CONTENTS

HOISTING INSTRUCTIONS

HOISTING

> ⚠ Heavy parts (25 kg or more) must be lifted with a hoist, etc. In the **DISASSEMBLY AND ASSEMBLY** section, every part weighing 25 kg or more is indicated clearly with the symbol 

- If a part cannot be smoothly removed from the machine by hoisting, the following checks should be made:
  1) Check for removal of all bolts fastening the part to the relative parts.
  2) Check for existence of another part causing interference with the part to be removed.

WIRE ROPES

1) Use adequate ropes depending on the weight of parts to be hoisted, referring to the table below:

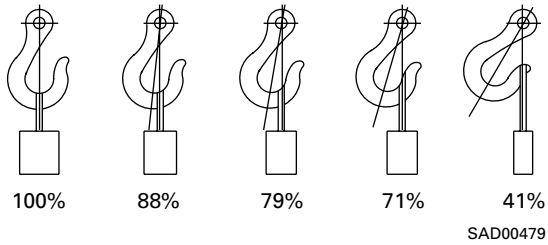
Wire ropes
(Standard "Z" or "S" twist ropes
without galvanizing)

Rope diameter	Allowable load	
mm	kN	tons
10	9.8	1.0
11.5	13.7	1.4
12.5	15.7	1.6
14	21.6	2.2
16	27.5	2.8
18	35.3	3.6
20	43.1	4.4
22.4	54.9	5.6
30	98.1	10.0
40	176.5	18.0
50	274.6	28.0
60	392.2	40.0

★ The allowable load value is estimated to be one-sixth or one-seventh of the breaking strength of the rope used.

2) Sling wire ropes from the middle portion of the hook.

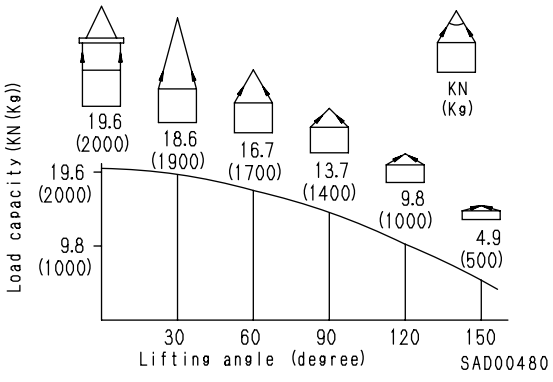
Slinging near the edge of the hook may cause the rope to slip off the hook during hoisting, and a serious accident can result. Hooks have maximum strength at the middle portion.



3) Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound onto the load.

> ⚠ Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original winding position on the load, which can result in a dangerous accident.

4) Do not sling a heavy load with ropes forming a wide hanging angle from the hook.
When hoisting a load with two or more ropes, the force subjected to each rope will increase with the hanging angles. The table below shows the variation of allowable load kN {kg} when hoisting is made with two ropes, each of which is allowed to sling up to 9.8 kN {1000 kg} vertically, at various hanging angles.
When two ropes sling a load vertically, up to 19.6 kN {2000 kg} of total weight can be suspended. This weight becomes 9.8 kN {1000 kg} when two ropes make a 120° hanging angle. On the other hand, two ropes are subjected to an excessive force as large as 39.2 kN {4000 kg} if they sling a 19.6 kN {2000 kg} load at a lifting angle of 150°.



CONVERSION TABLE

METHOD OF USING THE CONVERSION TABLE

The Conversion Table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion Table, see the example given below.

EXAMPLE

- Method of using the Conversion Table to convert from millimeters to inches

1. Convert 55 mm into inches.
   (1) Locate the number 50 in the vertical column at the left side, take this as Ⓐ, then draw a horizontal line from Ⓐ.
   (2) Locate the number 5 in the row across the top, take this as Ⓑ, then draw a perpendicular line down from Ⓑ.
   (3) Take the point where the two lines cross as Ⓒ. This point Ⓒ gives the value when converting from millimeters to inches. Therefore, 55 mm = 2.165 inches.
2. Convert 550 mm into inches.
   (1) The number 550 does not appear in the table, so divide by 10 (move the decimal point one place to the left) to convert it to 55 mm.
   (2) Carry out the same procedure as above to convert 55 mm to 2.165 inches.
   (3) The original value (550 mm) was divided by 10, so multiply 2.165 inches by 10 (move the decimal point one place to the right) to return to the original value. This gives 550 mm = 21.65 inches.

