

ENGINE SECTION 2

This service manual has been prepared to provide SUBARU service personnel with the necessary information and data for the correct maintenance and repair of SUBARU vehicles.

This manual includes the procedures for maintenance, disassembling, reassembling, inspection and adjustment of components and diagnostics for guidance of experienced mechanics.

Please peruse and utilize this manual fully to ensure complete repair work for satisfying our customers by keeping their vehicle in optimum condition. When replacement of parts during repair work is needed, be sure to use SUBARU genuine parts.

All information, illustration and specifications contained in this manual are based on the latest product information available at the time of publication approval.

FUEL INJECTION (FUEL SYSTEMS) FU(H4DOTC)

**EMISSION CONTROL
(AUX. EMISSION CONTROL DEVICES) EC(H4DOTC)**

INTAKE (INDUCTION) IN(H4DOTC)

MECHANICAL ME(H4DOTC)

EXHAUST EX(H4DOTC)

COOLING CO(H4DOTC)

LUBRICATION LU(H4DOTC)

SPEED CONTROL SYSTEMS SP(H4DOTC)

IGNITION IG(H4DOTC)

STARTING/CHARGING SYSTEMS SC(H4DOTC)

ENGINE (DIAGNOSTICS) EN(H4DOTC)(diag)

LUBRICATION

LU(H4DOTC)

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General Description

LUBRICATION

1. General Description

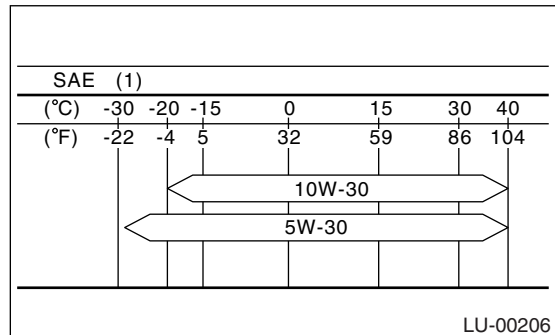
A: SPECIFICATION

| Lubrication method | | | Forced lubrication | |
|--|--|--|---|-------------------------|
| Oil pump | Pump type | | Trochoid type | |
| | Number of teeth | Inner rotor | 9 | |
| | | Outer rotor | 10 | |
| | Outer rotor diameter × thickness | | mm (in) 78 × 12 (3.07 × 0.47) | |
| | Tip clearance between inner and outer rotors | | mm (in) 0.04 — 0.14 (0.0016 — 0.0055) | |
| | Side clearance between inner rotor and pump case | | mm (in) 0.02 — 0.07 (0.0008 — 0.0028) | |
| | Case clearance between outer rotor and pump case | | Standard value mm (in) 0.10 — 0.175 (0.0039 — 0.0069) | |
| | Performance at 80°C (176°F) | 600 rpm | Discharge pressure kPa (kg/cm ² , psi) | 98 (1.0, 14) |
| | | | Discharge \varnothing (US qt, Imp qt)/min. | 6.5 (6.9, 5.7) or more |
| | | 6,000 rpm | Discharge pressure kPa (kg/cm ² , psi) | 588 (6.0, 85) |
| Discharge \varnothing (US qt, Imp qt)/min. | | | 59.0 (62.3, 51.9) or more | |
| Relief valve working pressure | | kPa (kg/cm ² , psi) 588 (6.0, 85) | | |
| Oil filter | Filter type | | Full-flow filter type | |
| | Filtration area | cm ² (sq in) | Outer diameter 68 mm (2.68 in) | 800 (124) |
| | | | Outer diameter 65 mm (2.56 in) | 470 (72.9) |
| | By-pass valve opening pressure | | kPa (kg/cm ² , psi) 160 (1.63, 23.2) | |
| | Outer diameter × width | mm (in) | Outer diameter 68 mm (2.68 in) | 68 × 65 (2.68 × 2.56) |
| | | | Outer diameter 65 mm (2.56 in) | 65 × 74.4 (2.56 × 2.93) |
| Installation screw specifications | | M 20 × 1.5 | | |
| Oil pressure switch | Type | | Immersed contact point type | |
| | Working voltage — wattage | | 12 V — 3.4 W or less | |
| | Warning light activation pressure | | kPa (kg/cm ² , psi) 14.7 (0.15, 2.1) | |
| | Proof pressure | | kPa (kg/cm ² , psi) 981 (10, 142) or more | |
| Oil capacity (at replacement) | | \varnothing (US qt, Imp qt) 4.0 (4.2, 3.5) | | |

Recommended oil

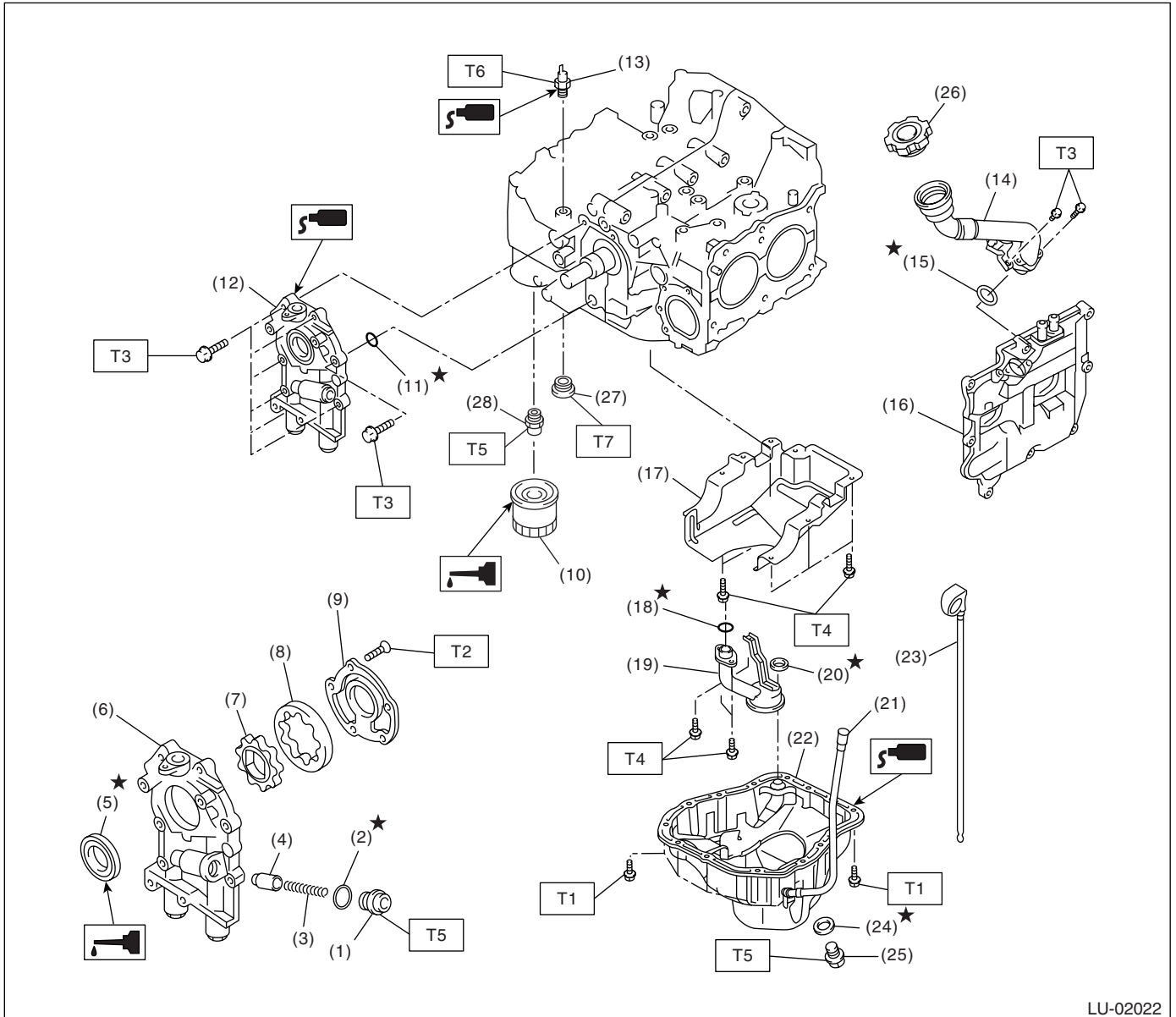
API classification

SL or SJ or SH with the words “Energy Conserving or Energy conserving II”, CCMC specification G4 or G5, ACEA specification A1, A2 or A3, or New API mark displayed on the container (If it is impossible to get SL or SJ or SH grade, you may use SG grade.)



