

YANMAR

SERVICE MANUAL

INDUSTRIAL ENGINES

3TNV88C

3TNV86CT

4TNV88C

4TNV86CT

4TNV98C

4TNV98CT

50950137, Revision B, 08/13

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The foregoing is YANMAR's only obligation to you and your exclusive remedy for breach of warranty. Failure to follow the requirements for submitting a claim under this warranty may result in a waiver of all claims for damages and other relief. **In no event shall YANMAR or any authorized industrial engine dealer or distributor be liable for incidental, special or consequential damages.** Such consequential damages may include, but not be limited to, loss of revenue, loan payments, cost of rental of substitute equipment, insurance coverage, storage, lodging, transportation, fuel, mileage, and telephone costs. The limitations in this warranty apply regardless of whether your claims are based on breach of contract, tort (including negligence and strict liability) or any other theory. Any action arising hereunder must be brought within one (1) year after the cause of action accrues or it shall be barred. Some states and countries do not allow certain limitations on warranties or for breach of warranties. **This warranty gives you specific legal rights, and you may also have other rights which vary from state to state and country to country.** Limitations set forth in this paragraph shall not apply to the extent that they are prohibited by law.

Warranty Modifications:

Except as modified in writing and signed by the parties, this warranty is and shall remain the complete and exclusive agreement between the parties with respect to warranties, superseding all prior agreements, written and oral, and all other communications between the parties relating to warranties. **No person or entity is authorized to give any other warranty or to assume any other obligation on behalf of YANMAR, either orally or in writing.**

Questions:

If you have any questions or concerns regarding this warranty, please call or write to the nearest authorized YANMAR industrial engine dealer or distributor or other authorized facility.

⚠ WARNING**Exposure Hazard!**

- Wear personal protective equipment such as gloves, work shoes, eye and hearing protection as required by the task at hand.
- Never wear jewelry, unbuttoned cuffs, ties or loose-fitting clothing when you are working near moving/rotating parts such as the cooling fan, flywheel or PTO shaft.
- Always tie back long hair when you are working near moving/rotating parts such as a cooling fan, flywheel, or PTO shaft.
- Never operate the engine while wearing a headset to listen to music or radio because it will be difficult to hear the alert signals.
- Failure to comply could result in death or serious injury.

Burn Hazard!

- If you must drain the engine oil while it is still hot, stay clear of the hot engine oil to avoid being burned.
- Always wear eye protection.
- Wait until the engine cools before you drain the engine coolant. Hot engine coolant may splash and burn you.
- 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**Burn Hazard!**

- Batteries contain sulfuric acid. Never allow battery fluid to come in contact with clothing, skin or eyes. Severe burns could result. Always wear safety goggles and protective clothing when servicing the battery. If battery fluid contacts the eyes and/or skin, immediately flush the affected area with a large amount of clean water and obtain prompt medical treatment.
- Failure to comply could result in death or serious injury.

High-Pressure Hazard!

- Avoid skin contact with the high-pressure diesel fuel spray caused by a fuel system leak such as a broken fuel injection line. High-pressure fuel can penetrate your skin and result in serious injury. If you are exposed to high-pressure fuel spray, obtain prompt medical treatment.
- Never check for a fuel leak with your hands. Always use a piece of wood or cardboard. Have your authorized YANMAR industrial engine dealer or distributor repair the damage.
- Failure to comply could result in death or serious injury.

Section 4

GENERAL SERVICE INFORMATION

	Page
Component Identification.....	4-3
Location of Labels	4-5
Engine Nameplate (Typical)	4-6
Emission Control Regulations	4-6
EPA/ARB Regulations - USA Only	4-6
Emission Control Labels.....	4-6
EPA/CARB labels (Typical)	4-6
The 97/68/EC Directive Certified Engines	4-7
Engine Family.....	4-7
Function of Major Engine Components	4-8
Function of Cooling System Components	4-9
Main Electronic Control Components and Features.....	4-10
Installation Position of Sensors	4-12
Crank Rotation Sensor	4-13
Cam Speed Sensor	4-13
New Air Temperature Sensor	4-14
EGR Temperature Sensor.....	4-14
Intake Temperature Sensor.....	4-14
Fuel Temperature Sensor (equipped on supply pump)	4-15
Cooling Water Temperature Sensor.....	4-15
Diesel Particulate Filter (DPF) Inside/Inlet, Exhaust Temperature Sensor.....	4-16
Rail Pressure Sensor.....	4-16
EGR Pressure Sensor	4-17
Diesel Particulate Filter (DPF) Differential Pressure Sensor ...	4-18
EGR Valve.....	4-19
Intake Air Throttles	4-20

Component/feature		Description
Engine diagnosis tool		Allows the operator to troubleshoot the cause of a problem based on detailed information regarding the problem occurring in the ECU. This tool can also be used for data maintenance tasks including programming and mapping. <i>See Failure Diagnosis on page 15-1.</i>
Option for service		
Engine coolant temperature sensor		Allows the fuel injection volume and ERG to be controlled in engine cold-start conditions.
Glow plugs	Optional	When the key switch is turned to the ON position, the glow plugs/air heater are/is energized for up to 15 seconds (glow plugs). The duration of energization depends on the engine coolant temperature. The HEAT indicator is on during energization. When the indicator goes out, turn the key switch to the START position to start the engine.
Droop control	Standard with VM series	Reduces the engine speed by a certain percentage from no load to full (rated) load in steady state operation. The same percentage droop is maintained even when the load increases at any no-load speed.
Isochronous control	Standard with CL series Optional with VM series	Offers a constant engine speed from no load to full load. The engine speed does not decrease even when the load increases at any no-load speed.
Low-idling speed up		When the engine is cold, increases the low-idling speed to up to 1000 min ⁻¹ (rpm) depending on the engine coolant temperature. When the coolant temperature reaches a predetermined value, this feature returns the engine speed to the normal low idle setting, thus reducing the warm-up time.
High-idling speed down	Turbocharged specification	The high-idling speed is controlled to 1500 min ⁻¹ when starting the engine in cold weather conditions (-15 °C or below). At least 10 seconds after the engine starts, the engine speed returns to the normal high idle setting by operating the accelerator lever, thus preventing the seizures of the turbocharger.
Auto deceleration	Optional	Brings the running engine in low idle mode automatically when the accelerator pedal is not operated for a predetermined period of time. When the pedal is operated, i.e., the accelerator sensor is activated, the low idle mode is cancelled.

Acceleration Sensor (YANMAR Standard)