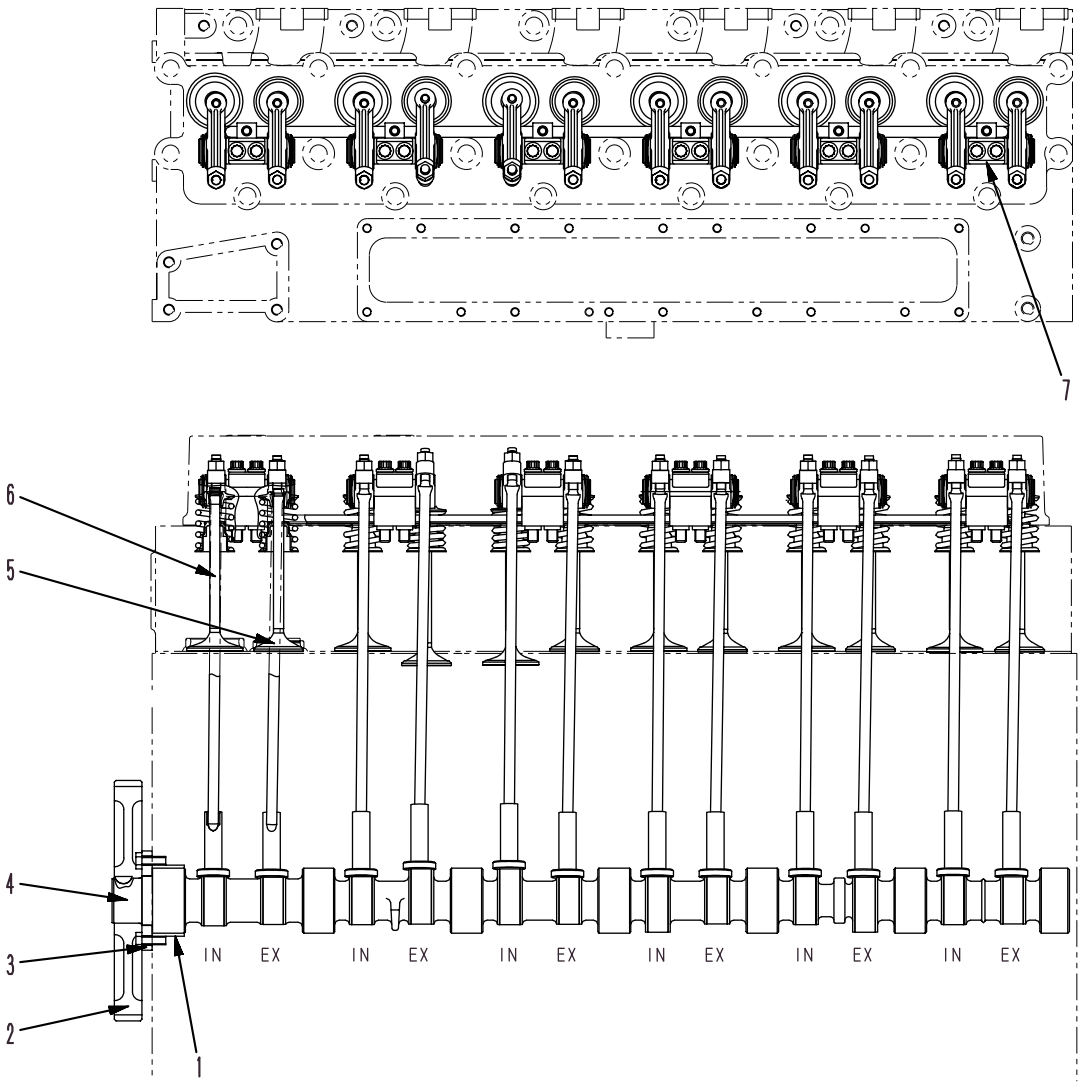
Millimeters to inches

1 mm = 0.03937 in

	0	1	2	3	4	5 (Ⓑ)	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50 (Ⓐ)	1.969	2.008	2.047	2.087	2.126	2.165 (Ⓒ)	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

VALVE MECHANISM

SAA6D114E-2



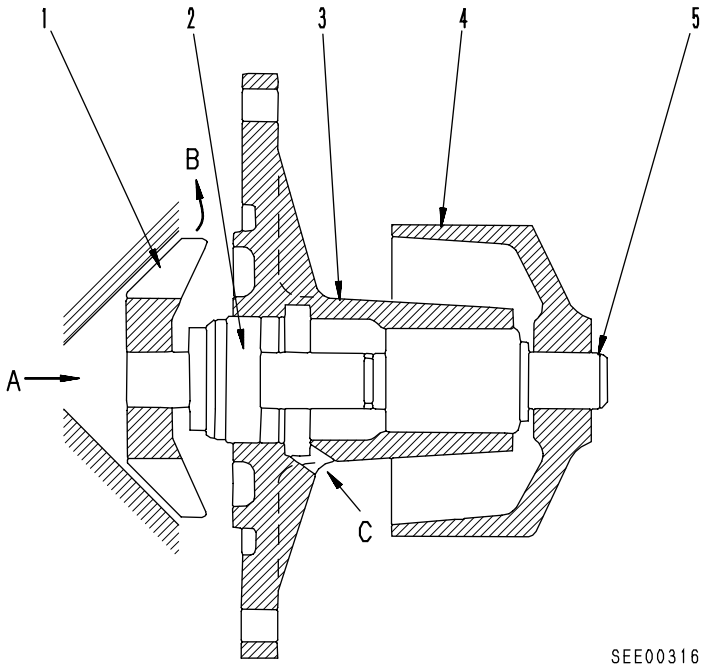
SJE01924

1. Cam bushing (No. 1 journal)
2. Cam gear (No. of teeth: 84)
3. Thrust plate
4. Camshaft
5. Exhaust valve
6. Intake valve
7. Rocker arm bracket
8. Valve seat (intake, exhaust)
9. Valve spring
10. Valve cotter
11. Spring seal
12. Adjustment screw
13. Locknut
14. Rocker arm
15. Push rod
16. Tappet

WATER PUMP

(WITH ONE-PIECE BEARING, SHAFT, ONE-PIECE WATER SEAL)

★ Depending on the machine model, the actual component may be different from the diagram.



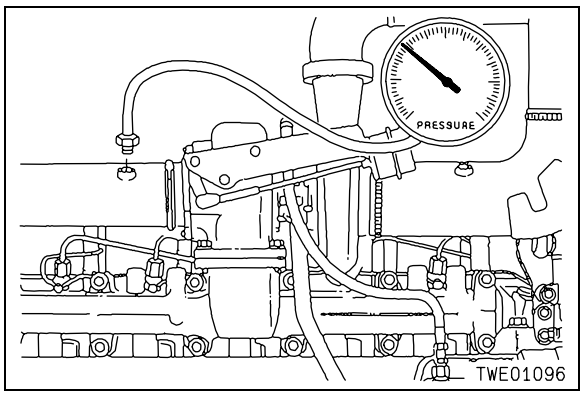
1. Impeller
2. Water seal
3. Pump body
4. Pulley
5. Drive shaft

