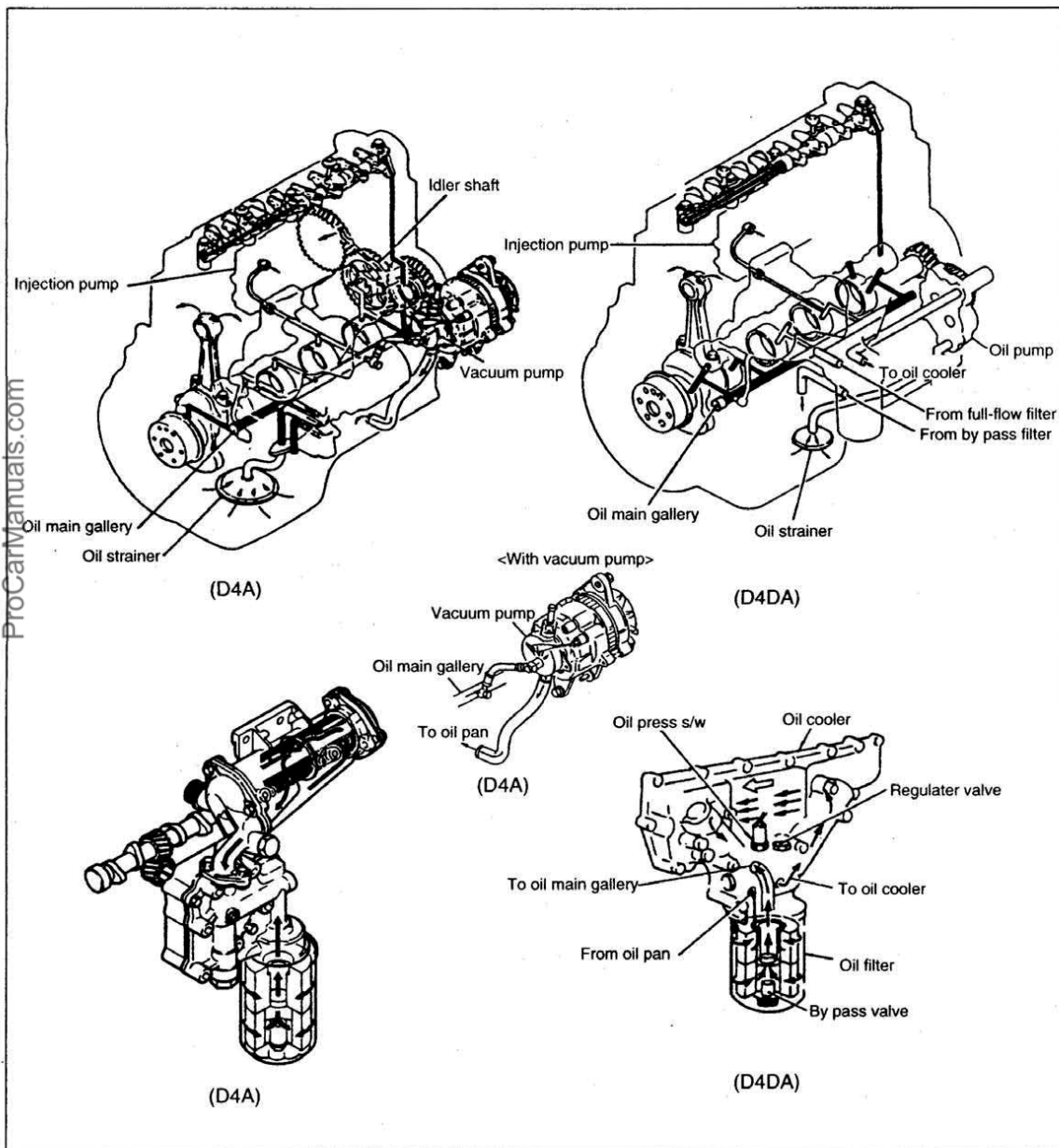


1.GENERAL

The engine is lubricated by a gear-type oil pump that forces engine oil through the oil cooler and oil filter into the engine for lubrication of various engine parts.

The illustration below shows the flow of engine oil.

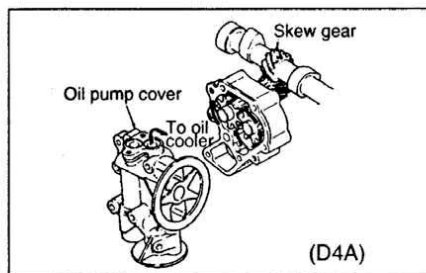


(1) Oil pump

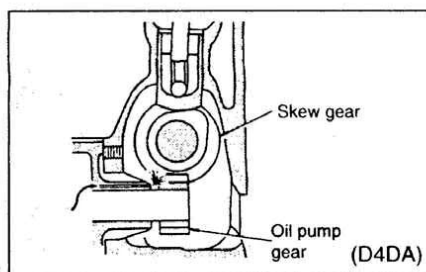
<D4A>

The oil pump, of a gear type, is driven by the skew gear mounted on the camshaft.

The oil pump cover serves also as the oil filter head, requiring no oil pipe.



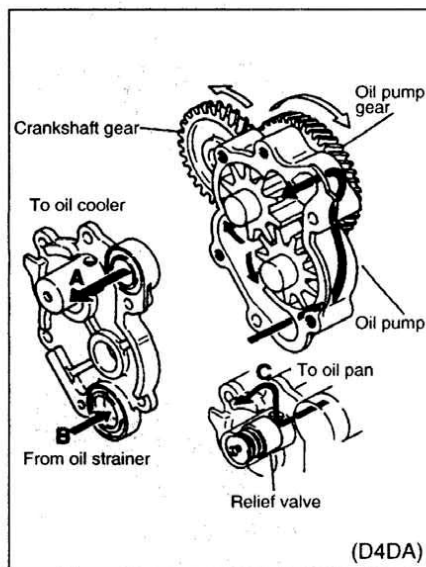
The camshaft skew gear and oil pump gear are lubricated by oil sprayed from the oil hole drilled in the oil pump case. The engine oil fed under pressure by the oil pump is delivered to the oil cooler.



<D4DA>

Oil pump is a gear type. It is driven by rotation of the crankshaft via crankshaft gear and oil pump gear.

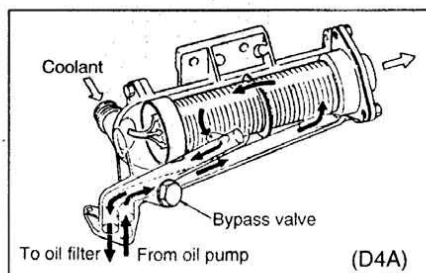
Relief valve is fitted to the oil pump. When the oil pump discharge pressure exceeds a specified level, the relief valve returns some of the engine oil to the oil pan, thus protecting the lubrication system from excessive oil pressure.

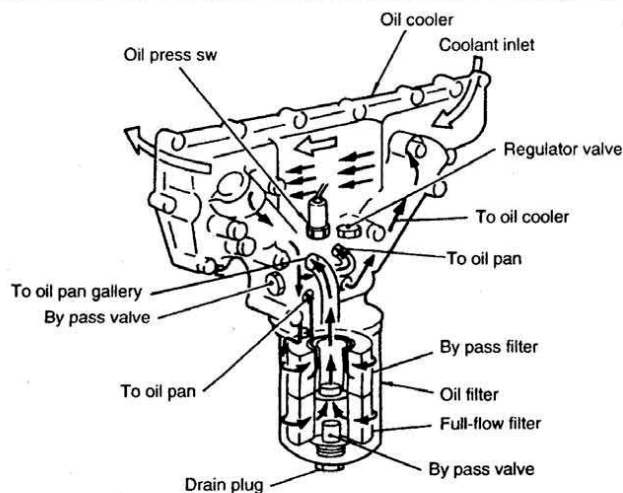


(2) Oil Cooler

The oil cooler is an equipment for heat exchange between the coolant and oil fed under pressure from the crankcase water jacket and oil pump, respectively.

