Section 6

ENGINE

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1 – Baffle Plate
2 – Oil Fill Cap
3 – Valve Cover / Intake Manifold
4 – Gasket
5 – Rocker Arm Shaft
6 – Rocker Arm Shaft Support
7 – Adjuster Lock Nut
8 – Valve Adjuster Screw
9 – Rocker Arm
10 – Circlip
11 – Valve Cap
12 – Keeper
13 – Valve Spring Retainer

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

IMPORTANT

Mark all valve train components so they can be installed in their original locations.

Note: Record all measurements taken during

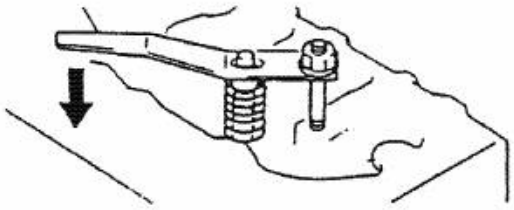
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Removal of Intake / Exhaust Valves

1. Put the cylinder head on the work bench with the combustion side down **(Figure 6-8)**.



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Note: If the valves are to be reused, identify them so they can be reinstalled in their original location.

8. Turn the cylinder head so the exhaust port side faces down. Remove the intake and exhaust valves **(Figure 6-9, (6))** from the cylinder head.
9. Remove the valve stem seals **(Figure 6-9, (5))**.

Removal of Valve Guides

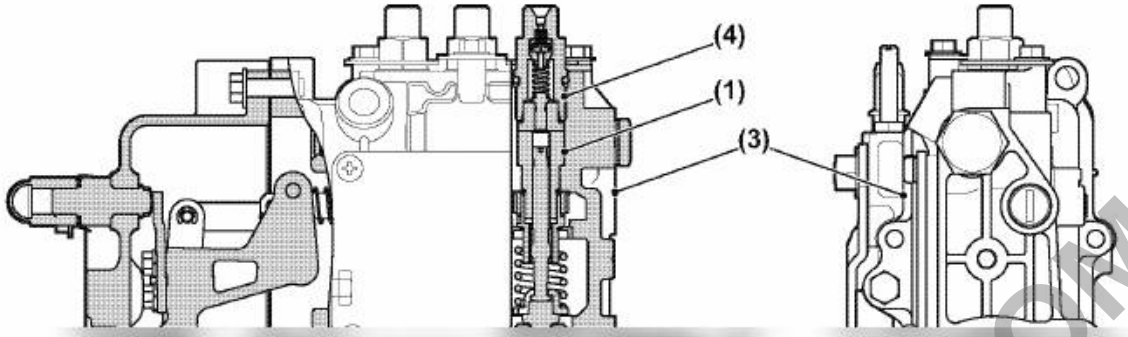
Note: Removal of valve guides should be postponed until inspection and

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INTRODUCTION



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Record the measurement(s) and see Outer Rotor to Inner Rotor Tip Clearance on page 9-5 for the service limits.

Check Outer Rotor Side Clearance

Inspect the side clearance between the lubricating oil pump body and the outer rotor. To measure the side clearance, use a straight edge and feeler gauge (as shown in **Figure 9-7**) or a depth micrometer.

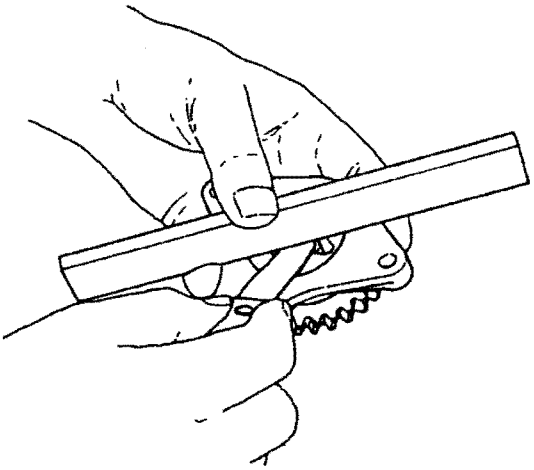


Figure 9-7

Record the measurement(s) and see Outer Rotor Outside Clearance on page 9-5 for the service limits.

