

LUBRICATION SYSTEM

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LU

A pressure feeding lubrication system has been adopted to supply oil to the moving parts of this engine. The lubrication system consists of an oil pan, oil pump, oil filter and other external parts which supply oil to the moving parts in the engine block. The oil circuit is shown in the illustration at the top of the previous page. Oil from the oil pan is pumped up by the oil pump. After it passes through the oil filter, it is fed through the various oil holes in the crankshaft and cylinder block. After passing through the cylinder block and performing its lubricating function, the oil is returned by gravity to the oil pan. A dipstick on the side of the cylinder block is provided to check the oil level.

OIL PUMP

The oil pump pumps up oil from the oil pan and sends it under pressure to the various parts of the engine. An oil strainer is mounted in front of the inlet to the oil pump. The oil pump itself is a gear pump, which uses a drive gear and driven gear inside the pump body. When the drive gear rotates, the driven gear rotates in the opposite direction. When the gear teeth disengage oil is drawn in, and when the gear teeth engage oil is discharged.

OIL PRESSURE REGULATOR

At high engine speeds, the engine oil supplied by the oil pump exceeds the capacity of the engine to utilize it. For that reason, the oil pressure regulator works to prevent an oversupply of oil. During normal oil supply, a coil spring and valve keep the bypass closed, but when too much oil is being fed, the pressure becomes extremely high, overpowering the force of the spring and opening the valves. This allows the excess oil to flow through the valve and return to the oil pan.

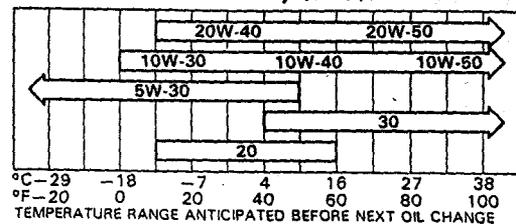
OIL FILTER

The oil filter is a full flow type filter with a built-in paper filter element. Particles of metal from wear, airborne dirt, carbon and other impurities can get in the oil during use and could cause accelerated wear or siezing if allowed to circulate through the engine. The oil filter, integrated into the oil line, removes these impurities as the oil passes through it. The filter is mounted outside the engine to simplify replacement of the filter element. A relief valve is also included ahead of the filter element to relieve the high oil pressure in case the filter element becomes clogged with impurities. The relief valve opens when the oil pressure overpowers the force of the spring. Oil passing through the relief valve bypasses the oil filter and flows directly into the main oil hole in the engine.

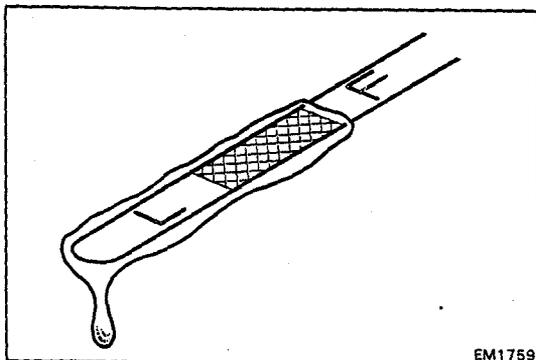
TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Oil leakage	Cylinder head, cylinder block or oil pump body damaged or cracked Oil seal faulty Gasket faulty	Repair as necessary Replace oil seal Replace gasket	EM-84
Low oil pressure	Oil leakage Relief valve faulty Oil pump faulty Engine oil poor quality Crankshaft bearing faulty Connecting rod bearing faulty Oil filter clogged	Repair as necessary Repair relief valve Repair oil pump Replace engine oil Replace bearing Replace bearing Replace oil filter	LU-8 LU-8 LU-6 EM-65 EM-65 LU-8
High oil pressure	Relief valve faulty	Repair relief valve	LU-8

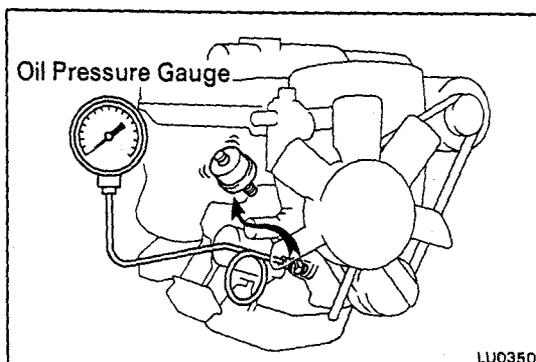
Recommended Viscosity (SAE):



LU0310



EM1759



LU0350

OIL PRESSURE CHECK

1. CHECK ENGINE OIL QUALITY

Check the oil for deterioration, entry of water, discoloring or thinning.

If oil quality is poor, replace the oil.

Europe (7M-GE) and Australia

Use API grade SE, SF or better and recommended viscosity oil.

Europe (7M-GTE)

Use API grade SF or better and recommended viscosity oil.

Others

Use API grade SC, SD, SE, SF or better and recommended viscosity oil.

2. CHECK ENGINE OIL LEVEL

The oil level should be between the "L" and "F" marks on the dipstick.

If low, check for leakage and add oil up to the "F" mark.

3. REMOVE OIL PRESSURE SENDER GAUGE

4. INSTALL OIL PRESSURE GAUGE

5. START ENGINE

Start engine and warm it up to normal operating temperature.

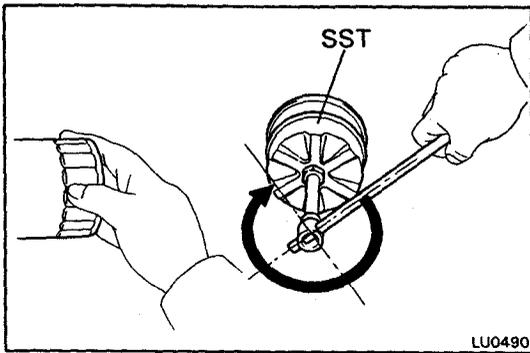
6. MEASURE OIL PRESSURE

Oil pressure:

At idle 0.3 kg/cm² (4.3 psi, 29 kPa)
or more

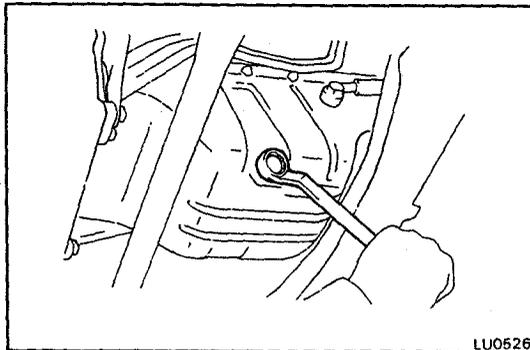
At 3,000 rpm 2.5 – 5.0 kg/cm²
(36 – 71 psi, 245 – 490 kPa)

NOTE: Check for oil leakage after reinstalling the oil pressure sender gauge.



- (d) Lightly screw in the oil filter to where you feel resistance.
- (e) Then, using SST, tighten the oil filter an extra 3/4 turn.

SST 09228-07500



3. FILL WITH ENGINE OIL

- (a) Clean and install the oil drain plug with a new gasket.

Torque: 350 kg-cm (25 ft-lb, 34 N·m)

- (b) Fill the engine with new oil.

