
GROUP 12 LUBRICATION

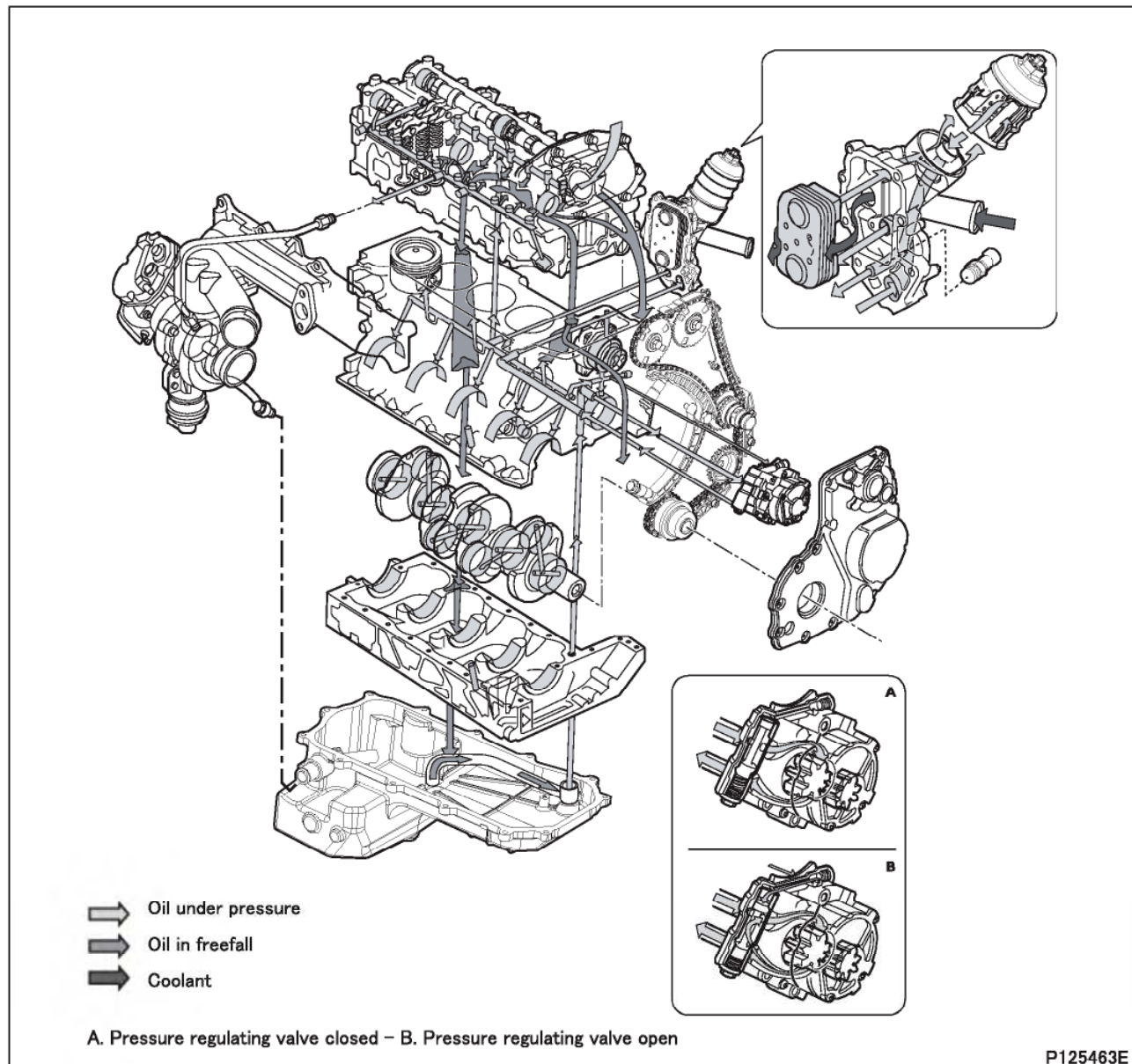
SPECIFICATIONS.....	12-2
STRUCTURE AND OPERATION	
1. Lubrication System.....	12-3
2. Oil Pump/Vacuum Unit.....	12-4
3. Oil Filter.....	12-6
4. Oil Cooler	12-6
TRUBLESHOOTING	12-7
ON-VEHICLE INSPECTION AND ADJUSTMENT	
1. Oil Filter Replacement	12-8
2. Engine Oil Replacement	12-10
3. Inspection of Engine Oil Level	12-12
4. Inspection of Engine Oil Leaks	12-12
5. Oil Pressure Measurement.....	12-13
OIL PAN, OIL STRAINER	12-14
OIL PUMP/VACUUM UNIT	12-17
OIL FILTER, OIL COOLER.....	12-18



SPECIFICATIONS

Item		Specifications
Method of lubrication		Forced lubrication by oil pump
Oil filter		Element filter paper type
Oil cooler		Shell and plate type (multiple-plate type)
Engine oil	Classification	ACEA C2
	Viscosity	SAE 0W-30, SAE 5W-30
	Quantity	dm ³ {L}
Regulator valve opening pressure	kPa {kgf/cm ² }	440 {4.5}
Bypass valve opening pressure	kPa {kgf/cm ² }	250 ± 40 {2.5 ± 0.4}

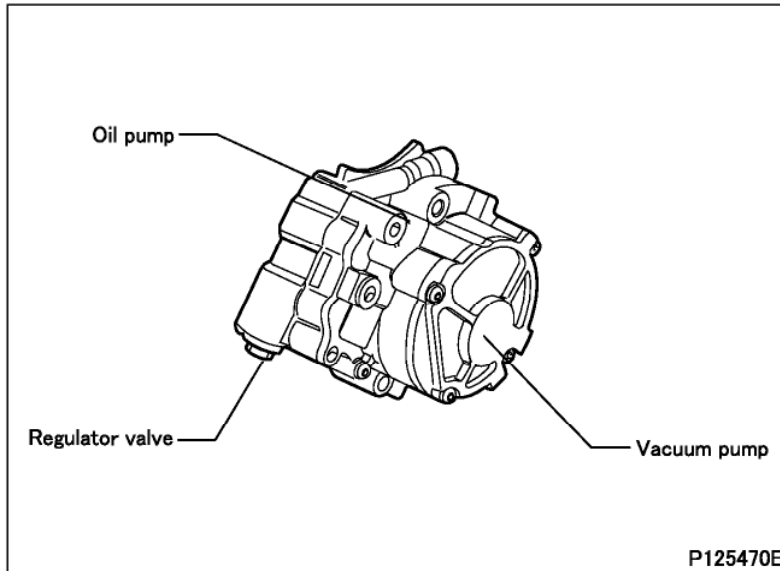
1. Lubrication System



- The engine is lubricated by forced circulation performed by the following parts.
 - A gear oil pump with built-in vacuum pump.
 - A pressure regulator valve integrated in the oil pump.
 - An oil cooler made up of five elements.
 - Engine oil is drawn up from the sump by the oil pump via the oil strainer and delivered under pressure to the oil cooler where it is cooled.
 - The oil continues through the oil filter and goes to lubricate the relevant parts through ducts or pipes.
 - At the end of the lubrication cycle, the oil returns to the oil pan by gravity. The oil filter can be bypassed by the bypass valve built into it if it gets clogged.
- In addition, the lubricating oil feeds the chain hydraulic tightening devices for the control of the auxiliary elements and the timing system and the hydraulic tappet.