A. Water inlet port
B. Water outlet port (to engine)
C. Breather (drain hole)

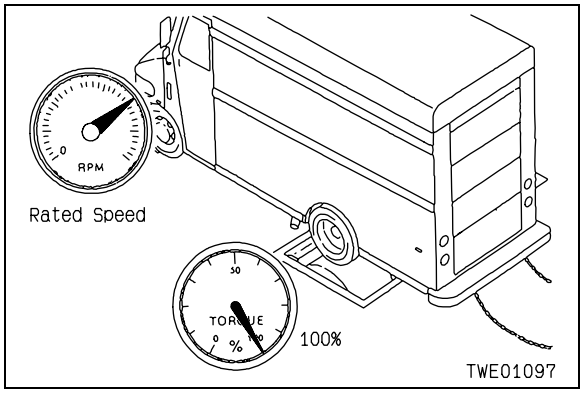
Water pump
Type: Centrifugal, driven by poly vinyl V-belt

MEASURING EXHAUST RESISTANCE

Install a pressure gauge (795-790-1470) to the inlet port where the pressure tap of the exhaust head pipe passes through to the catalyst/muffler assembly.
Run the engine at rated speed and no load, and note the exhaust resistance.



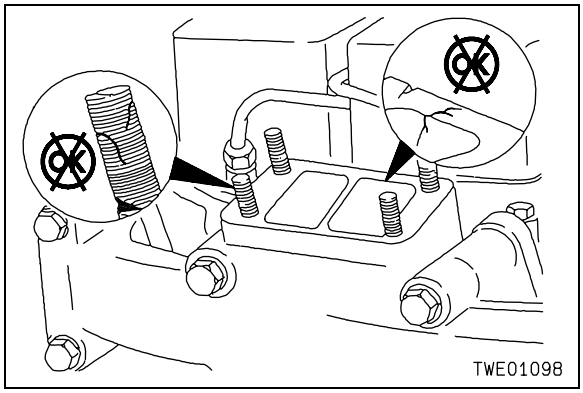
If the resistance exceeds the specification, check the oxidizing catalyst and/or muffler, and replace.
Industrial use: 10.13 kPa {76 mmHg}
Oxidizing catalyst equipment
(94 EPA certification): 20.26 kPa {152 mmHg}



REPLACING TUBOCHARGER (ENGINE WITH TURBOCHARGER)

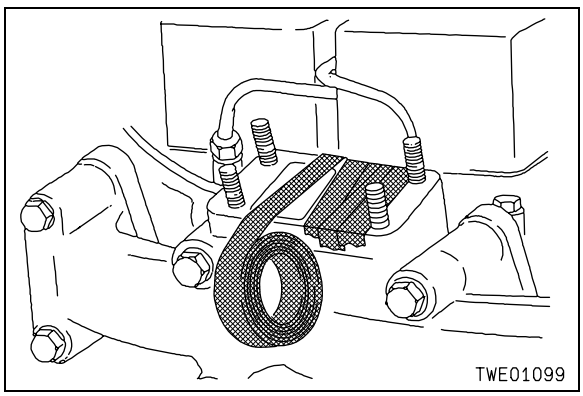
Cleaning and testing

Clean the seal surface. Check for damage to the seal surface and mounting stud.



Caution: If you are not going to replace the turbocharger immediately, block the opening to prevent dust from entering the manifold.

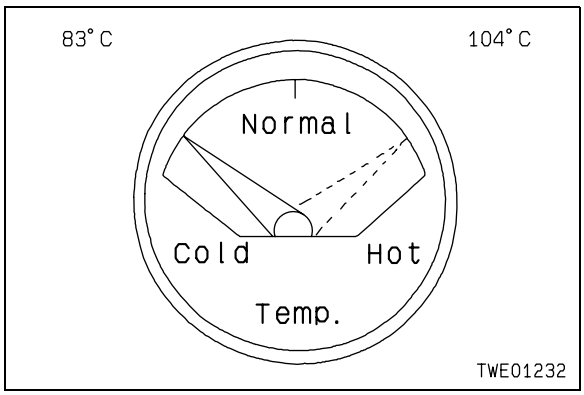
Check the turbocharger westgate link, valve shaft, module, and pressure signal line.
Check and adjust the westgate.

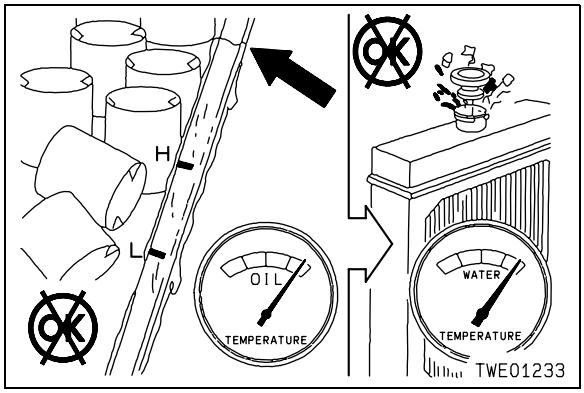


TROUBLESHOOTING DEFECTIVE OPERATION OF COOLING SYSTEM

TROUBLESHOOTING

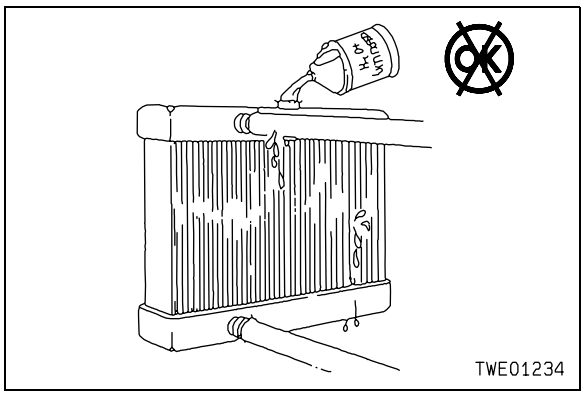
The function of the cooling system is to maintain the engine at the specified operating temperature. The heat produced by the engine is partially absorbed by the cooling water circulating in the cylinder block and cylinder head. The heat absorbed by the cooling water is removed while the water flows inside the radiator. When carrying out troubleshooting for overheating, do not forget that if the level of the oil in the oil pan is too high, the friction caused when the connecting rod journal is immersed in the oil will generate more heat.
Filling with oil above the specified level will increase the oil temperature, and this will increase the temperature of the cooling water passing through the oil cooler.