Oil capacity:

Dry fill

7M-GE MA (GCC Countries*)

5.0 liters (5.3 US qts, 4.4 Imp. qts)

7M-GE MA (Others)

4.9 liters (5.2 US qts, 4.3 Imp. qts)

7M-GE MS

5.3 liters (5.6 US qts, 4.7 Imp. qts)

7M-GTE (A/T)

5.0 liters (5.3 US qts, 4.4 Imp. qts)

7M-GTE (M/T)

5.1 liters (5.4 US qts, 4.5 Imp. qts)

Drain and refill

w/o oil filter change

MA

3.9 liters (4.1 US qts, 3.4 Imp. qts)

MS

4.1 liters (4.3 US qts, 3.6 Imp. qts)

w/ oil filter change

MA

4.2 liters (4.4 US qts, 3.7 Imp. qts)

MS

4.4 liters (4.7 US qts, 3.9 Imp. qts)

4. START ENGINE AND CHECK FOR LEAKS

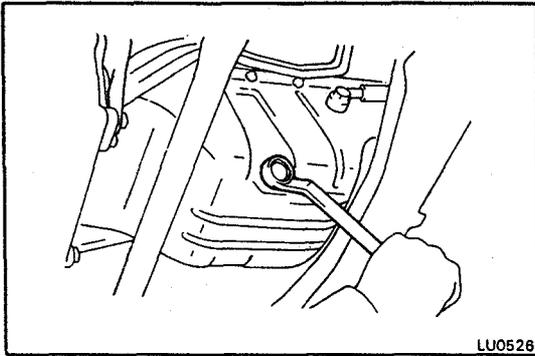
5. RECHECK ENGINE OIL LEVEL (See page LU-5)

* GCC Countries: Saudi Arabia, Sultanate of Oman, Bahrain, United Arab Emirates, Qatar, Kuwait.

REPLACEMENT OF ENGINE OIL AND OIL FILTER

1. DRAIN ENGINE OIL

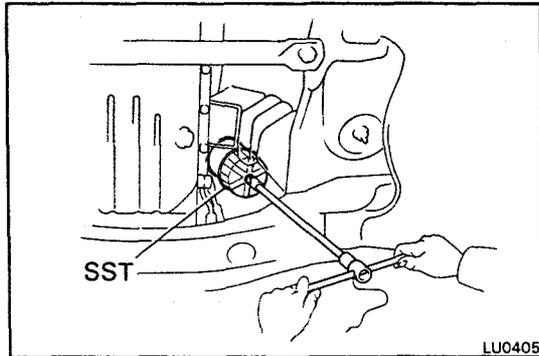
- (a) Remove the oil filler cap.
- (b) Remove the oil drain plug and drain the oil into a container.



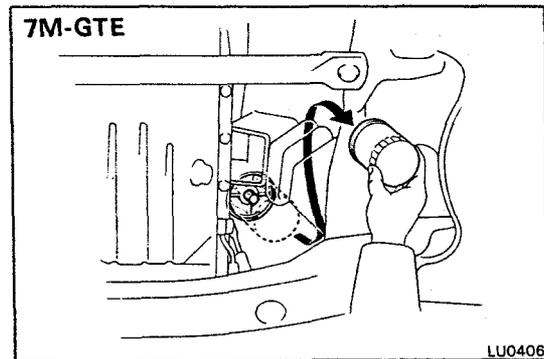
2. REPLACE OIL FILTER

- (a) Using SST, remove the oil filter (located on right side of the engine block).

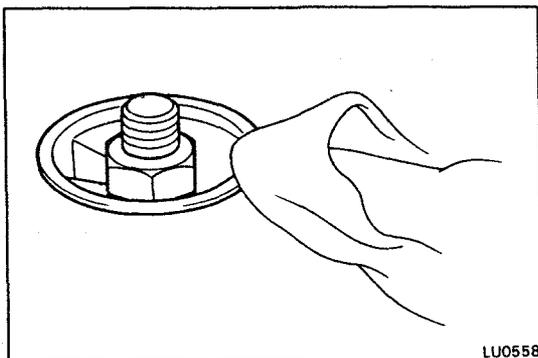
SST 09228-07500



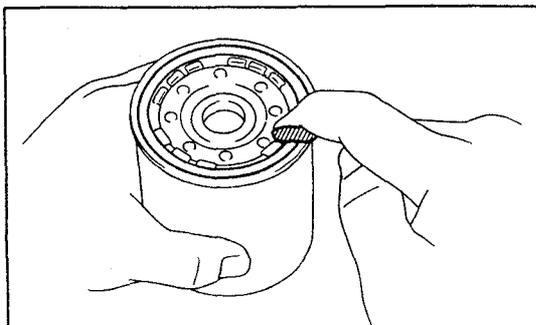
NOTE (7M-GTE): Remove the oil filter taking it over the engine mounting bracket and down between the bracket and No. 1 suspension crossmember.

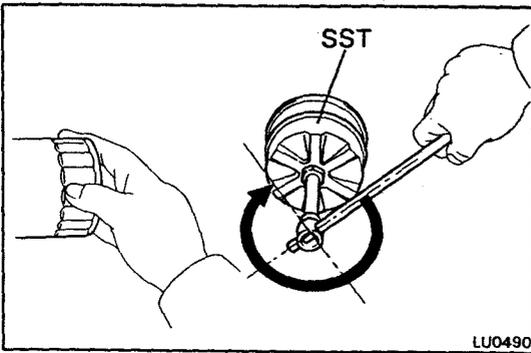


- (b) Clean and check the oil filter installation surface.



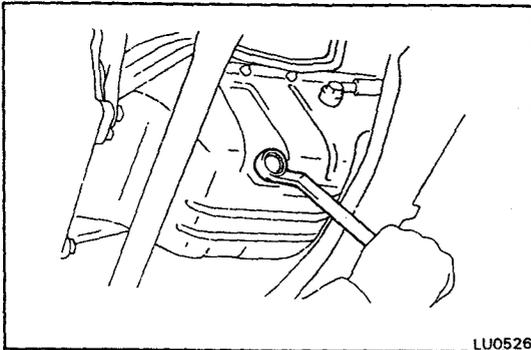
- (c) Apply clean engine oil to the gasket of the new oil filter.





- (d) Lightly screw in the oil filter to where you feel resistance.
- (e) Then, using SST, tighten the oil filter an extra 3/4 turn.

SST 09228-07500



3. FILL WITH ENGINE OIL

- (a) Clean and install the oil drain plug with a new gasket.

Torque: 350 kg-cm (25 ft-lb, 34 N·m)

- (b) Fill the engine with new oil.

Oil capacity:

Dry fill

7M-GE MA (GCC Countries*)

5.0 liters (5.3 US qts, 4.4 Imp. qts)

7M-GE MA (Others)

4.9 liters (5.2 US qts, 4.3 Imp. qts)

7M-GE MS

5.3 liters (5.6 US qts, 4.7 Imp. qts)

7M-GTE (A/T)

5.0 liters (5.3 US qts, 4.4 Imp. qts)

7M-GTE (M/T)

5.1 liters (5.4 US qts, 4.5 Imp. qts)

Drain and refill

w/o oil filter change

MA

3.9 liters (4.1 US qts, 3.4 Imp. qts)

MS

4.1 liters (4.3 US qts, 3.6 Imp. qts)

w/ oil filter change

MA

4.2 liters (4.4 US qts, 3.7 Imp. qts)

MS

4.4 liters (4.7 US qts, 3.9 Imp. qts)