(1) SAE viscosity No. and applicable temperature

B: COMPONENT



LU-02022

- | | |
|--------------------------|----------------------------|
| (1) Plug | (14) Oil filler duct |
| (2) Gasket | (15) O-ring |
| (3) Relief valve spring | (16) Rocker cover |
| (4) Relief valve | (17) Baffle plate |
| (5) Oil seal | (18) O-ring |
| (6) Oil pump case | (19) Oil strainer |
| (7) Inner rotor | (20) Gasket |
| (8) Outer rotor | (21) Oil level gauge guide |
| (9) Oil pump cover | (22) Oil pan |
| (10) Oil filter | (23) Oil level gauge |
| (11) O-ring | (24) Metal gasket |
| (12) Oil pump ASSY | (25) Drain plug |
| (13) Oil pressure switch | (26) Oil filler cap |

- | |
|----------------|
| (27) Plug |
| (28) Connector |

Tightening torque: N·m (kgf·m, ft·lb)

- | |
|----------------------------|
| T1: 5 (0.5, 3.6) |
| T2: 5.4 (0.55, 4.0) |
| T3: 6.4 (0.65, 4.7) |
| T4: 10 (1.0, 7.0) |
| T5: 44 (4.5, 32.5) |
| T6: 25 (2.5, 18.1) |
| T7: 70 (7.1, 51.6) |

General Description

LUBRICATION

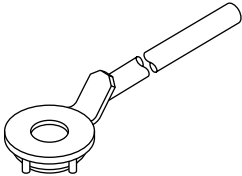
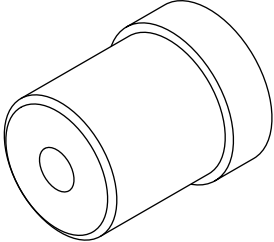
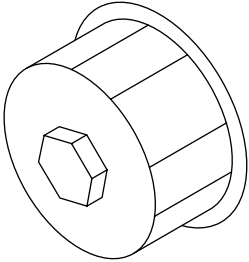
C: CAUTION

- Wear work clothing, including a cap, protective goggles and protective shoes during operation.
- Remove contamination including dirt and corrosion before removal, installation or disassembly.
- Keep the disassembled parts in order and protect them from dust and dirt.
- Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly and replacement.

- Be careful not to burn yourself, because each part on the vehicle is hot after running.
- Be sure to tighten fasteners including bolts and nuts to the specified torque.
- Place shop jacks or rigid racks at the specified points.
- Before disconnecting electrical connectors of sensors or units, be sure to disconnect the ground cable from battery.

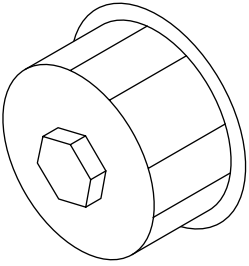
D: PREPARATION TOOL

1. SPECIAL TOOL

| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|-------------|---------------------|--|
|  <p style="text-align: center;">ST-499977400</p> | 499977400 | CRANK PULLEY WRENCH | Used for stopping rotation of crank pulley when removing and tightening crank pulley bolt. |
|  <p style="text-align: center;">ST-499587100</p> | 499587100 | OIL SEAL INSTALLER | Used for installing oil seal into oil pump. |
|  <p style="text-align: center;">ST18332AA000</p> | 18332AA000 | OIL FILTER WRENCH | Used for removing and installing oil filter. (Outer diameter: 68 mm (2.68 in)) |

General Description

LUBRICATION

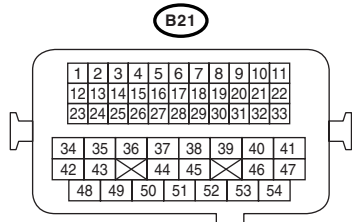
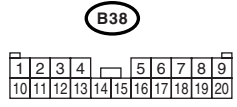
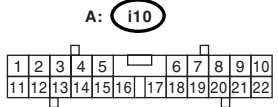
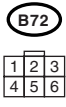
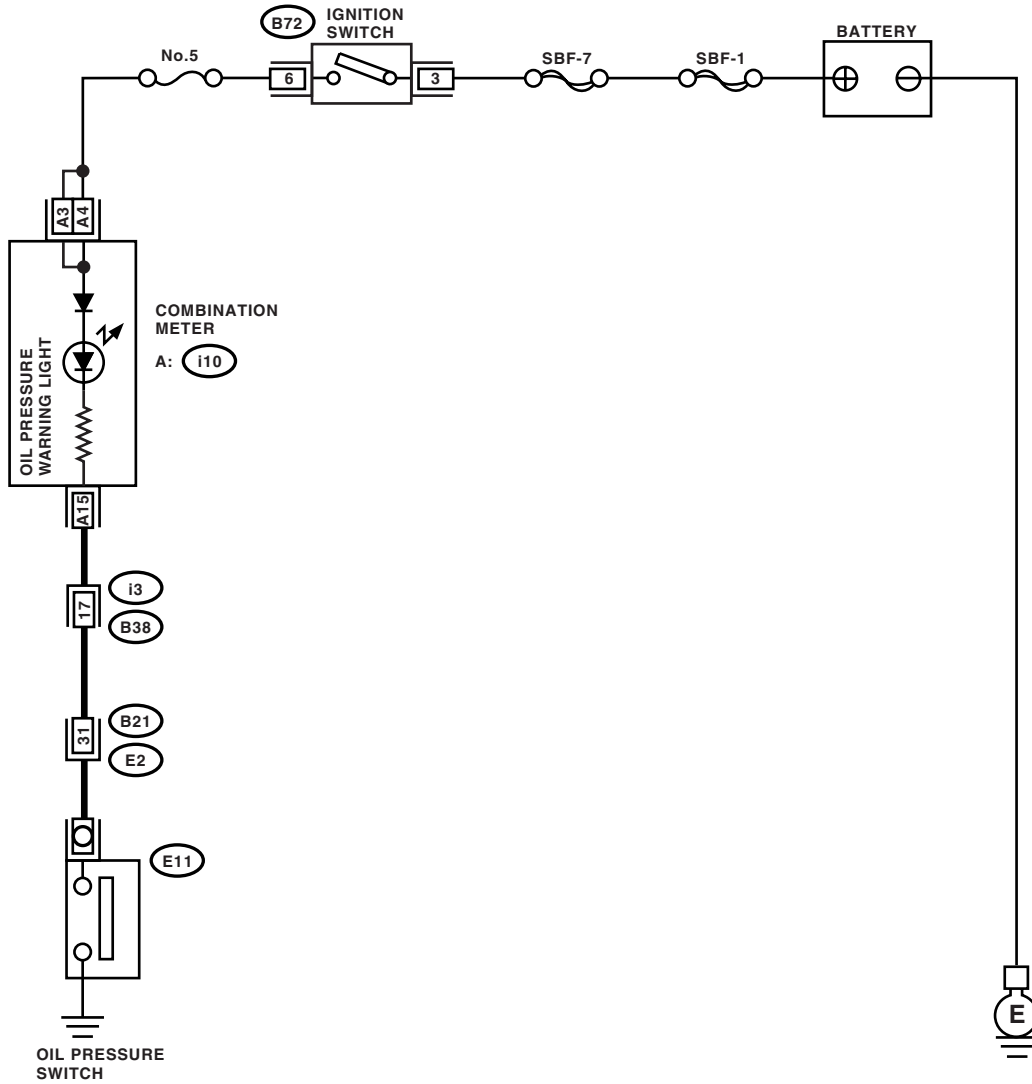
| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|-------------|----------------------|--|
|  <p>ST18332AA010</p> | 18332AA010 | OIL FILTER WRENCH | Used for removing and installing oil filter. (Outer diameter: 65 mm (2.56 in)) |