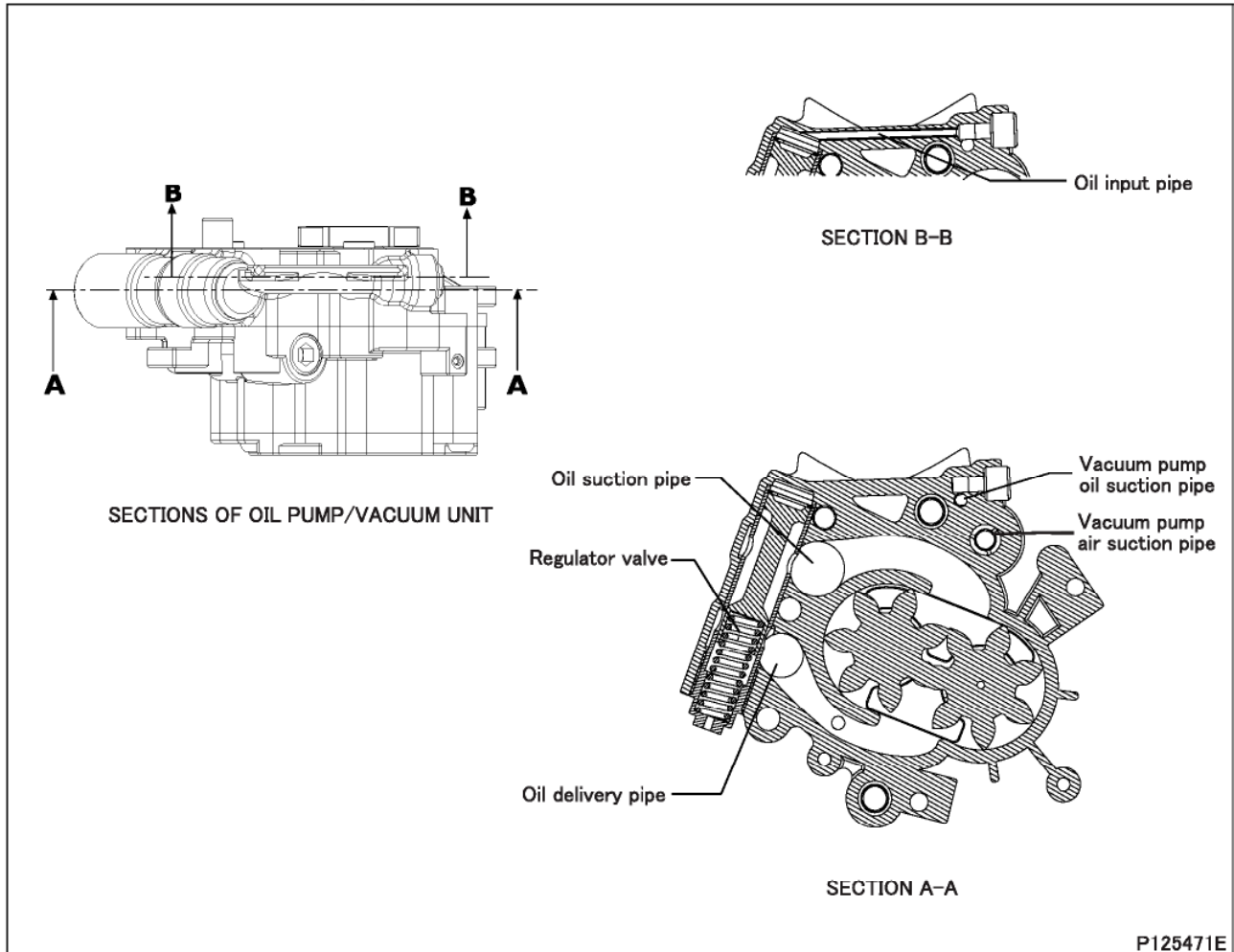
STRUCTURE AND OPERATION

2. Oil Pump/Vacuum Unit

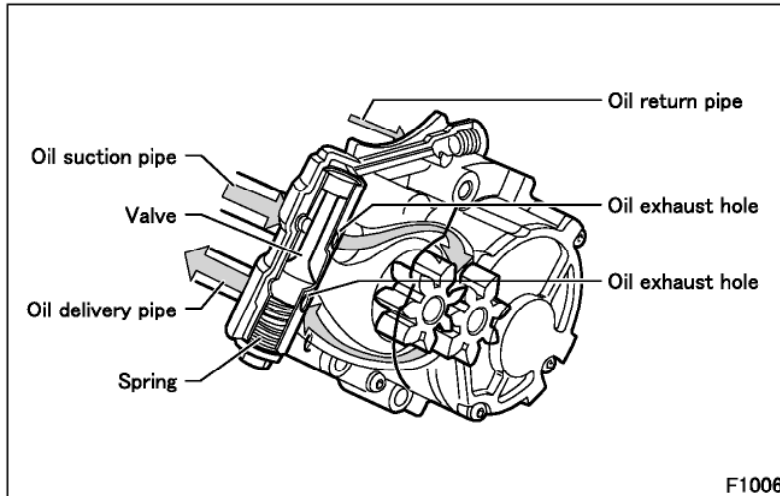


- The vacuum pump, with radial blades, is also incorporated in the oil pump. It is driven directly by the oil pump.

2.1 Cross section of the oil pump/vacuum unit



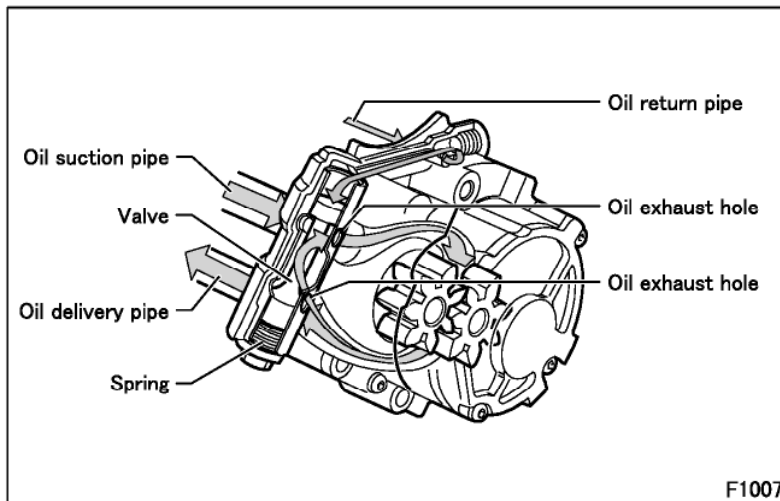
2.2 Regulator valve



Pressure at opening start: 440 kPa {4.5 kgf/cm²}

(1) Regulator valve closed

- If in pipe the oil pressure is below 440 kPa {4.5 kgf/cm²}, the valve closes the holes.