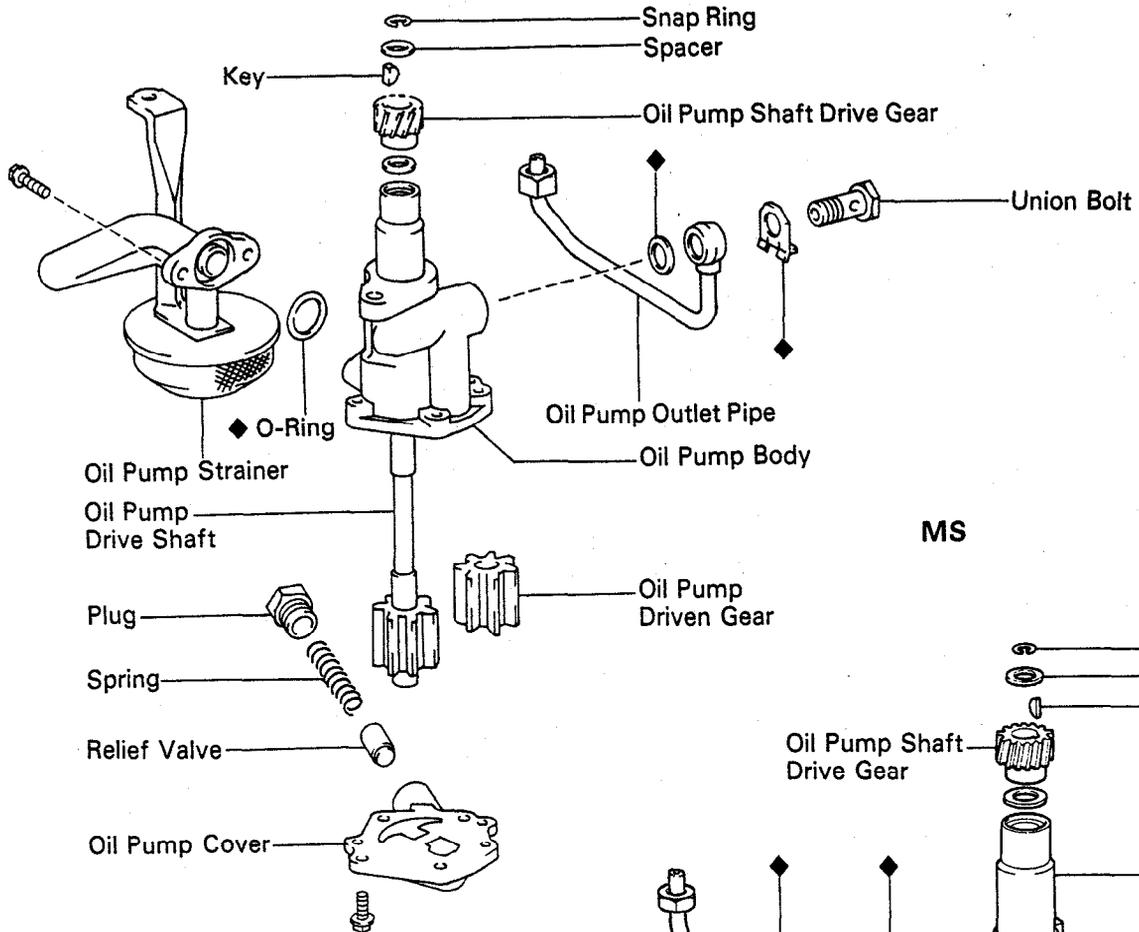
4. START ENGINE AND CHECK FOR LEAKS

5. RECHECK ENGINE OIL LEVEL (See page LU-5)

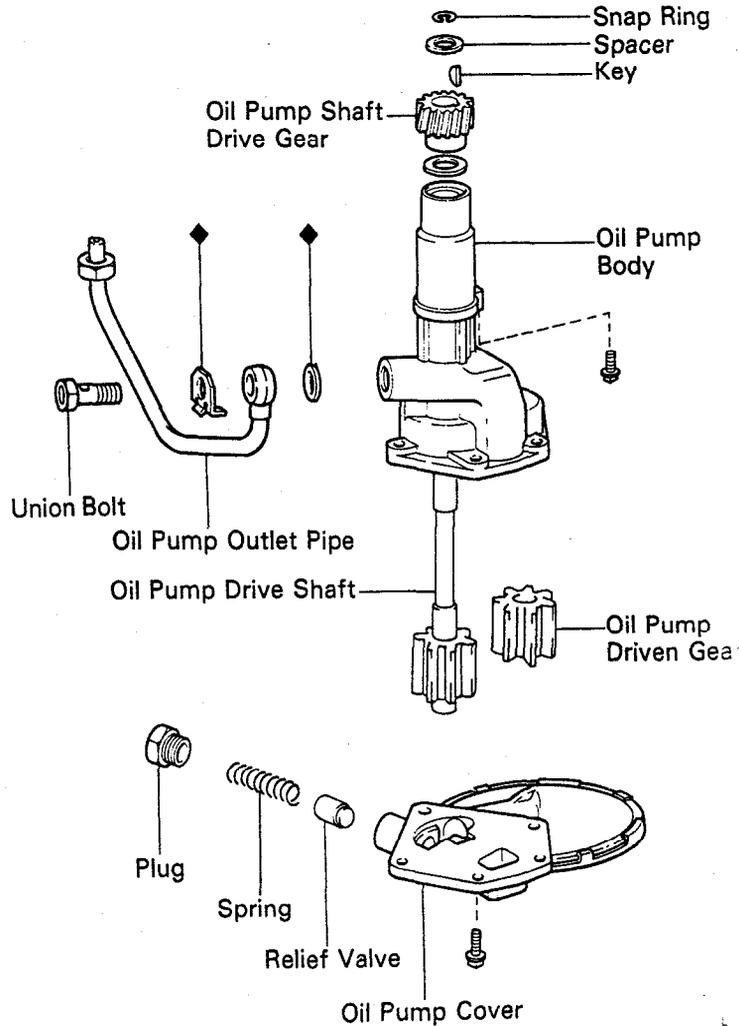
* GCC Countries: Saudi Arabia, Sultanate of Oman, Bahrain, United Arab Emirates, Qatar, Kuwait.

OIL PUMP COMPONENTS

MA



MS



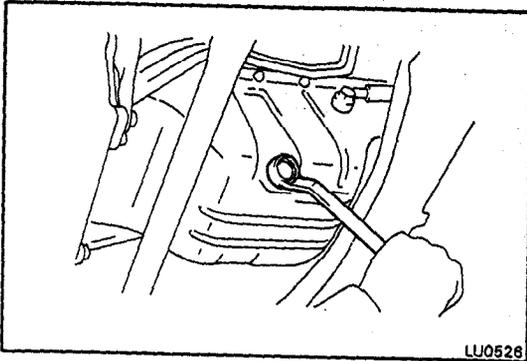
◆ Non-reusable part

REMOVAL OF OIL PUMP

(See page LU-8)

1. DRAIN ENGINE OIL

- (a) Remove the oil filler cap.
- (b) Remove the oil drain plug and drain the oil into a container.

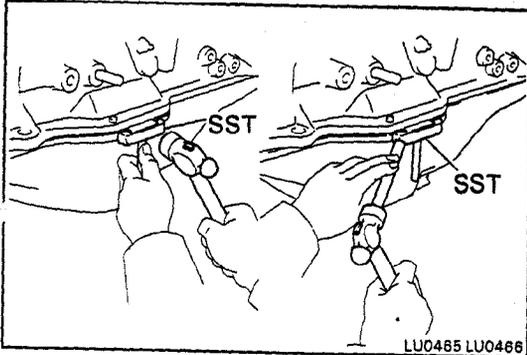


LU0526

2. REMOVE OIL PAN

- (a) Remove the dipstick.
- (b) Remove the bolts and nuts.
- (c) Insert the blade of SST between the cylinder block and oil pan, cut off applied sealer and then remove the oil pan.