The oil cooler has bypass valve that opens when the element passes less oil as it becomes clogged.

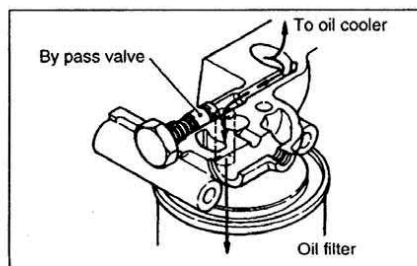




(D4DA)

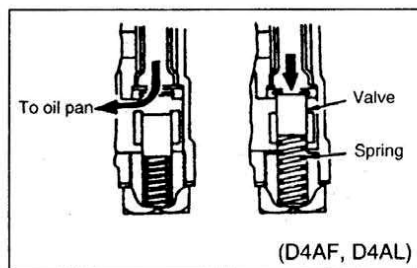
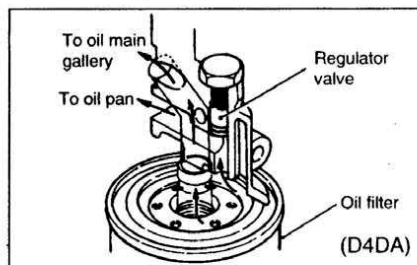
(a) Operation of bypass valve

When the oil's viscosity is high at low temperatures or when oil cooler element is clogged and resists the oil's flow, bypass valve opens, thus allowing oil to flow to oil filter without passing through the cooler.



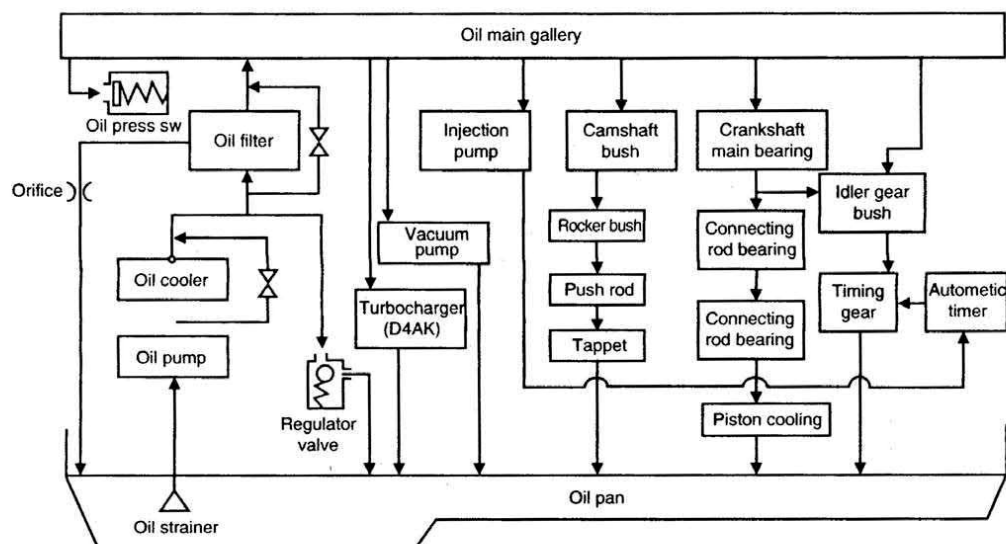
(b) Operation of regulator valve

When the pressure of oil going to the main oil gallery exceeds a specified level, regulator valve opens, allowing some of the oil to return to the oil pan. The oil pressure is thus constantly regulated.

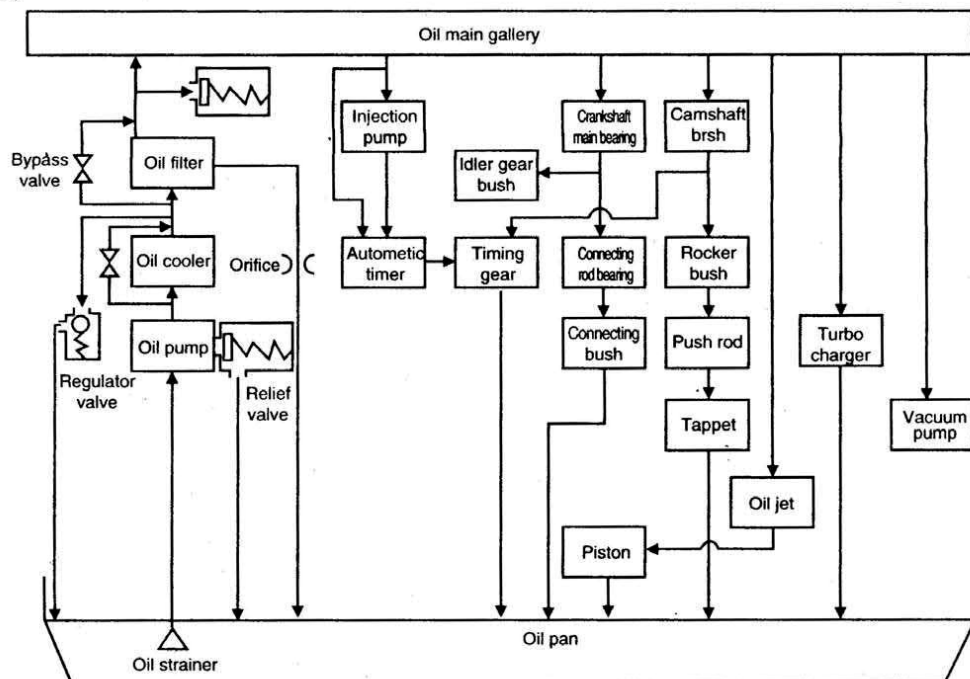


Lubrication system (Oil flow)

(D4A)

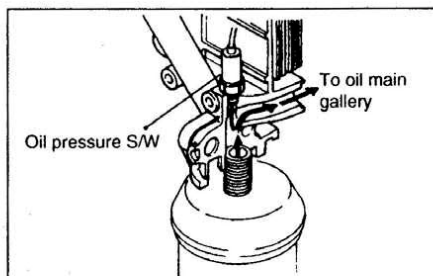


(D4DA)



(C) Operation of oil pressure switch

If the pressure of oil fed to main oil gallery drops below the specified level, electric contacts close inside pressure switch. As a result, a warning lamp illuminates in the meter cluster to alert the driver.



(3) Oil filter

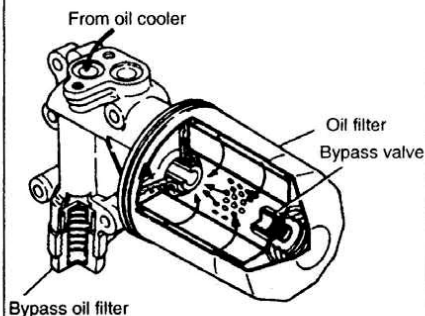
<D4A>

The oil filter is a type incorporating both the full-flow and bypass filters. The element is a spin-on type that allows easy replacement.

The engine oil filtered through the full-flow filter is delivered to the crankcase oil main gallery and the oil circulating through the bypass filter returns through the crankcase to the oil pan.

The oil pump cover has a relief valve that reroutes the engine oil to the oil pan when the oil pressure exceeds a predetermined level, thus preventing the lubricating system from being overloaded.