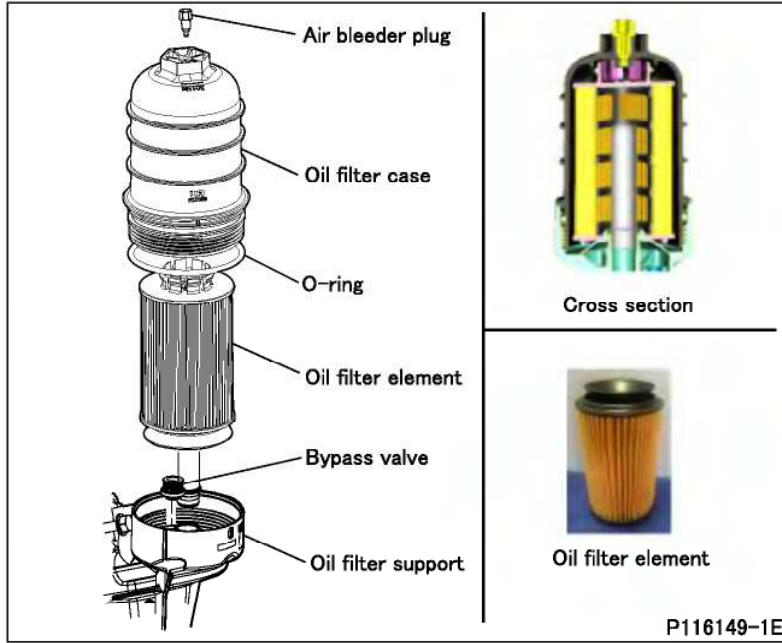
(2) Regulator valve open

- If in oil return pipe the oil pressure is equal or above 440 kPa {4.5 kgf/cm²}, the valve, as a result of the pressure itself, wins through the spring reaction and goes down, thus opening communication between the delivery pipe and the suction pipe, through draining holes, and therefore the pressure drops.

When the pressure falls below 440 kPa {4.5 kgf/cm²}, the spring takes the valve to the initial position of closed valve.

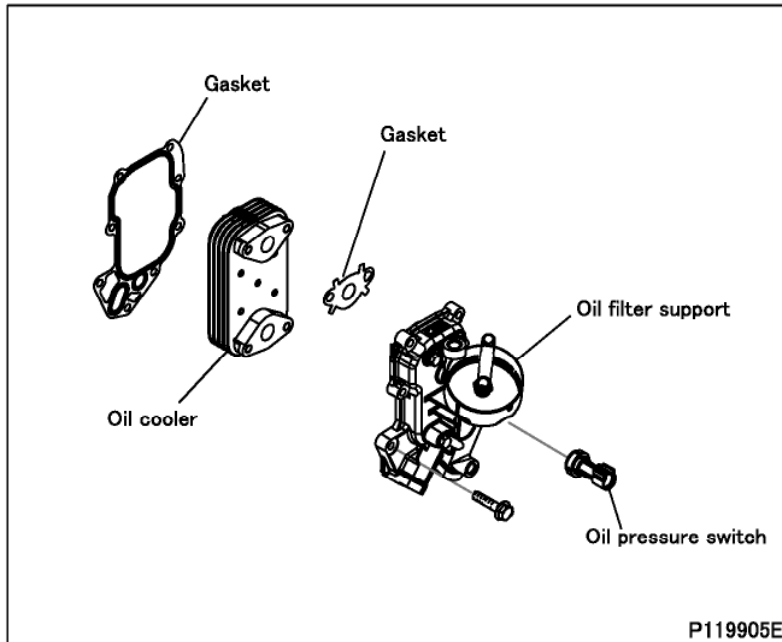
STRUCTURE AND OPERATION

3. Oil Filter



- Bypass valve opening pressure 250 ± 40 kPa $\{2.5 \pm 0.4$ kgf/cm² $\}$.

4. Oil Cooler



Possible causes		Symptoms				Reference Gr
		Engine is difficult to start	Overheating	Low oil pressure	Excessive oil consumption (oil leakage)	
Oil cooler	Incorrectly mounted element		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Defective gasket		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Clogged element		<input type="radio"/>	<input type="radio"/>		
	Damaged element		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Weakened bypass valve spring		<input type="radio"/>			
	Weakened regulator valve spring			<input type="radio"/>		
Oil pump/ vacuum unit	Malfunctioning oil pump		<input type="radio"/>	<input type="radio"/>		
	Interference between oil pump gear and oil pump case and/or cover	<input type="radio"/>		<input type="radio"/>		
	Weakened relief valve spring			<input type="radio"/>		
Oil filter	Incorrect installation				<input type="radio"/>	
	Clogged element		<input type="radio"/>	<input type="radio"/>		
	Defective gasket			<input type="radio"/>	<input type="radio"/>	
Incorrectly mounted and/or clogged oil strainer			<input type="radio"/>	<input type="radio"/>		
Defective crankshaft front oil seal					<input type="radio"/>	Gr11
Defective crankshaft rear oil seal					<input type="radio"/>	
Incorrectly mounted timing chain/sprockets		<input type="radio"/>			<input type="radio"/>	
Oil working its way up into combustion chamber(s) through piston rings					<input type="radio"/>	
Oil working its way down into combustion chamber(s) through valves					<input type="radio"/>	
Oil viscosity too high		<input type="radio"/>				
Poor oil quality			<input type="radio"/>			
Deterioration of oil			<input type="radio"/>			
Fuel mixed with oil			<input type="radio"/>			

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Oil Filter Replacement

WARNING

- If engine oil is spilled, wipe it off carefully. Spilled oil may cause a fire.
- Be careful when handling hot engine oil, which may cause a burn.

CAUTION

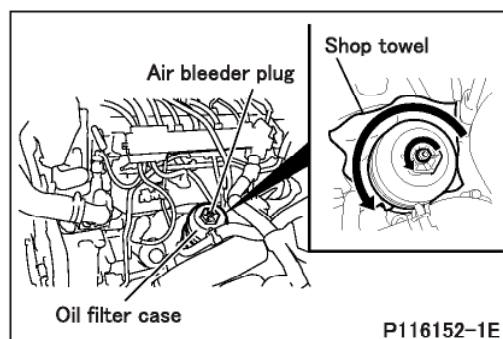
- Use the specified type of engine oil. Otherwise, the diesel particulate filter may be prematurely clogged.
- Do not allow engine oil to adhere to the belt. Otherwise, the belt may become slippery, resulting in degraded cooling performance.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Oil filter support	25 to 30 {2.5 to 3.0}	–
–	Air bleeder plug	1.5 ± 0.6 {0.2 ± 0.1}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	O-ring	Engine oil	As required

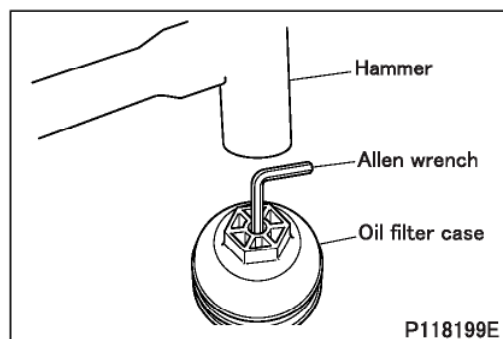


■ Removal: Oil filter element

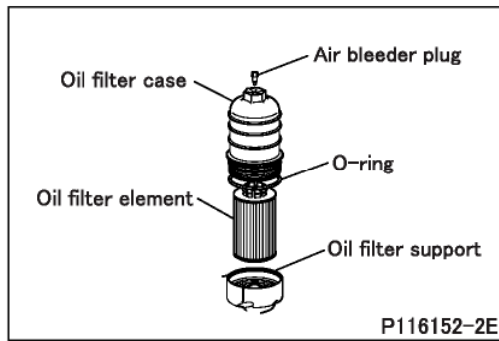
- Warm up the engine if it is cold.
Let the engine oil temperature rise to about 40°C. (Run the engine at idle for about 20 min. to increase the engine oil temperature from about 0°C to 40°C.) Without warming up the engine, the engine oil will come out when the oil filter case is removed.
- Loosen the oil filter case. (Approx. 2.5 rotations.)
- Remove the air bleeder plug from the oil filter case. Wait for at least 5 minutes to drain the engine oil in the oil filter case.
- Remove the oil filter case.
Wrap up the oil filter case with a shop towel when removing it so that oil will not spill out.

