

Section 1. GENERAL SERVICE INFORMATION

Component Identification

Figure 4-1a, Figure 4-1b shows where the major engine components are located.

4TNV98 ENGINE

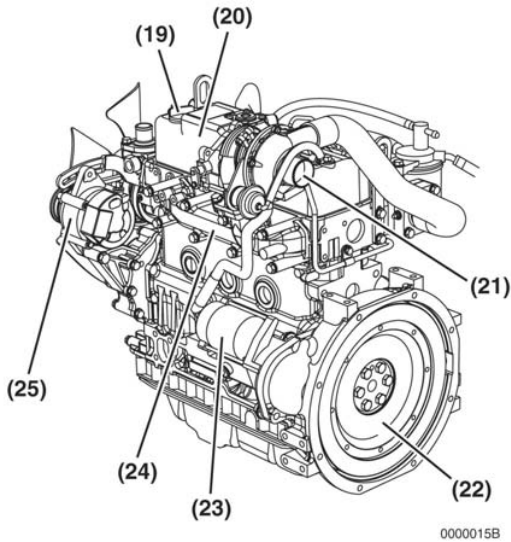
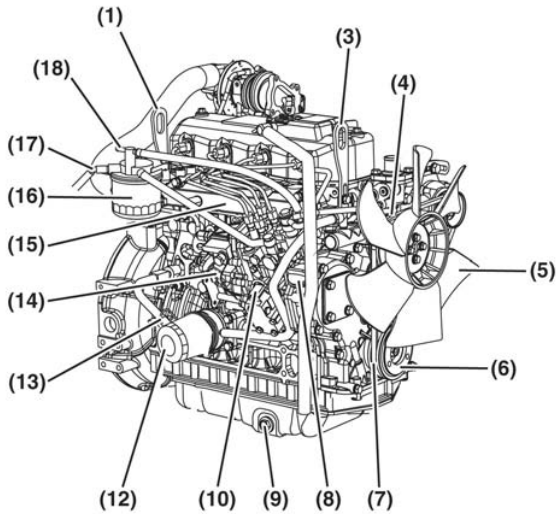


Figure 4-1a

- (1) Lifting Eye (Flywheel End).
- (3) Lifting Eye (Engine Cooling Fan End).
- (4) Engine Coolant Pump. (5) Engine Cooling Fan.
- (6) Crankshaft V-Pulley. (7) V-Belt.
- (8) Side Filler Port (Engine Oil). (9) Drain Plug (Engine Oil).
- (10) Fuel Injection Pump. (12) Engine Oil Filter.
- (13) Dipstick (Engine Oil) (14) Governor Lever.
- (15) Intake Manifold. (16) Fuel Filter.
- (17) Fuel Inlet. (18) Fuel Return to Fuel Tank.
- (19) Top Filler Port (Engine Oil). (20) Rocker Arm Cover.
- (21) Air Intake Port (From Air Cleaner).
- (22) Flywheel. (23) Starter Motor.
- (24) Exhaust Manifold. (25) Alternator.

4TNE98 ENGINE

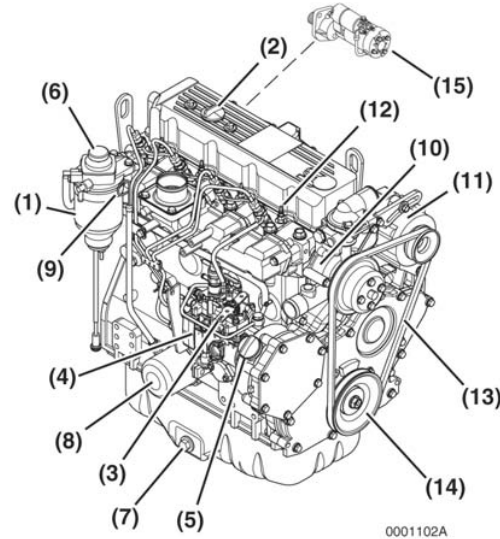


Figure 4-1b

- (1) Fuel Filter / Water Separator
- (2) Top Filler Port (Engine Oil)
- (3) Governor Lever
- (4) Fuel Injection Pump
- (5) Side Filler Port (Engine Oil)
- (6) Fuel Priming Pump
- (7) Drain Plug (Engine Oil)
- (8) Engine Oil Filter
- (9) Dipstick (Engine Oil)
- (10) Engine Coolant Pump
- (11) Alternator
- (12) Glow Plug
- (13) V-Belt
- (14) Crankshaft V-Pulley
- (15) Starter Motor

Engine Oil

⚠ 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.