Oil Pressure System

LUBRICATION

2. Oil Pressure System

A: WIRING DIAGRAM



LU-00241

B: INSPECTION

| Step | Check | Yes | No |
|---|---|--|---|
| 1 CHECK COMBINATION METER. 1) Turn the ignition switch to ON (engine OFF). 2) Check the warning light of combination meter. | Does the warning light illuminate? | Go to step 2. | Repair or replace the combination meter. <Ref. to IDI-3, INSPECTION, Combination Meter System.> |
| 2 CHECK HARNESS CONNECTOR BETWEEN COMBINATION METER AND OIL PRESSURE SWITCH. 1) Turn the ignition switch to OFF. 2) Disconnect the connector from oil pressure switch. 3) Turn the ignition switch to ON. 4) Measure the voltage of harness between combination meter connector and chassis ground. <i>Connector & terminal (E11) No. 1 (+) — Chassis ground (-):</i> | Is the voltage more than 10 V? | Replace the oil pressure switch. | Go to step 3. |
| 3 CHECK COMBINATION METER. 1) Turn the ignition switch to OFF. 2) Remove the combination meter. 3) Measure the resistance of combination meter. <i>Terminals No. 4 — No. 15: No. 3 — No. 15:</i> | Is the resistance less than 10 Ω ? | Replace the harness connector between combination meter and oil pressure switch. | Repair or replace the combination meter. <Ref. to IDI-3, INSPECTION, Combination Meter System.> |

Engine Oil

LUBRICATION

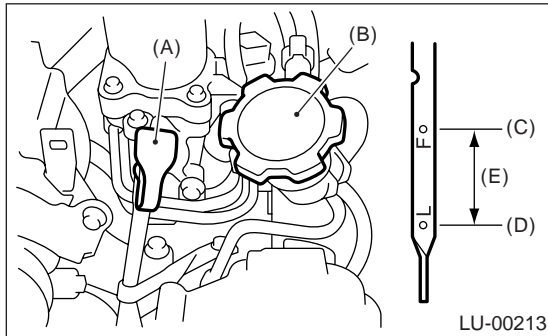
3. Engine Oil

A: INSPECTION

- 1) Park the vehicle on a level surface.
- 2) Remove the oil level gauge and wipe it clean.
- 3) Reinsert the level gauge all the way. Be sure that the level gauge is correctly inserted and properly orientated.
- 4) Remove it again and check the engine oil level. If the engine oil level is below "L" line, add oil to bring the level up to "F" line.
- 5) After turning off the engine, wait a few minutes for the oil to return to the oil pan before checking the level.
- 6) Just after driving or while the engine is warm, engine oil level show in the range between "F" line and notch mark. This is caused by thermal expansion of the engine oil.

NOTE:

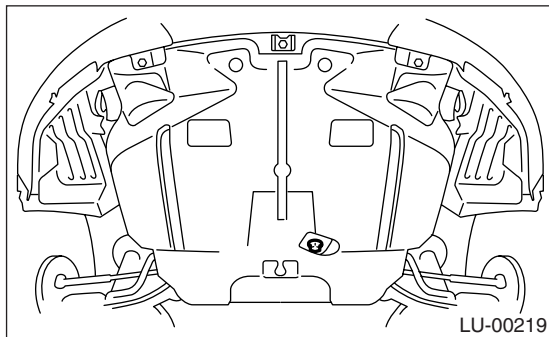
To prevent overfilling the engine oil, do not add oil above "F" line when the engine is cold.



- (A) Oil level gauge
- (B) Engine oil filler cap
- (C) Upper level
- (D) Lower level
- (E) Approx. 1.0 ℓ (1.1 US qt, 0.9 Imp qt)

B: REPLACEMENT

- 1) Open the engine oil filler cap for quick draining of engine oil.
- 2) Lift-up the vehicle.
- 3) Drain engine oil by loosening the engine oil drain plug.



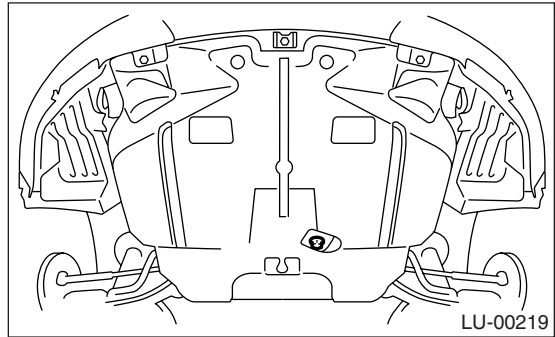
- 4) Tighten the engine oil drain plug after draining engine oil.

NOTE:

Use a new metal gasket.

Tightening torque:

44 N·m (4.5 kgf·m, 32.5 ft·lb)



- 5) Use the engine oil of proper quality and viscosity, fill engine oil through the oil filler duct to upper point on level gauge. Make sure that the vehicle is parked on a level surface when checking oil level.

Recommended oil:

<Ref. to LU(H4DOTC)-2, SPECIFICATION, General Description.>

Engine oil capacity:

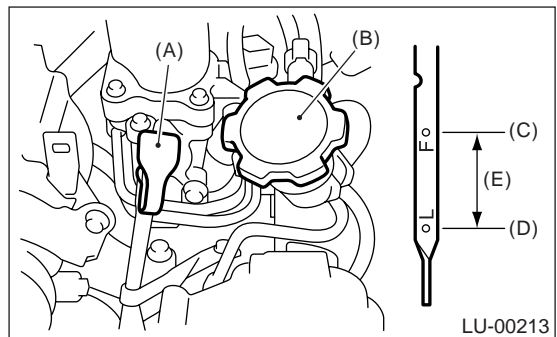
Upper level

4.0 ℓ (4.2 US qt, 3.5 Imp qt)

Lower level

3.0 ℓ (3.2 US qt, 2.6 Imp qt)

- 6) Close the engine oil filler cap.
- 7) Start the engine and warm it up for a time.
- 8) After the engine stops, recheck the oil level. If necessary, add engine oil up to the upper level on level gauge.

