MITSUBISHI
FORKLIFT TRUCKS

Service Manual

Chassis & Mast

FGC15K
AF81C-00011-up
AF81D-00011-up
AF81E-00011-up

FGC18K
AF81C-00011-up
AF81D-00011-up
AF81E-00011-up

FGC20K
AF82C-00011-up
AF82D-00011-up
AF82E-00011-up

FGC20K HO
AF82C-90011-up
AF82D-90011-up
AF82E-90011-up

FGC25K
AF82C-00011-up
AF82D-00011-up
AF82E-00011-up

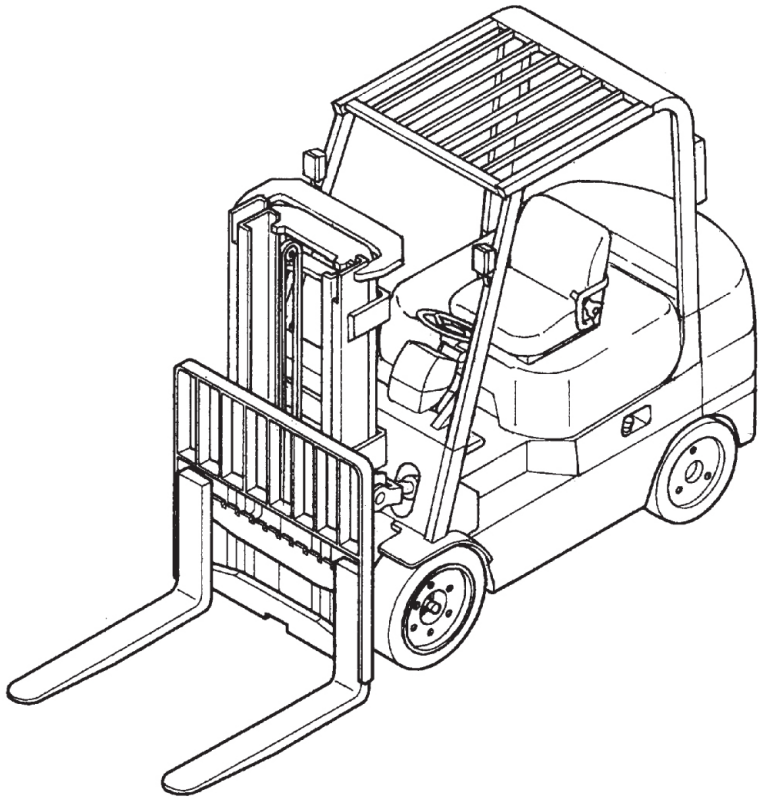
FGC25K HO
AF82C-90011-up
AF82D-90011-up
AF82E-90011-up

FGC30K
AF83C-00011-up
AF83D-00011-up
AF83E-00011-up

For use with 4G63/4G64 Engine Service Manual and Liquefied Petroleum Gas Supplements.

99719-70150

Vehicle Exterior



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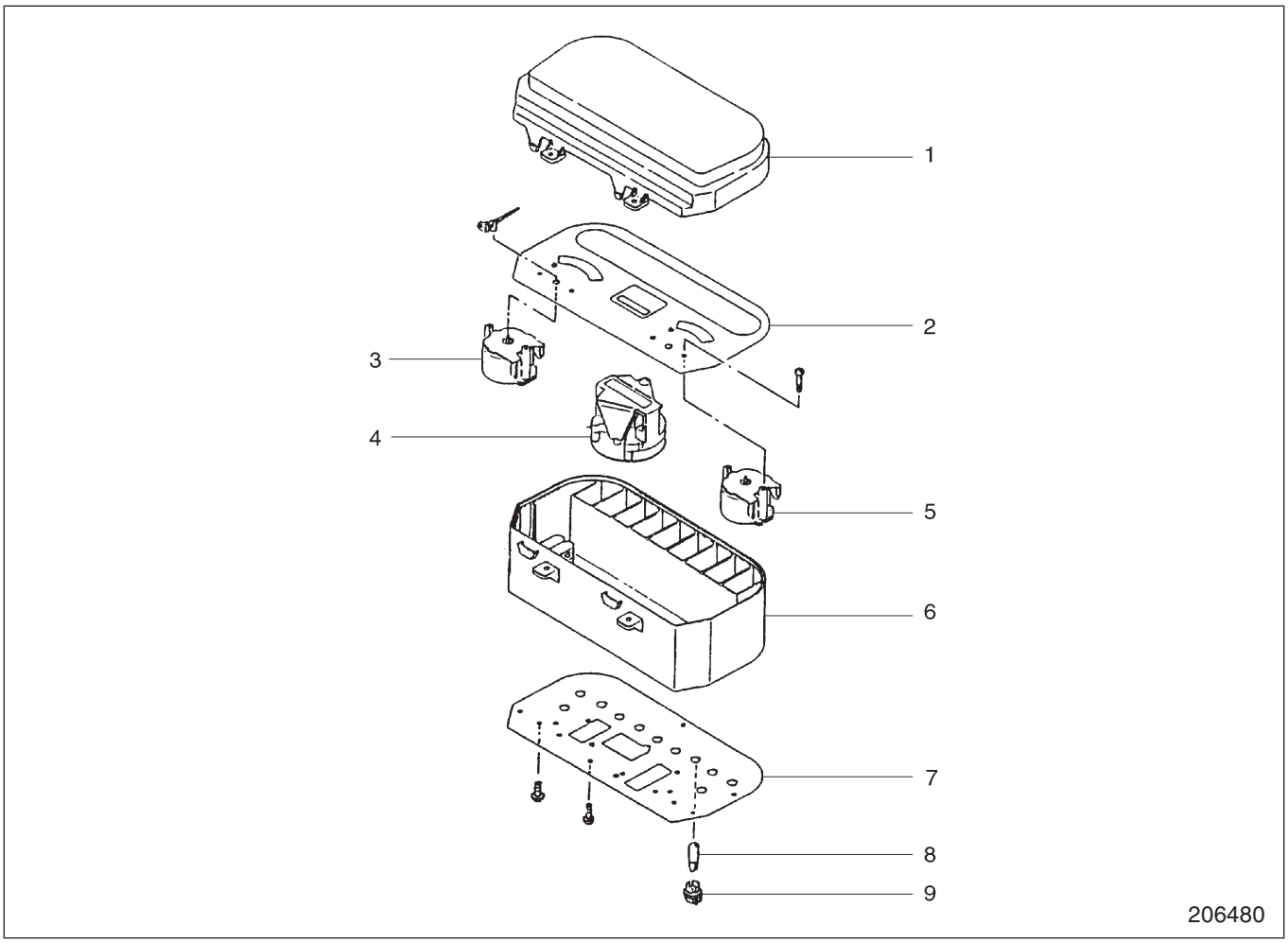
Models

Truck model	Model code – Serial number	Engine mounted
FGC15K	AF81C – 00011- up AF81D – 00011- up AF81E – 00011- up	Mitsubishi 4G63 gasoline engine
FGC18K	AF81C – 00011- up AF81D – 00011- up AF81E – 00011- up	
FGC20K	AF82C – 00011- up AF82D – 00011- up AF82E – 00011- up	
FGC25K	AF82C – 00011- up AF82D – 00011- up AF82E – 00011- up	
FGC20K HO	AF82C – 90011- up AF82D – 90011- up AF82E – 90011- up	Mitsubishi 4G64 gasoline engine
FGC25K HO	AF82C – 90011- up AF82C – 90011- up AF82C – 90011- up	
FGC30K	AF83C – 00011- up AF83C – 00011- up AF83C – 00011- up	

Combination Meter

Disassembly



Sequence

1 Meter cover
2 Dial
3 Engine coolant temperature gauge
4 Service hourmeter
5 Fuel gauge
6 Meter case
7 Printed circuit
8 Bulb
9 Socket

⚠ CAUTION

Be careful not to damage the printed circuit when disassembling the combination meter.

Reassembly

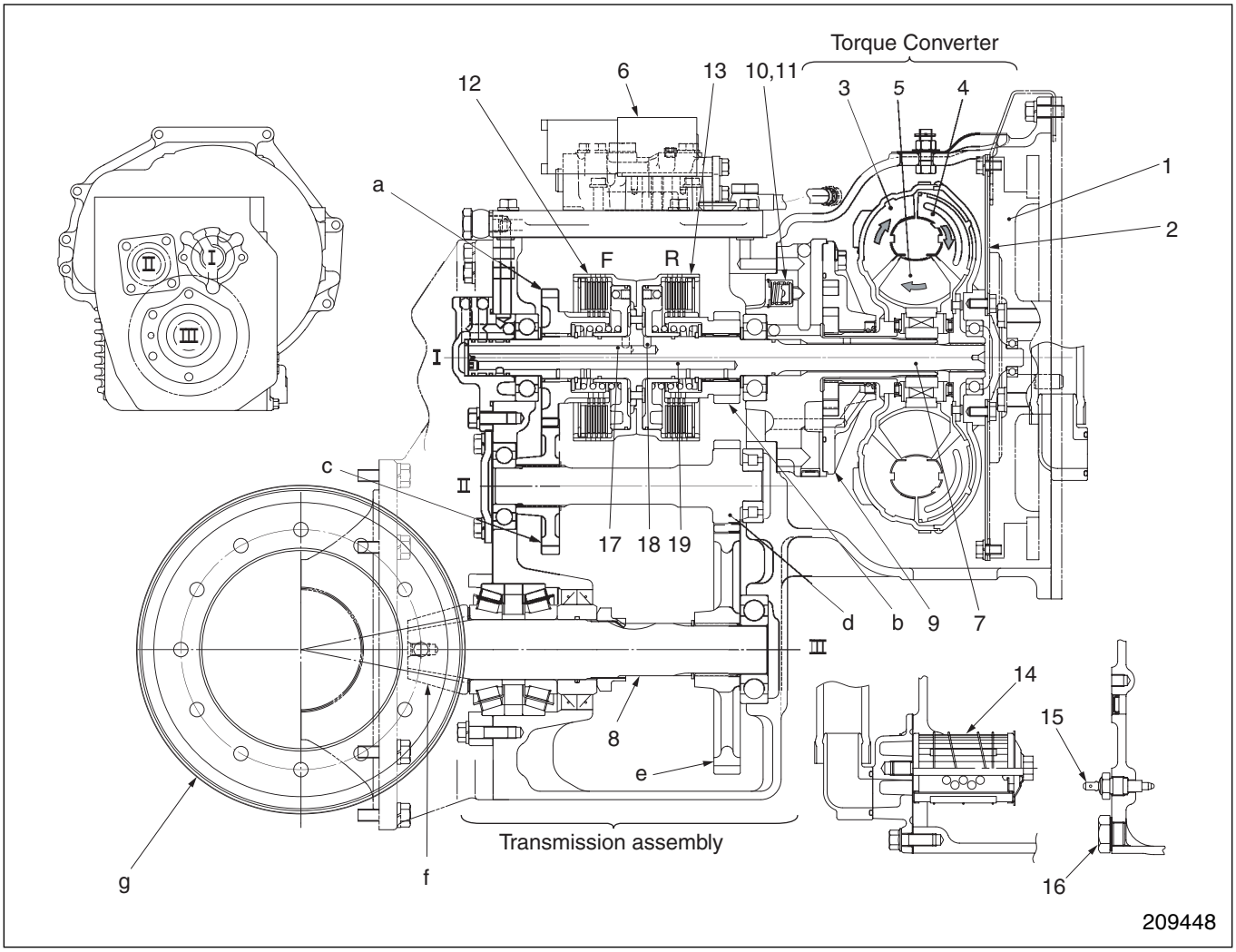
To reassemble the combination meter, follow the reverse of disassembly procedure.

Bulb Replacement

For bulb replacement, remove the socket from the printed circuit by turning it to the left. For configuration of the indicator lights, refer to “OK Monitor”.

POWER TRAIN

Transmission for FGC20K, FGC20K HO, FGC25K, FGC25K HO and FGC30K



Main components

1 Engine flywheel
2 Flexible plate

Items 3 to 5 are inner parts of torque converter.

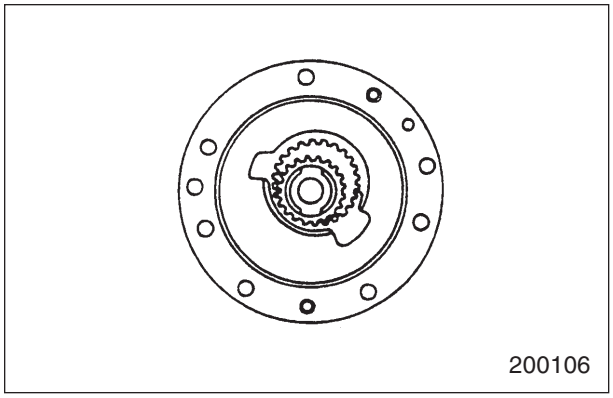
3 Impeller
4 Turbine
5 Stator
6 Control valve assembly

Item 7 and following items are inner parts of transmission assembly.

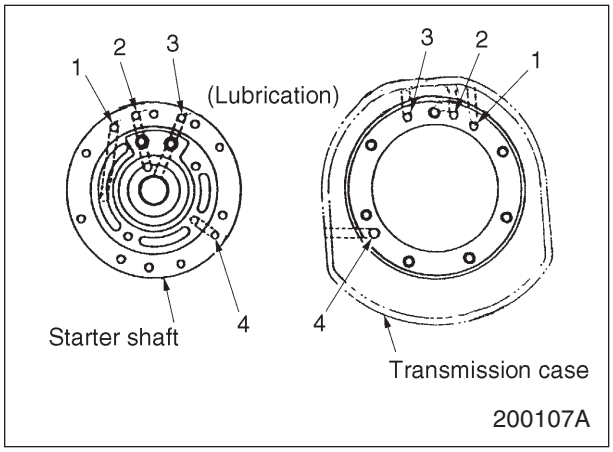
7 Input shaft
8 Output shaft
9 Oil pump
10 Converter inlet relief valve
11 Converter outlet relief valve
12 Forward clutch
13 Reverse clutch
14 Suction strainer
15 Thermo-switch (oil temperature sensing)
16 Drain plug
17 Forward clutch engaging oil passage
18 Reverse clutch engaging oil passage
19 Clutch cooling and lubrication oil passage

a: Forward gear (35 teeth)
b: Reverse gear (23 teeth)
c: Counter gear (35 teeth)
d: Counter gear (23 teeth)
e: Output gear (67 teeth)
f: Bevel pinion (7 teeth, left-hand spiral)
g: Bevel gear (35 teeth, right-hand spiral)

(2) Apply a light coat of grease or oil to both sides of the gear teeth and bushing.



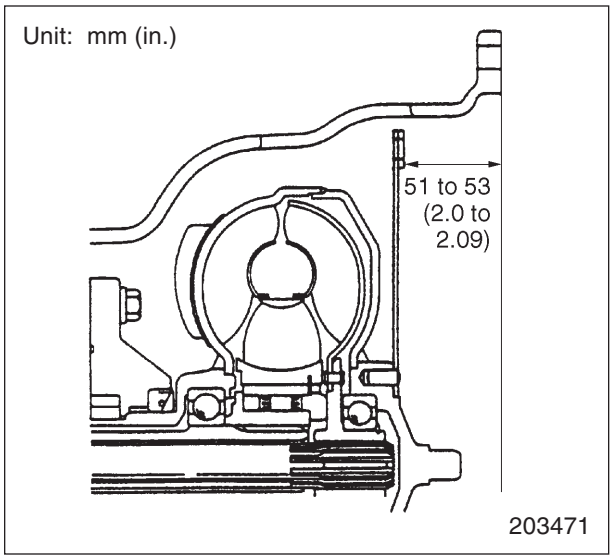
(3) Install the pump to the case, making sure the oilways are not plugged. Put marks across the pump and the case so they can be installed in the same position.



1 Pump outlet port
2 Torque converter inlet port
3 Torque converter outlet port
4 Pump inlet port

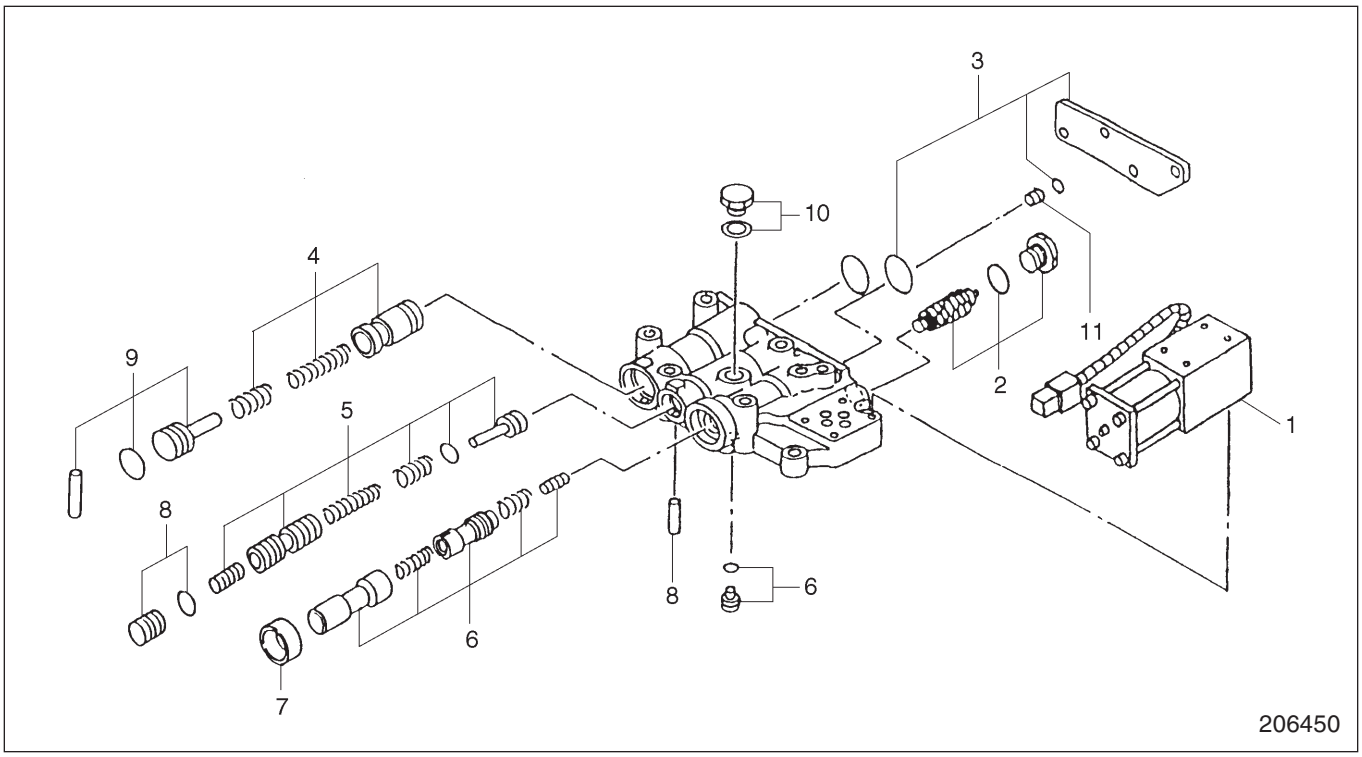
2. Tighten the flexible plate bolts to the specified torque. After reassembling the torque converter, check the dimension shown.

Item \ Truck Model	FGC15K FGC18K	FGC20K/20K HO FGC25K/25K HO FGC30K
Tightening torque for flexible plate bolts	16.4 N·m (1.7 kgf·m) [12.3 lbf·ft]	29.4 N·m (3.0 kgf·m) [21.7 lbf·ft]



Control Valve

Disassembly



Sequence

1 Solenoid valve
2 Plug, O-ring, Strainer
3 Cover, O-ring
4 Accumulator piston, Spring
5 Main regulator valve, Spring seat, O-ring, Main regulator spring, Plug
6 Clutch valve plunger, Valve spring, Clutch valve, Return spring, Slug, Stopper pin, O-ring
7 Oil seal
8 Plug, Bearing roller, O-ring
9 Accumulator spring seat, Pin, O-ring
10 Drain plug, Gasket
11 Orifice screw

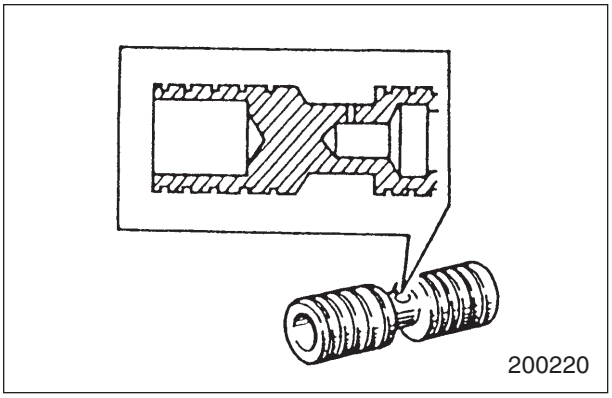
Inspection after Disassembly

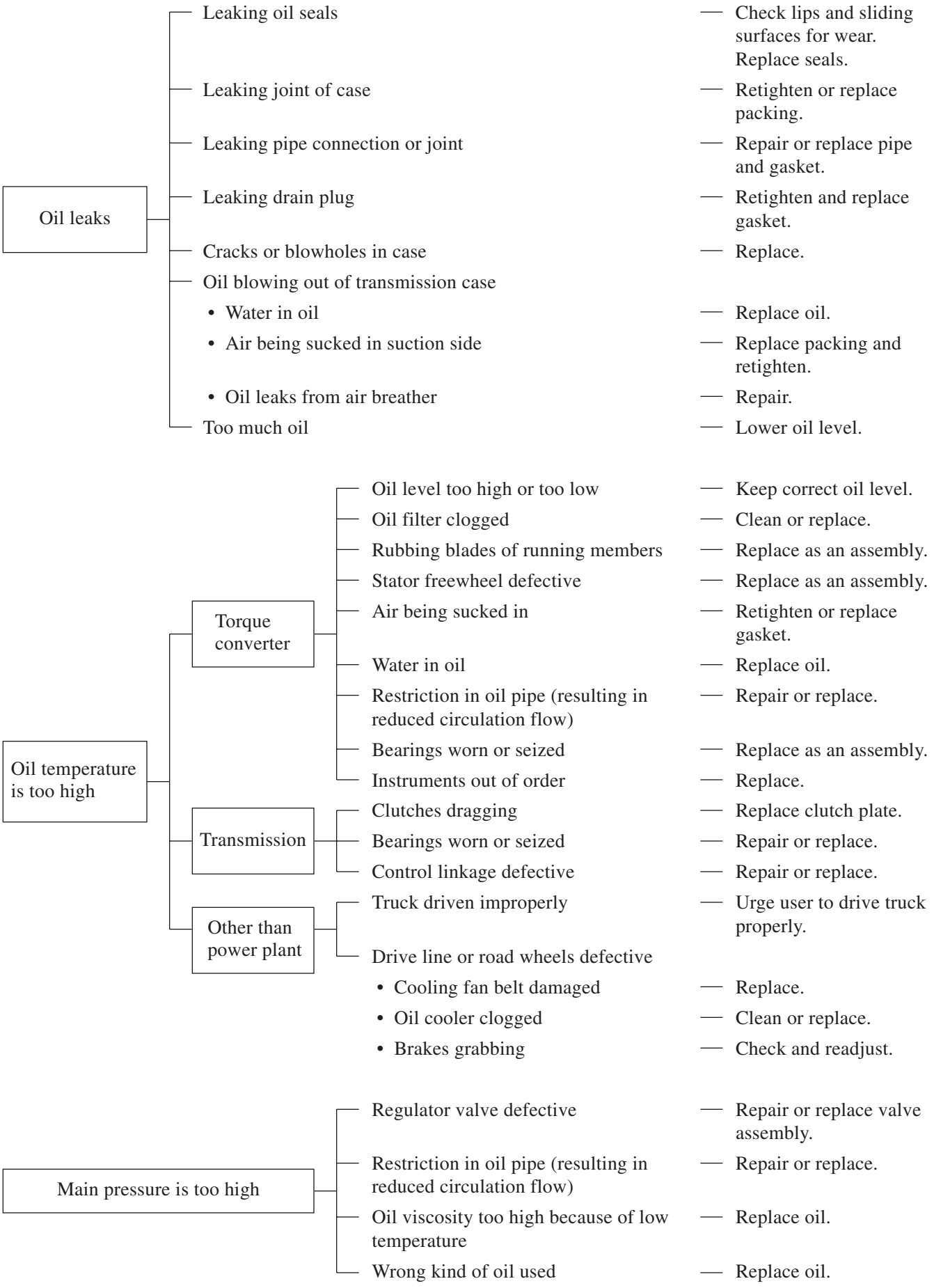
(1) Check oil ways and passages for clogging.

(2) Check each spool for sign of wear, damage or seizure.