Engine Oil Specifications

Use an engine oil that meets or exceeds the following guidelines and classifications:

Service Categories

- API Service Categories CD or higher
- ACEA Service Categories E-3, E-4, and E-5
- JASO Service Category DH-1

Definitions

- API Classification (American Petroleum Institute)
- ACEA Classification (Association des Constructeurs Européens d'Automobilies)
- JASO (Japanese Automobile Standards Organization)

NOTE:

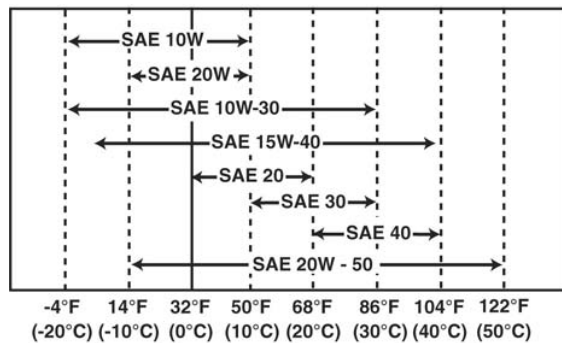
- Be sure the engine oil, engine oil storage containers, and engine oil filling equipment are free of sediment and water.
- Change the engine oil after the first 50 hours of operation and then every 500 hours thereafter.
- Select the oil viscosity based on the ambient temperature where the engine is being operated. See the SAE Service Grade Viscosity Chart (Figure 4-4a)
- Yanmar does not recommend the use of engine oil "additives."

Additional Technical Engine Oil Requirements:

The engine oil must be changed when the Total Base Number (TBN) has been reduced to 1.0 mgKOH /g test method; JIS K-201-5.2-2 (HCl), ASTM D4739 (HCl).

Engine Oil Viscosity

Select the appropriate engine oil viscosity based on the ambient temperature and use the SAE Service Grade Viscosity Chart in Figure 4-4a.



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Figure 4-4a

Principal Engine Specifications

4TNV98 EPA Tier 2

Engine Model	4TNV98	
Version	VM (SDF)	
Type	Vertical In-line Diesel Engine	
Combustion System	Direct Injection	
Aspiration	Natural	
No. of Cylinders	4	
Bore x Stroke	3.858 x 4.331 in. (98 x 110 mm)	
Displacement	202.502 cu in. (3.319 L)	
Max. Rated Output (Net)	RPM	2200
	hp SAE	61.2
	kW	45.6
	PS	62.0
High Idling	RPM	2400±25
Engine Weight (Dry) with Flywheel Housing	518.2 lb (235 kg)	
PTO Position	Flywheel End (Option)	
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	42 - 57 psi (0.29 - 0.39 MPa, 2.96 - 3.98 kgf/cm ²)	
Normal Oil Pressure at Low Idle Speed	8.5 psi (0.06 MPa, 0.6 kgf/cm ²) or greater	
Starting System	Electric Starting - Starter Motor: DC12V, 3.1 hp (2.3 kW)**	
	Alternator: DC12V, 40A**	
	Recommended Battery Capacity: 12V, 64 Amp-Hour (5h rating)**	
Dimensions (L x W x H)*	28.31 x 19.61 x 29.21 in. (719 x 498 x 742 mm)	
Engine Oil Pan	11.1 / 6.3 qt (10.5 / 6.0 L) (Dipstick Upper Limit / Lower Limit)	
Engine Coolant Capacity	1.1 gal (4.2 L) Engine Only	
Standard Cooling Fan	16.14 in. (410 mm) O.D., 6 Blade Pusher-Type**	

