CAT® Lift Trucks

Service Manual

Engine

4G15
4G63
4G64
6G72

For use with GP15-35, GP15K-35K, GP40, GPL40, GC15-30, GC15K-30K, GC35K-70K Lift Trucks

99719-34130

ACTIONS TO BE TAKEN IN THE EVENT OF A FAILURE

(1) When you smell the gas or notice something wrong with the LP-gas equipment during operation, immediately stop the lift truck in a safe area, turn the starter switch to “OFF” position, close the service valve (RED) of LP-gas tank, and try to find the cause. (It is advisable to have a test kit on hand for detecting gas leakage in the event of the failure.)

(2) If the internal pressure of LP-gas tank rises too high for one reason or another to cause the safety valve to open and let out the excess pressure, sprinkle water over the tank and, at the same time, extinguish the fire burning near the lift truck, if any, and ventilate the working area to rarefy the leakage gas.

(3) When gas leakage is evident, extinguish the fire burning near by and close the service valve (RED) of the tank as soon as possible, then take a split-second action.

(4) If there is a possibility of fire in the event of collision or overturning of the lift truck, close the service valve (RED) of the tank as soon as possible.

(5) The LP-gas tank installed in correct position will not explode even if it is in a blaze. What to do in the event of emergency is to remove inflammable material from around the tank quickly.

(6) Use a dry-chemical (powder) type or carbon dioxide type extinguisher. Never use water. It is a good practice, however to sprinkle a large quantity of water over the LP-gas tank for cooling it down while extinguishing the fire.

(7) Only trained and authorized personnel should fill or exchange LP-gas tanks.

(8) Personnel engaged in filling of LP-gas tanks should wear protective clothing such as a face shield, long sleeves and gauntlet gloves.

(9) Do not refuel or store LP-gas powered lift trucks near any underground entrances, elevator shafts, or any other place where LP-gas could collect in a pocket causing a potentially dangerous condition.

(10) Do not leave the lift truck, for even a short period of time, in the vicinity of objects with high temperatures, such as ovens and furnaces. The heat may raise the pressure of the fuel and open the relief valve.

(11) Close the service valve on the tank when LP-gas fueled lift trucks are parked overnight or stored for a long period of time indoors with the fuel tank in place.

(12) Close the valves on empty tanks.

(13) Examine all LP-gas tanks before filling again before reuse, for damage to the valves, liquid gauge, fitting and hand wheels.

(14) Check for dents, scrapes or other damage to the pressure vessel and for dirt or debris in the openings.

(15) All defective or damaged LP-gas tanks must be removed from service.

(16) The careless handling of LP-gas tanks can result in a serious accident. Extreme care should be exercised when transporting tanks so that the tanks are not damaged.

(17) The storage and handling of liquid fuels in the U.S.A., should be in accordance with the NFPA No.30, “Flammable and Combustion Code.” Outside the U.S.A. store and handle in accordance with local regulations.

(18) The lift truck should be refueled only at designated safe locations. Safe outdoor locations are preferable to those indoors.

DISASSEMBLY AND REASSEMBLY

Reassembly

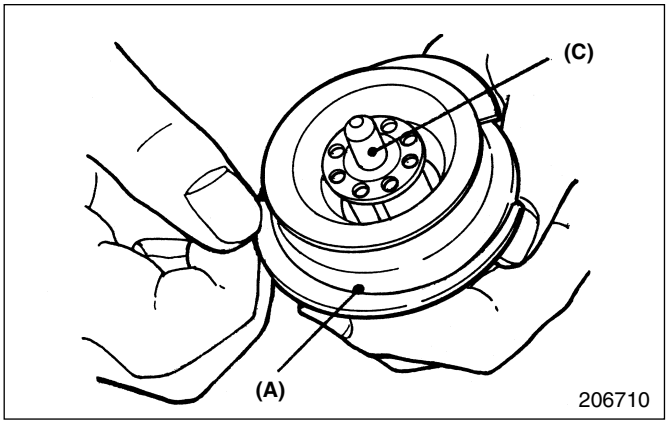
(1) Take out parts from the repair kit.
- Screws (4)
- Gasket (1)
- Check valve plate (1)
- Air valve sealing ring (1)
- Air valve (1)

(2) Install sealing ring in piston groove.

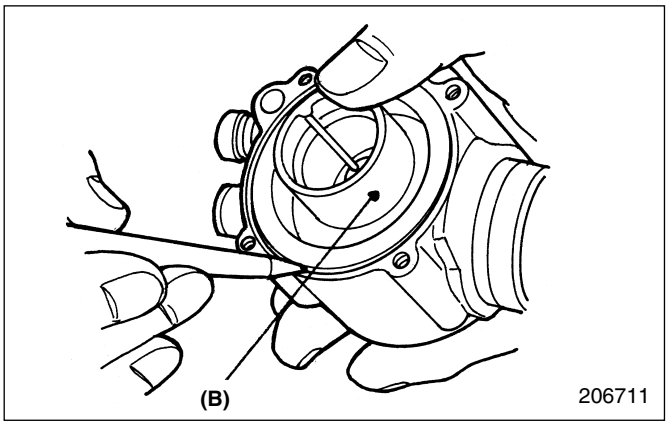
– CAUTION

Insert one end of sealing ring into piston groove, then coax the ring with a spiral movement to avoid breaking or creasing the ring.

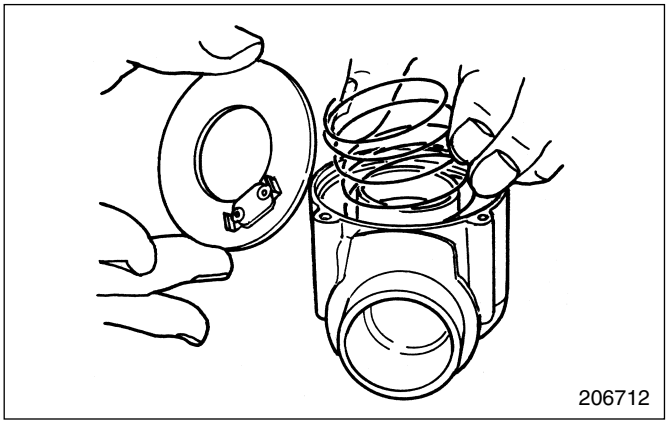
Apply molybdenum disulfide grease on sections (A), (B) and (C) for smooth air valve movement.



(3) Mount air valve on air horn.
Tilt air valve slightly to insert one end of the split sealing ring into the cylinder of air horn.
Then, using the tip of a pencil or other pointed tool, press the circumference of sealing ring to firmly mount the sealing ring and air valve on air horn.

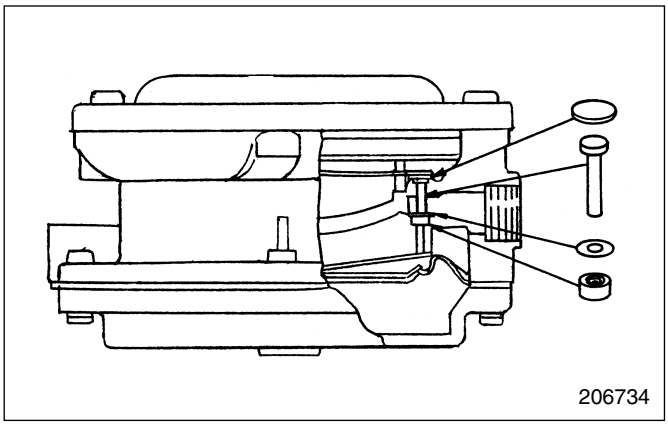


(4) Install air valve spring and check valve plate in the air horn.



DISASSEMBLY AND REASSEMBLY

(5) Diagram on the right shows the relationship of valve spring, valve seat, valve operating pin, seat retaining washer and O-ring.
When valve operating pin is removed, seat retaining washer can be taken out through the “Fuel Out” opening.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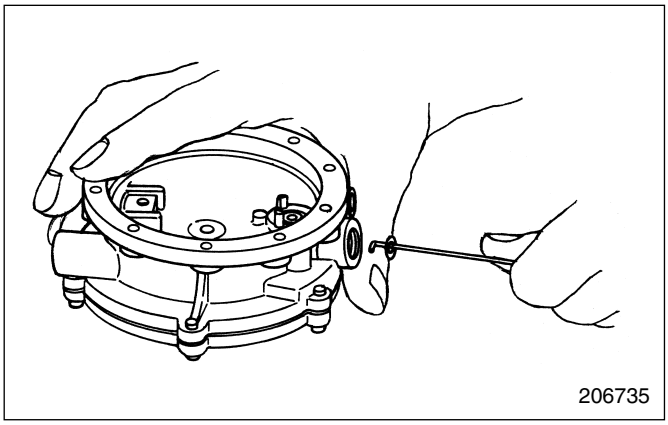
(6) Insert wire through the “Fuel Out” jet hole, hook the wire on retaining washer, then pull it out.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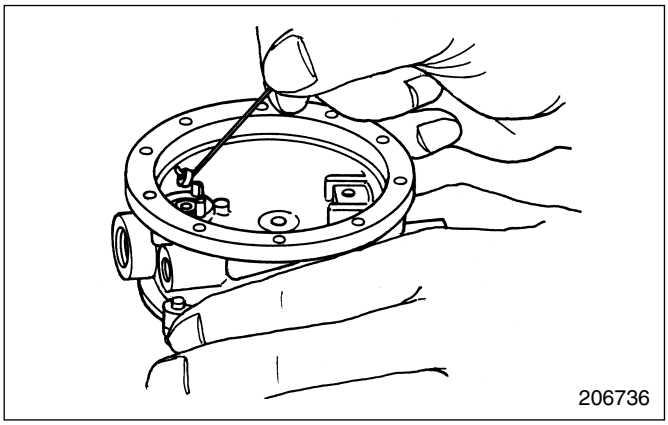
(7) Using the same wire, take out O-ring lip seal through the hole from which valve operating pin is removed in step (4).
Wash body, cover and jet as needed, using kerosene or cleaning oil. Do not use carburetor cleaner since it erodes synthetic rubber seals.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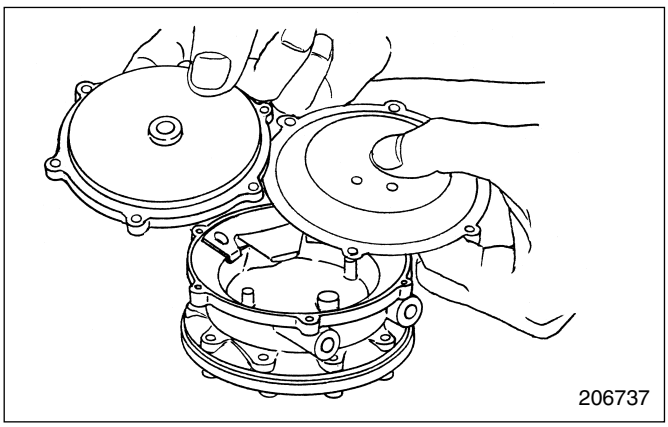
(8) Take out six screws on diaphragm side, and remove diaphragm cover and diaphragm.
Wash parts as needed, using kerosene or cleaning oil.
Do not remove fulcrum or valve activating lever on diaphragm side.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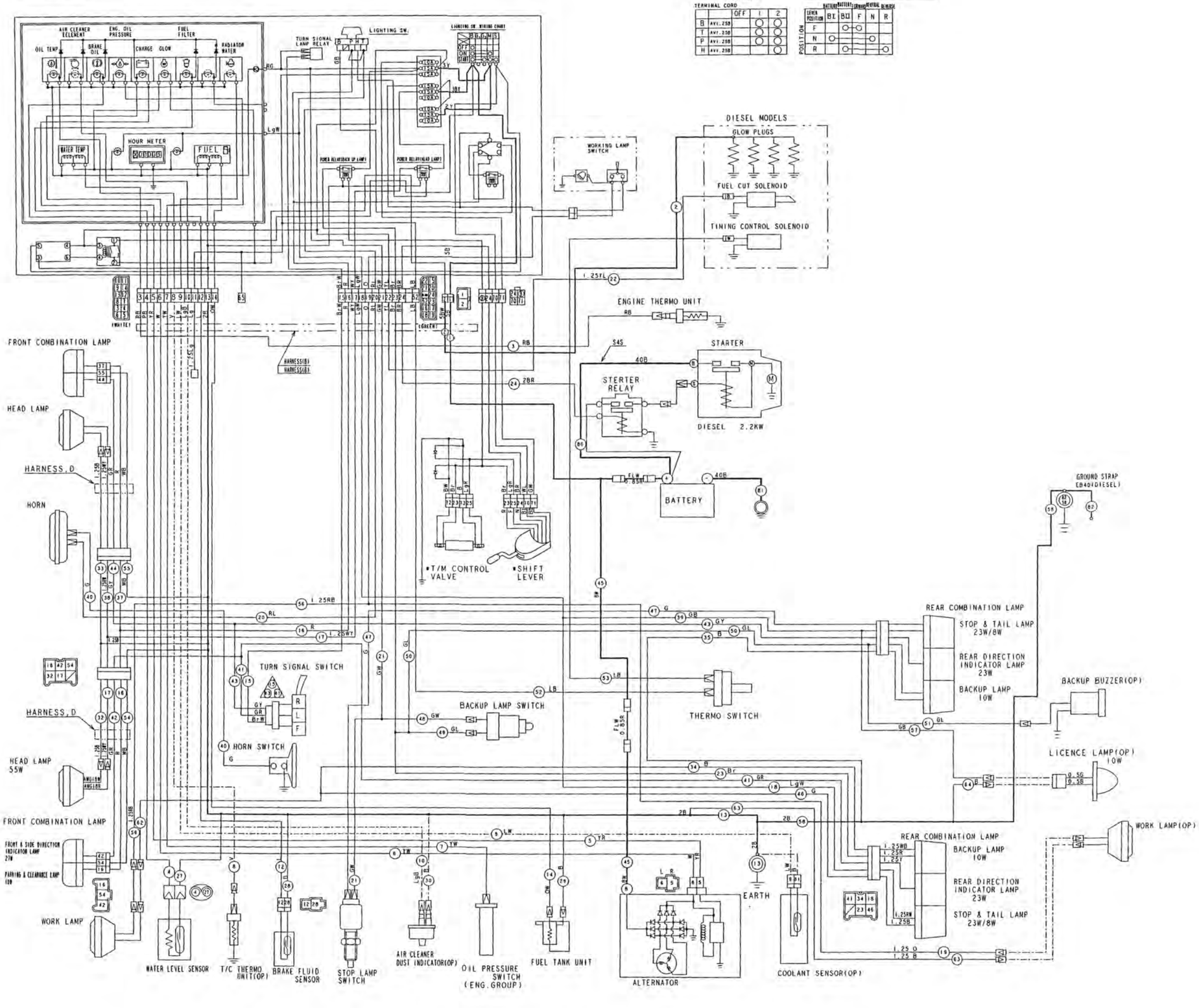
ELECTRICAL SYSTEM SCHEMATIC (DIESEL)