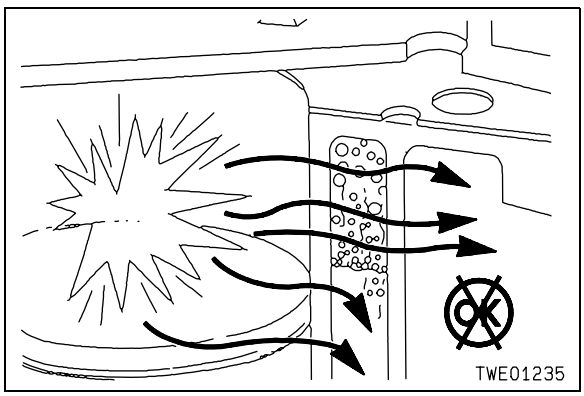
The cooling system is designed so that the specified amount of cooling water is used. If the water level is low, the engine will operate at a temperature higher than the specified temperature.

Caution: If water must be added frequently, there is leakage in the cooling system. Locate the cause of the leakage and repair it.



Caution: The cooling water passages in the engine must be completely filled with cooling water.

When the engine is running, air (bubbles) in the cooling water will cause corrosion due to cavitation, and this will reduce the efficiency of the heat transfer. If there are excessive bubbles, it will cause concentrated overheating at one part of the cylinder head and cylinder block, and this will cause cracking of the cylinder head, scoring of the cylinder, and blowing out from the head gasket.



S-6 Engine lacks output (or lacks power)

General causes why engine lacks output

- Insufficient intake of air
- Insufficient supply of fuel
- Improper condition of fuel injection
- Improper fuel used
  (if non-specified fuel is used, output drops)
- Lack of output due to overtaking

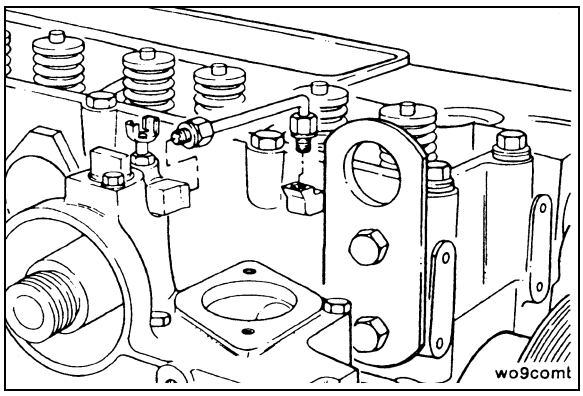
★ If there is overheating and lack of output, carry out troubleshooting for S-14 overheating.

			Causes: Clogged air cleaner element	Seized turbocharger, interference	Worn piston ring, cylinder	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged injection nozzle, defective spray	Seized injection pump plunger	Improper valve clearance	Defective contact of valve and valve seat	Bent fuel lever linkage, defective adjustment	Clogged, leaking fuel piping	Clogged air breather hole in fuel tank	Defective boost compensator diaphragm	Defective westgate diaphragm
Questions	Confirm recent repair history															
	Degree of use of machine	Operated for long period	△		△	△	△				△					
	Power was lost	Suddenly		◎											◎	◎
		Gradually	○		○	○	○	○			○					
	Engine oil must be added more frequently				◎											
	Replacement of filters has not been carried out according to Operation Manual		◎			◎	◎									
	Non-specified fuel is being used					◎	◎	◎	◎							
Check items	Dust indicator lamp is red		◎													
	Color of exhaust gas	Black	◎	◎												
		Blue under light load			◎											
	Noise of interference is heard from around turbocharger			◎												
	Blow-by gas is excessive				◎									○		
	Engine pickup is poor and combustion is irregular			◎				○				○	○			
	High idling speed under no load is normal, but speed suddenly drops when load is applied				◎	◎							○			
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low						◎	○								
	There is hunting from engine (rotation is irregular)					○	○					○	○			
	Clanging sound is heard from around cylinder head								◎							
	High idling speed of engine is low							○			◎					
	Leakage from fuel piping											◎				
Troubleshooting	When air cleaner element is inspected directly, it is found to be clogged		●													
	When turbocharger is rotated by hand, it is found to be heavy			●												
	When compression pressure is measured, it is found to be low				●					●						
	When fuel filter, strainer are inspected directly, they are found to be clogged					●										
	When feed pump strainer is inspected directly, it is found to be clogged						●									
	Speed does not change when operation of certain cylinders is stopped							●								
	When control rack is pushed, it is found to be heavy, or does not return								●							
	When valve clearance is checked directly, it is found to be outside standard value									●						
	When lever is placed at FULL position, it does not contact stopper										●					
	When feed pump is operated, operation is too light or too heavy											●				
	When fuel tank cap is inspected directly, it is found to be clogged												●			
		Remedy	Clean	Replace	Replace	Clean	Clean	Correct	Replace	Adjust	Replace	Adjust	Correct	Clean	Replace	Replace

REMOVAL OF COOLANT AIR BLEED TUBE

9/16 inch

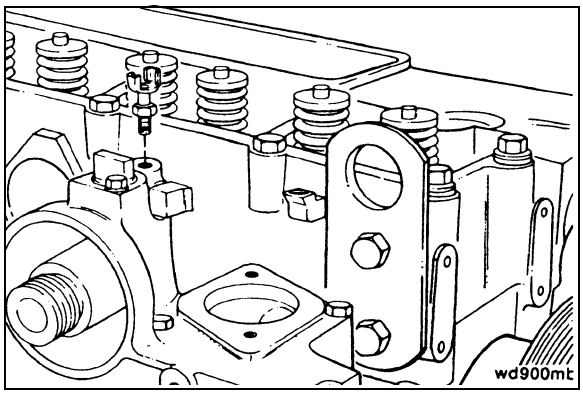
Remove the coolant air bleed tube.