* Engine specifications without radiator

** May vary depending on application.

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

○:Check ◇:Replace

System	Check Item	Daily	Periodic Maintenance Interval					
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 1500 hours	Every 2000 hours
Cooling System	Check and Refill Engine Cool	○						
	Check and Clean Radiator Fins			○				
	Check Engine Coolant Temp. Indicator	○						
	Check and Adjust Cooling Fan V-Belt		○1st time	○2nd and after				
	Drain, Flush and Refill Cooling System with New Coolant					◇ or every year whichever comes first		
Cylinder Head	Adjust Intake / Exhaust Valve Clearance					○		
	Lap Intake / Exhaust Valve Seats							○
Electrical Equipment	Check Indicators	○						
	Check Battery		○					
Engine Oil	Check Engine Oil Level	○						
	Check Engine Oil Pressure Indicator	○						
	Drain and Fill Engine Oil							
	Replace Engine Oil Filter		◇1st time		◇2nd and after			
Engine Speed Control	Check and Adjust Governor Lever and Engine Speed Control	○		○				
Emission Control Warranty	Inspect, Clean and Test Fuel Injectors						○	
	Inspect Crankcase Breather System						○	
Fuel	Check and Refill Fuel Tank Level	○						
	Check Fuel Filter Indicator	○						
	Drain Fuel Tank			○				
	Drain Fuel Filter / Water Separator		○					
	Check Fuel Filter / Water Separator	○						
	Clean Fuel Filter / Water Separator				○			
	Replace Fuel Filter				◇			
Hoses	Replace Fuel System and Cooling System Hoses							○ or every 2 years
Intake and Exhaust	Clean or Replace Air Cleaner Element			○	◇			
Complete Engine	Overall Visual Check Daily	○						

NOTE: These procedures are considered normal maintenance and are performed at the owner's expense.

Every 1000 Hours of Operation

Perform the following maintenance every 1000 hours of operation.

- Drain, Flush and Refill Cooling System With New Coolant
- Adjust Intake/Exhaust Valve Clearance

Drain, Flush and Refill Cooling System With New Coolant

DANGER



SCALD HAZARD!

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.

WARNING



BURN HAZARD!

Wait until the engine cools before you drain the engine coolant. Hot engine coolant may splash and burn you.

Failure to comply could result in death or serious injury.

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.

CAUTION



ALWAYS be environmentally responsible.

Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.

NEVER dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.

Failure to follow these procedures may seriously harm the environment.

Engine coolant contaminated with rust or scale reduces the cooling effect. Even when extended life engine coolant is properly mixed, the engine coolant gets contaminated as its ingredients deteriorate. Drain, flush and refill the cooling system with new coolant every 1000 hours or once a year, whichever comes first.

1. Allow engine and coolant to cool.
2. Remove the radiator cap (**Figure 5-16, (1)**).
3. Remove the drain plug or open the drain cock (**Figure 5-16, (2)**) at the lower portion of the radiator and drain the engine coolant.

Disassembly of Cylinder Head

Prepare a clean, flat working surface on a workbench large enough to accommodate the cylinder head assembly. Discard all gaskets, O-rings and seals.

CAUTION

Identify all parts and their location using an appropriate method. It is important that all parts are returned to the same position during the assembly process.

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1. Remove the intake manifold bolts (Figure 6-2, (1)). Remove the intake manifold (Figure 6-2, (3)). Discard the intake manifold gasket (Figure 6-2, (3)).

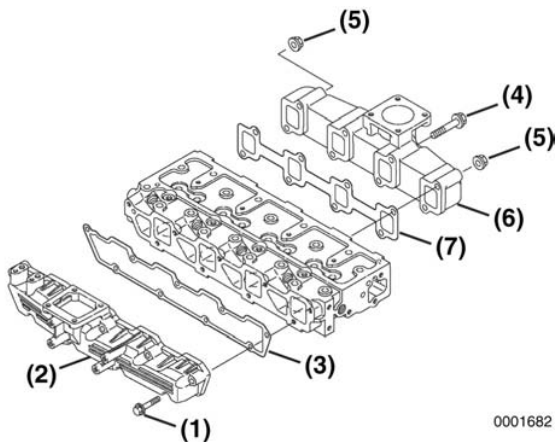


Figure 6-2

2. Remove the exhaust manifold bolts (Figure 6-2, (4)) and nuts (Figure 6-2, (5)). Remove the exhaust manifold (Figure 6-2, (6)). Discard the exhaust manifold gasket (Figure 6-2, (7)).
3. Remove the water pump from the engine. See Disassembly of Engine Coolant Pump on 205.
4. Remove the fuel injectors from the cylinder head. See Removal of the Fuel Injectors on page 196.

Removal of Glow Plugs

1. Remove the glow plug cover (Figure 6-3, (2)) from each of the glow plugs (Figure 6-3, (1)).
2. Disconnect the glow plug harness (Figure 6-3, (3)) from the glow plugs.
3. Remove the glow plugs from the cylinder head (Figure 6-3, (4)).

