Manual Part No. 0E6246

GENERAC®
POWER SYSTEMS, INC.

3.3 LITER

DAEWOO DIESEL ENGINE

SERVICE MANUAL

FOREWORD

This manual has been published by GENERAC® POWER SYSTEMS, INC. to aid our dealers' mechanics, company service personnel and general consumers when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures for these products, or like or similar products, manufactured and marketed by GENERAC® POWER SYSTEMS, INC. It is also assumed that they have been trained in the recommended servicing procedures for these products, which includes the use of mechanics hand tools and any special tools that might be required.

Proper service and repair is important to the safe, economical and reliable operation of the products described herein. The troubleshooting, testing, service and repair procedures recommended by GENERAC® POWER SYSTEMS, INC. and described in this manual are effective methods of performing such operations. Some of these operations or procedures may require the use of specialized equipment. Such equipment should be used when and as recommended.

We could not possibly know of and advise the service trade of all conceivable procedures or methods by which a service might be performed, nor of any possible hazards and/or results of each procedure or method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a procedure or method not recommended by the manufacturer must first satisfy himself that neither his safety, nor the product's safety, will be endangered by the service or operating procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. However, GENERAC® POWER SYSTEMS, INC. reserves the right to change, alter or otherwise improve the product at any time without prior notice.

Some components or assemblies of the product described in this manual may not be considered repairable. Disassembly, repair and reassembly of such components may not be included in this manual.

The engines described herein may be used to power a wide variety of products. Service and repair instructions relating to any such products are not covered in this manual. For information pertaining to use of these engines with other products, refer to any owner's or service manuals pertaining to said products.

The 3.3 Liter Diesel Engine has been engineered for use in Generac Power Systems products. The contents of this manual have been reprinted from the original manufacturer's service and repair manual. The exploded view section at the front of this manual is for reference only, showing parts added by Generac.

◆ ENGINE OIL RECOMMENDATIONS

The unit has been filled with "break in" engine oil at the factory. Use a high-quality detergent oil classified "For Service CC, SD, SE or SF." Detergent oils keep the engine cleaner and reduce carbon deposits. Use oil having the following SAE viscosity rating, based on the ambient temperature range anticipated before the next oil change:

Engine Lubrication System:

Type of Oil Pump .....Gear
Oil Filter .....Full Flow, Cartridge
Crankcase Oil Capacity .....6.5 L (6.9 U.S. qts.)

Temperature	Oil Grade (Recommended)
Above 86° F (30° C)	SAE 40 or 15W-40
32° to 86° F (0° to 30° C)	SAE 30 or 15W-40
Below 32° F (0° C)	SAE 20W or 15W-40
All Seasons	SAE 15W-40

◆ COOLANT

Use a mixture of half low silicate, ethylene glycol base antifreeze and half soft water. Use only soft water and only low silicate antifreeze. If desired, you may add a high quality rust inhibitor to the recommended coolant mixture. When adding coolant, always add the recommended 50-50 mixture.

Cooling System:

Type.....Pressurized, Closed Recovery
Coolant Capacity
System.....14.6 L (15.5 U.S. qts.)
Engine .....8.5 L (9.0 U.S. qts.)

⚠ DANGER ⚠

Do not remove the radiator pressure cap while the engine is hot or serious burns from boiling liquid or steam could result.

Ethylene glycol base antifreeze is poisonous. Do not use your mouth to siphon coolant from the radiator, recovery bottle or any container. Wash your hands thoroughly after handling. Never store used antifreeze in an open container because animals are attracted to the smell and taste of antifreeze even though it is poisonous to them.

⚠ CAUTION ⚠

Do not use any chromate base rust inhibitor with ethylene glycol base antifreeze, or chromium hydroxide ("green slime") will form and cause overheating. Engines that have been operated with a chromate base rust inhibitor must be chemically cleaned before adding ethylene glycol base antifreeze. Using any high silicate antifreeze boosters or additives also will cause overheating. We also recommend that you DO NOT use any soluble oil inhibitor for this equipment.

PERIODIC MAINTENANCE SCHEDULE:

SERVICE SCHEDULE

◆ AUTHORIZED OPERATOR MAINTENANCE FUNCTIONS

Every Month or 100 Hours
(whichever comes first)

- Test standby generator system.
- Inspect battery and cables.
- Check engine oil level.
- Check gearbox oil level (if so equipped).
- Check engine coolant level.
- Check generator ground connections.
- Test/inspect starting aids.

Every Three Months or Every 120 Hours
(whichever comes first)

- Inspect and test fuel system and connections.
- Inspect exhaust system.
- Inspect/test fuel supply system.

◆ AUTHORIZED SERVICE TECHNICIAN MAINTENANCE FUNCTIONS

After First 30 Hours of Operation

- Inspect wiring.
- Change engine crankcase oil and oil filter.
- Inspect engine fan belts.
- Inspect battery and cables.

Every Six Months or Every 100 Hours
(whichever comes first)

- Change engine oil and filter.
- Lubricate engine controls.
- Service engine air cleaner.
- Service engine fuel filter.
- Inspect AC generator.
- Test engine safety controls.
- Inspect fan belts.
- Check engine coolant level.
- Inspect engine cooling system hoses.
- Check optional starting aids.
- Check battery.
- Check engine compression.
- Check electrical connections.
- Check/test annunciator panel.
- Perform operational test.

Annually or Every 600 Hours
(whichever comes first)

- Check engine valve clearance.
- Test fuel injection nozzles.
- Test injection timing.
- Inspect all wiring.
- Test engine starter operation.
- Drain water from fuel tank.
- Retorque fan bolts.
- Drain and refill gearbox (if so equipped)

Every Two Years

- Replace all rubber hoses.
- Replace engine fan belts.
- Inspect the Standby Generator System.
- Drain, flush, refill cooling system.

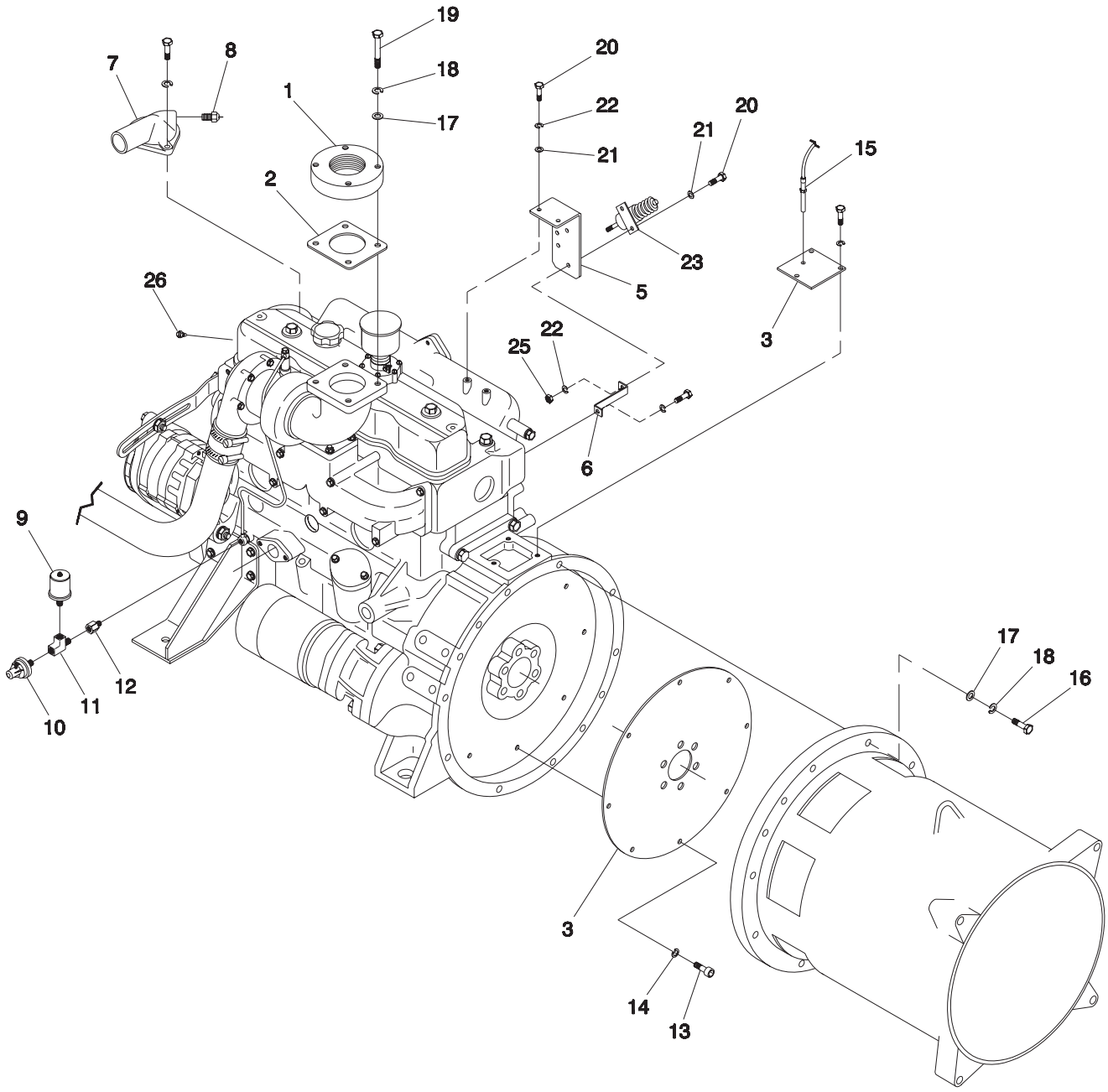
Every 1,000 Operating Hours

- Inspect engine DC alternator.
- Inspect engine starter.
- Retorque engine mounting brackets.
- Remove/test fuel injection pump.
- Remove/test cooling system thermostat.

As Required

- Bleed engine fuel system.

Exploded View



ITEM	DESCRIPTION	QTY
1	EXHAUST ADAPTER	1
2	GASKET, EXHAUST	1
3	MAGNETIC PICKUP PLATE	1
*	RPM SENSOR PLATE	1
4	FLEX PLATE 11-1/2" SAE	2
5	SOLENOID BRACKET	1
6	SOLENOID SUPPORT BRACKET	1
7	THERMOSTAT HOUSING, MACHINED	1
8	WATER LEVEL SENSOR	1
9	OIL LEVEL SWITCH	1
10	OIL TEMPERATURE SWITCH	1
11	TEE 1/8" NPT BRASS	1
12	ADAPTER, 1/8" NPT-1/8"-28 BSP	1
13	SHCS M10-1.5 X 25 LONG	8
14	LOCK WASHER M10	8
15	RPM SENSOR	1
*	RPM SENSOR	1
16	HHCS M10-1.5 X 40 LONG	12
17	FLAT WASHER M10-3/8"	16
18	LOCK WASHER M10	16
19	HHCS M10-1.5 X 50 LONG	4
20	HHCS M6-1.0 X 16 LONG	4
21	FLAT WASHER 1/4"-M6	6
22	LOCK WASHER 1/4"-M6	4
23	SOLENOID	1
25	HEX NUT 1/4"-20	2
26	WATER TEMPERATURE SWITCH 245 DEG. 3/8" NPT	1

* REQUIRED FOR ELECTRONIC GOVERNOR ONLY.

TO THE CUSTOMERS

This operation and maintenance manual is designed to serve as a reference for DAEWOO Heavy Industries Ltd's (here after DAEWOO's) customers and distributors who wish to gain basic product knowledge on DAEWOO's DB33 and P034TI Generator Diesel engine.
To maintain the engine in optimum condition and retain maximum performance for a long time, CORRECT OPERATION and PROPER MAINTENANCE are essential.
In this manual, the following symbols are used to indicate the type of service operations to be performed.


Removal


Installation


Disassembly


Reassembly


Align the marks


Directional Indication


Inspection


Measurement


Adjustment


Cleaning


Pay close attention-Important


Tighten to specified torque


Use special tools of manufacturer's


Lubricate with oil


Lubricate with grease

During engine maintenance, please observe following instructions to prevent environmental damage ;

- Take old oil to an old oil disposal point only.
- Ensure without fail that oil and diesel fuel will not get into the sea or rivers and canals or the ground.
- Treat undiluted anti-corrosion agents, antifreeze agents, filter element and cartridges as special waste.
- The regulations of the relevant local authorities are to be observed for the disposal of spent coolant and special waste.

If you have any question or recommendation in connection with this manual, please do not hesitate to contact our head office, dealers or authorized service shops.
For the last, the content of this maintenance instruction may be changed without notice for some quality improvement. Thank you.

DAEWOO Heavy Industries LTD.
April. 1999

CONTENTS

1. General Information

1.1. General Repair Instructions

1. Before performing service operation, disconnect the grounding cable from the battery for reducing the chance of cable damage and burning due to short-circuiting.
2. Use covers for preventing the components from damage or pollution.
3. Engine oil and anti-freeze solution must be handled with reasonable care as they cause paint damage.
4. The use of proper tools and special tools where specified is important to efficient and reliable service operation.
5. Use genuine DAEWOO parts necessarily.
6. Used cotter pins, gaskets, O-rings, oil seals, lock washer and self-lock nuts should be discarded and new ones should be prepared for installation as normal function of the parts can not be maintained if these parts are reused.
7. To facilitate proper and smooth reassemble operation, keep disassembled parts neatly in groups. Keeping flexing bolts and nut separate is very important as they vary in hardness and design depending on position of installation.
8. Clean the parts before inspection or reassembly. Also clean oil ports, etc. using compressed air to make certain they are free from restrictions.
9. Lubricate rotating and sliding faces of parts with oil or grease before installation.
10. When necessary, use a sealer on gaskets to prevent leakage.
11. Carefully observe all specifications for bolts and nuts torques.
12. When service operation is completed, make a final check to be sure service has been done property.

1.2. Engine Specifications

Items \ Engine Model		DB33		P034TI	
Engine type		Water-cooled, 4 cycle in-line		← Turbo charged & intercooled	
Combustion chamber type		Direct injection type			
Cylinder liner type		Dry type, chromated or casting liner			
Timing gear system		Gear driven type			
No. of piston ring		Compression ring 2, oil ring 1			
No. of cylinder-bore x stroke (mm)		4 - 102 x 100			
Total piston displacement (cc)		3,268			
Compression ratio		17.5 : 1		17.2 : 1	
Engine dimension (length x width x height) (mm)		870 x 705 x 723		847.5 x 728 x 832	
Engine weight (kg)		310		335	
Rotating direction(from fly wheel)		Counter clockwise			
Fuel injection order		1 - 3 - 4 - 2			
Fuel injection timing (B.T.D.C static)		18°		13°	
Injection pump type		Zexel in-line A type			
Governor type		Mechanical governor RSV type			
Injection nozzle type		Multi-hole type (5 hole)			
Fuel injection pressure (kg/cm^2)		220			
Compression pressure (kg/cm^2)		28 (at 200 rpm)			
Power (ISO 3046)	Condition	60Hz (1,800rpm)	50Hz (1,500rpm)	60Hz (1,800rpm)	50Hz (1,500rpm)
	Continuous	-	-	69PS (51kW)	48PS (35kW)
	Prime	43PS (32kW)	35PS (26kW)	75PS (55kW)	57PS (42kW)
	Stand by	47PS (35kW)	39PS (29kW)	82PS (60kW)	65PS (48kW)
Intake and exhaust valve clearance (at cold) (mm)		0.4			
Intake valve	Open at	28° (B.T.D.C)			
	Close at	62° (A.B.D.C)			
Exhaust valve	Open at	70° (B.B.D.C)			
	Close at	28° (A.T.D.C)			
Lubrication method		Pressurized circulation			
Oil pump type		Gear type			
Oil filter type		Full-flow, cartridge type			
Lubricating oil capacity (max./min.) (lit)		7.5/ 6.5		6.5/ 5.5	
Oil cooler type		Water cooled			
Water pump		Belt driven impeller type			
Cooling Method		Pressurized circulation			
Cooling water capacity (engine only) (lit)		8.5			
Thermostat type		Wax pallet type (82 ~ 95 °C)			
Alternator voltage - capacity (V - A)		24 - 45			
Starting Motor voltage - output (V - kW)		24 - 4.5			

1.3. Torque Specifications

- **Standards bolts**

The torque values given in the following table should be applied where a particular torque is not specified.

(Unit : kg.m)

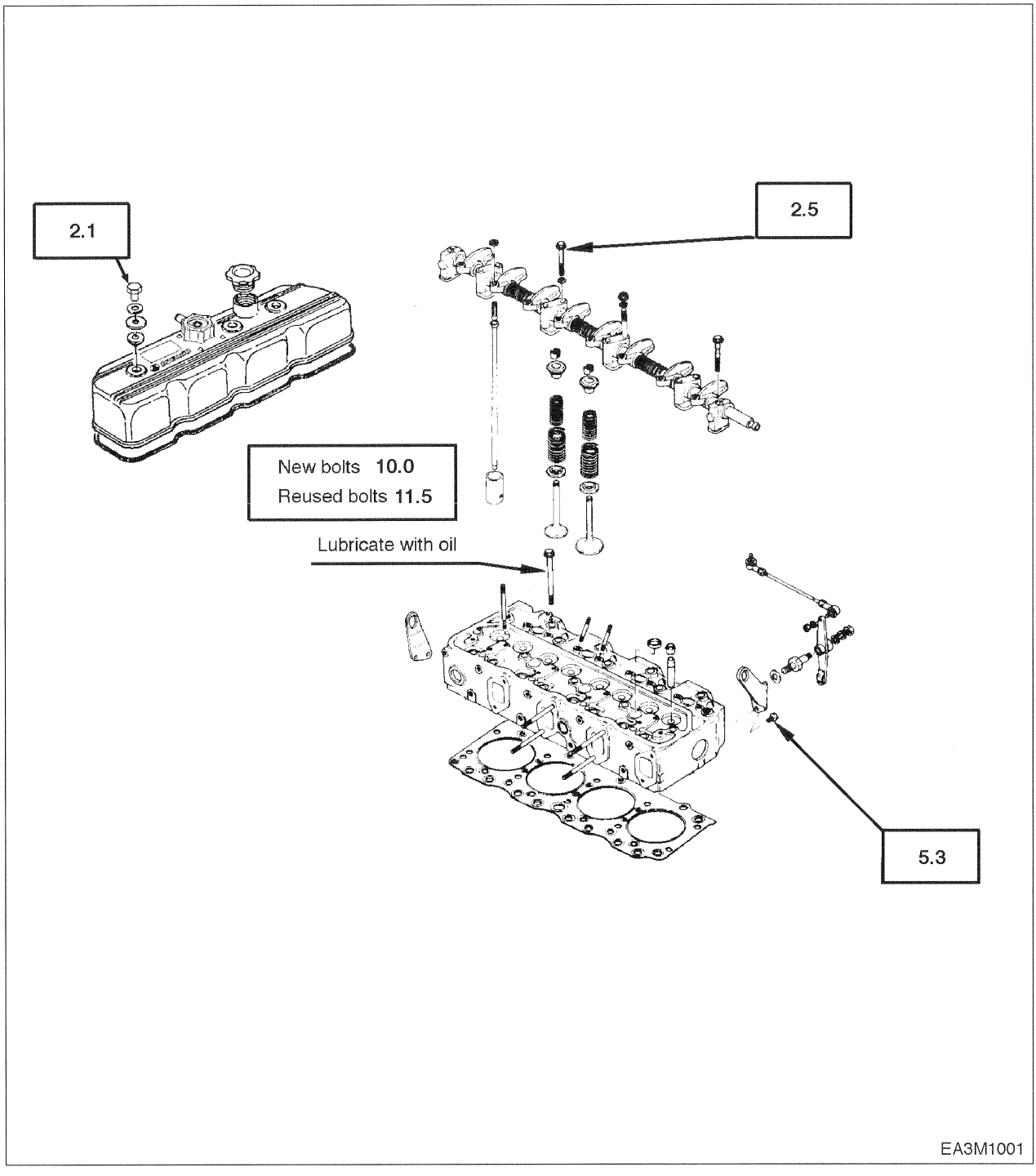
Bolt identification / Bolt diameter x pitch			
	4T Low carbon steel	7T High carbon steel	9T Alloy steel
6 X 1.0	0.4 ~ 0.8	0.5 ~ 1.0	-
8 X1.25	0.8 ~ 1.8	1.2 ~ 2.3	1.7 ~ 3.1
10 X 1.25	2.1 ~ 3.5	2.8 ~ 4.7	3.8 ~ 6.4
★ 10 X 1.5	2.0 ~ 3.4	2.8 ~ 4.6	3.7 ~ 6.1
12 X1.25	5.0 ~ 7.5	6.2 ~ 9.3	7.7 ~ 11.6
★ 12 X1.75	4.6 ~ 7.0	5.8 ~ 8.6	7.3 ~ 10.9
14 X1.5	7.8 ~ 11.7	9.5 ~ 14.2	11.6 ~ 17.4
★ 14 X 2.0	7.3 ~ 10.9	9.0 ~ 13.4	10.9 ~ 16.3
16 X 1.5	10.6 ~ 16.0	13.8 ~ 20.8	16.3 ~ 24.5
★ 16 X 2.0	10.2 ~ 15.2	13.2 ~ 19.8	15.6 ~ 23.4
18 X1.5	15.4 ~ 23.0	19.9 ~ 29.9	23.4 ~ 35.2
★ 20 X 1.5	21.0 ~ 31.6	27.5 ~ 41.3	32.3 ~ 48.5
22 X1.5	25.6 ~ 42.2	37.0 ~ 55.5	43.3 ~ 64.5
24 X 2.0	36.6 ~ 55.0	43.9 ~ 72.5	50.5 ~ 54.7

The ★ mark indicates that the bolts are used for female-threaded parts that are made of soft materials such as casting, etc.

1.4. Major Parts Fixing Bolts

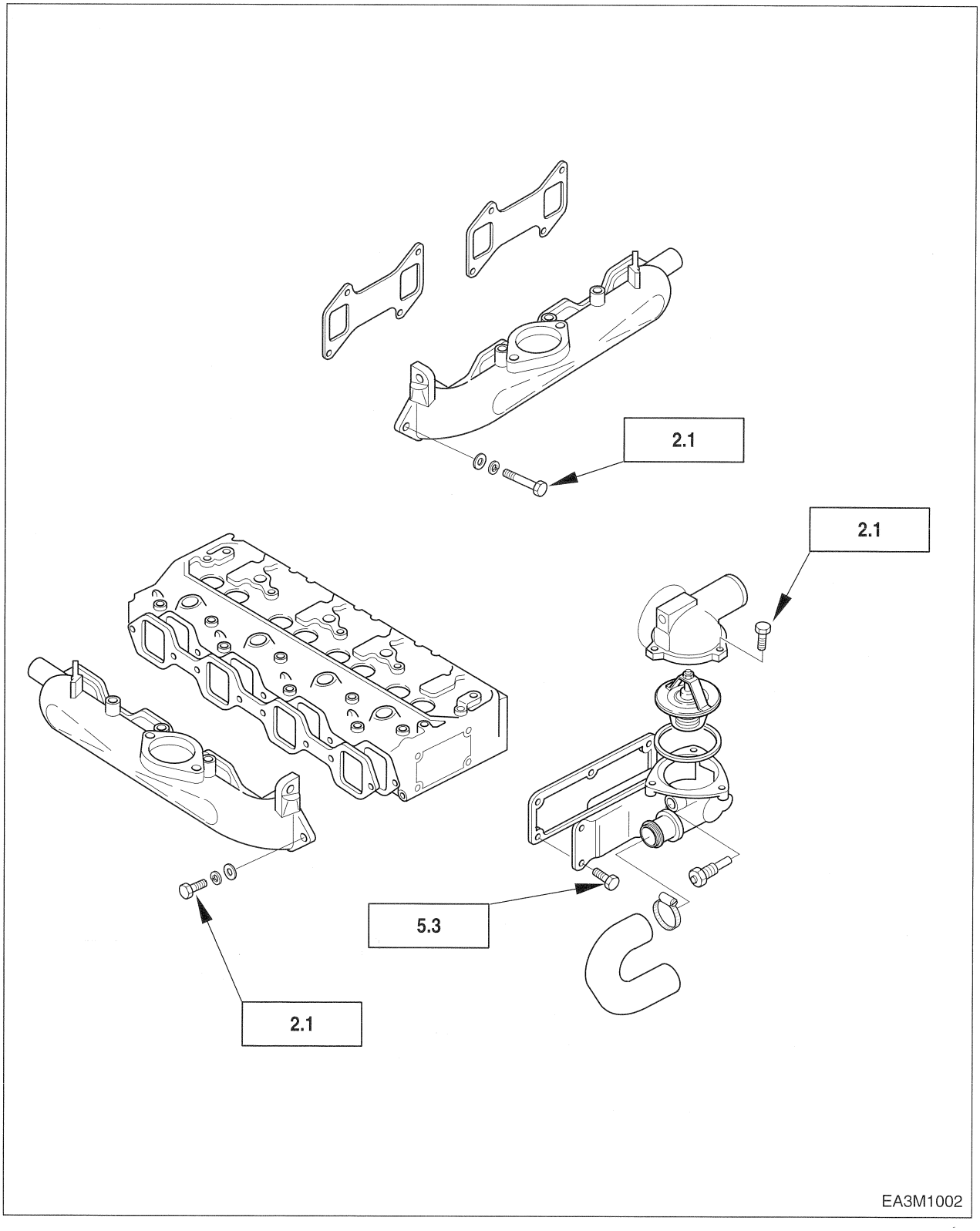
- **Cylinder head and cover, rocker arm**

(unit : kg.m)



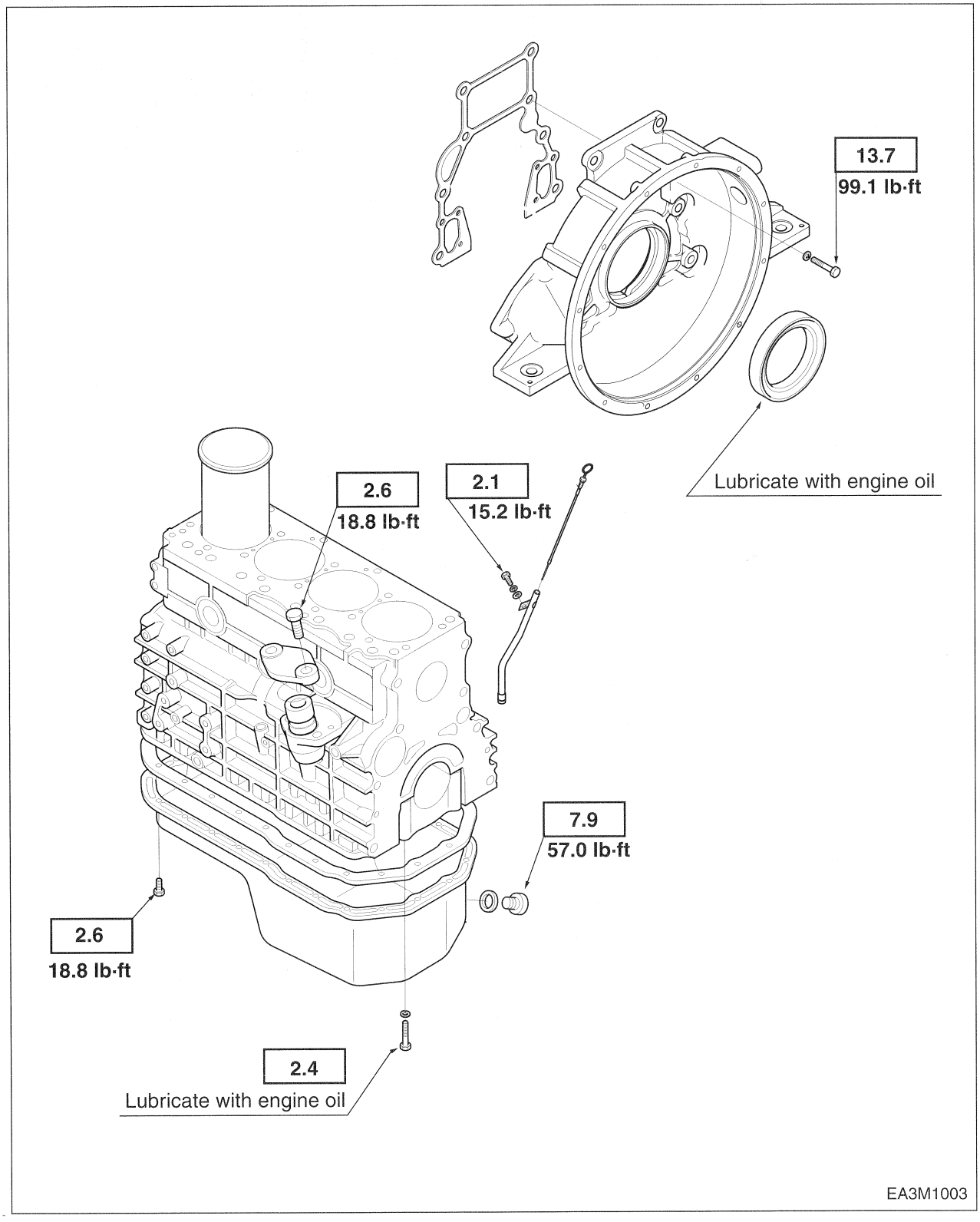
● Intake and exhaust manifold

(unit : kg.m)



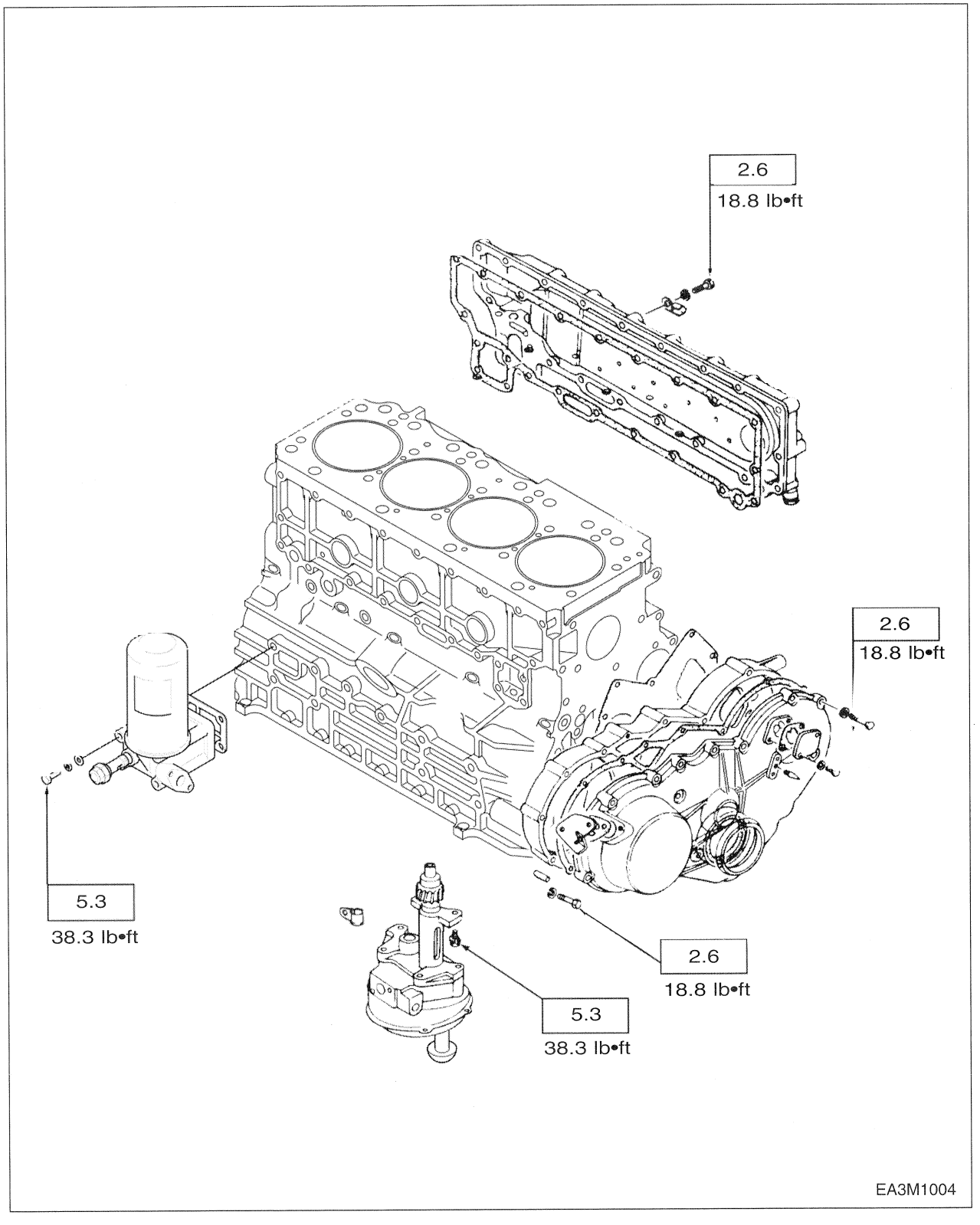
● Cylinder block and others

(unit : kg.m)



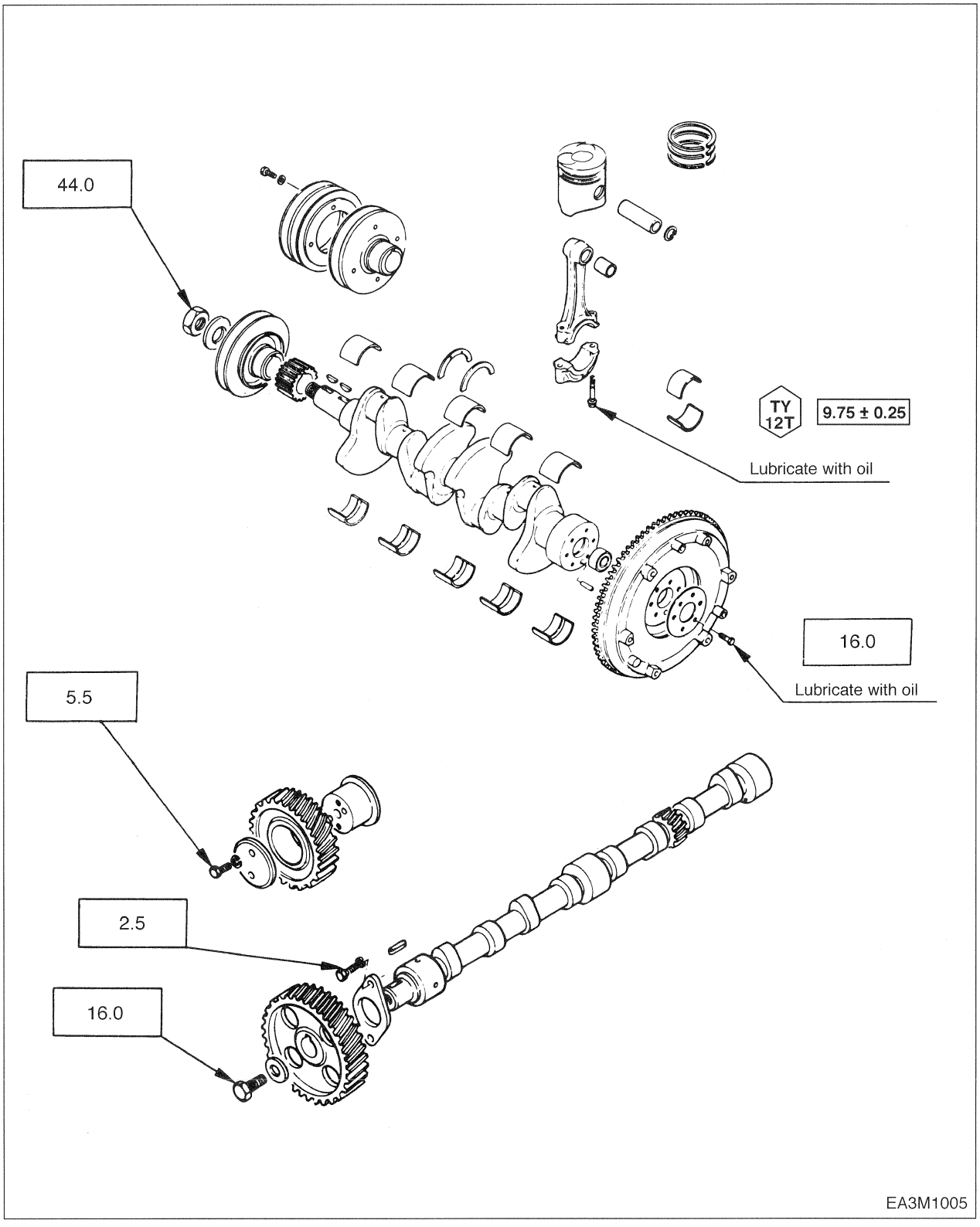
● **Cylinder block and others**

(unit : kg.m)



● Crankshaft and camshaft

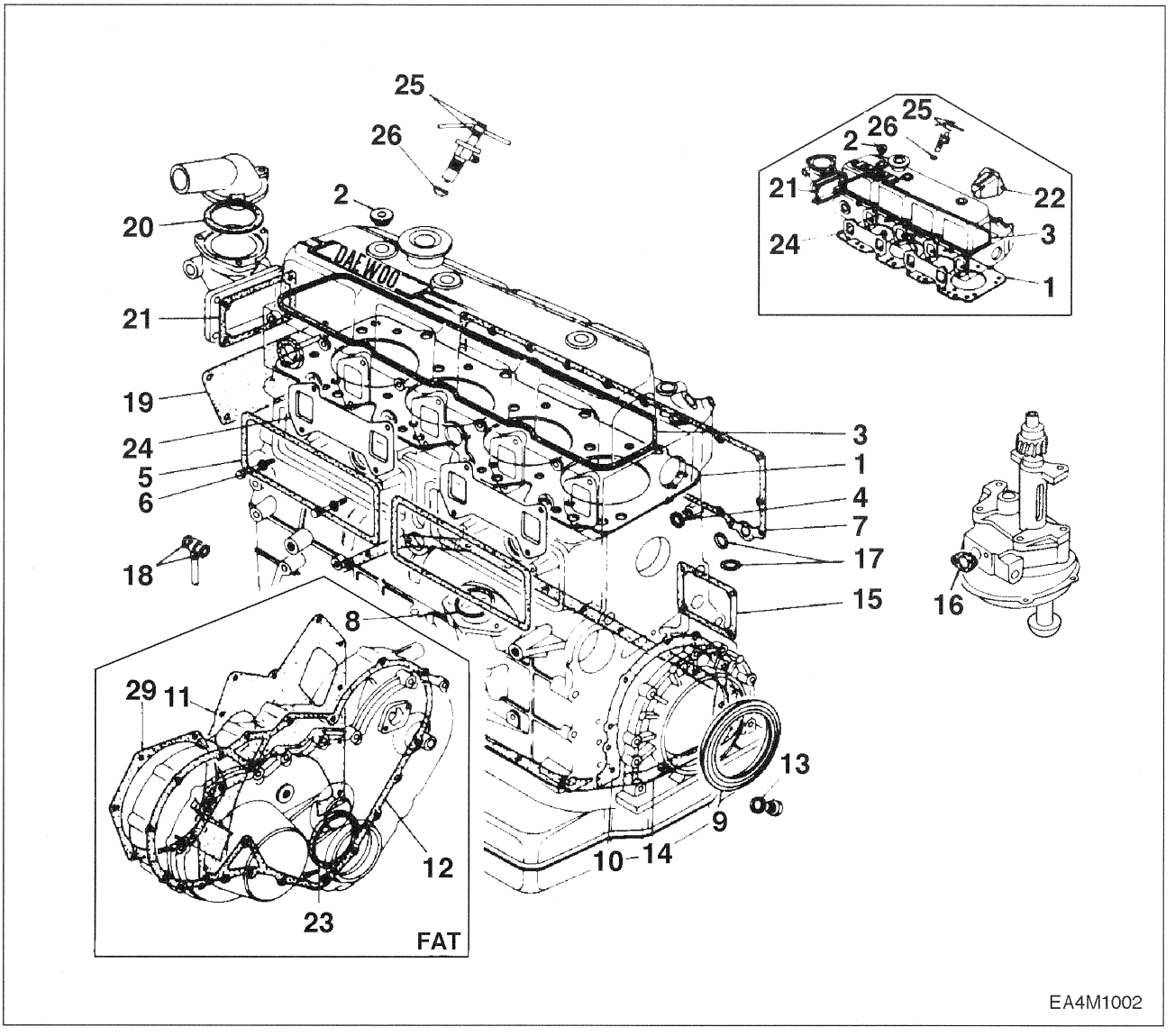
(unit : kg.m)



1.5. Engine Repair kit

Part No. 1 ~ 26 : Engine disassembly components

Part No. 1, 3, 21, 25 : Engine top disassembly components



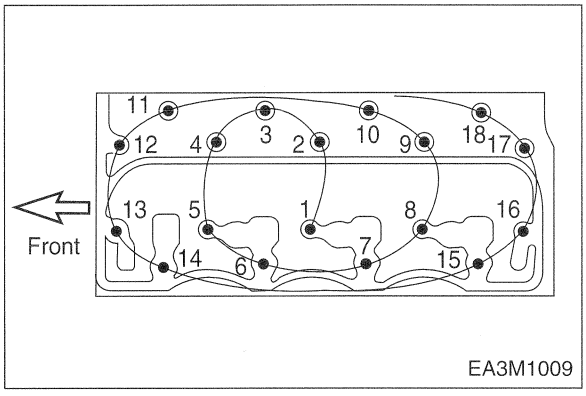
1. Gasket : Cylinder head
2. Packing : Cylinder head cover and bolt
3. Gasket : Head cover
4. Gasket : Relief valve
5. Gasket : Gasket : Injection pump
6. Gasket : Tappet chamber and bolt
7. Gasket : Oil cooler
8. Casket : Oil pump cover
9. Oil seal : Crankshaft(RR)
10. Gasket : Retainer
11. Gasket : Case and cylinder block
12. Gasket : Cover and case
13. Seal Ring : Oil pan drain plug
14. Gasket : Oil pan and body
15. Gasket : Oil filter
16. Gasket : Oil pump and pipe
17. Gasket : Oil filter pipe
18. Gasket : Oil jet pipe
19. Gasket : Water pump
20. Gasket : Outlet pipe
21. Gasket : Thermostat housing
23. Oil seal : Crank gear case (FR)
24. Gasket : Exhaust manifold
25. Seal Ring : Injection nozzle
26. Seal Ring : Nozzle gasket

1.6. Repair

1.6.1. Cylinder Head Bolt

Tighten the cylinder head bolts in sequence as shown in the figure.

Torque	11.5 kg.m

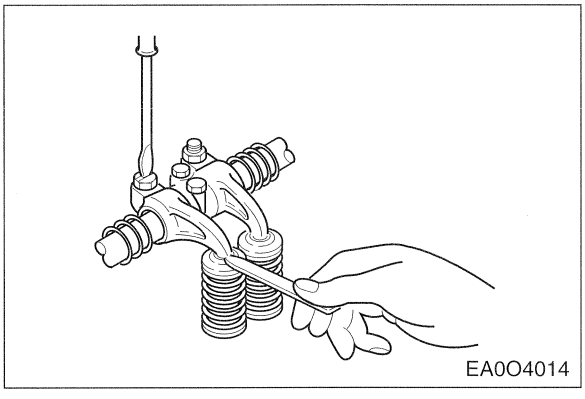


1.6.2. Valve Clearance

Adjust the valve clearance in the following manner using a feeler gauge.

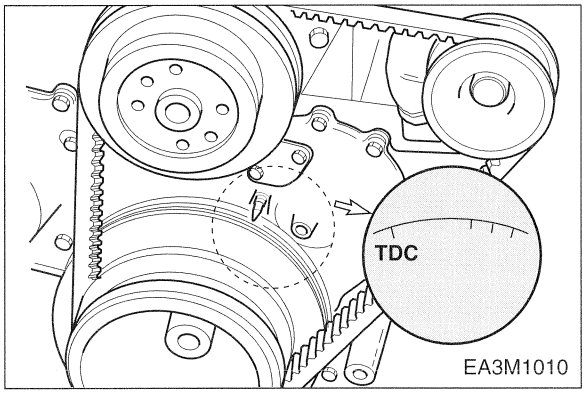
Standard(in cold)

Intake and exhaust	0.4 mm



1. Bring the piston in either the No. 1 cylinder or the No. 4 cylinder to top dead center on the compression stroke by turning the crankshaft until the TDC notched line on the crankshaft pulley is aligned the timing pointer.