CAUTION

- When removing the oil filter case, take care not to spill any engine oil on the starter.
Contact with spilled engine oil can damage inner parts of the starter.
- After removing the oil filter case, be careful not to allow foreign objects to enter the oil filter case or oil filter support.



- Remove the oil filter case and filter element by lightly tapping the Allen wrench inserted in the air bleeder plug hole by a hammer. Use care not to damage the oil filter case by the Allen wrench. (Use a 4 mm Allen wrench.)



- Remove the O-ring from the oil filter case.
- Remove the oil filter element from the oil filter support.
- Clean the oil filter case, oil filter support surface that contacts the O-ring, and the O-ring groove on the filter case with a rag.

■ Installation: Oil filter element

- Apply a thin coat of engine oil to a new O-ring and install the O-ring on the oil filter case.

CAUTION ⚠

- **Use the O-ring and air bleeder plug that came with a new oil filter element.**

- Install an oil filter element with its hole located on the bottom side.
- Apply engine oil to the O-ring of the new air bleeder plug and install the plug to the oil filter case.

CAUTION ⚠

- **Do not tighten the air bleeder plug to more than the specified torque. Otherwise, air bleeder plug or oil filter case can be broken.**

- After installing the oil filter case, check that there is no gap between the contact surfaces of the oil filter case and oil filter support.

CAUTION ⚠

- **Do not tighten the oil filter case to more than the specified torque. Otherwise, oil filter case can be broken.**

- Following the procedure given in the section “Starting the engine after parking for a long period” (See later section.), start the engine and warm it up until the needle of the water temperature gauge begins to move.

- Stop the engine. After at least 10 minutes, check the engine oil level. (See later section.)
- Start the engine and check that oil is not leaking. (See later section.)
- If any abnormality is found, reinstall the oil filter.
- Stop the engine and check the engine oil level. (See later section.)
- Add engine oil if the oil level is too low.

- When the engine oil has been replaced, reset the inspection/service memory of the multi-information system. (See Chapter 6 “Multi-information system” in the Owner’s Manual.)

ON-VEHICLE INSPECTION AND ADJUSTMENT

2. Engine Oil Replacement

WARNING

- If engine oil is spilled, wipe it off carefully. Spilled oil may cause a fire.
- Be careful when handling hot engine oil, which may cause a burn.

CAUTION

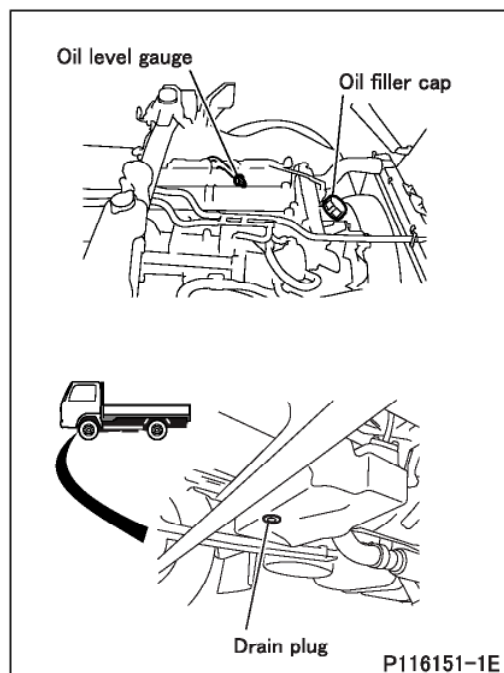
- Use the specified type of engine oil. Otherwise, the diesel particulate filter may be prematurely clogged.
- Do not allow engine oil to adhere to the belt. Otherwise, the belt may become slippery, resulting in degraded cooling performance.
- Make sure to reset the engine electronic control unit every time after refilling. Because the engine control unit calculates the engine oil life.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Drain plug (oil pan)	30 ± 10 {3.0 ± 1.0}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil pan	Engine oil	Approx. 6.2 dm ³ {6.2 L}



■ Draining: Engine oil

- Warm up the engine if it is cold.
Let the engine oil temperature rise to about 40°C. (Run the engine at idle for about 20 min. to increase the engine oil temperature from about 0°C to 40°C.) Without warming up the engine, you may not drain the engine oil from the oil filter.
- Remove the filler cap.

CAUTION

- After removing the filler cap, be careful not to allow foreign objects to enter the engine case.

- Remove the drain plug to drain the engine oil.

■ Refilling: Engine oil

- Install a new O-ring on the drain plug, and then install the drain plug.
- Add new oil through the oil filler.

CAUTION

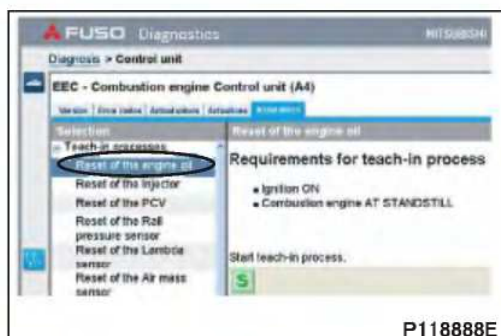
- Use a jug when adding engine oil through the oil filler to prevent the oil from spilling on the belt or other components.
- If the oil has spilled on the belt, quickly wipe it off with a shop towel.

- Follow the procedure below to crank the engine, and then start the engine to warm it up until the needle of the water temperature gauge begins to move.

[Starting the engine after parking for a long period]

If the vehicle has not been used for more than 1 week, or when the engine oil or oil filter element has been replaced, follow the procedure below to crank the engine, then start the engine.

- Start the engine in the ordinary way. You don't have to wait for the indicator lamp to go off.
- Place the starter switch in the "START" position without depressing the accelerator pedal and crank the engine for about 15 seconds.
- If the engine has started, release the starter key and leave the accelerator pedal unpressed for about 15 seconds.
- Stop the engine. After at least 10 minutes, check the engine oil level.
- Start the engine and check that oil is not leaking.
- Add the engine oil if the oil level is too low.
- When the engine oil has been replaced, reset the inspection/service memory of the multi-information system. (See Chapter 6 "Multi-information system" in the Owner's Manual.)



■ Resetting the engine electronic control unit

<Resetting with FUSO Diagnostics>

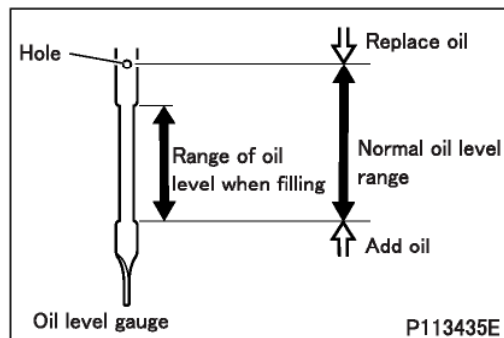
- Connect the FUSO Diagnostics to the vehicle.
- Select "Reset of the engine oil" from the "EEC - Combustion engine Control unit" menu. After making sure that the "Requirements for teach-in process" are met, press "S" to reset the engine electronic control unit.

<Resetting without FUSO Diagnostics>

- Turn the starter switch to the "ON" position. Do not start the engine.
- Fully depress and hold the accelerator pedal for more than 20 seconds.
- With the accelerator held in that position, depress the brake pedal 6 times.
- Turn the starter switch to the "LOCK" position and wait for 2 minutes.
- If the electronic control unit resetting is not performed, the engine electronic control unit will keep counting the melting amount in the engine oil even after the engine oil has been replaced, causing a diagnosis code to be generated and a warning lamp (red) to light up. (See Gr13E.)