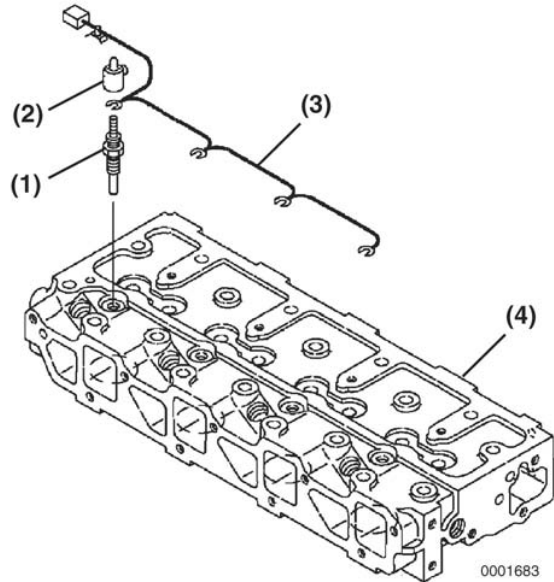


Figure 6-3

Removal of Valve Cover

1. Remove the valve cover nuts (Figure 6-4, (1)).
2. Check the condition of the O-ring (Figure 6-4, (2)) on each valve cover nut. Replace the O-ring if necessary.

Measuring Idler Gear-to-Camshaft Gear Backlash

1. Drive a small wooden wedge between the crankshaft gear and idler gear to prevent the idler gear from rotating.
2. Install the dial indicator to read the camshaft gear backlash. Rotate the camshaft drive gear against the idler gear to measure the backlash. Record the measurement.
3. Check the idler gear-to-fuel injection pump drive gear backlash in the same manner as the camshaft drive gear. Record the measurement.

Removal of Timing Gears

1. Remove the bolts from the idler gear shaft (Figure 6-88, (1)). Remove the idler gear shaft, idler gear (Figure 6-88, (2)) and bushing (Figure 6-88, (3)).

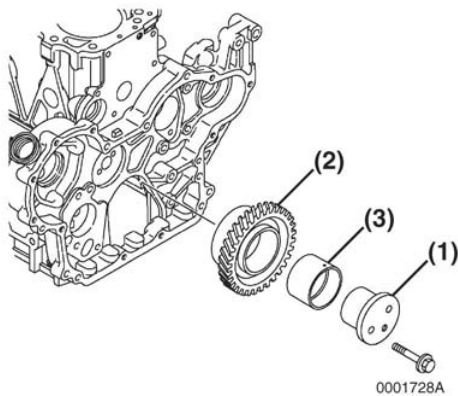


Figure 6-88

2. Do not remove the crankshaft gear unless it is damaged and requires replacement. If the gear must be removed, remove it using a gear puller.
3. Removal of the camshaft gear requires the camshaft be removed and placed in a press. Do not remove the camshaft gear unless it or the camshaft is damaged and requires replacement. See Removal of Camshaft on page 114.

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.

4. Do not remove the fuel injection pump drive gear unless absolutely necessary to avoid damage to the gear or pump. Do not loosen or remove the four bolts (Figure 115, (3)) retaining the pump drive gear to the hub. Only remove the nut (Figure 6-89, (1)) and washer (Figure 115, (2)), leaving the hub attached to the gear. Remove the pump drive gear and hub as an assembly using a gear puller.

4TNV98 Engine

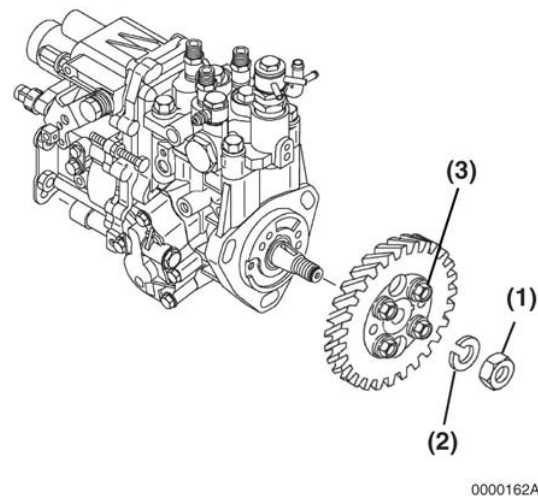


Figure 6-89

Removal of Oil Pan

1. Invert the engine (oil pan up) on the engine stand.
2. Remove the oil pan (Figure 116, (1)).

4TNE98 Engine

1. Lubricate No. 1 piston and piston rings.
2. Using the piston insertion tool (piston ring compressor), compress the piston rings on the No.1 piston.
3. Carefully install the piston into No.1 cylinder. Be sure the punched mark on the connecting rod is facing the fuel injector side and the embossed mark on the connecting rod is facing the flywheel.