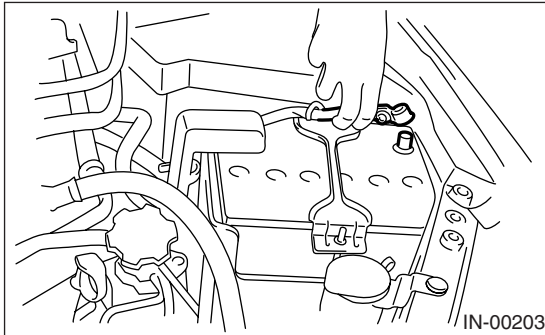


- (A) Oil level gauge
- (B) Engine oil filler cap
- (C) Upper level
- (D) Lower level
- (E) Approx. 1.0 ℓ (1.1 US qt, 0.9 Imp qt)

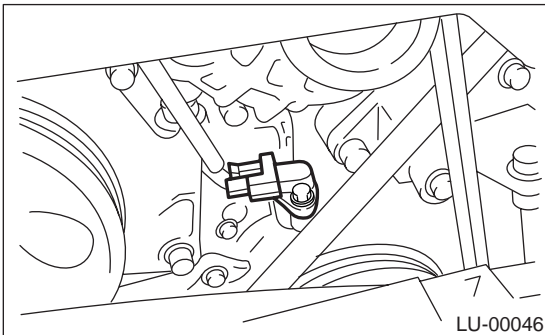
4. Oil Pump

A: REMOVAL

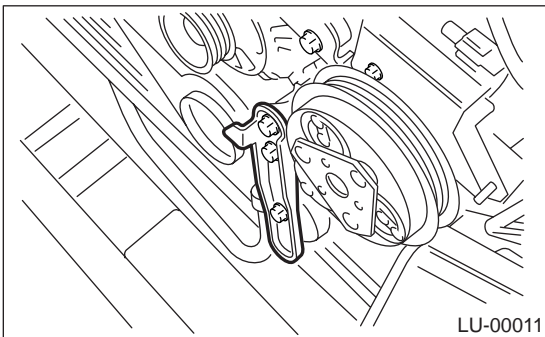
- 1) Remove the collector cover.
- 2) Disconnect the ground cable from battery.



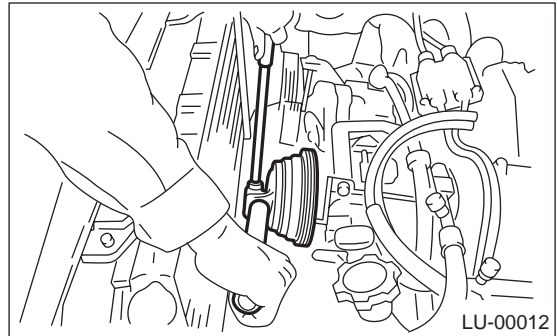
- 3) Lift-up the vehicle.
- 4) Remove the under cover.
- 5) Remove the radiator. <Ref. to CO(H4DOTC)-19, REMOVAL, Radiator.>
- 6) Remove the crankshaft position sensor.



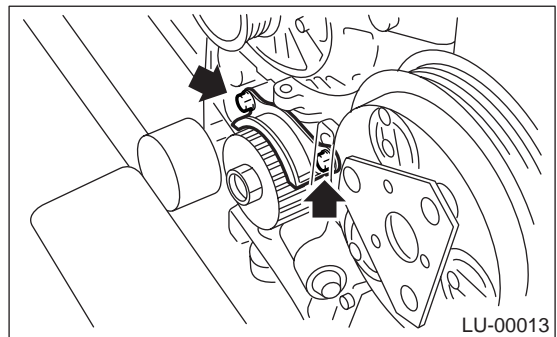
- 7) Remove the V-belts. <Ref. to ME(H4DOTC)-39, REMOVAL, V-belt.>
- 8) Remove the rear side V-belt tensioner.



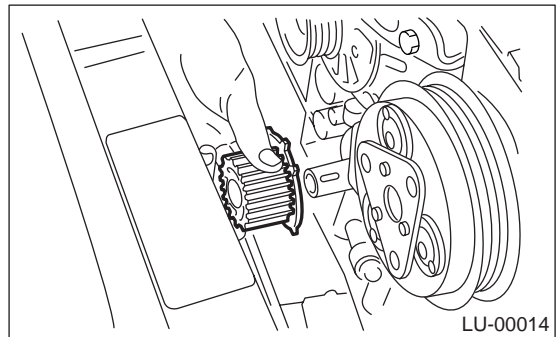
- 9) Remove the crank pulley by using ST. <Ref. to ME(H4DOTC)-41, REMOVAL, Crank Pulley.>



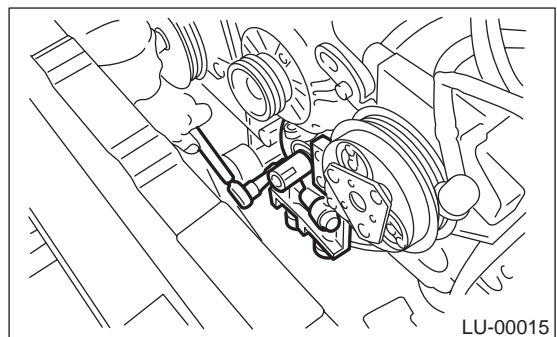
- 10) Remove the water pump. <Ref. to CO(H4DOTC)-15, REMOVAL, Water Pump.>
- 11) Remove the timing belt guide.



- 12) Remove the crank sprocket.



- 13) Remove the bolts which hold oil pump onto cylinder block.



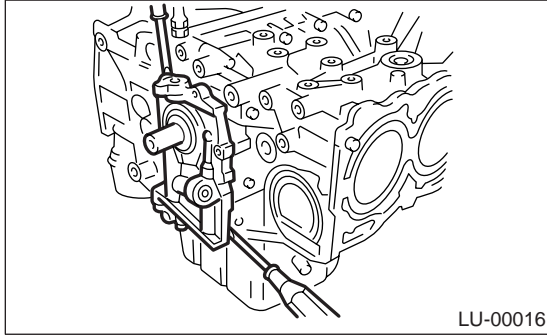
- 14) Remove the oil pump by using flat bladed screwdriver.

Oil Pump

LUBRICATION

CAUTION:

Be careful not to scratch mating surfaces of cylinder block and oil pump.



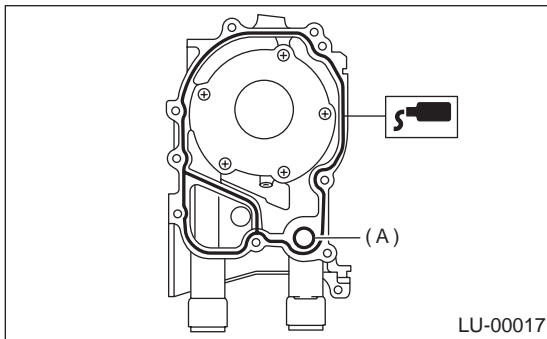
B: INSTALLATION

Install in the reverse order of removal.
Perform the following.

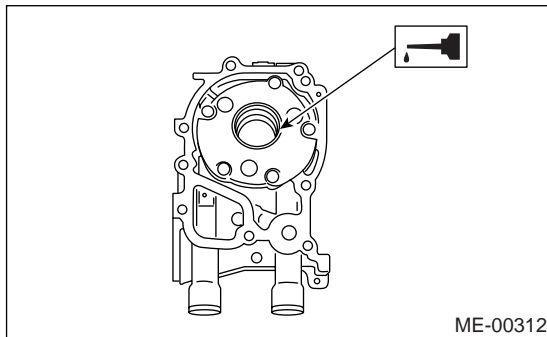
1) Apply liquid gasket to the matching surfaces of oil pump.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent



2) Replace the O-ring (A) with a new one.
3) Apply a coat of engine oil to the inside of oil seal.



4) Position the oil pump, aligning the notched area with crankshaft, and push the oil pump straight.

