LUBRICATION SYSTEM

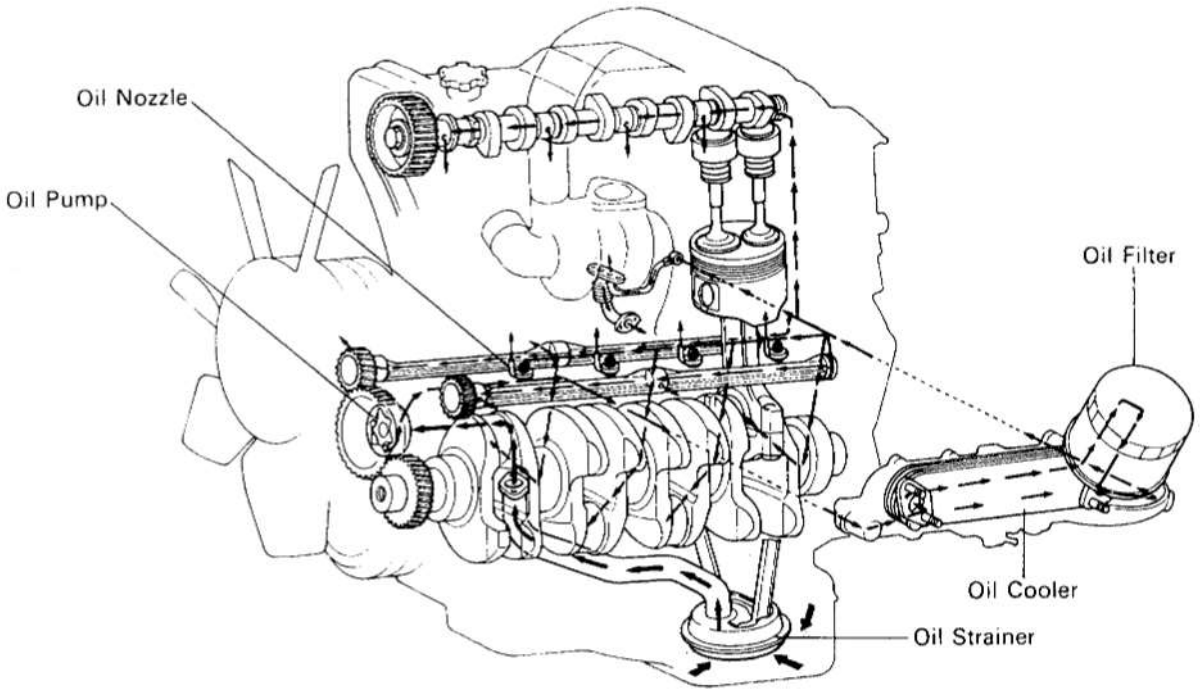
DESCRIPTION

EG140-02

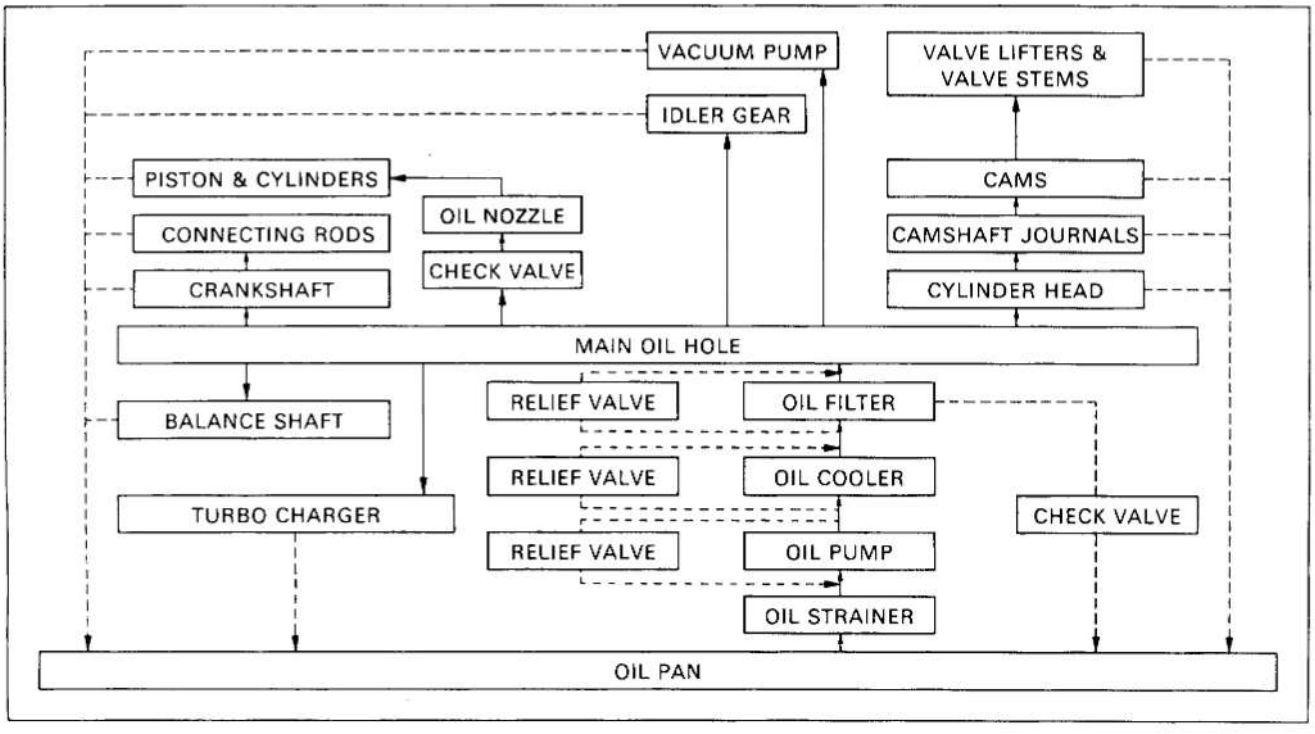
A fully pressurized, fully filtered lubrication system has been adopted for this engine.

OPERATION

EG145-08



P11699



209337

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 oil pump 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 to remove impurities. The oil pump itself is a trochoid type pump, which uses a drive rotor and a driven inside the pump body. When the drive rotor rotates, the driven rotor rotates in the same direction. The axis of the drive rotor shaft is different from the center of the driven rotor, so when both rotors rotate, the space between the 2 rotors changes. Oil is drawn in when the space widens and is discharged when the space becomes narrow.

OIL PRESSURE REGULATOR (RELIEF VALVE)

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 by pass closed, but when too much oil is being fed, the pressure becomes extremely high, overpowering the force of the spring and opening the valve. 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 relief valve built into the paper filter element. Particles of metal from wear, airborne dirt, carbon and other impurities can get into the oil during use and could cause accelerated wear or seizing 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 by passes the oil filter and flows directly into the main oil hole in the engine.

PREPARATION

SST (SPECIAL SERVICE TOOLS)

EG14U-06

	09032–00100	Oil Pan Seal Cutter	
	09228–10001	Oil Filter Wrench	

RECOMMENDED TOOLS

EG14V-02

	09200–00010	Engine Adjust Kit	
	09905–00013	Snap Ring Pliers	

EQUIPMENT

EG14W-06

Oil pressure gauge	
Precision straight edge	
Torque wrench	

LUBRICANT

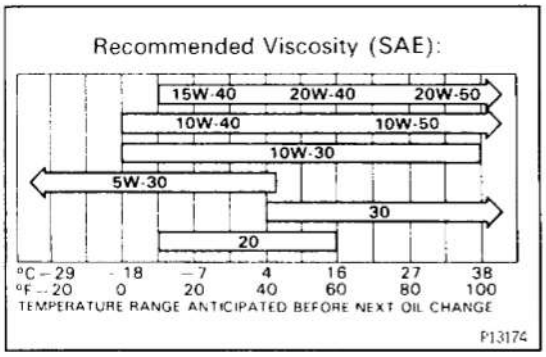
EG14X-07

Item	Capacity	Classification
Engine oil		API grade CD or better
Dry fill	8.5 liters (9.0 US qts, 7.5 Imp. qts)	
Drain and refill		
w/ Oil filter change	8.0 liters (8.5 US qts, 7.0 Imp. qts)	
w/o Oil filter change	7.3 liters (7.7 US qts, 6.4 Imp. qts)	

SSM (SPECIAL SERVICE MATERIALS)

EG14Y-06

	08826–00080	Seal packing or equivalent	Oil pan
	08833–00080	Adhesive 1344, THREE BOND 1344, LOCTITE 242 or equivalent	Oil pressure sender gauge



OIL PRESSURE CHECK

EG35A-01

1. CHECK ENGINE OIL QUALITY

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

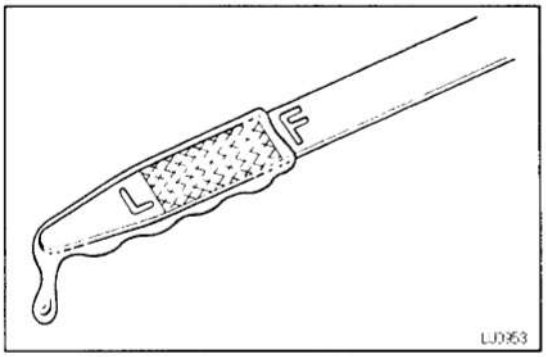
If the quality is visibly poor, replace the oil.

