TNE series

SERVICE MANUAL

4TNE92-NMH • 4TNE92-NMHA
4TNE98-NMH

P/N: 0B2991-U0001

INDUSTRIAL ENGINES

Yanmar Limited Warranty - Continued

What is Not Covered by this Warranty?

This Warranty does not cover parts affected by or damaged by, but not limited to, accident, misuse, abuse, “Acts of God,” neglect, improper installation, improper maintenance, improper storage, the use of unsuitable attachments or parts, the use of contaminated fuels, the use of fuels, oils, lubricants, or fluids other than those recommended in your Yanmar Operation Manual, unauthorized alterations or modifications, ordinary wear and tear, and rust or corrosion. This Warranty does not cover the cost of parts and / or labor required to perform normal / scheduled maintenance on your Yanmar engine. This Warranty does not cover consumable parts such as, but not limited to filters, belts, hoses, fuel injector nozzles, lubricants and cleaning fluids.

Warranty Limitations:

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.

Customer Registration

Customer registration is very important for the original retail purchaser to enable Yanmar to provide the best support for your engine.

At the time of purchase, Yanmar highly recommends registering the customer’s information through website http://www.yanmar.co.jp as soon as possible.

If it is not possible to access the website, please contact the nearest authorized Yanmar industrial engine dealer or distributor.

⚠ WARNING

SEVER HAZARD!

- Keep hands and other body parts away from moving / rotating parts such as the cooling fan, flywheel or PTO shaft.
- Wear tight fitting clothing and keep your hair short or tie it back while the engine is running.
- Remove all jewelry before you operate or service the machine.
- NEVER start the engine in gear. Sudden movement of the engine and / or machine could cause death or serious personal injury.
- NEVER operate the engine without the guards in place.
- Before you start the engine make sure that all bystanders are clear of the area.
- Keep children and pets away while the engine is operating.
- Check before starting the engine that any tools or shop rags used during maintenance have been removed from the area.
- Failure to comply could result in death or serious injury.

0000002en

⚠ WARNING

EXHAUST HAZARD!

- NEVER operate the engine in an enclosed area such as a garage, tunnel, underground room, manhole or ship's hold without proper ventilation.
- NEVER block windows, vents, or other means of ventilation if the engine is operating in an enclosed area. All internal combustion engines create carbon monoxide gas during operation. Accumulation of this gas within an enclosure could cause illness or even death.
- Make sure that all connections are tightened to specifications after repair is made to the exhaust system.
- Failure to comply could result in death or serious injury.

0000003en

⚠ WARNING

ALCOHOL AND DRUG HAZARD!

- NEVER operate the engine while you are under the influence of alcohol or drugs.
- NEVER operate the engine when you are feeling ill.
- Failure to comply could result in death or serious injury.

0000004en

3. Observe the fuel level sight gauge **(Figure 4-2, (3))** and stop fueling when gauge shows fuel tank is full. NEVER overfill the fuel tank.
4. Replace the fuel cap **(Figure 4-2, (1))** and hand tighten. Over-tightening the fuel cap will damage it.

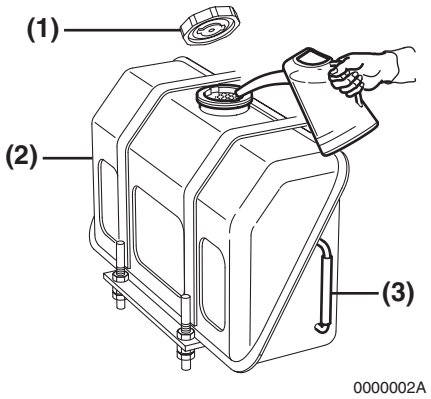


Figure 4-3

Priming the Fuel System

DANGER

FIRE AND EXPLOSION HAZARD!

- **Diesel fuel is extremely flammable and explosive under certain conditions.**
- **Place an approved container under the air bleed port when you prime the fuel system. Never use a shop rag to catch the fuel. Wipe up any spills immediately. ALWAYS close the air bleed port after you complete priming the system.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you open the air bleed port.**
- **If the unit has an electric fuel pump, turn the key switch to the ON position for 10 to 15 seconds, or until the fuel coming out of the air bleed port is free of bubbles, to allow the electric fuel pump to prime the system.**
- **If the unit has a mechanical fuel pump, operate the fuel priming pump several times until the fuel coming out of the air bleed port is free of bubbles.**
- **Failure to comply will result in death or serious injury.**

0000006en

4TNE98-NMH

Engine Model	4TNE98-NMH	
Version	VM	
Type	Vertical Inline Diesel Engine	
Combustion System	Indirect Injection	
Aspiration	Natural	
No. of Cylinders	4	
Bore × Stroke	3.86 x 4.33 in (98 × 110 mm)	
Displacement	202.5 cu in (3.319 L)	
Max. Rated Output (Net)	rpm (min^{-1})	2400
	hp SAE	63.6
	kW	47.4
	PS	64.4
High Idle Speed (Bare Engine)	2725 ± 25 rpm	
Low Idle Speed (Bare Engine)	850 ± 25 rpm	
Engine Weight (Dry)*	491.6 lb (194 kg)	
PTO Position	Flywheel Side	
Direction of Rotation	Counterclockwise Viewed From Flywheel Side	
Cooling System	Liquid-Cooled With Radiator	
Lubricating System	Forced Lubrication With Trochoid Pump At normal operating speeds, oil pressure is: 42 - 57 psi (0.29 - 0.39 MPa; 3.0 - 4.0 kgf/cm^2) At idle, oil pressure is: No less than 8.5 psi (0.06 MPa; 0.6 kgf/cm^2)	
Starting System	Electric Starting - Starter Motor: DC12V, 3.1 hp (2.3 kW)	
	Alternator: DC12V, 60A	
	Recommended Battery Capacity: 12V, 622 CCA (Cold Cranking Amps)	
Dimensions (L × W × H)*	24.9 x 19.6 x 28.0 in (632 x 498 x 711 mm)	
Engine Oil Pan Capacity	9.7 / 7.6 qt (9.2 / 7.2 L) (Dipstick Upper Limit / Lower Limit)	
Engine Coolant Capacity	1.11 gal (4.2 L) Engine Only	

* Engine Specifications Without Cooling Fan, Radiator, Muffler, and Air Cleaner.