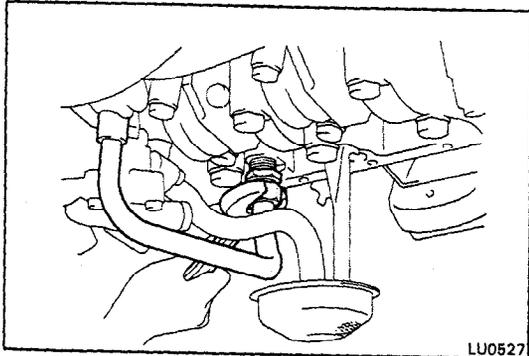
SST 09032-00100

CAUTION: Be careful not to damage the oil pan flange.

LU0485 LU0486

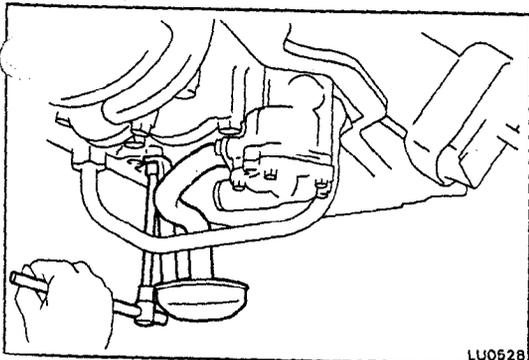
3. REMOVE OIL PUMP

- (a) Loosen the union nut of the oil pump outlet pipe.



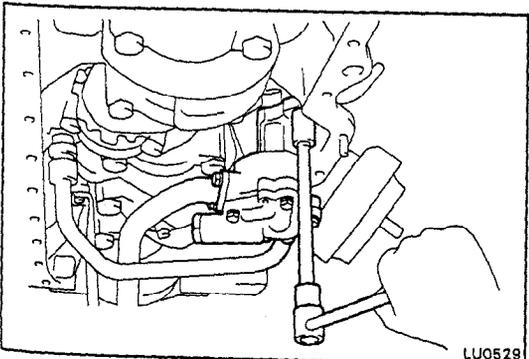
LU0527

- (b) (MA)
Remove the mount bolt of the oil pump strainer stay.



LU0528

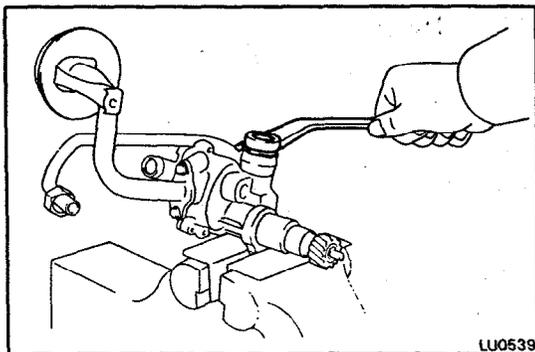
- (c) Remove the bolt and oil pump.



LU0529

DISASSEMBLY OF OIL PUMP

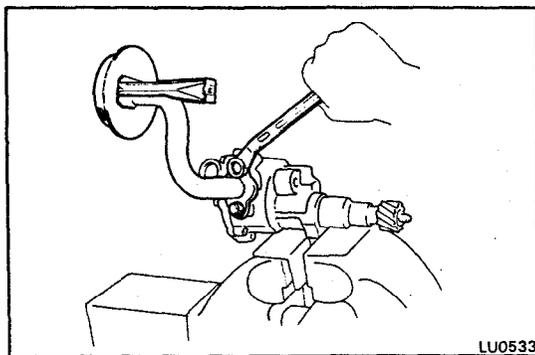
(See page LU-8)



LU0539

1. REMOVE OIL PUMP OUTLET PIPE

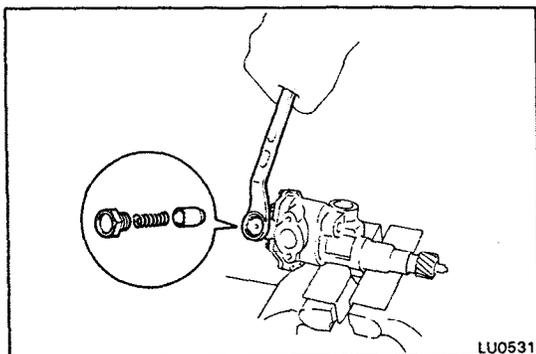
- (a) Unstake the lock washer.
- (b) Remove the union bolt, lock washer, oil pump outlet pipe and gasket.



LU0533

2. (MA) REMOVE OIL PUMP STRAINER

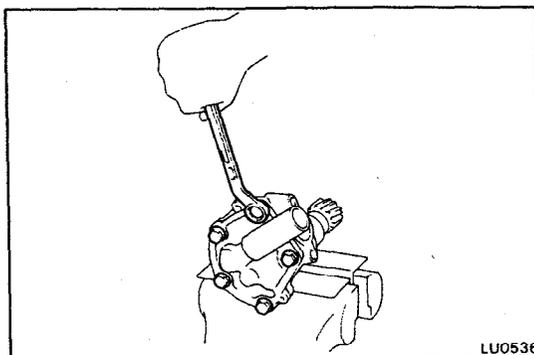
Remove the two bolts, oil pump strainer and O-ring.



LU0531

3. REMOVE RELIEF VALVE

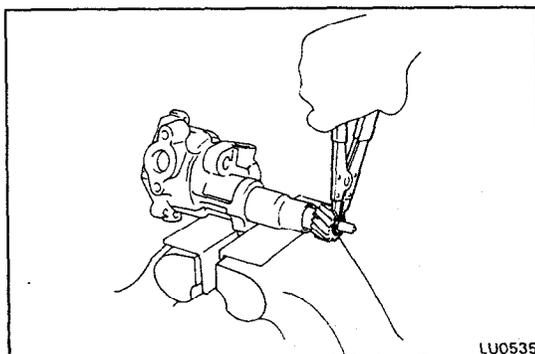
Unscrew the relief valve plug, and remove the spring and relief valve.



LU0536

4. REMOVE OIL PUMP COVER

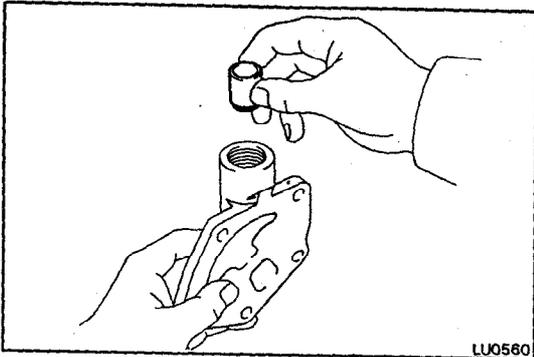
Remove the five bolts and oil pump cover.

5. REMOVE OIL PUMP DRIVEN GEAR

LU0535

6. REMOVE OIL PUMP DRIVE SHAFT

Using snap ring pliers, remove the snap ring, spacer, shaft drive gear, key and oil pump drive shaft.