Oil grade:

API grade CD or better

Recommended viscosity:

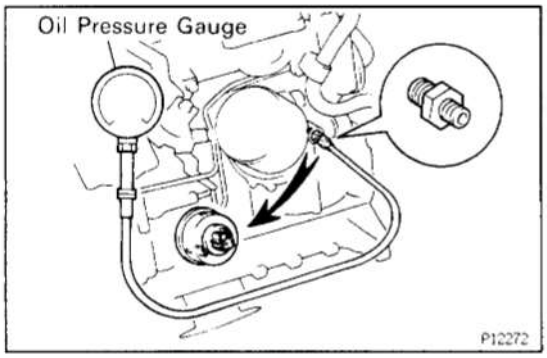
Refer to illustration



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 "F" mark.



3. REMOVE OIL PRESSURE SENDER GAUGE

4. INSTALL OIL PRESSURE GAUGE

5. WARM UP ENGINE

Allow the engine to warm up to normal operating temperature.

6. CHECK OIL PRESSURE

Oil pressure:

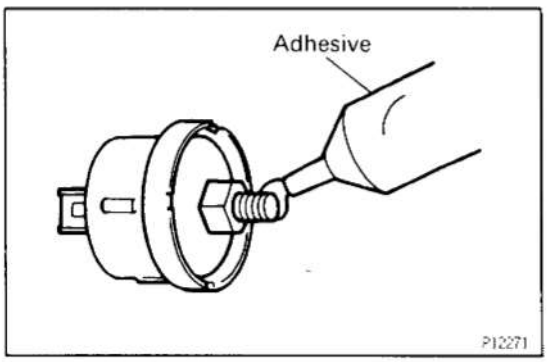
At idle

29 kPa (0.3 kgf/cm², 4.3 psi) or more

At 3,000 rpm

250 – 600 kPa (2.5 – 6.1 kgf/cm², 18 – 42 psi)

7. REMOVE OIL PRESSURE GAUGE



8. REINSTALL OIL PRESSURE SENDER GAUGE

(a) Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:

Part No. 08833–00080, THREE BOND 1344, LOCTITE 242 or equivalent

(b) Install the oil pressure sender gauge.

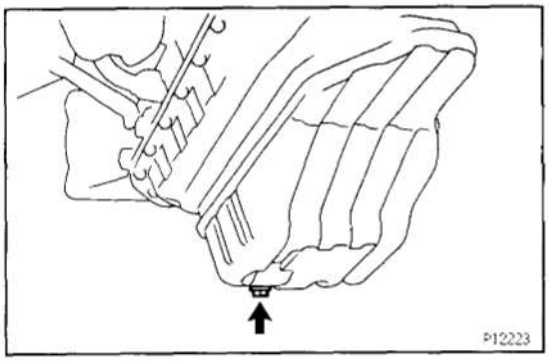
9. START ENGINE, AND CHECK FOR OIL LEAKS

OIL AND FILTER REPLACEMENT

EG177-03

CAUTION:

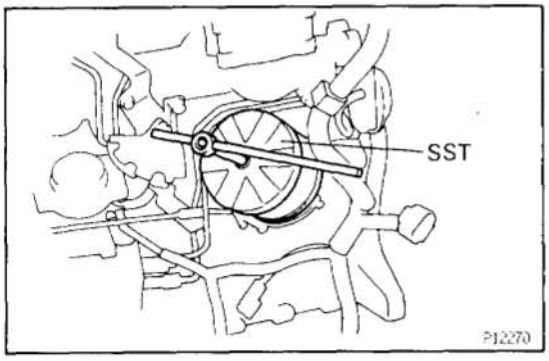
- **Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**
- **Care should be taken, therefore, when changing engine oil to minimize the frequency and length of time your skin is exposed to used engine oil. Protective clothing and gloves that cannot be penetrated by oil should be worn. The skin should be thoroughthly washed with soap and water, or use water–less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.**
- **In order to preserve the environment, used oil and used oil filter must be disposed of only at designated disposal sites.**



1. DRAIN ENGINE OIL

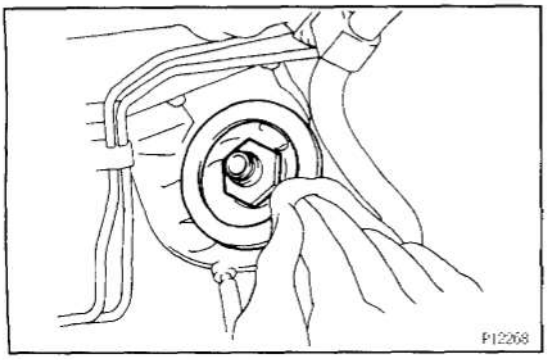
(a) Remove the oil filler cap.

(b) Remove the oil drain plug, and drain the oil into a container.

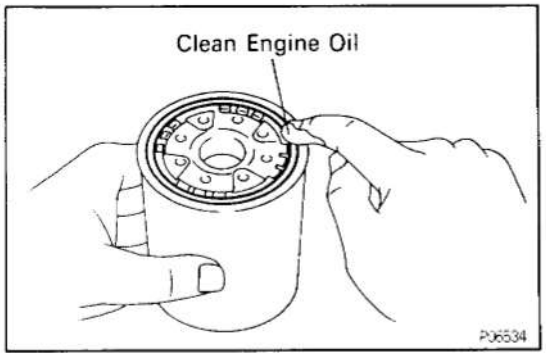


2. REPLACE OIL FILTER

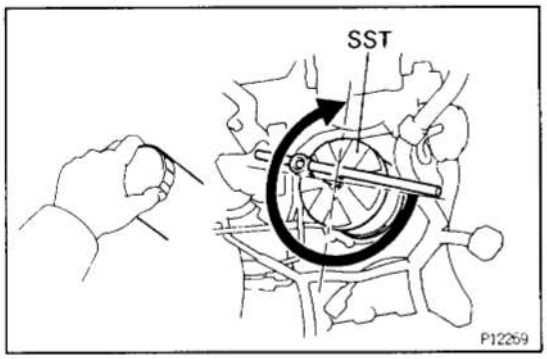
(a) Using SST, remove the oil filter.
SST 09228–10001
HINT: Put a container under the drain hose.



(b) Clean the oil filter contact surface on the oil filter mounting.

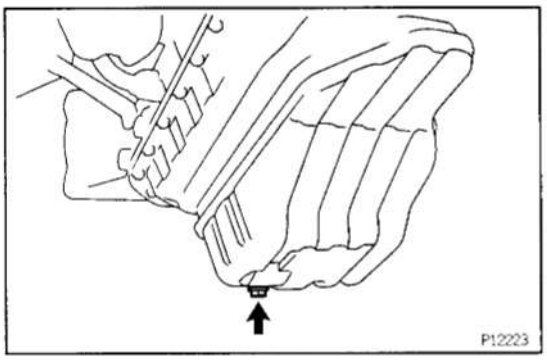


(c) Lubricate the filter rubber gasket with clean engine oil.



(d) Tighten the oil filter by hand until the rubber gasket contacts the seat of the filter mounting.

(e) Using SST, give it an additional 3/4 turn to seat the filter.
SST 09228–10001



3. FILL WITH ENGINE OIL

(a) Clean and install the oil drain plug with a new gasket.
Torque: 34 N·m (350 kgf·cm, 25 ft·lbf)

(b) Fill with new engine oil.
Oil grade: (See step 1 Oil Pressure Check)
Capacity:
Drain and refill
w/ Oil filter change
8.0 liters (8.5 US qts, 7.0 Imp. qts)
w/o Oil filter change
7.3 liters (7.7 US qts, 6.4 Imp. qts)
Dry fill
8.5 liters (9.0 US qts, 7.5 Imp. qts)

(c) Reinstall the oil filler cap.

