

Shop Manual

ENGINE

82E-6 - 98E-6 SERIES

KOMATSU

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Safety Statements


Komatsu is concerned for your safety and your machine's condition. Safety statements are one of the primary ways to call your attention to the potential hazards associated with Komatsu diesel engine operation. Follow the precautions listed throughout the manual before operation, during operation and during periodic maintenance procedures for your safety, the safety of others and to protect the performance of your engine. Keep the labels from becoming dirty or torn and replace them if they are lost or damaged. Also, if you need to replace a part that has a label attached to it, make sure you order the new part and label at the same time.




This safety alert symbol appears with most safety statements. It means attention, become alert, your safety is involved! Please read and abide by the message that follows the safety alert symbol.


 CAUTION
Caution (the word "CAUTION" is in black letters with a yellow rectangle behind it) – indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
<small>0000001en</small>

CAUTION
Caution without the safety alert symbol indicates a potentially hazardous situation that can cause damage to the machine, personal property and / or the environment or cause the machine to operate improperly.
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 DANGER
Danger (the word "DANGER" is in white letters with a red rectangle behind it) - indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Danger is limited to the most extreme situations.
<small>0000001en</small>

 WARNING
Warning (the word "WARNING" is in black letters with an orange rectangle behind it) – indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
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CAUTION




COOLANT HAZARD!

- Wear eye protection and rubber gloves when you handle long life or extended life engine coolant. If contact with the eyes or skin should occur, flush eyes and wash immediately with clean water.
- Failure to comply may result in minor or moderate injury.

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CAUTION



FLYING OBJECT HAZARD!

- ALWAYS wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.
- Failure to comply may result in minor or moderate injury.


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CAUTION

Be sure to secure the engine solidly to prevent injury or damage to parts due to the engine falling during work on the engine.

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CAUTION



PINCH HAZARD!

Carefully rotate the alternator toward the cylinder block while loosening the V-belt. Failure to comply may result in minor or moderate injury.

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CAUTION

If any oil pump component clearance exceeds its limit, the oil pump must be replaced as an assembly.

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CAUTION

- Only use diesel fuels recommended by Komatsu for the best engine performance, to prevent engine damage and to comply with EPA / ARB warranty requirements.
- Only use clean diesel fuel.
- NEVER remove the primary strainer (if equipped) from the fuel tank filler port. If removed, dirt and debris could get into the fuel system causing it to clog.

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CAUTION

NEVER attempt to adjust the low or high idle speed limit screw. This may impair the safety and performance of the machine and shorten its life. If adjustment is ever required, contact your Komatsu distributor.

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CAUTION

- Do not plug or unplug the E-ECU for a period of at least 6 seconds after power to the unit has been turned on or off.
- Do not touch connector pins of the E-ECU with bare hands.
Doing so may result in corrosion of the connector pins and/or damage to the internal circuits of the E-ECU due to static electricity.
- Do not force a measuring probe into the female coupler.
Doing so may cause contact failure of the connector pins, resulting in malfunction of the E-ECU.
- Take care to prevent water from entering the couplers when plugging or unplugging the connector.
Water inside the couplers may cause corrosion, resulting in malfunction of the E-ECU.
- Avoid plugging/unplugging the connector more than approx. 10 times.
Frequent plugging/unplugging of the connector may cause contact failure of the connector pins, resulting in malfunction of the E-ECU.
- Do not use the E-ECU that has ever suffered drop impact.

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CAUTION

Always check the battery for proper charge.

Otherwise the electronically controlled engines may fail to start.

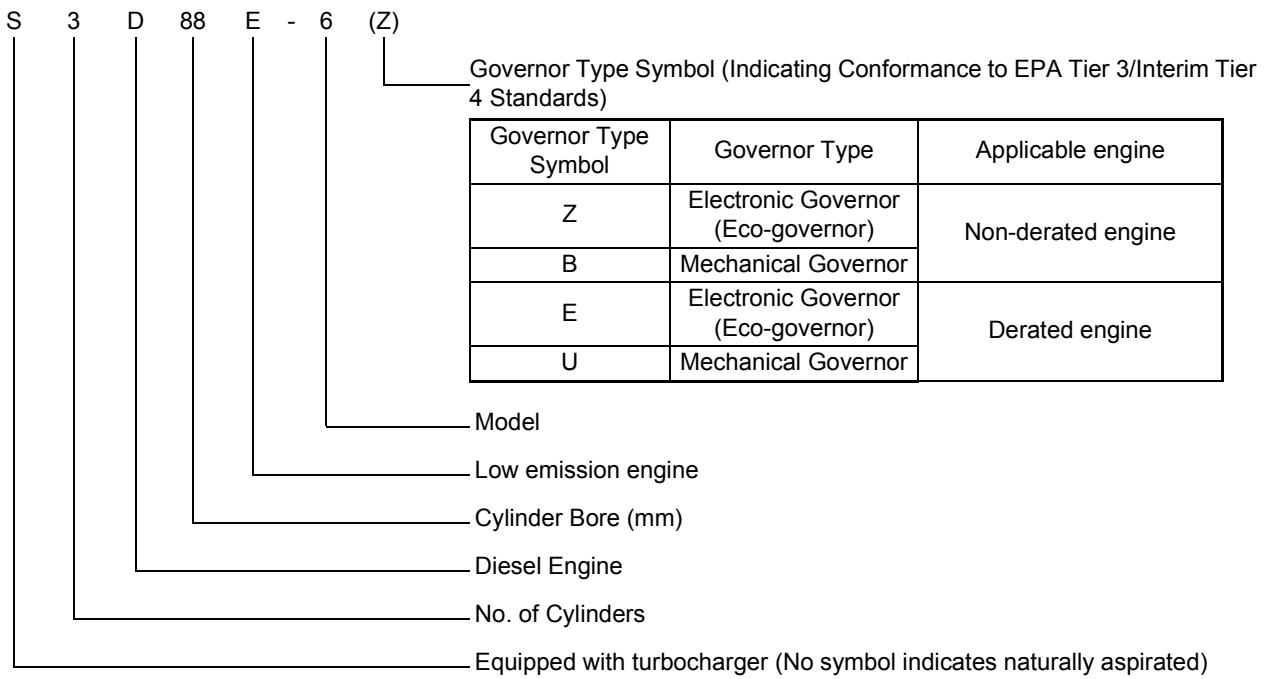
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Function of cooling system components

Components	Functions
Cooling System	The 82E to 98E Series engine is liquid-cooled by means of a cooling system. The cooling system consists of a radiator, radiator cap, engine cooling fan, engine coolant pump, thermostat, and reserve tank. Note that all cooling system components are required for proper engine operation.
Engine Cooling Fan	The engine cooling fan is driven by a V-belt which is powered by the crankshaft V-pulley. The purpose of the engine cooling fan is to circulate air through the radiator.
Engine Coolant Pump	The engine coolant pump circulates the engine coolant through the cylinder block and the cylinder head and returns the engine coolant to the radiator.
Radiator	The radiator acts as a heat exchanger. As the engine coolant circulates through the cylinder block it absorbs heat. The heat in the engine coolant is dissipated in the radiator. As the engine cooling fan circulates air through the radiator, the heat is transferred to the air.
Radiator Cap	The radiator cap controls the cooling system pressure. The cooling system is pressurized to raise the boiling point of the engine coolant. As the engine coolant temperature rises, the system pressure and the coolant volume increases. When the pressure reaches a preset value, the release valve in the radiator cap opens and the excess engine coolant flows into the reserve tank. As the engine coolant temperature is reduced, the system pressure and volume is reduced and the vacuum valve in the radiator cap opens allowing the engine coolant to flow from the reserve tank back into the radiator.
Reserve Tank	The reserve tank contains the overflow of engine coolant from the radiator. If you need to add engine coolant to the system, add it to the reserve tank; not the radiator.
Thermostat	A thermostat is placed in the cooling system to prevent the engine coolant from circulating into the radiator until the engine coolant temperature reaches a preset temperature. When the engine is cold, no engine coolant flows through the radiator. Once the engine reaches its operating temperature, the thermostat opens and allows the engine coolant to flow through the radiator. By letting the engine warm up as quickly as possible, the thermostat reduces engine wear, deposits and emissions.

Specifications

Description of Model Number



Engine speed specifications

Notation	Available Engine Speed	Intended Uses
VH	3200 – 3600 RPM (min ⁻¹)	Lawn Mower, Construction, Industrial Machinery
VM	2000 – 3000 RPM (min ⁻¹)	Agricultural, Construction, Industrial Machinery
CH	3000 or 3600 RPM (min ⁻¹)	2-pole Generator Sets, Irrigation Pumps
CL	1500 or 1800 RPM (min ⁻¹)	4-pole Generator Sets, Irrigation Pumps

VH: Variable High Speed
 VM: Variable Medium Speed

CH: Constant High Speed
 CL: Constant Low Speed

4D98E (– EPA Tier2)

Engine Model	4D98E						
Version	CL			VM			
Type	Vertical In-line Diesel Engine						
Combustion System	Direct Injection						
Aspiration	Natural						
No. of Cylinders	4						
Bore × Stroke	98 × 110mm						
Displacement	3.319L						
Continuous Rated Output	min ⁻¹	1500	1800				
	kW	30.9	36.8				
	PS	42.0	50.0				
Max. Rated Output (Net)	min ⁻¹	1500	1800	2000	2200	2400	2500
	kW	34.6	41.2	41.9	45.6	49.3	51.1
	PS	47.0	56.0	57.0	62.0	67.0	69.5
High Idle	min ⁻¹	1600 ± 25	1895 ± 25	2180 ± 25	2400 ± 25	2590 ± 25	2700 ± 25
Engine Weight (Dry) *with Flywheel Housing	248 kg			235 kg			
PTO Position	Flywheel End						
Direction of Rotation	Counterclockwise Viewed From Flywheel End						
Cooling System	Liquid-Cooled with Radiator						
Lubricating System	Forced Lubrication with Trochoid Pump						
Normal Oil Pressure at Rated Engine Speed	0.29 – 0.39 MPa						
Normal Oil Pressure at Low Idle Speed	0.06 MPa						
Starting System	Electric Starting (Starter Motor: DC12V (2.3 kW)) ***						
	Alternator: DC12V, 40A***						
	Recommended Battery Capacity: 12V, 64Ah*** (5h rating)						
Dimensions (L × W × H)*	719 × 498 × 742 mm						
Engine Oil Pan Capacity**	10.5/6.0L (Dipstick Upper Limit / Lower Limit)						
Engine Coolant Capacity	4.2L Engine Only						
Standard Cooling Fan	410mm O.D., 6 Blade Pusher-Type ***						
Crank V-pulley dia./ Fan V-pulley dia.	φ130/ φ130mm ***						

* Engine specifications without radiator.

