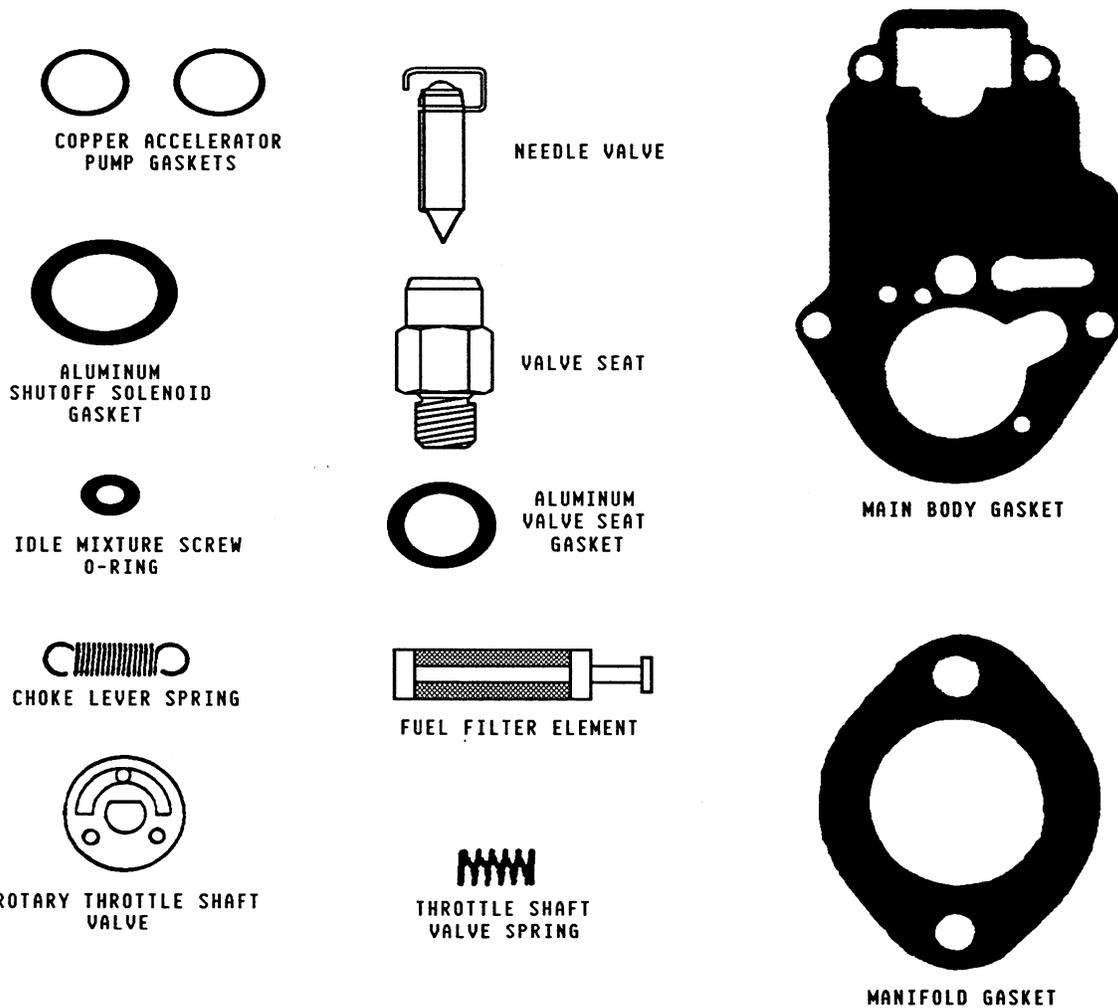
One (1) needle valve and seat (two pieces to the set)

One (1) aluminum seat gasket

One (1) idle mixture screw O-ring

One (1) throttle shaft valve spring

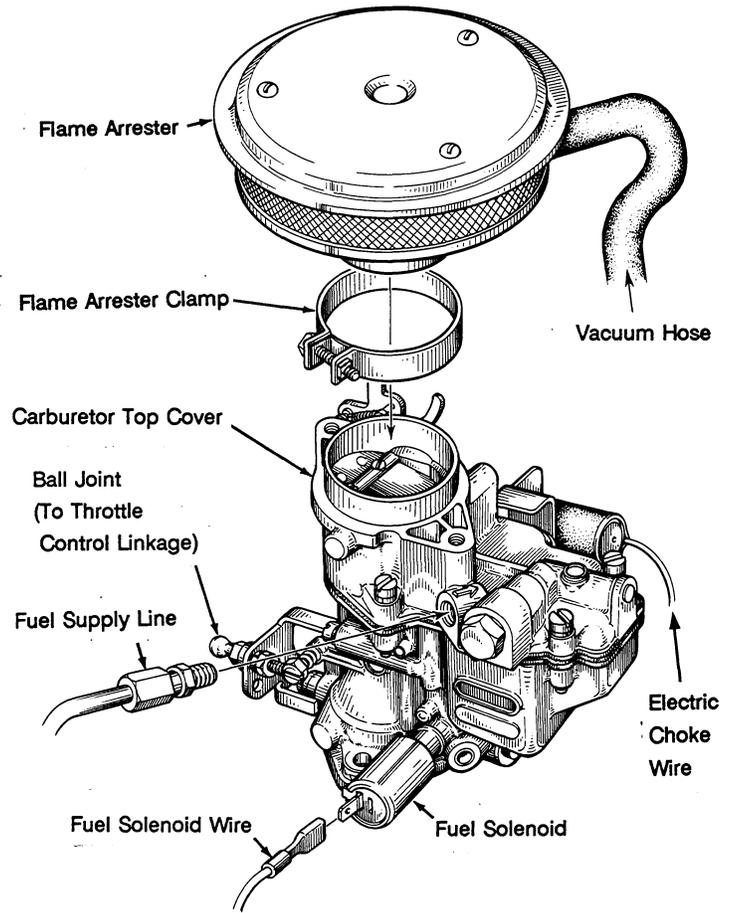
One (1) aluminum shutoff solenoid gasket



1. Loosen the flame arrester's clamp and remove the arrester followed by the clamp.

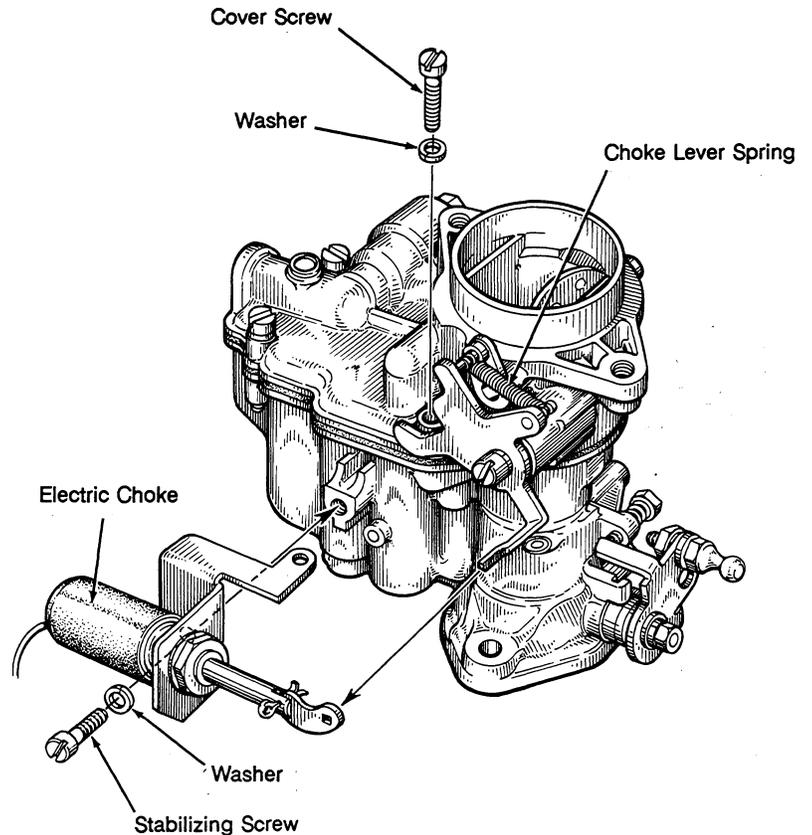
2. Disconnect the fuel supply line, fuel solenoid wire, electric choke wire, and the throttle control linkage (not shown).

3. Remove the two nuts and washers that secure the carburetor to the intake manifold. Lift the carburetor from the intake manifold.



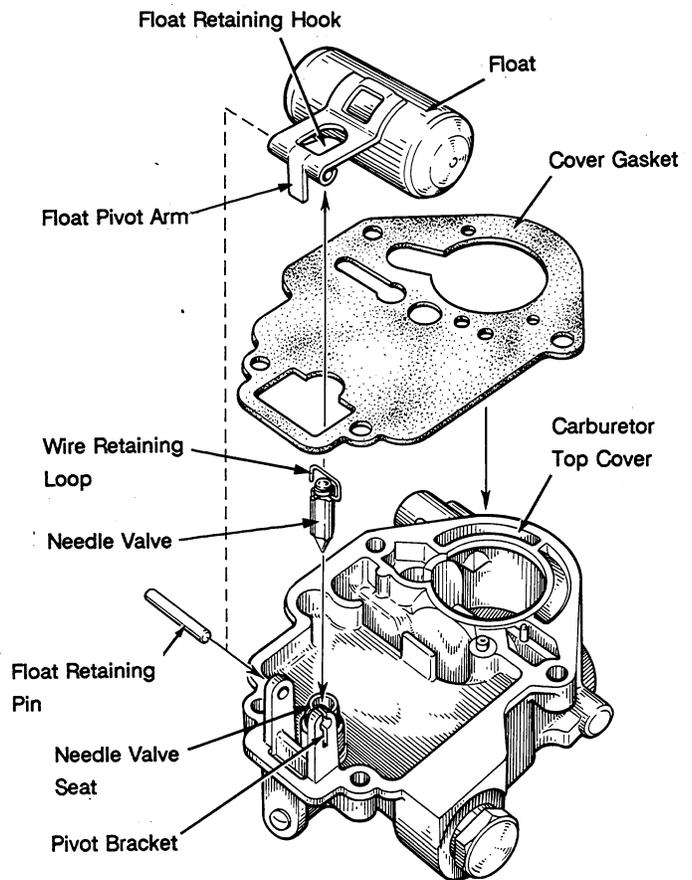
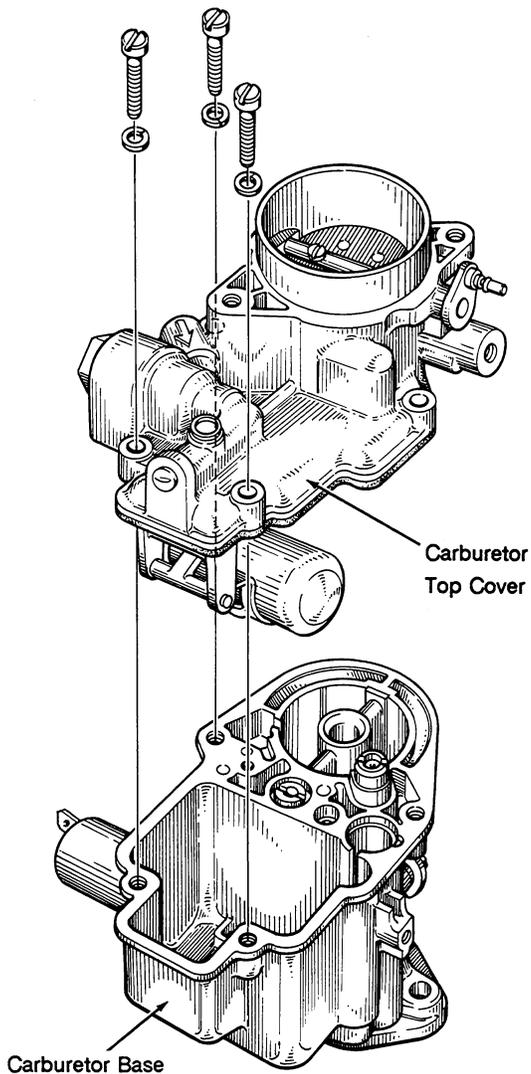
4. Remove the electric choke's stabilizing screw and the indicated (one of four) cover screw and washer. Remove the electric choke.

5. Replace the choke lever spring, if necessary.



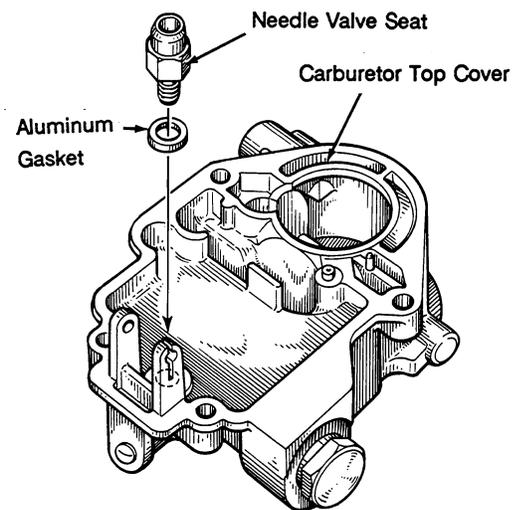
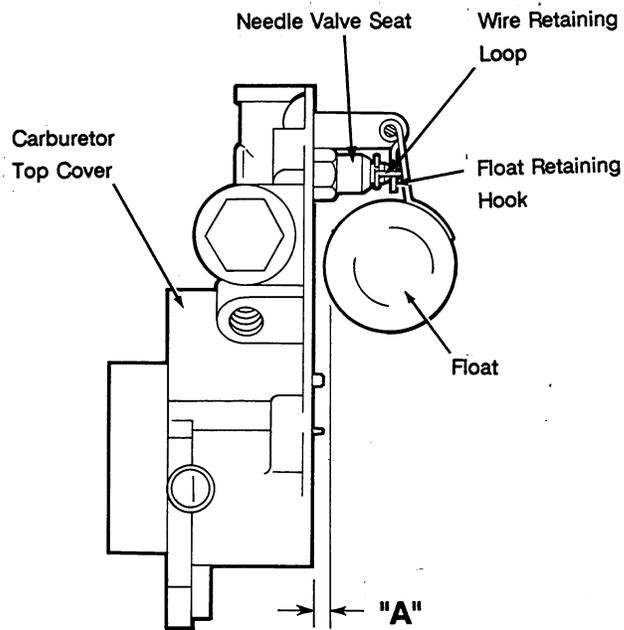
6. Remove the remaining three cover screws and their washers. Lift the carburetor's top cover straight up and away from the carburetor's base.
7. In the carburetor top cover, gently punch out the float retaining pin in the opposite direction of the split side of the pivot bracket and remove the float. **Make sure you catch the needle valve that hangs from the float retaining hook under the float's pivot arm and place it aside.**
8. Remove all of the old cover gasket from both halves of the carburetor.
9. Shake the float. If you can hear any sand-like particles moving inside the float, replace it.

Cover Screws & Washers
(Remaining 3 Of 4)

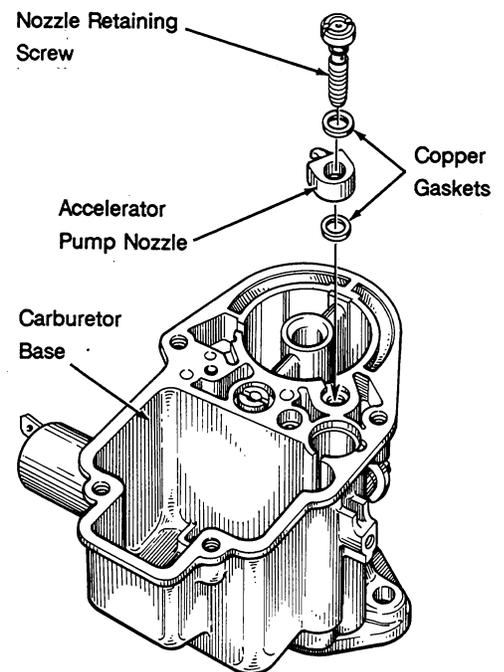


10. Remove the needle valve's seat with a 10 mm wrench. Make sure that the seat's aluminum gasket is removed at this time. Screw in the new seat along with a new gasket.
11. Place a new carburetor cover gasket on the carburetor top cover. **Do not** use any gasket sealer on this gasket.
12. Gently place the needle valve in the needle valve seat. Replace the float and float retaining pin so that the needle valve's wire retaining loop hooks onto the float's retaining hook. Now check the float level distance from the housing mating surface with the housing held vertically.