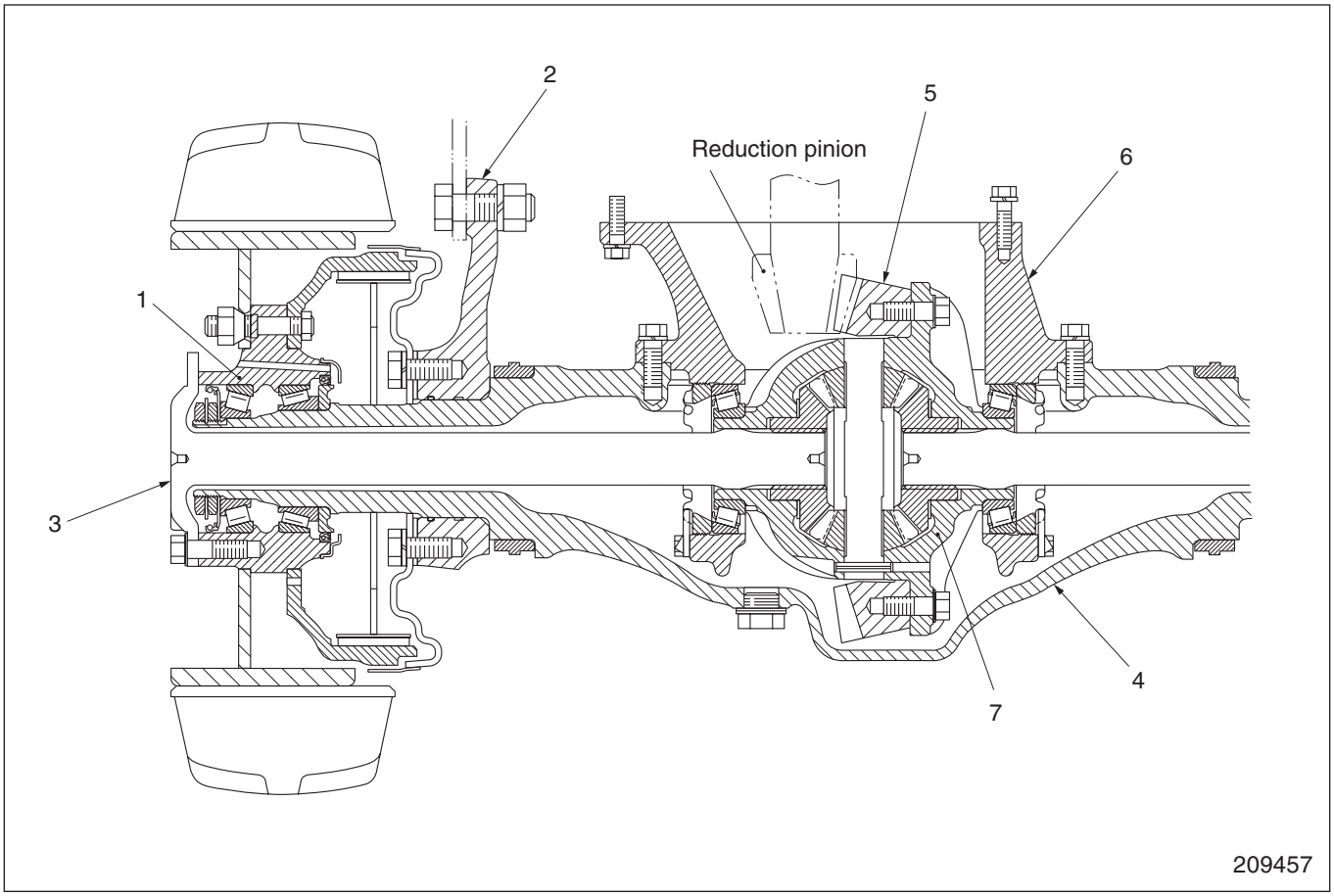
(3) Check oil seals for damaged lips.

(4) Check the orifice in the main regulator valve for cleanliness; also check the valve spring for weakness or damage.




Oil leaks
Leaking oil seals
Check lips and sliding surfaces for wear. Replace seals.
Leaking joint of case
Retighten or replace packing.
Leaking pipe connection or joint
Repair or replace pipe and gasket.
Leaking drain plug
Retighten and replace gasket.
Cracks or blowholes in case
Replace.
Oil blowing out of transmission case
• Water in oil
Replace oil.
• Air being sucked in suction side
Replace packing and retighten.
• Oil leaks from air breather
Repair.
Too much oil
Lower oil level.
Oil temperature is too high
Torque converter
Oil level too high or too low
Keep correct oil level.
Oil filter clogged
Clean or replace.
Rubbing blades of running members
Replace as an assembly.
Stator freewheel defective
Replace as an assembly.
Air being sucked in
Retighten or replace gasket.
Water in oil
Replace oil.
Restriction in oil pipe (resulting in reduced circulation flow)
Repair or replace.
Bearings worn or seized
Replace as an assembly.
Instruments out of order
Replace.
Transmission
Clutches dragging
Replace clutch plate.
Bearings worn or seized
Repair or replace.
Control linkage defective
Repair or replace.
Other than power plant
Truck driven improperly
Urge user to drive truck properly.
Drive line or road wheels defective
• Cooling fan belt damaged
Replace.
• Oil cooler clogged
Clean or replace.
• Brakes grabbing
Check and readjust.
Main pressure is too high
Regulator valve defective
Repair or replace valve assembly.
Restriction in oil pipe (resulting in reduced circulation flow)
Repair or replace.
Oil viscosity too high because of low temperature
Replace oil.
Wrong kind of oil used
Replace oil.

Structure and Function



Main components

1 Front wheel hub
2 Frame support
3 Axle shaft
4 Axle housing
5 Reduction gear
6 Differential carrier
7 Differential gear assembly

The frame supports hold the front axle housing in such a manner as to allow a limited amount of rotary motion of the housing, the rotary sliding surfaces being lubricated with grease.

The cushion tire is press fitted to the outer ring of the wheel hub.

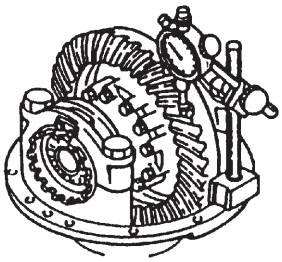
Service limit for cushion tire

Replace the tire if the height of the solid rubber portion is 25.4 mm (1 in.). For tire replacement, consult your forklift truck dealer.

Suggestions for Disassembly

(1) Before removing the differential carrier from the transmission case, measure the gear backlash to aid in obtaining correct backlash at the time of reassembly.

Backlash between reduction gear and pinion	0.15 to 0.25 mm (0.0059 to 0.0098 in.)



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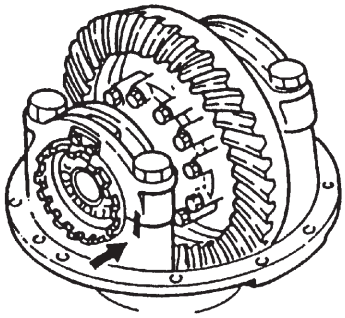
(2) Put a mark across the bearing cap, adjusting screw and carrier on each side.



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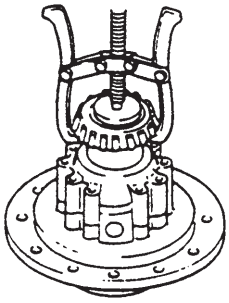
Removing bearing inner races

Use a bearing puller to remove the inner races from the differential case.



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REAR AXLE

Installation

To install, follow the reverse of removal sequence and do the following steps:

1. Adjusting bearing support clearances

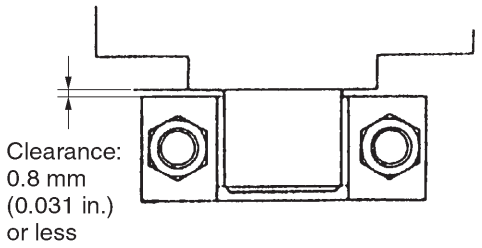
Adjusting the front and rear clearances by using thrust washers so that the total clearance becomes 0.8 mm (0.031 in.) or less.

NOTE

Insert thrust washers evenly.

Thrust washer type	0.8 mm (0.031 in.) 2.0 mm (0.078 in.)

FGC15K, FGC18K



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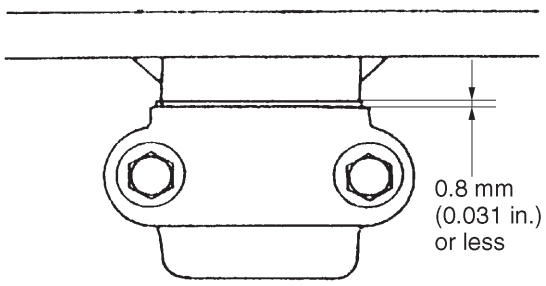
FGC20K, FGC20K HO, FGC25K, FGC25K HO, FGC30K



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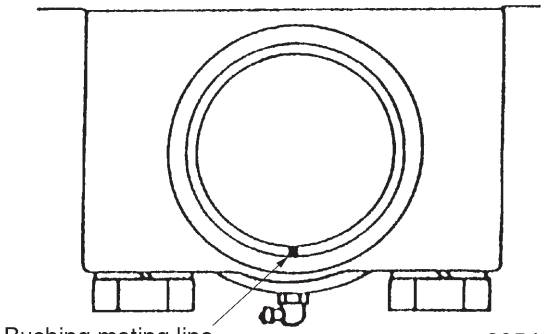
2. Removing support bushing

Do not remove the bushing in the support if acceptable.

If not replace the bushing together with the support assembly, or break and remove the bushing.

Assemble a new bushing so that the match mark faces downward (toward the grease nipple).



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3. Tightening bearing support

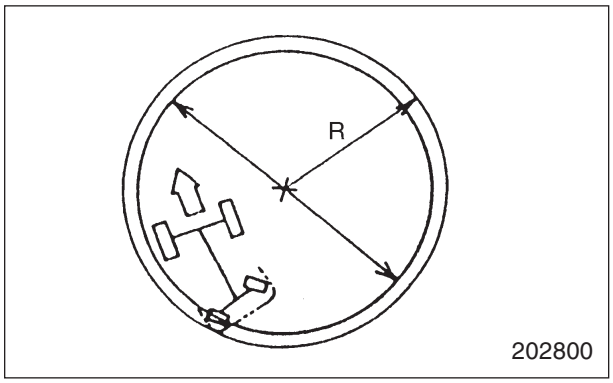
Tighten the bolts holding the bearing support to the specified torque.

Tightening torque for bearing support bolts	145 N·m (14.8 kgf·m) [107 lbf·ft]

Adjustment

Adjusting of Minimum Turning Radius

1. Measure the turn angle of the rear wheel by using a turning radius gauge.
2. If the turning angle is out of the specified range, adjust the angle by the stopper bolt with the knuckle.



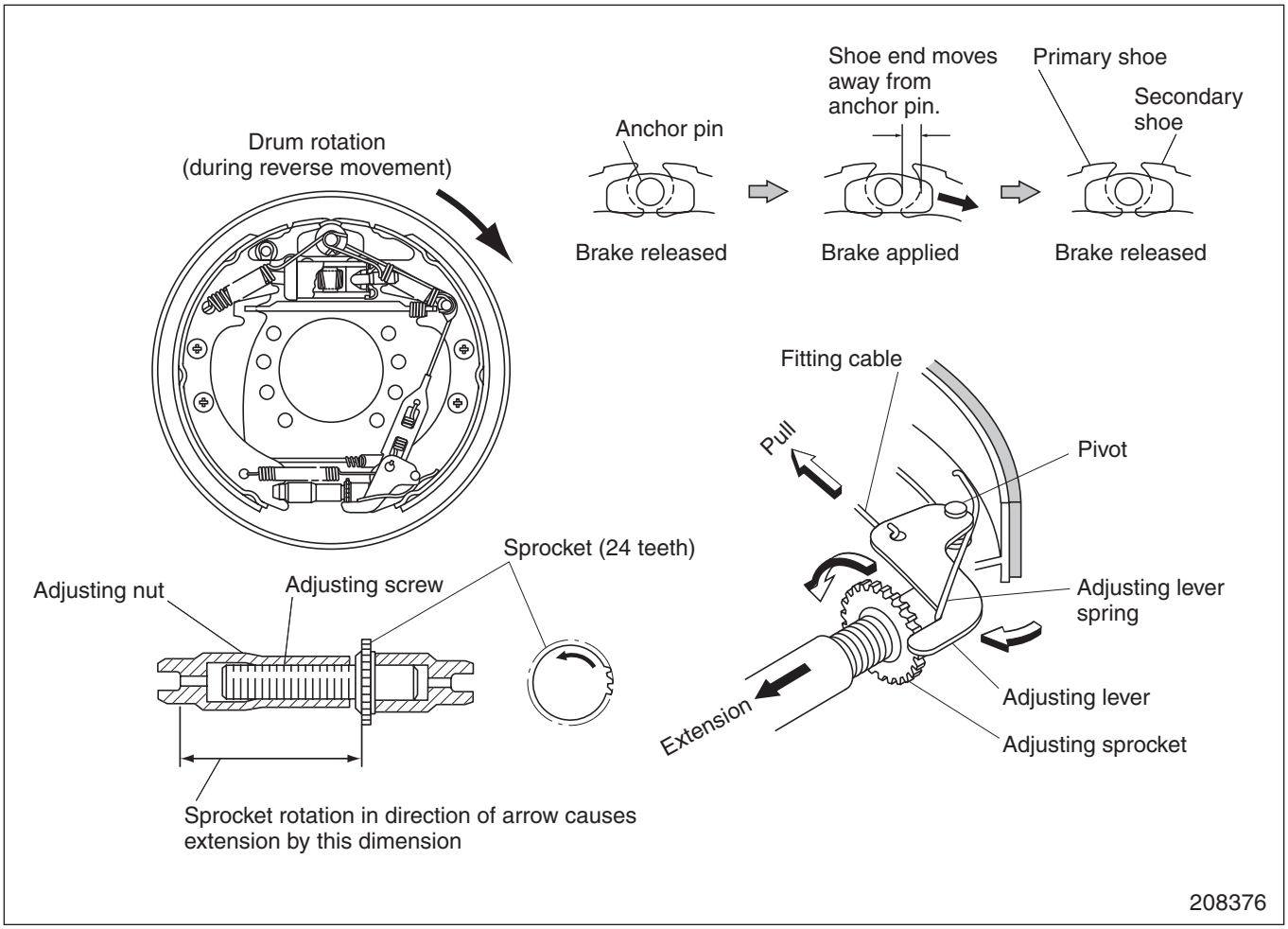
Item \ Truck Model		FGC15K FGC18K	FGC20K/20K HO FGC25K/25K HO FGC30K
Turning angle	Inside	82°	80°
	Outside	59°	55°
Tightening torque for knuckle stopper bolt lock nut		67 N·m (6.8 kgf·m) [49 lbf·ft]	

3. While driving the truck at low speed, turn the steering wheel fully in both directions, and check the diameter of the tire tracks at the outside of the rear wheel in both turning operations.
4. Minimum turning radius R is obtained from half of the turning diameter plus the length from the center of the rear tire to the outside edge of the counterweight.

Unit: mm (in.)

Truck Model	Minimum turning radius
FGC15K	1759 (69)
FGC18K	1787 (70.5)
FGC20K/20K HO	1945 (76.5)
FGC25K/25K HO	2002 (79)
FGC30K	2169 (85.5)

3. Automatic adjusting mechanism



The automatic adjusting mechanism maintains the correct lining-to-drum clearance of approximately 0.3 mm (0.012 in.). It can operate only when the brakes are applied during reverse movement of the truck. When the lining has worn approximately 0.01 mm (0.0004 in.), the adjusting sprocket turns by one tooth to recover a proper lining-to-drum clearance.

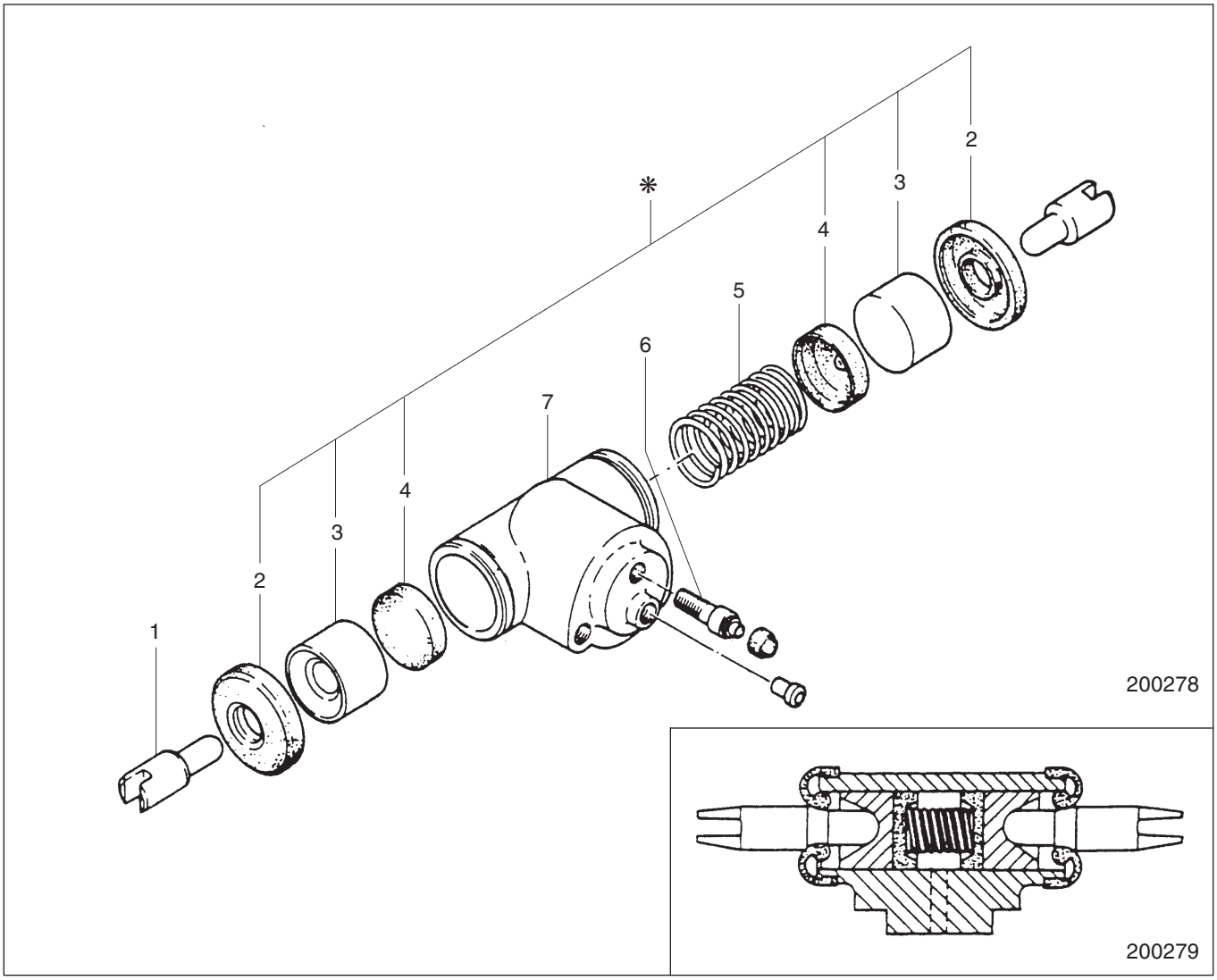
When the operator depresses the brake pedal with the lining-to-drum clearance excessively large, the top end of the secondary shoe moves away from the anchor pin. At this time, the fitting cable that runs from the anchor pin to the adjusting lever via the sheave on the secondary shoe is pulled upward, causing the adjusting lever to swing about its pivot. The edge of the adjusting lever thus turns the sprocket. The resulting increase in the adjuster's dimension causes the lining-to-drum clearance to decrease.

The adjusting mechanism does not operate while the lining-to-drum clearance is within the proper range.

The adjusting screw in the brake on an RH wheel has a right-handed thread, and the adjusting screw in the brake on an LH wheel has a left-handed thread.

Wheel Cylinders

Disassembly



Sequence

1 Connector link
2 Boots
3 Piston
4 Piston cup
5 Return spring
6 Bleeder screw and Cap
7 Cylinder body

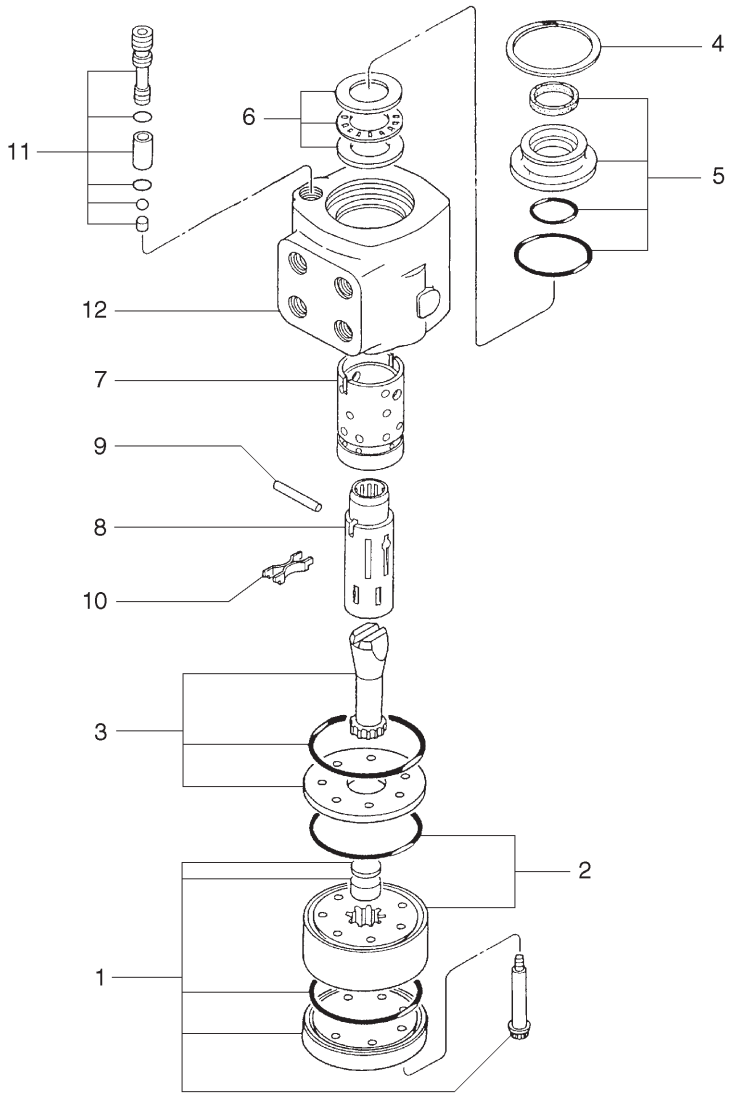
NOTE

The parts (✻) to be changed periodically are included in the Repair Kit.

STEERING SYSTEM

Steering Gear

Disassembly

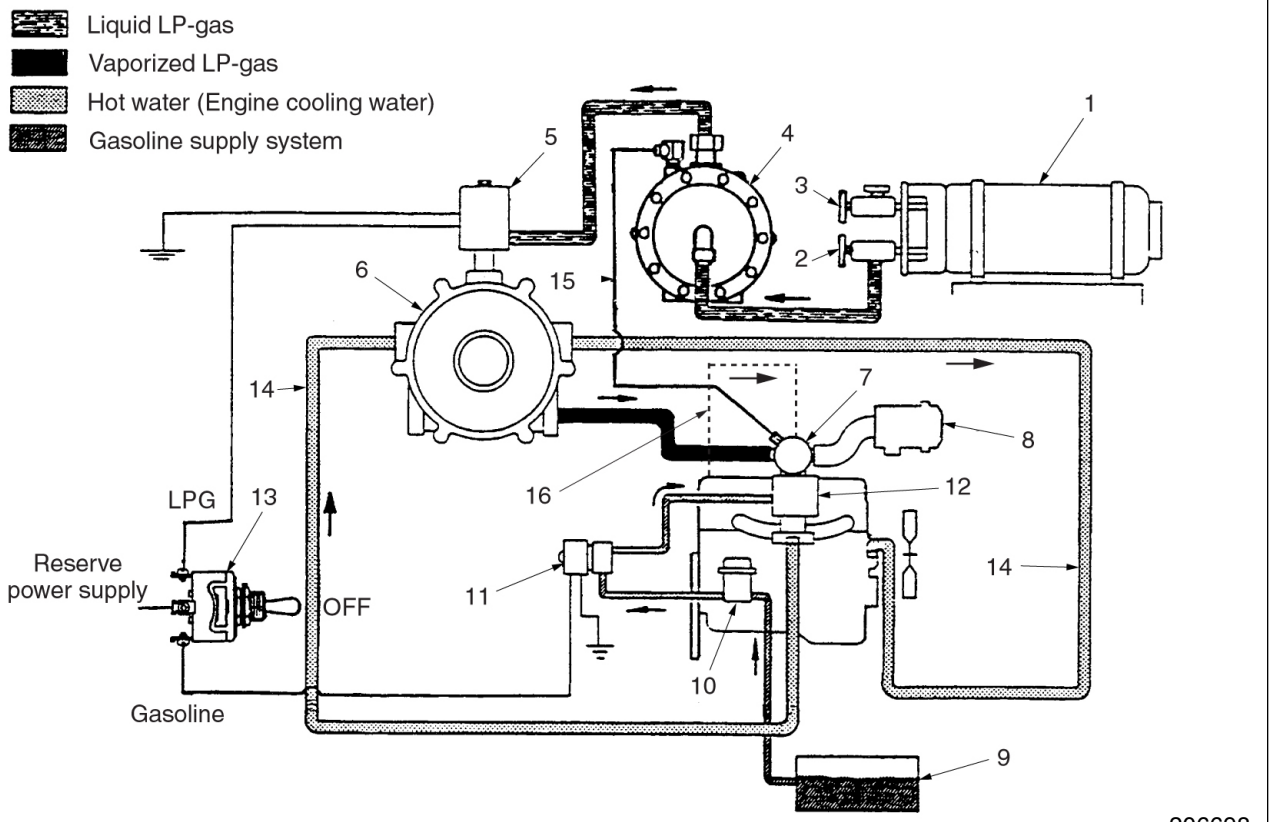


Sequence

1 End cap, Bolt, O-ring, Spacer
2 “Gerotor” set, O-ring
3 Drive shaft, Spacer plate, O-ring
4 Retaining ring
5 Seal gland bushing, O-ring, Oil seal, Dust seal
6 Thrust needle, Race bearing
7 Control sleeve
8 Control spool
9 Pin
10 Centering spring
11 Check valve, Retainer, Ball, O-ring, Check seat, Set screw
12 Long housing

Structure and Function

Outline of Dual Fuel Type



1	LP-gas tank	7	LP-gas carburetor	13	Gasoline/LPG selector switch
2	LP-gas charge valve	8	Air cleaner	14	Hot-water hose
3	LP-gas outlet valve	9	Gasoline tank	15	Vacuum hose
4	Vacuum fuel lock filter	10	Fuel pump	16	Blow-by hose
5	LP-gas solenoid valve	11	Gasoline solenoid valve		
6	Converter (vaporizer)	12	Gasoline carburetor		

The LP-gas device of the units with a “C” in the chassis serial number is comprised of components shown above.