(D4A)

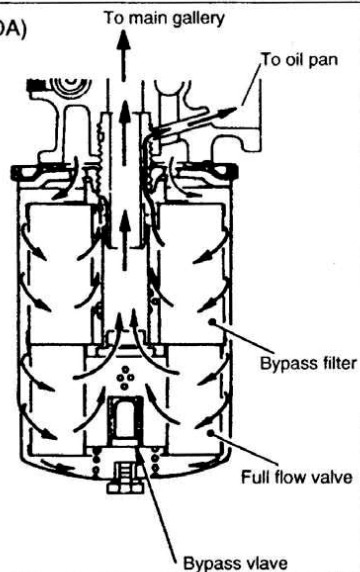


<D4DA>

The oil filter is a spin-on filter-paper type incorporating a full-flow filter and a bypass filter.

A bypass valve is fitted at the bottom of the filter assembly. If the elements become clogged, the bypass valve opens and allows oil to flow to main gallery without passing through the elements. This operation prevents seizure of the engine.

(D4DA)



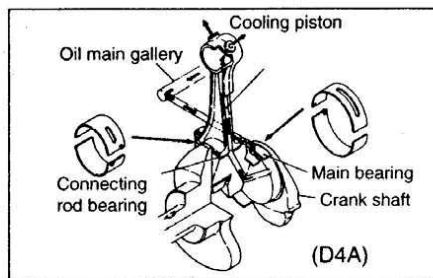
(4) Lubrication of parts

The engine oil routed from the oil filter to crankcase oil main gallery lubricates all engine parts as detailed below before returning to the oil pan.

(a) Main bearing and connecting rod bearing.

<D4A>

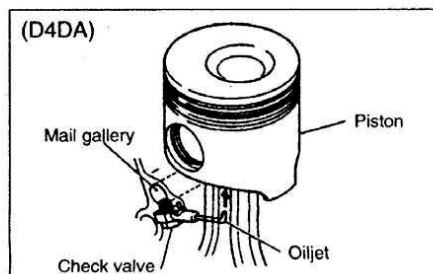
There is an oil passage provided from the oil main gallery to each main bearing. The oil flows through the oil hole to lubricate the main bearing and passes through the oil passage drilled into the crankshaft to lubricate the connecting rod bearing.



<D4DA>

An oil jet is fitted in the lower part of main oil gallery for each piston. These oil jets cool pistons by injecting oil into them. Each oil jet is fitted with a check valve that opens and closes at specified oil pressure levels.

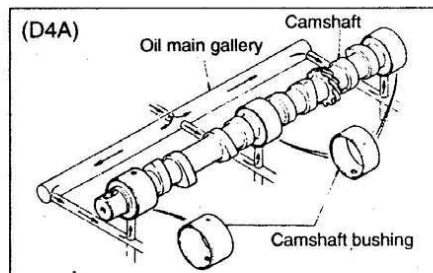
At low oil pressures, these check valves close to maintain the required volume of oil in the lubrication system and prevent reductions in oil pressure.



(b) Camshaft

Camshaft bushings are lubricated by the oil flowing through the oil passages leading from the oil main gallery to each bushing.

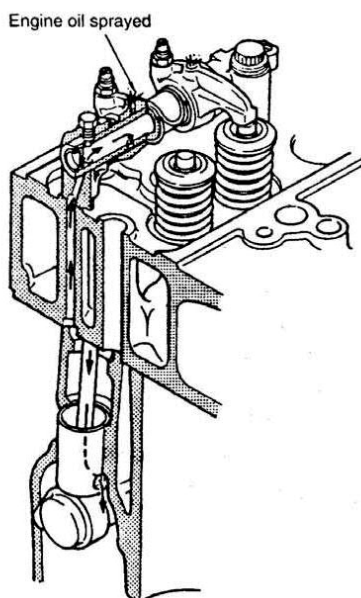
There is an oil hole provided in the journal at the front end of engine that serves as an oil passage to lubricate the camshaft gear and valve mechanism.



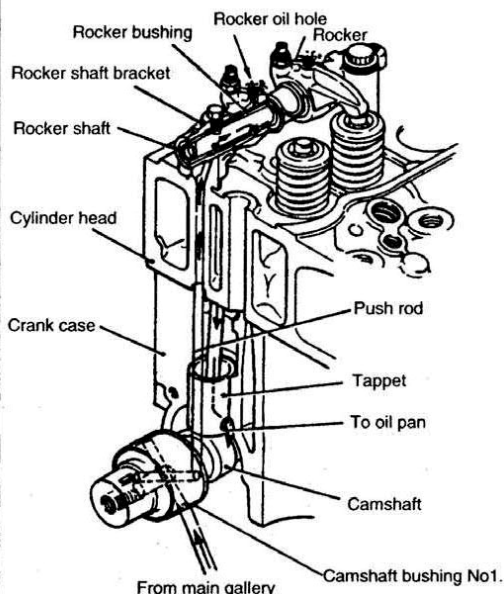
(c) Valve mechanism

The engine oil that has lubricated No. 1 camshaft bushing passes through the oil hole and pipe provided at the top portion of crankcase to the cylinder head.

The engine oil then goes through the front-end rocker shaft bracket into the rocker shaft, lubricating each rocker bushing. At the same time, it sprays from the oil hole at top of rocker to lubricate the surfaces over which the valve cap slides and valve stem. The oil then passes through in the cylinder head and crankcase to lubricate the tappets and camshaft cams before returning to the oil pan.



(D4A)



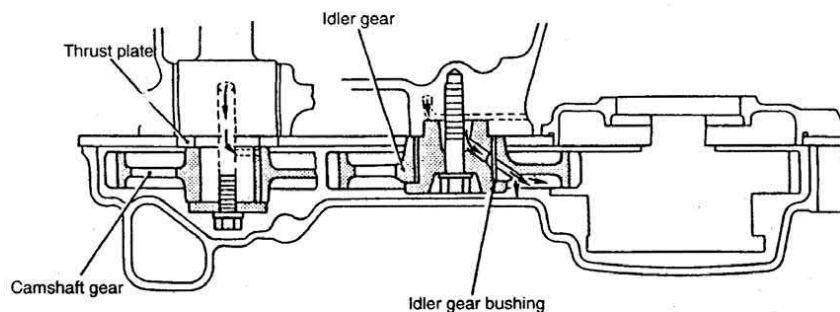
(D4DA)

(5) Timing gear

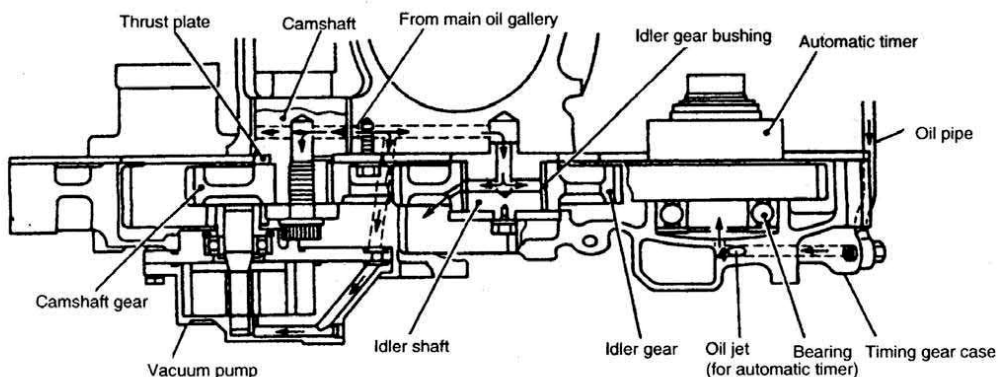
The timing gear idler gear bushing is lubricated by the engine oil routed from the oil main gallery, part of which spraying from the idler gear oil hole to lubricate each gear.

The camshaft gear and thrust plate are lubricated by the engine oil routed from NO.1 camshaft bushing through the camshaft oil hole.