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

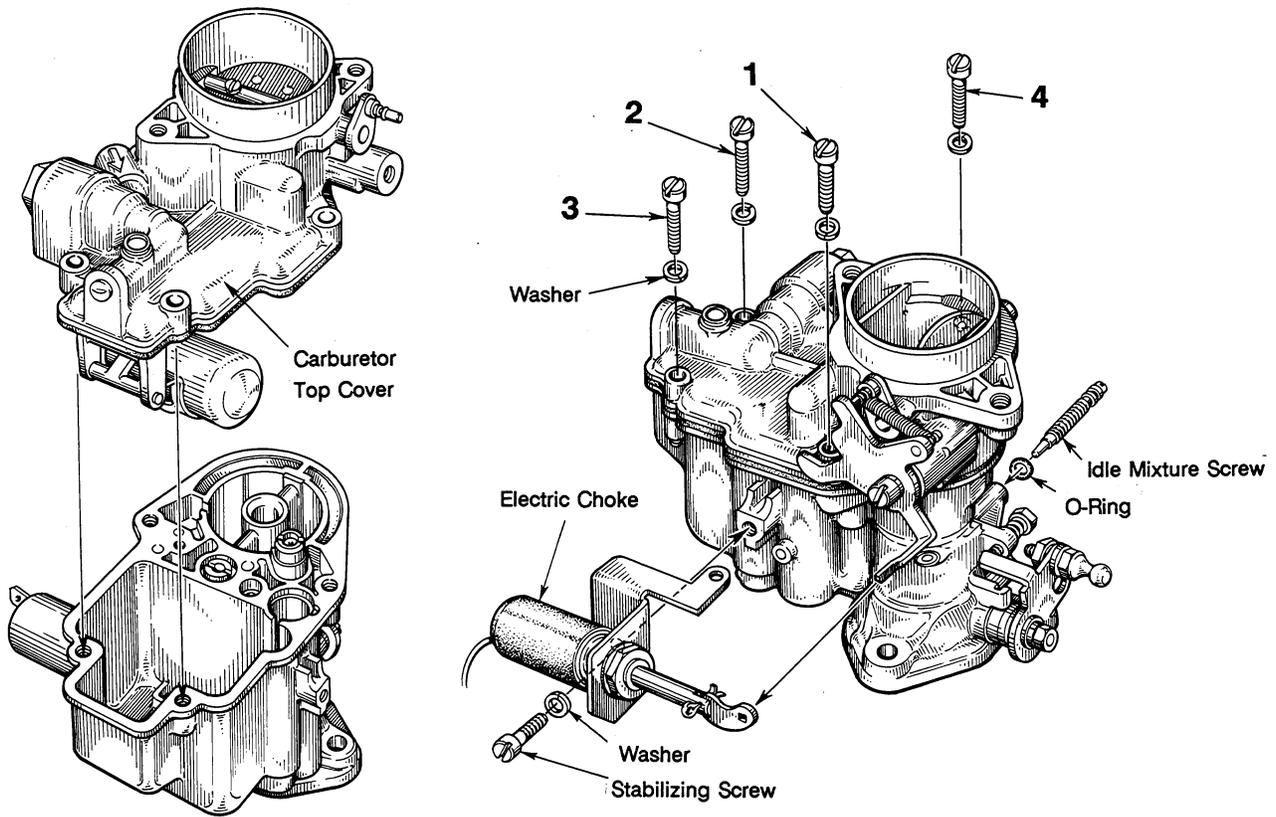


13. On the carburetor base, remove the retaining screw to the accelerator pump nozzle, the nozzle, and the two copper gaskets placed above and below the nozzle.
14. Replace the two copper gaskets and reinstall the accelerator pump nozzle. Snug down the nozzle's retaining screw. **Do not** overtighten the screw.



15. Place the carburetor top cover straight down on the carburetor base and reposition the electric choke on the carburetor. Hand tighten the cover screw that secures the electric choke to the carburetor. Be sure to replace the old washer. Then, replace stabilizing screw's washer and tighten the stabilizing screw. Replace the remaining three cover screw's washers and tighten the cover screws in the indicated order. **Do not** overtighten the cover screws. This can strip the threads in the carburetor.

16. Unscrew the idle mixture screw and replace the idle mixture screw's O-ring.



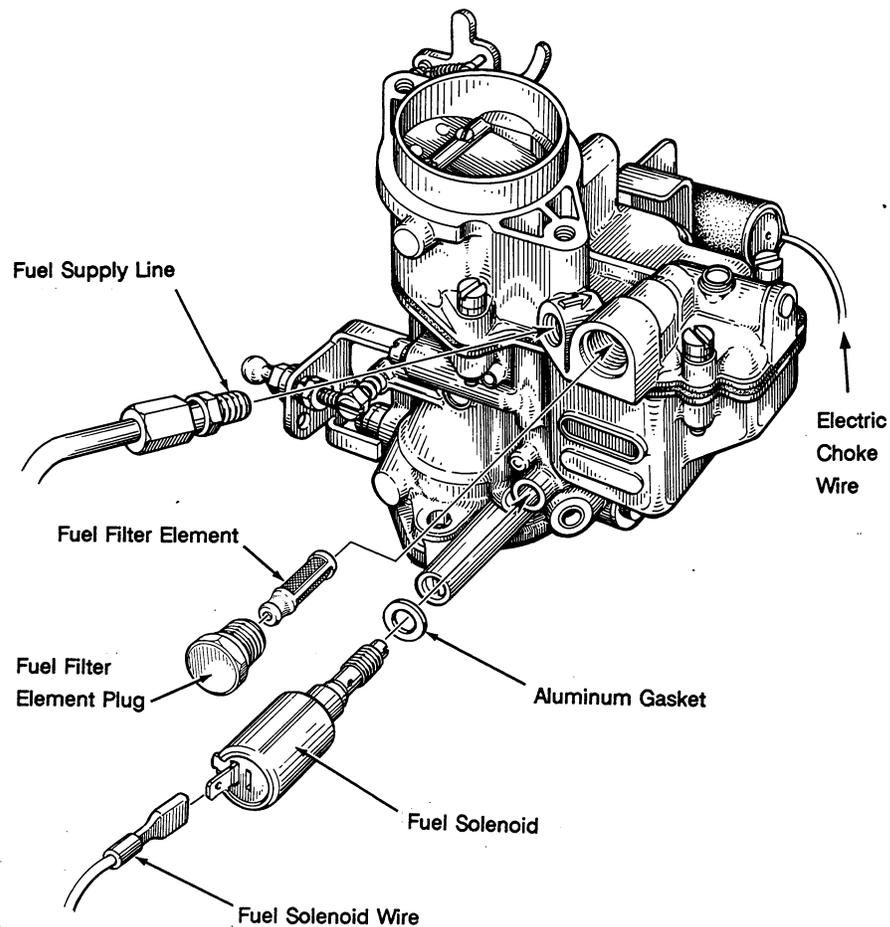
17. Replace the rotary throttle shaft valve and the throttle shaft valve spring.

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

19. Unscrew the fuel 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. Resecure the carburetor to the intake manifold.

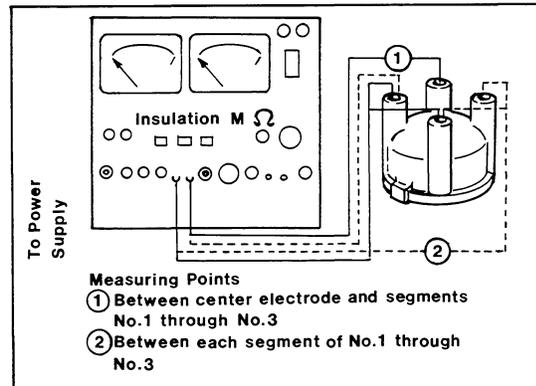
Reconnect the fuel supply line, fuel solenoid wire, electric choke wire, and the throttle control linkage. Reattach the flame arrester and tighten the flame arrester's clamp.



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 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 ohm, clean the cap using a neutral detergent. After drying the cap, remeasure the insulation resistance. If the insulation resistance is still less than 20M ohm, replace the cap.

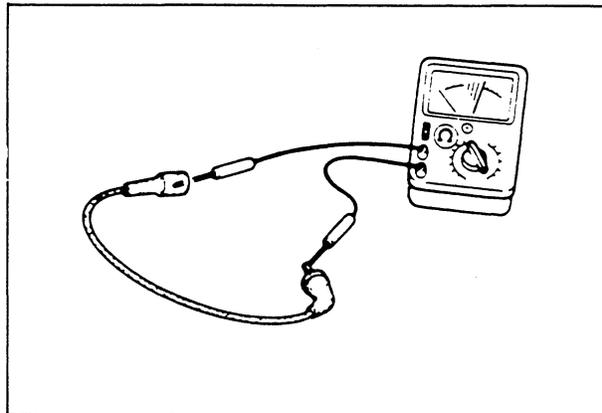


3. Check the distributor shaft for wear or damage. Replace all damaged parts.
4. Measure the condenser capacity with a circuit tester. If the reading does not fall within the specified range, replace the condenser.

Specified range:
(Condenser Capacity)

0.25 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.



Specified resistance:

10 - 22 ohm/m

Testing the Ignition Coil

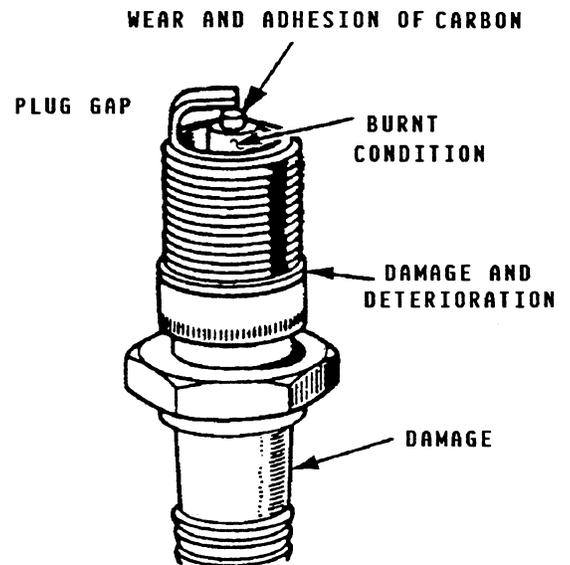
Measure the Ignition coil's primary and secondary resistance and capacitance as follows. Replace the coil if any test fails to meet the resistance value given.

Primary Coil Resistance:	1.2 ±0.12 ohm
Secondary Coil Resistance:	26 ±3.9 ohm
Resistor Resistance: (Replace only the resistor if it fails this test.)	1.7 ±0.17 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 in. (0.7 - 0.9 mm)



Testing the Starter

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

Performance Specifications

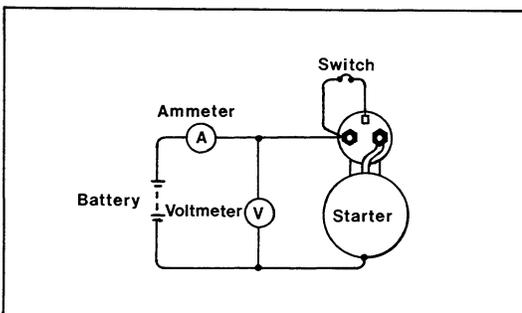
	Voltage	Current	Torque	Speed
No-load Performance	11.5 V	Max 90 A		Min. 3300 rpm
Loaded Performance	7.7 V	300 A	Min. 0.93 kg-m	Min. 850 rpm
Stall Performance	4 V	Max 570 A	Min. 2.5 kg-m	
Rated Output	12 kw (12 V)			
	435 kg			

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 volts).	1.2 KW 100 A or less	3,000 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 above 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.

Description	Standard Value	Service Limit
Bush spring tension 1.2 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.)

c. Check continuity between the positive brush holder and the brush holder base. In case of continuity, replace the holder assembly.

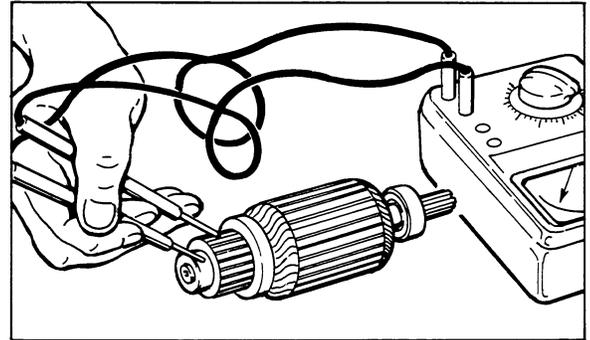
d. Check the brush holder caulk.

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 it, 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.

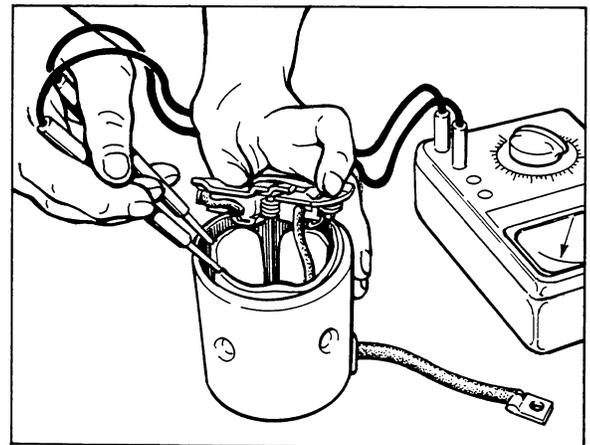


5. Field Coil

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

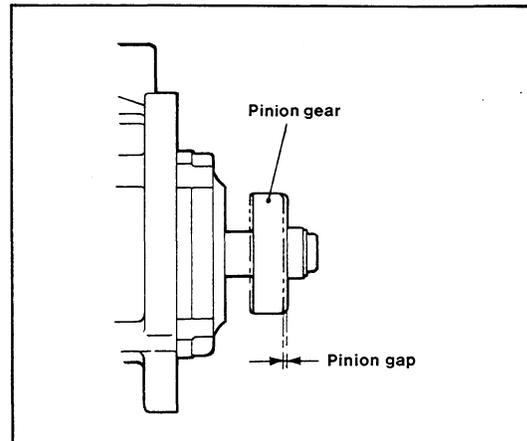
The solenoid must be conducting between S and M terminals and between the S terminal and body.

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) so the pinion moves out and stops. Lightly push the pinion back toward the armature to measure the 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	1.2 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

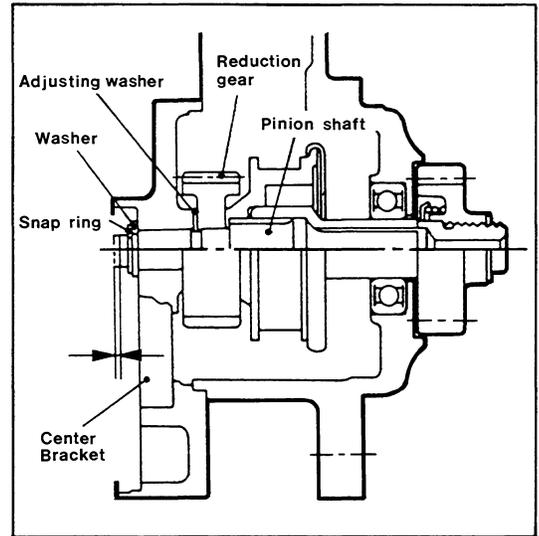
A pinion shaft thrust gap is an axial play of the shaft. Adjust the gap to a value less than the standard value by the adjusting washer between the center bracket and the reduction gear.

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.

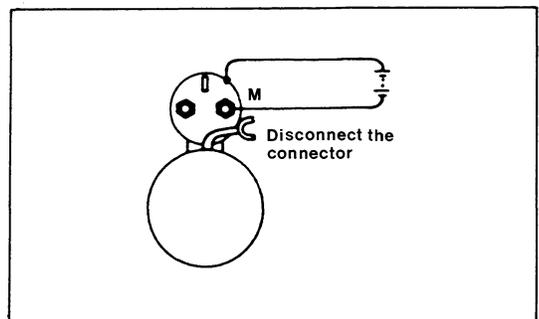
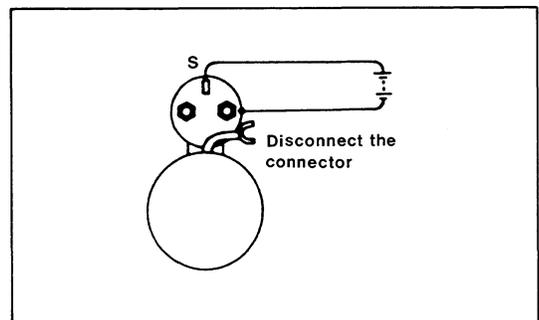
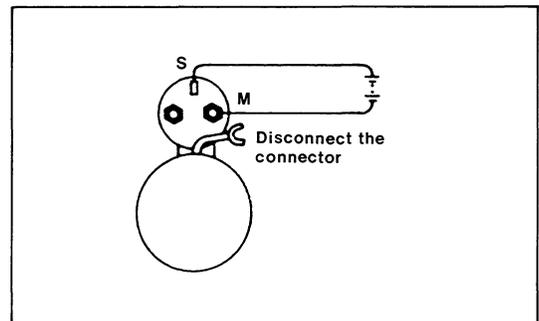
b. Holding Test

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

ENGINE ASSEMBLY

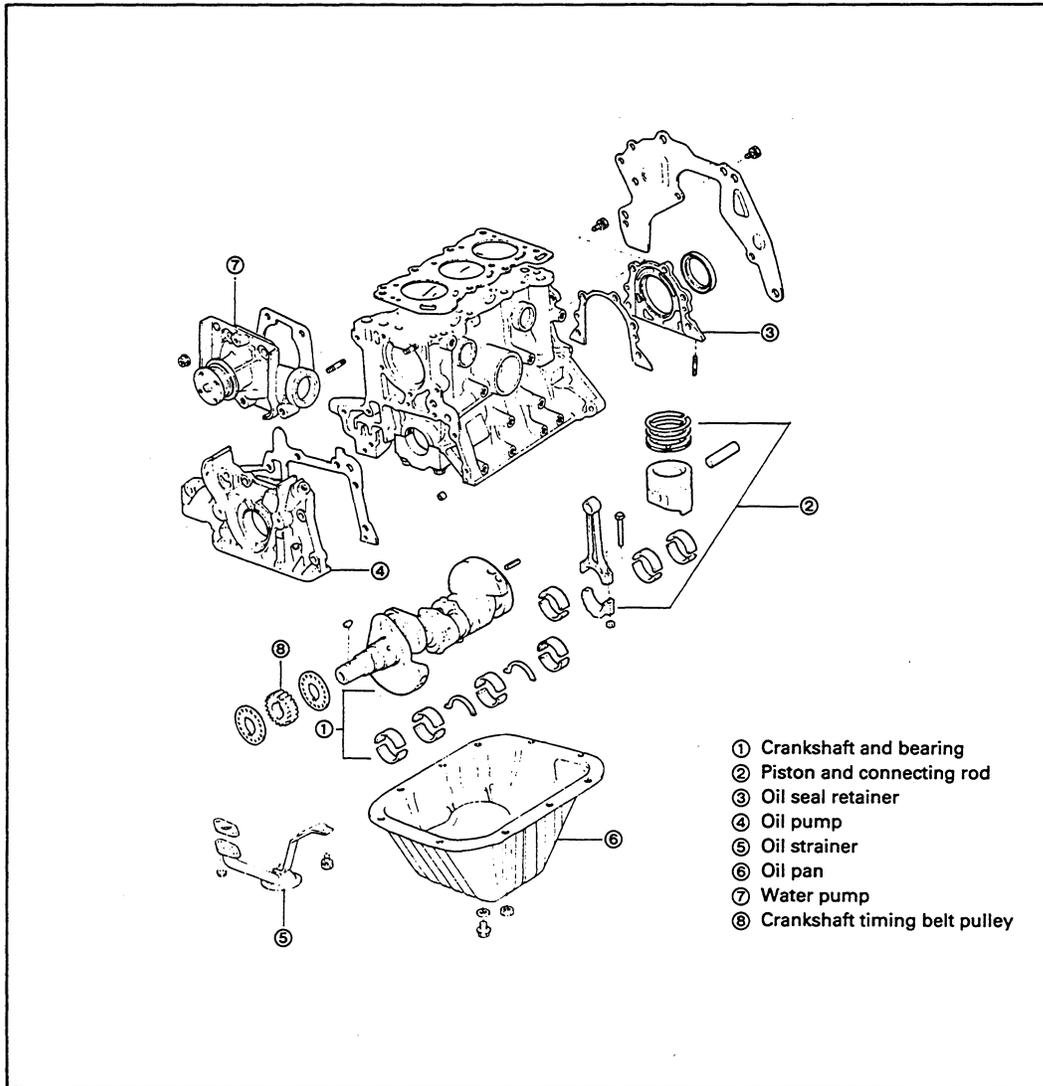
Take the following precautions when assembling the engine:

- 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).....	102
Assembling the Crankshaft.....	103
Piston Ring Installation and Connecting Rod Assembly	104
CYLINDER HEAD ASSEMBLY (Illustration and Numerical Order).....	109
Installation of the Generator to the Engine	117

CYLINDER BLOCK ASSEMBLY

Assemble the components in the order indicated below.