ON-VEHICLE INSPECTION AND ADJUSTMENT

3. Inspection of Engine Oil Level



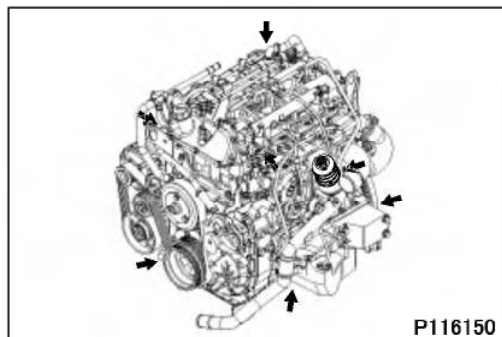
- Inspection should be performed in a level place.
- Warm up the engine until the needle of the water temperature gauge reaches close to the center of the gauge.
- Stop the engine. After at least 10 minutes, measure the engine oil level.
- If the measured oil level is higher than upper side of the hole, it indicates an increase in the oil amount due to such reason that some of the injected fuel has mixed into the engine oil during DPF regeneration. Replace the engine oil.

CAUTION

- **If the oil level is higher than the upper side of the hole, quality of the engine oil is reduced, which could lead to an engine failure or a sudden increase in the engine speed.**

- If the measured oil level is too low, add oil to a level within the specified oil level range for filling.
- If it is found the engine oil decreases too quickly in daily checks although the measured oil level was inside the normal oil level range, perform an inspection to check for the following causes.
 - Seizure between the piston ring and piston
 - Too much clearance between the piston and crankcase cylinder

4. Inspection of Engine Oil Leaks



- Warm up the engine until the needle of the water temperature gauge reaches close to the center of the gauge.
- Visually check each part of the engine (oil pan, oil filter, cylinder head gasket, etc.) for oil leaks. If oil is leaking, replace the faulty component.

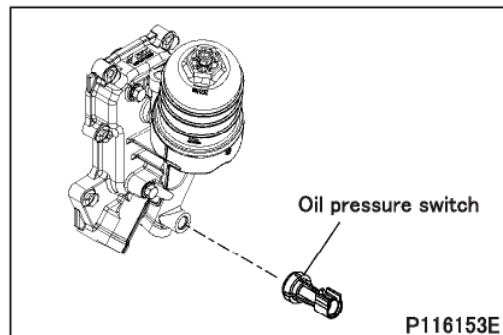
5. Oil Pressure Measurement

Service standards

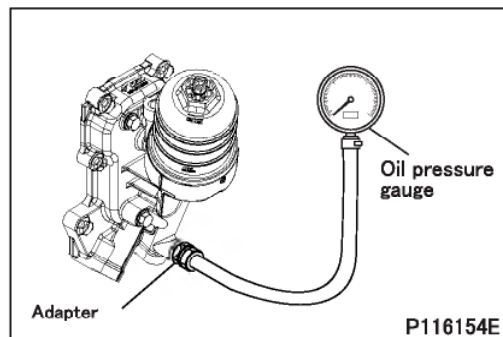
Location	Maintenance item	Standard value	Limit	Remedy	
-	Oil pressure (oil temperature at $100 \pm 5^\circ\text{C}$)	No-load minimum speed	100 kPa {1.0 kgf/cm ² }	-	Inspect
		No-load maximum speed	450 kPa {4.6 kgf/cm ² }	-	

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
-	Oil pressure switch	25 {2.5}	Sealant With cold engine



- Remove the oil pressure switch.

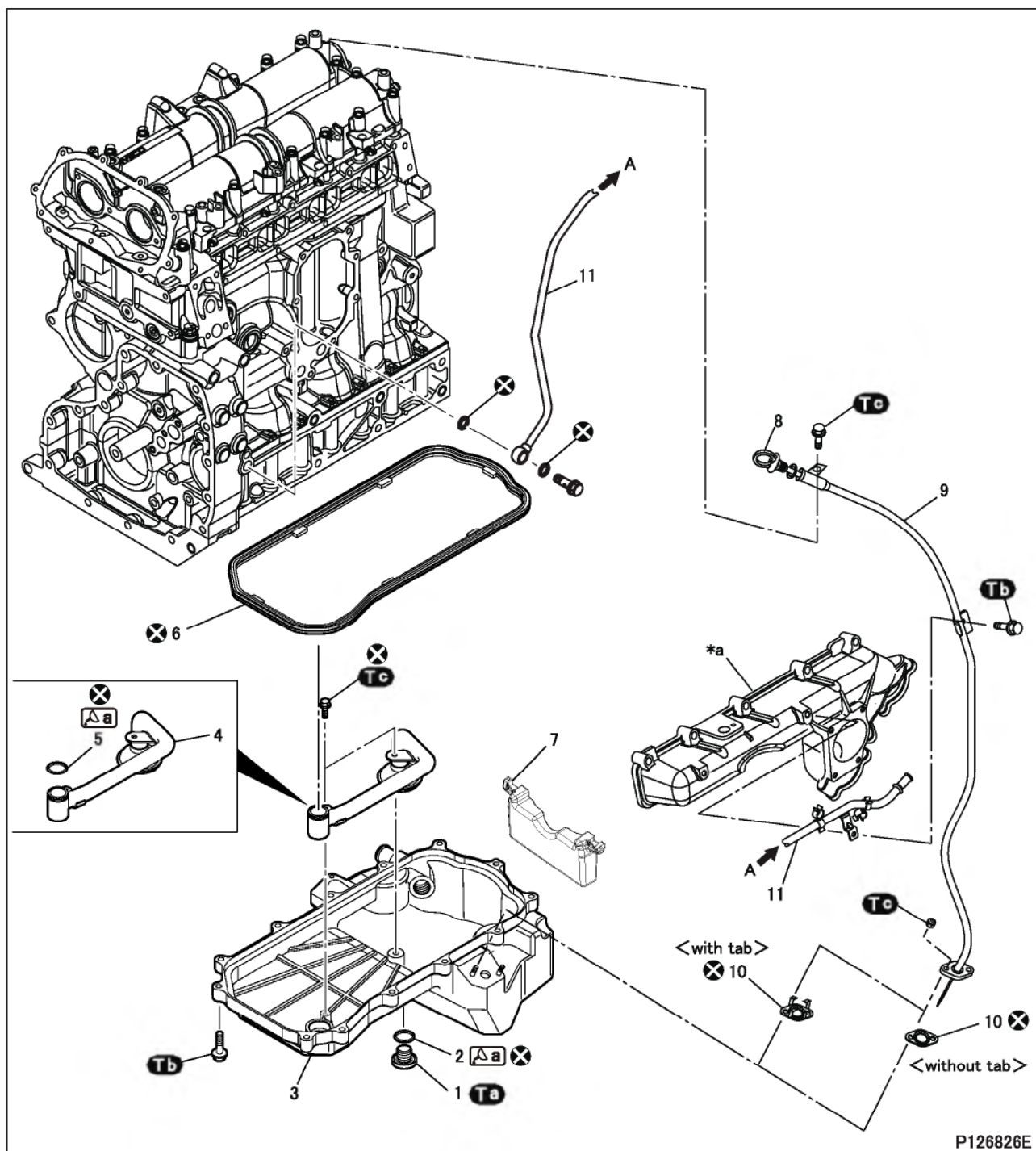


- Using an adapter, connect an oil pressure gauge to the oil pressure switch mounting hole.
- Warm up the engine until the oil temperature reaches $100 \pm 5^\circ\text{C}$.
- Measure the oil pressure while running the engine at a minimum speed and then at maximum speed, both under no load.
- If the measurements are below the specified limits, overhaul the lubrication system.
- Tighten the engine oil pressure switch to the specified torque.