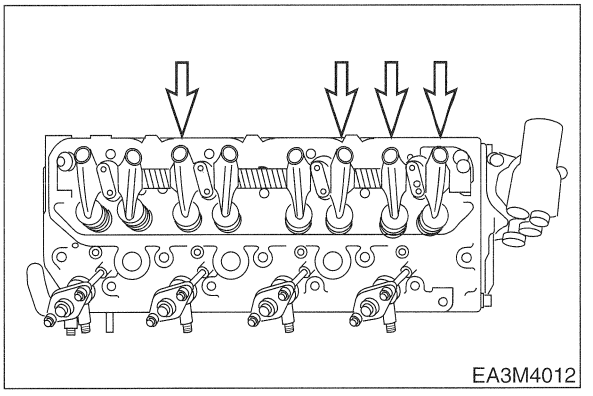
2. Check to see if there is play in the No. 1 intake and exhaust valve rocker arms. If the No. 1 cylinder intake and exhaust valve rocker arms are depressed, the No.4 piston is at TDC on the compression stroke.



Adjust the clearances of valves marked with an arrow.

Rocker arm screw lock nut torque	2.5 kg.m

After adjusting the valve clearances referring to the drawing, turn the crankshaft one full turn in the rotative direction and align the TDC mark with the pointer, then adjust the remaining valve clearances.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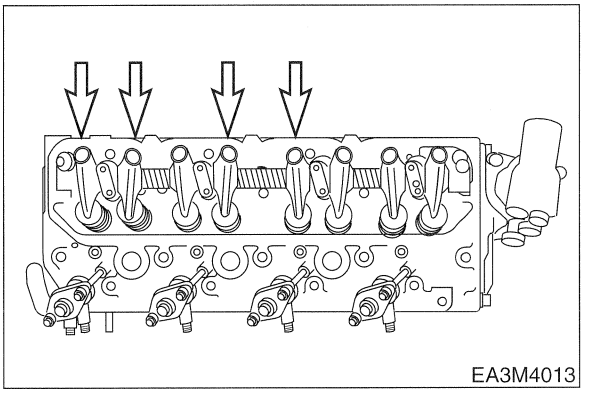
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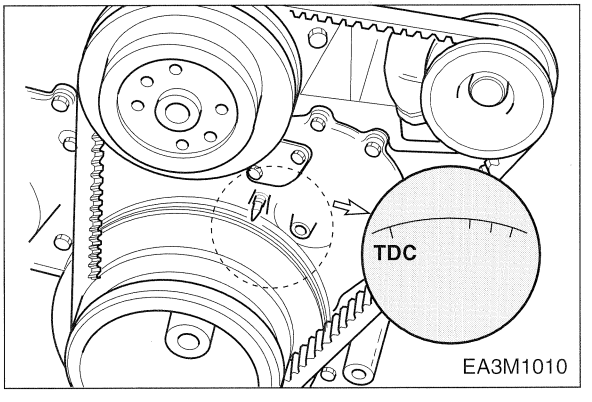
1.6.3. Injection Timing

Inspection

Check the notched line on the crankshaft pulley and timing pointer are aligned.

	DB33	P034TI
Timing (BTDC)	18°	13°



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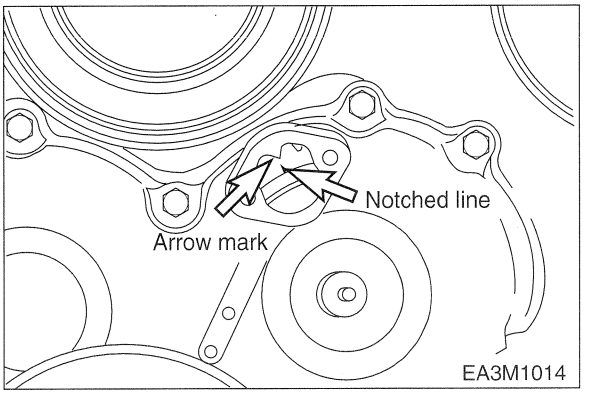
Remove the inspection hole cover at the front of gear case cover.Check the alignment between the notched line on the camshaft gear and the arrow mark of gear case cover.



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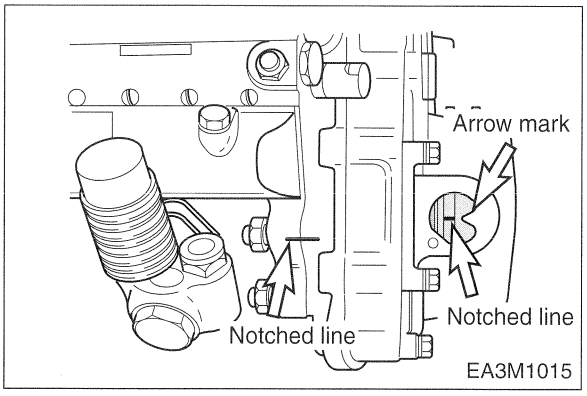
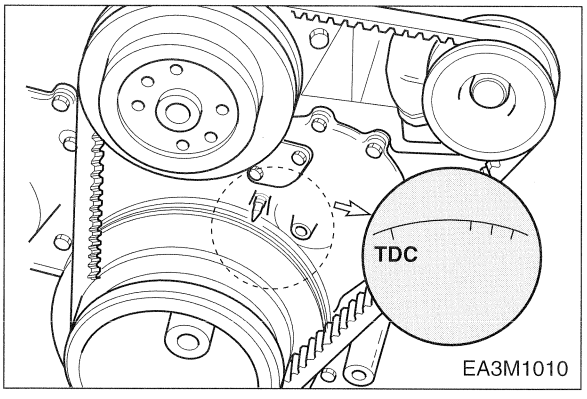
Check the notched line on the injection pump is in alignment with the notched line on the timing gear cover.

Check the alignment of the notched lines injection pump and bracket.

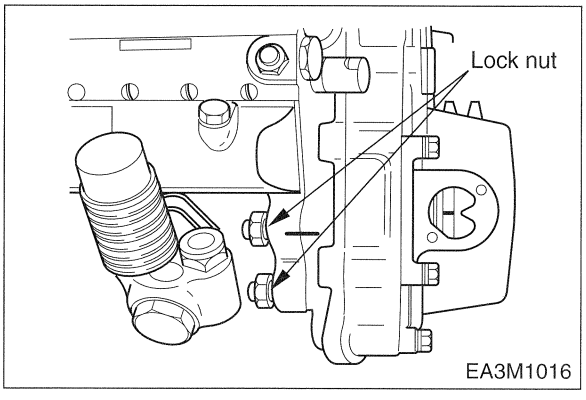


Injection timing adjustment

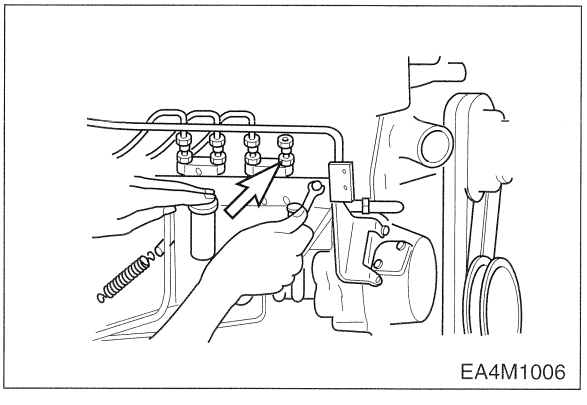
1. Adjust fuel injection timing with crank pulley notched line and timing pointer.



2. Remove 4 fixing bolts of injection pump.

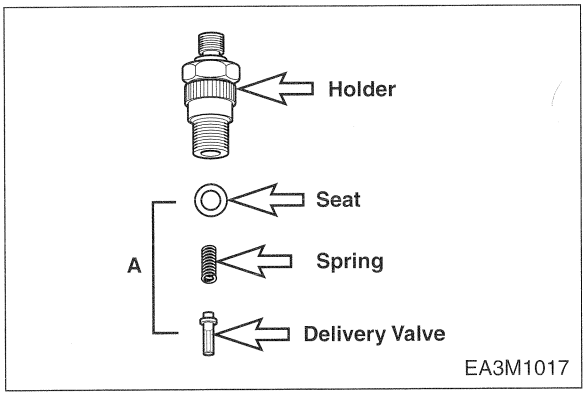


3. Disconnect the injection pipe from the No 1 plunger.



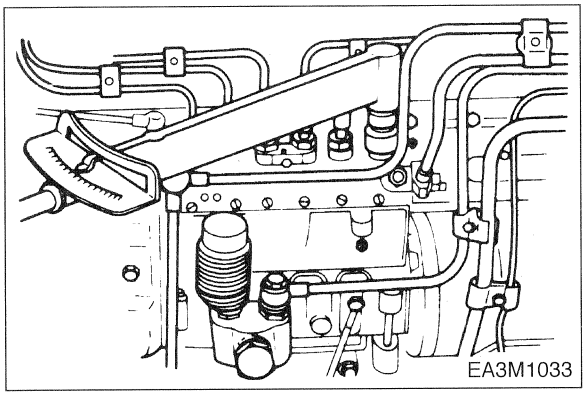
4. Remove the delivery valve holder valve spring, valve seat and delivery valve from the No. 1 plunger.

This will allow you to visually check the fuel injection starting flow at No. 1 plunger.

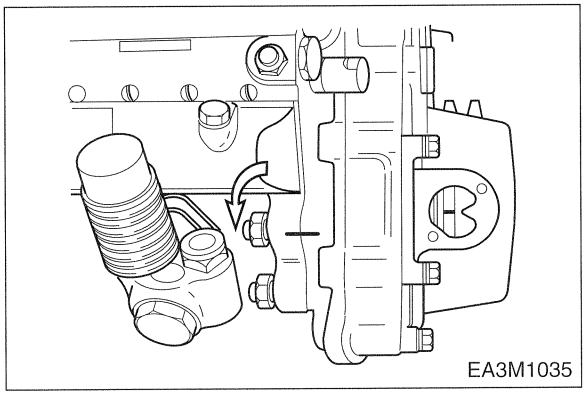


5. Reinstall the delivery valve holder and tighten it. (except "A")

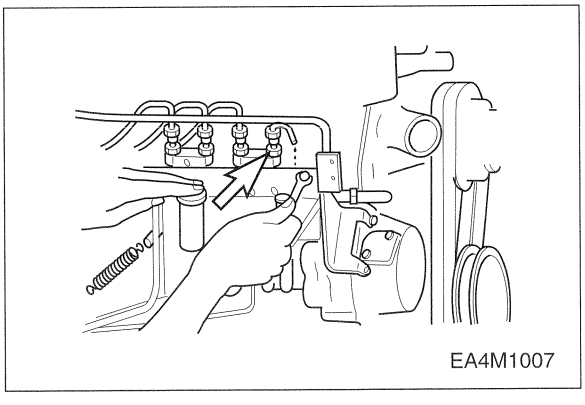
Torque	4 ~ 4.5 kg•m



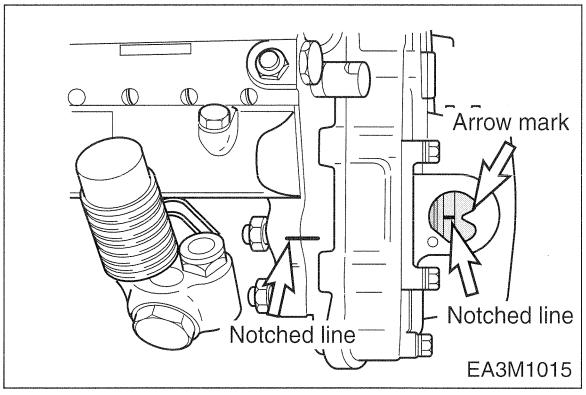
6. Turn the injection pump body clockwise.



7. While operating the priming pump, turn the injection pump body in reverse direction paragraph 6, until fuel stops flowing from the delivery valve holder. This crank angle position is the fuel injection starting point of the engine. And slowly turn the crankshaft pulley clockwise, at the same time, continue to feed the fuel with pumping the priming pump. When the fuel stop to flow out from the No. 1 delivery valve holder, stop the pump instantaneously.

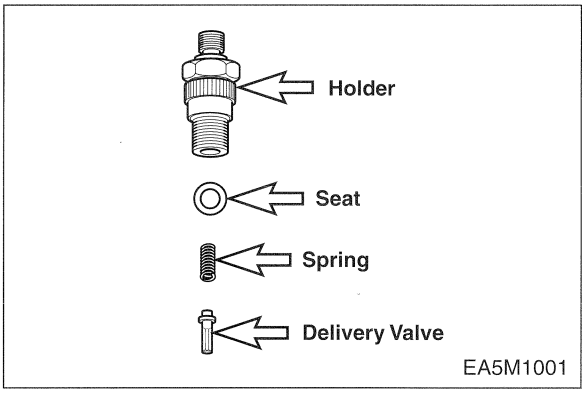


8. Blow out the remaining fuel from the delivery valve holder.
   Make sure that there is no fuel being delivered from the priming pump and then retighten the coupling bolts.



9. Remove the delivery valve holder and then reinstall the internal parts (seat, spring, valve) including valve holder.
   Tighten it to the specified torque.

Torque	4 ~ 4.5 kg•m



10. Install the No. 1 injection pipe and tighten it specified torque.

Injection pipe nut torque	3 ~ 3.5 kg•m

Do not overtighten the delivery valve holder. It will distort the injection pump body shape and adversely affect control rack operation.

1.6.4. Compression Pressure

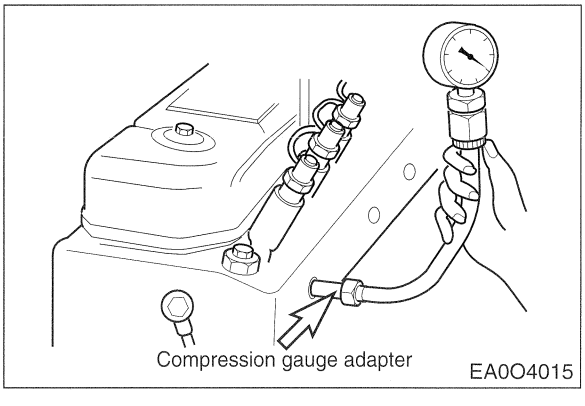
Remove the glow plugs from all cylinders, then check the compression pressure in each cylinder with a compression gauge by engaging starter.

Before this step, disconnect the fuel line.

(at 200 rpm)

Standard	28 kg/cm² over
Limit	23 kg/cm² or less
Difference between each cylinder	±10% or less

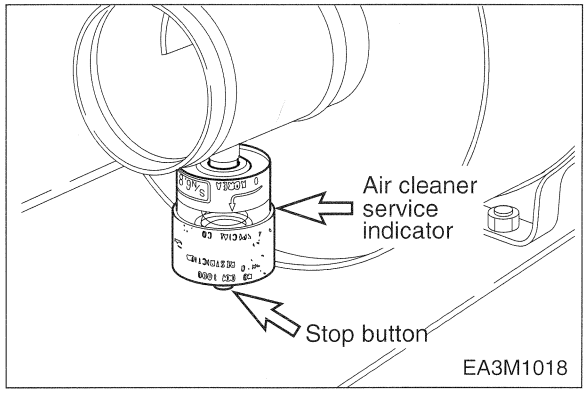
Compression gauge adapter.



1.6.5. Air Cleaner

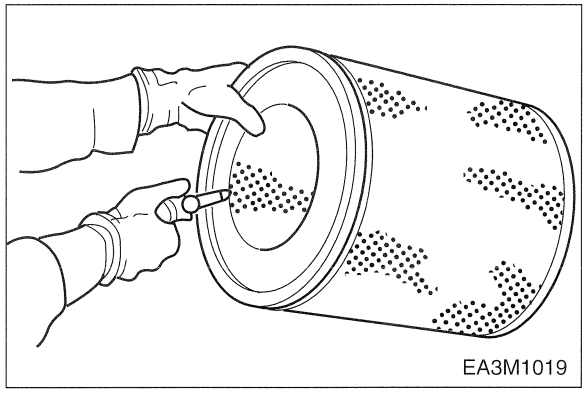
Dry type air cleaner

- Observe the air cleaner service indicator
- Clean the air cleaner element and dust pan when the RED band in the service indicator looks in the visible position.



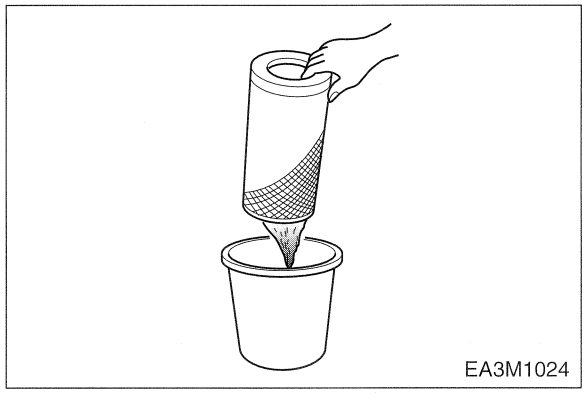
Cleaning element

- Direct air inside of the element and blow out dusts from the pleat completely.
  (Maximum air pressure does not excess 7 kg /cm^2)



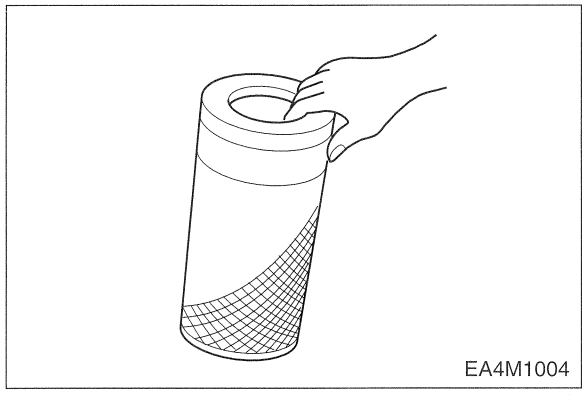
Detergent

- Wash the element in warm water and nonsudsing household detergent.
- Rinse the element with clean water
- Dry it thoroughly with natural air or electric fan.
  Don't use a flame or compressed air for dry. It makes damages to the element.



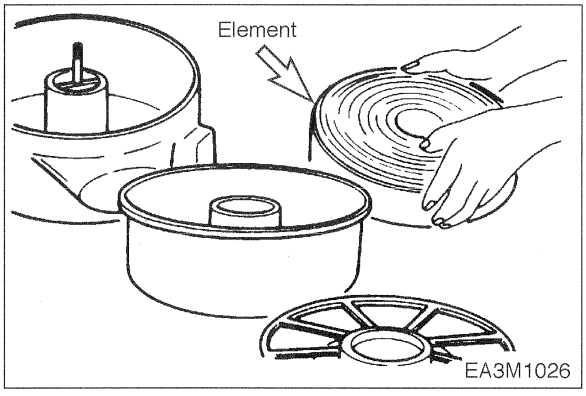
Checking element

- Confirm inside the clean and dry element.
- Replace the new element if tears, rips or damages are found.



Oil bath type air cleaner

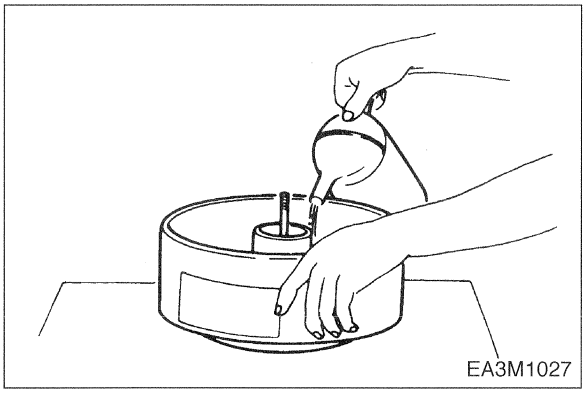
- Wash the element cleanly with oil detergent.



- Fill the engine oil in the oil pan to the indicated volume.

Oil	about 0.7 liter

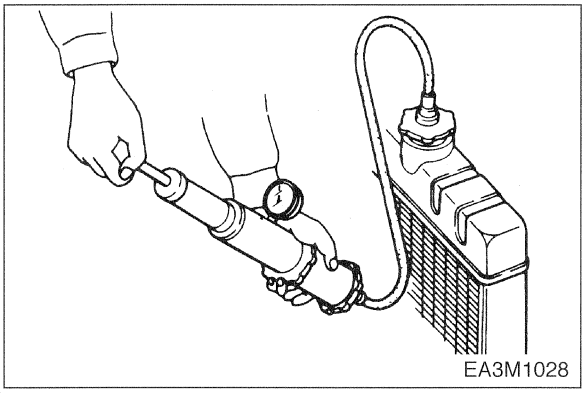
- Refer to operation manual for oil volume specification.



1.6.6. Radiator

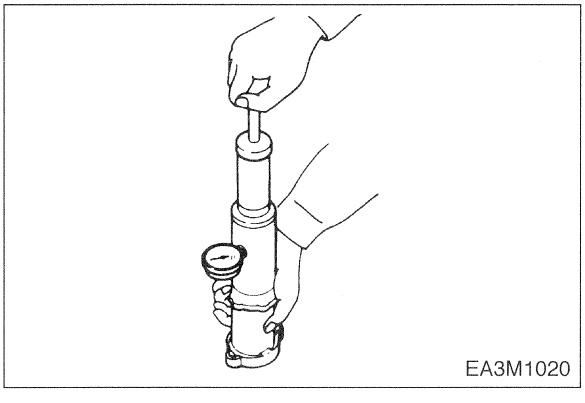
- Install the radiator cap tester and compressing the measuring pressure.
- Inspect the cooling system if there any leak.

Measuring pressure	1.0 kg/cm^2



Radiator cap

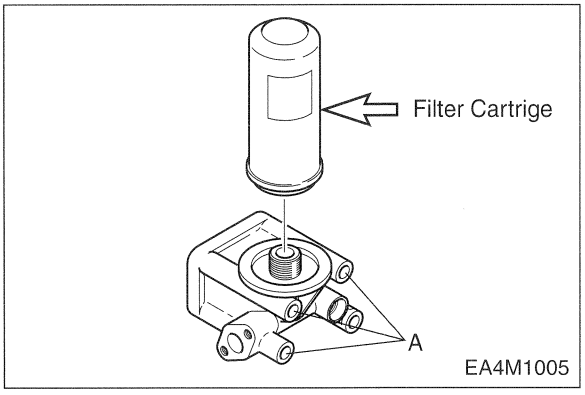
Measuring pressure	1.0 kg/cm^2



1.6.7. Lubricating System

Oil filter replacement

- Before installing a new filter cartridge apply a light coat of clean engine oil to the element O-ring and filter housing.
- Install the new cartridge. When the O-ring contacts the base, tighten it 3/4 of a turn more. Do not overtighten.

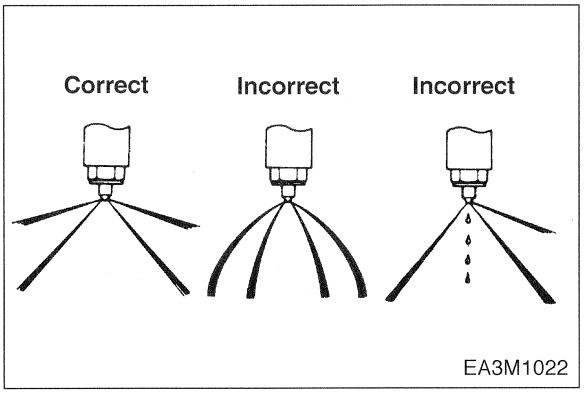


1.6.8. Fuel System

Injection nozzle

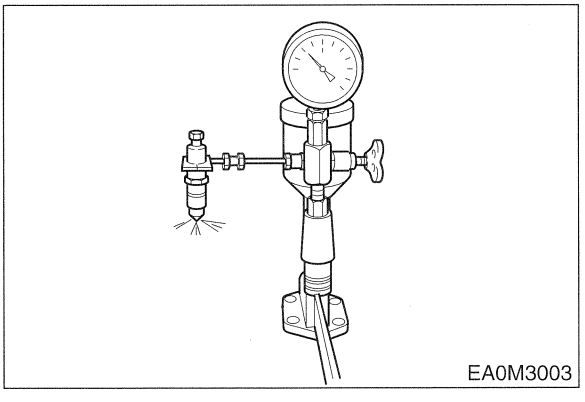
Check the spraying condition and injection starting pressure.

Injection starting pressure	220 kg/cm²



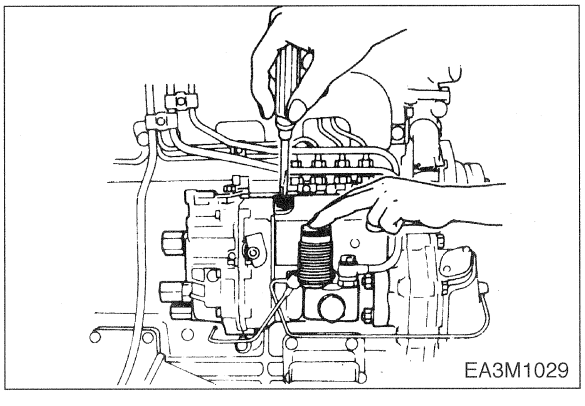
Adjustment

Adjust the injection starting pressure with adjusting screw using a nozzle tester.



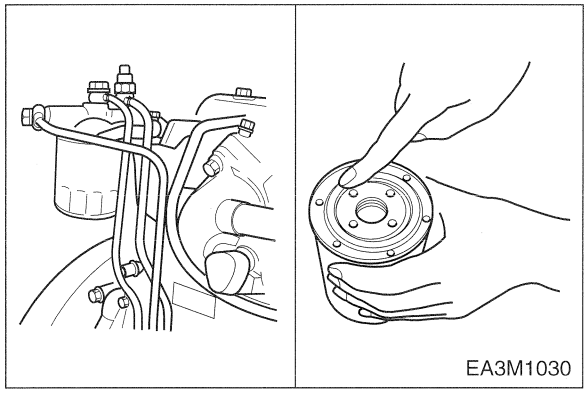
Air bleeding

Bleed the system by manually operating the priming pump with the fuel filter outlet joint bolt and injection pump bleeder screw loosened.

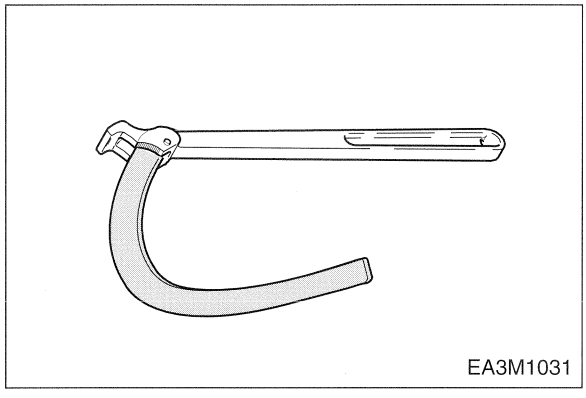


Fuel filter

- Loosen the fuel filter by turning it counterclockwise with the filter wrench.
  - Discard the used filter
- Wipe the filter fitting face clean
- Apply a light coat of engine oil to the O-ring and supply fuel to the new filter
- Turn in the next filter until the filter O-ring is fitted against the sealing face.
- Use the filter wrench.

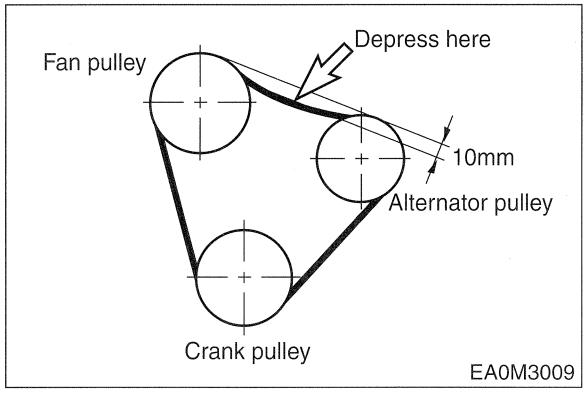


Remover and installer
Filter wrench



1.6.9. Fan Belt

Specified belt deflection	10 mm

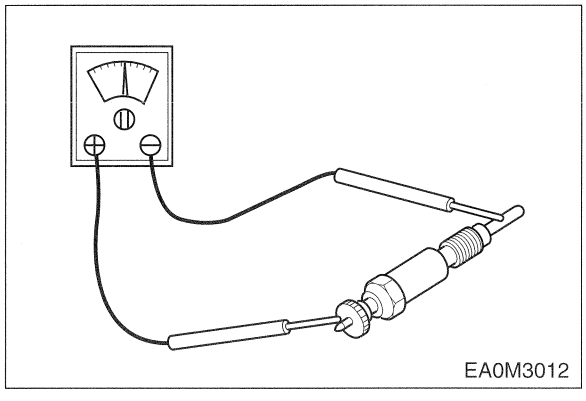


1.6.10. Glow Plug

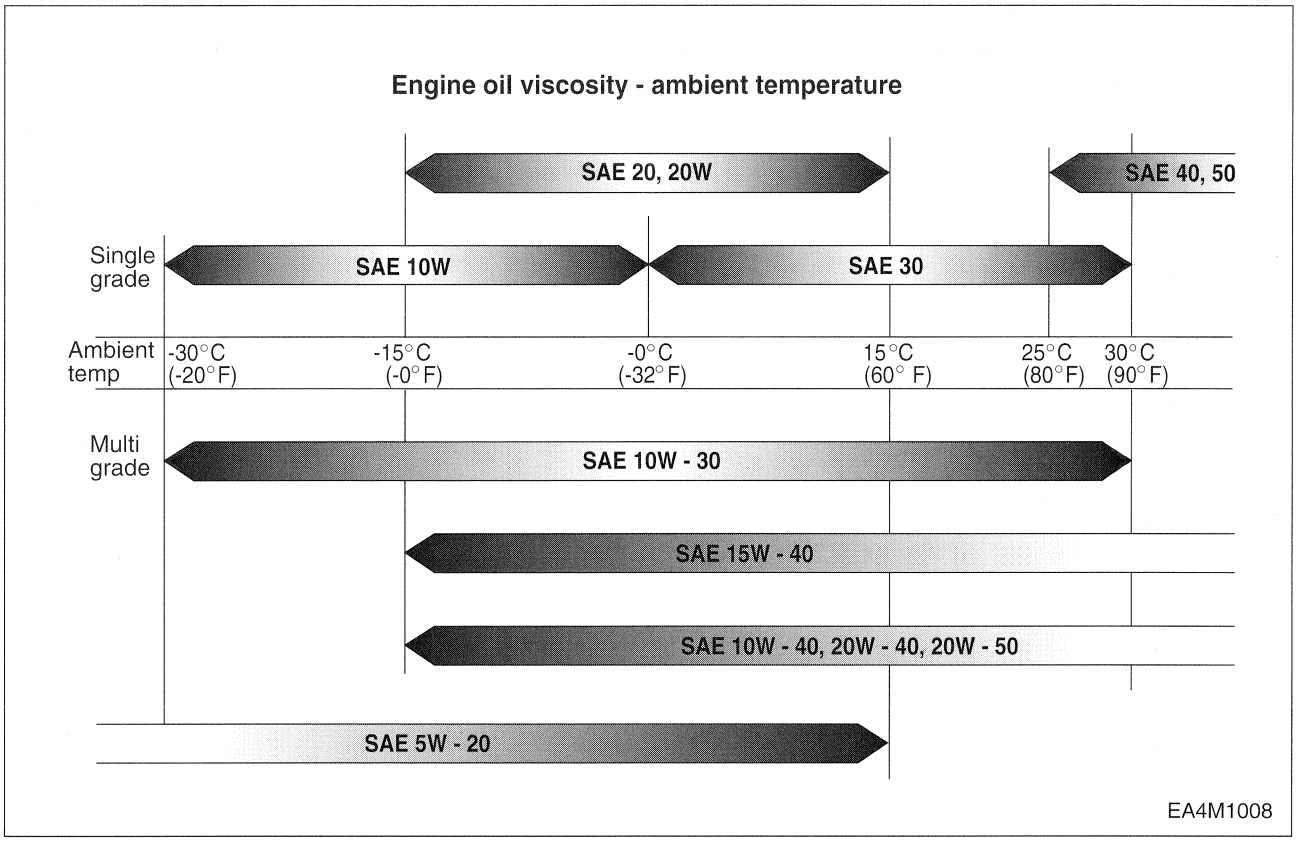
Inspection (Resistance)

Silver color	1.8 Ω
Black color	4.8 Ω

Check the continuity across the plug terminals and body.



1.7. Engine Oil Viscosity Chart

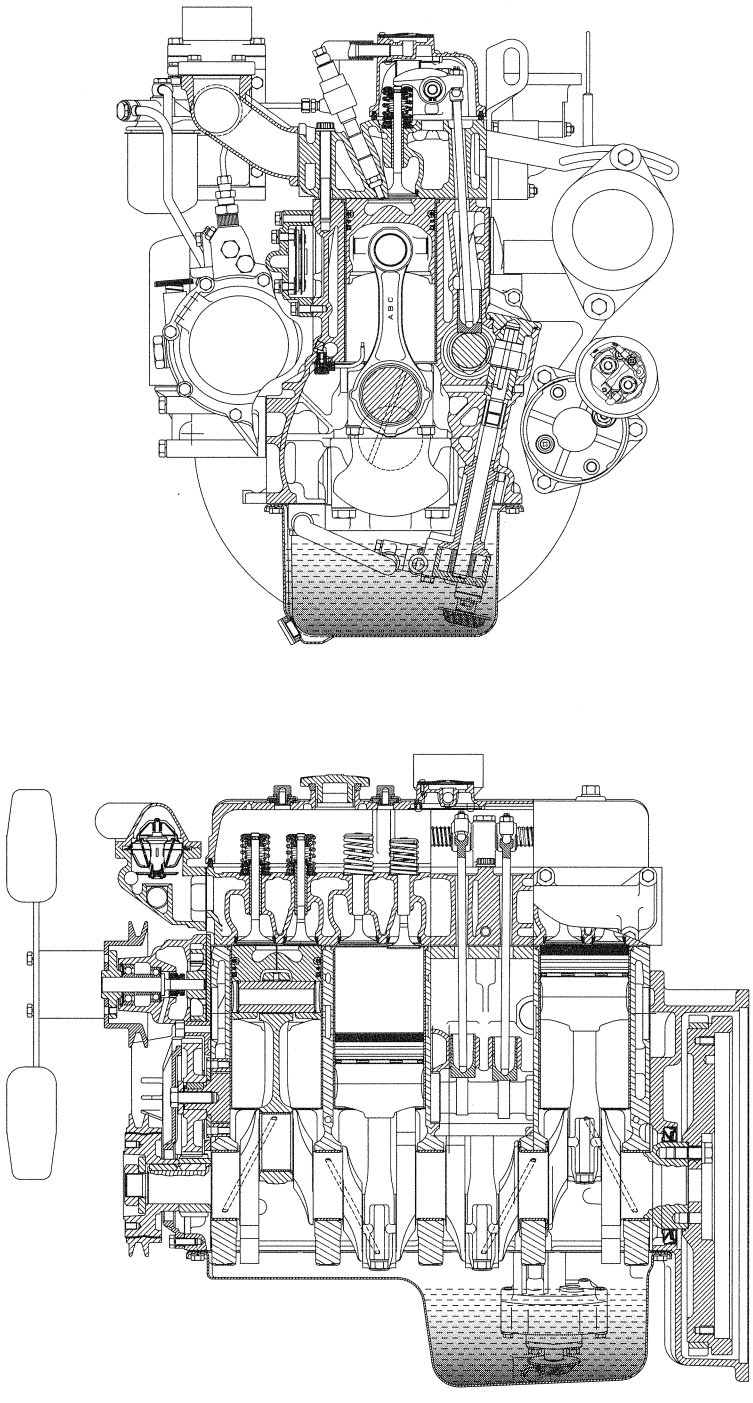


* Recommended lubricants

-Diesel engine oil “CD” or “CE” grade (API)

2. Engine Assembly

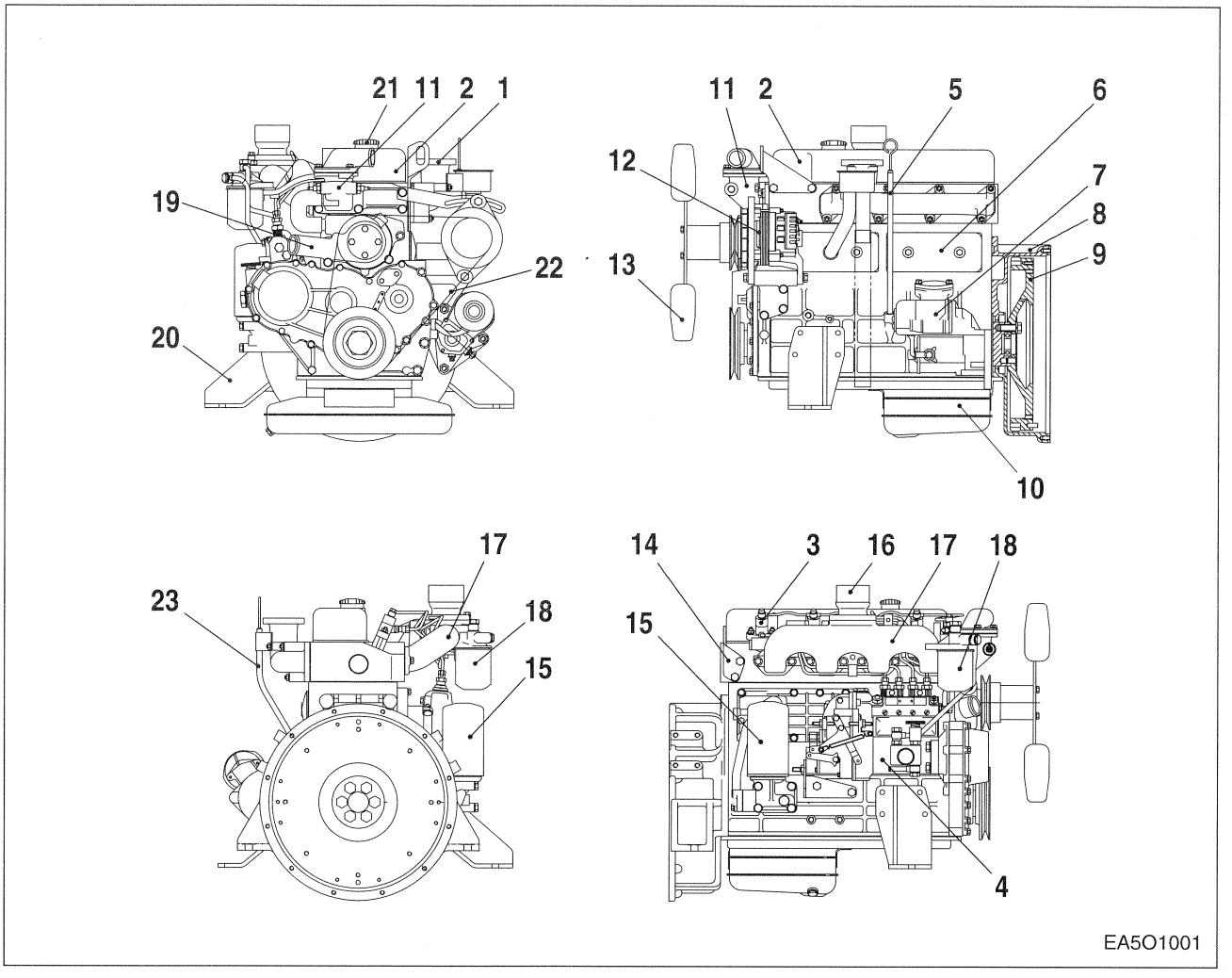
2.1. Sectional Figures(DB33)



EA5M2001

2.2. Disassembly

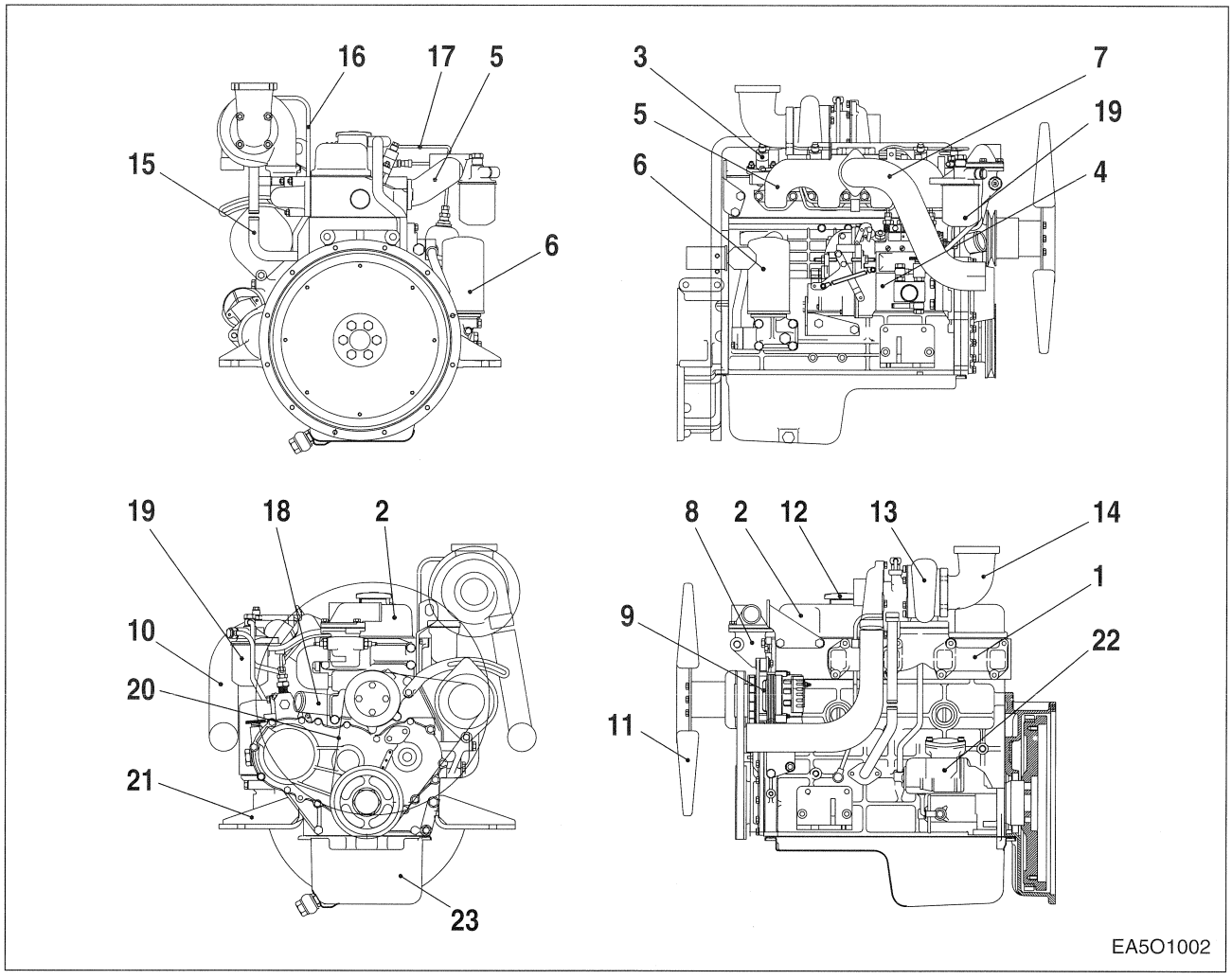
2.2.1. External Parts(DB33)



<Disassembly steps>

- ▲ 1. Exhaust manifold assembly
- ▲ 2. Cylinder head cover
- ▲ 3. Injection nozzle
- ▲ 4. Injection pump assembly
- 5. Oil level gauge
- 6. Push rod chamber cover
- 7. Starting Motor assembly
- 8. Flywheel housing
- 9. Flywheel
- 10. Oil pump assembly
- 11. Thermostat housing assembly
- 12. Alternator assembly
- 13. Cooling fan
- 14. Lifting hook
- 15. Oil filter assembly
- 16. Intake stake
- 17. Intake manifold assembly
- 18. Fuel filter assembly
- 19. Water pump assembly
- 20. Mounting bracket assembly
- 21. Oil filler cap
- 22. V-belt
- 23. Oil level gauge

2.2.2. External Parts(P034TI)



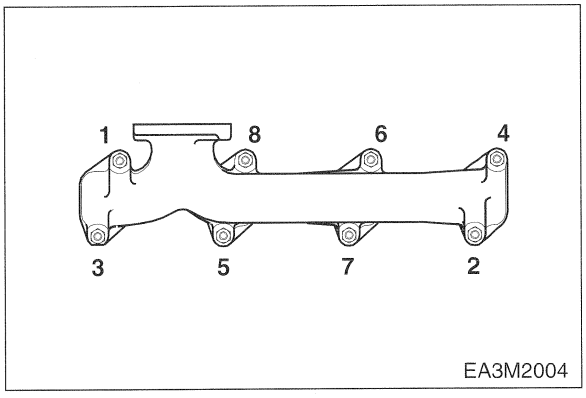
<Disassembly steps>

- ▲ 1. Exhaust manifold assembly
- ▲ 2. Cylinder head cover
- ▲ 3. Injection nozzle
- ▲ 4. Injection pump assembly
- 5. Intake manifold assembly
- 6. Oil filter assembly
- 7. Air pipe assembly(from intercooler ass'y)
- 8. Thermostat housing assembly
- 9. Alternator assembly
- 10. Air pipe assembly(to intercooler ass'y)
- 11. Cooling fan
- 12. Oil filler cap
- 13. Turbocharger assembly
- 14. Exhaust elbow
- 15. Oil return pipe
- 16. Oil delivery pipe
- 17. Fuel return pipe
- 18. Water pump assembly
- 19. Fuel filter assembly
- 20. V belt
- 21. Mounting bracket
- 22. Starting Motor assembly
- 23. Oil pan assembly

Important operation

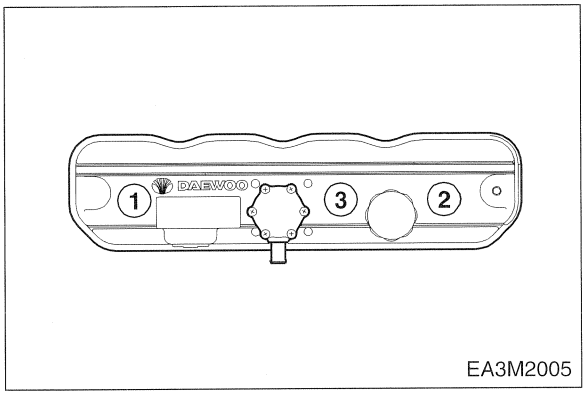
1. Exhaust manifold assembly

Loosen the manifold fixing bolts in sequence of figure's shown



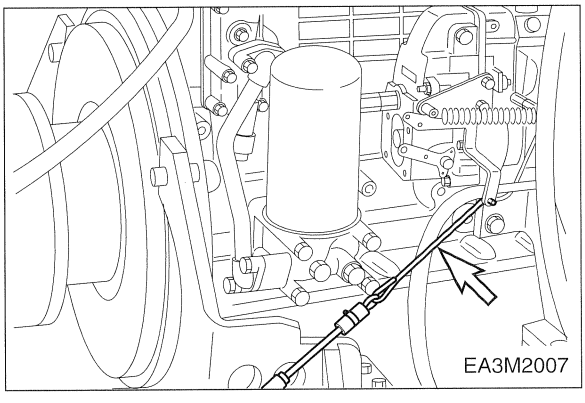
2. Cylinder head cover

Loosen the head cover bolts in sequence of figure's shown.