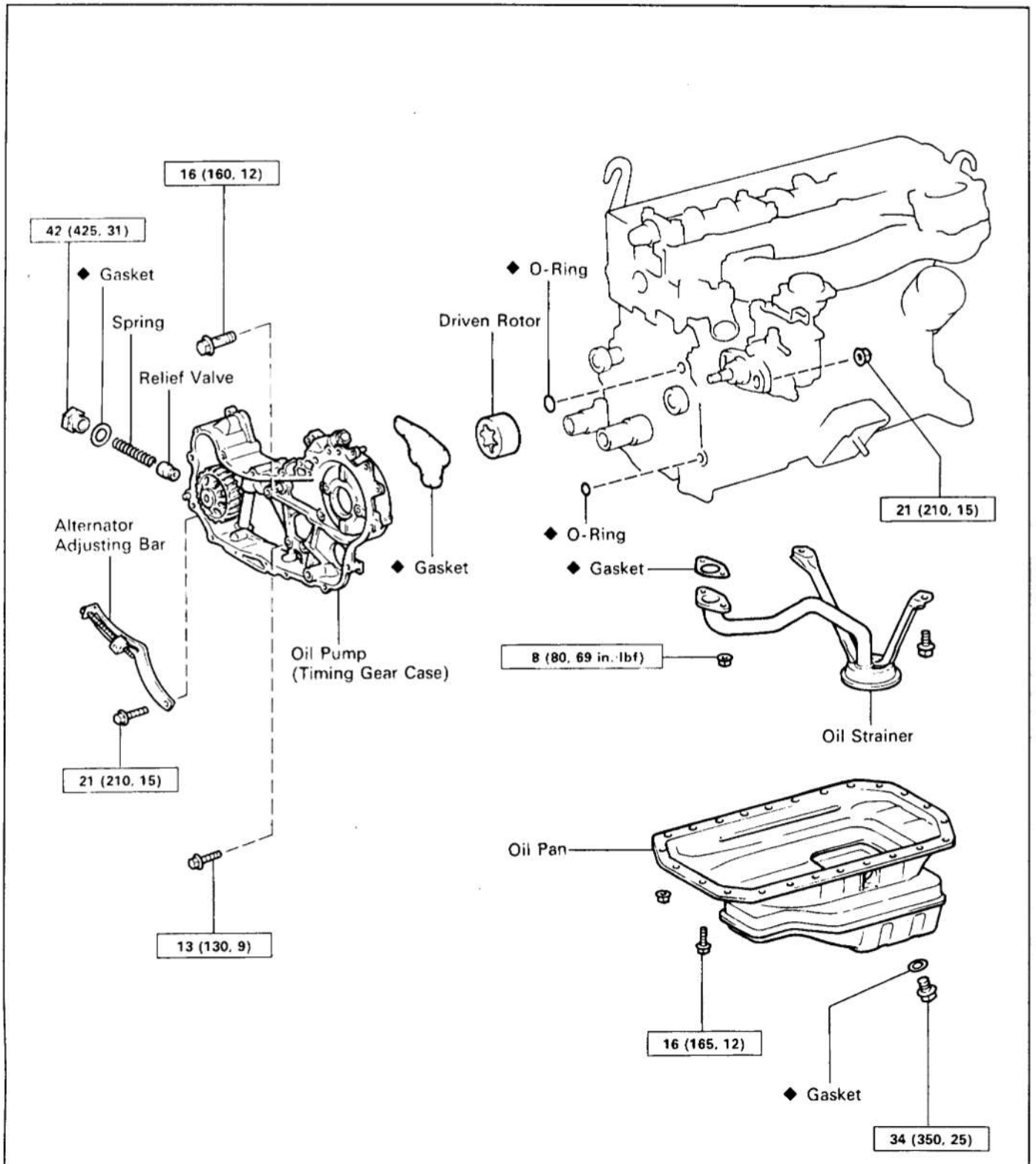
4. START ENGINE AND CHECK FOR OIL LEAKS

5. RECHECK ENGINE OIL LEVEL

OIL PUMP

COMPONENTS FOR REMOVAL AND INSTALLATION

EG178-03



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

P12377

EG358-01

OIL PUMP REMOVAL

(See Components for Removal and Installation)

HINT: When repairing the oil pump, the oil pan and strainer should be removed and cleaned.

1. **DRAIN ENGINE COOLANT**
2. **DRAIN ENGINE OIL**
3. **REMOVE DRIVE BELT, FAN AND WATER PUMP PULLEY(See step 2 on page EG–235)**
4. **REMOVE TIMING BELT**
   (See page EG–32)
5. **REMOVE TIMING GEARS**
   (See page EG–41)
6. **REMOVE ALTERNATOR ADJUSTING BAR**

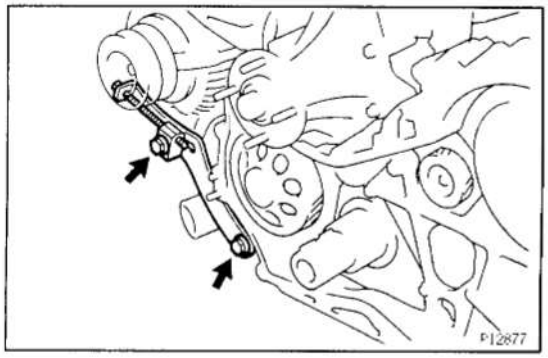
(a) Remove the lock bolt.

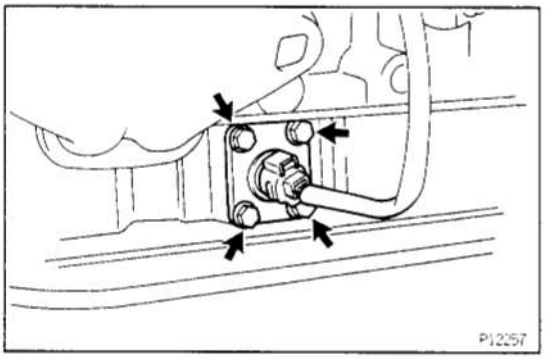
(b) Remove the bolt and adjusting bar.

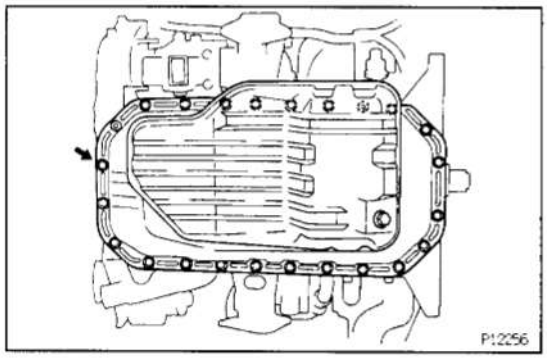
7. **REMOVE ALTERNATOR AND ALTERNATOR BRACKET**
   (See step 6 on page EG–235)
8. **REMOVE WATER PUMP**
   (See step 6 on page EG–235)
9. **REMOVE OIL LEVEL SENSOR**

(a) Disconnct the oil level sensor connector.

(b) Remove the 4 bolts and oil level sensor.

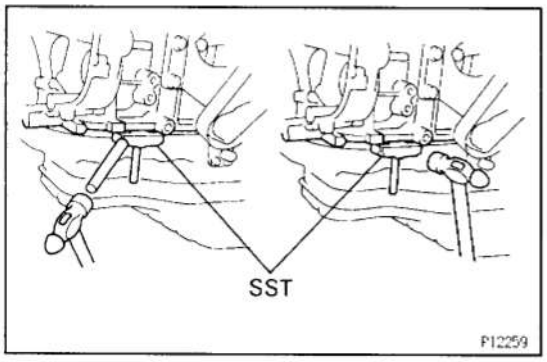






10. **REMOVE OIL PAN**

(a) Remove the 22 bolts and 2 nuts.

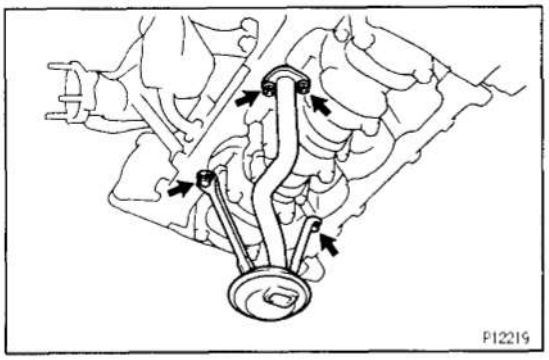


(b) Insert the blade of SST between the cylinder block and oil pan, and cut off applied sealer and remove the oil pan.

SST 09032–00100

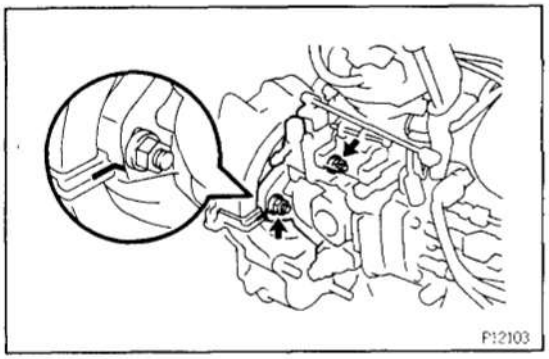
NOTICE:

- **Do not use SST for the oil pump body side and rear oil seal retainer.**
- **Be careful not to damage the oil pan flange.**



11. REMOVE OIL STRAINER

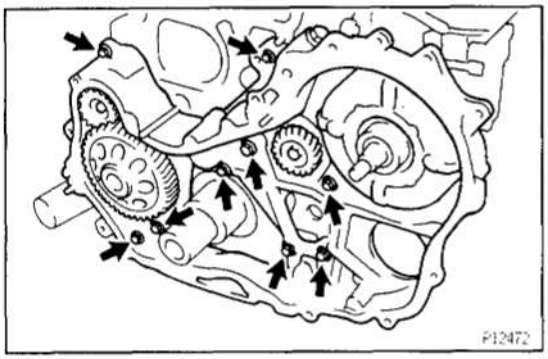
Remove the 2 bolts, 2 nuts, oil strainer and gasket.



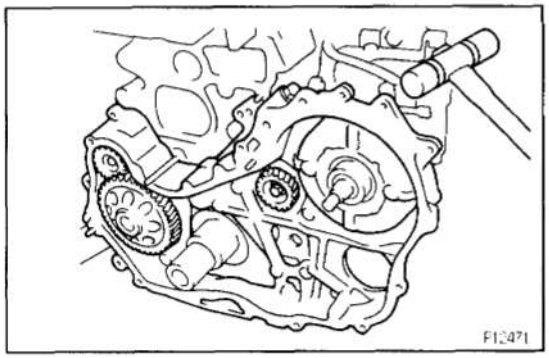
12. REMOVE OIL PUMP (TIMING GEAR CASE)

(a) Before removing the 2 nuts holding the timing gear case to the injection pump, check if the injection pump period lines are aligned.
If not, place new matchmarks for reinstallation.

(b) Remove the 2 nuts.



(c) Remove the 8 bolts and union bolt.



(d) Using a plastic–faced hammer, lightly tap out the timing gear case.

(e) Remove the 3 O–rings.