CAUTION

- Reinstall the oil pressure switch only when the engine is cold.

OIL PAN, OIL STRAINER



● Removal sequence

- | | |
|-----------------------------------|-------------------------|
| 1 Oil drain plug | 8 Oil level gauge |
| 2 O-ring | 9 Oil level gauge guide |
| 3 Oil pan | 10 Gasket |
| 4 Oil strainer | 11 Vacuum pipe |
| 5 O-ring | |
| 6 Gasket | ⊗: Non-reusable parts |
| 7 Rubber spacer | |
| <Manual transmission (C4 Clutch)> | |

● Installation sequence

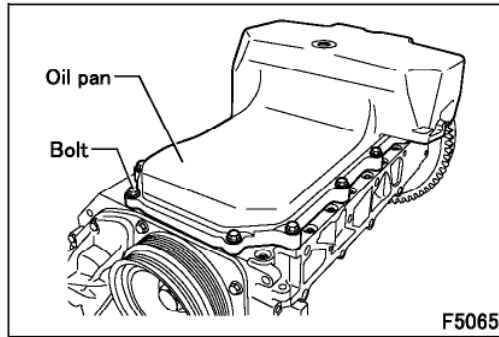
Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Oil drain plug	30 ± 10 {3.0 ± 1.0}	-
Tb	Bolt (oil pan mounting)	25 {2.5}	-
Tc	Screw (oil strainer mounting)	10 {1.0}	-

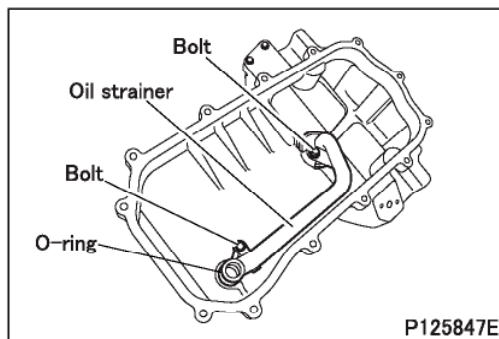
Lubricant and/or sealant ◆ Removal procedure ◆

Mark	Points of application	Specified lubricant and/or sealant	Quantity
Aa	O-ring	Engine oil	As required



■ Removal: Oil pan

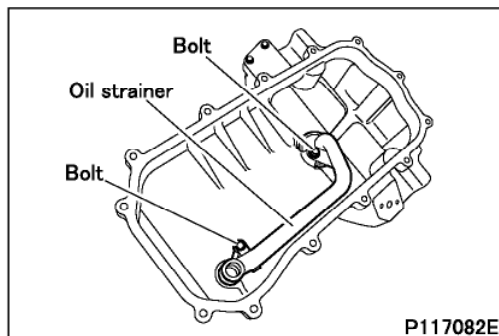
- Take out the bolts and remove the oil pan.



■ Removal: Oil strainer

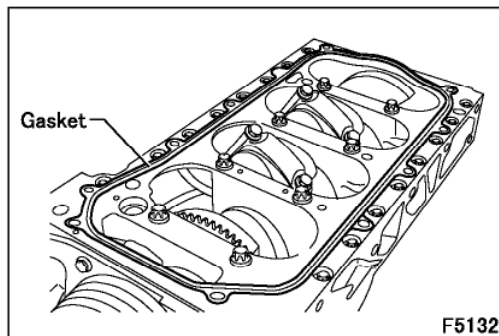
- Apply engine oil to the new O-ring and install it to the strainer.
- Unscrew and remove the fixing bolts.
- Detach the oil strainer from the oil pan.

◆ Installation procedure ◆



■ Installation: Oil strainer

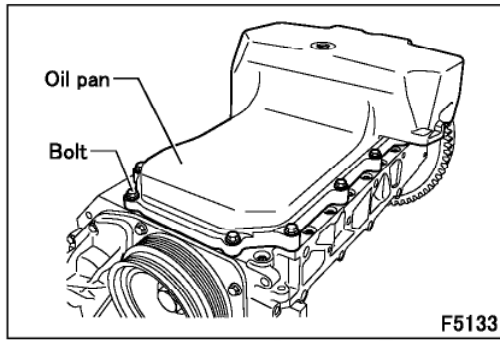
- Mount the suction strainer together with the pipe.
- Screw down the fixing bolts and tighten them to the prescribed torque 10 N·m {1.0 kgf·m}.



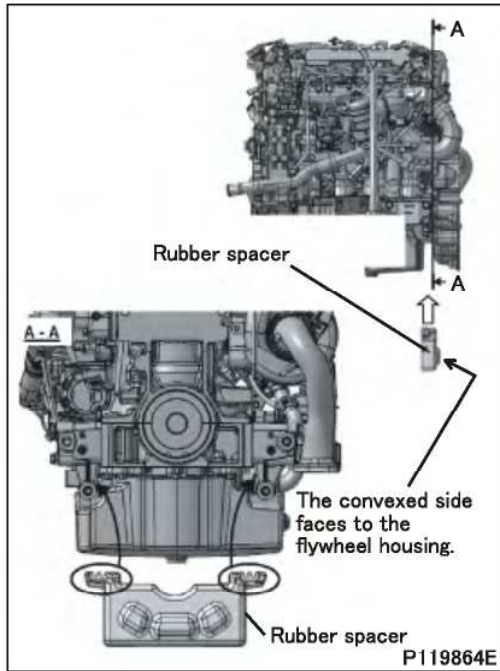
■ Installation: Oil pan

- Position the gasket on the engine block.

OIL PAN, OIL STRAINER

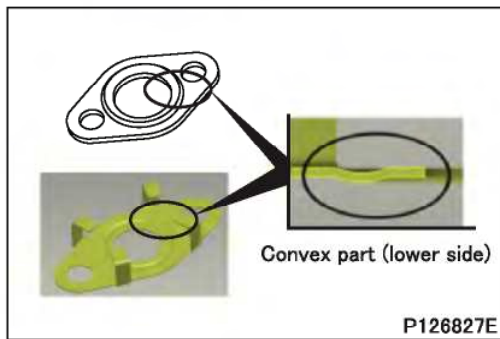


- Fit the oil pan and tighten the fixing bolts to a torque of 25 N·m {2.5 kgf·m}.
- Tighten the oil drain plug to a torque of 30 ± 10 N·m { 3.0 ± 1.0 kgf·m}.



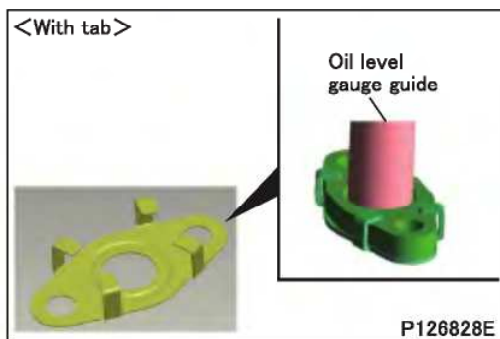
■ Installation: Rubber spacer <Manual transmission (C4 Clutch)>

- Install the rubber spacer with its convexed surface to the flywheel side, fitting its arm part all the way into the mating hole in the stiffener.