CONSOLE BOX - AY20D, AY20T



LIGHTING SWITCH CONNECTION CHART

MC MODELS

TERMINAL CORD		OFF	I	2
B	AVI. 2SB		○	○
T	AVI. 2SB		○	○
P	AVI. 2SB		○	○
H	AVI. 2SB			○

F-N-R LEVER SWITCH CONNECTION CHART (TORQUE-CONVERTER MODELS)

POSITION / LEVER POSITION	BATTERY BI	BATTERY BU	CRANK F	NEUTRAL N	REVERSE R
F		○	○		
N	○			○	
R		○			○

NOTES:

(5) *MARK IS FOR TORQUE-CONVERTER MODELS.
(4) ARRANGEMENT OF TERMINALS IN FIGURE OF CONNECTOR SHOWS MALE SIDE.
(3) CHAIN-LINE SHOWS OPTIONAL WIRING.
(2) UNLESS OTHERWISE SPECIFIED. WIRE DIAMETER SHALL BE AVS 0.5mm².
(1) THIS FIGURE SHOWS WIRING FOR DIESEL MODELS.

B : BLACK
W : WHITE
R : RED
G : GRREN
Y : YELLOW
Br : BROWN
L : BLUE
Lg : LIGHT GREEN
V : VIOLET

CAT

Schematic No.	Used for	Truck Model	Serial No.
ES019-31400	99719-31400	DP15	3BP-20058-up
		DP18	4BP-20004-up
		DP20	5BP-00384-up
		DP25	6BP-00754-up
		DP30	7BP-02087-up
		DP35	8BP-00020-up

GENERAL SPECIFICATIONS

Item \ Engine model			4G15
Type			Water-cooled, 4-cycle, gasoline
No. of cylinders and arrangement			4, in-line
Combustion chamber type			Semi-spherical
Valve mechanism			OHC
Total displacement, cm³ (cc) [cu in.]			1468 (1 468) [90]
Bore x stroke, mm (in.)			75.5 x 82.0 (2.97 x 3.23)
Dry weight, kg (lb)		31FD	118 (260)
		31FW	120 (265)
Compression ratio			9.4
Valve timing	Intake valves	Open	15° BTDC
		Close	53° ABDC
	Exhaust valves	Open	57° BBDC
		Close	15° ATDC
Firing order			1 – 3 – 4 – 2
Ignition timing, BTDC/rpm			0°/740
Fuel pump			Plunger (electrical) type
Carburetor			Down-draft type
Governor			Pneumatic type
Lubrication system			Pressure feed, full-flow filtration type
Oil pump			Trochoid, driven by cranckshaft
Oil filter			Filter paper, cartridge type
Cooling system			Water-cooled, forced circulation
Water pump			Centrifugal, driven by V-belt
Thermostat			Wax type
Electrical system			12V DC, negative ground
Alternator, (12V – 65A)			Alternator current, built-in fan and regulator
Starter motor, (12V – 1.2kW)			Reduction drive
Distributor			Contact point less (transistor type)
Spark plug (NGK or ND)			BP4ES or W14EX-U
Capacity of lubricating oil, cm³ (liter) [U.S. gal]			3300 (3.3) [0.9] (including 300 cm³ (0.3 liter) [0.08 U.S. gal] in oil filter)
Capacity of coolant, cm³ (liter) [U.S. gal]			2500 (2.5) [0.7] (in engine proper)

Part to be applied	Brand
Water temperature gauge unit	Three Bond 1104, 3M ATD Part No. 8660 or equivalent
Oil pressure switch	Three Bond 1211, 3M ATD Part No. 8660 or equivalent
* Oil pan	Three Bond 1207F, Genuine Part No. MD990389 or equivalent
Rear plate	Three Bond 1104, 3M ATD Part No. 8660 or equivalent
Rear plate bolt	Three Bond 1104, 3M ATD Part No. 8660 or equivalent
Oil seal case bolt	Three Bond 1104, 3M ATD Part No. 8660 or equivalent

* FIPG is used.

FROM-IN-PLACE GASKET (FIPG)

The engine has several areas where the from-in-place gasket (FIPG) is in use. To ensure that gasket fully serves its purpose, it is necessary to observe some precautions when applying the gasket. Bead size, continuity and location are of paramount importance. Too thin a bead could cause leaks. Too thick a bead, on the other hand, could be squeezed out of location, causing blocking or narrowing of the fluid feed line. To eliminate the possibility of leaks from a joint, therefore, it is absolutely necessary to apply the gasket evenly without a break, while observing the correct bead size.

Since the FIPG used in the engine hardens as it reacts with the moisture in the atmospheric air, it is normally used in the metallic flange areas.

Disassembly

The parts assembled with the FIPG can be easily disassembled without use of a special method. In some cases, however, the sealant between the joined surfaces may have broken by lightly striking with a mallet or similar tool. A flat and thin gasket scraper may be lightly hammered in between the joined surfaces. In this case, however, care must be taken to prevent damage to the joined surfaces.

Surface Preparation

Thoroughly remove all substances deposited on the gasket application surfaces, using a gasket scraper or wire brush. Check to ensure that the surfaces to which the FIPG is to be applied is flat. Make sure that there are no oils, greases and foreign substances deposited on the application surfaces. Do not forget to remove the old FIPG remaining in the bolt holes.

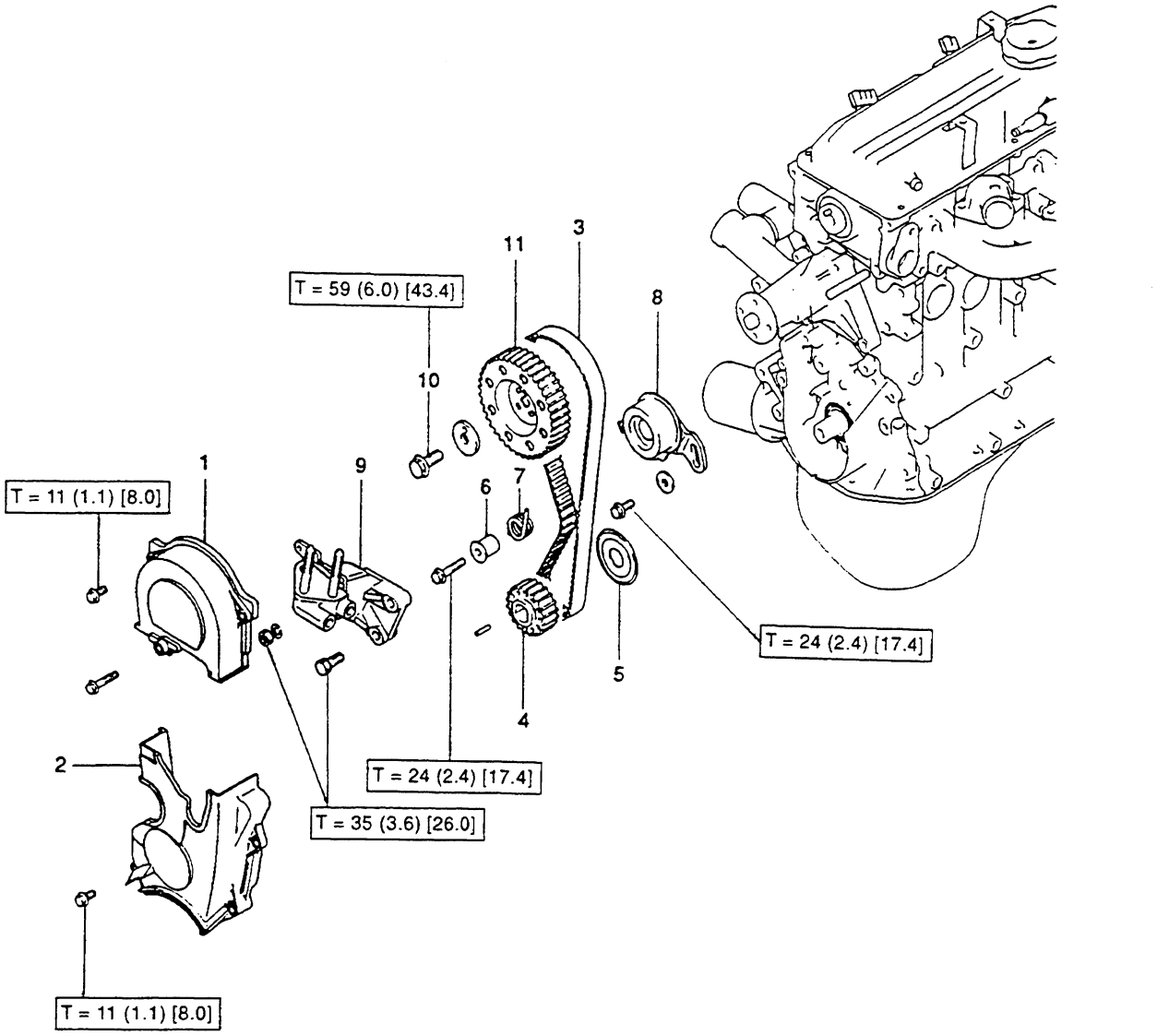
From-In-Place Gasket Application

Applied FIPG bead should be of the specified size and without breaks. Also be sure to encircle the bolt hole circumference with a completely continuous bead. The FIPG can be wiped away unless it is hardened. While the FIPG is still moist (in less than 15 minutes), mount the parts in position. When the parts are mounted, make sure that the gasket is applied to the required area only.

The FIPG application procedure may vary on different areas. Observe the procedure described in the text when applying the FIPG.