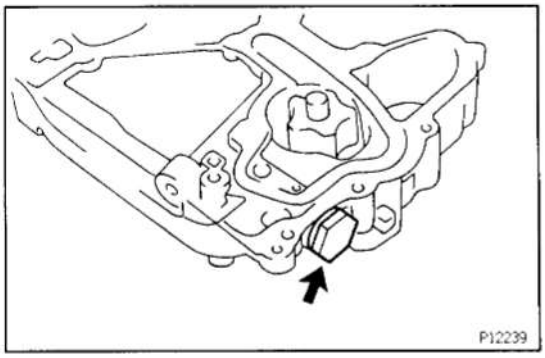
EG156-07

OIL PUMP DISASSEMBLY


P12235

(See Components for Removal and Installation)

1. REMOVE DRIVEN ROTOR

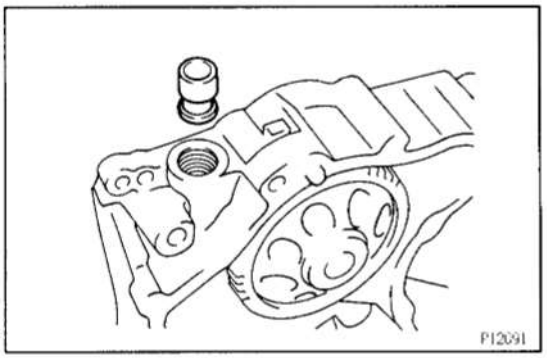

P12239

2. REMOVE RELIEF VALVE

Remove the plug, gasket, spring and relief valve.

EG17A-03

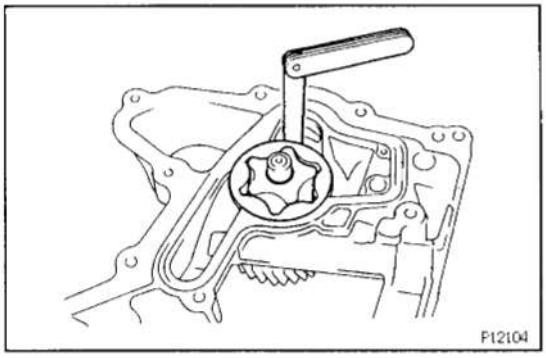
OIL PUMP INSPECTION


P12091

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 doesn't, replace the relief valve. If necessary, replace the oil pump assembly.


P12104

2. INSPECT DRIVE AND DRIVEN ROTORS

A. **Inspect rotor body clearance**

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

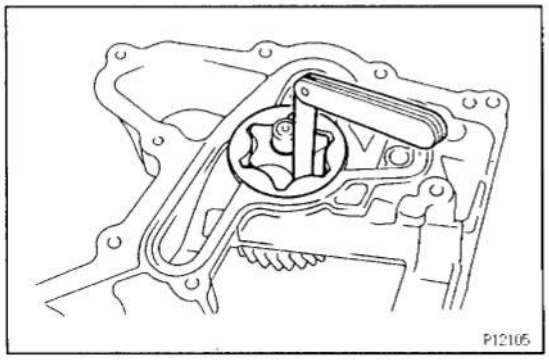
Standard body clearance:

0.100 – 0.170 mm (0.0039 – 0.0067 in.)

Maximum body clearance:

0.20 mm (0.0079 in.)

If the body clearance is greater than maximum, replace the rotors as a set. If necessary, replace the oil pump assembly.


P12105

B. **Inspect rotor tip clearance**

Using a thickness gauge, measure the clearance between the drive and driven rotor tips.

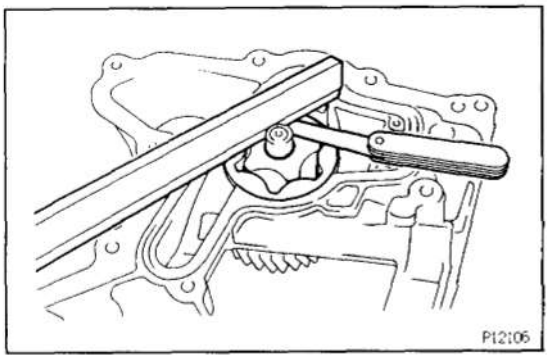
Standard tip clearance:

0.060 – 0.160 mm (0.0024 – 0.0063 in.)

Maximum tip clearance:

0.21 mm (0.0083 in.)

If the tip clearance is greater than maximum, replace the rotors as a set.



C. Inspect rotor side clearance

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

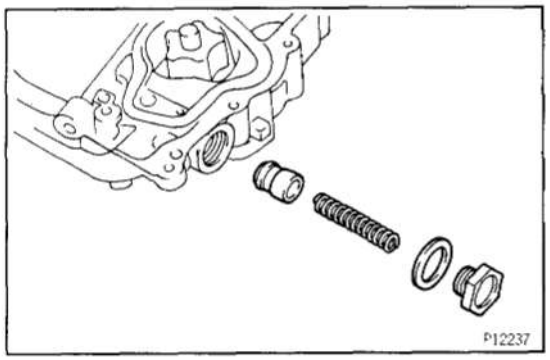
Standard side clearance:

0.030 – 0.090 mm (0.0012 – 0.0035 in.)

Maximum side clearance:

0.15 mm (0.0059 in.)

If the side clearance is greater than maximum, replace the rotors as a set. If necessary, replace the oil pump assembly.



OIL PUMP ASSEMBLY

EG38C-01

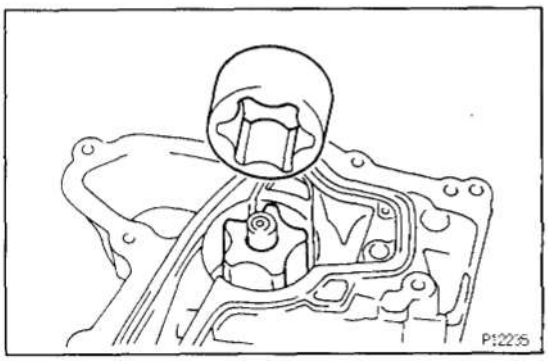
(See Components for Removal and Installation)

1. INSTALL RELIEF VALVE

(a) Insert the relief valve and spring into the installation hole of the timing gear case.

(b) Install a new gasket and the plug.

Torque: 42 N·m (425 kgf·cm, 31 ft·lbf)



2. INSTALL DRIVE AND DRIVEN ROTORS

EG360-01

OIL PUMP INSTALLATION

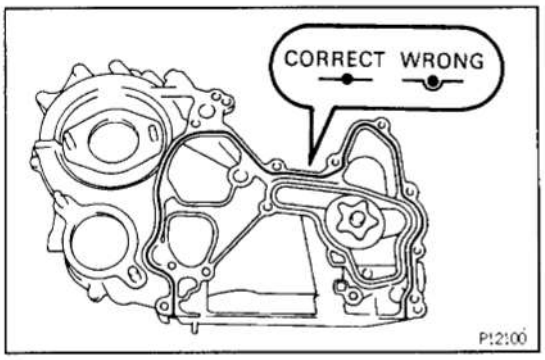
(See Components for Removal and Installation)

1. INSTALL OIL PUMP (TIMING GEAR CASE)

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the timing gear case and cylinder block.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.

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

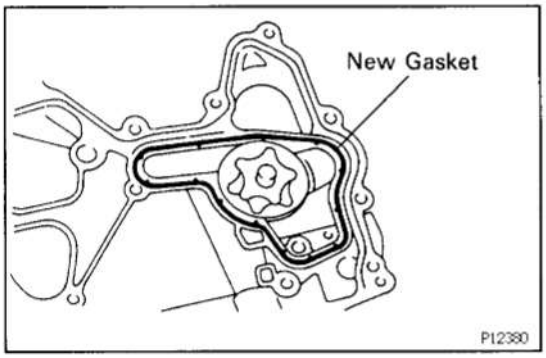


(b) Apply seal packing to the timing gear case as shown in the illustration.

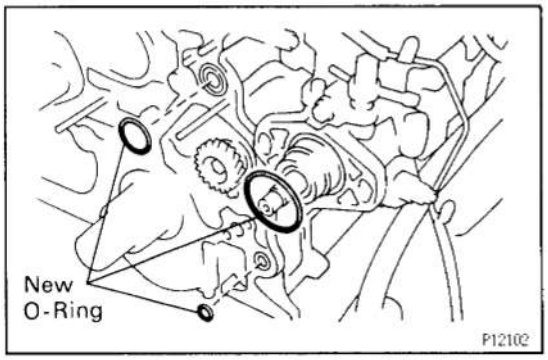
Seal packing:

Part No. 08826–00080 or equivalent

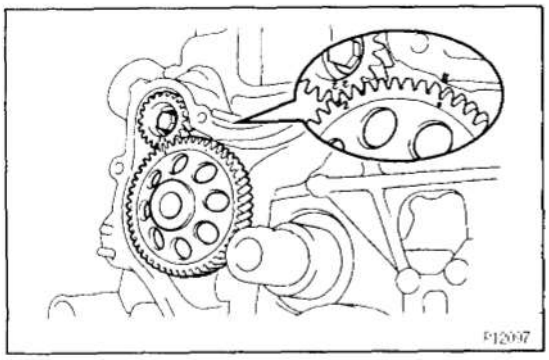
- Install a nozzle that has been cut to a 3 – 5 mm (0.12 – 0.20 in.) opening.
- Parts must be assembled within 3 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



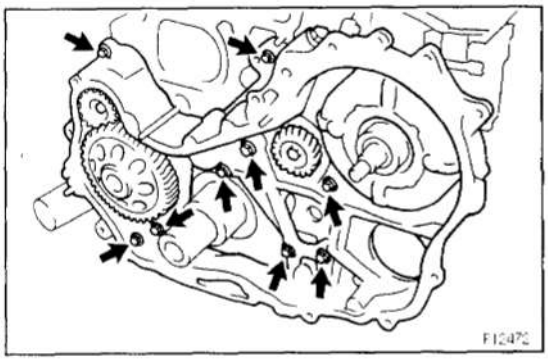
(c) Place a new gasket into the groove of the timing gear case as shown in the illustration.