** Engine oil capacity for a "Deep Standard" oil pan. Refer to the operation manual for the actual engine oil capacity of your machine.

*** May vary depending on application.

4D98E-Z (complies with EPA Interim Tier4)

Engine Model		4D98E-Z							
Version		CL			VM				
Type		Vertical, 4-cycle water-cooled diesel engine							
Combustion System		Direct Injection							
Aspiration		Natural aspiration							
No. of Cylinders		4							
Bore × Stroke		98 × 110mm							
Displacement		3.319L							
Continuous Rated Output	min ⁻¹	1500	1800						
	kW	30.9	36.8						
	PS	42.0	50.0						
Max. Rated Output (Net)	min ⁻¹	1500	1800	2000	2100	2200	2300	2400	2500
	kW	34.6	41.2	41.9	43.8	45.6	47.4	49.3	51.1
	PS	47.0	56.0	57.0	59.5	62.0	64.5	67.0	69.5
High Idle	min ⁻¹	1530 ± 25	1830 ± 25	2150 ± 25	2250 ± 25	2350 ± 25	2450 ± 25	2550 ± 25	2650 ± 25
Engine Weight (dry) *with Flywheel Housing		248kg			235kg				
PTO Position		Flywheel End							
Direction of Rotation		Counterclockwise Viewed From Flywheel End							
Governor		Electronic governor (All-speed governor)							
Cooling System		Liquid-Cooled with Radiator							
Lubricating System		Forced Lubrication with Trochoid Pump							
Normal Oil Pressure	Rated Engine Speed	0.29-0.39 (3.0-4.0) MPa							
	Low Idle Speed	0.06 (0.6) MPa							
Starting System		Electric Starting (Starter Motor: DC12V (2.3kW)) ***							
Charging system		Alternator (DC12V/40A) ***							
Recommended Battery Capacity		12V-64Ah*** (5h rating)							
Starting aid device		Air heater (12VDC/500W)							
Dimensions (L × W × H)*		719 × 540 × 721mm							
Engine Oil Pan Capacity**		10.2L/5.7L (Dipstick Upper Limit / Lower Limit)							
Engine Coolant Capacity		4.2L Engine Only							
Standard Cooling Fan		Resin F type pusher fan – φ410(AI) x 6							
Crank V-pulley dia./ Fan V-pulley dia.		φ130/ φ130mm							

* Engine specifications without radiator.

** Engine oil capacity for a "Deep Standard" oil pan. Refer to the operation manual for the actual engine oil capacity of your machine.

*** May vary depending on application.

Every 2000 hours of operation..... 5-41

CAUTION

- Only use the engine coolant specified. Other engine coolants may affect warranty coverage, cause an internal buildup of rust and scale and / or shorten engine life.
- Prevent dirt and debris from contaminating the engine coolant. Carefully clean the radiator cap and the surrounding area before you remove the cap.
- NEVER mix different types of engine coolants. This may adversely affect the properties of the engine coolant.

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CAUTION

- NEVER attempt to modify the engine's design or safety features such as defeating the engine speed limit control or the diesel fuel injection quantity control.
- Modifications may impair the engine's safety and performance characteristics and shorten the engine's life. Any alterations to this engine may void its warranty. Be sure to use Komatsu genuine replacement parts.

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CAUTION

Observe the following environmental operating conditions to maintain engine performance and avoid premature engine wear:

- Avoid operating in extremely dusty conditions.
- Avoid operating in the presence of chemical gases or fumes.
- Avoid operating in a corrosive atmosphere such as salt water spray.
- NEVER install the engine in a floodplain unless proper precautions are taken to avoid being subject to a flood.
- NEVER expose the engine to the rain.

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CAUTION

Observe the following environmental operating conditions to maintain engine performance and avoid premature engine wear:

- The standard range of ambient temperatures for the normal operation of Komatsu engines is from +5°F (-15°C) to +113°F (+45°C).
- If the ambient temperature exceeds +113°F (+45°C) the engine may overheat and cause the engine oil to break down.
- If the ambient temperature is below +5°F (-15°C) the engine will be hard to start and the engine oil may not flow easily.
- Contact your Komatsu distributor if the engine will be operated outside of this standard temperature range.

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Engine Oil Filter Part No.		
	Standard	Dust proof *
3D82AE – 4D98E, 3D82AE-B – S4D98E-Z	YM129150- 35153	YM119005- 35151
S4D98E, S4D98E-Z	YM119005- 35151	

* Consult the operation manual for the driven machine for applicability of the dust proof filter.

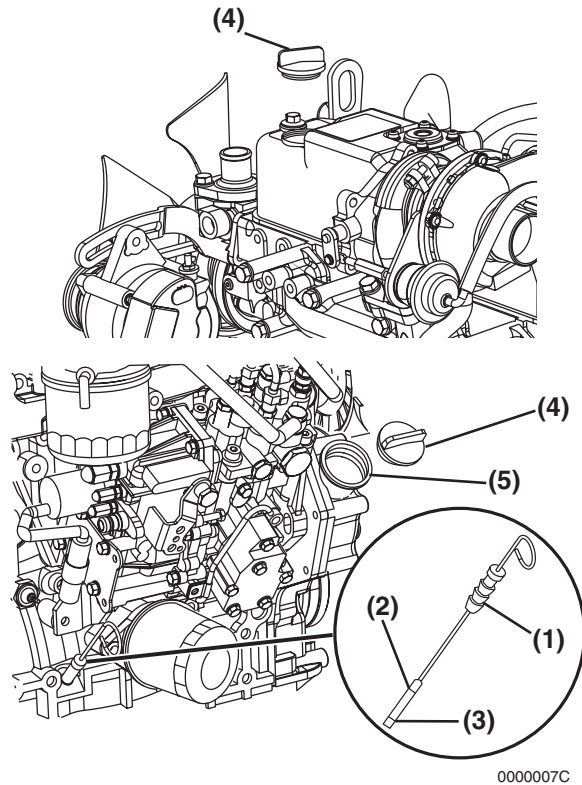
4. Add new engine oil to the engine as specified in Adding engine oil on page 4-14.

CAUTION

- NEVER overfill the engine with engine oil.
- ALWAYS keep the oil level between the upper and lower lines on the oil cap / dipstick.

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5. Warm up the engine by running it for five minutes and check for any engine oil leaks.
6. After engine is warm, shut it off and let it sit for 10 minutes.
7. Recheck the engine oil level.
8. Add engine oil (**Figure 5-3, (5)**) as needed until the level is between the upper (**Figure 5-3, (2)**) and lower lines (**Figure 5-3, (3)**) shown on the dipstick (**Figure 5-3, (1)**).



0000007C

Figure 5-3

9. Reinstall the oil filler cap (**Figure 5-3, (4)**). If any engine oil is spilled, wipe it away with a clean cloth.

Check and adjust cooling fan V-Belt

The V-belt will slip if it does not have the proper tension. This will prevent the alternator from generating sufficient power. Also, the engine will overheat due to the engine coolant pump pulley slipping.

Check and adjust the V-belt tension (deflection) as follows:

1. Press the V-belt down with your thumb with a force of approximately 22 ft·lb (98 N·m; 10 kgf) to check the deflection.

There are three positions to check for V-belt tension (**Figure 5-4, (A), (B) and (C)**). You can check the tension at whichever position is the most accessible. The proper deflection of a used V-belt at each position is:

6. Replace the element with a new one if the element is damaged, excessively dirty or oily.
7. Clean inside of the air cleaner cover.
8. Install the element into the air cleaner case (**Figure 5-12, (4)**).
9. Reinstall the air cleaner cover making sure you match the arrow (**Figure 5-12, (5)**) on the cover with the arrow on the case (**Figure 5-12, (6)**).
10. Latch the air cleaner cover to the case.

CAUTION

- When the engine is operated in dusty conditions, clean the air cleaner element more frequently.
- NEVER operate the engine with the air cleaner element(s) removed. This may allow foreign material to enter the engine and damage it.

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Every 500 hours of operation

Perform the following maintenance every 500 hours of operation.

- Replace Air Cleaner Element
- Replace Fuel Filter
- Clean Fuel Filter / Water Separator

Replace Air Cleaner Element

CAUTION

The maximum air intake restriction, in terms of differential pressure measurement, must not exceed 0.90 psi (6.23 kPa; 635 mmAq). Clean or replace the air cleaner element if the air intake restriction exceeds the above mentioned value.

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Replace the air cleaner element (**Figure 5-12, (2)**) every 500 hours even if it is not damaged or dirty.

When replacing the element, clean the inside of the air cleaner case (**Figure 5-12, (4)**).

If the air cleaner is equipped with a double element, only remove and replace the inner element (**Figure 5-13, (1)**) if the engine lacks power or the dust indicator actuates (if equipped). This is in addition to replacing the outer element.