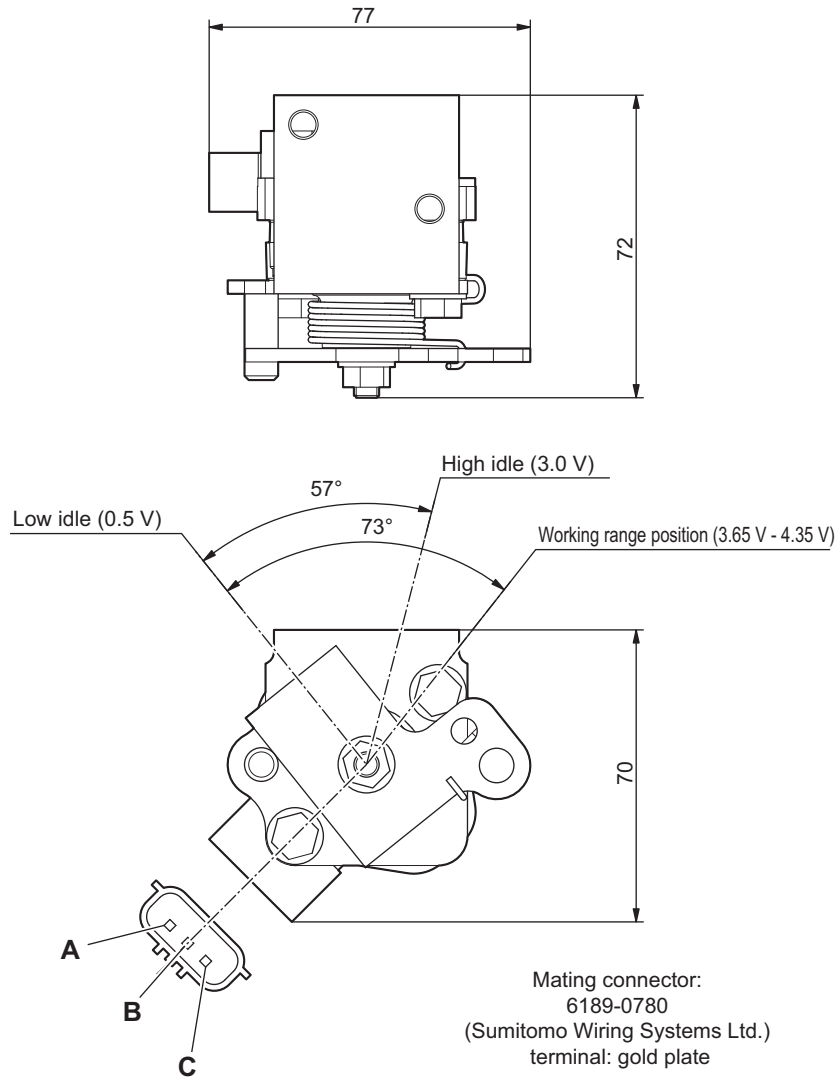


Figure 4-18

Terminal	Wire
A	GND GND-A
B	OUTPUT APS
C	INPUT AVCC

Rated voltage	DC 5 V ± 0.01 V
Part No.	129938-77800
Total resistance (sensor unit)	5 ± 1.5 kΩ

PRINCIPAL ENGINE SPECIFICATIONS

3TNV88C

Engine model	3TNV88C
Version	VM
Type	Vertical in-line diesel engine (Common rail system)
Combustion system	Direct injection
Aspiration	Naturally aspiration
No. of cylinders	3
Bore × stroke	88 × 90 mm
Displacement	1.642 ℓ
Max. rated output (Gross)	3000 min ⁻¹
	27.5 kW
	37.4 PS
High idling	3150 ± 25 min ⁻¹
Engine weight (Dry)	188 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	0.34 - 0.54 MPa
Normal oil pressure at low idle speed	0.06 MPa
Starting system	Electric starting (Starter motor: DC 12 V - 1.7 kW)
	Alternator (12 V - 55 A)
	Recommended battery capacity: 12 V 413CCA
Dimensions (L × W × H)	Depend on DPF layout
Engine oil pan capacity	6.7/3.9 ℓ Dipstick upper limit/lower limit)
Engine coolant capacity	2.0 ℓ (Engine only)
Standard cooling fan	ø335 pusher
Crank V-pulley dia./ fan V-pulley dia.	ø110/ø110 mm
Top clearance	0.73 ± 0.06 mm

UNIT CONVERSIONS

■ Unit prefixes

Prefix	Symbol	Power
mega	M	× 1,000,000
kilo	k	× 1,000
centi	c	× 0.01
milli	m	× 0.001
micro	μ	× 0.000001

■ Units of length

mile	×	1.6090	= km
ft	×	0.3050	= m
in.	×	2.5400	= cm
in.	×	25.4000	= mm
km	×	0.6210	= mile
m	×	3.2810	= ft
cm	×	0.3940	= in.
mm	×	0.0394	= in.

■ Units of volume

gal (U.S.)	×	3.78540	= ℓ
qt (U.S.)	×	0.94635	= ℓ
cu in.	×	0.01639	= ℓ
cu in.	×	16.38700	= ml
fl oz (U.S.)	×	0.02957	= ℓ
fl oz (U.S.)	×	29.57000	= ml
cm ³	×	1.00000	= ml
cm ³	×	0.03382	= fl oz (U.S.)

■ Units of mass

lb	×	0.45360	= kg
oz	×	28.35000	= g
kg	×	2.20500	= lb
g	×	0.03527	= oz

■ Units of force

lbf	×	4.4480	= N
lbf	×	0.4536	= kgf
N	×	0.2248	= lbf
N	×	0.1020	= kgf
kgf	×	2.2050	= lbf
kgf	×	9.8070	= N

■ Units of torque

ft-lb	×	1.3558	= N·m
ft-lb	×	0.1383	= kgf/m
in.-lb	×	0.1130	= N·m
in.-lb	×	0.0115	= kgf/m
kgf/m	×	7.2330	= ft-lb
kgf/m	×	86.8000	= in.-lb
kgf/m	×	9.8070	= N·m
N·m	×	0.7376	= ft-lb
N·m	×	8.8510	= in.-lb
N·m	×	0.1020	= kgf/m

■ Units of pressure

PSI	×	0.0689	= bar
PSI	×	6.8950	= kPa
PSI	×	0.0703	= kg/cm ²
bar	×	14.5030	= PSI
bar	×	100.0000	= kPa
bar	×	29.5300	= in.Hg (60 °F)
kPa	×	0.1450	= PSI
kPa	×	0.0100	= bar
kPa	×	0.0102	= kg/cm ²
kg/cm ²	×	98.0700	= PSI
kg/cm ²	×	0.9807	= bar
kg/cm ²	×	14.2200	= kPa
in.Hg (60°)	×	0.0333	= bar
in.Hg (60°)	×	3.3770	= kPa
in.Hg (60°)	×	0.0344	= kg/cm ²
mmAq	×	0.0394	= in.Aq

■ Units of power

hp (metric or PS)	×	0.9863201	= hp SAE
hp (metric or PS)	×	0.7354988	= kW
hp SAE	×	1.0138697	= hp (metric or PS)
hp SAE	×	0.7456999	= kW
kW	×	1.3596216	= hp (metric or PS)
kW	×	1.3410221	= hp SAE

■ Units of temperature

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

$$^{\circ}\text{C} = 0.556 \times (^{\circ}\text{F} - 32)$$

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, (3)**) as needed until the level is between the upper and lower lines shown on the dipstick (**Figure 5-3, (1)**).

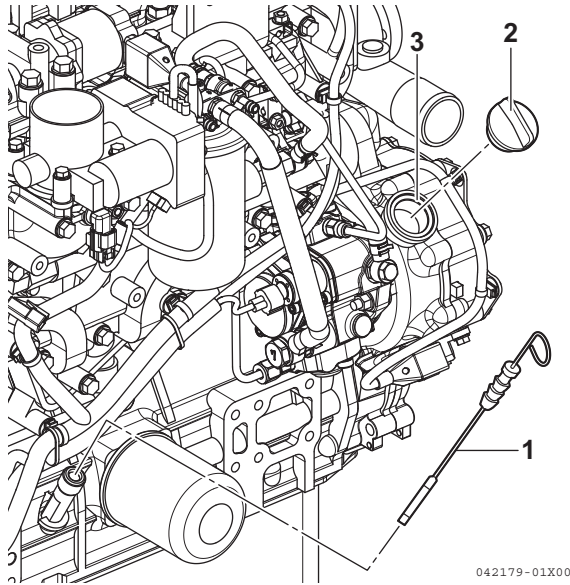


Figure 5-3

9. Reinstall the oil filler cap (**Figure 5-3, (2)**). 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:

Used V-belt tension		
A	B	C
3/8 - 1/2 in. (10 - 14 mm)	1/4 - 3/8 in. (7 - 10 mm)	5/16 - 1/2 in. (9 - 13 mm)

Note: A "Used V-belt" refers to a V-belt which has been used on a running engine for five minutes or more.

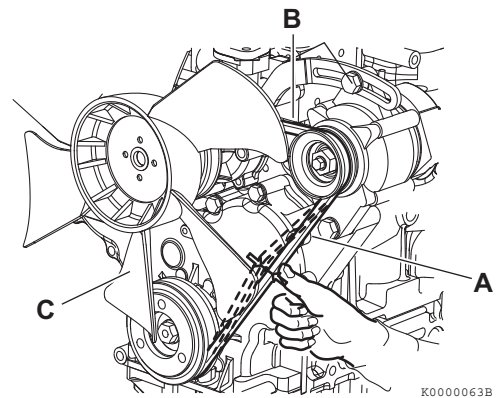


Figure 5-4

2. If necessary, adjust the V-belt tension. Loosen the adjusting bolt (**Figure 5-5, (1)**) and the other related bolts and/or nuts, then move the alternator (**Figure 5-5, (2)**) with a pry bar (**Figure 5-5, (3)**) to tighten the V-belt to the desired tension. Then tighten the adjusting bolts and/or nuts.