⚠ 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.
- Securely tighten the radiator cap after you check the radiator. Steam can spurt out during engine operation if the cap is loose.
- ALWAYS check the level of engine coolant by observing the reserve tank.
- Failure to comply will result in death or serious injury.

0000002en

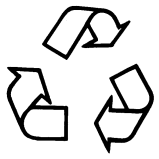
⚠ DANGER

FIRE AND EXPLOSION HAZARD!

- Diesel fuel is extremely flammable and explosive under certain conditions.
- Only fill fuel tank with diesel fuel. Filling fuel tank with gasoline may result in a fire.
- NEVER refuel with engine running.
- Wipe up all spills immediately.
- Keep sparks, open flames or any other form of ignition (match, cigarette, static electric source) away when fueling / refueling.
- NEVER overfill the fuel tank.
- Fill fuel tank and store fuel in a well-ventilated area only.
- Failure to comply will result in death or serious injury.

0000005en

CAUTION



Be environmentally responsible. Follow these procedures for hazardous waste disposal. Failure to follow these procedures may seriously harm the environment.

- Follow the guidelines of the EPA or other governmental agency 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.

0000013en

CAUTION

Protect the air cleaner, turbocharger (if equipped) and electric components from damage when you use steam or use high-pressure water to clean the engine.

0000014en

CAUTION

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

0000015en

CAUTION

NEVER use high pressure water or compressed air at greater than 28 psi or a wire brush to clean the radiator fins. Radiator fins damage easily.

0000016en

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 the idle speed limit screws require adjustment, see your authorized Yanmar industrial engine dealer or distributor.

0000017en

CAUTION

If the fuel filter / water separator is positioned higher than the fuel level in the fuel tank, water may not drip out when the fuel filter / water separator drain cock is opened. If this happens, turn the air vent screw on the top of the fuel filter / water separator 2-3 turns counterclockwise.

Be sure to tighten the air vent screw after the water has drained out.

0000025en

CAUTION

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

0000026en

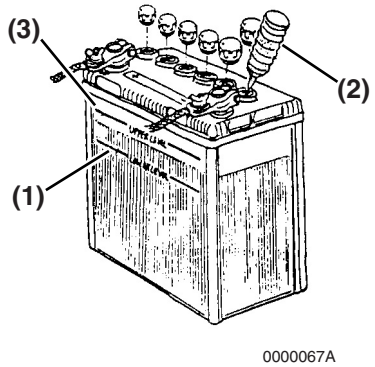


Figure 5-6

- When the amount of fluid nears the lower limit **(Figure 5-6, (1))**, fill with distilled water **(Figure 5-6, (2))** so it is at the upper limit **(Figure 5-6, (3))**. If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode. During the summer, check the fluid level more often than specified.
- If the engine cranking speed is so slow that the engine does not start, recharge the battery.
- If the engine still will not start after charging, have your authorized Yanmar industrial engine dealer or distributor check the battery and the engine's starting system.
- If operating the machine where the ambient temperature could drop to 5°F (-15°C) or less, remove the battery from the machine at the end of the day. Store the battery in a warm place until the next use. This will help start the engine easily at low ambient temperatures.

Clean Air Cleaner Element

Note that a typical air cleaner is shown in **Figure 5-7** and **Figure 5-8** for illustrative purposes only.

The engine performance is adversely affected when the air cleaner element is clogged with dust. Be sure to clean the air filter element periodically.

1. Unlatch and remove the air cleaner cover **(Figure 5-7, (1))**.
2. Remove the element **(Figure 5-7, (2))** (outer element if equipped with two elements).

⚠ CAUTION

FLYING OBJECT HAZARD!

- **ALWAYS wear eye protection when servicing 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.**

0000003en

Every 2000 Hours of Operation

Perform the following maintenance every 2000 hours of operation.

- **Replace Air Cleaner Element**
- **Inspect Clean and Test Fuel Injectors**

Replace Air Cleaner Element

CAUTION

The maximum air intake restriction shall be 0.90 psi (6.23 kPa; 635 mm Aq) or less. Clean or replace the air cleaner element if the air intake restriction exceeds the above mentioned value.

0000046en

Replace the air cleaner element **(Figure 5-7, (2))** every 2000 hours even if it is not damaged or dirty.

When replacing the element, clean the inside of the air cleaner case **(Figure 5-7, (4))**.

If the air cleaner is equipped with a double element, *only remove and replace the inner element* **(Figure 5-8, (1))** *if the engine lacks power or the dust indicator actuates (if equipped).* This is in addition to replacing the outer element.

Inspect Clean and Test Fuel Injectors

WARNING

HIGH PRESSURE HAZARD!

- **Avoid skin contact with 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.**

0000008en

Proper operation of the fuel injectors is required to obtain the optimum injection pattern for full engine performance. The EPA / ARB requires that you have the injectors inspected, cleaned and tested every 2000 hours. *See Servicing the Fuel Injectors on page 7-35.*

Backlash of Each Gear

Inspection Item	Standard	Limit	Reference Page
Crankshaft Gear, Camshaft Gear, Idler Gear, Fuel Injection Pump Gear	0.0031 - 0.0055 in (0.08 - 0.14 mm)	0.0063 in (0.16 mm)	-
Lubricating Oil Pump Gear	0.0035 - 0.0059 in (0.09 - 0.15 mm)	0.0067 in (0.17 mm)	-

Cylinder Block

Inspection Item		Standard	Limit	Reference Page
Cylinder Inside Diameter	4TNE92	3.6220 - 3.6232 in (92.000 - 92.030 mm)	3.6272 in (92.130 mm)	*See Inspection of Cylinder Block on page 6-40*
	4TNE94	3.7008 - 3.7020 in (94.000 - 94.030 mm)	3.7059 in (94.130 mm)	
	4TNE98	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)	
	Inclination			

