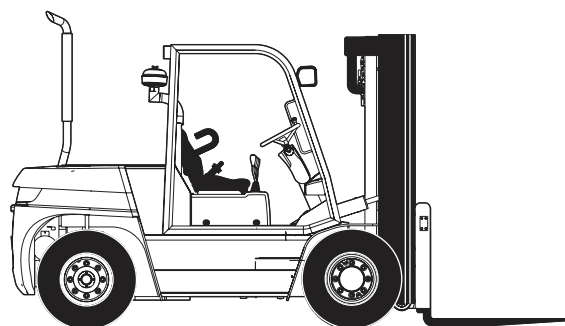


SERVICE MANUAL

C 60/70/75/80 D
C 60/70/75 L

RATED CAPACITY : 6000– 8000kg



Part No. 8051043
Book No. SM 751
Feb. 2009

CLARK
THE FORKLIFT

(Head office) 202-1 Ojung-Dong, Ojung-Gu,
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Kyungnam, Korea

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IMPORTANT

Do not lift the disabled truck or any wheels off the floor while the truck is being towed.

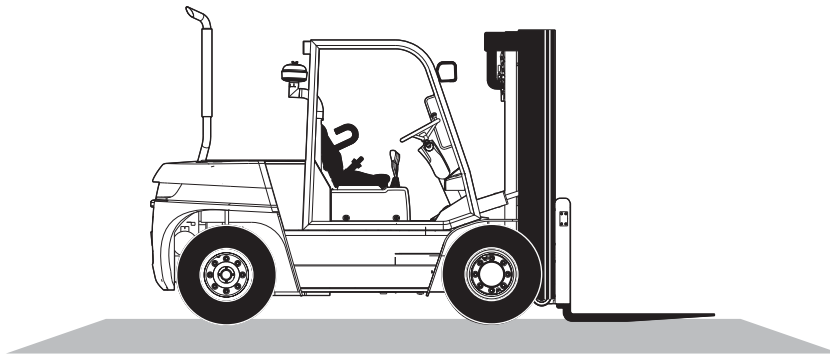
9. Park the disabled truck in authorized areas only. Fully lower the forks on the floor, leave the directional control in neutral, turn the ignition switch to OFF, and engage the parking brake. Remove the ignition key and, when necessary, block the wheels to prevent the truck from rolling.



WARNING

Always engage the parking brake when parking a lift truck. The truck can roll and cause injury or death to personnel near it.

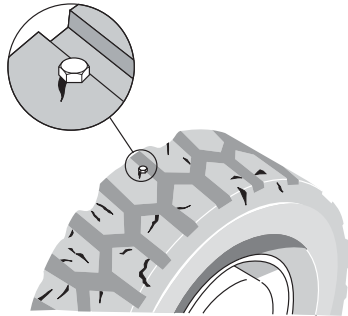
LIFT TRUCK PARKING



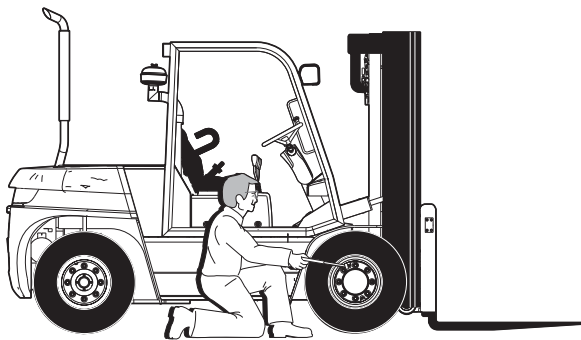
Inspect the fork latches to ensure that they are in good condition, operate freely, and lock correctly.

Wheels and Tires

Check the condition of the drive and steer wheels and tires. Remove objects that are embedded in the tread. Inspect the tires for excessive wear or breaks or "chunking out."



Check all wheel lug nuts or bolts to be sure none are loose or missing. Have missing bolts or lug nuts replaced and tightened to correct torque as explained in Group 22.



WARNING

Check tire pressure from a position facing the tread of the tire, not the side. Use a long-handled gauge to keep your body away. If tires are low, the tire may require removal and repair. Incorrect (low) tire pressure can reduce truck stability. See "Specifications" in Group 22 for proper inflation pressure.

Brake and Inching Pedal Freeplay

There should be no inching and 4~6mm braking pedal freeplay. Both pedals should be at same the height. Adjust as described in Group 23.

Functional Tests

Be sure that:

- Parking brake is applied
- Directional control is in "N" (neutral).

Test the horn, lights, and all other safety equipment. Be sure they are properly mounted and working correctly. Test all controls to ensure that they operate freely and return to neutral properly.

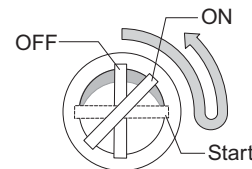
Now prepare to start the truck and test its operation.

Starting System

A 3-position starter switch is standard equipment.

Check the **neutral start** function by placing the direction control lever in forward or reverse and turning key switch to "start" position. The starter must not engage until the direction control lever is moved to "neutral" position.

As you start the engine, check the instrument display. All indicator lights should come on for a 2-second lamp check. The seat belt prompt light should remain on for 4 seconds, accompanied by a buzzer sound. The parking brake light should remain on if the brake is set. If the truck has a diesel engine, the glow plug preheat light should remain on for 6 seconds. If the lights do not operate as described, refer to Group 13 to diagnose the problem.



Engine Shut Down Mode

If the truck's fault protection system detects low engine oil pressure, excessive transmission oil temperature, or excessive engine coolant temperature, the truck will go into "shutdown mode"—a buzzer will sound for 30 seconds, after which the truck will shut itself off. The truck may be restarted, but if the fault condition still exists, the engine will again shutdown in 30 seconds.

Parking Brake Interlock

The transmission should disengage when the parking brake is on and reengage when the parking brake is released.

1. Apply the parking brake.
2. Start the engine, if it is not already running.
3. Place the direction control in forward or reverse. Make sure the path is clear in the chosen direction.

Description of working principles

Fuel is sucked from the fuel tank by the priming pump. This last one is placed on the engine basement and is driven by the camshaft.

Throughout the filter/s, the fuel is piped to the union fitting vacuum chamber of the transfer pump. (For applications to be equipped in cold climate areas, the fuel filter is provided with heater).

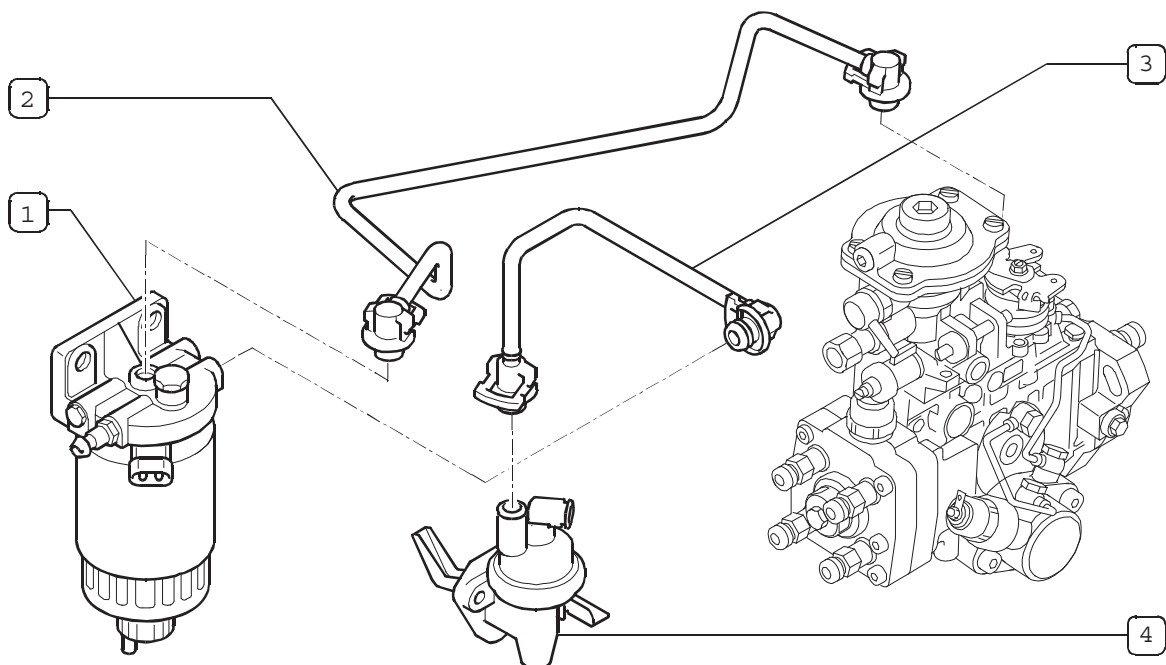
Transfer pump is placed inside the feed pump, and is bladed type; its duty is to increase fuel pressure in correspondence with the increase of the number of revolutions.

The fuel arrives therefore to the valve gauging the pressure inside feed pump.

The distribution plunger further increases this pressure and delivers fuel throughout the delivery pipe fitting to the injectors.

The fuel drawing from the injectors is recovered and delivered to the tank again.

Figure 2



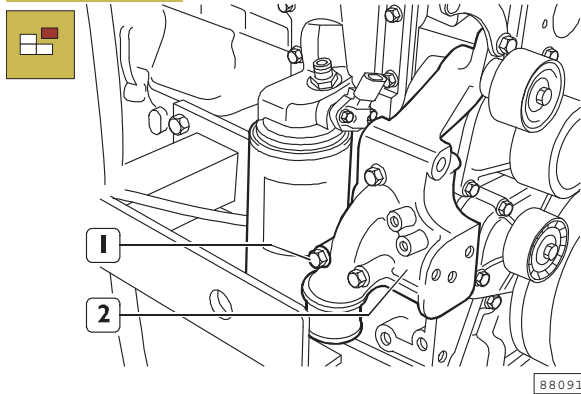
75807

–Loosen the screws (1) and withdraw the alternator bearing (2).

NOTE

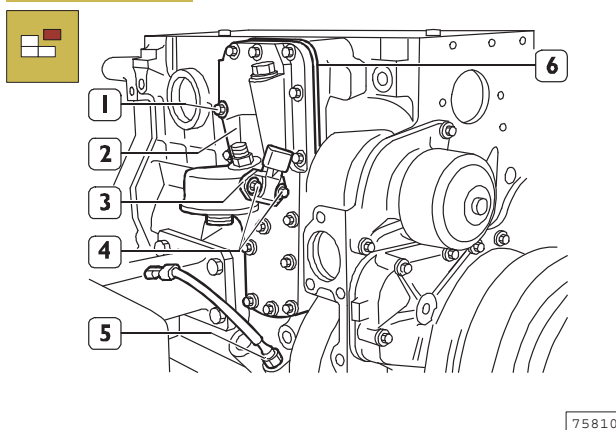
The shape and the dimensions of the support of the alternator vary according to the use of the engine. The relevant pictures provide a general guide of the procedure that is to be carried out. The procedures described are always applicable.

Figure22



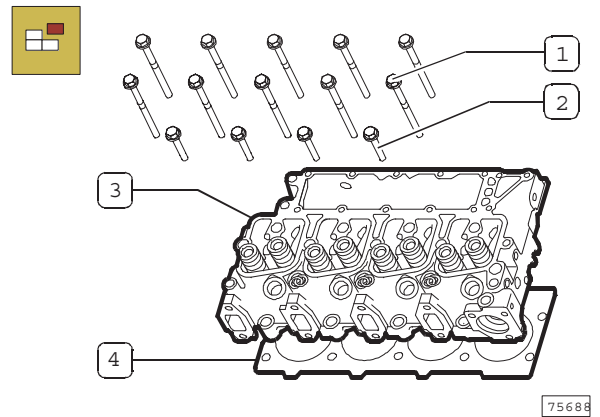
–Loosen the screws (4) and disassemble the oil pressure/temperature sensor (3) (if fitted).
 –Loosen the screws (1) and disassemble the oil filter/heat exchanger bearing (2), interlayer plate (6) and relating gaskets.
 –Disassemble oil level sensor (5) (whether provided).
 –Disassemble injection pump (see specific procedure) and the power take-off underneath.

Figure23



–Disassemble cylinder head; loosen the screws (1) and (2) fixing the cylinder head (3); hook the brackets with metal ropes and, through-out a hoist withdraw cylinder head from the block.

Figure24



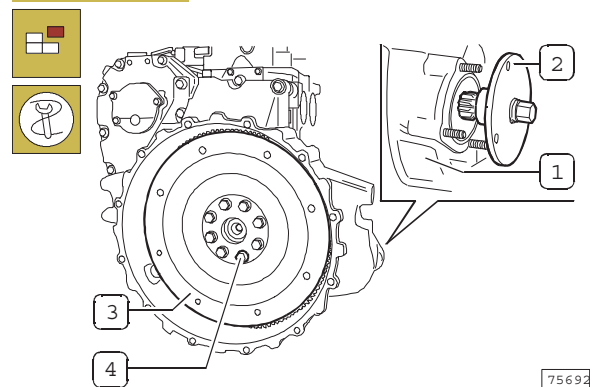
–Use the tool 99360339 (2) to operate on the flywheel cover box (1) in order to block flywheel rotation (3). (Utilise starter holding down studs and fixing screw-nuts).

–Loosen the flywheel fixing screws (4) to engine drive shaft.

NOTE

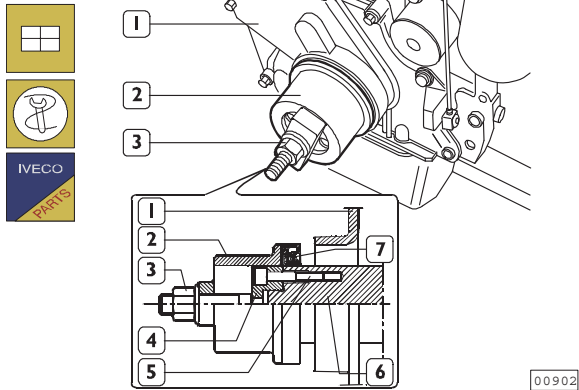
In some versions there is provided 99360351 tool checking the flywheel.

Figure25



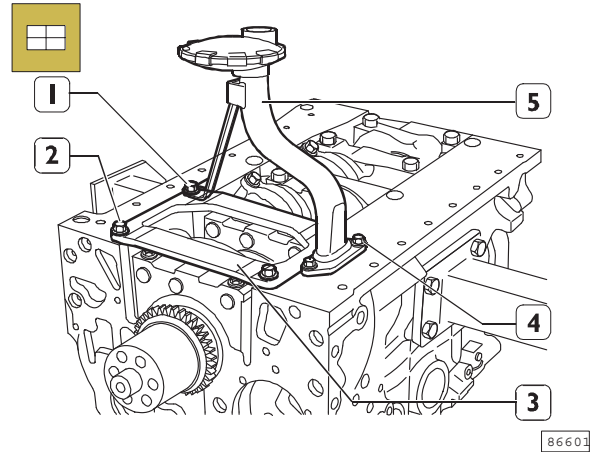
- Apply on engine drive shaft front tang (6) the detail (4) of the tool 99346252, fix it with the screws (5) and key the new holding ring on it (7).
- Place the detail (2) on the detail (4), screw-up the threaded nut until carrying out the complete assembly of the holding ring (7) to the front cover.

Figure60



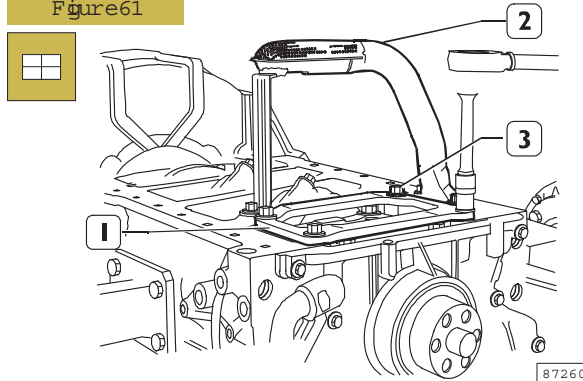
- Assemble the plate (3), the suction rose (5) and tighten the fixing screws (1, 2 and 4) to the prescribed torque.

Figure62



- Assemble the plate (1), the rose pipe (2), tighten the fixing screws (3) and fix them to the prescribed couple.

Figure61



Rotary feed pump disassembly and assembly procedure

NOTE

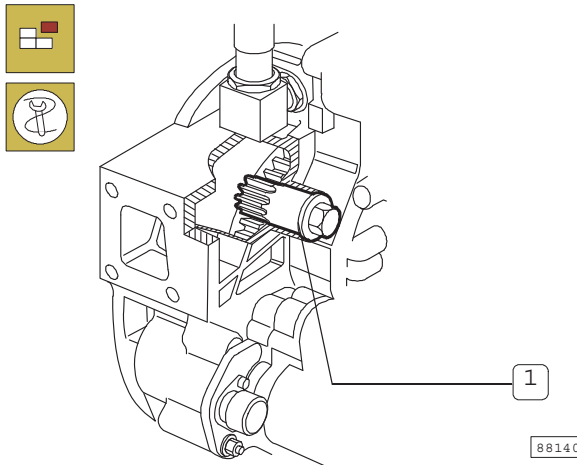
This procedure prescribes that:

- The fuel pipelines (from pumping elements to injectors, bleeding recovery pipes from injectors to pump, LDA pipeline and feed provided by priming pump) shall all be disassembled.
- Electrical connection to feed pump shall be disconnected.
- Accelerator cable shall be disconnected.

Engine versions with tool (99360330)

Disassemble the starter from the flywheel box and use tool 99360330 (2) to rotate the flywheel.

Figure 103



Engine versions with tool (99360339)

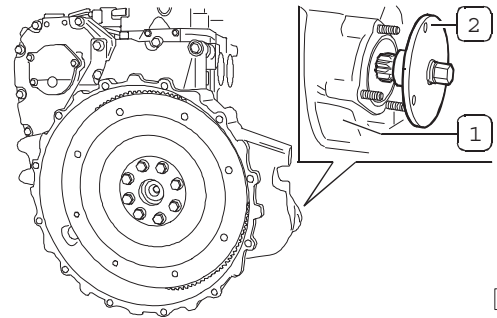
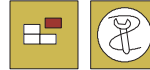
Disassemble the starter from the flywheel box (1) and use tool 99360339 (2) to rotate the flywheel.

In case feed pump replacement is necessary, this shall be supplied pre-set already as spare part.

On the other hand, in case the pump shall be disassembled and reassembled later on without being repaired it will be necessary to pre-set it while it is still assembled to the engine and disassemble it only afterwards.

The following procedure analyses this second hypothesis since it is the more complex.

Figure 104



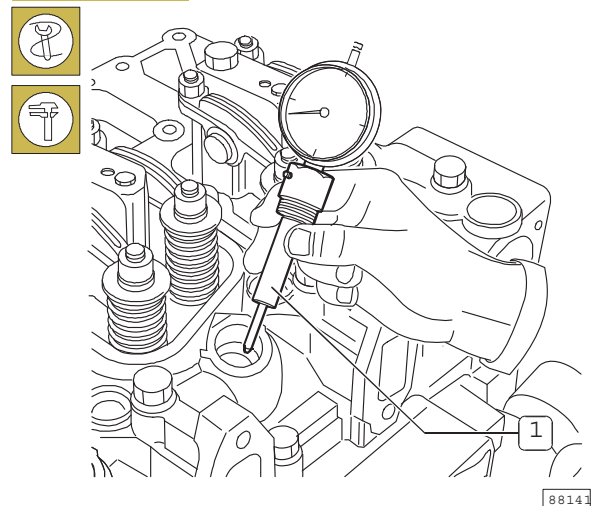
Find the top dead centre with the tool (99395097) - False injector

Remove the rocker covers of the 1st cylinder; remove the 1st injector and place the tool (1) to set the 1st cylinder top dead centre position (end-of-compression phase). Pre-load the gauge.

The searched condition is obtained by rotating the engine shaft properly until you find the maximum value on the comparator and then checking that the intake and exhaust valves are both closed.


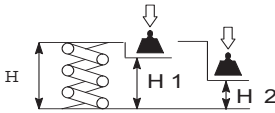
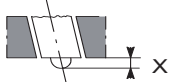
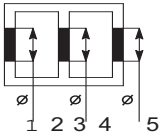
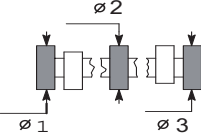
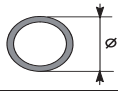



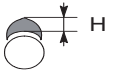


Once PMS has been obtained, lock the flywheel by means of tool 99360339 (Figure 104).

Figure 105 (Demonstration)



- Unscrew the side screw that locks the pump shaft partially (1) and remove spacer (2). This must be kept on

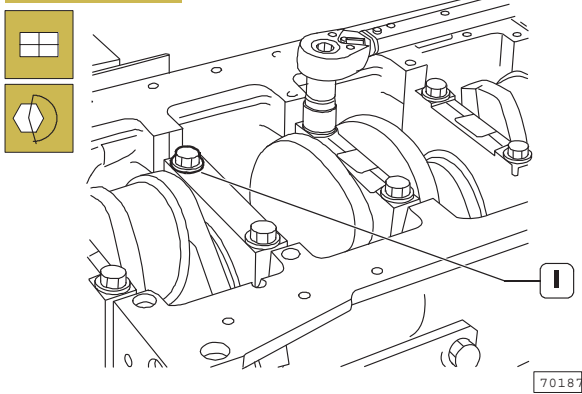
ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
Engine running with abnormal knocking	Knocking of crankshaft causing excessive play on one or more main or rod bearings or excessive play on shoulders.	Rectify the pins of the crankshaft and install smaller bearings. Replace the thrust half-rings.	
	Crankshaft unbalanced.	Check alignment of crankshaft.	
	Loosening of screws securing flywheel.	Replace the loosened screws and tighten all the screws to the specified torque.	
	Misalignment of rods.	Replace the rods.	
	Noise from piston journals due to excessive play of piston hubs and in the rod bushing.	Replace the piston journal and/or the piston and rod bushing.	
	Loose bushings in the rod seatings.	Replace with new bushings.	
	Noisy timing.	Adjust the play between camshaft cams and tappets and check that there are no broken springs, that there is no excessive play between the valve stems and the valve guides, tappets and seatings.	
The engine smokes abnormally. Black or dark grey smoke.	Excessive maximum pump output.	Disconnect the pump and adjust delivery in accordance with the data given in the calibration table.	See your Iveco dealer.
	K.S.B. device out of calibration or malfunctioning.	Check operation by a tester and adjust correctly as described in the manual.	
	There is an excessive delay on the injection pump.	Correct the set-up.	

	Type	4 CYLINDERS	6 CYLINDERS
CYLINDER HEAD . TIMING SYSTEM		mm	
	Valve spring height:		
	free spring H		63.50
	under a load equal to:		
	329 N H1		49.02
	641 N H2		38.20
	Injector protrusion X		-
	Camshaft bush housings No. 1-5		59.222 to 59.248
	Camshaft housings No. 2-3-4		54.089 to 54.139
	Camshaft journals:		
	1 → 5 ∅		53.995 to 54.045
	1 → 7 ∅		
	Camshaft bush outside diameter: ∅		59.222 to 59.248
	Bush inside diameter ∅		54.083 to 54.147
	Bushes and housings on block		-
	Bushes and journals		0.038 to 0.162
	Cam lift:		
		H	11.02
		H	10.74

Tighten the pre-lubricated screws (1) in the following three successive stages:

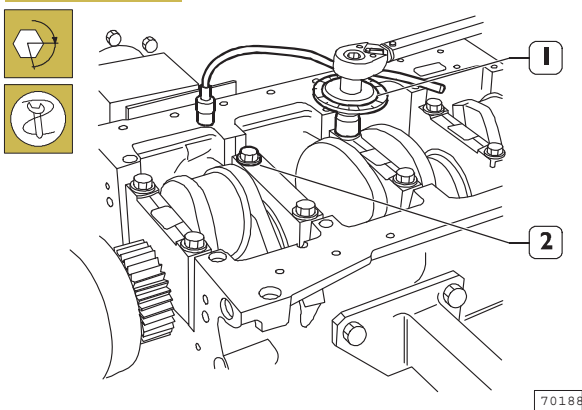
- 1st stage, with torque wrench to 50 ± 6 Nm.
- 2nd stage, with torque wrench to 80 ± 6 Nm.

Figure36



-3rd stage, with tool 99395216 (1) set as shown in the figure, tighten the screws (2) with $90^\circ \pm 5^\circ$ angle.

Figure37



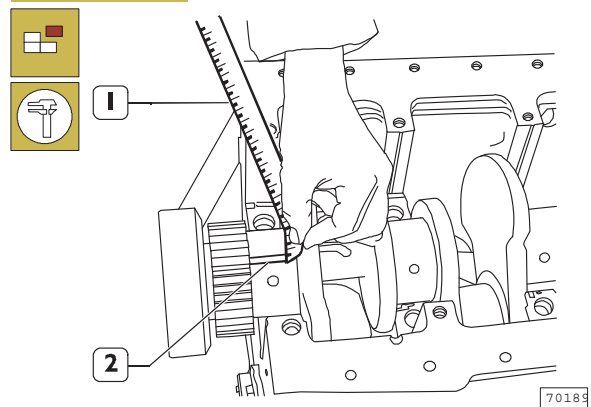
-Remove caps from supports.

The backlash between the main bearings and the pins is found by comparing the width of the calibrated wire (2) at the narrowest point with the scale on the envelope (1) containing the calibrated wire.

The numbers on the scale indicate the backlash in mm.

Replace the half bearings and repeat the check if a different backlash value is found. Once the specified backlash is obtained, lubricate the main bearings and fit the supports by tightening the fastening screws as previously described.

Figure38

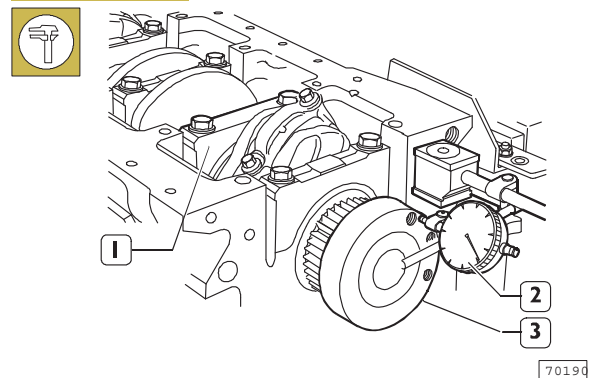


Checking output shaft shoulder clearance

This check is performed by setting a magnetic-base dial gauge (2) on the output shaft (3) as shown in the figure, standard value is 0.068 to 0.41.

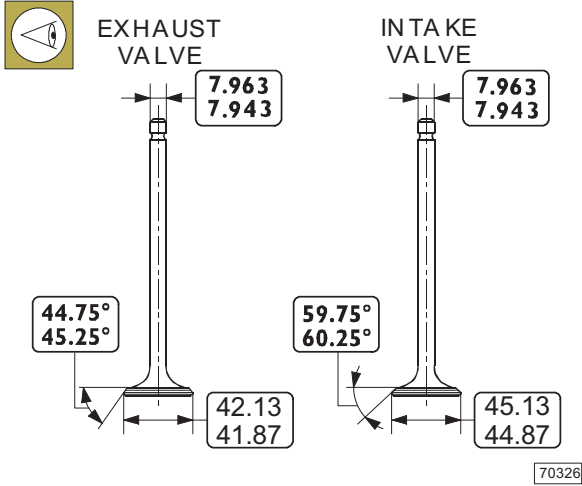
If higher value is found, replace main thrust half bearings of the second last rear support (1) and repeat the clearance check between output shaft pins and main half bearings.

Figure39



VALVES

Figure 80



INTAKE AND EXHAUST VALVE MAIN DATA

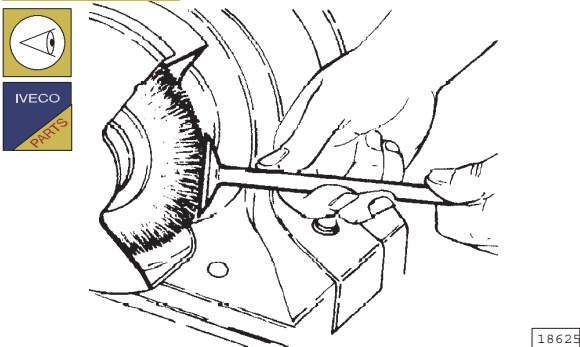
Removing carbon deposits, checking and grinding valves

Remove carbon deposits from valves using the proper metal brush.

Check that the valves show no signs of seizing, scoring or cracking.

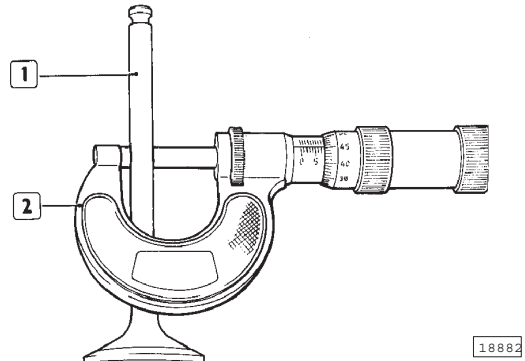
Regrind the valve seats, if required, using tool 99305018 and removing as less material as possible.

Figure 81



Check the valve stem (1) using a micrometer (2), it shall be 7.943 to 7.963.

Figure 82

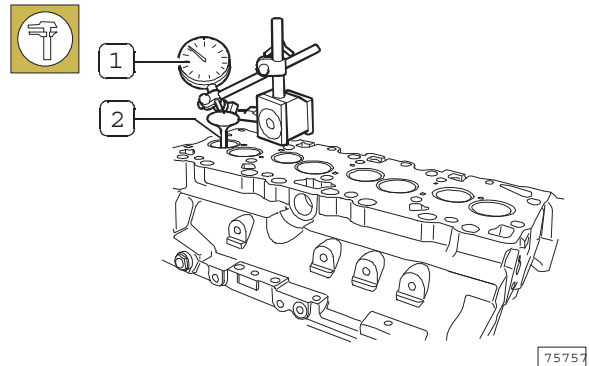


Checking clearance between valve stem and valve guide and valve centering

Use a magnetic base dial gauge (1) set as shown in the figure, the assembling clearance shall be 0.056 0.096 mm.

Turn the valve (2) and check that the centering error is not exceeding 0.03 mm.

Figure 83



APPENDIX

SAFETY PRESCRIPTIONS

Particular attention shall be drawn on some precautions that must be followed absolutely in a standard working area and whose non fulfillment will make any other measure useless or not sufficient to ensure safety to the personnel in-charge of maintenance.

Be informed and inform personnel as well of the laws in force regulating safety, providing information documentation available for consultation.