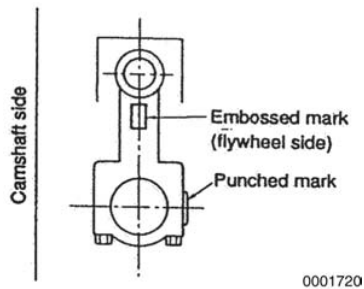


Figure 6-78

4. Install the connecting rod bearing halves (**Figure6-79,(1)**) and connecting rod cap (**Figure6-79,(2)**). Tighten the connecting rod bolts to the specified torque.

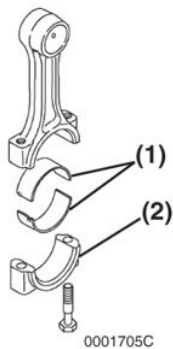


Figure 6-79

5. Install the remaining pistons in their respective cylinders.

16. To position the fuel injection pump for easier removal and installation, install a dial indicator (see Checking and Adjusting Fuel Injection Timing on page 157) into the injection pump plunger opening. Using a wrench on the crankshaft pulley bolt, rotate the crankshaft until the dial indicator shows that injection pump plunger is at the bottom of its stroke.
17. To aid in reassembly, make reference marks on the fuel injection pump drive gear, and on either the gear case cover or idler gear.

CAUTION

After marking the position of the pump drive gear, do not rotate the engine crankshaft. Rotating the crankshaft will cause the fuel injection pump to become misaligned.

- On 4TNV98 model engines, the idler gear is visible. Make a reference mark (Figure 7-12, (1)) across both the fuel injection pump drive gear and the idler gear.

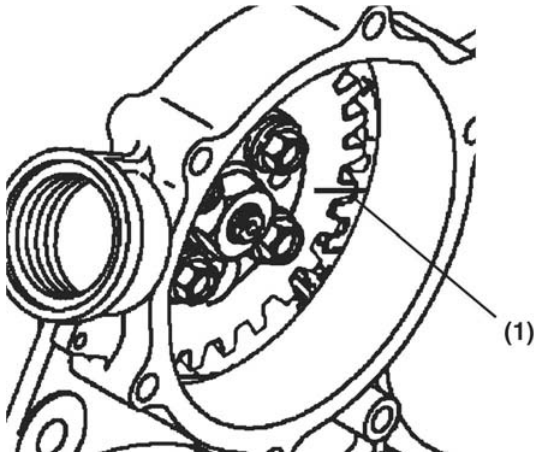
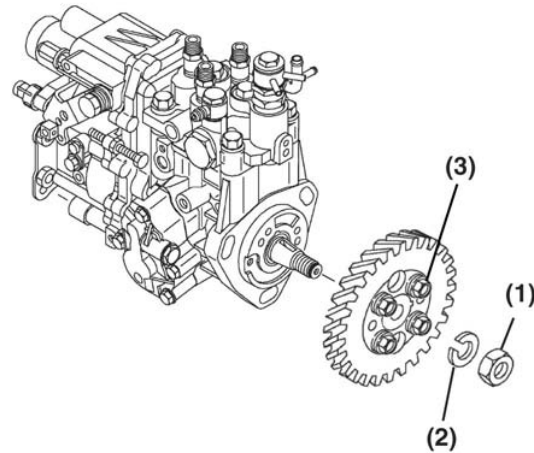


Figure7-12

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.

18. Do not loosen or remove the four bolts (Figure7-13, (3)) retaining the pump drive gear to the hub. Only remove the single drive gear nut (Figure7-13, (1)) and washer (Figure7-13, (2)), leaving the hub attached to the gear.



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Figure 7-13

19. Hold the gear train using a large socket wrench on the crankshaft pulley nut. Loosen the fuel injection pump drive gear retaining nut (Figure 7-13, (1)) and turn it out to the end of the fuel injection pump shaft.