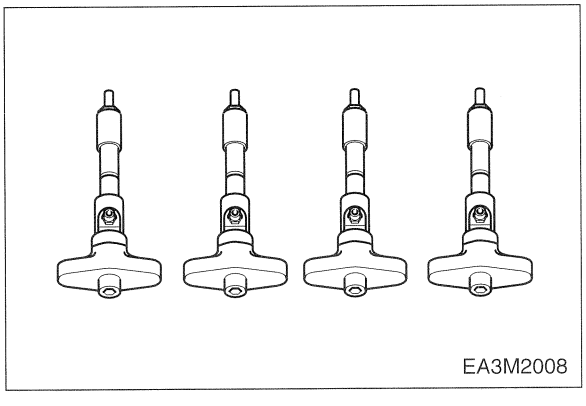
Engine control rod

Disassemble the engine control rod.



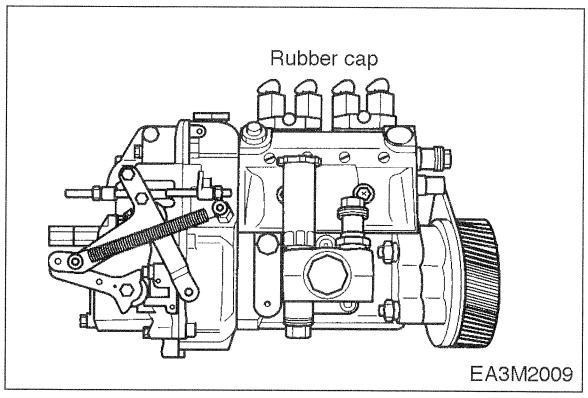
3. Injection nozzle

Be careful of nozzle tip or other parts from damage when disassemble.



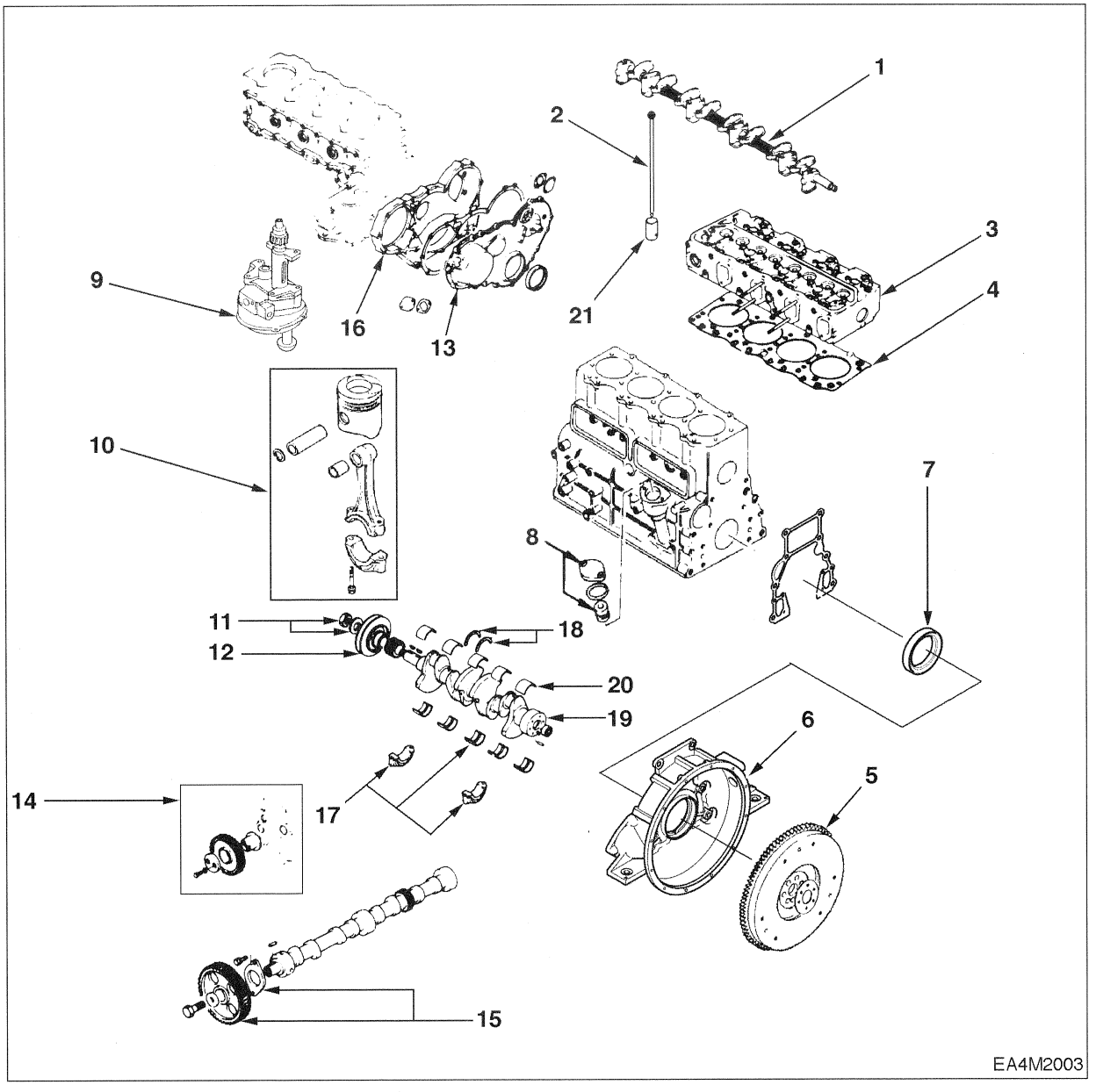
4. Injection pump assembly

When injection pump disassemble, put on rubber cap or taping the delivery valve holder for preventing from dusts.



2.2.3. Internal Parts

• Major Components



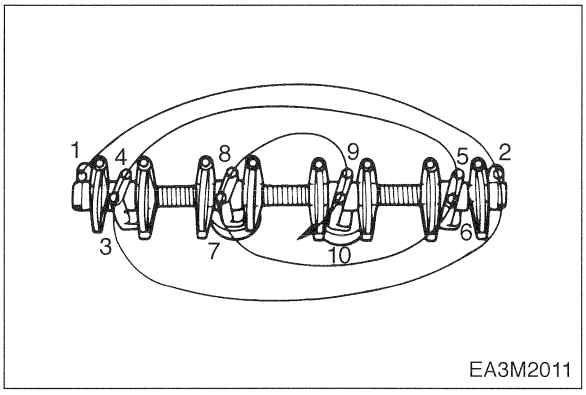
<Disassembly steps>

- ▲ 1. Rocker arm shaft assembly
- 2. Push rod
- ▲ 3. Cylinder head assembly
- 4. Cylinder head gasket
- ▲ 5. Fly wheel
- 6. Fly wheel housing
- 7. Rear oil seal assembly
- 8. Oil pump cover
- 9. Oil pump assembly
- ▲ 10. Piston and connecting rod assembly
- ▲ 11. Crankshaft front nut and washer
- 12. Crankshaft pulley
- 13. Gear case cover
- ▲ 14. Idle gear
- 15. Camshaft assembly
- 16. Timing gear case
- ▲ 17. Crankshaft bearing cap and bearing
- ▲ 18. Thrust bearing
- 19. Crankshaft assembly
- 20. Crankshaft bearing
- ▲ 21. Tappet

Important operations

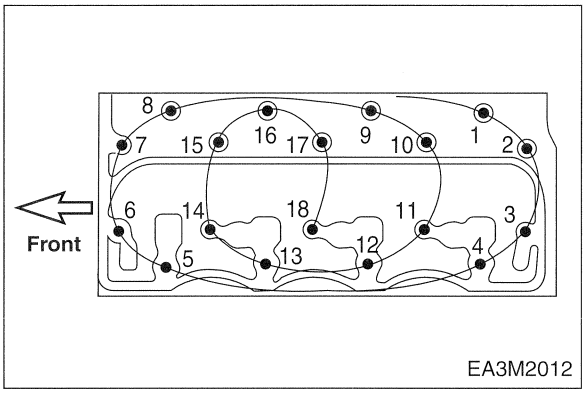
1. Rocker arm shaft assembly

Loosen the rocker arm shaft assembly fixing bolts a little at a time in numerical sequence as shown in the figure.



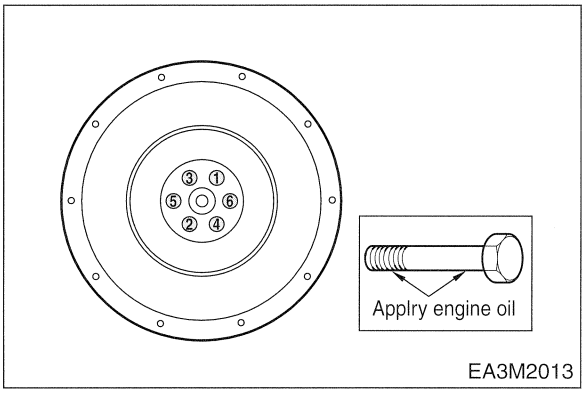
3. Cylinder head assembly

Loosen the cylinder head bolts a little at a time in the numerical sequence as shown in the figure.



5. Fly wheel

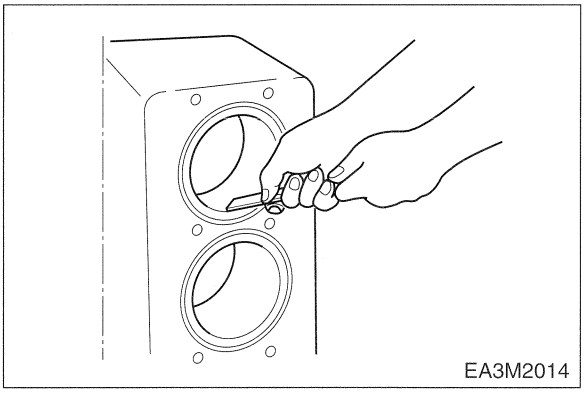
Loosen the flywheel fixing bolts a little at a time in numerical sequence as shown in the figure.



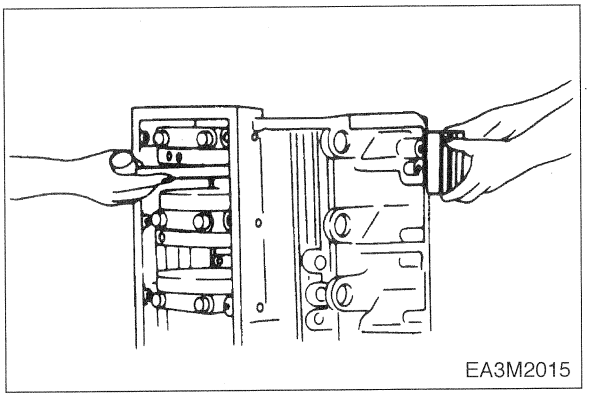
10. Piston assembly

Remove any carbon deposits from the upper part of the cylinder bore using a scraper.

This will prevent damage to the piston and the piston rings when they are removed from the cylinder bore.

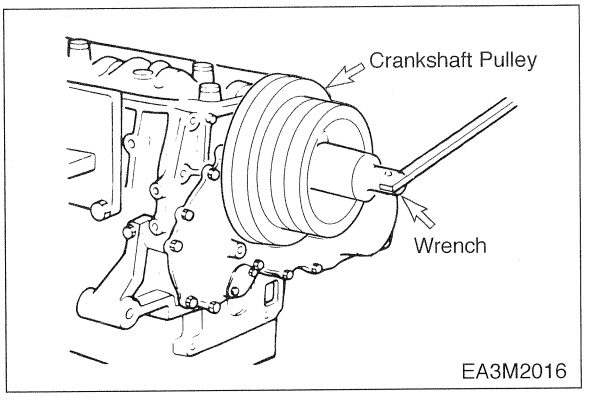


Bring the piston to top dead center by turning the crankshaft, then push out the piston and connecting rod assembly from the cylinder using the handle of a hammer or wooden bar.


EA3M2015

11. Crankshaft front nut and washer

Wrench : 41 mm



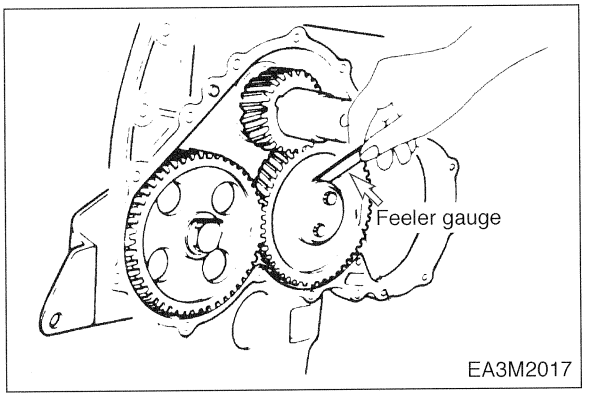
EA3M2016

14. Idle gear

Measure the following points before disassembly.

Idle gear end play

Standard	Limit
0.058 ~ 0.115	0.2 mm

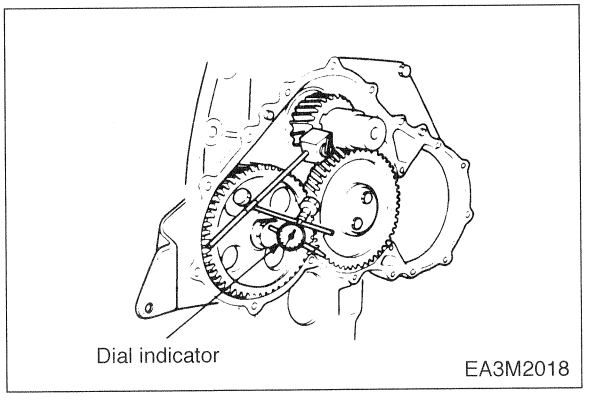


EA3M2017

Backlash

Standard	Limit
0.10 ~ 0.17	0.3 mm

Includes the crankshaft gear, camshaft gear and idle gear.



EA3M2018

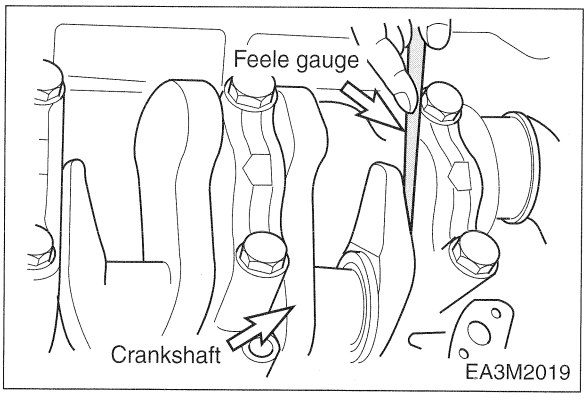
17. Crankshaft bearing cap & bearing

Measure the crankshaft end play before disassembly.

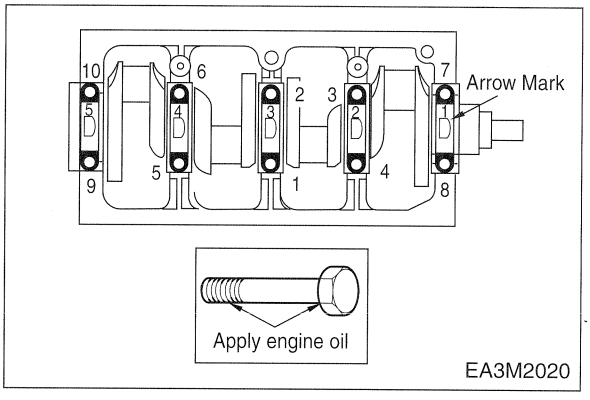
Crankshaft end play

Standard	Limit
0.10 ~ 0.17	0.3 mm

Includes the crankshaft gear, camshaft gear and idle gear.

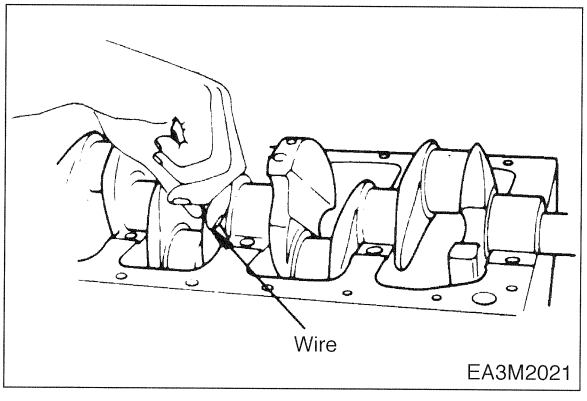


Loosen the crankshaft bearing cap bolts in numerical sequence as shown in the figure.



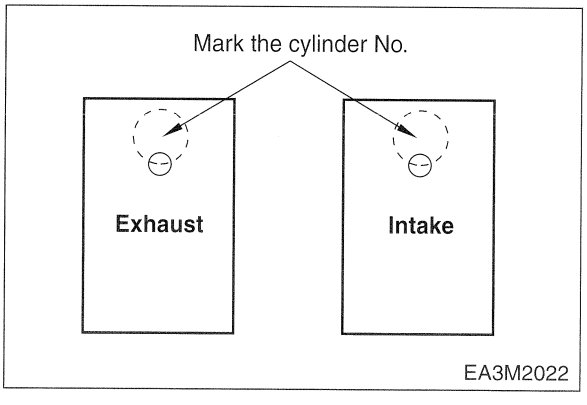
18. Thrust bearing

Remove the thrust bearing with steel wire.



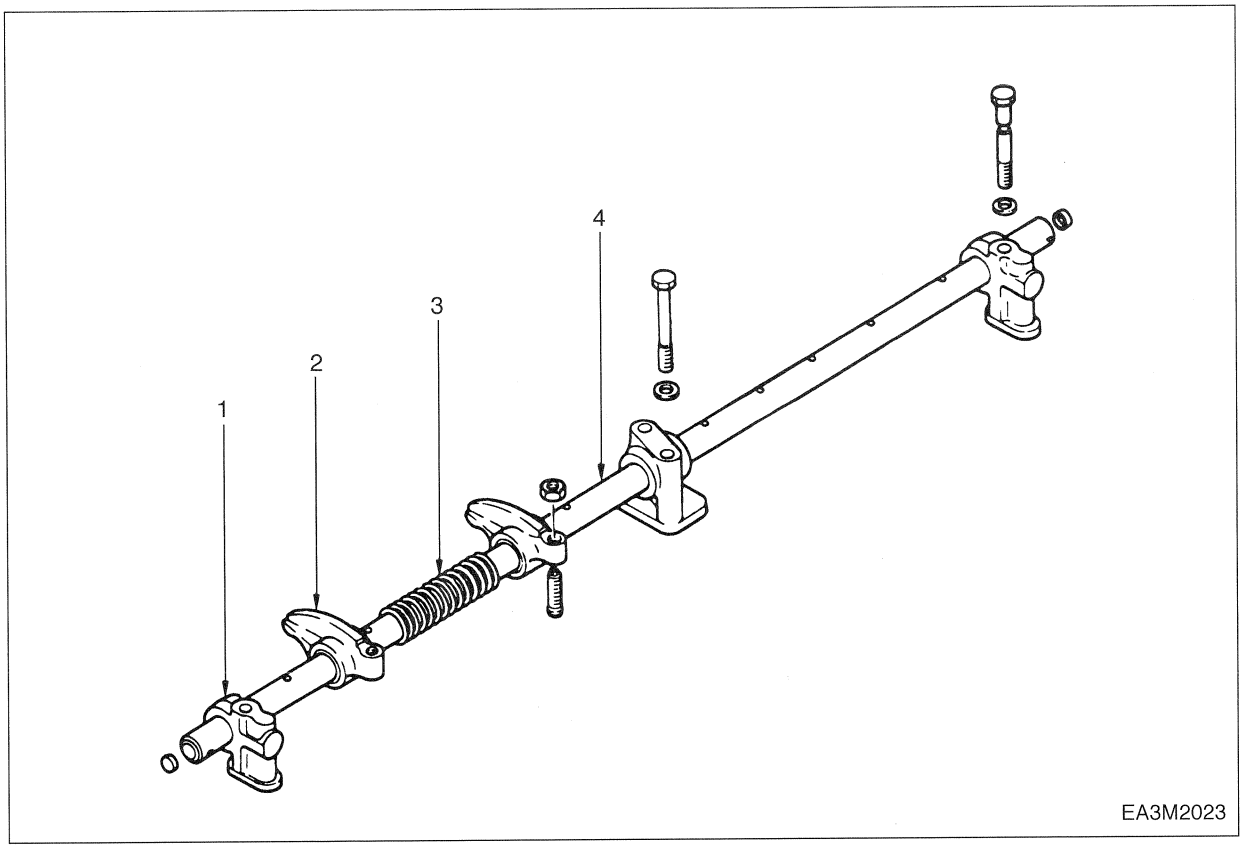
21. Tappet

Remove the tappets and mark the cylinder number each tappet.(Be careful against the damages)



2.2.4. General Components

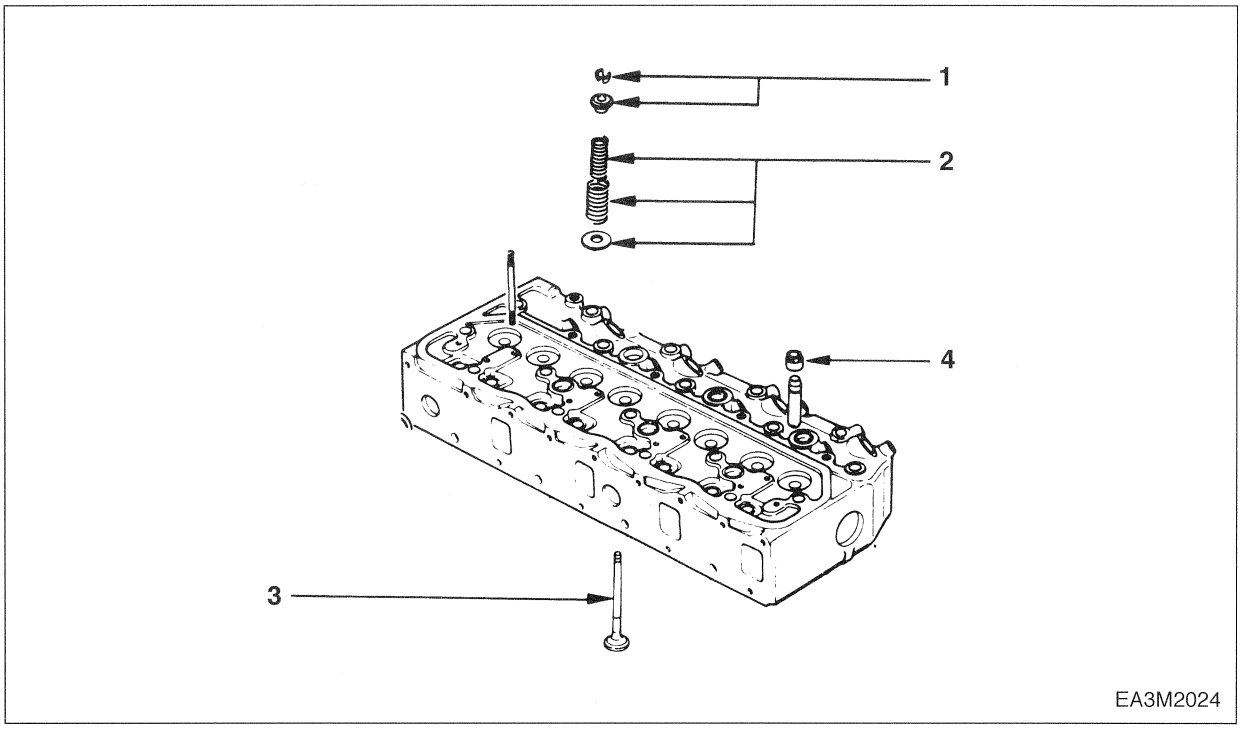
- **Rocker arm, Bracket and shafts assembly**



<Disassembly steps>

1. Bracket
2. Rocker arm
3. Spring
4. Rocker arm shaft

• Cylinder head assembly



<Disassembly steps>

- ▲ 1. Spring retainer and valve cotter
- ▲ 2. Spring and spring seat
- ▲ 3. Valve
- 4. Valve stem and oil seal

Important operations

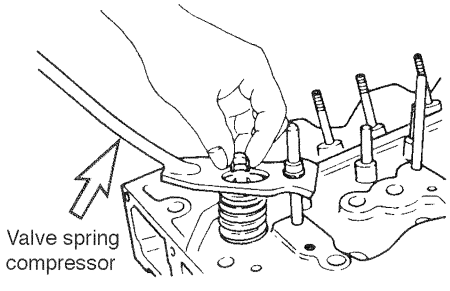
Mark the cylinder No. each component when it disassembles.

- **Valve spring**
- **Valve**
- **Valve seat**

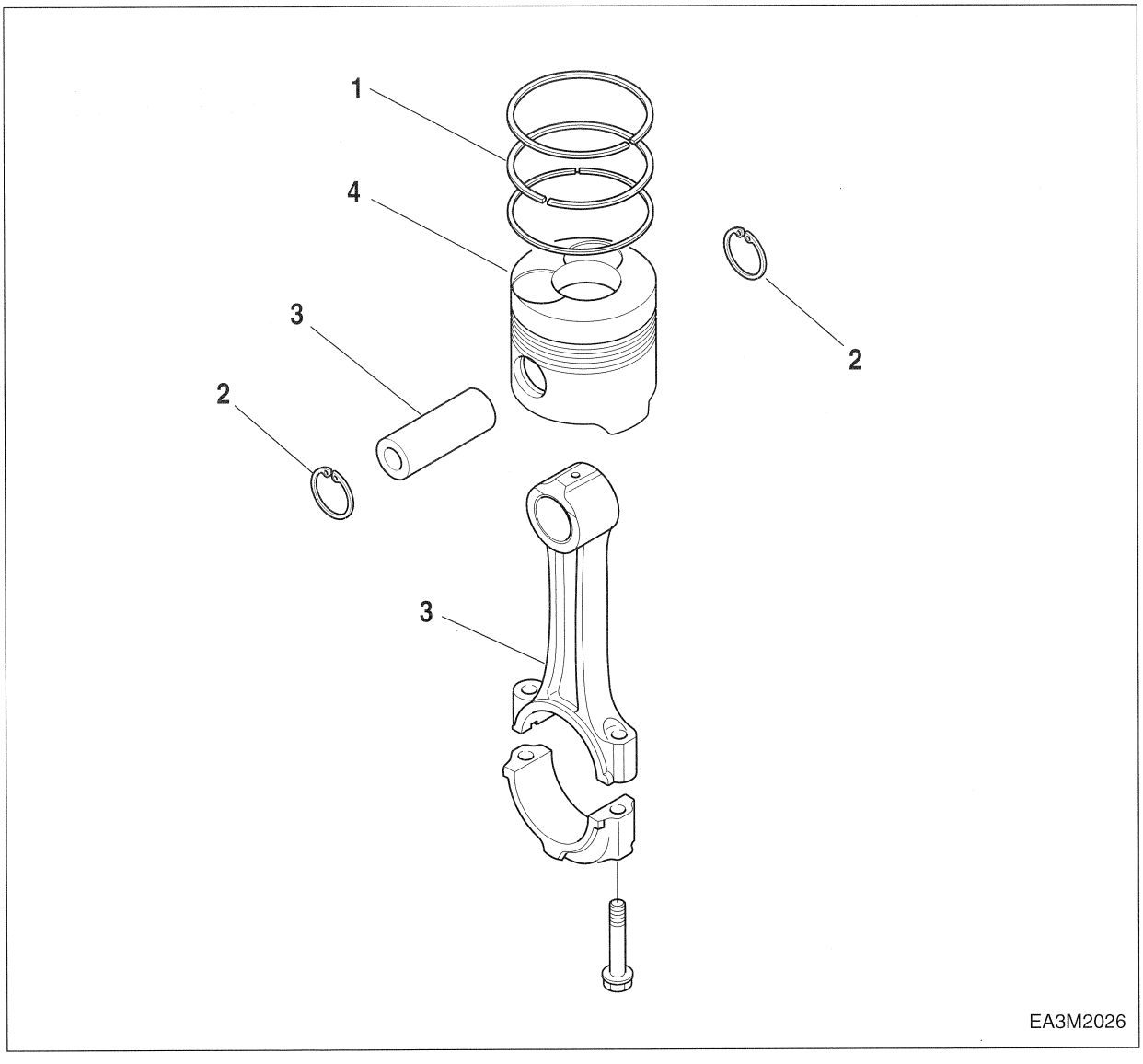
EA3M2025

1. Retainer and valve cotter

Spring compressor



• Piston and connecting-rod assembly



EA3M2026

<Disassembly steps>

▲ 1. Piston ring
▲ 2. Snap ring
▲ 3. Piston pin and connecting-rod
4. Piston

Important operations

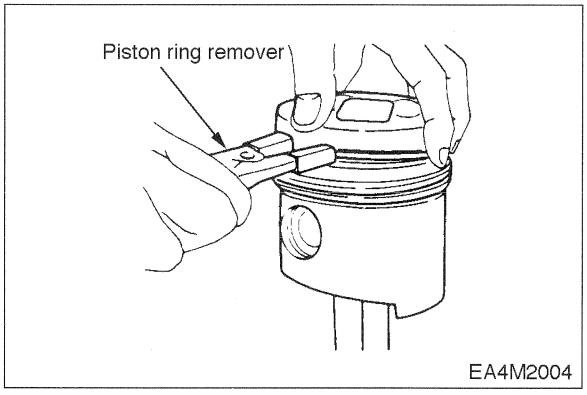
Mark the cylinder No. each component when it disassembles.

- **Piston ring**
- **Piston**
- **Piston pin**
- **Connecting-rod**

EA3M2027

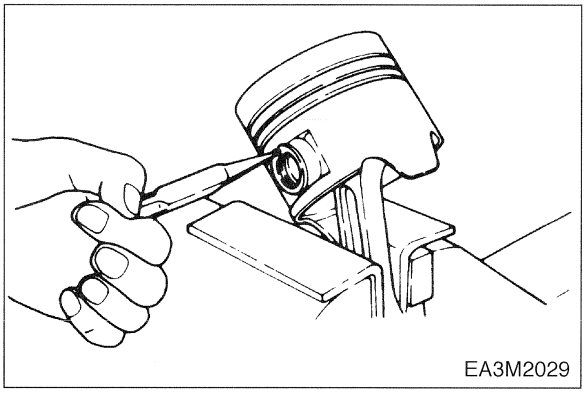
1. Piston ring

Remove the piston rings.



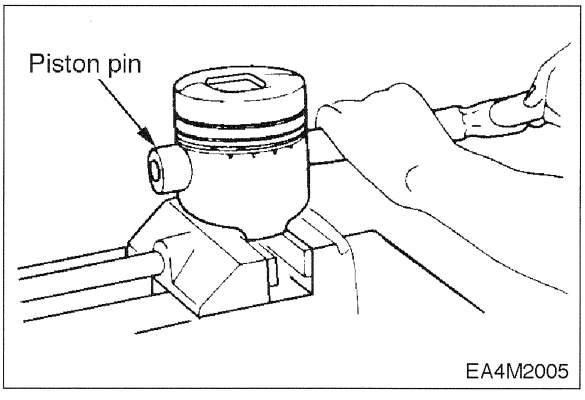
2. Snap ring

Remove the piston pin snap ring.



3. Piston pin and connecting-rod

Pull out the piston pin with brass bar.



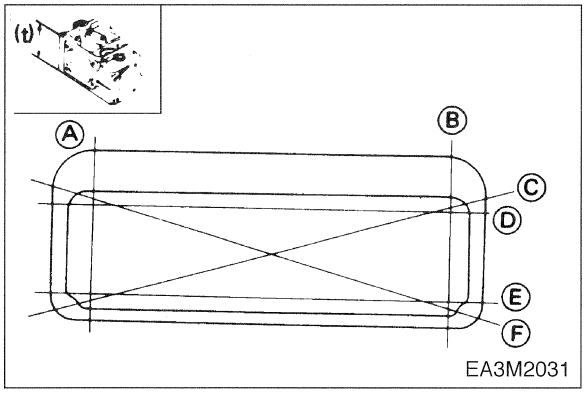
2.3. Inspection and Repair

Make the necessary adjustments, repairs and replacements if excessive wear or damage is discovered during inspection.

2.3.1. Cylinder Head

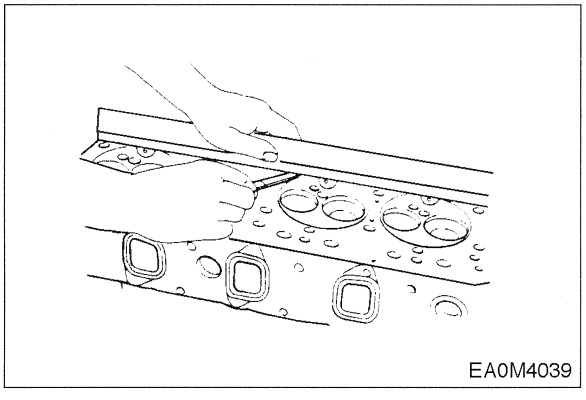
Distortion at lower face

- Check in six different (A ~ F) using a straight edge and a feeler gauge.



Lower face warpage and height

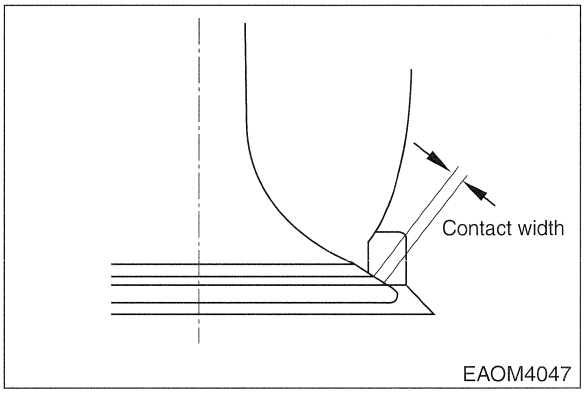
	Standard	Limit
Warpage	0.05mm or less	0.2 mm
Thickness : t (reference)	89.95~90.05 mm	89.75 mm



2.3.2. Valve, Valve Guide and Valve Seat Insert

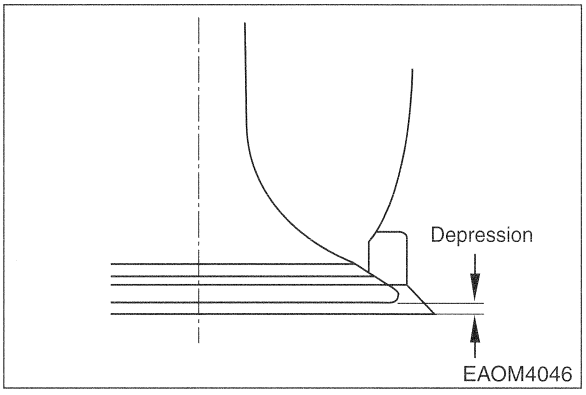
Valve contact width

Standard	Limit
1.5 mm	2.0 mm

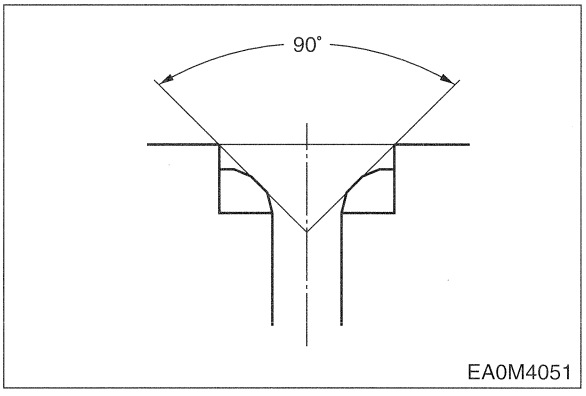


Valve depression

Standard	Limit
1.0 mm	2.5 mm



Valve seat angle

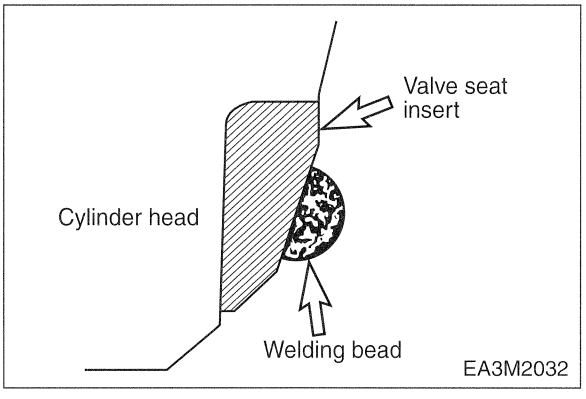


Valve seat insert replacement

Removal : Arc weld the entire inside circumference of the valve seat insert.

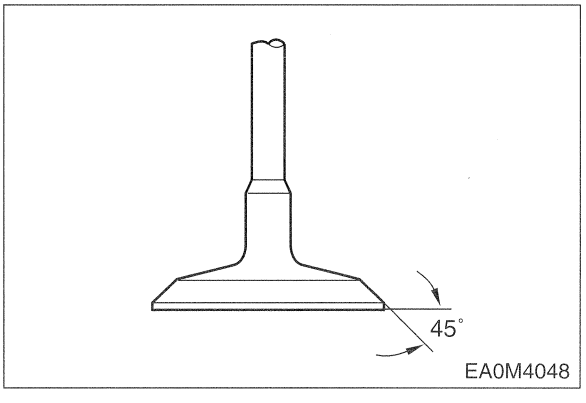
- Cooling the valve insert for a few minutes and pull out with a screw driver.

Installation : Use a bench press to smoothly press the valve seat insert.



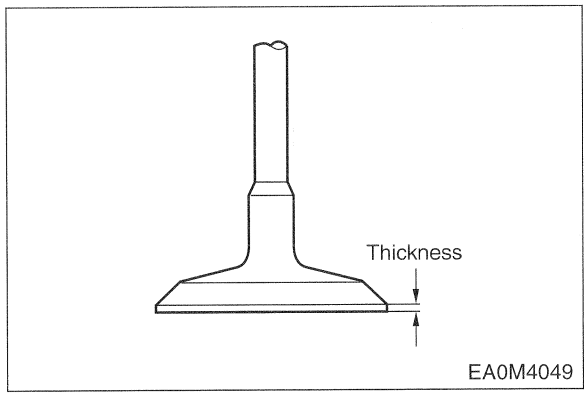
Valve angle

Intake	45°
Exhaust	45°



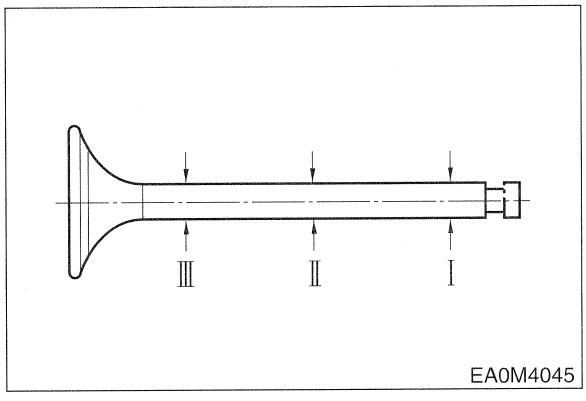
Valve seat thickness

Standard	Limit
1.5 mm	2.0 mm



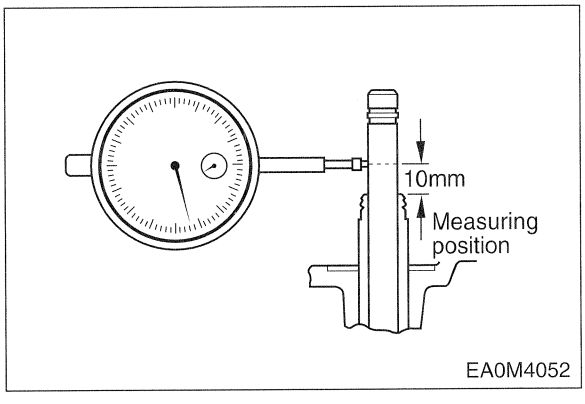
Valve stern outer diameter

	Standard	Limit
Intake valve	ϕ8.946 ~ ϕ8.961 mm	ϕ8.88 mm
Exhaust valve	ϕ8.921 ~ ϕ8.936 mm	ϕ8.88 mm



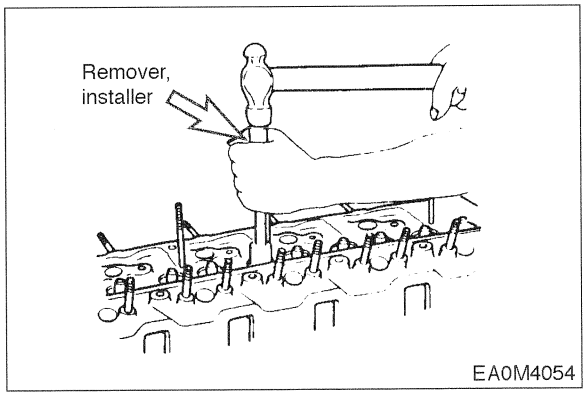
Valve stem end play

	Standard	Limit
Intake valve	0.04 ~ 0.07 mm	0.2 mm
Exhaust valve	0.06 ~ 0.09 mm	0.25 mm



Valve guide replacement

Remover, installer

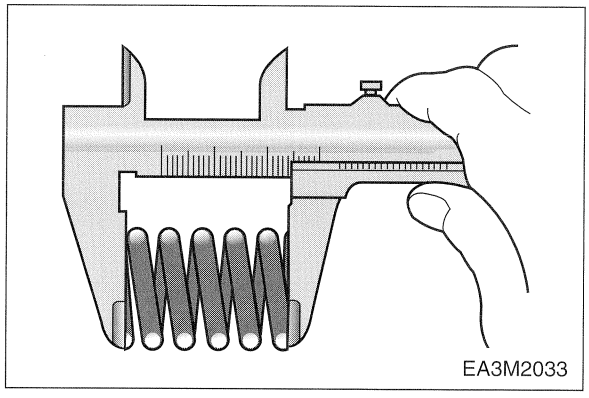


2.3.3. Valve Spring

Valve spring free length

Use a vernier caliper to measure the valve spring free length.