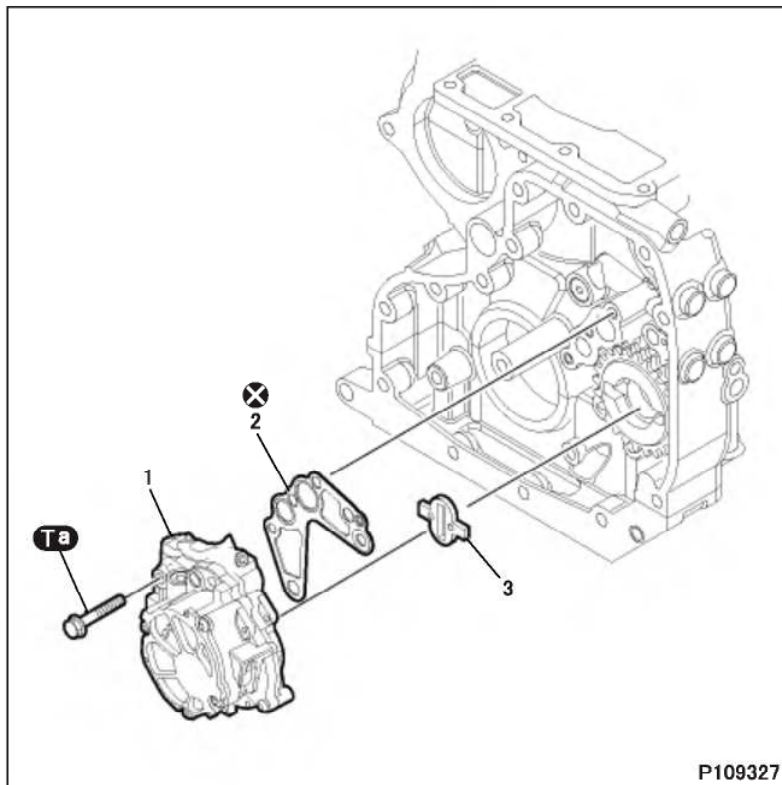


■ Installation: Gasket

- Install the gasket with a convex side facing downward.



- Install the claw coupling gasket as shown.



● **Removal sequence**

- 1 Oil pump/vacuum unit
- 2 Gasket
- 3 Coupling

⊗: Non-reusable parts

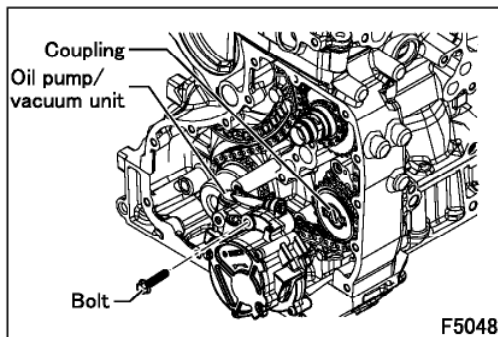
● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (oil pump/vacuum unit mounting)	25 {2.5}	–

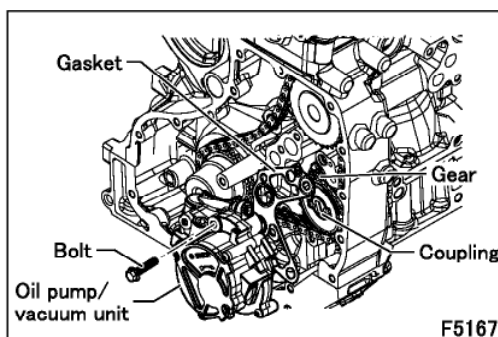
◆ **Removal procedure** ◆



■ **Removal: Oil pump/vacuum unit**

- Remove the bolt and then remove the oil pump/vacuum unit.
- Remove the coupling.

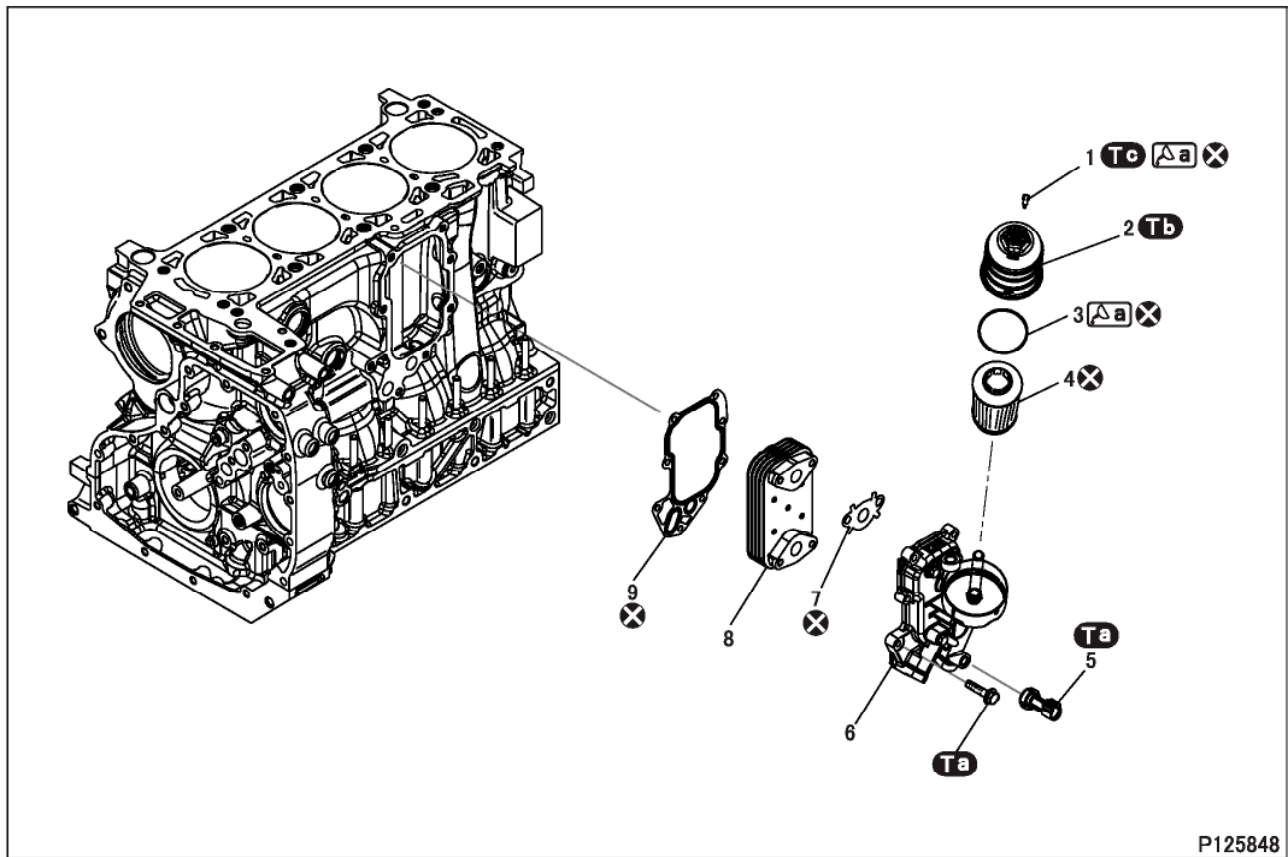
◆ **Installation procedure** ◆



■ **Installation: Oil pump/vacuum unit**

- Position the coupling in the gear.
- Fit the oil pump/vacuum unit placing a new gasket in between.
- Screw in the bolts placing the oil pump/vacuum unit assembly in the end of travel position and check it is correctly fitted on the coupling.
- Tighten the bolts to the recommended torque 25 N·m {2.5 kgf·m}.