Fuel System Components

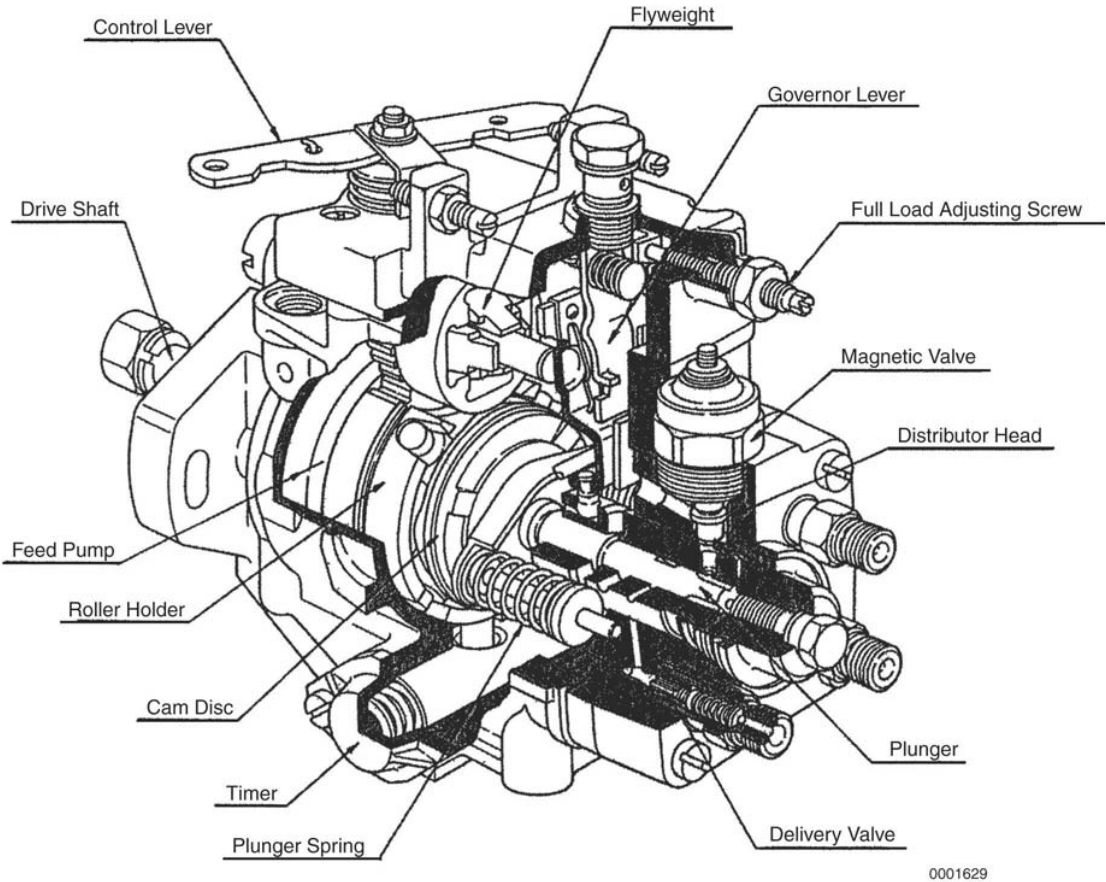


Figure 7-1

During Idling

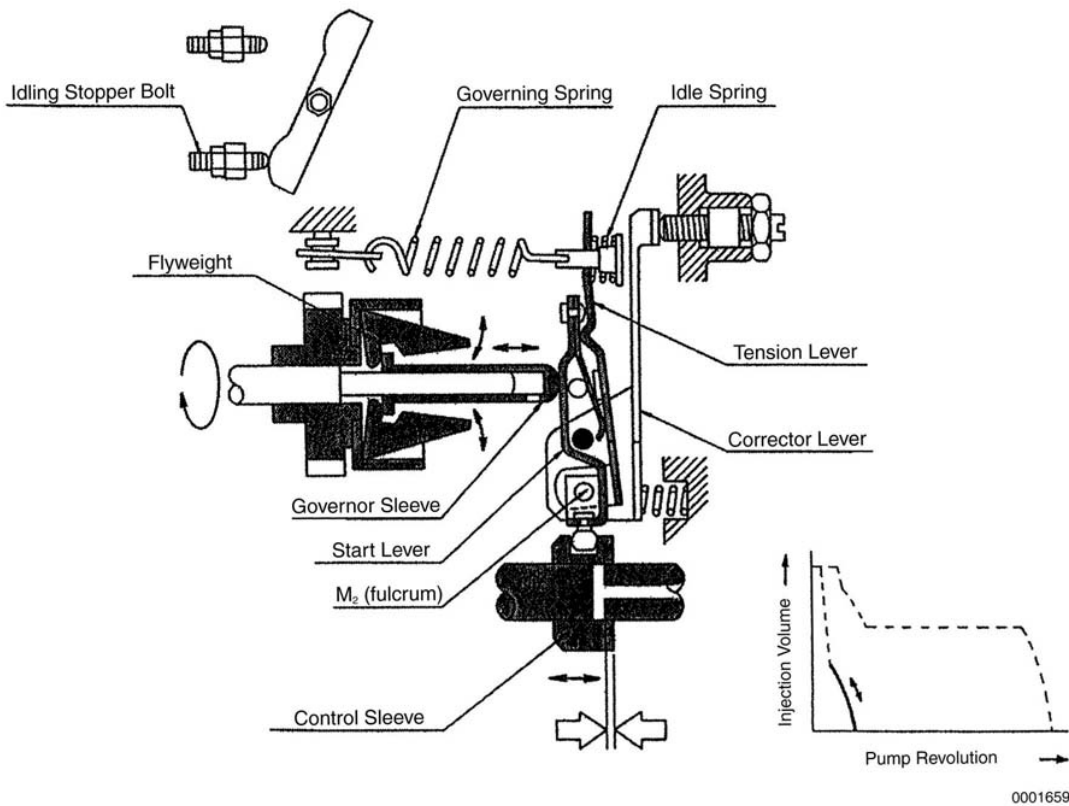


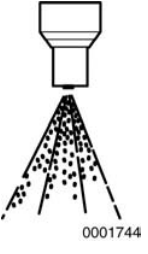









Figure 7-26

When the engine starts and the accelerator pedal is released, the control lever returns to the idle position and the tension of the governor spring becomes zero. Therefore, the flyweight opens outwardly even at low revolutions to move the governor sleeve to the right.

This makes the start lever turn clockwise with M_2 being the fulcrum to move the control sleeve in the direction to reduce the fuel volume. The governor sleeve stops at a point where the flyweight centrifugal and idle spring force are balanced to ensure stable idling.

Judgement Criteria on Atomization Condition

	A	B	C	D	E
Injection Pattern	 0001742	 0001743	 0001744	 0001745	 0001746
Pressure Gauge Reading	 0001747 Pointer fluctuate around the valve opening pressure.	 0001748 Same as A.	 0001749 Pointer stays at a position near the valve opening pressure.	 0001750 Although the pointer reaches the valve opening pressure, the pressure drop is large.	 0001751 Pressure does not increase even when the tester lever is