KOMATSU 82E-6 – 98E-6 Series engine

Form No. SEN04218-00

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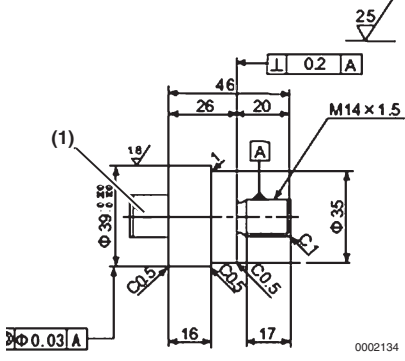
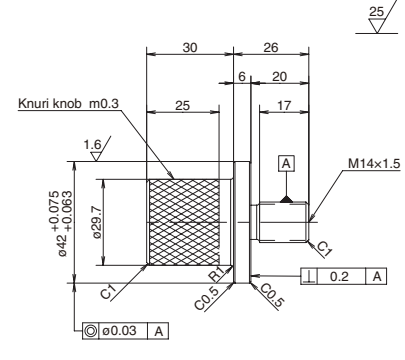
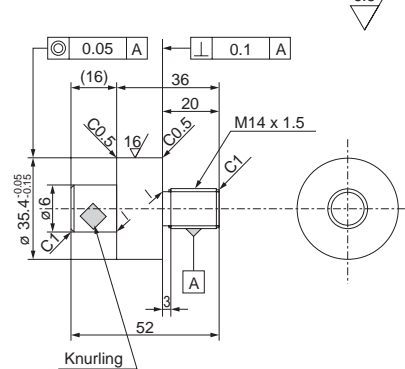
Valve spring

Inspection Item	Model	Standard	Limit	Reference Page
Free Length	3D82AE (2-Valve Head)	1.7480 in. (44.4 mm)	1.7283 in. (43.9 mm)	See Inspection of valve springs on page 6-43 and 6-59.
	4D84E, 3D84E, S3D84E, 4D88E (2-Valve Head)	1.6535 in. (42.0 mm)	1.6339 in. (41.5 mm)	
	S4D84E (4-Valve Head)	1.4724 in. (37.4 mm)	1.4528 in. (36.9 mm)	
	4D94LE, 4D98E, S4D98E (4-Valve Head)	1.5630 in. (39.7 mm)	1.5433 in. (39.2 mm)	
Squareness	3D82AE (2-Valve Head)	-	0.0551 in. (1.4 mm)	
	4D84E, 3D84E, S3D84E, 4D88E (2-Valve Head)	-	0.0551 in. (1.4 mm)	
	S4D84E (4-Valve Head)	-	0.0551 in. (1.3 mm)	
	4D94LE, 4D98E, S4D98E (4-Valve Head)	-	0.0551 in. (1.4 mm)	

(Piston ring Cont.)

Model	Inspection Item		Standard	Limit	Reference Page
4D94LE, 4D98E, S4D98E	Top Ring	Ring Groove Width	0.0803 – 0.0811 in. (2.040 – 2.060 mm)	-	See Inspection of pistons, piston rings and wrist pin on page 6-82.
		Ring Width	0.0764 – 0.0772 in. (1.940 – 1.960 mm)	0.0756 in. (1.920 mm)	
		Side Clearance	0.0031 – 0.0047 in. (0.080 – 0.120 mm)	-	
		End Gap	0.0098 – 0.0177 in. (0.250 – 0.450 mm)	0.0213 in. (0.540 mm)	
	Second Ring	Ring Groove Width	0.0819 – 0.0825 in. (2.080 – 2.095 mm)	0.0864 in. (2.195 mm)	
		Ring Width	0.0776 – 0.0783 in. (1.970 – 1.990 mm)	0.0768 in. (1.950 mm)	
		Side Clearance	0.0035 – 0.0049 in. (0.090 – 0.125 mm)	0.0096 in. (0.245 mm)	
		End Gap	0.0177 – 0.0256 in. (0.450 – 0.650 mm)	0.0287 in. (0.730 mm)	
	Oil Ring	Ring Groove Width	0.1187 – 0.1193 in. (3.015 – 3.030 mm)	0.1232 in. (3.130 mm)	
		Ring Width	0.1169 – 0.1177 in. (2.970 – 2.990 mm)	0.1161 in. (2.950 mm)	
		Side Clearance	0.0010 – 0.0024 in. (0.025 – 0.060 mm)	0.0071 in. (0.180 mm)	
		End Gap	0.0098 – 0.0177 in. (0.250 – 0.450 mm)	0.0217 in. (0.550 mm)	

(Special service tools Cont.)

No.	Tool Name	Applicable Model and Tool Size		Illustration
12	Crankshaft Pulley Installing Tool (For taper pilot)	Locally Manufactured (4D94LE, (S)4D98E series) (Knurl knob (1))		
13	Crankshaft Pulley Installing Tool (For straight pilot)	Locally Manufactured (4D94LE, (S)4D98E series)		
14	Pulley Installing Tool	3D82AE – 4D88E For all series		

CAUTION

Any part determined not to meet the service standard or limit before the next service, as determined from the state of current rate of wear, should be replaced even though the part currently meets the service standard limit.

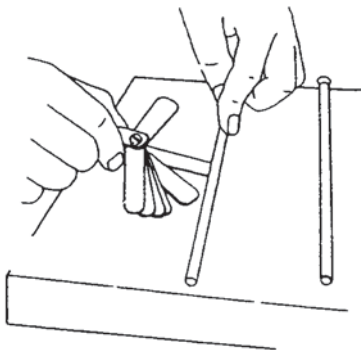
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Inspection of push rods

Push rod bend

Determine if the bend of the push rods are within the specified limit.

1. Place the push rods on a flat inspection block or layout bed.
2. Roll the push rods until a gap can be observed between a portion of the push rod and the surface of the block or layout bed.
3. Use a feeler gauge to measure the gap (**Figure 6-15**). See Push rod on page 6-9 for the service limit.



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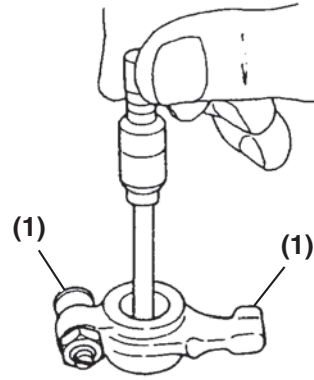
Figure 6-15

Inspection of rocker arm assembly

Rocker arm shaft hole diameter

Use a test indicator and micrometer to determine if the inside diameter of all the rocker arm support brackets and the rocker arms (**Figure 6-16**) are within the specified limits. See Rocker arm and shaft on page 6-9 for the service limit.

Inspect the contact areas (**Figure 6-16, (1)**) for excessive wear or damage.

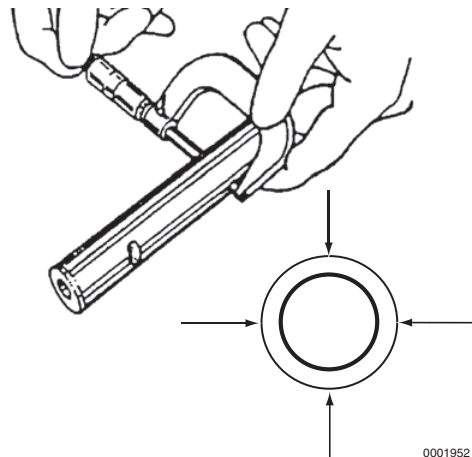


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Figure 6-16

Rocker arm shaft outside diameter

Use a micrometer to measure the rocker arm shaft diameter. Measure at each rocker arm location in two directions 90° apart (**Figure 6-17**). See Rocker arm and shaft on page 6-9 for the service limit.



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Figure 6-17

Inspection of valve guides

Visually inspect the valve guides for distortions, scoring or other damage.

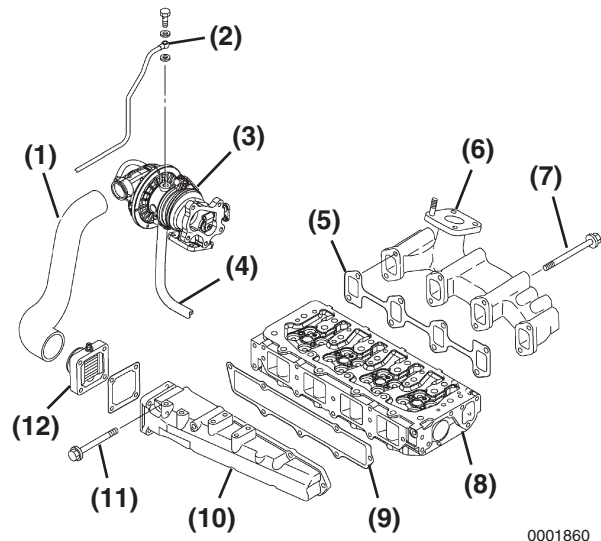
Note: Measure the valve guides while they are installed in the cylinder head.

CAUTION

Remove or install the high-pressure fuel injection lines as an assembly whenever possible. Disassembling the high-pressure fuel injection lines from the retainers or bending any of the fuel lines will make it difficult to reinstall the fuel lines.

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3. Disconnect the fuel return hose (**Figure 6-40, (2)**) from the cylinder head.
4. Disconnect the hoses (**Figure 6-40, (3)**) from the cold start device on the fuel injection pump. This cooling water pipe is not used in electronically controlled engines S4D84E-Z, 4D98E-Z, 4D98E-E and S4D98E-Z. Instead, these engines use a solenoid valve and connecting coupler but, when removing the cylinder head only, it is not necessary to remove the connecting coupler.
5. Remove the turbocharger-to-intake manifold hose (**Figure 6-41, (1)**) (if equipped).
6. Disconnect the electrical wire from the intake air heater (**Figure 6-41, (12)**).
7. Remove the intake manifold bolts (**Figure 6-41, (11)**). Remove the intake manifold (**Figure 6-41, (10)**). Discard the intake manifold gasket (**Figure 6-41, (9)**).
8. Disconnect the turbocharger oil supply (**Figure 6-41, (2)**) and the return lines (**Figure 6-41, (4)**) (if equipped).
9. Remove the exhaust manifold bolts (**Figure 6-41, (7)**). Remove the exhaust manifold (**Figure 6-41, (6)**) with the turbocharger attached. Discard the exhaust manifold gasket. (**Figure 6-41, (5)**).



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Figure 6-41

10. Remove the engine coolant pump. See Disassembly of engine coolant pump on page 8-10.

Reassembly of cylinder head

Use new gaskets, O-rings, and seals on reassembly of the cylinder head.

IMPORTANT

Liberalily oil all components during reassembly to prevent premature wear or damage.

Reassembly of valve guides

1. The valve guides are installed into the cylinder head with an extremely tight press fit. Before installing the valve guides, place the valve guides in a freezer for at least twenty minutes. This will cause the valve guides to contract, making it easier to install the valve guides into place.
2. Immediately after removing the valve guides from the freezer, insert the valve guides (Figure 6-65, (1)) in their proper positions.