OIL FILTER, OIL COOLER



P125848

● Disassembly sequence

- 1 Air bleeder plug
- 2 Oil filter case
- 3 O-ring
- 4 Oil filter element
- 5 Oil pressure switch (See Gr54.)
- 6 Oil filter support

- 7 Gasket
- 8 Oil cooler
- 9 Gasket

⊗: Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

WARNING

- Wipe up any spilled engine oil, as it can cause fires.
- To avoid any risk of burns, take care not to touch the engine oil when the engine is hot.

CAUTION

- Make sure not to put any engine oil on the belt when working on the oil filter. Belts soiled with oil may easily slip, resulting in deteriorated performance of the cooling system.
- Be sure to attach the gasket in the right direction shown in the figure. Otherwise, the oil holes will be covered.
- Do not reuse oil filters by washing them.

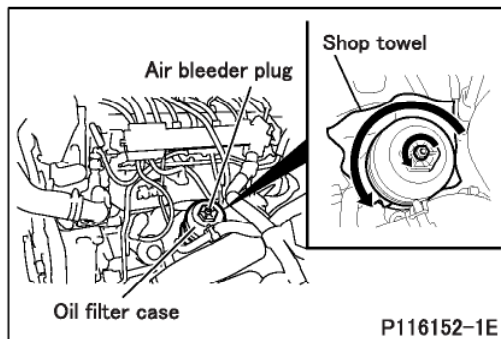
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (oil filter support mounting)	25 {2.5}	-
	Oil pressure switch		
Tb	Oil filter case	25 to 30 {2.5 to 3.0}	-
Tc	Air bleeder plug	1.5 ± 0.6 {0.2 ± 0.1}	-

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
Aa	O-ring	Engine oil	As required
	O-ring on the air bleeder plug		

◆ **Removal procedure** ◆

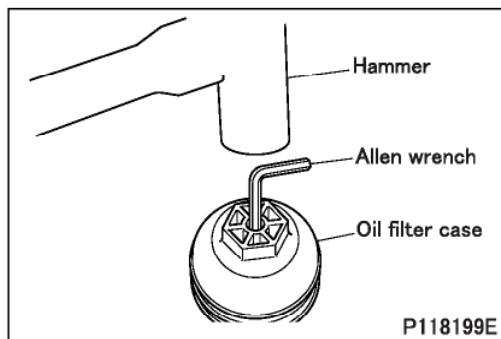


■ **Removal: Oil filter element**

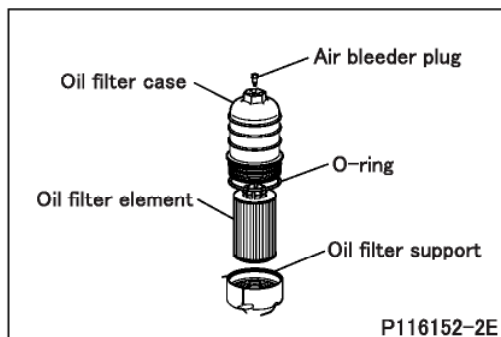
- Warm up the engine if it is cold. Let the engine oil temperature rise to about 40°C. (Run the engine at idle for about 20 min. to increase the engine oil temperature from about 0°C to 40°C.) Without warming up the engine, the engine oil will come out when the oil filter case is removed.
- Loosen the oil filter case. (Approx. 2.5 rotations.)
- Remove the air bleeder plug from the oil filter case. Wait for at least 5 minutes to drain the engine oil in the oil filter case.
- Remove the oil filter case. Wrap up the oil filter case with a rag when removing it so that oil will not spill out.

CAUTION ⚠

- **When removing the oil filter case, take care not to spill any engine oil on the starter. Contact with spilled engine oil can damage inner parts of the starter.**
- **After removing the oil filter case, be careful not to allow foreign objects to enter the oil filter case or oil filter support.**

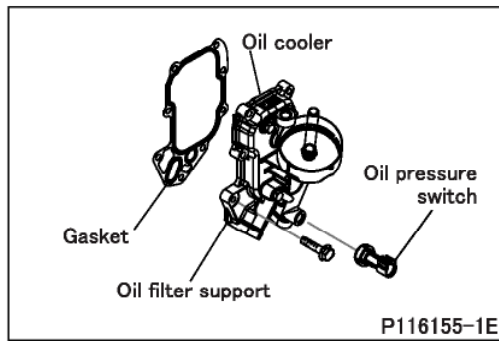


- Remove the oil filter case and filter element by lightly tapping the Allen wrench inserted in the air bleeder plug hole by a hammer. Use care not to damage the oil filter case by the Allen wrench. (Use a 4 mm Allen wrench.)



- Remove the O-ring from the oil filter case.
- Remove the oil filter element from the oil filter support.
- Clean the oil filter case, oil filter support surface that contacts the O-ring, and the O-ring groove on the filter case with a rag.

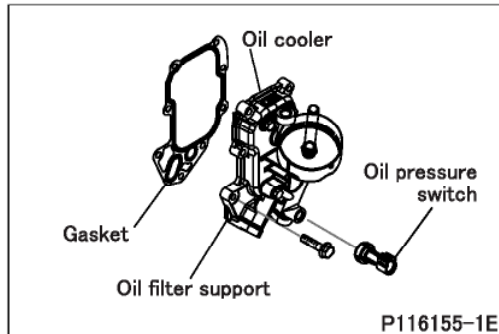
OIL FILTER, OIL COOLER



■ Removal: Oil cooler and oil cooler support

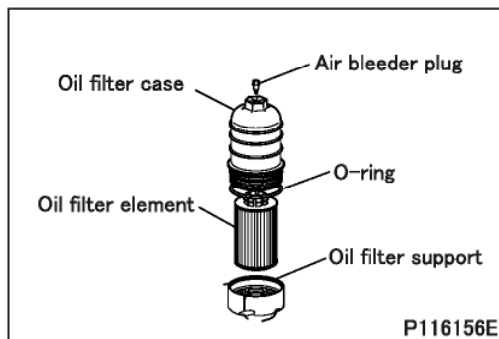
- Remove the oil cooler support together with the oil cooler and gasket.

◆ Installation procedure ◆



■ Installation: Oil cooler support and oil cooler

- Install the oil cooler together with a new gasket on the crankcase.
- Install the oil pressure switch.



■ Installation: Oil filter element

- Apply a thin coat of engine oil to a new O-ring and install the O-ring on the oil filter case.

CAUTION ⚠

- **Use the O-ring and air bleeder plug that came with a new oil filter element.**

- Install an oil filter element with its hole located on the bottom side.
- Apply engine oil to the O-ring of the new air bleeder plug and install the plug to the oil filter case.

CAUTION ⚠

- **Use care not to tighten the air bleeder plug to a torque more than the specified. Otherwise, the air bleeder plug can be damaged.**

- Following the procedure given in the section "Starting the engine after parking for a long period," start the engine and warm it up until the needle of the water temperature gauge begins to move.

- Stop the engine. After at least 10 minutes, check the engine oil level.
- Start the engine and check that oil is not leaking.
- If any abnormality is found, reinstall the oil filter.
- Stop the engine and check the engine oil level.
- Add engine oil if the oil level is too low.

- When the engine oil has been replaced, reset the inspection/service memory of the multi-information system. (See Chapter 6 "Multi-information system" in the Owner's Manual.)