- Keep working areas as clean as possible, ensuring adequate aeration.
- Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.
- Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.
- Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.
- Smoking in working areas subject to fire danger must be strictly prohibited.
- Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

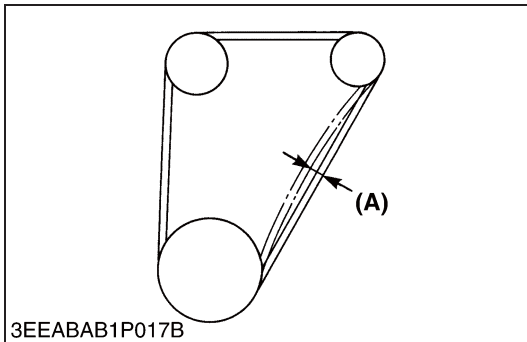
- Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.
- Wear safety gloves and goggles when performing the following operations:
 - filling inhibitors or anti-frost
 - lubrication oil topping or replacement
 - utilization of compressed air or liquids under pressure (pressure allowed: ≤ 2 bar)
- Wear safety helmet when working close to hanging loads or equipment working at head height level.
- Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.
- Use protection cream for hands.
- Change wet cloths as soon as possible
- In presence of current tension exceeding 48-60 V verify efficiency of earth and mass electrical connections.

Ensure that hands and feet are dry and execute working operations utilizing isolating foot-boards. Do not carry out working operations if not trained for.

- Do not smoke nor light up flames close to batteries and to any fuel material.
- Put the dirty rags with oil, diesel fuel or solvents in anti-fire specially provided containers.
- Do not execute any intervention if not provided with necessary instructions.
- Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.
- In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

- Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait until the temperature decreases under 50°C.
- Never top up an overheated engine with cooler and utilize only appropriate liquids.
- Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.
- Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.
- Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.
- Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.
- Do not leave rags impregnated with flammable substances close to the engine.
- Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.
- Do not utilize fast screw-tightening tools.
- Never disconnect batteries when the engine is running.
- Disconnect batteries before any intervention on the electrical system.
- Disconnect batteries from system aboard to load them with the battery loader.
- After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.



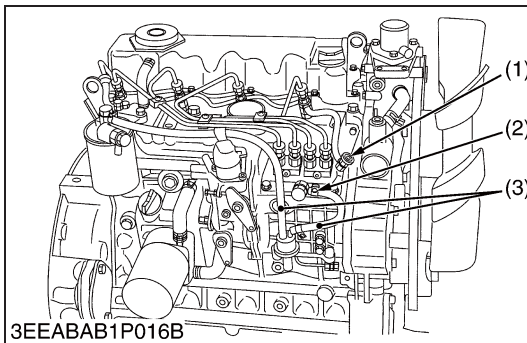
Fan Belt Tension

1. Measure the deflection (A), depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection (A)	Factory spec.	10 to 12 mm 0.394 to 0.472 in.
----------------	---------------	-----------------------------------

(A) Deflection

[3] CHECK POINT OF EVERY 50 HOURS



Checking Fuel Hose and Clamp Bands

1. If the clamp (2) is loose, apply oil to the threads and securely retighten it.
2. The fuel hose (3) is made of rubber and ages regardless of the period service.
Change the fuel pipe together with the clamp every two years.
3. However, if the fuel hose and clamps are found to be damaged or deteriorate earlier than two years, then change or remedy.
4. After the fuel hose and the clamps have been changed, bleed the fuel system.



CAUTION

- Stop the engine when attempting the check and change prescribed above.

(When bleeding fuel system)

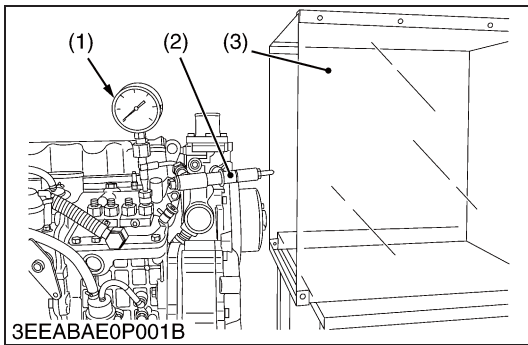
1. Fill the tank with fuel and open the cock.
2. Loosen the air vent coupling bolt of fuel filter a few turns.
3. When there is no more air bubbles in the fuel coming out of this coupling bolt, tighten the coupling bolt.
4. Open the air vent cock (1) on the top of fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key on **AC** position and pump the fuel up for 10 to 15 seconds.
If equipped mechanical fuel feed pump, set the stop lever on stop position and crank the engine for 10 to 15 seconds.
6. Close securely the air vent cock (1) after air bleeding.

■ IMPORTANT

- Except when venting the air, be sure to keep closed the air vent coupling bolt of the fuel injection pump. Otherwise, the engine may stall.

(1) Air Vent Cock
(2) Clamp

(3) Fuel Hose



Checking Injection Pump

(Fuel Tightness of Pump Element)

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

(Fuel Tightness of Delivery Valve)

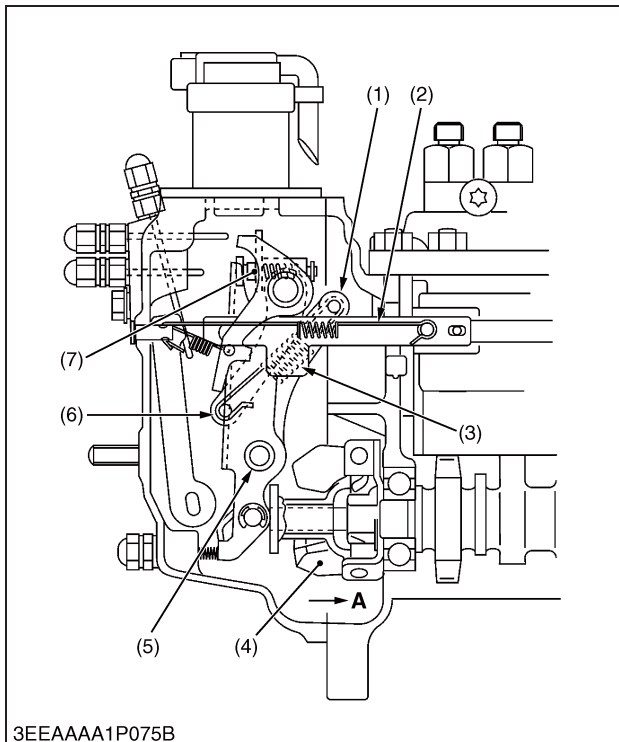
1. Remove the engine stop solenoid.
2. Remove the injection pipes.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hand and raise the pressure to approx. 18.63 MPa (190 kgf/cm², 2702 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 18.63 to 17.65 MPa (from 190 to 180 kgf/cm², from 2702 to 2560 psi).
8. Measure the time needed to decrease the pressure from 18.63 to 17.65 MPa (from 190 to 180 kgf/cm², from 2702 to 2560 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of pump element	Allowable limit	18.63 MPa 190 kgf/cm ² 2702 psi
Fuel tightness of delivery valve	Factory spec.	10 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm ² 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm ² 2702 → 2560 psi

■ NOTE

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

- (1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

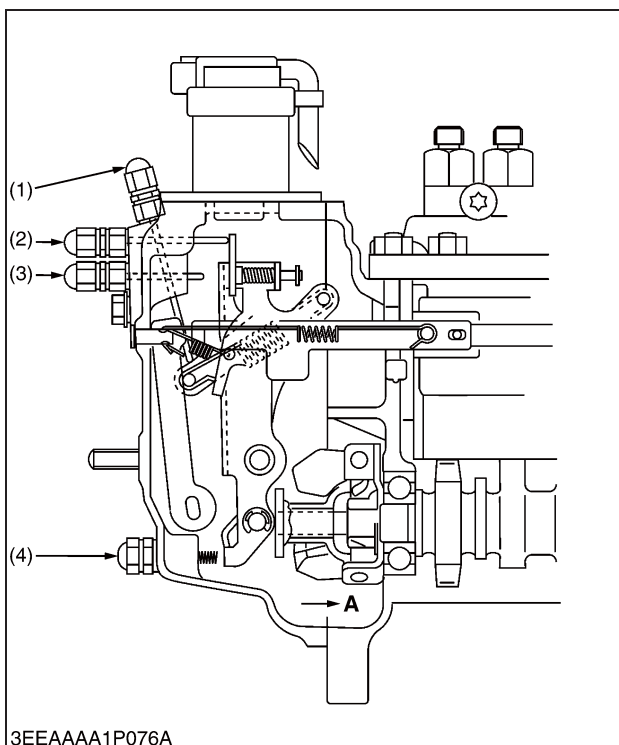


■ At Idling

Turn the speed control lever (6) clockwise to idle the engine. It tensions the governor spring (3) to pull the fork lever 2 (1).

When the fork lever 2 is pulled, it moves the torque spring pin (7) and the fork lever 1 (5) in the direction of the arrow **A** to restrain the weight. In combination with the start spring tension, it is balanced with the centrifugal force of flywheel weight to keep idling.

- | | |
|---------------------|-------------------------|
| (1) Fork Lever 2 | (5) Fork Lever 1 |
| (2) Start Spring | (6) Speed Control Lever |
| (3) Governor Spring | (7) Spring Pin |
| (4) Flyweight | |



■ At rated speed with full load and overload

As the speed control lever is changed from the middle speed to high speed, the governor spring tension increases to compress the torque spring and move the fork lever 1 in the direction of the arrow **A**.

The fork lever 2 moves until it reaches the output limiting bolt to keep rated rotation and rated output.

When the engine is overloaded, the engine rotating speed decreases and the centrifugal force of flywheel weight decreases. Then the torque spring moves the fork lever 1 in the direction of arrow **A**.

The control rack moves in the direction that increases fuel supply to increase the output. It is balanced with the centrifugal force of the flywheel weight to produce low-speed output (torque output).

- | | |
|------------------------------|---------------------------|
| (1) No-load Maximum Rotation | (3) Torque Limiting Bolt |
| (2) Output Limiting Bolt | (4) Idling Adjusting Bolt |

Symptom	Probable Cause	Solution	Reference Page
Deficient Output	Incorrect injection timing	Adjust	
	Engine's moving parts seem to be seizing	Repair or replace	–
	Injection pump malfunctioning	Repair or replace	
	Deficient nozzle injection	Repair or replace nozzle	
	Compression leak	Check the compression pressure and repair	
	Gas leak from exhaust system	Repair or replace	
	Air leak from compressor discharge side	Repair or replace	
	Air cleaner dirty or clogged	Clean or replace	
Excessive Lubricant Oil Consumption	Compressor wheel turning heavily	Replace the turbo-charger assembly	
	Piston ring's gap facing the same direction	Shift ring gap direction	
	Oil ring worn or stuck	Replace	
	Piston ring groove worn	Replace piston	
	Valve stem and valve guide worn	Replace	
	Crankshaft bearing and crank pin bearing worn	Replace	
Fuel Mixed into Lubricant Oil	Oil leaking due to defective seals or packing	Replace	–
	Injection pump's plunger worn	Repair or replace	
	Deficient nozzle injection	Repair or replace nozzle	
Water Mixed into Lubricant Oil	Injection pump broken	Replace	
	Head gasket defective	Replace	
Water Mixed into Lubricant Oil	Cylinder block or cylinder head flawed	Replace	
	Low Oil Pressure	Engine oil insufficient	Replenish
Oil strainer clogged		Clean	
Relief valve stuck with dirt		Clean	
Relief valve spring weaken or broken		Replace	
Excessive oil clearance of crankshaft bearing		Replace	
Excessive oil clearance of crankpin bearing		Replace	
Excessive oil clearance of rocker arm		Replace	
Oil passage clogged		Clean	–
Different type of oil		Use specified type of oil	
Oil pump defective		Replace	

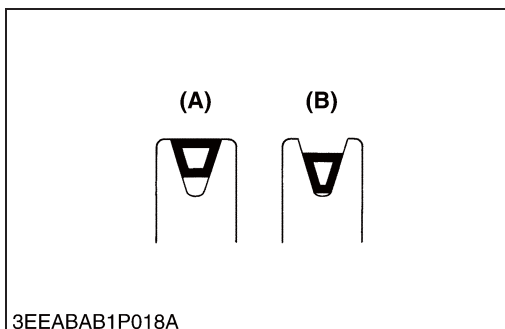


Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

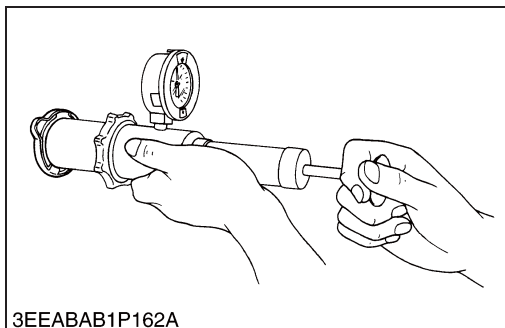
(A) Good

(B) Bad



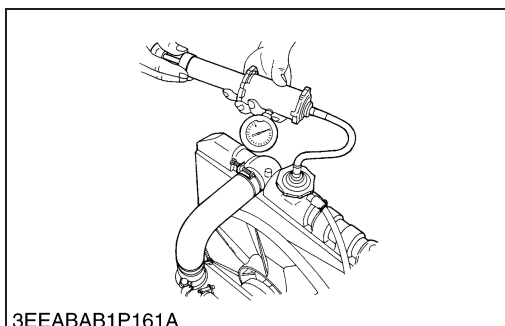
CAUTION

- When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.



Radiator Cap Air Leakage

1. Set a radiator tester on the radiator cap.
2. Attach a radiator tester.
Apply the specified pressure of 88 kPa (0.9 kgf/cm², 13 psi).
3. Check if the pressure drop to less than 59 kPa (0.6 kgf/cm², 9 psi) in 10 seconds.
4. If the pressure is less than the factory specification, replace it.

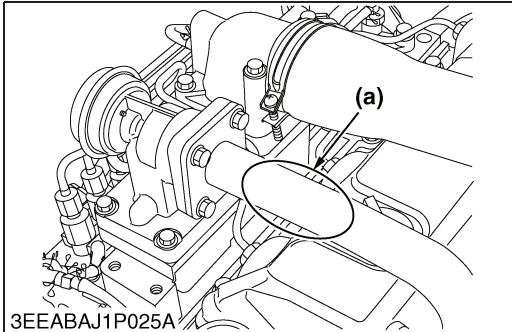


Radiator Water Leakage

1. Pour a specified amount of water into the radiator.
2. Attach a radiator tester.
Increase water pressure to the specified pressure of 137 kPa (1.4 kgf/cm², 20 psi).
3. Check the radiator for water leaks.
4. When water leakage is excessive, replace the radiator. If water leakage is caused by a small pinhole, correct the radiator with radiator sealant.

[2] EGR SYSTEM

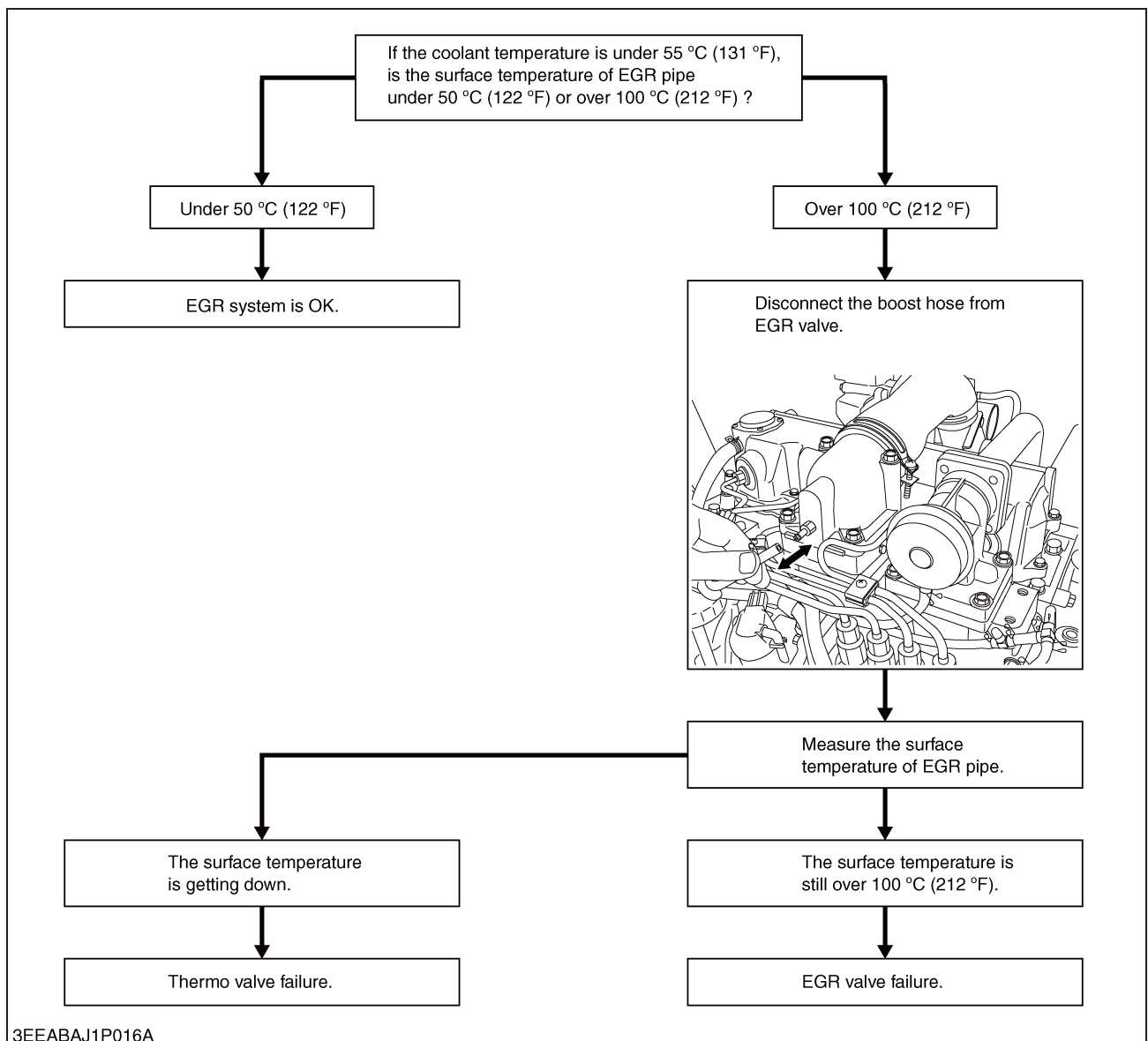
(1) Checking the function of EGR system (V3800DI-T-E3B Engine)



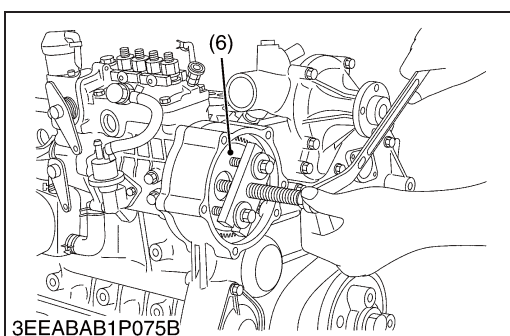
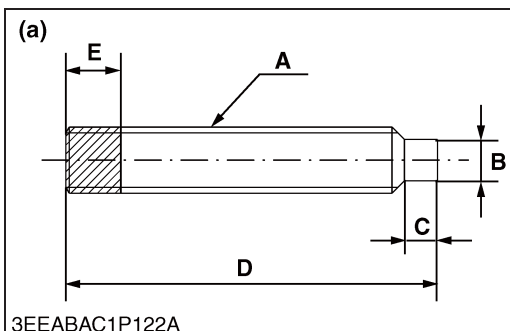
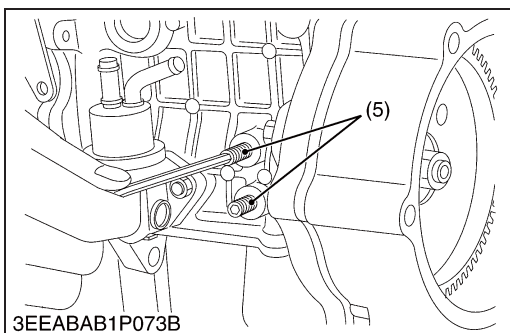
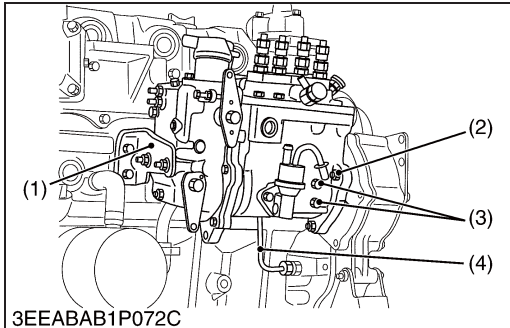
1. Check the coolant temperature and monitor the coolant temperature while checking 1) and 2).
2. If the coolant temperature is already 55 °C (131 °F), cool down the engine.
3. Start the engine and go to check 1) immediately.
4. After completing checking 1), arrange the coolant temperature is getting over 70 °C (158 °F).
5. If the coolant temperature is over 70 °C (158 °F), go to check 2).

(a) Measuring Place of EGR Pipe Surface Temperature

1) If the coolant temperature is under 55 °C (131 °F), the surface temperature of EGR pipe must be under 50 °C (122 °F).



(8) Injection Pump Unit



Injection Pump Unit (V3800DI-T-E2B Engine)

(Removing the fuel injection pump unit)

1. Detach the gear cover for the fuel injection pump unit from the gearcase.
2. Place the piston of the 4th cylinder at the top dead center in the compression stroke. Fix the flywheel with the flywheel stopper.

■ IMPORTANT

- Look for the align mark on the idle gear 2. Using a white marking pen or the like, put an align mark on the engaged tooth of the idle gear. This helps to reassemble these gears in mesh later.

■ NOTE

- When the already existing align marks align with each other, there is no need to put another align mark.
3. Unscrew the two plugs (3) of the injection pump unit.
 4. Tighten the upper fuel cam shaft lock screw (5) until it comes into contact with the fuel cam shaft. Make sure the cam shaft does not move any longer.
 5. Tighten the lower fuel cam shaft lock screw (5) until it comes into contact with the fuel cam shaft.

■ NOTE

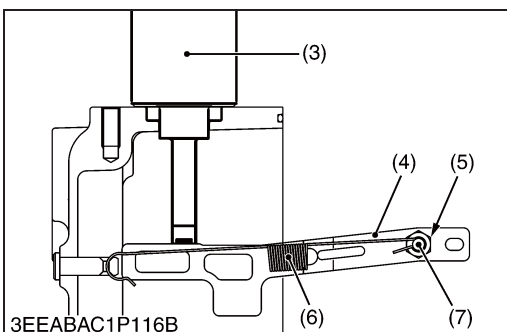
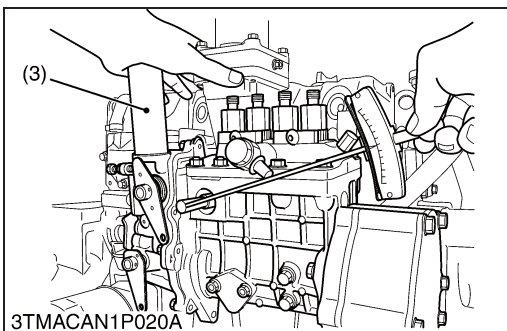
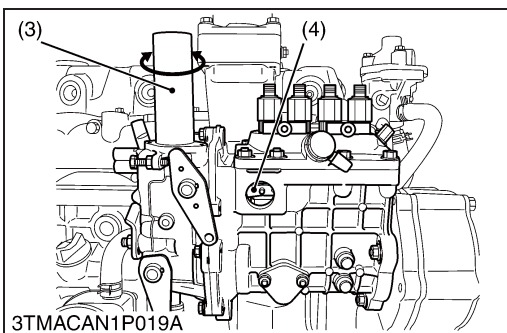
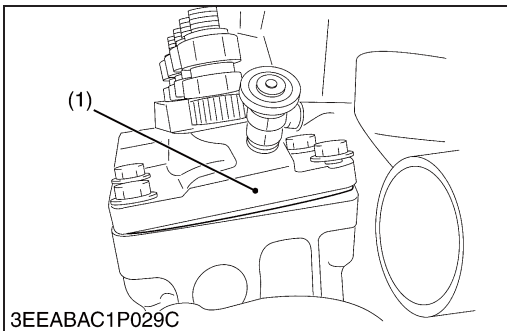
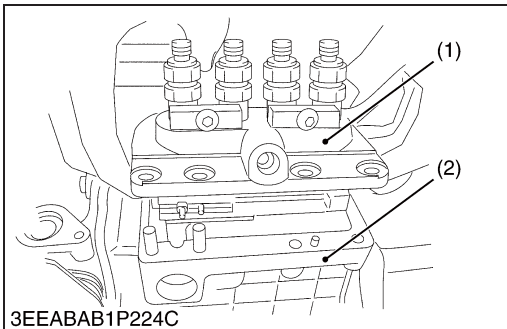
- Never overtighten the lock screws when they have come into contact with the cam shaft. Otherwise the injection pump itself may get damaged.
 - Use of a socket set screw (dog point type) is recommended for best results. Such screw can be constructed as shown in figure (a).
6. Loosen the injection pump gear mounting nut. Using the specific gear puller, take out the gear (6).

■ NOTE

- Be careful not to drop the key.
7. Disconnect the lubricating oil pipe (4).
 8. Loosen the three injection pump unit mounting nuts (2).
 9. Remove the injection pump unit support (1) and take out the injection pump unit.

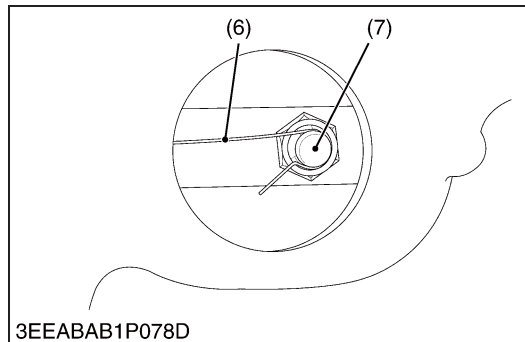
A	M8 □ Pitch 1.25
B	5 mm dia. (0.197 in. dia.)
C	4 mm (0.157 in.)
D	45 mm (1.772 in.)
E	10 mm (0.39 in.) : Conspicuously Painted

- | | |
|--------------------------------------|--------------------------------------------------------------------|
| (1) Injection Pump Unit Support | (4) Lubricating Oil Pipe |
| (2) Injection Pump Unit Mounting Nut | (5) Fuel Cam Shaft Lock Screw
(Socket Set Screw Dog Point Type) |
| (3) Plug | (6) Injection Pump Gear |



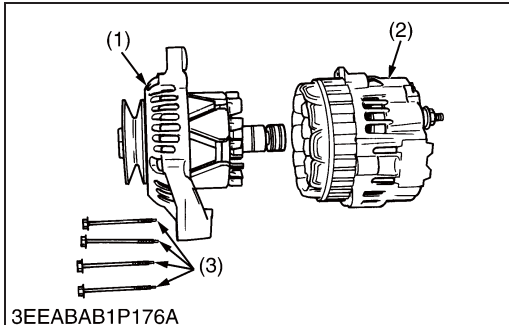
Installing Procedure of Injection Pump Assembly

1. Install the fuel injection pump assembly (1) in its unit (2), and tighten the mounting screws and nuts like the figure, which the injection pump assembly (1) keeps tilted.
2. Hook the governor connecting rod (4) to the rack pin of the injection pump assembly (1).
3. Tighten the mounting screws and nuts with the specified torque, not to slide off the governor connecting rod (4) from the rack pin.
4. Place the service jig (3) in the stop solenoid mounting hole of the fuel injection pump unit.
5. Make sure the permanent magnet at the tip of the service jig is attracted to the governor connecting rod (4). To do this, turn the jig a little clockwise and counterclockwise and look into the fuel injection pump unit sight hole to see if the governor connecting rod (4) moves right and left accordingly.
6. Slightly tighten the anti-rotation nut of the governor connecting rod.
7. Holding down the service jig (3) by hand, tighten up the anti-rotation nut (5) to the specified torque.
8. Hook the start spring (6) to the rack pin (7).



- | | |
|----------------------------------|-----------------------|
| (1) Fuel Injection Pump Assembly | (5) Anti-rotation Nut |
| (2) Fuel Injection Pump Unit | (6) Start Spring |
| (3) Service Jig | (7) Rack Pin |
| (4) Governor Connecting Rod | |

(15) Alternator



Front Bracket

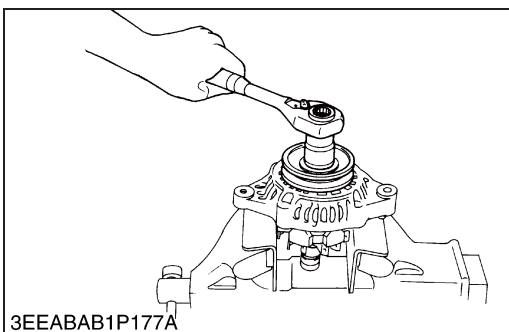
1. Remove the 4 screws (3).
2. Separate the front bracket (1) and the rear bracket (2) from each other.

■ IMPORTANT

- Put a tally line on the front bracket and the rear bracket for reassembling them later.

(1) Front Bracket
(2) Rear Bracket

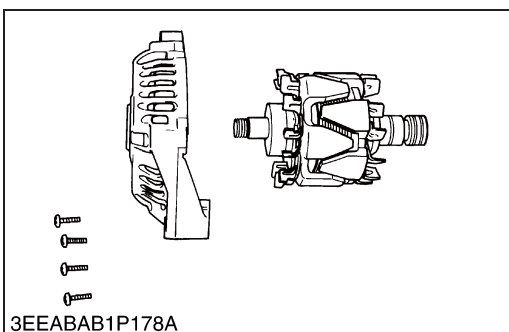
(3) Screw



Pulley

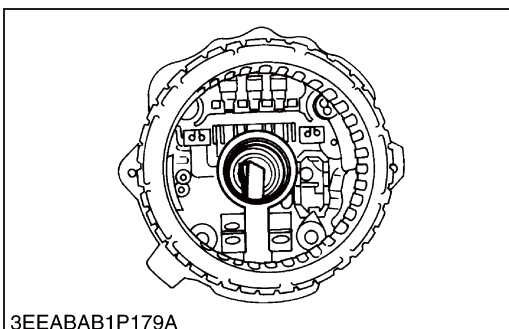
1. Hold the rotor (base of the claw) in a vise. Loosen the lock nut using a M24 box wrench.

Tightening torque	Pulley nut	58.3 to 78.9 N·m 5.95 to 8.05 kgf·m 43.0 to 58.2 ft-lbs
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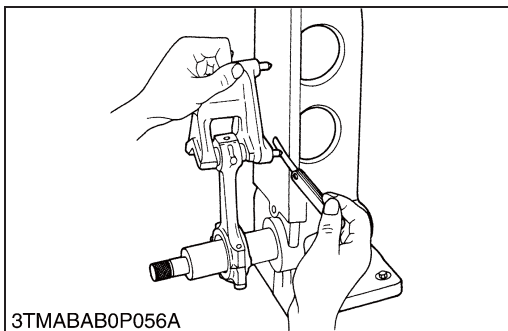
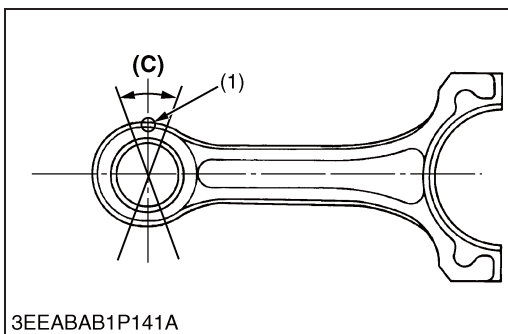
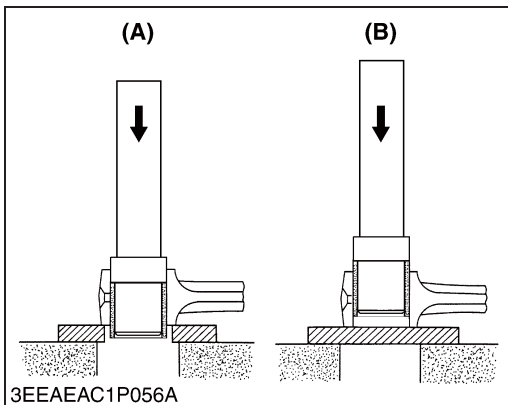
Rotor

1. Remove the 4 screws and detach the bearing retainer.
2. Temporarily install the nut on the pulley screw, and detach the rotor.