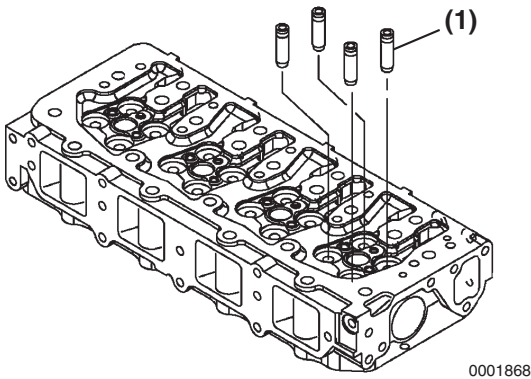


Figure 6-65

3. Finish installing the valve guides (Figure 6-66, (1)) into the cylinder head to the proper height (Figure 6-66, (3)) using the valve guide installation tool (Figure 6-66, (2)). See Intake / exhaust valve and guide on page 6-7.

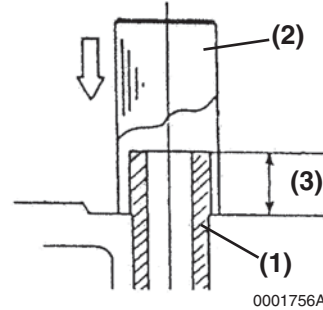


Figure 6-66

Reassembly of intake and exhaust valves

IMPORTANT

When installing valve stem seals, use new ones instead of reusing removed seals.

Exhaust valve and intake valve stem seals are different. They can be distinguished based on the paint marks on the outer side of the seal or the color of the seal spring (Figure 6-67, (4)). When installing each stem seal, take care to correctly position it.

Engine Model	Marking	
	Intake	Exhaust
4D84E	White (Seal Spring)	Black (Seal Spring)
4D94LE, 4D98E, S4D98E	None	Black (Seal Spring)

1. Oil the lip of the valve stem seal (Figure 6-67, (2)). Using the valve stem seal installation tool (Figure 6-67, (1)), install a new valve stem seal on each of the valve guides (Figure 6-67, (3)).

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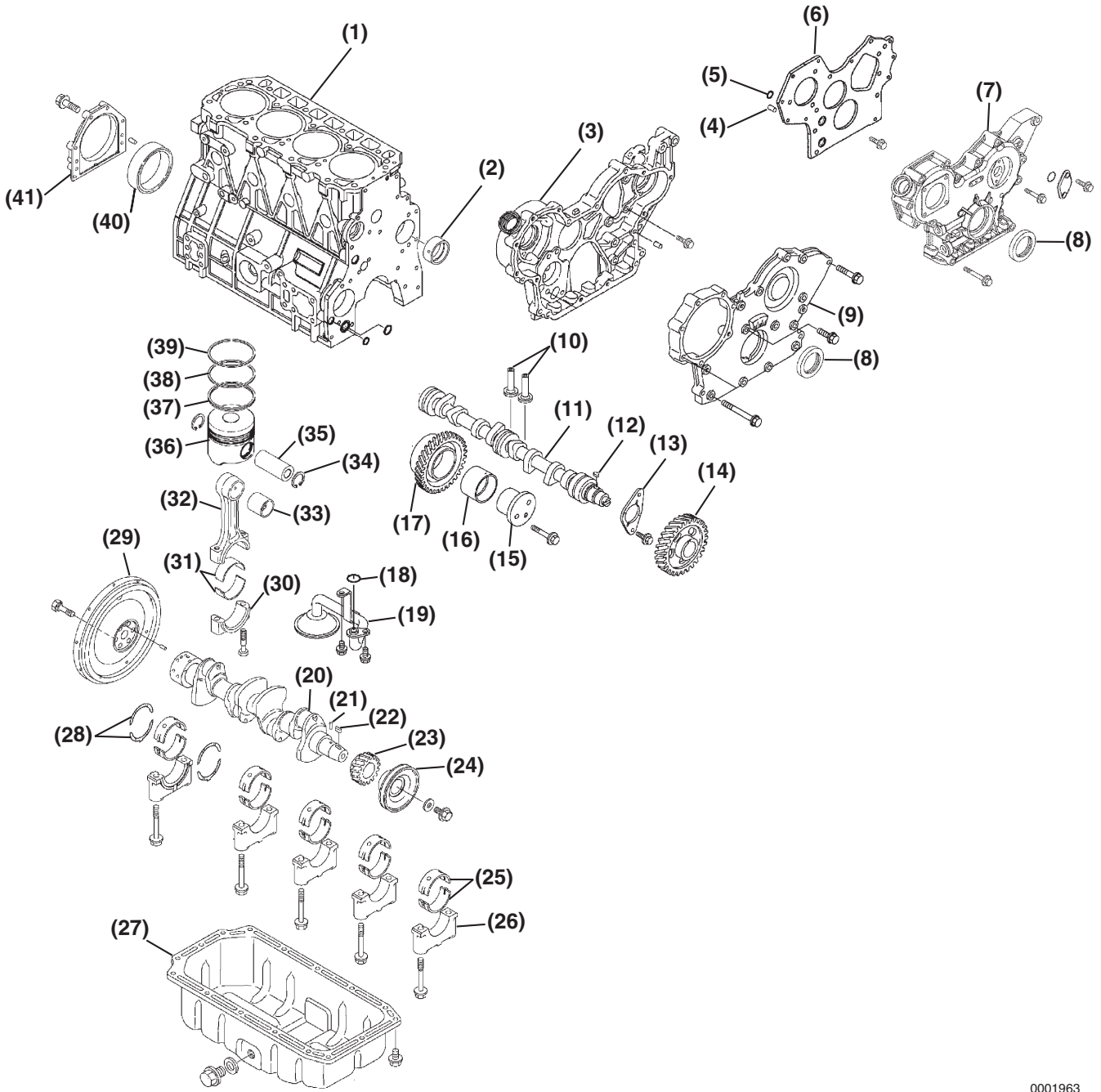
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Crankshaft and camshaft components



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Figure 6-87

4. Remove the main bearing caps (**Figure 6-107, (3)**). Be sure to note the markings on the main bearing caps, or mark them yourself, so they can be reinstalled in the same order as they were removed. Do not remove the bearing inserts at this time.

Note: The “arrows” on the main bearing caps point to the flywheel end of the engine.

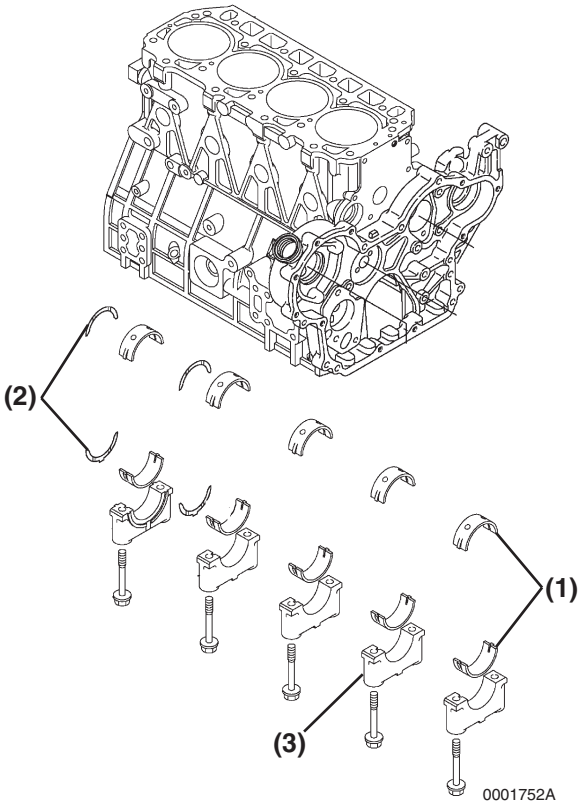


Figure 6-107

5. Measure bearing oil clearance prior to removing the crankshaft to determine extent of wear. Record the measurements.
 - (a) Wipe oil from the bearing insert and crankshaft journal surfaces.
 - (b) Place a piece of PLASTIGAGE (**Figure 6-108, (1)**) along the full width of each bearing insert.

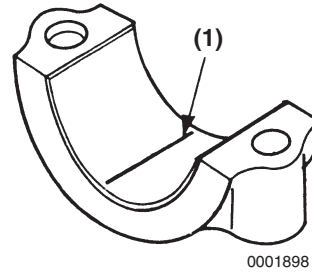


Figure 6-108

IMPORTANT

Do not rotate the crankshaft when using PLASTIGAGE. A false reading may result.

- (c) Reinstall bearing caps and tighten to specification. See Special torque chart on page 6-24.
- (d) Remove bearing caps.
- (e) Compare the width of the flattened PLASTIGAGE to the graduation marks on the package (**Figure 6-109, (1)**). The mark that most closely matches the width of the flattened PLASTIGAGE will indicate the bearing oil clearance.

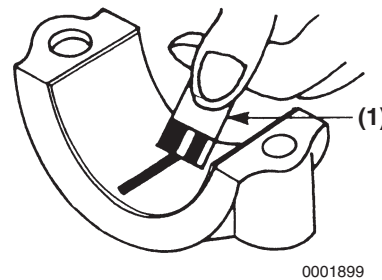


Figure 6-109

6. Remove the crankshaft from the engine.
7. Remove the bearing inserts (**Figure 6-107, (1)**) and thrust bearings (**Figure 6-107, (2)**).

Note: Do not remove the crankshaft gear unless the gear or crankshaft are damaged and require replacement.

1. Lubricate and reinstall the wrist pin (Figure 6-133, (3)) through the piston and connecting rod.
2. Reinstall the second circlip (Figure 6-133, (4)) and ensure it is securely seated in the groove.

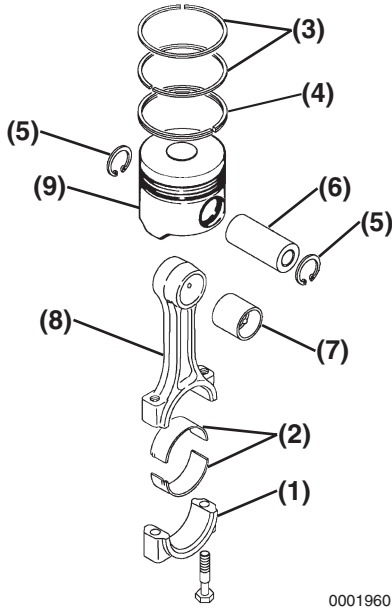


Figure 6-133

0001960

Note: If installing new piston rings the end gap must be checked and adjusted as necessary. See Inspection of pistons, piston rings and wrist pin on page 6-82 for specifications. Use a piston ring end gap filing tool to adjust the piston ring end gap on new piston rings.