Crankshaft

Inspection Item		Standard	Limit	Reference Page
Bending (1/2 the dial gauge reading)		-	0.0008 in (0.02 mm)	*See Inspection of Crankshaft on page 6-45*
Connecting Rod Journals	Pin Outside Diameter	2.2816 - 2.2820 in (57.952 - 57.962 mm)	2.2796 in (57.902 mm)	
	Bearing Halves Inside Diameter	2.2835 - 2.2845 in (58.000 - 58.026 mm)	-	
	Bearing Halves Thickness	0.0587 - 0.0591 in (1.492 - 1.500 mm)	-	
	Oil Clearance	0.0015 - 0.0029 in (0.038 - 0.074 mm)	0.0059 in (0.150 mm)	
Crank Journal Selective Pairing	Journal Outside Diameter	2.5572 - 2.5576 in (64.952 - 64.962 mm)	2.5552 in (64.902 mm)	
	Bearing Halves Inside Diameter	2.5591 - 2.5598 in (65.000 - 65.020 mm)	-	
	Bearing Halves Thickness	0.0785 - 0.0791 in (1.995 - 2.010 mm)	-	
	Oil Clearance	0.0015 - 0.0027 in (0.038 - 0.068 mm)	0.0059 in (0.150 mm)	

Before You Begin Servicing

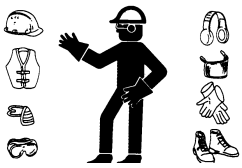
⚠ WARNING

SEVER 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.

0000010en

⚠ WARNING



EXPOSURE 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.

0000014en

⚠ CAUTION

FLYING OBJECT HAZARD!

- ALWAYS wear eye protection when servicing 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.

0000003en

CAUTION

- Only use the engine oil specified. Other engine oils may affect warranty coverage, cause internal engine components to seize, or shorten engine life.
- Prevent dirt and debris from contaminating 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.

0000005en

If the valve requires grinding, lap the valve after grinding.

Be sure to thoroughly wash the 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

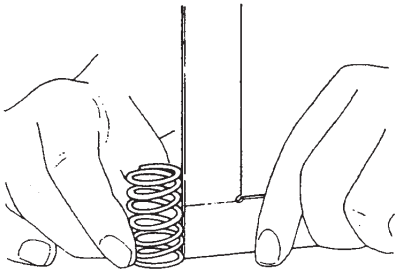
Check for fractures on the inside and outside portions of the springs. If the valve spring is fractured, replace the valve spring.

Corrosion

Check for corrosion of spring material caused by oxidation.

Square

Use a flat surface and a square to check each spring for squareness **(Figure 6-22)**. *See Valve Spring on page 6-6 for the service limit.*

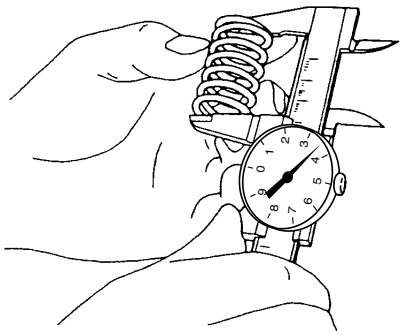


0000201

Figure 6-22

Free Length

Use a caliper to measure the length of the spring **(Figure 6-23)**. *See Valve Spring on page 6-6* for the service limit.



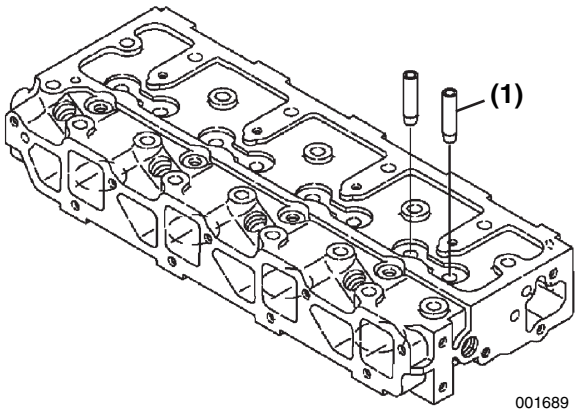
0000200

Figure 6-23

Assembly of Cylinder Head

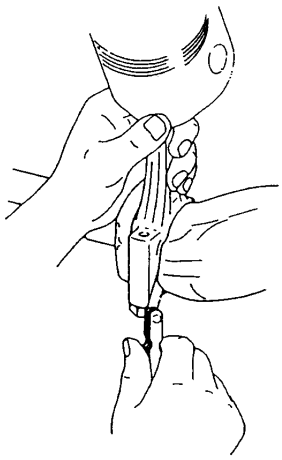
Assembly of Valve Guides

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 6-24, (1))** in their proper positions.



001689

Figure 6-24



0000219

Figure 6-43

2. Remove the two bolts from one of the connecting rod caps **(Figure 6-44, (1))**.

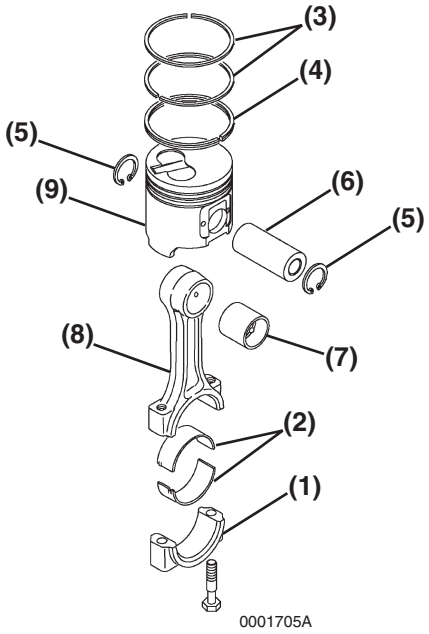


Figure 6-44

3. Remove the connecting rod cap.
4. Remove the bearing halves **(Figure 6-44, (2))**.
5. Tap the piston through the cylinder and remove the piston assembly with the large portion of the connecting rod. Place this assembly on the bench. Mark the connecting rod caps and the connecting rods so the caps and connecting rods stay together.
6. Using a ring pliers, remove the two compression rings **(Figure 6-44, (3))** from the piston.
7. Using a ring pliers, remove the oil seal ring **(Figure 6-44, (4))** from the piston.
8. Using a snap-ring pliers, remove the circlips **(Figure 6-44, (5))** from the wrist pin.
9. Dissemble the wrist pin **(Figure 6-44, (6))**, wrist pin bushing **(Figure 6-44, (7))**, connecting rod **(Figure 6-44, (8))** and piston **(Figure 6-44, (9))**.
10. Repeat Steps 1 through 9 until all of the pistons are removed and dissembled.