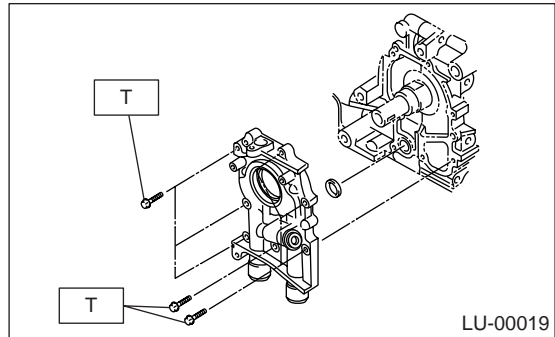
CAUTION:

- Make sure the oil seal lip is not folded.
- Be careful not to scratch oil seal when installing oil pump on cylinder block.

5) Install the oil pump.

Tightening torque:

6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

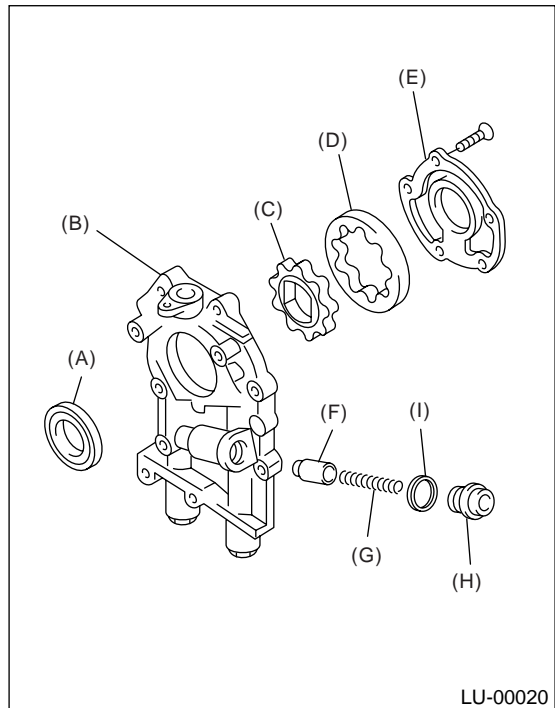


C: DISASSEMBLY

Remove the screws which secure oil pump cover and then disassemble oil pump. Inscribe alignment marks on the inner and outer rotors so that they can be replaced in their original positions during reassembly.

CAUTION:

Before disassembling the oil pump, remove the relief valve.

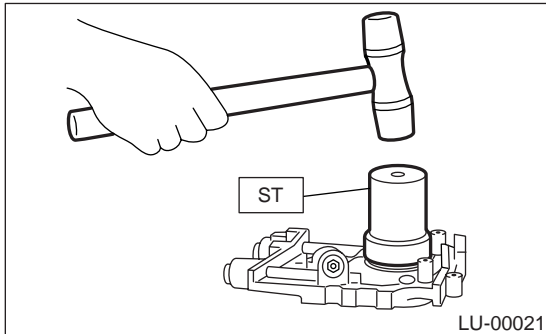


- (A) Oil seal
- (B) Pump case
- (C) Inner rotor
- (D) Outer rotor
- (E) Pump cover
- (F) Relief valve
- (G) Relief valve spring
- (H) Plug
- (I) Gasket

D: ASSEMBLY

1) Install the front oil seal by using ST.
ST 499587100 OIL SEAL INSTALLER

NOTE:
Use a new oil seal.



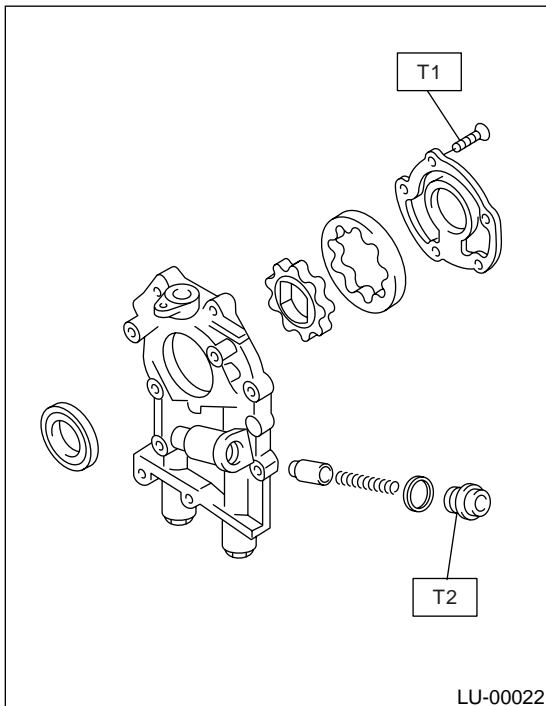
- 2) Apply a coat of engine oil to the inner and outer rotors.
- 3) Install the inner and outer rotors in their original positions.
- 4) Install the oil relief valve and relief valve spring and plug.

NOTE:
Use a new gasket.

5) Install the oil pump cover.

Tightening torque:

T1: 5.4 N·m (0.55 kgf-m, 4.0 ft-lb)
T2: 44 N·m (4.5 kgf-m, 32.5 ft-lb)



E: INSPECTION

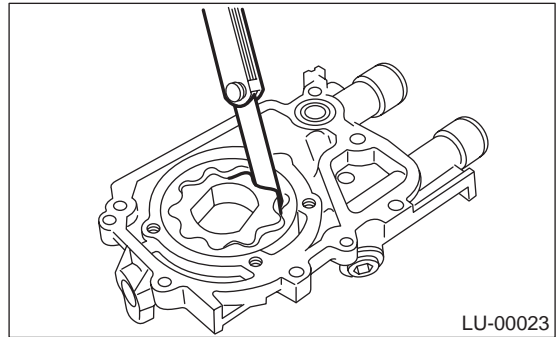
1. TIP CLEARANCE

Measure the tip clearance of rotors. If the clearance exceeds the standard value, replace the rotors as a matched set.

Tip clearance:

Standard value

0.04 — 0.14 mm (0.0016 — 0.0055 in)



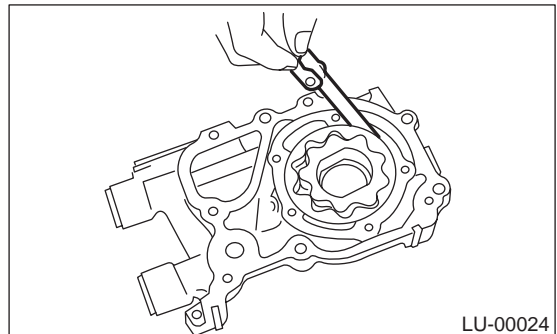
2. CASE CLEARANCE

Measure the clearance between outer rotor and oil pump rotor housing. If the clearance exceeds the standard value, replace the oil pump case.

Case clearance:

Standard value

0.10 — 0.175 mm (0.0039 — 0.0069 in)



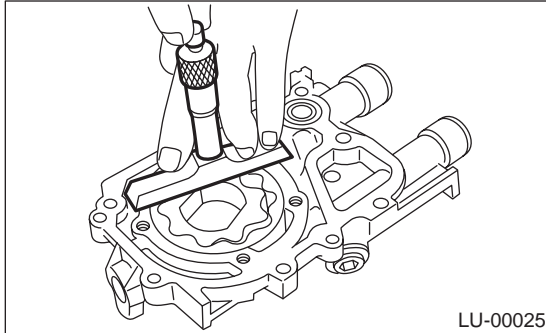
3. SIDE CLEARANCE

Measure the clearance between oil pump inner rotor and pump cover. If the clearance exceeds the standard value, replace the rotor or pump body.

Side clearance:

Standard value

0.02 — 0.07 mm (0.0008 — 0.0028 in)



4. OIL RELIEF VALVE

Check the valve for fitting condition and damage, and the relief valve spring for damage and deterioration. Replace the parts if defective.