(D4A)

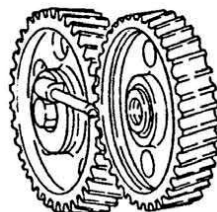


(D4DA)



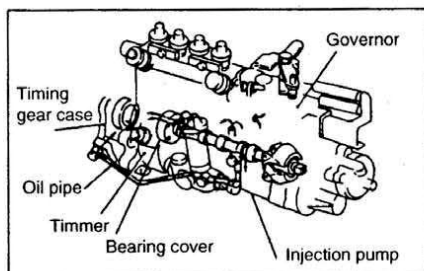
Engine oil from main oil gallery passes through camshaft and idler to lubricate the gears and vacuum pump. An oil jet is provided in timing gear case to provide constant, forced lubrication of the automatic timer.

On D4A the idler shaft is provided with an oil pipe for the forced-lubrication of the auto timer.



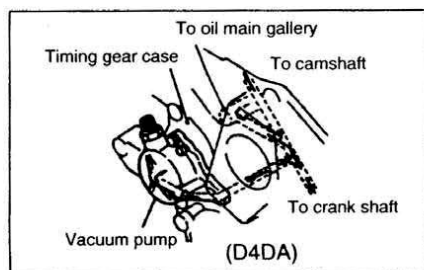
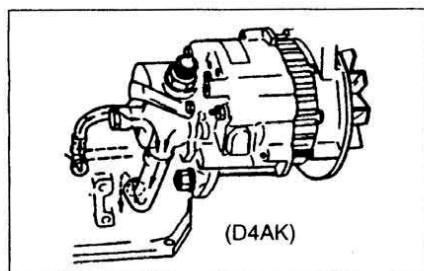
(6) Injection pump

Engine oil that has lubricated injection pump and governor returns to the oil pan through the oil passage of bearing cover.



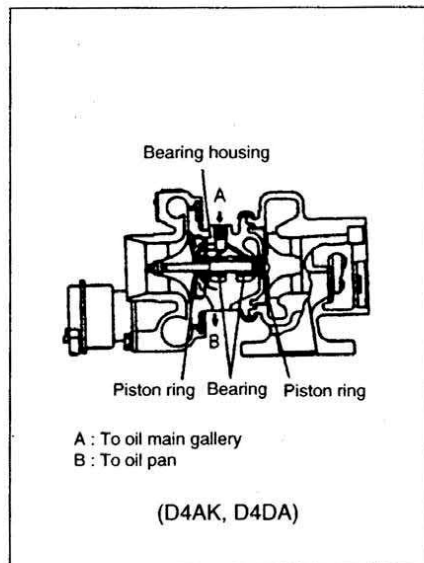
(7) Vacuum pump

Engine oil is delivered from main oil gallery to vacuum pump through the oil passage of timing gear case to lubricate the vanes. Then, the oil is discharged to timing gear case through the air outlet port together with air to be returned to the oil pan.



(8) Turbocharger

Via an oil pipe, engine oil is delivered from the main oil gallery to bearing housing to lubricate bearing. At each end of the turbine wheel shaft, piston ring acts as an oil seal.



2. SPECIFICATIONS

Item \ Model	D4AN	D4AK	D4DA
Engine oil			
Quality	API classification class CC or better	API classification class CC or better	←
Capacity	Oil pan Approx. 8.2 lit.	←	7.5 l (oil filter 1 l)
Lubrication method	Pressure feed by oil pump	←	←
Oil pump			
Type	Gear pump	←	←
Relief valve	Piston valve		
Oil filter			
Full-flow filter element	Spin-on type filter paper(with built- in bypass valve)	←	←
Bypass filter element	Spin-on, type filter paper	←	←
Regulator valve		-	Piston valve type
Oil cooler			
Type	Shell-and-tube	←	Shell-and-plate
Bypass valve	Piston valve	←	←

3. SERVICE STANDARDS

1. Service Standard Table

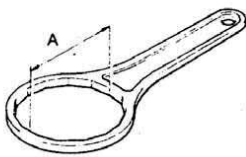
Unit : mm

Description			Nominal value [Basic diameter]	Limit	Correction and remarks
Oil pressure (Oil temperature at 70 to 90℃)	At idle		1.5 kg/cm ² or more	49kPa(0.5 kg/cm ²)	Adjust
	At maximum speed		3~5kg/cm ²	195kPa(2 kg/cm ²)	Adjust
Oil pump	Oil pump case to gear tooth end clearance		0.10 ~ 0.19	0.2	Replace
	Difference between oil pump case depth and gear height (Sinkage)		0.01 ~ 0.07	0.18	Replace
	Driven gear to driven shaft clearance		0.04 ~ 0.07[20]	0.15	Replace
	Drive gear end play		0.03 or more		Replace
	Relief valve opening pressure	D4A	3.7~4.3kg/cm ²		Replace
		D4DA	10~12kg/cm ²		
Oil cooler	Bypass valve Opening pressure	D4A	1.8~2.2kg/cm ²		Replace
		D4DA	3.7~4.3kg/cm ²		
	Bypass valve spring installed load (Installed length : 51)	D4A	2.6~2.7kg/cm ²		Replace
	Regulator valve opening pressure	D4DA	5.7~6.3kg/cm ²		Replace

2. Tightening Torque Table

Description			Thread size O.D. × pitch mm	Tightening torque (kgf m)	Remarks
Oil pump	Relief valve	D4A	M27 × 1.5	7	
	Cover to case mounting bolt	D4A	M8 × 1.5	2	
Oil Filter	Combination filter element		M26 × 1.5	1.8 ~ 2.2	
	Bypass filter			12 to 20(1.2 to 2)	
Oil cooler	Mounting bolt		M10 × 1.5	4.5	
	Front and rear cover bolt	D4A	M8 × 1.5	1.3 ~ 2.1	
	Bypass vlave	D4A	M20 × 1.5	1.5 ~ 2	
		D4DA	M16 × 1.5	2	
Strainer mounting bolt			M10 × 1.5	4.1	

4. SPECIAL TOOLS

Tool name	Part number	Shape (Unit : mm)	Use						
Filter wrench	MH06158	 <table><tr><th>Part No.</th><th>Dimension A</th><th>Application</th></tr><tr><td>MH06158</td><td>101.2</td><td>Full-flow filter element</td></tr></table>	Part No.	Dimension A	Application	MH06158	101.2	Full-flow filter element	Removal and installation of oil filter element
Part No.	Dimension A	Application							
MH06158	101.2	Full-flow filter element							

5. SERVICE PROCEDURES

5-1 Engine oil replacement

1) Draining

Warm up the engine and remove oil filler cap. Then, remove oil pan drain plug and allow the engine oil to drain out.

<D4DA>

Remove the oil filter drain plug to allow the engine oil inside the oil filter to drain out.

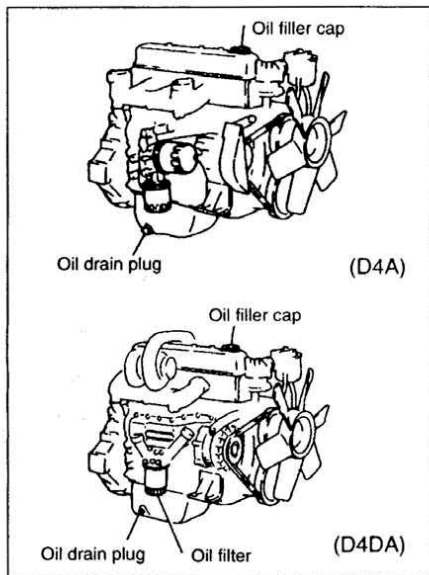
2) Filling

Tighten oil pan drain plug to the specified torque. Then, pour the specified amount of new engine oil into the engine.

Tightening torque: 34 to 39 N · m {3.5~4.0 kgf · m}

3) Engine oil.

Engine	D4AN/AF	D4AK	D4DA
API Quality	CC or above	CD or above	←
Oil Quality	8.2 l	←	7.5 l



Oil pressure measurement

With the oil pressure switch removed and pressure gauge installed, warm up the engine until the oil temperature reaches 70℃ to 90℃.