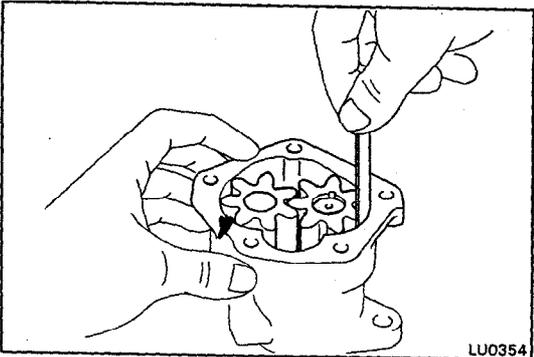


INSPECTION OF OIL PUMP

1. INSPECT RELIEF VALVE

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If it does not, replace the relief valve. If necessary, replace the oil pump assembly.



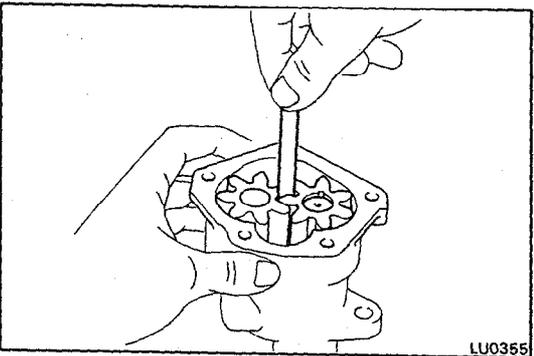
2. INSPECT BODY CLEARANCE

Using a thickness gauge, measure the clearance between the driven gear and pump body.

Standard clearance: 0.105 – 0.175 mm
(0.0041 – 0.0069 in.)

Maximum clearance: 0.2 mm (0.008 in.)

If the clearance is greater than maximum, replace the gear or oil pump assembly.



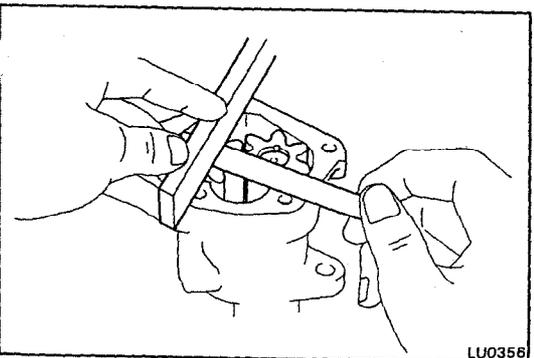
3. INSPECT GEAR BACKLASH

Using a thickness gauge, measure the backlash as shown in several places.

Standard backlash: 0.5 – 0.6 mm
(0.020 – 0.024 in.)

Maximum backlash: 0.9 mm (0.035 in.)

If the backlash is greater than maximum, replace the oil pump drive shaft and driven gear.



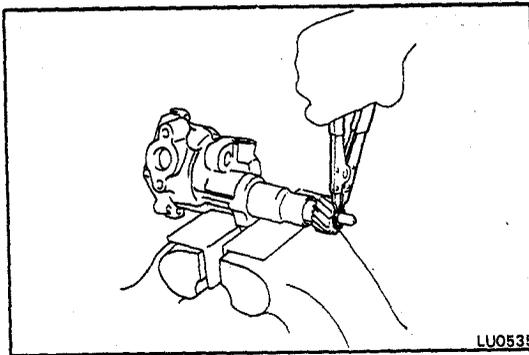
4. INSPECT SIDE CLEARANCE

Using a thickness gauge and precision straight edge, measure the clearance between the gears and precision straight edge.

Standard clearance: 0.03 – 0.09 mm
(0.0012 – 0.0035 in.)

Maximum clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than maximum, replace the drive shaft and driven gear. If necessary, the oil pump assembly.



LU0535

ASSEMBLY AND OPERATION CHECK OF OIL PUMP

(See page LU-8)

1. INSTALL OIL PUMP DRIVE SHAFT

Install the oil pump drive shaft, key, shaft drive gear, spacer, and using snap ring pliers, install the snap ring.

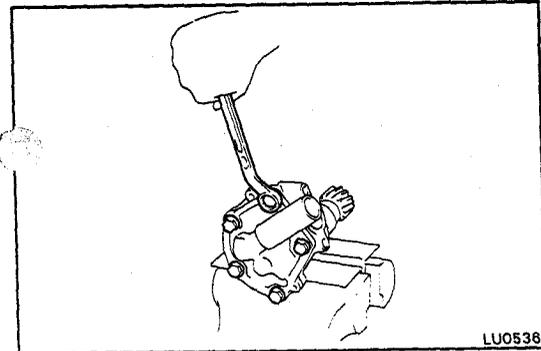
2. INSTALL OIL PUMP DRIVEN GEAR

3. INSTALL OIL PUMP COVER

Install the oil pump cover with the five bolts.

Torque the bolts.

Torque: 75 kg-cm (65 in.-lb, 7.4 N·m)

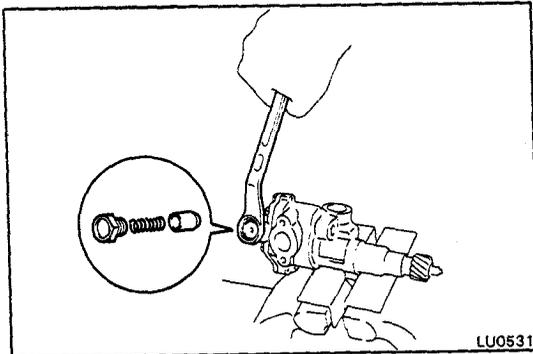


LU0538

4. INSTALL RELIEF VALVE

Install the relief valve and spring with the relief valve plug. Torque the plug.

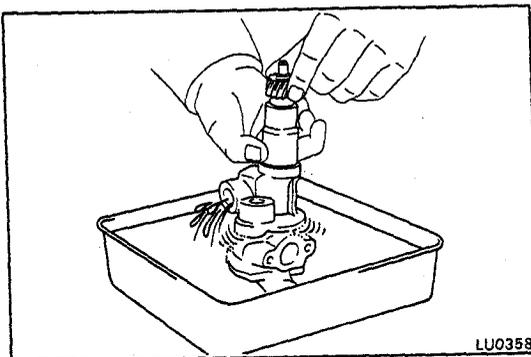
Torque: 375 kg-cm (27 ft-lb, 37 N·m)



LU0531

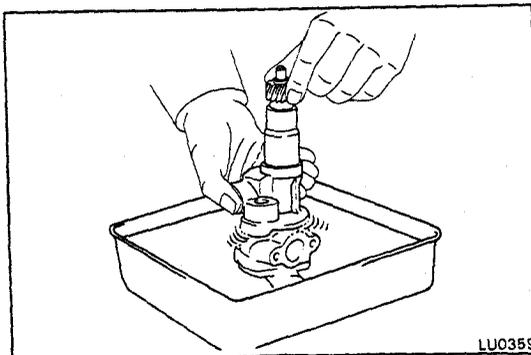
5. CHECK PUMP OPERATION

(a) Immerse the suction end of the pump into clean engine oil and turn the shaft counterclockwise. Oil should come out of the discharge hole.

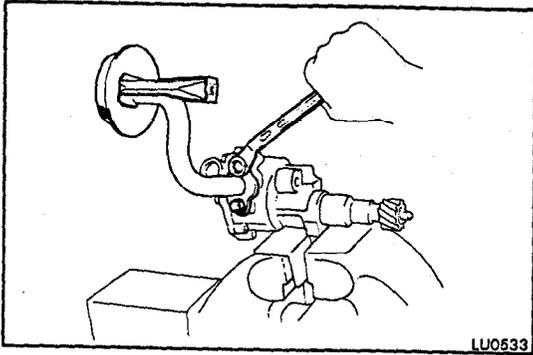


LU0358

(b) Close the discharge hole with your thumb, and turn the shaft as before. The shaft should be difficult to turn.