If the measured value is less than the specified limit, the valve spring must be replaced.

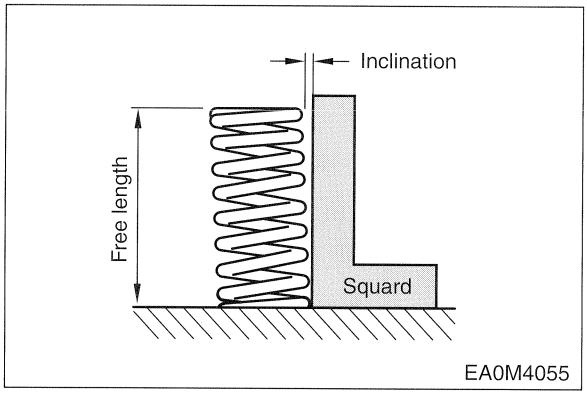


(unit : mm)		Standard	Limit	Remark
Exhaust and Intake valve Spring free Length		49.0	47.0	Generator and Industrial
Free length	Inner	52.4	50.0	Marine and Automotive
	Outer	53.6	50.6	

Valve spring inclination

Use a surface plate and a square to measure the valve spring inclination.

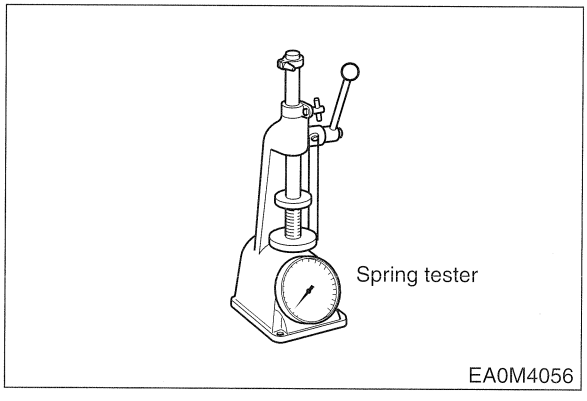
If the measured value exceeds the specified limit, the valve spring must be replaced.



(unit : mm)		Standard	Limit	Remark
Valve Spring Inclination		less than 1.3	2.7	Generator and Industrial
Free length	Inner	-	1.0	Marine and Automotive
	Outer	-	1.6	

Valve spring tension

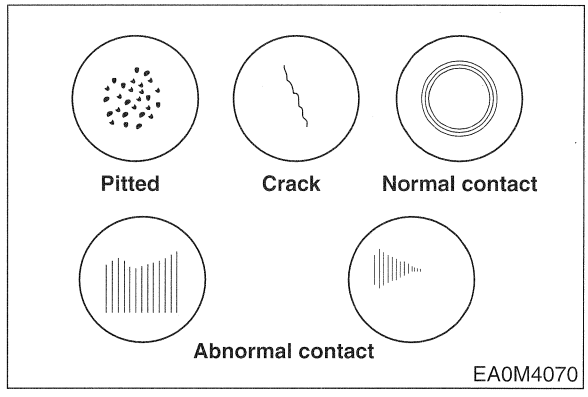
Use a spring tester to measure the valve spring tension if the measured value is less than the specified limit, the valve spring must be replaced.



(Set Length)		Standard	Limit	Remark
Valve Spring Tension at 40mm Set Length		14.5 kg	11.5 kg	Generator and Industrial
Inner Outer	42 mm	10.9 kg	9.9 kg	Marine and Automotive
	44 mm	23.0 kg	20.0 kg	

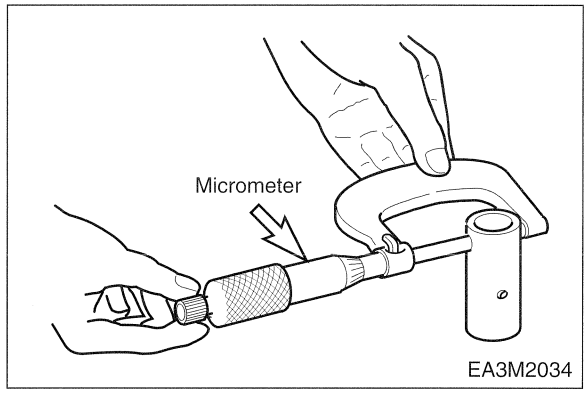
2.3.4. Tappet

Inspect the tappets for excessive wear, damage and any abnormal conditions.



Diameter

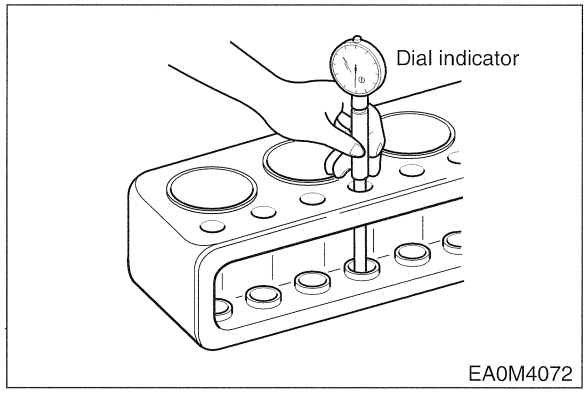
Standard	Limit
27.97 ~ 27.98 mm	27.92 mm



Clearance

between the tappet and cylinder body

Standard	Limit
0.02 ~ 0.054 mm	0.1 mm

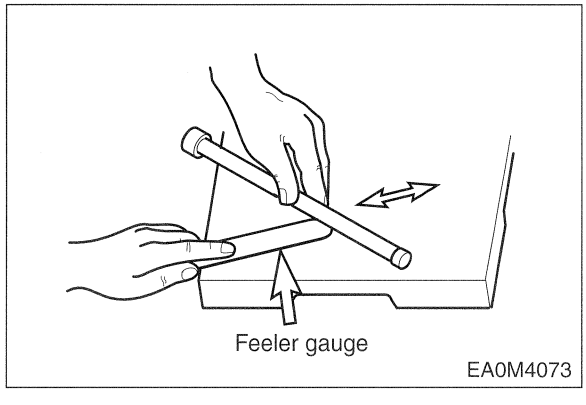


2.3.5. Push Rod

Run-out

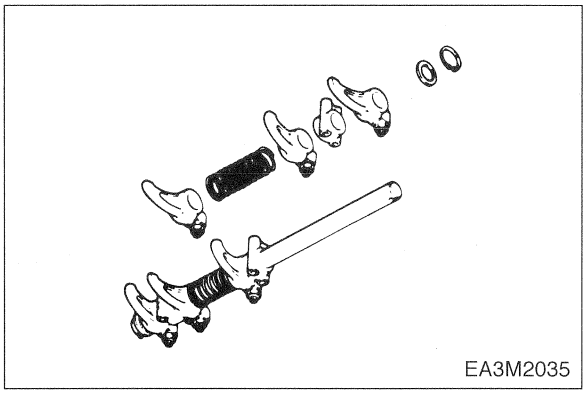
Limit	0.3 mm or less

- Use a feeler gauge to measure the push rod run-out.
- Roll the push rod along a smooth flat surface as shown in the figure.



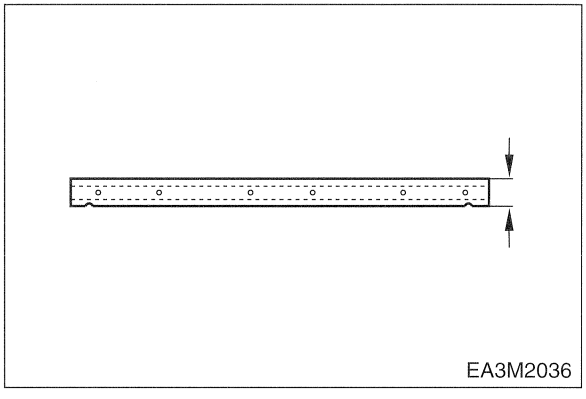
2.3.6. Rocker Arm Shaft Assembly

Inspect all disassembled parts for wear, damage and any abnormalities.


EA3M2035

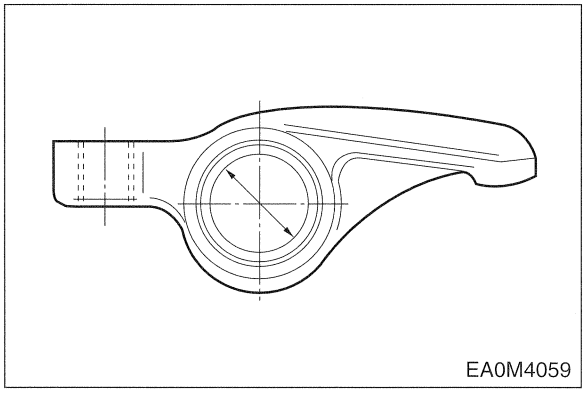
Rocker arm shaft

Standard	Limit
ϕ18.98 ~ ϕ19.00	ϕ18.85 mm


EA3M2036

Rocker arm bushing

Standard	Limit
ϕ19.01 ~ 19.03	ϕ19.05 mm


EA0M4059

Clearance

Between the rocker arm shaft and bushing

Standard	Limit
0.01 ~ 0.05 mm	0.2 mm

2.3.7. Camshaft Assembly

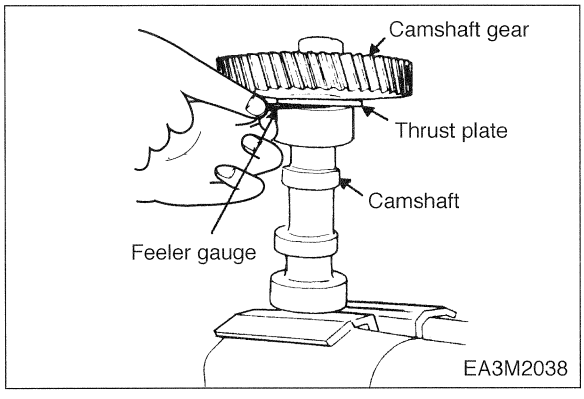
Inspection all disassembled parts for wear, damaged and other abnormal conditions.

- **Camshaft**
- **Cam gear**
- **Thrust plate**

EA3M2037

Cam gear end play

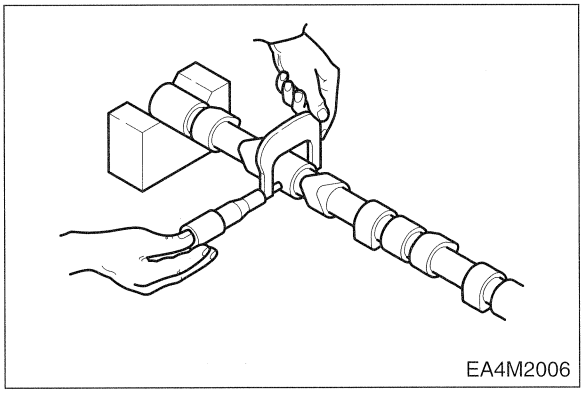
Standard	Limit
0.050 ~ 0.114 mm	0.2 mm



EA3M2038

Camshaft journal diameter

Standard	Limit
ϕ55.94 ~ ϕ55.97 mm	ϕ55.60 mm



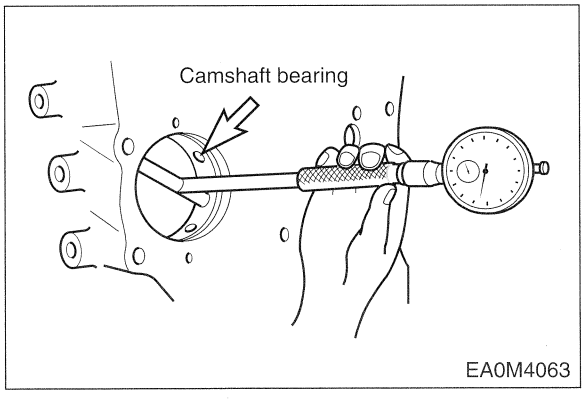
EA4M2006

Cam bearing diameter

Standard	ϕ56.00 ~ ϕ56.03 mm

Clearance between camshaft journal and body

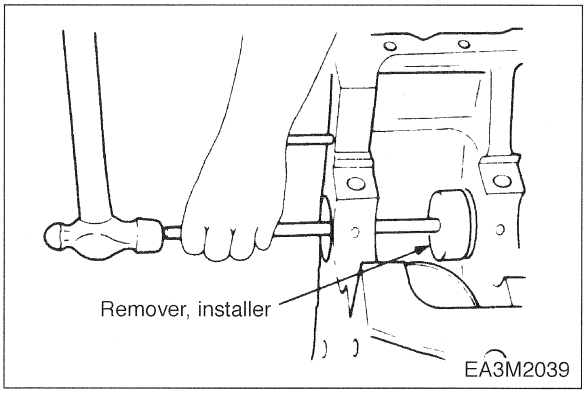
Standard	Limit
0.03 ~ 0.09 mm	0.15 mm



EA0M4063

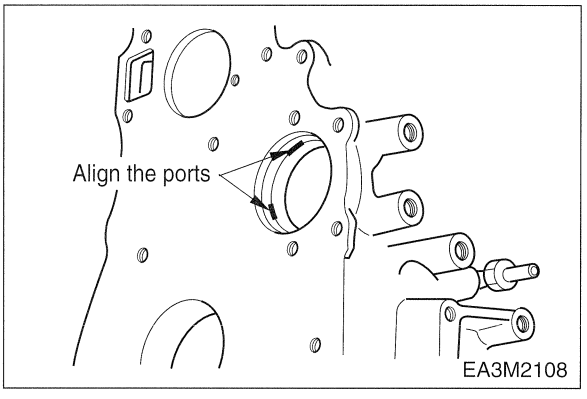
Camshaft bearing replacement

Remover, installer



Align the camshaft bearing oil holes with the ports in the cylinder body.

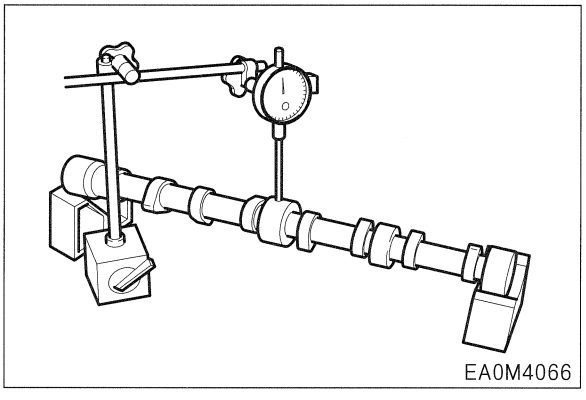
No. 1 camshaft bearing (front side) has two oil ports while others have only one oil port.



Camshaft run-out (T.I.R.)

Standard	0.1 mm

- Place the camshaft on a measuring stand.
- Use a dial indicator to measure the camshaft run-out.
- Note the total indicator values. (T.I.R.)



Camshaft gear

Replace the camshaft gear if any damages or excessive backlash are found.

Gear bolt torque	14.0 kg.m

- **Refer to "Major components disassembly" for the backlash measurement (2.2.3 - 14)**

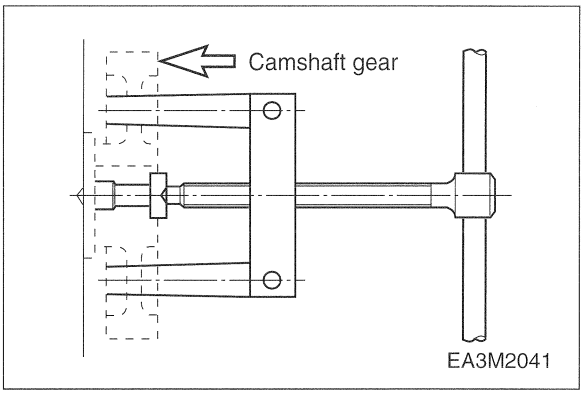
EA4M2020

Cam gear and thrust plate replacement

Disassembly : Gear puller

Install : Use a bench press and a hammer

Torque	14.0 kg.m

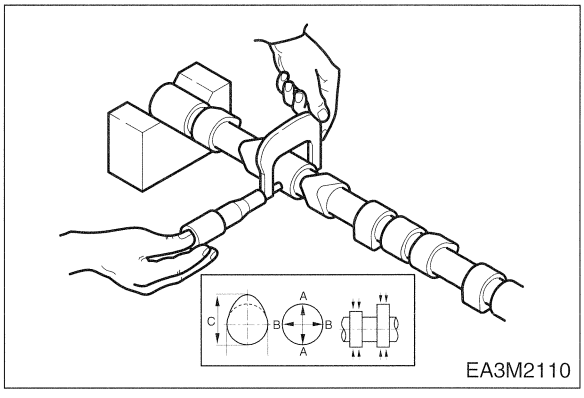


Cam lobe height

	Standard	Limit
Cam lobe height (C)	47.7 mm	46.5 mm
Cam journal diameter(A,B)	ϕ56.0 mm	ϕ55.6 mm

Use a micrometer to measure the cam lobe height and journal diameter.

If the measured number is less than the specified limit, the camshaft must replaced.



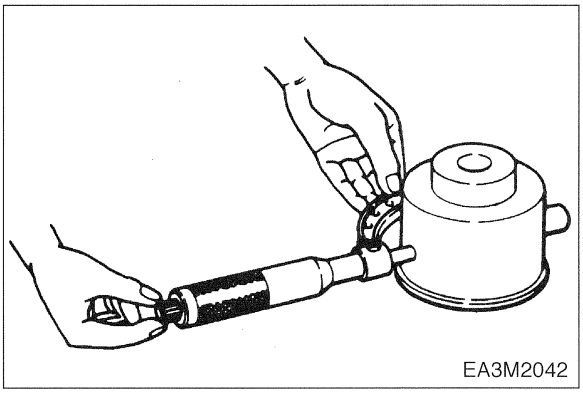
2.3.8. Idle Gear and Idle Gear Shaft

Shaft outside diameter

Replace the idle gear shaft if the measured value escaped from the specified limit.

Use a micrometer.

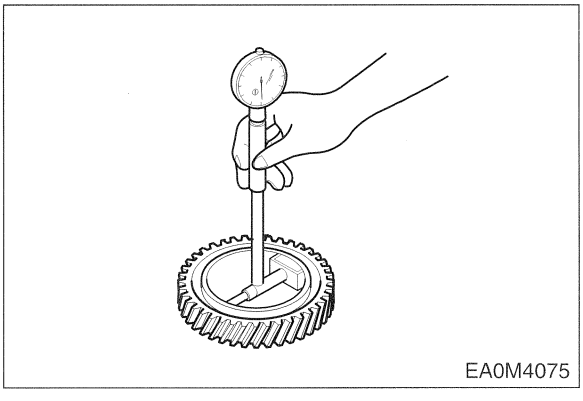
Standard	Limit
ϕ44.94 ~ ϕ44.97 mm	ϕ44.84 mm



Clearance between shaft and gear

Measure the inside diameter of idle gear with the dial indicator.

Standard	Limit
0.009 ~ 0.060 mm	0.2 mm

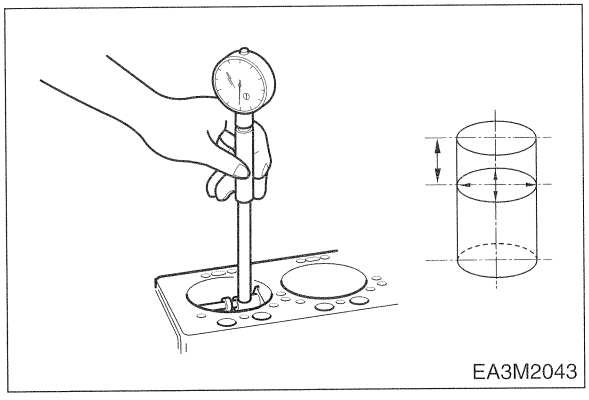


2.3.9. Cylinder Block and Liner

Cylinder body bore measurement

Measuring point : Approx. 20mm below from upper face (Maximum wear portion)

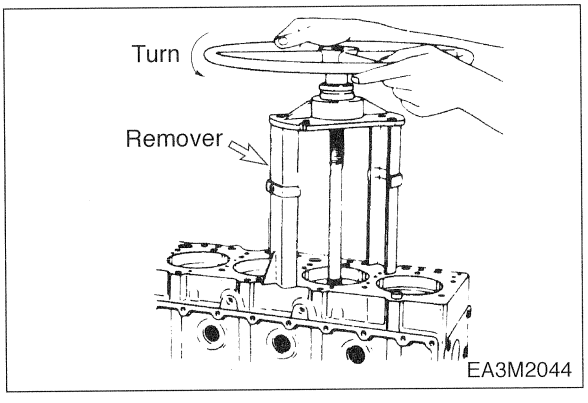
	Standard	Limit
For cast liner	ϕ105.99 ~ϕ106.01 mm	ϕ106.10 mm
For steel liner	ϕ105.00 ~ϕ105.04 mm	ϕ105.10 mm



Cylinder liner replacement

Disassembly : Remover

(Turn for steel liner only)



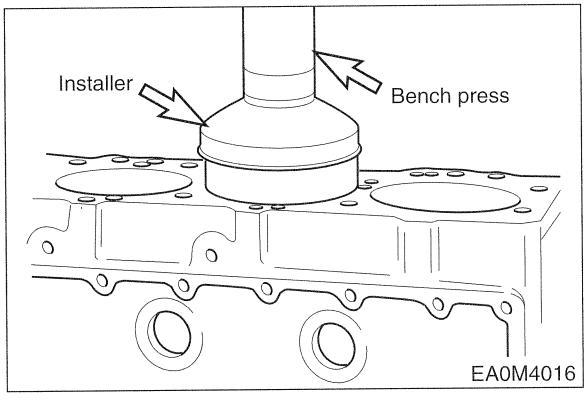
Liner Installation

Installer

- First, apply a load of 500kg using a bench press. Do not use a hammer.
- And then apply a final seating force of 2,500kg to seat the cylinder liner fully.

Cast liner	Loose fit	0.005 ~ 0.026 mm
Steel liner	Tight fit	0.001 ~ 0.019 mm

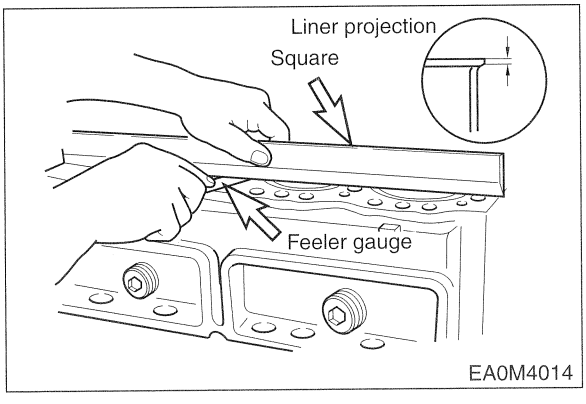
After installing the liner, measure the cylinder liner projection and inner diameter.



Liner projection

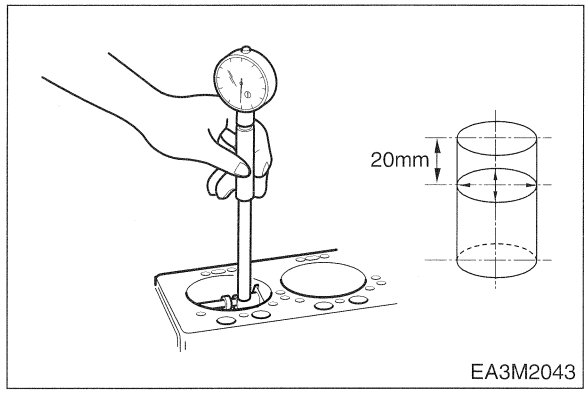
Standard	0.03~0.10 mm

- For the cast liner, removal or installation is worked smoothly.



Cylinder liner inner diameter

	Liner Grade	Standard
For cast liner	A	ϕ102.021~ϕ102.030 mm
	B	ϕ102.031~ϕ102.042 mm
For steel liner	A	ϕ102.021~ϕ102.040 mm
	B	ϕ102.041~ϕ102.060 mm



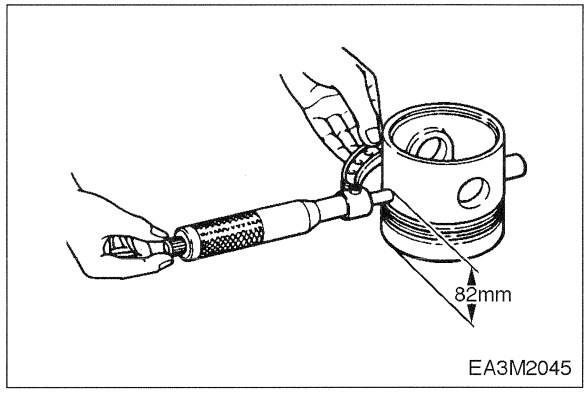
2.3.10. Piston, Piston Pin and Piston Ring

Piston outer diameter

	Piston Grade	Standard
For cast liner	A	ϕ101.953~ϕ101.967 mm
	B	ϕ101.963~ϕ101.977 mm
For steel liner	A	ϕ101.955~ϕ101.974 mm
	B	ϕ101.975~ϕ101.994 mm

Piston and liner bore clearance

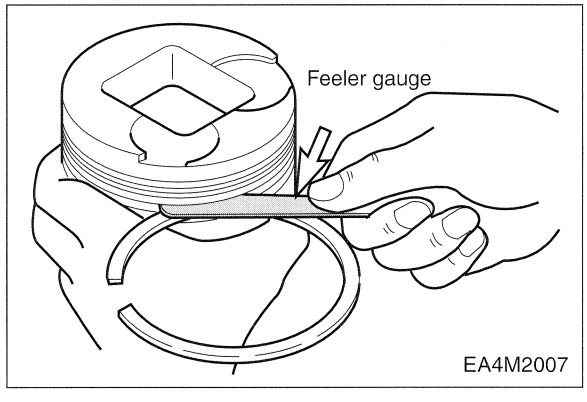
Standard	0.055 ~ 0.075 mm



Piston ring

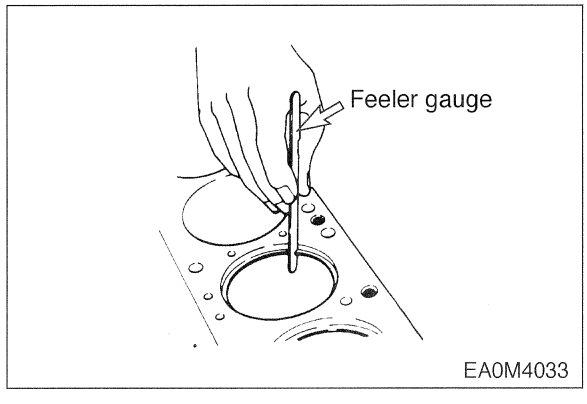
Piston ring and ring groove clearance

	Standard	Limit
1st compression ring	0.085 ~ 0.11 mm	0.2 mm
2nd compression ring	0.035 ~ 0.055 mm	0.15 mm
Oil ring	0.03 ~ 0.07 mm	0.15 mm



Piston ring gap

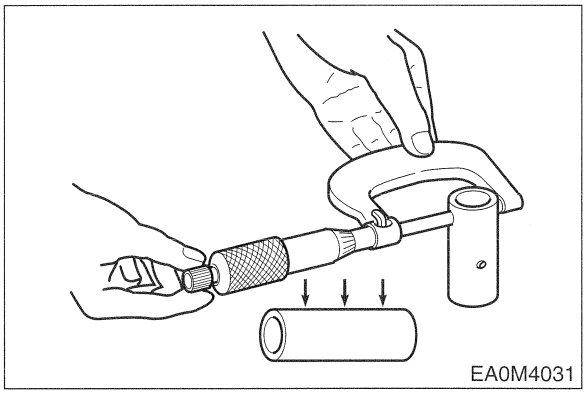
	Standard	Limit
1st compression ring	0.25 ~ 0.45 mm	1.5 mm
2nd compression ring	0.2 ~ 0.4 mm	1.5 mm
Oil ring	0.2 ~ 0.4 mm	1.5 mm



Piston pin outer diameter

Measure the various placed pin outside with a micrometer. Replace the pin if the measured value escaped from the specified limit.

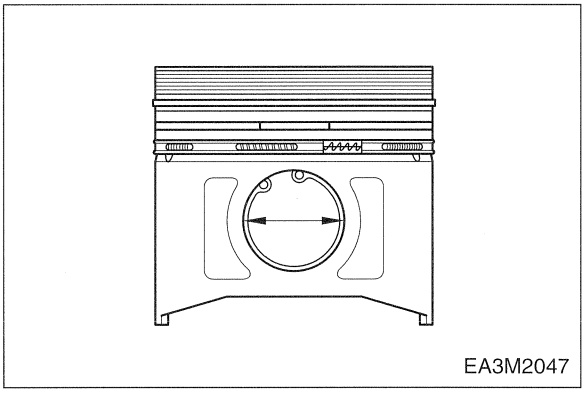
Standard	Limit
ϕ35.000 ~ ϕ35.005 mm	ϕ34.95 mm


EA0M4031

Piston pin and piston clearance

Measure diameter of the piston pin hole with an inside dial gauge.

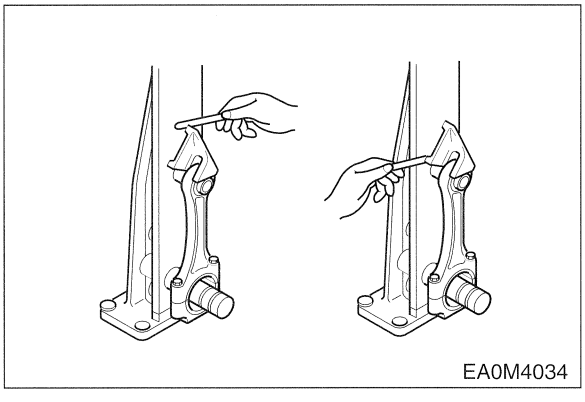
Limit	0.05 mm


EA3M2047

2.3.11. Connecting Rod and Bearing

Connecting rod alignment (parallelism)

Standard	Limit
0.05 mm	0.2 mm


EA0M4034

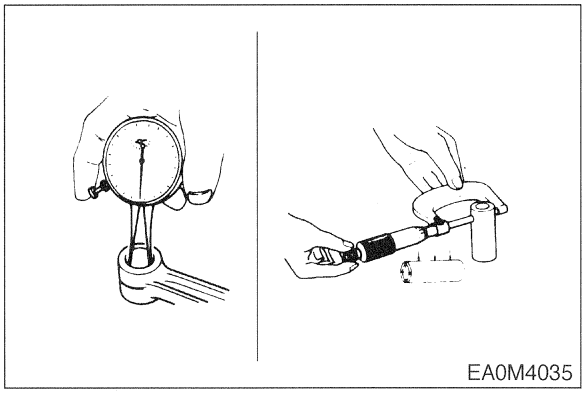
Bushing inside diameter

Standard	ϕ35.017~ϕ35.025 mm

Use a caliper calibrator and micrometer to measure the piston pin and connecting rod small end bushing clearance.

Clearance between piston pin and connecting rod small end bushing

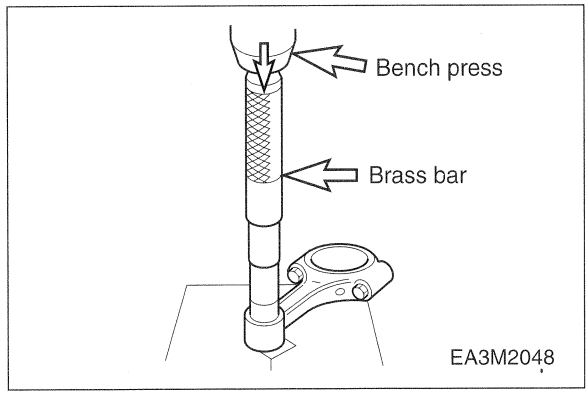
Standard	Limit
0.01 ~ 0.03 mm	0.05 mm


EA0M4035

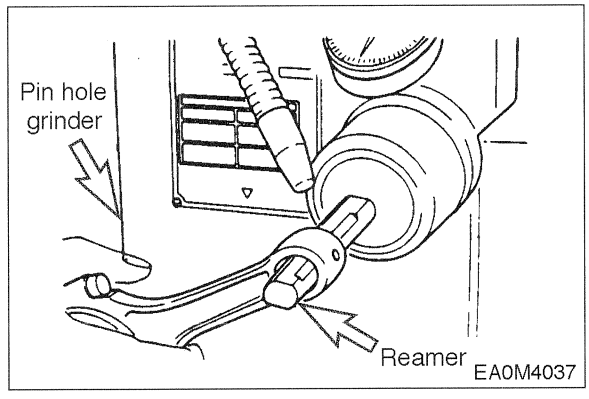
Bushing replacement

Removal : Use a brass bar and a bench press or hammer.

Installation : Use a brass bar and a bench press. The connecting rod busing oil port must be aligned with the connecting rod oil port.



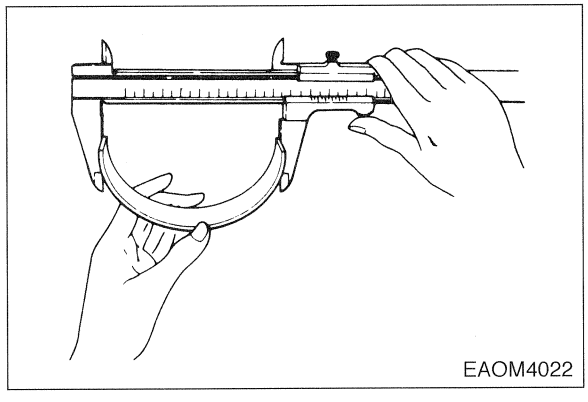
After new bushing installation, finish the bushing inside diameter with a pin hole grinder or a reamer to fit the piston pin.



Connecting rod bearing

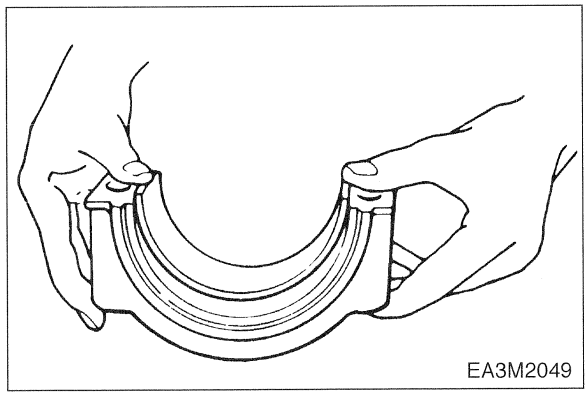
Bearing spread

Standard	68.00 ~ 68.01 mm



Bearing tension

1. Check to see if the bearing has enough tension, so that a good finger pressure is needed to fit the bearing into position.
2. Reassemble the connecting rod and bearing cap.



2.3.12. Crankshaft and Bearing

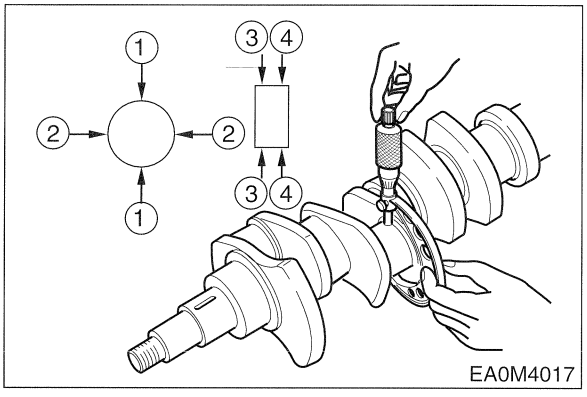
- **Crankshaft and bearing inspection**

1. Inspect the crankshaft journal and pin surfaces for excessive wear and damage.
2. Inspect the oil seal fitting surfaces of the crankshaft front and rear ends for excessive wear and damage.
3. Replace or repair the crankshaft if any excessive wear or damage is found.
4. Inspect the crankshaft oil ports for obstructions.
5. Use high pressure air to clean the oil ports if necessary.

Crankshaft pin outside diameter

Standard	ϕ63.932~ϕ63.944 mm

Use a micrometer to measure the crankshaft pin outside diameter across points ① and ② at the two each points ③ and ④.

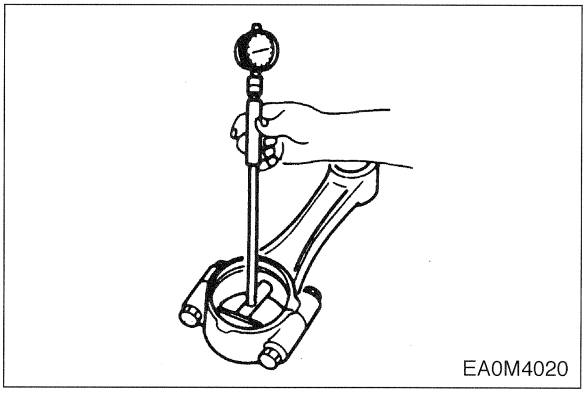


EA0M4017

Connecting rod bearing cap reassembly

Connecting rod bolt torque	9.75±0.25kg.m

Bolt Head : TY 12T


EA0M4020

Inside diameter

- Measure the connecting rod inside diameter with an inside dial indicator.

Connecting rod bearing nominal diameter	ϕ 64 mm

- Apply engine oil to bearing surface.

Crankshaft pin and bearing clearance

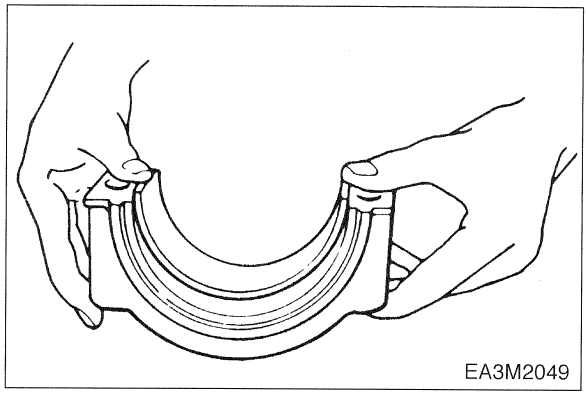
Standard	Limit
0.03 ~ 0.07 mm	0.10 mm

Under size bearing specification	0.25~0.50 mm

Crankshaft journal bearing

Tension

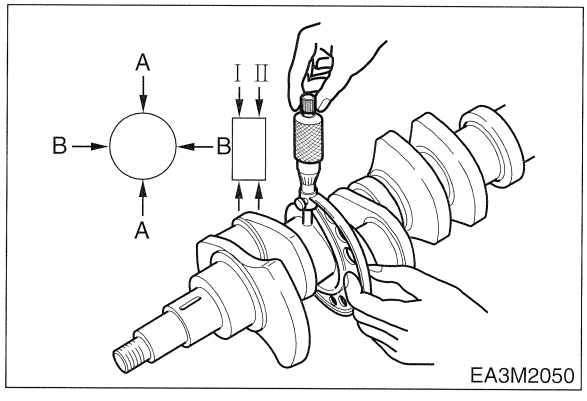
Fit the journal bearing into the journal bearing cap and check the tension with the same method of connecting rod cap bearing.


EA3M2049

Crankshaft journal outside diameter

Standard	ϕ75.913~ϕ75.925 mm

Use a micrometer to measure the crankshaft journal outside diameter across points (A) and (B) at the two each points (I) and (II).



EA3M2050

Journal bearing cap reassembly

Torque	24 kg.m

Inside diameter

- Apply engine oil to bearing surface.
- Measure the journal bearing cap inside diameter with an inside dial indicator.

Journal bearing nominal diameter	ϕ 76 mm

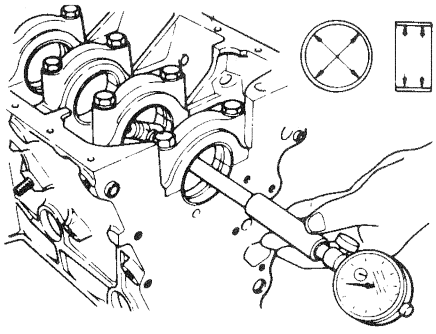
- **Refer to "Major components reassembly" for the crankshaft bearing cap (2.4.2.-5)**

EA4M3004

Crankshaft journal and bearing clearance

	Standard	Limit
Center bearing	0.065~0.116 mm	0.15 mm
Other bearing	0.025~0.076 mm	0.11 mm

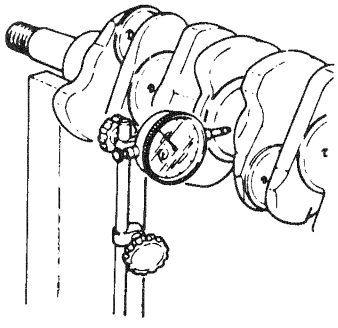
Under size bearing specification	0.25~0.50 mm


EA0M4019

Crankshaft run-out

Standard	Limit
0.05 mm	0.40 mm

1. Place the crankshaft on a set of v-blocks.
2. Set a dial indicator to the center of the crankshaft journal.
3. Gently turn the crankshaft in the normal direction of engine rotation.
4. Read the dial indicator (TIR) as you from the crankshaft.


EA0M4023

Crankshaft gear

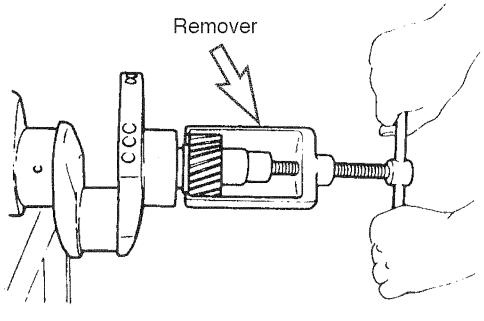
Inspect the crankshaft gear
If any abnormal conditions are found, or if the amount of backlash measured at disassembly is excessive, replace the crankshaft gear.

- **Refer to "Major components disassembly" for the backlash measurement (2.2.3 - 14)**

EA4M2020

Crank gear replacement

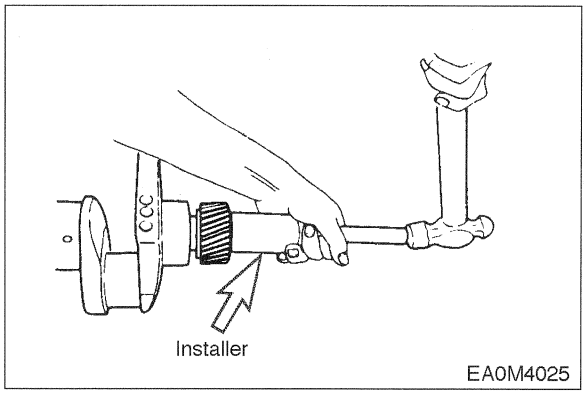
Removal : Use a remover.