Measure the oil pressure at idle and maximum speeds.

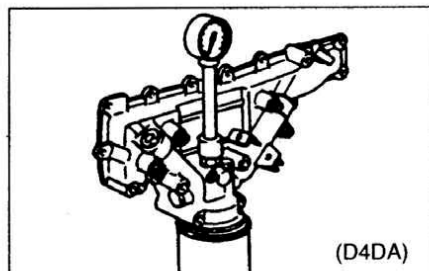
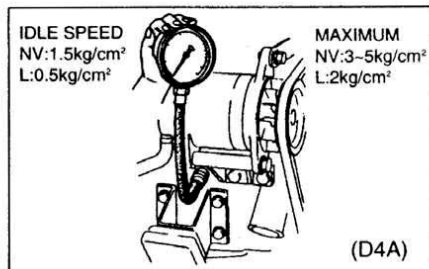
If the measurement is below the limit, overhaul the lubricating system.

<D4DA>

Removal engine oil pressure switch from oil cooler.

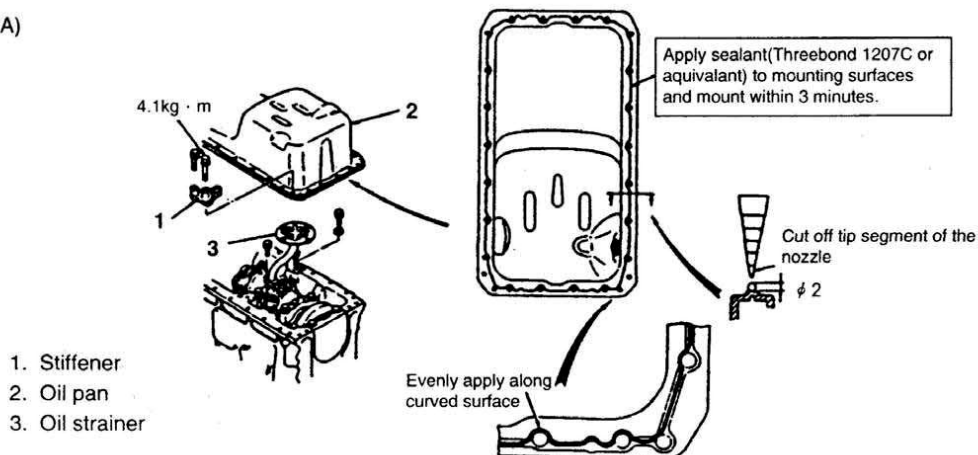
Mount an oil pressure gauge in the place

	Standard value	Limit	Remedy
At no-load minimum speed	1.5kg/cm ²	0.5kg/cm ²	Inspect
At no-load maximum speed	3~5kg/cm ²	2kg/cm ²	

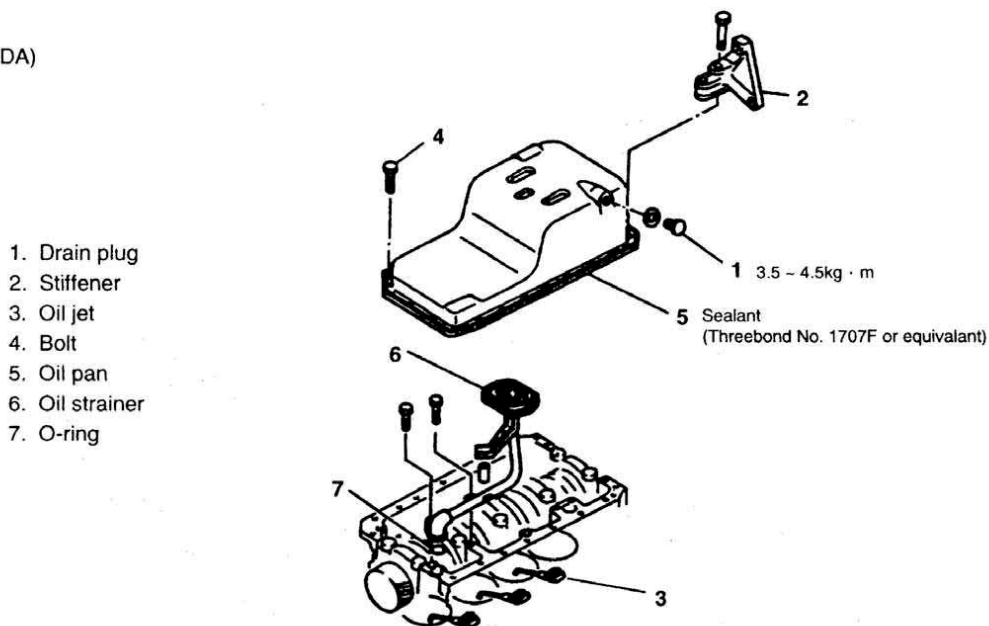


5-2 OIL STRAINER, OIL PAN

(D4A)



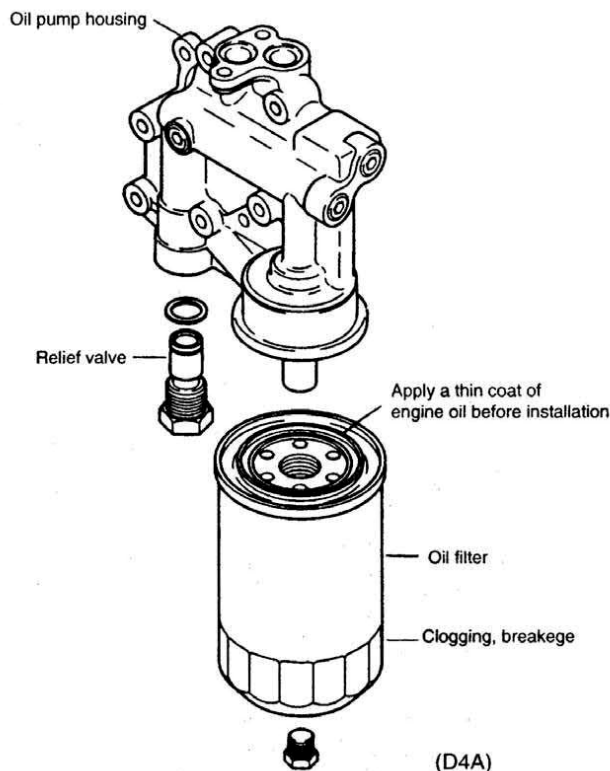
(D4DA)



NOTE:

1. When applying sealant to the oil pan surfaces, make sure that the surfaces are free from oil and grease.
2. Sealant must be applied evenly.
3. After installing the oil pan, ensure that there is no shift.
4. Never attempt to start the engine within one hour after the oil pan is installed.
5. If the oil pan attaching bolt has been loosened, be sure to apply new sealant.