Note: Reinstall the top and second piston rings with the stamped “makers mark” (Figure 6-134, (1)) facing the top of the piston. The “makers mark” may vary in appearance but will always be located on the top surface of the piston ring adjacent to the piston ring gap. The oil ring and oil ring expander can be installed either side up.

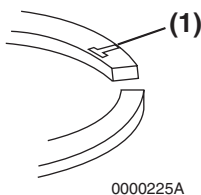


Figure 6-134

0000225A

IMPORTANT

Always use a piston ring installation tool (expander) when installing piston rings. Never attempt to install piston rings by hand.

3. Reinstall the oil ring expander (Figure 6-135, (4)). Reinstall the oil ring (Figure 6-135, (3)) with the end gap at 180° from the expander end gap.
4. Reinstall the second compression ring (Figure 6-135, (2)). This ring is identified by its dark color and tapered face profile.
5. Reinstall the top compression ring (Figure 6-135, (1)). This ring is identified by its silver color and barrel-shaped face profile.

IMPORTANT

The oil ring expander (Figure 6-135, (4)) end gap must be located 180° from the oil ring (Figure 6-135, (3)) end gap.

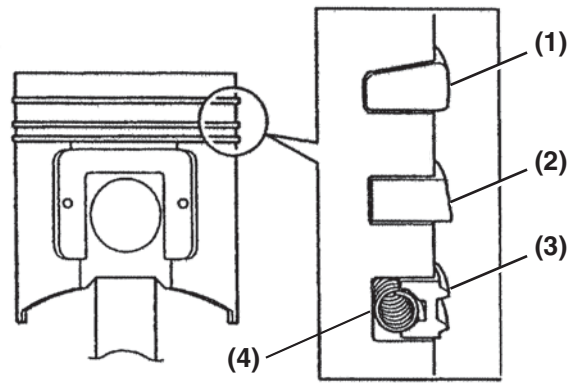






Figure 6-135



0001722B

6. Stagger the piston ring end gaps at 120° intervals (Figure 6-136, (1, 2, 3)). Do not position the top piston ring end gap in line with the wrist pin.

EGR system

 DANGER

<p style="text-align: center;">SCALD HAZARD!</p> <ul style="list-style-type: none"> • NEVER remove the radiator cap if the engine is hot. Steam and hot engine coolant will spurt out and seriously burn you. Allow the engine to cool down before you attempt to remove the radiator cap. • Tighten the radiator cap securely after you check the radiator. Steam can spurt out during engine operation if the cap is loose. • ALWAYS check the level of the engine coolant by observing the reserve tank. • Failure to comply will result in death or serious injury. <p style="text-align: right;"><small>000002en</small></p>

 WARNING

<p style="text-align: center;">BURN HAZARD!</p> <ul style="list-style-type: none"> • Keep your hands and other body parts away from hot engine surfaces such as the muffler, exhaust pipe, turbocharger (if equipped) and engine block during operation and shortly after you shut the engine down. These surfaces are extremely hot while the engine is operating and could seriously burn you. • Failure to comply could result in death or serious injury. <p style="text-align: right;"><small>0000015en</small></p>

 WARNING

<p style="text-align: center;">ENTANGLEMENT HAZARD!</p> <ul style="list-style-type: none"> • Stop the engine before you begin to service it. • NEVER leave the key in the key switch when you are servicing the engine. Someone may accidentally start the engine and not realize you are servicing it. This could result in a serious injury. • If you must service the engine while it is operating, remove all jewelry, tie back long hair, and keep your hands, other body parts and clothing away from moving / rotating parts. • Failure to comply could result in death or serious injury. <p style="text-align: right;"><small>0000010en</small></p>

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Test and adjustment specifications

Model	Engine Class	Injector ID mark*	Fuel Injector Pressure	Fuel Injection Timing
3D82AE – 4D88E	CL	W	2843 – 2988 psi (19.6 – 20.6 MPa; 200 – 210 kgf/cm ²)	See Checking and adjusting fuel injection timing on page 7-30
3D82AE – 4D88E S3D84E – S4D84E	VM	W**	2843 – 2988 psi (19.6 – 20.6 MPa; 200 – 210 kgf/cm ²)	
		or	or	
		V**	3133 – 3278 psi (21.6 – 22.6 MPa; 220 – 230 kgf/cm ²)	
4D94LE – 4D98E S4D98E	CL VM	V	3133 – 3278 psi (21.6 – 22.6 MPa; 220 – 230 kgf/cm ²)	

Note: Fuel injection pressure of a new fuel injector is reduced approximately 72.5 psi (0.5 MPa; 5.0 kgf/cm²) after about 5 hours of operation due to the initial break in of the engine. When adjusting a new fuel injector or after it has been disassembled for service, adjust the fuel injector 72.5 psi (0.5 MPa; 5.0 kgf/cm²) higher than the above standard.

Note: All fuel injectors have a three character identification mark (**Figure 7-3, (1)**). The first character starts with “V” or “W”.

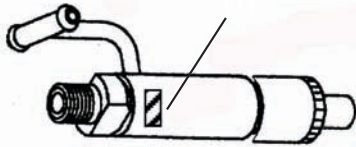


Figure 7-3

** Fuel injector identification is critical as each engine has a unique fuel injection pressure. The fuel nozzle is specifically matched to the fuel injector by engine model and / or engine speed.

- On 94E – 98E model engines, the idler gear is visible. Make a reference mark **(Figure 7-15, (1))** across both the fuel injection pump drive gear and the idler gear.

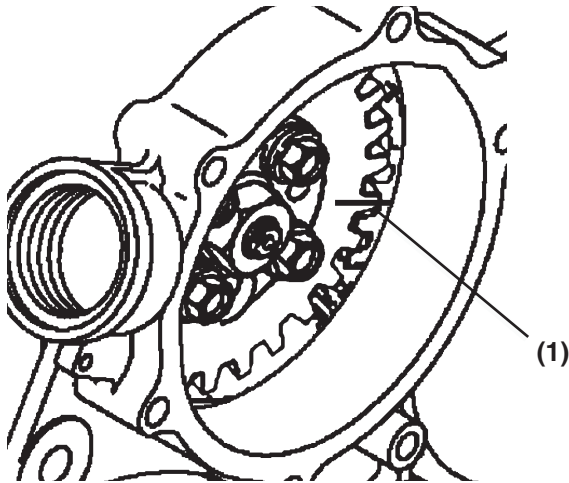


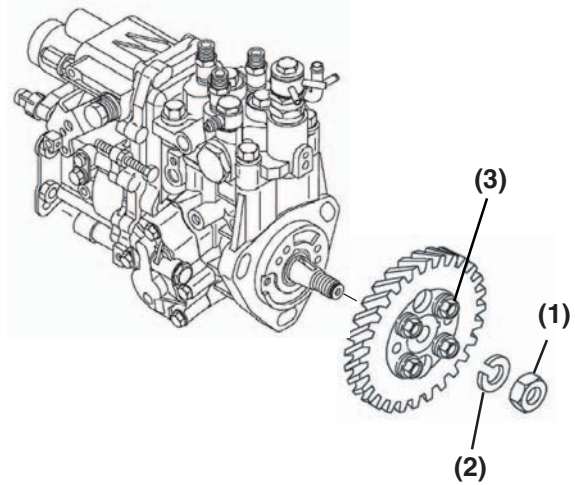
Figure 7-15

CAUTION

Do not loosen or remove the four bolts retaining the fuel injection pump drive gear to the fuel injection pump hub. Do not disassemble the fuel injection pump drive gear from the hub. Correct fuel injection timing will be very difficult or impossible to achieve.

0000031en

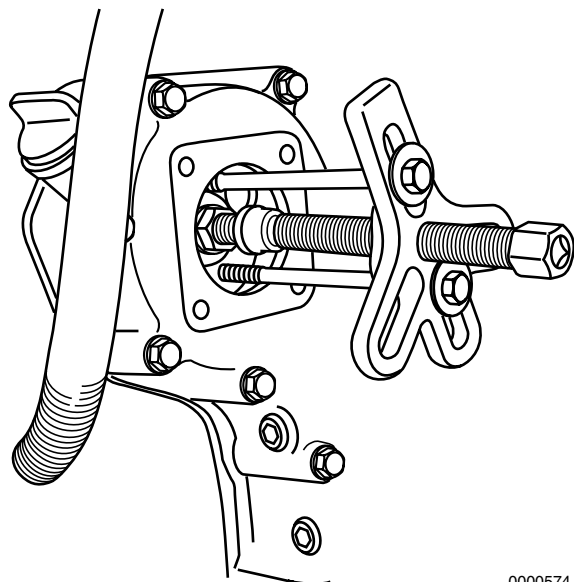
- Do not loosen or remove the four bolts **(Figure 7-16, (3))** retaining the pump drive gear to the hub. Only remove the single drive gear nut **(Figure 7-16, (1))** and washer **(Figure 7-16, (2))**, leaving the hub attached to the gear.



0000162A

Figure 7-16

- Hold the gear train using a large socket wrench on the crankshaft pulley nut. Loosen the fuel injection pump drive gear retaining nut **(Figure 7-16, (1))** and turn it out to the end of the fuel injection pump shaft.
- Remove the pump drive gear and hub as an assembly using an appropriate two-bolt gear puller **(Figure 7-17)**.



0000574

Figure 7-17

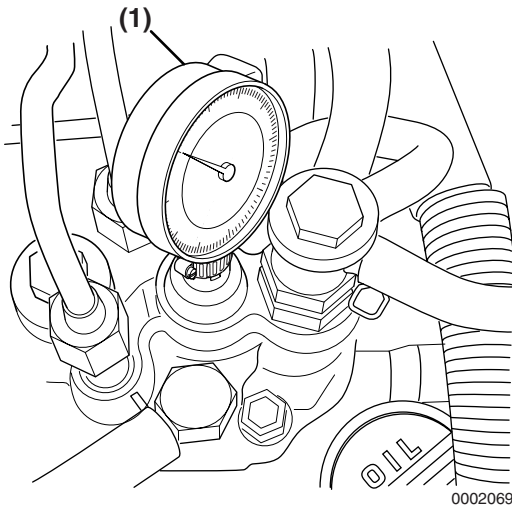


Figure 7-40

Note: The following references to the direction-of-rotation are facing the coolant pump end of the engine and are adjusted by turning the crankshaft pulley.