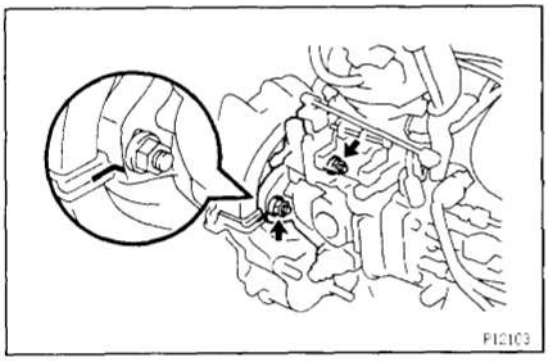
(d) Install the 3 new O–rings to the cylinder block and injection pump.



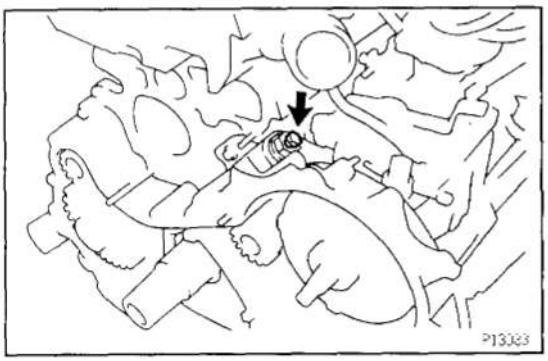
(e) Install the timing gear case.
(f) The match mark on the No.1 balance shaft driven gear should be aligned with the "2" mark.
(g) Align the mark on the oil pump drive gear with the mark on the timing gear case.



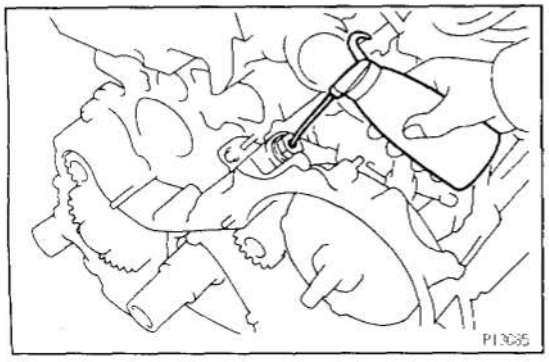
(h) Install the 8 bolts and union bolt.
Torque: 13 N·m (130 kgf·cm, 9 ft·lbf) for Bolt
Torque: 16 N·m (160 kgf·cm, 12 ft·lbf) for Union bolt



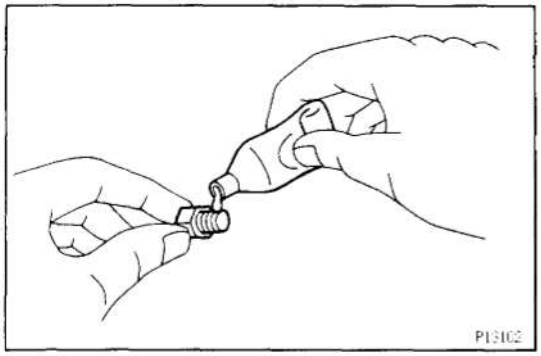
(i) Install the 2 nuts holding the injection pump to the timing gear case.
Torque: 21 N·m (210 kgf·cm, 15 ft·lbf)
(j) Check that the injection pump period lines (or match-marks) by tilting the injection pump.



2. POUR ENGINE OIL INTO OIL PUMP
(a) Remove the taper screw plug.

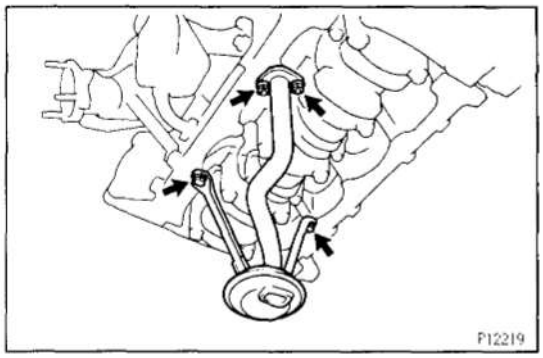


(b) Pour in approx. 20 cc (0.12 cu in.) of engine oil into the oil pump.



(c) Apply adheshive to 2 or 3 threads of the taper screw.
Adhesive:
Part No. 08833–00080, THREE BOND 1344, LOCTITE 242 or equivalent.

(d) Install the taper screw plug.



3. INSTALL OIL STRAINER

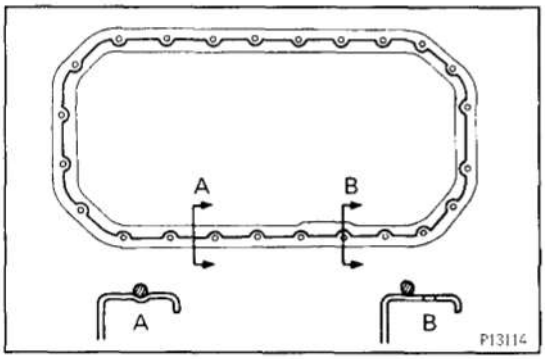
Install a new gasket and the oil strainer with the 2 bolts and 2 nuts.
Torque: 8 N·m (80 kgf·cm, 69 in.·lbf)

4. INSTALL OIL PAN

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil pan and cylinder block.

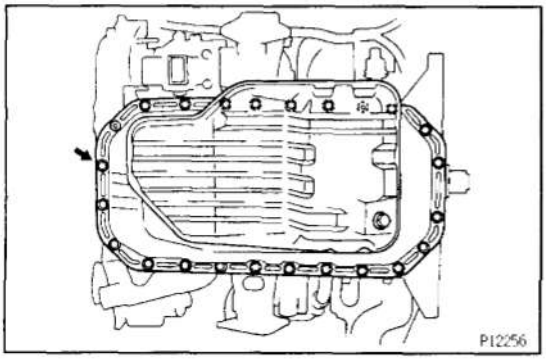
- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.

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

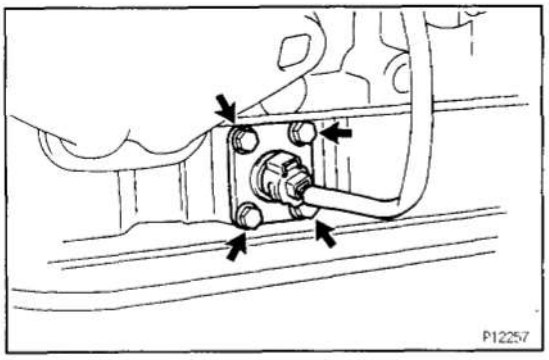


(b) Apply seal packing to the oil pan as shown in the illustration.
Seal packing:
Part No. 08826–00080 or equivalent

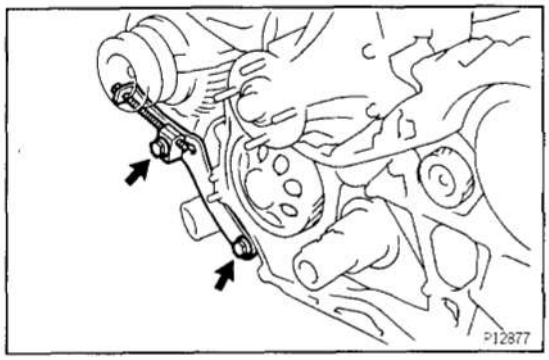
- Install a nozzle that has been cut to a 3 – 5 mm (0.12 – 0.20 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



(c) Install the oil pan with the 22 bolts and 2 nuts.
Torque: 16 N·m (165 kgf·cm, 12 in.·lbf)



5. **INSTALL OIL LEVEL SENSOR**
(a) Install the oil level sensor with the 4 bolts.
(b) Connect the oil level sensor connector.
6. **INSTALL WATER PUMP**
(See step 1 on page EG–237)
7. **INSTALL ALTERNATOR AND ALTERNATOR BRACKET**
(See step 1 on page EG–237)