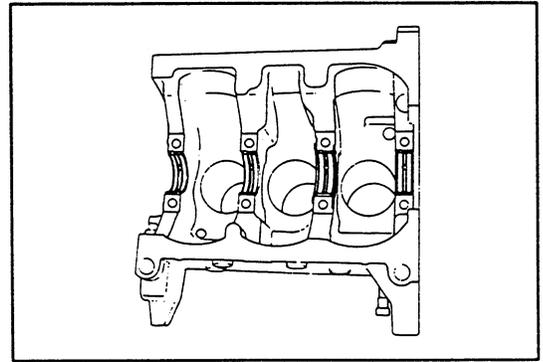
4.5 KW BCG AND 7.0 KW BCG & BCGA ASSEMBLY ORDER

1. Crankshaft and Bearings
2. Piston and Connecting Rod Assembly
3. Oil Seal Retainer
4. Oil Pump
5. Oil Strainer
6. Oil Pan
7. Water Pump
8. Crankshaft Timing Belt Pulley

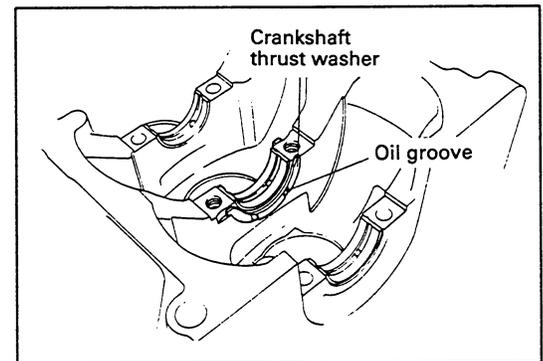
*Denotes that assembly instructions for these parts follow on the indicated pages.

Assembling the Crankshaft

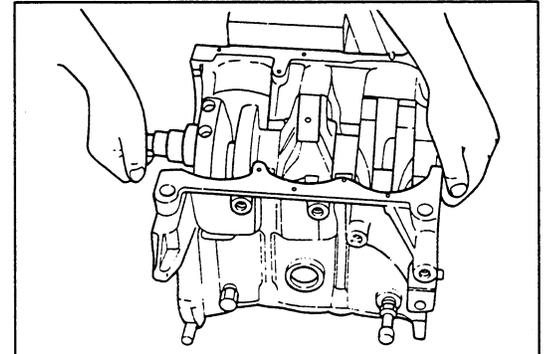
1. Install the crankshaft upper bearing.
 - a. Install the upper bearing which is provided with an oil groove to the cylinder block. Ensure the oil port is aligned with the gallery port.
 - b. Apply a small amount of engine oil to the bearing face.



2. Attach the crankshaft thrust washer.



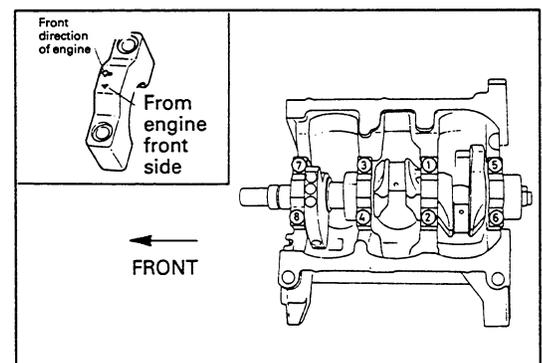
3. Install the crankshaft.



4. Install the crankshaft bearing cap with the crankshaft lower bearing. (No oil groove in lower bearing.)

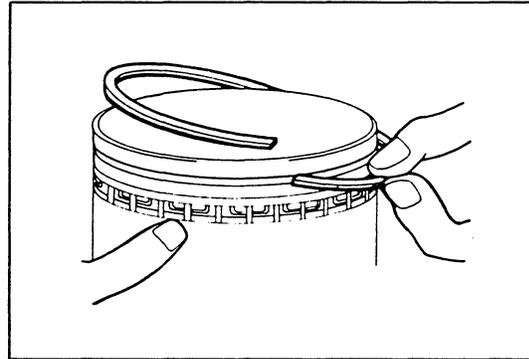
- a. Apply a small amount of engine oil to the threaded portion of each attaching bolt and bearing surface.
- b. Install the bearing cap with its front mark facing toward the front side.
- c. Each time one bearing cap is tightened, make sure that the crankshaft can still turn slightly.

Tightening torque: 39.1 - 47.7 ft-lb
(5.4 - 6.6 kg-m)



Piston Ring Installation and Connecting Rod Assembly

1. Install the oil expander and rail by hand.



Piston Ring Installation (1)

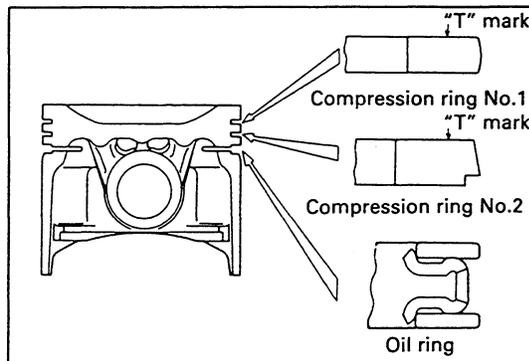
2. Install the piston ring with a piston expander. Make sure that the "T" marks stamped on the rings face upwards towards the piston crown.

3. Apply engine oil to the cylinder inner wall, the piston's periphery and the inner surface of each bearing.

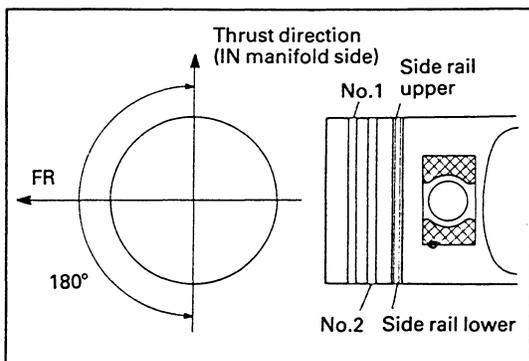
4. Attach a vinyl tube to each bolt section of the connecting rod.

5. Using a piston ring compressor, install the piston with the connecting rod into the cylinder bore, making sure that the front marks face the correct direction.

6. Assemble the piston with the connecting rod by placing the ends of each piston ring at the respective positions as indicated.

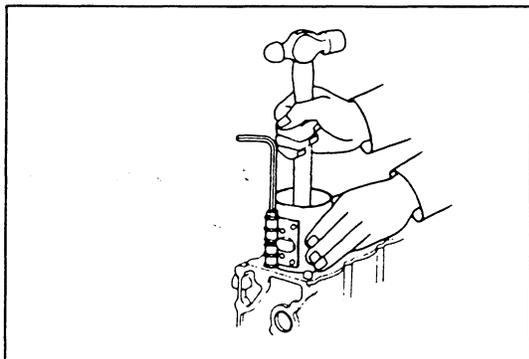


Piston Ring Installation (2)



Piston Ring Installation (3)

7. Using the ring compressor, install the piston with the connecting rod into the cylinder bore, making sure that the front marks face the correct direction.

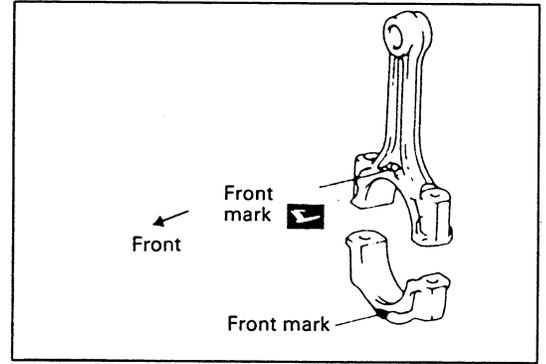


8. Assemble the connecting rod cap.

- a. Apply engine oil to the inner surface of the bearing (the sliding surface relative to the crankshaft journal) as well as to the nut seating surface. Then, install the connecting rod cap with its front mark facing toward the front side.

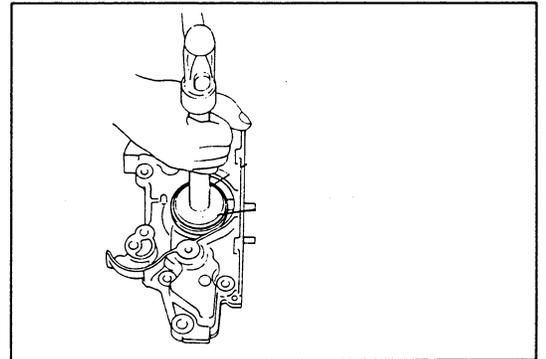
Tightening Torque: 15.2 - 21.0 ft-lb
 (2.1 - 2.9 kg-m)

- b. After the rod cap has been installed, make sure that there exists a proper thrust clearance. After all of the connecting rods have been installed, ensure that the crankshaft turns slightly.

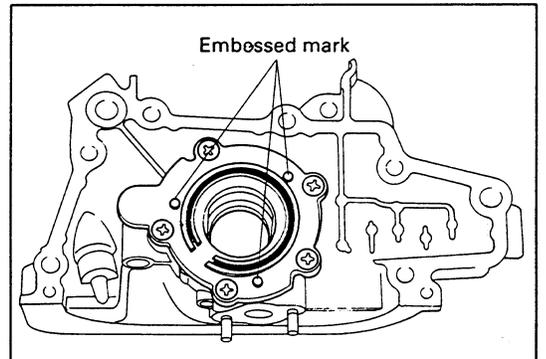


9. Replace the Oil Seal and O-Ring

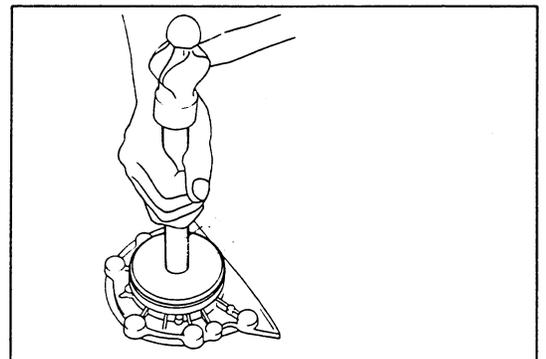
- a. Type T oil seal. (Crankshaft front oil seal.) Using a suitable seal installer, install the oil seal. Supply engine oil to the lip portion of the oil seal.



- b. O-ring (oil pump). Install the O-ring to the oil pump cover. To ensure the seating of the O-ring, push the O-ring at the position of the embossed marks on the cover as indicated.



- c. Type T oil seal (crankshaft rear oil seal). Using an appropriate service tool, install the oil seal. Apply engine oil to the lip portion of the oil seal.

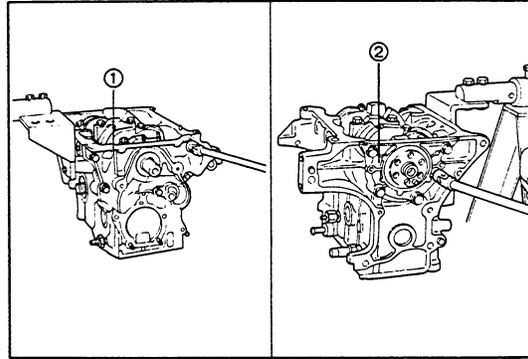


10. Assemble the oil pump ay and rear oil seal retainer.

Tightening Torque

Rear Oil Seal Retainer: 7.2 - 11.6 ft-lb
(1.0 - 1.6 kg-m)

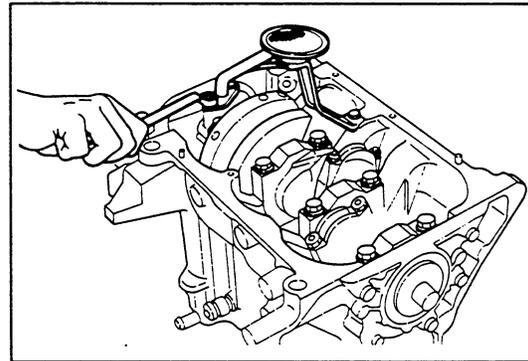
Oil Pump Ay: 11.3 - 16.9 ft-lb
(1.56 - 2.34 kg-m)



11. Assemble the oil strainer.

Tightening Torque

Bolt, Nut: 4.62 - 6.93 ft-lb
(0.64 - 0.96 kg-m)



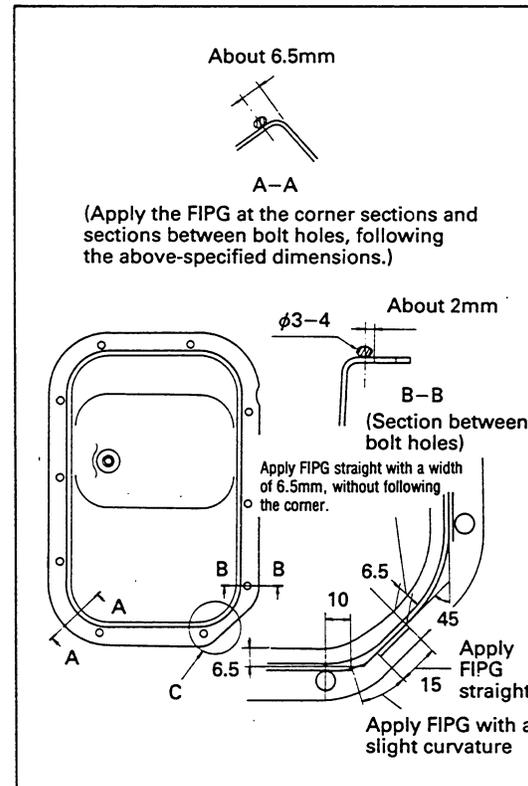
12. Install the filter.

13. Check the flange section of the oil pan. If it's deformed, make it flat by tapping it slightly with a hammer.

14. Install the oil pan S/A. Thoroughly remove any foreign matter (grease, water and seal packing) from the oil pan flange surface. Then, apply new FIPG to the flange surface and assemble the oil pan subassembly. Be sure to apply FIPG in such a way that the FIPG sealing may be formed, without any discontinued spot, in a size equivalent to 3 mm to 4 mm diameter, following the procedure given in the figure.

NOTE: Be sure to assemble the oil pan within fifteen minutes after the application of the FIPG. If more than fifteen minutes should elapse, remove the FIPG and apply the FIPG again. Then, assemble the oil pan. Also, do not perform rigorous driving (high load driving) within three hours after the assembling of the oil pan.

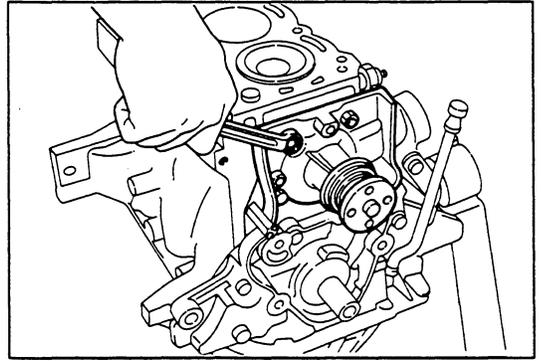
NOTE: No harmful effect will be made even if the excess FIPG is oozed out from the applied sections.