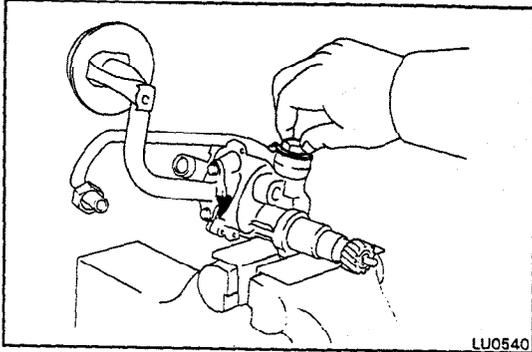
LU0359



**6. (MA)
INSTALL OIL PUMP STRAINER**

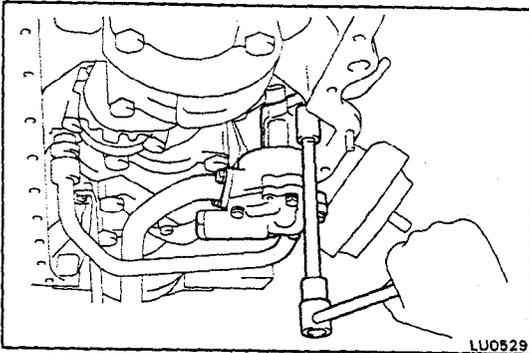
- (a) Install a new O-ring to oil pump strainer.
- (b) Install the oil pump strainer with the two bolts.

Torque: 130 kg-cm (9 ft-lb, 13 N·m)



7. INSTALL OIL PUMP OUTLET PIPE

Install the oil pump outlet pipe with a new lock washer, gasket and the union bolt. Finger tighten the union bolt.



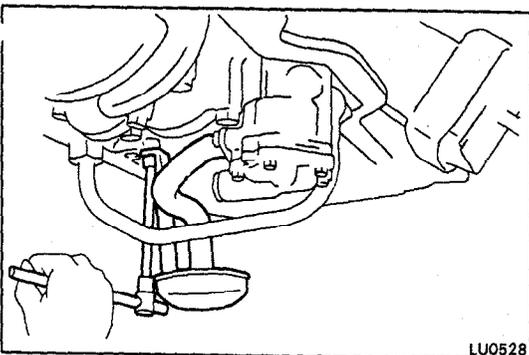
INSTALLATION OF OIL PUMP

(See page LU-8)

1. INSTALL OIL PUMP

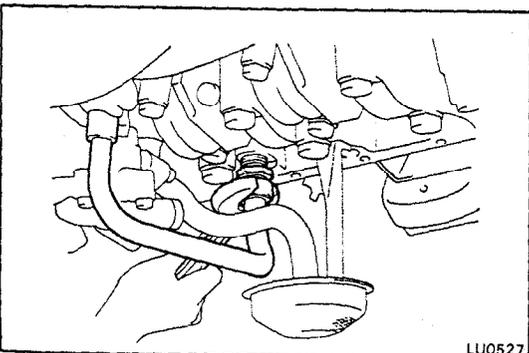
- (a) Install the oil pump with the bolt. Torque the bolt.

Torque: 220 kg-cm (16 ft-lb, 22 N·m)



- (b) Install the mount bolt holding the oil pump strainer stay to block.

Torque: 60 kg-cm (52 in.-lb, 5.9 N·m)



- (c) Connect the outlet pipe with the union bolt. Torque the union bolt and nut.

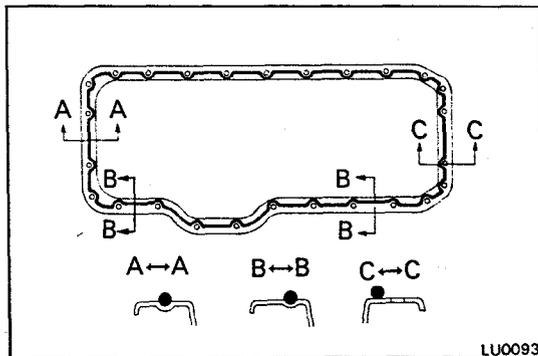
Torque: 350 kg-cm (25 ft-lb, 34 N·m)

- (d) Stake the lock washer.

2. INSTALL OIL PAN

- (a) Remove any old packing (FIG) material and be careful not to drop any oil on the contact surfaces of the oil pan and cylinder block.
- Using a razor blade and gasket scraper, remove all the packing (FIG) material from the gasket surfaces.
 - Thoroughly clean all components to remove all the loose material.
 - Clean both sealing surfaces with a non-residue solvent.

CAUTION: Do not use a solvent which will affect the painted surfaces.



- (b) Apply seal packing to the oil pan as shown in the figure.

Seal packing: Part No. 08826-00080 or equivalent

- Install a nozzle that has been cut to a 5 mm (0.20 in.) opening.

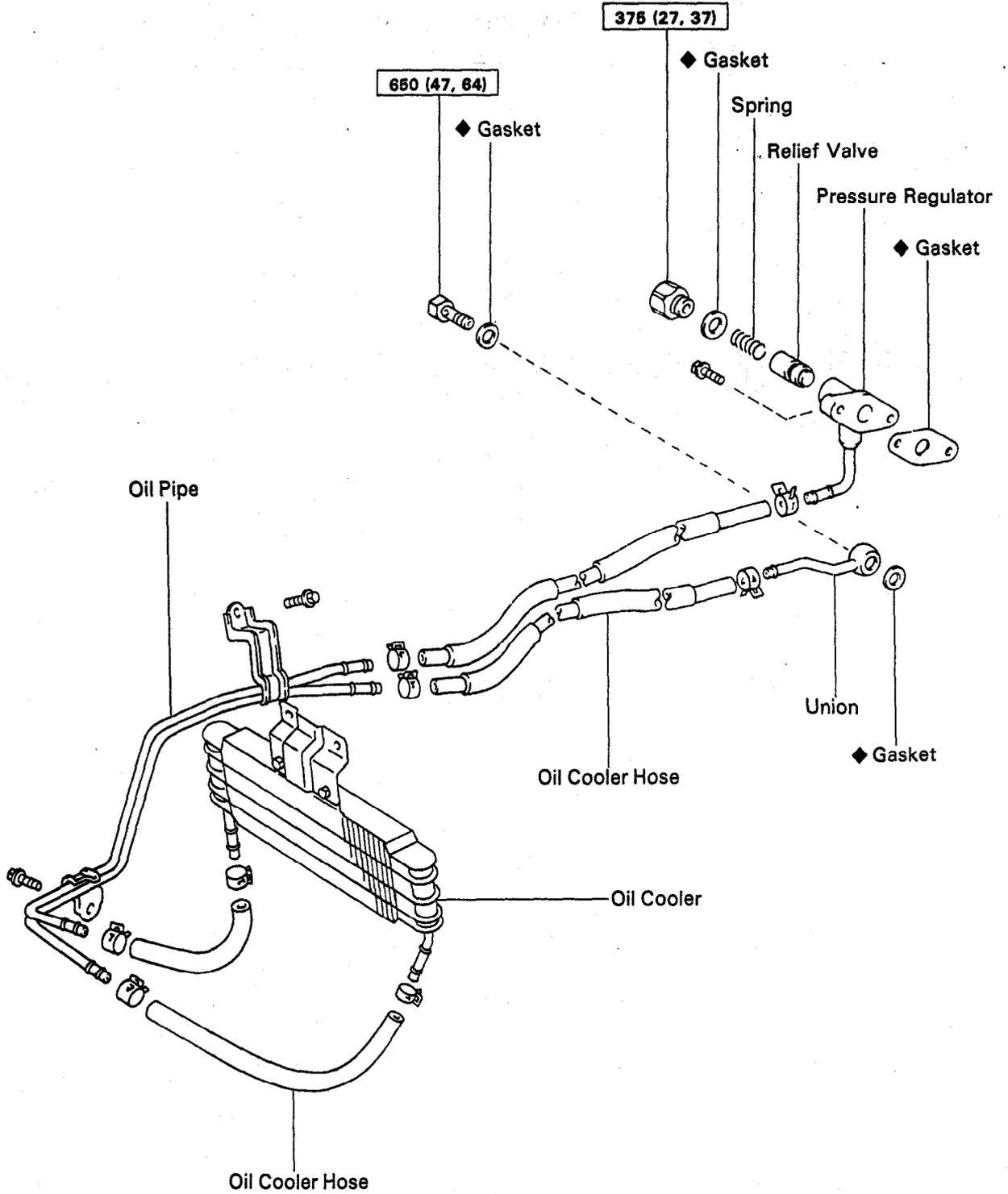
- (c) Install the oil pan with the bolts and nuts.