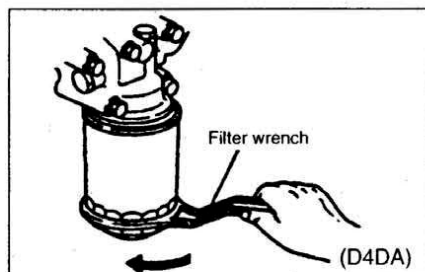
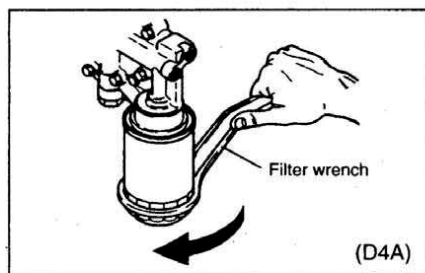
5-3 OIL FILTER



Removal use of filter wrench(Special tool) oil filter

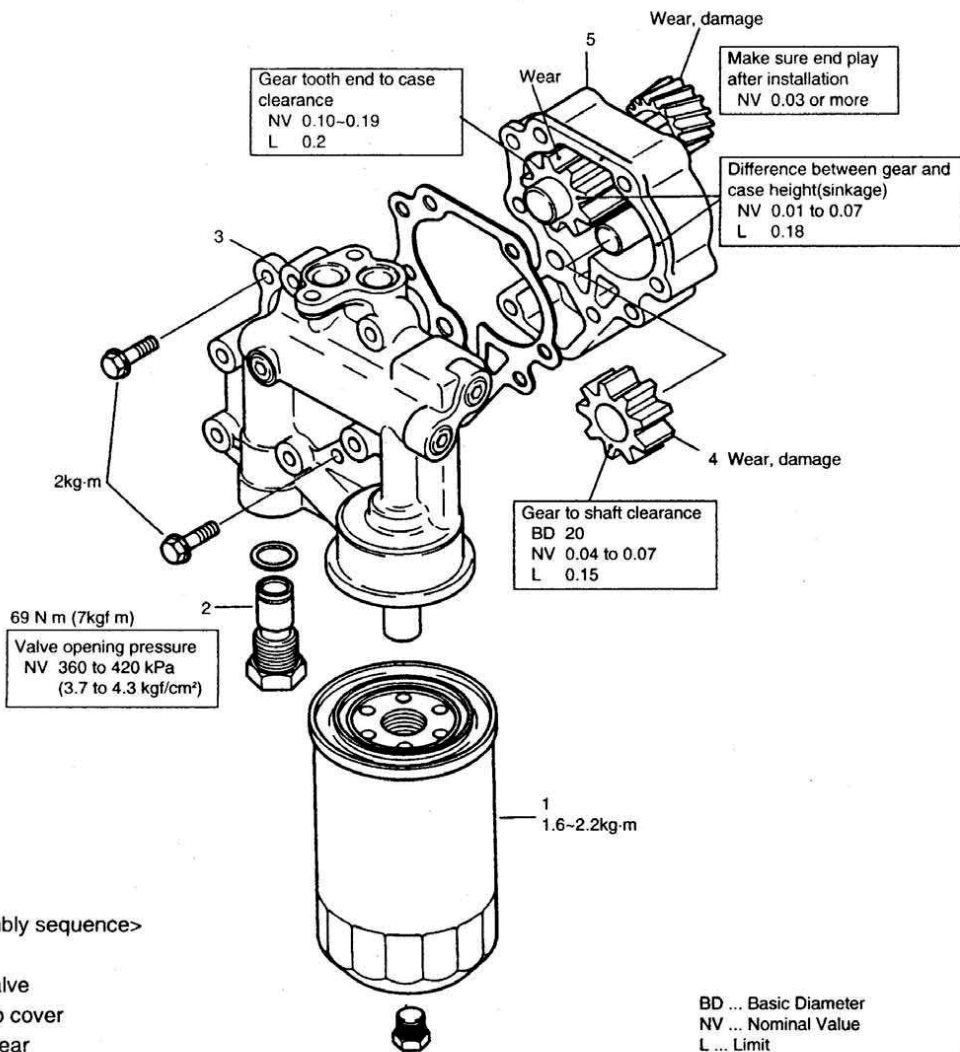
NOTE:

1. For removal and installation of the spin-on type element, use Filter Wrench (special tool). Note, however, that the bypass oil filter element must be tightened by hand.
2. After the element has been installed, start the engine and check connections for oil leaks.



5-4 OIL PUMP

<D4A>



<Disassembly sequence>

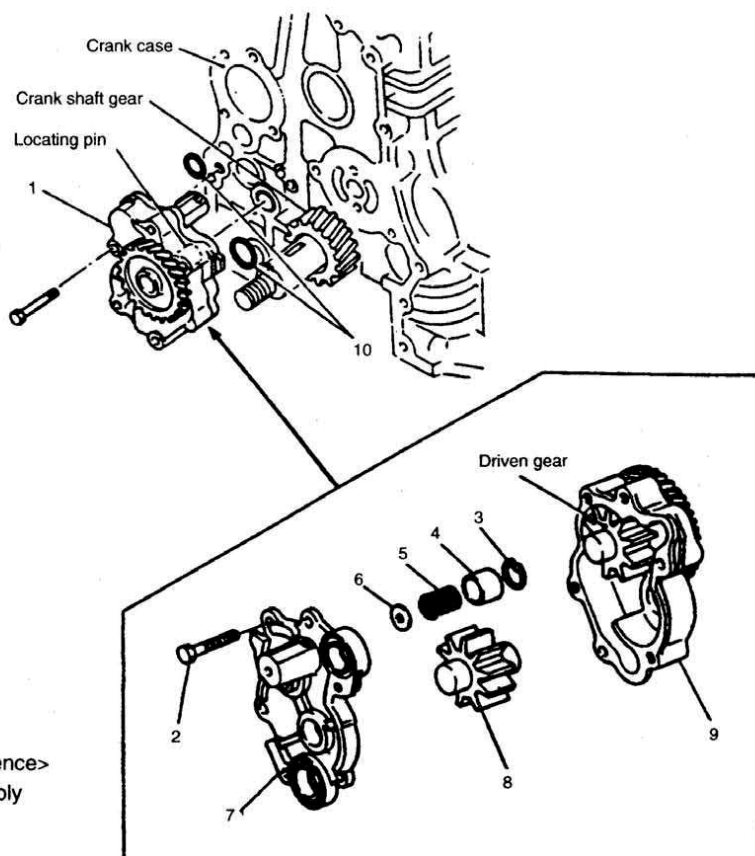
1. Oil filter
2. Relief valve
3. Oil pump cover
4. Driven gear
5. Oil pump case assembly

NOTE:

1. The gear is a shrink fit in the shaft of the oil pump case assembly and do not attempt to disassemble more than the illustration.
2. Before reassembly, be sure to apply engine oil to parts.

For reassembly, reverse the order of disassembly.

<D4DA>



<Disassembly sequence>

1. Oil pump assembly
2. Bolt
3. Snap ring
4. Relief valve
5. Spring
6. Seat
7. Oil pump cover
8. Driven gear assembly
9. Oil pump case assembly
10. O-ring

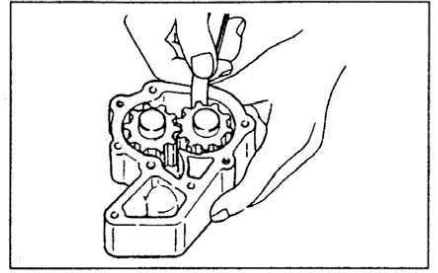
Assembly sequence

Reverse the order of disassembly

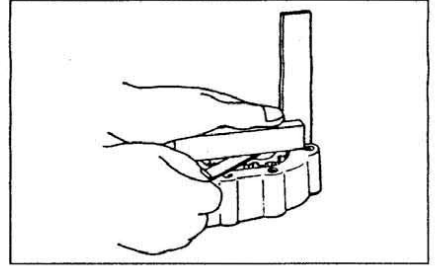
Service procedure

<D4A>

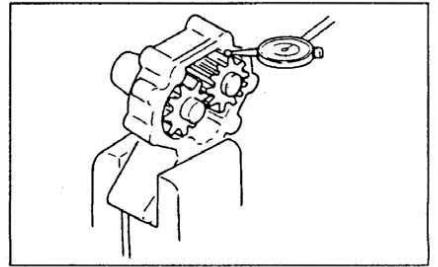
- (a) Measure the drive and driven gear tooth end to oil pump case clearance. If the measurement exceeds the limit, replace the parts.