REMOVAL OF COOLANT AIR BLEED VALVE

7/16 inch

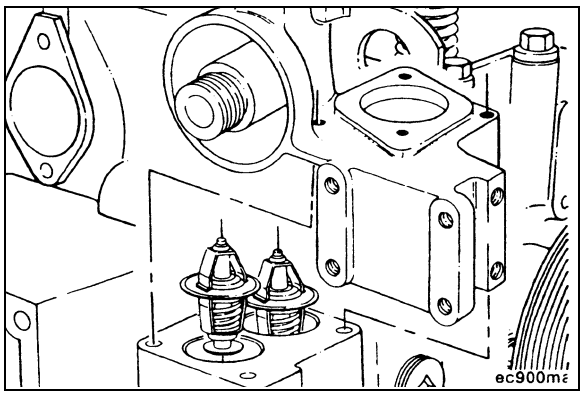
Remove the coolant air bleed valve.



REMOVAL OF THERMOSTAT AND HOUSING

10 mm

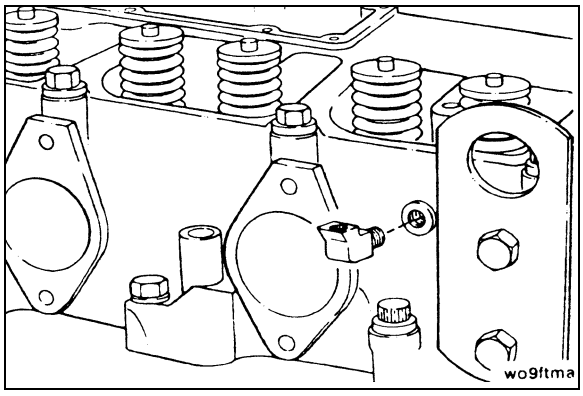
Remove the thermostat housing and thermostat.



REMOVAL OF THERMOSTAT AND HOUSING

1/2 inch

Remove the 1/8 inch brass joint from cylinder head.

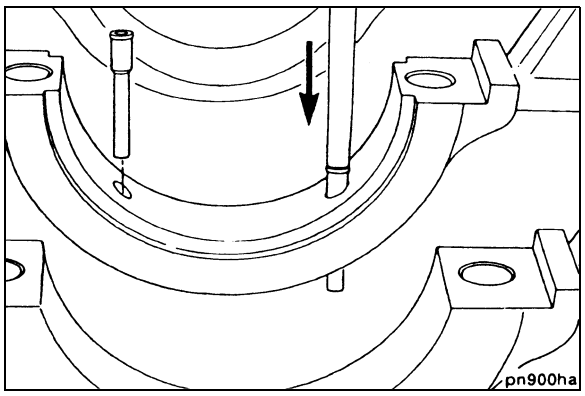


1/2 inch center punch

Install the piston cooling nozzle so that it is level with the bearing saddle surface or below it.

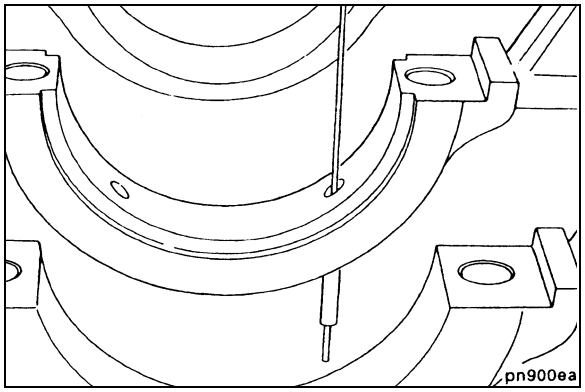
★ If the piston cooling nozzle has been removed, use a new piston cooling nozzle.

★ Because of the relationship between the position of the nozzle and the angle of the spray, there is no need for a bore in the No. 3 main bearing saddle.



Make sure that the spray hole is clean and not clogged.

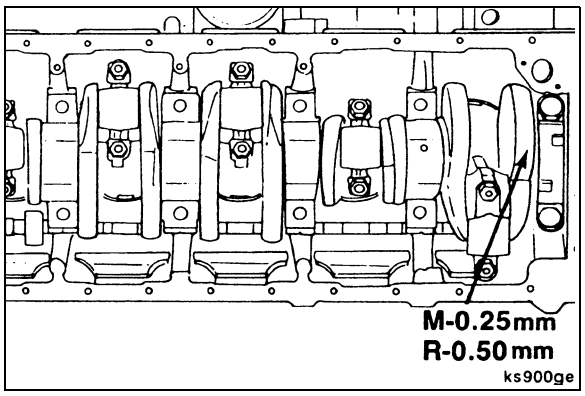
★ When washing, be careful not to damage the hole in the piston cooling nozzle.



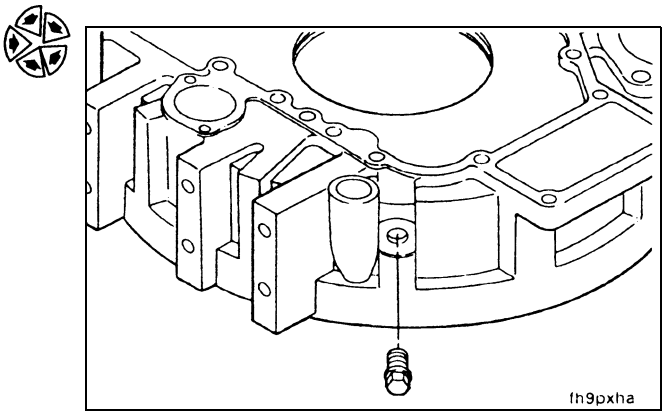
INSTALLATION OF MAIN BEARING (UPPER)

There are two oil holes in the upper bearing. There are no oil holes in the lower bearing. Both the upper main bearing and lower main bearing have a mark on the rear side showing the standard (STD) or oversize (OS) thickness.