Removal of Crankshaft

1. Remove the flywheel bolts from the flywheel **(Figure 6-45, (1))**. Lift the flywheel away from the engine.
2. Remove the bolts from the rear oil seal assembly **(Figure 6-45, (2))**. Remove the assembly from the engine. Thoroughly clean all sealant from the oil seal housing.
3. Remove the rear oil seal **(Figure 6-45, (3))** if necessary.

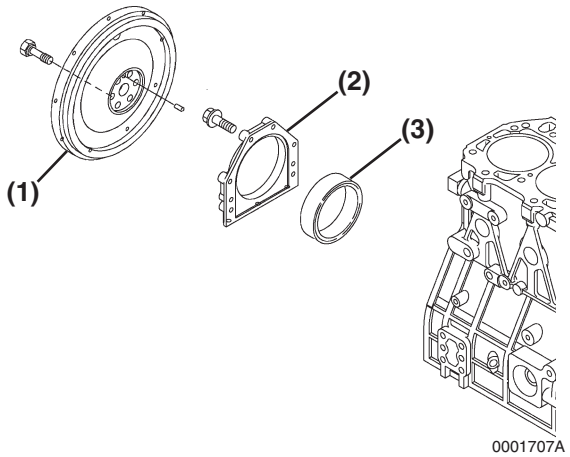


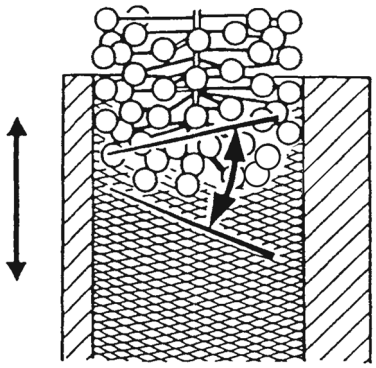
Figure 6-45

Honing and Boring

Pistons must move freely in the cylinders while maintaining adequate compression and oil sealing. If the cylinder walls are scuffed, scored, out of round or have poor cylindricity, boring or boring and honing might correct cylinder problems. Re-boring is necessary if the bore dimensions fall outside specified limits. Honing must follow any re-boring operations. Slight imperfections can be corrected by honing alone.

1. **Boring** - Significant cylinder damage might be corrected by re-boring.
   - Boring out a cylinder block can only be done in a properly equipped machine shop.
   - After re-boring, existing pistons must be replaced with over-sized pistons.
   - After re-boring a cylinder block, each cylinder must be honed.
2. **Honing** - Slight cylinder imperfections might be corrected by honing.

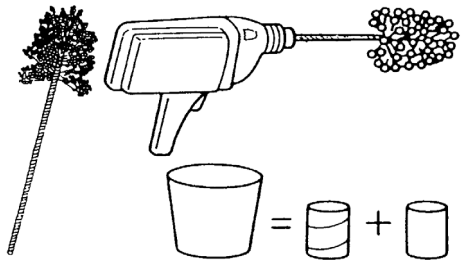
Note: Tilt the honing tool at a 30 to 40 degree angle during the honing operation, to leave a cross hatch mark on the cylinder wall. **(Figure 6-67)**



0000248

Figure 6-67

- Insert the appropriate honing tool in the chuck of an electric drill. **(Figure 6-68)**



0000247

Figure 6-68

- Saturate the cylinder wall with solvent using a 50-50 mixture of diesel fuel and engine oil.

CAUTION

Do not allow the honing tool to operate in one position for any length of time. Damage to the cylinder wall will occur. Keep the tool in constant up-and-down motion.

0000090en

- Rotate the honing tool at 300 to 1200 rpm.
- Insert the rotating honing tool in the cylinder and move it down through the entire length of the cylinder in a five-second motion.

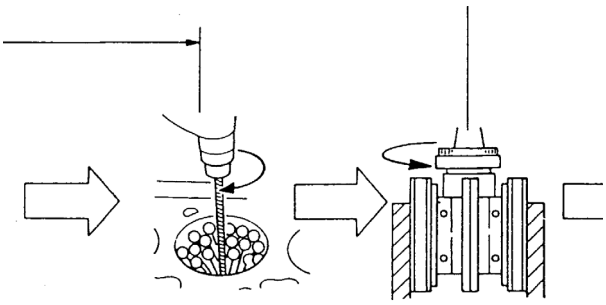


Figure 6-69

- Without stopping the honing tool, pull it up through the entire length of the cylinder in a five-second motion.

This section of the *Service Manual* describes the theory of operation of the fuel injection pump, the procedures necessary to remove and install the fuel injection pump and the procedures for inspecting and testing the fuel injectors.

⚠ WARNING

SEVER 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.**

0000010en

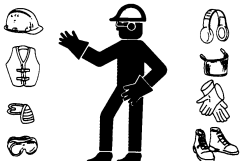
⚠ WARNING

SUDDEN MOVEMENT HAZARD!

- **Allow the engine to warm-up for at least 5 minutes to allow the engine idle speed to return to normal before engaging the transmission or any PTO attachments. Engaging the transmission or PTO at an elevated engine speed could result in an unexpected movement of the equipment.**
- **Failure to comply could result in death or serious injury.**

0000006en

⚠ WARNING



EXPOSURE 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.**

0000014en

⚠ CAUTION

FLYING OBJECT HAZARD!