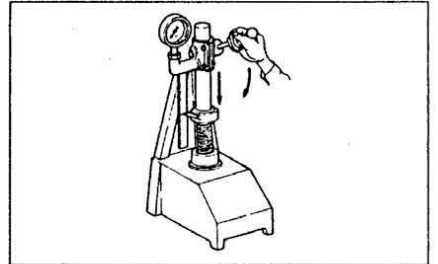
- (b) Measure the difference between the drive and driven gears tooth end height and the oil pump case depth. If the limit is exceeded, replace the parts.



- (c) Measure the play in the diametral direction of the driven gear to check for driven gear to shaft clearance. If the clearance exceeds the limit, replace the parts.



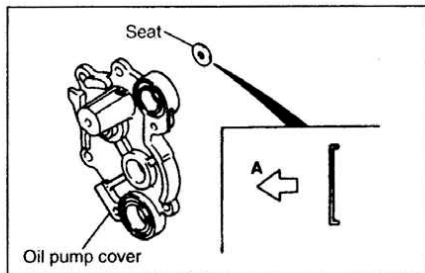
- (d) Measure the load at installed length of the relief valve spring. If the load is far beyond the nominal value, replace parts.



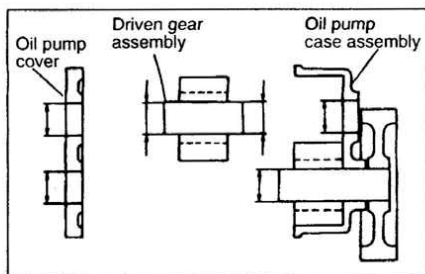
<D4DA>

(a) Installation of seat

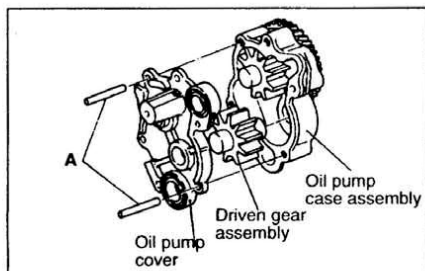
A: Oil pump assembly side.



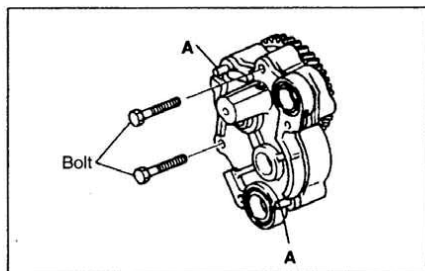
- (b) Measure the clearance between each gear shaft and the oil pump case or cover. If the measured value exceeds the limit, replace the faulty parts



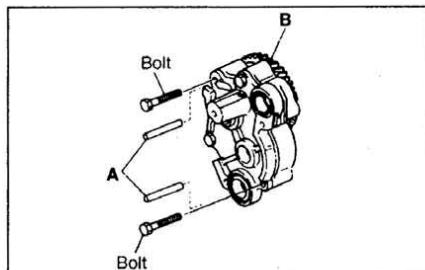
- (c) Position oil pump cover on oil pump case assembly using two $\phi 9\text{mm}$ pins A.



- (d) Fit bolts and tighten to the specified torque.



- (e) Remove pins A, then fit other bolts and tighten to the specified torque.

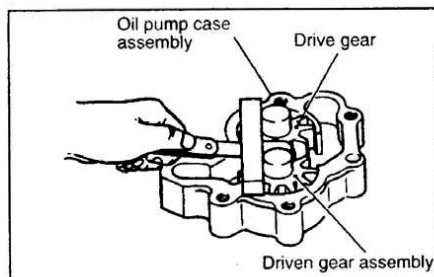


NOTE:

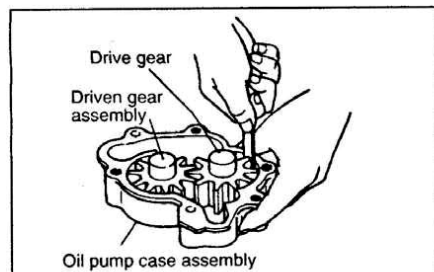
After assembly, turn the oil pump gear B by hand and check that it rotates smoothly.

If the gear does not rotate smoothly, disassemble and reassemble the components.

- (f) Differences between gear heights and case depth
Replace any component whose measurement is out of specification.



- (g) Clearance between gear teeth and oil pump case
Replace any component whose measurement is out of specification.