EA0M4024

Installer

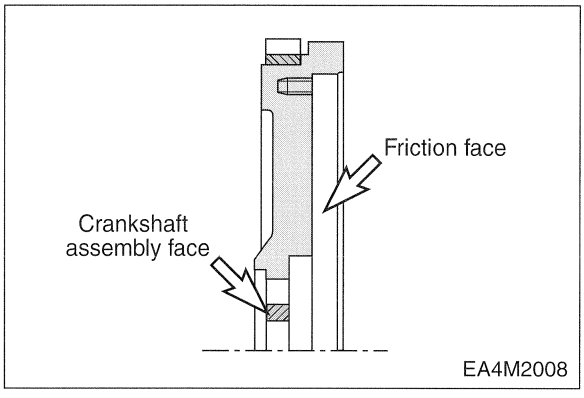
Use an installer.



2.3.13. Flywheel and housing (Rear oil seal)

- **Flywheel thickness (Friction face)**

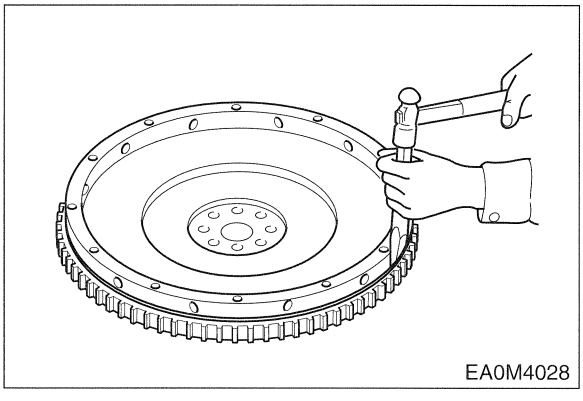
Standard	Limit
33.4 ~ 33.6 mm	32.5 mm



Ring gear replacement

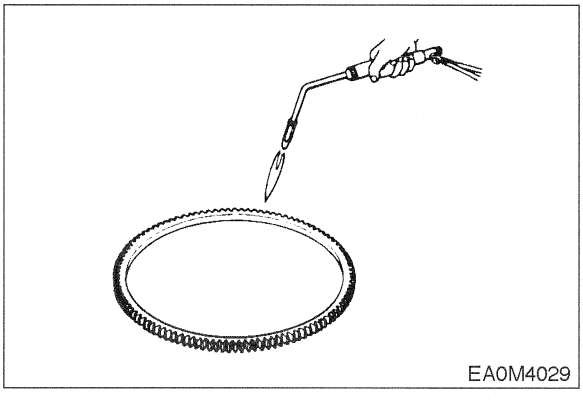
Removal : Use a brass bar and hammer

- Strike around the edges of the ring gear with a hammer and brass bar to remove it.



Installation

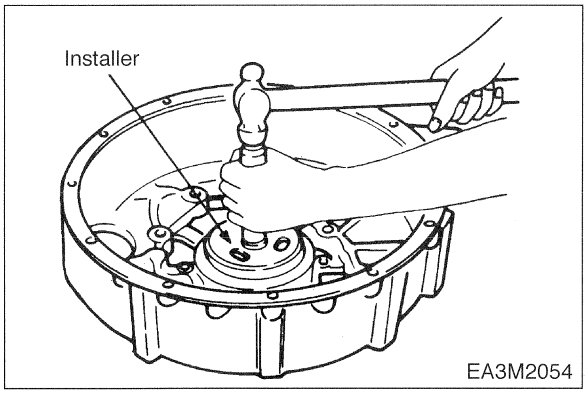
- With a gas burner, heat the ring gear evenly until heat expansion takes place, then install it using a hammer.
- Do not allow the temperature of the ring gear to exceed 200 °C (390 °F).



Flywheel housing oil seal replacement

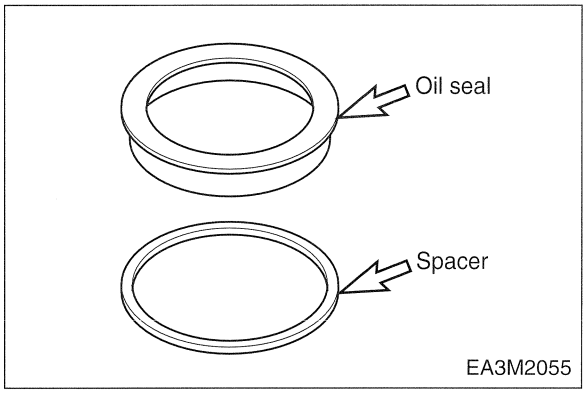
Removal : Pull out with a pry bar or brass hammer.

Installation : Use an oil seal installer.



When the oil seal face in contact with the crankshaft is worn, the contact portion on the crankshaft can be changed by taking out the spacer.

Discard the used one, and install a new one.

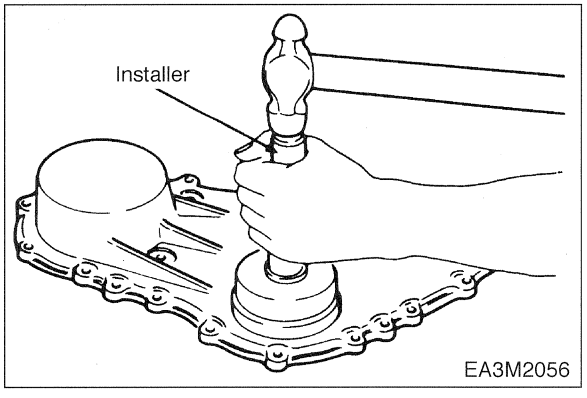


2.3.14. Timing gear case cover

Oil seal replacement

Removal : Pry off or pull out.

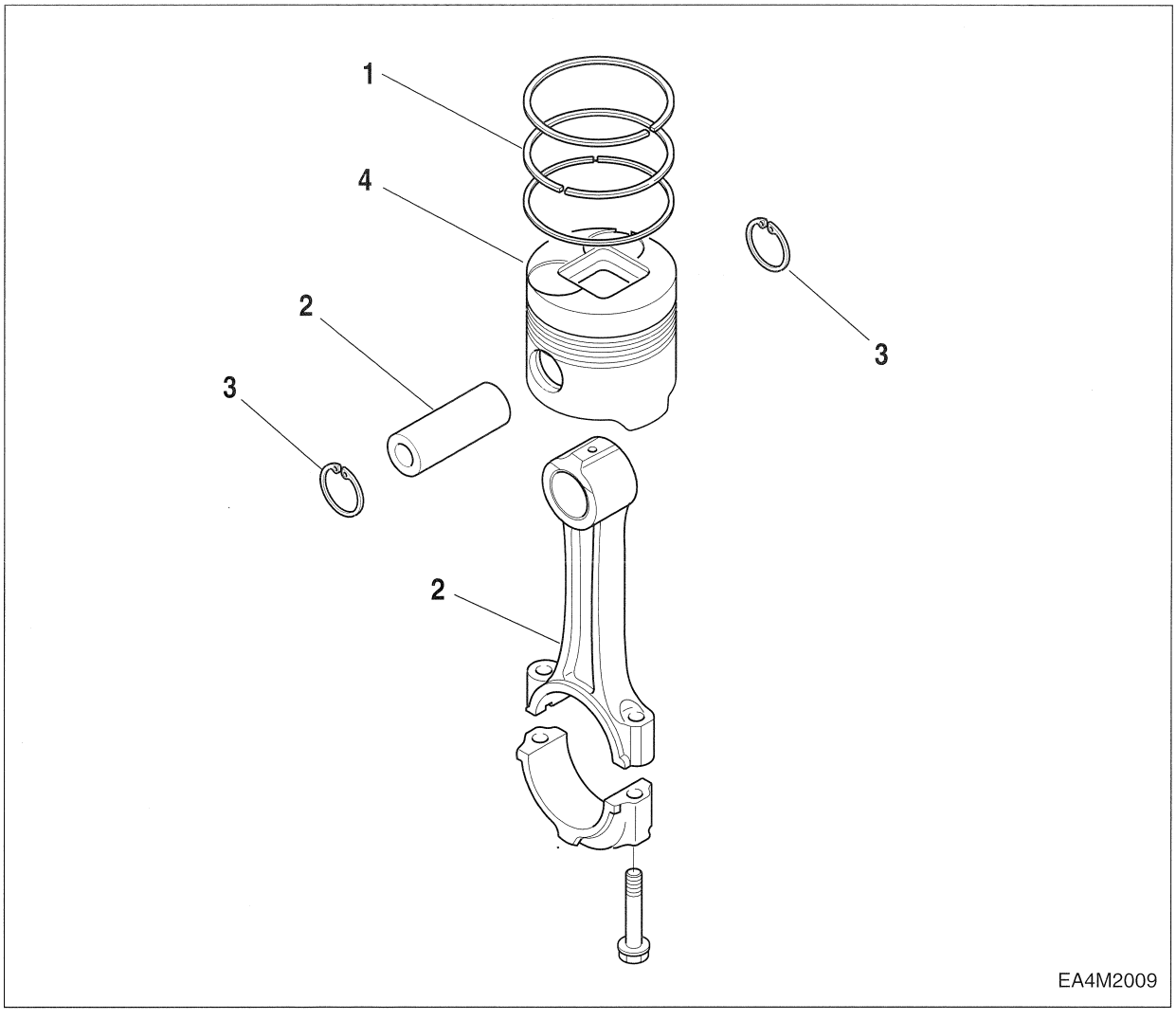
Installation : Use an installer.



2.4. Engine Reassemble

2.4.1. General Component

- **Piston and connecting-rod assembly**



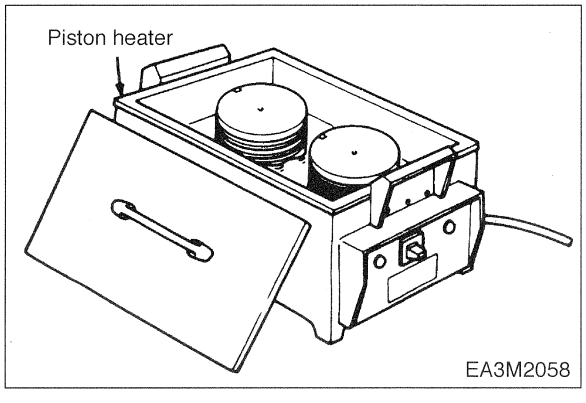
<Reassemble steps>

- ▲ 1. Piston
- ▲ 2. Piston pin and connecting-rod
- ▲ 3. Snap ring
- ▲ 4. Piston ring

Important operation

1. Piston

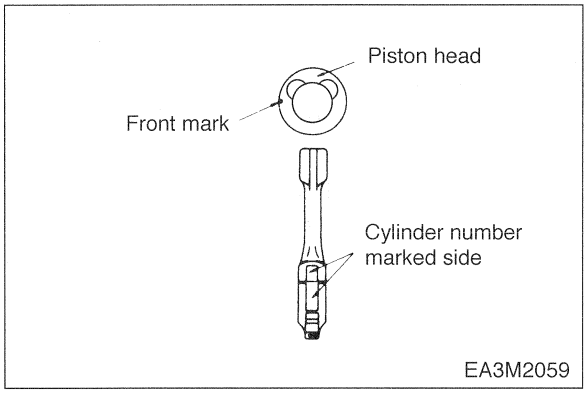
Use a piston heater to heat the piston approximately 60 °C (140 °F).



2. Piston pin and connecting-rod

1) Install the connecting-rod to the piston with setting the marks as illustrated.

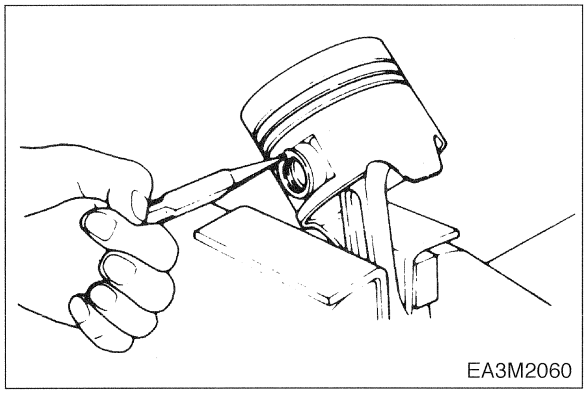
2) Install the piston pin into the piston and the connecting-rod bushing.



3. Snap ring

1) Use a pair of snap ring pliers to install the piston pin snap ring.

2) Check that the piston moves smoothly on the piston pin.



4. Piston ring

1) Use a piston ring installer to install the three piston rings.

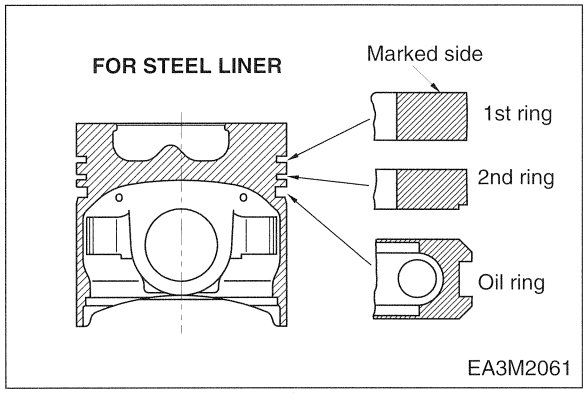
- Install the piston rings in the following order oil ring.
  → 2nd compression ring
  → 1st compression ring

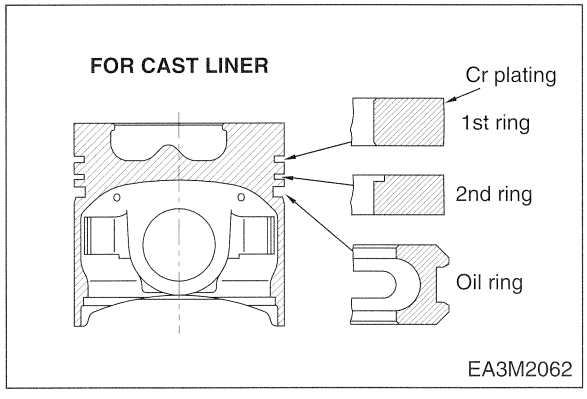
The marked side of the two compression ring must be facing up. The undercut side of the 2nd compression ring will be facing up(for cast liner). As the oil ring has no any facing mark, it may face in either direction.

2) Lubricate the piston ring surfaces with engine oil.

3) Check the piston ring rotate smoothly in the piston.

4) Use Cr-coating piston ring for cast liner and normal piston ring for steel liner

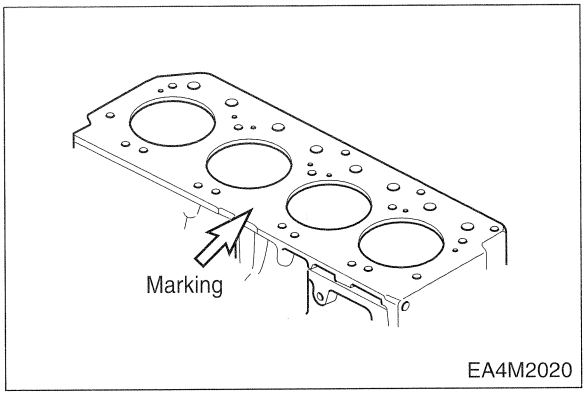




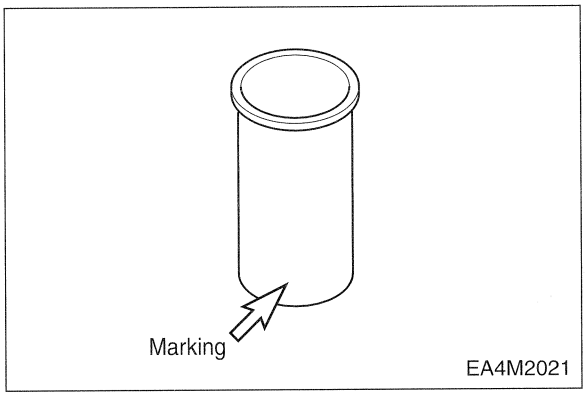
Maintenance of cylinder block, cylinder liner and piston

To maintain the engine in optimum condition and retain maximum performance for a long time, the cylinder block, cylinder liner and piston which have the same grade marking number (the same size tolerance) should be assembled. The marking number (the part's grade) and marking position is as follows.

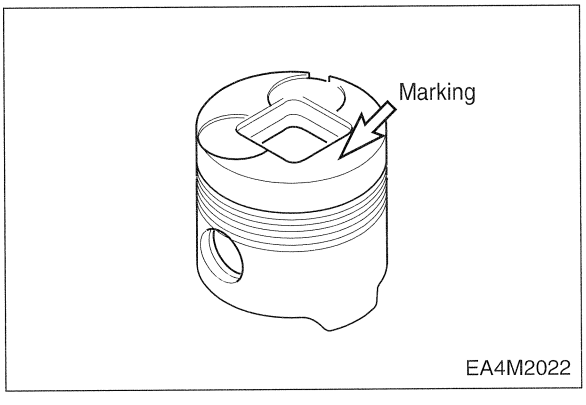
- **Cylinder block**
  a) Marking number ; 1 or 2
  (Size grade for of cylinder bore diameter)
  b) Marking position ; Center of the cylinder block upper surface



- **Cylinder liner**
  a) Marking number ; 1A, 1B, 2A, 2B
  (Size grade for cylinder liner inner diameter)
  b) Marking position ; Cylinder liner lower surface



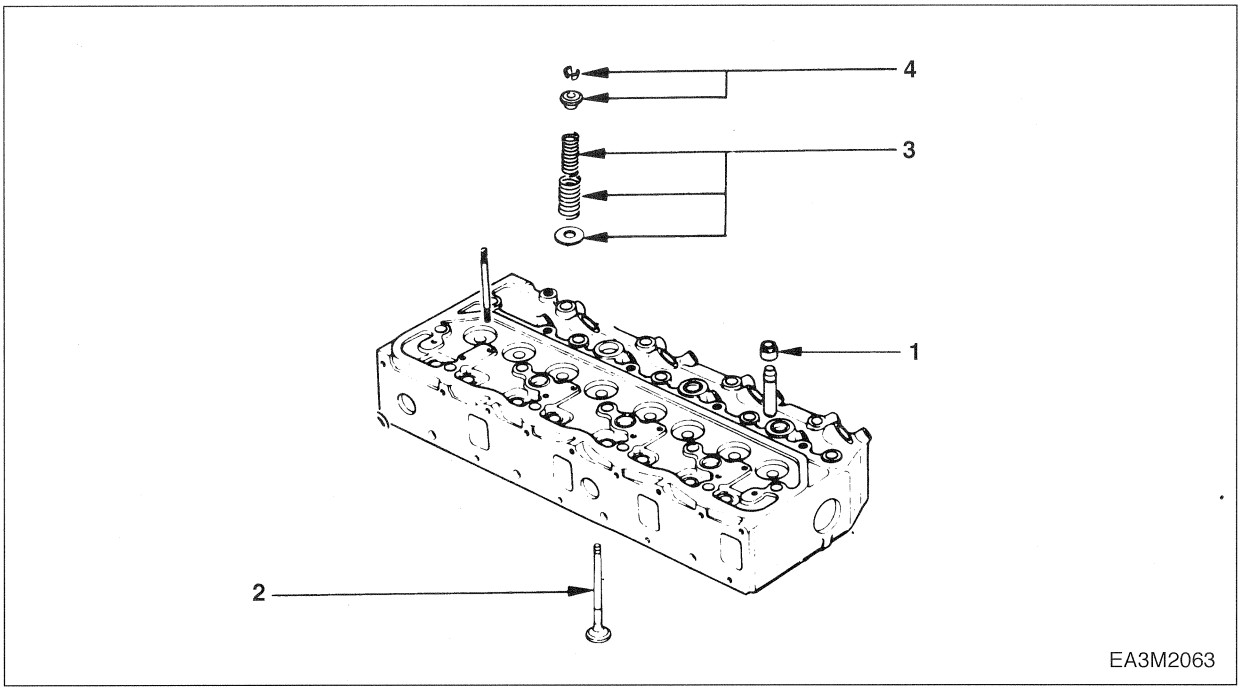
- **Piston**
  a) Marking number ; A or B
  (Size grade for piston outer diameter)
  b) Marking position ; Center of the piston upper surface



Assembly process of cylinder block, cylinder liner and piston

1. Check the marking number (1 or 2) of cylinder block. (center of upper surface)
2. Then assemble the liner whose first digit of the marking(1A, 1B, 2A, 2B) is just the same with it on the cylinder block.
3. Assemble the piston whose marking is just same with the second digit(A or B) of the assembled cylinder liner's marking.

• Cylinder head assembly



<Reassembly steps>

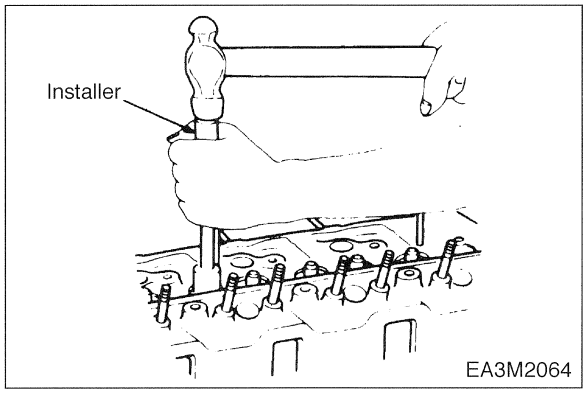
- ▲ 1. Valve stem oil seal
- ▲ 2. Valve
- ▲ 3. Spring seat and spring
- ▲ 4. Spring retainer and cotter key

Important operation

1. Valve stem oil seal

Installer

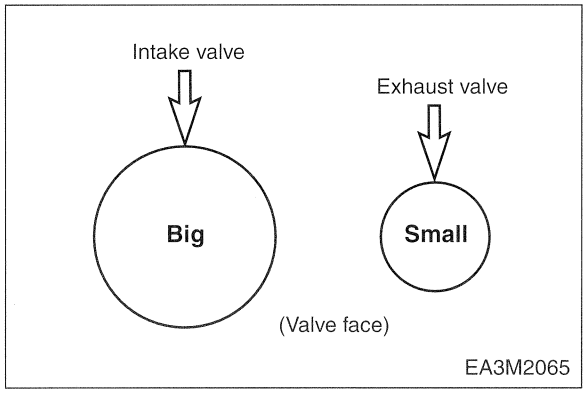
Install valve stem oil seals after lubricating them with clean engine oil.



2. Intake and exhaust valves

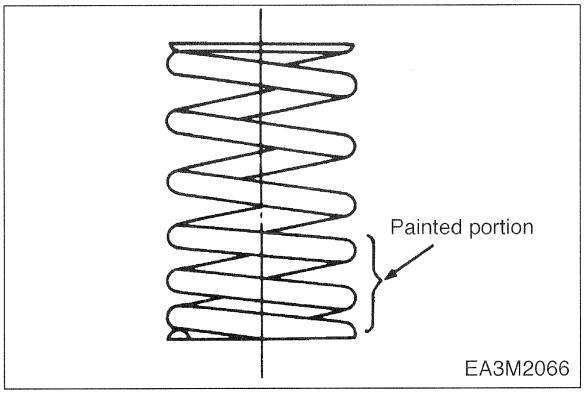
1) Lubricate valve stem with clean engine oil.

2) Install the each valves in the intake and exhaust valve seats.



3. Spring seat and spring

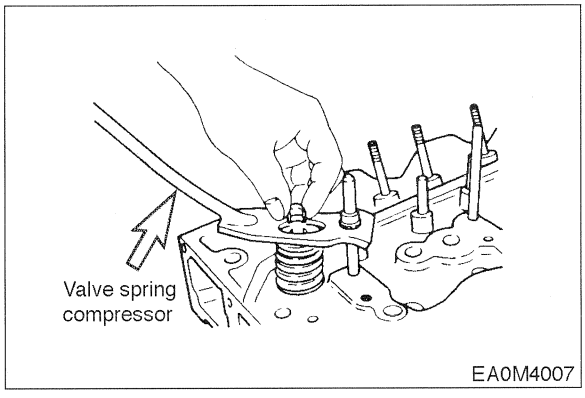
Install the valve spring to contact their painted end face downward.

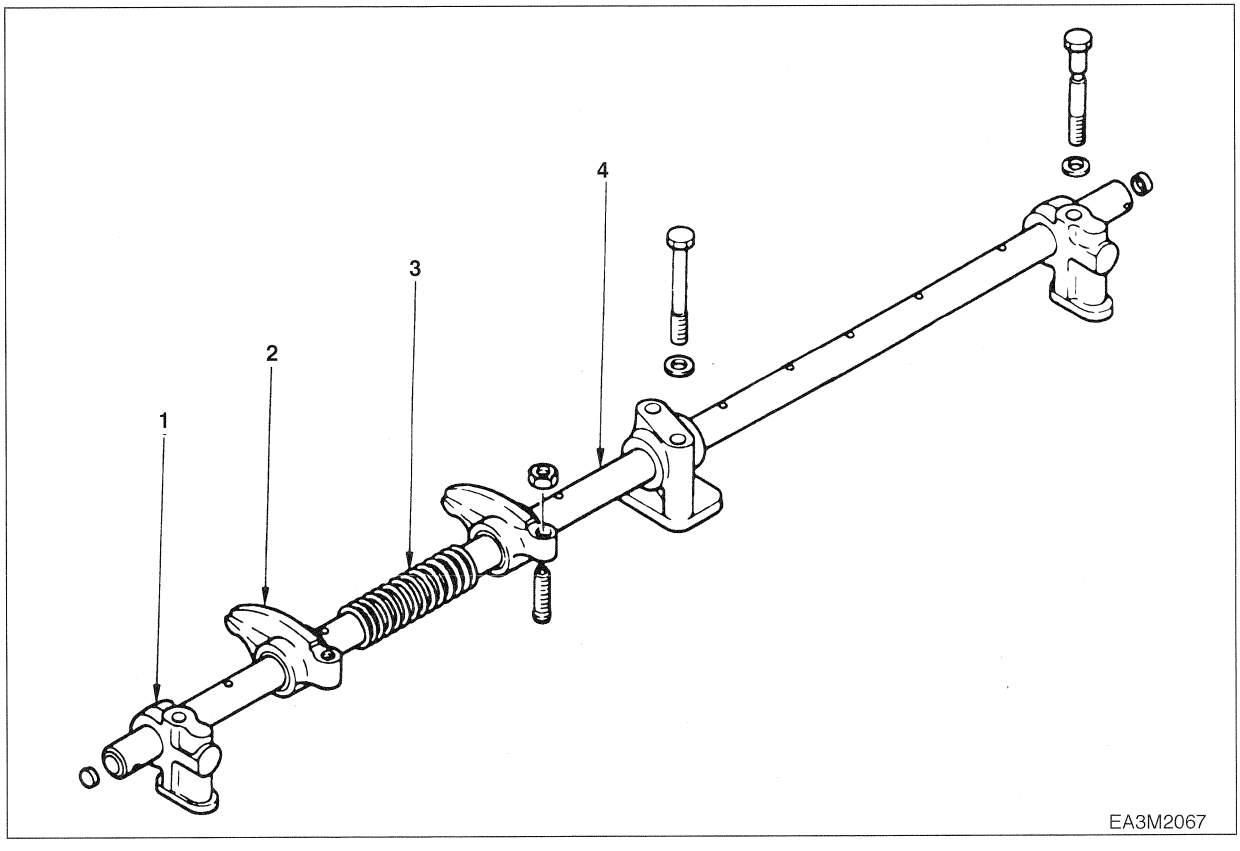


4. Spring retainer and cotter

Installer : Spring compressor

- Using the spring compressor, press the valve spring to each position downward.
- And then install cotter key.
- Set the cotter key by tapping lightly around the head of the cotter with a rubber hammer.



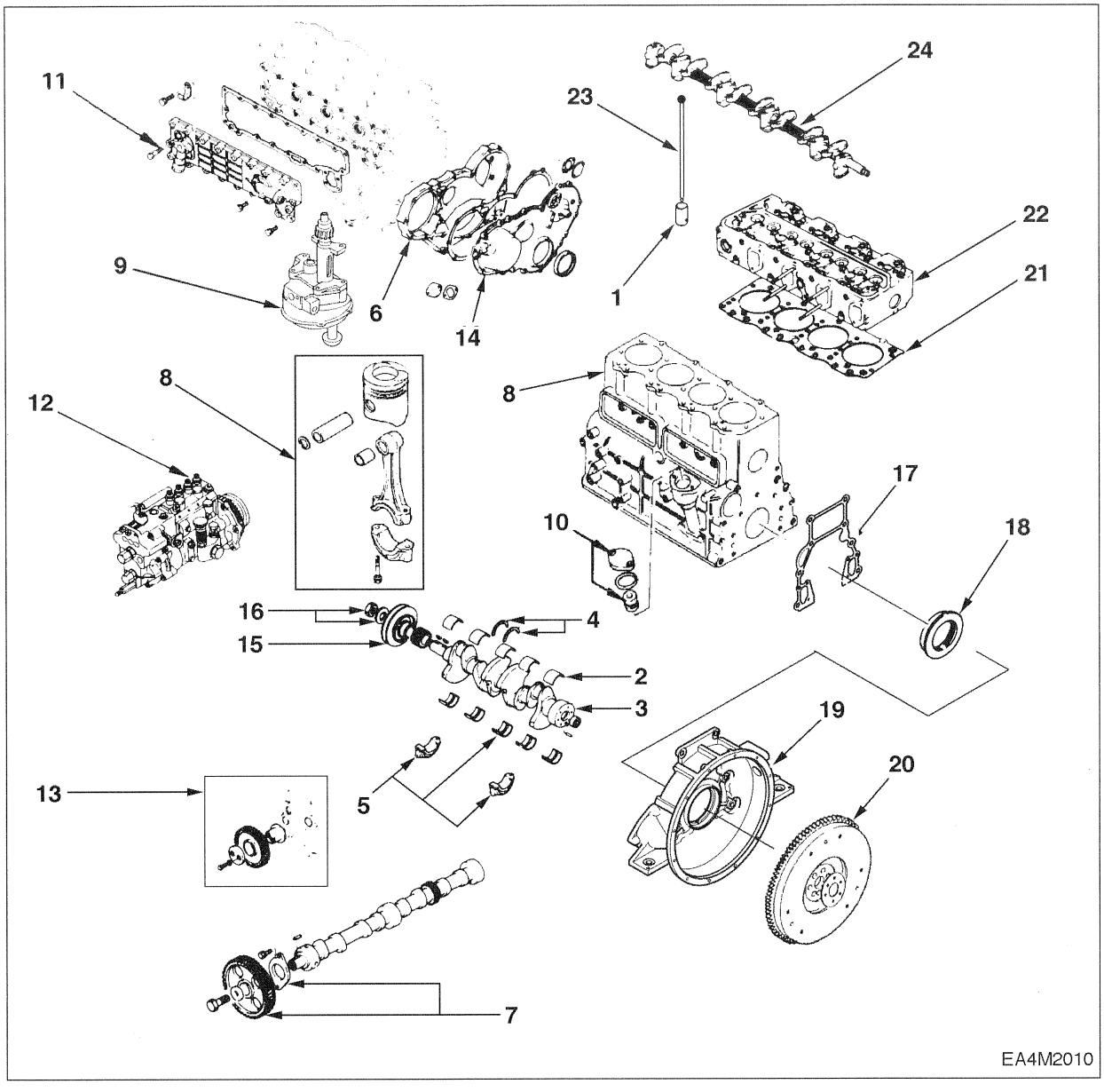


<Reassembly steps>

▲ 1. Bracket
▲ 2. Rocker arm
▲ 3. Spring
▲ 4. Rocker arm shaft

2.4.2. Internal Parts

• Major components



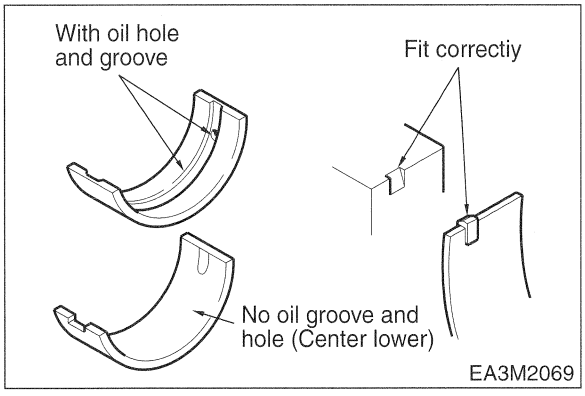
<Reassembly steps>

1. Tappet
▲ 2. Crankshaft bearing (upper)
▲ 3. Crankshaft
▲ 4. Thrust bearing
▲ 5. Crankshaft bearing cap and bearing (lower)
▲ 6. Timing gear case
▲ 7. Camshaft assembly
▲ 8. Piston and connecting rod assembly
▲ 9. Oil pump assembly
10. Oil pump cover
▲ 11. Oil cooler
▲ 12. Injection pump assembly
▲ 13. Idle gear
14. Timing gear case cover
15. Crankshaft pulley
▲ 16. Crankshaft front nut and washer
17. Gasket
▲ 18. Rear oil seal
▲ 19. Flywheel housing
▲ 20. Flywheel
▲ 21. Cylinder head gasket
▲ 22. Cylinder head assembly
23. Push rod
▲ 24. Rocker arm shaft assembly

Important operation

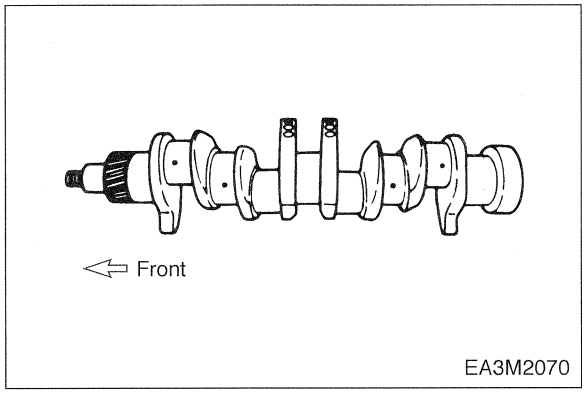
2. Crankshaft bearing (upper)
5. Crankshaft bearing (lower)

The center lower half bearing has no oil groove and oil hole, but the others have oil groove and oil hole.



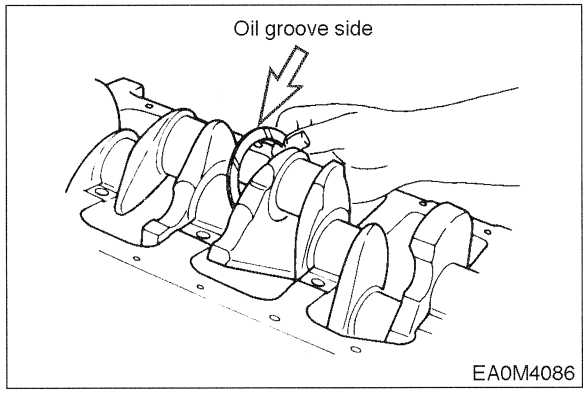
3. Crankshaft

Install the crankshaft so that crank gear assembled part must be placed towards the front of the engine.



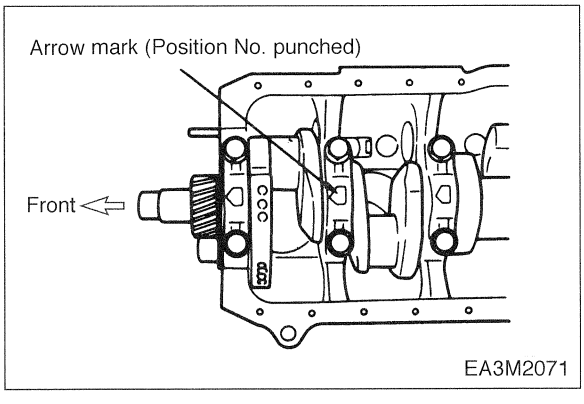
4. Thrust bearing

Thrust bearing should be installed so that their oil grooves are faced to the sliding face of crankshaft.



5. Crankshaft bearing cap and bearing (lower)

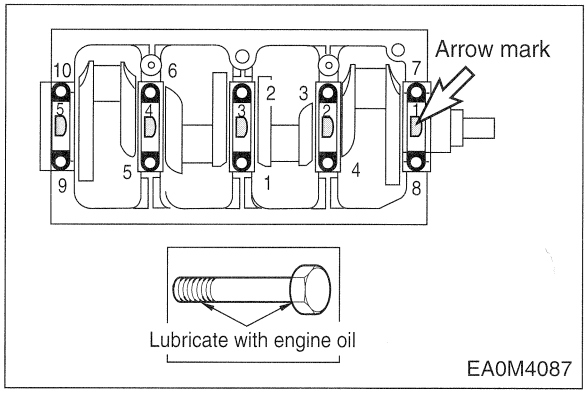
- Lubricate the bearing cap bolts with engine oil.
- Each bearing cap has a position number that is punched onto the arrow mark.
- The arrow mark should be pointed to the front of engine.



Tighten the bearing cap bolts to the specified torque a little at a time in the numerical order shown in the figure.

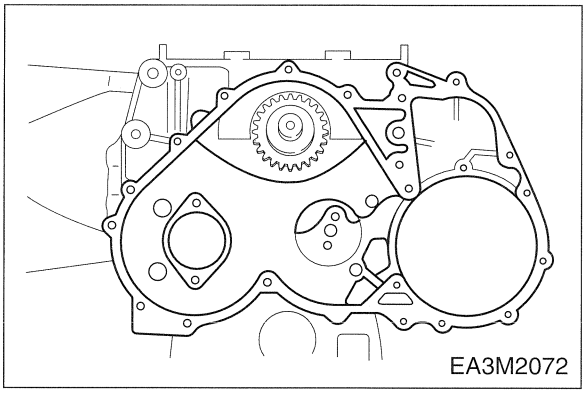
Torque	24 kg•m

Check whether the crankshaft turns smoothly by rotating it manually.



6. Timing gear case

Torque	2.6 kg•m

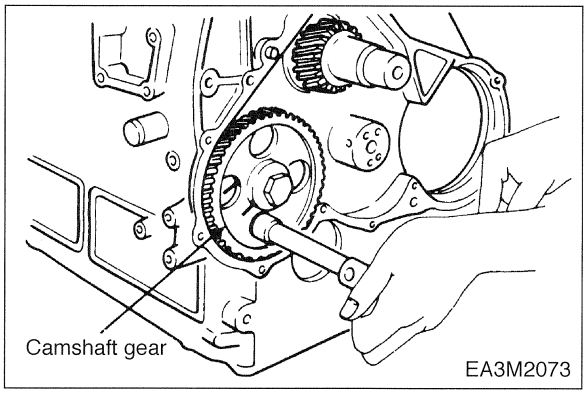


7. Camshaft

Tighten the thrust plate bolts through the camshaft gear hole.

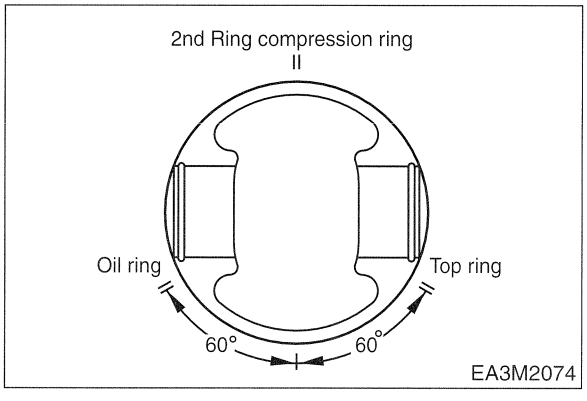
- Torque

Thrust plate bolt	2.1 kg•m
Camshaft gear bolt	16 kg•m

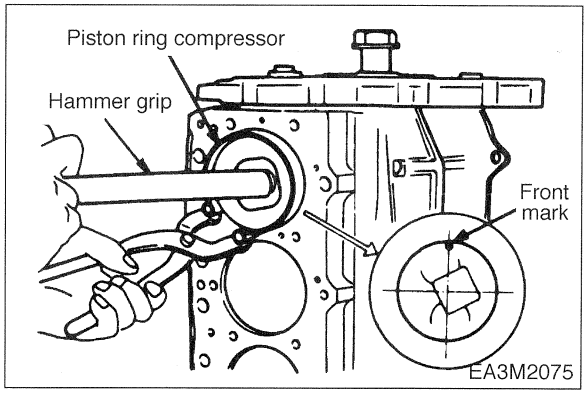


8. Piston and connecting rod assembly

Set the piston ring gaps as shown in the figure.



Set the piston front mark towards the front of the engine. After rotating the crankshaft until the crank pin reaches its highest point, and then push the piston using a grip until it contacts with the crank pin.

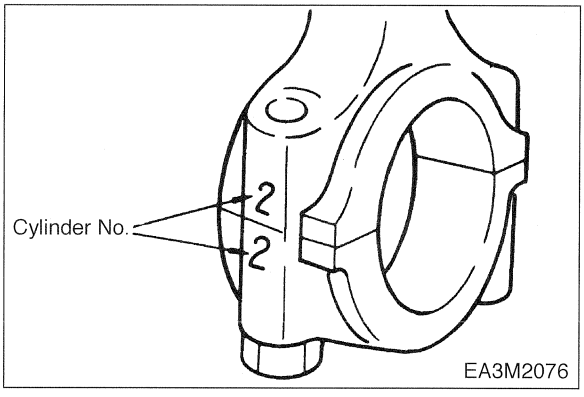


Set the cylinder number marked on the cap and the connecting-rod.
The marks must be faced on the exhaust manifold.

● Connecting rod cap bolt

Bolt head	TY 12T
Torque	9.75±0.25 kg.m

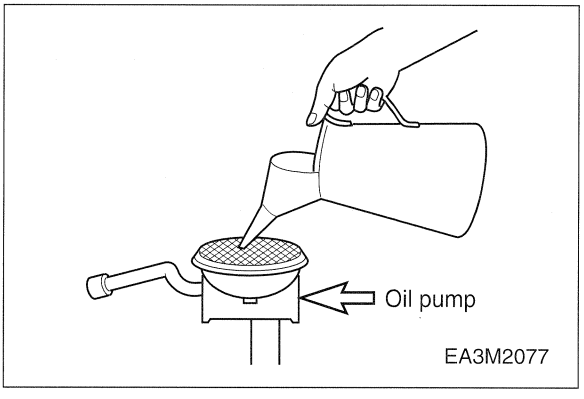
- Lubricate the connecting-rod cap bolt threads surface.



9. Oil pump assembly

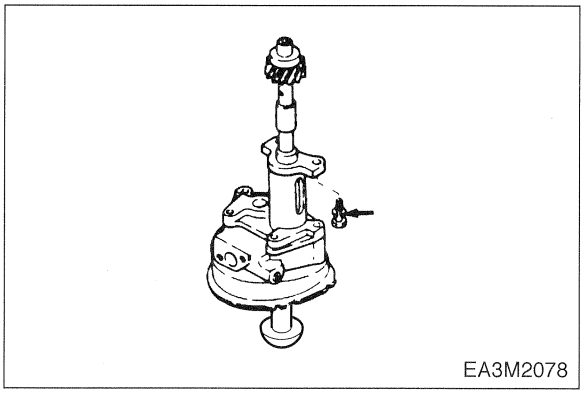
Install the oil pump after filling it with engine oil.

Grade	CD or CE



10. Oil pump fixing bolts

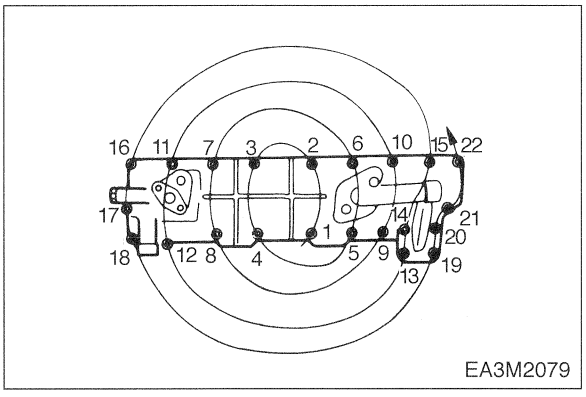
Torque	3.8 kg.m



11. Oil cooler

Tighten the cooler bolts to the specified torque. Start from the middle and work out to the out side.