Liquid LP-gas in the LP-gas tank located at the back side of the truck flows through the LP-gas outlet valve into the LP-gas hose. It then passes through the filter and LP-gas solenoid valve and reaches the converter.

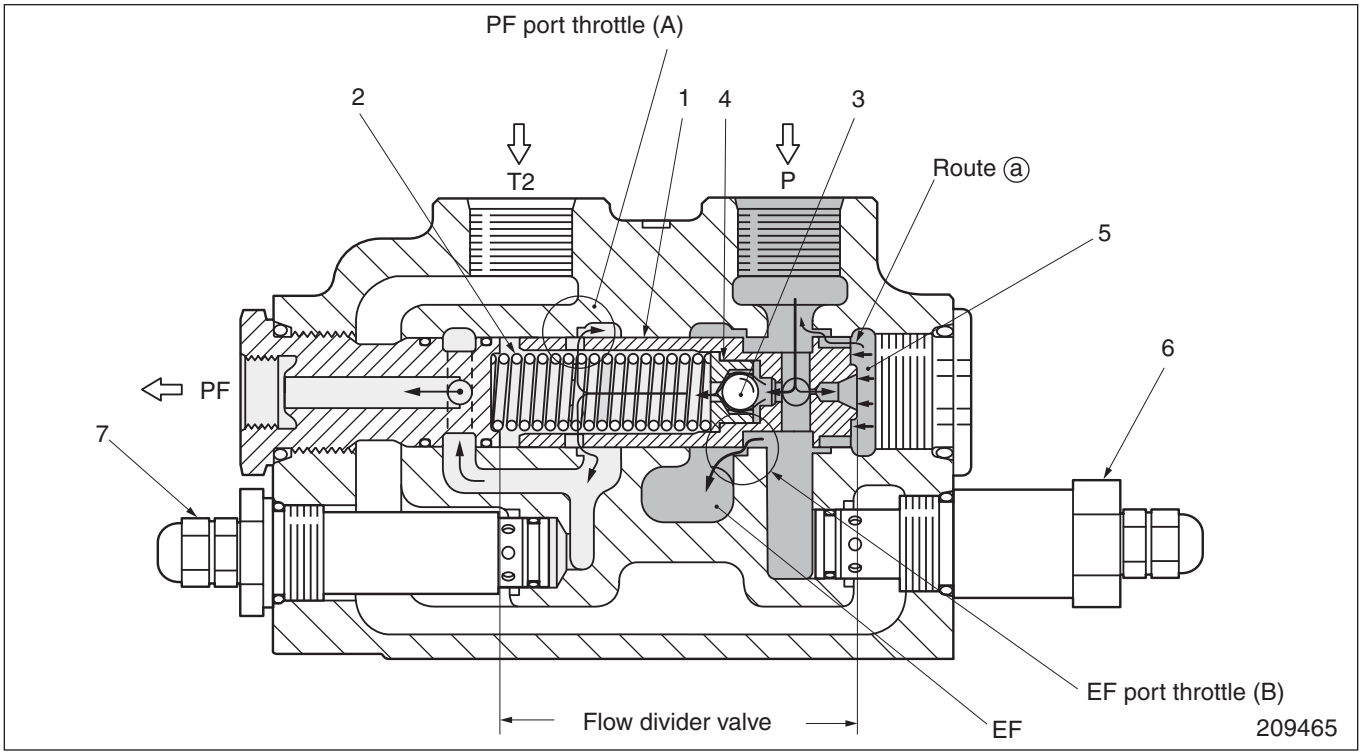
The converter vaporizes liquid LP-gas and reduces its pressure. The vaporized LP-gas mixes with air at the LP-gas carburetor and enters the engine.

A gasoline solenoid valve is provided between the fuel pump and gasoline carburetor. This valve is operated by the gasolin/LPG selector switch, and allows the use of either LP-gas or gasoline as fuel.

The converter is connected with hot-water hoses that circulate the engine cooling water (hot water). The converter uses the heat from this water to vaporixe LP-gas.

For further details, refer to the separate supplement to this manual entitled “LP-gas Supplement”

Inlet Section



1 Flow divider valve spool
2 Spring
3 Ball check
4 Ball retainer
5 Dumper chamber
6 Main relief valve
7 Steering system relief valve (flow divider relief valve)

P: From hydraulic pump (pressure oil)
PF: To steering gear
EF: To lift, tilt and attachment section
T2: From steering gear (return oil)

There are three valves inside the inlet section of the control valve: main relief valve 6 that limits the maximum pressure of the hydraulic system; flow divider valve that distributes pressure oil to the steering system with higher priority over the other systems; and steering system relief valve 7 that limits the maximum pressure of the oil to the steering system.

The flow divider valve ensures that the pump output oil is distributed preferentially and at a constant flow rate to the steering gear through the PF port and the excess oil is made flow through the EF port.

The illustration above shows the position of the flow divider valve spool 1 when the engine is operating at a mid-range speed (i.e., the pump delivery rate is medium). The oil from pump port P flows into the spring chamber through the four grooves formed in the inner surface (guide portion for ball check 3) of ball retainer 4. The oil then flows toward the steering gear through the PF port.

The oil passage to the steering system is always open except when a reverse flow occurs.

During truck operation, the port EF pressure and port PF pressure are always changing and so is the pressure difference between both ends of spool 1. (The spool moves right or left as the pressure difference changes.) The flow divider valve keeps the pressure difference between the spool ends by balancing the openings of the "PF port throttle (A)" and "EF port throttle (B)", thus keeping the flow rate of the PF port oil constant.

Ball check 3 works to close the passage only when a reverse flow of the PF port oil occurs.

Route ⓐ is provided for the purpose of preventing undesirable "kickback" effect that may occur during steering operation. Kickback can be effectively prevented by moving spool 1 toward the right quickly and smoothly. Route ⓐ enables the oil in chamber 5 to drain quickly and thus spool 1 to move fast to the right.

⚠ CAUTION

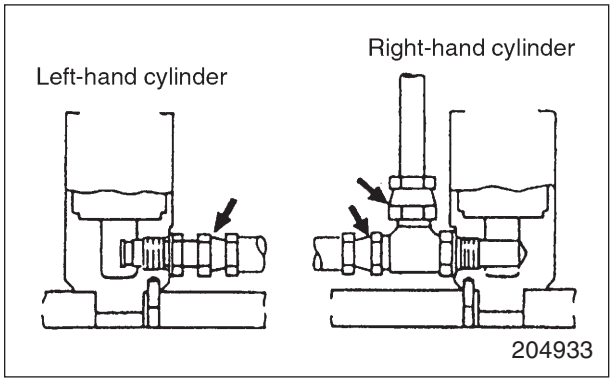
Be careful not to touch the lift control lever.

2. Lowering lift bracket

Lower the lift bracket by carefully operating the lift control lever.

3. Disconnecting high-pressure hoses

Disconnect the high-pressure hoses at the joints indicated by arrows. Use a container to catch oil flowing out of the hoses.

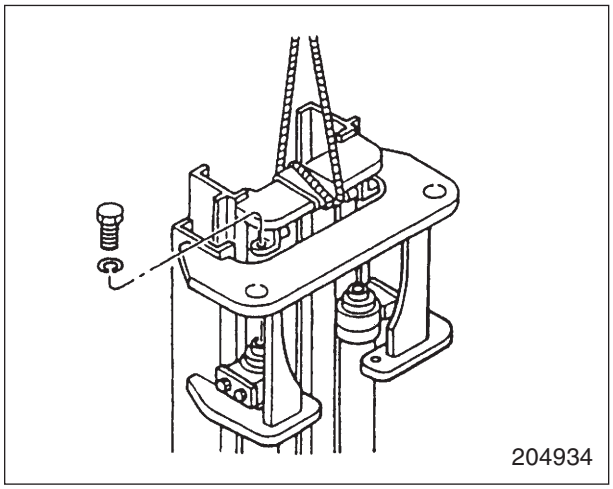


5. Removing set bolts

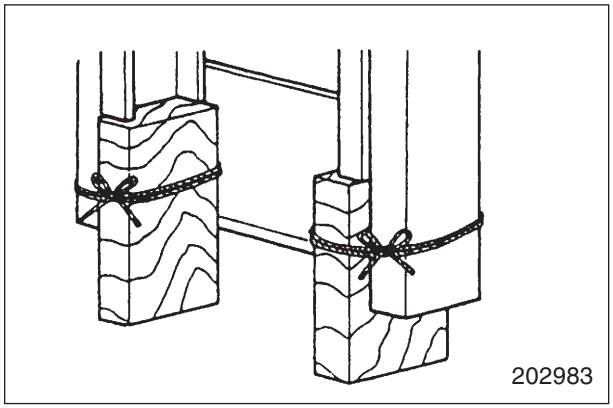
(1) Remove the set bolt at the top of each lift cylinder. Lift the inner mast to separate the cylinder rod ends. To lift the inner mast, clove-hitch a sling to the mast with protective wad.

NOTE

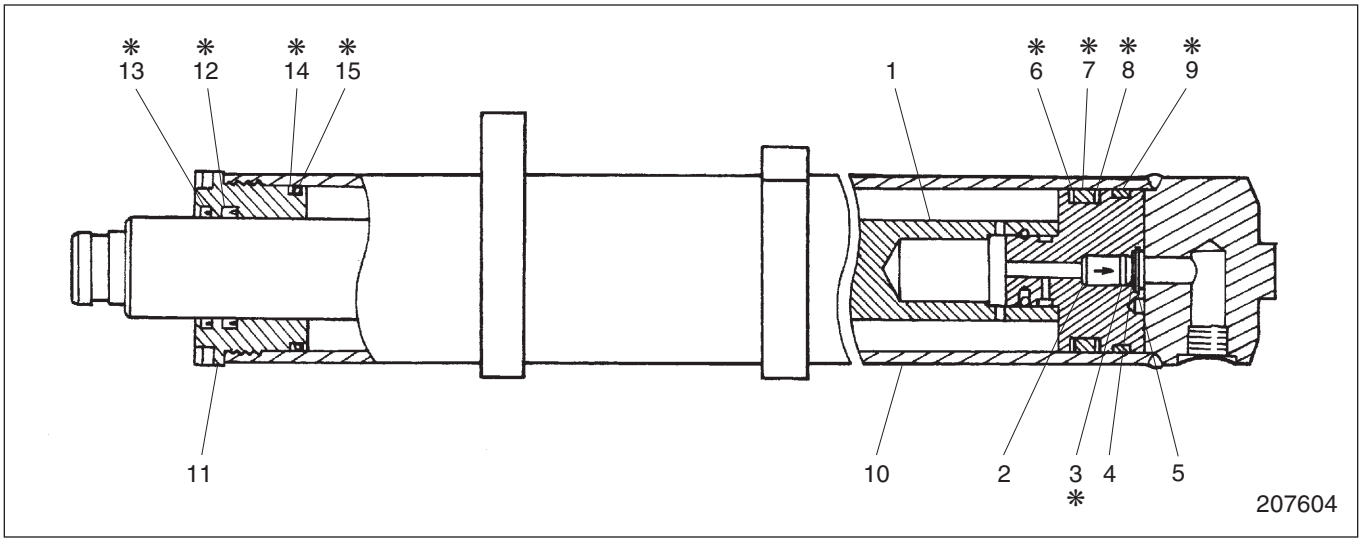
The rod end of either lift cylinder is shim adjusted to eliminate the difference in stroke between the cylinders. Before removing the stopper bolts, make a record of the amount of shims and a cylinder to which the shims are fitted.



(2) Place wood blocks under the inner mast and detach the sling. Use the blocks strong enough to support the mast.



Reassembly



Sequence

1 Piston rod, Piston

Install parts 2 through 9 to part 1.

2 Check valve
3 O-ring
4 Washer
5 Circlip
6 Nylon ring
7 Piston seal
8 Nylon ring
9 Wear ring
10 Cylinder tube
11 Retainer

Install parts 12 through 15 to part 11.

12 Rod seal
13 Wiper
14 Backup ring
15 O-ring

NOTE

Replacement parts marked with an asterisk (✻) are included in the seal kit.

Suggestions for Reassembly

1. Use all parts in the seal kit to replace removed parts.
2. After installing seal kit parts, apply hydraulic oil before installing to the cylinder tube or piston rod.
3. Fill the space between the cylinder tube and piston rod with the specified amount of hydraulic oil before installing the retainer.

Unit: cc (cu in.)

	FGC15K FGC18K	FGC20K FGC20K HO FGC25K FGC25K HO	FGC30K
Amount of hydraulic oil	70 to 80 (4.27 to 4.88)	85 to 90 (5.18 to 5.49)	125 to 130 (7.62 to 7.93)

4. Tighten the retainer to the specified torque.

Unit: N·m (kgf·m) [lbf·ft]

	FGC15K FGC18K	FGC20K FGC20K HO FGC25K FGC25K HO	FGC30K
Retainer tightening torque	305 to 370 (31 to 3.77) [225 to 275]	340 to 405 (34.7 to 41.3) [250 to 300]	440 to 475 (44.9 to 48.5) [325 to 350]

(3) If the setting is incorrect, loosen the lock nut of adjusting screw and, while observing the pressure gauge reading, slowly turn the adjusting screw in either direction until the gauge indicates the prescribed set value.

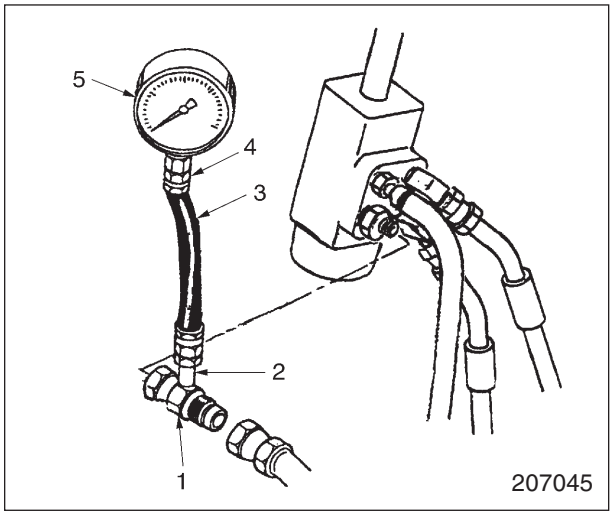
(4) While holding the adjusting screw, tighten the lock nut to secure the adjusting screw.

(5) After securing the adjusting screw, recheck the setting.

Main relief valve setting	18142 $^{+490}_{0}$ kPa (185 $^{+5}_{0}$ kgf/cm^2) [2631 $^{+71}_{0}$ psi]

4. Steering system relief valve adjustment

(1) Set up a pressure gauge capable of measuring up to 25000 kPa (250 kgf/cm^2) [3555 psi] as shown.



Special tools needed

No.	Tool Name	Tool No.
1	Connector	91268 - 06200
2	Connector	64309 - 17733 [R(PT)1/8 thread]
3	Hose	64309 - 17722
4	Connector	64309 - 17731 (for gauge)
5	Gauge	64309 - 17712 25000 kPa (250 kgf/cm^2) [3555 psi]

NOTE

(1) The tools 2 thru 5 are included in the gauge kit 64309 - 17701.

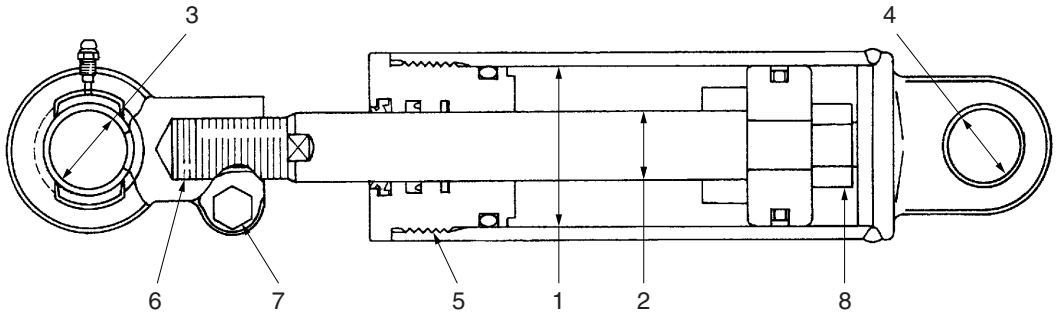
(2) Use the gauge included in this gauge kit.

(2) Start the engine. With the engine running at the maximum speed, turn the steering wheel counterclockwise to the lock, and check the flow divider valve setting.

A: Standard value B: Repair or service limit

Unit: mm (in.)

Item			Truck Model	FGC15K FGC18K	FGC20K FGC20K HO FGC25K FGC25K HO	FGC30K
Tilt cylinders	Inside diameter of cylinder tube 1		A	$63\ ^{+0.1}_{0}$ ($2.48\ ^{+0.004}_{0}$)	$70\ ^{+0.1}_{0}$ ($2.76\ ^{+0.004}_{0}$)	$80\ ^{+0.1}_{0}$ ($3.15\ ^{+0.004}_{0}$)
			B	63.12 (2.4850)	70.12 (2.7606)	80.12 (3.1543)
	[Guide bushing] Diameter of piston rod 2		A	$25\ ^{+0.045}_{+0.025}$ ($0.98\ ^{+0.0018}_{+0.0010}$)	$30\ ^{+0.045}_{+0.025}$ ($1.18\ ^{+0.0018}_{+0.0010}$)	$35\ ^{+0.04}_{+0.03}$ ($1.38\ ^{+0.0015}_{+0.0012}$)
	Inside diameter of tilt socket bushing (fitted) 3		A	$35\ ^{0}_{-0.012}$ ($1.38\ ^{0}_{-0.005}$)		
			B	35.5 (1.39)		
	Inside diameter of cylinder tube head bushing (fitted) 4		A	$32\ ^{+0.085}_{0}$ ($1.26\ ^{+0.0033}_{0}$)		
			B	32.6 (1.283)		
	[Guide bushing] Thread diameter 5		A	M68 × 2	M75 × 2	M85 × 2
	[Guide bushing] Tightening torque 5 N·m (kgf·m) [lbf·ft]		A	265 ± 29 (27 ± 3) [195 ± 21.7]	314 ± 31 (32 ± 3.2) [231 ± 23]	373 ± 37 (38 ± 3.8) [275 ± 27]
	[Tilt socket] Thread diameter 6		A	M24 × 1.5	M27 × 1.5	M30 × 1.5
	Tightening torque N·m (kgf·m) [lbf·ft]	Tilt socket bolt 7	A	127 to 152 (13 to 15.5) [94 to 112]		
		Self-locking nut 8	A	127 ± 9.8 (13 ± 1.0) [94 ± 7.2]	235 ± 19.6 (24 ± 2.0) [173 ± 14.4]	392 ± 25 (40 ± 2.5) [289 ± 18]



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Installation

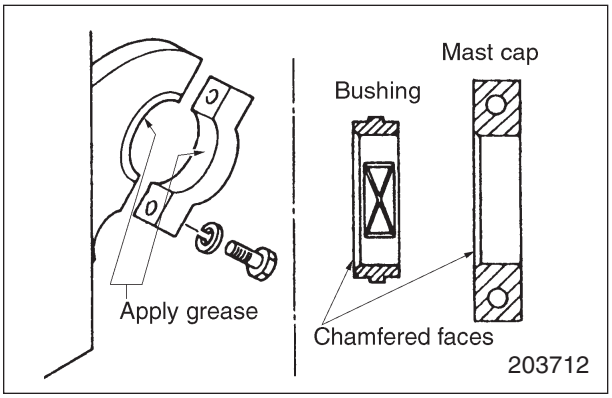
To install, follow the removal sequence in reverse, and service as follows.

1. Procedure for mounting mast support bushings and caps.

(1) Apply grease to the inner surfaces of caps and mast support bushings.

(2) Install mast support bushings and caps, making sure that the sides with larger chamfered area face toward the center of the vehicle.

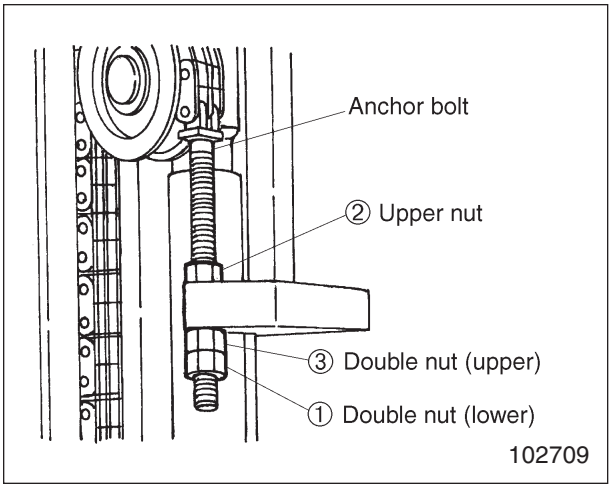
(3) Be sure to tighten the support tightening bolts securely.



2. Adjust the chain tensions.
   (Refer to the "Inspection and Adjustment" section.)

(1) Tighten the nuts to the specified torque.

Item \ Truck Model	FGC15K/18K FGC20K/25K	FGC30K
Upper nut ②	57 N·m (5.8 kgf·m) [42.0 lbf·ft]	84 N·m (8.6 kgf·m) [62.2 lbf·ft]
Double nut (lower) ①	98 N·m (10 kgf·m) [72.3 lbf·ft]	147 N·m (15.0 kgf·m) [108.5 lbf·ft]



(2) Make sure that the chain tension is correct with the mast in vertical (0°) position.

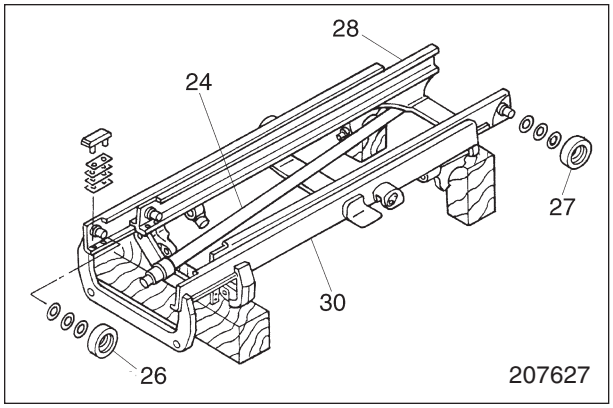
3. Air bleeding of lift cylinders

   Start the engine. Raise and lower the lift bracket over full stroke several times to bleed the cylinder.

4. After proper operation is confirmed, check the oil level.

4. Removing main rollers 26, 27 from middle mast 28 and outer mast 30

   Remove the bolts that are holding second lift cylinders 24. Place the cylinder rod ends on the outer mast. Lower middle mast 28 until main rollers 26, 27 can be removed. Then, remove the main rollers.



Inspection after Disassembly (All Mast Models)

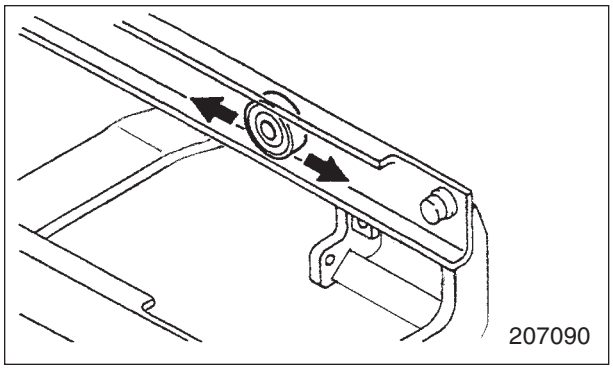
1. Mast

(1) Check each roller for wear, binding or other defects.

(2) Check each roller on rolling surface for pitting or other defects.

(3) Check the mast member and the welded joints of crossmembers, shafts and supports for cracks.

(4) Check the mast support bushings for wear or other defects.



2. Lift bracket

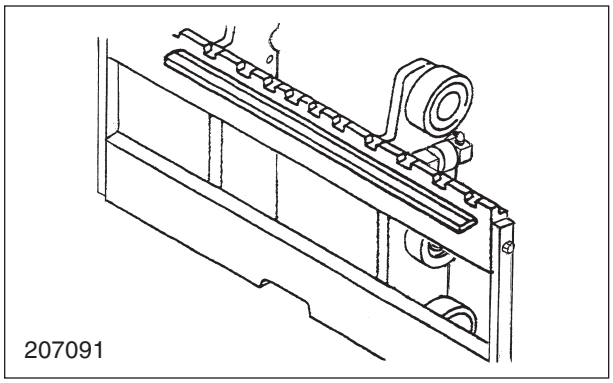
(1) Check the main rollers and side rollers for smooth rotation. Inspect each roller for wear and cracks.

(2) Check the welded portions of the bracket for cracks.

(3) Check the finger bar for bend or distortion.

A: Standard value
Unit: mm (in.)

Distortion of finger bar	A	5 (0.19) or less



3. Lift chains, chain wheels and chain wheel supports

(1) Measure the length of each chain to make sure that two chains are equal in length. Also check the chains for wear, indication of breakage, link binding and twist.

(2) Check each chain anchor bolt for cracks or defects on the threads.

(3) Check each chain wheel support and chain wheel for cracks or wear. Check that the wheels rotate smoothly.

Length of lift chain (per 20 links)

A: Standard value B: Repair or service limit
Unit: mm (in.)

	FGC15K FGC18K	FGC20K FGC20K HO FGC25K FGC25K HO	FGC30K
A	318 (12.52)	381 (15.00)	508 (20.00)
B	327 (12.87)	392 (15.43)	523 (20.59)

4. Mast strips

Check the mast strips for damage, wear or distortion.

Removal/Installation of Mast Rollers and Mast Strips without Removing Mast from Truck

Simplex mast

The mast rollers and mast strips can be removed/installed when the inner mast is lowered until it is below the outer mast. Follow the steps described below.

1. Separate the lift bracket from the mast.

NOTE

For lift bracket separating procedure, refer to "Removing lift bracket" on page 12-6.