Brush

1. When the rotor is detached, the 2 brushes are found to stretch out of the shaft hole.



Replacing Small End Bushing

(When removing)

1. Press out the used bushing using a small end bushing replacing tool.

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Insert a new bushing onto the tool and press-fit it with a press so that the seam (1) of bushing position as shown in the figure, until it is flush with the connecting rod.

(1) Seam

(A) When Removing

(B) When Installing

(C) 0.26 rad (15 °)

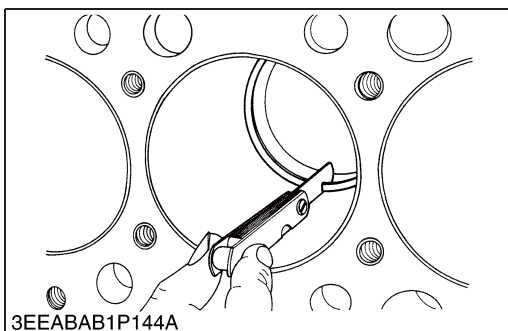
Connecting Rod Alignment

NOTE

- Since the I.D. of the connecting rod small end bushing is the basis of this check, check the bushing for wear beforehand.

1. Remove the piston pin from the piston.
2. Install the piston pin in the connecting rod.
3. Install the connecting rod on the connecting rod alignment tool.
4. Put a gauge over the piston pin, and move it against the face plate.
5. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
6. If the measurement exceeds the allowable limit, replace the connecting rod.

Connecting rod alignment	Allowable limit	0.05 mm 0.0020 in.
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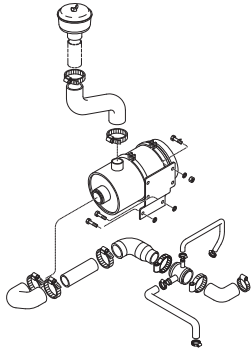
Piston Ring Gap

1. Insert the piston ring into the lower part of the liner (the least worn part) with the piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the piston ring.

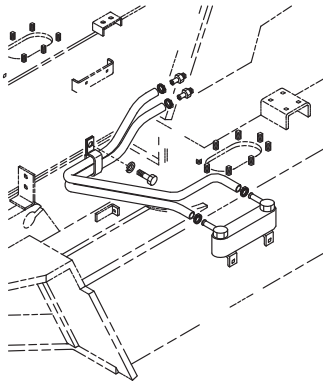
Top ring and second ring	Factory spec.	0.30 to 0.45 mm 0.0118 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.

Oil ring	Factory spec.	0.25 to 0.45 mm 0.0098 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.

- Remove the air cleaner and air cleaner hoses and clamps.



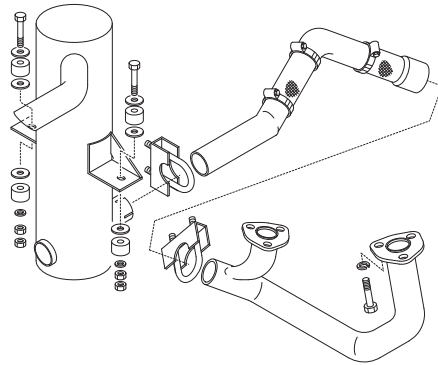
- Remove the engine oil cooler and hose.



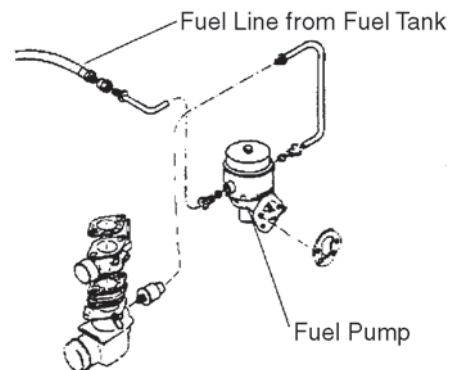
- Remove the main pump inlet fitting assembly, inlet hose, and stiffener.



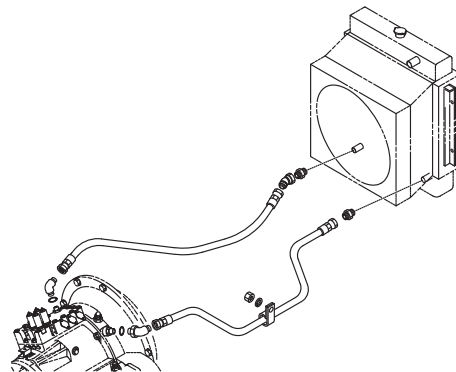
- Remove heat shield from the the muffler and manifold.
- Remove the muffler and tail-pipe.
- Remove the exhaust pipe and heat shield wrap.



- Remove accelerator control at carburetor throttle lever.
- Remove the fuel line that goes from fuel pump to fuel tank in frame.



- Remove the oil line from transmission.
- Remove and tag all wire harness leads to engine components. Coil the wire harness and tie it out of the way to prevent damage when the engine is removed.



GENERAL INFORMATION

STATEMENT ON CLEANLINESS AND CARE

- An engine is a combination of many machined, honed, polished, and lapped surfaces with very fine tolerances.
- Whenever valve train components, cylinder head, cylinder, crankshaft, or connecting rod components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.
- Any time the air cleaner or TBI unit is removed, the intake opening must be covered. This will protect against the entrance of foreign material which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.
- When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

IMPORTANT

Use of RTV sealer and anaerobic gasket eliminator

Two types of sealer are commonly used in the engines covered by this manual. These are RTV sealer and anaerobic “gasket eliminator” sealer.

It is important that these sealers be applied properly and in their proper place to prevent oil leaks. **The two types of sealers are not interchangeable.** Use the sealer recommended in the procedure.

- RTV (room temperature vulcanization) sealer is used where a nonrigid part is assembled to a rigid part. Common examples are oil pans and rocker covers.
- Anaerobic gasket eliminator hardens in the absence of air. This sealer is used where two rigid parts (such as castings) are assembled together. When two rigid parts are disassembled and sealer or gasket is readily noticeable, the parts were probably assembled using gasket eliminator.

USING RTV SEALER

- Do not use RTV when extreme temperatures are expected, such as exhaust manifold, head gasket or where gasket eliminator is specified.
- When separating components sealed with RTV, use a rubber mallet and “bump” the part sideways to shear the RTV sealer. “Bumping” should be done at bends or reinforced areas to prevent distortion of parts. RTV is weaker in shear (lateral) strength than in tensile (vertical) strength.

NOTICE

Attempting to pry or pull components apart may result in damage to the part.

- Surfaces to be resealed must be clean and dry. Remove all traces of oil and RTV with a chlorinated solvent (GM P/N 1050454 or equivalent). Do not use petroleum cleaners such as mineral spirits. They leave a film onto which RTV will not stick.
- Apply RTV to one of the clean surfaces. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer in any blind threaded holes, as it may prevent the bolt from seating properly or cause damage when the bolt is tightened.
- Assemble while RTV is still wet (within 3 minutes). Do not wait for RTV to skin over.
- Torque bolts to specifications. Do not over-torque.

USING ANAEROBIC GASKET ELIMINATOR

- Clean surfaces to be resealed with a chlorinated solvent (GM P/N 1050454 or equivalent) to remove all oil, grease, and old material.
- Apply a continuous bead of gasket eliminator to one flange.
- Spread the bead evenly with your finger to get a uniform coating on the complete flange.
- Assemble parts in the normal manner and torque immediately to specifications.

IMPORTANT

Anaerobic sealed joints that are partially torqued and allowed to cure more than five minutes may result in incorrect shimming of the joint.

CYLINDER BORE

Inspect

- Cylinder bores for scoring or other damage.
- Cylinder bore taper and out-of-round.

MEASURING CYLINDER BORE TAPER AND OUT-OF-ROUND

Tool required

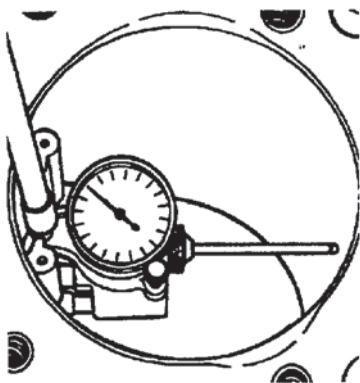
58087 Cylinder Bore Gage (or equivalent)

IMPORTANT

If one or more cylinder bores are rough, scored or worn beyond limits, it will be necessary to smooth or true up such bores to fit new pistons.

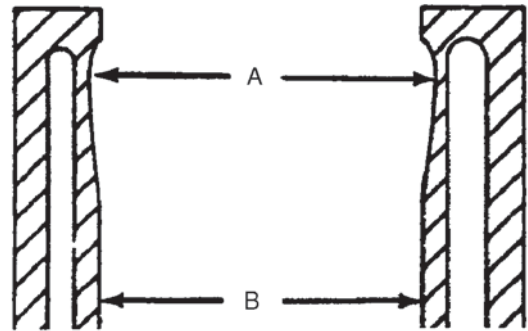
No attempt should be made to cut down oversize pistons to fit cylinder bored as this will destroy the surface treatment and affect the weight. The smallest possible oversize pistons should be used and the cylinder bores should be honed to size for proper clearances.

- Refer to "Specifications" for tolerances.
- Set the gage so the thrust pin must be forced in about 7 mm (1/4 in.) to enter the gage in the cylinder bore.
- Center the gage in the cylinder and turn the dial to "0".
- Carefully work the gage up and down to determine taper and turn it to different points around the cylinder wall to determine the out-of-round condition. Measure the bore both parallel to and at right angles to the engine centerline. Measure at the top, middle, and bottom of the bore and note the readings.
- Recondition the cylinder bore as necessary, as outlined later.

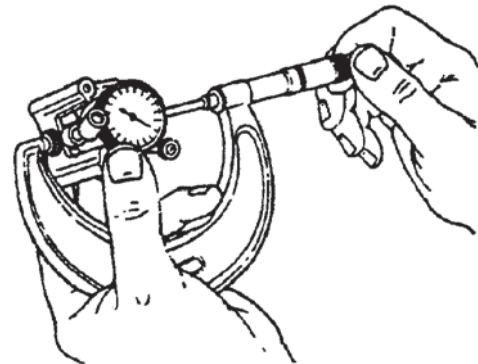


CYLINDER BORE RECONDITIONING

- Measure the cylinder bore for out of round and taper as outlined previously.
- Measure for wear at the top of the bore (point "A") and at the bottom (point "B").



- Cylinder bores can be measured by setting the cylinder gage dial at zero in the cylinder at the point of desired measurement. Lock the dial indicator at zero before removing from the cylinder, and measure across the gage contact points with an outside micrometer, with the gage at the same zero setting when removed from the cylinder (figure right).



- If the cylinders are found to exceed the specified out-of-round or taper, honing or boring will be necessary. Any cylinders that were found to have less than 0.13 mm (0.005 in.) wear or taper may not entirely clean up when fitted to a high limit piston. If it is desired to entirely clean up the bore in these cases, it will be necessary to rebores for an oversize piston. If more than 0.13 mm (0.005 in.) taper or wear, they should be bored and honed to the smallest oversize that will permit complete resurfacing of all cylinders.
- Fine vertical scratches made by ring ends will not, by themselves, cause excessive oil consumption; therefore, honing to remove them is unnecessary.

CYLINDER HEAD

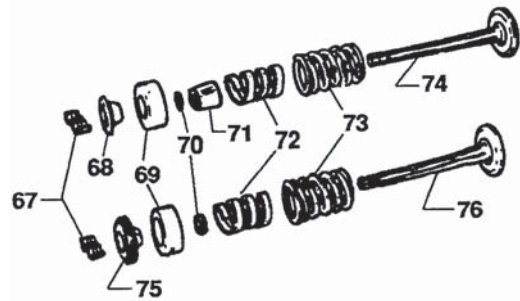
DISASSEMBLY

Tool required

J 8062 Valve Spring Compressor

Remove or disconnect

1. Valve keepers (67).
 - Compress the springs with 8062 (figure
 - Remove the keepers (67).
 - Remove J 8062.
2. Intake valve components.
 - Cap (68).
 - Shield (69).
 - Seal (71).
 - Damper (72).
 - Spring (73).
3. Exhaust valve components.
 - Rotator (75)
 - Shield (69).
 - Seal (71).
 - Damper (72).
 - Spring (73).

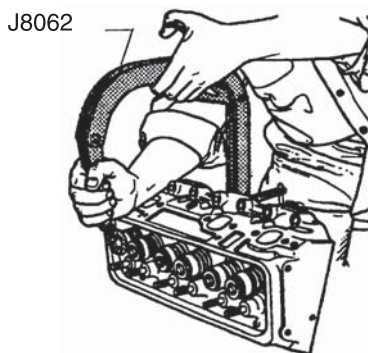


Valves and components

- | | |
|------------------|------------------|
| 67. Valve keeper | 73. Spring |
| 68. Cap | 74. Intake valve |
| 69. Shield | 75. Rotator |
| 70. O-ring seal | 76. Exhaust |
| 71. Seal | |

IMPORTANT

- Place the valves (74 and 76) in an organizer rack so they can be replaced in their original position at reassembly.



Compressing the valve springs

TORSIONAL DAMPER INSTALLATION

Tool Required :

39046 Torsional Damper Ruller and Installer

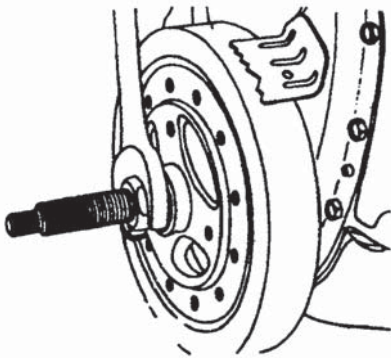
Install or Connect

1. Crankshaft key (if removed).

NOTICE

The inertial weight section of the torsional damper is assembled to the hub with rubber type material. The correct installation procedure with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the torsional damper.

2. Stud (item A.) to the crankshaft. Thread the stud fully into the tapped hole in the crankshaft.



Installing the torsional damper

3. Torsional damper over the end of the stud. Align the key way in the torsional damper shaft with the crankshaft
4. Bearing, washer, and nut (figure 71).
 - Turn the nut to pull the vibration damper into place.
 - Remove the tool.

NOTICE

Refer to "Notice" on page 00(L)-2-1.

5. Torsional damper bolt and washer.

Tighten

- Bolt to 95 N·m (70 lbs·ft).

PISTON AND CONNECTING ROD INSTALLATION

CONNECTING ROD BEARING SELECTION

Tools required :

5239 Connecting Rod Guide Set

8037 Ring Compressor

36660 Torque/Angle Meter

Connecting rod bearings are of the precision insert type and do not use shims for adjustment.

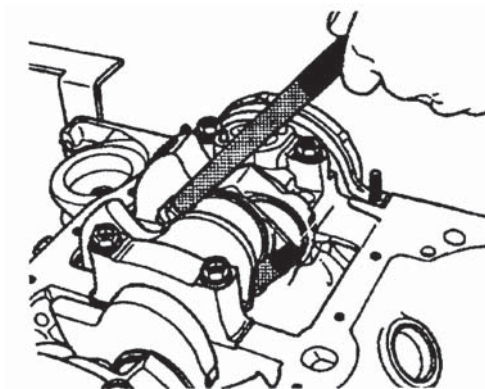
DO NOT FILE RODS OR ROD CAPS.

IMPORTANT

- If clearances are excessive, install a new bearing. Service bearings are available in standard size and 0.050 mm (0.002 in), 0.254 mm (0.010 in), 0.508 mm (0.020 in), undersize for use with new and used standard size crankshafts.
- Lubricate the cylinder walls lightly with engine oil.
- Make sure the piston is installed in the matching cylinder.

Install or connect

1. Connecting rod bearings.
 - Make sure that the bearing inserts are of the proper size.
 - Install the bearing inserts in the connecting rod and connecting rod cap.
 - Lubricate the bearings with engine oil.



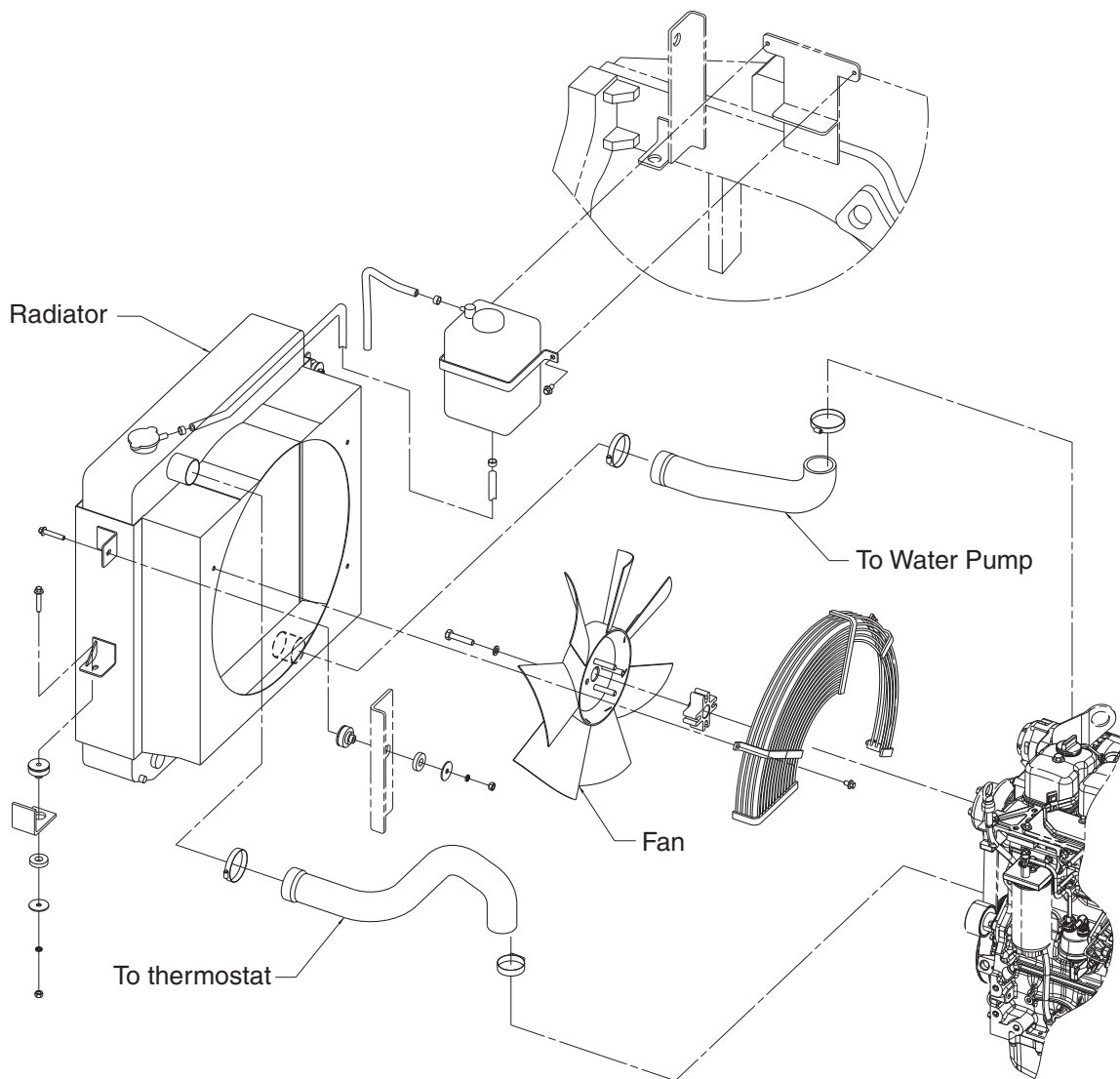
Guiding the connecting rod

FASTENER TIGHTENING SPECIFICATIONS

Item	N·m	lb · ft	lb · in
Balance shaft drive gear retaining bolt	6	12	–
Balance Gear driven gear bolt (torque plus a 35° turn)	20	15	–
Balance shaft retainer bolt	14	–	124
Camshaft sprocket bolts	28	21	–
Camshaft thrust plate screws	14	–	124
Connecting rod bolt nuts (torque plus a 70° turn).	27	20	–
Coolant outlet bolts	28	21	–
Coolant pump bolts	40	30	–
Crankshaft rear oil seal retainer screws and nuts	15	11	–
Cylinder head bolts (in sequence)	90	65	–
EGR valve bolt	22	16	–
Engine block drain plug	20	15	–
Exhaust manifold bolts			
Center two bolts	36	26	–
All other bolts	28	20	–
Flywheel bolts	100	74	–
Flywheel housing bolts	44	32	–
Front cover bolts	14	–	124
Hydraulic lifter guide assembly	16	12	–
Intake manifold bolts (in sequence)	47	35	–
Main bearing cap bolts	110	81	–
Oil filter adapter bolts	22	16	–
Oil gallery plug, left rear	40	30	–
Oil gallery plug, right rear	40	30	–
Oil gallery plug, left side rear	30	22	–
Oil pan bolts	11	–	97
Oil pan drain plug	25	18	–
Oil pan nuts	23	17	–
Oil pan studs to oil seal retainer or engine block	23	17	–
Oil pressure fitting	11	–	97
Oil pump bolt	88	65	–
Oil pump cover bolts	9	–	80
Rocker arm cover bolts	10	–	90
Rocker arm nuts	27	20	–
Rocker arm stud	47	35	–
Torsional damper bolt	95	70	–

Section 4

Radiator Removal and Replacemant



Left uncorrected, fuel temperature variations can cause significant variations in air fuel ratio.

A higher flow mixer is required on larger engines. A lower flow mixer is required on smaller engines.



Figure 7. CA100 Mixer

CA100 Mixer Operation

Vapor propane fuel is supplied to the CA100 mixer by the N-2007 pressure regulator/converter. The mixer uses a diaphragm type air valve assembly to operate a gas-metering valve inside the mixer. The gas-metering valve is normally closed, requiring a negative pressure (vacuum) signal from a cranking or running engine to open. This is the third of the three safety locks in the MI-07 system. If the engine stops or is turned off, the air valve assembly closes the gas-metering valve, stopping fuel flow past the mixer. The gas-metering valve controls the amount of fuel to be mixed with the incoming air at the proper ratio. The air/fuel mixture then travels past the throttle, through the intake manifold and into the engine cylinders where it is compressed, ignited and burned.



Figure 8. CA100 Mixer Attached to Throttle Body

(Refer to Figure 9.)

The air/fuel mixer is mounted in the intake air stream between the air cleaner and the throttle. The design of the main body incorporates a cylindrical bore or mixer bore, fuel inlet (1) and a gas discharge jet (2). In the center of the main body is the air valve assembly, which is made up of the air valve (3), the gas-metering valve (4), and air valve diaphragm (5) and air valve spring (6). The gas-metering valve is permanently mounted to the air valve diaphragm assembly with a face seal mounted between the two parts.

When the engine is not running this face seal creates a barrier against the gas discharge jet, preventing fuel flow with the aid (downward force) of the air valve spring. When the engine is cranked over it begins to draw in air, creating a negative pressure signal. This negative pressure signal is transmitted through four vacuum ports in the air valve.

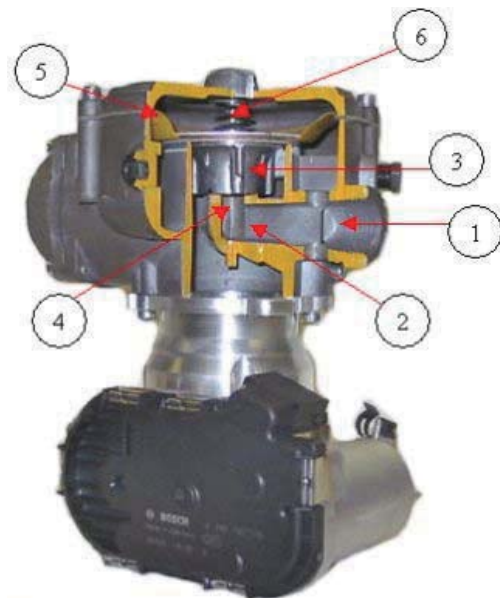


Figure 9. Parts View of CA100 Mixer

A pressure/force imbalance begins to build across the air valve diaphragm between the air valve vacuum (AVV) chamber (above the diaphragm) and atmospheric pressure below the diaphragm. Approximately 6 inH₂O (14.945 mbar) of negative pressure is required to overcome the air valve spring force and push the air valve assembly upward off the valve seat. Approximately 24 inH₂O (59.781 mbar) pulls the valve assembly to the top of its travel in the full open position.

The amount of negative pressure generated is a direct result of throttle position and the amount of air flowing through the mixer to the engine. At low engine speeds,

With the exception of battery voltage, all inputs are 0-5 Vdc, ground referenced.

Resolution should be 0.1% or better. Accuracy should be 2% or better.

Frequency/Position Inputs

- **Crankshaft position**
Variable reluctance (2-wire, 200 Vpp max) or 0-5 V Hall Effect with calibration selectable pull-up resistor for open collector sensors Permits speed resolution of 0.25 rpm and crankshaft position resolution of 0.5°
- **Camshaft position**
Variable reluctance (2-wire, 200 Vpp max) or 0-5 V Hall Effect with calibration selectable pull-up resistor for open collector sensors.

Digital Inputs

- **Oil pressure switch**
Normally open, internal pull-up resistor provided to detect external switch to ground
- **Transmission oil temperature switch**
Normally open, internal pull-up resistor provided to detect external switch to ground
- **Ground speed select switch**
Permits selecting two different maximum engine speeds
- **Vswitched**
Switched battery voltage

Outputs

- **FTV drivers (2)**
10A peak, 45V max. To drive an on/off fuel trim valve with a minimum impedance of 5 ohms
Capable of continuous on-time
Drive circuit designed for minimum turn-on /turn-off delay
FTVs will be pulse width modulated between 8 and 40 Hz with a minimum pulse width resolution of 50 usec
- **Fuel lock-off solenoid valve**
Low side switch, 10A peak, 4A continuous 45 V max
- **Electronic Spark Timing (EST) (4)**
TTL compatible outputs
Software configured for coil-on-plug ignition system
- **Throttle control (1)**
H-Bridge, 5A peak, 2.5A continuous at 2500 Hz
PWM includes current feedback for diagnostic purposes.
- **MIL (malfunction indicator lamp)**
Low side switch, sufficient to drive a 7W incandescent lamp continuously
- **CANBus**
CAN 2.0b serial communication for J1939 communications, programming and diagnostics. Requires proper termination resistance per CAN 2.0b.

SECM-48 Wiring Diagram



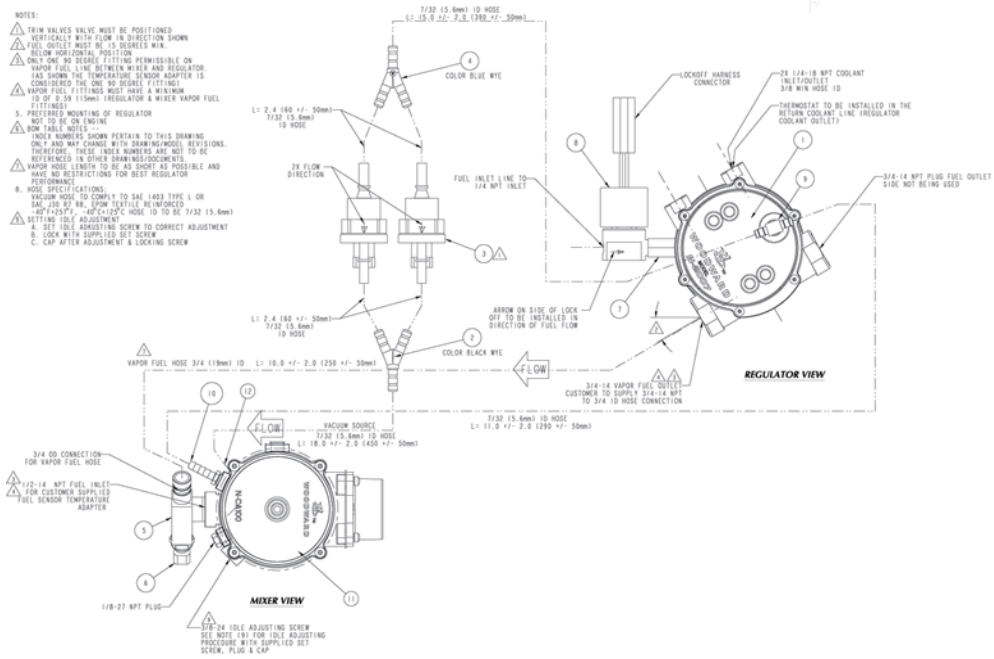
PROPER WIRING

To prevent system faults be sure to follow good wiring practices. Poor wiring may cause unexpected or intermittent failures not related to MI-07 components.



Always refer to MOR-furnished wiring diagrams for your specific application.