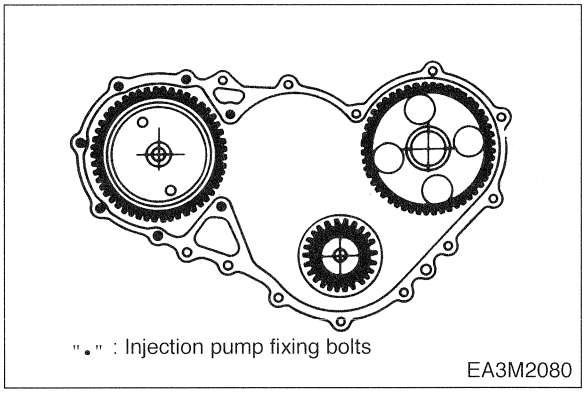
Torque	1.8 kg.m



EA3M2079

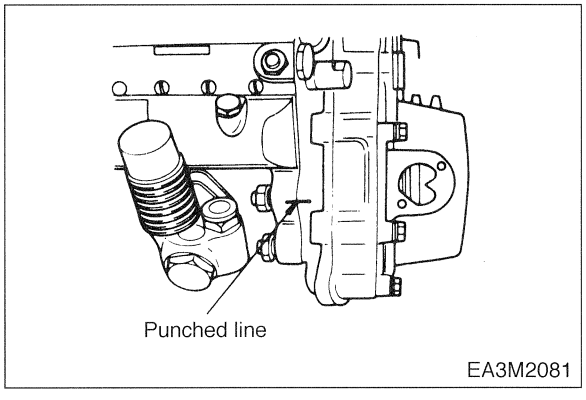
12. Injection pump assembly

Torque	2.6 kg.m



EA3M2080

Check whether the punched line of the injection pump body is aligned to the pump bracket line.

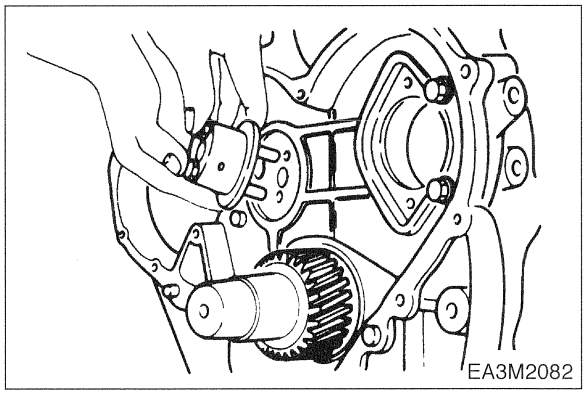


EA3M2081

13. Idle gear

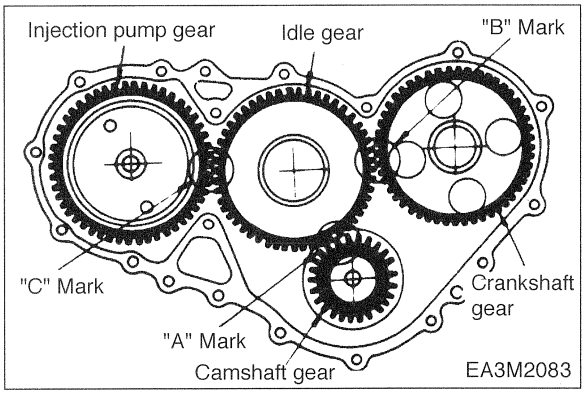
Use the thrust collar fixed bolt as a guide to install the idle gear shaft. The oil port should be faced on the camshaft.

Torque	2.6 kg.m


EA3M2082

Set the timing marks ("A", "B", "C") on the gear as shown in the figure.

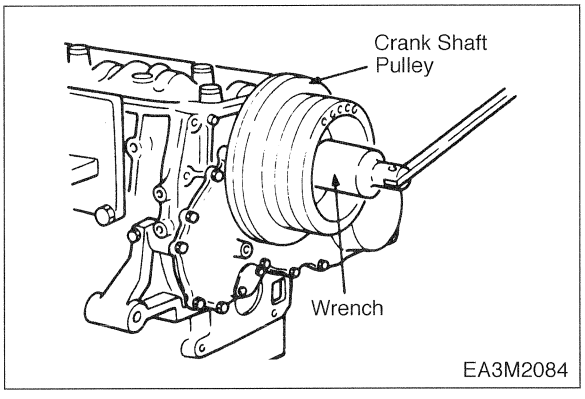
Torque	5.3 kg.m



16. Crankshaft front nut

Wrench : 41 mm

Torque	44.0 kg.m

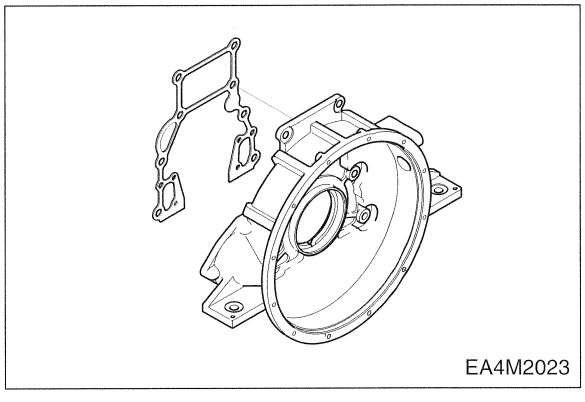


18. Rear oil seal

19. Flywheel housing

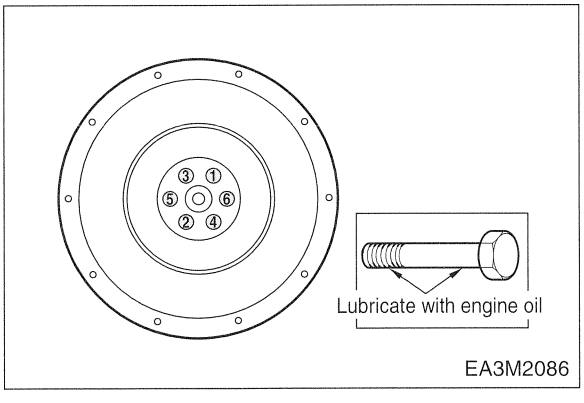
Apply a gasket.

Fixing bolts torque	14.0 kg.m



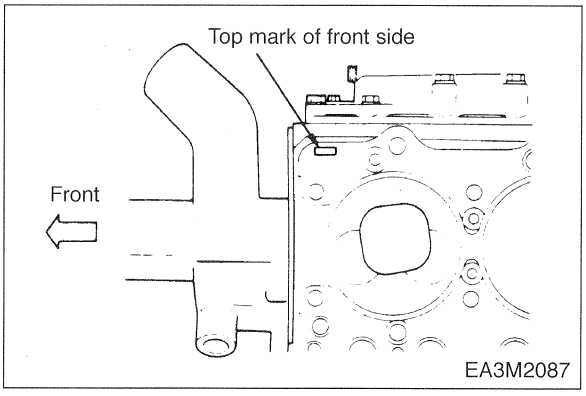
20. Flywheel

Torque	16.0 kg.m



21. Cylinder head gasket

The gasket "TOP" mark should be faced up and "FRONT" mark is towards the front of the engine.



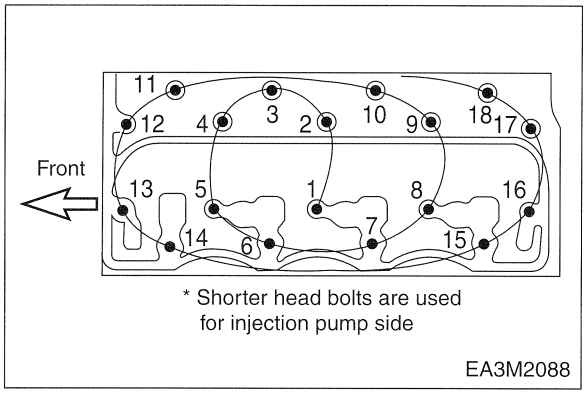
22. Cylinder head assembly

Lubricate the head bolts with engine oil and tighten them in the following two steps. there are two kinds of head bolt in length. The shorter ones are used on injection pump side.

Tighten the head bolts in the numerical order as shown in the figure.

DB33	1st step	2nd step
	7.0 kg.m	11.5 kg.m

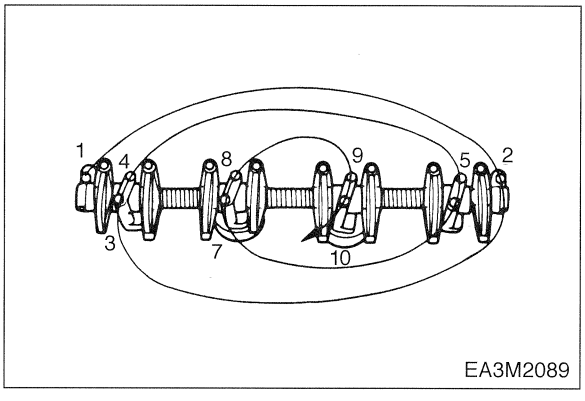
P034TI	1st step	2nd step	3rd step
	4.0 kg.m	+ 90°	+ 60°(+ 30°)



24. Rocker arm shaft assembly

Tighten the rocker arm bracket bolts a little at a time as specified torque according to the numerical order shown in the figure.

Torque	3.1 kg.m



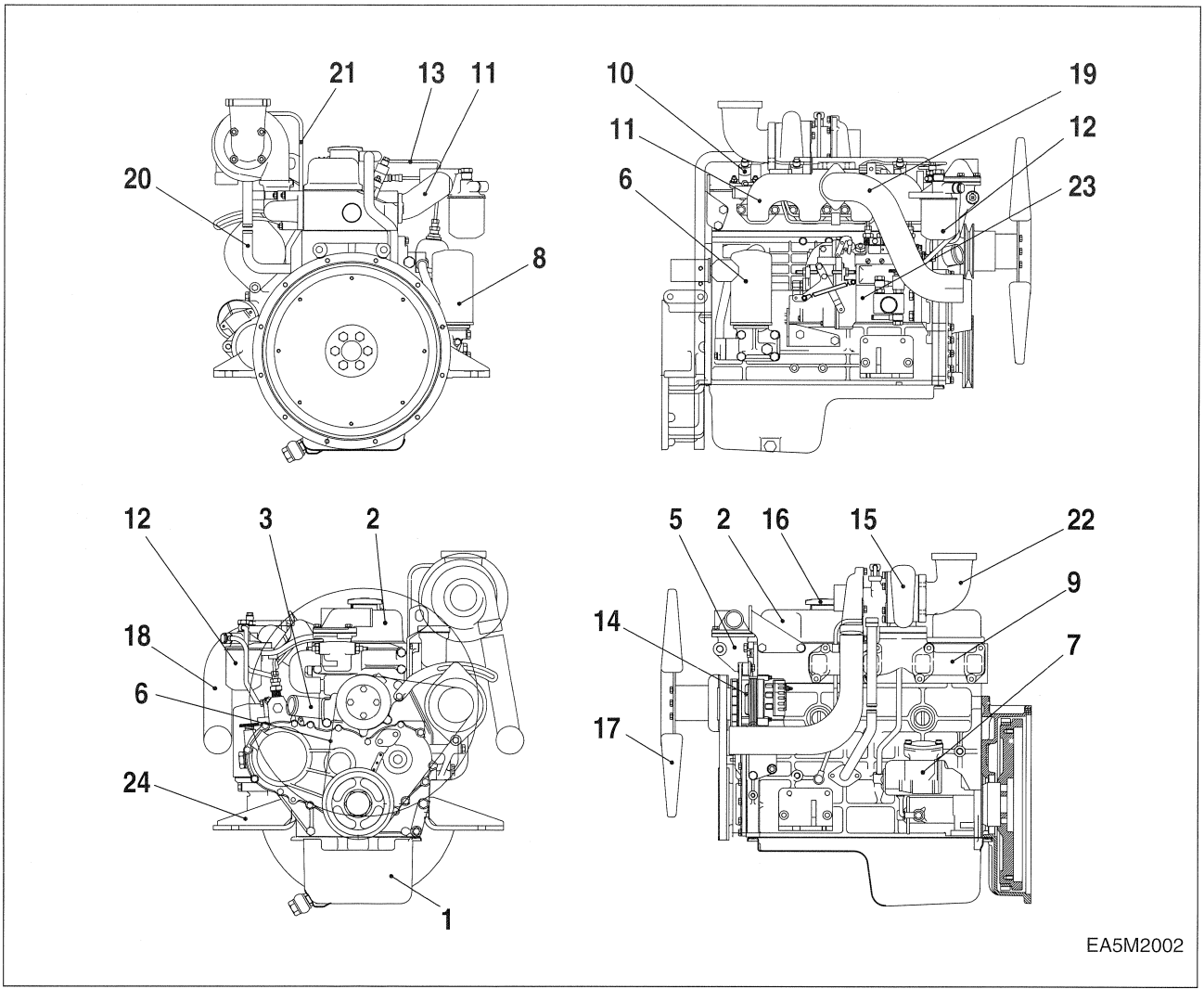
Adjust the valve clearance.

Intake	0.4 mm
Exhaust	0.4 mm

- **Refer to MAINTENANCE for the valve clearance adjustment procedure. (1.6.2)**

EA3M2090

2.4.3. External Parts(P034Ti)



<Reassembly steps>

- ▲ 1. Oil pan assembly
- ▲ 2. Cylinder head cover
- ▲ 3. Water pump assembly
- 4. Fuel return pipe
- ▲ 5. Thermostat housing assembly
- ▲ Push rod chamber cover
- ▲ 6. Cooling fan belt
- ▲ 7. Starter motor assembly
- ▲ 8. Oil filter assembly
- ▲ Exhaust manifold gasdet
- ▲ 9. Exhaust manifold assembly
- ▲ Glow plug
- ▲ 10. Injection nozzle
- ▲ Intake manifold gasket
- 11. Intake manifold assembly
- ▲ Fuel injection pipe
- 12. Fuel filter assembly
- ▲ 13. Fuel pipe
- 14. Alternator assembly
- ▲ Gasket, turbo-charger
- ▲ 15. Turbo-charger assembly
- 16. Oil filler cap
- 17. Cooling fan
- 18. Air pipe assembly(to intercooler)
- 19. Air pipe assembly(from intercooler)
- ▲ 20. Oil return pipe
- ▲ 21. Oil delivery pipe
- 22. Exhaust elbow
- 23. Injection pump assembly
- 24. Mounting bracket

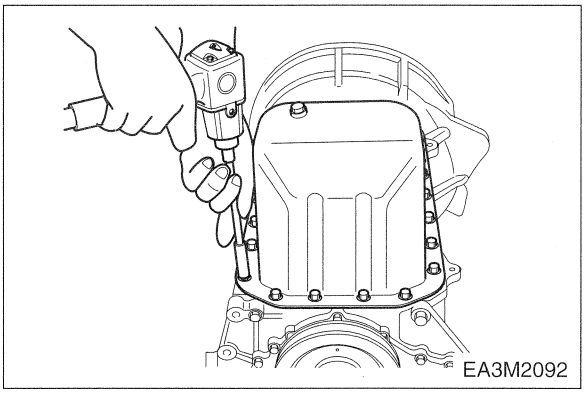
Important operation

1. Oil pan assembly

Apply the gasket to the cylinder block and oil pan.

Install oil pan gasket and oil pan.

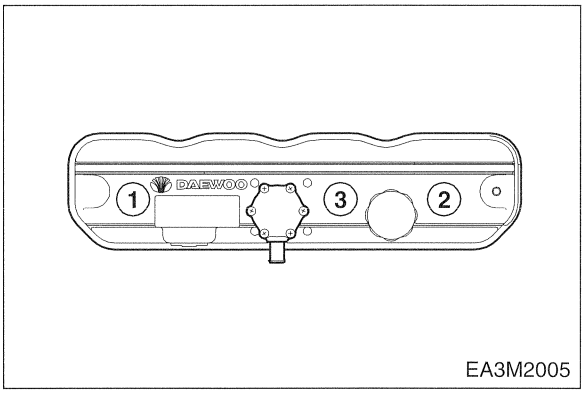
Bolt torque	1.6 kg.m



2. Cylinder head cover

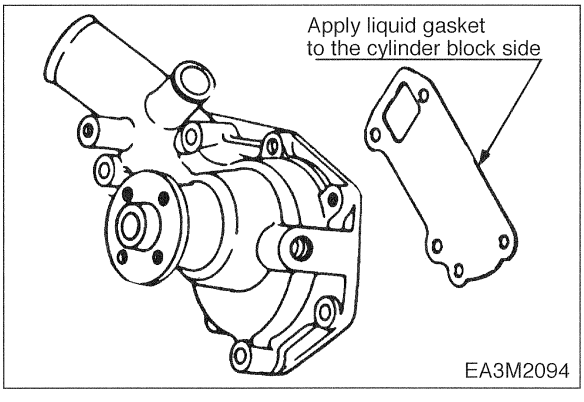
Bolt torque	2.1 kg.m

Tighten the bolts as shown in the figure.



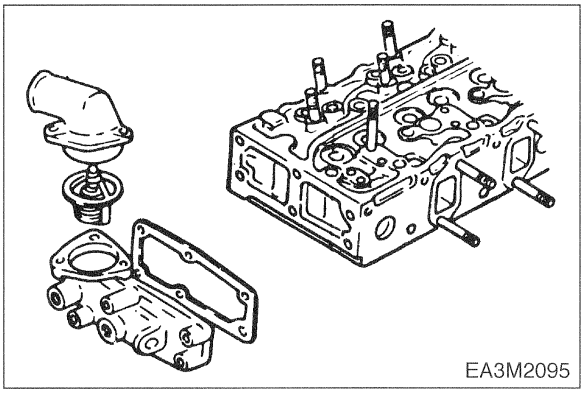
3. Water pump assembly

Apply the water pump gasket before installing the water pump.



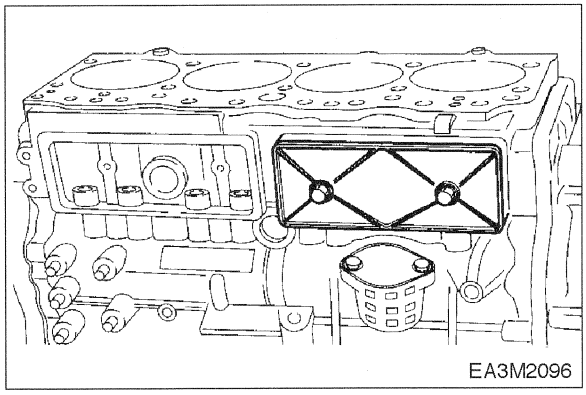
5. Thermostat housing assembly

Bolt torque	5.3 kg.m



- **Push rod chamber cover**

	Aluminium	Steel
Torque	2.1 kg.m	2.6 kg.m


EA3M2096

6. Cooling fan belt

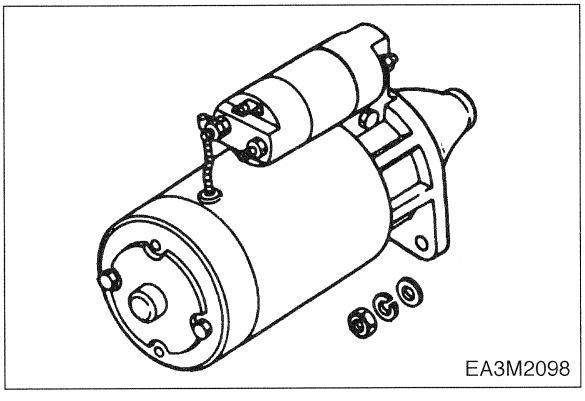
Adjust the cooling fan belt tension

- **Refer to maintenance for the fan belt tention adjustment (1.6.9.)**

EA5M2004

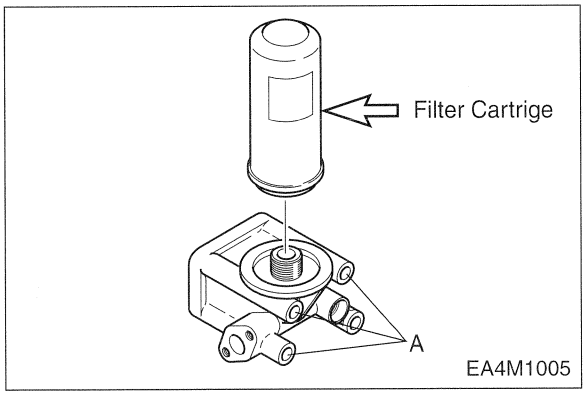
7. Starting motor assembly

Torque	8.6 kg.m


EA3M2098

8. Oil filter assembly

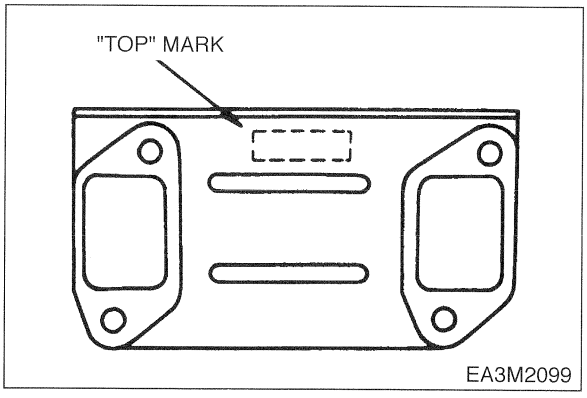
'A' bolt torque	5.3 kg.m



EA4M1005

- **Exhaust manifold gasket**

  Carefully install the gasket so that the "TOP" mark side is faced on outside and upwards as figure.

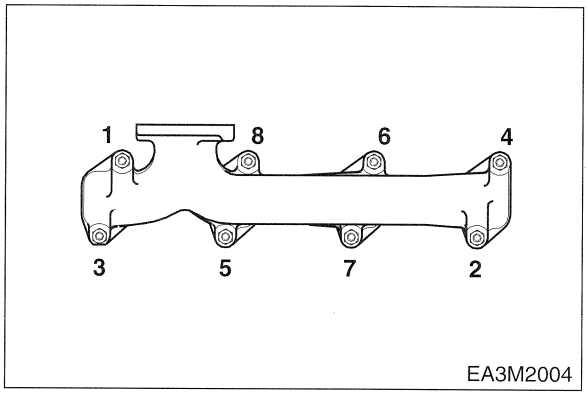


EA3M2099

9. Exhaust manifold assembly

Tighten the exhaust manifold and gasket fixing bolts in numerical order as shown in the figure.

Torque	2.6 kg.m



EA3M2004

- **Glow plug**

Torque	5.3 kg.m

10. Injection nozzle

Adjust the injection nozzle opening pressure with the adjusting screw using a nozzle tester.

Opening pressure	220 kg/cm²

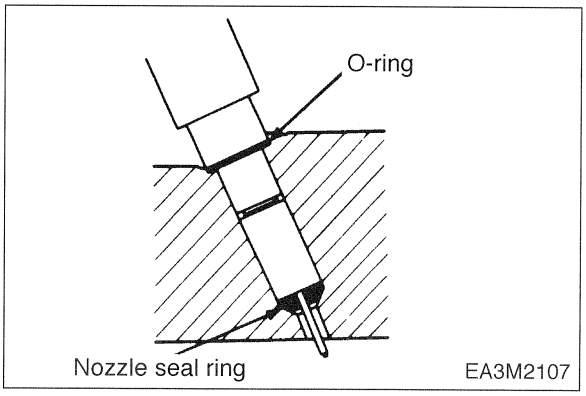
- **Refer to "5. the fuel system" of maintenance for the injection nozzle opening pressure adjustment.**

EA4M2012

Replace the nozzle seal ring and o-ring to new one.

Tighten the injection pipe sleeve nut and flange nut.

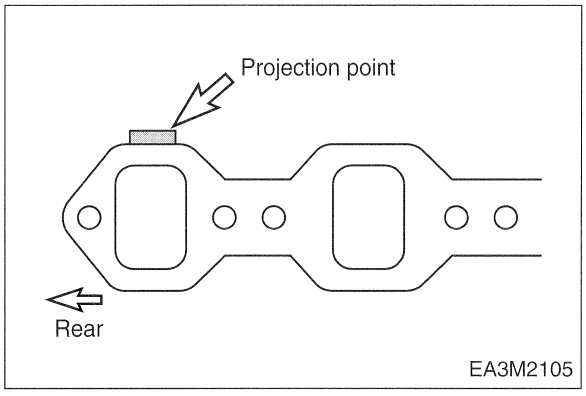
Torque	2.6 kg.m



EA3M2107

● **Intake manifold gasket**

Install gasket so that the side with the projection is faced on rearward and upward.



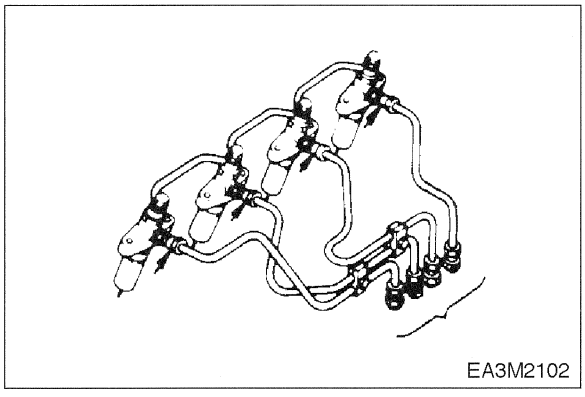
● **Fuel injection pipe**

Torque	3.0 kg.m

Delivery valve holder must be tightened as specified torque.

It may cause the malfunction of control rack, holder clip and pipe, if the torque is excessive.

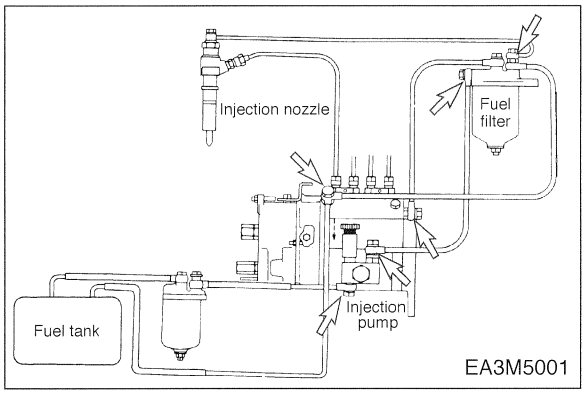
Delivery valve holder torque	4.0~4.5 kg.m



13. Fuel pipe

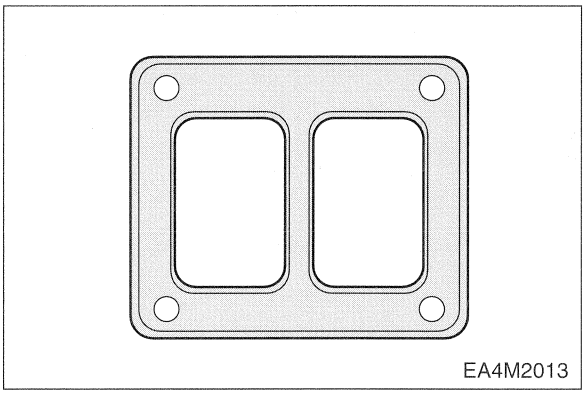
When installing fuel pipes, avoid interchanging check valve and joint bolts.

Torque	1.7~1.8 kg.m



- **Turbocharger mounting flange gasket**

  Carefully posit the gasket with the edged side facing up.

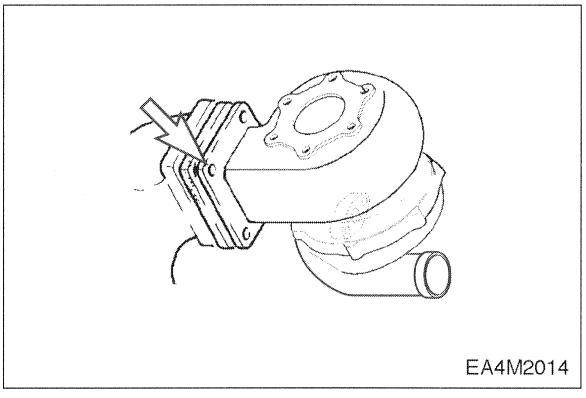


EA4M2013

15. Turbocharger assembly

Tighten in the turbocharger mounting nut. Completely tighten the nut after it is assemble oil pipe.

Torque	5.3 ± 1 kg.m

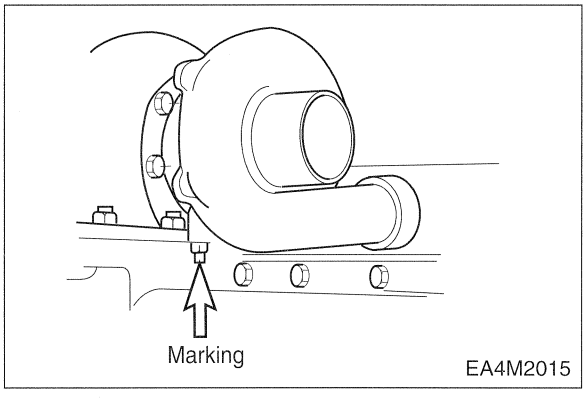


EA4M2014

20. Oil return pipe

- Disassemble the exhaust manifold spacer which it is just bottom of the turbocharger part so as to be easily set up oil drain pipe.
- Tighten the flange nut as it is the specified torque after it is assemble oil return pipe.

Oil return pipe torque	2.6 ±0.7 kg.m

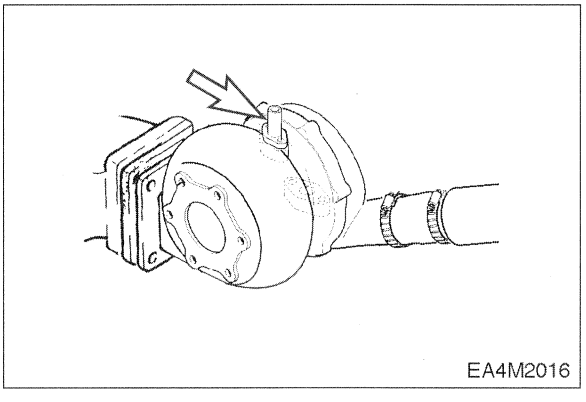


EA4M2015

21. Oil delivery pipe

- Pre-lubricate turbocharger with CD grade oil through the oil port shown by the arrow in the figure.
- Tighten flange bolt as it is a specified torque after oil delivery pipe is installed on the flange.

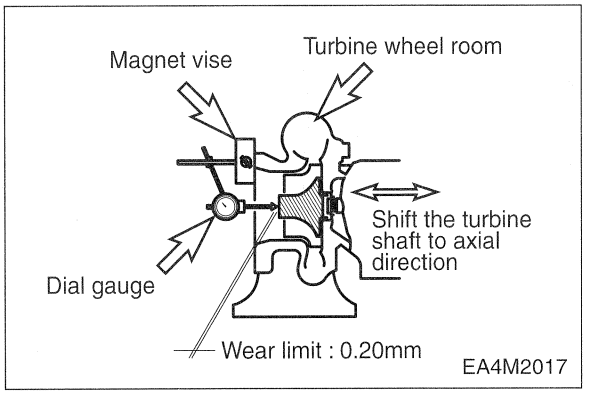
Oil delivery pipe torque	2.6±0.5 kg.m



EA4M2016

2.4.4. Inspection of Rotor Shaft

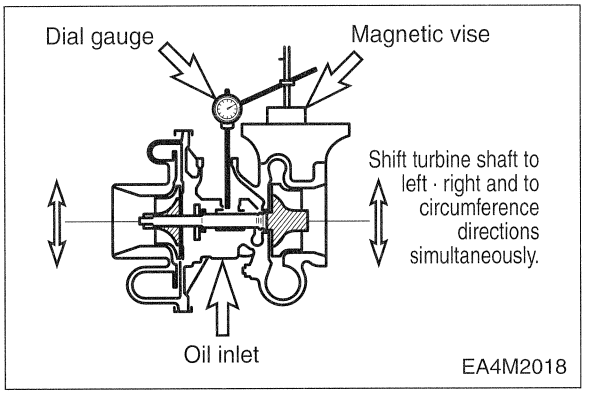
- **Rotor Shaft Axial Play Measurement**
  - Assemble dial indicator at the turbine housing as the shown in figure.
  - Use dial indicator to measure the rotor shaft axial play with the moving shaft push and pull. Read the total indicator reading (TIR).



Item	Limit
Rotor shaft axial play (TIR)	0.11 mm

  - Replace the shaft if the measured value is in excessive of specified limit.

- **Rotor Shaft Radial Play Measurement**
  - Turn over the turbo charger with the turbine exhaust inlet flange facing up.
  - Install a dial indicator to measure the rotor shaft radial play.
    Use the dial indicator to measure the play.
    Read the TIR.



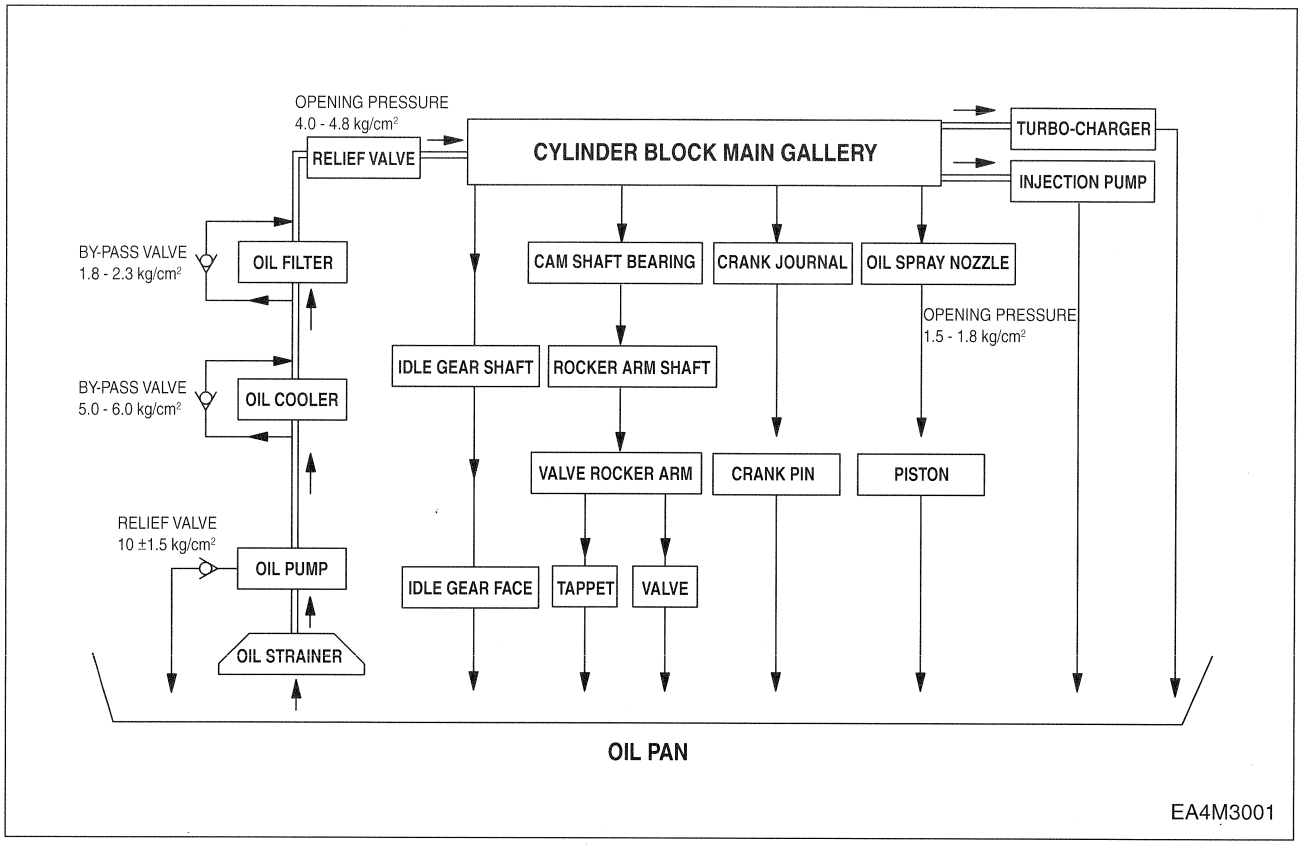
RHB6A	Limit
Rotor shaft radial play (TIR)	0.19 mm

RHC7, RHB7	Limit
Rotor shaft radial play (TIR)	0.215 mm

  - Replace the shaft if the measured value is in excessive of specified limit.

3. Lubricating System

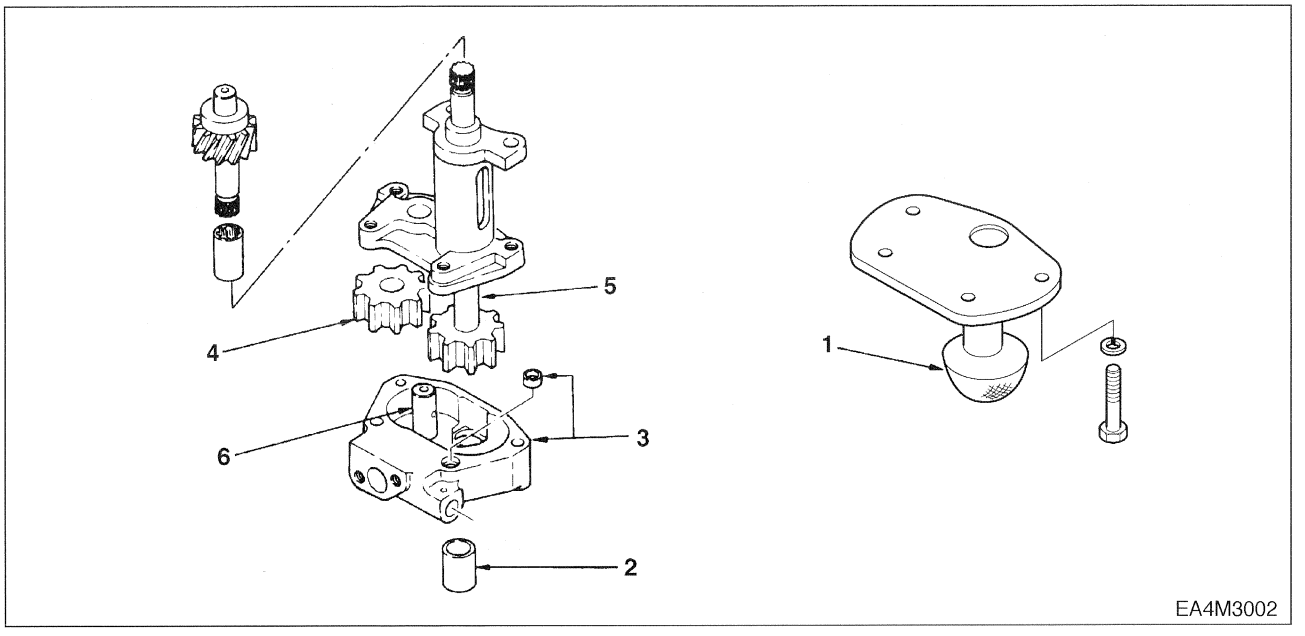
3.1. General Description



Notes : DB33 model does not have a turbo-charger. (Turbo-charger is only for P034TI.)

3.2. Oil Pump

Disassemble



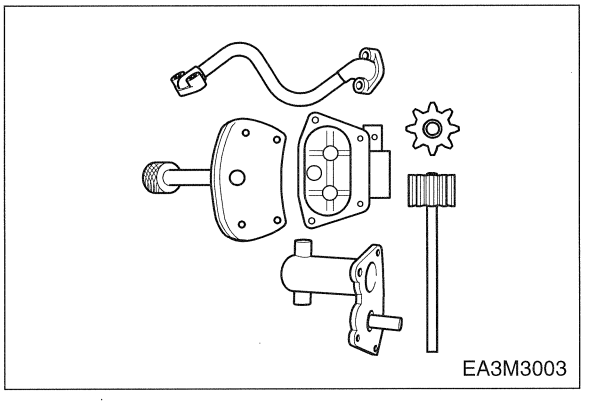
<Disassembly steps>

▲ 1. Strainer
2. Suction pipe
3. Cover and dowel
4. Drive gear
5. Drive shaft and gear
6. Drive gear shaft

Inspection and repair

Make the necessary adjustments, repairs and part replacements if excessive wear or damage is found through inspection.

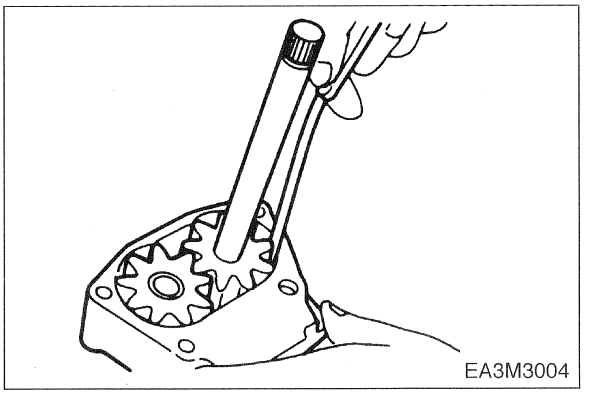
Visually inspection the disassembled parts for excessive wear and damage.



Oil pump cover and

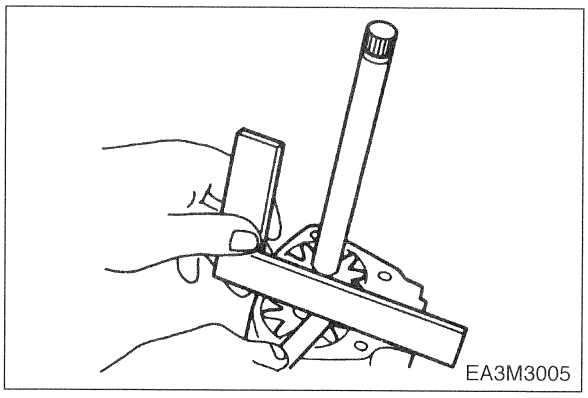
oil pump drive gear clearance

Limit	0.18.mm



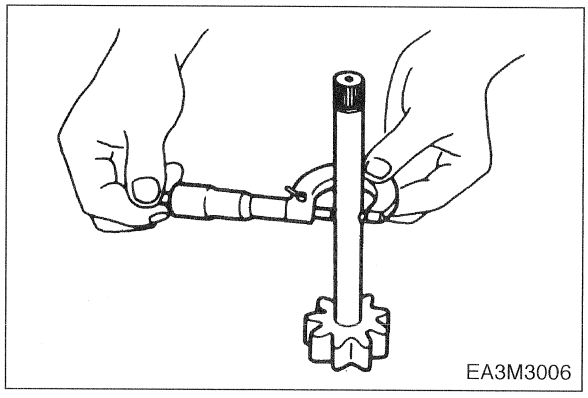
Cover and drive gear clearance

Limit	0.12.mm



Drive gear shaft diameter

Standard	Limit
16.0 mm	15.9.mm



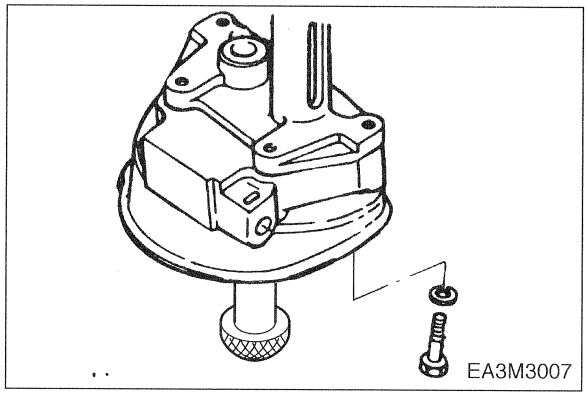
Reassembly

To assemble, follow the disassembly procedures in reverse order.