REMOVAL AND INSTALLATION

Unit: N·m (kgf·m) [lbf·ft]



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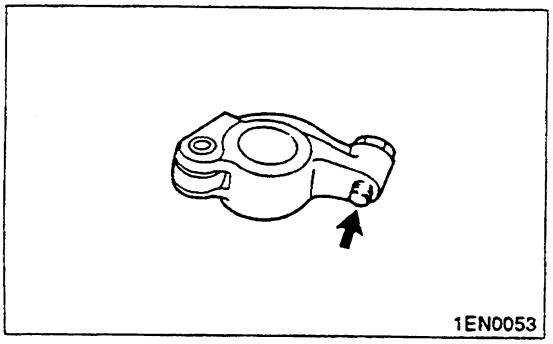
Removal steps

1. Timing belt cover (upper)
2. Timing belt cover (lower)
◊A◊ ◆D◆ 3. Timing belt
◊B◊ 4. Crankshaft sprocket
◆C◆ 5. Flange
6. Tensioner spacer
◆B◆ 7. Tensioner spring
◆B◆ 8. Timing belt tensioner
9. Engine support bracket (left)
◊C◊ ◆A◆ 10. Camshaft sprocket bolt
11. Camshaft sprocket



INSPECTION

1. Rocker Arms

(1) Check the roller contact surface for dent or other defects and, if necessary, replace the arm.

(2) Check the roller for flat spots or scuff marks. If the roller does not turn freely or has been worn flat, replace the arm.

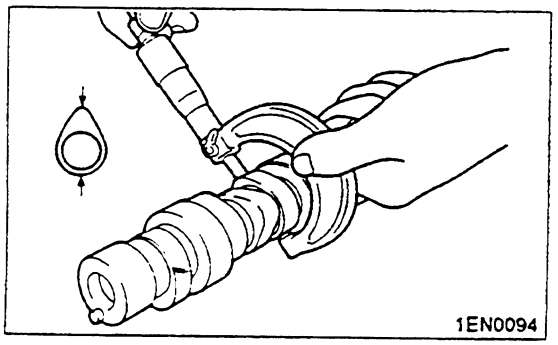
(3) Check the bore for the rocker arm shaft for damage and, if necessary, replace the arm.

(4) Check the surface indicated by an arrow for wear or damage and, if necessary, replace the arm.

2. Rocker Arm Shafts

(1) Check the oil holes for clogging and, if necessary, clean the shaft.

(2) Check the rocker arm contact surface for damage and, if necessary, replace the shaft.



3. Camshaft

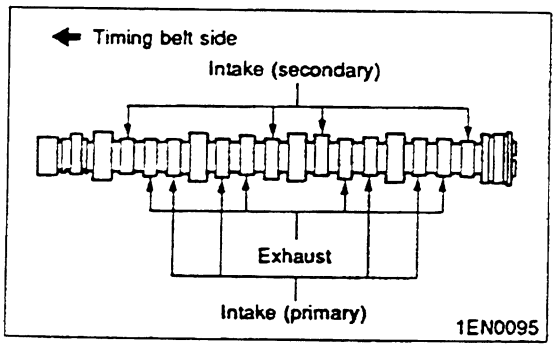
(1) Measure the lobe height. Replace the camshaft if the cam is worn beyond the limit.

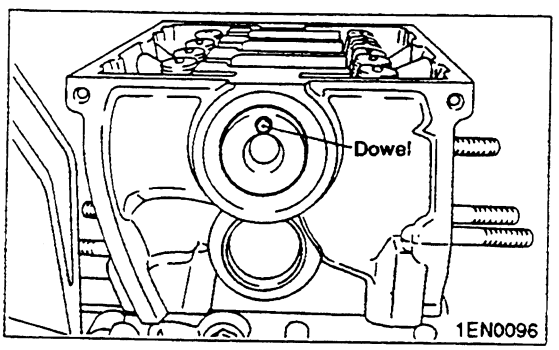
Standard value

Intake (primary): 38.78 mm (1.526 8 in.)
Intake (secondary): 38.78 mm (1.526 8 in.)
Exhaust: 39.10 mm (1.539 4 in.)

Limit

Intake (primary): 38.28 mm (1.507 1 in.)
Intake (secondary): 38.28 mm (1.507 1 in.)
Exhaust: 38.60 mm (1.519 7 in.)

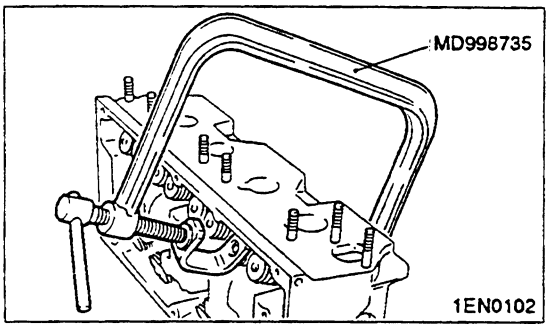




INSTALLATION

◆A◆ Camshaft

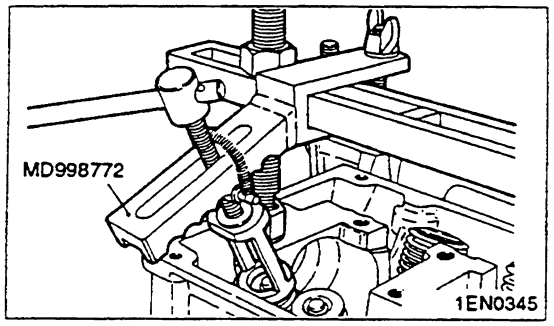
Install the camshaft with dowel right above.

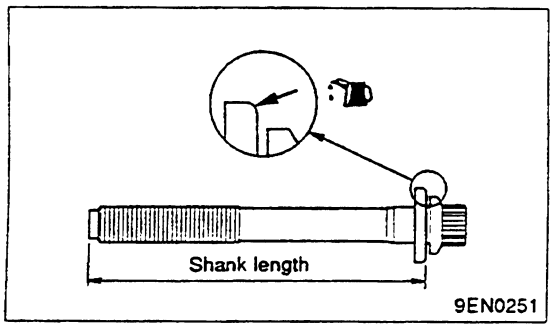


◆C◆ Retainer locks

The retainer for intake valve spring differs from that for exhaust valve spring in size. Use the following Retainer Holders (special tools):

Intake: MD998744
Exhaust: MD998743



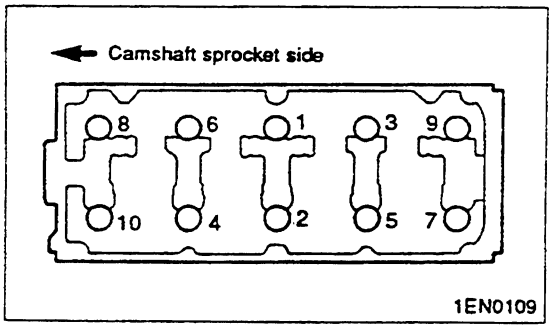


◆D◆ Cylinder head bolts

(1) Check the shank length of each bolt. Replace the bolt if the shank length exceeds the limit.

Limit: 103.2 mm (4.063 in.)

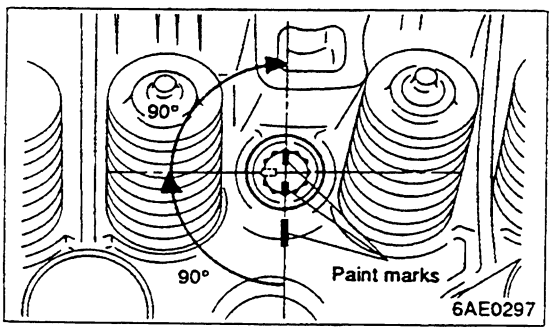
(2) Apply engine oil to the bolt threads and the washer.



(3) Tighten the bolts in number sequence to 49 N·m (5.0 kgf·m) [36.2 lbf·ft].

(4) Loosen the bolts completely.

(5) Retighten the bolts in number sequence to 20 N·m (2.0 kgf·m) [14.4 lbf·ft].



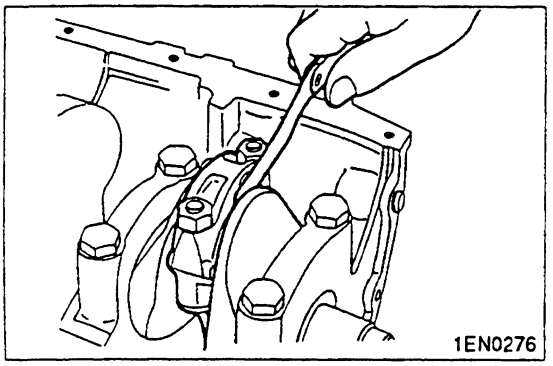
(6) Put a paint mark across the head of each bolt and the cylinder head.

(7) Tighten the bolts 90° in number sequence.

(8) Tighten the bolts the additional 90° in number sequence. Make sure the pain marks on the bolt and the head are in line as shown.

CAUTION

1) Be sure to tighten the bolts the specified degree of angle to keep them tight, even under vibrating conditions.
2) If the bolts happen to be tightened beyond the specified degree of angle, loosen them completely and make a new start of tightening.



(2) Check to make sure the thrust clearance of the connecting rod big end is correct.

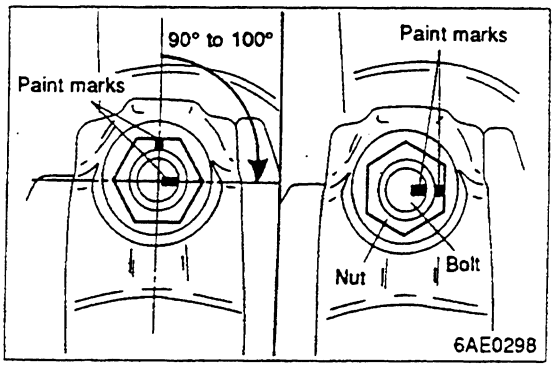
Standard value: 0.10 to 0.25 mm
(0.003 9 to 0.009 8 in.)

Limit: 0.4 mm (0.016 in.)

◆G◆ Connecting rod cap nuts

CAUTION
Be sure to remove the spark plugs when installing the connecting rod caps with the cylinder head on the engine.

(1) When the connecting rod bolts and nuts are to be reused, the bolts should be checked for stretching. To check, turn the nut onto the threads on the bolt with fingers to see how it is turned. If the nut cannot be turned all the way onto the bolt freely, it is an indication that the threaded section of the bolt has been stretched. Replace such a bolt.



(2) Apply engine oil to the threads and bearing face of the nut before installing the nut.

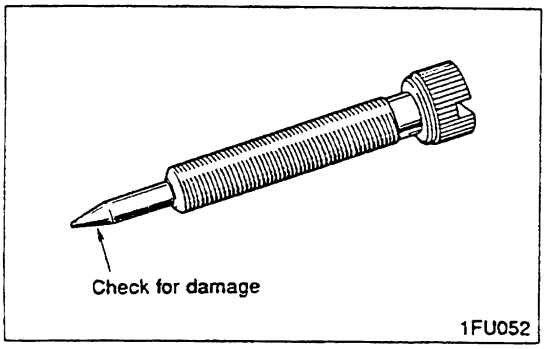
(3) Put the nuts on the bolts. Tighten the nuts finger tight first, then tighten them alternately to 16.7 N·m (1.7 kgf·m) [12.3 lbf·ft]

(4) Put a paint mark on the nut.

(5) Put a paint mark on the bolt at a position 90° to 100° apart from the mark on the nut in the tightening direction.

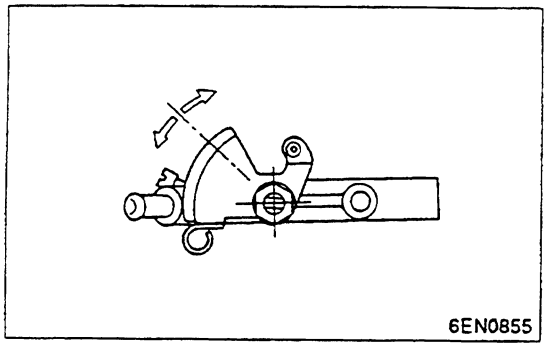
(6) Tighten the nut 90° to 100° or until the mark on the nut is aligned with the mark on the bolt.

CAUTION
1) If the nut tightening angle is less than 90°, the nuts would become loose.
2) If the nut happens to be tightened more than 100°, completely loosen the nut once and retighten it from the beginning.