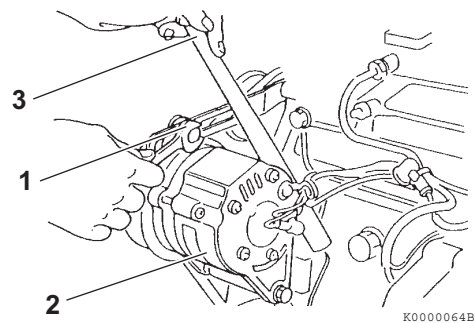


Figure 5-5

13. Open the fuel cock (**Figure 5-14, (3)**).
14. Prime the fuel system. See *Priming the Fuel System* on page 4-24.

NOTICE

Be sure to perform priming. If air is mixed to the fuel, seizure to the supply pump and the injector may result.

15. Check for leaks.

Every 1000 Hours of Operation

Perform the following maintenance every 1000 hours of operation.

- **Change coolant**
- **Adjust intake/exhaust valve clearance (if required)**

⚠ 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.**

Intake/Exhaust Valve and Guide

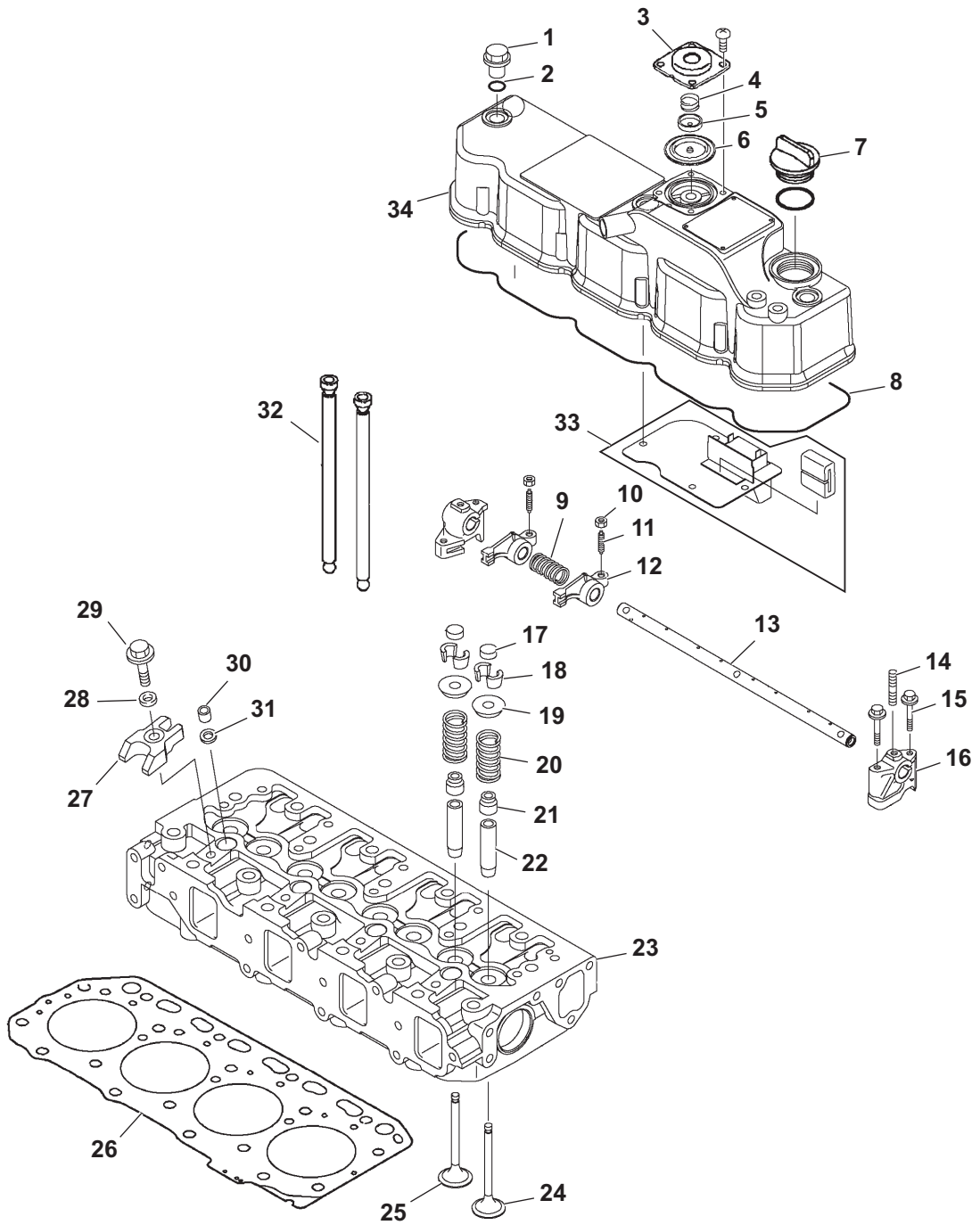
Inspection item			Standard	Limit	Reference page
3TNV88C, 3TNV86CT, 4TNV88, 4TNV86CT	Intake	Guide inside diameter	0.3154 - 0.3159 in. (8.010 - 8.025 mm)	0.3189 in. (8.10 mm)	<i>See Inspection of valve guides on page 6-33.</i>
		Valve stem outside diameter	0.3132 - 0.3140 in. (7.955 - 7.975 mm)	0.3110 in. (7.90 mm)	
		Valve stem bend	0.0014 - 0.0028 in. (0.035 - 0.070 mm)	0.0071 in. (0.18 mm)	
	Exhaust	Guide inside diameter	0.3156 - 0.3161 in. (8.015 - 8.030 mm)	0.3189 in. (8.10 mm)	
		Valve stem outside diameter	0.3132 - 0.3134 in. (7.955 - 7.960 mm)	0.3110 in. (7.90 mm)	
		Valve stem bend	0.0018 - 0.0030 in. (0.045 - 0.075 mm)	0.0071 in. (0.18 mm)	
4TNV98C, 4TNV98CT	Intake	Guide inside diameter	0.2756 - 0.2762 in. (7.000 - 7.015 mm)	0.2787 in. (7.08 mm)	<i>See Inspection of valve guides on page 6-33.</i>
		Valve stem outside diameter	0.2734 - 0.2740 in. (6.945 - 6.960 mm)	0.2717 in. (6.90 mm)	
		Oil clearance	0.0016 - 0.0028 in. (0.040 - 0.070 mm)	0.0067 in. (0.17 mm)	
	Exhaust	Guide inside diameter	0.2756 - 0.2762 in. (7.000 - 7.015 mm)	0.2787 in. (7.08 mm)	
		Valve stem outside diameter	0.2732 - 0.2738 in. (6.940 - 6.955 mm)	0.2717 in. (6.90 mm)	
		Valve stem bend	0.0018 - 0.0030 in. (0.045 - 0.075 mm)	0.0067 in. (0.17 mm)	
Valve guide projection from cylinder head		3TNV88C, 3TNV86CT, 4TNV88C, 4TNV86CT, 4TNV98C, 4TNV98CT	0.5791 - 0.5905 in. (14.71 - 15.00 mm)	—	<i>See Reassembly of valve guides on page 6-36.</i>
Valve guide installation method			Cold-fitted	—	
Valve stem seal projection from cylinder head		3TNV88C, 3TNV86CT, 4TNV88C, 4TNV86CT, 4TNV98C, 4TNV98CT	0.736 - 0.748 in. (18.7 - 19.0 mm)	—	<i>See Reassembly of intake and exhaust valves on page 6-36</i>

CYLINDER BLOCK SPECIFICATIONS**Cylinder Block**

Inspection item	Model	Standard	Limit	Reference page
Cylinder inside diameter	3TNV88C - 4TNV88C	3.4646 - 3.4657 in. (88.000 - 88.030 mm)	3.4724 in. (88.200 mm)	<i>See Inspection of cylinder block on page 6-52.</i>
	3TNV86CT, 4TNV86CT	3.3858 - 3.3870 in. (86.000 - 86.030 mm)	3.3937 in. (86.200 mm)	
	4TNV98C, 4TNV98CT	3.8583 - 3.8594 in. (98.000 - 98.030 mm)	3.8634 in. (98.130 mm)	
Cylinder bore	Roundness	0.0004 in. (0.01 mm) or less	0.0012 in. (0.03 mm)	
	Taper			

CYLINDER HEAD

Cylinder Head Components



K0001919

Figure 6-1

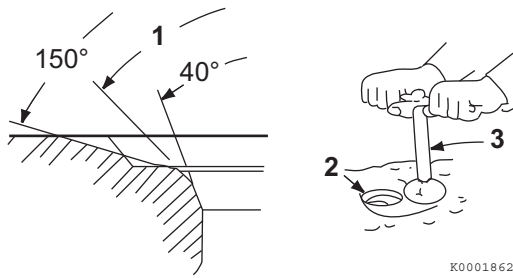


Figure 6-24

The valve seat diameter can be adjusted by top-grinding with a 150° stone to make the seat diameter smaller, and bottom-grinding using a 40° stone to make the seat diameter larger. Once the seat location has been corrected, grind and lap the seat angle (**Figure 6-24, (1)**) to specification. See *Cylinder Head* on page 6-4 for specifications.