- **ALWAYS wear eye protection when servicing 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.**

0000003en

Process

Suction Process

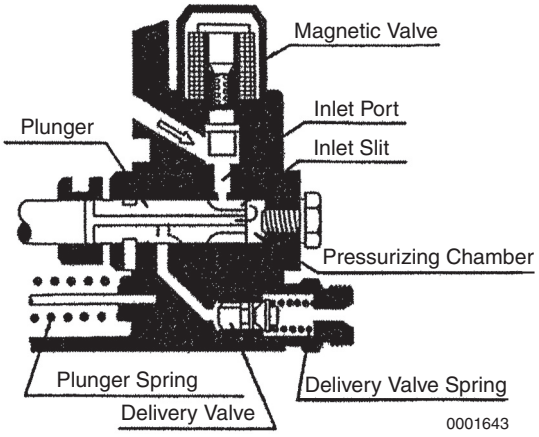


Figure 7-10

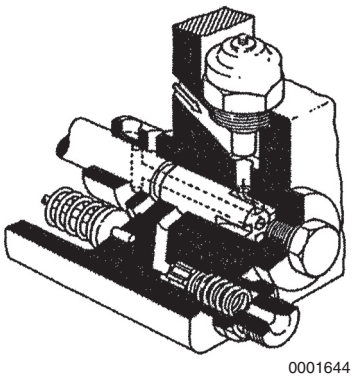


Figure 7-11

When the inlet port of the plunger barrel overlaps the inlet slit of the plunger during the lowering process of the plunger, the fuel in the pump chamber is drawn into the plunger.

Injection Process

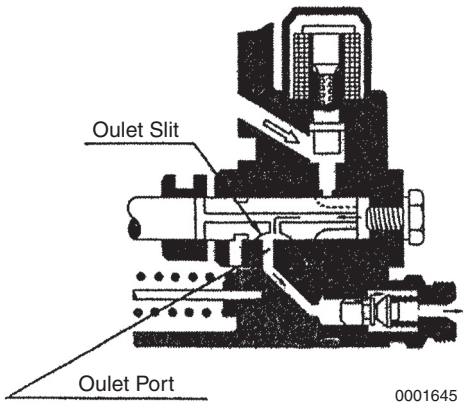


Figure 7-12

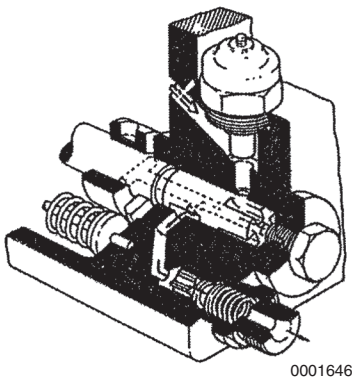


Figure 7-13

The plunger begins rotating at the same time the lifting process of the cam disc begins. When the inlet port of the plunger barrel is covered by the plunger, pressure feeding of fuel is initiated. At the same time, the highly pressurized fuel presses up the delivery valve when the outlet slit of the plunger meets the outlet port of the plunger barrel. The fuel is then injected into the engine combustion chamber via the nozzle and nozzle holder.

When the engine revolutions increase and the flyweight centrifugal force exceeds the governor spring set force, the governor sleeve moves to make the governor lever assembly turn clockwise with fulcrum M_2. As a result, the control sleeve moves in the direction of no-injection (to the left) for controlling speed so as not to exceed the full-load maximum speed.

When the accelerator pedal is not pressed down fully, the set force of the governor spring changes accordingly in order to achieve governor control based on the governor spring set force during partial load operation.

Full-Load Position Adjustment Mechanism

CAUTION

NEVER remove or attempt to remove the tamper-proof devices from the full-load fuel adjusting screw or the high-speed throttle limit screw on the fuel injection pump and governor assembly. These adjustments have been made at the factory to meet all applicable emissions regulations and then sealed.

NEVER attempt to make any adjustments to these sealed adjustment screws. If adjustments are required, they can be made only by a qualified fuel injection shop that will ensure the injection pump continues to meet all applicable emissions regulations and then replace the tamper-proof seals.

0000146en

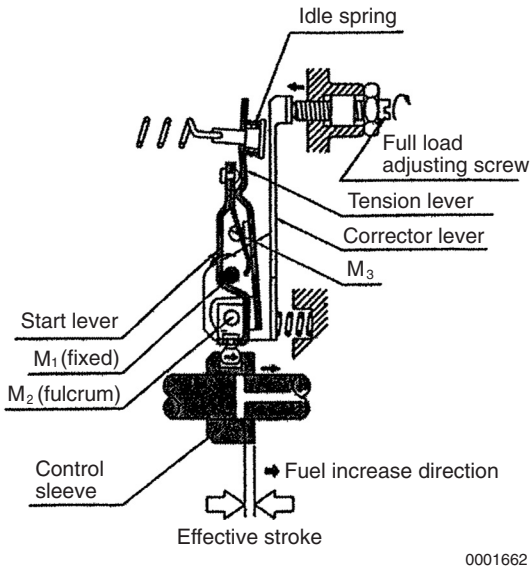


Figure 7-29

The full-load position is determined by the amount the full-load adjusting screw is driven. When the screw is driven, the corrector lever turns counterclockwise with M_1 being the fulcrum to move the control sleeve to the fuel increase direction.

When the screw is loosened, the control sleeve moves to the fuel decrease direction.

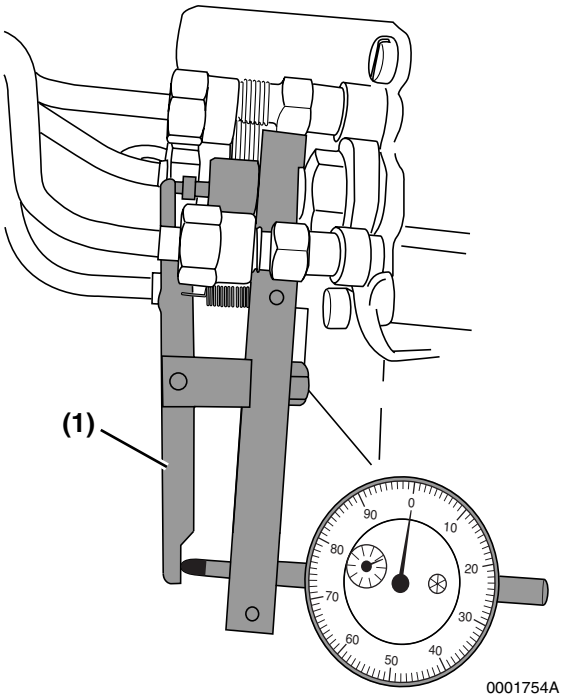


Figure 7-49

5. Rotate the engine about 25° in the counterclockwise direction. The dial indicator should move for approximately the first 10° of engine rotation and then stop. When you reach approximately the 25° position, rotate the engine slightly back and forth to make sure the needle of the dial indicator does not move.
6. Set the dial indicator to “0”.
7. Rotate the engine in the clockwise rotation until the timing mark on the crankshaft pulley is aligned with the mark at 4° or 6° ATDC (After Top Dead Center) on the timing grid on the gear case cover.