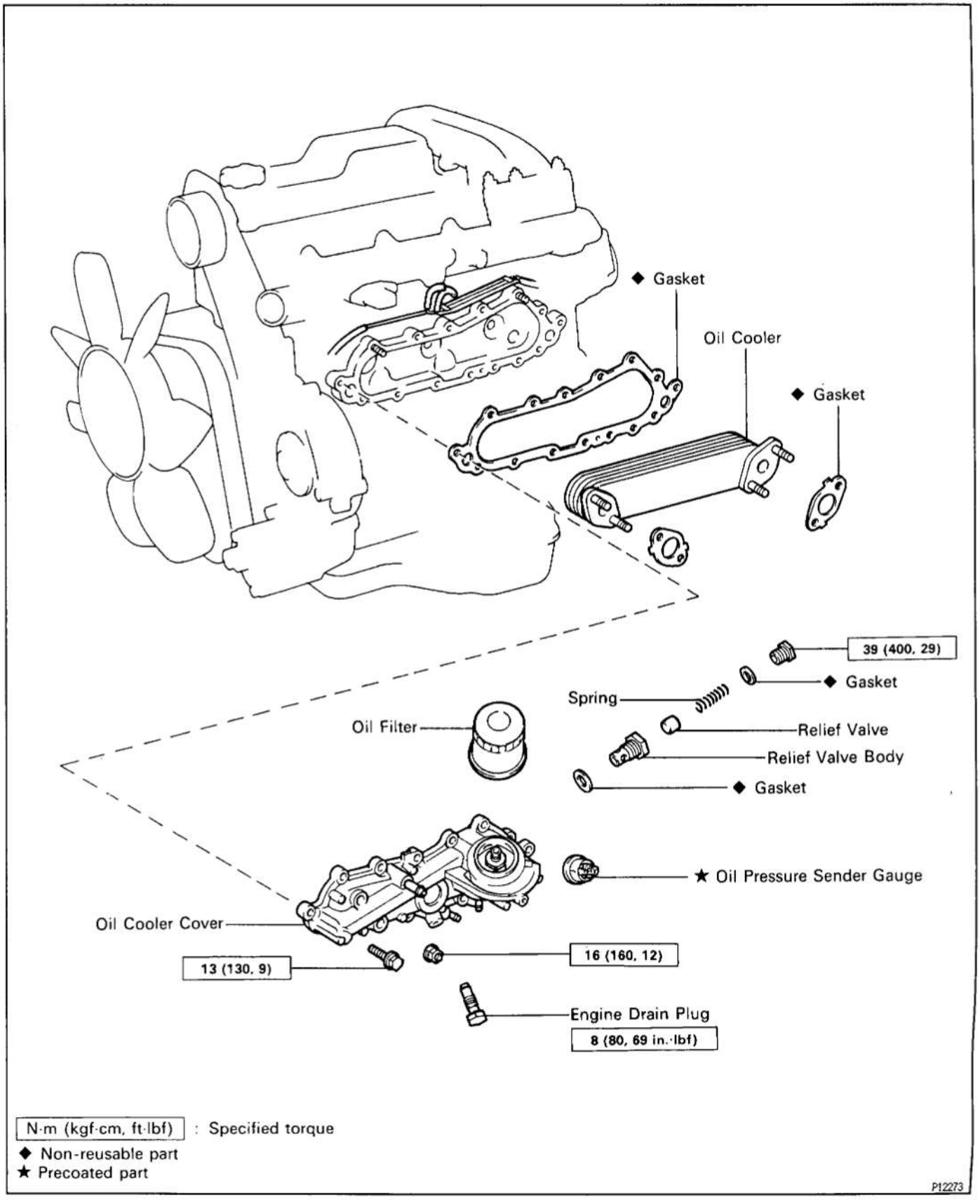
8. **INSTALL ALTERNATOR ADJUSTING BAR**
Install the adjusting bar with the bolt and lock bolt.
Torque: 21 N·m (210 kgf·cm, 15 in.·lbf)

9. **INSTALL TIMING GEARS**
(See page EG–50)
10. **INSTALL TIMING BELT**
(See page EG–36)
11. **INSTALL WATER PUMP PULLEY, FAN AND DRIVE BELT(See step 5 on page EG–238)**
12. **FILL WITH ENGINE OIL**
13. **FILL WITH ENGINE COOLANT**
14. **START ENGINE AND CHECK FOR OIL LEAKS**
15. **RECHECK ENGINE OIL LEVEL**

OIL COOLER

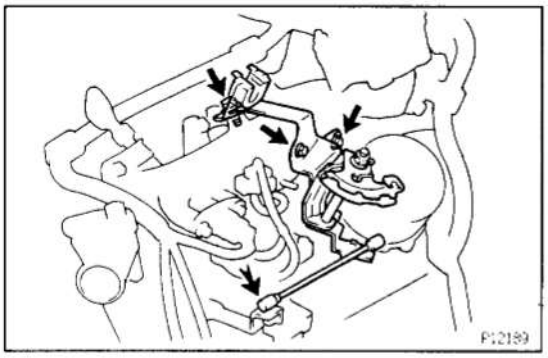
COMPONENTS FOR REMOVAL AND INSTALLATION

EG17D-03



N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non-reusable part
★ Precoated part

P12273



EG35E-01

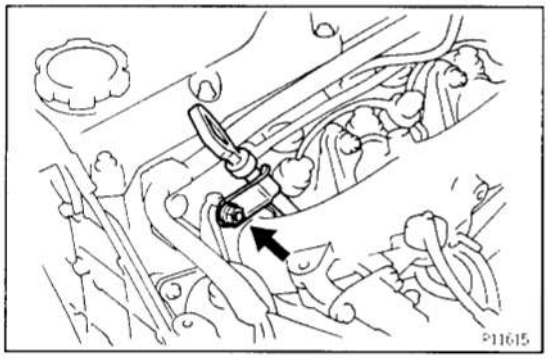
OIL COOLER AND RELIEF VALVE REMOVAL

1. **DRAIN ENGINE COOLANT**
2. **REMOVE ACCELERATOR CABLE BRACKET AND LINK**

(a) Disconnect the accelerator link from the injection pump.

(b) Remove the 3 bolts and accelerator cable bracket and link.

3. **REMOVE TIMING BELT**
   (See page EG–32)
4. **REMOVE INJECTION PIPES**
   (See page EG–152)
5. **REMOVE INJECTION PUMP**
   (See page EG–161)

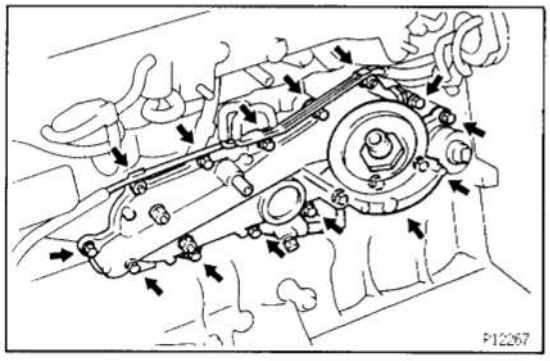


6. **REMOVE OIL DIPSTICK AND GUIDE**

(a) Remove the nut and oil dipstick guide assembly.

(b) Remove the O–ring from the oil dipstick guide.

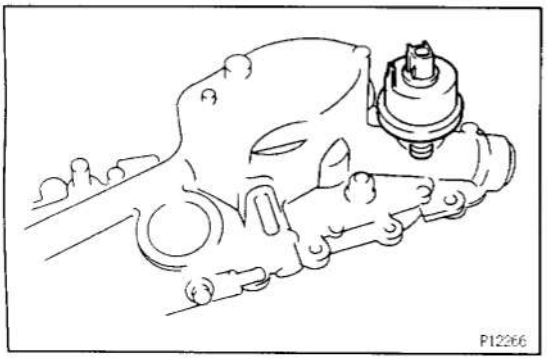
7. **REMOVE OIL FILTER**
   (See page EG–248)



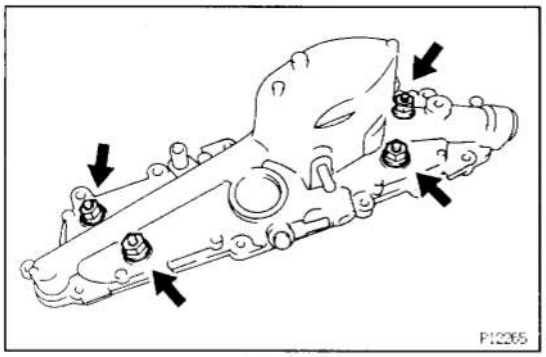
8. **REMOVE OIL COOLER AND OIL COOLER COVER ASSEMBLY**

(a) Remove the 2 nuts, and disconnect the vacuum pipe.

(b) Remove the 13 bolts, oil cooler, oil cooler cover assembly and gasket.

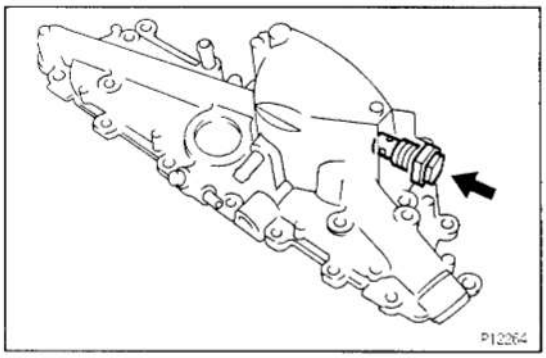


9. **REMOVE OIL PRESSURE SENDER GAUGE**

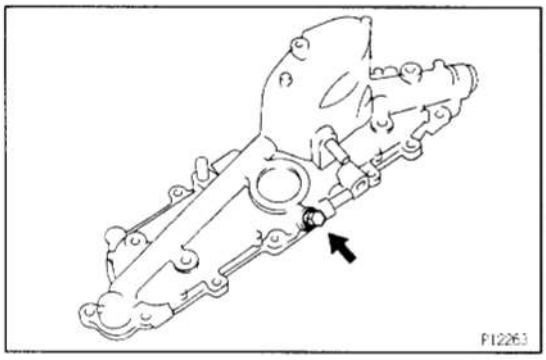


10. SEPARATE OIL COOLER AND OIL COOLER COVER

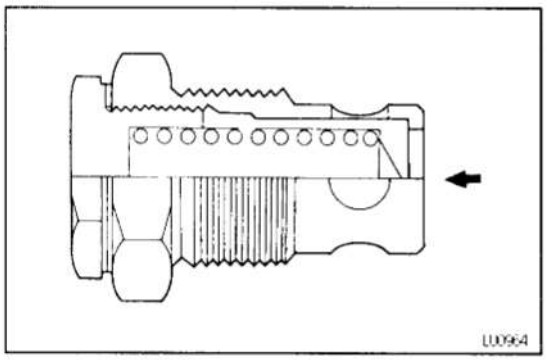
Remove the 4 nuts, oil cooler and 2 gaskets from the oil cooler cover.