Certified System Connections



DWG NO 5555-1202

Figure 23. Hose Connections for 4.3L Engine

DIAGRAM NOTES

<p>1 ▲ Trim valves must be positioned vertically with flow arrows in position shown</p> <p>2 ▲ Fuel outlet must be min 15° below horizontal position</p> <p>3 ▲ Only one 90° fitting permissible on vapor fuel line between mixer and regulator (As shown the temp sensor adaptor is considered the one 90° fitting.)</p> <p>4 ▲ Vapor fuel fittings (regulator and mixer) must have minimum ID of 0.46" (11.68mm)</p> <p>8 ▲ Vapor hose length to be as short as possible and have no restrictions for best regulator performance</p>	<p>① N-2007 Regulator</p> <p>② Plastic WYE Fitting (black color) for 7/32" (5.56mm) ID Tube Hose</p> <p>③ Valve (TEV Bosch Canister)</p> <p>④ Plastic WYE Fitting (blue color) for 7/32" (5.56mm) ID Tube Hose</p> <p>⑤ Adapter (temperature sensor)</p> <p>⑥ Sensor (coolant, temperature)</p> <p>⑦ Nipple (.625 hex 4mp, 2.5L steel)</p>	<p>⑧ Solenoid (AFS Lock Off Valve)</p> <p>⑨ Brass Tee Fitting. 1/4 Tube x 1/8 NPTF x 1/4 Tube</p> <p>⑩ CA100 Mixer</p> <p>⑪ 1/4" (6.35mm) hose barb to 1/8" (3.2mm) male pipe, 125HBL, .062 flow ID</p> <p>⑫ 1/4-28 UNF x 1/4" (6.35mm) hose barb</p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Engine Cranking but Will Not Start / Difficult to Start

Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS
<p>Perform the visual checks as described at start of “Basic Troubleshooting” chapter.</p> <p>Be sure driver is using correct method to start engine as explained in operator’s manual. Use “clear flood” mode during cranking by fully depressing the pedal and cranking the engine. If engine does not start, continue troubleshooting.</p>

PROBABLE CAUSE	CORRECTIVE ACTION
Fuel container empty	Check for LPG vapor from LPG liquid outlet valve on tank. Fill fuel container. Do not exceed 80% of liquid capacity.
Liquid valve closed	Slowly open liquid valve.
Propane excess flow valve closed	Reset excess flow valve in LPG tank. Close liquid valve. Wait for a “click” sound; slowly open liquid valve.
Plugged fuel line	Remove obstruction from the fuel line. <ul style="list-style-type: none"> • Close liquid fuel valve. • Using caution, disconnect the fuel line (some propane may escape). • Clear obstruction with compressed air. • Re-connect fuel line. • Slowly open liquid fuel valve. • Leak test.
Clogged fuel filter	Repair/replace as required. See Chapter 3 Fuel Filter replacement.
Faulty vapor connection between the pressure regulator/converter and the mixer	Check connection <ul style="list-style-type: none"> • Verify no holes in hose. • Clamps must be tight. • Look for kinked, pinched and/or collapsed hose.
Fuel lock-off malfunction	Repair/replace fuel lock-off. See Chapter 3 Fuel Lock-off.
Pressure regulator/converter malfunction	Test regulator/converter operation and pressure. See Chapter 5 Tests and Adjustments.
Incorrect air/fuel or ignition/spark control	See Chapter 7 Advanced Diagnostics.
No crankshaft position sensor signal	Verify the crankshaft position signal is present See Chapter 7 Advanced Diagnostics.

Diagnostic Aids for Rich / Lean Operation

SERVICE TOOL ITEM	RICH	LEAN
Pre-catalyst O2 A/ D counts	Consistently > 250	Consistently < 170
Pre-catalyst O2 sensor switching between high and low	Always high ADC	Always low ADC
Trim valve duty cycle	> 90%	< 10%
Malfunction codes	<ul style="list-style-type: none"> • Pre-catalyst O2 sensor failed rich • Pre-catalyst O2 sensor high • Fuel adapts 	<ul style="list-style-type: none"> • Pre-catalyst O2 sensor failed lean • Pre-catalyst O2 sensor low • Fuel adapts
Closed loop operation	Stuck in open loop	Stuck in open loop

RICH OPERATION

LP (Trim valve duty cycle>90%)

- Inspect hoses from AVV port (port on bottom of mixer) to trim valves and regulator for leaks or blockages, replace as necessary.
- Inspect in-line orifices for blockages (in wye), replace as necessary
- Check trim valves for proper operation, replace as necessary
- Check regulator out pressure, replace if out of spec
- Inspect fuel cone for damage, replace mixer assembly as necessary

LEAN OPERATION

LP (Trim valve duty cycle<10%)

- Check for vacuum leaks, replace hoses, o-rings, and gaskets as necessary
- Check balance line for blockage, replace as necessary
- Check vapor hose for restrictions, replace as necessary
- Check trim valves for proper operation, replace as necessary
- Check regulator out pressure, replace if out of spec

Table 2. Diagnostic Fault Codes (Flash Codes) cont'd

DFC	PROBABLE FAULT	FAULT ACTION *	CORRECTIVE ACTION FIRST CHECK
272	TPS2AdaptHiMin Learned WOT end of TPS2 sensor range lower than expected	None	N/A
281	TPS1AdaptLoMax Learned closed throttle end of TPS1 sensor range higher than expected	None	N/A
282	TPS2AdaptLoMax Learned closed throttle end of TPS2 sensor range higher than expected	None	N/A
291	TPS_Sensors_Conflict TPS sensors differ by more than expected amount NOTE: The TPS is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly.	(1) Turn On Mil (2) Engine Shutdown	Perform checks for DFCs 241 & 242
331 (33)	MAPTimeRangeLow Manifold Absolute Pressure sensor input is low, normally set if the TMAP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the SECM	None	Check TMAP connector and MAP signal wiring for an open circuit TMAP Pin 4 to SECM Pin B18 (signal) TMAP Pin 1 to SECM Pin B1 (sensor GND) TMAP Pin 3 to SECM Pin B24 (XDRP +5 Vdc) Check the MAP sensor by disconnecting the TMAP connector and measuring at the sensor: TMAP Pin 1(GND) to Pin 4 (pressure signal KPA) (2.4k Ω - 8.2k Ω) TMAP Pin 3 (power) to Pin 4 (pressure signal KPA) (3.4k Ω - 8.2k Ω)
332	MAPRangeLow Manifold Absolute Pressure sensor input is low, normally set if the TMAP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the SECM	(1) Turn On Mil (2) Cut Throttle	Check TMAP connector and MAP signal wiring for an open circuit TMAP Pin 4 to SECM Pin B18 (signal) TMAP Pin 1 to SECM Pin B1 (sensor GND) TMAP Pin 3 to SECM Pin B24 (XDRP +5 Vdc) Check the MAP sensor by disconnecting the TMAP connector and measuring at the sensor: TMAP Pin 1(GND) to Pin 4 (pressure signal KPA) (2.4k Ω - 8.2k Ω) TMAP Pin 3 (power) to Pin 4 (pressure signal KPA) (3.4k Ω - 8.2k Ω)

(*) Fault actions shown are default values specified by the OEM.

CA100 Mixer

Refer to Figure 37 exploded view on facing page.

Parts List CA100 Mixer

REF NO.	DESCRIPTION	QTY
1	Torx Screws (T-25) #10-24 x 5/8"	4
2	Lockwashers (T-210) #10 SST	4
3	Mixer Cover	1
4	Mixer Spring	1
5	Diaphragm	1
6	Air Valve Assembly	1
7	Gas Valve Cone (part of air valve assembly)	1
8	Mixer Body	1
9	Expansion Plug Cap $\phi 1/2"$ x $1/16"$ thick ($\phi 12.7\text{mm}$ x 27mm)	1
10	Fuel Inlet	1
11	Air Horn Gasket	1
12	Air Horn Adapter $2-1/16"$ (52.37mm)	1
13	Fillister Head Screws SEMS Lockwasher 10-24 UNC x 5/8"	4
14	Throttle Body Gasket	1
15	Fillister Head Screws SEMS Split Lockwasher #12-24 x 5/8"	4

Exploded View CA100 Mixer

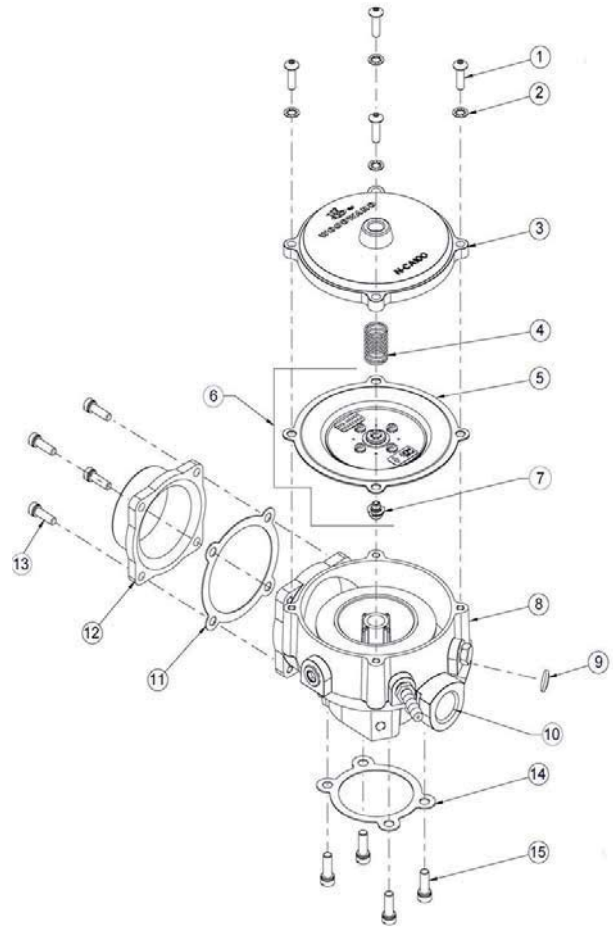


Figure 37. CA100 Mixer Exploded View

IMPORTANT

The manufacturers of the engine and fuel system do not recommend the use of “stop leak” additives to repair leaks in the cooling system. If leaks are present the radiator should be removed and repaired or replaced.

ENGINE ELECTRICAL SYSTEM MAINTENANCE

The engine’s electrical system incorporates an electronic control module (ECM) to control various related components. The electrical system connections and ground circuits require good connections. Follow the recommended maintenance schedule in this section to maintain optimum performance. When inspecting the electrical system check the following:

- Check Positive and Negative cables for corrosion, rubbing, chafing, burning and to ensure tight connections at both ends.
- Check battery for cracks or damage to the case and replace if necessary.
- Inspect engine wire harness for rubbing, chafing, pinching, burning, and cracks or breaks in the wiring.
- Verify that engine harness connectors are correctly locked in by pushing in and then pulling the connector halves outward.
- Inspect ignition coil wire for hardening, cracking, arcing, chafing, burning, separation, split boot covers.
- Check spark plug wires for hardening, cracking, chafing, arcing or burning, separation, and split boot covers.
- Replace spark plugs at the required intervals per the recommended maintenance schedule.
- Verify that all electrical components are securely mounted to the engine or chassis.
- Verify that any additional electrical services installed by the owner are properly installed in the system.
- Verify that the MIL, charging, and oil pressure lights illuminate momentarily during engine start.

ENGINE CRANKCASE OIL**OIL RECOMMENDATION**

To achieve proper engine performance and durability, it is important that you only use engine lubricating oils displaying the American Petroleum Institute (API) “Starburst” Certification Mark ‘FOR GASOLINE ENGINES’ on the container.



Gasoline engines that are converted to run on LPG or NG fuels must use oils labeled for gasoline engines. Oils specifically formulated for Heavy Duty or Natural Gas Engines are not acceptable

IMPORTANT

Oils recommended by the engine manufacturer already contain a balanced additive treatment. Oils containing “solid” additives, non-detergent oils, or low quality oils are not recommended by the engine manufacturer. Supplemental additives added to the engine oil are not necessary and may be harmful. The engine and fuel system supplier do not review, approve or recommend such products.

SYNTHETIC OILS

Synthetic oils have been available for use in industrial engines for a relatively long period of time and may offer advantages in cold and hot temperatures. However, it is not known if synthetic oils provide operational or economic benefits over conventional petroleum-based oils in industrial engines. Use of synthetic oils does not permit the extension of oil change intervals.

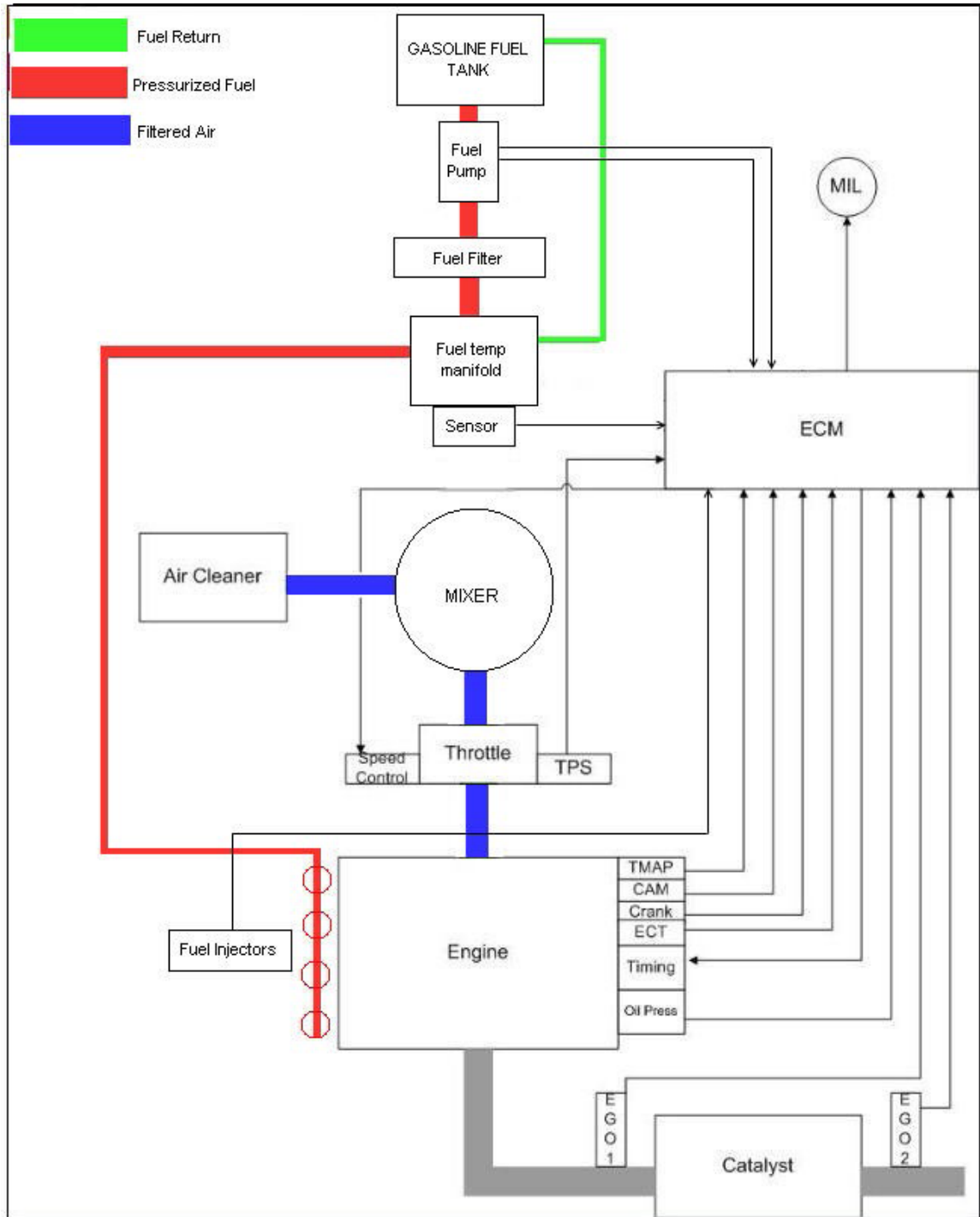
CHECKING/FILLING ENGINE OIL LEVEL**IMPORTANT**

Care must be taken when checking engine oil level. Oil level must be maintained between the “ADD” mark and the “FULL” mark on the dipstick. To ensure that you are not getting a false reading, make sure the following steps are taken before checking the oil level.

Section 4

GASOLINE Fuel System

MOBILE ENGINE GASOLINE FUEL SYSTEM SCHEMATIC



CUTS OUT, MISSES

Checks	Action
<p>DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases, but normally felt below 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.</p>	
Preliminary Checks	None
Ignition System Checks	<ol style="list-style-type: none"> 1. Start the engine. 2. Check for proper ignition output voltage with spark tester J 26792. 3. Check for a cylinder mis re. 4. Verify that the spark plugs are the correct type and properly gapped. <p>Remove the spark plugs and check for the following conditions:</p> <ul style="list-style-type: none"> • Insulation cracks. • Wear. • Improper gap. • Burned electrodes. • Heavy deposits. <p>Visually/Physically inspect the secondary ignition for the following:</p> <ul style="list-style-type: none"> • Ignition wires for arcing and proper routing. • Cross- ring. • Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	<p>Perform a cylinder compression check. Check the engine for the following:</p> <ul style="list-style-type: none"> • Improper valve timing. • Improper valve clearance. • Worn rocker arms. • Worn camshaft lobes. • Broken or weak valve springs. • Check the intake and exhaust manifold passages for casting ash.
Fuel System Checks	<p>Check the fuel system:</p> <ul style="list-style-type: none"> • Plugged fuel lter. • Low fuel pressure, etc. Refer to <i>LPG Fuel System Diagnosis</i>. • Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	<p>Check for Electromagnetic Interference (EMI), which may cause a misfire condition. Using the DST, monitor the engine RPM and note sudden increases in rpms displayed on the scan tool but with little change in the actual engine rpm. If this condition exists, EMI may be present. Check the routing of the secondary wires and the ground circuit.</p>

Diagnostic Scan Tool (DST)

CONTENTS

- Installation of the DST package to a personal computer (PC).
- Software login and password functionality. DST service pages.
- Updating the ECM calibration using a MOT file.
- DTC pages.

Examples and snapshots used in this manual are based off of the initial DST tool release as of July, 2007. This tool is frequently updated and the illustrations may vary depending on the changes included in any updated DST display Interface. For example, the Electronic Pressure Regulator (EPR) may be referred to as the “megajector.” Terms, names and descriptions of parts and servicing procedures will be updated based on trade, brand, or common description to more accurately describe the part or service procedure.

DST INSTALLATION INSTRUCTIONS

Before installing the DST software, please be sure your computer meets the minimum system requirements.

Supported operating systems are:

- Windows Vista
- Windows XP
- Windows 2000

Minimum processor speed:

- Pentium II 450 MHz
- Pentium III 1.0 GHz for Windows Vista

Minimum RAM requirement:

- Windows Vista 512 MB
- Windows XP 256 MB
- Windows 2000 128 MB

* At least one available RS232 serial or USB port.

* ECOM cable supports USB port only.

DBW TEST MODE

The DBW (Drive by Wire) test mode allows the technician to control the throttle directly with the foot pedal or throttle input and is used during the diagnostic routines specified for FPP and TPS for Spectrum systems that use DBW control. FPP position displays the current position of the foot pedal as a percentage. FPP volts display the voltage which the ECM is reading from the FPP sensor. TPS Command displays the commanded throttle position expressed as a percentage, which is being sent to the throttle. TPS Position is the actual percent of throttle opening being sent to the ECM from the throttle. TPS volts display the actual TPS signal voltage the ECM is receiving from the throttle. To select this test mode the engine must be off and the key must be in the ON position.

EXTERNAL POWER TEST

The external power test manually activates relays (relay power, fuel pump, and drive-by wire power) controlled by the ECM while the engine is in the “Stopped” or “Running” states. Reverts to normal operation if “Automatic” state is selected or ignition voltage is cycled from high to low.

The screenshot shows the EDIS ECI Target Communications software interface. The main window displays a 'Faults' tab with a 'Connected' status. The interface is divided into several sections:

- Fault Access:** Shows MIL (Malfunction Indicator Lamp) status.
- Closed-Loop Control:** Displays parameters for EGO1, EGO2, and EGO3 sensors, including voltage and percentage values.
- System States:** Shows Run Mode (Stopped), Power Mode (Standby), Fuel Type (Propane), Fuel Supply (Off), Fuel/Spark inhibit input (Normal), Fuel Control Mode (Open Loop), Governor switch state (None), Active governor type (Min), and Active governor mode (Isochronous).
- Monitored Drivers:** Lists injector and spark coil drivers with their respective firing orders and dwell times.
- Diagnostic Modes:** Includes Spark kill (Normal), Injector kill (Normal), DBW (test) (Off), External power (Automatic), and Cylinder numbering (Firing Order).
- Derates / Warnings:** Shows Derate1, Derate2, Low Rev-Lim, MIL output pin, and Buzzer output pin.
- Input Voltages:** Lists various system voltages such as Gov1, Gov2, Oil pressure, MAP, ECT/CHT, and IAT.
- DBW Variables:** Shows TPS command, TPS position, TPS1 and TPS2 percentages, TPS1 and TPS2 voltages, FPP command, FPP position, FPP1 and FPP2 voltages, and IVS voltage.
- Historic Faults:** Lists DTC codes, such as DTC 1637: PWM4 open / ground short.
- Active Faults:** A section for currently active fault codes.

Faults Page

Stores DTC codes that may have occurred in the past (Historic Faults) or current set codes (Active Faults). Includes useful system voltages and sensor readings used while working with the fuel and emission trouble shooting charts. Shows power derate mode status. To erase a historic DTC code, double click on the code with the left mouse button. Then choose to “Clear All Faults.”

Diagnostic Trouble Codes (DTCs)

How does my MIL work?

The emissions control system utilizes a MIL to warn the operator or technician of a possible issue with the engine or emissions control system. The system will keep the MIL illuminated for the entire key cycle in which the trouble code was set. It will keep the MIL illuminated for three additional engine run cycles under the following two circumstances: (1) The fault caused the engine to shut down or (2) the fault is related to the exhaust gas oxygen (EGO) sensors. This function is called MIL persistence.

How does MIL persistence work?

In the event the DTC is related to either an engine shutdown fault OR an oxygen sensor fault the following statement applies: If the vehicle is not serviced by a technician and the condition causing the MIL illumination (DTC) no longer exists, the MIL will remain illuminated for the 3 additional start cycles. The MIL will go out on the 4th start cycle if the condition does not reoccur.

In the event the DTC is not related to an engine shut down or an oxygen sensor fault and the condition causing the MIL illumination (DTC) no longer exists, the MIL will go out at the next run cycle.

If the condition is serviced by a technician and the DTC is cleared using a Diagnostic Service Tool (DST), the MIL will go out immediately.

Diagnostic Trouble Codes (DTC) are permanently retained in the historic DTC section until cleared with a DST or the auto clear requirements are met. The auto clear feature will clear out historic faults after 40 run cycles.

What are the requirements for a run cycle?

A run cycle is when the engine speed is above the “run speed” set point for 1.5 seconds or longer. The “run speed” is the transition point when the ECM recognizes the engine is going from the cranking parameters to the engine running parameters. The run speed is typically set at 450 rpm.

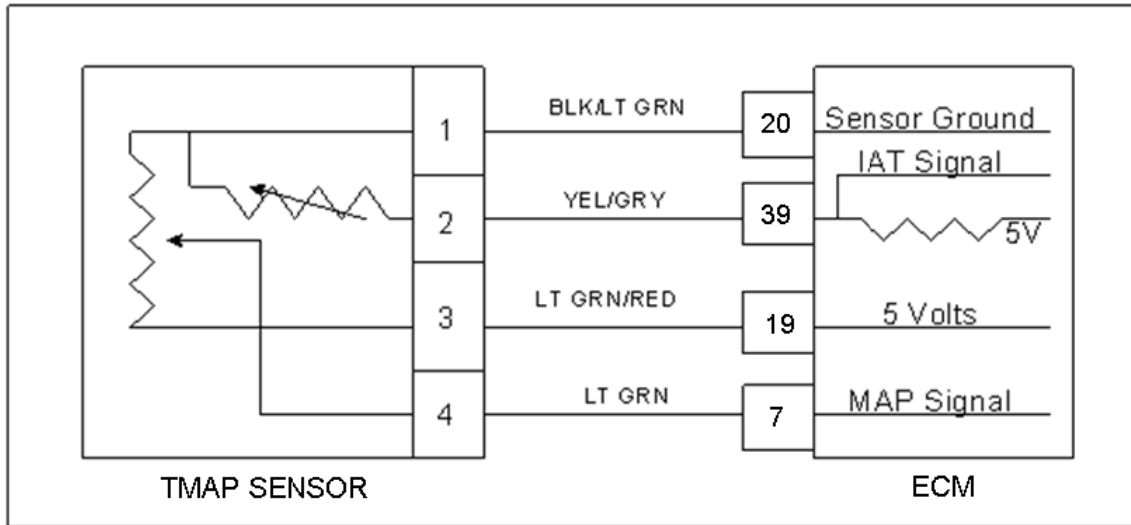
Ignition Control System Diagnostic Chart

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	<ul style="list-style-type: none"> DST connected and in the system data mode. Crank the engine and observe the engine speed signal on the DST Is the value greater than the specified value?	125 RPM	Go to Step (5)	Go to Step (3)
3	<ul style="list-style-type: none"> Check the DST for historical code sets. (Always diagnose and repair codes with the lowest numerical value first). Run the diagnostic chart for DTC 337 Did you find and correct the problem?		Go to Step (16)	Go to Step (4)
4	<ul style="list-style-type: none"> Run the diagnostic chart for DTC 342 Did you find and correct the problem?		Go to Step (16)	Go to Step (5)
5	<ul style="list-style-type: none"> Disconnect the ignition module connector C011 Using an LED type test lamp check for a signal between the ignition module connector pin B and battery positive Crank the engine Does the LED test lamp flash while cranking the engine?		Go to Step (6)	Go to Step (10)
6	<ul style="list-style-type: none"> Using a DVOM check for power between the ignition module connector pin A and engine ground Do you have power?		Go to Step (7)	Repair the system power circuit. Check all system fuses and power relay connections
7	<ul style="list-style-type: none"> Disconnect the ignition coil connector C009 Using a digital LED test lamp check for a signal between the ignition coil connector pin B and battery positive Crank the engine Does the LED test lamp flash while cranking the engine?		Go to Step(8)	Go to Step (13)
8	<ul style="list-style-type: none"> Using a DVOM check for voltage between the ignition coil connector pin A and engine ground Does the DVOM show voltage?	System voltage	Go to Step (9)	Repair the system power circuit. Check all system fuses and power relay connections
9	<ul style="list-style-type: none"> Replace the ignition coil Is the replacement complete?		Go to Step (16)	-
10	<ul style="list-style-type: none"> Key OFF Disconnect the ECM connector C001 Using a DVOM check for continuity between ignition module connector pin B and ECM connector pin 31 Do you have continuity between them?		Go to Step (11)	Repair the open ignition control circuit. See wiring harness repair section.

DTC 88 – Fuel Pressure High

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	<ul style="list-style-type: none"> • Key On • DST (Diagnostic Scan Tool) connected On the FAULTS page, check the value for fuel rail pressure. Does the DST display 90 psia or greater?	90 psia or greater	Go to Step (3)	Intermittent problem. Go to intermittent section
3	<ul style="list-style-type: none"> • Check the fuel pressure using a manual fuel pressure gauge from the CKP sensor while cranking the engine. Does the manual gauge display 90 psi or greater?	90 psia or greater	Go to Step (4)	Go to Step (5)
4	<ul style="list-style-type: none"> • Check for a short to ground in the fuel pump ground circuit (OEM supplied) Is the ground circuit shorted to a ground?		Repair the short to ground	Go to Step (6)
5	<ul style="list-style-type: none"> • Jumper pins C and D at the fuel pressure sensor connector • Monitor the FRP_Raw volts on the VOLTAGE page. Does FRP_Raw display 5 volts?	5 volts	Replace the Fuel pressure Sensor	Repair the wiring between the fuel pump pressure sensor and the ECM
6	<ul style="list-style-type: none"> • Check the OEM fuel hoses for proper installation and routing • Check the OEM fuel hoses for blockages Were the OEM fuel hoses improperly installed or have a blockage?		Repair the OEM fuel hose issue	Replace ECM

DTC 113-IAT High Voltage (SPN 105:FMI 3)



Conditions for Setting the DTC

- Intake Air Temperature
- Check Condition-Engine Running
- Fault Condition-IAT Sensor Voltage greater than 4.950 volts
- MIL-ON during active fault
- Adaptive-Disabled during active 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 is located in the engine’s air intake or intake manifold.. 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. This fault will set if the signal voltage is greater than 4.950 volts for 1 second or longer. The ECM will use a default value for the IAT sensor in the event of this fault.

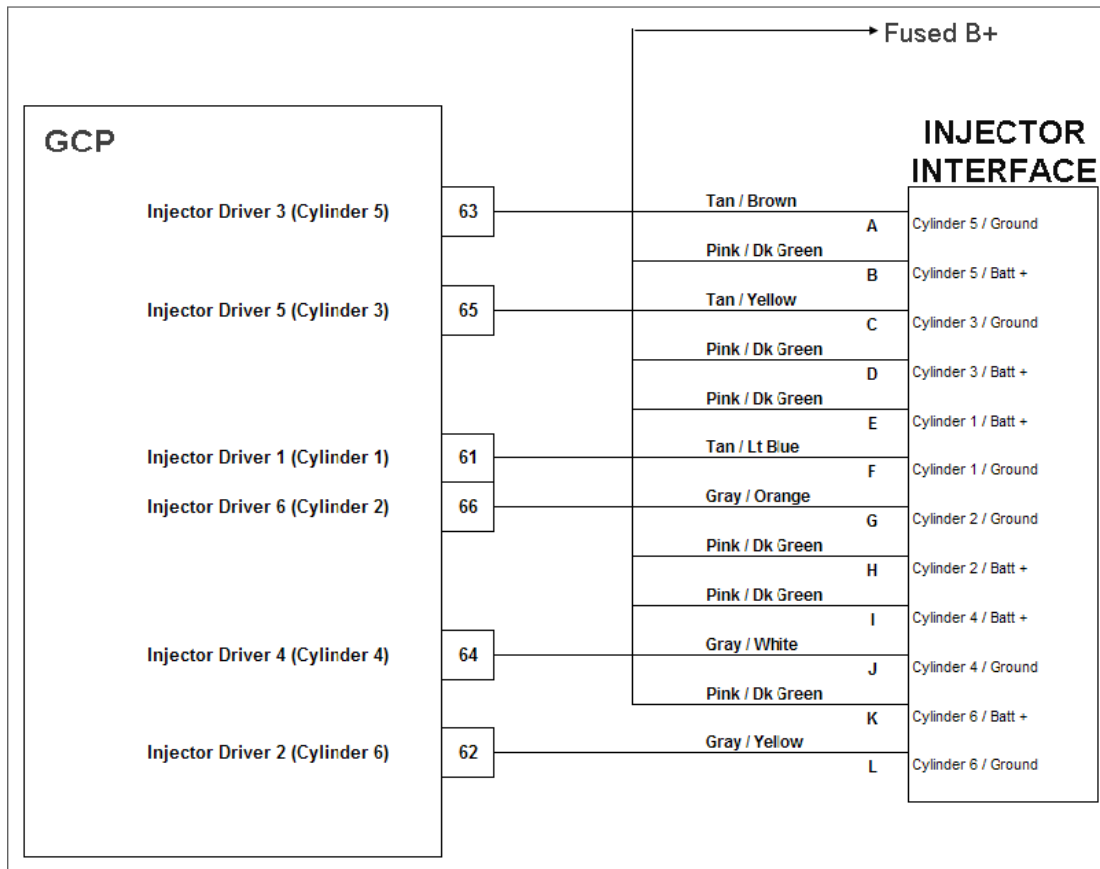
Step	Action	Value(s)	Yes	No
11	<ul style="list-style-type: none"> • Replace ECM Is the replacement complete?		Go to Step (12)	-
12	<ul style="list-style-type: none"> • Remove all test equipment except the DST. • Connect any disconnected components, fuses, etc. • Using the DST clear DTC information from 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-121 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

Step	Action	Value(s)	Yes	No
9	<ul style="list-style-type: none"> Using a DVOM check for continuity between EGO 1 pin A and ECM connector pin 20 Do you have continuity?		Go to Step (10)	Repair open EGO 1 signal ground
10	<ul style="list-style-type: none"> Replace EGO 1 sensor Is the replacement complete?		Go to Step (11)	-
11	<ul style="list-style-type: none"> 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-134 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 217-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	<ul style="list-style-type: none"> • Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Warm engine to normal operating temperature, then run the engine above 1200 rpm for at least 60 seconds Does the DST display ECT temperture of 250 degrees F or greater?		Go to Step (3)	Intermittent problem. Go to Intermittent section
3	Verify with a temperature gauge that the engine coolant is over 250 degrees F. Does the temperature gauge indicated 250 degrees F. or greater?		Repair cooling system	Go to Step (4)
4	Verify ECT Circuit function.		-	-

DTC 264: Injector driver 2 (Cyl 6) open or short to ground (SPN 264:FMI 5)



Conditions for Setting the DTC

- Injector is in the Off State
- Low side voltage is less than 4.0 volts
- Battery voltage is above 9.0 volts
- MIL Light turned on
- Closed Loop is disabled while this fault is active
- Adaptive Learn is disabled while this fault is active.