15. Assemble the water pump ay with the oil level gauge guide.

Tightening Torque: 11.3 - 16.9 ft-lb
(1.56 - 2.34 kg-m)

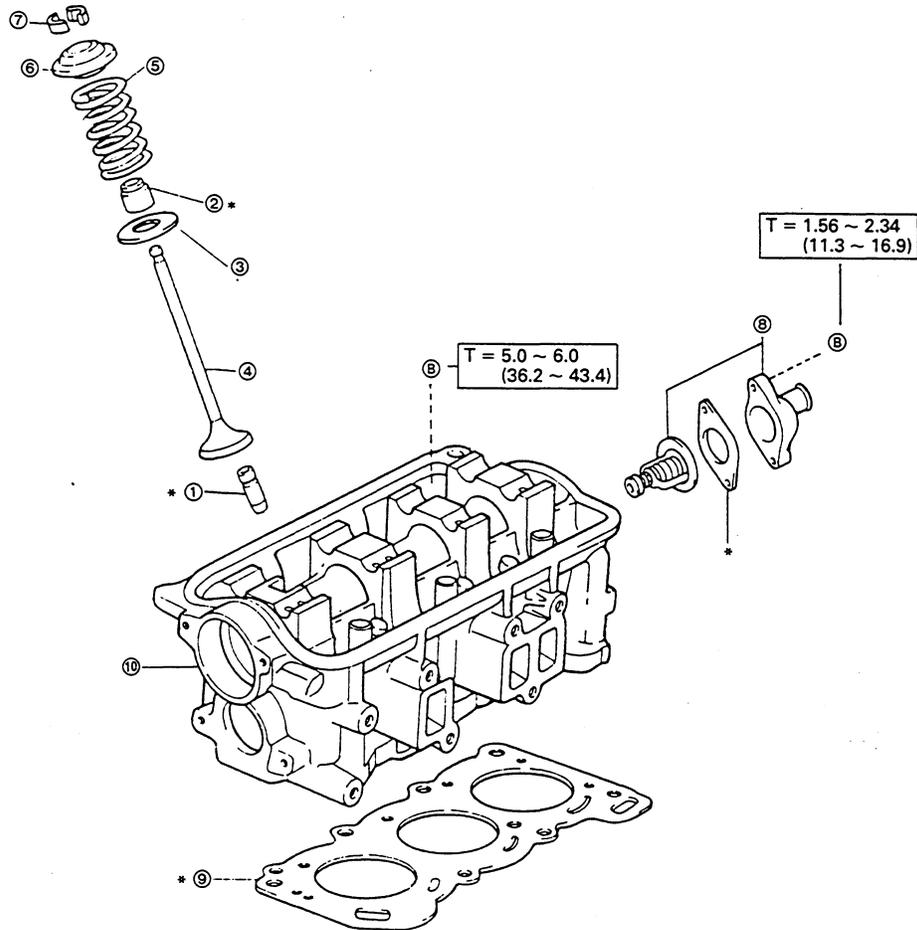
16. Assemble the cylinder head, IN & EX manifold and flywheel related parts.



NOTES

CYLINDER HEAD ASSEMBLY

For the 4.5 KW BCG and 7.0 KW BCG & BCGA cylinder head, assemble the components in the order indicated below.



T: Tightening torque
Unit: kg-m (ft-lb)

*: The parts which do not permit their reuse.

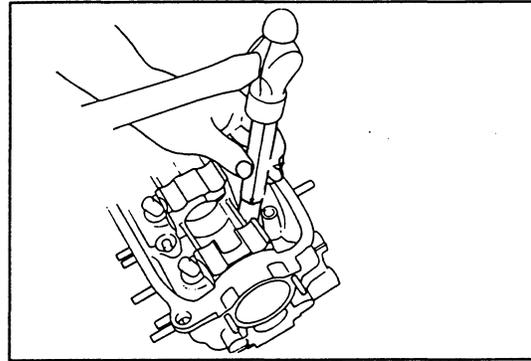
4.5 KW BCG and 7.0 KW BCG & BCGA ASSEMBLY ORDER

1. Valve Guide Bushings
2. Valve Stem Oil Seal
3. Valve Spring Seat
4. Valves
5. Compression Spring
6. Valve Spring Retainer
7. Valve Spring Retainer Lock
8. Water Outlet
9. Cylinder Head Gasket
10. Cylinder Head Ay

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

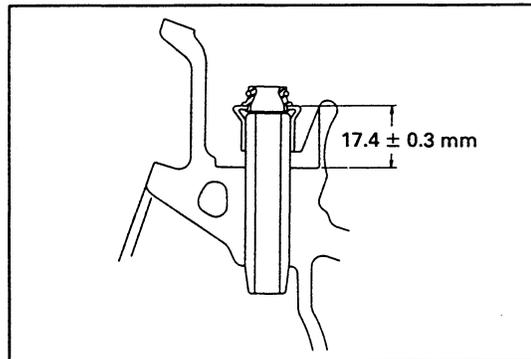
1. Assemble the new valve stem oil seal with the SST.

NOTE: Apply the engine oil to the inner surface and lip section of the valve stem oil seal.



Valve Stem Oil Seal Installation (1)

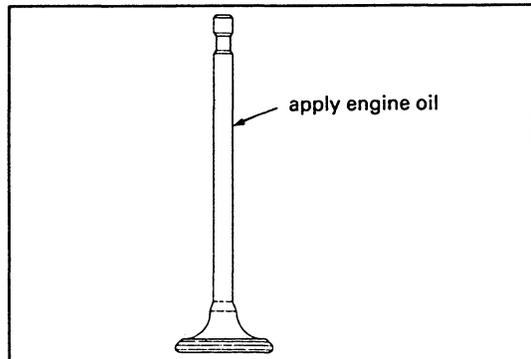
Before the oil seal is driven into the position, make sure that the valve spring is not installed.



Valve Stem Oil Seal Installation (2)

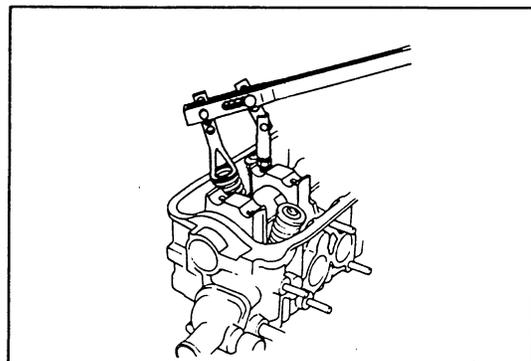
2. Assemble the valve spring seat and valve stem.

NOTE: Apply the engine oil to the sliding portion of the valve stem.

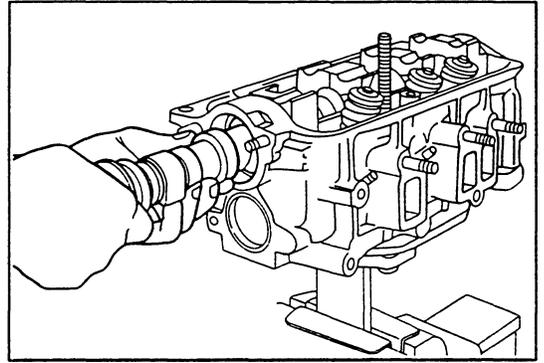


3. Using a valve spring compressor, assemble the valve spring.

NOTE: Install the valve spring so that the painted portion faces the upper side.

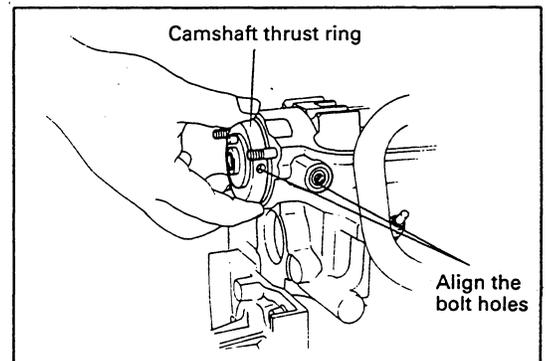


4. Insert the camshaft into the cylinder head.



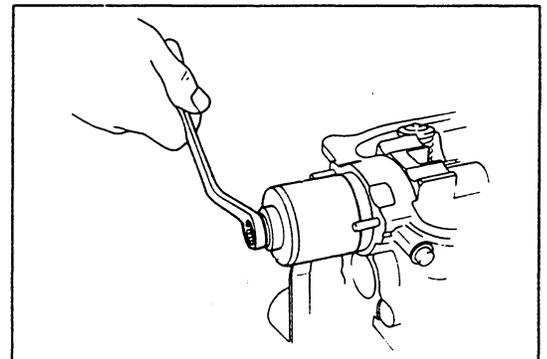
5. Assemble the thrust ring and oil seal.

- a. Align the flange bolt installing hole of the camshaft thrust ring and flange bolt hole of the cylinder block. Insert the thrust ring and temporarily tighten the flange bolt. (Make sure the flange bolt gasket is installed.)



- b. Apply engine oil to the lip portion of the oil seal and press the oil seal by means of the tool #038751.

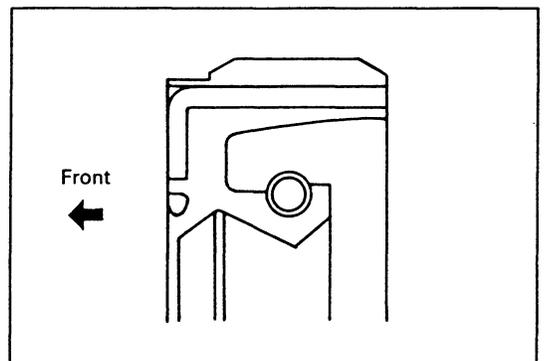
Bolt: M10, length below head
40 - 45 mm



Oil Seal Installation (1)

- c. Remove the bolt. Hit the tool with a hammer to confirm the fitting condition of the oil seal.

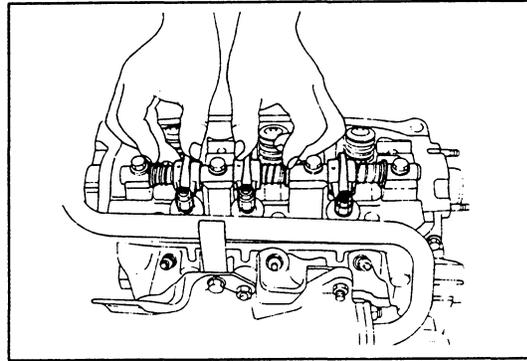
Oil Seal Protrusion Amount:
 0.0078 ± 0.0098 in. (0.2 ± 0.25 mm)



Oil Seal Installation (2)

6. Assemble the valve rocker shaft related parts.

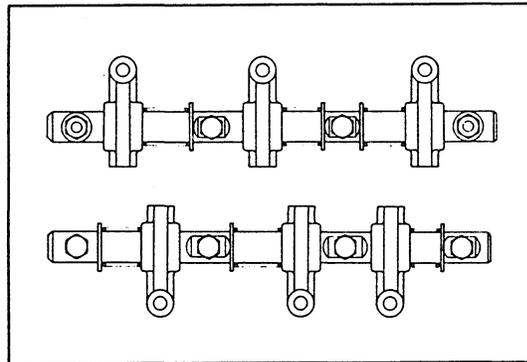
- a. Apply engine oil to the valve rocker arm inner surface, pad surface and valve contact position of the valve adjusting screw. Then assemble the plate washer, compression spring and valve rocker arm to the valve rocker shaft.



Rocker Shaft Installation (1)

- b. Assemble the valve rocker shaft.

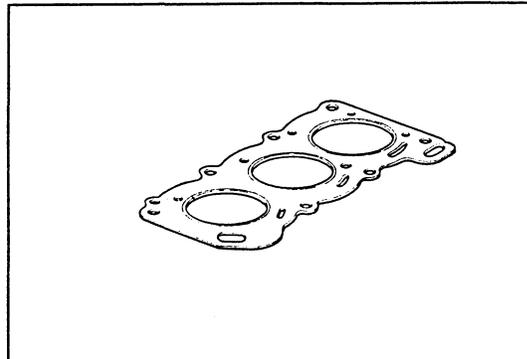
NOTE: Care must be exercised to ensure that the valve rocker arm or plate is assembled properly.



Rocker Shaft Installation (2)

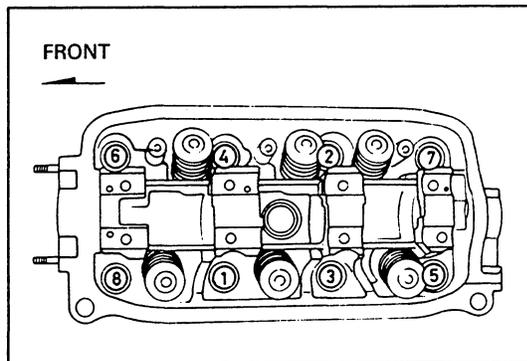
Installation of Cylinder Head and Timing Belt

- 1. Install the cylinder head gasket.



- 2. Install the cylinder head assembly and tighten the cylinder head bolts, as indicated in the sequence evenly and progressively several times over.

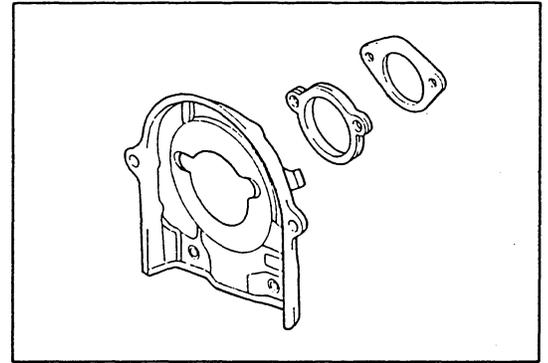
Tightening Torque: 36.2 - 33.4 ft-lb
(5.0 - 6.0 kg-m)



3. Install the camshaft timing belt pulley.

- a. Install the oil seal plate.
- b. Install the timing belt cover No. 2 together with the grommet.

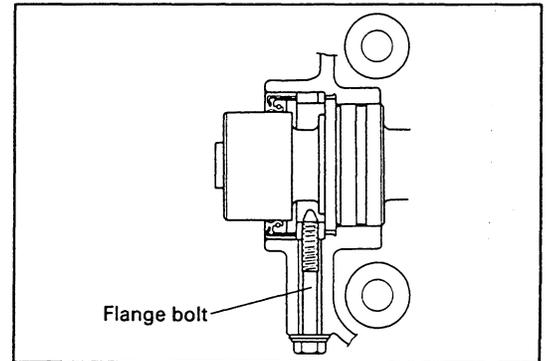
Tightening Torque: 5.2 - 7.8 ft-lb
(0.72 - 1.08 kg-m)



Camshaft timing Belt Pulley
Installation (1)

- c. Tighten the temporarily tightened flange bolt for camshaft thrust ring correctly by the specified torque.

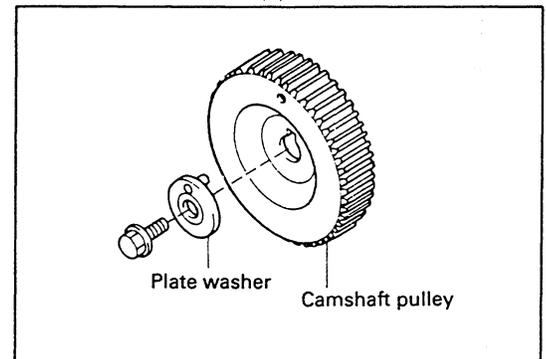
Tightening Torque: 5.2 - 7.8 ft-lb
(0.72 - 1.08 kg-m)



Camshaft timing Belt Pulley
Installation (2)

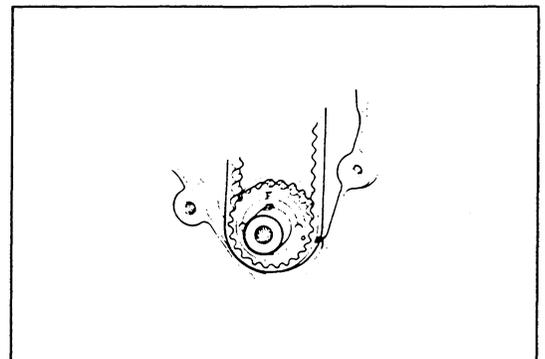
- d. Align the knock pin of the plate washer with the hole and install the timing belt pulley.

Tightening Torque: 25.5 - 38.2 ft-lb
(3.52 - 5.28 kg-m)



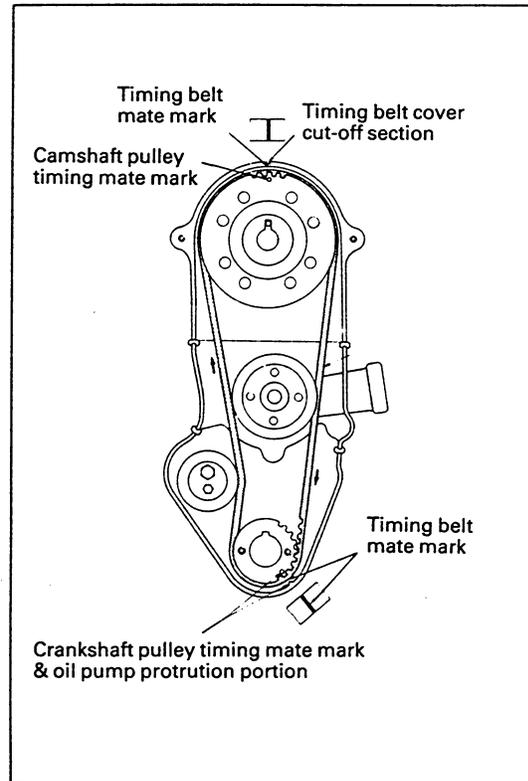
4. Install the crankshaft inner flange and crankshaft timing belt pulley.

NOTE: Be sure to install the crankshaft timing belt pulley so that the "F" mark stamped on the pulley faces the front side.



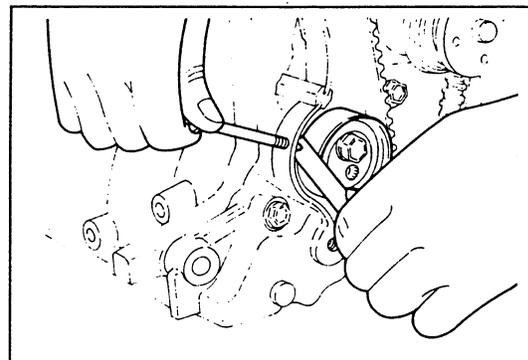
5. Install the timing belt.

- a. Align each camshaft and crankshaft pulley mate mark to the respective indicator as indicated in the figure.
- b. Install the timing belt with its direction of rotation mark put at the time of the removal facing toward the same direction as before.
- c. Make sure that all of the mate marks put at the time of the removal and the pulley marks are aligned with each other.