Grind the valve face and/or valve seat only enough to return them to serviceable condition. Grinding is needed if the valve and the valve seat do not contact correctly. Check the recession after grinding.

If the valve or seat require grinding, lap the valve after grinding. Lap the valve face to the valve seat using a mixture of valve lapping compound and engine oil.

Be sure to thoroughly wash all parts to remove all grinding powder or compound.

■ Inspection of valve springs

Inspect the valve springs. If damage or corrosion is seen, or if measurements exceed the specified limits, replace the springs.

Fractures

Check for fractures on the inside and outside portions of the springs. If the valve spring is fractured, replace the valve spring.

Corrosion

Check for corrosion of the spring material caused by oxidation.

Squareness

Use a flat surface and a square to check each spring for squareness (**Figure 6-25**). See *Valve Spring* on page 6-6 for the service limit.

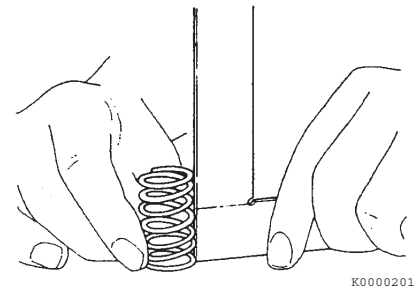


Figure 6-25

Free length

Use a caliper to measure the length of the spring (**Figure 6-26**). See *Valve Spring* on page 6-6 for the service limit.

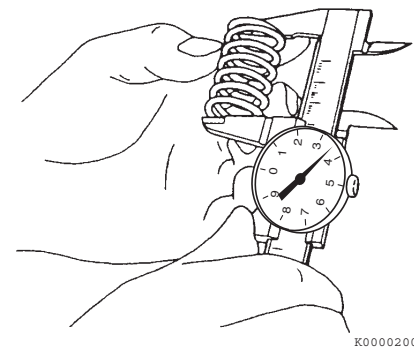


Figure 6-26

■ Measuring idler gear-to-crankshaft gear backlash

1. Install a dial indicator as shown in **Figure 6-44**.

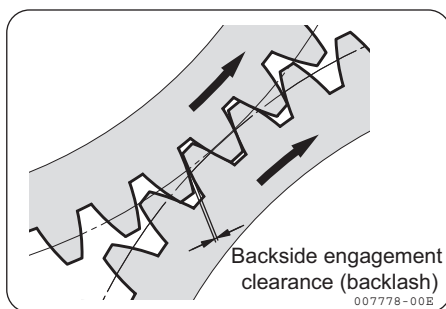
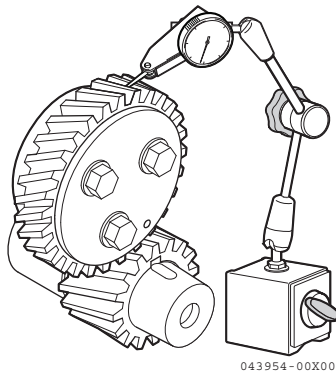


Figure 6-44

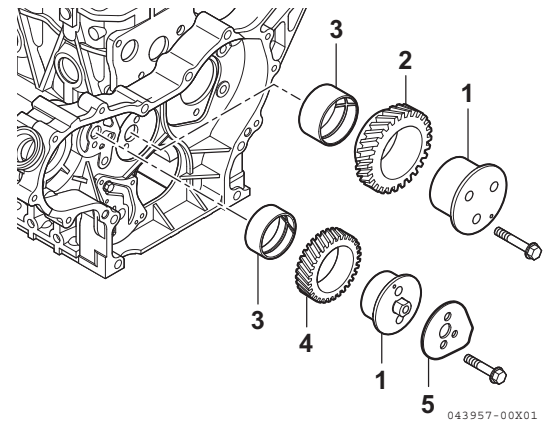
2. Rotate the idler gear back and forth to check the idler gear-to-crankshaft gear backlash. The total indicator reading is the backlash. Record the measurement.

■ 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 6-45, (1)**). Remove the idler gear shaft, idler gear (**Figure 6-45, (2)**) and bushing (**Figure 6-45, (3)**).



- 1 – Idler gear shaft
- 2 – Idler gear (B)
- 3 – Idler gear bushing
- 4 – Idler gear (A)
- 5 – Plate, idle shaft

Figure 6-45

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 6-46.*
4. Remove the supply pump drive gear using a gear puller.

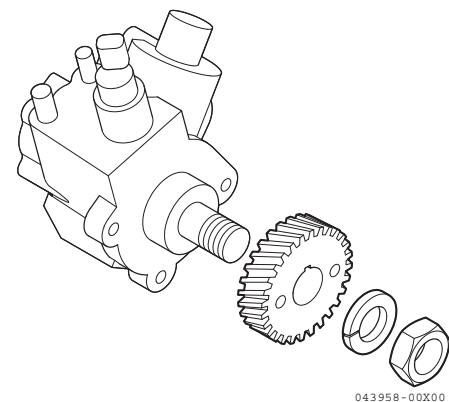


Figure 6-46

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■ Inspection of tappets

1. Inspect the tappet contact surfaces for abnormal wear (**Figure 6-74, (1)**). Normal wear will be even as shown in (**Figure 6-74, (2)**). Slight surface defects can be corrected using an oilstone.

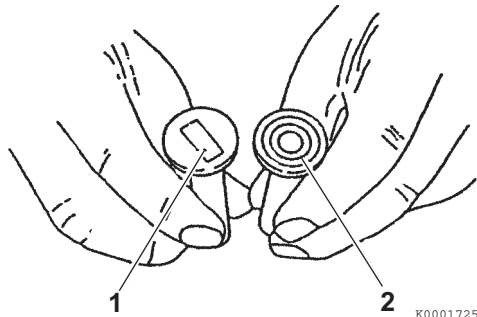


Figure 6-74

2. Measure the outside diameter of the tappet stem (**Figure 6-75, (1)**). See *Tappet* on page 6-14 for the service limit.

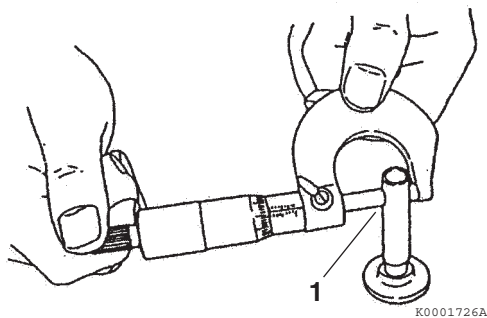


Figure 6-75

3. Measure the tappet bores in the cylinder block. See *Tappet* on page 6-14 for the service limit.

■ Inspection of crankshaft

1. Place the crankshaft end journals (**Figure 6-76, (4)**) on V-blocks.
2. Place a dial indicator (**Figure 6-76, (3)**) on a center main bearing surface.