Relief valve spring:

Free length

73.7 mm (2.902 in)

Installed length

54.7 mm (2.154 in)

Load when installed

93.1 N (9.49 kgf, 20.88 lb)

5. OIL PUMP CASE

Check the oil pump case for worn shaft hole, clogged oil passage, worn rotor chamber, cracks and other faults.

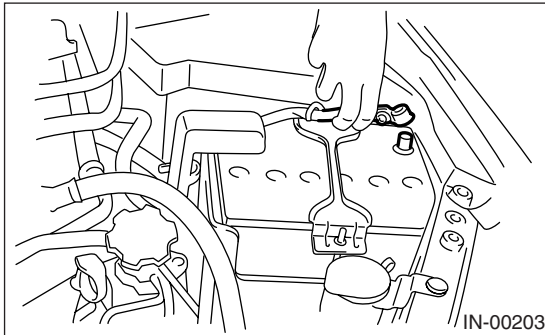
6. OIL SEAL

Check the oil seal lips for deformation, hardening, wear, etc. and replace if defective.

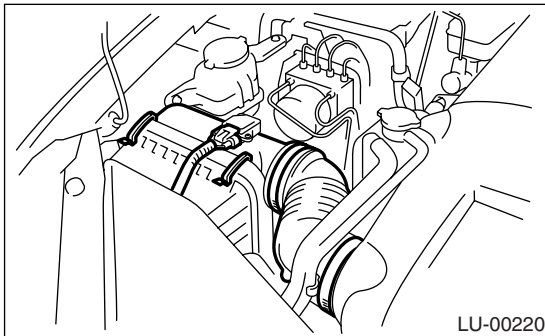
5. Oil Pan and Strainer

A: REMOVAL

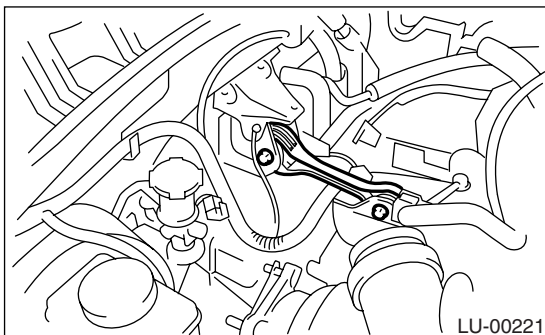
- 1) Set the vehicle on a lift.
- 2) Remove the front wheels.
- 3) Remove the collector cover.
- 4) Disconnect the ground cable from battery.



- 5) Disconnect the connector from mass airflow sensor.
- 6) Remove the air intake boot and air cleaner upper cover.

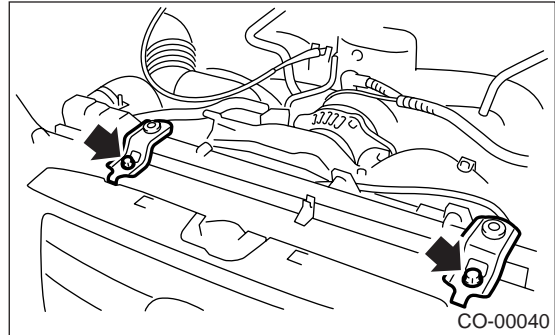


- 7) Remove the intercooler.
<Ref. to IN(H4DOTC)-12, REMOVAL, Intercooler.>
- 8) Remove the pitching stopper.

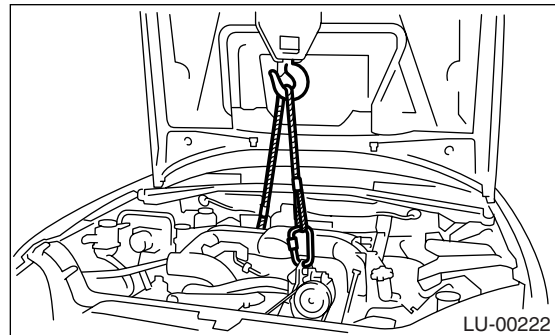


- 9) Remove the linear motion mounting.
<Ref. to ME(H4DOTC)-37, REMOVAL, Linear Motion Mounting.>

- 10) Remove the radiator upper brackets.



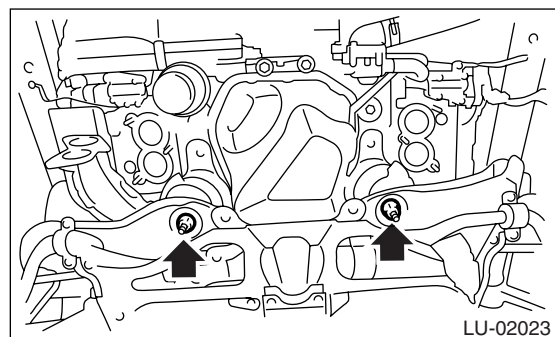
- 11) Support the engine with a lifting device and wire ropes.



- 12) Lift-up the vehicle.

CAUTION:
When lifting up the vehicle, raise up wire ropes at the same time.

- 13) Remove the under cover.
- 14) Drain engine oil.
- 15) Remove the front exhaust pipe.
<Ref. to EX(H4DOTC)-5, REMOVAL, Front Exhaust Pipe.>
- 16) Remove the nuts which install front cushion rubber onto front crossmember.



- 17) Remove the bolts which install oil pan on cylinder block with the engine raised up.
- 18) Insert the oil pan cutter blade into the clearance between cylinder block and oil pan.

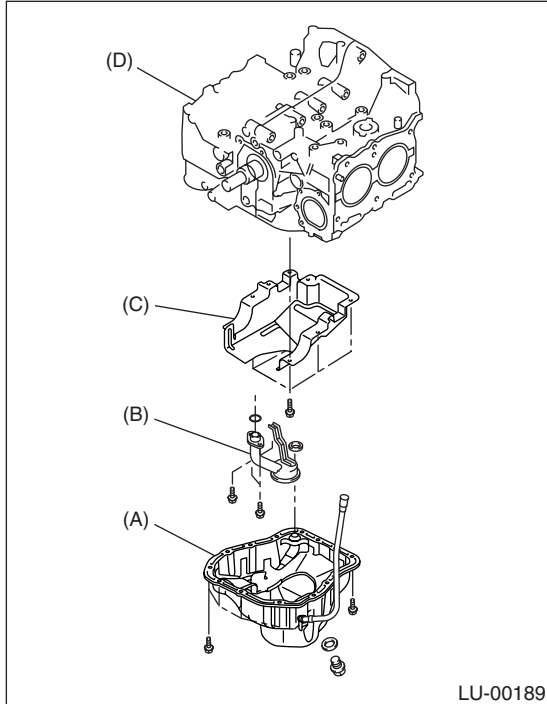
CAUTION:
Do not use a screwdriver or similar tool in place of oil pan cutter.

- 19) Remove the oil strainer.

Oil Pan and Strainer

LUBRICATION

20) Remove the baffle plate.



- (A) Oil pan
- (B) Oil strainer
- (C) Baffle plate
- (D) Cylinder block

B: INSTALLATION

CAUTION:

Before installing the oil pan, wipe clean the oil pan and the mating face of engine block.

1) Install the baffle plate.

Tightening torque:

6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

2) Install the oil strainer onto baffle plate.

NOTE:

Replace O-ring with new one.