Important operation

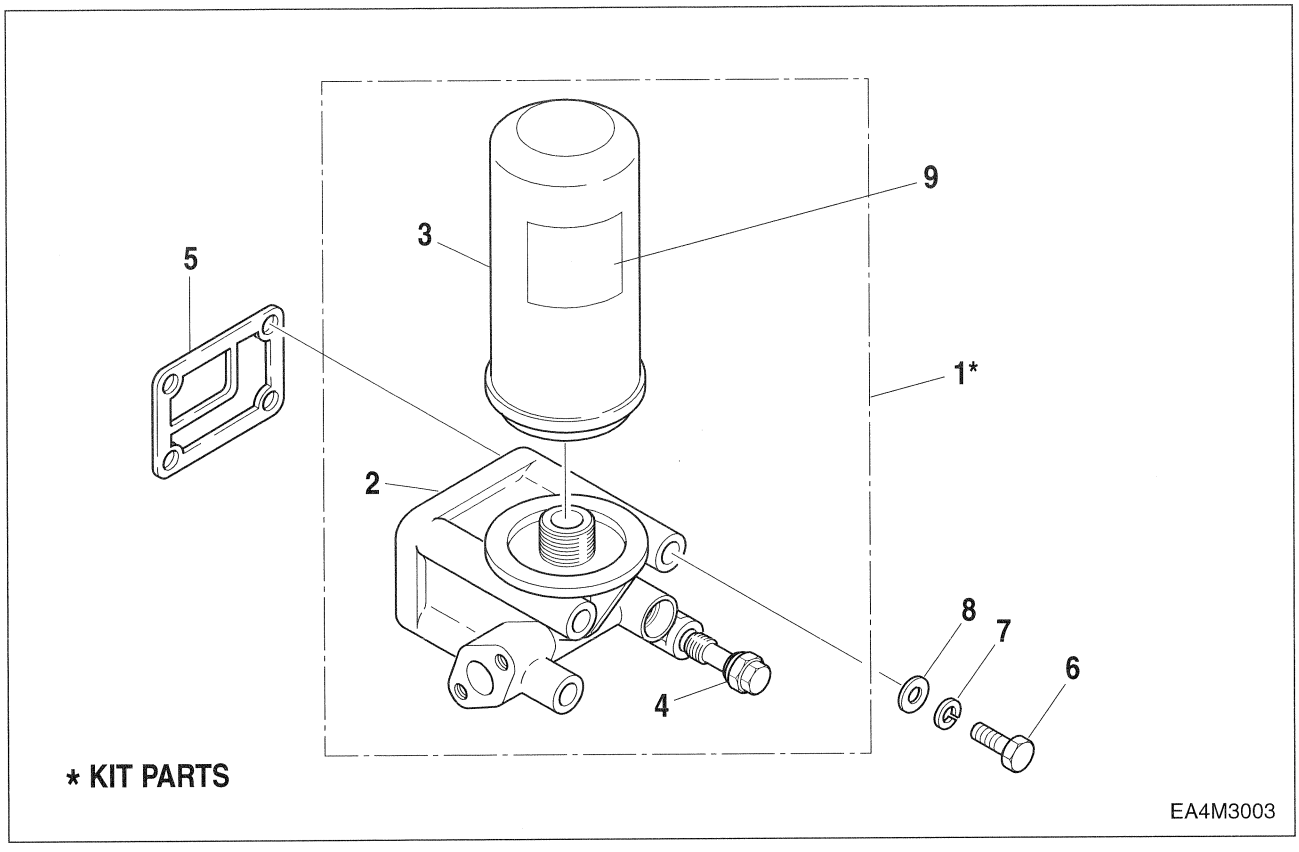
1. Strainer

Torque	1.0~1.8 kg.m



3.3. Oil Filter

Disassemble



<Disassembly steps>

*	1. Oil filter assembly	▲ 4. Relief valve assembly	7. Spring washer
	2. Head-oil filter	5. Gasket	8. Plain washer
	3. Element-oil filter	6. Bolt	9. Plate-caution

Inspection and repair

Make the necessary adjustments, repairs and part replacements if excessive wear or damage is found through inspection.

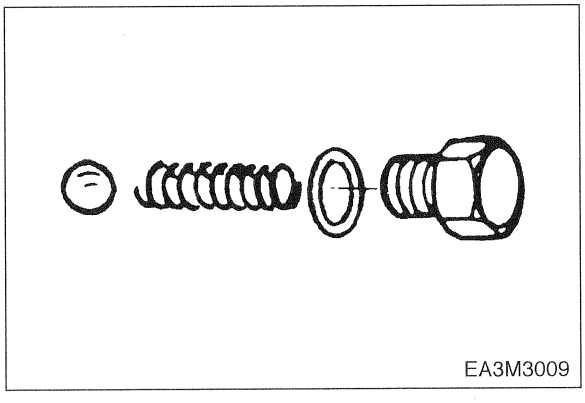
Reassembly

To assemble, follow the disassembly procedures in reverse order.

Important operation

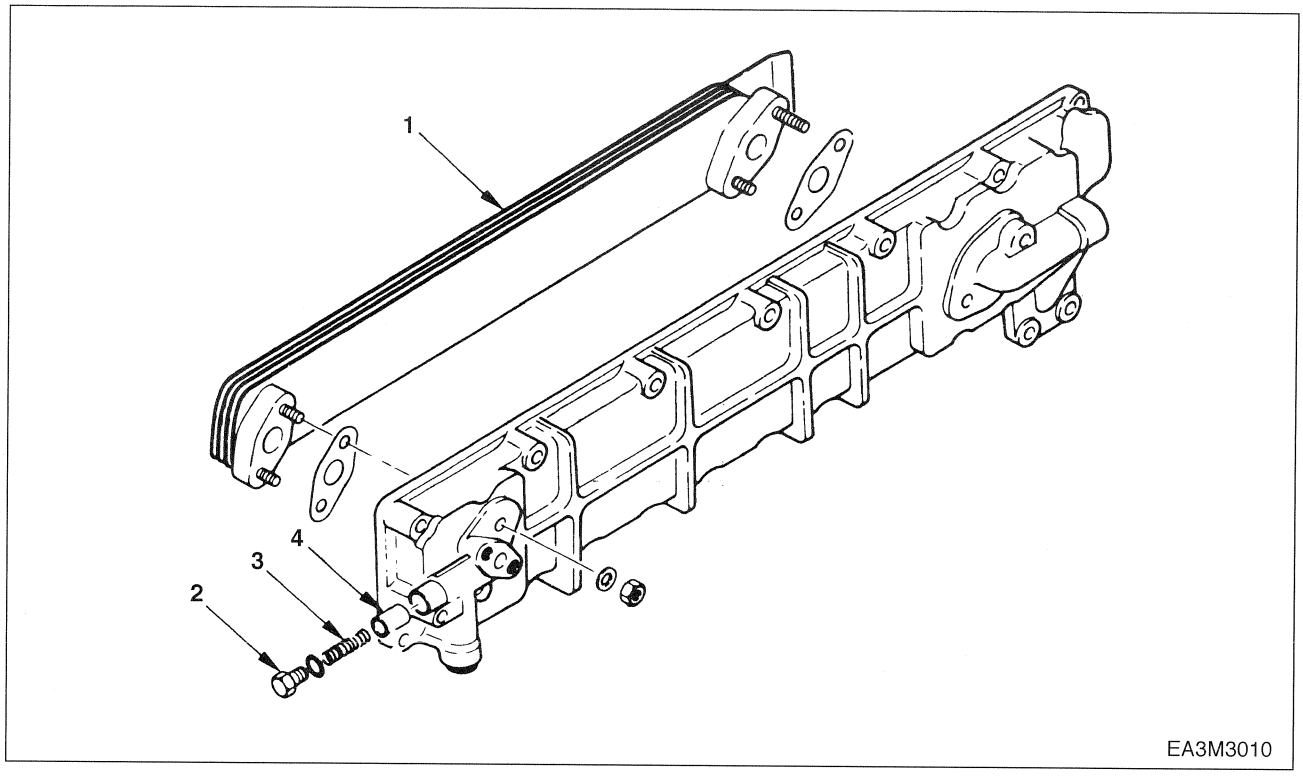
4. Relief valve assembly

Torque	2.5 kg.m



3.4. Oil Cooler

Disassemble



<Disassembly steps>

1. Element
2. Bolt
3. Spring
4. By-pass valve

Inspection and repair

Make the necessary adjustments, repairs and part replacements if excessive wear or damage is found through inspection.

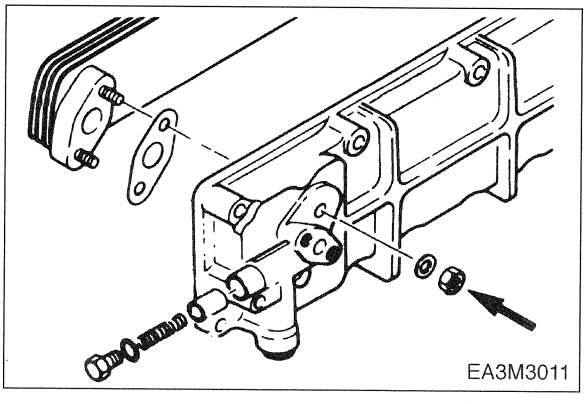
Reassembly

To assemble, follow the disassembly procedures in reverse order.

Important operation

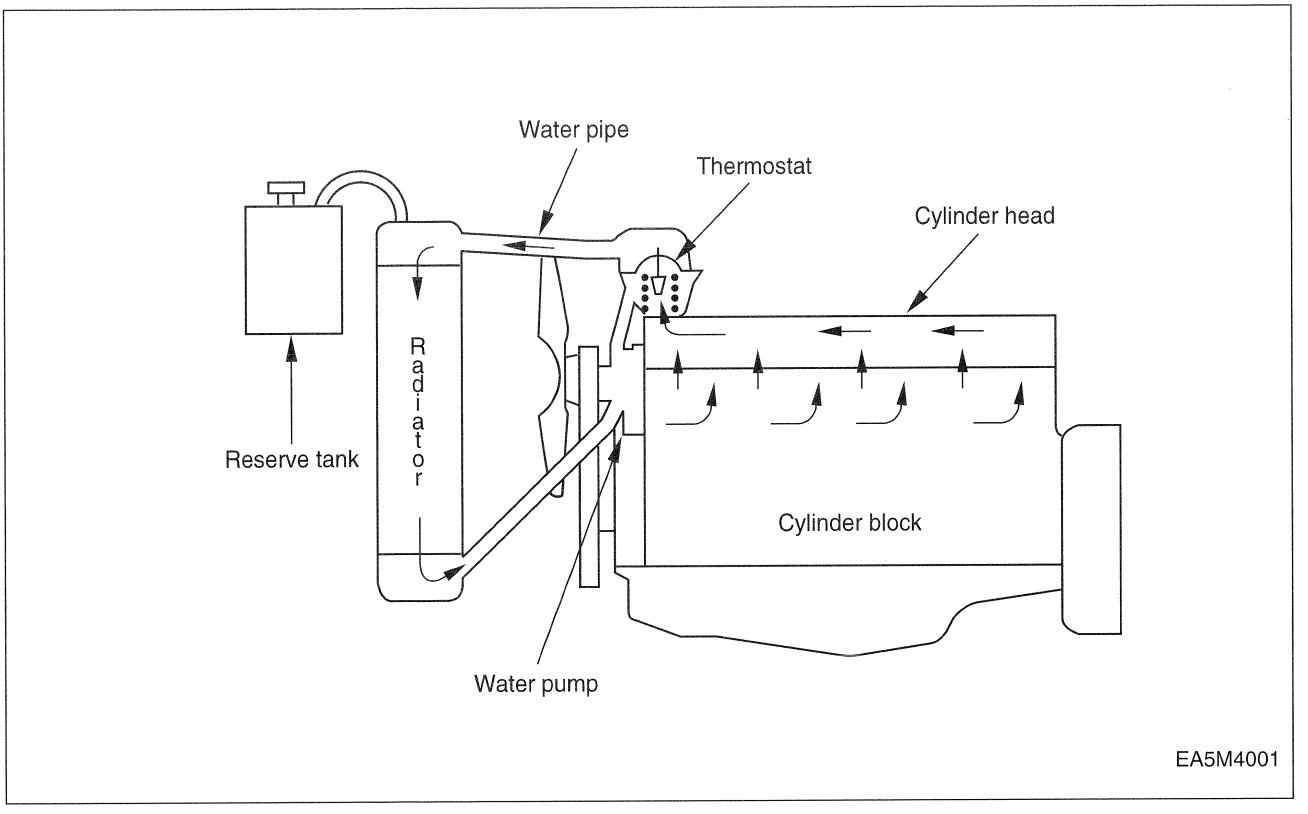
1. Element

Torque	2.6 kg.m



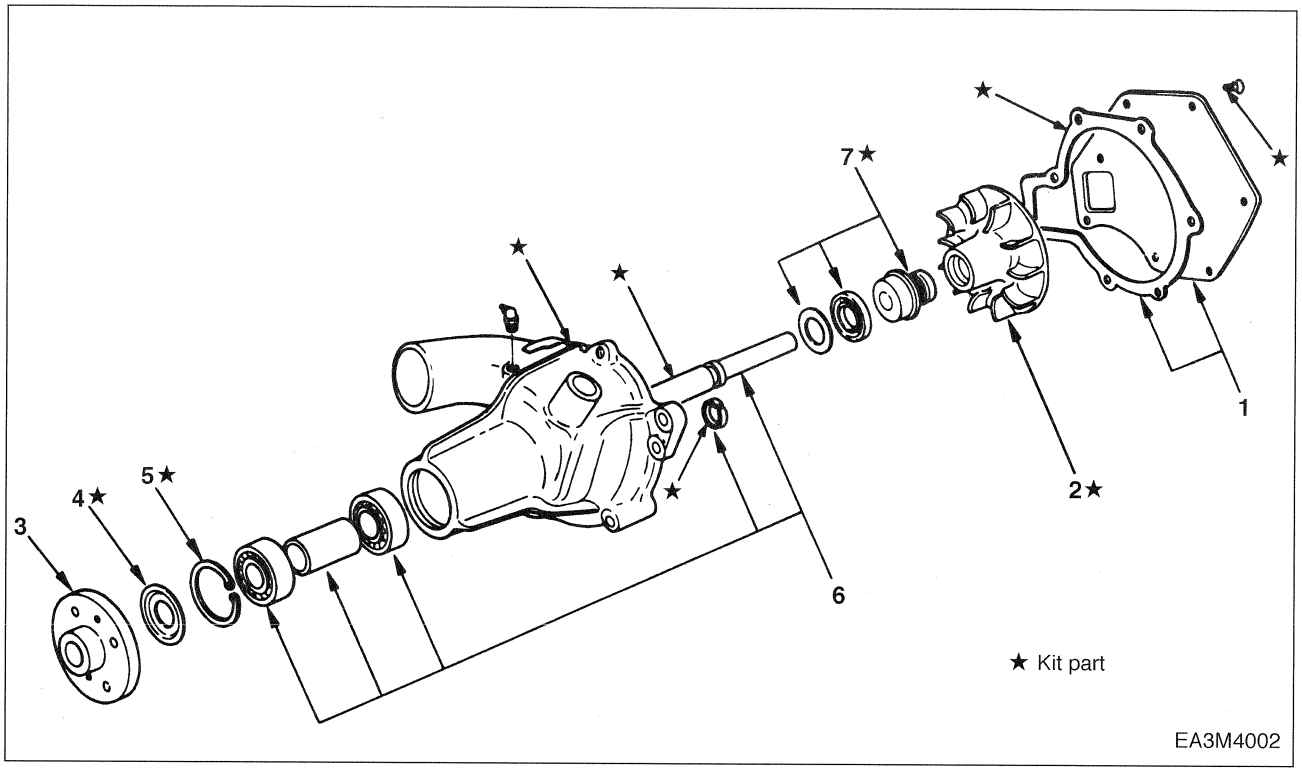
4. Cooling System

4.1. General Description



4.2. Water Pump

Disassemble



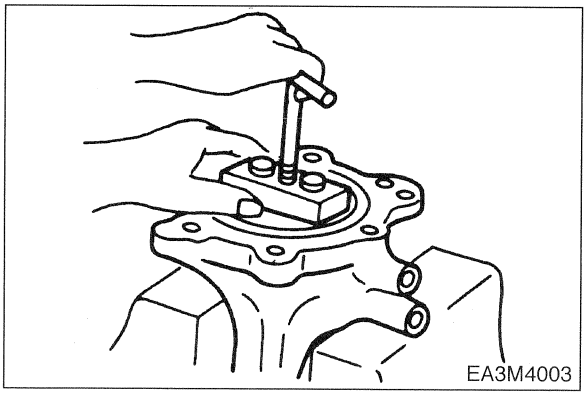
<Disassembly steps>

1. Cover
▲ 2. Impeller
▲ 3. Pulley center
4. Dust thrower
▲ 5. Snap ring
▲ 6. Shaft bearing and spacer
▲ 7. Seal unit, washer and seal

Important operation

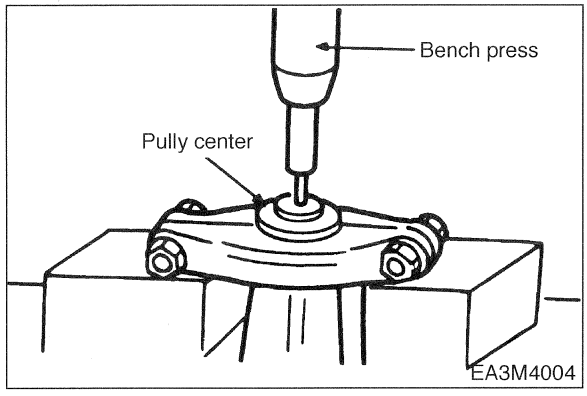
2. Impeller

Removal : Remover



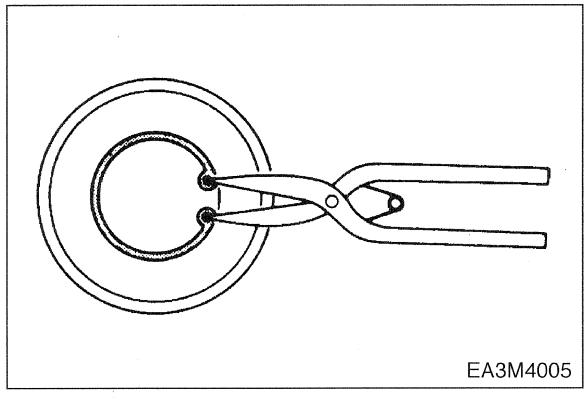
3. Pulley center

Remove the pulley center using a bench press and a bar.



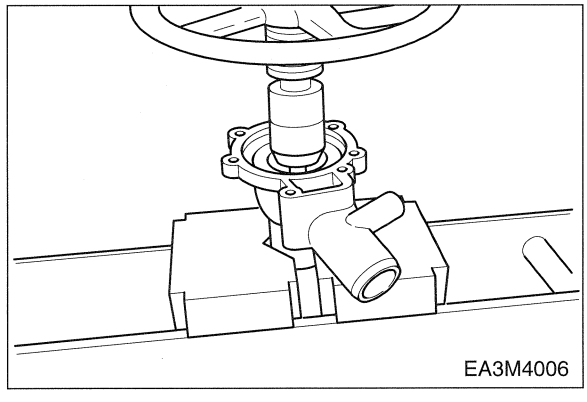
5. Snap ring

Remove the snap ring using a pair of snap ring pliers.



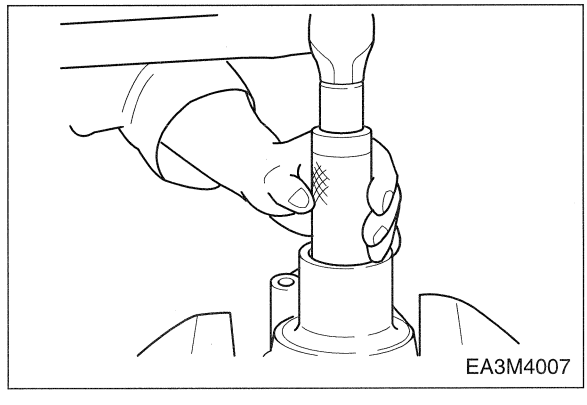
6. Shaft, bearing and spacer

Remove the shaft and bearings using a bench press and suitable remover.



7. Seal unit, washer and seal

Remove the seal unit using a bench press and suitable remover.



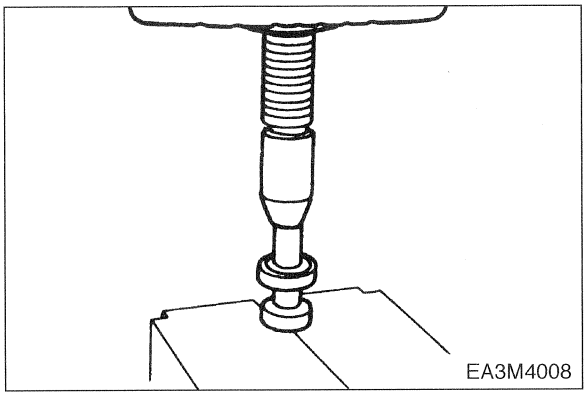
Inspection and repair

Make the necessary adjustments, repairs and part replacements if excessive wear or damage is found through inspection.

- **Bearing replacement Procedure**

Removal

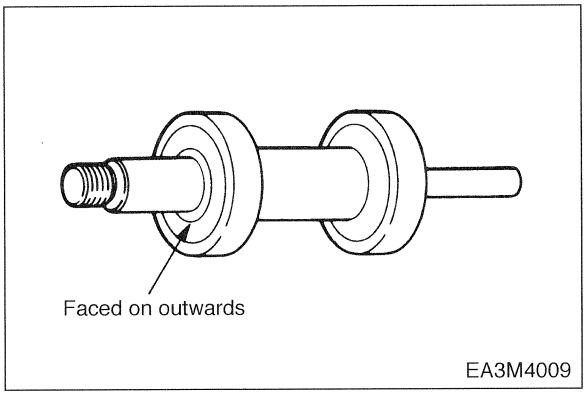
Use a bench press



Assembly

Use a bench press to install the front and rear bearing.

The bearings should be installed so that their sealed sides are faced on outwards.



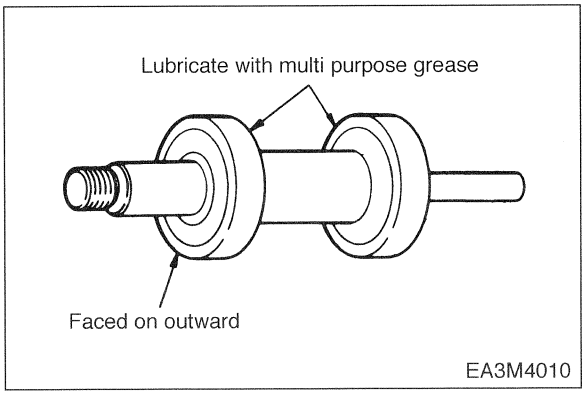
Reassembly

To assemble, follow the disassembly procedures in reverse order.

Important operation

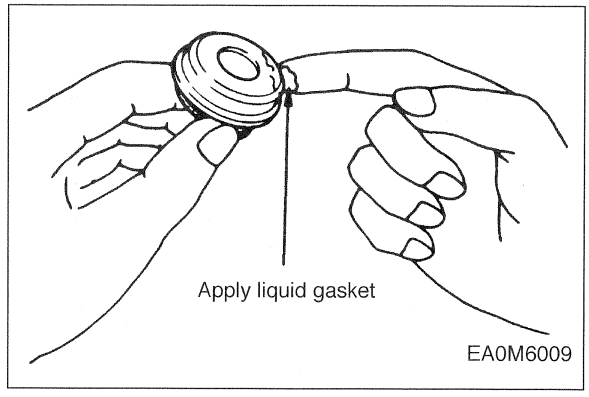
6. Shaft, bearing and spacer

Lubricate the bearing with multi-purpose grease before installing into the pump body.



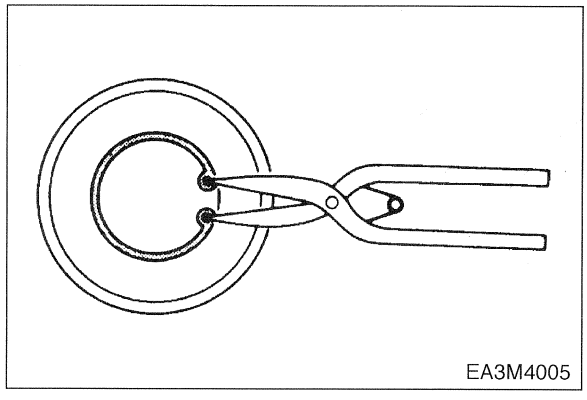
7. Washer, seal and seal unit

Before installation, apply a thin coat of liquid seal (Belco bond No. 4) on the surface in contact with the pump body as figure.



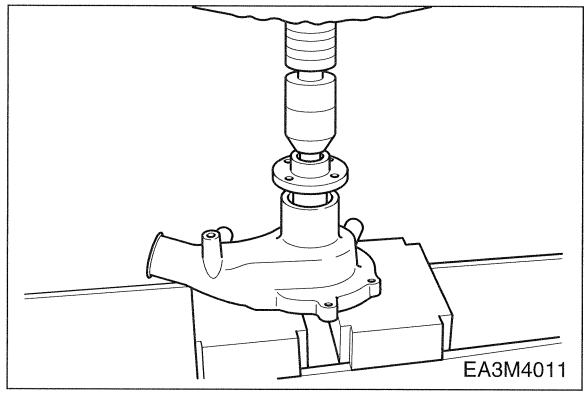
4. Snap ring

Install the snap ring using a pair of snap ring pliers.



3. Pulley center

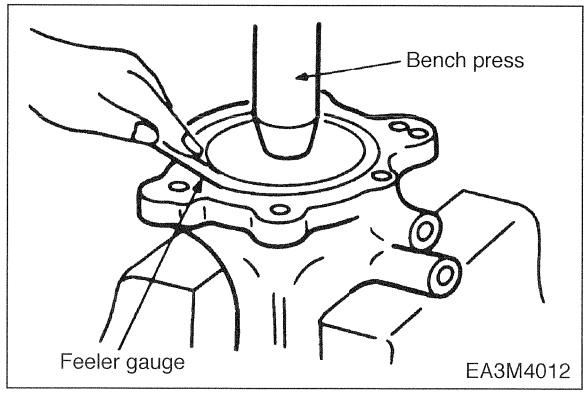
Press in until it stops using a bench press.



2. Impeller

Install the impeller using a bench press so that the clearance between the impeller and body is reached within the specified value.

Standard	0.3 ~ 0.8 mm



4.3. Thermostat

Inspection and repair

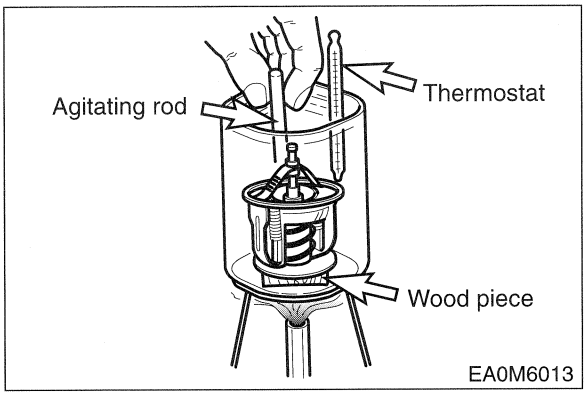
Make the necessary adjustments, repairs and part replacements if excessive wear or damage is found through inspection.

Valve opening temperature

Opening temperature	82 °C
Full opening temperature	95 °C

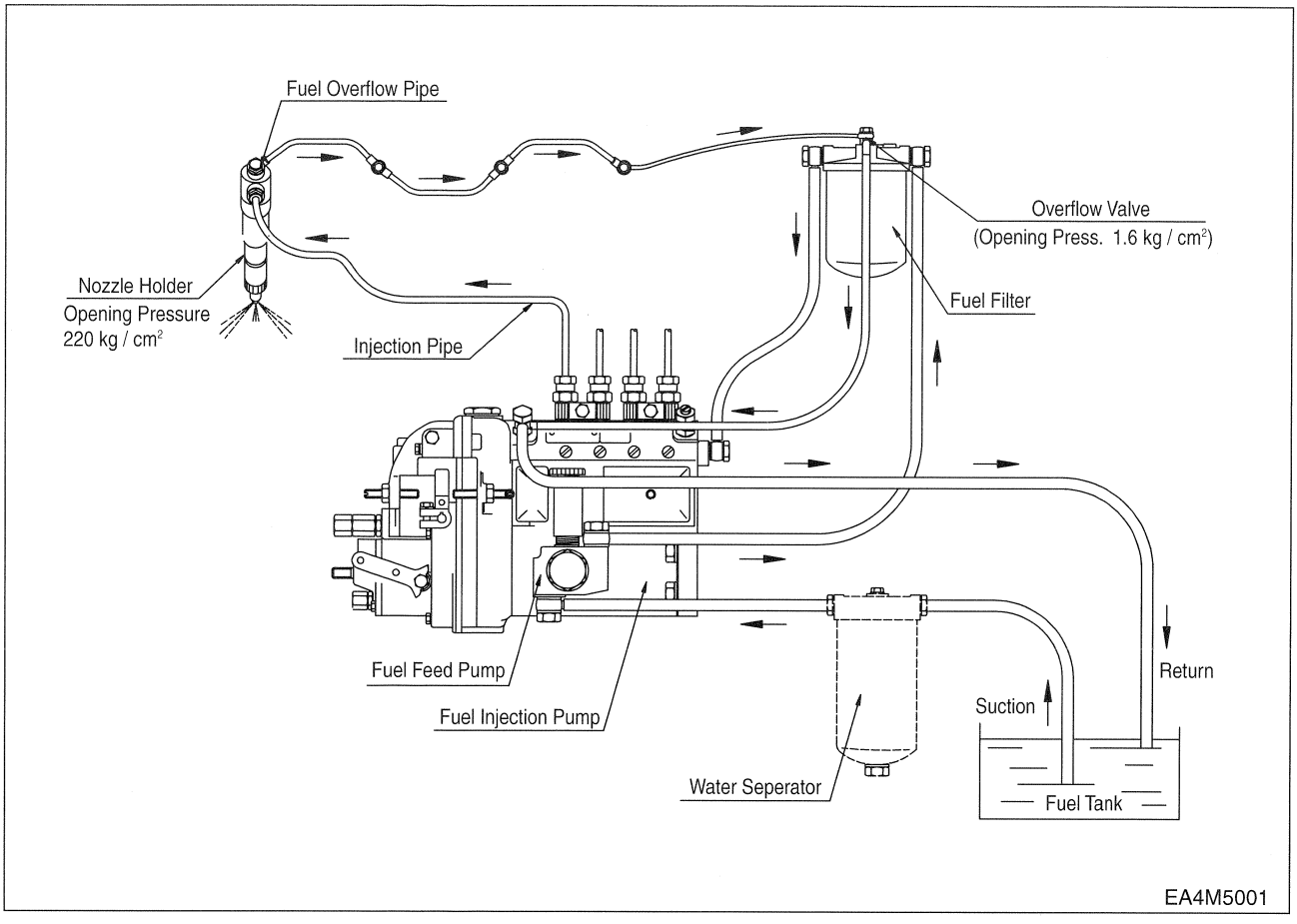
Valve lift (at testing temperature)

Standard	approx. 10 mm (at 95 °C)



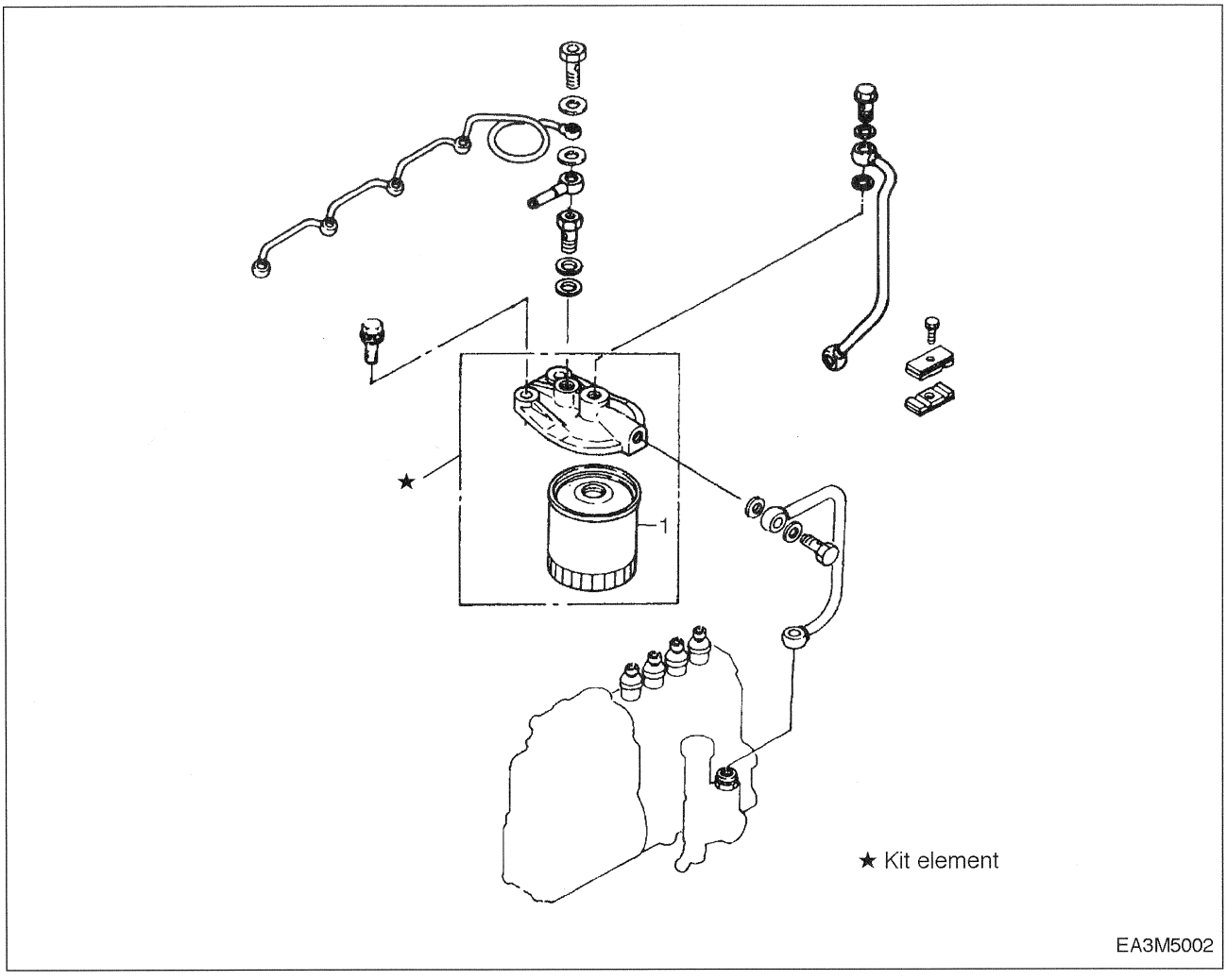
5. Fuel System

5.1. General Description



5.2. Fuel Filter

Disassemble



<Disassembly steps>

1. Catridge

Inspection and repair

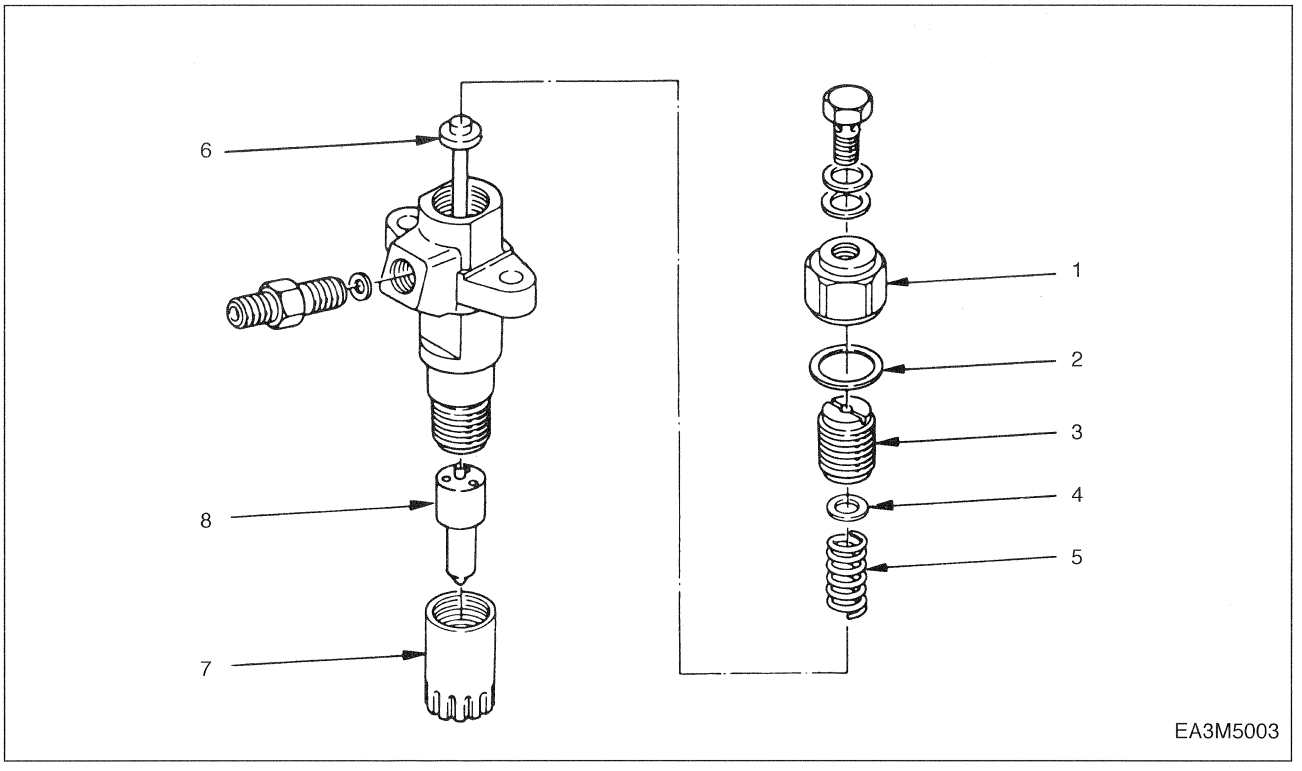
Make the necessary adjustments, repairs and part replacements if excessive wear or damage is found through inspection.

Reassembly

To assemble, follow the disassembly procedures in reverse order.

5.3. Injection Nozzle

Disassemble



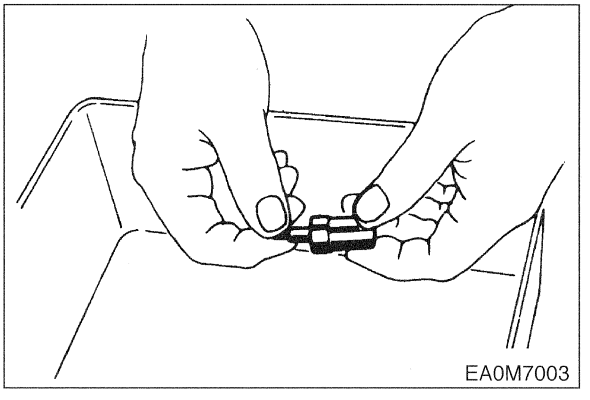
<Disassembly steps>

1. Cap nut
2. Seal ring
3. Adjust screw
4. Washer
5. Snap ring
6. Push rod
7. Retaining nut
▲ 8. Injection nozzle

Important operation

8. Injection nozzle

Remove the nozzle assembly from the nozzle body. Keep the parts separately to maintain the proper needle valve and body combination.



Inspection and repair

Make the necessary adjustments, repairs and part replacements if excessive wear or damage is found through inspection.

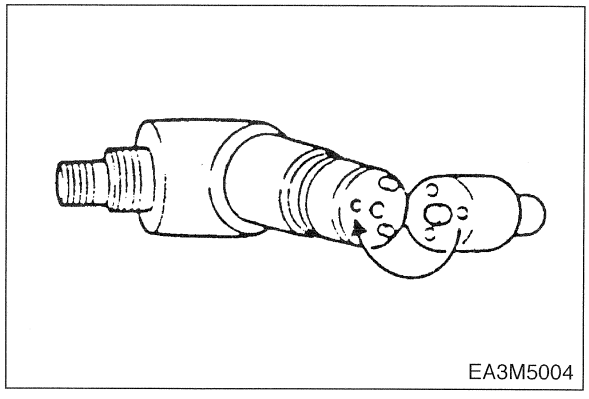
Reassembly

To assemble, follow the disassembly procedures in reverse order.

Important operation

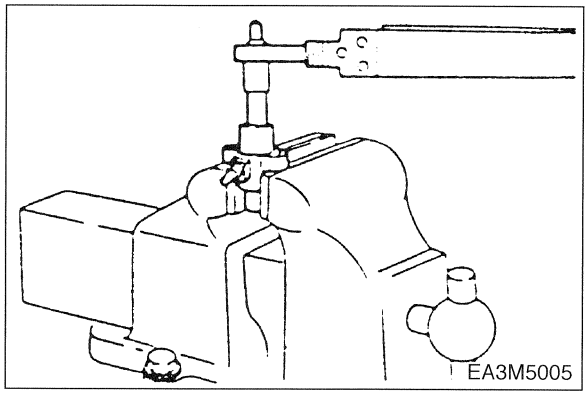
8. Injection nozzle

Align the nozzle dowel pin with the dowel hole in the nozzle holder body.


EA3M5004

7. Retaining nut

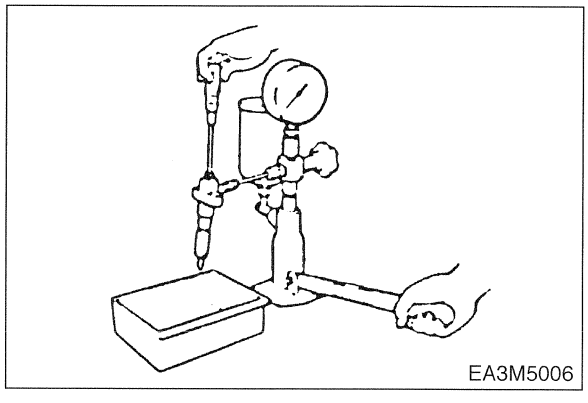
Torque	6 ~ 8 kg.m


EA3M5005

3. Adjust screw

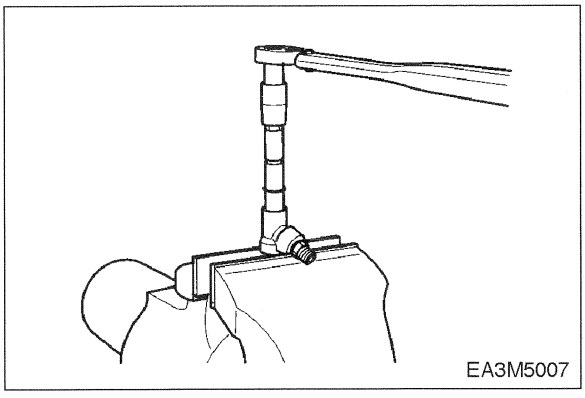
The injection nozzle injection opening pressure must be confirmed after the adjusting screw is installed.