2. Position the inner mast lower than the outer mast as follows:

(1) Raise the front end of the truck, and support that end with block or the like.

(2) Remove the upper set bolts from the lift cylinders, and lift the inner mast with a hoist. Remove the hose guard.

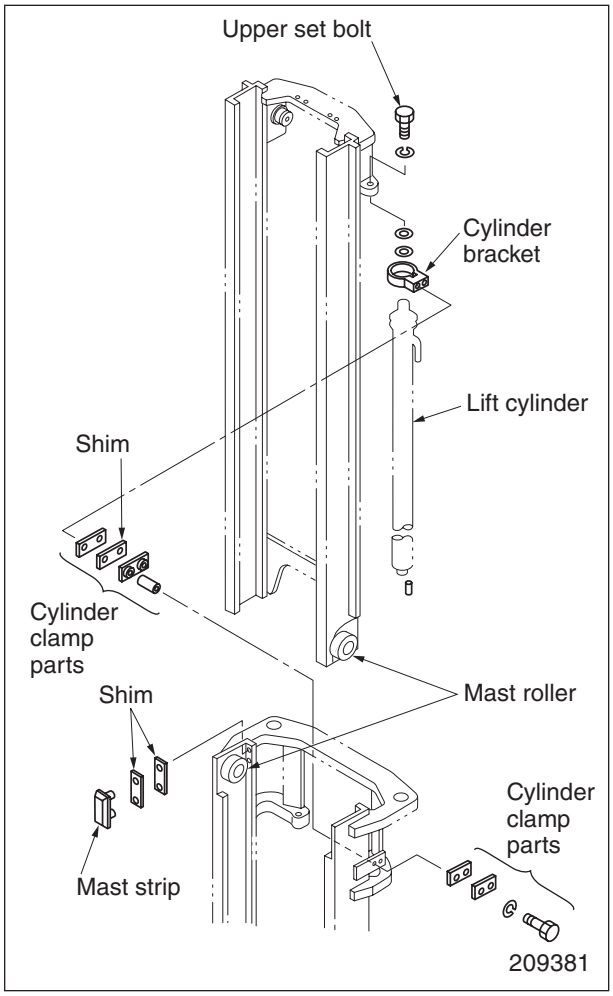
(3) Remove the clamps from the lift cylinders. Pull out the bottom ends of the cylinders from the outer mast, tilt the cylinders to the center of the mast, and tie them to the cross-member of outer mast with rope.

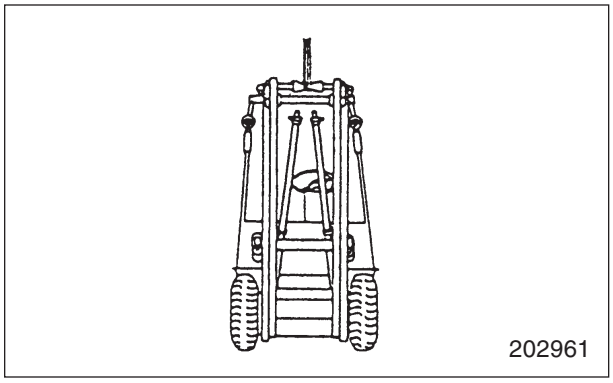
(4) Slowly lower the inner mast until it comes in contact with the lift cylinders.

(5) Now the main rollers can be removed from the inner and outer masts. Remove the mast strips and shims in advance because they are apt to come off under this condition.

3. Perform clearance adjustment of the removed rollers using shims, replacement of rollers, and/or clearance adjustment of the mast strips as necessary.

• Reassemble the mast by following the removal procedure in reverse.



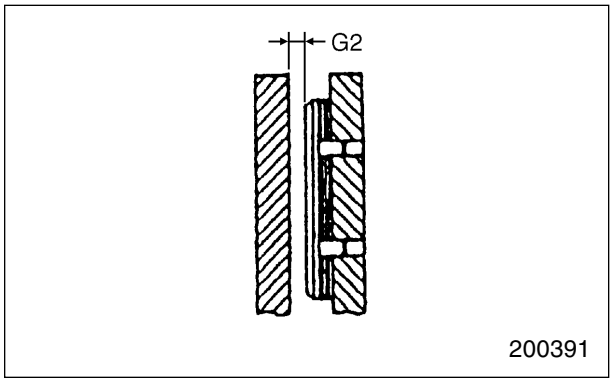


Mast Strip Clearance, Inspection and Adjustment

1. Check the clearance G2 with the clearance between the outer mast rollers and inner mast set to zero (0) in maximum lift position.

Clearance G2	0.1 to 0.5 mm (0.004 to 0.020 in.)

2. If clearance G2 is out of specification, remove upper mast roller (refer to "Removing mast rollers"). Remove mast strip and adjust the clearance. For adjustment procedure, refer to "Measuring and adjusting clearance G2 between mast strip and inner mast" on page 12-23.
3. After adjusting all of the clearance, move the mast and lift bracket slowly to make sure that they move smoothly through their full stroke.



Tilt Angle Adjustment

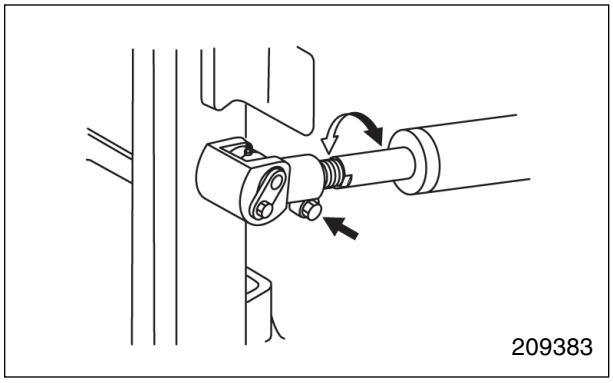
1. Park the truck on a level ground.
2. Tilt the mast fully backward and stop the engine.
3. Measure the backward tilt angle of the mast at both sides.
4. To adjust the tilt angle, loosen the bolt of tilt cylinder socket, and adjust the rod length by turning the rod. Adjust cylinder so that there is no difference in stroke tilt angle between the cylinders, right and left.

NOTE

It is not necessary to adjust the forward tilt angle if the backward tilt angle is properly adjusted.

5. After adjusting the tilt angle, tighten the socket bolts to the specified torque.

Tightening torque for tilt cylinder socket bolt	127 to 152 N·m (13 to 15 kgf·m) [94 to 108 lbf·ft]



Tilt angles

Mast Models	Forward	Backward
Simplex mast		
3A15B28, 30 & 33	5°	10°
3A15B37	5°	6°
3A25B20	5°	6°
3A25B28, 30 & 33	5°	10°
3A25B37 & 41	5°	6°
3A30B30, 33, 37 & 40	5°	6°
Duplex mast		
3B15C28, 30 & 33	5°	10°
3B25C28, 30 & 33	5°	10°
3B30C28 & 33	5°	6°
Triplex mast		
3C15C43, 48, 51 & 55	5°	6°
3C25C43, 48, 51 & 55	5°	6°
3C30C43, 47, 51 & 55	5°	6°

Inspection point		How to check	Intervals					Service data
			Daily (pre-start)	Every 50 hours or weekly	Every 200 hours or monthly	Every 1200 hours or 6 months	Every 2400 hours or 1 year	
Front axle	Cracks, distortion or other defects	Dye check/ visual					○	
	Front wheel bearings — preload	Spring scale						Hub bearings preload 0.5 to 4.9 N·m (5 to 50 kgf·cm) [0.4 to 3.6 lbf·ft]
	Fore-aft play	Test					○	
	Cracks, distortion or other defects	Visual					○	
Differential	Oil leaks	Visual	○					
	Oil level	Visual			○			FGC15K/18K: 4.2 liters [1.1 U.S. gal.] FGC20K/25K/30K: 5 liters [1.3 U.S. gal.]
	Mounting bolts	Torque wrench					○	
Rear axle	Rear wheel bearings — preload	Spring scale/ torque wrench						Hub bearing preload: 2.5 to 6.4 N·m (25 to 65 kgf·cm) [2.5 to 6.4 lbf·ft] Lock nut (outside) 157 N·m (16 kgf·cm) [116 lbf·ft]
Wheels	Tires — cuts or gouges	Visual	○					
	Tires — wear	Depth gauge	○					
	Tires — imbedded objects	Visual	○					
	Wheel nuts — tightness	Torque wrench			○			
		<table><tr><th>Item \ Truck Model</th><th>FGC15K FGC18K</th><th>FGC20K FGC25K FGC30K</th></tr><tr><td>Front wheel nuts</td><td>157 N·m (16 kgf·cm) [116 lbf·ft]</td><td>378 N·m (38.5 kgf·cm) [278 lbf·ft]</td></tr></table>						
	Rims — damage	Visual	○					
Hydraulic tank	Oil leaks	Visual	○				⊗	
	Oil level and contamination	Visual		○				
	Strainer — clogging	Visual					⊗	
	Return filter — clogging	Visual					⊗	

Fuel Information

Use only fuel as recommended in this section.

◆ Gasoline (Gas) specifications

You truck must use unleaded gasoline only.

Oxygenated gasoline

Some gasolines sold at service stations contain oxygenates such as ethanol, methanol, and MTBE (Methyl Tertlary Butyl Ether), although they may not to be so identified. The use of fuels containing oxygenates is not recommended unless the nature of the blend can determined as being satisfactory.

Ethanol (Gasohol)

A mixture of 10% ethanol (grain alcohol) and 90% unleaded gasoline may be used in you truck provided the octane rating is at lease as least as that recommended for unleaded gasoline.

Methanol

Do not operate you truck on gasoline containing methanol (wood alcohol). The use of this type of alcohol can result in truck performance problems and could damage critical fuel system parts.

MTBE (Methyl Tertlary Butyl Ether)

A mixture of 15% or less MTBE and unleaded gasoline may be used in you truck provided the octane rating is at least as high as that recommended for unleaded gasoline.

NOTE

If you experience driving problems which you suspect are fuel related, try switching to a different fuel.

◆ Liquified petroleum (LP-Gas) specifications

Use grade HD5 LPB. LP-gas is a highly volatile fuel with an octane rating of 100 to 140. Follow local ordinances regarding storage and/or filling of LP-gas tanks.

Unit: mm (in.)

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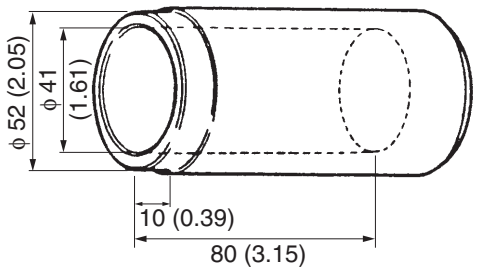

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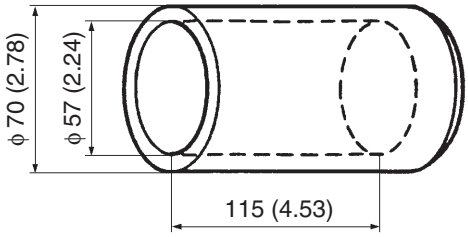

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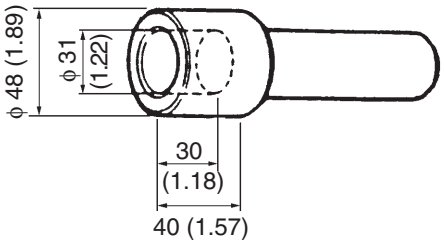

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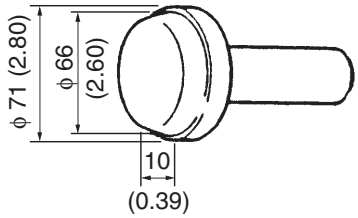

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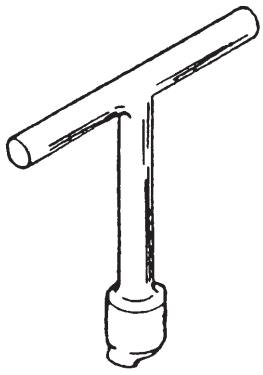

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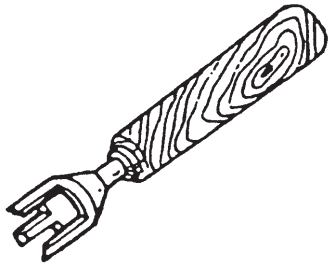

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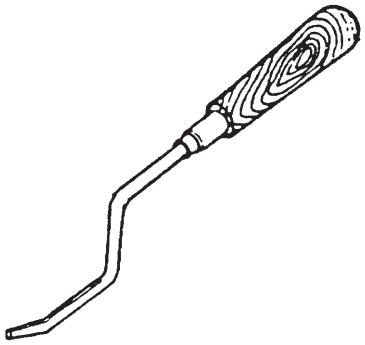

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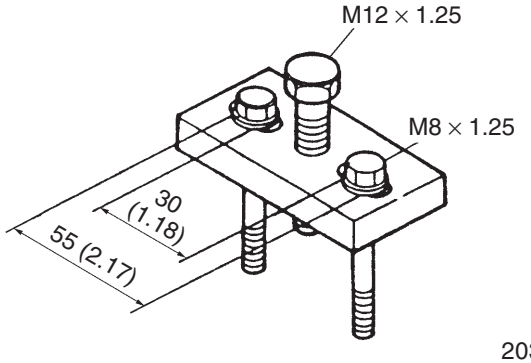

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FOREWORD

This service manual has instructions and procedures for the 4G63 and 4G64 gasoline engines. The information, specifications, and illustrations used in this manual are based on information that was current at the time this issue was written.

Correct servicing will give the engines a long productive life. Before attempting to start a test, repair or rebuild job, be sure that you have studied the respective sections of this manual, and know all the components you will work on.

Continuing advancement and improvement of product design may have caused changes to your engines which are not included in this manual.

Whenever a question arises regarding your engines, or this manual, please consult your dealer for the latest available information.

WARNING INDICATION

NOTE

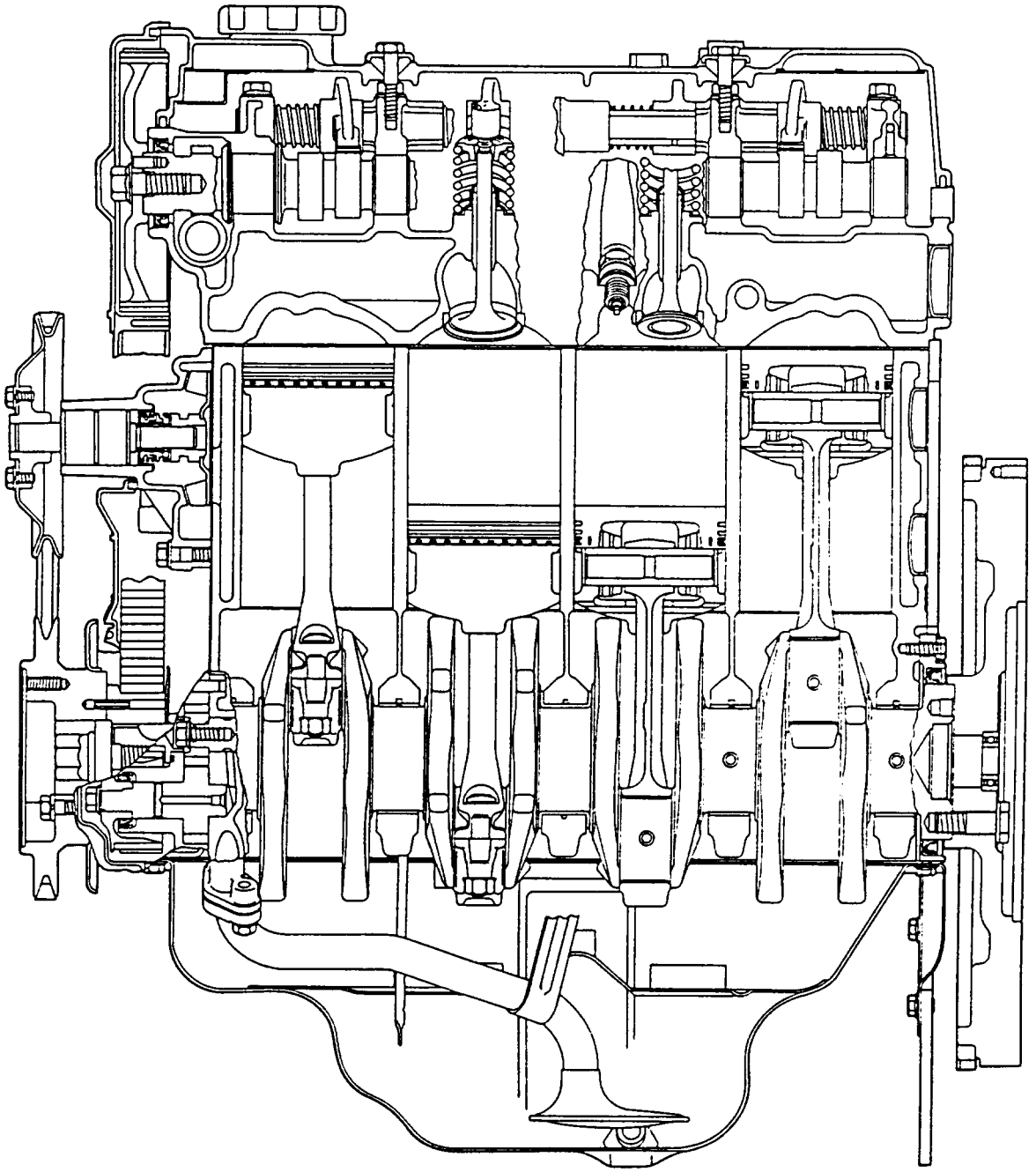
Indicates supplementary explanation.

CAUTION

Indicates items that users must always observe in order to prevent injuries and damage to the vehicle and surrounding area.

Pub. No. 99729-84120

4G63 SIDE CUTAWAY VIEW



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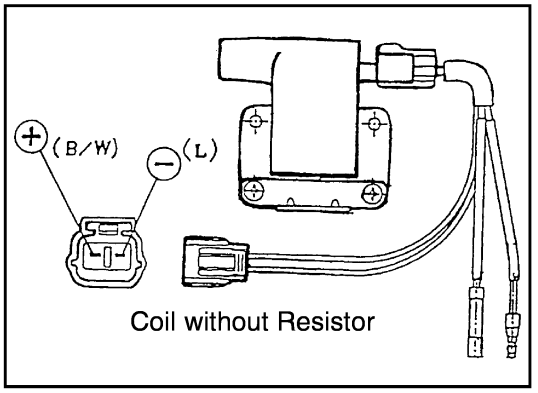
Note

All special tool part numbers beginning with MCF- can be found in your new dealer service tool and equipment catalog/manual. This catalog contains a wide assortment of tool and equipment used to service your forklift truck. Information on ordering, warranty and repair will be covered in this service tool and equipment manual. MCF-5000. For tool information on part numbers beginning with MCF, contact SPX/OTC service tools department at 1-800-533-0492.

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



Coil without Resistor

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

Standard values:

Primary coil resistance value:	1.08 to 1.32Ω
Secondary coil resistance value:	22.1 to 29.9Ω
External resistor resistance value:	1.22 to 1.48Ω

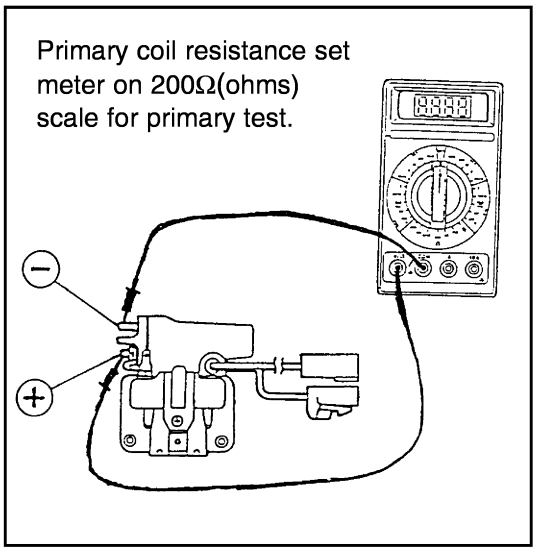
Standard values:

Primary coil resistance value:	1.08 to 1.32Ω
Secondary coil resistance value:	22.1 to 29.9Ω

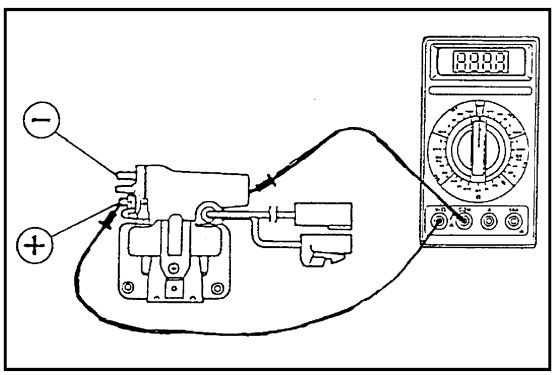
Ignition Coil Testing with External Resistor

Standard values:

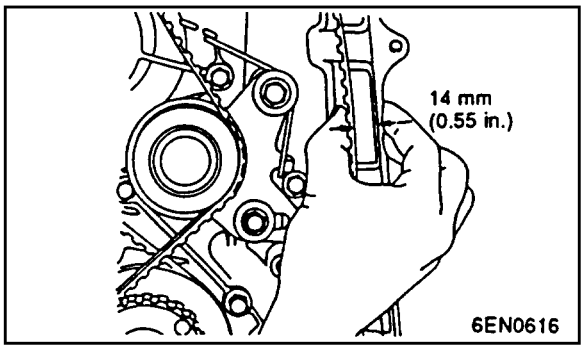
Primary coil resistance value:	1.08 to 1.32Ω
Secondary coil resistance value:	22.1 to 29.9Ω



(1) Set the primary coil resistance meter on 200Ω scale for primary test.

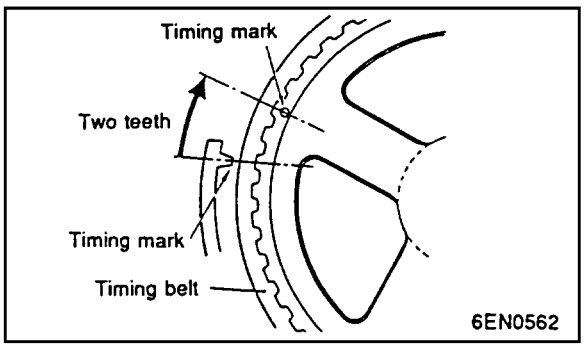


(2) Set the secondary coil resistance meter on 200 kΩ scale for secondary test.



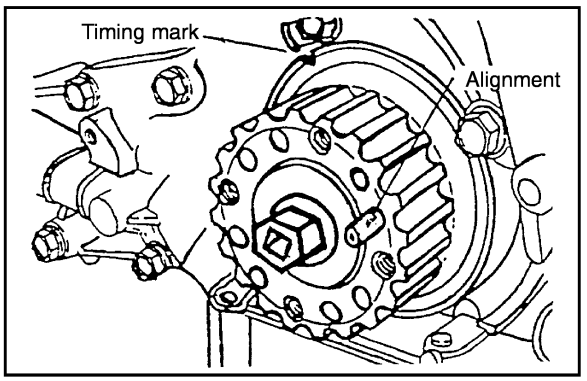
(9) Hold the center of the tension side span of the timing belt (between the camshaft and the pump sprockets) between your thumb and index finger as shown. Make sure the clearance between the belt back surface and cover meets the standard value.

Standard Value: 14 mm (0.55 in.)



(10) Loosen a turn or two the tensioner bolt and nut that was temporarily tightened to hold the tensioner on the water pump side. This gives tension to the belt by the action of the tensioner spring.

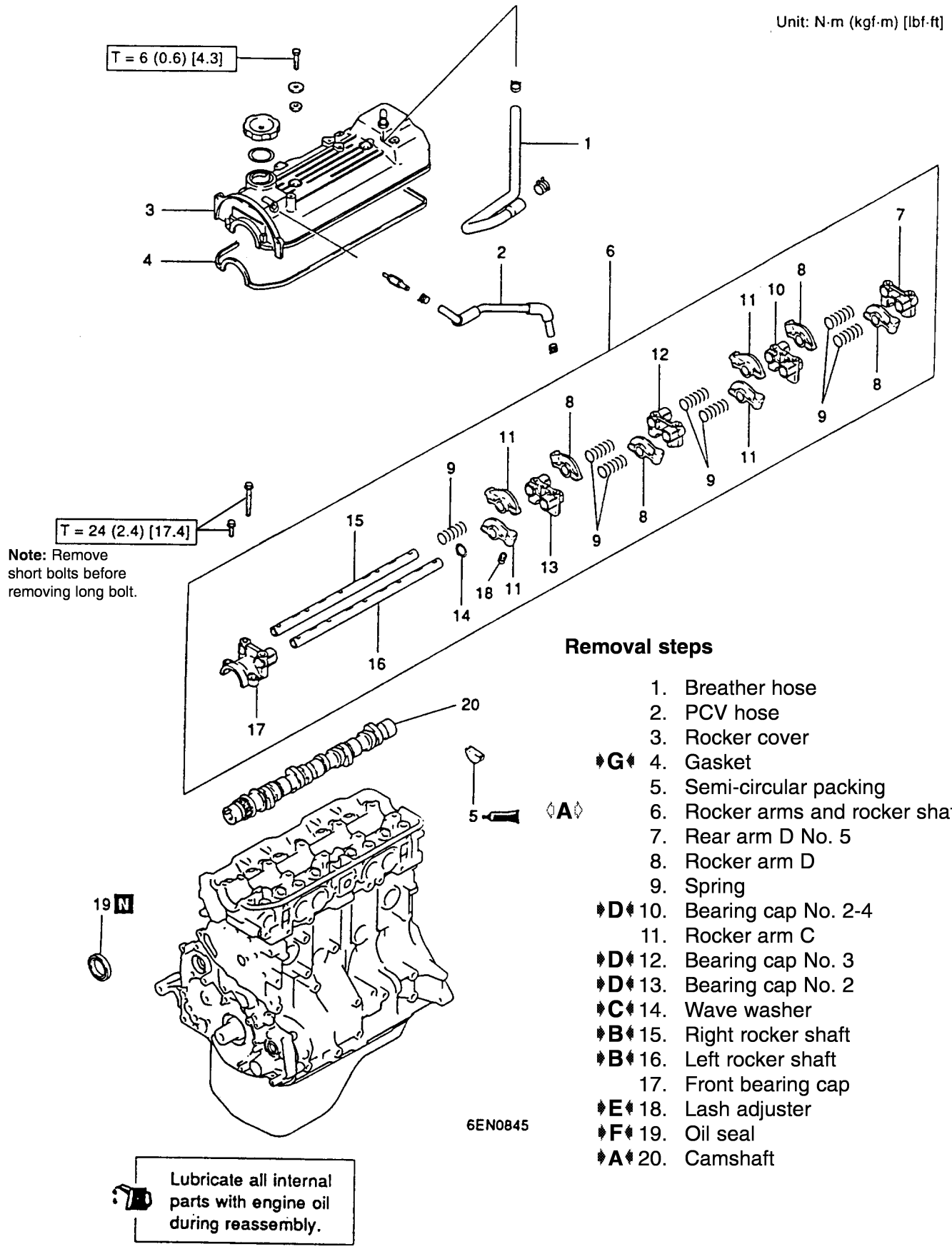
(11) Rotate the crankshaft by the amount equivalent to two camshaft sprocket teeth in the forward (clockwise) direction. Since this step is intended to give the timing belt proper tension, do not attempt to rotate the crankshaft in the reverse (counterclockwise) direction or press the belt to check the tension.