4. Mixture Adjusting Screw (MAS)

Check tapered end of mixture adjusting screw (MAS) for damage due to overtightening, etc.



5. Throttle Body

Make sure that the throttle shaft moves smoothly. If any sticky movement is found, thoroughly clean the shaft, and then coat it with a small amount of engine oil. Do not disassemble the shaft unnecessarily.

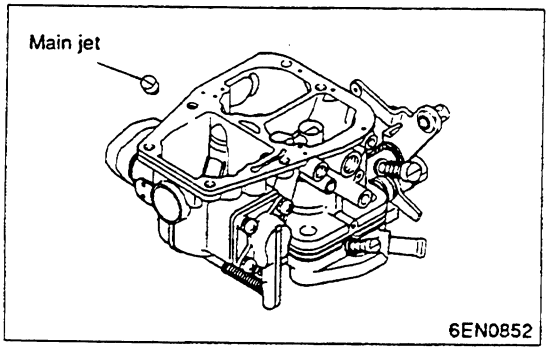
REASSEMBLY PROCEDURES

Preparation

(1) Clean every parts with clear cleaning oil before reassembly. Check all passages for clogging.

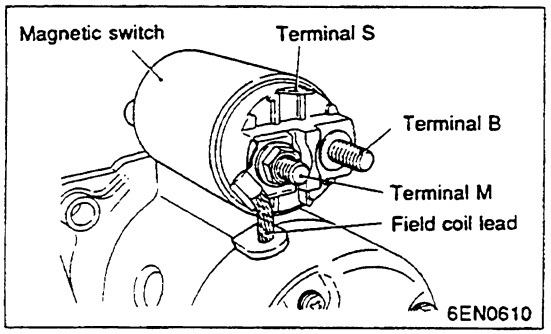
(2) Replace all the removed packings and gaskets.

(3) Make sure the throttle and choke linkage operates smoothly. If any sticky movement is found, clean or replace the linkage, and make sure that the carburetor operates without any problem.



◆A◆ Main Jets

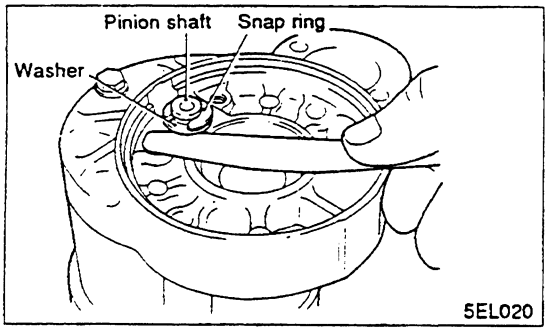
(1) When replacing the main jet, the old jet and the new jet must be of the same size, because the jet is selected after exact flow measurement by factory. (A size symbol is stamped on each jet.)



DISASSEMBLY PROCEDURES

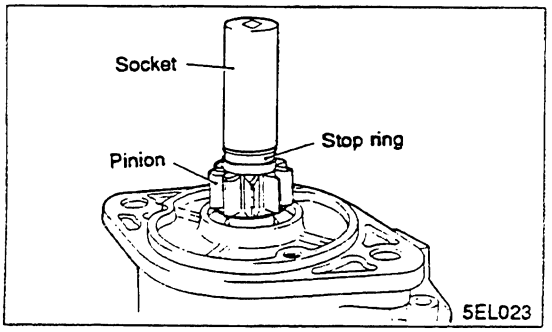
◊A◊ Magnetic switch removal

Disconnect the field coil lead from terminal M of the magnetic switch.



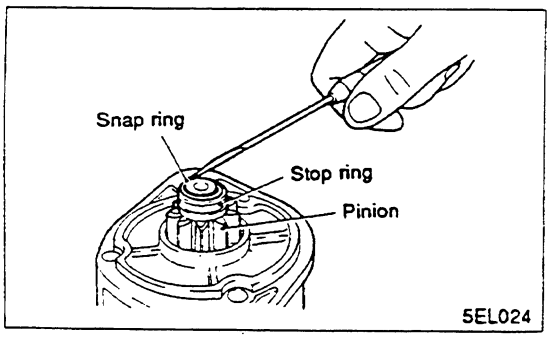
◊B◊ Snap ring removal

Measure the end play of the pinion shaft with a feeler gauge and make a note of the reading.

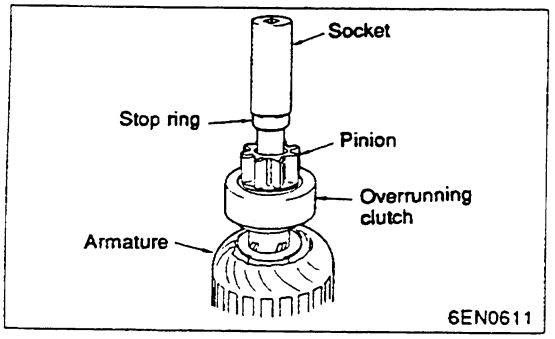


◊C◊ Stop ring removal (gear reduction type starter motor)

(1) Using a proper socket, push the stop ring over the snap ring.

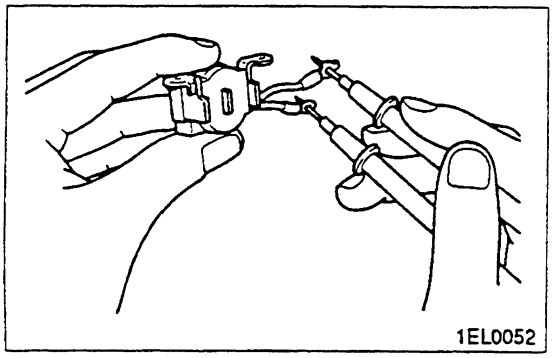


(2) Remove the snap ring with a screwdriver, then remove the stop ring.



◊D◊ Snap ring and stop ring removal (planetary gear reduction type)

(1) Using a proper socket, push the stop ring toward the snap ring.

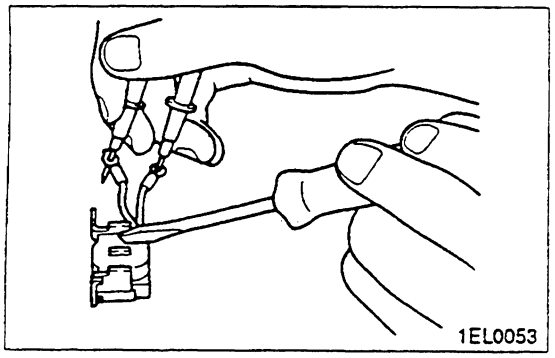


INSPECTION

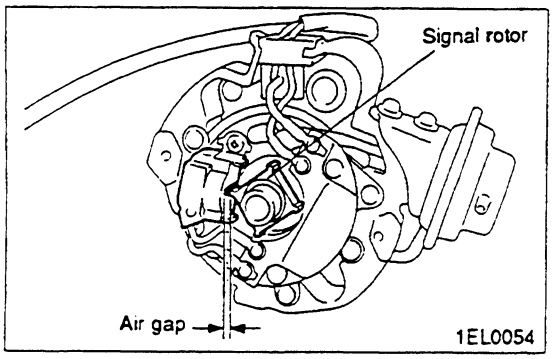
Pickup Coil

(1) Using a tester, check the resistance of the pickup coil.

Standard value: 420 to 540 Ω



(2) Check to make sure the pointer of the tester oscillates when the tip of a screwdriver is moved past by the core of the pickup coil assembly.



REASSEMBLY PROCEDURE

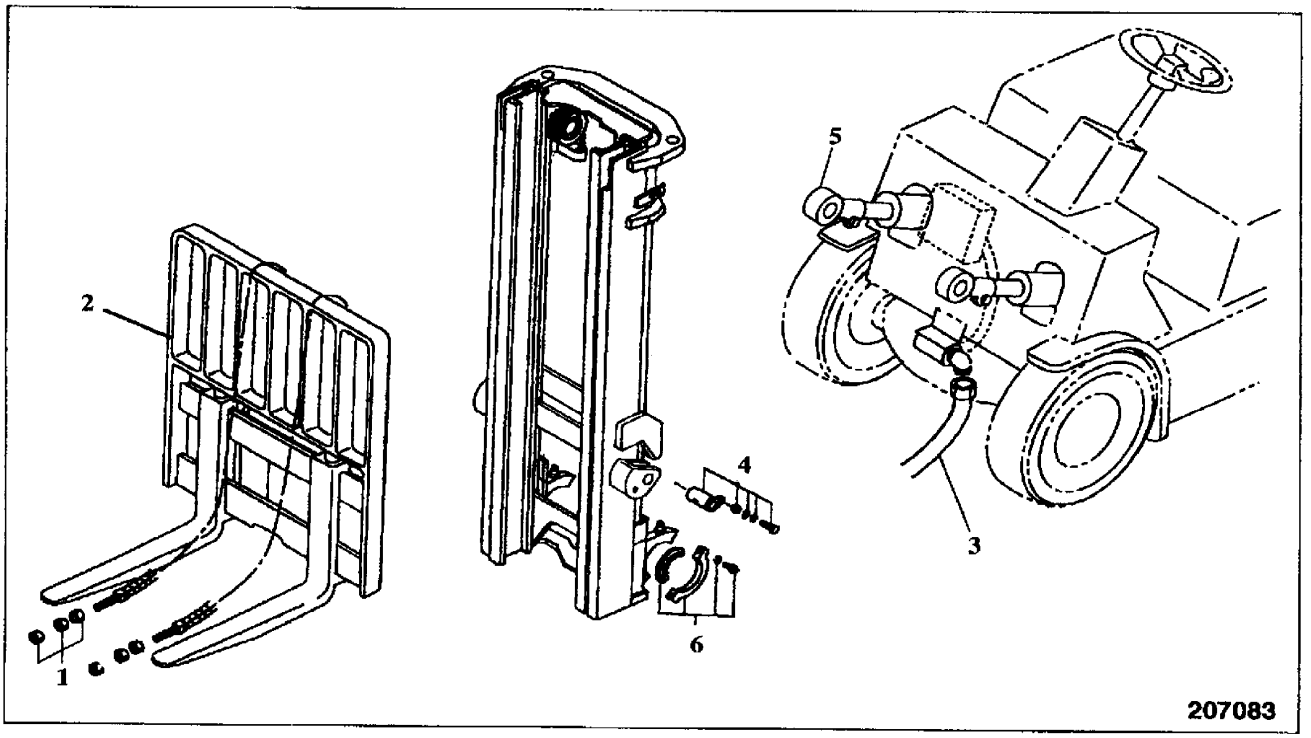
◆A◆ Pickup coil assembly installation

Check the air gap between the signal rotor and pickup assembly.

Standard value: 0.35 to 0.45 mm
(0.013 8 to 0.017 7 in.)

REMOVAL AND INSTALLATION

Mast and Lift Bracket Assembly



Sequence

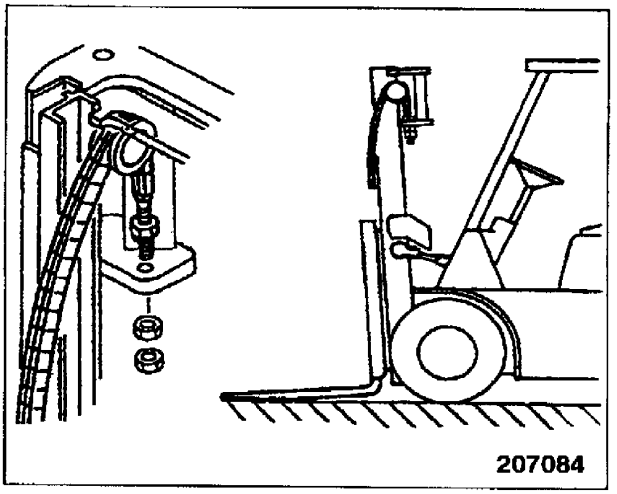
1 Nut
2 Forks and Lift bracket
3 High-pressure hose for lift cylinders
4 Tilt socket pins
5 Tilt cylinders
6 Mast-support bearing cap and Bushing

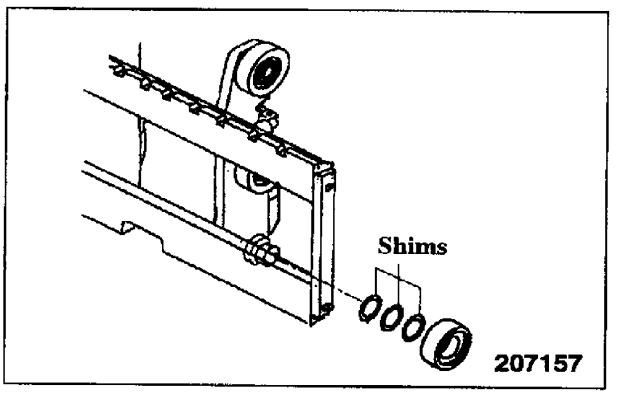
Suggestions

1. Removing lift bracket

(1) Tilt the mast forward, and lower the inner mast all the way. Slacken the lift chains, and remove the nuts from the anchor bolts.