Check Rotor Shaft Clearance

Inspect the rotor shaft clearance. Measure the outside diameter of the rotor shaft **(Figure 9-8, (1))** and the inside diameter of the cover.

Determine the clearance by subtracting the outside diameter of the rotor from the inside diameter of the cover.

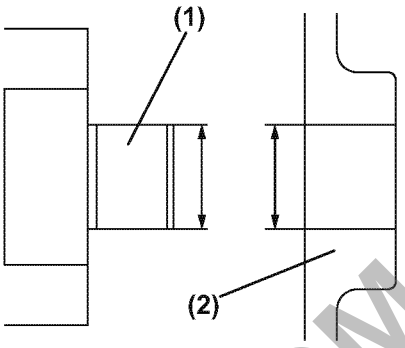


Figure 9-8

Reassembly of Oil Pump

1. Apply clean lubricating oil to the lubricating oil pump body and inner rotor assembly as well as to the outer rotor.
2. Insert the outer rotor into the lubricating oil pump body and inner rotor assembly and install the cover.
3. Replace the packing with new one.
4. Install the lubricating oil pump assembly to the gear case flange by tightening the bolts with the specified torque.
5. Install the gear case cover. For more information, See Installation of Gear Case Cover on page 6-59.
6. Install the crank shaft pulley.
7. Install the cooling water pump V-pulley **(Figure 9-9, (1))**, spacer **(Figure 9-9, (2))**, cooling water fan **(Figure 9-9, (3))**, and fan guard (if equipped).

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CAUTION

Do not turn the battery switch OFF while the engine is operating. Damage to the alternator will result.

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CAUTION

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

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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.

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CAUTION

Use a new special O-ring between the engine coolant pump and the joint. Be sure to use the special O-ring for each engine model. Although the O-ring dimensions are the same as a commercially available O-ring, the material is different.

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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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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.

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CAUTION

Do not use a high-pressure wash directly on the alternator. Water will damage the alternator and result in inadequate charging.

0000049en

CAUTION

Do not reverse the positive (+) and negative (-) ends of the battery cable. The alternator diode and stator coil will be damaged.

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CAUTION

When the battery indicator goes out, it should not come on again. The battery indicator only comes on during operation if the alternator fails. However, if an LED is used in the battery indicator, the LED will shine faintly during normal operation.

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CAUTION

Using a non-specified V-belt will cause inadequate charging and shorten the belt life. Use the specified belt.

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3TNM72 (EPA Tier 4)

Engine Model		3TNM72												
Version		CL		VM						CH		VH		
Type		Vertical In-line Diesel Engine												
Combustion System		Ball-Type Swirl Chamber												
Aspiration		Natural												
No. of Cylinders		3												
Bore × Stroke		2.83 x 2.91 in. (72 × 74 mm)												
Displacement		55.1 cu in. (0.904 L)												
Continuous Rated Output	rpm (min^{-1})	1500	1800						3000	3600				
	hp SAE	8.8	10.4						17.7	21.3				
	kW	6.6	7.8						13.2	15.9				
	PS	9.0	10.6						17.9	21.6				
Max. Rated Output (Net)	rpm (min^{-1})	1500	1800	2000	2200	2400	2600	2800	3000	3000	3600	3200	3400	3600
	hp SAE	9.7	11.5	12.7	14.2	15.6	16.8	18.2	19.7	19.4	23.4	20.9	22.1	23.6
	kW	7.3	8.6	9.5	10.6	11.7	12.6	13.6	14.7	14.5	17.5	15.6	16.5	17.6
	PS	9.9	11.7	12.9	14.4	15.9	17.1	18.5	20.0	19.7	23.8	21.2	22.4	23.9
High Idling	rpm (min^{-1}) ± 25	1600	1900	2185	2380	2595	2805	3020	3235	3175	3770	3415	3630	3840
Engine Weight (Dry) with Flywheel Housing*		242 lb (110 kg) SAE#5		205 lb (93 kg)						242 lb (110 kg) SAE#5		187 lb (85 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		34.8 - 63.8 psi (0.240 -0.440 MPa, 2.4 - 4.4 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, 1.6 hp (1.2 kW)												
		Dynamo: DC12V, 20A												
		Recommended Battery Capacity: 12V, 36 Amp-Hour (5h rating)												
Dimensions (L × W × H)*		19.5 x 16.8 x 21.3 in. (497 × 427 × 542 mm)												
Engine Oil Pan Capacity		3.1 / 1.7 qt (2.9 / 1.6 L) (Dipstick Upper Limit / Lower Limit)								4.1 / 2.2 qt (3.9 / 2.1 L) (Dipstick Upper Limit / Lower Limit)		3.3 / 1.9 qt (3.1 / 1.8 L) (Dipstick Upper Limit / Lower Limit)		
Engine Coolant Capacity**		0.26 gal (1.0 L) Engine Only												
Standard Cooling Fan***		12.2 in. (310 mm) O.D., 5 Blade Pusher-Type												
Crank / Fan V-pulley Dia.***		3.9 / 3.5 in.(100 mm / 90 mm)												