★ With the main bearing, it is possible to use a crankshaft machined to 1 mm undersize from the original diameter. For the connecting rod and main bearing journal, the crankshaft machined to undersize has a mark on the counterweight at the front. If there is a mark on the crankshaft, check the part number of the main bearing and connecting rod to ensure that the correct bearing size is used.



Install the plastic plug in the tachometer drive access hole.

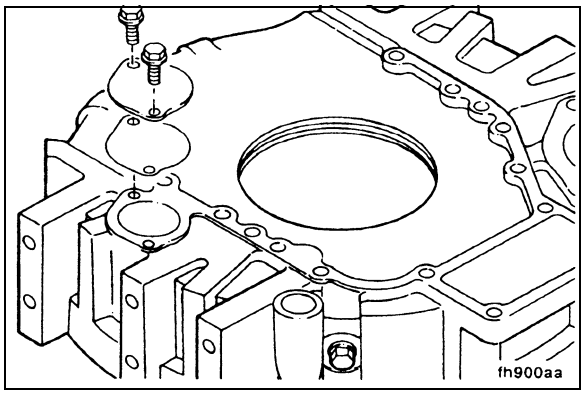


13 mm

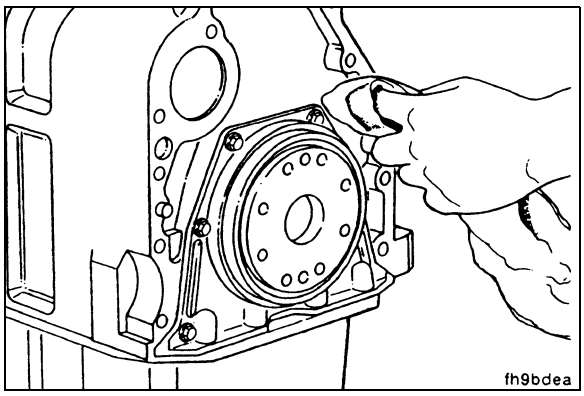
Install the access plate and new access plate gasket.

Install the access plate mounting bolts and tighten.

kgm **Mounting bolt: 24 Nm {2.4 kgm}**

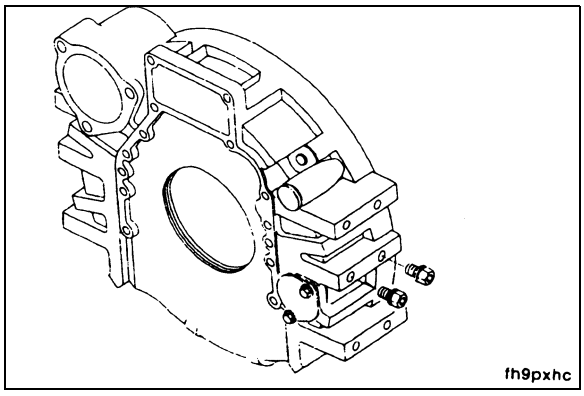


Clean the flywheel housing and cylinder block mounting surfaces completely. Wash these surfaces. There must be no oil or accumulated dirt on them.



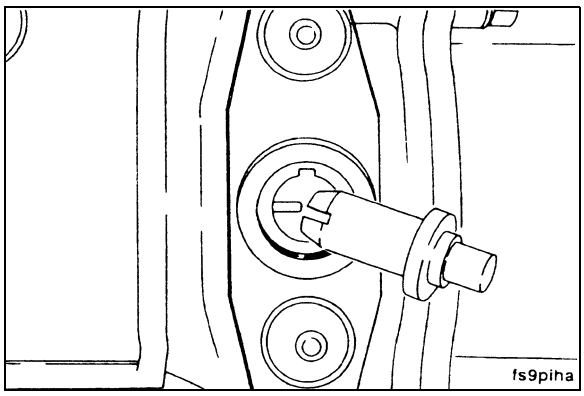
★ The center bolt hole on the flywheel housing mounting pad passes right through. Coat the stop screw with Loctite 277 and install it in the hole.

Limit for stopper bolt mounting depth	
	mm
Min.	0.00
Max.	3.0



Reverse the position of the timing pin and align it with the timing pin slot at the top of the timing teeth inside the pump.

Using the access plug, install the timing pin and fix it in position.

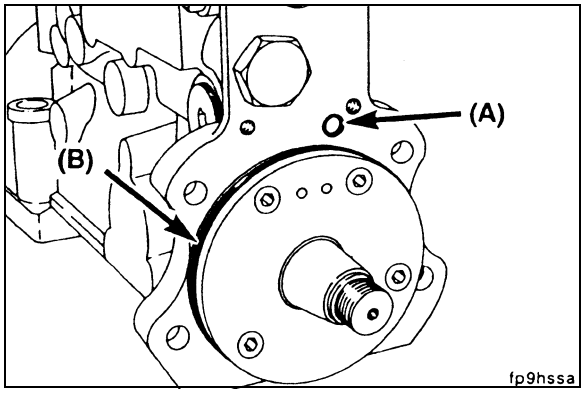


★ Install the fuel injection pump O-ring. Check that the position of the O-ring is correct and that it is not damaged.

Add oil to the mounting flange of the fuel injection pump.