6. Install the timing belt tensioner subassembly. To adjust the tension of the timing belt:

- a. Remove the resin cap attached to the oil pump body.
- b. Temporarily install the timing belt tensioner (only to the extent that it can swing slightly.)
- c. Screw an M6 screw (pitch: 1 mm, length: 20 - 30 mm) fully into place from which the resin cap was removed, using your thumb and index finger. At this time, make sure to insert a steel plate between the screw and the tensioner so that no damage may be made to the roller section of the tensioner.

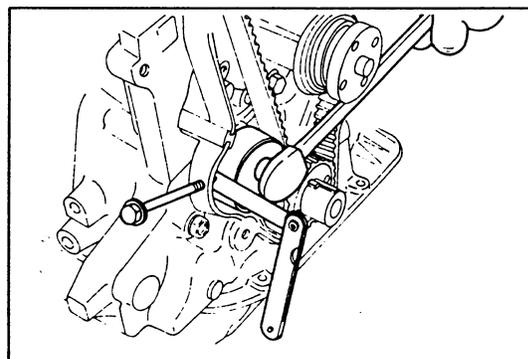


Adjusting Timing Belt Tension (1)

- d. Tighten the tensioner to the specified torque.

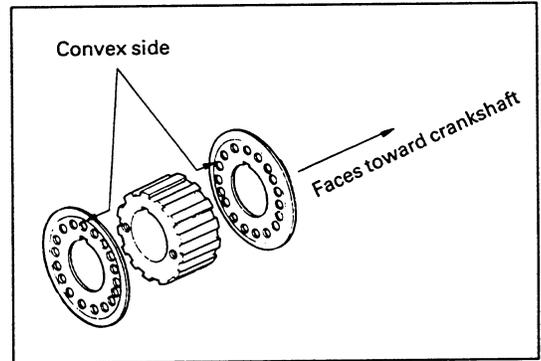
Tightening Torque: 23.1 - 34.7 ft-lb
(3.2 - 4.8 kg-m)

- e. Remove the M6 screw and steel plate. Install the resin cap.



Adjusting Timing Belt Tension (2)

- f. Rotate the crankshaft two turns in the normal direction and stop the crankshaft again at the top dead center. Make sure that the relationship between the timing belt and pulleys is correct

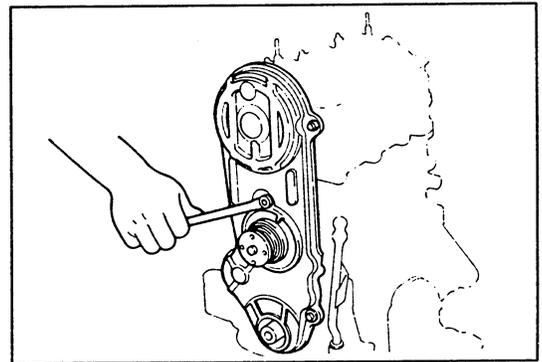


- g. Install the timing pulley outer flange and timing belt cover No. 1.

Tightening Torque: 3.2 - 4.8 ft-lb
(0.44 - 0.66 kg-m)

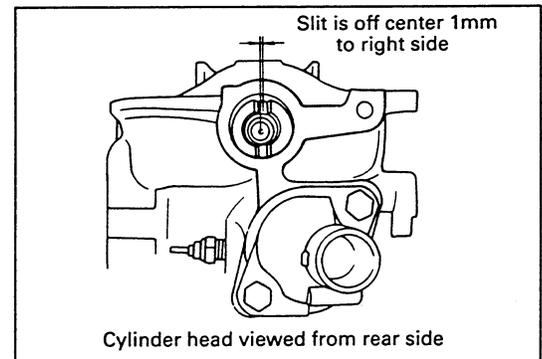
7. Install the following parts to the right side of the engine:

- a. The oil filter.
- b. The exhaust manifold with related hoses.

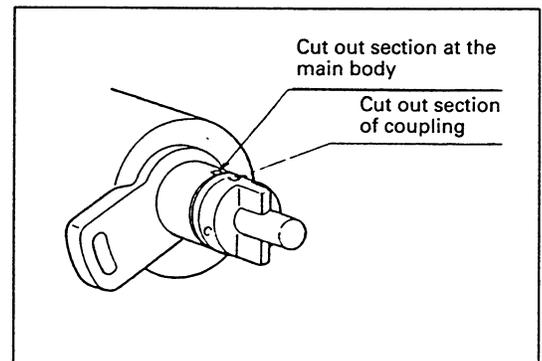


8. Install the distributor.

- a. Turn the crankshaft and camshaft in such a way that the No.1 cylinder may be set to the top dead center on the compression stroke. At this time, the slit at the rear end of the camshaft is off center to the right side when viewed from the engine's rear side.



- b. Align the cutout section of the distributor coupling with the cutout section at the main body.
- c. Apply engine oil to the "O" ring and the forward end section of the shaft. Then, proceed to insert them into place.



9. Install the following parts to the left side of the engine:

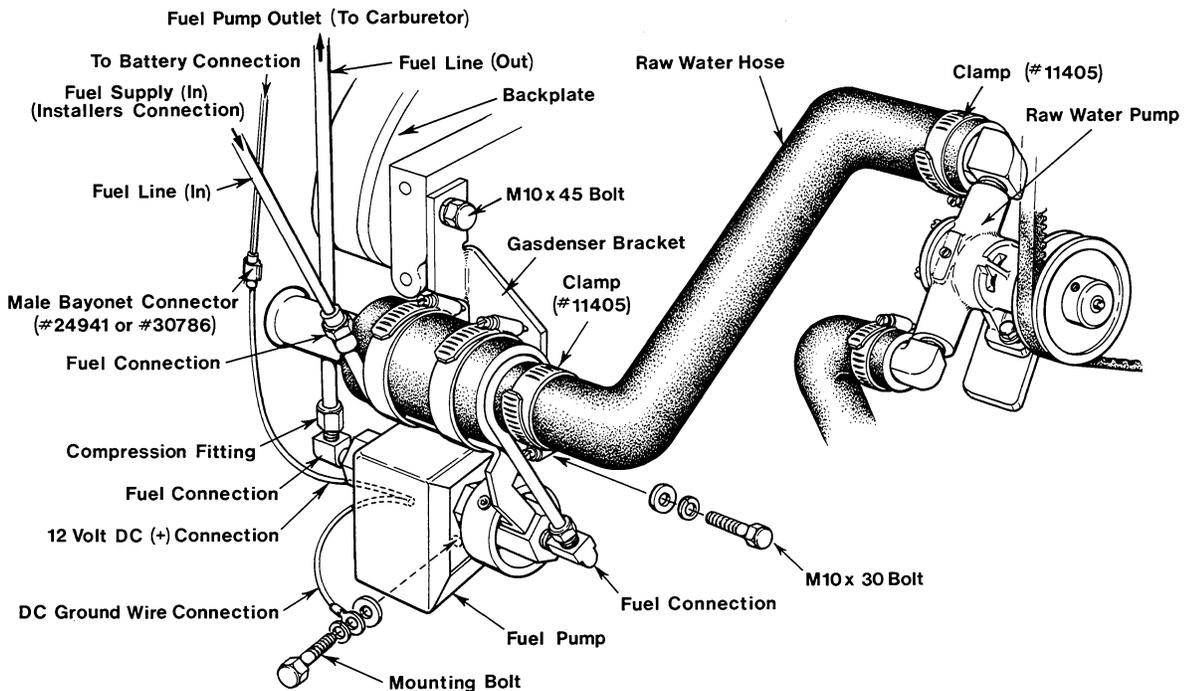
a. Intake manifold

Tightening Torque: 11.3 - 16.9 ft-lb
(1.56 - 2.34 kg-m)

b. Carburetor

Tightening Torque: 7.5 - 11.3 ft-lb
(1.04 - 1.56 kg-m)

c. Install gasdenser assembly.



10. Install the following parts to the front side of the engine.

a. Cylinder head cover

Tightening Torque: 2.9 - 4.3 ft-lb
(0.4 - 0.6 kg-m)

b. Install raw water pump mounting bracket and raw water pump.

c. Crankshaft pulley

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

d. Fresh water pump pulley

Tightening Torque: 3.2 - 4.8 ft-lb
(0.44 - 0.66 kg-m)

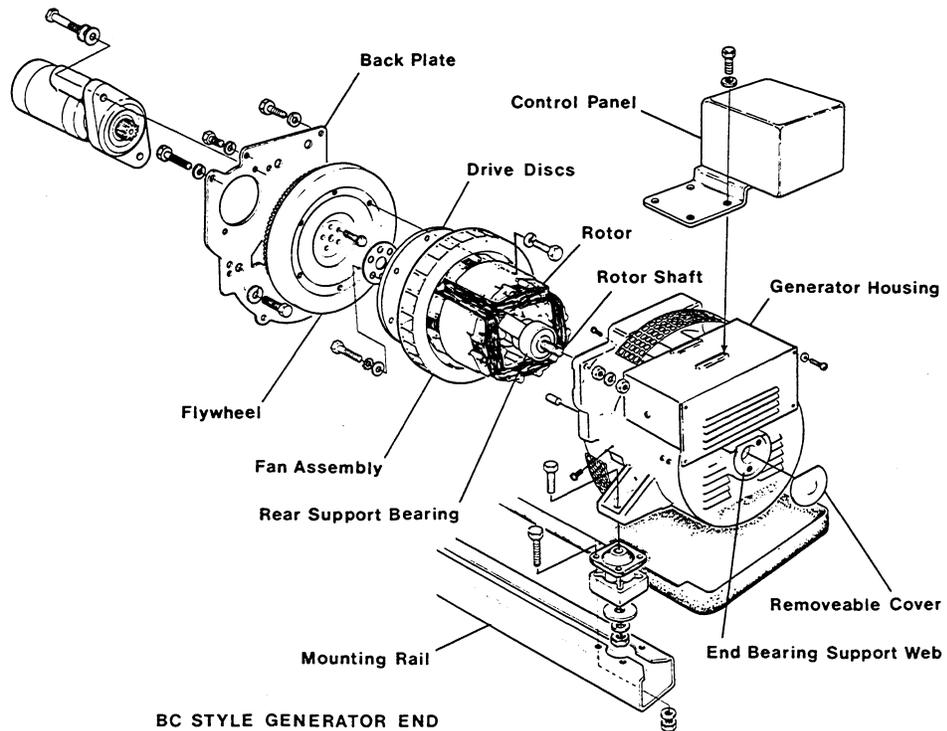
11. Install the V belt.

Belt Deflection Amount

Specified Value: 0.37 - 0.45 in./22 lb
(9.5 - 11.5 mm/10 kg)

Installation of the Generator to the Engine

1. Rotor and fan assembly to flywheel and distributor.
2. Assemble the stator housing to the engine using field fabricated tool). Secure to back plate.
3. Mount control panel and install wiring harness. Ensure connections are clean and secure. (Follow unit DC schematic.)



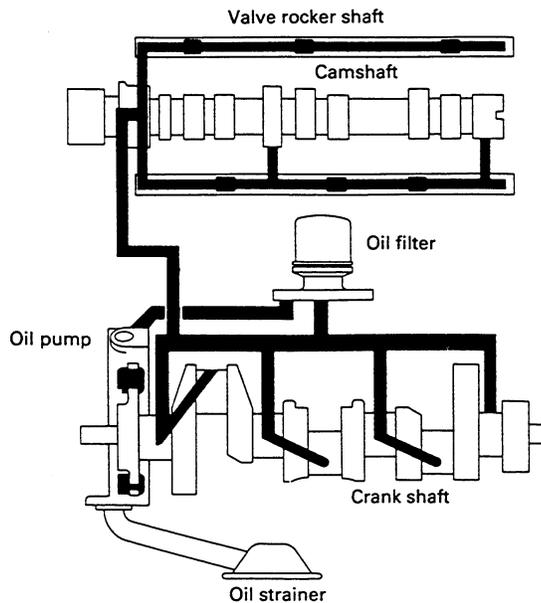
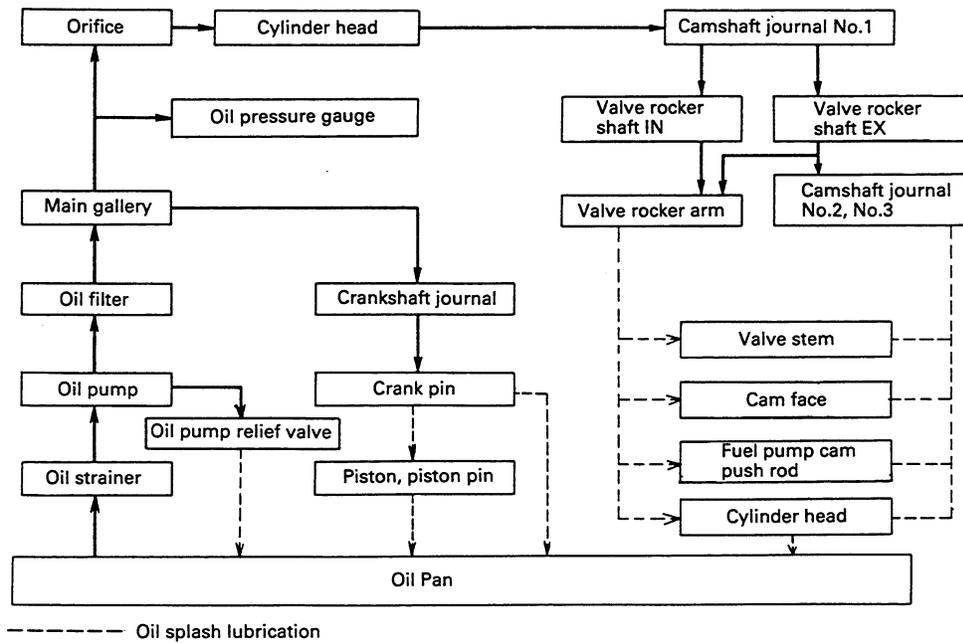
NOTES

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.



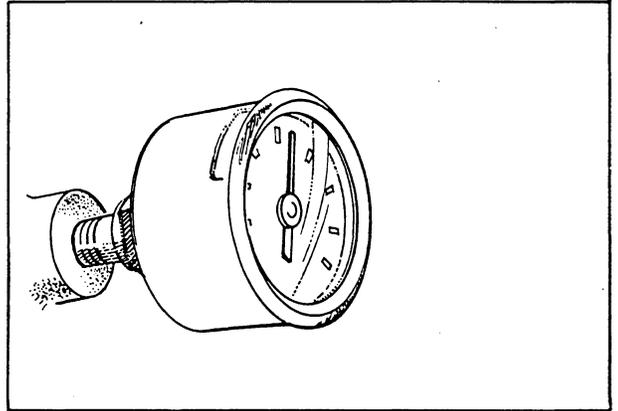
Oil capacity (whole)	2.8 ℓ
Maximum oil pan capacity	2.2 ℓ
Minimum oil pan capacity	1.6 ℓ
Oil pump relief valve opening pressure (60°C, 4000 rpm)	3.5 ~ 4.3 kg/cm ² (49.8 ~ 61.2 psi)

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.
Low Oil Pressure (unit shutdown).	1. Oil leaks.	1. Locate and repair.
	2. Low oil level or incorrect grade.	2. Add oil to proper level or change.
	3. Faulty oil pressure switch or sender.	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 SE, SF, SG OR SJ.

Cooling System Troubleshooting

Trouble

Possible Cause

Remedy

Coolant leaks: It is recommended that when trying to locate a leak in the cooling system that the system be pressure tested using a commercially available pressure tester such as the STANT #ST255. Follow instructions with the tester. Locate and correct the leak.

1. Leaking pressure cap.

1. Test with above unit and/or replace.

2. Faulty plastic coolant recovery tank.

2. 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 (Raw Water System).