Atomization Pattern	Roughly uniform.	Atomization is excessively one sided.	Although atomized, the needle does not pulsate (burner like shape).	Bar shape with excessive after drops.	Drops (bar shape).
Possible Cause	(Normal)	<ol style="list-style-type: none"> Normally caused by carbon contamination of the nozzle tip. Sometimes caused by flaws in or damage to the needle tip. 	<ol style="list-style-type: none"> Caused by excessive carbon contamination of the nozzle tip. Sometimes caused by contamination . 	<ol style="list-style-type: none"> Damage to the seat. Contamination of seat by fine foreign particles. Excessively worn seat. 	<ol style="list-style-type: none"> Sticking of needle. Excessively damaged or worn seat. Contamination of seat by foreign matter. Damaged or broken internal parts of nozzle holder.

Section 6. LUBRICATION SYSTEM

Before You Begin Servicing

WARNING



ENTANGLEMENT HAZARD!

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..

WARNING



BURN HAZARD!

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.

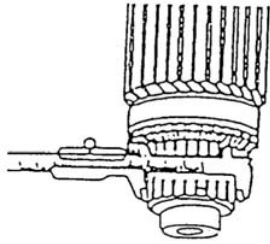
WARNING



FUME / BURN HAZARD!

Always read and follow safety related precautions found on containers of hazardous substances like parts cleaners, primers, sealants and sealant removers.

Failure to comply could result in death or serious injury.