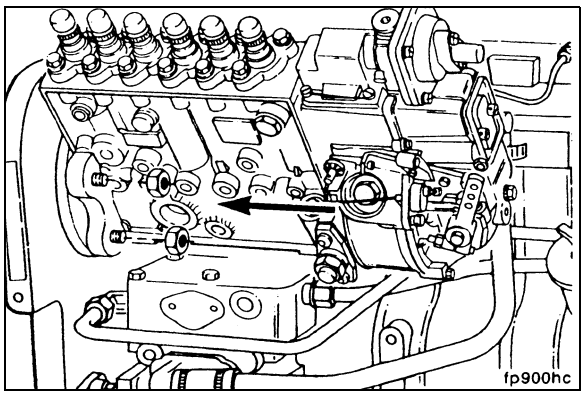
★ Before installing the gear, clean the inside diameter of the fuel injection pump drive gear and the outside diameter of the shaft, and dry them.

★ The O-ring of the oil supply orifice on the Bosch PES.P fuel injection pump is inside the gear housing.



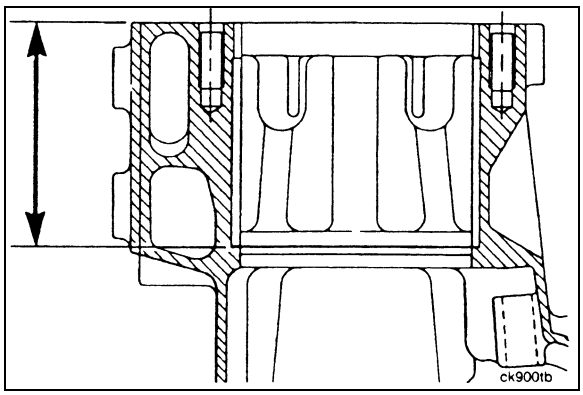
★ The semicircular key is not necessary for the drive gear. When using a new replacement pump, remove the key and dispose of it.

Position the pump flange on the mounting stud.

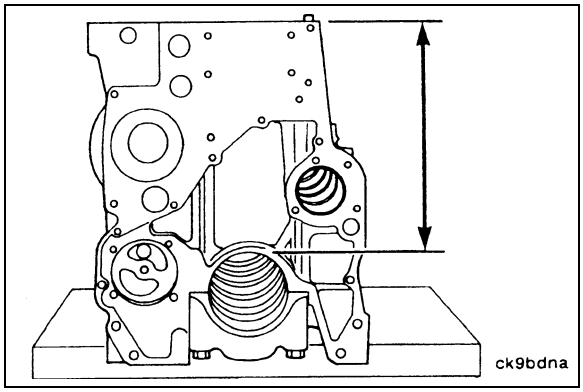


Measure the depth of the liner counterbore.

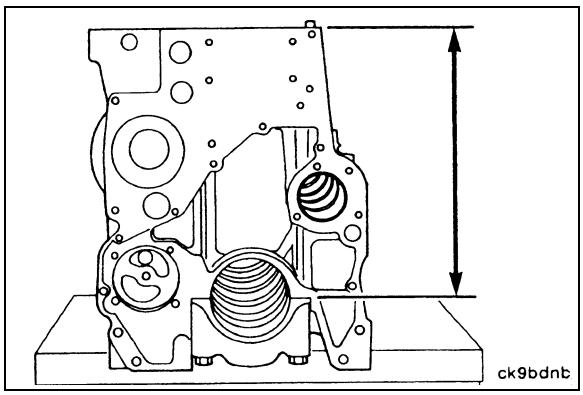
Boring depth of cylinder from top of cylinder block head	
	mm
Min.	122.930
Max.	123.000



Distance from top of cylinder block head to top of main bearing hole	
	mm
Min.	309.4
Max.	309.6



Distance from top of cylinder block head to center line of main bearing hole	
	mm
Min.	361.90
Max.	362.10

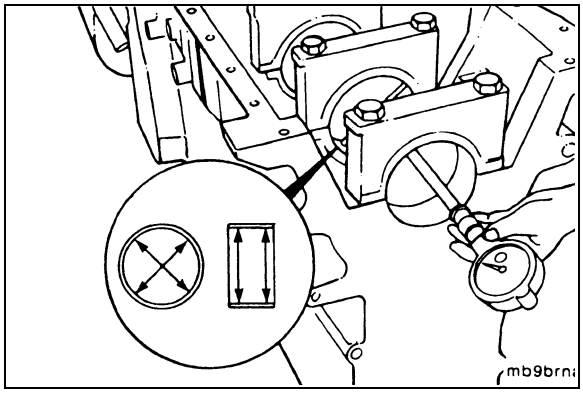


Check the main bearing holes for wear and damage. Install new main bearings and tighten the main caps, then measure the diameters of the holes.

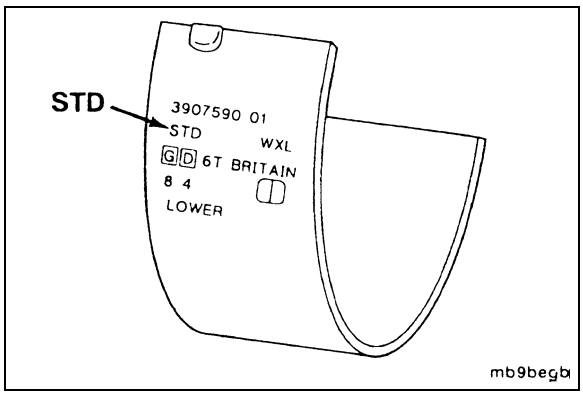
kgm **Main cap bolt: 176 Nm {17.9 kgm}**

Diameter of main bearing hole		
		mm
With new bearings installed:	Min.	98.079
	Max.	98.125
Without bearings	Min.	104.982
	Max.	105.018

★ The radial runout must not exceed 0.0127 mm.