1. Loose or broken raw water pump drive belt.

1. Adjust or replace.

2. Faulty raw water pump.

2. Check raw water pump for wear and/or defective impeller. Repair or replace as needed.

3. Clogged heat exchanger.

3. Remove exchanger, clean and flush.

4. Scale in exhaust elbow.

4. Remove elbow and clean.

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

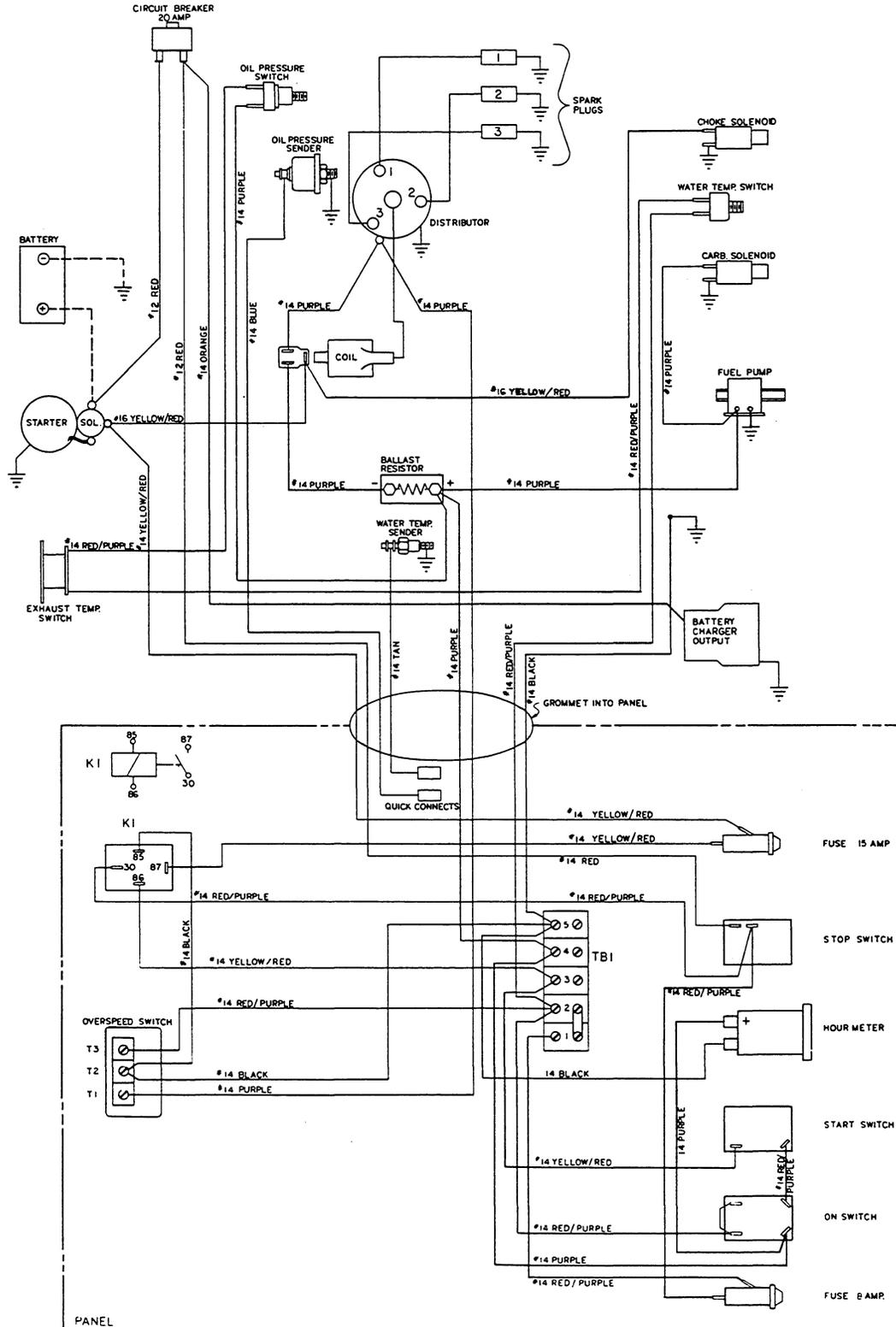
Fuel System Troubleshooting

<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.
<hr/>		
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.
<hr/>		
Poor performance at generator speed.	1. Main jet clogged.	1. Remove and clean.
	2. Carburetor inlet filter clogged.	2. Remove and clean.
	3. Air intake filter screen dirty.	3. Remove and clean.

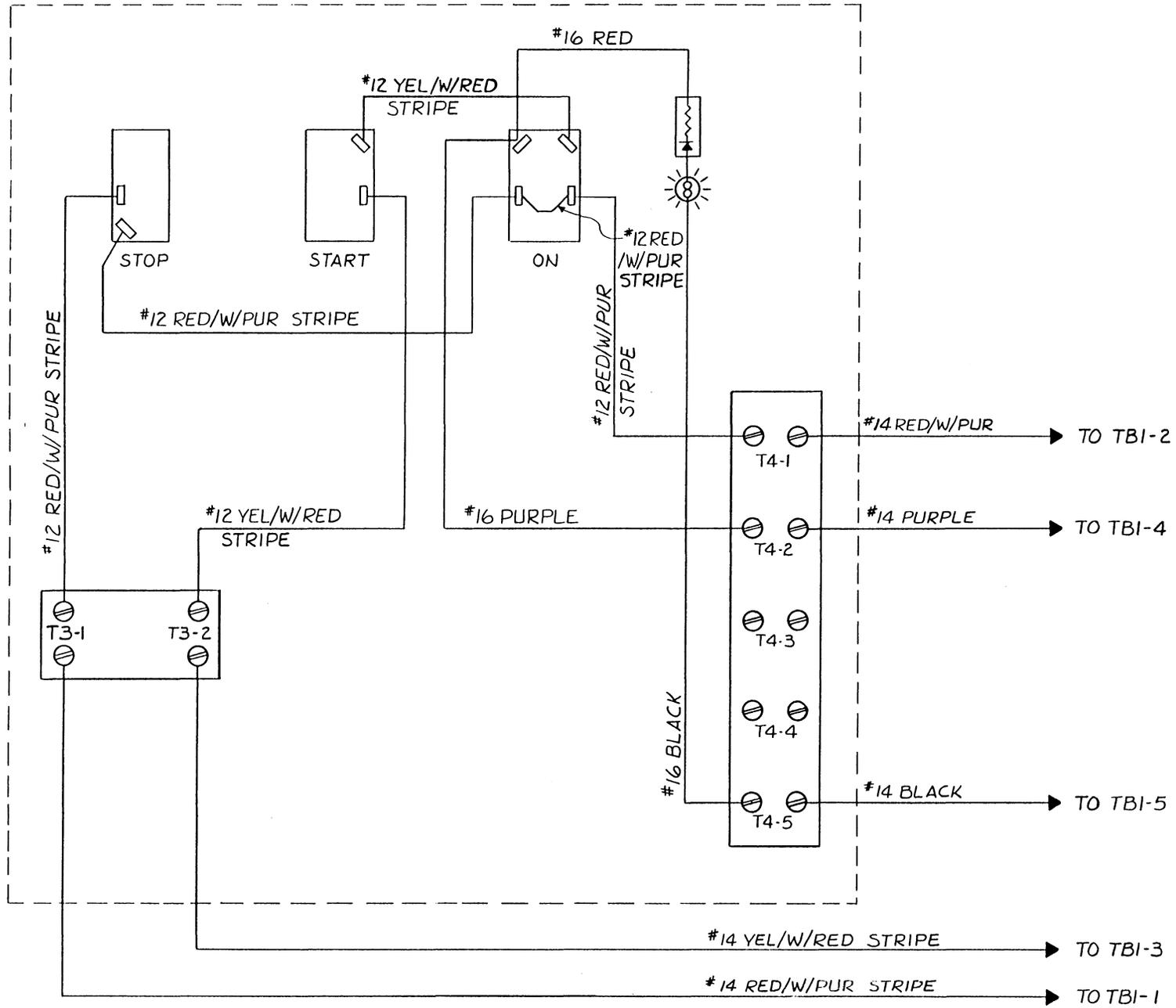
DC CONTROL CIRCUIT WIRING DIAGRAM #38028

Page 1 of 2

WIRING DIAGRAM



OPTIONAL REMOTE START PANEL (REAR VIEW) P.N. 33703



OPTIONAL REMOTE START PANEL WIRING DIAGRAM #38024

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 de- pressing 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. Solenoid inoperable.	4. Check to see that it is not jammed. Should close when engine is cranking over, only.

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
No ignition, cranks, does not start. (continued)	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 bypass test.
Engine stops.	1. Low oil pressure or overheated.	2. Check oil, fresh water and raw water cooling.
	2. Low oil pressure switch fails to close.	2. Check for satisfactory operation with switch bypassed.
	3. High water or exhaust temperature switches open at too low a temperature.	3. Same as above.
	4. Overspeed module.	4. Check engine speed. Check module for proper operation.
	5. Switch and wiring.	5. Inspect all wiring for loose connections and short circuits.

<u>Trouble</u>	<u>Possible Cause</u>	<u>Remedy</u>
Not charging battery or battery runs down.	1. DC controller.	1. Check controller circuit for faulty component. Ensure bridge rectifier and controller connections are clean and tight.
	2. Oil pressure switch.	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. High resistance leak to ground.	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. Low resistance leak to ground.	4. Check all wires for temperature rise to locate fault.
	6. Overspeed circuit drained battery.	6. Unit not run for months and fuse left in circuit drawing 0.025 amp.

GENERATOR DESCRIPTION AND MODEL RATING

Characteristics

Design: Four pole, revolving field, self-exciting. Capacitor saturated field excitation. Pre-lubricated, single bearing design.

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.

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 4.5 - 614	37.5/18.7	60	4.5
BCG 3.5 - 514	16	50	3.5
BCG 7.0 - 614	58/29	60	7.0
BCG 5.0 - 514	22.7	50	5.0
BCGA 7.0 - 614	58/29	60 (only)	7.0

Derating

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

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 4.5 KW BCG and 7.0 KW BCG & BCGA 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.

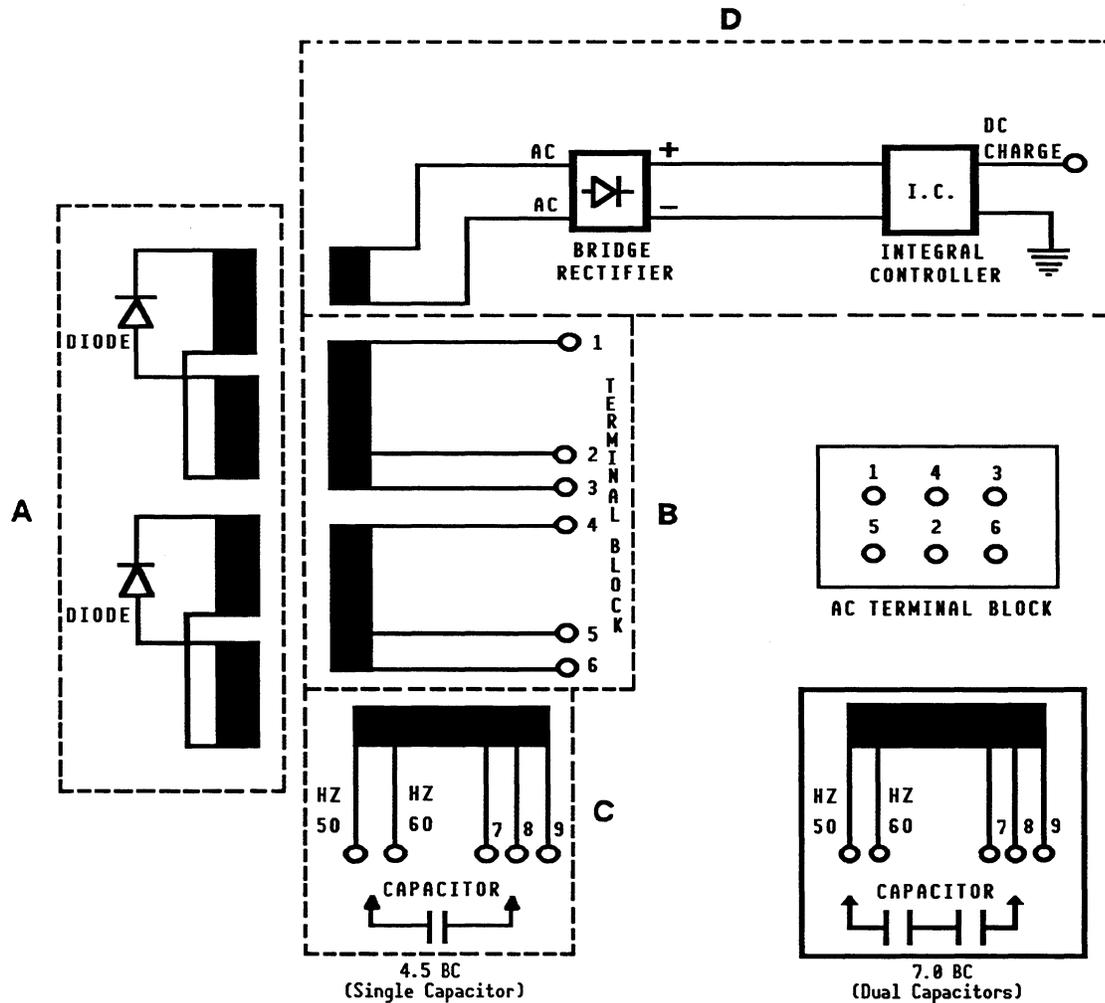
NOTE: Do not always rely on the vessel's instruments for accurate readings; try to bring your own.

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.

**4.5 KW BCG & 7.0 KW BCG
Generator Internal Wiring Schematic with Battery DC Charging Circuit.
60 Hertz - 50 Hertz Models**

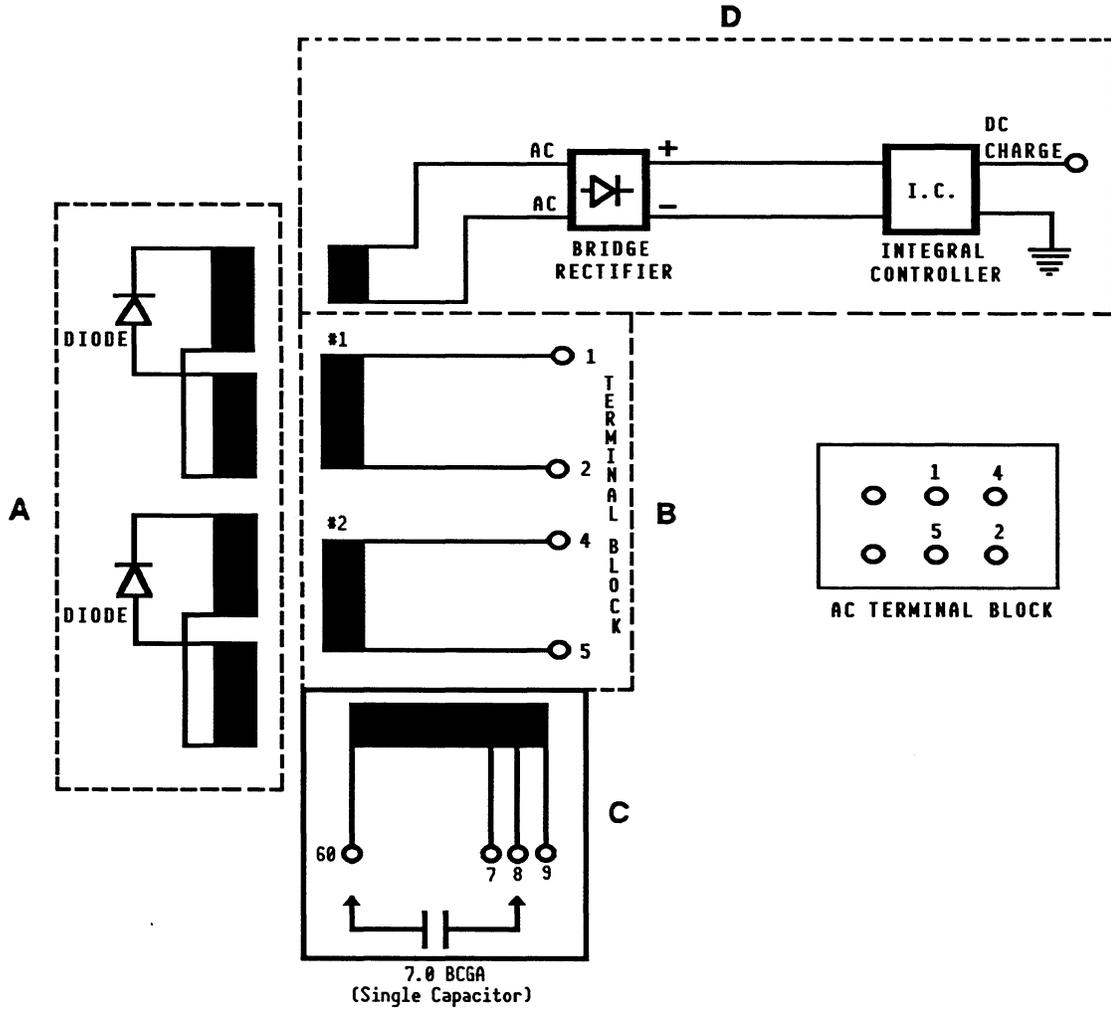


Components

- A. Rotating Field and Diodes** (page 134)
- B. Main Stator Windings** (page 135)
- C. Exciter Windings and Capacitor(s)** (page 136)
- D. Battery Charging Circuit** (page 138)

A description of each component follows.

**7.0 KW BCGA
Generator Internal Wiring Schematic with Battery DC Charging Circuit.
60 Hertz Model (Only)**



COMPONENT RESISTANCE VALUES

A. Rotating Field/Auxiliary Windings and Diodes

Two sets of windings are found in the rotor assembly. An AC voltage is produced in the two groups of windings as the rotor turns at rated rpm. This AC voltage passes through each of the two diodes mounted on the isolated fixture just before the rotor carrier bearing. The AC sign wave is changed to a DC and this DC voltage is passed through the two groups of rotating field windings producing a DC field around these windings. This field affects the AC winding of the two main stator groups inducing an AC voltage in these windings that is available at the AC terminal block connections.

1. Rotating Field/Auxiliary Windings

4.5 KW BCG and 7.0 KW BCG & BCGA: 3.8 ohm

To check the resistance values, rotate the engine's crankshaft to position the diode(s) on the generator's shaft at 12 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 its isolated heat sink using a thin walled, deep well 11 mm socket (7/16 in. equivalent).

NOTE: The aluminum heat sink that the diode threads into can be bent carefully outboard to make access to the diode better.

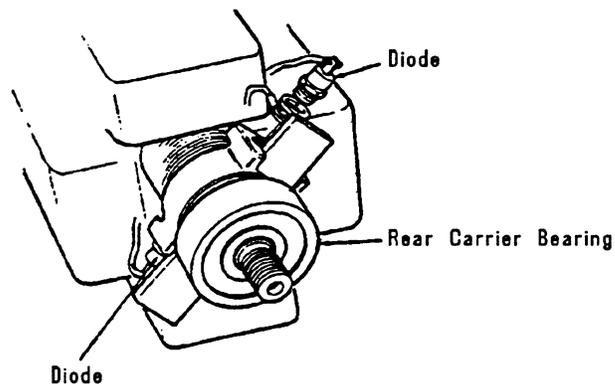
With the diode removed, both leads for the first group of rotating field/auxiliary windings will be isolated with no interference from a possibly faulty diode.

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 o'clock.

No continuity should be found between these two groups of windings.

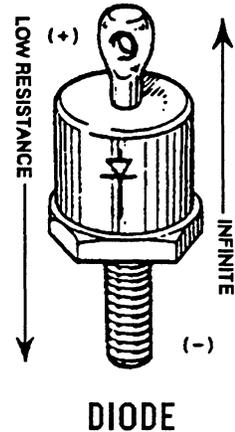


2. Diodes 8 - 9.5 ohm (approximate)
using a 260 Simpson Analog Meter

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. Different meters will read different resistance values through the diode.