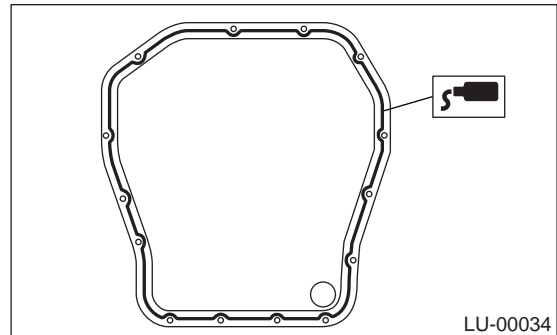
Tightening torque:

10 N·m (1.0 kgf-m, 7.2 ft-lb)

3) Apply liquid gasket to the mating surfaces and install the oil pan.

Liquid gasket:

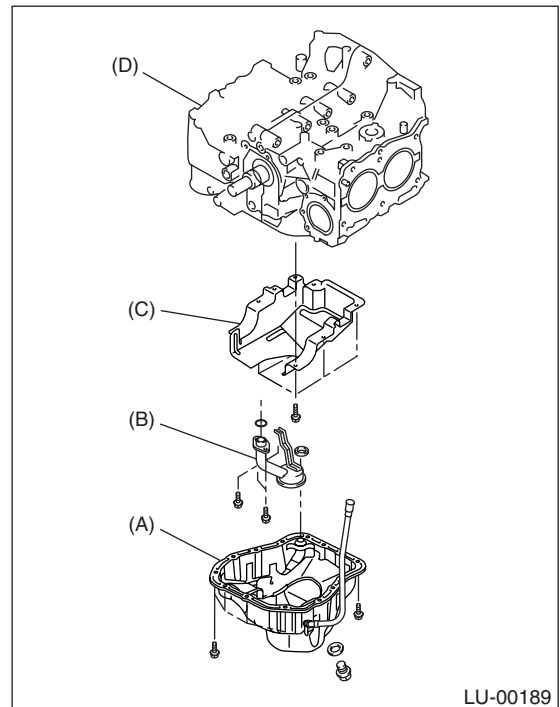
THREE BOND 1207C (Part No. 004403012) or equivalent



4) Tighten the bolts which install oil pan onto engine block.

Tightening torque:

5 N·m (0.5 kgf-m, 3.6 ft-lb)



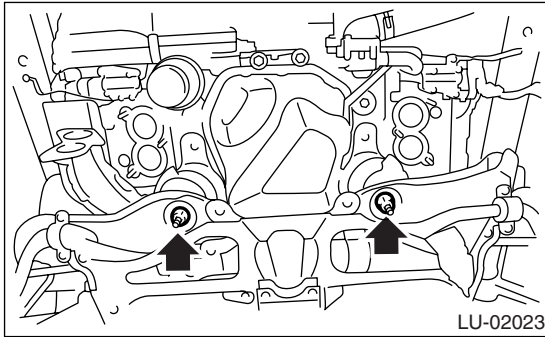
- (A) Oil pan
- (B) Oil strainer
- (C) Baffle plate
- (D) Cylinder block

5) Lower the engine onto front crossmember.

6) Tighten the nuts which hold front cushion rubber onto front crossmember.

Tightening torque:

83 N·m (8.5 kgf·m, 61 ft·lb)

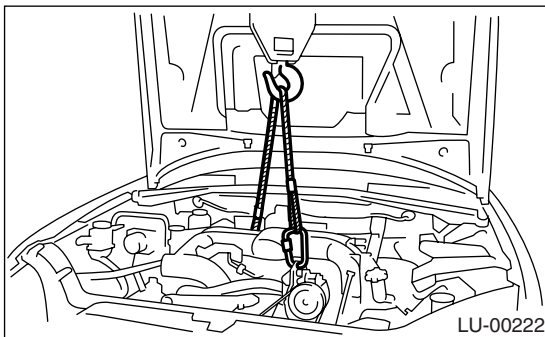


- 7) Install the front exhaust pipe.
<Ref. to EX(H4DOTC)-5, INSTALLATION, Front Exhaust Pipe.> <Ref. to EX(H4SO 2.0)-8, INSTALLATION, Front Exhaust Pipe.>
- 8) Install the under cover.
- 9) Lower the vehicle.

CAUTION:

When lowering the vehicle, lower the lift-up device and wire ropes at the same time.

- 10) Remove the lifting device and wire ropes.

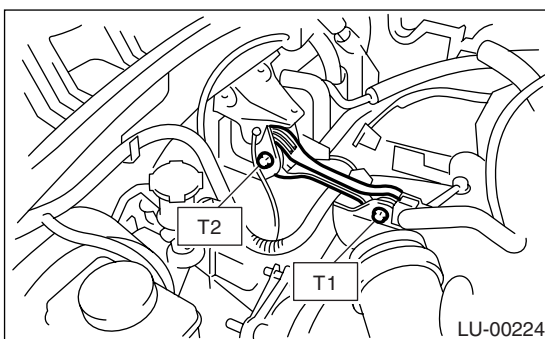


- 11) Install the pitching stopper.

Tightening torque:

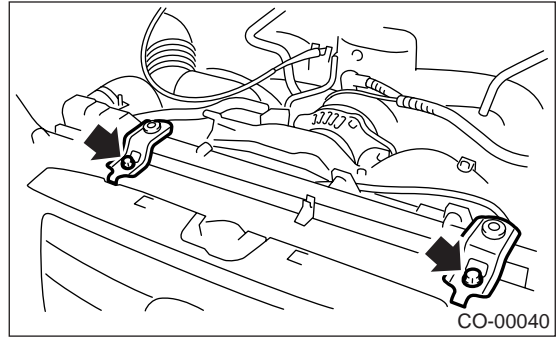
T1: 50 N·m (5.1 kgf·m, 36.9 ft·lb)

T2: 58 N·m (5.9 kgf·m, 42.8 ft·lb)

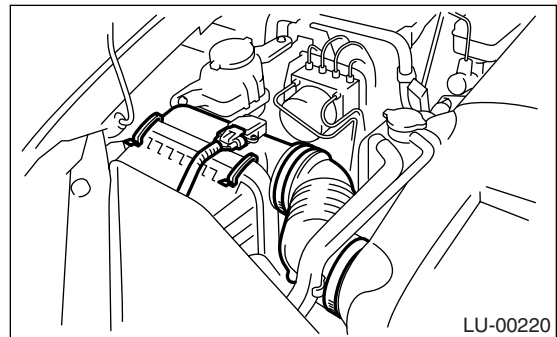


- 12) Install the linear motion mounting.
<Ref. to ME(H4DOTC)-37, INSTALLATION, Linear Motion Mounting.>

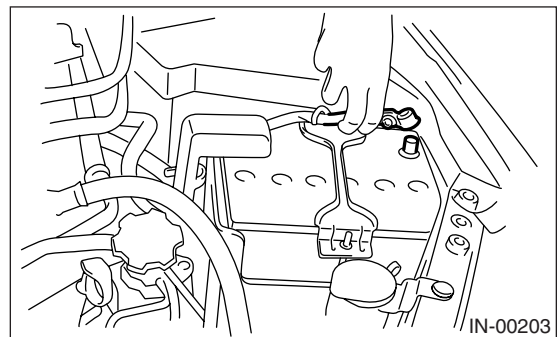
- 13) Install the radiator upper brackets.



- 14) Install the intercooler. <Ref. to IN(H4DOTC)-12, INSTALLATION, Intercooler.>
- 15) Install the air intake boot and air cleaner upper cover.
- 16) Connect the connector to mass air flow sensor.



- 17) Install the front wheels.
- 18) Install the collector cover.
- 19) Connect the battery ground cable to battery.



- 20) Fill engine oil. <Ref. to LU(H4DOTC)-8, INSPECTION, Engine Oil.>

C: INSPECTION

Visually check that the oil pan, oil strainer, oil strainer stay and baffle plate are not damaged.