Circuit Description

The fuel injectors turn on when the GCP provides a ground circuit to the injector. Battery positive is constantly provided through the ignition fuse and the Pink / DK Green wire. Each Injector has a ground side driver assigned to it inside the GCP. The driver number does not match up with the mating cylinder number in each case. The driver is assigned in numerical order according to the engine firing order (4.3L = 1, 6, 5, 4, 3, 2). The ECM is monitoring the low side voltage internally in the ECM. This code will set if it sees a low voltage on the low side during an “injector off” state. This indicates the injector is open or there is a short to ground in the circuit.

The technician should check the wiring and the injector resistance. If the resistance is out of specification or you get an infinite reading on the DVOM you should replace the injector. If there is a short to ground in the wiring circuit you should repair the faulty circuit in accordance with the recommended wire repair instructions provided in this manual.

DTC 336-Crank Sync Noise

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	<ul style="list-style-type: none"> Check that the ECM ground terminals C010, C022 and C023 are clean and tight Are the ground terminals clean and tight?		Go to Step (3)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
3	<ul style="list-style-type: none"> Key On, Engine OFF Disconnect the CKP (Crankshaft position) Sensor connector C015 Using A DVOM check for voltage at the CKP sensor connector pin 1 and engine ground (CHECK THIS BEFORE THE POWER RELAY SHUTS OFF) Do you have voltage?	5.0 volts	Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	<ul style="list-style-type: none"> Key OFF Disconnect ECM connector C001 Using a DVOM check for continuity between CKP connector pin 2 and ECM connector pin 22 Do you have continuity between them?		Go to Step (5)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	<ul style="list-style-type: none"> Using a DVOM check for continuity between CKP connector pin 3 and ECM connector pin 21 Do you have continuity between them?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	<ul style="list-style-type: none"> Inspect the CKP connector C015 terminals 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)
7	<ul style="list-style-type: none"> Inspect the ECM connector C001 terminals 19, 22, and 21 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 (8)
8	<ul style="list-style-type: none"> Replace CKP sensor Is the replacement complete?		Go to Step (10)	-
9	<ul style="list-style-type: none"> Replace ECM Is the replacement complete?		Go to Step (11)	-

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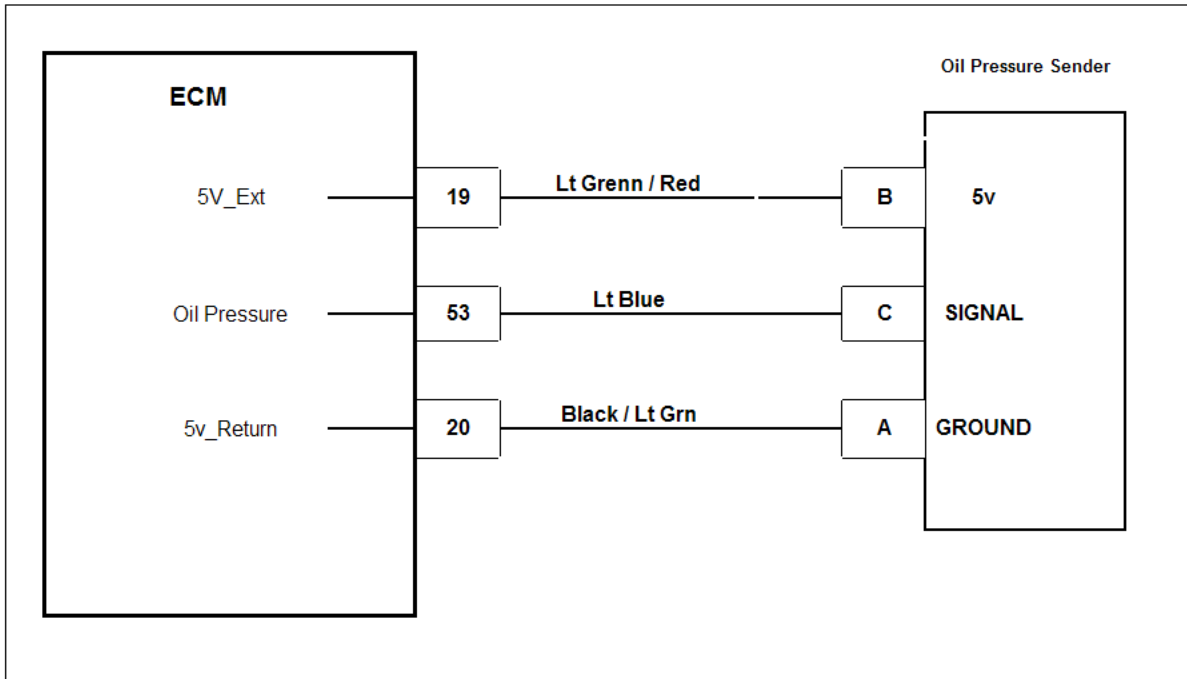
- Please note: If there is no response to CLICKING the link, please download this PDF first and then click on it.

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DTC-359 Fuel Run-out Longer Than Expected

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board (OBD) System Check?	-	Go to Step (2)	
2	<ul style="list-style-type: none"> Disconnect the LPG shut off solenoid connector C003 Using a DVOM check for power across terminals A and B while cranking the engine, then turn the key to the OFF position Did the voltage immediately turn OFF with the key cycle?	System Voltage	Go to Step (3)	Go to Step (5)
3	<ul style="list-style-type: none"> Turn off the LPG manual valve at the fuel tank Start the engine and let it idle until the engine stops. (THIS MAY TAKE SEVERAL MINUTES) Did the engine ever stop?		Intermittent problem. See intermittent problems in the electrical section of this manual.	Go to Step (4)
4	<ul style="list-style-type: none"> Replace the LPG shut off solenoid Is the replacement complete?		Go to Step (8)	-
5	<ul style="list-style-type: none"> Key OFF Disconnect the ECM wire harness connector C001 Using a DVOM check for continuity between ECM pin 12 and engine ground Do you have continuity?		Repair the LPG solenoid control short to ground	Go to Step (6)
6	<ul style="list-style-type: none"> Inspect the ECM wire harness and connector for damage corrosion or contamination Did you find a problem?		Correct the problem as required. See wire harness repair.	Go to Step (7)
7	<ul style="list-style-type: none"> Replace the ECM Is the replacement complete?		Go to Step (8)	-
8	<ul style="list-style-type: none"> 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-359 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 524-Oil Pressure Low Stage 2 (SPN 100:FMI 1)

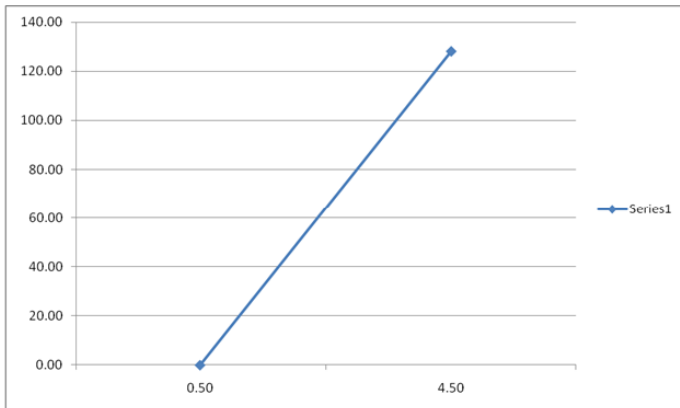


Conditions for Setting the DTC

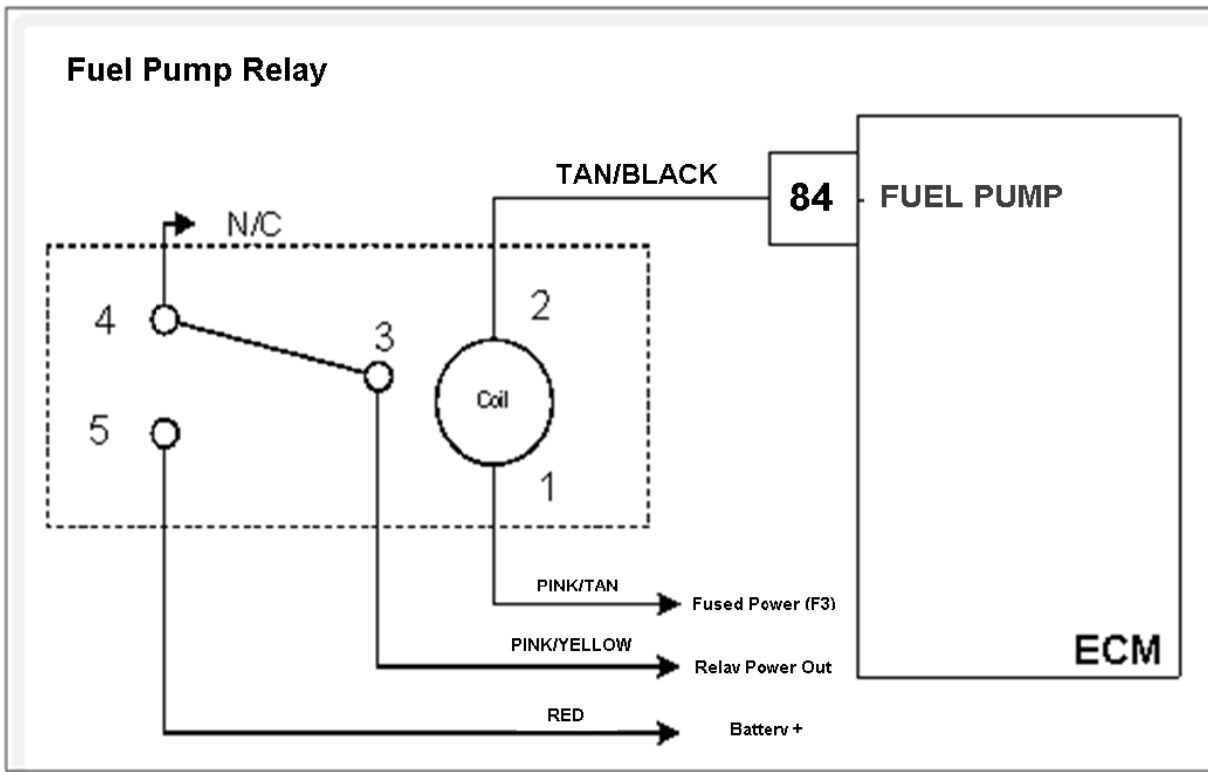
- Engine Oil Pressure low.
- Fault Condition- Oil pressure less than 8 psi for 5 or more seconds
- Engine Shut Down.

Circuit Description

The Oil Pressure Sender is used to communicate the oil pressure condition to the ECM. Engine damage can occur if the engine is operated with low oil pressure. The ECM sends a 5v signal to the oil pressure sender. The sender will report a signal back to the ECM on the signal wire depending on the pressure that is applied on its diaphragm. The voltage is linear in comparison to the pressure applied (see chart below). The MIL command is ON and the engine will shut down in the event of this fault to help prevent possible engine damage.



DTC 627-Fuel Pump Relay Coil Open (SPN 1348:FMI 5)



Conditions for Setting the DTC

- Fuel Pump relay check
- Check Condition-Key ON
- Fault Condition-Relay coil open

Circuit Description

The fuel pump relay switches power out to the gasoline fuel pump. This fault will set if the ECM detects an open circuit on the relay control output.

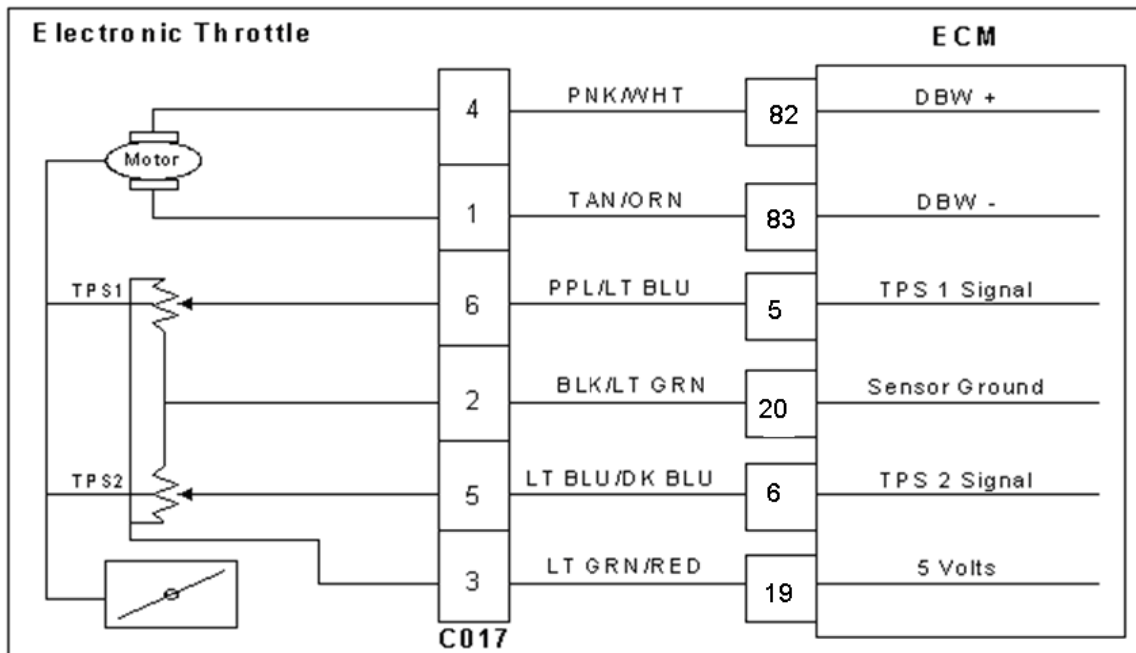
Diagnostic Aid

Relay coil resistance changes with temperature. The following diagnostic charts have steps to measure relay coil resistance values. When checking the resistance values be sure the relay is at a reasonable temperature, between +20 and +100 degrees F.

DTC 650-MIL Control Open

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	<ul style="list-style-type: none"> • Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code • Key OFF • Key ON Does DTC 650 reset?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	<ul style="list-style-type: none"> • Remove the MIL bulb or driver circuit • Using a DVOM check for continuity through the bulb or driver device Do you have continuity?		Go to Step (5)	Go to Step (4)
4	<ul style="list-style-type: none"> • Replace the open bulb or driver device Is the replacement complete?		Go to Step (8)	-
5	<ul style="list-style-type: none"> • Key OFF • Re-install the bulb or driver device • Disconnect vehicle interface connector C012 • Using a DVOM check for continuity between vehicle interface connector pin G and battery positive • Key ON Do you have continuity?		Go to Step (6)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
6	<ul style="list-style-type: none"> • Disconnect ECM wire harness connector C001 • Using a DVOM check for continuity between ECM harness connector pin 80 and vehicle interface connector pin G Do you have continuity?		Go to Step (7)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
7	<ul style="list-style-type: none"> • Inspect ECM wire harness connector pin 80 and vehicle interface connector pin G for damage, corrosion or contamination Did you find a problem?		Correct the problem as required. See wiring harness repair	Go to Step (8)
8	<ul style="list-style-type: none"> • 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-650 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1111-Fuel Rev Limit (SPN 515:FMI 16)



Conditions for Setting the DTC

- Fuel Rev Limit
- Check Condition-Engine Running
- Fault Condition-Engine rpm greater than set limit
- MIL-ON during active fault

Circuit Description

This fault will set anytime the engine rpm exceeds the specified speed settings in the calibration. This is generally set at 3000 rpms. The MIL command is ON during this active fault

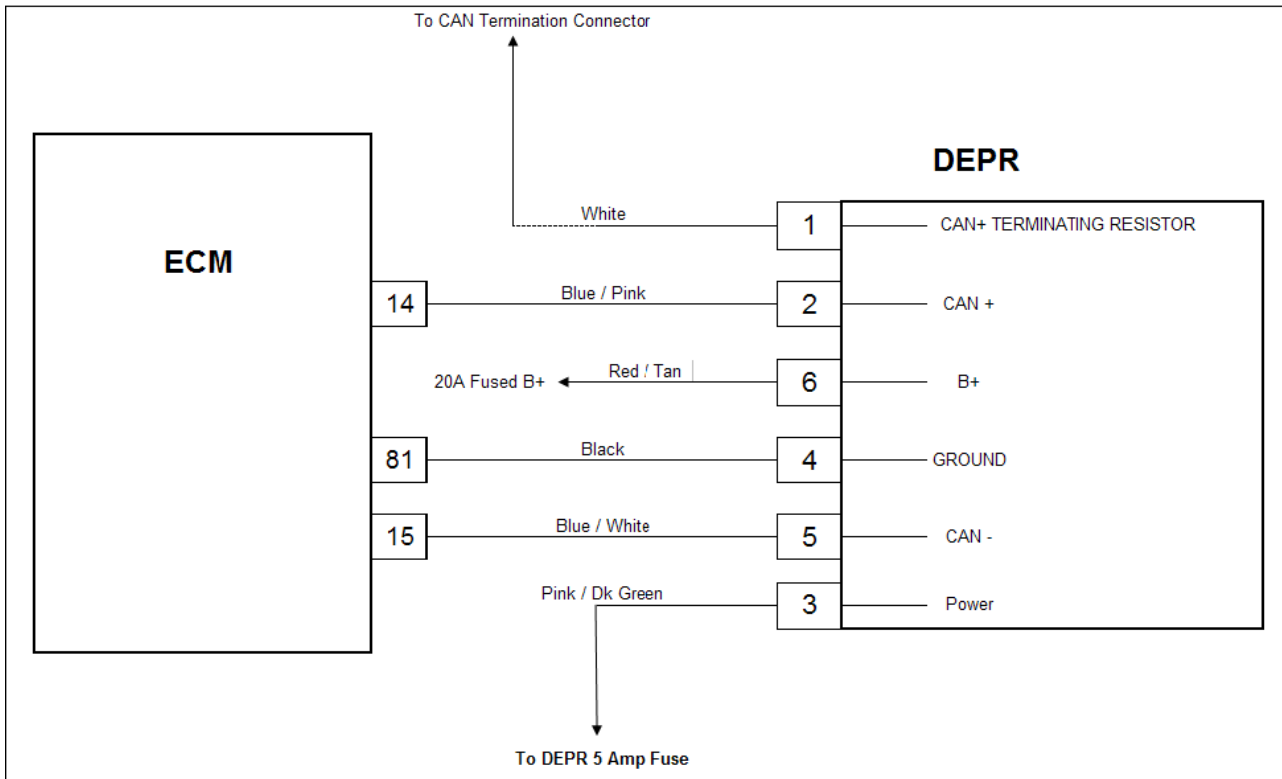
Diagnostic Aid

Always check for other stored DTC codes before using the following DTC chart for this code set. Repair any existing codes starting with the lowest numerical code first.

DTC 1155-Closed Loop Multiplier High Gasoline

Step	Action	Value(s)	Yes	No
1	<ul style="list-style-type: none"> Perform the On-Board (OBD) System Check? Are any other DTCs present?		Go to Step (3)	Go to Step (2)
2	Visually and physically check the following items: <ul style="list-style-type: none"> The air intake duct for being collapsed or restricted The air filter for being plugged System power fuses are good and in the proper location The EGO 1 sensor installed securely and the wire leads not contacting the exhaust manifold or ignition wires ECM grounds must be clean and tight. Refer to Engine Electrical Power and Ground Distribution Fuel System Diagnostics. Refer to Fuel System Diagnostics Was a repair made?		Go to Step (9)	Go to Step (4)
3	<ul style="list-style-type: none"> Diagnose any other DTC codes before proceeding with this chart. Always repair existing codes starting with the lowest numerical code set first. Have any other DTC codes been detected, diagnosed and repaired?		Go to Step (9)	Go to Step (4)
4	<ul style="list-style-type: none"> Disconnect EGO1 connector C005 Using a DVOM check for voltage between EGO 1 connector pin B and engine ground Key ON (CHECK MUST BE MADE WITHIN 30 SECONDS OR BEFORE POWER RELAY SHUTS DOWN) Do you have voltage?	System voltage	Go to Step (5)	Repair the open EGO power circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
5	<ul style="list-style-type: none"> Key OFF Disconnect EGO 1 sensor wire harness connector C005 Disconnect ECM wire harness connector C001 Key ON Using a high impedance DVOM check for continuity between EGO 1 connector signal pin A and engine ground Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (6)
6	<ul style="list-style-type: none"> Using a high impedance DVOM check for continuity between EGO 1 connector signal ground pin C and EGO 1 signal pin A Do you have continuity?		Repair the shorted circuit as necessary. Refer to Wiring Repairs in Engine Electrical.	Go to Step (7)

DTC 1172-EPR Pressure Lower Than Expected (SPN 520260:FMI 1)



Conditions for Setting the DTC

- EPR delivery pressure
- Check condition-Engine running or cranking
- MIL-ON during active fault
- Fault condition-EPR actual pressure less than 1.5 inches below commanded pressure
- Adaptive disabled
- Closed loop disabled

Circuit Description

The EPR (Electronic Pressure Regulator) unit measures and controls the amount of fuel that is able to pass to the fuel mixer. This code will set in the event the actual pressure is 1.0 inches water pressure lower than the actual commanded pressure. Adaptive is disabled and the MIL command is ON during this fault. Engine will shutdown if this fault occurs.

Diagnostic Aid

Always run the fuel system diagnostic pressure check before proceeding with the following diagnostic chart. Low secondary fuel pressure due to a fuel restriction or faulty regulator may cause this fault.

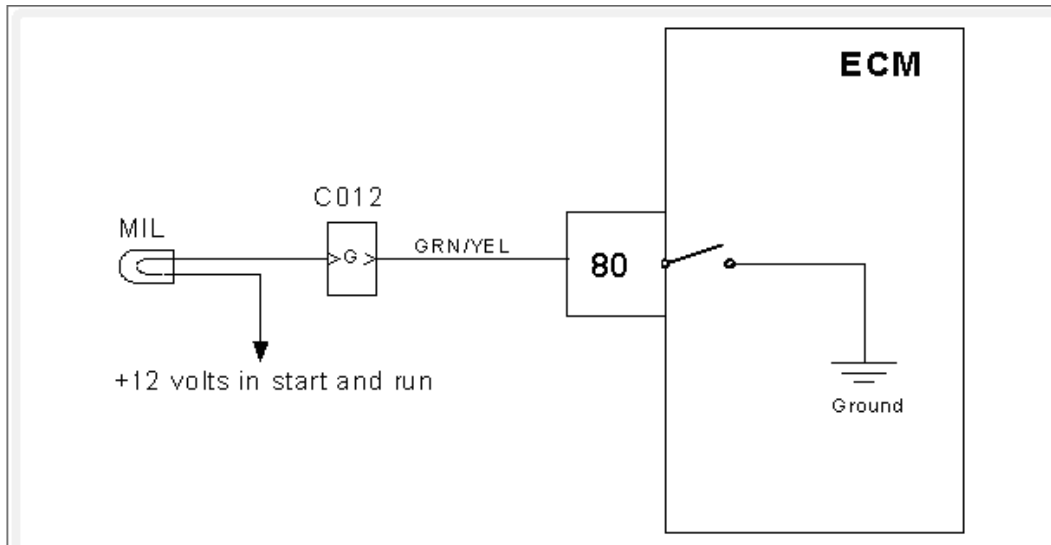
DTC 1176-EPR Internal Actuator Fault

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	<ul style="list-style-type: none"> DST connected and in the system data mode. Check for any other current or active DTCs Does the DST show any other codes set?		Go to Step (3)	Go to Step (6)
3	<ul style="list-style-type: none"> Repair any other DTCs set starting with the lowest DTC number first. Have the other DTCs set been corrected?		Go to Step (4)	-
4	<ul style="list-style-type: none"> 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 DTC1176 check for any stored codes. Does DTC 1176 still re-set?		Go to Step (5)	System OK
5	<ul style="list-style-type: none"> Replace the EPR Is the replacement complete?		Go to Step (6)	-
6	<ul style="list-style-type: none"> 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 DTC1176 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1614-RTI 3 Loss

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	<ul style="list-style-type: none"> • Key ON, Engine Running • DST (Diagnostic Scan Tool) connected in System Data Mode • Clear system fault code Does DTC 1614 reset with the engine idling?		Go to Step (3)	Intermittent problem Go to Intermittent section
3	<ul style="list-style-type: none"> • Check ECM power and ground circuits Did the power and ground circuits check OK?		Go to Step (4)	Repair the circuit as necessary. Refer to Wiring Repairs in Engine Electrical.
4	<ul style="list-style-type: none"> • Replace ECM Is the replacement complete?		Go to Step (5)	-
5	<ul style="list-style-type: none"> • 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-1614 check for any stored codes. Does the engine operate normally with no stored codes?		System OK	Go to OBD System Check

DTC 1644-MIL Control Ground Short (SPN 1213:FMI 4)



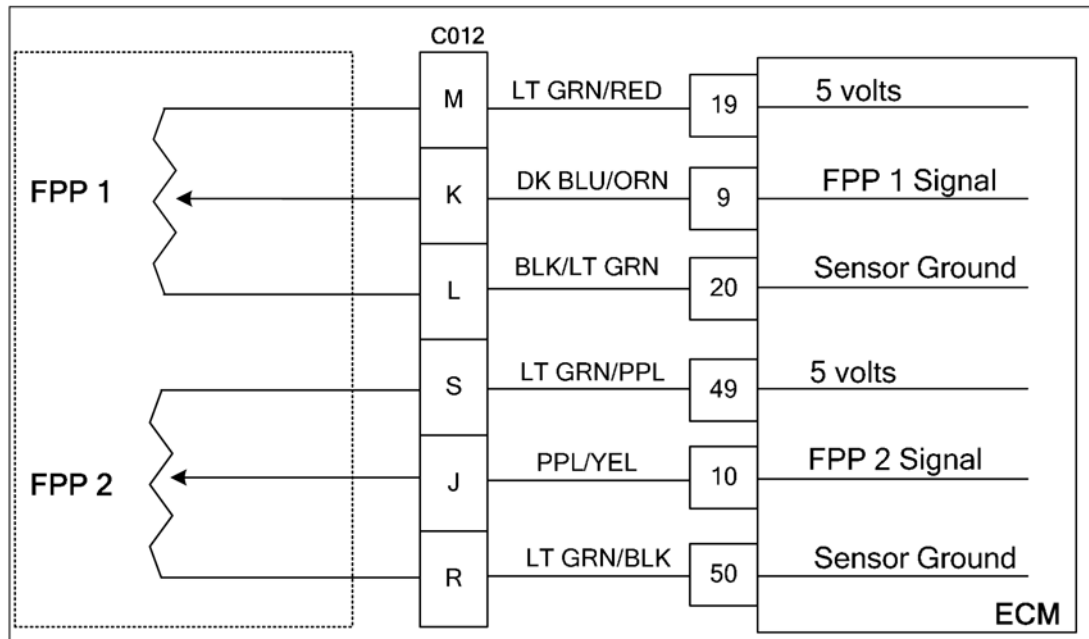
Conditions for Setting the DTC

- MIL
- Check Condition-Key ON engine OFF
- Fault Condition-ECM MIL output shorted to ground
- MIL Command-ON

Circuit Description

The Spectrum Fuel system is equipped with OBD (On-Board Diagnostics). The system has a dash mounted MIL (Malfunction Indicator Lamp). The MIL serves as notification of an emissions related problem. The MIL also has the ability to flash DTC codes in what is referred to as the blink code mode. It will display DTCs that have been stored due to a possible system malfunction. The following DTC charts in this manual will instruct the technician to perform the OBD system check. This simply means to verify the operation of the MIL. The lamp should illuminate when the key is in the ON position, and the engine is not running. This feature verifies that the lamp is in proper working order. If the lamp does not illuminate with the vehicle key ON and engine OFF, repair it as soon as possible. Once the engine is in start or run mode, the lamp should go off. If the lamp stays on while the engine is in the start or run mode, a current diagnostic trouble code may be set or a problem may exist with the MIL electrical wiring. The electrical schematic above shows the MIL power source supplied to the lamp. The ECM completes the circuit to ground to turn the lamp ON. This fault will set if the ECM MIL control is shorted to ground.

DTC 2121-FPP 1 Lower Than FPP 2 (SPN 91:FMI 18)



Conditions for Setting the DTC

- Foot pedal position sensor 1 and 2
- Check Condition-Key ON
- Fault Condition-FPP1 sensor higher than FPP 2
- MIL-ON
- Force idle
- Low rev limit

Circuit Description

The foot pedal position sensor uses variable resistors to determine signal voltage based on foot pedal position. Although the voltage outputs are different, the calculated throttle position values should be very close to the same. This fault will set if FPP 1 is 20% or greater than the FPP 2. The MIL command is ON. Forced idle and low rev limit are in effect during this fault limiting full power output.

Diagnostic Aid

FPP sensors are OEM specific and vary in configuration. The exact wire color and pin numbers for the FPP must be verified in the OEM chassis wiring schematic. The FPP sensor used in this system provides two sensors in one packaged assembly. FPP1 and FPP 2 are not serviceable individually, and in the event of a failure the complete FPP assembly must be replaced.

DTC 2127 FPP 2 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	<ul style="list-style-type: none"> Key ON, Engine OFF DST (Diagnostic Scan Tool) connected in System Data Mode Does the DST display FPP 2 voltage of less than 0.400 volts with the foot pedal in the idle position?	Less than 0.400 volts	Go to Step (3)	Go to Step (3)
3	<ul style="list-style-type: none"> Slowly increase the FPP while observing the FPP 2 voltage Does the DST ever display FPP voltage below 0.400 volts?		Go to Step (4)	Intermittent problem Go to Intermittent section
4	<ul style="list-style-type: none"> Disconnect the FPP sensor connector Jump the pins from the FPP sensor connector that leads to C012 signal pin J and 5 volt supply pin S Does the DST now show FPP 1 voltage above 0.400 volts?	Greater than 0.400 volts	Go to Step (5)	Go to Step (7)
5	<ul style="list-style-type: none"> Inspect the FPP and C012 connectors for damage corrosion or contamination Did you find a problem?		Repair the circuit as required. See wiring harness repair section	Go to Step (6)
6	<ul style="list-style-type: none"> Replace FPP sensor Is the replacement complete?		Go to Step (12)	-
7	<ul style="list-style-type: none"> Key OFF Disconnect ECM connector C001 Disconnect the vehicle interface connector C012 Using a DVOM check for continuity between C012 pin S and ECM 5 volt pin 49 Do you have continuity?		Go to Step (8)	Repair the open 5 volt circuit as required. See wiring harness repair section
8	<ul style="list-style-type: none"> Using a DVOM check for continuity between C012 signal pin J and ECM signal pin 10 Do you have continuity?		Go to Step (9)	Repair the open signal circuit as required. See wiring harness repair section
9	<ul style="list-style-type: none"> Using a DVOM check for continuity between ECM connector signal pin 10 and engine ground Do you have continuity?		Repair the signal shorted to ground circuit as required. See wiring harness repair section	Go to Step (10)
10	<ul style="list-style-type: none"> Inspect FPP connector C012 and ECM connector pins for damage corrosion or contamination Did you find a problem?		Repair the circuit as required. See wiring harness repair section	Go to Step (11)
11	<ul style="list-style-type: none"> Replace ECM Is the replacement complete?		Go to Step (12)	-

the sun. Ground level ozone is formed by NOX, during the formation of photochemical smog.