11. REMOVE RELIEF VALVE



12. REMOVE DRAIN PLUG



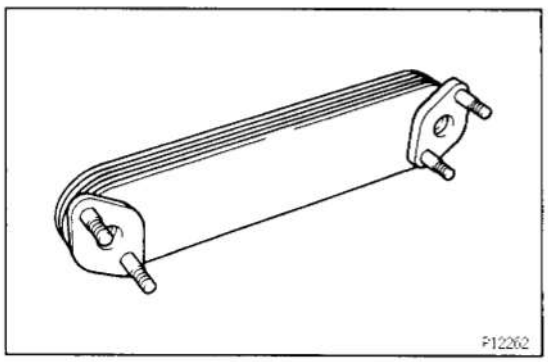
OIL COOLER AND RELIEF VALVE INSPECTION

EG2K0-02

1. INSPECT RELIEF VALVE

Push the valve with a wooden stick to check if it is stuck.

If stuck, replace the relief valve.



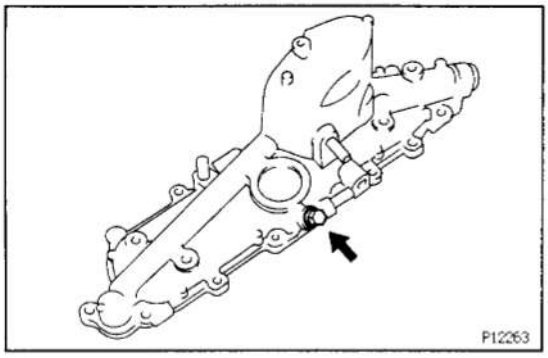
2. INSPECT OIL COOLER

Check the oil cooler for damage or clogging.

If necessary, replace the oil cooler.

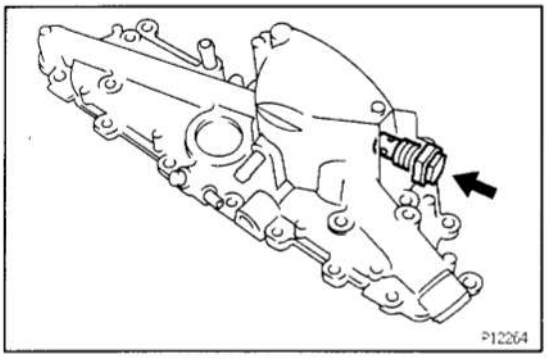
EG35F-01

OIL COOLER AND RELIEF VALVE INSTALLATION

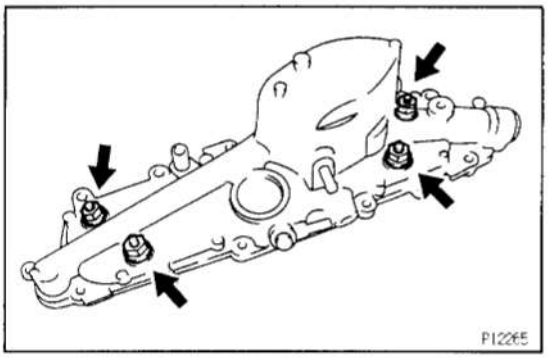


(See Components for Removal and Installation)

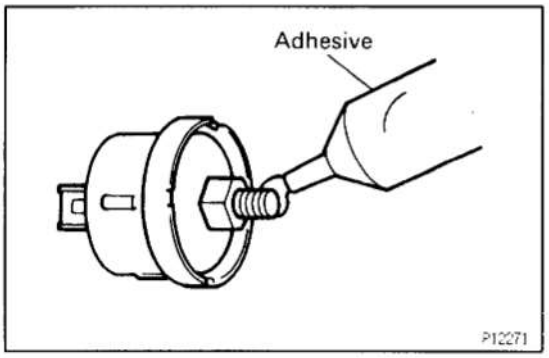
1. **INSTALL ENGINE DRAIN PLUG**
   Torque: 8 N·m (80 kgf·cm, 69 in.·lbf)



2. **INSTALL RELIEF VALVE**
   Install a new gasket with the relief valve.
   Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

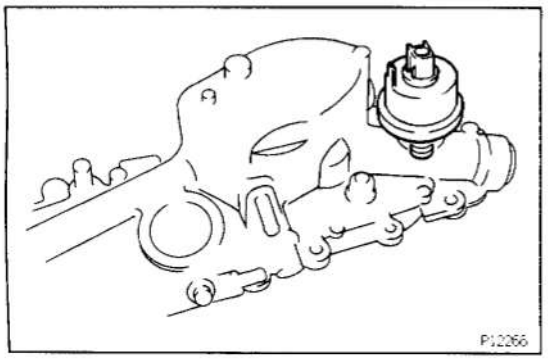


3. **ASSEMBLY OIL COOLER AND OIL COOLER COVER**
   Install 2 new gaskets and the oil cooler to the oil cooler cover with the 4 nuts.
   Torque: 16 N·m (160 kgf·cm, 12 ft·lbf)

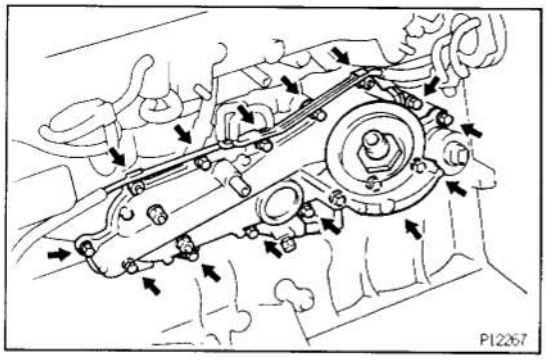


4. **INSTALL OIL PRESSURE SENDER GAUGE**

(a) Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.
Adhesive:
Part No. 08833–00080, THREE BOND 1344, LOCTITE 242 or equivalent



(b) Install the oil pressure sender gauge.

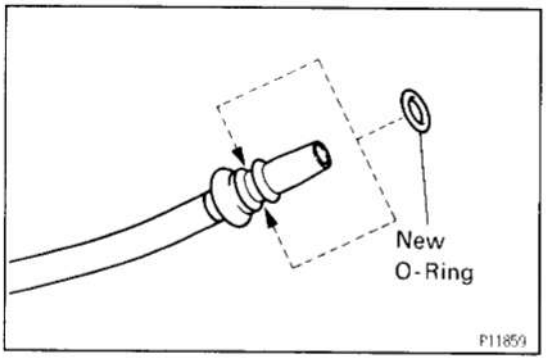


5. INSTALL OIL COOLER AND OIL COOLER COVER ASSEMBLY

(a) Install a new gasket, the oil cooler and oil cooler cover assembly with the 13 bolts.
Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)

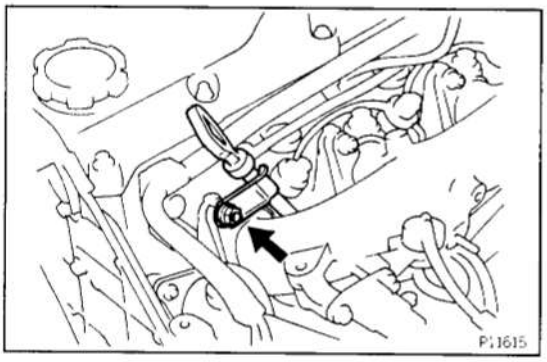
(b) Connect the vaccum pipe with the 2 nuts.
Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)

6. INSTALL OIL FILTER
(See page EG–248)



7. INSTALL OIL DIPSTICK GUIDE AND OIL DIPSTICK

(a) Install a new O–ring to the dipstick guide.

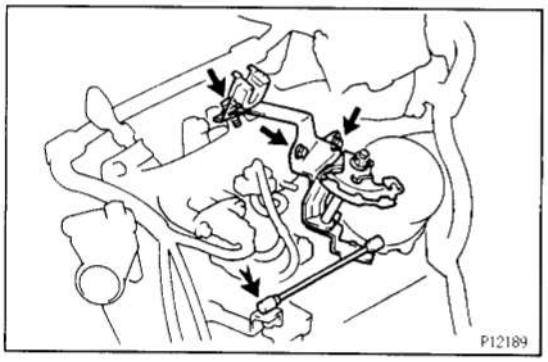


(b) Install the oil dipstick guide assembly with the nut.
Torque: 29 N·m (300 kgf·cm, 22 ft·lbf)

8. INSTALL INJECTION PUMP
(See page EG–218)

9. INSTALL INJECTION PIPES
(See page EG–158)

10. INSTALL TIMING BELT
(See page EG–36)



11. INSTALL ACCELERATOR CABLE BRACKET AND LINK

(a) Install the accelerator cable bracket and link with the 3 bolts.

(b) Connect the accelerator link to the injection pump.