(2) Tilt the mast back to vertical position. Raise the inner mast until the lift bracket becomes free. Then, back the truck away, leaving the lift bracket and fork assembly standing on the floor.





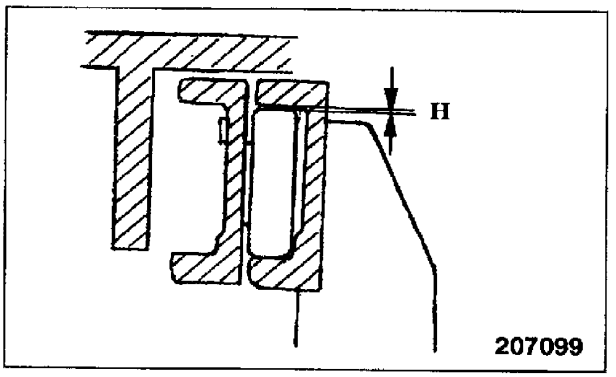
Mast Clearance Adjustment

1. Longitudinal clearance adjustment on mast main rollers

(1) Tilt the mast all the way backward.

(2) Using a feeler gauge, measure the clearance H between the inner mast lower roller and outer mast.

Clearance H	0.1 to 1.0 mm (0.004 to 0.039 in.)



(3) If the clearance H is out of specification, use oversize rollers.

Roller Sizes

Unit: mm (in.)

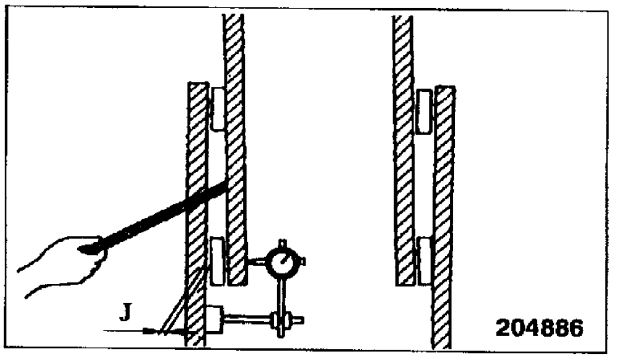
Diam. of main roller	GP15, GP18	GP20 thru GP35 DP20 thru DP35
S	99 (3.90)	113.8 (4.48)
M	100 (3.94)	115 (4.53)
L	101 (3.98)	116 (4.57)

2. Lateral clearance adjustment on inner mast main rollers

(1) Raise the mast all the way.

(2) Set a dial indicator on the inside of the outer mast with its contact point rested on the inner mast.

(3) Go over to the opposite of the mast, and push the inner mast against the outer mast. Set the indicator to zero.



GENERAL SPECIFICATIONS

Item \ Engine model			4G63	4G64
Type			Water-cooled, 4-cycle, gasoline-powered and L.P.G.-powered	
No. of cylinders and arrangement			4, in-line	
Combustion chamber type			Semi-spherical	
Valve mechanism			OHC	
Total displacement, cm^3 (cc) [cu in.]			1997 (1997) [122]	2350 (2350) [143]
Bore x stroke, mm (in.)			85 x 88 (3.35 x 3.46)	86.5 x 100 (3.41 x 3.94)
Dry weight, kg (lb)		31FD	142 (313)	145 (320)
		31FW	139 (306)	142 (313)
Compression ratio			8.5	8.6
Compression pressure, kPa (kgf/cm^2) [psi]			1128 (11.5) [163.5]	
Valve timing	Intake valve	Open	12° BTDC	
		Close	40° ABDC	
	Exhaust valve	Open	54° BBDC	
		Close	6° ATDC	
Firing order			1 - 3 - 4 - 2	
Ignition timing, BTDC/rpm			4° /740 (gasoline), 9° /740 (L.P.G.)	
Fuel pump			Mechanical (diaphragm type)	
Carburetor			Down-draft type	
Governor			Pneumatic type	
Lubrication system			Pressure feed, full-flow filtration type	
Oil pump			Gear, driven by timing belt	
Oil filter			Filter paper, cartridge type	
Cooling system			Water-cooled, forced circulation	
Water pump			Centrifugal, driven by V-belt	
Thermostat			Wax type	
Electrical system			12V DC, negative ground	
Alternator, (12V - 65A)			Alternator current, built-in fan and regulator	
Starter motor, (12V - 1.2 kW)			Reduction drive	
Distributor			Contact point less (transistor type)	
Spark plug (NGK or ND)		Gasoline	BP4ES or W14EX-U	
		L.P.G.	BP5ES or W16EX-U	
Quantity of lubricating oil, cm^3 (liter) [U.S. gal]			4800 (4.8) [1.27] (including 300 cm^3 (0.3 liter) [0.08 U.S. gal] in oil filter)	
Quantity of coolant, cm^3 (liter) [U.S. gal]			3100 (3.1) [0.82] (in engine proper)	

Part to be applied	Brand
Water temperature gauge unit	Three Bond 1104F, 3M ATD Part No. 8660 or equivalent
Semi circular packing	Three Bond 1212D, 3M ATD Part No. 8660 or equivalent
Rocker cover	Three Bond 1212D, 3M ATD Part No. 8660 or equivalent
Oil pressure switch	Three Bond 1211, 3M ATD Part No. 8660 or equivalent
Oil pan	Three Bond 1207F, Genuine Part No. MD990389 or equivalent
Rear oil seal case	Three Bond 1207F, Genuine Part No. MD990389 or equivalent
Rear plate bolt	Three Bond 1104, 3M ATD Part No. 8660 or equivalent
Oil seal case bolt	Three Bond 1104, 3M ATD Part No. 8660 or equivalent

FROM-IN-PLACE GASKET (FIPG)

The engine has several areas where the from-in-place gasket (FIPG) is in use. To ensure that the gasket fully serves its purpose, it is necessary to observe some precautions when applying the gasket. Bead size, continuity and location are of paramount importance. Too thin a bead could cause leaks. Too thick a bead, on the other hand, could be squeezed out of location, causing blocking or narrowing of the fluid feed line. To eliminate the possibility of leaks from a joint, therefore, it is absolutely necessary to apply the gasket evenly without a break, while observing the correct bead size.

Since the FIPG used in the engine hardens as it reacts with the moisture in the atmospheric air, it is normally used in the metallic flange areas.

Disassembly

The parts assembled with the FIPG can be easily disassembled without the use of a special method. In some cases, however, the sealant between the joined surfaces may have to be broken by lightly striking it with a mallet or similar tool. A flat and thin gasket scraper may be lightly hammered in between the joined surfaces. In this case, however, care must be taken to prevent damage to the joined surfaces. For removal of the oil pan, the special tool Oil Pan Remover (MD998727) is available. Be sure to use the special tool to remove the oil pan.

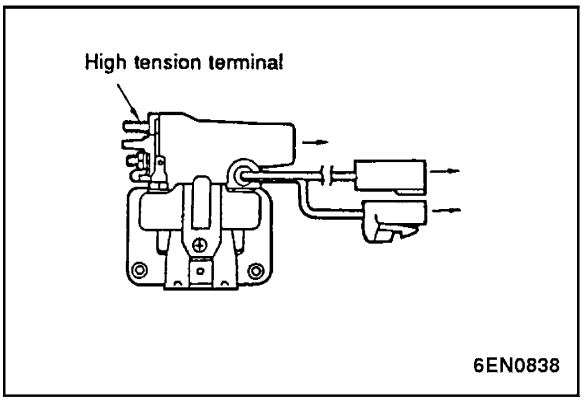
Surface preparation

Thoroughly remove all substances deposited on the gasket application surfaces, using a gasket scraper or wire brush. Check to ensure that the surfaces to which the FIPG is to be applied is flat. Make sure that there are no oils, greases, and foreign substances deposited on the application surfaces. Do not forget to remove the old FIPG remaining in the bolt holes.

From-in-place gasket application

The applied FIPG bead should be of the specified size and without breaks. Also be sure to encircle the bolt hole circumference with a completely continuous bead. The FIPG can be wiped away unless it is hardened. While the FIPG is still moist (in less than 15 minutes), mount the parts in position. When the parts are mounted, make sure that the gasket is applied to the required area only.

The FIPG application procedure may vary on different areas. Observe the procedure described in the text when applying the FIPG.



INSPECTION

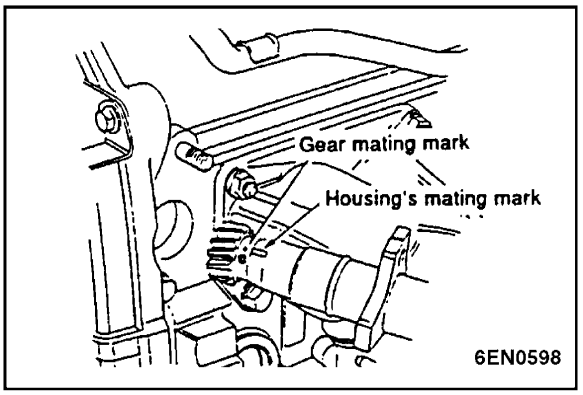
Ignition Coil

Perform the following measurements. Replace the ignition coil if the standard values are not met.

(1) Measure the resistance values of the primary and secondary coils and of the external resistor with a tester. If the readings are within the standard limits, it follows that there is no short or open circuit in the ignition coil.

Standard value:

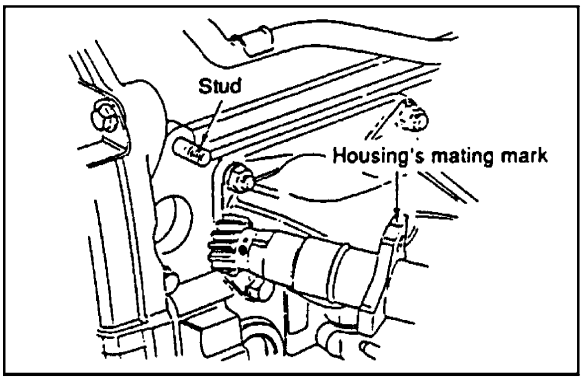
Primary coil resistance value:	1.08 to 1.32Ω
Secondary coil resistance value:	22.1 to 29.9kΩ
External resistor resistance value: (if equipped)	1.22 to 1.48Ω



◆A◆ Distributor Installation

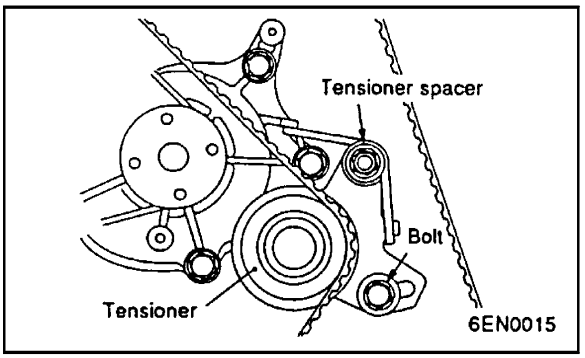
(1) Turn the crankshaft so that the No. 1 cylinder is at top dead center.