Note: Timing for the 4TNE92-NMH/NMHA models is 4° ATDC. Timing for the 4TNE98-NMH is 6° ATDC.

8. If the injection timing is correct, the dial indicator should read 0.038 - 0.041 in (0.97 - 1.03 mm).
9. If the injection timing is not correct, loosen the three fuel Injection pump mounting nuts and the bolts retaining the bottom / rear L-shaped injection pump mounting brackets. Rotate the injection pump to bring the dial indicator reading into the correct range.
10. Then retighten the pump mounting nuts and the mounting bracket bolts.

Note: Rotating the injection pump away from the engine advances the injection timing. Rotating the injection pump toward the engine retards the injection timing.

11. Remove the timing tool and dial indicator. Replace and tighten the center bolt and sealing washer into the injection pump port.

⚠ CAUTION

FLYING OBJECT HAZARD!

- **ALWAYS wear eye protection when servicing 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.**

0000003en

⚠ 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.

0000014en

CAUTION

- **Only use the engine coolant specified. Other engine coolants may affect warranty coverage, cause an internal build up of rust and scale and / or shorten engine life.**
- **Prevent dirt and debris from contaminating 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.**

0000006en

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

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.

0000042en

MEASURING INSTRUMENTS

2. Remove coolant pump pipe **(Figure 8-11, (3))** from engine block. Discard the O-rings **(Figure 8-11, (4))**.
3. Remove the bolts **(Figure 8-11, (5))** holding the cover **(Figure 8-11, (7))** on the pump**.** Discard the gasket **(Figure 8-11, (8))**.

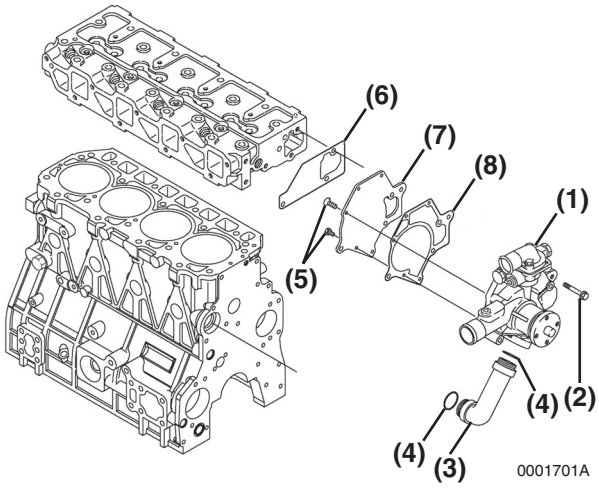


Figure 8-11

4. Remove the thermostat cover **(Figure 8-12, (1))**. Discard the gasket **(Figure 8-12, (2))**.

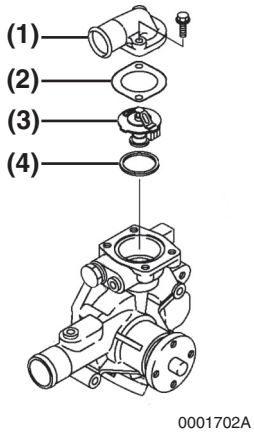


Figure 8-12

5. Remove the thermostat **(Figure 8-12, (3))**. Discard the gasket **(Figure 8-12, (4))**.

CLEANING AND INSPECTION

Thermostat

1. Check for proper operation of the thermostat. Place the thermostat **(FIgure 8-13, (1))** and an accurate thermometer **(FIgure 8-13, (2))** in warm water.

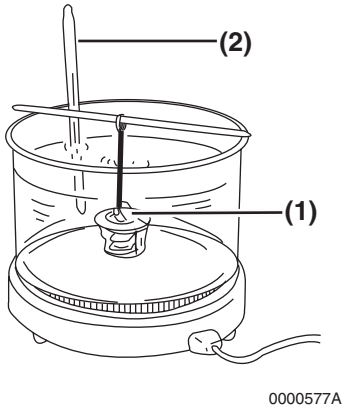


FIgure 8-13

2. Slowly increase temperature of the water using an external heat source.
3. The thermostat is normal if it starts to open at 160°F (71°C) and fully opens at 185°F (85°C).

Radiator Cap

1. Check for proper operation of the radiator cap. Install the radiator cap **(Figure 8-14, (1))** on a cooling system tester.

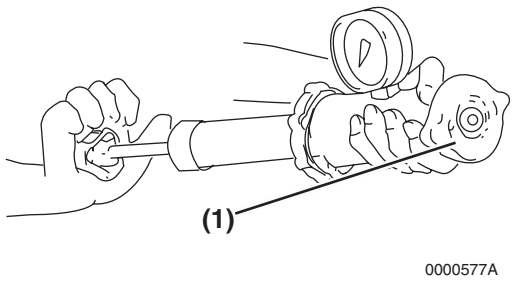


Figure 8-14

2. Apply 10.8 - 14.8 psi (75 - 105 Kpa, 0.75 - 1.05 kgf/cm^2) to the radiator cap. The radiator cap must open within the specified range.