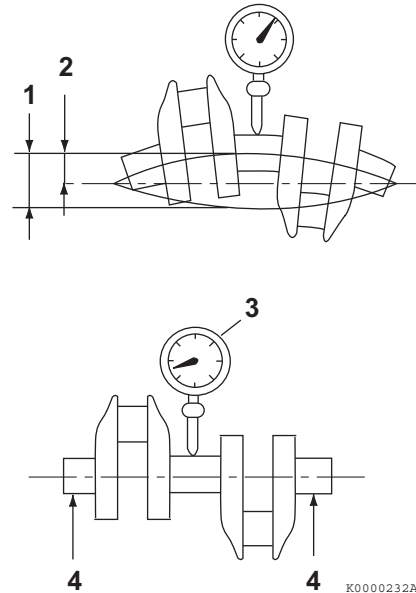
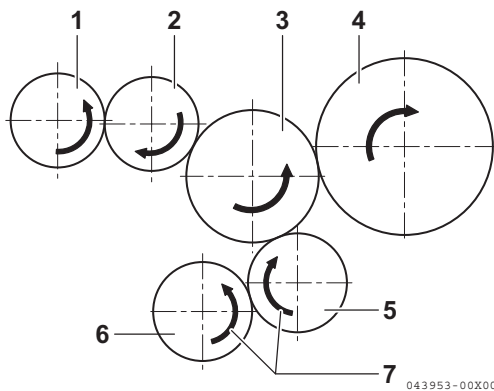


Figure 6-76

3. Rotate the crankshaft and observe runout. See *Crankshaft* on page 6-9 for specifications.
4. Use the color check method or Magnaflux® to inspect the crankshaft for cracks. Replace the crankshaft if evidence of fractures are found.
5. Measure the outside diameter of each crankpin (**Figure 6-77, (2)**) and main bearing journal (**Figure 6-77, (1)**). See *Crankshaft* on page 6-9 for specifications. Take measurements at several places around each bearing surface. If not within specification, grind the journals and install undersize bearings, or replace the crankshaft.

■ Installation of timing gears

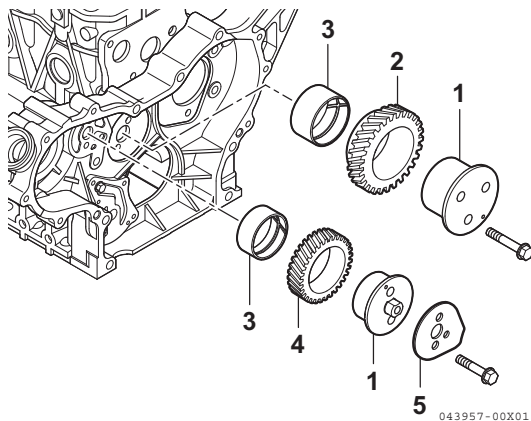
1. Set the No. 1 piston to top dead center.
2. Rotate the camshaft until the mark **(Figure 6-99, (C))** is approximately at the 9 o'clock position.



- 043953-00X00
- 1 – Supply pump gear
 - 2 – Idler gear (A)
 - 3 – Idler gear (B)
 - 4 – Camshaft gear
 - 5 – Crankshaft gear
 - 6 – Lubricating oil pump gear
 - 7 – Direction of rotation

Figure 6-99

3. Lubricate the idler gear **(Figure 6-100, (2))**, bushing **(Figure 6-100, (3))** and idler gear shaft **(Figure 6-100, (1))** with clean engine oil.



- 043957-00X01
- 1 – Idler gear shaft
 - 2 – Idler gear (A)
 - 3 – Idler gear bushing
 - 4 – Idler gear (B)
 - 5 – Plate, idle shaft

Figure 6-100

4. Align the timing gears as shown in **(Figure 6-99)**.
5. Reinstall the idler gear and idler gear shaft. Be sure the oil hole in the bushing is facing toward the top of the engine.
6. Ensure all three timing marks on idle gear A and two timing marks on idle gear B **(Figure 6-99, (A, B, C))** are aligned.
7. When all gears are properly aligned, tighten the idler gear retaining bolts to specified torque. *See Special Torque Chart on page 6-16 for specifications.*

■ Installation of gear case cover

1. Apply a continuous bead of ThreeBond Liquid Gasket No. 1207F, YANMAR Part No. 977770-1207F to the mounting area of the gear case cover **(Figure 6-101, (1))**. Be sure to circle the bolt holes.
2. Reinstall and tighten the gear case cover bolts.

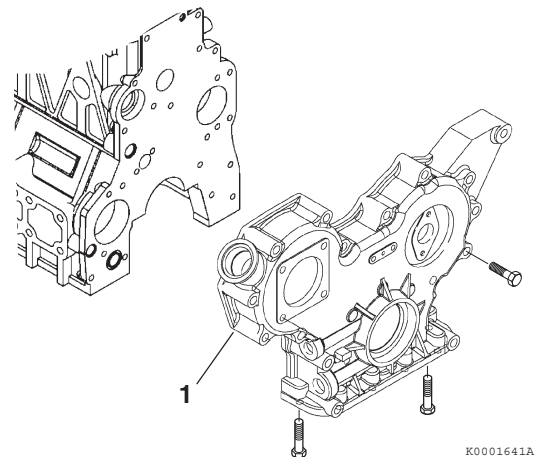


Figure 6-101

3. Reinstall the crankshaft pulley.

NOTICE

Use the crankshaft pulley installation tool **(Figure 6-102, (3))** when reinstalling the pulley **(Figure 6-102, (1))**. The tool will guide the pulley hub and protect the front seal **(Figure 6-102, (2))** from damage.

EGR Pipe and Other Connecting Elbows

The exhaust gas passage is subject to carbon deposition when used over time. To remove deposited carbon from the gas passage, use compressed air (0.19 MPa (2 kg/cm²) or lower). If the exhaust gas passage is heavily fouled, clean it by dipping it in carbon cleaner, kerosene, or some other liquid capable of removing carbon.

NOTICE



- 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.

Installing EGR Related Components/Parts

To install these components/parts, reverse the disassembly procedure described above: thus install the lead valve, spacer, EGR valve, EGR pipe, EGR cooler, elbow, cooler cooling water hose, and EGR cooling water hose exactly in this order.

The EGR system uses steel gaskets at the joints between its components/parts. When you remove the system's components/parts and reinstall them, replace the steel gaskets between them with new correct ones.

Removal of Common Rail

1. Remove the wiring of the injector coupler on the injector.

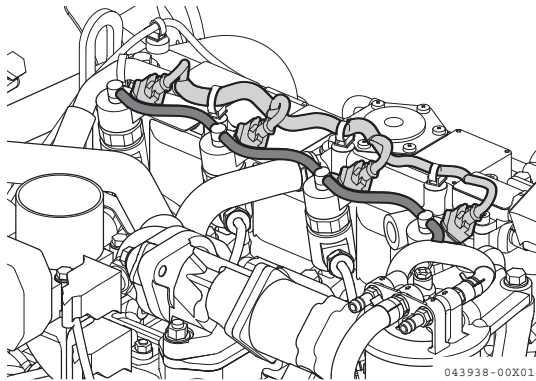


Figure 7-4

2. Remove the wiring coupler of the pressure sensor (Figure 7-6, (3)).

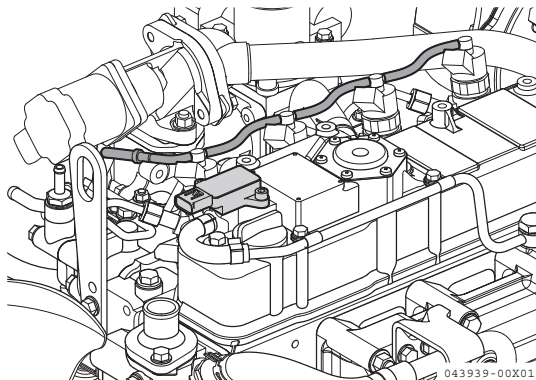


Figure 7-5

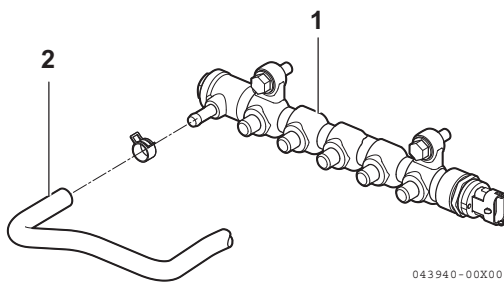


Figure 7-6

3. Remove the leak piping (Figure 7-6, (2)) from the pressure limiter (Figure 7-6, (1)).

4. Remove the fuel return hose from the injector. Pull out the fuel return hose connector (back leak rail connector) (Figure 7-7, (2)) vertically while fully pressing the retaining ring (clip) (Figure 7-7, (1)) attached on the top of the injector in the direction of the arrow A (Figure 7-7). Do not hold the hose. This may damage the hose. Do not reuse the removed clips.