E Crankshaft pulley installation

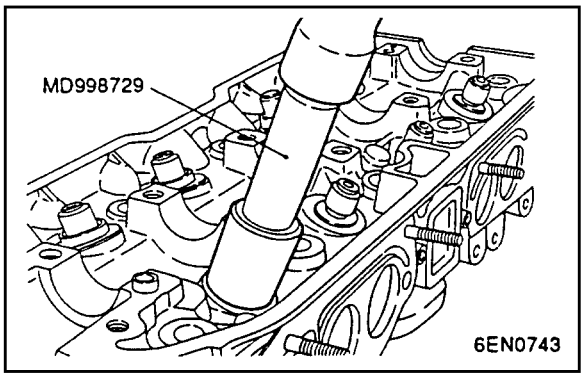
(1) Make sure that the alignment pin in the crankshaft sprocket is not missing and in good condition before installing the crankshaft pulley. The pulley must be installed correctly on the alignment pin and the crankshaft sprocket. This will ensure that the timing mark on the pulley will be in the correct location with the timing mark on the front cover.

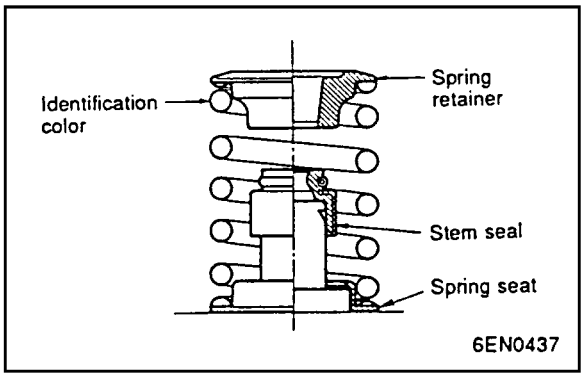
REMOVAL AND INSTALLATION

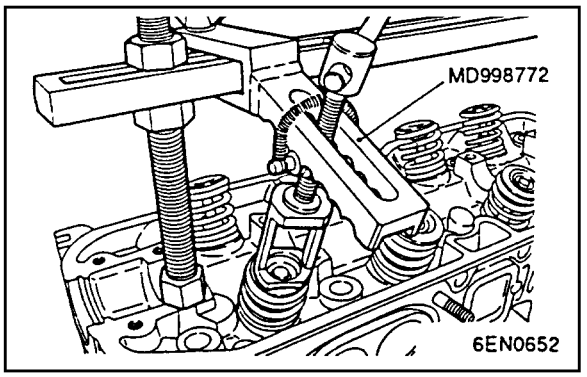


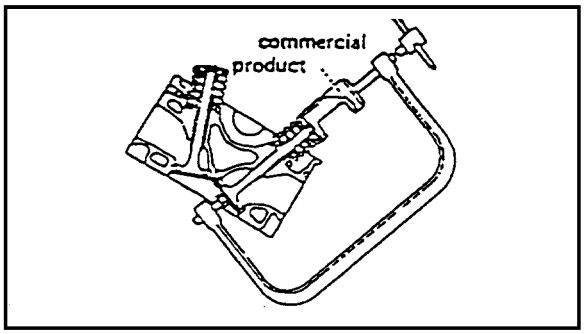
Removal steps

1. Breather hose
2. PCV hose
3. Rocker cover
◆G◆ 4. Gasket
5. Semi-circular packing
6. Rocker arms and rocker shaft
7. Rear arm D No. 5
8. Rocker arm D
9. Spring
◆D◆ 10. Bearing cap No. 2-4
11. Rocker arm C
◆D◆ 12. Bearing cap No. 3
◆D◆ 13. Bearing cap No. 2
◆C◆ 14. Wave washer
◆B◆ 15. Right rocker shaft
◆B◆ 16. Left rocker shaft
17. Front bearing cap
◆E◆ 18. Lash adjuster
◆F◆ 19. Oil seal
◆A◆ 20. Camshaft









INSTALLATION SERVICE POINTS

◆A◆ Valve stem seal installation

(1) Install the valve spring seat.

(2) Using special tool, install the new valve stem seal to the valve guide.

CAUTION

Do not reuse removed valve stem seal. The special tool must be used to install the valve stem seal. Improper installation could result in oil leaking past the valve guide.

◆B◆ Valve spring installation

(1) Direct the valve spring end with identification color toward the rocker arm.

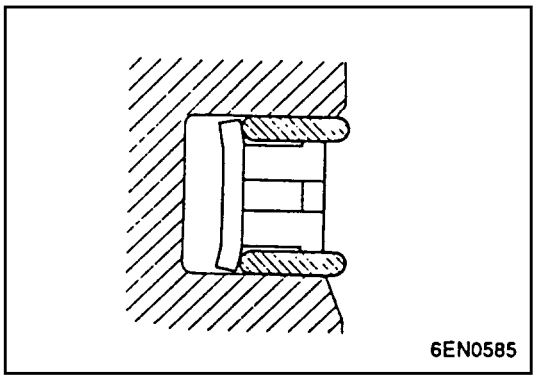
(2) Do not mix valve spring colors on intake or exhaust valves.

◆C◆ Retainer lock installation

When installing the retainer lock, compress the valve spring using a special tool for valve spring compressor or equivalent.

CAUTION

To prevent the retainer bottom from coming into contact with the stem seal and damaging it, do not compress the spring excessively.

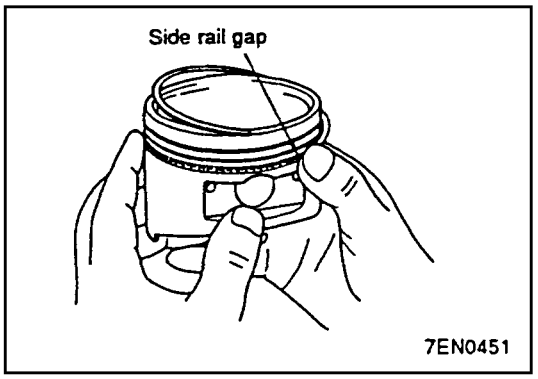


◆B◆ Oil ring installation

(1) Fit the oil ring spacer into the piston ring groove. First, install the upper side rail, and then install the lower side rail.

NOTE
The side rails and spacer may be installed in either direction. The new spacers and side rails are painted in the following colors to identify their sizes.

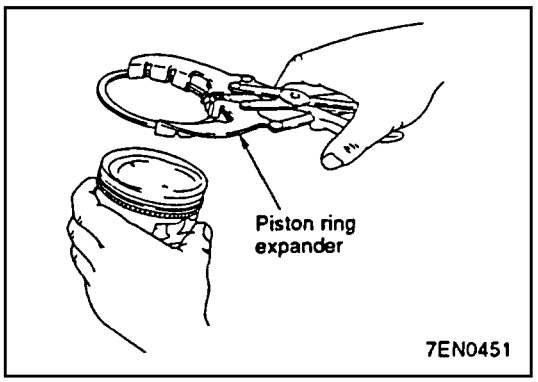
Size	Identification color
STD	No color
0.25 mm	No color
0.50 mm (0.0197 in.) O.S.	Blue
0.75 mm	No color
1.00 mm (0.0394 in.) O.S.	Yellow



(2) To install the side rail, first fit one end of the rail into the piston groove, then press the remaining portion into position. See illustration.

CAUTION
The side rail could be broken if it is expanded with a piston ring expander in the same way as with a compression ring.

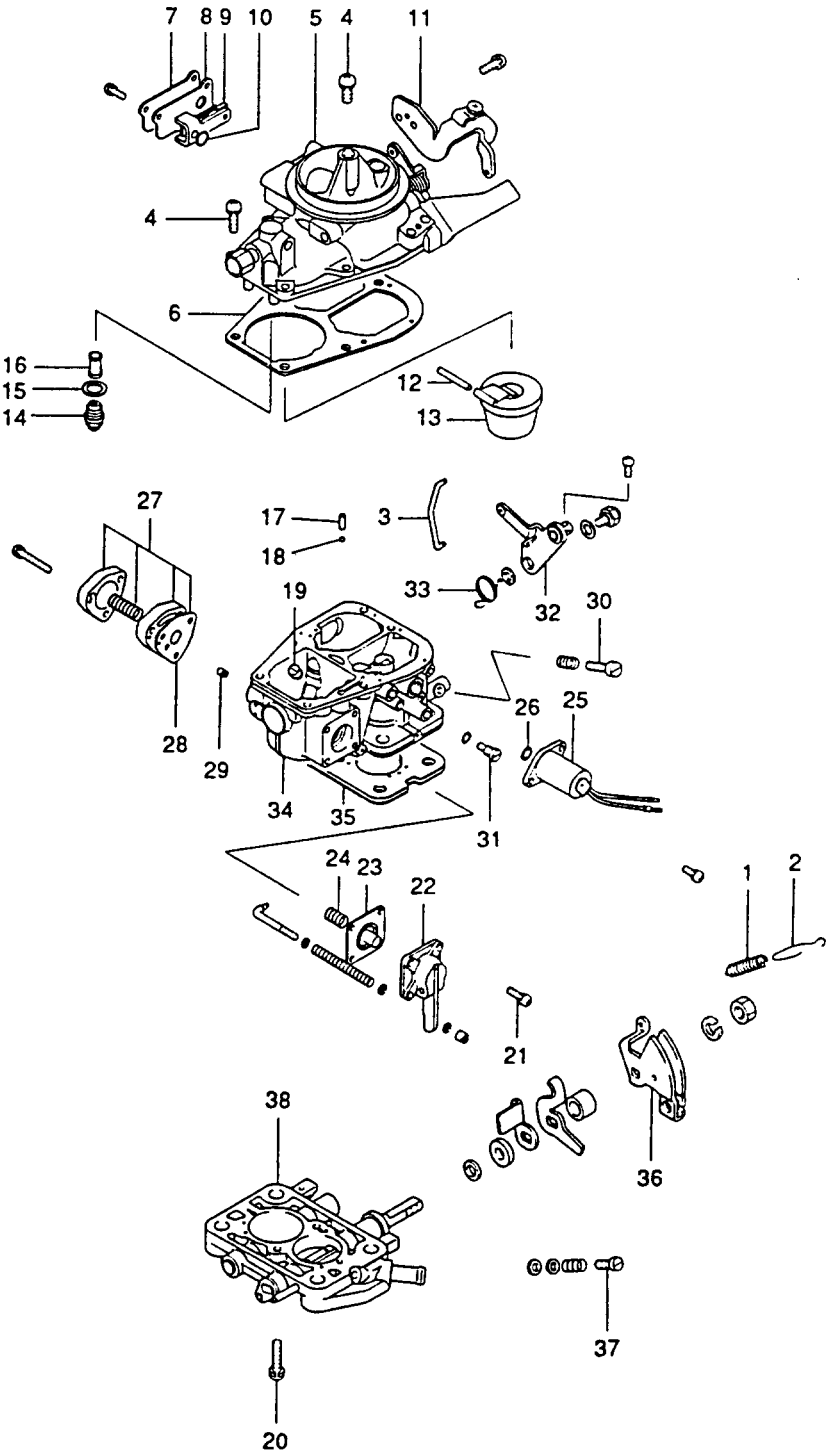
(3) Make sure that the side rails move smoothly in either direction.



◆C◆ Piston ring No. 2/piston ring No. 1 installation

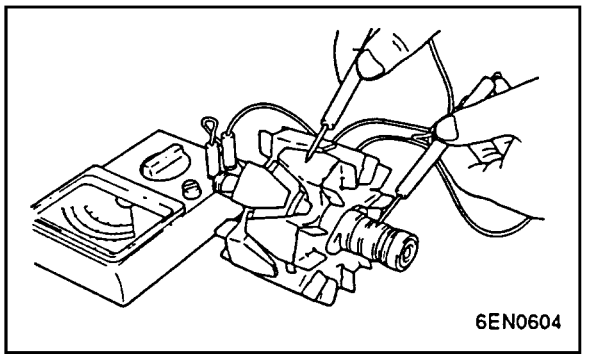
(1) Using piston ring expander, fit No. 2 and then No. 1 piston ring into position.

DISASSEMBLY AND REASSEMBLY

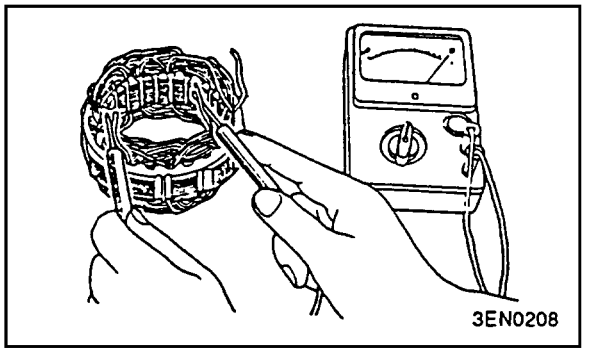


Disassembly steps

- ◊A◊ 1. Throttle return spring
- 2. Damper spring
- ◊A◊ 3. Choke rod
- 4. Screw
- ◊B◊ 5. Float chamber cover
- 6. Float chamber cover gasket
- 7. Cover
- 8. Packing
- 9. Bimetal
- 10. O-ring
- 11. Accelerator wire bracket
- ◗C◖ 12. Float pin
- ◗C◖ 13. Float
- 14. Needle valve assembly
- 15. Packing
- 16. Filter
- ◊C◊ ◗B◖ 17. Weight
- ◊C◊ ◗B◖ 18. Ball
- ◊D◊ ◗A◖ 19. Main jet
- 20. Screw
- 21. Screw
- 22. Accelerator pump cover
- 23. Diaphragm
- 24. Spring
- 25. Fuel cut solenoid
- 26. O-ring
- 27. Enrichment
- 28. Packing
- 29. Enrichment jet
- 30. Speed adjust screw (SAS)
- 31. Pilot jet
- 32. Choke lever
- 33. Spring
- 34. Main body
- 35. Insulator gasket
- 36. Throttle lever
- 37. Mixture adjusting screw (MAS)
- 38. Throttle body

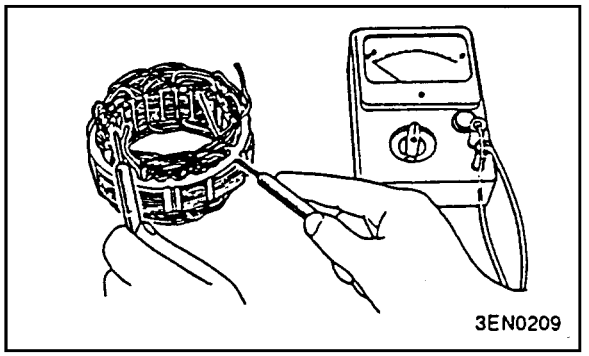


(2) Check for rotor coil grounding. Make sure that there is no continuity between the slip ring and the core. Replace the rotor assembly if there is continuity.

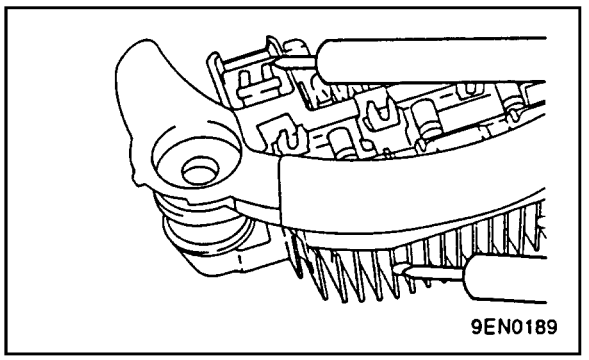


2. Stator

(1) Check the stator continuity. Make sure that there is continuity between the coil leads. Replace the stator assembly if there is no continuity.



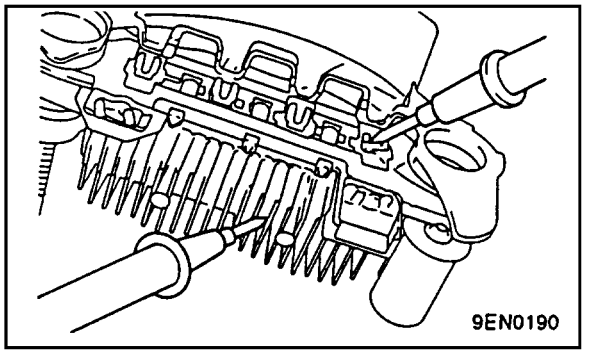
(2) Check for coil grounding. Make sure that there is no continuity between the coil and the core. Replace the stator assembly if there is continuity.



3. Rectifier

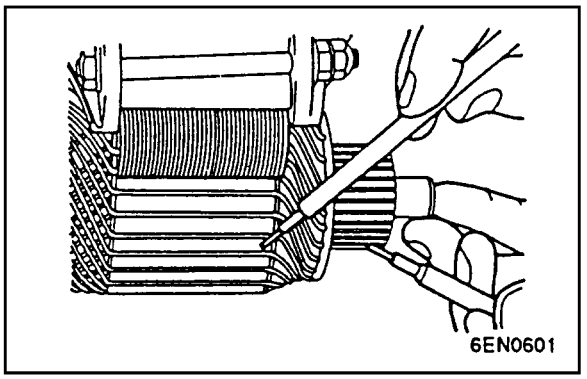
(1) Inspection of (+) heat sink assembly

Using a circuit tester, check continuity between the (+) heat sink and the stator coil lead connection terminals. If there is continuity in both directions, the diode is shorted and the rectifier assembly must be replaced.



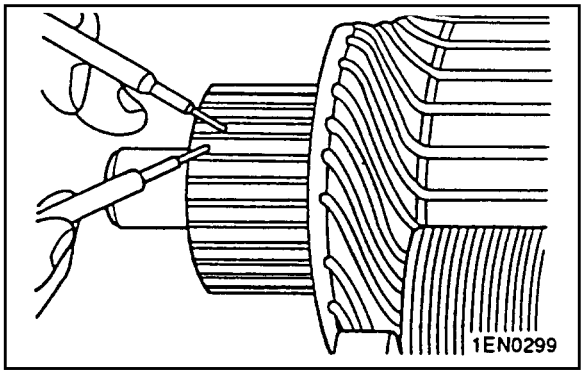
(2) Inspection of (-) heat sink assembly

Check continuity between the (-) heat sink and the stator coil lead connection terminals. If there is continuity in both directions, the diode is shorted and the rectifier assembly must be replaced.



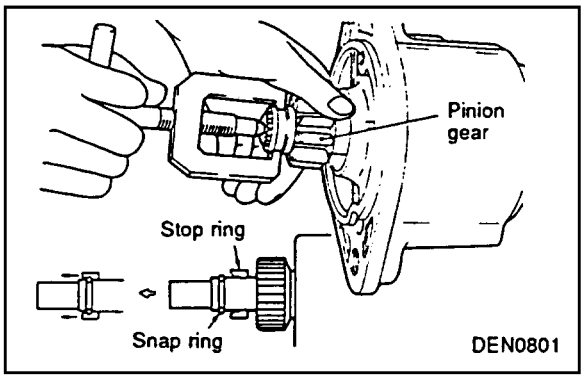
8. Armature Coil Ground Test

Check continuity between the commutator segments and the armature coil core. There should be no continuity.



9. Open Circuit Check of Armature

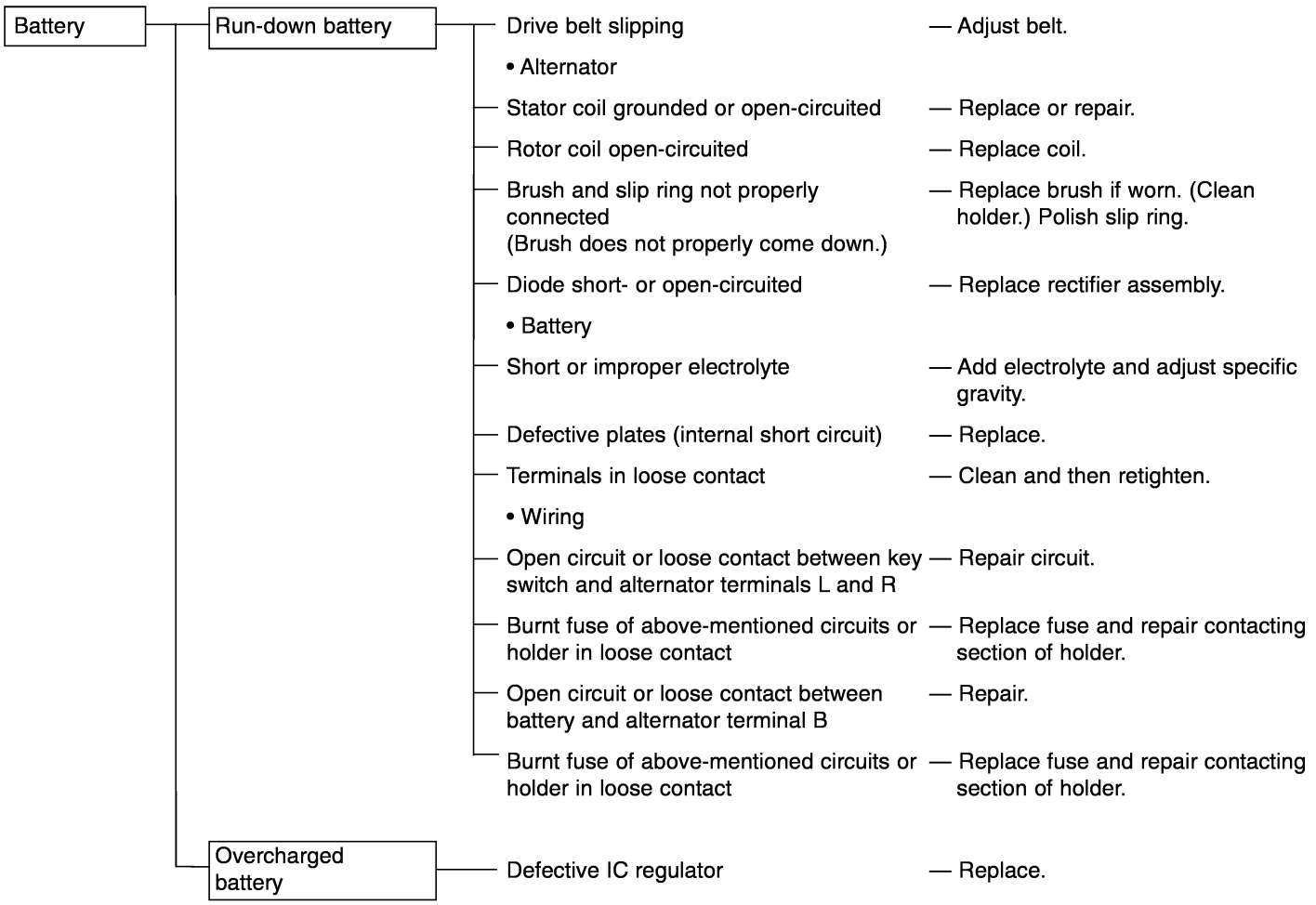
Check continuity between segments. There should be continuity.



SERVICE POINTS OF REASSEMBLY

◆A◆ Installation of stop ring/snap ring

Using an appropriate tool, pull the stop ring over the snap ring.


Battery
Run-down battery
Drive belt slipping — Adjust belt.
• Alternator
Stator coil grounded or open-circuited — Replace or repair.
Rotor coil open-circuited — Replace coil.
Brush and slip ring not properly connected (Brush does not properly come down.) — Replace brush if worn. (Clean holder.) Polish slip ring.
Diode short- or open-circuited — Replace rectifier assembly.
• Battery
Short or improper electrolyte — Add electrolyte and adjust specific gravity.
Defective plates (internal short circuit) — Replace.
Terminals in loose contact — Clean and then retighten.
• Wiring
Open circuit or loose contact between key switch and alternator terminals L and R — Repair circuit.
Burnt fuse of above-mentioned circuits or holder in loose contact — Replace fuse and repair contacting section of holder.
Open circuit or loose contact between battery and alternator terminal B — Repair.
Burnt fuse of above-mentioned circuits or holder in loose contact — Replace fuse and repair contacting section of holder.
Overcharged battery
Defective IC regulator — Replace.

TYPES OF LP-GAS

Gasoline is volatile, so must be the LP-gas. The yardstick of volatility is the vapor pressure. Here resides the reason why the maximum vapor pressure is specified for each grade of LP-gas.