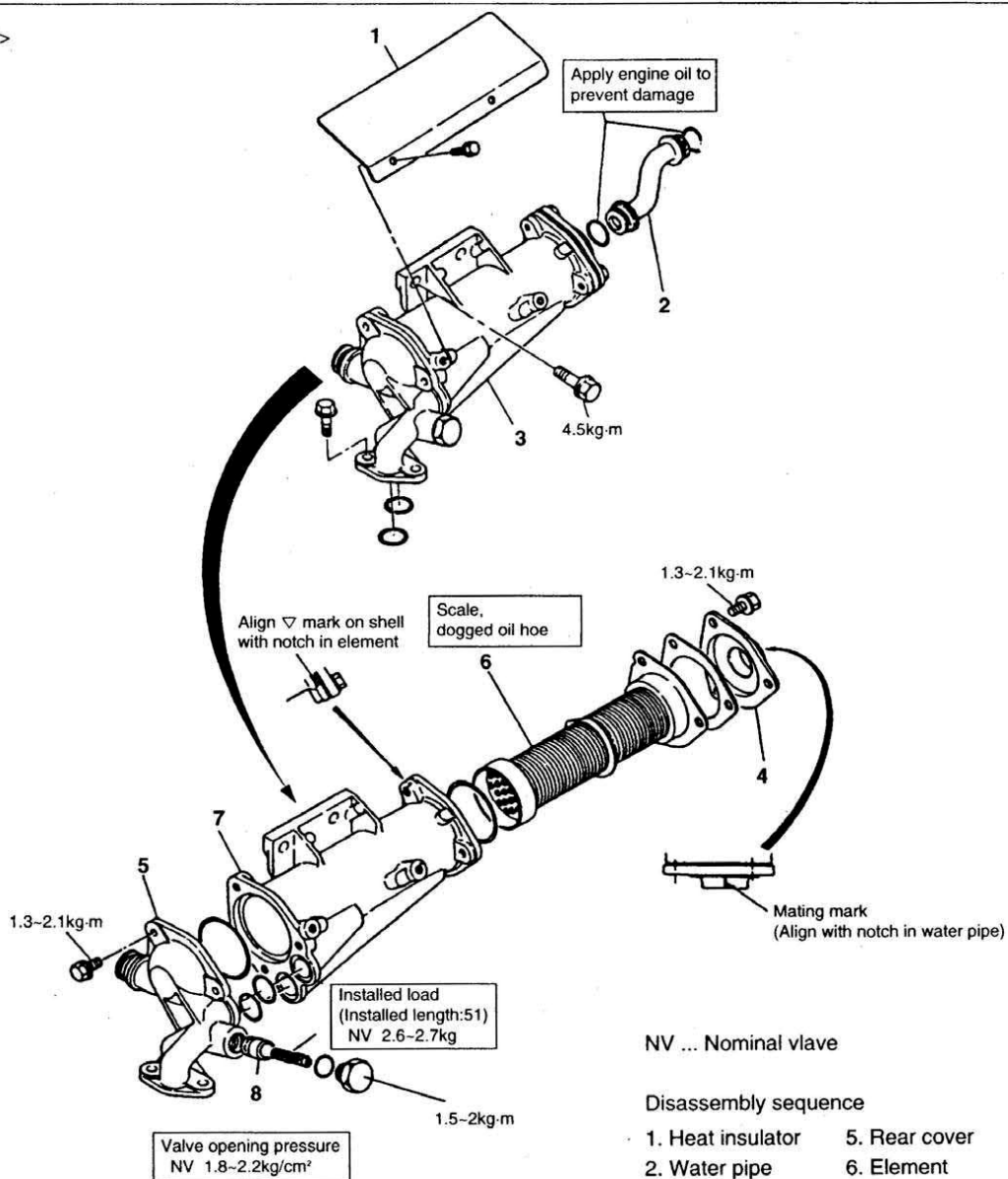
5-5. OIL COOLER

Disassembly and Reassembly

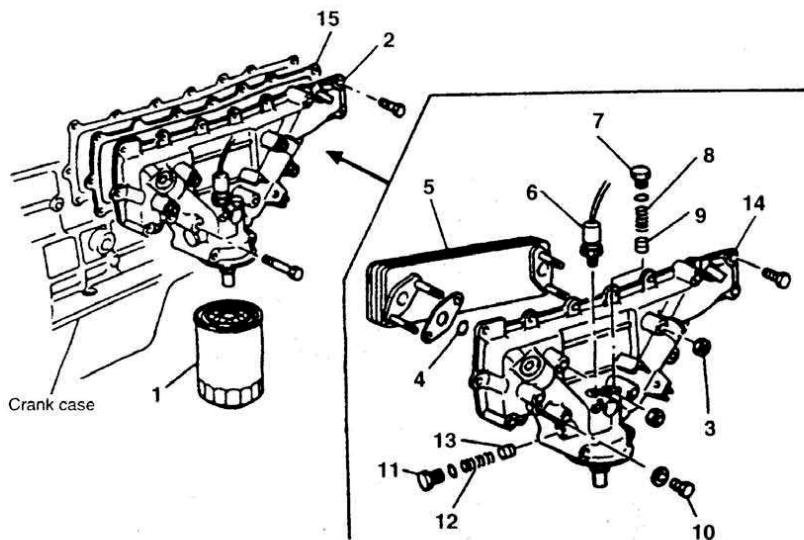
Removal oil cooler after removing exhaust manifold.

When installing the oil cooler, align it with the oil pump mounting surface.

<D4A>



<D4DA>



Disassembly sequence

- | | | |
|-----------------------|------------------------|---------------------|
| 1. Oil filter | 6. Oil pressure switch | 11. Plug |
| 2. Oil cooler | 7. Plug | 12. Spring |
| 3. Nut | 8. Spring | 13. By pass valve |
| 4. O-ring | 9. Regulator valve | 14. Oil cooler body |
| 5. Oil cooler element | 10. Drain plug | 15. Gasket |

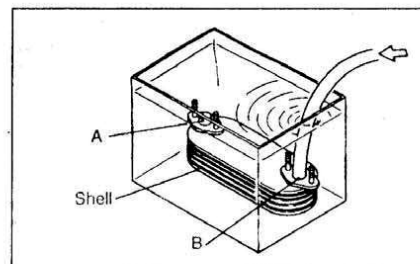
(a) Cleaning

- Check whether carbon deposits or sludge have accumulated in the oil passages of oil cooler element and the oil cooler's bypass arrangement. Remove any deposits with cleaning sealant.
- Clean out any water scale or fur that has accumulated in oil cooler element or oil cooler body.

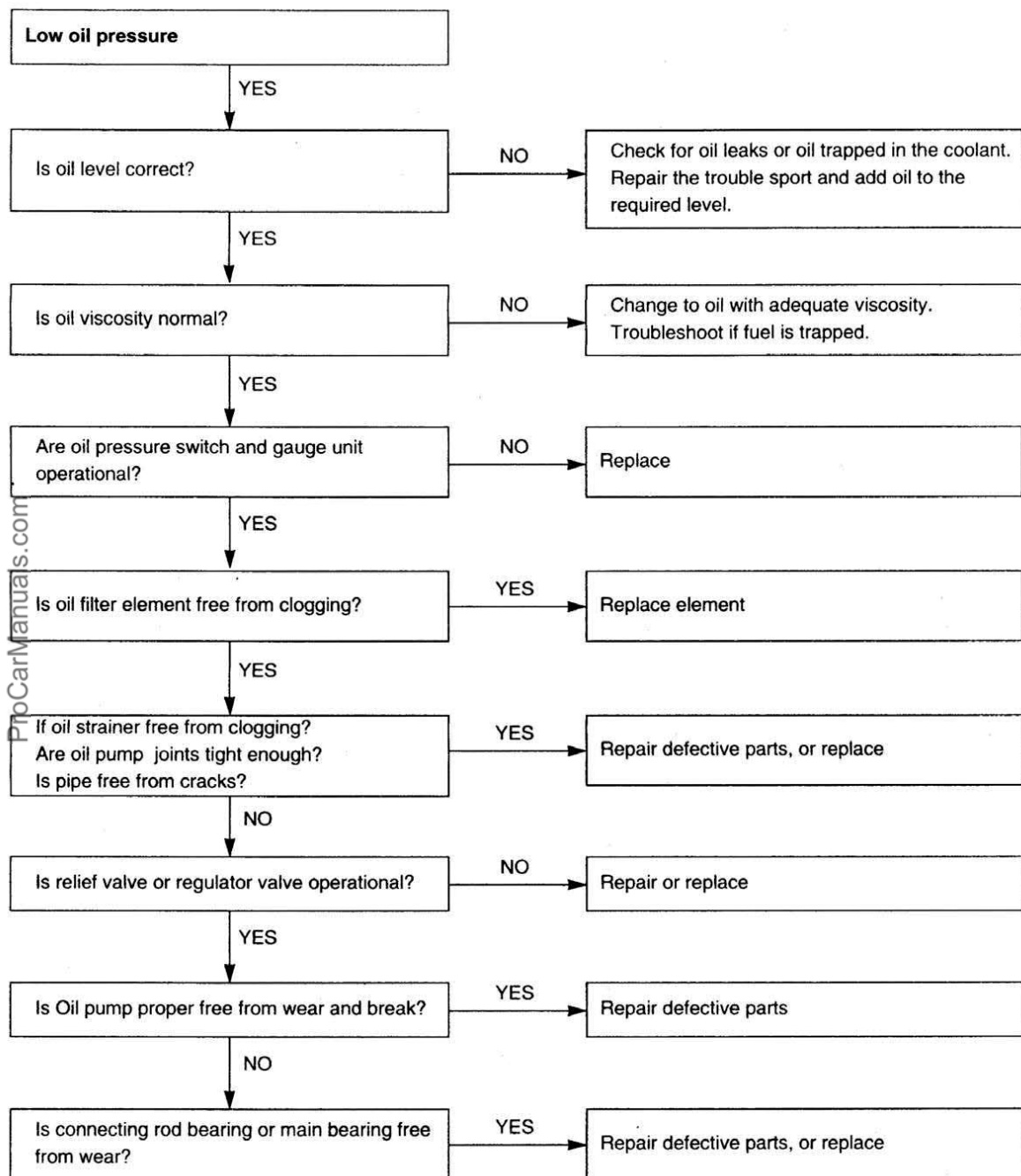
(b) Inspection of oil cooler element (D4DA)

[inspection]

- Seal outlet A of oil cooler element and connect a hose to engine oil inlet B. Then, immerse the oil cooler element in a tank of water.
- Apply air pressure of 980 kPa (10 kgf/cm²) for seconds via the hose and check whether air leaks out of oil cooler element.
- If any air leaks, replace the oil cooler element.



6.TROUBLESHOOTING



Excessive oil consumption

Check following parts for leaks:

- Oil filter
- Oil cooler
- Oil pan
- Pipings
- Rocker cover

YES

Repair leaks

NO

Are front and rear crankshaft oil seals free from leaks?

NO

Repair defective parts, or replace

YES

Are liner to cooling system free from leaks?

NO

Repair leaks of oil cooler-water jacket, etc.

YES

Check engine bearings for wear, resulting in oil working up, etc.

NO

Correct or replace