* *Engine specifications without radiator*

** *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.*

*** *May vary depending on application*

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Connecting Rod

Connecting Rod Small End

Inspection Item	Standard		Limit		Reference Page
	3TNM68	3TNM72	3TNM68	3TNM72	
Wrist Pin Bushing Inside Diameter	0.7884 - 0.7891 in. (20.025 - 20.042 mm)	0.8671 - 0.8678 in. (22.025 - 22.042 mm)	0.7902 in. (20.072 mm)	0.7902 in. (20.072 mm)	*See Inspection of Connecting Rod on page 6-47*
Wrist Pin Outside Diameter	0.7872 - 0.7874 in. (19.995 - 20.000 mm)	0.8659 - 0.8661 in. (21.995 - 22.000 mm)	0.7861 in. (19.967 mm)	0.7861 in. (19.967 mm)	
Oil Clearance	0.0010 - 0.0019 in. (0.025 - 0.047 mm)		0.0041 in. (0.105 mm)		

Connecting Rod Big End

Inspection Item	Standard		Limit		Reference Page
	3TNM68	3TNM72	3TNM68	3TNM72	
Side Clearance	0.0079 - 0.0157 in. (0.20 - 0.40 mm)		-		*See Inspection of Connecting Rod on page 6-47*
Bearing Inside Diameter and Oil Clearance	*See Crankshaft on page 6-8*		-		

Connecting Rod Distortion

Inspection Item	Standard		Limit		Reference Page
	3TNM68	3TNM72	3TNM68	3TNM72	
Twist and Bend per 3.937 in.(100 mm)	Less than 0.001 in. (0.03 mm)		0.003 in. (0.08 mm)		*See Inspection of Connecting Rod on page 6-47*

Tappet

Inspection Item	Standard		Limit		Reference Page
	3TNM68	3TNM72	3TNM68	3TNM72	
Tappet Bore (Block) Inside Diameter	0.7087 - 0.7094 in. (18.000 - 18.018 mm)	0.8268 - 0.8276 in. (21.000 - 21.021 mm)	0.7102 in. (18.038 mm)	0.8284 in. (21.041 mm)	*See Inspection of Tappets on page 6-48*
Tappet Stem Outside Diameter	0.7067 - 0.7074 in. (17.950 - 17.968 mm)	0.8239 - 0.8252 in. (20.927 - 20.960 mm)	0.7059 in. (17.930mm)	0.8231 in. (20.907 mm)	
Oil Clearance	0.0013 - 0.0027 in. (0.032 - 0.068 mm)	0.0016 - 0.0037 in. (0.040 - 0.094 mm)	0.0043 in. (0.108 mm)	0.0053 in. (0.134 mm)	

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13. Remove the pinion stop **(Figure 10-10, (3))**, return spring (if equipped), and pinion clutch assembly **(Figure 10-10, (2))**, from the pinion shaft **(Figure 10-10, (1))**.