Torque: 130 kg-cm (9 ft-lb, 13 N·m)

3. **FILL WITH ENGINE OIL (See step 3 on page LU-7)**
4. **START ENGINE AND CHECK FOR LEAKS**
5. **RECHECK OIL LEVEL (See step 2 on page LU-5)**

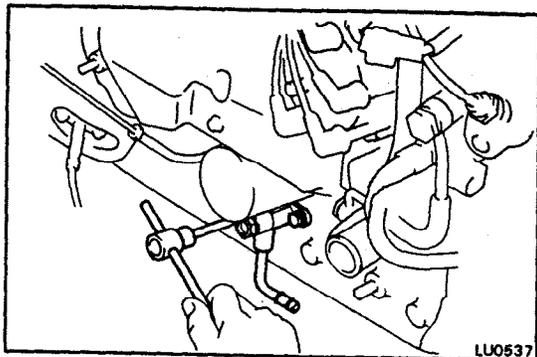
COMPONENTS (Cont'd)

MS



kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part



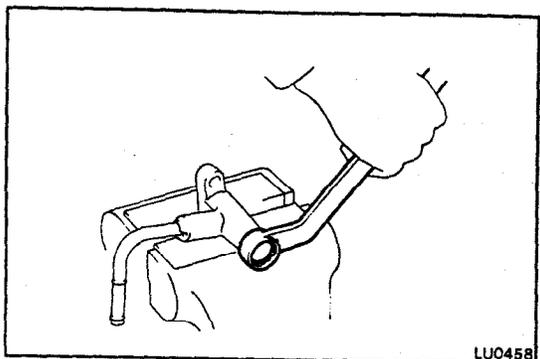
REMOVAL AND DISASSEMBLY OF OIL PRESSURE REGULATOR

(See pages LU-15, 16)

1. **DISCONNECT OIL HOSE**
2. **REMOVE OIL PRESSURE REGULATOR**
Remove the two bolts, oil pressure regulator and gasket.

3. **REMOVE RELIEF VALVE**

Unscrew the plug, and remove the spring, relief valve and gasket.

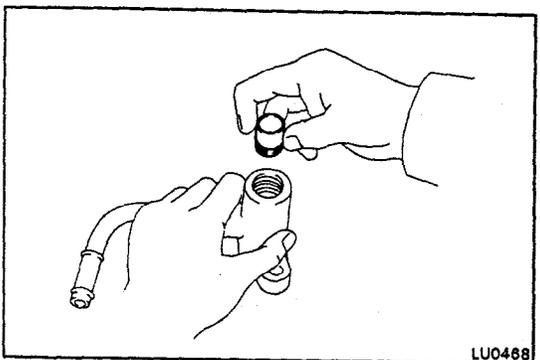


INSPECTION OF OIL PRESSURE REGULATOR

INSPECT RELIEF VALVE

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If it does not, replace the relief valve. If necessary, replace the oil pressure regulator assembly.



ASSEMBLY AND INSTALLATION OF OIL PRESSURE REGULATOR

(See pages LU-15, 16)

1. **INSTALL RELIEF VALVE**

Install the relief valve and spring with the plug and a new gasket. Torque the plug.

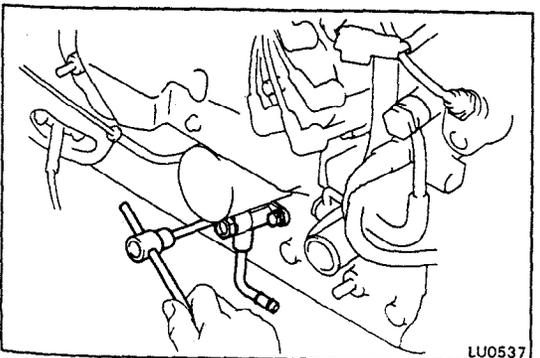
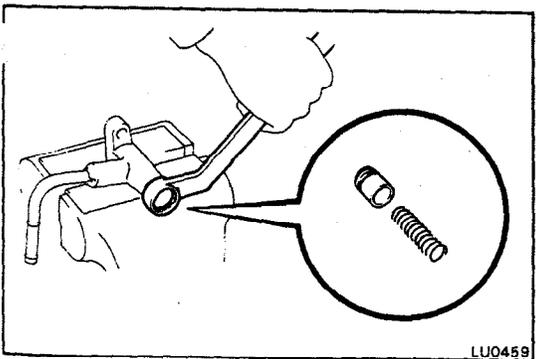
Torque: 375 kg-cm (27 ft-lb, 37 N·m)