The LP-gas is contained in the supply tank at a pressure sufficiently higher than that of the atmosphere, so that, when its outlet valve is opened, it will flow out by its own pressure: this is one of the reasons why a pump is not used to forward it to the engine. Imagine a tank containing mostly butane and suppose that the tank gets chilled deep to drastically lower the temperature of its LP-gas inside. Then, the inside pressure will fall and the LP-gas might not flow out by its own pressure. Even if the butane came out, it might not turn to gas because its vapor pressure at low temperatures is low. The remedy in such a case is to use a more volatile LP-gas.

LP-gas knock rating and octane number

As compared with gasoline, LP-gases are generally high in terms of anti-knock value and hence octane number. An LP-gas of nearly 100% propane is reported to have an octane number of well over 100; the octane number of the 100% butane is reported to range from 97 to 98, a level not far from that of what is sold as “premium gasoline” today.

The octane number of a fuel for the spark-ignition engine is a measure of its anti-knock quality: the higher the octane number, the less is the tendency of the fuel to knock.

Adverse effects of olefIns on LP-gas fuel system

Olefins (unsaturated hydrocarbons) are trouble-makers: they are more prone to undergo chemical reactions. Take ethylene, the first and therefore simplest olefin of the series, for example: it can combine with chlorine gas (Cl_2) to form ethylene dichloride through what is called “addition reaction.” Ethylene molecules can combine to form a larger molecule, polyethylene, through “polymerization reaction.” Propylene (C_3H_6) and butylene (C_4H_8), both olefins, are more reactive than ethylene and, if present in the LP-gas, are likely to form tar-like and rubbery substances and thus foul up the vaporizer, an important device in the LP-gas fuel system. Moreover, they are erosive: eroded diaphragms in the vaporizer are often explained by the presence of these olefins in the LP-gas.

Water and compounds of sulfur or sulfides as impurities can play the serious mischief with metal surfaces in the LP-gas fuel system by their corrosive action and also with the engine exhaust line by giving rise to sulfureous acid gas in the outgoing gases.

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 forklift 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 forklift 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.

(4) If there is a possibility of fire in the event of collision or overturning of the forklift 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 forklift 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 forklift 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 forklift 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.

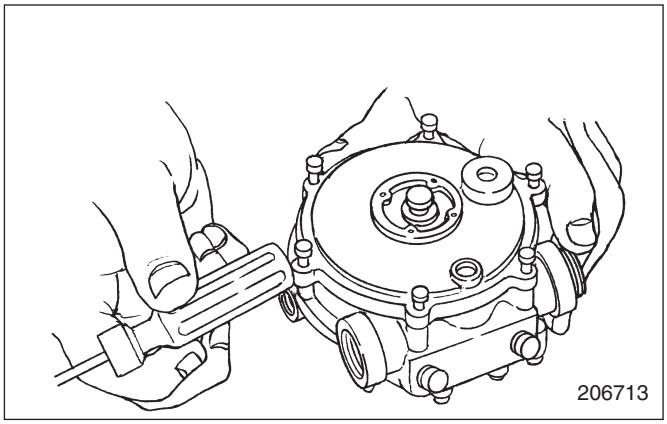
(16) The careless handling of LP-gas tanks can result in a serious accident. Extreme care should be exercised when transporting tanks so that the tanks are not damaged.

(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.

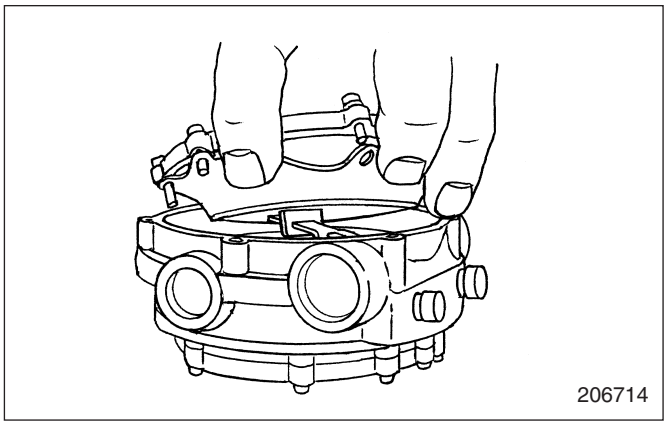
(18) The forklift truck should be refueled only at designated safe locations. Safe outdoor locations are preferable to those indoors.

DISASSEMBLY AND REASSEMBLY

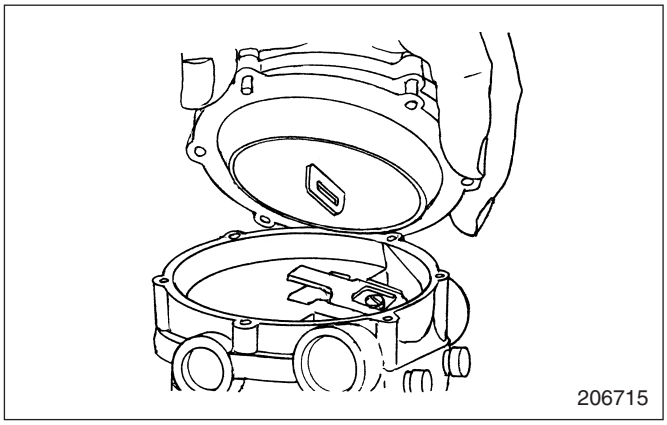
(2) Start disassembly by removing secondary cover. Take out six screws, and tap the perimeter of the cover with the plastic handle of a screwdriver to loosen secondary cover from its mounting position.



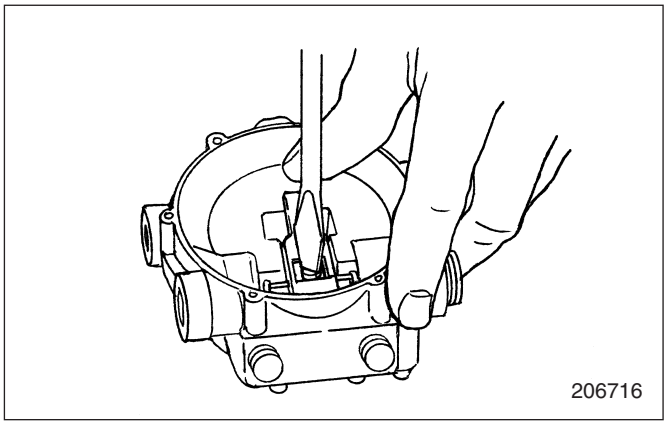
(3) Remove secondary diaphragm.
Slide secondary diaphragm toward gas inlet side to disengage diaphragm link from secondary seat lever.



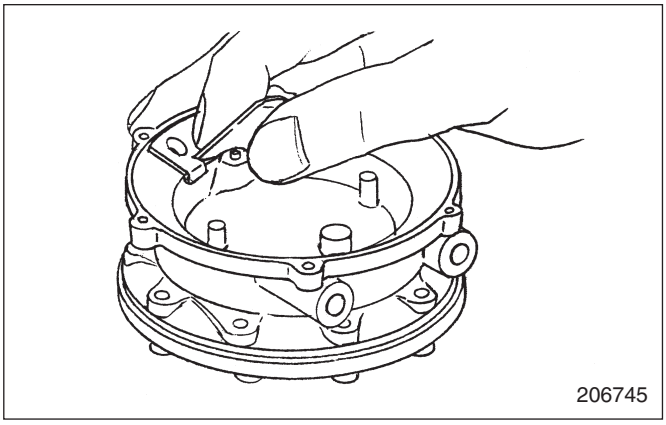
(4) At this stage, secondary seat lever is still positioned in link slot. Move secondary diaphragm to clear the slot.



(5) Remove screw, and dismount secondary seat lever, secondary seat, secondary seat pin, fulcrum pin and spring from converter body.
Note that locating tabs for spring are provided on both sides of lever. These tabs, together with the tab on the top of lever, retain the spring in proper position and prevent it from slipping out of place.



(8) Reassembly of diaphragm side
Check valve operating lever for freedom of movement.
Use silicone grease to coat the surface of the gasket that contacts the body. Note that holes align only when the gasket is installed correctly.
Rivet heads on diaphragm should be on the cover side, not the body side.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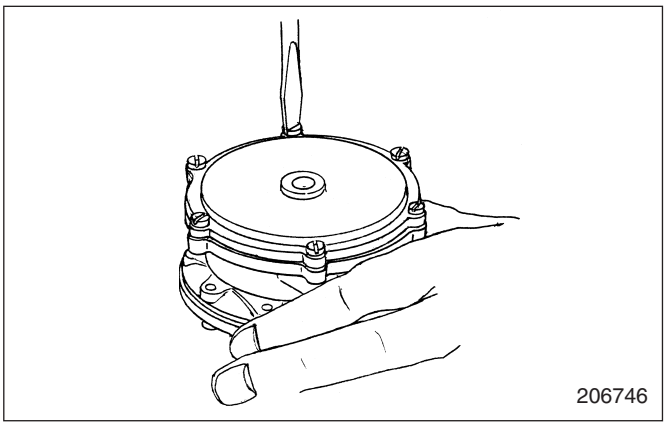
(9) Install diaphragm to the body, and mount diaphragm cover with screws.
Tighten screws evenly.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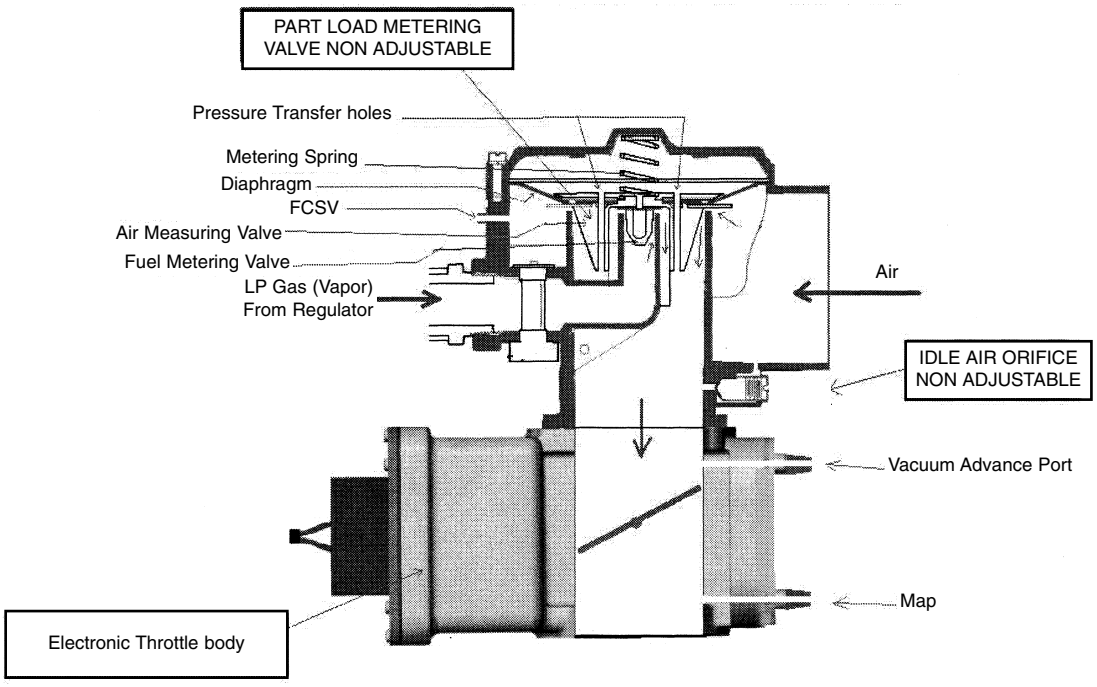
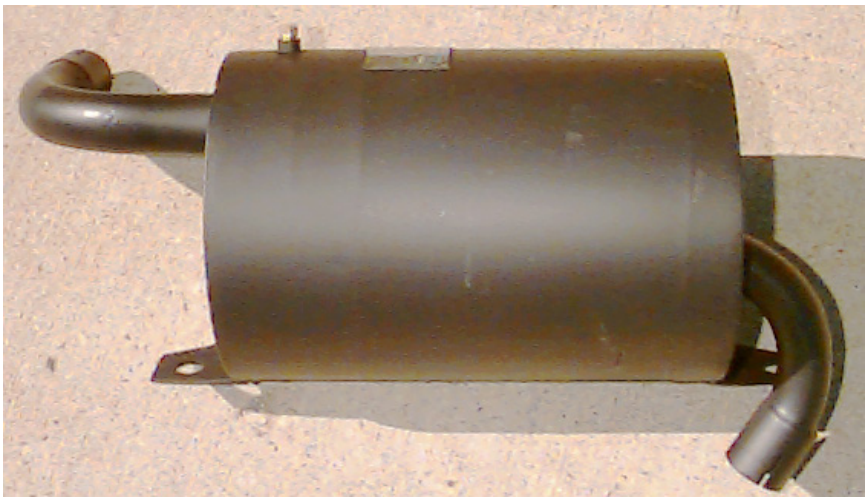
3.6. Mixer and Throttle Body Illustration

LP GAS VALVE CARBURETOR INTERNAL GAS FLOW



3.7. Three Way Catalytic Converter



System Adjustments:

1. Diagnostic Kit Installation
This system requires that the service technician have available a diagnostic device. Two diagnostic tools are available. A laptop computer with a diagnostic kit or hand held diagnostic unit are available to troubleshoot the system.
Note: This service manual will reference the Laptop diagnostic kit for troubleshooting.
The Hand Held unit will provide the same information as a laptop with the diagnostic kit. The Hand Held unit however, requires the selection of each screen individually whereas the Laptop will show all the information on one screen. Refer to the instructions that are included with these tools for information on their use.

Diagnostic kit for Laptop Computer - part #93060-06300
Hand Held Diagnostic unit - part #93060-06400

This software is designed to provide diagnostic information from lift trucks equipped with the S-15G industrial engine management systems. It is to be used with a Windows compatible PC.

System Requirements:
Pentium I or greater
Windows 95, 98 or NT
16 MB memory
Disk space: 86 KB

Software Installation:
Insert the Diagnostic installation disk into the drive.

1. Click on START, RUN and browse to a:\Setup.exe
2. Click on OPEN.
3. Click on OK
4. Follow installation instructions displayed on screen
5. Once installation is complete, start the diagnostic software and on the S-15G screen by double clicking on the "MCFA Diag" icon on the desktop screen.
6. Select "File" in the upper left screen.
7. Select the "Comport" option and select the "Com 1"

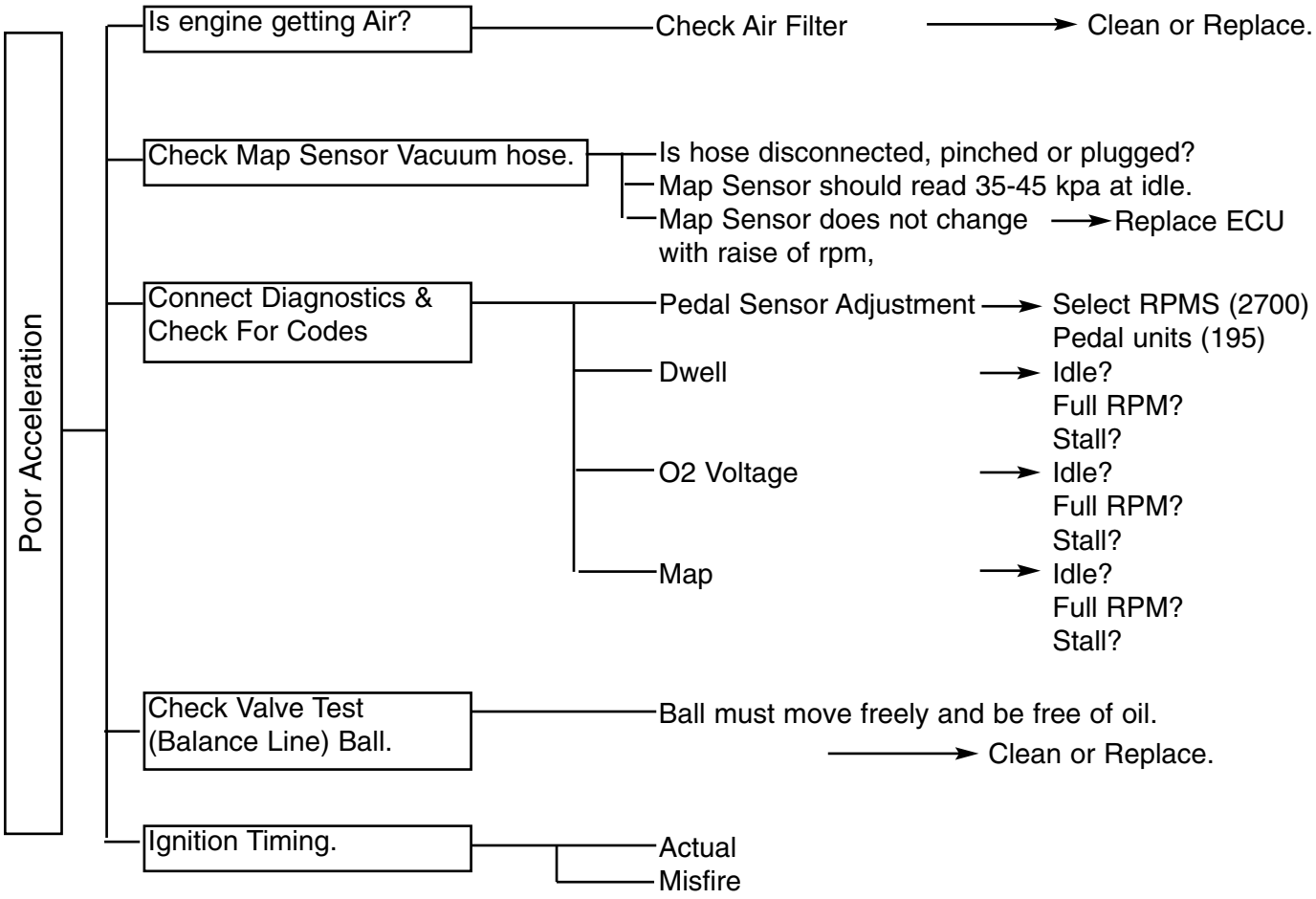
Note: After installation and before using the laptop for diagnostics use, ensure that the COM1 port is selected for use with this software.

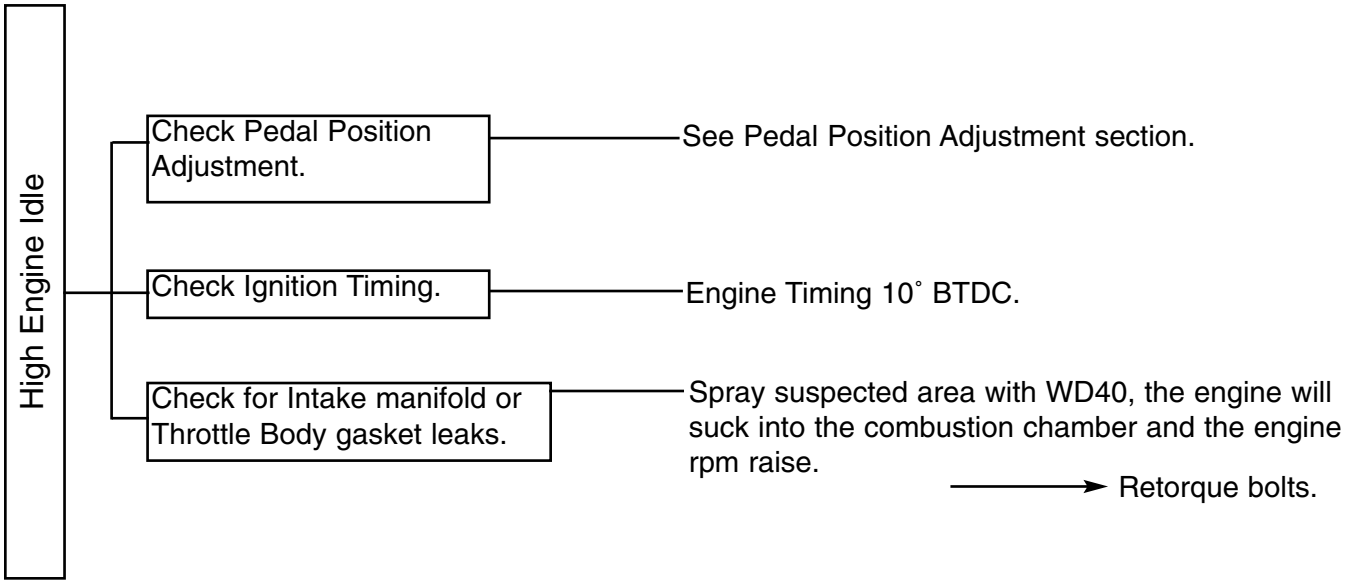
When utilizing these diagnostic tools you will be able to access information on the following system functions. **Note: Only functions frequently used to troubleshoot will be detailed fully. Refer to the instructions that are included with each of the diagnostic tools for more information**. General operating specifications are included with each parameter. These values can vary from the nominal values due to variation in local atmospheric conditions, fuel quality, age of truck, hours of use, and method of operations. Values that do not fall within the ranges specified do not necessarily indicate a malfunction. Rather, these values can be used to identify operating parameters that fall outside of the average range and used to investigate or to identify a possible operational problem.

Note: These adjustments require the use of an MCFA diagnostic tool. The following instructions reflect the use of a Laptop computer with Windows based diagnostic software.

2. Adjustments:
The majority of system functions and operating parameters are pre-programmed and not able to be routinely altered by service technicians. There are several adjustments which can be made if necessary, as follows:

- Idle mixture. The mixers are preset at the factory and it is not expected that routine re-adjustment will be needed in the field. Following factory adjustment, a cap is installed over the idle mixture adjustment screw to prevent tampering. In the event a mixer is replaced or the tamper resistant cap has been removed,


Poor Acceleration
Is engine getting Air?
Check Air Filter
Clean or Replace.
Check Map Sensor Vacuum hose.
Is hose disconnected, pinched or plugged?
Map Sensor should read 35-45 kpa at idle.
Map Sensor does not change with raise of rpm,
Replace ECU
Connect Diagnostics & Check For Codes
Pedal Sensor Adjustment
Select RPMS (2700)
Pedal units (195)
Dwell
Idle?
Full RPM?
Stall?
O2 Voltage
Idle?
Full RPM?
Stall?
Map
Idle?
Full RPM?
Stall?
Check Valve Test (Balance Line) Ball.
Ball must move freely and be free of oil.
Clean or Replace.
Ignition Timing.
Actual
Misfire


High Engine Idle
Check Pedal Position Adjustment.
See Pedal Position Adjustment section.
Check Ignition Timing.
Engine Timing 10˚ BTDC.
Check for Intake manifold or Throttle Body gasket leaks.
Spray suspected area with WD40, the engine will suck into the combustion chamber and the engine rpm raise.
Retorque bolts.

FORWARD

This service manual supplement has instructions and procedures for the 4G63, 4G64 Engine EPA Fuel Systems and is to be used in conjunction with the engine service manual. The information, specifications and illustrations used in this manual are based on information that was current at the time this issue was written.

Correct servicing will give the engine a long productive life. Before attempting to start a test, repair or rebuild job be sure that you have read and understood the respective sections of this manual, and know all the components you will be working on.

Continuing advancement and improvement of product design may have caused changes to your engine which are not included in this manual.

Whenever a question arises regarding your engine or this manual, please consult your dealer for the latest available information.

Pub No. 99729-75110

GLOSSARY OF TERMS

Air Valve Vacuum (AVV): The vacuum signal taken from below the air valve assembly and above the throttle butterfly.

ADP: Adaptive Digital Processor.

Air/Fuel Ratio: The amount of air and fuel in the air fuel mixture, which enters the engine, shown in a ratio.

Analog Voltmeter: A meter that uses a needle to point to a value on a scale of numbers usually of the low impedance type; used to measure voltage and resistance.

Aromatics: Pertaining to or containing the six-carbon ring characteristic of the benzene series. Found in many crude oils.

Backfire: Combustion of the air/fuel mixture in the intake or exhaust manifolds. A backfire can occur if the intake or exhaust valves are open when there is a mis-timed ignition spark.

Benzene: An aromatic (C6H6). Sometimes blended with gasoline to improve antiknock value. Benzene is toxic and suspected of causing cancer.

Bi-Fueled: A vehicle equipped to run on two fuels at the same time such as a fumigated diesel.

Blow-By: Gases formed by the combustion of fuel and air, which ordinarily should exert pressure only against the piston crown and first compression ring. When rings do not seal, these gases (blowby) escape down the side of the piston into the crankcase.

BTU: British Thermal Unit. A measurement of the amount of heat required to raise the temperature of 1lb. of water 1 degree F.

Butane: An odorless, colorless gas, C4H10 found in natural gas and petroleum. One of the five LP gases.

CAFE: Corporate Average Fuel Economy.

CARB: California Air Resources Board.

Carbon Monoxide (CO): A chemical compound of a highly toxic gas that is both odorless and colorless.

Carburetor: An apparatus for supplying an internal-combustion engine a mixture of vaporized fuel and air.

Cathode Ray Tube: A vacuum tube in which cathode rays usually in the form of a slender beam are projected on a fluorescent screen and produce a luminous spot.

Circuit: A path of conductors through which electricity flows before it returns to its source.

Closed Loop Operation: Applies to systems utilizing an oxygen sensor. In this mode of operation, the system uses oxygen sensor information to determine air/fuel ratio. Adjustments are made accordingly and checked by comparing the new oxygen sensor to previous signals. No stored information is used.

CNG: Compressed Natural Gas.

CKP: Crankshaft Position Sensor

CMP: Camshaft Position Sensor

Conductor: A material, normally metallic, that permits easy passage of electricity.

Contaminants: Impurities or foreign material present in fuel.

Control Module: One of several names for a solid state microcomputer which monitors engine conditions and controls certain engine functions; i.e. air/fuel ratio, injection and ignition time, etc.

Converter: A LPG fuel system component containing varying stages of fuel pressure regulation combined with a vaporizer.

Cryogen: A refrigerant used to obtain very low temperatures.

Current: The directed flow of electrons through a conductor. Measured in amps.

Dedicated Fuel System: A motor fuel system designed to operate on only one fuel type.