Injection opening pressure	220 kg/cm^2


EA3M5006

1. Cap nut

Torque	4 ~ 5 kg.m



5.4. Injection Pump Calibration

5.4.1. P034Ti engine

(1) Injection pump : 65.11101-7312(101402-9900 ZEXEL)
(2) Nozzle holder assembly : 65.10101-7073
(3) Injection pipe : 65.10301-6032
(4) Injection order : 1-3-4-2
(5) Injection timing : BTDC 13 ± 1°

(A)Test condition for injection pump	Nozzle & holder ass'y	105780-8140	Opening pressure:175 kg/cm²
	Injection pipe(ID,OD,L)	-	ø6.0 X ø2.0 - 600mm
	Test oil	ISO4113	Temperature:40 ± 5°C
(B) Engine standard parts	Nozzle & Holder Ass'y	9135-236(LUCAS)	Nozzle(5 X ø0.26)
		9135-237(LUCAS)	NHA(220 bar)
	Injection pipe(ID,L)		ø1.8 X 400MM

Rack diagram and setting valve at each point(Refer to next figure)

Check point	Rack position (mm)	Pump speed (rpm)	Injection Q'ty on RIG(mm³/1,000st)		Press. (mmHg)
			(A) Test condition for inj.pump	(B) Engine standard parts	
A	9.1	900	76.7	-	-
B	10.0	890	90	-	-
C	7.8	350	13.9	-	-
E	-	100	106.5	-	-
F	5.94	940	4.0	-	-

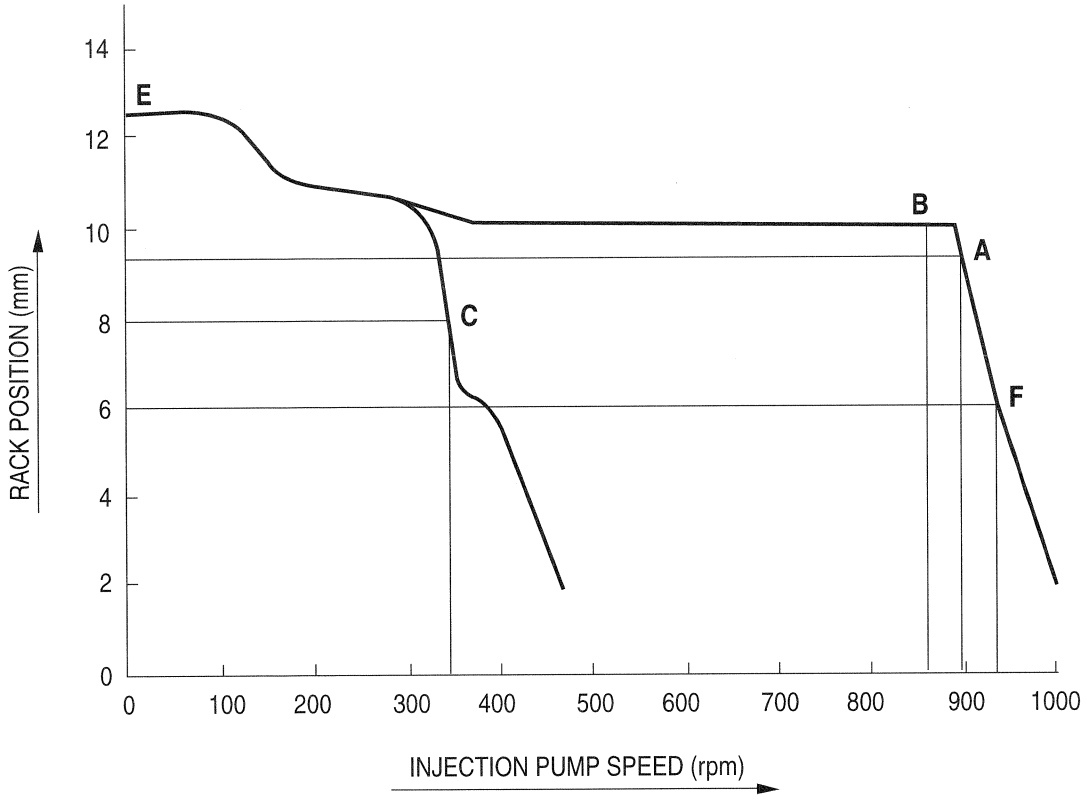
Notch- Approx. 12

Boost pressure dependent full-load stop(boost compensator spring operation point)

No boost compensator	Check point	Rack position (mm)	Pump speed (rpm)	Injection Q'ty RIG (mm³/1,000st)		Press. (mmHg)
				(A) Test condition for inj. pump	(B) Engine standard parts	

Weight	Weight=740 kg	Lever ratio(min/max)	1 : 1.2
Governor	k=6.08 kg/mm	Plunger	ø9.5, 30 lead
Idle spring	k=2.2 kg/mm	Delivery valve retraction volume	43 mm³/st
Start spring	k=0.014 kg/mm	Delivery valve opening pressure	12.4 kg/cm²
Boost compensator spring	-	Delivery valve spring	k=0.64 kg/mm
Feed pump		Timer	-

● **Rack Diagram**



EA5M5001

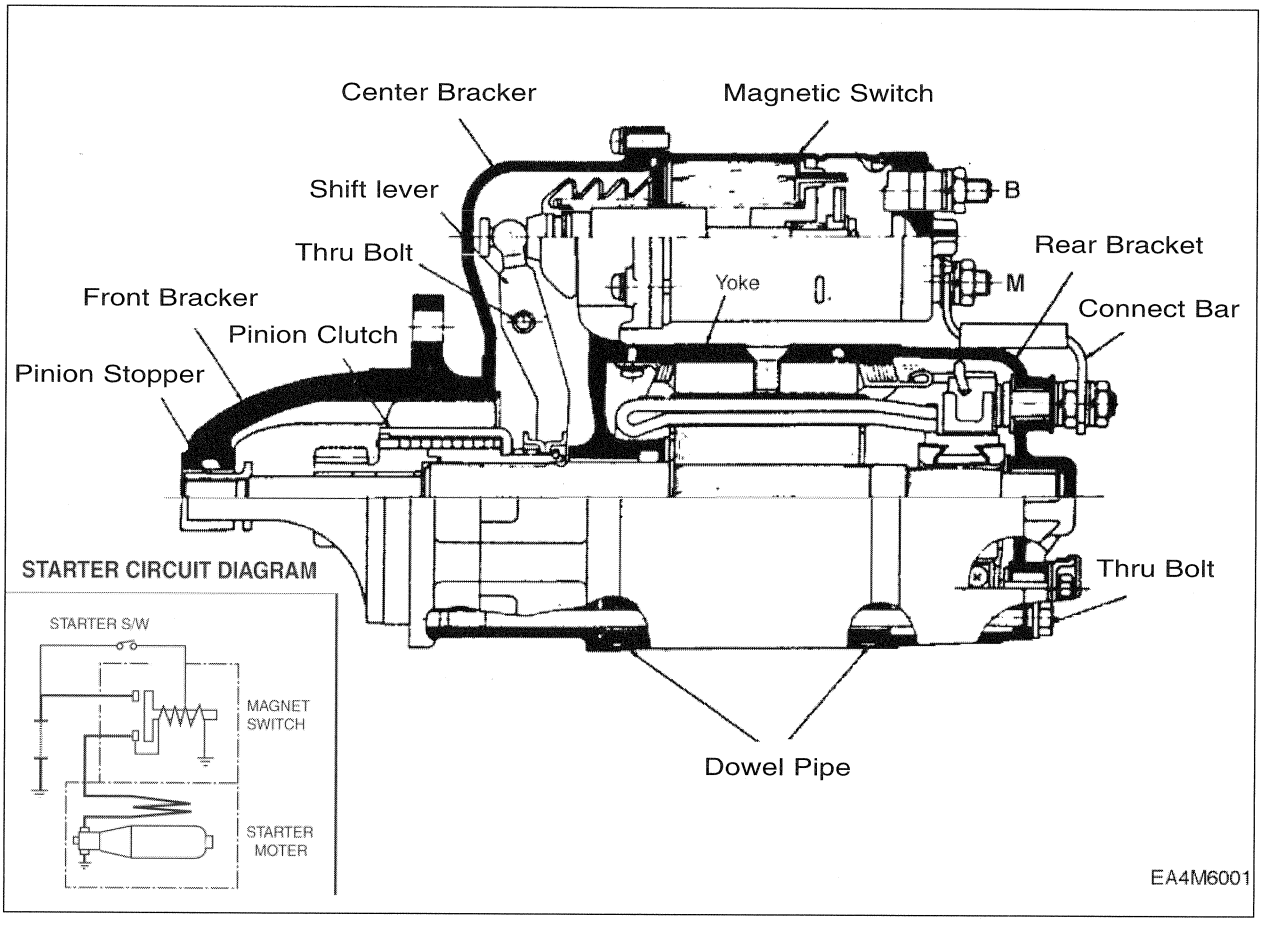
6. Engine Electricals

6.1. Starting Motor

• Main data and specification

Rated voltage	24 V
Rated output	4.5 kW
Rating	30 sec
Direction of rotation(viewed from the pinion side)	clockwise
Operation speed	More than 3,500 rpm (No load)
	More than 1,080 rpm (Load)

• Construction

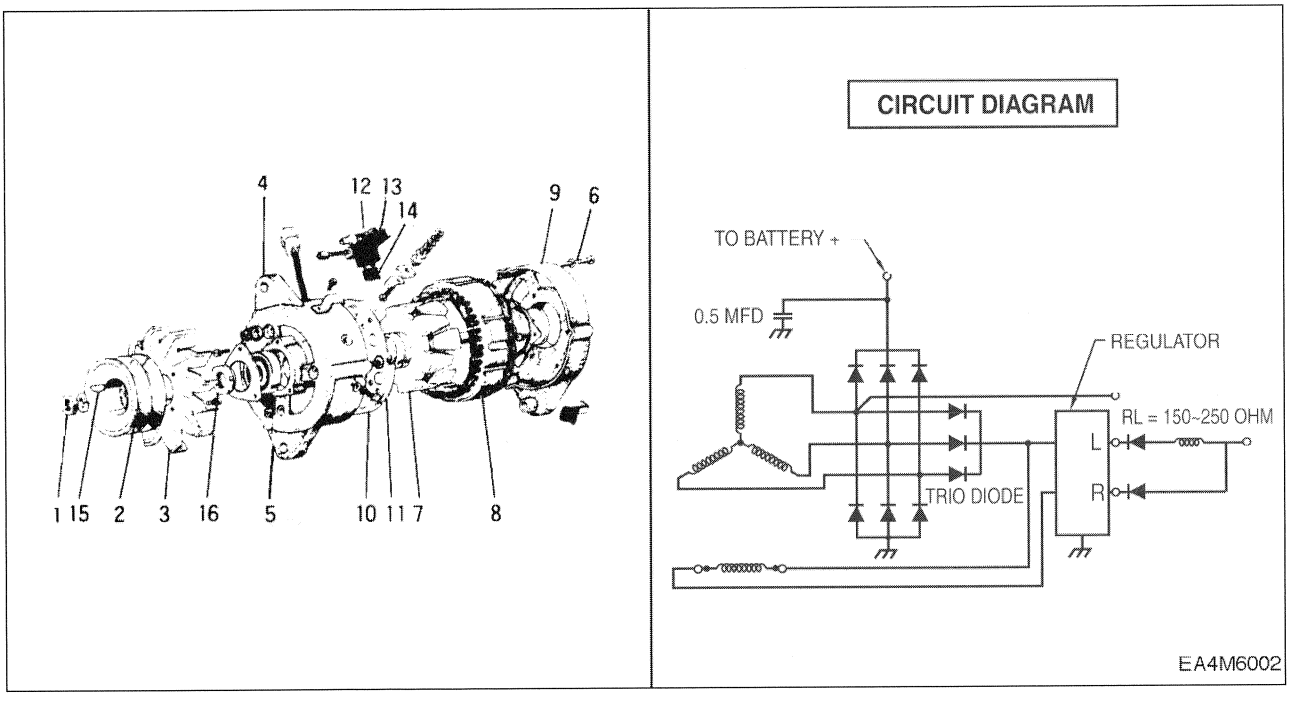


6.2. Alternator

• Specification

Type	3 phase AC alternator (Built in IC regulator)
Rated voltage	24 V
Rated output	45 A
Max. allowable speed	5,000 rpm
Polarity grounded	Negative (-)
Direction of rotation	clockwise (viewed from pulley side)
Weight	6 kg

• Construction

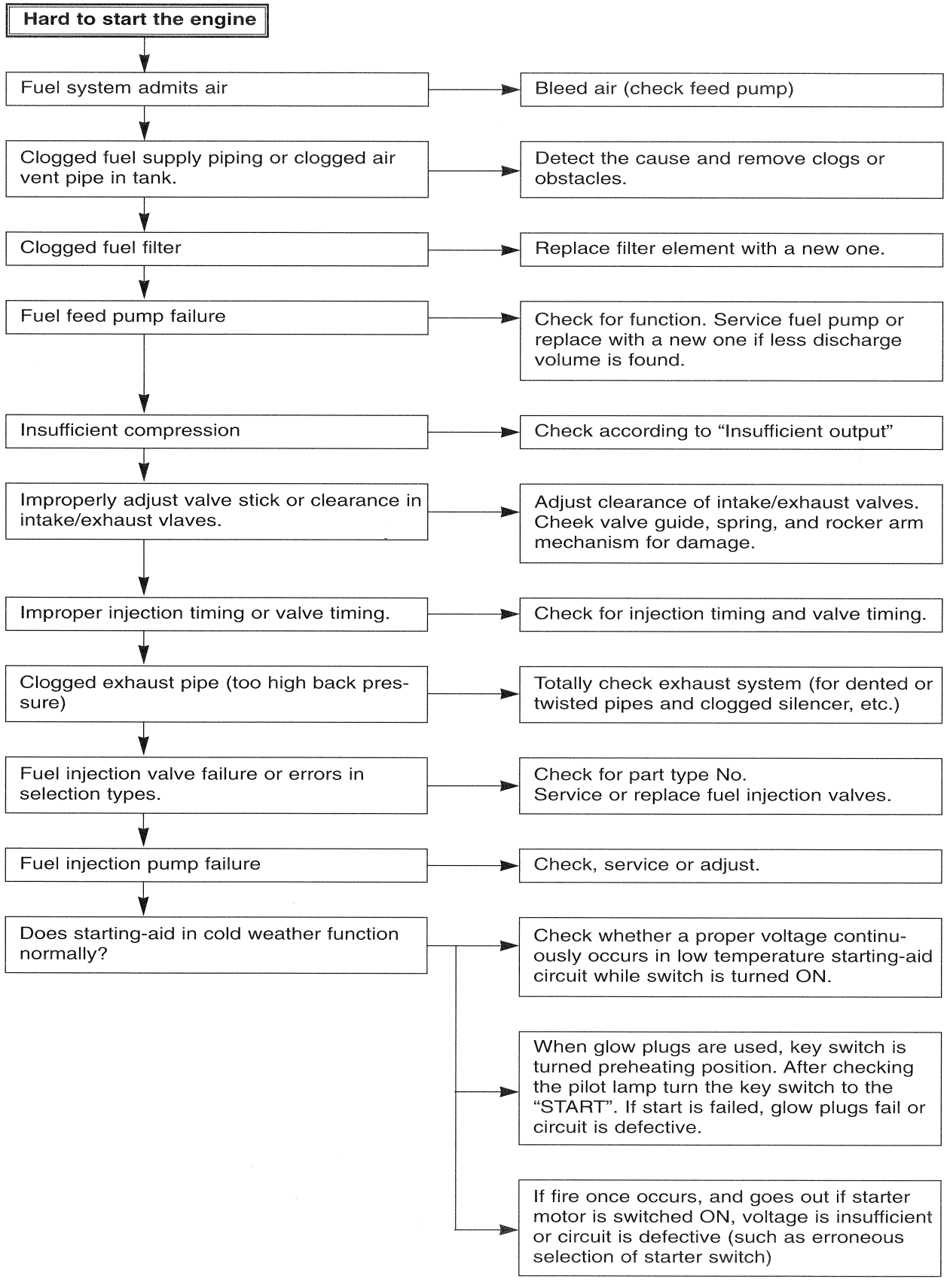


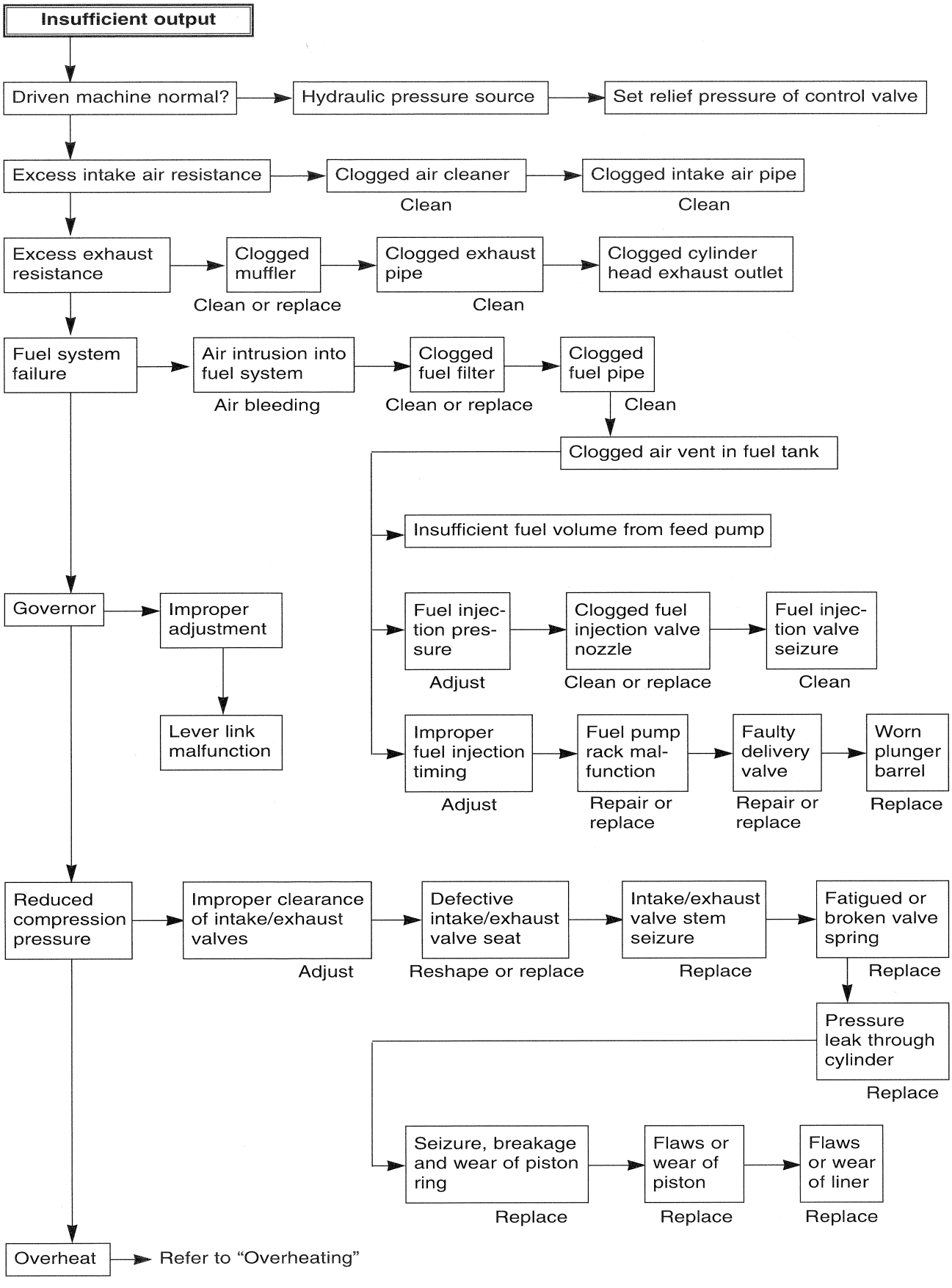
<Disassembly steps>

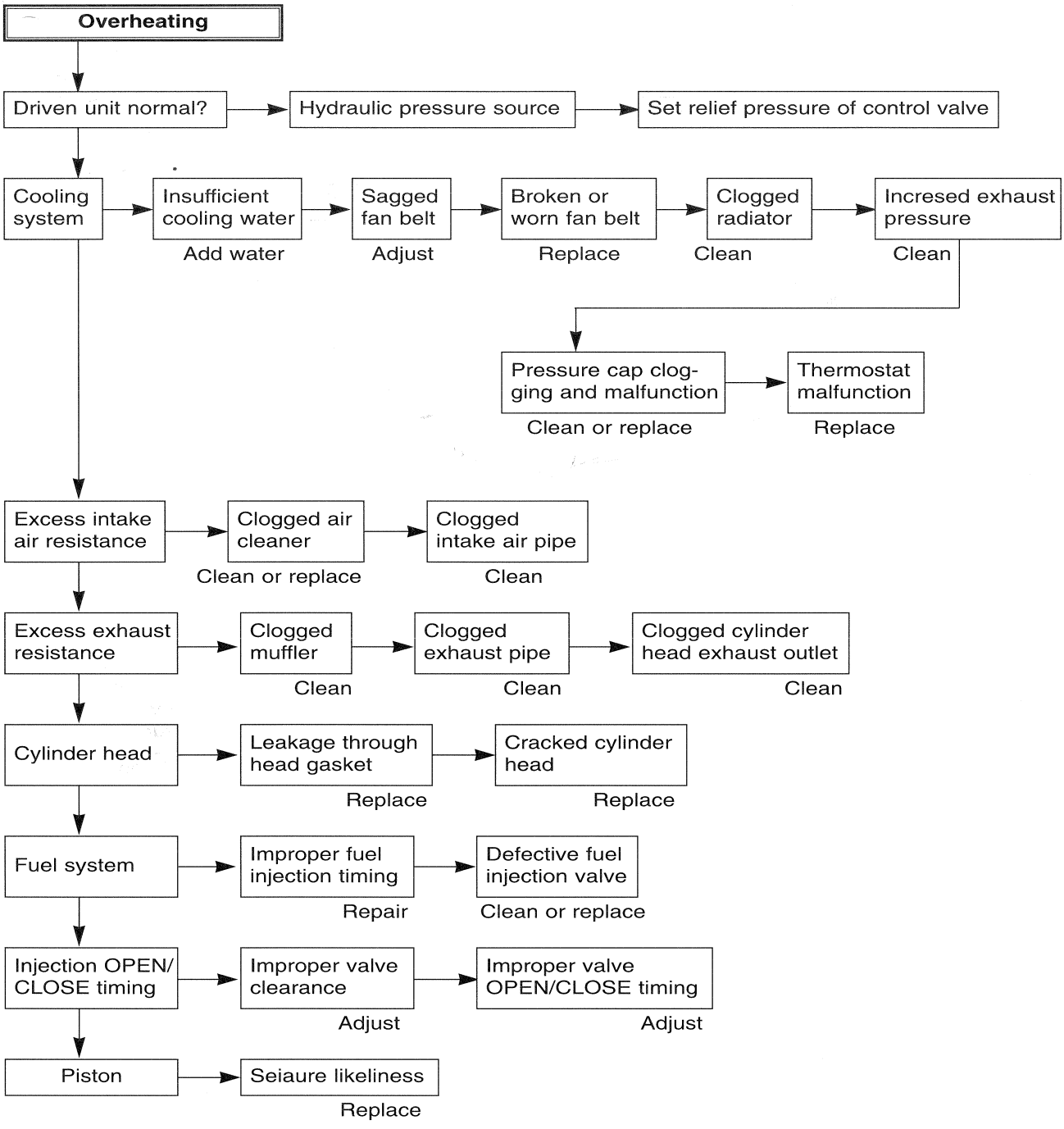
1. Lock nut
2. Pulley
3. Fan
4. Front cover
5. Ball bearing
6. Thread bolt
7. Rotor assembly
8. Stator assembly
9. Rear side cover assembly
10. Diode assembly (+)
11. Diode assembly (-)
12. Brush holder assembly
13. Brush spring
14. Brush
15. Key
16. Bearing lock nut

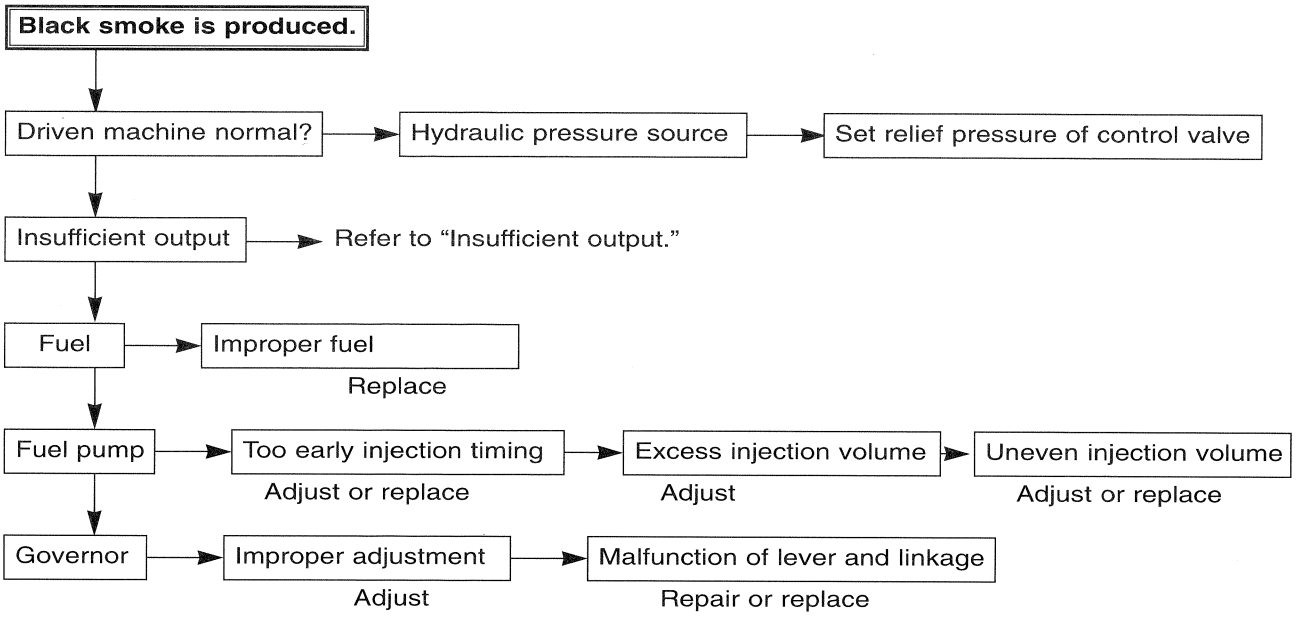
7. Troubleshooting

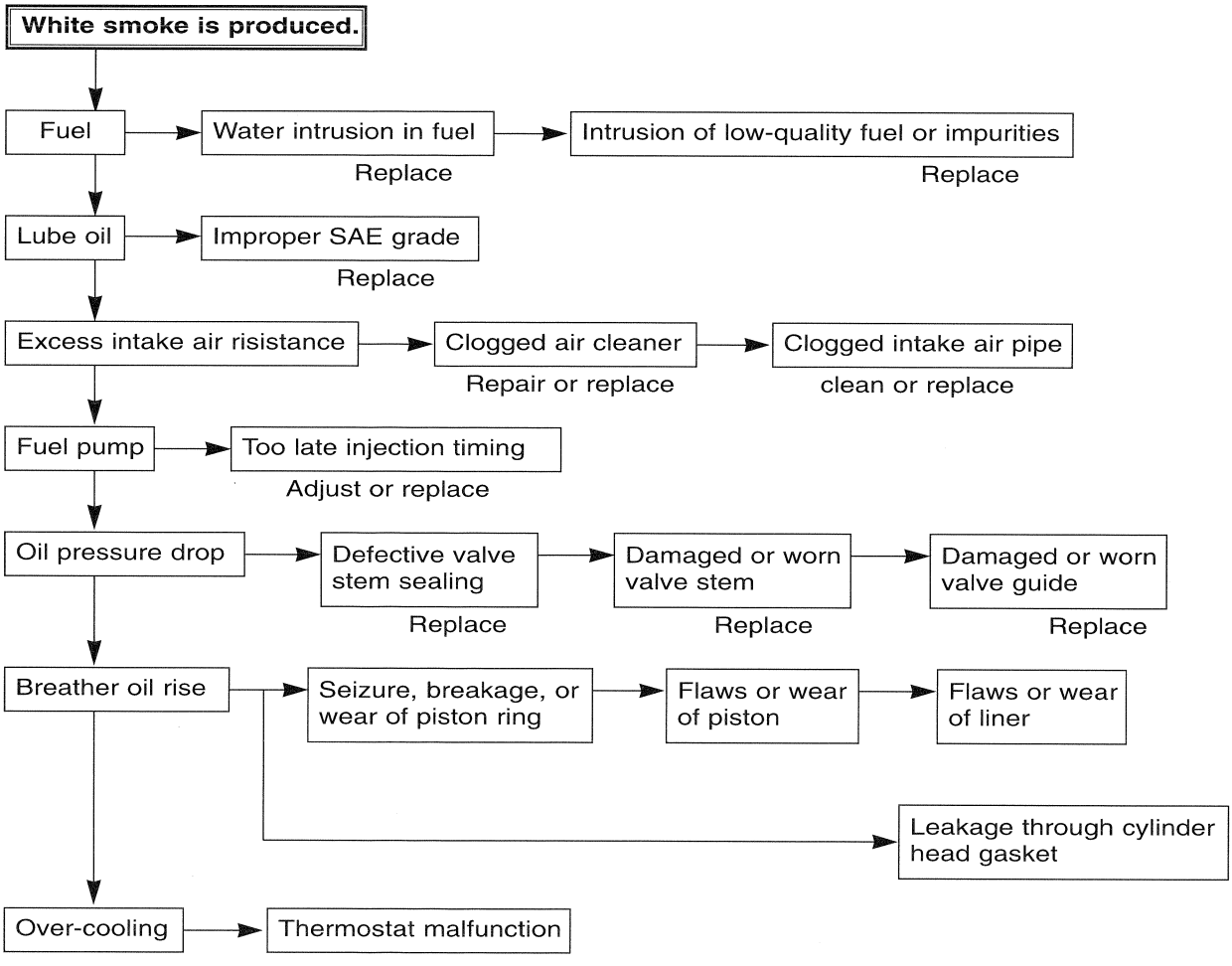
The following description summarizes the probable cause of and remedy for general failure by item. Immediate countermeasures should be taken before a failure is inflamed if any symptom is detected.

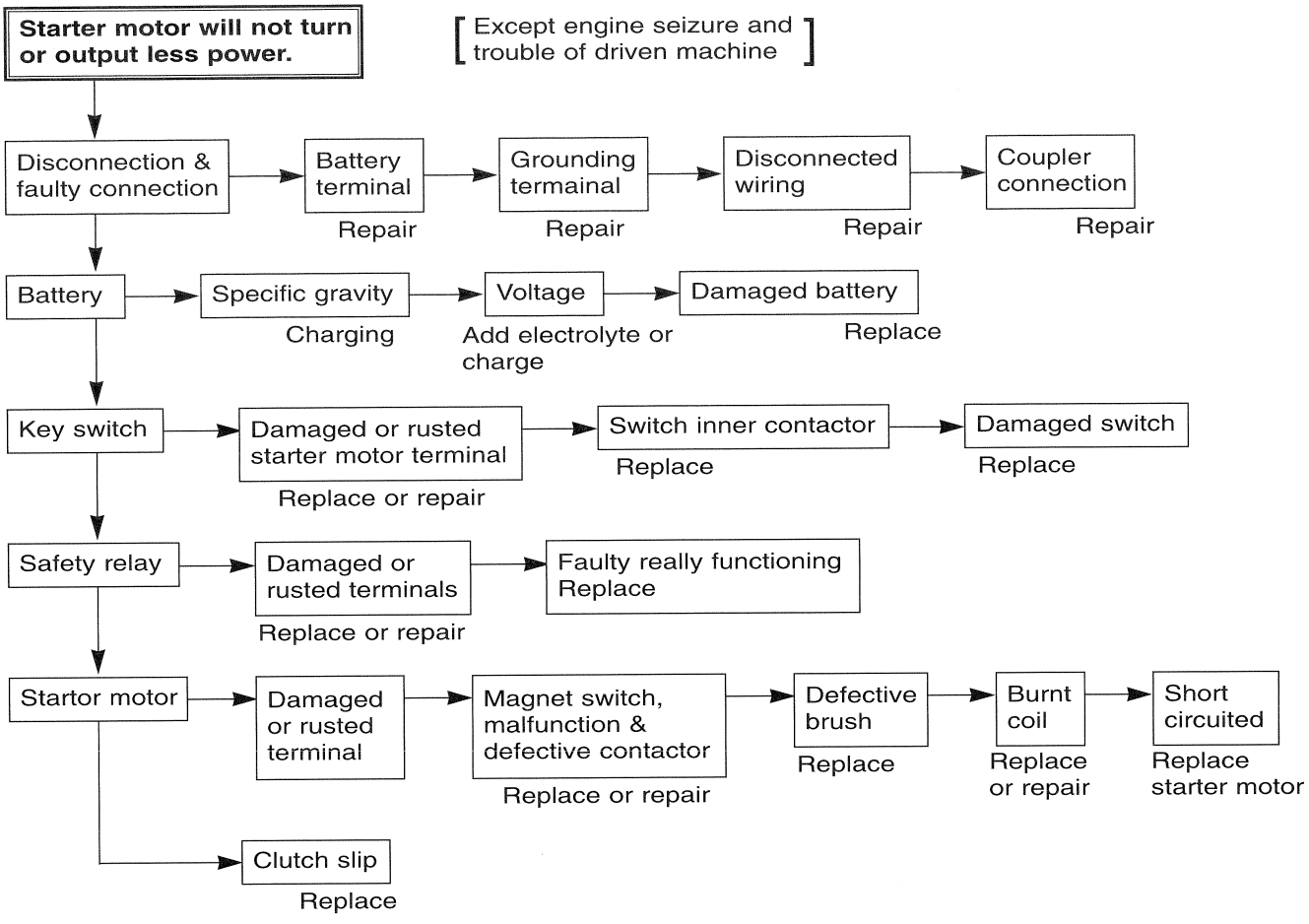



Insufficient output
Driven machine normal?
Hydraulic pressure source
Set relief pressure of control valve
Excess intake air resistance
Clogged air cleaner
Clean
Clogged intake air pipe
Clean
Excess exhaust resistance
Clogged muffler
Clean or replace
Clogged exhaust pipe
Clean
Clogged cylinder head exhaust outlet
Fuel system failure
Air intrusion into fuel system
Air bleeding
Clogged fuel filter
Clean or replace
Clogged fuel pipe
Clean
Clogged air vent in fuel tank
Insufficient fuel volume from feed pump
Governor
Improper adjustment
Lever link malfunction
Fuel injection pressure
Adjust
Clogged fuel injection valve nozzle
Clean or replace
Fuel injection valve seizure
Clean
Improper fuel injection timing
Adjust
Fuel pump rack malfunction
Repair or replace
Faulty delivery valve
Repair or replace
Worn plunger barrel
Replace
Reduced compression pressure
Improper clearance of intake/exhaust valves
Adjust
Defective intake/exhaust valve seat
Reshape or replace
Intake/exhaust valve stem seizure
Replace
Fatigued or broken valve spring
Replace
Pressure leak through cylinder
Replace
Seizure, breakage and wear of piston ring
Replace
Flaws or wear of piston
Replace
Flaws or wear of liner
Replace
Overheat
Refer to "Overheating"

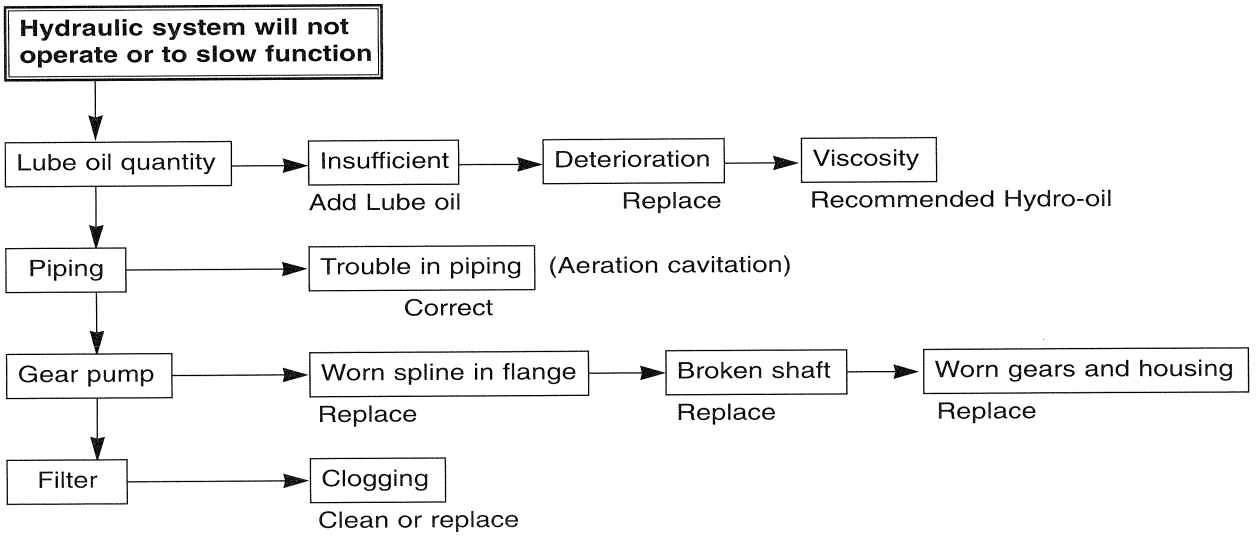

Overheating
Driven unit normal?
Hydraulic pressure source
Set relief pressure of control valve
Cooling system
Insufficient cooling water
Add water
Sagged fan belt
Adjust
Broken or worn fan belt
Replace
Clogged radiator
Clean
Incresed exhaust pressure
Clean
Pressure cap clog-ging and malfunction
Clean or replace
Thermostat malfunction
Replace
Excess intake air resistance
Clogged air cleaner
Clean or replace
Clogged intake air pipe
Clean
Excess exhaust resistance
Clogged muffler
Clean
Clogged exhaust pipe
Clean
Clogged cylinder head exhaust outlet
Clean
Cylinder head
Leakage through head gasket
Replace
Cracked cylinder head
Replace
Fuel system
Improper fuel injection timing
Repair
Defective fuel injection valve
Clean or replace
Injection OPEN/ CLOSE timing
Improper valve clearance
Adjust
Improper valve OPEN/CLOSE timing
Adjust
Piston
Seiaure likeliness
Replace

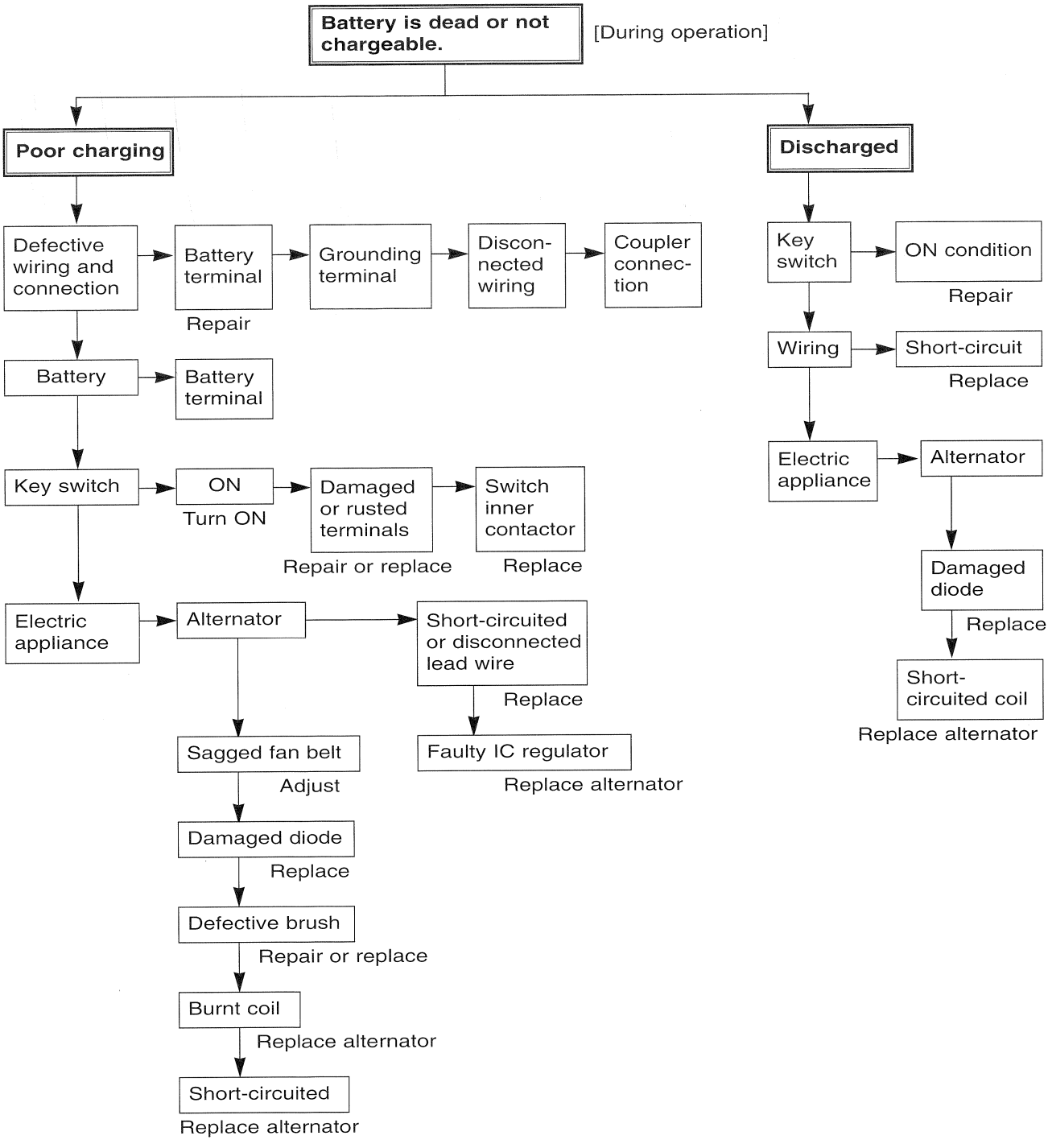

Black smoke is produced.
Driven machine normal?
Hydraulic pressure source
Set relief pressure of control valve
Insufficient output
Refer to "Insufficient output."
Fuel
Improper fuel
Replace
Fuel pump
Too early injection timing
Adjust or replace
Excess injection volume
Adjust
Uneven injection volume
Adjust or replace
Governor
Improper adjustment
Adjust
Malfunction of lever and linkage
Repair or replace


White smoke is produced.
Fuel
Water intrusion in fuel
Replace
Intrusion of low-quality fuel or impurities
Replace
Lube oil
Improper SAE grade
Replace
Excess intake air risistance
Clogged air cleaner
Repair or replace
Clogged intake air pipe
clean or replace
Fuel pump
Too late injection timing
Adjust or replace
Oil pressure drop
Defective valve stem sealing
Replace
Damaged or worn valve stem
Replace
Damaged or worn valve guide
Replace
Breather oil rise
Seizure, breakage, or wear of piston ring
Flaws or wear of piston
Flaws or wear of liner
Leakage through cylinder head gasket
Over-cooling
Thermostat malfunction

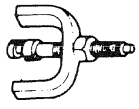
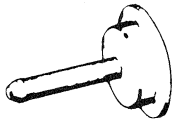
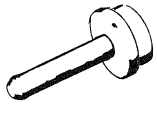
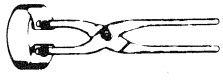


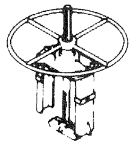
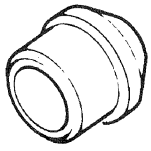
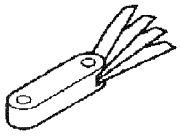
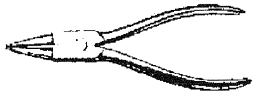
Hydraulic pressure source




Battery is dead or not chargeable.
[During operation]
Poor charging
Discharged
Defective wiring and connection
Battery terminal
Repair
Grounding terminal
Discon-nected wiring
Coupler connec-tion
Battery
Battery terminal
Key switch
ON
Turn ON
Damaged or rusted terminals
Repair or replace
Switch inner contactor
Replace
Electric appliance
Alternator
Short-circuited or disconnected lead wire
Replace
Faulty IC regulator
Replace alternator
Sagged fan belt
Adjust
Damaged diode
Replace
Defective brush
Repair or replace
Burnt coil
Replace alternator
Short-circuited
Replace alternator
Key switch
ON condition
Repair
Wiring
Short-circuit
Replace
Electric appliance
Alternator
Damaged diode
Replace
Short-circuited coil
Replace alternator

8. Special Tool List

No.	Part No.	Figure	Tool Name
1	EU.2-0528		Compression gauge adapter
2	EF.122-249		Valve spring compressor
3	EF.122-265		Crankshaft gear punch
4	EF.122-253		Crankshaft pilot bearing remover
5	EF.122-257		Crankshaft rear oil seal punch
6	EF.122-255		Crankshaft front oil seal punch
7	EF.122-289		Valve stem oil seal installer
8	T7621010E		Piston ring compressor
9	E1.03901-0124	 EA5M8001	Piston sleeve

No.	Part No.	Figure	Tool Name
10	EF.122-259		Cylinder liner remover
11	EF.122-261		Cylinder liner installer
12	T7621010E		Piston ring plier
13	60.99901-0027		Feeler gauge
14	T761-0001E	 EA5M8001	Snap ring plier

Notes

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Part No. 0E6246 **Revision 0 (05/01/03)** **Printed in U.S.A.**