- Using a wrench on the crankshaft pulley bolt, rotate the crankshaft in a clockwise direction while looking through the flywheel inspection port (**Figure 7-41, (1)**). Rotate the crankshaft until the injection timing marks on the flywheel are visible.

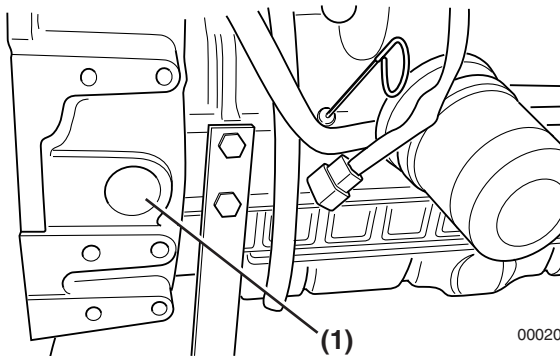
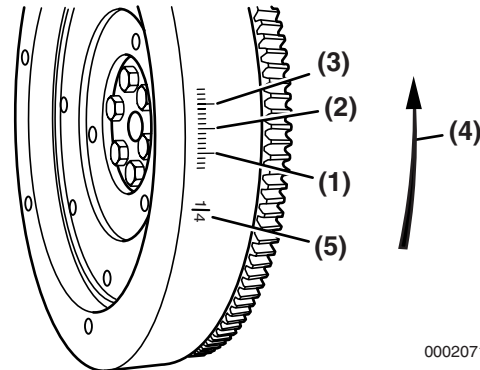


Figure 7-41

- Typical flywheel markings are as shown in (**Figure 7-42, (1)**).

Note: A typical flywheel will have multiple timing grids depending on the number of cylinders. Any grid can be used to check the fuel injection timing.

The flywheel shown in **Figure 7-42** is for 82E – 98E “Standard Specification” DI engine. Flywheels used on some DI engines may be marked differently.



- 1 – 10° BTDC (Before Top Dead Center)**
- 2 – 15° BTDC**
- 3 – 20° BTDC**
- 4 – Direction of Rotation**
- 5 – TDC (Top Dead Center)**

Figure 7-42

Note: The TDC (Top Dead Center) mark can be identified by the cylinder numbers stamped near the TDC mark on the flywheel.

If you are uncertain as to the timing degree designation of the timing marks on the flywheel timing grid, you can determine the timing degree designation by measuring the timing grid.

- First measure the distance between two of the “longer” marks on the timing grid. (They are 5° apart.) Then measure the distance from the TDC mark to the first “longer” mark on the timing grid. Divide that measurement by the distance between the two “longer” marks. The resulting answer will tell you how many degrees there are between the TDC mark and the first “longer” mark.

Installation of the fuel injectors

2-valve cylinder head

1. Reinsert a new nozzle seat (**Figure 7-58, (4)**) and nozzle protector (**Figure 7-58, (3)**) in the cylinder head for each injector.
2. Reinsert each fuel injector into the cylinder head.
3. Reinstall the fuel injector retainers (**Figure 7-58, (2)**) and torque the retaining bolts to specification.
4. Reinstall the fuel return hoses (**Figure 7-58, (1)**), one on each side of each injector.
5. Reinstall the fuel high-pressure fuel line assembly and tighten the nuts using a "line" or "flare nut" wrench.

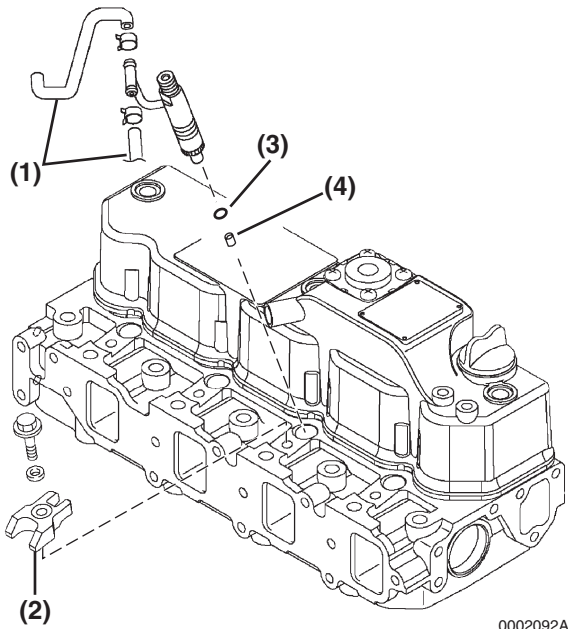


Figure 7-58

6. Prime the fuel system. See Priming the fuel system on page 4-12.
7. Operate the engine and check for fuel and coolant leaks.

4-valve cylinder head

1. Reinsert a new nozzle seat (**Figure 7-59, (6)**) and nozzle protector (**Figure 7-59, (5)**) in the cylinder head for each injector.
2. Reinstall an O-ring on to each injector body.
3. Reinsert each fuel injector (**Figure 7-59, (4)**) into the cylinder head.
4. Reinstall the fuel injector retainers (**Figure 7-59, (3)**) and torque the retaining bolts (**Figure 7-59, (2)**) to specification.
5. Reinstall the fuel injector return line assembly using new gaskets on each side of the injector line screws.
6. Reinstall the fuel high-pressure fuel lines to each injector and tighten the nuts using a "line" or "flare nut" wrench.

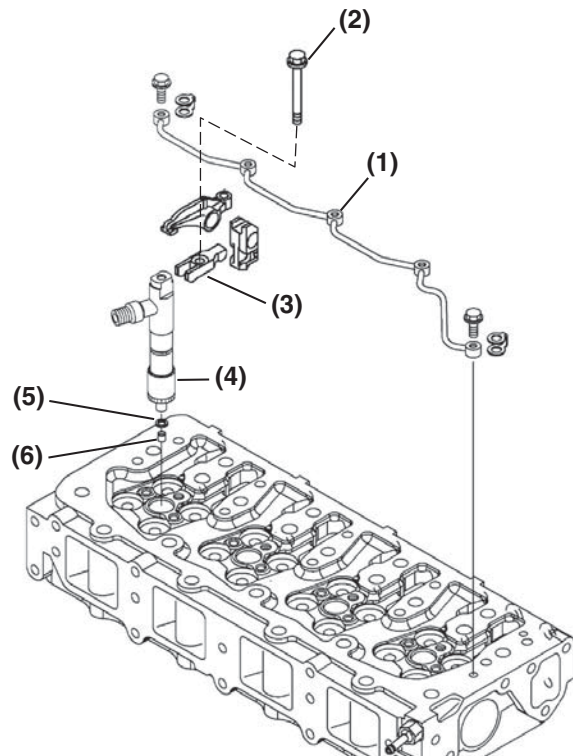


Figure 7-59

7. Prime the fuel system. See Priming the fuel system on page 4-12.
8. Operate the engine and check for fuel and coolant leaks.

Engine coolant system check

Check the engine coolant system for leakage.

1. With the radiator properly filled, install a cooling system tester (**Figure 8-3, (1)**).

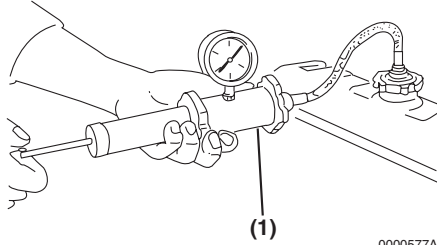


Figure 8-3

0000577A

2. Apply 10.8 – 14.8 psi (75 – 105 kPa; 0.75 – 1.05 kgf/cm²) to the cooling system. If the pressure reading drops, the engine coolant system is leaking. Identify the source of the leak and repair it.

Engine coolant pump

Removal of engine coolant pump

Verify the condition of the engine coolant pump before disassembling it from the engine. Check the engine coolant pump shaft bearing for abnormal noise, sticking, excessive play and water leakage. Replace the coolant pump if any of these conditions are present.

CAUTION

If the engine coolant pump must be replaced, replace the engine coolant pump as an assembly only. Do not attempt to repair the engine coolant pump or replace individual components.

0000041en

IMPORTANT

Make sure the engine and engine coolant are not hot.

1. Before removing the engine coolant pump or thermostat, it will be necessary to drain the engine coolant. Drain the coolant into a clean container if the coolant is to be reused. Otherwise, properly dispose of the coolant.
2. Remove the radiator cap (**Figure 8-4, (1)**).
3. Remove the drain plug or open the drain cock (**Figure 8-4, (1)**) at the lower portion of the radiator and drain the coolant.

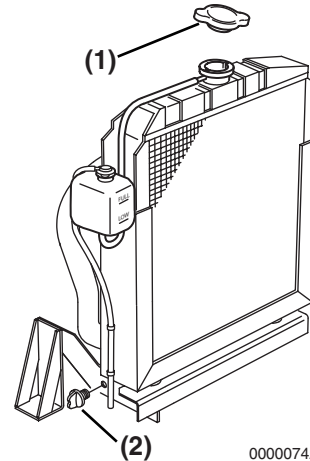


Figure 8-4

0000074A

4. Drain the coolant from the engine block.
 - On models equipped with an oil cooler, remove the coolant hose (**Figure 8-5, (1)**) at the oil cooler.

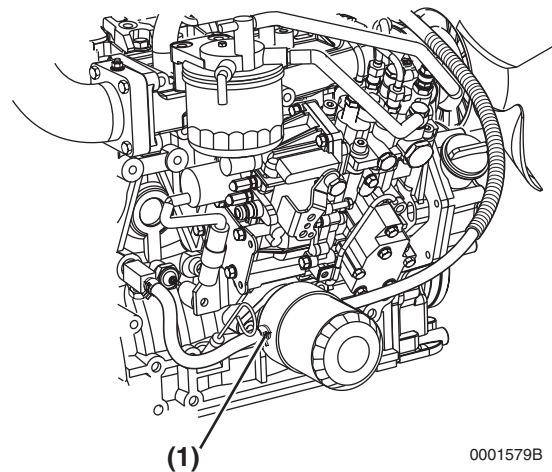


Figure 8-5

0001579B

 **CAUTION**



FLYING OBJECT HAZARD!