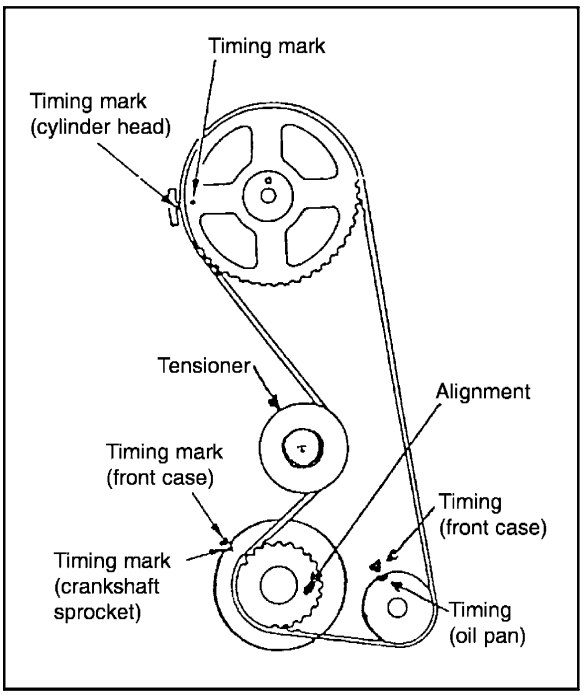
(2) Align the distributor housing and gear mating marks.

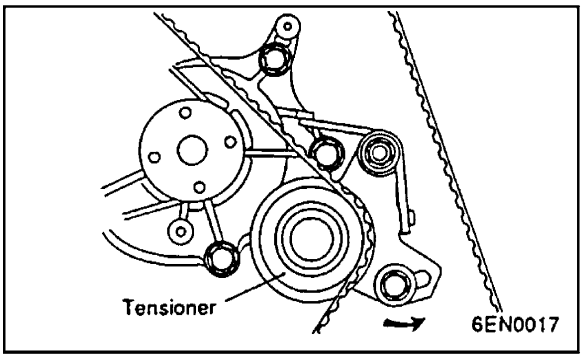


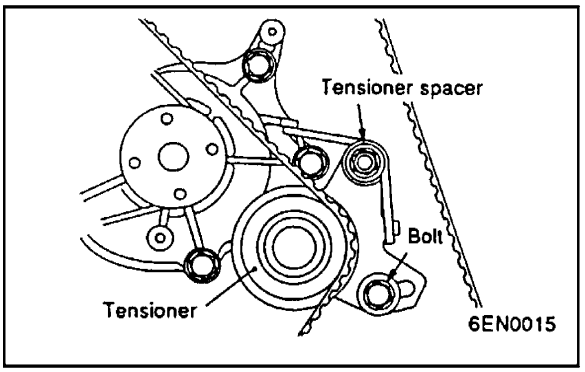
(3) Install the distributor to the engine while aligning the fine cut (groove or projection) of the distributor's installation flange with the center of the distributor installation stud.

Ignition Coil









(4) Install the timing belt on the crankshaft sprocket, oil pump sprocket and camshaft sprocket in that order. There should be no slack on the tension side.

(5) Apply a reverse direction (counterclockwise) force to the camshaft sprocket to make the tension side of the belt "tight." In that state, recheck that all the timing marks are still in alignment.

(6) Apply force to the tensioner in the direction shown by the arrow to make the belt engage completely with each sprocket.

Do not attempt to check the belt tension with your hand until the tensioner bolt is tightened.

(7) Tighten the tensioner attaching bolt at the specified torque.

(8) Tighten the tensioner spacer to the specified torque.

NOTE

If the nut is tightened first, the tensioner may also turn together with the nut and loose tension of the belt may result. Always tighten the bolt (at the bottom of the tensioner) first and then tighten the nut (at the top of the tensioner).

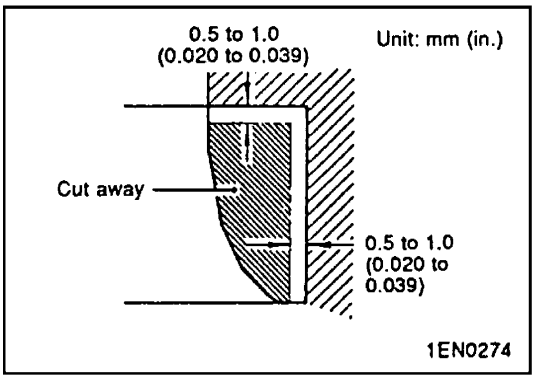
Never apply engine oil or any other oil or grease to the O-ring.

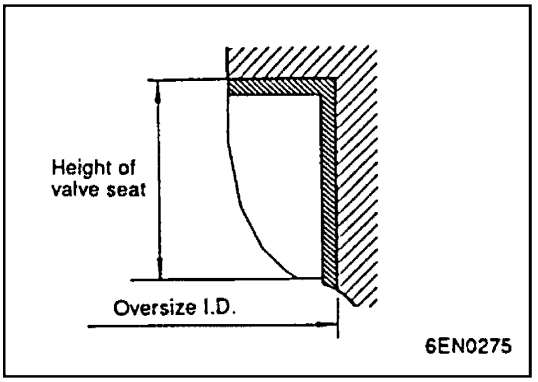
Fasten the water pipe after the thermostat housing has been installed.

REMOVAL SERVICE POINTS

◊A◊ Rocker arm and rocker shaft removal

(1) Before removing rocker arms and shafts assembly, install the special tool as illustrated to prevent the adjusters from dropping.





Valve Seat Replacement Procedure

(1) Cut the valve seat to be replaced from the inside to thin the wall thickness. Then, remove the valve seat.

(2) Rebore the valve seat hole in the cylinder head to a selected oversize valve seat diameter.

(3) Before fitting the valve seat, cool the valve seat in liquid nitrogen, to prevent the cylinder head bore from galling.

(4) Using a valve seat cutter, correct the valve seat to the specified width and angle.

See "Valve Seat Reconditioning Procedure."

Valve Guide Replacement Procedure

(1) Using a press, remove the valve guide toward the cylinder block side.

(2) Rebore the valve guide hole to the new oversize valve guide outside diameter.

NOTE

Do not install a valve guide of the same size again.

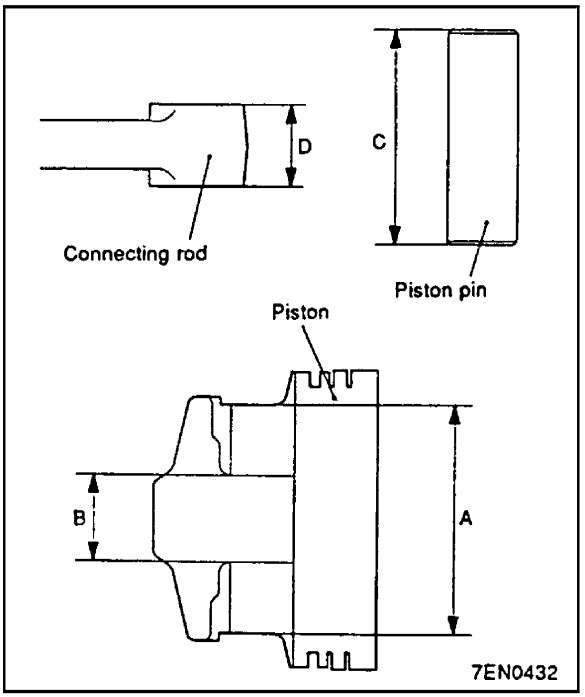
Valve guide hole diameter:
0.05 O.S. 13.05 to 13.07 mm (0.5138 to 0.5146 in.)
0.25 O.S. 13.25 to 13.27 mm (0.5217 to 0.5224 in.)
0.50 O.S. 13.50 to 13.52 mm (0.5315 to 0.5323 in.)

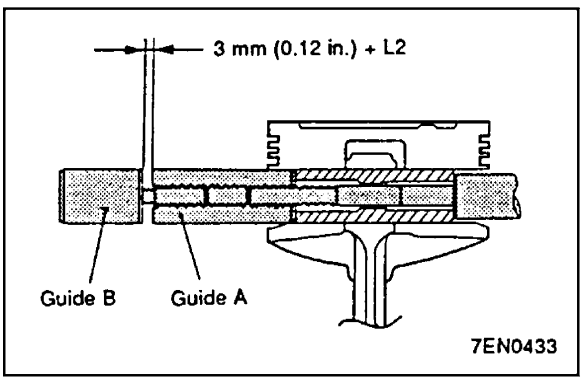
(3) Press in the valve guide to the position shown in the illustration.

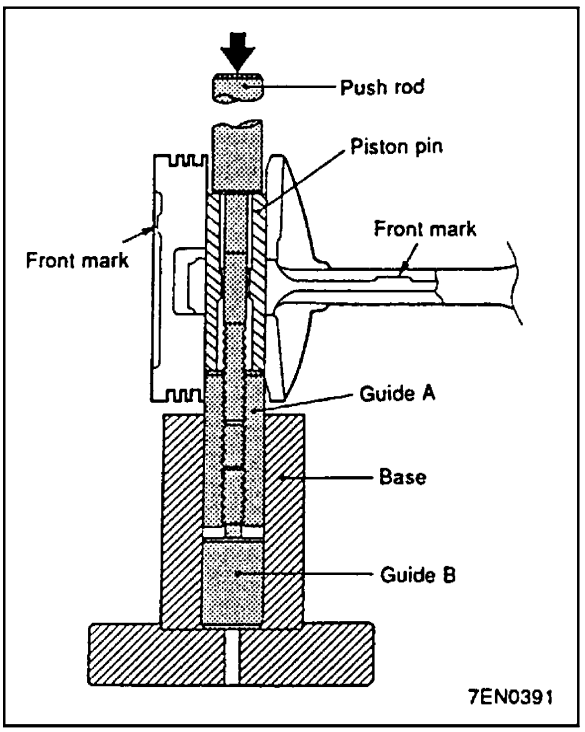
Standard value: 11.5 mm (0.453 in.)

NOTE

Press-fit the valve guide, working from the cylinder head top surface. Note that the intake and exhaust side valve guides are different in length. After installing valve guides, insert new valves in them to check for sliding condition.







INSTALLATION SERVICE POINTS

◆A◆ Piston pin installation

(1) Measure the following dimensions of the piston, piston pin, and connecting rod.

A: Piston pin insertion hole length
B: Distance between piston bosses
C: Piston pin length
D: Connecting rod

(2) Obtain dimension L (to be used later) from the above measurements the using by following formula.

$$L = \frac{(A - C) - (B - D)}{2}$$

(3) Insert the special tool, Push Rod, into the piston pin and attach the guide A to the push rod end.

(4) Assemble the connecting rod in the piston with the front marks facing the same direction.

(5) Apply engine oil to the entire periphery of the piston pin.

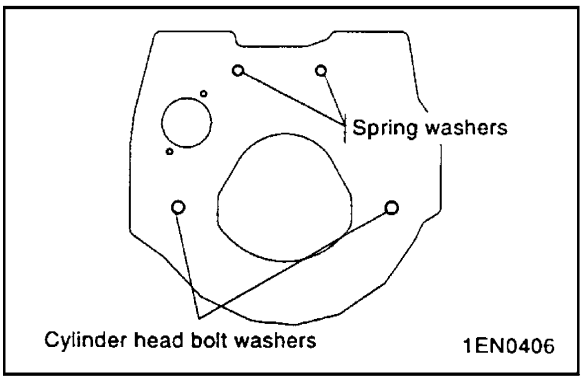
(6) Insert the piston pin, push rod and guide A assembly (assembled in step 3) from the guide A side into the piston pin hole on the front marked side.

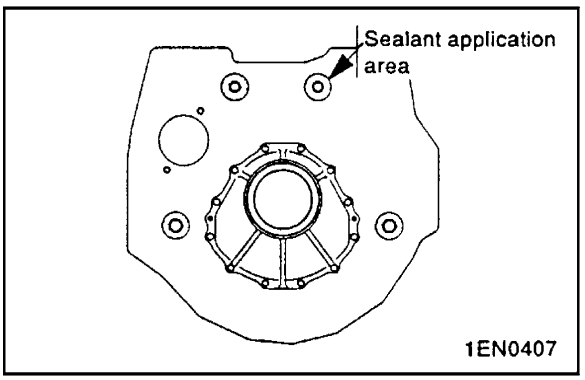
(7) Screw the guide B into the guide A until the gap between both guides amounts to the value L obtained in step (2) plus 3 mm (0.12 in.).

(8) Place the piston onto the piston setting base with the front marks directed upward.

(9) Press-fit the piston pin using a press. If the press-fitting force required is less than the standard value, replace the piston and piston pin set or/and the connecting rod.