Particulates: Microscopic pieces of solid or liquid substances such as lead and carbon that are discharged into the atmosphere by internal combustion engines.

Positive Crankcase Ventilation (PCV): An automotive emission control system designed to reduce hydrocarbon emissions by routing crankcase fumes into the intake manifold rather than to the atmosphere.

Power Derate: A mode of reduced engine power output for the purposes of protecting engine components during a failure or malfunction.

Pressure Differential: The differential between atmospheric pressure and intake manifold (referred to as vacuum) pressure.

Pressure Regulator: A device to control the pressure of fuel delivered to the fuel injector(s).

Primary Circuit: The low-voltage or input side of the ignition coil.

Propane: An odorless and colorless gas, C₃H₈, found in natural gas and petroleum.

Psia: pounds per square inch absolute

PTV: Pressure Trim Valve

Reactivity: Refers to the tendency of an HC in the presence of NOX and sunlight to cause a smogforming reaction. The lighter the HC, the lower reactivity tends to be.

Regulator: An assembly used to reduce and control the pressure of a liquid or vapor.

Resistance: The opposition to the flow of current in an electrical circuit. Measured in ohms.

Rest Pressure: Fuel pressure maintained within the system after engine shutdown.

Rich Mixture: An air to fuel ratio below the stoichiometric ratio; too much fuel.

SAE: Society of Automotive Engineers.

Secondary Circuit: The high-voltage output side of the ignition coil.

SEFI or SFI: Sequential Electronic Fuel Injection or Sequential Fuel Injection.

Sensors: Devices that provide the control module with engine information as needed to properly control engine function.

Spark Line: The portion of an oscilloscope pattern that represents the time during which the air/fuel mixture is being burned in the combustion chamber.

Splice: An electrical term for the joining of two or more conductors at a single point.

Stoichiometric Ratio: An ideal fuel/air ratio for combustion in which all of the fuel and most of the oxygen will be burned.

Sulfur Oxides: Chemical compounds where sulfur is bonded to oxygen produced by the combustion of gasoline or any other fuel that contains sulfur. As sulfur oxides combine with water in the atmosphere to form sulfuric acid.

System Pressure: The fuel pressure maintained in the system during normal engine operation.

Tap: An electrical term for a type of splice where the original circuit is not interrupted.

TBI: Throttle Body Injection. Any of several injection systems that have the fuel injector(s) mounted in a centrally located throttle body.

Throttle Body: Controls engine RPM by adjusting the engine manifold vacuum to the mixer. Consists of a housing shaft, throttle liner and butterfly valve.

TLEV: Transitional Low Emission Vehicle.

TMAP: Combined Air Inlet and Manifold Pressure Sensor.

Toluene: A liquid aromatic hydrocarbon C₇H₈.

TPS: Throttle Position Sensor.

TSB: Technical Service Bulletin.

ULEV: Ultra Low Emission Vehicle.

USB: Universal Serial Bus. A plug or interface supplied on most personal computers.

Vaporization: A process in which liquid changes states into gas.

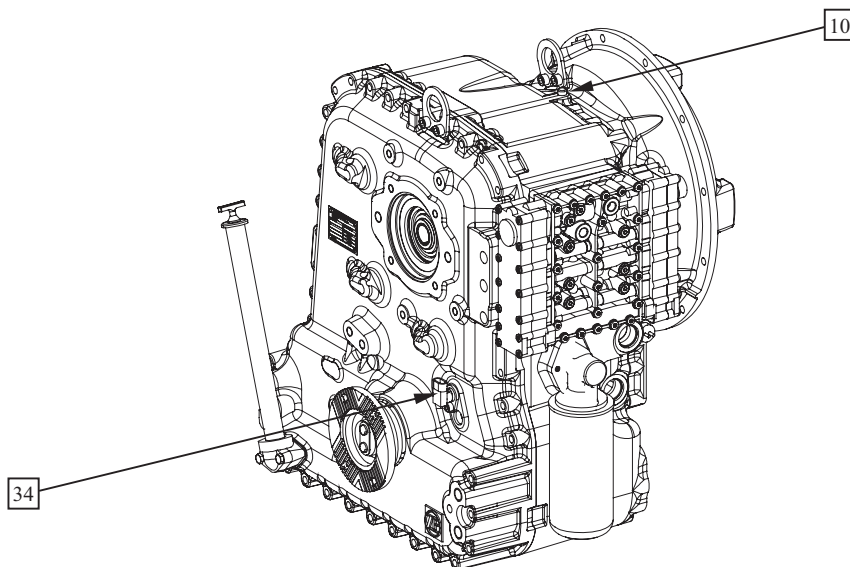
Venturi Air Valve Vacuum (VAVV): An amplified air valve vacuum signal coming from the venturi area of the mixer, directly exposed to airflow before the addition of vaporized LPG.

Volt/ohmmeter (VOM): A combination meter used to measure voltage and resistance in an electrical circuit. Available in both analog and digital types. May also be referred to as AVOM and DVOM.

MEASURING PLAN AND CONNECTIONS

Measurements have to be made with the transmission at operating temperature (approx. 80°C - 90°C)!

NO.	DESIGNATION OF THE ITEM	CONNECTION	IDENTIFICATION ON VALVE BLOCK	
MEASURING POINTS FOR PRESSURE OIL AND TEMPERATURE:				
51	Before converter	Opening pressure 11+2 bar	M10x1	H
52	After converter	Opening pressure 4.3+3 bar	M10x1	
53	Clutch Forward	16 +2 bar	KV M10x1	B
55	Clutch Reverse	16 +2 bar	KR M10x1	E
56	Clutch	16 +2 bar	K1 M10x1	D
57	Clutch	16 +2 bar	K2 M10x1	A
58	Clutch	16 +2 bar	K3 M10x1	C
60	Not applicable		K4 M10x1	F
63	After converter		M14x1.5	
	Temperature 100°C, short-time 120°C			
65	System pressure	16 +2.5 bar	M10x1	K
MEASURING POINTS FOR FLOW RATES:				
15	Connection from heat exchanger		1 5/16" - 12 UN-2B	
16	Connection to heat exchanger		1 5/16" - 12 UN-2B	
INDUCTIVE- PULSE- SPEED TRANSMITTERS AND SWITCHES:				
21	Inductive transmitter n Turbine		M18x1.5	
34	Speed transmitter n Output		-----	
47	Inductive transmitter n Internal speed input		M18x1.5	
48	Inductive transmitter n Engine		M18x1.5	
54	Differential pressure switch for pressure filter		M14x1.5	
CONNECTIONS:				
10	Breather		M10x1	
49	Plug connection on electro-hydraulic control unit			



Unsnap the retaining ring (2) from the idler (1) and remove the ball bearing.

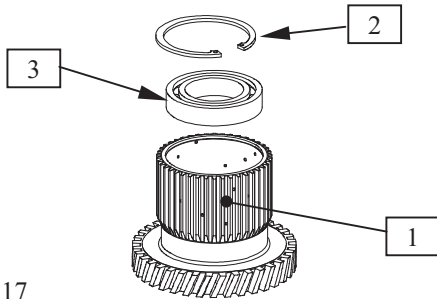


Figure 17

Remove the needle cage (1) from the shaft (2).

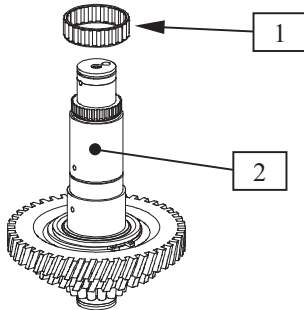


Figure 18

Shaft (2) and gear (1) cannot be separated (shrink fit).

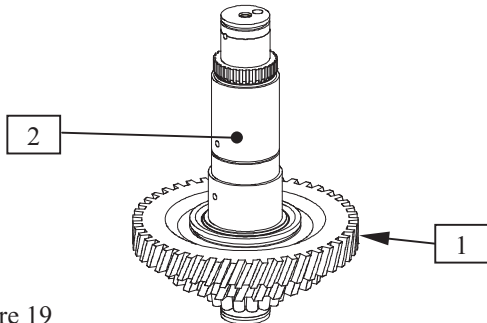


Figure 19

Rotate the shaft (2) by 180° and unsnap the piston ring (1).

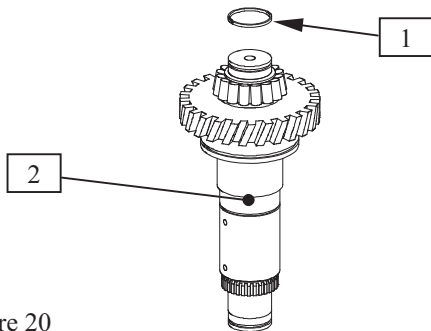


Figure 20

Pull the taper roller bearing (inner ring) from the shaft.

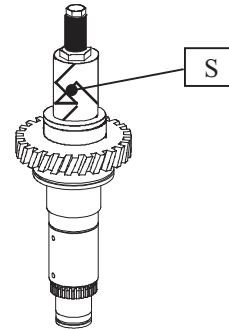


Figure 21

4.3 Clutch K1

Remove the stud (1) and unsnap the piston ring (2).

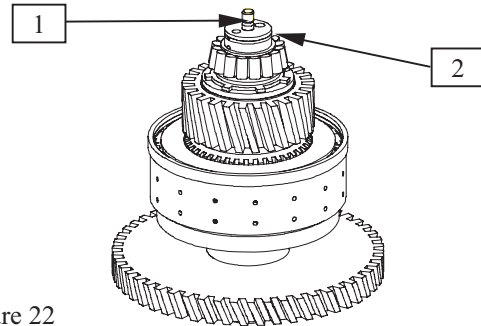


Figure 22

Pull the taper roller bearing (inner ring) from the shaft.

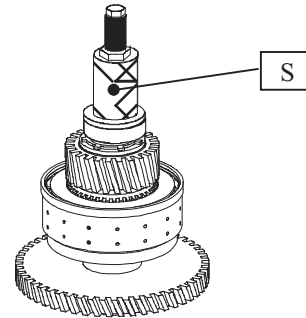


Figure 23

Unsnap the retaining ring (1).

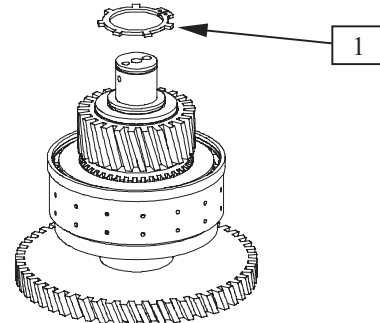


Figure 24

1.5 Clutch K3

Press the taper roller bearing (inner ring) (1) onto the shaft until contact.

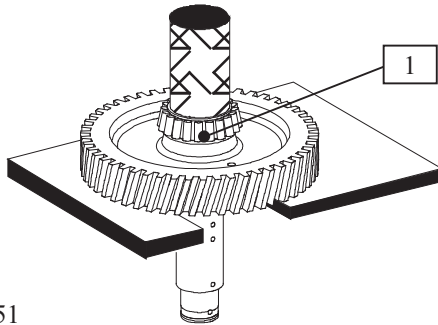


Figure 51

Install the piston ring (1).

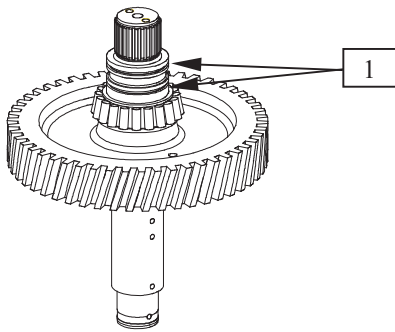


Figure 52

Install the sealing cap (1)
Wet the contact surface with (Loctite Type No. 262) !

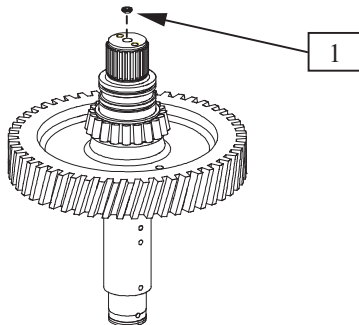


Figure 53

Heat up the inner diameter of the clutch (1) (approx. 120° C).

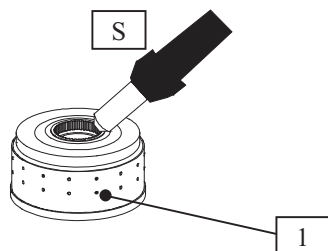


Figure 54

Mount the clutch (1) until contact is obtained.

CAUTION

Wear safety gloves!

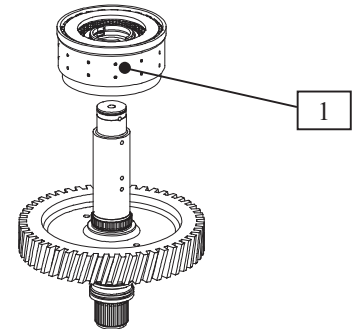


Figure 55

Mount the running disc (1), axial cage (2) and axial washer (3).
Install chamfer (see arrow) of the running disc (3) showing towards the axial cage!

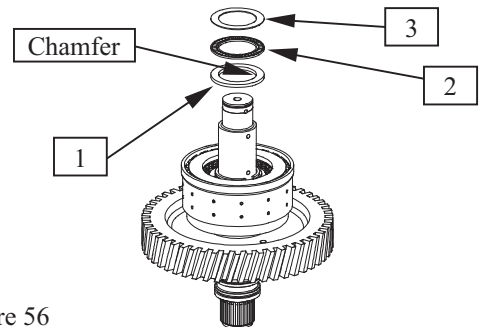


Figure 56

Mount the needle cage (1).

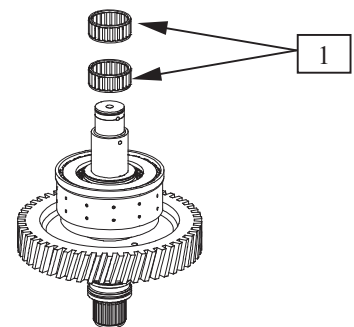


Figure 57

Mount the pressure regulators (1) and fasten them by means of fixing plates (2) and cap screws (3).
Install the fixing plate with the neck showing downwards!
Observe radial installation position of the pressure regulators, see Figure!
Tightening torque MA = 5.5 Nm

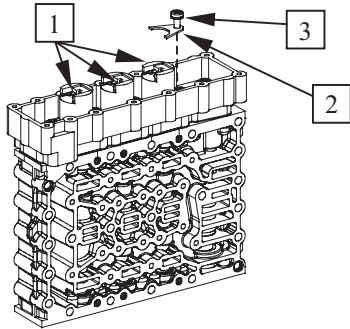


Figure 10

Preassemble the opposite side

The figure on the left shows the following single parts:
1 = Main pressure valve (1x, Piston a. compr.spring)
2 = Vibration damper (3x, Piston a. compr.spring)
3 = Follow-on slide (3x, Piston a. compr.spring)

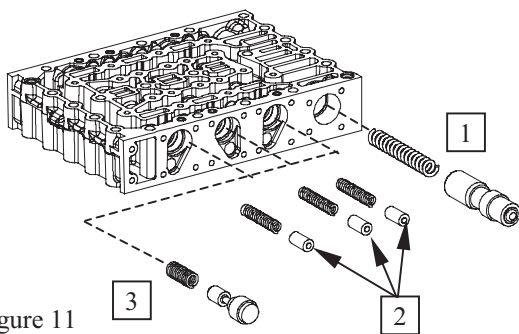


Figure 11

Install the single parts acc. to Figure 11.

Preload the compression springs of the follow-on slides and fasten the pistons preliminarily by means of cylindrical pins (S) Φ 5.0 mm (assembly aid), see arrows (S)!

Install two adjusting screws.

Assemble flat gasket (1) and housing cover. Then place the housing cover by means of adjusting screws equally until contact.

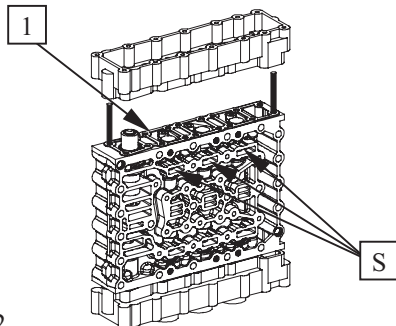


Figure 12

Preload the pistons with cap screws and remove the cyl. pins (assembly aid) again.
Then fasten the housing cover by means of cap screws (1).

Tightening torque MA = 5.5 Nm

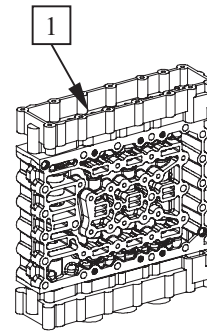


Figure 13

Mount the pressure regulators (1) and fasten them by means of fixing plates and cap screws.

Install the fixing plate with the neck showing downwards!

Observe radial installation position of the pressure regulators, see Figure!

Tightening torque MA = 5.5 Nm

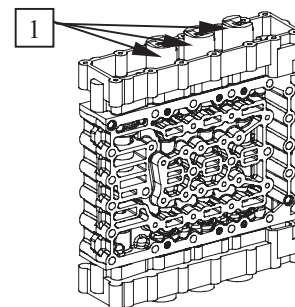


Figure 14

Assemble the wiring harness (1) and connect the pressure regulators (6x).

See Figure 1 for installation position of pressure regulators!
Pay attention to the installation position of the wiring harness, also see markings (Chapter/Figure 6)!

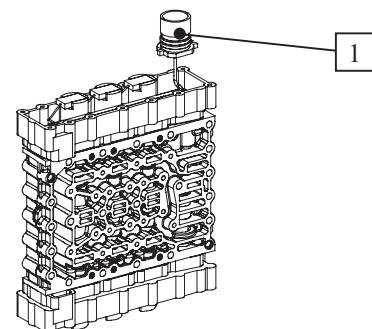
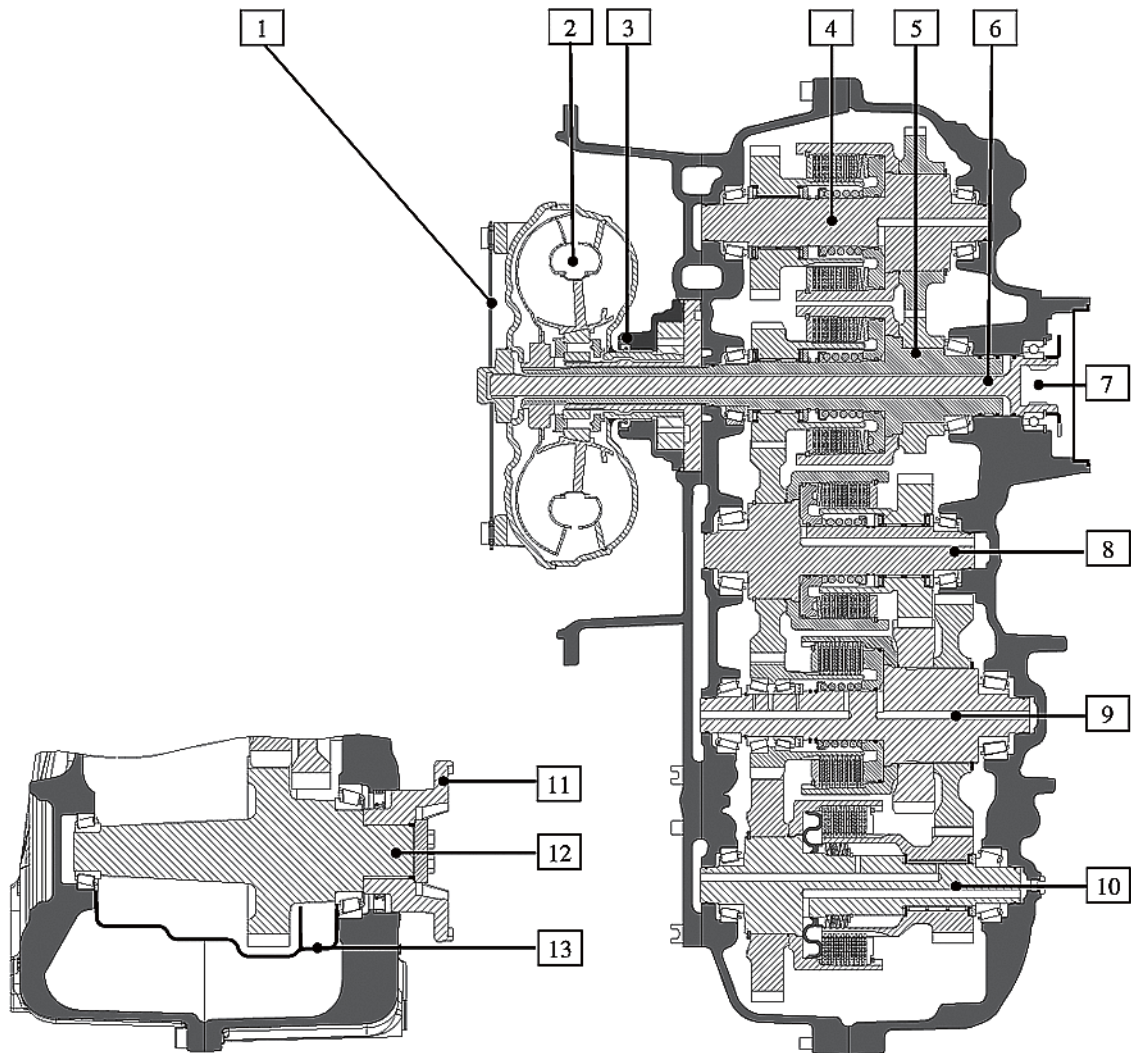


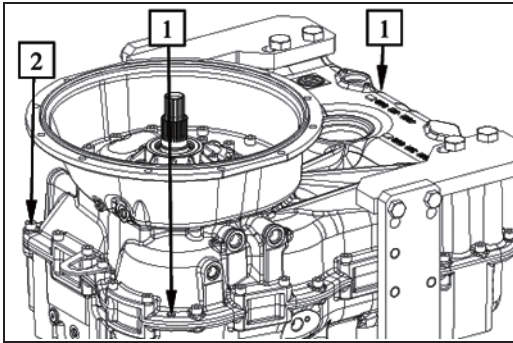
Figure 15

Fault Code	MEANING OF THE FAULT CODE possible reason for fault detection	reaction of the TCU	possible steps to repair	remarks
36	36 : Logical Error TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero <ul style="list-style-type: none"> • cable / connector is defective and has bad contact • speed sensor has an internal defect • sensor gap has the wrong size 	OP-Mode: substitute clutch control if a failure is existing at output speed, TCU shifts to neutral OP-Mode: limp home	<ul style="list-style-type: none"> • check the cable from TCU to the sensor • check the connectors • check the speed sensor • check the sensor gap 	This fault is reset after power up of TCU
37	37 : T/M Error TCU measures a voltage higher than 7.00 V at speed input pin <ul style="list-style-type: none"> • cable is defective and is contacted to battery voltage • cable has no connection to TCU • speed sensor has an internal defect • connector pin is contacted to battery voltage or has no contact 	OP-Mode: substitute clutch control	<ul style="list-style-type: none"> • check the cable from TCU to the sensor • check the connectors • check the speed sensor 	
38	38 : T/M Error TCU measures a voltage less than 0.45V at speed input pin <ul style="list-style-type: none"> • cable / connector is defective and is contacted to vehicle ground • speed sensor has an internal defect 	OP-Mode: substitute clutch control	<ul style="list-style-type: none"> • check the cable from TCU to the sensor • check the connectors • check the speed sensor 	
39	39 : Logical Error TCU measures a internal speed over a threshold and at the next moment the measured speed is zero <ul style="list-style-type: none"> • cable / connector is defective and has bad contact • speed sensor has an internal defect • sensor gap has the wrong size 	OP-Mode: substitute clutch control	<ul style="list-style-type: none"> • check the cable from TCU to the sensor • check the connectors • check the speed sensor • check the sensor gap 	This fault is reset after power up of TCU
3A	3A : T/M Error TCU measures a voltage higher than 12.5 V at speed input pin <ul style="list-style-type: none"> • cable is defective and is contacted to battery voltage • cable has no connection to TCU • speed sensor has an internal defect • connector pin is contacted to battery voltage or has no contact 	special mode for gear selection OP-Mode: substitute clutch control if a failure is existing at turbine speed, TCU shifts to neutral OP-Mode: limp home	<ul style="list-style-type: none"> • check the cable from TCU to the sensor • check the connectors • check the speed sensor 	

Section 1 LAYOUT 3WG-94EC

- 1 = Flex plate for direct mount
- 2 = Converter
- 3 = Transmission pump
- 4 = Clutch shaft „KV“
- 5 = Input shaft / clutch shaft „KR“
- 6 = Central shaft / input shaft PTO
- 7 = Connection, PTO; coaxial, engine-dependent
- 8 = Clutch shaft „KD“
- 9 = Clutch shaft „KE“
- 10 = Clutch shaft „KC“
- 11 = Output flange
- 12 = Output shaft
- 13 = Screen sheet





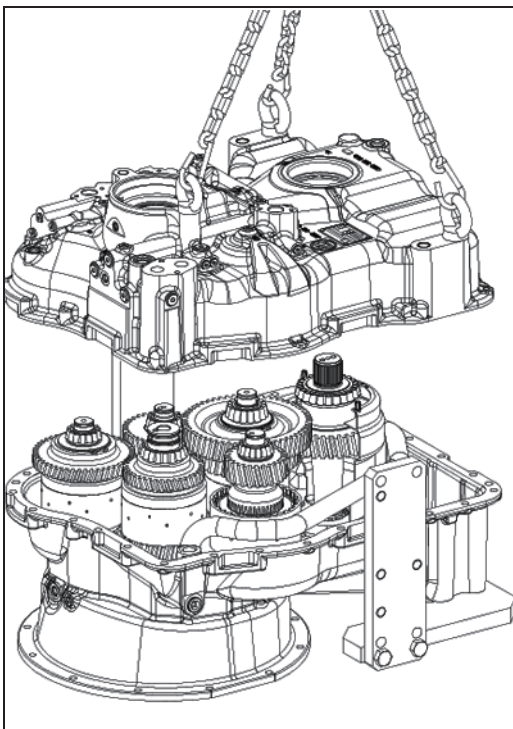
6. REMOVAL of clutches and DISASSEMBLY of oil pressure pump

Force out cylindrical pins (1).

Loosen bolted connection (2) of housing front and rear part.



Make sure to leave 2 cylindrical screws crosswise in the bolted connection (2)!
Transmission rear part is not fixed to the clamping angle and could get loose when turning!

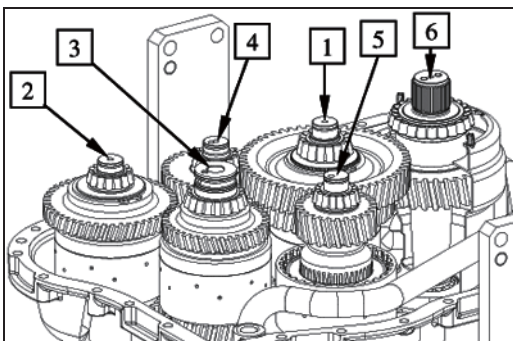


Rotate transmission housing 180°, loosen the last 2 cylindrical screws from the bolted connection housing front and rear part and separate housing rear part by means of lifting device.

Support by means of assembly lever!

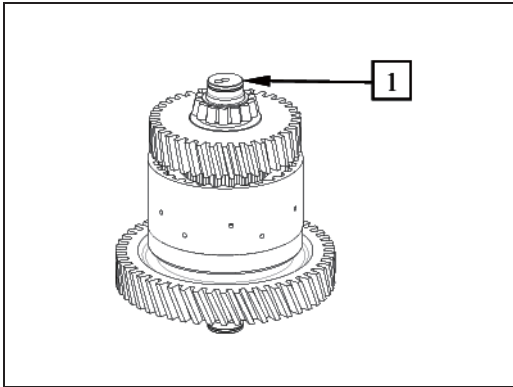
(S) Assembly lever

5870 345 036

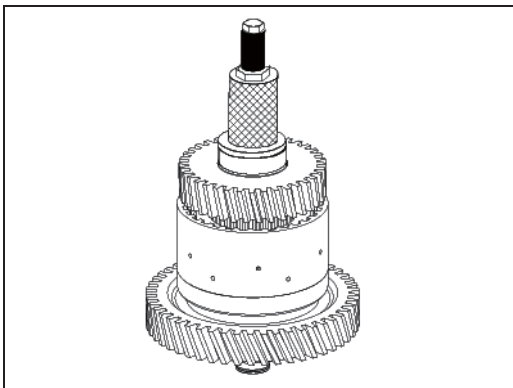


Lift the clutches out of the housing in the following sequence:

- 1 = Clutch KE (Clutch – 3rd gear)
- 2 = Clutch KV (Clutch - forward)
- 3 = Clutch KR (Clutch – reverse and input)
- 4 = Clutch KD (Clutch – 2nd gear)
- 5 = Clutch KC (Clutch – 1st gear)
- 6 = Output with screen sheet

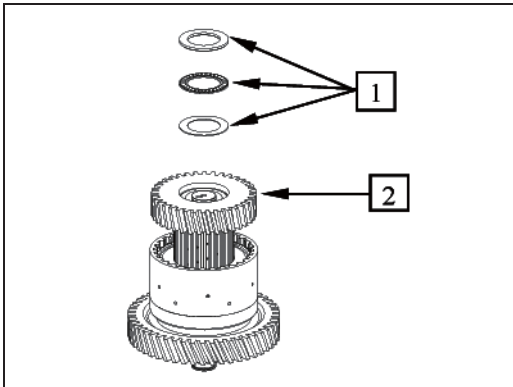
**7.3 Clutch KD**

Snap out rectangular ring (1).

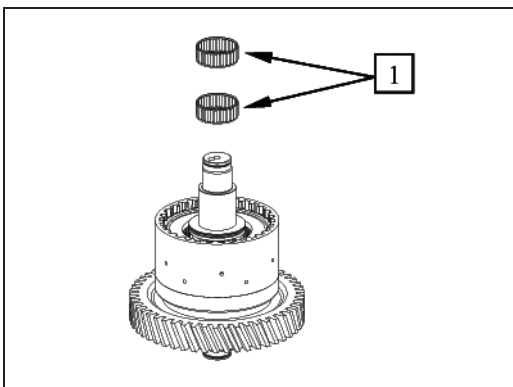


Pull tapered roller bearing (inner ring) off the shaft.