LUBRICATION SYSTEM DIAGRAM

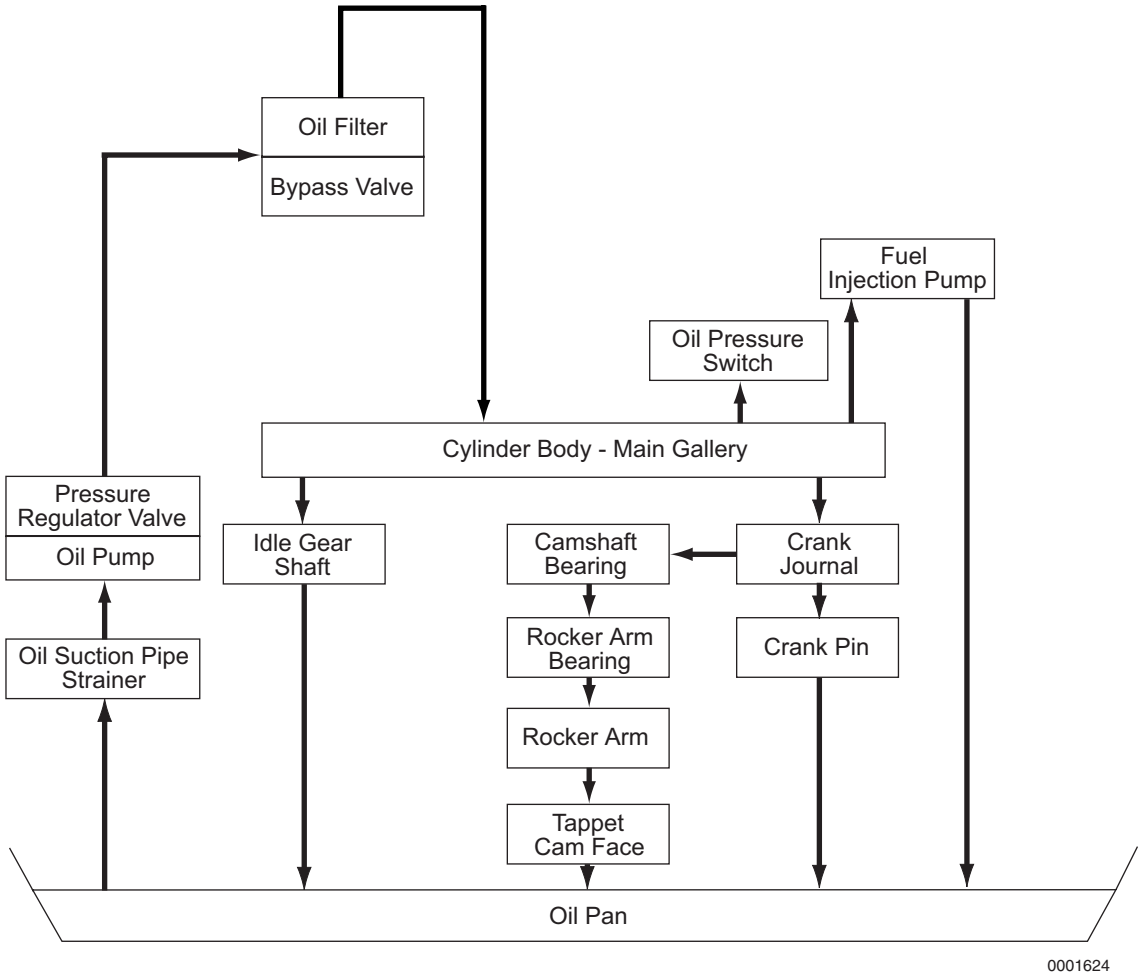


FIgure 9-1

⚠ CAUTION

FLYING OBJECT HAZARD!

- **ALWAYS wear eye protection when servicing 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.**

0000003en

CAUTION

The starter motor can be damaged if operated continuously longer than 30 seconds while performing the no load test.

0000034en

Armature Coil Insulation Test

Check for continuity between a commutator segment and the shaft or armature using a multimeter. The multimeter should not indicate continuity.

If the multimeter indicates continuity, replace the armature.

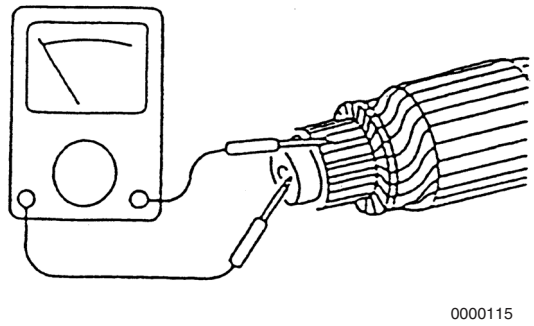


Figure 10-16

Measure Armature and Commutator Run-Outs

Measure the armature core run-out and the commutator run-out using a dial indicator. Replace the armature if either of the measurements is less than the limit.

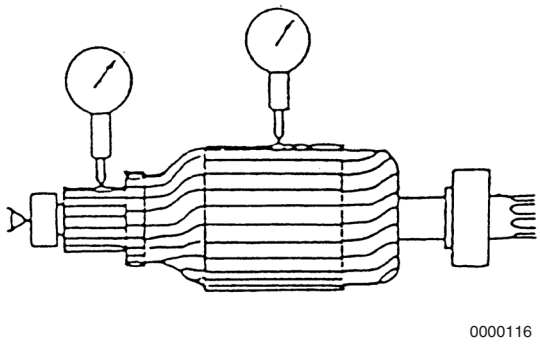


FIgure 10-17

	Standard	Limit
Armature	0.001 in (0.03 mm)	0.008 in (0.2 mm)
Commutator	0.001 in (0.03 mm)	0.008 in (0.2 mm)

Field Coil

Field Coil Continuity Test

Check for continuity between the field coil terminals using a multimeter. The multimeter should indicate continuity.

If the multimeter does not indicate continuity, replace the field coil assembly.

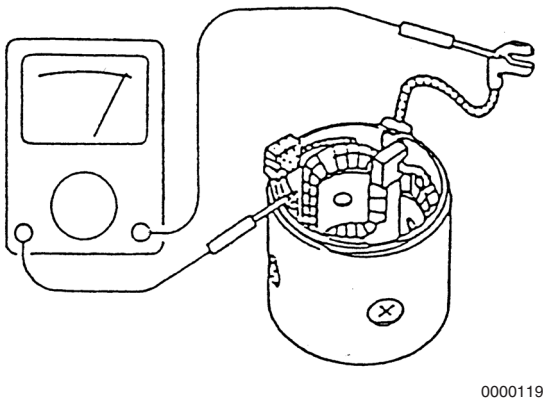


Figure 10-18

Field Coil Insulation Test

Check for continuity between field coil terminal and yoke using a multimeter. The multimeter should not indicate continuity.