NOTE: Different meter models may show different ohm values but, should be the same for both diodes.



Diode Rating:

1600 Volts

26 Amps

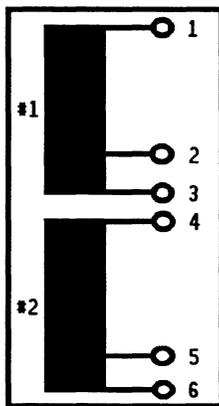
The diode's rating is far in excess of the circuit's requirements. Most likely a diode failure will result from an overspeed or load surge. A diode failure would be attributed to a manufacturing defect.

B. Main Stator Windings

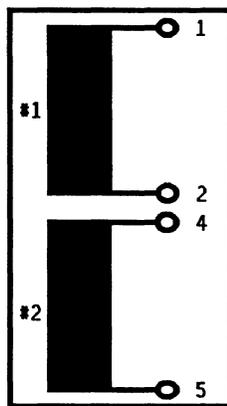
4.5 KW BCG: 0.6 ohm

7.0 KW BCG & BCGA: 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 and brass interconnects from the terminals on the block. This will isolate the 6 or 4 leads on the terminal block which make up the two main stator groups.

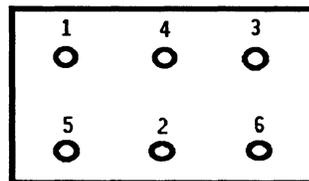


4.5 KW BCG & 7.0 KW BCG

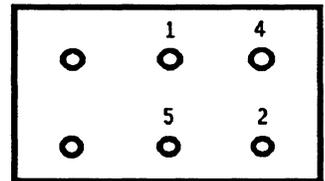


7.0 KW BCGA

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



4.5 & 7.0 KW BCG



7.0 KW BCGA

Terminal Blocks

Checking Stator Windings for the 4.5 KW BCG and 7.0 KW BCG

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.)

Checking Stator Windings for the 7.0 KW BCGA

Group # 1 - Measure resistance value between terminal with lead # 1, and terminal with lead # 2. (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 # 5. (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 #1 and the other ohmmeter lead on the terminal with stator lead # 4. There should be no continuity between the two groups of stator windings.

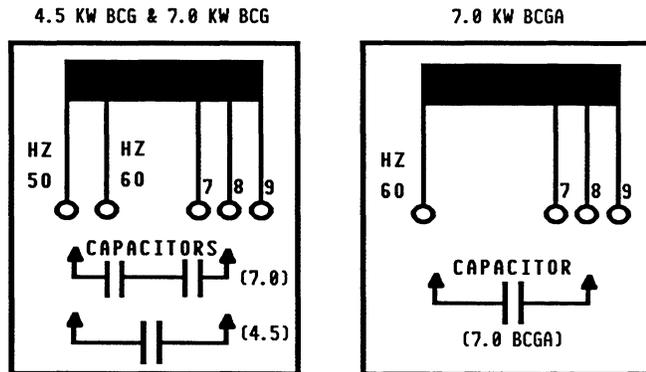
C. Exciter Windings

4.5 KW BCG: 1.9 ohm

7.0 KW BCG & BCGA: 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 or the #9 and the 60 hertz leads for the 7.0 BCGA model unplugged from the capacitor.) This residual voltage must be present for the exciter circuit to function. **Do not** unplug capacitor leads while the generator is operating. The residual voltage is 14 - 16 volts AC.

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 or the #60 hertz connector and #9 connection for the 7.0 BCGA 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 on the 4.5 and 7.0 BCG models, locate the #9 and the #50 hertz capacitor connections. On the 7.0 BCGA model it would be the #60 hertz connection.

NOTE: Three numbered capacitor connections exist: #7, #8, and #9; and two hertz connections, #50 and #60 for the 4.5 BCG and 7.0 BCG. There is only one hertz connection for the 7.0 BCGA - that is the #60.

Unplug any other connections from the capacitor(s) noting their position on the capacitor.

We want to measure the resistance value of the complete group of exciter windings. Place one of your ohmmeter leads on the #9 connector and the other on the #50 or the #60 for the 7.0 KW BCGA and note the value.

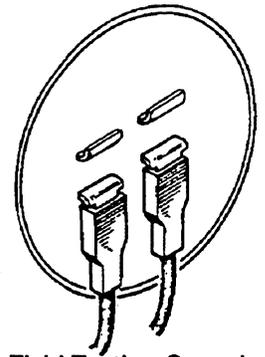
Check to make sure there is no continuity to the ground/generator case from either of the two leads. Also, check that no continuity exists between these exciter leads and any of the main stator winding leads on the AC terminal block (refer to paragraph B). If continuity is found here, a fault exists between these two winding groups.

1. Capacitor (Field Testing of the Capacitor[s])

One capacitor is used in the 4.5 and 7.0 KW BCGA generator sets, and two capacitors in series are used in the 7.0 KW BCG generator set.

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.

When a capacitor meter is not available, follow the simple field test below.



Field Testing Capacitor(s)

- 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)

4.5 KW BCG: 31.5 microfarads (uF) $\pm 5^\circ$
7.0 KW BCG: 31.5 microfarads (uF) $\pm 5^\circ$
7.0 KW BCGA: 31.5 microfarads (uF) $\pm 5^\circ$

NOTE: Ratings are found on the capacitor case. Check the rating on the capacitor case when in doubt.

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

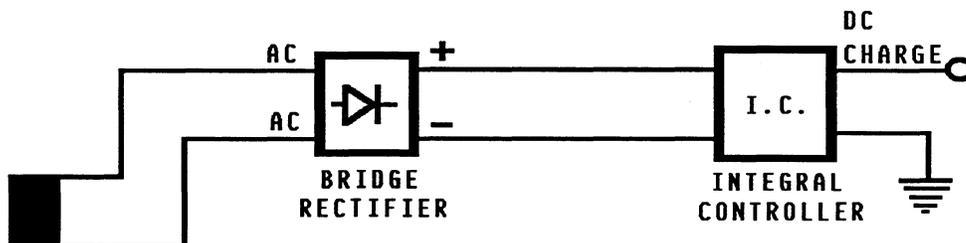
Normal DC voltage out of rectifier - volts DC. This voltage is measured across the two DC connections of the bridge rectifier, + to + and - to -.

DC voltage from the rectifier (approximate):

- a. No-load off generator - 17.0 volts DC
- b. Full-load off generator - 18.5 volts DC

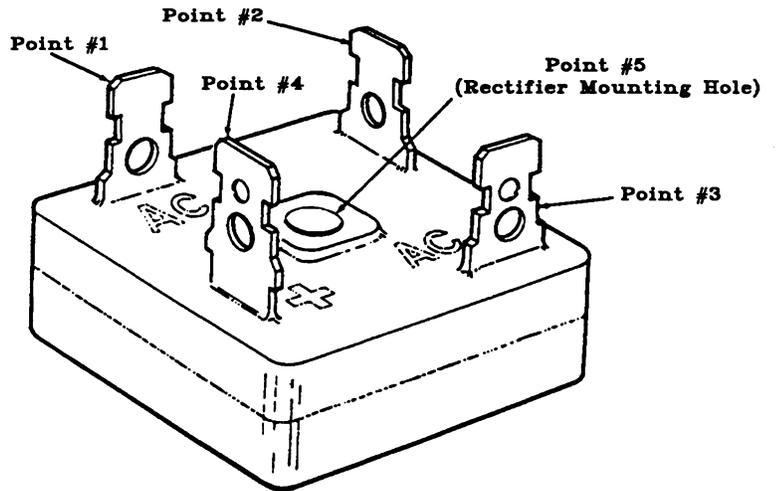
2. AC Stator Winding: 0.14 Ohm

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.

NOTE: Some ohmmeter models have internally differing polarities between their red and black leads. The test results above may read the opposite to your meter when performing above tests with meter needle deflection.

3. Integral Controller (I.C.)

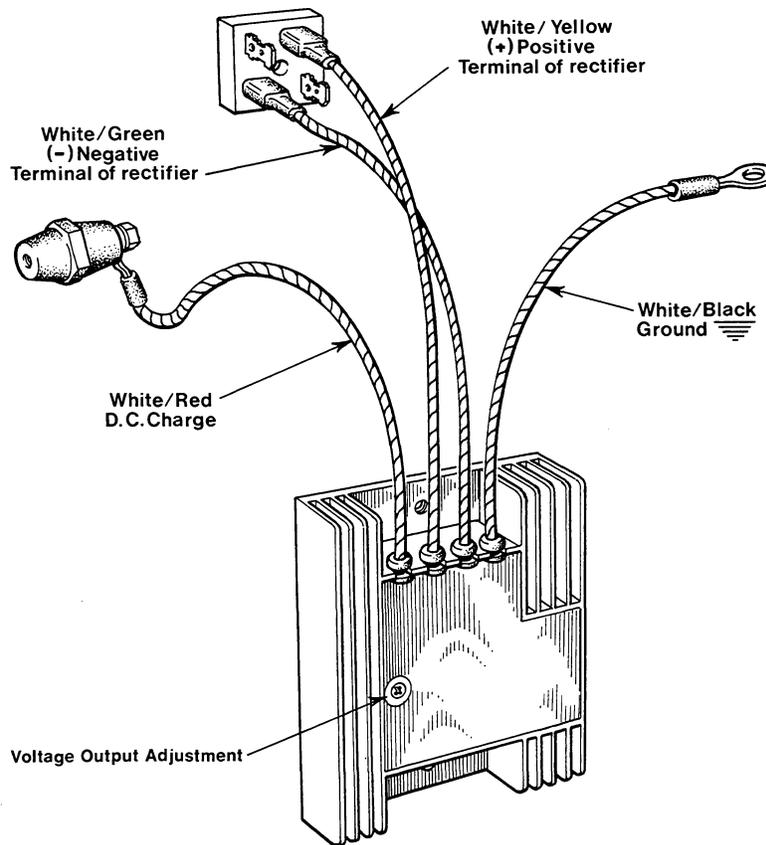
The integral controller is an encapsulated solid state unit that supplies a DC charging voltage to the generator's starting battery while the generator is operating.

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.



NOTE: White/ Green (-) Negative and White/ Black Ground are interchangeable.

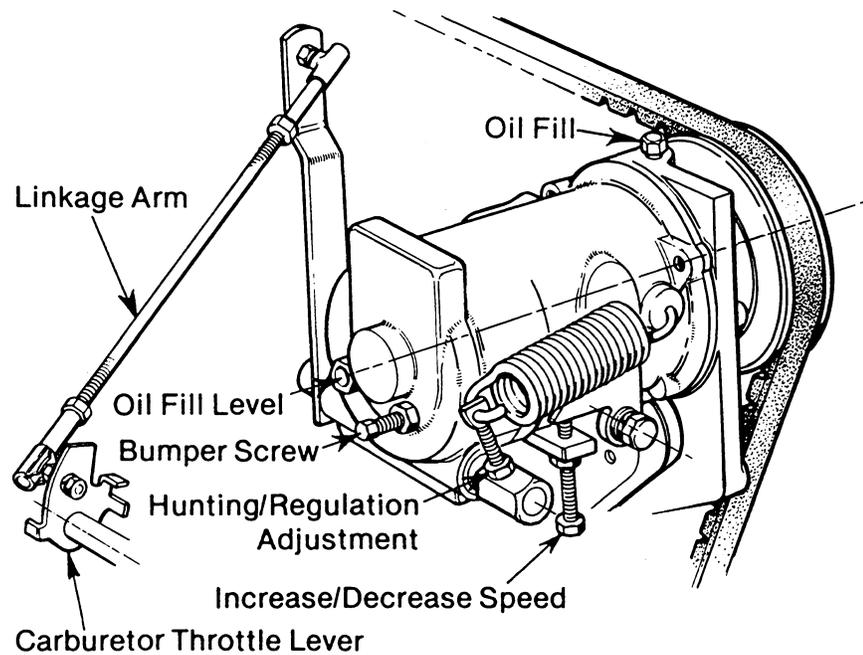
Four Wire Controller Showing its Connections

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

The Governor/Speed Adjustment may be the source of no AC output, low AC output, or high AC output.



4.5 KW BCG and 7.0 KW BCG & BCGA Belt-Driven Governor

Gasoline Model Governor Adjustments

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

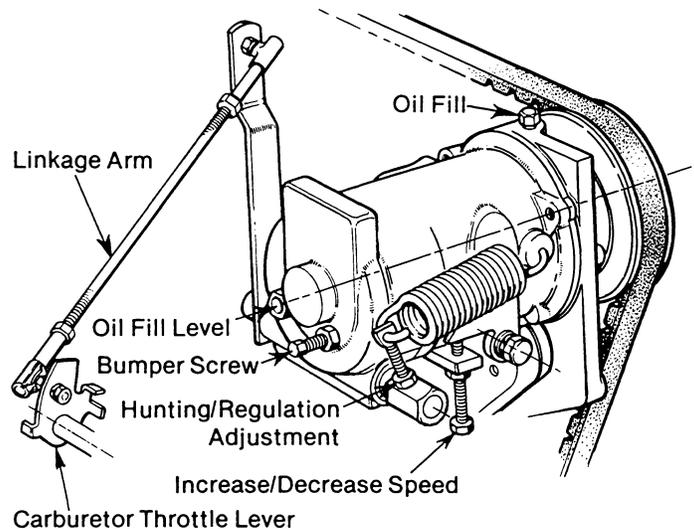
NOTE: If the governor is severely out of adjustment, manually adjust the linkage without any load on the generator to obtain a safe output voltage before proceeding with the adjustment.

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.
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.)

4. **Fine Adjusting Bumper Screw** Fine adjust the bumper screw by slowly unscrewing it with the unit running unloaded until a surge starts. Then, slowly screw it back in until the surge stops and recheck other adjustments.



4.5 KW BCG and 7.0 KW BCG & BCGA Belt-Driven Governor

GENERATOR TROUBLESHOOTING

FAULT	CAUSE	CORRECTION
Low voltage output at no-load (70 - 105 volts).	1. Engine speed too slow.	1. Adjust the governor to obtain proper hertz and voltage output.
	2. Faulty electrical connection.	2. Check the numbered connection on the capacitor for proper no-load output.
<div style="border: 1px solid black; padding: 2px; display: inline-block;">WARNING</div> <p>Stop the generator before checking the connections.</p>		
	3. Faulty diode on rotor.	3. Check diodes and replace as needed.
	4. Fault in rotor windings (A).	4. Check the winding for open or short. Replace the rotor as needed.
<hr/>		
High no-load AC voltage output (132 volts or higher).	1. Engine speed is too fast.	1. Adjust the governor to obtain the correct hertz and voltage output.
	2. Capacitor connections are incorrect.	2. Check the capacitor connections - hertz and no-load #7, #8, and #9.
	3. Faulty capacitor.	3. Check rating of capacitor.
<hr/>		
Correct no-load voltage but low voltage output when load applied.	1. Poor governor reaction-loss of engine speed.	1. Adjust the hunting/regulation on the governor.
	2. Overload on the generator.	2. Check the load (amps) that is being drawn from the generator using an amp-probe.
	3. Diode(s) in rotor shorting.	3. Isolate diodes, compare resistance values between diodes, and replace with new diode.

FAULT	CAUSE	CORRECTION
No voltage or less than residual produced (0 - 5 volts). (H - N)	1. Shorted or open main stator windings (B).	1. Check resistance value of windings and short to case. Artificially excite the generator to induce a short.
Residual voltage only present at no-load (6 - 8 volts). (H - N)	1. Engine speed. 2. Exciter windings faulty. 3. Capacitors faulty.	1. Adjust governor. 2. Check winding resistance for open or short. 3. Check capacitors.
Correct no-load voltage, but high voltage output when load applied.	1. Engine speed is too fast.	1. Adjust hunting/regulation on the governor. Adjust to proper no-load voltage hertz.
Unstable voltage output.	1. Poor governor reaction. 2. Loose electrical connections.	1. Adjust hunting/regulation on the belt-driven governor. 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). 2. Rear support bearing is faulty. 3. Generator connection to engine is loose.	1. Check each load as it is taken off each 120 volt leg with an amp-probe. 2. Check each load as it is taken off each 120 volt leg with an amp-probe. 3. Stop the generator and check the connection.
------------------	--	---

GENERATOR HERTZ (CYCLE) AND VOLTAGE CHANGES

The BC model generator is capable of 60 or 50 hertz operation with corresponding AC output voltage. The following steps must be followed when changing the generator's hertz rating and corresponding AC voltage output.

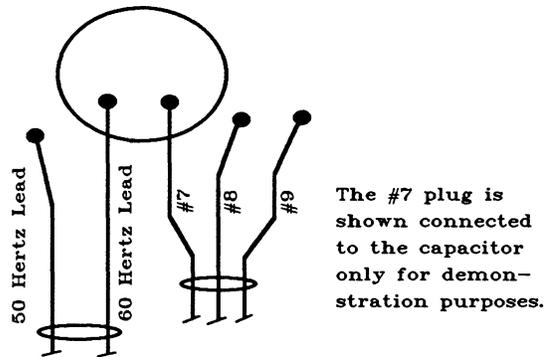
NOTE: The 7.0 KW BCGA model can only be used for 60 hertz operation.