(S) Grab sleeve 5873 000 029
(S) Basic tool 5873 000 000

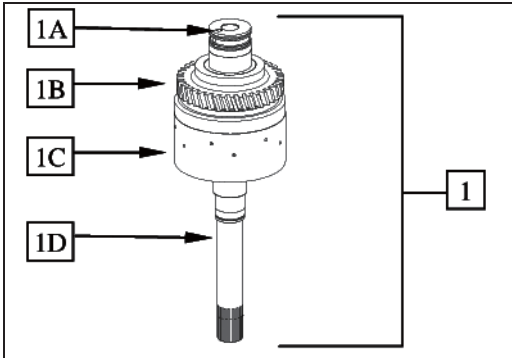


Remove axial bearing assy (1) and inner disk carrier.



Remove needle cage (1).

**Section 4
Reassembly**

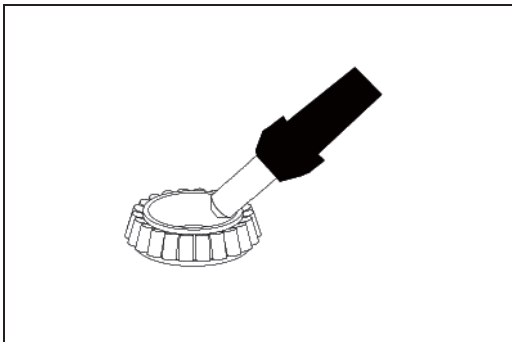


1. Reassembly of clutches :

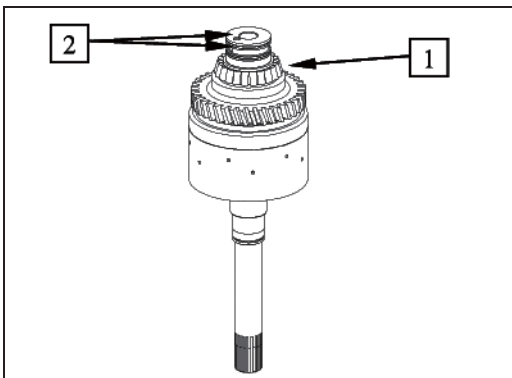
1.1 Clutch KR/input

The clutch (1) is supplied by the spare parts service only as a complete assy which consists of :

- 1A = Ball
- 1B = Helical gear
- 1C = Disk carrier
- 1D = Input shaft



Heat up bearing inner ring (approx. 120° C).

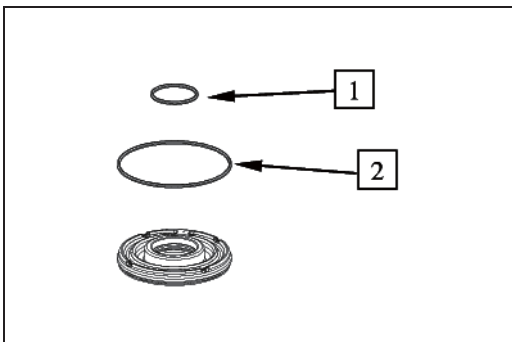


Mount bearing inner ring (1) until contact is obtained.
Fit rectangular rings 50x2.5 (2).



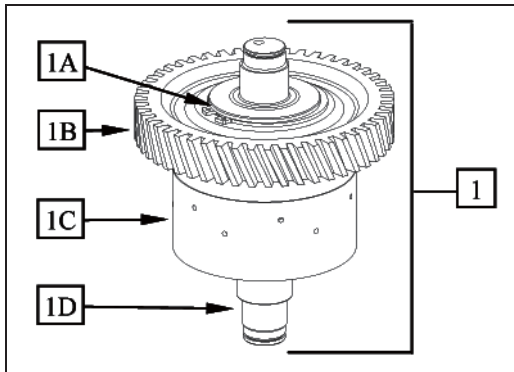
Wear protective gloves!

Adjust bearing inner ring after cooling-down.



Insert both O-rings (1 and 2) into the piston grooves and oil

- 1 = 40x3
- 2 = 104.5x3



1.3 Clutch KD

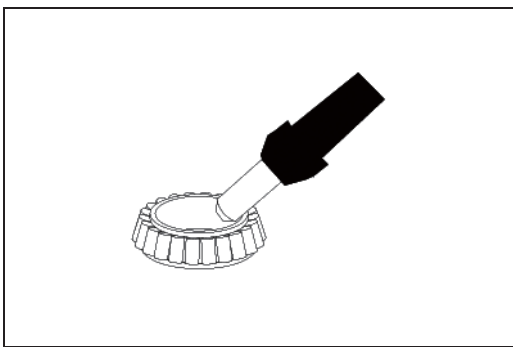
The clutch (1) is supplied by the spare parts service only as a complete assy which consists of :

1A = Retaining ring

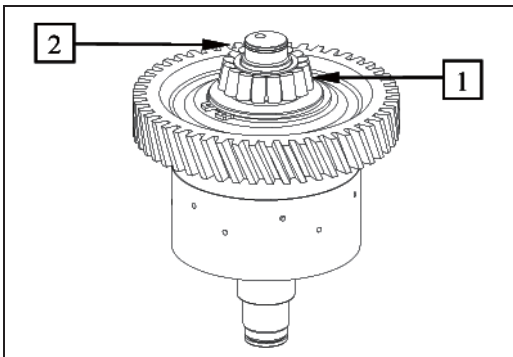
1B = Helical gear

1C = Disk carrier

1D = Shaft



Heat up bearing inner ring (approx. 120° C).



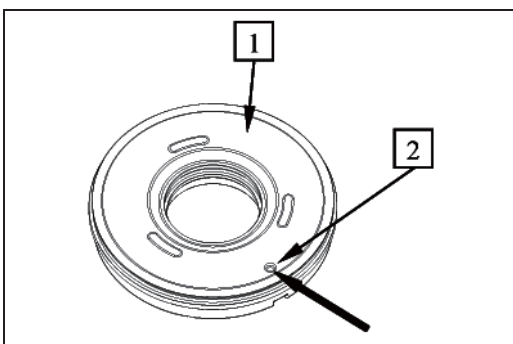
Mount bearing inner ring (1) until contact is obtained.

Fit rectangular rings 30x2 (2).



Wear protective gloves!

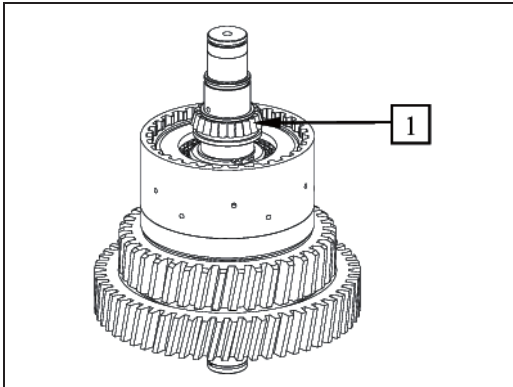
Adjust bearing inner ring after cooling-down.



Piston (1) with drain valve.

Check function of the drain valve (2). There must be no jamming of the ball (see arrow).

The piston (1) is supplied by the spare parts service only as a complete assy!

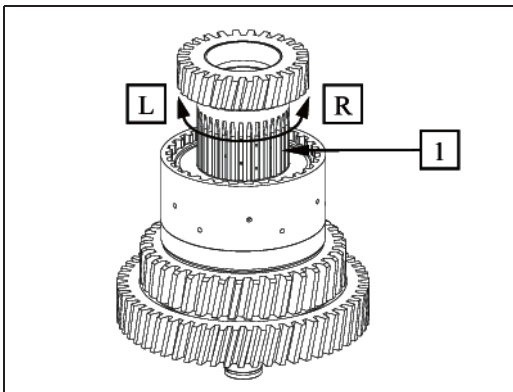


Mount bearing inner ring (1) until contact is obtained.



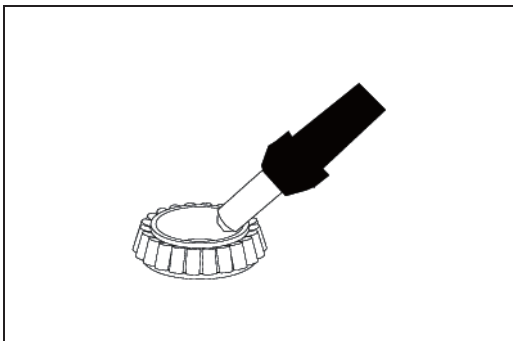
Wear protective gloves!

Adjust bearing inner ring after cooling-down.

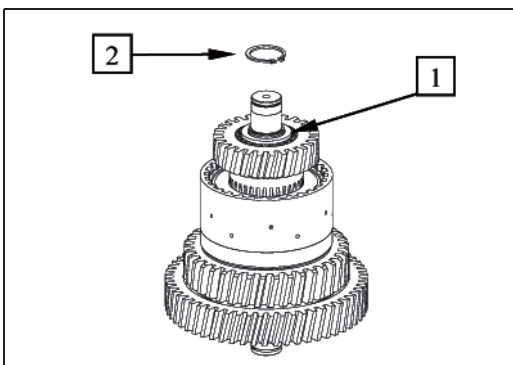


Mount inner disk carrier until contact is obtained.

Install inner disks by short ccw/cw rotations of the inner disk carrier (1).



Heat up bearing inner ring (approx. 120° C).



Mount bearing inner ring (1) until contact is obtained.

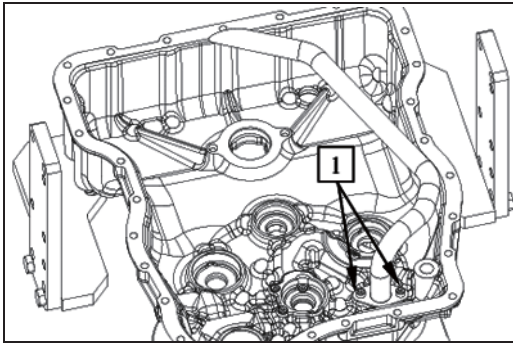


Wear protective gloves!

Adjust bearing inner ring after cooling-down.

Snap in retaining ring 35x2.1 (2).

Pay attention to an exact contact of the retaining ring in the groove!



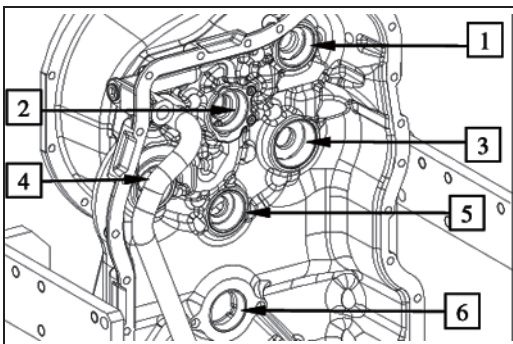
Fix suction tube (1) with cylindrical screws M8x16 (2).

Tightening torque M8/8.8x16..... $M_A = 23 \text{ Nm}$

When reusing the cylindrical screws, they must be secured with Loctite no. 243!

New cylindrical screws are already provided with adhesive (microcapsule).

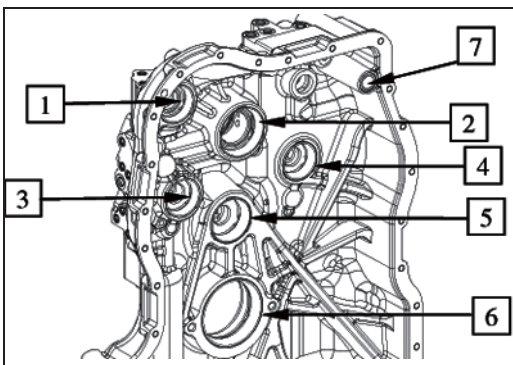
The microcapsule bursts when the screw is turned in, wets screw and nut thread and hardens.



Insert all bearing outer rings into the bearing holes of both housing parts (see Figure).

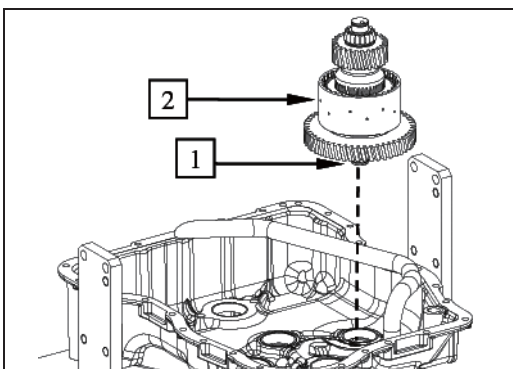
- 1 = „KV“ clutch - forward
- 2 = „KR“ clutch - reverse and input
- 3 = „KD“ clutch - 2nd gear
- 4 = „KC“ clutch - 1st gear
- 5 = „KE“ clutch - 3rd gear
- 6 = Output

Place bearing outer rings into the bearing holes using assembly grease.



If, contrary to the ZF recommendation, the tapered roller bearings of clutches and input are not replaced, it is imperative to ensure the previous pairing (bearing inner ring/bearing outer ring) - see Chapter -6 Figure 4 and 5!

Insert O-ring 24x2.5 (7) into the hole and grease it.



2.2 Reinstallation of clutches

Align and grease rectangular ring 30x2 (1).

Position clutch KC (2).

GROUP 08**TRANSMISSION (T12313 MODEL)
(FOR LPG TRUCK)**

DISASSEMBLY	Section 1
DISASSEMBLY AND REASSEMBLY OF (1ST) AND 2ND CLUTCH	Section 2
DISASSEMBLY AND REASSEMBLY OF 3RD CLUTCH.....	Section 3
DISASSEMBLY AND REASSEMBLY OF FORWARD AND REVERSE CLUTCHES	Section 4
REGULATOR VALVE DISASSEMBLY AND REASSEMBLY.....	Section 5
CLEANING AND INSPECTION.....	Section 6
TROUBLESHOOTING PROCEDURES	Section 7
TRANSMISSION CONTROLLER.....	Section 8

- Remove gear locating ring from shaft.



- Remove clutch gear and hub and gear bearings.



- Remove thrust bearing and clutch gear retainer ring.



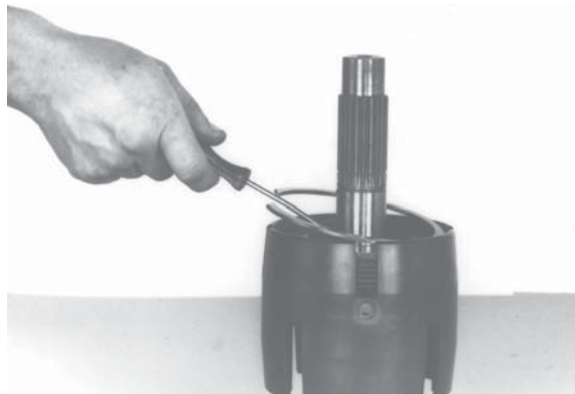
- Remove outer thrust washer, thrust bearing and inner thrust washer.



- Remove outer thrust washer, thrust bearing, and inner thrust washer.



- Remove clutch disc end plate retainer ring.



- Remove inner and outer clutch discs.



- Remove disc springs.



- Compress disc springs and remove retainer ring.



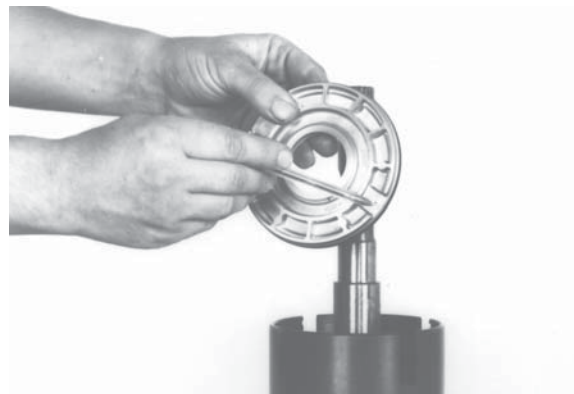
- Remove clutch piston wear plate.



- Remove retainer ring retainer.



- Remove clutch piston.



- Install inner and outer clutch piston seal rings. Size inner ring as explained on page 20-02-21 install clutch piston in clutch drum. Use caution as not to damage sealing rings.

△ Assembly instruction.



- Install clutch piston wear plate.



- Install piston return disc springs. First spring with large diameter of bevel toward wear plate. Alternate five (5) springs.

△ Assembly instruction.



- Position return spring ring retainer in clutch shaft.



- Start ring on shaft with snap ring pliers.



- Use a sleeve with the proper inner diameter to fit over shaft and against retainer ring. A sharp blow with a soft hammer will compress springs and seat retainer ring. Be sure ring is in full seated position in groove.



Section 6

CLEANING AND INSPECTION

- **CLEANING**

Clean all parts thoroughly using solvent type cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.



CAUTION

Care should be exercised to avoid skin rashes, fire hazards, and inhalation of vapors when using solvent type cleaners.

- ① **BEARINGS**

Remove bearings from cleaning fluid and strike flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. Dry bearings using moisture-free compressed air. Be careful to direct air stream across bearing to avoid spinning. Do not spin bearings when drying. Bearings may be rotated slowly by hand to facilitate drying process.

- ② **HOUSINGS**

Rclean interior and exterior of housings, bearing caps, etc., thoroughly. Cast parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts do not have ground or polished surfaces. Parts should remain in solution long enough to be thoroughly cleaned and heated. This will aid the evaporation of the cleaning solution and rinse water.

Parts cleaned in solution tanks must be thoroughly rinsed with clean water to remove all traces of alkali. Cast parts may also be cleaned with a steam cleaner.



CAUTION

Care should be exercised to avoid inhalation of vapors and skin rashes when using alkali cleaner.

All parts cleaned must be thoroughly dried immediately by using moisture – free compressed air or soft, lintless absorbent wiping rags free of abrasive materials such as metal filings, contaminated oil, or lapping compound.

- **INSPECTION**

The importance of careful and thorough inspection of all parts cannot be overstressed.

Replacement of all parts showing indication of wear or stress will eliminate costly and avoidable failures at a later date.

- ① **BEARINGS**

Carefully inspect all rollers : cages and cups for wear, chipping, or nicks to determine fitness of bearings for further use. Do not replace a bearing cone or cup individually without replacing the mating cup or cone at the same time. After inspection, dip bearings in automatic transmission fluid and wrap in clean lintless cloth to protect them until installed.

- ② **OIL SEALS, GASKETS, ETC.**

Replacement of spring load oil seals, O-rings, metal sealing rings, gaskets, and snap rings is more economical when unit is disassembled than premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when being installed. Cutting, scratching, or curling under of the seal lip seriously impairs its efficiency. Apply a thin coat of Permatex No. 2 on the outer diameter of the oil seal to assure an oil tight fit into the retainer. When assembling new metal type sealing rings, same should be lubricated with coat of chassis grease to stabilize rings in their grooves for ease of assembly of mating members. Lubricate all O-rings and seals with recommended type automatic transmission fluid before assembly.

- ③ **GEARS AND SHAFTS**

If magnaflux process is available, use process to check parts. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks, or scores. If gear teeth show spots where case hardening is worn through or cracked, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they are not sprung, bent, or splines twisted, and that shafts are true.

- ④ **HOUSING, COVERS, ETC**

Inspect housings, covers, and bearing caps to be certain they are thoroughly cleaned and that mating surfaces, bearing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence of cracks or condition which would cause subsequent oil leaks or failures.

TC20	K2	Analogue input 1	ptg	Not used
TC21	A3	Engine speed		Engine speed – magneto resistive pickup
TC22	B3	Input 7		Declutch request on/off
TC23	C3	Not used		Not used
TC24	D3	Turbine speed		Turbine speed – magnetoresistive pickup
TC25	E3	Input 2	ptp	Shift lever range selection
TC26	F3	Output8	stp	Not used
TC27	G3	TXD		Not used
TC28	H3	CAN L		Not used
TC29	J3	Input 5	ptp	Manual / automatic selection
TC30	K3	Analogue input 0	ptg	Not used

1.3 Man Machine interface

1.3.1 Shift lever

The main interface with the driver is the shift lever. It allows selecting the driving direction and the different ranges. The shift lever output signals serve as inputs for the APC73-12. See wiring diagram W4212885 for detailed information on shiftlever pattern.

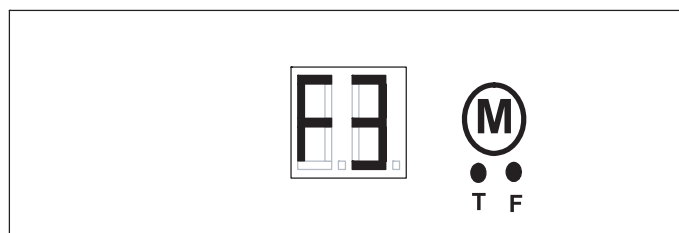
1.3.2 Display

The display is located on the APC73-12 front panel and consists of:

- 2 red 7-segment LED digits
- 2 status LED lamps
- a push button labelled 'M' for display mode selection.

The LED lamp labelled 'T' is yellow and is used to indicate test modes and faults.

The LED lamp labelled 'F' is red and is switched on when the APC73-12 is in the reset condition.



APC73-12 front panel display

Refer to Dana drawing **IAPC73** for installation dimensions.

After power up, the display defaults to the **gear position mode**. In this mode, the left digit shows the actually engaged direction and the right digit shows the currently engaged range (gear).

4. Guidelines and Conditions for Use

4.1 Diagnostics and maintenance

Principally there are no specific devices required for first level troubleshooting as the APC73-12 incorporates several self-test features assisting in this process.

Nevertheless, use of digital multi-meters and simple tools such as an indicator lamp will be required to pinpoint exact causes of problems.

More in depth troubleshooting and system tuning involves use of an IBM Compatible PC with appropriate software and EPROM programming equipment.

The APC73-12 allows recall and modification of non-volatile parameters through RS232.

This way, customers can (given the necessary equipment) choose to adapt certain parameters to suit their needs.

From a maintenance point of view, this is relevant in so far that the APC73-12 allows reading back the (modified) parameters along with serial number, part number and modification date.

4.1.1 Self test Functions

The APC73-12 has special circuitry to help verifying its operation.

Four self-test modes are built into the APC73-12 control programs:

- Turbine speed monitor
- Engine speed monitor
- Speed ratio monitor
- Battery voltage monitor
- Input Test
- Output Test

The 'T' led is **on** while operating the APC73-12 in test mode.

Depending on the application, it's possible that additional test modes are supported.

4.1.1.a Self test Operation

Self-test mode is activated by pressing the mode switch on the APC73-12 front panel while powering up the APC73-12.

Switching off the power of the APC73-12 leaves the self-test mode.

After powering up, the **turbine speed monitor** is activated.

Pushing the mode switch after powering up selects the next mode in the order listed above.

After output test, turbine speed monitoring is again selected.

4.1.1.b Turbine Speed Monitor

When selecting this mode the display shows:



After releasing the mode switch the display shows turbine speed in RPM (rotations per minute).

From 0 - 999 rpm the display displays 10's - i.e. below display corresponds with 630 RPM.



From 1000 RPM on, the display shows thousands. The example indicates 1400 RPM



4.1.1.c Engine Speed Monitor

When selecting this mode the display shows:



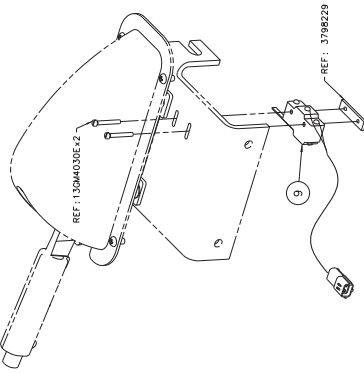
After releasing the mode switch the display shows engine speed in RPM (rotations per minute).

The display method is identical as described above for turbine speed.

Electrical Parts Arrangement

- Electrical (C60-80D)

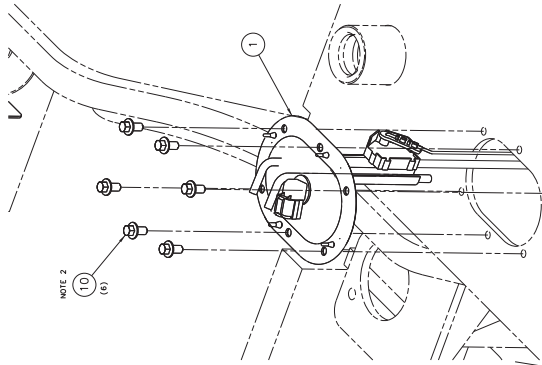
1. TORQUE TO 7 ± 8 N·m.
2. TORQUE TO 30 - 35 N·m.
3. ORIGINAL PARTS ONLY. IVECO PART NO. : IVECO 504060981
GRID HEATER RELAY : IVECO 50403887
GRID HEATER ECU : IVECO 50403887



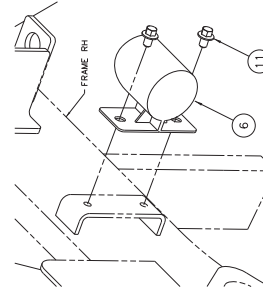
P/BRAKE SWITCH INSTALL

IVECO ENGINE
D40 HYD ENGINE

NO	PART NO	DWG NO	PART NAME	Q-TY	REMARK
16	20CM408R		CAPSCREW-FLANGED	2	
15	8042716		RELAY-30DINT-24V	3	
14	20CM510ER		CAPSCREW-FLANGED	4	
13	8047857		PLATE FUSE BOX	1	
12	8522-120B0		HORN ASSY-24V	1	
11	20CM812ER		CAPSCREW-FLANGED	5	
10	20CM816ER		CAPSCREW-FLANGED	8	
9	8039386		P/BRAKE SWITCH	1	
8	20CM812ER		CAPSCREW-FLANGED	4	
7	8027047		RELAY-24V	3	
6	8021030		BUZZER-24V	1	
5	8042129		POWER RELAY-24V	1	STARTER RELAY
4	8042336		SGO-CONTROLLER	1	
3	8037694		KEY SWITCH COMBINATION	1	
2	8041020		DISPLAY ASSY	1	
1	8042310		FUEL SENDER ASSY	1	

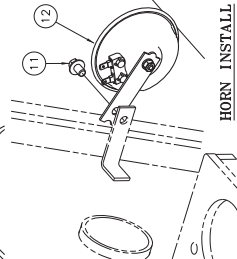
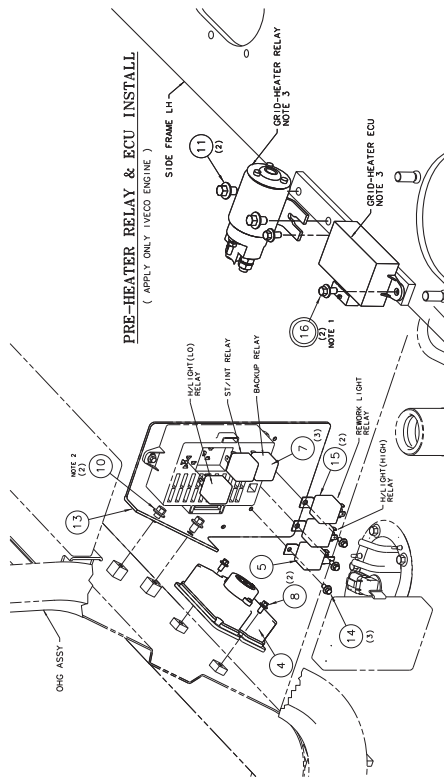


FUEL SENDER INSTALL

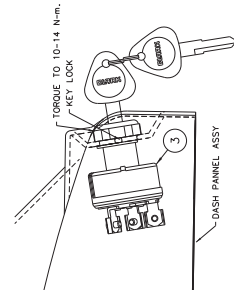


B/BUZZER INSTALL

PRE-HEATER RELAY & ECU INSTALL
(APPLY ONLY IVECO ENGINE)

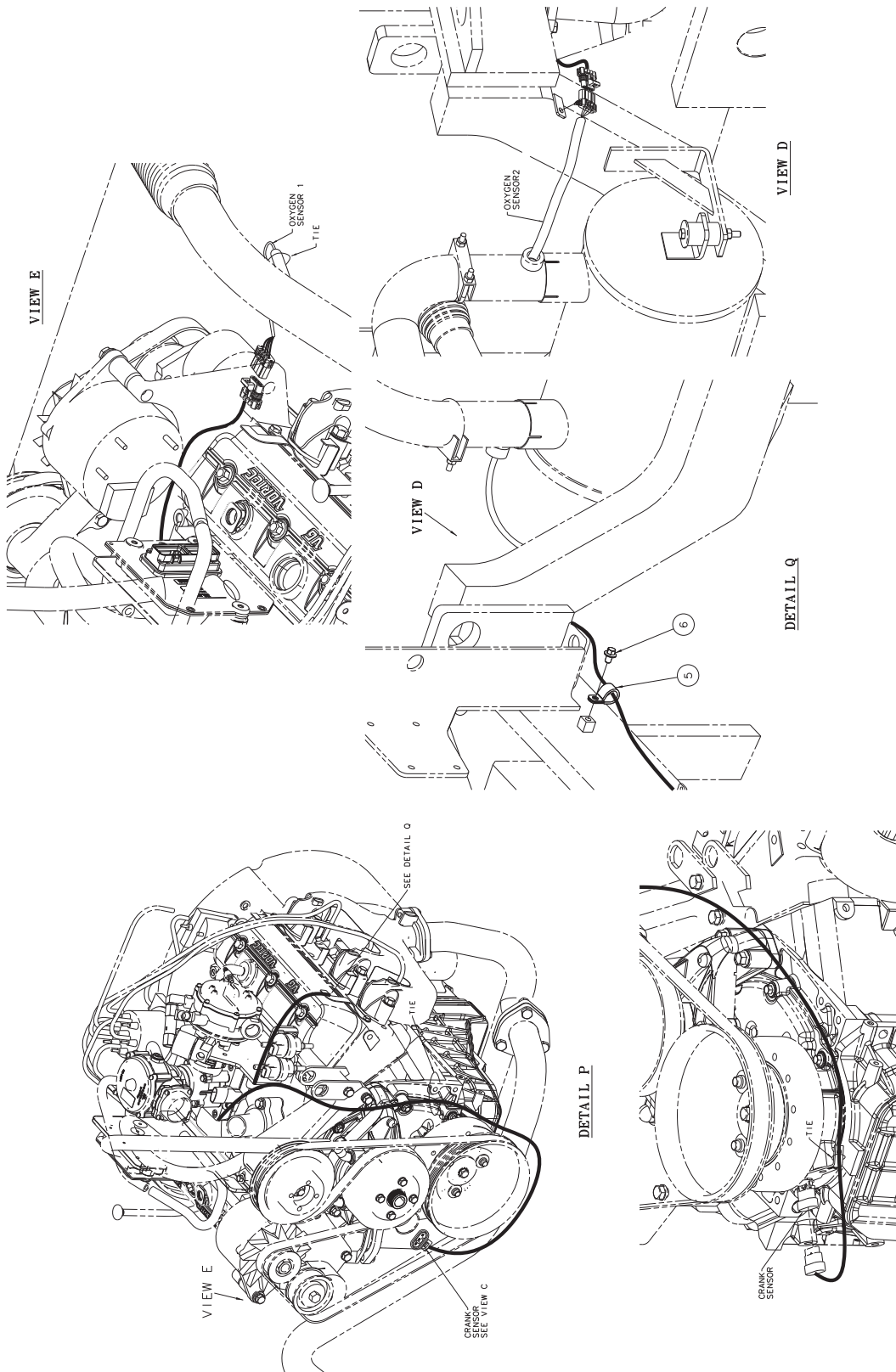


HORN INSTALL



DETAIL B

- Main wire harness (C60-75L Tier 3) 4/4



Pod Symbols and Functions

Functions

- General function**
 The instrument pod consists of indicator lights, an hour meter, a circuit board and attached gauges. Provides the operator with important information about truck condition and shut down the truck in the event that certain critical conditions are present.
- Engine shutdown function**
 The instrument pod circuit board receives signals from sensors in various locations and shut down the truck when coolant temperature, transaxle fluid temperature are excessive or engine oil pressure is low. Before shutting down the truck, the instrument pod sounds alarm for 30 seconds and flashes indicator lights. After shutdown, the truck may be restarted, but if the fault condition persists, the truck is shut down again in 30 seconds.