- **ALWAYS** wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.
- Failure to comply may result in minor or moderate injury.

000003en

 **CAUTION**

If any oil pump component clearance exceeds its limit, the oil pump must be replaced as an assembly.

0000015en

CAUTION

- Only use the engine oil specified. Other engine oils may affect warranty coverage, cause internal engine components to seize and / or shorten engine life.
- Prevent dirt and debris from contaminating the engine oil. Carefully clean the oil cap / dipstick and the surrounding area before you remove the cap.
- **NEVER** mix different types of engine oil. This may adversely affect the lubricating properties of the engine oil.
- **NEVER** overfill. Overfilling may result in white exhaust smoke, engine overspeed or internal damage.

000005en

CAUTION

If the oil pump must be replaced, replace it as an assembly only. Do not replace individual components.

0000030en

Disassembly of oil pump

CAUTION

If the oil pump must be replaced, replace it as an assembly only. Do not replace individual components.

0000030en

Remove the cooling water fan guard (if equipped), cooling fan (**Figure 9-15, (3)**), spacer (**Figure 9-15, (2)**), cooling water pump V-pulley (**Figure 9-15, (1)**), and V-belt.

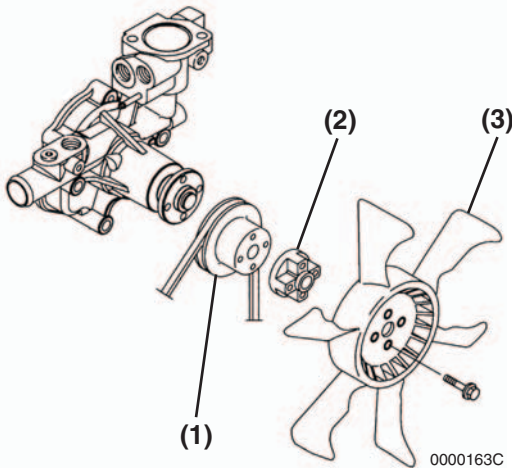


Figure 9-15

1. Remove the crank shaft pulley and gear case cover. See Removal of timing gear case cover on page 6-72.
2. Remove the lubricating oil pump assembly mounting bolts. Remove the lubricating oil pump assembly (**Figure 9-16, (1)**) from the gear case flange (**Figure 9-16, (2)**).
3. You can remove by hand the lubricating oil pump cover (**Figure 9-14, (5)**) and outer rotor (**Figure 9-14, (4)**).

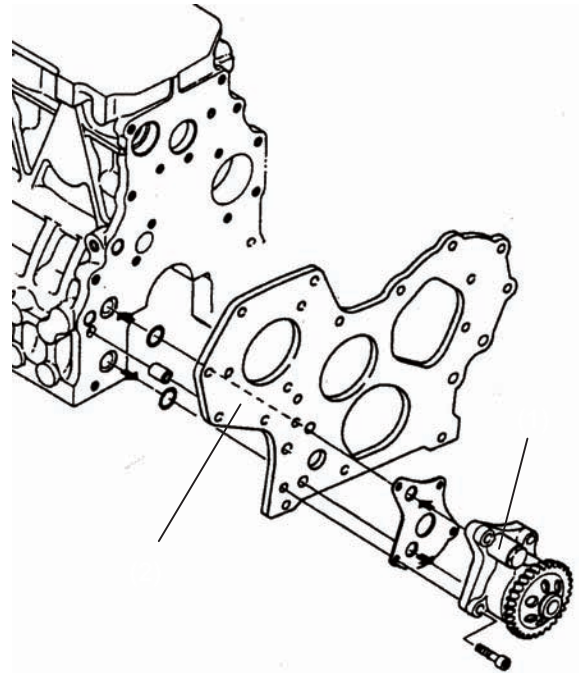


Figure 9-16

Cleaning and inspection

Clean the lubricating oil pump, pressure regulator valve (**Figure 9-14, (7)**), and rotor inserting portion. Check the parts for wear or flaw. Replace the parts with new ones as needed.

CAUTION

- **NEVER** overfill the engine with engine oil.
- **ALWAYS** keep the oil level between the upper and lower lines on the oil cap / dipstick.

0000015en

Check outer rotor outside clearance

Inspect the outside diameter clearance of the outer rotor. To inspect this, insert a feeler gauge between the outer rotor (**Figure 9-17, (1)**) and the lubricating oil pump body (**Figure 9-17, (2)**).

CAUTION

Avoid damage to the turbocharger or the engine. Do not spray blower wash fluid or water too quickly.

Use short strokes from a spray bottle to inject blower wash fluid or water into the turbocharger.

Spraying too much wash fluid or water, or spraying too quickly will damage the turbocharger.

0000063en

CAUTION

Do not allow any material to fall into the oil lines or the oil inlet and outlet ports of the turbocharger.

0000064en

CAUTION

If the waste valve does not meet specifications, replace the turbocharger or have it repaired by Komatsu distributor.

0000078en

Checking rotor play

Note: If rotor play measurements are not within specification, replace the turbocharger assembly or have it repaired by Komatsu distributor.

Rotor Play	Standard Dimension			Wear Limit		
	RHF5	RHB31	RHB51	RHF5	RHB31	RHB51
End Play	0.0011 – 0.0024 in. (0.03 – 0.06 mm)	0.0009 – 0.0021 in. (0.022 – 0.053 mm)	0.0012 – 0.0024 in. (0.03 – 0.06 mm)	0.0044 in. (0.09 mm)	0.0028 in. (0.07 mm)	0.0035 in. (0.09 mm)
Run-out	0.0031 – 0.0051 in. (0.08 – 0.13 mm)	0.0024 – 0.0037 in. (0.061 – 0.093 mm)	0.0031 – 0.0051 in. (0.08 – 0.13 mm)	0.007 in. (0.17 mm)	0.0047 in. (0.12 mm)	0.0067 in. (0.17 mm)

To check rotor end play:

1. Set up a dial indicator as shown (Figure 10-4).
2. Manually move the rotor end-to-end while observing indicated readings. Replace the turbocharger if end play measurements are outside specified limits. See table above.

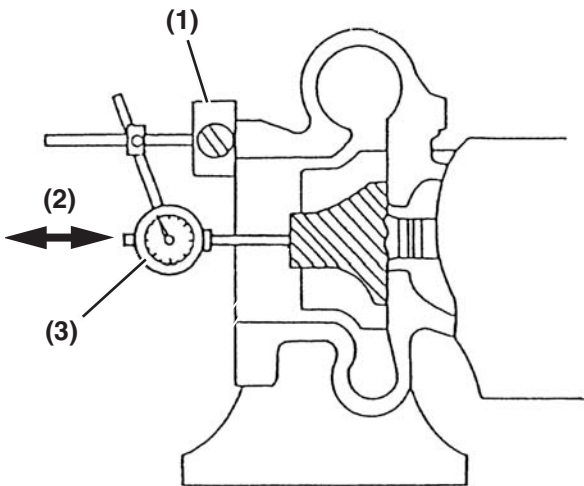


Figure 10-4

0000080A

To check rotor run-out:

1. Set up a dial indicator as shown (Figure 10-5).
2. Manually rotate the rotor while observing indicated limits. Replace the turbocharger if run-out measurements are outside specified limits. See table above.