Standard value: 7350 to 17160 N
(750 to 1750 kgf)
[1654 to 3859 lbf]



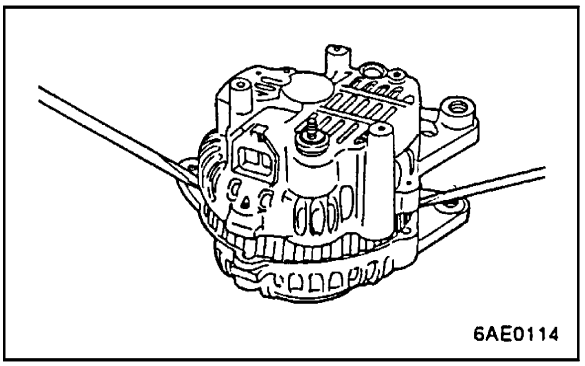


◆E◆ Rear plate installation

(1) Be sure to install the spring washers and cylinder head bolt washers in correct position.

(2) When installing the rear plate to the engine equipped with the wet clutch, apply the recommended sealant to the threads of the rear plate bolts. Apply the same sealant to 30 to 40 mm (1.2 to 1.6 in.) diameter circular area around each bolt hole in the rear plate and cylinder block.

Recommended sealant: Three Bond 1104 or equivalent

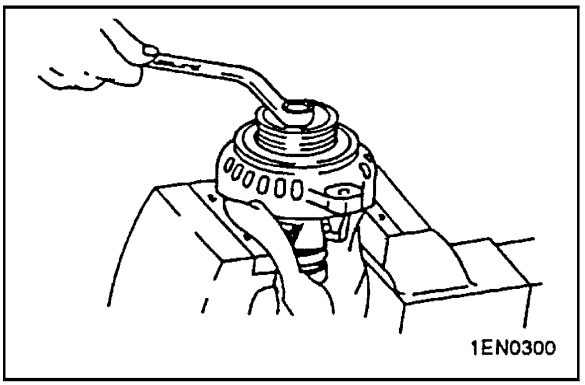

6AE0114

SERVICE POINTS OF DISASSEMBLY

Separation of the stator and front bracket

With a screwdriver blade inserted between the front bracket and stator core, pry to separate the stator from the front bracket.

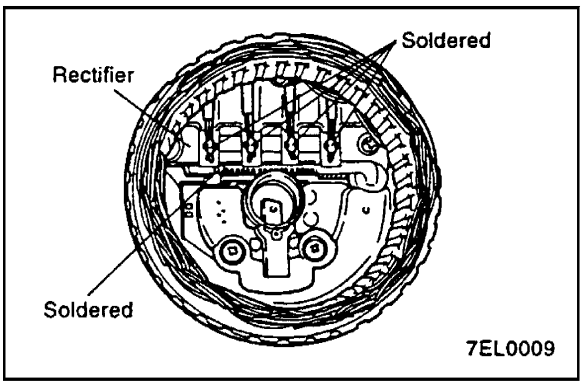
CAUTION
Do not insert the screwdriver too deep as the stator core could be damaged.


1EN0300

◊A◊ Removal of alternator pulley

With the pulley side facing up, hold the rotor in a vice and remove the pulley.

CAUTION
Use care not to damage the rotor.



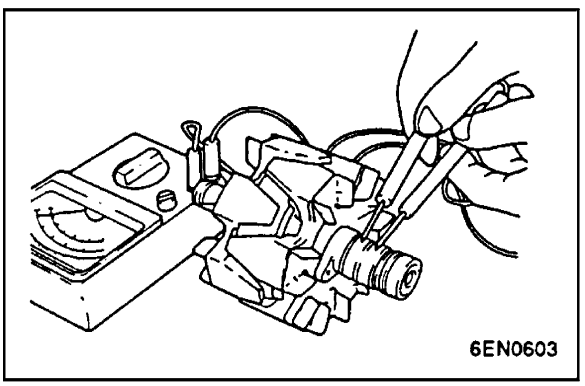
7EL0009

◊B◊ Stator/regulator assembly removal

(1) Use a soldering iron (180 to 250 W) to unsolder the stator. This work should be completed within approximately four seconds to prevent heat from transferring to the diode.

(2) When removing the rectifier from the regulator assembly, remove the soldered sections of the rectifier.

CAUTION
Use care to make sure that the heat of the soldering iron is not transmitted to the diodes for a long period. Use care that no undue force is exerted to leads of diodes.

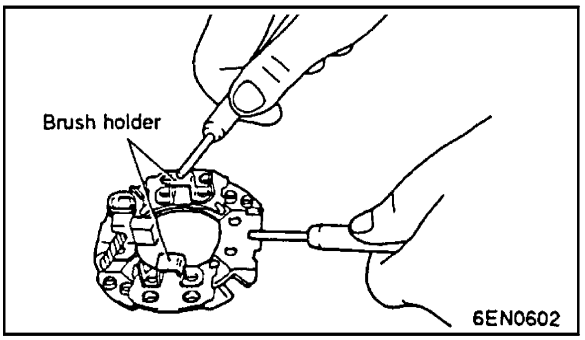

6EN0603

INSPECTION

1. Rotor

(1) Check the rotor coil continuity. Make sure that there is continuity between the slip rings. Measure the rotor resistance. If it is excessively small, it indicates a shorted rotor. If there is no continuity or if it is shorted, replace the rotor assembly.

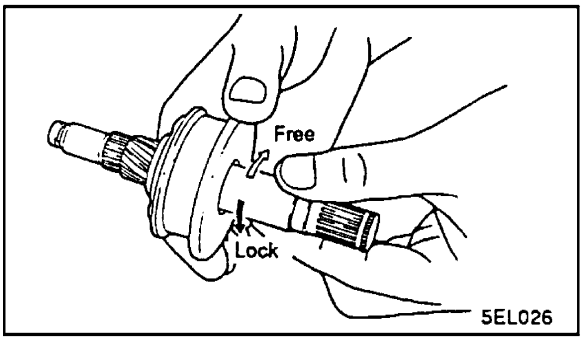
Standard value: 3 to 5Ω



4. Brush Holder

Check continuity between the brush holder plate and the brush holder.

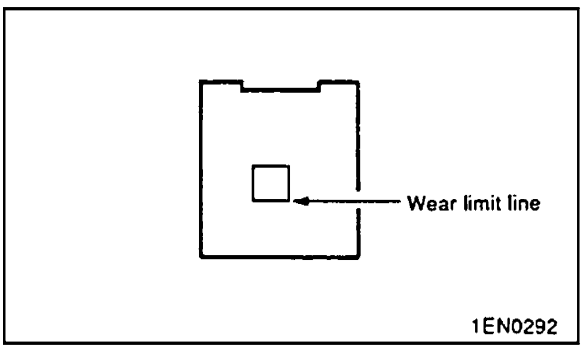
The brush holder is okay if there is no continuity.



5. Overrunning Clutch

(1) Check that the pinion locks when it is turned counterclockwise and moves smoothly when it is turned clockwise.

(2) Check the pinion for wear or damage.



6. Brush

(1) Check the brush for roughness of the surface that contacts the commutator and check the brush length.

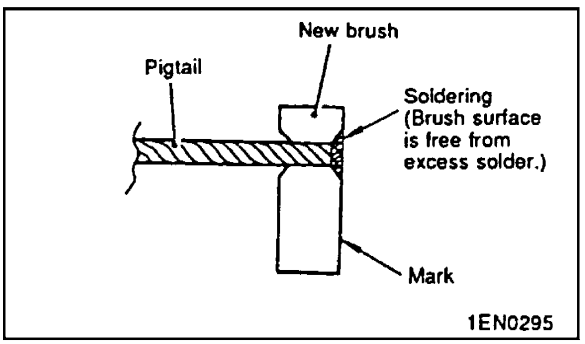
Limit: Wear limit line

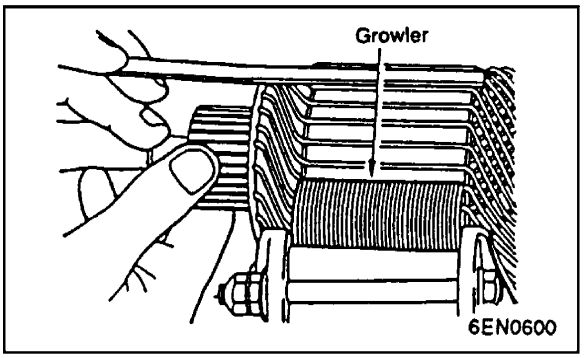
(2) In case the contacting surface has been corrected or the brush has been replaced, correct the contacting surface by winding sandpaper around the commutator.

(3) When removing a worn brush by breaking with pliers, use care to prevent damage to the pigtail.

(4) Polish the pigtail end with sandpaper for secure soldering.

(5) Insert the pigtail into the hole of a new brush and solder. Make sure that there is no excess solder on the brush surface.





7. Armature Coil Short Circuit Test

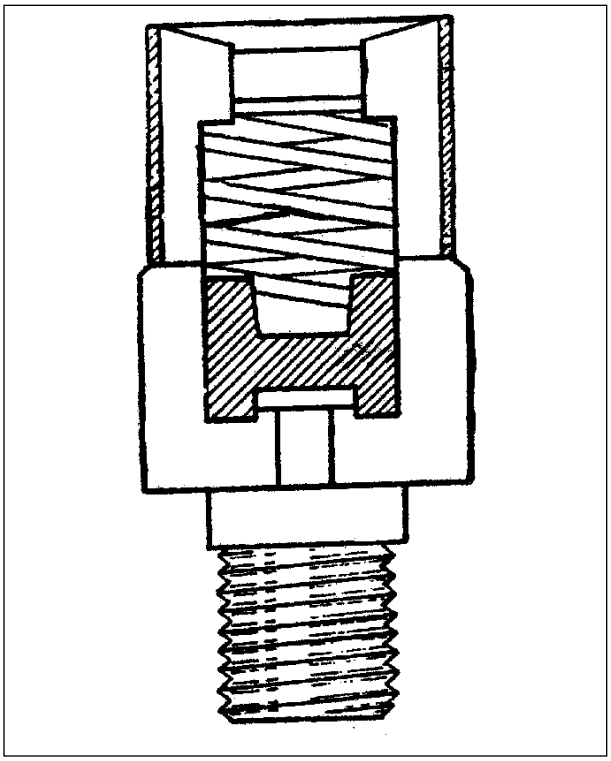
(1) Set the armature on a growler.

(2) While applying a thin piece of iron in parallel with the armature, turn the armature slowly. The armature is okay if the piece of iron is not attracted or does not vibrate.

CAUTION

Clean the armature surface thoroughly before checking.

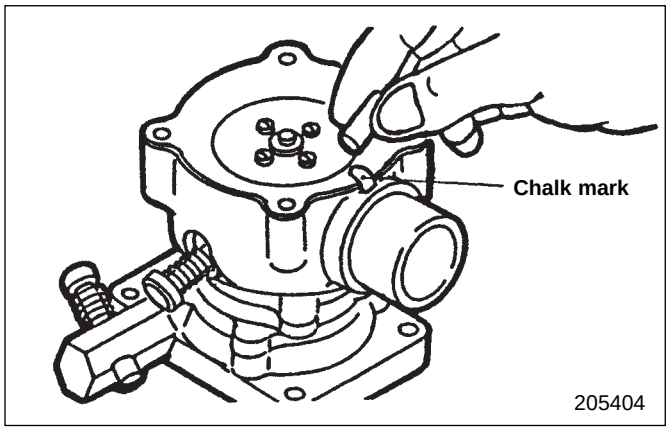
3.3 Hydrostatic relief valve



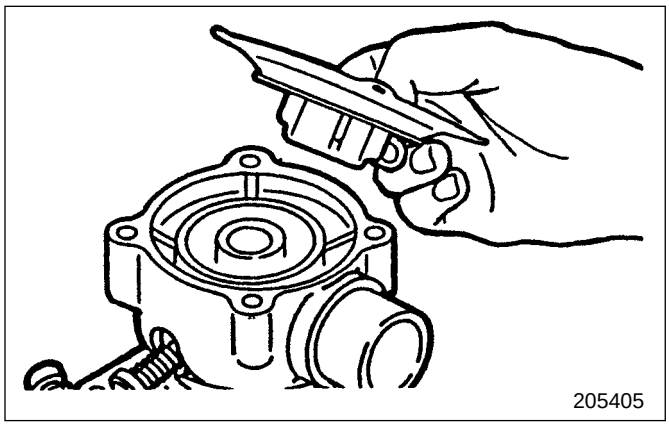
The hydrostatic relief valve is a simple spring loaded valve which is normally closed. A hydrostatic relief valve must be present in all fuel transfer lines between shutoffs. The hydrostatic relief valve must have a dust cap covering the outlet to prevent contamination of the valve.