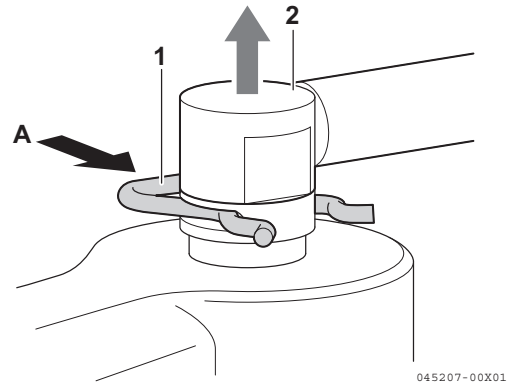


Figure 7-7

5. Removal of engine valve cover
Loosen the nuts and remove the engine valve cover.

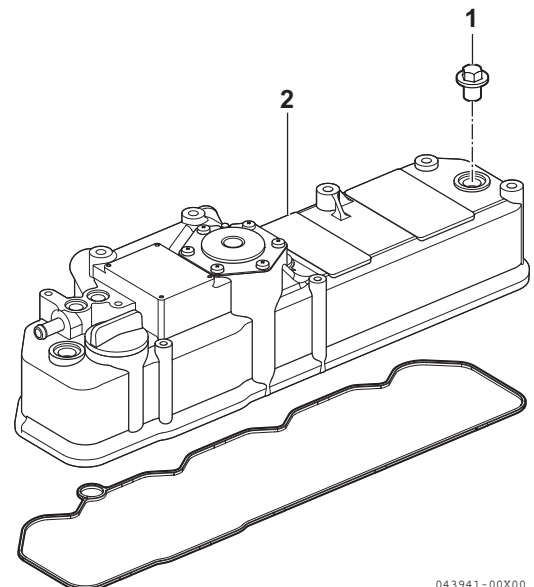


Figure 7-8

6. Removal of high-pressure pipe (1)
(Common rail - injector)
1- Clean around the cap nuts on both the injector and rail sides, using a brush or aspirator.

BEFORE YOU BEGIN SERVICING

Before performing any service procedures within this section, read the following safety information and review the *Safety* section on page 3-1.

BEFORE YOU BEGIN SERVICING

Before performing any service procedures within this section, read the following safety information and review the *Safety* section on page 3-1.

INTRODUCTION

This section of the Service Manual describes the procedures necessary to service the 3TNV88C to 4TNV86CT and 4TNV98C/4TNV98CT Trochoid oil pumps.

See Replace engine oil and engine oil filter on page 5-14 for engine oil and engine oil filter replacement procedures.

Section 10

TURBOCHARGER

	Page
Before You Begin Servicing	10-3
Introduction.....	10-4
Specifications	10-4
Turbocharger Service Information	10-4
Troubleshooting.....	10-5
Turbocharger Components	10-7
Turbocharger Component Functions.....	10-8
Theory of Operation.....	10-9
Compressor Side Sealing Mechanism	10-9
Waste Gate Modulation	10-9
Washing Procedure.....	10-10
Periodic Inspection	10-11
Visual Inspection	10-11
Inspection of Rotor Rotation.....	10-11
Inspection of Rotor Play	10-11
Removal of Turbocharger.....	10-11
Waste Gate Valve Test.....	10-13
Waste Gate Actuator Leak Test	10-13
Installation of Turbocharger.....	10-13

PERIODIC INSPECTION

Inspect the turbocharger at regularly scheduled intervals (for reference).

Visual Inspection

1. Check for indications of oil leaks at the oil inlet and outlet lines. Repair or replace the oil lines as needed.
2. Inspect the air inlet connection to the turbocharger's turbine side for cracks or broken hardware. Repair or replace the connection as needed.
3. Inspect the exhaust outlet connection to the turbocharger's compressor side for cracks or broken hardware. Repair or replace the connection as needed.

Inspection of Rotor Rotation

1. With the engine cool and not operating, manually rotate the rotor. Smooth rotation is normal. Any catching or resistance to rotation is an indication of abnormal operation. Replace the turbocharger or have it repaired by a qualified repair facility.
2. Start the engine.
3. After the engine reaches normal operating temperature, place a stethoscope firmly against the turbocharger case.
4. Increase the rpm gradually. A high-pitched sound, occurring at intervals of two or three seconds, is an indication of abnormal operation. Replace the turbocharger or have it repaired by a qualified repair facility.

Inspection of Rotor Play

To inspect the rotor, the turbocharger must be removed. Inspect for maximum rotor end play and run-out limits before reinstalling.

Removal of Turbocharger

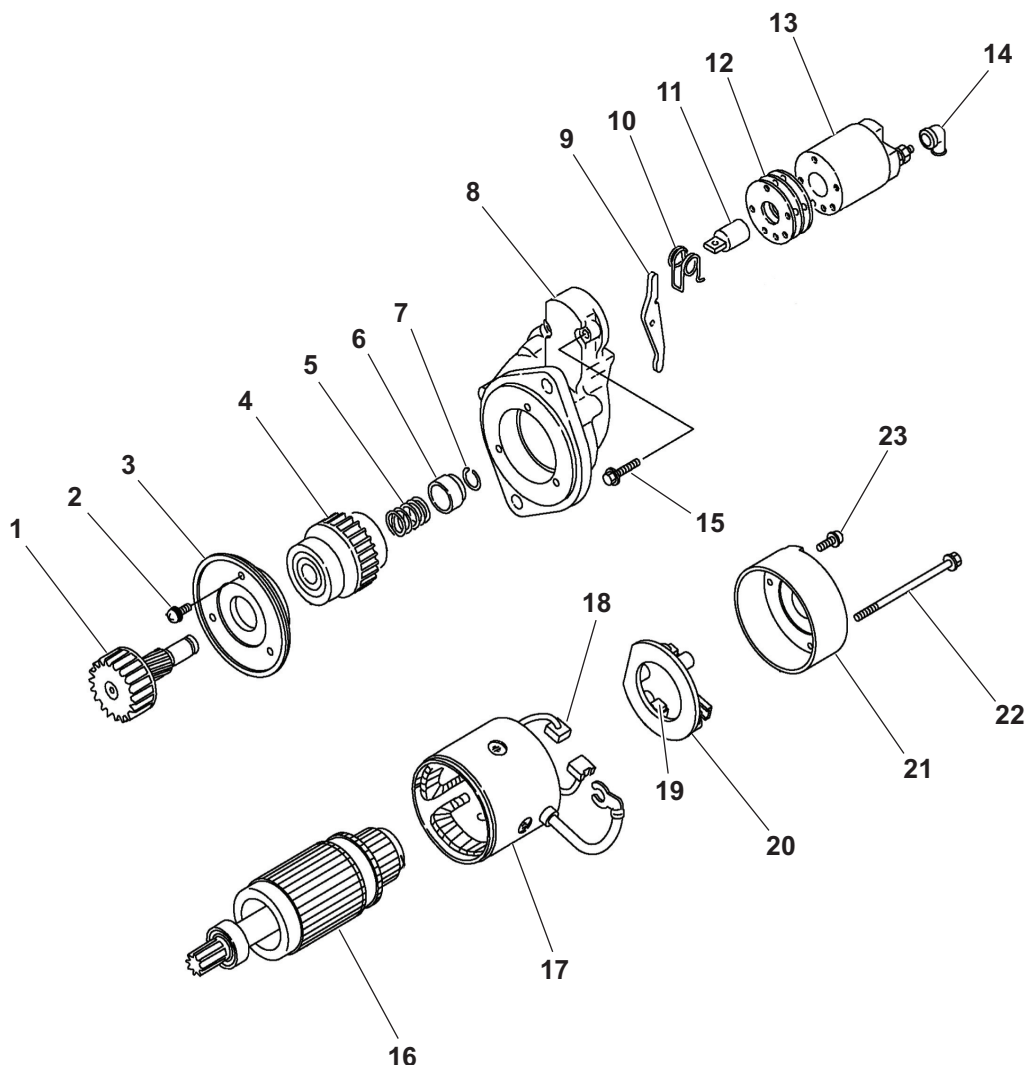
1. Shut down the engine and allow the turbocharger to cool. Remove the exhaust outlet connection from the turbocharger housing.
2. Remove the air inlet connection from the turbocharger housing.