1. Engine Speed Adjustment - Capacitor Connection

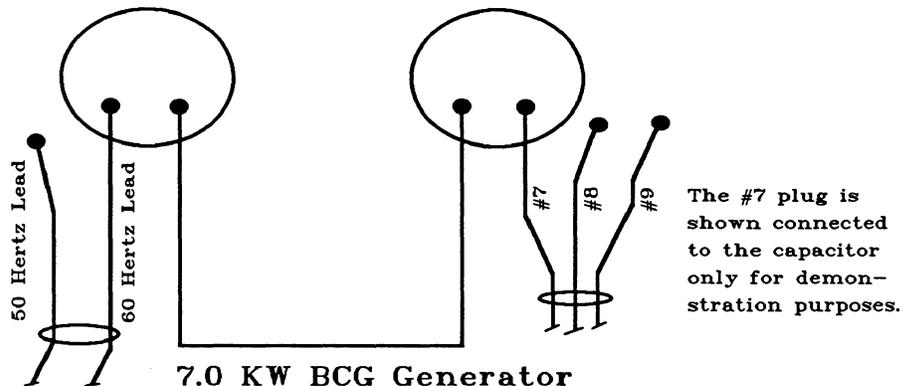
With the engine stopped, disconnect the hertz connection from the capacitor. Start the engine and adjust the governor speed screw to 1850 - 1880 rpm for 60 hertz or 1550 - 1580 rpm for 50 hertz. Stop the engine and plug the correct hertz lead into the capacitor #5 or #50 for 50 hertz and #6 or #60 for 60 hertz.

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.



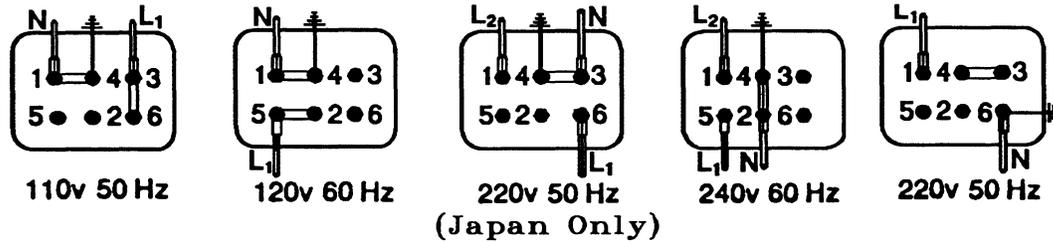
4.5 KW BCG Generator



7.0 KW BCG Generator

2. Terminal Block Hertz/AC Voltage Connections

To make the desired hertz and AC voltage change, properly connect the AC terminal connection to the generator's terminal block (see the illustration below). Note the positioning of the copper connectors between terminals as well as the repositioning of the white or white with green stripe ground wire from the neutral bar to generator case ground. Failure to do so will result in damage to the main stator windings.



3. Speed Adjustment - Hertz - Voltage

Gasoline Models:

Start the generator and check the hertz and voltage being produced. Adjust the governor as needed for 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.

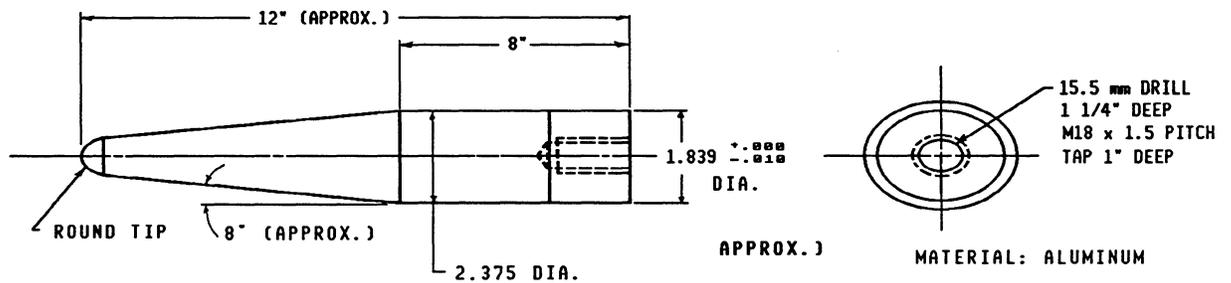
B. Refer to the illustrations on the previous page before making any adjustments. Note that there are three plugs grouped for the right capacitor terminal, #7, #8, and #9. If the generator's no-load voltage is low, then disconnect the lower number plug and connect the plug with the next higher number. 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.

NOTE: Voltage variation between each plug is approximately 8 - 10 volts AC.

FIELD FABRICATED TOOLS

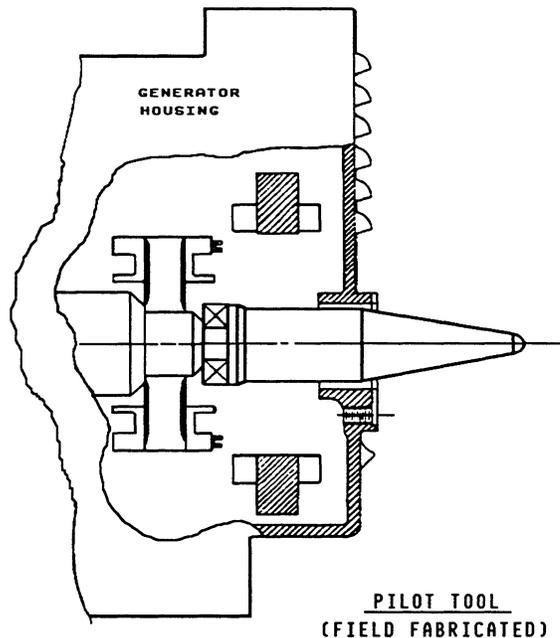
The mechanical drawings that follow provide a means by which simple tools can be made to assist in the removal of the generator end from the engine and in the replacement of the generator end on the engine. A local machine shop should be able to manufacture these tools at a modest price, but first check 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 at the bottom of the page.

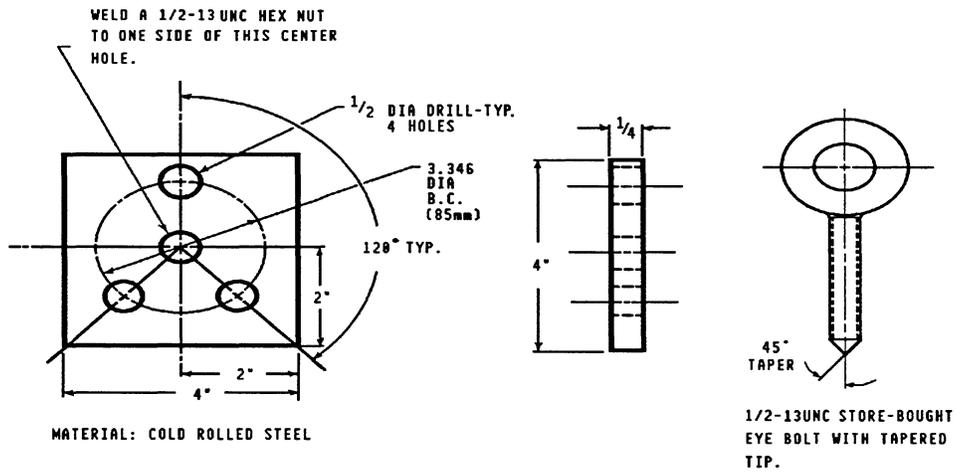


PILOT TOOL FOR THE 4.5 KW BCG AND THE 7.0 KW BCG & BCGA
(FIELD FABRICATED)

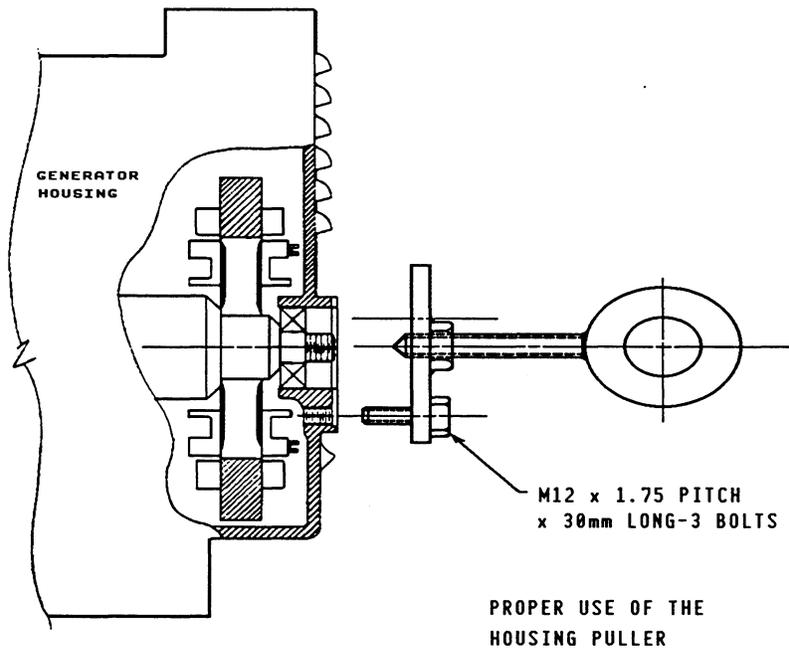
This tool allows the generator housing to be either removed or replaced without damaging the generator windings.



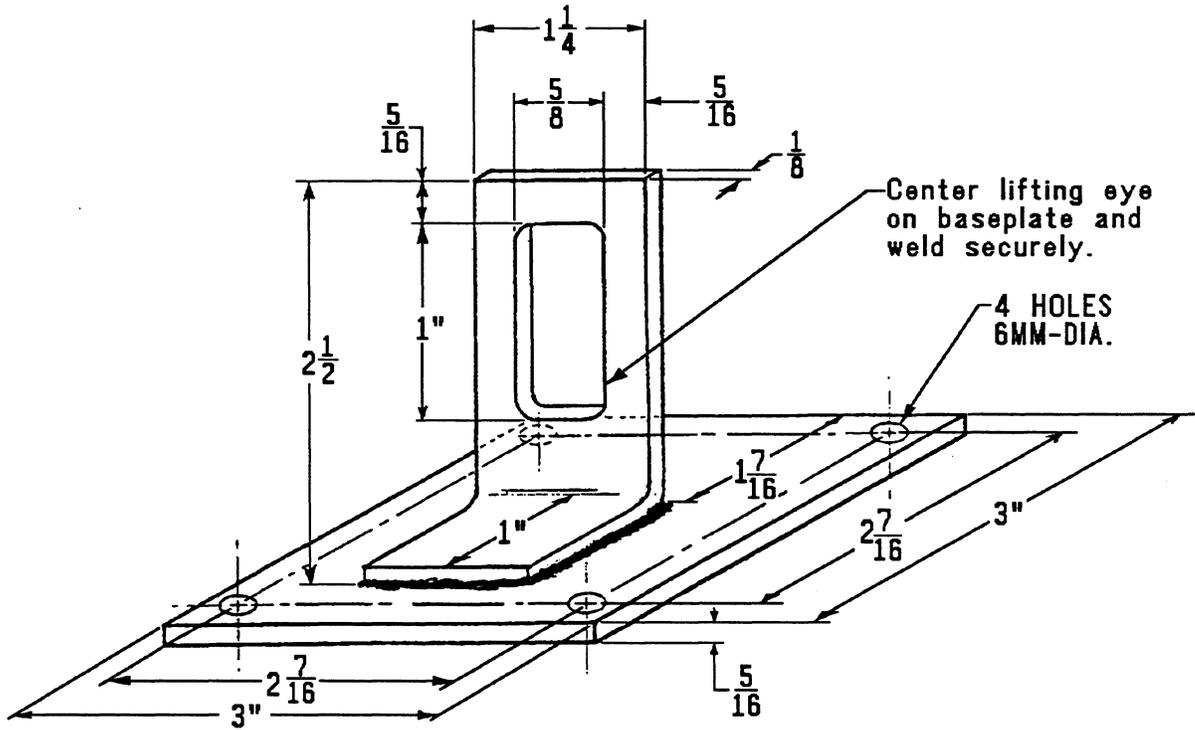
This tool allows the bearing in the generator housing to be gently pushed straight off the housing without any twisting. If a nut of the same specifications as that of the tapped hole in the pilot tool were to be welded on the end of the eye bolt, this tool would be able to pull the bearing back into place without any twisting. Please refer to these drawings before the generator end is removed.



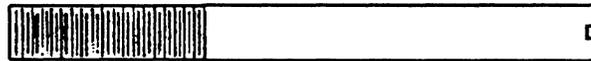
HOUSING PULLER TOOL
(FIELD FABRICATED)



This tool allows a mechanic to safely remove the generator end from the engine by attaching this Generator End Lifting Eye to the four screw holes located under the control panel. To use this Lifting Eye, remove the generator's control panel and screw the Lifting Eye to the generator end.



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.

NOTES

INDEX

A

Assembling the Crankshaft	103
Assembling the Oil Pump	84

B

Battery Charging Circuit	138
--------------------------------	-----

C

CAUTION

DO NOT APPLY CURRENT OVER 20 SECONDS.....	98
ENGINE FAILS TO TURN OVER WITH STARTER ENERGIZED	96
GENERIC THERMOSTATS MAY DAMAGE ENGINE.....	85
KEEP TIMING BELT CLEAN	52
MAKE SHURE INSULATING COVERS ARE ON LEADS	145
PRIOR TO MEASURING THRUST GAP, REMOVE LEVER SPRING.....	99
REMOVING TIMING BELT	52
USE CARE WHEN REMOVING CAMSHAFT	55

Camshaft	42
Checking Oil Pressure with a mechanical gauge	121
Checking Rocker Arms and the Rocker Shaft	68
Checking the Camshaft.....	76
Checking the Connecting Rod Bearings.....	73
Checking the Connecting Rods.....	72
Checking the Crankshaft	74
Checking the Crankshaft Timing Belt Pulleys	78
Checking the Cylinder Block	69
Checking the Cylinder Head.....	64
Checking the Flywheel and Ring Gear	80
Checking the Piston Rings.....	71
Checking the Piston Pins.....	73
Checking the Pistons	71
Checking the Valve Guides.....	65
Checking Valve Springs.....	69
Checking Valves.....	66
COMPONENT RESISTANCE VALUES.....	134
Connecting Rods	39
Cooling System Troubleshooting.....	122
Crankshaft and Bearings	40
Cylinder Block	38
CYLINDER BLOCK ASSEMBLY	102
CYLINDER BLOCK DISASSEMBLY	57

Cylinder Head and Combustion Chamber	37
CYLINDER HEAD AND ENGINE BLOCK INSPECTION AND REPAIR.....	63
CYLINDER HEAD ASSEMBLY	109
Cylinder Head Cover	38
CYLINDER HEAD DISASSEMBLY	54

D

DC Voltmeter.....	127
Disassembling and Inspecting the Oil Pump.....	82
Disassembling and Inspecting the Raw Water Pump	86
Disassembling and Rebuilding the Carburetor.....	88
DISASSEMBLY FOR OVERHAUL	48
DISCLAIMER, PRODUCT SOFTWARE	1

E

Electric Fuel Pump.....	87
Electrical System Troubleshooting	127
ENGINE ASSEMBLY.....	101
ENGINE DESCRIPTION	37
ENGINE DISASSEMBLY.....	50
ENGINE INSPECTION AND REPAIR.....	64
ENGINE SERVICE SPECIFICATIONS, 4.5 KW BCG.....	17
ENGINE SERVICE SPECIFICATIONS, 7.0 KW BCG & BCGA.....	27
Exciter Windings.....	136

F

FIELD FABRICATED TOOLS.....	147
Fuel System Troubleshooting	123

G

Gasoline Model Governor Adjustments.....	142
GENERAL SPECIFICATIONS, 4.5 KW BCG	9
GENERAL SPECIFICATIONS, 7.0 KW BCG & BCGA	13
GENERATOR DESCRIPTION AND MODEL RATING.....	130
GENERATOR HERTZ (CYCLE) AND VOLTAGE CHANGES	145
Generator Internal Wiring Schematic, 4.5 KW and 7.0 KW BCG	132
Generator Internal Wiring Schematic, 7.0 KW BCGA.....	133
GENERATOR OVERHAUL.....	46
GENERATOR TROUBLESHOOTING	143

I	
Inspecting the Distributor and its Components	94
Inspecting the Spark Plugs.....	95
Installation of Cylinder Head and Timing Belt.....	112
Installation of the Generator to the Engine	117
L	
LUBRICATION SYSTEM	119
M	
Main Stator Windings.....	135
N	
No-Load Voltage Adjustment	146
P	
Piston Ring Installation and Connecting Rod Assembly	104
Pistons and Piston Rings	39
PREPARATIONS FOR OVERHAUL	47
PRODUCT SOFTWARE DISCLAIMER.....	1
R	
Refacing the Valve and Valve Seat	68
Removal of External Parts and Subassemblies	50
REMOVING THE CYLINDER HEAD FROM THE CYLINDER BLOCK.....	53
Removing the Generator End from the Engine.....	48
Replacing Front and Rear Crankshaft Oil Seals	79
Replacing Valve Guides	65
Rotating Field/Auxiliary Windings and Diodes	134
S	
SPECIAL SERVICE TOOLS	61
SUBASSEMBLY INSPECTION, REPAIR, AND ASSEMBLY	81
SYSTEM SPECIFICATIONS, 4.5 KW BCG	10
SYSTEM SPECIFICATIONS, 7.0 KW BCG & BCGA	14

T

TABLE OF CONTENTS.....2
Testing the Ignition Coil.....95
Testing the Starter.....96
Thermostat Removal and Inspection85
Timing Belt42
Timing Belt Cover44
Timing Belt Pulley43
Timing Belt Removal.....51
Timing Belt Tensioner.....43
TROUBLESHOOTING AND ADJUSTMENTS FOR THE BC GENERATOR.....131
Troubleshooting the Oil System.....120

U

UNIT I.D. PLATES8

V

Valve Actuating Mechanism41
Valve Guide Bushes and Stem Oil Seals45
Valve Rocker Arms.....45
Valve Rocker Shafts.....45
Valves and Valve Springs44

W

WARNING

DO NOT MAKE NO-LOAD ADJUSTMENT WITH GENERATOR ON..... 146
FUEL LEAKAGE 87
STOP GENERATOR BEFORE CHECKING CONNECTIONS 143 and 144

WIRING DIAGRAM #38024, OPTIONAL REMOTE START PANEL.....126
WIRING DIAGRAM #38028, DC CONTROL CIRCUIT124