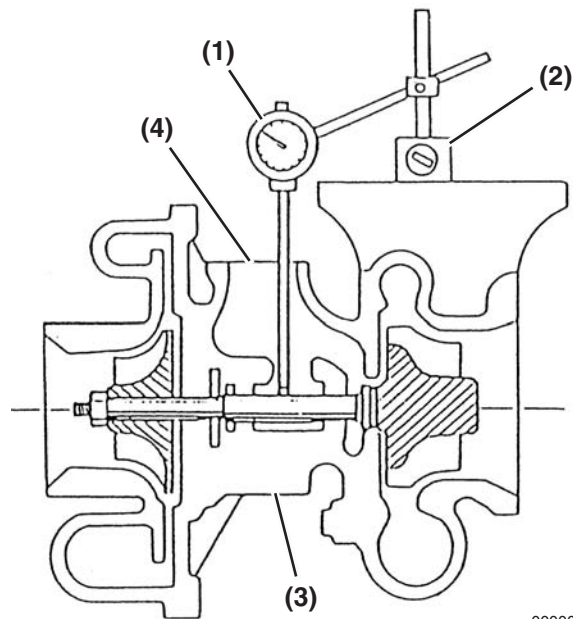


Figure 10-5

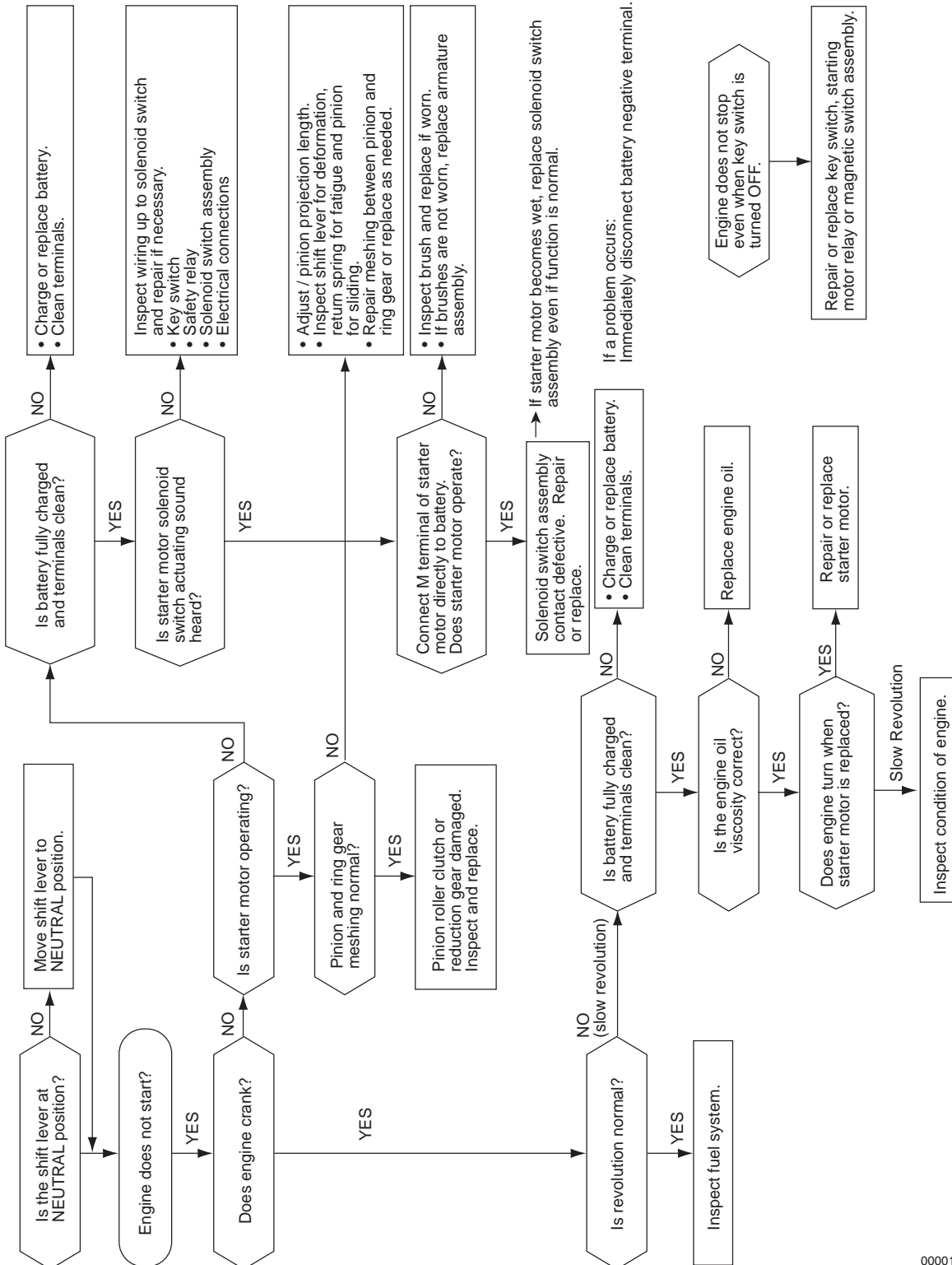
0000081A

Waste gate valve test

Before reinstalling the turbocharger, verify the operation of the waste gate valve. Poor waste gate operation will adversely affect the engine performance.

CAUTION
If the waste valve does not meet specifications, replace the turbocharger or have it repaired by Komatsu distributor.
0000078en

Starter motor troubleshooting



0000102

7. Carefully install the armature assembly (**Figure 11-30, (1)**) into the field coil assembly (**Figure 11-30, (2)**).

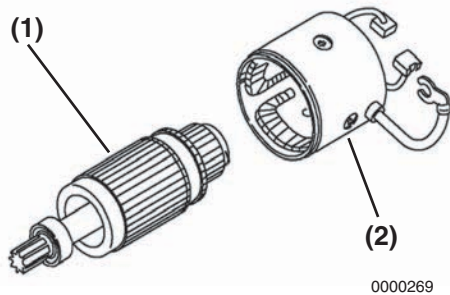


Figure 11-30

8. Position the brush springs in brush holders (**Figure 11-31**). Reinstall the brushes in the brush holders. Reversing the brushes will cause the starter motor to turn backwards.

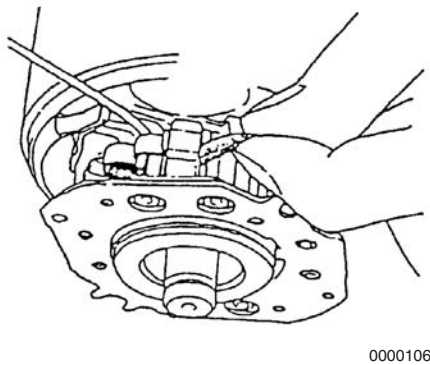


Figure 11-31

9. Carefully install the brush holder assembly to the armature assembly.
 10. Reinstall the field coil assembly with the armature assembly to the gear housing.
 11. Reinstall the rear cover to the brush holder assembly. Securely tighten the two bolts.

12. Reinstall the two M4 through bolts (**Figure 11-32**). Securely tighten the through bolts. Reconnect the wire to the magnetic switch assembly. Tighten the M8 nut. Reinstall the cover over the connection.

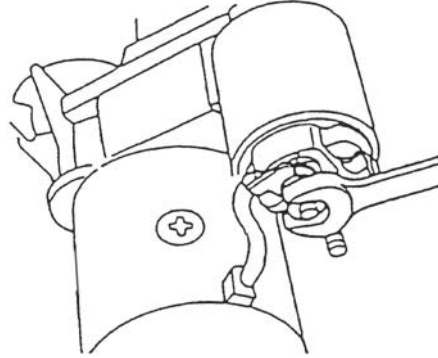
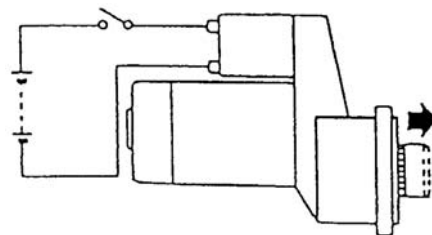


Figure 11-32

Check pinion projection length

1. Connect the positive (+) lead from a battery to the "S" terminal.
2. Connect the negative (-) lead to the "M" terminal.
3. Lightly pull the pinion away from the gear housing.
4. Turn the switch ON and measure the pinion moving distance L in the thrust direction (**Figure 11-33**). Perform this test within 10 seconds. See Starter motor specifications on page 11-7 for the service limit.



0000132

Figure 11-33

Introduction

This section of the Service Manual describes the servicing of the dynamos and alternators. Part No. YM129423-77200 alternator is used in this section to show the service procedures for the representative alternator. Part No. YM171301-77201 dynamo is used in this section to show the service procedures for the representative dynamo. For specific part detail, see the Parts Book for the engine you are working on.

Dynamo and alternator information

3D82AE to S4D98E - Standard and optional dynamos

Part No.	Mfg.	Mfg. Part Number	Specification
YM171301-77201	Kokusan	GP8138	DC12V-15A
YM119910-77200	Kokusan	GP9191	DC12V-20A

3D82AE to S4D98E - Standard and optional alternators

Part No.	Mfg.	Mfg. Part Number	Specification
YM119620-77201	Denso	100211-4531	DC12V-40A
YM129423-77200	Denso	101211-1170	DC12V-40A with Pulse
YM129961-77200	Denso	101211-2591	DC12V-55A
YM119626-77210	Denso	101211-2951	DC12V-55A with Pulse
YM129612-77290	Hitachi	LR180-772	DC12V-80A with Pulse
YM129900-77240	Hitachi	LR235-705	DC24V-35A with Pulse

8. Reinstall the brush holder (**Figure 12-17, (3)**), springs (**Figure 12-17, (4)**) and brushes (**Figure 12-17, (5)**).
9. Reattach the regulator assembly and holder to the rear frame housing.

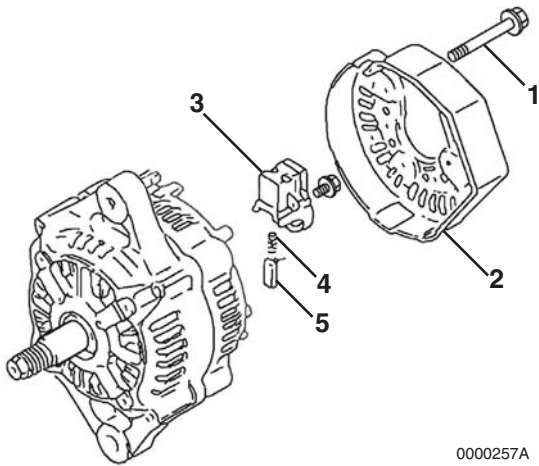


Figure 12-17

10. Reinstall the rear cover (**Figure 12-17, (2)**) to the rear frame housing with three bolts (**Figure 12-17, (1)**).
11. Reassemble the pulley (**Figure 12-18, (2)**) and nut (**Figure 12-18, (1)**) to the shaft of the rotor assembly. Tighten the nut.

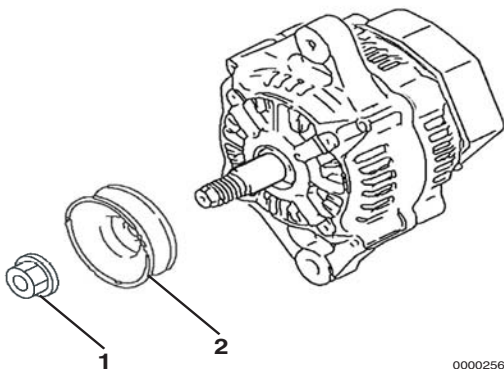


Figure 12-18

Installation of alternator

1. Position the alternator on the gear case. Loosely reinstall the nut (**Figure 12-19, (2)**) on the gear case stud and the V-belt adjuster bolt (**Figure 12-19, (1)**).

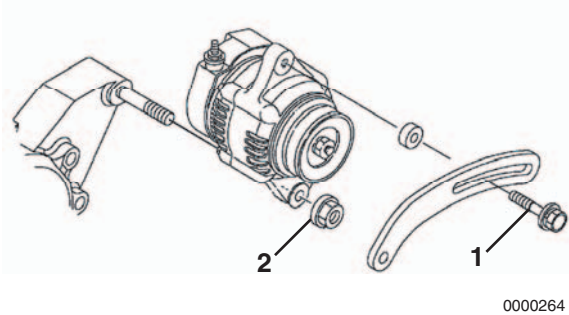


Figure 12-19

2. Reconnect the electrical wires to the alternator. Tighten the nuts to 15 – 20 in.-lb (1.7 – 2.3 N·m; 17 – 23 kgf·m).
3. Reinstall the V-belt. Tighten the V-belt to the proper tension as described in Check and adjust cooling fan V-Belt on page 5-22.
4. Start the engine. Listen for any unusual sounds from the alternator.

CAUTION

Do not operate the engine if the alternator is producing unusual sounds. Damage to the alternator will result.

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5. Verify that the charge indicator is ON while the engine is operating. If the charge indicator is not ON, repair the problem before operating the engine.

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