Seat switch application (optional)

The instrument pod shuts down the running truck without warning when the operator leaves the seat over 3 seconds with the FWD/REV switch is engaged. Directional switch must open and key switch must always be turned OFF, to restart engine. When directional switch is open and parking brake is not engaged, if the operator leaves a seat, after 3 seconds, the instrument pod will sound buzzer, and then honk horn. Setting the parking brake shall reset the alarm.(The engine is not shut down.)

- Neutral start function and Anti-restart function**
Neutral start function
 The instrument pod will not allow the stater to be engaged if directional switches are closed or key has been in start position once. Key switch must always be turned OFF to restart engine.

Anti-restart function

When engine is already running, the start motor does not rotate although the key switch is turned start position.

- Anti-drive and parking brake reminder function**
 When parking brake is engaged, the truck cannot be driven although the directional switch closed. A parking brake alarm shall be activated if key switch is turned to the OFF position and the parking brake is not applied. Applying the park brake will reset the alarm.

Indication of display : Turn on the key switch

When turning the key to ON

- The system will be initialized as displayed in the following figure: To be displayed in 0.5sec
- After 1sec, the data will be displayed normally. (However, the clock displays the real time.)
- Seat belt LED and Buzzer: To be operated as 1hz in 3sec.

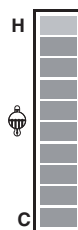
Basic display screen (Normal display mode)

- Display screen after initialization of system
- Display the data delivered(CANBus) from other instruments
- The date and time are controlled by internal system, so the real-time information will be displayed.

When the fuel level is low, the buzzer and warning lamp will be operated in the interval of 1sec. "LOW FUEL" message will be displayed on LCD screen.

Gauges and indicators

Coolant temperature gauge



•It is divided into 2 colour zones according to temperature.

10 Step specifications

Step	Status	Temperature	Remark
10	Hot Shutdown	116°C Above	Flashers(1Hz)
10	Hot Warning	113~115°C	
10	Hot	110~112°C	
9	Normal	106~109°C	
8	Normal	100~105°C	
7	Normal	94~99°C	
6	Normal	88~93°C	
5	Normal	82~87°C	
4	Normal	76~81°C	
3	Normal	50~75°C	
2	Normal	26~49°C	
1	Cold	25°C below	

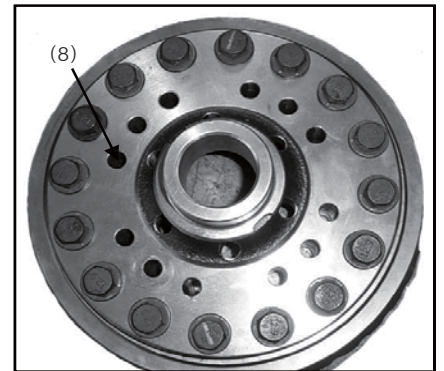
ERROR CODE	LCD ERROR MESSAGE	DESCRIPTION	reaction of the TCU	possible steps to repair	REMARK
35	35 : T/M Error	S.C.TO GROUND AT TURBINE SPEED INPUT TCU measures a voltage less than 0.45V at speed input pin	if a failure is existing at output speed, TCU shifts to neutral	<ol style="list-style-type: none"> 1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the speed sensor 	
36	36 : Logical Error	LOGICAL ERROR AT TURBINE SPEED INPUT TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero	if a failure is existing at output speed, TCU shifts to neutral	<ol style="list-style-type: none"> 1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the speed sensor 4. Check the sensor gap 	
37	37 : T/M Error	S.C.TO BATTERY VOLTAGE OR O.C.AT INTERNAL SPEED INPUT TCU measures a voltage higher than 7.00V at speed input pin	-	<ol style="list-style-type: none"> 1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the speed sensor 	
38	38 : T/M Error	S.C.TO GROUND AT INTERNAL SPEED INPUT TCU measures a voltage less than 0.45V at speed input pin	-	<ol style="list-style-type: none"> 1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the speed sensor 	
39	39 : Logical Error	LOGICAL ERROR AT INTERNAL SPEED INPUT TCU measures a internal speed over a threshold and at the next moment the measured speed is zero	-	<ol style="list-style-type: none"> 1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the speed sensor 4. Check the sensor gap 	
3A	3A : T/M Error	S.C.TO BATTERY VOLTAGE OR O.C.AT OUTPUT SPEED INPUT TCU measures a voltage higher than 12.5V at speed input pin	if a failure is existing at turbine speed, TCU shifts to neutral	<ol style="list-style-type: none"> 1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the speed sensor 	
3B	3B : T/M Error	S.C.TO GROUND AT OUTPUT SPEED INPUT TCU measures a voltage less than 1.00V at speed input pin	if a failure is existing at turbine speed, TCU shifts to neutral	<ol style="list-style-type: none"> 1. Check the cable from TCU to the sensor 2. Check the connectors 3. Check the speed sensor 	

2. Specification (Powertrain)

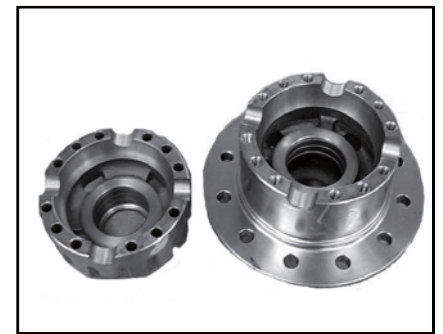
Drive axle	Gear ratio	Differential	2.636
		Planetary	4
		Total	10.545
	Axle oil		MOBIL #424
	Oil quantity		12.5 L
Brake	Service brake		Oil disk brake
	Brake oil		AZOLLA – ZS10
	Parking brake		Drum brake
Differential	Gear type		Spiral bevel gear
	Differential type		4 pinions
U-JOINT			6C

6) Remove differential assembly from the carrier.

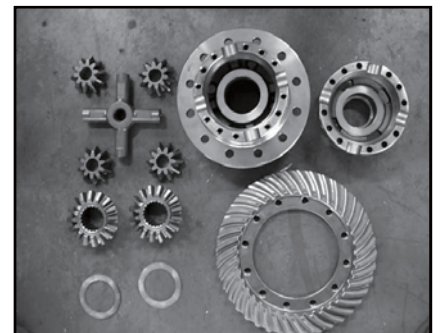
7) After removing 12 mounting bolts(8) from the housing and then disassemble ring gear.



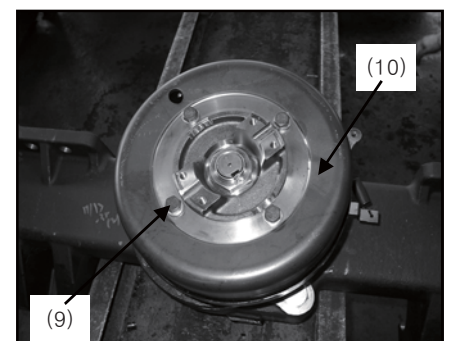
8) Check the mark on the housing and separate the housing from the differential.
If there is no mark, be sure to mark on the housing.
When reassembling, it must be placed at the same position that before



9) Remove thrust washer, side gear, pinion gear and spider and then place them on the clean bench.

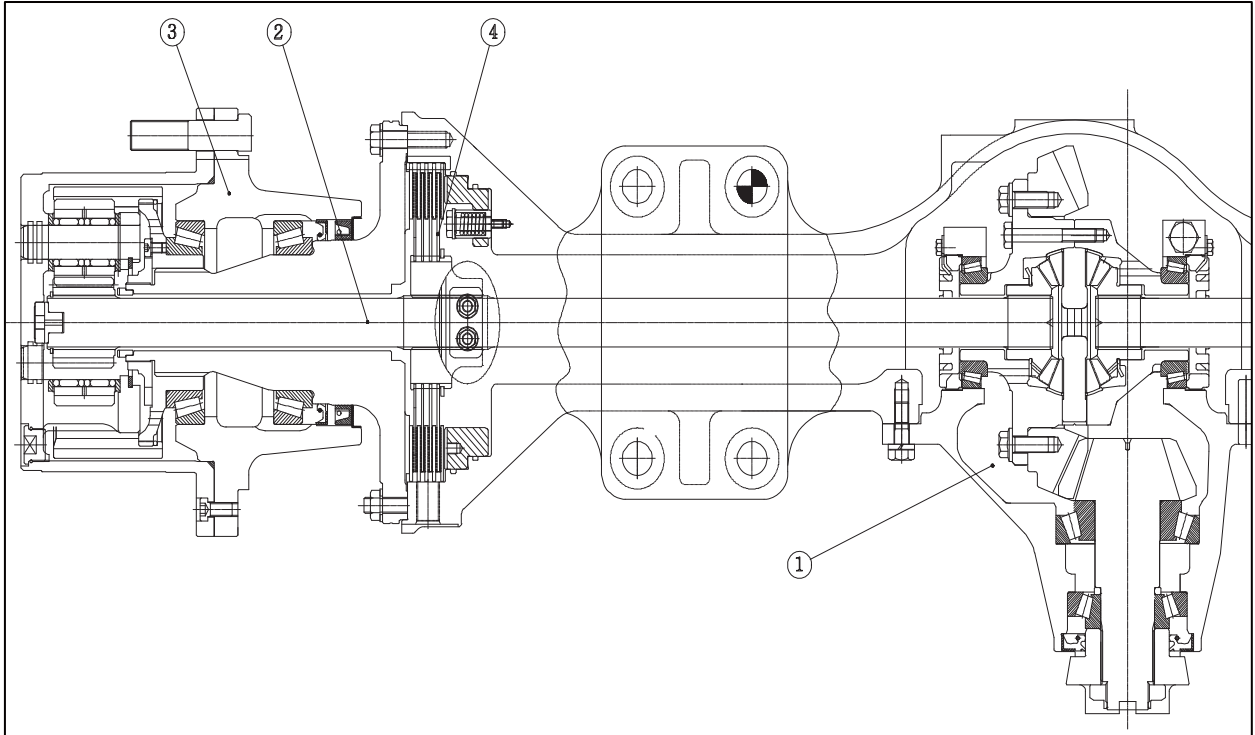


10) Loosen 4 bolts(9) and then remove Drum(10) from the Parking Brake



Section 1. System Operation

1. General Specification

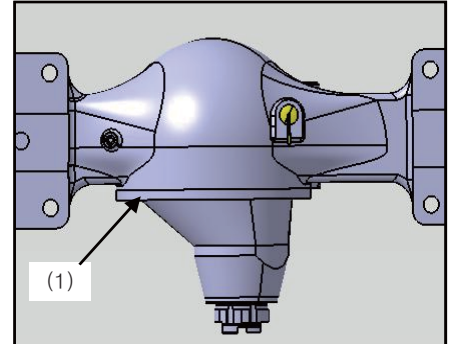


No.	NAME
1	Differential carrier assy
2	Drive shaft
3	Drive wheel
4	Brake disc

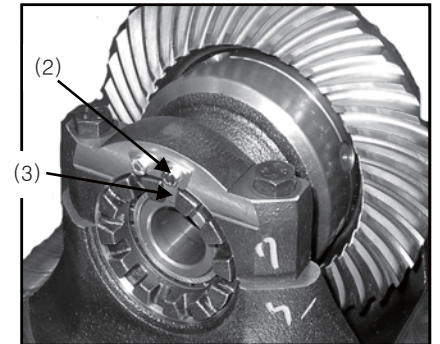
- ◆ Drive axle is composed of differential carrier assy(1), drive shaft(2), and drive wheel(3).
The power is transmitted from engine fly wheel to transmission.
The power of transmission is transmitted to the spiral bevel gear through the output gear.
And the power of differential is transmitted to the wheel through the drive shaft.

< REMOVAL AND DISASSEMBLY OF AXLE HOUSING >

- 1) Loosen 12 bolts(1) and then remove carrier from the housing by using a lifting machine.

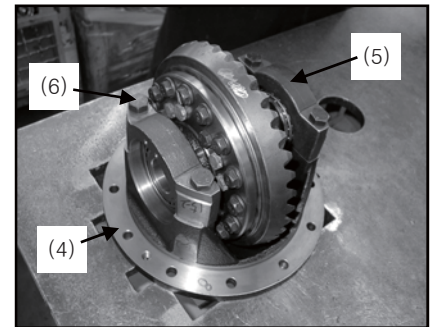


- 2) For the reassembly, check rolling resistance and record it. After loosen 2 bolt(2) and then remove backing plate(3).

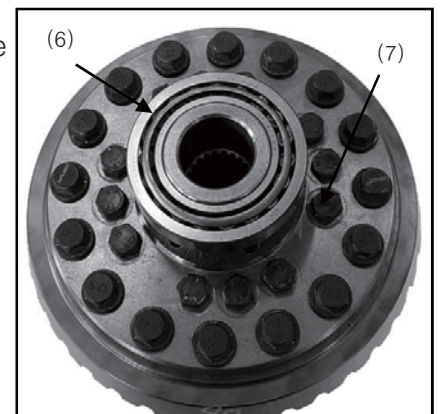


- 3) Before removing differential assembly from carrier(4), check the location of cap(5) and mark it for reassembly.

- 4) Remove 4 hexagon bolts(6) and cap(5).



- 5) Disassemble bearing(6) from the differential housing and remove 12 bolts(7).



Section 1

**Wheels and Tires
Specifications and Description**

Specifications

Steer Tire Types : Pneumatic rubber/Cushion rubber, non-marking, and urethane.

Drive Tire Types : Pneumatic rubber/Cushion rubber, non-marking, and urethane.

Pneumatic Drive and Steer Tire Inflation Pressure :

Drive C60-C75: 820 kPa (119psi)
C80 : 1000 kPa (145psi)

Steer C60-C75 : 820 kPa (119psi)
C80 : 1000 kPa (145psi)

Fastener Torques

Steer Tire Mounting Nut Torque : Check mounting procedure in Sections 2 and 3 for pneumatic tires and wheels.

Wheel Mounting Nut Torques :

Classification	Model	Torque
Drive Wheel (Dual Tire)	C60/C75	540-588 N.m(398-434 ft.lb)
	C80	540-588 N.m(398-434 ft.lb)
Steer Wheel	C60/C75	440-490 N.m(325-362 ft.lb)
	C80	440-490 N.m(325-362 ft.lb)

Service Intervals

Wheel Mounting Bolts Check and Tightening : Every 50-250 hours of operation and each PM.

Tire Condition : Daily inspection.

Tire Pressure Check : Daily inspection.

Description

The wheels and tires used on the truck come in pneumatic or cushion types in a variety of sizes depending on truck model and application. Pneumatic tires are mounted on multi-piece rims with locking rings.



WARNING

For your safety and the safety of others, before you do tire or rim maintenance or service, read the OSHA rules regarding owner responsibility. Do not work on tires or rims unless you have been trained in the correct procedures. Read and understand all maintenance and repair procedures on tires and rims. Serious injury or death can result if safety messages are ignored.

The Occupational Safety and Health Act (OSHA) specifies required procedures for servicing multi-piece rim wheels in 29 CFR Section 1910.177. It is the owner's responsibility to comply with OSHA.

In accordance with OSHA, the owner must provide a training program to train and instruct all employees who service multi-piece rim wheels in the hazards involved and the safety procedures to be followed. Do not let anyone mount, demount, or service multi-piece rim wheels without correct training.

The owner should obtain and maintain in the service area current copies of the United States Department of Transportation, National Highway Traffic Safety Administration publications entitled "Safety Precautions for Mounting and Demounting Tube-Type Truck/Bus Tires," and Multi-Piece Rim/Wheel Matching Chart" or other similar publications applicable to the types of multi-piece rim wheels being serviced.

GROUP 23

BRAKE SYSTEM

Braking/Inching System	
Specifications and Description	Section 1
Service Brake Troubleshooting	Section 2
Brake/Inching Pedals and Linkages	
Adjustments	Section 3
Brake Bleeding	Section 4
Brake Master Cylinder Service	Section 5
Parking Brake Service	Section 6

GROUP 25

STEERING COLUMN AND GEAR

Steering System Specifications and Description	Section 1
Steering System Troubleshooting	Section 2
Steering Column and Component Removal and Replacement	Section 3
Steering System Relief Pressure Check and Adjustment	Section 4
Steering Gear Overhaul	Section 5

Fault	Possible cause	Remedy
Leakage at either input shaft, end cover, gerotor set, housing or ports.	<ul style="list-style-type: none">• Shaft defective.• Screws loose.• Washers or O-rings defective.	<ul style="list-style-type: none">• Replace shaft seal, see service manual.• Tighten screws (3±0.3 kgf·m).• Replace washers or O-rings.

Bearing Disassembly

1. Be sure truck is parked and blocked up correctly and safely to raise steer wheels off the floor. Refer to "Lifting, Jacking, and Blocking," in the Group "SA."
2. Loosen lug nuts of pneumatic-tire wheels before completely raising rear wheels off the floor.
3. Lower truck onto blocking. Remove lug nuts and then wheel assembly.

NOTE

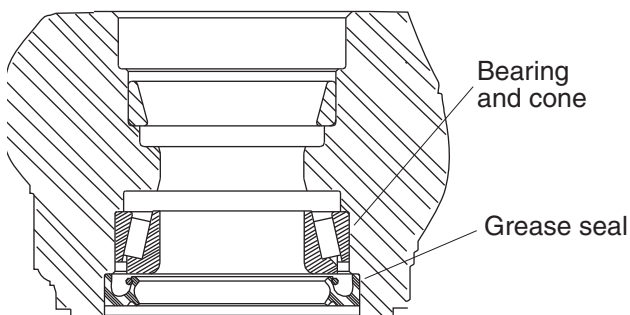
Because of the heavy weight of the pneumatic wheel and tire, it is suggested to first remove the wheel and tire assembly from hub when servicing the bearings to avoid damage to the grease seal when the wheel hub is moved off or on the spindle. It also makes the work simpler and easier.

4. Clean the excess grease from around the wheel nut.
5. Remove cotter pin, loosen and remove wheel nut and bearing washer.

NOTE

Remove outer bearing by pulling out on the cushion wheel or pneumatic hub slightly to loosen bearings.

6. Pull the wheel or hub off the spindle. Support the wheel or hub to avoid dragging the grease seal at the back side across the thread on spindle end. Spindle guard remains on spindle.
7. Clean the old grease out of center of the wheel or hub.
8. To remove inner bearing and seal, lay wheel or hub down with outer edge up (support hub on blocking). Remove the inner bearing cone and grease seal, using a brass drift pin, rod, or piece of pipe to drive the bearing and seal out of the hub.



9. Clean and inspect the bearing cups and cones for wear or other damage. Replace, as necessary.

IMPORTANT

Keep serviceable bearing cups and cones matched together. Always replace bearing cups and cones as a set.

10. Inspect grease seal for wear and damage. Replace as necessary. It is recommended to install a new grease seal whenever old ones are removed.
11. Use a standard puller to remove bearing cups from hub or wheel if bearings require replacement.

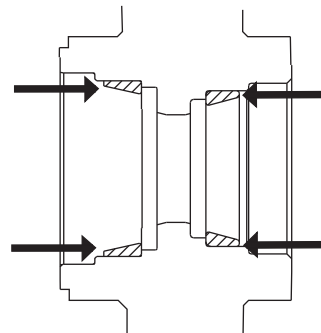
Bearing Reassembly

The procedures for packing and reassembling the bearing are the same for the cushion wheel or pneumatic wheel hub.

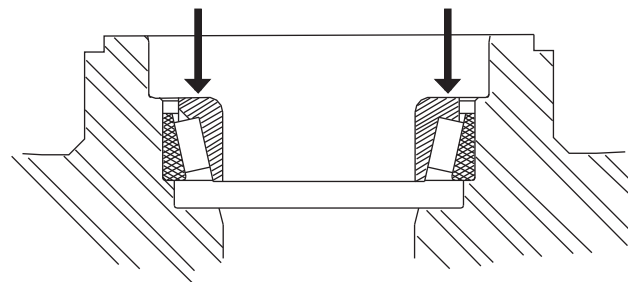
NOTE

Use Grade No. 2 EP multi-purpose grease, Clark MS-107C.

1. Install new inner and outer bearing cups by pressing into hub or wheel. Be sure cups are fully seated in bore.



2. Pack the bearings with grease and install the inner bearing in the hub or wheel.



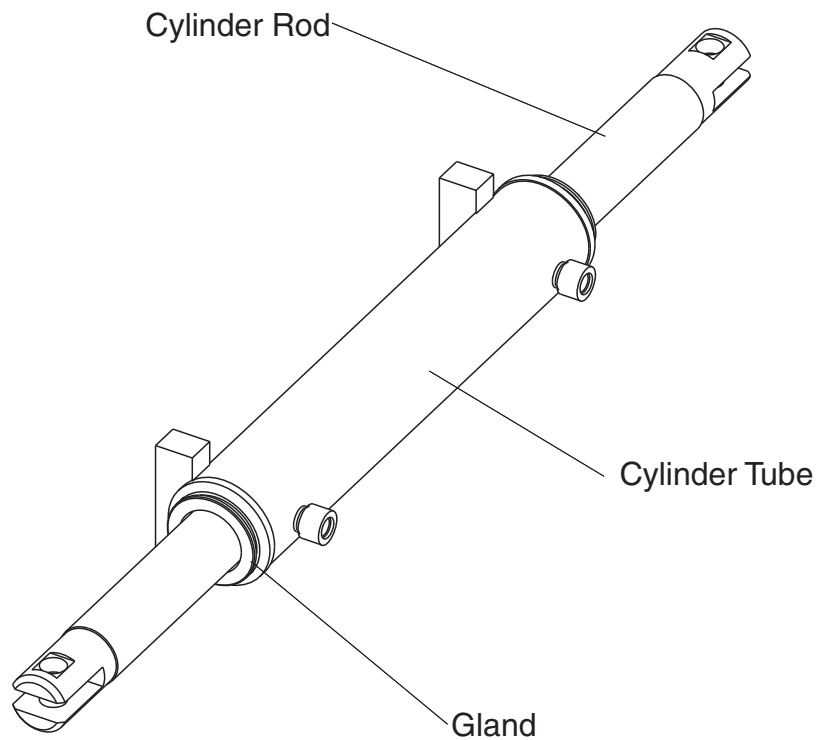
3. Pack cavity between bearing and grease seal half full with grease.

Section 6

Steer Cylinder Overhaul

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.



*Steering Cylinder
Pneumatic-tire truck cylinder with "P" stamped on rod end.*

The following is a list of problems and solutions relating to the main hydraulic pump and associated components. For other hydraulic system troubleshooting, refer to Groups 30 and 34.

Noisy Pump

- Hydraulic fluid level low; measure and correct fluid level.
- Fluid viscosity too high; change to specified fluid.
- Sump strainer dirty; check and clean.
- Air leak at pump inlet line; check plumbing tightness.
- Inlet line restriction; check for foreign material or line kinks, check and clean sump suction screen.
- Air leak at pump shaft packing; replace packing.
- Defective hydraulic pump; continue other troubleshooting items, then consider servicing or replacing pump.

Pump Not Delivering Hydraulic Fluid

- Hydraulic fluid level low; check and correct fluid level.
- Sump suction screen dirty; check and clean.
- Inlet line restriction; check for foreign material or line kinks, check and clean sump suction screen.
- Air leak in suction line: check plumbing tightness.
- Fluid viscosity too high: check fluid viscosity and change to specified fluid.
- Defective hydraulic pump; continue other troubleshooting items, then consider servicing or replacing pump.

Failure to Build Pressure

- Hydraulic fluid level low; measure and correct fluid level.
- Defective relief valve or pump: perform pressure check to test valve and pump.

Pump Not Developing Sufficient Pressure

- Leak in hydraulic control system; check system for and correct leaks.
- Inlet line restriction; check for foreign material or line kinks, check and clean sump suction screen.
- Suction screen dirty; clean screen.
- Defective hydraulic pump; continue other troubleshooting items, then consider servicing or replacing pump.

Pump Output Low

- Cavitating pump; see “Noisy Pump.”
- Air in fluid or wrong fluid; drain and fill with correct fluid.
- System relief valve set too low or too high, stuck or leaking; correct relief valve, pump may be OK.
- Overheated fluid; see “Overheated Pump and/or Fluid.”
- Contaminated fluid; eliminate contamination source and replace fluid.
- Gear face, body or cover nicked; repair or replace pump.
- Excessive side loading, wear plate tight in body bore, pinched thrust plate; inspect and service pump.

Foaming Fluid

- Cavitating pump; see “Noisy Pump.”
- Wrong fluid; drain and fill with correct fluid.

Overheated Pump and/or Fluid

- Low viscosity fluid; drain and fill with correct fluid.
- Contaminated fluid; drain fluid, clean suction screen, replace filter and fill sump.
- Cavitating pump: see “Noisy Pump.”
- Pump drive shaft misaligned; check mounting and alignment.
- Axial loading on drive shaft; check shaft end clearance and shaft alignment; check for worn key/spline.
- Relief valve usually in bypass; check relief setting.

Spring-centered spools do not return to neutral

- Broken springs; rebuild valve.
- Entrapped foreign particles; check and clean system and valve.
- Bent spool; replace with new valve section.
- Misalignment or binding of linkage; check and align/adjust linkage.

No relief valve action (high pressure)

- Small particles of dirt in relief valve subassembly; check, clean, and/or replace relief valve, clean hole.
- Relief valve subassembly installed backwards; reinstall correctly.

Load drops when spool is moved from neutral to lift position

- Dirt or foreign particles lodged between check valve ball and seat; check and clean.
- Sticking or scored check valve; clean if sticking, replace if scored, replace poppet.

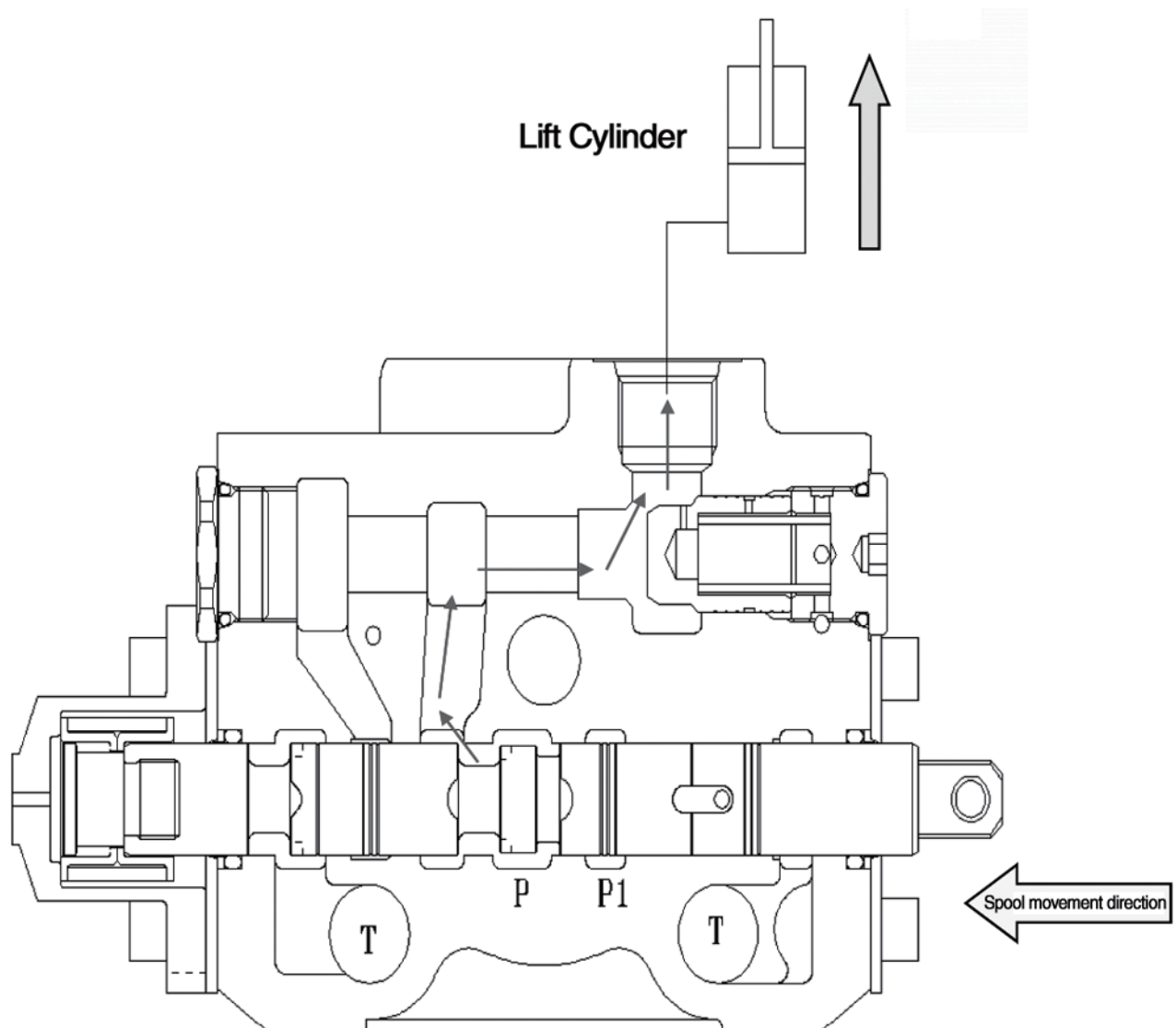
Section 1





Operation of Hydraulic Control Valve

1. Lift Section

1) Lifting Position

When the lift lever is pulled, the spool moves downwards to open the oil path from the pump to the lift cylinder, and the lift cylinder rises.



Disassembly	Picture
<p>3. Disassembling auxiliary relief valve</p> <ul style="list-style-type: none"> - Disassemble the relief valve with a spanner (24mm). <p>[CAUTION] Store separately from the main relief valves to prevent confusion.</p>	
<p>4. Disassembling main relief valve</p> <ul style="list-style-type: none"> - Disassemble the relief valve with a spanner (24mm). <p>[CAUTION] Store separately from the auxiliary relief valves to prevent confusion.</p>	
<p>5. Disassemble the tilt auxiliary cap</p> <p>Remove the cap screw (M5 x 12) of the tilt auxiliary cap with an L-wrench (4mm) as shown in the picture on the right.</p>	
<p>6. After removing the cap screw, remove the spool cap and put the valve on a clean table.</p> <p>[CAUTION] Store separately from the seal plate screws to prevent confusion.</p>	

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