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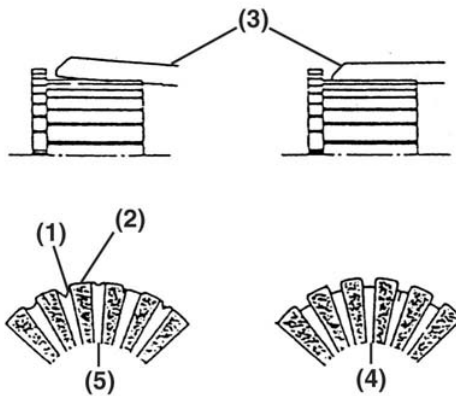
Figure 11-13

See Starter Motor Specifications on page 222 for the service limit.

Measure Commutator Insulation Depth

Measure the depth of the insulating material **(Figure11-14, (1))** between commutator segments **(Figure11-14, (2))**. If the depth measures less than the limit, use a hacksaw blade **(Figure11-14, (3))** to remove the insulating material until the depth is within the limit.

A normal commutator condition is indicated in **(Figure11-14, (4))**. An abnormal commutator condition is indicated in **(Figure11-14, (5))**.



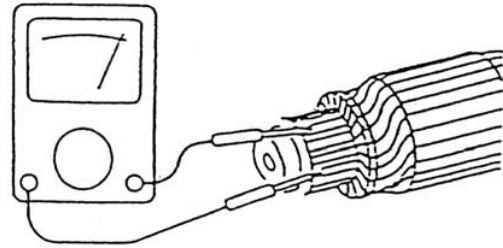
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Figure 11-14

See Starter Motor Specifications on page 222 for the service limit.

Armature Coil Continuity Test

Check for continuity between the commutator segments using a multimeter **(Figure 11-15)**. The multimeter should indicate continuity.



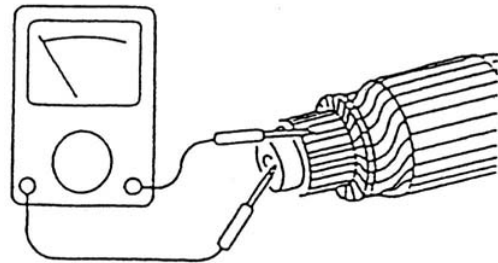
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Figure 11-15

If the multimeter does not indicate continuity, replace the armature.

Armature Coil Insulation Test

Check for continuity between a commutator segment and the shaft or armature using a multimeter **(Figure11-16)**. The multimeter should not indicate continuity.



0000115

Figure 11-16

If the multimeter indicates continuity, replace the armature.

Engine Model	Compression Pressure at 250 rpm (250 min-1)		Deviation Between Cylinders
	Standard	Limit	
4TNE98	426 ± 15 psi (2.94 ± 0.1 MPa, 30 ± 1 kgf/cm ²)	341 ± 15 psi (2.35 ± 0.1 MPa, 24 ± 1 kgf/cm ²)	29 to 43 psi (0.2 to 0.3 MPa; 2 to 3 kgf/cm ²)

Engine Speed and Compression Pressure (Use for Reference)

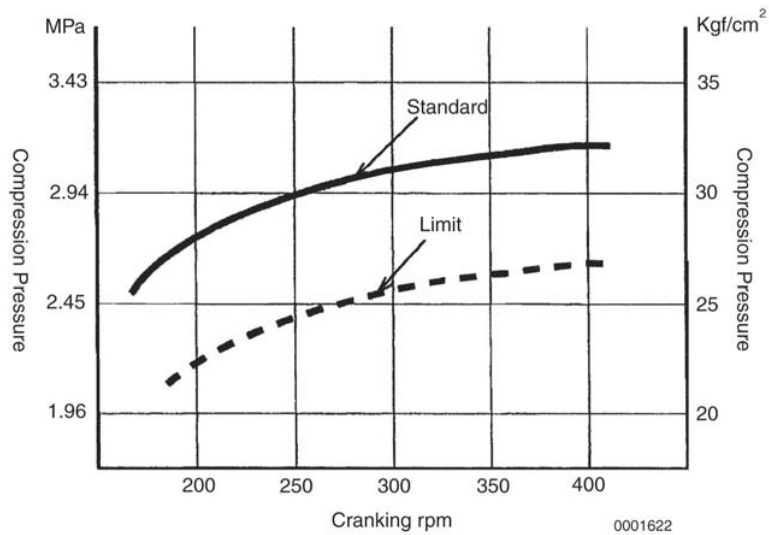


Figure 13-2