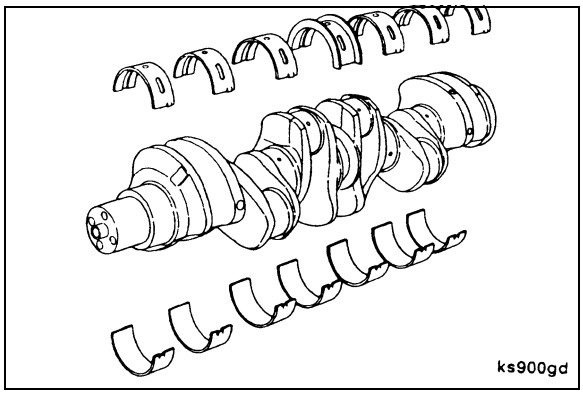


The upper bearings contain two oil holes. The lower bearings do not. Both bearings are marked on the back to indicate either standard (STD) or oversize (OS).



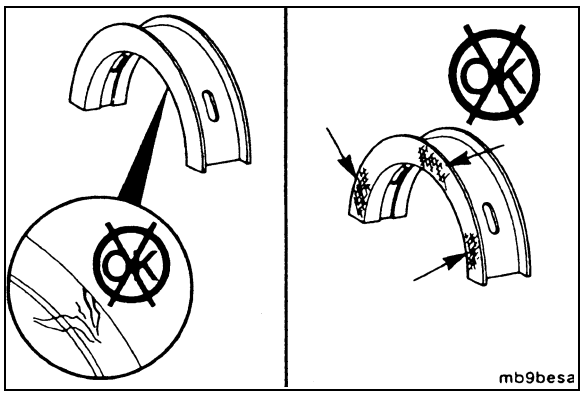
The following oversize service main and thrust bearing combinations are available for crankshafts that have been machined undersize, either on the main journal or thrust bearing face:

		Size of thrust bearing		
	Oversize	**0.000**	**0.25mm**	**0.50mm**
Journal Outside diameter	0.000	x	x	x
	0.25mm	x	x	
	0.50mm	x		x
	0.75mm	x		
	1.00mm	x		



INSPECTION OF THRUST BEARING

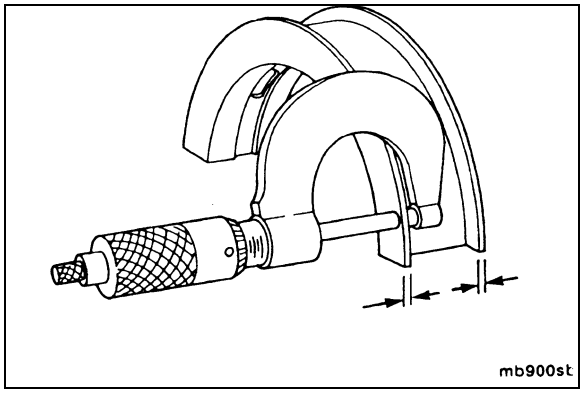
Visually inspect the faces of the thrust bearing in contact with the front side, rear side, and crankshaft for wear, cracking, and damage.



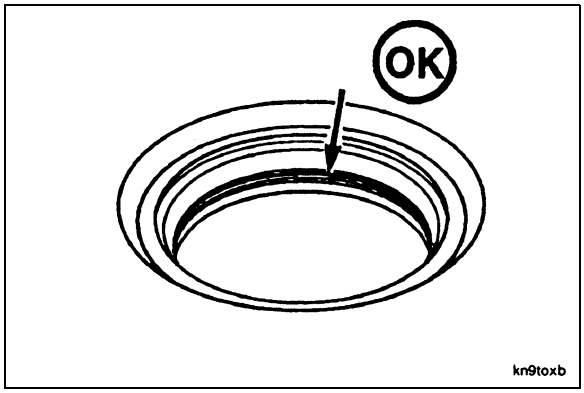
Measure the thickness of the flange of each thrust bearing. Measure the contact areas on front and rear sides.

Thickness of flange of thrust bearing	
	mm
Min.	3.517
Max.	3.567

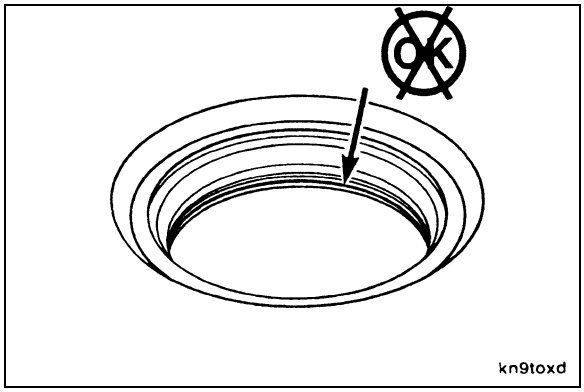
Thrust bearings 0.25 mm and 0.50 mm thicker than the standard are available. See the above table.



Cut to a sufficient depth so that the expanded seat pulling tool will be engaged fully with the groove.



Set the cutter motor so that the cutting tool will cut only the valve seat insert and will not enter the machined valve pocket of the cylinder head.

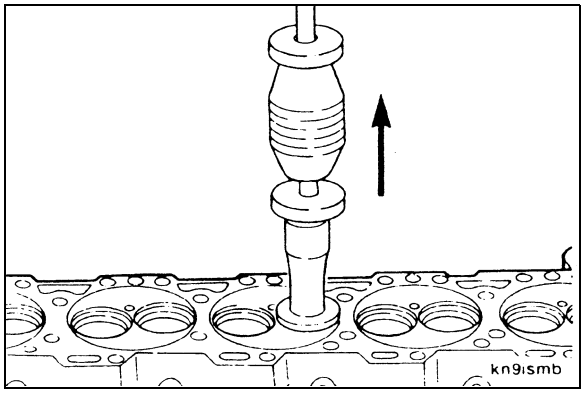


Slide hammer assembly (Part No. 33776617)

Air intake valve seat pulling tool (Part No. 3377396)

Exhaust valve seat pulling tool (Part No. ST-1276-1)

Remove the valve seat insert.



Remove the all sediment from the valve seat insert hole with a wire brush and solvent.

Clean the cylinder head with solvent, then dry it with compressed air.