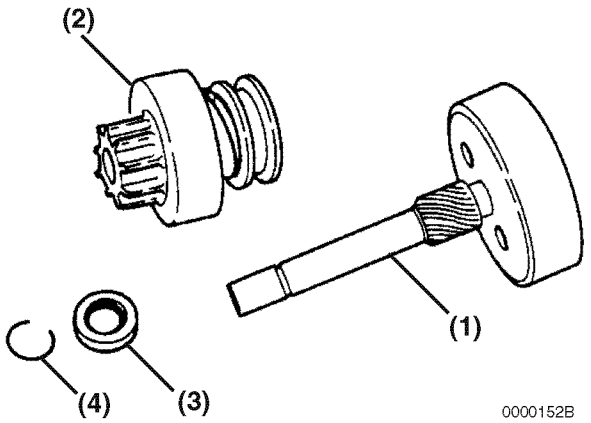


Figure 10-10

14. Remove the snap ring **(Figure 10-11, (1))**. Remove the pinion shaft **(Figure 10-11, (5))**, planetary gears **(Figure 10-11, (6))**, washers, and reduction gear **(Figure 10-11, (4))** from the intermediate housing **(Figure 10-11, (3))**.

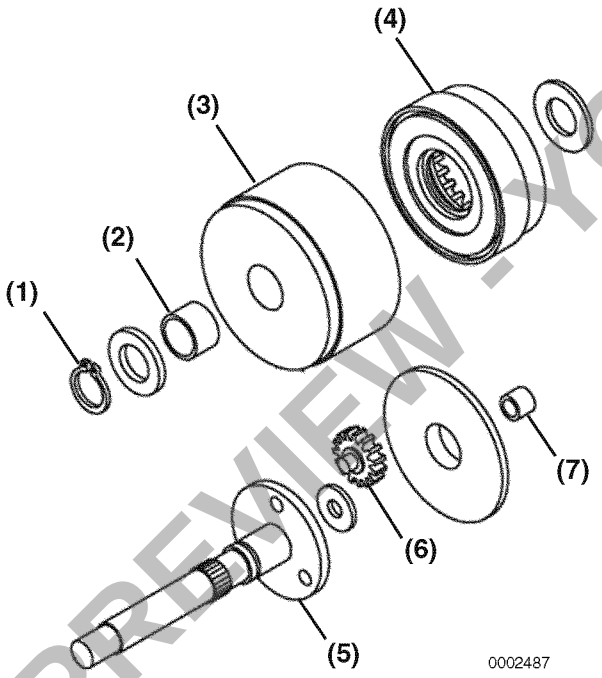


Figure 10-11

15. Inspect the intermediate bushing **(Figure 10-11, (2))** and replace if worn or damaged.
16. Inspect armature bushing **(Figure 10-11, (7))** and replace if worn or damaged.

Cleaning and Inspection

Armature

Commutator Surface Inspection

If the commutator surface is rough, polish the surface with a #500 to #600 emery cloth.

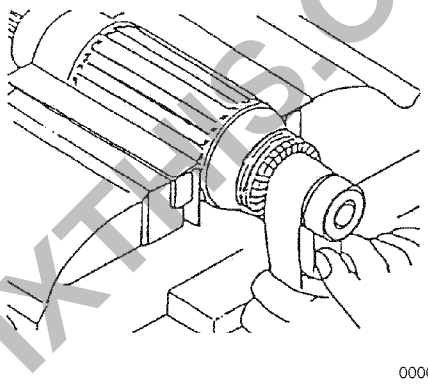


Figure 10-12

Measure Commutator Outside Diameter

Measure the commutator outside diameter. Replace the armature if the measurement is less than the limit. *See Starter Motor Specifications on page 10-6*.

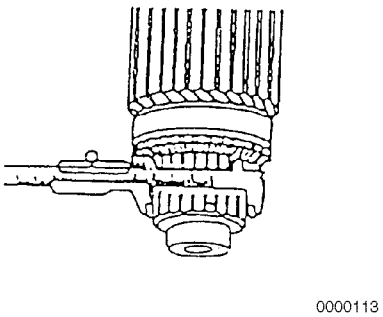


Figure 10-13

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