12. FILL WITH ENGINE COOLANT

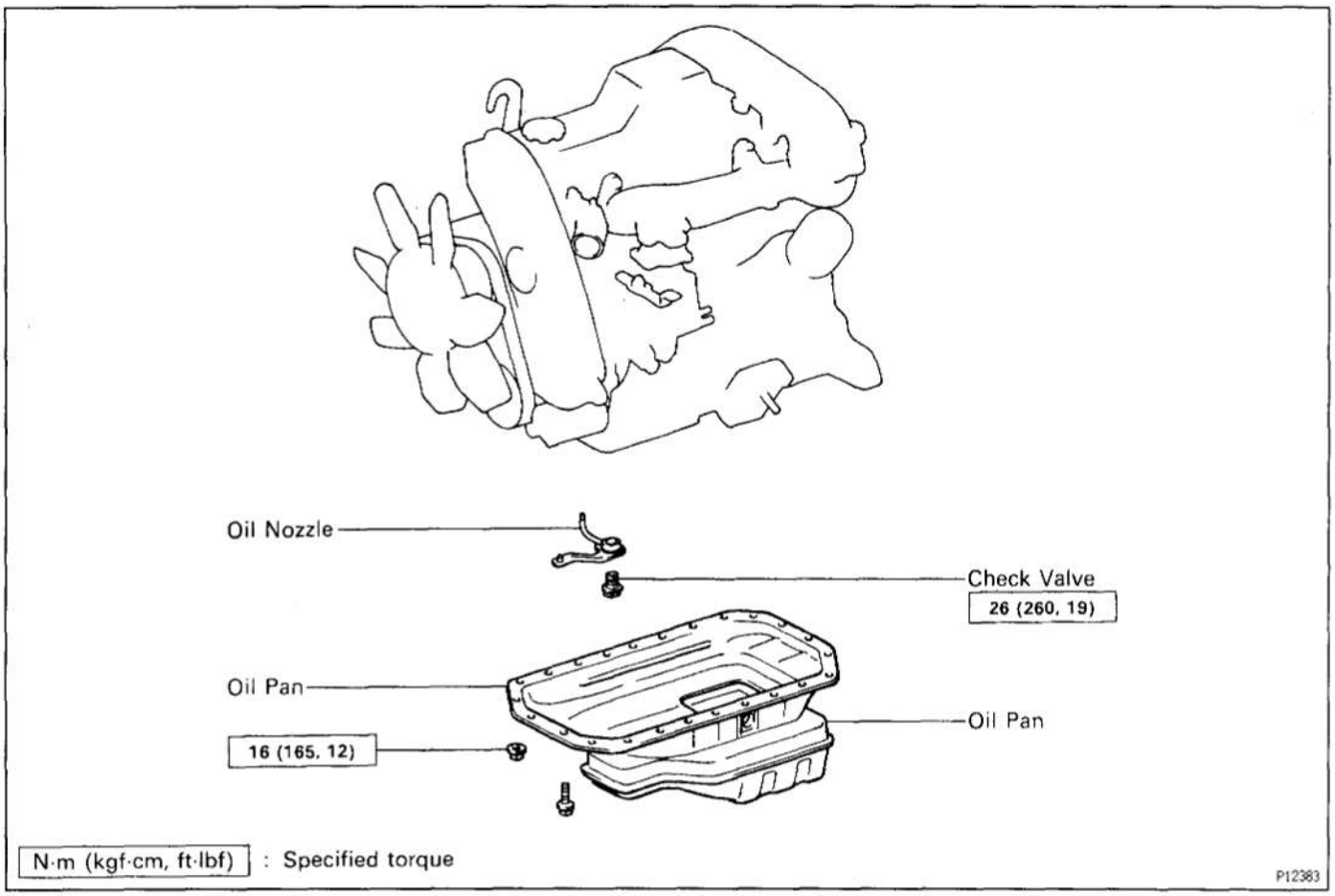
13. START ENGINE AND CHECK FOR LEAKS

14. CHECK ENGINE OIL LEVEL

OIL NOZZLE

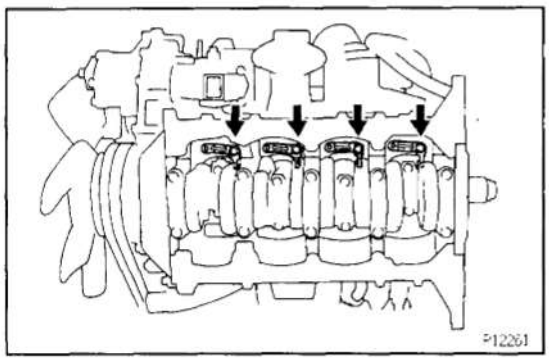
COMPONENTS FOR REMOVAL AND INSTALLATION

EG2K2-03



N·m (kgf·cm, ft·lbf) : Specified torque

P12383

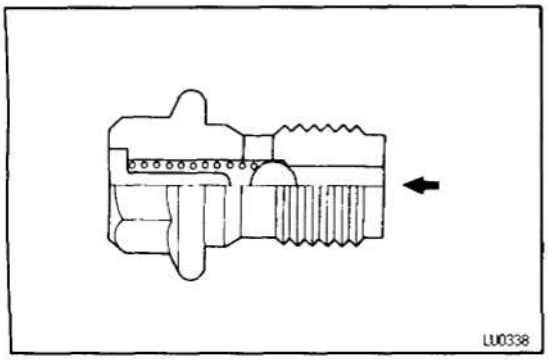


P12261

OIL NOZZLES REMOVAL

EG2K3-04

1. **DRAIN ENGINE OIL**
2. **REMOVE OIL PAN**
   (See step 9 on page EG–251)
3. **REMOVE CHECK VALVE AND OIL NOZZLES**
   Remove the 4 check valves and oil nozzles.

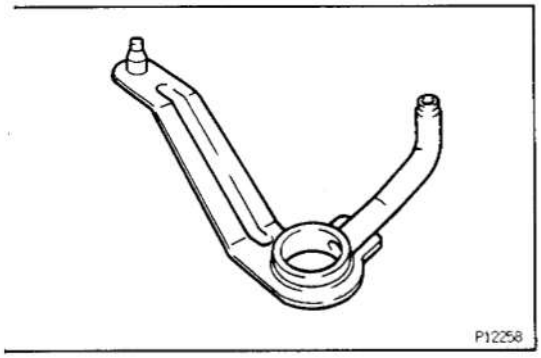


LU0338

OIL NOZZLES INSPECTION

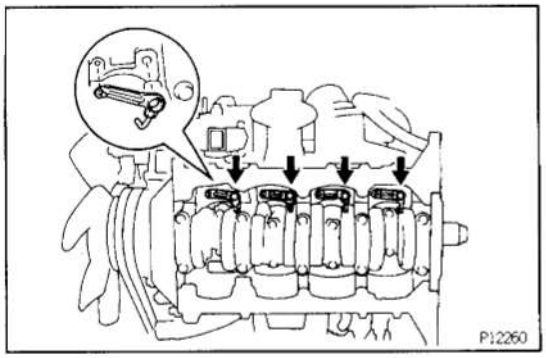
EG35G-01

1. **INSPECT CHECK VALVES**
   Push the valve with a wooden stick to check if it is stuck.
   If stuck, replace the check valve.



2. INSPECT OIL NOZZLES

Check the oil nozzles for damage or clogging. If necessary, replace the oil nozzle.



EG35H-01

OIL NOZZLES INSTALLATION

(See Components for Removal and Installation)

1. INSTALL OIL NOZZLES AND CHECK VALVES

(a) Align the pin of the oil nozzle with the pin hole of the cylinder block.

(a) Install the oil nozzle with the check valve. Install the 4 oil nozzles and check valves.

Torque: 26 N·m (260 kgf·cm, 19 ft·lbf)

2. INSTALL OIL PAN

(See step 4 on page EG−257)

3. FILL WITH ENGINE OIL

4. START ENGINE AND CHECK FOR LEEAKS

SERVICE SPECIFICATIONS

SERVICE DATA

EG15A–07

Oil presuure	At idle speed (normal operating temperature)	29 kPa (0.3 kgf/cm², 43 psi) or more
	At 3,000 rpm (normal operating temperature)	250 – 600 kPa (2.5 – 6.1 kgf/cm², 18 – 42 psi)
Oil pump	Body clearance (STD)	0.100 – 0.170 mm (0.0039 – 0.0067 in.)
	Body clearance Maximum)	0.20 mm (0.0079 in.)
	Tip clearance (STD)	0.060 – 0.160 mm (0.0024 – 0.0063 in.)
	Tip clearance (Maximum)	0.21 mm (0.0083 in.)
	Side clearance (STD)	0.030 – 0.090 mm (0.0012 – 0.0035 in.)
	Side clearance (Maximum)	0.15 mm (0.0059 in.)

TORQUE SPECIFICATIONS

EG15C–08

Part tightened		N·m	kgf·cm	ft·lbf
Oil pan x Drain plug		34	350	25
Relief valve x Oil pump		42	425	31
Oil pump x Cylinder block	Bolt	13	130	9
	Union bolt	16	160	12
Injection pump x Oil pump		21	210	15
Oil strainer x Cylinder block		8	80	69 in.·lbf
Oil pan x Cylinder block		16	165	12
Alternator adjusting bar x Oil pump		21	210	15
Oil cooler cover x Drain plug		8	80	69 in.·lbf
Oil cooler cover x Oil cooler		16	160	12
Oil cooler cover x Cylinder block		13	130	9
Dipstick guide x Intake manifold		29	300	22
Oil nozzle x Cylinder block		26	260	19