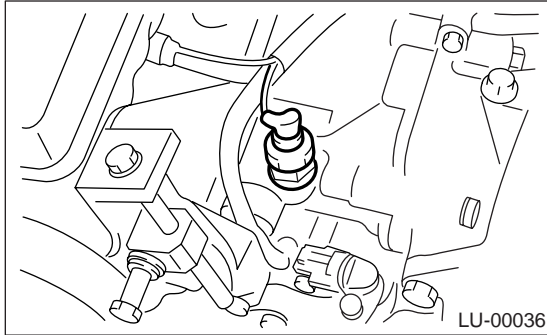
Oil Pressure Switch

LUBRICATION

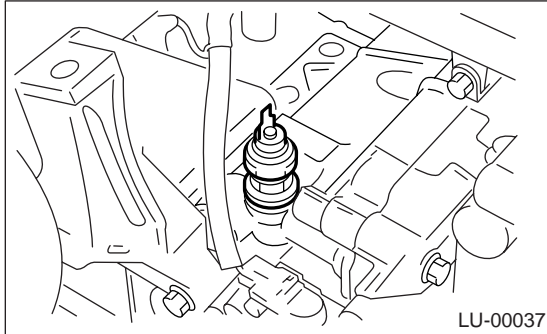
6. Oil Pressure Switch

A: REMOVAL

- 1) Remove the collector cover.
- 2) Remove the generator from bracket.
<Ref. to SC(H4SO 2.0)-14, REMOVAL, Generator.>
- 3) Disconnect the terminal from oil pressure switch.



- 4) Remove the oil pressure switch.

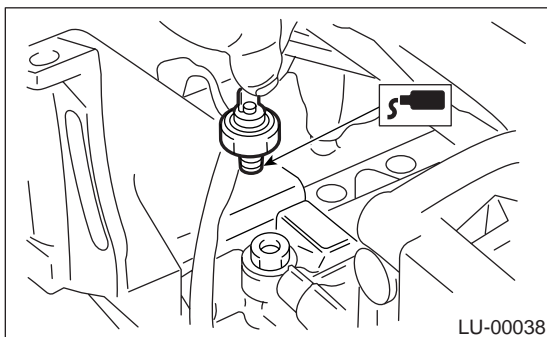


B: INSTALLATION

- 1) Apply liquid gasket to the oil pressure switch threads.

Liquid gasket:

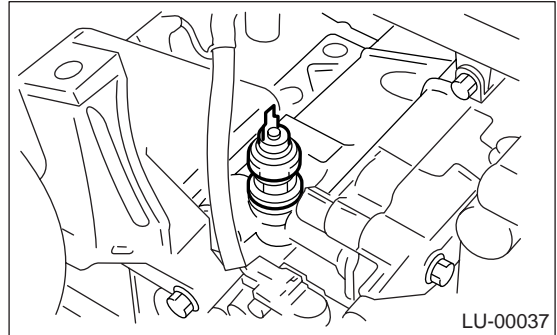
THREE BOND 1324 (Part No. 004403007) or equivalent



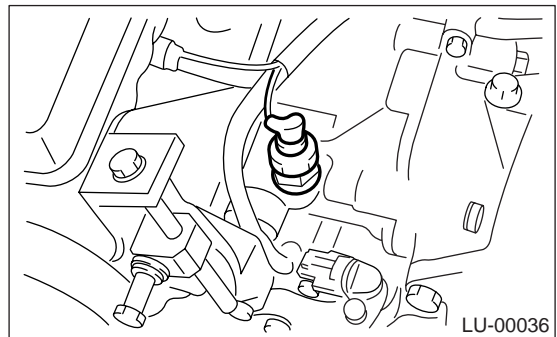
- 2) Install the oil pressure switch onto engine block.

Tightening torque:

25 N·m (2.5 kgf·m, 18.1 ft·lb)



- 3) Connect the terminal to oil pressure switch.



- 4) Install the generator to bracket.
<Ref. to SC(H4SO 2.0)-14, INSTALLATION, Generator.>

- 5) Install the collector cover.

C: INSPECTION

Make sure oil does not leak or seep from where the oil pressure switch is installed.

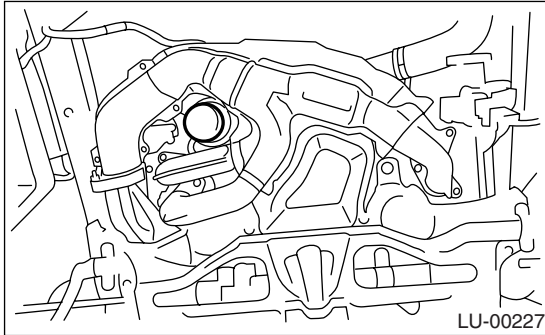
7. Engine Oil Filter

A: REMOVAL

- 1) Lift-up the vehicle.
- 2) Remove the under cover.
- 3) Remove the oil filter using STs.

ST 18332AA000 OIL FILTER WRENCH (Outer diameter: 68 mm (2.68 in))

ST 18332AA010 OIL FILTER WRENCH (Outer diameter: 65 mm (2.56 in))



B: INSTALLATION

- 1) Clean the oil filter installation surface on cylinder block or oil cooler.
- 2) Obtain a new oil filter and apply a thin coat of engine oil to seal rubber.
- 3) Install the oil filter, turning it by hand, being careful not to damage seal rubber.
- 4) Tighten more after the seal rubber contacts oil cooler.

NOTE:

- In case of oil filter in diameter 68 mm (2.68 in), tighten by approx. one turn.
- In case of oil filter in diameter 65 mm (2.56 in), tighten by approx. 2/3 to 3/4 turn.
- Over-tightening may cause oil leak.

- 5) Install the under cover.
- 6) Lower the vehicle.

C: INSPECTION

- 1) After installing the oil filter, run the engine and make sure that no oil is leaking around seal rubber.

NOTE:

The filter element and filter case are permanently jointed; therefore, interior cleaning is not necessary.

- 2) Check the engine oil level.

<Ref. to LU(H4DOTC)-8, INSPECTION, Engine Oil.>

Engine Lubrication System Trouble in General

LUBRICATION

8. Engine Lubrication System Trouble in General

A: INSPECTION

Before performing diagnosis, make sure that the engine oil level is correct and no oil leakage exists.

| Symptom | Possible cause | | Corrective action |
|--|--|---|--|
| 1. Warning light remains on. | 1) Oil pressure switch failure | Cracked diaphragm or oil leakage within switch | Replace. |
| | | Broken spring or seized contacts | Replace. |
| | 2) Low oil pressure | Clogging of oil filter | Replace. |
| | | Malfunction of oil by-pass valve in oil filter | Clean or replace. |
| | | Malfunction of oil relief valve in oil pump | Clean or replace. |
| | | Clogged oil passage | Clean. |
| | | Excessive tip clearance and side clearance of oil pump rotor and gear | Replace. |
| | | Clogged oil strainer or broken pipe | Clean or replace. |
| | 3) No oil pressure | Insufficient engine oil | Replenish. |
| | | Broken pipe of oil strainer | Replace. |
| Stuck oil pump rotor | | Replace. | |
| 2. Warning light does not come on. | 1) Malfunction of combination meter | | Replace. |
| | 2) Poor contact of switch contact points | | Replace. |
| | 3) Disconnection of wiring | | Repair. |
| 3. Warning light flickers momentarily. | 1) Poor contact at terminals | | Repair. |
| | 2) Defective wiring harness | | Repair. |
| | 3) Low oil pressure | | Check for the same possible causes as listed in 1).— 2). |