If the multimeter indicates continuity, replace the field coil assembly.

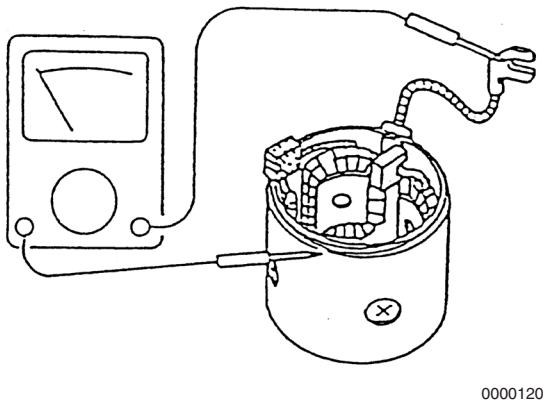
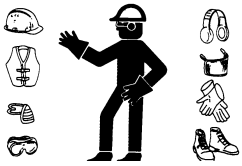


Figure 10-19

⚠ WARNING



EXPOSURE 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.

0000014en

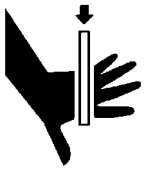
⚠ CAUTION

FLYING OBJECT HAZARD!

- ALWAYS wear eye protection when servicing 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.

0000003en

⚠ 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.

0000014en

CAUTION

NEVER permit anyone to operate the engine or driven machine without proper training.

- Read and understand this Operation Manual before you operate the machine to ensure that you follow safe operating practices and maintenance procedures.
- Machine safety signs and labels are additional reminders for safe operating and maintenance techniques.
- See your authorized Yanmar industrial engine dealer or distributor for additional training.

0000002en

CAUTION

Do not remove the positive (+) battery cable from alternator terminal B while the engine is operating. Damage to the alternator will result.

0000037en

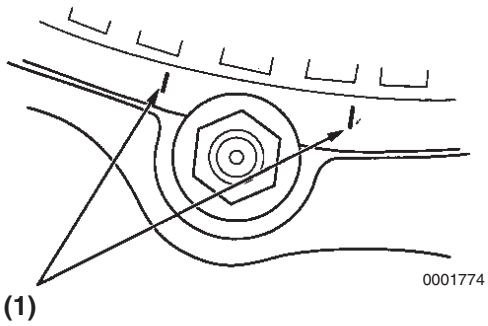


Figure 11-8

10. Using a press, remove the rotor assembly **(Figure 11-9, (1))** from the front frame housing **(Figure 11-9, (2))** and rear frame housing **(Figure 11-10, (1))**.

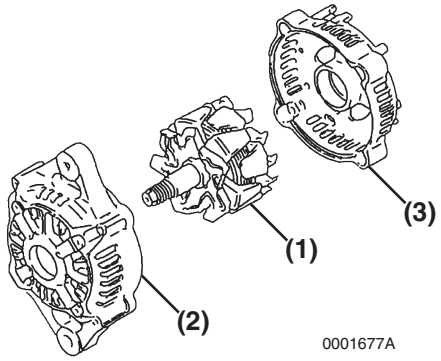


Figure 11-9

CAUTION

Be careful not to drop the rotor. Damage to the slip rings or fan can result.

11. Remove the stator assembly **(Figure 11-10, (1))** from the front frame housing.

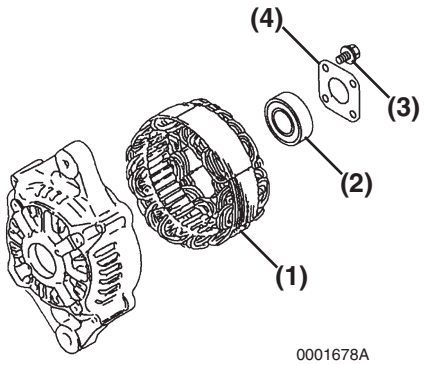


Figure 11-10

12. If necessary to replace the bearing **(Figure 11-10, (2))** in the front frame housing, remove the four bolts **(Figure 11-10, (3))** securing the plate **(Figure 11-10, (4))** to the front frame housing. Remove the plate. Use a puller to remove the bearing. Discard the bearing.

Bench Test

1. Check that the test bench is set up and that the charge light is ON.
2. Position the alternator **(Figure 11-35, (1))** in the test bench.
3. Insert the main wiring harness **(Figure 11-35, (6))** inspection connector into the alternator **(Figure 11-35, (1))**.
4. Connect the main wiring harness **(Figure 11-35, (6))** and sub-wiring harness C **(Figure 11-35, (7))**.
5. Connect the voltmeter **(Figure 11-35, (2) and (3))** and the ammeter **(Figure 11-35, (5))** as shown.
6. Turn SW1 ON and check that the main wiring harness light (the charge light) **(Figure 11-35, (8))** turns ON.

Note: If terminal S is disconnected during inspection, the charge light **(Figure 11-35, (8))** may remain ON continuously. In this case, use sub-wiring harness B instead of sub-wiring harness C. Connect terminal S of sub-wiring harness B to terminal S on the alternator, turn SW1 ON, connect IG and L and check again.

7. Turn the test bench motor ON, increase speed and check that the charge light turns OFF **(Figure 11-35, (8))**.

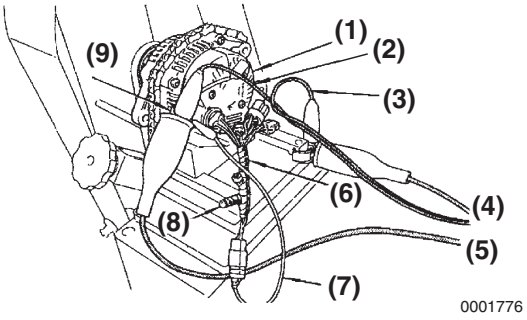


Figure 11-35

Item	Description
1	Alternator
2	Voltmeter Positive Side (+)
3	Voltmeter Negative Side (-)
4	To Battery Negative (-) Terminal
5	To Ammeter Positive (+) Terminal
6	Main Wiring Harness
7	Sub-wiring Harness C
8	Light
9	Terminal B

ELECTRIC WIRING DIAGRAM