2. **INSTALL OIL PRESSURE REGULATOR**

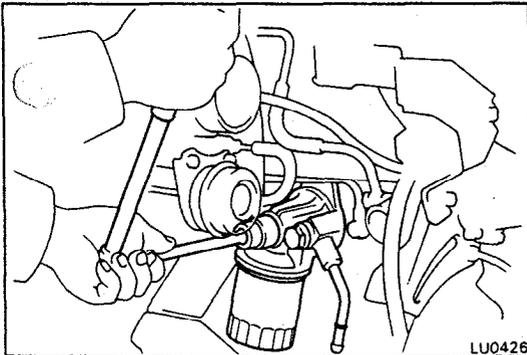
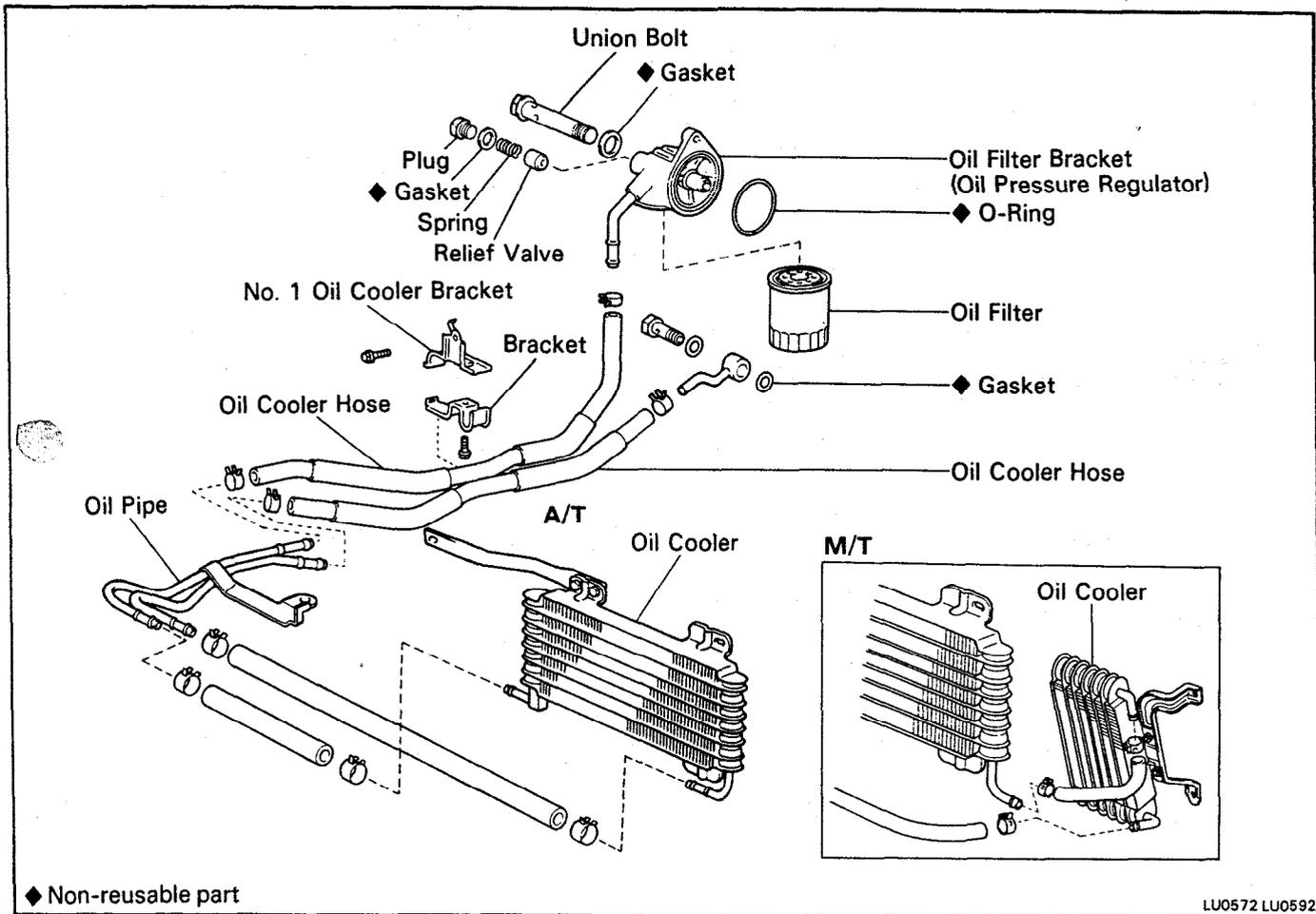
Install the oil pressure regulator with the two bolts. Torque the bolts.

Torque: 145 kg-cm (10 ft-lb, 14 N·m)

3. **CONNECT OIL HOSE**



OIL COOLER AND OIL PRESSURE REGULATOR (7M-GTE) COMPONENTS



REMOVAL AND DISASSEMBLY OF OIL FILTER BRACKET

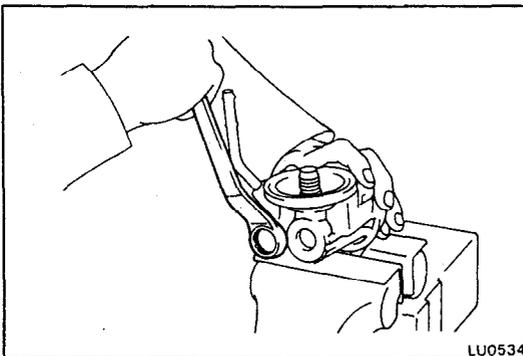
1. REMOVE OIL FILTER BRACKET

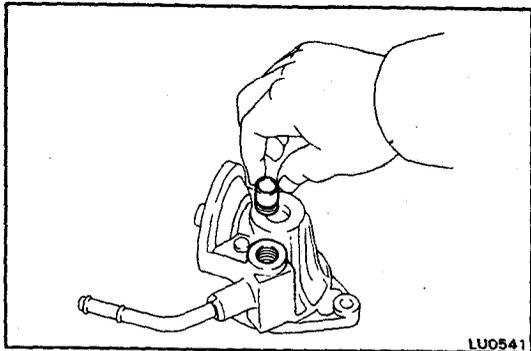
Remove the union bolt, gasket, oil filter bracket and O-ring.

2. REMOVE OIL FILTER (See page LU-6)

3. REMOVE RELIEF VALVE

Unscrew the plug, and remove the spring, relief valve and gasket.

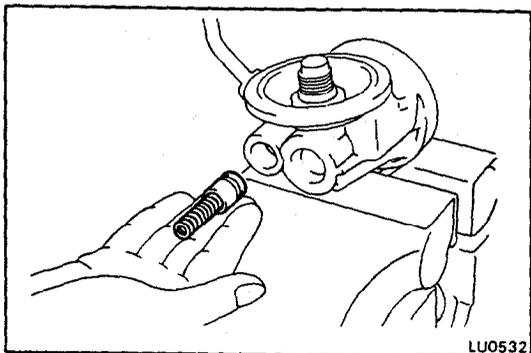




INSPECTION OF RELIEF VALVE

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If it does not, replace the relief valve. If necessary, replace the oil filter bracket assembly.



ASSEMBLY AND INSTALLATION OF OIL FILTER BRACKET

(See page LU-18)

1. INSTALL RELIEF VALVE

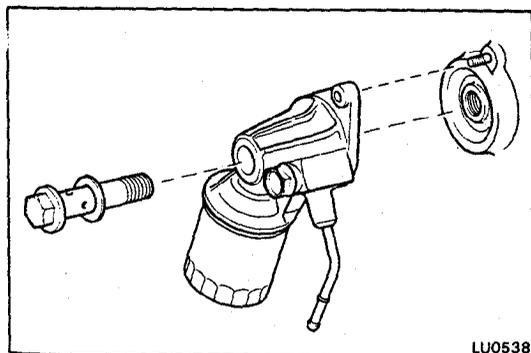
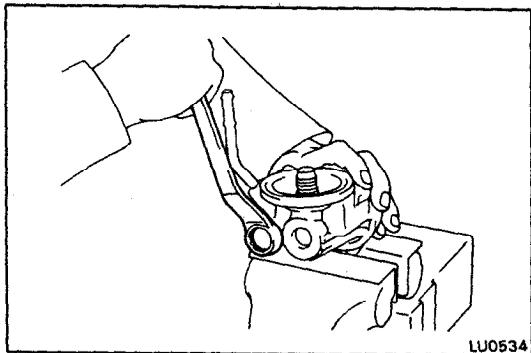
(a) Install the relief valve and spring.

(b) Install and torque the plug with a new gasket.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

2. INSTALL OIL FILTER

(See page LU-6)



3. INSTALL OIL FILTER BRACKET

(a) Install a new O-ring to bracket.

(b) Install a new gasket to union bolt.

(c) Put the oil filter bracket hole over the cylinder block stud bolt and install the oil filter bracket with the union bolt.

(d) Torque the union bolt.

Torque: 500 kg-cm (36 ft-lb, 49 N·m)