The purpose of the hydrostatic relief valve is to protect the fuel transfer line from over pressure of not less than 400 psi/2.8 mPa and not more than 500 psi/3.5 mPa. When the pressure in the fuel transfer line exceeds the operating pressure of the hydrostatic relief valve, the valve is forced off of it's seat allowing LPG to escape thus reducing the pressure in the fuel transfer line. When the pressure drops below the opening pressure of the hydrostatic relief valve, the valve closes.

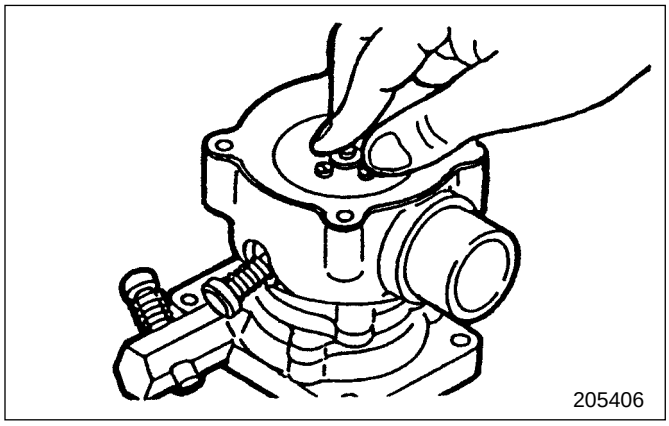
DISASSEMBLY AND REASSEMBLY



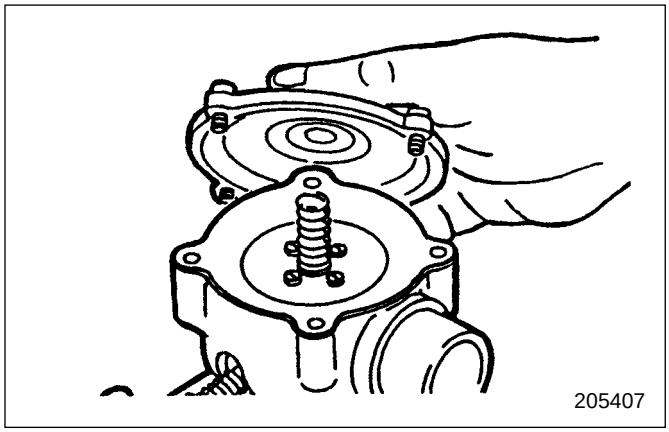
(1) Remove the air valve cover and retaining screw. Place a chalk mark on the air valve diaphragm and the mixer body. This mark will allow correct positioning during re-assembly.



(2) Lift out and replace the air valve assembly in the mixer body.



(3) Press the air valve down until it bottoms into the body.

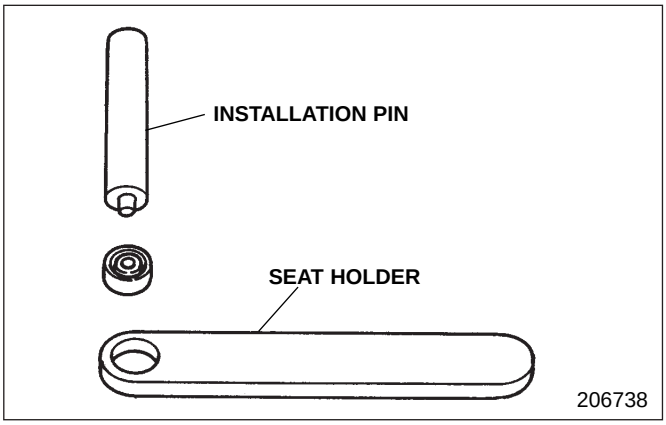


(4) Align the chalk mark on the air valve diaphragm with the chalk mark on the mixer body. Reassemble the air valve cover and install retaining screws.

DISASSEMBLY AND REASSEMBLY

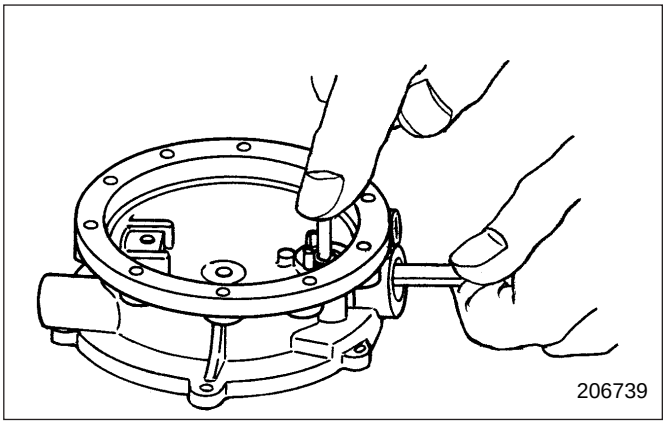
Reassembly

(1) Seat holder (H1-14236) should be positioned as shown in illustration (bottom tool).
Note that the hole in which the O-ring lip seal is installed is tapered, and that the wider end of the opening faces up.
Replacement seal must be coated with silicone grease before it is inserted into holder. Place greased O-ring lip seal into the holder using installation pin (P1-14235), and re-coat seal with silicone grease.
The seal must be in the position shown in illustration, with groove facing up and visible. Seal is tapered to match the hole in the holder.

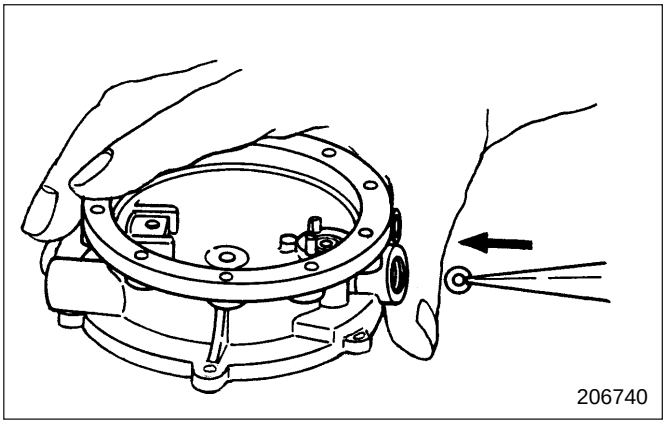


Note "H1-14236" and "P1-14235" are special tool numbers of Impco Company.

(2) With O-ring lip seal in the holder, groove visible and facing up, slide holder (with O-ring lip seal) into the body.
Look through the fuel hole to check positioning of the seal. The seal must be positioned above the cavity of the seal recess.
Coat installation pin with silicone grease, and push seal through holder and into the seal recess of the body.
Remove installation pin, and look through the fuel hole to check for proper installation. The seal should be seated in the seal recess, and groove should be visible.



(3) Use needle nose pliers to install retaining washer through the "Fuel Out" opening.
Refer to the cross-sectional diagram for step (5) of the disassembly procedure.



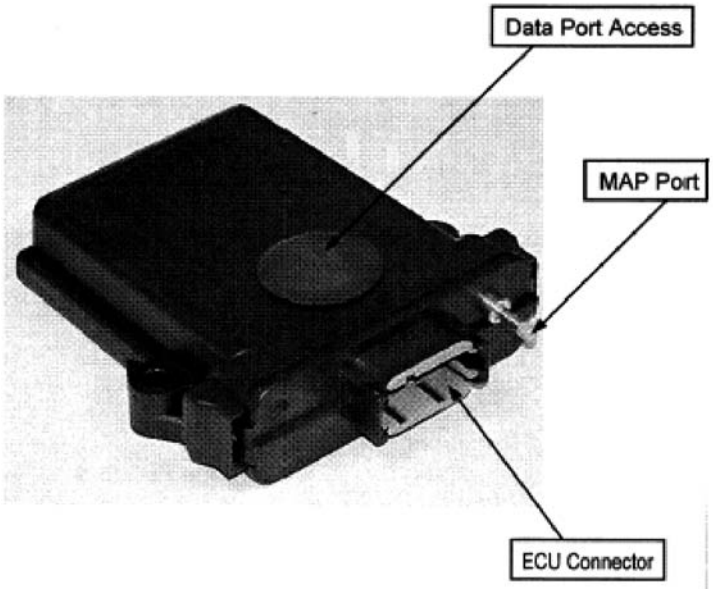
3. Main Component Illustrations

3.1 Electronic Control Unit (ECU)
Identification of ECU is shown in examples below

version 1

version 2

3.2. Electronic Control Unit (ECU)



fuel pressure has the effect of reducing the amount of fuel flow to the engine. As the DWELL of the FCSV is varied during operation, and based on input information the ECU processes, the fuel flow is adjusted accordingly. Any unapproved alteration to the vacuum lines, FCSV, and associated check valves (not described in this section) may cause the fuel control system to malfunction. Engine and catalyst damage may result and may void the manufacturer's warranty.

Note: If during a service attempt, an ECU is not operating as described in this manual contact your local authorized Caterpillar Lift Truck dealer. Please note the truck serial number and prepare a detailed explanation of the operating characteristics prior to contacting dealer.

3. Throttle and Governor:
The throttle and governor sub-system utilizes a "drive by wire" electronic throttle body. The electronic throttle body is a single "electro-mechanical" component. The electronic throttle body has 2 electric coils and a shaft mounted mechanical throttle valve. When voltage is applied to the coils, the shaft with the throttle valve will rotate. The throttle valve is mounted in the intake passage. As the voltage to the coils is increased, the shaft rotates opening the throttle valve, and allows increased airflow to the engine which increases the RPM.

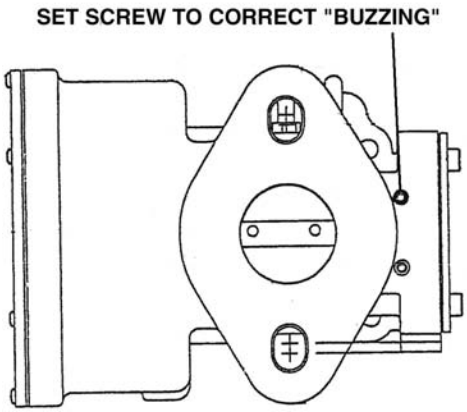
INPUT (To ECU)	OUTPUT (From ECU)
Throttle sensor	Voltage to electronic
RPM	throttle body
MAP	

The electronic throttle body has full authority over the throttle valve at all engine speeds and loads. The ECU will only allow the engine to operate in the manner it was programmed, and neither the operator nor service technician can alter the operating characteristic of this system without causing system failures. Idle RPM is 700. Maximum RPM is 2700. The system utilizes a throttle sensor which is connected to the foot pedal either by a bracket and rod or a throttle cable, depending on the specific truck model.

Regardless of the specific throttle sensor used, the operating principals are the same. The throttle sensor includes a component called a potentiometer which relays a variable voltage to the ECU. As the potentiometer is rotated the voltage increases. The potentiometer has a voltage range from 0 volts to a maximum of 5 volts. (The minimum voltage at idle should never be less than .2 volts or at full pedal stop bolt position more than 4.865 volts.) As the operator depresses the foot pedal the throttle sensor also rotates and sends a voltage to the ECU. The ECU is programmed to interpret this voltage to a specific engine RPM. The ECU then increases voltage to the throttle body which opens the throttle valve until an engine speed is reached that is preprogrammed to correspond to the voltage output of the throttle sensor. The ECU will vary the voltage to the throttle body to open or close the throttle valve, depending on the throttle sensor position and engine load, to maintain the selected speed.

1.4. Problem: The check engine light comes on intermittently while the engine is allowed to idle for extended periods of time.

Analysis: Some trucks in the field can occasionally have this happen. In the event this problem occurs and also is accompanied by a "buzzing" noise coming from the mixer. This "buzzing" can be corrected by adjusting the "minimum" limit set screw on the throttle body.



1) Remove the throttle body from the intake manifold.
2) Locate the correct setscrew. (see diagram for location of setscrew)
3) Turn the screw counter clockwise 1 turn.
4) Reinstall the throttle body and check for operation.
5) If not corrected repeat the same procedure as above and rotate the setscrew an additional HALF turn counterclockwise.
6) If problem is not corrected contact your local Authorized Caterpillar dealer for further assistance.