NOTICE

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

3. Remove the inlet and outlet oil lines from the turbocharger. Plug the lines and ports with tape to prevent contamination. Discard the sealing washers and O-rings. Inspect the oil lines and replace if damaged.
4. Remove the turbocharger mounting nuts from the mounting studs. Lift the turbocharger from the engine and place it on a clean, level working surface.
5. Discard the turbocharger exhaust manifold gasket.

STARTER MOTOR COMPONENTS



K0000103A

- | | |
|---|---|
| <ul style="list-style-type: none"> 1 – Pinion shaft 2 – M4 bolts (3 used) 3 – Bearing retainer 4 – Pinion clutch assembly 5 – Return spring 6 – Pinion stop 7 – Retaining ring 8 – Gear housing 9 – Shift lever 10 – Torsion spring 11 – Plunger 12 – Dust covers (shims) | <ul style="list-style-type: none"> 13 – Magnetic switch assembly (solenoid) 14 – Cover 15 – M6 bolts (2 used) 16 – Armature assembly 17 – Field coil assembly 18 – Positive (+) brushes 19 – Negative (-) brushes 20 – Brush holder assembly 21 – Rear cover 22 – M5 through bolts (2 used) 23 – M4 bolts (2 used) |
|---|---|

Figure 11-1

Installation of Starter Motor

1. Reinstall the starter motor to the flywheel housing.
2. Reinstall the starter mounting bolts (**Figure 11-36, (1)**). Tighten the bolts to specification. See *Tightening Torques for Standard Bolts and Nuts* on page 4-39.

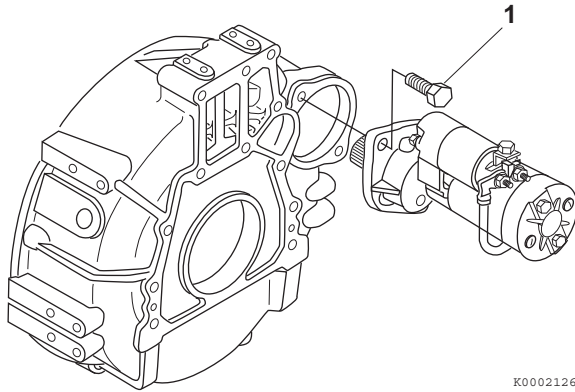


Figure 11-36

3. Reconnect the electrical wires to the magnetic switch assembly (solenoid). Be sure to place the cover over the battery positive (+) cable connection.
4. Reconnect the battery cables at the battery.

ALTERNATOR STANDARD OUTPUT

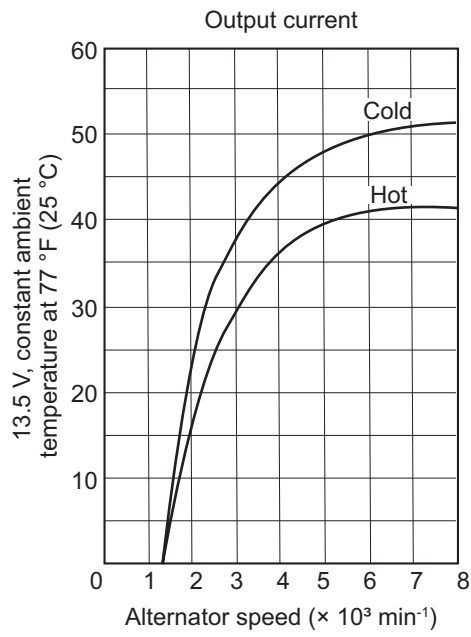


Figure 12-3

Disassembly of Dynamo

1. Remove the rear cover (Figure 12-24, (1)).
2. Remove the nut (Figure 12-24, (2)), lock washer (Figure 12-24, (3)), and flat washer (Figure 12-24, (4)).

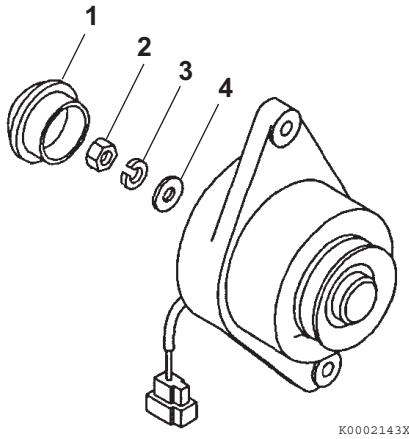


Figure 12-24

3. Remove the through bolt (Figure 12-25, (1)), pulley half (Figure 12-25, (2)), flywheel (Figure 12-25, (3)), flat washer (Figure 12-25, (4)), bearings (Figure 12-25, (5)), and spacer (Figure 12-25, (6)).

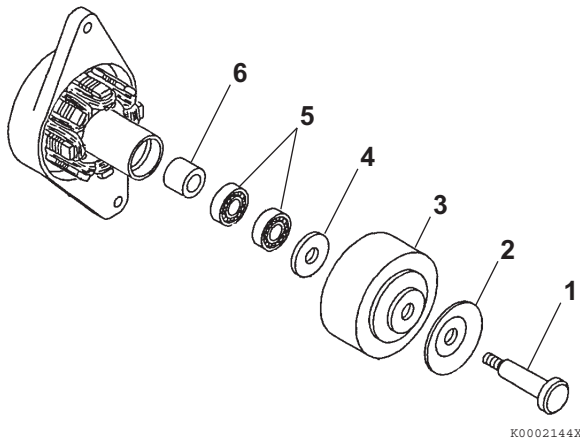


Figure 12-25

4. Remove the screws (Figure 12-26, (1)) and the stator assembly (Figure 12-26, (2)).
5. Remove the rear bearing (Figure 12-26, (3)).

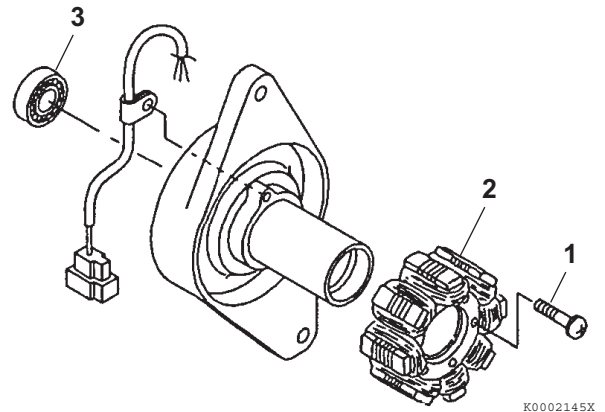


Figure 12-26

Reassembly of Dynamo

1. Reinstall the rear bearing (Figure 12-27, (3)).
2. Reinstall the stator (Figure 12-27, (2)) and screws.

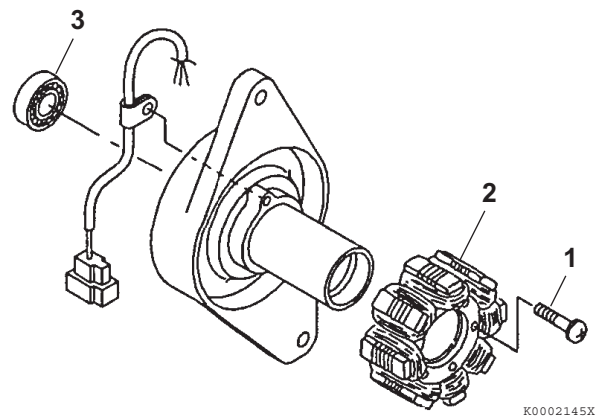


Figure 12-27

If the DPF regeneration request lamp is lit, immediately conduct the stationary regeneration by performing the following operation.