Diaphragm: A thin, flexible membrane that separates two chambers. When the pressure in one chamber is lower than in the other chamber, the diaphragm will move toward the side with the low pressure.

Diaphragm Port: The external port located at the fuel inlet assembly and connected to the vacuum chamber above the air valve diaphragm.

Digital Volt/Ohm Meter (DVOM): A meter that uses a numerical display in place of a gauge and is usually of the high impedance type.

NOTE

Draining the regulator when the engine is warm will help the oils to flow freely from the regulator.

To drain the LPR use the following steps:

1. Move the equipment to a well ventilated area and ensure no external ignition sources are present.
2. Start the engine.
3. With the engine running close the manual valve.
4. When the engine runs out of fuel turn OFF the key when the engine stops and disconnect the battery negative cable.

⚠ WARNING

A small amount of fuel may still be present in the fuel line, use gloves to prevent burns, wear proper eye protection. If liquid fuels continues to flow from the connections when loosened check to make sure the manual valve is fully closed.

5. Slowly loosen the inlet fitting and disconnect.
6. Loosen the hose clamp at the outlet hose fitting and remove the hose.
7. Remove and retain the locking pin in the outlet fitting and remove the outlet fitting from the LPR
8. Disconnect PTV connection and disconnect the vacuum hose.
9. Remove the two LPR mounting bolts and retain.
10. Place a small receptacle in the engine compartment.
11. Rotate the LPR to 90° so that the outlet fitting is pointing down into the receptacle and drain the LPR.
12. Inspect the secondary chamber for any large dried particles and remove.
13. Remove the receptacle and reinstall the LPR with the two retaining bolts and tighten to specifications.
14. Reinstall the outlet fitting and secure with the previously removed locking pin.
15. Reconnect the PTV electrical connection push connector until lock “Click”, pull on the connector to ensure it is locked, connect the vacuum line.
16. Reconnect the outlet hose and secure the hose clamp.
17. Reinstall the fuel inlet line and tighten connection to specification.
18. Slowly open the manual service valve.

NOTE

The fuel cylinder manual valve contains an “Excess Flow Check Valve” open the manual valve slowly to prevent activating the “Excess Flow Check Valve”.

19. Check for leaks at the inlet and outlet fittings using a soapy solution or an electronic leak detector, if leaks are detected make repairs. Check coolant line connections to ensure no leaks are present.
20. Start engine recheck for leaks at the regulator.
21. Dispose of any drained material in safe and proper manner.

Air Fuel Mixer/throttle Control Device Maintenance And Inspection

⚠ CAUTION

The Air Fuel Mixer components have been specifically designed and calibrated to meet the fuel system requirements of the emission certified engine. The mixer should not be disassembled or rebuilt. If the mixer fails to operate or develops a leak the mixer should be replaced with the OEM recommended replacement parts.

When inspecting the mixer check for the following items:

- Check for any fuel leaks at the inlet fitting.
- Check the fuel inlet hose for cracking, splitting or chaffing, replace if any of these condition exist.
- Check to ensure the mixer is securely mounted.
- Check air inlet hose connection and insure clamp is tight, check inlet hose for cracking, splitting or chaffing, replace if any of these condition exist.
- Check air cleaner element according to the *Recommended Maintenance Schedule* found in this section.
- Check fuel line to Throttle body mounted Fuel

fuel control while the engine is operating. The FTV is a 12 volt normally closed electric valve and is connected to the LPR by a fuel line. The FTV normally receives a pulse from the ECM which causes the FTV to be cycled open and closed to allow additional fuel to be supplied to the air stream above the throttle plate. During normal closed loop operating condition the ECM provides a electrical pulse to both the FTV and the PTV which controls the amount of fuel being introduced into the air stream. The PTV is connected to the Air Valve Vacuum (AVV) which reduces the amount of fuel flow to the regulator; the FTV introduces additional fuel into the air stream. By cycling the PTV more frequently and the FTV less frequently the air fuel ratio can be leaned, by decreasing the PTV duty cycles and increasing the FTV duty cycles the air fuel ratio can be increased.

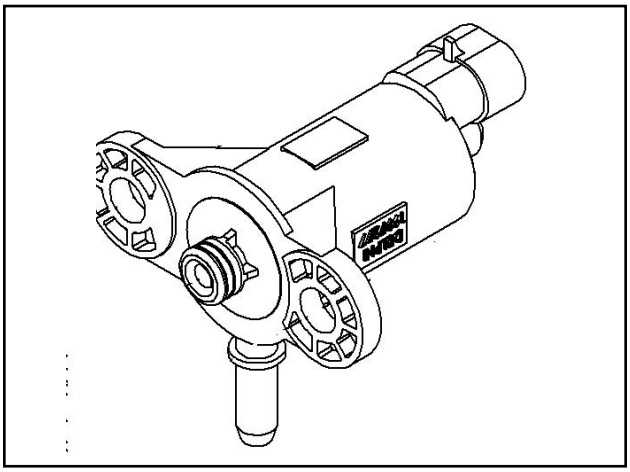


Figure 7 Pressure Trim Valve and Fuel Trim Valve

Throttle Control Device

Drive By Wire

Engine speed control is maintained by the amount of pressure applied to the foot pedal located in the engine compartment. In a Drive By Wire (DBW) application there is no direct connection between the operator pedal and the throttle shaft. Speed and load control are determined by the ECM. Defaults programmed into the ECM software and throttle position sensors allow the ECM to maintain safe operating control over the engine.

In a drive by wire application the Electronic Throttle Control device or “throttle body assembly” is connected to the intake manifold of the engine. The electronic throttle control device utilizes an electric motor connected to the throttle shaft. In addition a Foot Pedal Position sensor (FPP) is located in the operator’s compartment. When the engine is running electrical signals are sent from the foot pedal position sensor to the engine ECM when the operator depresses or release the foot pedal. The ECM then sends an electrical signal to the motor on the electronic throttle control to increase or decrease the angle of the throttle blade thus increasing or decreasing the air/fuel charge to the engine.

The electronic throttle control device incorporates two internal Throttle Position Sensors (TPS) which provide output signals to the ECM as to the location of the throttle shaft and blade. The TPS information is used by the ECM to correct for speed and load control as well as emission control.

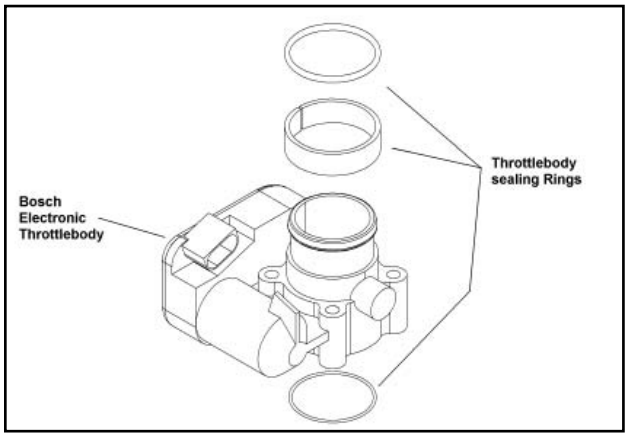


Figure 8 Electronic Throttle control device “Drive by Wire” throttle body assembly”

Three Way Catalytic Muffler

The emission certified engine has been designed and calibrated to meet the emission standards in effect for 2004. To help meet the emission requirements the vehicle has been equipped with a Three Way Catalytic (TWC) muffler. The catalyst muffler is a three way

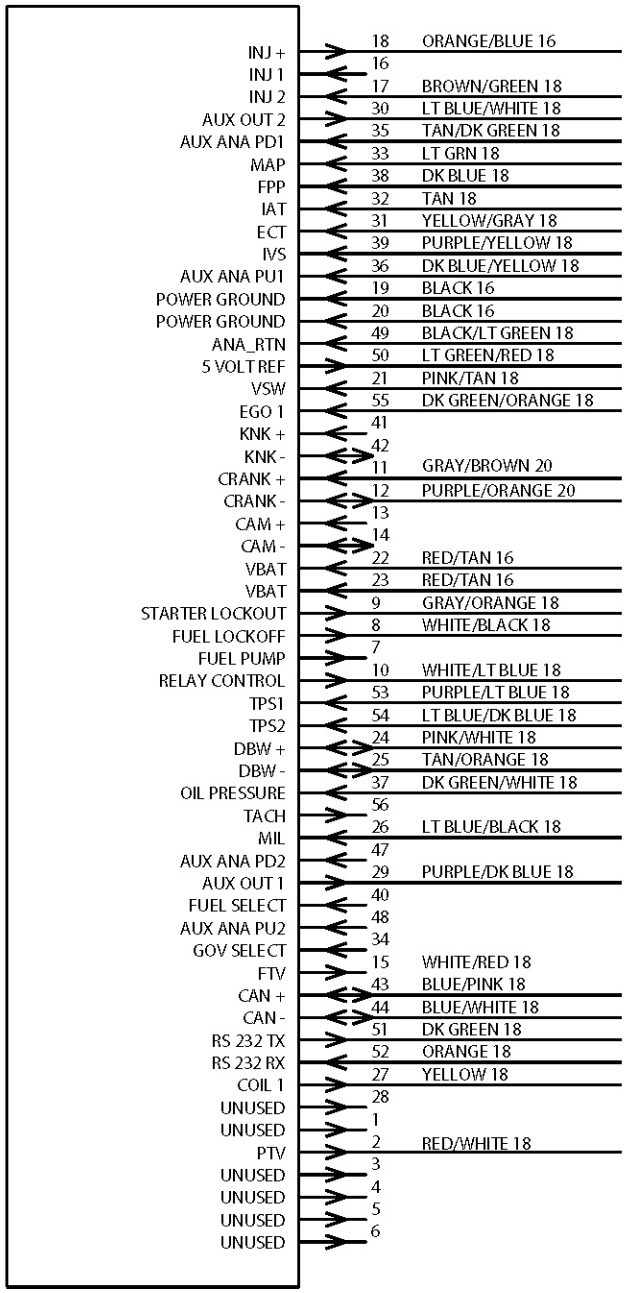
10	1. Inspect the air intake stream to the mixer assembly and the throttle body for vacuum leaks. 2. Inspect the vacuum hoses from the mixer to the PTV solenoids for proper connection and condition. Was a problem found and repaired?	—	Go to *Step 26*	Go to *Step 24*
11	Inspect the fuel hose connection between the LPR and the mixer assembly for damage or leakage. Was a problem found and repaired?	—	Go to *Step 26*	Go to *Step 12*
12	1. Connect a 0-10 psi gauge to the primary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR primary pressure. Is the fuel pressure **ABOVE** the specified value?	2.0 – 4.0 psi	Go to *Step 22*	Go to *Step 13*
13	1. Turn OFF the ignition. 2. Disconnect the LPL connector. 3. Install a test light between the pins of the LPL connector. 4. Crank the engine. The test light should illuminate. Does the test light illuminate?	—	Go to *Step 14*	Go to *Step 16*
14	Using a DVOM, check the resistance of the low pressure lock-off (LPL). Is the resistance within the specified range?	12 - 24 Ω	Go to *Step 15*	Go to *Step 23*

Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. • Check for the proper ignition voltage output with *J 26792* or the equivalent. • Verify that the spark plugs are correct for use with LPG (R46TS) • Check the spark plugs for the following conditions: − Wet plugs − Cracks − Wear − Improper gap − Burned electrodes − Heavy deposits • Check for bare or shorted ignition wires. • Check for loose ignition coil connections at the coil.
Engine Mechanical Checks	**Important:** The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. • Check for the following: − Vacuum leaks − Improper valve timing − Low compression − Bent pushrods − Worn rocker arms − Broken or weak valve springs − Worn camshaft lobes.
Exhaust System Checks	• Check the exhaust system for a possible restriction: − Inspect the exhaust system for damaged or collapsed pipes − Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis*

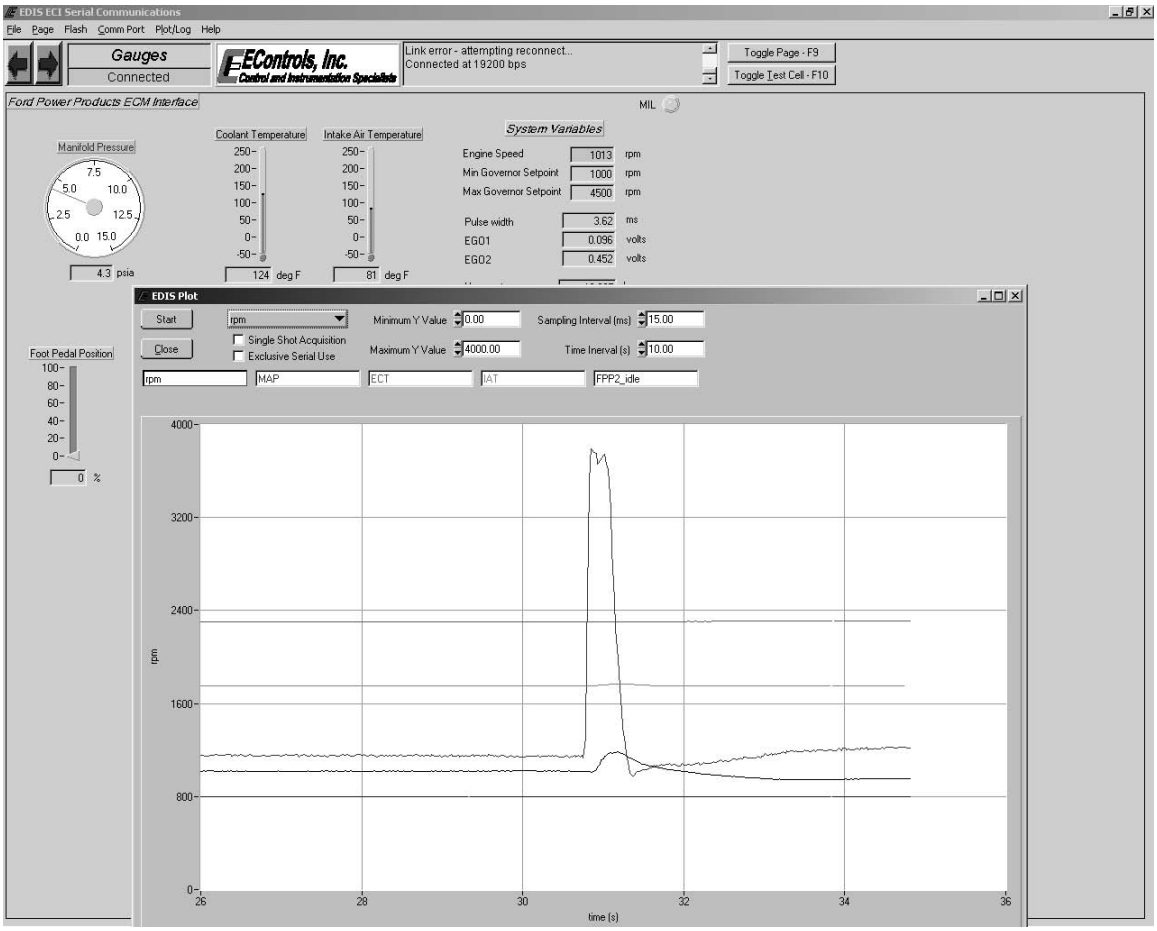
Engine Mechanical Check	Check the engine for the following: • Engine compression • Valve timing • Improper or worn camshaft. Refer to *Engine Mechanical* in the Service Manual.
Additional Check	• Check the ECM grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. • If all procedures have been completed and no malfunction has been found, review and inspect the following items: • Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. • Check the scan tool data.

ENGINE CONTROL MODULE C001

211 PC 56 2S 0 009 CONNECTOR
211 A 56 7007 LOCKING CAM
211 A 56 0008 COVER
211 CC 2S 1120 TERM



GRAPHING AND DATA LOGGING



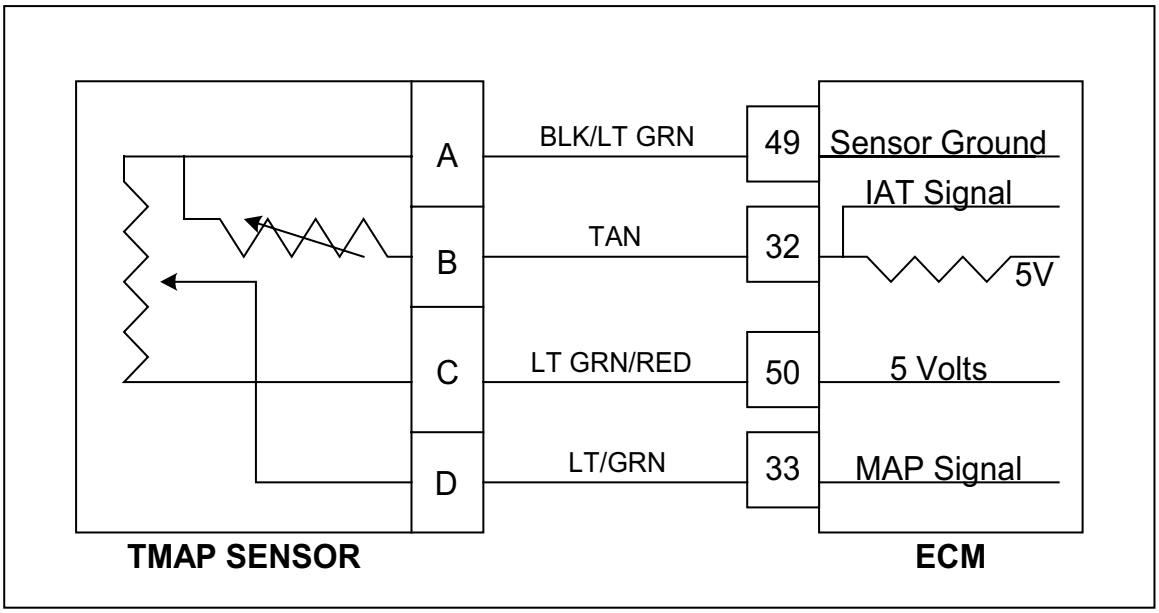
Graphing the values and voltages can be a very useful tool in doing intermittent diagnosis. The system diagnostic monitoring software includes graphing and data logging capability. These features enhance the ability to diagnose and repair possible problems with the system. The graphing feature allows sensor inputs and select control output variables to be plotted in real-time while the engine is running.

To plot a variable you must first “TAG” the variable you wish to plot. To do this, use the mouse to highlight the variable, and then right click.

Next press the “P” key or double click the Plot/Log button to invoke the plotting feature. You may change the desired time interval for each display screen. The default is 10 seconds. This can be increased or decreased as necessary to display the desired results. You can also change the sample rate.

You are now ready to plot. Simply click the “START” button to observe the plotted variables. The plot sweeps across the screen from left to right. To pause the display screen press the “SPACE BAR” at any time during plotting. To continue plotting simply press the “SPACE BAR” again. To stop the plotting feature simply click the “STOP” button. To exit the plotting screen click the “CLOSE” button. The range of each variable is listed along the left side of the display and the time is listed along the bottom of the screen.

DTC 112-IAT Low Voltage



Conditions for Setting the DTC

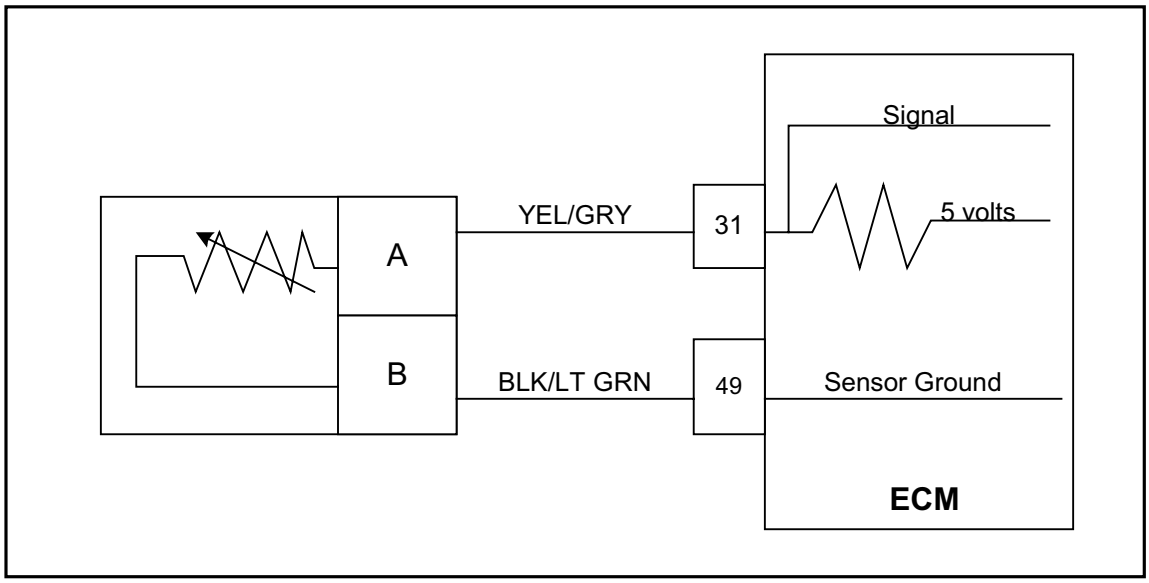
- Intake Air Temperature
- Check Condition Engine Cranking or Running
- Fault Condition-IAT Sensor Voltage less than 0.05
- MIL-On during active fault and for 2 seconds after active fault
- Adaptive-Disabled during active fault
- Closed Loop-Enabled and allowed to stay at limit if required but will then also set the limiting fault.

Circuit Description

The TMAP is a combined IAT (Intake Air Temperature) and MAP (Manifold Absolute Pressure) sensor. A temperature sensitive resistor is used in the TMAP located in the intake manifold of the engine. It is used to monitor incoming air temperature, and the output in conjunction with other sensors is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm.
The IAT is a calculated value based mainly on the IAT sensor at high airflow, and influenced more by the ECT (Engine Coolant Temperature) at low airflow.

This fault will set if the signal voltage is less than 0.05 volts anytime the engine is cranking or running. The ECM will use the default value for the IAT sensor in the event of this fault.

DTC 121-ECT / High Voltage



Conditions for Setting the DTC

- Engine Coolant Temperature
- Check Condition-Engine Running
- Fault Condition-ECT sensor voltage exceeds 4.95
- MIL-On during active fault and for 2 seconds after active fault
- Adaptive-Disabled during active fault
- Closed Loop-Enabled

Circuit Description

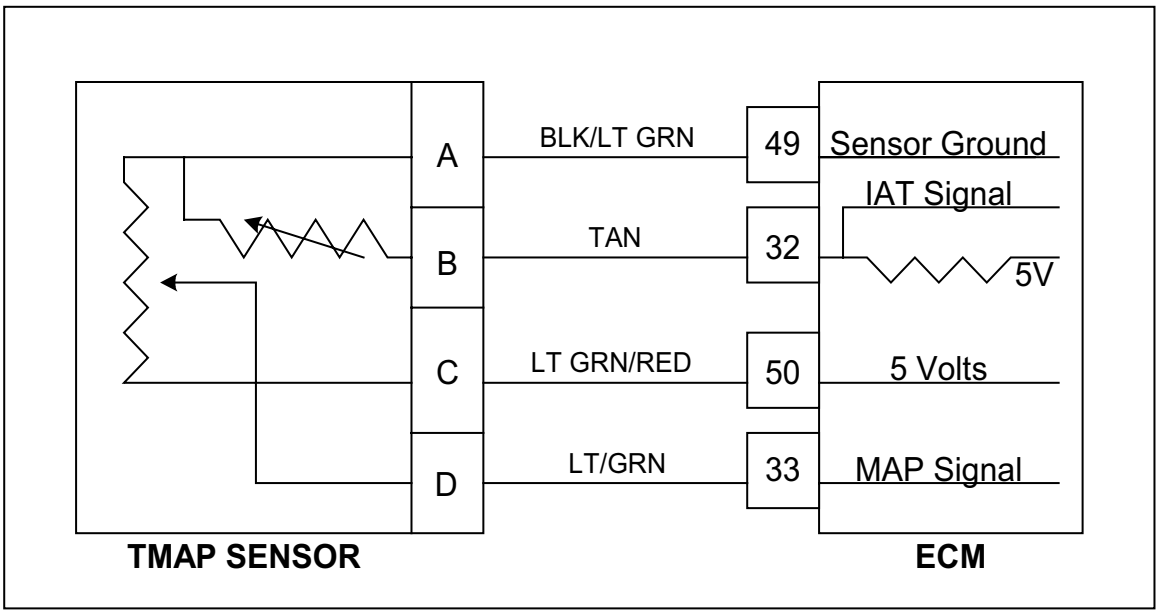
The ECT (Engine Coolant Temperature) sensor is a temperature sensitive resistor located in the engine coolant. It is used for the engine airflow calculation, gasoline cold enrichment and to enable other temperature dependant features. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm. This fault will set if the signal voltage is greater than 4.95 volts anytime the engine is running. The ECM will use a default value for the ECT sensor in the event of this fault.

ECT Data:	
Temp (deg F)	**Ohms**
242.4	101
231.9	121
211.6	175
201.4	209
181.9	302
163.1	434
144.9	625
127.4	901
102.4	1,556
78.9	2,689
49.9	5,576
23.5	11,562
-5.7	28,770
-21.2	49,715
-30.8	71,589
-40.0	99,301

DTC 124 ECT Higher Than Expected 2

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On • DST (Diagnostic Scan Tool) connected in System Data Mode • Warm Engine to normal operating temperature, then run the engine above 500 rpm for 60 seconds • Does DST display ECT temperature of 235 degrees F. or greater with the engine running over 500 rpm?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Verify with a temperature gauge that the engine coolant is over 235 degrees F. Does the temperature gauge indicate 235 degrees F. or greater?		Repair Cooling system.	Go to step (4)
4	Verify ECT circuit function. Follow diagnostic test procedure for DTC-122 ECT Low Voltage		-	-

DTC 135-BP Low Pressure



Conditions for Setting the DTC

- Barometric Pressure
- Check Condition-Key On
- Fault Condition-BP less than 8.3 psia
- MIL-On for active fault and for 2 seconds after active fault
- Adaptive-Disabled for remainder of key on cycle
- Closed Loop-Enabled

Circuit Description

The BP (Barometric Pressure) is estimated from the TMAP sensor. The barometric pressure value is used for fuel and airflow calculations. This fault sets in the event the BP value is out of the normal range.