If the operation is continued with the DPF regeneration request lamp lit up, an excessive amount of PM will accumulate. Abnormal combustion of PM may cause fire and damage to the DPF.

Operation procedures of stationary regeneration

1. Move to a well-ventilated and safe location.
2. Move the accelerator lever to the lowest position and operate the engine in idling.

Note: If the DPF regeneration prohibition switch is installed, turn the DPF regeneration prohibition switch to "Regeneration Permitted".
3. Operate the interlock mechanism including the parking brake and activate the interlock function.

Note: When the ECU verifies that the interlock mechanism is enabled with the regeneration interlock switch, the DPF regeneration approval lamp starts blinking.
4. Press the DPF regeneration request switch for 3 seconds (standard) or longer to start the stationary regeneration. (The time required to start the stationary regeneration can be changed. Refer to the operation manual for the detailed operation.)
 - When the stationary regeneration starts, the engine speed increases gradually to high idle speed. Then the reset regeneration is performed at that operation condition.
 - When the stationary regeneration starts, the DPF regeneration request lamp turns off, the DPF regeneration approval lamp switches from blinking to continuously lit, and the exhaust temperature warning lamp lights up.
 - The stationary regeneration is complete after approximately 25 to 30 minutes.
 - If you want to interrupt the stationary regeneration, perform one of the following operations.
 - Turn the interlock switch to "Regeneration Disabled".

- Turn the DPF regeneration prohibition switch to "Regeneration Prohibited".
 - Raise the accelerator lever above the lowest position.
 - Turn off the power switch.
5. When the above-mentioned time has elapsed, the engine speed decreases to low idling, the regeneration approval lamp and the exhaust temperature warning lamp turn off, and the stationary regeneration is complete.

■ Precautions for stationary regeneration

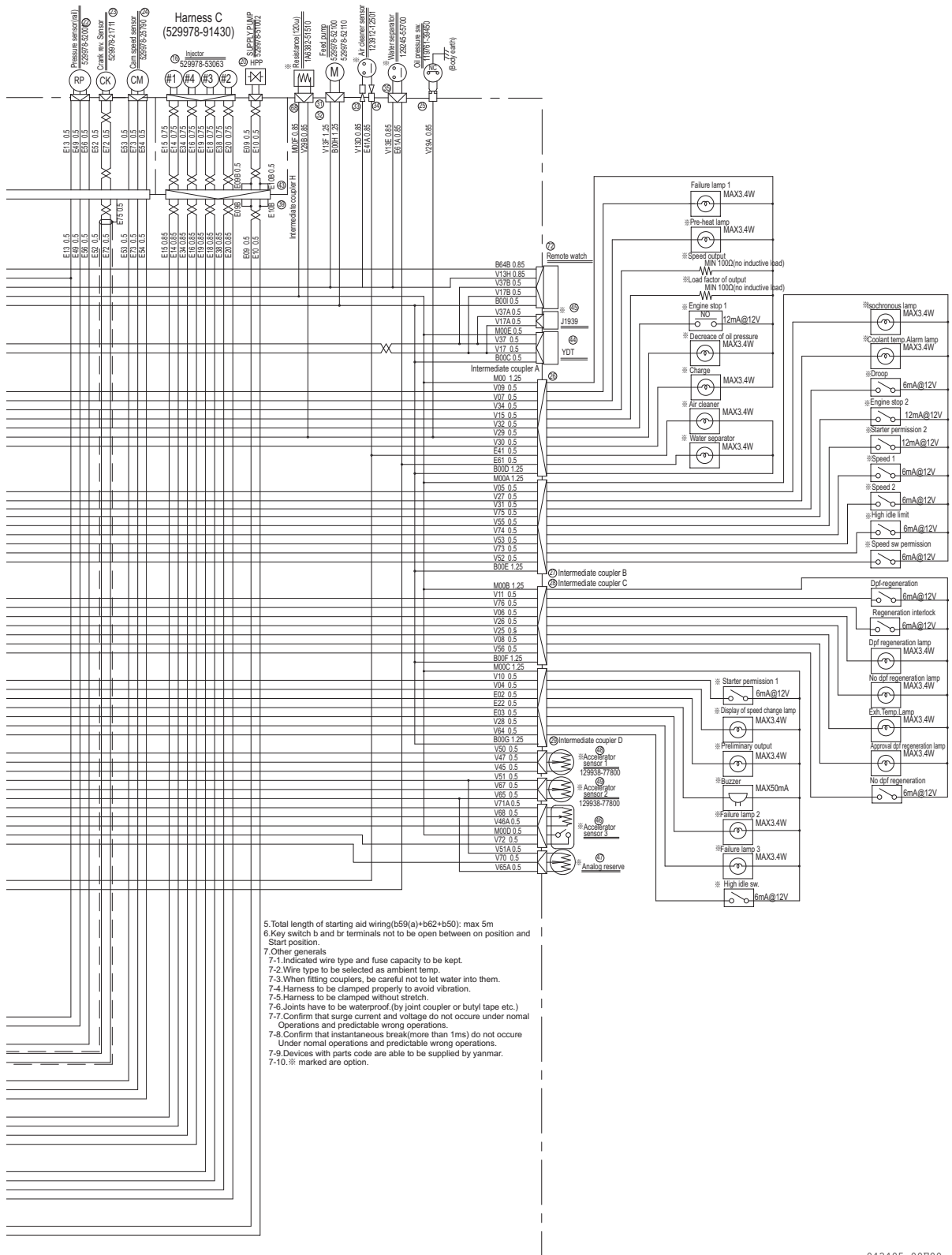
- Do not disconnect SMARTASSIST DIRECT (SAD) or the computer while performing the stationary regeneration. (Check the remaining battery level. Stationary regeneration takes approximately 1 hour to complete.)
- Be sure to check the remaining fuel level to avoid the engine from running out of fuel. (Stationary regeneration requires sufficient fuel that can run the engine for at least 1 hour.)
- Make sure that no other failure other than excessive deposits is observed.

■ Recovery regeneration (optional)

The DPF can not be regenerated by the reset regeneration or the stationary regeneration when the excessive PM is accumulated. Therefore, optional recovery regeneration function is available. The recovery regeneration requires longer regeneration time and lower temperature than that of the reset regeneration and the stationary regeneration. However, the function varies depending on the driven machine. For details, refer to the operation manual provided by the driven machine manufacturer for these functions.

■ Precautions for recovery regeneration

- Do not disconnect SMARTASSIST DIRECT (SAD) or the computer while performing the recovery regeneration. (Check the remaining battery level. Recovery regeneration takes approximately 4 hour to complete.)
- Be sure to check the remaining fuel level to avoid the engine from running out of fuel. (Recovery regeneration requires sufficient fuel that can run the engine for at least 4 hour.)
- Make sure that no other failure other than excessive deposits is observed.



042405-00E00

BATTERY CABLE RESISTANCE

AWG	mm ²	Maximum total battery cable length (positive cable + negative cable + a*) 12 V starter motor output			
		Less than 2.68 HP (2 kW)		Greater than 2.68 HP (2 kW)	
		m	ft	m	ft
6	15	1.5	4.75	N/A	N/A
4	20	2.3	7.4	N/A	N/A
2	30	3.8	12.6	2.3	7.5
1	40	4.6	15.3	2.8	9.2
0 (1/0)	50	5.9	19.5	3.5	11.6
00 (2/0)	60	7.0	22.8	4.2	13.7
000(3/0)	85	9.3	30.5	5.6	18.3
0000 (4/0)	100	11.9	39.0	7.1	23.4
00000 (5/0)	125	N/A	N/A	8.3	27.3
000000 (6/0)	150	N/A	N/A	10.1	33.3

Note:

- Total allowable resistance of the complete battery cable circuit (positive cable + negative cable + a*) (a*: Resistance (Ω) of a battery switch or other electrical equipment having high resistance).
- For starter motors of less than 2.68 HP (2 kW): the total resistance must be less than 0.002 Ω .
For starter motors of greater than 2.68 HP (2 kW): the total resistance must be less than 0.0012 Ω .

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