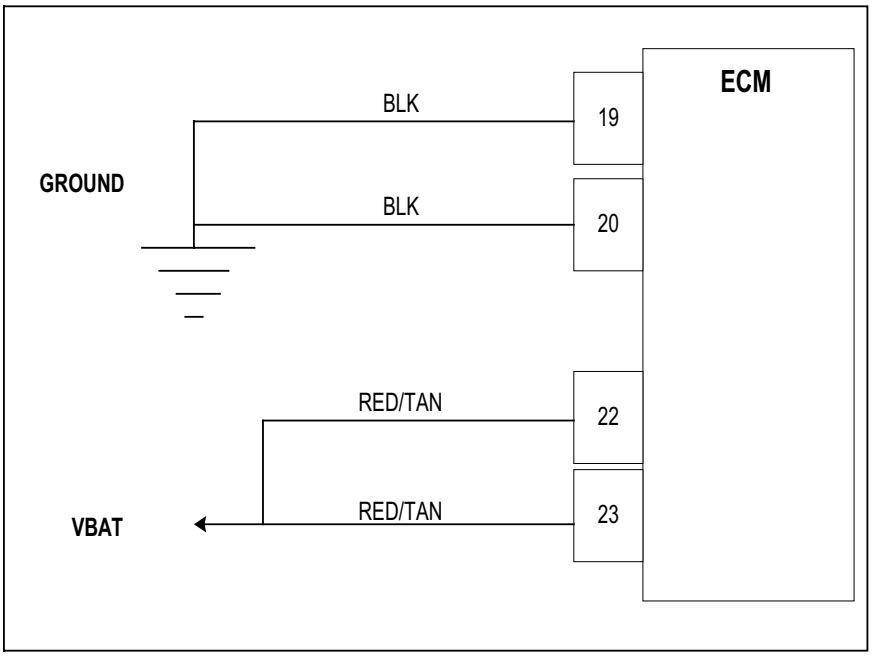
DTC 143 Never Crank Sync at Start

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Check to be sure that the ECM ground terminal G1 to engine ground is clean and tight. Is terminal G1 clean and tight?		Go to Step (3)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
3	• Key OFF • Disconnect the CKP sensor connector • Using a DVOM check for voltage output from the CKP sensor while cranking the engine • Do you have voltage output?	Over .5 volts	Go to Step (4)	Go to Step (11)
4	• Key OFF • Disconnect ECM connector C001 • Using a DVOM check for continuity between CKP connector pin A and ECM connector pin 11 • Do you have continuity between them?		Go to Step (5)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	• Using a DVOM check for continuity between CKP connector pin B and ECM connector pin 12 Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Inspect the CKP connector C011 pins for damage, corrosion or contamination Did you find a problem?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)

DTC 224- Closed Loop Multiplier Low (LPG)

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key On, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Run engine to full operating temperature and then idle for a minimum of 2 minutes Does DST display HO2S voltage fixed above 0.7 volts after 2 minutes of idle run time?		Go to step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect HO2S wire harness connector • Disconnect ECM wiring harness connector • Key ON • Using a high impedance DVOM check for voltage between HO2S connector signal pin B and engine ground Do you have voltage?		Repair wire harness shorted signal to voltage Refer to Wiring Repairs in Engine Electrical.	Refer to Diagnostic Aids for DTC 224

DTC 262-System Voltage High



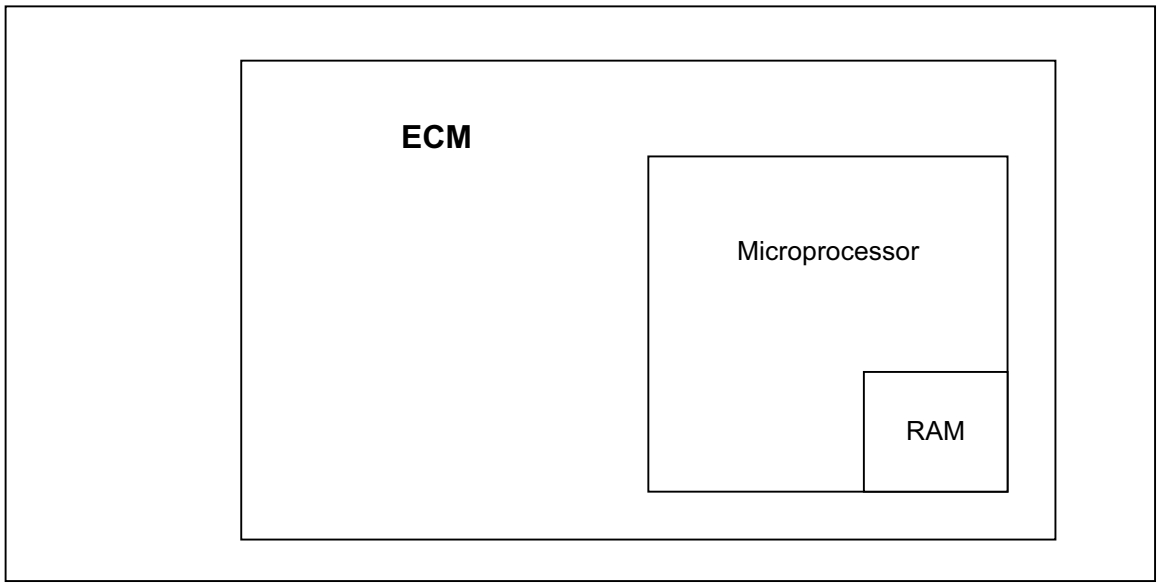
Conditions for Setting the DTC

- System Voltage to ECM
- Check Condition-Cranking or Running
- Fault Condition-Switched battery voltage at ECM greater than 18 volts for 3 seconds
- MIL-On for active fault and for 5 seconds after active fault
- Adaptive-Disabled for remainder of key on cycle
- Closed Loop-Enabled

Circuit Description

The battery voltage powers the ECM and must be measured to correctly operate injector drivers, trim valves and ignition coils. This fault will set if the ECM detects voltage greater than 18 volts for 3 seconds at anytime the engine is cranking or running. The adaptive learn is disabled. The ECM will shut down with internal protection if the system voltage exceeds 26 volts.

DTC 515-Flash Checksum Invalid



Conditions for Setting the DTC

- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

Circuit Description

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

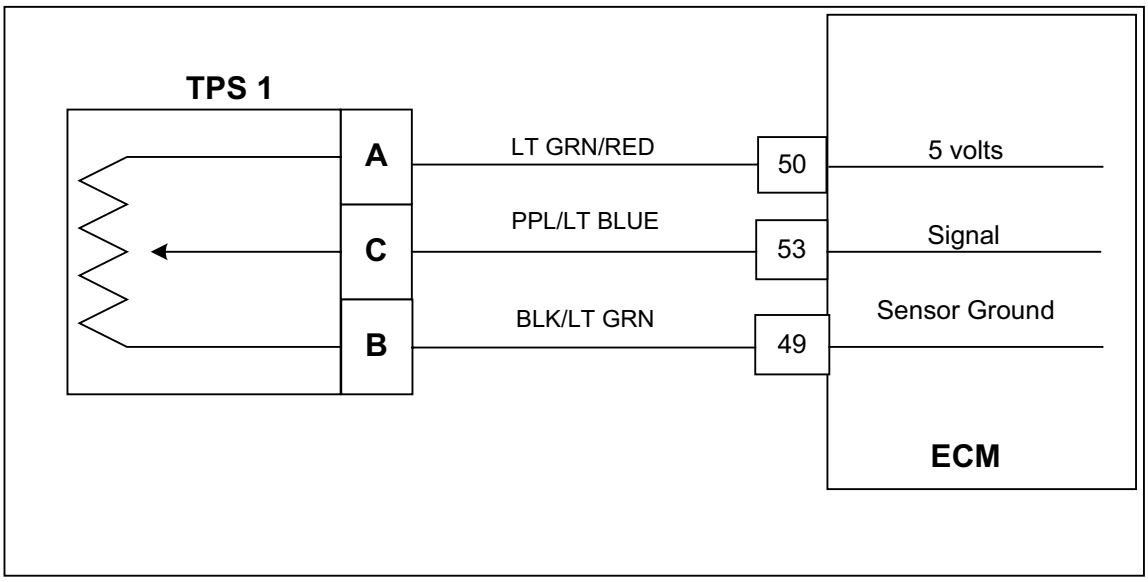
DTC 554-Gaseous Fuel Flow Rev Limit

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Check for other DTC codes that may be stored in ECM memory Did you find other DTC codes stored in the ECM memory?		Go to Step (3)	Go to Step (4)
3	• Repair DCT codes starting with the lowest code first. Have the other codes been diagnosed and repaired?		Go to Step (5)	-
4	Follow the diagnostic chart recommendations for DTC 637		-	-
5	• Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from the ECM. • Turn the ignition OFF and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature • Observe the MIL • Observe engine performance and driveability • After operating the engine within the test parameters of DTC-554 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 612 FPP Voltage Low

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display FPP voltage of 0.2 volts or less with the foot pedal in the idle position?		Go to Step (7)	Go to Step (3)
3	• Slowly depress FP while observing FPP voltage Does DST FPP voltage ever drop below 0.2 volts?		Go to step (4)	Intermittent problem Go to Intermittent section
4	• Key OFF • Disconnect FPP sensor connector • Inspect connector and wire terminals for damage, corrosion or contamination Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (5)
5	• Key ON • Using A DVOM check for voltage at the FPP sensor connector between 5 volt reference pin A and FPP sensor ground pin B Do you have voltage between them?	5.0 Volts	Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	• Replace FPP Sensor Is the replacement complete?		Go to Step (18)	-
7	• Key OFF • Disconnect FPP Sensor from wire harness • Jumper 5 volt reference circuit pin A and FPP signal circuit pin C together • Key ON Does DST display FPP voltage of 4.8 volts or greater?		Go to Step (8)	Go to Step (9)

DTC 632-TPS 1 Signal Voltage Low



Conditions for Setting the DTC

- Throttle Position Sensor #1
- Check Condition-Cranking or Running
- Fault Condition-TPS sensor voltage less than 0.2
- MIL-On during active fault
- Power Derate 1
- Low rev limit 1300 rpm
- Forced idle 700 rpm

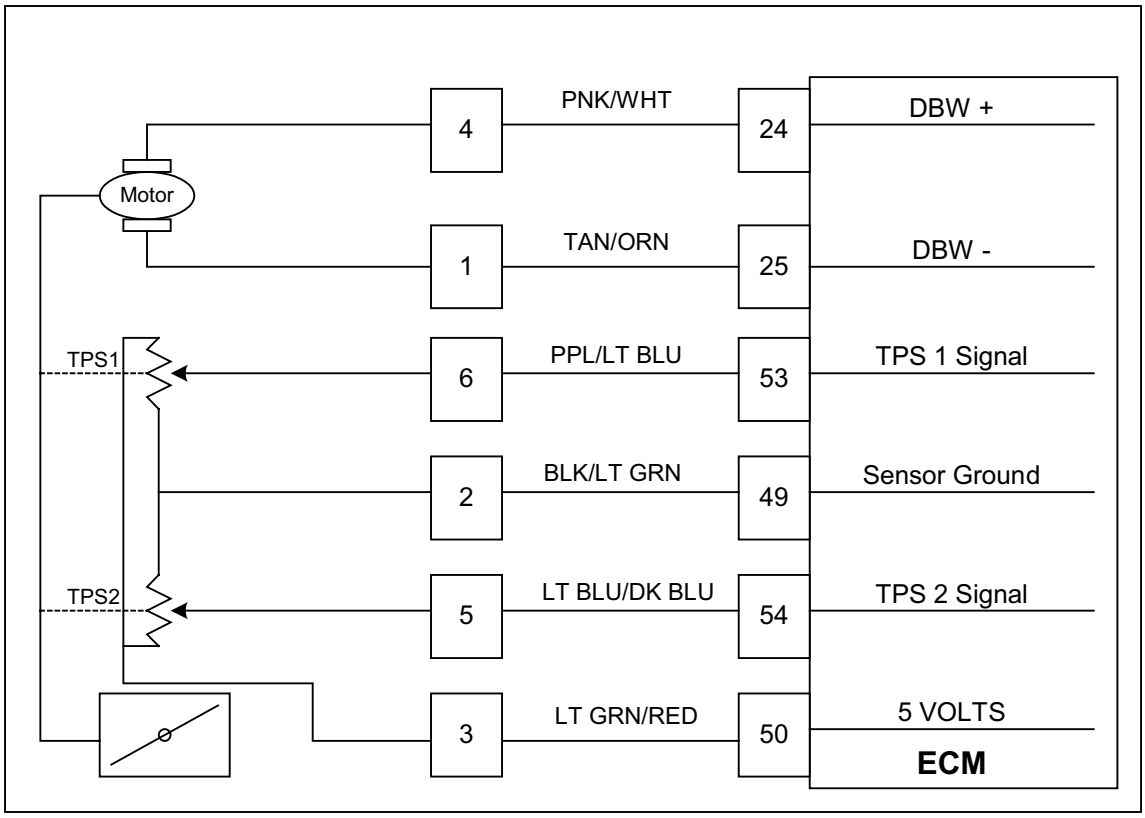
Circuit Description

The Electronic Throttle has two counter acting Throttle Position Sensors. Two sensors are used for improved safety and redundancy. The Throttle Position sensor uses a variable resistor to determine signal voltage based on throttle plate position, and is located within the throttle. Less opening results in lower voltage, and greater opening in higher voltage. The TPS value is used by the ECM to determine if the throttle is opening as commanded. This fault will set if voltage is less than 0.2 volts at any operating condition while the engine is cranking or running. Power derate 1 will be enforced limiting the throttle to 50% maximum and low rev limit and forced idle will also be enforced during this fault.

DTC 635 TPS 1 Higher Than TPS 2

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	Go to OBD System Check Section
2	• Key ON, Engine OFF • DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display more than a 20% difference between TPS 1 and TPS 2?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	• Key OFF • Disconnect wiring harness connector to throttle • Key ON • Change DST mode to DBW (drive by wire) test mode Is the voltage for TPS 1 and TPS 2 less than 0.1 volts?		Go to Step (5)	Go to Step (4)
4	• Key OFF • Disconnect ECM wiring harness connector • Key ON • Using a DVOM check for voltage between TPS 1 or TPS 2 (the one that is over 0.1 volts) and engine ground Do you have voltage?		Repair the TPS 1 or TPS 2 circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (13)
5	• Jumper TPS 1 and TPS 2 signal to the 5 volt reference at the throttle connector Does DST display TPS 1 and TPS 2 voltage over 4.95 volts		Go to Step (6)	Go to Step (8)
6	• Inspect wire terminals at throttle connector for damage corrosion or contamination Any problems found?		Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)
7	• Replace Throttle Is the replacement complete?		Go to Step (14)	-

DTC 638-Throttle Unable To Close



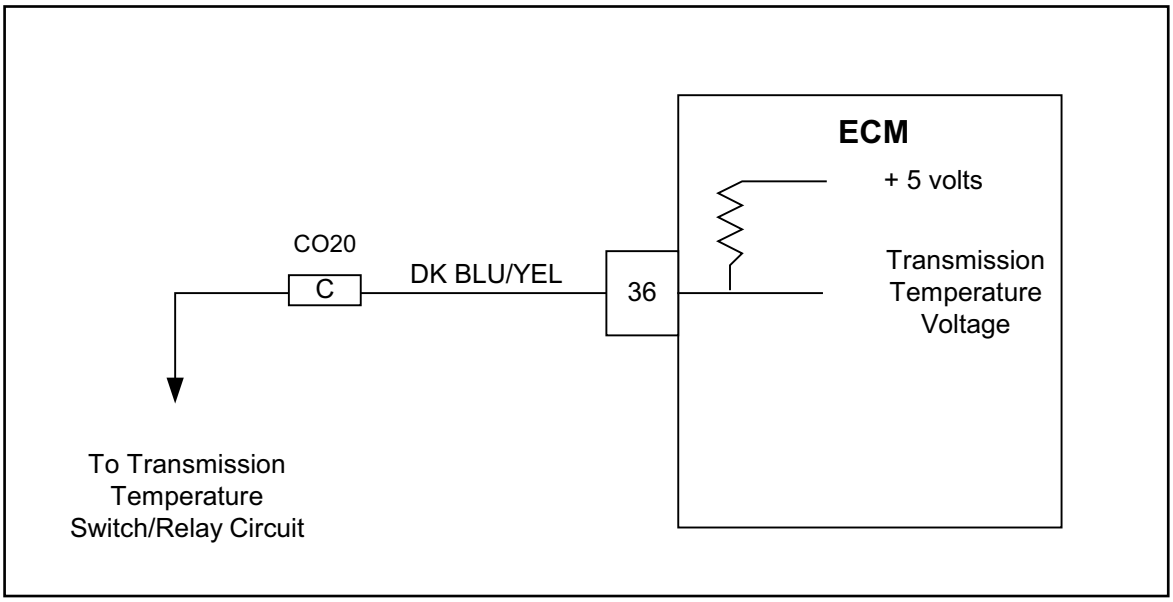
Conditions for Setting the DTC

- Throttle Position Sensor
- Check Condition-Cranking or Running
- Fault Condition-Throttle position is 20% greater than throttle command
- MIL-On during active fault
- Engine Shut Down

Circuit Description

There are 2 Throttle Position Sensors located within the throttle which use variable resistors to determine signal voltage based on throttle plate position. TPS1 will read low voltage when closed and TPS2 will read high voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded. This fault will set if the throttle command is 20% less than the actual throttle position. During this active fault the MIL light will turn on and the engine will shut down.

DTC 721-Transmission Over Temperature



Conditions for Setting the DTC

- Check Condition-Engine running
- Transmission Temperature High
- Fault Condition- closed circuit/voltage low
- MIL-On during active fault
- Power Derate 2

Circuit Description

The transmission temperature switch is used to communicate a high temperature condition to the ECM. Transmission damage can occur if the transmission is operated at high temperature. The ECM uses an analog voltage input with an internal 5 volt reference. If the transmission temperature circuit is grounded, the input voltage will be near zero. If it is open the input will be near 5 volts. The temperature switch is normally open and should close at 122C and remain closed until the temperature drops to 115C. The fault will set if the switch becomes closed with the engine running for longer than 10 seconds. Power derate 2 will be enforced to a maximum throttle position of 20%.

Diagnostic Aids

Before performing any electrical diagnostics be sure to check the transmission fluid levels and cooling systems for proper operation. Also verify that the truck is being operated to the manufactures specifications in regards to load, speed and environmental conditions. Failure to follow this recommendation may result in a false DTC diagnosis.

MIXER REPLACEMENT

Figure 3

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Remove the Throttle body assembly *Refer to Throttle Body Assembly Replacement.*
4. Remove the four (4) screws in the throttle body to FTV adapter and retain.
5. Remove and discard the mixer to FTV adapter O-ring.

Installation Procedure

NOTE

Lightly Lubricate the o-ring of the Mixer to FTV adapter before installing

Cover Throttle body adapter opening to prevent debris from entering engine until reassembly

1. Install Mixer to FTV adapter and secure with the four (4) screws.

   Tighten
   9 N•m (80 lb-in)

2. Install Throttle body Refer to Electronic Throttle Body Assembly Replacement.

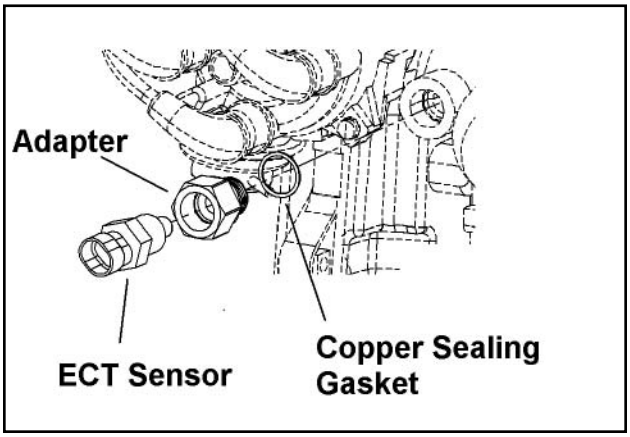


FIGURE 4
ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

Figure 4

1. Disconnect the ECT electrical connect.
2. Remove ECT from the adapter, do not remove the adapter.
3. Remove the ECT and discard.

Installation Procedure

- If the ECT adapter to the block is removed locate the brass washer and replace.
- If the ECT adapter is replaced with a new adapter **remove the O-ring supplied with the adapter** before installing the brass sealing washer.

4. Apply liquid pipe sealant to the ECT.
5. Install the ECT to the adapter and tighten to finger tight.
6. Tighten to specification.

   Tighten
   1 to 2 turns after finger tight

COOLANT HOSE REPLACEMENT

1. Drain coolant.
2. Using a hose clamp pliers disconnect both hose clamps on each hose.
3. Remove the coolant inlet hose form each fitting.
4. Remove the coolant outlet hose.

Installation Procedure

⚠ CAUTION

Coolant hose are specifically designed, DO NOT use hose material or length other than the OEM specified parts.

DO NOT mix the inlet or outlet hoses when re-installing.

1. Install hose clamps and set back on each hose.
2. Reinstall the coolant inlet hose to each fitting.
3. Reinstall the coolant outlet hose to each fitting.

10. Always use tools that are in good condition and be sure you understand how to use them before performing any service work.
11. Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary. Do not mix metric fasteners with standard nuts and bolts.
12. If possible, make all repairs with the truck parked on a level, hard surface. Block truck so it does not roll while working on or under truck.
13. Disconnect battery and discharge any capacitors (electric trucks) before starting to work on truck. Hang "Do not Operate" tag in the Operator's Compartment.
14. Repairs, which require welding, should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.
15. Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Do not connect wiring to a line containing fluid.
16. Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution.
17. Always support the mast and carriage to keep carriage or attachments raised when maintenance or repair work is performed, which requires the mast in the raised position.
18. Loose or damaged fuel, lubricant and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones which have been bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.
19. Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in event of a line, tube or seal failure, must be installed correctly.
20. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.
21. Do not operate a truck if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.

ENCLOSED ALTERNATOR KIT

Description

This kit provides an alternator of dust proof type or DS-type of UL standard.

Installation

(1) Remove the standard type alternator and install the enclosed type alternator.

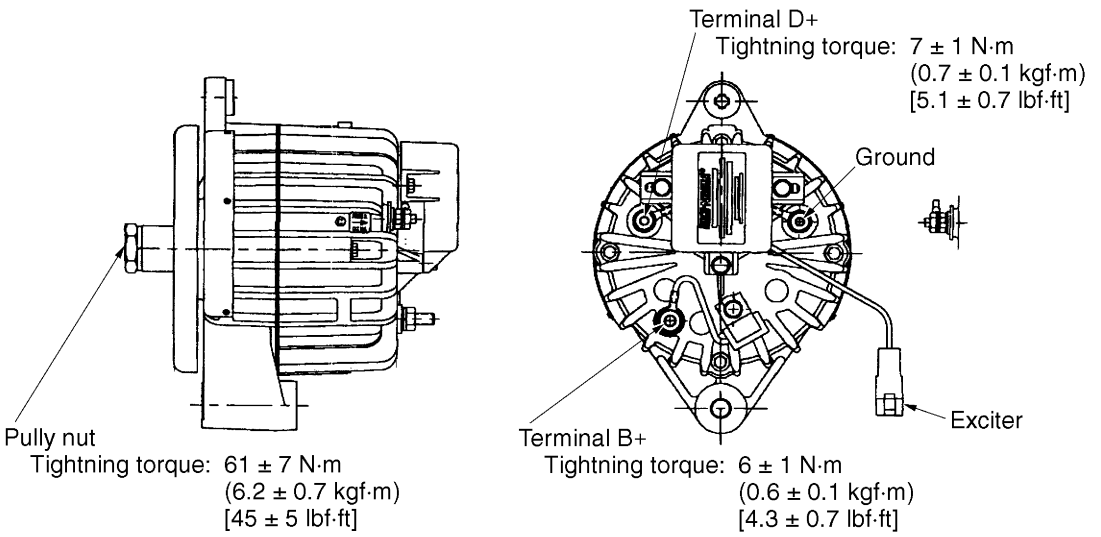
(2) All connectors included in this kit are to be sealed with RTV silicone or equivalent.

System check

(1) With key on, engine off, console should have three engine lights turned on.

(2) With engine running, battery charging voltage should be 14 V (± 0.5 V).

(3) Battery disconnect switch should function properly (if equipped).



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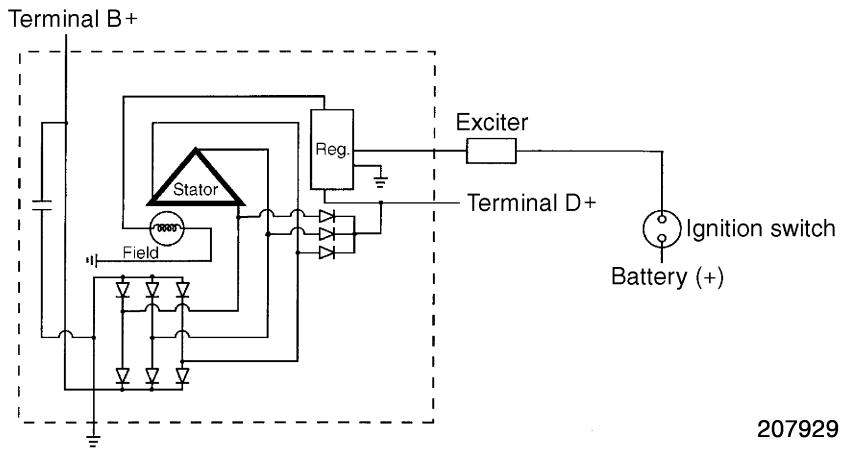
Wiring Diagram



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